CONTEMPORARY BIOLOGY CURRICULUM FOR NON-MAJORS

THESIS

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

Susan Smallwood, B.S.
Denton, Texas
August, 1998

The proposed biology curriculum for non-majors has one main objective, namely to improve scientific literacy among college students. The National Science Education Standards defines scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity". The suggested strategies to accomplish this goal are to limit the number of topics covered, introduce relevant scientific terminology, emphasize general biological concepts and themes, and hone critical thinking and problem solving skills. Activities such as group projects, written and oral assignments, and class discussions are effective tools to assess student ability to communicate scientifically. It is also important for students to make connections between the course subject matter and how it affects real life events.
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TABLE OF CONTENTS

Chapter

1. INTRODUCTION ................................................................. 1

2. PROPOSED CURRICULUM .................................................. 5
   Need for curriculum change
   Research
   Current curriculum reforms
   Proposed curriculum

3. CONTENT OF CURRICULUM ............................................. 19
   SEMESTERS I & II
   Course Goals
   Discussion Goals
   Laboratory Goals
   Lecture Outline
   Lecture Content
   Discussion Content
   Laboratory Content

BIBLIOGRAPHY ................................................................. 71
CHAPTER 1

INTRODUCTION

I am proposing to design a contemporary college biology curriculum for non-majors. The purpose of this curriculum is to improve scientific literacy among college students. The National Science Education Standards defines scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity".

The goal in this class is for students to have a grasp of important biological concepts, be able to think critically and solve problems, develop effective scientific communication skills, and to understand how biological issues have relevance in their lives.

The need for a new curriculum is made clear by educators and researchers that believe the current traditional method is not effective in conveying the importance of critical thinking and problem solving skills in the field of science and in everyday life. Students do not make a connection between the biology they study in school and how it affects the world around them. The goals at Pomona College, where current curriculum reform is taking place, are to "explore a few topics in depth, emphasizing the connections of biology or biologists and the rest of society" (Bierzychudek & Reiness, 1992). Most college classes tend to cover as much material as possible; students cram and memorize the information in order to do well on an exam. The "thinking" part of the brain is not efficiently utilized and a real connection is never made between the knowledge gained and how to use it. As a result, students forget most of what they
"learned" by the time the semester is over. The students in a biology course for non-majors may not ever step into a life science class again after two semesters. It seems imperative to give students an experience that is effective in getting them to view science as a subject that affects their lives.

Students do not come equipped with a sufficient science background by the time they enter college. According to the Third International Mathematics and Science Study (TIMSS), the United States scored below the international average. The Netherlands and Sweden scored the highest in mathematics and science literacy. A statement was made in reference to the results of the advanced mathematics scores, but has significant meaning that can be applied to the field of science. They noted, as an indicator of high achievement was the ability to frequently solve equations and do reasoning tasks. Those are important skills for solving biological problems, as well as making everyday decisions. American adults do not have a basic understanding of general biology. A recent National Science Foundation survey showed that less than half of American adults did not know that the Earth rotated around the sun yearly, 21 percent could define DNA and 9 percent knew what a molecule was. While humorous, it is disconcerting when a woman that demonstrated against a proposed biomedical research laboratory reportedly exclaimed; "They're trying to bring DNA into my neighborhood!"

How could such a course be designed?

Based on research some of the tools to improve scientific literacy include:

- Limited number of topics covered in lecture
- Introduction and use of scientific terminology
- General biological themes and concepts
- Critical thinking and problem solving skills
• Ability to communicate scientifically through written assignments, oral presentations and discussion activities
• Getting involved at some level with real life activities that have a biological impact
• Small classroom setting

The course layout is a three part design that includes lecture, discussion and laboratory sections. The instructor presents the lecture and covers the topics and concepts outlined in the course syllabus. The class atmosphere should be conducive to student inquiries and discussions. The discussion portion is utilized to review scientific articles, debate biological issues and implement critical thinking activities. This is also a good time to review for exams and discuss projects. The laboratory section is used for group projects such as designing experiments for hypothesis testing, poster presentations and performing experiments pertaining to the course material.

These ideas will be discussed and expanded in chapter two of the proposed curriculum. The content chapter will also help illuminate the approaches to accomplish the goals mentioned.

How is current curriculum reform working?

As mentioned previously, the biology professors at Pomona College are teaching a class where the approach to the class content is less traditional. Their “DNA and Evolution” class has been a success based on the students’ evaluation. Students have commented that they found the material to be interesting and easier to understand after having class discussions. One student was able to successfully contribute to a scientific discussion with upper class biology majors after taking the class (Bierzychudek & Reiness, 1992). At Emory University a two semester introductory course was offered
that focused mainly on critical thinking skills by utilizing the students' creative energy and curiosity. The curriculum included nontraditional science readings, discussion exercises, oral reports, peer evaluation, computer exercises, guest speakers, and small group projects. The student evaluation of the pilot course was positive. Instructors noted that students' written and oral skills improved during the course of a year (Eisen, Morgan, & Marsteller, 1992). At the University of Oregon, professors in the science department have been working on a project called the Workshop Biology. Their goals and methods will be discussed and referred to throughout this paper. The overall student evaluations of this course as compared to the traditional approach were very positive. Many students commented that they had a better grasp of biological concepts and most importantly how science affects their lives and the world around them (Workshop Biology, University of Oregon).

How are students assessed?

With assessment criteria changing in all levels of education it is difficult to know how to best determine student performance in the classroom. Jargon such as "standards", "scoring", "student proficiency" and "student mastery" are commonplace in some institutions and words like "grades" and "memorization" have become obsolete. It is important that the class instructor clearly define the course expectations and how student performance will be assessed.

The topic of student assessment is worthy of exploration. This paper, however, concentrates on a curriculum that deals mostly with the process and content of teaching biology. This is also more of a theoretical design. For a non-majors class there may not be enough time or resources to incorporate all of the ideas. There is a variety of ways that these ideas could be modified and used in the actual course proposed.
CHAPTER 2

PROPOSED CURRICULUM

There is a need for a change in current college biology curriculum. In the 80's, Wartell suggested that the traditional approach to teaching college science classes was not very effective. He states that entry-level college science courses focus on "definition training" and "technique training" rather than a "mode of thought" or "conceptual framework" approach (Wartell, 1984). The teaching philosophies and goals at the University of Oregon describe similar ideas. "Just as cookbook labs don't work for students, cookbook curricula don't work for instructors". Their aim is to help students think more critically, develop their own opinions and decisions on thoughtful, rational analyses and not on habit, hearsay, prejudice, or authority (Workshop Biology, University of Oregon).

Brain and education researchers as well as biology professors have asked questions pertaining to the practice of education. How do people learn? How can instructors get students excited about biology? How do educators equip students with necessary tools for thinking, solving problems, asking questions, and so on, that students can use in any classroom and in real life situations?

It is important to discuss the brain. "The need for connectedness in education goes even deeper than the pressures of contemporary society or the demands of the workplace. The process of brain-based learning calls for making connections. Unless connections are made between subject content and the context of application, little long-
lasting learning occurs for the majority of students” (Parnell, 1996). The brain can be divided into three functional parts. The lower brain consists of the brain stem, which concentrates on automatic body functions like breathing, heartbeat and the cerebellum, which controls balance and muscular activity. Collectively this is known as the “automatic reflex brain”. The second part is the limbic system, which is responsible primarily for memory, emotions, and motivation. This is the area most students use without utilizing the third part, which can be thought of as the “thinking brain”. The thinking part of the brain is contained within the cerebral cortex. This part of the brain can be thought of as a large computer connecting the higher functions of learning, judgment and intelligence (Parnell, 1996).

