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ABSTRACT

This report is an account of the development of a minicourse program for the purpose of college-level introductory biology instruction. The complete implementation effort is described from an examination of the program which the minicourses replace, to the proposals concerning implementation of the new curriculum. Sections of the report are devoted to exploration of other modular programs and to the creation of each particular biology module. This work, along with reference materials cited, should provide a helpful guide for the creation and implementation of an introductory biology program with a minicourse format. (CP)

Report on a Project to Develop a Minicourse Program in Introductory Biology

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REPORT ON A PROJECT TO DEVELOP A MINICOURSE PROGRAM IN INTRODUCTORY BIOLOGY

SEPTEMBER 9 - DECEMBER 21
1974

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PREFACE

This project was initiated by Mr. Stanley M. Dahlman, Executive Associate for Multi-Campus Planning Coordination. The purpose of the project was to prepare a modular instructional program in biology for the campus at Germantown. A complete statement of the charge is set forth in I, Statement of Project. Soon after work on the project began, it was felt necessary to extend the plan to include areas not considered in the original proposal. Indeed, it was imperative to find out what others were doing in the modularization of first-year college biology and with what success. This necessitated a review of the literature, a review of commercially produced materials, as well as consultations and conferences. After a trip to Purdue University, the field was narrowed to the current status of minicourses in biology. These added areas are outlined in III, Exploration of New Methods.

Most of the ideas in this Report are assimilated, transformed or borrowed from teachers who have used the new minicourse method and who have shared their data and thoughts with others through publications. In the rapidly developing field of modular education, any complete coverage of the pertinent literature is quite impossible. The items included in VII, References, represent only a sampling of current articles reporting on this method.

In the following pages, enthusiastic endorsement of minicourse programs should not be interpreted as complete dissatisfaction with the conventional practices of the Biology Department of Montgomery College, either past or present. The College can be proud of the Department's successes: (1) the high caliber of the faculty it has attracted, inspiring teachers as well as good biologists; (2) the thousands of students who have successfully completed our courses, many of whom are pursuing careers in biologically related sciences.

I am indebted to many people for indispensable cooperation in the preparation of this Report: To Dr. Dyckman Vermilye, Executive Director, American Association for Higher Education, for pointing me in the right direction; to the folks in the office of ERIC, Clearing House on Higher Education, for making a literature search of the resources of the ERIC tapes which yielded 48 Citations on the Retrieval File Set; and to the Librarian in the American Council on Education Library for interpreting the off-line Bibliographic List and for locating journal articles.

I owe thanks to Mrs. Lillian Zugby of the Takoma Park Campus Library for searching through the Montgomery College catalogs since 1946 to locate the biology offerings and course descriptions, and to Mr. Bruce Hill, former student, now Instructor, Zoology A-I Program, Rockville Campus, for his contagious enthusiasm and willing aid. I am especially indebted to Dr. Postlethwait and his staff for being helpful, as well as hospitable and generous with materials, during the visit to Purdue University.

Also, I express appreciation to Professor Margaret Aldrich for practical advice and encouragement; to Dr. Robert Frieders for constructive criticism and suggestions; and to Dr. Clifford Rall for his continued support, as well as his kindness in producing the graphic art work for the Report. I am especially grateful to Mr. Stanley Dahlman for his faith in me and his interest and concern in the project. Finally, to Mrs. Peggy Bebee, who can take an illegible scrawl and turn it into perfect copy, I owe grateful thanks for her patience in expertly typing this Report.

EXPERIENCE OF THE AUTHOR

TEACHING EXPERIENCE:

Biological sciences, at the following institutions:

The Johns Hopkins University; Dental and Pharmacy Schools of the University of Maryland; Maryland State College at Towson; University of Baltimore; National Park College; Montgomery College since its founding in 1946.

At Montgomery College: Head Biology, 1946-1961; awarded Career Recognition by the Montgomery County Board of Education for distinguished teaching, 1960; Chairman, Biology Department, 1961-1970; involved in the A-T Learning Center (Zoology, Rockville), 1967-1973; retired 1973.

RESEARCH EXPERIENCE:

Project under the Office of Scientific Research and Development for three years during World War II; several publications in the fields of morphology and physiology of the Protozoa; investigations on the metabolism of vanadium in Ascidians.

EDUCATION:

Elementary and secondary education in the public schools of California and Maryland. B.A., Case Western Reserve University; M.A. and Ph.D., The Johns Hopkins University. Studied at George Washington University; spent several summers in course work and research at the Marine Biological Laboratory, Woods Hole, Massachusetts.

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American Association for the Advancement of Science; American Association of University Professors; Sigma Xi; Society of Protozoologists; American Microscopical Society; American Society of Zoologists.

CONTENTS OF REPORT

TABLES, FIGURES AND CHARTS

I. Statement of Project and Definitions

A. Statement of Project

This document contains tables, charts and supporting text of a proposed minicourse program in biology for a third campus of Montgomery College. A preliminary plan is offered using the audio-tutorial strategy, embracing three introductory courses and three second-level courses, and allowing for more flexibility than do either the present conventional or audio-tutorial approaches.

The original goal of the project was to develop a modular instructional program in biology. This undertaking was to involve the following:

1. The examination of the present course offerings in biology at Montgomery College, particularly at the introductory level. The purpose was to present ways by which these courses could be strengthened, i.e. their deficiencies remedied and their redundancies eliminated.

2. The preparation of an instructional program in biology designed to allow for individualized instruction (student-centered education) and for flexibility, both in allowing the student to proceed at his own rate, and in offering him a greater variety of options in planning his educational program.

3. The delineation of a program of minicourses for introductory biology indicating, among these, what the student options might be.

As work proceeded, it was necessary to enlarge this goal. First, after examining our own offerings, an exploration was undertaken to determine present modular instruction in beginning biology courses at other colleges and universities. This involved a review of the literature, as well as consultations, and included a trip to Purdue's Minicourse Project. Second, a survey was made of the current status of minicourses in college biology through correspondence. Third, recommendations concerning the proposed minicourse program, such as curriculum considerations, staffing, facilities, timetable, etc., were added to the report. This addition was to assure that the new program, when adopted, would stand as a successful academic effort, maintaining the Biology Department's reputation for quality and high standards.

B. Definitions

In education, as in other disciplines, the invention of too many terms with nearly similar meanings can be confusing. At a time when college biology programs are in transition, one finds similar approaches to modular instruction being developed under the titles of audio-tutorial units or packages, audio-video tutorials, conceptopaks, microcourses, instruct-o-pacs, unipacs, quests, miniunits, learning activity packages, modules and minicourses. For the purposes of this report, it is necessary to distinguish between three of these: audio-tutorial units; modules; and minicourses.

Audio-Tutorial Units

A unit of information treated in the audio-tutorial system usually involves two weeks' work. Each unit is structured around a self-instructional learning booth or carrel and incorporates a few specific objectives, a programmed audio tape, printed study guides, visual aids, a microscope, and actual biological materials. In audio-tutorial instruction, the conventional division of the course into lectures and laboratories is done away with and open scheduling is introduced. The "Center" is open all day, every day, and available for the student to work at times best suited to his personal schedule, and in an atmosphere conducive to study and greater concentration. Qualified demonstrators and tutors are present in the Center at all times. In addition to the independent study sessions, each unit of work includes an hour's tutorial session where the students meet the tutors informally in groups of eight or ten. This may be an oral quiz session for which marks are given, or a seminar. Also, for each unit there are pre-tests, self-tests, and post-tests with maximum feedback on correct answers and grades. The audio-tutorial approach may include periodic large-assembly sessions. Although AT originated in biology at Purdue University, this method is now beginning to branch into other disciplines.

Modules

In The Yellow Pages: A Guide to Undergraduate Innovations, modular instruction is defined as "made up of self-contained and independent instructional units or 'modules.'" Each module includes a statement of purpose, specification of the behavioral instructional objectives, individualized instructional materials, and a post-test to evaluate the student's achievement of the instructional objectives of the module. A module is self-contained, and modules can be arranged in a variety of sequences to suit individual needs or preferences of the student. (Reference #26)

At some colleges, a module contains a diagnostic pre-test, which the student is encouraged to try. If he does well on the pre-test (he compares his answers with the correct answers) he is asked to again read over the instructional objectives. If he is confident that he can perform most of the behaviors listed, he may skip directly to the post-test. If he passes this, he receives credit for the module and may select another immediately.

Modules may vary in length, but usually represent a week or more of work, with several topics included in each.

The format of the modules may be much the same in many disciplines. However, modules in biology will differ from social science modules, for example, in three ways. First, biology modules have assembly sessions or conferences associated with them. Second, many modules in biology have other modules as pre-requisites. This means that there is a more rigid sequence that must be followed in modular biology programs. Third, because of the nature of the subject matter, most of the study toward mastery of behavioral objectives should be done in the Learning Center, not in a library or learning resource center. If a student is studying a plant or a bone or a starfish, or a serial section of an embryo, those items should be in front of him in the booth or on a demonstration table. In the small assembly session he will be asked to demonstrate his mastery of the objectives on this material.

Modular approaches in biology and mathematics differ, particularly in the emphasis on and definition of flexibility. As described by Brown, Schulz, Scott and Aldrich in "Report on a Project to Develop a Modular Instructional Program in Pre-Calculus Mathematics, 1974," flexibility implies that a variety of modes of delivery should be available for student choice. These could include instruction in large groups, in small groups, by media, or by computer. The student should be able to move from one mode to another almost at will. In this proposed modular program in mathematics for Montgomery College, variably called units, modules and minicourses, the student may choose one of three options as his method of study of a module: Option 1 - Lecture; Option 2 - Audio-tape; Option 3 - Programmed Text. No matter which option the student chooses, the other two are available for him for supplementary use. In "Pre-Calculus Mathematics, A Modular Program," at Brigham Young University, (as described by Brown, Schulz, Scott and Aldrich) "Each module is completely covered in a series of class periods." The student should attend the classes for any module which covers material new to him. In the biology modular approach, there are no scheduled classes, i.e., lectures or laboratories. There are weekly small group assemblies which all must attend. (Reference #1)

Minicourses

Many of the characteristics of both audio-tutorial units and modules are found in minicourses. Each are self-contained and independent units of instruction. In each, the primary focus is on a few well-defined objectives. The substance of each consists of materials and instructions needed to accomplish these objectives -- each stresses self-pacing.

A minicourse is a small course over a limited amount of subject matter for which a student receives a certain amount of credit. The content of a minicourse is an educational experience relating to one topic, usually a smaller parcel of knowledge than an AT unit or module. Commonly, a minicourse would represent less than one credit hour of conventional course work. (At Purdue, the average is 8 to 10 minicourses per credit hour.) The instructional strategy used in a minicourse should be appropriate to the nature of the subject matter. In biology, self-instructional programs such as audio-tutorial are most commonly used. A minicourse is usually designed for use by one student, but it may be used by two or more, or even a large group.

Minicourses can be used individually or combined in a variety of sequences to total the equivalent of a conventional course. The behavioral objectives are clearly stated. Achievement (mastery) is assessed with regard to attaining the stated objectives at the completion of each minicourse.

Minicourses, their components and guidelines for development, will be discussed in Section V.

II. A Case for Change

A. Biology Department's Offerings - Table 1 (Page 8)

Before undertaking the development of a new instructional program, it is imperative to take a long, hard look at the present course offerings. Table 1 summarizes the history of the 100-courses as offered by the Biology Department from the inauguration of Montgomery College in 1946 until the present year, 1974-75. Since the first catalog was printed before an instructor was employed, the sequence 101-102, General Zoology and Vertebrate Zoology, (including the dogfish shark and the cat!) was the choice of the new Dean, not the biology faculty.

The titles and content of the courses offered the second year, 1947-1948, indicated an attempt to incorporate the study of all life. With the inclusion of "plants" the first semester and "and man" the second semester, the change of the title to "General Biology" was necessary. Even the numbers of the courses were changed -- 103-104.

The changes in the introductory offerings the third year, 1948-1949, were dictated by the University of Maryland, the College's major transfer institution. Since the University had no course entitled "Biology," its departments of Botany and Zoology were distinct, the faculty felt that Montgomery College's courses also must be strictly "Botany" and "Zoology," although the sequence retained the title of "Biology 103-104." This pattern remained without change for seven years, until the mid 1950's.

Because of the prodding of the administration, the first major alteration of the offerings was undertaken by the Biology faculty. By the middle of the decade, General Education and General Education with Science Sequence were added to the curriculums of the College. The influence of James Bryant Conant was being felt over the country. That brilliant organic chemist at Harvard, who was particularly successful in writing about science for the non-scientifically trained person, started a rash of survey courses nationwide. Educating the "whole person" was thought by many to be accomplished by offering introductory survey courses, with which non-biology majors and "I-hate-science people" could complete their science requirements and thus become "well-rounded." (Reference #2.)

But the courses Biology 101-102 which were added at Montgomery were not truly "survey" in nature. The teachers in the department, with their strong orientation toward taxonomy and morphology resisted pressure to introduce non-laboratory courses and continued to present blocks of material on botany and zoology, much as they were taught in Botany 103 and Zoology 104 -- at least at first. The Biology 101-102 sequence continues until the present; its content having undergone many revisions, especially in the direction of more relevancy, by adding sections on human biology and man's environment.

In the next five years, 1955-1956 through 1959-1960, the department's course offerings remained the same: a two-semester sequence of courses in General Biology, one semester of Botany, and one semester of Zoology.

During the period following World War II, there gradually accumulated a large amount of biological information, particularly at the molecular and cellular levels of organization. When bits and pieces of this information explosion began to be incorporated in the introductory courses, one of two things happened. Either the "new biology" emphasis was at the expense of morphology and systematics in existing courses, or new courses were added to the curriculums. Montgomery's Biology Department added courses.

In 1961-1962, both Botany and Zoology were expanded to two-course sequences and the course numbers changed to 111-112; 121-122. These courses also continue to be offered and are so listed in the 1974-1975 catalog.

The next six years saw no modification in the pattern of the offerings, but the content of each course often was drastically changed. Gradually, new blocks of study were added to the first courses of each of the three 100-sequences. At one time or another these included: Chemical Basis of Life, Cellular Basis of Life, Energy Transformations, Ultrastructure, Radiation Biology, Chemical Control, DNA-Protein Synthesis, Population Biology, etc. Recently, new laboratory "exercises" have been authored and a programmed instructional unit in the chemical basis of biology has been developed.

By 1967, again at the suggestion of the administration, audio-tutorial programs for biology were being investigated, and on February 2, 1968, a government grant was applied for (and subsequently approved) to implement pilot programs in AT zoology on the Rockville Campus. Two pilot programs with twelve students each and two summer AT zoology programs were eventually completed. With the opening of the new wing, Science West, and the full-scale implementation of the AT Learning Center in September 1971, the Rockville Introductory Zoology, Bi 121, "went" audio-tutorial.

In the meantime, 1969-1970, Bi 105, a one-semester course in basic Human Biology, was introduced at the request of Allied Health Certificate and Associate in Arts programs on the Takoma Park Campus.

In 1972-1973, Bi 131-132, a 100-level, two-course sequence entitled "Human Structure and Function," was added for the basic nursing curriculum. Human Biology, Bi 105, became Basic Human Science, Bi 103.

The foregoing review of the growth of the Biology Department's Introductory Curriculums leads to the following conclusions:

1. Innovations in the context of courses were either induced by the University of Maryland, instigated by the administration, or forced on the department by other departments; none were self-generated.

2. The 100-courses of a department could remain relatively unchanged, at least in context, for twenty-five years. "The wonder is that this curricular pattern has endured so long." Marchese (Reference #13) was speaking of the lower-level division study sequence in four-year colleges and universities. Montgomery College was not unique in this respect.

3. Even in a tradition-bound department, where change was painful, the instructors "kept up" with changing times by showing creativity and ingenuity in updating and adding to the contents of the courses.

Upon re-examining Table 1, one might ask why Biology 101 was never made the "core" course, required of all students entering a biology program of studies. Most biologists agree that a minimum amount of knowledge at each level, molecular, cellular, etc., is necessary in order that a student be well educated in biology. The subject was discussed at many a departmental faculty meeting. (Reference #24.)

There are several reasons why this particular curriculum reform was not adopted at Montgomery:

1. It would have taken away all freedom of choice from the entering student, who now has four options in putting together an eight-hour sequence.

2. If four credits of a science is all that a student needs to fulfill the requirement of his curriculum, Biology 101 would be the only college biology course to which he would be exposed. "Core" suggests a nucleus with many other aspects --all the remainder of biology -- to be built around it.

3. Biology 101 would have become a screening device to weed out the poorer students. Certainly, it would be one of the most difficult courses in the curriculum, with much chemistry, as in the sections on Chemical Basis of Life and Cellular Respiration.

4. The faculty wished to avoid the shortcomings of mass production techniques. Upon adoption, the department would have been thrown into the large university situation with one beginning course of a thousand or more students and many, many laboratory sections, assistants handling the laboratories, and the professor either giving the same lecture over many times or using TV monitors along the wall of a huge lecture hall. To synchronize lectures and laboratories is almost impossible in this situation.

5. Throughout the years, the student-faculty ratio has been kept low. One instructor could handle, at the most, four laboratory sections of 24 students each and one lecture section of 96. The same instructor taught both lecture and laboratory, thus maintaining a close faculty-student relationship, the hall-mark of a junior college. Moreover, each instructor had considerable latitude in planning his own course.

