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the teaching of

GENERAL BIOLOGY

In the Public High Schools of the United States

*An Inquiry into Offerings, Enrollments, Course Organization, Facilities,
Equipment, and Expenditures, 1949-50*

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Foreword

THE REPORTS on *Offerings and Registrations in High-School Subjects* which have been issued periodically since 1890 by the Office of Education have furnished information on the courses offered in the secondary schools of the country and on the number of pupils enrolled in these courses. Because of the large number of schools involved and the great variety of courses offered, it has not been feasible in these reports to provide specific information on the nature of the courses, how the courses were organized for instructional purposes, and the types of facilities and instructional aids which were used in teaching the courses.

This study was designed to obtain general information on the courses in the biological sciences which were offered in a representative sample of the public secondary schools of the United States in 1949-50, and specific information on the important quantitative and qualitative aspects of the course in general biology as it was taught in these schools.

The information which is summarized in this report should prove useful not only to profes-

sional educators, such as teachers, administrators, and members of curriculum committees, but also to those who are concerned with the planning of "functional" school facilities and with furnishing essential equipment and supplies for use in the instructional program.

The Office of Education is deeply grateful to the secondary school principals and to the teachers and supervisors of the biological sciences who supplied the data on which this report is based. Without their intelligent and willing cooperation, this report could not have been prepared.

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the teaching of GENERAL BIOLOGY

In Public High Schools of the United States



THIS STUDY reports on the courses in biological science offered in public high schools, enrollments in the courses in general biology, number of teachers of general biology, organization of the courses, nature of the laboratory work, laboratory and supplementary facilities, the equipment used in teaching the courses, appropriations for equipment and supplies, and innovations and problems related to the teaching of general biology.¹ The findings are based on data collected for the school year 1949-50, from a representative sampling of the Nation's public high schools.

Nature of the Sample

The sample used in this study was a stratified random sample of the public secondary schools of the country, exclusive of separately administered junior high schools, in which the schools were selected according to size and type of school. The sample included 1,072 of the 21,300 junior-senior, senior, regular, and undivided public high schools of continental United States. A total of 851 schools responded to the questionnaire. Of these schools, 786, or 73.3 percent of the sample, provided information which was used in preparing this report. Returns with usable data were received from schools in each of the 48 States and from the District of Columbia. The smallest number of returns with usable data from any State was 1 from Arizona and 1 from Nevada. The largest number of returns from any State was 54 each from New York,

¹ In the development of the plan for this study, the author received valuable assistance from the following members of the National Association of Biology Teachers and the National Association for Research in Science Teaching: John Beneshman, Emporia State Teachers College; Francis D. Curtis, University of Michigan; Charlotte L. Grant, Oak Park High School; John P. Harrell, Millard Senior High School; Elsiebeth L. Weather, Central Michigan College of Education; D. F. Miller, Ohio State University; Oscar Riddle, Union of American Biological Societies; and Leo R. Yostson, Railway Public Schools. The author also wishes to acknowledge the helpful cooperation given by various members of the staff of the Office of Education.

Ohio, and Pennsylvania. Some of the responses from the schools were not used in this study; 12 schools reported that general biology was offered in alternate years, but did not supply complete information on the course; 11 schools offered the course in general biology each year, but returned the questionnaire with incomplete information about the course; 21 schools reported that general biology was not offered; and 21 schools were reported as closed or consolidated. Only 221 schools, 20.6 percent of the sample, failed to respond. The 851 schools that responded constituted 4.0 percent of the public secondary schools of the United States, and the 786 schools that reported usable data constituted 3.7 percent of the Nation's public high schools.

Table 1 shows the number of public high schools of different types in the country, exclusive of the separately administered junior high schools, with the number of pupils enrolled in them, and the number of schools of different types with their enrollments, which supplied the data used in this study.

Table 2 shows the number of public secondary schools of different sizes in the United States and the number of schools of different sizes which supplied information for this study.

The sample was more closely related to all public high schools in terms of the sizes of the schools than it was to the types of schools. For this reason the data submitted by the schools were summarized, and they are presented in most of the tables in the report, on the basis of size of school rather than on the type of school.

Throughout the report the term "small high school" is used to designate those schools with enrollments of fewer than 500 pupils; and "large high school" to designate those with enrollments of 500 pupils and more.

Table 1.—Public high schools in the United States and number returning data, by type of school

Type of school	In the United States				Returning data			
	Schools		Pupils enrolled		Schools		Pupils enrolled	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7	8	9
Junior-senior and undivided.....	6,222	22.2	1,782,202	21.7	202	22.2	97,911	22.2
Senior.....	1,217	6.2	1,129,471	20.5	114	14.5	129,129	22.0
Regular.....	12,925	64.0	2,694,922	47.8	410	62.2	214,659	42.8
Total.....	21,264	100.0	5,606,595	100.0	726	100.0	441,700	100.0

¹ Exclusive of separately administered junior high schools, ungraded schools, and high schools with fewer than 10 pupils enrolled. From *Statistics of Public High Schools, 1945-46*, Biennial Survey of Education in the United States, 1944-46, Ch. v, table 9, p. 20-22.

Table 2.—Public high schools in the United States, number in the sample, and number returning data, by size of school

Size of school	Public high schools					
	In the United States		In the sample		Returning data	
	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7
1-99 pupils.....	8,841	41.6	223	21.7	114	14.5
100-299 pupils.....	7,005	37.1	219	20.8	254	32.3
300-499 pupils.....	1,013	5.0	147	13.7	129	16.4
500-999 pupils.....	1,491	7.0	169	15.2	138	17.6
1,000-1,499 pupils.....	558	2.6	92	8.6	72	9.2
1,500 and over.....	504	2.5	118	11.0	79	10.0
Total.....	21,300	100.0	1,073	100.0	796	100.0

¹ Exclusive of separately administered junior high schools, ungraded schools, and high schools with fewer than 10 pupils enrolled. From *Statistics of Public High Schools, 1948-49*, Biennial Survey of Education in the United States, 1944-46, Ch. v; table 2, p. 22-23.

A higher percentage of large high schools was sampled than small high schools for two reasons. Previous studies conducted by the Office of Education had shown that in the small high schools the course in general biology was usually offered in alternate years, while in the large high schools it was offered each year. The study was designed to obtain information on the qualitative as well as the quantitative aspects of the course as it was taught in the high schools of the country for the school year 1949-50. Since the course was more likely to be offered in large high schools and information would be more readily available in these schools, the proportional representation of these schools in the sample was increased. In addition, a higher percentage of the large high schools than of the small high schools in the sample returned usable data.

Course Offerings in the Biological Sciences

The primary purpose of this study was to obtain data on the course in general biology as it was taught in a representative sample of the public secondary schools of the country in the school year 1949-50. Since the instruction in general biology is an integral part of the instruction in other courses in science, it was necessary to secure some information on these other courses and on specific aspects of the science-related activities of pupils in order to interpret the data relating to the qualitative aspects of the course in general biology. This information is incorporated in the report in the sections to which it is most directly related.

The Course in General Biology

The course with the title general biology, or an equivalent course with a different title, was offered in 809 schools, 95.1 percent of the schools

which responded to the questionnaire. A total of 729 of these schools reported that the course was offered each year; and 80 schools offered the course in alternate years.

Twenty-three of the schools which offered the course did not supply complete information about it. The information from these schools was not used in the summaries which follow.

The information summarized in the report is based on the data supplied by 786 schools which offered the course in general biology, and which supplied usable data on the various aspects of the course covered in the questionnaire.

These 786 schools are distributed according to their types and sizes in tables 1 and 2, and they are designated throughout the report as "the schools which offered general biology."

Courses Offered Other Than General Biology

The extent to which the high schools in the sample were offering courses in the biological sciences, in addition to general biology, during the school year 1949-50 is shown in table 3.

A total of 40 different courses in addition to general biology was reported by the 786 schools. A separate course in health, offered either in the biology department or in the physical education department, was reported most frequently. Of the schools offering general biology, 373, or 47.4 percent, reported that separate courses in health were offered from a minimum of 1 semester during the 4 years of high school to a maximum of every semester throughout these years.

The course in advanced biology offered in the eleventh or twelfth grades in 60 schools, 7.6 percent, is a comparatively recent addition to the curriculum. It is offered more frequently in large high schools than in small high schools. According to the comments of teachers written in on the questionnaire, the course has been added in some of these schools to meet the needs of general education pupils for a terminal course preparing them for more effective home and family living and for more intelligent participation in our democratic society. In other schools, the course gives specialized training for college and the professions.

A separate course in conservation was reported much more frequently by the small high schools than by the large schools. There is no apparent uniformity in regard to the grade in which this course was offered. In some schools it was offered in the upper grades of the high school; in others it was offered as a ninth-grade subject. Many teachers commented that although conservation was not offered as a separate course it was emphasized in the general biology course and in other science courses.

The extent of the emphasis on problems of conservation in the general biology course is shown in table 17.

The highest number of courses in biological sciences in addition to general biology reported by any one school for the year 1949-50 was four. These courses were: Invertebrate zoology, vertebrate zoology, botany, and physiology reported by one large urban school.

The majority of the public high schools of the country offer only one course in biological science during the school year. This course is general biology or its equivalent. A total of 80 small high schools reported that this course was not taught each year, but that it was offered in alternate years, or that it was part of a 3-year sequence of biology, chemistry, and physics.

Some of the newer courses which were reported as having been added to the curriculum of the secondary schools in the last 10 years are the following: Advanced biology, genetics, home nursing, first aid, conservation, greenhouse practice, laboratory techniques, and life science-consumer problems.

Table 3.—Courses in biological science offered in addition to general biology, by size of school

Courses in biological science	Schools with enrollment of —									
	1-50 pupils		100-200 pupils		200-400 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7	8	9	10	11
Schools offering general biology	114	100.0	254	100.0	129	100.0	209	100.0	706	100.0
Health.....	22	19.3	124	48.8	71	55.0	115	55.1	332	47.4
Agriculture.....	45	39.5	137	53.9	51	39.5	61	29.2	294	41.9
Hygiene.....	21	18.4	44	17.3	20	15.5	31	14.9	116	16.4
Physiology.....	11	9.6	15	5.9	7	5.4	44	20.6	77	11.0
Advanced biology.....	8	7.0	18	7.1	11	8.5	25	11.9	62	8.8
Conservation.....	14	12.3	29	11.4	8	6.2	13	6.2	64	9.1
Nature study.....	6	5.2	12	4.7	5	3.9	13	6.2	36	5.1
Botany.....	8	7.0	4	1.6	3	2.3	15	7.1	28	4.0
Zoology.....	1	.9	4	1.6	3	2.3	14	6.6	22	3.1
Other.....	10	8.8	21	8.3	9	7.0	43	20.3	83	11.8

Thirty-one different courses, each of which was offered in fewer than 5 schools, are classified under "Other" in table 3. Some of these, such as botany III and IV, advanced zoology III and IV, college biology, invertebrate zoology, vertebrate zoology, genetics, laboratory techniques, and psychology, obviously offer specialized instruction as training for college or for the professions. Others, such as home nursing, first aid, personal hygiene, personal science and personal regimen, and consumer problems in life science, are offered to meet the need of general education pupils.

Requirements in Science

The amount of science offered in a school is not a reliable index of the amount of instruction which a graduate of that school has received in science, since in many schools part or all of the science offered is either elective, or is required only in specified curricula.

Data on the extent to which science courses were required for graduation from high school and in particular curricula; the amount of biological science which could be used to satisfy these requirements, and the extent to which the course in general biology was used to satisfy the science requirements in the schools offering general biology are given below.

Science Requirements for Graduation

Information on the number of schools requiring work in science in the college-preparatory, the vocational, and the general education curricula, and the number of these schools which specified that biological science should be included in this requirement is shown in table 4.

