AP Biology Course Syllabus

OVERVIEW

Goals I have taught AP Biology at my high school since the course was implemented in 1994. My goal is to show my students the amazing beauty in the structures and functions of the living world and to engender in them appreciation and respect for life in all its forms. I also seek to develop in my students an increased capacity for analytical thought. I must also keep in my sights the pragmatic goals of school and parental expectations regarding student performance on the AP exam. Ideally, these goals would be completely congruent but in the real world they are somewhat competing, mainly due to time constraints. Therefore a balance must be achieved.

Course Structure

Time Considerations Our high school day is divided into the traditional nine 40 minute periods with an alternating A/B schedule. AP Biology meets every day. The class time is one period per day on A days and a double period on B days. (This turns out to be seven periods one week, eight periods the next, etc.) The second period on B days is a "lab period," however in practice the time devoted to lab is much more flexible. Many lab activities utilize the full double period or run for several days in succession. Thus it would be difficult to calculate an exact percentage of time devoted to lab activities. The time allocated for labs based on the A/B schedule is 33% (2.5 periods out of 7.5 periods per week). As already stated, this schedule is not rigidly adhered to but over the course of the year is probably a reasonable estimate. There are other factors contributing to variability in percent lab time. For example, I am continually trying out new lab activities and replacing old ones, which may require more or less time from year to year. Also, as the AP exam date approaches, I use lab time for review time. This loss of lab time is compensated for by the fact that, as a school in the northeast, our academic year runs through June. Much of the five or six weeks of school remaining after the AP exam is spent in the lab.

Course Content As a first year college "intro" course, the content follows the traditional breakdown, which also follows the "three overarching topics," - Molecules and Cells, Heredity and Evolution, and Organisms and Populations, as outlined in the AP Biology Course Description published by the College Board. I follow this micro to macro arc, starting with molecules and then cells. This is followed by genetics and evolution, then organisms, and finishing with populations-ecosystems. (Of course, this is a simplistic description as many topics must be examined on several levels. The study of genetics, for example, must include molecular genetics, cell biology in inheritance patterns, organism biology in understanding phenotypic expression, population dynamics in the Hardy-Weinberg model, and evolution.)

The eight themes identified in the Course Description are woven into the treatment of the course material at appropriate points all year. They form a conceptual underpinning that unifies apparently disparate topics and reminds course participants to step back and look at the big picture. A particular theme manifests in many different topics. Some examples are listed below:

1. Science as a Process: analysis of lab data; study of historical development of a particular topic such as identification of DNA as the molecule of heredity (Griffith, Avery, Hershey-Chase, Chargaff, Franklin, Watson-Crick, Meselson-Stahl, etc.)
2. Evolution - genetic recombination as the "grist" for evolution; heterozygote advantage in sickle-cell anemia; phylogenetic patterns
3. Energy transfer - conservation of energy; respiration and photosynthesis; ATP as an energy storage molecule to drive cell processes; food and energy pyramids.

4. Continuity and change - Mendelian genetics, DNA replication, mutation, selective advantage, behavioral reproductive barriers

5. Relationship of Structure to Function - enzyme specificity; cell type diversity; organ structure and function ex: inner ear

6. Regulation - Positive and negative feedback loops in metabolic pathways; feedback loops in human endocrine pathways ex. thyroid goiter; competition in regulating population

7. Interdependence in Nature - coevolution, mutualisms ex. mycorhizzae, lichen; predator-prey cycles; food webs; decomposers; nitrogen fixation

8. Science, Technology, and Society - lab activities such as DNA electrophoresis and gene transfer; class discussions on ethical issues ex. cloning, "designer" babies; environmental impact of industrial society.

A poster listing the eight themes is displayed in the class room. At appropriate opportunities during class discussions students are challenged to identify connections of the topic at hand to one or more of the themes.

Instructional and Learning Resources. Each student is issued a copy of the textbook "Biology", Raven and Johnson, 6th ed., (2002). Students also use the on-line learning center accompanying the textbook for tutorials, simulations, and practice test questions. An extensive list of web sites is also provided during the course to supplement these resources. Each student also receives the AP Biology Lab manual published by the College Board, as well as handouts for other lab activities. Other resources employed at various times are magazine articles, video tapes, and field trips. An important teaching resource for me is the AP Biology teachers electronic discussion group. (How nice such a resource would have been when I started my teaching career 27 years ago!)