MONTGOMERY COLLEGE
Biology Department

Introductory Course Offerings as Listed in College Catalogs, 1946 - 1975

Year	First Semester	Second Semester
	-- Courses in the 100 Series	
1946-1947	Zoology 101 - General Zoology Three lectures and two two-hour laboratory periods each week (5)	Zoology 102 - Vertebrate Zoology Three lectures and two two-hour laboratory periods each week (5)
1947-1948	General Biology 103 - Survey of Plants & Animals (Illustrated by selected forms) Two hours of lecture and four hours of laboratory per week. (4) (Hereafter all courses except 105 and 131-132 are four-credit hour courses.)	General Biology 104 - Study of Principles Higher Vertebrates and Man Two hours of lecture and four hours of laboratory per week. (4)
1948-1949 thru 1954-1955	Biology Sequence 103-104 Biology 103 Botany (4)	Biology 104 Zoology (4)
1955-1956 thru 1960-1961	Biology 101 - 102 Survey Courses Biology 101 Human Anatomy & Physiology/Health & Hygiene (4) Biology 103 - Botany (4)	Biology 102 Survey Plant & Animal Kingdoms/Man's Environment (4) Biology 104 - Zoology (4)
1961-1962 thru 1968-1969	Bi Biology 101 - General Principles of Biology I (4) Botany 111 - Fundamental Principles & Flowering Plants I (4) Zoology 121 - Systems of Vertebrate Body Genetics (4) (Applied for government grant for development of AT Zoology, February 2, 1968)	Bi Biology 102 - Plant & Animal Biology II (4) Botany 112 - Survey of Plant Kingdoms II (4) Zoology 122 - Major Groups of Animals II Evolution/Distribution (4)
1969-1970 thru 1970-1971	Bi Biology 101/Botany 111/Zoology 121 (4) Biology 105 (Takoma Park Only) - Human Biology (3)	Bi Biology 102/Botany 112/Zoology 122 (4) (Invertebrate Zoology) Pilot Program in AT Zoology - Rockville - 12 Students
1971-1972	Same as above except AT Zoology full-scale program in Learning Center at Rockville, September 1971.	Same as above
1972-1973 thru 1974-1975	Bi Biology 101/Botany 111/Zoology 121 (4) (Rockville AT Zoology in Learning Center) Biology 103 (Takoma Park Only) - Basic Human Science (one semester only) (3) Biology 131 (3) Human Structure & Function	Bi Biology 102/Botany 112/Zoology 122 (4) Biology 132 (3)

Note: Numbers in parentheses indicate credit hours

TABLE 1 - Evolution of the Present 100-Courses Offered on Both Takoma Park and Rockville Campuses

(BI) BIOLOGICAL SCIENCES

BI 101 GENERAL BIOLOGY

Introduction to the basic principles governing living organisms with emphasis on the molecular and cellular basis of life. Not open to those students with credit in BI 111 or BI 121. *Two hours of lecture and four hours of laboratory each week.* *4 semester hours*

BI 102 GENERAL BIOLOGY

Survey of the plant and animal kingdoms. Topics in evolution, adaptation and ecology. Not open to those students with credit in BI 121 without consent of instructor. PREREQUISITE: *Four hours of biological science. Two hours of lecture and four hours of laboratory each week.* *4 semester hours*

BI 103 BASIC HUMAN SCIENCE (Takoma Park only)

The relationships between the structure and function of the body systems. Basic concepts of microbiology as they apply to medical and dental procedures. The scientific background essential for performing and understanding technical procedures. PREREQUISITE: *Admission to a health-related certificate program requiring this course or consent of the instructor. Four hours each week combining lecture, laboratory, demonstration, and discussion.* *3 semester hours*

BI 111 BOTANY I

Emphasis on the fundamental biological principles, with special attention to morphology and physiology of the flowering plant. A synopsis of various plant groups included. Field trips. Not open to those students with credit in BI 101 without consent of the instructor. *Two hours of lecture and four hours of laboratory each week.* *4 semester hours*

BI 112 BOTANY II

Brief evolutionary study of algae, fungi, liverworts, mosses, ferns and their allies, and the seed plants. Emphasis on the morphology, reproduction, ecology and economic importance of selected plants. Field trips. PREREQUISITE: *Four hours of biological science. Two hours of lecture and four hours of laboratory each week.* *4 semester hours*

BI 121 ZOOLOGY I

The systems of the vertebrate body and their functions. Introduction to embryology and genetics: acquainting students with the techniques of handling biological materials. Dissection of a representative vertebrate. Not open to those students with credit in BI 101 without consent of instructor. *Two hours of lecture and four hours of laboratory each week at Takoma Park. Audio-tutorial (there are no scheduled classes; quiz sections to be arranged) at Rockville.* *4 semester hours*

BI 122 ZOOLOGY II

Evolution, distribution, and morphology of major groups of invertebrate animals. Opportunity to observe behavior and to experiment with living invertebrates. PREREQUISITE: *Four hours of biological science. Two hours of lecture and four hours of laboratory each week.* *4 semester hours*

BI 131-132 HUMAN STRUCTURE AND FUNCTION I AND II (Takoma Park only)

A two-semester introductory course in anatomy and physiology of each of the body systems. Includes basic concepts of cytology, histology, embryology, and genetics. PREREQUISITES: *None. Designed for, but not limited to, students in two-year health-related curriculums. Other students must obtain consent of the instructor to enroll. Two hours of lecture and three hours of laboratory each week.* *3-3 semester hours*

B. Areas Where Change is Indicated

The following deficiencies and redundancies are cited as possible characteristics of conventional methods used in introductory biology courses.

1. Allowances made for individual differences are inadequate. Conventional methods do not take into consideration the uniqueness of all individuals. Certainly, the lock-step and assembly-line techniques used fail to acknowledge such differences. There is no opportunity for each student to proceed at the rate best suited for his abilities since he has no control over this. All begin and finish together. Repetition of material for the weak student and in-depth study or rapid progress for the talented is impossible.

2. No options are built into the programs. There are few choices which the student can make; no opportunities to make decisions concerning what he will study and when. There is a lack of opportunity for the undecided student to sample the possibilities of biology. With enlarged enrollments and the increased heterogenity of the campus population, there is an ever-widening range of abilities, backgrounds, study practices and goals among students. The need for options is greater than ever.

3. Often there is too infrequent evaluation of the student's progress. Deficiencies are not determined nor remedial work prescribed soon enough in the semester. The weak student can hide -- it may be midterms or finals before the instructor becomes aware of his problems. There may be too long a time between taking an exam and receiving the results.

4. In the conventional programs: students may not enter a course after the first week or two of the semester; students are penalized for having tried and failed or done poorly; students are penalized if they drop out for whatever reason.*

5. Under the present credit-hour-per-course system, it is impossible for a student to earn more credits or less credits than four hours in most of the introductory courses in biology. This is true, even though his curriculum, or the curriculum into which he wishes to transfer, calls for more, or less, credit. Credit by examination is not available.

(*) Even though the following leniencies in the grading system prevail at Montgomery College, often the "penalty" is the outcome of many weeks of wasted time, and the student receives no credit for the segments of the course which he may pass. True: The grades of "W" and "WP" (Withdrawn and Withdrawn, Passing) are not counted in computing the value of quality points earned. True: Up to the end of the fifth week, "W" is not even put on the Transcript. True: The student can withdraw from a course up to the eleventh week. But he cannot enter another course to take the place of the one he drops until the next semester.

6. Frequently, two or more courses at the same level in a department will include virtually the same material. Often one finds subjects common to two or more, even in sequential courses. It is redundant to involve students with the same subject matter a second time.

7. Often the subject matter of a course cannot be changed drastically without changing the entire syllabus. Updating subject matter which is constantly changing may necessitate revisions of text or study guide and major changes of all study material.

8. In the conventional structuring, the faculty are busy presenting adequately the instructional material for a course. There is little time left for motivation, imparting the excitement of research and the thrill of discovery -- the very essence of biology.

9. To familiarize the student with the processes by which biological information is generated is one of the goals of the discipline. In the conventional facilities, it is difficult for the student to undertake on-going research projects.

10. Under the conventional method, the student's role is sometimes a passive one. He may become too dependent on the teacher who usually specifies exactly how he should proceed. This often makes a timid student and fosters dependence on authority. In this atmosphere, the student does not develop a sense of responsibility for his own learning.

11. Conventional methods are group-oriented. Usually the main focus is on teacher performance, especially in lectures. The teacher is the disseminator of knowledge which is primarily directed to the group as a whole, not to the individual student.

12. Although we know the value of seminars and group discussions as an educational method, there is little place or time available for these in the present system. Free exchange of ideas among students in small groups and between students and faculty in groups of no more than eight or ten is not possible.* Every student in biology should have these experiences.

(*) In laboratory sessions, where discussions may take place, the number of students is usually twenty-four or more and the time for discussions or student presentations is often limited.

13. In large classes of one or more lecture sections with many laboratory sections, it is almost impossible to synchronize the lecture material with the laboratory material. This situation does not make for the most effective teaching, because the learning events are not close enough to one another to be an integrated sequence.

14. In any learning situation, the environment around the learner plays an important part in success or failure. Certainly, the atmosphere should be one conducive to study and concentration. Large groups in both lectures and laboratories provide distractions to the student and thus, at times, tend to lower his concentration on the subject matter.

15. Increases in enrollment have resulted in full use of teaching areas, hence inflexibility of room scheduling and heavy teacher loads. As a result, there is a lack of both facilities and free faculty for either make-up work or advanced study.

16. Precise techniques, such as delicate dissections, identification of materials on microscopic examination, and many experimental procedures, cannot be shown effectively to a class as a whole or even to groups of students. If the materials involved are minute, the procedure must be repeated many times in the conventional laboratory.

Most of the above deficiencies and limitations of existing practices in the Biology Department were itemized under Deficiencies to be Remedied in Project Proposal for Federal Grant, 1968. (Reference #17) An audio-visual-tutorial program for improving the zoology course on the Rockville Campus was proposed. Since the inauguration of this program four years ago, many of these deficiencies have been remedied -- in one course on one campus, Zoology I, Bi 121.

However, with all of the advantages of the A-T technique and all the many successes of the program, it has developed its own set of peculiar deficiencies at Montgomery College. Because the modular instructional program - the minicourse - advocated in this report, uses the audio-tutorial instructional strategy, it seemed wise to enumerate these shortcomings.

With the adoption of the minicourse program, the College must not compound its educational problems. This is exactly what will happen if the planners do not avoid what Elwood B. Ehrle calls "The Audio-Tutorial Mistake." (Reference #6)

Limitations of an A-T Course, Such as Zoology (Bi 121), Rockville Campus

The limitations of the A-T program at Rockville are due primarily to two factors: (1) too many "holdovers" of conventional strategies are built into it; (2) many indispensable elements of an A-T program were not understood by the developers. Because of the first of these two factors, many of the weaknesses and deficiencies of the conventional courses, as enumerated above, apply to the A-T course as well. Students cannot: begin the course at any point; drop out and still be given credit for the units they have completed, i.e. one, two, three units of credit; rearrange the units in any way; go beyond the current units or go into depth in a particular field; or select optional units to substitute for the ones in the course. The units are too long and complete mastery of the subject matter is neither demanded or expected.

Indispensable elements of an A-T program, not well understood by the developers, are as follows:

1. Precise, clearly stated objectives for small blocks of information or few skills are absolutely essential. The subject matter should be limited.

2. Every part of a unit -- media, displays, materials, guides, etc. -- must be well programmed and should all be integral steps toward attainment of the objectives. The relation of one item to another is very important.

3. Test items are equally important, should be prepared immediately after the objectives, and should test only the attainment of the objectives.

4. Relation of one unit to the other units, as well as to the whole of life, should be evident.

5. There should be evidence of scholarship, i.e. high standards of quality, in all materials given to the students -- student guides, tapes, displays, review questions and test questions. Too many errors can be a "disaster" and result in poor quality work by the students and time not well spent in the Learning Center.

6. Tapes should not be "excessive pre-digests" of textbook information.

7. Sizable reading collection should be provided in the Center -- issues of journals, etc. Readings should be required for each unit and the students should write resumes during examination periods (at least for grades above "C").

8. Complete dependence on objective exams is not fair to students, nor is it good practice.

9. The importance of "selling" the course to the students, the department, and other departments, and to the "man in the street" should be stressed. Enthusiasm should be generated about a new and exciting venture.

10. The small assemblies, preferably 8-10 students, are not mini-lectures or free-for-all discussions or short-answer quizzes. They are sessions in which each student is expected to present a prepared little lecture about each of the items used in the unit, identifying the item, explaining its role in meeting the objectives, and pointing out how it fulfills this role. The student teaches and so really learns. After the presentation, each is quizzed by other students. All students are graded both on their presentations and on questions asked of those presenting the material. Grades are given at the end of the sessions. Competition should be keen. These sessions become seminars where students see the relationships and concepts which may not have been evident in the independent study sessions in the Learning Center.

Concerning the following statements, it should be pointed out that in many respects the A-T program has not lived up to the promises made for it in the Project Proposal for a Federal Grant (Reference #17).

11. The projected enrollments, 500 students, in A-T Zoology, per semester, by 1970-1971, have fallen far short, and enrollments seem to be decreasing rather than increasing as expected. There is a high attrition rate; a high number of "failures" (I's).

12. There is little evidence of any impact having been made on other courses in the department. The domino effect hoped for in the Federal Grant Proposal has not taken place. Few instructors have "fallen" for the A-T techniques.*

The following quotation is from the Proposal: "The Techniques developed will permit the audio-tutorial approach to be applied to the other science courses, so that the number benefiting could easily increase to 4,000 students." (Reference #17) Perhaps Dr. Hurst was right when he said ". . .only a professor dissatisfied with his current teaching is likely to be motivated to take on the A-T burden." (Reference #9)

Contribution of Current Practices to Goals of the College:

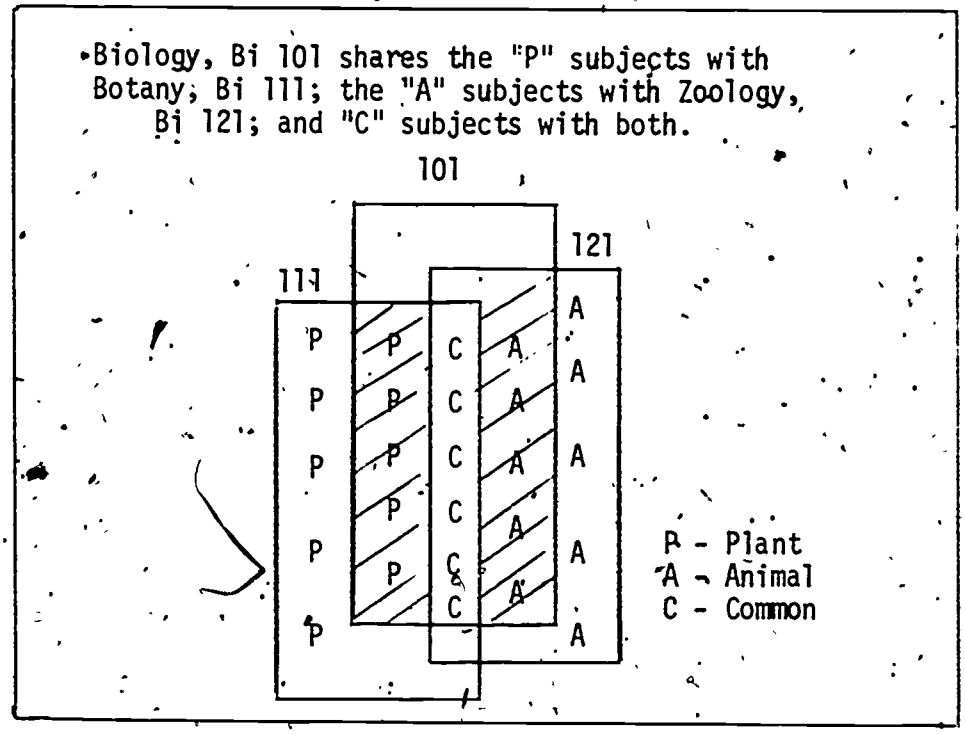
A department's curriculums and teaching strategies must contribute to the overall goals of its parent institution. The aims and objectives of Montgomery College are achieved only by the present practices of all the departments of the College. A critical examination of the Objectives and Philosophy of the College, and a re-reading of the above list of possible inadequacies where change is indicated in the conventional teaching methods, should disclose some areas in which improvements could be made (see pages 16 and 17).

Redundancies:

After having read the history of the Biology Department's Course offerings, Section II-A, and studying Table 1, it should not come as any great surprise that the syllabi for Biology I (Bi 101), Botany I (Bi 111), and Zoology I (Bi 121) contain many subjects common to all three and certain subjects common to two. There is a pervading sameness to the courses which is illustrated in Table 2 (page 18), where the various common areas are identified.

The subjects common to all three courses are the "core" subjects, such as: use of the microscope, cells, tissues, cellular respiration, DNA replication and protein synthesis, mitosis and meiosis, genetics, etc. Since the syllabus for Biology I contains information about both plants and animals, it shares subject matter with both Botany I and Zoology I. (See Figure 1, page 15)

(*) There are learning laboratories, using electronic media, in self-paced instruction in certain courses in English, History and Mathematics.



(Figure 1.)

To further complicate the redundancies, as Tables 2 (page 18) and 3 (page 19) reveal, Biology II (Bi 102) and Zoology I (Bi 121) both contain large blocks of subject matter concerned with the dissection of a representative vertebrate and the study of its systems, anatomically and physiologically. Both Biology II and Botany II present the lower plants, and Biology II and Zoology II, the invertebrate phyla.* (See Table 3, page 19)

(*) The question arises: Are the students in these three courses the same?

Most of the curricula of the College, where science electives are indicated, simply state "science elective" or "biology elective" or "biological sciences elective" or "biology, zoology or botany." Therefore, the students taking biology, zoology or botany courses tend to be the same students. In five curricula only are zoology or botany/zoology specified. In one curriculum alone, general biology is specified. The pre-professional requirements of most universities include "eight units of biology," without indicating specific courses. The registration policy requiring that all three of these courses be filled before new sections of any one of them are opened up furthers the tendency for the population of the three courses to be the same.

FROM MONTGOMERY COLLEGE CATALOG, 1974-1975

OBJECTIVES

The primary aim of Montgomery College is to create an educational environment which opens up opportunities for each student to learn and to work in a community of scholars and to develop the following abilities and attitudes:

- To appraise realistically his goals, abilities, achievements, and behavior.
- To expand his knowledge, understanding, and appreciation of the world about him.
- To prepare for adult responsibilities as a citizen and a member of family and community groups.
- To practice social conduct based on ethical and spiritual values.
- To develop skills and basic intellectual qualities for further higher education, continuing education, and occupational proficiency.
- To develop aesthetic appreciation of literature, music, the visual arts and his cultural heritage.
- To develop social responsibilities and leadership characteristics and to learn how to participate in a democratic society.
- To learn to judge men and issues critically and to base decisions and conduct on such judgment.
- To understand conditions for healthful and effective living and to develop social poise and mature conduct.

FROM MONTGOMERY COLLEGE CATALOG, 1974-1975

PHILOSOPHY

The vitality of a democracy depends upon the continuing development of the capacities of all its citizens both for their self-realization and for the common good. The American public educational system is designed to provide the motivation and education to fulfill this ideal of democracy. Thus, education beyond the high school is a public responsibility, especially since a large portion of the population will benefit from it.

The public has assumed this responsibility by establishing and supporting Montgomery College. The function of the college is to provide comprehensive higher education by offering within a single institution diverse curriculums for technical, semi-professional careers, as well as programs for transfer to baccalaureate programs in other institutions.

In addition, the college offers community services through continuing education and cultural programs.

The philosophy of Montgomery College is expressed in the following generalizations:

The college must strive for excellence in each of its different programs with the aim of educating each individual to the level of his highest potential.

The college has an obligation to keep its program varied in accordance with the changing educational needs and interests of the community.

The college provides a favorable learning climate to meet the needs of a diverse student body by a close student-teacher relationship, by individualized instruction and, above all, by a faculty and administration devoted to teaching and to continued improvement in instructional methods.

The college believes that a sound guidance and counseling program, which helps students to achieve self-understanding and to make realistic educational plans, is an essential part of a community college program.

The college sponsors a variety of cultural, educational, and leisure activities outside the classroom to encourage the student to broaden his knowledge and appreciation of the arts, the sciences, the humanities, and the social issues of our time.

The college considers it to be a fundamental responsibility to provide a broad liberal education for *all* students enrolled in a curriculum so that they may increase their appreciation and understanding of the world of ideas, scientific inquiry, and human relations.

The college, although liberal in its admissions policy, will require of its students academic performance of high quality and rigorous intellectual discipline.

