INVERTEBRATE DIVERSITY

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AN

INDIVIDUALIZED PROGRAMME

By

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ABSTRACT

Educational changes in Ontario, initiated by the Hall-Dennis Report, resulted in a public perception of declining educational standards in the 1970's. Ministry of Education Guidelines, which were implemented in an attempt to remedy this, created a major disruption in our grade nine and ten science programmes.

The grade ten Life Science course had become fragmented and the classes polarized between bright and slow students. Traditional teaching methods were no longer functioning well and, as a result, students were poorly motivated.

In this project, the Life Science curriculum is restructured to improve continuity of subject matter and student motivation. The major innovation is an individualized unit on invertebrate diversity. This modular unit is designed for self-paced mastery learning. The six modules of this unit are based on the Personalized System of Instruction (P.S.I.). Optional activities are incorporated into each module to challenge and motivate industrious students.

The means of evaluation of the new curriculum unit are outlined and various criteria for the success of the project are specified.

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PREFACE

This project is submitted to the School of Graduate Studies in partial fulfilment of the requirements for the degree of Master of Science (Teaching), McMaster University.

The major part of this project is a modular teaching unit for grade ten Life Science. The unit consists of six modules based on each of the major invertebrate phyla. Each module is designed for individualized mastery learning.

The content of the new unit is described, since the whole Life Science curriculum is being redeveloped in our school.

The background to this new development is outlined together with its educational rationale. An evaluation of the new course design is explained together with the criteria for its successful implementation.

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CHAPTER I

THE BACKGROUND

The last two decades have brought many changes to science curricula in Ontario. The decade of the 1960's was a period of relative stability as the academic constraints of Provincial-wide Grade 13 examinations percolated down through the grades of the high school system. Educational changes in Ontario were initiated by the Hall-Dennis Report in June 1968. The outcome of the report was the establishment of a new credit system at the beginning of the 1970's. Within the credit system, there were only a few constraints and students were able to select subjects appropriate to their achievement level, in order to obtain 27 credits for a high school diploma.

Toward the end of the 1970's, a public perception of declining educational standards was apparent. Many students were perceived as graduating with a selection of credits, which were easy options, leaving them weak in basic language and mathematical skills. Curricula were being adapted and standards compromised by some teachers in an attempt to attract students. In the light of this laissez-faire system, parents and employees began to demand accountability; a move back to the basics.

In Hamilton, Life Science was one of three credits offered in science in Grades 9 or 10. It was little different from Junior Biology, a subject offered through the 1960's. During the early years of the credit system, the original Junior Biology curriculum guideline was adapted by teachers to their own strengths and interests, and to the

varying needs of their students. Each school in Hamilton was required by the Board of Education to have a course outline for each subject on file. By 1978, there were probably as many different Life Science course outlines as there were high schools in the city.

In response to public pressure to improve declining educational standards, politicians imposed mandatory constraints on the credit system. In 1978, the Minister of Education for Ontario, the Honourable Bette Stephenson, introduced new curriculum guidelines for the Intermediate Division (Grades 7 to 10).

In the senior division of The Intermediate Science Guideline (Grades 9 and 10), 27 different units were prescribed. Nine of these units were in biology; 14 in physics and chemistry; and 4 were left open for "Locally Developed Units". Eight of these units were specified as core units required for all students. Eight units were also required for a full science credit.

Since only one science credit is needed for graduation, most schools in Hamilton decided to offer a general science course, Sc.101, in Grade 9, which would include all eight mandatory units. Four of these Sc.101 units were biological. This new Grade 9 course left our Grade 10 Life Science course (L.S.201) rather depleated. Even if all the remaining five optional biology units were used, at least three Locally Developed Units were needed.

Each school in Hamilton was required to develop its own Life Science curriculum within these constraints. In our school, Sherwood Secondary, the revised L.S.201 was first taught in 1980 to Grade 10 students. Physical Science (P.S.201), a combination of physics and chemistry, was also offered in the same year.

During this period, there was little time for curriculum development in Life Science. Most of our effort was concentrated on developing the General Science (Sc.101) course. The curriculum design of this Grade 9 course was developed with three general aims in mind:

1. To stay within the constraints of the Ministry Guidelines.
2. To develop concepts, skills and attitudes which would form a basis for systematic course design in higher grades.
3. To develop largely activity-oriented units in order to meet the various needs of general and advanced level students. It was also recognized that these activities would be of such a level that we could avoid high failure rates without compromising academic standards.

While this Grade 9 course development was continuing, the Life Science course was taught with a makeshift curriculum, patched together from the remnants of the pre-guideline Life Science course. The first two years 1980 and 1981 indicated two major curriculum problems with the Life Science course which required both curriculum development and a change of teaching strategy. These two curriculum problems will be discussed in Chapter II.

CHAPTER II

THE PROBLEM

The first curriculum problem concerning the Life Science course involved the content of the course. A major part of the pre-guideline L.S.201 course was now incorporated into the new Sc.101 (Grade 9 General Science) course. In order to satisfy the requirements of the new Ministry Guidelines, eight units were required for the new course, four or five of which could be selected from the guideline units. Three or four completely new units had to be developed by us. These new units are designated in the guideline as "Locally Developed Units".

In setting up eight units for the L.S.201 curriculum, we hoped that we could meet two objectives:

1. to build on the scientific principles, skills and attitudes developed in our Grade 9 course, and
2. to put together a series of units which had good continuity from one unit to the next.

The essence of the first problem was that the units specified in the guidelines made it very difficult to meet these two objectives. For instance, two of the choices for our Grade 10 course were Viruses, Monerans and Protists or Simple Plants. These were difficult to relate to such Grade 9 units as Ecology or Plant and Animal Physiology.

The second curriculum problem involved the heterogeneous nature of the students taking the course since 1981. Neither P.S.201 (physical science) nor L.S.201 is required credits for a high school diploma.

In 1980 students were allowed to choose both subjects and many did. There were over 120 students in L.S.201 in our school. The Hamilton Board of Education Curriculum Committee then made a ruling that, except in special circumstances, no student should be allowed to take two sciences in Grade 10. The ruling was made in order to protect other disciplines and ensure a more balanced overall programme in the schools.

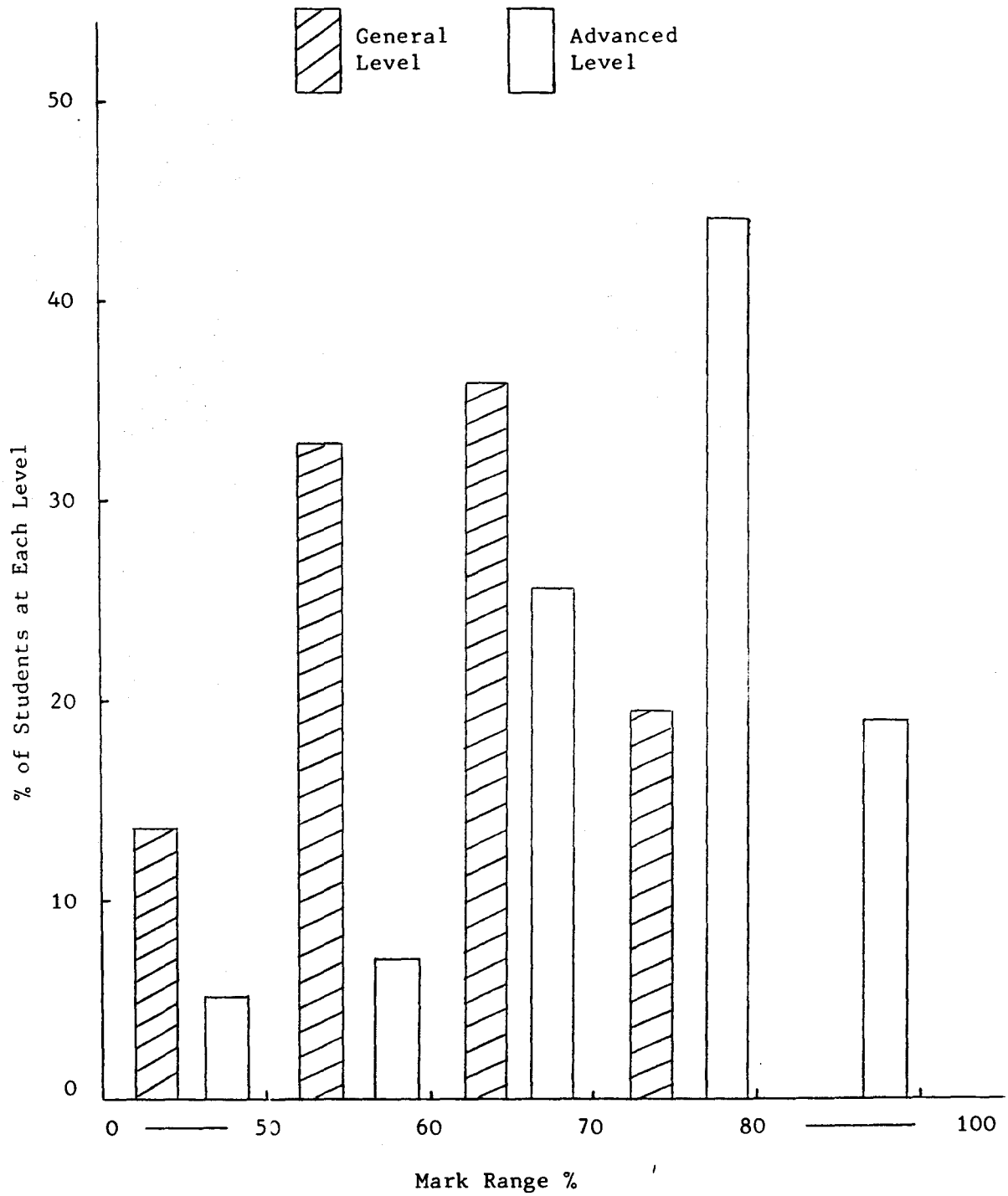
Largely as a consequence of this, the number of students choosing Life Science in 1981 dropped to about 80. The figure has remained at that level since then. Numbers in Physical Science have remained consistently well over 100. Mathematics and English in Grade 9 are subjects in which students are streamed according to ability, into General level and Advanced level. Using this as a criterion, it has been possible to analyze the students entering L.S.201 and P.S.201.

Life Science includes 53% advanced and 47% general. Advanced students are identified as those taking advanced English and Advanced Math. The corresponding figures for Physical Science are 69% advanced and 31% general. In Sherwood as a whole, the figure in Grade 10 is 61% advanced and 39% general. As Grade 10 students are limited to a single science, it would appear that more of the advanced students opt for Physical Science, while most general level students, who choose science in Grade 10, choose Life Science. These are probably logical choices since P.S.201 provides a more comprehensive background for future science courses taken by most advanced students. Life Science, on the other hand, appeals to general level students since it is less mathematical than P.S.201. Despite this, 50% of the Life Science students are advanced level. Some of these are keen biology students who are really able and hard working. On the other hand, some of the general level

students have poor work habits and consequently they do not perform as well in the course. The result of this is a dichotomous population with both extremes of the class underachieving. The more able, industrious students complete the assigned work quickly and become bored by the slow pace. Conversely, the weaker students complain about lack of time and often fail to complete their assignments. The conventional lock-step approach used in the first two years of the post-guideline course has not been successful in motivating these two extreme groups of students.

Closer examination of the marks for term one, November 1981, indicate the following: 63% of the advanced level students scored over 70% and 19% over 80%. Of the general level students, only 19% scored over 70% and no students scored over 80%. 13.5% of the general level students failed, while only 4.6% of the advanced students failed. Figure 1 on page 7 shows the distribution of marks for general and advanced level students. It can be seen that general level students form a curve with a median of around 60%, while the advanced students form a distinctly different distribution with a much higher median. However, no advanced marks were in the 90% range. Clearly, conventional teaching methods are not successful for many general level and some advanced level students in the classes. This situation is worse in some classes than in others. For instance, in one class there were over 60% general level students and consequently the disparity in results was even greater.

FIGURE 1: Mark Distribution of General and Advanced Level Students in Life Science After One Term (November 1981)



CHAPTER III

THE SOLUTION

Two major areas of curriculum development were carried out in our school in 1982 in an attempt to overcome the problems indicated in Chapter II. The first was the establishment of eight units for the course within the constraints of the guidelines. The second was the development of a major unit of Individualized Study on the subject of Invertebrate Diversity. The individualized unit was designed to improve both the motivation and the performance of all students. It forms the major part of this project and will be discussed in some detail later.

A brief overview of the first curriculum development will now be given.

A new unit called Scientific Investigation was developed in our school as an introduction to the course. This new unit, designated as a Locally Designed Unit, is activity oriented and was designed to interest and motivate the whole class.

The second unit, called Classification, is another Locally Designed Unit, and was developed using some new material and some from the old course. Once again, the unit was made activity oriented.

The third unit in the revised course is called Viruses, Monerans and Protists and is the optional unit S22 from the Ministry Guidelines. An experimental approach is used wherever possible.

The fourth unit, Invertebrate Diversity, is the individualized unit developed for this project. It was developed as one of the Locally

Designed Units in the course.

The fifth unit, Vertebrate Diversity, is also a Locally Designed Unit. In 1982 it will not be developed for individualized learning. However, if the Individualized unit in unit four is successful, it will be rewritten in a similar format for 1983-84.

The sixth unit, Animal Adaptation, is a modified ecological study based on the optional unit S20 in the guidelines.

The seventh unit, called Continuity, was adapted from the guideline optional unit S10. this unit was used in 1980 and 1981. Certain topics such as Embryology have now been included only as optional topics for enrichment activities.

The final unit, Fungi and Simple Plants, is the optional unit S13 in the guidelines.

All of these units incorporate a variety of learning strategies with a strong emphasis on experimental work. It is hoped that the hands-on approach will improve learning and motivation through active participation in the learning process.

CHAPTER IV

THE COURSE

The units outlined in the previous chapter fulfill the Ministry requirements under the 1978 guidelines. Each unit will now be explained in more detail, together with the rationale for its inclusion, sequence in the course, and methodology. This will enable the unit prepared for this project to be placed in its proper context.

UNIT 1: SCIENTIFIC INVESTIGATION

This short unit forms an introduction to Grade 10 science by use of the principles of the Scientific Method in problem solving. Critics of the scientific method frequently suggest that very few scientific discoveries are made in this rather formalized fashion. Although this may to some extent be true, the principles are sound. Scientists must be good observers, must be able to form hypotheses which they test by experimentation, and should be able to draw conclusions after examination of their experimental data.

Students faced with everyday problems should have some facility with the scientific approach to solve their problems.

The unit is designed around four simple investigations in which students first learn to be good observers, then solve problems using the scientific method.

The last of these investigations involves observing a large number of organisms from different phyla. After recording their observations,

students are required to suggest which organisms are animals and which are plants. Previously they have formed hypotheses about characteristics for each group. This investigation is included to form a bridge between the introductory scientific investigations and the second unit, Classification.

UNIT 2: CLASSIFICATION

The principles of taxonomy are covered by a series of short activities and observations of biological specimens. Students learn the use of a dichotomous key. Activities include one which involves making a leaf collection and forming a key by which others can identify the leaves.

Students will be aware of the major groups of organisms and that structural similarities form the basis for their classification. The study of various groups of organisms in later units follows logically from this section.

UNIT 3: VIRUSES, MONERANS AND PROTISTS

Viruses, their structure, reproduction and significance are covered using textbooks, articles and a movie.

The theoretical study of bacteria is kept simple, while a series of articles and experimental bacteriology investigations cover the growth, control and importance of bacteria to life.

Microscopy is reviewed after which three representative protists are studied both by observation and research.

Throughout this unit, the guideline is followed carefully with the emphasis on experimentation and student research.

UNIT 4: INVERTEBRATE DIVERSITY

This is the unit which forms the major part of this project. It is a continuation of the study of organisms more complex than those in the previous unit.

The six "major" invertebrate phyla are studied starting from the most simple, the coelenterates.

Unlike previous units, this unit is set up in modular fashion. Students work individually or in small groups at their own pace. Only one formal lesson is taught in each module. Students locate their own information and carry out experiments, while the teacher acts as an adviser. Modular tests are written when students are ready, although there are time limits for each module. Optional activities are available for those students who achieve a degree of mastery of the basic work, and can be completed for marks over 80%.

The educational rationale and theory for this new approach will be covered in a later section of the project.

The complete unit is included in the appendix.

UNIT 5: VERTEBRATE DIVERSITY

This unit in which students study diversity among chordates, follows logically from the previous unit.

It covers the major chordate classes and like Unit 4, is highly experimental and student centred. Unlike the previous unit though,

it will not be modular. Students will do their work lock-step and will write tests at the same time. There will only be a limited amount of optional work which will be available to all students without regard to mastery. This unit may be adapted to a modular form later, if Unit 4 proves successful. However, for the time being, until an evaluation of the criteria for the success of the new unit has been made, it seems prudent to restrict the modular approach to one unit.