A total of 572 schools, 72.7 percent of the schools offering general biology, required science in the college-preparatory curriculum; 369 schools, 46.9 percent, required science in the vocational curricula, and 511 schools, 65.0 percent, required some science in the curriculum for general education. A total of 326 schools of different sizes, 41.5 percent, reported that some biological science was required as a part of the science requirements for graduation from high school. In 313 of these schools the requirement could be satisfied by 2 semesters, or less, of a biological science, but in 13 schools, a pupil had to take more than 2 semesters of a biological science to satisfy the requirement.

Table 4.—Semesters of science required in various curricula, and number of schools requiring biological science

Semesters of science required	Schools requiring science in—						Schools requiring biological science	
	College-preparatory curriculum		Vocational ¹ curricula		General education curriculum			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1								
2	53	9.1	44	12.0	67	13.1	41	12.6
3	260	45.0	168	45.1	250	48.7	272	83.5
4	34	5.9	13	3.5	10	2.0	6	1.8
5	178	31.1	84	22.8	112	22.0	6	1.8
6	3	0.5	3	.8	2	.4	—	—
Over 6	58	10.1	19	5.1	13	2.5	1	.3
Over 6	13	2.2	13	3.5	17	3.3	3	.9
Total	572	100.0	369	100.0	511	100.0	326	100.0

¹ Includes the following curricula: Agriculture, commercial, home economics, nursing, industrial arts, and fine arts.

Information on the extent to which the course in general biology was used to satisfy these requirements in biological science is given in the section which follows.

Curricula in Which General Biology was Required

Information on the number of schools requiring general biology of all pupils and those requiring the course in the college-preparatory, the vocational, and the general education curricula is given in table 5.

Of the 786 schools which offered general biology and gave information on the course, 326, 41.5 percent, stated that the course was required of all pupils or in one or more of the curricula offered in the schools. The course was offered as an elective in 423 schools, 53.8 percent of those offering biology. The course was required in the college-preparatory curriculum in 41.1 percent of the schools, 36.6 percent required it in the vocational curricula, and 32.8 percent required it in the general education curriculum.

The course was required much more frequently by small high schools than by large high schools. It is probable that the reason for this lies in the fact that large high schools have a greater variety of offerings in the biological sciences than do small high schools, and they are not limited to one course in this area when they are setting up requirements.

Enrollment and Class Size in General Biology

The information which is summarized in this section of the report relates to the grades in which general biology was offered in the schools reporting, the number of pupils enrolled in the course, and the size of the

Table 5.—Requirements in general biology, by size of school

Size of school	Schools offering general biology	Schools requiring general biology—								Schools not requiring general biology	
		Of all pupils		In curricula							
				College-preparatory		Vocational ¹		General education			
Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
1	2	3	4	5	6	7	8	9	10	11	12
All sizes.....	786	340	43.1	326	41.1	258	34.6	268	32.8	423	53.8
1-99 pupils.....	114	64	56.1	71	62.3	65	57.0	62	54.4	39	34.2
100-299 pupils.....	304	98	32.6	137	45.0	108	35.5	99	32.6	124	40.8
300-499 pupils.....	139	32	23.0	45	32.4	30	21.6	30	21.6	75	53.9
500 and over.....	229	51	22.3	89	38.9	76	33.2	68	29.7	124	53.7

¹ Includes the following curricula: Agriculture, commercial, home economics, nursing, industrial arts, and fine arts.

biology classes in these schools. No information was obtained on enrollment and class size in other courses in the biological sciences which were offered in the schools.

Enrollment in General Biology, 1949-50

Table 6 shows the number of schools which offered general biology in specified grades, the total number of pupils enrolled in the grades in which biology was offered, and the number of these pupils enrolled in general biology.

In the 786 schools which offered general biology, there were 441,749 pupils enrolled in grades 9, 10, 11, and 12. A total of 95,669 of these pupils, 21.65 percent, were enrolled in the course in general biology.

Because of the different combinations of grades in which general biology was offered, it was impossible to determine the total number of pupils from any one grade who were actually enrolled in the course during the school year 1949-50. However, approximately 59 percent of the schools offering general biology offered the course in the tenth grade only, and 76 percent of the pupils enrolled in the tenth grade in these schools were enrolled in the course.

If all the grade combinations are considered in which the tenth grade was included as one of the grades in which general biology was offered, then a total of 695 schools, 88.4 percent of the schools offering biology, offered it to tenth-grade pupils.

Approximately 4 percent of the schools offered the course to ninth-grade pupils only, and 77.8 percent of the pupils in the ninth grade in these schools were enrolled in the course. Fifty-one other schools offered the course in combinations of grades which included the ninth grade.

Table 6.—Grades in which general biology was offered, number of pupils enrolled in these grades, and number enrolled in general biology

Grades in which biology is offered	Schools offering the course in the grades		Pupils enrolled					Pupils enrolled in—		
	Number	Percent	Ninth grade	Tenth grade	Eleventh grade	Twelfth grade	Total	Grades in which biology is offered	Biology in these grades	
									Number	Percent
1	2	3	4	5	6	7	8	9	10	11
9.....	33	4.2	3,187	3,374	2,728	2,744	12,068	3,187	2,490	77.8
9 and 10.....	45	5.7	5,474	6,115	4,091	4,095	23,048	11,559	4,392	37.9
9, 10, and 11.....	6	.8	681	688	688	458	2,199	1,058	383	36.8
10.....	425	54.1	55,673	73,199	67,790	59,237	300,830	78,100	39,418	50.8
10 and 11.....	47	6.0	4,144	7,025	6,419	5,644	23,812	14,034	4,747	33.8
10, 11, and 12.....	130	16.5	20,530	31,785	23,181	24,045	104,494	32,044	21,475	25.6
10 and 12.....	2	.3	255	275	201	225	1,246	670	347	51.8
11.....	10	1.3	741	614	452	295	2,120	493	459	93.5
11 and 12.....	40	5.1	2,635	2,667	2,999	2,992	11,214	5,401	1,524	28.5
12.....	8	1.0	197	1,038	683	884	3,003	884	610	67.7
Total.....	786	100.0	92,769	122,699	115,179	100,296	421,749	200,205	95,669	47.7

Ten schools, 1.3 percent, offered the course to eleventh-grade pupils only, and 98.5 percent of the pupils in the eleventh grade in these schools were enrolled in the course. The course was offered in combinations of grades which included the eleventh in 223 other schools.

The course was offered to twelfth-grade pupils only in 8 schools, and 57.7 percent of the twelfth-grade pupils in these schools were enrolled in the course. The course was offered in combinations of grades which included the twelfth grade in 172 other schools.

Many of the schools offered additional courses in biological science during the school year 1949-50 (table 3); therefore the total number of pupils who were enrolled in biological sciences would be higher than that shown in table 6, which is limited to the enrollments in the general biology course.

Trends in Enrollment in Biological Sciences Since 1900

The periodic reports made by the Office of Education on the offerings and registrations in high-school subjects give information on the enrollments in the various science subjects and enrollments in the different years of high school.¹ This information furnishes some evidence as to the trends in the subject-matter areas involved. A summary of the information on the percentage of pupils in the last 4 years of high school enrolled in biological science and in related courses since 1900 is given in table 7.

Biology was first reported as a subject, separate and distinct from botany and zoology, in 1910. In that year a total of 1.1 percent of the pupils enrolled in the last 4 years of high school were reported to be taking courses in biology. If the enrollments in zoology and botany are added to that for biology, then a total of 23.8 percent of the high-school pupils were enrolled in these three courses in the biological sciences during that year.

In the 786 schools in the sample used in this study, and covering the school year 1949-50, 441,749 pupils were enrolled in the last 4 years of high school. A total of 95,669, or 21.7 percent, of these pupils were enrolled in the course in general biology or its equivalent. Information on the number of pupils enrolled in the other courses in biological science which were offered in these schools during 1949-50 was not obtained. However, the fact that 21.7 percent of the pupils enrolled in the high schools in the sample were enrolled in general biology alone, and that many of the schools reported from one to four other courses in biological

¹ Some other studies containing information on the offerings and enrollments in science subjects are: Riddle, Oscar, Ed. *The Teaching of Biology in the Secondary Schools of the United States*. Union of American Biological Societies, Cold Spring Harbor, N. Y., 1942. 76p.
Johnson, Philip G. *The Teaching of Science in Public High Schools*. Federal Security Agency, Office of Education, Bulletin 1950, No. 9. Washington, U. S. Government Printing Office, 1950. 48p.

Table 7.—Enrollments in biological science and related courses in the last 4 years of public secondary day schools, 1910-50

Year reported	Pupils enrolled in biological sciences											
	Total number of pupils enrolled in schools reporting		Physiology		Agriculture		Zoology		Botany		Biology	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1910	3	4	5	6	7	8	9	10	11	12		
1915	729,143	14.3	94,418	4.6	51,270	6.9	116,467	15.8	7,893	1.1		
1920	1,185,486	9.8	82,573	7.1	37,456	3.2	198,520	9.1	86,485	6.9		
1925	2,184,480	6.1	110,343	5.1	32,663	1.5	82,241	2.9	199,285	2.8		
1930	2,866,030	2.7	108,025	3.7	29,183	.8	64,062	1.6	268,201	12.6		
1935	4,496,514	1.8	108,793	2.6	27,278	.6	41,675	.9	454,200	14.6		
1940	104,551	1.0	294,125	6.7	4,061	.1	7,670	.1	52,104	12.5		
1945	5,329,422								985,200	12.4		
1950	441,749								95,689	11.7		

1 Based on data derived from *Overviews and Enrollments in High School Subjects, 1915-49*, Biennial Survey of Education in the United States, 1949-50, Ch. V, p. 107-108.
 2 Based on data derived from *The Teaching of Science in Public High Schools, 1947-48*, p. 7, (Office of Education Bulletin 1950, No. 6)
 3 Total enrollment for all public secondary day schools in the United States for the school year, 1948-49.
 4 Based on the sample used in this study.

science offered during the same year, would seem to warrant the conclusion that practically all of the pupils entering our high schools take at least one course in biological science during their high-school years. In the majority of cases this course is general biology, or its equivalent, taken in the tenth grade (table 6).

Furthermore, from other data given in the reports on offerings and registrations but not shown in table 7, it is evident that biology is the only science course offered in the high school which has shown consistent increases in enrollment in relation to the general increase in high-school enrollments throughout the period for which information is available. This is true as regards the actual number of pupils enrolled in the course, as well as the percentage of pupils in the last 4 years of high school enrolled in the course. All of the other science courses have shown either marked decreases in enrollment or in percentages, or slight and intermittent increases which are not proportional to the gains in the total enrollment in the schools reporting.

Class Size in General Biology, 1949-50

Information on the number of pupils enrolled in general biology, the number of sections of the course, and the average enrollment in each section for the first and the second terms of 1949-50 is summarized in table 8.

This table shows that there was a direct relationship between the size of the high-school enrollment and the average class size for general biology.

When the average enrollments in the sections (classes) for schools of different sizes are compared, it is apparent that the large high schools with enrollments of more than 500 pupils, with an average of 30.67 pupils per section in the first term and 30.63 for the second term, had the largest classes in general biology. Some of the classes in these schools had more than 50 pupils in them (table 9). Since about 79 percent of the pupils taking general biology were enrolled in schools of this size it is apparent that the majority of the pupils taking general biology in these schools are in classes of 30 or more pupils.

When the average enrollments in each section for schools of different types are compared, it is apparent that the largest sections were in the senior high schools. The average enrollment for each section for all types of high schools was 29.32 pupils for the first term and 29.10 for the second term; the average for senior high schools for the first term was 32.85 and for the second term, 33.21.

The drop in enrollment in general biology between the first and the second terms, involving 2,423 pupils, can be accounted for in many ways. Chief among these are the following: many of the large high schools had midyear promotions and graduations. This resulted in a number of

pupils completing the second half of the year's course in general biology at the end of the first term. None of these pupils, except those who failed the course, would enroll in the course during the second term of the year.

It also is probable that the pupils who dropped out of the course during the first term, and those who dropped out of school because they had reached school-leaving age, would not be enrolled in the course during the second term of the year.