TOPICS FOR LECTURE AND LABORATORY COMBINED
(Takoma Park and Rockville)

BIOLOGY I (Bi 101)

- * Introduction
  - * Biology and Scientific Method
  - * Some Major Generalization of Biological Systems
- * Use and Care of Microscope
- * Basic Chemical Principles
- * Chemical Basis of Life
- * Chemistry of Living Systems
- * Chemistry of Life
- * Physical Aspects of Protoplasm
- * Physical Basis of Life
- * Molecular Basis of Life
- * The Cell
  - △ Plant Cells
  - ○ Animal Cells
- * Movement of Materials Across Cell Membranes
- △ Plant Tissues
- ○ Animal Tissues
- * Enzymes and Chemical Reactions
- * Cellular Metabolism: Enzymes
- * Enzymes in Action
- * Cellular Respiration
- * Metabolism
- * Biologic Interfrelationships
- ○ Metabolic Measurements for Small Animals
- * Evaluating the Impact of the Environment
- △ Photosynthesis (Pigments & Light)
- * Cellular Reproduction: Mitosis
- * Cellular Reproduction: Meiosis
- * The Chromosome Theory of Heredity
- * Genetics: Inheritance Patterns
- * General Genetics
- * Structure and Function of Genes
- * DNA
- ○ Inheritance in Man
- ○ Human Genetics
- ○ Reproduction and Development in Animals
  - ○ Starfish Development
  - ○ Frog Development
  - ○ Chick Development
- △ Reproductive Processes in Plants
- △ Development in Plants (Plant Hormones/Light)
- △ Plant Cycles
- * Evolution
- * Mechanisms of Evolution
- * Ecology
  - ○ Man and His Environment

BOTANY I (Bi 111)

- Introduction
  - △ Plant Kingdom
  - △ Taxonomy: Classification of Plants
  - △ Plant Identification
- * Compound Microscope
- * The Cell - Cytology
  - * Cell Morphology
  - * Protoplasm
  - * Types of Cells
- * Multiplication of Cells - Mitosis
- * Biophysical Phenomena
- * Organic Chemistry
- * Study of Membranes
  - * Diffusion
  - * Osmosis
  - * Water Relationships
- * Tissues - △Plant
- △ Vegetative Plant Body - Leaf, Root, Stem
  - △ Stem and Leaf Anatomy
  - △ Photosynthesis (Pigments & Light)
  - △ Metabolism and Respiration
- △ Mounting Specimens
- △ Lumber and Modified Structures
- △ Test of Known & Unknown Compounds:
  - * Carbohydrates, Proteins, Lipids
- * Enzyme Study
- △ The Reproductive Plant Body --
  - △ Flower, Fruit, Seed, Seedling
- △ Growth and Development - Plant
  - △ Hormones/Light
- * Meiosis and Alternation of Generations
- △ Life Cycle of Flowering Plant
- * DNA - Protein Synthesis
- * Genetics
- * Evolution
- △ Plant Communities (Quadrant & Bisect Studies)
- * Ecology

ZOOLOGY I (Bi 121)

- Introduction
  - ○ Animal Kingdom
  - ○ Taxonomy
  - ○ Identification
  - * Biological Vocabulary
- * Microscope
- * Constituents of Living Material
- * Structure of Cells
- * Cells and Cell Organelles
- * Aspects of Cell Function
  - * Movement of Molecules Through Membranes
- * Cells and Tissues
  - * Diffusion and Osmosis
- * Mitotic Cell Division
- * Characteristics of Tissues
  - * Structure of Tissues - Animal Tissue
- * Energy for Life Cycles
- * Chemistry of Living Systems
- * Factors Effecting Enzyme Activity
- ○ Study of a Representative Vertebrate
  - ○ External Anatomy
  - ○ Skeletal System
  - ○ Muscular System
    - ○ Muscle Action
    - ○ Muscle and Nerves
    - ○ Muscle-Nerve Preparation
      - ○ Kymograph
- ○ Internal Anatomy
  - ○ Digestive System
  - ○ Food Utilization
  - ○ Respiratory System
    - ○ Physiology of Respiration
  - ○ Circulation
  - ○ Heart Structure
  - ○ Functions of Blood
  - ○ Physiology of Circulation
  - ○ Urogenital System
  - ○ Hormonal Integration
  - ○ Central Nervous System
    - ○ Nerve Impulse
- * Cellular Respiration
  - * Biochemistry and Physiology
- * Meiotic Cell Division
- * Genetics
  - * Mendelian Inheritance
  - * Genetic Concepts
  - * Sex Determination
  - * Sex Linkage
  - ○ Human Inheritance
  - * DNA - The Genetic Material
- * Protein Synthesis
- ○ Reproduction and Development
  - ○ Embryonic Development
    - ○ Frog and Chick
  - ○ Human Embryology
  - ○ Hormones and Reproduction
- * The Biology of Populations Ecology

* Common
△ Plant
○ Animal

TABLE 2.

TOPICS FOR LECTURE AND LABORATORY - TAKOMA PARK AND ROCKVILLE COMBINED

BIOLOGY II (Bi 102)

- Introduction
- △ ○ Origin of Life
- ○ Animal Diversity
  - △ ○ Lower Phyla
  - △ ○ Classification
- △ Kingdom Monera
- ○ Protozoa
- △ True Fungi
- △ Algae
- △ Mosses
- △ Vascular Plants
  - △ Ferns
- △ Vascular Plants
  - Gymosperms
- △ Vascular Plants
  - △ Angiosperms
- △ Fruits
- ○ The Poriferans and Coelenterates
- ○ The Platyhelminths and Aschelminthes
- ○ Annelids
- ○ Mollusks
- ○ Arthropods
- ○ The Deuterostomes
  - ○ Echinodermata
  - ○ Prochordates
- ○ Dissection of Fetal Pig
  - ○ External Anatomy
  - ○ Digestive System
  - ○ Respiratory System
  - ○ Circulatory System
  - ○ Urogenital System
  - ○ Nervous System
  - ○ Support System
- ○ Muscles
- ○ Stimulus Receptors
- △ Transport in Plants
- △ Growth Regulation (Plant)
  - Tropisms and Chemical Control

BOTANY II (Bi 112)

- △ Diversity of Plants
- △ Examination of Representatives of the Plant Divisions (Systematic Study)
- △ Bacteria
- △ Blue-Green Algae — △ Monera
- △ Algae
  - △ Green
  - △ Yellow, Green or Golden Brown
  - △ Brown
  - △ Red
- △ Slime Molds
- △ True Fungi
- △ Sac Fungi
- △ Club Fungi
- △ Liverworts and Mosses
- △ Club Mosses
- △ Horsetails
- △ Ferns
- △ Gymnosperms
- △ Angiosperms

ZOOLOGY II (Bi 122)

- ○ Introduction
  - ○ Invertebrate Relationships
- ○ Protozoa
- ○ Porifera
- ○ Coelenterata
- ○ Platyhelminths
- ○ Aschelminthes
- ○ Annelida
- ○ Mollusca
- ○ Arthropoda
- ○ Echinodermata
  - ○ Anatomy and Embryology
- ○ Chordata
  - ○ Evolution
- △ ○ Origin of Life and Phylogeny
- △ ○ Ecology

* Common
△ Plant
○ Animal

TABLE 3.

In examining Tables 2 and 3, one must bear in mind that the three columns of each table contain the actual syllabus titles of the lectures and the laboratory exercises of both Takoma and Rockville combined. This accounts for repetition and various wording for the same topic. The emphasis on certain topics is not always the same on both campuses, although they share the same course descriptions in the College Catalog (see page 9). (Also see footnote, page 42.).

Catalog descriptions are misleading. For instance, compare Bi 101, which emphasizes molecular and cellular basis of life, and Bi 121, which does not mention these subjects at all in the description, yet devotes more than one quarter of the semester course to them (at least in Rockville A-T-121). A better evidence of the extent of overlapping of subject matter in the introductory courses is the notation at the end of each course description.

Course	Notation
Bi 101	Not open to those students with credit in Bi 111 or Bi 121.
Bi 102	Not open to those students with credit in Bi 121 without consent of instructor. Pre-requisite: Four hours of biological science.
Bi 111	Not open to those students with credit in Bi 101 without consent of the instructor.
Bi 112	Pre-requisite: Four hours of biological science.
Bi 121	Not open to those students with credit in Bi 101 without consent of the instructor.
Bi 122	Pre-requisite: Four hours of a biological science.

Since "consent of the instructor" often is easily obtained, it is possible for students to accumulate 100-course credits and, because of repetition of subject matter, to "pull up" poor grades to A's or B's.

The overall picture is one of great waste -- waste of students' time, waste of faculty time, and waste from the administration's point of view.

III. Exploration of New Methods

A. Consultations

In undertaking any project, the value of consulting authorities in the subject is axiomatic. In the Washington, D. C., area we are fortunate to have many of these as neighbors. Others come to Washington to attend meetings of national organizations. Following is a list of individuals consulted, with comments regarding the contributions of each.

1. Professor Margaret G. Aldrich, Chairman, Mathematics Department, Takoma Park Campus, Montgomery College.

2. Dr. Clifford L. Rall, Assistant for Multi-Campus Planning Coordination, Montgomery College.

Mrs. Aldrich, one of the authors of "A Report on a Project to Develop a Modular Instructional Program in Pre-Calculus Mathematics" 1974, and Dr. Rall outlined steps for the preparation of a report on a modular instructional program in introductory biology. A copy of the "Program in Pre-Calculus Mathematics, Brigham Young University, was supplied, as well as a copy of The Yellow Pages: A Guide to Undergraduate Innovations.

3. Dr. Dyckman W. Vermilye, Executive Director, American Association for Higher Education, One Dupont Circle, Suite 780, Washington, D. C. 20036.

In two conferences, Dr. Vermilye outlined the project "Nexus," the function of which is "linking people with questions, with people with answers," (see Appendix) and explained the advantages of asking specific questions, related to specific problems, of someone who has previously dealt with similar problems. Often a telephone call is the best way to start a search. Dr. Vermilye pointed out the value of first surveying the available literature on modular instructional programs and flexible scheduling, using ERIC, Educational Resources Information Center, A Clearing House on Higher Education. A computer search of the literature was requested and a bibliographic Citation List generated.

4. Dr. Eileen Kuhns, Executive Associate for Council Development, American Association of Community and Junior Colleges, Washington, D. C.

A telephone call to Dr. Kuhns resulted in encouragement, an offer of future help, and, above all, generated a discussion of the value of "the analysis," an examination of existing practices before outlining innovations. For articles concerning modules written by Dr. Kuhns, see References #10 and #11 at the end of this report.

5. Dr. Lois Beisher, Science Division, Antelope Valley College, 3041 West Avenue K, Lancaster, California 93534.

The opportunity of participation in the program A Day With Visitor-Consultant, Professor Beisher, was helpful. The visit, sponsored by the American Institute of Biological Sciences, was for the purpose of discussing with the Takoma Park Biology faculty innovative methods of individualized instruction in Biology: self-instructional microbiology laboratories and audio-tutorial biology. There were three discussion groups and a luncheon meeting scheduled.

Professor Beisher has had wide experience in developing innovative programs at Antelope Valley College and has published individualized materials for use in microbiology laboratories. (See Section, Review of Commercially Produced Materials.) Her enthusiasm for her program was contagious. (See copy of Dr. Beisher's follow-up report in Appendix: Attachments.)

6. Dr. Samuel N. Postlethwait, Department of Biological Sciences, Lilly Hall of Life Sciences, West Lafayette, Indiana 47907. (See Section, Notes From Visit to Purdue University, page 23.)

NOTES FROM VISIT TO PURDUE UNIVERSITY

On October 29, Dr. Clifford L. Rall, Assistant for Multi-Campus Planning Coordination, Montgomery College, and I flew to West Lafayette, Indiana, to visit Dr. Samuel N. Postlethwait and the Purdue Minicourse Project. Due to bad connections in Chicago, we were unable to begin our conference with Dr. Postlethwait that day, although he and his staff were expecting us.

On October 30, we had two informal sessions with Dr. Postlethwait, one in the morning and one in the afternoon. Three of the Teaching Interns in the Purdue Biology courses, Drs. Gerold Melaragno, Rodney Myatt and William Langley, and the Secretary-Coordinator of the Purdue Minicourse Development Project, Miss Joyce Bell, joined from time to time and entered into the discussions and answered questions. The teaching interns are young PhD's who are learning the minicourse approach to Biology by working under a special grant at the Purdue Center. They prepare minicourses for the pool in General Biology, have charge of the large and small assemblies, work with the students at the learning center, correct papers, give oral examinations, and help the students with their experiments. One of the interns, Dr. Jerry Melaragno, accepted our invitation to have lunch with us at the motel. Dr. Myatt and Dr. Melaragno conducted us on a tour through the learning center where we saw the students working at the booths, in groups, and discussing their course work and preparing for presentations in the small assembly sessions.

The learning center consisted of two large rooms with an open stock-preparation room between. It is usually open from 7:30 a.m. to 8:30 p.m. (at least 74 hours per week).

Size of space - 3,000 ± square feet
Number of booths (student stations) - Burgess Co. booths - 112
(15.2 students per booth)

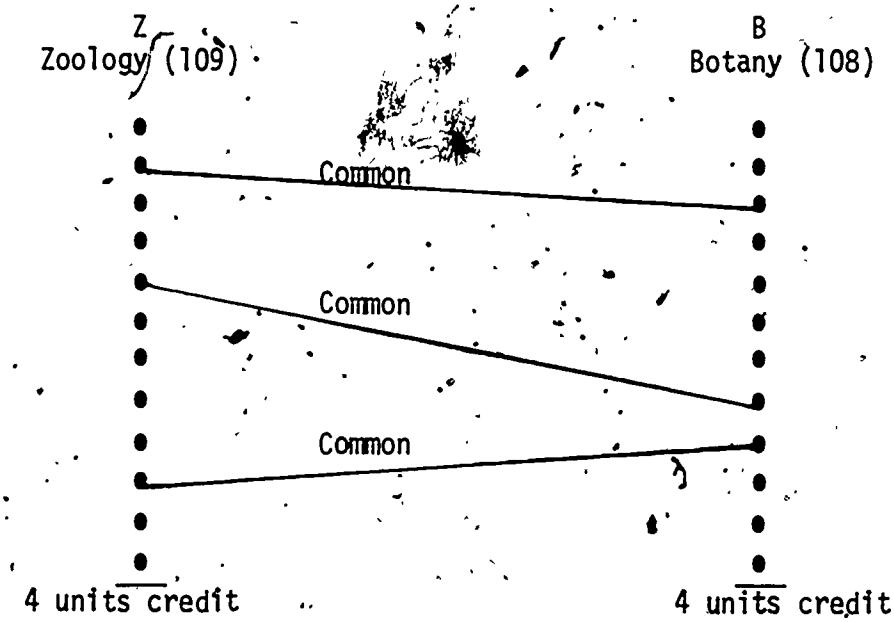
Number of round study tables (well lit) --4 in coffee area in Center
Number of students in course - 1,700
Number of instructors - 7
Number of minicourses in "pool" - over 100.

In the morning we started our session with Dr. Postlethwait by looking and listening to slides and audio, synchronized, describing the minicourse concept. It was shown on a Singer Graflex Caramate. The machine was stopped and started often as we asked questions and Dr. Postlethwait and his teacher-interns explained procedures to us. Using the blackboard, Dr. Postlethwait diagrammed the growth of the audio-tutorial and minicourse approach to learning at Purdue.

The audio-tutorial system at Purdue was begun in 1961 as an attempt to assist students with limited backgrounds in Biology. Special lessons, particularly in Botany, were prepared, using audio tape, and made available to students in the Audio-Visual Center. At first they were used as a supplement to the conventional instruction program. Later, all instructional procedures were totally reorganized around the taped tutorials.

In 1969, Dr. Hurst joined the staff to place the Zoology course on audio-tutorial. It was realized that self-instructional programs would provide a great potential for flexibility in a learning system, and at that time a further modification to provide still greater individualization was explored. The content of a Botany course and the Zoology course were divided into units called minicourses. For each minicourse, a self-instructional program was produced. From this a highly flexible scheme evolved.

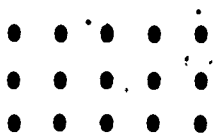
Dr. Postlethwait illustrated on the blackboard the steps in the evolution of the flexible scheme of minicourses in the Biology sequence 108-109 at Purdue. The content of the courses were divided into small units of subject matter.



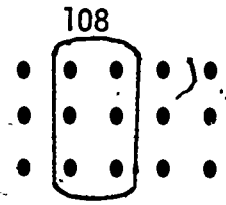
We were then told how the units were designed into small courses, covering a limited amount of subject matter whose content is a coherent whole -- with definite beginning and ending -- relating primarily to one topic. The designation, Module, was rejected for a number of reasons which will be examined later. Usually, each minicourse represents less than one credit hour of conventional course work. At Purdue the average is 8 to 10 minicourses per credit hour.

Minicourses can be used individually, e.g. for enrichment or remedial study as a part of a conventional course, or be combined in a variety of sequences to total the equivalent of 1, 2, 3, 4 to 8 credit hours, depending on how a student is enrolled in 108-109.

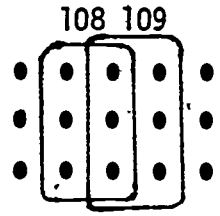
An analysis of these units of information showed many to be common to both courses, e.g. the cell, cell division, genetics, ecosystems, etc. Dr. Postlethwait drew a series of symbolic representations of a pool of minicourses. A series of dots represented the minicourses.



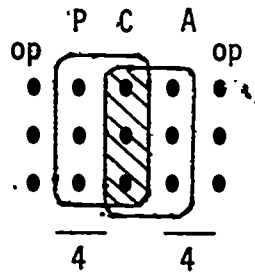
A circle around several dots separated those dealing with subjects taught in 108, Plant Biology (P).



A second circle was placed around the dots representing subjects taught in 109, Animal Biology (A).

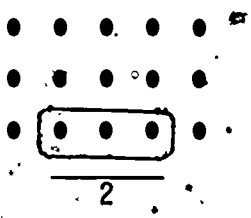


Immediately, the redundancy became apparent as we could see the overlapping of the circles around those minicourses common to both courses (C).



The dots outside the circles adjacent to P and A, representing those minicourses dealing with a large variety of topics within the context of the two-course sequence, are optional (op). The optionals may be selected by the student as needed to complete the credit hour requirement in Botany or Zoology. The student may trade-off A or P courses for options, depending on the course in which he is registered and when. The C minicourses must be taken during the first semester of registration, whether Botany or Zoology is taken first. The usual sequence is 108-109.

A study of the blackboard illustrations revealed the many ways in which minicourses can provide flexibility and individualization.



The advantages and pitfalls were discussed. Dr. Postlethwait admitted that there were "several early problems" which were identified and solutions determined as the project progressed.

In 1970, a three-year Minicourse Development Project, funded by the National Science Foundation, was begun. As many as 100 persons from this country, and some foreign lands, prepared minicourses in their respective areas of specialty. A pool of over 200 minicourses, covering basic biology courses (admittedly, some better than others), have been accumulated at Purdue. The Minicourse Development Project was an operation apart from the freshman introductory biology courses (108-109), where the AT and minicourse systems originated.

A supplemental National Science Foundation Evaluation Program began in July 1972. Through this, the pool of minicourses underwent systematic testing and evaluation in selected mid-western colleges and universities. This program continued through June 1974.

In July 1973, when the MDP terminated, the NSF supported a coöperative endeavor between the MDP of Purdue University and the Biological Sciences Curriculum Study (BSCS) at Boulder, Colorado.* The MDP has moved to Boulder, where the Purdue-BSCS Project is completing the development of a pool of minicourses covering a core of biology (college-introductory-course-level). Dr. Postlethwait participates in this and commutes regularly between West Lafayette, Indiana, and Boulder, Colorado. It is the intent of this program to identify with a producer/publisher for distribution of the minicourses. (A book on minicourses by Dr. Postlethwait, and a pool of minicourses, are being published by Saunders Publishing Company and will be on the market early next year.)

Upon completion of the Boulder Project, it will be possible to purchase instructional materials from the minicourse pool, which can then be used in tailoring biology courses to meet the individual needs and interests of our students at Montgomery College. Biology of the degree of sophistication found in major universities will be made available to colleges everywhere. Even now, the Project is actively cooperating in the exchange of materials on an international, as well as a national, basis.