The next question is how are students taught to think? “If the teacher desires the student to become a better thinker, then inquiry level questions are asked, conceptual problems are posed, or thought provoking statements are made in the hope that the student will develop and test hypotheses; thus, improving his/her ability to think rationally and logically” (Govindarajan, 1991). Just covering the facts and details of biology does not give the student a real understanding of how biology works and why biologists find the subject so exciting (Bierzychudek & Reiness, 1992). Some college programs introduce students to current biological research. Historical views can also be added that focus attention on scientific reasoning (Gottfried et. al., 1993). One example of a historical event “collaborating” with science is seen in an article published in Invention and Technology discussing the impact of W.W.II on the progress of medicine. A long shelf life for blood was crucial in the War since many wounded soldiers and war victims could not get to hospitals quickly. Something had to be done to get blood to the wounded quickly and the blood had to be in good condition. The shelf life of blood at the
time was only a few days. Doctors found that by adding dextrose to the blood supply the shelf life doubled. Sterilizing the blood was an important factor in a long shelf life, but this introduced the problem of carmelization. By adding acid to the blood (ACD solution), carmelization was prevented and blood was good for up to 21 days. The blood cells maintained shape and were not scavenged by the spleen. Another medical breakthrough that came about as a result of the War was heart surgery. Before the War the heart was rarely touched or tampered. “The heart alone of all viscera cannot withstand serious injury” Aristotle. Dwight Harken believed the heart was strong and resilient and could withstand surgeries. During W.W.II he removed several bullets with his bare fingers from the hearts of wounded soldiers (Berlinger, 1996).

What are some current applications of curriculum reform? At the University of Oregon the Workshop Biology course is part of the current curriculum. There are three main components to their approach; concept activities, investigative activities, and issues activities. Concept activities are designed to help students learn the important ideas of biology and shatter some of their misconceptions. They accomplish these goals through discovery and hypothesis-testing exercises. Investigative activities discuss the importance of current scientific controversies, and the skills and attitudes required for asking questions and finding answers. The students research an issue and discuss both sides and present their findings in writing. The issues activities utilizes the students conceptual knowledge, scientific reasoning skills, and their own values to investigate an issue with a social or personal impact (Workshop Biology, University of Oregon). At Emory University in Atlanta, a two-semester introductory course was designed to teach critical thinking skills. They incorporated several non-traditional approaches into their syllabi. The thought catalysts as they refer to them, include nontraditional science
readings, discussion exercises, oral reports, peer evaluation, computer exercises, guest
speakers, field trips, proposals for further experimentation, and small group experiments

The purpose of the curriculum proposed here is to improve scientific literacy
among college students. The goal in this class is for students to have a grasp of
important biological concepts, be able to think critically and problem solve, develop
effective scientific communication skills, understand how biological issues have
relevance in their lives. There are several ideas that would be useful in a college non-
majors biology class. Based on research some of the tools to improve scientific
literacy include:

• Limited number of topics covered in lecture
• Introduction and use of scientific terminology
• General biological themes and concepts
• Critical thinking and problem solving skills
• Ability to communicate scientifically through written assignments, oral
  presentations and discussions activities
• Getting involved at some level with real life activities that have a
  biological impact
• Smaller classroom setting

Each idea is described in more detail:
Limited Number of Topics

By limiting the number of topics in this type of class, a greater opportunity is provided to explore specific topics at a deeper level. This provides more room for exploration and discovery of topics chosen for each semester. Fewer topics allows more time to include historical and social context as it relates to biology to help students understand how these ideas are relevant to their lives (Bierzychudek & Reiness, 1992).

Introduction and Use of Scientific Terminology

The introduction of scientific terminology is fundamental in this class. It is important to begin with terms that are most relevant to the topics covered. This may have to be a drill and practice approach. One technique that has been an effective tool for teaching this new scientific language is to study the Latin and Greek meanings to the root words of biology. Students receive a list of word origins and their meanings. As new terminology is introduced students can refer to their list of root words to decipher term meanings. "Cephale" pertains to the head and "pous" to the foot. A cephalopod would mean head foot; a squid is an example of a cephalopod. "Itis" means inflammation and "en" means inside, therefore encephalitis would mean inflammation inside the head. The students could mix and match parts of words and come up with their own words. This technique would need to be coupled with other strategies for learning terminology, but this would be a good way to spark student interest. The idea in this course is to build up to having an extensive workable vocabulary. Just like weight training, it cannot be done all at once; the muscle (brain) has to build up to large weights (information).
General Biological Themes and Concepts

Another strategy to equip students with the necessary tools is by presenting essential biological ideas. The introduction and explanation of the scientific method, processes like cellular respiration and protein synthesis should be thorough. Students need to grasp the fundamental importance of these topics and should not be inundated with copious amounts of details and facts. It is not necessary at this level to go into the details of the Krebs' cycle and every intermediate molecule. The students need to understand in general what happens to a molecule of glucose. Where does it go? What do we get out of it? Is cellular respiration an example of catabolism or anabolism? What about protein synthesis? How is energy used? How is it obtained?

Critical Thinking and Problem Solving Skills

Critical thinking is a skill everyone should have in order to analyze arguments and interpret data presented in magazines, television, newspapers and other news sources that report scientific information. Tyser and Cerbin (1991) have developed in their "critical thinking exercises for introductory biology courses" a five step activity to teach students how to critically evaluate claims made by reporters, politicians, sales people, etc. The steps are:

- Identify a claim and restate it clearly and determine its importance
- Identify evidence relevant to the claim
- Evaluate the quality of the evidence found
- Evaluate the validity of the claim
- Summarize the reasoning used to evaluate the claim

(Tyser & Cerbin, 1991)
Communicating Scientifically

The ability to communicate scientifically is paramount. This skill provides the evidence students’ grasp concepts and terminology. Group projects pull together the main ideas and processes of biology. There are different ways to implement a group project activity. Students could test hypotheses, study themes, or investigate and present posters pertaining to important biological issues.

One idea is to give students a few days to think of inquiries pertaining to the specific content of that semester. The questions could range from complex concepts like Natural Selection to curiosities like why we look like our parents. The instructor can take these lists of questions from the students and divide students into groups based on the similarity of their questions. If one general theme can be used to answer several questions, the students in one group could come up with a workable approach. Students ask questions and develop hypotheses. If a hypothesis can be tested, the students, with the help of the instructor, can set up experiments to collect data. The results are interpreted and presented by the students. If physical testing cannot be done, students could set up a theoretical situation and access the Internet and other computer aids along with exploring the resources in the library to work through their hypotheses.

Another idea for a group project is for the instructor to choose a theme and have students approach it from different angles. This would provide a variety of ways to look at one theme. For example, in a holistic approach to science that teaches principles like self-activity, learning through self-discovery, differentiation and intrinsic motivation, students are divided into groups according to their specific areas of interest. Each group prepares a short paper and presents it orally to the class. Using the theme, Insecta, one
group that has an aptitude and an interest in a statistical-mathematical direction could gather information on the size of this animal group. How many new species are described annually, the total biomass of the insect population and so on. Students with an interest in history could approach this project by finding out how insects have evolved or how they have affected our society. Students with interests in psychology and sociology could research the subject of social insects as their theme (van Rooyen, et al., 1994). Each group could ask questions that are relevant to their approach. The statistical group may predict how a particular population may increase in numbers over a given period of time or how factors in our changing world could influence insects and their survival.

