SECT. XXXIX.

OF GENERATION.

Felix, qui causas altà caligine mersas

Pandit, et evolvit tenuissima vincula rerum.

I. *Habits of acting and feeling of individuals attend the soul into a future life, and attend the new embryon at the time of its production. The new speck of entity absorbs nutriment, and receives oxygene. Spreads the terminations of its vessels on cells, which communicate with the arteries of the uterus; sometimes with those of the peritoneum. Afterwards it swallows the liquor amnii, which it produces by its irritation from the uterus, or peritoneum. Like insects in the heads of calves and sheep. Why the white of egg is of two consistencies. Why nothing is found in quadrupeds similar to the yolk, nor in most vegetable seeds.* II. 1. *Eggs of frogs and fish impregnated out of their bodies. Eggs of fowls which are not fecundated, contain only the nutriment for the embryon. The embryon is produced by the male, and the nutriment by the female. Animalcula in semine. Profusion of nature's births.* 2. *Vegetables viviparous. Buds and bulbs have each a father but no mother. Vessels of the leaf and bud inosculate. The paternal offspring exactly resembles the parent.* 3. *Insects impregnated for six generations. Polypus branches like buds. Creeping roots. Viviparous flowers. Tænia, volvox. Eve from Adam's rib. Semen not a stimulus to the egg.* III. 1. *Embryons not originally created within other embryons. Organized matter is not so minute.* 2. *All the parts of the embryon are not formed in the male parent. Crabs produce their legs, worms produce their heads and tails. In wens, cancers, and inflammations, new vessels are formed. Mules partake of the forms of both parents. Hair and nails grow by elongation, not by distention.* 3. *Organic particles of Buffon.* IV. 1. *Rudiment of the embryon a simple living filament, becomes a living ring, and then a living tube.* 2. *It acquires irritabilities, and sensibilities with new organizations, as in wounded snails, polypi, moths, gnats, tadpoles. Hence new parts are acquired by addition not by distention.* 3. *All parts of the body grow if not confined.* 4. *Fetuses deficient at their extremities, or have a duplicature of parts. Monstrous births. Double parts of vegetables.* 5. *Mules cannot be formed by distention of the seminal ens.* 6. *Families of animals from a mixture of their orders. Mules imperfect.* 7. *Animal appetency like chemical affinity. Vis fabricatrix and medicatrix of nature.* 8. *The changes of animals before and after nativity. Similarity of their structure. Changes in them from lust, hunger, and danger. All warm-blooded animals derived from one living filament. Cold-blooded animals, insects, worms, vegetables, derived also from one living filament. Male animals have teats. Male pigeon gives milk. The world itself generated. The cause of causes. A state of probation and responsibility.* V. 1. *Efficient cause of the colours of birds eggs, and of hair and feathers, which become white in snowy countries. Imagination of the female colours the egg. Ideas or motions of the retina imitated by the extremities of the nerves of touch, or rete mucosum.* 2. *Nutriment supplied by the female of three kinds. Her imagination can only affect the first kind. Mules how produced, and mulattoes. Organs of reproduction why deficient in mules. Eggs with double yolks.* VI. 1. *Various secretions produced by the extremities of the vessels, as in the glands. Contagious matter. Many glands affected by pleasurable ideas, as those which*

secrete the semen. 2. *Snails and worms are hermaphrodite, yet cannot impregnate themselves. Final cause of this.* 3. *The imagination of the male forms the sex. Ideas, or motions of the nerves of vision or of touch, are imitated by the ultimate extremities of the glands of the testes, which mark the sex. This effect of the imagination belongs only to the male. The sex of the embryon is not owing to accident.* 4. *Causes of the changes in animals from imagination as in monsters. From the male. From the female.* 5. *Miscarriages from fear.* 6. *Power of the imagination of the male over the colour, form, and sex of the progeny. An instance of.* 7. *Act of generation accompanied with ideas of the male or female form. Art of begetting beautiful children of either sex.* VII. *Recapitulation.* VIII. *Conclusion. Of cause and effect. The atomic philosophy leads to a first cause.*

I. The ingenious Dr. Hartley in his work on man, and some other philosophers, have been of opinion, that our immortal part acquires during this life certain habits of action or of sentiment, which become for ever indissoluble, continuing after death in a future state of existence; and add, that if these habits are of the malevolent kind, they must render the possessor miserable even in heaven. I would apply this ingenious idea to the generation or production of the embryon, or new animal, which partakes so much of the form and propensities of the parent.

Owing to the imperfection of language the offspring is termed a *new* animal, but is in truth a branch or elongation of the parent; since a part of the embryon-animal is, or was, a part of the parent; and therefore in strict language it cannot be said to be entirely *new* at the time of its production; and therefore it may retain some of the habits of the parent-system.

At the earliest period of its existence the embryon, as secreted from the blood of the male, would seem to consist of a living filament with certain capabilities of irritation, sensation, volition, and association; and also with some acquired habits or propensities peculiar to the parent: the former of these are in common with other animals; the latter seem to distinguish or produce the kind of animal, whether man or quadruped, with the similarity of feature or form to the parent. It is difficult to be conceived, that a living entity can be separated or produced from the blood by the action of a gland; and which shall afterwards become an animal similar to that in whose vessels it is formed; even though we should suppose with some modern theorists, that the blood is alive; yet every other hypothesis concerning generation rests on principles still more difficult to our comprehension.

At the time of procreation this speck of entity is received into an appropriated nidus, in which it must acquire two circumstances necessary to its life and growth; one of these is food or sustenance, which is to be received by the absorbent mouths of its vessels; and the other is that part of atmospherical air, or of water, which by the new chemistry is termed oxygene, and which affects the blood by passing through the coats of the vessels which contain it. The fluid surrounding the embryon in its new habitation, which is called liquor amnii, supplies it with nourishment; and as some air cannot but be introduced into the uterus along with a new embryon, it would seem that this same fluid would for a short time, suppose for a few hours, supply likewise a sufficient quantity of the oxygene for its immediate existence.

On this account the vegetable impregnation of aquatic plants is performed in the air; and it is probable that the honey-cup or nectary of vegetables requires to be open to the air, that the

anthers and stigmas of the flower may have food of a more oxygenated kind than the common vegetable sap-juice.

On the introduction of this primordium of entity into the uterus the irritation of the liquor amnii, which surrounds it, excites the absorbent mouths of the new vessels into action; they drink up a part of it, and a pleasurable sensation accompanies this new action; at the same time the chemical affinity of the oxygene acts through the vessels of the rubescent blood; and a previous want, or disagreeable sensation, is relieved by this process.

As the want of this oxygenation of the blood is perpetual, (as appears from the incessant necessity of breathing by lungs or gills,) the vessels become extended by the efforts of pain or desire to seek this necessary object of oxygenation, and to remove the disagreeable sensation, which that want occasions. At the same time new particles of matter are absorbed, or applied to these extended vessels, and they become permanently elongated, as the fluid in contact with them soon loses the oxygenous part, which it at first possessed, which was owing to the introduction of air along with the embryon. These new blood-vessels approach the sides of the uterus, and penetrate with their fine terminations into the vessels of the mother; or adhere to them, acquiring oxygene through their coats from the passing currents of the arterial blood of the mother. See Sect. XXXVIII. 2.

This attachment of the placental vessels to the internal side of the uterus by their own proper efforts appears further illustrated by the many instances of extra-uterine fetuses, which have thus attached or inserted their vessels into the peritoneum; or on the viscera, exactly in the same manner as they naturally insert or attach them to the uterus.

The absorbent vessels of the embryon continue to drink up nourishment from the fluid in which they swim, or liquor amnii; and which at first needs no previous digestive preparation; but which, when the whole apparatus of digestion becomes complete, is swallowed by the mouth into the stomach, and being mixed with saliva, gastric juice, bile, pancreatic juice, and mucus of the intestines, becomes digested, and leaves a recrement, which produces the first feces of the infant, called meconium.

The liquor amnii is secreted into the uterus, as the fetus requires it, and may probably be produced by the irritation of the fetus as an extraneous body; since a similar fluid is acquired from the peritoneum in cases of extra-uterine gestation. The young caterpillars of the gadfly placed in the skins of cows, and the young of the ichneumon-fly placed in the backs of the caterpillars on cabbages, seem to produce their nourishment by their irritating the sides of their nidus. A vegetable secretion and concretion is thus produced on oak-leaves by the gall-insect, and by the cynips in the bedeguar of the rose; and by the young grasshopper on many plants, by which the animal surrounds itself with froth. But in no circumstance is extra-uterine gestation so exactly resembled as by the eggs of a fly, which are deposited in the frontal sinus of sheep and calves. These eggs float in some ounces of fluid collected in a thin pellicle or hydatide. This bag of fluid compresses the optic nerve on one side, by which the vision being less distinct in that eye, the animal turns in perpetual circles towards the side affected, in order to get a more accurate view of objects; for the same reason as in squinting the affected eye is turned away from

the object contemplated. Sheep in the warm months keep their noses close to the ground to prevent this fly from so readily getting into their nostrils.

The liquor amnii is secreted into the womb as it is required, not only in respect to quantity, but, as the digestive powers of the fetus become formed, this fluid becomes of a different consistence and quality, till it is exchanged for milk after nativity. Haller. Physiol. V. 1. In the egg the white part, which is analogous to the liquor amnii of quadrupeds, consists of two distinct parts; one of which is more viscid, and probably more difficult of digestion, and more nutritive than the other; and this latter is used in the last week of incubation. The yolk of the egg is a still stronger or more nutritive fluid, which is drawn up into the bowels of the chick just at its exclusion from the shell, and serves it for nourishment for a day or two, till it is able to digest, and has learnt to choose the harder seeds or grains, which are to afford it sustenance. Nothing analogous to this yolk is found in the fetus of lactiferous animals, as the milk is another nutritive fluid ready prepared for the young progeny.

The yolk therefore is not necessary to the spawn of fish, the eggs of insects, or for the seeds of vegetables; as their embryons have probably their food presented to them as soon as they are excluded from their shells, or have extended their roots. Whence it happens that some insects produce a living progeny in the spring and summer, and eggs in the autumn; and some vegetables have living roots or buds produced in the place of seeds, as the polygonum viviparum, and magical onions. See Botanic Garden, p. 11. art. anthoxanthum.

There seems however to be a reservoir of nutriment prepared for some seeds besides their cotyledons or seed-leaves, which may be supposed in some measure analogous to the yolk of the egg. Such are the saccharine juices of apples, grapes and other fruits, which supply nutrition to the seeds after they fall on the ground. And such is the milky juice in the centre of the cocoa-nut, and part of the kernel of it; the same I suppose of all other monocotyledon seeds, as of the palms, grasses, and lilies.