In the afternoon session, Dr. Postlethwait gave us more details about the Purdue minicourses and how they "worked" within the framework of Biology 108-109, as well as within the University administration and registration policies. Many of the pitfalls in the use of minicourses were discussed and emphatic warnings given. We came home with our heads full of new and exciting ideas and our arms full of pamphlets and reprints about minicourses (see Appendix); also packets of a few minicourses and a Dr. Postlethwait tape.

Submitted by,

Bernice F. Pierson
Professor Emeritus, Biology

(*) In the 1960's, the BSCS three-group laboratory blocks - "blue," "yellow," and "green," authored by secondary school biology teachers working at Boulder, made considerable impact on the biology taught in high schools over the country. It is not easy to determine the effect of the "new" secondary school biology on the college introductory course of the 1970's. Admittedly, however, certain secondary courses are equal or superior to the introductory college course offered at some institutions. (Reference #13)

Note: Although the diagrams in this section were drawn on the blackboard for us, the ones used to illustrate this section were taken from Minicourses - What Are They? by Postlethwait, S. N. and Frank Mercer, Purdue Research Foundation, 1972. (Reference #18)

C. Current Status of Minicourses in Biology

1. Location of Minicourse Programs

The following list of professors, currently known to be teaching biology by the "minicourse" method, indicates how widespread the A-T minicourse concept has already become. A letter has been written to each of these professors asking pertinent questions concerning their programs:

(a) Samuel N. Postlethwait
Robert B. Hurst

Minicourse Project: Botany and Zoology
Department of Biological Sciences
Purdue University
W. Lafayette, Indiana 47907
Phone: (317) 494-4080

Joyce Bell, Secretary-Coordinator

Note: The minicourse program at Purdue is in its fifth year of operation.

(b) Harry Fulton

Olivet Nazarene College
Kankakee, Illinois 60901

(c) Frank V. Mercer

School of Biological Sciences
Macquarie University
North Ryde
N S W 2113, Australia

(d) James Jenkins

Elizabeth City State University
Elizabeth City, North Carolina 27909

(e) Mildred Campbell

Wharton County Junior College
Wharton, Texas 77488

(f) John E. Frey

Northern Michigan University
Marquette, Michigan 49855
Phone: (906) 227-1000

Note: The audio-tutorial biology laboratory consists of 12 minicourses in biology, self-paced.

An additional list of A-T and minicourse programs over the country has been placed in the Appendix.

2. Review of Commercially Produced Materials

It is recommended elsewhere in this report that the developer of the minicourse program in biology for the third campus make extensive use of available commercially produced materials. The following list, with added comments, is a resume of the results of an investigation which was made of commercial sources:

(a) Fifty (50) new "how to" modules, teaching laboratory skills for the life sciences, from the AIBS Project; BIOTECH.

These independent teaching units have been tested in more than thirty teaching and training environments representing high schools, two and four-year colleges and universities, and in industry. Each module is a multi-media package consisting of a filmstrip (or 35 mm slides), a compact audio cassette, and a student guide. The study guide introduces and lists the topic, objectives, pre-requisite skills, materials and equipment needed to actually perform the task. The fifty modules are divided into five series:

General Skills Series 8100
Animal Handling Skills Series 8200
Environmental Skills Series 8300
Field and Museum Skills Series 8400
Allied Health Skills Series 8600

Other BIOTECH modules are being produced. The prices per title are from $25.00 to $29.50. The modules may be ordered from:

Communication Skills Corporation
P.O. Box 684
Fairfield, Connecticut 06430

For information concerning the developing of modules, write:

Project BIOTECH
American Institute of Biological Sciences
Box 9197, Rosslyn Station
Arlington, Virginia 22209

A thorough description of the AIBS BIOTECH modules may be found in:

Project BIOTECH: A Modularized Answer to a Critical Manpower Question, by Elwood B. Ehrle, published in The Use of Modules in College Biology Teaching, edited by Creager, J. G. and D. L. Murray, 1971. (Reference #4.)

(b) A series of fifty-four (54) half-hour programs on video cassettes, entitled Today's Biological Revolution, presents an understanding of the basic facts concerning the nature of life, its origins, and molecular and cellular mechanisms. The course professor is Dr. Bernard L. Strehler. The cassettes are either in color or black and white and retail for $175.00. The cassettes may be used with a monitor or a regular TV, with or without recording capabilities. These programs are produced by:

Video Cassette Industries
451 Melrose Avenue
Hollywood, California 90069

The local distributor is:

Video Communications Associates, Inc.
Suite 904, Watergate Office Building
2600 Virginia Avenue, N.W.
Washington, D. C. 20037
Phone: (202) 333-3881

(An affiliate of the American Video Network)

At a meeting with Video Communications Associates' president, Charles B. King, on the Takoma Park Campus (Takoma's Learning Resources Department has a monitor), portions of two programs were viewed: "Life Organized as Cells" and "Evolution of the Nervous System." The material was well organized and excellently presented. This meeting was arranged by Mrs. Helen Ackerman, Learning Resources Department, and Dr. Evelyn Hurlburt, Biology Department.

VCA sells other instructional programs which would be worth investigating, such as:

Tellstar's: Anatomy, Biology, Microbiology
Minnesota Video-Nursing Education Cassettes
Any Time Life Films
Videorecord Systems: Comparative Anatomy.

(c) Individualized Instruction for the Allied Health Sciences, by Lois Beishir, Canfield Press, Huffer and Row, 1974.

This publication contains fifty-three (53) self-instructional packages of techniques used in bacteriology, including many difficult and aseptic techniques. The packages or modules answer the students' questions before they are asked, remove the need for the repetition of demonstrations in microbiology in practice, and give many "dry runs" and practice activities. The author claims that even a poor or average student, if he can read a cook book, can master the techniques taught in this course.

(d) Minicourse Development Project of Purdue University and Biological Sciences Curriculum Study.

W. B. Saunders Company
Philadelphia - London - Toronto.

Publication is scheduled for December, 1975. Nearly eighty (80) minicourses have been developed by the project and more are being developed. Collectively, the minicourses to be published next year will cover a full year's introductory biology course. Enough extra material will be available to allow for areas of special emphasis and supplementary study.

The Purdue University and BSCS Project is headed by Dr. S. N. Postlethwait, the pioneer in audio-tutorial biology instruction.

The minicourses are organized into twelve subject clusters. Each cluster has a study guide, instructor's manual (with printed tape script), audio tapes (both cassette and reel-to-reel), and an array of visual aids (filmstrips, slides, charts, etc.).

Instructors may choose any combination of subject clusters for their courses and will receive the corresponding teacher's guides and tape scripts free of charge. Sound tapes and visual materials will be available for departmental purchases and will be packaged separately for each cluster. A catalog of the entire project will also be available.

Advertising materials for the AIBS BIOTECH modules and the Purdue-BSCS minicourses accompany this report. (See Appendix.) Seventeen preliminary versions of minicourses, produced by the Purdue Research Foundation, will be placed in the Office of the Executive Associate for Multi-Campus Planning Coordination. They include Study Guide, Instructor's Manual, and Tape Script.

(e) Biology: An Individualized Course, by Robert N. Hurst, Purdue University, and Kenneth H. Bush, David McGaw and Curtis L. Smiley. $175.00, published by Westinghouse Learning Corporation, 770 Lucerne Drive, Sunnyvale, California 94086, 1973.

The course includes thirty-seven minicourses. The kit includes 37 Study Guides, 37 Instructor's Guides, 1 Instructor's Orientation Guide, 1 Student's Orientation Guide, and Tests and Exercise Answers. The senior author of these minicourses, Robert N. Hurst, worked with Dr.

Postlethwait in developing minicourses for Biology 108-109 at Purdue University and is presently in charge of the year's course. Many of the Westinghouse Learning Press minicourses are used in the Purdue Program.

The kit containing the 37 minicourses is in the office of the Executive Associate for Multi-Campus Planning Coordination.

(f) Topics in The Study of Life: The *BIO* (Biology Individually Organized) Source Book, published by Harper and Row, New York, Evanston, San Francisco, and London, 1971.

This book contains 61 articles whose authors are outstanding scientists in their field. It "takes advantage of the flexible, individualized format provided by audio-tutorial techniques to give the student an opportunity for repetitive instruction on a schedule that is more adaptable to his needs than is the typical classroom situation." It is from this book that students in Biology 108-109 at Purdue read certain articles in order to write summaries, without any notes, for bonus points for A-B grades.

3. Minicourses: Advantages and Cautions

A. Advantages:

Some advantages of the Minicourse -- the integrated, independent study method.

The minicourse is simply the knowledge module or unit of the A-T course, broken up into smaller, "more readily managed bites." It has all the advantages of A-T, plus more flexibility and more individualization. The content of one, two, or even three courses may be put into a single collection of minicourses. Topics identified as essentially the same in each course become a pool of common minicourses, which the students take when they first enroll in any one of the courses.

A few of the ways in which the minicourse strategy provides more flexibility and individualization are:

(1) Minicourse programs accommodate to the goals, interests, capacities and backgrounds of the students. Minicourses may be selected and combined in a variety of ways for individually prescribed instruction. (See Figure 2, page 34)

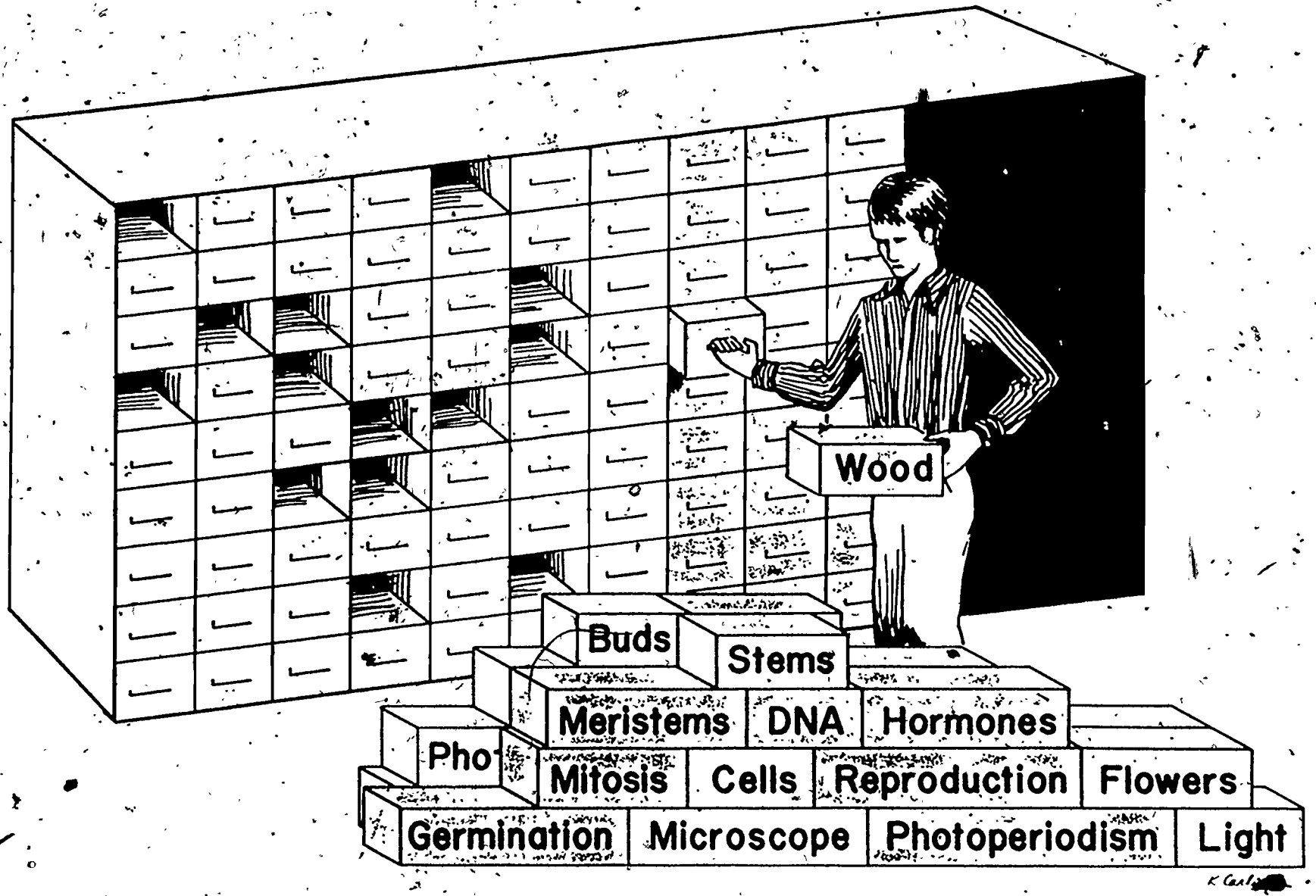
(2) Alternate or optional minicourses can be provided giving students the opportunity to choose different approaches to the same subject, or to substitute different subjects, according to his needs or interests. Minicourse programs allow a student to control the rate and emphasis of his study. Since each minicourse is essentially an independent learning system, a student can start and stop (within certain limits) at any point. He can repeat or skip segments of the program according to his needs.

(3) Poor achievement will be identified at many points in each minicourse: pre-test, self-test, in the independent study session and small oral quiz session, as well as at the post-test, all within a short time. The small unit of material in each minicourse permits frequent evaluation of a student's progress. Results of all tests are learned by the student immediately.

(4) Since each minicourse is essentially an independent learning system, a student can start and stop a program of minicourses at any point. He can repeat or skip segments of the program according to his needs. If he drops out, he may receive credit for those minicourses which he has satisfactorily completed.

(5) A minicourse program makes it possible to give variable credit. How a student is registered for a course determines whether he receives one, two, three, four or even more credits. A stated number of minicourses would have to be completed in order to receive one credit. Also, credit by examination would be available.

(6) Minicourse programs eliminate redundancy in courses covering partially similar content. Thus, efficient use of facilities, staff, and student time can be achieved.



MINICOURSES - WHAT ARE THEY? - Postlethwait and Mercer (Reference #18)

Figure 2.

(7) Revising or updating a minicourse or several minicourses is much easier and less costly than revising an entire conventional course. The small unit of material in the minicourse permits this. Minicourses may easily be added, subtracted or changed. Revisions should be based on student performance.

(8) Once a bank of minicourses have been prepared, a teacher has time to perform the important functions of motivation and communicating the excitement of scientific discovery. Other means of motivation might be through "The *BIO* Source Book" articles assigned to be precised and through guest speakers in general assemblies.

(9) In minicourse programs it is possible to include minicourses designed to show students how experiments are performed, observations made, and data collected without having to experience the frequently discouraging episodes of frustration and disappointment which accompany most experiments. Such a minicourse is: "Observing Behavioral Patterns on Rat Pups," BSCS Experimental Edition 1974. (See VIII, Appendix, Attachments)

Often conventional teaching methods encroach on the creative life of the teacher, replacing rather than supplementing the teacher's own development as a scientist. Introducing minicourse programs may remedy this. Preparing minicourses can be very creative, involving much research, especially ones like the rat pup minicourse mentioned above. In the new programs, teachers should have more time to examine and explore biological materials with their students.

(10) The outstanding characteristic of a minicourse is active student participation at every step. The student learns by doing. The responsibility for learning is placed directly on the student.

(11) In minicourses, the emphasis is on the student's learning activities rather than on the teacher's teaching activities. Rather than be group-oriented, they are individual-oriented, providing maximum student freedom for independent study. The teacher's role in the minicourse programs is quite different than in conventional courses. Here he is a resource person, giving guidance and encouragement when needed.

(12) The Integrated Quiz Session (seminar-type) with 8-10 students is one of the most important educational experiences of a minicourse program.

(13) Minicourses, using the audio-tutorial system, bring into an integrated sequence all the learning experiences of the conventional courses -- lecture, laboratory, recitation. All learning events tend to complement and enhance each other. Teachers need no longer worry about synchronizing lectures and laboratories.

(14) The audio-tutorial system used in the minicourses permits the students to concentrate during their study: In the individual booths they are not distracted, for there they are isolated from their surroundings.

(15) In a minicourse program, using the A-T strategy, the Learning Center is open every day, all day long, and in the evenings. Inflexibility of room scheduling is no problem. All make-up and advanced or in-depth work is done here. Tapes and other self-helps free the teachers to work with the individual students or have timely discussions with groups of students.

(16) Once minicourses are available, the teacher is freed from the routine of teaching repeatedly the same material. This is true because multiple lecture and laboratory sections are dispensed with. It is true also as regards small groups or individual demonstrations. If the tapes are properly structured, there is little need for demonstrating. Labeled photographic prints, 2x2 Kodachrome slides and programmed notes substitute for the tedious repeating of demonstrations of precise techniques as in microbiology, or delicate dissections in anatomy. Students can find even the smallest structure in a microscope section if the directions on the tape are explicit and the photographs for illustration, taken at different levels of magnification, are clearly labeled. (See VIII, Appendix, Attachments - Ilma M. Brewer, "An Audio-Visual Method of Teaching and Learning," Section K, Reference and Attachment Booklet. Also, see Lois Beishir, "Individualized Instruction for the Allied Health Sciences," 1974.)

(17) If a minicourse or cluster of minicourses involves primarily portable items, they can be made available outside the Learning Center. Conceivably, several minicourses, constituting a relatively high proportion of a regular course, could be studied at home, or in a hospital.

(18) Transfer of materials between courses and between institutions is more readily accomplished with minicourses. A minicourse can be used in several different courses, thus reducing the cost of development. [Credit received for passing a minicourse is permanent. Since students may retain credit for any minicourse completed, they need not repeat a minicourse even though they take several courses in which the same minicourse is required.] They make exchange programs feasible.

B. Some Limitations and Cautions:

(1) If the "bite of knowledge" -- the minicourse, is not small enough, or if the objectives are too numerous or too vague, the results are likely to be disastrous.

(2) A certain type of student may not be ready or able to accept the responsibility for learning which the minicourse places squarely on his shoulders. The emphasis is on the student's learning activities rather than on the teacher's teaching activities. There may be a lack of interest on the part of the student since the teacher is not always present and watching over his shoulder. No one tells him exactly what to do and when to do it. This type usually suffers from "carrel or headphone claustrophobia."

(3) The content and style of the minicourse, as well as the behavior of the teacher, must create an environment in which the student is inspired to become involved in the process of learning. If it does not do this, it fails. The student's attitude is very important in learning.

(4) A minicourse is considered a failure if a significant number of students fail to reach the criterion of performance. Revisions, which often are necessary, are based on student performance.

(5) The development and testing of an A-T minicourse program is time consuming and requires considerable skill and talent.

(6) Many teachers are uncomfortable with A-T techniques. It forces them to change dramatically their accustomed role and to state exactly what they are trying to teach.

(7) The A-T minicourse strategy is more likely to reveal the true nature of a teacher, his attitude toward his students, toward his profession and toward himself. For example, if a teacher is not a good counselor, is not genuinely friendly with students, and is not totally committed to helping all students learn, he should perhaps not enter a minicourse program.

(8) The teacher may use the minicourses as an excuse to spend Learning-Center time in the teacher's lounge, in his office, or on the golfcourse. Minicourses would then, indeed, be "void of human interaction" as some critics feel. It is a fallacy to think that the A-T minicourse, once it is begun, can run itself.