UNIT 6: ANIMAL ADAPTATION

This unit is developed from the modification of the optional unit S20: Terrestrial and Aquatic Environments.

Instead of visiting the local field centre as suggested and which was done in Grade 9, students visit the exhibits at the Royal Ontario Museum and Metro Toronto Zoo. On these two field trips, students observe preserved and living animals and study their adaptation to their biomes.

One of the serious drawbacks of the Grade 9 field trips is the lack of large and "exciting" animals. These two field trips remedy this deficiency.

Students are already familiar with the concept of adaptive radiation in regard to certain animal groups studied in Units 4 and 5. This unit will make the reasons for the tremendous diversity of life more understandable.

UNIT 7: CONTINUITY

This unit covers the reproduction of cells and organisms and the inheritance of characteristics from one generation to another.

The unit will not only show students how traits are transmitted from one generation to another, but through a discussion of D.N.A. and meiosis will indicate how animal diversity has arisen.

This unit is usually taught mainly by lecture and Socratic means and forms a basis for more advanced studies in Grades 11 and 13.

UNIT 8: FUNGI AND SIMPLE PLANTS

This unit provides students with a brief glimpse of plant diversity. The unit, coming at the end of the academic year, must be kept brief because of time constraints. It consists mainly of activities selected from a curriculum guideline produced in 1981 by a small writing team of Hamilton biology teachers.

CHAPTER V

EDUCATIONAL RATIONALE

The redevelopment of the Life Science course has involved changes in both content and teaching methodology. As outlined earlier, the new units were needed because of the reorganization of the Grade 9 and 10 science courses resulting from the implementation of the new Ministry Guidelines.

The new Life Science curriculum was designed within the constraints of the guideline to form a cohesive course with some continuity from one unit to the next. The units include skills and concepts which are to some extent sequential. A variety of teaching strategies are used, with a distinct emphasis on student-centred activities, designed to provide motivation and a suitable learning process for all levels of ability.

A comprehensive flow chart, Figure 2, which incorporates all of these facets is given on page 16.

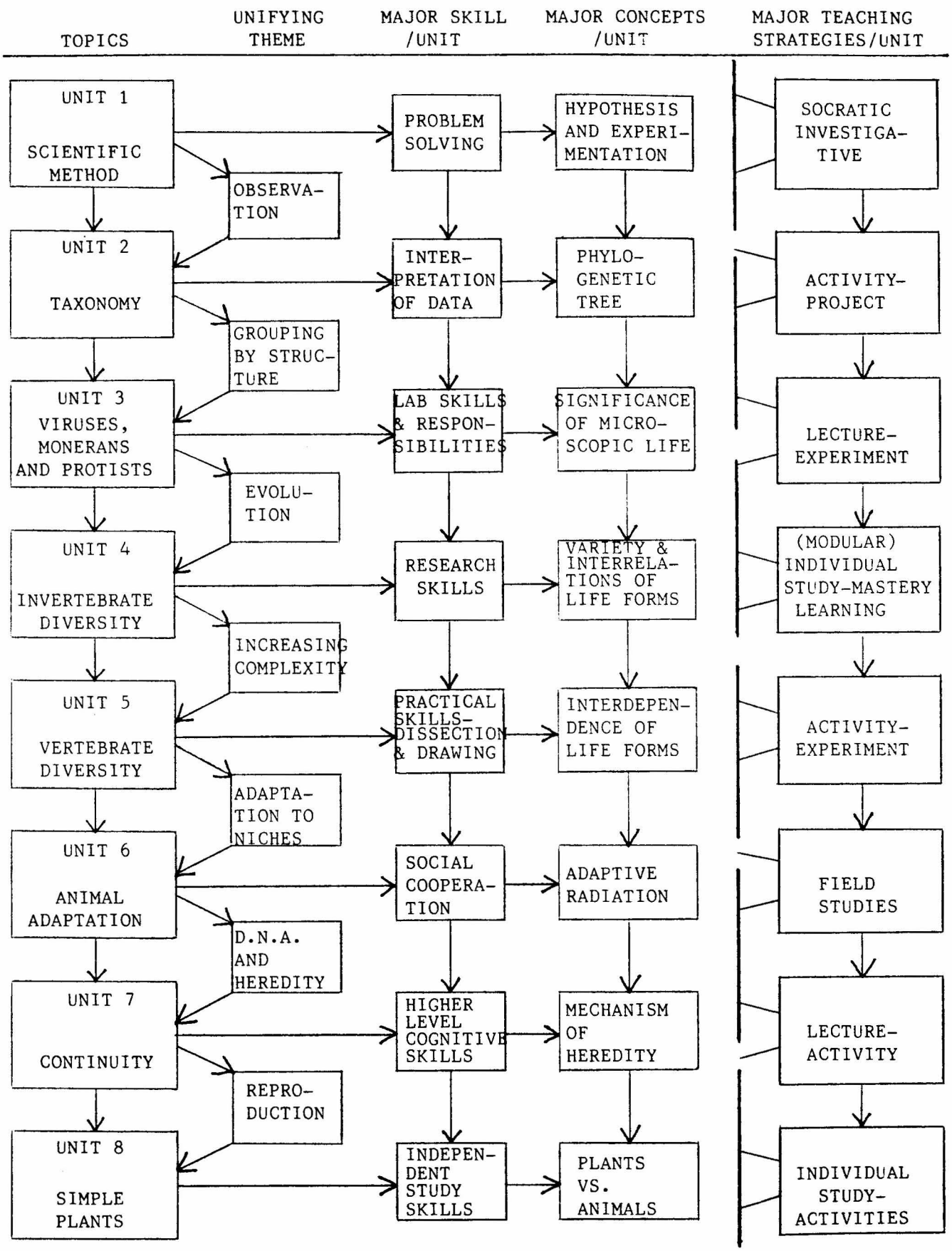
The revised teaching strategy incorporates three new aspects:

1. A change in classroom orientation.
2. An increase in activities and laboratory experiences.
3. A major section of individualized learning.

The rationale for these changes in methodology is outlined below.

In response to the reorganization of our Grade 9 and 10 science courses, with the implementation of the new guidelines, there has been a degree of polarization of science students. Fewer of the

FIGURE 2: LIFE SCIENCE: COURSE OUTLINE FLOW CHART



academically-oriented students are now taking Life Science. Many of the non-academic students are poorly motivated, particularly in the traditional classroom setting. In order to redress the diversity of student ability and motivation, the students are required to take a more active part in the learning process. In the revised curriculum there are now far more individual and group-oriented activities and fewer teacher-centred lessons.

Elliott Eisner, in The Educational Imagination, makes a case for a less formal classroom situation. He proposes a progressive philosophy of education which is student-centred, rather than a traditional subject-centred ideology based mainly on specific behavioural objectives. Eisner contends that student-centred learning will help students improve their understanding of humanistic and democratic issues and develop "artistically" through active participation and class interaction.

Eisner's suggestions are an alternative to the increasing prescription of courses by a centralized authority. He views recent educational developments as tending to exclude things from the curriculum which cannot be measured. Eisner is concerned about a reduction in student participation and the exclusion of "global objectives".

It is the author's contention that Eisner's normative claims have some validity. An effort has been made to incorporate "artistry" into this curriculum development.

The increase in student activities in the Life Science course is in keeping with Eisner's philosophy. Some use is, however, made of objectives, but not to the extent that it detracts from a student-centred learning philosophy.

Robert Sidwell, in a paper written for Phi. Delta, Kappan in 1973

describes a teacher-directed learning situation.

> "The large desk at the front of the classroom is analogous to the driver's seat and transmits directional messages... The movement is in one direction only, a direction determined by the driver..."[1]

Munsinger compares teacher-oriented and pupil-oriented teachers:

> "...Pupil-oriented teachers cultivate individuality and variation among their students. They try to integrate the behaviour of the child, to give him feedback and influence his thoughts indirectly by praise and reinforcement."[2]

Impressed enough by the claims of Eisner, Sidwell and Munsinger, a change in our Life Science course to a student-oriented, activity-based classroom was made in 1981. It is apparent that the students work well under the new system. There are few discipline problems and there is a marked improvement in the quality and quantity of student-teacher interaction. Based on subjective impressions and informal comments made by class members, students enjoy taking the course.

One major drawback emerged. The lock-step approach, combined with heterogeneous classes, resulted in many high achievers finishing their work quickly and then losing interest. The slow workers who were unable or unwilling to keep up, frequently objected to the time constraints. This latter group often became frustrated and, like the former group, were often under achieving. It became very difficult to set a time limit for units which would suit everyone.

The third revision of the teaching strategy is an attempt to

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[1]Robert Sidwell, "The Medium is Mostly Tedium", Phi. Delta Kappan, 1973, p. 2.

[2]Henry Munsinger, Fundamentals of Child Development, 1971, p. 384.

overcome this drawback. This final aspect of the revised methodology is the development of the major unit of individualized learning which forms the main part of this project. This unit has been modelled after the Personalized System of Instruction (P.S.I.) initially proposed by Fred S. Keller. The new unit of P.S.I. will be field tested in 1982-83 before expanding this modular approach to further units.

P.S.I. was first developed by Fred S. Keller and others after Keller's experiences in training military personnel. In a paper, "P.S.I. and Reinforcement Theory", Keller outlines seven principles of learning based on reinforcement theory which are incorporated into P.S.I.

1. Reinforcement: This is roughly equivalent to reward. In a laboratory subject reinforcement may be food while in the classroom it may be marks or social approval. "The reward must be systematically associated with the desired learning and not correlated with undesired responses for learning to occur."[3]
2. Extinction: This is where already learned behaviour can be weakened by discontinuing reinforcement. Extinction, a Pavlovian term, is frequently associated with anger or frustration.
3. Punishment: This can decrease the recurrence of behaviour which is punished. "Fear may be evoked and any behaviour of escape from the situation will be reinforced."[4]
4. Discrimination: This is where behaviour is reinforced in one

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[3] Ibid., p. 106.

[4] Fred S. Keller, "P.S.I. and Reinforcement Theory" from Learning: Reinforcement Theory, 1969, p. 2.

situation but extinguished in other situations. "Stimulus control of the behaviour is achieved.....a child may come to 'tell the difference' between a robin and a crow."[5]

5. Secondary reinforcers: This is where the stimuli, in the presence of which behaviour has been reinforced or punished, become rewarding or aversive. For example, the classroom in which successful learning is achieved can itself be a reinforcer.

6. Generalized reinforcers: These would include approval, affection or token rewards such as diplomas or academic grades.

7. Shaping: This is where selective reinforcement of successive approximations toward desired learning occurs.

"The seven principles...are especially important in connection with the 'psychology' of P.S.I. The designers of the system had the goal of maximizing the rewards for educational behaviour, minimizing chances for extinction and frustration, eliminating punishment and fear and facilitating the development of precise discriminations. They tried to use as many forms of generalized reinforcement as they could within the classroom, and they followed the rule of 'successive small approximations' in the shifting of control from one stimulus situation to another or in the shaping of response itself."[6]

The new modular Life Science unit is similar to the Keller Plan and so incorporates many of these important learning principles. The main features in the design of the unit are as follows:

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[5] Ibid., p. 2.

[6] Ibid., p. 3.

1. The objectives are clearly stated for each module. Each of the six modules covers one of the major invertebrate phyla.
2. The content is prescribed in manageable amounts.
3. The unit is carefully organized with overall instructions as well as a guide for each individual section (module).
4. The physical resources provide a variety of learning aids including the facilities of the school library. The teacher acts mainly as an adviser.
5. Each module has a means of self-evaluation and opportunity for remedial work or revision.
6. A teacher-administered test is available for each module and is written when the student is ready.
7. The test may be repeated to achieve "mastery", so establishing a no-fail environment.
8. Enrichment possibilities are available in the form of optional activities.
9. Test results provide frequent and immediate feedback for both teachers and students.
10. Instruction within each module is self-paced although deadlines are imposed for each one.
11. There is built-in formative evaluation of the course itself. This is explained later.
12. There is an expectation of success associated with mastery.
13. There is increased student-teacher interaction and social interaction between students.
14. There is built-in motivation associated with the variety of work and the frequent reinforcement.

15. Live teaching is reduced to a single "dynamic, highly motivating" lesson in each module.

The concept of mastery learning is an integral part of P.S.I. In the units written for this project, 80% mastery is expected before students can write a unit test and a 66% mark on the test is required before students can proceed with optional work.

Lee Harrisberger, in a paper entitled "Self-Paced Individually Prescribed Instruction" in 1971, points out the advantages of the mastery concept. Ninety percent of his engineering students achieved "A" grades and this success-oriented programme resulted in ego-building and an enhancement of morale. In the same article from Engineering Education, Harrisberger points to greater retention of learning with increased student involvement.

Brethower (1977) reviews some recent research in learning behaviour. He concludes that the amount of learning is not proportional to the amount of teaching. He points out the high rate of forgetting and outlines a number of steps which would improve "learning". In his list he stresses the need for learning to be related to the learning skills and ability of the student. In setting up an instructional design, Brethower stipulates six guidelines including: clearly-stated objectives and testing of these objectives, with frequent and immediate feedback. These guidelines and the other conclusion in the paper give further credence to the educational principles of P.S.I.

Objectives are stated for each module. These objectives, however, do not constitute specific behavioural objectives as outlined by Esbensen (1967), Bloom, Tyler and others.

> "A well-written instructional objective should say three things: 1) what it is that a student who has

> mastered the objective will be able to do, 2) under what conditions he will be able to do it, and 3) to what extent he will be able to do it."[7]

It is the contention of the author that such objectives may lead toward narrow, stereotyped learning.

Eisner suggested that behavioural objectives may be useful but that many of our most valued objectives cannot be stated in operational terms and, therefore, a programme based entirely on behavioural objectives would be educationally thin.

Stenhouse (1975) suggested that objectives, which were introduced during an era of criticism of subjective marking standards, fail to take into account the quality of learning. "The more objective an examination, the more it fails to reveal the quality of good teaching and good learning."[8]

The objectives written for each module in the new unit are a compromise between the highly specific behavioural objectives of Esbensen and others and very general objectives of a less structured curriculum such as that favoured by Stenhouse and Eisner. In each module of the new unit, the major objectives which are to be learned and which will be tested are stated. Laboratory notebooks are also marked as a means of broadening the evaluation of the students' learning to include the psychomotor and affective domains.

Whenever possible, the modules are set up to also comply with

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[7]Thorwald Esbensen, "Writing Instructional Objectives", Phi. Delta Kappan, 1967, p. 1.

[8]Lawrence Stenhouse, An Introduction to Curriculum Research and Development, 1975, p. 65.

Ausubel's Assimilation Learning Theory. According to Ausubel (1967), learning is made meaningful by relating new information to aspects of existing knowledge. Novak (1977) writes that such meaningful learning is retained longer than information learned by rote. He suggests that rote learning may be necessary in cases where no relevant concepts exist. Novak goes on to say that concept development proceeds best from the generalized to the more specific. In this way, a conceptual hierarchy is established. Such a conceptual hierarchy will reduce cognitive dissonance, the negative emotional response to two apparently contradictory concepts. When concepts are related in this fashion to existing knowledge, integrative reconciliation occurs. That is, inconsistencies are reconciled by recognizing relationships, similarities or differences.

In the new unit, the topics are set up in accordance to Ausubel's philosophy of learning, so that "logical order is replaced by psychological order". For example, in the module on Platyhelminthes, characteristics of the phylum are studied before details of specific animals. The distinction between parasitism and free-living existence is made clear before comparing the tape worm with Planaria. Novak contends that such learning will lead to better understanding and, hence, will increase student motivation. As Invertebrate Diversity is a highly factual subject, there are many times when rote learning is necessary, but wherever possible, the Assimilation Learning Theory has been incorporated into the curriculum design of the unit.

CHAPTER VI

EVALUATION

During the implementation of this "Locally Developed Curriculum Unit", full field testing is impractical. The new Life Science unit will be used by three classes in 1982-83, during which period an evaluation will be made.

Derek Rowntree defines evaluation as "the means whereby we systematically collect and analyse information about the results of a student's encounter with a learning experience."[9] He suggests that evaluation may occur at the micro level when assessing something like group cooperation in a class, or at the macro level when comparing new courses or teaching methods with conventional ones. Such micro and macro evaluation would be appropriate in evaluating the new modular course.

Rowntree also notes that, as well as the formal evaluation based on marks, informal evaluation can provide valuable information about teaching effectiveness which can show up weaknesses or strengths.