II. 1. The process of generation is still involved in impenetrable obscurity, conjectures may nevertheless be formed concerning some of its circumstances. First, the eggs of fish and frogs are impregnated, after they leave the body of the female; because they are deposited in a fluid, and are not therefore covered with a hard shell. It is however remarkable, that neither frogs nor fish will part with their spawn without the presence of the male; on which account female carp and gold-fish in small ponds, where there are no males, frequently die from the distention of their growing spawn. 2. The eggs of fowls, which are laid without being impregnated, are seen to contain only the yolk and white, which are evidently the food or sustenance for the future chick. 3. As the cicatricula of these eggs is given by the cock, and is evidently the rudiment of the new animal; we may conclude, that the embryon is produced by the male, and the proper food and nidus by the female. For if the female be supposed to form an equal part of the embryon, why should she form the whole of the apparatus for nutriment and for oxygenation? the male in many animals is larger, stronger, and digests more food than the female, and therefore should contribute as much or more towards the reproduction of the species; but if he contributes only half the embryon and none of the apparatus for sustenance and oxygenation, the division is unequal; the strength of the male, and his consumption of food are too great for the effect, compared with that of the female, which is contrary to the usual course of nature.

In objection to this theory of generation it may be said, if the animalcula in femine, as seen by the microscope, be all of them rudiments of homunculi, when but one of them can find a nidus, what a waste nature has made of her productions? I do not assert that these moving particles, visible by the microscope, are homunciones; perhaps they may be the creatures of stagnation or putridity, or perhaps no creatures at all; but if they are supposed to be rudiments of homunculi, or embryons, such a profusion of them corresponds with the general efforts of nature to provide for the continuance of her species of animals. Every individual tree produces innumerable seeds, and every individual fish innumerable spawn, in such inconceivable abundance as would in a short space of time crowd the earth and ocean with inhabitants; and these are much more perfect animals than the animalcula in femine can be supposed to be, and perish in uncounted millions. This argument only shews, that the productions of nature are governed by general laws; and that by a wise superfluity of provision she has ensured their continuance.

2. That the embryon is secreted or produced by the male, and not by the conjunction of fluids from both male and female, appears from the analogy of vegetable seeds. In the large flowers, as the tulip, there is no similarity of apparatus between the anthers and the stigma: the seed is produced according to the observations of Spallanzani long before the flowers open, and in consequence long before it can be impregnated, like the egg in the pullet. And after the prolific dust is shed on the stigma, the seed becomes coagulated in one point first, like the cicatricula of the impregnated egg. See Botanic Garden, Part I. additional note 38. Now in these simple products of nature, if the female contributed to produce the new embryon equally with the male, there would probably have been some visible similarity of parts for this purpose, besides those necessary for the nidus and sustenance of the new progeny. Besides in many flowers the males are more numerous than the females, or than the separate uterine cells in their germs, which would shew, that the office of the male was at least as important as that of the female; whereas if the female, besides producing the egg or seed, was to produce an equal part of the embryon, the office of reproduction would be unequally divided between them.

Add to this, that in the most simple kind of vegetable reproduction, I mean the buds of trees, which are their viviparous offspring, the leaf is evidently the parent of the bud, which rises in its bosom, according to the observation of Linnaeus. This leaf consists of absorbent vessels, and pulmonary ones, to obtain its nutriment, and to impregnate it with oxygene. This simple piece of living organization is also furnished with a power of reproduction; and as the new offspring is thus supported adhering to its father, it needs no mother to supply it with a nidus, and nutriment, and oxygenation; and hence no female leaf has existence.

I conceive that the vessels between the bud and the leaf communicate or inosculate; and that the bud is thus served with vegetable blood, that is, with both nutriment and oxygenation, till the death of the parent-leaf in autumn. And in this respect it differs from the fetus of viviparous animals. Secondly, that then the bark-vessels belonging to the dead-leaf, and in which I suppose a kind of manna to have been deposited, become now the placental vessels, if they may be so called, of the new bud. From the vernal sap thus produced of one sugar-maple-tree in New-York and in Pennsylvania, five or six pounds of good sugar may be made annually without destroying the tree. Account of maple-sugar by B. Rushes. London, Phillips. (See Botanic Garden, Part I. additional note on vegetable placentation.)

These vessels, when the warmth of the vernal sun hatches the young bud, serve it with a saccharine nutriment, till it acquires leaves of its own, and shoots a new system of absorbents down the bark and root of the tree, just as the farinaceous or oily matter in seeds, and the saccharine matter in fruits, serve their embryons with nutriment, till they acquire leaves and roots. This analogy is as forceable in so obscure a subject, as it is curious, and may in large buds, as of the horse-chesnut, be almost seen by the naked eye; if with a penknife the remaining rudiment of the last year's leaf, and of the new bud in its bosom, be cut away slice by slice. The seven ribs of the last year's leaf will be seen to have arisen from the pith in seven distinct points making a curve; and the new bud to have been produced in their centre, and to have pierced the alburnum and cortex, and grown without the assistance of a mother. A similar process may be seen on dissecting a tulip-root in winter; the leaves, which inclosed the last year's flower-stalk, were not necessary for the flower; but each of these was the father of a new bud, which may be now found at its base; and which, as it adheres to the parent, required no mother.

This paternal offspring of vegetables, I mean their buds and bulbs, is attended with a very curious circumstance; and that is, that they exactly resemble their parents, as is observable in grafting fruit-trees, and in propagating flower-roots; whereas the seminal offspring of plants, being supplied with nutriment by the mother, is liable to perpetual variation. Thus also in the vegetable class dioicia, where the male flowers are produced on one tree, and the female ones on another; the buds of the male trees uniformly produce either male flowers, or other buds similar to themselves; and the buds of the female trees produce either female flowers, or other buds similar to themselves; whereas the seeds of these trees produce either male or female plants. From this analogy of the production of vegetable buds without a mother, I contend that the mother does not contribute to the formation of the living ens in animal generation, but is necessary only for supplying its nutriment and oxygenation.

There is another vegetable fact published by M. Koelreuter, which he calls "a complete metamorphosis of one natural species of plants into another," which shews, that in seeds as well as in buds, the embryon proceeds from the male parent, though the form of the subsequent mature plant is in part dependant on the female. M. Koelreuter impregnated a stigma of the nicotiana rustica with the farina of the nicotiana paniculata, and obtained prolific seeds from it. With the plants which sprung from these seeds, he repeated the experiment, impregnating them with the farina of the nicotiana paniculata. As the mule plants which he thus produced were prolific, he continued to impregnate them for many generations with the farina of the nicotiana paniculata, and they became more and more like the male parent, till he at length obtained six plants in every respect perfectly similar to the nicotiana paniculata; and in no respect resembling their female parent the nicotiana rustica. *Blumenbach* on Generation.

3. It is probable that the insects, which are said to require but one impregnation for six generations, as the aphis (see Amenit. Academ.) produce their progeny in the manner above described, that is, without a mother, and not without a father; and thus experience a lucina sine concubitu. Those who have attended to the habits of the polypus, which is found in the stagnant water of our ditches in July, affirm, that the young ones branch out from the side of the parent like the buds of trees, and after a time separate themselves from them. This is so analogous to the manner in which the buds of trees appear to be produced, that these polypi may be considered as

all male animals, producing embryons, which require no mother to supply them with a nidus, or with nutriment, and oxygenation.

This lateral or lineal generation of plants, not only obtains in the buds of trees, which continue to adhere to them, but is beautifully seen in the wires of knot-grass, polygonum aviculare, and in those of strawberries, fragaria vesca. In these an elongated creeping bud is protruded, and, where it touches the ground, takes root, and produces a new plant derived from its father, from which it acquires both nutriment and oxygenation; and in consequence needs no maternal apparatus for these purposes. In viviparous flowers, as those of allium magicum, and polygonum viviparum, the anthers and the stigmas become effete and perish; and the lateral or paternal offspring succeeds instead of seeds, which adhere till they are sufficiently mature, and then fall upon the ground, and take root like other bulbs.

The lateral production of plants by wires, while each new plant is thus chained to its parent, and continues to put forth another and another, as the wire creeps onward on the ground, is exactly resembled by the tape-worm, or tænia, so often found in the bowels, stretching itself in a chain quite from the stomach to the rectum. Linnæus asserts, "that it grows old at one extremity, while it continues to generate young ones at the other, proceeding ad infinitum, like a root of grass. The separate joints are called gourd-worms, and propagate new joints like the parent without end, each joint being furnished with its proper mouth, and organs of digestion." Systema naturæ. Vermes tenia. In this animal there evidently appears a power of reproduction without any maternal apparatus for the purpose of supplying nutriment and oxygenation to the embryon, as it remains attached to its father till its maturity. The volvox globator, which is a transparent animal, is said by Linnæus to bear within it sons and grand-sons to the fifth generation. These are probably living fetuses, produced by the father, of different degrees of maturity, to be detruded at different periods of time, like the unimpregnated eggs of various sizes, which are found in poultry; and as they are produced without any known copulation, contribute to evince, that the living embryon in other orders of animals is formed by the male-parent, and not by the mother, as one parent has the power to produce it.

This idea of the reproduction of animals from a single living filament of their fathers, appears to have been shadowed or allegorized in the curious account in sacred writ of the formation of Eve from a rib of Adam.

From all these analogies I conclude, that the embryon is produced solely by the male, and that the female supplies it with a proper nidus, with sustenance, and with oxygenation; and that the idea of the semen of the male constituting only a stimulus to the egg of the female, exciting it into life, (as held by some philosophers) has no support from experiment or analogy.

III. 1. Many ingenious philosophers have found so great difficulty in conceiving the manner of the reproduction of animals, that they have supposed all the numerous progeny, to have existed in miniature in the animal originally created; and that these infinitely minute forms are only evolved or distended, as the embryon increases in the womb. This idea, besides its being unsupported by any analogy we are acquainted with, ascribes a greater tenuity to organized matter, than we can readily admit; as these included embryons are supposed each of them to consist of the various and complicate parts of animal bodies: they must possess a much greater

degree of minuteness, than that which was ascribed to the devils that tempted St. Anthony; of whom 20,000 were said to have been able to dance a saraband on the point of the finest needle without incommoding each other.

2. Others have supposed, that all the parts of the embryon are formed in the male, previous to its being deposited in the egg or uterus; and that it is then only to have its parts evolved or distended as mentioned above; but this is only to get rid of one difficulty by proposing another equally incomprehensible: they found it difficult to conceive, how the embryon could be formed in the uterus or egg, and therefore wished it to be formed before it came thither. In answer to both these doctrines it may be observed, 1st, that some animals, as the crab-fish, can reproduce a whole limb, as a leg which has been broken off; others, as worms and snails, can reproduce a head, or a tail, when either of them has been cut away; and that hence in these animals at least a part can be formed anew, which cannot be supposed to have existed previously in miniature.

Secondly, there are new parts or new vessels produced in many diseases, as on the cornea of the eye in ophthalmy, in wens and cancers, which cannot be supposed to have had a prototype or original miniature in the embryon.

Thirdly, how could mule-animals be produced, which partake of the forms of both the parents, if the original embryon was a miniature existing in the semen of the male parent? if an embryon of the male ass was only expanded, no resemblance to the mare could exist in the mule.