(9) Because of the limitations listed above, it may not be easy to convert existing faculty, who are content in their familiar classroom surroundings, to the A-T minicourse system. Most professors, who already have their conventional courses well prepared and who are happy with clearly defined and limited teaching assignments, may not elect to change. (Reference #9)

(10) To plan the educational procedures of an entire campus, or even of one department, around the minicourse concept would entail problems. Chief among these would be that of providing coherent educational programs for from 1,000 to 20,000 or more students, not all of whom will be motivated and responsible. (Reference #9)

(11) It should not be expected that minicourse programs will be less expensive than conventional programs, either in staffing or equipment -- they are not likely to be. The reasons for adopting them should not be that they will be cheaper, or easier, or even more efficient, but that, in the hands of teachers with imagination as well as knowledge, they will provide a better way for students to learn. (Reference #4, page 91)

DISADVANTAGES OF CONVENTIONAL METHODS	ADVANTAGES OF MINICOURSES
1. Allowances made for individual differences are inadequate. Conventional methods do not take into consideration the uniqueness of all individuals. Certainly, the lock-step and assembly-line techniques used fail to acknowledge such differences. There is no opportunity for each student to proceed at the rate best suited for his abilities since he has no control over this. All begin and finish together. Repetition of material for the weak student and in-depth study or rapid progress for the talented is impossible.	1. Minicourse programs accommodate to the goals, interests, capacities and backgrounds of the students. Minicourses may be selected and combined in a variety of ways for individually prescribed instruction. (See Figure 2, page 34)
2. No options are built into the programs. There are few choices which the student can make; no opportunities to make decisions concerning what he will study and when. There is a lack of opportunity for the undecided student to sample the possibilities of biology. With enlarged enrollments and the increased heterogenity of the campus population, there is an ever-widening range of abilities, backgrounds, study practices and goals among students. The need for options is greater than ever.	2. Alternate or optional minicourses can be provided giving students the opportunity to choose different approaches to the same subject, or to substitute different subjects, according to his needs or interests. Minicourse programs allow a student to control the rate and emphasis of his study. Since each minicourse is essentially an independent learning system, a student can start and stop (within certain limits) at any point. He can repeat or skip segments of the program according to his needs.
3. Often there is too infrequent evaluation of the student's progress. Deficiencies are not determined for remedial work prescribed soon enough in the semester. The weak student can hide -- it may be mid-terms or finals before the instructor becomes aware of his problems. There may be too long a time between taking an exam and receiving the results.	3. Poor achievement will be identified at many points in each minicourse: pre-test, self-test, in the independent study session and small oral quiz session, as well as at the post-test, all within a short time. The small unit of material in each minicourse permits frequent evaluation of a student's progress. Results of the tests are learned by the student immediately.
4. In the conventional programs: students may not enter a course after the first week or two of the semester; students are penalized for having tried and failed or done poorly; students are penalized if they drop out, for whatever reason.*	4. Since each minicourse is essentially an independent learning system, a student can start and stop a program of minicourses at any point. He can repeat or skip segments of the program according to his needs. If he drops out, he may receive credit for those minicourses which he has satisfactorily completed.
5. Under the present credit-hour-per-course system, it is impossible for a student to earn more credits or less credits than four hours in most of the introductory courses in biology. This is true, even though his curriculum, or the curriculum into which he wishes to transfer, calls for more, or less, credit. Credit by examination is not available.	5. A minicourse program makes it possible to give variable credit. How a student is registered for a course determines whether he receives one, two, three, four or even more credits. A stated number of minicourses would have to be completed in order to receive one credit. Also, credit by examination would be available.
6. Frequently, two or more courses at the same level in a department will include virtually the same material. Often one finds subjects common to two or more, even in sequential courses. It is redundant to involve students with the same subject matter a second time.	6. Minicourse programs eliminate redundancy in courses covering partially similar content. Thus, efficient use of facilities, staff, and student time can be achieved.
7. Often the subject matter of a course cannot be changed drastically without changing the entire syllabus. Updating subject matter which is constantly changing may necessitate revisions of text or study guide and major changes of all study material.	7. Revising or updating a minicourse or several minicourses is much easier and less costly than revising an entire conventional course. The small unit of material in the minicourse permits this. Minicourses may easily be added, subtracted or changed. Revisions should be based on student performance.
8. In the conventional structuring, the faculty are busy presenting adequately the instructional material for a course. There is little time left for motivation, imparting the excitement of research and the thrill of discovery -- the very essence of biology.	8. Once a bank of minicourses have been prepared, a teacher has time to perform the important functions of motivation and communicating the excitement of scientific discovery. Other means of motivation might be through "The *BIO* Source Book" articles assigned to be precised and through guest speakers in general assemblies.

CHART 1. Disadvantages of Conventional Methods and Advantages of Minicourses, Summarized

9. To familiarize the student with the processes by which biological information is generated is one of the goals of the discipline. In the conventional facilities, it is difficult for the student to undertake on-going research projects.	9. In minicourse programs it is possible to include minicourses designed to show students how experiments are performed, observations made, and data collected without having to experience the frequently discouraging episodes of frustration and disappointment which accompany most experiments. Such a minicourse is: "Observing Behavioral Patterns on Rap Pups," BSCS Experimental Edition 1974. (See VIII, Appendix, Attachments) Often conventional teaching methods encroach on the creative life of the teacher, replacing rather than supplementing the teacher's own development as a scientist. Introducing minicourse programs may remedy this. Preparing minicourses can be very creative, involving much research, especially ones like the rat pup minicourse mentioned above. In the new programs, teachers should have more time to examine and explore biological materials with their students.
10. Under the conventional method, the student's role is sometimes a passive one. He may become too dependent on the teacher who usually specifies exactly how he should proceed. This often makes a timid student and fosters dependence on authority. In this atmosphere, the student does not develop a sense of responsibility for his own learning.	10. The outstanding characteristic of a minicourse is active student participation at every step. The student learns by doing. The responsibility for learning is placed directly on the student.
11. Conventional methods are group-oriented. Usually, the main focus is on teacher performance, especially in lectures. The teacher is the disseminator of knowledge which is primarily directed to the group as a whole, not to the individual student.	11. In minicourses, the emphasis is on the student's learning activities rather than on the teacher's teaching activities. Rather than be group-oriented, they are individual-oriented, providing maximum student freedom for independent study. The teacher's role in the minicourse programs is quite different than in conventional courses. Here he is a resource person, giving guidance and encouragement when needed.
12. Although we know the value of seminars and group discussions as an educational method, there is little place or time available for these in the present system. Free exchange of ideas among students in small groups of no more than eight or ten is not possible.** Every student in biology should have these experiences.	12. The Integrated Quiz Session (seminar-type) with 8-10 students is one of the most important educational experiences of a minicourse program.
13. In large classes of one or more lecture sections with many laboratory sections, it is almost impossible to synchronize the lecture material with the laboratory material. This situation does not make for the most effective teaching because the learning events are not close enough to one another to be an integrated sequence.	13. Minicourses, using the audio-tutorial system, bring into an integrated sequence all the learning experiences of the conventional courses -- lecture, laboratory, recitation. All learning events tend to complement and enhance each other. Teachers need no longer worry about synchronizing lectures and laboratories.
14. In any learning situation, the environment around the learner plays an important part in the success or failure. Certainly, the atmosphere should be one conducive to study and concentration. Large groups in both lectures and laboratories provide distractions to the student and thus, at times, tend to lower his concentration on the subject matter.	14. The audio-tutorial system used in the minicourses permits the students to concentrate during their study. In the individual booths they are not distracted, for there they are isolated from their surroundings.
15. Increases in enrollment have resulted in full use of teaching areas, hence inflexibility of room scheduling and heavy teacher loads. As a result, there is a lack of both facilities and free faculty for either make-up work or advanced study.	15. In a minicourse program, using the A-T strategy, the Learning Center is open every day, all day long, and in the evenings. Inflexibility of room scheduling is no problem. All make-up and advanced or in-depth work is done here. Tapes and other self-helps free the teachers to work with the individual students or have timely discussions with groups of students.

16. Precise techniques, such as delicate dissections, identification of materials on microscopic examination, and many experimental procedures, cannot be shown effectively to a class as a whole or even to groups of students. If the materials involved are minute, the procedure must be repeated many times in the conventional laboratory.	16. Once minicourses are available, the teacher is freed from the routine of teaching repeatedly the same material. This is true because multiple lecture and laboratory sections are dispensed with. It is true also as regards small groups or individual demonstrations. If the tapes are properly structured, there is little need for demonstrating. Labeled photographic prints, 2x2 Kodachrome slides and programmed notes substitute for the tedious repeating of demonstrations of precise techniques as in microbiology, or delicate dissections in anatomy. Students can find even the smallest structure in a microscope section if the directions on the tape are explicit and the photographs for illustration, taken at different levels of magnification, are clearly labeled. (See VIII, Appendix, Attachments - Ilma M. Brewer, "An Audio-Visual Method of Teaching and Learning," Section K, Reference and Attachment Booklet. Also, see Lois Beishir, "Individualized Instruction for the Allied Health Sciences," 1974.)
	ADDITIONAL ADVANTAGES
	If a minicourse or cluster of minicourses involves primarily portable items, they can be made available outside the Learning Center. Conceivably, several minicourses, constituting a relatively high proportion of a regular course, could be studied at home, or in a hospital. Transfer of materials between courses and between institutions is more readily accomplished with minicourses. A minicourse can be used in several different courses, thus reducing the cost of development. [Credit received for passing a minicourse is permanent. Since students may retain credit for any minicourse completed, they need not repeat a minicourse even though they take several courses in which the same minicourse is required.] They make exchange programs feasible.

(*) Even though the following leniencies in the grading system prevail at Montgomery College, often the penalty is the outcome of weeks of wasted time, and the student receives no credit for the segments of the course which he may pass. True: The grades of "W" and "WP" (Withdrawn and Withdrawn, Passing) are not counted in computing the value of quality points earned. True: Up to the end of the fifth week, "W" is not even put on the Transcript. True: The student can withdraw from a course up to the eleventh week. But, he cannot enter another course to take the place of the one he drops until the next semester.

(**) In laboratory sessions, where discussions may take place, the numbers of students are usually twenty-four or more and the time for discussions or student presentations is often limited.

IV. Proposed Program of Minicourses for Third Campus

A. Analysis: Table 4 - Analysis and Organization of Minicourses

An examination of Tables 2 and 3 revealed duplications of subject matter in courses in biology, botany and zoology offered at Montgomery College.* In Table 4, the information in Tables 2 and 3 is condensed so that it can be shown on one table. Subjects included in all 100-courses are arranged as titles of minicourses. Bi 103 and Bi 131 and 132, although added to the table, are not completely analyzed; only the areas of overlap with the other courses are shown. They are in the health-related curriculums on the Takoma Park Campus and will not be offered at Germantown.

Following the organization patterns used at Purdue University, the minicourses are arranged in groups and given numbers: the minicourses which deal with fundamental concepts and principles of biology and are common to the first-level courses, C's, Group 1; the first-level plant subjects, P's, Group 2; the first-level animal subjects, A's, Group 3; the second-level plant subjects, 2 P's, Group 5; the second-level animal subjects, 2A's, Group 6. The designations Groups 4, 7, and possibly 8, are reserved for pools of optional minicourses, which deal with a large variety of topics in biology. From these special-emphasis and supplementary-study optionals, the students may choose the specified number of units required to complete a course or to obtain a grade higher than "C."

The checks in the blocks indicate the inclusion of a minicourse subject in particular conventional courses. The redundancies are immediately evident. Conventional course distinctions become blurred as attention is focused on the 65 basic minicourses.

(*) The fact that the same topic appears in two or three different courses does not mean that the topic includes the same material, takes the same amount of time and has the same emphasis in each course. For example, the phylum Annelida is "covered" in both Biology II (Bi 102) and Zoology II (Bi 122). In Biology II, where anatomy and physiology are often taught comparatively, the organs and systems of the earthworm are compared with those of higher organisms including man. Very little, if any, time is spent studying examples of the three classes of the Annelida: Polychaeta, Oligochaeta, and Hirudinea. Whereas, in Zoology II, often examples of all three classes are studied, as well as the trochophore larval stage of the archiannelid, Polygordius. Reproduction, development and behavior of all may be included.

In order to overcome this difficulty, minicourses should be prepared in clusters or series so that some may be taken without others. There might be the Energy Series, the Genetics Series, the Cell Cluster, even the Annelids Cluster. In this system, a student may explore as deeply into a subject as his inclinations, abilities and curriculum will allow.

Conventional Course Titles and Numbers	Group 1												Group 2														Group 3		
	1 INTRODUCTION TO BIOLOGY (DIVERSITY)	2 MICROSCOPE	3 UNIT OF LIFE E.C.U.	4 PHYSICAL ENVIRONMENT OF CELLS	5 HUMAN STRUCTURES	6 COMPLEMENTARITY: STRUCTURE & FUNCTION (Cells)	7 RESPIRATION - CELLULAR	8 DNA REPLICATION	9 MITOSIS	10 DNA MEIOSIS	11 GENETICS	12 ECOSYSTEM STRUCTURE & FUNCTION	13 PLANT DIVERSITY	14 PIGMENTS & LIGHT	15 LEAF	16 PHOTO-SYNTHESIS	17 MERISTEMS	18 STEMS	19 ROOTS	20 TRANSPORATION	21 MINERAL NUTRITION	22 GROWTH DEVELOPMENT: HORMONES	23 GROWTH DEVELOPMENT: LIGHT	24 REPRODUCTION: PLANT, FLOWER FRUIT, SEED	25 GERMINATION	26 LIFE CYCLES PLANT	27 SPECIAL LIFE CYCLES PLANT	28 HOMEOSTASIS	29 ANIMAL DIVERSITY LOWER ANIM	30 ANIMAL DIVERSITY HIGHER ANIM
First Level:	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	A1	A2	A3
101 Gen.Bio. I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
103 Basic Hum.Sci.	✓		✓			✓			✓		✓																			
111 Botany I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
121 Zoology I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																✓	✓	✓
131 Human Structure & Functions	✓	✓	✓	✓		✓			✓																					
Second Level:																														
132 Human Structure & Functions							✓																							
102 Gen. Bio. II																						✓	✓	✓						
112 Botany II																														
122 Zoology II																													✓	

Conventional Course Titles and Numbers	Group 3 (continued)															Group 5						Group 6								
	31 ORGANIZATIONAL LEVELS	32 SUPPORT SYSTEMS	33 ANIMAL NUTRITION	34 DIGESTION	35 ABSORPTION UTILIZATION	36 TRANSPORT	37 GAS EXCHANGE	38 EXCRETION	39 KIDNEY STRUCTURE & FUNCTION	40 LOCOMOTION	41 MUSCLE: STRUCTURE & FUNCTION	42 CHEMICAL REGULATION	43 COORDINATION	44 GAME TO GENESIS	45 ANIMAL DEVELOPMENT	46 MONERA	47/48 ALGAE	49/50 FUNGI	51/52 BRYOPHYTES	53 PTERIDO-PHYTES	54 SPERMATO-PHYTES	55 INVERTEBRATE RELATIONSHIPS	56 PROTOZOANS	57/58 PORIFERANS-COELENTERATES	59 PLATYHEL-MINTHS	60 ANNELIDS	61 MOLLUSKS	62/63 ARTHROPODS	64 ECHINO-DERMS	65 LOWER CHOR-DATE-EVOLUTION
First Level:	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	P3	2P 4, 5	2P7-9	2P10, 11	2 P 14	2 P 15	2A1	2A2	2A 3, 4	2A5	2A7	2A6	2A 9, 10	2A 11	2A 12
101 Gen. Bio. I												✓																		
103 Basic Hum.Sci.	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓													
111 Botany I																														
121 Zoology I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓															
131 Human Structure & Functions		✓								✓	✓	✓	✓																	
Second Level:																														
132 Human Structure & Functions			✓	✓	✓	✓	✓	✓	✓					✓	✓															
102 Gen. Bio. II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
112 Botany II																✓	✓	✓	✓	✓	✓									
122 Zoology II																						✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE 4. MINICOURSE SUBJECTS AND NUMBERS

B. Breakdown: Suggested Groups of Minicourses

1. Introductory Series, Groups 1 through 4

After comparison of the syllabi of lectures and laboratories, Takoma Park and Rockville Campuses, Bi 101, Bi 111, Bi 121, with the titles of the pool of 80 minicourses from which Purdue's Bi 108-109 operates, it was decided to use Purdue's four groups of minicourses, with slight revision, for the purposes of this report. The reasons for this decision are threefold:

a. The topics are sufficiently similar to allow for the adoption, with minor alterations, under the umbrella of the three conventional courses.

b. The Purdue Minicourse Program has been in existence since 1969, and has been constantly reviewed and perfected during that time. All the minicourses have been given units of credit, and the number of units per course credit determined. The pre-requisites, if any, have been stated. Presumably, there is no question about their transferability.

c. Seventeen of Purdue's minicourses (preliminary versions) have been obtained already. In 1975, enough minicourses will be published by W. B. Saunders Company to cover a full year's introductory biology course. If the minicourse concept is adopted, it is recommended that Montgomery College use some of these to supplement the ones prepared by their own team of teachers. (In a minicourse program, substitutions and alterations can be made as needed with a minimum of cost and effort.)

In Groups 1 - 4 there are:

Minicourse Series	Number of Minicourses	Units
A	18	26.5
P	15	26.5
C	12	17.0
Op	35 (from which to pick 17.0 units)	46.5
	80	

For 8 credits of biology:

First Course	Second Course
Biology (Bi 101)	Biology (Bi 102)
Botany (Bi 111)	Zoology (Bi 121) or Botany (Bi 112)
Zoology (Bi 121)	Botany (Bi 111) or Zoology (Bi 122)

Four (4) credits = 43.5 units (26.5 A's or P's + 17.0 C's or Op's)

The three first-level conventional courses have now become a pool of eighty minicourses. Each offers the series of common (C) minicourses, and in addition, a series of plant (P) or animal (A) minicourses; or in the case of Bi 101, a combination of (P) and (A) minicourses. A student takes only one of these courses in a semester. The series of common (C) minicourses are taken with the first course in which a student is enrolled. A student taking both botany (Bi 111) and zoology (BI 121) would skip the minicourses he had already taken and go on to some of the optional ones. In other words, he trades off commons for optionals in the second semester.

The usual sequence at Purdue University is botany with the commons the first semester, and zoology with the optionals the second semester. It is recommended that Montgomery College's third campus start with this sequence. After second-level minicourses are developed, it would be possible for a student to begin his biology program with Zoology II (Bi 122) or Botany II (Bi 112), provided he takes the common (C's) with the first course in which he was enrolled. "The compatibility of the minicourse system with conventional procedures makes it possible to intermix the two approaches with no loss or problem to the student." (Reference #19)

A few of the "slight revisions" referred to above might be cited:

a. A 2 Group 3 — Animal Diversity: The Lower Animal Phyla might be moved to the first of "2A" Series, Group 6, and another substituted.

b. P16 & P17 Group 2 — Life Cycles and Special Life Cycles A-F. Probably these are included with the "2P" Series. If they are completed in Bi 111, they need not be repeated in Bi 112.

c. Op 47 Group 4 — Fishing Indiana Lakes and Streams might be changed to "Harvesting Crabs and/or Oysters in the Chesapeake Bay" (see 2 Op's and 3 Op's, Groups 7 and 8).

The optional courses offered for the student's choices should be of current interest and regionally applicable.