The net loss of 2,423 pupils between the first and second terms represents approximately 2.5 percent of the pupils enrolled in biology in the first term, and 0.54 percent of the 441,749 pupils enrolled in grades 9, 10, 11, and 12 in the schools reporting.

Table 8.—Class size in general biology for first and second terms of 1949-50, by size of school, and by type of school

Classification of schools	First term, 1949-50			Second term, 1949-50		
	Number of pupils enrolled in biology	Number of sections of the course	Average enrollment per section	Number of pupils enrolled in biology	Number of sections of the course	Average enrollment per section
1	2	3	4	5	6	7
<i>Size</i>						
1-99 pupils.....	2,155	120	17.95	2,125	119	17.85
100-299 pupils.....	2,961	366	25.00	2,533	208	24.67
300-499 pupils.....	8,940	319	28.04	8,795	328	26.81
500 and over.....	74,617	2,466	30.67	73,498	2,399	30.63
Total.....	88,683	3,271	29.23	86,951	2,934	29.63
<i>Type</i>						
Junior-senior and undivided.....	22,897	820	27.92	22,455	804	28.05
Senior.....	31,375	985	32.85	31,207	941	33.21
Regular.....	41,397	1,467	27.93	39,484	1,439	27.43
Total.....	85,669	3,272	29.22	83,146	2,984	29.19

Largest, Smallest, and Typical Class Sizes

Several national committees have recommended that in view of the nature of the instruction which should be given in science classes, class size should be limited to a maximum of 25 pupils and that under most circumstances the register should be held rigidly below 30 pupils. Information on the sizes of the largest, the smallest, and the typical classes in general biology in each school for the school year 1949-50 was supplied by 783 schools, 99.6 percent of the schools offering biology. A summary of this information is given in table 9.

If the recommendations of these national committees are accepted as valid, then 482 schools, 61.6 percent of those which responded, were not meeting this recommendation in all of their classes since the typical class

in general biology in each of these schools had from 25 to more than 50 pupils. If the size of the largest class reported by each of the schools is considered, then 552 schools, 70.4 percent had at least one class in general biology which equalled or exceeded the size recommended. Even when the size of the smallest class reported by each school is considered, 337 schools, 43 percent, exceeded the class size recommended.

If the maximum number of 30 pupils for a science class, as recommended by the national committees, is considered, then 389 schools, 49.6 percent, reported that their largest class in general biology exceeded this number of pupils; 160 schools, 20.4 percent, reported their smallest class in excess of this number; and 297 schools, 38.0 percent, reported their typical class in excess of this recommended maximum.

The largest class in general biology was 64 pupils, reported by a large urban high school with an enrollment of 1,950 pupils; the smallest was 2 pupils reported by a small rural high school with an enrollment of 86 pupils.

Information on the actual enrollments in general biology for the first and the second terms of 1949-50 and on the number of sections of the course taught during these terms is given in table 8.

Instructional Time and Methods of Scheduling

Many recent studies of the courses offered in science and in other subject areas in the high schools of the country have shown that there are wide variations in the time allotted to the same subject in different schools and in the methods of scheduling the work in the courses. These wide variations indicate that there are marked inequalities in the oppor-

Table 9.—Largest, smallest, and typical class sizes in general biology

Class size	Schools reporting—					
	Largest class		Smallest class		Typical class	
	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7
Under 10 pupils.....	56	2.8	23	4.2	29	2.7
10-14.....	55	4.6	60	7.7	36	4.6
15-19.....	62	5.0	109	17.6	70	10.0
20-24.....	107	12.7	215	27.5	169	21.1
25-29.....	193	20.8	177	22.8	185	23.6
30-34.....	197	24.1	69	12.6	209	26.6
35-39.....	130	15.8	45	5.9	60	10.2
40-44.....	51	6.5	9	1.1	12	1.8
45-49.....	7	.9	2	.3	3	.5
50 or more.....	4	.5	4	.5	3	.4
Total.....	793	100.0	793	100.0	793	100.0

tunities which are provided for pupils taking the courses. The extent to which this is true for the pupils enrolled in the general biology classes is shown in this section of the report.

Length of School Year and Class Period

The average number of weeks in the school year, for all of the schools reporting, was 36.3. The maximum was 42 weeks reported by one large high school; the minimum was 32 weeks reported by 10 small high schools. In general, the small high school tends to have a shorter school year than the large high school; the average for schools under 500 enrollment was 35.5 weeks; the average for schools over 500 enrollment was 37.7 weeks.

In 623 schools, 79.2 percent, promotion of pupils was at the end of the year only, from which it can be inferred that in approximately 80 percent of the schools of the country, the course in general biology starts in September and continues into June of the following year.

The average length of a class period, for all schools reporting, was 52.1 minutes. The maximum number of minutes of instructional time for a single class period was 83 minutes reported by a large high school; the minimum was 38 minutes reported by a small high school. In general, the small high schools had shorter class periods than the large high schools. The average for schools under 500 enrollment was 51.5 minutes; a total of 88 small high schools reported class periods only 40 minutes in length. For schools with over 500 enrollment the average length of class period was 53.2 minutes.

Instructional Time Allotted to General Biology

All but 4 of the schools in the sample reported that general biology was offered as a 2-semester course. Two of these schools offered the course for 18 weeks only, and 2 others offered it for 20 weeks. However, the fact that most of the schools offer a 2-semester course in general biology does not insure that the pupils taking the course receive equivalent instruction. This is reflected in the great range in the number of minutes of instructional time allotted to the course in schools of various sizes as shown in table 10.

This table shows that such a 2-semester course in 2 schools in the sample provides for less than 7,000 minutes of instruction per year, whereas the course in 12 schools provides for more than 15,000 minutes of instruction. The average for schools of all sizes was approximately 9,638 minutes. The minimum number of minutes reported for the 2-semester course was 4,000; the maximum was 17,100 reported by a large high school in an urban area.

Table 10.—Instructional time allotted to general biology, by size of school

Minutes of instructional time per year	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
1	2	3	4	5	6	7	8	9	10	11
Less than 7,000	1	0.0	0		2	1.6	3	1.0	6	0.8
7,000-7,499	8	7.0	9	3.5	4	3.1	7	2.5	28	3.6
7,500-7,999	5	4.4	7	2.7	5	3.9	13	4.5	30	3.8
8,000-8,499	22	19.3	40	15.7	13	10.1	37	12.8	112	14.2
8,500-8,999	2	1.7	6	2.4	3	2.3	12	4.2	23	3.0
9,000-9,499	13	11.4	26	10.2	13	10.1	22	11.1	84	10.7
9,500-9,999	11	9.6	32	12.5	28	20.5	51	17.7	132	16.3
10,000-10,499	5	4.4	19	7.5	14	10.9	44	15.2	82	10.4
10,500-10,999	21	27.2	65	25.6	23	17.8	37	12.8	156	19.9
11,000-11,499	10	8.8	19	7.5	10	7.8	22	11.1	71	9.0
11,500-11,999	0		2	.8	0		4	1.7	7	.9
12,000-12,499	1	.9	1	.4	1	.8	5	1.7	8	1.0
12,500-12,999	0		2	.8	2	1.5	3	1.0	7	.9
13,000-13,499	0		0		0		2	.7	2	.3
13,500-13,999	0		1	.4	0		0		1	.1
14,000-14,499	1	.9	1	.4	0		3	1.0	5	.6
14,500-14,999	0		0		0		0		0	
15,000 and over	4	3.5	4	1.6	1	0.8	3	1.0	12	1.5
Total	114	100.0	354	100.0	139	100.0	269	100.0	786	100.0

¹ Includes four schools which offered general biology as a 1-semester course.

Table 11.—Number of periods allotted to general biology each week and methods of scheduling these periods, by size of school

Number of periods per week	Method of scheduling periods	Schools with enrollment of—									
		1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
		Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
1	2	3	4	5	6	7	8	9	10 ¹	11	12
4	4 single	2	1.7							2	0.3
	2 double							1	0.3	1	.1
5	5 single	83	72.8	212	82.5	109	84.4	242	83.8	646	82.1
	3 single—1 double	8	7.0	1	.4	1	.8	2	.7	12	1.5
	1 single—2 double							1	.3	1	.1
6	6 single					1	.8	1	.3	2	.3
	5 single—1 single laboratory					1	.8	1	.3	2	.3
	4 single—1 double			4	1.6	2	1.5	5	1.8	11	1.4
	2 single—2 double							1	.3	1	.1
7	7 single			3	1.1	1	.8	1	.3	5	.7
	4 single—1 double	8	7.0	5	2.0	4	3.1	8	1.1	20	2.5
	3 single—2 double	10	8.8	26	10.2	9	7.0	27	9.4	72	9.2
7½	5 single—2¼ single laboratory					1	.8			1	.1
8	4 single—2 double	1	.9							1	.1
9	5 single—3 double							1	.3	1	.1
10	10 single	1	.9	1	.4					2	.3
	4 double	1	.9	3	.8			3	1.1	6	.8
Total		114	100.0	354	100.0	139	100.0	269	100.0	786	100.0

Methods of Scheduling

Information on the number of class periods per week devoted to instruction in general biology, and the ways in which these periods were scheduled throughout the week by schools of different sizes is shown in table 11.

This table shows that scheduling the course for 5 single periods per week was by far the most common method for both small and large high schools. This method of scheduling the course was reported by 646 schools, 82.1 percent of the schools offering biology. Scheduling the course for 3 single and 2 double periods per week was the second most frequently mentioned method, reported by 72 schools, 9.2 percent. There was no significant difference between the small and the large high schools in regard to the ways in which the instructional periods were scheduled. In every case where a double-period was reported the time was used for laboratory work rather than for recitation and class discussion.

Teachers, Teaching Load, Certification, and Experience

The effectiveness of the instruction in any course is obviously dependent to a large degree on the size of the classes and on the preparation and the years of experience of the teachers who are teaching the course. Information on the number of teachers of general biology, the number of pupils taught by these teachers, the preparation of the teachers, and the number of years of experience of these teachers is given in this section of the report.

Teachers of General Biology

In the 786 schools which offered general biology, the total number of biology teachers in the first term of 1949-50 was 1,236; in the second term it was 1,221 (table 12).

Table 12.—Number of classes of general biology taught each day by biology teachers in the first and second terms

Classes of biology per day	First term, 1949-50		Second term, 1949-50	
	Number of teachers	Percent	Number of teachers	Percent
1	2	3	4	5
0.....	18	1.5	22	1.8
1.....	169	13.6	165	13.5
2.....	195	15.8	179	14.7
3.....	184	14.9	178	14.6
4.....	257	20.8	255	20.9
5.....	413	33.4	422	34.5
Total	1,236	100.0	1,221	100.0

The total number of biology teachers in these schools for which information on certification was reported was 1,245 (table 14); the total for whom experience was reported was 1,273 (table 15). The apparent discrepancy between these numbers and the number reported in table 12 can be accounted for by the fact that in some of the schools promotion was in the middle of the year and new classes were organized and different teachers were assigned to teach these classes during the second semester of the school year, so that the teachers who were teaching the biology classes in the first term are not necessarily the same teachers who were reported for the second term. Another factor in the discrepancies between table 12 and tables 14 and 15 is that some of the principals, or heads of departments, who supplied the information, reported on the certification and experience of all of the biology teachers on their staffs even though these teachers were not actually teaching biology classes during the 1949-50 school year.

Table 13.—Number of biology teachers and number of pupils enrolled in general biology, by size of school

Size of school	Number of schools offering biology	Number of biology teachers	Average number of biology teachers per school	Number of pupils enrolled in biology	Average number of pupils per teacher
1	2	3	4	5	6
All sizes.....	706	1,236	1.67	94,689	77.46
1-49 pupils.....	114	115	1.01	2,155	18.74
100-299 pupils.....	254	200	1.02	8,951	34.43
300-499 pupils.....	120	120	1.08	8,846	64.38
500 and over.....	218	722	2.80	75,617	104.73

Teaching Load of Biology Teachers

The questionnaire used in this study was designed to secure information on the course offerings and enrollments in general biology, and not on the enrollments in other courses taught by the biology teachers. Consequently, the data summarized in table 12 shows only the number of classes of general biology which were taught each day by the biology teachers; it does not include other classes in biological science which were taught by these teachers.

