The Catholic High School and the BSCS Program

• *Sister Mary Ivo, BVM, The Immaculata, Chicago, Illinois*

One of the most stimulating papers presented to the NABT at the AAAS meetings in Denver, December, 1961, is this paper by a teacher of the BSCS Blue version materials. In it, the author describes the responsibility of the Catholic high schools in improving the teaching of biology.

In a recent article Dr. Bentley Glass stated that we are living in an age of revolution, a scientific revolution which is bringing far greater changes than the Industrial Revolution did over the past two centuries. This twentieth century revolution has ushered in the eras of atomic power and space launching and will, scientists predict, yield more momentous biological discoveries than have any of the changes that have affected man's life through the advances of the physical sciences in the first half of our century. Since 1900 biology shows a growth pattern far beyond normal, and in looking to the future one can hardly speculate what will be found. This past progress is but a beginning; it is a dream to the awakening of the fulfillment of man's potentialities. The scientist of today is indeed a pioneer.

We who are here today are also pioneers. We are pioneering in an educational movement—the BSCS, which promises to open new vistas to our students and which indeed may change the course of their futures.

Now where do we religious teachers fit into the pattern of this tremendous new scientific revolution? My answer to this question is still another question. Have we grown professionally along with the biological advances? To this challenging adventure with its great promises and its still greater implications for the future, we cannot be mere bystanders. We cannot run the risk of missing the significance of a single key phase. We have compelling obligations. Our Holy Father Pope Pius XII was the first to make us realize this with his pertinent message " . . . that we are to be teachers of professional competency above average, better still, outstanding on all levels of instruction." Now he did not exclude science from his remark. He said, " . . . all levels of instruction."

Cardinal Cushing of Boston recently stated that theologians (and here I think that the Cardinal could have included religious teachers as well) were failing to keep abreast with the scientific explorations and discoveries. "The failure of theologians to join forces with the scientists" the Cardinal said, "was the cause for the estrangement of religion and science." Another well known clergyman, The Reverend Theodore Hesburgh, president of Notre Dame University, stated that the vitality of Catholic learning in any era must be seen in the light of its influence on that era. "What must future judges think of us if we live in the most exciting age of science and then philosophize mainly about Aristotle's physics?" Father Hesburgh then continued with the startling remark, "Must we always be the last to initiate anything new and imaginative, anything intellectual . . . the first in those obvious causes like anti-Communism and old clothing drives? We took the wrong turn in the road of science as far back as Galilee and we are still lagging behind."

Here are expressed the sentiments of three outstanding leaders of the Catholic Church in reference to modernizing our teaching and learning of science. Religious teachers have security in their positions in the Catholic school system, but this is all the more reason why we must not allow ourselves to grow intellectually apathetic. That Catholic school enrollments have increased approximately 500% since 1900 reveals the Catholic parents' trust in us as educational leaders. Are we worthy of this trust? Catholic schools, wherever it is posible, must incorporate scientific progress into their educational program, for leadership in the scientific field constitutes a major strength of a democratic nation.

A staggering figure of some 2,000,000 students take biology each year and an equally staggering figure come away from the introductory course without enough interest to take a second course. One asks why? Some educators believe that the endless factual materials presented in the traditional course make it boring. Laboratory work consists primarily of collecting and looking at preserved slides and specimens. Students perform experiments to prove points that they have already memorized. They poke away at frogs, which for the most part are the pickled type: they recite a great deal of rote material, learning little of the processes by which life exists; yet it is these life processes that fascinate. Traditional biology is not taught as an exact science; little or no quantitative results are sought.

In contrast, the BSCS texts are a complete departure from the phylogenetic approach. The authors have organized facts of biology around a few ideas so that the student gets a better grasp of the whole. Acknowledging that it is impossible to cover all the facts of biology, they have abandoned touring the whole plant and animal kingdom. The authors also realize that dogma has little place in science and that it is detrimental to an experimental attitude; so the avoidance of dogma is the first goal of the curriculum. This attitude is beautifully exemplified in the first chapters where the evidence of the heterotroph hypothesis is presented. The BSCS supports and encourages the spirit of inquiry in students. Investigating, examining, and questioning is the core of the program. It is the second goal of the curriculum.

Last, the tremendous avalanche of material has been sifted and a series of conceptual themes has been selected for the framework of the three versions. Evolution is the warp and woof of the BSCS program. Facts of fossil discoveries, mutations, and variations have little meaning as individual quanta of knowledge, but when considered as parts of a whole they become highly significant in understanding evolution. The Green, or ecological version, traces the evolution of forms and how they relate to one another. The Yellow, which is the developmental and genetic version, compares structures and types. Lastly, the Blue version, consists of a physiological and biochemical approach emphasizing cellular activity in all living matter. This version is drastically different from the other two versions challenging both student and teacher. Academically it is the most demanding of the three texts, dealing with methods of thinking and of analyzing problems. Since I am working with the Blue version, I shall confine remarks to this text.