This mistaken idea of the extension of parts seems to have had its rise from the mature man resembling the general form of the fetus; and from thence it was believed, that the parts of the fetus were distended into the man; whereas they have increased 100 times in weight, as well as 100 times in size; now no one will call the additional 99 parts a distention of the original one part in respect to weight. Thus the uterus during pregnancy is greatly enlarged in thickness and solidity as well as in capacity, and hence must have acquired this additional size by accretion of new parts, not by an extension of the old ones; the familiar act of blowing up the bladder of an animal recently slaughtered has led our imaginations to apply this idea of distention to the increase of size from natural growth; which however must be owing to the apposition of new parts; as it is evinced from the increase of weight along with the increase of dimension; and is even visible to our eyes in the elongation of our hair from the colour of its ends; or when it has been dyed on the head; and in the growth of our nails from the specks sometimes observable on them; and in the increase of the white crescent at their roots, and in the growth of new flesh in wounds, which consists of new nerves as well as of new blood-vessels.

3. Lastly, Mr. Buffon has with great ingenuity imagined the existence of certain organic particles, which are supposed to be partly alive, and partly mechanic springs. The latter of these were discovered by Mr. Needham in the milt or male organ of a species of cuttle fish, called calmar; the former, or living animalcula, are found in both male and female secretions, in the infusions of seeds, as of pepper, in the jelly of roasted veal, and in all other animal and vegetable substances. These organic particles he supposes to exist in the spermatic fluids of both sexes, and that they are derived thither from every part of the body, and must therefore resemble, as he supposes, the parts from whence they are derived. These organic particles he believes to be in

constant activity, till they become mixed in the womb, and then they instantly join and produce an embryon or fetus similar to the two parents.

Many objections might be adduced to this fanciful theory, I shall only mention two. First, that it is analogous to no known animal laws. And secondly, that as these fluids, replete with organic particles derived both from the male and female organs, are supposed to be similar; there is no reason why the mother should not produce a female embryon without the assistance of the male, and realize the lucina sine concubitu.

IV. 1. I conceive the primordium, or rudiment of the embryon, as secreted from the blood of the parent, to consist of a simple living filament as a muscular fibre; which I suppose to be an extremity of a nerve of loco-motion, as a fibre of the retina is an extremity of a nerve of sensation; as for instance one of the fibrils, which compose the mouth of an absorbent vessel; I suppose this living filament, of whatever form it may be, whether sphere, cube, or cylinder, to be endued with the capability of being excited into action by certain kinds of stimulus. By the stimulus of the surrounding fluid, in which it is received from the male, it may bend into a ring; and thus form the beginning of a tube. Such moving filaments, and such rings, are described by those, who have attended to microscopic animalcula. This living ring may now embrace or absorb a nutritive particle of the fluid, in which it swims; and by drawing it into its pores, or joining it by compression to its extremities, may increase its own length or crassitude; and by degrees the living ring may become a living tube.

2. With this new organization, or accretion of parts, new kinds of irritability may commence; for so long as there was but one living organ, it could only be supposed to possess irritability; since sensibility may be conceived to be an extension of the effect of irritability over the rest of the system. These new kinds of irritability and of sensibility in consequence of new organization, appear from variety of facts in the more mature animal; thus the formation of the testes, and consequent secretion of the semen, occasion the passion of lust; the lungs must be previously formed before their exertions to obtain fresh air can exist; the throat or œsophagus must be formed previous to the sensation or appetites of hunger and thirst; one of which seems to reside at the upper end, and the other at the lower end of that canal.

Thus also the glans penis, when it is distended with blood, acquires a new sensibility, and a new appetency. The same occurs to the nipples of the breasts of female animals, when they are distended with blood, they acquire the new appetency of giving milk. So inflamed tendons and membranes, and even bones, acquire new sensations; and the parts of mutilated animals, as of wounded snails, and polypi, and crabs, are reproduced; and at the same time acquire sensations adapted to their situations. Thus when the head of a snail is reproduced after decollation with a sharp rasor, those curious telescopic eyes are also reproduced, and acquire their sensibility to light, as well as their adapted muscles for retraction on the approach of injury.

With every new change, therefore, of organic form, or addition of organic parts, I suppose a new kind of irritability or of sensibility to be produced; such varieties of irritability or of sensibility exist in our adult state in the glands; every one of which is furnished with an irritability, or a taste, or appetency, and a consequent mode of action peculiar to itself.

In this manner I conceive the vessels of the jaws to produce those of the teeth, those of the fingers to produce the nails, those of the skin to produce the hair; in the same manner as afterwards about the age of puberty the beard and other great changes in the form of the body, and disposition of the mind, are produced in consequence of the new secretion of semen; for if the animal is deprived of this secretion those changes do not take place. These changes I conceive to be formed not by elongation or distention of primeval stamina, but by apposition of parts; as the mature crab-fish, when deprived of a limb, in a certain space of time has power to regenerate it; and the tadpole puts forth its feet long after its exclusion from the spawn; and the caterpillar in changing into a butterfly acquires a new form, with new powers, new sensations, and new desires.

The natural history of butterflies, and moths, and beetles, and gnats, is full of curiosity; some of them pass many months, and others even years, in their caterpillar or grub state; they then rest many weeks without food, suspended in the air, buried in the earth, or submersed in water; and change themselves during this time into an animal apparently of a different nature; the stomachs of some of them, which before digested vegetable leaves or roots, now only digest honey; they have acquired wings for the purpose of seeking this new food, and a long proboscis to collect it from flowers, and I suppose a sense of smell to detect the secret places in flowers, where it is formed. The moths, which fly by night, have a much longer proboscis rolled up under their chins like a watch spring; which they extend to collect the honey from flowers in their sleeping state; when they are closed, and the nectaries in consequence more difficult to be plundered. The beetle kind are furnished with an external covering of a hard material to their wings, that they may occasionally again make holes in the earth, in which they passed the former state of their existence.

But what most of all distinguishes these new animals is, that they are new furnished with the powers of reproduction; and that they now differ from each other in sex, which does not appear in their caterpillar or grub state. In some of them the change from a caterpillar into a butterfly or moth seems to be accomplished for the sole purpose of their propagation; since they immediately die after this is finished, and take no food in the interim, as the silk-worm in this climate; though it is possible, it might take honey as food, if it was presented to it. For in general it would seem, that food of a more stimulating kind, the honey of vegetables instead of their leaves, was necessary for the purpose of the seminal reproduction of these animals, exactly similar to what happens in vegetables; in these the juices of the earth are sufficient for their purpose of reproduction by buds or bulbs; in which the new plant seems to be formed by irritative motions, like the growth of their other parts, as their leaves or roots; but for the purpose of seminal or amatorial reproduction, where sensation is required, a more stimulating food becomes necessary for the anther, and stigma; and this food is honey; as explained in Sect. XIII. on Vegetable Animation.

The gnat and the tadpole resemble each other in their change from natant animals with gills into aerial animals with lungs; and in their change of the element in which they live; and probably of the food, with which they are supported; and lastly, with their acquiring in their new state the difference of sex, and the organs of seminal or amatorial reproduction. While the polypus, who is their companion in their former state of life, not being allowed to change his form and element, can only propagate like vegetable buds by the same kind of irritative motions, which produces

the growth of his own body, without the seminal or amatorial propagation, which requires sensation; and which in gnats and tadpoles seems to require a change both of food and of respiration.

From hence I conclude, that with the acquisition of new parts, new sensations, and new desires, as well as new powers, are produced; and this by accretion to the old ones, and not by distention of them. And finally, that the most essential parts of the system, as the brain for the purpose of distributing the power of life, and the placenta for the purpose of oxygenating the blood, and the additional absorbent vessels for the purpose of acquiring aliment, are first formed by the irritations above mentioned, and by the pleasurable sensations attending those irritations, and by the exertions in consequence of painful sensations, similar to those of hunger and suffocation. After these an apparatus of limbs for future uses, or for the purpose of moving the body in its present natant state, and of lungs for future respiration, and of testes for future reproduction, are formed by the irritations and sensations, and consequent exertions of the parts previously existing, and to which the new parts are to be attached.

3. In confirmation of these ideas it may be observed, that all the parts of the body endeavour to grow, or to make additional parts to themselves throughout our lives; but are restrained by the parts immediately containing them; thus, if the skin be taken away, the fleshy parts beneath soon shoot out new granulations, called by the vulgar proud flesh. If the periosteum be removed, a similar growth commences from the bone. Now in the case of the imperfect embryon, the containing or confining parts are not yet supposed to be formed, and hence there is nothing to restrain its growth.

4. By the parts of the embryon being thus produced by new apportions, many phenomena both of animal and vegetable productions receive an easier explanation; such as that many fetuses are deficient at the extremities, as in a finger or a toe, or in the end of the tongue, or in what is called a hare-lip with deficiency of the palate. For if there should be a deficiency in the quantity of the first nutritive particles laid up in the egg for the reception of the first living filament, the extreme parts, as being last formed, must shew this deficiency by their being imperfect.

This idea of the growth of the embryon accords also with the production of some monstrous births, which consist of a duplicature of the limbs, as chickens with four legs; which could not occur, if the fetus was formed by the distention of an original stamen, or miniature. For if there should be a superfluity of the first nutritive particles laid up in the egg for the first living filament; it is easy to conceive, that a duplicature of some parts may be formed. And that such superfluous nourishment sometimes exists, is evinced by the double yolks in some eggs, which I suppose were thus formed previous to their impregnation by the exuberant nutriment of the hen.

This idea is confirmed by the analogy of the monsters in the vegetable world also; in which a duplicate or triplicate production of various parts of the flower is observable, as a triple nectary in some columbines, and a triple petal in some primroses; and which are supposed to be produced by abundant nourishment.

5. If the embryon be received into a fluid, whose stimulus is different in some degree from the natural, as in the production of mule-animals, the new irritabilities or sensibilities acquired by the

increasing or growing organized parts may differ, and thence produce parts not similar to the father, but of a kind belonging in part to the mother; and thus, though the original stamen or living ens was derived totally from the father, yet new irritabilities or sensibilities being excited, a change of form corresponding with them will be produced. Nor could the production of mules exist, if the stamen or miniature of all the parts of the embryon is previously formed in the male semen, and is only distended by nourishment in the female uterus. Whereas this difficulty ceases, if the embryon be supposed to consist of a living filament, which acquires or makes new parts with new irritabilities, as it advances in its growth.

The form, solidity, and colour, of the particles of nutriment laid up for the reception of the first living filament, as well as their peculiar kind of stimulus, may contribute to produce a difference in the form, solidity, and colour of the fetus, so as to resemble the mother, as it advances in life. This also may especially happen during the first state of the existence of the embryon, before it has acquired organs, which can change these first nutritive particles, as explained in No. 5. 2. of this Section. And as these nutritive particles are supposed to be similar to those, which are formed for her own nutrition, it follows that the fetus should so far resemble the mother.