Rowntree sees two major purposes in evaluation. First, he sees it as a means of improving teaching, and secondly, he sees it as having "political" value. By this, he means that evaluation of the curriculum would lead towards a guarantee of performance for the new curriculum,

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[9]Derek Rowntree, Educational Technology in Curriculum Development, 1981, p. 130.

which is important in the competition for funds. In our Life Science course, this could be interpreted as competition for students or survival of the course in a period of consolidation of subjects due to declining enrolment.

Eisner identifies five aspects of curriculum evaluation which have been or will be made use of in the development of the new curriculum unit.

1. To diagnose the curriculum and the teaching of the students.

   Eisner suggests that when students' achievements are poor, either the curriculum or the teaching approach needs to be changed, not a change in the students.

   Students were underachieving in Life Science for reasons given earlier. The P.S.I. unit is an attempt to remedy this by a change of methodology.

2. To compare innovative courses or school plans.

   Eisner proposes that marks and grades alone should not be the basis for comparison. He sees "artistic evaluation" as a means of forming a new perspective before making judgements. Such evaluation could be carried out by means of using photographs of the classroom activities, audio-tapes of lessons, video-tapes, informal reports by other teachers or interviews with students.

   The new P.S.I. unit is innovative in our school science programme and some aspects of such artistic evaluation could provide revealing insights into the success of the new unit.

3. To revise the curriculum.

   Eisner describes the process by which a major curriculum package such as Biological Sciences Curriculum Study (B.S.C.S.)

is evaluated. Hothouse testing in selected schools followed by field testing in more schools is completed before a polished, "teacher proof" curriculum is made available to all schools.

As indicated earlier, such evaluation is beyond the scope of this new curriculum unit. The complete unit will be field tested, modified and then retested the following year in the same school. However, should it prove to be successful, it is quite possible that other schools may wish to adopt the "polished" module in subsequent years. Eisner is concerned that such an evaluation should include more than just the evaluation of pre-planned outcomes. He would like to include the evaluation of expressive (affective) outcomes which arise from the curriculum.

4. To anticipate educational needs.

This evaluation, according to Eisner, would be based on a needs assessment carried out by using interviews between community leaders and teachers together with student grades. Such a needs assessment could be used to justify a new innovation. Eisner sees a problem here with regard to the set of values which are held by the groups interviewed. Two contrasting viewpoints would be presented by academic rationalists compared to social reconstructionists. In other words, Eisner suggests that we often find what we want to find. This is rather a frightening proposition since the educational foundation of the new unit has made its evolution without a proper needs assessment. At this late stage, this will not be done. If further changes are anticipated in the future, a limited needs assessment will be carried out.

5. To determine if educational objectives have been met.

Here Eisner is emphasizing that such evaluation should not be entirely concerned with marks based on objective testing. He would like to see greater use made of "artistic evaluation". This, he contends, would enable a more accurate assessment to be made of those objectives which are unstated but implicit.

The new modules contain a large amount of objective testing. In support of Eisner's view that there should be more informal evaluation, student laboratory notebooks will be marked. In such marking, value can be assigned to neatness, grammar, artistry, form, completeness and accuracy. Although this is not really the same as Eisner's artistic evaluation, it will form a subjective counterbalance to the objective testing which makes up such a large part of the student's evaluation in the new P.S.I. unit.

In light of Eisner's ideas, the evaluation of the new unit will be improved by the incorporation of some of the following:

- student questionnaires.
- visiting teacher questionnaires.
- audio-taping of class lessons.
- the teacher writing a critical review of his own lesson.
- making a video-tape of the class.

Tests which are used for summative evaluation are incorporated into each module of the new unit. Such evaluation of students' knowledge and skills will be an invaluable help in the formative evaluation of the new curriculum innovation. It can be used also to compare the P.S.I. unit with earlier, more traditional units. Furthermore, it can be used

to compare classes and to predict success in future science classes.

In the new unit, optional work may be attempted by those students who achieve 66% mastery in order to obtain marks over 80%. Since this is often challenging and is at the same time voluntary, an evaluation of the students' work would produce some interesting information in addition to the marks. It could, for instance, be used to select students who were innovative, conscientious, industrious or very intelligent. It could be used as a means of prediction of a student's suitability for subsequent science courses. The number of students attempting optional activities would give an indication of such intangibles as attitude and degree of motivation.

CHAPTER VII

CRITERIA FOR SUCCESS

During the implementation of the new P.S.I. unit, both formal and informal evaluation will be made as suggested in Chapter VI. The criteria for the success of the new curriculum are suggested below and will serve as the norm for formative evaluation.

1. Whether students are able to achieve marks at least as high as in the other conventional units.
2. Whether students are able to learn the material and complete the activities using individualized study methods.
3. Whether students keep active and interested irrespective of their ability, and demonstrate their interest through spontaneous questions.
4. Whether students are able to grasp the concepts in the new unit with at least the same facility as when taught formally by the teacher.
5. That a pleasant atmosphere exists in the classroom where there are few discipline problems.
6. That the logistics of laboratory supplies, equipment and space for individual study are not unmanageable.
7. Whether students are self motivated in obtaining their goals.
8. Whether students are interested in and attentive to the "formal" module lessons.
9. Whether students are able to work within the deadlines without

being too pressured or overworked.

10. Whether opportunities for teacher-pupil contacts are increased.
11. Whether students are able to achieve the mastery level expected.
12. Whether many students are willing to complete optional activities.
13. Whether the classroom atmosphere is a relaxed one, with little need for the teacher to take an authoritarian attitude with the students.
14. Whether students are able to work cooperatively in small teams.
15. Whether students retain good laboratory habits developed previously during the more formal classes and keep the room in at least the same order as during previous units.
16. Whether the frequent ordering of films, live specimens and obtaining duplicated material impedes smooth operation of the unit.
17. Whether the marking and record keeping become too burdensome compared to other units.
18. Whether students improved their facility to research information.
19. Whether students, as a result of their laboratory work, improve their manipulative skills and operations which facilitate problem solving activities and the acquisition of knowledge.
20. Whether, as a result of the new classroom interactions, students show recognition of the balance between freedom and responsibility and demonstrate cooperation, mutual respect, patience and courtesy in their social attitudes.

By considering the criteria checklist, a formative evaluation will be carried out, so that curriculum changes may be made before the next academic year. In the long run, however, the students will have the

final say. As they choose their options for the next year, students get candid opinions from others who took the course previously. If they hear favourable reports, the numbers remain stable or increase; if not, the numbers drop.

CHAPTER VIII

THE FUTURE

In the light of a continuing decline in high school enrolment, predicted to continue until the early 1990's, plans have been prepared to consolidate the Hamilton high school programme. Certain subjects will have to be dropped in order to facilitate timetabling in smaller schools. In this way, it is hoped to keep most high schools open during the period of declining enrolment. Since our school has one of the smallest enrolments in Hamilton, the prospect for Life Science in the future is not too good. One possible move would be to replace P.S.201 and L.S.201 with a Grade 10 General Science Sc.201. The actual consolidation would be an internal policy matter within the school, so there may be other alterratives. If it were replaced, the new Sc.201 would contain between 30% and 50% biological units. The success or otherwise of the new modular unit would determine whether or not it would be included as one of these units.

On 29th November 1982 the Minister of Education announced that radical changes in the high school programme would be made (Reorganization of Secondary Education - R.O.S.E.). These changes, based on the S.E.R.P. report would start to be implemented in 1984. Among the changes will be a reduction of high school credits to 30 but with a single diploma, the reintroduction of examinations and the abolition of "open" courses.

Assuming that these proposals are all adopted unchanged and that Life Science is still being offered in our school, the most far-reaching

change would be the latter one, to abolish open courses. The only way Life Science could then survive would be if the classes were to be "stacked". This means two levels, advanced and general, in one class, with two separate credits earned for different work. As the author views this problem, individualized teaching would become a necessity in this situation, and the new P.S.I. unit would make the subsequent curriculum development that much easier.

Yet another problem on the horizon is the complete restructuring of the Provincial School Science Programme to accommodate the changes in the R.O.S.E. report. The Minister of Education for Ontario has put forward proposals for far-reaching changes in Science. Environmental Science is to have a much bigger place in the curriculum, while a number of fringe subjects are to be removed. Just how many of these changes will be implemented and how they will affect Life Science is open for speculation. In the meantime, curriculum development of the Life Science course will proceed optimistically. If our school produces a successful course in Life Science, its chances of survival are better. If not, much of the curriculum work can be adapted for other courses. The Ministry may change the names of high school biology courses, but much of the content, concepts and methodology remain unchanged.

This curriculum development will prove useful even if Life Science is removed from our science programme. It seems probable that other science subjects will have to be "stacked". One of the ways this can be achieved is by individualizing the courses. The lessons learned in developing a major unit of P.S.I. for this project will prove invaluable for similar curriculum development in other courses.

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APPENDIX

THE MODULAR COURSE

INVERTEBRATE DIVERSITY - AN INDIVIDUAL STUDY PROGRAMME

INSTRUCTION SHEET FOR EACH MODULE

1. Objective

Read the objectives. You will be tested on these.

2. Basic Activities

Complete the answers on the activity sheets.

- Do not copy. You will need accurate information to study for your module tests.
- Do not remove any books from the classroom without permission. Other students will need them so don't be selfish.

3. Lab. Books

Complete the laboratory activities.

- Record your labs and drawings in your laboratory notebook. This will be marked (30% of your total mark).

4. Modular Test

Try the short self test. If you get 80% or more you are ready to write the module test (50% of your module mark). (Ask the teacher for your test when you are ready - allow 15 minutes to write it.)

NOTE: If you complete all the basic work above, your maximum mark is 80%.

5. Optional Work

If you score 66% or more on your test (you may rewrite it - all marks count), you may do some or all of the optional activities.

- These are rated with a degree of difficulty from 1 to 4 points.
- A total of 10 points can earn 20%.
- Points over 10 are counted as bonus marks (in theory you could score over 100%!).

6. Extra Help

If you don't understand anything the teacher is available to help you.

7. Deadline

Each module states the time to be allocated for the work. Lab. books handed in late or tests written after the deadline are subject to a penalty of 10% per day late.

Although you may have some time in class for optional work, much of it will have to be done at home. Basic activities can all be done in class time.

I N V E R T E B R A T E D I V E R S I T Y

MODULE 1 - COELENTERATES

(10 periods)

MODULE 1 COELENTERATES

Teacher Centred Lesson

Outline:

This will take the form of a lecture-demonstration using blackboard, overhead and specimens.

1. Review of the phylum and where they are found.
2. Some representative coelenterates: show specimens and discuss.
3. Corals: plant-like animals.
4. Characteristics of the group.
5. A simple multicellur phylum: advances over protists.

MODULE 1 OBJECTIVES

After completing this unit, the student should be able to:

1. State at least six characteristics which may be used to identify coelenterates.
2. Name the three major groups of coelenterates and briefly describe an example from each group.
3. Distinguish between a sessile and a free swimming mode of life.
4. Describe the nature of coral and the result of its accumulation over many years.
5. Explain the differences and similarities between a polyp and a medusa.
6. Use an example to describe the nature of a colonial coelenterate.
7. Label given diagrams of hydra and its cell types and briefly state the function of these parts and cells.
8. Briefly describe the: movement, nutrition, excretion, sensitivity, respiration and reproduction of hydra.
9. Explain the connection between size and gas exchange in simple organisms.
10. Distinguish between sexual and asexual reproduction using hydra as an example.
11. Make neat, accurate lab reports and drawings.

MODULE 1 - COELENTERATES

Activity Sheet

1. Examine the jellyfish (Aurelia) and the sea-anemone (Metridium). Touch each one lightly with your finger (you may wear rubber gloves).

   a) What do you notice about the body of each animal?

   _____

   b) Do they seem to have a skeleton? _____

   c) How do they support their bodies? _____

   _____

   d) Look at the animals from the anterior (mouth) end:

   What is the shape of the body? _____

   e) Imagine the body sliced through the centre:

   Will it look the same on both sides no matter which way it is cut? _____

   f) What is this called? (see Andrews p. 434) _____

   g) What structures are found around the margin of the mouth? (body) _____

   h) Which of the two species is sessile and how do you know?

   _____

   (i) Why is the sea anemone so named? _____

   _____

   _____

2. Examine the pieces of coral "shell".

   a) There is some evidence that they once contained anemone-like creatures. What is the evidence? _____

   _____

   b) What is the hard material made from and what is its purpose? (Buchsbaum pp. 100-102) _____

   _____

   c) What is the result of accumulated coral "skeletons"?

   _____

3. Look at the specimen of obelia with the low power of your microscope.

   a) What are the two "polyps" and how are they connected? (Buchsbaum p. 85) _____

   _____

   b) In your lab. book, draw a pencil diagram of the two polyps. Your drawing must be from your slide and fully labelled. (1/2 to 2/3 page)

   c) What is a medusa? _____

   _____

   d) Draw a sketch below to show that a medusa is like an upside down polyp. (Buchsbaum p. 87)

3. e) In its life history, the jelly-fish has both a polyp stage and a medusa stage. Briefly explain this. (Buchsbaum p. 96)

_____

_____

_____

f) Examine the "Portuguese Man-of-War". Why isn't it a true jelly-fish? (Buchsbaum p. 94 - pictures 100-4 + 100-5)

_____

_____

_____

4. a) List the three major groups of coelenterates. (B.S.C.S. - p 791)

(i) _____ (ii) _____

(iii) _____

b) Complete the list of the characteristics of coelenterates below: (reference Life Science - pp. 330-333 - copies are available)

(i) Symmetry _____

(ii) Layers of Tissue _____

(iii) Digestive System _____

(iv) Specialized Organs for Feeding or Moving _____

(v) Specialized Cells to Capture Prey _____

(vi) Nervous System _____

(vii) Systems Lacking _____

5. View the film "STINGING-CELLED ANIMALS: COELENTERATES". Answer the question sheet.

6. a) Label the given diagrams of:

   (i) a cut away section of hydra, and

   (ii) a portion of the body wall of hydra showing cell types (Buchsbaum pp. 72-73)

   b) Tabulate these parts and their functions (Buchsbaum, pp. 76 & 80)

7. Examine a preserved hydra with a binocular microscope. Make a clearly labelled drawing of your specimen in your lab. book. (Put a proper title and state the magnification of your picture.)

8. Describe the habitat of hydra (Buchsbaum p. 69) and its general appearance. _____

_____

_____

_____

9. Complete an investigation of living hydra - obtain separate sheets. Make proper observations in your laboratory note book.
(Note: Some observations may not be possible.)

10. Draw diagrams of hydra feeding (Andrews p. 457) in the space below.

11. Describe how hydra can take and digest its food whole. (Andrews pp. 458 + 463) _____

_____

_____

_____

_____

12. a) Complete investigation - gas exchange, the size factor. (Andrews p. 491) Answer the discussion questions and include in your lab. book with the lab. report.

b) How does hydra obtain its oxygen supply, in view of its "large" size? _____

_____

_____

_____

c) How does the body plan of hydra assist transportation and excretion? (Andrews pp. 573 + 588) _____

_____

13. Explain the difference between asexual and sexual reproduction using hydra as your example. (Be concise.)

Asexual: _____

_____

_____

Sexual: _____

_____

_____

(Ref. Andrews and Buchsbaum)

FILM STINGING-CELLED ANIMALS: COELENTERATES

1. What is the origin of the word coelenterate? _____

_____

_____

2. What are the distinguishing characteristics of the phylum coelenterates?

_____ _____

_____ _____

3. Which distinguishing characteristics of coelenterates are "firsts" among the animals? _____

_____

4. How are the nematocyst (sting cell) threads discharged?

_____

_____

5. What purpose does each of the two body cell layers serve?

Ectoderm: _____

_____

Endoderm: _____

_____

6. Describe the reproductive cycle of a hydroid colony.

_____

_____

_____

MODULE 1 - SELF TEST

(study your notes before answering)

(Complete the statements below - answers overleaf)

1. The body parts of coelenterates are symmetrically distributed around any cut through the mouth. This is known as: (_____ _____).
2. An animal which is fixed in one place is known as a: (_____) animal.
3. The gut of hydra like other coelenterates is shaped like a simple: (_____).
4. The nervous system of hydra consists of a group of nerves forming a: (_____).
5. The habitat of hydra is: (_____).
6. Surface area increases in relation to volume as the volume of an organism: (_____).
7. Cells which replace discharged nematocysts come from the (_____) cells.
8. Reefs are often formed by the accumulation of: (_____).
9. Complete the matching word:
   hydrozoa: obelia, anthozoa: sea anemone, scyphozoa: (_____).
10. The outer layer of hydra is the: (_____).

(TURN OVER FOR ANSWERS)

ANSWERS:

1. radial symmetry
2. sessile
3. sac
4. network
5. fresh water ponds and streams
6. decreases
7. mesenchyme
8. coral skeletons
9. jelly fish
10. ectoderm

* NOTE: Do not attempt the module test unless you score 8/10 or better!!

