AP* Biology
Syllabus

Course Description

Biology is a college-level, yearlong course designed to prepare students for the Advanced Placement® Biology Exam. The goal of the course is to discover how biological information is acquired and by whom. Throughout the course students will be exposed to the four "big ideas" that are essential to the study of AP Biology:

Big Idea 1: The process of evolution drives the diversity and unity of life.

Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.

Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.

Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

Through a combination of direct instruction, animated presentations, online readings and textbook readings, and interactive media exercises and exploration activities, students will organize and categorize important concepts relating to the four big ideas. Laboratory work will allow students to reflect on these big ideas and draw conclusions about their relationships to one another.

Topics covered include cell structure and function; the gene; principles of heredity; evolutionary biology; biological diversity; the energetics of life; animal structure, reproduction, and development; circulation, body's defenses, and nutrition; nervous system and internal controls; the form and function of plants; and ecology. Students will demonstrate their understanding and acquisition of skills through quizzes, tests, and practice AP questions.

Laboratory Work

Students will spend approximately 25% of their course time engaged in laboratory activity. Wet labs and virtual labs will draw upon the seven science practices (listed below) outlined by the AP Biology Curriculum Framework. Laboratory investigations will challenge students to draw upon their understanding of biological concepts, apply mathematical and scientific skills, utilize critical thinking, and develop communication skills through written reports and interactions with classmates. Students will conduct experiments that require them to collect, analyze, and interpret data, and to present their conclusions in thoughtfully written lab reports and reflections.

Seven Science Practices

Throughout this course, students will engage in lab work that draws upon these seven science practices:

1. The student can use representations and models to communicate scientific phenomena and solve scientific problems
2. The student can apply mathematics appropriately
3. The student can engage in scientific questioning to extend thinking or to guide investigation within the context of the AP course
4. The student can plan and implement data collection strategies appropriate to a particular scientific question
5. The student can perform data analysis and evaluation of evidence
6. The student can work with scientific explanations and theories
7. The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains

Course Materials

Required Text

- Campbell, N. A., Reece, J. B., & Mitchell, L. G. (2004). *Biology.* (7th ed.). San Francisco, CA: Benjamin-Cummings Publishing Company.

Course Goals

- Use themes, processes, and methods to help understand the connections between the topics in biology.
- Categorize information into science, technology, and society; evolution; the relationship between structure and function; and science as a process.

Course Outline

UNIT 1 – Welcome to Biology

This unit introduces the study of biology and its many facets including the connections between science, technology, and society. Students will explore important chemical ideas using familiar examples from biology. They will apply their foundation in chemistry to biological molecules and be introduced to organic chemistry.

In this unit students will explore important concepts found in Big Idea 4: "biological systems interact, and these systems and their interactions possess complex properties." Several enduring understandings are addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work in this unit exposes students to the essential knowledge that "interactions within biological system lead to complex properties (4.A)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 1–4 (Concepts 3.1–3.4)

Key Activities

Online Discussion Question:

What is Biology?
Welcome to your Advanced Placement Biology course! This discussion will give you an opportunity to introduce yourself to your instructor and classmates. Take this time to learn a little about the other students in the course, where they're from and why they are taking AP Biology online. This discussion will also give you a chance to get acquainted with communicating in an online learning environment.

Introduce yourself and give your age, grade level, where you are from, other science classes you have taken, personal interests, future plans, why you are taking this course and anything else you want to share. Take some time to get to know something about each of your classmates and your online instructor.

Vocabulary: Review key terms necessary for the AP Biology exam.

Lab:

Measurement — Explore mass, volume, and density using a laboratory procedure.

- Compare metric and customary units
- Measure the volume of regularly shaped objects, irregularly shaped objects, and liquids
- Measure the mass of solids and liquids
- Calculate density

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Lab:

Identifying Nutrients — Explore the presence of nutrients in food using a laboratory experiment and deductive reasoning.