The data summarized in table 13 show the number of pupils enrolled in the general biology course in relation to the number of teachers who were teaching the course in the first term of 1949-50.

The average number of pupils taught by each biology teacher for schools of all sizes was 77.4; the average for small high schools was 39; for large high schools, 104.7. Thus the typical biology teacher in a small high

school is responsible for one or two classes of biology a day. Since many of these schools offer only one science course each year, the remainder of the teacher's time is likely to be devoted to non-science courses. The typical biology teacher in a large high school is likely to be a full-time teacher of biology with little or no time in the school day devoted to other courses.

Table 14.—Biology teachers with a major or a minor in biological science, by size of school

Certification in biological science	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over pupils		Total	
	Number of teachers	Per cent	Number of teachers	Per cent	Number of teachers	Per cent	Number of teachers	Per cent	Number of teachers	Per cent
1	2	3	4	5	6	7	8	9	10	11
With a major.....	25	30.2	110	43.0	64	45.3	321	71.3	730	59.6
With a minor.....	55	47.4	120	45.4	45	32.0	108	23.1	358	29.2
Without a major or a minor.....	36	32.4	23	12.4	32	22.7	37	5.1	127	10.2
Total.....	116	100.0	253	100.0	141	100.0	736	100.0	1,245	100.0

Certification of Biology Teachers

Information on the number of biology teachers with a major, those with a minor, and those without certification to teach biology courses is summarized in table 14.

Of the 1,245 biology teachers for whom information on certification was reported, 1,118, 89.8 percent, had a major or a minor in biological sciences; while 127, 10.2 percent, were teaching the course without a major or a minor in biological science. Of those who were trained in the biological sciences, 65.3 percent had a major and 34.7 percent a minor in biological science.

Only 5.1 percent of the biology teachers in large high schools were teaching the course without a biology major or minor, while 17.3 percent of the teachers in small high schools were teaching without this preparation.

If training in a single science minor is inadequate as preparation for teaching that science, as has been indicated in the reports of several national committees on certification for science teaching, then only 730 teachers, 59 percent, were adequately trained for teaching biology courses at the high-school level. Of these teachers 521 were teaching in the large high schools; only 209 were teaching in the small schools.

Teaching Experience of Biology Teachers

Information on the number of years of experience in biology teaching for the biology teachers on their staffs in 1949-50 was reported by all of the schools offering biology. This information is summarized in table 15.

The average number of years of experience for the 1,273 biology teachers was approximately 10.

A total of 121 teachers, 9.5 percent, were teaching the course in 1949-50 for the first time. Of these teachers 39 were in large high schools and 82 were in small high schools.

Since the average number of biology teachers for small high schools was 1.0, it is obvious that practically all of these new teachers were starting out in their teaching careers without the benefit of the assistance and advice of other, more experienced, biology teachers on the staff in the same school.

Of the 368 teachers who had from 1 to 5 years' experience 230 were teaching in small high schools; 138 were teaching in large high schools. Thus, of the 489 teachers with less than 5 years of biology teaching, 312 were teaching in small high schools, and only 177 were in large high schools.

A total of 225 teachers had more than 20 years' experience in biology teaching. Only 22 of these teachers were in small high schools, while 203 were in large high schools.

If the quality of biology teaching is influenced by the amount of experience which the teachers have had in teaching the course, then the evidence is preponderantly in favor of the large high school having an effective course.

Organization of the General Biology Course

The manner in which a course is organized for instructional purposes is in all probability a more reliable index of the philosophy underlying the course and the major objectives sought in the instruction than the written statement of the philosophy or a listing of the major objectives.

This section of the report is concerned with the basic organization of the course in general biology and with the problem areas, or topics, which are emphasized in the course.

Basic Organization

How the course in general biology was organized for instructional purposes in the schools reporting is shown in table 16.

The course organization which occurred most frequently was that based on principles related to the whole field of biology reported by 599 schools, 76.5 percent of the schools offering biology. In 98 schools, 12.6 percent,

The course was based on specialized treatments of botany, zoology, and physiology; while in 86 schools, 10.9 percent, it was based on topics selected for their importance in daily living without reference to the field of biology. Only 3 schools reported courses which were organized on a different basis from those described above.

A comparison of the data presented in table 16 on the general organization of the course with that given in table 17 on the specific problem areas (topics) which were emphasized in the course shows that in a majority of the schools the course in general biology was actually taught as an integrated course, rather than as a specialized course covering the separate areas of botany, zoology, and physiology.

A total of 499 schools followed a basic text in organizing their general biology course; 100 followed a State course of study, and 157 followed a local course of study.

Table 15.—Teaching experience of biology teachers

Years of experience in teaching biology	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over pupils		Total	
	Number of teachers	Percent	Number of teachers	Percent	Number of teachers	Percent	Number of teachers	Percent	Number of teachers	Percent
1	2	3	4	5	6	7	8	9	10	11
Over 20.....	5	4.4	7	2.7	10	7.0	205	27.0	225	17.7
15-20.....	3	2.6	12	4.5	11	7.8	126	16.6	152	12.0
10-15.....	6	5.2	33	12.5	23	15.8	126	16.6	186	14.6
5-10.....	19	16.6	54	20.5	27	19.0	121	16.1	221	17.3
1-5.....	50	51.8	116	43.9	55	39.7	125	18.3	305	28.9
Under 1 year.....	23	20.0	42	15.0	17	12.0	30	3.9	121	9.5
Total.....	115	100.0	264	100.0	142	100.0	782	100.0	1,273	100.0

Problem Areas Emphasized

A total of 540 schools, 68.7 percent of those offering biology, responded to the question, "List the important areas, such as health, conservation, heredity, classification, etc., on which most emphasis is placed in the course, and estimate the number of days of instruction devoted to each."

In the free responses to this item in the questionnaire many problem areas which were obviously identical were given different names by the schools reporting them. For example, kinds of living things, kinds of plants, kinds of animals, classification, and taxonomy were some of the areas of emphasis reported by different schools. In the initial tabulation of the responses, each name for a problem area, as reported by the school,

was retained and recorded separately along with the amount of instructional time devoted to it. When the tabulations for all of the schools were completed, the problem areas which were reported under different

Table 16.—Organization of the General Biology course, by size of school

Type of course organization	Schools with enrollment of—										
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total		
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
	1	2	3	4	5	6	7	8	9	10	11
Based on principles	95		199		99		216		599		
Following a basic text	76	65.7	164	64.5	88	45.0	106	37.1	404	51.6	
Following a State course of study	12	10.5	18	6.3	17	13.2	41	14.4	85	11.0	
Following a local course of study	4	3.8	18	6.0	12	9.3	66	23.0	97	12.4	
Other	3	2.6	4	1.6	2	1.5	3	1.0	12	1.5	
Specialized treatment of botany, zoology, and physiology	7		26		29		63		96		
Following a basic text	4	3.6	20	7.9	12	6.3	21	7.4	57	7.3	
Following a State course of study	1	.9	3	.8	2	1.5	2	.7	7	.9	
Following a local course of study	1	.9	5	2.0	5	2.9	17	6.0	28	3.6	
Other	1	.9	1	.4	1	.8	3	1.0	6	.8	
Based on problems of daily living	12		27		29		27		96		
Following a basic text	8	7.0	16	5.5	6	4.7	10	3.5	38	4.8	
Following a State course of study	0		3	1.1	3	2.3	1	.3	7	.9	
Following a local course of study	4	3.5	8	2.1	8	6.2	12	4.2	32	4.1	
Other	0		2	.8	3	2.3	4	1.4	9	1.1	
Total	114	100.0	264	100.0	129	100.0	266	100.0	783	100.0	

Table 17.—Problem areas (topics) emphasized in general biology and the instructional time devoted to each area

Problem areas emphasized	Schools reporting problem areas and time		Number of days of instructional time devoted to area		
	Number	Percent	Minimum reported	Average	Maximum reported
All schools reporting areas	548	100.0			
Kinds of living things	321	95.3	2	49.75	180
Health, disease, and nutrition	513	94.9	4	34.16	172
Heredity, genetics, and eugenics	312	94.8	1	18.06	75
Conservation	474	87.8	2	18.98	90
Organization of living things	268	48.6	5	35.92	110
Protoplasm, cells, and life processes	240	44.4	5	33.33	105
Modification of species	75	13.9	3	13.08	70
Energy, matter, and life	73	13.5	3	17.95	80
Ecological relationships	69	12.5	2	19.22	60
Paleontology	32	5.9	4	11.25	30
Embryonic development	18	3.3	5	16.88	45
Geographical distribution of living things	4	.7	10	11.25	15
Miscellaneous	147	27.2	2	22.94	35

names but which were obviously identical were grouped together, and each group was arbitrarily assigned a name from those reported by the schools, which characterized all of the areas subsumed under it. The areas listed above were grouped together under the name, "Kinds of Living Things." The instructional times reported by each school for each separate area of emphasis classified under this name, were added together and the total time assigned to the topic. This procedure was used for each of the problem areas listed in table 17. Areas of emphasis which could not be grouped, justifiably, under the major topics are reported under "Miscellaneous" in table 17. Some of these problem areas are: Microscopic material, scientific method, vocational guidance, biological contributions, medicine, history of civilization, safety, and first aid.

Laboratory Work In General Biology

Information has not been readily available on the extent to which laboratory work is used in the instruction in general biology, the methods of scheduling this work, the amount of instructional time devoted to laboratory work, and the kinds of activities engaged in by pupils in the laboratory. The traditional pattern in biology teaching has been to allot regular days for laboratory work with single or double periods on these days used only for laboratory work. In recent years there has been a movement, particularly strong in the field of biology, to eliminate rigid laboratory schedules and to replace them either with flexible laboratory schedules, that is, laboratory work given at no scheduled period during the week, or with integrated laboratory-recitation periods, that is, laboratory work used as needed in the solution of problems.

Nature of Laboratory Work

Information on the extent to which the traditional pattern described above has been replaced by these methods is shown in table 18. A total of 768 schools, 97.7 percent, reported that laboratory work of some kind was used in teaching the course in general biology, and gave information on the ways in which the laboratory work was scheduled, the procedures used most often in conducting the work, and the type of pupil guides which were followed in performing the laboratory work. Only 18 schools, 2.3 percent of those offering general biology, reported that no laboratory work was used in the instruction.

Approximately 37 percent of the schools using laboratory work in the general biology classes had regular days on which this work was scheduled in either single or double periods. The remainder of the schools, 63 percent, have eliminated the rigid laboratory schedule and were using the flexible schedule or the integrated laboratory-recitation period.

In the large high schools the laboratory procedure used most often was individual laboratory work, while "small groups" and "pairs of pupils" performing experiments were the procedures reported most frequently by small high schools.

In the past, science teachers have been criticized for their reliance on a workbook or a laboratory manual, as a guide for the learning experiences of their pupils, and for their neglect of the problem-solving approach to scientific knowledge. In the light of this criticism, it is rather encouraging to find that only 260 schools, about 34 percent, reported that the experiments in a textbook or a workbook were followed as a guide for the laboratory experiences in the general biology course; while 495 schools, about 65 percent, reported that they were using either teacher-prepared guides, pupil-teacher planned experiments, or a problem-solving approach in the laboratory work in general biology.

In at least two of these approaches, pupil-teacher planned experiments and the problem-solving approach, the pupils participate in selecting and defining the problems to be solved, in planning the procedures and performing the experiments, and in drawing their own conclusions from the observations which they make.

