An Overture

Let's Get It (Biology) Together

Unifying concepts can be used to help us and our students organize and integrate information about biology—to get it all together. Far too often unifying concepts—continuity of life, homeostasis, evolution, structure-function relationships—appear as units in our textbooks, but they are ignored otherwise. We may mention a concept briefly at the beginning of a unit, just before we plunge into the massive body of facts packed into the unit. Generally, unifying concepts are not used as regularly or as effectively as they might be to organize the whole of biology. Some specific examples will be helpful in amplifying these points.

The CONTINUITY OF LIFE is the most general unifying concept in all biology. Continuity is maintained on a day-to-day level by homeostatic mechanisms, and from generation to generation by the process of reproduction and inheritance. On a long-term basis, continuity is maintained by the process of evolution. Yet, how many of us take this broad view of continuity of life, or if we do, how many share it with students?

HOMEOSTASIS is another important unifying concept. It can be used to integrate information from many areas of biology. Movement of materials across cell membranes and metabolic activities within cells all contribute to the maintenance of internal equilibrium within the cell. The combined functions of all the systems within an organism contribute to maintaining homeostasis in the whole organism. We could even extend the concept of homeostasis to show by analogy the importance of maintaining blance in ecosystems. If we limit our consideration of homeostasis to one class period per year, we have failed to effectively use this powerful unifying concept.

The concept of COMPLEMENTARITY OF STRUCTURE AND FUNCTION also affords us many opportunities to organize information. When introducing a structure, and giving its name and function, we also need to help our students see that the structure is closely related to function. From the arrangement of enzymes with mitochondria, to the compatibility of male and female reproductive organs, to the forms of appendages adapted for walking, swimming or flying, structure and function are complementary. Such complementarities abound throughout biology and contribute to higher-level concepts. The structure and function of mitochrondria contribute to homeostasis by maintaining a constant energy supply. Structure-function relationships in reproductive organs contribute to successful reproduction and transmission of inherited characteristics. Structure function adaptations of limbs contribute to the process of evolution. Together, all of these relationships help to maintain continuity of life.

The concept of LEVELS OF COMPLEXITY also helps to organize biology. All the concepts mentioned above can be illustrated at every level of biological complexity from molecules to populations.

Finally, the whole of life can be viewed as taking place in the environment and interacting in many ways with it. In figure 1, the environment is represented by the entire boxed area. Within the environment, unifying concepts of biology are represented in a hierarchical sequence. The idea of hierarchical concepts is developed further in the work of Novak (1977).

How to Use Unifying Concepts

As teachers, we can do several things to help our students use concepts to organize and integrate information. First, we can organize our own thinking. Perhaps each of us could start

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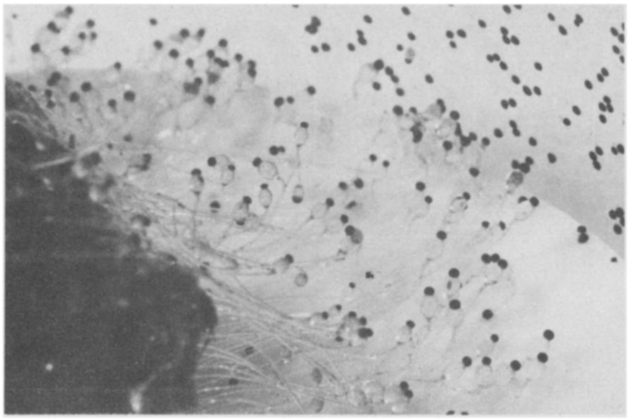

FIGURE 6. Sporangiophores and sporangia of *Pilobolus* growing on horse dung. Notice the released sporangia attached to the wall of the moist chamber on the upper right.

4). Microscopic examination of this zone of sexual interaction generally reveals all stages of sexual development. Mature zygospores are surrounded by black, dichotomously branched appendages that grow out from the suspensors (fig. 5).

Pilobolus is one of the most unusual and most strikingly beautiful of all organisms, despite its humble habitat—horse dung. *Pilobolus* is also one of the easiest to demonstrate. Place some fresh horse dung in a moist chamber and expose it to light from one direction. A succession of fungi will develop on dung, but one of the first is *Pilobolus*. It generally makes its appearance within a few days after the dung is placed in the moist chamber. Numerous sporangiophores will be observed, all directed toward the light source as they are strongly phototropic.

Phototropism is accomplished by means of swollen, transparent, subsporangial vesicle. This fluid-filled vesicle acts as a lens to focus light rays on a carotene-rich photoreceptive region at the base of the vesicle. If light falls on one side of the vesicle, the sporangiophore will soon to make a corresponding realignment.

Usually around mid-day, these fungal canons begin to explode, as the increasingly turgid vesicles rupture. The sporangia are shot towards the light source and attach to the wall of the moist chamber (fig. 6). They can be projected horizontally up to two meters. This distance can be determined by laying down white paper towards the light source in front of the partially opened moist chamber and subsequently locating the small black specks (sporangia). In nature, the sporangia are shot away from the dung where they are formed and may land on vegetation where they are more likely to be consumed by local herbivores. Spore release and germination are promoted within the digestive tract of herbivores.

You will not see a more spectacular organism under a dissecting steremicroscope than *Pilobolus* with its transparent, yellow, turgit sporangiophores laden with water droplets.

A study of the organisms described above should provide students with an interesting glimpse into the unappreciated world of the lower fungi. It might also stimulate some students to further investigate these fascinating organisms.

A very useful reference on laboratory studies of numerous lower fungi was recently published; it is: *Lower Fungi in the Laboratory,* edited by M. S. Fuller, Department of Botany, University of Georgia, Athens 30602.

Getting It Together

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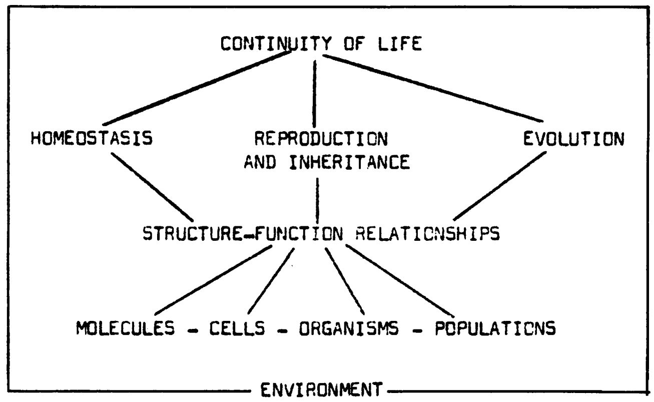

FIGURE 1. An example of a concept map

by making her/his own concept map similar to the one shown in figure 1. Each map should reflect the views of the maker about what concepts are most important and most unifying. It should also illustrate interrelationships among concepts.

Second, we can give our students a copy of our concept map and discuss it with them. Perhaps students will be able to contribute ideas on how things fit together in their minds and suggest ways to improve the map.

Third, we can purposely relate topics considered in each class to the concept map. In this way, each class discussion will not only increase the students' factual information, but also their understanding of how the new information fits into the unifying concepts of biology.

Finally, we might have our students create their own concept maps and add to them periodically as they increase their understanding of biology. The whole class might prepare and regularly revise a wall-size concept map. As teachers, we might find it instructive to observe the growth of student-prepared maps and to compare maps from class to class and from year to year.

Making use of these suggestions could help us and our students to get it all together.

Joan G. Creager, *editor*

Reference

NOVAK, J.D. 1977. *A theory of education.* Ithaca, New York: Cornell University Press.