ADVANCED GRADE 11 BIOLOGY

CONCEPTUAL AND INSTRUCTIONAL CHANGES IN THE ONTARIO ADVANCED LEVEL, GRADE 11 BIOLOGY

BY

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ABSTRACT

The introduction of the Ministry of Education, curriculum guideline in Science, 1987, precipitated changes in Hamilton's Glendale Secondary School Biology program. The primary aims of this project is to translate the Ministry document into a viable course that would both inform the students of the basic language of biology, and make the learning process enjoyable.

This project outlines the development, implementation and evaluation of the grade 11 advanced level biology course (SBi3A) at Glendale. In the development of this course, the curricular component attempted to enhance learning by moving from general to specific concepts.

To aid in this process the major concepts were organized into conceptual hierarchies that progressively differentiated the major principles and created a network of ideas .

The instructional component which actually moves the information to the students uses a diversity of course designs. The variety in course designs allows us to use the best features of each format to accommodate both different rates of learning and various learning styles much more effectively.

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CHAPTER 1

The Background

The 1980's have seen numerous changes in Ontario secondary school education. Included in these changes has been the complete re-organization of all the science courses from Grade 7 to Grade 12, together with the introduction of the Ontario Academic Courses (OAC's). The printed version of the science curriculum renewal project for the Ontario Ministry of Education guideline was published in 1987, after the pre-edit drafts were examined in the fall of 1986. (Ministry of Education, 1987) It is expected that all of the new courses will be in place by September 1990, after the local boards have prepared for implementation. The new science guideline will have varying impact on all the science courses offered at the secondary school level.

The pre-edit draft of the biology guideline made it apparent that major changes would be necessary in the Grade 11 biology courses taught in Hamilton's secondary schools.

Overview

The aim of this project is to discuss the development, implementation and evaluation of the grade 11, advanced level biology course (SBi3A) at Glendale Secondary School in Hamilton. This course was first taught during the

spring semester of 1987 and repeated during the 1988 school year. The course consists of eight core units:

1. Cell Structure and Processes
2. Vascular Plants: Growth and Structure
3. Genetic Continuity
4. Bacteria and Viruses
5. Vertebrate Digestive System
6. Vertebrate Transport System
7. Vertebrate Gas Exchange System
8. Vertebrate Reproduction and Development

and two optional units:

1. Vertebrate Skeletal and Support System
2. Impact of Science on Society

These units are prescribed by the Ministry of Education, Curriculum Guideline, Science, Intermediate and Senior Division, 1987, Part twelve: Biology Grade 11, Advanced Level (SBi3A). This document represents only one of a series of guidelines (15) published to bring about a renewal in science curriculum from Grade 7 through to Ontario Academic Courses (OAC's).

The advanced level Grade 11 biology SBi3A supersedes a popular and well regarded human biology course in Hamilton. The human biology program (By351) emphasized anatomy and physiology and their role in homeostasis. By351 provided a good knowledge base for further academic training in biology, medicine and other paramedical field by

acquainting the students with medical terminology and use of medical instruments.

The subject matter in the new biology curriculum was designed to bridge the gap between the diversified general science course taught in grade 10 and the more specialized biology of the OAC level. One intention of this new biology program is to ensure a continuum between the Grade 11 course and the OAC biology. As noted earlier, the Grade 11 advanced biology provides an overview of many of the major areas in the field. Thus, the Grade 11 course provides not only a good foundation for the more rigorous biology of the OAC level, but also a survey of the subject for students with a general interest in biology, but who may not continue formal studies in biology.

The new curriculum allows the student to examine a broad range of topics rather than an in-depth analysis of a few areas of biology. Thus, rather than restricting the study of anatomy and physiology to humans, the core units examine the comparative physiology of different vertebrate. With the addition of such topical units as genetics, bacteria and viruses, vascular plants and the cell, the new biology curriculum is designed to appeal to both the science and non-science oriented students.

Rationale for the Project

The project will attempt to deal with both curriculum and instructional problems that exist in the

development, implementation and evaluation of this new biology course.

The Ministry has created a document that outlines each unit by specific topics, with objectives, (attitudes, skill and knowledge) student activities, applications, social implications and evaluation of the student achievement. The Ministry's new Biology, Grade 11, Advanced Level Curriculum Guideline is a logical organization of the subject matter. Despite this, some important concepts in the field are buried beneath an index of topics and objectives. Thus, this project outlines our attempt to translate the guidelines into a viable course.

1. This course develops from general concepts to specific ideas. It is desirable to outline the most inclusive general concepts early in the course to allow for maximum reinforcement of the main ideas (Ausubel, 1963, 1967 and Ausubel, etal., 1978). The general concepts can be used as a master plan for many of the topics and objectives, thus providing the student with a base to help recognize the value of more specific details.

The major concepts should ideally be identified and organized into a conceptual hierarchy to facilitate meaningful learning by progressively differentiating concepts (Ausubel, 1963, 1967 and Ausubel, etal., 1978).

2. The second component of creating a viable course requires the transmission of the concepts. The

instructional plan must effectively move the ideas to the students, motivate and develop the skills associated with the specific objectives. However, problems inevitably arise depending upon the exact nature of course design chosen.

i) Whole class lessons do not meet the needs of the varying ability levels and learning styles.

ii) In individualized activity oriented programs, without appropriate feedback, students develop a sense of insecurity from the vast accumulation of factual knowledge through experimentation.

iii) In individualized programs the opportunity to discuss the results from a given activity are greatly reduced if students are doing different assignments.

iv) Activity oriented programs should not simply substitute activity for conceptual development (Ausubel, etal., 1978).

The most appropriate instructional format will be used to develop the concepts, thus it is apparent that a variety of instruction designs will have to be used.

1. Lectures - allows the teacher to introduce, guide and summarize each unit.

2. Individual Component - allows the students to progress at their own rate through activities, so each individual works with a variety of instructional aids and develops motor skills.

3. Group Work - allows for increased student interaction to utilize the knowledge acquired. Science in today's world is often no longer an individual quest, but involves the interaction of groups of individuals. The development of communication skills within the group structure has become increasingly important.

Thus, the two major components of the project are summarized as follows:

1. The curriculum plan will attempt to create a systematic course by the identification and development of a conceptual hierarchy to provide a framework for the grade eleven biology program. This conceptual hierarchy should assist the student in the development of his/her cognitive structure.

2. The instructional component is dependent upon a diversity of course designs. It will attempt to utilize some of the best features of individual programs, group work and whole class instruction.

Both the cognitive curriculum plan and instructional elements are important for the development of a successful program.

CHAPTER II

A Theoretical Basis of Curriculum and Instructional Planning

A biology program should allow students to increase their knowledge and understanding of the language of the subject. However, a biology course cannot deal with all the knowledge of the field. Thus, at some point in the process of curriculum and instructional planning, it is essential to consider "what" knowledge will be taught and "how" it will be taught.

P. H. Hirst and R. S. Peters state that there are three logically necessary conditions for teaching to occur:

"(i) They must be conducted with the intention of bringing about learning

(ii) They must indicate or exhibit what is to be learnt

(iii) They must do this in a way which is intelligible to and within the capacities of, the learner" (Hirst and Peters, 1970, p. 81).

"To plan deliberately for such activities, so that others will learn, is to take a first step towards teaching in a fully intentional sense" (Hirst and Peters, 1970, p.82).

The means by which these conditions are accomplished depends upon the theoretical framework of the course design. Both curriculum and instruction are considered to be part of any theoretical framework for a systematic course design. There are many definitions to the term "curriculum".

Elliot Eisner in The Educational Imagination (1979) defines the concept of curriculum as: "The curriculum of a school, or a course, or a classroom can be conceived of as a series of planned events that are intended to have educational consequences for one or more students" (Eisner, 1979, p.39). In Eisner's definition four basic criteria determine his concept of curriculum. A curriculum is "a series of planned events". The second criteria observes that the curriculum is planned to convey some purpose or objective. The third feature of curriculum is its intent to be of an educational nature. The last feature relates to the term "consequences". Educational events do more than just what was planned or intended. Eisner (1979) wants to leave room for the educational benefits which might not be realized until during or as a result of the activity. Eisner maintains that this degree of flexibility is an essential component of good course design.

Ralph Tyler in Basic Principles of Curriculum and Instruction (1949) conceptualized that decisions about objectives or "what" knowledge must be decided first, because objectives "become the criteria by which materials

are selected, content outlined, instructional procedures are developed and tests and examinations are prepared" (Tyler, 1949, p.3). Tyler (1977) also adds that the learner plays an active role and not a passive role in this process. Thus, a course cannot just act as an "educational delivery system" but must take into account the learner. Can the concept of curriculum and instruction be differentiated?

Instruction is a series of events that intends to lead to some learning outcome. The instructional matter deals with the nature of the activities and the process of instruction. If "curriculum" is to be separated from "instruction" then a more precise view of curriculum can be established (Posner and Ruduitsky, 1978).

According to Johnson (1967) curriculum represents a set of intended learning outcomes. Curriculum is the "structured series of learning outcomes" but it doesn't prescribe the means, ie. the activites, materials or even the instructional content, to be used in achieving the results. The curriculum is concerned with the end product of "what" knowledge should be learned, not "why" or "how" it should be learned.

Curriculum, Johnson (1967) states, "must play some role in guiding instruction". "Curriculum implies intent." However, "a useful concept of curriculum must leave some room for creativity and individual style in instruction"

(Johnson, 1967, p.130). Curriculum doesn't fully imply the instructional content.

The instructional content not only includes "that which is implied or specified in the curriculum, but also a large body of instrumental content selected by the teacher, not to be learned, but to facilitate the desired learning" (Johnson, 1967, p.131). Concepts are not learned directly but are acquired through some process, the selection of which is an instructional, rather than curricular component. Thus, curriculum planning is involved with the content or "what" is to be taught, while instructional planning determines "how" it shall be presented. Neither of these planning processes, curriculum development or instructional planning actually result in any learning. Only the actual instructional process results in student learning (Johnson, 1967).

The content of the curriculum should be determined prior to the development of the instructional component. According to Ausubel, "The most important factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, etal., 1978, p.iv). This implies that the ideas and skills to be taught must relate to what cognitive structure the learner possesses. Jerome Bruner phrases this in a slightly different manner. "Any idea or problem or body of knowledge can be presented in a form simple enough so that any particular

learner can understand it in a recognized form" (Bruner, 1966, p.44).

The most important factor influencing the learning value of any instructional material is to what extent it facilitates meaningful learning. Thus, the learning material must relate to the relevant aspects of the learner's cognitive structure (Ausubel, 1963, 1967 and Ausubel, etal., 1978).

According to Bruner: "Instruction consists of leading the learner through a sequence of statements and restatements of a problem or body of knowledge that increase the learner's ability to grasp, transform and transfer what he is learning. In short, the sequence in which a learner encounters materials within a domain of knowledge affects the difficulty he will have in achieving mastery" (Bruner, 1960, p.49).

The sequencing of concepts may best be accomplished by moving from the general to more specific ideas. Hirst and Peters (1970) noted that there can be "no knowledge without the acquisition of the relevant concepts".

Bruner (1960) claims that in the organization of the curriculum the fundamental understanding of a subject is necessary to teach the specific topics or skills of any course. Without teaching the general principles to provide a general structure of the subject, it makes it difficult to generalize. It also is difficult to create interest and

make the topic worth knowing. Bruner states, "knowledge one has acquired without sufficient structure to tie it together is knowledge that is likely to be forgotten...Organizing facts in terms of principles and ideas from which they may be inferred is the only known way of reducing the quick rate of loss of human memory" (Bruner, 1960, p.31-32).

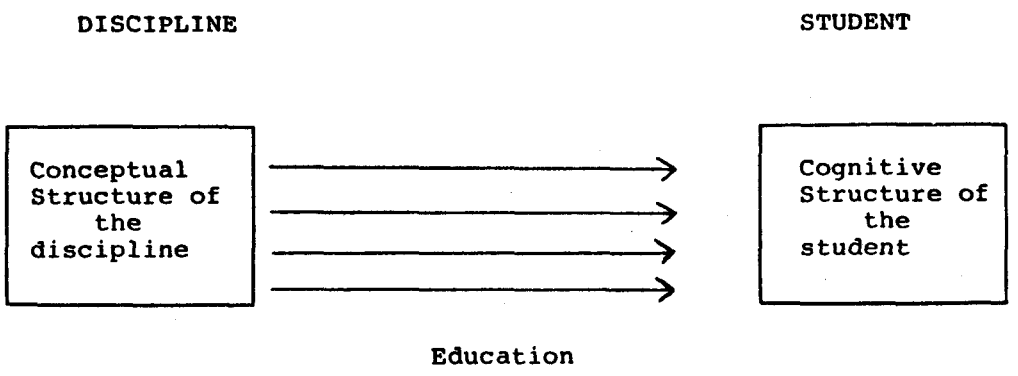
A Framework for Course Design

The SBi3A biology course design was developed within the context of a theoretical framework adapted from Johnson (1967). Novak (1977) represents the process of education as a transfer of principles and concepts which exists in the discipline to the cognitive structure of the student (Fig. 1). This basic representation of the process of education as the movement of ideas from subject matter to the student via the teacher can be modified to incorporate both student centered or teacher centered orientations. In the teacher centered model of education the teacher selects what the student will learn, thus the teachers cognitive structure provides a "limitation in a kind of filtering" (Novak, 1977, p.33) process that takes place. In the student centered orientation the teacher acts as a counsellor assisting the student to select and use the available resources.

The Johnson Model

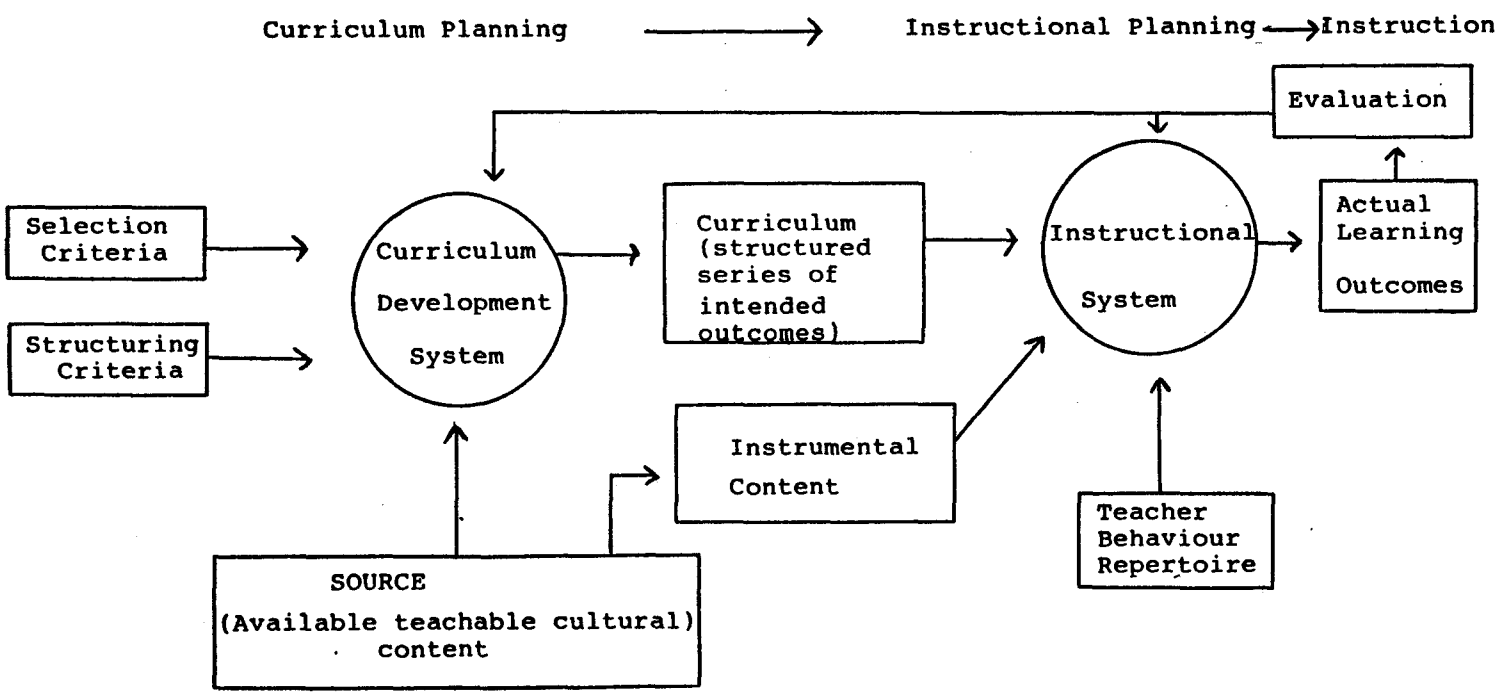
Johnson's (1967) model (fig. 2) of curriculum and instructional design provides a scheme by which the SBi3A biology course can be developed, implemented and evaluated.

Figure 1: A representation of the process of education when viewed as the transfer of concepts from the discipline to the student's cognitive structure.



Novak, 1977, p. 133
figure 5.2

Figure 2: A model showing curriculum as an output of one system and an input of another.



Johnson, 1967, p. 133, Figure 1

According to Johnson's model a partial source of the curriculum is the discipline, however, it ignores the unorganized ideas, attitudes and skills outside the discipline. Thus, "the only possible source - is the total available culture" (Johnson, 1967, p.132). But not all cultural content is incorporated into the curriculum. The concepts to be taught are selected from the available culture using a variety of selection criteria to produce a list of intended learning outcomes.

Eisner (1979) noted five orientations to the curriculum which impose the criteria for the selection of the curriculum items. These are listed below:

(i) The cognitive development orientation emphasizes process not content.

(ii) Academic rationalism suggest that a course should be true to the discipline.

(iii) Personal relevance orientation believes the child should be the most important component of the educational process.

(iv) The social adaptation and reconstruction orientation believes educational philosophies should revolve around society. Education should either produce students to adapt to society or change it.

(v) Technological orientation suggests a "means - ends model of curriculum planning has the virtue of systematizing educational planning; it reminds educators to

formulate purposes and to use those purposes as criteria for evaluating the efficiency and effectiveness of the plans that were made" (Eisner, 1979, p.67).

Each of the above orientations would alter the type of choices made and thus has significant implications on the criteria for the selection of the curriculum.

The SBi3A course already has most of its selection prescribed by the Ministry of Education. However, selection of curriculum material can still be made to some degree from the available variety of material within the Ministry of Education guideline.

The ordering process results in the organization of the intended learning outcomes. The concepts are organized as outlined by Ausubel (1963, 1967), Ausubel, etal. (1978) and Bruner (1960, 1966). The ordering process creates a hierarchy or clusters of intended learning outcomes.

The instructional system has three facets: planning, instruction and evaluation.

An instructional system requires the selection of methods. In the SBi3A a diversity of instructional designs has been chosen to maximize attention and interest. Such as lectures, individual laboratory activities, library research, experimental projects and group work to name some.

In teaching, it is not only important to produce the desired outcomes, but also equally important, is "how" we

teach. Thus, the instructional design is highly dependent upon the teacher (Highet, 1950).

The actual instruction which occurs in the classroom results in the actual learning outcomes. This is "what" is achieved.

In any curriculum development scheme there must be feedback. The evaluation obviously involves the comparison of the intended learning outcomes with the actual outcomes. However, numerous other questions must be asked because the feedback can effect both the curriculum system and instructional system (Johnson, 1967 and Novak, 1977).

In the evaluation of the curriculum component which develops the concepts, perhaps a more general starting point may prove more effective; or an alternative sequence of concepts may prove more meaningful; or perhaps a clarification of the relationships between ideas may be in order. While in the evaluation of the instructional component it may be observed that the pacing may be inappropriate, or a better instructional strategy could be used, or additional motor skills developed.

All these and more factors have to be examined during the course evaluation. This should result in an improvement of both curriculum and instructional method as the course evolves.

Meaningful Learning as Viewed by Ausubel

The conceptual hierarchy which guided the selection and ordering of the concepts during the curriculum development phase of SBi3A was in part motivated by Ausubel's learning theory (Ausubel, 1963, 1967 and Ausubel, etal., 1978). Concepts, according to Novak (1980, 1981) are the regularity in observations or objects illustrated in human language by signs or symbols. Through education we come to understand these concept "signs" or words. The meanings of which are not stagnant.

A good biology course should elaborate the meanings of concepts that have already been acquired and allow the establishment of new concept meanings. The creation of these meanings is dependent upon the idiosyncratic conceptual framework the student has already established.

Ausubel implies meaningful learning is the means by which new meaning or knowledge is connected to and incorporated into the existing relevant concepts of the students cognitive structure (Ausubel, 1963, 1967 and Ausubel, etal., 1978). Thus, in the process of learning the concept has to be related in a "nonarbitrary and nonverbatim fashion to relevant aspects of what the learner already knows" (Ausubel, 1967, p.18). Rote learning, by contrast, occurs if the learning task occurs in a purely arbitrary, verbatim fashion in which the learner lacks the important prior concepts necessary to make the learning task

potentially meaningful. Rote learning can also occur if the student adopts a potential meaningful concept in an arbitrary and verbatim manner as a series of words (Ausubel, 1963, 1967 and Ausubel, etal., 1978).

Ausubel elaborates on the two separate continuums of rote learning and meaningful learning as opposed to reception learning and discovery learning. In reception learning (rote or meaningful) the concepts are presented to the students in the final form. While in discovery learning the essential feature is that the student must discover the idea before incorporating it into the conceptual framework (Ausubel, 1963 and Ausubel, etal., 1978). Discovery learning can also range from rote problem solving to meaningful concept formation. The discovery method hardly serves as an efficient primary means of transmitting the subject matter (Ausubel, etal., 1978).

These two continuums are often confused and many educators associate reception learning with rote learning and discovery learning with meaningful learning. "This confusion is partly responsible for the widespread but unwarranted twin beliefs that reception learning is invariably rote and that discovery learning is inherently and necessarily meaningful. Both assumptions, of course, reflect the long-standing belief in many educational circles that the only knowledge one "really" possesses and understands is knowledge that one discovers for oneself.

Actually, each distinction rote versus meaningful learning and receptive versus discovery learning constitutes an entirely independent dimension of learning. Hence a much more defensible proposition is that "both" reception "and" discovery learning can be "either" rote "or" meaningful depending on the conditions under which learning occurs" (Ausubel, etal., 1978, p.27).

Assimilation Theory

Assimilation theory is a form of cognitive learning theory which deals with the process of "concept formation and the nature of human understanding" (Ausubel, etal., 1978, p.67). Behaviourists as outlined in Skinner (1968) maintain that what is learnt can be "seen" by changes in the behaviour of the organism and stimuli are effective means to produce the desired behavioural changes. Thus, behaviourists claim "only the stimuli applied and resultant observable behavour are legitimate components for study (Ausubel, etal., 1978, p.67). This, according to cognitive learning theory, is superficial because learning that is meaningful is dependent upon new concepts interacting with relevant subsumer concepts. The resultant cognitive structure is an "assimilation" of old and new ideas.

Forms of Meaningful Learning as Viewed in Assimilation Theory

(modified from Ausubel, etal., 1978,p.68)

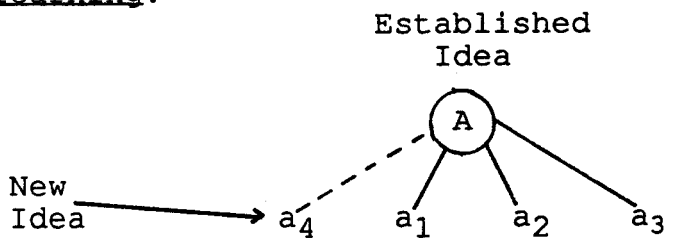
Assimilation Theory:

New ideas are linked to relevant pre-existing aspect of the cognitive structure. Thus the new idea and existing concepts are modified.

All of the following are simple examples of the assimilation of old and new concepts.

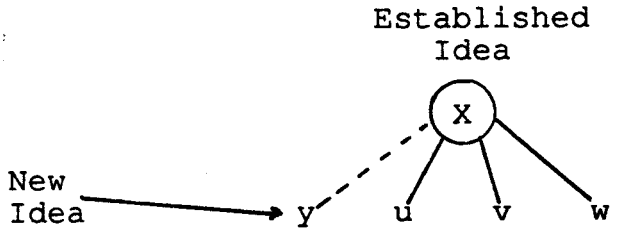
1. Subordinate learning:

A. Derivative Subsumption



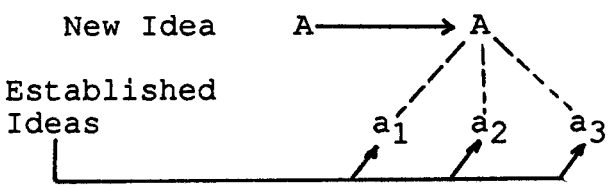
The new idea a_4 is linked to an established, more inclusive idea A.

