1789.

Lecture VI.th

Properties of Matter.

In our last Lecture we endeavoured to give you some idea of the primary matter, or to speak more correctly, some notion of the opinion of Philosophers on this abstruse subject —

The enquiry after the primary mr. out of wc. all things were made is purely metaphysical, for substantial forms & Essences can scarcely be made an object for scientific contemplation. What this primary, or original mr. is, GOD, who made it, only knows! We can have no adequate idea of it, because every thing we see is matter wrought or worked up, into some substance, for then, and then only it can it strike either of the five senses. It can indeed strike the mind before it attains the grossness of what we call substance. To arrest this fleeting being, and make it the subject of scientific contemplation, is, I confess, somewhat like "giving to airy nothing a local habitation, and a name!"

We told you, that certain internal adjustments, disposition, or arrangement was called Organization; and that this accession to matter gave rise to body physical, or body natural; — and that it was probable, that from a variation of these internal arrangements adjustments, or dispositions, arose most of those secondary forms called sensible qualities: Such are roughness, smoothness, hardness, softness; — all the tribe of colours, tastes & odours, as well as those of a character more subtile, viz the powers electric, magnetic, me: &c.

Over & above that arrangement of matter called Organization, we ~~discover~~ are led to enquire after the moving principle, and from the Elements of Natural Substances to enquire after its Efficient cause, that is to say after that cause wch associates those elements & wch employs them, when associated according to their various & peculiar characters.

Here the contemplation is nobler yet than that of a passive element. Here the subject assumes the dignity of a living moving power: a power destined by its nature to use, & not to be used.

The animating moving power in a natural body, is neither its organization, nor its figure, nor any other of those inferior forms, wch make up the system of its visible qualities; but 'tis the power, which not being that organization, nor that figure, nor those qualities, is yet able to produce, to preserve, & to employ them.

'Tis therefore the power, wch first moves, & then conducts that latent process by wch the Acorn becomes an Oak; the Egg becomes a chicken. 'Tis the power by wch the Aliment of plants & animals is digested & by such digestion, transformed into a part of themselves. 'Tis the power wch departing the body ceases to live, & the members soon pass into putrefaction & decay! —

Were you to ask the Stoics what this power is? they would tell you that it was a portion of that spirit wch pervades & animates the world. David seems to have had the same idea, when speaking of living things. "Thou sen "forth thy spirit and they are created; thou takest away their breath, they die, a "return to the dust" (CIV. Ps.) So much by way of recapitulation.

The ultimate design of this Lecture is to give you a rapid idea of origin & growth of 1st a Vegetable & then of an Animal —

Let us now attend to such properties of matter, as are the result of experiment, before we speak of animal matter, or matter to which life is super-added. As I presume many of you are acquainted w.th these properties, as they are well taught in this place, it w.d only be re-minding you that in matter we are able to distinguish a principle of attraction & gravitation. W.n the particles of m.r come closer together making a firmer body it is called attraction of cohesion. We moreover discover another property in m.r termed elective attraction; or an affinity, or desire to some other body, forming w.th it a regular homogeneous substance. The knowledge of this affinity, constitutes in a great measure, the science of Chymistry. Chemists enumerate 10 laws of affinity.

Another property of m.r is its inertia, or passiveness, by w.h it always endeavours to continue in the state it is in, whether of rest, or motion. We find that all m.r is capable of being moved, if a sufficient degree of force be applied to overcome this natural inactivity, or resistance. We said in our last lecture that m.r could never move itself.

Philosophers tell us, that m.r can be infinitely divided. May not this be a mathematical truth, & a physical falshood? — Of the divisibility of m.r, however, we have many surprising instances related by Ferguson & others: — thus,

(1.) If 8i. of Silver be fused w.th a single grain of Gold, the gold will be equally diffused thro.h the whole silver, so that taking one grain from any part of the mass (in w.h there can be no more y.n 6700.th part of a grain of gold), and dissolving it in Aq. fortis, the gold will fall to the bottom!