Table 18.—Nature of the laboratory work in general biology, by size of school

Nature of laboratory work	Schools with enrollment of—										
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total		
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
	1	2	3	4	5	6	7	8	9	10	11
Schools reporting laboratory work used.....	169	100.0	246	100.0	177	100.0	766	100.0	785	100.0	
Method of scheduling:											
Regularly scheduled periods.....	47	43.1	97	39.4	44	34.6	93	32.5	281	36.6	
Single periods.....	29		73		31		60		193		
Double periods.....	16		23		13		31		88		
Single and double periods.....	2		1		0		2		5		
Integrated lab-recitation periods.....	35	32.1	72	29.3	49	36.6	114	39.9	270	35.2	
Flexible laboratory schedule.....	27	24.8	77	31.3	34	26.8	79	27.6	217	28.2	
Procedure used most often:											
Small group experiments.....	55	50.4	104	42.3	48	37.8	71	24.9	278	36.2	
Individual laboratory work.....	13	12.0	26	10.6	27	21.2	89	31.1	155	20.2	
Pupils paired for experiments.....	13	12.0	51	20.7	24	18.9	63	20.3	146	19.0	
Teacher demonstrations only.....	20	18.3	42	17.1	10	7.9	47	16.5	119	15.5	
Pupil observation in classroom.....	6	5.5	20	8.1	10	7.9	9	3.1	45	5.9	
Pupil demonstrations.....	1	.9	2	.8	5	4.0	9	3.1	17	2.3	
Other.....	1	.9	1	.4	3	2.3	3	1.0	8	1.0	
Following:											
Pupil-teacher planned experiments.....	45	41.3	99	40.2	55	43.3	106	37.0	305	39.7	
Experiments in a workbook (manual).....	42	38.5	83	33.8	38	30.0	68	20.3	221	28.8	
Teacher-prepared guides.....	4	3.7	20	14.6	16	12.6	96	33.6	152	19.8	
Experiments in a textbook.....	9	8.3	12	5.3	7	5.5	10	3.5	39	5.0	
Problem-solving approach.....	5	4.6	12	4.9	9	7.1	12	4.2	38	5.0	
Other.....	4	3.7	3	1.2	2	1.5	4	1.4	13	1.7	

Instructional Time Devoted to Laboratory Work

Of the 786 schools that offered general biology, 637, or 81 percent, reported on the percentage of instructional time devoted to laboratory work and 149, 19 percent, failed to report (table 19). In answer to another question, 18 schools reported that they were not using laboratory work as part of the instruction. A total of 131 schools which were using laboratory work did not report the percentage of time devoted to it. The responses from large high schools in this group indicated that with several teachers teaching biology classes of different types it was difficult, or impossible, to give a percentage which would be representative of all the different classes in the schools. For the small high schools the difficulty in reporting the time devoted to laboratory work arose from the fact that experiments and demonstrations were used only when sufficient equipment was available for use, and that the time devoted to laboratory work varied considerably from unit to unit throughout the course due to a shortage of equipment.

For those schools using laboratory work and reporting the time devoted to it the range was from a minimum of 2 percent, reported by a school with an enrollment of 916 pupils, to a maximum of 75 percent reported by 2 large high schools. The average percentage of time reported by schools of all sizes was approximately 26.4 percent.

There were no outstanding differences between large and small high schools in regard to the amount of time devoted to laboratory work, although the very small high schools with fewer than 100 pupils enrolled, and with only one class in general biology, devoted more time to laboratory work than did the other small high schools.

Table 19.—Percent of instructional time devoted to laboratory work, by size of school

Percent of time to laboratory work	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	3	3	4	5	6	7	8	9	10	11
0.....	23	20.2	59	23.3	37	21.0	40	13.8	149	19.0
1-9.....	5	4.4	13	5.1	10	7.7	15	5.2	43	5.5
10-19.....	20	17.5	41	16.1	25	19.3	45	16.6	134	17.0
20-29.....	22	19.3	69	27.2	36	28.0	79	27.3	206	26.2
30-39.....	19	16.7	19	7.5	14	10.8	33	11.4	85	10.8
40-49.....	18	15.8	28	11.0	9	7.0	23	13.2	68	11.8
50 and over.....	7	6.1	25	9.8	8	6.2	26	12.5	78	9.7
Total.....	114	100.0	254	100.0	139	100.0	239	100.0	756	100.0

¹ Includes 18 schools which reported that laboratory experiences were not used in the course, and 131 schools which used laboratory work in the instruction, but did not supply information on the time devoted to it.

These very small high schools also reported considerably larger average expenditures per pupil for biological equipment and supplies than the schools of all other sizes (table 33).

Facilities and Equipment

Adequate, well-equipped facilities are essential if an effective program of instruction is to be carried on. The extent to which such facilities were available for the general biology classes in the schools used in this study is shown in tables 20 through 24.

Types of Rooms Used for General Biology

A total of 786 schools, 100 percent of the schools returning usable data, gave information on the types of rooms in which the instruction in general biology was carried on (table 20). Four general types of rooms were reported: Combined laboratory-classrooms; laboratories which were separate from the classrooms and specially equipped for providing the characteristic experiences of science subjects; rooms equipped and used for other non-science subjects, such as English and social studies; and regular classrooms with no special provisions, such as water, electricity, and gas, for carrying on laboratory experiments and demonstrations.

Approximately 6 out of every 10 schools reported that a combined laboratory-classroom was used for the biology classes. A laboratory separate from a classroom, was reported by approximately 1 out of every 4 schools in the sample used in this study. These separate laboratories were reported more frequently by schools with from 300 to 499 pupils than by schools of other sizes. Information on the services and facilities which

Table 20.—Types of rooms used for biology instruction, by size of school

Type of room	Schools with enrollment of—										
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total		
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
	1	2	3	4	5	6	7	8	9	10	11
Combined laboratory-classroom.....	78	65.4	135	53.1	67	51.9	196	67.8	476	60.6	
Separate laboratory.....	20	17.5	77	30.3	42	32.6	77	26.6	216	27.5	
Room equipped and used for other subjects.....	11	9.7	22	12.6	6	6.2	8	2.8	59	7.5	
Room with no special provisions.....	6	4.4	10	4.0	12	9.3	8	2.8	35	4.4	
Total.....	114	100.0	254	100.0	120	100.0	209	100.0	786	100.0	

were provided in laboratory classrooms and in separate laboratories is given in table 21.

Rooms used for general biology classes but equipped for and used by other classes were reported by approximately 1 out of every 12 schools. The other subjects taught in these rooms were usually English, social studies, or health. No information was secured on the types of services and facilities which were provided in these rooms for use in teaching the "other" subjects. However, from the nature of the courses taught and the fact that many of the teachers in these schools "wrote in" criticisms of the teaching facilities, it can be inferred that these services and facilities were not the kinds which would contribute to the effectiveness of the biological instruction carried on in these rooms. Schools with from 100 to 299 pupils reported the use of this type of room more frequently than schools of other sizes.

Regular classrooms with no special provisions, such as water, gas, electricity, and demonstration tables, were used for biology classes in approximately 5 out of every 100 schools in the sample. Use of rooms of this type was reported twice as frequently by schools with from 300 to 499 pupils enrolled as by schools of other sizes.

Types of Services and Facilities Available

A total of 439 schools, 55.8 percent of those offering general biology, gave information on the kinds of services, such as running water, gas, and electricity, and the types of facilities, such as demonstration tables, storage cases, laboratory tables, and workbenches, which were provided in the rooms where biology classes were taught. Of these 439 schools, 216 reported that a laboratory, separate from a classroom, was used and gave information on the services and facilities in these laboratories; 223 schools reported the use of combined laboratory-classrooms and the services and facilities provided in them. These data are summarized in table 21.

There are no significant differences among schools of different sizes in regard to the types of services and facilities provided for biology. However, when separate laboratories and combined laboratory-classrooms are compared, the laboratory-classrooms have fewer services and facilities than the separate laboratories.

The service which was reported less frequently than the others is "gas outlets," but many of the schools without this service reported that "bottled gas" or alcohol lamps were used as sources of heat for experiments.

Less than half of the rooms where biology was taught were equipped with a workbench and tools, and there was no significant difference between the small and large high schools in this respect.

When tables 20 and 21 are compared, it is apparent that many more

Table 21.—Types of services and facilities in schools with separate laboratories or with combined laboratory-classrooms, by size of school

Types of services and facilities	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Separate laboratory	Combined laboratory-classrooms	Separate laboratory	Combined laboratory-classrooms	Separate laboratory	Combined laboratory-classrooms	Separate laboratory	Combined laboratory-classrooms	Separate laboratory	Combined laboratory-classrooms
1	2	3	4	5	6	7	8	9	10	11
All schools reporting	29	24	77	59	43	29	77	161	216	233
Running water.....	19	23	76	53	42	27	75	100	212	213
Electric outlets.....	19	31	79	52	41	29	73	94	208	206
Sinks.....	16	31	75	46	37	26	72	89	200	192
Gas outlets.....	12	18	59	29	31	21	67	84	169	163
Demonstration table.....	19	29	71	47	38	26	72	95	200	197
Storage case.....	18	31	77	45	37	25	70	91	202	192
Laboratory tables (pupil).....	16	22	70	35	36	24	74	84	196	166
Work bench and tools.....	10	18	48	23	21	13	31	42	110	96

schools reported on the types of rooms used for instruction than on the types of services and facilities in these rooms. The comments from the teachers in the small high schools for which services and facilities were not reported would indicate that these schools actually do not have the services and facilities. However, the large high schools for which facilities were not reported were those which used the combined laboratory-classroom and in many cases "inadequate facilities" were not reported by these schools as one of the conditions which seriously limited the effectiveness of the course. Hence, it can be assumed that minimum services and facilities were available for carrying on an effective program.

Supplementary School-Owned Facilities

Information on supplementary facilities, such as greenhouses, forests, camps, and gardens, which were owned by the schools and were used by the pupils in the biology classes is given in table 22.

The facilities reported in this table are limited to those which were actually owned by the schools. Many schools reported that the facilities specified were available to, and used by, their biology classes, but that they were owned by the city, State, or private individuals or organizations. These facilities are not included in the table.

Some of the school-owned facilities classified under "Other" in the table and mentioned most frequently by the schools are the following: A school campus with trees and shrubbery, an enclosed court with growing plants

and animal cages, a museum for use of all schools in the community, an athletic field with shrubbery, a small lake, large aquaria and vivaria, showcases of plant and animal specimens, a visual aids room, and a preparation room used by teachers and pupils for individual projects and experiments.

From the large number and variety of school and community-owned facilities which were reported as being used by biology classes, it is apparent that the teachers were conscious of the value of these facilities in the "functional" education of children. However, many of them reported that they were unable to use these facilities as regularly as they would like because of community or administrative disapproval, a teaching load which was too heavy, or an inflexible schedule of classes.

Supplementary Aids Used Regularly

Information on the number of schools which regularly used different types of instructional aids in general biology is given in table 23.

A total of 769 schools, 97.8 percent, used one or more of the aids listed in the table. Only 17 schools, 2.2 percent, reported that supplementary aids were not used regularly in the instruction.

Table 23.—Types of school-owned facilities used by biology classes, by size of school

School-owned facilities	Schools with enrollment of—										
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total		
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
	1	2	3	4	5	6	7	8	9	10	11
Schools offering biology.....	114	100.0	254	100.0	120	100.0	200	100.0	768	100.0	
Greenhouse.....	3	2.6	10	3.9	5	3.5	32	17.9	70	8.9	
Nature trail.....	11	9.6	20	11.4	12	10.1	12	4.5	65	8.4	
Forest.....	10	8.8	30	11.8	7	5.4	12	4.5	60	7.6	
Museum.....	2	1.8	12	4.7	5	3.9	34	11.8	53	6.7	
Farm.....	11	9.6	25	9.8	7	5.4	3	1.4	47	6.0	
Garden.....	7	6.1	12	4.1	2	1.6	16	5.8	38	4.8	
Camp.....	2	1.8	5	2.0	1	.8	2	1.0	11	1.4	
Other.....	8	7.0	17	6.7	11	8.5	28	11.4	69	8.8	

The aids which were used regularly by more than 70 percent of the schools were: Charts, preserved specimens, microscope slides, posters and pictures, and living specimens.