B. Correlative Subsumption



The new idea y is linked to the established idea X but y changes, extends, modifies or qualifies the established idea X.

2. Superordinate Learning:



The established ideas a_1, a_2, and a_3 which may appear to be unrelated are actually more specific examples of the more inclusive new idea A and become linked to A.

3. Combinatorial Learning:

New Idea A ⟶ B - C - D

Established Ideas

The new idea A is seen to relate to the established idea B, C, and D but is neither more inclusive or specific in nature.

If we accept Ausubel's learning theory, then the organization of the course concepts should be developed using some of the principles illustrated above to produce meaningful learning.

Application of Learning Theory to SBi3A

The Ministry of Education Curriculum Guideline for Grade 11 Advanced biology (1987) determines the mandatory and optional units. Mandatory topics are also prescribed within the context of each unit. The guideline, however, does not mandate the order of presentation or identify key inclusive concepts to facilitate meaningful learning.

It is essential for meaningful learning that concepts be developed from general to specific and that a conceptual hierarchy is achieved through progressive differentiation of the relevant concepts. This conceptual

hierarchy can then be used to determine a possible path the course may follow.

In the SBi3A course we attempt to organize the course, the units and the lessons in a manner that progressively differentiate the major concepts of the Ministry's 1987 biology guideline.

Initially in the development of the biology program one has to establish the large scale ideas or principles that govern the many lesser concept in biology. Seven major "themes" have been identified by Biological Science Curriculum Study (cited in Novak, 1981) and two additional key propositions were added by Novak (1981). After examining these and the unifying concepts proposed by Creager (1979), we modified these themes or principles into the "big ideas" which guided the development of SBi3A. These as follows:

1. Energy is a basic requirement for life. Energy transformations and exchanges drive the activites of living things.

2. All functions can be associated with specific structure.

3. Levels of organization can be found in all organisms.

4. The functions of an organism can be associated with structures at a lower level of organization.

5. Despite the diversity of structure in the living world there seems to be a similarity in the functions necessary to maintain life.

6. Reproduction is essential to maintain a species and allow living things to display genetic continuity.

7. Homeostosis permits living things to function in the face of changes in the environment.

It became apparent that an introductory section was required in order to establish these basic principles upon which the remainder of the course would be built.

Each unit should follow naturally from the previous unit so that the basic principles listed above could be developed using more specific concepts. Thus the following sequence of units were chosen to assist in the development or clustering of concepts.

1) Introduction to Biology
2) Cellular Structure and Process
3) Vertebrate Skeletal and Support Systems
4) Vertebrate Digestive Systems
5) Vertebrate Gas-Exchange Systems
6) Vertebrate Transport Systems
7) Vertebrate Reproduction and Development
8) Genetic Continuity
9) Bacteria and Viruses
10) Impact of Science on Society (these ideas were incorporated into the other units)

11) Vascular Plants: Growth and Structure (major individual project-research and experimentation)

Concept Maps

Once the sequence of units was chosen it became possible to work on each unit to develop a conceptual hierarchy. Figs. 3, 4, 5 show examples of the conceptual hierachies of three units. These concept maps demonstrate the relationship in concept learning, starting with the most general all inclusive concepts going to more specific, less inclusive ideas. A concept map can help translate theory into practice. In order to construct a concept map a possible sequence is outlined below modified from the work of Novak (1977, 1979, 1980 and 1981), Stewart, etal., (1979), and Heinze-Fry, etal., (1984).

1. Concepts or the description of some regularity are designated. The source of the concepts for SBi3A are taken primarily from the Ministry of Education guideline; however, as Johnson (1967) noted, the culture also has an imput.

2. Concepts are clustered and related to each other.

3. The concepts are linked together in a hierarchy from the most general concepts at the top to progressively more specific concepts at the bottom of the map.

4. Cross-links are the relationships that are made between the concepts. These are the interrelationships that may not at first appear obvious, but allows the student to progressively differentiate general concepts.

Figure 6 provides an example of a generalized concept map which organizes the ideas in a conceptual hierarchy.

The concepts are enclosed in either rectangles or circles in Figure 6. R_1, R_2, R_3 and R_4 represent linkage between concepts. Note the hierarchy from general to specific concepts. R_4 represents the cross-linking between two subsections of the map.

From the concepts, the instructional plan can be developed. The conceptual hierarchy can be translated into specific intended learning outcomes (Johnson, 1967). These objectives are then developed into instructional activites which are also organized on a conceptual hierarchy to facilitate meaningful learning (Novak, 1981). The concept maps allows for the increased linkage of ideas to make the learning meaningful. This process may increase the chances that students learn meaningfully as opposed to by rote. (Novak, 1977, 1979, 1980, 1981, Stewart, etal., 1979 and Heinze-Fry, etal., 1984).

Figure 3: **Conceptual Hierarchy of Unit 1: Introduction to Biology**

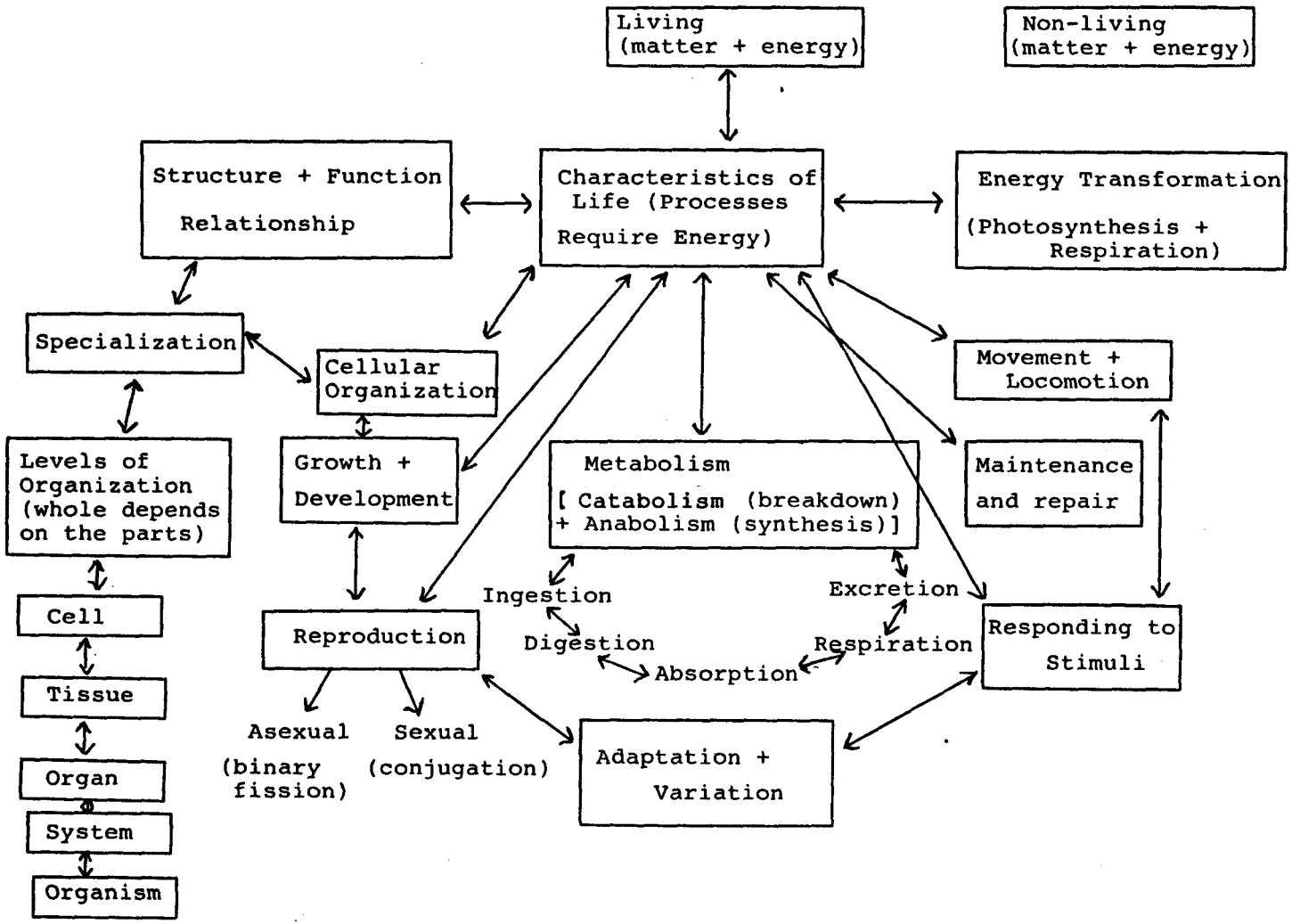


Figure 4: **Conceptual Hierarchy of Unit II: Cell Structure and Processes**

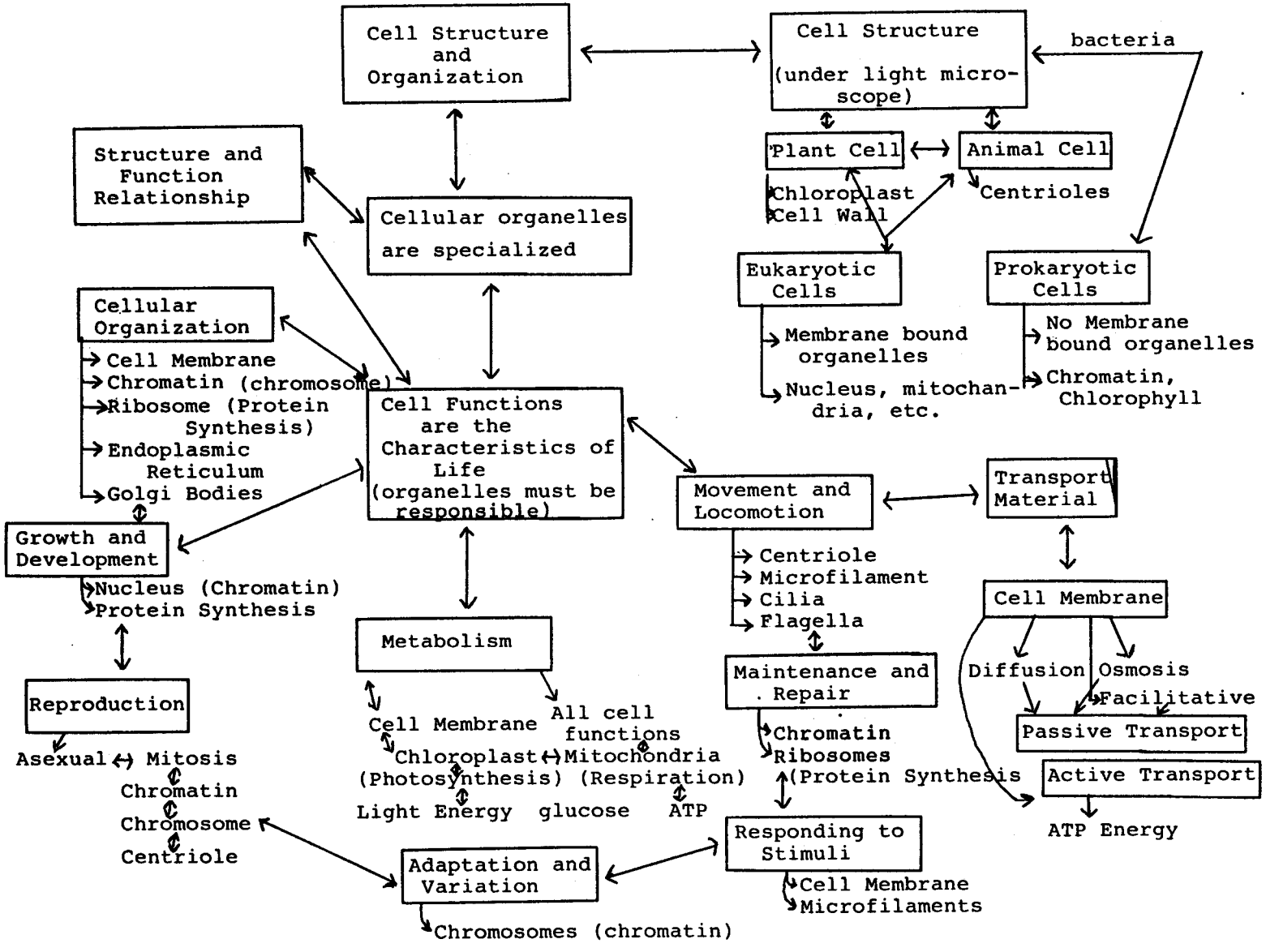


Figure 5 : **Conceptual Hierarchy of Unit III: Skeletal and Muscular Systems**

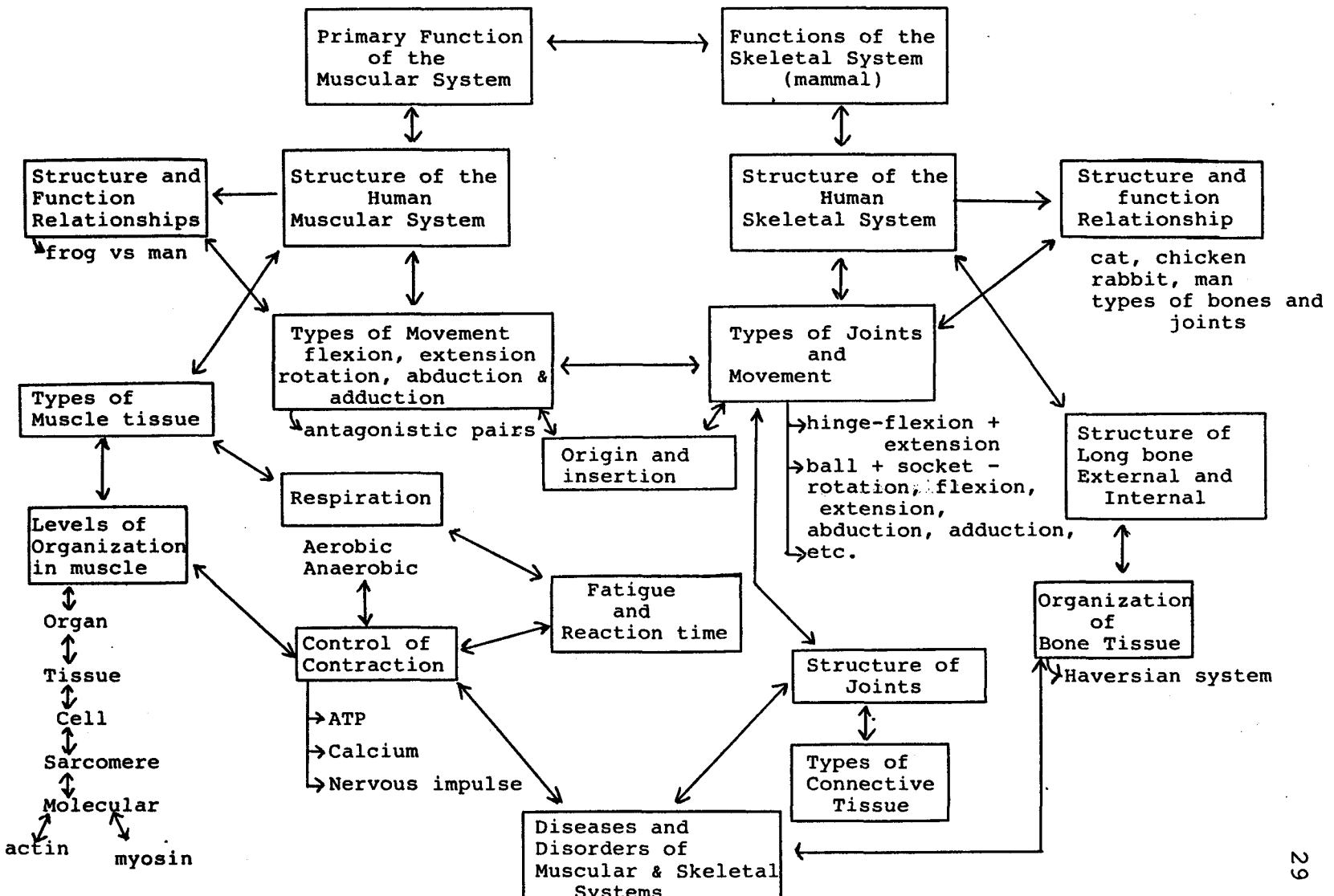


Figure 6: Generalized Concept Map

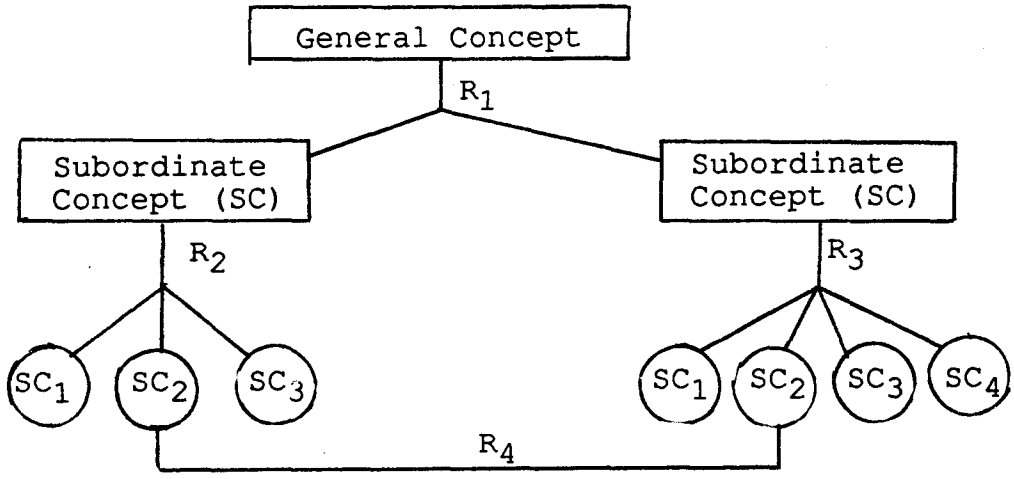


Figure adapted from: (Heinze-Fry, etal., 1984, p.152)

According to the Johnson's (1967) model curriculum and instruction are interdependent components. Successful planning requires "cycling" back and forth between curriculum design and instructional design decisions. The selection, ordering and emphasis of concepts to be learned must precede instructional planning and the consideration of objectives.

From the conceptual framework provided by the conceptual hierarchies of each unit the instructional plans were developed.

Major Principles in the Theoretical Rationale of SBi3A

A diversity of theoretical principles has been incorporated into the instructional component of the SBi3A course at Glendale. The following principles have played key roles in guiding the courses development.

1. The instructional sequence moves from general to specific to faciliate meaningful learning. In Educational Psychology: A Cognitive View, Ausubel, etal., (1978) used an organizer-like introduction to each chapter. These advanced organizers presented the key ideas or generalities as a conceptual framework for the material to follow. Eisner comments, "One must - I must at least - have some sense of the whole in order to know where things belong and how they function" (Eisner, 1979, p.IX). A similar format

was used in SBi3A with the presentation of the major objectives at the start of each unit.

The major concepts are introduced early within the course and within each unit. Each individual lesson or activity is structured to move from general to specific concepts to achieve increasingly differentiated concepts.

The arrangement of the units have also attempted to achieve the same effect.

2. Student should have the prerequisite motor skills and abstractions (Novak, 1977). In order to increasingly differentiate concepts, the motor skills used in any activity should have been already developed in grade 9 and 10. The skills used in class activities associated with library research, stop watches, and even the microscope have been well practised in previous courses. Using well established motor skills during individual and group activities allows the students to dedicate more effort on the conceptual development; as opposed to learning new motor skills.

The primary and secondary abstractions which most students have about living things will be adequate due to the systematic sequencing of concepts based upon meaningful learning.

3. Move from concrete to abstract (Novak, 1977). If an abstract concept is not well established then the use

of concrete examples will aid in developing primary abstractions. Lab activities allow for direct experience with concrete learning materials to help in the development of abstractions. Lectures can also facilitate the movement of concrete to the abstract by appropriate examples and models.

4. Different learning styles should be accounted for in both the presentation and evaluation. Learning style represents the factors that are biological or environmental which either inhibit or foster learning. Gregorc (1979) views learning styles as consisting of the behaviours which suggest we have different mind qualities to interact with the environment. Dunn (1984) outlines the diversity of environmental, emotional, sociological, physical and psychological factors which effect the learning capabilities of an individual.

Within each unit a variety of course designs are used:

i) lecture

ii) individual activities

iii) group work activities

Each method provides diversity in the mode of presentation such as: lectures, discussions, board and written work, overheads, slides, oral student presentations, films and videos, activity sheets, microscope, audio tapes, drawings, textbooks and individual research projects.

The diversity in the method of presentation accommodates various learning styles. However, the same principle should be utilized in the evaluation of the student. The student evaluation was based upon a variety of sources (eg. lab sheets, drawings, lab tests, quizzes, unit tests, informal discussions with students, oral presentations and peer evaluation of group activities).

5. Novelty stimulates attention. If the student performs the same type of activity each day, they quickly lose interest, even if, the students initially believed the activity to be stimulating. Variety in the method of presentation gives a sense of novelty to the course, which in turn stimulates the students attention level.

Even within the context of one class it is essential to diversify the mode of presentation. For example, a lecture can be broken up by the use of a class discussion, a slide presentation or a demonstration of a principle.

6. Shaping of desired outcomes by small logical steps (Novak, 1977). The lectures, individual and group activities of each unit are systematically organized.

i) General background for each lecture or individual activity are outlined at the beginning to provide a framework for the new concepts.

ii) The objectives are stated at the start of each lecture, individual or group activity.

iii) The lectures or individual activites move in small steps from broad general concepts to specific ideas to differentiate the major concepts.

iv) Consultations with the teacher or comparing results with other individuals will insure the proper shaping of concepts.

7. Pleasant conditions and consequences have a tremendous affect upon both affective and cognitive development (Novak, 1977) . If a student has a positive emotional reaction to what he is learning then he generally acquires more cognitive knowledge. Students working individually or in group activities have an opportunity for the enhancement of personal association and emotional interaction. Even testing can be a positive experience if the fear of failure is reduced by providing the objectives for the test and offering re-test possibilities. A cyclical effect occurs, in which the success in the student's cognitive development results in a benefit to his affective development and vice versa.

8. Positive reinforcement of cognitive learning occurs in numerous situations.

i) During the individual and group activities the teacher can visit with small groups to provide informal feedback or praise for a job well done.

ii) Numerous short quizzes and tests on pre-determined learning outcomes.

iii) The students are allowed to repeat a quiz or test on any concept which they haven't successfully understood.

iv) Numerous high marks are accumulated by the students through the regularly administered quizzes, tests, individual or group activity evaluations.

9. A definite effort was made to accommodate different rates of learning during the course.

i) The establishment of a set of core learning objectives provides a guage by which a student can monitor his own progress.

ii) Remedial and enrichment sessions were available two noon hours a week.

iii) Enrichment activity are provided at the end of some individual activities.

iv) Reading on related topics are available to motivated students.

v) Retests and re-quizzes are possible until the desired mark is acquired.

10. Value development should be a natural outgrowth of science activities. The development of values should be an on-going part of a student's growth. The SBi3A course provides numerous opportunities to develop values.

i) Intellectual honesty: During the individual lab activities the students should record exactly what they observe.

ii) Curiosity: The students should ask questions about things they discuss or observe in class.

iii) Co-operation: The students should work together to achieve a common goal especially in group activities.

iv) Good Citizenship: During individual or group activities students should assist each other in learning.

CHAPTER III

THE COURSE

The SBi3A course that has been described in the previous chapters meets the recent Ministry guidelines (1987). The course was developed to progress from general concepts to more specific concepts. Many of the basic principles are outlined early in the program; thus having the potential of being reviewed and developed during the course as more specific knowledge is introduced. The course also allows for the use of a variety of instructional formats which both enhance the level of interest and the development of different skills.

In this chapter the course will be summarized as each unit is presented in overview. Along with the summary of the SBi3A course in this chapter, the course outline (Appendix A), the objectives (Appendix B), Conceptual Hierarchies (Appendix C) and two complete units will be available as a sample of this course in the appendices (Appendices E and F).

Unit #1: Introduction to Biology

In order for real understanding to occur and to minimize rote learning, concepts have to be developed in an appropriate order. One form of development is the movement

from general to specific concepts, in which ideas are continually differentiated to result in what Ausubel, (1963, 1967) refers to as meaningful learning.

