AP Biology Syllabus

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Personal Philosophy:

Fundamentally, I teach biology because it is the unifying thread in my philosophical world view and as such it is my hope that I impart that knowledge to my students to help them inform their own views and opinions. We live in a time when scientific literacy is largely under appreciated by the general public and yet our impact as a species on the biosphere of our planet has never been larger. I believe that we, as educators, owe it to our students to impart the current state of knowledge regarding planetary and biological processes. It is only through this process that we have any hope of reversing the current trends of global ecosystem decline and unsustainable practices.

Course Overview:

My AP Biology course is intended as an introductory survey to the various sub-disciplines that comprise the modern biological sciences. The course is designed to emulate a two-semester sequence in introductory college-level biology. I believe that Science is more than a collection of facts, it is a process of observing and understanding the natural world. To that end, I try to foster scientific literacy and allow my students a large opportunity to practice the process of science. We meet for two, 45-minute periods every day, five days a week. Typically, this allows three periods every week to spend on laboratory exercises. By devoting 30% of my instructional time to authentic laboratory activities, I can ensure that my students have an adequate amount of time to practice the process of being scientists. Laboratory activities include all twelve of the recommended labs listed in the AP Biology Course Description, with additional supplemental laboratory activities taken from a variety of other sources, most notably the on-line laboratory database of the Cornell Institute for Biology Teachers (CIBT).

As well as laboratory activities, I assign my students a variety of research projects, independent analysis of pertinent scientific research and scientific writing. Most of these projects are done in conjunction with an on-line course wiki that also provides my students with a forum for discussion and collaborative approaches to all assigned coursework. Weekly discussion topics are posted and students are required to respond to those topics.

The course is divided into nine units that span all levels of biological

organization, from atoms and molecules, through cells and organs and into interactions among and between organisms. These units have been developed with the eight major themes from the AP biology curriculum in mind: Science as a process, Evolution, Energy Transfer, Continuity and Change, Relationship of Structure to function, Regulation, Interdependence in Nature and Science, Technology and Society. While some units in the course stress certain themes more heavily than others, these themes are demonstrated at every level of biological organization covered in my class. In particular, I stress the role of the modern theory of evolution as a unifying theme across the entire breadth of the course, and tie all material that is covered to at least one aspect of modern evolutionary theory. I believe that it is important to foster discussion of topics in class as students learn about them. To that end, I try to provide students with multiple perspectives and ample opportunity to develop their own conception of the material.

Quizzes are given on a weekly basis. Every unit concludes with a cumulative unit exam. Exams are comprised of 40 AP-style multiple choice questions and 1-2 essay questions taken from old AP Biology exams. A midterm is given after the first semester that mimics the format and administration of the AP Biology Exam.

In addition to the curriculum outlined below, I allow for a two-day introduction to the course, reviewing the nature of the scientific method (Chapter 1 in the textbook) and one week for dedicated AP Exam Review at the end of the course. I have indicated what chapters from the textbook cover the material that I teach in each unit.

Curriculum:

<u>Unit 1- Atoms, Molecules and Enzymes</u>
Time Frame: 3 weeks
Textbook chapters: 2,3,4,5,7

Content:

I. Atoms and Molecules (Chapters 2,3,4,5)

A. Basic Chemistry Review: Atomic theory, types of bonding, properties of molecules
B. Water: structure, chemistry, hydrogen bonding, properties of water
C. pH: Acids, buffers, dissociation of water molecules.
D. Carbon: Central role of carbon in living things, functional groups

E. Biological Molecules: Structure and function of carbohydrates, lipids, proteins and nucleic acids

II. Metabolism and Enzymes (Chapter 8)

A. Metabolism introduction: What is metabolism? Nature of chemical reactions (rate, redox, equilibrium), thermodynamics of chemical reactions.