(2.) The Gold-beaters can extend a grain of gold into a leaf containing

50 square inches; and this leaf may be divided into 500,000 parts. For an inch in length can be divided into a 100 parts, every one of which will be visible to the bare eye: consequently a square inch can be divided into 10,000 parts, & 50 square inches into 500,000, And if one of these parts be viewed w.th a microscope that magnifies the diameter of an object only ten times, it will magnify the area 100 times, and then the 100.th part of 500,000 or the 50 millionth part will be visible

Yet all this is nothing, in comparison of the length that "wonder working "Nature", goes in the division of matter in Animal bodies. For according to Leeuwenhoek there are more animals in the Milt of a single Cod-fish, yn there are men upon the whole face of the earth. When he compared one single grain of sand by the microscope, he found it bigger than four million of them. In Vinegar, in Water, wherein ginger, pepper, or some such hot spice has been steeped, the microscope discovers inconceivably small animalculæ, of different sorts swimming up & down: whence we infer that the air itself (in the summer months) is full of invisible living creatures; for if these waters be kept close covered, no such creatures are found in it. —— Now each of these animals must have muscles, heart, arteries, veins & nerves, otherwise they c.d never live or move; and each of these arteries & veins, must have arteries, veins & nerves, belonging to them as vessels, the (vasa vasorum) or they c.d not subsist much less act. How inconceivably small must the particles of their blood be to circulate through the smallest ramifications of such minute arteries & veins?

If it be asked, what brings these Animalculæ to Vinegar, or these spicy waters? I answer the, the peculiar Odor invites them to deposite their eggs in such liquors. And, how astonishingly small must the particles of odor be w.ch such creatures can smell! —

It deserves

It distresses the imagination, to conceive an organized body with difference & distinction of parts, fit for life, motion, & doubtless pleasure, wrought up in such narrow bounds! — And yet these particles of odor we speak of, is probably grossness itself when compared with the infinitesimally small particles of light! these particles of light may be as gross compared with the animalcula!!! We do not mention these things ~~in order~~ to amaze & confound you, but in order to give you some idea of the subtilty of nature; and to remind you how far the subtilty of nature exceeds the subtilty of our ~~understanding~~ senses. [Nov. Organ. A. X.]

No The particles of ~~matter~~ bodies do not touch, but adhere by attraction. Jody.

Philosophers conclude that the attraction of matter is rather infused, yn inherent. They reckon four kinds of attraction viz cohesion, gravitation, magnetism, & electricity. And where the sphere of attraction ends, a repulsive force begins; thus water repels most bodies till they are wet, hence it is, a cambrick needle, if dry, swims on the surface of the water. The repelling force of the particles of a fluid, is but small; and hence if a fluid be divided, it easily unites again. But if glass, or any such substance be broken in small parts, they cannot be made to stick together again, without being first wetted.

All bodies are full of pores, or spaces void of their specific matter. Even in Gold, one of the heaviest of all bodies, there is thought to be ~~more~~ a greater quantity of space yn matter; for the particles of heat & magnetism find an easy passage through it: and water itself has been force through a hollow sphere of gold. And were not glass porous would the rays of light pass through it? — Now the particles of bodies do not touch each other, but adhere by attraction. —

All matter is affected by heat, even metals are found to be expanded in length, breadth, & thickness. The particles of bodies do not touch but adhere by attraction.

Matter is inert; any one particle of mr. left to itself will continue always in the same state, with regard to its motion or rest. There are however, certain powers, wc. two particles of mr. have of acting on one another, viz. the attraction of gravitation, & cohesion, by wc. ~~bodies~~ the particles of mr., when at a certain distance, come nearer one another, & remain in that state. Besides this there is the attraction of chrystallization, by wc. bodies when fluid become in time, solid (as the formation of Salts) and assume a particular figure. There is an attraction of magnetism, by wc. a peice of Iron, in certain circumstances, attracts another peice of Iron. There is an attraction of Electricity by wc. a substance wc. is charged with more electric matter, attracts another, charged with less. Then, there is chemical attraction, by wc. two particles of different bodies rush together & form one. These are all the powers of inanimate mr., that we are acquainted with; ~~but~~ observe, that most of these attrac-tions have their opposite repulsions. But, there is in animal matter, or mr. to wc. life or yc. efficient cause is superadded, something wc. is over and above all this, for an animal fibre will move, that not by the power of gravitation, co-hesion, chrystallization, electricity, magnetism, or chemical attraction.

Within every animal, there is an innate & active power, wc. ceases not its work, when sense & appetite are asleep; wc. without any conscious-~~ness~~ co-operation of the animal itself, carries it from an embryo, or seed, to its destined magnitude. At maturity it stops; and from this point it gradually decays. 'Tis by this principle, that the size, or magnitude of the Oak, the Bee, the Elephant and every other natural production whether animal, or vegetable, is to a certain degree limited; and when that limit either fails, or exceeds, in a conspicuous manner, the being becomes a Monster.

