A

SURVEY

OF THE

WISDOM OF GOD

IN

THE *CREATION:*

OR, A

COMPENDIUM

OF

NATURAL PHILOSOPHY:

IN FIVE VOLUMES.

THE THIRD EDITION, ENLARGED.

BY *JOHN WESLEY*, A. M.

VOL. I.

These are thy glorious Works, Parent of Good,
Almighty! Thine this universal Frame,
Thus wond'rous fair! Thyself how wond'rous then!

MILTON.

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THE

PREFACE.

1. *I HAVE long desired to see such a* Compendium of Natural Philosophy, *as was,* 1. *Not too diffuse, not expressed in many words, but comprized in so moderate a compass, as not to require any large expence, either of time or money:* 2. *Not maimed or imperfect, but containing the heads of whatever (after all our discoveries) is known with any degree of certainty, either with regard to the Earth or Heavens. And this I wanted to see,* 3. *In the plainest dress, simply and nakedly exprest, in the most clear, easy and intelligible manner, that the Nature of the things would allow: particularly free from all the jargon of* Mathematics, *which is mere* Heathen Greek *to common readers. At the same time I wished to see this short, full, plain Account of the visible Creation, directed to its*

right end: *Not barely to entertain an idle, barren curiosity, but to display* the invisible things of God, *his Power, Wisdom and Goodness.*

2. *But I cannot find such a Treatise as this in any modern, any more than antient language. And I am certain, there is none such in the* English *Tongue. What comes nearest to it of any thing I have seen, is Mr.* Ray's Wisdom of *God* in the Creation, Dr. Derham's Physico *and* Astro-Theology, Niewentyt's Religious Philosopher, Mather's Christian Philosopher, *and* Nature delineated. *But none of these, single, answers the design. And who will be at the pains, to extract the Substance of them all, and add the later discoveries, of which they had little knowledge, and therefore could take but little notice? This is a* Desideratum *still; and one that a lover of mankind would rejoice to see even tolerably supplied.*

3, *I am throughly sensible, there are many who have far more Ability, as well as Leisure, for such a Work than me. But as none of them undertakes it, I have myself made some little attempt*

in

in the enſuing Volumes. Herein following Mr. Derham's *Plan, I divide the Work into* Text *and* Notes§. *The Text is in great meaſure tranſlated from the* Latin *Work of* John Francis Buddœus, *the late celebrated Profeſſor of Philoſophy, in the Univerſity of* Jena, *in* Germany. *But I have found occaſion to retrench, inlarge or alter every Chapter, and almoſt every Section. So that it is now, I believe, not only* pure, *containing nothing falſe or uncertain, but as* full *as any Tract can be expected to be, which is comprized in ſo narrow a compaſs; and likewiſe* plain, *clear and intelligible to one of a tolerable underſtanding. The Notes contain the Sum of what is moſt valuable, in the above-named Writers: To which are added the choiceſt diſcoveries both of our own, and of the Foreign Societies. Theſe likewiſe, I truſt, are as plain and clear, as the Nature of the things ſpoken will allow: Although ſome of them, I know, will not be underſtood, by an unlearned or inattentive reader.* a 3 4. *Mean-*

§ It was, in the firſt edition. Many of theſe are now taken into the Text.

4. *Meantime I muſt apprize the Reader, that I have ſometimes a little digreſſed, by reciting both uncommon appearances of Nature, and uncommon inſtances of Art: and yet this is not properly a digreſſion, from the main deſign I have in view. For ſurely in theſe appearances alſo, the Wiſdom of God is diſplayed: even that manifold Wiſdom, which is able to anſwer the ſame ends by ſo various means. And thoſe ſurprizing inſtances of Art, do likewiſe reflect glory upon Him, whoſe* Spirit in Man giveth *that* Wiſdom, *whoſe* Inſpiration teacheth Underſtanding.

5. *It will be eaſily obſerved, that I endeavour throughout, not to* account for *things, but only to* deſcribe *them. I undertake barely to ſet down what* appears *in nature, not the* cauſe *of thoſe appearances. The* facts *lie within the reach of our ſenſes and underſtanding; the* cauſes *are more remote.* That things are ſo, *we know with certainty: but* why they are ſo, *we know not. In many caſes we cannot know; and the more*

more we inquire, the more we are perplext and intangled. God hath ſo done his works, *that we may admire and adore: but* we cannot ſearch them out to perfection.

6. *And does not this open to us another proſpect? Although one we do not care to dwell upon. Does not the ſame Survey of the Creation, which ſhews us the Wiſdom of God, ſhew the aſtoniſhing ignorance and ſhort-ſightedneſs of man? For when we have finiſhed our ſurvey, what do we know? How inconceivably little! Is not every thinking man conſtrained to cry out, And is* this All? *Do all the boaſted diſcoveries of ſo* enlightened *an age, amount to no more than this?* Vain man would be wiſe! *Would know all things! But with how little ſucceſs does he attempt it? How ſmall a part do we know even of the things that encompaſs us on every ſide? I mean as to the very* fact: *for as to the* reaſons *of almoſt every thing which we ſee, hear or feel, after all our reſearches and diſquiſitions, they are hid in impenetrable darkneſs.*

 7. *I truſt*

7. *I truſt therefore the following ſheets may, in ſome degree, anſwer both theſe important purpoſes. It may be a means, on the one hand, of humbling the pride of man, by ſhewing that he is ſurrounded on every ſide, with things which he can no more account for, than for immenſity or eternety: and it may ſerve on the other, to diſplay the amazing power, wiſdom and goodneſs of the great Creator; to warm our hearts, and to fill our mouths with wonder, love and praiſe!*

JOHN WESLEY.

March 25. 1775.

1. *I HAD finiſhed the additions which I deſigned to make to the Syſtem of Natural Philoſophy, before I ſaw Dr.* Goldſmith's *"Hiſtory of the Earth and Animated Nature." I had not read over the firſt volume of this, when I almoſt*

I almoſt repented of having wrote any thing on the head. It ſeemed to me, that had he publiſhed this but a few years ſooner, my deſign would have been quite ſuperſeded; ſince the ſubject had fallen into the hands of one, who had both greater abilities and more leiſure for the work. It cannot be denied, that he is a fine writer; he was a perſon of ſtrong judgment, of a lively imagination, and a maſter of language, both of the beauty and ſtrength of the Engliſh *tongue.*

2. *Yet I could not altogether approve of this, that it ſeemed to be the deſign of the author, to ſay* all he could *upon every article, rather than* all he ſhould *ſay. Hence aroſe his numerous and large digreſſions, making no inconſiderable part of his work. Hence his minute deſcriptions of cows, horſes, dogs; of cocks, hens and pigeons, and of abundance of animals equally known to every man, woman and child: deſcriptions that are of little or no uſe, and no more entertaining than uſeful: at leaſt uſeful only to the bookſeller, by ſwelling the bulk, and conſequently the price of his book.*

3. *Indeed this, the price of it muſt ever remain a weighty objection to many readers. They cannot afford to purchaſe eight volumes, at ſix or ſeven ſhillings a volume. Ten or fifteen ſhillings they may poſſibly afford, for five or ſix ſmaller volumes; eſpecially when they contain all that is curious or uſeful, in the far more coſtly work. Nay, I hope, conſiderably more than all; as I have conſulted abundance of authors, and taken abundance of paſſages from them, whom, I apprehend the Doctor had not ſeen.*

4. *I have another objection to this ingenious book: I doubt ſome parts of it are not true. The author indeed has corrected many vulgar errors, but has, I fear, adopted others in their place. Many times he expoſes the credulity of other writers: but does he not ſometimes fall under the ſame imputation? As where he terms it* preſumption, *to deny the exiſtence of Biſhop* Pontopedan's Croker *and* Sea-ſerpent, *the one a mile acroſs, the other raiſing himſelf out of the water, higher than the main maſt of a man of war!*

war! Could one who made the leaſt ſcruple of rejecting theſe groſs abſurdities, accuſe other writers of credulity?

5. *Meantime the accounts which he has given us of many animals, being taken from the beſt and lateſt authorities, are both more accurate and more to be depended on, than any which had been publiſhed before. Many of theſe I have inſerted in their proper places; (only contracting thirty or forty pages into four or five) often in the room of thoſe, which were leſs accurate and probably leſs authentic: as alſo ſeveral of his beautiful remarks, ſuch as directly tended to illuſtrate that great truth,* O Lord, how manifold are thy works! In wiſdom haſt thou made them all!

A

COMPENDIUM

OF

Natural Philoſophy.

The INTRODUCTION.

Of the gradual Improvement of Natural Philoſophy.

1. *The Order obſerved in this Treatiſe:*
2. *The method of philoſophizing among the* Hebrews *and* Egyptians:
3. — *Among the* Greeks:—*The Philoſophy of* Pythagoras, Plato, Ariſtotle:
4. *The different method purſued by the four* Greek *Sects:*
5. *The Philoſophy of the* Schoolmen:
6. *The Revival of Philoſophy by Lord* Bacon:
7. —*Greatly promoted by Philoſophical Societies:*
8. *The improvement made in every Branch of it: In* Anatomy; *the Diſcovery of the Circulation of the Blood, of the Lacteal Veins, and the Thoracic Duct.*
9. *Of the generation of all animals from Eggs:*
10. *Of the Transfuſion of Blood:*

11. *Diſeaſes*

11. *Diſeaſes themſelves and the operations of Medicines give occaſion for farther Diſcoveries:*
12. *Many Anatomical Diſcoveries have been made by* Microſcopes:
13. *Many, with regard to Brutes, particularly Fiſhes and Inſects:*
14. *Many likewiſe, with regard to Plants, Stones, Metals and Minerals:*
15. *Great Improvements from the art of* Chemiſtry:
16. *Diſcoveries concerning the Loadſtone:*
17. *Concerning Glaſs and Burning-glaſſes:*
18. *The Nature of the Air is more accurately diſcovered by means of the Barometer, the Thermometer, and the Air-Pump:*
19. *Diſcoveries relating to Water.*
20. *Diſcoveries which ſhew the nature of Fire: Of Gunpowder, Phoſphorus, Aurum Fulminans:*
21. *Of the Earth, and the chief Syſtems of the Univerſe:*
22. *Of the Sun, the Planets and their Satellites:*
23. *Of the cauſes of Natural Bodies:*
24. *Of Spirits and Divine Things.*

1. NATURAL PHILOSOPHY treats both of God Himſelf, and of his Creatures, viſible and inviſible. Of theſe I purpoſe to ſpeak in ſuch a manner, as to aſcend from the conſideration of Man, through all the orders of things, as they are farther and farther removed from us, to God the center of all Knowledge. (I mean, of *viſible* Things:—of the *inviſible* world we cannot know much, while we dwell in

in houſes of clay.) Thus Speculative Philoſophy aſcends from man to GOD, Practical deſcends from GOD to man.

2. The moſt ancient nations, the *Egyptians* and *Hebrews* in particular, philoſophized much concerning GOD, and concerning *Genii*, good or evil Spirits, of an order ſuperior to Man: What they taught concerning the viſible world, related chiefly to its origin, the changes it was to undergo, and its final diſſolution. But on all theſe heads they only delivered to their poſterity, what they had received from their forefathers.

3. Among the *Greeks*, *Thales Mileſius* and his followers applied themſelves, with great induſtry, to diſcover, with the beſt helps they had, the material cauſes of natural things. They were ſucceeded by others, who more curiouſly ſearched into the ſtructure of natural bodies. Here the foundation of natural hiſtory was laid, in various obſervations on plants, animals, and other things. And herein the endeavours of *Ariſtotle* and *Theophraſtus* in particular are to be commended. Yet in other reſpects, *Ariſtotle* did not promote, but rather obſtruct the knowledge of nature: for he made philoſophy as unintelligible by his abſtract and metaphyſical notions, as *Plato*, *Pythagoras* and others did, by their ideas, numbers and ſymbols.

4. In ſucceeding times, when the four *Greek* ſects, the *Platonic*, *Peripatetic*, *Epicurean* and *Stoic* divided the Weſtern world between them, the *Platoniſts* almoſt confined themſelves and their opinions to the ſubject of divinity; the *Peripatetics* regarded little but logic; the *Stoics* little

little but moral philoſophy; and the *Epicureans* had ſmall concern about any, being immerſed in ſenſual pleaſures: ſo that none of them made any conſiderable improvement in any branch of natural philoſophy.

5. When the utter Barbariſm which followed was a little diſpelled, *Ariſtotle* began to reign. His followers (the *School-men*, as they were called) might have improved natural philoſophy, if (like their maſter) they had diligently cultivated the knowledge of nature, and ſearched out the properties of particular things. But it was their misfortune, to neglect what was commendable in him, and to follow only what was blame-worthy; ſo as to obſcure and pollute all philoſophy, with abſtract, idle, vain ſpeculations. Yet ſome of them, after the *Arabians* had introduced the knowledge of Chemiſtry into *Europe*, were wiſe above the age they lived in; and penetrated ſo far into the ſecret receſſes of nature, as ſcarce to eſcape the ſuſpicion of magic. Such were *Roger Bacon* and *Albertus Magnus*.

6. After the revival of learning, as all other branches of philoſophy, ſo this in particular received new light. And none was more ſerviceable herein than lord *Bacon*: who, well underſtanding the defects of the ſchool-philoſophy, incited all lovers of natural philoſophy to a diligent ſearch into natural hiſtory. And he himſelf led them the way, by many experiments and obſervations.

7. After this, not ſingle perſons only, but whole ſocieties applied themſelves carefully to make experiments; that having accurately obſerved the ſtructure and properties of each body

body, they might the more ſafely judge of its nature. And the advantages, which have ariſen from hence, manifeſtly appear from the memoirs of the royal ſociety at *London*, of the academy of ſciences at *Paris*, and thoſe of the ſame kind in *Germany*, as well as ſeveral other parts of *Europe*.

8. To mention but a few of the late diſcoveries in each branch of natural philoſophy. With regard to the ſtructure of an human body, how many things have modern anatomiſts diſcovered, which were either little underſtood by the antients, or wholly unknown to them? Such, for inſtance, is the circulation of the blood, diſcovered by Dr. *William Harvey*, whoſe "Anatomical Exercitations" concerning it were firſt publiſhed in the year 1628. Such were the lacteal veins, diſcovered firſt in brutes by *Caſpar Aſellius*, of *Cremona*; and ſoon after in men. Such the thoracic duct, and receptacle of the chyle, obſerved firſt by Dr. *John Pecquet*, of *Paris*, whereby the whole courſe of the blood is now clearly underſtood.

9. Dr *Harvey* improved natural philoſophy, by another no leſs eminent diſcovery: for he was the firſt of the moderns that ſhewed all animals to be generated from eggs. That the antients knew and taught this, (*Orpheus* in particular) cannot reaſonably be doubted. But as the knowledge of it was intirely loſt, to revive was the ſame thing as to invent it. It is obvious, how great a light this pours upon that dark ſubject, with regard to the generation of men, as well as of other animals.

10. Another remarkable diſcovery in the laſt century, was that of the transfuſion of blood.

The

The blood of a young, lively, healthy animal was transfuſed, by means of a ſmall, ſilver tube, properly adjuſted, into the veins of another, which was old, weak and ſickly. And the effect amazed all the beholders. When the experiment was tried before ſeveral of the royal ſociety, a feeble, worn-out dog, ready to die with age, and hardly able to trail his legs after him, was no ſooner filled with young blood, than he leaped up, as from ſleep, ſhook himſelf, and ran up and down, as lively and active as a puppy. In *France* the experiment has been made upon men, and with as ſurprizing ſucceſs. What pity, that ſo important an experiment ſhould ever fall into diſuſe! That it is not ſtill repeated upon proper occaſions! Eſpecially where all other means fail.

11. It cannot be denied, that *Phyſicians* have ſignally improved this branch of philoſophy, as they have continual opportunities of making new diſcoveries in the human body. In diſeaſes themſelves, the wonderful wiſdom of the Author of Nature appears: and by means of them many hidden receſſes of the human frame are unexpectedly diſcovered. The powers of medicines alſo variouſly exerting themſelves, lay open many ſecrets of nature.

12. And how many things in all bodies, as well as in the human, which eluded all the art and induſtry of the antients, have the moderns diſcovered by the help of *microſcopes*? Altho' theſe are not properly a modern invention: it being certain, ſomething of this kind was in uſe, many hundred years ago. There are ſeveral works of great antiquity ſtill extant, the beauties of which cannot even be diſcerned, much

much leſs could they have been wrought, by the fineſt naked eye, which ever was in the world. Such is that ſeal, now in the cabinet of the king of *France*, allowed to be at leaſt fifteen hundred years old, ſix-tenths of an inch long, and four broad, which to the naked eye preſents only a confuſed groupe, but ſurveyed with a microſcope, diſtinctly exhibits trees, a river, a boat, and ſixteen or ſeventeen perſons.

13. Now whatever aſſiſts us in ſearching out the ſtructure of an human body, equally helps us to find out the nature and properties of other animals. Hence in theſe likewiſe we have received great light, from anatomical and microſcopical obſervations. Thoſe eſpecially who have beſtowed their whole time and thoughts on one kind of animals, (as Dr. *Willoughby*, on fiſhes, Dr. *Swammerdam*, of *Amſterdam*, on inſects) have illuſtrated to a ſurpriſing degree, the ſubjects on which they wrote.

14. Many have diligently ſearched into the nature of plants; particularly Mr. *Ray*, who has not only ranged them in a new method, but alſo wrote an elaborate hiſtory of them. Others have deſcribed, with equal diligence, either plants in general, or thoſe of a particular country. And others have ſhewn the like induſtry in finding out and explaining the nature of ſtones, metals, minerals, and other foſſils.

15. Nor is it ſtrange that the moderns have penetrated farther into the receſſes of nature than the antients, conſidering the advantages they have received, from the art of *chemiſtry*. Not that this is an invention of later ages: it was in ſome meaſure known long ago. But as this art has been cultivated in our age, with far

far greater accuracy than ever, ſo by this means many properties of natural bodies have been diſcovered; of foſſils in particular.

16. But none of theſe have ſo much engaged the ſtudy of the learned, or ſo well deſerved it, as the *load-ſtone*. Its attractive force was known to the antients, and the origin of that diſcovery is recorded by *Pliny*. But it does not appear that they knew of its pointing to the pole, or of the uſe of the compaſs. This [the compaſs] was invented by *John Goia*, in the year 1300. But it has been ſince obſerved, that the magnetic needle ſeldom points exactly to the pole, but varies from it ſome degrees to the Eaſt or Weſt, in a fixt and regular order.

17. Nearly related to the nature of foſſils is *glaſs*, which was well known to the antients, being mentioned by *Plutarch* and *Lucian* among the *Greeks*, by *Lucretius*, *Pliny*, and others among the *Latins*. Yet the art of making glaſs has been ſince their times abundantly improved. One branch of this is, the art of making burning-glaſſes, which are now brought to ſo great perfection, as either to melt or reduce to aſhes the moſt ſolid bodies, in a very few moments. If theſe were known to the antients at all, (which may reaſonably be doubted) yet the art was wholly loſt for many ages, and not recovered till of late years.

18. Later ages have likewiſe made many diſcoveries with regard to Earth, Water, Fire and Air: the laſt of which, *Air*, though it be of ſo fine a texture as to be wholly inviſible, yet producing ſuch amazing effects, has excited the moſt diligent enquiries of the curious. Nor does any part of Philoſophy afford a wider field for experiments and diſcoveries. The weight

of

of it we can aſcertain by that curious inſtrument, the *Barometer*, invented by *Torricellius*, the degrees of Heat and Cold, by the *Thermometer*. By the Air-pump (invented by *Otto Guerick*, Mayor of *Magdeburgh*) the air is drawn out of any bodies, or more largely thrown into them. And hereby many effects are produced, which deſerve our diligent conſideration.

19. With regard to *Water* the diſcoveries of later times are numerous and important. Such are the Diving-bell, invented by *George Sinclair*; the Diving-Machine of *Alphonſo Borelli*, a kind of boat, which is ſo contrived as to be navigated under water: and the art of making Salt-water freſh, which is now done with little expence, ſo far that the ſaltneſs is taken away, and it is fit for almoſt all uſes.

20. The nature and properties of *Fire* alſo have been accurately traced in late ages: for which new occaſion was given by the invention of *Gunpowder*, by *Berthold Schwartz*, in the fourteenth century. *Aurum Fulminans*, a yet later invention, goes off with a louder explоſion than gunpowder. Other Bodies there are, which do not burn, and yet emit Light. Such is the *Bononian Stone*, which placed in the dark, diffuſes Light like a burning coal. It is well known that the preparation called *Phoſphorus*, has the ſame property.

21. Various Theories of the *Earth* have lately appeared. But they are no more than ingenious conjectures. The ſame may be ſaid of the ſyſtems of the Univerſe, a few particulars excepted. The *Ptolemaic* ſyſtem, which ſuppoſes the Earth to be the center of the univerſe is now deſervedly exploded: Since *Copernicus* has revived that of *Pythagoras*, which was probably

bably received by moſt of the ancients. *Tycho Brahe*'s, which jumbles both together, is too complex and intricate, and contrary to that beautiful ſimplicity, conſpicuous in all the works of Nature.

22. The Teleſcope (invented by *Galileo*) has diſcovered many Stars unknown to the Antients, together with the nature and motion of the Planets both primary and ſecondary. By this alſo have been diſcovered the ſpots on the Sun, the inequality of the ſurface of the Moon, the nature of the Galaxy or Milky-way, and many other particulars relating to the Heavens.

23. With regard to *Body* in general, it is commonly ſuppoſed, that our age has a vaſt advantage over antiquity, by having found out new Principles and Hypotheſes, whereby we can account for all the ſecrets of Nature. But this will bear a diſpute. For beſide that the chief of our Hypotheſes are not new, but known long ago, the learned have hitherto very little profited by all their Hypotheſes. And in truth all their diſquiſitions touching the cauſes of natural Bodies, terminate in mere conjectures: one whereof is often more probable than another, but none admits of any ſolid proof.

24. What remains of Natural Philoſophy, is, The doctrine concerning God and Spirits. But in the tracing of this we can neither depend upon Reaſon nor Experiment. Whatſoever men know, or can know concerning them, muſt be drawn from the oracles of God. Here therefore we are to look for no new improvements, but to *ſtand in the good old paths:* To content ourſelves with what God has been pleaſed to reveal; with *the Faith once delivered to the Saints.*

PART

PART the FIRST.

Of MAN.

CHAP. I.

Of the Structure of the Human Body.

1. *The ſimilar, ſolid Parts.*
2. *A Fibre.*
3. *The Cellular Membrane.*
4. *A Bone.*
5. *A Cartilage.*
6. *A Membrane.*
7. *An Artery.*
8. *A Vein.*
9. *The Lymphatic Veſſels, and their Uſe.*
10. *A Nerve.*
11. *The Fleſh.*
12. *A Gland.*
13. *A Muſcle.*
14. *The Cuticula and Skin.*
    A Boy with a dappled Skin.
15. *The Fat.*
16. *The Panniculus carnoſus.*
17. *The diſſimilar Parts, in particular the Head, Cerebrum, Cerebellum, Medulla oblongata.*
18. *The Meninges.*
19. *The Brain.*
20. *The Origin of the Nerves.*
21. *The Pineal Gland.*
22. *The Guards of the Eye.*
23. *Muſcles of the Eye.*
    Tunica adnata.
    Structure of the Eye.
24. *The Coats of the Eye.*
25. *Humours of the Eye.*
26. *Peculiarities*

Of

Of MAN.

1. AS Man ought to know himſelf beſt, we begin our treatiſe here. And firſt, let us contemplate the Human Body. The parts of this are either *ſolid* or *fluid*. Thoſe of the Solid, of which the reſt are formed, are termed *Similar* parts. Such are fibres, bones, membranes, ligaments, arteries, veins, lymphatic veſſels, nerves, fleſh, muſcles, tendons: and thoſe general coverings of the body, the Cuticle, the Skin, Fat, and the Panniculus Carnoſus.

2. A fibre is a kind of ſlender thread, of which all the other parts of the body are woven: according to the difference of which, the ſubſtance of the fibres is different alſo.

Earth, as an element, is a ſolid, opaque, angular, friable ſubſtance, of ſuch ſmall volatile particles, that it readily diffuſes itſelf through air and water, and reſides inviſibly in them; as earth eagerly imbibing both air and water, by their means forms the permament baſis and growth of all mineral, vegetable, and animal bodies.

Theſe earthly particles have their connexion and power of coheſion not from themſelves or a mere contact, but from the intermediate glue placed betwixt them,

That this glue is compoſed of oil combined with water by the vital attrition in animals, appears from the chemical analyſis of bones and hair; from the jelly of bones, ivory, and horns; and from the nature of our aliments themſelves. Nor is there any kind of glue that could more powerfully join the parts of animals as we experience in fiſh-glue, and that of joiners or cabinet-makers.

Earthy particles then cohering longitudinally, and tied together by an intervening coheſive glue, compoſe firſt one of the leaſt or moſt ſimple fibres; ſuch as we have a knowledge of rather from reaſon than ſenſe.

The fineſt microſcopes have been hitherto inſufficient to lead us to a ſight of the ſmalleſt moving and nervous fibrils, and ſtill leſs can we ever expect from them to get any ſenſible idea of the mechaniſm by which ſenſation and motion are effected.

But the leaſt fibres which appear to the ſight, are of two kinds.

From theſe two kinds of fibres, as we ſhall preſently ſee, we may diſtinguiſh the form by the title of filamentary, and the latter of membranous.

The firſt kind of theſe fibres is lineal, namely, ſuch a form as makes their length conſiderably large in proportion to their breadth; and which, by diſpoſing of the elementary particles in a right line, muſt of courſe lay them generally parallel with the neighbouring or contiguous fibres. Examples of ſuch fibres we ſee in the bones, and moſt eaſily in thoſe of a fœtus; and likewiſe in the tendons, ligaments, and muſcles; only we muſt here always remember

member, that the eye never reaches to the ſmalleſt fibres, but to larger ones made up of the ſmalleſt, and like to them in ſlenderneſs, placed together in a rectilineal courſe. That theſe are not different from the ſmalleſt fibres, we are perſwaded by the moſt accurate microſcopes of *Muyſe* and *Lewenhoeck*; by which, the muſcular fibres divided even to the laſt, appears ſimilar to the larger, till, at length, they ſeem mere lines, like ſpiders threads.

The ſecond kind of fibres are thoſe which are conjoined with a breadth frequently larger than their length.

From what has been ſaid, we may admire nature no leſs for her wiſe œconomy than ſimplicity, in thus forming all that variety of parts we ſee in an animal from one ſimple maſs of clay or ſlimy matter, compounded of earth and glue; from whence the body is not only augmented from a ſingle point in the ovum to its full growth and ſtature; but, like the timbers of a ſhip, is alſo every day repaired during life 'till, at length, not two jots of the old or firſt materials remain. This renovation of parts is made ſlower in ſome conſtitutions, and in ſome organs, than in others. How quickly the animal humours with the hair, nails, &c. are renewed every one knows: and we may venture to ſay, that once in three years the change is univerſal; at the end of which time, tho' a man remains the ſame identical perſon, he is not the ſame matter.

3. But we proceed from theſe ſimple fibres to the next leaſt compounded ſolid which they compoſe, viz. the cellular web-like ſubſtance.

This is made up partly of the ſimple fibrils and partly by an infinite number of little plates

or ſcales, which, joined in various directions intercept ſmall cells and web-like ſpaces; and by extending round every, even the leaſt moving ſolid parts of the body, conjoins them all together in ſuch a manner as not only ſuſtains, but allows them a free and ample motion.

The extenſion of this ſubſtance, not only with the ſkin round the whole body, but alſo round every viſcus or organ, and round every individual moving fibre or veſſel of them, into the cavities of the bones, and even the ſubſtance of the brain and its medulla, is a modern and wonderful diſcovery. This ſubſtance in its ultimate ſtate being compoſed of ſimple membranes, when compacted and convoluted, gives birth to the leaſt or moſt ſimple veſſels, which, again reflected through plates of the ſame ſubſtance compacted together, make compound and vaſcular membranes: to the conſideration of which we next proceed.

Out of this cellular ſubſtance compacted by a concretion of the membranous plates or partitions, and preſſed together by the force of the incumbent muſcles and diſtending fluids, ariſe other broad and flat plates or ſkins in various parts of the body, which being generally diſpoſed in one and the ſame direction, ſeem to have a better right to the name of membrane than the former; and theſe being convoluted into cones and cylinders, pervaded by a flux of ſome juice or liquors brought to them; put on the name of *veſſels*, or elſe being extended round ſome ſpace that is in a plane parallel of itſelf, we call it a *tunic* or coat.

This cellular ſubſtance in the Human Body is found throughout the whole; wherever any veſſel

veſſel or moving muſcular fibre can be traced, and this without the leaſt exception, that I know of, in any part whatever. But ſo far as ever we can trace, it hardly ever admits of any fat into the cells; which are rather moiſtened by a watry vapour, ſomewhat oily, exhaled out of the arteries and received again into the veins.

Its plates or ſcales are ſtill more looſe and open where it divides the muſcles and all their fibres (even to the ultimate fibre); and likewiſe where it ſurrounds and ſuſtains the leaſt veſſels with their free motion. That within the cavities of the bones is alſo made up of bony plates, with membranous ones intermixed; and laſtly it is the moſt looſe and open of all, round the ſurface of the body on all ſides, betwixt the muſcles and the ſkin.

Through this cellular ſubſtance the ſmall veſſels are ſpread and ramified in all parts of the body, from whoſe arterial extremities the fat is depoſited into the cells, and afterwards abſorbed by the venal orifices. This paſſage from the arteries, into the adipoſe cells, is ſo free and ſhort, that there muſt needs be very large mouths by which they open, and by which they give admittance to injected mercury, air, or water. The oily fat, in this ſubſtance, is ſeparated and expelled from the artery, not by any long ducts, but by tranſuding on all ſides through the whole extent of the veſſel. How quickly it is collected from the arteries, appears from the ſpeedy renovation of it, by a returning fatneſs after acute diſeaſes.

With regard to the ſponge-like communications of this ſubſtance, 'tis remarkable, the

intervals or ſpaces betwixt the plates or ſcales that make up their ſides in the cellular membrane, are every where open, and form one continuous cavity throughout the whole body.

That out of this ſubſtance joined with veſſels, nerves, muſcular and tendinous fibres (a great part of all which are before formed of this ſubſtance only) all the viſcera, all the muſcles and glands, with their ligaments and capſules, are entirely compoſed; and that only from the different length, tenſion, quantity or proportion of this the diverſity of our glands and viſcera ariſes; and laſtly, that this alone makes up by far the greateſt part of the whole body, we are certain, if the whole be not formed out of the cellular filaments of this kind.

4. The hardeſt part of the body, white and void of ſenſe, is termed a *Bone*. The Bones are covered with a thin ſkin, called the Perioſteum, extremely ſenſible.

The Bones conſiſt of thin plates, lying one upon another; and theſe again, of fibres running lengthways, ſome to the extremity of the Bone, ſome not ſo far. Yet none of them terminate there, but are continued tranſverſely, and as it were arched, the fibres of one ſide meeting and uniting with thoſe of the other, and this at each extremity.

Theſe plates are differently diſpoſed in different Bones: in thoſe that have a large cavity, they are contiguous on each ſide, and very cloſely united. In thoſe whoſe cavities are ſmall, many of the inner plates are diſtant from each other, having little long cells between them. In bones whoſe plates are contiguous, there

there are pores through and between them, (beſide thoſe for the blood-veſſels. The firſt pierce them tranſverſely, from the cavity to the external ſurface of each plate. The ſecond run lengthways between the plates, and diffuſe an oil with which they are ſupplied by the tranſverſe pores.

The bones are generally bigger at each end than in the middle, that the joints may be firm, and the bones not ſo eaſily diſlocated. But to ſtrengthen the middle of the bone, the fibres there are more cloſely compacted. Likewiſe the bone, being large and hollow, is not ſo eaſily broke, as if it had been ſolid and ſmaller: For of two bones of equal length and equal number of fibres, that is ſtronger which has the larger diameter.

The *Blood-Veſſels* uſually enter the ends of the bones, the arteries at one end, the veins at the other. The *Medullary veſſels* commonly enter the ſides of the bone, and that obliquely.

The *Marrow* is covered with a membrane, wherein are incloſed little bags. In theſe bags are glandulous bladders, ſerving both to ſecern the marrow from the blood, and to receive it. Both theſe and the bags have paſſages into each other, whereby the marrow has free courſe. It paſſes firſt thro' the tranſverſe pores of the firſt internal plate into the longitudinal ones. Thence it proceeds into other tranſverſe pores, when it alters its courſe again, and exſudes farther. Thus it paſſes alternately thro' and between the plates, 'till it is diffuſed throughout. In this manner it is diffuſed thro' bones, whoſe plates are contiguous. But where the plates are at a diſtance, the ſmall cells contain glands, which directly ſupply the plates with marrow.

The *Marrow* not only ſerves to keep the ſubſtance of the bone moiſt, but to lubricate the joints, and to hinder the ends of the bone, from being worn or over-heated with motion. It alſo moiſtens the Ligaments, which tie them to each other: as do likewiſe the glands found in all the joints. The *back-bone* hath theſe two things peculiarly remarkable. 1. Its different articulations from the other joints of the body. For here moſt of the joints are flat, and withal guarded with aſperities and hollows, made for catching and holding; ſo as firmly to lock and keep the joints from luxations, but withal to afford them ſuch a motion, as is neceſſary for the incurvations of the body. 2. The difference of its own joints in the neck, back and loins. In the neck the two upper *vertebræ*, are curiouſly made, and jointed (different from the reſt) for the commodious and eaſy bending and turning the head every way. In the *thorax*, and back, the joints are more cloſe and firm; and in the loins more lax and pliant; alſo the knobs and ſockets are turned a quite contrary way, to anſwer the occaſions the body hath to bend more there, than higher in the back. So that its ſtructure is the very beſt that can be contrived; for had it been all bone, we could have had no motion in our body; had it been two or three bones articulated for motion, the *medulla ſpinalis* muſt have been neceſſarily bruiſed at every angle or joint; beſides, the whole would not have been ſo pliable, for the ſeveral poſtures we have occaſion to put ourſelves in. If it had been made of ſeveral bones without intervening cartilages, we ſhould have had no more uſe of it, than if it had been but one bone.

If

If each *vertebra* had had its own diſtinct cartilage, it might have been eaſily diſlocated. And laſtly, the oblique proceſſes of each ſuperior and inferior *vertebra*, keep the middle one, that it can neither be thruſt backwards nor forwards to compreſs the *medulla ſpinalis*.

The *Pelvis* made in the belly by the *ilium*, *oſſa coxendicis*, and *pubis*, is larger in a female than in a male ſkeleton, that there may be more room for the lying of the *viſcera* and *fœtus*. So the cartilage bracing together the two *ſharebones*, is twice thicker and laxer in women than men. As alſo is the cartilage that ties the *os ſacrum* to its *vertebra*; and all, to give way to the paſſage of the fœtus.

Another conſiderable difference is, in the cartilaginous production of the ſeven long ribs, whereby they are braced to the breaſt-bone. Theſe are harder and firmer in women than in men; the better to ſupport the weight of the breaſts, the ſucking infants, &c.

It is remarkable in the joints, and a manifeſt act of caution and deſign, 1. That altho' the motion of the limbs be circular, yet the center of that motion is not in a point, but an ample ſuperficies. In a point, the bones would wear and penetrate one another, and the joints would be exceeding weak. But the joint conſiſting of two large ſuperficies, concave and convex, ſome furrowed and ridged, ſome like a ball and ſocket, and all lubricated with an oily ſubſtance, they are incomparably prepared both for motion and ſtrength. 2. That the bones next the joints are not ſpungy, as their extremities commonly are, nor hard and brittle, but capped with a ſtrong, tough, ſmooth, cartilaginous ſubſtance, ſerving both for ſtrength and motion.

For affording this oily matter there are *Glandules* very commodiouſly placed near the joints, ſo as not to ſuffer too great compreſſion by the motion of the neighbouring bones, and yet to receive a due preſſure, to cauſe a ſufficient emiſſion of the oil into the joints. Another thing conſiderable is, that the excretory ducts of the *mucilaginous glands* have ſome length in their paſſage from the glands to their mouths; which is a good contrivance, to prevent their mouth being oppreſſed by the mucilage, and alſo to hinder the too plentiful effuſion thereof, but yet to afford a due expreſſure of it at all times, and on all occaſions; particularly in violent and long-continued motions of the joints, when there is a greater than ordinary expence of it.

That the nouriſhment taken in, is continually conveyed through the *Bones*, as well as the Fleſh, appears from an eaſy experiment. Mix red liquor with the food of any animals, and in a ſhort time, their Bones are died red. When madder root was mixed with the food of a cock, which died after ſixteen days, all his Bones were red, the internal parts as well as the external. And the moſt ſolid parts were the moſt deeply tinctured: in ſwine, the teeth above all the reſt.

5. Annext to the bones are the *Cartilages*, white, flexible and ſmooth; moſt of which in proceſs of time become bones, hard and quite void of ſenſe.

A *Cartilage* is an elaſtic ſubſtance, uniformly compact and ſomewhat tranſparent, harder and more brittle than a ligament, ſofter than a bone. It is covered with a fine membrane, folded over the bone, from where the ligament is inſerted.

Every

Every joint is inſerted with a membrane, which forms a complete bag, and covers every thing within the articulation. The blood-veſſels are ſo ſmall, that they do not admit the red globules, and are demonſtrable only in very young ſubjects. All round the neck of the bone, there are numerous arteries and veins which ſpread into ſmaller branches, and communicate with each other. Theſe divide into ſtill ſmaller branches on the adjoining ſurface, as they run toward the center of the cartilage. We can ſeldom trace them into its ſubſtance, becauſe they end abruptly, at the edge of the cartilage. The larger veſſels, plunge in by numberleſs ſmall holes, and diſperſe themſelves into branches between the cartilage and bone. From theſe again there ariſe many ſhort, ſmall twigs, which ſhoot toward the outward ſurface. This diſtribution of the blood-veſſels is very peculiar, and calculated for obviating great inconveniencies. Had they run on the outward ſurface, the preſſure and motion of the two cartilages muſt have occaſioned frequent obſtructions and inflammations. But by creeping round the cartilaginous brim, where there is little friction, or under the cartilage, where there is none, they are perfectly well defended from all ſuch accidents.

Cartilages are admirably contrived for all the purpoſes of motion. By their uniform ſurface they move upon one another with eaſe: by their ſoft, ſmooth and ſlippery ſurface, mutual abraſion is prevented. By their flexibility the contiguous ſurfaces are conſtantly adapted to each other. By their elaſticity the violence of any ſhock, which might happen in running,

jumping, or the like, is broken, which muſt have been extremely pernicious, if the hard ſurfaces of bones had been immediately contiguous. The cartilaginous Fibres appear calculated chiefly for this laſt advantage. To conclude, the inſenſibility of theſe Cartilages is no leſs wiſely deſigned, that by this means the neceſſary motions of the body may be performed without pain.

6. The various parts of the body are clothed with *Membranes*, which are whitiſh tunicles, extremely thin and flexible, compoſed of fibres interwoven with each other, as a piece of cloth is of threads. They are faſtened together by a kind of Cartilages, which are termed *Ligaments*.

7. An *Artery* is an hollow canal, compoſed of fibres cloſely twiſted together, which conveys the blood from the cavity of the heart to all the parts of the body. All the arteries ſpring from two, the *Aorta* or *great Artery*, and the *Pulmonary Artery*. The latter conveys the blood from the right ventricle of the heart, thro' the lungs, into the left ventricle. The former conveys it from the left, to all other parts of the body.

The Arteries ordinarily conſiſt of three *coats* or membranes. The outermoſt has been generally thought to be compoſed of fine blood-veſſels. The ſecond is muſcular, and made of firm and ſtrong circular, or rather ſpiral fibres: of which there are more or fewer ſtrata, as the artery is larger or ſmaller. Theſe fibres are extremely elaſtic. The inmoſt coat is a fine denſe, tranſparent

parent membrane, containing the blood, which otherwiſe would eaſily ooze through the ſpiral fibres.

On a more accurate examination it has been found, that the outermoſt coat of all arteries is a cellular ſubſtance, compoſed of fine, pellucid membranes, which may be ſtretched even ſuddenly to a great extent without breaking. And they as ſuddenly collapſe, when that ſtretching force is removed. Theſe cells contain an oily liquor which their coats ſecern from the branches of the artery that are ſpread over them. This cellular ſubſtance of the arteries ſerves to connect them with the ſurrounding part, without hindering their actions or motions. It gives a ſafe paſſage to the veſſels of their other coats, and ſupplies oil for lubricating them. There is alſo another cellular ſubſtance, between the membranes and the muſcular coat.

All the arteries begin with a larger trunk, and grow leſs and leſs till they are no longer ſeen by the naked eye. Hence they are continued, 'till they inoſculate with the veins, and ſo form one uninterrupted channel.

They appear white, becauſe their coats are of ſo denſe a contexture, that the blood is not viſible through them. This proceeding from wider to narrower canals, is continually obſtructed in its paſſage. But being puſhed on from behind, it diſtends the coats, and cauſes that leaping motion called the Pulſe. By this, as well as by their whiteneſs, arteries are diſtinguiſhed from veins.

The *Pulſe* of an healthy perſon, riſing in the morning, beats 65 in a minute; but after the fatigue of the day, it will in the evening beat

Eighty

Eighty in that time; and again, by the night's reſt or ſleep, it will become leſs frequent till in the morning, you will find it return to Sixty-five. For the voluntary motions of the muſcles, and actions of the external and internal ſenſes, urge the venal blood on to the heart, which, being thereby oftner ſtimulated, makes more frequent contractions. This is the cauſe of thoſe paroxyſms or fits of increaſe, obſervable in all fevers towards the evening. For ſleep not only retards the motion of the blood, but of all the other humours and actions in the body.

It is one of the curious obſervations of Dr. *Hales*, that the pulſe is quicker in ſmall animals. He found the pulſe of a horſe ſlower by half than in a man, *viz.* 32 only in a minute; whereas in a dog, the pulſe beat 97 in that time. And this we ſee is conformable to the blood's heat, meaſured by the mercurial thermometer of *Farenheit*'s ſcale. For the blood in oxen, horſes, and other large animals at reſt, being five or ſix degrees cooler than in us, will not riſe to our heat, but by labour; whereas dogs, cats, and fowls, are five or ſix degrees hotter than we, (*viz.* about 102); and the latter, when ſitting or brooding on their eggs for young, are ſtill four or five degrees hotter, *viz.* 107 or 108, which is commonly the heat of our blood in the fit of an ague; where it is obſervable, that during the greateſt ſenſe of cold chill, the blood is three or four degrees hotter than in health, after which it gains four or five degrees more in the height of the hot fit, *viz.* 104 or 105 degrees; but in ardent fevers, where the pulſe beats 140, the heat of blood will ſtill be four

four or five degrees higher, *viz.* 110; i. e. two or three degrees more than equal to a brooding hen.

The pulſe is more quick in children, and becomes ſlower in perſons as they grow older. The ſalient point of an *ovum* beats 134 in a minute. New born infants have their pulſe 120, and from thence down to old age it grows ſlower, to 60 in a minute. A feveriſh pulſe begins at 96 per minute; it is exceſſive at 130 or 140, which is the number of the pulſe with which a perſon dies. The pulſe beats ſlower in winter, and quicker in ſummer, by about ten ſtrokes per minute; and under the torrid zone, it grows quicker to 120.

8. A *Vein* is a hollow canal, which receives the blood from the artery, and conveys it back to the heart. The chief veins are three, The *Vena Cava*, which pours the blood thro' a wide paſſage into the right ventricle of the heart, the *Pulmonary Vein*, which in like manner pours it into the left ventricle: and the *Vena Portæ*, which does not like the two former, end in a large trunk, but ſpreads itſelf at each extremity into numerous branches.

In the cavity of the veins, there are certain thin tunicles, which are termed *Valves*. Theſe, during the regular motion of the blood, lie cloſe to the ſide of the inner coat: but in caſe of any obſtruction, recede from it and cloſe the paſſage, to prevent the blood's falling back.

9. The *Lymphatic Veſſels* are ſmall canals full of valves, conſiſting of a thin, tranſparent tunic, which convey an extremely clear liquid into the maſs of blood. Probably theſe (as well as the veins) and all the other veſſels, are only continuations of the arteries.

It

It has been lately discovered, that the *Lymphatic Vessels* have two coats, betwixt which there are innumerable fine filaments, containing a nutricious juice, which is conveyed into all parts of the body, by a motion from the center to the circumference, and returns through the inner pipes, of the same watry vessels. But this juice when returning is no more water or dew, but ferment, and the vessels may be termed ferment-vessels. This ferment is conveyed into the blood, by a motion from the circumference to the center.

The Lymphatics carry their dewy particles through the glandules, which lie between the two coats. In the lowermost end of these glandules, the ferment-vessels take their rise. Most of the juice of the Lymphatic-Vessels is discharged between the coats of the veins, arteries, and vessels, in the mesentery to be conveyed into all the parts of the body, both internal and external. Even in bearing females the fruit is not nourished by blood, but by this nutritious juice: the remaining part of which, is transmitted into the blood through the thoracic duct and jugular veins.

10. A *Nerve* is a whitish, round, slender body, arising from the brain, which is supposed to convey the animal spirits to all parts of the body. What these spirits are none can shew: nay we are not sure they have any being. For none can certainly tell, whether the nerves are hollow canals, or only solid threads, inclosed in proper integuments.

11. The fibrous, soft, reddish part of the body is termed *Flesh*. All fleshy fibres are hollow, and divided through their whole length into

into little caverns, wherein the blood is detained, as occaſion requires.

12. A *Gland* is a ſoft and ſpungy body, which ſeparates ſome particular liquid from the blood. The larger glands contain arteries, veins, and lymphatic veſſels: but the glands of the inteſtines are only the tops of the arteries.

There is a kind of Down in the cavity of every gland, which probably does the office of a filter, and is that whereby a particular humour is ſeparated from the blood.

The ſtructure of this Down-veſſel is different according to the different purpoſes of nature. Sometimes the liquor filtrated through it, falls drop by drop on a membrane, to which one end of the veſſel is faſtened, as where it is deſigned only to moiſten the part. Sometimes many of theſe Down veſſels ſpread over the inner ſurface of a membranous cell, into which they all pour their liquor, which is diſcharged at a ſmall orifice.

Theſe veſſels are often of a great length, tho' they take up little room, being wound over one another, ſometimes in a ſingle knot, and ſometimes in ſeveral, incloſed in a common membrane. And hence is the diſtinction of glands into *conglobate* and *conglomerate*.

A conglobate gland is a little, ſmooth body, wrapt up in a fine, double ſkin, with only an artery and nerve paſſing in, and a vein and *excretory duct* going out.

A conglomerate gland is an irregular aſſemblage of ſeveral ſimple glands, which are tied together and wrapt up under one common membrane.

13. A

13. A *Muſcle* is a bundle of fibres joined and faſtened together, with their proper veins, arteries and nerves. It is divided into little cells by tranſverſe fibres, parallel to each one, whereby it may be contracted and ſhortened, or relaxed and lengthened again. Its extreme parts are more cloſely compacted, which we term *tendons*. By theſe the muſcles are connected with the neighbouring parts. A muſcle generally conſiſts of three parts; The upper, termed the *Head*, the middle, termed the *Belly*, and the lower part, or *Tail*.

Every muſcle is diviſible into ſmaller muſcles, and thoſe into other ſtill ſmaller: and ſo on, beyond all imagination. The laſt and ſmalleſt parts are Muſcular Fibres. But there is no aſſignable point in any muſcle, wherein there is not ſome Nerve. And here all the nerves diſappear; (in other parts their extremities expand into membranes.) It is therefore probable that the muſcular fibres, are only the Nervous continued.

14. The *Cuticle* or *Scarf-ſkin* is an extremely thin and tranſparent membrane, void of ſenſe, and covering the *ſkin* all over, ſticking faſt to its ſurface, to which it is alſo tied by the veſſels that feed it. It conſiſts of ſeveral layers of exceeding ſmall ſcales, which cover one another where it is thick. But in the lips, where it is extremely thin, they little more than touch one another.

In ſome creatures, (as fiſhes) theſe ſcales are only the excretory ducts of the glands of the ſkin. In others thoſe glands have their proper ducts, opening between the ſcales.

It

It is ſuppoſed, there are in one ſcale 500 excretory ducts, and that a grain of ſand will cover 250 ſcales. If ſo, a grain of ſand will cover 125000 of our pores.

The cuticle ſerves to defend the nerves of the ſkin, both from the air, which would dry and make them leſs ſenſible, and from rough and hard bodies, which would make a painful impreſſion on the naked nerves.

Negroes have a ſkin between the cuticle and the true ſkin. They are born white; but the middle ſkin, in a little time, turns black, and gives that colour to the whole body.

But who can account for the following caſe? Sir *Charles Wager* had a boy about eleven years old, who was born in *Virginia*, of negro parents. Till he was three years old, he was like other black children. He then, without any diſtemper, began to have little white ſpecks, upon his neck and breaſt. Theſe increaſed with his years, both in number and bigneſs, ſo that from the upper part of his neck, quite down to his knees, he was dappled with white ſpots, ſome of them broader than the palm of a man's hand. They were wonderfully white, equal to the ſkin of the faireſt lady, only ſomewhat paler. His face, arms and legs, were perfectly black. He was exceeding active, ſprightly, and more ingenious, than is common among that generation.

Perhaps the following fact is no leſs difficult to be accounted for. A Negro woman, cook to colonel *Barnes*, in *Maryland*, about forty years of age, remarkably healthy, had her ſkin as dark as that of the moſt ſwarthy *African*. But that part of it next her finger nails, about fifteen years ago became white. Her mouth ſoon under-

underwent the ſame change, which has ſince gradually extended over the whole body. At preſent four parts in five of her ſkin, are white, ſmooth, and tranſparent, as in a fair European, elegantly ſhewing the ramifications of the ſubjacent blood-veſſels. The other parts daily loſe their blackneſs, and partake of the prevailing colour. The neck and back retain moſt of their priſtine hue; the head, face, breaſt, legs and arms are all white. Her face and breaſt, when anger or ſhame has been excited in her, have been immediately obſerved to glow with bluſhes. This is the naked fact; but upon what principles of Philoſophy can we account for it?

The *Skin* covers almoſt the whole body, and is formed of whitiſh fibres, intermixt with numberleſs branches of nerves, veins and arteries. On its ſurface are many furrows or indented lines, having generally hairs on each ſide, and *Pores*, or little holes of various ſizes, ſerving for the tranſpiration of ſuperfluous particles. Under the Skin lie the *Subcutaneous Glands*, which are ſuppoſed to tranſmit thro' the pores an inſenſible ſteam, commonly believed to be of the ſame kind with what, when ſenſibly thrown out, is called *Sweat*.

The *Pores* in our hands and feet are very remarkable. Survey with a glaſs the palm of your hand well waſhed, and you may perceive innumerable little ridges, of equal bigneſs and diſtance, every where running parallel with each other: Theſe are very obſervable on the ends and firſt joints of the fingers and thumb, and near its root, a little above the wriſt.

On theſe ridges ſtand the Pores, all in even rows. Through a good glaſs every pore looks like

like a fountain. The Sweat may be ſeen to ſtand therein, as clear as rock water. The ridges are ſo placed, that they may better ſuit with the uſe and motion of the hand: thoſe on the lower ſide of each triangle, to the bending in of the fingers: thoſe on the other two ſides, and on the elliptic ridges, to the preſſure of the hand or fingers ends againſt any body, requiring them to yield to the right and left.

The pores are placed on theſe ridges, not in the furrows between them, that their ſtructure may be leſs liable to be injured by compreſſion, whereby the furrows only are dilated or contracted: the ridges conſtantly maintaining themſelves; and ſo the pores are unaltered. For the ſame reaſon the pores are very large, that they may be the better preſerved; though the Skin be never ſo much compreſſed and condenſed, by the conſtant labour of the hand: and ſo thoſe on the feet, that they may be preſerved, notwithſtanding the compreſſion of the ſkin, by the weight of the whole body.

Through the pores there continually tranſudes a ſubtle vapour from every point of the body, being what redounds of the aliment, comminuted to the higheſt degree, and ſent to repair every particle of it. And the matter thus evacuated is more than is thrown out by all the other paſſages together.

A perſon of middle age found what he perſpired was five eighths of the food taken in: ſo that there remained only three eighths for nouriſhment and all other evacuations. He obſerved alſo that as much is perſpired in one day, as paſſes by ſtool in fourteen: and more particularly, that in a night's time about ſixteen oun-

ounces are uſually thrown out by urine, four by ſtool, and about forty by inſenſible perſpiration.

If a man eats and drinks eight pounds in a day, five pounds of it paſs by perſpiration: namely about one pound within five hours after eating; (perſpiration being leaſt of all ſoon after eating) from the fifth to the twelfth hour, about three pounds, and from the 12th. to the 16th. ſcarce half a pound. Exerciſe increaſes perſpiration much. But it is naturally leſs in women than men.

While this ſteam flows from our body, it conſtantly imbibes a ſupply of moiſture from the air, which ſerves to keep all its parts ſoft, pliant and fit for motion. Hence, from the greater moiſture of the air, we perſpire leſs in winter than in ſummer, and in rainy weather than in fair. Live therefore if poſſible, in a clean houſe, and in a pure, dry air.

This inhalation is very conſiderable. Dr. *Keil* found his body to have imbibed in one night eighteen ounces of moiſture. And on a ſudden change of weather from dry to wet, the inſpiration ſometimes exceeds the expiration: there being *Abſorbent-Veins*, which accompany the numberleſs arteries from which the perſpiration is diſcharged. To the matter thus imbibed (not the obſtruction of the pores) he aſcribes what we term a *Cold*. Sweating cures this, by throwing out the noxious matter which was imbibed before.

The cutaneous veſſels both exhaling and inhaling, are capable of contraction and relaxation, by the power of the nerves. This appears from the effects of the paſſions which if joyful increaſe the circulation, and relax the exhaling veſſels. Thoſe paſſions on the contrary, which

which are ſorrowful, and retard the circulation, contract the exhaling veſſels, as appears from the dryneſs and corrugation of the ſkin, like a gooſe-ſkin after frights; and from a diarrhœa cauſed by fear. But the ſame affections ſeem to open the inhaling veſſels whence the variolous or peſtilential contagions are eaſily contracted by fear.

The benefits of inſenſible perſpiration are ſo great, that life cannot be preſerved without it. And the ſubtilty, equability and plenty of what we perſpire, are the grand ſymptoms of health.

But how little do we know even of our own frame! It has hitherto paſſed as an unqueſtionable truth, that the ſame matter which paſſes by inſenſible perſpiration, paſſing in greater quantities, is ſweat. Whereas an ingenious phyſician, Dr. *Rogers*, has found by numerous experiments, that a perſon perſpires abundantly leſs, when he ſweats, than when he does not: that one who perſpires 24 ounces in ſeven hours ſleep, if he ſweat, does not perſpire above ſix. This he tried many times, and never found it to fail. Whence he infers, 1. That it is not the ſame matter which is evacuated by inſenſible perſpiration and by ſweat: 2. That it is not evacuated through the ſame pores: 3. That the ſweat-pores are abundantly larger and fewer, than thoſe which ſerve inſenſible perſpiration: 4. That ſweat greatly hinders that perſpiration, both by covering thoſe pores with a clammy liquor, and by conſtringing them ſo that they cannot open; which muſt be the caſe, when the ſweat-pores are dilated. What a field does this open!

Some queries propoſed concerning perſpiration, by an ingenious writer, ſeem to deſerve a ſerious conſideration. 1. "Why do carnivorous animals ſweat ſo little? A fox hunted almoſt to death

death never ſweats. 2. Why do thoſe which feed on vegetables perſpire ſo much? Horſes and cows for example. We may often ſee them involved in a cloud of their own vapours, yea, almoſt covered with froth. 3. How can animals, whoſe natural food is vegetables, be kept alive and in health in very cold climates, by purely animal food? Cows in *Iceland* and in *Norway*, are fed in winter upon fiſh-bones." I would beg leave to aſk, 4. Do the *ſweat-pores* only, *imbibe?* Or thoſe alſo, which ſerve for *inſenſible perſpiration?*

15. *Fat*, a whitiſh, oily ſubſtance, void of ſenſe, is ſecreted from the blood, and lodged in ſmall, oval, membranous bags, which ſhoot out of the arteries. It is found in various parts, but chiefly under the ſkin, where (unleſs a man be emaciated) it runs co-extended with the ſkin over moſt parts of the body.

Fat is ſecerted from the arterial blood by the *adipoſe glands*, and tranſmitted again from the membranous cells to the blood through the veins. It ſeems to be a portion of the blood coagulated by the nitrous air mixed with it in the lungs. Artificial Fat is made, by mixing for ſome days oil of olives with ſpirit of nitre. Hence divers animals grow fat in froſty weather, the air then abounding with nitre.

The uſes of the Fat are various; as to facilitate the motions of the muſcles in all parts, leſſen their attrition againſt each other, and prevent a ſtiffneſs or rigidity; it fills up the intermediate ſpaces between the muſcles in ſuch a manner, with the cavities about many of the viſcera, that it readily yields to their motions, and yet ſupports them when at reſt; it ſerves as a ſtratum or bed

to

to conduct and defend the veſſels in their courſe to all parts; it gives an uniform extenſion to the ſkin, and ſerving as a cuſhion to eaſe the weight of the body in many parts, at the ſame time it renders the whole of a comely, agreeable ſhape: it probably by returning and mixing with many of the humours, abates their acrimony; it has a principal ſhare in forming the matter of the bile, and by tranſuding through the cartiliginous incruſtations of the bones, it mixes with the articular liniment or ſynovia; alſo by exhaling in a living perſon from the meſentery, meſocolon, omentum, and round the kidnies, it lubricates the ſurfaces of the viſcera with an oily emollient vapour, and by interpoſing betwixt their integuments, prevents their growing one to another.

Yet too much Fat is a real diſeaſe, which hinders the motion of the lungs, intangles the moſt active particles of the blood, and naturally creates dulneſs and heavineſs. You may cure this, by following three plain rules: eat and drink little; ſleep little; work much.

16. The fourth general integument is the *Panniculus carnoſus*, which in ſome parts is of a fleſhy ſubſtance, in others a mere membrane, lying juſt under the fat.

17. The diſſimilar parts are compoſed of the ſimilar. The chief of theſe is the *Head*. The cavity of the *ſkull* is nearly filled with a ſoft ſubſtance, termed in general the *brain*. But this is properly that part of it which lies forward. The hinder part (conſiderably ſmaller) is called the *cerebellum*. Under both, but chiefly the latter, and ſpringing from the internal ſubſtance of both, is the *medulla oblongata*.

The *Skull* is divided into two plates, one laid over the other. Between theſe is a ſpongeous ſubſtance, made of bony fibres detached from each plate. Hereby the ſkull is made not only lighter, but far leſs liable to fractures.

The ſkull is covered with a membrane called the *Pericranium*. This has ſeveral holes, which give paſſage to the ſpinal marrow, the nerves, arteries and veins. But theſe fill them ſo nicely, that nothing can paſs into, or out of the head, but through theſe veſſels.

It is round, that it may contain the more; but a little depreſſed and longiſh, advancing out behind, and flatted on the ſides, which contributes to the enlargement of the ſight and hearing.

It is divided into pieces by four ſutures. This makes it leſs liable to break, gives paſſage to the membranes of the Pericranium, and vent to the matter of inſenſible perſpiration.

18. All theſe are involved in two membranes, the inner (called *pia mater*) extremely thin; the outer (called *dura mater*) conſiderably harder and thicker. Where they involve the cerebellum, there is interpoſed between them the *arachnoides*, a very ſubtle and tranſparent membrane, which deſcending through the hinder part of the ſkull, together with them involves the whole *ſpinal marrow*.

19. The outer part of the brain (called the *cortex* or *bark*) is of an aſhy or greyiſh colour. It is formed from the minute branches of the neighbouring arteries, which being wove together in the pia mater, incloſe the inner part, ordinarily to the thickneſs of about half an inch.

It

It conſiſts therefore of innumerable little glands, contiguous to each other, (ſuppoſed to ſecern the animal ſpirits) which are of themſelves oval, but by their mutual preſſure become angular, and run waving with each other.

The inner part (called the *medulla*) is white, and terminates in another medullary ſubſtance, very white and hard, called the *corpus calloſum*. The medulla is thought to conſiſt of fine tubes, which when collected into little bundles, and covered with membranes, are termed nerves.

20. To trace this a little farther. From every point of the outer brain ariſe minute fibres, which in their progreſs uniting together, are eaſily perceptible. Theſe conſtitute the ſubſtance of the inner brain, and of the ſpinal marrow. In their farther progreſs they are diſtinguiſhed by coats detached from the two membranes of the brain, into ſeveral bundles called *nerves*, reſembling ſo many horſe-tails, each wrapt up in a double tunic.

