principle, which may be employed with equal advantage and certainty as any of thoſe that are already known.

The defect of Ariſtotle's philoſophy was the employing particular effects as cauſes; and that of Des Cartes conſiſts in the rejection of every cauſe, but a few general effects. To uſe nothing as cauſes but general effects, to endeavour to augment the number of theſe, and to attempt to generalize particular effects, would conſtitute the moſt perfect principles of genuine philoſophy.

In my theory of expanſion and reproduction, I firſt admit the mechanical principles, then the penetrating force of gravity, and, from analogy and experience, I have concluded the exiſtence of other penetrating forces peculiar to organized bodies. I have proved by facts, that matter has a ſtrong tendency towards organization; and that there are in Nature an infinite number of organic particles. I have, therefore, only generalized particular obſervations, without advancing any thing contrary to mechanical principles, when that term is uſed in its proper ſenſe, as denoting the general effects of Nature.

CHAP. IV.

Of the Generation of Animals.

AS the organization of man, and of other animals, is the moſt perfect, and the moſt complex, the propagation of them is likewiſe moſt difficult, and the number of individuals is leſs abundant. I except here ſuch animals as can be multiplied by a ſeparation of their parts, or without the aid of generation, theſe having been ſufficiently treated of in the preceding chapter*.

But how will the theory delivered in the former chapter apply to the generation of men, and other animals, who are diſtinguiſhed by ſexes? We underſtand, from what has been ſaid, how every individual may reproduce; but we cannot conceive how two individuals, the one a male, and the other a female, ſhould uniformly produce a third.

Before replying to this objection, I muſt obſerve, that the writers on this ſubject have confined their ideas ſolely to the generation of men and of animals, without attending to the nature

* Here the author gives an unneceſſary recapitulation of Chap. III. to which the reader is referred.

of reproduction in general: And as the generation of animals is the moſt complicated ſpecies of reproduction, they have laboured under great diſadvantages, not only by attacking the moſt difficult point, but by leaving themſelves no ſubject of compariſon to enable them to illuſtrate the queſtion. To this circumſtance I chiefly attribute the unſucceſsfulneſs of their attempts. But, by the method I have obſerved, I am perſuaded that I ſhall be able to give a ſatisfactory explanation of every ſpecies of reproduction.

Let the generation of man ſerve as an example. To begin with infancy.

The expanſion and growth of the different parts of man's body being effected by the intimate penetration of organic particles, analogous to each of theſe parts, all the organic particles, in early life, are abſorbed, and entirely employed in unfolding and augmenting his different members. He has, of courſe, little or no ſuperfluous particles, till his growth be completed. It is for this reaſon that infants are incapable of propagating. But, when man's body has nearly attained its full ſize, he requires not the ſame quantity of organic particles; the ſurplus is, therefore, ſent from all parts into reſervoirs deſtined for their reception. Theſe reſervoirs are the teſtes and ſeminal veſſels. At this very period, when the growth of the body is nearly finiſhed, puberty commences, and every phænomenon attending it diſcovers a ſuperabundance of

of nouriſhment: The voice changes into a deeper tone; the beard begins to appear, and other parts of the body are covered with hair; the parts deſtined for generation are ſuddenly expanded; the ſeminal fluid fills the reſervoirs prepared for its reception, and ſpontaneouſly eſcapes from the body during ſleep. This ſuperabundance is ſtill more evident in the female: It diſcovers itſelf by a periodic evacuation, which begins and terminates with the faculty of propagating, by a quick increaſe of the breaſts; and by a change in the ſexual parts, which ſhall be afterwards explained*.

I conceive, then, that the organic particles ſent from all parts of the body into the teſticles and ſeminal veſſels of the male, and into the ovarium of the female, compoſe the ſeminal fluid which, in either ſex, as formerly obſerved, is a kind of extract from the ſeveral parts of the body. Theſe organic particles, inſtead of uniting and forming an individual ſimilar to that in whoſe body they are contained, as happens in vegetables, and ſome imperfect animals, cannot accompliſh this end without a mixture of the fluids of both ſexes. When this mixture is made, if the organic particles of the male exceed thoſe of the female, the reſult is a male; and if thoſe of the female abound moſt, a female is generated. I mean not that the organic particles of the male or of the female could ſingly produce

* See below the Nat. Hiſt. of Man, chap. ii.

 individuals:

individuals: A concurrence or union of both is requiſite to accompliſh this end. Thoſe ſmall moving bodies, called *ſpermatic animals*, which, by the aſſiſtance of the microſcope, are ſeen in the ſeminal fluids of all male animals, are, perhaps, organized ſubſtances proceeding from the individual which contains them; but, of themſelves, they are incapable of expanſion, or of becoming animals ſimilar to thoſe in whom they exiſt. We ſhall afterwards demonſtrate, that there are ſimilar animalcules in the ſeminal fluids of females, and point out the place where this fluid is to be found.