Of the projected aids, filmstrips were used regularly by more schools than either motion pictures or 2 x 2 slides. Approximately 67 percent of schools of all sizes used motion pictures in the instruction in general

biology; but only 37.8 percent of the large high schools, compared with 84.3 percent of the small high schools, used them regularly.

The small high schools reported almost as frequently as the large high schools that motion picture projectors were owned by the science departments in these schools. Thus the fact that projection equipment is owned by the science department in a school seems to influence directly the extent to which projected aids are used in the science classes.

The small high schools also reported "the increased use of audio-visual aids" as a recent innovation in the biology program more frequently than the large high schools, and "the lack of equipment for performing experiments and demonstrations" as a factor which limited the effectiveness of the instruction in general biology. Information on the extent to which "seeing motion pictures about living things" has been substituted for "actual experiences with living things" as a learning activity for pupils in these schools was not obtained. However, it can be inferred from the facts reported above that in many of the small high schools this substitution has occurred.

Equipment Owned by Science Departments

In many schools, particularly large high schools, equipment for use in the instructional program is purchased with departmental funds rather than from the general school budget. Where this is done the equipment is more readily available for use by the departments concerned.

All of the schools which offered general biology responded to the question "Which of the following are owned by the science department in

Table 23.—Instructional aids used in general biology, by size of school

Supplementary aids	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
	3	3	4	5	6	7	8	9	10	11
Schools using aids	197	100.0	269	100.0	128	100.0	295	100.0	789	100.0
Charts.....	90	94.1	223	82.2	121	94.5	283	95.9	715	98.0
Preserved specimens.....	78	72.9	215	80.3	118	92.2	290	98.3	691	89.8
Slides (microscope).....	69	64.4	196	73.7	110	85.9	292	92.0	667	82.8
Posters and pictures.....	49	64.4	167	78.1	109	85.2	298	98.4	617	80.2
Living specimens.....	63	58.8	161	64.7	102	79.7	262	88.4	578	78.1
Filmstrips.....	51	47.6	170	68.8	99	72.7	211	74.0	508	68.3
Motion pictures.....	64	78.5	214	85.9	110	85.0	198	67.9	516	67.1
Models.....	40	37.4	167	68.0	82	64.1	294	99.1	493	62.8
Slides (3 x 3 transparencies).....	27	25.3	94	37.8	23	18.4	198	64.0	303	47.1
Recordings.....	11	10.3	28	10.4	34	26.6	81	28.4	153	19.8
Schools not using supplementary aids	7	.....	5	.....	1	.....	4	.....	17	.....

your school: silent film projector; sound film projector; slide projector; microscopes; hand lenses?"

A summary of the information supplied in response to this question is as follows: Microscopes were owned by the science departments in 714 schools, 90.8 percent of those offering biology; hand lenses in 613 schools, 78 percent; sound film projectors in 526 schools, 67 percent; slide projectors in 458 schools, 58.2 percent; and silent film projectors in 232 schools, 29.5 percent.

In general the smaller high schools reported equipment owned by the science departments much less frequently than did large high schools. The exceptions were: Sound film projectors, owned by the science departments in 68 percent of the high schools with fewer than 100 pupils enrolled, and by only 69 percent of the large high schools with 500 or more pupils enrolled; and microscopes owned by the science departments in 82 and 96 percent of these schools, respectively.

Microscopes, Microprojectors, and Hand Lenses

A total of 715 schools, 91 percent of those offering general biology, reported that compound microscopes were available for use in the general biology classes. Of these schools 541 gave information on the number of microscopes, and the number of microprojectors and hand lenses which were available for use. The information on microscopes is summarized in table 24.

An examination of this table shows that the number of microscopes available in a school bears a direct relationship to the size of the school. The average for small high schools with fewer than 500 pupils enrolled was 3.5 microscopes; the average for large high schools with 500 or more pupils enrolled was 18.5.

The smallest number of compound microscopes available in a school was 1, reported by 7 large high schools and by 73 small high schools; the largest number was 96 reported by a large urban high school.

When the number of microscopes available in a school is compared with the number of sections of general biology offered in that school and the number of pupils enrolled in the course, it is evident that in most of the high schools with fewer than 1,000 pupils enrolled all of the microscopes available in a school can be used in each of the sections of general biology taught in that school since the average number of sections of biology in these schools is 4.55 or less, and the average number of periods per day is between 5 and 6. However, in large high schools with 1,000-1,499 pupils enrolled the average number of sections of biology was 8.9; in the schools with 1,500 or more pupils the average was 15.1 sections. This means that in most of these large schools there must be two or three sections of biology in session during each period of the day. If individual

microscope work is carried on, then the available microscopes in these schools must be concentrated for use in one or two of these sections. This conclusion is borne out by the fact that several of the large schools reported that individual laboratory work was required for the college-preparatory pupils only; pupils taking the curriculum in general education were given generalized rather than specialized training. This would apply to work with the microscope as well as to other laboratory experiences.

A total of 71 of the schools which offered biology had no compound microscopes; 62 of these were small high schools, 9 were large high schools. In addition, 47 of these small high schools and 7 of the large high schools reported that no microprojectors or hand lenses were available for use in teaching the course.

Textbooks and Supplementary Reading Materials

Although it is generally recognized that the primary source of information for pupils studying science should be through direct experiences with actual objects and processes, there are many occasions when such experiences are inadvisable, or impossible to secure, because of limitations of time and place. Under such circumstances the vicarious experiences which can be provided through reading in textbooks, reference books, and magazines are invaluable aids to education in science.

This section of the report is concerned with the use of textbooks, biological reference books, and scientific magazines as supplementary aids to the instruction in general biology.

Table 24.—Number of schools with microscopes, number of sections, and number of pupils enrolled in general biology in these schools, by size of school

Size of school	Schools offering general biology	Schools with microscopes		Microscopes					Section of general biology		Pupils enrolled in general biology	
		No.	Per cent	Schools reporting number	Total reported	Average per school	Range		In schools reporting number of microscopes	Average per school	In schools reporting number of microscopes	Average per school
							Min.	Max.				
1	2	3	4	5	6	7	8	9	10	11	12	13
1-99 pupils...	114	94	82.5	55	101	1.84	1	12	55	1.02	949	17.25
100-299.....	254	222	87.0	161	544	3.38	1	28	226	1.40	5,459	23.90
300-499.....	129	119	92.3	97	436	4.49	1	25	370	2.78	6,758	69.65
500-999.....	138	123	89.1	107	901	8.42	1	34	457	4.55	14,881	139.06
1,000-1,499.....	72	69	95.8	54	1,066	19.73	3	80	481	8.90	14,395	266.57
1,500 and over..	79	79	100.0	67	2,344	33.49	2	96	1,012	15.10	32,060	478.95

Use of Textbooks and Methods of Selection

Responses to the question, "Is one basic textbook used for the course? Is it selected by: committee of teachers? State adoption? teacher? principal? superintendent? other?" were received from all of the 786 schools which offered general biology. The responses are summarized in table 25.

Since most of the schools used more than one of the methods of selection specified in the question, the actual combinations of different methods which were reported by the schools were tabulated, and these combinations are shown in the table, along with the other methods of selection which were reported by the schools but which were not included in the questionnaire.

A total of 736 schools, 93.6 percent of those offering general biology, used a basic textbook in the course. According to information obtained on the way in which the course was organized (table 16), 499 of these schools followed the basic text in organizing the course for instructional purposes.

Fifty schools, 6.4 percent, reported that a basic text was not used in the course. A majority of these schools were using several texts along with magazines, industry-prepared materials, and supplementary references of various types in the course.

Table 25.—Number of schools using a basic textbook in the course, and methods of selecting the text, by size of school

Method of selection of text	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent
1	2	8	4	5	6	7	8	8	10	11
Schools using a single basic text.....	111	97.4	244	96.1	119	92.2	262	90.7	736	98.6
Schools not using a basic text.....	8	2.6	10	2.9	10	7.8	27	9.3	80	6.4
Total	114	100.0	254	100.0	129	100.0	289	100.0	736	100.0
Selected by:										
Committee of teachers and principal from a State list.....	35	30.7	110	43.3	41	31.8	77	26.6	263	35.7
Teacher and principal.....	30	26.3	71	28.0	50	38.7	68	23.5	219	29.7
Committee of teachers, principal, and superintendent.....	20	17.5	30	11.8	12	9.3	112	38.7	174	23.5
Teacher, principal, and superintendent.....	9	7.9	34	13.4	20	15.5	18	6.2	81	10.9
Teacher and superintendent.....	17	14.9	0	0	5	3.9	1	.4	23	3.1
Teacher and supervisor.....	1	.9	2	.8	0	0	12	4.1	15	2.0
County.....	0	0	6	2.3	0	0	0	0	6	.8
School board.....	2	1.8	1	.4	0	0	1	.4	4	.5
Chairman of department.....	0	0	0	0	0	0	3	1.0	3	.4
County and principal, from a State list.....	0	0	0	0	0	0	1	.4	1	.1
Science supervisor.....	0	0	0	0	0	0	1	.4	1	.1
Total	114	100.0	254	100.0	129	100.0	289	100.0	736	100.0

In 264 of the schools, the basic text was selected from a State-approved list of textbooks.

Previous studies of science instruction have shown that dissatisfaction with the textbook used in the course was frequently mentioned by teachers as one of the factors which limited the effectiveness of the course. The fact that the biology teachers in 771 of the schools which participated in this study were directly involved in the selection of the textbooks used in their classes may account for the relative infrequency with which dissatisfaction with the textbook was mentioned by these teachers as an interfering condition.

Biological Books in Library

A total of 726 schools, 92.4 percent of the schools offering biology, reported that supplementary reading was used in the course and gave information on the number of biological books which were available for pupil use in the school library and in the classroom library. This information is summarized in table 26.

Only 589 of the school libraries in the schools which reported that supplementary reading was used had books dealing with biological subjects in them. Classroom libraries for the use of pupils in biological science classes were reported by 430 schools.

The average number of biological books reported in the school library for each school was 64.1; the average number in the classroom library was 26.8. Many of the schools with a classroom library indicated that the books in this library were high-school biology textbooks or college textbooks used to supplement the basic text.

Table 26.—Use of supplementary reading in general biology and number of biological books for pupil use in school and classroom libraries

Number of biological books	In school library		In classroom library	
	Number of schools	Percent	Number of schools	Percent
	1	2	4	5
Schools using supplementary reading	726	100.0	726	100.0
0.....	137	18.9	206	28.4
1-24.....	287	39.4	207	28.5
25-49.....	119	16.4	69	9.5
50-74.....	87	11.9	35	4.8
75-99.....	22	3.0	9	1.2
100-124.....	20	2.8	6	.8
125-149.....	5	.7	2	.3
150-174.....	14	1.9	3	.4
175-199.....	5	.7	1	.1
200 and over.....	64	8.8	8	1.1

Scientific Magazines Available for Pupil Use

Information on the number of scientific magazines which were available for pupil use was supplied by each of the 786 schools which offered biology. This information is summarized in table 27.

A total of 105 schools, 13.3 percent, reported that they had no magazines available for pupil use. Only 9.7 percent of the large high schools reported that no magazines were available, while 15.5 percent of the small high schools with enrollments of fewer than 500 pupils so reported. The typical small high school had approximately 3 magazines for pupil use; the typical large high school had 5.

In addition to the 6 magazines listed by name in the questionnaire, a total of 59 other magazines were reported as being used in the schools. The majority of these were general magazines with sections devoted to science and State publications dealing with conservation of natural resources or with the wildlife of the region in which the schools were located.

Methods of Supplementation

If the study of living things and the interrelationships between them and their natural environments is to be effective, it must be supplemented in many ways and by a variety of pupil activities other than those which can be carried on during the regular class time and within the school building.