Several of theſe part from the reſt, in the brain itſelf, of which there are ten pair; one on each ſide. From the ſpinal marrow there ariſe thirty pair more. All theſe, while within the ſkull or the ſpine, are pulpous; but afterwards harden, acquire a coat, and ſpread thro' the ſmalleſt points of the ſolid parts of the body. Their coats are every where furniſhed with blood-veſſels, lymphatics, and veſicles of a very tight texture, which ſerve to collect, ſtrengthen, and contract their fibres. And if we conſider, 1. The great bulk of the brain, cerebellum, and ſpinal marrow, (whereof the whole ſubſtance goes to conſtitute nerves, being

continued into, and ending in them:) 2. The great number of nerves diſtributed hence, throughout the whole body: 3. That the brain and ſpinal marrow are the baſis of an embryo, whence the other parts are afterwards formed: And laſtly, That there is ſcarce any part of the body, which does not feel or move: it may ſeem not altogether improbable, that all the ſolid parts of the body, are woven out of nervous fibres, and wholly conſiſt of them.

21. The brain is divided into four *ventricles*, Near the riſe of the fourth, there is a round hole, over which is ſuſpended the *Pineal Gland*, ſo called from its reſembling the ſhape of a pine-apple. It is furniſhed with veins and arteries, and incloſed in a thin membrane, derived from the pia mater. *Des Cartes* imagined this to be the ſeat of the ſoul; but without any ſolid reaſon. Nor has any one yet been able to diſcover, what is the uſe of it.—Is it ſuch a reſervoir of blood for extraordinary occaſions, as ſome imagine the *ſplcen* to be?

The brain is abundantly bigger in proportion in man than in other animals. In other animals, it is commonly biggeſt, cæteris paribus, in thoſe that have moſt ſagacity.

There are in the brain multitudes of veſſels, ſo extremely ſmall, that if a globule of blood (a million of which exceed not a grain of ſand in bigneſs) were divided into 500 parts, thoſe parts would be too large to paſs thro' them. And theſe veſſels are as large in the brain of a ſparrow, as in that of an ox. Nor is there any difference between the brain of a large animal and a ſmall, but that one contains far more of theſe veſ-

veſſels than the other. But the globules of the fluid paſſing thro' them are in all animals of the ſame ſize.

The outer part of a turkey's brain is a very clear and tranſparent oily matter. Innumerable fine blood-veſſels are ſpread thro' every part of this. And if a ſmall part is cut, there flows out a ſmall globule of pellucid fluid.

The brain is not abſolutely neceſſary to animal life. Infants have been born, and lived ſome time without any. We have an authentic account from *Paris*, of a child that ſurvived the birth four days, not only without a brain, but even an head: inſtead of which it had a maſs of fleſh, ſomewhat like liver. In 1673, a child was born alive without any brain, cerebellum, or medulla oblongata; the ſkull being ſolid: nor had it any communication with the ſpinal marrow. Mr. *du Verney* took out the brain and cerebellum of a pigeon: yet it lived and walked about. Monſ. *Chirac* took out the brain of a dog; yet he lived. On taking out the cerebellum, he ſeemed dead; but revived, when he blew into the lungs, and continued alive an hour. Nay, there are many inſtances of inſects living a long time, after their head is cut off. Hence it appears, that the ſpinal marrow alone may, for a ſeaſon, ſuffice both for life, ſenſation and motion.

Are there diſtinct provinces for the vital or ſpontaneous, and for the animal or voluntary actions? And does the cerebellum furniſh the heart and other vital organs with nerves, while the brain ſupplies the nerves, which go out to the organs of ſenſe and voluntary motion? This is an elegant ſyſtem, but is every where con-

futed by anatomy. From the cerebellum, the fifth pair of nerves is manifeſtly produced; but this goes to the tongue, to the muſcles of the outward ear, of the eye, and of the noſe, which are parts all of them either moved by the will or elſe deſtined to ſenſation. Again, from one and the ſame nerve there are vital branches ſent to the heart and lungs, and others that are animal and voluntary to the larynx, or ſenſitive in the ſtomach. Laſtly, the repeated accounts of injuries to the cerebellum, being ſo ſpeedily fatal, are not altogether true; for that both wounds and ſcirrhoſities of this part have been ſuſtained without any fatality to the patient, may be affirmed by certain experience.

22. The *Eyes* next offer themſelves to our obſervation, guarded by the *eye-lids*, *eye-laſhes*, and *eye-brows*. The eye-lids conſiſt of the cuticle, the ſkin, a thin expanſion of the panniculus carnoſus, and an inward coat. A paliſade of ſhort, but ſtiff hairs grows out of their cartilaginous edge, both to break the too fierce impreſſion of the rays of light, and to prevent any thing from getting into the eye, when open. Theſe hairs only grow to a convenient length, and their points ſtand out of the way, thoſe of the upper eye-lids being bent upward, and thoſe of the lower, downward. Meantime the eye-brows hinder ſweat, or any thing elſe which might be hurtful, from falling down from the forehead.

Both the eye-lids are moveable, but chiefly the upper. Animals which have hard eyes, as lobſters, need none, and therefore have no eye-lids. But moſt brutes have an additional eye-lid

lid (called the *nictitating membrane*) which draws like a curtain, to wipe off what might incommode the eye. The monkey indeed has it not, as being furniſhed with hands like a man.

23. The eye can move upward, downward, to either ſide, and round, either toward the right or left. For theſe ſix motions, ſix muſcles are allotted, which ſpread their tendons far into the eye. At each inner corner of the eye, there is a gland with two or three ducts, which opening on the inner ſurface of the eye-lid, keep the eye-ball moiſt, to facilitate its motion. By theſe glands tears alſo are ſecerned. The eye is connected with the ſurrounding bones by the *tunica adnata*, commonly called *the white of the eye:* in the midſt of which is a large hole for the *tunica cornea*, thro' which the *Iris* and *Pupil* appear. The whole ball of the eye riſes from the *optic nerve*, and is formed of three coats, propagated from it, and as many humours: two of which, have each a coat of its own alſo. The eye therefore has five coats in all: three common, and two to contain their ſeveral humours.

24. The outermoſt coat, proceeding from the Dura Mater, and ſurrounding the whole eye, is termed the *Sclerotica:* The fore part of it being tranſparent like horn, is thence ſtiled the *Cornea*. This is more convex than the reſt of the eye. It is compoſed of ſeveral parallel plates, which are nouriſhed by many blood-veſſels, but ſo fine, as not to hinder the ſmalleſt rays of light. It has an exquiſite ſenſe, that on the leaſt touch of any thing, the tears may be expreſſed, to waſh off any filth, which by adhering to it might render it dim or cloudy.

The reſt of the ſclerotica is opaque, and of the ſame colour with the dura mater.

The ſecond coat is called *Uvea*. It is much thinner than the former, tho' thicker than the *Pia Mater*, from which it proceeds. In the forepart of it is a round hole, which with the chryſtaline humour interpoſed, conſtitutes the *Pupil*, ſurrounded by the *Iris*, ſo named, from its ſuppoſed reſemblance to the colours of the rainbow. The third and inmoſt coat is termed the *Retina*. It is extremely thin and ſoft, and darker-coloured than the lower part of the optic nerve, of which it is a continuation.

" If it be queſtioned, ſays Dr. *Haller*, whether the object is painted upon the retina or upon the choroides? We anſwer, this late ſuppoſition is inconſiſtent with known obſervation, by which the retina is evidently a moſt ſenſible expanſion of the nerve, while the choroides has only a few nerves, with ſmall veſſels, which are certainly blind. It is alſo oppoſed by the great variety of the choroides in different animals, while the conſtant uniformity of the retina is equally remarkable; to which add the black membrane, that is interpoſed betwixt the retina, and choroides, in ſome kinds of fiſh. Finally, anatomy demonſtrates, that the choroides is ſeated in the blind part of the eye, but is itſelf of a white colour."

25. The *Aqueous Humour*, reſembling the colour and conſiſtence of water, lies in the forepart of the eye, juſt behind the cornea: its interior ſurface is convex, the other a little concave. Whence this humour is derived we cannot tell: but its ſource muſt be plentiful: for

for if the coat containing it be ſo wounded, that all the humour runs out, it needs only to keep the eye cloſe for a ſeaſon, and the wound will heal, and the humour recruit.

Indeed an eminent *Italian* affirms, that he has ſlit the pupil of divers animals, and ſqueezed out all the humours, and has afterwards reſtored them perfectly to ſight: nay, that the eyes of many, inſtead of being damaged thereby, ſeemed more lively and vigorous than before.

The ſecond humour, termed (improperly enough) the *Chryſtalline*, conſiſts of many thouſand filaments, tending from the circumference to the center, and cloſely woven together. It is a little convex before, and more behind. It ſerves to refract the rays of light, ſo that they may meet and form an image, on the bottom of the eye. It is ſet in the forepart of the vitreous humour, like a diamond in its collet, and is retained there by a membrane that ſurrounds it, thence called its *Capſula*. It is toward the outſide like a jelly, but toward the center as hard as ſalt. The figure of the outer part is varied by a ligament annext, which can make it either more or leſs convex, or move it to or from the retina. And this is abſolutely neceſſary, in order to diſtinct viſion: for as the rays of diſtant objects diverge leſs than thoſe of near objects, the Chriſtalline muſt either be made leſs convex, or be ſet farther from the retina.

When dried, it appears to conſiſt of a vaſt number of thin, round ſcales one upon another, 2000 of which have been counted in one Chryſtalline. Each of theſe conſiſts of a ſingle fibre, wound this way and that, in a ſtupen-

dous manner, ſo as to run ſeveral courſes, and meet in as many centers, and yet not interfere or croſs in any place.

The third, which is termed the *Vitreous Humour*, is not unlike melted glaſs. It is covered with an exceeding thin coat. The forepart is concave, as receiving the Chryſtalline; the other ſide is convex.

The whole apparatus of the Eye tends to this, that there be produced in the bottom of it, a diſtinct collection of all the rays, which proceeding from any point of an object, penetrate the chryſtalline humour, that ſo an image of that object may be painted there. In order to this, the rays ſtriking on the cornea, are reflected toward the perpendicular, and thus directed thro' the pupil to the chryſtalline. Meantime the Iris, contracting or dilating the pupil, admits fewer or more rays, as the object is more or leſs vivid.

Now the flatter the cornea is, the fewer rays does it collect and tranſmit to the chryſtalline, and thoſe more diverging. The rounder it is, the more rays does it collect and tranſmit, and thoſe more converging. It is too flat in old men; it is too round in them that are ſhort-ſighted. The rays tranſmitted thro' the pupil to the chryſtalline humour, are there refracted anew, collected and rendered converging, and thoſe that come from the ſame point, are thrown in one point on the bottom of the eye. But if the Chryſtalline be too denſe, the *Focus* (or point wherein they unite) will be too near: if that be not denſe enough, it will be too remote. And this is another cauſe of ſhort-ſightedneſs, or the contrary defect.

In

In all viſion both the eyes are uſed at once. And both together (as any one will find upon trial) behold an object in another ſituation than either of them apart would do. Hence a gentleman who had one of his eyes ſtruck out, for ſome months after was apt to miſtake the ſituation of things: and when he attempted to pour liquors into phials, often poured them quite beſide the neck of the phials.

Two eyes greatly contribute, if not to diſtinct, at leaſt to extenſive viſion. When an object is placed at a moderate diſtance, by the means of both eyes we ſee a larger ſhare of it than we poſſibly could with one; the right eye ſeeing a greater portion of its right ſide, and the left eye of its correſpondent ſide. Thus both eyes in ſome meaſure ſee round the object; and it is this that gives it in nature, that bold relievo, or ſwelling, with which they appear; and which no painting, how exquiſite ſoever, can attain to. The painter muſt be contented with ſhading on a flat ſurface; but the eyes, in obſerving nature, do not behold the ſhading only, but a part of the figure alſo, that lies behind thoſe very ſhadings, which gives it that ſwelling, which painters can never fully imitate.

There is another defect, which either of the eyes, taken ſingly, would have, but which is corrected, by having the organ double. In either eye there is a point, which has no viſion, ſo that if one of them only is employed in ſeeing, there is a part of the object to which it is always totally blind. This is that part of the optic nerve where its vein and artery run; that point of the object that is painted there, muſt continue unſeen. To be convinced of this we have

only to try a very eaſy experiment. If we take three black patches, and ſtick them upon a white wall, about a foot diſtant from each other, each about as high as the eye that is to obſerve them; then retiring ſix or ſeven feet back, and ſhutting one eye, by trying for ſome time, we ſhall find, that while we diſtinctly behold the black ſpots that are to the right and left, that which is in the middle remains totally unſeen. When we bring that part of the eye, where the optic artery runs, to fall upon the object, it will become inviſible. This defect, in either eye, is corrected by both, ſince the part of the object that is unſeen by one, will be diſtinctly perceived by the other.

The *Form* of the eye is the moſt commodious which can be imagined. It is fitteſt both to contain the humours within, and to receive the images of objects from without. Was it ſquare, or of any multangular Form, ſome of its parts would lie too far off, and ſome too nigh thoſe lenticular humours, which by their refractions cauſe viſion. But by means of this Form, the humours are fitly placed to perform their office of refraction, and the little darkned cell neatly adapted to receive the image of the object.

Again. As it is neceſſary for the eye to move various ways in order to adjuſt itſelf to various objects, ſo by this figure it is well prepared for ſuch motions, and can with eaſe direct itſelf as occaſion requires.

No leſs commodious is the *Situation* of the eye: in the moſt eminent part of the body, and near the moſt ſenſible part, the brain. By its eminence in the body, it can take in the more objects: and by its ſituation in the head, beſide

beſide its nearneſs to the brain, it is moſt conveniently placed for defence and ſecurity, in the hand it might have been more ready for ſervice; but to how many dangers would it have been expoſed? The ſame may be ſaid, as to its ſite in any other part but where it is. But the head is a part that ſeems contrived and made, chiefly for the uſe of the principal ſenſes.

Some odd circumſtances relative to the eyes, are related by a phyſician in the *Philoſophical Tranſactions*.

"A perſon had no viſible diſeaſe in his eyes; yet could not ſee, unleſs he ſqueezed his noſe with his fingers, or ſaddled it with narrow ſpectacles, and then he ſaw very well.

"A Maid, 23 years old could ſee very well, but no colour beſide white or black. She could ſometimes, in the greateſt darkneſs, ſee to read almoſt a quarter of an hour.

"A Saddler's daughter had an impoſthume, which broke in the corner of her eyes. And out of it there came about thirty ſtones, as big as ſmall pearls.

"A young man in *Suffolk*, about 20 years of age, has all the day a clear and ſtrong ſight. But when twilight comes, he is quite blind; nor can he ſee any thing at all, either by fire-light or candle light. No glaſſes give him any help. He has been thus, ever ſince he can remember. This cloudineſs comes gradually upon him, like a miſt, as day-light declines. It is juſt the ſame, both in ſummer and winter, and at all times of the moon.

"When I was about ſixty, my ſight was ſo decayed, that I could not diſtinguiſh men from women. I received no help from any glaſſes, till

till I took ſpectacles with the largeſt circles. Cloſe to the upper ſemicircle on both ſides, I cut the bone, and taking out the glaſſes, put black Spaniſh leather taper-wiſe into the emptied circles. Theſe took in my whole eye at the wider end, and through the narrow end I can read the ſmalleſt print. Into this end I can only put my little finger, not quite to the firſt joint. But they may be made wider or narrower, and longer or ſhorter, as beſt fits every eye.

" At firſt I could not bear them above two hours at a time: now I can uſe them above twelve hours in four and twenty. And they prove a great help to thoſe who are purblind, who have weak eyes, or decayed with age. But for the purblind they muſt be made ſhorter; longer, for eyes decayed with age.

" Inſtead of leather, they may be made of paper, coloured black and paſted on; and with inner folds to be drawn out, from one inch to three."

In ſome men the Iris has a faculty of darting out light. Dr. *Willis* mentions one, who after drinking wine plentifully, could ſee to read in the darkeſt night. And *Pliny* records of *Tiberius Ceſar*, that if he awaked in the night, he could ſee every thing for a while, as in the broad day-light. Dr. *Briggs* gives a parallel inſtance of a gentleman in *Bedfordſhire*.

We find various ſubſtitutes for the uſe of the eyes, in many blind perſons. In ſome the defect has been ſupplied, by an excellent gift of remembring what they had ſeen: in ſome by a delicate ſenſe of ſmelling: in others, by a fine ſenſe of hearing. So *Richard Clutterbuck* of *Redborough* in *Glouceſterſhire*, who was ſtone-

blind

blind, had ſo curious an ear, that he could hear the fine ſand of an hour-glaſs fall. In ſome it has been ſupplied by an exquiſite ſenſe of feeling: ſo that the ſame *Richard Clutterbuck* was able to perform all ſorts of curious works. He could not only take a watch in pieces, and ſet it together again, but could alſo make all ſorts of ſtring muſical inſtruments. He likewiſe played on them by notes cut in their uſual form, and ſet upon protuberant lines on the wood. Yet even this hardly came up to the ſkill of *Van-Eyck*, the organiſt of *Utrecht*, who, tho' he had been blind from two years old, played on all ſorts of inſtruments.

Others have been able to take a face by the touch, and mould it in wax with the utmoſt exactneſs: as was the blind ſculptor, who thus took the likeneſs of the *Duke de Bracciano*, and made a marble ſtatue of King *Charles* the firſt extremely well.

26. But more than all this, ſome perſons have been able even to diſtinguiſh colours by the touch. *Peter* of *Maeſtricht*, tho' perfectly blind, diſtinguiſhed by his touch the different colours of cloth. *John Vermaaſen* of *Utrecht* did the ſame, judging by the different degrees of roughneſs which he felt.

Yet blind perſons, even tho' they diſtinguiſh them by the touch, have no idea of viſible objects. Thus the gentleman couched by Dr. *Cheſelden*: add to this, that he had no idea of diſtance, but imagined all the objects he ſaw, touched his eyes, in the ſame manner as thoſe he felt did his ſkin.

An extract from Dr. *Cheſſelden*'s account of this perſon, will not be unacceptable to the curious.

" This

" This young gentleman could in a ſtrong light diſtinguiſh black, white, and ſcarlet. Yet the faint ideas he had of them before he was couched, did not ſuffice to make him know them after. He now thought ſcarlet the moſt beautiful of all colours. Of others, the moſt gay, were the moſt pleaſing. But the firſt time he ſaw black, he was very uneaſy; yet after a while he was reconciled to it. When he firſt ſaw, no objects were ſo agreeable to him, as thoſe that were ſmooth and regular: although he knew not the ſhape of any thing, nor could diſtinguiſh one from another, either by its ſhape or ſize. Being told, what thoſe things were, whoſe forms he knew by feeling, he would carefully obſerve, that he might know them again. Thus having often forgot, which was the cat, and which the dog, he was aſhamed to aſk: but catching the cat, (which he knew by feeling) he looked at her ſtedfaſtly, and ſaid, " So, Puſs, I ſhall know you another time." He was ſurprized, that the things or perſons he liked beſt, did not appear moſt agreeable to his ſight, expecting that what was moſt pleaſing to his other ſenſes, would be ſo to his ſight alſo.

We thought he ſoon knew the nature of pictures, but found afterward we were miſtaken: for it was two months after the operation, before he diſcovered that they repreſented ſolid bodies. Even then he was no leſs ſurprized, expecting they would feel like the things they repreſented. He was amazed, that thoſe parts, which by their light and ſhade appeared round and uneven, ſhould feel like the reſt, and aſked, which was the *lying ſenſe*, feeling or ſeeing? Being ſhewn his father's picture drawn in miniature

niature, and told, what it was, he acknowledged the likeneſs; but aſked, how it could be, that ſo large a face ſhould be contained in ſo little room? Saying, it would have ſeemed as impoſſible to him, as to put a buſhel of any thing into a pint. But even blindneſs he obſerved, had this advantage, that he could go any where in the dark, better than thoſe that could ſee. And after he was couched, he did not loſe it, but could go all about the houſe without a light. Every new object gave him new delight, ſuch as he wanted words to expreſs. He was particularly delighted when he firſt ſaw a large proſpect, and called it, a new kind of ſeeing. Being afterwards couched in his other eye, he ſaid, that objects appeared larger to this eye; though not ſo large as they did to the other, when it was newly couched. But looking on them with both eyes, they ſeemed twice as large, as if he looked with that only."

27. I would beg leave to propoſe a few queries here, to which I have not found a ſatisfactory anſwer.

1. Why do we ſee things *falſe* with one eye? Particularly with regard to their ſituation.

2. How do the two eyes *compound* the rays of light, ſo as to ſee right?

3. Why do we not ſee all things *double*?

4. Since all things are painted *upſide down* on the bottom of the eye, why do we not ſee them ſo?

28. We proceed to the *Ear*, formed with exquiſite wiſdom, for the reception of ſounds. The *Outward Ear* conſiſting of an oval cartilage, externally convex, concave within, leads by

by various windings to the *Meatus Auditorius*, which is firſt cartilaginous, and then bony. It is filled with a viſcid matter, called the *Ear-wax*, which is ſupplied from the veſſels placed in the ſkin, ſurrounding the *Meatus*, to hinder any hurtful animal from creeping into the Ear. The *Meatus* is cloſed within by a thin, dry, tranſparent membrane, affixt to a bony circle, which is called the *Membrana Tympani*. Behind it is that cavity of the *Os Petroſum*, which is termed the *Drum*.

The outward ear has two parts, that which ſtands out from the head, called the *auricle*, and the narrow paſſage which enters the ſkull, called *meatus auditorius*.

The auricle is furrowed with divers winding canals, which receive and collect the various undulations of the air. They who have loſt this, hear very confuſedly, unleſs they uſe a trumpet, or form a cavity round the ear, with their hands.

It is a wiſe proviſion, that the ſubſtance of the auricle is cartilaginous. Had it been bone, it would have been troubleſome, and might by many accidents have been broken off. If fleſh, it would neither have remained expanded, nor ſo well have received or conveyed the ſounds. Rather it would have blunted them, and retarded their progreſs into the organ. But being hard, and curiouſly ſmooth and winding, ſounds find an eaſy paſſage, with a regular refraction, as in a well-built arch.

It is obſervable, that in infants in the womb and newly born, the *meatus auditorius* is cloſe ſhut up, partly by the conſtriction of the paſſage, and partly by a glutinous ſubſtance, whereby

whereby the drum is guarded againſt the water in the *ſecundine*, and againſt the injuries of the air, as ſoon as the infant is born.

It is remarkable, that in the ears of moſt if not in all animals, where the *meatus auditorius* is long enough to afford harbour to *ear-wigs*, or other inſects; *ear-wax* is conſtantly to be found. But in birds, whoſe ears are covered with feathers, and where the drum lies but a little within the ſkull, no *ear-wax* is found, becauſe none is neceſſary to the ears ſo well guarded, and ſo little tunnelled.

29. In this, beſides a little branch of nerves, there are four little *bones*, two *paſſages*, and two *windows*. Three of thoſe bones, from ſome imagined reſemblance, are ſtiled the *hammer*, the *anvil* and the *ſtaple:* the fourth is termed, *the orbicular bone*. Theſe are faſtened by ſtrong ligaments to each other, and to the neighbouring parts. The paſſages go from the ſide of the drum: one of which, termed the *labyrinth*, by a very winding way, carries a part of the auditory nerve to the external muſcles of the head. The other paſſes from the bottom of the drum to the palate; whereby not only air, if needful, may be received, but the defect of hearing, in ſome meaſure ſupplied by ſpeaking to the mouth.

The *Labyrinth* contains, beſides the entrance, three bony, ſemicircular cavities, and a bony canal, in the form of a *ſcrew*, divided into two parts, from the top to the bottom. The labyrinth is lined throughout with a thin membrane, furniſhed with veins, arteries and nerves. And this membrane may not improbably be the organ of hearing.

The

The curious ſtructure of the labyrinth and ſcrew tend to make the weakeſt ſounds audible. Thoſe canals, by their winding, contain large portions of the *auditory* nerve, upon every point of which at once the ſound being impreſt becomes audible; and by their narrowneſs the ſounds are hindered from dilating, which muſt have weakened them proportionably.

The ſtrength of the impreſſion is likewiſe increaſed by the elaſticity of the ſides of the bony canal, which receiving the firſt impulſes of the air, reverberate them on the auditory nerve.

The *Auditory Nerves* are diſtributed, one to the ear, the other to the eye, tongue, and parts adjoining. By the diſtribution thereof to different parts, an admirable conſent is eſtabliſhed between them. Hence it is, that moſt animals hearing a ſtrange ſound, erect their ears to catch it, open their eyes, and are ready with their mouth, to ſhriek or call for help. A farther uſe of this nervous communication between the ear and the mouth is, that the voice may correſpond with the hearing, and be a kind of echo thereof: and that what is heard with one of theſe nerves, may readily be expreſſed by the help of the other.

And now what leſs than an infinitely wiſe God, could contrive ſo fine an organ, and ſuch a medium, ſo ſuſceptible of every impreſſion, that the ſenſe of hearing hath occaſion for, to impower all animals to expreſs their meaning to each other, with endleſs variety? Yea, what leſs could form ſuch an œconomy as that of muſic is? So that the medium conveys the melodious vibration of every animal voice or well-tuned

tuned inſtrument, and the ear receives them, to allay the perturbations, and calm and cheer the heart of man!

Tho' the ear be the ordinary organ of hearing, yet it is not the only one. We may hear by the teeth. For if one end of a knife be applied to a ſpinnet, and the other held between the teeth, the muſic will be diſtinctly heard, tho' the ears be ever ſo cloſely ſtopped. Yet this is not properly by the teeth, but by the auditory nerve which paſſes from the drum to the palate.

In thoſe who are born deaf, the eyes may in ſome meaſure ſerve in the place of ears. Some can underſtand what is ſaid, by nicely obſerving the lips and tongue of the ſpeaker: and may even accuſtom themſelves to uſe their own, till they learn a kind of ſpeech. Thus a phyſician at *Amſterdam* taught ſeveral children born deaf, to underſtand what was ſaid, and to give pertinent anſwers.

Mr. *Goddy's* daughter of *Geneva* loſt her hearing at two years old. Yet by obſerving the lips of others, ſhe had acquired many words, whereby ſhe would talk whole days with thoſe that could underſtand her. But ſhe knew nothing of what was ſaid, unleſs ſhe ſaw the mouth of the ſpeaker: ſo that if they wanted to ſpeak to her in the night, they were obliged to light a candle. Only ſhe knew what her ſiſter ſaid even in the dark, by laying her hand on her mouth.

But many deaf perſons can hear, if a loud noiſe be made while you ſpeak. Dr. *Willis* mentions one, who, if a drum was beat in the room, could hear very clearly. So that her huſband

husband hired a drummer for his ſervant, and by that means converſed with her daily.

30. The *noſtrils* are made not of fleſh or bone, but of cartilage, the better to be kept open, and as occaſion requires, to be dilated or contracted: for which purpoſe they are furniſhed with proper and curious muſcles. The tubes therein growing narrower and narrower, lead into ſeveral little cells and winding cavities, covered with a ſoft coat, and provided with arteries, veins, glands, and filaments of the *olfactory nerves*. This therefore is without all doubt the proper organ of Smelling.

And foraſmuch as it is by Breathing, that the odorant particles are drawn in, the *laminæ* with which the upper part of the noſe is barricaded, ſerve two excellent purpoſes, partly to prevent any thing hurtful from entering the breathing paſſages in our ſleep (for which end likewiſe the hairs placed at the entrance of the noſtrils ſerve), and partly to receive the divarications of the olfactory nerves, which are here thick ſpread, and by this means meet the ſmells entering with the breath.

Each of the *cartilaginous Laminæ* is divided into many others, folded into a ſpiral line. The *os cribroſum* is made up of the extremities of theſe; the holes therein being the intervals between them. They are deſigned to uphold the inner tunic of the *noſe*, which is folded round about together with theſe laminæ, that by its great expanſion it may receive a greater number of the odorant particles. For the ſame reaſon, it is furniſhed with many ſmall glands, which open into it, and moiſten it with a ſlimy

ex-

exudation, fitted to entangle and detain the ſubtle effluvia that touch it. And not only the number, but alſo the length of theſe Laminæ, is of great uſe for the ſtrength of ſmelling. For this purpoſe moſt beaſts, which either hunt, or diſtinguiſh their food by ſmell, have not their noſe in the middle of their face, like man, but prolonged to the very end.

31. The *Tongue* has for its baſis that forked bone, called the *os gutturis*. It conſiſts of various muſcles interwoven together, that it may be fit for various kinds of motion. To theſe are added very many ſmall branches of nerves, which paſs through the middle of it to the outſide, and being gathered into little bundles conſtitute thoſe *papillæ*, which make its ſurface rough and uneven. Beſides theſe there appear alſo on the ſurface of the tongue, certain pointed fibres, not unlike the ends of birds claws, inclining toward the baſis of it, with which are interſperſed innumerable *ſalival glands*. And all theſe are in their ſeveral ways ſubſervient to the ſenſe of *Taſting*.

It has been generally ſuppoſed, that the *tongue* is eſſentially neceſſary to the formation of *ſpeech*. But as ſure as we have been of this, it is an entire miſtake. A child in Eſſex ſome years ago, had her tongue entirely cut out, by reaſon of an incurable canker. She was then three years old. Twenty years after, it was reported, that ſhe was able to ſpeak. To be ſatisfied hereof, Mr. *Benjamin Boddington*, Turkey-Merchant of Ipſwich, with two other gentlemen, went to *Wickham Market*, where the young woman then lived, whoſe caſe they thus deſcribe.

" We

" We have this day been at *Wickham Market*, to ſatisfy ourſelves concerning *Margaret Cutting*. We examined her mouth with the greateſt exactneſs, but found no part of the tongue remaining; nor was there any Uvula. The paſſage down the throat is a circular open hole, large enough to admit a ſmall nutmeg.

" Notwithſtanding this, ſhe ſwallowed both ſolids and fluids as well as we could do, and in the ſame manner. Yea, and ſhe talked as fluently as other perſons do. She pronounced letters and ſyllables very articulately, even thoſe which ſeem neceſſarily to require the help of the tongue, as d, l, t, w. She read to us in a book diſtinctly; ſhe ſings very prettily; nay, and ſhe diſtinguiſhes taſtes, and can tell the leaſt difference either in taſte or ſmell."

But is it poſſible to teach any one to ſpeak, who has been *deaf and dumb* from his birth?—It is. Dr. *Wallis* taught ſuch an one to ſpeak, Mr. *Daniel Whaley*, of *Northampton*. He was preſent before the Royal Society, May 21, 1662, and did there pronounce, diſtinctly enough, ſuch words as the company propoſed to him: indeed not altogether with the uſual tone, yet ſo as eaſily to be underſtood. In a year, which was the time he ſtayed with Dr. *Wallis*, he read over great part of the Engliſh Bible, and learned to expreſs himſelf intelligibly in common affairs, to underſtand letters written to him, and to anſwer them. And in the preſence of many foreigners, he has not only read *Engliſh* and *Latin* to them, but has pronounced the moſt difficult words in their languages, which they could propoſe to him.

The

The Doctor has ſince done the ſame for Mr. *Alexander Popham*, a gentleman of a fair eſtate.

But we have an inſtance of *Dumbneſs* cured in a ſhorter time. *Henry Axford*, ſon of *Henry Axford*, in the *Devizes*, at twenty-eight years of age, perceived an hoarſeneſs, and in about ſix days became quite ſpeechleſs; not only unable to ſpeak articulately, but to utter the leaſt ſound with his tongue. His cold went off, but he remained abſolutely ſpeechleſs; and the advice of all the neighbouring phyſicians did not help him.

He continued totally dumb for four years, till in July, 1741, being at *Stoke*, in returning homeward at night, he fell from his horſe, and was taken up and put to bed in an houſe upon the road. He ſoon fell aſleep, and dreamed, he was fallen into a veſſel of boiling wort. Struggling with all his might to call for help, he actually did call aloud, and recovered the uſe of his tongue from that moment, as perfectly as ever he had it in his life.

Perhaps therefore there is truth in that antient ſtory, concerning the ſon of king *Cræſus*: namely, having been dumb from his birth, he had never ſpoke at all, till in the battle, ſeeing a man ready to kill his father, his tongue was looſed, and he cried out aloud, "Soldier, ſpare the King!"

The time of cutting the *Teeth* is uſually from the ſeventh to the ſeventeenth month. It is commonly preceded by an itching of the gums, and by convulſions, fevers, and looſeneſs: moſt of which ſymptoms happen to birds alſo, upon moulting or caſting their feathers.

The ſeed of the teeth is a mucous matter, like the white of an egg, contained in the cells of the Jaw bone, which grows harder and bigger till it breaks thro' the gum.

That part of the tooth which ſtands out of the gum, is covered with a peculiar ſubſtance called *enamel*. It is compoſed of an infinity of little tubes, which grow on the bone by their roots. If any part of this be broken off, ſo that the bone is left bare, it grows carious; there being no bone which will bear the air.

We may farther obſerve, 1. That the teeth only of all the bones, grow in length during a man's whole life: which is providently deſigned, to repair the waſte that is continually made by attrition; 2. That the teeth are the only bones which are not covered with that exquiſitely ſenſible membrane, the *perioſteum*: 3. That they are harder and firmer than any other bone, that they may be more durable and fit to chew the moſt ſolid aliments; 4. That for their nouriſhment, there is a cavity contrived in each ſide of the jaw-bone, in which are lodged an artery, a vein, and a nerve, which thro' ſmaller cavities ſend their twigs to every tooth; 5. That as infants are deſigned to live on milk for ſome months, they are ſo long without any teeth: whereas animals that need them, have them ſooner, and ſome are even born with them. 6. The different ſhape of the teeth is remarkable. The fore-teeth are formed broad, and with a thin and ſharp edge, like chiſſels, to cut off a morſel from any ſolid food. The next, one on each ſide, are ſtronger, deeper-rooted, and more pointed, to tear tougher aliments: the reſt are made flat and broad at top, and withal

withal ſomewhat uneven, that thereby they may the better retain, grind and mix the aliment. 7. Becauſe biting and chewing require much ſtrength, partly in the teeth themſelves, partly in the inſtruments that move the lower jaw, which alone is moveable; nature has given it ſtrong muſcles, which make it bear forcibly againſt the upper jaw: and has not only fixt each tooth in a diſtinct cavity, as in a cloſe, ſtrong and deep ſocket, but has given holdfaſt to the ſeveral ſorts of teeth, ſuitable to the ſtreſs that is to be laid upon them. So whereas the *cutters* and *eye-teeth* have only one root, the *grinders*, deſigned for harder work, have three: in the upper jaw often four, becauſe they are pendulous, and the ſubſtance of the jaw ſomewhat ſofter. 8. The ſituation of the teeth is moſt convenient. The *grinders* are behind, near the center of motion, becauſe chewing requires a conſiderable force: the *cutters* before, ready for their eaſier work.

32. The *Palate* is of a bony ſubſtance, a little concave, and cloathed with a thick membrane, which has the ſame kind of nervous *papillæ* and ſmall glands, that are ſeen in the ſurface of the tongue. And hence it is qualified to aſſiſt the taſte, as well as the *ſpeech*.

It would be endleſs to ſpecify the curious mechaniſm of all the parts that concur to form the voice. However, let us note two things: 1. There are thirteen muſcles provided for moving the five cartilages of the *wind-pipe*. 2. It is amazing that the *glottis*, (the upper part of the wind-pipe) can ſo exquiſitely contract or dilate itſelf, to form all notes. "Suppoſe

(ſays Dr. *Keil*) the greateſt diſtance of the two ſides of the *glottis* to be one tenth of an inch, in ſounding twelve notes (to which the voice eaſily reaches) this line muſt be divided into twelve parts, each of which gives the aperture requiſite for ſuch a note. But if we conſider the ſubdiviſion of notes into which the voice can run, the motion of the ſides of the glottis is ſtill vaſtly nicer: for if of two chords, ſounding exactly uniſons, one be ſhortened but the two thouſandth part of its length, a juſt ear will perceive the diſagreement and a good voice will ſound the difference: and yet this is only the one hundredth and ninety-ſixth part of a note. But ſuppoſe the voice can divide only into an hundred parts, it follows, that the different apertures of the Glottis, actually divide the tenth part of an inch, into twelve hundred parts, the effect of each of which produces a ſenſible alteration upon a good ear.

33. The *Uvula* is a round, oblong, fleſhy ſubſtance, ſuſpended near the paſſage from the mouth into the noſtrils, and probably deſigned to hinder the cold air, from ruſhing too faſt into the lungs, as well as to prevent the food we ſwallow from regurgitating into the noſtrils.

The *Tonſils*, or almonds of the ear, are two ſmall glands, placed at the root of the tongue, which ſupply an humour, to keep the mouth and the tongue continually moiſt.

The *Wind-pipe* is wonderful in its conformation: becauſe continual reſpiration is neceſſary, it is made with *annular cartilages*, to keep it conſtantly open, that its ſides may not fall together; and leſt, when we ſwallow, any particle of

of food ſhould fall in, which might cauſe convulſions, or even death, it has a ſtrong ſhutter, or lid, called the *Epiglottis*, which, whenever we eat or drink, falls down of itſelf, and covers it cloſe, ſo that no crum or drop can enter. It is for the more convenient bending of our necks, that the wind-pipe is not made of one entire continued cartilage, but of many circular ones.

What is farther remarkable in theſe cartilages is, that all the way where they are contiguous to the gullet, they are membranous, to give an eaſy paſſage to the food: but after that, they are, ſome completely round, ſome triangular. Another obſervable is, in the wind-pipe, the cartilages run parallel to each other: but, in the lungs, the lower parts of the ſuperior cartilages, receive the upper parts of the inferior: hereby enabling them to contract themſelves in expiration, and to dilate in inſpiration.

34. The *Hairs* are all hollow. The root of each hair is fixt in a mucous globule, of an oval figure, which often adheres to it, when it is pulled up by the root. They are jointed like a reed or cane, and ſhoot out into ſmall branches. They ſerve not only for a covering, but alſo for the excretion and expiration of an oily matter.

Every hair does properly live, and receive nouriſhment like the other parts. The roots do not turn white or grey in age, any ſooner than the extremes. But the whole of each hair changes colour at once. Or (to ſpeak more properly) the hairs of another colour fall off, and white ones grow in their place.

But extreme Fear may turn the hair *grey*, or even *white* in a ſhort ſpace. So it was in that famous inſtance ſome years ago. A nobleman in *Germany* was condemned to die, and ordered for execution in the morning. During the night, in ten or twelve hours time, all his hair turned white as flax. The emperor being informed of this, ſaid, "He has ſuffered enough:" and pardoned him.

Since that time there has been an inſtance of one of our own countrymen, who being ſhip-wrecked, ſaved himſelf on a ſmall rock, ſurrounded by the ſea. A boat took him off after he had ſtaid there four hours. But in that ſpace his hair was turned quite white.

Perhaps a ſtill ſtranger inſtance of this kind is related in the duke of *Sully*'s memoirs, "*Henry* IV. told the marquis *de la Force* That the moment he was informed, *Henry* the III. had publiſhed an edict, (in July, 1585) ordering all the Hugonots either to go to maſs, or to abandon the kingdom in ſix months, his muſtaches turned ſuddenly white on that ſide of his face, which he ſupported with his hand."

Its life is of a peculiar kind, and approaches to the nature of vegetation. Hairs grow much as plants grow out of the earth, or as ſome plants grow upon others: from which they draw their nouriſhment, and yet each has its life diſtinct from the other. So Hair derives its food from ſome juices in the body, but not from the nutritious juices. Accordingly the Hair may live and grow, while the body is ſtarved to death.

That Hair may grow, merely as an excreſcence of the vegetable kind, appears from that memorable caſe recited by Mr. *Hook*, of a body which, having been buried forty-three years, was

was found in a manner wholly converted into Hair. The woman was buried in a coffin of wood, and lay the loweſt of three in the ſame grave. The others being removed and this coffin appearing, it was obſerved, that much hair came thro' the clefts of it: on removing the lid, the whole appeared a very ſurprizing ſight. There was the whole figure of the corpſe, exhibiting the eyes, mouth, ears, and every part. But from the very crown of the head, even to the ſole of the foot, it was covered over with a very thick ſet hair, long and much curled. The people, amazed at this appearance, went to touch the corpſe. But the ſhape fell away, as it was handled, leaving only a quantity of ſhapeleſs hair, but neither fleſh nor bones, only a ſmall part of the great toe of the right foot.

Each hair conſiſts of ſeveral ſmaller ones, wrapt up in one common covering. They ſend out branches at the joints. The root lies pretty deep in the ſkin: and by this they imbibe their proper nouriſhment, from the adjacent humours. Their extremes alſo ſplit into two or three branches, eſpecially if they are very dry, or too long. So that what appears a ſingle hair to the naked eye, to the microſcope appears a bruſh. They are grey on the fore part of the head firſt, particularly about the temples: the back-part affords them nouriſhment longer. From the ſame reaſon they fall from the crown of the head firſt. Their thickneſs depends on the ſize of the pores they iſſue from: if theſe are ſmall, the hair is fine. If the pores be ſtrait, the hairs are ſtrait; if oblique or ſinuous, the hairs are curled.

All hairs appear round. But the microſcope diſcovers ſome of them to be ſquare, others tri-

angular; which diverſity of figures ariſes merely from the diverſity of the pores. Their length depends on the quantity of humours proper to feed them, and their colour on the quality. And hence the colour uſually differs in the different ſtages of life.

The hair of a mouſe is a tranſparent tube, with a pith of ſmall fibres convolved, running in ſome hairs ſpirally, in ſome tranſverſely, in others from top to bottom.

The nails are of the nature and fabric of the cuticle, like which they are alſo inſenſible, and renewable, after being cut or fallen off. They are placed upon the backs of the ends of the fingers and toes, which they ſupport to make a due reſiſtance in the apprehenſion of objects, having the nervous papillary bodies, that ſerve the organ of touch, placed under their lower ſurface. They ariſe with a ſquare root, intermixed with the perioſteum, a little before the laſt joints, from betwixt the outer and inner ſtratum of the ſkin, and paſſing on ſoft, go out by a lunar cleft in the external plate of the ſkin, where the cuticle returns back, and enters into a cloſe adheſion with the root of the nail, together with which it is extended as an outer covering.

35. We proceed to the middle cavity of the body. Herein the principal part is the *Heart*, conſiſting of a ſtrong tendon, extended obliquely from the *baſis* or broader part, to the *cone*, into which the fleſhy fibres are inſerted, in an elegant ſeries, with a ſpiral bending, one half oppoſite to, and croſſing the other: by which means

means the grand muſcle is admirably fitted, both to receive and to propel the blood. It has two great cavities, uſually termed the *ventricles of the heart*. They are divided from each other by an intermediate part, called the *ſeptum*, conſtituted by the ſame fibres, which is convex on the ſide next the right ventricle, and concave on the other. The *vena cava* is inſerted in the right ventricle, and two inches from its inſertion, divides into the *upper* and *lower*. The former brings the blood into it from the upper, the latter, from the lower parts of the body. The *pulmonary artery* carries the blood from that ventricle into the lungs, which the *pulmonary vein* brings from thence into the left ventricle. At the upper ſide of theſe veins, there is added to each ventricle, a kind of purſe called the *auricle*, which is an hollow muſcle of the ſame ſtructure with the heart, in order to ſtay the blood, that it pour not too violently into the ventricle. Before the orifices of the veins of the heart, there are *triangular* valves, and *ſemilunar* in the orifices of the arteries, to hinder the reflux of the blood, from the ventricles into the veins, and from the arteries into the ventricles. In an healthy perſon, the heart contracts little leſs than five thouſand times in an hour.

36. The heart is covered with a fine membrane; and near the baſe of it on the outſide, there is a little fat, probably deſigned to facilitate its motion. It is placed near the middle of the breaſt; only its cone inclines a little to the left. It hangs by its baſe on veins and arteries, communicating with all parts of the body. The other part of it is looſe in the *pericardium*, that

it may be the more commodiouſly conſtringed and dilated. The pericardium is a kind of membrane, that l ke a kind of purſe, looſely incloſes the heart. The ſhape of it is ſuited to that of the heart, and it contains a thin, ſaltiſh, reddiſh humour, exuding from the arteries.

The brain has an alternate contraction and dilatation, anſwering thoſe of the heart. It is highly probable, the weight of the atmoſphere, is the counterpoiſe to the contractile force of the heart. That of the brain, being not near ſo ſtrong, does not need ſo ſtrong a counterpoiſe.

In the baſis of the heart of ſome animals, there is a bone frequently found. Such an one was found in the heart of Pope *Urban*. Probably it was only the tendons of the heart oſſified.

Wounds of the heart are not always ſo immediately mortal as is generally ſuppoſed. A ſoldier was brought into one of the hoſpitals in *Paris*, with a wound in the upper part of the left breaſt. He ſeemed very well for three days: but on the fourth was taken with a fever, and difficulty of breathing, and died on the tenth. On opening the body, it was found the ſword had pierced the pericardium, traverſed the right ventricle of the heart in its lower part, pierced the pericardium on the oppoſite ſide, and gone thro' the diaphragm and an inch deep into the liver.

37. The heart is placed in the middle of the *lungs*, which conſiſt of two parts, the *right* and *left lobe*. Each of theſe is divided into two other lobes; One of theſe frequently into three, ſometimes into four, by fiſſures, ſometimes deeper,

deeper, ſometimes ſhallower, running from the interior margin towards the back part. The lungs are divided into cells, which are no other than expanſions of the ſmall branches of the *trachea* or *wind-pipe*. And there is an eaſy paſſage from one branch into many cells, and again into it from them all. The upper part of the *trachea* opens into the mouth; the lower, divided into two branches, ſhoots out into various ramifications, which are termed *bronchia*. And theſe little canals running on, conſtitute the lungs, whoſe cells are wonderfully connected together, and intermixed with numberleſs branches of veins and arteries.

The upper end of the trachea is called the *larynx*. At the fourth vertebra of the back it divides and enters the lungs. Its cartilages ranged at ſmall and equal diſtances, are ſmaller and ſmaller as they approach the lungs.

Theſe cartilages have two membranes. The external, compoſed of circular fibres, covers the whole *Trachea*. That which lines it within, conſiſts of three diſtinct membranes, the firſt woven of two orders of fibres, part longitudinal, to ſhorten it, by drawing the cartilages together; part circular, to contract them. Both theſe, together with the external membrane, aſſiſt in breathing, coughing, and varying the tone of voice. The ſecond membrane is glandulous; and its glands opening into the cavity of the Trachea, ſeparate a liquor which moiſtens and defends it from the acrimony of the air. The third is a net-work of nerves, veins, and arteries.

The organs which form the voice of man, have not been accurately obſerved by the anti-

ents. As the *trachea* bears ſome reſemblance to a flute, they conſidered the voice, according to the ſounds of that inſtrument. Mr. *Dodart* was the firſt who ſhewed the *glottis* to be the chief organ in producing it, and conſidered it both as a ſtring and wind inſtrument, far more perfect than any which art can produce.

The organs which form the various voices of other animals, are likewiſe worthy of our attention. Thoſe of each ſpecies have peculiar ſounds, whereby they underſtand each other.—Wherein do theſe organs reſemble ours, and wherein do they differ?

The human voice is almoſt wholly formed by the *glottis*, and various tones are produced by the various modifications of it. But all theſe depend on one only, the ſeparation and junction of its lips. This comprehends two circumſtances, the one capital and primitive, the other, a conſequence of it. The firſt is, That the lips are more and more bent, from the loweſt to the higheſt note. The ſecond, that the more they bend, the nearer they draw to each other. It follows from the firſt, that their vibrations will be more frequent, as they come nearer the higheſt tone, and that the voice will be exact when they are equally bent, and the reverſe when unequally: which correſponds perfectly well with the nature of ſtring-inſtruments. It follows from the ſecond, that the higher the tone, the nearer they draw to each other. And this agrees perfectly with thoſe wind-inſtruments which are governed by reeds. From theſe ſimple and almoſt imperceptible variations proceeds the infinite variety of ſounds.

In moſt quadrupeds too the glottis is the prin-

principal organ of the voice. So it is in cats, ſheep, and ſeveral others. But many have ſomething more than a glottis. As horſes, aſſes, mules, and ſwine. Some of theſe have alſo a tendinous membrane, which concurs in forming the voice. Others have ſeveral membranes: others a kind of bags, which in ſome are membranous, and in others bony. Others have both membranes and bags. Others laſtly have in their larynx a kind of cavity or drum, which aſſiſts them in uttering very ſtrong and long continued notes.

All ſounds are produced by a ſwift ſucceſſion of vibrations from the particles of ſonorous bodies, which agitate the air. But the vibrations of the lips of the glottis would not ſuffice to produce the neighing of a horſe. This begins by more or leſs acute interrupted tones, accompanied by quaverings, and ends by tones more or leſs grave, which is performed by jirks. This ſecond part is done by the lips of the glottis: the other chiefly by a ſmall, elaſtic membrane. This is tendinous, very thin, of a triangular figure, and lies flat on each extremity of the lips of the glottis. As it adheres but looſely to theſe, it can eaſily flutter up and down: and it is the play of the membrane up and down, which produces the acute ſounds of neighing. Theſe are more or leſs acute, as the membrane is more or leſs thin, and its adheſion more or leſs ſlack. The grave ſounds that conclude the neighing, are excited by the flutterings of the thick ſtrings which form the lips of the glottis.

The hoarſe ſound of the aſſes voice is not ſo much produced by the lips of the glottis, as by a tendinous part which adheres looſely on the aper-

aperture of a kind of drum, ſituate under the extremity of the lips of the glottis: above which are alſo found two large and thick bags, one on the right, the other on the left. Each of theſe has a roundiſh aperture, cut much like the ſtopple of an organ.

Such are the organs which form this amazing ſound. A kind of drum is the principal: and the two bags above the lips of the glottis, are the main auxiliaries: while thoſe lips, as plain experiments ſhew, contribute very little thereto. The mule's voice much reſembles that of his ſire, and is formed by much the ſame organs: the drum of ſo ſingular a compoſition, being found in mules alſo.

There is another animal which affords us a particular diſpoſition of the vocal organs. This is the hog: whoſe ſhrill cries are more inſupportable than his uſual grunting. Yet neither are theſe excited by the lips of the glottis, but by the fluttering of two large membranous bags: ſituated on each ſide, above the lips of the glottis. What is moſt remarkable is, that each lip is cloven, almoſt its whole length. By this cleft each lip has a communication with the bag belonging to it. And the motions of theſe bags produce moſt of the ſounds peculiar to this animal.

Tho' the voice of birds bears a nearer reſemblance to ours than that of quadrupeds, yet their organs have far leſs reſemblance to ours, and contain a greater number of ſingularities. They, like us, have a glottis at the top of the trachea: but they have another at the bottom of it, which much contributes both to the ſtrengthening and modifying of their voice. Theſe have different membranes more or leſs fine,

more

more or leſs bent, and in a variety of poſitions. In ſome birds, as in geeſe, there are four of theſe, figured and diſpoſed like the reeds in hautboys.

With regard to the *human voice*, an ingenious man obſerves, " Sitting in company I chanced to take notice, that in ordinary diſcourſe, all that is ſpoke, is ſpoken in *perfect notes*; and that ſome of the company uſed eighths, ſome fifths, and others thirds. I obſerved likewiſe of him whoſe ſpeech was the moſt pleaſing, that all the tones he uſed, conſiſted either of concords, or of ſuch diſcords as made up harmony.

Cutting the *trachea* was long reputed mortal, but it is now uſual to open it in dangerous quinſies. This phyſicians were at firſt encouraged to do, from the caſe of a *Corniſh* gentleman, who had his wind-pipe quite cut through, and yet was cured and lived ſeveral years after.

38. In order to the admiſſion and expulſion of the air by the *Lungs*, it is neceſſary the breaſt ſhould be contracted and dilated. This end is ſerved by the bony part of the *Thorax*, the *intercoſtal muſcles*, and the *Diaphragm*, a broad, muſcular part, reaching croſs the breaſt, and dividing the middle from the lower cavity. It runs obliquely from the *ſternum* and ribs before, to the *vertebræ* of the loins behind.

39. The whole thorax is covered on the inſide with a firm, white membrane, called the *Pleura*. It is double throughout, conſiſting of two folds, the innermoſt whereof has a ſmooth ſurface, that it may not hurt the tender ſubſtance of the lungs, the ſurface of the outer is rough

rough and uneven. From the pleura riſes the *Mediaſtinum*, which is a doubled membrane, that divides the lungs and the cavity of the thorax lengthways into two parts.

40. On the ſlighteſt obſervation we cannot but acknowledge, the conſummate wiſdom wherewith the *external parts* of the middle cavity are formed, for beauty, as well as for the defence of the internal. This is commodiouſly connected with the head by the *Neck*. The *Breaſt*, or fore-part of the thorax, which begins at the throat, and ends at the *Sternum*, or breaſt-bone, is an admirable guard to the nobleſt parts. To the ſame end ſerve the *ſhoulder blades* and the *back-bone*, as well as to ſupport the whole fabric.

The *Breaſts* conſiſt of numberleſs oval glands, intermixed with globular veſſels of fat. Their ducts as they approach the nipple unite together, till they form eight or more ſmall pipes, communicating with each other by croſs canals, which are of great uſe, when ſome of them happen to be obſtructed. Theſe tubes are in ſome parts narrower, in ſome wider, ſo as to form cells, which hinder the efflux of the milk. The *Paps* conſiſt chiefly of the concurrence of theſe tubes, but with a glandulous ſubſtance intermixt. There are likewiſe joined herewith abundance of fibres, from the external teguments of the breaſts, by means of which the tubes are conſtringed, and the motion of the milk is modified.

In virgins the glands of the breaſts are ſo contracted, that no blood can enter them. But when the womb ſwells with the fœtus, and com-

compreſſes the deſcending trunk of the great artery, the blood forces its way into them. They admit thicker and thicker Serum, till after the birth, they run with a thick milk.

It is more difficult to account for the milk which ſome men have in conſiderable plenty. Thus in the year 1684, a countryman called *Billardino di Billo*, living in a village near *Nocæra* in *Umbria*, when his wife was dead, took the child, and putting the nipples of his breaſts into its mouth, invited it to ſuck; which the infant did, and after ſeveral times drawing, fetched ſome milk. After a while it brought down the milk ſo plentifully as to nouriſh it for many months till it was weaned.

Almoſt as ſtrange is the following account. "One informing me of an *old woman that gave ſuck*, I went to the houſe in *Tottenham-court-road*. Her name is *Elizabeth Bryan*. She is in the 68th year of her age, and has not borne a child for many years: her face is withered, her cheeks and mouth ſunk in; but her breaſts are full, fair, and void of wrinkles. About four years ago, her daughter was obliged to leave an infant ſhe gave ſuck to, in the care of her mother. The old woman finding the child froward for want of the breaſt, applied it to her own. Having done this ſeveral times, her ſon thought the child ſeemed to ſwallow. and begged his mother, he might try, if ſhe had not milk? It ſoon appeared ſhe had; and ſhe then continued to ſuckle the child in earneſt. Two years after, her daughter had another child; on which the grand-mother weaned the firſt, and ſuckled the ſecond. Both the children

dren are healthy, plump, and firm in fleſh, and as briſk and lively as can be deſired.

41. In the lower cavity firſt occurs the *Stomach* with the *Oeſophagus* or *Gullet*, which reaches to it from the mouth. The right orifice, called the *pylorus*, tranſmits the digeſted food to the inteſtines. It is narrower than the other, as being deſigned to tranſmit nothing, 'till it is reduced to a kind of liquid. And it goes by a long and oblique deſcent into the duodenum, that the chyle may not paſs out, either too ſwiftly or too ſlowly.

The upper opening of the ſtomach, is compreſſed in ſuch a manner, by the lower muſcle of the diaphragm, in every inſpiration, as to confine the food within the ſtomach, and direct it in every reſpiration, towards the *pylorus*. By this means this orifice of the ſtomach, is ſo cloſely ſhut, as to confine even wind or vapours within the capacity of an healthy ſtomach, from whence they never eſcape but by a morbid affection.

The fabric of the ſtomach anſwers to that of the œſophagus, of which it is an expanſion. (1) The outmoſt coat is from the peritoneum, of conſiderable ſtrength, ſo as to limit the extenſion of the reſt, and afford a ſupport to the ſubjacent muſcular fibres. (2) The cellular coat lies immediately under the former, whence the outer and muſcular tunic cloſely cohere together; in this ſubſtance the larger branches of the veſſels are diſtributed. Next in order appears (3) the muſcular coat. Here, the longitudinal fibres of the œſophágus, coming to the ſtomach are detached one from another in all directions.

Im-

Immediately under the muſcular fibres, follows (4), another cellular ſtratum, larger than the outermoſt, ſofter, more eaſily inflatible, and conſiſting of larger veſicles than what we uſually obſerve, even in the inteſtines. Within this cellular ſubſtance are ſpread the ſmall veſſels, which, coming from the larger branches of the ſtomach, enter through its muſcular coat, and ſpread internally after the manner of a plexus. Under this lies, (5) the nervous coat, which is thick, white, and firm, and makes up the true ſubſtance of the ſtomach itſelf, and this is again lined internally with a third cellular ſtratum, whoſe vaſcular net-work is much more minute than that of the former, from whence it is derived. Immediately within this, lies (6) the villous or velvet-like coat, that lines the cavity of the ſtomach itſelf, continuous with the external cuticle, like which it is renewable, but of a ſoft mucous texture, and extended into a very ſhort pile, like that of the tongue, only leſs conſpicuous, and folded into large plates.

42. The *Inteſtines* are a continuation of the alimentary tube from the pylorus, wound together in various wreaths, yet without confuſion, and to keep them in their ſituation, faſtened together by the *Meſentery*, a ſtrong membrane, which faſtens them alſo to the back. The inteſtinal duct is really but one; but becauſe the parts of it differ in figure and uſe, the upper part of it, divided into the *duodenum*, *iejunum* and *ileon*, is termed the *ſmall guts*; the lower part, divided into the *cæcum*, *colon* and *rectum*, is called the *great guts*. All theſe are full of turnings and windings, eſpecially the ſmall, that the

the more ſubtle part of the chyle, both thro' the length and narrowneſs of the paſſage, and the agitation of the inteſtines, may enter the *lacteal veins*, and paſs from thence into the *receptacle of the chyle*.

When the inteſtines are ſeparated from the meſentery, they are uſually ſix times as long as the man. They have all a kind of vermicular motion, called the *periſtaltic motion* from the ſtomach downwards; and are lubricated with much fat, eſpecially the great ones, whoſe ſurface being more uneven, and their contents leſs fluid, they need ſomewhat more to make them ſlide eaſily.

Likewiſe from the exhaling arteries diſtils a thin watry liquor into the cavity of the inteſtines not at all acid, but like the juice of the ſtomach; the quantity of which liquor may be computed from the large extent of all the excretory orifices, and from the ſection of the ſecretory artery, a larger than which, we ſee no where in the body.

The Duodenum, (ſo called becauſe it is uſually ten or twelve inches long) receives the gall and pancreatic juice, which are here mixt with the chyle. The iejunum is ſo termed, becauſe it is generally more empty than the reſt. This may be occaſioned partly by its capacity, which gives a free paſſage to its contents; partly to its irritation thro' the bile, which falls in a little above it. It takes up almoſt the whole umbilical region, and is uſually twelve or thirteen hands long. The Ileon, ſituate below the navel, fills the Ilia with its numerous convolutions. It is much the longeſt of all the inteſtines, generally one and twenty hands long.

In

In both this and the iejunum the inner coat is much wrinkled, and lies in looſe folds. They are formed (as the folds in the ſtomach) only by the inner coat being larger than the outer.

The firſt of the great guts, called the *Cæcum*, is laterally inſerted at the upper end of the *colon*. It is not perforated at the other end, but hangs to it, like the finger of a glove, and is three or four inches long. In new-born children and in beaſts it is found full of excrements; but in adults it frequently hangs like a worm. In a fætus it is doubtleſs a receptacle of the fœces, during the time it does not diſcharge by ſtool. And may it not occaſionally ſerve the ſame end in adults? Perhaps in thoſe animals wherein it is very large, it may likewiſe ſerve as a kind of ſecond ſtomach. But it is not abſolutely neceſſary. The cœcum of a dog has been cut out, without any perceivable prejudice.

The Colon is the largeſt of the great guts. It runs in various circumvolutions from the cœcum to the rectum. It has many cavities, formed by two ligaments, running on each ſide of it, oppoſite to each other the whole length, and as it were guiding it at certain diſtances. The rectum, which reaches from the *os ſacrum* to the *anus*, is uſually about an hand and an half long.

43. The *Lacteal Veins*, which are of a whitiſh colour, are in all the inteſtines, ſmall and great, and receive the chyle by imperceptible paſſages, throughout the whole canal. And for this end the food remains ſo long in the inteſtines, and is carried through various windings

ings, that whatſoever of nouriſhment it contains, may be expreſt before it leaves the body.