Poster presentations are also a good idea for a group project. One approach used in the Workshop Biology class at the University of Oregon was to explore a current issue that has a biological relevance. The students work in groups and find an issue that they want to explore and present evidence that supports both sides. Students could view other poster presentations from graduate students or professors to get an idea of how a poster is prepared. Professors should invite students to attend poster presentations if they are exhibited on campus. Students would include a title, list of authors, abstract summarizing what the poster is about, and biological concepts that apply to the issue. In addition it should include the position and evidence that support both sides of the controversy, evaluation of the arguments, the groups conclusion and opinions along with references. Group projects provide a comfortable arena for students to share and discuss their perceptions of biology. Small groups are an appropriate venue for students to learn through trial and error. Students learn the importance of collecting data correctly and reporting honest findings. Students understand that making
mistakes and obtaining results that they did not predict is part of the scientific process. This, however, is not justification for sloppy procedure.

Two caveats that have been brought to my attention about group projects will be addressed. One is the tendency of one or two people in a group to do most of the work. To avoid this possibility, each member of the group will be responsible for one part of the project and graded individually. The projects should be set up so that each group member's information has to come together to fit into an overall tested hypothesis or theme. This cooperative approach hopefully alleviates the problem of an unbalanced work effort. The groups present their projects in class and are assessed as a group for the oral portion. The other possible downfall to group work is that people with different abilities may be put in the same group. While the judging of a student's ability may be subjective, it is important to discuss. Typically educators frown upon grouping by ability. However, by the time of college matriculation students need to understand that they have to work and be responsible for their own education. It is not the responsibility of those who do well and work hard to bring the other students up to a higher level. The students that do not always do well may benefit and be challenged and that is good, however, those that excel are not challenged and may be left with an unsatisfactory educational experience. Therefore, the students will choose group partners. The groups are chosen in lab since the lab time is used to work together either performing experiments to collect data, or to do library or computer research. The three-hour lab time is used to work on the group project. This provides students with lab time to work in their groups. Responsibilities outside of class and time constraints have to be taken into consideration when working on group activities.
Real Life Activities

Real life connections are helpful in bringing science to the realm of what students see as reality. Attending or volunteering at community affairs that have a biological significance such as Earth Day events, blood drives or taking tours of university or commercial research labs help students make a connection between biology and how it is being used in real life applications. Another idea is to have guest speakers such as doctors, scientists, or laboratory technicians talk to the class about their job responsibilities. It is also beneficial for students to see how biology can affect the food industry or economy. One example is a project sponsored by the Alaska Fisheries Science Center. The project is funded in part by the Exxon Valdez Oil Spill Trustee Council. After the oil spill in Prince William Sound scientists began taking water samples and analyzing them for various chemicals and compounds. They noted a high level of the hydrocarbon, pristane. Upon analysis they found that this compound was found in places where the oil spill had no effect. Scientists discovered that pristane was made by copepods which are zooplankton found in the ocean. Certain fish, like herring and salmon, eat the copepods. The pristane, which is a stable compound that concentrates in fat deposits, is passed in the fish feces. Mussels, which are filter feeders, filter water and collect the feces containing the pristane. Mussels are collected and the levels of pristane are used as a tracer of energy from the copepods through the ecosystem. Analyses of pristane in mussel beds is a way to see how much of this energy flows through the lower levels of the foodweb. A plentiful zooplankton supply helps insure healthy populations of animals higher up on the food chain like salmon and herring. The students in some of the surrounding areas are part of a Youth Area Watch program; they collect mussels and test for pristane levels. This is a great opportunity for students to
see many aspects of biology and how it can affect them and their food sources. Instructors could explore similar cooperative projects with local scientists. Time and student availability constraints will have to be taken into consideration so that a realistic number of activities can be chosen.

Smaller Classroom Setting

A small classroom setting is an optimum condition to improve the lecture environment for both the students and the instructor. Large student populated lecture halls are more out of necessity than a desire from the instructors. Research shows the large lecture hall setting to be detrimental to teaching effectiveness (Allen & Niss, 1990). A classroom with a large student population may discourage inquiries from students and class discussions. The instructor has less time to evaluate student performance and as a result exams and activities may not be as thorough. If this cannot be changed, instructors can request help from teaching assistants and graduate students to help score exams and the lab time can be utilized for smaller group activities.

The topics for the semester are limited in quantity, but explored thoroughly so that students can have a better grasp on some of the important concepts and applications of biology. The semester begins with a discussion of the scientific process and how it is used in the project assignment. The project information is covered in depth during the lab section. There is a biological perception survey distributed in order to obtain a glimpse of students' scientific perspectives. The results of this survey will give the instructor an idea of what students know and what misconceptions they have. Borrowing from the pilot course at Pomona College the first semester will start with the study of DNA and heredity and continue into evolution. Campbell's Biology textbook will
be used in addition to selected readings from Darwin for Beginners (Miller & Van Loon, 1982). Selected text form original writings from Watson and Crick’s original formulation of the DNA double helix (Bierzychudek & Reiness, 1992) and Darwin’s Origin of Species (1859) will also be used. Current commentaries from scientific magazines and journals will be read and reviewed during the discussion time.

The second semester will cover basic concepts in cell biology, physiology, and ecology. Campbell’s textbook will also be used along with other resources.

Lectures are held for two hours each week. They cover the general concepts and terminology pertaining to the content. The environment in the class is conducive to student inquires and short discussions if necessary.

Discussions will be held for one hour a week. They are an important part to this contemporary approach. As with the group project, students will learn to feel comfortable sharing ideas, questions, and thoughts about biology. It is important for the instructor to provide an atmosphere that welcomes an interactive verbal environment. The instructor is responsible for the control and organization of the activities. Discussions should be held at least once a week for about an hour. If it is possible, instructors could arrange for a time slot that has some slack in case eager students want to continue discussions. Students examine important biological issues by setting up a debate over a current controversy. The class members divide into two groups. One group argues one side of the issue while the other group supports the opposing bias. The discussion time is also used to explore and review readings from scientific articles.
Laboratory time is an excellent way to put some of the concepts of biology to work. Most labs try to follow the course sequence so students have been introduced to the concepts before they apply them in lab. Professors and teaching assistants need to work out a coordinating lecture/lab juxtaposition. Part of the allotted time in lab is used to work on the group projects. Students are able to use this time to work on the experiment part of their project providing their topic requires such lab experience. Some of the lab days are set aside to perform experiments that pertain directly to the topics covered in lecture. Another approach to the lab that can be used in conjunction with the before mentioned uses is to incorporate lab simulations. There are software programs offered by different companies and universities. The University of Oregon uses computer simulations to study a variety of topics. Epidemiology is one that enables students to study infectious diseases through populations. Selection in Action is helpful in challenging students to come up with their own hypotheses and work to discover how traits are determined for different groups of mice. And, Cumulative Selection demonstrates how small changes in nature accumulate from one generation to another to produce specific characteristics in living things. There are also new creative experiments that could replace some of the old cookbook experiments and labs could even be organized for the semester based on the particular interests of the students.

The lecture part of the course includes a survey given to find out student perceptions of biological issues, ideas, and themes. Concept exams are given in essay form, and multiple choice, which requires a written explanation. The University of Oregon has an extensive test bank of questions that try to cover concepts that are frequently misconceived by students. This is a good resource to utilize when making up the exams. The assessment for the issue debate is based on student preparation and
persuasive impact. This could include a peer and instructor evaluation. Discussions over current research articles will be reviewed and explored. Student participation and preparation will be assessed to determine score.

The laboratory section includes group project assignments and lab activities. The intention of the group project is to examine how well students ask questions, pursue the answers, interpret and report findings. The grade for the written portion of the project is based on content and technical writing skills. The content covers the basic design of the project and students are assessed on how well they pulled together concepts and inquiries and applied them to the scientific method. The technical portion includes knowledge and application of basic English composition skills such as grammar, syntax, punctuation and so on. Assessment also includes student’s ability to effectively communicate scientific terminology and ideas. The oral presentation is assessed primarily on student preparation and group connectedness. The poster presentation assessment will follow the same template as the group project with some alterations. These assessment guidelines are theoretical and may need to be modified in an actual situation.