This explains, why hereditary diseases may be derived either from the male or female parent, as well as the peculiar form of either of their bodies. Some of these hereditary diseases are simply owing to a deficient activity of a part of the system, as of the absorbent vessels, which open into the cells or cavities of the body, and thus occasion dropsies. Others are at the same time owing to an increase of sensation, as in scrophula and consumption; in these the obstruction of the fluids is first caused by the inirritability of the vessels, and the inflammation and ulcers which succeed, are caused by the consequent increase of sensation in the obstructed part. Other hereditary diseases, as the epilepsy, and other convulsions, consist in too great voluntary exertions in consequence of disagreeable sensation in some particular diseased part. Now as the pains, which occasion these convulsions, are owing to defect of the action of the diseased part, as shewn in Sect. XXXIV. it is plain, that all these hereditary diseases may have their origin either from defective irritability derived from the father, or from deficiency of the stimulus of the nutriment derived from the mother. In either case the effect would be similar; as a scrophulous race is frequently produced among the poor from the deficient stimulus of bad diet, or of hunger; and among the rich, by a deficient irritability from their having been long accustomed to too great stimulus, as of vinous spirit.

6. From this account of reproduction it appears, that all animals have a similar origin, viz. from a single living filament; and that the difference of their forms and qualities has arisen only from the different irritabilities and sensibilities, or voluntarities, or associabilities, of this original living filament; and perhaps in some degree from the different forms of the particles of the fluids, by which it has been at first stimulated into activity. And that from hence, as Linnæus has conjectured in respect to the vegetable world, it is not impossible, but the great variety of species of animals, which now tenant the earth, may have had their origin from the mixture of a few natural orders. And that those animal and vegetable mules, which could continue their species, have done so, and constitute the numerous families of animals and vegetables which now exist; and that those mules, which were produced with imperfect organs of generation, perished without reproduction, according to the observation of Aristotle; and are the animals, which we now call mules. See Botanic Garden, Part II. Note on Dianthus.

Such a promiscuous intercourse of animals is said to exist at this day in New South Wales by Captain Hunter. And that not only amongst the quadrupeds and birds of different kinds, but even amongst the fish, and, as he believes, amongst the vegetables. He speaks of an animal between the opossum and the kangaroo, from the size of a sheep to that of a rat. Many fish seemed to partake of the shark; some with a shark's head and shoulders, and the hind part of a shark; others with a shark's head and the body of a mullet; and some with a shark's head and the flat body of a sting-ray. Many birds partake of the parrot; some have the head, neck, and bill of a parrot, with long straight feet and legs; others with legs and feet of a parrot, with head and neck of a sea gull. Voyage to South Wales by Captain John Hunter, p. 68.

7. All animals therefore, I contend, have a similar cause of their organization, originating from a single living filament, endued indeed with different kinds of irritabilities and sensibilities, or of animal appetencies; which exist in every gland, and in every moving organ of the body, and are as essential to living organization as chemical affinities are to certain combinations of inanimate matter.

If I might be indulged to make a simile in a philosophical work, I should say, that the animal appetencies are not only perhaps less numerous originally than the chemical affinities; but that like these latter, they change with every new combination; thus vital air and azote, when combined, produce nitrous acid; which now acquires the property of dissolving silver; so with every new additional part to the embryon, as of the throat or lungs, I suppose a new animal appetency to be produced.

In this early formation of the embryon from the irritabilities, sensibilities, and associabilities, and consequent appetencies, the faculty of volition can scarcely be supposed to have had its birth. For about what can the fetus deliberate, when it has no choice of objects? But in the more advanced state of the fetus, it evidently possesses volition; as it frequently changes its attitude, though it seems to sleep the greatest part of its time; and afterwards the power of volition contributes to change or alter many parts of the body during its growth to manhood, by our early modes of exertion in the various departments of life. All these faculties then constitute the vis fabricatrix, and the vis conservatrix, as well as the vis medicatrix of nature, so much spoken of, but so little understood by philosophers.

8. When we revolve in our minds, first, the great changes, which we see naturally produced in animals after their nativity, as in the production of the butterfly with painted wings from the crawling caterpillar; or of the respiring frog from the subnatant tadpole; from the feminine boy to the bearded man, and from the infant girl to the lactescent woman; both which changes may be prevented by certain mutilations of the glands necessary to reproduction.

Secondly, when we think over the great changes introduced into various animals by artificial or accidental cultivation, as in horses, which we have exercised for the different purposes of strength or swiftness, in carrying burthens or in running races; or in dogs, which have been cultivated for strength and courage, as the bull-dog; or for acuteness of his sense or smell, as the hound and spaniel; or for the swiftness of his foot, as the greyhound; or for his swimming in the water, or for drawing snow-sledges, as the rough-haired dogs of the north; or lastly, as a play-dog for children, as the lap-dog; with the changes of the forms of the cattle, which have been

domesticated from the greatest antiquity, as camels, and sheep; which have undergone so total a transformation, that we are now ignorant from what species of wild animals they had their origin. Add to these the great changes of shape and colour, which we daily see produced in smaller animals from our domestication of them, as rabbits, or pigeons; or from the difference of climates and even of seasons; thus the sheep of warm climates are covered with hair instead of wool; and the hares and partridges of the latitudes, which are long buried in snow, become white during the winter months; add to these the various changes produced in the forms of mankind, by their early modes of exertion; or by the diseases occasioned by their habits of life; both of which became hereditary, and that through many generations. Those who labour at the anvil, the oar, or the loom, as well as those who carry sedan-chairs, or who have been educated to dance upon the rope, are distinguishable by the shape of their limbs; and the diseases occasioned by intoxication deform the countenance with leprous eruptions, or the body with tumid viscera, or the joints with knots and distortions.

Thirdly, when we enumerate the great changes produced in the species of animals before their nativity; these are such as resemble the form or colour of their parents, which have been altered by the cultivation or accidents above related, and are thus continued to their posterity. Or they are changes produced by the mixture of species as in mules; or changes produced probably by the exuberance of nourishment supplied to the fetus, as in monstrous births with additional limbs; many of these enormities of shape are propagated, and continued as a variety at least, if not as a new species of animal. I have seen a breed of cats with an additional claw on every foot; of poultry also with an additional claw, and with wings to their feet; and of others without rumps. Mr. Buffon mentions a breed of dogs without tails, which are common at Rome and at Naples, which he supposes to have been produced by a custom long established of cutting their tails close off. There are many kinds of pigeons, admired for their peculiarities, which are monsters thus produced and propagated. And to these must be added, the changes produced by the imagination of the male parent, as will be treated of more at large in No. VI. of this Section.

When we consider all these changes of animal form, and innumerable others, which may be collected from the books of natural history; we cannot but be convinced, that the fetus or embryon is formed by apposition of new parts, and not by the distention of a primordial nest of germs, included one within another, like the cups of a conjurer.

Fourthly, when we revolve in our minds the great similarity of structure, which obtains in all the warm-blooded animals, as well quadrupeds, birds, and amphibious animals, as in mankind; from the mouse and bat to the elephant and whale; one is led to conclude, that they have alike been produced from a similar living filament. In some this filament in its advance to maturity has acquired hands and fingers, with a fine sense of touch, as in mankind. In others it has acquired claws or talons, as in tygers and eagles. In others, toes with an intervening web, or membrane, as in seals and geese. In others it has acquired cloven hoofs, as in cows and swine; and whole hoofs in others, as in the horse. While in the bird kind this original living filament has put forth wings instead of arms or legs, and feathers instead of hair. In some it has protruded horns on the forehead instead of teeth in the fore part of the upper jaw; in others tushes instead of horns; and in others beaks instead of either. And all this exactly as is daily seen in the transmutations of the tadpole, which acquires legs and lungs, when he wants them; and loses his tail, when it is no longer of service to him.

Fifthly, from their first rudiment, or primordium, to the termination of their lives, all animals undergo perpetual transformations; which are in part produced by their own exertions in consequence of their desires and aversions, of their pleasures and their pains, or of irritations, or of associations; and many of these acquired forms or propensities are transmitted to their posterity. See Sect. XXXI. 1.

As air and water are supplied to animals in sufficient profusion, the three great objects of desire, which have changed the forms of many animals by their exertions to gratify them, are those of lust, hunger, and security. A great want of one part of the animal world has consisted in the desire of the exclusive possession of the females; and these have acquired weapons to combat each other for this purpose, as the very thick, shield-like, horny skin on the shoulder of the boar is a defence only against animals of his own species, who strike obliquely upwards, nor are his tushes for other purposes, except to defend himself, as he is not naturally a carnivorous animal. So the horns of the stag are sharp to offend his adversary, but are branched for the purpose of parrying or receiving the thrusts of horns similar to his own, and have therefore been formed for the purpose of combating other stags for the exclusive possession of the females; who are observed, like the ladies in the times of chivalry, to attend the car of the victor.

The birds, which do not carry food to their young, and do not therefore marry, are armed with spurs for the purpose of fighting for the exclusive possession of the females, as cocks and quails. It is certain that these weapons are not provided for their defence against other adversaries, because the females of these species are without this armour. The final cause of this contest amongst the males seems to be, that the strongest and most active animal should propagate the species, which should thence become improved.

Another great want consists in the means of procuring food, which has diversified the forms of all species of animals. Thus the nose of the swine has become hard for the purpose of turning up the soil in search of insects and of roots. The trunk of the elephant is an elongation of the nose for the purpose of pulling down the branches of trees for his food, and for taking up water without bending his knees. Beasts of prey have acquired strong jaws or talons. Cattle have acquired a rough tongue and a rough palate to pull off the blades of grass, as cows and sheep. Some birds have acquired harder beaks to crack nuts, as the parrot. Others have acquired beaks adapted to break the harder seeds, as sparrows. Others for the softer seeds of flowers, or the buds of trees, as the finches. Other birds have acquired long beaks to penetrate the moister soils in search of insects or roots, as woodcocks; and others broad ones to filtrate the water of lakes, and to retain aquatic insects. All which seem to have been gradually produced during many generations by the perpetual endeavour of the creatures to supply the want of food, and to have been delivered to their posterity with constant improvement of them for the purposes required.

The third great want amongst animals is that of security, which seems much to have diversified the forms of their bodies and the colour of them; these consist in the means of escaping other animals more powerful than themselves. Hence some animals have acquired wings instead of legs, as the smaller birds, for the purpose of escape. Others great length of fin, or of membrane, as the flying fish, and the bat. Others great swiftness of foot, as the hare. Others have acquired hard or armed shells, as the tortoise and the echinus marinus.

Mr. Osbeck, a pupil of Linnæus, mentions the American frog fish, Lophius Histrio, which inhabits the large floating islands of sea-weed about the Cape of Good Hope, and has fulcra resembling leaves, that the fishes of prey may mistake it for the sea-weed, which it inhabits. Voyage to China, p. 113.

The contrivances for the purposes of security extend even to vegetables, as is seen in the wonderful and various means of their concealing or defending their honey from insects, and their seeds from birds. On the other hand swiftness of wing has been acquired by hawks and swallows to pursue their prey; and a proboscis of admirable structure has been acquired by the bee, the moth, and the humming bird, for the purpose of plundering the nectaries of flowers. All which seem to have been formed by the original living filament, excited into action by the necessities of the creatures, which possess them, and on which their existence depends.