44. The inteſtines are covered with the *omentum* or *cawl*, which is contained within the *peritoneum*, a very thin, ſoft, double membrane, and wholly conſiſts of little bags of fat. Its uſe is, to keep the inteſtines warm; to promote their periſtaltic motion by lubricating them with its oily ſubſtance: by following them in their doublings and windings, to ſerve them as a bolſter to ſlide upon, and by filling up their hollows, to prevent their being too much diſtended by flatulencies; yet giving way to them when filled with aliments.

Under the ſtomach behind lies the *Pancreas*, (exrended towards the ſpleen) which tranſmits to the inteſtines a liquor of the nature of ſpittle, helping to diſſolve the food.

45. Under the diaphragm, on the right ſide, lies the *Liver*, whence it extends over the right part of the ſtomach, below the ſternum, toward the left, growing gradually ſmaller, that it may not hinder the diſtention of the ſtomach. It conſiſts partly of gall-ducts, partly of fine ramifications of the vena portæ. The blood contained in theſe, depoſits oily particles in the ducts, and then returns, chiefly thro' the vena cava, to the heart. It is thus the *bile* is ſecreted, for which purpoſe the *gall-bladder* alſo is deſigned. This both receives and retains the bile, by which delay the power of it is greatly heightened. Part of the bile is conveyed to the inteſtines by the *hepatic duct*, which pours it into the *ductus choledochus*. Part goes

firſt

firſt into the gall-bladder, thence into the ductus choledocus, and then into the duodenum.

The principal uſe of the bile is, to abſterge and ſtimulate the inteſtines, to aſſimilate crude things to things concocted, to bruiſe and blunt ſharp and ſaline particles, to divide thoſe that are coagulated: to excite appetite, to open the paſſages for the chyle, and where need is, act the part of a ferment.

46. The *Spleen* is an elegant net-work of numberleſs veſſels, incloſed in a double membrane. It is placed on the left ſide, between the ſhort ribs and the ſtomach. Some ſuppoſe it to ſecrete a peculiar juice, which paſſes with the blood through the vena portæ. Others imagine it to be a kind of reſervoir, wherein on extraordinary occaſions, that blood may be received, which would otherwiſe oppreſs the viſcera and diſturb the animal functions.

47. On the muſcles of the loins on each ſide lie the *Kidneys*, to ſeparate from the blood that part of the ſerum which is ſuperfluous, and would be hurtful were it retained in the habit. This is carried by the *ureters* into the bladder, which is placed in the loweſt part of the belly. What remains of the blood is conveyed to the heart by the veins and lymphatic veſſels.

The *Bladder* is compoſed of three coats: the firſt is an extenſion of the *peritoneum*; the ſecond conſiſts of muſcular fibres; the third is both glandulous and nervous, and full of wrinkles, that it may be capable of contraction and dilatation. Its glands ſeparate a ſlimy matter, which defends the bladder from the acri-

acrimony of the urine. The involuntary emiſſion of this is prevented, by a ſmall muſcle which goes round the neck of the blader.

48. We proceed to the *Limbs*. The *Hand* (phyſically ſpeaking) is divided, into the *Arm*, the *Cubit*, and the hand, properly ſo called. In this there are twelve bones, beſide fifteen in the fingers, all oblong, ſlender, hollow, and ſo fitly joined together by ligaments, ſo wonderfully provided with various muſcles, adapted to ſo many different motions, that the *Hand* alone gives us an abundant argument of the admirable Wiſdom of GOD.

Is there any poſſibility, that the want of ſo neceſſary an inſtrument as the arm ſhould be ſupplied? One would think it impoſſible. But it is not: ſuch is the amazing power of God! *James Walker* was born in 1718, in *Ireland*, in the pariſh of *Hilſborough*. His mother could not be delivered, till the ſurgeon totally ſeparated the arms of the child from the body. Nevertheleſs he lived, and in the room of his arms, had little protuberances that appeared as ſtumps. He grew to be ſix feet high, ſlender, and active. "He ſits a ſaddle, ſays an eye-witneſs, upright and firm, will ride 40 miles a day to a fair, and deals in buying and ſelling horſes, which he dreſſes and curries as well as any groom can do, holding the curry-comb between his chin and ſhoulders. The ſame way he holds the goad in driving the plow, and the ſpade when he digs. He throws a ſtone from the top of his foot with greater force than moſt men can with their hand, and ſeldom fails to hit his mark. He mounts a horſe without any aſſiſt-

assistance, and shuffling the bridle over his head, till he gets it on his shoulders, guiding his horse with as little fear, and as much skill as any man."

49. The *Thigh* consists of one bone, the largest and longest in the whole body. It is a little crooked, bending forward before, that there may be more room for the muscles. The bones of the *Leg* are two, distant from each other in the middle, but joined together at each end. They are nearly of the same length, but the inner is much thicker than the outer. The bones of the *Foot* are twelve, beside fourteen in the *Toes*; which like those in the hands, are most aptly connected by ligaments, and fitted with muscles of various kinds, serving for equally various motions.

50. Thus far we have spoken concerning the *Solid Parts* of the body. Among the fluid are usually reckoned *the Animal Spirits*, supposed to be secreted in the brain, to flow thro' the nerves, and to be the instruments of sense and motion.

"But are the nerves in general hollow canals, which contain a circulating fluid? Or are they solid threads, which being highly elastic, vibrate variously to occasion various sensations"? The latter supposition is wholly overthrown, by the phenomena of wounded nerves. A nerve cut asunder does not retract its divided extremities, but becomes rather longer, extruding its medulla into a round tubercle. Again, were it elastic, it should be composed of hard fibres, having their extremi-

ties fixt to ſome firm bodies: ſince ſtrings, otherwiſe conſtituted and diſpoſed, have no elaſticity. But it is evident, all nerves are ſoft at their origin, as well as void of tenſion: and ſome ſoft in every part, as the olfactory nerve, and the ſoft portion of the auditory nerve. Yea, they all grow ſoft in the viſcera, the muſcles, and the ſenſories, before they exert their functions. Beſides, ſome nerves are ſo ſituate, that they cannot vibrate, as thoſe of the heart, which are faſtened to the great veſſels and the pericardium. Further, the influence of an irritated nerve is never propagated upwards; whereas an elaſtic chord communicates its tremors to both ends from the point of percuſſion. Hence it is plain, the nerves do not act by their ſpring, but by the motion of their proper fluid. The extreme ſmallneſs of theſe canals, which no microſcope can reach, is no valid objection to this: neither our inability to diſcern that fluid. This only proves the imperfection of our ſenſes.

"But what is this fluid?" Who can tell? We may very probably conjecture, it conſiſts of ſome ſubtle fire or ether, diffuſed thro' the whole ſyſtem of nature, and acting by laws unknown to us.

58. Of the other fluids, ſome ſerve to prepare the chyle; ſome to thin the blood and preſerve it from putrefaction. Others only remain till they can be thrown out of the body, as being uſeleſs and ſuperfluous. All of theſe, but the chyle, ariſe from the blood, being ſecreted from it by proper glands. But as to the manner of ſecretion, after all the moſt accurate and

and laborious enquiries, it ſtill remains abſolutely uncertain, and every one abounds in his own ſenſe. Some believe it depends on the *ſuitableneſs* of the fluid ſecerned, to the ſhape of the ſecerning pores. Some lay the ſtreſs rather on the various *ſize* and *diameters* of thoſe pores: others on this, That the conſtituent particles, ſuppoſe of the bile, from their peculiar proportion, texture and figure, may be more eaſily united to each other, than to the particles of lymph, or any other fluid.

52. The chief of all the fluids in our body, and the fountain of life is the *Blood*. It conſiſts of a watry *ſerum*, *fibrous particles*, and *red globules*, which laſt are ſcarce a twelfth part of it. It is generated thus. The meat and drink being digeſted into chyle, paſs from the inteſtines, through the lacteal veins and the thoracic duct, into the left ſubclavian vein, and thence into the *vena cava*, where it mixes with the blood, and then circulates with it, till it is wholly aſſimulated.

Blood freſh drawn appears to the naked eye uniform and homogenous. But when cold, it ſeparates into two parts, the one red and fibrous, which clots together; the other thin and tranſparent, called the *ſerum*, in which the former ſwims. The ſerum is in bulk three fourths of the blood, in weight fifteen ſeventeenths.

A red globule is computed to be 25000 times ſmaller than the ſmalleſt grain of ſand.

But whence ariſes the *Heat of the Blood*? This deſerves a particular enquiry.

Fermentation is that ſpontaneous, inteſtine motion, which by the heat of ſubterraneous ca-

verns, will in a few hours ſo change vegetable juices (for fermentation is confined to the vegetable kingdom) as from a vapid wort quenching fire, to nouriſh fire, and to afford that inflammable liquor commonly called ſpirits.

Effervescence ariſes from an inteſtine motion excited in various fluids, by the mixture of other fluids, or of ſalts or powders of a different nature. Acids and alcalis, when mixt, cauſe a great ebullition, but no great heat: whereas the ſolution of ſome metals in aqua-fortis, cauſes intenſe heat, and emits flame. Aromatic oils mixt with acid mineral ſpirits, kindle and burn with violent exploſions.

In theſe caſes, as there is no adventitious fire, there muſt be fire lying hid in one or other of the bodies. And it is known, much air lies dormant in all bodies. It is known likewiſe, that fire cannot exert itſelf, without the help of air. It being granted then, that fire and air lie dormant in all bodies, there is only required ſuch an action as may ſet at liberty the particles of air and of fire. By this action the particles of air recover their elaſticity, and putting thoſe of fire in motion, cauſe heat, but not incenſion, unleſs this fire meet a proper pabulum, which pabulum is ſulphur only, though differently modified, whether in the appearance of brimſtone, oil, ſpirits, metalline ſulphur, or the moſt inflammable of all, animal ſulphur, commonly called *phoſphorus*.

In *fermentation* the fire and air being let looſe produce warmth, but ſeldom kindle, becauſe of the water predominating. But in the *effervescence* produced by the ſolution of metalline ſulphur, they kindle and ſometimes cauſe exploſions. Aromatic oils, containing little but the

the ſulphureous parts of the vegetables, immediately kindle and break out into flame. And phoſphorus is ſo highly inflammable, that if it be only expoſed to the air a few minutes, it kindles and flames.

Now all animals contain more or leſs phoſphorus. Some inſects conſtantly ſhine in the open air. Many ſorts of fiſh are luminous: ſome quadrupeds emit light, on a very ſlight friction. Theſe are proofs of phoſphorus lying dormant in animal fluids: and as they all contain air likewiſe, let only the phoſphoreal and aereal particles be brought into contact, and heat neceſſarily enſues.

This clearly explains the cauſe of animal heat: of which the heart and arteries are the occaſion, not by friction, but by the inteſtine motion which the circulation gives to the ſeveral particles that conſtitute the maſs of animal fluids. As the velocity of theſe fluids is increaſed, the particles of which they conſiſt, come oftner into contact, and the oftner the phoſphoreal and aereal meet, the more heat they produce.

But to what cauſe is the colour of the *blood* owing?—

Borelli took ſome of the red part, and waſhing it frequently in water, found it ſeparable into a viſcous ſlippery ſubſtance, conſiſting of colourleſs fibres, which roſe and gathered into a ſcum on the top of the water, and a deep red powder, which precipitated plentifully to the bottom. Hence it appears that the redneſs of the blood ſprings from red tinging particles, as in the caſe of Dying.

However, this red colour, though generally found in the blood of land-animals, is not

abſolutely neceſſary, there being ſome ſpecies, whoſe blood is white or limpid. Nay Dr. *Drake* let out of the Median vein of a man, a pure, white blood, like milk, which when cold, did not ſeparate into two parts, as the red uſually does. Nor yet did it yield any ſkim or cream, neither turn ſour as milk uſes to do. Dr. *Beal* gives an inſtance of the ſame kind; and Dr. *Lower* relates one as ſtrange. A perſon bled at the noſe, till at length the broth he drank flowed out very little altered.

It is amazing to ſee, how careful Providence has been, to prevent the blood's running into concretions, which might deſtroy life, by the very diſpoſitions of the veſſels it is to run thro'. Theſe are ſo contrived, as to cauſe the globules to come together with a briſk colliſion. The arteries which convey the blood from the heart to the extremities, continually leſſen, as they recede from their ſource; in conſequence of which, the globules of blood muſt ruſh with force againſt one another, as they are driven on impetuouſly. And the veins which bring it back from the extremities to the heart, inlarging all the way as they go on, while the ſtreams of ſeveral continually run into one, each of theſe ingreſſes cauſes new commotions, capable tho' not of diſſolving that natural connexion of the red and ſerous particles, yet of preventing any preternatural concretions or coagulations.

53. Theſe are the parts of which this wonderful machine is compoſed, which the chymiſts ſay, conſiſts of four ſorts of matter, earth, water, ſalt, and ſulphur, the particles of which be-

being variouſly mixt together, conſtitute larger particles of different kinds; out of which, more looſely or cloſely connected, all the parts of the body, ſolid or fluid are compoſed.

But this is far from being an accurate account. For what are ſalt and ſulphur but ſpecies of earth? May not we then much more properly ſay, with the antients, that the body is chiefly compoſed of earth and water, yet cannot enjoy even animal life, unleſs air and fire alſo be wrought into its frame? So that at whatſoever time, it is deprived either of air or fire, it is an uſeleſs, lifeleſs clod. And yet the manner how theſe are ſo intimately mixt, both with our fluid and ſolid parts, as much exceeds our comprehenſion, as the manner how the ſoul is united to its houſe of clay.

That much air is wrought into the whole animal frame, appears by the following experiments. The blood of a ſheep freſh drawn was in a wide-mouthed glaſs put into a receiver, and the air drawn out. After a while, the ſubtle parts of the blood forced their way through the clammy ones, and ſeemed to boil in large cluſters, ſome as big as nutmegs. And ſometimes the expanſion was ſo vehement, that it boiled over the glaſs.———Some milk being put into a veſſel four or five inches high, when the air was drawn out, it boiled ſo impetuouſly, as to throw up ſeveral parts out of the glaſs that contained it.

And to ſhew, that not only the blood, but the other parts of animals include air; the liver of an eel was put into a receiver, and even this apparently ſwelled every way, as ſoon as the air was withdrawn.

The air as a fixt element in the compoſition of ſolid and fluid bodies, has been generally overlooked by philoſophers, and even by the chymiſts, who have above all ſects, gloried in their knowledge of principles or elements; until Mr. Boyle, Sir Is. Newton, and more eſpecially Dr. Hales, by many experiments demonſtrated, that a great part of the ſubſtance of moſt bodies, in ſeveral to half their weight, is a permanent or unelaſtic air, which being freed [either (1) *ſlowly*, by the air-pump, putrefaction, fermentation, diſtillation, &c, or (2) *ſuddenly* by exploſions, fulminations, ebullitions, mixtures, &c.] from the other ſolid particles, aſſumes its elaſticity, and fills an immenſe ſpace, in compariſon of the body from whence it came. Dr. Hales found a cubic inch of blood in diſtillation, afforded above 30 times its bulk of elaſtic air; whoſe particles are in effect the wedges of nature which pin and cement together the other elements, and particles of bodies for their growth of accretion; and under other circumſtances, regaining their elaſticity, ſerve to break again thoſe parts for the diſſolution of the compound, whoſe matter may be, by the ſame inſtrument, again differently aſſembled and combined for the forming of other bodies.

54. It remains to add ſome reflections on the Wiſdom of God, diſplayed in the ſtructure of the human body. And how eminently is this diſplayed, firſt, in the *ſituation* of its ſeveral parts and members! They are ſituated moſt conveniently for uſe, for ornament, and for mutual aſſiſtance. 1. For uſe. The principal ſenſes are placed in the head, as centinels in a watch-

watch-tower. How could the eyes have been more commodiouſly fixt, for the guidance of the whole body? The ears likewiſe, made for the reception of ſounds, which naturally move upward, are rightly placed in the uppermoſt parts of the body: and ſo are the noſtrils, as all odours aſcend. Again: how could the hands have been more conveniently placed, for all ſorts of exerciſes? Or the heart, to diſpenſe life and heat to the whole body? Or the ſinks of the body, than in the moſt remote parts of it? 2. For ornament. Not to deſcend to particulars, what could be better contrived, than that thoſe members which are pairs ſhould be of equal length, and juſt anſwer one another on each ſide? 3. For mutual aſſiſtance. So the eye ſtands moſt conveniently to guide the hand, and the hand to defend the eye. The ſame may be ſaid of the other parts: they are all ſo placed, as to direct or help each other. This will clearly appear, if you ſuppoſe the poſition of any of them to be changed. Had our arms been bent backward, what direction could our eyes have afforded us in working? Or how could we even have fed ourſelves? Nay, had one arm bent backward, and the other forward, half the uſe of them had been loſt; for one could not have aſſiſted the other in any action.

How is his wiſdom diſplayed, Secondly, in the ample proviſion made for the ſecurity of the principal parts! Theſe are 1. The Heart, the fountain of life. This lies in the center of the trunk of the body, covered with its own membrane, the pericardium, lodged within the ſoft bed of the lungs, incompaſt round with a double fence; both of thick muſcles and ſkins,

and of firm ribs and bones; beſides the arms, conveniently placed to ward off any violence: 2. The Brain, the principle of all ſenſe and motion, is ſurrounded with ſo ſtrong a defence, that it muſt be a mighty force indeed, which is able to injure it. The ſkull is ſo hard, thick and tough, that 'tis almoſt as firm as an helmet of iron. This is covered with ſkin and hair, which both keep it warm, and ſoften the violence of a ſtroke. Yet more, a thick and tough membrane hangs looſe about it, which often ſaves it, even when the ſkull is broke. And laſtly, a fine membrane cloſely adheres, to keep it from quaſhing and ſhaking.

How is it diſplayed, Thirdly, in the abundant proviſion that is made againſt evil accidents and inconveniencies! To this end, 1. The members which are of eminent uſe are in pairs. We have two eyes, ears, noſtrils, hands; two feet, two breaſts, two kidneys; that if one ſhould be rendered uſeleſs, the other might ſerve us tolerably well: whereas had a man but one hand or eye, if that were gone, all were gone. 2. All the veſſels have many ramifications, which ſend forth twigs to the neighbouring veſſels: ſo that if one branch be cut or obſtructed, its want may be ſupplied by the twigs from the neighbouring veſſels. 3. Many ways are provided to evacuate, whatever might be hurtful to us. If any thing oppreſs the head, it can free itſelf by ſneezing; if the lungs, they can caſt it off by coughing. If any thing burden the ſtomach, it can contract itſelf, and throw it up by vomit. Beſide theſe evacuations, there are ſiege, urine, ſweat, and hæmorhages of various kinds. 4. Whereas Sleep is neceſſary

neceſſary for us in many reſpects, Nature has provided, that though we lie long on one ſide, we ſhould feel no uneaſineſs while we ſleep, no, nor when we awake. One would think, the whole weight of the body preſſing the muſcles on which we lie, would be very burdenſome. And we find by experience, ſo it is, when we lie long awake in the night. Probably this proviſion is made, by an inflation of the muſcles, making them ſoft, and yet renitent, like pillows. That they are inflated during ſleep, appears to the very eye, in the faces of children; and from the common experiment, that if we ſleep in our cloaths, we muſt looſen our garters and other ligatures. Otherwiſe we find uneaſineſs in thoſe parts. 5. Becauſe ſleep is inconſiſtent with the ſenſe of pain, therefore during reſt, thoſe nerves that convey the motions to the brain, which excite the ſenſe of pain are obſtructed. "This I myſelf, ſays Mr. *Ray*, have have often experienced, ſince I have had ſores on my legs. Waking ſuddenly, I find myſelf at perfect eaſe for a while. Then the pain by degrees returns."

It is diſplayed, Fourthly, in the *multitude* of *intentions* GOD hath in the formation of the ſeveral parts, and the multitude of *qualifications* they require to fit them for their ſeveral uſes. *Galen* obſerves, "that there are in an human body, above ſix hundred muſcles. And there are at leaſt ten ſeveral intentions in each, and as many qualifications needful: ſo that about the Muſcles alone, no leſs than 6000 ends are to be attended to. The bones are reckoned to be 284. The diſtinct intentions in each of theſe are above forty: in all about an hundred

thouſand. And thus it is, in proportion, with all the other parts, the ſkin, ligaments, veins, arteries, nerves, glands, humours: but more eſpecially with the members of the body, which as to the multitude of intentions and qualifications, far exceed the ſimilar parts. And ſhould one of theſe qualifications fail, great inconvenience would enſue."

It is diſplayed, Fifthly, in the *Stature* of man, ſo admirably well adapted to the circumſtances of his exiſtence. Had man been only a foot or two high, he had been quite diſproportioned to every thing round about him. Had he been much larger, he could not well have been ſupplied with food: all the edible animals would not have ſufficed. And had they too been proportionably larger, the ſurface of the earth would not have ſufficed to feed them.

It is however a common opinion, and has been ſo ever ſince old *Homer*'s time, that the people in the early ages of the world, were much larger than us. And it is true, we read of ſome men of a ſurprizing ſtature. But they were even then eſteemed giants. The ordinary ſtature of men, is probably juſt the ſame now, as it was at the beginning. This may be gathered from the monuments ſtill remaining, particularly the pyramids of *Egypt*. The cavities for bodies now viſible herein, are little larger than our ordinary coffins: likewiſe from ſeveral embalmed bodies taken out of them it appears, that men are of the ſame ſtature now, that they were when thoſe pyramids were built, which is at leaſt three thouſand years ago.—— Eighteen hundred years ago, the emperor *Auguſtus* was five foot ſeven inches high: Queen *Elizabeth*

Elizabeth was taller by two inches, being five foot nine.

But what a paradox is it, that all men are taller in the morning than in the evening? In a young man the difference is near an inch, try the experiment as often as you pleaſe. Does not the difference proceed from hence, that as long as the trunk of the body is in an erect poſture, there is a conſtant preſſure on the large cartilages connecting the vertebræ of the ſpine? So long they gradually contract, and conſequently a man grows ſhorter. But they again gradually expand themſelves, while we are in a reclining poſture.

As to the art of *Embalming*, it appears from a mummy, not long ſince dug up in France, that this was more completely underſtood in the weſtern world ſome ages ſince, than ever it was in Egypt. This mummy which was dug up at Auvergne, was an amazing inſtance of their ſkill. As ſome peaſants, were digging in a field near Rion, within about twenty-ſix paces of the highway, between that and the river Artier, they diſcovered a tomb, that was about a foot and a half beneath the ſurface. It was compoſed only of two ſtones; one of which formed the body of the ſepulchre, and the other the cover.

This tomb was of freeſtone; ſeven feet and an half long, three feet and an half broad, and about three feet high. It was of rude workmanſhip; the cover had been poliſhed, but was without figure or inſcription: within this tomb was placed a leaden-coffin, four feet ſeven inches long, fourteen inches broad, and fifteen

fifteen high. It was oblong, like a box, equally broad at both ends, and covered with a lid that fitted on like a ſnuff-box, without an hinge. Within this coffin was a mummy, in the moſt perfect preſervation. The internal ſides of the coffin were filled with an aromatic ſubſtance, mingled with clay. Round the mummy was wrapped a coarſe cloth; under this were two ſhirts, or ſhrouds, of the moſt exquiſite texture; beneath theſe a bandage, which covered all parts of the body, like an infant in ſwadling clothes; under this general bandage there was another, which went particularly round the extremities, the hands and legs, the head was covered with two caps; the feet and hands were without any particular bandages; and the whole body was covered with an aromatic ſubſtance, an inch thick. When theſe were removed, and the body expoſed naked to view, nothing could be more aſtoniſhing than the exact reſemblance it bore to a body that had been dead a day or two before. It appeared well proportioned, except the head was rather large, and the feet ſmall. The ſkin had all the pliancy, and colour of a body lately dead; the viſage, however was of a browniſh hue. The belly yielded to the touch; all the joints were flexible, except thoſe of the legs and feet; the fingers ſtretched forth of themſelves when bent inwards. The nails ſtill continued perfect; and all the marks of the joints, both in the fingers, the palms of the hands, and the ſoles of the feet, remained perfectly viſible. The bones of the arms and legs, were ſoft and pliant; thoſe of the ſcull preſerved their rigidity; the hair which only covered the back of the head

head, was of a chesnut colour, and about two inches long. The pericranium at top was separated from the skull, by an incision, in order to the introducing aromatics in the place of the brain, where they were found mixed with clay. The teeth, the tongue, and the ears, were all preserved in perfect form. The intestines were not taken out of the body, but remained pliant and entire, as in a fresh subject; and the breast was made to rise and fall like a pair of bellows. The embalming preparation had a very strong and pungent smell, which the body preserved for more than a month after it was exposed to the air. If one touch'd either the mummy, or any part of the preparation, the hands smelt of it for several hours after. This mummy, having remained exposed for some months, began to suffer some mutilations. A part of the skin of the forehead was cut off; all its teeth were drawn out, and some attempts were made to pull away the tongue. It was therefore put into a glass case, and transmitted to the king's cabinet, at *Paris*.

There are many reasons to believe this to be the body of a person of the highest distinction; however no marks remain to assure us either of the quality of the person, or the time of his decease. There only are to be seen some irregular figures on the coffin: one of which represents a kind of star.

There were also some singular characters upon the bandages, which were totally defaced by those who had tore them. It should seem that it had remained for several ages in this state, since the first years immediately succeeding the interment, are usually those in which the body is most liable to decay.

On

On this remarkable ſubject, I beg leave to add an extract from a late author.

" I always apprehended that human bodies after death, if interred, or expoſed to the air without any preparation to defend them from the attacks of it, would of neceſſity corrupt, become offenſive, and putrify. The art of embalming is very ancient, and was invented to preſerve them from this inevitable conſequence of death; but that they may remain unputrified for centuries without any ſort of artificial aid, I have ſeen ſo inconteſtably proved ſince my arrival at *Bremen*, that I imagine not the ſhadow of doubt can remain about it. Under the cathedral church is a vaulted apartment, ſupported on pillars; it is near ſixty paces long, and half as many broad. The light and air are conſtantly admitted into it by three windows, though it is ſeveral feet beneath the level of the ground. Here are five large oak coffers, rather than coffins, each containing a corpſe. I examined them ſeverally for near two hours. The moſt curious and perfect, is that of a woman. Tradition ſays, ſhe was an Engliſh counteſs, who dying here at Bremen, ordered her body to be placed in this vault uninterred, in the apprehenſion that her relations would cauſe it to be brought over to her native country. They ſay it has lain here 250 years. Though the muſcular ſkin is totally dried in every part, yet ſo little are the features of the face ſunk or changed, that nothing is more certain than that ſhe was young, and even beautiful. It is a ſmall countenance, round in its contour: the cartilage of the noſe and the noſtrils

trils have undergone no alteration: her teeth are all firm in the ſockets, but the lips are drawn away from over them. The cheeks are ſhrunk in, but yet leſs than I ever remember to have ſeen in embalmed bodies. The hair of her head is at this time more than eighteen inches long, very thick, and ſo faſt, that I heaved the corpſe out of the coffer by it: the colour is a light brown, and I cut off a ſmall lock, which is as freſh and gloſſy as that of a living perſon. That this lady was of high rank ſeems evident from the extreme fineneſs of the linen which covers her body. The landlord of the inn, who was with me, ſaid, he remembered it for forty years paſt; during which time there is not the leaſt perceptible alteration in it.——In another coffer is the body of a workman, who is ſaid to have tumbled off the church, and was killed by the fall. His features evince this moſt forcibly. Extreme agony is marked in them: his mouth is wide open, and his eyelids the ſame; the eyes are dried up. His breaſt is unnaturally diſtended, and his whole frame betrays a violent death.—A little child who died of the ſmall-pox is ſtill more remarkable. The marks of the puſtules, which have broken the ſkin on his hands and head, are very diſcernable; tho' one ſhould ſuppoſe that a body which died of ſuch a diſtemper, muſt contain in a high degree the ſeeds of putrefaction.—The two other corpſes are not leſs extraordinary. There are in this vault likewiſe turkeys, hawks, weaſels, and other animals, which have been hung up here ſome time immemorial, ſome very lately, and are in the moſt complete preſervation: the ſkin, bills,

bills, feathers, all unaltered. The magiſtrates do not permit that any freſh bodies be brought here. The cauſe of this phænomenon is doubtleſs the dryneſs of the place where they are laid. It is in vain to ſeek for any other."

A repoſitory of nearly the ſame kind, a late writer informs us is at a monaſtery, near *Palermo*, in *Sicily*. It is a long, ſubterranean gallery, having niches on every ſide, between ſix and ſeven feet high. In each of theſe is an human body ſtanding erect, in its uſual apparel. The face and the hands are uncovered, and preſerve their ſhape, and natural colour, only a little browner. They are faſtened to the wall by the back. Some of them are believed to have been there two or three hundred years.—Suppoſe they could remain there for ever, what would it profit their former inhabitants!

A late traveller gives a ſtill ſtranger account of them.

"This morning we went to ſee a celebrated convent of Capuchins, about a mile without the city of *Palermo*; it contains nothing very remarkable, but the burial-place, which indeed is a great curioſity. This is a vaſt ſubterraneous apartment, divided into large commodious galleries, the walls on each ſide of which are hollowed into a variety of niches, as if intended for a great collection of ſtatues: theſe niches, inſtead of ſtatues, are all filled with dead bodies, ſet upright upon their legs, and fixed by the back to the inſide of the nich. Their

Their number is about three hundred; they are all dreſſed in the clothes they uſually wore, and form a moſt reſpectable and venerable aſſembly. The ſkin and muſcles, by a certain preparation, become as dry and hard as a piece of ſtock-fiſh; and although many of them have been here upwards of two hundred and fifty years, yet none are reduced to ſkeletons; though the muſcles in ſome are more ſhrunk than in others; probably becauſe theſe perſons had been more extenuated at the time of their death.

Here the people of *Palermo* pay daily viſits to their deceaſed friends, and recall with pleaſure and regret the ſcenes of their paſt life: here they familiarize themſelves with their future ſtate and chooſe the company they would wiſh to keep in the other world. It is a common thing to make choice of their nich, and to try if their body fits it, that no alterations may be neceſſary after they are dead; and ſometimes by way of voluntary penance, they ſtand for hours in theſe niches.

The bodies of the princes and firſt nobility are lodged in handſome cheſts or trunks, ſome of them richly adorned: theſe are not in the ſhape of coffins, but all of one width, and about a foot and a half, or two feet deep. The keys are kept by the neareſt relations of the family, who ſometimes come and drop a tear over their departed friends.

Theſe viſits muſt prove admirable leſſons of humility; and they are not ſuch objects of horror as one would imagine: they are ſaid, even for ages after death, to retain a ſtrong likeneſs of what they were when alive; ſo that, as ſoon as you have conquered the firſt feelings excited by

by theſe venerable figures, you only conſider this as a vaſt gallery of original portraits, drawn after the life, by the juſteſt and moſt unprejudiced hand. It muſt be owned, that the colours are rather faded; and the pencil does not appear to have been the moſt flattering in the world: but no matter; it is the pencil of truth, and not of a mercenary, who only wants to pleaſe.

It might alſo be made of very conſiderable uſe to ſociety: theſe dumb orators could give the moſt pathetic lectures upon pride and vanity. Whenever a fellow began to ſtrut, or to affect the haughty, ſupercilious air, he ſhould be ſent to converſe with his friends in the gallery: and if their arguments did not bring him to a proper way of thinking, I would give him up as incorrigible."

I cannot better conclude this chapter than by an extract from the late pious and ingenious Mr. *Hervey*, which may ſerve for a recapitulation of what has been ſaid, as well as an improvement of it.

" Let us begin with the leſs adorned, but more *ſolid* parts, thoſe which *ſupport*, and which *contain* the reſt. Firſt, you have a ſyſtem of *Bones*, caſt in a variety of moulds, in a variety of ſizes: all ſtrong, that they may bear up the machine, yet light, that they may not weigh us down: bored with an inward cavity to contain the moiſtning marrow, and perforated with fine ducts, to admit the nouriſhing veſſels. Inſenſible themſelves, they are covered with a membrane, exquiſitely ſenſible, which warns them of, and ſecures them from the annoyance of

of any hurtful friction; and alſo preſerves the muſcles from being fretted in their action, by the hard and rough ſubſtance of the bone. They are largeſt at the extremities, that they may be joined more firmly, and not ſo eaſily diſlocated. The manner of their articulation is truly admirable, and remarkably various: yet never varied without demonſtrating ſome wiſe deſign, and anſwering ſome valuable end. Frequently when two are united, the one is nicely rounded and capped with a ſmooth ſubſtance; the other is ſcooped into an hollow of the ſame dimenſions to receive it. And both are lubricated with an unctuous fluid, to facilitate the rotation.

The *Feet* compoſe the firmeſt pedeſtal, infinitely beyond all that ſtatuary can accompliſh, capable of altering its form, and extending its ſize, as different circumſtances require. They likewiſe contain a ſet of the niceſt ſprings, which help to place the body in a variety of attitudes, and qualify it for a multiplicity of motions. The undermoſt part of the heel, and the extremity of the ſole, are ſhod with a tough inſenſible ſubſtance: a kind of natural ſandal, which never wears out, never wants repair: and which prevents an undue compreſſion of the veſſels by the weight of the body. The *legs* and *thighs* are like ſtately columns, ſo articulated that they are commodious for walking, and yet do not obſtruct the eaſy poſture of ſitting. The legs ſwell out towards the top with a genteel projection, and are neatly wrought off toward the bottom: a variation which leſſens their bulk, while it increaſes their beauty.

The *Ribs*, turned into a regular arch, are gently moveable, for the act of reſpiration. They

They form a ſafe lodgement for the lungs and heart, ſome of the moſt important organs of life. The *Back-bone* is deſigned, not only to ſtrengthen the body, and ſuſtain its moſt capacious ſtore-rooms, but alſo to bring down the continuation of the brain, uſually termed the *Spinal Marrow*. It both conveys and guards this *ſilver cord*, as *Solomon* terms it, and by commodious outlets tranſmits it to all parts. Had it been only ſtrait and hollow, it might have ſerved theſe purpoſes. But then the loins muſt have been inflexible: to avoid which, it conſiſts of very ſhort bones, knit together by cartilages. This peculiarity of ſtructure gives it the pliancy of an oſier, with the firmneſs of an oak. By this means it is capable of various inflections, without bruiſing the ſoft marrow, or diminiſhing that ſtrength which is neceſſary to ſupport all the upper ſtories. Such a formation in any other of the ſolids, muſt have occaſioned great inconvenience. Here it is unſpeakably uſeful, a maſter-piece of creating ſkill.

The *Arms* are exactly proportioned to each other, to preſerve the equilibrium of the ſtructure. Theſe being the guards that defend, and the miniſters that ſerve the whole body, are fitted for the moſt diverſified and extenſive operations: firm with bone, yet not weighty with fleſh, and capable of performing all uſeful motions. They bend inwards and turn outwards; they move upward or downward. They wheel about in whatever direction we pleaſe. To theſe are added the *Hands*, terminated by the fingers, not of the ſame length, nor of equal bigneſs, but in both reſpects different, which gives

gives the more beauty, and far greater uſefulneſs. Were they all fleſh, they would be weak: were they one entire bone, they would be utterly inflexible: but conſiſting of various little bones and muſcles, what ſhape can they not aſſume? Being placed at the end of the arm the ſphere of their action is exceedingly inlarged. Their extremities are an aſſemblage of fine tendinous fibres, acutely ſenſible: which notwithſtanding are deſtined to almoſt inceſſant employ, and frequently among rugged objects. For this reaſon they are overlaid with nails, which preſerve them from any painful impreſſions.

In the hand we have a caſe of the fineſt inſtruments. To theſe we owe thoſe beautiful ſtatues, this melodious trumpet. By the ſtrength of the hand the talleſt firs fall, and the largeſt oaks deſcend from the mountains. Faſhioned by the hand they are a floating warehouſe, and carry the productions of art and nature from *Britain* to *Japan*.

The hand is the original and univerſal ſceptre, which not only repreſents, but aſcertains our dominion over all the elements and over every creature. Tho' we have not the ſtrength of the horſe, the ſwiftneſs of the greyhound, or the quick ſcent of the ſpaniel, yet directed by the underſtanding, and enabled by the hand, we can as it were make them all our own. Theſe ſhort hands have found a way to penetrate the bowels of the earth, to touch the bottom of the ſea. Theſe feeble hands can manage the wings of the wind, arm themſelves with the violence of fire, and preſs into their ſervice the forcible impetuoſity of water. How greatly then are

we

we indebted to our wiſe Creator, for this diſtinguiſhing, this invaluable member?

Above all is the *Head*, for the reſidence of the brain, ample to receive, and firm to defend it. It has a communication with all, even the remoteſt parts; has outlets, for diſpatching couriers to all quarters, and avenues for receiving ſpeedy intelligence, on all needful occaſions. It has lodgments wherein to poſt centinels, for various offices: to expedite whoſe operations the whole turns on a curious pivot, nicely contrived to afford the largeſt and freeſt circumvolutions.

This is ſcreened from heat, defended from cold, and at the ſame time beautified by the *Hair:* a decoration ſo delicate, as no art can ſupply, ſo perfectly light, as no way to incumber the wearer.

While other animals are prone in their aſpect, the attitude of man is *erect*, which is by far the moſt graceful, and beſpeaks ſuperiority. It is by far the moſt commodious, for proſecution of all our extenſive deſigns. It is likewiſe ſafeſt, leſs expoſed to dangers, and better contrived to repel or avoid them. Does it not alſo remind us of our noble original, and our ſublime end? Our original, which was the breath of the almighty: our end, which was the enjoyment of him in glory?

Thus much for the *rafters* and *beams* of the houſe. Let us now ſurvey the lodgings within. Here are *Ligaments*, a tough and ſtrong arrangement of fibres, to unite the ſeveral parts, and render what would otherwiſe be an unwieldy jumble, a well compacted and ſelf-manageable ſyſtem: *Membranes*, thin and flexile tunicles

tunicles, to inwrap the fleſhy parts, to connect ſome, and form a ſeparation beween others: *Arteries*, the rivers of our little world, that ſtriking out as they go, into numberleſs ſmall canals, viſit every ſtreet, yea every apartment in the vital city. Theſe being wide at firſt, and growing narrower and narrower, check the rapidity of the blood. This thrown from the heart, dilates the arteries, and their own elaſtic force contracts them: by which means they vibrate againſt the finger, and much aſſiſt both in the diſcovery and cure of diſeaſes. The larger arteries, wherever the blood is forced to bend, are ſituate on the bending ſide; leſt being ſtretched to an improper length, the circulation ſhould be retarded. They are not, like ſeveral of the veins, near the ſurface, but placed at a proper depth. And hereby they are more ſecure from external injuries. In thoſe parts which are moſt liable to preſſure, an admirable expedient takes place. The arteries *inoſculate* with each other: breaking into a new track, they fetch a little circuit, and afterwards return into the main road. So that if any thing block up or ſtraiten the direct paſſage, the current by diverting to this new channel, eludes the impediment, flows on, and ſoon regains its wonted courſe.

The *Veins* receive the blood from the arteries, and re-convey it to the heart. The preſſure of the blood is not near ſo forcible in theſe as in the arteries. Therefore their texture is conſiderably ſlighter. Such an exact œconomiſt is Nature, amidſt all her liberality! In many of theſe canals, the current, tho' widening continually, is obliged to puſh its way againſt

the perpendicular: hereby it is expoſed to the danger of falling back and overloading the veſſels. To prevent this, *Valves* are interpoſed at proper diſtances, which are no hindrance to the regular paſſage, but prevent the reflux, and facilitate the paſſage of the blood to the grand receptacle. But theſe valves are only where the blood is conſtrained to climb: where the aſcent ceaſes, they ceaſe alſo.

Here are *Glands* to filtrate the paſſing fluids, each of which is an aſſemblage of veſſels, complicated with ſeeming confuſion, but with perfect regularity. Each forms a ſecretion far more curious than the moſt admired operations of chymiſtry: *Muſcles*, compoſed of the fineſt fibres, yet endued with incredible ſtrength, faſhioned after a variety of patterns, but all in the higheſt taſte for elegance and conveniency. Theſe are the inſtruments of motion, and at the command of the will, execute their functions quick as lightning: *Nerves*, ſurprizingly minute, which ſet the muſcles at work, diffuſe the power of ſenſation thro' the body, and upon any impreſſion from without, give all needful intelligence to the ſoul: *Veſicles*, diſtended with an unctuous matter, in ſome places compoſe a ſoft cuſhion; as in the calf of the leg, whoſe large muſcles, mixt with *fat* are of ſingular ſervice to thoſe important bones. This flanks and fortifies them, like a ſtrong baſtion, ſupports and cheriſhes them, like a ſoft pillow. In other places they fill up the vacuities, and ſmooth the inequalities of the fleſh. Inwardly they ſupply the machine for motion; outwardly they render it ſmooth and graceful.

The *Skin*, like a curious ſurtout, covers the whole, formed of the moſt delicate net-work, whoſe

whoſe meſhes are minute, and whoſe threads are multiplied, even to a prodigy: the meſhes are ſo minute, that nothing paſſes them, which is diſcernible by the eye; tho' they diſcharge every moment myriads and myriads of ſuperfluous incumbrances. The threads are ſo multiplied, that neither the point of the ſmalleſt needle, nor the infinitely finer lance of a gnat, can pierce any part, without drawing blood, and cauſing an uneaſy ſenſation. Conſequently, without wounding by ſo ſmall a puncture, both a nerve and a vein!

But a courſe of inceſſant action muſt exhauſt the ſolids and waſte the fluids, and unleſs both are properly recruited, in a ſhort time deſtroy the machine. For this reaſon it is furniſhed with the *organs*, and endued with the *powers* of *nutrition*: *Teeth*, the foremoſt, thin and ſharp, to bite aſunder the food; the hindermoſt, broad and ſtrong, indented with ſmall cavities, the better to grind in pieces what is tranſmitted to them. But in children, the formation of teeth is poſtponed till they have occaſion for them.

Were the teeth, like other bones, covered with the perioſteum, chewing would give much pain. Were they quite naked, they would ſoon decay and periſh. To guard againſt both, they are overlaid with a neat *enamel*, harder than the bone itſelf, which gives no pain in chewing, and yet ſecures them from various injuries.

The *Lips* prevent the food from ſlipping out of the mouth, and aſſiſted by the tongue, return it to the grinders. While they do this in concert with the cheeks, they ſqueeze a thin liquor from the adjacent glands. This moiſtens

the food and prepares it for digeſtion. When the mouth is inactive theſe are nearly cloſed: but when we ſpeak or eat, their moiſture being then neceſſary, is expreſt as need requires.

But the food could not deſcend merely by its own weight, thro' a narrow and clammy paſſage into the ſtomach. Therefore to effect this, muſcles both *ſtrait* and *circular* are provided. The former inlarge the cavity, and give an eaſy admittance. The latter, cloſing behind the deſcending aliment, preſs it downward. But before the food enters the gullet, it muſt of neceſſity paſs over the orifice of the wind-pipe: whence it is in danger of falling upon the lungs, which might occaſion inſtant death. To obviate this, a *moveable lid* is placed, which when the ſmalleſt particle advances, is pulled down and ſhut cloſe, but as ſoon as it is ſwallowed, is let looſe and ſtands open. Thus the important paſs is always made ſure againſt any noxious approaches; yet always left free for the air, and open for reſpiration.

The food deſcending into the ſtomach is not yet ready for the bowels. Therefore that great receiver is ſtrong to bear, and proper to detain it, till it is wrought into the ſmootheſt pulp imaginable. From hence it is diſcharged by a gentle force, and paſſes gradually into the inteſtines.

Near the entrance waits the *gall-bladder*, ready to pour its ſalutary juice upon the aliment, which diſſolves any thing viſcid, ſcours the inteſtines, and keeps all the fine apertures clear. This bag as the ſtomach fills, is preſt thereby, and then only diſcharges its contents. It is alſo furniſh-

furniſhed with a valve of a very peculiar, namely, of a ſpiral form; through which the deterſive liquid cannot haſtily pour, but muſt gently ooze. Admirable conſtruction! which without any care of ours, gives the needful ſupply, and no more.

The nutriment then purſues its way through the mazes of the *inteſtines*: which by a worm-like motion protrude it and force its ſmall particles into the *lacteal veſſels*. Theſe are a ſeries of the fineſt ſtrainers, ranged in countleſs multitudes all along the ſides of the winding paſſage. Had this been ſtrait or ſhort, the food could not have reſigned a ſufficient quantity of its nouriſhing particles. Therefore it is artfully convolved and greatly extended, that whatever paſſes may be ſifted throughly. As the aliment proceeds, it is more and more drained of its nutritious juices. In conſequence of this, it would become hard and pain the tender parts, but that glands are poſted in proper places, to diſcharge a lubricated fluid. Theſe are ſmaller or fewer near the ſtomach, becauſe there the aliment is moiſt enough: whereas in the bowels remote from the ſtomach, they are either multiplied or inlarged.

The *Chyle* drawn off by the lacteals is carried through millions of ducts, too fine even for the microſcope to diſcover. To this it is owing, that nothing enters the blood, but what is capable of paſſing through the fineſt veſſels. It is then lodged in ſeveral commodious cells (the glands of the *Meſentary*) and there mixt with a thin diluting lymph, which makes it more apt to flow. Hence it is conveyed to the *common receptacle*, and mounts through a perpendicular

tube into the left *ſubclavian vein*. This tube lies contiguous to the *great artery*, whoſe ſtrong pulſation drives on the fluid, and enables it to aſcend and unload its treaſure, at the very door of the heart.

But the chyle is as yet in too crude a ſtate, to be fit for the animal functions. Therefore it is thrown into the lungs. In the ſpungy cells of this amazing laboratory, it mixes with the external air, and its whole ſubſtance is made more ſmooth and uniform. Thus improved it enters the left ventricle of the heart, a ſtrong, active, indefatigable muſcle. The large muſcles of the arm or of the thigh are ſoon wearied: a day's labour, or a day's journey exhauſts their ſtrength. But the Heart toils whole weeks, whole months, nay years, unwearied: is equally a ſtranger to intermiſſion and fatigue. Impelled by this, part of the blood ſhoots upward to the head; part rolls through the whole body.

But how ſhall a ſtream divided into myriads of channels, be brought back to its ſource? Should any portion of it be unable to return, putrefaction, if not death, muſt enſue. Therefore the all-wiſe Creator has connected the extremities of the arteries, with the beginning of the veins: ſo that the ſame force which darts the blood through the former, helps to drive it thro' the latter. Thus it is re-conducted to the great ciſtern, and there played off afreſh.

Where two oppoſite currents would be in danger of claſhing, where the ſtreams from the *vena cava* and *vena aſcendens* co-incide, a fibrous excreſcence interpoſes, which like a projecting pier, breaks the ſtroke of each, and throws both into

into their proper receptacle. Where the motion is to be ſpeedy, the channels either forbear to wind (as in the great artery, which deſcends to the feet) or leſſen in their dimenſions, as in every interval between all the ramifications. When the progreſs is to be retarded, the tubes are variouſly convolved or their diameter contracted. Thus guarded, the living flood never diſcontinues its courſe, but night and day, whether we ſleep or wake, ſtill perſeveres to run briſkly through the arteries, and return ſoftly through the veins.

But farther. The great Creator has made us an invaluable preſent of the ſenſes, to be the inlets of innumerable pleaſures, and the means of the moſt valuable advantages.

The *Eye*, in its elevated ſtation, commands the moſt enlarged proſpects. Conſiſting only of fluids, incloſed within coats, it ſhews us all the graces and glories of Nature. How wonderful, that an image of the hugeſt mountains, and the wideſt landſcapes ſhould enter the ſmall pupil! that the rays of light ſhould paint on the optic nerve, paint in an inſtant of time, paint in their trueſt colours and exacteſt lineaments, every ſpecies of external objects!

The *Eye* is ſo tender, that the ſlighteſt touch might injure its delicate frame. It is guarded therefore with peculiar care, intrenched deep, and barricaded round with bones. As the ſmalleſt fly might incommode its poliſhed ſurface, it is farther protected by two ſubſtantial *curtains*. In ſleep, when there is no occaſion for the ſenſe, but a neceſſity to guard the organ, theſe curtains cloſe of their own accord. At any time they fly together as quick as thought.

They are lined with an extremely fine ſponge, moiſt with its own dew. Its briſtly paliſades keep out the leaſt mote, and moderate the too ſtrong impreſſions of the light.

As in our waking hours we have almoſt inceſſant need for theſe little orbs, they run upon the fineſt caſtors, rolling every way with the utmoſt eaſe: which circumſtance, added to the flexibility of the neck, renders our two eyes as uſeful as a thouſand.

The *Ear* conſiſts of an outward porch and inner rooms. The porch, ſomewhat prominent from the head, is of a cartilaginous ſubſtance, covered with tight membranes and wrought into ſinuous cavities. Theſe, like circling hills, collect the wandring undulations of the air, and tranſmit them with a vigorous impulſe, to the finely ſtretched membrane of the *drum*. This is expanded upon a circle of bones, over a poliſhed, reverberating cavity. It is furniſhed with *braces* that ſtrain or relax, as the ſound is faint or ſtrong. The *hammer* and the *anvil*, the winding *labyrinth*, and the ſounding *galleries*, theſe and other pieces of mechaniſm, all inſtrumental to *hearing*, are inexpreſſibly curious.

Amazingly exact muſt be the tenſion of the *auditory nerves*, ſince they anſwer the ſmalleſt tremors of the atmoſphere, and diſtinguiſh their moſt ſubtle variations. Theſe living chords, turned by an almighty hand, and ſpread thro' the echoing iſles, receive all the impreſſions of ſound, and propagate them to the brain. Theſe give exiſtence to the charms of muſic, and the ſtill nobler charms of diſcourſe.

The eye is uſeleſs amidſt the gloom of night. But the ear hears thro' the darkeſt medium.

The

The eye is on duty only in our waking hours: but the ear is always acceſſible.

As there are concuſſions of the air, which are diſcernible only by the inſtruments of hearing, ſo there are *odoriferous* particles wafted in the air, which are perceivable only by the *Smell*. The *noſtrils* are wide at the bottom, that more effluvia may enter, narrow at the top, that when entered they may act more ſtrongly. The ſteams that exhale from fragrant bodies, are fine beyond imagination. Microſcopes that ſhew thouſands of animals in a drop of water, cannot bring one of theſe to our ſight. Yet ſo judiciouſly are the olfactory nets ſet, that they catch the vaniſhing fugitives. They imbibe all the roaming perfumes of Spring, and make us banquet even on the inviſible dainties of Nature.

Another capacity for pleaſure our bountiful Creator has beſtowed, by granting us the powers of *Taſte*. This is circumſtanced in a manner ſo benign and wiſe, as to be a ſtanding plea for temperance, which ſets the fineſt edge on the taſte, and adds the moſt poignant reliſh to its enjoyments.

And theſe ſenſes are not only ſo many ſources of delight, but a joint ſecurity to our health. They are the inſpectors that examine our food, and enquire into the properties of it. For the diſcharge of this office they are excellently qualified, and moſt commodiouſly ſituate. So that nothing can gain admiſſion, till it has paſt their ſcrutiny.

To all theſe, as a moſt neceſſary ſupplement, is added the ſenſe of *Feeling*. And how happily is it tempered between the two extremes, neither too acute, nor too obtuſe! Indeed all the

ſenſes are exactly adapted to the exigencies of our preſent ſtate. Were they ſtrained much higher, they would be avenues of anguiſh, were they much relaxt, they would be well nigh uſeleſs.

The crowning gift which augments the benefits accruing from all the ſenſes, is *Speech*. Speech makes me a gainer by the eyes and ears of others; by their ideas and obſervations. And what an admirable inſtrument for articulating the voice, and modifying it into ſpeech, is the *tongue?* This little collection of muſcular fibres under the direction of the Creator, is the artificer of our words. By this we communicate the ſecrets of our breaſts, and make our very thoughts audible. This likewiſe is the efficient cauſe of muſic; it is ſoft as the lute, or ſhrill as the trumpet. As the tongue requires an eaſy play, it is lodged in an ample cavity. It moves under a concave roof, which gives additional vigour to the voice, as the ſhell of a violin to the ſound of the ſtrings.

Wonderfully wiſe is the regulation of *voluntary* and *involuntary* motions. The will in ſome caſes has no power: in others ſhe is an abſolute ſovereign. If ſhe command, the arm is ſtretched, the hand is cloſed. How eaſily how punctually are her orders obeyed!—To turn the ſcrew, or work the lever, is laborious and weariſome. But we work the vertebræ of the neck, with all their appendent chambers; we advance the leg, with the whole incumbent body: we riſe, we ſpring from the ground, and though ſo great a weight is raiſed, we meet with no difficulty or fatigue.

That all this ſhould be effected without any toil, by a bare act of the Will, is very ſurprizing.

But

But that it ſhould be done, even while we are entirely ignorant of the manner in which it is performed, is moſt aſtoniſhing! Who can play a ſingle tune upon the ſpinnet, without learning the difference of the keys? Yet the mind touches every ſpring of the human machine, with the moſt maſterly ſkill, tho' ſhe knows nothing at all of the nature of her inſtrument, or the proceſs of her operations.

The eye of a ruſtic, who has no notion of optics, or any of its laws, ſhall lengthen and ſhorten its axis, dilate and contract its pupil, without the leaſt heſitation, and with the utmoſt propriety: exactly adapting itſelf to the particular diſtance of objects, and the different degrees of light. By this means it performs ſome of the moſt curious experiments in the Newtonian philoſophy, without the leaſt knowledge of the ſcience, or conſciouſneſs of its own dexterity!

Which ſhall we admire moſt, the multitude of organs? Their finiſhed form and faultleſs order? Or the power which the ſoul exerciſes over them? Ten thouſand reins are put into her hands: and ſhe manages all, conducts all, without the leaſt perplexity or irregularity. Rather with a promptitude, a conſiſtency and ſpeed, that nothing elſe can equal!

So *fearfully and wonderfully* are we *made!* Made of ſuch complicated parts, each ſo nicely faſhioned, and all ſo exactly arranged; every one executing ſuch curious functions, and many of them operating in ſo myſterious a manner! And ſince health depends on ſuch a numerous aſſemblage of moving organs; ſince a ſingle ſecretion ſtopped may ſpoil the tempe-

rature of the fluid, a ſingle wheel clogged may put an end to the ſolids: with what holy fear, ſhould we *paſs the time of our ſojourning here* below! Truſting for continual preſervation, not merely to our own care, but to the Almighty Hand, which formed the admirable machine, directs its agency and ſupports its being!

CHAP. II.

Of the Natural State of the Human Body.

1. THAT is the *natural ſtate* of the human body, wherein all parts of it duly perform their natural operations. The chief of theſe are, the Circulation of the blood, Reſpiration, Chylification, Nutrition, and Motion.

2. That

2. That the blood circulates through the whole body appears hence. Any of the arteries being tied with a thread, will ſwell and beat between the bandage and the heart, but grow flaccid between the bandage and the extremities of the body. And if the artery be cut between the bandage and the heart, blood ſtreams out, even to death: but if it be cut between the bandage and extremities, very little blood comes out. The vital blood therefore flows from the heart through the arteries, toward the extremes of the body, and ſtill out of a wider part into a narrower, out of the trunk into the branches.

Any of the larger veins being tied with a thread, ſwells between the extremes and the bandage, but grows flaccid between the bandage and the heart. If opened in the former part, it bleeds largely; if in the latter, ſcarce at all. The blood therefore flows from all the extremes, thro' the veins into the heart, and ſtill from the narrower parts of the vein to the larger, from the branches to the trunk.

Upon the whole it is evident, that all the arteries are continually bringing the blood from the left ventricle of the heart, thro' the trunks of the arteries into their branches, and from thence to all parts of the body: and on the contrary, that all the veins, (except the vena portæ) are continually bringing it back from all parts of the body, thro' the ſmall branches into the larger, and thence thro' the trunks and vena cava into the right ventricle of the heart. So that the whole blood paſſes thro' the heart once in five or ſix minutes.

It is certain, that all the arteries and veins communicate or open one into the other; becauſe

cauſe often from one, and that a ſmall artery, all the blood ſhall run even unto death, not only out of the wounded limb, but from the whole body. Of ſuch fatal examples, we have a number; from an inward artery of the noſe, from the gums, a finger, tooth, cutaneous pore inlarged, from the lactrymal point, from the wound of cupping on the ſkin, and even the bite of a leach. There are, therefore, of courſe, open ways by which the blood ſpeedily flows from the venal, into the arterial ſyſtem, and the reverſe.

Late writers have purſued the globules of blood to a great length, and found ſeveral orders of them. The large ones viſible to the naked eye, are globules of the *firſt order*. Each of theſe is compoſed of ſix ſmaller, joined together in a very regular way. But ſometimes a red globule is ſeen looſening, and breaking into theſe compounding ſpherules. And ſometimes one may perceive theſe running together, and beginning the compoſition of a new red globule. Theſe ſmaller ſpherules they call globules of the *ſecond order*. But we are not to ſtop here. There are in the blood a great many particles ſix times leſs than theſe. Globules of the ſecond order are compounded of theſe ſmaller ones, which therefore are globules of the *third order*.

Farther. There are innumerable blood veſſels of ſuch ſmallneſs, that none of the above-mentioned globules can paſs them: ſo that we cannot but ſuppoſe ſtill ſmaller globules. The diameter of ſome veſſels, is leſs than the eighth part of the diameter of a red globule: ſo that the particles paſſing thro' them, muſt be above

five

five hundred times leſs than thoſe globules. Nay, on a careful examination, we perceive veſſels narrower, than the tenth part of the diameter of a red globule: which conſequently can tranſmit ſpherules no greater, than the thouſandth part of a red globule.

On the whole then, each globule of the firſt order is made up of ſix of the ſecond: theſe of ſix of the third, thoſe of ſix of the fourth; theſe of ſix of the fifth, and ſo on. And accordingly we find, the globules of the higheſt orders, may be broken down into their compounding particles.

The diameter of a common red globule is about the 1938th part of an inch. The diameter of a globule of the tenth order is leſs than the one 400,000th part of an inch.

Anatomiſts and Phyſicians have generally determined the quantity of blood in the human body, to be between fifteen and twenty-five pounds. But Dr. *Keil* ſhews from many inſtances of profuſe hemorrhages, that a far greater quantity muſt be allowed. Otherwiſe the patient could never have furniſhed, or at leaſt, ſurvived ſuch evacuations; the leaſt of which exceeded the whole quantity of blood, ſuppoſed to be in the body.

In reality, the quantity of blood in an human body, is difficult to be determined. Bleeding to death, the uſual method, can never ſhew what is its true quantity: becauſe no animal can bleed longer, than while the great artery is full; which will require a longer or a ſhorter time, as the wounded artery is ſmaller or greater. And the great artery muſt always be, the firſt veſſel that empties.

The

The only certain way of calculating is, to find what proportion the cavities of the veſſels of which the whole body is compoſed, bear to the thickneſs of the coats. This in the veins and arteries may be exactly found. But in the other veſſels we only know the quantity of fluid they contain, by carefully evaporating as much as poſſible. Thus the Doctor found the fluids to be in the arteries as 17 to 1; in the veins as 15,6 to 1: in the bones as 1 to 1. The leaſt of theſe proportions ſhews the liquors to be one half of the weight of the body. And if a calculation be made, on the proportion of the blood in the arteries alſo to their coats in a body weighing 160 pounds, there will be found 100 pounds of blood or circulating fluid.

In a fœtus the circulation is performed in a peculiar manner. The ſeptum which ſeparates the two ventricles of the heart is pierced thro' with an aperture, called the *foramen ovale*, and the pulmonary artery, a little after it has left the heart, ſends out a tube into the deſcending aorta called the *communicating canal*. When the fœtus is born, the foramen ovale cloſes, and that canal dries up into a ſimple ligament.

The fœtus while in the womb receives little air. Its lungs therefore cannot ſwell and ſubſide. They continue almoſt at reſt: nor can they allow the blood to circulate, either in abundance, or with eaſe. Nature therefore has excuſed them from the paſſage of the greateſt part of the blood, and has contrived the foramen ovale, by which part of the blood of the vena cava paſſes thro' the right ventricle into the left. And by this means it is found as far on its journey, as if it had paſſed the lungs. But this

this is not all. For that blood of the cava, which miſſing the foramen ovale, paſſes from the right auricle into the right ventricle, being ſtill too much to paſs by the lungs, the communicant canal intercepts part of it, and pours it immediately into the deſcending aorta.

3. Reſpiration is performed by receiving the air into the lungs, and breathing it out alternately. In the former, the cavity of the breaſt is inlarged, by the ſinking of the diaphragm, and the erection of the ribs, thro' the force of the muſcles placed between them. In the latter, it is contracted, the diaphragm riſing and the ribs falling again. Whenever the cavity of the breaſt is inlarged, the air by its weight naturally preſſes into it, and mixing with the blood in the veſicles of the lungs, makes it more fluid, globular and fit for motion. Air is likewiſe abſolutely neceſſary in the body, to counter-act the preſſure of the outward air.

But if the blood in the lungs of a fœtus has not the advantage of reſpiration, it receives a portion of air, tranſmitted with its mother's blood by the umbilical veſſels, to be diffuſed through the body. This is quite neceſſary, as appears hence: Tie the navel ſtring very tight, and the child dies, like a man ſtrangled.