The present edition is divided into three parts, each containing some eleven or twelve chapters. The book begins by introducing the student to the nature of scientific knowledge and the method of solving a problem. This is followed by a chapter on living things and how they are classified. From here on the evolutionary theme prevails. Darwin's theory of natural selection and the heterotroph hypothesis are developed chapter by chapter. It is a distinct advantage to present this hypothesis because it is so deeply rooted in chemical evolution and provides the opportunity to develop the necessary concepts from the inorganic to the organic. The hypothesis is further developed to include the problems of energy utilization as it relates to primitive life on earth. Oparin's sixth and seventh assumption introduces DNA and how this material applies to self duplication, coding, and variation. There is an unravelling of structure at cellular and subcellular levels and a complete elucidation of that trigger mechanism, ATP, by which chemical energy derived from primary oxidation is stored and then released for such diverse functions as movement, uptake of nutrients by active transport, transmission of impluse, and in the lower animals, bioluminescence and bioelectricity. Again the evolutionary theme is developed in photosynthesis; it becomes more meaningful to the students when they do the accompanying experiments with *Chlorella* and autotrophic bacteria. Respiration is discussed after photosynthesis on the assumption that oxygen-related metabolism evolved after the autotrophs. Part 1 concludes with a completely modern view of the cell, both morphologically and physiologically.

Because of two new factors—the tremendous breakthrough in chemistry and physics and the resulting development of instrumentation—molecular biology has emerged as a new and exciting subject in the Blue Version of the BSCS. Since approximately 65% of the time is spent on specific experiments that fit into the overall pattern of the text, one can easily see that the laboratory is accentuated. Here is where the work of science is done, where methods are transmitted, where one learns which question can be answered fruitfully; here is where one learns why science insists on precise measurements, accurate observations, and clarity of communication. Because the BSCS is a quantitative program, the same quantitative techniques used in chemistry and physics are used to answer the biological question of "How much?" For example, until recently the origin of the oxygen that evolves in photosynthesis was not understood. Did it come from carbon dioxide or did it come from the water. Scientists finally solved the problem by using oxygen of two different weights, one being incorporated into the carbon dioxide and the other into the water. The evolved oxygen that came from the photosynthesizing plant was weighed and found to be the oxygen derived from the water. This is not a high school experiment, but research contributions like this powerfully enrich the course and stimulate the students. The laboratory manuals that accompany each part of the text provide opportunities for the students to make actual measurements and to interpret them, to make observations, and to chart graphs. Many of the experiments are simple exercises in measurements but they give the lab work a fascinating vitality.

What are the needs of a teacher who is thinking of adopting this text? Really nothing more than what the ordinary science teacher already has, surely an average amount of scientific knowledge and a receptive mind. While a background of organic chemistry is not necessary, it is certainly most helpful. One is encouraged to read widely in all current scientific journals and to keep abreast with the newest discoveries. James Harlow recently wrote, "Perhaps the most frightening aspect of America's predicament with respect to education in the sciences is the possibility if not the probability that fewer than 10% of the precollege teaching staff holds any real awareness of the basic nature of science."

This problem is becoming increasingly grave. Those of us who took our degrees fifteen or more years ago are presenting a material that lacks modern concepts. Modern biology does not confine itself to elementary facts and generalizations; it constitutes something broader, something larger; it reflects the principles of science as a whole. The BSCS with its emphasis on modern biology contributes to the development of attitudes and skills that are functional, that stimulate conceptual thinking, and that consequently lessen the students' dependence on the teacher. And have not all students the right to become self educable? Herein is the dynamic force of the BSCS program: it takes a subject that has been made trite by reliance on outmoded, weak, descriptive teaching techniques and catapults it to the level of a modern experimental science.

Cover Picture

Bees occasionally build a honeycomb in an exposed manner unlike their usual use of enclosed cavities. Built in a small "Manzanita" tree in California and photographed by E. T. Kendrick, 401 36th Street, Richmond, California, with Ansco All Weather film, Minolta Twin-Lens, one-twenty fifth, at 5.6.

Mathematics in Biology

The 25 trillion red blood cells in a human make up about half the blood volume and would occupy a volume of about two liters. What is the volume of one red blood cell?

A wooden panel immersed in sea water at Miami will develop a bacterial population of 40 live bacteria per square micron after 24 hours. How many bacteria would there be on a panel 10cm x 20cm after 24 hours?

An adult male housefly weighs 3.8 mg. How many adult male houseflies would be needed to total one pound?

Research Costs

During the years 1941-1956 the U.S. expenditure on research climbed from $900 million to $4 billion annually. Roughly 95% of this goes into exploiting previous scientific breakthroughs, perhaps 5% into expanding the storehouse of fundamental knowledge.