The first unit should attempt to develop some basic principles or generalizations that can be used as a scaffolding so more detailed material can be added in future units. As stated in the previous chapter, we have identified seven basic principles which are to be utilized as a conceptual foundation for this course (Refer to Chapter II, p. 23-24).

These basic principles of biology (energy transformation, structure function relationship, levels of organization, functions based upon lower level structures, similarity in characteristics of life, reproduction and genetic continuity and homeostasis) are used to develop the conceptual hierarchy for each unit.

In the first unit, the movement from general to specific ideas is initiated by the differentiation of living and non-living matter as the base of the hierarchy. Animals and plants versus rocks and water can be used as examples. Both living things and non-living things are composed of matter and energy; but what is life?

The difference between living and non-living can be examined under the microscope by determining the fundamental characteristics shared by all creatures. Living things exhibit characteristics such as reproduction, cellular

organization, growth, homeostosis and heredity and are driven by internal energy transformations. Despite the diversity of structures found in the various organism chosen for study, the similarity in the characteristics of life are observed. It should also become evident that specific structures may be associated with specific functions such as cilia and flagella with movement and chloroplasts with photosynthesis.

During the chicken wing activity, levels of organizations are examined. The multi-cellular organisms are composed of functioning groups of cells, tissues, organs, and organ systems, each with a specific purpose. The movement of a wing can be traced back to the contraction of muscle at a lower level of organization.

In this, as in other units, three different instructional formats are used.

1) Lectures: Introductory and summary lectures are used at the beginning and end of the unit. Mini lectures are also used to instruct students on the care, and use of microscopes, characteristics of life and levels of organization.

The lectures also attempt to tie the major concepts together with the aid of the objective sheets and the conceptual hierarchy.

2) Individual Activities: The students work through individual activities on the care and use of microscopes, determination of the field of view and measurement under a microscope and observations on the characteristics of life. The activity sheets associated with the individualized component of the unit are systematically organized.

i) The activities start with a "Background" of the concepts to be learned.

ii) The objectives are stated in behavioural terms.

iii) The lab activities are outlined in detail.

iv) Questions are used to attempt to differentiate the major concepts.

v) Results can be checked by consultation with the teacher, texts or by comparison with other individuals.

(vi) Students are evaluated by their lab reports and quizzes.

3) Group Work: The chicken wing activity is an exercise in which a group of about five students examine fresh tissue from various regions of the chicken wing to observe specialization and organization. The students are evaluated on a common group effort and peer evaluation.

The presentation of the first unit of SBi3A developed concepts in a selected and organized fashion using

a variety of instructional methods. This unit hopefully acts as a general conceptual base upon which the rest of the course is built.

Unit 2: Cell Structure and Processes

This unit has many similarities in instructional format to the previous unit. Conceptually this unit attempts to review and build upon the cell concepts outlined in grade nine science and relates these to some principles outlined in the first unit, Introduction to Biology.

In grade nine the basic animal and plant organelles were examined, along with a brief description of their functions. The organelles included in grade nine were the nucleus, nucleoli, cell membranes, cytoplasm, mitochondria, chromosomes, chloroplasts, vacuoles, centrioles and cell wall. Some basic techniques of the use and care of the light microscope and tissue preparation (of plant and animal cells) were also introduced. These ideas are quickly reviewed within the first activity. Along with the differentiation of plant and animal cell, a more general classification is addressed that of the difference between eukaryotic and prokaryotic cells.

In the second activity the students undergo a more thorough examination of the organelles with the aid of election micrographs and texts. In addition to the structures outlined previously, the students become familiar

with the structure and function of the nuclear membrane, nuclear pore, endoplasmic reticulum, ribosome, lysosome, Golgi apparatus, microtubules, microfilaments, cilia, flagella and pinocytic vessicle.

Individually or in small groups, the students use a variety of sources such as: texts (Andrews, 1980, Kormondy and Essenfield, 1984, Berry, etal., 1982 and Jensen and Park, 1970) Ward's Solo Learn System program on the "Introduction to the Animal Cell" and Introducing Biology video series, Program 3, The Cell to research the importance of the major organelles in a functioning eukaryotic cell. Key processes such as respiration, protein synthesis, mitosis and transport are also examined.

A model of the cell membrane and the processes of passive and active transport are developed through lecture and activity format.

Throughout this unit, an attempt is made to relate some of the basic principles such as the characteristics of life, specialization and levels of organization outlined in the first unit with the organelles and processes discussed in unit two.

In this unit the students are evaluated by quizzes on cell structure and function, osmosis and transport, and by lab reports. A major test summarizes the concepts outlined in unit I and II.

Unit 3: Vertebrate Skeletal and Muscular System

A basic premise of this course is the movement from general to specific. This optional unit provides obvious examples of structure and function relationship and specialization at various levels of organization. The students readily understand these principles as they relate to both the skeletal and muscular system.

The unit starts with the identification of the main functions of the bones of the mammalian skeleton. The student relate structure and function and examples of specializations by the examination of the available vertebrate skeletons and X-rays (human, rabbit, cat and chicken). During this activity the names of the major bones on the human skeleton are learned.

In activity two the students examines the specialization at various levels of organization, from the long bone to the Haversian canal system. These adaptations allow for the survival of the organism and the bone cell.

The joints are specialized to accommodate various types of movement and provides an excellent junction to the second component of this unit the mammalian (human) muscular system. As in the skeletal system the concepts are developed starting from the human anatomy and proceeding to the subcellular. A dissection of the frog is compared and contrasted to the human.

The individual reading of the article Athletic Training: And How Diet Affects It, (Hanley, 1979) and the ISIS book Keeping Fit introduce the student to the levels of organization of a muscle (from an organ to actin and myosin), contraction and aerobic and anerobic respiration. The association of muscles with sports and physical fitness stimulates interest.

A group activity on muscular fatigue and reaction time modified from Body Works, (Scarrow, 1979) relates the effect of muscle fatigue and reaction time to their bodies and provides an avenue to discuss skeletal and muscular diseases.

The Introducting Biology video series on Locomotion and Skeletons, program 12 and Muscles and Exercise, program 13 are used to review many of the major concepts.

Throughout this unit the students are evaluated by their performance on quizzes, (human muscular, skeletal system, bone structure and joints and movement) the dissection of the frog, group activity and a major unit test. As in the previous unit if a student desired an improvement in his/her mark, re-quizzes and tests were available.

Unit 4: Vertebrate Digestive System

In this unit the student examines the structure and function of a typical vertebrate (human digestive system. The comparitive structure, function and adaptive nature of

various organs in the daphnia, frog and mammal are examined through dissection.

Lectures on the processes of physical digestion and the chemical digestion of carbohydrates, proteins and fats by enzymes are discussed. (An optional student activity is available.) The movement of food along the human digestive tract, the release of digestive chemicals, the structure and function of various components of the digestive system, absorption and the elimination of waste are all highlighted during the discussions.

Throughout this unit references are made to the importance of structure to function, lower levels of organization and cellular metabolism. The student should also become aware of the nutritional requirements for a balanced diet and its role in maintaining homeostasis.

Students are evaluated by quizzes and class activities. No major test was presented for this unit due to the time constraints of the mid-term examinations.

Unit 5: Vertebrate Gas Exchange

As in the case of the vertebrate digestive system, the students were introduced to the respiratory system in the grade 10 core unit "Organisms and their Internal Environment".

This unit, unfortunately had to be abbreviated due to time constraints. Through lectures the students were provided with an understanding of how oxygen and delivered

to the body cells by hemoglobin and how the waste products are removed.

The anatomy of humans, fetal pig, fish and frog were also compared. A quick review was provided by Introducing Biology Video Series: Program 14, Respiration.

The students were given a review quiz on the unit and were also evaluated on their fetal pig dissection. The first five units were evaluated in the mid-term examination.

Unit 6: Vascular Plants: Growth and Structure

Early in the second term this unit was assigned as a term project composed of two parts. The project provides the student with an extended section of independent research work and experimentation.

Part I is a library research project in which the student learns about:

i) seed structure and germination

ii) vascular tissue; structure and function

iii) meristemic tissue and plant growth

iv) plant growth regulators and tropism

In Part II the student must design and perform a controlled experiment.

The student will be marked on:

i) a written report on: Part I - 40%
Part II - 40%

ii) an oral presentation briefly outlining the experiment, results and conclusions of Part II - 20%

Unit 7: Vertebrate Transport System

This unit develops the structure and function relationship of the circulatory systems of mammals (human and fetal pig), frog and daphnia. In addition, it reinforces the concepts of transport of nutrients, hormones, oxygen, carbon dioxide and waste products in the blood as noted in previous units. The roles of homeostasis and protection are also examined.

Through the initial lecture the student learn that the basic three functions of the circulatory system are transport, protection and homeostosis. In addition the structure and function of the mammalian heart, arteries, veins and capillaries are discussed. These concepts are reinforced through activities on the goldfish and dissection of the fetal pig and beef heart. The concept of blood pressure and heart beat regulation are developed with the aid of lab activities.

The composition and function of the components of the blood are examined through lecture, activities and an article The Seven Percent Solution, (Larned, 1979).

Two video tapes from the Introducing Biology series; The Heart, program 15 and Circulation, program 16 are used as a review.

A group work activity on the disorders of the circulatory system highlights some of the major problems

associated with circulation and sums up some of the ideas discussed in this unit.

The students are evaluated through several quizzes, laboratory activity 3, 4, and 5 and the questions from the reading assignment "The Seven Percent Solution", (Larned, 1979). A major term test came at the end of this unit.

Unit 7: Vertebrate Reproduction and Development

In this unit a quick survey of asexual and sexual reproduction of a diversity of organisms was accomplished in activity I. The students examined the structure and function of the human male and female reproductive system through a series of filmstrips (Schloat, 1972) and lecture presentations.

Special attention was placed upon the role of hormones in the uterine and ovarian cycle in females. The importance of hormones in male sexuality was also studied with the aid of the Vista video, "The Fight to Be Male".

A group activity follows the development of Xenopus eggs through the early stages of development and compares it to human development as shown in a series of filmstrips (Schloat, 1973).

New hi-tech reproduction techniques (eg. artificial insemination, InVitro Fertilization (I.V.F.), embryo freezing, etc.) are examined in both humans and animals. Moral and ethical problems associated with these controversial techniques are discussed (eg. I.V.F. research,

contraception, etc.). Dr. Anne McLaren's (1986) "Why Study Early Human Development" provided a good starting point for both a discussion and an essay.

The students are evaluated on the lab report of activity one, the essay on the morality of I.V.F. research, the group activity on Xenopus development and the quiz on male and female reproductive structures. A unit test reviews all the major ideas.

Unit 8: Genetic Continuity

Sexual reproduction and gamete formation provides an excellent conceptual scaffolding for the unit of heredity. The first activity thus deals with a review of meiosis. The sex chromosomes are followed through the processes of meiosis and are used to predict sex determination using a Punnett square. Once this process has been outlined, it was emphasized that the chromosomes carry the genes as sections of DNA.

The work of Gregor Mendel was used to demonstrate aspects of the scientific process and provided a conceptual framework for the standard terminology (dominant, recessive, homozygous, heterozygous, genotype, phenotype, etc.). This discussion lead to several types of problems such as: monohybrid and dihybrid crosses, incomplete dominance, co-dominance or multiple gene in blood types and sex linkage and chromosomal dysfunction. Each concept was outlined on a separate problem sheet which provided a background, step by

step example and a set of problems. Numerous quizzes and the Merlan Series Computer review (Smythe, 1982) are used to promote success in this section.

A group library assignment examined a number of genetic diseases which affect our society. The techniques of genetic engineering and amniocentesis are examined by the student as to their possible positive and negative implications on society. The student should gain an understanding that the heredity factor, the gene, more specifically DNA, provides both continuity and variation in the human population. The video, The Infinite Voyage series on "The Geometry of Life" was used to show the importance of DNA.

The numerous quizzes on the various genetics problems, a library assignment, an essay on one aspect of the video and a unit test provided the basis for the evaluation of this unit.

Unit 9: Bacteria and Viruses

In this unit, the students reinforced the basic understanding of the structure and function of the cell, the basic characteristics of life and the use of the microscope. The students were introduced to the structure, variety and forms of reproduction in both bacteria and viruses. Gram staining was used to identify gram positive and gram negative bacteria from the students' mouth. A quick survey

is made of the importance of bacteria in the biosphere. In conclusion, the students studied viral and bacterial diseases and immunity. This lead to an extensive examination of the structure, reproduction and social problems associated with the AIDS (HIV) virus.

The availability of time limited the amount of evaluation in this unit. The final examination reviews the information only from the second term (which included the units from Vascular Plants to Bacteria and Viruses).

CHAPTER IV

EVALUATION

The evaluation of the SBi3A course taught at Glendale Secondary School in Hamilton is an ongoing process. Planning and evaluation never stop, but continues to evolve. A mixture of evaluation techniques are used to monitor the outcomes of this program (both planned and unexpected learning).

In the earlier chapters it was noted that a systematic course development requires both curriculum and instructional planning. It follows that both components should be evaluated, along with the courses overall effect on the students' learning. We must ask, "Where the concepts developed from general to specific? Did the instructional technique effectively develop the concept?"

Johnson (1967) states that, "curriculum evaluation is all too often conducted at the output point of instruction rather than at the input position. Thus curriculum evaluation is confounded with instructional evaluation" (Johnson, 1967, p.135). Posner and Rudnitsky (1978) likens course evaluation to a TV repairman facing a broken TV. Trouble shooting allows him to isolate the problem and thus repair it. However, a course of study,

though analogous, is much more complex because there are generally few simple cause and effect relationships.

Evaluation Techniques

The evaluation of this course used a mixture of techniques. Improvement through evaluation should be attempted at every stage. The following techniques were used.

1. Development testing to improve activity sheets in the individualized component of the course. A selected group of former students will be invited back at the beginning of the next semester to work through chosen activity sheets in order to improve them for future classes.

2. "Uninvolved" colleagues (the head of the department, principal and subject supervisor) have been invited to monitor the program. Their role was to find any curriculum or instructional problems and provide feedback.

3. Students evaluate the "best" and "worst" components of the course from their perceptions via course evaluation forms (Appendix D).

4. Personal interviews with selected students regarding the cognitive and affective value of this course have proved enlightening.

5. Objective tests and quizzes on the predetermined learning objectives monitor the level of success in the transmission of knowledge.

6. The authors subjective evaluation of the positive and negative aspects of the course.

Value and Uses of Curriculum and Instructional Evaluation

Ralph W. Tyler feels that the basic notion regarding evaluation is "essentially the process of determining to what extent the educational objectives are actually being realized by the program of curriculum and instruction" (Tyler, 1949, p.105). Derek Roundtree also states, "We wish to know which objectives have been achieved and which not: and what unforeseen results (beneficial or disastrous) have also materialized?" "Hopefully, the insights gained from evaluation will help us improve our teaching (or enhance the learning) not just for the present students but for future students also." (Roundtree, 1974, p.130).

Tyler (1949) points out that the main function of evaluation in curriculum development is "in identifying the strengths and weakness of the curriculum program" (Tyler, 1949, p.123). He continues to say that, "Evaluation also has a powerful influence on learning"..."Students are influenced in their study by the kind of evaluation to be made and even teachers are influenced in their emphasis by the sort of evaluation which they expect to be made" (Tyler, 1949, p.124).

Thus, as noted above, Tyler (1949) points out three main uses of evaluation. He clearly states that in the process of course evaluation:

a) Teachers monitor the changes in the students' knowledge of the learning objectives.

b) Teachers determine the effectiveness of the course in its ability to accomplish the transmission of ideas.

c) How the students are evaluated plays an extremely important role in cognitive and affective learning. The curriculum objective should remain the focus of the students' and teachers' attention, not the evaluation procedure.

Roundtree (1974) also acknowledges that learning goes beyond the pre-set objectives and involves unforeseen results. The ability of the teacher to recognize these and evaluate their beneficial or negative effect can also enhance the learning in the course.

The quizzes and tests in SBi3A were based upon the objectives. The quizzes provide formative evaluation. The prime purpose is to improve instruction and learning, rather than merely rank or grade the student. The tests which are at the end of the unit require a high level of competence and are summative in nature. These student evaluations provide a greater measure of student achievement and program effectiveness.

Re-write possibilities are always available on tests and quizzes if the student feels that the desired level was not achieved. It creates a positive attitude about the use

of testing as a measure of learning, rather than simple grading. The immediate evaluation of the quizzes provides feedback for the clarification of concepts. The vast majority of students felt extremely positive about the large number of quizzes (96%). They believed that not only did it improve their mark, but it also assisted them in the learning of the material (Appendix D, p. 109). In addition, some students felt with the availability of retests and extra bonus activities, that high marks became a reward. Numerous smaller evaluations on lab reports, group work, essays, quizzes and tests creates a situation in which the partial grades may have a greater value than the final grade in the motivation of the students.

Numerous quizzes and tests also provided a means of shaping desired outcomes in small logical steps rather than on giant leaps. This also stimulates student learning because the student feels a sense of understanding. The students like to show their understanding or skill. Emotional experience can optimize cognitive learning (Novak, 1977).

This course is designed to give the student frequent and immediate feedback, because the feedback facilitates learning.

Eisner (1979) further differentiates the functions of evaluation. He outlines five in detail. They are:

1. To diagnose

2. To revise curricula

3. To compare

4. To anticipate educational needs

5. To determine if objectives have been achieved

(Eisner, 1979, p.168)

1. To Diagnose: The potential target of the diagnosis can be the curriculum, the teaching and the student. Most commonly the term evaluation is referred to in the context of the students educational experience. Evaluation is an continuous, comprehensive and integral component of the teacher/learning process. As noted earlier, evaluation is more than testing! The widest possible variety of procedures are used in SBi3A to evaluate the students in order to determine whether the ideas were understood. In this course the diversity of evaluation techniques reads like a menu.

A Menu of Evaluation Techniques in SBi3A

a) Quizzes (oral and written).

b) Individual research projects.

c) Group research projects.

d) Individual oral presentations.

e) Marking completed lab work.

f) Video reports.

g) Marking classroom discussions.

h) Experiments.

i) Marking diagrams and dissections.

j) Essays.

k) Teacher/student interview.

l) Teacher made tests and examinations with

i) Multiple choice questions

ii) Matching questions

iii) Diagrams

iv) Short answer questions

v) Essay type questions

Thus evaluation allows us to locate any difficulties the student has in understanding the concept. It provides us with a general plan to "prescribe" an educational "treatment".

Eisner (1979) points out, "When a teacher monitors his or her teaching tactics to suit students, a diagnostic form of evaluation has occurred" (Eisner, 1979, p.170). Therefore, self-diagnosis can be used not only to evaluate the process of teaching, but also for the purpose of curriculum change. During this course, we were sensitive to the comments from the students on how the concepts were organized and presented. The student course evaluation results (Appendix D, p. 107) appears to support the course was organized in a manner acceptable to the students, with 77.9% of the respondence giving the course a high mark (80% or better) for organization.

2. <u>To Revise Curricula</u>: Eisner (1979) discusses curriculum packages developed by a curriculum development group which

are sets of material to be used by the teachers and students in a pilot project known as "hot house test". The major purpose is to appraise and improve the curriculum package. Thus, to make it "teacher proof". This type of curricula revision is not applicable to this course. However, it is important that the curriculum and instructional components are free of major educational problems so that the learning materials are developed to achieve meaningful learning. In this course, along with the teachers subjective evaluation, a few colleagues were asked to monitor the development of concepts and instructional techniques.

3. To Compare Program and Teacher: The unique aspects of this course are found in its movement of concepts from general to specific and the diversity of instructional formats. The implementation and success of this project is based upon the premise that these two points are philosophically desirable, rather than on any "hard data". Thus, the effectiveness of this program has to be compared to its "own goals and unanticipated consequences" (Eisner, 1979, p.172).

From individual discussion with students and the student questionaire, (Appendix D, p. 107), the conceptual framework of the course, in their opinion assisted them in learning. The diversity of instructional formats also stimulated interest in many topics. "It wasn't boring!" or "It wasn'tthe same old thing all the time!" were student

the same old thing all the time!" were student comments which indicated an appreciation for the diversity of formats. The majority of students (80.5%) gave the course a mark over 80% in response to their overall feeling to the course (Appendix D, p. 104).

4. To Anticipate Educational Needs: "Educational needs are the products of judgements about what counts in educational matters. What constitutes an educational need depends upon the educational values one holds." (Eisner, 1979, p.173). We therefore look for information in our evaluation that will satisfy what we believe in.

5. To Determine If The Objectives Have Been Achieved: This function of evaluation is similar to the role of evaluation expressed by Tyler (1949) and Roundtree (1974) in which evaluation is a feedback mechanism for the students success at attaining the preset objectives. However, Eisner (1979) like Roundtree (1974) feels that educational programs should evaluate more than the preplanned objectives.

Did the students develop the relevent concepts? If not, should we develop a more general starting point or use an alternate sequence of concepts to achieve understanding. Can better clarification of the relationship between concepts be developed?

The role of feedback may also be used to monitor the effectiveness of the instructional format. One might ask,

"Was the pacing appropriate?", "Did the instructional strategy develop the concept?" or "Could a more appropriate instructional format be used to develop the concept?"

It is important to emphasis that evaluation is an on going process. It occurs in the process of planning the concepts to be taught and how one will transmit the ideas, during the actual presentation and at the end of the program. The evaluation should examine the organization and selection of the concepts and the instructional formats. Hopefully, the net result of the various evaluations will be the improvement of the course for today's and future students.

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APPENDIX A

COURSE OUTLINE

GLENDALE SECONDARY SCHOOL

ADVANCED LEVEL BIOLOGY

SBI3A

COURSE TOPICS

TERM 1

1. Introduction to Biology
2. Cell Structure and Processes
3. Skeletal and Support System
4. Digestive System
5. Respiratory System

MAJOR TERM PROJECT (Vascular Plants: Growth and Structure)

TERM 2

1. Transport System
2. Reproductive System
3. Genetic Continuity
4. Bacteria and Viruses
5. Impact of Science on Society (Discussed in a variety of units.)

EVALUATION (Subject to Change)

Final Mark: The final mark in the course will be calculated from:

60% Class Mark
40% Exams

Class Mark: This will be an accumulative mark from unit tests, quizzes, laboratory and group activities and research projects.

Exams: Two examinations will be written, one at the end of each term. Details will be announced in advance.

ABSENCE FROM EVALUATION

In a semestered program, punctual and regular attendance is essential. The responsibility to supply a satisfactory explanation of absence or lateness is the student's. Students who miss any in-class evaluation will be assigned a temporary mark of zero. Remedial and enrichment activities will be available two noon hours a week. Requizzes and retests will also be available at this time. Dates will be announced.

ABSENCE FROM EVALUATION (continued)

Unit tests are a major source of marks in both terms. Students who miss or do poorly on these tests may be assigned a make-up test, providing a satisfactory explanation of absence has been received. DO NOT EXPECT THE MAKE-UP TEST TO DEAL WITH THE SAME CONTENT IN THE SAME MANNER!

APPENDIX B

STUDENT OBJECTIVE SHEETS

OBJECTIVES FOR THE "INTRODUCTION TO BIOLOGY"

The student should be able to:

1. Use and care for a light microscope.
2. Distinguish between magnification and resolution.
3. Describe the relationship that exists between magnification and field of view.
4. Calculate the size of a specimen under various fields of view given the relationship between magnifications and field of view.
5. Prepare and examine slides for use under the microscope.
6. Identify, draw, label and measure a variety of organisms observed through the microscope.
7. Distinguish between living and non-living organisms.
8. Give examples of how energy transformation and exchanges drive the various life processes.
9. Explain the following statement, "Living things have a diversity of form, but there is unity in the characteristic of life".
10. List the characteristics of living things.
11. Explain that the underlying similarities among all living things are based upon the cell as the basic unit of life and the observation that structure and function are related.
12. State the name and the main functions of the tissues in the chicken wings.
13. Identify a diagram of any of the following tissue types: (a) muscle, (b) bone, (c) fat, (d) blood, (e) cartilage
14. State the levels of organizations in an organism and its importance to the organism.
15. Realize that the function of the whole is dependent upon the function of the individual parts.
16. Explain and give examples of specialization in multicellular organisms.

OBJECTIVES FOR THE "CELL STRUCTURE AND PROCESSES"

The student should be able to:

1. Realize that the existence of the organism is based upon the cell.

2. Describe the structure and functions of the following cell organelles; nucleus, nuclear membrane, nucleoplasm, chromatin, nucleolus, cytoplasm, mitochondria, lysosome, endoplasmic reticulum, ribosome, centriole, microfilament, vacuole, microtubules, Golgi apparatus, plastids (chloroplasts), cell wall, cilia, flagella and pinocytic vessicle.