One uſe of reſpiration is, to puſh the blood from the right to the left ventricle of the heart: Hence it is, that perſons ſtrangled ſo ſuddenly die, becauſe with reſpiration, the circulation of the blood ceaſes. And this is the true cauſe of the diaſtole of the heart: the weight of the incumbent atmoſphere, being the true antagoniſt to all the muſcles that ſerve both for inſpiration and the contraction of the heart. As

in

in the elevation of the ribs, a paſſage is opened for the blood into the lungs, ſo in the depreſſion thereof, by the ſubſiding of the lungs and compreſſion of the blood-veſſels thereby, the blood is driven thro' the pulmonary vein, into the left ventricle of the heart. And this, together with the general compreſſion of the body, by the weight of the atmoſphere, is that power which cauſes the blood to mount in the veins, when the force impreſt on it by the heart is nearly ſpent, and which forces the heart itſelf from its natural ſtate of contraction, to that of dilatation.

When in an ordinary expiration, the preſſure on the larynx is two ounces, the preſſure on the whole internal ſubſtance of the lungs, is 14412 pounds. So vaſt is the extent of the ſurface of the veſicles, on which it was neceſſary the blood ſhould be ſpread in the fineſt capillary veſſels, that each globule of blood might as it were immediately receive the whole force of the air, and thereby be broken into ſmaller parts, fit for ſecretion and circulation.

And hence we ſee the reaſon for the ſtructure of the lungs. For ſince all the blood is to paſs thro' them, in order to receive the effect of the air, and that this could not be done, unleſs it were diffuſed in very ſmall veſſels: it was neceſſary the ſurface on which they were to be ſpread, ſhould be proportioned to their number. And this is admirably well provided for, by the fabric of the lungs.

If the diameter of the trachea at the time of every expiration were the ſame in all, and the weight of the air always equal, the preſſure on the lungs would be always the ſame. But as the

the difference between its leaſt and greateſt gravity, is no leſs than a tenth part of the whole, that preſſure is likewiſe greater by a tenth part at ſome times than it is at others.

This is a difference which the Aſthmatic muſt ſenſibly feel; eſpecially as they breathe thicker, that is, every expiration is performed in leſs time. In truth, theſe feel a difference in the air, upon the greateſt riſe and fall of the barometer, equal to above one third of its preſſure in ordinary breathing.

The alternate dilatation and contraction of the Thorax are ſo neceſſary to animal life, that there is no animal without this, or ſomething analogous to it. Fiſhes and inſects have no dilatable Thorax. But fiſhes have gills, which receive and expel the water alternately, whereby the blood-veſſels ſuffer the ſame alterations of dimenſion as thoſe in our lungs do. And inſects have air-veſſels diſtributed through the whole trunk of their bodies. By theſe they communicate with the external air through ſeveral vent-holes, to which are faſtened ſo many wind-pipes, which ſend branches to all parts, and ſeem to accompany the blood-veſſels all over the body, as they do in our lungs only. And hereby in every inſpiration the whole body is dilated, and in every expiration compreſſed.

But may it not be doubted, whether the primary end of reſpiration, be not to ſupply the whole animal machine, with the ethereal fire, a particle of which is connected with every particle of air? Is not this detached from it by the action of the lungs, and thence communicated to every part of the body? And is not this the true vital flame, the original ſource of life and motion?

4. *Chyli-*

4. *Chylification* is preceded by *Digeſtion*, which is much illuſtrated by Mr. *Papin*'s *Digeſter*. This is a veſſel wherein meat is put, with juſt as much water as will fill it. Then the lid is ſcrewed on ſo cloſe, as to admit of no external air. The meat herein is by the flame of a ſmall lamp, in ſix or eight minutes brought to a perfect pulp. In a few minutes more the hardeſt bones are reduced to a jelly. No air entering, the ſuccuſſions cauſed by the air incloſed in the fleſh, reſolve the whole into one homogeneous body. It is juſt ſo in Digeſtion. In proportion to its heat, the ſtomach does the very ſame thing as the Digeſter.

Add to this, that the muſcular coat of the ſtomach continually contracting, and preſſing its contents by its periſtaltic motion, occaſions a more intimate mixture, and works the more fluid parts, through the pylorus into the duodenum. Along the ſides of this and the other ſmall inteſtines the lacteals are planted: into the minute orifices whereof, the chyle or finer part of the maſs is received. The lacteal veins of the firſt kind diſcharge themſelves into the glands of the baſis of the meſentery. The chyle is afterward received by the lacteals of the ſecond kind, and conveyed into glands between the two tendons of the diaphragm. And hence it is carried to the heart, where it mixes with the blood.

5. By the perpetual motion of the fluids (eſpecially in the minute veſſels) as well as the conſtant action of the muſcles, ſmall particles are continually worn off, from the ſolids of the body. The fluids likewiſe are continually diminiſhing. And hence every animal body, by the

the very condition of its frame, is liable to deſtruction. To prevent this, a reſtitution muſt be made to the juices and ſolids of the body, equal and ſimilar to what is loſt. And this we call *Nutrition*.

It ſeems to be performed thus. The blood forcibly thrown by the heart into the arteries, endeavours to go out every way through the pores. But theſe are uſually too ſmall to give its particles a free paſſage. They can only paſs where any of the pores are open. Here one will naturally follow another in a line, and conſtitute a fibre or part of a fibre. When as much is thus added to one end of the fibre, as is waſted at the other, the body is *nouriſhed:* when more is added than is waſted, we are ſaid to *grow*.

We ſee then how abſolutely neceſſary food is, to repair the conſtant decay of the body: ſo that few men or women can live without it, above five or ſix days. And yet the abſtaining from it for a ſeaſon has its uſe. Indeed great is the efficacy of abſtinence, both in prolonging life beyond its uſual period, and in the cure of many ſtubborn diſorders.

Lewis Cornaro, a nobleman of *Venice*, after all other means had failed, ſo that his life was deſpaired of at forty, recovered and lived to near an hundred, by mere dint of abſtinence.

'Tis ſurprizing to obſerve, to what an age thoſe antient chriſtians lived, who retired from the fury of perſecution, into the deſerts of *Arabia* and *Egypt*. They drank only water, and took no other food than 12 ounces of bread in 24 hours. On this St. *Anthony* lived 105 years, *Epiphanius* 115, *Simon Stylites* 112, and *Romuald* an hundred and twenty.

Among

Among animals we ſee ſurprizing inſtances of long abſtinence. Several ſpecies paſs 4, 5, or 6 months every year without eating or drinking. So tortoiſes and dormice regularly retire at the ſeaſon to their reſpective cells. Some kinds get into ruins, or the hollows of rocks; others, into clefts of trees. Some ſleep in holes under the earth: others bury themſelves under water.

The ſerpent-kind bear abſtinence to a miracle. Rattle-ſnakes will ſubſiſt many months without food. Dr. *Shaw* ſaw two *Egyptian* ſerpents, which had been kept in a bottle five years, (on a ſmall quantity of ſand wherein they coiled themſelves up) without any ſort of food. Yet when he ſaw them they had juſt caſt their ſkins, and were as lively as if juſt taken.

There has been inſtances even of men paſſing ſeveral months, with ſcarce any ſuſtenance. So *Samuel Chilton* of *Tinſbury*, near *Bath*, in the Year, 1693, 1694 and 1695, ſlept ſometimes four months, and ſometimes above ſix together, with very little food: and ſix weeks without any, but a little tent conveyed with a quill thro' his teeth.

And ſince this, *John Ferguſon*, of *Killmelford* in *Argyle-ſhire*, about 18 years ago, overheated himſelf, drank largely of cold water, and fell aſleep. He ſlept for four and twenty hours, and waked in an high fever; ever ſince his ſtomach loaths, and can retain no kind of aliment but water. A neighbouring gentleman to whom his father is tenant, locked him up for 20 days, ſupplying him daily with water, and taking care that he ſhould have no other food. But it made no difference either in his look or ſtrength.

He

He is now six and thirty years of age, of a fresh complexion, and as strong as any common man.

Still more strange is the case of *Gilbert Jackson*. About fifteen years of age, in February 1716, he was seized with a violent fever: it returned in April for three weeks, and again on the tenth of June; he then lost his speech, his stomach, and the use of his limbs, and could not be persuaded either to eat or drink any thing. May the 17th 1717, his fever left him, but still deprived of speech and of the use of his limbs, and taking no food whatever. June 30th, he was seized with a fever again, and the next day recovered his speech, but without eating or drinking, or the use of his limbs. On the 11th of October he recovered his health, with the use of one of his legs, but neither eat nor drank; only sometimes washed his mouth with water.

On the 18th of June 1718, the fever returned and lasted till September. He then recovered, and continued in pretty good health and fresh coloured, but took no kind of meat or drink. On the 9th of June, 1719, he was again seized with a severe fever. On the tenth at night, his father prevailed on him to take a spoonful of milk boiled with oatmeal. It stuck so long in his throat, that his parents feared he had been choaked; but ever since that time he has taken food, tho' so little, that an half-penny loaf serves him for eight days. All the time he fasted, he had no evacuation, either by stool, or urine: and it was fourteen days after he began to eat, before he had any. He is now in pretty good health.

I ſuppoſe ſuch another inſtance as this, has ſcarce been known in the memory of man.

It is not improbable, that the air itſelf furniſhes ſome nutritive particles. It is certain, there are ſubſtances of all kinds, floating in the atmoſphere. And that an animal body may be nouriſhed hereby, is evident in the caſe of vipers. Theſe, if taken when firſt brought forth, and kept from every thing but air, will yet grow very conſiderably in a few days.

6. As without reſpiration and nutrition we cannot live at all, ſo without *Senſe*, life would be like death. In every ſenſation there is, 1. An outward object; 2. Its action in the organ of ſenſe, 3. A perception of it in the mind. The action of the object on the organ, is by means of the nerves communicated to the brain. And then, not otherwiſe, the perception follows. But how, none but He that made man can explain.

7. In *Sight*, the action on the organ is performed juſt in the manner of that in a camera obſcura. The rays of light reaching from the ſurface of bodies to the eye, variouſly penetrate the coats and humours of it, and paint on the bottom of the eye the images of the things which we ſee. This is communicated by the optic nerve to the brain, and then the Perception, which is properly *Sight*, follows. But the Eye has many advantages above a camera obſcura: not only as it can be moved various ways, by the help of its muſcles; but alſo as the pupil, by the help of the iris, is inſtantly either dilated or conſtringed, according to the degree

degree of light. The Eye likewiſe accommodates itſelf to the various diſtances of the objects, the bottom of the eye approaching to or receding from the chryſtalline humour, as the object is nearer or farther off.

8. *Sound* is a tremulous motion of the air, produced by the ſtroke or colliſion of bodies. *Hearing* is performed in the following manner. The undulating air enters the outward cavity of the ear, and then ſtrikes upon the drum; from which the motion is communicated to the little bones within, and the air contained in the inner cavity. This by means of the nerve conveys it to the brain, and then follows the perception which we term *Hearing*.

9. The fine effluvia which ſpread every way from odorous bodies, aſcending with the air into the noſtrils, variouſly twitch the filaments of the olfactory nerves, according to the variety of their natures. When this motion is by thoſe nerves communicated to the brain, the perception follows which is called *Smelling*.

10. It was obſerved before, that the ſurface of the Tongue is filled with ſmall *papillæ*, which are no other than fine ramifications of the guſtatory nerve. Theſe are variouſly moved, by the particles of meat and drink. And this motion being by that nerve tranſmitted to the brain, that perception ariſes which we ſtile *Taſting*.

11. The organ of *Feeling* is the ſkin in general, with which innumerable nervous *papillæ* are interwoven, which being moved by the ſlighteſt touch of other bodies, convey that motion to the brain. But theſe *papillæ* abound in all

the extremities, particularly the palms of the hand, and the tips of the fingers. And hence it is, that the ſenſe of feeling is far more exquiſite in thoſe than in other parts.

12. Nearly allied to the Senſes are the natural Appetites, particularly *Hunger* and *Thirſt*. The uſual way of accounting for them is this. When the food, now reduced to a pulp, is expreſt out of the ſtomach, it is of courſe contracted by its muſcular coat. This cauſes the inner coat to lie in folds; which by means of the periſtaltic motion, rubbing lightly on each other, occaſion the uneaſy ſenſation which we term Hunger. This is felt firſt in the upper orifice which is firſt evacuated. But as by degrees the reſt of the contents are expelled, this rubbing of the membranes on each other ſpreads over the whole ſtomach, and renders our hunger more urgent.

This uneaſy ſenſation is increaſed by the acidity, which the blood in the arteries of the ſtomach contracts through long abſtinence, its ſoft balſamic parts having been all drawn off. Likewiſe its velocity is conſiderably augmented, when we have not eaten for ſome time.

Hence it is, that Hunger, if it continues long, will occaſion a violent fever: that young perſons, and thoſe who labour hard, or are of a bilious conſtitution, are ſooneſt hungry: whereas thoſe whoſe humours are thick and viſcid, are not ſo ſoon incommoded therewith.

Hot vapours aſcending from the ſtomach, and drying the throat and mouth, are ſuppoſed to be the occaſion of that uneaſy ſenſation, which we term *Thirſt*.

I ſay, *are ſuppoſed.* For I apprehend nothing can be known with any certainty upon the head. In like manner it is ſuppoſed, that we are then *awake*, when the nerves are braced, and filled with animal ſpirits; and that when they are unbraced and empty, we *ſleep*. But who can give any ſatisfactory account of *Sleep?* Some aſcribe it to the ſtoppage of the nerves: ſome to the quieſcency, and others to a deficiency of the animal ſpirits. The truth is, we are ignorant of the whole affair; and no more underſtand Sleep than we do Death.

But this we know, that during Sleep ſeveral functions are ſuſpended, the organs of ſenſe are at reſt, the muſcles are quieſcent, ſo that hardly any ſpirits flow through them. The fibres of the nerves are little changed, and an equilibrium obtains throughout. There is no difference of preſſure on the veſſels, nor of velocity in the humours, which circulate equally thro' all the canals. Meantime, all diſturbing cauſes being at reſt, the waſted humours are reſtored, and the particles ſupplied, which were worn off the Solids.

We may obſerve farther, that when the head is hot, and the feet cold, we cannot ſleep; that perſpiration is twice as great while we ſleep as while we are awake; that too much ſleep makes the ſenſes dull, the memory weak, and the whole body liſtleſs; that ſleep will for a conſiderable time ſupply the place of meat and drink: that a fœtus ſleeps always; children much; youths more than adults, and they than old men.

To ſpeak a little more particularly. While we are awake there is a continual motion of the voluntary muſcles, of the parts ſubſervient to

ſenſe, and to the affections, all which ſtimulate the nerves, blood-veſſels and heart. Thus the finer parts of the blood are continually waſted, whence wearineſs enſues: and if the vigilance be continued, a feveriſh heat and ſenſible loſs of ſtrength.

As the night advances, a weight falls on the large muſcles and their tendons; and the mind becomes heavy. The powers that hold the body erect, begin to ſhrink from their office, the eye-lids cloſe, the head nods, and we take leſs notice of outward objects, till at length all the thoughts are in confuſion, and a ſort of Deliſium enſues, from whence there is a tranſition to ſleep, not known to us. This is haſtened by Darkneſs, compoſure of mind, and abſence of irritation from all parts of the body.

Again, Whatever weakens the natural powers, inclines to and increaſes ſleep: ſuch as loſs of blood, cooling medicines, yea the cold of the external air. Add to theſe, whatever calls off the quantity of blood flowing to the heart, as warm bathing of the feet, a plentiful ingeſtion of food into the ſtomach: likewiſe whatever leſſens the motions of the ſpirits, whether in the brain, or ſtomach, heart or arteries. —On the contrary, ſome hot medicines induce ſleep, by cauſing a greater afflux of blood to the brain. The ſame effect have ſome fevers; as alſo fatneſs, and whatever elſe retards the venal blood. In all theſe caſes, the blood collected in the head compreſſes the brain, ſo as to leſſen the courſe of the ſpirits into the nerves.

Sleepineſs is likewiſe produced by any compreſſion of the brain, whether from extravaſated blood, a depreſſed part of ſome bones, or a collection of ſerous water within the ventricles.

Sleep

Sleep therefore ſometimes riſes from a defect of the ſpirits: always from a collapſing of the nervous fibres, thro' which the ſpirits paſs from their fountain to all parts of the body.

It is hindered by intenſe thought, pain of body, and ſtrong emotions of mind: all which urge the ſpirits on, and prevent the nervous fibres from collapſing.

In ſleep the heart is gradually reſtored from its quick and almoſt feveriſh pulſation, to its ſlow and calm motion: the breathing is ſlower and ſmaller, the motion of the ſtomach and inteſtines, the digeſtion of the aliments and the progreſſion of the fæces are diminiſhed. At the ſame time the thinner juices move more ſlowly, while the more groſs are called together, the fat is accumulated in its cells, and the nutritive particles adhere more plentifully to the inner ſurfaces of the ſmall veſſels, and the ſides of the fibres. Thus while the ſpirits are ſecreted with a leſs conſumption, they are by degrees accumulated in the brain, ſo as to diſtend and fill the collapſed nerves. And then we awake out of ſleep.

Let us conſider in another view theſe remarkable incidents of our frame, *Sleep* and *Dreams*: ſo remarkable, that they are a kind of experimental myſtery, a ſtanding miracle. Behold the moſt vigorous conſtitution, when reſigned to the ſlumbers of the night. Its activity is oppreſſed with indolence; its ſtrength ſuffers a temporary annihilation. The nerves are like a bow unſtrung, the whole animal like a motionleſs log. Behold a perſon of the moſt delicate ſenſations and amiable diſpoſitions. His eyes, if wide open, diſcern no light, diſtinguiſh

no objects. His ears, with the organs unimpaired, perceive not the ſounds that are round about them. The exquiſitely fine ſenſe of feeling is overwhelmed with an utter ſtupefaction. Where are his ſocial affections? He knows not the father that begat him, the friend that is as his own ſoul. Behold the moſt ingenious ſcholar, whoſe judgment traces the moſt intricate ſciences, whoſe taſte reliſhes all the beauties of compoſition. The thinking faculties are unhinged, and inſtead of cloſe-connected reaſonings, there is nothing but a disjointed huddle of abſurd ideas. Inſtead of well-digeſted principles, nothing but a diſorderly jumble of crude conceptions.

Yet no ſooner does he awake, than he is poſſeſt of all his former endowments. His ſinews are braced and fit for action, his ſenſes alert and keen. The frozen affections melt with tenderneſs: the romantic viſionary is again the maſter of reaſon. And (what is beyond meaſure ſurprizing) the intoxicated mind does not work itſelf ſober by ſlow degrees, but in the twinkling of an eye, is poſſeſt of all its faculties! Why does not the numbneſs, which ſeized the animal powers, chain the limbs perpetually? Why does not the ſtupor, that deadens all the ſenſes, hold faſt its poſſeſſion? When the thoughts are once diſadjuſted, why are they not always in confuſion? How is it, that they are rallied in a moment, and reduced from the wildeſt irregularity to the moſt orderly array? From an inactivity reſembling death, and from extravagancies little differing from madneſs, how ſuddenly is the body reſtored to vigour and agility? How inſtantaneouſly is the mind re-eſtabliſhed

liſhed in ſedateneſs and harmony! Surely *this is the Lord's doing. And it is marvellous in our eyes!*

14. That all *Motion* is performed by means of the muſcles, all men are now agreed. And it is ſuppoſed that the motions of the muſcles proceed, from the influx of the animal ſpirits; which, entering them by means of the nerves, ſwell and ſhorten the belly of the muſcle, and thereby draw the extremities together, and move the parts connected therewith. But all this likewiſe is mere conjecture. God only knows his own work.

15. That ſome motions are *voluntary*, and ſome are not, is another amazing proof of the Creator's wiſdom. Thoſe which are abſolutely neceſſary for the conſervation of the machine, as the beating of the pulſe, and the circulation of the blood, go on by a kind of mechanic law, which no way depends upon our will: while a thouſand other motions begin and end, by a ſingle act of our will, when we pleaſe. But how this bodily motion is connected with that act of our mind, who is able to explain?

16. There is a manifeſt congruity between the ſtature of man, and his age during the time of his growth. And as five feet and an half may be thought the ordinary height of man, ſo may ſeventy years the ordinary period of his life. Yet ſome vaſtly exceed in both reſpects. And as we know *Thomas Parre* and *Henry Jenkins* compleated double that uſual term of life, ſo we have no reaſon to queſtion, that ſome have doubled the common ſtature of man. *Walter*

Parſons, King *James* the Firſt's porter, was full ſeven feet, ſeven inches high. Mr. *Ray* ſaw a man at *Bruges*, who was eight feet and a half; all his limbs well ſhaped, and his ſtrength proportionable. *Becanus* ſays, he ſaw a youth almoſt nine feet high, a man near ten, and a woman quite ten feet. *Pliny* mentions ſeveral men of the ſame height in his age. Yea, *Thevenot* tells us, that he met a *Spaniſh* merchant on the coaſt of *Afric*, who had in a coffer the ſkull and bones of an *American* giant, which he brought with him from that country, who was 11 feet, five inches in height, and died in the year 1559.

From theſe warrantable accounts we learn, that there have been men 11 or 12 feet high, which equals, if not exceeds, the ſtature of the talleſt giant mentioned in ſcripture. The height of *Goliah* was but ſix cubits and a ſpan, which is only nine feet, nine inches. Indeed the bedſtead of *Og*, the king of *Baſan*, is ſaid to have been nine cubits in length. But his bed muſt have been longer than his body: we may fairly allow nine inches above his head, and as much below his feet. And making this deduction, he was not above twelve feet high: much of the ſame ſtature with the giant, whoſe forehead bone is ſtill kept in the medicine-ſchool at *Leyden*.

Is this deviation from the common ſtature of man by largeneſs, more remarkable than its oppoſite? The deviation from it by littleneſs, which has been obſerved in ſome inſtances? Such was the dwarf, who lived for ſeveral years in the palace of the king of *Poland*. His parents were healthy, ſtrong peaſants, who af-

firmed, that at his birth he weighed ſcarce a pound and a quarter, that he was preſented on a plate to be baptized, and for a long time had a wooden ſhoe for his bed. When 18 months old, he could ſpeak ſome words; when two years old, he could walk almoſt without help. His ſhoes were then juſt an inch and a half long. When he was ſix years of age, the king of *Poland* gave him the name of *Bebe*, and kept him in his palace. His height was then fifteen inches, and he weighed thirteen pounds. He was in perfect health, his perſon was agreeable and well-proportioned; but there was little appearance of underſtanding. He had no ſenſe of religion, was incapable of reaſoning, and could learn neither muſic nor dancing. Yet he was ſuſceptible of paſſions in an high degree, anger and jealouſy in particular. When 16 years old, he was 29 inches high, being ſtill healthy and well-proportioned; but from that time his health declined; yet he grew four inches in the four ſucceeding years. At 21 he was ſhrunk and decrepit, and at twenty-two it was with difficulty he could walk an hundred ſteps. In his 23d year he fell into a kind of lethargy, and in a few days died, as it were of old age.

17. The two moſt eminent inſtances of longevity in *England* were *Thomas Parre* and *Henry Jenkins*. *Thomas Parre* was a poor countryman of *Shropſhire*, whence he was brought up to *London* by *Thomas* Earl of *Arundel*. At the age of 120 he married a widow: at 130 he could do any huſbandry work, even threſhing of corn, although ſoon after, his ſight began to fail; nor had he the uſe of his memory, or but

in a ſmall degree for ſeveral years before he died; but he retained his hearing and apprehenſion to the laſt. He uſed to eat often, by day and by night, of milk, old cheeſe with courſe bread, whey and ſmall beer. He died at the age of an hundred and fifty two years and nine months. He might have lived much longer, but coming out of a clear, thin, and free air to *London*, and from a plain country diet, to that of a ſplendid family, where he fed high, and drank the beſt wines, the natural functions were overcharged, and death could not but ſoon enſue.

" *Henry Jenkins* calling at my houſe, I aſked how old he was? He pauſed and ſaid, " About 162, or 163." I aſked, what was the firſt public tranſaction he remembered? He ſaid, " The battle of *Flowden-field*, being then 11 or 12 years old."

For many years he was a fiſherman, and uſed to wade in the ſtreams. After he was an hundred years old, he frequently ſwam in the rivers. The latter part of his life, he was obliged to beg. He died at *Ellerton upon Swale*, in *Yorkſhire*, Dec. 8. 1670: having lived (ſuppoſing him to have been 12 years old, at the battle of *Flowden-field*, which was fought *Sept.* the 9th, 1513) an hundred and ſixty-nine years, that is, ſixteen longer than *Thomas Parre*.

CHAP.

CHAP. III.

Of the preternatural State of the Human Body.

1. *What the preternatural ſtate of the Body means.*
2. *The Variety of Diſeaſes,*
3. *Reduced to three claſſes, thoſe of the Solids;*
4. *Thoſe of the Fluids, particularly, the Blood;*
5. *Thoſe of the Animal Spirits:*
6. *The remote Cauſes of Diſeaſes:*
7. *Of Fevers:*
8. *The Way to preſerve Health:*
9. *Of Life and Death.*

1. WHEN the ſtructure or diſpoſition of the parts of the body is ſo diſturbed and diſordered, that the natural operations are no longer performed, or not in the manner they ought: this is a preternatural ſtate of the body, otherwiſe termed a *diſeaſe*.

2. There cannot but be a great variety of Diſeaſes, whether we conſider the manner, wherein that ſtructure or diſpoſition is diſturbed, the part wherein each diſeaſe has its ſeat, or the various effects and circumſtances of them. Some diſeaſes only hurt the uſe of the parts; ſome wholly *deſtroy* it. Some affect this or that

part; others the whole body. Some diſorder the body, ſome the mind; and others both mind and body,

3. But they are all reducible to three claſſes, thoſe of the *Solids*, of the *Fluids*, and of *both*. The ſolid parts may be bruiſed, wounded, ſwelled, or removed out of their natural place.

It is a wonderful proviſion which Nature makes in one of the moſt dreadful calamities incident to the Solids. When a bone is broken, let it only be replaced, and preſerved in that ſituation, and nature does the reſt, by ſupplying the divided parts with a *Callus*.

This oozes out from the ſmall arteries and bony fibres of the divided parts, in form of a jelly, and ſoon fills up the cavities between them. It ſoon grows cartilaginous, afterwards bony, and joins the fractured parts ſo firmly, that the bone will be more eaſily broken in any other part than in that.

A callus of a different kind is formed on our hands and feet. This is compoſed of ſeveral layers of particles looſely connected. Theſe if ſteeped in fair water eaſily ſeparate; and then are found, if viewed thro' a microſcope, to be all of one ſhape, reſembling that of a weaver's ſhuttle, broad in the middle and pointed at each end. Being ſteeped again, they divide into a great number of ſmaller particles, all of the ſame figure with the firſt.

The thickneſs of the ſkin in the hands of thoſe who labour hard, is wholly owing to vaſt numbers of theſe particles which combine together, but ſo looſely that they are eaſily ſeparated on moiſtning. That thick ſkin is compoſed of ſeveral layers of different thickneſs, which

which have been added from time to time: each of which layers is only a congeries of almoſt an infinity of theſe particles.

But people who labour ever ſo hard, will have little callus on their hands if they waſh them often. The waſhing the hands daily rubs off a great quantity of theſe ſcales. Indeed it is ſurprizing to ſee, how large a quantity of them is daily thrown off from our hands and feet, though from no other part of the body. We may learn from this the great bounty of Nature, in ſo carefully ſupplying the parts deſigned for walking or labour, with an additional matter for their defence, which is not in any other part of the body.

4. The diſeaſes of the *Fluids* lie chiefly in the blood, when it is either too thick and ſizy, whereby its motion becomes too languid and ſlow, whence ſpring the diſeaſes owing to obſtruction: or too thin. From the former cauſe ariſe leproſies, ſcirrhus's, lethargies, melancholy, hyſteric affections, and if at the ſame time it abound in acid ſalts, the ſharp points of theſe tear the tender fibres, and occaſion the ſcurvy, king's-evil, conſumption, with a whole train of painful diſtempers.—Fevers frequently ariſe from the too great thinneſs of the blood.

The *Plague* is not an *European* diſeaſe. It is properly a diſeaſe of *Aſia*, where it is epidemical, and is never known elſewhere, but by importation from thence. The ſmall-pox alſo is an exotic diſeaſe, and was not known in *Europe*, or even *Aſia Minor*, till a ſpice-trade was opened by the later princes of *Egypt* to the remoteſt

remoteſt part of the *Eaſt-Indies*. Thence it originally came, and there it rages at this day.

5. As to the Diſeaſes aſcribed to the *Animal Spirits*, ſome are thought to proceed from the ſuppreſſion or diminution of their motion, as apoplexies and palſies: ſome from their exceſſive or irregular motion, as madneſs, convulſions, epilepſies.

I know not whether the gentlemen of the faculty would not term the following, "a diſeaſe of the *animal ſpirits*." *Donald Monro*, at *Strathbogie*, in *Scotland*, imitates unawares all the motions of thoſe he is with. He is a little ſlender old man, and was ſubject to this infirmity from his infancy. He is loath to have it obſerved, and therefore caſts down his eyes in the ſtreets, and turns them aſide when in company. We had made ſeveral trials before he perceived it, and afterward had much a-do to make him ſtay. He imitated not only our ſcratching our heads, but the wringing our hands, and every other motion. We needed not to perſuade him to be covered; for he ſtill covered or uncovered as we did: and all ſo exactly, and yet with ſuch a natural and unaffected air, that none could ſuſpect he did it deſignedly. When we held both his hands, and cauſed another to make ſuch motions, he ſtruggled to get free. But when we would have known more particularly, how he found himſelf affected, he would only give us this ſimple anſwer, That "it vexed his heart and his brain."

But to what claſs ſhall we refer the diſeaſe of *Ann Jackſon*? She was born at *Waterford*, of *Engliſh*

Engliſh parents, both ſaid to be ſound and healthy, and from three years old, had *Horns* growing on various parts of her body. She is now thirteen or fourteen; the horns grow chiefly about the joints, they are faſtened to the ſkin like warts, and about the roots reſemble them much in ſubſtance, but toward the end are much harder. At the end of each finger and toe is one, as long as the finger or toe itſelf, riſing a little between the nail and fleſh, and bending again like a turkey's claw. On the joints of each finger and toe are ſmaller ones, which ſometimes fall off, but others come in their place. Round her knees and elbows are many; two in particular at each elbow, which twiſt like rams-horns. At each ear grows one: yet ſhe eats and drinks heartily, ſleeps ſoundly, and performs all the offices of nature, like other healthy perſons.

6. Such are the proximate cauſes of diſeaſes. As to the remote, the chief are theſe, 1. Intemperance in meat or drink, either with regard to the quantity or quality. 2. Want of exerciſe, or exceſs therein. 3. Immoderate ſleep or watching. 4. Unwholeſome air. 5. The diminution of ſome natural evacuation. 6. Irregular paſſions. All or any of theſe affect the temperature and motion of the blood and ſpirits.

7. But it can ſcarce be conceived, after all that has been ſaid and wrote, on almoſt every ſubject, how very little is known to this day, concerning the cauſes of diſeaſes. In moſt caſes the moſt ſkilful phyſicians acknowledge they

they have nothing but conjectures to offer. We may give a ſpecimen with regard to *fevers*, the moſt common of all diſtempers. Theſe are of various kinds: at preſent we will ſpeak of *intermitting* fevers only. Moſt of theſe agree in the following ſymptoms. During the approach of the fit, cold and ſhivering ſeize the body, with a ſmall and ſlow pulſe. Heat ſucceeds, with a quick, ſtrong, hard pulſe, followed by ſweat and a ſofter pulſe. Theſe fits return at ſtated times.

It is ſuppoſed, that theſe changes in the blood ariſe from ſome foreign matter mixt with it, which it cannot readily aſſimilate, and which therefore muſt in ſome meaſure hinder its motion: perhaps becauſe the particles of it are too large, too long, or branching out. When the circulation is hindered or retarded, *chilneſs* naturally follows. And if theſe particles ſticking in the finer paſſages are preſt on by the affluent blood, this will occaſion both a ſhock and tremor of the muſcles, and make the pulſe more *weak* and *ſlow*. But when they are at length broken and comminuted by the continued afflux of the blood, it will flow more violently, and of courſe occaſion *heat*, which driving the blood to the ſurface of the body, many of its thinner particles will burſt through the pores, in the form of *ſweat*. As to the fevers returning at ſtated times, it is ſuppoſed, the peccant matter is generated from time to time, and mingled with the blood afreſh; whence the ſame ſymptoms of courſe return, and that with more or leſs violence, as more or leſs of that matter is generated. And as this is done more ſwiftly or ſlowly, the fever returns in one, two, or three days.

days. But all this is mere conjecture. It may be ſo; and it may not. So that though we may gueſs much, we know nothing about it.

8. It is ſufficient for us to know, how we may avoid diſeaſes, whether we can account for them, or not. To this end, we ſhould avoid whatever in meat, drink, motion or reſt, is likely to produce any conſiderable change in the blood. The body likewiſe ſhould be as far as poſſible accuſtomed to bear ſome change of food, air, and other externals, that if we ſhould at any time be conſtrained to make ſuch a change, no ill conſequence may inſue. But no preciſe rule can be laid down, which will ſuit all conſtitutions. Every man muſt conſult his own reaſon and experience, and carefully follow them.

A moſt unaccountable method of removing many diſeaſes, was that of the famous Mr. *Greatrix*. "I give you nothing concerning him, ſays Mr. *Boyle*, but from eye-witneſſes. My own brother, ſome time ſince was ſeized with a violent pain in his head and back. Mr. *Greatrix* coming by accident to our houſe, gave preſent eaſe to his head by ſtroking it. He then ſtroked his back: the pain immediately fled to his right thigh. He purſued it with his hand to the knee, ankle, foot, toe, then he ſtroked this, and it was gone.

My uncle's daughter was ſeized with a pain in her knees, which occaſioned a white ſwelling. She tried many remedies without effect, for ſix or ſeven years. Mr. *Greatrix* then coming to *Dublin*, my aunt brought her to him. He ſtroked her knees, and the pain fled downward

ward from his hands, till he drove it out of her toes. And in a little time the white ſwelling went away.

I had an acquaintance, who after a fever was very deaf, and had a violent pain in her ears. Mr. *Greatrix* put ſome ſpittle into her ears and rubbed them, which cured both the pain and deafneſs.

Another told me, that when a child, ſhe was extremely troubled with the *king's evil*. She tried many remedies in vain; but Mr. *Greatrix* ſtroked and perfectly cured her. A Smith near us had two daugters troubled with the ſame diſtemper. One of theſe had a running ſore in the thigh, the other in the arm: he cured them both. He cured all kinds of hyſteric fits. He likewiſe cured the falling ſickneſs, and without any relapſe, provided he could ſee the patient in three or four fits."

9. As long as the ſoul and body are united, a man is ſaid to be *alive*. But it is extremely difficult to determine the preciſe time at which life ceaſes, or what that is, which is abſolutely neceſſary to the continuance of it. Is reſpiration? But when this is entirely ceaſed, as is the caſe in a perſon ſtrangled, blow ſtrongly into the lungs, and they play again; which ſhews he was not dead before.—Is the beating of the heart? But when this alſo is ceaſed, in the forementioned caſe, take the ſame method, and when the lungs begin to play, the heart begins to beat anew.—Is the circulation of the blood? But perſons drowned, who have been ſo long under water, as to have no pulſe remaining in any artery, and conſequently no cir-

circulation, have recovered by the uſe of proper means, and lived many years after.—Is the fluidity of the blood? Nay, but it is a common thing in *Sweden*, to recover to life one who has been twenty-four hours under water; and who not only has no pulſe, but is as ſtiff all over, as any dead corpſe can be. What then is *Death?* Undoubtedly it is the ſeparation of the ſoul and body. But there are many caſes wherein none but God can tell the moment wherein they ſeparate.

Many who *ſeem* to be dead, may be recovered. ——A perſon ſuffocated by the ſteam of coals, ſet on fire in the pit, fell down as dead. He lay between half an hour and three quarters, and was then drawn up, his eyes ſtaring, his mouth gaping, his ſkin cold: not the leaſt breathing being perceivable, nor the leaſt pulſe either in his heart or arteries.

A ſurgeon applied his mouth to that of the patient, and by blowing ſtrongly, holding the noſtrils at the ſame time, raiſed the cheſt by his breath. Immediately he felt ſix or ſeven quick beats of the heart: the lungs began to play, and ſoon after the pulſe was felt in the arteries. He then opened a vein, which at firſt bled drop by drop, but in a while bled freely. Mean time he cauſed him to be pulled and rubbed. In an hour he began to come to himſelf; in four hours walked home, and in four days returned to his work.

Wherever the ſolids are whole, and their tone unimpaired, where the juices are not corrupted, where there is the leaſt remains of animal heat, it would be wrong not to try this ex-

experiment. This takes in a few diſeaſes, and many accidents. Among the firſt are many that cauſe ſudden deaths, as apoplexies and fits of various kinds. In many of theſe it might be of uſe to apply this method: and in various caſualties, ſuch as ſuffocations from the damps of mines and coal-pits, the condenſed air of long-unopen'd wells, the noxious vapours of fermenting liquors received from a narrow vent, the ſteam of burning charcoal, arſenical effluvia, or thoſe of ſulphureous mineral acids. —And perhaps thoſe who ſeem to be ſtruck dead by lightning, or any violent agitation of the paſſions, as joy, fear, anger, ſurprize, might frequently be recovered by this ſimple proceſs.

The animal machine is like a clock: the wheels whereof may be in ever ſo good order, the mechaniſm compleat in every part, and wound up to the full pitch; yet without ſome impulſe communicated to the pendulum, the whole continues motionleſs.

Thus in theſe accidents, the Solids are whole and elaſtic, and the juices no otherwiſe vitiated, than by a ſhort ſtagnation, from the quieſcence of that moving *Something*, which enables matter in animated bodies, to overcome the reſiſtance of the medium it acts in. Inflating the lungs, and thus communicating motion to the heart, like giving the firſt vibration to a pendulum, enables this Something to reſume the government of the fabric, and actuate its organs afreſh.——It has been ſuggeſted, That "a pair of bellows might be applied, better than a man's mouth." But, 1. Bellows may not be at hand: 2. The lungs of one man may

may ſafely bear as great a force, as the lungs of another can exert, which by the bellows cannot always be determined: 3. The warmth and moiſture of the breath may likewiſe be of uſe.

But what is properly a *natural Death?* From the very birth, every veſſel in the human body grows ſtiffer and ſtiffer, by the adheſion of more and more earthy particles to its inner ſurface. Not only ſolid food ſupplies it with theſe, but every fluid that circulates through it. Hereby more and more of the ſmall veſſels are ſo filled up, as to be no longer pervious. In proportion, the coats of the larger veſſels grow harder, and their cavities narrower. Hence the dryneſs and ſtiffneſs of all the parts, which are obſervable in old age. By this means, more and more of the veſſels are deſtroyed, the finer fluids ſecerned in leſs quantity, the concoctions weakened, and the reparation of the decayed and injured parts prevented. So that only the coarſer juices continue to run ſlowly through the larger veſſels. Soon theſe alſo not only become narrow, but ſtiff, bony, and unelaſtic, till even the great artery having loſt its ſpring, can propel the blood no longer. And then follows death by old age, which is a purely *natural* death. But this is a very rare caſe: it is ſeldom life is ſo long protracted, the lamp of life being eaſily blown out, when it burns with ſo feeble a flame. So that the age of man ſeldom exceeds threeſcore years and ten, before duſt returns to duſt.

The term of life can be prolonged but a very little time, by any art we can uſe. A few only have lived beyond the ordinary duration of human

human exiſtence; ſuch as *Parre*, and *Jenkins*: yet theſe men uſed no peculiar arts to prolong life; on the contrary, they were peaſants, accuſtomed to the greateſt fatigues, and who had no ſettled rules. Indeed, if we conſider that the *European*, the *Negroe*, the *Chineſe*, and the *American*, the civilized man, and the *Savage*, the rich and the poor, the inhabitant of the city, and of the country, though all ſo different in other reſpects, are yet entirely ſimilar in the period allotted them for living; if we conſider that neither the difference of race, of climate, of nouriſhment, of convenience, or of ſoil, makes any difference in the term of life; if we conſider that thoſe men, who live upon raw fleſh, or dried fiſhes, upon ſage or rice, upon caſſava, or upon roots, nevertheleſs live as long as thoſe who are fed upon bread and meat; we ſhall readily acknowledge, that the duration of life depends neither upon habit, cuſtoms, nor the quantity of food, and that nothing can change the laws of that mechaniſm, which regulates the number of our years.

If there be any difference in the different periods of man's exiſtence, it ought principally to be aſcribed to the quality of the air. It has been obſerved, that in elevated ſituations there have been found more old people than in thoſe that were low. The mountains of *Scotland*, *Wales*, *Auvergne*, and *Switzerland*, have furniſhed more inſtances of extreme old age, than the plains of *Holland*, *Flanders*, *Germany*, or *Poland*. But, in general, the duration of life is nearly the ſame in moſt countries. Man, if not cut off by accidental diſeaſes, is generally found

found to live ninety or an hundred years. Our anceſtors did not live beyond that date; and, ſince the times of *David*, this term has made but little alteration.

If we be aſked how, in the beginning, men lived ſo much longer than at preſent, and by what means their lives were extended to nine hundred and thirty, or even nine hundred and ſixty years, it may be anſwered, that the productions of the earth, upon which they fed, might be of a different nature at that time, from what they are at preſent. But perhaps it is better to ſay, that the term was abridged by divine command, in order to keep the earth from being over-ſtocked with human inhabitants; ſince, if every perſon were now to live and generate for nine hundred years, mankind would be increaſed to ſuch a degree, that there would be no room for ſubſiſtence: ſo that the plan of Providence would be altered; which is ſeen not to produce life, without providing a proper ſupply!

But to whatever extent life may be prolonged, or however ſome may have delayed the effects of age, death is the certain goal to which all are haſtening. All the cauſes of decay, which have been mentioned, contribute to bring on this dreaded diſſolution. However, nature approaches to this awful period, by ſlow and imperceptible degrees, life is conſuming day after day, and ſome one of our faculties, or vital principles, is every hour dying before the reſt; ſo that death is only the laſt ſhade in the picture: and it is probable, that man ſuffers a greater change in going from youth to age, than from age into the grave. When we firſt begin to live, our lives

lives may ſcarcely be ſaid to be our own; as the child grows, life increaſes in the ſame proportion, and is at its height in the prime of manhood. But as ſoon as the body begins to decreaſe, life decreaſes alſo; for, as the human frame diminiſhes, and its juices circulate in ſmaller quantity, life diminiſhes and circulates with leſs vigour: ſo that as we begin to live by degrees, we begin to die in the ſame manner.

Why then ſhould we fear *Death*, if our lives have been ſuch as not to make *Eternity* dreadful? Why ſhould we fear that moment which is prepared by a thouſand other moments of the ſame kind, the firſt pangs of ſickneſs being probably greater than the laſt ſtruggles of departure. Death, in moſt perſons, is as calmly endured, as the diſorder that brings it on. If we enquire from thoſe, whoſe buſineſs it is to attend the ſick, and the dying, we ſhall find, that, except in a very few acute caſes, where the patient dies in agonies, the greateſt number die quietly, and ſeemingly without pain. And even the agonies of the former rather terrify the ſpectators, than torment the patient; for how many have we not ſeen, who have been accidentally relieved from this extremity, and yet had no memory of what they then endured? In fact, they had ceaſed to live, during that time when they ceaſed to have ſenſation; and their pains were only thoſe of which they had an idea.

The greateſt number of mankind die, therefore, without ſenſation; and of thoſe few that ſtill preſerve their faculties to the laſt moment, there is ſcarce one that does not alſo preſerve the hopes of ſtill out-living his diſorder. Nature, for the happineſs of man, has rendered this

this ſentiment ſtronger than his reaſon. A perſon dying of an incurable diſorder, which he muſt know to be ſo, by frequent examples of his caſe; which he perceives to be ſo, by the inquietude of all around him, by the tears of his friends, and the departure, or the face of the phyſician, is, nevertheleſs, ſtill in hopes of getting over it. His intereſt is ſo great, that he only attends to his own repreſentations; the judgment of others is conſidered as an haſty concluſion; and while death every moment makes new inroads upon his conſtitution, and deſtroys life in ſome part, hope ſtill ſeems to eſcape the univerſal ruin, and is the laſt that ſubmits to the blow.

Death, therefore, is not the terrible thing which we ſuppoſe it to be. It is a ſpectre which frights us at a diſtance, but which diſappears when we come to approach it more cloſely. Our ideas of its terrors are conceived in prejudice, and dreſſed up by fancy; we regard it not only as the greateſt misfortune, but as alſo an evil accompanied with the moſt excruciating tortures: we have even encreaſed our apprehenſions, by reaſoning on the extent of our ſufferings. It muſt be dreadful, ſay ſome, ſince it is ſufficient to ſeparate the ſoul from the body; it muſt be long, ſince our ſufferings are proportioned to the ſucceſſion of our ideas; and theſe being painful, muſt ſucceed each other with extreme rapidity. In this manner falſe philoſophy labours to augment the miſeries of our nature, and to aggravate that period, which Nature has kindly covered with inſenſibility. Neither the mind, nor the body, can ſuffer theſe calamities; the mind is, at that

time, moſtly without ideas, and the body too much enfeebled, to be capable of perceiving its pain. A very acute pain produces either death, or fainting, which is a ſtate ſimilar to death: the body can ſuffer but to a certain degree; if the torture becomes exceſſive, it deſtroys itſelf; and the mind ceaſes to perceive, when the body can no longer endure.

In this manner, exceſſive pain admits of no reflection; and wherever there are any ſigns of it, we may be ſure, that the ſufferings of the patient are no greater than what we ourſelves may have remembered to endure.

But, in the article of death, we have many inſtances in which the dying perſon has ſhewn, that every reflection that pre-ſuppoſes an abſence of great pain, and, conſequently, that pang which ends life, cannot even be ſo great as thoſe which have preceded. Thus, when *Charles* XII. was ſhot at the ſiege of *Frederick-ſhall*, he was ſeen to clap his hand on the hilt of his ſword; and although the blow was great enough to terminate one of the boldeſt and braveſt lives in the world, yet it was not painful enough to deſtroy reflection. He perceived himſelf attacked, he reflected that he ought to defend himſelf, and his body obeyed the impulſe of his mind, even in the laſt extremity. Thus it is the prejudice of perſons in health, and not the body in pain, that makes us ſuffer from the approach of death: we have, all our lives, contracted an habit of making out exceſſive pleaſures and pains; and nothing but repeated experience ſhews us, how ſeldom the one can be ſuffered, or the other enjoyed to the utmoſt.

If there be any thing neceſſary to confirm what we have ſaid, concerning the gradual ceſſation

ſation of life, or the inſenſible approaches of our end, nothing can more effectually prove it, than the uncertainty of the ſigns of death. If we conſult what *Winſlow* or *Bruhier* have ſaid upon this ſubject, we ſhall be convinced, that between life and death, the ſhade is ſo very undiſtinguiſhable, that even all the powers of art can ſcarcely determine where the one ends, and the other begins. The colour of the viſage, the warmth of the body, the ſuppleneſs of the joints, are but uncertain ſigns of life ſtill ſubſiſting; while, on the contrary, the paleneſs of the complexion, the coldneſs of the body, the ſtiffneſs of the extremities, the ceſſation of all motion, and the total inſenſibility of the parts, are but uncertain marks of death begun. In the ſame manner alſo, with regard to the pulſe, and the breathing: theſe motions are often ſo kept under, that it is impoſſible to perceive them. By approaching a looking-glaſs to the mouth of the perſon ſuppoſed to be dead, people often expect to find whether he breathes or not. But this is a very uncertain experiment. The glaſs is frequently ſullied by the vapour of the dead man's body; and often the perſon is ſtill alive, although the glaſs is no way tarniſhed. In the ſame manner, neither burning, nor ſcarifying, neither noiſes in the ears, nor pungent ſpirits applied to the noſtrils, give certain ſigns of the diſcontinuance of life; and there are many inſtances of perſons who have endured them all, and afterwards recovered, without any external aſſiſtance, to the aſtoniſhment of the ſpectators. How careful, therefore, ſhould we be, before we commit thoſe who are deareſt to us to the grave, to be

well assured of their departure. Experience, justice, humanity, all persuade us not to hasten the funerals of our friends, but to keep their bodies unburied, until we have certain signs of their real decease.

Indeed, soon after the creation, when the earth was to be peopled by one man and one woman, the wise Providence of GOD prolonged the life of man to above 900 years. After the Flood, when there were three men to people the earth, their age was cut shorter. And none of these patriarchs, except *Shem*, attained to five hundred years. In the next century none reached 240. In the third, none but *Terah* lived 200: men being then so increased, that they built cities, and divided into different nations. As their number increased, the length of their lives diminished, 'till about the time of *Moses* it was reduced to 70 or 80 years, where it stands at this day. This is a good medium, so that the earth is neither over-stocked, nor kept too thin of inhabitants. If men were now to live to *Methuselah's* age, of 969 years, or only to *Abraham's* of 175, the earth would be over-peopled. If on the contrary, the age of man was limited like that of divers other animals) to 10, 20 or 30 years, it would not be peopled enough. But at the present rate, the balance is nearly even, and life and death keep on an equal pace.

This is highly remarkable, that wherever any account has been taken, there is a certain rate and proportion in the propagation of mankind. Such a number marry, and so many are born, in proportion to the number of persons in every town or nation. And as to births,

two

two things are very obſervable: One, the proportion of males and females, fourteen males to thirteen females, which is exactly agreeable to all the bills of mortality. And this ſurpluſage of males allows one man to one woman, notwithſtanding the caſualties to which men are expoſed above women. The other is, that a few more are born, than appear to die in any place. This is an admirable proviſion for extraordinary emergencies, to ſupply unhealthy places, to make up the ravages of epidemic diſtempers, and the depredations of war; and to afford a ſufficient number for colonies, in the yet unpeopled parts of the earth. On the other hand, thoſe extraordinary expences, are not only a juſt puniſhment of ſin, but alſo a wiſe means, to keep the balance of mankind even. So one would be ready to conclude, by conſidering the *Aſiatic*, and other more fertile countries, where prodigious multitudes are ſwept away by wars and plagues; and ſtill they remain full of people.

As to the length of life, it has been an antient opinion, that men lived longer in cold countries than in hot. But the reverſe is true. The inhabitants of the *Caribbee* Iſlands, uſually live an hundred and fifty years. In the *Molucca* Iſlands, the ordinary life of the natives is an hundred and thirty years. In *Sumatra*, *Iava*, and the neighbouring iſlands, the life of the inhabitants commonly extends to an hundred and forty years: in the realm of *Caſſuby*, to 150. The *Braſilians* frequently live 160 years, and many in *Florida* and *Iucatan* ſtill longer.

Nor is this at all improbable. For there being no ſuch inequality of weather in thoſe

climates as in ours, the body is not ſhocked by ſudden changes, but kept in a more equal temper. And ſickly perſons with us, when fixt to their beds, and kept in an equal degree of heat, are often found to hold out many years, who would otherwiſe ſcarce have ſurvived one.

Before concluding this head, we may obſerve one more eminent inſtance of the divine Wiſdom, in the great *variety* throughout the world of men's faces, voices, and hand-writing. Had men's faces been caſt in the ſame mould, their organs of ſpeech given the ſame ſound; and had the ſame ſtructure of muſcles and nerves given the hand the ſame direction in writing: what confuſion, what numberleſs inconveniencies muſt we have been expoſed to? No ſecurity could have been to our perſons, no certainty of our poſſeſſions. Our courts of juſtice abundantly teſtify the effects of miſtaking men's faces or hand-writing. But this the wiſe Creator has taken care to prevent from being a general caſe. A man's face diſtinguiſhes him in the light, as his voice does in the dark: and his hand-writing can ſpeak for him when abſent, and ſecure his contracts to future generations.

Laſtly, How admirably has God ſecured the execution of his original ſentence, upon every child of man, *Duſt thou art, and unto duſt ſhalt thou return?*—From the moment we live, we prepare for death, by the adheſion of duſt, mixt with all our aliments, to our native duſt; ſo that whatever we eat or drink, to prolong life, muſt ſap the foundation of it. Thus, in ſpite of all the wiſdom of man and all the precautions which can be uſed, every morſel we take, poiſons while it feeds, and brings us nearer to the duſt from whence we came.

CHAP.

CHAP. IV.

Of the Soul, and of the Origin of MAN.

1. *There is Something in Man which perceives the various Motions of the Body:*
2. *This Perception is sometimes continued, and recalled:*
3. *We know some Things in a more sublime Manner:*
4. *There is Something in us which has an Appetite to sensible Things:*
5. *And another Appetite, which is often contrary to this:*
6. *How Philosophers account for the Direction of our bodily Motions;*
7. *For the External Senses,*
8. *The Imagination and Memory,*
9. *The Understanding, Will, and Affections:*
10. *This may be so, or may not:*
11. *Of the Immortality of the Soul:*
12. *Of the Union of the Soul and Body:*
13. *Reason cannot discover the Origin of Man:*
14. *The Scriptural Account of it:*
15. *Of the Production of the Soul:*
16. *Of the Generation of the Body.*

1. EVERY one finds, there is something in himself, which *perceives* the motions raised in his body by outward objects. For when we see, hear, taste, smell or feel, while

the objects affect our bodily organs, we find alſo various perceptions in our mind, according to the variety of thoſe objects.

2. We obſerve likewiſe, that after the objects are removed, thoſe perceptions often *continue*, yea and are variouſly mixed and compounded together, which we term *Imagination*. And a long time after, when thoſe objects are not only removed, but even ceaſe to exiſt, thoſe perceptions *return* into our mind. And this we call *Memory*.

3. And as we *perceive* theſe outward objects, ſo we *know* that we do perceive them. The mind can look inward upon itſelf, and *reflect* upon its own perceptions. Over and above this, we ſeem to find in ourſelves, a knowledge of things *abſtracted* from matter. But the more we labour to penetrate into the nature of this divine principle, the more it ſeems to retire and withdraw itſelf from our moſt ſtudious reſearches.

4. In like manner we find in ourſelves various *Appetites* for good things, and *Averſions* to evil things: yea, the very involuntary motions of the body tend to avoid the evil and attain the good. And the things which are perceived by our ſenſes, or repreſented by our imagination, ſo neceſſarily affect us, that we can by no means hinder ourſelves from having an appetite for ſome, and an averſion to others.

5. Yet frequently a more hidden and *ſublime Appetite* exerts itſelf in our minds: one that checks, controls, and exerciſes authority over all the reſt. For if we are convinced, that

that the things which are pleaſant, are nevertheleſs hurtful, the appetite for them is overruled, and we find a deſire, not to enjoy, but to avoid them.

6. In order to explain theſe things, philoſophic men ſuppoſe, that all the *involuntary motions* of the body, are performed in a mechanical manner, by matter ſo and ſo modified: and that ſuch effects ſpring of courſe from ſuch cauſes, according to the ſtated laws of motion.

7. As to the *Senſes*, they ſuppoſe, that when the organs of ſenſe are ſtruck by any of the bodies that ſurround us, and the motion cauſed thereby continued thro' the nerves to the brain, the ſoul reſiding there is ſuitably affected: God having ſo cloſely connected the ſoul and the body, that on certain motions of the body, (if conveyed to the brain by means of the nerves) certain perceptions of the mind always follow: as, on the other hand, on certain perceptions of the mind, certain bodily motions follow.

8. They ſuppoſe, if theſe motions, which are by the nerves communicated to the brain, continue there after the objects are removed, the perception of theſe is *Imagination*: which, if it occurs after it has ceaſed, is then ſtiled *Memory*. Others ſuppoſe, that Imagination reſults from the motion of the animal ſpirits, thro' thoſe traces which were made in the brain, while the outward objects were preſent; and Memory, from the ſpirits moving thro' them afreſh, after ſome intermiſſion.

9. Once more. They ſuppoſe there are two faculties in the ſoul, one that is paſſive, the

Underſtanding, by which it perceives all the motions of the body, and knows and reflects on its own operation: the other active the *Will*, by which we incline to good, and are averſe to evil. The *Affections* are only, the Will exerting itſelf variouſly on various objects.

10. To ſpeak freely upon the matter. I know the body of man is contrived with ſuch exquiſite wiſdom, that he is able, by means of the organs of ſenſe, to *perceive* outward objects, to *continue* thoſe perceptions, to *recall* them after they are gone, and by a *reflex* act, to know what paſſes in his mind or body. But I know not how to account for any of theſe things.

11. That the *Soul* is immaterial is clear from hence, that it is a *thinking* ſubſtance. If it be ſaid, "GOD can endue matter with a faculty of Thinking:" We anſwer, no otherwiſe than he can endue a Spirit with ſolidity and extenſion; that is, he can change ſpirit into matter: and he can change matter into ſpirit. But even the Almighty cannot make it *think* while it remains *matter*; becauſe this implies a contradiction.

12. The *union* of the ſoul and body is another of thoſe things which human underſtanding cannot comprehend. That body and ſpirit can't be implicated or twiſted together like two bodily ſubſtances, we know. But how two ſubſtances of ſo widely different natures, can be joined at all, we know not. All we can tell is this; God has ordered that certain perceptions in the ſoul, ſhould conſtantly follow certain motions of the body, and certain motions of the body, ſuch perceptions in the ſoul.

13. How

13. How mankind began, is another point, which is too hard for our reaſon to determine. That men always exiſted, is no way probable, were it only on this account, the late invention of arts. For ſince it appears, at what time the moſt neceſſary arts were invented, we cannot reaſonably ſuppoſe, that men began to exiſt long before that period: ſeeing if they had always exiſted, no reaſon can be given, why theſe and many more arts, were not invented long before. And yet the accounts given of the origin of mankind, by the wiſeſt of the heathen philoſophers, are ſo above meaſure ridiculous, that they ſerve as a melancholy proof of the weakneſs of barely natural reaſon.

14. The ſcriptural account is this. God made the body of man out of the earth, and breathed into him the *Breath of Lives:* not only an animal life, but a ſpiritual principle, created to live for ever. Even his body was then perfect in its kind; neither liable to death nor pain. But what the difference was between the original and the preſent body we cannot determine.

But, to form it even as it is now, no leſs than a divine power was requiſite. No leſs could mix earth, water, air and fire, in ſo exact a proportion, and then frame ſo many different parts, of ſo various figure, texture and magnitude. God alone was able to form the original fibres; to weave thoſe fibres into hollow tubes; to diſpoſe theſe tubes, filled with their ſeveral humours and variouſly interwoven with each other, into different organs; and of thoſe organs connected together in a continued

ſeries and due ſituation, to finiſh ſo compli-cated and wonderful a machine as the human body.

15. Nothing was wanting now, but that the immortal Spirit ſhould be ſent into its habitation, to bear the image of its Creator, and enjoy his glory. But the manner wherein this was done we cannot tell: this knowledge is too wonderful for us. And it is of no uſe to indulge mere conjecture, where knowledge is unattainable.

16. Even the preſent production of the body by *Generation* is what no man can fully explain. But this we know: The female *Ovaries*, which hang on each ſide the womb, contain abundance of ſmall veſicles, filled with a tranſparent liquor. It is ſuppoſed, that each of theſe contains in miniature, all the parts of a human body: that when one of them is penetrated by the male ſeed, it is rarified and expanded thereby, 'till it breaks the membranous ſhell, and by the *Fallopian Tube*, falls down into the womb. Here being ſlightly faſtened to the ſides of the womb, it receives nouriſhment from the mother, till the heart is formed and begins to propel the blood to the extremities of the ſtill increaſing body. When it is come to its full ſize, by rolling to and fro, it tears aſunder the incloſing membranes, and having burſt as it were the priſon-bars, emerges into light.

The firſt thing that appears of a fœtus is the *Placenta*, like a little cloud on one ſide of the outer coat of the egg. About the ſame time the *Spine* becomes viſible; and a little after, the

the *Brain* and *Cerebellum* appear like two ſmall bladders. Next the *Eyes* ſtand prominent in the head: then the *Punctum Saliens*, the heart-beating is plainly ſeen, and laſt of all, the extremities. When formed, the fœtus lying in the womb, is almoſt of an oval figure. For the head hangs down with the chin upon the breaſt. Its back is round. With its arms it embraces the knees, which are drawn up to the belly, and its heels are cloſe to the buttocks. Its head is upward, and its face to the mother's belly. About the ninth month, the head, which 'till then was lighter, becomes heavier than any other part. In conſequence of this, the head falls down in the liquor that contains it; the feet get looſe, and the face turns toward the mother's back. But being now in an uneaſy poſture, it ſtruggles and brings on the mother's throes.

Mr. *Dodart* nicely obſerving an embryo, one and twenty days old, found the placenta more than half of the whole; and thence concludes the younger the embryo is, the larger is the placenta in proportion to it: a plain reaſon, why miſcarriages, though the fœtus is leſs, are more dangerous than regular deliveries. For though the embryo in a miſcarriage makes a way ſufficient for itſelf, it does not make a way for ſo large a placenta as is to follow it.