B. Enzymes: Structure and function, coenzymes, environmental effects on enzymes, enzymes and the control of metabolic pathways, regulation of metabolic pathways, ATP structure and function.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 2- Enzyme Catalysis

CIBT- Biological Shapes

Major Projects:

None

Major Assessment: Unit 1 Cumulative Exam

<u>Unit 2- Cell Structure and Function</u>

Time Frame: 3 weeks

Textbook Chapters: 6,7,11

Content:

I. Cell Structure and Function (Chapter 6)

A. Prokaryotic cell structure and function

B. Eukaryotic cell structure and function: The endomembrane system, chloroplasts and mitochondria, other eukaryotic organelles

II. The Cell Membrane (Chapter 7, Chapter 11)

A. Structure and Function of the Cell Membrane: fluid-mosaic model, function of membrane proteins, cellular receptors

B. Transport: Diffusion/osmosis, active transport, endocytosis/exocytosis

C. Signal Transduction.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 1- Diffusion and Osmosis

Cell anatomy and Microscopy Review Laboratory Activity.

Major Projects:

Cell Organelle Advertisement: Students research eukaryotic organelles and construct a one-page advertisement "selling" their organelle.

Major Assessment:

Unit 2 Cumulative Exam

<u>Unit 3- Energy Transformations: Respiration and Photosynthesis</u>
Time Frame: 3 weeks
Textbook Chapters: 9,10

Content:

I. Respiration (Chapter 9)

A. Overview of Respiration: Redox reaction review, chemiosmotic model, mitochondria structure and function.

B. Glycolysis: Overview, reactants and products, fermentation vs. aerobic respiration.

C. Krebs Cycle: Overview, acetyl-CoA cycle, reactants and products.

D. Electron Transport Chain: Overview, oxidative phosphorylation vs. substrate level phosphorylation, Control of oxidative phosphorylation.

E. Respiration Extensions: Overall energy, relationship of respiration to other catabolic pathways, anabolic pathways.

II. Photosynthesis (Chapter 10)

A. Overview of Photosynthesis: Nature of light, chlorophyll and other pigments, chloroplast structure and function.

B. Light Dependent Reactions: Photosynthetic membranes, photosystem structure and function, cyclic and non-cyclic electron flow, reactants and products.

C. Light Independent Reactions: Calvin cycle, rubisco structure and function. Reactants and products.

D. Photosynthesis Extensions: Overall Energy, products of photosynthesis, Relationship between light dependent and

light independent reactions, photorespiration, C3 and C4 plants

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 5- Cell Respiration

AP Lab 4- Plant Pigments and Photosynthesis

Major Projects:

Respiration and Photosynthesis Play: Students act out the processes of Respiration and Photosynthesis in class, playing the roles of the various molecules involved in both processes.

Major Assessment:

Unit 3 Cumulative Exam

<u>Unit 4- Classical Genetics</u>
Time Frame: 4 weeks
Textbook Chapters:12, 13, 14, 15

Content:

I. Cell Division (Chapter 12, 13)

A. Binary fission

B. Mitotic Cell Division: Eukaryotic nucleus structure and function, cell cycle overview and checkpoints, phases of mitosis, cytokinesis.

C. Meiotic Cell Division: Haploid vs. Diploid, meiosis and life cycle, phases of meiosis, meiosis in humans.

D. Mitosis vs. Meiosis: Comparisons, asexual and sexual Reproduction.

II. Classical Genetics (Chapter 14, 15)

A. Early ideas about heredity

B. Probability

C. Mendel's experiments: Process of Mendel's experiments, law of segregation, law of independent assortment, dominant and recessive alleles, monohybrid and dihybrid crosses.

D. Mendel and meiosis

E. Exceptions and Extensions to Mendelian Genetics: Codominance, Multiple alleles (blood groups), epistasis,

pleiotropy, penetrance, expressivity.

F. The relationship of an organisms environment and its heredity on its phenotypes.

G. Sex-linkage: T.H.Morgan's experiments, sex-linked traits in humans and fruit flies, sex-linked human conditions, karyotype analysis, pedigree analysis.

H. Gene Linkage: How and Why, linkage mapping, three-point test cross.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 3- Mitosis and Meiosis

AP Lab 7- Genetics of Organisms

Chi-Square M and M Analysis

Major Project:

None.

Major Assessment:

Unit 4 Cumulative Exam.

<u>Unit 5- Molecular Genetics</u>

Time Frame: 5 weeks

Textbook Chapters: 16, 17, 18, 19, 20

Content:

I. DNA- Structure and Function (Chapter 16)

A. What is a gene: historical modification of the gene concept, relationship between DNA and protein, Griffith experiments, Hershey-Chase experiments, Chargaff experiments.

