

AN ACCOUNT OF THE CHANGES IN BIOLOGY EDUCATION
IN ONTARIO HIGH SCHOOLS (1871-1978)

by

STANLEY JAMES TAYLOR

B.A., The University of Toronto, 1932
M.A., The University of Toronto, 1949
M.Ed., The University of Toronto, 1955
M.A.T., The University of North Carolina, 1969
A.M., The University of Michigan, 1971

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF EDUCATION

in

The Faculty of Graduate Studies
Department of Mathematics and Science Education

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

March 1981

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Department of Mathematics and Science Education

The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

Date May 28, 1981

A B S T R A C T

This study traces biology education in Ontario High schools from 1871 to 1978, and is the first major study of the development of Ontario biology in forty years.

The author examines a variety of data sources for information about the biology curricula in regard to aims, content, methods and evaluation. For convenience in organizing the data, the century studied is divided into three periods:

- (a) a period of education for a minority (1871-1920)
- (b) a period of expanding enrolment (1921-1960) and
- (c) a period of educational flux (1961-1978).

Over the three periods the following changes were noted:

- (i) The topics covered changed considerably over the hundred years starting with taxonomy and proceeding through morphology and related physiology, applications of biology, genetics, ecology and cell biology.
- (ii) The educational emphasis and authorship of the textbooks changed. In the first period, the authors were university biologists and stressed the structure of biology; in the second period, the authors were teachers and emphasized the topics of pupil interest; while in the third, the authors were teams of biologists and teachers and stressed both

biological structure and student interest.

- (iii) The physical facilities changed throughout the period reflecting the curricular concept currently in vogue.
- (iv) Over most of the hundred years Ontario secondary teachers of biology had high academic and professional qualifications. However, there were times of teacher shortages in which qualifications declined.
- (v) The opportunities for the "average" high school pupil to learn biology increased greatly over the hundred years as the proportion of pupils attending high school increased eighteen-fold. Pupils enrolled in agriculture much later than in biology and the proportion of pupils studying agriculture varied with the community's need for farmers.

The biology programs are related to the four curricular ideologies or concepts outlined by Michael Schiro (1978); the scholar academic ideology, the child study ideology, the social efficiency ideology and the social reconstruction ideology. The author found that the scholar academic concept was dominant throughout but declined during the second period; the social efficiency concept appeared in the first period but was declining by the third; the child study approach provided a competing ideology in the second and third periods; and the social reconstruction concept emerged during the third.

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ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to the following persons for their invaluable assistance in compiling this thesis;

i Dissertation Committee -

Dr. Robert W. Carlisle (Advisor)
Dr. Sherman G. Brough
Dr. G. Harry Cannon
Professor Frederick A. Gornall
Dr. Neil Sutherland

ii Editors:

Dr. Rosemary Carter
Jophus Anamuah-Mensah

iii Librarians:

The Library Staff at U.B.C. and O.I.S.E.

iv Typist:

Mrs. Carmen de Silva

Without the skilled help and understanding of these people such an undertaking would have been impossible.

INTRODUCTION

The purpose of this study is to analyse the changes in biology education from 1871 to 1978 in Ontario high schools. Investigations of the changes in science education have been made of other systems and of other periods: Gatewood and Obourn (1963)¹ and del Giorno (1969)² investigated changes in science education in the United States; Hurd (1961) restricted his study of science education in the United States to biology³; Murawsky (1969) dealt with the development of biology education in Saskatchewan⁴; Croal (1940) reviewed the changes in science education in Ontario up to 1900;⁵ and Hofferd analysed the changes in biology education in Ontario Grade 9's and 10's to 1932.⁶ But there has not been a reported study dealing with the development of Ontario high school biology education during recent times, when dramatic increases in the proportion of the population attending Ontario high schools occurred (the increase being eighteen-fold during the hundred years studied) and spectacular progress in research in biological science was made.

A wide range of sources of information has been used in this study including authorized or approved textbooks, courses of study, reports of the Minister of Education, census statistics, the Provincial Archives of Ontario, journals of general teaching and biology instruction, departmental examinations, tape recordings of educators who were involved in decision-making, and the author's personal experience.

To permit the data gathered to be studied with convenience, the century studied has been divided into three separate periods:

- (i) a period of education for a minority (1871-1920),
- (ii) a period of expansion in enrolment (1921-1960),
- (iii) a period of educational flux (1961-1978).

The changes in curricular content, the variations in textbooks, emphasis and content, the modifications in facilities, differences in teacher qualifications, and changes in enrolment are all analysed and related to the prominent educational ideologies operating during the period of study, i.e. the scholar academic, the social efficiency, the child study and the social efficiency ideologies.

Conclusions are drawn about the above aspects of biology education, personal reflections are presented about the century of change, and tentative predictions are made about the future of biology education.

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Chapter I

HIGH SCHOOL BIOLOGY IN THE PERIOD OF EDUCATION FOR A MINORITY (1871-1920)

1.00 The Introduction of Biology into the Schools

1.01 Admission of Science and Biology as High School Subjects

The last decades of the nineteenth and the early decades of the twentieth century were times of far reaching educational change¹, and "between the 1880's and the 1920's a growing band of Canadians worked to transform Canadian education."² However, even earlier in 1871, secondary education was changed with the passage of the High School Act by which the former grammar schools were replaced by two new institutions*, high schools, which were designed to provide general education, and collegiate institutes, which were planned to offer university preparation.³ It seems appropriate, therefore, that this era and the date, 1871, be chosen as a suitable starting point for tracing the development of biology education in Ontario High Schools.

During the period 1871-1920 the proportion of young people attending high school increased considerably. In the early part of the period, particularly, Ontario high schools could be called the schools of the few as "secondary education was available to a restricted minority - the privileged in every sense of

* Although the functions of high schools and collegiate institutes were intended to be different, in practice both provided general education and university preparation, with stress on the latter. Robert M. Stamp, "Evolving Patterns of Education: English-Canada from the 1870's to 1914", in Canadian Education : A History, eds. J. Donald Wilson and others, (Scarborough, Ont. : Prentice-Hall of Canada, 1970), pp. 322-323.

the word,"⁴ since the schools were designed to train a few selected youths for special positions in society. Indeed, Adam Crooks, Ontario's first Minister of Education (1876), saw the schools as "affording to each youth of ability the opportunity of the highest intellectual career."⁵ However, other purposes for the schools emerged during the period. Crooks, Harcourt and others came to see that the schools should open the "avenues of learning to every child in the province."⁶ and "that the training given ... should be as practical as possible and that the subjects taken should have in view the pursuits that will be necessarily followed by the majority of our citizens."⁷ However, even by 1920 the high school students were relatively few in number and secondary schooling was still for the minority (Appendix H).

The views of Ontario educators in the 1870's on the purposes and methods of secondary education were similar to those of their counterparts in Victorian England. The main purpose of secondary education was seen to be the development of the mental faculties of a minority, while the method of education was conceived as one of steady student application to difficult classical languages which trained the mental abilities and strengthened character through persistence with difficult concepts.⁸

Many educators, in the early part of the period, thought that biology did not fit this conception of formal education, and its introduction as a high school subject was opposed. However, the arguments in favour of introducing experimental science were strong. Popular interest was aroused by the great scientific inventions and discoveries of the age; and it could be argued that by studying

science, the pupils felt they were keeping up with the march of progress.⁹ Moreover the teaching of science could be supported by the dominant psychological theory of the day which suggested that mental development took place by the "exercise of the faculties". Hence as the study of science employed the "faculties" of observation and reason, education in science could be considered to foster mental growth.¹⁰

In Britain, Herbert Spencer and Thomas Huxley encouraged the introduction of science into the school curriculum, and were quoted extensively in Ontario education circles. Spencer maintained that the purpose of education was to train for life and that science education did this most effectively since it furthered self-preservation and the ability to earn a living.¹¹ Huxley contended that the extension of education in science was essential for industrial progress and also claimed that

"for the purpose of attaining pure culture,
an exclusively scientific education is at
least as effective as an exclusively literary
education."¹²

Support for the British concept of science education became evident in Ontario when Inspector MacKenzie, in the 1870 Report of the Superintendent of Education to the Legislature, described the positive effects of science teaching at Rugby Public School. MacKenzie noted that there was no decline in the high standards in the classics at Rugby School following the introduction of science into the curriculum. He noted further that some boys who had shown little interest in the classics were highly motivated and competent in science.¹³ In a similar vein, Ontario's Superintendent of

Education (1844-1877), Egerton Ryerson, affirmed the value of teaching science by claiming that pupils

- i develop patterns of independent thinking and working habits,
- ii learn the scientific method which would become a permanent skill, and
- iii apply scientific skills and knowledge to many occupations.¹⁴

Another Ontario educator, Inspector George Paxton Young justified the inclusion of science in the curriculum as early as the 1860's on the grounds that pupils would be involved actively in discoveries. He asserted that a single law discovered by the pupil was worth a thousand given by the teacher.¹⁵

In the climate of such sentiments as these, Ryerson (1871) attempted to place science in the high school curriculum with science subjects identified as physics, chemistry, natural history, physiology, and applied biology (agriculture).¹⁶ However, in spite of the cogent reasons for the introduction of science into the high schools, this first attempt did not succeed as it attracted very few students. Ryerson suggested that the failure of the science program was due to the impractical nature of the prescribed courses, the absence of qualified teachers, the indifference of the public to the value of an education in science, and the school boards' lack of funds.¹⁷

In 1876, Adam Crooks, Ontario's first Minister of Education, made another attempt to introduce science into the high school curriculum. The new program did not require specific science subjects to be taken in a particular year.¹⁸ In this program natural history was replaced by botany while agriculture, which had received prominence

in the 1871 course, was omitted altogether.¹⁹ However Crooks' revisions did not attract more students (Table 1). While the enrolment in chemistry and geography increased, enrolment in physics and botany declined. The net result was that no increase showed in the proportion of pupils studying science.

Table 1

Ontario Secondary School Enrolment in Science (1867, 1880)

1867	Percentage of Total School Enrolment	1880	Percentage of Total School Enrolment
Natural Philosophy (Physics) and Geology	27	Natural Philosophy (Physics)	15
Chemistry and Physiology	15	Chemistry	27
Natural History	12	Physiology Botany	5 2
Geography	92	Geography and Astronomy	97

Source: A.G. Croal, "The History of Teaching Science in Ontario 1800-1900", (Doctoral Dissertation, University of Toronto, 1940), pp. 59-60.

Few pupils studied botany at this time (1880) and A.G. Croal, Professor of Methods in Science at the Ontario College of Education (O.C.E.), accounted for the early low enrolment by suggesting that there was a lack of a good Canadian textbook, the absence of qualified botany instructors, and the treatment of the subject as an exercise in memory rather than as an experimental science.²⁰ This state of

affairs persisted until Henry B. Spotton helped increase the enrolment in botany through his personal involvement, his published paper on the teaching of the subject, (1878),²¹ and his textbook (1879).^{*} Spotton's text changed botany from an exercise in memorization to one of examination of living plant material. Following the introduction of his text in the 1880's, pupils examined living plants, observed the characteristics of flowers and learned to identify plants with the use of botanical keys. Thus, the pupils gained experience in taxonomic botany, an aspect of the subject which many teachers thought was over-emphasized. However, Spotton promoted botany as a first-hand experience in contrast to the previous emphasis on memorization, even if he may have unduly stressed the importance of taxonomy. His effective approach of examining living plant material lasted for a long time.²² Indeed, his books remained on the authorized list of texts until 1909. His influence and the recognition of the high calibre of his teaching were widespread and acknowledged by the Department of Education in 1885 when he was asked to conduct summer classes for his colleagues²³ and later (1906) when he was appointed inspector of schools.²⁴

^{*} John Macoun and Henry B. Spotton, The Elements of Structural Botany with Special Reference to the Study of Canadian Plants (Toronto: W.J. Gage, 1879).

Henry B. Spotton, Elementary Botany, Parts I and II. (Toronto: W.J. Gage, 1886).

1.02 Admission of Science and Biology as Subjects for Matriculation

The biology program, as influenced by Spotton, was challenging and demanded qualities of keen observation, dogged persistence and sound judgement while the student learned to identify individual plant specimens, wrote examinations, and came to recognize the characteristics of fifteen families of flowering plants. Such a program would seem to be in keeping with the academic schooling of the day.²⁵ However, in spite of the rigorous nature of the course, biology was not accepted for university admission at the beginning of the period. Indeed, no science subject was accepted for university admission at this time, 1871.

Without the goal of matriculation few pupils enrolled in the science courses and school administrators granted little time to science in the weekly school time-table. This lack of recognition and condition of low prestige was addressed by the science teachers' organization, the Natural Science Section of the Ontario Education Association (O.E.A.) in 1882. They appointed a committee to petition the University Matriculation Board* to recognize science for all university entrance.²⁶ The successful work of the committee culminated in a revision of the university entrance requirements (1885) in which any one of the science subjects - physics, chemistry or botany, was acceptable as one of the ten subjects required for matriculation.²⁷

The science subjects approved for matriculation are shown for the

*The University Matriculation Board was a group of educators containing representatives from the universities who set and marked the matriculation papers.

years 1871-1903 in Table 2 in which the continued acceptance of traditional school subjects is illustrated by the presence of Latin throughout the period.

Table 2
University Requirements for Junior Matriculation*
Sciences and Latin (1871-1903)

Year Subject	1871	1876	1885	1891	1896	1899	1903
Latin	X	X	X	X	X	X	X
Botany	-	-	X	-	-	X	X
Zoology	-	-	-	-	-	X	X
Physics	-	-	X	X	X	X	X
Chemistry	-	-	X	X	X	X	X

X accepted for university entrance

- not accepted for university entrance

Sources: The University of Toronto and its Colleges (1906),
edited by the Librarian, (Toronto : University of Toronto
Press 1906) pp. 81-82.

Notes: * Junior Matriculation was the standing obtained after passing examinations on three years of high school work in specific subjects. The junior matriculation standing admitted a student to first year Arts at the universities. Senior Matriculation was granted at the end of four years high school and admitted a graduate to second year Arts of the universities. By 1913 the times required for Junior and Senior Matriculation were five and six years respectively. Robin Harris, Quiet Evolution (Toronto: University of Toronto Press, 1964), p.50.

The data show that when changes were made in the choice of subjects acceptable for matriculation, physics and chemistry were acceptable in all the years 1885-1903, while zoology was made acceptable only in 1899 and 1903 and botany in the years 1885, 1899 and 1903. The consistent recognition of Latin for matriculation is in contrast to the late recognition of the experimental sciences, and is evidence of the continued acceptance of the classics.

Accounting for the single year of acceptance of botany (1885) is difficult but the late acceptance of the biological sciences may be accounted for in the following way. It would appear that the university authorities accepted only those subjects for matriculation which had been taught in the schools for some time. The data in Table 4 showing the numbers of pupils 'taking' the various experimental sciences indicate that in the 1870's and the early 1880's more than one fifth of all pupils were enrolled in the physical sciences while none were enrolled in biology classes. It can be conjectured that the universities considered the standards of biological science adequate for university entrance only after the subjects had been established in the schools for some time with significant numbers of students enrolled.

1.03 Time Allotted for Biology

The time allotted to biological subjects in the school timetable varied over the period 1871-1920, but the general trend was towards more time being made available. The High School Act of 1871 stated that provision should be made for instruction in natural

science but the time allotted was not fixed, and depended on the principal's conception of the importance of science in general education.²⁸

Before science became a requirement for matriculation many principals allocated token time to science,²⁹ but following its acceptance by the universities more generous allocations were made. However, even then some educators maintained that insufficient time was being devoted to the sciences in the school curriculum.³⁰

Evidence of this concern appeared in the 1901 minutes of the Natural Science Section of the Ontario Educational Association* in which a motion that biology be given three half-hour periods a week was recorded.³¹ The Ontario science teachers hoped that this stance would influence principals to apportion more time to biology, and apparently the complaints had some effect. The new Department of Education regulations (1904) specified that the time for general science in Grade 9 and 10 be five half-hour periods per week so ensuring a minimum time allotment throughout Ontario.³²

*The Ontario Educational Association (O.E.A.) was a group of teachers, administrators and trustees who met annually to discuss educational problems of the day. There were several sections representing different interests and subject areas.

1.10 Changes : The Biology Curriculum (1871-1920)

1.11 Biology

High school biology education of the period 1871-1920 had common features*: all the pupils studied the same textbooks, followed the same course of study and, with minor exceptions, wrote the same departmental examinations. These features of the high school program will be considered by the author from the viewpoints of objectives (why it was taught); content (what was taught), methods (how it was taught), and evaluation (how well it was taught in the opinion of the inspectors). To facilitate this analysis of the biology program, four major content areas have been identified, human physiology, botany, zoology, and general science (biology). One general objective has been noted for all the subject areas, that of teaching the basic biological concepts to future university students, prospective teachers and pupils in general. Later the general objective will be amplified by specific objectives in the discussion of particular subject areas.

Physiology

The course in human physiology was designed to give the pupil biological understandings of health. As it was thought desirable that all pupils should gain these understandings, it was initially made compulsory for Grade 10 students (1872). However, later (1876)

*An exception occurred from 1871-1880 when more flexibility was allowed during the introduction of biology.

the departmental officials considered physiology to be more appropriate for older students and it was moved to Grades 11 and 12.³³ This change in grade placement of the physiology program resulted in a much smaller enrolment as there were fewer students in the upper school (Grades 11 and 12).

The course consisted of the study of anatomy (the human organ systems), the related physiology and hygiene.³⁴ The content was outlined in prescribed textbooks which were well organized and suitably illustrated, (Appendix C). The authors of these texts suggested that students examine accessible animal material obtainable at butcher shops but teachers rarely carried this out. The methods used were very different from those of direct observation as, for the most part, the course was taught according to the "assignment-recitation method." The teacher assigned topics from the texts, then the pupils later had to recall or recite the relevant facts.³⁵ With this approach the course was dull as the pupils rarely made observations from actual specimens or conducted experiments.³⁶ By 1885 human physiology was no longer taught in secondary schools in this period.³⁷

Botany

Human physiology gave way in the mid 1880's to botany in which students were encouraged to make first-hand observations from biological materials.³⁸ Botany was made compulsory for Grade 9 students from 1885 to 1896, and it was also made available as an option in the senior grades. Many prospective elementary teachers

of the time needed credit for additional botany courses in the senior years after taking the compulsory Grade 9 course.³⁹

The Department of Education officials believed that the logical and systematic skill needed to identify a plant helped to develop the faculties of observation and reasoning. Accordingly the Departmental officials advocated the study of 15 families of flowering plants using first-hand experience with living specimens. (Appendices A and B). The course was supported by the authorized texts written by Gray⁴⁰ and Macoun and Spotton.⁴¹

At this time botany teaching in the schools was regarded as a success by Inspector Seath (1887). He said:

In botany the condition is ... gratifying. I did not find in many of the schools inspected in 1887, classes "getting up" for the examination a few definitions or descriptions as I did in almost all the schools inspected in 1885. The work is now largely practical. In some schools, the work is admirably done. The result is, of course, due mainly to the changed character of the examination. Much, however, is also due to the influence of the departmental summer class, whose members are among the best teachers of Botany we have in the schools.⁴²

Student learning was evaluated by Department of Education examinations, which were set and marked by a departmental committee. The botany examinations consisted of two parts: a series of theoretical questions and a practical exercise in the identification of plant specimens. The latter tested the student's mastery of laboratory skills, presented many difficulties and was the object of criticism from many students.⁴³ Teachers, also, questioned the value of a botany course which gave emphasis to taxonomy. One

teacher commented thus:

Natural questions when a new [interesting] object is presented to a child are: 'What is it? What is it for? How does it work? Why does it do that?' The child experimenting with the object and making it reveal the answers to these questions is getting the benefit of a training in science. That can hardly be said of one who asks only the first question and is satisfied only with a name. ⁴⁴

With such a criticism being made of the taxonomic aspect of the examinations, it is not surprising that the identification of plant specimens was discontinued as part of the departmental examination for all but the honour students (1899). ⁴⁵

The 1904 revised course showed a new emphasis; more attention was directed to general physiology and the interrelations of structure and function in both the lower and upper school programs. In the upper school botany course, the functions of the organs of plants was related to their microscopic structure as illustrated by the bean and corn plants. ⁴⁶

In general, in spite of the emphasis on taxonomy which elicited criticism, botany was widely accepted and many pupils enrolled in it. (Table 4).

Zoology

In comparison to botany the introduction of zoology was difficult, and by 1900 it had been accepted in only a few, large schools. Like botany, the zoology courses selected by the Department of Education officials, were designed to permit students to develop

"faculties of observation and reasoning". To achieve this, stress was laid on taxonomy and morphology, and little attention was paid to physiology or evolution. The zoology course surveyed major groups of animals, both vertebrate and invertebrates. So, in essence, the zoology course shared the goals and teaching methodologies of its counterpart, botany.⁴⁷

Two major problems were encountered in the introduction of zoology into the schools. The absence of a good zoology textbook hindered the effective and widespread introduction of zoology. One of the available texts, Nicholson's Outline of Natural History (1875),⁴⁸ was unpopular because it was difficult to understand;⁴⁹ Ramsay Wright's High School Zoology (1889),⁵⁰ was uninteresting and technical, although it did include a timely section on evolution (Appendix C).⁵¹ Not until Colton's * Descriptive and Applied Zoology⁵² was published in 1896 was the problem solved. Colton's text provided a clear and understandable introduction to zoological taxonomy and combined sound biological knowledge with good pedagogy and was acknowledged by most teachers as being an excellent textbook.⁵³

This text emphasized the need for the students' direct experience with living materials and made many suggestions for

* Colton, a Professor of Natural Science in the Illinois State University, instructed prospective teachers in the methods of presenting science and was himself an able teacher. Hence his textbook benefitted both from his sound scientific knowledge and his skilled pedagogical approach. He was typical of the high school biology textbook writers of this period of which seventy-five percent were university biologists (Appendix E).

Buell P. Colton, Zoology, Descriptive and Practical (Toronto: Copp Clark, 1896).

interesting activities: examining living specimens, observing stages in the life histories, collecting, preserving and studying specimens, dissecting preserved specimens, noting the relationship between structure and function, making drawings and answering questions. A few representative animals were studied in some detail, while classification was emphasized using a variety of insects (Appendices A, B and C).⁵⁴

The second factor which delayed the acceptance of zoology in Ontario high schools was probably the manner in which the subject was implemented. While zoology was taught in the 1880's in a few large schools with pupils dissecting, drawing and answering questions, the few pupils who studied it were interested.⁵⁵ However, when an attempt was made to teach some zoology in all schools difficulties arose. Inspector Seath had been impressed with a general survey topic in biology used in the United States and Germany and encouraged its introduction in all of the Ontario high schools (1887). This new topic, "the aims and scope of biology" included the study of some animal forms with an ecological approach. The new topic was added to Grade 10 botany although it included work on zoology. Moreover, questions on this topic were to be included in the departmental examination. Biology teachers objected to these questions and asked that they be omitted.⁵⁶ The Department of Education officials

refused but promised a summer course to familiarize teachers with the new topic.⁵⁷ However, teachers' dissatisfaction with the topic, "the aims and scope of biology" persisted until finally it was discontinued (1896).⁵⁸ Hence, wide-spread teacher disapproval of the new topic with its zoological material did not provide a congenial climate for acceptance of zoology. Although this early attempt to establish zoology in the schools did not have wide-spread success, in 1904 a departmental committee spearheaded a different approach to upper school zoology which made it more popular with teachers and pupils. This new approach to zoology included more physiology, stressed relationships between structure and function in organisms, and included microscopic work.⁵⁹

General Science (Biology)

Toward the end of the nineteenth century there was a wide-spread movement to change secondary schools from institutions for the elite to schools for the "average" pupil. Ontario's Department of Education attempted to follow this trend by setting up a committee for revising the curricula, the "committee of nineteen."⁶⁰ The duty of this group of subject specialists was to update the curriculum of their specific subjects and to provide programs of interest for the average pupil.⁶¹

The recommendations of the "committee of nineteen" included the continuation of the study of the specialized subjects, botany and zoology in upper school and the introduction of a course in general science for Grades 9 and 10. The general science course was begun in 1904 and was compulsory for most pupils. It consisted of topics from

all four science areas, botany, zoology, physics and chemistry. This general course replaced all previous science courses in Grades 9 and 10 and continued until 1920. General science, it was believed, would present topics of wider interest than offered by previous specialized subjects and hence would have greater appeal to average pupils.⁶² Ontario's general science course followed the trend of the United States in offering courses in general, rather than in specialized sciences.⁶³ Ontario Grade 9 and 10 science courses differed however from those in the United States in that the United States programs separated the physical and biological sciences while the Ontario curriculum taught them as one course. Also the biological topics gave less emphasis to taxonomy and more to physiology than the courses prior to 1904, while organisms of importance to man were given major attention.⁶⁴

The 1904 curriculum advocated that the teacher undertake activities which would direct the pupil to make specific observations about the biological environment. These included outdoor activities, examination of museum specimens, class experimentation, teacher demonstrations and the reading of supplementary books.⁶⁵ The teacher discussed the pupil's findings and organized them into recognized biological principles, and following these discussions, the pupil was responsible for making his own notes which became his basic textbook.⁶⁶ Not only did this method assume that an able student was a true investigator, but his teacher had to play a many-faceted role: director of research, leader of discussion, demonstrator of experiments, supervisor of laboratory activities, curator of biological

museum, organizer of pupils' observations and critic of note books.

For most pupils the evaluation of their achievement in science continued to be a rigidly administered departmental examination.⁶⁷ However, for some pupils the Ontario departmental examinations were relaxed by the curriculum of 1904.⁶⁸ Prospective elementary teachers in approved schools no longer had to write lower school departmental examinations in certain subjects, including science. To be approved, a school had to satisfy the provincial inspector* that, among other things, science had been taught in an experimental manner. This exemption from departmental examinations was expected to lessen the stress on some pupils and to bring some relief to the teachers, since they could spend less time preparing their pupils for the examinations.

For a pupil who had to take the departmental examinations, the main material for review was his own notebook as there was no longer an authorized text-book. However, the pupil's notebook was created individually, based on observations, reasoning and class discussions but was often disorganized, experiential and anecdotal. This individual pupil record contrasted markedly with the examinations, which demanded answers that were organized, conceptual and factual.

*The duties of the inspector were outlined in the Regulations: "The Inspector shall make enquiry and examination, in such manner as he may think proper into the qualifications and efficiency of the staff, the adequacy and suitability of the accommodations and equipment of the school and all matters affecting the health and comfort of the pupils". Ontario, Report of the Minister of Education, 1885, p. 24.

Inspector G.F. Rogers (1919) stated his view of this inconsistency between the examination and the pupil's notebook thus:

The difficulties of the course have been increased by insisting on the pupils making their own text-books. This has led the teacher to choose one of the evils which he considers the less objectionable; he may stress note-books and in so doing be forced to give diagrams and drawings and only slightly camouflage the dictation of notes, or he may stress practical work, discard all book drawings and black board drawings and refuse to dictate any notes, and as a result be satisfied with mediocre note-books, which cannot be of much assistance to the pupils when they come to review their work for the Lower School examination. The crying needs of the Lower School Science course are a new syllabus of biology for the Lower School and a well-illustrated authorized text-book in the same subject.⁶⁹

Despite the criticisms of student produced notebooks by Rogers* and other educators such notebooks remained the main source of pupil reference for sixteen years.

* The criticism by George Franklin Rogers deserved serious attention because he was an able student, science teacher, inspector and administrator and eventually reached the highest position on the Ontario educational system, Chief Director of Education. Graduating with first class honours in both English and Science from Victoria University (1892), he won the Prince of Wales Gold Medal for General Proficiency and the Silver Medal for Natural Science. Rogers was Science Master at Orilla Collegiate for six years; Principal at Seaforth Collegiate (1900-1913), Principal at London Collegiate (1913-1918), Inspector of High Schools (1918-1928), Assistant to the Chief Director of Education (1928-30), Chief Director of Education (1930-34) and Chief Inspector of Secondary Schools (1934-37). Sir Charles G.D. Roberts and Arthur L. Tunnell, eds. The Canadian Who's Who (London: The Times, 1936-37), p.937.

The existence of a departmental examination and the absence of an authorized textbook affected not only the pupils' standing but also the evaluation of the teacher's performance. If the teacher was to retain the confidence of the community, his pupils had to secure good examination results and this was difficult when the teacher had no standard text to use in preparing the pupils for the examination. Further judgments about the teacher's efficiency were made by the provincial inspector and included an assessment of the teacher's classroom instruction, a perusal of student science notebooks and a scrutiny of the biological collections.⁷⁰

The provincial inspectors, besides judging the teachers' performance, had opportunities to gauge the effectiveness of the high school programs, including those in biology. The inspectors' opinions of programs had considerable merit for several reasons: they were former able teachers; they were in contact with other departmental officials and so were cognizant of the objectives of the department's programs; and they saw directly the working of the programs in classrooms. In spite of their objective viewpoint, inspectors offered only unfavourable comments about the 1904 programs in Grades 9 and 10 biology. Two examples of criticism from inspectors are cited:

Elementary [lower school] biology caused more heart-burning, trouble, and hard work for pupils, teachers and inspectors than any other subject on the program.⁷¹

In this course the schools have attempted to give pupils, during the first and second years in the High School a sort of general survey of the biological and physical sciences. The results have proved what a knowledge

of the psychology of the immature pupil could have foretold, viz., that pupils of the early 'teen' age cannot gain any general view of, say, biology, by touching lightly here and there the various types of plant and animal life.⁷²

The Department of Education responded to the perceived difficulties in the biology programs with two significant recommendations, one in 1905 and the other in 1910. The advice given in 1905 included the following:

- i) The teacher was required to become familiar with the biological conditions of the local area and to give precise instructions for field work.
- ii) The teacher was expected to ensure that full and accurate pupil notes be kept. The following sequence was suggested:
 - (a) insist that the pupils make their records in a scribbler,
 - (b) discuss the results in class, (c) see that the pupils correct their scribbler notes, (d) have the pupils copy their scribbler notes into permanent notebooks, (e) check their notebooks thoroughly initially and spot check later.
- iii) The instructor should encourage the board of education to buy reference books and help pupils use them.⁷³

In 1910, the Ontario Department of Education's response to criticism of the course was to publish a science manual, A Manual of Suggestions for Teachers of Science⁷⁴ designed to serve as a teachers' guide. Prepared by an experienced group of science teachers, this small single volume provided lesson plans for each topic. The manual was easy to use since each topic was presented in the same order as in the course of study, and gave a basis for teacher

confidence, particularly for inexperienced instructors. In addition it made suggestions for class management, gave advice on the selecting and ordering supplies and the manipulating of apparatus.⁷⁵ But, according to Inspector G.F. Rogers (1919), none of these attempts to help the teacher was effective:

The Lower School course . . . of Science is not, even in its present modified form, a conspicuous success, and it has added not a little to the burden borne by the conscientious science teachers⁷⁶

1.12 Applied Biology or Agriculture*

In contrast to biology, which in spite of criticism, made quite rapid progress in acceptance during the period 1871-1920, applied biology, or agriculture,** was a "slow starter".