From thus meditating on the great similarity of the structure of the warm-blooded animals, and at the same time of the great changes they undergo both before and after their nativity; and by considering in how minute a portion of time many of the changes of animals above described have been produced; would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!

Sixthly, The cold-blooded animals, as the fish-tribes, which are furnished with but one ventricle of the heart, and with gills instead of lungs, and with fins instead of feet or wings, bear a great similarity to each other; but they differ, nevertheless, so much in their general structure from the warm-blooded animals, that it may not seem probable at first view, that the same living filament could have given origin to this kingdom of animals, as to the former. Yet are there some creatures, which unite or partake of both these orders of animation, as the whales and seals; and more particularly the frog, who changes from an aquatic animal furnished with gills to an aerial one furnished with lungs.

The numerous tribes of insects without wings, from the spider to the scorpion, from the flea to the lobster; or with wings, from the gnat and the ant to the wasp and the dragon-fly, differ so totally from each other, and from the red-blooded classes above described, both in the forms of their bodies, and their modes of life; besides the organ of sense, which they seem to possess in their antennæ or horns, to which it has been thought by some naturalists, that other creatures have nothing similar; that it can scarcely be supposed that this nation of animals could have been produced by the same kind of living filament, as the red-blooded classes above mentioned. And yet the changes which many of them undergo in their early state to that of their maturity, are as different, as one animal can be from another. As those of the gnat, which passes his early state in water, and then stretching out his new wings, and expanding his new lungs, rises in the air; as of the caterpillar, and bee-nymph, which feed on vegetable leaves or farina, and at length bursting

from their self-formed graves, become beautiful winged inhabitants of the skies, journeying from flower to flower, and nourished by the ambrosial food of honey.

There is still another class of animals, which are termed vermes by Linnæus, which are without feet, or brain, and are hermaphrodites, as worms, leeches, snails, shell-fish, coralline insects, and sponges; which possess the simplest structure of all animals, and appear totally different from those already described. The simplicity of their structure, however, can afford no argument against their having been produced from a living filament as above contended.

Last of all the various tribes of vegetables are to be enumerated amongst the inferior orders of animals. Of these the anthers and stigmas have already been shewn to possess some organs of sense, to be nourished by honey, and to have the power of generation like insects, and have thence been announced amongst the animal kingdom in Sect. XIII. and to these must be added the buds and bulbs which constitute the viviparous offspring of vegetation. The former I suppose to be beholden to a single living filament for their seminal or amatorial procreation; and the latter to the same cause for their lateral or branching generation, which they possess in common with the polypus, tænia, and volvox; and the simplicity of which is an argument in favour of the similarity of its cause.

Linnæus supposes, in the Introduction to his Natural Orders, that very few vegetables were at first created, and that their numbers were increased by their intermarriages, and adds, suadent hæc Creatoris leges a simplicibus ad composita. Many other changes seem to have arisen in them by their perpetual contest for light and air above ground, and for food or moisture beneath the soil. As noted in Botanic Garden, Part II. Note on Cuscuta. Other changes of vegetables from climate, or other causes, are remarked in the Note on Curcuma in the same work. From these one might be led to imagine, that each plant at first consisted of a single bulb or flower to each root, as the gentianella and daisy; and that in the contest for air and light new buds grew on the old decaying flower stem, shooting down their elongated roots to the ground, and that in process of ages tall trees were thus formed, and an individual bulb became a swarm of vegetables. Other plants, which in this contest for light and air were too slender to rise by their own strength, learned by degrees to adhere to their neighbours, either by putting forth roots like the ivy, or by tendrils like the vine, or by spiral contortions like the honeysuckle; or by growing upon them like the misleto, and taking nourishment from their barks; or by only lodging or adhering on them, and deriving nourishment from the air, as tillandsia.

Shall we then say that the vegetable living filament was originally different from that of each tribe of animals above described? And that the productive living filament of each of those tribes was different originally from the other? Or, as the earth and ocean were probably peopled with vegetable productions long before the existence of animals; and many families of these animals long before other families of them, shall we conjecture that one and the same kind of living filaments is and has been the cause of all organic life?

This idea of the gradual formation and improvement of the animal world accords with the observations of some modern philosophers, who have supposed that the continent of America has been raised out of the ocean at a later period of time than the other three quarters of the globe, which they deduce from the greater comparative heights of its mountains, and the

consequent greater coldness of its respective climates, and from the less size and strength of its animals, as the tygers and allegators compared with those of Asia or Africa. And lastly, from the less progress in the improvements of the mind of its inhabitants in respect to voluntary exertions.

This idea of the gradual formation and improvement of the animal world seems not to have been unknown to the ancient philosophers. Plato having probably observed the reciprocal generation of inferior animals, as snails and worms, was of opinion, that mankind with all other animals were originally hermaphrodites during the infancy of the world, and were in process of time separated into male and female. The breasts and teats of all male quadrupeds, to which no use can be now assigned, adds perhaps some shadow of probability to this opinion. Linnæus excepts the horse from the male quadrupeds, who have teats; which might have shewn the earlier origin of his exigence; but Mr. J. Hunter asserts, that he has discovered the vestiges of them on his sheath, and has at the same time enriched natural history with a very curious fact concerning the male pigeon; at the time of hatching the eggs both the male and female pigeon undergo a great change in their crops; which thicken and become corrugated, and secrete a kind of milky fluid, which coagulates, and with which alone they for a few days feed their young, and afterwards feed them with this coagulated fluid mixed with other food. How this resembles the breasts of female quadrupeds after the production of their young! and how extraordinary, that the male should at this time give milk as well as the female! See Botanic Garden, Part II. Note on Curcuma.

The late Mr. David Hume, in his posthumous works, places the powers of generation much above those of our boasted reason; and adds, that reason can only make a machine, as a clock or a ship, but the power of generation makes the maker of the machine; and probably from having observed, that the greatest part of the earth has been formed out of organic recrements; as the immense beds of limestone, chalk, marble, from the shells of fish; and the extensive provinces of clay, sandstone, ironstone, coals, from decomposed vegetables; all which have been first produced by generation, or by the secretions of organic life; he concludes that the world itself might have been generated, rather than created; that is, it might have been gradually produced from very small beginnings, increasing by the activity of its inherent principles, rather than by a sudden evolution of the whole by the Almighty fire.—What a magnificent idea of the infinite power of THE GREAT ARCHITECT! THE CAUSE OF CAUSES! PARENT OF PARENTS! ENS ENTIUM!

For if we may compare infinities, it would seem to require a greater infinity of power to cause the causes of effects, than to cause the effects themselves. This idea is analogous to the improving excellence observable in every part of the creation; such as in the progressive increase of the solid or habitable parts of the earth from water; and in the progressive increase of the wisdom and happiness of its inhabitants; and is consonant to the idea of our present situation being a state of probation, which by our exertions we may improve, and are consequently responsible for our actions.

V. 1. The efficient cause of the various colours of the eggs of birds, and of the air and feathers of animals, is a subject so curious, that I shall beg to introduce it in this place. The colours of many animals seem adapted to their purposes of concealing themselves either to avoid danger, or to spring upon their prey. Thus the snake and wild cat, and leopard, are so coloured as to resemble

dark leaves and their lighter interstices; birds resemble the colour of the brown ground, or the green hedges, which they frequent; and moths and butterflies are coloured like the flowers which they rob of their honey. Many instances are mentioned of this kind in Botanic Garden, p. 2. Note on Rubia.

These colours have, however, in some instances another use, as the black diverging area from the eyes of the swan; which, as his eyes are placed less prominent than those of other birds, for the convenience of putting down his head under water, prevents the rays of light from being reflected into his eye, and thus dazzling his sight, both in air and beneath the water; which must have happened, if that surface had been white like the rest of his feathers.

There is a still more wonderful thing concerning these colours adapted to the purpose of concealment; which is, that the eggs of birds are so coloured as to resemble the colour of the adjacent objects and their interfaces. The eggs of hedge-birds are greenish with dark spots; those of crows and magpies, which are seen from beneath through wicker nests, are white with dark spots; and those of larks and partridges are russet or brown, like their nests or situations.

A thing still more astonishing is, that many animals in countries covered with snow become white in winter, and are said to change their colour again in the warmer months, as bears, hares, and partridges. Our domesticated animals lose their natural colours, and break into great variety, as horses, dogs, pigeons. The final cause of these colours is easily understood, as they serve some purposes of the animal, but the efficient cause would seem almost beyond conjecture.

First, the choroid coat of the eye, on which the semitransparent retina is expanded, is of different colour in different animals; in those which feed on grass it is green; from hence there would appear some connexion between the colour of the choroid coat and of that constantly painted on the retina by the green grass. Now, when the ground becomes covered with snow, it would seem, that that action of the retina, which is called whiteness, being constantly excited in the eye, may be gradually imitated by the extremities of the nerves of touch, or rete mucosum of the skin. And if it be supposed, that the action of the retina in producing the perception of any colour consists in so disposing its own fibres or surface, as to reflect those coloured rays only, and transmit the others like soap-bubbles; then that part of the retina, which gives us the perception of snow, must at that time be white; and that which gives us the perception of grass, must be green.

Then if by the laws of imitation, as explained in Section XII. 3. 3. and XXXIX. 6. the extremities of the nerves of touch in the rete mucosum be induced into similar action, the skin or feathers, or hair, may in like manner so dispose their extreme fibres, as to reflect white; for it is evident, that all these parts were originally obedient to irritative motions during their growth, and probably continue to be so; that those irritative motions are not liable in a healthy state to be succeeded by sensation; which however is no uncommon thing in their diseased state, or in their infant state, as in plica polonica, and in very young pen-feathers, which are still full of blood.

It was shewn in Section XV. on the Production of Ideas, that the moving organ of sense in some circumstances resembled the object which produced that motion. Hence it may be conceived, that the rete mucosum, which is the extremity of the nerves of touch, may by imitating the motions of the retina become coloured. And thus, like the fable of the camelion, all animals may

possess a tendency to be coloured somewhat like the colours they most frequently inspect, and finally, that colours may be thus given to the egg-shell by the imagination of the female parent; which shell is previously a mucous membrane, indued with irritability, without which it could not circulate its fluids, and increase in its bulk. Nor is this more wonderful than that a single idea of imagination mould in an instant colour the whole surface of the body of a bright scarlet, as in the blush of shame, though by a very different process. In this intricate subject nothing but loose analogical conjectures can be had, which may however lead to future discoveries; but certain it is that both the change of the colour of animals to white in the winters of snowy countries, and the spots on birds eggs, must have some efficient cause; since the uniformity of their production shews it cannot arise from a fortuitous concurrence of circumstances; and how is this efficient cause to be detected, or explained, but from its analogy to other animal facts?

