

results; we can, as it were, play upon this beautifully adjusted mechanism, so as to produce at will the balancing or this stimulus against that one—the results, as expressed in the movements of the animal, being so many exemplifications of the mechanical principle of the parallelogram of forces.*

As we proceed through the animal series we find nervous systems becoming more and more integrated; nerve-centres multiply, become larger, and serve to innervate more numerous and more complex groups of muscles. It is, however, needless for me to devote space to describing this advance of structure, because the subject is one belonging to comparative anatomy. It is enough to say that everywhere the nervous machinery is so arranged that, owing to the anatomical plan of a nerve-centre with its attached nerves, there is no alternative of action presented to the nerve-centre other than that of co-ordinating the group of muscles over the combined contraction of which it presides. The next question, therefore, which arises is—How are we to explain the fact that the anatomical plan of a ganglion, with its attached nerves, comes to be that which is needed to direct the nervous tremours into the particular channels required? The following is the theory whereby Mr. Herbert Spencer seeks to answer this question, and in order fully to understand it we must begin by noticing the effects of stimulation upon undifferentiated protoplasm. A stimulus, then, applied to homogeneous protoplasm, which is everywhere contractile and nowhere presents nerves, has the effect of giving rise to a visible wave of contraction, which spreads in all directions from the seat of stimulation as from a centre. A nerve, on the other hand, conducts a stimulus without undergoing any contraction, or change of shape. Nerves, then, are functionally distinguished from undifferentiated protoplasm by the property of conducting invisible or molecular waves of stimulation from one part of an organism to another, so establishing physiological continuity between such parts without the necessary passage of visible waves of contraction.

Now, beginning with the case of undifferentiated protoplasm, Mr. Spencer starts from the fact that every portion of the colloidal mass is equally excitable and equally contrac-

* For a full account of these experiments, see *Croonian Lecture, Phil. Trans.*, 1882.