Student Assignments In order to take AP Biology, students must fill out an application the previous Spring. Parental signature is required. The application includes an overview of course expectations with the statement, "you should be prepared to spend an average of one hour a day on AP Biology outside of class." Assignments assume different forms: daily reading and questions, lab reports, essay question practice, long term projects, and studying for tests.

a. Daily reading. Daily reading is assigned from the text. For each chapter students are given a reading guide written by me. The reading guide is a list of questions designed to focus attention on important content. Some of the questions require specific information; others involve analysis and application of concepts. (A sample Reading Guide for the first chapter is attached as an appendix to this syllabus.) The questions form the basis for the class discussion, which is how a typical class period is structured. There is very little formal lecturing. Generally each chapter in the text is divided into two to four reading assignments/class discussions. A unit test is given after three to five chapters.

b. Lab reports. Every lab activity requires a lab report. These vary considerably depending on the nature of the lab. Generally, I require students to write a complete report including purpose, procedure, results, data analysis, questions, and error discussion.

c. Essay question practice. Even though AP Biology generally draws the academically most motivated and capable students, essay writing is almost always one of the skills most lacking. Essays are always included on tests but extra practice as separate assignments is necessary to bring students to an acceptable level. Sometimes these essays are taken from actual AP exams, in which case students are often given the grading rubric and required to rate their own answers.

d. Long term projects. The unavoidable reality of AP Biology is that there is not enough time in the school year to cover all of the material in a meaningful fashion. Choices have to made.

Some topics are skimmed or just not covered. But I have also found that a significant amount of material can be covered through independent projects. These are generally correlated with extended vacation periods: Christmas break, midwinter break, and Spring break. The specific nature of these assignments is described in the Unit Syllabus descriptions following this overview.

e. Tests. Tests in this course generally follow the AP exam in format: 60-70% multiple choice and 30-40% essay. For most students, AP Biology tests are a serious reality check. Students who are accustomed to A's in other courses all of a sudden have to contend with grades of C, D, or F. Most students eventually work their way back up to a level of performance they feel comfortable with although the time varies greatly. Learning how to study is a major part of the experience of the course. Indeed for some it turns out to be one of the most important benefits, judging from visits from returning graduates. Students are expected to prepare for tests independently outside of class. However, one after school review session (optional) is offered before each test.

The last two weeks of class time are spent reviewing for the AP exam. Old exams, old essay questions, review outlines, etc. are used. There are also three or four Saturday morning breakfast/review classes before the exam.

Student Laboratory Experience As noted earlier, a significant portion of the course is devoted to lab time. When the course was first implemented (1994), I followed the AP lab manual quite closely. Over the years I have found some of the lab activities offer rewarding learning opportunities. Others I have found to be frustrating or not very worthwhile and have replaced them with other activities. Unfortunately, the audit guidelines are somewhat ambiguous on this practice. While other lab activities are permitted they must "meet the objectives ..." listed in the AP manual. These objectives are very specific to the lab procedures in the published labs and therefore how much substitution is acceptable is somewhat vague. I have done some neat labs that I think provide valuable experiences but are not related to published labs. (These change from year to year.) For example I have done: comparison of phenotype and genotype through chromatography of mutant Drosophila eye pigments; plant physiology using C-Fern; purification of fluorescent green protein from transformed E. coli; sampling of environmental bacteria with several staining techniques; and an AIDS virus detection simulation using ELISA. Because of time constraints, I will probably have to delete some of these activities in order to restore some of the "required" labs. I will still be experimenting with new approaches to these labs I have been downloading from the AP teachers electronic discussion group. I do not use on-line labs or computer simulations as lab activities (with one exception). I believe labs should be hands-on manipulative experiences.

The lab space is well equipped to perform all activities. Student generally work in groups of two or three, except for microscopy which is done individually.