- Use Biuret reagent to test for proteins
- Use Sudan red to test for lipids
- Use Lugol's solution to test for polysaccharides
- Use Benedict's solution to test for monosaccharides

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this l

Unit and Chapter Tests: AP style questions review key concepts.

Content

Important concepts covered in this unit include, but are not limited to; science, technology, and society; evolution; the relationship between structure and function; science as a process; organization of life; the scientific method; causation and correlation; observation and experiments; chemical concepts; major elements and trace elements; atoms; isotopes; ions; covalent, ionic, and hydrogen bonds; molecules and compounds; chemical reactions; chemical equations; molecular structure of water; properties of water; co-hesion, adhesion, and surface tension; specific heat; acids, bases, and buffers; pH and the pH scale; zwitterions; organic and carbon-based compounds; isomers; functional groups; macromolecules; polysaccharides; hexoses and pentoses; glucose, ribose, and deoxyribose; ribonucleotides and deoxyribonucleotides; fats; saturated and unsaturated fatty acids; cholesterol; proteins; amino acids; and protein structure.

Direct Instruction:

- What is Biology?
  - Biology and Biologists
  - Laboratory Safety
  - Lab: Measurement
- Chemical and Physical Properties of Solutions
  - The Chemical Basis of Life
  - Water and Life
  - Acids, Bases, and Buffers
- Biomolecules
  - Organic Molecules
  - Macromolecules
  - Lab: Identifying Nutrients

UNIT 2 – Cell Structure and Function

This unit introduces cells, including important tools, and methods used for studying them. Students will explore the basics of cell structure and function. They will then learn about organelles, extracellular structures, and cell mobility. This unit also focuses on the structural components of cells and the plasma membrane.

In this unit, students will explore important concepts found in each of the four Big Ideas. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work will provide students opportunities to draw conclusions about the relationships of the big ideas to one another. This unit exposes students to the enduring understandings that "organisms are linked by lines of descent from common ancestry (1.B);" "growth, reproduction, and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments(2.B);" "the processing of genetic information is imperfect and is a source of genetic variation (3.C);" "interactions within biological systems lead to complex properties (4.A);" and "completion and cooperation are important aspects of biological systems (4.B)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 6, 7, and 26 (Concepts 6.1–6.7 and 26.4)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Lab:

Using a Compound Microscope — Explore cells using a compound microscope.

- Become familiar with the parts and functions of a compound microscope
- Prepare a wet mount slide to explore the features of a compound microscope
- Explore depth of field
- Examine cell structures

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Virtual Lab:

The Purification of Hemoglobin — Participate in a virtual lab to explain what happens at the molecular level when a cell is placed in hypotonic or hypertonic solutions, explain why plant cells thrive in hypotonic solutions while animal cells may rupture, and describe the biological consequences of water gain or loss in a cell.

- Calculate the percent viability of a cell sample
- Use cell viability data to determine the best solution for hypotonic lysis
- Illustrate the processes of diffusion and osmosis during a dialysis experiment

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Lab:

Diffusion Across a Semi-Permeable Membrane — Explore how materials move across a semipermeable membrane.

- Verify Lugol's solution as an indicator for the presence of starch
- Prepare a "membrane" for testing starch solution
- Test for diffusion of starch through the membrane
- Verify Benedict's solution as an indicator for the presence of glucose
- Prepare a "membrane" for testing glucose solution
- Test for diffusion of glucose through the membrane

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit include, but are not limited to, function and structure of cells; light microscope; electron microscope; techniques to study cells; cell theory; spontaneous generation; structural features of plasma membrane; prokaryotes and eukaryotes; archaebacteria and eubacteria; eukaryotic organelles and their functions; plant cells and animal cells; cytosol; cytoskeleton; cellular movement within a cell; movement of molecules and organelles within a cell; extracellular matrix; cell membranes; membrane fluidity; passive and active transport mechanisms; diffusion and osmosis; the processes of phagocytosis, pinocytosis, receptor-mediated endocytosis, and exocytosis; membrane proteins; staphylococcus aureus; water potential; laboratory centrifuge; hypotonic and hypertonic solutions; plasmolysis; cell viability; and selective precipitation.