*The analysis below is based on the accounts of Madill and Lawr: Alonzo J. Madill, History of Agricultural Education in Ontario. (Toronto: University of Toronto Press, 1930); Douglas Lawr, "Development of Agricultural Education in Ontario 1870-1910", (Doctoral Dissertation, University of Toronto, 1973).

**Exception might be taken to equating agriculture to applied biology with the contention that agriculture includes a broader field of knowledge than biology. While this contention is true, however this paper deals with agriculture in Grades 9 and 10 in which the programs are largely biology. This study does not include the agriculture of Grade 11 which contained much physics nor the Grade 12 course in agriculture which consisted largely of chemistry. Hence the designation of Grade 9 and 10 agriculture as applied biology is considered appropriate.

Before the beginning of the period, Egerton Ryerson, Ontario's Chief Superintendent of Education (1844-1876), had promised that he would make the school system "more directly and effectively subservient to the interests of Agriculture, Manufacture and Mechanics."⁷⁷ During visits to European secondary schools, Ryerson had been impressed with the training given, not only for the professions, but for agriculture, manufacturing and commerce. On his return, he attempted repeatedly to devise similar provisions for Ontario schools. As early as 1847 he proposed a Grammar School Amendment Act by which two hundred acres of land would be set aside for each of the secondary schools. This land was to be used for instruction in agriculture. But the bill was subsequently withdrawn because of lack of support in the legislature. Subsequently, a similar bill was presented and defeated in 1849 and again in 1868-69. Finally, in the High School Act of 1871, agriculture was scheduled as one of the subjects of instruction.⁷⁸ However, agriculture training still met with an unfavourable reception in schools and in society. According to Madill in his review of agricultural education in Ontario:

Conditions were not ripe for [instruction in] agriculture. It was many years before the people were ready for it, and before capable and qualified instructors were available to teach the subject properly.⁷⁹

It is ironic that when Ryerson finally succeeded in introducing instruction in agriculture into the Ontario high schools in 1871 his own textbook worked against the success of the hard-won program. His textbook, First Lessons in Agriculture, Parts I and II (1870)⁸⁰, was inaccurate, biased and dull.⁸¹ The first part described some outdated chemistry and devoted one chapter to plants; while the

second part described farming practices. In the latter part, Ryerson used the catechism method of presentation in which a question was asked and then the answer given. Not only was the presentation dull but the text evidenced teleological thinking, unacceptable to both scientists and educators. The following is an example:

Question: Why do ears of wheat stand up by day and turn down by night?

Answer: Because when the ear is becoming ripe, the cold dew, falling into the ear, might induce blight; the ears therefore turn down to the earth at night and receive heat by radiation.⁸²

Ryerson was ahead of his time in trying to introduce agriculture, a utilitarian subject, into the high schools whose dominant emphasis was on academic scholarship.⁸³ While this 1871 attempt to introduce agriculture failed, changes in education during the latter part of the nineteenth century gave agricultural education in high schools a chance of success. Advances had been made in agricultural teaching abroad; science education had improved in high schools; prominent educators and agriculturalists spoke of the desirability of agricultural instruction in high schools; and the Ontario Agricultural College (O.A.C.) had become a prestigious agricultural institution. Given these changes in the popular mood, the Department of Education planned again to bring agriculture into the high schools. To this end a new textbook was authorized in 1898. This text, Agriculture, (1889)⁸⁴ was written by the provincial Deputy-Minister of Agriculture, C.C. James, (Appendix C). However, there was a shortage of trained personnel to carry out the

instruction and not a single high school taught agriculture.⁸⁵

Despite the problems and failures of agricultural education during the period 1871-1920 and beyond, it received the support of one group of people in Ontario society, the agrarians, who placed a high value on the rural way of life.⁸⁶ They fostered the myth that the tiller of the soil was apart from, and morally superior to, the city dweller. And many believed that farmers were threatened by the ever-expanding, urban-dominated society.⁸⁷ The agrarians also believed that the high schools had a detrimental effect on rural life since they attracted able young people into urban professions away from the farms.⁸⁸ And they thought that the introduction of agricultural instruction into the high schools would counteract this effect.⁸⁹ So the attitude of this group towards the introduction of agricultural instruction in the high school was positive and persistent. Because they spanned a wide segment of society including educators, clergymen, editors, politicians and some farmers, they were influential.

The attitude of many practising farmers, however, differed from that of the agrarians in regard to high school agriculture. The farmers believed that most young people learned the art of farming on their home farms and, in general, did not send their children to secondary schools. In fact, in the late 1890's less than one percent of rural elementary pupils progressed to high school.⁹⁰ The parents of the few children attending high school wanted them to leave the farms for the cities where there were greater rewards for less expenditure of effort, time and money.⁹¹

Because of this lack of rural support for agricultural instruction, the Department of Education officials were understandably ambivalent in their attitude towards high school agriculture. While it was official policy to compliment agricultural instruction, the Department officials did not consider high school agriculture of sufficient merit to substitute it for any other subject in the curriculum. This lack of regard was in marked contrast to the treatment afforded time-honoured Latin, which was required for matriculation certificates until the end of the nineteenth century.⁹²

Early in the twentieth century further efforts were made to introduce agricultural instruction into high schools, which culminated in success by 1920. The labourers in this enterprise were editors of farm magazines, local politicians, the personnel of boards of education, of the provincial Departments of Agriculture and Education and, finally, the federal Ministry of Agriculture.

When the new high school curriculum was introduced in 1904, "the committee of nineteen" urged that utilitarian and practical training have priority over theoretical and academic education. Hence a high school could provide instruction in agriculture in place of general science if the board of education made the necessary equipment available (Appendix I). But not one board of education began instruction in agriculture because qualified teachers were not available.⁹³ An attempt was made in 1907 to overcome this problem, through the collaboration between the provincial Departments of Agriculture and Education. The Department of Agriculture provided instruction through their agricultural representatives, free of charge, on the condition

that the Department of Education made available necessary accommodation and equipment through local boards of education.⁹⁴ Six high school boards of education participated: Collingwood, Essex, Galt, Lindsay, Morrisburg and Perth. However, the enrolment in the courses was low as instruction began early in September when the young farmers were too busy with the harvest to attend. In addition, the agricultural representatives were essentially itinerant teachers not members of the school staff and had many duties as farm consultants. The result was that they were unable to take part fully in the school program. The scheme was not a success and the program became attenuated to short courses of practical agriculture offered in the slack farming seasons.⁹⁵

Starting in 1909 a "grass roots" approach was tried, in which local boards of education (Appendix I) were encouraged to hire full-time teachers of agriculture for which regular high school grants (1909) and then additional agricultural grants (1912) were made available from the Department of Education.⁹⁶ This approach was supported by a few prosperous farming communities which hoped that the young people would be encouraged to remain on the productive farms. In addition to providing grants the Department of Education aided the program⁹⁷ by specifying the requirements for teachers of agriculture (1911)⁹⁸, by appointing an agricultural inspector (1911) and by providing a viable course of study (1914). The latter was an essential element in the successful introduction of agricultural instruction.⁹⁹ (Appendix A). It offered a worthy alternative to biology, covering such topics as the flowers of fruit trees, grasses,

seeds, weeds, propagation of plants, soils, bacteria, incubation and rearing of chickens, breeds of farm animals, insect life histories and control of insects. In this course, agricultural pupils, like those in biology, studied many biological topics. Moreover, the agricultural pupils had the added advantage that they could put biological principles to practical uses in rural settings.

The final support for the "grass-roots" plan came in the form of a federal government grant. Through the Agriculture Instruction Act of 1913, ten million dollars were to be paid to the provinces over ten years to aid instruction in agricultural science. Some of this money was used to pay teachers to attend agricultural summer schools, to meet the cost of school agricultural equipment and, to reward teachers and boards who gave agricultural courses.¹⁰⁰

The governmental initiatives to foster agricultural instruction in high schools met with a favourable reception in the community at this time due to certain prevailing trends which were: a noticeable sense of pride in rural life; a respect for scientific farming earned through the persistent and capable efforts of the agricultural representatives and support for high school agriculture from farm magazines.¹⁰¹ The mood of the communities was so positive that by 1914, thirteen high schools taught agriculture; and by 1920, 1406 pupils were enrolled. So Ryerson's promise (1871) to make the school system "more directly and effectively subservient to the interests of Agriculture, Manufacture and Mechanics"¹⁰² had begun to be realized, at least in regard to agriculture.

The resistance to the introduction of agriculture showed how firmly entrenched the support of academic schooling was. However, the fact that agriculture was finally admitted, indicated the beginning of a change in the public conception of education, from an academic to a more utilitarian one.

1.13 Physical Facilities for Biology Education

During the first part of the period 1871-1920, teachers and pupils had to contend with inadequate laboratories, judged by today's standards, or do without specialized rooms altogether. There were often too few tables and too little equipment for pupils to carry out individual experiments, and the teacher frequently had to depend on an alcohol lamp for a heat source and a schoolyard pump for water. Because of these conditions many teachers presented science through demonstration experiments with the students watching rather than investigating.¹⁰³

The Department of Education tried to improve the situation of inadequate laboratory facilities in a variety of ways:

- 1) by making good laboratory accommodation a requirement for collegiate institutes*,

* A collegiate institute was defined in 1884 as a secondary school with at least four masters who were specialists, and a laboratory in teaching Science. Ontario, Report of the Minister of Education, 1884, p.73.

2) by offering cheap laboratory equipment at a provincial Depository*,

3) by penalizing school boards who provided poor equipment.

Such systems worked in urban areas and by 1900 most urban high schools provided well-equipped laboratories for the teaching of biology. The advantages to the pupils of such accommodations were emphasized by the high school inspector, J.E. Wetherell (1910):

Students accomplished more fully the primary purpose of science if they have the facilities for individual work, adequate space, equipment and materials. Students acquired manual efficiency and intellectual independence that would remain with them as permanent assets. 104

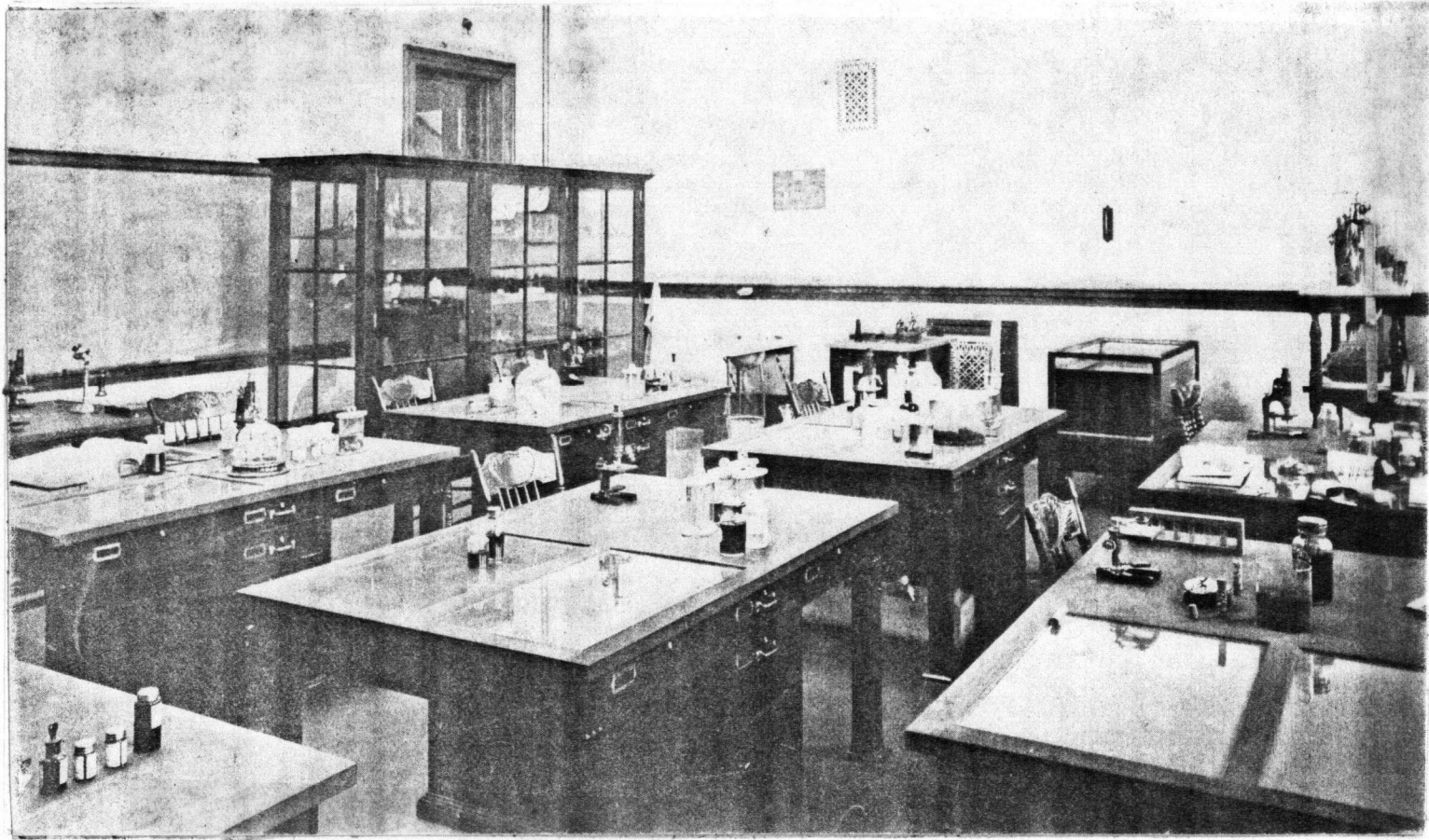
The quality of the urban biological laboratories can be appreciated from the description of a model laboratory of the Ottawa Collegiate Institute (1910) (Fig. 1):

The biological laboratory has nine tables with large tops. Each table is provided with a large cupboard and drawers, suitable for holding microscopes The room has one stationary aquarium of ample size and twelve small movable aquaria on shelves equipped with water supply and overflow. The small aquaria containing aquatic life may be taken to the students' tables for special study

*The Depository maintained by the Department of Education: provided laboratory equipment, maps, charts and museum specimens to any Board of Education in Ontario at half price. This institution was a source of contention to commercial suppliers who argued that it restricted trade. Ontario, Department of Education, Descriptive catalogue of maps, globes, prints, books, etc. for sale at the educational depository to public schools in Upper Canada (Toronto: Lovell and Gibson, 1856).

Figure 1

Biology Laboratory of the Ottawa Collegiate Institute 1910



and observations. There is also in the room a wash basin and incubator stand. The school is provided with large glass cases for museum purposes and for apparatus, and breeding cages 105

By comparison, the equipment and space in many rural high schools were too limited for individual work. Therefore the training in laboratory skills in rural settings fell well below standards achieved in urban areas. Hence graduates of rural high schools who proceeded to university science courses lacked the training in laboratory methods which their fellow students from urban schools had acquired. 106

The conditions of biological museums in many schools tended to be poor as well. In 1910, according to a high school inspector:

One section of the equipment that is exceedingly meagre in all but half a dozen schools is biological material. School museums are rare indeed and collections of biological material are inconsiderable. It is hoped that the payment of an annual grant for museums, now for the first time, will produce the desired results. 107

Suggestions for correcting these deficiencies were made in the Regulations of 1914: Preparations in fluid, illustrating the different stages in the development of a frog, a snake, and a fish would be useful. A collection of birds was indispensable in all schools. There should be at least twenty specimens representative of the locality and showing the different types of feet and bills. Such a collection could be obtained for fifteen dollars. The museum should contain stuffed specimens of a few wild animals of the locality. A standard collection of insects arranged in orders could be accumulated by the pupils. Care should be taken in mounting the specimens and protecting them from injury. All of the museum materials should be kept in glass

fronted, dust-proof cabinets provided with shelves and drawers.¹⁰⁸

Recommendations for laboratory equipment for pupils were also given in the 1914 Regulations and Courses of Study: each pupil would require:

- i) a pocket magnifier,
- ii) a compound microscope (price \$11.00),
- iii) a dozen glass slides and cover slips,
- iv) a couple of needles mounted on wooden handles.¹⁰⁹

Additional zoological equipment was suggested in the same recommendations (1914): Breeding cages for observing the development of insects could be made from waste chalk boxes covering one side with mosquito netting or a plate of glass. Aquaria of almost any desired form or price were available from the dealers of school apparatus from whom information about aquarium management should be obtained. Skeletons should be added gradually, beginning with that of a dog or cat. Included eventually should be the skeletons of a perch, a frog, a snake, a turtle and a crow; the feet and skulls of pig, horse, sheep, rabbit, dog and mole should be accumulated by degrees.¹¹⁰

The 1914 recommendations also made suggestions regarding botanical collections:

For botanical work the pupils should be encouraged to collect the material themselves. A suitable cabinet with drawers would be needed for the herbarium. The specimens in the herbarium should be carefully selected and mounted to provide a model for the pupils in their work. Standard collections of wood should be kept in view with specimens illustrating special points.¹¹¹

In the literature of the period relevant recommendations appeared for planning and equipping a laboratory as for example, in George A. Cornish's, Laboratory Accommodation in Continuation and High Schools and Collegiate Institutes (1915).¹¹² Cornish's pamphlet contained numerous diagrams, space requirements and commercial sources of equipment.

As criticism of biological laboratories no longer occurred in inspectors' reports at the end of the period it is possible that the physical equipment available for biological instruction had improved.

1.20 Changes : The Biology Teachers (1871-1920)*

As academic excellence was important in this period it might be expected that teachers would be highly qualified. This was true for most of the period.¹¹³ However, at the beginning of the period few biology teachers were available so that the Department of Education could not insist on high qualifications for teachers. In fact teachers of science were not required to have undertaken any specific academic training.¹¹⁴ Indeed, some biology teachers had earned Second Class Teaching Certificates at normal school** and did not have university training. This condition was deplored by Inspectors Buchan and Marling:

* Since data for biology teachers was not available, information about secondary teachers is submitted.

** A Second Class Teaching Certificate was awarded to a candidate after three years in high school and a year at normal school.

A . . . difficulty arises from the inferior scholarship of too many of the assistant Masters in the High Schools . . .; it is undeniable, although a Second Class Teacher may have qualified himself . . . for the proper performance of the duties assigned to him in the School to which he belongs, the mere possession of the knowledge necessary to take such a Certificate does not render him a sufficiently good Scholar, and does not ensure a sufficient amount of culture for an appointment on a High School staff.¹¹⁵

The scarcity of trained teachers in the 1870's, which the inspectors deprecated, was corrected in four ways: (i) the promotion of summer courses, (ii) undergraduate training for specialist certificates, (iii) professional courses in teaching and (iv) the up-grading of elementary teachers' qualifications. For non-graduate practising teachers and others who lacked undergraduate laboratory training, summer classes were made available in botany (1885) and in zoology (1887). The courses were conducted by expert teachers like Henry Spotton and Ramsay Wright so that teachers who attended had an opportunity to improve both their knowledge of biology and their methods of teaching.¹¹⁶

At this time the universities were offering more undergraduate programs in honour science. The successful completion of a four year honour program in science with at least two years of honour biology earned for the prospective teacher a specialist's certificate in science¹¹⁷ (1884). This certificate was the qualification needed for the head of a science department in a collegiate institute. The specialist's certificate was widely obtained in that by 1901 two-thirds of all secondary teachers had specialist certificates.¹¹⁸

In 1885 professional training in biology teaching was introduced. Several arrangements for training Ontario secondary teachers were in operation before a permanent secondary teachers' college was established. At first (1885-1889) practice teaching for student teachers was provided in five collegiate institutes throughout the province. However this method of training was criticized as it lacked theory. From 1889 to 1897 both theory and practice were afforded by courses which lasted for four, and later, eight months at the School of Pedagogy, an adjunct of the Toronto Normal School.¹¹⁹ From 1897 to 1907 secondary teacher training was offered at the Hamilton Collegiate Institute. During the period 1907-1920 prospective secondary teachers obtained professional training at the Faculties of Education operated at Queens University of Kingston and at the University of Toronto. Finally in 1920, all secondary teachers received their training at the Faculty of Education of the University of Toronto, then called the Ontario College of Education (O.C.E.). At O.C.E. facilities for practice teaching were available from the affiliated University of Toronto Schools and the surrounding collegiate institutes.¹²⁰

Following the introduction of professional training, the inspectors' evaluation of the teachers' performance improved. In 1887 only 38 percent of the science teachers had an inspector's ranking of second class* or better; while, in 1889, after professional

* Second class ranking refers to an inspector's classification based on teaching performance and is not to be confused with a Second Class Teaching Certificate.

training had been in operation four years, 88 percent had this ranking.¹²¹ In addition, many teachers had qualifications above the minimum, i.e. a High School Assistant's Certificate^{*} or a First Class Teacher's Certificate.

While many biology teachers followed the training route indicated, i.e. enrolling in an honours university course and attending a teacher training institution after graduation, others became high school teachers of biology by first becoming elementary teachers. Such teachers attended high school, trained at Normal or Model schools, completed university subjects in the summer or by correspondence and finally secured degrees. These teachers were accepted as teachers in high schools either on the basis of their degrees or their teaching certificates. Such teachers lacked the specialist background of honours courses, but they were often able people, who had learned to work with children.¹²²

While the supply of secondary teachers fluctuated throughout the period, depending on economic conditions and the demands of wartime governments, the qualifications of teachers in high schools and collegiate institutes remained more or less the same (Table 3) for the first two decades of the twentieth century. However, a slight decrease in the proportion of specialists was noted.

* An Interim High School Assistant's Certificate was granted a teacher who had a bachelor's degree and had completed the attendance requirements at a teacher training institution. After two years of successful experience the interim certificate could be made permanent on the inspector's recommendation.

Table 3
Ontario Secondary School Teachers (1900-1920)

	Teachers in High School and Collegiate Institutes		Teachers in Continuation Schools*
Year	Percentage of University Graduates	Percentage of Graduate Specialists	Percentage of University Graduates
1900	75.3	69.1	4.6
1910	73.5	62.7	13.0
1920	73.1	63.7	21.9

Source: Ontario, Report of the Minister of Education, 1899, p. 210; ibid., 1900, 198; ibid., 1901, pp.60-66; ibid., 1909, pp.60, 277-289; ibid., 1910, pp. viii, 324-348; ibid., 1919, pp. 315, 352; ibid., 1920, pp. 36, 40, 190; ibid., 1921, pp.85, 87-8.

Notes: * The continuation schools were rural secondary schools that were established as extensions of elementary schools. W.G. Fleming, Education : Ontario's Preoccupation (Toronto: University of Toronto Press, 1972). p.69. Continuation school teachers were 16% of the secondary school teachers and had at least First Class Public School Certificates. To secure such a certificate a teacher was required to spend a year in normal school and four years in high school in 1900 but six years in high school in 1920.

Unlike the teachers in high schools and collegiate institutes, few teachers in continuation schools were graduates. However, the percentage of graduates in these schools increased as more teachers became qualified.

1.30 Changes : The Biology Pupils (1871-1920)

1.31 The Number of Biology Pupils

The number of biology students reflected the numbers in the total high school enrolment. In 1871 when the emphasis in the schools was on academic studies only one twenty-fifth of the possible pupils attended high school. By the end of the fifty-year period, when a utilitarian emphasis was perceptible in education and when agriculture (see Chap. 1, p.32) and commercial subjects¹²³ had been introduced, the pupil enrolment had increased to one-fifth of the possible enrolment (Appendix H).

The number of pupils enrolled in the high schools and those who chose to study the sciences are shown in Table 4. From 1877 to 1902, the total high school enrolment increased almost three fold. By 1902, physics showed the highest enrolment, with biology in second place and chemistry third. Also by 1902, the percentage of students studying physics doubled; in biology, the percentage increased from zero to fifty-three percent then declined to thirty-seven percent; while the percentage of chemistry students decreased slightly.

Table 4 shows also the changes in enrolment and in the proportion of pupils taking all sciences after the 1904 curriculum was introduced. For the latter part of the period (1904-1920) physics had the largest proportion while biology and chemistry had almost equal proportions.

Table 4

Ontario Secondary School Enrolment in Science Subjects, 1877-1920

Year	Total Enrolment in High School	PHYSICS		CHEMISTRY		BIOLOGY*	
		Number Enrolled	Percentage of Total High School Enrolment	Number Enrolled	Percentage of Total High School Enrolment	Number Enrolled	Percentage of Total High School Enrolment
1877	9229	2168	23.5	2547	27.6	-	-
1882	12348	2880	23.3	2522	20.4	-	-
1887	17459	5265	30.2	3411	19.5	4640	26.6
1892	22837	6601	28.9	3710	16.2	6189	27.1
1897	24390	11002	45.1	5489	22.5	12892	52.9
1902	24472	12758	52.1	5860	23.9	9051	37.0
1907**	30331	23421	77.2	15064	49.7	15,572	51.3
1912	39840	30794	77.3	20520	51.5	21283	53.4
1917	37302	28196	75.6	18008	48.3	19340	51.8
1920	42052	31023	73.8	19039	45.3	19966	47.5

Sources: Ontario, Report of the Minister of Education, 1910, p. xxxviii; Dominion of Canada, Dominion Bureau of Statistics, Annual Survey of Education, 1931-34, pp. 47-48.

Notes: * Before 1907 enrolment in botany only is recorded as very few studied zoology. From 1907 on enrolment in both botany and zoology are included.

** Continuation school enrolment was not available.

Accounting for these changes involves many variables including those of demography, economics, the structure and content of schooling and the nature of society itself. In this paper the author looks only at how changes in educational practice particularly in science could have influenced the changes in enrolment.

One possible reason for the increased enrolment in physics was the change in the method of teaching in 1887. In that year a mathematical treatment of physics was replaced by a more descriptive approach using demonstration experiments and fewer problems with mathematical concepts.¹²⁴ If this new approach caused the increase in enrolment, the increase should have occurred a year or two after the change. However, the large increase did not take place until ten years after the curriculum innovation. Hence factors other than the nature of the instruction must have been involved. In contrast to physics, chemistry declined in enrolment. This may have been primarily due to difficulties in organization and management of laboratories.¹²⁵

The change in enrolment in biology (largely botany) is significant. When botany was introduced in the 1880's with its direct examination of plants, it illustrated scientific enquiry and was of marked interest to the pupils. However, by 1902 taxonomy was being stressed.¹²⁶ Hence many pupils may have lost interest and the enrolment declined. One might postulate that this illustrates a relationship between the content taught and enrolment.

The data in Table 5 show considerable variations. There was an increase in enrolment in Grade 9 and 10 biology from 1900 to 1910 that can be accounted for by biology being compulsory for most students after 1904.¹²⁷ In addition, there was an increase in the proportion of pupils taking upper school biology in 1910. It is difficult to account for this; however, there was a need at this time for elementary teachers whose training included biology.¹²⁸ It is noteworthy also that by 1920, agriculture was being selected by some students as a subject for study.

Table 5

Ontario Secondary School Enrolment in Biology and Agricultural Science (1878-1920)

Enrol- ment Year Percent	Lower School Biology Grade 9,10	Upper School Biology	Lower School Agri- culture Grade 9,10
1878	N.A.	N.A.	0
1890*	21	11	0
1900*	40	8	0
1910	78	54	0.2
1920	68	20	3

Source: Ontario, Provincial Archives of Ontario (PAO), High School Inspectors' Reports, 1890. *ibid.*, 1900; *ibid.*, 1910; *ibid.* 1920; Ontario, Report of the Minister of Education, 1878, p. 14-16; *ibid.*, 1891, p.56; *ibid.*, 1901, pp. viii; *ibid.*, 1911, p. xvii; *ibid.*, 1921, pp.115, 178-9, 211, 240.

Note: * Continuation school enrolment was missing.

An earlier attempt was made to relate a change in enrolment in biology to the biology curriculum. This was noted in the decline in biology enrolment from 1897 to 1902 (Table 3) and its association with the emphasis on taxonomy. However, the explanation may be found in changes that were occurring in other areas of the school curriculum.

For example, in the period 1871-1920, commercial and technical training were begun in urban secondary schools, so that by 1914, courses in these subjects were well established in larger cities.¹²⁹ Pupils who were interested in careers in business and industry would likely have been attracted to the 'practical' subjects rather than to academic biology.

1.32 Biology for Prospective Elementary School Teachers

Many young people (40%) who attended high school in the 1880's and 1890's did so to qualify as elementary school teachers.¹³⁰ For these pupils, botany was a required course prescribed by the Department of Education because at that time it was thought a study of botany trained the "faculties" of observation and reasoning.

Table 6 shows the botany requirements for prospective teachers for the period 1871-1903.

Table 6

Botany Requirement, by Grades, for Elementary School
Teaching Certificates (1871-1903)

Year**	1st Class Teaching Certificate	2nd Class Teaching Certificate	3rd Class Teaching Certificate**
1871	X X X -	X X X	X X
1876	X X X X	- - -	- -
1885	X X X X	X 0 0	0 0
1891	X *** 0 X X	X *** 0 X	X *** 0
1896	X - X 0	X - X 0	X -
1903	X - X 0	X - X 0	X - X 0
Grade in high school	9 10 11 12	9 10 11	9 10 11

Sources: A.G. Croal, "The History of the Teaching of Science in Ontario 1800-1900", (Doctoral Dissertation, University of Toronto, 1940), pp.85-86, 164, 169; Ontario, Report of the Minister of Education, 1885, pp.30-32.

Note: X : Obligatory; 0 : Optional; - : Not Offered.

* The year selected were those at which changes in requirements occurred.

** The Third Class Teaching Certificate was obtained by success at an examination for entrance to and training in a Model School. Two years of high school training were needed for this certificate until 1898 when any candidate for teacher training required a Junior Leaving Certificate (Grade 11). Ontario, Report of the Minister of Education, 1898, p.71.

*** Some zoology was included in the topic "the scope and aims of biology."

The data show that the requirements varied, particularly in the later years when fewer botany courses were required for First Class Teaching Certificates. This decline appeared at a time when the botany courses emphasized taxonomy. It is tempting to speculate that there was a cause/effect relationship between the reduced number of botany courses required for First Class Teaching certificates and the difficulty experienced by prospective teachers with taxonomy. The supposition is that the high school teachers, noting their pupils' difficulties with taxonomy, requested the Department of Education to reduce the number of botany courses required and that the Department acceded to this request. There is evidence that the Department of Education officials did at times respond to criticism of their administration by making adjustments. For example, when criticism was made of the practical identification of specimens on botany examinations, the practical aspects of the examination were removed for most students (1899, see Chap. 1, p.17). It is consistent, therefore, that the officials would also respond to the expressed difficulties in taxonomic botany by reducing the number of courses in botany needed for First Class Teaching Certificates. But it is also possible that a complex of causes was involved, including concerns about the efficacy of botany as a trainer of minds and the need for more teachers. Some of this demand for teachers came from the Canadian prairies in the early part of the twentieth century.¹³¹ However the actual reason for the reduction of the number of botany courses required for elementary teachers is not known.