It is probable, that theſe organic bodies are only the firſt rudiments of an animal, containing nothing but its eſſential parts. We ſhall not enter into a detail of proofs on this ſubject, but content ourſelves with remarking, that the organization of theſe pretended ſpermatic animals may be very imperfect; or rather, that they are the living organic particles mentioned above, which are common both to vegetables and to animals; or, at moſt, that they are only the firſt junction of theſe particles.

But, to return to our ſubject. It may be aſked, how is it poſſible that the ſuperfluous organic particles ſhould be detached from all parts of the body, and unite upon the mixture of the male and female fluids? Beſides, are we certain that ſuch a mixture takes place? Has it not been maintained, that the female furniſhes no fluid of this

this kind? Is it an eſtabliſhed fact, that the male fluid enters the uterus? &c.

To the firſt queſtion I reply, that, if what I had ſaid concerning the penetration of the internal mould by the organic particles, in growth and nutrition, had been properly underſtood, it would be eaſy to conceive, that, when theſe particles are unable to penetrate the parts into which they formerly entered, they muſt take another route, and, of courſe, arrive at ſome other part, as the teſticles and ſeminal veſſels. Every attempt to explain the animal œconomy, and the various motions of the human body, by mechanical principles alone, muſt be vain and ineffectual: for it is evident, that the circulation of the blood, muſcular motion, and other functions of an animated body, cannot be accounted for by impulſion, or by any of the common laws of mechaniſm. It is equally evident, that growth and reproduction are effects of laws of a different nature. Why, then, do we refuſe the exiſtence of penetrating forces which act upon the whole ſubſtances of bodies, when we have examples of ſuch powers in gravity, in magnetic attraction, in chemical affinities? Since, therefore, we are aſſured by facts, and by a number of conſtant and uniform obſervations, that there are powers in nature which act not by impulſion, why are not theſe powers ranked among mechanical principles? Why do we reject them in the explanation of effects

which they are known to produce? Why are we desirous of employing the power of compulsion only? Is not this equally absurd as to judge of painting by the touch; to explain the phænomena which belong to the mass by those that relate only to the surface; or to use one sense in place of another? It is limiting the reasoning faculty to a small number of mechanical principles, which are by no means sufficient to explain the various effects of Nature.

But, if these penetrating forces be admitted, is it not natural to imagine, that those particles which are most analogous to one another will unite in the most intimate manner; that each part of the body will appropriate those which are most agreeable to its nature; and that the whole superfluous particles will form a seminal fluid, which shall contain all the organic particles necessary for forming a small organized body, similar in every respect to that from which the fluid is extracted? May not a force similar to that which is the cause of growth, be sufficient to collect the superfluous organic particles, and bestow on them the figure of the body from which they proceed?

That our food contains an immense number of organic particles, requires no formal proof; since we are solely nourished by animals and vegetables, which are organized substances. In the stomach and intestines, the gross parts of the aliment are separated and rejected by the excretories.

tories. The chyle, which is a purer part of the aliment, is absorbed by the lacteal vessels; from thence it is carried into the mass of blood, and, in the course of circulation, it is more and more refined, the unorganic and useless particles being thrown out by transpiration and other secretions: But the organic particles are retained, because they are analogous to the blood, and are attracted by it. Hence, as the whole mass of blood passes several times through the body, during the course of this perpetual circulation, I suppose, that each particular part attracts those particles which are most analogous to it, and allows the rest to move on. In this manner all the parts are nourished and unfolded, not, as is commonly imagined, by a simple addition of matter to their surfaces, but by an intimate penetration of substance, effected by a force which acts equally upon every point of the whole mass: And, after the different parts have acquired their utmost growth, and are fully impregnated with similar organic particles, as their substance becomes then more dense and solid, I imagine that they lose their faculty of attracting and receiving the particles presented to them. But, as the particles continue to be carried round in the course of the circulation, and are no longer absorbed in such quantities as formerly, they must, of necessity, be deposited in some particular reservoir, such as the testicles and seminal vessels. When this fluid extract of the male is mixed

with that of the female, the particles which are moſt analogous to each other, being actuated by a penetrating force, unite and form a ſmall organized body, ſimilar to the one or the other ſex; and this body, when once formed, requires only an expanſion of its parts, an operation which is performed in the womb of the mother.