2. The nutriment supplied by the female parent in viviparous animals to their young progeny may be divided into three kinds, corresponding with the age of the new creature. 1. The nutriment contained in the ovum as previously prepared for the embryon in the ovary. 2. The liquor amnii prepared for the fetus in the uterus, and in which it swims; and lastly, the milk prepared in the pectoral glands for the new born-child. There is reason to conclude that variety of changes may be produced in the new animal from all these sources of nutriment, but particularly from the first of them..

The organs of digestion and of sanguification in adults, and afterwards those of secretion, prepare or separate the particles proper for nourishment from other combinations of matter, or recombine them into new kinds of matter, proper to excite into action the filaments, which absorb or attract them by animal appetency. In this process we must attend not only to the action of the living filament which receives a nutritive particle to its bosom, but also to the kind of particle, in respect to form, or size, or colour, or hardness, which is thus previously prepared for it by digestion, sanguification, and secretion. Now as the first filament of entity cannot be furnished with the preparative organs above mentioned, the nutritive particles, which are at first to be received by it, are prepared by the mother; and deposited in the ovum ready for its reception. These nutritive particles must be supposed to differ in some respects, when thus prepared by different animals. They may differ in size, solidity, colour, and form; and yet may be sufficiently congenial to the living filament, to which they are applied, as to excite its activity by their stimulus, and its animal appetency to receive them, and to combine them with itself into organization.

By this first nutriment thus prepared for the embryon is not meant the liquor amnii, which is produced afterwards, nor the larger exterior parts of the white of the egg; but the fluid prepared, I suppose, in the ovary of viviparous animals, and that which immediately surrounds the cicatricula of an impregnated egg, and is visible to the eye in a boiled one.

Now these ultimate particles of animal matter prepared by the glands of the mother may be supposed to resemble the similar ultimate particles, which were prepared for her own nourishment; that is, to the ultimate particles of which her own organization consists. And that hence when these become combined with a new embryon, which in its early state is not furnished with stomach, or glands, to alter them; that new embryon will bear some resemblance to the mother.

This seems to be the origin of the compound forms of mules, which evidently partake of both parents, but principally of the male parent. In this production of chimeras the antients seem to have indulged their fancies, whence the sphinxes, griffins, dragons, centaurs, and minotaurs, which are vanished from modern credulity.

It would seem, that in these unnatural conjunctions, when the nutriment deposited by the female was so ill adapted to stimulate the living filament derived from the male into action, and to be received; or embraced by it, and combined with it into organization, as not to produce the organs necessary to life, as the brain, or heart, or stomach, that no mule was produced. Where all the parts necessary to life in these compound animals were formed sufficiently perfect, except the parts of generation, those animals were produced which are now called mules.

The formation of the organs of sexual generation, in contradistinction to that by lateral buds, in vegetables, and in some animals, as the polypus, the tænia, and the volvox, seems the chef d'œuvre, the master-piece of nature; as appears from many flying insects, as in moths and butterflies, who seem to undergo a general change of their forms solely for the purpose of sexual reproduction, and in all other animals this organ is not complete till the maturity of the creature. Whence it happens that, in the copulation of animals of different species, the parts necessary to life are frequently completely formed; but those for the purpose of generation are defective, as requiring a nicer organization; or more exact coincidence of the particles of nutriment to the irritabilities or appetencies of the original living filament. Whereas those mules, where all the parts could be perfectly formed, may have been produced in early periods of time, and may have added to the numbers of our various species of animals, as before observed.

As this production of mules is a constant effect from the conjunction of different species of animals, those between the horse and the female ass always resembling the horse more than the ass; and those, on the contrary, between the male ass and the mare, always resembling the ass more than the mare; it cannot be ascribed to the imagination of the male animal which cannot be supposed to operate so uniformly; but to the form of the first nutritive particles, and to their peculiar stimulus exciting the living filament to select and combine them with itself. There is a similar uniformity of effect in respect to the colour of the progeny produced between a white man, and a black woman, which, if I am well informed, is always of the mulatto kind, or a mixture of the two; which may perhaps be imputed to the peculiar form of the particles of nutriment supplied to the embryon by the mother at the early period of its existence, and their peculiar stimulus; as this effect, like that of the mule progeny above treated of, is uniform and consistent, and cannot therefore be ascribed to the imagination of either of the parents.

Dr. Thunberg observes, in his Journey to the Cape of Good Hope, that there are some families, which have descended from blacks in the female line for three generations. The first generation proceeding from an European, who married a tawny slave, remains tawny, but approaches to a white complexion; but the children of the third generation, mixed with Europeans, become quite white, and are often remarkably beautiful. V. i. p. 112.

When the embryon has produced a placenta, and furnished itself with vessels for selection of nutritious particles, and for oxygenation of them, no great change in its form or colour is likely to be produced by the particles of sustenance it now takes from the fluid, in which it is immersed;

because it has now acquired organs to alter or new combine them. Hence it continues to grow, whether this fluid, in which it swims, be formed by the uterus or by any other cavity of the body, as in extra-uterine gestation; and which would seem to be produced by the stimulus of the fetus on the sides of the cavity, where it is found, as mentioned before. And thirdly, there is still less reason to expect any unnatural change to happen to the child after its birth from the difference of the milk it now takes; because it has acquired a stomach, and lungs, and glands, of sufficient power to decompose and recombine the milk; and thus to prepare from it the various kinds of nutritious particles, which the appetencies of the various fibrils or nerves may require.

From all this reasoning I would conclude, that though the imagination of the female may be supposed to affect the embryon by producing a difference in its early nutriment; yet that no such power can affect it after it has obtained a placenta, and other organs; which may select or change the food, which is presented to it either in the liquor amnii, or in the milk. Now as the eggs in pullets, like the seeds in vegetables, are produced gradually, long before they are impregnated, it does not appear how any sudden effect of imagination of the mother at the time of impregnation can produce any considerable change in the nutriment already thus laid up for the expected or desired embryon. And that hence any changes of the embryon, except those uniform ones in the production of mules and mulattoes, more probably depend on the imagination of the male parent. At the same time it seems manifest, that those monstrous births, which consist in some deficiencies only, or some redundancies of parts, originate from the deficiency or redundance of the first nutriment prepared in the ovary, or in the part of the egg immediately surrounding the cicatricula, as described above; and which continues some time to excite the first living filament into action, after the simple animal is completed; or ceases to excite it, before the complete form is accomplished. The former of these circumstances is evinced by the eggs with double yolks, which frequently happen to our domesticated poultry, and which, I believe, are so formed before impregnation, but which would be well worth attending to, both before and after impregnation; as it is probable, something valuable on this subject might be learnt from them. The latter circumstance, or that of deficiency of original nutriment, may be deduced from reverse analogy.

There are, however, other kinds of monstrous births, which neither depend on deficiency of parts, or supernumerary ones; nor are owing to the conjunction of animals of different species; but which appear to be new conformations, or new dispositions of parts in respect to each other, and which, like the variation of colours and forms of our domesticated animals, and probably the sexual parts of all animals, may depend on the imagination of the male parent, which we now come to consider.

VI. 1. The nice actions of the extremities of our various glands are exhibited in their various productions, which are believed to be made by the gland, and not previously to exist as such in the blood.

Thus the glands, which constitute the liver, make bile; those of the stomach make gastric acid; those beneath the jaw, saliva; those of the ears, ear-wax; and the like. Every kind of gland must possess a peculiar irritability, and probably a sensibility, at the early state of its existence; and must be furnished with a nerve of sense, or of motion, to perceive, and to select, and to combine the particles, which compose the fluid it secretes. And this nerve of sense which perceives the

different articles which compose the blood, must at least be conceived to be as fine and subtile an organ, as the optic or auditory nerve, which perceive light or sound. See Sect. XIV. 9.

But in nothing is this nice action of the extremities of the blood-vessels so wonderful, as in the production of contagious matter. A small drop of variolous contagion diffused in the blood, or perhaps only by being inserted beneath the cuticle, after a time, (as about a quarter of a lunation,) excites the extreme vessels of the skin into certain motions, which produce a similar contagious material, filling with it a thousand pustules. So that by irritation, or by sensation in consequence of irritation, or by association of motions, a material is formed by the extremities of certain cutaneous vessels, exactly similar to the stimulating material, which caused the irritation, or consequent sensation, or association.

Many glands of the body have their motions, and in consequence their secreted fluids, affected by pleasurable or painful ideas, since they are in many instances influenced by sensitive associations, as well as by the irritations of the particles of the passing blood. Thus the idea of meat, excited in the minds of hungry dogs, by their sense of vision, or of smell, increases the discharge of saliva, both in quantity and viscidity; as is seen in its hanging down in threads from their mouths, as they stand round a dinner-table. The sensations of pleasure, or of pain, of peculiar kinds, excite in the same manner a great discharge of tears; which appear also to be more saline at the time of their secretion, from their inflaming the eyes and eye-lids. The paleness from fear, and the blush of shame, and of joy, are other instances of the effects of painful, or pleasurable sensations, on the extremities of the arterial system.

It is probable, that the pleasurable sensation excited in the stomach by food, as well as its irritation, contributes to excite into action the gastric glands, and to produce a greater secretion of their fluids. The same probably occurs in the secretion of bile; that is, that the pleasurable sensation excited in the stomach, affects this secretion by sensitive association, as well as by irritative association.

And lastly it would seem, that all the glands in the body have their secreted fluids affected, in quantity and quality, by the pleasurable or painful sensations, which produce or accompany those secretions. And that the pleasurable sensations arising from these secretions may constitute the unnamed pleasure of exigence, which is contrary to what is meant by tedium vitæ, or ennui; and by which we sometimes feel ourselves happy, without being able to ascribe it to any mental cause, as after an agreeable meal, or in the beginning of intoxication.

Now it would appear, that no secretion or excretion of fluid is attended with so much agreeable sensation, as that of the semen; and it would thence follow, that the glands, which perform this secretion, are more likely to be much affected by their catenations with pleasurable sensations. This circumstance is certain, that much more of this fluid is produced in a given time, when the object of its exclusion is agreeable to the mind.

2. A forceable argument, which shews the necessity of pleasurable sensation to copulation, is, that the act cannot be performed without it; it is easily interrupted by the pain of fear or bashfulness; and no efforts of volition or of irritation can effect this process, except such as induce pleasurable ideas or sensations. See Sect. XXXIII. 1. 1.

A curious analogical circumstance attending hermaphrodite insects, as snails and worms, still further illustrates this theory; if the snail or worm could have impregnated itself, there might have been a saving of a large male apparatus; but as this is not so ordered by nature, but each snail and worm reciprocally receives and gives impregnation, it appears, that a pleasurable excitation seems also to have been required.

This wonderful circumstance of many insects being hermaphrodites, and at the same time not having power to impregnate themselves, is attended to by Dr. Lister, in his Exercitationes Anatom. de Limacibus, p. 145; who, amongst many other final causes, which he adduces to account for it, adds, ut tam tristibus et frigidis animalibus majori cum voluptate perficiatur venus.

