The Use of Physical Concepts in Teaching Biology

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Much of biology consists of applied chemistry and physics; yet the most of our elementary biology is taught today without making adequate use of these sciences, particularly the latter. There are several reasons for this: (1) the limited basic training of the teachers, (2) the meager background of the students, (3) the inertia of the teachers, (4) the failure of most biological textbooks to use correct chemical or physical explanations. In these modern times with so much emphasis on the physical sciences in our daily lives, we are derelict in our duties if we fail to use these sciences adequately in our biology teaching.

One phase of physics most neglected (and which will serve as an example) in the teaching of biology is that of molecular motion and diffusion. The following statements are frequently heard and accepted in our classes: "Plants take in and give off water"; "The body gives off carbon dioxide through the lungs"; "The capillaries take food from the alimentary tract." Not only are these statements inadequate but they obscure the physical phenomena which are involved, and they perpetuate misconceptions of long standing.

It is not too difficult to get children of average intelligence to visualize that the world and its inhabitants are composed of various minute particles, molecules, *all of which are in motion.* It is a concept which they cannot get too early in life, and it is most fundamental to an understanding of the universe in which they live. Nor is it impossible for the students to visualize living membranes: the tissues of a root, the lining of the lungs, the wall of a blood vessel, etc., serving as screens through which the various molecules move with more or less freedom. For instance, a water molecule generally passes through a living membrane more readily than a sugar molecule. Even though both may pass through, they do so quite independently of each other.

The relative number of molecules of a given substance which are bombarding the two sides of a membrane at any given time determines the direction in which the greater number of molecules of this substance will pass through the membrane. For example, if there are more water molecules hitting the root membranes from the soil solution on the outside than from the sap on the inside of the root, the net result will be an increase in the amount of water in the root system as a result of diffusion. This phenomenon (further exemplified in the following paragraphs) is often referred to as *osmosis.*

Another example is the diffusion of glucose into the blood stream from the intestines. If as a result of ingestion and digestion, the number of glucose molecules which hit the lining of the intestines from the interior is increased over those which are bombarding it from the blood, the net result will be an increase of glucose in the blood.

The movement of soluble foods from the capillaries to the individual cells can be satisfactorily explained on a similar physical basis. It must not be forgotten that the molecules of each substance

move independently of the molecules of every other substance.

The loss of water from plants into the surrounding atmosphere (transpiration) is due to the fact that there are more water molecules from the plant sap bombarding and passing through the membranes separating the interior of the leaf from the atmosphere (intercellular space) than there are water molecules passing into the leaf from that same atmosphere. Should the atmosphere become saturated more water might move into the leaf from the exterior than would be leaving.

Factors which cause the concentration or speed of molecules to change will indirectly affect the rate of diffusion. Thus, the addition of fertilizers (solutes) to soil water (solvent), digestion, a change of temperature, a change in atmospheric humidity will each affect some of the diffusion phenomena described above.

One of the many advantages of the above physical concepts is that they place the action where it belongs: "*the molecule* of water moves into or out of plants" rather than ascribing it to the tissue or organism: "*the plant takes in* and *gives off water.*"

While it is admitted that there are still higher levels of interpretation, the above explanations more nearly approximate the facts than those more frequently used and therefore are more stimulating to further inquiry. They certainly lead the student to a better understanding of his universe.

Nursery Inspection—A Form of Applied Biology

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Biology teachers are frequently called upon to justify their teaching subject in the school program. They should also be prepared to point out to their students, especially those interested in following up biology as a career, the multitudinous ways in which biology plays an important part in the broad fields of medicine, agriculture, plant and animal industries, and conservation. In recent years more and more emphasis has been given to the economic and cultural aspects of biology. It is realized that for the general student it is much more important to understand the role of biology in his civic life than to know the details of earthworm anatomy or the names of frog musculature. Textbooks often devote a chapter to the importance of biology to the welfare of modern man. The common applications are well known, but little or nothing has been written about the field of nursery inspection which should receive attention by educators.

Nursery inspection is important in the field of biology teaching for three reasons. First, landscaping is no longer confined to wealthy estates but is rapidly becoming a part of the maintenance of the average American home. Nurserymen who formerly propagated ornamentals for large-scale landscaping have found that the best market now is producing smaller plants suitable for the yard and house borders and gardens of the average householder. More and more homes are being planned with attention given to the outside decoration as well as to inside decoration. The