A new emphasis appeared in 1904 with the introduction of Grade 9 and 10 general science that was designed specifically to train prospective elementary teachers to instruct in nature study. This subject was given a prominent place in the elementary schools. This was supported by agrarians and "new educators",* the former because they saw it as providing some rural environment for the deprived urban dwellers. The latter supported the program because they viewed it as being in accordance with their educational philosophy in which the child is the centre of the learning situation "as the sun is the centre of the solar system."¹³² According to the view of the "new educators" the active child was considered to interact with the environment as he learned; the elementary teacher acted as motivator, interpreter and model, arranging the environment and so aiding learning. Through his responses, the child was believed to build up a stock of useful skills, a repertoire of positive attitudes and a store of desirable knowledge.

In order to give appropriate backgrounds for prospective elementary school teachers who were to instruct in nature study special training was provided in the high school general science course, including training in botany and zoology as well as physics and

*The new educators such as James L. Hughes, Toronto's Chief Inspector of Public Schools, (1874-1913) stressed child activities as in kindergartens. "Robert M. Stamp," *Evolving Patterns of Education : English Canada from the 1870's to 1914*, in *Canadian Education : A History*, eds. J. Donald Wilson and others, (Scarborough, Ont.: Prentice-Hall of Canada, 1970), pp. 318-320.

chemistry. This training emphasized individual investigations, with the teacher simply directing the pupil's observations and providing secondary sources of information. The student's findings were then discussed and organized into recognized principles of biology.¹³³ In this way the prospective teachers were encouraged to think as teachers of nature study. As this learning experience was very similar to that in which the training was to be used, it can be argued that it should have been effective. However, Inspector Rogers after observing this training for fifteen years, contended that the training came when the prospective teachers (Grade 9 and 10 students) were too young and immature to profit fully from it, and that the method assumed a level of thought not possessed by many teen age pupils (see Chap. 1, p. 25). In spite of the criticism directed to this method of instructing prospective teachers of nature study, the methodology remained in operation until the end of the period (1920).

1.40 Summary

During the period 1871-1920 several changes have been noted in both general and in biological education in Ontario high schools. While the proportion of possible pupils attending increased five fold it was still a minority (1/5 of the possible students). The biological program for Grades 9 and 10 changed from human physiology, to botanical taxonomy and, eventually to biology in general science. Also, methods of teaching biology changed from textbook assignments, to examination of plants for identification and finally to pupil activities directed to the natural environment.

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Chapter 2

BIOLOGY EDUCATION IN A PERIOD OF EXPANDING ENROLMENT (1921-1960)

2.00 Introduction

The period 1921-1960 began with a rapid increase in secondary school enrolment. While Ontario's population rose by 17 percent during the 1920s, the secondary school enrolment increased by more than 100 percent (Appendix H). However, the rate of increase in high school enrolment was less rapid in the 1930s and 1940s but it expanded again in the 1950s. This increase in enrolment had a significant effect on the development of biology education. Also, exerting an influence there was a wide variety of social and economic conditions: the 1920's provided a period of prosperity; the 1930's brought a depression; the 1940's had the Second World War and its aftermath; and the 1950s was a period of readjustment.

In this chapter, the author traces the changes in biology education during the period of expanding enrolment (1921-1960).

2.10 The Context of Biological Education in the Period (1921-1960)

General education and biological education are so bound together that changes in general education frequently entail

alterations in the program in biology. For this reason the chapter begins with statements on the background of general education, against which biological education can be focused.

2.11 Innovative Arrangements Extending Secondary Education

During this period educative innovations were introduced in Ontario, and among them the following increased the length of time a student attended secondary school:

- i Secondary education was made compulsory to age 16;
- ii Rural pupils were afforded special opportunities;
- iii Diplomas were made available for different levels of pupil development;
- iv Reductions were made in the number of departmental examinations.

Each of these innovative changes is discussed in the following pages.

i Compulsory Attendance

In 1919 H.J. Cody, Minister of Education, introduced the Adolescent Attendance Act which raised the school leaving age from 14 to 16 years. He stated that the purpose of the act was to train the workers needed for industry.¹ Possibly for this reason, young people already working on farms were exempt.² Although the legislation was passed in 1919, it was not enforced until 1921 at which time all high school fees were abolished. Soon after its implementation, enrolment increased. R.H. Grant, the Minister of Education, asserted that the increase was due to the attendance act.³ However, F.P. Gavin,

a high school principal, claimed that increased high school attendance had begun before the First World War.⁴ Robert Stamp, the Canadian historian, contended that the real reason for the increased enrolment was not compulsory attendance, but the desire of parents to secure for their children a controlled environment for citizenship training and the competitive advantages of high school education.⁵ It seems likely that it was really a combination of factors which contributed to the increased attendance.

ii Improved Opportunities for Secondary School Education in Rural Areas

While urban secondary school attendance increased in the early 1920's the enrolment of pupils in rural areas was low. Rural secondary pupils until the late 1940's had two alternatives, boarding near a town high school or attending a rural continuation school. The cost of boarding was prohibitive for many, while the continuation school afforded a training which was largely academic.⁶

In the early 1940's Inspectors Rendall and Dutton were appointed by the Department of Education to make recommendations for the improvement of rural secondary education. They recommended that the high school districts be enlarged to include rural areas and that small continuation schools be closed.⁷ This recommendation was accepted by the Department of Education. The resulting high school districts had a school population of at least 300 pupils and assessments of at least 7 million dollars.⁸ Some advantages of these larger units of administration were pointed out by Frederick W. Harvie, former Superintendent of St. Catharines and Lincoln High Schools District, who helped to bring about the formation of one of the enlarged high school districts: A district high school could offer a

variety of options such as shop work, music and upper school biology. Moreover, the boards of the enlarged school districts (Appendix 1) would have sufficient tax income to hire a competent teaching staff, guidance personnel and provide bus transportation for pupils from the remote parts of the district.⁹ By 1948, seventy-five percent of the province had enlarged high school districts so that up-to-date secondary education was made possible for most rural pupils.¹⁰ The transference of some small classes following the closing of continuation schools resulted in enlarged classes in the central high school. Such an increase in numbers was noted by the author for his upper school biology classes.

iii Provision of Diplomas

Before 1921, only those students working toward a teacher's certificate or university entrance were given diplomas. But, in 1921, a pupil interested solely in gaining a general education could also earn a diploma on the successful completion of Grade 12.¹¹ This High School Graduation Diploma was accepted by the community as a measure of competence and preparedness for entering into the adult work force. In 1939, a certificate was issued to all students successfully completing Grade 10, thus acknowledging a level of accomplishment reached by a sixteen-year-old at the completion of his compulsory schooling. It was called the Department of Education Intermediate Certificate and was awarded on the recommendation of the high school principal.¹² In addition, in 1942, the successful completion of Grade 13 was recognized by the awarding of an Honour Graduation

Diploma.¹³ By 1942 the Department of Education issued diplomas at three levels of achievement: Grade 10, 12 and 13, and so provided a series of end points for schooling and goals for individual pupils. These diplomas were seen to provide a sequence of incentives to help all students reach their appropriate educational levels.

iv Reduction in Numbers of Departmental Examinations

In the early days of Ontario secondary schooling a pupil's standing was determined by his mark on examinations set and graded by Department of Education officials. This departmental examination routine was one feature of the Ontario educational system criticized by pupils, parents and inspectors. As early as 1913, James L. Hughes, Chief Inspector of Toronto Public Schools, commented: ". . . we are behind every other part of the civilized world in our reverence for examinations."¹⁴ Gradually this burden to the "average" pupil was removed: In 1904, promotion in lower school subjects, including science, was possible without departmental examinations.¹⁵ By 1940 the elimination of departmental examinations was extended to Grades 11 and 12.¹⁶ Thereafter all high school certificates, except those in Grade 13*, were granted on the recommendation of the high school principals.¹⁷ The reduction of the examination hurdles encouraged more pupils to make use of the secondary school opportunities

* Exemption from writing Grade 13 departmental examinations was possible during the Second World War for a student who left school early in his final school year. Such a student was required to have been regular in attendance, successful in his years work and have enlisted in the armed services, or have been employed on a farm or in a food industry. A student who obtained his standing by working had to present a statement from his employer that he was employed for at least 13 weeks. (Ontario, Report of the Minister of Education, 1942, p.2).

including education in biology.

2.12 Expanding Biological Research

During this period (1921-1960), comparatively little research was carried on in biological education although extensive investigation was conducted in biology with the total number of research investigations carried out in the world increasing more than five fold from 1927 to 1960.¹⁸ Perhaps the most profound effect on human life was the increase in life expectancy by eight years for men and by twelve years for women from 1931 to 1961.¹⁹ On the other hand, biological research made possible a reduction in the birth rates. Indeed, the number of offspring born to Ontario women of child bearing age declined by almost one half between the year 1951 and 1974.²⁰

In contrast to the challenging problems of the research biologist, the high school teacher of biology was faced with more commonplace and less fundamental issues:

- i Should the Umbelliferae, Labiatae and Gramineae be included or eliminated from the Grade 13 high school course?²¹
- ii Should there be two courses of general science, or a course of physical science and one of biological science, in the first two years of high school?
- iii Which is better pedagogically, a laboratory exercise or a demonstration experiment?²³

Educators and biologists criticized the American high school biology courses as out-dated, unimaginative and stereotyped. They claimed

that the available texts promoted the memorization of names, facts and dates.²⁴ Such dissatisfaction led to the development of some changes during the period, but it was not until the next period (1961-1978) that innovative programs were introduced.*

2.20 Changes : The Biology Curriculum

2.21 Grade 9 and 10 Biology

In this section the author examines the curricula and textbooks in biology and agricultural science for Grades 9, 10 and 13 in the light of the general changes in education discussed previously. In addition, the author relates the curriculum changes to two contrasting educational viewpoints of the time : progressivism and conservatism.

Because the existing biology course had proved unsatisfactory, a new course of study was prepared by the Ontario Department of Education in 1921. It included new content and methods of teaching and testing, but, surprisingly, it also separated biology into botany and zoology, a departure from the general science approach used earlier.²⁵ The aim of the 1921 botany and zoology courses was to acquaint the pupil with his biological environment through experimentation, observing and reasoning. The content emphasized biological topics believed to be useful to the individual as a student and as an adult. The topics included the following: control of weeds, methods of vegetative reproduction of plants, orchard practices, reforestation,

*The curriculum proposed by George Hofferd (1932) was a notable exception, (see Chap. 2, p.71).

economic uses of plants, fungi harmful to crops, game fish, economically important animals among the insects, amphibians, réptiles, birds and mammals.²⁶ Nevertheless, George Hofferd (1932), the Science Master at London (Ontario) Normal School, criticized the program of 1921 because it did not appeal to pupil interest. He commented: "The analysis of the Ontario course showed that [the course], largely emphasized description, morpholôgy, modes of life from the standpoint of pure science, at the expense of investigating cause and effect relationships which function in life processes".²⁷ Hofferd, moreover, maintained that : "[pupils] had their greatest interest in ecology, and the life history of living things, . . . they were less interested in morphology and least in classification".²⁸ Hofferd's overall assessment was that the 1921 revision was too specialized and it over-emphasized taxonomy.²⁹

In 1937 general science was reintroduced and was retained throughout the remainder of the period of the study. Its reintroduction was justified by the educators' belief that it would offer a wide range of topics of interest to all students more effectively than the specialized sciences (Appendix A). To provide time for the physical sciences in the 1937 revision of the course of study, some streamlining of the biology content was required. Only those biological topics which were thought essential to an elementary understanding of biological science and suitable for the average pupils were retained. Several examples follow (Appendix A). The emphasis was placed on the biology of healthful living and the development of the pupils' ability to observe and reason. This new program (1937) laid greater stress on individual investigations and on the use of projects, and when demonstrations were required, they were to be carried out as a cooperative

effort between teacher and pupils. The topics of practical interest included an experimental study of bacteria, a consideration of the relation of bacteria to disease, a laboratory investigation of foods, an informative scientific approach to human physiology and a discussion of the balance of nature. A detailed study of molluscs and ferns was omitted, and there was a reduction in the emphasis on taxonomy.³⁰

In spite of these revisions, the 1937 curriculum failed to come up to expectations. Two new difficulties arose: First, the course failed to arouse pupil interest,³¹ so in 1951 the Department of Education tried to make the course more stimulating by making some topics optional and recommending the use of motion pictures, slides and film strips.³² The second difficulty was caused by the inconveniences of implementing general science in larger schools which had separate laboratories for physics, chemistry and biology but were not equipped for general science. The general science program, in addition, presented difficulties for many teachers who were specialists in a particular discipline. For example, biology specialists sometimes had to teach a Grade 9 science course, which included components which required special knowledge of physics or chemistry. Such inconveniences were reduced by revisions in the curriculum, (1954) (Appendix A) in which the Grade 9 course included physical science only and the Grade 10 program contained biological sciences,³³ a division of the sciences which continued until 1961.

2.22 Grade 13 Biology* (Appendix B)³⁴

Changes were introduced in 1921 in an attempt to cope with the needs of the average pupils in Grade 9 and 10 biology; and corresponding changes were made in Grade 13 biology. Although the Grade 13 program showed detailed academic content, it was also intended to be suitable for a varied clientele: prospective nurses, elementary school teachers and university students. Thus, the course had to be both a terminal program and one in which an initial training was given in basic biological concepts on which the more detailed university courses could be built. While it is difficult to get documentation for this contention, it is the author's opinion that the courses (1941-1960) served both purposes. Pupils attending university usually expressed satisfaction with the basic understandings that they had acquired from the upper school biology. Moreover, this program afforded a terminal credit in science to pupils who, although able to understand and remember details accurately, had difficulty with the mathematics needed for the physical sciences.³⁵

The content of the 1921 Grade 13 biology course showed significant alterations from that of the previous period (Appendix B). It stressed experimentation and observations on morphology (as seen by dissection and microscopic studies), an examination of the basic groups of organisms with emphasis on economically important forms, the adaptations of structure to function and ecology. Much of the

* Biology in Grade 11 or Grade 12 was not introduced until 1964.

new content was appropriate for the average upper school student, as evidenced by examination results. In 1922, for example, 85 percent of the students were successful in departmental examinations in biology.³⁶

Some twenty years later (1941) significant changes to accommodate a variety of pupils and to update the program were again made to the Grade 13 biology syllabus (Appendix B): the study of ecology was expanded; genetics was introduced; taxonomic studies were reduced by the omission of three families of flowering plants, a detailed study of alternation of generation in the plant kingdom replaced a more general treatment; and an intensive course in human physiology was added. Human reproduction and theory of evolution which were active fields in biological research were still not included.³⁷

2.23 Grades 9 and 10 Agricultural Science

The program in agricultural science of 1921 contained many biological topics, but its aim was to provide a practical approach to farming, and included two distinctively practical features, school gardens and home projects. In addition, it offered biological topics: flowering plants, fungi, bacteria* and entomology. The agricultural aspect (1921) concentrated on weeds and grasses, dairying, bee-keeping, poultry raising, the breeds of livestock and soils.³⁸ Agriculture, thus,

*The topic, bacteria, had not been included in the 1921 course in botany but was included in the course in agriculture, a difference that emphasized the practical nature of the latter.

included a great deal of general biology with an approach directed towards rural life.

The 1937-38 revision of agricultural science (Appendix A) made the course much like its alternative, general science. In fact, the Grade 9 general science and agricultural science programs were identical except for three additional topics in the latter: milk, chickens and gardening. The Grade 10 agricultural science course was also basically the same as the Grade 10 general science course except that astronomy was excluded from agricultural science; and bee-keeping, livestock, soils, methods and practice in gardening, and home projects were included.³⁹ The similarity of content made it possible for the Department to authorize the same text-books for both science and agriculture.

During the period 1921-1960 the courses of biology and agricultural science changed in that they gave less attention to taxonomy than they had previously. The programs included topics which related structure to function, contained considerable descriptive physiology, practical applications and considerations of food and human physiology, but lacked a detailed consideration of cell biology, genetics and ecology which were current research fields. The most serious defect, however, as viewed by contemporary critics was the neglect of biological processes and structure* as there were very few investigations

* Biological processes refer to the methods used by biologists to conduct research, while biological content or structure describes the facts, concepts and principles of biology (Norman Massey, Patterns for the Teaching of Science, Toronto: MacMillan Canada, 1965), pp. 215-217.

requiring the pupil to think as a research biologist.⁴⁰ As early as 1932 there were suggestions to improve the biology program by making it more of a problem-solving enterprise. Indeed, George Hoffer published such a program and it contained many of the biological topics which were included in the 1937 departmental course. He developed biological concepts in problem-solving settings and provided many student activities involving living organisms.⁴¹ It is interesting to note that George Hoffer published a process-oriented biology program, (A Study of the Content and Methodology of Ontario Lower School Biology, 1932) that predated by thirty years the Biological Sciences Curriculum Study.

2.24 Authorized Textbooks and Reference Books in Biology*

In 1916, Inspector Rogers noted that there was a "crying need" for a well-illustrated text for the Grade 9 and 10 Science course since no science text had been authorized for Grades 9 and 10 since 1903 (see Chap. 1, p. 23). Apparently, Rogers' advice was heeded by the Department of Education officials since they authorized textbooks in biology for the 1921 program and continued this practice throughout the period (1921-1960). To help facilitate the review the author has

*Upper school textbooks were not authorized but listed in the courses of study as reference books. The books used in the upper school were selected from the approved list by the high school principals after consultation with their staffs. The local board of education confirmed the principals' suggestions and recorded approval in their minutes.

Table 7

Authorized Textbooks for Ontario Lower School Biology
Group 1, (1921-1937)

Publisher and Publisher's Location	Author	Title	Period of Authorization	Grade Level Readability Flesch Index	Personal Evaluation
MacMillan (Toronto)	L.H. Bailey, normal school teacher	<u>Beginners' Botany</u> (1921)	1921-1927	8	attempts to consider plant as a living organism, stresses pupil activities.
MacMillan (Toronto)	W.M. Coleman, professor of biology at normal school	<u>Beginners' Zoology</u> (1921)	1921-1927	12	directs pupil observations, drawings only fair.
Education Book (Toronto)	* A. Cosens and T.J. Ivy, teachers	<u>Botany for High Schools</u> (1928)	1928-1937	8	topics probably of pupil interest, e.g. fungus diseases of crops, several demonstration experiments, diagrams clear.
Education Book (Toronto)	* J.F. Calvert and J.H. Cameron, teachers	<u>Zoology for High Schools</u> (1928)	1928-1937	8	detailed instructions for pupil observations, interesting accounts of practical applications and natural history.
Copp Clark (Toronto)	B.P. Colton, professor at teachers' college	<u>Zoology Descriptive and Practical</u> revised ed. of 1911, 1923(1903)	1928-1937	10-12	excellent organization of pupil activities to illustrate principles of classification.

Notes : * Ontario authors

divided the texts of the period (1921-1960) into two groups: lower school and upper school texts.* And he has further divided the lower school texts into three groups on the basis of their dates of authorization; Group I (1921-1937), Group II (1938-1956). Group III (1953-1960) and upper school texts constitute Group IV.

In Tables 7, 8 9 and 10 the authorized texts are described and evaluated. A readability score was determined by the author using the Flesch Index.⁴²

The above descriptions of the textbooks of the lower school in Group I show that most of them followed the conservative academic viewpoint of the period. All the books stressed the principles of biological content rather than biological processes and were organized on the basis of the discipline rather than on pupil interest. Nevertheless, some topics were selected because of perceived interest, e.g., topics of practical applications and social relevance of biology. This may have been because most of the authors were secondary teachers.⁴³ It is noteworthy also, that the authors of this period lacked the research background of the authors of the previous period. The result was that, although the books were mainly organized on the basis of content, the texts did not reflect the condition of current research as well as texts of the previous period. The texts supported a deductive, rather than a discovery-oriented method of teaching. The teacher, moreover, was considered central in instruction processes and often used the demonstrations which the texts described. None of the textbooks had graded assignments which

*The modus operandi for textbook authorization is shown in Appendix D.

Table 8

Authorized Textbooks for Ontario Lower School General Science
Group II, (1938-1956)

Publisher and Publisher's Location	Author	Title	Period of Authorization	Grade Level Read-ability Flesch Index	Personal Evaluation
Dent (Toronto)	* H. Bowers , teacher at normal school	<u>General Science</u> Book One (1938)	1938-1956	10	topics introduced as problems, coherence excellent, many individual pupil activities, quantitative expressions for biological phenomena
Dent (Toronto)	* H. Bowers , teacher at normal school	<u>General Science</u> Book Two (1938)	1939-1956		
Pitman and Sons (Toronto)	* V.N. Bruce, teacher	<u>Junior Science for Secondary Schools</u> Pt I (1938)	1938-1953	9	diagrams large and clear, numerous individual pupil activities, many practical applications
Pitman and Sons (Toronto)	* V.N. Bruce, teacher	<u>Junior Science for Secondary Schools</u> Pt II (1938)	1939-1953		

Note: * Ontario Authors

some authors use in making provisions for individual differences in pupils. The absence of graded assignments suggested that the texts reflected the importance of the discipline more than the adjustment of the pupil to it.

However, the texts after 1937 in the second and third groups showed some distinctive changes: They stressed class experiments instead of teacher demonstrations. Pupil projects focused more on topics which were related to the pupils' health or their understanding of themselves. The topics included the study of bacteria, human foods and human physiology (Appendix A). This emphasis on pupil activities and interests was typical of the progressive approach which became important in Ontario education in the 1930s; (see Chapter 2, p.81).

The authorized books from 1953 to 1960 continued to include many student experiments and social applications of biology (Appendix A). Several optional topics were added, a feature that permitted adjustment to differences in pupil interests. For example, Bruce and Carter's textbook, Intermediate Science, Book 2 (1954), had the following optional topics: heredity, studies of identification, soil and climatology; Bowers and Bissonnette's text, General Science, Intermediate, Book 4 (1953), contained optional chapters on the following subjects: the development of the chick, further studies in gardening, safety with food and drugs, conservation of human resources and home projects in agriculture. (See Chap. 2, p.70).

In addition, the placement of the physical and biological science in separate grades and texts facilitated the conducting of classes in

Table 9

Authorized TextBooks for Ontario Lower School Biological Science
Group III, (1953-1960)

Publisher and Location	Author	Title	Period of Authorization	Grade Level Readability Flesch Index	Personal Evaluation
Pitman & Sons (Toronto)	* V.N. Bruce , and A.H. Carter , teachers	<u>Inter- mediate Science</u> Book 2 (1954)	1954-1960	11	historical approach occasionally used, experiments with thorough consideration of errors, options offered, diagrams clear
Dent (Toronto)	* H. Bowers , and R.N. Bissonnette , teachers normal school and high school	<u>General Science</u> <u>Inter- mediate</u> Book 4 (1953)	1953-1960	9	numerous activities suggested for both class and individual, practical applications indicated, options, offered illustrations excellent

Notes * Ontario Authors

Table 10

Recommended Text-Books for Ontario Grade 13 Biology
Group IV, 1921-1960

Period of Recommendation	Publisher and Location	Authors	Title	Grade Level Readability Flesch's Index	Personal Evaluation
1928-1937	Educational Book (Toronto)	A. Cosens* & T.J. Ivy*, teachers	<u>Botany for High Schools</u> (1928)	8	not sufficient detail of alternation of generation of plant groups
1932-1937	Ginn (Toronto)	J.Y. Bergen & B.M. Davis, teacher and professor	<u>Principles of Botany</u> (1906)	13	thorough, more plant groups than Gr.13 course,
1932-1937	H. Holt (New York)	C. Curtis, professor	<u>Nature & Development of Plants</u> (1931)	10	content difficult for Gr.13, diagrams numerous and clear
1928-1937	Educational Book (Toronto)	J.F. Calvert & Cameron*, teachers	<u>Zoology for High Schools</u> (1928)	8	good questions on pupil activities not sufficient, detail of morphology for Gr. 13
1928-1937	Copp Clark (Toronto)	B.P. Colton, professor teacher's college	<u>Zoology Descriptive & Practical</u> (1903)	10-12	excellent exercises on dissection, drawings rather few
1932-1937	John Wiley & Sons (New York)	W.C. Curtis** & M.J. Guthrie, professors	<u>Text-Book of General Zoology</u> (1927)	13	stresses an understanding of structure to appreciate function

Table 10 continued ...

Table 10 continued

Period of Re-commendation	Publisher and Location	Authors	Title	Grade Level Read-ability Flesch's Index	Personal Evaluation
1953-1955	John Wiley & Sons (New York)	Richard M. Holman & Wilfred W. Robins, professors	<u>Elements of Botany</u> (1939)	13	diagrams detailed and precise, rather lacking in student activities
1954-1962	Clark Irwin (Toronto)	Truman J. Moon & Paul B. Mann teachers	<u>Biology</u> (1954)	13	clear but not detailed enough for Gr.13 examinations
1948-1964	Copp Clark (Toronto)	* A.G. Croal, professor, A. H. Loudon, professor, L.A. Smith, teacher K.L. Wismer, teacher	<u>General Biology</u> (1948)	13	followed the Ontario Gr.13 course closely with sufficient detail, diagrams clear
1947-1962	Macmillan (New York)	Robert E. Hegner, professor	<u>College Zoology</u> (1944)	13+	describes a typical vertebrate and its body systems
1942-1962	Gage (Toronto)	* C.H. Best & N.B. Taylor, professors	<u>Human Body and its Functions</u> (1932)	12	thorough treatment of human physiology, good illustrations
1947-1962	McGraw-Hill (New York)	Mary S. Mac Dougall & Robert Hegner, professors	<u>Biology, The Science of Life</u> (1943)	13+	complete account of biological concepts, few laboratory exercises, large diagrams
1942-1946	Holt (New York)	C.G. Weymouth, research biologist	<u>Science of Living Things</u> (1941)	12	lacks sufficient detail of alternation of generation, of morphology plants and of most animal groups

Notes: * Ontario Authors

** Curtis and Guthrie maintained: "Work that simply entertains or imparts information and that does not create the sufferings associated with mental effort can be of little permanent value or make for any considerable development".
W.C. Curtis and M.J. Guthrie, Text-Book of General Zoology (New York: John Wiley and Sons, 1927), p.v.

large schools with specialized laboratories (see Chap. 2, p.67).

The selection of a Grade 13 textbook (Table 10) presented a serious problem to the teacher as the students in the Grade 13 biology had to write departmental examinations. Hence the textbooks chosen by the boards of education (on the advice of the principals and staffs) had to cover the courses of study in sufficient detail to ensure that the pupils gained creditable marks on the departmental examinations. Neither of the Canadian textbooks available, Calvert and Cameron's Zoology for High School (1928) nor Cosens and Ivy's Botany for High Schools (1929), was sufficiently detailed to do so. The other textbooks were specialized college textbooks which were often difficult for the pupils to use.

The problem was alleviated when a reliable textbook written by Ontario authors and designed for the Grade 13 courses of study was published. This book, General Biology (1948) by Croal and others was clearly written, well illustrated, covered the Ontario course completely and provided numerous references. It had the disadvantages of not having a laboratory guide or student exercises; and practising biologists commented that its biological content was not kept up to date. However, for nearly twenty years, it filled a great need by giving a clear account of the material on the prescribed Ontario Grade 13 Biology course.

Textbooks, like other educational facilities, were becoming expensive. To reduce the cost to pupils and their parents the Department of Education gave textbook grants to boards of education (1952). The boards used the grants to buy Grade 9 and 10 textbooks to be issued on loan to the pupils. This saving

to the pupils became a permanent feature of Ontario secondary schooling.⁴⁴

2.25 Interpretation of the Changes in Biology Education in Terms of Progressivism and Conservatism

Peter Sandiford, educational psychologist and student of comparative education, identified two conflicting influences in Ontario education during this period: conservatism and progressivism.⁴⁵

Conservatism or traditionalism* followed the stress on the academic disciplines and applications of science, while progressivism embodied many of the emphases of John Dewey who maintained that the active child's deep-seated drives should be encouraged and cultivated and that child-oriented activities should form the basis of the curriculum.⁴⁶

Sandiford recognized the following characteristics of the Ontario conservative educational system prior to 1937:

- i Education experts could select what was desirable for everyone to know.
- ii This information could be embodied in a textbook.
- iii Teachers could be trained to teach the program efficiently.
- iv Inspectors, former successful teachers, were appointed to see that teachers did teach efficiently and carried out the

* Conservatism is the point of view which favours a minimum of change and stresses the importance of preserving the values already achieved. Traditionalism is the point of view in which innovation and experimentation are minimal. G.V. Good, Dictionary of Education (New York: McGraw-Hill, 1973).

regulations.

v. The Department of Education set examinations to test the mastery of this material.⁴⁷

The conservative approach, Sandiford stated, had the advantage that emphasis was placed on those things regarded as significant by those competent to judge and stressed thoroughness from beginning to end. Sandiford contended however that it stressed the acquisition of old knowledge while neglecting the furthering of the new. The Ontario educators, he claimed, worshipped the past and so did not prepare pupils to live in a rapidly changing world.⁴⁸

Opposing conservatism and exerting a powerful influence on all North American education was the movement of progressivism. This viewpoint had followers in the Ontario school system, in particular, Thornton Mustard of Toronto Normal School, and Stanley Watson of the Toronto Board of Education staff, who both helped draft the 1937 course of study.⁴⁹ Thus, its influence was felt in the 1937 curriculum, particularly in the lower school biology curriculum by the inclusion of health-oriented topics on food and human physiology (Appendix A). The 1937 biology course was based less on the taxonomic grouping of organisms and more on areas of interest to pupils as perceived by a progressive educator. In addition the emphasis was to a greater extent on individual experimentation, enterprises, activities and projects than in the previous course.

Although progressivism had some influence in Ontario high schools during the 1930's,⁵⁰ the scarcity of teachers in the 1940's and 1950's hampered the impact of the progressive emphasis at that time.⁵¹

In fact in the 1950's, conservatism appeared to dominate. When Sidney Smith, the President of the University of Toronto, addressed the Ontario Secondary School Teachers' Federation (O.S.S.T.F.) he quoted the conservative viewpoint of Arthur Bestor, the historian: "Our civilization requires of every man and woman a variety of skills which rest upon the ability to read, write and calculate and upon sound knowledge of science, history and other fundamental disciplines."⁵²

Ontario's conservative stance during the latter part of the period in high school education appeared in other ways also. The biology programs initiated in 1937 for Grade 9 and in 1941 for Grade 13 remained almost unchanged throughout the 1950's. Although progressives urged the provision of another type of school, the junior high school, to accommodate the widening interests and potentials of early adolescent pupils, Ontario, failed to provide this kind of schooling.⁵³ In addition Ontario retained the academic Grade 13 with its final Department of Education examinations. The conservative attitude was personified by W.J. Dunlop, Minister of Education in the 1950's. According to the Ontario educator, W.G. Fleming, the Dunlop administration was "characterized by defensiveness, negativism and resistance to change."⁵⁴

2.30 Changes : The Biology Teachers (1921-1960)

While provincial policy, the direction of educational research and educational approaches had their influence on biology education, the biology teacher, then as now, was of paramount importance.⁵⁵

In this section, the quality of biology teaching will be traced by

discussing the professional qualifications of teachers*, the organizations for improving teaching, the inspectoral reports on teaching effectiveness and the contributions of two outstanding science teachers.

