tive constituents of living systems, Bonner invokes the ultimate microconstitution. Biologists always manifest an unusual penchant for hoping that chemists and physicists will promote their fields to the clarification of biology. When the biologists think usefully in precise instead of generally descriptive analogies, the significance of chemical and physical fundamentals will be biologically applicable. Bonner has considered selected morphogenetic examples from the entire biological field. He has stressed the cardinal factors which focus attention on the development of form. Although he may be accused of superficial treatment, he has picked his materials wisely.

The provocative points revolve around oversimplified definitions and bring to our attention our own shortcomings in this regard. For example:

> Growth is the increase in size in living matter, involving the intake and storage of energy by new protoplasmic synthesis. . . . Morphogenetic movements are migrations of the protoplasm without synthesis of living materials. . . . Differentiation is an increase in the detectable differences in chemical composition (resulting from synthesis) of parts of an organism which occurs between one time during development and another time.

It is not fair to remove these passages from context. There is in most cases sufficient textual amplification to give a much better picture than expressed here, but the primary definitions should carry a greater degree of precision than is expressed.

The discussion of size and pattern is illustrated mainly by plants. The analogy with crystals, with a clear consideration of surface-volume relations, serves as a fitting interlude for the discussion of physics and chemistry in development. The complexity of the energetics, as Bonner points out, will not of itself explain development. Other physical aspects, such as surface tension, crystallization, or diffusion, are considered as possible parts of the picture of change. Their possible nature in the living system is discussed. This is subject, of course, to the necessary modifications imposed by the biological system, which seems to have an unerring way of never being as completely dependent upon the physical conditions as we would like to have it be. Growth in all its diversity has been discussed. The problems of intrinsic control, genic control, hormonal control, and internal configuration are all touched upon. The logical conclusion is evident that we do not know how the genes and the protoplasmic components manage to create the perfect pattern of growth.

The succeeding chapter deals with the patterns of morphogenetic movements. The synthesis of descriptive reactions moves smoothly through the entire first part, which deals with plants, but as we turn to animal development the picture is not nearly so sharp. The tendency is to accede to a much simpler formalization of vertebrate eggs than is at present possible. Much study will be necessary before the reactive components can be isolated and their relative import on development known.

When the discussion comes to patterns of differentiation we find that "differentiation" is used without any specific reference to the structure involved. The pattern is different from the process by which it has become a pattern, a resultant determination without process of becoming. In attaining differentiation we again must consider the multiple factors that are at work. Bonner points out that there are different levels of differentiation, which may be arrived at independently—although not necessarily so. It is a corollary to this that the pattern of differentiation may also follow a like rule.

Bonner deserves our thanks. He makes no pretense of giving the answer to the problem of form. He has, however, placed it succinctly before us and has focused attention on what we do not know but need to know before a more definite answer can be given to the significant factors underlying the formative pattern of development which results in the specific form of the organism.

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