We ſhall now conſider the ſecond queſtion, namely, Whether the female has a ſeminal fluid ſimilar to that of the male? In the *firſt* place, though ſuch a fluid exiſts in females, the mode of emiſſion is very different from that of the male, being generally confined within the body *. The ancients were ſo confident of the exiſtence of a female fluid, that they diſtinguiſhed the two ſexes by their different modes of emiſſion. But thoſe phyſicians who attempt to explain generation by eggs, or by ſpermatic animalcules, inſiſt, that females have no peculiar fluid; that the mucus iſſuing from the parts has been miſtaken for a ſeminal fluid; and that the opinion of the ancients on this ſubject is deſtitute of foundation. This fluid, however, does exiſt; and the doubts concerning it have ariſen ſolely from attachment to ſyſtems, and from the difficulty of diſcovering its reſervoir. The fluid which is ſeparated from the glands about the neck and orifice of the uterus, has no viſible reſervoir; and, as it flows out of the body, it is natural to think that it is

* Quod intra ſe ſemen jacit, fœmina vocatur; quod in hac jacit, mas; *Ariſtot. de animalibus, art.* 18.

not

not the prolific fluid, becauſe it cannot co-operate in the formation of the fœtus, which is performed within the uterus. The reſervoir for the prolific fluid of the female, therefore, muſt be ſituated in a different part: It even flows abundantly; though, like that of the male, a ſmall quantity is ſufficient to produce a fœtus. If a little of the male fluid enters the uterus, either by its orifice or by abſorption, and meets with the ſmalleſt drop of the female fluid, it is ſufficient for the purpoſe of propagation. Thus, neither the obſervations of ſome anatomiſts, who maintain that the ſeminal fluid of the male can have no admiſſion into the uterus, nor the oppoſite opinion maintained by their antagoniſts, have any influence upon the theory we are endeavouring to eſtabliſh. But the diſcuſſion of theſe points we leave to a future opportunity.

Having obviated ſuch objections as might be made, let us attend to the evidences which concur in ſupporting our hypotheſis. The firſt ariſes from the analogy between growth and reproduction. It is impoſſible to give a ſatisfactory account of growth or expanſion, without having recourſe to thoſe penetrating forces, thoſe affinities or attractions which we employed in explaining the formation of the ſmall organic bodies, that are ſimilar to the large bodies which contain them. A ſecond analogy is derived from this circumſtance, that both nutrition and reproduction proceed, not only from the ſame efficient,

cient, but from the ſame material cauſe, namely, the organic particles of food; and what proves the ſurplus of the nutritive particles to be the cauſe of reproduction, is, that the body is not in a condition to propagate till its growth be finiſhed: Of this we have daily examples, in dogs and other animals, who follow, more cloſely than we do, the laws of Nature: They have no inclination to propagate till they have nearly attained their full growth; and by this we know whether the growth of a dog be finiſhed; for he ſeldom grows after being in a condition to generate.

Another proof that the ſeminal fluid is formed of the ſurplus of the nutritive particles, ariſes from the condition of eunuchs and other mutilated animals: In this unnatural ſtate, animals grow fatter than thoſe who retain all their parts. The ſuperabundance of nutriment, having no organs for its evacuation, changes the whole habit of their bodies. The knees and haunches of eunuchs grow uncommonly large. The reaſon is evident. After their bodies have acquired the common ſize, if the ſuperfluous organic particles found an iſſue, as in other men, the growth would proceed no farther. But, as they want organs for emitting the ſeminal fluid, which is nothing but the ſuperfluous nutritive particles, it remains in the body, and has a conſtant tendency to expand the parts beyond their natural ſize. Now, bones, it is well known, grow or extend

extend by their extremities, which are ſoft and ſpongy, and when they have once acquired ſolidity, they are incapable of farther extenſion: Hence the ſuperfluous organic particles can only enlarge the ſpongy extremities of bones; and this is the reaſon why the haunches, knees, &c. of eunuchs augment to a diſproportioned bulk.

But the ſtrongeſt proof of the truth of our preſent doctrine ariſes from the reſemblance of children to their parents. Sons, in general, reſemble their fathers more than their mothers, and daughters have a greater reſemblance to their mothers than their fathers; becauſe, with regard to the general habit of body, a man reſembles a man more than a woman, and a woman reſembles a woman more than a man. But, as to particular features or habits, children ſometimes reſemble the father, ſometimes the mother, and ſometimes both. A child, for example, will have the eyes of the father, and the mouth of the mother, or the colour of the mother, and the ſtature of the father. Of ſuch phænomena it is impoſſible to give any explication, unleſs we admit that both parents have contributed to the formation of the child, and, conſequently, that there has been a mixture of two ſeminal fluids.