2.31 Qualifications of Secondary Teachers (Biology)

Table 11 shows the characteristics of secondary teachers in regard to sex, academic status and specialist standing.

The percentage of male secondary teachers was smallest in the 1920's when there was a smaller proportion of men than women. But even then the percentage of male science teachers was much greater than that of their female colleagues.** It is also interesting that during the Second World War the percentage of males remained high. This may be because teaching was considered an essential war-time service.⁵⁶ Moreover, the preponderance of males in the secondary school teaching profession is most striking in the 1950's when there was a shortage of teachers, particularly for science.⁵⁷

The proportion of university graduate, secondary teachers in the schools, including biology teachers, remained quite high throughout the period. However, the percentage of the most highly qualified teachers fell after 1940. These were the specialists who had completed four

* Since data on the qualifications for biology teachers are not available as distinct from other secondary teachers in this or in other chapters, the discussion will deal with secondary school teachers' qualifications in general.

** A personal survey of the staff list for 1921 showed that 87.7 per cent of the science specialists were men. Ontario, Report of the Minister of Education, 1921, pp. 345-386.

years of an honour university program.

The decrease in the proportion of specialists including biology teachers accompanied the crucial shortage of teachers in the 1950's. The Minister of Education's Report of 1954 noted this problem of teacher shortage:

. . . the number of Secondary School Teachers qualifying annually at the Ontario College of Education has not been sufficient in recent years to overcome the losses to the profession and the increased requirements of the school system arising from the expanding school population.⁵⁸

The Department of Education attempted to correct this shortage of secondary teachers by several means: A large number of students were admitted to the Ontario College of Education. Letters of Standing were given to qualified teachers from other provinces. Letters of Permission were granted to university graduates who had no teaching certificates. Summer courses were provided for unqualified people to secure certificates.⁵⁹

The shortage of teachers adversely affected the teaching of all subjects including biology. At times instruction was given by teachers with little background in the subject who had been assigned a few periods of science to complete their time tables. The teachers with provisional certificates, while able, were often inexperienced and their classes were large. While it is difficult to find in the usual sources statements that there were incidents of deficient teaching, certain actions were taken by the Department of Education that probably had for their basis, shortcomings in the existing instruction. For example, from the Professional Development Branch organized in 1957 skilled teachers visited the classrooms of teachers with little

Table 11
Ontario Secondary School Teachers (1920-1960)

Year	Number of Secondary School Teachers	Percentage of Males	Percentage of Females	Percentage of Univer- sity Graduates	Percentage of Specialists
1920	1462	45.0	55.0	74.2	63.7
1925	2677	43.4	56.6	82.5	72.4
1930	3756	48.6	51.4	91.3	61.0*
1935	4353	54.6	45.4	82.7	66.4
1940	4605	57.9	42.1	82.8	68.0
1945	5169	55.3	44.7	82.5	61.0
1950	5795	63.1	36.9	84.1	57.5
1955	7484	65.0	35.0	83.5	51.1
1960	11478	66.4	33.6	87.7	N.A.

Sources: Ontario, Report of the Minister of Education, 1920, pp. 35, 40, 386; *ibid.*, 1925, pp. 15, 59; *ibid.*, 1930, pp. 89, 95-97; *ibid.*, 1935, pp. 79, 81; *ibid.*, 1940, pp. 121-123; *ibid.*, 1945, pp. 110, 111, 113; *ibid.*, 1950, pp. 96-97; *ibid.*, 1955, pp. 33-35; *ibid.*, 1960, p. 5, 95.

Note: * Vocational Teachers were omitted.

experience and taught demonstration lessons. Apparently there was a need for such a service.⁶⁰

2.32 Agencies for the Professional Development of Biology Teachers

Since there were many teachers with minimum qualifications, opportunities were provided to permit them to upgrade their teaching skills and qualifications by in-service training. One means by which biology teachers kept up-to-date was by attending the professional development sessions of the Ontario Secondary School Teachers' Federation (O.S.S.T.F.). The professional development committee of the O.S.S.T.F. planned local gatherings at which there were discussions of curriculum changes and innovations in teaching procedures. The O.S.S.T.F. also set up summer courses for the subject areas of which those in biology were conducted by able leaders.⁶¹ In times of curriculum change and the rapid influx of inexperienced teachers, these summer programs and winter discussion groups helped to maintain the teachers' professional competence.⁶² In addition, the Natural Science Section of the Ontario Educational Association was another organization that was instrumental in acquainting biology teachers with current changes. This organization became the Science Teachers' Association of Ontario (S.T.A.O.) and its publication, The Crucible, was, and still is, a source of ideas for the biology teacher.⁶³ Additionally, branches of S.T.A.O. met at regional or local levels to discuss problems and exchange information. Often these meetings were planned with the help of local science consultants or curriculum superintendents.

Several provincial universities offered academic courses to permit a teacher to upgrade his certificate to the specialist level. In addition, Ontario biology teachers attended special American programs in neighbouring states supported by the National Science Foundation (N.S.F.). Occasionally, teachers were given financial help by an O.S.S.T.F. Fellowship, a Shell Fellowship or a sabbatical leave from the local board of education. Moreover, the Graduate School of the Ontario College of Education, later the Ontario Institute for Studies in Education (1966), offered post-graduate degrees in education.⁶⁴

One scheme in this period that helped to raise the qualifications of all secondary teachers, including those of biology, was to increase the pay of those with the highest qualifications. This certification plan was introduced by the O.S.S.T.F. in its 1958 assembly. Under this plan all secondary teachers were grouped into four salary levels, and each was paid by a stated amount on the board's salary schedule. Group one included non-specialists; group two contained non-specialists who had completed five courses in one discipline; group three had specialists who had obtained their standing by summer courses; and group four consisted of specialists with honour degrees. The prospect of a better salary for higher qualifications was an incentive to improve academic standing.⁶⁵

2.33 Views on the Quality of Teaching and Education

While it was difficult to maintain the quality of teaching in times of teacher shortage, the activities of the O.S.S.T.F. helped, and in general the high school teachers worked thoroughly and conscientiously. This is indicated by the occasional compliment in the Report of the High School Inspectors to the Minister of Education (1924):

During the past year your Inspectors have been impressed . . . with the quality of work carried out by a band of more than 1600 high school teachers in the Province. Thanks to them, the school is no longer a place where pupils go reluctantly to recite dull lessons, a dreaded place of drudgery and constant inhibition. It is the centre of all activities - mental, physical and social - of the young people of the community.⁶⁶

A further laudatory comment appeared:

It would be difficult to find a body of men [and women] more progressive, more conscious of their responsibilities and more loyal to their profession than our secondary school teachers.⁶⁷

It should not be thought, however, that Canadian secondary teachers only received praise. Hilda Neatby (1954) wrote pointedly of the shortcomings of the school system:

The central purposes of formal education have always been, first to dispel the ignorance that leaves one helpless; and second, to train the mind for control and power. Such a definition of purpose does not minimize the importance of character or of personality. It serves only to show the special means whereby the school is expected to serve the whole

child who goes there. It is, I believe, increasingly obvious that these intellectual purposes are not central in Canadian elementary and secondary schools.⁶⁸

2.34 Outstanding Biology Educators

A discussion of biology teaching in this period would be incomplete without recounting the contributions of two personalities: Professor George A. Cornish (1873-1960) and Inspector Norman Davies (1893-1963).

Cornish instructed in the methods of science teaching at the Ontario College of Education (O.C.E.) of the University of Toronto for thirty-four years (1910-1944).⁶⁹ No one else instructed in the methods of science teaching for so long, nor came in contact with so many science teachers; he gave demonstration lessons to show how to present the topics in science, conducted seminars for science specialists and supervised practice teaching in science.

As was evident from his lectures and advice to students, he viewed the teacher as a leader who must kindle classroom enthusiasm by his teaching. "If you don't seem interested in your work, certainly your students won't be!" Regarding discipline, he warned, "Some teachers can maintain discipline, others encourage disciplinary problems. Act so that you don't invite these problems." He was not afraid to strike a moral tone in dealing with student teachers. At

a time when social conformity was considered a virtue, even a necessity, amid strong community pressures, he urged wisely, "Avoid the appearance of evil."⁷⁰

Cornish stressed the Pestalozzian viewpoint that much learning takes place through the senses and that science offers many opportunities to learn in this way. So Cornish stacked his store-room with illustrative materials which student teachers were invited to borrow to make their lessons more vivid. He organized field trips and excursions to bring the classes in direct contact with nature.

Professor Cornish contributed frequently to The School.^{*} In the year 1917-18, for example, he wrote articles on the following topics: "Mushrooms," "Winter Buds," "The Cecropia Moth," "Wood Laurel Leaves," "A Summary of Nature Study Topics for Form IV" and "A Summary of Nature Study Topics for Form III". These were designed for elementary teachers and printed at a time in which these topics could be taught conveniently.

While Professor Cornish wrote a biology textbook his other texts were used over a wider area and for a longer time. His book on physical geography (1924)⁷¹ suggested many excellent activities

* The School was a monthly magazine which contained articles of current educational interest and was supported by the Department of Education. It was published from June 1912 to June 1948.

that formed the basis of many students' experiences in science. The Ontario High School Chemistry (1917)⁷² and the accompanying manual⁷³ were not only authorized in Ontario for more than twenty years but were used in Saskatchewan, Alberta and British Columbia. In addition, A Senior Chemistry for Canadian High Schools and Colleges (1934)⁷⁴ had a favourable reception. His textbooks were easy to read because of the clarity of expression and his ability to relate the subject to the pupils' everyday experience. And he was a master of picturesque expression; his prose was never vague or dull, although his choice of words may seem over enthusiastic to present-day readers. The following quotation, the introductory paragraph to the chapter dealing with carbon in the text-book, The Ontario High School Chemistry (1917), illustrates his style:

The element carbon occurs uncombined in several remarkable modifications, of which the best known is charcoal, with which we kindle our fires. But nobody would suspect that the lead of our lead pencils, much less the beautiful, flashing diamond, transparent as water, consists of the same element as charcoal. Yet both, except for a slight amount of impurities, are composed of carbon alone.⁷⁵

For many topics in the chemistry texts he used the historical approach, the technique more recently favoured for many topics of the prestigious Biological Science Curriculum Study (BSCS) (see Chap. 3, pp. 109-115).

Professor Cornish offered effective leadership in his discipline as exemplified by his ability to handle conflicts, such as those that arose at meetings of the Natural Science Section of the Ontario Educational Association, and by his powers of persuasion. His speech

delivered at the 1907 meeting of the Natural Science Section is an example in which he showed the latter ability. His speech was entitled, "Should the atomic and molecular theories be abolished from high schools?" His arguments for the inclusion of the atomic and molecular theories on the grounds that they were useful in "classifying and connecting the facts of science" were so convincing that the atomic and molecular theories were re-introduced.⁷⁶

In reviewing Professor Cornish's contribution to the teaching of biology, the author finds that he did not contribute anything which could be considered distinctively novel. But what he did was to exemplify good rational teaching and careful classroom management; he supported experimentation, learning through observing and relating the subject to the pupils' past experience. Through the force of his personality and his enthusiasm, his influence on biology teaching was profound. It is for this that he will be remembered.

Inspector Norman Davies was the other personality who had a deep influence on biology in schools during this period. He was appointed promoter and inspector of agricultural education at a time when the province was becoming progressively industrialized. So his appointment might seem to have been a questionable honour. However, Norman Davies was a man for whom the aphorism, "the man makes the job", was true. While he was inspector, the level of agricultural instruction remained high, and by his retirement one out of every four secondary school pupils was enrolled in some branch of agriculture.⁷⁷

For seventeen years Norman Davies taught high school, serving successfully as a teacher of science and agriculture and as a high school principal. For thirty years, from 1932 to 1962, he provided effective leadership as provincial inspector of agricultural science and science.⁷⁸ He offered help with difficult topics and in solving classroom problems. Davies also conducted seminars at the Ontario College of Education for prospective Specialists in Agriculture, and acted as principal for summer programs designed for teachers who were qualifying to teach agriculture.

The training in agriculture which Davies fostered helped the pupils of rural areas to produce needed food during the depression and the Second World War, and the interest he stimulated in conservation preserved a healthy perspective in an age of increasing pollution and hazardous industrial expansion.

2.40 Changes : The Biology Pupils (1921-1960)

As mentioned earlier in this paper, the "average" pupil was urged to acquire a secondary education aided by several measures adopted by the Department of Education. Some indication of the extent to which these measures were successful can be seen from the enrolment figures given in Tables 12 and 13.

2.41 Ontario Secondary School Pupils

Table 12 shows that the secondary school enrolment expanded six-fold. In the same forty-year period the provincial population doubled.

Table 12

Ontario Secondary School Enrolment (1920-1960)

Year	Secondary School Enrolment	Percentage of Population Aged 15-19 Years enrolled in Secondary School
1920	42,552	20.0
1925	78,657	27.8*
1930	98,277	29.0*
1935	111,769	31.3*
1941	102,462	29.5
1946	128,000	37.6
1950	132,690	41.0
1955	174,562	51.1
1960	262,775	62.6

Sources: Ontario, Report of the Minister of Education, 1921, pp. 206, 254, 256, 258; *ibid.*, 1926, pp. 168, 171; *ibid.*, 1931, pp. 87, 240, 248, 278, 311, 377; *ibid.*, 1936, pp. 190, 200, 205, 222; *ibid.*, 1942, p. 101; *ibid.*, 1947, p. 122, *ibid.*, 1951, pp. 52, 132, 139; *ibid.*, 1955, p. 94; *ibid.*, 1960, pp. 5, S-6, S-91; *ibid.*, 1965, p. 69; Canada, Bureau of Statistics, Canada Year Book, 1925, pp. 83, 93, 102; *ibid.*, 1934-35, p. 164, *ibid.*, 1951, p. 125; Canada, Bureau of Statistics, Census of Canada, 1931, Vol. 3:903; *ibid.*, 1941, Vol. 3:32; Ontario, Statistics, 1976, p. 40.

Notes: * Data from the whole of Canada.

However, the increase was far from uniform: during the 1920's the enrolment doubled; in the 1930's it increased more slowly; in the late 1930's and early 1940's (Table 12) a decrease actually occurred; while during the 1950's a second doubling took place. It can be conjectured that the prosperous times of the 1920's and the 1950's permitted parents to give their children the advantage of secondary school training. The slow rise in attendance in the 1930's would seem to be concomitant with the economic hardships of the Great Depression. However, the relationship between prosperity and high school attendance is not always direct. In hard times pupils tend to remain in school longer, as it is difficult for them to get employment. The prosperity of the early 1940's, during the Second World War, did not result in a large enrolment; in fact, high school enrolment declined. At that time the demand for workers in war industries, in food production and in the armed services encouraged pupils to leave school early.

The increase in the percentage of 15-19 year olds who were enrolled in high school was very large; indeed, it increased three-fold during the period (1921-1960). And towards the end of the period, high school attendance was being accepted as the norm.⁷⁹ The large numbers of students in each class made it more difficult to teach biology experimentally and to a great extent teacher demonstrations rather than class experiments were performed. An expanding school population occasionally necessitated the accommodation of two shifts of students in the existing school building with shortened periods of instruction. Such arrangements made it difficult

to conduct field work or laboratory exercises, and at times a laboratory class had to be taken in a regular classroom with the attendant reduction of work with microscopes and studies of living organisms. Under such circumstances the quality of biology education suffered.⁸⁰

2.42 Pupils in Secondary School Biology Classes (1921-60)

The enrolment in biology followed the enrolment in high school in general, but there were some differences. Table 13 shows a decrease in the percentage of enrolment during the 1920's in Grade 9 and 10 biology, a subject which became optional after 1921 with agriculture as an alternative.

The low enrolment in Grade 9 and 10 biology in the late 1920's and early 1930's is of interest. The fall in enrolment in Grades 9 and 10 biology was accompanied by an increase in the number of pupils studying agriculture, biology's alternative. Several factors might have been involved among which were: a greater dependence on the land during depression days, an increased need for food production during the war years and the dynamic leadership of Inspector Norman Davies. The enrolment in Grade 9 and 10 biology increased in the 1940's. This increase accompanied the 1937 change in the curriculum in which topics of social and personal interest were introduced. (see Chap. 2, pp. 66-67).

The enrolment in Grade 13 biology decreased gradually in the 1920's then increased in the 1930's and 1940's. This increase could

Table 13
Ontario Secondary School Enrolment in Biology
and Agriculture (1920-1960)

Year	Percentage of Grade 9 and 10 Pupils Studying Biology	Percentage of Grade 9 and 10 Pupils Studying Agriculture	Percentage of Grade 13 Pupils Studying Biology
1920	68.3*	2.9*	19.8* (1921)
1925	47.0	7.1	18.6
1930	29.8	16.1	16.1
1935	36.5	18.8	29.1
1940	43.5	21.3	31.0
1945	47.1***	21.6***	39.2
1950	39.0	37.3	37.3
1955**	72.5****	N.A.	37.8
1960**	77.2****	N.A.	29.1

Sources: Ontario, Report of the Minister of Education, 1921, pp. 178, 179, 228; *ibid.*, 1926, pp. 80-82, 210, 230, 243; *ibid.*, 1931, pp. 87, 244, 249, 281, 327; *ibid.*, 1936, pp. 90, 190, 200, 204, 205, 222; *ibid.*, 1941, pp. 174, 188; *ibid.*, 1945, pp. 178, 179, 198, 213; *ibid.*, 1946, pp. 108, 170, 198; *ibid.*, 1950, pp. 151, 154, 171; *ibid.*, 1951, pp. 114-116; *ibid.*, 1956, S-95, S-96, *ibid.*, 1961, pp. S-91, S-101, S-102; Canada, Dominion Bureau of Statistics, *Elementary and Secondary Education in Canada, 1944-45*, pp. 57, 59; *ibid.*, 1949-50, pp. 42-44.

Notes : * Data were obtained from samples of Ontario High School Inspectors' Reports available in the Provincial Archives of Ontario.

** The main source of data were the Minister of Education's Reports which gave individual subject enrolment of Grades 9 and 10 up to 1945 only. Beyond this date an estimate had to be made. The Minister of Education Reports after 1945 did give the proportion in Grade 12 who graduated with science options. To graduate with a science option Grade 9 and 10 science had to be taken as prerequisites. Hence the proportion of graduates in Grade 12 with science options was an estimate of the proportions taking Grade 9 and 10 sciences. For example, if the Minister of Education's Report shows 9000 had a science option among 10,000 graduates the proportion of graduates in Grade 12 with science options would be $\frac{9,000}{10,000} \times 100 = 90\%$. Since these Grade 12 students had to take Grades 9 and 10 science, an estimate of Grade 9 and 10 students taking science is also 90%.

*** Date for previous year as it was not available for 1945.

**** Both Biology and Agriculture are included together.

have resulted from one or both of the following factors. The biology course had been revised to include genetics and human physiology, to reduce the emphasis on taxonomy and to increase the emphasis on ecology. These changes might have made biology courses more attractive to students. Or students might have enrolled in the biology courses in order to satisfy the requirements for the Honour Graduation Diploma and at the same time avoid the physical sciences, which required greater mathematical ability.

Generally there was an increase in the proportion of pupils studying agriculture. However comments cannot be made about the latter part of the period for which no data were available. It is noteworthy that the proportion of pupils studying agricultural science increased from less than three percent of the lower school enrolment in 1920 to more than thirty-seven percent by 1950. Although many people during the depression and World War II engaged in amateur farming, the actual number of farmers was reduced to almost one half during this period (1921-1960).⁸¹ So, clearly, many of these pupils of agriculture did not become farmers. The high proportion of students in agriculture could be related to the crucial interest in food production in war time.

While the enrolment in agriculture declined somewhat in the 1950's, a large number of students, both rural and urban, continued

*An Honour Graduation Diploma is granted on completing Grade 13. For much of the period there were required nine credits. This certificate was accepted for admission to Teachers' Colleges, School for Nurses and Universities.

to attend agricultural classes.⁸² One reason for the decline may well have been the indifference of the Minister of Education, W. Dunlop, to non-academic programs.⁸³ While some of the provinces increased agricultural instruction with the federal funds available in the 1950's, Ontario made limited use of this federal money.⁸⁴

2.50 Summary

During the period 1921-1960, biology education in Ontario and biology textbooks underwent changes which resulted from the developments in Ontario general education, from contemporary biological research and from changes in the numbers of both students and teachers. More attention was given to student interest so that the biology content and methods of teaching were modified to make use of this educational asset, particularly in providing more student activities. In addition, biological researchers turned their attention from taxonomy and morphology to genetics, bacteriology, physiology and ecology. This was accompanied by a shift in the content of high school biology, particularly in the junior grades. This was a period, moreover, in which science was applied and directed toward social and personal interests in harmony with curricular trends of the period. High school agriculture, a form of applied biology, was under the direction of Norman Davies and reached its highest development during this period.

The whole high school curriculum, including biology, was being adopted gradually to suit an increasingly large proportion of high school aged young people. This increase was due mainly to the

parents' belief that high school training would prepare their children to live in an increasing complex society. In an attempt to appeal to the more varied student interests, the curriculum for junior biology students was reduced.

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Chapter Three

BIOLOGY EDUCATION IN A PERIOD OF EDUCATIONAL FLUX (1961-1978)

3.10 Introduction

The second period (1921-1960) was a time of expanding high school enrolment and continuing attempts to educate the "average" future citizens. Nevertheless, it was characterized by resistance to change, and although technical and vocational programs had been established in large urban schools, academic subjects continued to dominate the curriculum and most pupils enrolled in the prestigious academic course.¹ Science content had precedence over process so that what children learned in high school science was more important than how they learned it.²

Investigators studying biological education in the high schools of the United States reported similar patterns during the late 1950's. In fact, these researchers found that much of the factual content was really unsubstantiated belief to be memorized but not necessarily experienced nor understood, and that the processes of biology were usually ignored.³ However, some educators maintained that during the 1960's a veritable educational revolution in Ontario occurred. "A current of reform swept through the educational scene - a movement not seen since the early days of the century and a movement that turned

into reality, many of the hopes of the earlier generation of reformers."⁴ The revolution* involved a dramatic shift towards enquiry-oriented programs as espoused by Jerome Bruner, the United States psychologist and educator, the Nuffield Project investigators and the Biological Sciences Curriculum Study groups. They affirmed that the biology curriculum should teach the structure and processes of the discipline. Indeed, Bruner stated that

To instruct someone in these disciplines is . . . to teach him to participate in the process that makes possible the establishment of knowledge. We teach a subject . . . to get a student . . . to take part in the process of knowledge getting.⁵

However, some of the author's colleagues contended that the educational revolution of the 1960's did not take place in Ontario biology. They maintained that since the provincial government did not offer grants for the enquiry-directed books by non-Canadian authors, Ontario biology teachers could not use the new discovery programs.

Whether there was a revolution in Ontario secondary school biology in the 1960's or not, there were urgent requests for radical change, as will be noted, for both updating the curriculum and appealing to the learners' interests. Attempts to bring about these changes were in turn followed by a desire for emphasis on basic content.⁶ This was evident when in 1976 the Ontario Minister of Education, Thomas Wells, announced a "return to basics" in a core curriculum which would produce a

* An educational revolution is considered to apply to any complete change in an educational approach whether the change applies to the treatment of the pupil or the subject matter.

"well-rounded program with required subjects forming a foundation upon which optional subjects could be carefully chosen."⁷

The revolutionary mood of the 1960's and its reaction, the return-to-basics movement in the 1970's, was captured by educator Hugh Stevenson:

We thought [in the 1960's] education was in a state of ferment but we faced the difficulties ahead in a gay party mood, with optimistic spirits confident in our ability to inaugurate a renaissance in Canadian educational systems Many changes were made with little or no thought of chain reactions that had been initiated and the essentiality of integrating societal development and educational reform.⁸

In the remainder of this chapter the author will give an account of the development of general education as background for change in biological education and will present those changes.

3.20 Changes : The Biology Curriculum (1961-1978)

3.21 Contemporary Biological Programs

Textbooks, journals, teachers and visiting speakers informed Ontario's decision-makers about contemporary changes in the United States and British biological curricula. Indeed, some of these innovations so impressed administrators that such programs as the BSCS Green Version were adopted outright in Ontario for the Grade 11 and 12 four-year course. In addition, a close connection existed between the biology taught in neighbouring systems and in Ontario.

(i) The Biological Sciences Curriculum Study (BSCS) Course

Dissatisfaction with science instruction in the United States schools led the American Institute of Biological Sciences (A.I.B.S.), among others, to form an education committee in 1958 to develop new biology curricula.⁹ With Dr. Bentley Glass as chairman, the A.I.B.S. committee began the Biological Sciences Curriculum Study. The committee consisted of practising biologists, secondary school teachers, psychologists and educational administrators. As this group was funded by the United States government through the National Science Foundation, (N.S.F.), it had considerable financial support. The investigating team studied the condition of biology teaching in the United States (1959), wrote new units, tested these units in classrooms, rewrote the units on the basis of pupil responses, tested the revised units on a larger population (1961-1962), corrected the difficulties revealed by the tests and, finally, in 1962 published the material commercially.¹⁰ Several revisions of all three versions have been made with the Green Version undergoing its fifth revision in 1980.¹¹

The sixty members of the BSCS team agreed that high school biology should give a true picture of the nature of biological research, should focus on the nature of scientific enquiry and should present the pupil with a coherent picture of contemporary biology.¹² Because of the divergent approaches of biological research three biology programs or versions were developed. These were: (i) the Blue Version, which dealt with the molecular level of biology,

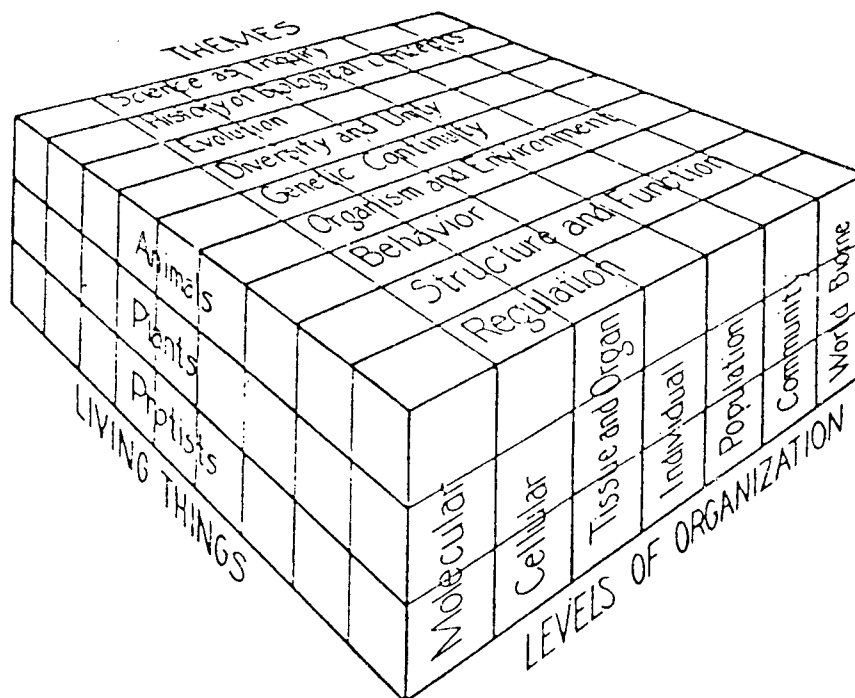
(ii) the Yellow Version, which described biology at the cellular level, and (iii) the Green Version, which concentrated on ecology.¹³

The BSCS writers, while illustrating the diversity of biological research by providing three versions, produced courses that also showed the unity and coherence of biological science. To achieve these purposes, the BSCS authors stressed nine themes common to all three versions: (a) the nature of science as enquiry, (b) the history of biological concepts, (c) the change of living things through time-evolution, (d) the diversity of type and unity of pattern among living things, (e) the genetic continuity of life, (f) the complementarity of organism and environment, (g) the biological basis of behaviour, (h) the complementarity of structure and function and (i) the regulation and homeostasis - the preservation of life in the face of change.¹⁴

The BSCS members stated that these themes should be illustrated by a representative variety of all organisms in any biology course, and thought that students should learn to appreciate biological phenomena at various levels of organization, molecular, cellular, tissue, organ, individual, population, community and world biome. To illustrate how the biological themes, the organisms and the levels of organization might be integrated into a course, these writers developed a model, represented by the three dimensions of a rectangular block as illustrated in the accompanying figure 2. From this model, the BSCS workers maintained, a course could be constructed from blocks formed by the intersection of the three

Figure 2

Schematic Model of BSCS Curriculum



Bentley Glass, "The BSCS - Retrospect and Prospect" Biological Sciences Curriculum Study Journal, 1(4): 2-4, 1978.

variables, - organisms, themes and levels of organization.¹⁵

In addition to the Blue, Green and Yellow Versions, the BSCS provided textbooks in many concept areas including up-dated learning materials for pupils at different ability levels and for teachers. Challenging programs were offered to able young students by Laboratory Blocks (12 titles, 1969)¹⁶ and The Interaction of Experiment and Ideas (BSCS, 1965)¹⁷, a second level course. Patterns and Processes (BSCS, 1966)¹⁸ which contained many activity-oriented exercises was published for pupils who had difficulty with biological

concepts. Among the books prepared for teachers was The Biology Teachers' Handbook (1963),¹⁹ which outlined the philosophy of the BSCS program and described new procedures useful for the programs.