Some Other Activities (some of these have already been mentioned under Resources)

1. On-line simulations. There are many resources with simulations that help students visualize complex processes. These may be utilized as part of class discussion or as assignments outside of class.
2. Presentations. Students are required to give several class presentations during the year. One is part of their Drosophila genetics lab - presentation of data, chi-square analysis, and discussion of inheritance pattern/mechanism. Another presentation (after AP exam) is from Scientific American. Each student chooses a (biology) article of interest and prepares a 15-20 minute presentation for the class.
3. Video and film. Certain topics come much more to life when supplemented with video material

- animal diversity, for example. Because of time constraints this resource is used sparingly. After the exam, a full length film, Lorenzo's Oil, is shown followed by individual research on the myelin.org website and class discussion.
5. Guest Lecture. Each year (early January) a professor from a local college gives a lecture to my AP Biology class on "Evidence for Evolution", accompanied by numerous manipulative materials - always a well received lesson.
4. Field Trips. Field trips taken during the course have included a visit to the American Museum of Natural History in NYC (during winter break) and an orchid greenhouse. After the AP exam other trips have included a visit to a local university biotechnology department, a rock quarry rich in Devonian fossils, and a peat bog.

Course Syllabus
(Note - all readings from Biology, Raven and Johnson, 6th ed., unless otherwise noted. Each chapter's reading assignments are accompanied by a reading guide/discussion question set. An example for the first chapter (Ch 3) is attached as an appendix to this syllabus.)

Unit I - Molecules, Cell, Membranes (2-3 weeks)

Ch 3 The Chemical Building Blocks of Life
Reading Assignment 3.1 Biological Molecules p. 35-37
Reading Assignment 3.2 Proteins p. 38-45
Reading Assignment 3.3 Nucleic Acids p. 46-49
Reading Assignment 3.4 Lipids p. 50-52
Reading Assignment 3.5 Carbohydrates p. 53-57

Ch 5 Cell Structure
Reading Assignment 5.1 & 5.2 Cells p. 77-85
Reading Assignment 5.3 A tour of the Cell, part I p. 86-93
Reading Assignment 5.3 A tour of the Cell, part II p. 94-101
Reading Assignment Section 7.4 Intracellular adhesion p. 135-9

Ch 6 Membrane Structure and Function
Reading Assignment 6.1 Lipid Structure of Membranes p. 104-5
Reading Assignment 6.2 Membrane Proteins p. 106-111
Reading Assignment 6.3 Passive Transport p. 112-115
Reading Assignment 6.4 Bulk Transport p. 116-117
Reading Assignment 6.5 Active Transport p. 118-121

Laboratory Activities
1. Collection of field specimens for class terrarium
2. Introduction to Microscopy. Calibration of stage micrometer; observation and drawing of cells from live and prepared specimens
3. Effect of surface area and volume of agar blocks on diffusion rate.
4. Diffusion and Osmosis (AP Lab #1)

Unit II Energy, Metabolism, Photosynthesis (3-4 weeks)

Ch 8 Energy and Metabolism
Reading Assignment 8.1 Energy Changes and Chemical Reactions p. 144-148
Reading Assignment 8.2 Enzymes p. 149-153

Ch 9 How Cells Harvest Energy
Reading Assignment 9.1 and 8.3 ATP p. 160-161 and p. 154
Reading Assignment 9.2 Cellular Respiration p. 162-177
A. Overview p. 162-163
B. Stage 1- Glycolysis p. 164-7
C. Stage 2 - Oxidation of Pyruvate p. 168
D. Stage 3 - The Krebs Cycle p. 169-173
E. Stage 4 - The Electron Transport Chain p. 174-177
Reading Assignment 9.3 Catabolism of Protein and Fat p. 178-9 & 9.4 Fermentation p. 181

Ch 10 Photosynthesis
Reading Assignment 10.1 Introduction p 183-185
Reading Assignment 10.2 History p 186-187
Reading Assignment 10.3 The Light Reactions
A. Photosynthetic Pigments p 188 - 193
B. Conversion of Light Energy to Chemical Energy p 194 - 197
Reading Assignment 10.4 Carbon Fixation (Dark Reactions) p 198-203