3. Label a diagram of plant or animal cell with the above structures.

4. Know the similarities and differences between plant and animal cells and prokaryotes and eurkaryotes.

5. Identify and describe cell structures on electron micrographs.

6. Recognize the limits of both the electron and light microscopes. (resolution and magnification)

7. Realize that the characteristics of life that the organism exhibits may actually be traced back to the organelles within the cells.

8. Explain how the generalized cell is an abstraction that is useful in describing and understanding the structure of the cells.

9. Briefly explain the importance of mitosis, respiration and protein synthesis.

10. Discuss the role of the cell membrane in terms of transport.

11. Compare passive and active transport and describe passive transport processes of diffusion, osmosis and facilitative transport.

12. Prepare simple demonstrations of osmosis and diffusion.

13. Explain and use the terms solution, solute, solvent, isotonic, hypotonic and hypertonic correctly.

OBJECTIVES FOR THE "CELL STRUCTURE AND PROCESSES" (cont'd)

14. Describe the effect of concentration of solvents, and solutes on the rate of movement of a substance across a cell membrane.

15. Describe the process of active transport and give an example of its significance in movement of material across a cell membrane.

16. Predict the net movement of solutes and solvents across a cell membrane in various cell environments.

OBJECTIVES FOR THE "SKELETAL AND MUSCULAR SYSTEMS"

The student should be able to:

1. Describe the five main functions of the skeletal system.

2. Label a diagram of the human skeleton, and locate on the human skeleton the following: skull, cranium, cervical, thoracic, lumbar vertebrae, ribs, (true, false, floating), scapula, clavicle, humerus, radius, ulna, carpals, metacarpals, phalanges, ilium, ischium, pubis, femur, patella, tibia, fibula, tarsals, metatarsals, calcaneus, greater trochanter, sternum, coatal cartilage, xiphoid process, Olecranon process.

3. Compare at least one structure on at least three different vertebrates and explain how the structure of each bone is adapted to serve a specific function.

4. Relate the position, structure and function of at least three different bones or groups of bones (eg. skull, vertebrae, ribs, etc.)

5. Label a diagram of a typical long bone and briefly explain the role of each of the following structures: diaphysis, epiphysis, marrow, medullary canal, spongy bone, compact bone, periosteum, endosteum, trabecula.

6. Draw and label a diagram of the Haversian system and explain each of the following structures: Haversian canal, osteocytes, lacunae, lamella, canaliculi.

7. State the importance of the Haversian system.

8. Name the three major types of joints (eg. immoveable, partially moveable and moveable) and an example of each type.

9. Name the types of moveable joints (eg. hinge, pivot, ball-and-socket, etc.) and describe the possible movement provided by each type.

10. Give an example of each type of moveable joint (eg. hinge = knee, etc.).

11. Name the five basic types of movement which occur at a joint (eg. flexion, extension, rotation, abduction, adduction).

OBJECTIVES (cont'd)

12. Draw a labelled diagram of a typical moveable joint, include the ligaments, bursa tendon, articular cartilage.

13. State the function of ligament, tendon, cartilage and synovial fluid.

14. Recognize bone tissue, ligament (white fibrous) connective tissue, tendon, cartilage (Hyaline) under the microscope.

15. State the primary function of the muscular system.

16. Predict the type of movement of the major muscles listed. (Activity #4)

17. Predict possible origins and insertions for the major muscles.

18. Explain with reference to antagonistic muscle pairs, how major body pairs are moved.

19. Label the diagram (Activity #4) of the human skeletal muscles.

20. Dissect a frog and find the major muscle of the muscular system. Relate the similarity and differences in the arrangement of the muscles on the frog and the human to their functions.

21. Describe the appearance and functions of the three types of muscle tissue. (smooth, skeletal and cardiac muscle).

22. Identify the levels of organization in muscles; from a muscle to the molecular arrangement of actin and myosin and relate their significance to contractions.

23. Discuss the nervous control of muscles contraction and the role of ATP and Calcium.

24. State the overall equation for cellular respiration and its importance.

25. Discuss the energy available from both aerobic and anaerobic respiration.

26. Draw a schematic diagram of aerobic and anaerobic respiration.

OBJECTIVES (cont'd)

27. Differentiate between slow and fast-twitch muscle fibers in terms of:

    a) energy source
    b) speed of contraction
    c) oxygen use
    d) type of athletic event

28. Examine the effects of muscle and reaction time on the human body.

29. Describe the cause, effect and treatment of three disorders or diseases of the skeletal and muscular system.

OBJECTIVES FOR THE "VERTEBRATE DIGESTIVE SYSTEM"

The student shall be able to:

1. State the major functions of a digestive system. i) ingestion ii) digestion iii) absorption and iv) elimination

2. List the parts of the vertebrate digestive tract.

3. State the functions for the structures of the human digestive tract.

4. Compare the structure and functions of the organs of the human digestive system with that of a Daphnia, frog and fetal pig.

5. Dissect a fetal pig and frog to examine and identify the parts of the digestive system.

6. Make a labelled diagram of the fetal pig's digestive system.

7. Discuss how the levels of organization play an important role in the digestive system.

8. Describe the process of physical and chemical breakdown that occur in the mouth and the movement of the bolus via peristalsis through the digestive tract.

9. State the essential nutrients of a balanced diet and give 3 examples of a good food source for each.

10. State the function of each major type of food in a healthy body.

11. Describe/observe the food tests for the identification of carbohydrates (sugar and starch), protein and lipids (fats).

12. Describe/observe the action of i) amylase ii) protease iii) bile and iv) lipase on the major types of organic nutrients.

13. Describe how and were carbohydrates, protein and lipids are chemically broken down as they pass along the digestive tract.

14. Describe how and where simple sugars, amino acids, fatty acids and glycerols are absorbed through the walls of the intestines and carried throughout the body.

OBJECTIVES (CONT'D)

15. Describe how the structure of the digestive tract is suited for the process of breakdown and absorption.

16. State the important of the large intestine prior to the elimination of the waste material.

17. Describe the causes, symptoms and treatment for three disorders of the digestive system.

18. Record the food that an individual consumed over a one week period and analyze it for its nutritional and energy value.

OBJECTIVES FOR THE "VERTEBRATE RESPIRATORY SYSTEM"

The student should be able to:

1. State the major function of the respiratory sytem.
2. List the parts of the human respiratory system.
3. State the function of each structure of the respiratory system and explain how each specific structure is suited to their function.
4. Compare the structure of the human respiratory system to that of the fetal pig, frog, fish and a single celled organism.
5. Identify the microscopic structure of lung tissue.
6. State the importance of cellular respiration and distinguish it from both respiration (breathing and gas exchange.
7. Describe the process of inspiration and expiration in humans.
8. Explain how and why oxygen and carbon dioxide moves across the alveolar membrane in the lungs and the rest of the body.
9. Explain how oxygen and carbon dioxide are transported in the blood of humans and discuss the role of hemoglobin and water in this transport.
10. Measure personal lung capacities, including tidal volume, expiratory and inspiratory reserve volume, vital capacity and rate.
11. Compare the relationship of lung capacity to factors such as:
    - (i) physical fitness
    - (ii) weight
    - (iii) gender
    - (iv) disease
12. Describe the Heimlich Manoeuvre as a means of first aid for a choking victim.
13. Describe and explain the steps in first aid to a drowning victim. (mouth-to-mouth resuscitation)

VASCULAR PLANTS: GROWTH AND STRUCTURE

MAJOR TERM PROJECT:

In this project the relationship between the structure and function of seeds, roots and stem in common vascular plants will be examined.

The project is divided up into two major components and the student is responsible for the completion of all two major parts on his/her own time. No less than 20 hours should be spent in total on this project over the course of this term. Two half-hour periods will also be given during the course of the term to help you prepare for your experiment and presentation.

The two sections of the project are as follows:

PART I: Prepare a series of notes on the topics of

i) seed structure and germination
ii) plant growth
iii) plant growth regulators
iv) structure and functions of vascular tissue
v) Bibliography must be included

PART II: Design and perform a controlled experiment to examine one of the following. An interview with the teacher is required to discuss the controlled experiment.

i) Plants responses to one or more external stimuli (i.e.) nitrogen, light, acids, etc.)
ii) The movement of liquid through the xylem and how it may be accelerated.
iii) Investigate the effects of one or more of the plant growth regulators (i.e.) auxins, gibberellins, cytokinins, abscisic acid).
iv) Investigate the factors that inititate flowering.
v) Investigate the process of germination and initial plant growth.
vi) Investigate structural changes due to varying light intensity.
vii) Any other investigation which is related to plants and that may interest you!

The student must show higher experimental design and discuss his/her hypothesis with the teacher before beginning. Therefore, a little background reading is required.

Vascular Plants: Growth and Structure (cont'd)

NOTE: Germination and growth of normal growing plants should be monitored as your control.

Content:

PART I: Investigate and write a note (with diagrams) on:

1. Compare the structure of a dicotyledon and a monocoytledon seed.

SEE GERMINATION

2. Describe the role in the germination process of the seed coat, endosperm, cotyledons, radicle, apical meristerms, plumule and hypocotyl.
3. Describe factors effecting germination.
4. Compare the structure of a moncot and a dicot stem and a woody stem.
5. Describe and compare the strucutre and function of xylem and phloem tissues.

VASCULAR TISSUE

6. Account for the movement of liquids through xylem cells.
7. State <u>two</u> theories to account for the movement of liquids through phloem cells.
8. Explain why each of the proposed theories concerning transport in phloem tissue is incomplete.

PLANT GROWTH

9. Describe the location and development of meristemic regions in a herbacous and a woody plant.
10. Describe three examples of tropisms in plants and explain the role of auxins in these responses.

GROWTH REGULATORS

11. Name and describe the effects of three other plant growth regulators other than auxins, e.g. gibberellins, cytokinins.

PART II: This is the experimental component of your project. The written portion should include:

1. <u>Background</u>: A short introduction to your experimental work. Make a hypothesis of what you assume will happen during the experiment.
2. <u>Method</u>: State what you did in your experiment.
3. <u>Observations</u>: Data tables and graphs of your results.
4. <u>Discussion</u>: Analyse your experimental results in light of your library research

work.

Vascular Plants: Growth and Structure (cont'd)

5. Conclusion: This is an answer to the question, "Do your experimental results support your hypothesis?"

The experiment should use a large number of plants (at least 3 plants for any variable). Example; if you examine the effect of fertilizer on your plants, you should have three plants for each concentration and control.

Evaluation:

The student will be marked on:

1. A written report: Part I - 40 marks
   Part II - 40 marks

2. An oral presentation of Part II - 20 marks. The oral presentation will briefly outline the experiment, results and conclusions.

Due Date: The written project must be handed in at the time of your presentation, which will be during the last week of the term. The exact date and time will be arranged later._____.

OBJECTIVES FOR THE "VERTEBRATE TRANSPORT SYSTEM"

The student should be able to:

1. State the major functions of the circulatory system i) transport ii) protection and iii) homeostasis.
2. Label a diagram of a mammalian heart.
3. Trace the route of blood through the human heart.
4. Explain how blood flows through the components of a closed system in mammals. (heart arteries capillaries veins heart).
5. Describe pulmonary, cardiac and systemic circulation in mammals.
6. State the structure and function of arteries, capillaries and veins.
7. Compare the structure of a fetal pig heart with that of a frog and discuss the implication in the structural differences.
8. Describe the movement of blood through the capillaries.
9. Compare an open circulatory system to a closed circulatory system.
10. Describe the effects of alcohol, nicotine and caffeine on the Daphnia heart rate and relate their effects to the human circulatory system.
11. Describe the effects of exercise on heart rate and blood pressure.
12. State the factors effecting blood pressure.
13. Compare systolic and diastolic pressure in humans and state how they are created.
14. Explain how the heart beat is initiated and controlled in humans.
15. Briefly describe the origin, structure and function of red and white blood cells and platelets.
16. Determine their own blood type (ABO and Rh) and explain antigen - antibody reaction.
17. Measure hemoglobin level and relate its significance.

OBJECTIVES (cont'd)

18. Briefly explain the process of blood clotting.

19. Describe the symptoms, causes, the methods of reducing susceptibility to, and the treatment to three common diseases/disorders of the human circulatory system.

20. Briefly describe the structure and function of the lymphatic system.

OBJECTIVES FOR THE "VERTEBRATE REPRODUCTION AND DEVELOPMENT

The student should be able to:

1. Explain the differences between sexual and asexual reproduction, given at least three different examples of each.

2. List at least two advantages and disadvantages of each form of reproduction.

3. Recall the differences of the cellular processes of mitosis and meiosis and explain the roll of meiosis in sexual reproduction. (Formation of the sperm and egg.)

4. Describe the structure and function of a male and a female human reproductive system.

5. Describe the human menstrual cycle in terms of hormonal (F.S.H., L.H., estrogen and progesterone) uterine changes (endometrium).

6. Describe the role of testosterone in male development and the fragile nature of the male.

7. Briefly describe the hormonal control of and physiological changes that occur during human puberty.

8. Outline some of the new techniques used in hi-tech reproduction (e.g. artificial insemination, I.V.F., etc.)

9. Express an appreciation of the moral and ethical controversies associated with the human reproductive process.

10. Briefly describe the mechanisms involved in three different methods of controlling fertilization.

11. Name and briefly describe the physiology of three malfunctions of the human reproductive system and three sexually transmitted diseases.

12. Gather information and report on the reproductive cycles of animals and the methods and applications of the control of the reproductive cycles in these animals.

13. Describe the method of reproduction and stages of development in Xenopus.

OBJECTIVES (cont'd)

14. Describe the major events in human development including the process of mammalian egg fertilization, stages of embryonic development, fetal development and birth.

OBJECTIVES FOR "GENETIC CONTINUITY"

The student should be able to:

1. Describe the process of meiosis, including the purpose and the major events in the two meiotic divisions which result in the formation of the four haploid cells.

2. Describe the relationship between a gene, a chromosome, and DNA in the transmission of traits from one generation to the next.

3. Explain sex determination in humans.

4. Describe the experiments of Gregor Mendel including his purpose, techniques, data, the ability of his hypothesis to predict the outcome and his conclusions.

5. Explain the terms: gene, allele, trait, dominant, recessive, pure-breeding, hybrid, self-pollination, phenotype, genotype, homozygous, heterozygous, P_1, F_1, and F_2.

6. Describe how the meiotic process accounts for Mendel's observations and conclusions and gene segregation and independent assortment.

7. Using a Punnett square solve problems involving monhybrid and dihybrid crosses including the F_1 and F_2 generations using the pea plant characteristics identified by Mendel.

8. Solve problems and demonstrate crosses involving dominance, incomplete dominance, co-dominance and sex-linked traits.

9. Using human blood types (ABO) describe co-dominance (multiple gene effect), possible inheritance patterns, and resulting phenotypes.

10. Explain how some human traits are sex-linked and describe the phenotypes of two of these traits.

11. Examine certain inherited characteristics which you possess and attempt to predict the genotype from observed phenotypes of you and your parents.

12. Describe at least two human disorders that result from the inheritance of a deleterious allelle.

Objectives for "Genetic Continuity (cont'd)

13. Show respect for the differences among people that result from genetic variability.

14. Express an appreciation for the complexity of the issues surrounding contemporary research in genetics.

BACTERIA AND VIRUSES

The student should be able to:

1. Define the terms prokaryote and eukaryote.

2. Describe the general structure of a virus including shape, for example rod and polyhedral.

3. Describe the general structural characteristics of bacteria, for example, size, shape, cell arrangement and cell structure.

4. Describe how viruses infect a host cell and reproduce; compare cell reproduction in bacteria with that in eukaryotic cells.

5. Explain conjugation, as they relate to reproduction in bacteria.

6. Explain how viruses display characteristics of both a living and a non-living entity.

7. Explain through reference to current research on tumor-causing viruses explain the probable link between some forms of human cancer and viral infection.

8. Discuss the specific structure of the AIDS virus (HIV-I) its reproduction, social problems, etc.

9. Explain why aseptic techniques are required when handling bacteria and viruses.

10. Identify and briefly describe the importance of three bacterial or viral diseases that infect plants and animals.

11. Describe three human bacterial or viral diseases in terms of disease transmission, symptoms and effects.

12. Describe the function of the immune system, including the skin, mucous, antibodies and white blood cells.

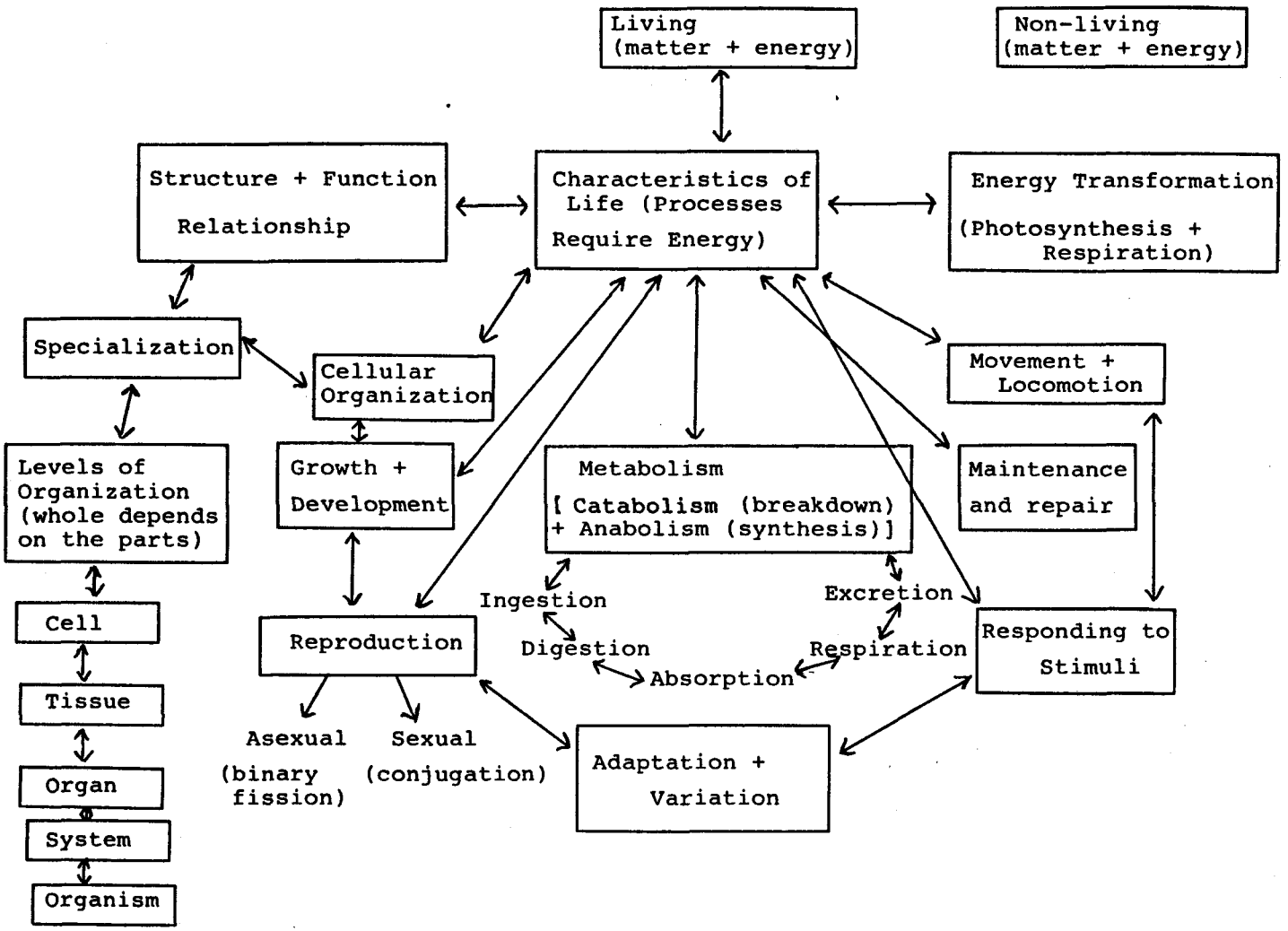
13. Describe the use of vaccine, (passive and active immunity) antibiotics, and antiseptics and compare their effects on bacteria and viruses.

14. With specific reference to autotrophic, heterotrophic (saprobes and parasites), and nitrogen fixing bacteria, describe the roles of bacteria in the biosphere.

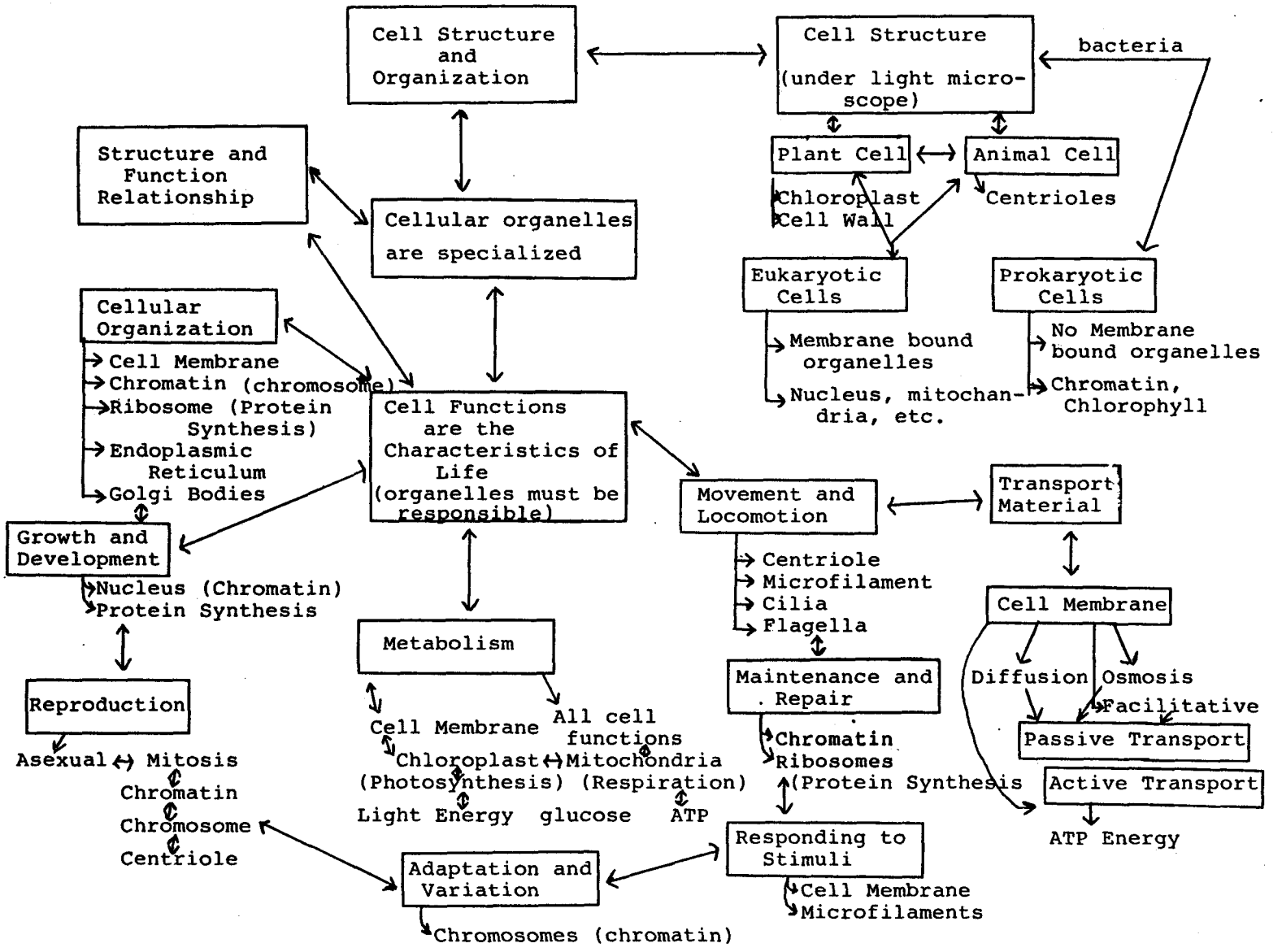
APPENDIX C

CONCEPTUAL HIERARCHIES

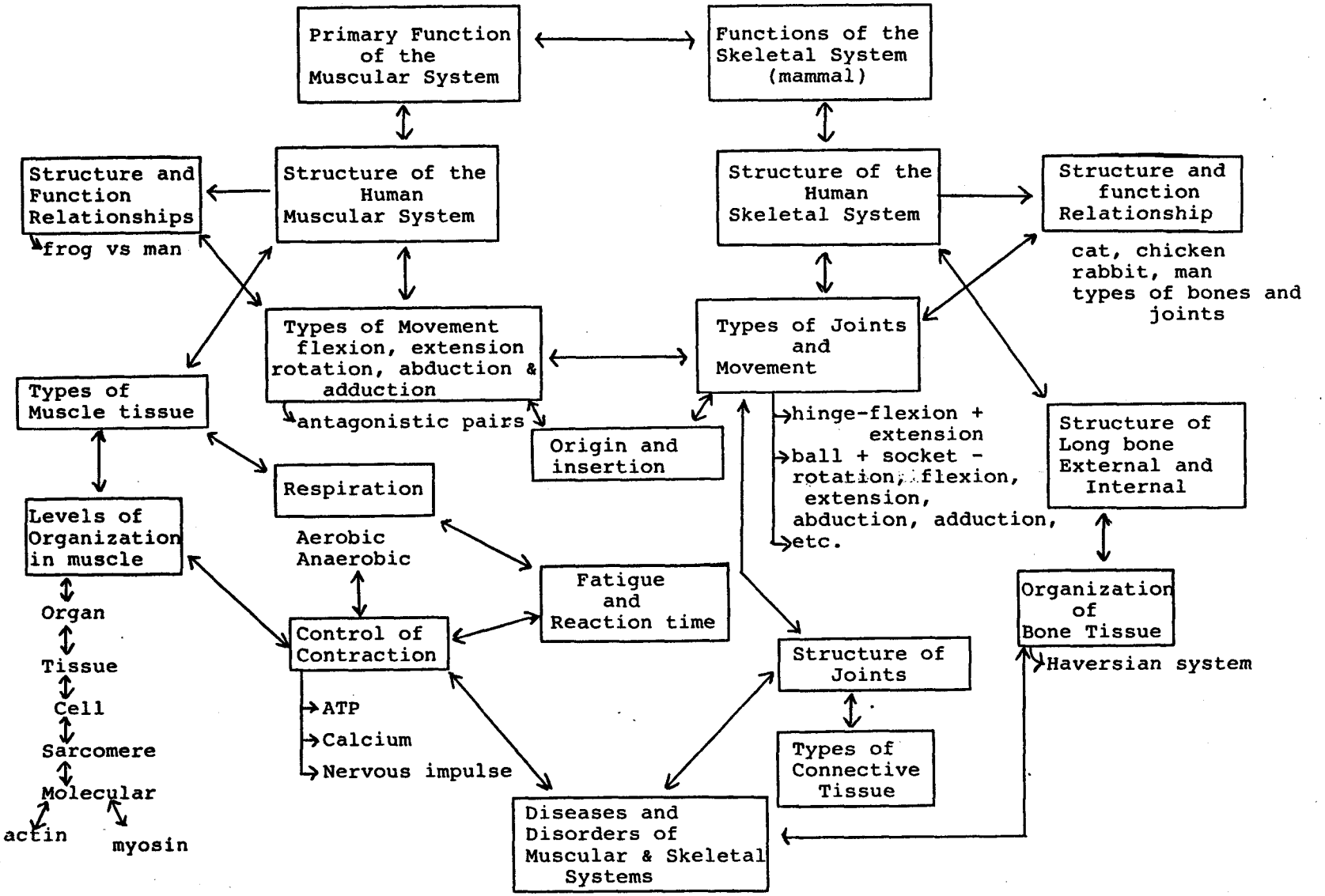
Conceptual Hierarchy of Unit 1: Introduction to Biology



