ONLINE ARTICLE

Biology First:

A History of the Grade Placement of High School Biology

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A recently held symposium, "Biology—A Capstone Science Course," explored the future of high school biology education in light of the "Physics First" reform movement (Biological Sciences Curriculum Study, 2004). Physics First has questioned the teaching of the sciences in the traditional biology-chemistry-physics (B-C-P) order and aims at providing a more "logical and coherent" science experience for students by inverting the traditional order of subjects. Proponents of Physics First view biologists as natural allies in their campaign, arguing that changing to a physics-chemistry-biology (P-C-B) sequence allows students to build a foundation for studying biology from previously studied physics and chemistry courses. Consequently, biology would become the "Capstone Science."

The history of high school biology education has been thoroughly documented (Finley, 1926; Christy, 1936; Rosen, 1959; Hurd, 1961; Mayer, 1986; Rosenthal & Bybee, 1988; Pauly, 1991). These histories and the Capstone Biology symposium, however, did not explain how and why biology became the first course in the traditional science order, nor did they describe the impact this grade placement had on the development of high school biology. With a growing number of high schools exploring Physics First curricular options, which necessitate changing the grade placement of biology, it seems an opportune time to consider these issues.

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Before Biology

There was a substantial period of time when biology, as a distinct subject, did not exist in American high schools. In the nineteenth century, there was no biology per se, but there were natural history courses, which were eventually replaced by separate courses in the biological sciences, namely botany, zoology and physiology (Table 1).

In the late 1800s the grade placements of the various biological sciences were erratic. Physiology was invariably taught in the freshman year. Botany usually appeared in the second or third year, although occasionally it was offered in the senior year. Courses in zoology were evenly distributed throughout the grades. In most schools, there was no relationship between the grade placements of zoology and botany, nor was the content of the two subjects correlated

(Stout, 1921). This situation changed, however, when the separate courses of botany, zoology, and physiology were replaced by a new single course called biology.

Table 1. The percentage of schools in the North Central states offering various biological sciences, 1860-1900.

Time Period	Natural History	Zoology	Botany	Physiology
1860-1865	25	20	70	85
1866-1870	30	20	75	75
1871-1875	20	40	85	85
1876-1880	30	45	85	95
1881-1885	12	40	72	92
1886-1890	No data	64	97	87
1891-1895	5	37.5	82.5	80
1896-1900	2.5	42.5	82.5	70

Data from Stout, 1921.

The Origins of General Biology

The origins of general biology can be traced to events that transpired in New York in the first decade of the twentieth century (Pauly, 1991). At this time New York City schools almost exclusively taught two separate half-year courses in botany and zoology. In 1899, the New York State Board of Regents created a syllabus for a generalized course in biology, and then offered the first Regents Exam in biology in 1906. George W. Hunter (1873-1948), a biology teacher at DeWitt Clinton High School, New York City, emerged as an important figure in the development of a generalized biology course. In 1907, he published the first of several high school textbooks titled *Elements of Biology*, which sought to "place the topics required or suggested by the Regents' syllabus into a connected form" (Hunter, 1907). Hunter combined the subjects of zoology, botany, and physiology into a single text. This text became a primary source of high school biology and had a significant impact on the acceptance of the general biology course. Hurd remarked on the influence of the new biology course:

> *By 1910 ... 1.1 percent of all high school students were enrolled in the course [Biology]. The separate subjects of botany, zoology and physiology were beginning to lose enrollments both from the lack of pupil interest and inroads of the new course. The "new" biology course, although it was established to present a unification of botany, human physiology and zoology, was actually three sub-courses combined in a one-year sequence.* (1961, p. 27)

The course became firmly rooted in the high school curriculum during the next few decades. General biology evolved with subsequent textbook revisions, as the content became more coordinated and less of a mixture of botanical and zoological topics. By 1914, the College Entrance Examination Board had created an examination for biology, solidifying its position as a standard high school science course and as a part of a college preparatory education. Biology appeared in national education statistics from 1915 onwards and its progress in terms of course offerings, grade placement, and student enrollment can be traced from this point forward. But why was biology placed early in the order?

The Grade Placement of Biology

The story of how biology came to be placed early in the high school science curriculum dates back to the first national committees on education. In 1892, the National Educational Association (NEA) created the so-called Committee of Ten to make recommendations about high school curricula. The impetus for this committee was the desire to rectify problems of the haphazard high school course offerings and a lack of a clear articulation between high schools and colleges. The Committee was organized into nine subcommittees representing different academic subject areas. There were three science subcommittees, one for physical science (physics, chemistry, and astronomy); one for natural history (botany, zoology, and physiology); and one for geography (physical geography, geology, and meteorology).