Laboratory Exercises
1. Enzyme Catalysis (AP Lab #2, using Vernier pressure sensor to monitor O_2 production)
2. Cellular Respiration using Vernier O_2 gas sensor to monitor O_2 consumption by pill bugs
3. Absorption spectra of synthetic pigments
4. Photosynthesis (AP Lab #4)

Unit III - Cellular Basis of Inheritance (2 weeks)

Ch 11 How Cells Divide
Reading Assignment 11.1 Prokaryotes & Section 11.2 Eukaryotic Chromosomes p 208-211
Reading Assignment 11.3 Mitosis p 212-217
Reading Assignment 11.4 Control of the Cell Cycle p 218-223

Ch 12 Meiosis
Reading Assignment 12.1 and 12.2 Introduction p. 225-229
Reading Assignment 12.3 Meiosis in Further Detail p. 230-235
Reading Assignment **1**2.4 Sexual Reproduction - An Evolutionary Perspective p. 236-237

Ch 13 Patterns of Inheritance
Reading Assignment 3.1 Mendel
Part A Mendel and the Law of Segregation p. 239-249
Part B Crosses With More Than One Character p. 250-256
Reading Assignment 3.2 Human Genetics p. 257-258

Reading Assignment 3.3 The Chromosomal Basis of Heredity
Part A Linkage p. 262-267
Part B More Human Genetics p. 267-273 & 259

Laboratory and Other Activities
1. Mitosis & Meiosis (AP Lab #3, Mitosis prepared slides, root squash, and Sordaria cross)
2. Student poster - Meiosis
3. Genetics of Drosophila - P, F_1 and F_2 generations (AP Lab #7)

Unit IV - Molecular Genetics (4-5 weeks)

Ch 14 DNA: Structure and Replication
Reading Assignment 14.1 What is the Genetic Material? p. 280-283
Reading Assignment 14.2 The Structure of DNA p. 284-287
Reading Assignment 14.3 DNA Replication p. 288-294
Reading Assignment 14.4 What is a Gene ? p. 295-297

Ch 15 Genes and How They Work
Reading Assignment 15.1- 15.2 The Central Dogma; The Genetic Code p 300-3
Reading Assignment 15.3 Transcription and Translation in More Detail p 304-8
Reading Assignment 15.4 RNA Processing p 309-311

Ch 16 Control of Gene Expression
Reading Assignment 16.1-16.3 Transcriptional Control of Gene Expression p 313-321
Reading Assignment 16.4 Transcriptional Control in Eukaryotes p 322-329 and p 126-7

Ch 18 Altering the Genetic Message
Reading Assignment 18.1 Mutation p 361-366
Reading Assignment 18.3 Genetic Recombination p 380-387

Ch 19 Gene Technology
Reading Assignment 19.1 Restriction Enzymes p 389-392
Reading Assignment 19.2 Techniques of Genetic Engineering p 394-401
Reading Assignment 19.3 The Biotechnology Revolution p 402-417

Laboratory Activities

1. Transformation (Bio-Rad p-Glo kit) (AP Lab #6)
2. Restriction enzyme digestion and electrophoresis of DNA (Bio-Rad kit) (AP Lab #6)

(Note: Unit IV is generally concluded before Christmas vacation. The next unit, Plant Anatomy and Transport, is given as a take home writing assignment over vacation.)

Unit V Plant Anatomy and Transport
This unit consists of a take home assignment comprised of three essay questions. The first essay

requires students to incorporate a list of vocabulary words into a narrative that gives each word an appropriate context. The vocabulary includes terms related to plant anatomy and growth (cell types, tissue types, meristems, primary and secondary growth, etc.) The second essay is basically an adaptation of an AP exam question (1988) on water transport. The last question is similar but deals with food (phloem) transport. Reference reading is from Chapters 38 and 39.

Laboratory Activities (carried out some time in February or March during Units IX and X)

1. Transpiration (AP Lab #9)
2. Misc. plant anatomy/physiology labs - ex. flower dissection; pollen germination; stomata obs.