B. The Structure of DNA: Watson and Crick model, evidence for DNA structure, Rosalind Franklin. Base pairing rules.

C. DNA Replication: How and why.

II. Protein Synthesis (Chapter 17)

A. Gene Structure: Promoters, enhancers, coding region.

B. Genetic Code overview: History of deciphering the genetic code, codons, relationship of DNA and RNA.

C. Transcription: Process, prokaryotes vs. Eukaryotes. RNA processing.

D. Translation: Process, prokaryotes vs. Eukaryotes.

E. Mutations: Types of mutations, effects of mutations, hemoglobin structure and sickle cell mutation effects. Mutagenesis. Role of mutations in generation of variety.

III. Genomics (Chapter 18, 19)

A. Virology: Viral life-cycles, prokaryotic and eukaryotic viruses, HIV life cycle.

B. Bacterial: Recombination mechanisms in bacteria, transformation, transduction, conjugation. Gene regulation in bacteria, operon structure and function.

C. Eukaryotic: Structure and function of eukaryotic genome, human genomics, nucleosome structure and function, transposable elements, current understanding of the constitution of the human genome.

III. Biotechnology (Chapter 20)

A. Strategies for genetic manipulation in prokaryotes and eukaryotes.

B. Gene technology: Process and applications

C. Ethical implications and considerations of genetic engineering.

D. Societal and Environmental Concerns of Biotechnology.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 6- Molecular Biology

CIBT- Statistics and Probability in the Evaluation of DNA Evidence.

Major Project:

Protein Synthesis Play: Students act out the process of Protein synthesis in-class, playing the roles of the various molecules involved in the process

Genetic Technology Techniques and Applications WebBook: Students research important Genetic Engineering Techniques and their applications and contribute to the construction of an on-line "WebBook" reference source on Genetic Technology.

Major Assessment:

Unit 6 Cumulative Exam

Unit 6- Evolution and Life's Diversity
Time Frame: 4 weeks
Textbook Chapters: 22, 23, 24, 25, 26, 27, 28, 31, 32, 33, 34,

Content:

I. Natural Selection (Chapter 22)
- A. Historical concepts of evolution
- B. Darwin and Natural Selection: The theory of Natural Selection, evidence for evolution by natural selection.

II. Population genetics (Chapter 23)
- A. Hardy-Weinberg principle
- B. Factors affecting allelic frequencies in populations

III. Speciation (Chapter 24)
- A. Mechanisms of reproductive isolation
- B. Allopatric speciation and sympatric speciation.
- C. Adaptive Gradation
- D. Patterns of Evolution: Gradualism and Punctuated Equilibrium
- E. Effects of Genetic alterations on the evolution of a species.

IV. Organization, Origin and History of Life on Earth (Chapter 25, 26)
- A. Phylogeny and Systematics: Historical Development and Current Models
- B. Origin of life: current hypotheses of abiogenesis,
- C. History of life: endosymbiosis, development of complexity.
- D. Brief survey of life's diversity: prokaryotes, protists, fungi, plants, animals.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 8- Population Genetics and Evolution
Hardy-Weinberg and Teddy Graham Population Genetics

Major Projects:

Debunking Creationist Claims Research Project: Students choose one creationist critique of modern evolutionary theory, research scientific arguments opposing their selected creationist critique and present their claim and the arguments against it to the class.

Kingdom Parade Independent Study: Working individually, students complete an analytical study of life's diversity, in conjunction with Chapters 27, 28, 30-34 in the textbook. This project is done during student's February Break.

Major Assessment: Unit 6 Cumulative Exam.

Unit 7- Ecology
Time Frame: 4 weeks
Textbook Chapters: 50, 51, 52, 53, 54, 55

Content:

I. Ecosystems (Chapter 50, 54)
- A. Levels of organization in ecosystems
- B. Ecosystem structure and function
- C. Environmental issues in ecosystems
- D. Trophic structure in ecosystems
- E. Biogeochemical Cycles
- F. Biome survey.