MODULE TEST #1

COELENTERATES

Place a cross in the appropriate space on the answer sheet provided. Do not mark this question paper.

1. The term radial symmetry means:
   a) cut through the mouth and body each half is identical no matter which direction the cut is made.
   b) there are tentacles radiating out from its mouth.
   c) cut through the mouth down the centre of the body, the right and left sides are identical in one plane only.
   d) The body is wheel shaped.

2. An animal which is sessile:
   a) can swim freely.
   b) is able to drift around with the tides and swim weakly.
   c) can only crawl over the sea bottom slowly.
   d) is fixed to one place all its adult life.

3. Coelenterates are characterized by having a body wall:
   a) with many layers of cells.
   b) with two tissue layers.
   c) with a layer of cells (ectoderm) and a jelly layer (mesogloea).
   d) with three tissue layers.

4. Coral is known to:
   a) form volcanic islands in the ocean over many generations.
   b) be a semi-precious stone.
   c) be a protective skeleton for certain multicellular creatures.
   d) be the dominant plant in coral reefs such as the great barrier reef.

5. The word "coelenterate" means:
   a) hollow gut.
   b) a hydra like creature.
   c) head-footed.
   d) flat-worm.

6. Coelenterates are the "first" phylum to:

   a) have the ability to reproduce both sexually and asexually.

   b) have organized cells.

   c) have species which can move around freely.

   d) have specialized cells which function for one main job.

7. Three major groups of coelenterates are: sea anemonies, jelly fish and:

   a) hydrozoans.

   b) protozoans.

   c) anthozoans.

   d) scyphozoans.

8. A nematocyst is a:

   a) cell in the endoderm concerned with enzyme secretion.

   b) sensory cell which detects chemicals and touch.

   c) cell which can inject paralysing poison into the prey.

   d) cell with a long flagellum (whip) which mixes food and digestive juices.

9. The outer protective layer of cells in a coelenterate is known as the:

   a) mesogloea.

   b) endoderm.

   c) cell membrane.

   d) ectoderm.

10. The reproductive cycle of a hydroid colony such as obelia involves both a:

   a) motile polyp and a sessile medusa.

   b) asexual medusa and a free swimming polyp.

   c) a sessile colonial stage and a sexually active free swimming medusa stage.

   d) testis and an ovary developing on the polyp.

11. An umbrella shaped, free swimming reproductive organism best describes a:

   a) medusa.

   b) planula larva.

   c) polyp.

   d) hydroid colony.

12. The similarities between a medusa and a polyp are most obvious when one considers:

a) one to be able to move and the other to be fixed.

b) that both have a limey skeleton.

c) that the medusa is like an upside down polyp.

d) the shape of the body and number of tentacles.

13. The young jelly-fish develops from:

a) the budding of a polyp stage.

b) a larva which forms after sperm and egg unite.

c) the budding of the medusa stage.

d) a ciliated (planula) larva.

14. The Portuguese man-of-war is:

a) a 17th century European battle ship.

b) a Portuguese soldier.

c) a floating hydroid colony.

d) a jelly fish with a sail.

15. The digestive system of coelenterates:

a) is tubular.

b) has two openings; a mouth and an anus.

c) has specialized regions each of which carry out different stages of the digestive process.

d) is a simple sac-like structure with a single opening.

16. The nervous system of coelenterates is best described as:

a) simple and net like.

b) having a small anterior brain with a dorsal nerve cord.

c) complex with segmental ganglia.

d) having a simple central nervous system with nerves branching to all parts.

17. One system which coelenterates lack is a:

a) nervous system.

b) circulatory system.

c) digestive system.

d) sensory system.

18. The mouth of hydra is surrounded by:

a) about 24 tentacles.

b) 10 to 12 tentacles.

c) 6 to 8 tentacles.

d) 2 to 4 tentacles.

19. Hydra is usually found:

a) on the seashore, in rock pools.

b) in a marine environment.

c) in marshes and wet soil.

d) in fresh water ponds and streams.

20. If hydra is touched with a toothpick it will:

a) move away from the area.

b) grasp the toothpick with its tentacles.

c) contract its body and tentacles.

d) slowly break apart.

21. Extracellular and intracellular digestion involve all the following cells except:

a) protective muscular epidermal cells.

b) flagellated endodermal cells.

c) glandular endodermal cells.

d) endodermal cells with pseudopodia.

22. Size is related to gas exchange in that:

a) the body of hydra is hollow to decrease its surface area for gas exchange.

b) diffusion is faster in large organisms to increase the rate of gas exchange.

c) surface area diminishes in relation to volume as an organism gets larger giving it a smaller area for diffusion of gases.

d) surface area increases in relation to volume as an organism gets smaller giving a smaller area for diffusion of gases.

23. The hollow fluid filled body of hydra is necessary for all of the following processes except.

a) reproduction.

b) respiration.

c) excretion.

d) nutrition.

24. In hydra the animal may reproduce asexually by:

a) forming ovaries and testes.

b) mating with a hydra of the opposite sex.

c) forming a zygote when a sperm and egg unite.

d) growing a new baby hydra from its ectoderm.

25. The nerve cells of hydra:

a) join with sensory cells to receive stimuli from the environment.

b) pass through the endoderm layer.

c) form part of the central nervous system.

d) do not pass through the mesogloea.

26. Nematocysts are concentrated mainly:

a) in the digestive cavity.

b) on the ectoderm of the body.

c) on the tentacles.

d) around the mouth.

27. In Ontario it is difficult to realize the importance of coelenterates because:

a) they are mainly microscopic.

b) none of the coelenterates are found in fresh water.

c) specimens must be imported from warm tropical waters.

d) they are mainly marine.

28. Hydra usually moves by:

a) gliding on its adhesive base.

b) somersaulting or looping on its base and tentacles like a caterpillar.

c) swimming with its tentacles.

d) walking on its tentacles.

29. Hydra is able to detect stimuli in its surroundings by means of:

a) simple eyes which can only detect light or dark.

b) small antennae on its tentacles.

c) an accute sense of hearing.

d) sensory cells in the ectoderm.

30. Mesenchyme cells (interstitial cells) function to:

a) detect stimuli.

b) replace other dead cells.

c) transmit nerve impulses.

d) protect underlying cells from damage.

OPTIONAL ACTIVITIES

(rated 1 - 4)

1. (3) Explain the term "division of labour" to describe how multi-cellular organisms have a distinct advantage over single-celled organisms. Your answer should be about a page plus diagrams.

   Reference: B.S.C.S. Blue version - pp. 210-212.

2. (1) With the help of diagrams, summarize the theory of coral reef formation.

   Reference: Buchsbaum - p. 101.

3. (2) Write a short paper on either: (a) Diversity in Corals OR (b) Comb Jellies.

   (not more than 500 words)

4. (4) Complete lab. investigation "Testing Pollutants Using Hydras as Test Animals". A complete lab. report is required.

   Reference: Projects Sourcebook - p. 15.

5. (1) Copy the following questions and answers into your report.

   a) What is embryology? (Ref. B.S.C.S. - green - p. 603)

   _____

   b) What is: a zygote? _____

   _____

   cleavage? _____

   _____

   a blastula? _____

   _____

   ectoderm & endoderm? _____

   _____

Describe the development of the embryo into a new hydra (you may include diagrams). _____

_____

_____

6. Investigate regeneration in hydra. (Ref. Andrews - p. 598) Answer discussion questions 2, 3, and 4. Write up a full lab. report. (An extra week is allowed for this assignment as it takes time.)

I N V E R T E B R A T E D I V E R S I T Y

MODULE 2 - PLATYHELMINTHES

(7 periods)

MODULE 2 PLATYHELMINTHES

Teacher Centred Lesson

Outline:

This will be a lecture-demonstration using blackboard, overheads, and specimens.

1. Review of the phylum and where they are found.
2. Some representative platyhelminthes: show specimens such as flukes and tapeworms. Planaria will be demonstrated in a dish on the overhead.
3. Parasitism and man.
4. Characteristics of the phylum.
5. Significance of bilateral symmetry.

MODULE 2 OBJECTIVES

After completing this unit the student should be able to:

1. Name the three groups of platyhelminthes and give at least one example from each class.
2. State at least five characteristics which may be used to identify platyhelminthes.
3. Distinguish between free-living and parasitic life.
4. Label a given diagram of planaria.
5. Briefly describe the: habitat, movement, feeding, sensitivity, respiration, excretion (osmo-regulation) and reproduction of planaria.
6. Explain the term hermaphrodite.
7. Relate the shape of planaria to the lack of certain systems and to the diffuse structure of other systems.
8. Name two parasitic flukes.
9. Explain the term "host" in relation to parasites.
10. Briefly describe the life cycle of the sheep liver fluke.
11. State how tapeworms live and feed.
12. Explain how humans may become infected with flukes or tapeworms.
13. Make neat, accurate lab. reports and drawings.

MODULE 2 - PLATYHELMINTHES (FLATWORMS)

Activity Sheet

1. Name the three groups of flatworms (common names will do) (Andrews p. 435) and give an example from each group.

	Group	Example
i)	_____	_____
ii)	_____	_____
iii)	_____	_____

2. Explain the meaning of bilateral symmetry (p. 435).

_____

_____

_____

3. Write a brief statement about each of the following platyhelminth characteristics (p. 435).

a) Layers of tissue: _____

_____

b) Organ systems lacking: _____

_____

c) Digestive system: _____

_____

d) Reproductive systems: _____

_____

4. State three ways in which the platyhelminth body shape and orientation is different from a coelenterate such as hydra (Buchsbaum p. 109).

i) _____

_____

ii) _____

_____

iii) _____

_____

5. Distinguish clearly between a free-living and a parasitic mode of life. _____

_____

6. Label the given diagram of planaria (Buchsbaum p. 112).

7. Where and how may planarias be obtained? (Buchsbaum p. 109)

_____

_____

_____

8. Remove one living planaria from its jar and place it in a petri dish containing water. Examine it with a hand lens and/or the binocular microscope.

i) Cover one half of the dish. Does the planaria prefer light or shade? How do you know?

ii) Describe its movement.

iii) Draw your planaria using the binocular microscope.

Record your results in your lab. book under the title "Observing a Living Planaria and Its Behaviour".

9. There are two mechanisms which help movement. Describe them briefly. (Buchsbaum pp. 109-110)

10. How does planaria detect light? (Buchsbaum p. 118) Explain how it determines its direction.

11. What does planaria feed on and how does it take in its food? (Andrews p. 460)

12. The tapeworm is a flatworm yet it has no digestive tract. Explain. (Andrews p. 460)

13. How does the shape of planaria help its gaseous exchange? (Andrews p. 493)

14. What is the connection between the digestive tract and the transport of materials through planaria? (Andrews p. 519)

_____

_____

15. In the space below draw a sketch of a part of the "flame-cell" system of planaria.

16. What is the function of the flame-cell and how does the system work? _____

_____

17. Suggest why the digestive and flame-cell systems extend to all parts of the body. _____

_____

18. Sketch (outline drawing only) the asexual reproduction of planaria in the space below. (Andrews p. 588)

19. What other method of reproduction is found in planaria? (Andrews p. 590) _____

20. What is the meaning of hermaphrodite? (p. 590) _____

_____

21. One advantage of being a hermaphrodite is that it is easier to find a mate. Why? _____

_____

22. List features which flatworms such as planaria share with coelenterates such as hydra:

i) _____

ii) _____

PARASITES: Read the article "Worms and Molluscs"

23. What are the two kinds of parasitic flukes?

i) _____

ii) _____

24. What is the parasite's host? _____

_____

25. What are the two hosts of the sheep liver fluke? Briefly describe its life cycle. (Fig. 18.4)

_____

_____

_____

_____

_____

26. Name two flukes which cause diseases in humans. How do they enter the body?

27. Where do tapeworms live and how do they feed?

28. What effect do tapeworms have on the body?

29. How are humans infected with tapeworms?

30. View the films: (a) PLATYHELMINTHES: FLATWORMS and (b) PARASITIC FLATWORMS. Answer the question sheets provided.

31. In your laboratory note books draw a clearly labelled diagram of:

a) fasciola, and;

b) a tapeworm.

(Use a binocular for details.)

FILM

FLATWORMS (PLATYHELMINTHES)

1. What is found in the body of Convoluta which makes it green?

_____

2. What is such a relationship between two organisms called?

_____

3. What are the advantages of having a head end to the body?

_____

_____

4. Name the two major sensory organs of planaria.

i) _____ ii) _____

5. What are the two main parts of the nervous system of planaria?

i) _____ ii) _____

6. What is the purpose of the mesoderm in planaria?

_____

7. When a planaria regenerates it grows head and tail from the ends where they were cut off. This is referred to as: _____

8. The head end of planaria will regenerate a complete animal more readily than the tail end does. This is called the:

_____

FILM PARASITISM: PARASITIC FLATWORMS

1. How are parasites removed from the intestine of the rat?

_____

_____

2. Name three stages by which parasites may have evolved:

a) _____

b) _____

c) _____

3. State one way in which a parasite attempts to ensure reinfection of a new host.

_____

_____

4. How are people infected with blood flukes?

_____

_____

5. How does a tapeworm hold on to its host?

_____

6. Why hasn't the tapeworm got a digestive system?

_____

7. What are bladder worms (cysticercus)?

_____

8. List two ways to prevent tapeworm infection:

a) _____

b) _____

MODULE 2 - SELF TEST

(study your notes thoroughly before writing this test)

(Complete the statements below - answers overleaf.)

1. Human blood flukes get into the body through the _____.
2. Tapeworm infection usually occurs by eating _____ _____.
3. Reproduction by one individual is referred to as _____ reproduction.
4. The secondary host of a fluke is often a _____.
5. Respiration in flatworms relies on the process of _____.
6. Surplus water is removed from the body of planaria by _____.
7. The digestive system has a _____ shape.
8. One body system lacking in tapeworms which is present in planaria is the _____ system.
9. Hermaphrodites are animals with _____.
10. The kind of symmetry found in platyhelminthes but not in coelenterates is _____ symmetry.

(TURN OVER TO CHECK YOUR ANSWERS)

ANSWERS:

1. skin
2. undercooked meat
3. asexual
4. snail
5. diffusion
6. flame cells
7. branching
8. digestive (also sensory)
9. both male and female reproductive organs
10. bilateral

* NOTE: Do not attempt the module test unless you score 8/10 or better!!

MODULE TEST #2

PLATYHELMINTHES

Place a cross in the appropriate space on the answer sheet provided. Do not mark this question paper.

1. The term bilateral symmetry means:
   a) cut through the mouth and body each half is identical no matter which direction the cut is made.
   b) there are legs on both sides of the body.
   c) cut down through the centre of the body, in one plane only, the right and left sides of the body are identical.
   d) the body is symmetrical in two different planes.

2. A class of flatworms with an example of that group is:
   a) tape worm: planaria
   b) free-living flatworms: taenia
   c) flukes: fasciola
   d) tapeworms: fasciola

3. Platyhelminthes are characterized by having a body wall:
   a) with three layers of tissue.
   b) with two layers of tissue.
   c) with two body layers enclosing a layer of jelly-like material.
   d) with many layers of cells and tissue.

4. The coelenterate and platyhelminth body plan is similar in that both have:
   a) bilateral symmetry.
   b) an incomplete digestive system with a single opening.
   c) radial symmetry.
   d) a nerve network.

5. Coelenterates and flatworms both lack:
   a) a digestive system.
   b) muscle cells.
   c) a circulatory system.
   d) a mouth.

6. Free-living flatworms have one system not found in coelenterates, which is:

   a) a nervous system.

   b) a circulatory system.

   c) a digestive system.

   d) an excretory system.

7. Planaria can swim with:

   a) tentacles and muscles.

   b) cilia and muscles.

   c) tentacles and cilia.

   d) umbrella like motions of the body wall.

8. An animal and its mode of life is:

   a) planaria: parasitic.

   b) fasciola: free-living.

   c) tapeworm: parasitic.

   d) liver fluke: free-living.

9. The word hermaphrodite means:

   a) having a parasitic mode of life.

   b) having the sexes separate in each animal.

   c) self fertilization.

   d) having both sexes in one animal.

10. The long protruding process on the underside of planaria is called the:

   a) anus.

   b) pharynx.

   c) penis.

   d) glottis.

11. The eyes of planaria can:

   a) be used to detect the direction of light.

   b) be used to locate its food.

   c) see images in black and white but not colour.

   d) only distinguish light from dark.

12. Planaria may be caught by:

    a) shining a light into a pond to attract them.

    b) searching the surface of a field at dawn when it is wet with dew.

    c) a piece of raw liver on a string.

    d) a fast dog such as a greyhound.

13. Planaria mainly feeds on:

    a) soft tissues.

    b) zooplankton.

    c) small fish.

    d) predigested food from the intestine.