Unit VI Evolution (3 weeks)

Ch 20 Population Genetics

Reading Assignment 20.1 Natural Variation p 422-423
Reading Assignment 20.2 Part A Hardy-Weinberg Equilibrium and Microevolution p 424-429
Reading Assignment 20.2 Part B Maintaining Polymorphism p 430-433
Reading Assignment 20.3 Natural Selection Acts on Combinations of Traits p 434-437

Ch 21 Evidence for Evolution

Reading Assignment 1.3 Charles Darwin p 10-14
Reading Assignment 21.2 Natural Selectionp 444-9; 419-420; Sexual Selection 27.2 p 557-559
Reading Assignment 21.3 Other Evidence p 450-455; 15-16; 479-481

Ch 22 The Origin of Species

Reading Assignment 22.1 The Nature of Species p 457-459
Reading Assignment 22.2 Reproductive Barriers p 460-462
Reading Assignment 22.3 How Can New Species Form? p 463-467
Reading Assignment 23.4 Adaptive Radiation p 468-475

Ch 32 Classification

Reading Assignment 32.1 Taxonomy p 649-653
Reading Assignment 32.2 Systematics and Cladistics p 654-656
Reading Assignment 32.3 Kingdoms and Domains p 657, 660-1

Laboratory Activities

1. Population Genetics and Hardy-Weinberg Equilibrium using on-line simulation PopCycle (http://faculty.washington.edu/~herronjc/SoftwareFolder/PopCycle.html) Note: This is the only lab activity done by computer simulation, mainly because of the small enrollment in AP Biology in our school (typically 6-10).
2. Creation of an “evolutionary tree” with Caminalcules.

Unit VII Organismal Biology: Simple Organisms through Plants (3 weeks)

Ch 33 Viruses

Reading Assignment Ch 33 Viruses p. 663, p 665-677, selected sections

Ch 4,8,32, &34 Bacteria

Reading Assignment 4.2 The Origin of Life p 62-69
Reading Assignment 8.4(part) Evolution of Metabolism (a scenario) p 157
Reading Assignment 34.1 & 34.2 Bacteria, Overview and Structure p 680-683
Reading Assignment 34.3 Bacterial Diversity p 72, 658-9, 684-691 parts

Ch 35 Protists

Reading Assignment 35.1 and 35.2 Introduction p 694-697
Reading Assignment 35.3 Overview of the Major Protist Phyla p 698-717

Ch 36 Fungi

Reading Assignment 36.1 Introduction p 719-723
Reading Assignment 36.2 Overview of Main Groups of Fungi p 724-729, parts
Reading Assignment 36.3 Two Key Mutualisms p 730-1

Ch 37 Evolutionary History of Plants

Reading Assignment 37.1 Introduction p 736-7
Reading Assignment 37.2 Nonvascular Plants p 738-739
Reading Assignment 37.3 Seedless Vascular Plants p 740-44
Reading Assignment 37.4 Seed Plants p 745-749, parts

Laboratory Activities

1. Collection, Culturing, Slide Preparation, and Staining of Environmental Bacteria
2. Protist Observation: Termite Gut and other cultures
3. Culture and Observation of C-fern life cycle.

Unit VIII Animal Body Plan and Phylogeny
The bulk of this unit is assigned as an independent project. An introductory lecture is given on the animal body plan (Ch 44, section 44.1). The remainder takes the form of an outline on the main invertebrate phyla. For each phylum, students research and provide information for approximately 12 headings (ex. body plan, circulatory system, digestive system, means of locomotion, etc.) Also required are descriptions of major classes within each phylum, representative organisms, and

illustrations. The information is based on Ch 44-48 in the text as well as several excellent websites (ex. http://animaldiversity.ummz.umich.edu/site/index.html; http://tolweb.org/tree/phylogeny.html.; http://www.ucmp.berkeley.edu/help/taxaform.html). The assignment is given before midwinter break (February) and is due after Spring break (April).