This is that internal principle, w.c descends from animals, even to Vegetables; and w.c as these last possess no other, is commonly called by Authors "Vegetative life"; tho sometimes it is denoted by the more obvious name of nature. —

In animal bodies, we perceive two sorts of motion; one communicated, & the other voluntary or spontaneous; for an animal has the power of begining motion by taking thought. In the former, the cause of motion is extrinsical to the body moved (1); in the latter 'tis within it.

In these Disquisitions, you must remember, that when we speak of motion, we mean the invisible cause, not the visible effects for these are purely physical. Thus, when we speak of the motive powers of magnetism, & electricity, the visible motions, w.c they produce are of a species merely physical, but the cause of these motions is totally concealed. For the same reason we must not grant spontaneity to fluids, not even to fire w.c constitutes their fluidity: so that when we say, heat evolves the Egg, & extends its growth into a chicken, and heat causes the Oak to grow out of an ~~acorn~~ acorn we only speak of the visible cause, without pretending to say what that original motion is, w.c produces heat. These you see are subtile speculations w.c go deeper than the art of chemistry —

These things being duly considered, enable us to contemplate w.th advantage the growth of organized bodies. By organized bodies we mean Vegetables & animals.

(1) Fire, food.

All vegetables

All Vegetables are originally produced by a seed, or grain — and all Animals by an Egg. (one exception in each, the slip & the polypus)

A fecund or ripe seed of a Plant is an organized body envelloped by several membranes containing within it, the plant in minature. — Here a bean is dissected, and Grew's engraving of one magnified exhibited.

In like manner, a fecunde egg, is an organized body, containing the little animal, envelloped in several membranes. Now, both these w.d remain inanimate unless except some agent, or stimulus from without excited, or began a motion in them. Now, whatever by its contact w.th an organized body, excites in it, a contraction, or oscillation, we call a "stimulus". Life is caused, & is continued by something w.e acts from without, and this something is, as far as we can discover, "heat" acting upon the seed, or egg. It is difficult to say in what manner an irritable body is operated upon by the exciting powers but whatever it be, either a certain quantity, or a certain energy of it is assigned to every individual system upon the commencement of its living state. And it w.d seem that the stimulus w.e operates upon the irritable, or excitable parts of an animal, or vegetable body is heat in different degrees: For without heat, as an exciting and preserving stimulus, vegetable & animal life cannot be supported. Thus, the hatching of eggs, is the effect of the application of a particular degree of heat, without w.e the egg remains becomes inanimate.

Things coming not within the scrutiny of human senses, says Locke, cannot be examined by them; and therefore, can appear, more or less probable only, as they more or less agree w.th truths that are established in our minds, & as they hold proportion to other parts of our knowledge, and observation. Analogy in these matters, is the only help we have, and it is from that alone we draw all our grounds of probability" Vol 2. 284

Now, the smallest eggs of plants & animals, not to mention the seeds of other things, come not within the scrutiny of the human senses; but the eggs of birds do come within their scrutiny & can be examined by the senses Let us ∴ examine such an Egg, & from the truths we discover, & the ob:=servations we make, judge of the operations in similar bodies, whose minuteness eludes search by the senses, for analogy in these matters is the only help we have, and it is from that alone we draw all our grounds of probability. — [we can form our opinions of that w^c. we know not, only by placing it in comparison with something that we know.]

Every seed of a Plant, is an organized body, endowed wth. vessels, and ~~envelloped~~ contains under several membranes, or envellopments the plant in minature. If this seed be put into the moist earth, and a certain degree of heat applied, these vessels with their containing fluid expand by the warmth, and being thus put into motion, gradually encrease, and grow up into a plant, w^c. plant produces a similar seed, capable of producing its kind [to all eternity] — forever.

In like manner, an egg, is an organized body w^c. contains under several envellopements, the chicken in minature. If warmed to a certain degree, whether by nature or art, the fluid w^c. surrounds the germ, or speck expands insinuates into the little ramifications of vessels, and the motion once begun, it devellopes by degrees, untill it becomes a perfect animal.

