

expression of anatomical observations and theories representing an enormous amount of research, labour, and ingenuity, but they involve no new line of reasoning, and they belong, accordingly, more to the history of Science than to that of Thought.

The first to attempt a mechanical explanation of the process of cellular division was Mr Herbert Spencer,<sup>1</sup> who, in his 'Principles of Biology' (1863), pointed out that there exists a limit of growth through assimilation or intussusception, inasmuch as volume and mass increase at a greater rate than the surrounding surface through which communication with the environment is afforded. A resultant tension brings about an increase of surface through rupture, and restores the balance between the contained mass and the surface. In his analysis of this process of readjustment, Spencer has given mechanical

45.  
Spencer's  
law of limit  
of growth.

<sup>1</sup> The principle here referred to sometimes goes under the name of the Leuckart-Spencer principle, it having been suggested independently by Rudolf Leuckart, Herbert Spencer, and Alexander James. It requires, of course, a great many qualifications. See the 'Principles of Biology,' vol. i. part 2, chap. i. But "it follows from these considerations that the cell can never surpass a certain size; for if the disturbance of metabolism that arises because of the increasing disproportion between the more superficial and the deeper layers has reached a certain extent, the cell can no longer continue living in its existing form. Thus the remarkable fact is explained very simply, that no cells of constant form are known that are larger than a few millimetres in diameter, and thus we are made to understand why the development of

large organisms is only possible by the arrangement of the living substance into an aggregate of small cells instead of into a single cell, for example, of the size of a man. . . . If, therefore, the living substance of such a cell is not to perish by growth, at some period in its growth a correction of this disproportion between mass and surface and of the disturbance of metabolism conditioned by it must come in: such a correction is realised in the reproduction of the cell by division. The reproduction of the cell by division is accordingly to be considered merely as a result of growth, and the morphologists for a long time have rightly termed reproduction a continuation of growth, 'a growth beyond the measure of the individual'" (Verworn, 'General Physiology,' Engl. transl., p. 530, &c.)