14. Planaria takes in food through:

    a) its body surface.

    b) a mouth at the centre of its tentacles.

    c) specialized nutritive cells in its endoderm.

    d) its mouth at the end of a long pharynx.

15. A tapeworm needs no digestive system since:

    a) it only feeds in the larval stage.

    b) it eats small bacteria which need no digesting.

    c) it is surrounded by food already digested by its host.

    d) it rarely gets hungry.

16. Gaseous exchange is facilitated in planaria by:

    a) pairs of segmental gills.

    b) its leaf-like shape.

    c) muscular breathing movements.

    d) the action of its cilia which move oxygenated water into its gastrovascular cavity.

17. The digestive tract in planaria serves a secondary function which is:

    a) excretion.

    b) water control (osmo-regulation).

    c) internal transport.

    d) sensory communication.

18. The system of flame-cells in planaria serves mainly to:

    a) remove surplus water from the body.

    b) digest small food particles.

    c) excrete nitrogenous waste.

    d) take in oxygen and give out CO_2.

19. The flame-cell system and the gastrovascular system pass to all parts of the body of planaria. This is because it lacks a:

    a) digestive system.

    b) excretory system.

    c) circulatory system.

    d) nervous system.

20. Planaria may occasionally reproduce when a part of the body separates by pinching off. This is called:

    a) budding.

    b) asexual fragmentation.

    c) sexual conjugation.

    d) vegetative propagation.

21. External parasitic flukes usually hold on to their hosts by means of:

    a) hooks or suckers.

    b) tentacles and stinging cells (nematocysts).

    c) cilia.

    d) strong teeth around the mouth.

22. The building of the Aswan High Dam in Egypt had the unexpected result of increasing the incidence of:

    a) blood flukes.

    b) sheep liver flukes.

    c) tapeworms.

    d) parasitic planaria infections.

23. The secondary host of a sheep liver fluke is a:

    a) fish.

    b) human.

    c) snail.

    d) bile duct.

24. Human flukes frequently enter the body through the:

a) respiratory tract.

b) skin.

c) urino-genital openings.

d) digestive system (mouth).

25. The liver fluke produces many eggs and larvae in the secondary host. This increases the chance of:

a) surviving the period of dormancy over the winter.

b) predators eating all the young before they are full grown.

c) reinfecting a new primary host (sheep).

d) finding the secondary host and destroying its tissues.

26. An organism which harbours a parasite is called a/an:

a) fluke.

b) internal parasite.

c) guest.

d) host.

27. Humans become infected by tapeworms through:

a) insanitary toilet habits.

b) eating eggs from an infected person.

c) eating undercooked meat.

d) the skin of their feet when wading in infected water such as paddy fields.

28. One good way of ridding an area of sheep liver flukes is to:

a) kill all infected sheep.

b) spray insecticide.

c) introduce ducks into the area since they eat snails.

d) give all the sheep anti-fluke injections.

29. The effect of tapeworms on people is:

a) not noticeable in well nourished humans.

b) to cause bladder worm infection, great pain and death.

c) to make a person die of starvation.

d) to block the intestine making it difficult to swallow.

30. Fluid is moved along ducts by flame cells through the action of:

a) the contraction of the cell.

b) a single whip-like flagellum in each cell.

c) the muscular action of the cell and duct.

d) the beating of a group of cilia in the cell.

OPTIONAL ACTIVITIES

(rated 1 - 4)

1. (3) Study regeneration in planaria. Write up a full report. (Andrews pp. 598-599) (An extra week is allowed as it takes time.)

2. (4) Investigate why planarians do not live in certain waters. Design a properly controlled experiment. (See teacher for help.)

3. (4)
   i) Explain the terms imprinting, habituation and conditioning. Use examples to help your answer.
   ii) Design an experiment similar to the one described in the article to determine if conditioned responses can be learned by planaria. Write up a full report.

4. (4) Using the information in Buchsbaum pp. 132-150 or any other source answer the following:
   a) Describe the special structural adaptations of parasites to their way of life using gyrodactylus and polystoma as examples.
   b) Suggest how parasites may have evolved from commensal animals to internal parasites.
   c) Internal parasites frequently show structural degeneration compared to their free living relatives. Use planaria and fasciola or the tapeworm to illustrate this.
   d) Internal parasites frequently have complex life histories. Using a diagram describe the life cycle of either a fluke or a tapeworm. Account for the following: (i) the number of eggs; (ii) the secondary host; (iii) the larval stages.
   e) Describe some serious human parasites and how they may be avoided.

5. Describe what has been learned about regeneration using planaria as an experimental animal. (2)

6. Frog Parasite Lab. - This may be done with special permission. Frogs must be ordered so speak to your teacher. A full report with drawings is required. (3)

I N V E R T E B R A T E D I V E R S I T Y

MODULE 3 - ANNELIDS

(8 periods)

MODULE 3 ANNELIDS

Teacher Centred Lesson

Outline:

This will be a lecture-demonstration using blackboard, overhead, and specimens.

1. Review of the phylum and their habitats.
2. Show representative annelids - preserved specimens and pictures of various tube worms.
3. Demonstrate the movement of a leech in a dish on the overhead.
4. Outline the important advances annelids over previous groups.
5. Describe Darwin's work on earthworms and the importance of worms to man.
6. Explain how evolutionary relationships between phyla are indicated by comparing their larval forms.

MODULE 3 OBJECTIVES

After completing this unit the student should be able to:

1, Name the three groups of annelids and give an example from each group.

2. State at least five characteristics which may be used to identify annelids.

3. Use the earthworm as an example to explain the advances in the structure and function of the annelid digestive system compared to that found in lower groups.

4. Explain where the coelom is found in annelids.

5. Use the earthworm as an example to illustrate the meaning of segmentation.

6. Give an example of at least one tube worm and explain how it feeds.

7. Give two or more parasitic adaptations of leeches.

8. Explain the medicinal use of leeches.

9. Give the features of a closed circulation, and state its function in the earthworm.

10. Briefly compare the nervous systems of annelids and flatworms.

11. Describe excretion in the earthworm.

12. Describe the process of reproduction in the earthworm.

13. Identify the external features of the earthworm and state their functions.

14. Dissect an earthworm to display its internal anatomy and give the function of its parts.

15. Make neat, accurate lab. reports and drawings.

MODULE 3 - ANNELIDS (SEGMENTED WORMS)

Activity Sheet

1. Name the three largest classes of annelids and give an example from each group. (Buchsbaum pp. 230, 232, and 233)

	Group	Example
i)	_____	_____
ii)	_____	_____
iii)	_____	_____

2. Write a brief statement about each of the following annelid characteristics: (Andrews p. 438)

a) Kind of Symmetry _____

_____

b) Number of Layers of Body Tissue _____

_____

c) Segmentation _____

_____

d) Characteristics of Its Digestive System _____

_____

e) Features of Its Transportation System _____

_____

f) Number of Species and Their Habitats _____

_____

3. Copy the drawing of the earthworm's digestive system and label it. (Andrews p. 458)

4. Give two advantages of the type of digestive system in annelids compared to platyhelminthes or coelenterates. (Andrews p. 463)

i) _____

_____

ii) _____

_____

5. What is the coelom and why is it an advantage to annelids? (Buchsbaum p. 210)

_____

_____

_____

6. What is the significance of segmentation? (Buchsbaum p. 218)

_____

_____

7. What are fan worms, feather worms and peacock worms and how do they feed? (Buchsbaum p. 234-2)

_____

_____

8. Where are giant earthworms to be found and how big are they? (Buchsbaum p. 234-3)

9. How are leeches adapted for parasitism? (Buchsbaum pp. 233, 234)

10. Describe the use of medicinal leeches. (Buchsbaum p. 234-5)

11. In your laboratory notebook, make carefully labelled drawings of a preserved leech and sandworm (nereis).

12. View the film: "Segmentation - The Annelid Worms". Answer the questions on the sheet provided.

13. What do you understand by a "closed" circulation? (B.S.C.S. p. 496)

14. Copy Fig. 20-10 (Andrews p. 525) in the space below.

15. Describe briefly how blood flows in the earthworm (p. 525).

16. What are the functions of this circulation? (p. 525)

17. What is the main difference between the nervous system of a segmented worm and that of planaria? (B.S.C.S. p. 516)

18. Answer the following questions about the excretory system of the earthworm (Andrews p. 574)

a) What is the system called?

b) What is each organ called?

c) What are the four parts of each organ?

d) How is fluid drawn into the tube?

e) Where are these organs found?

f) What happens to useful products passed into the tube?

g) Where are the wastes stored? _____

_____

h) What wastes are excreted in this way? _____

_____

19. Answer the following questions on the reproductive system and process in the earthworm. (Andrews p. 600)

a) Why is the process so complex in worms? _____

_____

b) What does hermaphrodite mean? _____

_____

c) What happens to ova after release by the ovary? _____

_____

d) What is the purpose of the large seminal vesicles of the worm?

_____

e) How do sperms get from the seminal vesicles to the outside?

_____

f) What is the purpose of the seminal receptacles? _____

_____

g) How does copulation take place? _____

_____

h) What is the purpose of the two slime tubes?

i) _____

_____

ii) _____

_____

i) What happens as the worm slips out of the mucous sleeve?

_____

_____

_____

j) What happens to the mucous sleeve? _____

_____

_____

20. Complete the activity: The Earthworm

Use the information sheets to obtain information.

Do not mark these sheets as they can be used by other classes.

SEGMENTATION - THE ANNELID WORMS

1. Give two ways in which annelid worms show an important evolutionary development over flatworms.

2. Briefly describe the structure and functions of the nervous system of the earthworm.

3. Explain how respiration takes place in the earthworm.

4. What function do the bristles of the earthworm serve?

5. What function do the bristles of the fireworm serve?

6. Describe the reproductive process of Nereis.

7. Give one important way in which the reproductive process of the earthworm is different from nereis.

8. Why is Polygordius described as a primitive or degenerate form of annelid worm?

ACTIVITY: THE EARTHWORM

Purpose: To study the earthworm, its structure, and the function of its parts.

Materials:

1. A preserved earthworm.
2. Dissecting tray.
3. A hand lens and/or a dissecting microscope.
4. Pins.
5. Dissection kit (scissors, forceps, probe).
6. Information sheets.

Procedure: (A) - External Features

1. Annelids are bilaterally symmetrical. Examine your worm. What evidence do you find for this? _____

_____

_____

2. Identify the lip or prostomium above the mouth. Give two other ways of distinguishing the anterior from the posterior end.

i) _____

ii) _____

3. Identify the saddle (clitellum). How far is it from the head end?

_____

4. The clitellum only extends over the dorsal and lateral sides of the body. Give one other way to recognize the dorsal region of the body. _____

_____

5. What is the visible external evidence that earthworms are segmented? _____

_____

6. Feel the body of your worm to locate the bristles (setae). Use a hand lens to locate them. How many are there in each segment?

_____

7. Worms can move their setae in and out. They have circular muscles which make the body long and thin and longitudinal muscles whose contraction makes the body short and fat. Try to suggest the way in which the worm moves through its burrow. (If possible watch a live worm crawling on a piece of paper.) _____

_____

_____

_____

8. What are the other openings in the body and in what segments are they found? Try to see them with a hand lens.

a) _____

b) _____

c) _____

9. How do you recognize the clitellum? _____

_____

10. What is it for? _____

_____

(B) - Internal Anatomy

11. Place the worm on the pan with its dorsal surface up and hold it in position with a pin through each end. Using scissors, cut through the body wall along the mid-dorsal line, from about 2 cm. behind the clitellum. Continue the cut anteriorly to the mouth taking care not to damage any internal organs. Use the forceps and pin out the sides of the body. You may need to break each septum with your probe to do this. (Note: Slope your pins out.) What do these septum walls do? _____

_____

12. Identify the long brown digestive system. Find each part starting at the mouth end. By counting the septa, find out which segments these parts are in. Use the information sheets to find out what each region does. Complete the chart below. (Note: You need not remember the exact segments for each organ.

ORGAN	LOCATION BY SEGMENTS	FUNCTION OF THE PART
PHARYNX		
ESOPHAGUS		
CROP		
GIZZARD		
INTESTINE		

13. In segments 9-12 there are white sac-like seminal vesicles. Use your sheets to find out their function and write it below.

_____

_____

14. Use a hand lens to identify the seminal receptacles - small round sacs - in segments 9 and 10. What is their function? _____

_____

15. See if you can identify the ovaries under the last seminal vesicle (segment 12 and 13). What is their function? _____

_____

16. Identify the brownish line running along the dorsal surface of the intestine. This is called the dorsal blood vessel. Near the seminal vesicles are 5 aortic arches (hearts). Cut off the seminal vesicles on the left to observe them. You may not see five since they may not all have blood left in them. What is the function of these five arches? (Note: Blood flows forwards in the dorsal vessel and backwards in a ventral vessel which is made visible by gently tilting over the intestine and looking under it.)

_____

_____

17. Use the hand lens to identify the nephridia. Look in each segment on each side of the intestine. What structures carry out the same function in humans? _____

_____

18. In your laboratory note books draw a diagram of your dissection. Use a pencil. Make your outline clear first and use about 2/3 of a page. Do not draw all of the posterior end of the worm. Label the parts clearly and neatly.

19. Identify the cerebral ganglia (brain) - these are found in segments 2 and 3 and are part of a nerve ring around the pharynx. Cut the pharynx through just posterior to the brain and carefully remove the whole intestine together with the seminal vesicles. Observe the nerve cord and look for segmental ganglia and nerves with your lens. In your lab. book draw the brain and nerve cord. An outline of the body will do.

20. What do you think are the functions of the following structures?

i) Brain: _____

_____

ii) Nerve Cord: _____

_____

iii) Segmental Ganglia and Nerves: _____

_____

MODULE 3 - SELF TEST

(Study your notes carefully before answering)

(Complete the statements below - answers overleaf.)

1. The aortic arches of the earthworm are often referred to as the _____.
2. The digestive organ of the worm which acts as a temporary food store is the _____.
3. The slime tubes are secreted by the _____.
4. Annular rings on the outside of the worm's body are evidence of _____.
5. During its movement part of the worm's body is held in place by _____.
6. An animal with both sexes is called a/an _____.
7. Earthworms breathe through _____.
8. Movement of food and oxygen around the body of the worm is by means of _____.
9. A parasitic adaptation of the _____ is having suckers.
10. The sandworm nereis belongs to the class of annelids known as _____.

(TURN OVER FOR ANSWERS)

ANSWERS:

1. hearts
2. crop
3. clitellum
4. segmentation
5. setae (bristles)
6. hermaphrodite
7. damp skin (epidermis)
8. circulating blood
9. leech
10. polychaetes

* NOTE: Do not attempt the module test unless your score is 8/10 or better!

MODULE TEST #3

ANNELIDS

Place a cross in the appropriate space on the answer sheet provided. Do not mark this question paper.

1. Leeches are members of the class:
   a) annelida
   b) oligochaetes
   c) hirudinea
   d) polychaetes

2. Body parts repeated along the length of an animal is known as:
   a) segmentation
   b) bilateral symmetry
   c) parasitism
   d) radial symmetry

3. A tubular digestive system enables:
   a) the animal to digest its food completely before taking in a new meal.
   b) the gut to be sac-like with a single opening.
   c) all parts of the tube to be identical.
   d) one way flow of food with step by step processing of food.

4. The coelom is:
   a) the name given to the bristles on the sides of the body.
   b) a space between the body wall and the intestine.
   c) the last part of the intestine.
   d) the excretory organ.

5. Fan worms, feather worms, and peacock worms all obtain their food by:
   a) burrowing in sand and ingesting organic matter.
   b) killing their prey with stinging cells (nematocysts).
   c) ciliary feeding.
   d) camouflaging their bodies so that they can trap their unwary prey.

6. Which one of the following is not a parasitic adaptation in the leech?

   a) having an oral sucker.

   b) digesting its food over a long period.

   c) the ability to inject an anticoagulant.

   d) lack of bristles (setae).

7. Medicinal leeches may be used to treat:

   a) bad cuts.

   b) black eyes.

   c) blood pressure.

   d) varicose veins.

8. One important difference between the earthworm and the sandworm (Nereis) is that nereis has:

   a) larger setae (bristles).

   b) no setae.

   c) no obvious external segmentation.

   d) a parasitic mode of life.

9. Which of the following is not a characteristic of a closed circulation? Having a:

   a) body space (hemocoel) filled with "blood".

   b) pumping organ (heart).

   c) transporting fluid (blood).

   d) system of tubes (vessels) in which blood flows.

10. The pattern of blood flow in the earthworm is:

   a) backwards in the dorsal vessel and forwards in the ventral vessel.

   b) from heart to aorta, to hemocoel then back to the heart.

   c) forwards in the dorsal vessel and backwards in the ventral vessel.

   d) from dorsal to ventral vessel then forward to the pseudo-hearts.