Now this hens-egg may be considered as a womb, detached from the body of the parent animal, in w^c. the embryo is just begining to be formed; a kind of incomplete delivery, w^c. requires a certain degree of heat, (whether of the sun, stove, or the parent animal) to bring it to per:=fection. The generation of an animal by an egg is considered as more simple, or inferior to that in which the animal is brought forth alive.

simple as it is, it will afford us no small insight into the generation of other things, and nobler animals. For this reason Philosophers, Mal:-pighius, & Haller more especially, have spent a great deal of time in watching the growth and gradual evolving of an animal in a Hen's egg, and have recorded the changes in every period of it's existence. (See Art. Animal life in Rees Cyclopad. last paragraph to be here inserted. Nov. 1810)

Description of the Hens: Egg.— Immediately under this shell, lies that common membrane, or skin, w.c lines it on the inside, adhering closely to it everywhere, except at this broad end, where a little space or cavity is left, w.c cavity is filled with air, w.c encreases as the chicken within (see oxygen + calorique) grows larger *. Under this membrane are two whites, altho they appear at first view to be only one, each of them are wrapped up in a membrane of it's own, one. In the centre of all is that yellow substance called the vitellum or yolk, wrapt round likewise w.th it's own membrane.

At each end of this, are two ligaments, called chalazæ, w.c being white dense substances made from the membranes, serve to keep the white & the yolk in their places.

The Cicatricula is the part where the Animal first begins to shew signs of life. It is like a vetch seed, or lentil, lying on one side of the yolk, and within it's membrane. The outer membranes & ligaments preserve the fluids in their proper places. The white serves as nourishment, and the yolk with it's membranes, after a time, become a part of the chicken's body.

Previous to putting the eggs under the Hen Malpighius & Haller, first examined this cicatricula, or little spot before mentioned, w.c they consider as

the most important part of the egg, and for that reason called by some the punctum vitæ. This was found in those impregnated by the Cock to be large, but in those laid without the cock very small. Upon examination w.th the microscope, it was found to be a kind of bag containing a ~~kind~~ transparent liquor, in the midst of which the embryo was seen to reside. The embryo resembled a composition of little threads, w.c the warmth of future incubation tended to enlarge, by varying & liquifying the other fluids contained in the shell; ~~and thus pressing them either into the pores, or tubes of their substance.~~

Upon placing the egg in a proper degree of heat, the punctum vitæ in six hours begins to dilate like the pupil of the eye. the head of the chicken is distinctly seen, with the back-bone something resembling a Tadpole floating in it's ambient fluid, but as yet assuming none of the functions of life.

In about six hours more, the chick is seen more distinctly; the head becomes more plainly visible, & the vertebræ of the back bone more distinctly seen. At the end of twenty four hours, the ribs are seen to be in their places, and the neck is lengthened.

At this time the fluids seem to change place: the yolk w.c was before in the center of the shell approaches nearer to the small end, and the little animal appears to have turned towards the part of the broad end. At the end 40 hours the work of life seems fairly begun, & the animal appears to move; the back-bone thickens, the first rudiments of the eyes begin to appear, the heart beats & the blood begins to circulate. At the end of two days, the liquor, in w.c the chicken swims, seems to encrease

In about 14 ~~days~~ hours after this, the chicken is grown more strong, the veins & arte-
-ries begin to appear, & branch out, in order to form, as it seems the Brain.
and now the spinal-marrow, is seen to stretch along the back-bone. In three
days the whole body appears bent, the thighs, & wings begin to be seen. —

At the end of the 4th day, the vesicles wc go to form the brain, approach each
other, & the body is so far formed, that the heart, wc was hitherto exposed, is now
covered up within the body, by a thin transparent membrane, and the um-
-bilical vessels, that unite the animal to the yolk, now appear to come
forth from the abdomen. After the 5th & 6th days, the vessels of the brain
begin to be covered over, the wings & thighs lengthen; the belly is closed up, the
Liver is seen; both the ventricles of the heart are discerned resembling two
distinct hearts, seperately beating. On ye 7th day the head appears very large,
the brain is covered over, & the bill begins to appear between the eyes, and
the wings, the thighs, and the legs have acquired their perfect figure.

Hitherto the chicken appears as if it had two bodies. The yolk is
joined to it by the Umbilical vessels, that come from the belly; & is furnished
wth vessels, thro wc the blood circulates, as it now does thro the rest of the
body. But the umbilical-vessels towards the end of incubation, shrink
the yolk, & wth it the Intestines are thrust up into the body of the chicken
by the action of the muscles of the abdomen, & so the two bodies are formed
into one

At this period, all the organs are found to perform their secretions; the
Bile is found to be seperated, but void of bitterness, & there is an appearance of
Lungs. On the 11th day the heart wc hitherto appeared divided, begins to unite; an
the operations are more distinctly seen, in proportion as the colour of the
fluids deepen. At this time viz. 11th or 12th day the chicken gathering stre
begins to grow uneasy, & exerts its powers to deliver itself from confinemen
& by the 20th day it breaks its prison, & the living active animal exercises h
powers in the open air.