Unit IX Animal Structure and Function, Part I (2-3 weeks)

Ch 49 Organization of the (Vertebrate) Animal Body p 984-987

Ch 50 Locomotion

Reading Assignment 50.1 & 50.2 Bones and Joints p 999-1003
Reading Assignment 50.3 Muscle p 1004-1015

Ch 51 Digestion

Reading Assignment 51.1 Types of Digestive Systems p 1017-1019
Reading Assignment 51.2 Swallowing and Transport of Food to Stomach p 1020-1023
Reading Assignment 51.3 Small and Large Intestine p 1024-1029
Reading Assignment 51.4 Accessory Organs and Control of Digestion p 1030-1033
Reading Assignment 51.4 Nutrition p 1034-1035

Ch 52 Circulation

Reading Assignment 52.1 Introduction p 1037-1039
Reading Assignment 52.2 Blood and Blood Vessels p 1040-1044
Reading Assignment 52.3 The Heart p. 1045-1047
Reading Assignment 52.4 The Cardiac Cycle p. 1048-1051

Ch 53 Respiration

Reading Assignment 52.1 and 53.2 Introduction; Gills p 1053-1057
Reading Assignment 53.3 Terrestrial Respiration p 1058-1061
Reading Assignment 53.4 Mammalian Breathing p 1062-1065
Reading Assignment 53.5 Blood Transport of O2 and CO2 p 1066-1069

Laboratory Exercises
1. Physiology of the Circulatory System (AP Lab #10)
2. Dissections (varies yearly; ex. fetal pig, sheep heart, sheep kidney, etc.)
3. Contraction of Glycerinated Muscle (Caroline Kit)
(4. Transpiration - already mentioned above in Unit V)
(5. Misc. plant anatomy/physiol. activities - already mentioned above in Unit V)

Unit X Animal Structure and Function, part II (3 weeks)

Ch 54 The Nervous System

Reading Assignment 54.1 Introduction p 1073-1075
Reading Assignment 54.2 Nerve Impulses p 1076-1080
Reading Assignment 54.3 The Synapse p 1081-1087
Reading Assignment 54.4 and 54.5 The Central and Peripheral Nervous Systems p 1088-97

Ch 56 The Endocrine System

Reading Assignment 56.1 Hormones p 1125-1127; omit 1130-1131
Reading Assignment 56.2 Cellular Mechanisms of Hormone Action p 1132-1134 **,**129-132
Reading Assignment 56.3 The Hypothalamic-Pituitary Axis p 1134-1139
Reading Assignment 56.4 Endocrine Control of Body Function p 1140-1145
Reading Assignment 41.2 Plant Hormones p 812-822; 826-7

Ch 57 The Immune System

Reading Assignment 57.1 Nonspecific Defenses p 1147-1151
Reading Assignment 57.2 Specific Defenses p 1152-1155
Reading Assignment 57.3 T Cells p 1156-1157
Reading Assignment 57.4 B Cells p 1158-1165
Reading Assignment 57.6 Immune System Failure p 1168-1171

Ch 58 Maintaining the Internal Environment

Reading Assignment 58.1 Homeostasis p 1173-1177
Reading Assignment 58.2 Osmoregulation in Animals p 1178-1185
Reading Assignment 58.3 The Kidney p 1186-1191
Reading Assignment 58.4 Hormonal Control of Kidney Function p 1192-93

Ch 59 (& 60, part) Human Reproduction

Reading Assignment 59.3 Human Reproduction p 1202-1209
Reading Assignment 60.3 Embryonic Development p 1216-1230, selected topics

Unit XI Ecology (2 weeks)

Ch 24 Population Ecology

Reading Assignment 24.1 Populations p 496-500
Reading Assignment 24.2 Age Dynamics of Populations p 501-503
Reading Assignment 24.3 Reproductive Trade-offs p 504-505
Reading Assignment 24.4 Population Growth p 506-510
Reading Assignment 24.5 Human Population p 511-513

Ch 25 Community Ecology

Reading Assignment 25.1 Ecological Niches p 515-519
Reading Assignment 25.2 Predator-Prey Relationships and Coevolution p 501-503
Reading Assignment 25.3 Other Coevolutionary Relationships p 524-529
Reading Assignment 25.4 Ecological Succession p 530-531

Ch 28 Ecosystems

Reading Assignment 28.1 Chemical Cycles p 571-577
Reading Assignment 28.2-28.3 Trophic Structure of Ecosystems p 578-585
Reading Assignment 28.4 Biodiversity p 586-589

Laboratory Activities (performed after AP exam)

AP Lab #11 - Behavior Habitat Selection
AP Lab #12 - Aquatic Primary Productivity

Appendix: Sample of student reading guide provided with each chapter. See syllabus Overview for further explanation.