11. Two major functions of the circulation in worms are to:

   a) transport oxygen to the tissues and to moisten the epidermis.

   b) bring waste to the nephridia and oxygen to the skin.

   c) carry food from intestine to tissues and oxygen from epidermis to tissues.

   d) transport food from intestines and waste to nephridia.

12. As contrasted to planaria, the nervous system of the earthworm:

a) has a less pronounced central nervous system.

b) an arrangement of segmental control.

c) has a nerve swelling (ganglion) in the head region - the "brain".

d) is a centralized nerve system with branching fibres as compared to a nerve network.

13. The nephridia of the earthworm are most similar to this organ in humans:

a) the kidney.

b) the heart.

c) the lung.

d) the stomach.

14. An animal which is an hemaphrodite is:

a) a parasite.

b) always aquatic (found in water).

c) capable of producing both eggs and sperms.

d) unable to cross fertilize since it can fertilize its own eggs.

15. The sperms of the earthworm complete their development in the:

a) testes.

b) seminal receptacles.

c) cocoon.

d) seminal vesicles.

16. After copulation the sperms from the second worm are stored in the:

a) testes.

b) seminal receptacles.

c) cocoon.

d) seminal vesicles.

17. The cocoon is formed by:

a) the shedding of the clitellum.

b) the outer layer of the egg.

c) the secretions of the nephridia.

d) the dried out mucous sleeve.

18. The earthworm respires through:

a) tracheal tubes.

b) a damp epidermis.

c) skin gills.

d) book lungs.

19. The bristles of the earthworm serve as:

a) anchors during locomotion.

b) accessory breathing organs.

c) sensory appendages.

d) a means of defence since it makes the worm difficult to swallow.

20. The prostomium of the earthworm is found:

a) anterior to the mouth and on the dorsal surface.

b) posterior to the anus and dorsal.

c) posterior to the mouth and ventral.

d) anterior to the anus and ventral.

21. The dorsal surface of the earthworm may be recognized by:

a) the light colour and openings of the nephridia.

b) the position of the bristles and a break in the thickening of the clitellum.

c) a dark colour and a complete thickened region of the clitellum.

d) the light colour and position of the prostomium.

22. A fireworm is so named because:

a) it always appears in the ground in areas where fires have occurred.

b) its bristles sting like fire.

c) its body lights up like fire.

d) people who start forest fires deserve no other name.

23. The best evidence of segmentation when examining the external features of the earthworm is the presence of:

a) a distinct mouth and anus.

b) bilateral symmetry.

c) a thickened region called the clitellum.

d) annualr rings and the arrangement of its bristles.

24. The clitellum functions during the process of:

a) respiration.

b) reproduction.

c) excretion.

d) circulation of blood.

25. The purpose of the septum walls is to:

a) shore up the worm's burrow.

b) allow new ploglottids to form.

c) keep the worm's blood flowing the right direction.

d) separate one segment from the next.

26. The correct sequence of organs in the digestive system, starting at the head is:

a) pharynx, esophagus, crop, gizzard.

b) esophagus, pharynx, crop, gizzard.

c) esophagus, gizzard, pharynx, crop.

d) gizzard, crop, esophagus, pharynx.

27. The organ which grinds up the worm's food is the:

a) crop.

b) intestine.

c) gizzard.

d) pharynx.

28. The structure which is used by the worm to take in food is the:

a) crop.

b) gizzard.

c) pharynx.

d) esophagus.

29. The organ in humans which most closely parallels the action of the aortic arches of the earthworm is the:

a) heart.

b) spleen.

c) lungs.

d) kidney.

30. Quite often it is possible to establish the evolutionary relationships between two phyla by examining:

a) highly specialized members of each phyla.

b) their natural environments.

c) their larval forms.

d) their behaviour and ecological niches.

OPTIONAL ACTIVITIES

(rated 1 - 4)

1. (2) Describe the subterranian adaptations of the earthworm. (Buchsbaum p. 220)

2. (4) Complete the activity: Do Earthworms Change the Soil? (Projects Sourcebook p. 25)
Write up a complete report including answers to the questions. (Extra time may be allocated.)

3. (4) Complete the activity: The Effects of Physical, Chemical or Biological Conditions on Earthworms. (Project Sourcebook p. 26)
A complete report is required. (Extra time may be allowed.)

4. (3) Complete the activity: The Effect of Pollutants on Leeches. (Project Sourcebook p. 38)
Write up a report including answers to the questions.

5. (3) Complete the activity: Earthworm Excretory Structures. (B.S.C.S. - blue p. 659)
Write up a full lab. report including answers to discussion questions 1-4.

6. (4) Write an illustrated account (about 500 words) on tube dwelling polychaetes.

7. (2) Describe the parasitic adaptations of leeches.

8. (4) Prepare a permanent stained slide of a single nephridium. (Ask the teacher for instructions.)

9. (3) Explain the connection between earthworms and soil fertility. (About 100 words.)

10. Make a stained slide of monocystis from the seminal vesicles of
(4) your worm. Draw diagrams of various stages in its life cycle.
Write up an account of the structure and life cycle of this
parasite. See the teacher for details.

11. Complete the activity: The Worm Turns. (Ref. How to Dissect
(3) p 29)
Write up a full report.

I N V E R T E B R A T E D I V E R S I T Y

MODULE 4 - ARTHROPODS

(20 periods)

MODULE 4 ARTHROPODS

Teacher Centred Lesson

Outline:

The lesson will take the form of a lecture-demonstration using audio-visual materials and specimens.

1. Review of arthropods, their numbers and habitats.
2. "Why not eat grasshoppers and grubs?"
3. "Small in size but huge in number" - anatomy dictates success but also limitations. How big, how small?
4. "Bigger fleas have little fleas upon their backs..." - parasites and insects parasitizing insects.
5. Drosophila - The "giant" amongst animals - genetics discussion.
6. Some unusual specimens such as a large tarantula, a giant scorpion, and a 12 cm. centipede.
7. (If time) pests and pesticides - the D.D.T. story.

MODULE 4 OBJECTIVES

After completing this unit the student should be able to:

1. List six characteristics which may be used to identify arthropods.
2. Name five major classes of arthropods giving an example of each class.
3. State three characteristics which arthropods have in common with annelids.
4. Give at least two characteristics by which each of the following classes may be distinguished from the others: crustacea, arachnida, chilopoda, diplopoda, insecta.
5. Label a given diagram of the external features of the crayfish.
6. Describe the habitat and way of life of the crayfish.
7. Give the functions of the exoskeleton.
8. Describe the nutrition, respiration, senses, movement, reproduction of the crayfish.
9. List the functions of the appendages of the crayfish.
10. Explain the process of regeneration.
11. Relate the nutrition of centipede and millipede to differences in their structure.
12. Give the relative numbers of species in each class of arthropods and account for the success of arthropods in general.
13. Describe the nutrition and breathing of spiders.
14. Place arthropod specimens in their appropriate classes.
15. Distinguish between complete and incomplete metamorphosis.
16. Label a given diagram of a grasshopper.

17. Describe the tracheal, digestive, circulatory and excretory systems of the grasshopper.

18. Explain the term social insect.

19. Describe the following aspects of the life of the honey-bee: the honey-comb, casts, the honey dance and swarming.

20. Make neat, accurate lab. reports and drawings.

MODULE 4 - ARTHROPODS

Activity Sheet

1. Examine the three specimens: grasshopper, lobster and spider, and the drawings of their internal organs. Complete inquiry 11: "What features are common to the phylum?" (arthropoda) (Inquiries into biology: Diversity of Life; Lang p. 43)

2. Read Andrews pp. 438 and 439 then answer the following questions:

   a) What does the name arthropod mean? _____

   _____

   _____

   b) How many species are classified as arthropods? _____

   _____

   c) What other characteristics of arthropods can you identify?

   _____

   _____

   _____

   _____

   d) Name the major classes of arthropods giving a well known example for each case.

	Name of Class	Example
i)	_____	_____
ii)	_____	_____
iii)	_____	_____
iv)	_____	_____
v)	_____	_____

3. List those characteristics which arthropods have in common with annelids.

_____

_____

_____

4. By what characteristics may crustaceans be distinguished from other arthropods? (Andrews p. 439)

_____

_____

5. Complete the activity: The Crayfish, A Representative Crustacean. (Obtain separate sheets.)

6. View the film "Arthropods - The Joint Legged Animals" and answer the question sheet supplied.

7. Examine the preserved crab. State three similarities between it and the crayfish.

i) _____

ii) _____

iii) _____

8. Turn your crab over. Using a probe, locate the abdomen. Describe its location. _____

_____

9. Sow bugs are crustaceans called wood lice. Give their habitat. (B.S.C.S. - green p. 130) _____

_____

10. Draw a diagram of a centipede and a millipede specimen in your lab. book.

11. Relate the differences in the structure of millipedes and centipedes to their different ways of life. (B.S.C.S. - green p. 129)

_____

_____

_____

_____

12. In your lab. book plot a bar graph of the number of species in each arthropod class. Give each bar a different colour. (B.S.C.S. p. 795)

13. Draw a diagram of a scorpion and a tarantula from the specimens supplied. Label the two body sections, the walking legs, the chelicerae (1st appendage) and the pedipalp (2nd appendage). Include these drawings in your lab. records.

14. Carefully examine the large preserved horseshoe crab (limulus). It is usually classified with scorpions and spiders. Name this class and give reasons for its classification in this group.

Class: _____

Reasons: i) _____

ii) _____

iii) _____

15. How do spiders capture and kill their prey? (Methods of Science 3 p. 242) _____

_____

_____

16. Describe the breathing mechanism of spiders. (Methods of Science 3 p. 243) _____

_____

_____

17. What is the purpose of the spider's cocoon? (p. 243)

_____

_____

18. Give six reasons for the numerical superiority of insects. (Methods of Science p. 245)

i) _____

ii) _____

iii) _____

iv) _____

v) _____

vi) _____

19. List five characteristics of insects which distinguish them from other arthropods.

i) _____

ii) _____

iii) _____

iv) _____

v) _____

20. For each of the numbered specimens (1-10), examine its structure and place it in its appropriate arthropod class. Complete a chart (in your lab. book) similar to the one below, giving reasons for your classification.

#	NAME OF ORGANISM	CLASS	REASONS
1			
2			
. . . 10			

21. Examine the plastic mounts of the life history of the grasshopper and butterfly. Draw three stages of each in your lab. books.

22. Explain the difference between complete and incomplete metamorphosis. (Methods of Science pp. 252-256)

Incomplete _____

_____

_____

Complete _____

_____

_____

23. Obtain a preserved grasshopper. Draw a side view in your lab. book labelling the following parts: head, thorax, abdomen, antennae, mouth parts, spiracles, wings, compound eyes.

24. To which part of the body are the wings and legs attached?

_____

25. Suggest a reason for the shape of the hind legs of the grasshopper.

_____

_____

26. In the space below copy Fig. 18-2. (Methods of Science p. 249)

27. Explain how the tracheal system gets gases to and from every cell without the help of the circulation. (Andrews p. 497)

_____

_____

_____

28. Examine the wings of your grasshopper. What is the difference between the fore and hind wings and how do you account for these differences? _____

_____

_____

_____

_____

29. Carefully remove the legs and wings from one side of the body. Cut along the mid-dorsal line through the exoskeleton starting near the posterior end. Continue the cut forward to the head. Then cut along the mid-ventral line in the same way. Carefully remove the exoskeleton from the side of the thorax and abdomen.

30. Using forceps remove a portion of the loose, white fibrous tissue from the body which should contain tracheae. Make a wet mount slide of the tissue, focus with a microscope and draw a small section of the tracheal system in your lab. book.

31. Carefully clear away the tissue to expose the digestive system of your grasshopper. Draw a clearly labelled diagram of <u>your dissection</u> in your lab. book. Refer to Andrews p. 264 for names.

32. For each part of the digestive system state its function in the chart below. (Andrews p. 264)

PART	FUNCTION
Salivary Glands	
Esophagus	
Crop	
Gizzard	
Gastric Pouches	
Stomach	
Anus	

33. What are the major differences between the circulation in the grasshopper and the earthworm? (Andrews p. 524)

34. Insects such as the grasshopper excrete uric acid. What advantage is this to the insect? (Andrews p 563)

35. What are malpighian tubules? Where are they found and what is their function? (Andrews p. 575)

36. View the film: Social Insects - The Honey Bee. Answer the question sheet provided.

Activity THE CRAYFISH: A REPRESENTATIVE CRUSTACEAN

Materials:

1. Information sheets: please return these, unmarked, when you are finished as they can be used again.
2. Live crayfish in a small aquarium.
3. Preserved crayfish for dissection.
4. Dissection pan and instruments.
5. Half a sheet of cardboard.
6. glue.

Procedure:

Read the information sheets and examine the specimens in order to answer the following questions:

1. Where does the crayfish live? _____

_____

2. Why are they often difficult to find? _____

_____

_____

3. What are the enemies of the crayfish? _____

_____

4. Touch the live crayfish with a probe. How does it escape?

_____

_____

_____

5. Label the given diagram of the crayfish. Identify the corresponding external features on your preserved specimen.

6. Push the exoskeleton gently with your probe. Bend the tail and appendages. What are the two functions of the exoskeleton?

i) _____

ii) _____

7. How can the crayfish be sensitive to touch with a thick exoskeleton over its body? _____

_____

_____

8. What are two functions of the antennae and antennules?

i) _____

ii) _____

9. Drop a small piece of cooked or raw meat into the aquarium. How does the crayfish feed? _____

_____

_____

10. How does the crayfish obtain its food in the wild? _____

_____

_____

11. Name some edible relatives of the crayfish. _____

_____

12. What are the main body divisions of the body of the crayfish?

_____

13. Describe the location and structure of the eyes. _____

_____

_____

_____

_____

14. How does the image perceived by a compound eye compare with a human eye? _____

_____

_____

15. Complete the activity on page 7 of the information sheets: To examine the appendages of the crayfish. (Hand this in with your lab. book for marking.)

16. Complete a chart as shown below in your lab book to give the function of the appendages.

NAME OF APPENDAGE	NUMBER	FUNCTION

17. Using a pair of scissors, cut away a section of the carapace (diagram p. 7) to expose the gills. Remove one gill, float it in water in a petri dish and focus it with a binocular microscope. Make a drawing of a portion of the gill in your lab. book.

18. Describe how water is moved through the gills. _____

19. How are gases exchanged by the gills? _____

20. Watch the live crayfish over a period of time. Describe how it moves. _____

21. What is regeneration? Give <u>two</u> reasons why it occurs. _____

22. Why do the appendages exhibit serial homology? _____

23. How do you distinguish a male from a female crayfish? _____

24. Where do young crayfish develop during their first few weeks after hatching? _____

25. You may dissect the internal organs of your specimen. Use the wall chart and models as a guide. No lab. drawings or notes are required as this dissection is rather difficult.

FILM: THE ARTHROPODS (THE JOINT LEGGED ANIMALS)

1. Give four reasons why Arthropods have been so successful in populating the world.

i) _____

_____

ii) _____

_____

iii) _____

_____

iv) _____

_____

2. Give four examples of crustaceans to show their wide diversity of form and way of life.

	SPECIES	HABITAT
i)		
ii)		
iii)		
iv)		

3. State two ways in which millipedes differ from centipedes.

i) _____

ii) _____

4. Name three arachnids excluding spiders and scorpions.

i) _____ ii) _____

iii) _____ iv) _____

5. State three ways insects cause harm to man.

i) _____

ii) _____

iii) _____

6. Give one positive and one negative aspect about insect control.

_____

_____

_____

_____

FILM: SOCIAL INSECTS - THE HONEYBEE

1. Explain the expression SOCIAL INSECTS. _____

_____

_____

2. Describe the cells in the honeybee hive. _____

_____

_____

3. Name the three casts of honeybees: What is the job of each one?

i) _____ _____

_____

_____

ii) _____ _____

_____

_____

iii) _____ _____

_____

_____

4. What is the HONEY DANCE? _____

_____

_____

5. What is the purpose of swarming? _____

_____

_____

_____

MODULE 4 - SELF TEST

(study your notes before answering)

(Complete the statements below - Answers overleaf)

1. The class crustacea are characterized by having two pairs of _____.
2. The types of bees are known as _____.
3. Scorpions belong to the class _____.
4. The type of circulation found in the phylum arthropods is an _____ circulation.
5. The crayfish bites off food with its _____.
6. Members of the diplopoda would include _____.
7. The tracheal system is used for _____.
8. The body of all arthropods is covered by a _____ _____ (two words).
9. The millipede feeds mainly on _____.
10. The change from an immature to an adult insect is called _____.

(TURN OVER FOR ANSWERS.)