LIST OF MINICOURSES
FIRST LEVEL
GROUPS 1 - 4

Group 3 — Series "A"

Mini-course No.	Units	Title	Pre-requisites
A 1	1.0	Homeostasis: The State of Changing Sameness (Westinghouse)	
A 2	2.0	Animal Diversity: The Lower Animal Phyla (Westinghouse)	
A 3	2.0	Animal Diversity: The Higher Animal Phyla (Westinghouse)	
A 4	1.0	Organizational Levels	
A 5	2.0	Support Systems	
A 6	1.0	Animal Nutrition	
A 7	1.5	Digestion	
A 8	1.0	Absorption and Utilization	
A 9	1.5	Transport	
A 10	1.0	Gas Exchange	
A 11	1.5	Excretion	
A 12	1.0	Kidney Function	
A 13	2.0	Coordination	
A 14	1.5	Chemical Regulation (Westinghouse)	
A 15	1.5	Locomotion	
A 16	1.5	Muscle: Structure and Function	
A 18	2.0	Gametogenesis and Reproduction	
A 19	1.5	Animal Development (Westinghouse)	
18	26.5		

Group 2 — Series "P"

P 1	2.0	Diversity of Plants	C 1
P 2	2.0	Germination	
P 3	2.0	Leaf	C 3, C 4
P 4	2.0	Transpiration	C 5, P 3
P 5	2.0	Photosynthesis	P 8
P 6	2.0	Mineral Nutrition	
P 7	1.0	Meristems	C 12
P 8	1.5	Pigments and Light	
P 9	1.5	Structure, Stem	P 7
P 10	1.5	Structure, Root	P 9
P 12	2.0	Growth and Development, Auxins	
P 13	2.0	Growth and Development, Light	
P 14	2.0	Reproduction in Plants	C 16
P 16	1.00	Life Cycles	
P 17	2.0	Special Life Cycles A-F	P 16
15	26.5		

Group 1 — Series "C"

Mini-course No.	Units	Title	Pre-requisites
C 1	1.0	Diversity	
C 2	1.0	Complementarity of Structure and Function	
C 3	1.0	Use of the Microscope	
C 4	2.0	Unit of Life	C 3
C 5	1.0	Physical Phenomena of Cells	
C 6	2.0	Ultrastructure	
C 9	1.5	Respiration	
C 11	0.5	DNA Replication	
C 12	1.5	Mitosis	C 11
C 13	2.0	Structure-Function of Ecosystem	
C 16	1.5	DNA - Meiosis	C 11
C 17	2.0	Genetics	C 16
12	17.0		

Group 4 — Series "OP"

Op 1	2.0	Evolution	
Op 5	1.5	Population Pollution	
*Op 6	1.5	Behavior	
Op 7	1.0	Regeneration	
Op 8	2.0	Human Genetics	C 17
Op 9	1.0	Wood Anatomy	
*Op 10	1.0	Origin of Life	
Op 11	1.0	Birth Control	
Op 12	1.5	The Vertebrate Skeleton	A 5
Op 14	1.5	The Problem of Population	
Op 16	2.0	Heart Dynamics	A 9
Op 17	1.0	The Eye: Structure & Function	
Op 18	2.0	Nerve Transmission	A 13
Op 19	1.0	Color of Man	Op 1 & C 17
Op 20	1.5	Evolution of Man	Op 1
Op 21	1.0	The Ear: Structure & Function	
Op 22	2.0	Complementarity of Organism & Environment	
Op 30	1.5	Animal Adaptation	
*Op 32	1.0	Drugs	
Op 34	1.5	Pulmonary and Heart Disease	
Op 35	1.5	The Biological Clock	
Op 36	1.5	Everglades	
Op 37	1.5	Venereal Disease	
*Op 38	1.0	You and Disease	
Op 39	1.0	Water Pollution	
Op 40	1.0	Protein Synthesis: Part I	
Op 41	2.0	Protein Synthesis: Part II	
Op 43	1.5	Endosymbiotic Theory of Evolution of Eucaryotic Cells	
Op 44	1.5	Human Reproduction	
Op 45	1.5	Puberty and Menstrual Cycle	
*Op 46	1.0	Succession	
Op 47	1.0	Fishing Indiana Lakes and Streams	
Op 48	1.0	Lawn and Turf Care	
Op 49	1.0	Fish Out of Water (TV Tape)	
Op 50	1.0	Echolocation (TV Tape)	
35	46.5		

(*) Study Guides for Certain Options May be Purchased at the Bookstore.

2. Second Series, Covering Existing Courses Bi 102, 112, 122

The Postlethwait A-T minicourse method adapted to Montgomery College's own requirements.

The list of minicourses - Second Level, Groups 5 and 6 - were the topics identified for Bi 112 and Bi 122. The curriculum of the two courses now becomes a collection of 30 minicourses:

Bi 112 - 4 credits = 26.5 2 P's + 17.0 2 Op's = 43.5 units
Bi 122 - 4 credits = 26.5 2 A's + 17.0 3 Op's = 43.5 units

The minicourses for Bi 102 will be found scattered between Series 2 P, Series 2 A, and Series A (Bi 112, Bi 122, Bi 121).

Students registered in either Biol 101 or 102 should see an instructor in the program to have a plan of study worked out for them.

The list of minicourses, Groups 7 and 8, the optional 2 Op Series and 3 Op Series, are suggestions only. Many of them propose as a possibility, in-depth studies or on-going research projects which could be completed for A/B grades. Some of these second and third series Op's, when developed, might be substituted for certain of the Group 4, Op Series now in use at Purdue University.

Optional minicourses provide students with a richer variety of subjects and a greater choice than the conventional courses. Through the development of more optionals and alternate minicourses, the "latitude of coverage" can be increased constantly (Reference #8).

Optional minicourses may be generated in the following ways:

a. In response to requests from students and advisors. (Students may develop minicourses.)

b. As a result of discussions around the coffee urn or in small assembly sessions.

c. Faculty members may put some of their particular areas of investigation into minicourses. Students usually are interested in learning about a professor's "pet" research project.

d. Need of students for more background in chemistry, mathematics, physics or geology. The optional minicourses resulting from this "need" plus some biology minicourses, would form the nucleus of an interdisciplinary "course."

LIST OF MINICOURSES
SECOND LEVEL
GROUPS 5 - 8

Group 5

Series "2 P" (Bi 112)

Mini-course No.	Units	Title	Pre-requisites
2 P 1	1.5	Diversity of Plants II	
2 P 2	1.5	Representatives of Plant Divisions	
2 P 3	2.0	Monera (Bacteria/Blue Green Algae)	
2 P 4	2.0	Algae (Green/Yellow)	
2 P 5	2.0	Algae (Brown/Red)	
2 P 6	1.5	Slime Molds	
2 P 7	2.0	True Fungi	
2 P 8	2.0	Sac Fungi	
2 P 9	2.0	Club Fungi	
2 P 10	2.0	Liverworts	
2 P 11	2.0	Mosses	
2 P 12	1.0	Club Mosses	
2 P 13	1.0	Horsetails	
2 P 14	2.0	Ferns	
2 P 15	2.0	Gymnosperms	
15	26.5		

Group 6

Series "2 A" (Bi 122)

2 A 1	1.5	Invertebrate Relationships	
2 A 2	2.0	Protozoa	
2 A 3	1.0	Porifera	
2 A 4	2.0	Coelenterata	
2 A 5	2.0	Platyhelminthes	
2 A 6	1.5	Aschelminthes	
2 A 7	2.0	Annelida	
2 A 8	2.0	Mollusca	
2 A 9	2.0	Arthropoda - Crustacea	
2 A 10	2.0	Arthropoda - Insecta	
2 A 11	2.0	Echinodermata - Anatomy & Physiology	
2 A 12	1.5	Invertebrate Chordata	
2 A 13	2.0	Evidences of Organic Evolution	
2 A 14	1.0	Origin of Life - Invertebrate Phylogeny	
2 A 15	2.0	Ecology	
15	26.5		

Group 7

Series "2 OP"
(Options with "2P"-Plant Options)

Mini-course No.	Units	Title	Pre-requisites
2 OP 1	1.0	Carolus Linnaeus	
2 OP 2	1.0	Tobacco Mosaic Virus	
2 OP 3	1.5	Nitrogen-Fixing Bacteria	
2 OP 4	2.0	Action of Penicillin on Bacteria	2P3 and 2P7
2 OP 5	1.0	Kelp Harvesting	2 P 5
2 OP 6	1.0	Importance of Red Algae in Nature	
2 OP 7	1.5	Diatoms - "The Grass of the Sea"	
2 OP 8	2.0	Lifecycle of Saprolegnia	
2 OP 9	1.5	Fungus Growth in Tropics & Operations of Military Force	
2 OP 10	1.5	Growing Mushrooms Commercially	
2 OP 11	2.0	Vegetative Reproduction	
2 OP 12	1.5	Preventing or Reducing Soil Erosion	
2 OP 13	2.0	The Lichen Symbiosis	
2 OP 14	1.0	Medicinal Properties of Plants	
2 OP 15	1.0	Paleobotany -- Study of Plant Fossils	3 OP 27
2 OP 16	1.5	Evolution of Plants	
2 OP 17	1.0	Medieval Herbals	
2 OP 18	2.0	Parasitic Plants - Parasitism, A Biotic Relationship	
2 OP 19	1.5	Allergenic Plants	
2 OP 20	1.5	Poisonous Plants	
2 OP 21	1.5	Ginkgo - "A Living Fossil"	
2 OP 22	1.5	Narcotic Plants	
2 OP 23	1.0	Marine Biological Laboratories	
2 OP 24	1.0	Oceanographic Institutions	
2 OP 25	1.0	Man's Future Beneath the Sea	
2 OP 26	1.0	Economic Botany	
2 OP 27	2.0	Maintaining Marine Aquaria	
2 OP 28	1.5	Life in a Sea Forest	
2 OP 29	1.5	Unbalanced Ecology in Coastal Seas	
2 OP 30	1.5	Chlorophyll in the Ocean	P8 and P5
2 OP 31	1.5	Polluting the Sea	
2 OP 32	1.0	Marine Ecology in Relation to Radioactive Wastes	
2 OP 33	1.0	The Effect of Pesticides on Life in the Sea	
33	46.0		

Group 8

Series "3 OP"
(Options with "2A"-Animal Options)

3 OP 1	1.5	Locomotion in Amoeba
3 OP 2	2.0	Conjugation in Paramecium
3 OP 3	2.0	Culturing Protozoa
3 OP 4	2.0	Identification of Three Species of Euplotes
3 OP 5	1.5	Marine Zooplankton
3 OP 6	1.0	Bioluminescence
3 OP 7	1.5	Light Receptors of Animals

Group 8 (continued)

Mini-course No.	Units	Title	Pre-requisites
3 OP 8	1.0	Poisonous Invertebrates	
3 OP 9	2.0	Reflexes and Behavior of Coelenterates	
3 OP 10	1.5	Regeneration	
3 OP 11	2.0	Parasitism as a Great Phenomenon of Life	
3 OP 12	1.0	Evolutionary Trends in Bilateral Nervous System	2A5, 2A7
3 OP 13	1.0	Species and Speciation	
3 OP 14	1.0	Coral Physiology and Reef Ecology	
3 OP 15	1.0	Behavior in Lower Organisms	
3 OP 16	2.0	Bryozoa	
3 OP 17	1.0	Rotifera or "Wheel Animalcules"	
3 OP 18	1.5	Coordinating Systems and Color Change	
3 OP 19	1.0	Movement Without Limbs	
3 OP 20	1.0	Evolution of Legs	
3 OP 21	1.5	Warning Coloration & Mimicry in Animals	
3 OP 22	1.5	Insect Communication	2 A 10
3 OP 23	1.5	Social Life of Bees	2 A 10
3 OP 24	1.5	Flight and Control of Movement (Insects)	2 A 10
3 OP 25	1.0	Cocoon Construction	2 A 10
3 OP 26	1.0	Fossil Forms and Extinct Groups (Fossil Rec.)	3 OP 27
3 OP 27	1.5	Geological Eras and Periods	
3 OP 28	1.5	Reproductive Patterns	
3 OP 29	1.0	Terrestrial Habitats	
3 OP 30	1.0	Radiocarbon Dating	
3 OP 31	1.5	Structure of an Ocean Basin	
3 OP 32	1.0	Voyages of Scientific Exploration	
3 OP 33	1.5	Competitive Coexistence Among Intertidal Invertebrates	
33	45.5		

3. Proposed Sequences and Schedules

Most of the following sequences and schedules of A, P, C, and Op minicourses are currently being used at Purdue University. They are presented in this report as suggested patterns only.

MINICOURSE SEQUENCE FOR BIOLOGY 111

WK	DATES	COMMON	NO.	UNIT VALUE	PLANTS	NO.	UNIT VALUE	OPTIONALS
1	Aug. Sept.	Diversity Microscope	C1 C3	1.0 1.0	Diversity	P1	2.0	STUDENTS TAKING OPTIONALS SHOULD REFER TO THE SCHEDULE FOR MINICOURSE SEQUENCE, BIOLOGY 121.
2	Sept. Sept.	Comp. Str. Function Unit of Life	C2 C4	1.0 2.0				
3	Sept. Sept.	Physical Phenomena	C5	1.0	Pigments & Light	P8	1.5	
4	Sept. Sept.				Leaf Photosynthesis	P3 P5	2.0 2.0	
5	Sept. Oct.	DNA Replication Mitosis	C11 C12	0.5 1.5	Meristems	P7	1.0	
6	Oct. Oct.				Stems Roots	P9 P10	1.5 1.5	
7	Oct. Oct.				Transpiration Mineral Nutrition	P4 P6	2.0 2.0	
8	Oct. Oct.	Ultrastructure	C6	2.0	Growth & Development: Auxins	P12	2.0	
9	Oct. Nov.	Respiration	C9	1.5	Growth & Development: Light	P13	2.0	
10	Nov. Nov.	Meiosis	C16	1.5	Reproduction	P14	2.0	
11	Nov. Nov.	Genetics Ecosystem	C17 C13	2.0 2.0				
12	Nov. Nov.				Germination Life Cycles	P2 P16	2.0 1.0	
13	Dec. Dec.				Special Life Cycles	P17 A-F	2.0	
14	Dec. Dec.							
			(12)	(17.0)		(15)	(26.5)	

MINICOURSE SEQUENCE FOR BIOLOGY 121

WK	DATES	ANIMAL	NO.	UNIT VALUE	OPTIONALS	NO.	UNIT VALUE
1	Aug. Sept.	Homeostasis	A1	1.0	Fishing. Ind. Lakes & Streams	47	1.0
					Evolution	1	2.0
2	Sept. Sept.	Animal Diversity: Lower Phyla	A2	2.0	The Problem of Population	14	1.5
					Wood Anatomy	9	1.0
					Origin of Life	10	1.0
					Birth Control	11	1.0
3	Sept.	Animal Diversity:Higher Phyla	A3	2.0	Fish Out of Water (TV Tape)	49	1.0
	Sept.	Organizational Levels	A4	1.0	Regeneration	7	1.0
					Evolution of Man	20	1.5
4	Sept.	Support Systems	A5	2.0	Com. of Org. Environment	22	2.0
	Sept.	Animal Nutrition	A6	1.0	Venereal Disease	37	1.5
					Lawn and Turf Care	48	1.0
5	Sept.	Digestion	A7	1.5	Echolocation (TV Tape)	50	1.0
	Oct.	Absorption/Utilization	A8	1.0	Population Pollution	5	1.5
					Behavior	6	1.5
6	Oct.	Transport	A9	1.5	Human Genetics	8	2.0
	Oct.	Gas Exchange	A10	1.0	Water Pollution	39	1.0
7	Oct.	Excretion	A11	1.5	Heart Dynamics	16	2.0
	Oct.	Kidney Str. & Function	A12	1.0	Pulmonary and Heart Disease	34	1.5
					Everglades	36	1.5
8	Oct.	Locomotion	A15	1.5	Vertebrate Skeleton	12	1.5
	Oct.				Puberty and Menstrual Cycle	45	1.5
9	Oct.	Muscle: Structure & Function	A16	1.5	Color of Man	19	1.0
	Nov.				Biological Clock	35	1.5
10	Nov.	Chemical Regulation	A14	1.5	Drugs	32	1.0
	Nov.				Animal Adaptation	30	1.5
					You and Disease	38	1.0
11	Nov.	Coordination	A13	2.0	Nerve Transmission	18	2.0
	Nov.				Human Reproduction	44	1.5
12	Nov.	Gametogenesis/Reprod.	A18	2.0	Protein Synthesis: Part I	40	1.0
	Nov.	Animal Development	A19	1.5	Protein Synthesis: Part II	41	2.0
13	Dec.				Endosymbiotic Theory: Origin of Eucaryotes	43	1.5
	Dec.				Succession	46	1.0
14	Dec.				The Eye	17	1.0
	Dec.				The Ear	21	1.0

Study Guides for Certain Optionals May Be Purchased at the Bookstore.

(18) (26.5) (35) (46.5)

FROM THE UNIVERSITY OF PURDUE PROGRAM

Large Assembly - Quiz and Summary Schedule for Biology 111

WK	DATE	ACTIVITY
1	Aug. 29 Sept. 5	Introduction to Biology 111 More Introduction and trouble shooting
2	Sept. 12	Summaries: Gibor - Mitochondria & Chloroplasts: Reproduction, Development & Heredity (p. 48) Dilley- Photosynthesis (p. 163)
3	Sept. 19	QUIZ over C1, C2, C3, C4
4	Sept. 26	Summaries: Comings - Chromosome Replication (p.62) Cronshaw- Support and Protection in Plants (p. 127)
5	Oct. 3	QUIZ over P1, P3, P5, P8
6	Oct. 10	QUIZ over C5, C11, C12
7	Oct. 17	Summaries: Evert - Transport of Food Substances in Plants (148) Bonner - Morphogenetic Movement in Plants (P. 176)
8	Oct. 24	QUIZ over P4, P7, P9, P10
9	Oct. 31	Summaries: Zeevaart - Plant Reproduction (p. 170) Beyer - Energy Transduction in Cells (p. 38)
10	Nov. 7	QUIZ over C6 and C9
11	Nov. 14	QUIZ over P6, P13, P13
12	Nov. 21	QUIZ over C13, C16, C17
13	Dec. 6	QUIZ over P2, P14, P16
14	Dec. 12	Summaries: Srb - Genes and Metabolic Pathways (p. 265) Pranka- Species Diversity (p. 401)

All summary articles are from: Topics in the Study of Life
The Bio Source Book
Copies are available in the Biology Library and from the bookstore.

Note: Dates shown are estimates only.

FROM THE UNIVERSITY OF PURDUE PROGRAM

Large Assembly - Quiz and Summary Schedule for Biology 121

WK	DATE	ACTIVITY
1	Sept. 4	Introduction to Biology 121
2	Sept. 11	More Introduction and trouble shooting
3	Sept. 18	Summaries: Kanwisher - Temperature Regulation in the Sea (p. 209) Sagan - Origin of Life (p. 430)
4	Sept. 25	QUIZ over A1, A2, A3, A4
5	Oct. 2	Summaries: Selander - Genetic Variation in Natural Populations (p. 441) Lash - Congenital Anomalies (p.123)
6	Oct. 9	QUIZ over A5, A6, A7, A8
7	Oct. 16	Summaries: Hess - The Imprinting Process (p. 314) Rhodin- Fine Structure of Capillaries (p. 215)
8	Oct. 23	QUIZ over A9, A10, A11, A12
9	Oct. 30	Summaries: Giebisch - Renal Function (p. 197) Schmidt-Nielsen - Marine Vertebrates--Problems of Salt and Water (p. 205)
10	Nov. 6	Summaries: Wilson - Lymphocytes and Immunity (p. 231) Konigeberg - Muscle Development in Culture (p. 105)
11	Nov. 13	QUIZ over A15, A16, A14
12	Nov. 20	Summaries: Hamilton - The Vertebrate Endocrine System and Its Regulation (p. 224) Smith - The Structure & Function of Synapses (p. 190)
13	Dec. 4	QUIZ over A13, A18, A19
14	Dec. 11	FILMS

All summary articles are from: Topics in the Study of Life
The Bio Source Book

Copies are available in the Biology Library and from the bookstore.