AP BIOLOGY CH 3: THE CHEMICAL BUILDING BLOCKS OF LIFE

Section 3.1 Biological Molecules (p. 35-37)

1. Describe the ***polarity*** of a hydrocarbon molecule and explain the reason for it.

2. What is a ***functional group***? How do functional groups affect the polarity of molecules. Why?

3. What connection is there between figure 3.2 (p. 36) and figure 2.8 (p. 24)?

4. a) Use the following terms in a paragraph to illustrate their meanings: ***macromolecule, polymer, dehydration synthesis, hydrolysis, water, bond, energy***.
   b) Diagram a condensation synthesis.
   c) Name the functional groups most likely to be involved in this type of reaction.
   d) Name the four classes of biological macromolecules.

Section 3.2 Proteins (p. 38-45)

5. Discuss the relationship between table 3.2 (p. 38) and table 13.2 (p. 261).

6. a) Diagram a generic ***amino acid*** .
   b) What do the white boxes in figure 3.6 signify?
   c) On what basis are the amino acids grouped?

d) Explain the sentence, p. 40 bottom left, "Portions of a protein chain with numerous ..... by hydrophobic exclusion."
e) What does the symbol at the right signify?

7. a) Diagram the formation of a peptide bond.
b) Define: ***peptide; dipeptide; tripeptide; polypeptide; protein***.

8. Discuss the organization and underlying forces that are involved in each of the following levels of protein structure: ***primary, secondary,*** *motif,* ***tertiary,*** *domain,* ***quaternary*** .

9. What is the "protein folding problem"? How do *chaperonins* help?

10. a) What is protein ***denaturation***? What causes it? Why?
b) In what way does the information in figure 3.9 (p. 45) seem to contradict the discussion on p. 44?

Section 3.3 Nucleic Acids (p. 46-49)

11. Complete the analogy: protein: amino acid = ***nucleic acid*** :__?__.

12. a) Name the three components of a ***nucleotide***.
b) Draw a generic diagram of a nucleotide.
c) Which component is <u>not</u> part of the polymerization reaction?
d) Name the sugar in ***DNA***_____ in ***RNA***_____
e) Compare *purines* and *pyrimidines.*
f) Name the nitrogen base found only in DNA_____ only in RNA_____.

13. Describe the structure of the DNA molecule. What is the main difference compared to RNA?

14. Define "dogma." What is the "central dogma of molecular biology."

15. What is the main difference between ATP (fig. 3.17) and the nucleotide in figure 3.13?

Section 3.4 Lipids (p. 50-52)

16. Describe and explain the behavior of lipids in water.

17. a) Draw a generic molecule of :
a ***phospholipid*** a ***fat*** (triglyceride)
b) Compare their behavior in water
c) Describe their main functions

18. Distinguish between saturated and unsaturated fatty acids with respect to structure, sources, and melting temperature.

19. Although structurally very different from fats, oils, and phospholipids ***steroids*** and *terpenes* are included in the lipid family. Why?

Section 3.5 Carbohydrates (p. 53-57)

20. Define: ***carbohydrate; sugar; monosaccharide; disaccharide***.

21. Identify the main distinguishing feature for each pair of molecules:
    a) glyceraldehyde glucose
    b) deoxyribose ribose
    c) fructose ribose
    d) fructose glucose
    e) galactose glucose

22. Define or describe:
    a) *structural isomer*
    b) *stereoisomer*
    c) *ring form*

23. What is the functional significance of a disaccharide?

24. Complete the analogy: protein : dehydration synthesis = ***polysaccharide*** : __?__

25. Define, describe, and give examples of ***storage polysaccharide (starch)***.

26. Define, describe, and give examples of ***structural polysaccharide***. Compare their properties with starches.