The embryo itſelf was only ſeven lines long, from the top of the head to the bottom of the ſpine, where it terminated. The thighs were not unfolded: they only appeared like two little warts at the bottom of the trunk. The arms made the ſame appearance on the ſhoulders. The head was one third of the whole length.

length. On this were two ſmall black points, which would have been eyes. The mouth was very big; a plain indication that it fed thereby. There was no eminence for the noſe; but two little, almoſt imperceptible, pits for the noſtrils. Always the younger the embryo, the bigger the head is, in proportion to the body. The parts nearer the head are likewiſe bigger, in proportion to the reſt.

It weighed leſs than ſeven grains, which is an extraordinary lightneſs, for a body ſeven lines long. It was ſo ſoft, that no part of it could be touched, without making a change in its figure. Upon opening it, Mr. *Dodart* diſcovered the heart and the right auricle. All the other parts in the thorax and the lower belly, were ſimple outlines, (all veſicular) except a part on the left ſide, probably the ſpleen.

Some ſuppoſe, that millions of animalcula ſwim in the ſeed of male animals, which are ſo many embryos, for which a receptacle only is provided in the eggs of the female. But all agree, that either the male ſeed, or the female egg, contains all the parts of the body; ſo that generation is no more than the growth or unfolding of the parts there delineated. But how thoſe ſeeds, whether male or female, are elaborated and prepared, abundantly tranſcends the higheſt reach of human underſtanding.

If the animalcula, of which all animals are formed, are originally in the male, yet they never can be formed into animals, without the egg of the female.

That all animals ſpring from animalcula, ſeems probable from the following conſiderations:

1. That

1. That ſomething may be obſerved in the *tread* of an egg, even before incubation, like the rudiments of an animal, in form of a tadpole.

2. That after incubation, all the parts of the animal ſuddenly appear, the *ſtamina*, which exiſted before, being then expanded. After three days incubation, the punctum-ſaliens of a chick is diſcovered by the naked eye. On the fifth day, the rudiments of the head and body appear, which were before diſcernible by glaſſes. After thirty hours, we ſee the head. the eyes, the heart, and the carina, with the vertebræ diſtinct. And by glaſſes we ſee all thoſe parts, after forty hours, which the naked eye cannot diſcern till the fifth day. Whence it is probable, that even the firſt diſcovery of them by the microſcope, is not the diſcovery of parts newly formed, but of thoſe that exiſted before incubation, tho' not then dilated enough to be viſible.

3. That there is a near analogy between animals and plants. Now we know, the ſeeds of theſe are only little plants, folded up in membranes. Hence we may eaſily infer, that animals proceed from animalcula folded up, till they are gradually inlarged and unfolded.

And that theſe animalcula are originally in the ſeed of the male, is probable. For 1. Numberleſs animalcula are obſerved in the ſeed of animals. 2. We obſerve the rudiments of a fœtus in eggs fecundated by the male, but not in others. 3. The rudiments in the egg, both before and after incubation, exactly reſemble the

the animalcula in the ſeed. 4. This gives a rational account of many fœtuſes at one birth, eſpecially that of the Counteſs of *Holland*. It accounts alſo for a whole cluſter of eggs in an hen, being fecundated at once. 5. This beſt ſuits the analogy between animals and plants. Every herb and tree bears its own ſeed; and a little plant of the ſame kind, which being thrown into the womb of the earth, ſpreads forth its root and receives its nouriſhment from the earth, but has its form within itſelf.

Yet, that no animal can be formed without the egg of the female, is evinced by the following conſiderations.

1. No animalcule can come forward, if it do not fall into a proper nidus. So though a thouſand ſhould fall into one egg, none of them would come forward, but that which was in the very center of the cicatricula, or tread. And perhaps the nidus neceſſary for their formation is ſo proportioned to their bulk, that it can hardly contain more than one animalcule. This is certainly the caſe in *oviparous* kinds. And all the difference between the viviparous and the oviparous is, that in the former, the egg is nothing but the cicatricula with its yolk: ſo that the fœtus muſt draw its nouriſhment from the womb. Whereas, in the oviparous, the egg itſelf is a kind of womb, containing all that is needful for the animal, till it is hatched.

2. It is acknowledged, that the fœtus in the womb is not connected with it, for a conſiderable time after conception: that it is wholly looſe from it, and is only a little round egg, with

with the embryo in the midſt, which ſends forth its umbilical veſſels by degrees, and at laſt lays hold on the womb. Hence it is plain, that the cicatricula, which nouriſhes the animalcule, does not ſpring from the womb, but only falls into it, as a fit ſoil, whence it may draw nouriſhment for the fœtus.

Yet there is a difficulty which preſſes equally on thoſe, who ſuppoſe the animal to ſpring either from the male or female parent. It is the caſe of monſters. In a mule, for inſtance: the body is of the form of the mare; whereas the feet, the tail, and the ears, reſemble thoſe of its ſire. If the male ſupplied the animalcula, one would imagine the fœtus ſhould always be of the ſame ſpecies with the male. If the female, it ſhould be of her kind: whereas monſters are of both: as if the main part of the animal lay in the egg, and the impregnation only conveyed or changed the extremities.

Yet, that ſome animals firſt exiſt, not in the ſeed of the male, but wholly *in the egg* of the female, undeniably appears from the caſe of frogs and toads. (And why may it not be the ſame thing with other animals?) The eggs of theſe are not impregnated by the male, till they iſſue from the womb. It is while they are ejected, that he fecundates them with his ſeminal liquor. And there is no circumſtance, by which the fecundated egg can be known from the unfecundated. It appears therefore, that tadpoles exiſt before fecundation. For the unfecundated eggs do not differ in the leaſt from thoſe that are fecundated. But theſe are only tadpoles coiled up. Such, therefore, are the unfecundated tadpoles: they exiſt before fecundation; only they cannot unfold themſelves without

out the liquid of the male. Frogs then ſhould not be placed among oviparous animals, but among viviparous: if they do not rather conſtitute a claſs between both. Thus nature ſeems to delight in diverſifying the modes of animal generation.

This may be the caſe, with regard to one, or perhaps a few ſpecies of animals. But, in general, where to place the pre-exiſtent animal or embryo, in the animalcule egg, is ſtill the queſtion. A diviſion of vital, eſſential, and original ſtamina, is impoſſible. Yet innumerable inſtances in monſters, mules, and many natural ſubjects, concur to prove, that the young partakes of the nature and qualities of both the parents, even to their defects and diſeaſes, which are often hereditary. How then can we ſuppoſe unalterable ſtamina? Can the viſible ſpecies of any production be determined by them, if every ſenſible quality may be influenced indiſcriminately by either parent?

If they are placed in the animalcule or the egg, how are they tranſmitted? If in the animalcule, why is the proceſs attended with ſo vaſt an expence, ſo great a waſte of millions of entities, each containing a ſeries of the moſt perfect and moſt wonderful productions, when one only of thoſe millions is to take place? And how are theſe animals generated? If in the common way, not only the proceſs will be boundleſs, (theſe in their ſeed will have others, and ſo on in an endleſs ſeries;) but they cannot then be unalterable, becauſe they are capable of being generated. Further, if they float in the air, or lie hid in food, how is it that the ſtamina

ſtamina of one ſpecies do not ſometimes inſinuate themſelves into a parent of another ſpecies? Or if they are excluded, by proper ſtrainers, in diſtant ſpecies, they cannot be ſo in thoſe that are near a-kin. For if the ſpermatic animal, which in the matrix of a mare, produces an horſe, is yet ſo fitted to that of an aſs, that it can poſſeſs a cellule there, excluſive of every other, which ſhews an exact co-aptitude; certainly the ſame animal, if contained in food or air, common to both horſe and aſs, might paſs indiſcriminately the ſtrainers of either: and ſo we might have mules without the promiſcuous congreſs of the two ſpecies.

In another view, if we conſider the extreme tenuity of one of theſe ſtamina, in its firſt origin at the diſtance of many ages, compared to the ſmalleſt fibre of the animal it is ſaid to conſtitute: can ſo minute a filament ſerve as a ſubſtratum for a cylinder, comparatively immenſe? Can the terraqueous globe derive its preſent dimenſions, from the dilatation of an atom? Such is a muſcular fibre in its preſent ſtate, compared to what it was in its origin. Conſequently, what muſt have been the increaſe of extraneous matter, either by appoſition or incorporation, which is now as much a part of the fibre, as the original ſtamen? And if thus much can be mechanically aſſimilated, why not the whole formed by mechanical cauſes? Or why muſt ſo inſignificant a part of it, be ſuppoſed to be concreated with the univerſe?

The difficulty ſtill increaſes immenſely, if we look into the vegetation of plants, and the wonderful reproduction of the parts of the polypus,

polypus, lobſters, and many other animals. The original ſtamina, how minute ſoever, queſtionleſs, are diffuſed through the whole production: ſince in this ſyſtem all animal and vegetable growth is made by developement only. But if diffuſed, then ſome or all may be loſt by ſucceſſive biſection. And if loſt, how can they be re-produced? If re-produced, how were they concreated with the univerſe? Theſe and a thouſand other difficulties can in no wiſe be evaded, but by multiplying ſuppoſition on ſuppoſition, which renders the hypotheſis ſo complex, as utterly contradicts the ordinary proceſs of nature.

It is more reaſonable to ſay, That ſo many ſecretory ducts, ſo many ſtrainers, ſo many preparatory veſſels in animals, and ſuch a curious diſpoſition in plants, for the continuation of every ſpecies, imply a digeſtion, ſecretion, and preparation of principles, invariably productive of every individual, when they fall into their reſpective matrixes, and find aliment proper to aſſimilate. Are not theſe principles contained in the nouriſhment taken by the parent plant or animal, the ſame that continually vegetate in it, and increaſe it till it is adult, then exuberate, while it is by new preparations fitted, invariably to propagate its kind? Elſe why this digeſtion? Why this ſecretion? Why ſo many ſtrainers, receivers, ducts and valves? And why is ſome food more productive of theſe principles than others?

And if every mixt body is made up by the combination of certain principles, we cannot doubt, but God may have eſtabliſhed forces in nature, by which ſuch principles may in certain

tain circumſtances, be invariably united, without any danger of deviating, ſo as to render generation equivocal. And if every production in queſtion is a mixt body, we know that how various ſo ever they are, a ſmall number of principles differently combined, will yield variety enough to produce them all. Thus we reduce nature to what it is ever found to be, ſimple in the beginning of its courſe, but afterwards, when it is diſtributed, magnificent beyond expreſſion.

Modern naturaliſts all agree, that every plant proceeds from its ſpecific ſeed, every animal from an egg, or ſomething analogous, pre-exiſting in its parent. But what do we mean by ſeeds and eggs? Theſe in the common ſenſe of the words, are certain mixt bodies, that immediately furniſh thoſe productions. They are ſaid to contain not only the pre-exiſtent germ, but the fit nidus alſo, and aliment to be aſſimilated in proper circumſtances. They are therefore heterogeneous bodies, that coaleſce in a known time. And their principles are ſo far from being united at the creation, that they ſenſibly come together from diſtant places, in all hermaphrodite plants, and from different individuals in all thoſe ſpecies, where the male and female are diſtinct.

But it is vain for us to lay down any certain rule, and to ſay to nature, "This is thy ſcheme; from this thou ſhalt not deviate." If ſhe makes it a law in many ſpecies, that every individual requires the co-operation of a male and female parent; ſhe has, at the ſame time, her hermaphrodites, both in plants and animals. And if in ſome hermaphrodites, the ſexes

ſexes are ſo diſtinct, that ſhe ſeems not to deviate far from her primitive law; ſhe will, in another inſtance, that of the pucerons, act either with or without the co-operation of a male. Again: In ſome ſpecies, the female may be ſo impregnated, that the impregnation ſhall diffuſe itſelf to five or ſix generations. Yet again: In many kinds of polypes, generation proceeds without male or female, egg or ſeed. And farther ſtill; there are ſome ſpecies of polypes, where a whole family, (after branching out by real vegetation, as far as nature deſigns) jointly concur to furniſh one egg, as the ſource of a future progeny. If at laſt you reſolve to ſtand by this, that at leaſt every individual proceeds from a parent like itſelf; even this is overthrown by late experiments. For we have now a cloud of inſtances, of a claſs of beings hitherto unknown, wherein animals grow upon, are produced by, and in the ſtrict ſenſe of the word, brought forth from plants. Then by a ſtrange viciſſitude they become plants of another kind. Theſe again become animals of another, and thus on, for a ſeries farther than the utmoſt power of glaſſes can carry the moſt inquiſitive obſerver.

And as to the animalcula ſuppoſed to be diſcovered in the male ſeed, the microſcope diſcovers the ſame in the ſeminal liquor of females. Probably neither the one, nor the other are real animals, but only inanimate particles in ſtrong fermentation.

PART

PART the SECOND.

Of Brutes.

CHAPTER I.

Of Beasts.

1. *The general Difference of Man and Beasts, as to the Structure and Posture of the Body:*
2. *Their Agreement:*
3. *Their Agreement and Disagreement, as to the Head and Brain:*
4. *The Heart and Lungs:*
5. *The Eyes:*
6. *The Ears, Nose, Teeth:*
7. *The Windpipe:*
8. *The Vegetative and Sensitive Motions in Brutes.*
9. *Of the Soul of Brutes.*
10. *Of some particular Sorts of Beasts.*
11. *Some general Reflections.*

1. NEXT to Man in the visible creation are *Beasts.*——And certainly, with regard to the structure of the Body, the difference is not extremely great, between man and

and other animals. Only in this, that the *ſtature* of Man is erect, and his *form* more elegant; that no beaſt has the *feet* of a man, much leſs a *hand* ſo admirably fitted for every purpoſe: and laſtly, that no other animal has a *brain*, ſo large in proportion to its bulk as Man. Concerning the prone *poſture* of their body we may obſerve two things; the parts miniſtring thereto, and the uſe thereof.

I. As to the parts, it is obſervable, that in all theſe creatures, the legs are made exactly conformable to their poſture, as thoſe of man are to his poſture: and farther, that the legs and feet are always admirably ſuited to the motion and exerciſe of each animal. In ſome they are made for ſtrength, to ſupport a vaſt unwieldy body: as in the elephant, which being a creature of ſuch prodigious weight, has its legs accordingly made like pillars. In others they are made for agility and ſwiftneſs. So deers, hares, and ſeveral other creatures, have their legs very ſlender, but ſtrong withal, and every way adapted for quick motion. In ſome they are formed only for walking and running; in others for ſwimming too. Thus in the feet of the otter, the toes are all conjoined with membranes, as they are in geeſe and ducks. And in ſwimming it is obſervable, that when the foot goes forward in the water, the toes are cloſe; but when backward they are ſpread out: whereby they more forcibly ſtrike the water, and drive themſelves forward. In others, as Moles, they are made for walking and digging: and in others, for walking and flying*. In ſome

* The membranous Wings of a *Bat* are a prodigious deviation from Nature's ordinary way.

ſome they are made more weak, for the plainer lands; in others, ſtiff and leſs flexible‖, for traverſing ice and dangerous precipices. In ſome they are ſhod with rough and hard hoofs, in others with only a callous ſkin‡. In the latter, the feet are compoſed of toes: ſome ſhort, barely for going; ſome long, to ſupply the place of an hand; ſome armed with long and ſtrong talons, to catch, hold and tear the prey; and ſome fenced only with ſhort nails, to confirm the ſteps in running and walking.

II. 1. As the poſture of Man's body is the fitteſt for a rational animal, ſo is the prone poſture of Beaſts, the moſt uſeful to themſelves, and the moſt fit for the ſervice they perform to man.

2. But there is a wonderful *agreement* between the bodies of men and beaſts, not only with regard to the ſtructure, but alſo the uſe of the ſeveral parts. How they differ, will be mentioned hereafter.

3. The *brain* in them is of nearly the ſame ſtructure and conſiſtence as in man, and undoubtedly

And ſo is the *Virginian* flying Squirrel; whoſe ſkin is extended, in the nature of wings, between its fore-legs and body.

‖ The *Elk* has legs ſo ſtiff and inflexible, that they run on ice without ſlipping. And this is the way they take in Winter, to ſave themſelves from the Wolves.

‡ The *Goat*, which generally dwells on mountains and rocks, and delights to walk on narrow ridges, and to take great and ſeemingly dangerous leaps, has the joints of the legs remarkably ſtiff and ſtrong. Likewiſe the hoof is hollow underneath, and its edges ſharp.

doubtedly performs the ſame office, ſecreting the animal ſpirits (if ſuch there be) in order to ſenſation and muſcular motion in every part of the body. The *cerebellum* is nearly of the ſame ſhape in all. But the ſhape of the *brain* neceſſarily varies according to that of the Head.

It is remarkable, that in man the Head is of one ſingle form: whereas in the four-footed race, it is as various as their ſpecies. It is in ſome, ſquare and large, ſuitable to their food, abode, and ſlow motion: in others, it is ſmall, ſlender and ſharp, agreeable to their ſwifter motion, or to make way to their food, or habitation under ground. And as to the brain contained therein, how ſmall is it in beaſts, in proportion to what it is in man! Another thing no leſs remarkable is, the ſituation of the brain and the cerebellum. As God has given to man a lofty countenance, and has lodged in his brain an immortal ſoul, to behold and contemplate heavenly things, ſo as his face is erect, his brain is ſet in an higher place, above the cerebellum and all the ſenſories. But in brutes, whoſe face is prone to the earth, and who are not capable of ſpeculation, the cerebellum, which miniſters merely to animal life, is placed above the brain. Alſo ſome of the organs of ſenſe are placed, if not above the brain, at leaſt on a level therewith.

Another very great convenience in this poſition of the brain and cerebellum is, in the head of man, the baſe of the brain and cerebell, yea, of the whole ſkull, is ſet parallel to the horizon: by which means there is the leſs danger of the two brains joggling or ſlipping out of their place. But in beaſts, whoſe heads hang down, the baſe of the ſkull

ſkull makes a right angle with the horizon. By which means the brain is beneath, and the cerebell above. And leſt the cerebellum ſhould hereby be liable to frequent concuſſions, an admirable proviſion is made, by that ſtrong membrane, the *dura mater*, cloſely incompaſſing it. Beſide this, it is guarded in ſome ſpecies with a ſtrong bony fence. In the hare, the coney, and ſeveral others, a part of the cerebell is on each ſide within the os petroſum. So that its whole maſs is, by this double ſtay, firmly contained within the ſkull.

4. The heart and lungs in beaſts are of the ſame ſtructure, with the ſame apparatus of veins and arteries as in men. We cannot therefore doubt but the blood circulates in them, and nutrition is performed as in us. Their food alſo being diſſolved in the ſtomach, is conveyed by the lacteals to the receptacle of the chyle. To the fore-part of this (in men the upper part) joins the thoracic duct, which extending thro' the length of the thorax, ends in the vein, called in beaſts, *cruralis anterior*. The remaining part of the circulation is performed in them, as in men.

But ſome beaſts have more ſtomachs than one. And ſome have the peculiar property of *chewing the cud*. The food, after it has been ſwallowed, is returned to the mouth, where it is chewed over again at leiſure.

Not that this is altogether peculiar to beaſts. There have been inſtances of men who had this property. Dr. *Slare* gives us a particular account of one whom he knew at *Briſtol*. "He begins, ſays he, to chew his meat over again, within a quarter of an hour after meals. This chewing, after a full meal, laſts an hour and an half. If he goes to bed ſoon after a meal,

he cannot ſleep, till the uſual time of chewing be over. The victuals returned taſte more pleaſantly than they did at firſt. Bread, fleſh, cheeſe and drink, are of much ſuch a colour, as they would be, if mixt together in a mortar. His victuals lie heavy on his ſtomach, till they have paſſed this ſecond chewing. He was thus ever ſince he can remember. His father does the ſame, but in ſmall quantities."—What a mercy is it, that we have not more ſuch inſtances! For how much of our precious time would it conſume!

5. The ſituation, number, and conformation of the *eyes* in various animals, is wonderfully adapted to their various circumſtances. In ſeveral, the eye looks chiefly forward, but ſo as to take in nearly the hemiſphere before it. In others, the eyes are ſo placed, as to take in nearly a whole ſphere. In ſome, they are ſo fixt as to look chiefly behind, ſo that they ſee their enemy following them. So in Rabbits and hares: whereas in Dogs they are more forward, to look after their prey.

Generally the *head* is moveable for the ſake of the eyes, and the eyes themſelves moveable every way. Where it is not ſo, other expedients are found, to anſwer the ſame end. Thus in ſome creatures, the eyes are ſet at a diſtance from the head, to be moved this way or that: as in Snails, whoſe eyes are fixed to the end of their horns, or rather of the optic nerves which are ſheathed therein. In other creatures, whoſe head and eyes are immoveable, this is made up by the number of eyes. So Spiders, which cannot move their head, have four, ſix, or eight eyes, all placed in the front of the head, (which is round) like a locket of diamonds.

Many

Many animals have muſcles to move the eye, and obvert it to the object. Fiſhes have none; but for amends, they have many little protuberances finely ranged on their large, bulging eyes; by which numberleſs rays of light are deflected from objects above, beneath, and on either ſide. Yea, ſome hundreds of theſe protuberances are curiouſly ranged on the convex eye of a fleſh-fly.

Scorpions have above an hundred eyes; an Ephemeron-fly full two thouſand.

In other creatures, which have only two eyes, the want of motion therein is ſupplied, by their eyes protuberating into hemiſpheres, each being a vaſt number of ſegments of a ſphere.

The eyes of a Cameleon reſemble a convex glaſs ſet in a round ſocket, which he turns backward and forward without ſtirring the head, and commonly one a contrary way to the other.

Laſtly, Moles living under ground, have not ſo much need of eyes as other creatures. Yet they have eyes, but exceeding ſmall, far in the head, and covered with ſtrong hair. When they are above ground they can put them forth beyond the ſkin, and draw them back at pleaſure.

Another circumſtance, relative to the Eye is highly remarkable. As we uſe various apertures to our optic glaſſes, ſo Nature has made a far more compleat proviſion, to admit enough, and not too much light, into the eyes of animals, by the dilatation and contraction of the pupil. And this in divers animals of divers forms, is according to their peculiar occaſions. In ſome it is round, particularly in Man, that being the moſt proper figure, for the poſition of our

eyes, and the uſe we make of them, both by day and night. In ſome animals it is of a longiſh form, in ſome tranſverſe, with its aperture large, (an admirable proviſion for their ſeeing ſide-ways, and thereby avoiding many inconveniences, as well as an help for gathering their food on the ground, whether by day or night. In others, that aperture is erect, and alſo capable of opening wide and ſhutting cloſe. The latter ſerves to exclude the bright light of the day, the former to take in the faint rays of the night: thereby enabling them to ſee and catch their prey, when there is no light diſcernible to us.

Thus Cats can ſo cloſe their pupil, as to admit but a ſingle ray of light. And again, by throwing all open, they can take in all the fainteſt rays: which is an incomparable proviſion for creatures that have occaſion to watch their prey both by day and night.

But beſide this, in Cats and other nocturnal animals, there is a ſort of carpet at the bottom of the eye, which gives a kind of radiation on the pupil, thereby enabling them to ſee in the dark.

To preſerve this tender organ, many creatures have a membrane, which is not commonly perceived, wherewith they can at pleaſure cover the eye, without too much hindering the ſight, being both tranſparent and ſtrong, ſo that it is a kind of moveable cornea.

Providence is conſpicuous in furniſhing *Frogs* with this. For as they live in watry places, which generally abound in plants that have ſharp edges or points; and as the Frog goes on, not by walking but by leaping, if he were not

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ſo furniſhed, he muſt either ſhut his eyes, and ſo leap blindfold, or run many riſques by leaving them open. But this membrane guards the eyes, without blinding him. And as ſoon as the occaſion for it is over, he draws it back into a little cell.—Many Birds alſo, as they muſt fly between trees and buſhes, are provided with the ſame membrane. And ſo is the *Rein-Deer*.

6. The comparative anatomy of the *Ear*, yields abundant inſtances of the Creator's Wiſdom. In Birds the outward ear is cloſe and covered, not protuberant, as that would obſtruct their flight. In Beaſts, its form is agreeable to the poſture and motion of the body, but admirably varied in the ſeveral ſpecies, according to their various occaſions. In ſome, as the Hare, it is large, open, and erect; by which means that timorous, helpleſs creature, is warned of the leaſt approach of danger. In others it is covered to keep out noxious bodies. In thoſe which are forced to mine and dig for their habitation, it is ſhort, and lodged deep and back-ward in the head. Thus Moles have no auricle at all, but only a round hole, between the neck and ſhoulder. And this is cloſed with a little ſkin, which opens and ſhuts like an eye-lid.——The Sea-calf alſo, as well as Lizards, and Serpents have no outward Ear. And the Tortoiſe, with moſt kinds of Fiſhes, have the paſſage quite covered over.

But among all the varieties in the ſtructure of this organ, none are more remarkable than thoſe of the *paſſage* into the *os petroſum*. In an Owl, which perches upon a tree or beam, and hearkens after the prey beneath her, it comes farther out above than below, for the better re-

reception of ſounds from beneath. In a Fox, which ſcouts under the prey at rooſt, it comes farther out below than above. In a Pole-cat, which hearkens ſtreight forward, it is produced behind, for the taking a forward ſound. Whereas a Hare, whoſe enemy comes behind, is ſupplied with a bony circle, directed backward: by means of which ſhe receives diſtinctly the ſmalleſt ſound which comes that way.

The more accurate the ſenſe of *Smelling* is in any creature, the longer are the laminæ in the noſtrils, and the more in number, folded up, and crouded together, to contain more nervous filaments, and to detain the odoriferous particles, in their windings and turnings. An admirable proviſion this, for the good of many creatures, the chief acts of whoſe lives are performed by the miniſtry of this ſenſe. In inſects and many other creatures, it is of great uſe, in helping them to proper places for hatching their eggs, and breeding up their young. And moſt irrational animals, beaſts, birds and reptiles, do by their ſmell find out their food. With what ſagacity do ſome of them diſcover it, in the midſt of mud and dirt? How curiouſly do others pick and chuſe ſuch plants as afford them wholeſome food, (perhaps medicine too) avoiding ſuch as tend to hurt or deſtroy them? And all this principally by the ſmell, together, with its near ally, the taſte.

The various forms of the *Teeth* in various creatures, is another inſtance of the Divine Wiſdom. How curiouſly are they adapted to the peculiar food and occaſion of each ſpecies! Thus in the Rapacious they are fitted to catch

and

and hold their prey; in the Herbaceous, to gather and chew vegetables. In thoſe which have no teeth, as Birds, the bill ſupplies that defect; together with their additional ſtomach. And it is a remark which hardly fails, All ſuch animals as have four ſtomachs, have no teeth at all.

There are great varieties in the teeth of other animals. Trout have teeth upon their tongues; Cod-fiſh at the bottom of their gullet. Crocodiles have three rows of teeth on the ſame jaw; Sharks, four or five; Sea-devils, ſo called, have ſeveral rows of moveable teeth.

7. The variation of the *Wind-pipe* in various creatures is likewiſe obſervable, as it is neceſſary for that of the voice. In an Hedge-hog, which has a very ſmall voice, it is hardly more than membranous. In a Pigeon, which has a low, ſoft note, it is partly membranous, partly cartilaginous. In an Owl, which has a good audible note, it is more cartilaginous. But that of a Jay (as of a Linnet) has bones inſtead of cartilages.

The rings of the wind-pipe likewiſe are fitted for the modulation of the voice. For in Dogs and Cats, which uſe a great many notes, they are (as in Man) open and flexible; whereby all or any of them is more or leſs dilated or contracted, in order to a deeper or ſhriller note. But they are one entire ring in the *Japan* Peacock, which uſes one ſingle note.

8. As to the *Motions* of Brutes, it is not eaſy to conceive, that even thoſe of the *Vegetative* kind, can be the mere mechanical effects of matter, however modified. Much leſs can we conceive this of their *Senſitive* motion: for we have not the leaſt reaſon to doubt, but the

ſame impreſſions of external objects, raiſe the ſame perceptions in them, as in us.—No queſtion, they ſee, and hear, and ſmell, and taſte, and feel in the ſame manner as men!

9. We cannot therefore deny, that there is ſomething in Brutes, which perceives the impreſſions made by outward objects; and that they perform a thouſand actions, which can never be explained by mere mechaniſm: thoſe in particular which ſpring from what we call *Inſtinct*, as the feeding and tending their young, the building their neſts and preparing their habitation, upon or in the earth.

It is true, ſome things in brutes, as well as in men, may be mechanically accounted for. But others cannot: ſo that we are conſtrained to own, there is in them alſo ſome ſuperior principle, of whatever kind it be, which is endued with ſenſe, perception and various appetites. For from their outward actions we may as eaſily learn, as we could from thoſe of a man born deaf and dumb, that there are in this principle or *Soul* two different faculties: that of *perceiving* or *knowing*, anſwerable to our underſtanding, and that of *deſiring* and *ſhunning*, anſwerable to our will. That this principle is immaterial appears, from this ſingle conſideration, it has a power of *Self-motion*; which no matter can have, being wholly and eſſentially paſſive.

10. It is not my deſign to enumerate the ſeveral ſpecies of beaſts. But it may illuſtrate the wiſdom of the great Creator, to give ſome account of a few; ſeveral of which are not ſo commonly known.

The

The largeſt land-animal in the world is an *Elephant*, which ſeems rather to belong to the hog-kind than any other. They are found only in the ſouth of *Afric*, and in the *Eaſt-Indies*, and are generally of a dark colour. Their eyes are like thoſe of a Hog. At the corners of their mouth grow two large teeth, ſix or ſeven feet long in the male, but not above one in the female. They feed on graſs, nuts, and other vegetables.

Of all quadrupeds, the Elephant is the ſtrongeſt, as well as the largeſt; and yet in a ſtate of nature, it is neither fierce nor formidable. Mild, peaceful, and brave, it never abuſes its ſtrength, and only uſes it for its own protection. In its native deſarts, the Elephant is a ſocial, friendly creature. The oldeſt of the company conducts the band; that which is next in ſeniority brings up the rear. The young, the weak, and the ſickly, fall into the center; while the females carry their young. They maintain this order only in dangerous marches, or when they deſire to feed in cultivated ground: they move with leſs precaution in the foreſts, and ſolitudes; but without ever removing far aſunder.

Nothing can be more formidable, than a drove of Elephants, as they appear at a diſtance, in an *African* landſcape: wherever they march, the foreſt ſeems to fall before them; in their paſſage they bear down the branches, on which they feed; and if they enter into an incloſure, they deſtroy all the labours of the huſbandman, in a very ſhort time. Their invaſions are the more diſagreeable, becauſe there is no means of repelling them; ſince it would require a

ſmall army to attack the whole drove when united. It now and then happens, that one or two is found lingering behind the reſt, and it is againſt theſe that the art and force of the hunters are united; but an attempt to moleſt the whole body, would certainly prove fatal. They go forward directly againſt him who offers the inſult, ſtick him with their tuſks, ſeize him with their trunks, fling him into the air, and then trample him to pieces under their feet. But they are thus dreadful, only when they are offended, and do no manner of perſonal injury, when ſuffered to feed without interruption.

The Elephant has very ſmall Eyes, when compared to the enormous bulk of its body. But, though their minuteneſs may at firſt ſight appear deformed, yet, when we come to examine them, they are ſeen to exhibit a variety of expreſſion. It turns them with attention and friendſhip to its maſter; it ſeems to reflect and deliberate; and as its paſſions ſlowly ſucceed each other, their various workings are diſtinctly ſeen. It is remarkable for the excellence of its hearing. Its ears are extremely large. They are uſually dependent; but it can readily raiſe and move them. They ſerve alſo to wipe its eyes, and to protect them againſt the duſt and flies. It appears delighted with muſic, and readily learns to beat time, to move in meaſure, and even to join its voice with the drum and trumpet.

This animal's ſenſe of ſmelling is not only exquiſite, but it is pleaſed with the ſame odours that delight mankind. The Elephant gathers flowers with great pleaſure; it picks them up one

one by one, unites them in a noſegay, and ſeems charmed with perfume. The orange-flower is particularly grateful, both to its taſte and ſmell; it ſtrips the tree of all its verdure, and eats every part of it, even to the branches themſelves. It ſeeks in the meadows the moſt odoriferous plants to feed upon; and in the woods it prefers the coco, the banana, the palm, and the ſage tree to all others.

But it is in the ſenſe of feeling, that this animal excels all others of the brute creation, and perhaps man himſelf. The organ of this ſenſe is wholly in the trunk, which is an inſtrument peculiar to this animal; and that ſerves it for all the purpoſes of an hand. The trunk ends in two openings, or noſtrils, like thoſe of an hog. An Elephant of fourteen feet high, has the trunk about three feet long, and five feet and an half in circumference, at the mouth. It is hollow all along, but with a partition running from one end of it to the other. This tube is compoſed of nerves and muſcles covered with a ſkin like that of the reſt of the body. It is capable of being moved in every direction, of being lengthened and ſhortened, of being bent or ſtreightened; ſo pliant as to embrace any body it is applied to, and yet ſo ſtrong that nothing can be torn from its gripe. To aid the force of this graſp, there are ſeveral very little eminences, like a caterpillar's feet on the under-ſide of this inſtrument, which without doubt contributes to the ſenſibility of the touch as well as the firmneſs of the hold. Through this trunk the animal breathes, drinks and ſmells; and at the very point of it, juſt above the noſtrils, there is an extenſion of the

ſkin,

ſkin, about five inches long, in the form of a finger, and which, in fact, anſwers all the purpoſes of one; for with the reſt of the extremity of the trunk, it is capable of aſſuming different forms at will, and, conſequently, of being adapted to the minuteſt objects. By means of this, the Elephant can untie the knots of a rope, unlock a door, and even write with a pen. It ſometimes happens, that the object is too large for the trunk to graſp; in ſuch a caſe the Elephant makes uſe of another expedient. It applies the extremity of the trunk to the furface of the object, and, ſucking up its breath lifts and ſuſtains ſuch a weight as the air in that caſe is capable of keeping ſuſpended. In this manner this inſtrument is uſeful in moſt of the purpoſes of life; it is an organ of ſmelling, of touching, and of ſuction; it not only provides for the animal's neceſſities, but it alſo ſerves for its ornament and defence.

The legs are not ſo inflexible as the neck, yet they are very ſtiff, and bend not without difficulty. Thoſe before, ſeem to be longer than the hinder; but, upon being meaſured are found to be ſomething ſhorter. The joints by which they bend are nearly in the middle like the knee of a man, and the large bulk which they are to ſupport, makes their flexure ungain. Yet while the Elephant is young, it bends the legs to lie down or riſe; but when it grows old, or ſickly, this becomes ſo inconvenient that the animal chuſes to ſleep ſtanding.

It is one of the ſtriking peculiarities of this animal, that his generative powers totally fail when he comes under the dominion of man; as if he ſeemed unwilling to propagate a race of ſlaves to increaſe the pride of his conqueror.

The

The Elephant when once tamed becomes the moſt gentle and obedient of all animals. It ſoon conceives an attachment for the perſon that attends it, careſſes him, obeys him, and ſeems to anticipate his deſires.

In a ſhort time it begins to comprehend the ſigns made to it, and even the different ſounds of the voice; it perfectly diſtinguiſhes the tone of command from that of anger or approbation, and acts accordingly. It receives his orders with attention, eagerly, yet without precipitation. All its motions are regulated, and its actions ſeem to partake of its magnitude, being grave and majeſtic. It is quickly taught to kneel down to receive its rider; it careſſes thoſe it knows with its trunk; with this ſalutes ſuch as it is ordered to diſtinguiſh, and with this, as with an hand, helps to take up part of its load. It ſuffers itſelf to be arrayed in harneſs; and ſeems to take a pleaſure in the finery of its trappings. It draws either chariots, cannons, or ſhipping with ſurprizing ſtrength and perſeverance; and this with a ſeeming ſatisfaction, provided its maſter appears pleaſed with its exertions. And he frequently takes ſuch an affection for his keeper that he will obey no other: and it has been known to die for grief, when in ſome ſudden fit of madneſs, it has killed its conductor.

In *Deli*, an Elephant paſſing the ſtreets, put his trunk into a taylor's ſhop, where ſeveral people were at work. One of the perſons of the ſhop deſirous of amuſement pricked the animal's trunk with his needle. The Elephant paſſed on without any ſigns of reſentment, but coming to a puddle of dirty water, filled his trunk

trunk, returned to the ſhop, and ſpurted it over all their finery.

Some of them are twenty feet in compaſs, and near fourteen high. They ſeem to have more ſenſe than any other brute, and are capable of fidelity and ſtrong affection: particularly to their companion: ſo that neither the male nor female is ever known to make a ſecond choice.

The female goes ſeventeen months with her young: they are fifty or ſixty years before they have their full ſtrength, are in full vigour at about an hundred, and live two or three hundred years.

A *Rhinoceros* next to the Elephant, is the moſt extraordinary animal in the *Indies*. It is uſually twelve feet long, from the tip of the noſe to the inſertion of the tail; from ſix to ſeven feet high; and the circumference of its body is nearly equal to its length. It is therefore equal to the Elephant in bulk, and if it appears much ſmaller to the eye, the reaſon is, the legs are much ſhorter. In other reſpects it is ſhaped like a wild-boar.

It is ſaid to have a very rough tongue, but this is ſo far from the truth, that no animal of near its ſize has ſo ſoft a one. It is ſmooth and ſmall like that of a Dog; and to the feel, it appears as if one paſſed the hand over velvet. It has a peculiar cry, a mixture between the grunting of a Hog, and the bellowing of the Calf.—The age of theſe animals is not well known; it is ſaid by ſome, that they bring forth at three years old, and if we may reaſon from analogy, it is probable they ſeldom live till above twenty.

That

That which was ſhewn in London, was ſaid by its keeper, to be eighteen years old, and even at that age, he pretended to conſider it as a young one; however it died ſhortly after, and that probably in the courſe of nature. It is a native of *Aſia* and *Africa*, and is uſually found in thoſe extenſive foreſts that are frequented by the Elephant and Lion. As it ſubſiſts entirely upon vegetable food, it is peaceful and harmleſs among its fellows of the brute creation; but tho' it never provokes to combat, it equally diſdains to fly. It is every way fitted for war, but reſts contented in the conſciouſneſs of its ſecurity.

His ſkin is without hair, and ſo full of ſcratches and ſcabs, that at a diſtance they may well be taken for ſcales. On his noſe he has a horn of a dark brown colour, which bends backward, and is often two foot long. He has often another horn a little above this, which never exceeds ſix inches. His eyes are exceeding ſmall, and he only ſees ſtrait forward: therefore he always runs in a ſtrait line, tearing up whatever ſtands in his way. With his horn he throws ſtones over his head to a great diſtance, and even tears up trees by the roots.

The outer ſkin of the *Rhinoceros*, which conſiſts of many folds, is thick and impenetrable. In running ones fingers under one of the folds, it feels like a piece of board half an inch thick. But between the folds the ſkin is as ſmooth and ſoft as ſilk, and eaſily penetrated.—See here the Wiſdom of the great Creator! If the outer ſkin, which is quite inflexible, was continued all over him without any fold, he could not perform any action whatever. But the ſuppleneſs

neſs of ſkin in other beaſts, is compenſated in this by theſe folds. It was neceſſary his ſkin ſhould be hard for his defence: meantime it was a noble contrivance, that it ſhould be ſo ſoft and ſmooth underneath, that when he bends himſelf any way, one part of this board-like ſkin, ſhould ſlide over the other. And theſe folds are placed in ſuch parts of his body, as to facilitate the performance of every voluntary motion.

Another native of the *Eaſt-Indies* is the *Camel*, one of the moſt ſerviceable animals in the world. He kneels down to receive his burden, and riſes when he hath his accuſtomed load. If he feels himſelf over-burthen'd he will not riſe, but cry till part of it is taken off. One of them will carry a thouſand or twelve hundred weight, forty miles a day, for thirty or forty days together. They have no teeth in the upper jaw. They will travel forty hours, without either meat or drink: and nine days without drink: they have two ſtomachs admirably contrived for this purpoſe. The gentleman who diſſected one at *Paris*, found in his ſecond ſtomach ſeveral ſquare holes, which were the orifices of about twenty cavities, made like ſacks, placed between the two membranes, which compoſe the ſubſtance of the ſtomach. And in theſe reſervoirs he contains water enough, to ſerve him for ſo many days.

The bunch on his back is not fleſh, much leſs bone, but mere hair. And when this is preſt cloſe down, he is no more hunch-backed than a ſwine. They ſubſiſt on very little, which enables them to travel through thoſe vaſt and

and barren deſerts.—How wiſe is He who cauſed theſe to be natives of thoſe countries, where ſuch creatures are abſolutely neceſſary! A farther inſtance of this is, that the *African* Camel, which has ſtill greater and more uncouth journeys to take, is larger and ſtronger, and capable of carrying heavier burdens than thoſe of *Aſia*.

Another wonderful property of Camels is, that of foreſeeing the poiſonous winds, which kill in a moment. A little before theſe come, they run together and cry, and hide their noſes in the earth. And as ſoon as they are paſt, they lift up their heads, and continue their journey.

The *Dromedary* in moſt reſpects reſembles the Camel: only it is of a ſlighter make, and inſtead of one bunch on its back, has two, about ſix inches in height. It goes frequently forty leagues a day: ſo that although it cannot carry above ſix hundred weight, yet its ſwiftneſs atones for its weakneſs. Its feet are ſoft as a ſponge, and are not hurt, either by ſtones or ſand. And (what is an excellent providence) they travel beſt, and have the greateſt ſpirits in the hotteſt weather.

The *Lama*'s in *Peru*, have ſmall heads, reſembling in ſome meaſure both an Horſe and a Sheep. The upper lip is cleft, like that of an Hare, through which when they are enraged, they ſpit, even to ten paces diſtance, a ſort of juice, which when it falls upon the ſkin, cauſes a red ſpot and great itching. The neck is long, like that of a Camel, the body like that of

of a Sheep, but with much longer legs. It yields ſtrong and fine wool, and is alſo a beaſt of burden, and kept at an eaſy expence. It carries a burden a vaſt way, without tiring, eats very little, and never drinks. At night he lies down, and no blows can make him riſe, or move one foot till morning.

A creature no leſs remarkable, but in a quite different way, is the *Caſtor* or *Beaver*. This creature is about four foot long, and fifteen inches broad. He is covered with two ſorts of Hair, one long, the other a ſoft Down. The Down, an inch long, is properly his cloathing, being extremely fine, and cloſe laid upon the ſkin. The long hair is ſpread over all, to preſerve it from dirt and wet.

Whether male or female, it has two bags under its belly, which contain a liquid ſubſtance, that congeals in air, and affords an excellent medicine, which we call *Caſtoreum*.

He has ſtrong teeth riveted faſt in his jaws, to cut wood, as well as chew his food. His fore feet are like thoſe of an Ape or Squirrel, to hold what he eats in his paws. And with theſe he digs, ſoftens and works the clay or loam for his habitation. His feet are remarkably formed, more proper to ſwim than to walk with, the five toes being joined together by a ſtrong membrane. His tail is long, flattiſh, covered with ſcales, and conſtantly lubricated with oil; becauſe, being an architect from his birth, he uſes his tail as a hod, to carry his clay or mortar, and as a trowel, to ſpread it into an incruſtation. Meantime the ſcales preſerve it from being hurt by the burden; and the oil which

which he ſqueezes from his bags, and rubs on with his ſnout, from the noxious air and water.

As they like to live together, they chuſe a ſituation near ſome rivulet. They firſt build a cauſeway, in which the water may riſe level with the firſt ſtory of their habitation. This is built of wood and clay, twelve feet thick at the bottom, deſcending in a ſlope on the ſide next the water. The other ſide is perpendicular: the top of this is about two foot broad. They cut their wood, though as thick as one's thigh, into pieces, from two to ſix foot long, drive them into the earth with their teeth, and lace them together with boughs, cloſing all the openings within and without with a ſtrong plaiſter made of clay. If the water increaſe upon them, they raiſe their wall higher. Knowing their materials are more eaſily brought by water than by land, they watch its increaſe, to ſwim with mortar on their tails, and ſtakes between their teeth to the place where they build. When the cauſeway is finiſhed, they begin their apartments, which are oval, and divided into three partitions, one above another. But the walls of theſe are perpendicular, and only two foot thick. All the wood that projects, they cut off with their teeth: and rough-caſt both the out and inſide of the work, with a mixture of clay and dry graſs. The firſt partition being below the level of the dyke, is full of water; for they love to have their hinder part hanging in the water. The other two are above it, ſo that if the water aſcend, they may aſcend proportionably.

At the bottom of their building, they ſtrike out two openings to the ſtream; one leads to

the place where they bathe, the other to that where they eaſe nature.

They aſſociate ten or twelve together, and proportion their houſe to their number. When all is finiſhed below, they vault the top or roof in an oval form.

In ſummer they feed on fruits and plants: in winter, on willow, aſh, or other wood. This they collect and ſtore up in time. They cut boughs from three to ſix feet long: the large pieces are brought to the magazine by ſeveral beavers, the ſmaller by one alone; but they take different ways, each having his path aſſigned, to prevent the labour being interrupted. They build up their pile with much art, which is proportioned to their number. A ſquare pile of thirty feet, about ten feet deep, ſerves for ten beavers. But the wood is not piled up in one continued heap: the pieces are laid acroſs one another, with cavities between, for the conveniency of drawing out what they want. They always uſe firſt the parcel at bottom, which lies in the water. And when it is taken up for uſe, they cut this wood into ſmall pieces, and convey it to their apartment, where the whole family come and receive their ſhares.

The feet of a female *Beaver*, which a gentleman kept in *England* ſome years ſince, were webbed, like thoſe of a Gooſe. The tail was ſcaly, and ſhaped like the blade of an oar. This ſhe uſed as a rudder to ſteer herſelf, eſpecially when ſhe ſwam under water, which ſhe would do for two or three minutes, and then come up to take breath, ſometimes raiſing only her noſtrils above water. She ſwam ſwifter than any water fowl; and under water as

ſwift as a Carp. The hind legs being longer than the fore, made her walk ſlow on dry land. or rather waddle like a Duck. If drove along faſt, ſhe could not run, but went by jumps, flapping her tail againſt the ground. She never made any noiſe, excepta little ſort of a grunting, when angry, or driven faſt.—As the Beaver frequents the water like water fowls, may not the caſtor be provided for him by nature, to anoint his fur with, and prevent the water from ſoaking to his ſkin. And as it is impregnated with penetrating, pungent particles, it may likewiſe contribute to keep off the chill, which the water might otherwiſe ſtrike to his body, when he remains long therein.

The *Shammoy*, though a wild animal, is eaſily tamed, and is to be found only in rocky and mountainous places. It is about the ſize of a domeſtic Goat. It is agreeably lively, and active beyond expreſſion. The Shammoy's hair is ſhort, like that of the Doe; in Spring it is of an aſh-colour; in Autumn, a dun colour, inclining to black; and in Winter of a blackiſh brown. This animal is found in great plenty in the mountains of *Dauphiny*, of *Piedmont*, *Savoy*, *Switzerland*, and *Germany*. They are peaceful, gentle creatures, and live in ſociety with each other. They are found in flocks of from four to fourſcore, diſperſed upon the crags of the mountains. The large males are ſeen feeding detached from the reſt, except in cutting time, when they approach the females, and drive away the young.

It is to be obſerved, that this creature is extremely vigilant, and has an eye the moſt piercing

cing in nature. Its ſmell alſo is not leſs diſtinguiſhing. When it ſees its enemy diſtinctly, it ſtops for a moment; and then if the perſon be near, in an inſtant flies off. In the ſame manner it can by its ſmell, diſcover a man at a great diſtance, and gives the earlieſt notice. Upon any alarm, the *Shammoy* begins his hiſſing note with ſuch force, that the rocks and the foreſts re-echo to the ſound. The animal having repoſed a moment, again looks round, and perceiving the reality of its fears, continues to hiſs by intervals. During this time, it ſeems in the moſt violent agitation; it ſtrikes the ground with its fore-foot, and ſometimes with both: it bounds from rock to rock; it turns and looks round; it runs to the edge of the precipice, and ſtill flies with all its ſpeed.

Its head is furniſhed with two ſmall horns, of about half a foot long, of a beautiful black. The ears are placed in a very elegant manner, near the horns; and there are two ſtripes of black on each ſide of the face, the reſt being of a whitiſh yellow, which never changes. They run along the rocks with great eaſe and indifference, and leap from one to another, ſo that no dogs are able to purſue them. They always mount or deſcend in an oblique direction; and throw themſelves down a rock of thirty feet, and light with great ſecurity upon ſome excreſcence or fragment, on the ſide of the precipice, which is juſt large enough to place their feet upon. The more craggy and uneven the foreſt, the more this animal is pleaſed with the abode, which thus adds to its ſecurity.

The *Roe-Buck* is the ſmalleſt of the Deer-kind in our climate, and is now almoſt extinct, ex-

except in the Highlands of *Scotland*. It is generally about three feet long, and about two feet high. The horns are from eight to nine inches long, upright, round, and divided into three branches. The body is covered with very long hair, well adapted to the rigor of its mountainous abode.

As the Stag frequents the thickeſt foreſts, and the ſides of the higheſt mountains, the *Roe-buck* courts the ſhady thicket, and the riſing ſlope. Although far inferior in ſtrength to the Stag, it is more active, and even more courageous. Its hair is always ſmooth, clean, and gloſſy; and it frequents only the dryeſt places, and of the pureſt air. Though but a very little animal, yet, when its young are attacked, it faces the Stag himſelf, and often comes off victorious. All its motions are elegant and eaſy; it bounds without effort, and continues the courſe with little fatigue. It is alſo poſſeſſed of more cunning in avoiding the hunter; and, although its ſcent is much ſtronger than that of the Stag, it is more frequently found to make good a retreat. The Stag never offers to uſe art until his ſtrength is beginning to decline; this more cunning animal, when it finds that its firſt efforts to eſcape are without ſucceſs, returns upon its former track, again goes forward, and again returns, until by its various windings, it has entirely deſtroyed the ſcent, and joined the laſt emanations to thoſe of its former courſe. It then by a bound, goes to one ſide, lies flat upon its belly, and permits the pack to paſs by very near, without offering to ſtir.

The Roe-buck differs from the Stag alſo, in its natural appetites, its inclinations, and its

whole habit of living. Inſtead of herding together, theſe animals live in ſeparate families; the ſire, the dam, and the young ones aſſociate together, and never admit a ſtranger into their little community. All others of the Deer kind are inconſtant in their affection; but the *Roe-buck* never leaves its mate; and as they have been generally bred up together, from their firſt fawning, the male and female never after ſeparate.

They drive away their Fawns upon theſe occaſions; the Buck forcing them to retire in order to make room for a ſucceeding progeny. However, when the ſeaſon is over, the Fawns return to their Does, and remain with them ſome time longer; after which, they quit them entirely, in order to begin an independent family of their own.

When the female is ready to bring forth, ſhe ſeeks a retreat in the thickeſt woods, being not leſs apprehenſive of the Buck, from whom ſhe then ſeparates, than of the Wolf, the wild Cat, and almoſt every ravening animal of the foreſt. She generally produces two at a time. In about ten or twelve days theſe are able to follow their dam, except in caſes of warm purſuit, when their ſtrength is not equal to the fatigue. Upon ſuch occaſions the tenderneſs of the dam is very extraordinary; leaving them in the deepeſt thicket, ſhe offers herſelf to the danger, flies before the hounds, and does all in her power to lead them from the retreat where ſhe has lodged her little ones. Such animals as are nearly upon her own level ſhe boldly encounters; attacks the Stag, the wild Cat, and even the Wolf; and while ſhe has life, continues her efforts to protect her young.

Of

Of all animals of the Deer kind, the *Rein-Deer* is the moſt uſeful. It is a native of the icy regions of the North, and cannot live in a more Southern climate. Nature ſeems to have fitted it entirely for that hardy race of mankind that live near the pole. As theſe would find it impoſſible to ſubſiſt among their barren, ſnowy mountains, without its aid, ſo this animal can live only there. From it alone, the natives of *Lapland* and *Greenland* ſupply moſt of their wants. It anſwers the purpoſes of an horſe, to convey them and their ſcanty furniture, from one mountain to another; it anſwers the purpoſes of a cow, in giving milk; and of the ſheep, in furniſhing them with a warm, though an homely kind of clothing. From this alone, therefore, they receive as many advantages, as we derive from three of our moſt uſeful creatures. It is lower and ſtronger built than the ſtag; its legs are ſhorter and thicker, and its hoofs much broader; its hair is much thicker and warmer; its horns much larger in proportion, and branching forward over its eyes; its ears are much larger; its pace is rather a trot than a bounding, and this it can continue for a whole day; its hoofs are cloven and moveable, ſo that it ſpreads them abroad as it goes, to prevent its ſinking in the ſnow.

Lapland is divided into two diſtricts, the mountainous and the woody. The mountainous part is barren and bleak, exceſſively cold, and uninhabitable, during the winter. Still, however, it is the moſt deſirable part of this frightful region, and is moſt thickly peopled, during the ſummer. The natives generally

reſide on the declivity of the mountains, three or four cottages together. Upon the approach of winter, they migrate into the plains below, each bringing down his whole herd, which often amounts to more than a thouſand, and leading them where the paſture is in greateſt plenty. The woody part of the country is much more hideous: a frightful ſcene of trees without fruit, and plains without verdure. As far as the eye can reach, nothing is to be ſeen, even in the midſt of ſummer, but barren fields, covered only with moſs, no graſs, no flowery landſcapes, only here and there a pine tree, which may have eſcaped the frequent conflagrations, by which the natives burn down their foreſts. This moſs, however, which deforms the country, ſerves for its only ſupport, as upon it alone the Rein-Deer can ſubſiſt. The inhabitants, who, during the ſummer, lived among the mountains, drive down their herds in winter, and people the plains and woods below.

There is ſomething worthy our notice even in that deſpiſed animal, an *Aſs*. There is a much greater reſemblance between the horſe and the Aſs, than between the ſheep and the goat. And yet the latter produce an animal, that is not barren; whereas the Mule always is.

The She-aſs is not leſs fond of her young, than the male is of her. She will ruſh either through fire or water, to protect or rejoin it. An Aſs is often no leſs attached to his own owner. He ſcents him at a conſiderable diſtance; he diſtinguiſhes him from others, in a crowd. He knows the way wherein he has paſſed, and the places where he inhabits.

When

When over-loaded, he ſhews it by hanging down his head, and lowering his ears. If his eyes are covered, he will not ſtir a ſtep; and, if he is laid down in ſuch a manner that one eye is covered with the graſs, while the other is hidden with a ſtone, or whatever is next at hand, he will continue fixed in the ſame ſituation, and will not ſo much as attempt to riſe, to free himſelf from thoſe ſlight impediments. He walks, trots, and gallops, like an horſe; but is ſoon tired; and then no beating will make him mend his pace. It is in vain that his unmerciful rider exerts his whip or his cudgel; the poor little animal bears it all with patience, and does not offer even to move.

The *Spaniards*, of all people in *Europe*, ſeem to be acquainted with the value of the Aſs. They take all precautions to improve the breed, and a Jack-aſs in *Spain* is above fifteen hands high. This animal, however, ſeems originally a native of *Arabia*. A warm climate is known to produce the largeſt and the beſt; their ſize and ſpirit decline, in proportion as they advance into colder regions.

In *Guinea*, they are larger and more beautiful, than even the horſes of the ſame country.

In *Perſia*, they have two kinds; one of which is uſed for burthens, being ſlow and heavy, the other is kept for the ſaddle, being ſmooth, ſtately, and nimble. An Aſs will live above ſixty years. He ſleeps much leſs than the horſe; and never lies down for that purpoſe, unleſs very much tired. The She-aſs goes above eleven months with young, and never brings forth more than one at a time.

The Mule may be engendered, either between an Horſe and a She-aſs, or between a Jack-aſs and a Mare. The latter breed is every way preferable, being larger, ſtronger, and better ſhaped. The common Mule is found very ſerviceable in carrying burthens, particularly in mountainous and ſtony places. Their manner of going down the precipices of the *Alps* is very extraordinary. In theſe paſſages, on one ſide, are ſteep eminences, and, on the other, frightful abyſſes; and, as they generally follow the direction of the mountain, the road, inſtead of lying in a level, forms at every little diſtance ſteep declivities, of ſeveral hundred yards downward. Theſe can only be deſcended by mules: and the animal itſelf ſeems ſenſible of the danger. When they come to the edge of one of theſe deſcents, they ſtop of themſelves, without being checked by the rider; and, if he inadvertently attempts to ſpur them on, they continue immoveable. They ſeem ruminating and preparing themſelves for the encounter. They not only attentively view the road, but tremble and ſnort. Having prepared for the deſcent, they place their fore-feet in a poſture, as if they were ſtopping themſelves; they then put their hinder feet together, but a little forward, as if they were going to lie down. In this attitude, having taken as it were a ſurvey of the road, they ſlide down with the ſwiftneſs of a meteor. In the mean time, all the rider has to do is to keep himſelf faſt on the ſaddle, without checking the rein, for the leaſt motion is ſufficient to diſorder the Mule; in which caſe they both unavoidably periſh. But their addreſs in this rapid deſcent, is truly wonderful; for in their ſwifteſt

ſwifteſt motion, when they ſeem to have loſt all government of themſelves, they follow exactly the different windings of the road, as if they had previouſly ſettled in their minds the route they were to follow.——In this journey, the natives, who are placed along the ſides of the mountains, and hold by the roots of the trees, animate the beaſt with ſhouts, and encourage him to perſeverance.

There are but three animals of the Horſe-hind. The *Horſe*, which is the moſt ſtately and courageous, the *Aſs*, which is the moſt patient, and the *Zebra*, which is the moſt beautiful, but at the ſame time the wildeſt animal in nature. Nothing can exceed the delicate regularity of this creature's colour, or the ſmoothneſs of its ſkin; but on the other hand, nothing can be more timid, or more untameable.

The *Zebra*, or Wild Aſs, is chiefly a native of the Southern parts of *Africa*, and there are whole herds of them often ſeen feeding in the extenſive plains near the *Cape of Good Hope*. However, their watchfulneſs is ſuch, that they ſuffer nothing to come near them; and their ſwifneſs ſo great, that they readily leave every purſuer far behind. The Zebra, in ſhape, rather reſembles the Mule than the Aſs. Its ears are not ſo long as thoſe of the Aſs, and yet not ſo ſmall as in the Horſe-kind. Like the Aſs, its head is large, its back ſtreight, and its tail tufted at the end; like the Horſe, its ſkin is ſmooth and cloſe, and its hind quarters round and fleſhy. But its greateſt beauty lies in the amazing elegance of its colours. In the

male, they are white and brown; in the female, white and black. Theſe colours are diſpoſed in alternate ſtripes over the whole body, and with ſuch exactneſs and ſymetry, that one would think Nature had employed the rule and compaſs to paint them. Theſe ſtripes, which, like ſo many ribbons are laid all over its body, are narrow, parallel, and exactly ſeparated from each other.

It is now not known, what were the pains and the dangers which were firſt undergone to reclaim the breed of Horſes from ſavage ferocity: theſe, no doubt, made an equal oppoſition; but by being oppoſed by an induſtrious and enterprizing race of mankind, their ſpirit was at laſt ſubdued, and their freedom reſtrained.

It is otherwiſe with regard to the Zebra: it is the native of countries where the human inhabitants are but little raiſed above the quadruped. The natives of *Angola* or *Cafraria*, have no other idea of advantage from Horſes, but as they are good for food; neither the fine ſtature of the *Arabian* courſer, nor the delicate colourings of the Zebra, have any allurements to a race of people who only conſider the quantity of fleſh, and not its conformation. The delicacy of the Zebra's ſhape, or the painted elegance of its form, are no more regarded by ſuch, than by the Lion that makes it his prey. Perhaps the Zebra may have hitherto continued wild, becauſe it is the native of a country where there have been no efforts made to reclaim it. All purſuits then were rather againſt its life than its liberty; the animal has thus been long taught to conſider man as its mortal enemy; and it is not to be wondered, that it refuſes to

yield obedience where it has ſo ſeldom experienced mercy.

All animals ſeem perfectly to know their enemies, and to avoid them at the ſame time; which we cannot account for. Inſtinct, indeed, may teach the Deer to fly from the Lion; or the Mouſe to avoid the Cat:—but what is the Principle that teaches the Dog to attack the *dog-butcher* wherever he ſees him? In *China*, where the killing and dreſſing Dogs is a trade, whenever one of theſe move out, all the Dogs in the village or the ſtreet are ſure to be after him.

I have ſeen, (ſays Dr. *G*—) more than one inſtance of the ſame kind among ourſelves. I have ſeen a poor fellow, who made a practice of ſtealing and killing Dogs for their ſkins, purſued hue and cry for three or four ſtreets together, by all the bolder breed of Dogs, while the weaker flew from his preſence with affright.