The topic of student assessment is worthy of exploration. This paper, however, concentrates on a curriculum that deals mostly with the content and process of teaching biology. This is also more of a theoretical design. For a non-majors class there may not be enough time or resources to incorporate all of the ideas. The poster presentation could be done instead of a group project or the discussion time may evolve into more of a review of the lecture topics and concepts. There are a variety of ways these ideas could be modified and used in an actual course.
CHAPTER 3

CONTENT OF CURRICULUM

Semester I

Course Goals

To examine the theories and ideas of Mendel and introduce concepts of heredity. Continue into evolution beginning with a look at early earth and when life began. Segue into evolution by discussing the connection between the ideas of Darwin and Mendel. Emphasize major concepts of genetics and evolution and discuss relevant biological issues concerning the impact genetics and evolution has on society. Students learn critical thinking skills and evaluate scientific claims made by scientists, theorists, and philosophers.

Discussion Goals

Small groups meet once a week to discuss assigned readings from scientific articles from journals, newspapers, or magazines that pertain to the lecture topics. Students apply their burgeoning knowledge of scientific concepts and terminology to interpret articles. A discussion/debate between students illuminates issues that have a biological significance. One group supports an argument and the other group supports the opposing side. The groups research information supporting their bias.
Lab Goals

Students work in groups investigating scientific questions and problems. They apply the scientific method by forming hypotheses, making predictions, collecting data, interpreting results and presenting findings orally and in written reports. The lab time is devoted in part to working on projects. The teaching assistant provides guidance and support. Other lab days are used to perform experiments that address concepts presented in lecture. Lab simulation can be used as a teaching aid with some activities.

Lecture Outline

I. Overview of Scientific Method

II. Concepts and Issue Survey: Students' Perceptions of Biology

III. Heredity
   A. Mendel
   B. Meiosis (overview of mitosis)
   C. Chromosomal basis of inheritance
   D. Molecular basis of inheritance
   E. Protein synthesis
      1. Transcription
      2. Translation
   F. DNA Technology
IV. Evolution

A. Origin of Life

B. Overview of Prokaryotes, Eukaryotes

C. Darwin's Views

D. Fossil records

E. Comprehensive theory of evolution

F. Biological classifications

G. Discussion of views of evolution

H. Questions

I. Terminology

J. Suggested reading
Lecture Content

I. Scientific Method

Discuss the scientific process. Give a brief overview with examples. Talk about projects for the semester and how students apply this method. A more thorough examination is given during the laboratory section.

II. Survey

Hand out list of questions concerning current issues and fundamental concepts. Students answer questions to the best of their ability. The purpose of this exercise is to see how students perceive scientific issues that are in the news and what their perception is of important biological concepts. Questions are prepared by the instructor and could include topics that are specific to the semester content or random and general to include a broad array of issues. Example questions could be:

- Should it be possible to patent human genes?
- What is gene therapy?
- How does cholesterol affect the heart?
- What are some differences between mitosis and meiosis?
- Do pesticides pose a significant health risk?
- What are our best options for national/international AIDS control policies?
- What biological concepts would you like to know better?

(Workshop Biology, University of Oregon)
III. Heredity

A. Mendel

Gregor Mendel observed traits in garden peas

1. Mendel’s background
   - Born in Austria, now part of the Czech republic
   - Entered monastery in 1843
   - Attended University of Vienna from 1851-1853
   - Taught at Brünn Modern School

2. Law of segregation

3. Law of Independent Assortment

4. Rules of probability

5. Genotype and Phenotype

6. Genetic disorders

B. Meiosis (overview of mitosis)

C. Chromosomal basis of inheritance

   - Genes are located on chromosomes
     - Linked genes and inheritance
     - Independent assortment and crossing over
     - Sex chromosomes
     - Genetic disorders
D. Molecular basis of inheritance

1. DNA makes up genes

   DNA $\rightarrow$ genes $\rightarrow$ chromosomes

   • DNA and bacteria

   Transformation

   • Viral DNA

   Phages

   • More evidence that DNA makes up genes

   Erwin Chargaff

2. DNA composition and structure

   Watson, Crick and Franklin

3. DNA replication

E. Protein Synthesis

1. Transcription

2. Translation
F. DNA Technology – Questions included throughout section

1. Cloning

Dolly, the sheep that made headlines as one of the first mammals to be successfully cloned.
• How is cloning done?
• What are some of the ethical questions posed with this type of cloning?
• Are humans playing God?
• What are some possible pros and cons to cloning?
• At what other levels has cloning been performed?
• How have bacteria been used to clone genes?
• What is a genomic library?

2. DNA testing

• What is DNA testing?
• What types of DNA tests are there?
• What kinds of tests were performed in O.J. Simpson's trial?
• How accurate are some of these tests?
• How would educating the public on such a technical procedure impact society?

3. Gene splicing

• What is “gene splicing”?
• What other terms are sued to describe gene splicing?
• How are genes removed from strands of DNA?
• How are genes inserted into strands of DNA?
• How has DNA recombination affected the health field?

4. Human Genome Project
• How will mapping the human genome affect DNA technology?
• What are some approaches to mapping the human genome?
• What is chromosome walking?

5. DNA technology in the medical and pharmaceutical industries
• How has DNA technology affected these industries?
  ▪ Diagnosis of disease
  ▪ Gene therapy
  ▪ Vaccines and pharmaceutical products

6. Terminology

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<th>Gel electrophoresis</th>
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<td>Hybridization</td>
<td>PCR</td>
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<td>Southern Blotting</td>
<td>Restriction Enzymes</td>
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<td>DNA Fingerprinting</td>
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(Campbell, 1996)
IV. Evolution

A. Origin of life

1. Early Earth: Time is a difficult concept to grasp, especially when one tries to conceive of the world billions of years ago. To help students get a perspective on time as it relates to the span between early earth and the present, instructors could use some useful aid. For example, the instructor could explain time from the origin of earth to present relative to one year. For example

<table>
<thead>
<tr>
<th>Yrs ago</th>
<th>Relative to a year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 bill</td>
<td>(3 yrs ago)</td>
<td>Big Bang – Creation</td>
</tr>
<tr>
<td>4.6 bill</td>
<td>Jan 1</td>
<td>Condensation</td>
</tr>
<tr>
<td>3.5 bill</td>
<td>Apr 1</td>
<td>Oldest known bacteria and &quot;algae&quot;</td>
</tr>
<tr>
<td>13 mill</td>
<td>Dec 31</td>
<td>Red Sea opens</td>
</tr>
<tr>
<td>11 thous</td>
<td>11:59 p.m.</td>
<td>Retreat of last glaciation</td>
</tr>
<tr>
<td>2 thous</td>
<td>14 sec</td>
<td>Christ</td>
</tr>
</tbody>
</table>

(The handout will include more events)

2. Association of geological and biological history

3. Fossil records
   - Oldest animal fossils – 700 million years ago
   - Prokaryotic fossils – 3.4 billion years ago
   - Prokaryotes in stromatolites – 3.5 billion years ago
   - Sedimentary rocks – 3.8 billion years ago
   - First Prokaryotes possibly 4.0 billion years ago
4. How did life begin?

Theories:

- Abiotic synthesis of organic molecules
- *Panspermia*: organic molecules from outer space

5. First genetic material – RNA

Abiotic replication?