Direct Instruction:

- Cellular Organization
  - Cells: The Basics
  - More about Cells
  - Lab: Using a Compound Microscope
- Membranes and Transport
  - Cell Membranes
  - The Purification of Hemoglobin
  - Lab: Diffusion Across a Semi-permeable Membrane

UNIT 3 – The Gene

This unit focuses on the gene. Students will first look at the structure of DNA and the molecular mechanism for DNA replication. Then, they learn about the central dogma of biology. Students also explore how different organisms organize their genetic material. Students will later explore the genomes of viruses and bac-teria. This unit closes with information on the methods and applications of biotechnology.

In this unit, students will explore important concepts found in each of the four Big Ideas. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work will provide students opportunities to draw conclusions about the relationships of the big ideas to one another. This unit exposes students to the enduring understandings that "organisms are linked by lines of descent from common ancestry (1.B);" "many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination (2.E);" "heritable information provides for continuity of life (3.A);" and "interactions within biological systems lead to complex properties (4.A)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company) Chapters 16—20 (Concepts 16.1,16.2, and 17.1–17.7)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Lab:

Building Proteins from RNA — Explore the molecular process of building proteins from the information carried by RNA using a laboratory procedure.

- Transcribe the information in DNA to mRNA
- Locate codons
- Translate mRNA
- Test for the diffusion of glucose through the membrane

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Virtual Lab:

Principles of Biotechnology — Explain how a plasmid can be engineered to contain a piece of foreign DNA, describe the action of restriction enzymes, explain how gel electrophoresis separates DNA molecules by size, and explain the importance of positive and negative controls.

- Design an experiment to select for antibiotic-resistant transformed bacterial cells
- Design controls for a transformation experiment
- Use a plasmid map to predict fragment sizes from a restriction digest
- Summarize the process of bacterial transformation
- Calculate transformation efficiency

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Online Discussion:

From DNA to Protein

Discuss with your classmates the advantages and disadvantages of using RNA or protein as the genetic material. It may help to think about the important qualities that the genetic material must possess in order to perform all of its functions. Try to come up with ideas about why a retrovirus uses reverse transcriptase to synthesize a complementary DNA molecule. Discuss some of the reasons why no organisms have been found that use protein as their genetic material.

Biotechnology

Each new biotechnological advance raises many ethical questions. The genetic manipulation of all types of organisms by humans has become a reality in the last several decades. As it becomes easier to alter the genetic makeup of organisms, we have to be careful to consider the long-term repercussions.

Some people think that the genetic manipulation of organisms by humans is a part of evolution. They feel that scientists are simply accelerating evolution by creating organ-isms that can survive more effectively than other organisms. Others see it as human-kind's attempt to "play God." They feel that organisms should be left to change as the environment dictates, without the help of humans.

Most people don't fall neatly into either of these categories. Biotechnology has many advantages, including medical and agricultural advances. But there is also the possibility for biotechnology to get out of control. It is up to the members of society to discuss the practical and ethical implications of all types of biotechnology.

This forum will give you a chance to discuss how you feel about recent advances in biotechnology. Think about several applications of biotechnology that you consider ethical, and explain why. Try to anticipate what others might find unethical about the application, and persuade them to see it your way. Then think about several applications of biotechnology that you consider unethical. Explain to your classmates why you feel the way you do. Respond to the applications presented by your classmates, and explain why you agree or disagree with their opinions.

Remember, in discussions like this, every person may have a different view, and there are no right or wrong answers. It's important to think about what your classmates have said and keep an open mind. A discussion about your viewpoint may lead you to keep your original view, change it slightly, or even change your mind completely!