From the history here given, we learn that — See the book on Evolving an body

Altho' heat expands & evolves the seed of a plant, and causes it to grow up to a large tree; and altho' it evolves the egg & causes it to grow up into a living animal, it is natural for you to enquire what the matter, or pabulum is w.^c encreases the size, and adds to the bulk of either plant or animal. Tho heat begins the process of life, yet it is evident that this vital motion only causes an absorption or accretion of some matter, or food w.^c encreases y.^e bulk of the vegetable, or animal. Now some Philosophers, among whom is Count Buffon suppose it is done by what they call ~~organic molecules~~ organic=molecules. Their idea is this, There was created at the begining, ~~seeds~~ vegetable or organic molecules, These are seeds, inconceivably small but capable of growth & reproduction. They conceive them to be almost as subtile as the atoms of the primary matter. These are supposed to be dispersed every where in the earth & in the air; and they suppose a growing vegetable to attract & absorb them by their numerous vessels from the earth & from the air. Their absorption, or accretion is continued till the plant attains th' full growth; and when the plant has attained th' acme, the vessels of it reject their further admission, & instead of their being distributed all over the plant, they are deposited in a particular place encrease greatly in size, & form what is called the seed, which (wch only are or some particles of larger size) put in the ground is capable

capable of producing its kind for ever.

In like manner they suppose animal-molecules, or living organic-particles, or live matter, capable of being assimilated & changed into our own nature, into our own flesh & blood. As the vegetable molecules were supposed to be seeds, these animal molecules are supposed to be eggs, but of the simplest form; so simple in their organization, as merely to be alive, or susceptible of life by the application of a due degree of heat. This is an old doctrine revived, "Omnia ex Ovo,"* says Ovid, and we have more upon once told you that most of these ~~Poets~~ fables of ye Poets, ~~are~~ have a reference to the antient theories or systems of philosophy. — Now tis supposed that a vegetable molecule can be converted into an animal molecule. Or in other words that the digestive organs can convert a vegetable substance taken into the stomach into an animal molecule, wc molecule is capable of becoming a part of ourselves; and by feeding on Vegetables, ~~and~~ a part of them is thrown out by perspiration & other outlets, while the finer parts are assimilized & soon become a part of ourselves. Thus we go on growing by receiving into our bodies vegetable matter, wc by the process of digestion is soon converted into animal molecules, wc our bodies receive & assimilates to itself untill it attains

* "Scarcely any author between Gulet & stones" says Bacon

attains its acme or perfection, and when that is completed & the body is entirely evolved, these organic living molecules are thrown back like the vegetable & deposited in a particular part, from whence they are capable of reproducing their kind for ever.

Thus you see the growing vegetable receives its ~~mol~~ molecules from the earth & air, and these perfect the Plant. When received into our stomachs they become animal molecules, wc perfect the man. The same thing happens but by a shorter process when we feed on flesh. — Nay, further when an animal dies, and putrefies, that is, dissolves into a fœtid vapour, these animal particles are absorbed with great avidity by a Vegetable, and thy absorption of animal matter makes them grow surprisingly. Thus you see how animals & vegetables mutually support each other. And thus you see an illustration of what we asserted yesterday, "that substances of every kind, either immediately, or medriately pass one into another;- and that re-

reciprocal deaths, dissolutions & digestions, support by turns all such substances out of each other. This is but one instance, among a thousand that could be brought to support of another assertion of ours, that in this world w.ch we inhabit, there is an universal change, or mutation of all things into all:- that nothing is truly lost, but the sum total of matter in the Universe remains perfectly the same, and that what some consider as fresh creations, or calling of something out of nothing is only a change or mutation of something w.ch was before existed. (See Hamlet grave digger scene)

Imperial Cæsar, dead & turn'd to clay
might stop a hole to keep the wind away!

t. From y.e history here given we learn that those parts w.ch conduce most to life are formed the first. The head, the back bone w.ch contains the spinal marrow are the first seen. Then we perceive the heart beat, and also discern some of the viscera of y.e abdomen and lastly the limbs. And it is observed that whatever the animal has double, or whatever it can live without the use of are last produced. Nature being careful to form those organs first, on w.ch life & action depend. (Evelyn)