6. Information on the origin of heredity supported Darwinian Evolution

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simple → complex
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B. Overview of Prokaryotes, Eukaryotes

1. Prokaryotes, bacteria
   - Overview of cell structure
   - Diverse adaptive ability
   - Prokaryote metabolism
   - Ecological impact

2. Eukaryotes
   - Overview of cell structure
   - Description of protozoans, fungi and plants

C. Darwin's views

1. Natural Selection

   *The Origin of Species*

   Two main ideas:
• Descent with modification

• Natural Selection and Adaptation

Examples: Galapagos finches, Western Butterfly, Mantids

• What do all of the “isms” mean?
  • Catastrophism
  • Actualism
  • Creationism
  • Progressionism
  • Essentialism
  • Uniformitarianism

• Rudimentary organs -- end of the 18th century

Observation of functionless organs
  • Flightless insects
  • Snakes with fragments of useless limbs

• Common underlying plan

Homology; underneath the surface difference of vertebrate limbs lay similar basic structure

• Descent from a common ancestor
  • Phyletic change
  • Cladogenesis
- Embryological development—common descent

"Ontogeny recapitulates phylogeny"

As organisms developed they went through stages that resembled adult forms of primitive types; gill slits, post anal tail

- Animal and Plant Breeding

Display of variations within same species

Darwin believed: Variation and difference was genuine—real

Stability and permanence—illusion

Struggle for existence Comte G.L.L. de Buffon, Erasmus Darwin

Animals multiplies faster than their food source
Nature: Survival of the fittest

Breeding: limited births, less struggle

- New Explorations
  - Existence of animals not listed in bible
  - Change of species as a result of migration and other factors

- Lamarck

  Suggested that onward and upward progress was directed by two natural forces;
  - Drive towards increasing complexity
  
  Shaping power of environment

Buffon vs. Lamarck

Buffon's ideas contained more truths than Lamarck's

1844 – Anonymous book "The Vestiges of the Natural History of the Creation"
2. Other theories:

Influential people and their views of evolution from 1700's to 1800's

Linnaeus (1707 – 1778)   Lyell (1797 – 1875)

Lamarck (1744 – 1829)   Darwin (1809 – 1822)

Malthus (1766 – 1834)   Mendel (1822 – 1884)

Cuvier (1769 – 1832)   Wallace (1823 – 1913)

How did each of these people contribute to our ideas about science, evolution, and life?

How were their views received and which views are still accepted and which are not?

3. Darwin’s background

Grandfather; Erasmus Darwin, biologist and doctor

Father; Robert, physician

Grandfather; Josiah Wedgwood, famous potter

Mother; Susannah, daughter of Josiah

Schooling:

Shrewsbury, 1818

Edinburgh University – 1825, to study medicine

Christ’s College Cambridge – 1827, to study for the clergy

(Miller, 1982)
D. Fossil Record

1825 gaps in the fossil record

Catastrophes?

Punctuated equilibrium?

maintained equilibrium—sudden change

As geology improved, gaps grew smaller giving credence to the notion of continuous transformation (Adam Sedgwick?)

Robert Chambers; more on transformation

E. Comprehensive Theory of Evolution

1. Process of Evolution
   - Potential for species to increase its numbers
   - Genetic variability of offspring due to mutation and recombination of genes
   - Finite supply of the resources
   - Survival of the fittest

2. Darwinian fitness – “favorable” genetic variations

3. Modern synthesis – 1940’s, incorporated ideas from different fields into theory of evolution
   - Hardy Weinberg Equilibrium
   - Evolution vs. Equilibrium
   - Genes are the functional unit of heredity
4. Causes of evolution:
   - Genetic drift
   - Gene flow
   - Mutations
   - Nonrandom mating

5. Natural selection
   - Mendel → Genetic variation
   - Darwin → Natural selection

6. Examples of Polymorphism

7. Genetic Variation through:
   - Mutations
   - Recombination

8. Preservation of Genetic Variation
   - Diploidy

9. Balanced Polymorphism

F. Biological Classifications

1. Classification systems – Taxonomy; Carolus Linnaeus

2. Species criteria

3. Compare view of taxonomy with modern systematics
G. Discussion of evolution

Theories of Evolution have been a controversy since the beginning of mankind. What is fact? What is speculation? Evolution in the purest since pertains to things changing over time. Theories as to how living things have changed have been a hot topic of debate. Due to gaps in fossil records and lack of direct evidence, theories have been numerous and varied. In one book "Darwin on Trial" Philip Johnson looks at the Theory of Evolution with a critical, suspect eye. Excerpts include various opinions from scientists and theorists. It is important to research topics like evolution so that one can make their own critical decisions about what to believe.

Johnson claims that many schools teach evolution as a fact. What does he mean by this? Evolution the process or theories of evolution?

He also states that creation does not oppose evolution as long as evolution is not defined as "fully naturalistic evolution". Evolution does no oppose creation as long as creation is not defined as "sudden creation".

Landmark case: the Scopes trial in Tennessee, one judge declared the teaching of evolution unconstitutional, but this ruling was not intended to be enforced. Scopes was a substitute teacher put on trial for teaching evolution in school. Clarence Darrow was the defense lawyer and William Jennings Bryan was the prosecutor. Darrow supposedly made Bryan look like a fool on the stand when Darrow questioned him about his knowledge of the bible. The outcome: Scopes was to pay a fine of 100$
that eventually got thrown out on a technicality. What did this trial represent? It brought up the issue of evolution in education.

Creation-Science is a term that describes a belief that tries to combine both Creationism with Darwin's Theory of Evolution. The National Academy of Sciences determined that creation-science was not a science because:

- It cannot be based on fundamental principal of “reliance upon naturalistic explanations”
- Theory cannot be tested using the scientific method Johnson replies to this by saying:
- Academy is making assumption that science answers all the questions of evolution
- Literature of Darwinism has anti-theistic conclusions like the Universe was designed without purpose. If religion is separate from science then science should not present opinions about religion

Views from various scholars:

- Dawkins states in his book titled the *Blind Watchmaker* that "Darwin made it possible to be an intellectually fulfilled atheist"
- Colin Patterson is a senior Paleontologist at the British Natural History Museum. He suggests that “both evolution and creation are forms of pseudo-knowledge, concepts which seem to imply information but do not".

• Irving Kristol, a social theorist believes that creation-science is a matter of faith and not science and should not be taught in schools, but believes proponents of creation-science have a point. He states that evolution should be taught as a conglomerate idea of conflicting hypotheses and not as fact. The religious fundamentalists are right in asserting that evolution has an anti-religious edge.

• Stephen Jay Gould, a Harvard professor responded to Kristol's statement by stating that he believes that biologists do teach evolutionary theory as a combination of different ideas, but that the process of things evolving is a fact of nature (Johnson, 1991).

These are only a few of many opinions. They are intended to give different perspectives on the issue and encourage students to take an initiative to find out more on the subject.

H. Additional Questions

What does the word evolution mean?

How have organisms evolved?

What was the Origin of Species all about?

How did western culture receive such ideas?

How did Plato and Aristotle influence western culture?

Do humans follow the Darwinian fitness theory?