Theſe reſemblances long embarraſſed me, and till I had maturely conſidered the ſubject of generation, led me into many errors and prejudices: And it was not without much thought, a minute examination

examination of a great number of families, and a multiplicity of evidence, that I could prevail on myſelf to alter my former opinion, and to embrace what I now believe to be truth. But the objections which might occur concerning mulattoes, mongrels, mules, and particular parental reſemblances, inſtead of oppoſing my theory, I deſpair not of being able to ſhow that they beſtow on it an additional ſtrength.

In youth, the ſeminal fluid is leſs copious, but more ſtimulating. Its quantity continues to augment till a certain age; becauſe, in proportion as we approach that age, the parts of the body become more ſolid, admit fewer nutritive particles, ſend back more of them to the common reſervoirs, and, of courſe, augment the quantity of the ſeminal fluid. Thus, if the external organs have not been uſed, middle-aged men, or even old men, procreate with more eaſe than young men. This is evidently the caſe with the vegetable tribes: A tree, the older it is, produces the greater quantity of fruit.

Young people, who, by forced irritations, determine an unnatural quantity of this fluid into the reſervoirs prepared for its reception, immediately ceaſe to grow, loſe their fleſh, and at laſt fall into conſumptions. The reaſon is apparent: They loſe, by premature and too frequent evacuations, the very ſubſtance which Nature intended for the nouriſhment and growth of their bodies.

Men

Men who are thin, but not emaciated, and thoſe who are plump, but not fat, are the moſt vigorous. Whenever the ſuperabundant nutritive particles begin to form fat, it is always at the expence of the ſeminal fluid and other generative powers. When the growth of the different parts of the body is complete, when the bones have acquired full ſolidity, when the cartillages begin to oſſify, and, laſtly, when the parts almoſt refuſe the admiſſion of nutritive particles, then the fat augments conſiderably, and the quantity of ſeminal fluid diminiſhes; becauſe the nutritive particles, inſtead of being ſent back to the reſervoirs, are arreſted in every part of the body.

The quantity of ſeminal fluid not only increaſes till we arrive at a certain age, but it becomes more thick. It contains, in the ſame bounds, a greater quantity of matter. Its ſpecific gravity is nearly double that of the blood; and, of courſe, it is heavier than any other animal fluid.

To a man in health, an evacuation of this fluid whets the appetite: He ſoon finds the neceſſity of repairing the loſs by freſh nouriſhment. Hence we may conclude, that abſtinence and hunger are the moſt effectual checks to luxury of every kind.

Many other remarks might be made on this ſubject, which muſt be deferred till we come to treat of the hiſtory of man: We ſhall, therefore,

conclude

conclude with a few obſervations. Moſt animals diſcover no inclination for the ſexes till their growth be nearly finiſhed: Thoſe which have but one ſeaſon in the year, have no ſeminal fluid, except at that time. Mr. Needham* not only ſaw this liquor forming in the milt of the *Calmar*, but likewiſe the ſpermatic animals, and the milt itſelf, which have no exiſtence till the month of October, when this fiſh ſpawns on the coaſts of Portugal, where Needham made the obſervation. After the ſpawning time is over, the ſeminal liquor, the ſpermatic animals, and the milt, dry up, and totally diſappear; till the ſame ſeaſon returns next year, when the ſuperfluous nutritive particles renew the milt as formerly. The hiſtory of the deer will furniſh us with an opportunity of remarking the various effects of rutting, the moſt conſpicuous of which is the extenuation of the animal; and, in thoſe ſpecies of animals whoſe rutting and ſpawning happens but once in a year, the extenuation of their bodies is proportionally great.

As women are ſmaller and weaker than men, as their conſtitutions are more delicate, and, as they take leſs food, it is natural to think that their ſuperfluous organic particles ſhould alſo be leſs abundant: Of courſe, their ſeminal fluid will be weaker and ſmaller in quantity than that of men; and, ſince the fluid of females contains fewer organic particles, muſt not a greater number of males than of females reſult from a mixture of theſe two fluids? This is really the caſe; and to account for it has hitherto been deemed impoſſible. The number of males born exceeds that of females about a ſixteenth part; and we ſhall afterwards ſee that the ſame effect is produced by the ſame cauſe in all the different ſpecies of animals.

* See Needh. new Microſcopical Diſcoveries, London 1745.