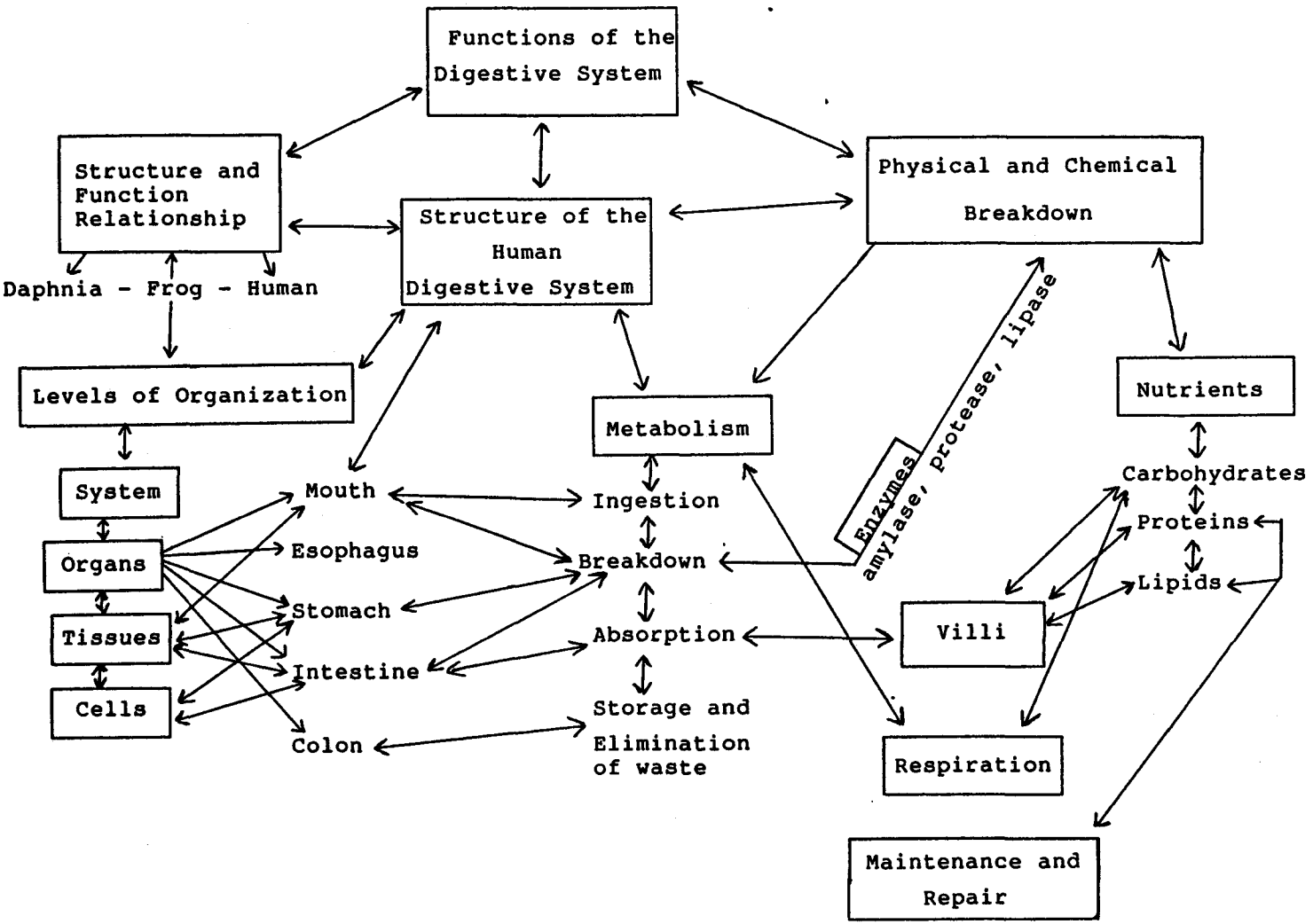
Conceptual Hierarchy of Unit II: Cell Structure and Processes



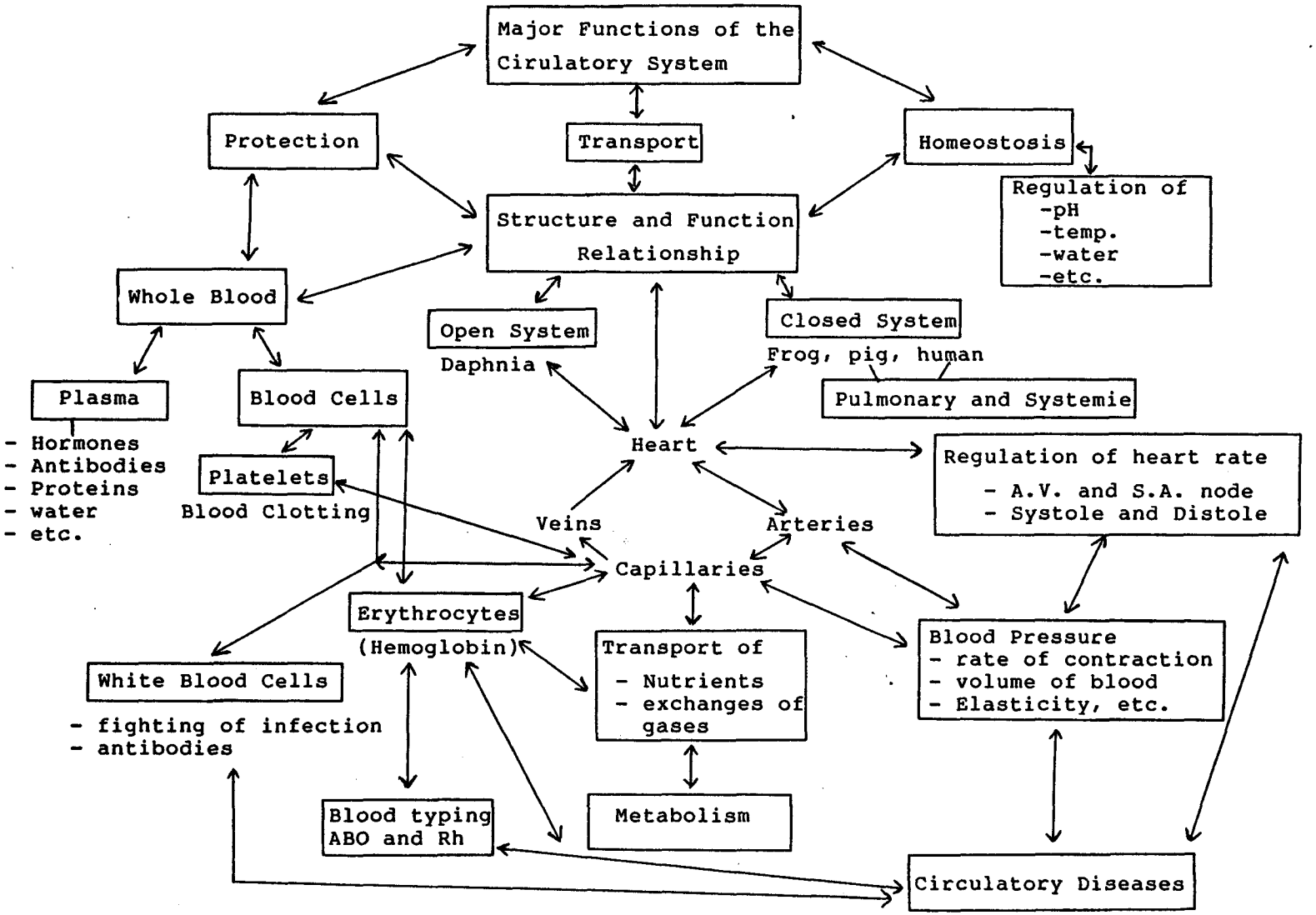
Conceptual Hierarchy of Unit III: Skeletal and Muscular Systems



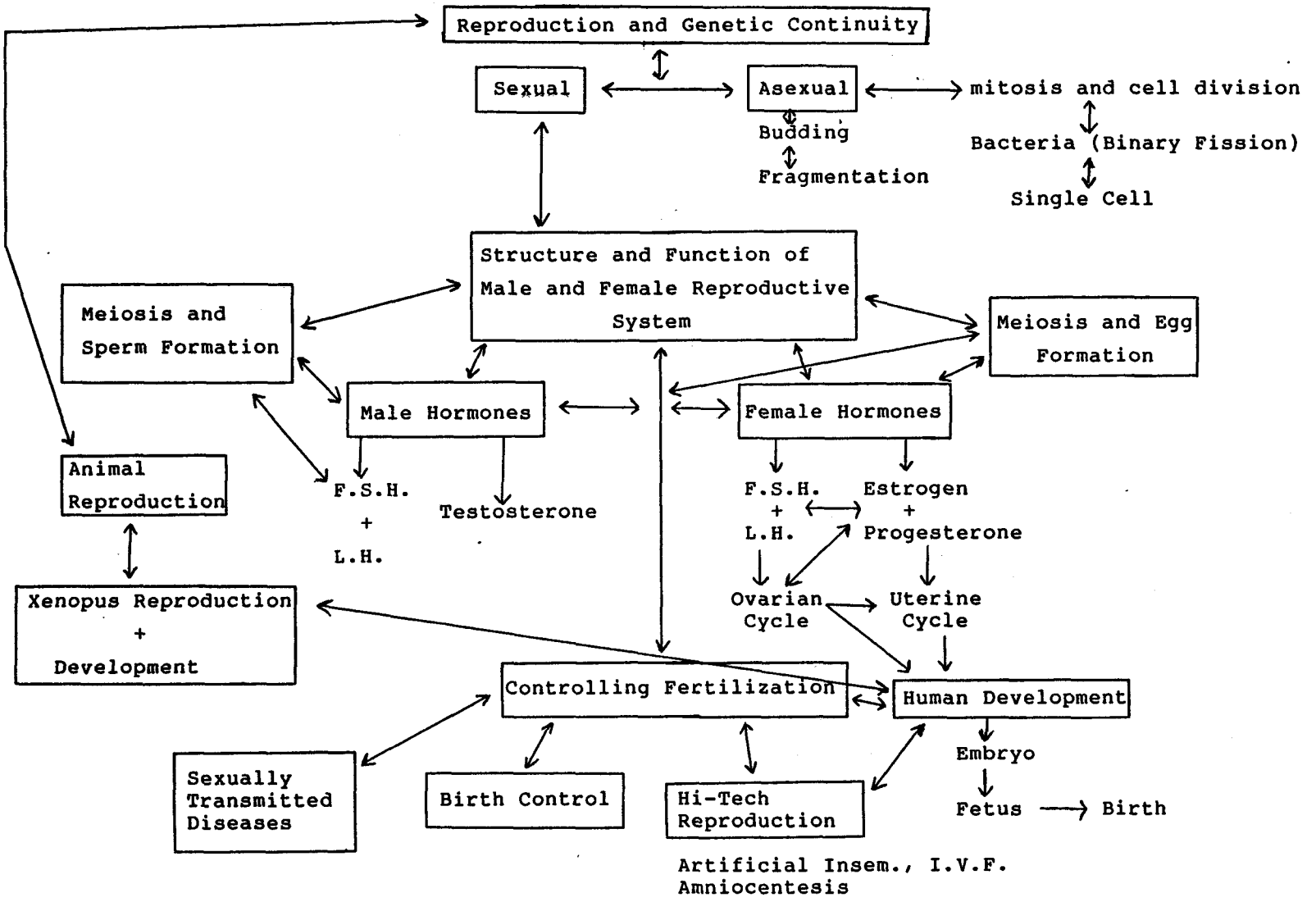
Conceptual Hierarchy of Unit IV: Vertebrate Digestive System



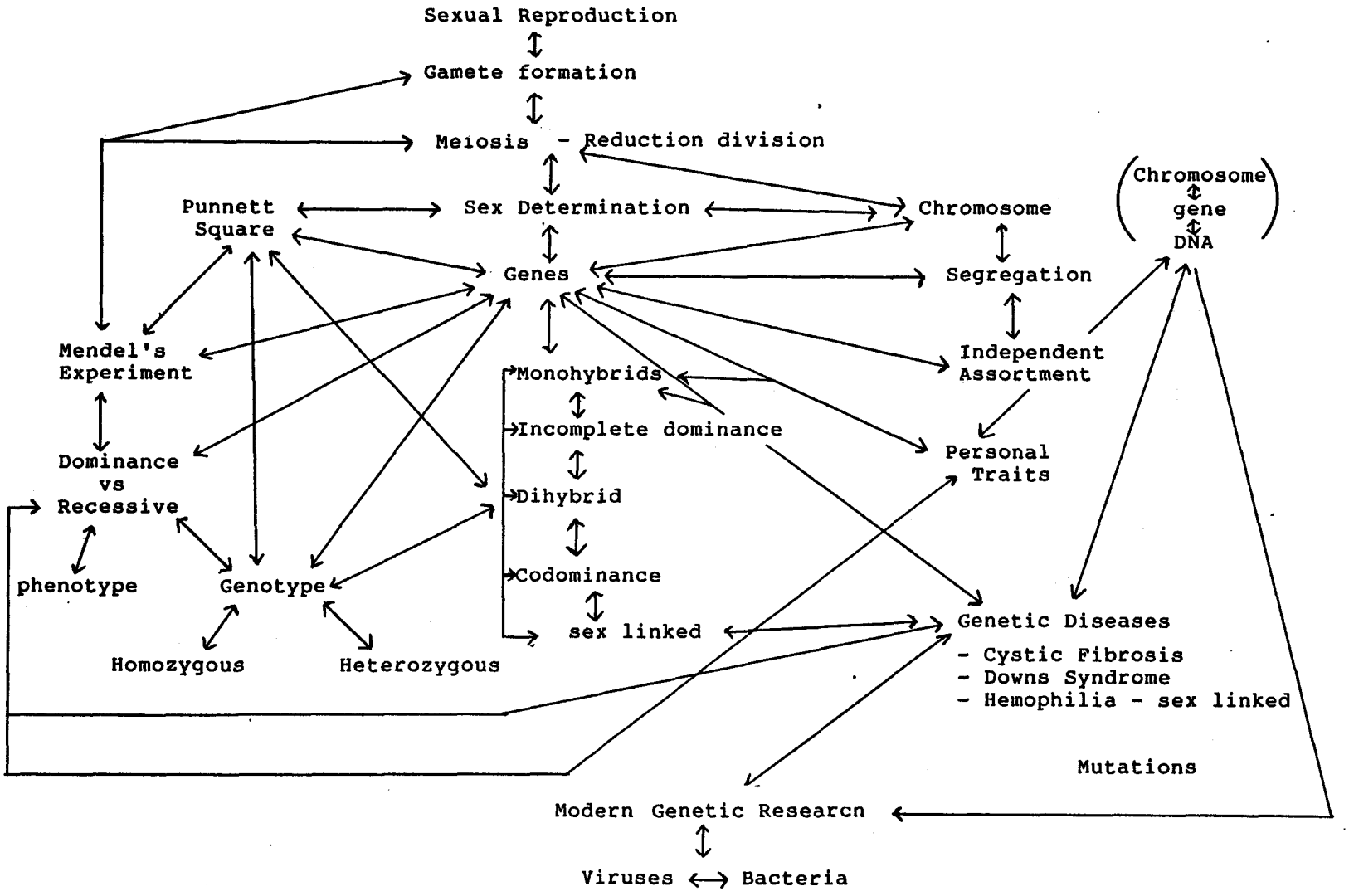
CONCEPTUAL HIERARCHY OF UNIT VI: VERTEBRATE TRANSPORT SYSTEM



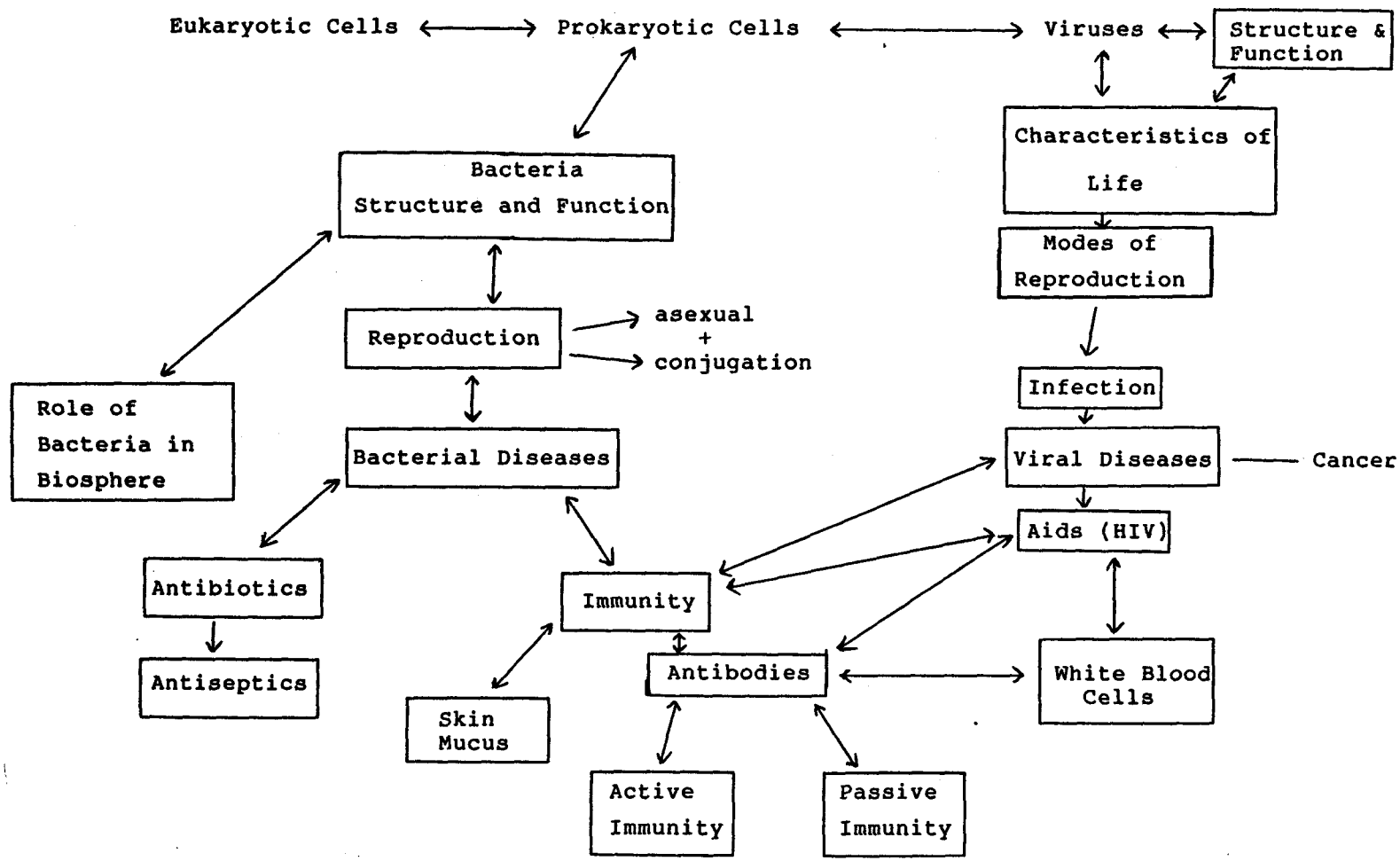
CONCEPTUAL HIERARCHY OF UNIT VII: VERTEBRATE REPRODUCTION AND DEVELOPMENT



THE CONCEPTUAL HIERARCHY FOR UNIT VIII: GENETIC CONTINUITY



CONCEPTUAL HIERARCHY OF UNIT IX: BACTERIA AND VIRUSES



APPENDIX D

STUDENT COURSE EVALUATION FOR SBI3A

SBI3A: COURSE EVALUATION

1. If you had to give this course a mark, how would you evaluate it? (Circle)

   Failure 50% 60% 70% 80% 90% 100%

2. Why did you give that mark?

3. What do you think will be your mark? _____

4. Which topics did you like the best in this course?

   i)

   ii)

   iii)

   Why did you like the above topics?

5. Which topics did you like the least in this course?

   i)

   ii)

   iii)

   Why did you dislike these topics?

6. How would you rate the organization of the material in this course? (Circle)

   Failure 50% 60% 70% 80% 90% 100%

7. Did the way that the material was organized help you learn the information? Explain.

Course Evaluation (cont'd)

8. Would you change the way the course was organized? If so, how?

9. Do you feel that the numerous quizzes and class assignments have helped you learn the course material?

10. Did the teacher effectively present the major ideas before getting into detail on any one topic?

11. Did the teacher systematically develop the ideas to make them easy to learn?

12. How would you rate the teacher?

Failure 50% 60% 70% 80% 90% 100%

13. On what reasons do you base your evaluation?

SBI3A: COURSE EVALUATION RESULTS

A total of 77 course evaluation sheets were collected from three classes. Under each question a summary of the raw scores are given.

1. If you had to give this course a mark, how would you evaluate it?

   ANSWERS: NOTE that the majority of students gave the course a mark of 80% or better (80.5%)

   Distribution of student responses to question 1.

PERCENTAGE	NUMBER OF STUDENTS
FAILURE:	0
50:	1
60:	0
70:	13
75:	1
80:	34
85:	2
90:	22
95:	1
100:	3

2. Why did you give that mark?

   ANSWERS: A sample of direct quotes are given. The vast majority of the respondence appear to have found the course a positive experience.