Because the BSCS courses were designed by leading research workers along with skilled teachers and at great expense, they were understandably thought to have much scientific merit. However, the evidence regarding their effectiveness is contradictory. Wimburn, a BSCS investigator (1963), reported that students who were trained by the BSCS approach out-performed the non-BSCS students.²⁰ But Lisonbee and Fullerton (1964) reported that, while pupils of the middle ability levels scored higher on the BSCS program, there was no difference for other ability levels.²¹ Lance (1964)²² and Lewis (1966) also stated that there was no difference between the achievement scores of BSCS students and those of the non-BSCS controls.²³ Welshar and Perry (1967) found that BSCS pupils who used the Yellow Version thought that they were learning biology in a scientific way and appreciated the content of the laboratory exercises, but only forty-five percent of the pupils liked the Yellow Version textbook.²⁴

Ausubel (1966), who analysed the contents of the BSCS textbooks contended that they were less useful than conventional texts. He agreed that the BSCS versions addressed both the content and the methods of modern biology, but he maintained that the Yellow and Blue Versions placed undue emphasis on the experimental foundations and history of biology while ignoring the naturalistic approach and important applications of biological science. This emphasis, Ausubel averred, rendered the Yellow and Blue Versions

"psychologically and pedagogically unsound for the majority of tenth graders."²⁵ Ausubel also condemned the complexity of the treatment of many topics: "[The Yellow and Blue Versions] introduce an absurd and unrealistic level of biochemical and biophysical sophistication for which the intended users lack any semblance of adequate background"²⁶

Numerous revisions have provided opportunities to correct the defects that Ausubel noted. For example, the reading level of the fifth revision of the Green Version was lowered from Grade 10 to Grade 9.²⁷ The revised texts sold well, so apparently they filled a perceived need. Indeed, sales by the end of 1978 totalled two million copies of the Yellow Version, one million of the Blue and more than two million of the Green.²⁸ The Green Version texts represented one quarter of all high school biology texts that were sold in the United States.²⁹

The long-range effect of the BSCS approach has also been investigated, but the results are somewhat contradictory. Heidgerd and Rayder (1974) measured the performances of university students four years after these students had taken various biological programs in Grade 10. The investigators compared the scores of students who had studied Blue Version, Green Version, Yellow Version, "conventional biology" and no biology. Their findings showed that there was little difference in the average scores of all the five groups, and they concluded that "such differences had no educational significance."³⁰ In contrast, Tamir (1975) found that pupils who had studied the BSCS Yellow Version (Yiddish translation) for each

of four years scored significantly higher on the same test on biological concepts at the end of the period than pupils who had taken "conventional biology" for the same time. This result is interesting in view of Ausubel's contention that the Yellow Version was "psychologically and pedagogically unsound for the majority of tenth graders."³¹

It is hard to find data that indicated the extent to which the investigative teaching techniques outlined by the BSCS were being used. The conclusions of Robert Stake and Jack Easley are significant. These educators were the joint directors of a group of observers under contract to the National Science Foundation (the funding agency of BSCS) to investigate the condition of education in the United States. They reported that in spite of the efforts made by BSCS group:

Seldom was science taught as scientific enquiry - all three subjects [mathematics, science and social studies] were presented as what the experts had found to be true.³²

This finding is in accord with the comments by John A. Moore, Supervisor of the Yellow Version (BSCS), that inquiry science was not the only possible approach. He noted the following limitations of the inquiry method:

- a) There is no evidence that it is superior [to other methods of teaching].
- b) It is really seduction, not induction. What happens in the classroom is that the students are asked to guess what the teacher has in mind
- c) Not all the subjects are amenable to the discovery mode.

- d) And one might add to the list, that Inquiry, properly done, is a slow, time-consuming method. For every topic developed via Inquiry, several other topics must be ignored. So one might compromise in an effort to achieve some Inquiry but not make it the method.³³

(ii) The Nuffield Biology Programs

Like the BSCS programs, the Nuffield Biology Projects were designed to provide enquiry-centred curricula.³⁴ The Nuffield Biology Programs were planned for two levels, the O-level for pupils 11-16 years of age (1966) and the A-level for pupils 16-18 (1970).³⁵ The O-level courses interested the pupils and stimulated individual investigations, but these courses were criticized because they required a higher level of mental maturity than most pupils possessed.³⁶ Pupils who had studied A-level biology were reported to be enthusiastic about their training in critical scientific thinking.³⁷

Although the Green Version of BSCS was only used in some Ontario secondary schools after departmental approval (1964), and the Nuffield programs were used sparingly in a few Ontario classrooms, the wide acclaim given to these programs predisposed Ontario teachers to try innovative teaching procedures.

3.22 General Education Changes in Ontario Secondary Schools (1961-1978)

In addition to the influence of the contemporary programs of the United States and Great Britain, Ontario biology education of 1961-1978 was affected by the changing educational scene in the province. During the early 1960's Premier John Robarts, and Minister

of Education, William Davis, were effective proponents of change. Their political plans were developed in accord with other reformers both inside and outside of the educational system.³⁸

i The Robarts Plan 1961

Robarts and Davis had two difficult educational responsibilities to meet in the early 1960's.. First, the pupils from the "post-war baby boom" reached the high schools at this time, resulting in an increased need for school buildings and teaching staff. Secondly, during the 1950's, industrial education had been neglected, and there was an urgent demand for skilled workers for Ontario's expanding economy. These two obligations, to increase high school accommodation and to provide industrial training, threatened the Ontario government with huge financial outlays.³⁹ Fortunately, the federal government offered the provinces and the municipalities help through the Technical and Vocational Act of 1961. By this act, seventy-five percent of the cost of secondary technical training was to be borne by the federal government with the remaining twenty-five percent divided between the province and the municipality.⁴⁰ Robarts and Davis used the federal grant to meet both of their obligations, to provide technical training and more high school

To help persuade the large number of additional pupils to enroll in vocational work, the Department of Education introduced the "Robarts Plan" which gave the same credit to a pupil who enrolled in vocational training as one who chose the business course or the time-honoured academic courses (Figure 3). So a pupil could secure

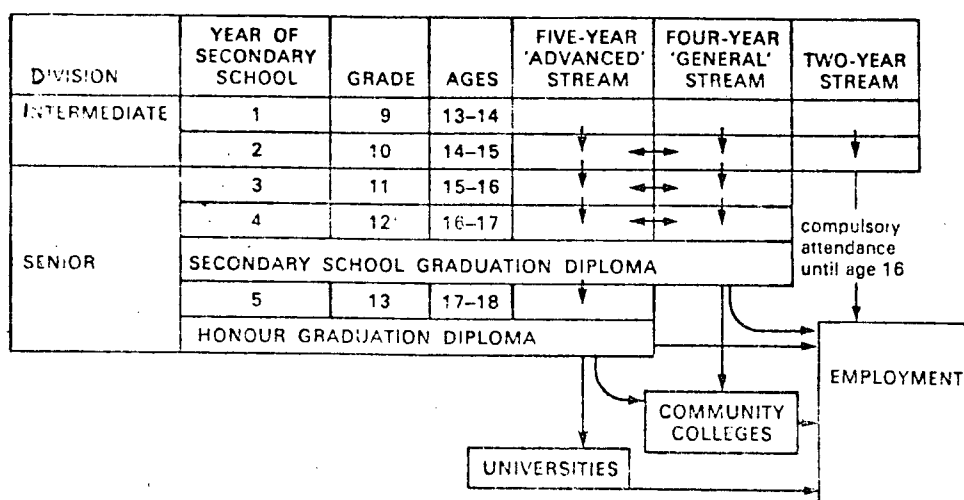
an Honour Graduation Diploma which was necessary for admission to university, by taking any one of the three programs: academic (Arts and Science), business (Business and Commerce) or vocational (Science, Technology and Trades). Moreover, each of these programs had three streams designed for a different ability level: a five-year stream leading to university; a four-year stream qualifying the pupil for community college* or industry; and a two-year occupational stream.⁴²

Davis maintained that the provision of different streams met a variety of different pupil needs.⁴³

However, an investigation by the Ontario Secondary School Teachers' Federation (O.S.S.T.F.) indicated that the new courses were introduced with such speed that teachers had little time to plan the approach for each level. The O.S.S.T.F. investigators noted that the two-year and four-year pupils suffered from this precipitous implementation and the program was unsatisfactory. In 1972-73, the Robarts Plan was dropped and a new approach, the Credit system (see Chap. 3, pp. 121-2) came into full operation.⁴⁴ The short-lived Robarts Plan made feasible the introduction of Grade 11 and 12 biology which attracted a large number of students and provided a science course with high chances of success.

* A community college was a non-degree granting institution offering training in technical, commercial or academic subjects.

Figure 3
Programs Offered by the Roberts Plan:



Source: Murray Lang, "The effects of changing patterns of curriculum developments on biology courses in the secondary schools of Ontario, Canada," Journal of Biological Education, 10(3) : 133-138, 1976.

ii The Hall-Dennis Report (1968)

Criticism in the 1960's of the highly structured academic programs led to an investigation of the education of the "average" pupil. In 1965 Education Minister Davis appointed a committee to investigate Ontario elementary education. Justice Emmett Hall was the chairman and Superintendent Lloyd Dennis, a consultant. The committee also obtained permission to include the condition of secondary education.⁴⁵ Their findings, The Hall-Dennis Report or Living and Learning : The Report of the Provincial Committee on Aims and Objectives of Education in the Schools of Ontario (1968),⁴⁶ criticized Ontario's education and argued that school programs should be pupil-centred.⁴⁷ The committee condemned the "lock-step" type of schooling that prevailed and envisaged "continuous progress without the hazards and frustrations of failure."⁴⁸ The report stressed more individualized instruction and more help from guidance and resource services.⁴⁹ However, no sooner was the report published, with its recommendations for expensive innovations, than education spending was limited by the imposition of ceilings on local expenditures.⁵⁰

The lack of money resulting from the ceilings prevented the Hall-Dennis Report from being implemented fully, but the report's recommendation that pupils be permitted to choose their own programs was accepted. This resulted in a falling in enrolment in science as it was forced to compete with other subjects on the basis of pupil interest.

iii Ceilings on Educational Spending (Bill 228, 1969)

Popular comments in the press appeared to indicate that some citizens believed that adequate educational service was not being rendered or "that the nation was not getting its \$12 billion-a-year worth [for education], that the six million young Canadians who enter or return to school . . . are undertaking a haphazard journey to an uncertain destination."⁵¹ Meanwhile high educational expenditures^{*} were considered to be needed to carry out the recommendations of the Hall-Dennis Report with its individual instruction, guidance and resource services.

As a compromise between these opposing viewpoints about educational expenditure, the Ontario Provincial Government passed Bill 228 in 1969. This bill imposed ceilings on the expenditures of municipalities on education including laboratory facilities. As a result of the passing of this bill many boards of education cut back immediately on their guidance and resource departments. In such ways the imposition of ceilings prevented the Hall-Dennis Report from having a full revolutionary effect.⁵²

* The cost of secondary education in Ontario rose rapidly in the period 1960-1978. In fact from 1960 to 1975 the cost of educating a secondary school pupil increased almost three times, almost double what would have been expected from inflation. Ontario, Report of the Minister of Education, 1961, pp. 149, 161; ibid., 1966, pp. 207, 212; ibid., 1970, Table 8.3; ibid., Statistics, 1976, pp. 38, 45, 76.

An example of the effect of ceilings on spending prevented the Board of Education of the Borough of Etobicoke (Appendix 1) from carrying out their plans for ecological education. The board had provided special facilities for bringing the pupils to a rural environment in a centre complete with dormitories, a kitchen, dining room and laboratories. On the passage of Bill 228 the use of this centre was curtailed.⁵³

iv The Credit System (1969)

One attempt to meet the criticism in the Hall-Dennis Report of "lock-step" schooling was to replace grade promotion by subject promotion. Prior to the late 1960's, promotion by grade was usual in Ontario high schools. If a pupil failed in one or two subjects usually he had to repeat the whole year's work, even if he had done well in certain subjects. Under this system, the pupil who had to repeat often lost interest and left school.

In 1969 some Ontario high schools attempted to prevent a pupil from being compelled to repeat a whole year by introducing the credit system. Under this arrangement, a pupil was given one credit for every subject of 110-120 hours of instruction completed successfully. When he had earned twenty-seven credits he was awarded a Secondary School Graduation Diploma.⁵⁴ The advantage of this credit system was that more students were encouraged to graduate from high school. But the credit system had two major defects: a student might select only the easiest subjects or he might choose subjects that were not prerequisites for future learning. For these reasons many

guidance counsellors were required to help the pupils make wise choices for their eventual goals. The danger of pupils choosing disjointed programs was also reduced by subject departments establishing their own prerequisites.⁵⁵ In spite of its defects the credit system was adopted widely and by 1972 was compulsory for all Ontario secondary schools. In the opinion of the author, the credit system had the advantage of giving decision - making about school choices to pupils and their parents; still the implications of some of those decisions were not too well understood by some pupils and parents.

v Wells' Core Curriculum (1976)

The Hall-Dennis Report, which recommended more pupil freedom, more options and more freedom regarding course content, met with many negative reactions from parents, pupils and teachers. The O.S.S.T.F. suggested a more specifically defined program by providing a core curriculum.⁵⁶ Thomas Wells, Minister of Education, introduced such a program in 1976. Under this program each pupil who graduated from high school had to have credit in English, mathematics, Canadian history, Canadian geography and science. Of the twenty-seven credits needed for securing a Secondary School Graduation Diploma, nine credits were obligatory, one of which was science.⁵⁷ Thus, in the balance between the needs of the pupil and the demands of society, it appeared that the shift at the end of the period was toward societal requirements.

vi Comments by Parents about the Programs Offered (1972)

During this period of change in the educational system the parents held strong viewpoints as indicated by a survey conducted by the Ontario Ministry of Education, entitled, Quality of Education in Ontario, A Survey of Parents' Perspective (1972). The survey showed that:

- a) Most children (according to their parents) ... seemed to be pleased with their education 87% of parents claimed their children were moderately to very happy. Only 11% claimed their children were less than content.
- b) Most parents (70%) felt that there had been some progress in education over the past five years. A sizeable minority (27%), however, did not hold this view Secondary school parents, older, male, or better educated respondents were least likely to perceive progress
- c) Despite the general satisfaction, considerable dissatisfaction was detected with regard to the vocational preparation which to-day's schooling provides. Fifty-one percent of the sample agreed that 'students are better prepared to go out in the working world than they were in the past.'⁵⁸ However, forty-seven percent did not share this view.⁵⁸

Thus parents did not all agree that the educational needs of all children were met fully.

3.30 Changes : The Biology Curriculum (1961-1978)

Within the framework of Ontario's general educational changes, biology education was developed at three levels:

Grade 9 and 10 General Science, an intermediate level,
Grade 11, a senior level, and
Grade 13, an honours level.

3.31 Grade 9 and 10 Biology in General Science

In the discussion of Grade 9 and 10 biology, attention is centred on (i) the 1961 five-year program on which most other courses are based, (ii) three additional programs developed from the 1961 program and (iii) the authorized textbooks used throughout the period. The four curricular revisions together with their distinctive characteristics shown in Table 14 and in Fig. 4 provide a framework for further discussion.

i 1961 Five-Year Course

While the 1960's were considered by many to be a time of striking educational change, spearheaded by the dynamic Ministers of Education Robarts and Davis, innovation was not conspicuous in the course of study introduced in 1961 for biology. In fact, the five-year 1961 course showed few differences from the syllabus of 1937⁵⁹ and contrasted sharply with the extensively redesigned biology program in the United States where courses planned by the Biological Sciences Curriculum Study (BSCS) (see Chap. 3, p.109) were being tested. The difference between the biology

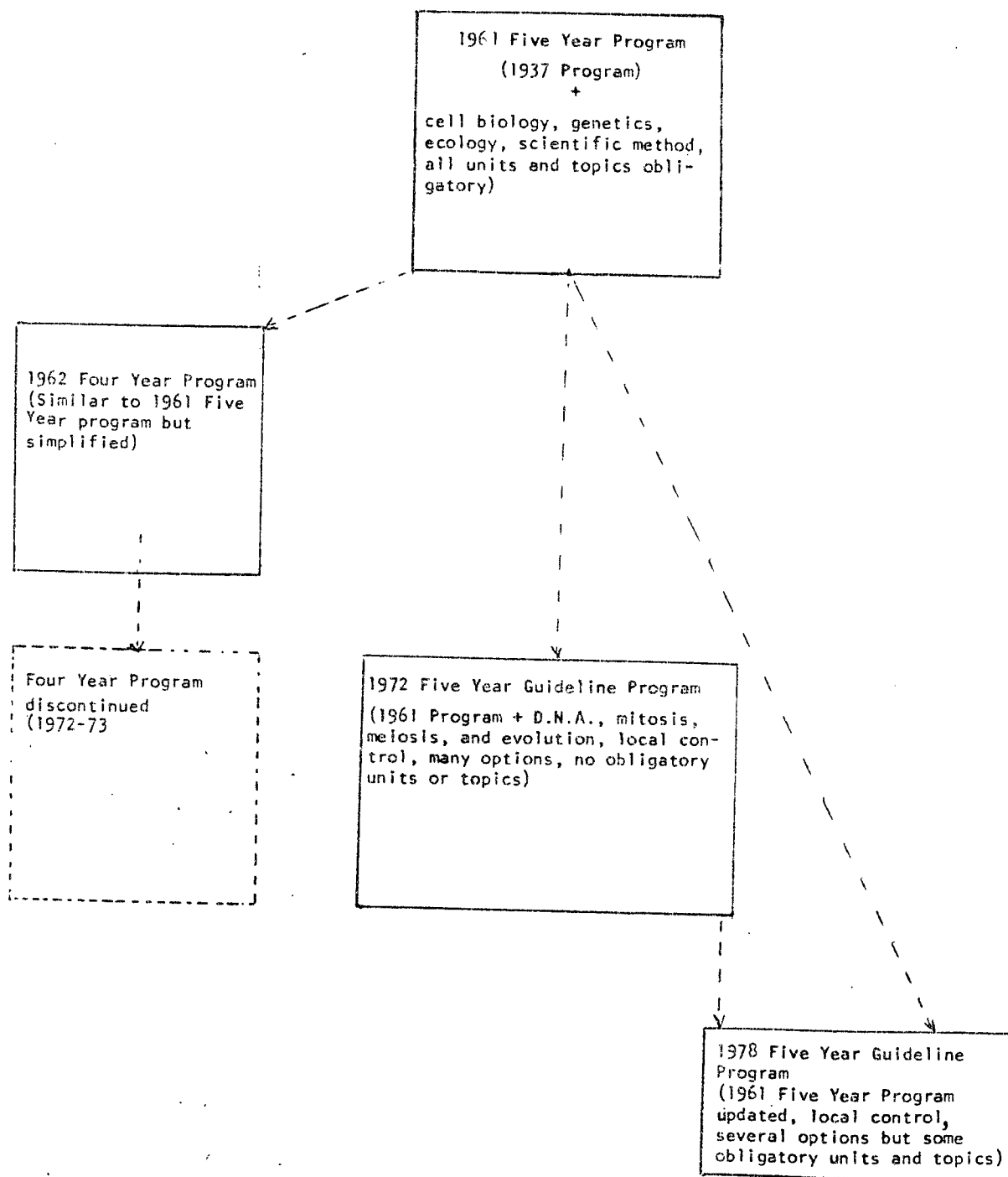
Table 14

Revisions in Ontario General Science Including Biology,
Grades 9, 10. (1961-1978)

Revision	Years of Operation	Length of Course	Percentage of Enrolment or Pupils	Salient Points
1961	1961-1972	5 years	65 (1966)	scientific method stressed. course simplified for average pupil. choice from alternatives in the curriculum. stresses structure and process of biology, provides a core.
1962	1962-1972	4 years	9 (1966)	
1972	1972-1978	5 years	95 (1975)	
1978	1978 +	5 years	95 (1978)	

Source: Ontario, Department of Education, Intermediate Division, Science Grades 7, 8, 9 and 10, Curriculum 1:(e), 1961; Ontario, Report of the Minister of Education, 1967, pp. 34, 77, 78; Ontario, Department of Education, Intermediate Division, Science Grades 7, 8, 9 and 10 Curriculum 1972; ibid., 1978;

Figure 4
Changes In Grade 9 and 10 Biology Programs (1961-1978)



programs in the United States and Ontario in 1961 were probably due partly to personnel and partly to finances. Revisions in Ontario were being made by practising teachers who included in the syllabus biological topics of pupil interest rather than those topics thought important by research biologists. In contrast the BSCS revision committee contained, in addition to teachers, research biologists fresh from the frontiers of discovery and both teacher experience and researcher viewpoint were incorporated into the BSCS curriculum. And while the local Ontario revision committees worked many hours without pay, their United States counterparts in three years spent one hundred million dollars for their revision of the physics, chemistry and biology programs.⁶⁰ Given these differences it is understandable that the Ontario course did not show innovations as spectacular as the United States versions.

The biological content of the 1961 Ontario general science course showed similarities to and differences from the previous 1937 program (Appendix A). The biology of the two courses both contained the study of the following topics: the parts of flowering plants and their functions, representatives of the major animal groups, human physiology, fungi and bacteria. Nonetheless, the 1961 course contained the following new topics: genetics, ecology, cell biology and the microscopic study of amoebae. In addition more emphasis was given to learning a "scientific method". This aspect of science education also received much attention in the United States schools. In fact, the theme of the 1956 National Science Teachers' Association was "The Scientific Method," reflecting in part the prestige accorded such

scientific achievements as space flight and the utilization of atomic energy.⁶¹ Teachers who approved of the 1961 program did so because they believed it provided a good basis for science in the senior years of high school and that this integrated science program could be related to the pupils' experience.⁶² Education Minister Robarts also was optimistic about the 1961 program for Grades 9 and 10. He stated:

Since it emphasizes experimental method and demonstrates the interrelationships among the various branches of science, it will almost certainly result in greater encouragement of the habit of making accurate observations, of withholding judgment until the evidence is in, of drawing conclusions that go only as far as the evidence permits, and of developing all the other aspects of critical thinking.⁶³

ii Three Revised Programs (Figure 4)

However, in spite of its initial promise, the 1961 course of study for biology in Grades 9 and 10 was revised three times, in 1962,⁶⁴ 1972⁶⁵ and 1978.⁶⁶ Each revision had some specific objective: The 1962 revision provided adjustments for differences in pupil abilities. The 1972 Guideline stressed flexibility through local curriculum planning, and the 1978 Guideline purported to up-date the program and included an essential core program. The author will discuss the distinctive features of each of the programs in more detail in the following pages.

1962 Revision : Biology in Grades 9, 10, General Science Four-Year Program (Figure 4)

In accordance with the Roberts Plan (see Chap. 3, pp. 116-5) a four-year program in general science was introduced for pupils who would have found the five-year program too difficult. The four-year program differed from the longer program in the following respects: it had simpler textbooks, separate examinations, flexibility regarding depth of treatment (dependent on the pupils' interest and aptitude) and less attention to technical terms. The difference in detail is illustrated in the following example from the 1961 and 1962 syllabi:

<u>Five Year Program</u>	<u>Four-Year Program</u>
<u>"Fertilization of Plants</u>	<u>"Fertilization of Plants</u>
a) The development of the pollen-tube from the pollen grain,	Brief description of the union of the male and female nuclei to form the zygote and endosperm." ⁶⁸
b) The development of the ovule prior to fertilization,	
c) The union of male and female nuclei to form the zygote and endosperm." ⁶⁷	

But some of the four-year general science programs were introduced too rapidly. And teachers had so much difficulty implementing them that they were not considered successful. Finally, in 1972-73 they were discontinued.

1972 Revision : Biology in Grade 9, 10 General Science (Figure 4)⁶⁹

The range of topics permitted by the 1961 five-year curriculum was considered too restricted, so a new guideline for science was issued in 1972 by the Ministry of Education in which teachers were provided with greater freedom to respond to pupil interest as recommended by the Hall-Dennis Report (1968). The Guideline included some suggested topics and examples of investigations, but they were neither prescriptive nor exhaustive. In effect, the 1972 Guideline permitted teachers to select and develop a wide variety of topics provided the curriculum was approved by the Ministry of Education officials.

While integration with other subject areas was encouraged, the actual content suggested in the 1972 Guideline showed little change from the 1961 course. Both 1961 and 1972 programs contained the following topics: cell structure and functions, invertebrates, vertebrates with particular attention to man, flowering plants, genetics, ecology, and fungi and bacteria. The new topics added in the 1972 Guideline were D.N.A., mitosis, meiosis and evolution. It was suggested that these new topics could be developed as themes to unify the course.⁷⁰ (Appendix A).

Although the 1972 Guideline introduced few new topics, it did encourage the development of innovative courses suitable to local conditions such as year-long courses in ecology and the up-dating of agriculture in rural schools to become environmental science (a combination of biology, chemistry, physics and geology).⁷¹

Thus, the 1972 Guideline introduced flexibility and local control into the science curriculum, dimensions which had been absent from the previous departmental course of study and which permitted the schools to respond to the particular needs of their communities. Moreover, the committees attempted to make the program more suitable for the "average" pupil and challenging to the more able student.⁷²

1978 Revision : Biology in Grade 9, 10 General Science (Figure 4)⁷³

Although the 1972 revision provided flexibility, parents and teachers criticized it as being too flexible to ensure that most pupils would experience a common program. The 1978 Guideline, therefore, was designed to overcome this criticism. To secure greater uniformity each program had both obligatory and optional units while each unit also had both obligatory as well as optional topics. Appendix F shows the topics in a typical unit, the possible units in a program and the possible programs that pupils could select. The presence of obligatory units and topics, the planners believed, would ensure that all pupils would have experience in the processes and structure of the scientific disciplines. Stress was given, too, to all pupils taking part in the solution of problems and learning to appreciate the importance of scientific endeavours.⁷⁴

Besides providing some common studies for all pupils the 1978 Guideline encouraged flexibility. A challenge was afforded to students who were especially interested in science in that they could take one, two or three programs in their first two years of high

school. Moreover, the courses were offered at both the general and advanced levels. These differed in the method of instruction, the time required for each unit and the required level of student performance.

A comparison of the biology content in the curriculum guide of 1978 with that of 1972 and the course of study of 1961 indicates that the following major trends of change from the previous period (1921-1960) continued (see Appendices A and F, Chap. 3, pp. 125-8, 130-131): There was an increased emphasis on genetics, on ecology and on the processes of science, with a reduction in morphology and classification (Appendix A). Fewer families of flowering plants were included and, while the function of the stem of a flowering plant was studied, little attention was given to its morphology.

It can be conjectured that the arrangements provided in Guideline 1978 should have produced an effective science program as the core curriculum was designed to help every pupil to experience the processes of biology and to acquire an understanding of its basic principles. The presence of many options enabled the pupil to select those which matched his interests. Moreover, an able student could be challenged by the many aspects of science as he could study up to three science courses in his first two years of high school. However, the multiplicity of choices caused some difficulties for teachers organizing classes and ordering equipment. But, at least in theory, Guideline 1978 permitted a wide expression of pupil choice.

iii Text-Books Authorized for Grade 9 and 10 Biology in General Science (1961-1978)

While general education in Ontario during the 1960's might have been considered innovative in its intent, there was no radical change apparent in the textbooks used for biology. Some texts, in fact, remained authorized throughout the period without any major change (Table 15). According to the writer's personal evaluation, most of the textbooks were well written; the biological concepts were developed logically and were related to the pupil's background; the books were made attractive with effective use of colour and photographs; review exercises were prepared; some had glossaries and summaries; and in a few texts, reference was made to the historical development of biology. The predominant emphasis in the texts was on providing logically organized concepts and the principles of science. Only at the end of the period did the textbooks attempt to identify the "mental processes" involved in scientific investigation and to give the pupils practice in them. Such an attempt was made in a textbook by John R. Reimer and William D. Wilson in Understanding Living Things (1977).

Table 15 provides a synopic view of the textbooks of the period. Key texts and their authors are identified and this writer's personal evaluation is given for each text.

Besides textbooks which covered the whole year's work in general science many modules or booklets were produced which dealt with a single biological topic or concept. Often these modules centred

Table 15
Authorized Textbooks for Ontario Grades 9 and 10
(1961-1978)

Grade Level Read-ability Flesch Index	Authors	Title	Period of Authorization	Publisher and Publisher's Location	Personal Evaluation
10-12	* V.N. Bruce and A. Hiles Carter, teachers	<u>Science for Secondary Schools Book 1</u> (1961)	1961-1978	Pitman & Sons, Canada, (Toronto)	clear, logical presentation explaining the basic concepts of biology.
	* A. Hiles Carter and Leslie Earl, teachers	<u>Science for Secondary Schools Book 2</u> (1962)	1962-1978	Pitman & Sons, Canada, (Toronto)	
8-9	* R.G. Casson, professor, J.H. Couke, professor, A.H. Loudon, professor, K.L. Wismer, teacher	<u>Science 9</u> (1965)	1965-1978	Copp Clark, (Toronto)	uses a historical approach, deals clearly with diffi- cult concepts, presents struct- ure of biology with up-to-date experiments, numerous review exercises, illustrations clear, widely used, some science process presented controls, excellent emphasis, inter- esting.
	* W.A. Andrews, professor, R.G. Casson, professor, A.H. Loudon, professor, K.L. Wismer, teacher	<u>Science 10</u> (1967)	1967-1978	Copp Clark, (Toronto)	
8-9	* S.J. Taylor, teacher M. Hallman, inspector, H. Gillies, teacher	<u>Intermediate Science 3</u> (1962)	1963-1973	Holt, Rinehart and Winston (Toronto)	good coloured illustrations, numerous pupil activities, no adjustment for in- dividual differences In exercises, some process (controls),
	* S.J. Taylor, teacher, M. Hallman, inspector, H.W. Harkness, professor	<u>Intermediate Science 4</u> (1962)	1963-1973	Holt, Rinehart and Winston (Toronto)	

Continued...

Table 15 continued

Grade Level Read- ability Flesch Index	Authors	Title	Period of Authori- zation	Publisher and Publisher Location	Personal Evaluation
8-9	* Edwin F. Bracken- borough, George W. Erwin, Robert G. Rist, and H. Kenneth Wooster, teachers	<u>The Methods of Science 3</u> (1961)	1963-1974	Clarke Irwin, (Toronto)	clear, development of concepts, good summaries, widely used, numerous observational exercises for pupils, questions adjusted for different levels, diagrams large and clear;
	* Edwin F. Bracken- borough, George W. Erwin, Robert G. Rist, and H. Kenneth Wooster, teachers	<u>The Methods of Science 4</u> (1963)	1963-1974	Clarke Irwin, (Toronto)	new terms in large type, brief, interesting.
10-12	* F.M. Speed, teacher, and H.M. Lang, professor	<u>Basic General Science Book 1</u> (1961)	1963-1970	Macmillan, Canada, (Toronto)	logical, uses historical approach, dia- grams at times fair only, many experiments in- dicated, often challenging, treatment gives some process and structure of biology, clear accounts, interesting.
	* H.M. Lang, professor, & F.M. Speed, teacher	<u>Basic General Science Book 2</u> (1962)	1963-1970	Macmillan, Canada, (Toronto)	
	F.M. Speed, teacher, & H.M. Lang,	<u>Basic Science Book 1</u> (1968)	1968-1978	MacMillan, Canada, (Toronto)	
	* H.M. Lang, professor, and F.M. Speed, teacher	<u>Basic Science Book 2</u> (1968)	1968-1978	Macmillan Canada, (Toronto)	
10-12	* John 'D. Reimer, and William G. Wilson, professors	<u>Under- standing Living Things</u> (1977)	1978+	D.C. Heath (Toronto) Canada)	research pro- jects, self- evaluation, excellent illustrations, process oriented.