In this pre-biology era, the natural history subcommittee recommended that students take physiology in the later years of high school. It also recommended a full year of either botany or zoology and stipulated that the subjects should *not* be combined into one course. It preferred zoology for the lower grades and botany in high school, though the subcommittee made no recommendation about the grade in which it should be offered (NEA, 1893). The physical science subcommittee recommended that both chemistry and physics be taught in the last two years of high school. The Committee of Ten compiled the recommendations from all the different subjects and created several possible programs of study for high school. It also made some modifications to the grade placements of the individual sciences. The final recommendations for science courses with their specified grade placements are shown in Table 2.

In order to implement the Committee of Ten recommendations, the NEA created the Committee on College Entrance Requirements (CCER). In 1899, the CCER proposed new college admission criteria, recommending that all colleges state their admission requirements in terms of national units, in which one unit would consist of a year of study of at least four periods per week (this unit would later become the Carnegie Unit). As a result, high school science subjects became single-year courses, while at the same time in Europe, high school sciences were taught over multiple years. The adoption of the credit system also constrained high schools to offer only one science subject per year. In its recommendations for high school science programs the CCER largely followed the final Committee of Ten recommendations about grade placements and proposed physical geography in 9th grade, zoology and/or botany in the 10th

Table 2. Committee of Ten Recommendations for high school science.

YEAR	CLASSICAL Three foreign languages (one modern)	LATIN-SCIENTIFIC Two foreign languages (one modern)	MODERN LANGUAGES Two foreign languages (both modern)	ENGLISH One foreign language (ancient or modern)
I.	Physical Geography	Physical Geography	Physical Geography	Physical Geography
II.	Physics	Physics **Botany or Zoology**	Physics **Botany or Zoology**	Physics **Botany or Zoology**
III.		Astronomy 1/2 yr. & Meteorology 1/2 yr.	Astronomy 1/2 yr. & Meteorology 1/2 yr.	Astronomy 1/2 yr. & Meteorology 1/2 yr.
IV.	Chemistry	Chemistry Geology or Physiography 1/2 yr. And **Anatomy, Physiology & Hygiene 1/2 yr.**	Chemistry Geology or Physiography 1/2 yr. And **Anatomy, Physiology & Hygiene 1/2 yr.**	Chemistry Geology or Physiography 1/2 yr. And **Anatomy, Physiology & Hygiene 1/2 yr.**

The Committee of Ten proposed four possible courses of study for high schools, based on the number and type of languages that would be studied. The Table shows the science sequences it recommended. Students were to take all the sciences listed in a course of study, so that at least 20% of their school time was to be spent in science. Notably, in the Classical course, considered the most rigorous at the time, all biological sciences were omitted with preference given instead to the study of Greek. In none of the proposed programs was Physics offered last.

grade, physics in 11th grade, and chemistry in 12th grade (NEA, 1899). Significantly, this Committee also recommended that only one year of science should be required for high school graduation and that additional sciences be electives.

Over the next 20 years, biology displaced botany and zoology, while physical geography was eventually replaced by general science, which came into being to both provide a foundation for the new biology course and to act as a terminal science class for students taking only one year of science. High school physics and chemistry courses were controlled by the colleges, with college professors, for instance, writing virtually all their textbooks. The New York Association of Biology Teachers argued that the existing botany, zoology, and physiology high school courses were too abstract and impractical because they had acquired the formalism of college courses and as such were unsuitable for secondary school students. The new biology and general science courses were created in the high schools with their textbooks written by high school teachers (Rosen, 1959). The content of the new courses was adapted to the interests, needs, and experiences of the high school students and reflected the growing progressive beliefs of the early 1900s that education should be less formal and more child-centered.

Administratively, the general biology course became especially popular as it allowed schools to efficiently replace a host of smaller courses, such as botany, zoology, and physiology with a single course. The one-year course also fit well into the Carnegie Unit system of accounting of high school courses, which was universally adopted after 1909 (Tompkins & Gaumnitz, 1954). Indeed, the new biology course was so successful that when the next National Education Committee (the Committee on the Reorganization of Secondary Education) met in 1920, it formally recommended that biology be included and that it be taught before physics and chemistry (NEA, 1920). Its recommendation was simply following what had become the accepted practice of the day.

The Practice in the Schools

While the various national committees were highly influential, schools were not mandated to follow their recommendations and could offer the sciences in whatever order they deemed appropriate. Interestingly, it was George W. Hunter, who in a series of studies surveyed the status and placement of high school science courses (1910, 1924a-b, 1931, 1934, 1941, 1942). The results of his studies showed that while biological subjects were still offered in all grades in 1908, over the years biology became concentrated in the earlier grades (see Figure 1).