There is, however, another final cause, to which this circumstance may be imputed: it was observed above, that vegetable buds and bulbs, which are produced without a mother, are always exact resemblances of their parent; as appears in grafting fruit-trees, and in the flower-buds of the dioiceous plants, which are always of the same sex on the same tree; hence those hermaphrodite insects, if they could have produced young without a mother, would not have been, capable of that change or improvement, which is seen in all other animals, and in those vegetables, which are procreated by the male embryon received and nourished by the female. And it is hence probable, that if vegetables could only have been produced by buds and bulbs, and not by sexual generation, that there would not at this time have existed one thousandth part of their present number of species; which have probably been originally mule-productions; nor could any kind of improvement or change have happened to them, except by the difference of soil or climate.

3. I conclude, that the imagination of the male at the time of copulation, or at the time of the secretion of the semen, may so affect this secretion by irritative or sensitive association, as described in No. 5. 1. of this section, as to cause the production of similarity of form and of features, with the distinction of sex; as the motions of the chissel of the turner imitate or correspond with those of the ideas of the artist. It is not here to be understood, that the first living fibre, which is to form an animal, is produced with any similarity of form to the future animal; but with propensities, or appetences, which shall produce by accretion of parts the similarity of form, feature, or sex, corresponding to the imagination of the father.

Our ideas are movements of the nerves of sense, as of the optic nerve in recollecting visible ideas, suppose of a triangular piece of ivory. The fine moving fibres of the retina act in a manner to which I give the name of white; and this action is confined to a defined part of it; to which figure I give the name of triangle. And it is a preceding pleasurable sensation existing in my mind, which occasions me to produce this particular motion of the retina, when no triangle is present. Now it is probable, that the acting fibres of the ultimate terminations of the secreting apertures of the vessels of the testes, are as fine as those of the retina; and that they are liable to be thrown into that peculiar action, which marks the sex of the secreted embryon, by sympathy with the pleasurable motions of the nerves of vision or of touch; that is, with certain ideas of imagination. From hence it would appear, that the world has long been mistaken in ascribing great power to the imagination of the female, whereas from this account of it, the real power of imagination, in the act of generation, belongs solely to the male. See Sect. XII. 3. 3.

It may be objected to this theory, that a man may be supposed to have in his mind, the idea of the form and features of the female, rather than his own, and therefore there should be a greater number of female births. On the contrary, the general idea of our own form occurs to every one almost perpetually, and is termed consciousness of our existence, and thus may effect, that the number of males surpasses that of females. See Sect. XV. 3. 4. and XVIII. 13. And what further confirms this idea is, that the male children most frequently resemble the father in form, or feature, as well as in sex; and the female most frequently resemble the mother, in feature, and form, as well as in sex.

It may again be objected, if a female child sometimes resembles the father, and a male child the mother, the ideas of the father, at the time of procreation, must suddenly change from himself to the mother, at the very instant, when the embryon is secreted or formed. This difficulty ceases when we consider, that it is as easy to form an idea of feminine features with male organs of reproduction, or of male features with female ones, as the contrary; as we conceive the idea of a sphinx or mermaid as easily and as distinctly as of a woman. Add to this, that at the time of procreation the idea of the male organs, and of the female features, are often both excited at the same time, by contact, or by vision.

I ask, in my turn, is the sex of the embryon produced by accident? Certainly whatever is produced has a cause; but when this cause is too minute for our comprehension, the effect is said in common language to happen by chance, as in throwing a certain number on dice. Now what cause can occasionally produce the male or female character of the embryon, but the peculiar actions of those glands, which form the embryon? And what can influence or govern these actions of the gland, but its associations or catenations with other sensitive motions? Nor is this more extraordinary, than that the catenations of irritative motions with the apparent vibrations of objects at sea should produce sickness of the stomach; or that a nauseous story should occasion vomiting.

4. An argument, which evinces the effect of imagination on the first rudiment of the embryon, may be deduced from the production of some peculiar monsters. Such, for instance, as those which have two heads joined to one body, and those which have two bodies joined to one head; of which frequent examples occur amongst our domesticated quadrupeds, and poultry. It is absurd to suppose, that such forms could exist in primordial germs, as explained in No. IV. 4. of this section. Nor is it possible, that such deformities could be produced by the growth of two embryons, or living filaments; which should afterwards adhere together; as the head and tail part of different polypi are said to do (Blumenbach on Generation, Cadel, London); since in that case one embryon, or living filament, must have begun to form one part first, and the other another part first. But such monstrous conformations become less difficult to comprehend, when they are considered as an effect of the imagination, as before explained, on the living filament at the time of its secretion; and that such duplicature of limbs were produced by accretion of new parts, in consequence of propensities, or animal appetencies thus acquired from the male parent.

For instance, I can conceive, if a turkey-cock should behold a rabbit, or a frog, at the time of procreation, that it might happen, that a forcible or even a pleasurable idea of the form of a quadruped might so occupy his imagination, as to cause a tendency in the nascent filament to resemble such a form, by the apposition of a duplicature of limbs. Experiments on the production

of mules and monsters would be worthy the attention of a Spallanzani, and might throw much light upon this subject, which at present must be explained by conjectural analogies.

The wonderful effect of imagination, both in the male and female parent, is shewn in the production of a kind of milk in the crops both of the male and female pigeons after the birth of their young, as observed by Mr. Hunter, and mentioned before. To this should be added, that there are some instances of men having had milk secreted in their breasts, and who have given suck to children, as recorded by Mr. Buffon. This effect of imagination, of both the male and female parent, seems to have been attended to in very early times; Jacob is said not only to have placed rods of trees, in part stripped of their bark, so as to appear spotted, but also to have placed spotted lambs before the flocks, at the time of their copulation. Genesis, chap. xxx. verse 40.

5. In respect to the imagination of the mother, it is difficult to comprehend, how this can produce any alteration in the fetus, except by affecting the nutriment laid up for its first reception, as described in No. V. 2. of this section, or by affecting the nourishment or oxygenation with which she supplies it afterwards. Perpetual anxiety may probably affect the secretion of the liquor amnii into the uterus, as it enfeebles the whole system; and sudden fear is a frequent cause of miscarriage; for fear, contrary to joy, decreases for a time the action of the extremities of the arterial system; hence sudden paleness succeeds, and a shrinking or contraction of the vessels of the skin, and other membranes. By this circumstance, I imagine, the terminations of the placental vessels are detached from their adhesions, or insertions, into the membrane of the uterus; and the death of the child succeeds, and consequent miscarriage.

Of this I recollect a remarkable instance, which could be ascribed to no other cause, and which I shall therefore relate in few words. A healthy young woman, about twenty years of age, had been about five months pregnant, and going down into her cellar to draw some beer, was frighted by a servant boy starting up from behind the barrel, where he had concealed himself with design to alarm the maid-servant, for whom he mistook his mistress. She came with difficulty up stairs, began to flood immediately, and miscarried in a few hours. She has since borne several children, nor ever had any tendency to miscarry of any of them.

6. In respect to the power of the imagination of the male over the form, colour, and sex of the progeny, the following instances have fallen under my observation, and may perhaps be found not very unfrequent, if they were more attended to. I am acquainted with a gentleman, who has one child with dark hair and eyes, though his lady and himself have light hair and eyes; and their other four children are like their parents. On observing this dissimilarity of one child to the others he assured me, that he believed it was his own imagination, that produced the difference; and related to me the following story. He said, that when his lady lay in of her third child, he became attached to a daughter of one of his inferior tenants, and offered her a bribe for her favours in vain; and afterwards a greater bribe, and was equally unsuccessful; that the form of this girl dwelt much in his mind for some weeks, and that the next child, which was the dark-ey'd young lady above mentioned, was exceedingly like, in both features and colour, to the young woman who refused his addresses.

To this instance I must add, that I have known two families, in which, on account of an intailed estate in expectation, a male heir was most eagerly desired by the father; and on the contrary,

girls were produced to the seventh in one, and to the ninth in another; and then they had each of them a son. I conclude, that the great desire of a male heir by the father produced rather a disagreeable than an agreeable sensation; and that his ideas dwelt more on the fear of generating a female, than on the pleasurable sensations or ideas of his own male form or organs at the time of copulation, or of the secretion of the semen; and that hence the idea of the female character was more present to his mind than that of the male one; till at length in despair of generating a male these ideas ceased, and those of the male character presided at the genial hour.

7. Hence I conclude, that the act of generation cannot exist without being accompanied with ideas, and that a man must have at that time either a general idea of his own male form, or of the form of his male organs; or an idea of the female form, or of her organs; and that this marks the sex, and the peculiar resemblances of the child to either parent. From whence it would appear, that the phalli, which were hung round the necks of the Roman ladies, or worn in their hair, might have effect in producing a greater proportion of male children; and that the calipædia, or art of begetting beautiful children, and of procreating either males or females, may be taught by affecting the imagination of the male-parent; that is, by the fine extremities of the seminal glands, imitating the actions of the organs of sense either of sight or touch. But the manner of accomplishing this cannot be unfolded with sufficient delicacy for the public eye; but may be worth the attention of those, who are seriously interested in the procreation of a male or female child.

Recapitulation.

VII. 1. A certain quantity of nutritive particles are produced by the female parent before impregnation, which require no further digestion, secretion, or oxygenation. Such are seen in the unimpregnated eggs of birds, and in the unimpregnated seed-vessels of vegetables.

2. A living filament is produced by the male, which being inserted amidst these first nutritive particles, is stimulated into action by them; and in consequence of this action, some of the nutritive particles are embraced, and added to the original living filament; in the same manner as common nutrition is performed in the adult animal.

3. Then this new organization, or additional part, becomes stimulated by the nutritive particles in its vicinity, and sensation is now superadded to irritation; and other particles are in consequence embraced, and added to the living filament; as is seen in the new granulations of flesh in ulcers.

By the power of association, or by irritation, the parts already produced continue their motions, and new ones are added by sensation, as above mentioned; and lastly by volition, which last sensorial power is proved to exist in the fetus in its maturer age, because it has evidently periods of activity and of sleeping; which last is another word for a temporary suspension of volition.

The original living filament may be conceived to possess a power of repulsing the particles applied to certain parts of it, as well as of embracing others, which stimulate other parts of it; as these powers exist in different parts of the mature animal; thus the mouth of every gland embraces the particles or fluid, which suits its appetency; and its excretory duct repulses those particles, which are disagreeable to it.

4. Thus the outline or miniature of the new animal is produced gradually, but in no great length of time; because the original nutritive particles require no previous preparation by digestion, secretion, and oxygenation: but require simply the selection and apposition, which is performed by the living filament. Mr. Blumenbach says, that he possesses a human fetus of only five weeks old, which is the size of a common bee, and has all the features of the face, every finger, and every toe, complete; and in which the organs of generation are distinctly seen. P. 76. In another fetus, whose head was not larger than a pea, the whole of the basis of the skull with all its depressions, apertures, and processes, were marked in the most sharp and distinct manner, though without any ossification. Ib.

