LIFE IN NATURE.

CHAPTER I.

OF FUNCTION; OR, HOW WE ACT.

The interest which attaches to the study of our bodily structure and powers is daily more widely felt, as the importance of the subject is more fully recognized, and especially as the relations which connect our bodily with our mental and moral life are better understood. Nor is this interest diminished by the difficulty with which its satisfaction is often attended. It is, indeed, stimulated rather than deadened by obstacles, and the desire to penetrate this mysterious world of material life, on which all that is best and highest in humanity rests as its foundation, is one that grows by disappointment. For the study of life is apt to end in a feeling of this kind. The multiplicity of the facts recorded by physiologists, the ingenuity of the experiments, the intricacy of the results—the astonishing amount of light, and the insuperable darkness—produce a mingled effect upon the mind. As observations multiply, doubts multiply with them. We are half disposed to ask whether we really know anything on the subject. Is there anything certain in physiology at all, besides what we can see?

If there is, it must be by virtue of some fixed and certain principles, which seem, indeed, to be sadly wanting in this department of science. We appear to be, in physiological inquiries, entirely at the mercy of our senses. Anything might be true, nor can we grasp any fact with a firmer hold than mere empirical inquiry can afford. Every inference, therefore, is open to doubt; no law is ascertained which can sustain the shock of apparent exceptions, nor any principle established to which we may with confidence seek to reduce anomalies.

No science has made real progress till it has passed out of this state. So long as no certain principles or necessary laws have been discovered in any branch of knowledge, we cannot tell what we may believe, and, at the best, its doctrines form a mass of truth and error inextricably mixed.

If, therefore, any relations in the vital processes could be ascertained, which must in the nature of things be true, like the propositions of geometry, or if any physiological laws could be found, based on a sufficiently wide induction to give them authority as standards, like the laws of gravitation in astronomy, or of definite proportions in chemistry, this would be a great aid both to the comprehension and to the advance of the science. And though we do not intend here to enter on any such inquiry we may try whether a clearer light cannot be thrown upon some of the points on which the main interest of physiology centres.

Too much must not be attempted at once. So, dismissing for the present all other subjects connected with the living body, we concentrate our attention on the question, Whence comes its active power? Taking the body as it stands, supposing it originated, developed, and nourished, by means which we do not now consider, we ask ourselves, Can we find the reason of its spontaneous activity?—why action should go on within it, and force be exerted by it on the world around?

There is a term we shall find it convenient to use in this inquiry, and may, therefore, briefly define. The actions of a living body are called its "functions." One of these functions is muscular motion, whether external or internal; another is the nervous action; and a third includes various processes of secretion. The growth and nourishment of the body we do not include among the "functions," as we propose to use the term.

We inquire, then, why the living body has in itself a power of acting, and is not like the inert masses of merely inorganic matter? And here let us first observe, that some other things besides the animal body possess an active power. "It died last night," exclaimed the Chinaman, in triumph, on selling the first watch he had ever seen. And certainly a watch is like an animal in some respects.

Under certain conditions, it has an active power as like that of the heart as could readily be devised, What are those conditions? They are very simple. It must contain a spring in a state of tension: that is, force must have been applied to it in such a way as to store up power, by opposing the tendency of the metal to straighten itself. Let us fix in our minds this conception of a tension, or balancing of two forces in the watch-spring. The power applied in winding it up is exerted in opposing the elasticity of the steel: it is compressed—coerced. The production of motion from it, when in this state, is a quite simple mechanical problem: let it unbend, and let wheels and levers be at hand to convey the force where it may be desired.

Let it be observed that the force thus exerted by the spring, and on which the "functions" of the watch depend, is truly the force that is applied by the hand in winding it up. That force is retained by the spring, as it were in a latent state, until it is applied to use: it exists in the spring, as tension—a state intermediate between the motion of the hand in bending it, and of the hands of the watch in their revolutions. But the motion is the same throughout. It is interrupted and stored up in the spring; it is not altered. We may say, that the tense spring is the unbent spring *plus motion.* It embodies the force we have exerted. It is not the same thing as it was in its relaxed state; it is more. And it can only pass again into the unbent state by giving out the force which has been thus put into it.