Taking planned field trips and excursions, planning original projects, participating in club activities, listening to talks by scientists, and taking

Table 27.—Number of scientific magazines available for pupil use, by size of school

Number of magazines	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
1	2	3	4	5	6	7	8	9	10	11
0.....	23	20.2	42	16.5	13	9.3	28	9.7	105	13.3
1.....	11	9.6	15	6.0	3	2.3	10	3.4	39	5.0
2.....	19	16.7	27	12.6	14	8.5	18	6.2	80	10.2
3.....	26	22.8	54	21.2	18	14.0	26	9.7	126	16.0
4.....	18	15.8	44	17.3	28	21.7	43	14.9	133	16.9
5.....	11	9.6	42	16.5	29	22.5	60	20.8	142	18.1
6.....	6	5.3	19	7.5	20	15.5	48	16.6	93	11.8
7.....	0		3	1.2	6	4.7	22	7.6	31	4.0
8.....	0		2	.8	3	1.5	10	3.4	14	1.8
9.....	0		0		0		12	4.2	12	1.5
10.....	0		0		0		4	1.4	4	.5
Over 10.....	0		1	.4	0		6	2.1	7	.9
Total.....	114	100.0	254	100.0	129	100.0	289	100.0	786	100.0

part in science exhibits and contests are a few of the science-related activities which pupils have been encouraged to engage in to supplement the regular work in science. The extent to which these and other supplementary activities were used in the biology classes in the schools in the sample is shown in this section of the report.

Field Trips and Excursions

Information on the number of planned field trips and excursions taken annually by the general biology classes in schools of different sizes is given in table 28. A total of 485 schools, 61.7 percent of the schools offering biology, reported that field trips and excursions were a regular part of the biology course and gave information on the number of trips taken each year and the season when the trips were taken.

A total of 2,529 trips taken during the course of a year was reported by the 485 schools. The range of the number of trips taken annually was from a minimum of 1 trip, reported by a small rural high school, to a maximum of 20 trips reported by two large urban high schools. The average number of trips taken annually by the biology classes in schools of all sizes was 5.2; the average for the small high schools was 5.2; the average for large high schools was 5.3.

However, when the average number of trips taken annually by the biology classes in schools of different sizes is compared with the average number of sections of general biology in schools of these sizes (table 8), it is apparent that the number of trips taken by each section is inversely proportional to the size of the school in which the section occurs. The average number of trips per year for each section of biology in schools of 1-99 enrollment was 5.1; for schools with 100-299 pupils it was 3.7; for schools with 300-499 enrollment it was 2.0; and for the large high schools with 500 or more pupils it was 0.6 trips per section.

The information which was supplied by the 485 schools regarding the seasons when these trips were taken is as follows: 473 of the schools reported a total of 1,223 trips taken in the spring; 50 schools, 85 trips taken in summer; 382 schools, 935 trips taken in autumn; and 165 schools, 286 trips taken in winter.

A total of 298 schools, approximately 38 percent of the schools offering biology, reported that no field trips or excursions were taken by the biology classes. "Field trips not taken by biology classes" was reported almost twice as frequently by large high schools as by small high schools. The reasons given by the large high schools for not taking trips were: They were located in congested areas with no suitable areas readily accessible, or the daily schedule of classes was so inflexible that no time over and above the regular class time could be used for trips.

Table 28.—Number of planned field trips and excursions taken each year, by size of school

Number of field trips and excursions taken each year	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
1	2	3	4	5	6	7	8	9	10	11
0.....	33	29.0	77	30.3	38	29.4	150	52.0	298	38.0
1-5.....	52	45.6	119	46.9	62	48.1	91	31.5	324	41.2
6-10.....	21	18.4	47	18.5	20	15.5	35	12.1	123	15.6
11-15.....	6	5.3	7	2.8	8	6.2	7	2.4	28	3.6
16-20.....	2	1.7	3	1.1	0	0	5	1.7	10	1.3
Schools not reporting	0	.....	1	.4	1	.8	1	.3	3	.4
Total.....	114	100.0	254	100.0	129	100.0	299	100.0	796	100.0

Several small schools reported that field trips were not taken because they were located in rural areas and the children were acquainted with the common living things of their region so that there was no need to use school time for trips.

Pupil Projects in General Biology

Information on the extent to which original pupil projects were used to supplement the regular work in general biology was supplied by 777 of the schools which offered the course; only 9 schools failed to supply information on this question. This information is summarized in table 29.

A total of 531 schools, 68.3 percent of those giving information, reported that pupil projects were used in the instruction. In 375 of these schools the projects were optional, that is they were not required as a part of the course but were chosen by the individual pupils; 156 schools reported that projects were "required" as a part of the work in the general biology course. However, many of the schools requiring projects indicated that the type and the scope of the project were left up to the individual pupil.

Large high schools reported the use of pupil projects much more frequently than did small high schools.

Information on the nature of the projects carried on by the pupils was not obtained, although the responses to another question in the questionnaire showed that in many of the schools using pupil projects the instruction in biology was supplemented by pupil participation in science fairs and science exhibits (table 31). It is highly probable that the projects prepared in the biology classes were used in the science fairs and in the science exhibits.

Table 29.—Use of original pupil projects in general biology, by size of school

Pupil projects	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7	8	9	10	11
Pupil projects used in the instruction.....	74	64.9	123	52.0	98	75.9	227	75.5	531	67.5
Projects required.....	27	23.7	33	13.0	39	30.2	57	19.7	166	19.8
Projects optional.....	47	41.2	90	39.0	59	45.7	170	53.8	375	47.7
Pupil projects not used in the instruction.....	36	31.6	120	47.2	30	23.3	60	20.8	246	31.3
Schools not reporting on projects.....	4	3.5	2	.8	1	.8	2	.7	9	1.2
Total.....	114	100.0	244	100.0	129	100.0	289	100.0	786	100.0

A total of 246 schools, 31.3 percent, reported that pupil projects were not used in the instruction.

Science Clubs

The success achieved by the science instruction in a particular school may be judged, in some measure, by the presence or absence of science clubs in the school, and by the number of pupils enrolled in these clubs. Many activities which are carried on by pupils in these clubs directly supplement the regular class work.

Information on the number of schools in the sample used in this study which had science clubs in 1949-50 available to pupils in the biology classes, and the number of pupils enrolled in these clubs is summarized in table 30.

Only 263 schools, 33.5 percent of those offering general biology, reported that they had one or more science clubs. Large high schools reported science clubs much more frequently than did small high schools. For those pupils who were enrolled in very small high schools (under 100 enrollment) opportunities to engage in club activities were practically nonexistent, since 108 of the 114 schools of this size reported that they had no clubs.

The majority of the schools with clubs had only one club which enrolled all of the pupils in the school who had an interest in science. Twenty-nine different names were reported for this type of general science club. From the names of these clubs and from the information supplied on the types of activities carried on by the members, it can be inferred that experiences with living things and with the out-of-doors are characteristic activities of most of these clubs.

The type of club which ranked second in frequency of mention was the

photography or camera club, reported by 108 of the 263 schools with clubs. Only 27 schools, most of them large high schools with several science clubs, reported clubs which were exclusively "biological" in nature.

The highest number of "science" clubs reported by any school was 10.

Information on the time when science clubs met was supplied by 251 schools. In 126 of these schools the science clubs met during school hours; in 114 the clubs met after school. In 10 large high schools, each of which had several clubs, they met during and after school hours. In one large high school the science clubs met during the noon hour.

A total of 523 schools, 66.5 percent of those offering general biology, had no science clubs. The major reasons given by these schools for not having clubs, in the order of their frequency of mention by schools of all sizes, are as follows: Teachers lack time, reported by 340 schools, 65 percent of those without clubs; lack of facilities, reported by 117 schools, 22 percent of those reporting; and lack of pupil interest, reported by 97 schools, 19 percent.

Several of the larger high schools reported that until a few years ago they had very active club programs, but that in the last few years teacher-load in these schools had increased to such an extent that science clubs had to be dropped. Other reasons given by large high schools were: Pupils work after school; too many conflicting activities already in the program; and no periods available during the day for club work.

The reasons reported by small high schools for not having clubs were: Student body too small; a transportation problem—pupils ride buses; and largely rural students. A few of the schools which had no clubs in 1949-50 indicated that an "activity period" had been added to the regular program, and that many of the activities which were previously carried on in clubs are now carried on during this period. Others reported that pupil projects and activities incorporated into the regular work of the biology classes had taken the place of clubs.

Table 30.—Schools with science clubs and number of pupils enrolled in clubs, by size of school

Size of school	Number of schools offering biology	Schools with science clubs		Number of schools reporting enrollment in clubs	Pupils enrolled		
		Number	Percent		In schools reporting	In science clubs	
						Number	Percent
1	2	3	4	5	6	7	8
1-99 pupils.....	114	6	0.1	5	321	89	25.9
100-299 pupils.....	254	47	18.5	42	8,332	1,422	17.1
300-499 pupils.....	129	49	38.0	44	17,273	3,018	17.5
500 and over.....	230	161	55.7	135	210,851	8,018	3.8
Total.....	786	263	33.5	226	226,777	12,541	5.3

Other Methods of Supplementation

Information on the extent to which the schools were supplementing the work in biology with talks by scientists, by pupil-participation in science fairs, exhibits, and talent search contests is summarized in table 31.

A total of 528 schools, 67.2 percent of the schools offering biology, reported that they supplemented the work in one or more of the ways listed in the table. The method of supplementation most frequently reported was "seeing science fairs." About 70 percent of the schools reported that the pupils in biology classes saw science fairs; only 66 percent of the schools reported that the pupils participated in fairs and exhibits.

Some of the supplementary activities reported by the schools and classified under "Other" in table 31 are: Participation in meetings of the State Junior Academy of Science; participation in conservation and cancer contests; publication of science journals; preparing and presenting films and plays at school assemblies; and visits to municipal museums, aquaria, and zoological parks.

Appropriations and Expenditures

Lack of funds for the purchase of essential equipment and supplies is often mentioned by science teachers as one of the major factors which prevent them from doing an effective job of teaching. Information obtained in response to the questions "Do you have an annual appropriation specifically for biological equipment and supplies?" "What was the appropriation for 1949-50?" "What amount was spent in the last 5 years: for equipment?; for supplies?" shows the extent to which this is true for the courses in biological science.

Table 31.—Methods of supplementing the instruction in general biology

Method of supplementation	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7	8	9	10	11
Schools supplementing work.	53		150		96		229		528	
Seeing science fairs.....	39	73.6	100	66.7	72	75.0	160	69.9	371	70.2
Participation in science exhibits.....	18	34.0	58	38.7	34	35.4	112	48.9	222	42.0
Talks by scientists.....	11	20.8	42	28.0	30	31.2	109	47.6	192	36.3
Participation in science talent search contests.....	7	13.2	39	26.0	26	27.1	106	46.3	178	33.7
Participation in science fairs.....	8	15.1	21	14.0	24	25.0	77	33.6	130	24.6
Participation in youth science congresses.....	1	(¹)	2	1.3	4	4.2	24	10.5	31	5.9
Other.....	3	.1	7	4.7	6	6.2	16	7.0	32	6.1

¹ Less than 0.1 percent.

Annual Appropriations for Equipment and Supplies

Information on the number of schools of different sizes which had annual appropriations specifically for biological equipment and supplies and the amount of these appropriations in 1949-50 is shown in tables 32 and 33.

A total of 310 schools, 39 percent of the schools offering biology had such an appropriation, and 476 schools, 61 percent, had no such appropriation. A few of the schools which reported no appropriation specifically for biology indicated that funds were appropriated for the science department and that biological equipment and supplies were purchased, as needed, from this appropriation. None of these schools supplied information on the amounts spent under this arrangement. The average annual appropriation per school for schools of all sizes was \$231.03, with a range from a minimum of \$138.14 for schools with 100-299 pupils to a maximum of \$292.40 for schools with 500 or more pupils enrolled.

The average annual appropriation for each pupil enrolled in biology for all schools reporting was 26 cents, with a range from a minimum of 20 cents per pupil for the large high schools with 500 or more pupils enrolled, to a maximum of \$2.28 per pupil for the very small high schools with fewer than 100 pupils enrolled.