Notes: * Ontario authors

Table T6

Modules for Biology Topics in Ontario Grades 9 and 10
(1972-1977) Examples

Authors	Title	Publisher and Publisher's Location
** i. W.A. Andrews, professor, D.K. Moore and A.C. Leroy, teachers, W.A. Andrews, ed.*	<u>A Guide to the Study of Environmental Pollution (1972)</u>	Prentice-Hall, (Scarborough, Ont.)
** ii. Daniel G. Stoker, Marcel Agsteribbe, Nancy R. Wilson, teachers, and W.A. Andrews, W.A. Andrews, ed., professor*	<u>A Guide to the Study of Freshwater Ecology, (1972)</u>	Prentice-Hall, (Scarborough, Ont.)
** iii. W.A. Andrews, professor, Daniel G. Stoker, Donna K. Moore, Larry N. Doble, Elaine C. McKnight, teachers, W.A. Andrews, ed.*	<u>A Guide to the Study of Terrestrial Ecology (1974)</u>	Prentice-Hall, (Scarborough, Ont.)
** iv. Nancy D. Davies, Daniel G. Stoker, Douglas E. Wilson, M. Terry Ashcroft, M. Carolyn Coburn, teachers, W.A. Andrews, ed., professor*	<u>A Guide to the Study of Soil Ecology, (1973)</u>	Prentice-Hall, (Scarborough, Ont.)
v. Charles Hopkins	<u>Ecology, Searching for Structure, (1977)</u>	Holt, (Toronto)
** vi. R.H. Horwood, professor	<u>Enquiry Into Environmental Pollution, 1973)</u>	Macmillan, (Toronto)
<u>Series of Modules</u>	<u>Searching for Structure, Examining your Environment, Investigations in Science A Modular Approach</u>	Holt, Rinehart and Winston, (Toronto) Holt, Rinehart and Winston (Toronto) John Wiley and Sons, (Toronto, Canada)

Notes: * Ontario editor
** Ontario authors

around ideas for pupil investigations. This approach earned them such support that they were approved for grants by the Ministry of Education and hence were included in Circular 14, (1978),* the memorandum from the Ministry of Education which lists authorized textbooks.

The first four modules listed in Table 16 made a significant contribution to the teaching of ecology in several ways: Each presented an account of a biological environment, a description for conducting observations and, finally a list of stimulating topics for research. However, the language used was closer to the Grade 11 level than that of the lower school as determined by the application of the Flesch Index.⁷⁵

In spite of the fact that the modules were included in Circular 14 they are not examined individually in this paper because of their large numbers. However, a general impression of the modules can be gained from a comment by a reviewer, John S. Chipsham:

The attitudes toward science and the understandings of science these modules engender may well surpass what was achieved either by the technological and fact-cramming approach of the fifties or the structure-of-the-disciplines sophistication of the sixties.⁷⁶

* Circular 14 listed all books on which the Ministry of Education would pay legislative grants to boards of education. If a board bought books not listed in Circular 14 the municipality had to pay for these books with no provincial governmental help.

3.32 Grade 11 and 12 Biology, Biological Sciences Curriculum Study (BSCS), Green Version.⁷⁷

The "Robarts Plan" of 1961 permitted four-year students in Grade 11 or 12 to take biology rather than physics and chemistry. The opportunity to study biology was valuable to students who had difficulty with the mathematics involved in physics and chemistry courses. They were frequently successful in biology and so would receive credit for science on their High School Graduation Diplomas.

In their search for a suitable course for the Grade 11 and 12 students, the Department of Education officials examined the BSCS programs of the United States (see Chap. 3, pp. 109-115). Interest in this ambitious program had been aroused by accounts in science teachers' journals, by speakers at the Science Teachers' Association of Ontario (STAO) and by reports of Ontario teachers who had taken part in Summer Institute or Year Institute programs of the National Science Foundation. (N.S.F.)⁷⁸ Eventually, in 1964, the Ontario Department of Education approved the use of the Green Version of BSCS. But it was used in only some Ontario schools: its implementation was hindered by the fact that there were no provincial grants available to buy American texts. However, it had some influence on the approach taken in other biology classes.⁷⁹ This probably came about partly because a teacher who had experienced the student interest aroused by enquiry learning would try the same methods with other classes.

The decision of the Department of Education to adopt the BSCS program, Green Version, can be justified on the following grounds: The stated objectives of the BSCS Green Version promised a stimulating course for students. This program provided training in basic biological concepts. It encouraged pupils to appreciate the role of science and biology. It would help pupils live in a world of interrelated organisms.⁸⁰ The Green Version of the BSCS course stressed outdoor activities which were thought appropriate for the four-year pupils. The topics in this ecological program are listed below:

Section A - Diversity of Life

- Unit I In what forms does life appear?
- Unit II Where does life occur?

Section B - What is an organism?

- Unit I Characteristics of life?
- Unit II The unit of structure and function - the cell
- Unit III A study of selected organisms

Section C - How does life start and how is it continued?

Section D - The community of organisms

- Unit I How organisms live together
- Unit II Where do I fit in?

Whatever the justification for the program the Minister of Education, William Davis, maintained that the introduction of a four year program including Grade 11 biology was a success:

Evidence indicates that students and parents have welcomed the diversity of opportunities and programs and that many students are remaining in school because they found courses that suited their needs, interests and abilities.⁸¹

The author's own nine years' knowledge of the program in the

Royal York Collegiate Institute supports the contention that it was successful. It is noteworthy that when most of the new courses introduced with the Robarts Plan were dropped in 1972, Grade 11 and 12 BSCS Biology was retained. In addition, the significant increase in the proportion of Grade 11 and 12 students who studied biology from 0.6 percent in 1965 to 16 percent in 1978 speaks favourably of the program.⁸²

The textbook used was designed specifically for BSCS program in ecology and was commended by such educators as David Ausubel, who had criticized the BSCS Yellow and Blue Version textbooks severely.⁸³ The Green Version text aroused interest with its laboratory work⁸⁴ and offered challenges within the range of the abilities of the less able Grade 11 and 12 pupils.

3.33 Grade 13 Biology

i The Revision of the Grade 13 Program⁸⁵

In the early 1960's the Grade 13 course was basically the same as in 1941 with minor changes. Thus, it had not undergone the revisions that some educators said characterized the educational revolution that was occurring in this period. This was due in part to the general contention that the previous Grade 13 botany and zoology were not overly burdensome for the students. The zoology program provided dissection that was interesting to the students and that could be carried out in most school laboratories. The topics on human physiology, while they contained much detail based on anatomy, were, nevertheless, of considerable interest. And

while the botany course had some complicated details of systematics, it still had several suitable experiments on plant physiology, some simple problems in Mendelian genetics and a modicum of theoretical ecology.⁸⁶ Moreover, there was a clearly written textbook, (General Biology, 1948, A.G. Croal and others), that was well suited to the Ontario course of study. It was a course that most pupils could pass and that instructors could teach without undue difficulty.

However, some science teachers wanted Grade 13 biology to be more challenging to the students. In addition, a Joint Committee of the Toronto Board of Education and the University of Toronto with Jerome Bruner as consultant examined the Ontario science courses (1960), and found that they did not reflect the current state of the disciplines. Members of this committee prepared lists of topics which the courses should include to present the existing structures of the science disciplines (1961).⁸⁷ In addition, a Department of Education survey of public opinion about the Grade 13 program (1964) elicited four adverse submissions, one of which presented by a university biology professor, maintained that the Ontario Grade 13 program in biology was fifty years behind the times.⁸⁸ Besides, Ontario educators of biology could not ignore the powerful influence of the fundamental changes in biology teaching emerging from the activities of the BSCS committees. In particular, the changes initiated in the BSCS programs caused Ontario educators to have doubts about the relevance of the current Grade 13 program to contemporary biology.⁸⁹

To keep the Ontario program up to date, the Minister of Education, William Davis, appointed revision committees for the Grade 13 subjects, including biology (1960).⁹⁰ Three biology professors, three high school teachers and one official of the Department of Education constituted the committee for the revision of the Grade 13 biology.*⁹¹

The changes in the arrangements for the biology education resulting from this committee's work are summarized below:

- a) One course in biology replaced the two separate courses in botany and zoology. This permitted pupils to view living processes as a whole rather than being restricted to the separate categories of plant and animal.
- b) Students wrote one examination paper in biology in 1966 and 1967. After that date the departmental upper school examination in biology was eliminated.
- c) Grade 13 biology consisted of one course for all students rather than a proposed general program for average students and an advanced course for those specializing in science

*The members of the committee were: Dr. Charlotte Sullivan, Professor of Zoology at the University of Toronto, Dr. Harold Good, Professor of Botany at Queen's University, Dr. Hugh Dale, Professor of Botany at the University of Guelph, Grant Hearn, Head of Science at Parkdale Collegiate Institute of Toronto, Leslie Smith, Biology Teacher at Harbord Collegiate Institute of Toronto, Hiles Carter, Vice-Principal of Forest Hill Collegiate Institute and Dr. C.A. Brown, Registrar of the Department of Education (Taped interview with Dr. Charlotte Sullivan, July 20, 1978; telephone conversation with Grant Hearn, July 20, 1978).

and biology.

- d) The revised program stressed the content and processes that were in keeping with modern research biology.
- e) The committee outlined a new course but did not specify suitable laboratory exercises or field activities. The committee assumed that teachers would plan these themselves.⁹²

The new course that the committee suggested in 1963 and that the Department of Education introduced in 1965 differed from the previous course in omitting many of the natural history aspects such as the life histories of organisms. Moreover, the descriptions of the representatives of the main plant and animals groups were eliminated. The new course gave less emphasis to details of classification in the major plant groups. Instead the seven units listed below, including for the first time a unit on evolution, were:

- Unit I - Characteristics of living organisms
- Unit II - Cell - structure and functions
- Unit III - Organisms - structure and functions of organ systems of an animal (man) and a flowering plant (bean)
- Unit IV - Classification as illustrated by the pine family
- Unit V - Ecology
- Unit VI - Reproduction
- Unit VII - Genetics and Evolution⁹³

Some teachers thought that certain changes instituted by the revision committee demanded too much of the pupils by stressing biological content rather than pupil enhancement,⁹⁴ and by insisting that the material conform more closely than previously to the structure of biology as research biologists conceived it. The revised program also required the pupils to use such research techniques as chromatography and calculation of biomass and to grasp such concepts as high-energy phosphates and activation energy. Because this new content required an understanding of biochemistry, sometimes serious problems were encountered by students who were unable to comprehend the chemistry involved.⁹⁵

While, on the one hand, these aspects required conformity to the biological discipline, on the other hand, other aspects appeared in the Grade 13 course which widened the scope of pupil participation by including new interesting activities. This was particularly true in the ecology sections which provided students with opportunities for carrying out exercises in the laboratory and the field. Discovering the difference between climax and succession communities and measuring the efficiency of food production of a particular farm crop were typical examples.⁹⁶ Hence, while the course required the pupils to adjust to the external world of research science, it also provided them with the opportunity to learn new concepts and ideas through their own initiative.⁹⁷

ii Implementation of Grade 13 Biology Program

To change from the former descriptive natural history to the new process-oriented course was a challenge to teachers who had

taught the previous conventional course for twenty years.

Realizing this, one of the members of the revising committee, Dr. Harold Good, Professor of Botany at Queens University, offered much needed help to biology teachers. In July 1965 Good organized a two-week course consisting of lectures, field trips, discussion groups and laboratory exercises. For those teachers who were unable to attend the summer session some detailed plans were published in The Crucible by the Science Teachers' Association of Ontario.⁹⁸ The summer session and The Crucible articles permitted many teachers to approach the new work with a measure of confidence which furthered the widespread acceptance of the up-dated course.

Another reason for the acceptance of the 1965 Grade 13 biology program by teachers and pupils was the elimination of departmental examinations. Previously a teacher was judged partly by the achievement of his pupils in the Grade 13 examinations. With a new course of study a teacher would be in a particularly precarious position because he would have difficulty in anticipating the new examination questions. However, when the new Grade 13 program was introduced, departmental examinations were considered less important and, in fact, for the first two years of the new course departmental examinations counted for only sixty-five percent of a pupil's year's standing. Finally, in 1968, the departmental examination was dispensed with completely; and the drive to emancipate the pupil (and the teacher) from the straight-jacket of the Grade 13 examinations was finally accomplished.*

* Pupils were encouraged to take competitive examinations by certain universities (York).

During the implementation of the new program difficulty with one unit became evident. Many teachers objected to Unit VI, Reproduction, which purported to trace the changes in reproduction in representatives of all the major groups of organisms. Since this unit required time to complete and since pupils were unfamiliar with several of the organisms, many teachers thought that this unit was not suitable for an average Grade 13 class. The Department of Education recognized this problem and omitted the unit on reproduction in the 1969 Grade 13 biology syllabus.⁹⁹

The 1969 syllabus, besides eliminating the criticized unit on reproduction, offered three alternative approaches in addition to the topical one: a homeostatic, an ecological and a principles approach¹⁰⁰ (Appendix G). Data showing which alternatives were chosen by the teacher were not available. This writer followed the topical alternative and most of the writer's colleagues did likewise. However, the writer also knew a number of teachers who, because of growing concern about the environment, chose the ecological approach.

iii Textbooks for Grade 13 Biology

The development of the new Grade 13 biology course opened the way for new textbooks. In addition to Canadian texts, the BSCS Yellow Version and the BSCS Blue Version were both recognized for use in Grade 13 even though they did not follow any of the sequences in the Ontario course of study.

Shorter publications, dealing with individual units, modules, earned approval in 1978.¹⁰¹ Table 17 shows the approved textbooks along with the writer's comments about each.

Table 17
Textbooks Approved for Grade 13 Biology (1965-1978)

Authors	Title	Period of recommendation	Publisher and Publisher's Location	Grade Level Readability Flesch Index	Personal Evaluation
* Donald L. Galbraith, teacher, David G. Wilson, professor	<u>Biological Science Principles and Patterns of Life</u> (1966)	1967-1978+	Holt, Rinehart and Winston, (Toronto)	13-16	thorough, more detailed than desirable for average pupil, biochemistry difficult, widely used.
* Fred M. Speed, teacher	<u>New Biology</u> (Second printing, 1965)	1965-1969	Ryerson, (Toronto)	10-12	good diagrams good coherence, not sufficient detail or accuracy.
* Douglas A. Penny, professor of teachers' college, and Regina Waern, teacher	<u>An Introduction to Aspects of Modern Biological Science</u> (1965)	1966-1978+	Pitman, (Toronto)	N.A.	detailed, a good reference book, lacks emphasis, leaves a great deal of the pupil organization.
B.S.C.S. (Yellow Version) professors and teachers	<u>Biological Science : An Inquiry Into Life, 2nd Edition</u> (1968)	1969-1978+	Harcourt, Brace and World, (New York)	10-12	widely used, well provided with summaries, questions, lab exercises, did not follow the Ontario course.
B.S.C.S. (Blue Version) professors and teachers	<u>Biological Science : Molecules to Man</u> (1963)	1968-1978+	Houghton, Mifflin, Nelson, (Toronto)	10-12	widely used, provided with self-check questions, excellent lab exercises.

Note: * Ontario authors

The professional background of all textbook authors in this period showed approximately equal numbers of professional biologists and secondary teachers (Appendix E). This was evident in the BSCS texts which were written by a team composed of numerous teachers and biologists, an arrangement designed to ensure that the texts expressed current research thinking. This equal proportion of researchers and teachers was quite different from that of the previous period (1921-1960) in which the authors were mostly secondary teachers. A textbook which showed the value of team authorship and which was widely used was Galbraith and Wilson's Biological Science : Principles and Patterns of Life (1966). It covered the departmental syllabus in sufficient detail and came with a laboratory manual containing many challenging experiments.

The topic, evolution, deserves special mention since this topic appeared in many Ontario texts and courses of study for the first time in this period. Previously, it can be argued, evolution was too controversial a topic to be included. In fact, most Grade 9 and 10 textbooks still omitted evolution. However, this topic was discussed fully in Ontario Grade 11, 12 and 13 texts. On the contrary, Gerald Skoog, the United States educator, noted a deemphasizing of the topic, evolution, in United States textbooks, even in the BSCS versions. Skoog warned that there was a danger that this unifying principle, evolution, was being neglected due to the pressure of fundamental religious groups on authors, publishers, educators and legislators.¹⁰²

3.30 Changes : The Biology Teachers (1961-1978)

Stake and Easley (1978) noted that the role of the teacher surpassed the effect of any other factor in determining the success of any science program.¹⁰³ And while the author considered this factor to be important in a discussion of biological education, unfortunately little data could be found on Ontario biology teachers. Such data as could be uncovered relating to qualifications and curriculum planning are presented. Table 18 shows the numbers of Ontario secondary teachers and the proportion of specialists among new teachers.

Table 18

Ontario Secondary Teachers (1960-1977)

Year	Number of Secondary Teachers	Percentage of New Teachers Granted Specialist's Certificates (Type A)	Percentage of New Teachers Granted High School Assistants' Certificates (Type B)
1960	11478	20.4	79.6
1965	21659	28.4	71.6
1970	33693	52.0	48.0
1975	34826	55.8	44.2
1977	36276	N.A.	N.A.

Sources: Ontario, Report of the Minister of Education, 1960, S-3; ibid., 1961, S16, S17; ibid., 1966, p. 100; ibid., 1970, pp. 14, 36; ibid., Educational Statistics, 1976, p. 90; Canada, Statistics Canada, Salaries and Qualifications of Teachers 1977-78, p. 82.

As shown the number of secondary teachers increased three-fold during the 1960's but increased more slowly during the 1970's. These changes in the numbers of teachers reflect the changes in the numbers of pupils (Table 19). However, the data in Table 18 do not tell the whole story, particularly for recent years and for certain municipalities. For example, in the Borough of Etobicoke in May 1980, 85 secondary teachers of the lowest seniority were informed that their services would not be needed to teach the anticipated reduced numbers of students.¹⁰⁴ Statistician Weisenthal (1974), who investigated the decrease in the required number of secondary teachers, estimated that by the mid-1980's Ontario would require 6000 fewer secondary teachers.¹⁰⁵ Clearly, given the declining secondary school system some of the young able teachers of biology would not be retained, and ambitious prospective teachers were discouraged by the grim prospect of diminishing employment.¹⁰⁶

The data in Table 18 also indicate that the proportion of specialist certificates held by new teachers was much lower in the 1960's than in the 1970's. (The specialist's certificate earned by graduation from a four-year honour course represented a higher qualification than an assistant's certificate, which did not require the honour course).¹⁰⁷ During the 1960's, when high school enrolment was high, there was a serious shortage of teachers. In such circumstances, all qualified teachers, even those with the lower qualifications secured positions. By contrast, in the 1970's the school population was growing more slowly, so there was no longer a shortage of teachers and boards of education could be more

selective in their appointments; hence young teachers with specialists' certificates had a competitive advantage.

During the period 1961-1978, biology teachers took a larger part than previously in decision-making about what they taught and how they taught it. This was partly due to the Guideline of 1972, (see Chap. 3, pp.130-131), which placed much of the responsibility of the content of the science program on the local curriculum committees.¹⁰⁸ The curriculum committee consisted, typically, of the science coordinator, the curriculum superintendent, heads of school science departments and other invited teachers. Meetings of these committees were held periodically to reach decisions about local science programs. Frequently, preliminary work or detailed follow-up assignments were carried out by skilled teachers who were interested in curricula and who were paid for their summer or part-time work. Such committee meetings provided opportunity for biology teachers to offer suggestions, to express opinions or to report innovations.¹⁰⁹

3.50 Changes in The Biology Pupils (1961-1978)

3.51 Ontario Secondary School Pupils

Table 19 shows the total enrolment in secondary schools from 1960-1978 and the proportion of the high school age population (15-19 year olds) who were attending high school.

Table 19

Ontario Secondary School Enrolment (1960-1978)

Year	Total Secondary School Enrolment	Percentage of the Secondary School Enrolment of the Population of 15-19 Year-olds
1960	262,775	62.6
1965	418,738	73.6
1970	556,910	80.4
1975	605,160	76.0
1978	611,669	74.2 (estimate)

Sources: Ontario, Report of the Minister of Education, 1966, pp. 127-132; ibid., Educational Statistics, 1976, pp. 45, 88, 117, 197; ibid., Guideline Courses, Statistics Section, Management Information System Branch, 1979, p. iii; Canada, Statistics 1976, Census of Canada, Supplementary Bulletin : Geographic and Demographic, Table 1-2.

The data in Table 19 show that the proportion of high school age young people attending school increased from 1960 to 1970 reaching more than eighty percent or approaching universal secondary school attendance. However, after 1970 this proportion of possible pupils attending decreased to 74.2 percent by 1978. This indicates a trend away from universal attendance of secondary school.

The data also show a doubling of pupil numbers during the 1960's but a more gradual increase in the school population in the 1970's. The expansion in pupil numbers was largely due to

the "post war baby boom", while a lower birth rate in the succeeding years caused the school population to grow more slowly. But the increase in high school enrolment was also partly due to a larger percentage of young people attending high school. On the one hand, Kubat and Thornton (1974) identified this trend and predicted "that before long secondary education will be universal,"¹¹⁰ On the other hand, Weisenthal (1974), the statistician, maintained that the prediction of universal secondary schooling was not apparent from the attitude of Ontario's parents. Weisenthal foretold a decline in enrolment in the 1980's, and claimed that there was no longer universal acceptance of secondary education.¹¹¹

In addition to encouraging the enrolment of every high school age pupil, it was an aim of Ontario's Department of Education in the period 1961-1978 to give individual attention to each pupil, (see Chap. 3, p. 119). The presence of this tendency was noted by Murray Lang, Professor of Methods in Science Teaching at the Faculty of Education of the University of Toronto: "The general trend was toward individualization : education must help each individual to develop to the full extent of his/her potential". . . ."¹¹²

Some suggestion of this trend towards individualization of instruction in the 1960's can be seen in the decrease in the pupil/teacher ratio of the 1960's in Table 20. From the data in the table it is apparent also that the pupil/teacher ratio increased slightly in the early 1970's suggesting less individualization in education.

Lang (1976) has described the attempts to introduce individualization of instruction and the results of these attempts:

Table 20

Ontario Secondary School Enrolment, Teacher Numbers and
Pupil/Teacher Ratio (1960-1976)

Year	Total Secondary School Enrolment	Number of Secondary School Teachers	Pupil/Teacher Ratio
1960	262,775	11,478	22.89
1965	418,738	21,659	19.33
1970	556,910	33,693	16.53
1975	605,160	34,826	17.38
1976	613,055	35,352	17.34

Sources: Ontario, Department of Education, Report of the Minister of Education, 1960, p.S-3; *ibid.*, 1961, pp. S-16, S-17; *ibid.*, 1966, pp. 100, 127-132; *ibid.*, 1970, pp. 14, 36; *ibid.*, Educational Statistics, 1976, pp. 45, 76, 88, 117, 197.

"... real efforts were made to implement the individualization of instruction. At the teacher education colleges we tried to prepare teachers . . . to design curricula and to meet individual needs. Teachers' groups negotiated with Boards of Education to reduce the pupil/teacher ratio by hiring more teachers, so reducing class sizes, and giving teachers more free time for preparation and marking. School libraries were expanded into spacious learning-resource centres, with copious audiovisual materials. Alas, by 1971, it became apparent that educational budgets were increasingly unreasonably. The government imposed ceilings to limit spending, and although the ceilings have been raised, they have not kept pace with inflation, and the net result has been a drastic reduction in available money. Yes, we should like to have individualization in education, but how much can the taxpayers afford?"¹¹³

Thus, attempts were made to implement individualized instruction but the cost was prohibitive.

3.52 Pupils in Secondary School Biology Classes

Table 21 shows the number of pupils enrolled in high school biology and it can be seen there was considerable variation over the years.

The high enrolment in biology, particularly toward the end of the period suggests that the various adjustments in curriculum content produced a program which was acceptable to many pupils. The decline in enrolment in Grades 9 and 10 in 1969 is worthy of comment as this decrease occurred immediately after pupils were allowed greater freedom in choosing courses for a Graduation Diploma.¹¹⁴ It is conceivable that easier options like theatre arts might have

Table 21

Ontario Secondary School Enrolment in Biology and Agriculture
(1960-1978)

Year	Percentage of Grade 9 and 10 Pupils Enrolled in Biology	Percentage Grade 11 Pupils Enrolled in Biology	Percentage of Grade 13 Pupils Enrolled in Biology
1960	77.2*	Not available until 1964	29.1
1965	73.3*	0.57	51.2
1969**	60.1*	0.33	32.4
1975	94.6*	N.A.	60.1
1978	94.9	15.6	53.8

Sources: Ontario, Report of the Minister of Education, 1965, pp. 69, 80, 129; *ibid.*, 1966, pp. 127-132; *ibid.*, 1969, p. 66; *ibid.*, 1970, pp. 28, 43, 66; *ibid.*, Educational Statistics 1976, pp. 14-18, 45, 88, 112; *ibid.*, Guideline Courses, 1978, pp. iii, 5; Ontario, Ministry of Treasury, Economics and Intergovernmental Affairs Statistics, 1976, pp. 40, 197;

Notes: * Includes agriculture and proportions in Grade 9 and 10 assumed to be the same as in Gr.12. This was necessary because education statistics did not give grade enrolment on subjects between 1945 and 1977. (See Chap. 2, p.97).

** First year of freedom of choice of subjects

been chosen in place of the more demanding science course.

The large enrolment in 1978 (94.9%) could have been due to the fact that one credit of science was needed for a high school graduation diploma.¹¹⁵ However, the high enrolment in 1975, the year before the regulation making science compulsory was passed, makes this assertion questionable. Presumably students chose science voluntarily in 1975. It is tempting to speculate that the large enrolment in science in 1975 and 1978 may have been due to concern of the younger generation for the preservation of proper living conditions on the earth at this time.

While an estimate could be made about the enrolment in general science little information was available about the number of students who enrolled in agriculture during this period. However the 1978 Report of the Ministry of Education showed that only 4.4 percent of Grade 9 and 10 pupils were enrolled in agricultural science compared with 94.9 percent in all Grade 9 and 10 science.¹¹⁵ This is a revealing indication of the declining importance of agricultural education in Ontario secondary schooling during this period.

The Grade 13 biology enrolment increased except for the year 1969. The explanation for the large proportion studying biology (53.4 percent) can be found partly in the fact that increasing proportions of pupils were remaining in school to secure Grade 13 standing. Then a greater proportion of students would have had difficulty with the mathematics needed for the physical sciences.

So they chose biology which did not require mathematics... (Certainly in the writer's experience non-mathematically inclined students often chose biology). In addition, the large enrolment in Grade 13 biology, more than half of the Grade 13 students, indicated that biology had a wide appeal. The students choosing biology included those interested in health services, in teaching and research and in the environment and out-door living. Whatever their ultimate occupations, these pupils had an opportunity to learn of the dangers of unrestricted industrial development and uncontrolled pollution and to see how the applications of biological principles could maintain the viability of the planet.

3.60 Summary

The period 1961-1978 was one of opposing trends. The 1960's was a time of large federal grants for education while the 1970's saw provincially legislated ceilings imposed on educational costs. During the sixties and early seventies there was a rapid increase in enrolment, while in the late seventies there was a slight decline in the proportion of young people of high school age who attended. The flexible options of the late sixties were followed by a firm core curriculum in the late seventies, while the shortage of teachers of the sixties was succeeded by a surplus in the seventies.

In spite of the changes, biology was studied by a larger proportion of pupils at the end of the period than at the beginning. In fact, by 1978 all high school pupils studied some basic science. Moreover, for talented pupils interested in science three science

courses were provided in the first two school years. The strengthening of biology as a high school subject accompanied increasing public awareness, at least among the young, of the necessity of maintaining the earth as a habitable planet.

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Chapter 4

A "CENTURY" OF BIOLOGY EDUCATION IN ONTARIO HIGH SCHOOLS (1871-1978): CURRICULAR CONCEPTS, CONCLUSIONS, REFLECTIONS AND PREDICTIONS

4.10 Introduction

After examining the changes in biology education in Ontario high schools extending over a century, one of the tasks remaining is to relate these changes to curricular concepts that are recognized by curriculum investigators. The author undertakes this in the present chapter.

Michael Schiro¹ identified four curricular concepts or ideologies as described below and also shown in Figure 5:

- I the social efficiency or utilitarianism ideology in which children were trained for their future roles in society,
- II the social reconstruction ideology in which children were taught to solve social problems with the hope that they would remake society,
- III the child study ideology in which the program was designed to draw out the inherent capacities of the children, and
- IV the scholar academic ideology in which children were inducted into the structure of the discipline.²

Figure 5

Ontario High School Education with Periods, Curricular Concepts and Conclusions (1871-1978)

Conclusion I
The Curriculum Concepts

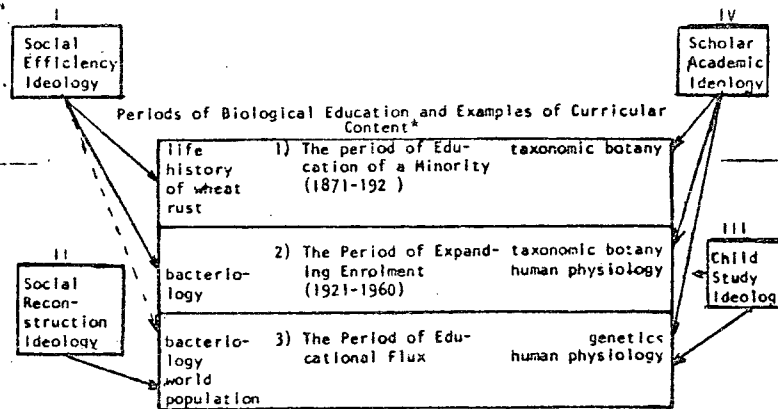
Throughout the hundred years of change in the biology curriculum the scholar academic concept was dominant, but declined during the second period; the social efficiency concept appeared in the biology curriculum during the first period but was declining by the third period; the child study approach was a competing concept in the second and third periods while social reconstruction as a curricular concept emerged during the third.

Conclusion II
The Curriculum Content

The topics that were prominent in biology education made up a chronological series: taxonomy, morphology and related physiology, applications of biology, genetics, ecology and cell biology.

Conclusion III
The Physical Facilities
for Biology Education

Physical facilities changed throughout the period reflecting the curricular concept currently in vogue.



Conclusion VII
The Biology Pupils

The proportion of high school-aged young people in school increased eighteen fold over this period. At the same time the opportunities for the "average" high school pupil to learn biological principles increased greatly. By 1978 95 percent of the Grade 9's and 10's, 16 percent of the Grade 11's and 12's and 53 percent of the Grade 13's were enrolled in biology.

Conclusion VI
The Agriculture Pupils

Until 1914 repeated attempts to introduce high school agriculture failed. From 1914 the enrolment in agriculture increased year by year to a peak in 1950 when 37 percent of Grade 9 and 10 pupils were enrolled. After 1950 the enrolment decreased sharply to 4 percent in 1978.