Note: Dates shown are estimates only.
These activities are on Wednesday of each week.

FROM THE UNIVERSITY OF PURDUE PROGRAM

ORAL QUIZ SCHEDULE

(Small Assembly Session)

Thur	Fri	Mon	Tues	ORAL QUIZ OVER	
				BIOL 111	BIOL 121
Sept. 5	Sept. 6	Sept. 9	Sept. 10	C1, P1, C3*	A1
Sept. 12	Sept. 13	Sept. 16	Sept. 17	C2, C4	A2
Sept. 19	Sept. 20	Sept. 23	Sept. 24	C5, P8	A3, A4
Sept. 26	Sept. 27	Sept. 30	Oct. 1	P3, P5	A5, A6
Oct. 3	Oct. 4	Oct. 7	Oct. 8	C11, C12, P7	A7, A8
Oct. 10	Oct. 11	Oct. 14	Oct. 15	P9, P10	A9, A10
Oct. 17	Oct. 18	Oct. 21	Oct. 22	P4, P6	A11, A12
Oct. 24	Oct. 25	Oct. 28	Oct. 29	C6, P12	A15
Oct. 31	Nov. 1	Nov. 4	Nov. 5	C9, P13	A16
Nov. 7	Nov. 8	Nov. 11	Nov. 12	C16, P14	A14
Nov. 14	Nov. 15	Nov. 18	Nov. 19	C17, C13	A13
Nov. 21	Nov. 22	Nov. 25	Nov. 26	P2, P16	A18, A19

*Students will take the quiz over C3, Microscope, with the instructor on duty when they are ready sometime between September 1 and September 15. Students will be asked oral questions and will demonstrate microscope techniques.

Note: Dates shown are estimates only.
Wednesday is reserved for Large Assembly sessions, when written quizzes are given and summary of scientific articles are written.

MINICOURSE SEQUENCE FOR BIOLOGY 112 - BOTANY II

WK	DATES	GROUP 5 - SECOND PLANT	NO.	UNIT VALUE	OPTIONALS	NO. 2 OP	UNIT VALUE
1	Aug. Sept.	Diversity of Plants II (Monera thru Gymnosperms)	2 P 1	1.5	Carolus Linnaeus , 1707-78, & Taxonomy	1	1.0
					Tobacco Mosaic Virus	2	1.0
2	Sept. Sept.	Representatives of the Plant Divisions - Systematic Study	2 P 2	1.5	Nitrogen - Fixing Bacteria	3	1.5
					Action of Penicillin on Bacteria	4	2.0
					Kelp Harvesting	5	1.0
					Importance of Red Algae in Nature	6	1.0
3	Sept. Sept.	Monera - Bacteria/Blue-green Algae	2 P 3	2.0	Diatoms - "The Grass of the Sea"	7	1.5
					Lifecycle of Saprolegnia	8	2.0
4	Sept. Sept.	Algae - Green/Yellow	2 P 4	2.0	Fungus Growth in Tropics & Operations of Military Force	9	1.5
					Growing Mushrooms Commercially	10	1.5
					Vegetative Reproduction	11	2.0
5	Sept. Oct.	Algae - Brown/Red	2 P 5	2.0	Preventing or Reducing Soil Erosion	12	1.5
					The Lichen Symbiosis	13	2.0
6	Oct. Oct.	Slime Molds	2 P 6	1.5	Medicinal Properties of Plants	14	1.0
					Paleobotany-Study of Plant Fossils	15	1.0
					Evolution of Plants	16	1.5
7	Oct. Oct.	True Fungi	2 P 7	2.0	Medieval Herbals	17	1.0
					Parasitic Plants-Parasitism a Biotic Relationship	18	2.0
8	Oct. Oct.	Sac Fungi	2 P 8	2.0	Allergenic Plants	19	1.5
					Poisonous Plants	20	1.5
					Ginkgo - "A Living Fossil"	21	1.5
9	Oct. Nov.	Club Fungi	2 P 9	2.0	Narcotic Plants	22	1.5
					Marine Biological Laboratories	23	1.0
10	Nov. Nov.	Liverworts	2 P 10	2.0	Oceanographic Institutions	24	1.0
					Man's Future Beneath the Sea	25	1.0
					Economic Botany	26	1.0
11	Nov. Nov.	Mosses	2 P 11	2.0	Maintaining Marine Aquaria	27	2.0
					Life in a Sea Forest	28	1.5
12	Nov. Nov.	Club Mosses	2 P 12	1.0	Unbalanced Ecology in Coastal Seas.	29	1.5
13	Dec. Dec.	Horsetails	2 P 13	1.0	Chlorophyll in the Ocean	30	1.5
					Polluting the Sea	31	1.5
14	Dec. Dec.	Ferns	2 P 14	2.0	Marine Ecology in Relation to Radioactive Wastes	32	1.0
		Gymnosperms	2 P 15	2.0	Effects of Pesticides on Life in the Sea	33	1.0
			(15)	(26.5)		(33)	(46.0)

Study Guides for Certain Optionals May be Purchased at the Bookstore.

Students who have not completed the Common Minicourses should substitute Group 1 - Common (C) for Optionals. (See Minicourse Sequence for Biology 111.)

MINICOURSE SEQUENCE FOR BIOLOGY 122 - ZOOLOGY II

WK	DATES	GROUP 6 - ANIMAL	NO.	UNIT VALUE	OPTIONALS	NO. OP	UNIT VALUE
1	Aug. Sept.	Invertebrate Relationships	2 A 1	1.5	Locomotion in Amoeba	1	
2	Sept. Sept.	Protozoa	2 A 2	2.0	Conjugation in Paramecium Culturing Protozoa Identification of three species of Euplotes Marine Zooplankton	2 3 4 5	
3	Sept. Sept.	Porifera	2 A 3	1.0	Bioluminescence Light Receptors of Animals Poisonous Invertebrates	6 7 8	
4	Sept. Sept.	Coelenterata	2 A 4	2.0	Reflexes & Behavior of Coelenterates Regeneration	9 10	
5	Sept. Oct.	Platyhelminthes	2 A 5	2.0	Parasitism as Great Phenomenon of Life Evolutionary Trends in Hilateral Nervous System	11 12	
6	Oct. Oct.	Aschelminthes	2 A 6	1.5	Species & Speciation Coral Physiology & Reef Ecology Behavior in Lower Organisms	13 14 15	
7	Oct. Oct.	Annelida	2 A 7	2.0	Bryozoa Rotifera or "Wheel Animalcules"	16 17	
8	Oct. Oct.	Mollusca	2 A 8	2.0	Coordinating Systems & Color Change Movement Without Limbs Evolution of Legs	18 19 20	
9	Oct. Nov.	Arthropoda-Crustacea	2 A 9	2.0	Warning Coloration & Mimicry in Animals Insect Communication	21 22	
10	Nov. Nov.	Arthropoda-Insecta	2 A 10	2.0	Social Life of Bees Flight & Control of Movement (Insects) Cocoon Construction	23 24 25	
11	Nov. Nov.	Echinodermata-Anatomy & Embryology	2 A 11	2.0	Fossil Forms & Extenct Groups(Fossil Rec.) Geological Eras & Periods	26 27	
12	Nov. Nov.	Invertebrate Chordata	2 A 12	1.5	Reproductive Patterns Terrestrial Habitats	28 29	
13	Dec. Dec.	Evidences of Organic Evolution	2 A 13	2.0	Radiocarbon Dating Structure of an Ocean Basin Voyages of Scientific Exploration	30 31 32	
14	Dec. Dec.	Origin of Life & Invertebrate Phylogeny Ecology	2 A 14 2 A 15	1.0 2.0	Competitive Coexistence Among Intertidal Invertebrates	33	
			(15)	(26.5)		(33)	(45.5)

Study Guides for Certain Optionals May be Purchased at the Bookstore.

Students who have not completed the Common Minicourses should substitute Group 1 - Common (C) for Optionals. (See Minicourse Sequence for Biology 111.)

4. Probable Common Combinations

The minicourses which the students will be studying depend on how they are enrolled - in biology Bi 101, botany Bi 111, or zoology Bi 121. The following combinations probably will be most commonly selected in the Introductory Series:

Option No.		
1	Bi 111 - 4 credits	No previous college biology, therefore, no previous Series C minicourses: Take all P and C minicourses.
2	Bi 111 - 4 credits	Had 121, therefore had C Series: Take all P minicourses and select 17 units of Op (optionals).
3	Bi 111 - 3 credits	No previous Series C minicourses, e.g. pre-pharmacy students: Take all C's and the following P's: 1, 3, 5, 6, 8, 12, 13, 14.
4	Bi 111 - 2 credits	Had 121, e.g. certain pre-pharmacy students: Take P's 1, 3, 5, 6, 8, 12, 13, 14, and select 8.5 units of Op.
5	Bi 111 - 1 credit	Student might already have had Biol 111 under Option 3 and is now taking the remaining plant minicourses (P 2, 4, 7, 9, 10, 16, 17) = 11.0 units.
6	Bi 121 - 4 credits	Had 111, 4 credits: Take all A's and select 17 units of Op.
7	Bi 121 - 4 credits	No previous college biology, therefore, no previous C Series minicourses: Take all A and C minicourses.
8	Bi 121 - 3 credits	All C's and selected A's (See Option 3).
9	Bi 121 - 2 credits	(See Option 4). If had all C's, select from A's for 2 credits.
10	Bi 121 - 1 credit	If had 121 under Option 8, take remainder of A minicourses.

If a student registers for General Biology I (Bi 101), or for some other reason does not fit into one of the above patterns, he would work out a plan of study with one of the full-time faculty in the Minicourse Program. For example, if a student registers for Bi 101 for 4 credits, he would have had no previous minicourses, so he would take all the C's and the remainder of necessary credits in about one-half A's and one-half P's.

V. Anatomy of a Minicourse

A. Minicourse Components

Title

Objectives
Test Items
Pre-requisites
Abstract
Audio Tape
Tangibles
Visuals
Study Guide
Instructor's Manual

Human Beings
Relationships
Student ⇄ Student
Teacher (*in person or on tape, or both*)
⇅
Student

Sessions
Independent Study Session
Tutorials
Integrated Quiz Session
General Assembly Session

Assessment Procedures

B. Guidelines for the Development of Minicourse Materials

The minicourses produced by the Minicourse Development Project at Purdue University are prepared by a development team, consisting of consultant, developer and student. The stages in the preparation of a minicourse are as follows: (See Chart No. 2, page 62)

Content Selection Stage
Initial Development Stage
Final Development Stage
Field Testing
Publication

"Each programme takes a minimum of about one hundred hours to prepare" for publication. (Ilma M. Brewer, Senior Lecturer in Biology, Sydney University, Australia)

Content Selection Stage

1. Title: Selecting the Topic

The first step in developing a minicourse is deciding what to teach; for example, dividing the content of three biology courses into small, reasonably coherent segments of subject matter (Table 4, page 43).

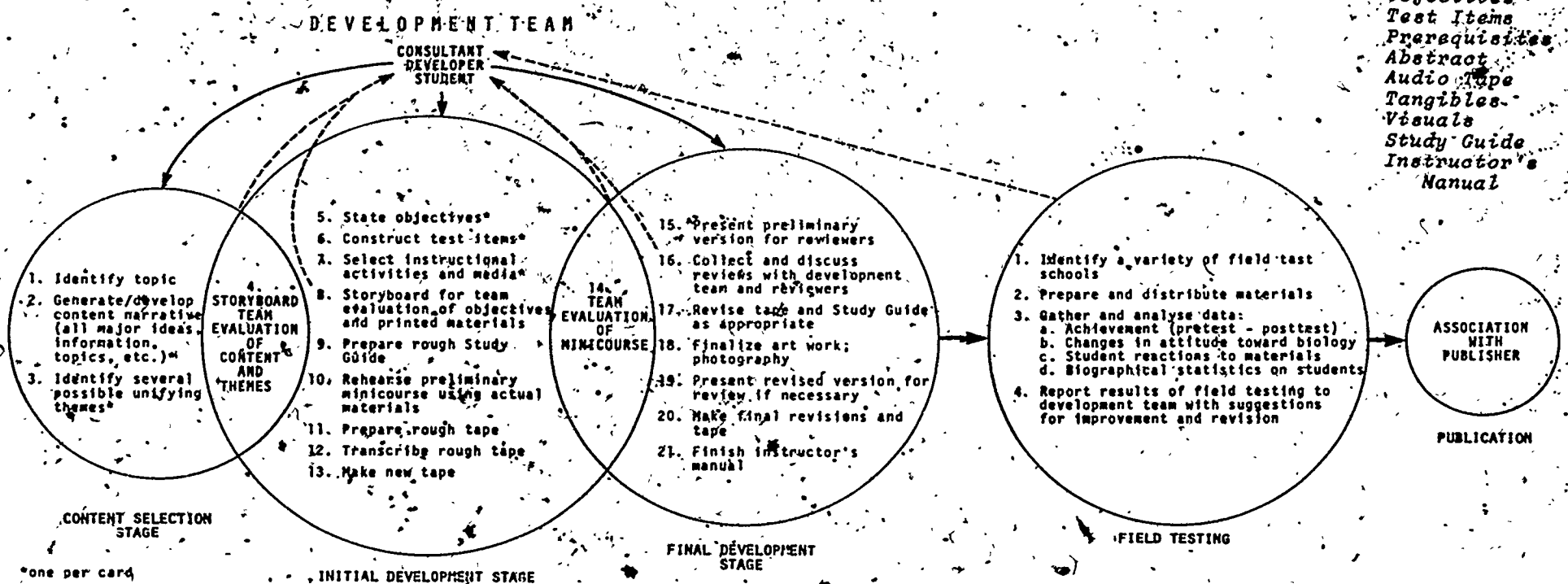


CHART 2. Guidelines for the Development of Minicourse Materials Used in the Minicourse Development Project at Purdue University. Study Guide: Minicourses - What Are They? (Reference #18)

Usually, minicourses are made up of a single concept which the average student is capable of mastering in a session of one to several hours. There are no rigid guidelines to follow in determining the limits of a minicourse, except perhaps "good judgment" or "what is appropriate" or "readily managed bites." A textbook is divided into chapters in much the same way.

Authorities agree, however, that each minicourse should represent less than one credit hour of conventional course work. At Purdue University there are about eight or ten minicourses per credit hour.

Before this stage is completed, a short narrative should be developed setting forth the major ideas, information, subtopics, and, if possible, several unifying themes of the proposed minicourse.

After working on the next component of a minicourse, the Objectives, the developer may find it necessary to change the limits of the topic.

Initial Development Stage

2. Objectives: Stating the Objectives

Each minicourse has a written set of specific objectives. These should be stated very clearly. Nothing should be introduced into the minicourse which is not covered by these objectives. In them, the teacher identifies for the student the ideas, concepts, responses, attitudes and possible manipulatory skills which he is going to learn in the minicourse.

The objectives are stated in terms of student performance expected, and thus can be used for testing the student's mastery of the concepts, etc., of the minicourse.

The objectives are presented to the student before instruction begins and all other components of the minicourse are directed toward helping him attain them. Since the student knows the objectives from the beginning of the course, he can direct his own activities toward complete mastery of them.

3. Test Items: Constructing the Test Items

Construction of test items should take place simultaneously with stating the objectives; since all tests are designed to measure the mastery of these objectives.

Tests may be of many types, but regardless of form, the "feedback"--students' performance results -- should be made without delay. Tests may take the form of "practicals;" for example, use of the compound microscope or animal dissection; or "identification" as in studies on classification.

During the Integrated Quiz Session, students are tested on their ability to see relationships, understand concepts, and correlate known facts, i.e., describe and tell the role of tangible items (specimens) in the objectives of the course. Also, students are evaluated on the questions which they ask of each other as all take turns in making presentations.

The evaluative post-test items are usually objective and graded by computer. There should be a mixture of types here.

Diagnostic pre-test items and self-test items must be assembled. The pre-test on the objectives should be prepared carefully, for passing gives students the privilege of taking the post-test for credit by examination. This allows for skipping minicourses or selecting optionals for special credit.

4. Pre-requisites:

Obviously, certain information and skills learned in certain minicourses are needed before beginning others; e.g., use of the microscope before cells or tissues and meiosis before genetics. These should be stated explicitly, but pre-requisites are less important than commonly thought. Students should be able to begin at almost any point in the system.

5. Abstract:

The short narrative or summary, written as an elaboration of the title, should serve as an abstract of the minicourse. This should contain a statement of purpose and perhaps the rationale. In a few words this tells what the minicourse is all about and why it was written, its relation to other minicourses in biology, and, in fact, to all of life.

The Abstract is the first item in the student's study guide.

6. Audio Tape:

The key to an effective minicourse is the quality of the message on the audio tape. After listing the objectives and the test items, the teacher developing a minicourse selects and assembles all the necessary instructional materials to teach one student how to master the objectives. While sitting among these materials, he designs a

combination of learning experiences -- an integrated sequence -- which will assist the student in mastering the objectives. Then, the teacher records on audio tape an imagined (a real one would be better) conversation with one student as he "tutors" that student step-by-step through the sequence of learning activities. The proper order here is very important, as well as the active involvement of the student in every step of the learning process. From this tape, after editing critically, the final script is written.

The final tapes, when completed should be recorded on large reel-to-reel tapes for use in the booths and for storage, and on cassette tapes of the best quality. Materials, including cassettes, for each minicourse should be made available to students for short-term use whenever feasible.

Characteristics of a Tape:

a. A tape is not a taped lecture nor is it a substitute for laboratory instructions. It is a "programming device to tutor the student through a variety of integrated learning experiences put together in logical sequence."

b. The teacher does not tell "all he knows" about a subject via the tape. Rather, he gives the "basic ideas upon which subsequent information and learning is dependent." The tape "includes the core material of the lecture, built up in an orderly sequence -- and incorporated with the practical work."

c. The tape does not go on and on without breaks; places where the student does something -- "gets involved." Instructed by the tape and using his Study Guide, "the student works by alternating such activities as listening, reading from texts, reprints or program notes, to handling material, observing or setting up experiments, looking at demonstrations, working out problems, or in short, engaging in any activity which the programmer can devise to allow the student to accomplish the objectives set out for the particular study session."

d. A tape should not be constructed so that the student spends his time stopping and starting, taking down every word of the tape. When the tape is strictly a lecture, the student has a tendency to do this, thus wasting much time.

(For all of the above quotes, see VIII, Appendix, Attachments - Ilma M. Brewer, "An Audio-Visual Method of Teaching and Learning," Section K, Reference and Attachment Booklet.)

7./8. The Communication Tools: Tangibles and Visuals

The instructional materials assembled by the teacher are of two sorts: tangibles and visuals. "Inquiry begins with something tangible." The tangible items are specimens, such as seeds, bones,

a plant, a frog; and models, microscopes and experimental equipment. Printed materials include study guide, Bio Source Book, reference books and journal articles. Visuals include large diagrams, charts and photographs; projected visuals are 2x2 slides, movies and videotape. All of these tools (the ones best suited to the objectives of any one minicourse) are integrated through the audio tape.