How theſe animals could thus find out their enemy, and purſue him, is unaccountable; but ſuch is the fact; and it not only obtains in Dogs, but in ſeveral other animals, though perhaps to a leſs degree.

The noiſe of the Zebra is neither like that of an Horſe or Aſs, but more reſembling the confuſed barking of a maſtiff Dog, In the two which I ſaw, there was a circumſtance, that ſeems to have eſcaped naturaliſts; which is, that the ſkin hangs looſe below the jaw, upon the neck, in a kind of dewlap, which takes away much from the general beauty.

The *Squirrel* is a beautiful little animal; which from the gentleneſs of its manners, deſerves our protection. It is not hurtful, its uſual food is fruits, nuts and acorns, it is

cleanly, nimble, active, and induſtrious; its eyes are ſparkling, and its phyſiognomy marked with meaning. It generally, like the Hare and Rabbit, ſits upon its hinder legs, and uſes the fore paws as hands; theſe have five claws as they are called, and one of them is ſeparated from the reſt like a thumb. This animal ſeems to approach the nature of a bird, from its lightneſs and ſurprizing agility. It ſeldom deſcends to the ground, except in caſe of ſtorms, but jumps from one branch to another; feeds in ſpring, on the buds and young ſhoots; in ſummer, on the ripening fruits; and particularly the young coves of the pine tree. In autumn it has an extenſive variety, the acorn, the philbard, the cheſnut, and the wilding. This ſeaſon of plenty, however, is not ſpent in idle enjoyment; the provident little animal gathers at that time its proviſions for the winter, and cautiouſly foreſees the ſeaſon when the foreſt ſhall be ſtripped of its leaves and fruitage.

Its neſt is generally formed among the large branches of a great tree, where they begin to fork off into ſmall ones. After chuſing the place where the timber begins to decay, and an hollow may eaſily be formed, the Squirrel begins by making a kind of level between the forks; and then bringing moſs, twigs, and dry leaves, it binds them together with great art, ſo as to reſiſt the moſt violent ſtorm. This is covered on all ſides; and has but a ſingle opening at top, which is juſt large enough to admit the little animal; and this opening is itſelf defended from the weather by a kind of canopy that throws off the rain, though never ſo heavy. The neſt thus formed, with a very little opening above is, nevertheleſs, very commodious and roomy below; ſoft, well knit together, and every way

way convenient and warm. In this retreat the little animal brings forth its young, ſhelters itſelf from the heat of the ſun, which it ſeems to fear, and from the ſtorms and inclemency of the winter, which it is ſtill leſs capable of ſupporting. Its proviſion of nuts and acorns is ſeldom in its neſt, but in the hollows of the tree, laid up carefully together, and never touched but in caſes of neceſſity. Thus one ſingle tree ſerves for a retreat and a ſtore-houſe, and without leaving it during the winter, the Squirrel poſſeſſes all thoſe enjoyments that its nature is capable of receiving.

The *Marmont* is almoſt as big as an Hare, but is more corpulent than a Cat, and has ſhorter legs. Its head pretty nearly reſembles that of an Hare, except that its ears are much ſhorter. It is cloathed all over with very long hair, and a ſhorter fur below. Theſe are of different colours, black and grey.

The length of the hair gives the body the appearance of greater corpulence than it really has, and at the ſame time ſhortens the feet ſo that its belly ſeems to touch the ground. Its tail is tufted and well furniſhed with hair, and it is carried in a ſtrait direction with its body. It has five claws behind, and only four before. Theſe it uſes as the Squirrel does, to carry its food to its mouth, and it uſually ſits upon its hinder parts to feed in the manner of that little animal. It is readily taught to dance, to wield a cudgel, and to obey the voice of its maſter. Like the cat, it has an antipathy to the Dog, and when it becomes familiar to the family, and is ſure of being ſupported by his maſter, it attacks and bites even the largeſt maſtiff. From its ſquat muſcular

make, it has great ſtrength joined to great agility. However, it is in general a very inoffenſive animal; and, except its enmity to Dogs, ſeems to live in friendſhip with every creature, unleſs when provoked. As its legs are very ſhort, and made ſomewhat like thoſe of a Bear, it is often ſeen ſitting up, and even walking on its hind legs. Like all the Hare kind, it runs much ſwifter up hill than down; it climbs trees with great eaſe, and runs up the clefts of rocks, or the contiguous walls of houſes, with great facility.

Thoſe arms which the *Hedge-hog* poſſeſſes in miniature, the *Porcupine* has in an enlarged degree.

In the one, the ſpines are but an inch long, in the other, a foot. The Porcupine is about two feet long, and fifteen inches high. It is covered with quills from ten to fourteen inches long, reſembling the barrel of a gooſe-quill in thickneſs; but tapering and ſharp at both ends. Each quill is thickeſt in the middle; and inſerted into the animal's ſkin, in the ſame manner as feathers in birds. The biggeſt are often fifteen inches long, and a quarter of an inch in diameter; extremely ſharp, and capable of inflicting a mortal wound. They are harder than common quills, and ſolid at the end which is not fixed in the ſkin. All theſe quills, incline backwards, like the briſtles of an Hog; but when the animal is irritated, riſe, and ſtand upright.

Such is the formation of this quadruped, in thoſe parts in which it differs from moſt others. As to the reſt of its figure, the muzzle bears ſome reſemblance to that of an Hare, but black; the

the legs are very ſhort, and the feet have five toes, both before and behind; and theſe, as well as the belly, the head, and all other parts of the body; are covered with a ſort of ſhort hair, like prickles, there being no part, except the ears and the ſole of the foot, that is free from them: the ears are thinly covered with very fine hair; and are in ſhape like thoſe of mankind: the eyes are ſmall like thoſe of an Hog, being only one third of an inch from one corner to the other. After the ſkin is taken off, there appears a kind of paps on thoſe parts of the body, from whence the large quills proceed; theſe are about the ſize of a ſmall pea, each anſwering to as many holes as appear on the outward ſurface of the ſkin, and which are about half an inch deep, like as many hollow pipes, wherein the quills are fixed, as in ſo many ſheaths.

This animal partakes much of the nature of the Hedge-hog; having this formidable apparatus rather to defend itſelf, than annoy the enemy. Indeed many have ſuppoſed that it was capable of diſcharging at its foes, its quills. But, it is now well known that its quills remain fixed in the ſkin, and are then only ſhed, when the animal moults them, as birds do their feathers.

The *Pangolin*, a native of the torrid climates of the ancient continent, is, of all animals, the beſt protected from external injury. It is three or four feet long, or, taking in the tail, from ſix to eight. It has a ſmall head, a very long noſe, a ſhort thick neck, a long body, legs very ſhort, and a tail extremely long. It has no teeth, but is armed with five toes on each foot, with long white claws. But what

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it is chiefly diſtinguiſhed by, is its ſcaly covering. Theſe ſcales defend the animal on all parts, except the under part of the head and neck, under the ſhoulders, the breaſt, the belly, and the inner ſide of the legs; all which parts are covered with a ſmooth ſoft ſkin, without hair. The ſcales of this extraordinary creature are of different ſizes and different forms, and ſtuck upon the body ſomewhat like the leaves of an artichoke. The largeſt are near the tail, which is covered with them like the reſt of the body. Theſe are above three inches broad, and about two inches long, thick in the middle and ſharp at the edges. They are extremely hard, like horn. They are convex on the outſide, and a little concave on the inner; one edge ſticks in the ſkin, while the other laps over that immediately behind it. Thoſe that cover the tail are ſo hard, when the animal has acquired its full growth, as to turn a muſquet-ball.

This is lapped round the reſt of the body, and, being defended with ſhells even more cutting than any other part, the creature continues in perfect ſecurity. Its ſhells are ſo large, ſo thick, and ſo pointed, that they repel every animal of prey; they make a coat of armour that wounds while it reſiſts, and at once protects and threatens. The moſt cruel beaſts of the foreſt, the Tiger, the Panther, and Hyena, make vain attempts to force it. They roll it about, but all to no purpoſe; the Pangolin remains ſafe while its invader feels the reward of its raſhneſs.

The *Armadillo* is chiefly an inhabitant of South America; an harmleſs creature, incapable of of-

offending any other, and furniſhed with a peculiar covering for its own defence.

This animal being covered like a Tortoiſe, with a ſhell, or rather a number of ſhells, its other proportions are not eaſily diſcerned. It appears at firſt view, around miſhapen maſs, with a long head, and a very large tail ſticking out at either end.

It is of different ſizes, from a foot to three feet long, and covered with ſhell divided into ſeveral pieces, that lap over each other like the plates in the tail of a Lobſter. This covers the head, the neck, the back, the ſides, the rump, and the tail to the very point. The only parts to which it does not extend are, the throat the breaſt, and the belly, which are covered with a white ſoft ſkin. By this means the animal has a motion in its back, and the armour gives way to its neceſſary inflexions. Theſe ſhells are differently coloured in different kinds, but moſt uſually they are of a dirty grey. This colour in all ariſes from another peculiar circumſtance in their conformation, for the ſhell itſelf is covered with a ſoftiſh ſkin which is ſmooth and tranſparent.

Beaſts may be conſidered as a numerous groupe, terminated on every ſide by ſome that but in part deſerve the name. On one quarter, we ſee a tribe covered with quills, or furniſhed with wings, that lift them among the inhabitants of the air; on another, we behold a diverſity cloathed with ſcales and ſhells, to rank with inſects; and ſtill, on a third, we ſee them deſcending into the waters, to live among the mute tenants of that element. We

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now come to a numerous tribe, that ſeem to make approaches even to humanity; that bear an aukward reſemblance of the human form, and diſcover the ſame fained efforts at intellectual ſagacity.

Animals of the *Monkey* claſs are furniſhed with hands inſtead of paws; their ears, eyes, eye-lids, lips, and breaſts, are like thoſe of mankind; their internal conformation alſo bears ſome diſtant likeneſs; and the whole offers a picture that may mortify the pride of ſuch as make their perſons the principal object of their admirations.

Theſe approaches, however, are gradual, and ſome bear the marks of our form, more ſtrongly than others.

In the *Ape* kind, we ſee the whole external machine ſtrongly impreſſed with the human likeneſs: theſe walk upright, want a tail, have fleſhy poſteriors, have calves to their legs, and feet nearly like ours.

In the *Baboon* kind, we perceive a more diſtant approach; the beaſt mixing in every part of the animal's figure: theſe generally go upon all fours; but ſome, when upright, are as tall as a man: they have ſhort tails, long ſnouts, and are poſſeſſed of brutal fierceneſs.

The Monkey kind are removed a ſtep further: theſe are much leſs; with tails as long as their bodies, and flattiſh faces.

Laſtly, the *Opoſſum* kind, ſeem to loſe all reſemblance of the human figure, except in having hands, their noſes are lengthened out, and

and every part of their bodies totally different from the human; however, as they graſp their food, with one hand, which Beaſts cannot do, this ſingle ſimilitude gives them an air of ſagacity, to which they have ſcarce any other pretenſions.

The Baboon, is from three to four feet high, very ſtrong built, with a thick body and limbs, and canine teeth, much longer than thoſe of men. It walks more commonly upon all fours than upright, and its hands as well as its feet are armed with long ſharp claws, inſtead of the broad round nails of the Ape kind.

At the Cape of Good Hope they are under a ſort of natural diſcipline, and go about whatever they undertake with ſurprizing ſkill and regularity. When they ſet about robbing an orchard or a vineyard, (for they are extremely fond of grapes, and apples;) they go in large companies, and with preconcerted deliberation; part of them enter the encloſure, while one is ſet to watch. The reſt ſtand without the fence, and form a line reaching all the way from their fellows within to their rendezvous without, which is generally in ſome craggy mountain. Every thing being thus diſpoſed, the plunderers within the orchard throw the fruit to thoſe that are without as faſt they can gather it; or, if the wall or hedge be high, to thoſe that ſit on the top; and theſe hand the plunder to thoſe next them on the other ſide. Thus the fruit is pitched from one to another all along the line, till it is ſafely depoſited at their head quarters. They catch it as readily as the moſt ſkilful tennis-player can a ball; and while the buſineſs is going forward, a profound ſilence is ob-

obſerved. Their centinel, during this whole time, continues upon the watch, and if he perceives any one coming, inſtantly ſets up a loud cry, on which ſignal the whole company ſcamper off. Nor yet are they willing to go empty handed; for if they be plundering a bed of melons, for inſtance, they go off with one in their mouths, one in their hands, and one under their arm. If the purſuit is hot, they drop firſt that from under their arm, then that from their hand; and, if it be continued, they at laſt let fall that which they had kept in their mouths.

The *Chimpanaze* is an animal found in *Angola*, nearly approaching to the human figure; but of a fierce diſpoſition, and remarkably miſchievous. In the year 1738, one of theſe creatures was brought over to *England*. It was about twenty months old. [The parent had it in her arms, when ſhe was killed: ſhe was five feet high.] It was of the female ſex, naturally walked erect, was hairy on ſome part of the body and limbs, and of a ſtrong, muſcular make. It would eat any courſe food, but was very fond of tea, which it drank out of a cup, with milk and ſugar, as we do. It ſlept in the manner of the human ſpecies, and its voice reſembled the human, when people ſpeak very haſtily; but without any articulate ſounds. The males of this ſpecies are very bold, and will fight a man, though he is armed. It is ſaid, they often aſſault and raviſh the negro women, when they meet them in the woods.

There is another ſtrange ſpecies of *Monkey* found in the *Weſt-Indies*, of the ſize of a fox. Its

Its face is raiſed high, its eyes black and ſhining, and its ears ſmall and round. His hairs are ſo nicely diſpoſed all over the body, that he appears perfectly ſmooth: and they are much longer under the chin, ſo that they form a kind of beard there.

Theſe are found in great numbers in the woods, and make a loud and frightful noiſe. But it is very common for one only to make a noiſe, and the reſt to form a mute aſſembly round him.

Marcgrave ſays "I have frequently ſeen great numbers of them, meeting about noon: at which time they formed a large circle, and one placing himſelf above the reſt, began to make a loud noiſe. When he had ſung thus by himſelf, for ſome time, the reſt all remaining ſilent, he lifted up his hand, and they all inſtantly joined in a ſort of chorus. This intolerable yell continued, till the ſame Monkey, who gave the ſignal for their beginning, lifted up his hand a ſecond time. On this they were all ſilent again, and ſo finiſhed the buſineſs of the aſſembly."

The *Opoſſum*, is about the ſize of a Cat, only more corpulent, and its legs more robuſt. It is of a kind of cheſnut colour, very bright and gloſſy. Its head is long, and terminates in a ſnout, ſomewhat like a Fox's. The tail is long, and much reſembles that of a Rat, which it twiſts about with a ſurprizing facility. The legs being ſhort, the body is carried at no great diſtance from the ground. On the belly of the female, a bag is formed by the ſkin being doubled. It is not very deep, the cloſed part being

being toward the upper part of the body, and the open part toward the lower. This is covered with fur, like the reſt of the body, ſo that it is not very obvious to the ſight.

It is an harmleſs, but likewiſe a defenceleſs animal: and the young of no creature, are produced ſo ſmall and tender, in reſpect of the parent animal. Therefore that bag is extremely uſeful to them. They are cheriſhed there by the warmth of the parent's body, 'till toward noon: then they go abroad, till at the firſt warning by the evening-cold, they retire into their lodging again. Nor is this all the help which it affords them. For as the tender young of the Opoſſum are delicate morſels, they would be expoſed to the rage of many animals, both by day and night. But the body of the parent is a ſafe and ready receptacle for them. By day ſhe is as watchful over her brood, as an Hen over her Chickens. She is alarmed at the ſlighteſt appearance of danger, and by a noiſe which they well underſtand, inſtantly calls them into her bag. At night ſhe conſtantly takes them in, and conſults for herſelf and them in a very uncommon manner. There are thoſe among the devourers of her young, who will climb a tree after her. Therefore when ſhe has climbed, to ſecure herſelf and her young ſtill farther, ſhe twiſts her tail twice round ſome ſmall bough, and then drops from it. There ſhe hangs with her head downward: and whenever ſhe pleaſes, ſhe recovers the branch with her feet by a ſwing, and looſening her tail, walks about as uſual.

To enable her thus to hang, there are *ſpikes* or hooks in the under ſide of the vertebræ of the

the tail. Indeed, in the firſt three vertebræ there are none; for there they would be of no uſe. But they are found in all the reſt. They are placed juſt at the articulation of each joint, and in the middle from the ſides. Nothing could be more advantageouſly contrived. For when the tail is twiſted round a bough, theſe hooks eaſily ſuſtain the weight. And there is no more labour of the muſcles required, than juſt to bow or crook the tail.

Another animal of a very peculiar kind is an *Ichneumon*. It is of the weaſel kind, with a longer and narrower body than a Cat, ſomething approaching to the ſhape and colour of a Badger. Its noſe is black and ſharp, like that of a Ferret. Its colour is a yellowiſh grey. Its legs are ſhort, and each of its feet has five toes. Its tail is very long; its teeth and tongue much like thoſe of a cat. It is a very cleanly animal, very briſk and nimble, and of great courage. It will engage a dog, and will deſtroy a cat, by three bites on the throat. But it is quite innoffenſive to mankind, and is kept tame in *Egypt*, running about the houſe, deſtroying all vermin, and playing tricks, like ſpaniels.

When wild, he cannot overtake any nimble animal. But he makes this up by aſſiduity. His legs being ſhort, he is not much ſeen; but he has a way of concealing himſelf yet more, by crawling with his belly cloſe to the ground, which he does all day long. But on the leaſt noiſe (for his hearing is exceeding quick) he ſtarts up erect on his hinder legs. If the noiſe is made by any reptile, bird, or ſmall

ſmall beaſt, he obſerves where abouts it is, places his noſe directly in a line with it, and begins to move toward it. He is ſilent and ſlow, but conſtant in his approach; often ſtopping to hear or look forward, and know exactly where the creature is: when he is got within about five feet, he ſtops. Nature, which has denied him ſpeed, has given him ſtrength to leap, beyond moſt other creatures. Having taken good aim, he ſprings from the place, and falls directly on his prey. Thus he deals with beaſts and birds. But to ſerpents he gives chaſe, and to avoid their bite, always ſeizes them by the neck.

Geſner tells, that the Ichneumon is not only an enemy to ſerpents themſelves, but to their eggs alſo: which he hunts after continually and deſtroys, though he does not feed upon them.—How mercifully has God given this animal in the countries where thoſe terrible reptiles moſt abound! And which, without this proviſion, would be ſo over-run with them, as to be uninhabitable.

The *Jackal* is of the carnivorous kind. They hunt by ſcent and go in packs. They purſue with patience rather than ſwiftneſs, and excite each other by a ſpirit of emulation.

It goes for current, that the *Jackal* diſcovers the Lion's prey: that each of theſe retains one of them, and having ſatiated himſelf, lets his dependent feed on the offals of his repaſt.

But the truth is, there are great numbers of Jackals in ſome woods, and when one of theſe ſees a Stag, or other large beaſt, which is not a beaſt

a beaſt of prey, he ſets up his cry, which is like that of a hound, and follows it. As he continues his cry, the other Jackals that are within hearing follow likewiſe. And could the creature outrun thoſe that began the chaſe, there is a continual ſupply; ſo that it cannot eſcape. When they have run it down, they worry it at once, and it is devoured almoſt in an inſtant. After this the Jackals diſperſe, till another cry invites them.

They hunt generally in the night, and in the parts of the Eaſt, where they are moſt frequent, there never is a night but they are heard, in one part or other of the woods. The other beaſts of prey underſtand the ſound: and frequently profit by it. If a Lion, Tyger, or Leopard happens to be near, he hears the cry, and ſtands upon the watch. Theſe large animals are all very ſwift, but they are lazy, and never make long purſuits. If the creature purſued be far off, and run another way, they never trouble themſelves about it. But if it be near, or if it run toward the place where the Lion is, he will dart out upon it as it goes by. And the little animals that hunted it down muſt ſtand by, and be content with what their maſter leaves.

The *Sable-mice*, (which were firſt obſerved in *Lapland*, in 1697,) are near as big as a ſmall Squirrel. Their ſkin is ſtreaked and ſpotted with black and light brown. They have two teeth above, and two under, very ſharp and pointed. Their feet are like a Squirrel's. They are ſo fierce, that if a ſtick be held out to them, they will

will bite it, and hold ſo faſt, that they may be ſwinged about in the air. In their march they keep a direct line, generally from north-eaſt to ſouth-weſt. Innumerable thouſands are in each troop, which is uſually a ſquare. They lie ſtill by day, and march by night. The diſtance of the lines they go in, parallel to each other, is of ſome ells. Whatever they meet in their way, tho' it were a fire, a deep well, a torrent lake, or moraſs, they avoid it not, but ruſh forward. By this means many thouſands of them are deſtroyed. If they are met ſwimming over a lake, and are forced out of their courſe, they quickly return into it again. If they are met in woods or fields and ſtopt, they raiſe themſelves on their hinder legs, like a dog, and make a kind of barking noiſe, leaping up as high as a man's knees, and defending their line as long as they can. If at laſt they are forced out of it, they creep into holes, and ſet up a cry, ſounding like *Biab*, *biab*. If a houſe ſtand in their way, they never come into it, but ſtop there till they die. But they will eat their way through a ſtack of corn or hay. When they march through a meadow, they eat the roots of the graſs: and if they encamp there by day, they utterly ſpoil it, and make it look juſt as if it had been burnt. They are exceeding fruitful: but their breeding does not hinder their march. For ſome of them have been obſerved, to carry one young in their mouth, and another upon their back. In winter they live under the ſnow, having their breathing-holes, as Hares and other creatures have.

I would

I would mention only two creatures more, very extraordinary, and yet but little known.

The *Glutton* is frequent in the foreſts of *Germany*. It is rarely ſeen twice of the ſame figure. It is of the Weaſel-kind, and is in its middle ſtate, about the ſize of a turn-ſpit Dog. Its body is long, its legs ſhort. Its colour is brown, with a reddiſh tinge; but its breaſt and belly are white. The tail is long and buſhy; the head ſmall and ſharp at the noſe. The teeth are exceeding ſharp, and the claws ſharper than almoſt in any creature.

This is the moſt hungry animal in the world, but is ill provided for catching its prey. Moſt creatures can outrun it, and itſelf can ſcarce run away from any thing. But what he wants in ſwiftneſs, he has in climbing, which he performs to admiration: its ſharp claws enabling it to run up a tree as faſt as on the ground. Its uſual place is ſome large and ſpreading oak, choſe both for ſafety and for catching its prey. He ſquats all day on ſome large branch; and if nothing offers below, he preys in the night on whatever creatures he can find on the tree above. Many birds rooſt on ſuch trees, which he climbs ſoftly to, and devours. But his favourite food is larger animals. He will lie many days on a ſlanting bough; and when any which he likes comes underneath, he drops down upon them. Hares and Rabbits ſeldom eſcape him; but he chuſes rather a Goat, or any creature of that ſize. When one of theſe comes under the tree, he creeps from bough to bough, till he comes juſt over it, and then drops down upon it. He always contrives to faſten on the neck. In an inſtant, he fixes

both his teeth and claws, and lies acroſs the neck, near the ſhoulders. Here he is ſecure; and while the poor creature runs with all its ſpeed, he is feeding on its fleſh. At length it drops, and he continues eating in the ſame ravenous manner, till from a mere ſkeleton, his back becomes round, and his ſides ſwelled out like a tun. Still he continues to eat, till he can eat no longer. He too drops down, and lies panting for breath. He reſembles a dead carcaſe, ſwelled and ready to burſt with lying in the ſun: and being unable to move for a long time, is frequently deſtroyed, and ſometimes periſhes without an enemy.

The GOD of Nature ſeems to have formed the *Sloth*, to repreſent to us in a ſtrong light, that odious and deſpicable vice, from which it takes its name. Its body is ſhort, its head ſmall, and it has ſcarce any tail. Its fur is long, thick, and of a greyiſh green, ſo that when ſeen on the bough of a tree, it appears only like an excreſcence or a cluſter of moſs. It is about the ſize of a Cat, but the legs are ſhort, as is the neck: and its long and thick covering, renders it ſo ſhapeleſs, that it ſeems only an irregular lump of living matter. Its little and remarkably ugly head ſtands cloſe between the ſhoulders. The face has much of the Monkey aſpect. Its ſmall and heavy eyes, are always half ſhut, and it has no appearance at all of any ears. Its feet are flat and very narrow, but armed with ſharp claws, for laying hold on the bark of a tree, by ſtriking deep into it.

He rarely changes his place; and never, but when compelled by abſolute neceſſity. As upon

on the ground it would be a prey to every other animal, ſo its conſtant reſidence is on a tree. Here it is ſafe from all animals but thoſe who climb theſe trees for the birds that rooſt on them. The leaves and tender part of the tree are its food, and ſerve it for drink as well as meat. It never moves to another branch, till it has devoured all the nouriſhment upon that where it is ſtationed: nor from one tree to another, till the firſt is wholly withered and waſted.

It is obſervable, the *Sloth* always aſcends to the top of a tree, only baiting as he goes, before he begins his devaſtations. And this is doubtleſs from the inſtinctive guidance of Nature. For was it to begin eating upward, when it had devoured all, it would have to climb down from the top of a dead tree, and would be half ſtarved in its journey. But this is not all. The havock which one Sloth makes on the largeſt tree is eaſily ſeen. For he eats not only the leaves, but all the buds and bark, leaving only a dead branch: ſo that unleſs the ſame thing might happen by accident, this would betray the creature. It does ſo happen; and trees then put on the ſame form, as when they are left by the Sloth. But they always die at the top firſt, and ſo gradually downward. This animal therefore, wonderfully taught, begins its havock at the top. As it feeds, the tree decays; but its decay is in the courſe of Nature. The decay ſpreads downward; and when he has eaten the laſt of his proviſion, he is near the ground, and has only to walk away to another tree. But if it is at any diſtance, his motion is ſo ſlow, that he grows quite lean in the expedition.

As the *Sloth* brings forth her young in the hollow of a tree, ſo is ſhe led by the ſame wonderful inſtinct, to conduct them to the topmoſt branches, as ſoon as they crawl out. When ſhe is big with young, ſhe climbs ſome old, hollow tree; and having fixed on a convenient ſpot for her young, ſhe climbs to the very higheſt bough, and there feeds faſter than uſual. When ſhe is full, ſhe deſcends with unaccuſtomed haſte, and brings forth one, two, or three young ones. It is well ſhe is full fed; for ſhe is to ſupport theſe with her milk, till they can crawl out, without having any ſupply herſelf. She is round and fleſhy when ſhe retires for this purpoſe, but a mere ſkeleton when ſhe comes out. She crawls as well as ſhe can, to the part where ſhe left off feeding, and her young follow her. Nor will ſhe touch any thing in the way, however both her hunger and lazineſs may prompt her to it.

It is the moſt timorous of all creatures. And with reaſon; for it can neither fight nor fly. While it is journeying on the ground, the tread of an human foot ſhakes the earth enough to put into terrors. It trembles: the head is turned about every way, and the mouth is open to cry like a young Kitten.

Inſignificant as this creature is, there is a ſpecial Providence in the formation and care of it. Not deſigned for walking, its claws enable it to climb, and then to hold faſt in its ſtation. Helpleſs as it is, the univerſal Provider has aſſigned it a place of ſafety, where it finds plenty of food; and as it cannot eaſily ſeek for drink, it has no need of any. To render it the leſs obnoxious to purſuit, its colour ſecures it even

even from view: and its amazing Inſtinct of feeding from the top to the bottom, proves a *deſigning* and *directing Hand.*

Before I proceed to ſome general Reflexions upon Beaſts, I beg leave to take notice of one circumſtance, relating to ſeveral ſpecies of them, which is very ſtrange, though very common.——The *Horns* of many animals fall off every year, and new ones come in their place. Our Deer drop them in *March*, and the new horns are full grown by the *July* following. We may very juſtly rank this, among the moſt wonderful phænomena of nature, which yields nothing analogous to the growth of ſuch hard ſolid bodies, of ſo great a bulk, in ſo ſhort a time. Many idle opinions have been maintained, concerning the cauſe of their falling off. The truth ſeems to be this: They are a ſort of vegetables, growing on animals, as the nails and hair on man, and feathers on birds. And there is ſome analogy between the growth of them, and that of branches and leaves in trees. Trees commonly drop their leaves in Autumn, becauſe the nouriſhing juice flows into them no longer. And at certain periods, theſe parts of the animal drop off, becauſe the blood and juices ceaſe to flow into them. At this time, the hollow part at the root of the horn grows hard, and the pores thro' which the juices paſſed, grow up. And as no more nouriſhment can then be carried to the horn, it decays and falls of. 'Tis probable this ſtoppage of the pores happens, as ſoon as the horns are at their full growth. But they are ſo fixt to the head, that it takes a long time for them to looſen and

fall. Whereas in leaves, their ſtalks are ſo tender, that when the juice ceaſes to flow, they preſently wither and fall.

The analogy between the falling off of Deer's horns and the falling of leaves and ripe fruit from the tree, will receive light from obſerving the proceſs of Nature in the latter caſe. If the ſtalk from which a ripe Orange has fallen, be compared with that part of a Deer's forehead, from which a horn is juſt fallen, it will plainly appear, that Nature has operated by the ſame laws in both. The young horns while yet ſoft, are full of blood-veſſels; and if cut off, eſpecially near the head, bleed violently. By theſe veſſels they are ſupplied with nouriſhment for their growth. But theſe dry up, when there is no farther occaſion for them. And hence it is, that no ill ſymptoms attend the falling off of theſe parts, when full grown.

So far we may give a probable account:—— But who can account for this, that if a Stag be caſtrated while he is ſo young as not to have horns, he will never have any: and if caſtrated afterward, while his horns are on, he will never caſt them?

10. It remains only to add a few *Reflexions*. And firſt, What admirable Wiſdom is diſplayed, in the *motion* of various animals, ſuited to to their various occaſions! In ſome their motion is ſwift, in others, ſlow; and both diverſified a thouſand ways.

And firſt, for ſwift or ſlow motion. This is exactly proportioned to the occaſion of each animal. *Reptiles*, whoſe food, habitation, and neſts

neſts lie in the next clod, plant, tree, or hole, or which can bear long hunger, need neither legs, nor wings, but their vermicular motion anſwers all their purpoſes.

Beaſts, whoſe occaſions require a larger room, have accordingly a ſwifter motion: and this in various degrees, anſwerable to their range for food, and the enemies they are to eſcape from.

But as for *Birds*, who are to traverſe vaſt tracts of land and water, for their food, habitation, breeding their young, and for places of retreat and ſecurity, from various inconveniences: they are endued with the faculty of *flying*; and that ſwiftly or ſlowly, a long or ſhort time, according to their occaſions. In all this, the Wiſdom of God appears, ordering all things well.

Again. How admirable in the motion of all creatures, is the neat, geometrical performance of it! The moſt accurate mathematician cannot preſcribe a nicer motion than that they perform, to the legs and wings of thoſe that fly or walk, or to the bodies of thoſe that creep. Neither can the body be more compleatly poiſed, for the motion it is to have in every creature. From the largeſt Elephant to the ſmalleſt Mite, the body is exactly balanced. The head is not too heavy, nor too light for the reſt of the body, nor the reſt of the body for it. The bowels are not looſe, or ſo placed as to ſwag, overbalance, or overſet the body: but well-braced, and accurately diſtributed to maintain the equipoiſe of it. The motive parts alſo are admirably well fixed, in reſpect to the center of gravity, placed in the very point which beſt ſerves to ſupport and convey the body. Every leg

bears its true ſhare of the weight. And the wings are ſo exactly placed, that even in the fluid medium, the air, the body is as truly balanced, as we could have balanced it with the niceſt ſcales.

Yet again. What an admirable proviſion is made for the motion of ſome creatures, by *temporary parts!* *Frogs* for inſtance have tails in their Tadpole ſtate, which fall off when their legs are grown out. The *Water-Newt* alſo when young, has four fins, two on a ſide, to poiſe and keep the body upright. But as ſoon as the legs are fully grown, theſe preſently drop off.

Secondly, The *Bore* of the *Gullet* in all creatures, is anſwerable to their occaſions. In a Fox, which feeds on bones, (as in all oſſivorous beaſts) it is very large. But in a Squirrel it is exceeding ſmall, leſt he ſhould diſgorge his meat in his deſcending leaps: And ſo in Rats and Mice, which often run along a wall with their heads downward.

Thirdly, In all animals the ſtrength and ſize of their *Stomach* are proportioned to their food. Thoſe whoſe food is more tender and nutritive, have it ſmaller, thinner, and weaker. Whereas it is large and ſtrong in thoſe whoſe food is leſs nutritive, and whoſe bodies require large ſupplies.

All carnivorous beaſts have the ſmalleſt ſtomachs, as fleſh goes the fartheſt. Thoſe that feed on fruits and roots have them of a middle ſize. Sheep and Oxen, which feed on graſs, have the greateſt. Yet the Horſe, Hare, and Rabbit, though graminivorous, have comparatively ſmall ones. For a Horſe is made for labour, and both this and the Hare for quick and con-

continued motion; for which the moſt eaſy reſpiration, and ſo the freeſt motion of the diaphragm is requiſite. But this could not be, did the ſtomach lie big and cumberſome upon it, as it does in Sheep and Oxen.

Another very remarkable circumſtance is, that thoſe animals which have teeth on both jaws, have but one ſtomach; whereas moſt of thoſe which have no *upper-teeth*, or no teeth at all, have three ſtomachs. For the meat which is firſt chewed, is eaſily digeſted; but that which is ſwallowed whole, requires a ſtronger concoctive power.

Fourthly, all the parts of the ſame animal are adapted one to the other. So, for inſtance, the length of the neck is always proportioned to that of the legs. Only the *Elephant* has a ſhort neck: for the weight of his head and teeth, would to a long neck have been unſupportable. But then he is provided with a trunk, which abundantly ſupplies the defect. In other beaſts and birds, the neck is always commenſurate to the legs: ſo that they which have long legs have long necks, and they that have ſhort legs ſhort ones; as may be obſerved in Lizards of all kinds, and the king of them, the Crocodile. And creatures that have no legs, as they want no necks, ſo they have none, as Fiſhes. This equality between the length of the neck and legs, is peculiarly ſeen in beaſts that feed on graſs. Their legs and necks are very near equal. Very near, I ſay, becauſe the neck muſt neceſſarily have ſome advantage; for it can't hang perpendicular, but muſt incline a little.

Moreover, as theſe creatures muſt hold their heads down, for a conſiderable time together, which would be very laborious and painful for the muſcles, therefore on each ſide of the neck, nature has placed a thick and ſtrong ligament, capable of ſtretching and ſhrinking again as need requires: this, which is vulgarly called *white-leather*, extends from the head (to which, and the next vertebræ of the neck it is faſtened at that end) to the middle vertebræ of the back, to which it is knit at the other. And by the aſſiſtance of this, they are able to hold the head in that poſture all day long.

Fifthly, The parts of all animals are exactly fitted to their manner of living. A notable inſtance of this is in the Swine. His natural food being chiefly the roots of plants, he is provided with a long and ſtrong ſnout; long, that he may thruſt it to a convenient depth in the ground, without offence to his eyes; ſtrong and conveniently formed, for rooting and turning up the ground. And beſides, he has an extremely quick ſcent, for finding out ſuch roots as are fit for him. Hence in *Italy*, the uſual way of finding truffles, or ſubterraneous muſhrooms is by tying a cord to the hind-leg of a pig, and driving him before them into their paſtures. They then obſerve, where he ſtops and begins to root: and digging there they are ſure to find a truffle. So in paſtures where there are earth-nuts, tho' the roots are deep in the ground, and the leaves are quite gone, the Swine will find them by their ſcent, and root only in the places where they grow.

Another inſtance of like nature we have in the *Porpes* (antiently wrote *Porc-peſce*, that is *Swine-fiſh*) which reſembles the Hog, both in the

the ſtrength of his ſnout and in the manner of getting his food. For the ſtomach of one of theſe when diſſected, was found full of ſand-eels, which lie deep in the ſand, and cannot be gotten, but by rooting and digging there.

That very action, for which we look upon Swine as unclean creatures, namely, wallowing in the mire, is deſigned by nature for a good end; not only to cool their bodies (which fair water would do as well) but alſo to ſuffocate and deſtroy fleas, lice, and other inſects, which are troubleſome and hurtful to them. For the ſame reaſon, poultry and divers other birds baſk themſelves in the duſt, in hot ſummer weather.

The *Variety* of ſhape and colour obſervable in *Beaſts*, prevents any two from being exactly alike, as much as the human features diſtinguiſh mankind one from another. Wherefore then was this variety beſtowed upon brutes? Are they at all ſenſible of ſuch diverſity? Are they the more happy, or more uſeful to one another for it? No. This variety then is doubtleſs intended for the ſake of man, to prevent confuſion, and decide and aſcertain his property.

CHAP. II.

Of Birds.

1. *Some general Remarks*
2. *Of their Motion:*
3. *Brain:*
4. *Organs of Senſe:*
5. *Lungs:*
6. *Stomach and Bladder:*
7. *Generation.*
8. *Of ſome particular Sorts of Birds.*
9. *Reflexions.*

NO part of Nature is deſtitute of Inhabitants. The woods, the waters, the depths of the earth, have their reſpective tenants; while the yielding air, and thoſe tracts where man never can aſcend, are alſo paſſed through by multitudes of the moſt beautiful beings of the creation.

Every order of animals is fitted for its ſituation in life: but none more apparently than Birds. Though they fall below Beaſts in the ſcale of Nature, yet they hold the next rank, and far ſurpaſs Fiſhes and inſects, both in the ſtructure of their bodies and in their ſagacity.

The body of Man preſents the greateſt variety: Beaſts leſs perfectly formed, diſcover their defects in the ſimplicity of their conformation: The mechaniſm of Birds is yet leſs complex: Fiſhes are furniſhed with fewer organs ſtill; while Inſects, more imperfect than all, fill up the chaſm between animal and vegetable

table nature. Of Man, the moſt perfect animal, there are but three or four ſpecies; the kinds of Beaſts are more numerous; Birds are more various ſtill; fiſhes yet more; but Inſects afford an immenſe variety.

In all birds, except nocturnal ones, the head is ſmaller, and bears leſs proportion to the body than in beaſts; that it may the more readily divide the air in flying. Their eyes alſo are more flat and depreſſed, and a circle of ſmall plates of bone, placed ſcale-wiſe under the outer coat of the organ, encompaſſes the pupil on each ſide to ſtrengthen and defend it from injuries. Beſide this, birds have a kind of ſkin, called the nictitating membrane, with which, like a veil, they can at pleaſure cover their eyes, tho' their eyelids continue open. This membrane ſerves alſo to wipe, cleanſe, and probably to moiſten its ſurface. The eyes, tho' they outwardly appear but ſmall, yet each almoſt equals the brain; whereas in man the brain is more than twenty times larger than the eye.

Hence it follows, that the ſenſe of *ſeeing* in birds is infinitely ſuperior to that of other animals. Indeed this piercing ſight ſeems neceſſary to the creature's ſupport and ſafety. Were it not ſo, from the rapidity of the bird's motion, it would be apt to ſtrike againſt every object in its way; and it could ſcarcely find ſubſiſtence, unleſs it could diſcern its food from above with aſtoniſhing ſagacity. An Hawk, for inſtance, perceives a Lark at a diſtance, which neither men nor dogs could ſpy; and a Kite, from an almoſt imperceptible height darts down on its prey with the moſt unerring aim.

Gra-

Granivorous birds, or such as live upon vegetables, have their intestines differently formed from those of the rapacious kind. Their gullet dilates just above the breast-bone, and forms itself into a pouch or bag, called the *crop*. This is replete with salival glands, which moisten and soften the food it contains. After the dry food of the bird has been macerated, it passes into the belly, where, instead of a soft moist stomach, as in the rapacious kinds, it is ground between two pair of muscles, commonly called the *gizzard*, covered on the inside with a strong ridgy coat. These coats rubbing against each other, are capable of attenuating the hardest substances; their action being often compared to that of the grinding teeth, in man and other animals.

Thus the organs of digestion are in a manner reversed in birds. Beasts grind their food with their teeth, and then it passes into the stomach, where it is softened and digested. On the contrary, birds of this sort first soften it in the crop, and then it is ground and comminuted in the stomach or gizzard. Birds are all careful to pick sand, gravel, and other hard substances, not to grind their food, as has been supposed, but to prevent the too violent action of the coats of the stomach against each other.

To birds the return of Spring is the beginning of pleasure. Those vital spirits which seemed locked up during the Winter, then begin to expand; vegetables and insects supply abundance of food; and the bird having more than a sufficiency for its own subsistence, is impelled to transfuse life as well as to maintain it. Those warblings which had been hushed

huſhed during the colder ſeaſons, now begin to animate the fields; every grove and buſh reſounds with the challenge of anger, or the call of allurement. The delightful concert of the grove, which is ſo much admired by man, is no way ſtudied for his amuſement: it is the call of the male to the female; his efforts to ſooth her during the times of incubation: or a challenge between two males for the affections of ſome common favourite.

It is by this call that birds begin to pair at the approach of Spring, and provide for the ſupport of a future progeny. The loudeſt notes are uſually from the male; the hen expreſſes her conſent, in a ſhort, interrupted twittering. Their compact holds with unbroken faith: moſt birds live with inviolable fidelity together; and when one dies, the other is always ſeen to ſhare the ſame fate ſoon after. We muſt look for it in our fields and in our foreſts, where nature continues in unadulterated ſimplicity; where the number of males is generally equal to that of females. But the male of all wild birds is as happy in the young brood as the female. They both ſeem, at that ſeaſon, tranſported with pleaſure; every action teſtifies their tender ſolicitude.

But previous to laying, the work of neſtling becomes the common care; and this is performed with no ſmall degree of aſſiduity. It has been aſſerted, that birds of one kind always make their neſts in the ſame manner, and of the ſame materials; but the truth is, they vary this as the materials, places, or climates differ. The Red-breaſt, in ſome parts of England, makes its neſt with oak leaves, where they

they are in plenty, and in other parts with moſs and hair. Some birds, that with us make a very warm neſt, are leſs ſolicitous in the warm climates. In general, however, every ſpecies of birds has a peculiar architecture of its own; and this adapted to the number of eggs, the temperature of the climate, or the heat of the animal's body. Where the eggs are numerous, the neſt is warm, that the animal's heat may be equally diffuſed to them all. Thus the Wren, and all the ſmall birds make their neſts very warm; for having many eggs, it is requiſite to diſtribute warmth to them all: on the contrary, the Plover, that has but two eggs, the Eagle, and the Crow, are not ſo ſolicitous in this reſpect, as their bodies are capable of being applied to the ſmall number upon which they ſit.

Nothing can exceed the patience of birds while hatching; neither hunger, nor danger, can drive them from the neſt. They are fat upon beginning to ſit, yet before incubation is over, are uſually waſted to ſkin and bone. Indeed ravens and crows, while the females are ſitting, take care to provide them with food in abundance. But it is different with moſt of the ſmaller kinds: during the whole time, the male ſits near his mate upon ſome tree, and ſooths her by his ſinging; and often when ſhe is tired takes her place, and patiently continues on the neſt till ſhe returns.

So great is the power of inſtinct, in theſe animals that they continue almoſt paſſive under its influence. Yet at the ſame time, the hen, that has all this ſeeming ingenuity, in other reſpects, is without the leaſt glimmerings of

of common ſenſe: ſhe miſtakes a piece of cake for an egg, and ſets upon it in the ſame manner; ſhe is inſenſible of any increaſe or diminution in the number of thoſe ſhe lays; ſhe does not diſtinguiſh between her own, and thoſe of another ſpecies; and when the birth appears of never ſo different a bird, will cheriſh it for her own.

As the principle which acts in theſe animals cannot be termed Reaſon, ſo when we call it Inſtinct, we mean ſomething we have no knowledge of. It appears to me the immediate direction of Providence; and ſuch an operation of the Supreme Being as that which determines all the portions of matter to their proper centers.

While the young are yet unfledged, the old one takes care to provide them with a regular ſupply: when the family is fully plumed, and capable of avoiding danger by flight, they are then led forth when the weather is fine, and taught the paternal art of providing for their ſubſiſtence. They are led to the places where their food lies; they are ſhewn the method of diſcovering or carrying it away; and then led back to the neſt, for a day or two longer. At length, when they are qualified to ſhift for themſelves, the old one takes them abroad, and leading them to the accuſtomed places, forſakes them for the laſt time; and all connection is at an end.

Birds in general, though they have ſo much to fear from man and each other, are ſeldom ſcared from their uſual haunts. The greateſt number remain contented, where they have been bred. The Rook, if undiſturbed, neve-

de-

desires to leave his native grove; the Black-bird still frequents its accustomed hedge; and the Red-breast, though seemingly mild, claims a certain district, from whence he seldom moves, but drives out every one of the same species from thence without pity. They are excited to migrations by no other motives, but those of fear, climate, or hunger. It is from one of these motives, that birds of passage, every year, forsake us for some time; and make their regular returns. The cause of their retreat is, either scarcity of food, or the want of an asylum from man, during the time of courtship, and bringing up their young. Thus the Starling, in *Sweden*, at the approach of winter, finding subsistence no longer, descends into *Germany*; and the hen Chaffinches of the same country are seen to fly every year through *Holland*, to pass their winter in a milder climate. Others prepare for longer journeys. Thus the Quails in spring forsake the heats of *Africa*, for the milder sun of *Europe*; and when they have passed the summer with us, steer their flight to enjoy, in *Egypt*, the temperate air. This with them seems a pre-concerted undertaking. They unite together in some open place, for some days before their departure, and, by an odd kind of chattering, seem to debate on the method to proceed. Then they all take flight together, and often in such numbers, that, to mariners at sea, they seem like a cloud upon the horizon. The strongest, and by far the greatest number, make good their intention; but many there are, who grow weary in the way, and drop down into the sea, and sometimes upon the decks of ships.

Of

Of the vaſt quantity of water-fowl, that frequent our ſhores, few are known to breed here. The cauſe that urges them to leave us ſeems to be, not merely the want of food, but the deſire of a ſecure retreat. Our country is too populous for birds ſo ſhy, as the greateſt number of theſe are. When great part of our iſland was an uncultivated tract of woods and marſhes, many ſpecies of birds, which now migrate, remained with us the whole year. The great Heron, and the Crane, that have now forſaken this country, in former times bred familiarly in our marſhes. Their neſts, like thoſe of moſt cloven-footed water-fowl, were built on the ground, and expoſed to every invader. But as rural œconomy encreaſed, theſe animals were more and more diſturbed. Once they had little to fear, as the ſurrounding marſh defended them from all the carnivorous ſurrounding quadrupeds, and their own ſtrength from birds of prey; but by a long ſeries of alarms, they have, at length, been obliged to ſeek, during the ſummer, ſome lonely habitation, at a ſafe diſtance from every deſtroyer.

Of the numerous tribes of the Duck kind, we know of no more than five that breed here. The reſt contribute to form that amazing multitude of water-fowl which annually repair to the dreary lakes and deſerts of *Lapland* from the more ſouthern countries of *Europe*. In thoſe ſolitary retreats, they perform the duties of incubation and nutrition in full ſecurity. There are few of this kind that may not be traced to the northern deſerts, to countries of lakes, rivers, ſwamps, and mountains

tains, covered with thick and gloomy foreſts. In thoſe regions, from the thickneſs of the foreſts, the ground remains moiſt and penetrable during the ſummer ſeaſon; the Woodcock, the Snipe, and other ſlender-billed birds, can there feed at eaſe; while the web-footed birds find more than ſufficient food from the number of inſects, which ſwarm to an incredible degree. The days there are long; and the beautiful nights afford them every opportunity of collecting ſo minute a food.

2. Birds have *feathers* which they expand in order to fly; the fine branches of which lie ſo cloſe together, that little air can inſinuate itſelf between them. Now when the column of air on which a body reſts is ſpecifically heavier than the body, it remains ſuſpended in the air; if it be lighter, the body ſinks. Hence the larger ſpace a body circumſcribes, the more eaſily does the air ſuſtain it. Conſequently the ſame bird which ſinks when the wings are cloſed, is ſuſtained when they are expanded. To this alſo the motion of the wings contributes: (as a body while moving ſwiftly, will ſwim in water, which immediately ſinks, if that motion ceaſes.) And ſo do the feathers, with which their bodies are cloathed, which increaſe their bulk, but not their weight in the ſame proportion.

The parts of birds chiefly concerned in flying, are the wings and the tail. By the firſt, the bird ſuſtains and wafts himſelf along. By the ſecond he is enabled to keep his body ſteady and upright, particularly in aſcending and deſcending. It is by the largeneſs and ſtrength of

of the pectoral muſcles, that they are qualified for flying. In men theſe are ſcarce a ſeventeenth part of the muſcles of the body. In birds they conſiderably outweigh all the other muſcles together. And this circumſtance alone, the want of ſuitable muſcles, makes all human attempts to fly, void and vain.

Nevertheleſs the *art of flying* has been ſeriouſly attempted by many, in various ages, particularly in the time of our famous Friar *Bacon*, who lived about 500 years ſince, and whom his excellent works ſhew to have been a rare chymiſt, an excellent mathematician, a knowing mechanic, and a moſt accompliſhed experimental philoſopher. Yet even he believed the art of flying poſſible, and ſays, he himſelf knew how to make an engine, in which a man ſitting might be able to convey himſelf through the air, like a bird. Nay he affirms, that there was then another perſon, who had actually tried it with ſucceſs.

In flying, the bird firſt bends his legs and leaps from the ground; then opens the joints of his wings, ſo as to make a right line, perpendicular to the ſides of his body. Being now raiſed and ſtrongly vibrating his wings, the air re-acts, as much as it is acted upon, and ſo protrudes his whole body. But in recovering his wing for freſh ſtrokes, it has a great reſiſtance to overcome. To elude this, the bony part of the wing, into which the feathers are inſerted, moves ſideways with its ſharp end foremoſt, and the feathers follow it like a flag.

All birds have near their tail a little bag, which contains oil, to moiſten their feathers. Geeſe have two glands for the ſecretion of this:

other

other birds only one. In this are divers little cells ending in two or three large ones, lying under the nipple of the oil-bag. This *nipple* is perforated, and being preſt by the birds bill, emits its oil.

In all birds that fly much, the wings are placed in the very beſt manner, to balance their bodies in the air, and to give as ſwift a progreſſion as they are ſeverally capable of. Otherwiſe they would reel and fly unſteadily; as we ſee they do, if we deſtroy the equipoiſe, by cutting one of their wings.

And what nicety may we obſerve, in a part no more conſiderable, than the *vanes* of the flag-feathers of the wing!—1. The edges of the exterior or narrow vanes bend downward, but the interior, wider vanes upward. By this means they catch hold and lie cloſe to each other, when the wing is ſpread; that not one feather may miſs its full force and impulſe upon the air. 2. Equal nicety is obſerved in the very ſloping the tips of the flag-feathers: the interior vanes are neatly ſloped away to a point, toward the outward part of the wing. The exterior, (at leaſt in many birds) are ſloped toward the body. And in the middle of the wing, the vanes being equal are but little ſloped. So that the wing, whether open or ſhut, is as neatly ſloped, as if conſtantly trimmed with a pair of ſciſſars.

The *Vane* conſiſts not of one continued membrane, becauſe if once broke, it would not eaſily be repaired: but of many laminæ, which are thin, ſtiff, and ſomething reſembling a thin quill. Toward the ſhaft of the feather (eſpecially in the flag-feathers of the wing) theſe laminæ

laminæ are broad and of a ſemicircular form, which ſerves for ſtrength, and for ſhutting them cloſe together, when impulſes are made on the air. Toward the outer part of the vane, they grow ſlender and taper. On their under ſide they are thin and ſmooth; but their upper outer edge is parted into two hairy edges.

As curiouſly made are the feathers in the wing, and no leſs curiouſly placed, exactly according to their ſeveral lengths and ſtrength; and theſe again are lined, faced, and guarded with *covers* and *ſecondary feathers*, to keep the air from paſſing thro' and ſo eluding the impulſe.

How admirably wrought are the bones of the wing! very ſtrong, but light withal; the *joints*, which open, ſhut, and move every way, as occaſion is; and the various *muſcles*, all ſuited to the motions which they miniſter to.

Next to the parts for flight, let us view the *Legs* and *Feet*, which miniſter to their other motions; both made light, for their eaſier paſſage thro' the air, and the latter, ſome with membranes for ſwimming, ſome without, for ſteady going, for perching, for catching and holding their prey, or for hanging by the heels to gather their food: the legs, all curved, for their eaſy perching or rooſting, as alſo to help them upon their wings, in taking their flight. In ſome they are long, for wading and ſearching the waters; in others, if need be, remarkably ſhort. And how wiſely are they placed! In all, ſomewhat out of the center of the body's gravity: But in ſuch as ſwim, more than in others, for the better rowing their bodies; as alſo to help them in diving.

Geeſe

Geeſe and *Ducks*, their bodies being made for ſwimming, have their wings too placed out of the center of gravity, nearer the head: but the extending the neck and head in flight, balances the body upon the wings: which is another excellent uſe (beſide ſearching for food) of the long necks of theſe birds.

But in the *Heron*, whoſe head and long neck (altho' tucked up in flight) overbalances the hinder part of the body; the long legs are extended, both to counterpoiſe the body, and to ſupply what is wanting in the tail.

It has been ſuppoſed, that the flying of birds is analogous to the rowing of veſſels. But it is a motion of quite another kind. Oars are ſtruck toward the ſtern: whereas birds do not vibrate their wings toward the tail, but waft them downward. Nor does the tail cut the air (as the rudder does the water) at right angles, but horizontally. It likewiſe keeps the ſame ſituation, which way ſoever the bird turns.

It is not therefore by the tail, that moſt birds turn to the right hand or the left, but by the wings. They turn to the right, by beating the air with the left wing alone toward the tail: to the left, by beating it with the right wing. Thus Pigeons changing their courſe toward the left, labour with the right wing, ſcarce ſtirring the other.

Birds

* It is a remarkable uſe which is made of Pigeons, in the Eaſtern countries. They are trained up in *Turky* and *Perſia*, to carry expreſſes; being firſt uſed to ſhort flights, afterwards to longer, 'till at length they will return from the fartheſt part of the kingdom. Yea, if they are brought hoodwinked

Birds with long necks have another way of altering their courſe, by only inclining their head and neck this or that way.

Birds rarely fly up or down perpendicularly, but rather in a crooked line. In aſcending directly, the natural and artificial tendency would counteract each other. In deſcending directly both would concur, and endanger too precipitate a motion.

Only the Hawk ſtoops directly to ſeize its prey: whereas other birds in deſcending, retard the motion by keeping their wings expanded, and at the ſame time ſtretching out their feet and legs.

There is no flying animal, but has feet as well as wings; becauſe there is not food, or at leaſt not food ſufficient for them, to be had always in the air. But if there were, yet ſuch birds could take no reſt; for having no feet, they could not perch upon trees. And if they alighted on the ground, they could not raiſe themſelves again: which birds that have ſhort feet can hardly do. Beſide, they would want means of breeding, having no way to lay their eggs, to ſit, hatch or brood their young.

Before we conclude this head, it may be obſerved, that all the parts of birds are fitted for the uſe of flying. Firſt, as the muſcles of the wings are peculiarly ſtrong, ſo the under ſide of them is made concave, and the upper convex, that they may be the more eaſily lifted up, and the more

 ſtrongly

winked twenty or thirty miles, nay, ſixty or an hundred, they will find their way in a very little time, to the place where they were bred. Every Baſhaw has a baſket of theſe pidgeons bred at the Seraglio; one of which he diſpatches thither on any emergent occaſion, with letters braced under her wings. This proves a more ſpeedy method, as well as ſafer, than any other. For one of theſe birds will carry a letter from Babylon to Aleppo, which is thirty days journey, in forty-eight hours.

ſtrongly ſtrike the air. Then the trunk of their body ſomewhat reſembles the hull of a ſhip, the head, the prow; which is generally ſmall, that it may the more readily cut the air, and make way for the body. Add to this, that the bodies of birds are ſmall in compariſon of beaſts, that they may be more eaſily ſupported by the air. And they are not only ſmall, but of a broad figure, that they may be buoyed up the better. They are alſo hollow and light: yea, their very bones are light. For even thoſe of the legs and wings have ample cavities: by this means alſo they become rigid and ſtiff: it being demonſtrable, that a hollow body is more ſtiff and inflexible, than a ſolid one of equal ſubſtance. The ſhafts alſo of the feathers are either empty, or filled with a light and ſpungy matter. And their webs conſiſt of two rows of contiguous filaments furniſhed all along with hooks on each ſide, whereby catching hold of one another, they ſtick faſt together.

As to their tails, although it is true, as was obſerved, that all birds whoſe tails are pointed and end in a right line, turn themſelves by their wings and not their tails, yet in thoſe that have forked tails it is otherwiſe. Thus it is manifeſt to ſight, that the forked-tail'd Kite, by turning her train ſideways, raiſing one horn, and depreſſing the other, turns her whole body. And doubtleſs the tail has the ſame uſe in Swallows, who have all forked tails, and make more ſudden turns in the air than any other bird.

To lighten birds ſtill farther, they have large membranes extending to the bottom of their bellies, into which the air is received, where, by the heat of the body it is expanded into twice or thrice the dimenſions of the external air. And this

this they can either compreſs by the muſcles of the abdomen, or expire more or leſs, in order to their deſcending ſwifter or ſlower, in what degree they pleaſe.

3. As to the *Brain* of Birds, whereas in men the cortical part of the brain is outermoſt, in birds it is innermoſt, and the membrane that covers the upper ventricle is medullary. The ventricles likewiſe are ſituated above, near the upper part of the ſkull.

Perhaps before we proceed, it may be well to premiſe one general obſervation, that the ſtructure of birds is in many reſpects different from thoſe both of men and beaſts; having ſeveral parts which theſe want, and wanting others which they have. Beſides, there are great variations in the contrivance of parts which are common to both: all wiſely adapted to their different conditions and manner of life.

Parts peculiar to birds are, 1. The Bill; 2. The Membrane to draw over the eyes; 3. Feathers and Wings. The parts wanting in birds are, 1. Teeth and Lips; 2. The Bladder, which they do not need, as they drink no more than juſt to moiſten their food. Variations in the parts of birds from thoſe of men and beaſts, are, 1. In the Ear, which is of a very peculiar make; 2. In the diviſion of the Aorta; 3. In the Spinal Marrow, which is divided into two in the middle of the back; 4. In the Bones, which are all hollow; 5. In the Heart, which has a fleſhy valve at the mouth of the Vena Cava; 6. In the Lungs, which are ſtrongly joined to the back, for the greater conveniency of flight; 7. In the Stomach: birds have two or more, to ſupply the want of

 chewing;

chewing; 8. In the Legs and Feet; 9. In their Tails; 10. In their Pectoral Muſcles, which are the ſtrongeſt of all, whereas in man the crural muſcles are the ſtrongeſt; 11. In the Brain, as was before obſerved; 12. In the Bronchia, which extends to the very bottom of the abdomen, ſo as to contain a large quantity of air; 13. In the Ovaries, which in birds are ſingle, and faſtened on their back.

4. The Ears of Birds differ much from thoſe both of men and beaſts. There is almoſt a direct paſſage from ear to ear: ſo that if the drum be pricked in either ear, water poured in at one ear, will run out at the other. And what is ſtill more remarkable, they have a ſmall winding paſſage, that opens into a large cavity, running betwixt two ſkulls, and paſſes all round the head. The upper of theſe ſkulls is ſupported by many hundreds of ſmall, thread-like pillars: which have another uſe alſo, to break their ſound, and hinder its making a confuſed echo.

This paſſage between the two ſkulls is much larger in ſinging-birds than in others. So that a perſon who has been ſhewn this, may hereby know them from all others.

The other organs of ſenſe are nearly the ſame in birds as in other animals. Only there is a difference in the organ of Smell. The noſtrils lie on each ſide of the beak, in the inner part whereof, beſide the tube which reaches to the lungs, there are little tubes, continued from the membranes and ſubſtance of the brain. And theſe ſeem to be the organ of Smell. Only two nerves paſs through the Os Criboſum to the beak: leſt if there were more

more perforations, as in other animals, too much air might flow into the brain.

The Bill of Birds is peculiarly remarkable. In the firſt place, it is neatly ſhaped for piercing the air. In the next, it is hard and horny, to ſupply the want of teeth, and alſo in ſome meaſure of an hand. Its hooked form is of great uſe to rapacious birds, in catching and holding their prey; and to others, in climbing, and in taking and comminuting their food.* Its extraordinary length and ſlenderneſs is of uſe to ſome, to ſearch for their food in mooriſh places:† as its length and breadth is to others, to hunt and ſearch in muddy places. ‡ The contrary form, a thick, ſhort, and ſharp-edged bill is as uſeful to all other birds, who muſt huſk the grain they ſwallow. But it would be endleſs to reckon up all the ſhapes and commodious mechaniſm of all: the ſharpneſs and ſtrength of thoſe that have occaſion to perforate wood and ſhells; § the ſlenderneſs and neatneſs of ſuch, as pick up ſmall inſects: the croſs

* Parrots have their bills nicely adapted to theſe ſervices, being hooked, for climbing and reaching what they want, and the lower jaw ſo exactly fitted to the hook of the upper, that it will break the food, as other creatures do with their teeth.