Conclusion IV
The Biology Textbooks

Over the hundred years the educational emphasis on textbooks changed. In the first period the authors were university biologists stressing the structure of biology; in the second period the authors were teachers emphasizing topics of pupil interest; while in the third there were teams of biologists and teachers stressing both biological structure and student interest.

Conclusion V
The Biology Teachers

Over most of the hundred years, Ontario secondary teachers of biology had high academic and professional qualifications. However there were times of teacher shortages in which qualifications in general declined.

The author will use these concepts in examining high school biology curricula to determine which of them was operative in each of the three periods of the study, namely, (1) the period of education for a minority (1871-1920), (2) the period of expanding enrolment (1921-1960) and (3) the period of educational flux (1961-1978) (Fig. 5). To do this, the curriculum of each period will be examined to see with which curricular concepts it is compatible.³ Such an exercise carried out on the curricula of the century will form an integrating device for this thesis.

Also in this chapter the author will look for the presence or absence of changes in the following aspects of biology education (Fig. 5):

- i the curricular concepts operative over the hundred years,
- ii the content of the biology curriculum,
- iii the physical facilities for biology education,
- iv the biology textbooks,
- v the biology teachers,
- vi the agriculture pupils,
- vii the biology pupils.

The examination of these aspects of biology education will lead to various conclusions, which are discussed at length and summarized in Figure 5. In addition, reflections and predictions with respect to the conclusions are offered, based on the author's forty years experience as a teacher.

4.20 Curricular Trends in Biology Education throughout the Century

4.21 The Period of Education for a Minority (1871-1920)

The examination of schooling during the early part of the period revealed that the scholar academic ideology which stressed the classical languages, was firmly entrenched.⁴ The high schools of the 1870's were "select schools" that provided training for entrance to university and teachers' training schools and in which the drop-out rate was high.⁵ It was difficult to introduce science, a subject considered by educators to be utilitarian, into this scholarly atmosphere (see Chapter 1, p. 4). However, Henry Spotton introduced a systematic way of teaching botany (1878) that revealed that taxonomic botany had a distinctive structure with definitions, rules and application exercises comparable to Latin (see Chap. 1, pp. 9, 16), and so taxonomic botany was accepted as a high school subject to be studied along with the classical languages.⁶

Once it was admitted as a subject on the high school course of study, biology made advances in the Ontario school program: it was granted a specified time allotment by provincial regulations (1904)⁷ and topics other than taxonomy such as physiology were added (see Chap. 1, p. 17).

A third advance was the inclusion of biological topics of economic importance (1904).⁸ The addition of the latter topics was consistent with the stated policy of that time of providing an education that would fit the child for his future life in

society (see Chap. 1, p. 4). This shows the emergence of the social efficiency concept and a decrease of the scholar academic ideology. The introduction of agriculture to the school curriculum also illustrates the influence of the social efficiency concept. Its introduction was opposed by two groups, the academic teachers who thought that this subject was incompatible with the scholarly tradition and the rural people who believed that future farmers could learn their vocation best on their home farms. However, instruction in agriculture received support from the Department of Education, who made it optional to science (1904). Later (1907), the Department of Education secured the cooperation of the Department of Agriculture officials who permitted their district representatives to give agricultural instruction in the high schools. In addition, the Department of Education offered further support: (i) in the form of grants (1909)(1912), (ii) in outlining the qualifications of teachers of agriculture and appointing an inspector (1911) and (iii) in planning a course of study (1914). However, little progress was made until the federal government provided grants (1913) and rural people began to appreciate scientific farming. Finally, by 1914 thirteen high schools taught agriculture. The persistence of these efforts indicates that the social efficiency ideology was gaining strength (see Chap. 1, 27-34).

During this period a third curricular concept, the child study ideology, was evident. It was supported in elementary schools by the additions of kindergartens, manual training,

household science, school gardening and nature study.

Nature study was considered by the followers of the child study ideology to aid child development because it permitted a child to learn directly from the natural environment by the teacher suggesting activities, presenting problems and answering questions. The elementary teacher received training to do this while still a student in the biology classes of the high school. Here the future elementary teachers learned to explore the natural environment, to observe phenomena, to record their observations and to discuss their findings. Except for this attempt to train future elementary teachers, the influence of the child study curricular concept was minimal in Ontario high schools during this period.⁹

In spite of the influences of the social efficiency and child study ideologies in the biology program, the major operative curricular concept was still that of the scholar academic. The highly 'selective' nature of the schools, the prominence given to academic subjects like Latin, mathematics and taxonomic botany, the minor attention given to subjects like art, music and agriculture, the use of authorized text books and the retention of examinations set by an external authority, support this viewpoint. In the author's view the predominance of this ideology was unfortunate since few pupils could be successful even with a small rigorously selected school population.¹⁰ However it did serve its purpose of preparing a few young people for university and teachers' colleges.¹¹

4.22 The Period of Expanding Enrolment (1921-1960)

During the first period the enrolment increased from one twenty-fifth to one-fifth of the possible enrolment, while in the second period it increased from one-fifth to three-fifths (Appendix H). The latter large increase in enrolment, particularly in the 1920's, reflected the demand of an industrial society for people with a higher level of education, a demand supported by parents. Also, at this time parents wished to use the high schools to protect their children by affording them the "supervised atmosphere and the socialization roles promised by the school."¹²

During the first period, with the scholar academic ideology as a major curricular concept, even though the total enrolment of highly selected pupils was low, the drop out rate was high. One could expect to find that the drop out rate would be even higher during the time of rapidly expanding enrolment of the less selected pupils of the 1920's, and indeed this was the case.¹³ In this situation social efficiency became an attractive alternative concept since it aimed to educate all pupils for their future roles in society.

In the 1920's the inclusion of practical topics such as important fungus diseases, control of harmful insects, reforestation and fish conservation (Appendix A), illustrated the continuing influence of the social efficiency approach. Still, Ontario schools did not neglect the scholar academic emphasis including its use in the study of biology. It was maintained

through the deductive presentation of lessons in the classrooms, prescribed textbooks and the domination of final examinations.¹⁴ But educators who were impressed with the social efficiency approach encouraged the schools to offer extra-curricular activities in which opportunities for citizenship training were provided.¹⁵ In this way, the Ontario high schools satisfied the interests of many additional students to whom citizenship training offered an obtainable goal and for whom academic excellence would have been difficult.

The influence of the social efficiency approach was apparent in making agricultural instruction more readily available (Appendix A). However, not as much use was made of agricultural instruction as might have been expected. In the author's experience during the 1920's, few children of practising farmers enrolled in high school agriculture as most future farmers learned their vocations on their home farms. During the author's high school days, (1922-1928) agriculture was studied in the local high school by most town students and by a few rural boarders and commuters. Curiously, only a few rural continuation schools, which were located close to the farms, provided agricultural instruction. While in the 1930's and 1940's agricultural science was offered in more rural high schools (see Chap.2, pp.97-99) enrolment in it declined in the late 1950's. This decline was concomitant with the lessened need for farmers and with the mechanization in agriculture. So, while there appeared to be an attempt to make the curriculum more socially efficient by stressing citizenship training,

introducing applications of biology, and providing instruction in agriculture, the viewpoint of the scholar academic was still operative in this period. It dominated the classrooms of the 1920's,¹⁶ competed with social efficiency and child study in the 1930's, acted as a stop-gap in the wartime emergencies of the 1940's and provided support for the conservatives of the 1950's.¹⁷

Progressivism was another curricular trend in the 1930's opposing the academic concept. Progressivism was similar to the child study emphasis introduced by a few "new educators" into the elementary schools during the first period¹⁸ and followed the learning-by-doing theme of John Dewey.¹⁹ In the 1930's, as W.G. Fleming the Ontario educator has stated, conflicts arose between those teachers who followed the progressive approach and those who adhered to the academic tradition (the so-called traditionalists or conservatives). The teachers who followed the progressive orientation believed that the pupil's motivation should come from his natural impulses. To these educators teaching was the act of providing opportunities for arousing the pupils' drives for self-development. The content of the curriculum for the progressivists consisted of the activities which appealed to the pupil's interests and led to further pupil activity. In contrast to the progressivists, the traditionalists or conservatives followed the scholar academic concept and believed that the curriculum should be made up of selected items from the highest cultural and intellectual achievements of man. This material was to be presented largely deductively and with authorized texts.

The traditionalists stressed student self-discipline and insisted that a pupil should not abandon his efforts because of his whims.²⁰

While the traditionalist viewpoint remained operative in secondary schools, child activities that were characteristic of the progressive movement appeared in the Ontario science curriculum in the 1937 revision.²¹ Changes were made which were consistent with progressivism; the replacement of teacher demonstrations with pupil experiments, the use of projects (see Chap. 2, p. 81), and inclusion of more options and topics of pupil interest²² such as human physiology, nutrition, the balance of nature and simple genetics (Appendices A and B). And the Department of Education officials made several adjustments to allow for individual differences so demonstrating support for progressivism. During the period (1921-1960) intermediate certificates were awarded to pupils as recognition for having successfully completed Grade 10, the usual level reached at the age of compulsory attendance (1939); several optional topics such as shopwork, farm mechanics and home economics were made available (1937); and the number of departmental examinations was reduced (1940) (see Chap. 2, pp. 63). However, the impetus of progressivism in Ontario weakened in the 1940's. One can argue that progressive education could not be emphasized as there were too few teachers in the 1940's skilled in this approach (see Chap. 2, p. 81). Hence, with the "hold-the-line" expedience of the Department of Education in the 1940's, progressive methods did not receive high priority. In the 1950's, progressivism was restricted further by the policy of the Minister of Education, W.J. Dunlop, who

supported a trend to return to basics in education²³ (see Chap. 2, p. 82). However, in spite of Dunlop's educational policy of stressing fundamentals, practising biologists were not favourably impressed with the high school biology programs in the 1950's. They maintained that the courses did not reflect current biology. Although the curricula stressed biological content the courses lacked the input of practising biologists needed to make the program consistent with contemporary research. In the biology courses pupils were not "doing science" in school but were learning about science and about practical applications of science. In fact, one professor of biology criticized the grade 13 program of biology as being fifty years behind the times (see Chap. 3, p. 141). Another unfavourable comment was made at this time in the United States by the American Institute of Biological Science whose research workers maintained that the teaching of the processes were largely ignored (see Chap. 3, p. 106). Thus the biology curriculum though subject oriented was still outdated.

So in this period, curriculum decisions still reflected the scholar academic approach although there were attempts to view the curriculum from the perspectives of child study (progressivism) and social efficiency.

4.23 The Period of Educational Flux (1961-1978)

During the third period (Figure 5) an additional curricular concept, social reconstruction, emerged as a basis for curricular decision making. As described by Eisner and Vallance, it is

"an approach in which social values, and often political positions, are clearly stated; social reconstructionism demands that schools recognize and respond to their role as a bridge between what is and what might be, between the real and the ideal. It is the traditional view of schooling as the bootstrap by which society can change itself".²⁴

Thus the advocates of social reconstruction attempted to deal with social issues in their courses. An examination of the Ontario biology curriculum shows that the social reconstruction concept had some influence during this period as the 1965 revision of the Grade 13 biology courses introduced topics that had a bearing on social problems: energy of a biosystem, world population, human sexual reproduction and evolution (Appendix B). These topics were added to the curriculum because they were stated by the educational administrators to give the pupils practice in dealing with issues that were both of social and biological concern. A statement of this intention appeared in the Department of Education's Guide for Grade 13 Biology (1969):

"[The aim is to provide students] with that kind of biological education required for future citizens who will have to pass judgment on questions of energy utilization, proper use of land, pollution and population."²⁵

Discussing biological issues of social importance could conceivably cause difficulties for the teacher since some of these topics could arouse strong emotional responses. However, the author's experience was that, once the topics were raised, they were given objective consideration. This was because the topics were highly structured and closely associated with other aspects of the course which ensured that the presentation and the reception

remained on an objective level.

While the social reconstruction concept of this period accounted for some curricular changes, the major changes were nevertheless consistent with the viewpoint of the scholar academics. These are reflected in the attempts to make the biology curriculum fit the structure and processes of the discipline that practising biologists recognized. Such curricular revisions were introduced in 1964 when the Green Version of the BSCS program was accepted for the few pupils in the Grade 11 and 12 four-year course. Biological content was up-dated also for all upper school biology students in 1965 and in the enquiry-directed units in the Grade 9 and 10 Guidelines of 1972 and 1978 (see Chap.3, pp. 130-132, 143-4, Appendix F). Thus, the biological content of the period, with the addition of genetics, ecology and cytology, reflected the current concerns of biologists. For some teachers the enquiry approach advocated by research biologists worked well, and when it did the pupils gained experience in the processes of science. But evidence secured by Stake and Easley indicates that many pupils in the United States did not succeed in learning this way.²⁶ Ontario pupils, most of whom did not have the advantage of the BSCS training available to the students investigated by Stake and Easley, could scarcely be expected to have done better than their American counterparts. This evidence concurs with the experience of many teachers, who found that the emphasis on biological structure and processes caused problems for both themselves and the pupils. While the author concedes that the

enquiry or process-oriented approach can be instrumental in motivation of the student, trying to follow the procedures by which a practising research biologist reached his conclusions often left the student confused. This could be because the pupil is led through complex mental detours in following the biologists' research. Such complexity of thought was encountered when the Grade 13 students attempted to follow the Kreb's cycle. However some of the material which reflected current research was suitable for the students, for example, chromatography and basic ecology, both of which widened their understanding.

Another major drawback to the enquiry approach, in addition to the complexity of the concepts, is insufficient time in a high school schedule. If a pupil is using an enquiry procedure in which he acts like a biologist, he needs time to reflect, to repeat experiments, to analyse and to discuss. Moreover, after the experimental work is complete, time is needed to draw the proper conclusions and to clarify the basic principles.

Besides the emerging impact of the social reconstructionists and the persistent influence of the scholar academics, the effect of the social efficiency followers was apparent on the biology curriculum by the provision of such topics as bacteriology, re-forestation and the control of insects. In addition, the supporters of the child study approach were influential during the period of 1961-1978. Consistent with their views the Department of Education made adjustments for individual differences in ability by providing three levels of courses, which consisted of a 2-year,

a 4-year and a 5-year program. This was included in the Robarts Plan, a proposal that came into effect in 1961 and remained until 1972-1973. Additionally, the Hall-Dennis Report recommended that "lock-step" schooling be replaced by individualized instruction in which cognizance was taken of the pupil's maturity. Furthermore, in keeping with the aims of the child study approach, more curricular choices were made possible by the introduction of the credit system (1969). And freedom of choice in subject matter was extended further by the Guideline (1972) issued by the Minister of Education, which allowed local curriculum committees to use almost any science curriculum provided it secured the approval of the Minister of Education (see Chap. 3, pp. 130-1).

However, individualized instruction and flexibility in subject matter both came under critical fire, the first because it was expensive and the second because it was thought by the supporters of the scholar academic and social efficiency ideologies to be less effective. Because educational costs had increased three times from 1960 to 1975, the provincial government imposed ceilings on local educational spending, which adversely affected efforts to provide individualized instruction. And in response to the criticisms levelled against flexible course content, and on the recommendation of the Ontario Secondary School Teachers Federation, Minister of Education Thomas Wells introduced core curricula into the high schools. The core curriculum required one credit in science as a condition for a secondary school graduation diploma (see Chap. 3, p. 122). In addition, the 1978 Guideline made specific science units obligatory. Nevertheless, the latter Guideline still afforded an abundant range

of choice to an able science student, who could complete three science courses in his or her first two years of high school (see Chap. 3, pp. 131-2).

One aspect of biological education that declined conspicuously in emphasis during this period was agriculture. By 1950, thirty-seven percent of Grade 9 and 10 pupils was enrolled in agricultural science (see Chap. 2, p.97). By 1978 the proportion of agricultural students in Grades 9 and 10 had fallen to 4.4 percent (see Chap. 2, p. 97; Chap. 3, p. 157). This decrease in enrolment was consistent with the application of the social efficiency curricular concept.

When agricultural science instruction was introduced into the high schools it was considered by its initiators to be a plan that would prevent rural depopulation and so keep the level of food production up to a "safe" level. However, David Jones, a Canadian educator, maintained that in spite of rural depopulation there was still a high level of food production; agriculture was simply concentrated in the hands of fewer and fewer people. Increasing costs of farming, including the value of arable land, the price of agricultural implements and their needed fuel, uncertain markets and high interest rates limited the number of people who could engage in farming. Since few people were needed on the farms, Jones contended, "significant justification of school agriculture evaporated."²⁷

Thus when more food and the farmers to produce it were needed in the 1930's and in the wartime 1940's, agricultural instruction

was encouraged. While during the 1960's and 1970's when fewer farmers were needed due to mechanization, high school agricultural instruction was not encouraged. Thus, in keeping with the social efficiency concept in curriculum, the schools offered training in agriculture in response to the perceived needs of the economy, and the enrolment reflected their emphasis.

While there were four curricular approaches in this period the two most important ones were the scholar academic and child study concepts. These two ideologies tended to direct the teacher's curricular decisions toward opposing goals. The scholar academic concept urged the teacher to present the structured biological discipline in a manner dictated by research requirements, while the child study ideology urged him to concentrate on developing the child's potential; the teacher attempted to adjust these two seemingly contradictory viewpoints. On the one hand, the teacher was anxious to provide courses that dealt with contemporary biology. To help with this, the departmental Guidelines (1972, 1978) offered sample programs, which could be clarified at local curriculum committee meetings, and at departmental meetings of the individual schools. In this way the teacher could keep the content up-to-date. On the other hand, she or he was anxious that the programs did not exceed the levels of pupil interest or ability. The question of J.R. McCarthy, (1961) Ontario educator, in dealing with the danger of an over-emphasis on structure, is relevant:

Does the structure of the discipline developed by scholars in the field mean that teachers and others who work with boys and girls will not longer be able to select from that discipline what they know to be within

the range of the student's abilities, interests and aptitudes and leave out the rest. If not, some of the major gains in education over the past half century will be threatened.²⁸

In general, in the author's experience the teachers followed a middle course between the extremes of these viewpoints, biological structure and processes on one hand and child development on the other.

Thus a comprehensive view of this period indicates that while all four curricular concepts were operative - scholar academic, social efficiency, child study and social reconstruction - the scholar academic concept continued as the major ideology for curricular decision-making. Even the revisions resulting from the criticisms of the biology program were made in accordance with this curricular concept. The social reconstruction concept emerged as a competing ideology during this period, but social issues dealt with were structured so that they were acceptable to the scholar academic. Also, during the period, the publication of the Hall-Dennis Report (1968) urged individualized instruction so that the child study concept was important.

4.30 Contrasts in Biological Education between the Periods : Conclusions, Reflections and Predictions

From the foregoing analysis of biology education over the past century, various conclusions can be drawn about the following aspects of biology education: (i) the curricular concepts, (ii) the content of the curriculum, (iii) the physical facilities for biology education, (iv) the biology textbooks, (v) the biology teachers, (vi) the agriculture pupils, and (vii) the biology pupils. The author will

reflect on past changes and make prediction about future ones.

4.31 Biology Curriculum

The Curriculum Concepts

Conclusion i Throughout the hundred years of change in the biology curriculum the scholar academic concept was dominant, but declined during the second period; the social efficiency concept appeared in the biology curriculum during the first period but was declining by the third period; the child study approach was a competing concept in the second and third periods, while social reconstruction as a curriculum concept emerged during the third.

The scholar academic concept remained dominant throughout because of the persistent resistance to change of the scholar academic educators. In the 1870's, the supporters of science education, who justified the inclusion of science on the basis of social efficiency, were opposed by the teachers of classics who stressed academic excellence. Likewise, in the early part of the twentieth century the child-centred "new educators" met with opposition from their scholar academic colleagues. In the 1930's progressive educators who gave priority to child development were in conflict with conservative teachers who stressed child conformity to academic subjects. Finally in the 1960's the supporters of the child-oriented Hall-Dennis Report were in opposition to the discipline-conscious BSCS proponents. In the future one could expect similar conflicts between the supporters of the

scholar academic concept and the sponsors of the more innovative approaches. Thus, on one side there will be educators who support the child study, social efficiency and social reconstruction concepts and who strive for continued improvement in both course content and methods of teaching. On the other side there will be a conservative group who will support scholar academic ideology and who will be anxious to preserve the more traditional elements of schooling.

The Content of the Curriculum

While the general conclusion (i) deals with the changes in curricular concepts throughout the century, a specific conclusion can be stated about the changes in biology curriculum content.

Conclusion ii The topics that were prominent in biology education made up a chronological series: taxonomy, morphology and related physiology, applications of biology, genetics, ecology and cell biology.

This sequence is similar to that reported by Hurd (1961) for biology in United States high schools during the same period.²⁹ The sequence followed the areas of research interest by a lag of several years. For example, the rediscovery of Mendel's work in 1900³⁰ was followed by the introduction of genetics in high school in the 1940's. Also the research work on vertebrate physiology of the 1920's³¹ was succeeded by human physiology as a school topic in the 1940's. The Watson-Crick model of DNA of 1953³² appeared in the Ontario Grade 13 course of study in 1965. The time lag between the research work and

the inclusion of the topic in the high school curriculum was further decreased in the 1960's possibly due to the close collaboration between research biologists and teachers in the curriculum revision process.

4.32 The Physical Facilities for Biology Education

Conclusion iii The physical facilities changed throughout the period reflecting the curriculuar concept currently in vogue.

In the 1870's, boards of education were reluctant to furnish a laboratory because they considered a teacher's demonstration table in a normal classroom to be an adequate facility for teaching. However, by the early part of the twentieth century, most urban high schools had well-equipped laboratories so that pupils could carry out individual experiments. By 1950 such facilities were extended to most rural district high schools. Improved audio-visual facilities appeared in the 1950's. In the same period, both classroom and laboratory space were considered useful and necessary.³³ In the late 1960's and early 1970's, when individualized instruction was introduced to some innovative schools, a separate working area or carrel was set up for each major topic of the course within the biological laboratory. In each carrel a pupil could carry out his own individual learning activities using the specific instruments needed for a particular topic.³⁴

The author believes that the first hand experience with biological ideas and materials provided by the improved laboratory facilities helped the pupils learn science. However, in the 1970's, the

achievement of this aim was hampered by the imposition of ceilings on educational spending making less money available to provide needed laboratory facilities.

4.32 The Biology Text-Books

Conclusion iv Over the hundred years the educational emphasis in the textbooks changed. In the first period the authors were university biologists stressing the structure of biology; in the second period the authors were teachers emphasizing topics of pupil interest; while in the third they were teams of biologists and teachers stressing both biological structure and student interest.

In the first fifty years covered by this study, the authors of the textbooks were university professors familiar with the structure and processes of biology. Their textbooks reflected this viewpoint first on taxonomy and later on morphology with its related physiology. By the 1920's the authors were mainly high school science teachers or faculty members of teacher colleges, who gave prominence to natural history, practical applications and social aspects of biology, topics that were perceived to appeal to pupil interest (Appendix E). Such texts described topics of pupil interest such as human physiology and had many class laboratory exercises rather than demonstrations. They also contained socially useful ideas e.g., the nature of bacteria and the spread of fungus diseases harmful to field crops. But some contemporary biologists stated that the texts were

so outdated that they needed thorough rewriting. This revision was attempted in the 1960's by research biologists and teachers teaming together with the intent of combining both the structure and processes of the biological discipline with an appeal to pupil interest. The texts produced by these teams stressed experimental biology, cell biology, genetics and ecology. The changes in authors' background and positions were similar to those noted by Hurd (1961)³⁵ and Gatewood and Obourn (1963)³⁶ for authors in the United States throughout the century.

In addition to the changes in authorship, there was a trend away from provincially authorized text-books during the last part of the century of biology education. The tendency was to use modules, books in which an author skilled in a topic of biology prepared a short teaching unit.

Individualized instruction and pupil investigation of a particular topic have been increasing in past years and, in the writer's opinion, are likely to continue to do so. Hence, unit modules will be used to a greater extent in future biology classes. Moreover, since these modules will be used by a large part of the school community they must show a high level of clarity, interest and emphasis on significant topics.

A second trend which could well continue into the future is the use of more Canadian texts and curricular materials. This trend, one with powerful political motivation, has been encouraged by the Science Council of Canada. However, in opposition to this trend are the increasing costs of publishing and the low volume of sales for Canadian

publications, which make them of questionable commercial value for publishers.

4.33 The Biology Teachers

Conclusion v Over most of the hundred years, Ontario secondary teachers of biology had high academic and professional qualifications. However there were times of teacher shortages in which qualifications in general declined.

Although at the beginning of the century, high school teachers of biology and other subjects did not require special academic or professional qualifications, by the 1890's most high school teachers were university graduates with teaching certificates. These high standards were generally maintained throughout the "century". However, in times of teacher shortages, some teachers were not fully qualified. This condition of teacher shortages persisted in the 1940's due to wartime enlistments, and in the 1950's and 1960's due to large pupil enrolments; in contrast, during the 1930's and 1970's, when secondary teachers were abundant, qualifications were high (see Chap. 1, pp.38-42; Chap. 2, pp.82-7; Chap. 3, pp.149-151).

The author's impression of his former high school teachers is that most of his instructors, both graduate and non-graduate were able, conscientious and stimulating. He considers that his teachers possessed qualities of personality and drive that transcended their academic qualifications.

The review of teachers' qualifications raises the query; "Is today's biology teacher better than his counterpart of eighty years ago?" Objective data relevant to this question would be difficult to obtain but examining some of the negative and positive aspects should be instructive.

To-day's biology teacher is not necessarily better qualified. In fact, at the beginning of the twentieth century, two-thirds of all secondary teachers in high schools or collegiate institutes were specialists and had been trained in teaching as well as in biology. These qualifications had not improved by 1975 (see Chap. 3, pp. 149-151). On the other hand, to-day's biology teacher has a better opportunity to present biology for the average pupil because he is less bound by the dictates of the scholar academic concept than was his predecessor. His position is no longer threatened by the pupils' results on examinations set by an external authority. With this greater freedom and the wide range of programs available, the present-day biology teacher is able to select content and method which he has found to be effective and in line with the pupils' interests and abilities. In addition, he has at his command up-to-date laboratory facilities and a wealth of audio-visual material to aid in the clarification of biological principles. Hence, in many ways, the biology teacher has greater freedom to practise his profession. Whether or not this actually results in more effective teaching is a question that has not yet been answered. But, present-day biology teaching clearly provides favourable opportunities for effective instruction. Another aspect of today's education system which could

make today's teachers better than those in the past is the fact that they play a more prominent part in the ongoing processes of curriculum revision. As advances are reported in the knowledge of the biological discipline, the educational authorities must modify the program so that it is consistent with scientific progress. The local curriculum committee in which teachers can participate is responsible for these modifications. Today's teacher also has more opportunity to learn about the innovations at summer school or workshops, to trial test the new programs and to discuss strengths and weaknesses with fellow teachers. Such opportunities were less available to his earlier counterpart for whom the curriculum was laid down by departmental ruling with little opportunity for choice.

4.35 The Agricultural Pupils

Conclusion vi Until 1914 the repeated attempts to introduce high school agriculture failed. From 1914 the enrolment in agriculture increased year by year to peak in 1950 when 37 percent of Grade 9 and 10 pupils were enrolled. After 1950 the enrolment decreased sharply to 4 percent in 1978.

The enrolment change in agriculture reflected the change in the community's need for farmers. Although there was a temporary tendency for more people to work on farms during the depression and the Second World War, the major trend throughout the period was toward increased mechanization of farming. Hence, by the end of the period fewer people were needed on the farms. In 1891 one half of the Canadian

labour force were working on farms; by 1975 this had fallen to one thirtieth of the employed population.³⁷

4.36 The Biology Pupils

Conclusion vii The proportion of high school-aged young people in school increased eighteen fold over the period. At the same time, the opportunities for the "average" high school pupil to learn biological principles increased greatly. By 1978 95 percent of the Grade 9's and 10's, 16 percent of the Grade 11's and 12's, and 53 percent of Grade 13's were enrolled in biology.

Over the period the proportion of the population attending high school increased greatly, and the opportunities to learn biology kept pace with the enrolment. Several factors permitted the increase of these opportunities: the changing nature of society, the influence of the parents and the actions of the officials of the Ministry of Education. Of these factors, parental influence was probably most significant in increasing the numbers of "average" pupils who attended school. While compulsory legislation (1919) ensured that most pupils would attend until their sixteenth birthday, many attended because they accepted their parents' belief that secondary education would aid their personal development and improve their chances of fitting into an industrial and skill-demanding society.³⁸ This attitude was consistent with the prevalent belief that schooling was necessary to equip pupils to perform efficiently.

The Department of Education removed obstacles and offered incentives to students to continue with their education including that in biology. In 1976 a departmental regulation made credit in science a necessary condition for high school graduation. Obstacles to the progress of the "average" pupil through high school were removed by the Department of Education in the following ways: tuition fees were abolished (1921); a local textbook loan scheme financed by provincial grants was introduced (1951); compulsory departmental examinations were reduced in number (1904, 1921, 1937) and finally were abolished (1968); a school bus system was inaugurated primarily to transport rural pupils to district high schools and the cost was borne mainly by the provincial government. In addition, the Department of Education provided incentives for students by offering diplomas at different levels of achievement, Grade 12 (1921), Grade 10 (1939) and Grade 13 (1942). Finally, the Department of Education officials recognized different ability levels by instituting 2, 4 and 5-year programs (1961) both general and advanced levels (1972, 1978). These departmental measures helped an average pupil select a program including biological topics which was consistent with his interests.

In the light of the many changes that have been made for the pupils enrolling in biology, one could ask: "Are pupils of to-day more interested in biology than their counterparts of eighty or ninety years ago?" As it is impossible to establish this empirically, one can only speculate. On the one hand, one might conjecture that the pupils would have been more interested

in biology eighty or ninety years ago because at that time, they were a highly selected group in regard to family backgrounds and career choices and would have been more interested in any academic subject than their present-day, unselected counterparts. On the other hand, the improved selection of biological topics such as ecology, outdoor activities and problems of efficient energy use should promote pupil interest and motivation. In addition, the ecologically hazardous position of man on this polluted planet stimulates many pupils to take an interest in biological science. Such world biological problems were largely unknown in the early part of the century covered by the study.

While any conclusion about a change in the degree of pupil interest during the century is speculative, it is clear that in the 1880's pupils' attention was focused on biology as a science while in the 1970's it was directed toward the environmental problems which a knowledge of biology would help to control.

In view of the many curricular changes effected, one might ask an additional question: "Do the pupils have a better understanding of biological principles than they did in earlier times?" The writer's opinion is that in general to-day's students do have a better understanding of biology. In the nineteenth century, the stress was primarily on taxonomy, while current biology covers many facets: genetics, ecology, cell biology, morphology, physiology and a reduced emphasis on classification. Hence the opportunities for pupils to understand a broad "spectrum" of biology have increased.