- More interesting than expected.
- I learned a lot. It was taught at a fair pace.
- It was enjoyable.
- The teacher makes it fun.
- Lots of info.
- Because it was taught well.
- It was informative and dealt with necessary information
- It was a lot of fun.
- I loved the course!
- Because this course is very interesting.
- It covered very much in great detail, but in an understandable way.
- Because it is a well organized, clear course that I found interesting most of the time.
- Overall atmosphere was friendly.
- Because it's O.K.
- The course had a great content, I actually learned something.

- Don't like biology.
- Learned a lot, but there is too much writing.
- Moves too fast with too much information to learn.
- Bulk of homework was given in second term.
- Student that gave the course 50% - because that's what I'll get.

3. What do you think will be your mark?

ANSWERS: The distribution of the percentage predicted by the students for their final grade is presented in the chart below.

PERCENTAGE	NUMBER OF STUDENTS
FAILURE	1
50 - 54	4
55 - 59	6
60 - 64	14
65 - 69	9 (PREDICTED MEDIAN MARK)
70 - 74	12
75 - 79	11
80 - 84	10
85 - 89	6
90 - 94	3
95 - 100	1

4. Which topics (possible 3 choices) did you like the best in this course?

5. Which topics (possible 3 choices) did you like the least in this course?

Distribution of student responses to question 4 or 5.

UNITS	NUMBER OF RESPONSES PER UNITS	
	MOST LIKED TOPICS	LEAST LIKED TOPICS
1. Introduction to Biology	3	15
2. Cell Structure and Processes	5	19
3. Vetebrate Skeletal and Muscular Systems	30	19
4. Vertebrate Digestive Systems	8	15
5. Vetebrate Respiratory Systems	8	6
6. Vascular Plants	2	11

7. Vertebrate Transport Systems	23	17
8. Vertebrate Reproduction and Development	46	2
9. Genetic Continuity	42	11
10. Bacteria and Viruses	43	10
11. Dissection	15	15

The second part to both questions 4 and 5 asked the students why did they like or dislike the topics.

ANSWERS TO QUESTION 4 (TOPICS STUDENTS LIKED MOST).

- They were interesting.
- Good topics.
- I could understand these topics the best.
- A.I.D.S. segment was good because it shoed how the immune system works.
- I learned a lot.
- Everyone was included and could participate in the discussions.
- The knowledge is useful.
- Dealt with controversial issues.
- Basic biology, which is knowledge we need for the rest of our life.
- Exciting!!
- Gave me a better loke at how our bodies work.
- Straightforward.

ANSWERS TO QUESTIONS 5 (TOPICS STUDENTS LIKED LEAST).

- Boring.
- Not as interesting as the rest.
- I liked these topics but I liked the above ones more.
- I just disliked cutting up animals.
- It was hard to learn them
- I had difficulty in understanding them.
- I have done the cell and microscope every year for the past 3 or 4 years.
- I didn't have enough time.
- Complicated.
- My plant project died.
- Felt rushed to complete these topics.
- None. I love biology.
- Dissection is sick and it stinks.
- Too much memorization associated with diagrams.
- Dull.
- Microscope work - quite repetative of work done in grade 9.
- Genetics - crosses and punnet square are boring and difficult.

6. How would you rate the organization of the material in this course?

ANSWERS: Of the 77 responses the majority of the students felt that the course was well organized and assisted them in the learning process. 77.9% of the students gave the course a mark of 80% or better.

Distribution of student responses to question 6 on organization of material.

PERCENTAGE	NUMBER OF STUDENTS
FAILURE	0
50	0
60	3
70	13
75	1
80	34
85	4
90	17
95	1
100	4

7. Did the way that the material was organized help you learn the information? Explain.

ANSWERS: A sample of direct quotes to question 7 are given.

- Easy material at the beginning of year, harder more complex topics at end of the year.
- I think the material was in order. Because of this, the information was easier to learn. The information was in sequence, if the cell wasn't taught, then the other material would be more difficult to learn.
- Yes, the way the material was organized helped me learn the information. This is because I felt that topics all went in order. The things we learned at the beginning of the semester were also used later on in the term.
- It was organized in such a fashion that most of it sunk in.
- Not really. If you didn't understand the first part really well, you were lost in the second part.
- It followed a well thought out system.
- The conceptual hierarchies were helpful when

studying.
- The conceptual hierarchies didn't help me at all, but, on the whole the handouts and the movies made it easy to learn and understand.
- Yes, because each section was related to the next in some way therefore when we hit that new section I had some background info.
- We were given proper intro to each new topics and material presented/organized in a way that allowed us to better understand.
- It was a logical progression.
- Yeah, cause it all fit together after awhile.
- Yeah, every sheet had a background to it.
- The way it was organized made us (the class) do the work/activities on our own and that way I think we learned more than we would if we had everything handed out to us.
- The conceptual hierarchies really helped to sum up what was learned during the topics.
- Sheets were good for studying, but there was too much work going on at one time.

8. Would you change the way the course was organized?

ANSWERS: A sample of responses to question 8.

- NO. (This was by far the most common response. 69% of the students gave this as their answer to the above question.)
- Spend more time on genetics.
- More time should be spent on the last part.
- Cut out the dissections.
- More dissections and less complicated exams.
- Give the students time to do the assignments in class to that they can ask questions.
- Take out the topic on the cell, I don't think it is necessary to learn.
- Easier exams.
- Go at a slower pace and do not rush the work near the exams.
- A choice of major project.
- Less quizzes and more class assignments should be marked.
- Less group work.

9. Do you feel that the numerous quizzes and class assignments have helped you learn the course material.

ANSWERS: A sample of student responses to question 9. The vast majority of the students felt very positive about the large number of quizzes (96%).

- Yes, because it forced you to study the material.
- Easier to study for the large tests because the information was in my head already.
- Yes, because I learned from my mistakes.
- Yes it meant constant review.
- Too many quizzes which didn't help because I did badly on the one the next day.
- I think you should only have a quiz a week.
- Not really.

10. Did the teacher effectively present the major ideas before getting into detail on any one topic?

ANSWERS: A sample of the student responses follows this paragraph. 92% of the students that answered the questionaire felt that the teacher effectively introduced the major ideas before getting into detail. Only one student felt that the teacher didn't accomplish this task.

- Yes, he very thoroughly covered the topics and answered any questions before going into detail.
- Yes he did. I understood what the topic was about enough to understand the detail information.
- Yes, but it was confusing at times.
- Yes he did a good job at discussion lessons.
- Yes, although I think it was taught too quickly.
- Usually if he wasn't sidetracked.
- No, because too many people asked complex questions.
- So, So.
- Sometimes.

11. Did the teacher systematically develop the ideas to make them easy to learn?

ANSWERS: Of the 77 students that responded, 91% felt the teacher systematically developed the concepts. From the negative replies, 2 answered no, while the rest made a variety of interesting comments. These are samples of the student quotes which felt the teacher <u>didn't</u> accomplish the goal.

- He tried very hard, but I can't really learn that way.
- I found some easy but, if it is the best you can do then...
- Kind of.
- Sort of but, still confusing.

12. How would you rate the teacher?

Distribution of student responses to teacher rating.

PERCENTAGE	NUMBER OF STUDENTS	
FAILURE	0	
50	0	
60	0	
70	4	**NOTE:** 94.5% OF THE
80	9	STUDENTS GAVE THE
85	5	TEACHER A MARK
90	23	BETTER THAN 80%.
95 - 99	2	
100	34	

13. On what reasons do you base your evaluation?

ANSWERS: The replies noted a vast array of positive traits that make the teacher effective at his art, such as humour, humanity, caring, good communicator of ideas, organizor, relates well with students, etc. Some individuals felt that the teacher allows to much self directed time to be spent (or wasted) in the class. However, the teacher feels that this time is generally well spent because it allows the teacher to personally interact with most of the students in the class on an informal level and better read their individual needs.

A sample of the students responses:

- Nice guy, easy to talk to.
- If you have a problem or if you disagree he will talk it out.
- Not too strict and not too lenient.
- Knows what he is doing.
- Laughs and induces class humour.
- Makes his own jokes and doesn't use cheap imitation jokes (they are usually funny).

- He organized the information and it occurs in an enjoyable atmosphere. Yet when he tells jokes, they are not funny!
- Make it fun to learn, because he didn't get angry if you didn't understand something, doesn't talk down to you and he really treats you well.
- He made his lectures actually stick in your mind. He could relate with his students which makes teaching something hard, easy.
- Always willing to help those in need. Feels students deserve second chance at tests.
- The subject itself was interesting and the teacher also made it more interesting by his teaching methods.
- At first I thought he would be a pretty easy teacher, then I realized I was wrong, which I like better because I can't stand teachers that don't have control over their class.
- I like him because there is a line he draws between joking around and being serious (when he gets us down to work).
- I felt that he spent a lot of time trying to teach the class and because he gave good ideas in how to study and what to study for each quiz.
- Patient.
- The class was made to be interesting. Most teachers just teach a class without caring whether we like or understand the course.
- Doesn't spend enough time with the students that are doing work. Talks to people who aren't.
- Tries to explain details in order to give the big picture.
- If we needed help he would help us or if we needed more time he would let us come in during lunch.
- Talks too fast while students are copying notes.

APPENDIX E

INTRODUCTION TO BIOLOGY: UNIT 1

(Student Handouts)

INTRODUCTION TO BIOLOGY

ACTIVITY #1 - MEASUREMENT UNDER THE MICROSCOPE

BACKGROUND:

Miscroscopes are very useful tools that allow us to magnify the image of an object, that is it makes the image larger. A good microscope not only magnifies but also discriminates between close points. This is known as resolving power, Therefore, because the microscope both magnifies and increases the resolution between points on an object, it is an important way of inventigating the microscopic world.

The microscope is also capable of measurement. In order to do this, two separte ideas have to be developed:

(1) the effect of magnification on the diameter of the field of view,
(2) that measurement depends on the relationship between a known and an unknown quantity.

In this activity we shall:

(a) Determine the lower power field of view by direct measurement.
(b) Determine the medium and high power field of views by calculation
(c) Measure specimens under a light microscope.
(d) Explain the relationship between magnification and field of view.
(e) Understand that a measurement is determined by comparison with some known standard.
(f) Draw a line diagram of an amoeba with appropriate measurements.

INVESTIGATION:

PART A: Determining the diameter of the field of view for each magnification.

How is magnification and field of view related?

As you're walking along the side of the road you look up and see a friend in the distance. He is only a small part of your field of view. As that person walks towards you, you recognize a number of things happening:

(1) He becomes larger.

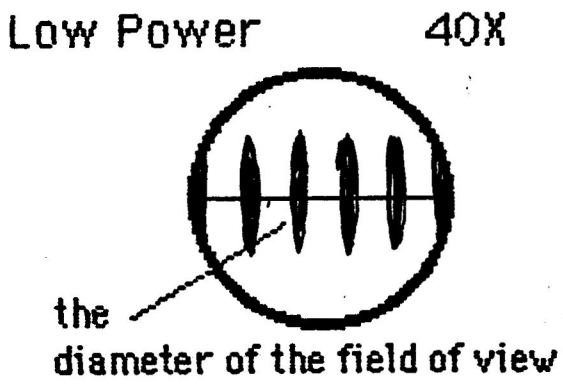
INVESTIGATION (cont'd)

(2) The features of his face become clear, you are capable of resolving the newly grown mustache.
(3) You begin to focus on him and he takes up most of your field of view.

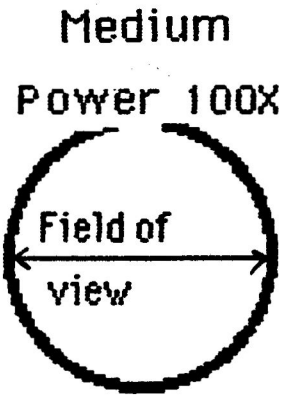
Is his size dependent on the field of view?

This is similar to what occurs when you move from low to high power on a microscope. In order to measure an object under a microscope we must determine the field of view. The field of view will vary depending upon the magnification, they are indirectly proportional. That is, if the magnification increases, the field of view gets smaller by the same proportion. For example, if an object is magnified by a factor of five, the diameter of the field of view is decreased by a factor of five.

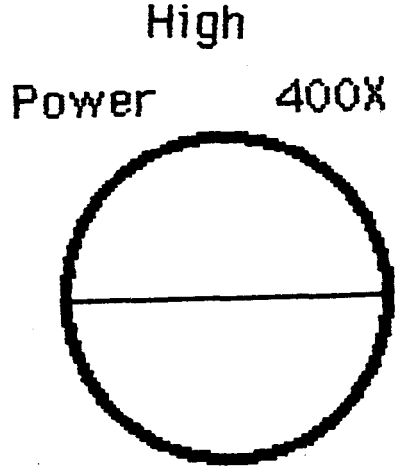
Example



To determine the field of view for low power:
(1) Measure the number of millimetres across the low power field of view.
_____mm
(2) The measurement above must be changed to micrometres (μm) by multiplying the direct measurement by 1000 x. (1000 μm = 1 mm)
$\therefore$ The diameter of the low power field of view = _____ μm. This value will be known as #2 in future calculations.
(3) To calculate the medium power field of view we must remember the relationship between magnification and field of view. The magnification has increased by a factor of 2.5x.
$\therefore$ the field of view will be 2.5 times smaller.



INVESTIGATION (cont'd



#(2) ÷ 2.5 = _____ μm

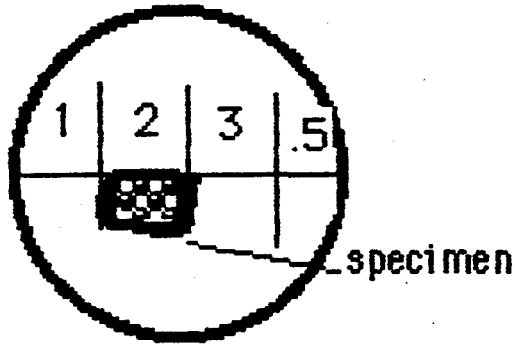
(4) To calculate the high power field of view we must remember that 400x magnification of high power is 10 times greater than the 40x magnification of low power, Therefore, the field of view will be 10 times smaller than low power.

#(2) ÷ 10 = _____ μm

PART B: Measurement under the microscope.

The values that you have determined for the three different levels of magnification can now be used to determine the size of various organisms and cellular structures by estimating relative sizes.

Using the diameter of the field of view from another microscope determine the size of the specimen found in this example, if the diameter of the field of view is 400 μm.



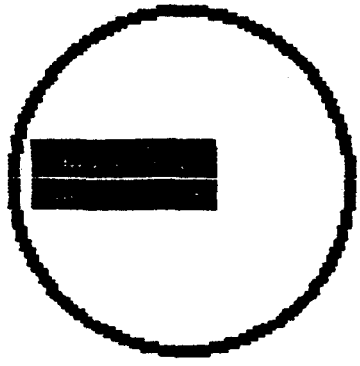
field of view=400μm

The specimen can fit into the field of view 3.5 times. The length of the specimen is determined by dividing the diameter of field of view by the number of times the specimen fits into the field of view

$= \frac{400\ \mu m}{3.5}$

$= 114\ \mu m$ this is an approximate value and should be rounded off

$= 110\ \mu m$



Determine the length and width of this specimen if the field of view is 1400 μm.

INVESTIGATION (cont'd

PART C:

Using the information acquired through yesterday's lecture and today's lab sheet:

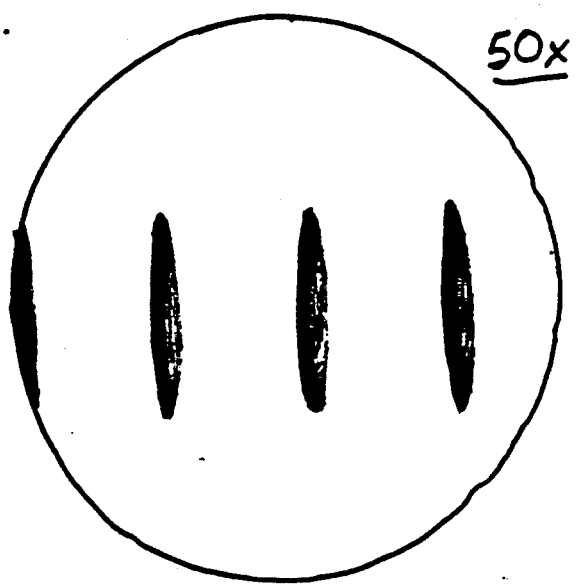
i) Examine the prepared slides of the amoeba under low, medium, and high power.

ii) Make a labelled drawing with measurements of its major features.

SBI3A - MICROSCOPIC MEASUREMENT QUIZ #1

NAME: _____

1.



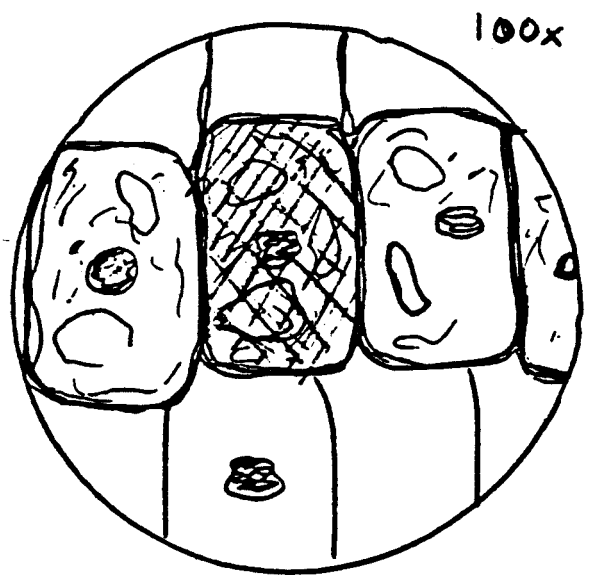
a) Measure the diameter of the field of view under low power.

_____

b) Calculate the diameter of the field of view for medium (100X) magnification. (Show your calculation.)

c) Calculate the diameter of the high (400X) power field of view.

2.



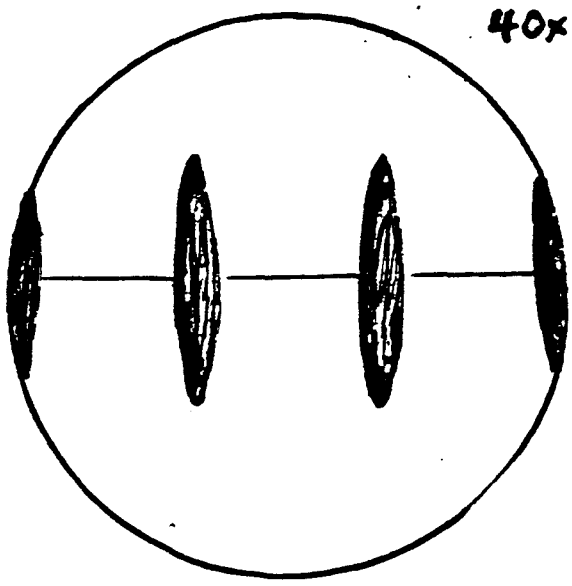
Determine the length and width of the specimen in the diagram.

The specimen was observed under medium power from the above microscope.

SBI3A - MICROSCOPIC MEASUREMENT QUIZ #2

NAME: _____

1.



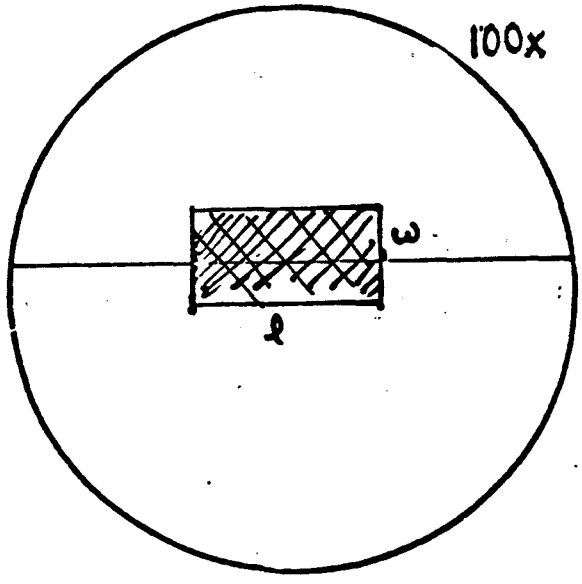
a) Measure the diameter of the field of view under low power.

_____

b) Calculate the diameter of the field of view for medium (100X) magnification. (Show your calculation.)

c) Calculate the diameter of the high (400X) power field of view.

2.



Determine the length and width of the crossed specimen in the diagram.

The specimen was observed under medium power from the above microscope.

INTRODUCTION TO BIOLOGY

ACTIVITY SHEET #2: CHARACTERISTICS OF LIVING THINGS

BACKGROUND:

What makes living things different from rocks and other non-living things? From your past experiences you can probably think of many differences. Rabbits move. They eat. They interact with other animals. They reproduce. Trees grow and lose their leaves in the fall, then repeat the cycle the following year. However, a rock will do none of these things.

The most important, although not the most obvious, characteristics of life is the requirement for energy. All living things need a continuous supply of energy to support the more obvious characteristics. This energy inititally comes from the sun and is pasted on to the living world by glucose produced during photosynthesis of green plants. Respiration then "burns" or breaks down the glucose, releasing energy to be used in the life process.

Studying millions of organims would be an overwhelming task. However, by studying a few selected microscopic organisms it is possible to observe some generalizations that constitute the characteristics or functions that all life-forms have in common. The various organisms that have been chosen are relatively simple compared to humans and provide an excellent way of observing the whole organism at work.

The activity sheets should guide you through a series of investigations on a variety of life forms.

Group discussions are useful to compare and evaluate your observations with other people.

Remember to use the variety of resource texts at the front of the room.

In this activity we shall:

(a) Distinguish between living and non-living organisms.
(b) List the characteristics of living things.
(c) Explain that the underlying similarities among all living things are shown to be based on the cell as the basic unit of living things and the observation that structure and function are related.
(d) Identify, draw, label and measure a variety of organisms observed through the microscope.

INVESTIGATION (cont'd)

(f) Display a "reverence for life" through the careful use of living materials.

I ALGAE - EUGLENA

1. Place a drop of Euglena culture on a slide with methyl cellulose. (prepare a wetmount slide)

2. Observe under low, medium and high power magnification.

3. What is the purpose of methyl cellulose?

4. Draw and label a half-page diagram of the Euglena.

5. On the drawing place the dimensions in micrometre (m).

6. Notice the means locomotion of these organisms (by means of a flagellum). See the texts and briefly describe the ways in which a flagellum serves to propel these organisms.

7. Notice the greenish colour of the Euglena, explain how this is related to their need for sunlight, and how it serves to sustain them and other organisms.

II PARAMEDIUM

1. Place a drop of Paramecium culture on a clean slide in the centre of a drop of methyl cellulose. Place the cover slip on top of the mixture.

2. Observe under the microscope. Note and describe the means of locomotion. Refer to the reference books to explain how they move.

3. Draw and label a half-page diagram of a paramecium. (Record the dimensions in m)

4. Attempt to observe a clear spherical shaped structure that appears to contract at each end of the elongated body of the paramecium. What functions do they serve? What human structure performs a similar function?

III To another drop of Paramecium culture stir in a drop of carmine red.

INVESTIGATION (cont'd)

1. Note how the carmine accumulates in the food vacuoles at the end of the gullet, which then follows a definite course through the cell. Make a drawing of the path that the vacuole takes.

2. Observe the egestion of solid wastes. Refer to the drawings in the various texts for its location.

IV (a) Make up another Paramecium slide without methyl cellullose and add a few fibres of lens tissue. Note how the Paramecium reacts to these fibres.

Attempt to answer the following questions:

1. Can a Paramecium back up?
2. How can they do this?
3. What must occur to the beating of the cilia?
4. Draw a series of diagrams to show the path taken by a single paramecium as it tries to avoid a fibre.
5. What is this reaction to an environmental factor called?

(b) Make up another Paramecium slide without methyl cellulose. Add a drop of dilute sodium hydroxide to one slide of the cover slip and quickly observe under low power. Note the behaviour of the paramecium as the sodium hydroxide diffuses across the slide.

V AMOEBA

Place an amoeba in a "well slide". These amoeba are fairly large protozoans and can be seen as white dots at the bottom of the jar. Watch the amoeba as it moves.

1. Make a series od diagrams to show the changes that take place over a few minutes as the amoeba moves using a pseudopodia (false feet).
2. Label the diagram, show the zie of the amoeba.
3. Explain how the amoeba moves.

VI CONJUGATION IN PARAMECIUM

1. How do Paramecium and other protozoans normally reproduce? See texts.
2. What is conjugation? See texts.

INVESTIGATION (cont'd)

Two types of Paramecium are available, strain A and strain B. Conjugation can be observed by mixing equal quantities of both types and recording your observations over the next 48 hours.