II. Behavioral Ecology (Chapter 51)
- A. Animal Behavior: Taxis, conditioning, habituation
- B. Learning
- C. Sociology and Sociobiology

III. Population and Community Dynamics (Chapter 52, 53)
- A. Growth and structure of populations
- B. Interactions between organisms: Competition, Predation, Symbiosis

IV. Conservation (Chapter 55)
- A. Why Conservation is Important- Societal and Environmental Concerns
- B. History of conservation
- C. Current practices in conservation

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 11- Animal Behavior

AP Lab 12- Dissolved Oxygen and Aquatic Primary Productivity

Major Project:

Common Sense Conservation: Students research one method of conservation that can be applied at the local or individual level and consider the barriers toward and consequences of implementation of their chosen method. Students present their method to the class and collaborate on the construction of an on-line "WebBook" reference.

Major Assessment:

Unit 7 Cumulative Exam.

Unit 8- Animal Physiology
Time Frame: 4 Weeks
Textbook Chapters: 21, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49

Content:

I. Vertebrate Systems (Chapters 21, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49)

A. Digestive System: Evolution of vertebrate digestion, Comparisons of animal digestive systems, overview of mammalian digestive system.

B. Circulatory System: Evolution of vertebrate circulation, comparisons of animal circulatory systems, overview of mammalian circulatory system, structure and function of mammalian heart.

C. Respiratory System: Evolution of vertebrate respiratory system, comparisons of animal respiratory systems, overview of mammalian respiratory system, structure and function of mammalian lung.

D. Immune System: Evolution of animal immune system, overview of mammalian immune system. Structure and function of mammalian humoral and cell-mediated immune response.

E. Excretory System: Evolution of animal excretory system, overview of mammalian excretory system. Structure and function of mammalian kidney.

F. Regulatory System: Evolution of animal regulatory systems, overview of mammalian nervous and endocrine systems. Structure and function of human brain. Structure

and function of neuron.

G. Reproductive System: Evolution of animal reproductive systems, overview of mammalian reproductive systems.

H. Development: Role of genetics in embryological development. Comparative embryology of amphibian, bird and human embryo.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 10- Physiology of the Circulatory System

Major Project:

None

Major Assessment:

Unit 8 Cumulative Exam.

<u>Unit 9- Plant Physiology</u>

Time Frame: 3 weeks

Textbook Chapters: 29, 30, 35, 36, 37, 38, 39

Content:

I. Plant Morphology and Histology (Chapters 29, 30, 35)

A. Evolutionary history of plants.

B. Types of plant tissue.

C. Asexual and Sexual Reproduction in Plants: Pollination, fertilization, fruiting, Seeds

II. Plant Physiology (Chapters 36, 37, 38, 39)

A. Water movement in plants: Transpiration

B. Sugar movement in plants: Translocation

C. Hormones and Regulation of Plant Growth: Auxins, Gibberellins, cytokinins, abscisic acid, ethylene.

D. Flowering and Photoperiodism.

Major Assignments and Assessments:

Major Laboratory Assignments:

AP Lab 9- Transpiration

CIBT- Plant Game

Major Project:

None.

Major Assessment:
Unit 9 Cumulative Exam.

Textbooks
Author:Campbell, Neil A.
Second Author:Reece, Jane B.
Title:Biology (7th Edition)
Publisher:Benjamin Cummings
Published Date:13 December, 2004

Author: The College Board
Title: AP Biology Lab Manual For Students (Revised 2001)
Publisher: The College Board
Published Date: 2001 (Revised)

Other Course Materials
1. Primary Sources
Description: I use multiple readings from scientific journals and scientific non-fiction writers. While this list changes from year to year below is a list of several materials that I use on a regular basis:

2. Audiovisual Materials
Description: I use multiple DVD's and video clips during the year. I am always looking for useful audio and visual materials to incorporate into my class.

3. Websites
URL: Http://wiknuffke.wikispaces.org
Description: This is the main course web page for my AP Biology Class. It serves as a hub for all weekly discussion topics and on-line research projects. It also provides students access to electronic versions of in-class handouts and notes, as well as a venue for web-based extra help.

URL: Http://cibt.bio.cornell.edu
Description: This is the website for the Cornell Institute for Biology Teachers (CIBT). It provides access to electronic versions of all CIBT labs referenced in the course outline.