† As to Woodcocks and Snipes, who hunt for worms in mooriſh ground, and likewiſe ſuck the unctuous humour out of the earth. So alſo the bills of Curlews, and other Sea-Fowl, are very long, to enable them to hunt for worms, &c. in the ſands.

‡ Ducks, Geeſe, and divers other ſpecies of birds, have bills both long and broad, whereby they are enabled to quaffer in the water or mud, till they find their food.

§ The Green Woodſpite, and all Woodpeckers have ſtrong and ſharp bills, curiouſly made for digging wood. An even ridge runs along to the top of the Green Woodpecker's bill, as if an artiſt had deſigned it at once for ſtrength and neatneſs.

Woodpeckers have alſo a tongue, ending in a ſharp bony rib, dented on each ſide, which they can at pleaſure ſhoot out to

form of ſuch as break up fruits; || the compreſſed §§ form of others, with many other curious forms, all ſuited to the occaſions of the ſeveral ſpecies.

In the flat-billed birds, as Ducks, there are three pair of nerves, which come down between the eyes into the upper bill, whereby they are enabled to ſmell and find out their food, in the mire or water. The like have been obſerved in ſeveral round-billed birds, but ſo ſmall as to be ſcarce diſcernible. Only in the Rook they are diſcernible enough: and it is remarkable that theſe, more than any other round-billed birds, grope for their meat in cow-dung, and the like.

5. Of their *Lungs* it is obſervable, that they are not only larger in proportion than thoſe of beaſts, but they admit the air, both above and beneath, by which means they become far lighter.

A Duck is furniſhed with a peculiar ſtructure of veſſels, which enables it to live ſome time under water. Yet ſhe cannot live without air. One that was put into the air-pump, and the air exhauſted, ſeemed to bear it better for a few moments

to a great length, and thruſt into the holes, clefts and crannies of trees. They ſtrike them likewiſe into ant-hills, and fetch out the ants and their eggs. Moreover, they have ſhort, but ſtrong legs, and their toes ſtand two forward, two backward; a diſpoſition which is particularly convenient for the climbing of trees. In this they are likewiſe aſſiſted by the uncommon ſtiffneſs of the feathers of their tails, and by their bending downward, whereby they are fitted to ſerve them as props to lean on.

|| The Croſs-Bill, whoſe bill is thick and ſtrong, with the tips croſſing each other, readily breaks open fir-cones and other fruits, to come at and feed on the kernels. And undoubtedly the croſſing of the bill was deſigned for this very ſervice.

§§ The Sea-Pye has a long, ſharp, narrow bill, compreſſed ſideways, and every way adapted to the raiſing limpets from the rocks, which are its chief, if not only, food.

ments than any other fowl. But in leſs than two minutes her head fell down, and ſhe appeared dying, 'till revived by letting in the air.

A young, callow Duck being tried in the ſame manner, was near death in leſs than two minutes. It is obſervable both of them ſwelled extremely, on pumping out the air. It not being intended, that water-fowl ſhould live in an exceeding rarified air, but only continue under water, they are qualified for this, but not at all for the other.

Yet that Ducks can live almoſt any where, we may learn from the blind Ducks of the Zerchintzer lake in Carniola, a territory of Auſtria. This communicates with another lake under ground in the mountain Savornick, and fills or empties itſelf according to the fulneſs or emptineſs of that. The waters of the upper lake, when it empties, run off by large holes in the bottom. The Ducks which are very plentiful in the water, are often carried down with it into the ſubterraneous lake. In this many of them undoubtedly periſh; yet ſome remain alive. But they loſe their ſight and their feathers: and at the next filling of the upper lake, both they and vaſt numbers of fiſh are thrown up with the water. They make a ſtrange appearance in their naked ſtate; and for want of ſight are eaſily caught. In about a fortnight they recover their ſight and their feathers, and are then as big as common wild-ducks. At their firſt coming up, their ſtomachs are full of ſmall fiſhes, and ſomething reſembling weeds. It ſeems therefore, they were not quite blind, when in their dark habitation, but could ſee by that ſmall quantity of light, to ſearch for and find their food.

Nor is it in this lake only that theſe Ducks are found. They are frequently thrown up, after

great rains, at a hole in a mountain, near the town of Laon, in the Iſle of France. The water then guſhing out with great violence, brings theſe blind and bald creatures with it. And their frequency and cheapneſs, from the vaſt quantities which are thrown out, make them eſteemed no variety.

The bodies of Duckers or Loons are admirably fitted for diving: being covered with a thick plumage, and the ſurface of it ſo ſmooth, that the water cannot penetrate it. Hereby their bodies are defended from the cold, the water being kept at a diſtance; and are ſo poiſed, that by a light impulſe, they eaſily aſcend in it. Again, their feet are ſituate in the hindmoſt part of their body, ſo that ſhooting them backward and ſtriking the water upwards, they plunge themſelves down with great eaſe, and move forward therein. Their legs alſo are made flat and broad, and their feet cloven into toes, with appendent membranes on each ſide. By this configuration they eaſily cut the water, and are drawn forward, to take their ſtroke backward: and by this, their feet being moved to the right or left, ſerve them as a rudder to turn under water. How they riſe above water is not determined: whether by their natural lightneſs, or by ſtriking againſt the bottom, in the manner of a leap, or by ſome peculiar motion of their legs. That they dive to the bottom is undeniable. For in the ſtomachs, both of the greater and leſſer kind, we find much graſs and other weeds; and in the leſſer kind, little elſe. Yet both prey upon fiſh; and their bills are ſtreight and ſharp, for the eaſier ſtriking their prey.

It is likewiſe remarkable, that whereas in other animals the lungs are looſe and have much play, in all birds they adhere to the Thorax, and have little

little play. This is a good proviſion for their ſteady flight. Alſo they want the Diaphragm, and inſtead thereof have divers large bladders, made of thin, tranſparent membranes, with pretty large holes, out of one into the other. Theſe membranes ſerve for braces to the viſcera, as well as to contain air. Toward the upper part, each lobe of the lungs is perforated in two places with large perforations; whereof one is toward the outer, the other toward the inner part of the lobe. Through theſe perforations the air has a paſſage into the fore-mentioned bladders; ſo that by blowing into the windpipe, the lungs are raiſed, and the whole belly blown up. This doubtleſs is a means to make them more or leſs buoyant, as they take in more or leſs air: and ſo anſwers the deſign of the air-bladder in fiſhes.

In general we may obſerve, whatever is peculiar in the wings, bills, and every other part of birds, on a cloſe inſpection will be found exactly ſuited to their wants. They are a ſet of implements nicely proportioned to their manner of life. To inſtance in a few, Sparrows and moſt ſmall birds, are ſupported by the little grains they find up and down. They have no effort to make, to obtain their food, or break it in peices, and therefore have a ſmall bill, as well as ſhort necks and legs, which are ſufficient for their purpoſes. But the Woodcock, Snipe, Curlew, and many other birds, ſeek their food deep in the earth or ſlime. Therefore they are provided with a long neck and bill, and with theſe they dig and ſearch and want for nothing. The Woodpecker, who lives in a quite different manner, is as differently formed. His bill is very long, ſolid, and ſtrong: his tongue is ſharp, and extremely long; beſide which, it is

armed with little points, and covered with glue toward the extremity. He has ſhort legs, two talons before, two behind, and all very crooked. All this equipage ſuits his manner of living. His food is worms or inſects, that live in the heart of branches of trees, or under the bark of old wood; frequently they are ſunk very deep, under the bark of large billets. The Woodpecker has hooked claws, to graſp theſe branches; and a ſtrong and pointed bill, to find out by darting it up and down, what parts of them are rotten. When he has found out theſe, he with his bill, ſhatters the bark and wood. He then ſends forth a loud whiſtling cry, into the cavity, to alarm the inſects and put them in motion. Next he darts in his tongue, and by the ſmall points which ariſe out of it, and the glue that covers it, draws out whatever lodged there.

The Heron, on the contrary, mounts aloft. His legs and thighs are very long, and bare of feathers. He has a great length of neck, and an enormous bill, very ſharp and jagged at the end. What reaſon can be aſſigned for a figure, which at firſt ſight ſeems ſo extravagant? He feeds on frogs and ſmall ſhell-fiſh, as well as other fiſh, which he finds in fens, or bogs, or near the ſhores of rivers. He wants no feathers on his thighs, to walk through water and ſlime; but he needs very long legs, to run in the water, along the ſhores, whither the fiſhes reſort for their food. A long neck and bill qualify him for purſuing and ſeizing his prey at ſome diſtance: and the jaggs of his bill enable him to hold the fiſh, which would otherwiſe ſlide away. In fine, his large wings, which ſeem incommodious to a bird of ſo ſmall a body, are abſolutely needful for his making ſo great movements in the air, and conveying

veying ſuch burdens to his neſt, which is frequently two or three leagues diſtant from the place where he fiſhes.

The imperfections therefore which we imagine we diſcover, in this (as in many other animals,) in reality belong only to our own underſtanding, and all our cenſures of the works of nature, are in truth, only ſo many indications of our own ignorance.

6. The Stomach (eſpecially of granivorous) birds, is of a peculiar ſtructure. Firſt, there is a glandulous receptacle, wherein the grains are kept for ſome time. They are then received into another ſtomach, conſiſting of two muſcles, and a callous membrane. One of theſe moves obliquely downward, and the other upward. Hereby the ſhell of the grain is broke, and the meal expreſſed and mixt with proper juices. The aliments thus prepared, fall into the bottom of the ſtomach, where they are purged again from the refuſe: to which end that part is a little raiſed, that the corn may not paſs out too ſoon. There is alſo a partition, which divides what is already digeſted from the reſt.

As birds have no bladder, in the room of urine, a whitiſh excrement is diſcharged from the kidneys into the rectum.

7. The generation of birds is now well known. In the ovary, placed between the liver and the back-bone, a great number of yolks are contained; one of which when impregnated, paſſes through the oviduct into the womb, where it receives the white and the ſhell, and remains till it comes to its full ſize. The parent then broods over it, till the young being gradually

formed, perfected, and quickened, burſts the ſhell.

Under the ſhell of an egg lies the Common Membrane, adhering cloſely to it, except at the bigger end, where a little ſpace is left between them. This membrane contains two whites, each encloſed in his own membrane. In the middle of the inner white is the yolk, incloſed likewiſe in a ſeparate cover. The outer white is oval, the inner round, (as is the yolk,) and of a more viſcid ſubſtance.

At each end is a Chalaza, a white denſe body conſiſting of three little globules, like grains of hail, (ſo the word ſignifies) all joined together. Theſe ſerve both to knit the ſeveral membranes together, and to keep the liquors in their proper places and poſition.

About the middle of the ſmall end of the yolk, is a little yellowiſh bladder, like a vetch, called the Cicatricula or Eye of the egg. This contains a humour, in and out of which the young bird is generated. The white ſerves it for food, till it becomes big; then the yolk, and likewiſe after it is hatched. For even then a good part of the yolk is lodged in its belly, as in a ſtore-houſe, and being conveyed thence by the Inteſtinal Duct into the bowels, ſerves it inſtead of milk.

An egg, improperly ſo called, is that, of the whole whereof the animal is formed. Such are the eggs of flies. Proper eggs, when excluded, need no external nutriment. Of proper eggs, ſome are perfect, that is, have all the parts above deſcribed, while in the ovary or womb: Some imperfect, which have them not, till after

after they are excluded: as thoſe of fiſhes, which aſſume a white in the water.

An egg not impregnated by the male, will never breed young, but always putrify. One impregnated contains the rudiments of the bird, even before incubation. By the microſcope we ſee the plain carina or ſpine of it ſwimming in the middle of the cicatriculá, conſiſting of fine, white threads, which incubation gradually perfects.

The Air-Bag is very ſmall in a new-laid egg, but becomes larger, when the egg is kept. The yolk is ſpecifically heavier than the white. Hence its ſmaller end is always uppermoſt, in all poſitions of the egg.

After incubation the Air-bag gradually extends, till near the hatching, it takes up a third of the egg. By incubation the white becomes thinner and more turbid, eſpecially near the air-bag, where it is firſt conſumed. Then it leſſens towards the ſharp end of the egg, till nothing is left, but a white, chalky ſubſtance. The white of an impregnated egg is as ſweet all the time of incubation as that of a new laid egg. They are only unimpregnated eggs, vulgarly called wind-eggs, which putrify and ſtink.

The yolk alſo remains freſh and uncorrupted all the time of the incubation. It is depreſt in the middle, as the chick grows, and is ſoon brought into a form, not much unlike that of a horſe-ſhoe, in the middle of which the chick lies.

Not long before the chick is hatched, the whole yolk is taken into the abdomen.

The eye or tread, in which the chick lies, is ſoon inlarged by incubation, and riſes to the upper

per part of the egg. The heart and umbilical veſſels, are ſome of the firſt parts, which we are able to diſtinguiſh.

The embryo is ſeen at firſt like a ſmall worm. Then its carina or ſpine appears, with the large prominencies that afterward ſhew themſelves to be the brain and eyes. The other bowels ſeem hanging from the ſpine. Then the chaſm of the mouth is diſcovered. The extremities ſprout out. The bowels are gradually covered with the teguments. At laſt the beak, nails, and feathers are ſeen. When all its parts are formed the chick is always found lying on its ſide, with its neck bent forward, the head covered with the upper wing, and the beak placed between the thighs.

The birds which nouriſh their young, have commonly very few. On the contrary, thoſe whoſe young feed themſelves when they firſt ſee the day, have ſometimes eighteen or twenty at a brood. This Prudence could only ſpring from Him, who regulates all things to the beſt advantage. Were thoſe who provide for their young to have ſo numerous a brood, both the parents would be ſlaves, and yet the young but ill accommodated. Whereas the mother, who only marches at their head, without nouriſhing them, can conduct twenty as well as four.

But when they firſt make their appearance, what care do the parents take, till their young can ſubſiſt without them? Of thoſe that feed their young, the linnet and the nightingale then labour like the reſt. Sometimes one parent goes in queſt of proviſions, ſometimes the other, and ſometimes both. They are up before the ſun. And the food they have procured, they diſtribute with

with great equality, giving each a portion in its turn, before ever they feed one bird twice.

And this tenderneſs for their offspring is ſo ſtrong, as even to change their natural diſpoſition, Follow the hen when ſhe is the parent of a family, and ſhe is no longer the ſame creature. She is no longer ravenous and inſatiable. If ſhe finds but a grain of corn or crumb of bread, ſhe never touches it herſelf, but calls her troop, by a note they well underſtand, and divides it among them. She is no longer timorous but at the head of her young, will ſpring even at the ſtouteſt dog.

When the Turkey-hen appears at the head of her young, ſhe ſometimes utters a mournful cry, and they immediately run under buſhes, furz or whatever preſents itſelf. She looks upward, and repeats her cry: which is occaſioned by her ſeeing a bird of prey, though ſo diſtant, that he appears unto us, only as a dark point under the clouds. But he no ſooner diſappears, than ſhe utters another cry, which revives all her brood. They run to her, flutter their wings, and ſhew all the tokens of joy. Now, who aprizes her of an enemy, that never yet committed any act of hoſtility in the country? And how is ſhe able to diſcover him, when at ſo great a diſtance? How are her family inſtructed, to underſtand her different cries, and regulate their behaviour accordingly? What wonders are theſe which are daily obvious to our view, though we treat them with inattention?

An amazing degree of natural inſtinct or underſtanding, God has imparted to *birds of paſſage*, They fly in troops, often in the form of a wedge, with the point foremoſt. They ſteer their courſe through unknown regions, without either guide or

or compaſs. And they are peculiarly accommodated for their flight, by the ſtructure of their parts.

In the act of migration, it is highly remarkable, 1. That they know (as the ſcripture ſpeaks) their appointed times, when to come, when to go. Appointed by whom? Surely by the great Creator, who has imprinted on their nature an inclination, at ſuch a time to fly from a place that would obſtruct their generation, or not afford food for them and their young, and betake themſelves to another place, which will afford all that is wanting.

It is highly remarkable, 2. That they know whither to go, and which way to ſteer their courſe! That they ſhould be directed yearly to the ſame place, perhaps to a little iſland, as the Baſſe in Edinburgh-Frith. How come land-birds to venture over a vaſt ocean, of which they can ſee no end? And how do they ſteer their courſe aright to their ſeveral quarters, which before the compaſs was invented, man himſelf was not able to do? They could not poſſibly ſee them at that diſtance. Or if they could, what ſhould teach or perſuade them that that land is more proper for their purpoſe than this? That Britain, for inſtance, ſhould afford them better accommodations, than Egypt, than the Canaries, than Spain, or any other of the intermediate places?

But it has been commonly ſuppoſed, that ſeveral birds are of this number, becauſe they diſappear in winter, which really are not: Cuckoos, for inſtance, and Swallows: for neither of theſe ever croſs the ſeas. Cuckoos lodge all the winter in hollow trees, or other warm and convenient cavities. And Swallows have been found

in

in vaſt quantities, clung together in a lump, like ſwarms of bees, but utterly cold and ſenſeleſs, even in ponds that have been cleaned out, hanging under the water.

I know not how we can doubt of this fact, that Swallows have been found in winter, under water, clung together, atteſted by men of unqueſtionable veracity. And yet others affirm, that they have ſeen flights of Swallows croſſing the ſea in autumn. The truth ſeems to be this. There are ſome ſpecies of Swallows, which ſeek a warmer climate at the approach of winter, while others remain here in a temporary death, like the flies on which they feed.

They have in Virginia, a Martin like ours, only larger, which builds in the ſame manner. Col. Bacon obſerved for ſeveral years, that they conſtantly came thither upon the tenth of March. Two of them always appeared a day or two before, hovering in the air. Then they went away, and ſpeedily returned, with the whole flock.

The following ſeems to be a very rational account of moſt of thoſe that are really Birds of Paſſage.

When by the approach of our winter their food fails, Birds of Paſſage are taught by inſtinct to ſeek it elſewhere. Want of food ſeems to be the chief reaſon of their migration. The length of their wings enables them to catch the flying inſects, with which the air is ſtored during the warm months. And moſt Summer Birds of Paſſage, feed on the wing upon ſuch inſects as are ſeen no more when winter comes. If it be conſidered, how much of the globe ſtill remains unknown, it

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is no wonder we are not yet acquainted with the places to which they retire. Probably they lie in the ſame latitude in the ſouthern hemiſphere, as thoſe from whence they depart.

As Swallows cannot bear ſo much cold, as ſome other Birds of Paſſage, they are conſtrained to viſit us ſomewhat later, and to depart ſomewhat ſooner. Some ſtay a month after them. Probably many of them perform their long journeys chiefly in the night. Lying on the deck of a ſloop on the north ſide of Cuba, I and the company with me heard three nights ſucceſſively, flights of Rice-Birds (their notes being plainly diſtinguiſhable) paſſing over our heads northerly, which is their direct way from the ſouthern continent of America, from whence they go yearly when the rice begins to ripen, and after growing fat, return back.

There are alſo Winter Birds of Paſſage, which arrive here in autumn and go away in ſpring, namely, the Fieldfare, Redwing, Woodcock, and Snipe. But the two latter ſometimes ſpend the whole year here. Whereas the two former conſtantly at the approach of ſummer, retire to more northern climates, where they breed, and remain till at the return of winter, they return to us again.

The winter food of theſe birds being berries and haws, which are far more plentiful here than in more northern regions, theſe are one reaſon of their coming over: but the principal is, the ſeverity of the weather in thoſe climates, which nature teaches them to exchange, for ſuch as are more temperate. But why do they depart from us in ſpring? This ſtill remains among the ſecrets of nature.

Beſide

Beſide theſe Summer and Winter Birds, there are others which come periodically to certain places, for the ſake of ſome ſort of food, which their own country is deſtitute of. Theſe quickly depart, and are ſeen no more till that time twelvemonth. Such are the Rice-Bird and Blue-Wing of Carolina.

But above half a century paſſed, from the time of cultivating rice and wheat in Carolina and Virginia, before theſe foreign birds made their appearance there. The Wheat Birds now come annually to Virginia, when the wheat ripens, and have come every year, ſince their firſt appearance, in numerous flights.

The ſpecies of birds already known, amount to about eight hundred. Linnæus divides them into ſix claſſes; namely, into birds of the *rapacious kind*, birds of the *pie kind*, birds of the *poultry kind*, birds of the *ſparrow kind*, birds of the *duck kind*, and birds of the *crane kind*. The four firſt comprehend the kinds of land birds; the two laſt, thoſe that belong to the water.

In beginning with the feathered tribe, the Oſtrich ſeems to unite the claſs of beaſts and of birds in itſelf. While it has the general outlines and properties of a bird, it retains many of the marks of a beaſt. In appearance it reſembles the camel, and is almoſt as tall; it is covered with a plumage that reſembles hair much more than feathers, and its internal parts bear as near a ſimilitude to thoſe of the beaſt as of the bird creation. It may be conſidered, therefore, as an animal made to fill up that chaſm in nature which ſeparates one claſs of beings from another. It is uſually ſeven feet high, from the top of the head to the

the ground. The external eye is like that of a man, the upper eye-lid being adorned with eye-laſhes which are longer than thoſe on the lid below.

They inhabit the moſt ſolitary deſarts, where there are few vegetables, and where the rain never comes. The Arabians aſſert, that the Oſtrich never drinks; and the place of its habitation confirms the aſſertion. In theſe regions, Oſtriches are ſeen in large flocks, which to the diſtant ſpectator appear like a regiment of cavalry. The Oſtrich is of all other animals the moſt voracious. It will devour leather, hair, graſs, iron, ſtones, or any thing that is given. But thoſe ſubſtances which the coats of the ſtomach cannot ſoften, paſs whole; ſo that hair, ſtones, and iron, are excluded in the form in which they were devoured.

In their native deſarts, however, they live chiefly upon vegetables, where they lead an inoffenſive and ſocial life; the male, as Thevenot aſſures us, aſſorting with the female with connubial fidelity. They lay generally from forty to fifty eggs. It has been commonly reported, that the female depoſits them in the ſand; leaves them to be hatched by the heat of the climate, and then permits the young to ſhift for themſelves. Very little of this, however, is true: no bird has a ſtronger affection for her young: none watches her eggs with greater aſſiduity. Indeed, in thoſe hot climates, there is no neceſſity for the continual incubation of the female: but though the female forſakes her eggs by day, ſhe carefully broods over them by night. Then they ſit on their eggs like other birds, and the male and female take this office by turns. Nor do they forſake their young after they are excluded the ſhell. On the contrary, the young ones are not even able to walk for

for ſeveral days after they are hatched. During this time, the old ones are very aſſiduous in ſupplying them with graſs, and very careful to defend them from danger: nay, they encounter every danger in their defence.

All land-birds of the rapacious kinds are furniſhed with a large head, and ſtrong crooked beak, notched at the end, for the purpoſe of tearing their prey. They have ſtrong ſhort legs, and ſharp crooked talons for the purpoſe of ſeizing it. Their bodies are formed for war, being fibrous and muſcular; and their wings for ſwiftneſs of flight, being well feathered and expanſive. The ſight of ſuch as prey by day is aſtoniſhing quick; and ſuch as ravage by night, have their ſight ſo fitted as to ſee objects in darkneſs. Thus formed for war, they lead a life of ſolitude. They inhabit, by choice, the moſt lonely places. They make their neſts in the clefts of rocks, and in the higheſt and moſt inacceſſible trees of the foreſt. Whenever they appear in the cultivated plain, it is only for the purpoſes of depredation; and they ſpread terror wherever they approach: all the variety of muſic, which but a moment before enlivened the grove, at their approach is at an end: leſſer birds ſeek for ſafety, either by concealment or flight; and ſome are even driven to take protection with man, to avoid their leſs merciful purſuers.

It would indeed be fatal to all the ſmaller race of birds, if, as they are weaker than all, they were alſo purſued by all: but it is contrived wiſely, that every order of carnivorous birds ſeek only for ſuch as are of the ſize approaching their own. The eagle flies at the buſtard or the pheaſant, the ſparrow-hawk at the thruſh and the linnet.

net. And nature has provided that each ſpecies ſhould make war only on ſuch as are furniſhed with adequate means of eſcape. The ſmalleſt birds avoid their purſuers by the extreme agility, rather than the ſwiftneſs of their flight; for every order would ſoon be at an end, if the eagle, to its ſwiftneſs of wing, added the verſatility of the ſparrow.

Another circumſtance which tends to render the tyranny of theſe animals more ſupportable, is, that they are leſs fruitful than other birds. Thoſe of the larger kind ſeldom produce above four eggs, often but two; thoſe of the ſmaller kinds, never above ſix or ſeven. Likewiſe the carnivorous kinds only breed annually, and of conſequence their fecundity is ſmall.

8. The largeſt of birds is the Contur of Peru. The body is as big as that of a ſheep. Its wings extended are fifteen or ſixteen feet from point to point. It is never ſeen in foreſts, becauſe it would not have room to fly, but frequents the ſea-ſhore and the banks of rivers. Nature to allay their fierceneſs has denied them the talons given to eagles, though they are of the eagle kind. However, their beak is ſtrong enough to tear off the hide, and rip up the bowels of an ox.

What a bleſſing is it to mankind, that there are but few (juſt enough to keep up the ſpecies) of this monſter in the feathered creation! And into what can we reſolve this, but the wiſe and overruling care of an adorable Providence?

In beaſts the ſmalleſt animals are noxious, and loathſome; the ſmalleſt of birds are the moſt beautiful, innocent, and ſportive. Of all thoſe that flutter

flutter in the garden, or paint the landſcape, the Humming-Bird is the moſt delightful to look upon, and the moſt inoffenſive.

Of this there are ſix or ſeven varieties, from the ſize of a ſmall wren, down to that of an humble-bee. An European could never have ſuppoſed a bird exiſting ſo very ſmall, and yet completely furniſhed out with a bill, feathers, wings, and inteſtines, exactly reſembling thoſe of the largeſt kind. A bird not ſo big as the end of one's little finger, would probably be ſuppoſed but a creature of imagination, were it not ſeen in infinite numbers, and as frequent as butterflies in a ſummer's day, ſporting in the fields of America, from flower to flower.

The ſmalleſt is about the ſize of an hazle-nut. The feathers on its wings and tail are black; but thoſe on its body, and under its wings, are of a greeniſh brown, with a fine red caſt or gloſs, which no ſilk or velvet can imitate. It has a ſmall creſt on its head, green at the bottom, and as it were gilded at the top; and which ſparkles in the ſun like a little ſtar in the middle of its forehead. The bill is black, ſtraight, ſlender, and of the length of a ſmall pin.

As ſoon as the ſun is riſen, the Humming-Birds, of different kinds, are ſeen fluttering about the flowers, without ever lighting upon them. Their wings are in ſuch rapid motion, that it is impoſſible to diſcern their colours, except by their glittering. They are never ſtill, but continually in motion, viſiting flower after flower: they are furniſhed with a forky tongue, that enters the cup of the flower, and extracts its nectared tribute. Upon this alone they ſubſiſt. The rapid motion

motion of their wings brings out an humming ſound, from whence they have their name.

The neſts of theſe birds are not leſs curious than the reſt: they are ſuſpended in the air, at the points of the twigs of an orange, a pomegranate, or a citron-tree. The female is the architect, while the male goes in queſt of materials; ſuch as cotton, fine moſs, and the fibres of vegetables. Of theſe materials a neſt is compoſed, of about the ſize of an hen's egg cut in two, admirably contrived, and warmly lined with cotton. They lay two eggs at a time, about the ſize of ſmall peas, and as white as ſnow, with here and there a yellow ſpeck. The male and the female ſit upon the neſt by turns; but the female takes to herſelf the greateſt ſhare. She ſeldom quits the neſt, except a few minutes in the morning and evening when the dew is upon flowers. The time of incubation continues twelve days; at the end of which the young ones appear, much about the ſize of a blue-bottle fly.

Father Labat's companion, in the miſſion to America, found the neſt of an Humming-Bird, and took it in, at a time when the young ones were about fifteen or twenty days old; he placed them in a cage at his chamber window; but he was ſoon ſurpriſed to ſee the old ones, that came and fed their brood regularly every hour in the day. By theſe means they themſelves ſoon grew ſo tame, that they ſeldom quitted the chamber; but without any conſtraint, came to live with their young ones.

All four have frequently come to perch upon their maſter's hand, chirruping as if they had been at liberty. He fed them with a fine clear paſte, made of wine, biſcuit, and ſugar. They thruſt their

their tongues into this paſte, till they were ſatisfied, and then fluttered and chirruped about the room. I never beheld any thing more agreeable, continues he, than this lovely little family, that had taken poſſeſſion of my companion's chamber, and that flew out and in juſt as they thought proper; but were ever attentive to the voice of their maſter when he called them. In this manner they lived with him for above ſix months; but, at a time when he expected to ſee a new colony, he unfortunately forgot to tie up their cage to the cieling at night, to preſerve them from the rats, and he found they were devoured in the morning.

Even Vultures are in Egypt of ſingular ſervice. There are great flocks of them in the neighbourhood of Grand Cairo, which no perſon is permitted to deſtroy. The ſervice they render the inhabitants, is the devouring the carrion and filth of that great city, which might otherwiſe corrupt and putrify the air. They are commonly ſeen in company with the wild dogs of the country, tearing a carcaſe very deliberately together. This odd aſſociation produces no quarrels; the beaſts and birds live amicably, and nothing but harmony ſubſiſts between them.

The wonder is ſtill the greater, as both are extremely rapacious, and both lean and bony to a very great degree, having no great plenty, even of the wretched food on which they ſubſiſt.

In America, wherever the hunters go, who purſue beaſts for their ſkins, theſe birds purſue them. They ſtill keep hovering at a little diſtance; and when they ſee the beaſt flead and abandoned, they call out to each other, pour

down upon the carcaſe, and in an inſtant, pick its bones as clean as if they had been ſcraped by a knife.

Rooks keep together in pairs; and when the offices of courtſhip are over, prepare for making their neſts and laying. The old inhabitants of the place are already provided; the neſt which ſerved them for years before, with a little dreſſing will ſerve again; the difficulty of neſtling lies only upon the young ones who have no neſt. And not only the materials are wanting, but alſo the place in which to fix it. Every part of a tree will not do for this purpoſe, as ſome branches may not be ſufficiently forked; others may not be ſufficiently ſtrong; and others may be too much expoſed to the rockings of the wind.

The male and female upon this occaſion are, for ſome days, ſeen examining all the trees of the grove very attentively; and when they have fixed upon a branch fit for that purpoſe, they continue to ſit upon and obſerve it very ſeduloufly for two or three days longer.

The place being determined, they begin to gather the materials; ſuch as ſticks and fibrous roots, which they regularly diſpoſe in the moſt ſubſtantial manner. But here a new and unexpected obſtacle ariſes: It often happens that the young couple have made choice of a place too near the manſion of an older pair, who do not chooſe to be incommoded by neighbours. A quarrel therefore inſtantly enſues, in which the old ones are always victorious.

The young couple thus expelled, are obliged again to go through the fatigues of examining, and

and chuſing; and having taken care to keep their due diſtance, the neſt begins again. But they grow weary of bringing materials from diſtant places; and perceive that ſticks may be provided nearer home. Away they go, therefore, to pilfer as faſt as they can; and wherever they ſee a neſt unguarded, they rob it of the choiceſt ſticks of which it is compoſed. But theſe thefts never go unpuniſhed. Eight or ten rooks come, and ſetting upon the new neſt of the young couple at once, tear it in pieces in a moment.

At length, therefore, the young pair find the neceſſity of going more honeſtly to work. While one flies to fetch the materials, the other ſits upon the tree to guard it; and thus in the ſpace of three or four days, with a ſkirmiſh now and then between, the pair have fitted up a commodious neſt, compoſed of ſticks without, and fibrous roots and long graſs within. From the inſtant the female begins to lay, all hoſtilities are at an end; not one of the whole grove, that a little before treated her ſo rudely, will now moleſt her; ſo that ſhe brings forth her brood with patient tranquility. Such is the ſeverity with which even native Rooks are treated by each other; but if a foreign Rook ſhould attempt to make himſelf a denizen of their ſociety; the whole grove would at once be up in arms againſt him, and expel him without mercy.

In all its habits the Magpie diſcovers a degree of inſtinct unuſual to other birds. Its neſt is not leſs remarkable for the manner in which it is compoſed, than for the place it is built in: either in the middle of ſome hawthorn buſh, or on the top of ſome high tree.

It is always difficult of acceſs: for the tree or buſh pitched upon, uſually grows in ſome thick hedge-row, fenced by brambles at the root.

When the place is choſen as inacceſſible as poſſible to men; the next care is to fence the neſt above from various enemies.

The kite, the crow, and the ſparrow-hawk, are to be guarded againſt; as their neſts have been ſometimes plundered by the magpie, ſo it may be, they will take an opportunity to retaliate. To prevent this, the magpie's neſt is built with ſurpriſing labour and ingenuity.

The body of the neſt is compoſed of haw-thorn branches; the thorns ſticking outward, but well united together by their mutual inſertion. It is lined with fibrous roots, wool, and long graſs, and nicely plaiſtered round with mud and clay. The body of the neſt being thus made firm and commodious, the next work is to make the canopy which is to defend it above.

This is compoſed of the ſharpeſt thorns, ſo wove together, as to deny all entrance except at the door, which is juſt large enough to permit egreſs and regreſs to the owners. In this fortreſs the male and female hatch and bring up their brood with ſecurity, ſheltered from all attacks but thoſe of the climbing ſchool-boy, who often finds his torn and bloody hands too dear a price for the eggs or the young ones.

As the Wood-Pecker is obliged to make holes in trees to procure food, ſo is it alſo to make cavities ſtill larger to form its neſt and to lay in. This is performed, as uſual with the bill. He chuſes for this purpoſe, trees that are decayed, or wood that is ſoft, like beech, elm and poplar.

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In theſe, with very little trouble, it can make holes as exactly round as a mathematician could with compaſſes. One of theſe holes the bird generally chuſes for its own uſe, to neſtle, and bring up its young in: but as they are eaſily made, it is delicate in its choice, and often makes twenty, before one gives entire ſatisfaction.

In our climate Wood-peckers are contented with a wainſcot habitation for their young; but in Guinea and Brazil, they take a very different method. A traveller who walks into the foreſts of theſe countries, among the firſt ſtrange objects, is ſtruck with the multitude of birds neſts hanging at the extremity of almoſt every branch. Many other kinds of birds build in this manner, but the chief of them are of the wood-pecker kind.

In cultivated countries a great part of the caution of the feathered tribe is to hide their neſts from the invaſion of man. But in the depths of thoſe remote and ſolitary foreſts, the little bird having nothing to apprehend from man, is careleſs how much the neſt is expoſed to general notice; ſatisfied if it be out of the reach of thoſe rapacious creatures that live by robbery, and ſurprize. If the monkey or the ſnake can be guarded againſt, the bird has no other enemies to fear: for this purpoſe, its neſt is built upon the depending points of the moſt outward branches of a tall tree. On one of thoſe immenſe trees, is ſeen the moſt various aſſemblage of creatures that can be imagined. The top is inhabited by monkies of ſome particular tribe, that drive off all others; lower down twine about the trunk numbers of ſnakes, waiting till ſome unwary animal comes within their reach, and at the edges of the tree

hang these artificial nests, inhabited by birds of the most delightful plumage.

The nests are usually formed in this manner: when the time of incubation approaches, they fly beautifully about, in quest of a kind of moss, called, by the English, *old man's beard*. It is a fibrous substance, not unlike hair, which bears being moulded into any form. This the little Woodpecker first glues by some viscous substance, to the extreme branch of a tree; then building downward, a nest is formed, that descends like a pouch, from the point of the branch: the hole to enter at, is on the side; and all the interior parts are lined with the finer parts of the same substance, which compose the whole.

Such is the general contrivance of these hanging nests; made by some other birds, with still superior art. A little bird in the Philippine Islands, makes its nest in such a manner that there is no opening but from the bottom. At the bottom the bird enters, and goes up through a funnel, like a chimney, till it comes to the real door of the nest, which lies on one side.

Some birds glue their nests to the leaf of the banana-tree, which makes two sides of their little habitation; while the other two are artificially composed by their own industry. But these and all of the kind, are built with the same precautions. to guard their young against the depredations of monkies and serpents. The nest hangs there, before the spoilers, a tempting object, which they can only gaze upon, while the bird goes in and out without danger and molestation.

The Bird of Paradise appears to be as large as a pigeon, though in reality not much greater than

than a thruſh. The tail is about ſix inches long, the wings are large, compared with the bird's other dimenſions. The head, the throat and the neck are of a pale gold colour. The baſe of the bill is ſurrounded by black feathers, as alſo the ſide of the head and throat, as ſoft as velvet, and changeable like thoſe on the neck of a mallard. The hinder part of the head is of a ſhining green, mixed with gold. The body and wings are chiefly covered with brown, purple and gold feathers. The uppermoſt part of the tail feathers are of a pale yellow, and thoſe under them white and longer than the former; for which reaſon the hinder part of the tail appears to be all white. But what chiefly excites curioſity, are, two long naked feathers, which ſpring from the upper part of the rump above the tail, and are uſually about three feet long. Theſe are bearded only at the beginning and the end, the whole ſhaft for above two feet nine inches, being of a deep black, the feathered extremity of a changeable colour.

This bird is a native of the Molucca Iſlands. There, in the delightful and ſpicy woods, do theſe beautiful creatures fly in large flocks; ſo that the groves which produce the richeſt ſpices, produce the fineſt birds alſo. They are called by ſome, the Swallows of Ternate, from their rapid flight, and from their being continually upon the wing, in purſuit of inſects, their uſual prey.

The American Mock-Bird, does not vie with the feathered inhabitants of that country in the beauty of his plumage. It is a plain bird about the ſize of a thruſh, of a white and grey colour, and a reddiſh bill. It is poſſeſſed not only of its own natural notes, which are muſical and ſo-

lemn, but can aſſume the tone of every other animal in the wood, from the wolf to the raven. It ſeems even to ſport itſelf in leading them aſtray. It will at one time allure the leſſer birds with the call of their males, and terrify them when they come near with the ſcreams of the eagle. There is no bird in the foreſt, but it can mimic; and there is none that it has not at times deceived by its call. But it is ſureſt to pleaſe, when it is moſt itſelf.

At thoſe times it frequents the houſes of the American Planters; and ſitting all night on the chimney-top, pours forth the ſweeteſt and the moſt various notes of any bird whatever.

The Crane, is above three feet from the tip to the tail, and four feet from the head to the toe. It is a tall, ſlender bird, with a long neck and long legs. The top of the head is covered with black briſtles, and the back of it is bald and red, which ſufficiently diſtinguiſhes this bird from the ſtork, to which it is very nearly allied in ſize and figure.

Cranes were formerly known in this iſland, and held in great eſtimation for the delicacy of their fleſh: there was even a penalty upon ſuch as deſtroyed their eggs; but at preſent, they never go ſo far out of their way.

Cultivation and populouſneſs go hand in hand; and though our fields may offer them a greater plenty, yet they find the venture greater than the enjoyment; and we are better off by their abſence than their company.

The Crane ſpends the autumn in Europe; then flies off to ſome more ſouthern climate; returns to Europe in ſpring; croſſes up to the north in ſummer;

ſummer; viſits thoſe lakes that are never dry; and then comes down again to Italy in autumn.

In theſe journeys it is amazing to conceive the heights to which they aſcend. Their note is the loudeſt of all birds; and that is often heard in the clouds, when the bird itſelf is entirely unſeen. But though unſeen themſelves, they have the diſtinct viſion of every object below. They govern and direct their flight by their cries; and exhort each other to proceed or deſcend, when a fit opportunity offers.

Their loud clangorous ſound is, when near, almoſt deafning: however, it is particularly ſerviceable to the animal itſelf, either during its migrations or ſtay: by it the flock is encouraged in their journies; and if while they are feeding, which is perſormed in profound ſilence, they are invaded on any ſide, the bird that firſt perceives it ſounds the alarm, and all are ſpeedily upon the wing.

The Stork alſo is a bird of paſſage, and goes away toward winter to the ſouthern countries. It has a very long beak, and long red legs. It feeds on ſerpents, frogs and inſects. As it ſeeks for theſe in watry places, nature has provided it with long legs. And as it flies to the neſt with its prey, its bill is ſtrong and jagged, to hold faſt what it has taken. She likewiſe digs with her bill into the earth for ſnakes or adders, which ſhe carries to her young. Moſt of her feathers are white. She lays but four eggs, and ſits for thirty days.

But what renders this bird moſt remarkable is, its ſteady love to its parents. It never forſakes them when they are old, but tenderly feeds and defends them, as long as they live.

The following adventure of a tame Stork ſome years ago in the Univerſity of Tubingen, ſeems to ſhew a degree of underſtanding, which one would ſcarce expect in the brute-creation. This bird lived quietly in the court-yard, till Count Victor Gravenitz, then a ſtudent there, ſhot at a ſtork's neſt, adjacent to the college, and probably wounded the ſtork then in it. This happened in autumn, when foreign Storks uſually leave Germany. The next ſpring a Stork was obſerved on the roof of the college, which after a time came down to the upper gallery, the next day ſomething lower, and at laſt, by degrees quite into the court. The tame ſtork went to meet him with a ſoft chearful note, when the other fell upon him with the utmoſt fury. The ſpectators drove him away; but he came again the next day, and during the whole ſummer, there were continual ſkirmiſhes between them. The ſpring following, inſtead of one Stork, came four, and attacked him all at once. A ſurpriſing event followed. All the turkies, ducks and geeſe, that were brought up in the court ran together, and formed a kind of rampart round him, againſt ſo unequal a combat. This ſecured him for the preſent. But in the beginning of the third ſpring, about twenty Storks ſuddenly alighted in the court, and before the poor Stork's life-guards could form themſelves, or the people come to his aſſiſtance, they left him dead on the ſpot: which none could impute to any thing but the ſhot fired by Count Victor at the ſtrange Stork's neſt.

The Pelican ſomewhat reſembles a ſwan. The body is as large, the neck nearly as long, the legs are ſhort, and the feet are black, broad and webbed

bed in the ſame manner. It is alſo of a whitiſh colour, only the tips of ſome of his feathers are black. It is much in the waters. It has a moſt horrid voice, like that of a man grievouſly lamenting.

Its beak is above a foot in length, and the point is very ſharp. The upper part is formed as in other birds; but the lower is unlike every thing in nature. It is made of two long flat ribs, with a tough membrane connected to one and the other. This reaches alſo to the throat, and is very broad and looſe, ſo that it can contain a vaſt quantity of proviſion.

Its eyes are very ſmall; there is a ſadneſs in its countenance; and its whole air is melancholy. They are torpid and inactive to the laſt degree, ſo that nothing can exceed their indolence, but their gluttony; it is only from hunger that they labour; otherwiſe they would continue in a fixed repoſe. When they have raiſed themſelves thirty or forty feet above the ſea, they turn their head with one eye downwards, and continue to fly in that poſture. As ſoon as they perceive a fiſh near the ſurface, they dart upon it with the ſwiftneſs of an arrow, ſeize it with unerring certainty, and ſtore it up in their pouch. They then riſe again, and continue hovering and fiſhing, with their head on one ſide as before.

This work they continue till their bag is full, and then fly to land to devour and digeſt it. This they are not long performing; for towards night they have another hungry call; and they again reluctantly go to labour. At night fiſhing is over, and they retire a little way from the ſhore; and though with the webbed feet and clumſy figure of a gooſe, they will be contented to perch nowhere but upon trees among the light and airy te-

nants of the foreſt. There they repoſe for the night; and often ſpend great part of the day, ſitting in diſmal ſolemnity, as it were half aſleep. Their attitude is, with the head reſting upon their great bag, and that reſting upon their breaſt. There they remain without motion till the calls of hunger break their repoſe.

The ſame indolence attends them, even in preparing for incubation, and defending their young. The female makes no preparation for her neſt, nor ſeems to chuſe any place to lay in; but drops her eggs on the bare ground to the number of five or ſix; and there continues to hatch them. Without any deſire of defending her eggs or her young, ſhe tamely ſits, and ſuffers them to be taken from under her. Now and then ſhe juſt ventures to peck or to cry out when a perſon offers to beat her off. She feeds her young with fiſh macerated in her bag; and when they cry, flies off for a new ſupply.

They are but diſagreeable and uſeleſs domeſtics; their gluttony can ſcarcely be ſatisfied; their fleſh ſmells very rancid, and taſtes a thouſand times worſe than it ſmells. The native Americans kill vaſt numbers; not to eat, for they are not fit even for the banquet of a ſavage; but to convert their large bags into purſes and tobacco-pouches. They beſtow no ſmall pains in dreſſing it with ſalt and aſhes, rubbing it well with oil, and then forming it to their purpoſe. It thus becomes ſo ſoft and pliant, that the Spaniſh women ſometimes adorn it with gold and embroidery to make work-bags of.

Yet with all the hebetude of this bird, it is not entirely incapable of inſtruction. The emperor Maximilian had a tame Pelican which lived for above

above eighty years, and always attended his army on the march.

The Albatrofs is one of the largeſt and moſt formidable birds of Africa and America. It is as large as a gooſe, of a brown colour, and is one of the moſt fierce of the aquatic tribe, not only living upon fiſh, but alſo ſuch ſmall water-fowl as it can take by ſurprize. It preys, as all the gull-kind do, upon the wing; and chiefly purſues the flying-fiſh. Theſe are every moment riſing to eſcape from their purſuers of the deep, only to encounter equal dangers in the air. Juſt as they riſe, the dolphin is ſeen to dart after them, but generally in vain. The gull has more ſucceſs, and often takes them at their riſe, while the Albatrofs purſues the gull, ſo that the whole horizon preſents but one living picture of rapacity and evaſion.

But though this bird be one of the tyrants of the deep, there are ſome aſſociations which even tyrants form, either by caprice, or neceſſity. The Albatrofs has a peculiar affection for the Penguin. They chuſe the ſame places for breeding; ſome diſtant, uninhabited iſland, where the ground ſlants to the ſea, as the Penguin is not formed either for flying or climbing. In ſuch places their neſts are ſeen together, as if they ſtood in need of mutual aſſiſtance. Our men upon Falkland Iſlands, were often amazed at the union preſerved between thoſe birds. In that bleak and deſolate ſpot, where they no way dreaded the encroachments of men, they ſeemed to make their abode as comfortable as they expected it to be laſting. They built with an amazing degree of uniformity: their neſts covering fields by thouſands, and reſembling

ſembling a regular plantation. In the middle on high, the Albatroſs raiſed its neſt, built of heath, ſticks, and long graſs, about two feet above the ſurface; round this the Penguins made their lower ſettlements, rather in holes in the ground, and moſt uſually eight Penguins to one Albatroſs.

Nothing is a ſtronger proof that the preſence of man, not only deſtroys the ſociety of meaner animals, but their inſtincts alſo. Theſe neſts are now totally deſtroyed; the ſociety is broke up, and Albatroſs and Penguins have gone to breed upon more deſert ſhores, in greater ſecurity.

The Swan is as delicate in its appetite, as elegant in its form. Its chief food is corn, bread, herbs growing in the water, and roots and ſeeds, which are found near the margin. It prepares a neſt in ſome retired part of the bank, and chiefly where there is an iſlet in the ſtream. This is compoſed of water plants, long graſs and ſticks; and the male and female aſſiſt in forming it with great aſſiduity. The Swan lays ſeven or eight eggs, white, much larger than thoſe of a gooſe. It ſits near two months before its young are excluded, which are aſh-coloured for ſome months. It is dangerous to approach the old ones, when their little family are feeding round them. They ſoon take the alarm, and they ſometimes give a blow with their pinion, that breaks a man's leg or arm.

It is not till they are a twelvemonth old, that the young ſwans change their colour with their plumage. All the ſtages of this bird's approach to maturity are ſlow; and mark its longevity. A gooſe has been known to live an hundred years, and the Swan is ſuppoſed to live ſtill longer.

The

The Gooſe, in its domeſtic ſtate, exhibits a variety of colours. The wild gooſe always retains the ſame marks; the whole upper part is aſh-coloured; the breaſt and belly are of a dirty white; the bill is narrow at the baſe, and at the tip it is black. Theſe marks are ſeldom found in the tame; whoſe bill is entirely red, and whoſe legs are entirely brown. The Wild Gooſe is rather leſs than the tame: but both invariably retain a white ring round the tail, which ſhews that they are both deſcended from the ſame original.

The wild gooſe breeds in the northern parts of Europe; and in the beginning of winter, deſcends into more temperate regions. They are often ſeen flying at very great heights, in flocks from fifty to an hundred. Their cry is frequently heard, when they are at an imperceptible diſtance above us; and this ſeems handed from one to the other, as among hounds in the purſuit.

Upon their coming to the ground by day, they range themſelves in a line, and ſeem rather to deſcend for reſt than refreſhment, When they have ſat in this manner for an hour or two, one of them, with a loud long note, ſounds a kind of charge, to which the reſt attend, and purſue their journey with renewed alacrity.

The Wild Gooſe ſeldom lays above eight eggs; the Tame Gooſe often above twenty. The female hatches her eggs with great aſſiduity; while the gander viſits her twice or thrice a day, and ſometimes drives her off to take her place, where he ſits with great ſtate and compoſure.

But beyond that of all animals is his pride when the young are excluded: he ſeems then to conſider himſelf as a champion; he purſues dogs and men that never attempt to moleſt him; and, though the moſt

moſt harmleſs thing alive, is then the moſt petulant and provoking. When, in this manner, he has purſued the calf or the maſtiff, to whoſe contempt alone he is indebted for ſafety, he returns to his female and her brood in triumph, clapping his wings, ſcreaming, and ſhewing all the marks of conſcious ſuperiority.

The Solan-Gooſe, ſomewhat leſs than a Land Gooſe, is white: only the tips of its wings are black, and the top of the head yellow. The bill is long, and ſo ſharp-pointed, that it pierces an inch deep into a board, when they ſtoop at fiſh which are laid thereon. This is one way of catching then. When they ſleep, they put their head under their wings: but one keeps watch. If that be ſurprized by the fowler, which frequently happens, all the reſt are eaſily caught by the neck, one after another. But if the centinel cries and gives them warning, the whole flock eſcapes. When they fiſh for herrings, which come in ſhoals, they fly near ſixty yards high, and ſtoop perpendicularly. But when they aim at a ſingle fiſh, they deſcend aſlant.

There is always one tribe among them which is barren: theſe keep together, and never mix with them that build and hatch. (Is it not probable, that theſe are the males, like the drones among the bees?) The Solan Geeſe come to the Weſtern Iſles in Scotland in March, taking the advantage of a ſouth-weſt wind. They ſend a few before them, who make a tour round the Iſles, and then return to their company. In a few days after, the whole flock comes together, and ſtays till September. All this time they are daily making up their neſts in the ſhelves of high rocks. They fiſh, hatch and make their neſts by turns. In order to this they amaſs

amaſs together, not only heaps of graſs, but whatever elſe they find floating on the water. In a neſt on St. Kilda, was found a ſoldier's red coat, and ſome Molucca beans in another.

They are thought the ſharpeſt ſighted of all Seafowls. They have a large gorget, ſomewhat like a Pelican, in which one of them will preſerve five or ſix herrings intire, and carry them to her neſt, where they empty them out, for food to their young, Nay, they have been obſerved to go a fiſhing, to ſome iſles which are thirty leagues diſtant, and bring the fiſh in their gorget all that way.

In the Iſle of Rona, (one of the Scotch Weſtern Iſles) there are a couple of eagles, which the natives ſay, not only drive away their young as ſoon as they are able to fly, but keep poſſeſſion of the iſland, not ſuffering any of their kind to live there but themſelves.

There are alſo a couple of Ravens in this Iſland, which beat away all ravenous fowls. And when their own young are able to fly, they beat away them likewiſe.

That which in Iceland they call the Down-bird, is very remarkable. It is a ſpecies of Duck, but covered with fine, ſoft, downy feathers. The drake is full as large as a gooſe, but the duck conſiderably ſmaller. They abound all over Iceland, but particularly the weſtern part, on account of the iſlands off the coaſt, where cheifly they build their neſts. They build them with the down they pull from their breaſt. They lay four green eggs, as large as a gooſe. The Inhabitants then take away both the eggs and the neſt. The ducks go to

to work again, pull more down from their breaſts, and lay four eggs more, which are again taken away by the Inhabitants. This does not however diſcourage the duck. She builds a third neſt, and lays four more eggs: but the drake is now obliged to ſupply the down, the duck having none left. They now let her hatch her young: for if they diſturb her the third time, ſhe builds no more that year, nor ever returns to the ſame place. When the young have left the neſt, they take it a third time, and ſo have two ſets of eggs, and three parcels of down from the ſame neſt.

The Bat ſeems a medium between bird and beaſt. But it comes nearer to the latter. They lay themſelves up and ſleep for the winter-months, in the dryeſt parts of caves. There fixing their talons in the roof, they cover their bodies with their wings, and hang perpendicularly in great numbers, but ſo as not to touch each other.

Who can account for another matter of fact which is continually obſerved on the Weſtern Iſlands? The Weſtern Ocean throws up on their ſhores, great quantities of weather-beaten timber, on which hang multitudes of little ſhells, faſtened to one another, much as muſcle-ſhells are. In every one of theſe ſhells is a perfect fowl: the little bill is like that of a gooſe; the eye marked; the head, neck, breaſt, wings, tail and feet formed. The feathers are perfectly ſhaped, and of a blackiſh colour, and the feet like thoſe of other water-fowl, but we cannot hear of any perſon, that ever ſaw any of them alive.

Now as Bats are a kind of medium between beaſts

beaſts and birds, are not Barnacles a kind of medium between birds and fiſhes?

I will conclude this account of Birds, with one that ſeems to unite in itſelf ſomewhat of every claſs preceding. It is at once poſſeſſed of appetites for prey like the rapacious kinds, and an attachment to water like the birds of that element. It exhibits in its form the beautiful plumage of the peacock, the ſhadings of the humming-bird, the bill of the crane, and the ſhort legs of the ſwallow. The bird I mean is the King-Fiſher. It is not much larger than a ſwallow; its ſhape is clumſy; the legs very ſmall, and the bill very long; it is two inches from the baſe to the tip; but the colours of this bird atone for its inelegant form. The crown of the head and the edges of the wings are of a deep blackiſh green, ſpotted with bright azure; the back and tail are of the moſt reſplendent azure; the whole under-ſide of the body is orange-coloured; a broad mark of the ſame paſſes from the bill beyond the eyes; beyond that is a large white ſpot; the tail is ſhort, and conſiſts of twelve feathers of a rich deep blue; the feet are of a reddiſh yellow.

From the diminutive ſize, and the beautiful colours of this bird, no perſon would be led to ſuppoſe it ſo rapacious an animal. It is ever on the wing, and feeds on fiſh, which it takes in ſurpriſing quantities, balancing itſelf at a certain diſtance above the water for a conſiderable ſpace, then darting down and ſeizing the fiſh with inevitable certainty.

The King-Fiſher with which we are acquainted has none of thoſe ſuppoſed powers of allaying the ſtorm, or building upon the waves. It is contented

tented to make its neſt on the banks of rivers, in ſuch ſituations as not to be affected by the riſing of the ſtream. When it has found a place for its purpoſe, it hollows out with its bill a hole about a yard deep. Or if it finds the deſerted hole of a rat, it takes quiet poſſeſſion. This hole it enlarges at the bottom, and, lining it with the down of the willow, lays its eggs there without any further preparation.

The female begins to lay early in the ſeaſon, and excludes her firſt brood about the beginning of April. The male brings her large proviſions of fiſh, while ſhe is thus employed; and ſhe, contrary to moſt other birds, is found fat at the ſeaſon of hatching.

9. I have now only to add a few Reflections.

And, 1. That birds ſhould all lay eggs, and not bring forth live young, is a clear argument of divine Providence, deſigning their preſervation thereby. For if they had been viviparous, had they brought any number at a time, the burden of their womb muſt have been ſo great and heavy, that their wings would have failed, and they become an eaſy prey to their enemies. And had they borne but one at a time, they would have been bearing all the year.

2. Since it would have been many ways inconvenient to birds to give ſuck; and yet inconvenient, if not deſtructive to the new-born chick, to paſs ſuddenly from liquid to hard food, before the ſtomach was ſtrengthened and able to digeſt it, and before the bird was accuſtomed to uſe its bill, and gather it up, which it does at firſt very ſlowly and imperfectly;

imperfectly: therefore nature has provided in every egg a large yolk, which ſerves the chicken a conſiderable time, inſtead of milk. Meantime it feeds by the mouth a little at a time, and that more and more, till the ſtomach is ſtrengthened to digeſt it.

3. Birds that feed their young in the neſt, though they bring but one morſel at a time, and have perhaps ſeven or eight, which all at once, with equal greedineſs, hold up their heads, and gape for; yet never miſtake, never omit one, but feed them all by turns.

4. Though birds cannot number, yet are they able to diſtinguiſh many from few. And when they have laid as many eggs as they can cover, they give over, and begin to ſit. Yet they are not determined to ſuch a number: they can go on and lay more at their pleaſure. Hens, for inſtance, if you let their eggs alone, lay fourteen or fifteen, and give over. But if you withdraw their eggs daily, they will go on, to lay five times that number. This holds not only in domeſtic birds, but alſo in the wild. A ſwallow, when her eggs were withdrawn daily, proceeded to lay nineteen.

5. It is remarkable, that birds, and ſuch other oviparous creatures as are long-lived, have eggs enough conceived in them at firſt, to ſerve laying for many years, allowing ſuch a proportion for every year, as will ſuffice for one or two incubations. Whereas inſects, which are to breed but once, lay all their eggs at once, be they ever ſo many.

6. How

6. How exceeding ſpeedy is the growth of birds that are fed by the old ones in the neſt! Moſt of them come to near the full bigneſs, within the ſhort term of a fortnight: an admirable proviſion, that they may not lie long in that helpleſs condition, expoſed to the ravine of any vermin, and utterly unable to ſhift for themſelves.

7. What amazing care do the parents take, for the hatching and rearing of their young? Firſt, they ſeek out a ſecret and quiet place, where they may be undiſturbed in their incubation. Then they make their neſts, every one after his kind, that their eggs and young may be ſoft and warm: and thoſe ſo elegant and artificial, as no art of man can imitate.

After they have laid their eggs, how diligently do they ſit upon them, ſcarce giving themſelves time to go off, to get them meat? When the young are hatched, how diligently do they brood over them, leſt the cold ſhould hurt them? All the while labouring hard to get them food, and almoſt ſtarving themſelves, leſt they ſhould want. Moreover, with what courage are they inſpired, ſo as to venture their own lives in defence of them? The moſt timorous, as hens and geeſe, daring then even to fly in the face of a man. And all theſe pains are beſtowed upon thoſe that will render them no thanks for it! And they are beſtowed juſt ſo long as is neceſſary. For when the young is able to ſhift for itſelf, the old retains no ſuch affection for it, but will beat it indifferently with others.

8. It is another proof of a ſuperintending Providence, that all animals are produced at the moſt

moſt convenient time of the year, juſt when there is food and entertainment ready for them. So lambs, kids, and many other living creatures, are brought into the world in the ſpring, when tender graſs and nutritive plants are provided for their food. The like may be obſerved concerning ſilk-worms, whoſe eggs are hatched juſt when the leaves of the mulberry-tree appear; the aliment being ſoft and tender, while the worms themſelves are ſo, and growing more ſtrong and ſubſtantial, as the inſects increaſe in bulk and vigour.

9. A ſtill farther proof hereof we have in the various Inſtincts of animals, directed to ends which they know not, as, 1. All creatures know how to defend themſelves and offend their enemies. All know what their natural weapons are, and how to make uſe of them. A boar knows the uſe of his tuſks, a horſe of his hoofs, a cock of his ſpurs, a bee of her ſting. Yea a calf will make a puſh with his head, even before any horns appear. 2. Thoſe creatures which have not ſtrength to fight, are uſually ſwift of foot or wing, and are naturally inclined to make uſe of that ſwiftneſs, and ſave themſelves by flight. 3. Every creature knows and ſhuns its natural enemy, as a lamb does the wolf, and partridge or poultry, birds of prey. And they make uſe of a peculiar note, to warn their young of their approach, who thereupon immediately run to ſhelter. 4. As ſoon as ever it is brought forth, every animal knows its food. Such as are nouriſhed with milk, immediately find their way to the paps, and ſuck: whereas thoſe which are deſigned for other nouriſhment, never make any ſuch attempt. 5. Birds that are fin-toed, or whole-

whole-footed, are naturally directed to go into the water. So ducklings, though hatched and led by a hen, if she brings them to the brink of a river or pond, presently leave her and go in, though they never saw any such thing before; and though the hen clucks and calls, and does all she can to keep them out. 6. Birds of the same kinds make their nests of the same materials, laid in the same order, and exactly of the same figure, so that by the sight of the nest one may certainly know what bird it belongs to. And this, though living in distant countries, and though they never saw any nest made; that is, although they were taken out of the nest, and brought up by hand. Nor were any of the same kind ever known to make a different nest, either for matter or fashion: unless where the usual matter was not to be had: in that case, some birds use what they can get.