Can something “unfit” be made into something “fit”?
I. Terminology

Natural Selection  Paleontology
Descent with Modification  Ontogeny
Divergent Evolution  Biogeography
Convergent Evolution  Homology
Catastrophism  Vestigial organs
Actualism  Phylogeny
Creationism  Cladogenesis
Progressionism  Taxonomy
Essentialism  Allopatry
Uniformitarianism  Sympatry
Modes of Speciation  Disruptive selection
Punctuated equilibrium  Hardy Weinberg
Systematics  Genetic drift
Sedimentary Rocks  Founder effect

(Campbell, 1996)
J. Suggested Reading material

*Panda's Thumb*; Stephen Jay Gould

*Climbing Mount Improbable*; Richard Dawkins

*The Blind Watchmaker*; Richard Dawkins

*The Selfish Gene*; Richard Dawkins

*Darwin on Trial*; Philip E. Johnson

*Origin of Species*; Charles Darwin

*Double Helix*; Watson & Crick

Discussion Content

Sources such as videos, books, newspapers, magazines, and scientific journals are used to explore current research and biological issues. The content should contain information on topics relating to the subject matter covered in the course, however, it does not have to be strictly limited to such topics. There are a variety of sources that can be utilized to obtain scientific knowledge. Samples of a few sources are listed:


News magazines: Time, Newsweek, Life

Journals: The New England Journal of Medicine

Newspapers: Dallas Morning News; Discovery; Monday's business section

Video and films: NOVA (PBS), Frontline (PBS), Discovery programs,

National Audubon society videos
1. Issue Debate

Students divide into two groups. The instructor or assistant can decide the best way to approach this activity. Half of the students could act as a critical audience and give a peer evaluation for the half performing the debate. The students' participating in the debate divide in half and one group chooses to support one side of a controversy, while the remaining members argue the other side of the issue. It is important to define what an issue is. An issue as defined by the Workshop biology at the University of Oregon, is "a problem or situation about which informed people disagree". This activity is good practice to prepare students for the poster presentation assigned in the lab section of next semester's syllabus. Several topics can be suggested and if a decision on an issue cannot be easily made, the instructor could write down the top three or four and choose one. Each group can decide how to research and prepare for the dispute. The peer group will prepare for the same type of debate. They choose their issue and schedule a discussion day for their case. Student assessments are based on preparation and persuasive impact, and if implemented, the peer reviews. It is important that the issues be current and convey important biological themes or concepts. A few ideas for this activity with corresponding sample articles are as follows:

- Nature vs. Nurture
  
  Were You Born That Way; *Life*; April, 1998

- Cloning
  
  Special Report: Cloning; *Time*; March 10, 1997
AIDS

Ethical Issues in Studies in Thailand of the Vertical Transmission of HIV; The
New England Journal of Medicine, March 19, 1998

2. Review and discuss scientific articles

The instructor/assistant can either choose articles or have students decide on areas of interest and choose readings accordingly. The class members read and examine the information. The students should be able to distinguish an article that discusses a biased issue from an article reporting data or factual occurrences. Students could turn in a summary of the article along with any inquiries. The questions and interpretations are explored during the discussion time. Examples of specific topics are:

Evolution

Kinship & Cannibalism: Understanding why animals avoid preying on relative offer insight into the evolution of social behavior; Bioscience; November, 1997

Genetics & Ecology

Genome Resource Banks: Living collections for biodiversity conservation; Bioscience; November, 1997

Virology

Parsasitoids and Polydnaviruses: An unusual mode of symbiosis in which a DNA virus causes host insect immunosuppressions and allows the parasitoid to develop; Bioscience, April, 1998
Heredity

A Dark Inheritance: The Amish get help in fighting hereditary disease; *Time*; Fall, 1997

Assessments are based on any written assignments and member participation. This discussion hour can also allow time for questions about lecture content or exams. The instructor can alter this time to best fit the needs of the class.

Lab Content

1. Lab experiments

Samples of possible activities:

- Modeling protein synthesis
- Virtual fly lab
- Microevolution activity: simulating "mouths" with various instruments like tweezers, toothpicks, etc. Test effectiveness of "mouth" for different types of food; seeds, gelatin, etc. Which mouths are more efficient for eating which kinds of food? If a sufficient amount of food cannot be "eaten" within a given period of time, the organism will go extinct.

2. Project ideas and design

Ideas for projects can range from simple to complex. The instructor/teaching assistant will help guide the students to formulate a testable hypothesis. If some groups have good ideas that are difficult to test, modifications can be made. Students
could utilize simulated experiments, access the Internet and use library resources to research similar hypotheses. Variables should be at a minimum. Students could use other lab members if needed to perform tests. Some ideas could include:

- What factors cause changes in blood pressure?
  Salt? Caffeine? Water?

- Why do the tip of our fingers and toes shrivel in the bath tub?
  Ion concentration? Temperature?

- Why does corn grow better in the dark?

Tests could be more involved or complex based on student desire. One of the objectives for this project is to get students to feel comfortable exploring ideas without a lot of hand holding from the instructor. It is important for the lab assistant to be helpful and available for the group members. The students will turn in portions of the project design and progress throughout designated times in the semester. They include:

- Hypothesis
- Design and setup for project
- Lab equipment and materials, methods
- Data
  Graphs, charts, table etc.
- Interpretation of results and discussion
  Did evidence support hypothesis?
  What important concepts were applied?
  What did students learn from this project?
Course Goals

The intent of this class is to examine the basic structure and function of cells and organelles. It also explores general physiological processes; form and function of human systems and the interactions between systems. In addition, this class covers the interactions of organisms with their environment in a study of ecology. This course also includes discussions of current issues and biological events.

Discussion Goals

Much like the first semester, the discussion time is utilized to explore current biological research and issues. Assigned readings and discussion help students keep up to date on scientific happenings and hone their scientific communication skills. Students will summarize biological articles and give critical examinations of findings.

Lab Goals

Students gain practical experience in performing experiments conveying important biological processes. Class members develop and work on poster presentations. Students work in groups and prepare posters analyzing and presenting both sides of a current, possibly local, biological controversy.
Lecture Outline

I. Cell Biology
   A. Cell Morphology/Characteristics
   B. Cell structure and function
   C. Overview of microscopes
   D. Homeostasis
   E. Cellular respiration and catabolism
   F. Mitosis

II. Animal Physiology
   A. Structure and function of tissues and organs
   B. Homeostatic mechanisms
   C. Digestive system
   D. Circulatory system and gas exchange
   E. Immune system
   F. Renal system and regulation of internal environment
   G. Endocrine system
   H. Nervous system
   I. Reproductive systems and animal development
III. Ecology

A. Ecosystems

B. Species interactions

C. Animal Behavior

IV. Current topics

Lecture Content

I. Cell Biology

A. Cell morphology/characteristics

1. Prokaryotes and Eukaryotic cells

2. Cell size

3. Organization

4. Nucleus

5. Organelles
   - Ribosomes
   - Endoplasmic reticulum
   - Golgi apparatus
   - Lysosomes
   - Vacuoles
   - Peroxisomes
   - Mitochondria
B. Cell structure and function

1. Relate structure to function

Ex. – mitochondria has many folds which increases the surface area to enhance productivity of cellular respiration

2. Description of each organelle’s structure and function

3. Cytoskeleton – structural support and motility

4. Cell membrane structure and function

5. Integration of cells through intercellular junctions

C. Microscopes

1. How microscopes work

2. Types of microscopes

D. Homeostasis

1. Cell membrane – semi permeable

2. Transport mechanisms

3. Osmosis and tonicity

E. Cellular respiration and catabolism

1. Energy

   • Catabolism – Breaking food down to produce energy

   • Anabolism – Energy harnessed and used to produce compounds such as proteins DNA
2. Electron transport, Krebs’ cycle and fermentation
   • Are “fat free” foods really fat free?
   • How is the excess glucose converted and stored?
   • Where is it stored?