Unit and Chapter Tests: AP style questions review key concepts

Free-response Essay: Respond to the exam prompt from the 2006 exam concerning sexual vs. asexual reproduction.

Sexual reproduction requires that half of the chromosomes in a zygote come from one parent and the other half from the second parent.

a. Describe the process by which a germ cell's complement of chromosomes is halved in the formation of gametes.

b. Choose one organism or group of organisms that reproduce asexually. Describe the mode of asexual reproduction in that organism and explain the advantages to the organism of asexual reproduction.

c. Choose one organism or group of organisms that reproduce sexually. Describe the mode of sexual reproduction in that organism and explain the advantages to the organism of sexual reproduction.

Content

Important concepts covered in this unit include, but are not limited to, chromosome theory of inheritance; transformation experiments; Hershey-Chase experiment; structure of DNA; DNA replication; origins of replication, helicase, DNA polymerase, and RNA primers in DNA replication; DNA repair mechanisms; central dogma of biology; structure of RNA; types of RNA and role of mRNA; transcription; nucleotides and amino acids; structure of a codon; translation; ribosome; mutations that affect protein synthesis; heterochromatin and euchromatin; centromere and telomere; gene expression; viruses; bacteriophages; viroids and prions; the bacterial genome; episomes; operon; positive and negative regulation; inducible and repressible systems; expression of the structural gene in the trp and lac operon; genetic engineering; DNA gun; Ti plasmid; applications of biotechnology; restriction enzymes; plasmid and plasmid maps; bacterial transformation; positive and negative controls; transformation experiment; and transformation efficiency.

Direct Instruction:

- DNA
  - DNA Discovery and Structure
  - DNA Replication
- From DNA to Protein
  - The Transcription of DNA to RNA
  - Translation: Protein Synthesis
  - Lab: Building Proteins from RNA
- Types of Genomes
  - Eukaryotic Genomes
  - Viral and Bacterial Genomes
  - Bacterial Gene Expression
- Biotechnology
  - Applications of Biotechnology
  - Principles of Biotechnology

UNIT 4 – Principles of Heredity

This unit opens with a description of cell division and explores both mitosis and meiosis. Students will discover how both sexual and asexual reproduction can be evolutionarily advantageous. They are then introduced to basic principles of inheritance based on Gregor Mendel's laws. Mendel's laws of inheritance and the chromosome theory of inheritance are then used to explain how chromosomes and genes are passed from one generation to the next. Students use the fruit fly to determine where in the genome a gene is located. They also learn what happens when cell division does not work properly and how to tell if two genes are linked or unlinked.

In this unit, students will be introduced to important concepts found in Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes and Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work in this unit exposes students to the enduring understandings that "heritable information provides for continuity of life (3.A);" "expression of genetic information involves cellular and molecular mechanisms (3.B);" "the processing of genetic information is imperfect and is a source of genetic variation (3.C);" and "interactions within biological systems lead to complex properties (4.A)." Students will reflect on these big ideas and draw conclusions about their relationships to one another.

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 12—15 (Concepts 14.1–14.4)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Virtual Lab:

Virtual Fly — Explain how the phenotypes of each generation of fruit flies can be used to determine the genotypes of the different fly classes and the mode of inheritance of a gene.

- Describe the life cycle of Drosophila melanogaster
- Describe the physical differences between male and female fruit flies
- Propose a null hypothesis for an experiment
- Describe how Chi-square analysis can be used to determine whether two genes are linked or unlinked

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Lab:

Mouse Genetics (One Trait) — Explore the relationship between genotype and phenotype.

- Cross female and male pairs of mice with varying genotypes and phenotypes to examine the inheritance of fur color

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Lab:

Mouse Genetics (Two Traits) — Explore the law of independent assortment by examining a di-hybrid cross in mice.

- Simulate a di-hybrid cross in mice
- Predict the genotypic and phenotypic outcome of the offspring

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Online Discussion:

Patterns of Inheritance

DNA tests are now widely available to test for the presence of disease alleles. DNA testing can have both positive and negative effects on health and quality of life.