5. In some cases by the nutriment originally deposited by the mother the filament acquires parts not exactly similar to those of the father, as in the production of mules and mulattoes. In other cases, the deficiency of this original nutriment causes deficiencies of the extreme parts of the fetus, which are last formed, as the fingers, toes, lips. In other cases, a duplicature of limbs are caused by the superabundance of this original nutritive fluid, as in the double yolks of eggs, and the chickens from them with four legs and four wings. But the production of other monsters, as those with two heads, or with parts placed in wrong situations, seems to arise from the imagination of the father being in some manner imitated by the extreme vessels of the seminal glands; as the colours of the spots on eggs, and the change of the colour of the hair and feathers of animals by domestication, may be caused in the same manner by the imagination of the mother.

6. The living filament is a part of the father, and has therefore certain propensities, or appetencies, which belong to him; which may have been gradually acquired during a million of generations, even from the infancy of the habitable earth; and which now possesses such properties, as would render, by the apposition of nutritious particles, the new fetus exactly similar to the father; as occurs in the buds and bulbs of vegetables, and in the polypus, and tænia or tape-worm. But as the first nutriment is supplied by the mother, and therefore resembles such nutritive particles, as have been used for her own nutriment or growth, the progeny takes in part of the likeness of the mother.

Other similarity of the excitability, or of the form of the male parent, such as the broad or narrow shoulders, or such as constitute certain hereditary diseases, as scrophula, epilepsy, insanity, have their origin produced in one or perhaps two generations; as in the progeny of those who drink much vinous spirits; and those hereditary propensities cease again, as I have observed, if one or two sober generations succeed; otherwise the family becomes extinct.

This living filament from the father is also liable to have its propensities, or appetencies, altered at the time of its production by the imagination of the male parent; the extremities of the seminal glands imitating the motions of the organs of sense; and thus the sex of the embryon is produced; which may be thus made a male or a female by affecting the imagination of the father at the time of impregnation. See Sect. XXXIX. 6. 3. and 7.

7. After the fetus is thus completely formed together with its umbilical vessels and placenta, it is now supplied with a different kind of food, as appears by the difference of consistency of the different parts of the white of the egg, and of the liquor amnii, for it has now acquired organs for

digestion or secretion, and for oxygenation, though they are as yet feeble; which can in some degree change, as well as select, the nutritive particles, which are now presented to it. But may yet be affected by the deficiency of the quantity of nutrition supplied by the mother, or by the degree of oxygenation supplied to its placenta by the maternal blood.

The augmentation of the complete fetus by additional particles of nutriment is not accomplished by distention only, but by apposition to every part both external and internal; each of which acquires by animal appetencies the new addition of the particles which it wants. And hence the enlarged parts are kept similar to their prototypes, and may be said to be extended; but their extension must be conceived only as a necessary consequence of the enlargement of all their parts by apposition of new particles.

Hence the new apposition of parts is not produced by capillary attraction, because the whole is extended; whereas capillary attraction would rather tend to bring the sides of flexible tubes together, and not to distend them. Nor is it produced by chemical affinities, for then a solution of continuity would succeed, as when sugar is dissolved in water; but it is produced by an animal process, which is the consequence of irritation, or sensation; and which may be termed animal appetency.

This is further evinced from experiments, which have been instituted to shew, that a living muscle of an animal body requires greater force to break it, than a similar muscle of a dead body. Which evinces, that besides the attraction of cohesion, which all matter possesses, and besides the chemical attractions of affinities, which hold many bodies together, there is an animal adhesion, which adds vigour to these common laws of the inanimate world.

8. At the nativity of the child it deposits the placenta or gills, and by expanding its lungs acquires more plentiful oxygenation from the currents of air, which it must now continue perpetually to respire to the end of its life; as it now quits the liquid element, in which it was produced, and like the tadpole, when it changes into a frog, becomes an aerial animal.

9. As the habitable parts of the earth have been, and continue to be, perpetually increasing by the production of sea-shells and corallines, and by the recrements of other animals, and vegetables; so from the beginning of the existence of this terraqueous globe, the animals, which inhabit it, have constantly improved, and are still in a state of progressive improvement.

This idea of the gradual generation of all things seems to have been as familiar to the ancient philosophers as to the modern ones; and to have given rise to the beautiful hieroglyphic figure of the προτον ωον, or first great egg, produced by NIGHT, that is, whose origin is involved in obscurity, and animated by ερος, that is, by DIVINE LOVE; from whence proceeded all things which exist.

Conclusion.

VIII. 1. Cause and effect may be considered as the progression, or successive motions, of the parts of the great system of Nature. The state of things at this moment is the effect of the state of

things, which existed in the preceding moment; and the cause of the state of things, which shall exist in the next moment.

These causes and effects may be more easily comprehended, if motion be considered as a change of the figure of a group of bodies, as proposed in Sect. XIV. 2. 2. inasmuch as our ideas of visible or tangible objects are more distinct, than our abstracted ideas of their motions. Now the change of the configuration of the system of nature at this moment must be an effect of the preceding configuration, for a change of configuration cannot exist without a previous configuration; and the proximate cause of every effect must immediately precede that effect. For example, a moving ivory ball could not proceed onwards, unless it had previously began to proceed; or unless an impulse had been previously given it; which previous motion or impulse constitutes a part of the last situation of things.

As the effects produced in this moment of time become causes in the next, we may consider the progressive motions of objects as a chain of causes only; whose first link proceeded from the great Creator, and which have existed from the beginning of the created universe, and are perpetually proceeding.

2. These causes may be conveniently divided into two kinds, efficient and inert causes, according with the two kinds of entity supposed to exist in the natural world, which may be termed matter and spirit, as proposed in Sect. I. and further treated of in Sect. XIV. The efficient causes of motion, or new configuration, consist either of the principle of general gravitation, which actuates the sun and planets; or of the principle of particular gravitation, as in electricity, magnetism, heat; or of the principle of chemical affinity, as in combustion, fermentation, combination; or of the principle of organic life, as in the contraction of vegetable and animal fibres. The inert causes of motion, or new configuration, consist of the parts of matter, which are introduced within the spheres of activity of the principles above described. Thus, when an apple falls on the ground, the principle of gravitation is the efficient cause, and the matter of the apple the inert cause. If a bar of iron be approximated to a magnet, it may be termed the inert cause of the motion, which brings these two bodies into contact; while the magnetic principle may be termed the efficient cause. In the same manner the fibres, which constitute the retina, may be called the inert cause of the motions of that organ in vision, while the sensorial power may be termed the efficient cause.

3. Another more common distribution of the perpetual chain of causes and effects, which constitute the motions, or changing configurations, of the natural world, is into active and passive. Thus, if a ball in motion impinges against another ball at rest, and communicates its motion to it, the former ball is said to act, and the latter to be acted upon. In this sense of the words a magnet is said to attract iron; and the prick of a spur to stimulate a horse into exertion; so that in this view of the works of nature all things may be said either simply to exist, or to exist as causes, or to exist as effects; that is, to exist either in an active or passive state.

This distribution of objects, and their motions, or changes of position, has been found so convenient for the purposes of common life, that on this foundation rests the whole construction or theory of language. The names of the things themselves are termed by grammarians Nouns, and their modes of existence are termed Verbs. The nouns are divided into substantives, which

denote the principal things spoken of; and into adjectives, which denote some circumstances, or less kinds of things, belonging to the former. The verbs are divided into three kinds, such as denote the existence of things simply, as, to be; or their existence in an active state, as, to eat; or their existence in a passive state, as, to be eaten. Whence it appears, that all languages consist only of nouns and verbs, with their abbreviations for the greater expedition of communicating our thoughts; as explained in the ingenious work of Mr. Horne Tooke, who has unfolded by a single flash of light the whole theory of language, which had so long lain buried beneath the learned lumber of the schools. Diversions of Purley. Johnson. London.

4. A third division of causes has been into proximate and remote; these have been much spoken of by the writers on medical subjects, but without sufficient precision. If to proximate and remote causes we add proximate and remote effects, we shall include four links of the perpetual chain of causation; which will be more convenient for the discussion of many philosophical subjects.

Thus if a particle of chyle be applied to the mouth of a lacteal vessel, it may be termed the remote cause of the motions of the fibres, which compose the mouth of that lacteal vessel; the sensorial power is the proximate cause; the contraction of the fibres of the mouth of the vessel is the proximate effect; and their embracing the particle of chyle is the remote effect; and these four links of causation constitute absorption.

Thus when we attend to the rising sun, first the yellow rays of light stimulate the sensorial power residing in the extremities of the optic nerve, this is the remote cause. 2. The sensorial power is excited into a state of activity, this is the proximate cause. 3. The fibrous extremities of the optic nerve are contracted, this is the proximate effect. 4. A pleasurable or painful sensation is produced in consequence of the contraction of these fibres of the optic nerve, this is the remote effect; and these four links of the chain of causation constitute the sensitive idea, or what is commonly termed the sensation of the rising sun.

5. Other causes have been announced by medical writers under the names of causa procatarctica, and causa proegumina, and causa sine quâ non. All which are links more or less distant of the chain of remote causes.

To these must be added the final cause, so called by many authors, which means the motive, for the accomplishment of which the preceding chain of causes was put into action. The idea of a final cause, therefore, includes that of a rational mind, which employs means to effect its purposes; thus the desire of preserving himself from the pain of cold, which he has frequently experienced, induces the savage to construct his hut; the fixing stakes into the ground for walls, branches of trees for rafters, and turf for a cover, are a series of successive voluntary exertions; which are so many means to produce a certain effect. This effect of preserving himself from cold, is termed the final cause; the construction of the hut is the remote effect; the action of the muscular fibres of the man, is the proximate effect; the volition, or activity of desire to preserve himself from cold, is the proximate cause; and the pain of cold, which excited that desire, is the remote cause.

6. This perpetual chain of causes and effects, whose first link is rivetted to the throne of GOD, divides itself into innumerable diverging branches, which, like the nerves arising from the brain,

permeate the most minute and most remote extremities of the system, diffusing motion and sensation to the whole. As every cause is superior in power to the effect, which it has produced, so our idea of the power of the Almighty Creator becomes more elevated and sublime, as we trace the operations of nature from cause to cause, climbing up the links of these chains of being, till we ascend to the Great Source of all things.

Hence the modern discoveries in chemistry and in geology, by having traced the causes of the combinations of bodies to remoter origins, as well as those in astronomy, which dignify the present age, contribute to enlarge and amplify our ideas of the power of the Great First Cause. And had those ancient philosophers, who contended that the world was formed from atoms, ascribed their combinations to certain immutable properties received from the hand of the Creator, such as general gravitation, chemical affinity, or animal appetency, instead of ascribing them to a blind chance; the doctrine of atoms, as constituting or composing the material world by the variety of their combinations, so far from leading the mind to atheism, would strengthen the demonstration of the existence of a Deity, as the first cause of all things; because the analogy resulting from our perpetual experience of cause and effect would have thus been exemplified through universal nature.

The heavens declare the glory of GOD*, and the firmament sheweth his handywork! One day telleth another, and one night certifieth another; they have neither speech nor language, yet their voice is gone forth into all lands, and their words into the ends of the world. Manifold are thy works,* O LORD! *in wisdom hast thou made them all.* Psal. xix. civ.