3. Diseases and Conditions
   • Diabetes
     • What is diabetes?
     • Is diabetes a curable or controllable disease?
     • Is there more than one kind of diabetes?
     • 1982, the U.S. Food and Drug Administration approves the
       1st drug developed with recombinant DNA technology, a
       form of human insulin.
   • Obesity
     • Can doctors determine the metabolisms of patients?
     • Do some people have less receptors on surface of their
       cell preventing glucose from entering, metabolizing, and
       producing energy?
     • What role does the thyroid play in metabolism
4. Metabolism

- What is energy?
- How is energy obtained?
- How is energy used?
- How is energy stored?
- What is catabolism and anabolism?
- What is cellular respiration?
- What is protein synthesis?

5. Understanding energy

Spontaneous Processes → Requires no outside energy

Nonspontaneous Processes → Requires outside energy

"A spontaneous process occurs in a system and the stability of that system increases"

"Unstable systems tend to change in such a way that they become more stable"

"A process can only occur spontaneously it increases the disorder of the universe"

What do the above statements mean?

How do the statements apply to the laws of thermodynamics?

Do the first and third statements seem to contradict each other?
6. Free energy

Free energy is the energy that can be used in a system to perform work if the temperature is consistent

\[ G = H - TS \]

\( G \) = free energy

\( H \) = Total energy

\( S \) = Entropy (disorder)

\( T \) = Absolute temperature

Free energy = instability of system

Spontaneous reaction = increase in \( G \) = decrease in \( S \)

As a result:

Entropy increases or energy decreases → system less likely to change spontaneously

After a spontaneous reaction, free energy decreases

7. Free Energy and Equilibrium

- \( G \) increases when a reaction is pushed away from equilibrium

8. Free energy and Metabolism

- Exergonic reaction
- Endergonic reaction
- Metabolic disequilibrium
- Energy coupling
9. Bioenergetics

How does the concept of energy apply to living things?

How is it obtained and used by the cell to do work?

Three kinds of work performed by the cell:
  • Mechanical
  • Transport
  • Chemical

What is ATP?

How does this relate to energy?

How are ATP’s made and used?

What is hydrolysis?
  • ATP→ADP
  • High energy→lower energy
  • unstable→more stable

How does energy (ATP) affect cellular respiration?

Where in the cell does cellular respiration take place?

What are enzymes?

What are ribozymes?

How do enzymes drive catabolic reactions?

How are enzymes made in anabolic reactions?

Enzymes are catalytic proteins. Catalysts change rate of reaction, but are not consumed.
10. Terminology

<table>
<thead>
<tr>
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<th>Definition</th>
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<tr>
<td>Enzyme</td>
<td>Energy barrier</td>
</tr>
<tr>
<td>Catalyst</td>
<td>Cofactors</td>
</tr>
<tr>
<td>Free energy of activation</td>
<td>Coenzymes</td>
</tr>
<tr>
<td>Substrate (reactant)</td>
<td>Inhibition</td>
</tr>
<tr>
<td>Active site (binding site)</td>
<td>Allosteric regulation</td>
</tr>
<tr>
<td>Induced fit</td>
<td>Cooperativity</td>
</tr>
<tr>
<td></td>
<td>Ribozymes</td>
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</table>

F. Mitosis

1. Cell division in bacteria

2. Cell division in eukaryotes
   - Interphase and mitosis
   - Stages of mitotic

3. Cancer
   - Cells do not exhibit density-dependent inhibition
   - What causes cells to grow abnormally?
   - Discussion of current progress of cancer research

II. Animal Physiology

A. Structure and function of tissues and organs

1. Function of tissues and organs are correlated with structures
   - Types of tissue
   - Organs and organ systems
2. Muscle types

3. Bioenergetics

B. Homeostatic mechanisms

1. Interaction of organ systems to regulate internal environment

Ex. After a large amount of blood loss:

How does the heart respond?

Do the kidneys play a role in stabilization?

How does the nervous system respond?

- Feedback mechanisms
- Arrangement of organs

C. Digestive system

1. Nutrition

2. What organs make up the digestive system?

3. Vertebrate digestive system exhibits evolutionary adaptations

D. Circulatory system and gas exchange

What role does the circulatory system play in gas exchange?

What does “gas exchange” mean?

What kinds of gases are exchanged?

How do circulatory systems differ between different animals?

How do plants exchange gases?

What role does the nervous system have in regulating the heart beat?

How is simple physics involved in blood flow and pressure?
How do the renal and circulatory systems work together?

How do the lymphatic and circulatory systems work together?

The circulatory system interacts and works together with many other systems to maintain homeostasis in the body.

1. Cardiovascular Diseases and Conditions
   - Hypertension
   - Cardiac arrest
   - Irregular heart beat
   - Anemia
   - Stroke
   - Atherosclerosis
   - Arterosclerosis
   - Hemophilia

2. History

   How did W.W.II affect the progression of medicine?

   - Blood Transfusions

   W.W.I – Citrate solutions used as anticoagulants; lasted only a few days on the shelf

   W.W.II – Added dextrose; nourished RBC’s and doubled blood’s survival time

   Sterilization of blood – caramelizing problem; acidifying solution prevented caramelization and blood was good for up to 21 days
(ACD solution). Blood maintained shape and was not scavenged by the spleen.

What role does the spleen play?

Thirty years later – Adding phosphate increased shelf life by another week.

- Heart surgery

Before the war the heart was rarely touched or tampered

Aristotle – “The heart alone of all viscera cannot withstand serious injury”

Theodor Billroth, surgical genius from Australia believed that any man who worked on the heart should lose the respect of his colleagues.

Dwight Harken believed the heart was strong and resilient and could withstand surgeries. During W.W.II he remove several bullets with his bare fingers from the hearts of wounded soldiers (Berlinger, 1996).

E. Immune system

1. General barriers of protection

2. Defense against specific invaders
   - Key features of immune system
   - Active vs. Passive
   - Humoral and cell mediated
• Cells of the immune system

3. Abnormal immune function

• Autoimmune

• AIDS

F. Renal system and regulation of internal environment

1. Overview of basic homeostatic mechanisms

2. Balance of water uptake and loss

• Osmoregulators

• Osmoconformers

3. Kidney

• Structure and function

• Adaptations of vertebrate kidney

4. Nitrogenous wastes

5. Thermoregulation

G. Endocrine system

What are hormones?

How are they produced in the body?

Where are they produced?

How are the neurosecretory and the endocrine systems alike and how do they differ?

How do hormones affect other systems in the body?

What are “glands” and where are they located?

What hormones regulate water reuptake in the kidneys?
Why do caffeine and alcohol cause frequent urination?

1. Endocrine Glands
   - Hypothalamus – releases hormones into and controls release of hormones in pituitary
   - Pituitary
     - Posterior – Oxytocin, ADH
     - Anterior – GH, FSH, LH, TSH, ACTH, and prolactin
   - Thyroid – Triiodothyronine, thyroxine, and calcitonin
   - Parathyroid – parathyroid hormone
   - Pancreas – insulin, glucagon
   - Adrenal – epinephrine, norepinephrine, glucocorticoids, and mineralcorticoids
   - Gonads – androgens, estrogens, and progesterone
   - Pineal – melatonin
   - Thymus – thymosin

2. Research and treatments
   - Strokes and estrogen

Hormone estrogen may protect against the brain cell death that occurs when a stroke blocks blood flow to the brain. Researchers from Johns Hopkins University in Baltimore compared brain damage after inducing stokes in male and female rats, and female rats with ovaries removed and the normal female rats had more blood flow to the area of the stroke.
What about the affects of estrogen on breast cancer?

- Treatments
  - Menopausal women
  - Diabetics

H. Nervous system

1. Overview

What are the main functions of the nervous system?

- Sensory input
- Integration
- Motor Output

What makes up the nervous system?