Place an equal drop of each culture on a slide. MAKE SURE YOU DO NOT MIX UP THE EYE DROPPERS!! Around the drops make a circle of silicone. This will prevent the culture from evaporation and allow for carbon dioxide and oxygen to move in and out of the sample.

The prepared sample of the two stains of Paramecium should be examined during the next two days of school (morning, noon, spares, and after school) so that a complete set of observations can be made.

3. Record your observations.
4. What is the importance of conjugation to the Paramecium?

Multicellular Organisms

The Euglena, paramecium and amoeba are all single celled organisms. Thus, all the characteristics of life must be accomplished by one cell. As organisms get larger they are made of many more cells that work together to sustain life as we will see in the Hydra, the Daphnia or the Brine Shrimp. These organisms are known as multicellular critters.

1. Suggest some advantages and disadvantages to an organism being multicellular.

VII THE HYDRA

The Hydra has a tendency to "stick" to the glass surface so be careful when removing the Hydra from the container (ask for the teacher's help). Place the hydra into a small petri dish surrounded by a small amount of water.

Examine the Hydra under low power of your monocular light microscope or with the dissecting microscope.

1. Draw a labelled diagram noting the dimensions of various structure. (see texts)
2. Feed some Daphnia to the Hydra. Observe the Hydra "catching" and "feeding" on the food. Describe the process of "food capture".

INVESTIGATION (cont'd)

3. Do you observe any other characteristics of life, if so, explain what was observed. (see texts for assistance)

SUMMARY QUESTIONS

1. Of all characteristics of life, which is the most important and why?
2. Despite the diversity of critters that you examined what characteristics did you observe were common to all the various life forms.
3. Construct a chart to summarize all the characteristics of life that you observed and beside each characteristic, name the organisms in which it was found.

VIII BRINE SHRIMPS (BONUS)

(a) Get some Brine Shrimp eggs from the teacher.
(b) Find out how to grow them and do so.
(c) Record their activities.
(d) Explain which characteristics of life were observed.
(e) Design an experiment to study one characteristic of life (example responding to stimuli), collect the data, write up a discussion and conclusion.

EVALUATION

After doing all the activities make sure you check with other members of your group to compare notes on the various characteristics of life that you have observed.

Hand in all the observations, drawings, comments, and answers to the questions in the form of a report.

Report Value = 50 marks

Bonus Activity = 15 marks

INTRODUCTION TO BIOLOGY

GROUP ACTIVITY:

The Chicken Wing: Levels of Biological Organization

BACKGROUND:

Organization is a characteristic of life. Humans as well as other animals and plants are organized at a variety of levels. All the various levels of organization are present to produce and maintain life.

We observed a variety of diverse critters in the last activity, many were made from single cells. Thus, all the characteristics of life must be carried out by the single cell in an organized way.

Multicellular organism, like humans and hydra, are composed of many cells, perhaps millions or trillions. In order for these organisms to carry out the characteristics of life, the cells must become specialized. That is, that each group of cells performs certain tasks better than others, with in the framework of the organism.

For example, muscle cells can actually contract, thus a large group of muscle cells can move a structure.

1. CELLULAR LEVEL: The basic structural unit of living things, thus all living things are made up of cells.

2. TISSUE LEVEL: A group of cells that have a similar structure and function.

   Types of Tissue: bone tissue, muscle tissue, nerve tissue, epithelial tissue, fat tissue, connective tissue.

   Plant Tissues: conducting tissue, storage tissue, etc.

3. ORGAN LEVEL: A group of tissues that act as a unit to do a specific job.

   Types of Organs: arm muscle, heart, kidney, stomach, brain, lungs, etc.
   - each of the above is made from a number of different tissues

GROUP ACTIVITY (cont'd)

Plant Organs: plant leaf, root, stem
- the leaf is composed of a variety of different tissues, conducting tissues, photosynthetic tissue, support tissue, storage tissue and others

4. SYSTEM LEVEL: An organ system is a group of organs working together in performing a function.

Types of Organ Systems: reproductive system, digestive system, muscular system, skeletal system, etc.

5. ORGANISM LEVEL: An organism is a living individual. In a multicellular structure the organ systems may have specialized to perform the various functions of life or in a single cellular structure this may be accomplished by the individual cell. Types of organisms: amoeba, euglena, tulip, dog, cat, human, etc.

Before looking at cell structure and processes, it would be interesting to examine a structure with a variety of levels of biological organization. The chicken wing is a good example of a structure that has a number of the above mentioned levels of organization, they are easily acquired and they TASTE GREAT!

In this activity we shall:

(a) State the names and the main functions of the tissues found in the chicken wing.
(b) Explain and give examples of specialization in multicellular organism. (the chicken wing)
(c) Observe that the basic unit of all the tissues that he/she examines is the cell.
(d) Identify, draw, label and measure at least five tissue types found in the chicken wing.
(e) Deep fry chicken wings safely.
(f) Clean up work area.

APPENDIX F

CELL STRUCTURE AND PROCESSES: UNIT II

(Student Handouts)

CELL STRUCTURE AND PROCESSES

Activity #1: Cell Structure under the Light Microscope

BACKGROUND: Over the last few days we have examined a number of different tissue types under the light microscope. Today, we will examine a typical plant and animal cell under the microscope.

In this activity we shall:

1. Make a detailed labelled drawing of a plant cell and an animal cell under high power.
2. Determine the differences between plant and animal cells.
3. Distinguish between prokaryotes and eukaryotes.

INVESTIGATION:

1. Make a wetmount slide of a thin layer of onion tissue. Stain with iodine (as demonstrated), focus on high power and draw a labelled diagram. Indicate the dimensions of the cell in micrometres and locate and label the nucleus, nucleoli, cytoplasm, cell membrane, cell wall and vacuoles.
2. Make a wetmount slide of the filamentous green algae, focus on high power and draw a labelled diagram of all recognized structures.
3. Obtain a clean toothpick and with the blunt end, scrape the inside of your cheek gently.
4. Stir into a small drop of water to make a wetmount slide. Then stain with Methylene Blue (as demonstrated).
5. Make a diagram indicating the cells dimensions and labelling all recognized structures.

QUESTIONS:

1. After examining the two types of plant cells, what major structural difference did you observe in the two specimens?
2. What factor may account for the differences which exists in these two types of plant cells?

ACTIVITY #1 (cont'd)

3. What differences did you observe between the representative plant and animal cells. (construct a chart of show similarities and differences)

4. The three different cells that you examined were all examples of eukaryotic cells. Using the available texts find the names of at least three prokaryotes and three eukaryotes.

5. What general statement can be made about prokaryotes compared to eukaryotes?

6. State the major structural differences between prokaryotic and eukaryotic cells.

CELL STRUCTURE AND PROCESSES

Activity #2: Cell Structure and Function

BACKGROUND: In our last set of activities, we examined the levels of organizations and found that the basic unit of life is the cell. All life processes can be traced back to the cell and because of specialization, different cells in multicellular organisms are responsible for specific tasks. Even within the cell various structures have specialized to be involved in one or more processes.

In this activity we shall:

1. Label a generalized diagram of both a plant and animal cell and attempt to locate the same structures on an electron micrograph.

2. Describe the structure and functions of the cellular structures.

3. Attempt to trace the characteristics of life that the organism exhibits back to the cellular organelles.

INVESTIGATION:

1. Label the diagrams of "A Generalized Animal Cell" and "A Generalized Plant Cell". Use the resource texts and the list below to help you label the diagrams.

Cell Boundary:
- a) Cell Membrane
- b) Cell Wall

Nucleus:
- c) Nucleus
- d) Nuclear membrane
- e) Nuclear pore
- f) Chromatin (Chromosome)
- g) Nucleolus
- h) Nucleoplasm

Cytoplasm:
- i) Cytoplasm
- j) Mitochondria
- k) Endoplasmic Reticulum
- l) Lysosome
- m) Golgi Apparatus
- n) Plastid (Chloroplast)
- o) Vacuole
- p) Centrioles
- q) Microtubules
- r) Microfilaments
- s) Cilia
- t) Flagella
- u) Pinocytic Vessicle
- v) Ribosomes

ACTIVITY #2 (cont'd)

2. Divide the members of your group so that each individual is responsible for about five (5) different structures from the above list. Construct a chart to help you organize your findings, using the following headings:

Name and approx. size of structure	General Description of structure	Functions and activities of structure

3. Exchange your research so that each individual has a complete chart containing all the information.

4. Pick up a set of electron micrographs and examine the various numbered structures. Attempt to name all the numbered structures. Check with the answer sheet to determine your mastery of the cellular organelles.

5. We have seen that the cells have specialized in multicellular organism to perform special functions. In a single cell the substructures or organelles are responsible for carrying on the specific characteristics of life.

   a) As a group, attempt to assign a specific life process to each of the cells components.

   b) Each part of the cell is specialized to be involved with one or more life processes. The following life process are some that occur in eukaryotic cells. What organelles are involved in each of the following? Fill in the chart "Structures Found in Cells" as a group.

NUTRITION: RESPONSE:

DIGESTION: REPRODUCTION:

ABSORPTION: STRUCTURE:

BIOSYNTHESIS: (organization and making larger carbohydrates, fats and proteins)

RESPIRATION: MOVEMENT:

EXCRETION: MAINTENANCE:

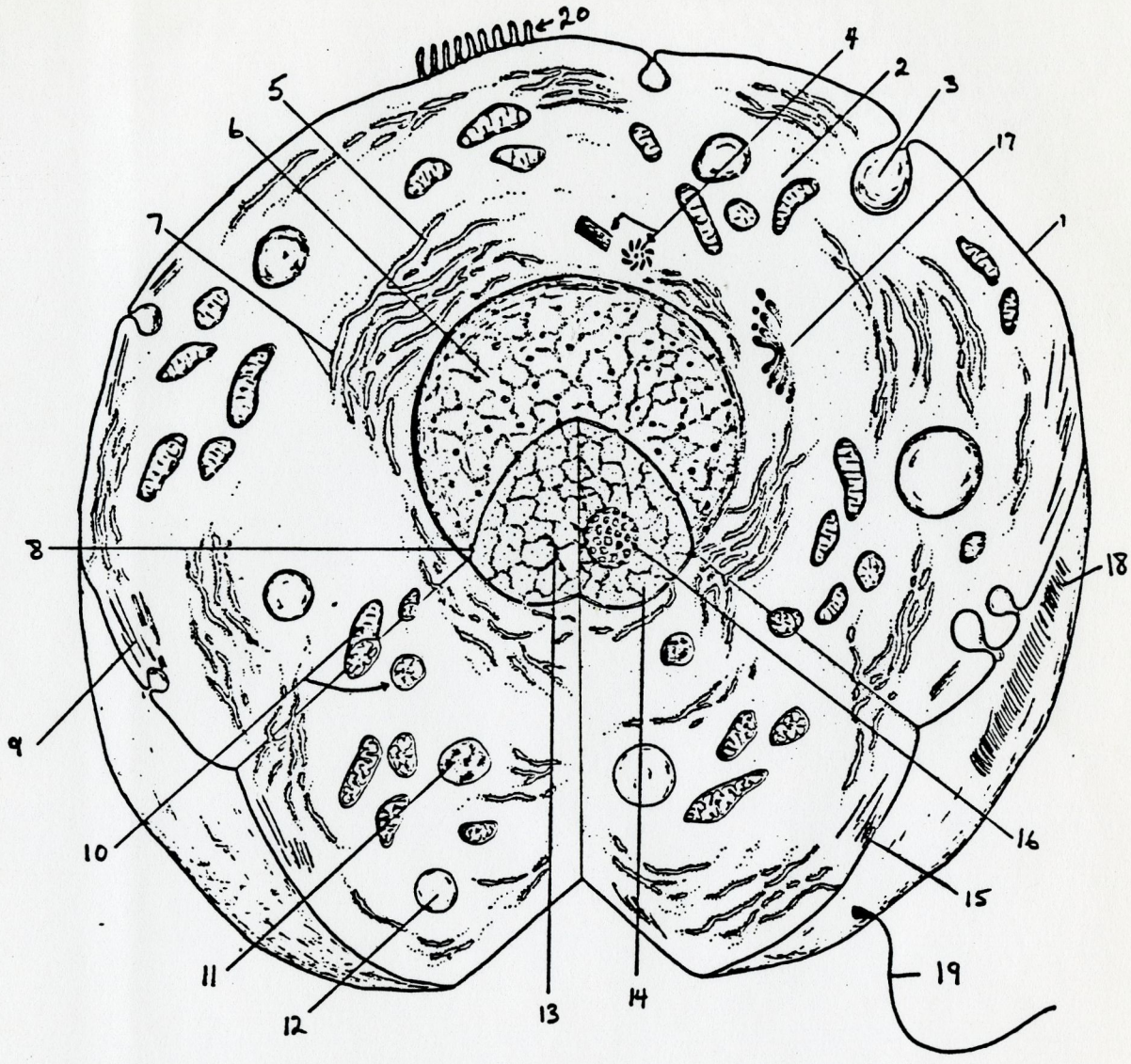
STRUCTURES FOUND IN CELLS

STRUCTURE	FUNCTION	CHARACTERISTIC OF LIFE OR LIFE PROCESSES
Cell Wall	Supports and protects moner and (bacteria) fungal, and plant cells	
Cell Membrane	Controls passage of materials into and out of cell	
Centriole	Takes part in animal cell reproduction	
Chloroplast	Produces food by photo-synthesis	
Chromosome	Carries information about heredity and control of cell	
Cytoplasm	Consists of fluid and organelles in which most cell functions occur; includes parts of cell other than nucleus and cell membrane (and cell wall)	
Endoplasmic reticulum	Transports substances within the cell	
Golgi Apparatus	Produce and package complex substances. Transports substances to the surface of the cell	
Lysosome	Digests materials in the cell	
Microtubule and microfilament	Give strength and help maintain shape of cell; involved in cell movement	
Mitochondrion	Energy transformation in the cell	
Nuclear membrane	Surrounds nucleus and controls passage of materials into and out of nucleus	

STRUCTURES FOUND IN CELLS (cont'd)

Nucleolus	Takes part in production of ribosomes
Nucleus	Controls all cell functions
Ribosome	Makes protein for the cell
Vacuole	Stores food, water and other materials

GENERALIZED ANIMAL CELL



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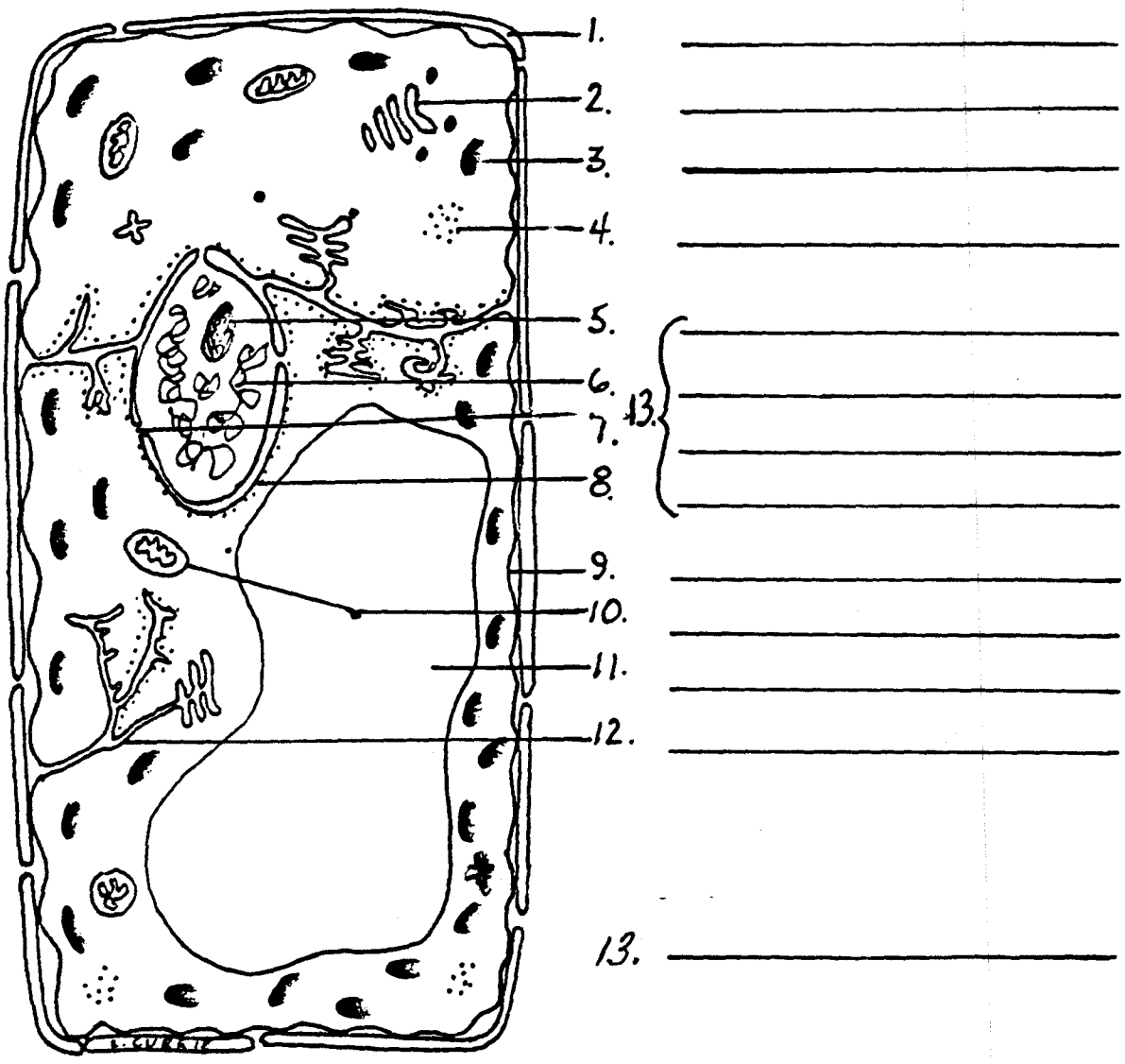
TYPICAL PLANT CELL



CELL STRUCTURE AND PROCESSES

Activity #3: The Relationship of Cell Structure to Function

BACKGROUND: In the last activity you tried to group the organelles into functional groups that carry out the specific tasks of the cell.

1. The cell must be able to acquire and process energy.
2. The cell must be able to regulate the various components and functions to keep it "alive".
3. The cell must be able to move material in and out of the cell
4. The cell must be able to manufcture itself and its parts.
5. The cell must be able to reproduce the information it needs to create ther next generation of cells.

These and many more functions are accomplished by the cells organelles.

In this activity we shall:

1. Briefly examine some processes which occur in the cell such as respiration, protein synthesis, mitosis and transport.

INVESTIGATION:

Part A

1. As a quick review of structure and function, view the video tape "The Cell". Attempt to group the structures according to their functions.

2. Identify some specialization that occurs in various cell types to more effectively perform specific functions.

3. a) Why is mitosis important?
   b) Briefly describe the process of mitosis.

4. Do the "Review Quiz" to test yourself on some of the points discussed in the video.

Part B

1. View Ward's Solo Learn System program on the "Introduction to the Animal Cell".

Activity #3 - cont'd

2. Complete the Student Review Sheet on the program and check your answers.

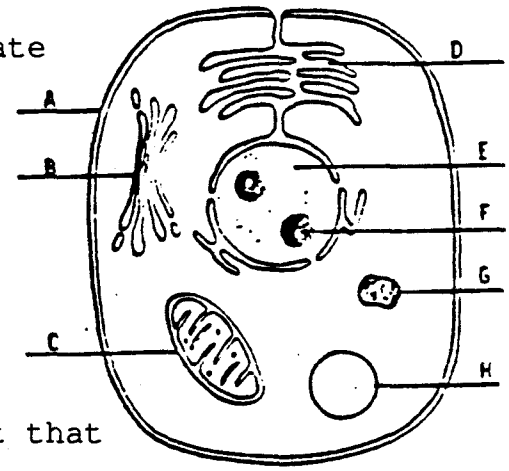
3. After a short group discussion on each section of the program, write a paragraph on the key concepts which were discussed. You should end up with five (5) paragraphs, one on each section of the tape.

(Introducing Biology Video Series: Program 3)
(Adapted from Luskin, etal., 1981)

REVIEW QUIZ

Select the one best answer and check your answer.

1. On the diagram to the right, locate the following parts:



_____ 1. cellmembrane
_____ 2. endoplasmic reticulum
_____ 3. nucleus
_____ 4. nucleolus
_____ 5. vacuole
_____ 6. lysosome
_____ 7. mitochondrion
_____ 8. Golgi body

2. Modern Cell Theory states in part that

a. all cells are identical in structure and function
b. the cell is the smallest unit of life.
c. all living things are made up of cells
d. both b and c above apply

3. Plant cells and naimal cells both contain

a. cell walls and cell membranes
b. cell membranes and mitochondria
c. centrioles and vacuoles

4. In _____, chromosomes are on the equatorial plane, and not yet separated.

a. metaphase
b. telephase
c. anaphase
d. prophase
e. interphase

5. Appearances of a nerve cell, muscle cell and skin cell are quite different. These cells differ in

a. all kinds of organelles present
b. presence of an organized nucleus
c. shape

The Cell Review Quiz - cont'd

7. Which kind of cell has a cell wall?

   a. animal cell
   b. plant cell
   c. both

8. Human skin cells divide in about ten hours.

   a. true
   b. false

9. When cell specializes, differences can occur in

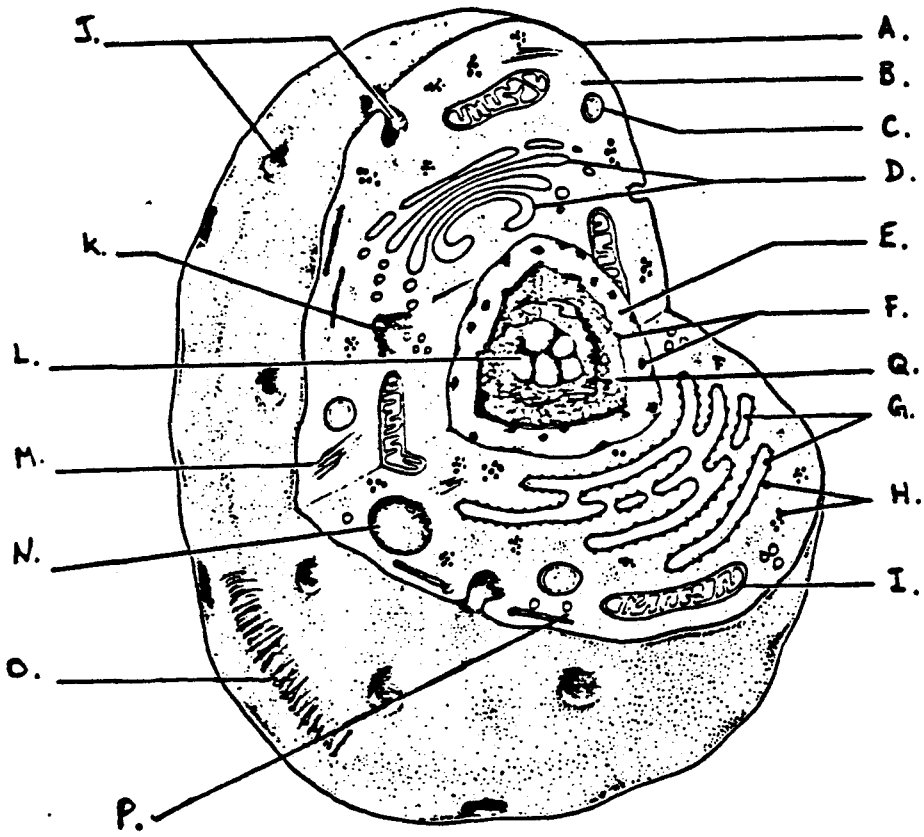
   a. function of the cell
   b. size
   c. shape
   d. function, size, and shape of the cell

SBI3A CELL QUIZ

NAME: _____

1. Label the diagram of the cell below:

TITLE: _____



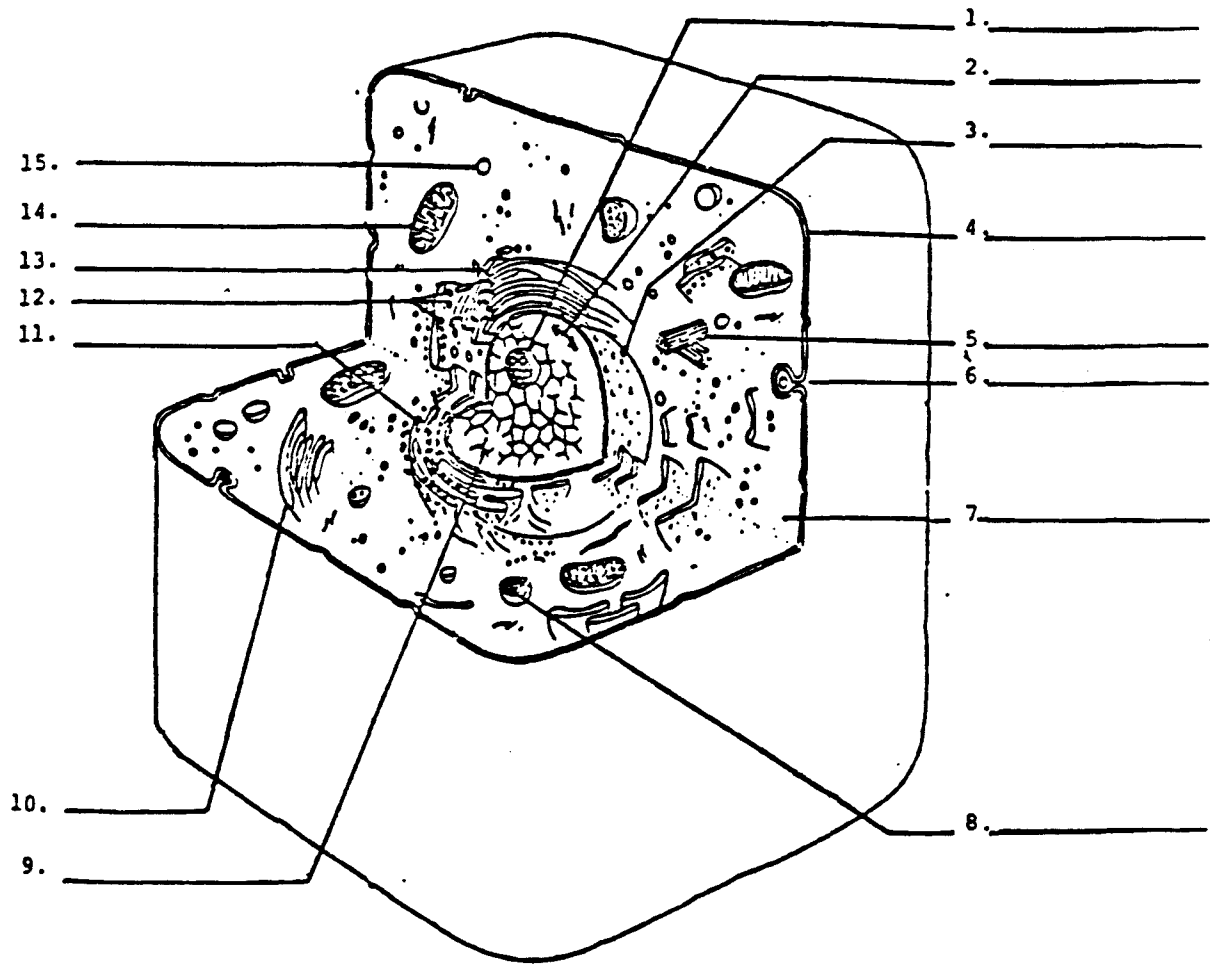
2. Draw a chart with the following headings: organelle and functions for structures D, Q, H, I and K.