ANSWERS:

1. Antennae
2. Casts
3. Arachnida
4. Open
5. Mandibles
6. Millipedes
7. Breathing (Gas Exchange)
8. Jointed Exoskeleton
9. Plant Food (Vegetation)
10. Metamorphosis

* NOTE: Do not attempt the module test unless you scored 8/10 or better!

MODULE TEST #4

ARTHROPODS

Place a cross in the appropriate box on the answer sheet provided. Do not mark this question paper.

1. The horseshoe crab (limulus) is a member of the class:
   a) arachnida.
   b) crustacea.
   c) insecta.
   d) chilopoda.

2. The grasshopper has:
   a) two body sections and four pairs of legs.
   b) three body sections and three pairs of legs.
   c) two body sections and three pairs of legs.
   d) three body sections and four pairs of legs.

3. Complete metamorphosis occurs in:
   a) the crayfish.
   b) all insects.
   c) insects which have immature nymph stages.
   d) insects which have a larva and a pupa stage.

4. The grasshopper breathes by means of:
   a) gills.
   b) small lungs.
   c) book lungs.
   d) tracheal tubes.

5. The grasshopper sees with:
   a) light sensitive antennae.
   b) compound eyes only.
   c) compound and simple eyes.
   d) simple eyes only.

6. The chelipeds of the crayfish are its:
   a) antennae.
   b) mouthparts.
   c) pincers.
   d) walking legs.

7. The grasshopper is a member of the class:
   a) insecta.
   b) arthropoda.
   c) arachnida.
   d) crustacea.

8. The tail of the crab is:
   a) wide with a broad flipper (uropod).
   b) under its cephalothorax.
   c) longer than its cephalothorax.
   d) lost during metamorphosis.

9. Centipedes differ from millipedes by having:
   a) more legs per segment.
   b) fewer legs per segment.
   c) a segmented body.
   d) a carnivorous diet.

10. The sterile female honey bees which act as nurse bees are:
   a) old drones.
   b) young workers.
   c) young drones.
   d) old workers.

11. The honey dance is a means of:
   a) sexual display by mature males (drones).
   b) celebrating the filling of a complete honey comb.
   c) communication between workers.
   d) raising money for crippled pollen gatherers.

12. After a new queen bee is hatched:
   a) the colony dies out leaving only the new queen.
   b) the new queen kills all other queens in the hive.
   c) swarming occurs.
   d) the hive goes into a period of dormancy.

13. The feature which the grasshopper, lobster and spider have in common is that they all have:

a) three distinct body parts.

b) a jointed exoskeleton

c) compound eyes.

d) pairs of jointed legs on the abdomen.

14. The largest class of animals known are the:

a) arthropods.

b) crustacea.

c) mammals.

d) insects.

15. One feature shared by arthropods and annelids is that:

a) the sexes are separate in both phyla.

b) they both have a closed circulation.

c) they have segmented bodies.

d) they both have compound eyes.

16. Crustaceans may be distinguished from other arthropods by having:

a) two pairs of antennae and gills.

b) two pairs of antennae and book lungs.

c) a hard exoskeleton and compound eyes.

d) four pairs of walking legs and compound eyes.

17. The habitat of sow bugs is:

a) the skin of swine (pigs), where they are parasites.

b) dry soil containing humus.

c) the sea shore, where they live in shallow rock pools.

d) a damp, terrestrial environment where plant food such as wood is available.

18. The horseshoe crab breathes through:

a) book lungs.

b) its trachael system.

c) skin gills.

d) gills under its carapace.

19. The spiracles of the grasshopper are:

a) part of its digestive system.

b) the openings into its respiratory system.

c) immature stages in its life cycle.

d) the female reproductive ducts.

20. Oxygen reaches every cell of the grasshopper by means of:

a) blood containing hemoglobin.

b) circulation from the book lungs to the tissues.

c) minute branches from the tracheal system.

d) blood which has picked up oxygen in the gills.

21. Food pieces are broken up into small particles by a part of the digestive system of the grasshopper called the:

a) gastric pouches.

b) stomach.

c) gizzard.

d) crop.

22. The excretion of uric acid by insects is a distinct advantage over the excretion of urea since it enables the insect to:

a) excrete nitrogenous waste (nitrogen containing waste formed by the breakdown of amino acids).

b) excrede waste without having kidneys.

c) conserve water.

d) remove wastes more quickly.

23. The excretory organs of insects are called:

a) malpighan tubules.

b) kidneys.

c) nephridia.

d) green glands.

24. The sense organs in the crayfish which are sensitive to touch are located on its:

a) exoskeleton only.

b) antennules only.

c) antennae and antennules only.

d) antennae, antennules and exoskeleton.

25. The mode of nutrition of the crayfish is usually that of a:

a) carnivore.

b) herbivore.

c) scavenger.

d) parasite.

26. The body divisions of the crayfish are the:

a) cephalothorax and abdomen.

b) head and cephalothorax.

c) head, thorax and abdomen.

d) head and abdomen only.

27. The correct sequence of appendages starting at the anterior end of the crayfish are the:

a) chelipeds, swimmerets, maxillae, mandibles.

b) swimmerets, chelipeds, mandibles, maxillae.

c) mandibles, maxillae, chelipeds, swimmerets.

d) chelipeds, mandibles, maxillae, swimmerets.

28. Young crayfish spend the first few weeks of life:

a) floating in the plankton.

b) clinging to their mother's swimmerets.

c) in a cocoon (crysalis).

d) hiding under weeds or rocks.

29. Millipedes, centipedes and scorpions belong respectively to the classes:

a) diplopoda, chilopoda, arachnida.

b) arachnida, diplopoda, chilopoda.

c) chilopoda, diplopoda, arachnida.

d) chilopoda, arachnida, diplopoda.

30. It would be a fair statement about the use of pesticides in insect control, to say:

a) they should not be used since they damage food chains.

b) there is no other solution than to continue their use if food production is to be maintained.

c) since they may have harmful side effects other methods of control such as biological ones should be tried to reduce the use of pesticides.

d) pesticides are useful since they kill harmful insects so leaving the crops in perfect condition.

OPTIONAL ACTIVITIES

(rated 1 - 4)

1. (1) Use diagrams and describe Karl Von Frisch's work on insect communication. (Animals without back bones: Hensley p. 68, B.S.C.S. - blue p. 531 and other sources).

2. (3) Complete investigation 17-B Variations in the Heartbeat of Daphnia. (B.S.C.S. - blue p. 647) Write up a full lab. report including answers to the discussion questions.

3. (2) Compare skeletal movement in arthropods with chordates. Include a diagram with your account but do not copy work for word. (B.S.C.S. - green p. 523; also Buchsbaum p. 242)

4. (2) Write an account of insect vectors and how man may fight disease by control of vectors. (Andrews pp. 233-234 - other sources must be found for "control")

5. (2) One of the major differences between present day insects is in the way in which the basic mouthparts of the ancestral insect are modified for different modes of nutrition. Write an illustrated explanation of this statement. (Andrews pp. 456 + 459; Buchsbaum pp. 290-291)

6. (1) What is the meaning of osmo-regulation? How is it achieved in the shore crab? (Andrews p. 565)

7. (1) Describe the reproductive process of the crayfish. Diagrams should be used. (Andrews pp. 602-604)

8. (3) Peripatus is often considered to be a missing link. What is this link and what are the reasons for this supposition? (Buchsbaum p. 235)

9. Describe the structure and physiology of the compound eye. Dia-
(2) grams are essential. (Buchsbaum p. 246)

10. The barnacle was once classified as a mollusc. What were the
(2) reasons for this mistake? Describe the evidence for its reclassi-
fication as a crustacean. (Buchsbaum p. 266)

11. Describe how mimicry and other forms of camouflage are used in
(2) insects for protective resemblance. (Buchsbaum pp 291-1 on)

12. Describe one group of social insects excluding bees. You should
(4) mention the casts, organization of the colony and the means of
communication. Write about 200-300 words. Give a bibliography.

13. Write a report on the natural control of insects by such parasites
(4) as a braconid fly (Buchsbaum pp. 292-29 and Methods of Science
p. 261). This paper must show evidence of research.

14. Make an insect collection in which your specimens are properly
(4) mounted and classified. (Extra time will be allowed for this
project. (See chapter 6, p. 79, small creatures, Couchman for
hints.)

15. Make a permanent slide of an insect's mouthparts. Draw and label
(3) your slide. Hand in your slide and drawing.

16. What does the fossil record show us about the ancestors of
(2) arthropods? (B.S.C.S. - green chapter 10)

I N V E R T E B R A T E D I V E R S I T Y

MODULE 5 - MOLLUSCS

(10 periods)

MODULE 5 MOLLUSCS

Teacher Centred Lesson

Outline:

This will take the form of a lecture-demonstration. Specimens will be used to illustrate the themes below.

1. "The Twisted Class" - Gastropods.
2. Dual residence by the sea snail - land or sea creature - A question of evolution.
3. "Slugs are slimey and taste horrible!" - Edible molluscs.
4. "Who's the brains of the bunch, the octopus or the squid?" - Cephalopod complexity.
5. "An eye for an eye" - Homologous organs.
6. "Shell collections make good wampum" - Adaptive radiation.
7. "The great Canadian snail race" (if live snails can be obtained) - Gastropod movement.

MODULE 5 OBJECTIVES

After completing this unit the student should be able to:

1. Compare the number of species of molluscs with that of arthropods.
2. State at least five unique characteristics of molluscs.
3. Give two characteristics which molluscs, annelids and arthropods share.
4. Label the major body parts of the chiton, snail, clam and squid.
5. Give the function of the radula and the foot.
6. State some uses of molluscs to man.
7. Describe two terrestrial adaptations of snails.
8. Name molluscs from different classes and give their habitats.
9. Identify the external parts of a cryptochiton, a slug and a snail.
10. Describe the movement of slugs and snails.
11. Name or describe the following aspects of the clam:
    a) external and internal anatomy;
    b) movement;
    c) feeding;
    d) habitat;
    e) its age;
    f) its larval development.
12. Give details of the structure, habitat and locomotion of the squid and state the functions of its major organs.
13. Explain the meaning of "adaptive radiation" in molluscs and give some examples.
14. Explain the importance of the discovery of neopilina.
15. Make neat, accurate lab. reports and drawings.

MODULE 5 MOLLUSCS

Activity Sheet

1. How many species of molluscs are there and how does this compare with arthropods? (Andrews p. 437) _____

_____

_____

2. List seven characteristics of molluscs:

i) _____

ii) _____

iii) _____

iv) _____

v) _____

vi) _____

vii) _____

3. Which two molluscan characteristics are shared by annelids and arthropods?

i) _____

ii) _____

4. Label the given diagram of a "primitive" mollusc, the chiton. (Buchsbaum p. 182)

5. Using this information, label the foot, shell and digestive tract on the diagram of the chiton, clam, snail and squid to show the molluscan body plan.

6. What purposes does the foot serve in various molluscs? _____

_____

7. Describe the action of the radula. _____

_____

8. Name <u>eight</u> edible molluscs. _____

_____

_____

9. What is the habitat of most molluscs? _____

_____

10. Name <u>two</u> of the largest molluscs. How big are they? (B.S.C.S. - green p. 132)

i) _____

ii) _____

11. How do snails survive dry conditions and obtain oxygen? _____

_____

_____

12. Complete a chart in your lab. book similar to the one below, for the <u>six</u> classes of molluscs. (B.S.C.S. p. 794) You are not expected to remember the names of all the classes, but this activity will help you understand the diversity of the molluscan body plan.

CLASS	MEANING OF THE CLASS NAME	EXAMPLE	DISTINCTIVE CHARACTERISTICS

13. Draw a ventral view of the cryptochiton specimen in your lab. book. Label its mouth, foot and position of its gills. Where is its shell? (Buchsbaum, pp. 180-182) _____

_____

14. Examine the slug and snail speciments. What are their two major differences?

i) _____

ii) _____

15. Watch a pond snail move over the aquarium glass. You may need to remove one and place it in a petri dish containing some water. Describe its movement. What additional factor is needed for locomotion of land snails or slugs? _____

_____

_____

_____

16. View the film "Molluscs". Answer the question sheet provided.

THE CLAM - A REPRESENTATIVE MOLLUSC

17. Read the information sheets and complete the following questions and dissection.

i) Open your clam by slicing through the two muscles which close the shell, using a sharp knife (see diagram). Locate all of the following structures:

a) muscles for closing the shell

b) shell

c) mantle

d) incurrent and excurrent siphons

e) mouth

f) palps

g) gills

h) foot

ii) Draw a diagram of your dissection in your lab. book and label all of the above parts.

iii) Describe how the clam moves (sheets and Buchsbaum p. 190).

_____

_____

_____

iv) The clam is said to be a ciliary feeder (or filter feeder). Say how this works by giving the function of parts (d) to (g) above (Buchsbaum pp. 191-193). _____

_____

_____

_____

_____

v) How can the age of a clam be determined? _____

_____

vi) What is the habitat of the clam? _____

_____

_____

vii) What are the two phases in the development of young clams?

_____

_____

_____

THE SQUID - THE PEAK OF INVERTEBRATE EVOLUTION?

18. Read the article: The Squid - The Hunter and the Hunted. Complete the following questions.

i) What were the reasons why squids were thought of as sea monsters? (see also Buchsbaum p. 206) _____

_____

_____

ii) How big are giant squids known to be? _____

_____

iii) What are the enemies of the squid? _____

_____

iv) Give <u>two</u> ways the squid avoids its enemies. _____

_____

_____

v) What is one unusual way that squids may be caught?

_____

_____

_____

vi) Which is the ventral part of the squid? _____

_____

vii) Label the given diagram of a dissected squid.

viii) Complete the chart below giving the function of each of the named parts (Buchsbaum p. 200)

PART	FUNCTION
ARMS	
GILL	
GILL HEART	
INK SAC	
EYE	
FUNNEL	
FIN	

ix) How does the squid use "jet propulsion" to swim?

_____

_____

_____

_____

FILM - MOLLUSCS

1. What is meant by "adaptive radiation"?

2. How do Molluscs illustrate the principle of adaptive radiation?

3. How did the discovery of Neopilina in the 1950's help in our understanding of the relationship of molluscs to other phyla?

4. In what ways are Molluscs valuable to man?

MODULE 5 - SELF TEST

(study your notes before answering)

(Complete the statements below - Answers overleaf.)

1. The young larva which spends part of its development as a parasite on the tissues of a fish, will eventually grow into a _____.
2. The shell of a mollusc is secreted by _____.
3. A squid can hide behind secretions of its _____ _____.
4. Molluscs which have a single shell, head, and gliding foot, also feed with the help of a file-like organ called a _____.
5. Cephalopods include the nautilus, octopus, cuttlefish and the _____.
6. The clam extracts plankton from water using sticky _____.
7. Rapid movement to escape from predators may be achieved by certain molluscs when they force water out of the mantle through the _____.
8. A simple mollusc with a shell in sections is called a _____.
9. The foot of the squid forms its _____.
10. Neopilina is unusual in that its body is divided into _____.

(TURN OVER FOR ANSWERS.)

ANSWERS:

1. Clam
2. Mantle
3. Ink Sac
4. Radula
5. Squid
6. Gills (Mucus Covered)
7. Siphon (Funnel)
8. Chiton
9. Tentacles (Arms)
10. Segments

* NOTE: Do not attempt the module test unless you scored 8/10 or better!

6. The foot of a squid is:
   a) around its head.
   b) flat and sucker-like.
   c) surrounded by gills.
   d) used to swim.

7. The odd one out in this group, for two reasons, is:
   a) snail.
   b) slug.
   c) oyster.
   d) clam.

8. Most molluscs inhabit a:
   a) damp terrestrial environment
   b) freshwater environment.
   c) marine environment.
   d) moist forest or garden where they is plenty of humus for food.

9. One feature that almost all molluscs have in common is that they:
   a) have both sexes (hermaphrodite).
   b) have tentacles.
   c) move around freely.
   d) are edible.

10. Two of the largest molluscs are the:
   a) squid and clam.
   b) octopus and cuttlefish.
   c) octopus and clam.
   d) clam and cuttlefish.

11. Snails obtain their oxygen through:
   a) gills.
   b) their damp slimey skin.
   c) the mantle cavity (lung).
   d) their tracheal system.

12. The animal which is <u>not</u> a mollusc is called:
   a) cryptochiton.
   b) nautilus.
   c) peripatus.
   d) neopilina.

13. A mollusc with no shell is the:

a) slug.

b) squid.

c) cryptochiton.

d) cuttlefish.

14. A group in which the body has undergone torsion (twisting), has a radula, a gliding foot and a single shell are the:

a) toothshells.

b) gastropods.

c) bivalves.

d) chitons.

15. Snails can move on land because of the presence of:

a) cilia under the foot.

b) strong muscles in the foot.

c) mucus as a lubricant.

d) a disc-like foot as found in all snails.

