
On Growth and Form

This voluminous book is an enlarged and revised edition of the book of the same title published twenty-five years ago. The problems of growth and form are discussed purely from the standpoint of mathematics and physics. In the words of the author his "sole purpose is to correlate with mathematical statement and physical law certain of the simpler outward phenomena of organic growth and structure or form, while all the while regarding the fabric of the organism as a material and physical configuration." The following paragraph contains samples of topics discussed and conclusions reached.

The total resultant force which the bird employs for its support varies empirically as the square of the air speed. Man is ruled by gravitation, whereas the surface of a pool is a matter of life and death to a water beetle. In the world where the bacillus lives gravitation is forgotten, whereas the viscosity of the liquid, molecular shocks of the Brownian movement and electrical charges of the ionized medium are all of great importance. The form of an organism is determined by its rate of growth in various directions and is an "event in space-time." The cell is a sphere of action of localised forces, of which surface tension is the most important in giving the cell its shape and individuality. The actual conformation of the cell usually is the complex resultant of surface tension, acting together with gravity, mechanical pressure, osmosis and other physical forces. The unique beauty of a soap bubble depends upon the absence of such forces from the field, the resulting form is in such a case so simple that we come to regard it as almost a mathematical abstraction. The various morphological characteristics of the tiny polyp have their parallels in the surface tension phenomena of the splash. The figure produced by using a hanging drop, which while it sinks remains suspended to the surface is analogous to that of a medusa or jellyfish, with its umbrella and manubrium. Flagella, cilia, chitinous hairs, etc., tend to occur where the surface tension would be least, were the surface fluid. Cell membrane and cell wall formation is the result of adsorption. In tissues or cell aggregates surface tension manifests itself in the minimum area which the circumstances of the case permit. Thus in a mass of soap bubbles enclosed in a narrow vessel with flat sides of glass, in a plane section of vegetable parenchyma, and on the surface of a honeycomb the cell walls meet by threes, at angles of 120° , forming hexagonal cells. This arrangement mathematically and physically, provides minimal surface. The efficient architecture of the bee cell is due to mechanical forces rather than to any planned economy on the part of the bee. The Nautilus, snail shell and Globigerna grow as equiangular spirals, rather than as the spiral of Archimedes. Shell forms which are mathematically identical are found in all geological periods, regardless of climate and on shores and in ocean depths. The quadruped skeleton has two balanced cantilevers, one supported on the fore-legs and the other on the hand. The skeletal construction of the bird is more complex, part of the time the whole weight is borne by the legs, and part of the time by the wings. Coordinate geometry may be of considerable value in illustrating differences between related forms.

The various subjects are treated along strictly physical and mathematical lines. Thus heredity and various physiological phenomena are not considered. Geometric and physical principles are discussed at length. Growth is considered in relation to magnitude, "as a phenomenon at the end of a morphological rather than at the beginning of a physical inquiry." While not offering solutions to any major biological problems, this book is a prolific source of unique and interesting material. The reader will likely learn more geometry and physics than biology.—*D. C. Rife.*

Growth and Form, by D'Arcy W. Thompson. xvii+1116 pp., 554 illus. MacMillan Co., New York, 1942. \$12.50.