I would add a little farther improvement of some particulars mentioned before.

What Master has taught Birds, that they have any need of Nests? Who has warned them, to prepare them in time, and not to suffer themselves to be prevented by necessity? Who hath shewn them how to build? What mathematician has given the figure of them? What architect has taught them to choose a firm place, and to build a solid foundation? What tender mother has advised them to cover the bottom with a soft and delicate substance, such as cotton or down, and when these fail, who has suggested to them that ingenious charity, to pluck off as many feathers from their own breast, as will prepare a soft cradle for their young?

Again:

Again. What Wiſdom has pointed out to each kind a peculiar manner of building? Who has commanded the Swallow, to inſtance in one, to draw near to man, and make choice of his houſe for the building her neſt, within his view, without fear of his knowing it, but ſeeming rather to invite him to a conſideration of her labour? Nor does ſhe build like other birds, with bits of ſticks, and ſtubble, but employs cement and mortar: and that in ſo firm a manner, that it requires ſome pains to demoliſh her work. And yet in all this, it has no other inſtrument to make uſe of but a little beak.

Yet again. Who has made the birds comprehend that they muſt hatch their eggs by ſitting upon them. That this neceſſity is indiſpenſable: that the father and mother could not leave them at the ſame time; and that if one went abroad to ſeek for food, the other muſt wait till it returns? Who has told them the preciſe number of days, this painful diligence is to coſt? Who has taught them to aſſiſt the young in coming out of the egg, by breaking the ſhell for them? Yea, and adverſtiſed them of the very moment, before which they never come?

Who has taught ſeveral of the birds that marvellous induſtry, of retaining food or water in their gullet, without ſwallowing either, and preſerving them for their young, to whom this preparation ſerves inſtead of milk?

Is it for the birds, O Lord, who have no knowledge thereof, that thou haſt joined together ſo many miracles? Is it for the men who give no

attention to them? Is it for thoſe who admire them, without thinking of Thee? Rather is it not thy deſign, by all theſe wonders to call us to Thyſelf? To make us ſenſible of thy wiſdom, and fill us with confidence in thy bounty, who watcheſt ſo carefully over thoſe inconſiderable creatures, two of which *are ſold for a farthing.*

But paſs we from the induſtry of birds, to hearken for a moment to their muſic: the firſt ſong of thankſgiving which was offered on earth, before man was formed. All their ſounds are different, but all harmonious, and all together compoſe a choir which we cannot imitate. One voice however more ſtrong and melodious I diſtinguiſh above the reſt. On enquiry I find it comes from a very ſmall bird. This leads me to conſider the reſt of the ſinging birds. They likewiſe are all ſmall: the great ones having an harſh and diſagreeable voice. Such an amends is made to theſe weak, little creatures, for their defect of ſtrength!

Some of theſe little birds are extremly beautiful, nor can any thing be more rich or variegated than their feathers. But it muſt be owned, that all ornament muſt give place to the finery of the Peacock; upon which God has plentifully beſtowed all the riches which ſet off the reſt, and laviſhed upon it with gold and azure, all the ſhades of every other colour. This bird ſeems ſenſible of its advantage, and looks as if it deſigned to diſplay all its beauties to our eyes, when it ſtalks along, and expands that ſplendid circumference, which ſets them all in open view.

But

But this pompous bird has of all others that are kept tame, the moſt diſagreeable cry, and is a proof, that there may be a ſhining outſide, when there is little ſubſtance within.

In examining the feathers of the reſt, I find one more circumſtance very obſervable. That feathers of ſwans and other water fowl, are proof againſt the water. And accordingly they continue dry, though the creature ſwims or dives ever ſo long. And yet neither our eyes, nor all our art can diſcover, wherein they differ from others.

I know not how to conclude this chapter, without adding a few more reflections.

All the univerſe is repleniſhed with life: and every part of it, with its proper animals. But would one expect to ſee them in the air? Nothing ſeems more natural to our eyes: but nothing is more aſtoniſhing to our reaſon. The fact is certain, and yet might ſeem to be altogether impoſſible. A bird in flight, is a maſs raiſed aloft, in ſpite of the gravity of the air, and the tendency of all bodies to the earth. This maſs is raiſed not by any foreign force, but by a movement ſuited to the purpoſe of the creature, and which ſuſtains it in the air, for a conſiderable time, with a peaceful vigour.

Again. In the whole kingdom of birds, none have more than two wings, and yet they all fly in a different manner. Some launch away by repeated ſprings; others glide through the air with an even motion. Theſe always ſkim over

the earth; thoſe ſoar up to the clouds. Some know to diverſify their flight, by a ſtrait, oblique, or circular motion: to ſuſpend their bodies, and continue motionleſs in an element lighter than themſelves: after this, to ſtart into an horizontal motion, and then dart either to the right or left, wheel into a contrary tract, remount, and then precipitate themſelves like a deſcending ſtone: in a word, they tranſport themſelves, without oppoſition or hazard, wherever their neceſſities or pleaſures call them.

The ſtructure of their neſts, the care with which they attend their eggs, the mechaniſm of the egg itſelf, and the birth and education of their young, are equally aſtoniſhing. See the perfect ſimilitude that appears in all the neſts of birds of the ſame ſpecies, the conſtant difference between the neſts of one ſpecies and another! Together with the neatneſs and precaution which all of them obſerve. One ſpecies builds its neſt on the top of trees; another on the ground, under a canopy of graſs: but always with a ſhelter, either of herbs, or a branch, or a double roof of leaves, down which the rain ſlides, without entering the opening, which lies concealed below. The outward part of the neſt is made of ſolid materials, thorns, reeds, clay, or compact moſs: the inner of ſofter materials cloſely interwoven, ſo as to keep out both winds and inſects. But each ſpecies has a peculiar taſte. When the building is compleated ſome hang the inſide with a tapeſtry of feathers, or quilt it with wool or ſilk.

How amiably does this diſplay the wiſdom of Him

Him who furniſhed man with reaſon, which extends to every thing around him, and inſpired animals with an imitation of it, limited indeed to a few points, but admirable in that limitation? For who informed the bird, that ſhe ſhould lay eggs, and want a neſt to lodge and nouriſh them with genial heat? That this heat would not be concentered round the eggs, if the neſt were too large? And that were it ſmaller, it would not be capable of containing all the young? Who has taught her not to miſ-calculate the time, or lay her eggs, before ſhe has compleated her neſt?

The ſame wiſdom will more fully appear, if we obſerve what the egg contains, with the manner how the young is there formed, and how it iſſues from its confinement.

The yolk lies in the heart of the egg, incloſed in the firſt membrane, which is ſurrounded by the ſecond. Near the center of the egg are the ligaments that ſuſtain the yolk, which is contained in a peculiar membrane. A ſecond membrane incloſes the firſt white; a third and fourth encompaſſes the whole. The ſhell is formed laſt of all, out of the ſalts evacuated from all the humours of the body, which the heat gradually fixes and conſolidates, to ſerve a double purpoſe, firſt that it may be excluded without cruſhing the contents; ſecondly, to defend the tender young, till it is throughly formed, and ready to forſake the egg.

Under the membrane which ſurrounds the yolk, is a white ſpeck, which is the ſeed of the chick, in miniature. If the ſmalleſt portion of the vital ſpirit be infuſed into it from the male, by a proceſs of which we have no idea, in the inſtant

the chick receives life, and the whole ſubſtance is in motion. If it is not infuſed, the egg may indeed be laid, but it never comes to a living creature.

The pulſation of the heart bears ſome analogy to the pendulum of a clock, from whoſe vibrations the whole machine derives all its motions. The moment the heart begins to beat, the animal is alive, and receives by the umbilic duct, the nouriſhment which it tranſmits to the other veſſels, whoſe branches diſtribute it to the whole body. All thoſe little canals, which were flat before, are now ſwelled and enlarged. The whole ſubſtance imbibes a proper aliment, and the chick begins to grow.

In this ſituation of the ſpeck out of which it is formed, one circumſtance is highly remarkable. This minute particle which is lodged on the film that includes the yolk, is always near the center of the egg, and toward the body of the dam, in order to be impregnated with a neceſſary warmth. But in how admirable a manner is this effected? The yolk is ſuſtained by two ligaments, which faſten it on each ſide to the common membrane, that is glued on the ſhell. A line drawn from one ligament to the other, would not paſs through the middle of the yolk, but above the center, and cut the yolk into two unequal parts, ſo that the ſmaller part, which contains the ſeed, is of neceſſity raiſed toward the belly of birds that ſit: the other part as neceſſarily ſubſides, ſo that let the egg turn as it will, the young receives no hurt, but ſtill enjoys a warmth that puts all about it in motion. So it feeds at eaſe, firſt on the white, which

which is more thin and delicate, and afterwards on the yolk, which affords more ſubſtantial nouriſhment. When his bill is hardened, and he grows uneaſy at his confinement, he pecks and breaks the ſhell, and iſſues out, fully repleniſhed with the yolk, which nouriſhes him a little longer, till he is ſtrong enough to raiſe himſelf upon his feet, and can march about to look for proviſions.

CHAP. III.

Of FISHES.

THE ocean is the great receptacle of Fiſhes. It has been thought by ſome, that all Fiſhes are naturally of the ſalt element, and that they have mounted up into freſh water, by ſome accidental migrations. A few ſtill ſwim up rivers to depoſit their ſpawn; but the great body of Fiſhes of which the ſize is enormous, and the ſhoals endleſs, keep to the ſea, and would expire in freſh water. In that extenſive and undiſcovered abode, millions reſide, whoſe manners are a ſecret to us, and whoſe very form is unknown. The curioſity of mankind, indeed, has drawn ſome from their depths, and his wants many more: with the figure of theſe at leaſt he is acquainted; but for their purſuits, ſocieties, antipathies, pleaſures, times of geſtation,

geſtation, and manner of bringing forth, theſe all are hidden in the turbulent element that protects them.

1. The Number of Fiſh to which we have given names, and of the figure, at leaſt, of which we know ſomething, are above four hundred. Thus to appearance the hiſtory of Fiſh is tolerably copious; but when we come to examine, it will be found the greateſt part of theſe we know very little of.

2. As moſt animals that live upon land have a covering to keep off the injuries of the weather, ſo all that live in the water are covered with a ſlimy, glutinous matter, that, like a ſheath, defends their bodies from the ſurrounding fluid. This ſubſtance, ſecreted from the pores of the animal's body, ſerves not only to defend, but to aſſiſt the fiſh's eaſy progreſs through the water. Beneath this, in many kinds is found a ſtrong covering of ſcales, that, like a coat of mail, defend it ſtill more powerfully; and under that, before we come to the muſcular parts of the body, an oily ſubſtance, which ſupplies the requiſite warmth and vigour.

3. It is obſervable in all, that though their heads are much larger in proportion to their bodies, yet their Brain is conſiderably leſs than that of other animals. It conſiſts of only two ſmall ventricles, placed in the fore-part of the head.

4. Their Organs of Senſe do not much differ from thoſe of other animals. But in their Eyes this is peculiar, that they are quite ſpherical, and that the optic nerves, in coming from the brain,

croſs each other: whereas in other animals they incline a little to each other, but do not meet. A protuberant eye would have been inconvenient for Fiſhes, by hindering their motion in ſo denſe a medium. And their continually bruſhing through the water, would have been apt to wear their eyes. Therefore their cornea is flat. But to make amends for this, and for the refraction of water, different from that of air, the wiſe Creator has made their chryſtalline ſpherical, which in other Animals is more flat. It was formerly believed, they did not *hear* at all. But from later experiments, there is reaſon to believe, that ſeveral ſpecies of them do hear, though but in a low degree. Over the two holes in their head which ſerve for *ſmelling*, a fine membrane is ſpread, by which means they can open and ſhut them at pleaſure; a contrivance highly neceſſary for creatures that live in the water.

The ſenſe of Smelling which in beaſts is ſo exquiſite, and among birds is not wholly unknown, ſeems given to fiſhes in a very moderate proportion. It is true, that all fiſhes have one or more noſtrils, and even thoſe that have not the holes perceptible without, yet have the proper formation of the bones for ſmelling within. But as air is the only medium we know, for the diſtribution of odours, it cannot be ſuppoſed that theſe animals reſiding in water, can be poſſeſſed of any power of being affected by them. If they have any perception of ſmells, it muſt be in the ſame manner as we diſtinguiſh by our taſte; and it is probable, the olfactory membrane in fiſh ſerves them inſtead of a diſtinguiſhing palate: by this they judge of ſubſtances, that firſt tincturing the water with their

their vapours, are thus ſent to the noſtrils of the fiſh, and no doubt produce ſome kind of ſenſation. This moſt probably muſt be the uſe of that organ in thoſe animals; as otherwiſe there would be the inſtruments of a ſenſe provided for them, without any power in them of enjoyment.

Hearing in Fiſhes is found ſtill more imperfect, if it be found at all. Certain it is, that anatomiſts have not been able to diſcover, except in the whale kind, the ſmalleſt traces of an organ of Hearing, either within or without the head. Indeed, of what advantage would this ſenſe be to animals that are incapable of making themſelves heard? They have no voice to communicate with each other, and conſequently have no need of an organ for hearing.

Seeing ſeems to be the ſenſe which Fiſhes are poſſeſſed of in the greateſt degree. And yet even this is obſcure, if we compare it to that of other animals. The eye, in almoſt all Fiſh, is covered with the ſame tranſparent ſkin that covers the reſt of the head: and which probably ſerves to defend it from the water, as they are without eye-lids. The globe of the eye is depreſſed before, and is furniſhed behind with a muſcle, which ſerves to lengthen or flatten it, according to the neceſſities of the animal. The chryſtalline humour, which in beaſts is flat, and of the ſhape of a button mould, in fiſhes is as round as a pea; or ſometimes oblong, like an egg.

From all this, it appears, that fiſhes are extremely near-ſighted; and that, even in the water, they can ſee objects only at a very ſmall diſtance.

Thus Nature ſeems to have fitted theſe animals with appetites and powers of an inferior kind; and formed them for a ſort of paſſive exiſtence in the obſcure and heavy element to which they are conſigned: to preſerve their own exiſtence, and to continue it to their poſterity, fill up the whole circle of their purſuits and enjoyments.

5. Some Fiſhes have Lungs. But in the greater part the place of them is ſupplied by Gills. As we take in and throw out the air by our Lungs, ſo they take in the air, mixt with the water by their mouth, and throw it out by their Gills.

There is always much air incloſed in water. This the Gills ſeparate from it, and preſent to the blood, as it is preſented in the lungs of other animals. Each Gill contains a great number of bony laminæ, conſiſting of an infinity of bony fibres, that ſuſtain the innumerable ramifications of the veins and arteries, which preſent the blood extremely ſub-divided, and as it were, each globule by itſelf to the water: between theſe laminæ, through the whole contexture of the Gills, are an infinity of very narrow paſſages, which receive and divide the water taken in by the mouth, into minute particles. Then the air, its priſon-doors being in ſome meaſure opened, eſcapes and joins the blood of all the little arteries.

The Gills have an alternate motion of dilatation and compreſſion. When they dilate, the water is taken in; when they contract, it is driven out. It ſeems that in the inſtant of contraction, the air expreſt from the water is forced into the blood-veſſels. It is the ſame, as to our Lungs. The air enters them at the time of inſpiration, but is received into the blood at the time of expiration

piration only. So that the water which is taken in by the mouth of fiſhes, when ſtript of its air, is carried off by the Gills. Meantime the air which thus gained is diſtributed firſt to thoſe fine ramifications of the arteries, which are expanded upon the Gill throughout, and then to the veins inoſculated therewith. And Fiſhes can no more live without a conſtant ſupply of this, than land animals can.

The Gills in all Fiſhes are eight, four on each ſide. The lower Gill is always ſmaller than the reſt. The other three on each ſide are gradually larger to the top one, which is always the largeſt. Each of theſe is formed of a bony ſubſtance, bent into the ſhape either of a ſemicircle or a bow. On the convex ſide of this, there is a ſort of plumes or leaves, each of which conſiſts of a double row of bony lamellæ, formed like ſo many ſickles, and fixed to the convex ſide of the bow by means of the membrane wherewith it is covered.

Theſe lamellæ have one part convex, and the other concave. The concave part of each lamella is applied to the convex part of the next oppoſite lamella. Every lamella is inveſted with a fine membrane, which receives the ramifications of the blood-veſſels. Every Gill has an artery, a vein, and a nerve. The Gills receive the blood which is thrown from the heart into the Aorta, and derive it to the utmoſt parts of the lamella, from whence it returns by veins which diſtribute it throughout the body.

6. In moſt fiſhes the Heart is like that in other animals. But in ſome it has only one ventricle; which neceſſarily occaſions a difference in the manner wherein the blood circulates. In ſome alſo

alſo the blood is not red, but clear and tranſparent. In others, eſpecially ſhell-fiſh, beſides the arteries and veins, there are open tubes, which convey the water to the fartheſt part of them: probably that they may find no want of water, when they continue ſome time on ſhore.

7. The Air-Bladder is deſcribed as a bag filled with air, ſometimes compoſed of one, ſometimes of two, and ſometimes of three diviſions, ſituated towards the back of the fiſh, and opening into the maw or the gullet. It is commonly ſuppoſed, by its ſwelling at the will of the animal, to increaſe the ſurface of the fiſh's body, and ſo to enable it to riſe to the top of the water, and keep there at pleaſure. On the contrary, when the fiſh wants to deſcend, it is ſuppoſed to empty this bladder of its air, and ſo ſinks to the bottom.

But many fiſhes have an Air-Bladder, that continually crawl at the bottom; ſuch as the eel and the flounder: and many more are entirely without it, that ſwim in every depth; ſuch as the anchovy and the freſh-water gudgeon. Indeed, the number of fiſhes that want this organ is alone a ſufficient proof that it is not neceſſary for the purpoſes of ſwimming; and the ventral fins, which in all fiſhes lie flat upon the water, are fully ſufficient to keep them at all depths.

8. The Stomach is in general, placed next the mouth, and though not ſenſibly hot, is endued with a ſurpriſing faculty of digeſtion. Its digeſtive power ſeems in ſome meaſure to increaſe with the quantity of food it is ſupplied with; a ſingle pike having been known to devour an hundred roaches in three days. Its faculties alſo are as extraordinary,

nary, for it digeſts not only ſoft fiſh, but prawns, crabs and lobſters, ſhells and all. Theſe the cod or the ſturgeon will not only devour, but diſſolve, though their ſhells are ſo much harder than the ſides of the Stomach which contains them. This amazing faculty in the cold Stomach of fiſhes has juſtly excited the curioſity of philoſophers; and has effectually overturned the ſyſtem of thoſe who ſuppoſe the heat of the Stomach is alone a ſufficient inſtrument for digeſtion. The truth ſeems to be, that there is a power of animal aſſimulation lodged in the ſtomach of all creatures, which we can neither deſcribe nor define, converting the ſubſtances they ſwallow into a fluid, fitted for their own peculiar ſupport. This is done neither by tieturation, nor by warmth, nor by motion, nor by a diſſolving fluid; but by ſome principle yet unknown, which acts in a different manner from all kinds of artificial maceration.

Yet though fiſh are thus hungry, and for ever prowling, no animals can ſuffer the want of food for ſo long a time. The gold and ſilver fiſh which we keep in vaſes, ſeem never to want any nouriſhment at all; whether it be that they feed on the water-inſects, too minute for our obſervation, or that water alone is a ſufficient ſupply. Even the pike, the moſt voracious of fiſhes, will live in a pond where there is none but himſelf, and what is more extraordinary, will be often found to thrive there.

Air however is ſo neceſſary to all fiſh, that they can live but a few minutes without it: yet nothing is more difficult to be accounted for, than the manner in which they obtain this neceſſary ſupply. Thoſe who have ſeen a fiſh in the water, muſt remember

remember the motion of its lips and its gills, or at leaſt of the bones on each ſide that cover them. This motion in the animal is without doubt, analogous to our breathing, but it is not air, but water, that the fiſh actually takes in and throws out through the gills at every motion.

The manner of its breathing ſeems to be this. The fiſh firſt takes a quantity of water by the mouth, which is driven to the gills, theſe cloſe and keep the water ſo ſwallowed from returning by the mouth, while the bony covering of the gills prevents it from going through them, until the animal has drawn the proper quantity of air from the body of water thus impriſoned: then the bony covers open and give it a free paſſage; by which means alſo the gills again are opened, and admit a freſh quantity of water. Should the fiſh be prevented from the free play of its gills, or ſhould the bony covers be kept from moving, by a ſtring tied round them, the animal would ſoon fall into convulſions, and die in a few minutes.

9. The chief inſtruments in a fiſh's motion are the Fins, which in ſome are much more numerous than in others. A fiſh compleatly fitted for ſailing is furniſhed with two pair; alſo three ſingle fins, two above and one below. Thus equipped it migrates with the utmoſt rapidity, and takes voyages of a thouſand leagues in a ſeaſon. But ſuch fiſh as have the greateſt number of fins have not always the ſwifteſt motion. The ſhark is one of the ſwifteſt ſwimmers, yet it wants the ventral Fins; the haddock does not move ſo ſwift, though it has them.

The Fins not only aſſiſt the animal in progreſſion, but in riſing or ſinking, in turning, or even leaping

leaping out of the water. To anſwer theſe purpoſes, the pectoral Fins ſerve like oars, to puſh the animal forward. They are placed behind the opening of the gills; they are generally large and ſtrong, and anſwer the ſame purpoſes to the fiſh as wings do to a bird. Thoſe alſo balance the fiſh's head, when it is too large for the body, and keep it from tumbling prone to the bottom, as is ſeen in large headed fiſhes, when the pectoral Fins are cut off. Next theſe are the ventral Fins, placed under the belly. Theſe are always ſeen to lie flat on the water, in whatever ſituation the fiſh may be; and they ſerve rather to raiſe or depreſs the fiſh, than to aſſiſt its progreſſive motion. The dorſal Fin is ſituated along the ridge of the back; and ſerves to keep it in equilibrio. In many fiſhes this is wanting; but in all flat fiſhes it is very large, as the pectoral Fins are proportionably ſmall. Laſtly, the tail, which in ſome fiſhes is flat and upright in others, ſeems the grand inſtrument of motion; the Fins are all ſubſervient to it, and give direction to its impetus, by which the fiſh darts forward with ſo much velocity. To explain all this, by experiment, a carp is taken, and put into a large veſſel. The fiſh, in a ſtate of repoſe, ſpreads all its Fins, and ſeems to reſt upon its pectoral and ventral Fins near the bottom: if the fiſh folds up either of its pectoral Fins, it inclines to the lame ſide; folding the right pectoral Fin, the fiſh inclines to the right ſide; folding the left Fin, it inclines to that ſide. When the fiſh deſires to have a retrograde motion, ſtriking with the pectoral Fins, in a contrary direction produces it. If the fiſh deſires to turn, a blow from the tail, ſends it about; but if the tail ſtrikes both ways, then the motion is progreſſive.

10. There

10. There is ſomething extremely odd in the Experiments of an ingenious man, on ſome of our common Fiſhes.

" I put a Banſtickle, ſays he, in a glaſs jar filled with water: at firſt it refuſed to eat any thing, which is common with all fiſhes; but afterward it grew ſo tame, as to take ſmall worms out of my hand. Nay, it was ſo bold at laſt, that when its belly was full, it would ſet up its prickles, and with all its ſtrength, make a ſtroke at my fingers, if I put them near it.

" This fiſh was ſo unſociable, that it would ſuffer no other fiſh to live in the jar with it, and ſo audacious as to attack whatever I put in, though ten times its own ſize. One day I put in a ſmall Ruff; the Banſtickle inſtantly aſſaulted it, and tore off part of its tail, and I am perſuaded would have killed it, had I not ſeparated them.

" The abilities they uſe to get from place to place, are likewiſe extraordinary. Though they are ſcarce two inches long, I have ſeen them leap out of the water a foot high perpendicularly, and much farther obliquely, when they wanted to get over ſome obſtacle in their way.

" Nature has furniſhed them with a kind of breaſt-plate, to be a defence againſt outward injury, and with prickles upon their ſides and back, which they erect on the leaſt appearance of danger.

" I have always obſerved among the fiſh I keep in jars, that ſuch as I keep awhile together, contract ſo great an affection for each other, that if they are ſeparated, they grow melancholy and ſullen. About Chriſtmas I put two Ruffs into a jar, where they lived together till April. I then gave one of them to a friend, the other was ſo affected,

affected, that for three weeks it would eat nothing. Fearing it would pine to death, I ſent it to its companion: being put to this, it ate immediately, and preſently recovered its former briſkneſs."

"In the beginning of September," ſays the ſame Gentleman, "I procured a ſmall Dace, which I kept in a glaſs jar till the latter end of May following. All this while it ate nothing except the ſmall animalcules, which happened to be in water I gave it, once a day in winter, and twice or thrice in the ſpring, as the weather grew warmer. When the water was freſh, it came up to the top about once an hour, to blow out ſome ſmall bubbles of air. Then putting its noſe near the ſurface, it took in freſh, and retired to the bottom again. But as the water became leſs pure by its uſe, its returns to the ſurface were more frequent, and at laſt it would remain there continually, till I gave it a freſh quantity. I believe I might have kept it for years, but buſineſs one day prevented me from giving it clean water in due time, which put a period to the life of my little companion.

"At firſt it would not ſuffer me to come nigh the glaſs, without the utmoſt confuſion and ſurprize; but at laſt it grew ſo tame, that if I came but in ſight, it would be ſure to be at the ſame ſide of the glaſs, and lie gazing at me, until I was weary of obſerving it. I often took the opportunity of looking at it by candle-light, which it ſeemed to take great pleaſure in.

"In the above-mentioned month, I put into another glaſs, a Ruff about three inches long. At firſt

firſt he too appeared mighty reſerved, and would not eat, nor ſuffer me to come nigh him; but in a ſhort time all-powerful hunger tamed him: for he could not, like the Dace, live on the ſmall inhabitants of the water, and ſo was quickly forced to take whatever I provided for him. In a while it grew ſo tame, that it would not only eat ſmall worms which I threw into the glaſs, but would take them out of my hands. Nay, it would even riſe out above the water for them; which is contrary to the way wherein this kind of fiſh uſes to take its food. At laſt, it would come to my hand, whenever I put it into the glaſs, and ſuffer me to handle it. When I had made all the obſervations I thought proper, after eight months I gave him his liberty."

11. It has long been ſuppoſed that all ſhells, as well as the animals in them, aroſe wholly from the egg. But it is now found by various experiments, that the ſhells of ſnails (and probably of all other animals) are formed of a matter which perſpires from their bodies, and then condenſes round them.

It is certain all animals perſpire and are encompaſſed with an atmoſphere which exhales from them. Snails have nothing peculiar in this reſpect, unleſs that their atmoſphere condenſes and hardens about them, and forms a viſible cover for the body, while that of other animals evaporates. This difference may ariſe from the different ſubſtance perſpired, that from ſnails being viſcous and ſtony. This is no ſuppoſition, but a matter of fact, proved by numerous experiments.

But

But the re-production of the ſhells of ſome fiſh, yea, and of the parts contained therein, is far more ſtrange and unaccountable, than their firſt production. This is particularly obſerved in Crabs and Lobſters. Lobſters caſt their ſhell yearly ſome time after Midſummer. In the room of the old, a new thin ſhell is immediately prepared by nature, which in leſs than eight days, acquires almoſt the ſame degree of hardneſs as the other.

The legs of a Lobſter conſiſt of five articulations. When any of theſe legs break, which frequently happens, the fracture is always near the fourth joint, and what they loſe is preciſely re-produced in ſome time after: four joints ſhooting out, the firſt whereof has two claws, as before.

If a leg be broken off purpoſely at the fourth or fifth joint, it is conſtantly re-produced: but very rarely, if at the firſt, ſecond or third joint. What is ſtill more ſurprizing is, that upon viſiting the Lobſter, which was maimed in theſe barren articulations, at the end of two or three days, all the other joints are found broken off at the fourth, which he has undoubtedly done himſelf.

The part re-produced is perfectly like that broke off, and in a certain time grows equal to it. Hence it is, that Lobſters have often their two big legs unequal. This ſhews the ſmaller leg to be a new one. If a part thus re-produced is broken off, there is a ſecond re-production. The ſummer, which is the only time when Lobſters eat, is the moſt favourable time for this. It is then performed in four or five days; otherwiſe it takes up eight or nine months.

The common Crab-fiſh has its abode from twenty to forty fathom water. They herd together

ther in diſtinct tribes, and have their ſeparate haunts for feeding and breeding, and will not aſſociate with their neighbours. This has been tried, by marking a Crab, carrying it two or three miles, and leaving it among other Crabs. This Crab has afterward found its way home, and been caught in its old abode.

This creature too can break off its own limbs. If when it is laid on its back, one of the outer joints of a ſmall leg be bruiſed, he ſhews uneaſineſs, by moving it about. Afterward he holds it quite ſtill, in a direct and natural poſition, without touching any part of the body, or of the other legs with it. Then on a ſudden with a gentle crack, the wounded part of the leg drops off. If an hole be pierced in the great leg, the effect will be the ſame; and the large limb is thrown off in the ſame manner, only with greater violence. A mucus then overſpreads the wound, which preſently ſtops the bleeding; and a ſmall leg is by degrees produced, which gradually attains the ſize of the former. Nature has given this ſingular power to theſe creatures, for the preſervation of their lives in their frequent quarrels. In theſe, one Crab lays hold of the claw of another, and cruſhes it in ſuch a manner, that it would bleed to death, had it not the power of giving up the limb, and healing the wound.

However different in figure the Lobſter and the Crab may ſeem, their manners are nearly the ſame. Though without any warmth in their bodies, or even red blood, they are wonderfully voracious. Whatever they ſeize upon that has life, is ſure to periſh, though never ſo well defended: they even devour each other; and, to increaſe our

our ſurprize, they may, in ſome meaſure, be ſaid to eat themſelves, as they change their ſhell and their ſtomach every year, and their old ſtomach is generally the firſt morſel that ſerves to glut the new.

What this animal differs in from all others, is, that the ſpinal marrow is in the breaſt-bone. It is furniſhed with two long feelers or horns, that iſſue on each ſide of the head, to correct the dimneſs of its ſight, and apprize the animal of its danger, or of its prey. The tail is the grand inſtrument of motion; and with this it can raiſe itſelf in the water.

When the young Lobſters leave the parent, they ſeek for refuge in the ſmalleſt clefts of rocks, and in crevices at the bottom of the ſea. There they grow larger in a few weeks, from the accidental ſubſtances which the water waſhes to their retreats. By this time alſo they acquire an hard firm ſhell, which furniſhes them with both offenſive and defenſive armour. They then iſſue from their fortreſſes, and creep along the bottom, in hopes of meeting with plunder. The ſpawn of fiſh, the ſmaller animals of their own kind, but chiefly the worms that keep at the bottom of the ſea, ſupply them with plenty. They keep in this manner cloſe among the rocks, buſily employed in ſcratching up the ſand with their claws for worms, or ſurprizing ſuch heedleſs animals as fall within their graſp: thus they have little to apprehend, except from each other, for in them, as among fiſhes, the large are the moſt formidable of all enemies to the ſmall.

But the body of the Lobſter ſtill continuing to increaſe, the animal ſoon becomes too large for its habitation. In general, all animals change their ſhell

ſhell once a year; and this is a moſt painful operation. Their molting ſeaſon is generally about the beginning of ſummer; at which time their food is in plenty, and their ſtrength and vigour in the higheſt perfection. But ſoon all their activity ceaſes: they ſeek ſome retired ſituation among the rocks, where they remain in ſafety from the attacks of their various enemies. For ſome days before their change, the animal diſcontinues its uſual voraciouſneſs; it is no longer ſeen harrowing up the ſand at the bottom, or fighting with others of its kind, or hunting its prey; it lies torpid and motionleſs. Juſt before caſting its ſhell, it throws itſelf upon its back, ſtrikes its claws againſt each other, and every limb ſeems to tremble; its feelers are agitated, and the whole body is in violent motion. It then ſwells itſelf in an unuſual manner, and at laſt the ſhell begins to divide at its junctures; particularly at the junctures of the belly, where, like a pair of jumps, it was before but ſeemingly united. It alſo ſeems turned inſide out; and its ſtomach comes away with its ſhell. After this it diſengages itſelf of the claws, which burſt at the joints; the animal, with a tremulous motion, caſting them off, as a man would kick off a boot that was too big for him.

Thus this wonderful creature is at liberty; but ſo weak that it continues for ſeveral hours motionleſs. Indeed, ſo violent and painful is the operation, that many of them die under it; and thoſe which ſurvive, for ſome time neither take food, nor venture from their retreats. Immediately after this change, they have not only the ſoftneſs, but the timidity of a worm. Every animal of the deep is then a powerful enemy, which they can neither eſcape, nor oppoſe; and this is the time when

when the dog-fiſh, the cod, and the ray devour them by hundreds. But this ſtate continues for a very ſhort time: in leſs than two days, the ſkin that covered its body is grown almoſt as hard as before.

When the Lobſter is completely equipped in its new ſhell, it appears how much it has grown in the ſpace of a very few days. The old ſhell being compared with thoſe of the new, it is increaſed above a third in its ſize; and, like a boy that has outgrown his cloaths, it ſeems wonderful how the deſerted ſhell was able to contain ſo great an animal as entirely fills up the new.

It may be worth obſerving, that Lobſters uſe their tails as fins, wherewith they commonly ſwim backward, by jerks or ſprings, reaching ſometimes ten yards at a ſpring. For this purpoſe, as the gill-fins of other fiſhes, which are their oars, are a little concave backward, theſe have the plates of their tails, when they bend them down as they uſe to do, a little concave forward.

Different from all theſe are the Land Crabs of the Caribbee Iſlands; which live in a kind of orderly ſociety, within their retreats in the mountains; and regularly once a year march down to the ſea ſide in a body of ſome millions. They chuſe the months of April and May to begin their expedition: and then ſally out from the ſtumps of hollow trees, from the clefts of rocks, and from the holes which they dig for themſelves under the ſurface of the earth. At that time the whole ground is covered with this band of adventurers. The ſea is their place of deſtination, and to that they direct their march. No geometrician could ſend them to their deſtined ſtation, by a ſhorter

courſe. They neither turn to the right or left, whatever obſtacles intervene. And even if they meet with a houſe, they will attempt to ſcale the walls, to keep the unbroken tenor of their way. But upon ſome occaſions they are compelled to conform to the face of the country; and if it be interſected by rivers, they wind along the courſe of the ſtream. They are commonly divided into three battalions; of which, the firſt conſiſts of the ſtrongeſt and boldeſt males, that like pioneers, march forward to clear the route, and face the greateſt dangers. Theſe are often obliged to halt for want of rain, and wait till the weather changes. The main body of the army is compoſed of females, which never leave the mountains till the rain is ſet in, and then deſcend in regular battalia, in columns of fifty paces broad, and three miles deep, and ſo cloſe, that they almoſt cover the ground. Three or four days after this, the rear-guard follows; a ſtraggling undiſciplined tribe, conſiſting of males and females, but neither ſo robuſt, nor ſo numerous as the former. The night is their chief time of proceeding; but if it rains by day, they do not fail to profit by the occaſion. And they continue to move forward in their ſlow, uniform manner. When the ſun ſhines hot, they make an univerſal halt, and wait till the cool of the evening. When they are terrified, they march back in a diſorderly manner, holding up their nippers with which they ſometimes tear off a piece of the fleſh of an aſſailant, and leave the weapon where they inflicted the wound. They often clatter their nippers together, as if it were to threaten thoſe that come to diſturb them. But though they thus ſtrive to be formidable to man, they are much more ſo to each other; for if any of them by accident is maimed in ſuch

a man-

a manner, as to be incapable of proceeding, the reſt fall upon and devour it on the ſpot, and then purſue their journey.

When after a fatiguing march, perhaps of three months, they arrive at their deſtined port, they prepare to caſt their ſpawn. The peas are as yet within their bodies, and not as is uſual in animals of this kind, under the tail. And the creature waits for the benefit of the ſea water, to help the delivery. For this purpoſe, the Crab has no ſooner reached the ſhore, than it eagerly goes to the edge of the water, and lets the waves waſh over its body, two or three times. Then they withdraw to ſeek a lodging upon land: in the meantime, the ſpawn grows larger, is excluded out of the body, and ſticks to the barbs under the tail. In this ſtate of pregnancy, they once more ſeek the ſhore, and ſhaking off their ſpawn into the water, leave it there. At this time whole ſhoals of hungry fiſh are in expectation of this annual ſupply. The ſea to a great diſtance is black with them; and about two thirds of the crabs eggs are immediately devoured. The eggs that eſcape are hatched under the ſand; and ſoon after millions at a time of theſe little crabs are ſeen quitting the ſhore, and ſlowly travelling up to the mountains.

The old ones however are not ſo active to return; they are become ſo feeble, that they can hardly creep along. Moſt of them, therefore, are obliged to continue in the flat parts of the country till they recover, making holes in the earth, which they cover at the mouth with leaves and dirt. There they throw off their old ſhells. At that time they are quite naked, and almoſt without motion for ſix days. They have then under their ſtomachs four large white ſtones, which gra-

dually decreaſe in proportion as the ſhell hardens, and when they come to perfection, are not to be found. It is at that time the animal is ſeen ſlowly making its way back, and all this is commonly performed in ſix weeks.

There is likewiſe an animal of the lobſter kind that annually deſcends from its mountains not only to produce an offſpring, but to provide itſelf a covering; not only to ſecure a family, but to furniſh an houſe. I mean the Soldier Crab. It is about four inches long, has no ſhell behind, but is covered down to the tail with a rough ſkin, terminating in a point. But what nature has denied this animal, it takes care to ſupply by art; and taking poſſeſſion of the deſerted ſhell of ſome other animal, it reſides in it, till, by growing too large for its habitation, it is under the neceſſity of a change. It is a native of the Weſt India Iſlands and every year deſcends from the mountains to the ſea-ſhore, to depoſit its ſpawn, and to provide itſelf with a new ſhell. Its firſt care is to provide for its offſpring, and it is thought from the number of little ſhells which it is ſeen examining, that it depoſits his ſpawn in them, which thus is placed in perfect ſecurity till the time of excluſion.

It is then mindful of itſelf. It is ſtill ſeen in its old ſhell, which it has conſiderably outgrown; a part of the naked body is ſeen at the mouth of it, which the habitation is too ſmall to hide. A ſhell therefore, is to be found large enough to cover the whole body; and yet not ſo large as to be unmanageable. To anſwer both theſe ends is no eaſy matter, nor the attainment of a ſlight enquiry. The little Soldier is ſeen buſily parading the ſhore along that line of pebbles and ſhells that

that is formed by the waves; ſtill, however, dragging its old habitation at his tail; unwilling to part with one ſhell, till it can find another more convenient. It is ſeen ſtopping at one ſhell, turning it and paſſing it by, going on to another, contemplating that for a while, and then ſlipping its tail from its old habitation, to try on the new. This alſo is found to be inconvenient, and it quickly returns to its old ſhell again. In this manner it frequently changes, till at laſt it finds one, light, roomy, and commodious. To this it adheres, though the ſhell be ſometimes ſo large as to hide the body of the animal, claws and all.

Yet it is not till after many trials, and many combats alſo, that the Soldier is thus completely equipped. For there is often a conteſt between two of them, for ſome well-looking ſhell. They both endeavour to take poſſeſſion; they ſtrike with their claws; they bite each other, till the weakeſt is obliged to yield. It is then that the victor takes poſſeſſion, and parades in his new conqueſt three or four times backward and forward upon the ſtrand before his envious antagoniſt.

Crabs-Eyes, ſo called, are found in the bodies of Cray-Fiſh. Each fiſh produces two yearly, one on each ſide of the ſtomach, between the coats of it. Here it grows coat upon coat, and is ſupplied with petrifying juices by veſſels opening on the inner ſurface of the outward coat. The firſt ſcale, whereon all the others are formed, may be perceived in the center, the brims or circumferences of many of the reſt being likewiſe apparent. It is believed, that they caſt theſe ſtones with their ſhells yearly; but this is not the caſe. For about the time of caſting their ſhell,

the ſtones break through the internal coat of the ſtomach, and being ground by the three ſerrated teeth therein, become diſſolved in the ſpace of a few days, which makes it difficult to find them juſt at this time.

They eat their old ſhells immediately after ſhedding them. Perhaps theſe ſtones may be deſigned to furniſh new petreſcent juices to its fluids, for the re-production of their annual dreſs.

As to turbinated ſhell-fiſh of the Snail kind, we may firſt obſerve the Snail itſelf. This is ſurpriſingly fitted for the life it is to lead. It has the organs of life in a manner almoſt as complete as the largeſt animal; a tongue, brain, ſalival ducts, glands, nerves, ſtomach, and inteſtines; liver, heart, and blood veſſels: beſides this it has a purple bag that furniſhes a red matter to different parts of the body, together with ſtrong muſcles that hold it to the ſhell, and which are hardened like tendons at their inſertion.

But theſe it poſſeſſes in common with other animals. We muſt now ſee what it has peculiar to itſelf. The firſt ſtriking peculiarity is, it has got its eyes on the points of its largeſt horns. When the Snail is in motion, four horns are ſeen diſtinctly; but the two longeſt deſerve peculiar conſideration, both on account of the various motions with which they are endued, and of their having eyes at the extreme ends of them. Theſe appear like two blackiſh points. The animal can direct them to different objects at pleaſure, by a regular motion out of the body; and ſometimes it hides them by a very ſwift contraction into the belly. Under the ſmall horns is the animal's mouth; and though it may appear too ſoft a ſub-

a ſubſtance to be furniſhed with teeth, yet it has no leſs than eight of them, with which it devours leaves, and other ſubſtances ſeemingly harder than itſelf.

It may ſeem whimſical to make a diſtinction between the animal perfections of turbinated and bivalved ſhell-fiſh, or to grant a degree of ſuperiority to the Snail above the Oyſter. Yet this diſtinction apparently obtains in nature; and we ſhall find the bivalved tribe of animals in every reſpect inferior to the other. Inferior in all their ſenſations; inferior in all their motions; but peculiarly inferior in their ſyſtem of animal generation. The Snail tribe are hermaphrodite; but require the aſſiſtance of each other for fecundation; all the bivalve tribe are hermaphrodite in like manner, but they require no aſſiſtance from each other towards impregnation; and a ſingle muſcle or oyſter, if there were no other in the world, would quickly repleniſh the ocean.

The multitude of theſe animals is in ſome places very great; but from their defenceleſs ſtate, the number of their deſtroyers are in equal proportion. The crab, the cray-fiſh, and many other animals are ſeen to devour them; but the tochus is their moſt formidable enemy. When their ſhells are found deſerted, if we then obſerve cloſely, it is moſt probable we ſhall find that the tochus has been at work in piercing them. There is ſcarce one of them without a hole in it; and this probably was the avenue by which the enemy entered to deſtroy the inhabitant.

But notwithſtanding the number of this creature's animated enemies, it ſeems ſtill more fearful of the agitations of the element in which it reſides; for if daſhed againſt rocks, or

thrown far on the beach, it is deſtroyed without a power of redreſs. In order to guard againſt theſe, which are to this animal the commoneſt and the moſt fatal accidents, although it has a power of ſlow motion, which I ſhall preſently deſcribe, yet it endeavours to become ſtationary, and to attach itſelf to any fixed object it happens to be near. For this purpoſe it is furniſhed with a very ſingular capacity of binding itſelf by a number of threads to whatever object it approaches; and there Reaumur ſuppoſed it ſpun artificially as ſpiders their webs, which they faſten againſt a wall. Be this as it will, nothing is more certain than that the muſcle is found attached by theſe threads to every fixed object; ſometimes, indeed, for want of ſuch an object, theſe animals are found united to each other, and though thrown into a lake ſeparately, they are taken out in bunches of many together.

To have ſome fixed reſting place, where the muſcle can continue, and take in its accidental food, ſeems the ſtate that this animal chiefly deſires. Its inſtrument of motion, by which it contrives to reach the object it wants to binds itſelf to, is that muſcular ſubſtance reſembling a tongue, which is found long in proportion to the ſize of the muſcle. This the animal has a power of thruſting out of its ſhell; and with this it is capable of making a ſlit in the ſand at the bottom. By means of this furrow it can erect itſelf upon the edge of its ſhell; and thus continuing to make the furrow in proportion as it goes forward, it reaches out its tongue, that anſwers the purpoſe of an arm, and thus carries its ſhell edge-ways, as in a groove, until it reaches the point intended. Then

Then where it determines to take up its reſidence, it fixes the ends of its beard, which are glutinous, to the rock, or the object, whatever it be; and thus like a ſhip at anchor, braves all the agitations of the waters. Sometimes the animal is attached by a large number of threads; ſometimes but by three or four, that ſeem ſcarce able to retain it. When the muſcle is fixed in this manner, it lives upon the little earthly particles that the water tranſports to its ſhells, and perhaps the fleſh of the moſt diminutive animals. However, it does not fail to grow conſiderably; and ſome of this kind have been found a foot long. I have ſeen the beards of a foot and a half; and of this ſubſtance the natives of Palermo make gloves and ſtockings.

Oyſters uſually caſt their ſpawn in May, which at firſt appear like drops of candle-greaſe, and ſtick to any hard ſubſtance they fall upon. Theſe are covered with a ſhell in two or three days, and in three years the animal is large enough to be brought to the market.

The Scallop is particularly remarkable for its method of moving forward upon land, or ſwiming upon the water. When it finds itſelf deſerted by the tide, it moves towards the ſea in a moſt ſingular manner. It firſt gapes with its ſhell as widely as it can, the edges being often an inch aſunder; then it ſhuts them with a jerk, and by this the whole animal riſes five or ſix inches from the ground. It thus tumbles any how forward, and renews the operation until it has attained its journey's end. When in the water it is capable of ſupporting itſelf on the ſurface; and there open-

ing and ſhutting its ſhells, it tumbles over and over, and makes its way with ſome celerity.

The Razor-ſhell has a very different kind of motion. As the former moves laborioufly forward, ſo the Razor-ſhell has only a power of ſinking point downward. The ſhells of this animal reſemble nothing ſo much as the haft of a razor; and by this form it is enabled to dive into the ſoft ſand. All its motions are confined to ſinking or riſing a foot downwards or upwards in the ſand, for it never leaves the ſpot where firſt it was planted. From time to time it riſes about half-way out of its hole; but if any way diſturbed ſinks perpendicularly down again. Juſt over the place where the Razor buries itſelf, there is a ſmall hole like a chimney, through which the animal breathes or imbibes the ſea-water. Upon the deſertion of the tide, theſe holes are eaſily diſtinguiſhed by the fiſhermen; and their method of enticing the Razor up is by ſprinkling a little ſea-ſalt upon the hole. This melting, no ſooner reaches the Razor below, than it riſes inſtantly, and ſhews above half its length above the ſurface. This appearance is inſtantaneous; and if the fiſher does not ſeize the opportunity, the Razor buries itſelf to its former depth. There it continues ſecure; no ſalt can allure it a ſecond time; but it remains unmoleſted unleſs the fiſher will be at the trouble of digging it out, ſometimes two feet below the ſurface.

Multivalve Shell-fiſh may be conſidered as animals ſhut up in round boxes. To view their habitations externally, one would be little apt to conſider them as the retreats of living creatures; and ſtill leſs, to ſuppoſe that ſome of them carry their

their boxes with tolerable ſhare of ſwiftneſs, ſo as to eſcape their purſuers. Of theſe there are principally two kinds; ſuch as move, and ſuch as are ſtationary: the firſt are uſually known in our cabinets by the name of ſea-eggs; the others are often admired for the cavities which they ſcoop out for their habitation in the hardeſt marble. The firſt are called, by naturaliſts, Echini, or Urchins: the latter are called Pholades, or File Fiſh. Of both theſe are ſeveral ſorts; but by deſcribing theſe two, we ſhall have a competent idea of all the reſt.

To a ſlight view, the Sea-Urchin may be compared to the huſk of a cheſnut; being like it, round, and with a number of bony prickles ſtanding out on every ſide. To exhibit this extraordinary animal in every light. If we could conceive a turnip ſtuck full of pins on every ſide, and running upon theſe pins with ſome degree of ſwiftneſs, we ſhould have ſome idea of this extraordinary creature. The mouth is placed downwards; the vent is above; the ſhell is a hollow vaſe, reſembling a ſcooped apple; and this filled with a ſoft muſcular ſubſtance, through which the inteſtines wind from the bottom to the top. The mouth, which is placed undermoſt, is large and red, furniſhed with fine ſharp teeth, which are eaſily diſcerned. The jaws are ſtrengthened by fine ſmall bones, in the centre of which is a ſmall fleſhly tongue; and from this the inteſtines make a winding of five ſpires, round the internal ſides of the ſhell, ending at the top, where the excrements are excluded. But what makes the moſt extraordinary part of this animal's conformation, are its horns, and its ſpires, that point from every part of the body, like the horns of a ſnail, and that ſerve at once as legs to

move upon, as arms to feel with, and as inſtruments of capture and defence. Between their horns it has alſo ſpires that are not endued with ſuch a ſhare of motion. The ſpires and the horns iſſue from every part of the body, the ſpires being hard and prickly, the horns being ſofter, longer than the ſpires, and never ſeen except in the water. They are put forward and withdrawn like the horns of a ſnail, and are hid at the baſs of the ſpire, ſerving, as was ſaid before, for procuring food and motion. All this apparatus, however, is only ſeen when the animal is hunting his prey at the bottom of the water; for a few minutes after it is taken, all the horns are withdrawn into the body, and moſt of the ſpires drop off.

It is generally ſaid of inſects, that thoſe which have the greateſt number of legs, always move the ſloweſt; but this animal ſeems to be an exception to the rule; for though furniſhed with two thouſand ſpires, and twelve hundred horns, all ſerving for legs, and from their number ſeem to impede each others motion, yet it runs with ſome ſhare of ſwiftneſs at the bottom, and it is ſometimes no eaſy matter to overtake it.

Very different in motion, though not much different in ſhape from them, are the Acorn Shell-Fiſh, the Thumb-footed Shell-Fiſh, and the Imaginary Barnacle. Theſe are fixed to one ſpot, and appear to vegitate from a ſtalk. Indeed, to an inattentive ſpectator, each actually ſeems to be a kind of fungus that grows in the deep, deſtitute of animal life, as well as motion. But the enquirer will ſoon change his opinion, when he comes to obſerve this muſhroom-like figure more minutely. He will then ſee that the animal reſiding within the

the ſhell, has not only life, but ſome degree of voraciouſneſs; that it has a cover, by which it opens and ſhuts its ſhell at pleaſure; that it has twelve large crooked arms, furniſhed with hair, which it thruſts forth for its prey; and eight ſmaller, which are generally kept in the ſhell. They are ſeen adhering to every ſubſtance that is to be met with in the ocean; rocks, roots of trees, ſhips bottoms, whales, lobſters, and even crabs; like bunches of grapes clung to each other. It is amuſing enough to behold their operations. They for ſome time remain motionleſs within their ſhell; but when the ſea is calm, they are ſeen opening the lid, and peeping about them. They then thruſt out their long neck, look round them for ſome time, and then abruptly retreat back into their box, ſhut the lid, and lurk in darkneſs and ſecurity.

Among the Shell-fiſh on the Waterford coaſt, is the Murex, which gave the Tyrian purple. It is in great plenty there, and is by the Engliſh called an Horſe-winkle. The ſhell is about an inch long, and half an inch broad, and turns ſpirally like a ſnail-ſhell. Each fiſh has a peculiar reſervoir, which contains a large drop of liquor: if this is preſſed out on linen, the linen firſt appears of a dirty yellow, inclining to green; afterward it changes to a lemon colour, then to a deep green; then it turns to a deep blue, and at laſt to a charming purple.

The ſhells of the ancient Purple fiſh, are ſtill common on the Tyrian ſhore. The fiſh itſelf is found in great abundance in the ſeas of the Spaniſh Weſt-Indies, near Panama and Nicoya, exactly agreeing with Pliny's account of the ancient Murex.

Murex. Cloth of Segovia, died with this purple, is ſold for twenty crowns an ell, and is very rarely worn by any, but the greateſt noblemen in Spain. The Caribbee Iſlands have alſo the ſame ſort of fiſh, which we may likewiſe find nearer home, namely on the coaſts of Somerſetſhire, as well as of South-Wales.

The Pearl Muſcles lie partly open: the inſide of the ſhell is of a pearly colour. The pearl lies in the ſmaller end of it, at the extremity of the gut, and out of the body of the fiſh, between the two films that line the ſhell. This anſwers to the Stone in other animals, increaſing by cruſts growing over one another. Accordingly if a Pearl be pinched in a vice, the upper coat will crack and leap away. And as it is now known, that the ſhells of fiſhes are formed of ſtony matter oozing out of their body, it is no wonder if that matter when it chances to overflow, burſts forth in any cavity of the body, and forms a little maſs, which hardening becomes a Pearl of the ſame colour with the ſhell.

Whereas all other animals take in nutriment by the mouth, the Muſcle takes it in by the anus. The part called the head, though without eyes, ears, or tongue, is immoveably faſtened to one of the ſhells; ſo that it cannot receive any thing. The food of a Muſcle is water, which as the ſhell opens, enters in at the anus, and paſſing on by certain canals running between the ſhell and the animal, is thence conveyed into the mouth.

What is farther ſurprizing is, that it is an hermaphrodite; but one of a peculiar kind, for it propagates (not as worms and ſnails, reciprocally) but

but independent of any other animal: ſo that itſelf is both the father and the mother of its own offspring.

We have lately diſcovered a progreſſive motion in thoſe ſhell-fiſh, which were ſuppoſed to be quite fixed. Even Oyſters, which one would think wholly immoveable, if they are thrown irregularly into a veſſel of water, will in a while turn themſelves, till the ſmooth ſhell becomes uppermoſt: otherwiſe they could hold no water in the concave ſhell for their ſuſtenance.

Muſcles can walk on the ground, which they do on this manner. Lying on the flat ſide of their ſhell, they thruſt out a part, in form of a tongue, wherewith they make little motions to the right and left, and thereby dig a paſſage in the ſand. In this digging they drop gradually on one ſide, and ſo get the ſhell mounted on its edge; then they ſtretch out the tongue as far as they can, and reſt for a minute or two on its extremity, to draw the ſhell after them, as water-ſnails do. This motion is repeated as long as they pleaſe; thus they form a ſort of groove in the ſand, which ſuſtains the ſhell on either ſide, and leaves behind them a ſort of irregular tract, three or four yards long. In rivers abounding with Muſcles one may ſee many of them, with a Muſcle at the end of each.

That called the Arm or Leg in a Sea-Muſcle, which in its natural ſtate is not above two lines long, may reach out of the ſhell two inches: and the Muſcle having laid hold on a fixed point therewith, bends and ſhortens it, and ſo drags itſelf on. The Beard ſerves for an anchor to faſten it to ſome heavy body, that it may not be carried away with the motion of the waves.

When

When a Pond Muſcle walks, it thruſts out its whole belly, in form of the keel of a ſhip, and creeps on its belly as the ſerpent does. So true it is, that Nature is not confined in her manner of operation, but is ever varying, though never confuſed.

In Port-Mahon Harbour, there are Stones from half an hundred to five hundred weight each, lying at all depths, full of ſhells, each containing a ſingle fiſh, of the Muſcle kind. The holes in the ſurface are far narrower than the hole in which is the fiſh, which it ſeems is capable of enlarging its room as it grows bigger, by abraiding the ſides of its cells. And this is apparent, from the ſandy matter found in the bottom of thoſe cells, whenever the orifice is higher than the bottom; for then the fiſh cannot throw it out.

The Bollani likewiſe in the Adriatic ſea, live in large ſtones. Their ſhell is rough and oblong, not unlike a Date. They are found in ſeveral kinds of porous ſtones. In the pores of theſe the ſpawn is depoſited. Frequently the aperture through which it was injected, is no longer perceivable; but the fiſh thrives notwithſtanding. On breaking ſome of theſe ſtones, one finds near thirty live fiſh, though no opening can be perceived on the outſide. Each has juſt room to open its ſhell, the inſide of which is white, the outſide aſh-colour; the largeſt is four or five inches long. Both the fiſh itſelf and its juices are ſo luminous, one may ſee to read by it; and even water in which it has been ſqueezed, put into a glaſs, will ſhine ten or twelve hours.

Likewiſe

Likewiſe in Toulon harbour are found ſolid ſtones, containing in ſeparate cells, ſecluded from all communication with the air, ſeveral living Shell-fiſh. The ſame are found along the coaſt of Ancona, in ſtones weighing fifty pounds and upwards, The outſide of which is ſoft, but the inſide ſo hard as to require an iron mall, and a ſtrong arm to break them.

Pholades Bollani, when diveſted of their ſhell, reſemble a roundiſh ſoft pudding, with no inſtrument that ſeems in the leaſt fitted for boring into ſtones, or even penetrating the ſofteſt ſubſtance. A Pholas is furniſhed with two teeth indeed; but theſe are placed in ſuch a ſituation as to be incapable of touching the hollow ſurface of its ſtony dwelling. It has alſo two covers to its ſhell that open and ſhut at either end; but theſe are totally unſerviceable to it as a miner. The inſtrument with which it performs all its operations, and buries itſelf in the hardeſt rocks, is only a broad fleſhy ſubſtance, ſomewhat reſembling a tongue, that is ſeen iſſuing from the bottom of its ſhell. With this ſoft yielding inſtrument, it perforates the moſt ſolid marbles; and having, while little and young, made its way, by a very narrow paſſage into the ſubſtance of the ſtone, it then begins to grow bigger, and thus to enlarge its apartment. While yet naked and very ſmall, it has effected an entrance, and has buried its body in the ſtone: it there continues for life at its eaſe; the ſea-water that enters at its apertures ſupplying it with luxurious plenty. When the animal has taken too great a quantity of water, it is ſeen to ſpurt it out of its hole with ſome violence. Upon this ſeemingly thin diet, it quickly grows larger, and ſoon finds

finds itſelf under a neceſſity of enlarging its habitation and its ſhell, The motion of the Pholas is ſlow beyond conception; its progreſs keeps pace with the growth of its body; and in proportion as it grows larger, it makes its way farther into the rock. When it has got a certain way in, it then turns from a certain direction, and hollows downward; till at laſt when its habitation is compleated, the whole apartment reſembles the bowl of a tobacco-pipe; the hole is the ſhank, being that by which the animal entered,

Thus immured, the Pholas lives in darkneſs, indolence, and plenty; it never removes from the narrow manſion into which it has penetrated; and ſeems perfectly content with being incloſed in its own ſepulchre. The influx of the ſea-water, that enters by its little gallery, ſatisfies all its wants; and without any other food, is found to grow from ſeven to eight inches long, and thick in proportion.

Yet the Pholas thus ſhut up is not ſo ſolitary an animal as it would at firſt appear; for tho' it is immured in its hole without egreſs; though it is impoſſible for the animal, grown to a great ſize, to get out by the way it made in, yet many of this kind meet in the heart of the rock, and like miners in a ſiege, who ſometimes croſs each other's galleries, they frequently break in upon each other's retreats: whether their thus meeting be the work of accident or of choice, few can take upon them to determine; certain it is they are moſt commonly found in numbers in the ſame rock; and ſometimes above twenty are diſcovered within a few inches of each other.

As

As to the neſt, this animal is found in greateſt numbers at Ancona in Italy; it is found along the ſhores of Normandy and Poitou, in France; it is found alſo upon ſome of the coaſts of Scotland, and in general is conſidered as a very great delicacy at the tables of the luxurious.

One of the moſt extraordinary kinds of Shell-fiſh is the Animal-Flower, in Barbadoes. In the pariſh of St. Lucy, on the north ſide of the iſland, there is a high rocky cliff fronting the ſea, near the bottom of which is a large cave. This opens into another cave, the bottom of which is a baſon of water. In the midſt of this baſon is a rock, always covered with water: on the ſides of which, a few inches below the water, are ſeen at all times of the year, iſſuing out of little holes, what have the appearance of finely radiated flowers, in ſize, colour and ſhape greatly reſembling a common marygold.

If you attempt to pluck one of theſe, as ſoon as your fingers come within two or three inches of it, it contracts, cloſes up its border, and ſhrinks back into the hole of the rock. But if left undiſturbed for a few minutes, it iſſues again, and ſoon appears in full bloom. This might induce one to believe, that it was no other than an aquatic ſenſitive plant.

But on a nearer inſpection we may diſcern four dark-coloured filaments, riſing from the center, moving with a quick and ſpontaneous motion, and frequently cloſing, to ſeize its prey, much like the claws of a lobſter. So that the ſeeming flower is really an animal; and its body, which appeared to be the ſtalk of the flower, is black, about as big as a raven's quill.

It

It seems the vivid yellow colour of its feelers, is absolutely necessary to procure its food. The water in the cave having no motion, cannot bring any food to them. Therefore the Creator has endued this creature with a quality which may allure its prey. For bright colours invite many aquatic animals, as the flame of a candle does flies.

END OF THE FIRST VOLUME.

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