Table 33.—Annual appropriations for biological equipment and supplies, by size of school

Annual appropriation in dollars	Schools with enrollment of—									
	1-99 pupils		100-299 pupils		300-499 pupils		500 and over		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	3	4	5	6	7	8	9	10	11
No appropriation	83	72.8	183	72.0	82	63.6	128	44.3	476	60.5
1-24	0		1	.4	2	2.3	2	.7	6	.8
25-49	5	4.4	3	1.2	2	1.5	3	1.0	13	1.6
50-74	4	3.5	18	7.1	6	4.7	8	2.8	36	4.6
75-99	5	4.4	7	2.8	2	1.5	5	1.7	19	2.4
100-124	3	2.6	10	3.9	10	7.8	24	8.3	47	6.0
125-149	0		3	1.2	1	.8	6	2.1	10	1.3
150-174	5	4.4	12	4.7	7	5.4	25	8.6	49	6.2
175-199	1	.9	0		2	1.5	2	.7	5	.7
200 and over	8	7.0	17	6.7	14	10.9	86	29.8	125	15.9
Total	114	100.0	254	100.0	129	100.0	289	100.0	785	100.0

Expenditures for Equipment and Supplies

A total of 427 schools supplied information on the estimated amounts which were spent during the last 5 years for biological equipment and for supplies. The average annual expenditure for each school was \$175.59,

with a range of from \$81.24 per year for schools with fewer than 100 pupils enrolled, to \$267.20 for large high schools with 500 or more pupils enrolled.

The average of the expenditures for equipment in all schools reporting was approximately 61 percent of the total amount spent. The average for supplies was 39 percent. However, there was a marked difference between the very small high schools and the large high schools in regard to these expenditures. The small high schools with fewer than 100 pupils enrolled spent 67 percent of the total amount for equipment and 33 percent for supplies. The large high schools spent 57 percent for equipment and 43 percent for supplies.

These differences can be accounted for, in part, by the fact that many of the small high schools reported that they were improving the instruction in general biology by adding laboratory work to the program, or by the addition of new equipment. These improvements were being financed out of current expense budgets. Many of the large high schools reported that their laboratories, or laboratory-classrooms, were well equipped so that there was no need for these schools to spend a disproportionate amount of the annual appropriation on new equipment.

Conditions Affecting the Course

Although this study was designed to obtain information about the course in general biology as it was taught during the school year 1949-50, some information was obtained on the innovations which had been made in the course during the preceding 5 years and on conditions in the school and the community which limited or contributed to, the effectiveness of the course.

Table 33.—Appropriations 1949-50 and expenditures 1945-50 for biological equipment and supplies, by size of school

Size of school	Appropriation for school year 1949-50					Amount spent 1945-50				
	Number of schools reporting	Total amount	Average per school	Total pupils enrolled in general biology	Average per pupil enrolled in general biology	Number of schools reporting	For equipment	For supplies	Total	Average annual expenditure for each school
1	2	3	4	5	6	7	8	9	10	11
1-99 pupils.....	31	\$4,687	\$151.19	2,061	\$2.28	51	\$12,930	\$6,787	\$20,717	\$81.24
100-299 pupils.....	71	9,808	138.14	12,702	.77	121	47,732	19,375	67,107	110.92
300-499 pupils.....	47	10,048	213.78	18,314	.55	66	21,123	13,416	34,540	104.66
500 and over.....	161	47,077	292.40	237,918	.20	189	146,178	106,326	252,504	267.20
Total.....	310	71,620	231.68	376,995	.36	427	228,973	145,994	374,977	178.59

Innovations Affecting the Teaching of Biology

A total of 435 schools, 55.3 percent of the schools offering general biology, responded to the question "What changes or innovations have been made in the last 5 years, which you feel have contributed significantly to the education of the youth in your school?"

Many different innovations which affected the instruction in general biology were reported, but they can be grouped under 13 major headings:

1. Increased use of audio-visual aids and biological equipment—reported by 261 schools, 61.4 percent of the schools offering general biology.
2. Changes in course offerings by the addition of new units in health, conservation, etc.—reported by 83 schools.
3. Addition of supplementary pupil activities, such as science clubs, field trips, pupil projects, science fairs, and camping, to the regular program—reported by 76 schools.
4. Adoption of new textbooks and increased use of references and magazines in the school library and in the classroom—reported by 60 schools.
5. Improvement in the facilities by equipping existing rooms for use of audio-visual aids or by the addition of a greenhouse, a museum, a projection room, or a laboratory to the existing facilities—reported by 56 schools.
6. Addition of new courses in health, conservation, or home and family living to the curriculum and making biology a required course for all pupils—reported by 41 schools.
7. Giving more attention to individual differences of pupils through the adoption of homogeneous grouping of pupils or by organizing smaller classes—reported by 33 schools.
8. Improvement in the teaching by the addition of better qualified teachers to the staff; and improved teaching conditions through the provision of free periods for science teachers for setting up and taking care of equipment—reported by 33 schools.
9. Improvement in teaching methods by the addition of more individual laboratory work, the elimination of technical vocabulary, or by the adoption of a unit testing program—reported by 29 schools.
10. Improvement in programs and schedules either through the elimination of double laboratory periods or through the addition of extra periods for laboratory work—reported by 19 schools.
11. Increased appropriations for the purchase of equipment and supplies—reported by 14 schools.

12. Increased use of community resources by biology teachers—reported by 9 schools.
13. Improved relationships with the administrative staff of the school—reported by 8 schools.

There were no significant differences between small and large high schools in regard to the types and the number of innovations reported.

Conditions Which Limited the Effectiveness of the Course

A total of 384 schools reported one or more conditions in the school or in the community which seriously limited the effectiveness of the instruction in general biology. These conditions in the order of their frequency of mention are:

1. Inadequate facilities for science instruction—reported by 162 schools, 42 per cent.
2. Inadequate equipment and supplies—reported by 88 schools.
3. Classes too large, or pupils in the classes with inadequate background in science—reported by 87 schools.
4. Staff members not trained to teach biology—reported by 68 schools.
5. Inadequate finances for the purchase of equipment and supplies—reported by 60 schools.
6. Lack of facilities for, or lack of time on the part of teachers to organize and conduct clubs, field trips, and other supplementary activities—reported by 57 schools.
7. Community objections to the teaching of certain phases of biology, such as sex education and evolution, and to the use of school time for trips and excursions—reported by 56 schools.
8. A daily schedule of classes for the biology teachers which was so crowded or so inflexible that time for taking care of equipment, preparing for laboratory work, or conducting field trips was not available—reported by 54 schools.

Only 13 schools reported that the attitudes of the administration had an adverse effect on the biology teaching, and dissatisfaction with the textbook or with the available supplementary reading materials was reported by only 11 schools.

There was no marked difference between small and large high schools in regard to the conditions limiting the effectiveness of the course which have not been discussed in the preceding sections of the report.

Conditions Which Contributed to the Effectiveness of the Course

A listing of the conditions in the school or the community which contributed to the effectiveness of the course, as they were reported by 380 schools, would be essentially the same as the limiting conditions described above, except that the descriptions would be stated positively, and the order of the frequency of mention by the schools would be different. The categories of these favoring conditions and the number of schools reporting each condition are as follows:

1. Good school and community relationships—reported by 278 schools.
2. Small classes and well-prepared pupils—reported by 125 schools.
3. Favorable administration—reported by 63 schools.
4. Well-qualified teaching staff—reported by 56 schools.
5. Adequate equipment and supplies—reported by 40 schools.
6. Adequate and well-equipped facilities—reported by 34 schools.
7. Well-organized program of supplementary activities—reported by 20 schools.
8. A flexible program and a teaching schedule which permitted the teachers to conduct clubs and field trips—reported by 17 schools.

Satisfactory textbooks and supplementary reading materials and adequate finances for the biology program were reported by 12 and 6 schools, respectively.

Summary

The findings in this study are based on returns from 786 public high schools, exclusive of separately administered junior high schools, and are for the school year 1949-50. These schools constituted 73.3 percent of the 1,072 schools in the sample, and 3.7 percent of the public high schools of the continental United States. The sample was selected from 21,300 junior-senior, senior, regular, and undivided high schools.

Offerings and Requirements in Biological Science

A total of 809 schools out of the 851 schools which returned the questionnaire offered the course in general biology. The course was offered each year in 729 schools, in alternate years in 80 schools.

Forty different courses in biological science in addition to general biology were offered in the schools.

At least 2 semesters of biological science were required for graduation in 272 schools. The course in general biology was required of all pupils in 240 schools.

Enrollments and Class Size in General Biology

A total of 95,669 pupils, 21.7 percent of the pupils enrolled in the last 4 years of high school, were enrolled in the general biology classes in 786 schools.

The average size of general biology classes for the first term of 1949-50 was 29.3 pupils. The largest class reported was 64 pupils; the smallest was 2 pupils.

Instructional Time and Methods of Scheduling the Course

General biology was offered as a 2-semester course in 99.5 percent of the schools.

The range in the number of minutes of instructional time allotted to the course for the school year was from a minimum of 4,000 minutes to a maximum of 17,100 minutes. The average for schools of all sizes was approximately 9,638 minutes.

In 82 percent of the schools the course was scheduled for 5 single periods each week.

Teachers, Teaching Load, Certification, and Experience

A total of 1,236 teachers were teaching the course in the 786 schools in the first term of 1949-50, and 1,221 in the second term.

The average daily load of pupils enrolled in general biology for each biology teacher in schools of all sizes was 77.4; for small high schools 39; for large high schools, 104.7. Approximately 90 percent of the biology teachers were certified to teach the course with either a major or a minor in biological science; 10 percent were teaching the course without a major or a minor.

Approximately 10 percent of the teachers were teaching the course for the first time in 1949-50; and 18 percent had more than 20 years of experience in teaching the course. The average number of years of experience for all biology teachers was 10 years.

Organization of the Course

In 76 percent of the schools the course in general biology was based on principles related to the whole field of biology; in 13 percent it was based on specialized treatments of botany, zoology, and physiology; and in 11 percent on problems selected for their importance in daily living.

Nature of the Laboratory Work

Laboratory work was used in the instruction in 98 percent of the schools.

Regularly scheduled single or double periods for laboratory work were used by 37 percent of the schools; integrated laboratory-recitation periods by 35 percent; and flexible laboratory schedules by 28 percent.

The average percent of instructional time devoted to laboratory work was 26; the range was from a minimum of 2 percent to a maximum of 75 percent.

Facilities and Equipment

Combined laboratory-classrooms were used for the general biology classes in 61 percent of the schools; separate laboratories and classrooms in 27 percent; rooms equipped and used for other subjects in 8 percent; and rooms with no special provisions in 4 percent.

The combined laboratory-classrooms and separate laboratories in 94 percent of the schools were supplied with running water; 94 percent with electric outlets; and 75 percent with gas outlets.

Ninety-one percent of the schools had one or more compound microscopes for pupil use. The average number of microscopes for all high schools was 3.5; the average for large high schools was 18.5.

Appropriations and Expenditures

Appropriations specifically for biological equipment and supplies were reported by 39 percent of the schools. The average annual appropriation for schools of all sizes was \$231.03; the average for each pupil enrolled in general biology was 26 cents.

The average annual expenditure by each school for biological equipment and supplies for the period 1945-50 was \$175.59.

The average percentage of the expenditures for equipment was 61 percent of the total amount spent; the average for supplies was 39 percent.

Conditions Affecting the Course

The innovations which were reported most frequently were related to the supplementary aids used in the instruction in general biology, the supplementary activities provided for pupils, and the physical facilities and equipment used in the course.

The major factors which limited the effectiveness of the course were: inadequacy of the physical facilities; the shortage of equipment for experiments and demonstrations; and the lack of funds for the purchase of equipment and supplies.

The major factors which contributed to the effectiveness of the course were: good community-school relationships; reasonable teacher load; well qualified teaching staff; and adequate, well-equipped facilities for carrying on the instructional program.