While in the past the school enrolment increased dramatically, the changing age distribution, with the proportion of elementary and secondary pupils decreasing relative to the population, has reversed this former trend. This has serious implications for future education: fewer people will be needed to engage in the education of young people; and education will need to be directed more toward adults. Continuing education programs offered by secondary schools, community colleges and universities are some ways in which these needs are presently being met. Such community educational programs tend to utilize many of the resources of the community: planetariums, astronomical observatories, conservation areas, television programs, museums, science centres, botanical and zoological gardens. While these facilities will continue to be used for non-formal education they will also provide learning opportunities for expanded adult educational programs.

In addition industries and ministries of government are increasingly carrying out educational functions. The Ontario Ministry of Agriculture, Canadian National, Ontario Hydro, Hudson's Bay Company, Green City Hydroponics and Cominco at present provide teaching materials to interest biology students.

Another recent trend appears to be toward fewer high school-aged individuals attending school (see Chap. 3, p. 152.). The author suggests that part-time attendance of senior students, who would otherwise leave school, be encouraged. This would provide both the social advantages of attendance and the financial advantages of working. In addition, such a combination would help pupils acquire

a background of practical experience which would be beneficial for academic training and a theoretical base for practical work.

Although much has been accomplished in biology education during the hundred years studied, much has yet to be done. In spite of the fact that by 1978, 95 percent of Grade 9 and 10 pupils were enrolled to learn basic concepts, science teachers admit that they had not succeeded yet in producing scientific literacy,* in producing satisfying programs for all pupils nor in aiding all pupils to adjust to a complex society. Parents apparently agree. A survey of parents' opinions of vocational guidance services (1972) revealed that forty-seven percent thought that not enough was being done to help fit young people for work in adult society (see Chap. 3, p. 123).

The goals of biology education are never fully attained as Hugh Stevenson, a Canadian educator, stated:

"For Canadians and for society the need will persist for a far better curriculum than has been developed thus far".³⁹

To meet the challenge of evolving biological education, teachers must be cognizant of current biological developments. They must, also, be sensitive, adaptable and imaginative in promoting pupils' investigations of living organisms and in furthering their pupils' satisfaction in the process.

* In fact in 1980, David Suzuki contended that all but a few gifted pupils came out of high school ignorant of science, the strongest force in society. David Galbraith, Editorial, The Crucible Vol. 11, No. 6 (October, 1980).

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APPENDICES

- A. Comparison of Courses of Study for Grades 9, 10 Biological and Agricultural Science in Ontario High Schools by Topics (1871-1978).
- B. Comparison of Upper School (Grade 13) Curricula in Biology in Ontario High Schools by Topics. (1871-1978)
- C. Analysis of Authorized and Recommended Texts in Biology and Agriculture in Ontario (1871-1903).
- D. Development of an Authorized and Recommended Textbook in Ontario.
- E. Occupations of the Authors of Ontario's Biology Textbooks Authorized and Recommended. (1871-1978)
- F. Units in A Typical Science Program for One Course, Grade 9, 10 1978 Guideline, Choices in a Science Program for Grade 9 and 10 (1978 Guideline) and The Content of a Typical Obligatory Unit, Grade 9 and 10, 1978 Guideline.
- G. Alternative Approaches for Grade 13 Biology (1969) ; Homeostatic, Ecological and Principles.
- H. Ontario Secondary Non-Sectarian School Enrolment and Enrolment in Biology and Agriculture in these Schools. Table and a Figure.
- I. Ontario Boards of Education.

Appendix A

Comparison of Courses of Study for Grade 9 and 10 Biological and Agricultural Science in Ontario High Schools by Topics (1871-1978)

Time Topic	Period 1		Period 2		Period 3		
	1871-1903	1904-1920	1921-1936	1937-1960	1961-1971	1972-1977	1978 +
Cells	X		X0	X0	X*0*		
Algae	X					1	1
Fungi	X	X0	X*0*	X*0*	X0	9	9
Bacteria			0	X0	X0	7	7
Viruses					X0	2	8
Liverwort	X						
Moss	X					G	G
Fern	X	X	X		X0	U	U
Clubmoss	X					I	I
Horsetail	X					D	D
Gymnosperm	X					E	E
Parts of a						L	L
Flowering Plant	X	X0	X0	X0	X0	I	I
Flower, Structure						N	N
and Function	X	X0	X0	X0	X0	E	E
Pollination and							
Fertilization	X	X0	X0	X0	X0	L	L
Fruits and Seeds	X	X0	X0	X0	X0	I	O
Families of Flowering						K	C
Plants	X	X0	X0	X0	X0	E	A
Leaf	X	X0	X0	X0	X0		L

continued -

Appendix A - continued -

Time Topic	Period 1		Period 2		Period 3		
	1871-1903	1904-1920	1921-1936	1937-1960	1961-1971	1972-1977	1978 +
Stem	X	X0	X0	X0	X0	1	S
Root	X	X0	X0	X0	X0	9	E
Vegetative Re-						6	L
production	X	X0	X0	X0	X0	1	E
Orchard Practice							C
and Reforesta-		X0	X0	X0	X0		T
tion						C	I
						O	O
						U	N
Soil and Gardening			0	0	X0	R	
Weeds	X	0	0	0	0	S	
Balance of Nature	X			X	X0	E	
Ecology					X0	S	
Genetics					X0	M	F
Protozoan	X				X0	I	R
						T	O
Earthworm	X		X			O	M
Mollusc	X		X			S	
Insects	X	X0	X0	X*0*	X0	S	B
Beekeeping		0	0	0	0	D	A
Crustacean	X	X	X		X	N	S
Arachnid	X	X	X			A	I
Myriopod	X	X	X		X	M	C
Fish	X	X	X	X	X	E	
Amphibian	X	X	X	X	X	I	
Reptile	X	X	X	X	X	O	C
Bird	X	X	X0	X	X	S	O
Poultry		0	0	0	0	S	R
							E

continued-

Appendix A - continued

Topic	Time	Period 1		Period 2		Period 3		
		1871-1903	1904-1920	1921-1936	1937-1960	1961-1971	1972-1978	1978+
Mammal		X	X	X0		X0		
Human Food					X0	X0	E	
Human Physiology					X0	X0	V	
Domestic Animals			0	0	0	0	0	
Milk Testing			0	0	0	0	L	
Scope and Aims of Biology	X						U	
Evolution							T	
Home Projects			0	0	0	0	I	
							O	
							N	

X - topic in biology ; 0 - topic in agriculture ; * - detailed treatment

Sources : Ontario, Course of Study (1881) Circular 3; Ontario, Report of the Minister of Education, 1904, pp. 149-151; ibid., 1914, pp. 337-343; Ontario, Department of Education, Changes in the Courses of Study and Examination Requirements in Continuation Schools, High Schools and Collegiate Institutes, 1921, pp. 7-16; Ontario, Department of Education, Courses of Study, Circular ix, 1937, pp. 3-33; Ontario, Department of Education, Curriculum 1 : (e), 1961, Intermediate Division, Science Grades 7, 8, 9 and 10, pp. 43-60; Ontario, Ministry of Education, Curriculum Guideline for the Intermediate Division Science Grades 7, 8, 9, 10 Curriculum (1972); ibid., (1978).

Appendix B

Comparison of Upper School (Grade 13) Biology Curricula in Ontario High Schools by Topics (1871-1978)

Topic	Period 1871-1920 Practical exam (1887-1899)	1921-1940	1941-1964	1965-1978
Cell	X	X	X	X*
Alga	X	X	X	
Fungi	X	X(4)	X(2)	
Bacteria		X	X	
Lichen	X	X	X	
Liverwort	X	X	X	
Moss	X	X	X	
Fern	X	X	X	
Horsetail	X	X	X	
Lycopod	X	X	X	
Gymnosperm		X	X	
Parts of Flowering Plant	X	X	X	X
Families of Flowering Plants	(15) X	X(11)	X(8)	X
Flower Structure	X	X	X	
Pollination & Fertilization	X	X	X	X
Fruit & Seed	X	X	X	X
Leaf	X	X	X	X
Stem	X	X	X	X
Root	X	X	X	X
Vegetative Reproduction		X	X	X
Plant Physiology		X	X	X
Protozoan	X	X	X	X
Hydra			X	
Earthworm	X	X	X	
Mollusc	X	X	X	
Crustacean	X	X	X	
Insect	X	X	X	
Arachnid	X	X	X	
Myriopod	X	X	X	
Fish	X	X	X	
Frog	X	X	X	
Reptile	X	X	X	
Bird	X	X	X	
Mammal	X	X	X	
Human Physiology	X	X	X	X
Characteristics of Life			X	X*
Homeostasis				X*
Ecology				X*
Genetics		X	X	X*
Evolution			X	X*

Sources: Ontario, Report of the Minister of Education, 1896, pp. 98-103; Ibid., 1904, pp. 159-160; Ontario Department of Education, Courses of Study and Examinations of the Continuation Schools, High Schools and Collegiate Institutes, 1921, pp. 84-87; Ibid., Grade 13 Biology, Circular, H.S. 23, 1953, pp. 3-15; Ibid., Curriculum, S17b, 1965, p.11.

Notes: X : prescribed topic
 * : detailed treatment
 () : number of organisms studied for the topic

Appendix C

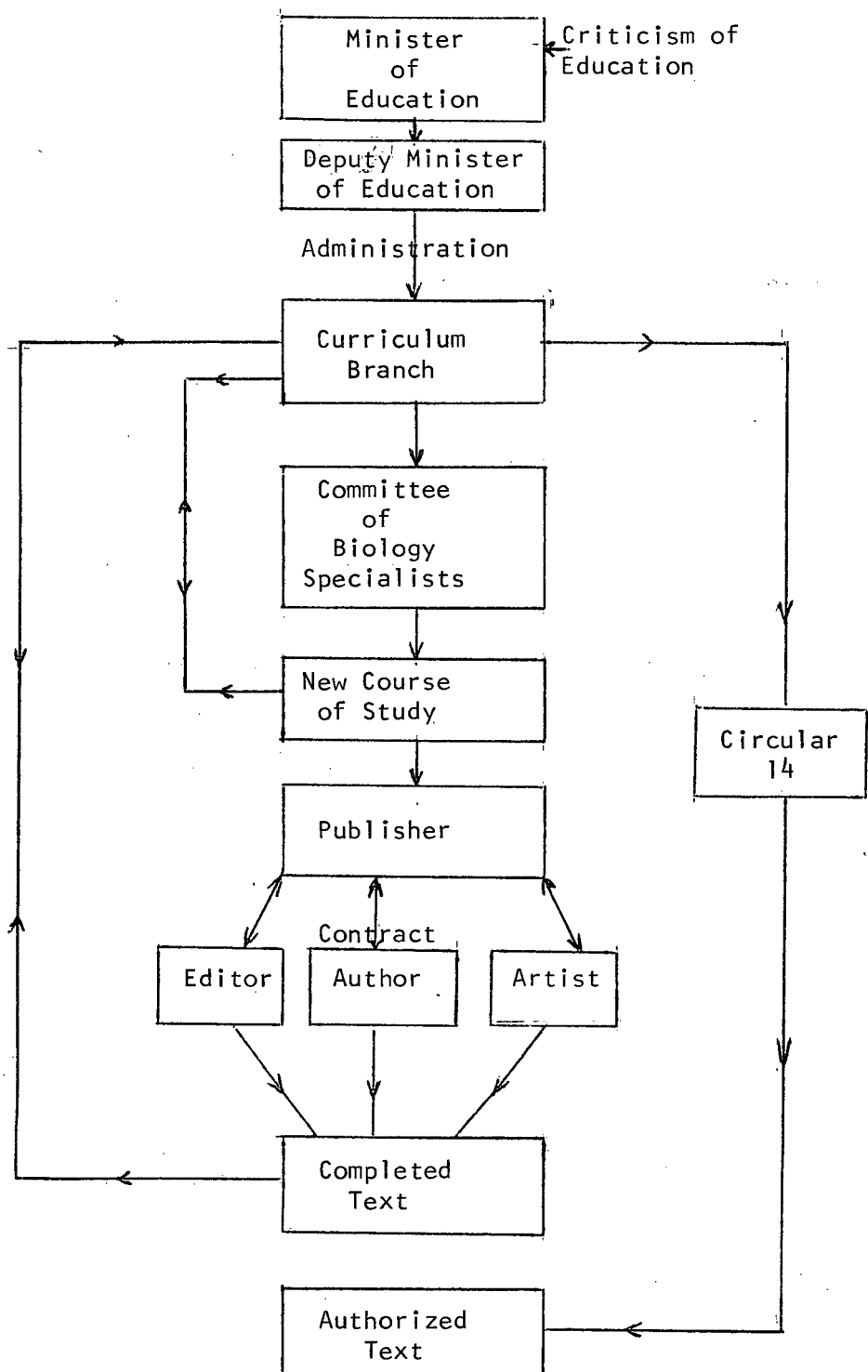
Analysis of Authorized and Recommended Texts In Biology and Agriculture (1871-1909)

Period	Author	Title	Publisher and Location	Dates of Authori- zation	Personal Comments
1871-1909	E. Ryerson, ad- ministrator	<u>Agriculture Pt. I and II</u> (1870)	Copp Clark (Toronto)	1870-1877	no illustrations, not scientific, clear inaccurate, biased, readability Gr. 8-9.
1871-1909	C.C. James, ad- ministrator	<u>Agriculture</u> (1889)	G.C. Morang (Toronto)	1898-1909	clear, several experiments, numerous activities, uses pupil background readability Gr. 10-12.
1871-1909	A. Gray, professor	<u>How Plants Grow</u> (1863)	Iveson, Phinney (New York)	1867-1886	good illustrations, clear, directs observations, strong teleological em- phasis, needs readability Gr. 7.
1871-1909	David Oliver, research biologist	<u>Lessons in Ele- mentary Botany</u> (1878)	Macmillan (London)	1877-1886	good illustrations, clear, directs observations, stresses classification, readability N.A.
1871-1909	J. Macoun, research biologist, and H.B. Spotton, teacher and re- searcher H.B. Spotton, teacher and research worker	<u>The Elements of Structural Botany with Special Refer- ence to Canadian Plants</u> (1879) High School Botany (1886) High School Botany (1895) Pt. I and II	W.J. Gage (Toronto)	1882-1887 1886-1894 1895-1909	good illustrations, clear, physiology weak, stresses classification, tables to be filled in with pupil observations, readability Gr. 8-9.
1871-1909	M. Foster, professor	<u>Physiology</u> (Primer) (1875)	Macmillan (Toronto)	1875-1878	illustrations good, clarity excellent, recalls pupil's experience, directs observations to butchershop specimens, readability Gr. 10-12.
1871-1909	A. Nichol- son, professor	<u>Outline of Natural History</u> (1875)	William Black- wood and Son (London)	1875-1877	illustrations and clarity fair, uninteresting and technical, readability N.A.
1871-1909	Calvin Cutter, medical doctor	<u>First Book of Anatomy Physio- logy and Hygiene</u> (1871)	A. Dredge (Toronto)	1871-1875	illustrations and clarity fair, recalls pupils experience, catechism method of instruction, readability Gr. 12.
1871-1909	Thomas Huxley, professor	<u>Lessons in Ele- mentary Phy- siology</u> (1875)	Macmillan (London)	1875-1876	illustrations good, logical explanations, directs observations, recalls pupil experience, readability Gr. 9.
1871-1909	Ellis A. Davidson, professor	<u>Our Bodies</u> (1871)	Cassells, Potter and Galpin, (London)	1871-1877	illustrations good, clarity fair, directs pupil observations and recalls their experiences, readability Gr. 9.
1871-1909	Ramsay Wright, professor	<u>High School Zoology</u> (1889)	Copp Clark (Toronto)	1889-1896	illustrations good, exposition technical, directs observations, stresses classifi- cation, uninteresting, readability Gr. 13-16.
1871-1909	Buell P. Colton, normal school master	<u>Zoology, Descriptive Practical</u> (1896)	Copp Clark (Toronto) Copp Clark	1896-1909	excellent illustrations, clear directions for showing principles of classification, interesting, readability Gr. 10-12.

Appendix D

Development of an Authorized and Recommended Textbook in Ontario

Flow Diagram



Appendix E

Occupations of the Authors of Ontario's Biology Textbooks,
Authorized and Recommended (1871-1978).

Occupation Period	Percentage of University Professors or Research Biologists	Percentage of Secondary Teachers or Normal School Masters	Percentage of Others e.g. Civil Servants School Admin- istrator
1871-1903	75	9	16
1904-1920	No text-books	authorized	-
1921-1960	30	64	6
1961-1978*	50	50	-

*These data reflect the very large number of authors who produced BSCS.

Appendix F

Units in A Typical Science Program for One Course
Grade 9 and 10, 1978 Guideline

Obligatory Units	Optional Units
4 +	4
chosen from	chosen from
S1 Cells and their Processes S2 Chemical Change S3 Functioning Animals S4 Green Plants S5 Heat S6 Measurement S7 Populations and Communities S8 Structure of Matter	S9 Consumer Chemistry S10 Continuity S11 Electricity and Magnetism S12 Environmental Chemistry S13 Fungi and Simple Plants S14 Geometric Optics S15 Human Interaction with the Biosphere S16 Machines S17 Mechanics S18 Separation of Substances S19 Solutions S20 Terrestrial and Aquatic Environments S21 Vibrations and Waves S22 Viruses, Monerans and Protists S23 Wise Use of Energy S24- Locally Designed Units S27 Locally Designed Units.

Sources: Ontario, Ministry of Education, Curriculum Guidelines for the Intermediate Division Science (1978), pp. 12-20.

Each course consists of eight units with varying numbers of obligatory and optional units. Various combinations of units may be used to provide a course as shown below.

Appendix F (continued)

Choices in a Science Program for
Grade 9 and 10 (1978 Guideline)

Science area	Obligatory or Optional units	Course 1 8 units	Course 2 8 units	Course 3 8 units
Biology or	Obligatory units	S1,S3,S4,S7 (4)	S2,S5,S6,S8 (4)	(0)
	Optional units	S10,S13,S15, S20,S22 Locally de- signed units (4)	any biology options (4)	any biology or physical science options (8)
Physical Science or	Obligatory units	S2,S5,S6,S8 (4)	S1,S3,S4,S7 (4)	- (0)
	Optional units	S9,S11,S12,S14 S,14,S17,S18, S19,S21,S23 Locally de- signed units (4)	any physical science options (4)	any physical science or biology options (8)
Inte- grated Science	Obligatory units	S1,S2,S3,S4,S5, S6,S7,S8 (8)	(0)	- (0)
	Optional units	(0)	any biology or physical science (8)	any biology or physical science options (8)

Source: Ontario, Ministry of Education, Curriculum Guidelines for the Intermediate Division Science (1978), pp.12-20.

Notes: () Number of units of each type.

Appendix F (continued)

Each obligatory unit contains both obligatory and optional topics.

The Content of a Typical Obligatory Unit
(Cells and their Processes),
Grade 9 and 10, 1978 Guideline

Obligatory Topics	Optional Topics
S1.1 Cell discovery, microscopic	
S1.3 Cell structure	S1.2 Cell theory
S1.4 Cell physiology	
S1.5 Mitosis (reproduction)	S1.6 Cell differentiation
S1.7 Cell organization	
S1.8 Diffusion and osmosis	

Appendix G

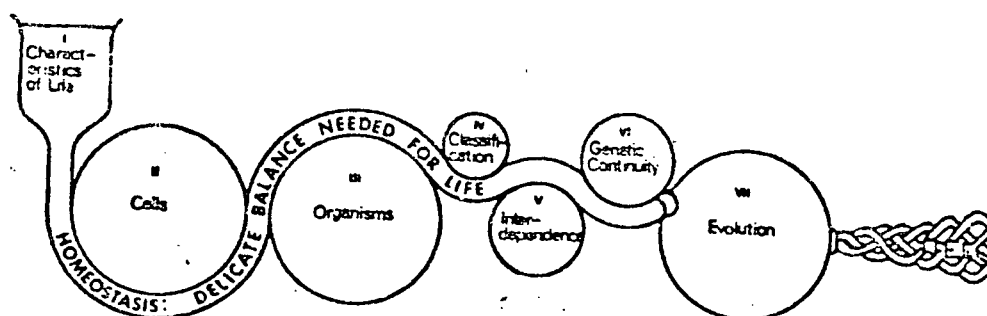
Alternative Approaches for Grade 13 Biology (1969)
Homeostatic, Ecological, Principles.

I A Homeostatic Approach

In this approach, "Homeostasis, the delicate balance required to maintain life in the face of the fluctuating environment, is the unifying theme. This theme progresses logically from the cell, through the organism, to the community, and through the continuity of the species from one generation to the next, to the evolutionary picture of life on this planet".

Figure

Diagrammatic Representation of a Homeostatic Approach



Source: Ontario, Department of Education, Grade 13 Biology (1969) p. 9.

II. An Ecological Approach

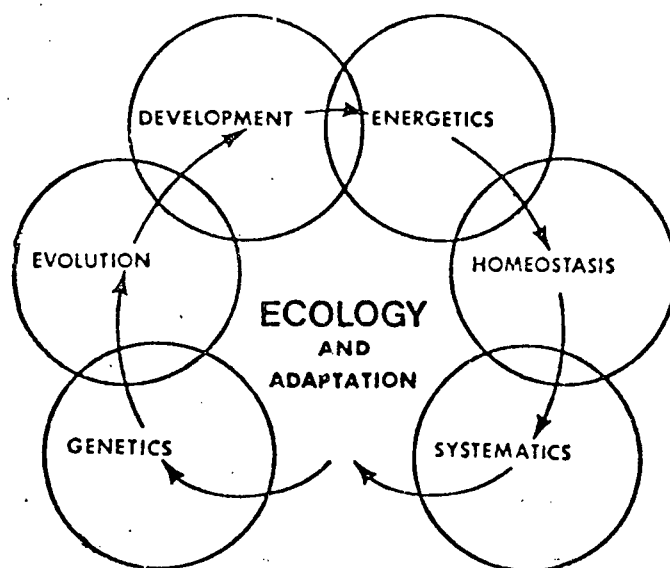
In this approach,

"Ecology and adaptation to the environment is the starting point, which leads into methods of adaptation involving genetics, including reference to mutations. Evolution can be thought of as a series of long-term adaptations, leading us to development from single cells to organisms, both on an evolutionary and embryonic scale."

The organs and systems can be studied next, followed or accompanied by a consideration of the energy relationship within the body at a molecular level. The study of homeostatic mechanisms on a molecular and community basis follows. The diverse ways in which homeostasis is brought about with respect to the environment and adaptation to a particular community has forced scientists to devise systems of classification."

Figure

Diagrammatic Representation of an Ecological Approach



Source: Ontario, Department of Education. Grade 13 Biology (1969), p.15.

III A Principles Approach

In a principles approach a teacher could organize the topics in seven biological principles:

- i Living things have characteristics which set them apart from non-living things.
- ii Hierarchies can be organized in the study of living things.
- iii Energy runs in a one-way course through the web of life.
- iv Reactions occurring in living organisms tend toward equilibrium.
- v Living things are dependent on each other and on their environment.
- vi Heredity and environment determine the nature of the individual.
- vii Animals and plants are in constant change."^{*}

^{*}Ontario, Department of Education, Grade 13 Biology (1969), p.16.

Appendix H

Ontario Secondary Non-Sectarian School Enrolment and Enrolment in Biology and Agriculture in these Schools of 15-19 Year-Olds (1871-1976)

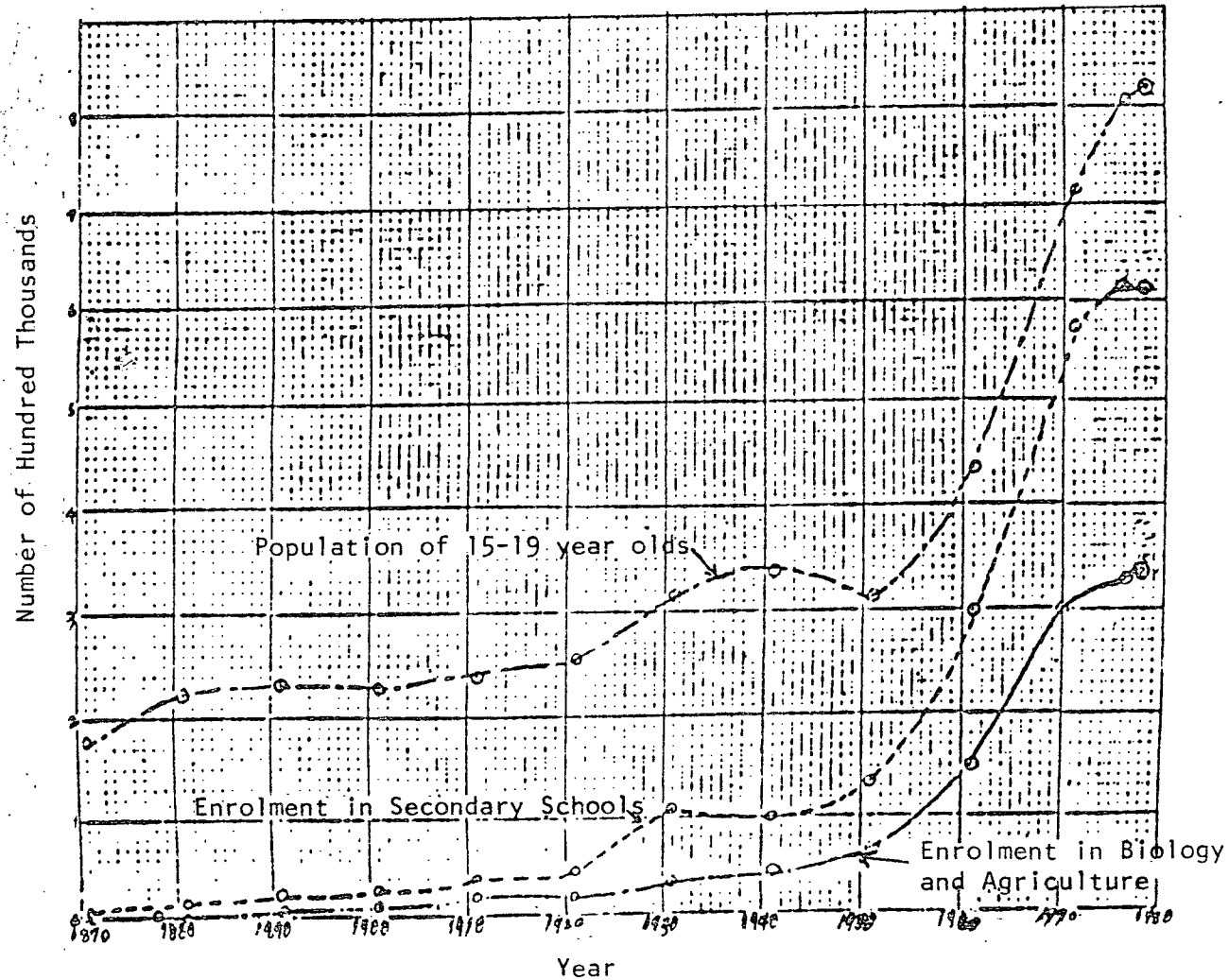
Year	1 Population of 15-19 year-olds	2 Enrolment in non-sectarian secondary schools	3 Proportion of 15-19 year-olds in non-sectarian secondary schools ($\frac{2}{1}$)	4 Enrolment in biology and agriculture in non-sectarian secondary schools	5 Proportion of pupils enrolled in biology and agriculture ($\frac{4}{2}$)
1871	179,117	7,490	.042	2,658	.355
1881	222,109	13,136	.059	226	.017
1891	232,073	22,230	.096	6,202	.279
1901	229,129	27,456	.120	10,441	.380
1911	239,851	37,780	.158	19,866	.523
1921	254,431	46,910	.184	20,916	.446
1931	318,803	109,635	.344	35,478	.324
1941	339,116	102,462	.295	44,266	.442
1951	315,700	135,487	.429	66,792	.493
1961	436,900	299,177	.685	169,472	.566
1971	713,400	574,520	.805	309,182	.538
1976	806,000	613,055	.761	322,274	.526
1978	824,360	611,668	.742	343,139	.561

Source: Ontario, Statistics (1976), pp.6-7, 24, 40-41; M.C. Urquhart and K.A.H. Buckley, eds. *Historical Statistics of Canada* pp.591-3; Canada, Census 1871, p.36; *ibid.*, 1921, p.10; *ibid.*, 1931, pp.153, 394; Ontario, Report of the Minister of Education 1881, pp. 195-6, 205; *ibid.*, 1883, p.62; *ibid.*, 1892, pp. xxi, xxii; *ibid.*, 1902, pp. 36, 46; *ibid.*, 1912, pp. xxi, 75, 107; *ibid.*, 1922, pp.102, 199, 243; *ibid.*, 1932, pp.101-103, 256, 284; *ibid.*, 1942, pp. 166, 182-3; *ibid.*, 1952, pp. 52, 59, 110, 112; *ibid.*, 1961, pp. 569, S100; *ibid.*, 1970, pp. 58, 65, 67; *ibid.*, 1976-77, pp. 24, 45, 47, 88. J.G. Hodgins, ed. *Documentary History of Education in Upper Canada*. Vol. 23, 1871, p. 189; Ontario, Ministry of Education, *Guideline Courses 1978*, Statistics Section, Management Information Systems Branch, June 1979, pp. iii, 5, 6; Canada, Statistics Canada, *1976 Census of Canada; Supplementary Bulletin : Geographic and Demographic*, Table 1-2.

Notes: There is a small number of Grade 9 and 10 pupils in Roman Catholic separate schools. Unfortunately the data for biology students for these schools was omitted in the Ministry reports until 1978.

Appendix H (continued)

Ontario Secondary Non-Sectarian School Enrolment and Enrolment in Biology and Agriculture in these Schools of 15-19 Year-Olds (1871-1976)



Appendix I

Ontario Boards of Education

The local administrative bodies for secondary schools were mainly the boards of education.* They obtained their funds from the municipal councils through property taxes and from the provincial government in the form of grants. The accompanying map of Ontario shows the location and the percentage of secondary pupils served in 1968 by several boards. At that time there were seventy-six boards of education in the province, one for each county in Southern Ontario (thirty-eight in number), one board for each of four large cities, one for each of the six boroughs in Metropolitan Toronto, and twenty-eight for the districts of Northern Ontario. While the percentage of the provincial secondary enrolment is shown for each board in Southern Ontario the percentage enrolment for each district of Northern Ontario is indicated as data for the individual boards were not available. The percentage of the total secondary pupils served varied from 7.8% for Toronto to 0.1% for Manitoulin.

Source: Ontario, Report of the Minister of Education, (1966), p.8; ibid., (1968), Table 3.23, p.10; Statistics Canada, 1976 Census of Canada, Vol. 1, Population, Geographic Distribution, Municipalities, Census Metropolitan Areas and Census Agglomeration, Table 5, (1971).

* Most boards of education administered elementary education also.

Appendix I (continued)

Map of Ontario Showing Educational Subdivisions with their
Secondary School Enrolment Expressed as a Percentage of the Total
(1968)