Huntington's disease is a fatal neurological disease, caused by a dominant allele of the Huntingtin gene. Individuals with one copy of the disease allele develop Huntingon's disease during middle age. There is no cure for Huntington's disease.

Imagine knowing that the Huntington's disease allele was present in your family. Would you want to be tested for the 's allele? Why or why not? If you found you had the disease allele, how would this information affect your life? Would it influence your decision to have children? Would it affect the way you live your daily life, choose your career, or work to achieve your goals and dreams?

People who have the Huntington's disease allele always get the disease. However, for some other diseases, such as breast cancer, doctors can test for alleles that only increase the chances that a person will develop the disease. For example, individuals with a particular allele for the BRCA 1 gene have an increased chance of developing breast cancer, but they won't necessarily get the disease.

Would you want to know if you had an allele that made it more likely you would get a disease? Would it change the way you live your life?

Discuss with your classmates some of the positive and negative effects that genetic testing could have on your life. Be sensitive to the fact that some students may have personal experience with the topics you are discussing.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, the cell cycle; mitotic division; mitosis; prophases; metaphase; anaphase; telophase; cytokinesis; parthenogenesis; binary fission; budding; frag-mentation and regeneration; sexual life cycle; meiosis I and II; sexual and asexual reproduction; synapsis; haploid and diploid cells; Gregor Mendel's laws and experiments; genotype and phenotype; heterozygous and homozygous; dominant and recessive; law of segregation; Punnett squares; genetic probabilities; law of independent assortment; chi-square analysis; incomplete dominance and codominance; human blood type genotypes and phenotypes; lethal alleles; epistatic genes; polygenic traits; human pedigrees; Drosophila melanogaster as a model organism; chromosome abnormalities; and null hypothesis.

Direct Instruction:

- The Reproduction of Cells
  - The Cell Cycle and Mitosis
  - Sexual Life Cycle and Meiosis
  - Mitosis and Meiosis
- Patterns of Inheritance
  - The Mendelian Model of Inheritance
  - Extensions of Mendel
  - Pedigree Analysis
- The Chromosomal Basis of Heredity
  - Genes and Chromosomes
  - Virtual Fly Lab
  - Lab: Mouse Genetics (One Trait)
  - Lab: Mouse Genetics (Two Traits)

UNIT 5 – Evolutionary Biology

This unit focuses on the mechanisms of evolutionary change. It covers Charles Darwin's theory of evolution as well as the ideas that preceded his theory. Students will learn the forces and conditions necessary for a population to evolve. The unit then goes on to describe how Darwin's theory of evolution can be used to explain the origin of new species.

In this unit, students will explore important concepts found in Big Idea 1: the process of evolution drives the diversity and unity of life and Big Idea 4: biological systems interact, and these systems and their interactions possess complex properties. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work in this unit exposes students to the enduring understandings that "change in the genetic makeup of a population over time is evolution (1.A);" and "naturally occurring diversity among and between components within biological systems affects interactions with the environment (4.C)," and asks them to make connections between the big ideas.

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 22–24

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Lab:

Natural Selection — Explore natural selection using a laboratory simulation.

- Simulate birds with different beak phenotypes and their feeding success
- Collect data to model and predict changes over time

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Virtual Lab:

Population Genetics and Evolution — State the Hardy-Weinberg conditions for non-evolution and estimate the allele frequency in a population using the Hardy-Weinberg equation.

- Discuss and predict how populations will deviate when the Hardy-Weinberg conditions are altered

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Online Discussion:

The Theory of Evolution

In this chapter, we've discussed the process of evolution. We've seen its effects at both the DNA level and the population level. While evolutionary changes are easier to track at the DNA level by measuring allele frequencies, the effects of mutations and shifts in allele frequencies are best evaluated at the population level.