16. The mode of nutrition of the clam is that of a:

a) herbivore.

b) predator.

c) ciliary feeder.

d) carnivore.

17. The clam moves by:

a) clapping its shells to eject water.

b) rotating its palps.

c) "jet propulsion" - water forced out of its siphon.

d) slow contractions of its foot.

18. The clam captures food with its:

a) gills.

b) mouthparts.

c) tentacles.

d) radula.

19. The age of a clam can be found by:

a) careful scrutiny of its teeth.

b) counting its annual rings.

c) finding out the number of growth lines on the shell.

d) examining its birth certificate.

20. The young clam spends its early life:

a) in its mother's brood pouch.

b) attached to gills of a clam then a fish.

c) parasitizing the gills of a clam.

d) attached to pond weed then in shallow burrows in the mud or gravel at the bottom of the pond.

21. An animal which may kill and eat a giant squid is a:

a) shark.

b) octopus.

c) tiger fish.

d) killer whale.

22. One device which the squid does not use to avoid being eaten is the use of:

a) its protective shell.

b) camouflage.

c) a "smoke screen".

d) "jet propulsion".

23. Squids may sometimes be caught because they are attracted by:

a) food.

b) sex.

c) light.

d) water.

24. The mouth and tentacles of a squid are on the:

a) dorsal surface.

b) anterior end.

c) posterior end.

d) ventral surface.

25. The organ of the squid most similar to the corresponding human organ is the:

a) brain.

b) eye.

c) heart.

d) kidney.

26. The primitive mollusc neopilina is unusual in that it:

a) has gills.

b) comes from the ocean floor.

c) is segmented.

d) has a complete digestive system.

27. The term "adaptive radiation" refers to:

a) radiation emitted by electrical adapters.

b) radial symmetry.

c) the many modifications of a basic body plan.

d) a form of radiation which may be changed to suit one's needs.

28. Two characteristics shared by annelids and molluscs are:

a) segmentation and bilateral symmetry.

b) three layers of tissue and a heart.

c) segmentation and a heart.

d) a complete digestive system and segmentation.

29. The feature which best helps the snail survive in its terrestrial environment is the:

a) digestive tract.

b) radula.

c) foot.

d) shell.

30. Water moves in and out of the body of a clam by way of its:

a) siphons.

b) mantle.

c) palps.

d) gills.

MODULE 5 OPTIONAL ACTIVITIES

(Rated 1 - 4)

1. (4) Dissect a preserved squid (you may work in pairs). Use the instruction sheets supplied. Make labelled drawings of the following:

   a) one grasping arm and one sucker as seen in detail with a magnifying glass.

   b) a general dissection of the mantle cavity.

   c) the beak.

   d) the shell (or part if damaged).

2. (3) Copy the diagram of an hypothetical mollusc (Elements of Biology, Weisz p. 496). Compare this to the structure of the chiton, clam and squid. Explain:

   i) why the chiton is the least specialized.

   ii) why the clam shows evidence of degeneration.

   iii) how the squid shows unusual specialization.

3. (3) Complete the lab. investigation: When does a substance become a pollutant? (Projects Source Book p. 100) Use no more than 5 different chemicals. Write up a full lab. report including answers to the questions.

4. (2) Write an illustrated report on embryology in molluscs (Buchsbaum pp. 183, 186, 187). What does it indicate about:

   a) relationships with other phyla?

   b) the asymmetry of body organs of many gastropods. (Weisz p. 497)

5. Relate the structure of the bivalve shell to the formation of
(2) pearls. (Buchsbaum p. 189)

6. Explain the term "Convergent Evolution". Use the example of the
(3) squid and human eyes as an illustration of this phenomenon.
(Buchsbaum p. 203)

7. Give an account of bioluminescence (about 200-300 words).
(2) (Buchsbaum p. 204; B.S.C.S. p. 330)

8. By using the index to locate various species, list the habitats
(1) of at least 10 molluscs. (B.S.C.S. - green)

I N V E R T E B R A T E D I V E R S I T Y

MODULE 6 - ECHINODERMS

(7 periods)

MODULE 6 ECHINODERMS

Teacher Centred Lesson

Outline:

This will be a lecture demonstration using audio-visual aids and specimens covering the following themes.

1. "What a rough skin you've got" - Echinoderm skin appendages and their uses.
2. "I've looked all over Ontario but can't find any echinoderms" - their habitats.
3. "What have echino.....what ever! Ever done for me?" - Why study them.
4. "The big, bad and ugly" - A look at sea cucumbers.
5. "When is a fish not a fish? - When is a star!" - Sea stars.
6. "Some spiney-skinned animals can be beautiful" - Plant like crinoids.
7. "Sea porcupines? - Why all those spines?" - A look at sea urchins.

MODULE 6 OBJECTIVES

After completing this unit the student should be able to:

1. Say where echinoderms are found and give the detailed habitats of some species.
2. Give five major characteristics of echinoderms.
3. Explain the link between echinoderms and chordates.
4. Describe the structure and functions of the skin appendages of echinoderms.
5. Name at least one animal from each class of echinoderms and give a distinctive characteristic of each class.
6. Give the function of the sieve plate and anus.
7. Label given diagrams of a section through a sea urchin and a sea star.
8. Give two differences between a sea urchin and a sand dollar.
9. Identify the mouth, tube feet and tentacles on a sea cucumber.
10. Describe how sea urchins and sea cucumbers obtain their food and avoid their enemies.
11. Say how crinoids feed.
12. Explain the naming of brittle stars.
13. Describe the external features, regeneration, feeding and action of the sea star.
14. Make neat, accurate lab. reports and drawings.

MODULE 6

ECHINODERMS

Activity Sheet

1. What is the habitat of all echinoderms? (Andrews p. 441)

_____

2. Describe the body covering of echinoderms. _____

_____

_____

3. Summarize the characteristics of echinoderms by completing the following statements.

   a) Their type of symmetry is called _____ _____.

   b) Tube feet project from the body and may function for _____, _____ or _____.

   c) Certain body features found in arthropods but lacking in echinoderms include _____, _____ and _____.

   d) Breathing is assisted by other structures on the skin called _____.

   e) Three complete but simple body systems found in echinoderms are: _____, _____ and _____.

4. What is the difference in the symmetry of the young echinoderm compared to the adult? (B.S.C.S. p. 133) _____

_____

_____

5. Why was a tenuous evolutionary link made between echinoderms and our phylum? _____

_____

6. Why are echonoderms often called the spiny-skinned animals?

_____

_____

7. Give the detailed habitats of the following echinoderms.

NAME	HABITAT
Crinoids and Brittle Stars	
Sea Cucumbers	
Sea Urchins	

8. One kind of fossil echinoderm is simply a _____. (B.S.C.S. p. 341)

9. List the five classes of echinoderms and for each class give one or two distinctive characteristics and one or more examples. B.S.C.S. p. 798) NOTE: You are not expected to remember the names of the classes.

CLASS	CHARACTERISTICS	EXAMPLES

10. Why are sea lilies and cucumbers so named? _____

_____

11. Draw a diagram of a sea urchin - oral view (mouth side). Take care in handling it as the spines break off easily. Label the mouth, "beak", spines and tube feet.

12. What function do the spines serve in addition to protection? (Buchsbaum p. 309 and pp. 310-8) _____

_____

13. There are two openings on the aboral surface (top). What are they? _____

14. What evidence of symmetry can you see on the body? _____

_____

15. Label the given diagrams of the body plan of a starfish and sea urchin. (Buchsbaum p. 310)

16. How do the tube feet of the sea urchin and starfish compare?

_____

17. Describe the feeding of the sea urchin. (Buchsbaum pp. 310-7)

_____

18. Examine the preserved sand dollar and its dried shell (or test). In what way does it resemble a dollar? What is the hole near the edge of the shell? (Buchsbaum pp. 310-10) _____

_____

_____

19. Draw a picture of a specimen of a sea cucumber and label the (tentacles, mouth and tube feet).

20. How does it capture its food? (pp. 310-11) _____

_____

21. How do some sea cucumbers escape from their enemies? _____

_____

_____

22. How does the sea lily feed? (pp. 310-12) _____

_____

23. Why are brittle stars so named and why are they also called serpent stars? (pp. 310-5) _____

_____

_____

24. View the film - "Echinoderms - Sea stars and their relatives". Answer the question sheet provided.

25. <u>The Sea Star - A Representative Echinoderm</u>

Read the article: Star of the Sea - The Starfish (ref. Berman p. 58). Complete the following questions and activities.

a) How do starfish feed on oysters which have such tough protective shells? _____

_____

_____

_____

b) Why is the starfish an enemy of man and how was the oyster population almost destroyed? _____

_____

_____

_____

c) How do present-day oyster fishermen remove unwanted starfish from their oyster beds? (See also Buchsbaum, p. 310-3)

_____

_____

_____

d) Draw a dorsal (aboral) and ventral (oral) view of your starfish. Label the: spines, tube feet, mouth, beak, arm and sieve plate. Only draw details of a small portion of one arm and outline the remainder of the arms.

e) Why is sea star a more appropriate name for the starfish? (See also Buchsbaum p. 300) _____

_____

_____

_____

FILM: ECHINODERMS - SEA STARS AND THEIR RELATIVES

1. Where is a good place to look for echinoderms? _____

2. What are the unusual features of this phylum? _____

3. What does the "skeleton" of echinoderms consist of? _____

4. When studying the classes and structure of echinoderms, 5 is the "magic" number. Why? _____

5. In what way is the body covering of the sea cucumber different from other echinoderms? _____

6. Describe why sea urchins are a valuable research tool for certain biologists. _____

MODULE 6 - SELF-TEST

(study your notes before answering)

(Complete the statements below - Answers overleaf)

1. Echinoderms lack brains, segmentation and a _____.
2. Brittle stars are also called _____.
3. Starfish cause serious damage to _____.
4. A structure moved by water and muscles is called a _____ _____.
5. The sieve plate lets in _____ to the body.
6. One plant-like crinoid is called a _____.
7. Two parts of the sea urchin which are longer than those on the sea star are _____ and _____.
8. Many echinoderms have skin appendages used for breathing called _____.
9. Sea cucumbers trap their prey with _____.
10. A calcareous endoskeleton is another name for a part of a sea urchin usually called its _____.

(TURN OVER FOR ANSWERS)

ANSWERS:

1. Head
2. Serpent Stars
3. Oysters (or Clams)
4. Tube Foot
5. Water
6. Sea Lily
7. Spines and Tube Feet
8. Skin Gills
9. Tentacles
10. Shell

* NOTE: Do not attempt the module test unless you scored 8/10 or better!

MODULE TEST #6

ECHINODERMS

Place a cross in the appropriate box on the answer sheet provided. Do not mark this paper.

1. The sea star is an enemy of man since:
   a) it carries disease to edible molluscs such as oysters.
   b) it eats molluscs which are harvested for human food.
   c) it feeds on plankton, so depriving edible molluscs of food.
   d) they occupy the same habitat as edible molluscs depriving them of living space.

2. A starfish is more correctly called a sea star since:
   a) it is shaped like a star and lives in the sea.
   b) it is one of the most beautiful and colourful sea creatures.
   c) it is radially symmetrical.
   d) it is not related to a cod.

3. Fishermen almost wiped out oysters by:
   a) "killing" starfish by cutting them up and throwing them back.
   b) overfishing.
   c) allowing starfish to prey on oysters.
   d) letting starfish spread disease in these molluscs.

4. A starfish opens an oyster by:
   a) inserting its tube feet between the shells.
   b) drilling through its tough shell with its beak.
   c) using great muscular strength.
   d) wrapping its arms over the shells and pulling with its tube feet.

5. Sea stars may be killed by:
   a) cutting them up.
   b) letting them dry out.
   c) removing their arms.
   d) putting them in salt water.

6. The "rays" (radiating sections) of a starfish are often called:
   a) tube feet.
   b) pincers.
   c) arms.
   d) the water vascular system.

7. Two structures on the dorsal (Aboral) surface are:
   a) mouth and sieve plate.
   b) mouth and anus.
   c) sieve plate and anus.
   d) mouth and calcareous spines.

8. The pincers (pedicellaria) of a starfish:
   a) are used for feeding.
   b) are big and three pronged.
   c) remove parasites between the gills.
   d) are around the mouth and capture prey.

9. Echinoderms breathe by means of:
   a) tube feet.
   b) feathery gills.
   c) book lungs.
   d) skin gills.

10. The sieve plate of the starfish:
   a) allows water, but not dirt into the body.
   b) enables food to enter the water-vascular system.
   c) is used to filter food such as plankton from the surrounding water.
   d) covers the underside (ventral) of the body.

11. Starfish have:
   a) a constant number of arms - always 5.
   b) an even number of arms - 4, 6, 8, 10, etc.
   c) 5 or multiples of 5 arms.
   d) a variable number of arms depending on how many have broken off.

12. The ability of starfish to grow a new arm is called:
    a) degeneration.
    b) regermination.
    c) germination.
    d) regeneration.

13. Starfish are protected by:
    a) calcareous spines.
    b) tube feet.
    c) pincers.
    d) both (a) and (c).

14. The anus of the starfish is located:
    a) at the tip of the ray (or arm).
    b) on the central surface.
    c) on the dorsal surface.
    d) near the mouth.

15. The evolutionary link between echinoderms and chordates is based on:
    a) the degree of segmentation of body parts.
    b) a comparison between the anatomy.
    c) fossil evidence.
    d) the similarities between certain larval forms.

16. The tube feet of the sea urchin are different from those of the sea star in that:
    a) they are shorter.
    b) they are only on the ventral surface.
    c) they are longer.
    d) they are only on the dorsal surface.

17. The sea urchin's diet consists of:
    a) oysters and other molluscs.
    b) plankton.
    c) mainly vegetation.
    d) small fish and crabs.

18. Compared to a sea urchin the skin of the sea cucumber:
    a) has a more leathery texture.
    b) has a much harder shell.
    c) has more spines.
    d) has much longer tube feet.

19. The sand dollar is so named because:
    a) it is shaped like a dollar.
    b) it is worth about a dollar.
    c) it is found buried in sand.
    d) both (a) and (c).

20. Calcareous means:
    a) soft.
    b) hard.
    c) containing calcium.
    d) spiny.

21. Echinoderms are:
    a) always covered with spines.
    b) always covered by a hard shell.
    c) only able to move by tube feet.
    d) only found in the sea.

22. Echinoderms have:
    a) a sac-like gut with a single opening.
    b) bilateral symmetry.
    c) a segmented body.
    d) radial symmetry.

23. Brittle stars are:
    a) another name for sea stars.
    b) often called serpent stars.
    c) sea stars which can regrow missing arms.
    d) in the same class as sea urchins.

24. The group of echinoderms which are stalked are:
    a) brittle stars.
    b) feather stars.
    c) sea urchins.
    d) sea stars.

25. Echinoderms are important to man because they:

a) are an important food source.

b) control marine parasites.

c) are decorative and colourful.

d) are used by biologists to study embryology.

For the following questions, choose the correct answer and place the appropriate letter(s) in the box.

a) large thin tube feet

b) a round "spherical" shape

c) 5 thick arms

d) 5 snake-like arms

26. Brittle stars have:

27. Edible sea urchins have:

28. Sand dollars have:

29. Sea stars have:

30. A sea cucumber is:

a) found in all good salad bars.

b) en echinoderm with none of the above features (questions 26-29).

c) grown in sea-side gardens.

d) best eaten with thin brown bread.

MODULE 6 OPTIONAL ACTIVITIES

(Rated 1 - 4)

1. Dissect the internal anatomy of a starfish. (Ref. Berman pp. 61-65) Make representative labelled drawings of each stage.

(4) Complete the following questions:

a) Describe the digestive gland.

b) Draw a detailed picture of the microscopic view of the skin. Label the parts.

c) What are the pedicellaria and what is their purpose?

d) What is your estimate of the number of tube feet?

e) How are tube feet used for movement?

f) Draw part of the digestive gland and stomach if it is visible.

g) How does reproduction take place?

h) Where are the gonads located?

i) Describe the circulation of the starfish.

j) What are the ameboid cells for? (Buchsbaum p. 304)

2.(3) Describe how to set up and maintain a salt water aquarium.

3. Describe the detailed structure and action of pedicellaria.

(2) (Buchsbaum p. 304)

4. Describe the structure and action of the water vascular system

(3) of the starfish. (See Buchsbaum) Diagrams (not photocopies) must be included.

5. Describe how embryological studies of echinoderms have contri-

(4) buted to our understanding of embryology and phylo-genetic relationships. Diagrams should be included but do not copy the

text word for word. (See Bachsbaum and B.S.C.S. - blue)
Evidence of understanding is required.

6. Write an account of regeneration in echinoderms. Buchsbaum and
(3) B.S.C.S. - green have some information but you will get higher marks if you show evidence of research.