By 1950, eighty percent of all biology courses were offered in 10th grade (United States Office of Education, 1950). This grade placement was not static, however, and eventually biology began to move down a grade (Yager, 1963). Placing biology in the early years of high school had an obvious and immediate impact on its enrollment.

Impact on Enrollment

The rise of biology and the fall of other biological sciences in high school programs are reflected in student

Figure 1. The percentage of general biology courses offered in the 10th grade. Data from the Hunter studies (1910, 1924a-b, 1931, 1934, 1941, 1942) and U.S. Office of Education (1950)

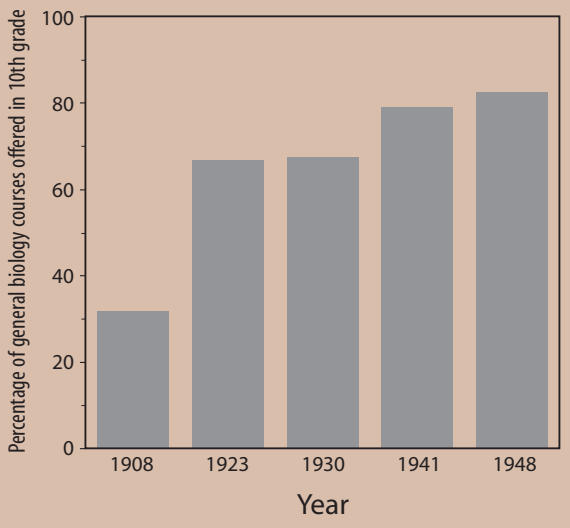
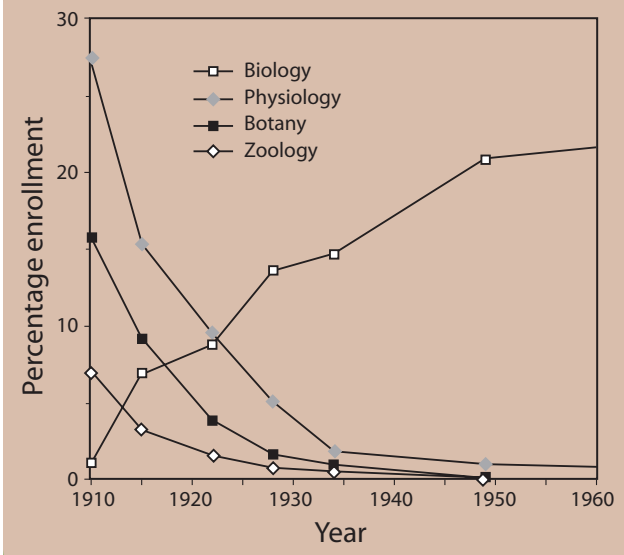


Figure 2. The percentage enrollment of high school students, 1910-1960. Data from Wright, 1965.



enrollment data. Figure 2 illustrates the dramatic rise in the percentage of high school students enrolled in biology after its inception at the expense of physiology, botany, and zoology.

The percentage of high school students enrolled in zoology and botany plummeted. By 1936, with so few students enrolling in zoology and botany, they were eliminated as College Board examination subjects. Conversely, biology thrived and quickly surpassed chemistry and physics in enrollment. By World War II, more students received credit in biology than in chemistry and physics combined (Sheppard & Robbins, 2003). By the time of *Sputnik*, the majority of high school students graduated with a credit in biology. Much of the enrollment success of biology can be attributed to its grade placement.

The Changing Nature of Biology Education & the Order

The relative grade placements of chemistry and physics were much debated in the late nineteenth century, while the placement of the biological sciences provoked little discussion. Botany was placed before the physical sciences not because of any intrinsic value of the subject, but because that is where a space existed in the program of studies. The newly-created biology course created in the early twentieth century was largely descriptive, non-technical and practical. It was created to be taken in the early years of high school.

Over the next half century, the subject of biology changed dramatically as new scientific advances in evolution, genetics, biochemistry, etc. were made and these developments were eventually incorporated into biology curricula and textbooks. It is these scientific developments that have brought into question the order in which the sciences are taught in high school.

BSCS suggested at its inception more than four decades ago that modern biology requires some understanding of chemistry and physics (Rudolph, 2002). There have been many articles written that have questioned the logic of continuing to teach high school sciences in the traditional biology-chemistry-physics order (see for example, Palombi, 1971; Gaudin, 1984; Haber-Schaim, 1984; Lederman, 1998, 2001). The National Research Council (2002) recognized that the twenty-first century will be the century of biological and medical discoveries and noted that, "Life science majors must acquire a much stronger foundation in the physical sciences (chemistry and physics) ..." (p. 1). The relationship of biology to the physical sciences is changing and it seems likely that high school biology will adapt to its new scientific and educational environment and evolve to become the Capstone Science course.

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