There are numerous examples of evolution that have occurred over your lifetime. Pesticide resistance in plants is one example of biological evolution that occurs over a relatively short time period. Can you think of others?

Analogous to biological evolution is the evolution of the automobile. Discuss with your classmates how the process of evolution has changed the automobile. Think about how selection by the car-buying public affects the design and production of a car. Use analogies to the mechanisms of evolution you've learned in this chapter.

Free-response Essay:

Respond to the exam prompt from the 2008 exam concerning regulation. Regulation is an important aspect of all biological processes. For FOUR of the following processes, describe the specific role of the regulator and discuss how it will be altered if the regulation is disrupted.

Process	Regulator
Cell Cycle	Cyclin
Metabolic rate	Throxine
Ovarian Cycle	Follicle–stimulating hormone (FSH)
Prey Population Dynamics	Predators
Ecological dynamics	Fire

Respond to the exam prompt from the 2008 exam concerning fertilization. Flowering plants have evolved various strategies for fertilization.

a. Describe the process of fertilization in flowering plants.

b. Discuss TWO mechanisms of pollen transfer and the adaptations that facilitate each mechanism.

Some species of flowering plants have evolved mechanisms to prevent self-fertilization.

c. Discuss an evolutionary advantage of preventing self-fertilization.

d. Describe TWO mechanisms that prevent self-fertilization.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, Charles Darwin and his theory of evolution; views on the origin of life prior to Darwin's theory; how Linnaeus named and classified organisms; Lamarck's theory of evolution; natural selection; allele frequency; the Hardy-Weinberg equilibrium; geographic, prezygotic, and postzygotic barriers that lead to speciation; gradual evolution; and punctuated equilibrium.

Direct Instruction:

- The Theory of Evolution
  - Darwin in Historical Context
  - Mechanisms of Evolution
  - Population Genetics and Evolution
  - Natural Selection
- The Origin of Species
  - Speciation
  - Population Genetics and Evolution

UNIT 6 – Biological Diversity

This unit discusses the diversity of organisms. It begins by examining the field systematics and then discusses the physical changes the Earth has undergone throughout its history. Students will learn about the plant and fungi kingdoms and their distinctive characteristics. They will also investigate the diversity of animals in the animal kingdom by answering the question: what makes an animal an animal?

In this unit, students will consider important concepts found in Big Idea 1: the process of evolution drives the diversity and unity of life. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work in this unit exposes students to the enduring understandings that "organisms are linked by lines of descent from common ancestry (1.B)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 25–34

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Virtual Lab:

Using a Dichotomous Key — Explore how dichotomous keys are used to identify unknown organisms.

- Identify characteristics of different fish
- Use those identified characteristics and a dichotomous key to identify the name of the fish

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Online Discussion:

Single-celled Organisms

Our survey of the prokaryotes has shown that bacteria exist anywhere life is possible. They can be found from mountaintops to the bottom of the ocean, and from boiling to the polar ice caps. Bacteria cover our bodies and live in our digestive tracts. The diverse metabolism of bacteria means that one species or another can cope with any imaginable food source. Many thrive without oxygen. Concentrated salt, acid, pollution, crushing underground pressure—bacterial species tolerate all these conditions.

Yet for most people concerned about hygiene and cleanliness, avoiding bacteria seems like a worthwhile goal. Washing with soap and hot water helps control the spread of disease causing bacteria, and thorough cooking of food can kill bacteria like Salmonella that cause food poisoning. But these measures don't kill all bacteria. Many species that live around us can form spores that are highly resistant to extreme conditions. Bacteria in the surroundings quickly fill the void left by those we killed or washed away.

Antibiotics have been a great boon to medicine because they can kill harmful bacteria specifically. But some bacteria evade them, and the misuse of antibiotics can lead to resistant bacterial strains.

Where in your own personal space are bacteria most plentiful? What do you do to control their spread? Can you think of a place where bacteria are completely absent?

Is it possible that humans might send bacteria to other planets? Could space probes carry microorganisms to Mars? Might they survive there?