Steam is an instance of a similar thing. Water, in passing into vapour, absorbs or embodies no less than 960 degrees of heat. Vapour is not the same thing as water; it is more—it is water plus heat. Nor can it return into the state of water again, without giving out all this heat. Vapour, therefore, in respect to force, is like a bent spring, and water is like the spring relaxed.

And further, as a bent spring *tends* constantly to relax, and will relax as soon as it is permitted, or as soon as ever the force which keeps it bent is taken away, so does vapour constantly tend to return to the state of water. It seeks every opportunity, we might say, of doing so, and of giving out its force. Like the spring, it is endowed with a power of acting. Let but the temperature of the air be cooled, let a little electricity be abstracted from the atmosphere, and the force-laden vapour *relaxes* into water, and descends in grateful showers.

In the vapour, heat opposes the force of cohesion. It is not hard to recognize a tension here; the heat being stored up in the vapour, not destroyed or lost, but only latent. And when the rain descends, all this heat is given off again, though perhaps not as heat. It may be changed in form, and appear as electricity for example, but it is the same force as the heat which changed the water into vapour at the first. Only its form is changed, or can be changed.

Now the living body is like vapour in this respect, that it embodies force. It has grown, directly or indirectly, by the light and heat of the sun, or other forces, and consists not of the material elements alone, but of these elements *plus force.* Like the vapour, too, or like the spring, it constantly tends to give off this force, and to *relax* into the inorganic form. It is continually decaying; some portion or other is at every moment decomposing, and approaching the inorganic state. And this it cannot do without producing some effect, the force it gives off must operate. What should this force do then? what should be its effects? What but the "functions?"

For the force stored up in the body, like all force, may exist in various forms. Motion, as the rudest nations know, produces heat, and heat continually produces motion. There is a ceaseless round of force-mutation throughout nature, each one generating, or changing into, the other. So the force which enters the plant as heat, or light, &c., and is stored up in its tissues, making them "organic"*—this force, transferred from the plant to the animal in digestion, is given out by its muscles in their decomposition, and produces motion: or by its nerves, and constitutes the nervous force.

In this there is nothing that is not according to known laws. The animal body, so far, answers exactly to a machine such as we ourselves construct. In various mechanical structures, adapted to work in certain ways, we accumulate, or store up, force:

* As heat, we may say, makes water "gaseous."

we render vapour tense in the steam-engine, we raise weights in the clock, we compress the atmosphere in the air-gun; and having done this, we know that there is a source of power within them from which the desired actions will ensue. The principle is the same in the animal functions: the source of power in the body is the storing up of force.

But in what way is force stored up in the body? It is stored up by *resistance* to chemical affinity. It is a common observation, that life seems to suspend or alter the chemical laws and ordinary properties of bodies; and in one sense this is true, though false in another. Life does not suspend the chemical or any other laws; they are operative still, and evidence of their action is everywhere to be met with; but in living structures force is employed in opposing chemical affinity, so that the chemical changes which go on in them take place under peculiar conditions, and manifest, accordingly, peculiar characteristics. If I lift a heavy body, I employ my muscular force in opposing gravity, but the law of gravity is neither suspended nor altered thereby; or if I compress an elastic body, my force opposes elasticity, but the laws of elasticity are not thereby altered. In truth, the forces of gravity and elasticity thus receive scope to operate, and display their laws. Just so it is in the living body. The force of chemical affinity is opposed, and thereby has scope to act; its laws are not altered, but they operate under new conditions. Owing to the opposition to chemical affinity, the living tissues ever tend to decompose; as a weight *that has been lifted* tends to fall.

But the living structures are not the only instances, in nature, of bodies which tend to decompose. There are several in the inorganic world: such are the fulminating powders (iodide or chloride of nitrogen, for example), which explode upon a touch. There is a strong analogy between these and the living tissues. In each case, there is a tendency to undergo chemical decomposition; in each case, this decomposition produces an enormous amount of force. Explosive powders may be compared to steam that has been heated under pressure, and which expands with violence when the pressure is