SBI3A CELL QUIZ #2

NAME: _____

1. Label the diagram of the cell below:

TITLE: _____

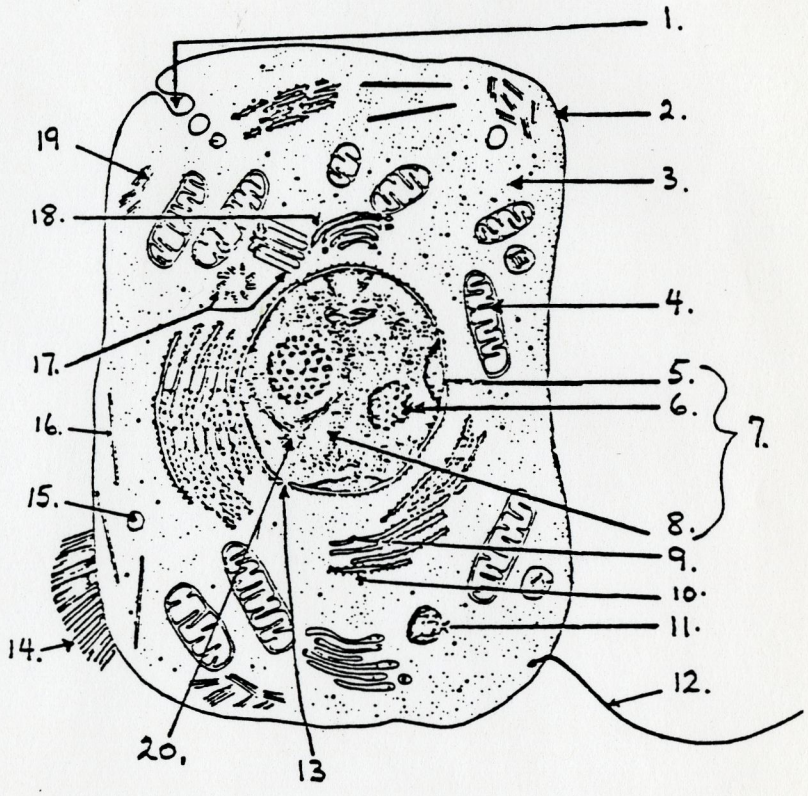


2. Draw a chart with the following headings: organelle and functions for structures 2, 4, 5, 9 and 14.

SBI3A CELL QUIZ #3

NAME: _____

1. Label the diagram of a typical animal cell. Place the correct name of the structures in the appropriate blanks below.



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17. _____
18. _____
19. _____
20. _____

CELL QUIZ (cont'd)

NAME: _____

2. Match each of the descriptions below with the appropriate structure:

1. Found in the nucleus, contains the genetic material._____
2. A series of membranes which often hold ribosomes._____
3. Structures in which energy is converted for cell activities. _____
4. Boundary around all cells._____
5. Site of protein synthesis._____
6. Membrane-lined channels which produce lipids and enzyme and package them for transport._____
7. Responsible for movement of material over top of cells (in tissues). Responsible for locomotion in some simgle celled organism._____
8. Two cylinderlike structures, found just outside the nucleus which is active during cell division in animal cells._____

A. cell membrane
B. nucleus
C. nucleolus
D. chromosomes
E. endoplasmic reticulum
F. ribosomes
G. centrioles
H. cell wall
I. mitochondrion
J. golgi bodies
K. cilia
L. flagella

Cell Quiz - cont'd

Name: _____

3. Describe the role of any five (5) of the following structures or molecules.

i) tRNA:

ii) mRNA:

iii) amino acids:

iv) DNA:

v) ATP:

vi) nucleolus:

vii) spindle fibers:

CELL STRUCTURE AND PROCESSES

Activity #4: Passive Transport across the Cell Membrane

BACKGROUND: After the demonstrations and lecture, you should have a good idea about the concept of diffusion and osmosis across a selectively permeable membrane. In this activity you will examine the effect of various solutions and describe the effect of the concentration of solvents and solutes on the direction of movement of the substances across the cell membrane.

INVESTIGATION:

1. We will examine a plant cell (onion) and an animal cell (blood) in three different solutions.

   a) Isotonic
   b) Hypotonic
   c) Hypertonic

2. Place a small piece of onion skin tissue on three slides. To each slide add two drops of each of the above solutions and observe.

3. Using the sterile technique demonstrated by the teacher lance your finger and place a single drop of blood on another set of three slides. To each slide add two drops of each solution and observe.

4. Draw a quick diagram of your observations.

PLANT CELLS

Isotonic Hypotonic Hypertonic

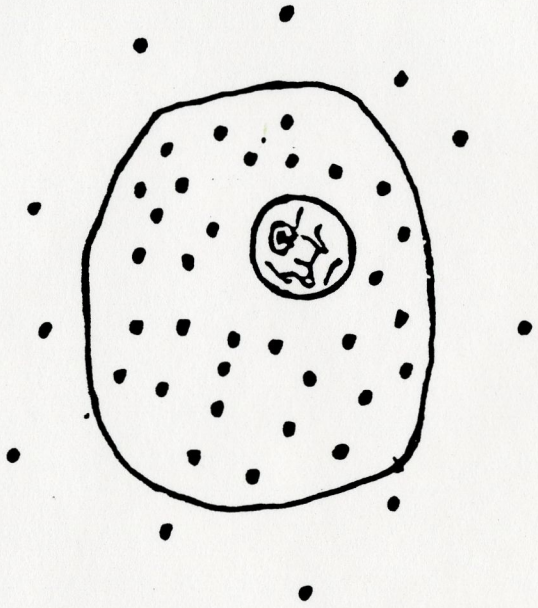
Activity #4 - cont'd

ANIMALS CELLS

Isotonic Hypotonic Hypertonic

5. Explain your observation, using the concept of diffusion and osmosis through a selectively permeable membrane.

QUESTIONS:

1. 

In the cell shown above, the dots represent water molecules. What change would you expect to see in this animal cell?

2. Why does a paramecium have to continually pump water out of itself?

3. A cell has a salt concentration of 0.2%. If it is placed into a solution with a salt concentration of 0.1%,

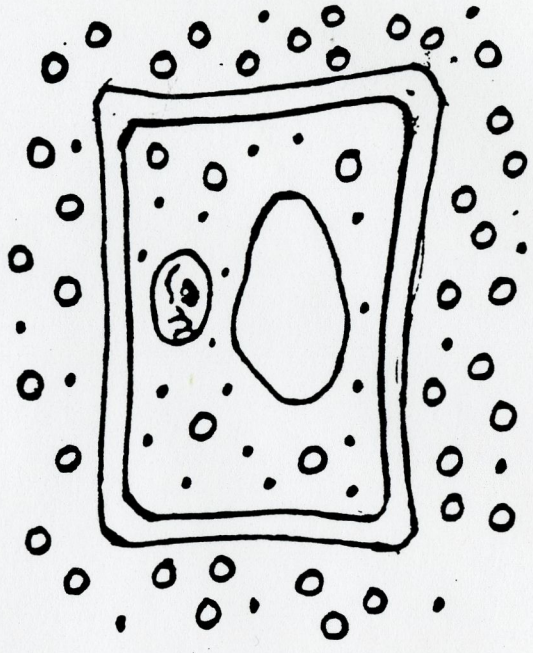
   a) What change will occur to the salt concentration inside the cell?

Activity #4 - cont'd

b) What change will occur to the water concentration inside the cell?

c) What condition will eventually result from the net movement of water and salt?

4.



In the diagram of the plant cell shown above, the dots represent water molelcules and the circles represent sugar molecules. Sugar is restricted in its ability to move across the membrane.

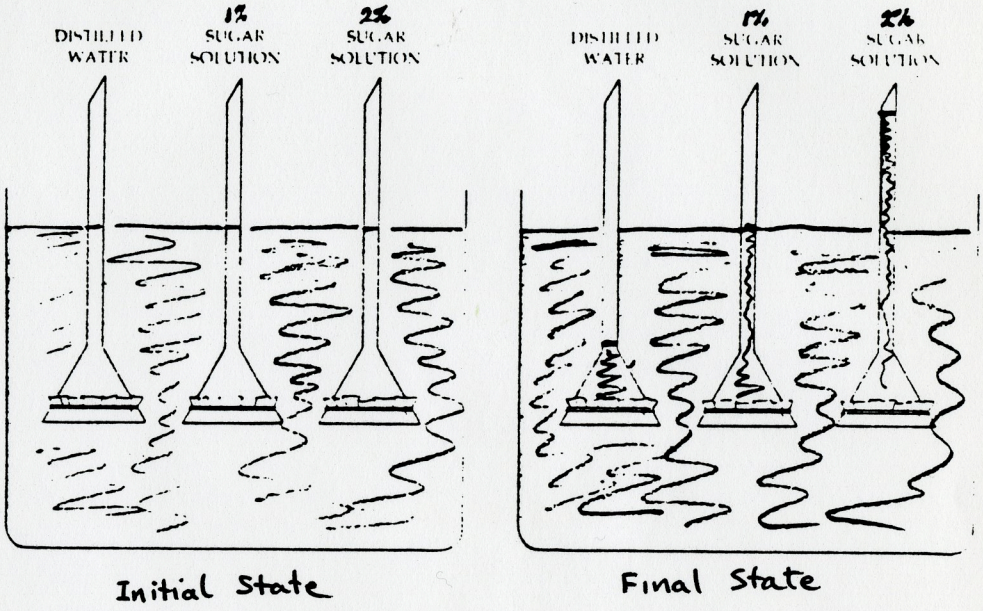
a) Explain the movement of sugar molecules into or out of the cell.
b) Explain the movement of water into or out of the cell.

5. If you took a fresh water amoeba and placed it into a drop of sea water, what changes would occur to the orgamism?

SBI3A TRANSPORT QUIZ #1
(adapted from Curtis, 1983)

NAME: _____

1. Three funnels have been placed in a beaker containing a solution (see the figure below). What is the concentration of the solution? Explain your answer.



2. Imagine a pouch with a selectively permeable membrane containing a saltwater solution. It is immersed in a dish of fresh water. Which way will the water move? If you add salt to the water in the dish, how will this affect water movement? What living systems exist under analogous conditons?

SBI3A - TRANSPORT QUIZ #2

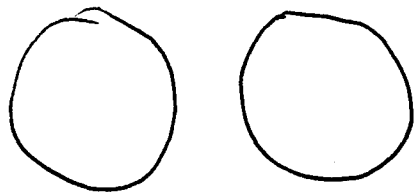
NAME: _____

1. From the observations made on a red blood cell, determine which solution is hypotonic, isotonic and hypertonic.

Solution A _____

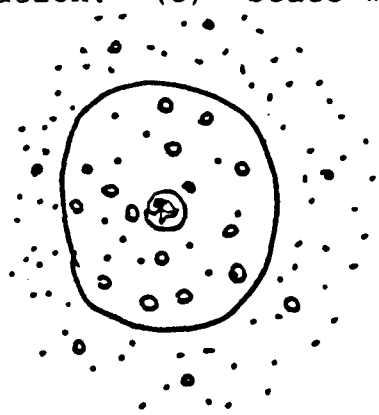
Solution B _____

Solution C _____

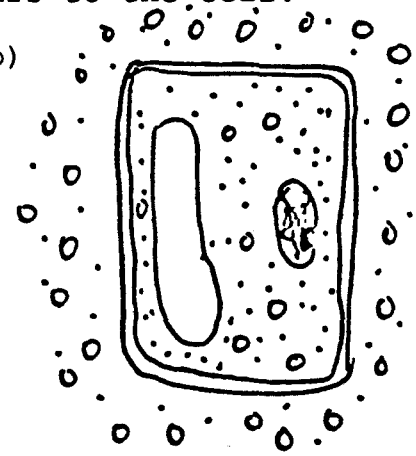


2. In the cells below, the dots represent water molecules and circles represent salt. (a) Show the net movement of particles in each situation. (b) Name each type of solution. (c) State what occurs to the cell.

a)



b)



3. What major differences exist between passive transport and active transport? (name 2)

1)

2)

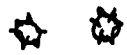
SBI3A - TRANSPORT QUIZ #2

NAME: _____

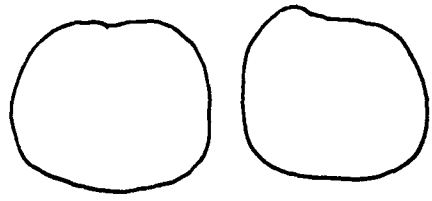
1. From the observations made on a red blood cell, determine which solution is hjypotonic, isotonic and hypertonic.

Solution A _____

Solution B _____

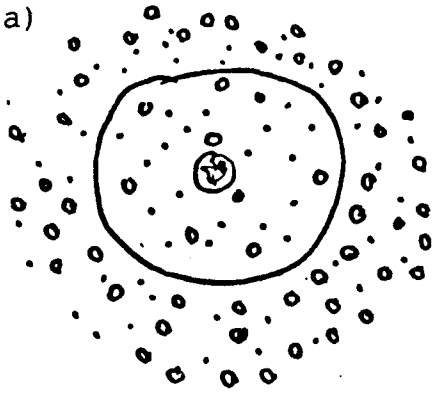


Solution C _____

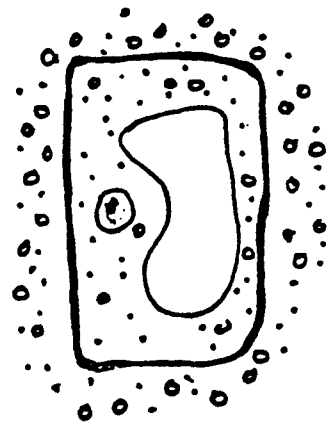


2. In the cells below, the dots represent water molecules and circles represent salt. (a) Show the net movement of particles in each situation. (b) Name each type of solution. (c) State what occurs to the cell.

a)



b)



3. Define and give an example of

a) Facilitated transport
b) Active transport
c) Passive transport

CELL STRUCTURE AND PROCESSES

Activity #5: Active Transport

BACKGROUND: The ability of a cell to survive depends in part upon the movement of materials into and out of the cell's interior. This at times may go against a concentration gradient. In other words, the material may move from an area of low concentration to an area of high concentration, this cannot be explained by either diffusion or osmosis. There are a variety of ways in which this is accomplished. This form of movement is known as active transport.

In this activity we shall:

a) Observe the effect of Congo Red on live and dead yeast cells.

b) Examine a type of active transport.

1. Place 5ml of yeast suspension in each of two test-tubes.

2. Add 3 drops of Congo Red stain to each test-tube.

3. Heat the contents of one test-tube to the boiling point in a beaker of boiling water.

4. Prepare a wet mount slide of both yeast suspensions and examine the slide with the microscope.

5. Record differences (especially colour) that you see between the cells on the two slides.

QUESTIONS:

1. Account for the differences seen in terms of the way the two yeast cells were prepared for observation. What hypothesis can you make about cell membranes and diffusion due to the results of this experiment?

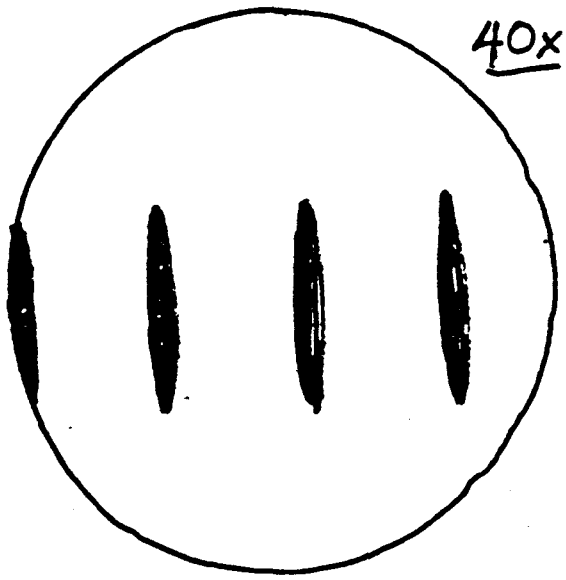
2. Define Active Transport. How is this activity a possible example of active transport?

3. Give two other examples of how active transport may be used by cells? (use reference books)

SBI3A TEST #1

NAME: _____

1.



A metric ruler graduated in mm was placed under a microscope with a magnification of 40x.

a) What was the diameter of the field of low power in mm?

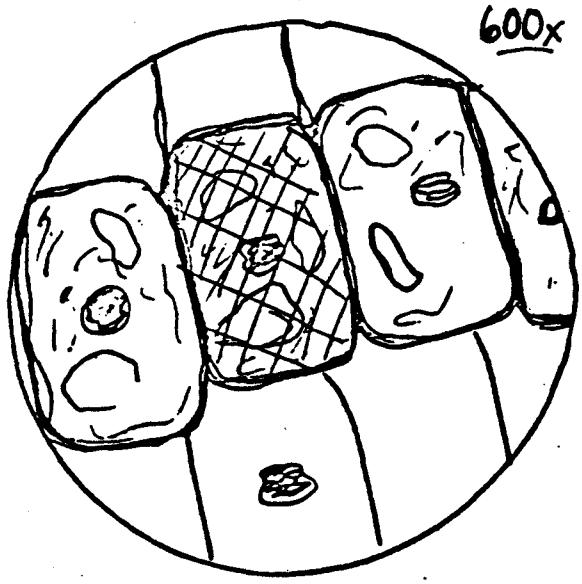
_____

b) What was the diameter of the low power field of view in m?

_____

c) Calculate the diameter of the medium power field of view of the above microscope if the magnification is 200x. (Show your reasoning).

d) Calculate the length and width of the crossed specimen under high power of the same microscope with a magnification of 600x. (Show your work.)



SBI3A TEST #1

NAME: _____

2. With the aid of a diagram show how energy gets into the biological world and is used for the more obvious characteristics of life.

3. State five characteristics of life observed in the lab activities. Explain why each is important for the survival of the organism.

4. (a) Discuss in general terms any one (1) of the following processes:

   i) Mitosis
   ii) Protein synthesis
   iii) Respiration

SBI3A TEST #1

NAME: _____

(b) Explain its significance to the survival of the organism. (Answer on the back!!)

5. (a) Sketch an animal cell. Include twelve (12) organelles and label them.
(b) Prepare a similar labeled sketch of a plant cell.
(c) What are the major differences between the animal cell and the plant cell?

SBI3A TEST #1

NAME: _____

6. Complete the chart below:

Name of Structure	Description of Structure	Function(s)
Nucleus		
	Tiny spheres (14-18 m) in the cytoplasm, which are also found on the surface of the endoplasmic reticulum	
		This structure manufacturers, packages and transports special products called glycoproteins, which are carbohydrates and proteins.
Centrioles		
Mitochondria		

7. (a) State the levels of organization in a multicellular organism.

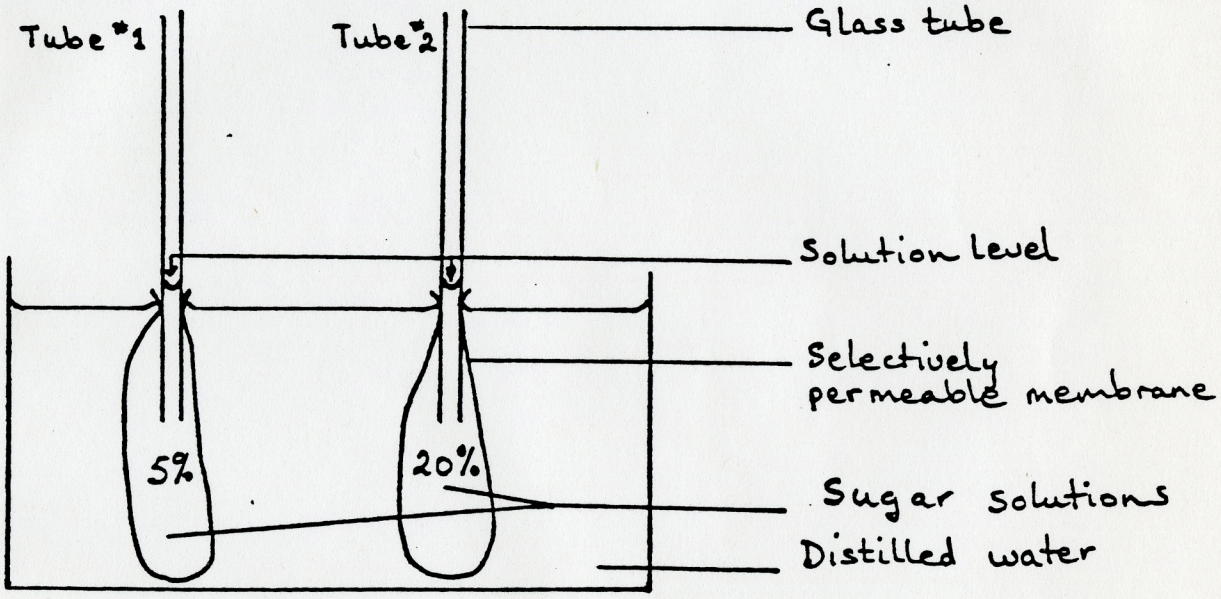
(b) Discuss the importance of the various levels of organization to the survival of the organism. (Answer question on the back.)

SBI3A TEST #1

NAME: _____

8. (a) Indicate three changes that will take place in the experiment that is represented in the diagram below. The sugar used in the selectively permeable membrane can <u>very</u> slowly pass through the membrane.

(b) <u>Explain</u> each change (on back).



i)

ii)

iii)