9. Study Guide:

The printed study guide is important. It outlines the minicourse, states the objectives, presents exercises, gives short paragraphs of reading material, raises questions and summarizes. It should include a glossary of terms and a list of references. The student should bring his study guide to all sessions. A textbook is not necessary.

10. Instructor's Manual:

The instructor's manual for each minicourse includes the following:

a. Instructional considerations:
   Who might use the minicourse
   What it does

b. Background information

c. Equipment and materials to be used in the booth, including, if possible, a picture of the booth and the demonstration table, set up for the minicourse.

   Audio-visual equipment
   Non-expendable material and supplies
   Expendable materials and supplies

   Everything referred to in the course should be there at the student's disposal and in the order in which they are referred to.

d. References for instructor

e. Suggested test items and answers, listed by objectives.

11. Human Beings:

Student-Student Relationship

"One really learns a subject when one is required to teach it." In a minicourse program, all students are teachers. For the Integrated Quiz Session, each student is expected to prepare little lectures about the tangible material (specimens) of the course. Other students, in turn, question him and comment on the items.

Teacher-Student Relationship

When students can assemble minicourses from a bank to construct their own curricula, the role of teacher as counselor becomes a very important one. The relationship teacher/counselor-to-student should not be overlooked. The most important component of the minicourse system is the teacher's capacity to identify the proper goals and the proper learning activities, in the proper sequence, to reach those goals.

In the booth, the teacher and student are "eyeball to eyeball" inquiring together of the specimens being studied. The student can ask questions of the teacher, but more often than not, his question will be answered by another question.

12. Sessions:

Independent Study Session:

This session usually takes place in the Learning Center where all the tangibles and visuals are assembled, and where the teachers are available. It takes place at the student's convenience and for as long a period or periods as he cares to spend. Through the audio tape, the student is piloted through a variety of learning experiences and activities using a variety of media. It combines what is conventionally presented as separate lectures and laboratory work.

Integrated Quiz Session: (A seminar-type session of 8-10 students each)

These are designed to produce student-to-student interaction. Before the quiz, students discuss difficult subject matter areas and quiz each other on the topic of the minicourse. They practice their individual presentations on each other. In the coffee areas and in the sessions themselves, the students learn by teaching. Each student's grade for the session is made known to him immediately after the session.

General Assembly Session:

a. Optional (At Purdue, at certain hours every Wednesday) Where resumes of articles, read for A, B grades, are written.

b. Where evaluative post-tests are written on scheduled dates.

c. Orientation

d. Guest lecturers > Attendance not required

13. Assessment Procedures:

The Integrated Quiz Session is an "effective feedback mechanism for information on the success or failure" of any minicourse or part of a minicourse. (Reference #19)

Assessment of a minicourse is based primarily on records of student performance. Revisions should be based on student achievement, changes in attitude toward biology, and student reactions to materials. If the students are not mastering the material, it is revised. The teacher is able to correct faulty material, know where he has succeeded, and if he has produced a successful minicourse by gathering and analyzing data all along the way.

C. Proposals Concerning Implementation

Curriculum Considerations

1. That the first offering of minicourses in biology on the new campus be limited to the Introductory Series, Groups 1 through 4; A, P, C, and Op.

2. That the faculty of the department be closely involved in scheduling. That the importance of counseling and scheduling in the department be fully understood. "Students are not prepared to take full responsibility for their own education." (Reference #9) There must be deadlines for getting minicourses completed. There must be quizzes at frequent intervals, as well as meetings (small and general assemblies). These are necessary procedures for monitoring a student's progress.

3. Recommend the use of a computer to "manage" the program. "Until the computer is brought in, the job of keeping track of which students are taking which minicourses, in what order, may be a limiting factor in the expansion of systems like Purdue's." (Reference #9) For in-the-department scheduling (units accumulated up to one credit)". . . the computer can keep a coherent, timely record of each student's educational program and prevent him from becoming lost in the pile of options available to him." (Reference #9)

4. The minicourse concept, if adopted by an entire college, would result in the "eventual blurring of the dimensions of both semesters and formal courses." (Reference #9) Administrators should note this and prepare to tackle the problems such an organization will pose.

5. The minicourse concept would be compatible with the proposed modular calendar, under which a student may take one course at a time in one module of time, or two courses at a time in two modules of time, etc. (Reference #11)

6. The "Incomplete" grade, which is used freely by the A-T minicourse system, "removes time as a factor in achievement since course credit is given when the material is learned, not when the semester ends." (Reference #9)

7. "Minicourses and Mastery" should be the slogan. The concept of mastery of material for everybody means that mastery of the required number of minicourses will result in a course grade of "C." There are no "D's" or "F's," only "I's" (Incomplete) for those who fail to learn the minimum amount; i.e. pass a sufficient number of minicourses.

8. For better and more ambitious students, work for "C" is not sufficiently challenging. "A" or "B" grades may be earned by accumulating additional points in a number of different ways: additional minicourses; research projects; extra readings; peer tutoring activities; special examinations which test problem-solving and synthesizing ability; library projects; outstanding performance on exams. Variable credit units will be possible and credit by examination available.

9. Early placement students (students still in high school) who take minicourses in advance may retain credit for them when they enter Montgomery College's Minicourse Program in Biology. Credit received for passing a minicourse is permanent.

Staffing

Recommended qualifications of the Developer-Director - First Full-Time Faculty Member:

1. A scholar, whose area of specialization is in one of the biological sciences. Probably scholarship is more important in an A-T minicourse program than in the conventional method.

2. Experience in teaching biology at college level, and in particular, A-T experience. As a further insurance of the program's success, the Developer should have had experience developing and teaching minicourses.

3. Of course, a genuine concern for and liking of students. No program will succeed without this quality in its faculty.

4. Must be completely committed to the A-T minicourse concept -- not just paying it "lip service," but giving proof of his commitment.

5. Evidence of leadership, so that he might persuade and/or train others in this concept.

6. Not employed by the so-many-credit-hour teaching load, but by the job. There must be a clear understanding of what is expected in that job; that the working week may be 60+ hours (Reference #9); that continual revision of minicourses, or writing of new ones, is a part of the job and not to be put off until "released time" is granted or a summer appointment made; and that student counseling is a part of the job as well.

Recommended qualifications of the Technical Assistant - Coordinator: This will be a key appointment, especially if the minicourse method is adapted to the entire curriculum of the third campus.

1. Experience in an A-T center (if possible, in two or more areas, such as Language Laboratory and A-T Zoology).

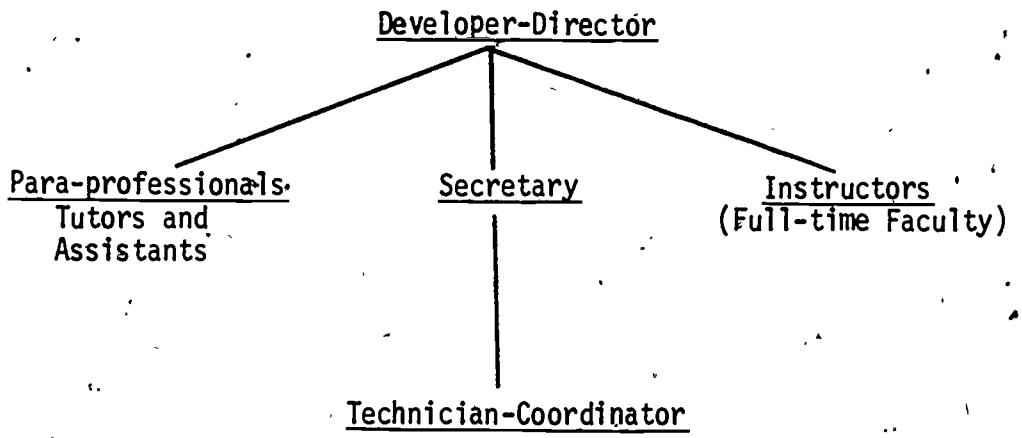
2. Experience in every aspect of recording, reproducing, evaluating and maintenance of sound equipment. Expert recordings will be very important.

3. Experience in developing visual materials, i.e. making museum and teaching displays.

4. Teaching experience, if possible, since this assistant will be working with students as well as faculty.

5. Knowledgeable in the latest and best educational media equipment, as well as the uses which can be made of them in college teaching.

Number of Staff:



The Secretary "can adequately handle all the records and administer and grade written quizzes for about 800 students each week during a normal 40-hour work week." (Reference #8)

Facilities

Learning Center:

1. Booths

   a. Large, solid, sturdy, such as the Burgess Company booths or the booths in the A-T zoology lab on the Rockville Campus.

   b. Sixty-four (64) booths per 800 students.

   c. Each booth equipped with reel-to-reel tape recorder-player, foot pedal control, a 2x2 slide projector,* and an adjustable stool on casters with a back.

   d. The booths should be arranged so that there is easy traffic flow; and so that the students at each booth will have maximum privacy for concentration, yet be close to a central demonstration table. Groups of 5 to 10 booths should be placed at angles to each other around a central area. (Purdue no longer has booths placed in straight rows.) The idea is to have a few booths with their own working area, i.e. arranged around a central table or working space with sink and large disposal jar.

(*) Plus screen for rear-screen projection.

e. Plenty of electrical outlets (wall conduits and both wall and floor outlets) will allow for future rearrangement of booths and for equipment as it is added over the years. Also, space and electrical hookups should be available in the Center for additional booths should the second-year biology courses adopt the minicourse method. (See Joyce Bell's letter, December 3, 1974; Minicourse Development Project, Purdue University; Appendix: Attachments.)

2. Walk-in environmental chambers in place of a greenhouse near the A-T booths in the Learning Center.

3. Plenty of large and small sinks with running water scattered throughout the biology area, which are necessary for washing specimens, dissecting pans and boards, as well as hands; also necessary for several aquaria in the room for student's experiments.

4. Display space near booths for: lighted window displays in indented wall space, charts, models, skeletons, movable blackboards, aquaria, terraria, and demonstration tables (movable, but able to be locked into position, with electrical outlets for setting up rows of microscopes, film-loop projectors and TV projectors).

5. Areas close by for: continuous running of motion picture films; tables for student study in groups, near coffee urn; small departmental library -- reference books, dictionaries, atlases, current issues of journals, etc.

6. Check-in, check-out center, time clock and bulletin board.

Stock Room Near Center (With several large pass-through windows with counters)

1. Small live-animal "room" with exhaust fan and scrubbable floor and shelves.

2. Formaldehyde "room" for barrels and boxes of preserved specimens with exhaust fan; also with concrete floor for "hosing down."

3. Large refrigerator for keeping live frogs in the crisper, culture bottles of live material, and frozen parts in the freezer, etc.

4. Commercial-size dishwasher.

5. Storage space for:

   a. Carboys of spring water and distilled water with dispensers.

   b. Chart racks.

c. Shelves for storage of preserved specimens in jars, and bones in boxes.

d. Mounted insect cabinets.

e. Cabinets for mounted plant specimens.

f. Glassware. (Glassware for living material must be kept separate from that to be used for chemicals.)

g. Microscopes:

One compound microscope per booth; monocular 3-way nosepiece.

One dissecting microscope - wide field binocular for every booth.

Tripod and gooseneck hand lenses - one per booth.

Several special compound microscopes for demonstration and experimentation, including a phase contrast microscope.

Microprojector

VI. Recommendations

A. Steps to be taken:

1. Approval of proposal to divide the content of the existing introductory biology, botany and zoology courses into small units called minicourses.

2. Approval, for registration purposes, for the development of minicourses "under the umbrella" of existing introductory courses, Bi 101, Bi 111, Bi 121. "The viable educational innovation must articulate with the existing pattern . . ." (Reference #11)

3. Arrangements made whereby variable credit units will be possible and credit-by-examination be available and encouraged.

4. Appointment of a Developer-Director (first full-time faculty member) in 1975, to plan the initial program, accumulate commercially prepared minicourses and prepare, with the help of a team, a bank of minicourses sufficiently large for the initial offering in biology on the third campus.

5. Use of present full-time faculty members (from biology, botany and zoology) on the Development Team to prepare minicourses: C-common, Group 1; P-plant, Group 2; A-animal, Group 3; and Op-Optional, Group 4. ("The experts in different fields prepare minicourses in their specialties.") (Reference #9)

6. Request Dr. Samuel Postlethwait to serve, periodically, as a Development Team Consultant.

7. Appointment of a qualified Technician-Coordinator to work closely with the Executive Associate for Multi-Campus Planning, as well as the Developer and the Development Team on preparation of tapes and visual materials -- a recording and electronic sound expert and artist.

8. Arrange for the Developer and the Development Team to have the services of a secretary and a printing shop staff.

9. Arrange for the Biology Departments on existing campuses to be "field test schools" for testing the preliminary minicourses so that final improvements and revisions can be made on the basis of analyzed data, student performance, and recommendations of students and faculty.

10. The major tasks of the Development Team are to produce the quantity and quality of minicourses necessary to accommodate the needs of the campus at Germantown, i.e., the number of conventional courses to be offered; and to devise the additional administrative procedures required to make the Minicourse Program successful.

VII. REFERENCES

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VIII. Appendix

A. Key to Abbreviations

AIBS	American Institute of Biological Sciences
AT	Audio-Tutorial
ATP	Audio-Tutorial Packages
AT-V	Audio-Tutorial Version
BSCS	Biological Sciences Curriculum Study
CUEBS	The Commission on Undergraduate Education in the Biological Sciences
ERIC	Educational Resources Information Center
MDP	Minicourse Development Program
NSF	National Science Foundation
NSFEP	National Science Foundation Evaluation Program

A	Animal (Biology)
P	Plant (Biology)
C	Common (Subjects Common to A and P)
OP	Optional (Biology)

VIII. Appendix

B. List of Additional A-T and Minicourse Programs

Ted F. Andrews, Dean
College of Environmental and Applied Sciences
Governors State University
Park Forest South, Illinois

The fundamental unit of instruction at Governors State University is called a learning module.

Howard W. Brown
Biological Sciences Audio-Tutorial Learning Centers
California State University
Pomona, California 91768
Phone: (714) 595-1241

Howard S. Brown
Biological Sciences Audio-Tutorial Learning Center
California State Polytechnic University
Pomona, California 91768
Phone: (714) 598-4454

J. M. Boda
Development of Physiology Laboratory Self-Instruction Carrels
University of California
Davis, California 95616
Phone: (916) 752-1011

Clifford Keeney
Audio-Tutorial Approach to Instruction in Anatomy and Physiology
Springfield College
Springfield, Massachusetts
Phone: (413) 787-2376

John Zimmerman
Audio-Tutorial Introductory Biology
Kansas State University
Manhattan, Kansas 66502
Phone: (913) 532-6659

Sandra Glover
Audio-Tutorial Laboratory in Biology
Appalachian State University
Boone, North Carolina 28607
Phone: (704) 262-3025

A. Douglas McLaren
A Demonstration Microscope System
(Biochemistry and Biology)
University of California
Berkeley, California 94720
Phone: (415) 642-6000

I. W. Sherman
I. P. Ting
Man and the Natural World
A Multi-Media Approach to Biology for the General Student
University of California at Riverside
Riverside, California 92502
Phone: (714) 787-1012

Walter A. Becker
Self-paced Instruction in Genetics
(Mastery Learning; Computerized Testing)
Washington State University
Pullman, Washington 99163
Phone: (509) 335-4283

Interest in A-T and minicourses is snowballing. Rapid expansion is expected in the 1970's and 1980's.

At Wytheville Community College in Virginia, ninety percent of the courses are taught using minicourses with specific performance objectives.

Western Michigan University provides A-T engineering minicourses as a supplement to the regular program.

At the new Permian Basin Campus of the University of Texas in Odessa, the whole upper division curriculum in the College of Arts and Sciences is going to be largely in a self-paced format.

Ohio State University uses the A-T approach in a course in biology with 4,500 students.

At the University of Mississippi, A-T is used for continuing education of schoolteachers. After they have used the materials of the course, they can take materials back to their own classrooms.

VIII. Appendix

C. Attachments

1. AIBS materials - Information on the new step-by-step skill development program in multi-media - 50 modules and Developers Kit.

2. W. B. Saunders Company announcement of the Minicourse Development Project of Purdue University and BSCS. Publication scheduled for December 1975.

3. Seventeen (17) minicourses, preliminary versions, Purdue Research Foundation:

Minicourse No.	Title	Author(s)	Contents
574.31	Meiosis	Vanable, Joseph W., Jr.	Study Guide Instructors Manual Tape Script
574.14	Unit of Life I	Mercer, Jan	Study Guide Tape Script
574.12	Physical Phenomena	Luce, Thomas G.	Study Guide Tape Script
574.01 (2 sets)	Classification of the Living World	Darst, Deirdre S.	Study Guide Instructors Manual Tape Script
518.15	Complementarity of Structure and Function	Johnson, Clay G. and Hurst, Robert N.	Study Guide Instructors Manual Tape Script
581.01	Transformation of Energy I (Photosynthesis)	Dilley, R.A. and Johnson, Clay G.	Study Guide Instructors Manual Tape Script
575.11 (2 sets)	Mendelian Genetics	Lester, Lane P.	Study Guide Instructors Manual Tape Script
575.2	An Introduction to the Structure and Replication of DNA	Luce, Thomas G.	Study Guide Instructors Manual Tape Script
578.13	How to Operate the Student Compound Microscope	Darst, Deirdre S.	Study Guide Instructors Manual Tape Script

Mini-course No.	Title	Author(s)	Contents
612.51	Birth Control	Wilcox, R. Stinson	Study Guide Instructors Manual Tape Script ("Dorm Version")
	Study Guide:	L. W. Combs, M.D. and S. Stimson Wilcox	
612.56	Introduction to Human Reproduction - Anatomy and Function	L.W. Combs, M.D. & Janet Dissauer Hannas	Study Guide
		Janet A. Dissauer	Instructors Manual
		Janet A. Dissauer	Tape Script
574.3	Mitosis	Vanable, Joseph W., Jr.	Study Guide
613.9	Venereal Disease	L.W. Combs, M.D. and Wright, E. Ronald	Study Guide
612.57	Pregnancy	Clark, J. H. and Egan, Ann L.	Study Guide
BSCS Experimental Edition 1974	Observing Behavioral Patterns on Rat Pups		Study Guide (Audio & Video available)
370.0	Minicourses - What Are They?		Study Guide Audio tape (cassette)
		Postlethwait, S.N. and Mercer, Frank	2 Instructors Manuals

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5. Description of the "Nexus" Program, a project of the American Association for Higher Education, One Dupont Circle, Suite 780, Washington, D. C. 20036.

6. Titles of 54 half-hour programs - Today's Biological Revolution; course professor, Dr. Bernard L. Strehler. The programs are produced by: Video Cassette Industries, 451 Melrose Avenue, Hollywood, California 90069. The local distributor is: Video Communications Associates, Inc., Suite 904, Watergate Office Building, 2600 Virginia Avenue, N.W., Washington, D. C. 20037; telephone (202) 333-3881.

7. Three reprints from journals:

   Kuhns, Eileen and S. V. Martorana, Of Time and Modules, The Organization of Instruction, Journal of Higher Education, Volume XLV, Number 6, June 1974, pages 430-440.

   Kuhns, Eileen, The Modular Calendar: Catalyst for Change, Educational Record, Winter 1974, pages 59-64.

   Marchese, Theodore J., Reexamining the Undergraduate Sequence in Studies, Journal of Higher Education, February 1972.

8. A package of ten reprints, either reprinted from journals or copies of manuscripts. These concern media, the audio-tutorial system, and minicourses.

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