- Central nervous system – Brain and spinal cord integration
- Peripheral nervous system – network of nervous system outside the CNS

Sensory input to CNS and motor commands from CNS to effector or target organs

Two main types of cells:

- Neurons – functional unit of nervous system, conduct messages
- Supporting cells – numerous; provide structural reinforcement; protect, insulate, and assist neurons

What are impulses?

- Also known as action potentials, impulses are signals that are carried along the length of a neuron
2. Anatomy of the brain

- Brain stem
- Medulla oblongata
- Pons
- Cerebellum
- Diencephalon
- Telencephalon
- Thalamus
- Hypothalamus
- Cerebral hemispheres
- Basal ganglia
- Cerebral cortex
- Corpus callosum

3. Functions

- Arousal and sleep
- Right and left brain
- Language and speech
- Emotions
- Memory
- Sensory receptors
  - Chemoreceptors
  - Mechanoreceptors
  - Electromagnetic receptors
- Thermoreceptors
- Pain receptors
- Vertebrate eye
- Auditory
- Smell and taste
4. Questions

Why would a callosectomy help an epileptic?

What are strokes and how do they affect the brain?

Why are most mature nerve cells unable to regenerate?

What research is being done on spinal cord injuries and cell regeneration?

Has nerve cell regeneration been observed in other animals and are there nerve cells in humans that can regenerate?

If a damaged nerve cell could repair itself, would that be all that was necessary for the cell to function properly?

What other reparative factors might be needed?

5. Terminology

<table>
<thead>
<tr>
<th>Dendrite</th>
<th>Axon</th>
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<tbody>
<tr>
<td>One way transmission</td>
<td>Action potential</td>
</tr>
<tr>
<td>Membrane potential</td>
<td>Sodium-potassium pump</td>
</tr>
<tr>
<td>Neurotransmitters</td>
<td>Afferent</td>
</tr>
<tr>
<td>Synapse</td>
<td>Electrical synapse</td>
</tr>
<tr>
<td>Chemical synapse</td>
<td>Synaptic cleft</td>
</tr>
<tr>
<td>Autonomic nervous system</td>
<td>Parasympathetic</td>
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<tr>
<td>Sympathetic</td>
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I. Reproductive systems and animal development

1. Animal reproduction

2. Human reproduction
   - Male pattern
   - Female pattern
   - Review of meiosis (covered in heredity)

3. Fetal development

4. Contraception

5. Human development
   - Zygote cleavage
   - Gastrulation
   - Organogenesis and the three embryonic germ layers

III. Ecology

A. Ecosystems

Living and non living factors that live in a community make up an ecosystem

1. What is a trophic structure
   - Dividing species into trophic levels
   - Trophic structure determines routes of energy flow and chemical cycling

2. Hierarchy of food chains
   - Producers
   - Consumers
• Decomposers

3. Primary producers set the spending limit for the energy budget of the ecosystems

• How much sunlight reaches the earth?
• How much light is used for photosynthesis?

4. Energy is lost as it passes through each trophic level

• How fast do ecosystem consumers convert chemical energy into food?

5. Recycling of essential chemical elements is necessary for life to exist on earth

Chemical cycling (water, elements) depends on both biological and geological processes

• Water, carbon, nitrogen and phosphorous cycle
• Variation in cycling time

6. Field experiments: vegetation (producers) regulate chemical cycling

7. Humans disrupt chemical cycles

• Oil spills
• Chemicals carried by wind causing acid rain
• Hunting

8. Agricultural affect on nutrient cycling
9. Eutrophication of lakes

Lakes that are well nourished and can be captured by primary producers

10. Poisons in food chains

11. Humans alter species distribution and reduce biodiversity
   • Introduction of exotic species
   • Human encroachment, loss of biodiversity

B. Species Interaction

1. Community
   • What is a community?
   • What factors are necessary in making up a community?
   • What kinds of species interactions are on our daily trips to work and school?
2. Alternative explanations for the structure of a community

3. Community interactions and evolution

4. Effects of interspecific interactions on communities

5. Predation and parasitism

6. Interspecific competitions

7. Commensalism and mutualism

8. Community structure defined by the activities and abundance of these diverse organisms

9. Succession sequence of changes in a community after a disturbance

10. Biogeography complements community ecology in the analysis of species distribution

C. Animal Behavior

What is behavior?

1. Animals increase Darwinian fitness by optimal behavior

   What behavior would be considered optimal?

2. Ultimate and proximate causation

   The "why" and "how" something exists

3. Stimulus and innate responses:

   Fix action patterns

4. Learning is experience based modification of behavior

   • Nature vs. Nurture
- Learning vs. Maturation
- Habituation Imprinting
- Classical Conditioning
- Operant Conditioning
- Observational Learning
- Play
- Insight
- Animal cognition

5. Rhythmic behaviors

Synchronize an animal's activities with daily and seasonal changes in the environment
- Mating in spring
- Sleeping at night

6. Environmental cues guide animal movement

- Kinesis and taxis
- Migration

7. Foraging behavior

- Cost/benefit analysis

8. Sociobiology: Social behavior and evolution

9. Competition for resources

- Agonistic
- Dominance hierarchies
• Territoriality

10. Mating behavior and animal fitness
• Courtship
• Mating systems

11. Social interactions depend on various kinds of communication

12. Explanation of altruistic behavior

Human sociobiology connects biology to the humanities and social sciences

(Campbell, 1996)

IV. Current topics

Discussion Content

The discussion time for the 2nd semester has the same basic design as the 1st semester. The students or instructor can decide what works best in this time slot based on the results from the previous course.

1. Assigned Reading

Material pertaining to the course content will be explored. For example:

Inhibition of Erythroid Progenitor Cells by Anti-Kell antibodies in Fetal Alloimmune anemia; The New England Journal of Medicine; March 19, 1998

"Addicted", Why do people get hooked, mounting evidence points to a powerful brain chemical called dopamine; Time; May 5, 1997
"Buying Time", The onset of Alzheimer's is delayed by vitamin E; *Time*; May 5, 1997

In search for sight; Use of fetal cells to combat macular degeneration; *Time*; Fall 1997

2. Critical Examination

A critical examination of reports and claims are examined during this time. The five steps suggested in chapter one of the proposed curriculum by Tyser & Cerbin are used. Reports made in newspapers, internet, magazines and various other sources could be used to obtain information. The class members will follow the steps given by the instructor on how to critically evaluate claims. This activity is useful not only for biological interpretations, but can be applied to everyday life. Students will have to make decisions involving politics, purchases, and issues that affect their community and standard of living. Assessment for both activities are based on student participation, preparation, and written assignments.
Lab Content

1. Experiments
   - Cell division in onion root tip
   - Exploring the heart
   - Blood pressure investigation
   - Mitosis modeling

2. Poster Presentation
   - Instructions
     - Work in groups of 3-4 people
     - Produce poster examining issue with a biological impact
     - Must have evidence to support both sides of the issue
     - Posters must include: title, authors, abstract, biological concepts, arguments for both sides, evaluation of arguments, conclusion/opinions, references
   - Task Order
     - Identify issues (handout of issue examples)
     - Choose groups
     - Clarify/focus issues (handout on "issues clarification")
     - Familiarization with resources (handout on "library/internet familiarization")
- Evaluate literature (handout and previous exercise on “critical evaluation of a claim”)
- Review models for poster ideas
- Complete periodic progress reports and summaries
- Dry run; feedback from peers and instructor/assistant
- Present final poster

- Assessment
  - Title
  - Abstract
  - Issue
  - Biological background
  - Arguments
  - Evaluation
  - Conclusion
  - References
  - Creativity
BIBLIOGRAPHY


Kiser, Stacey; Morris, Deborah; Wetherwax, Peter and Udovic, Dan (1991-1996). What Matters in Non-majors' Biology? Workshop Biology, University of Oregon