Use this forum to discuss these questions and issues about the bacteria that pervade our world.

Free-response Essay: Respond to the exam prompt from the 2006 exam concerning prokaryotes and eukaryotes.

A major distinction between prokaryotes and eukaryotes is the presence of membrane-bound organelles in eukaryotes.

a. Describe the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus.

b. Prokaryotic and eukaryotic cells have some non-membrane bound components in common. Describe the function of TWO of the following and discuss how each differs in prokaryotes and eukaryotes.
- DNA
- Cell wall
- Ribosomes

c. Explain the endosymbiotic theory of the origin of eukaryotic cells and discuss an example of evidence supporting this theory.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, cladograms and phylogenetic trees; taxonomic hierarchy; convergence; analogous and homologous structures; kingdoms; continental drift; eras; Earth's atmosphere and climate changes; macroevolution; prokaryotes and eukaryotes; cocci bacilli and spirilla; Gram-positive and Gram-negative eubacteria; the Protista kingdom; symbiosis and endosymbiosis; plants; fungus; animals; and mollusks, arthropods, echinoderms, and chordate.

Direct Instruction:

- The Family Tree of Life
  - Systematics: Classifying Organisms
  - The History of Life on Earth
  - Using a Dichotomous Key
- Single-celled Organisms
  - Prokaryotes
  - Unicellular Eukaryotes
- Still Life: Plants and Fungi
  - Plants and their Relatives
  - The Fungi
  - Lifestyles of the Plants and Fungi
- The Diversity of Animals
  - An Introduction to the Animals
  - From Invertebrates to Vertebrates
  - Comparative Anatomy

UNIT 7 – Energetics of Life

This unit begins with the principles of bioenergetics. Students will review basic principles of chemical thermodynamics and learn how they apply to biological systems. They will then study the central catabolic pathways glycolysis and the tricarboxylic acid cycle (TCA cycle). The unit finally covers electron transport and cellular respiration.

In this unit, students will explore important concepts found in Big Idea 2: biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work will expose students to the enduring understanding that "growth, reproduction, and maintenance of the organization of living systems require free energy and matter (2.A)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 8 and 9 (Concepts 8.1–8.4 and 9.1–9.6)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Virtual Lab:

Enzyme Catalysis — Compare uncatalyzed and catalyzed reaction rates.

- Measure the effects of changes in temperature, pH, and salt concentration on reaction rates of an enzyme-catalyzed reaction
- Explain how inhibitors and activators affect the rate of enzyme-catalyzed reactions

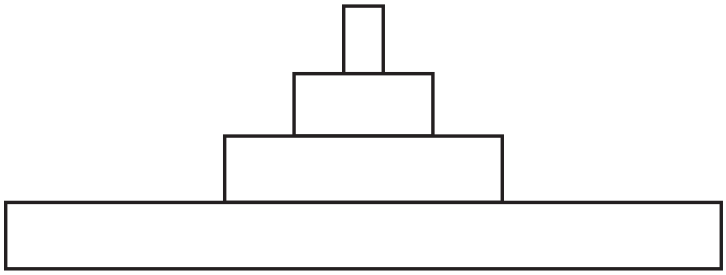
This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

In this unit, students will realize the synthesis of the four Big Ideas and draw connections among their various enduring understandings. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities.

Free-response Essay: Respond to the exam prompt from the 2009 exam concerning ATP and GTP energy sources in biochemical reactions.

ATP and GTP are primary sources of energy for biochemical reactions.

a. Describe the structure of the ATP or GTP molecule.
b. Explain how chemiosmosis produces ATP.
c. Describe TWO specific processes that require ATP and explain how ATP is used in each process.
d. An energy pyramid for a marine ecosystem is shown below. Label each trophic level of the pyramid and provide an example of marine organism found at each level of this pyramid. Explain why the energy available at the top layer of the pyramid is a small percentage of the energy present at the bottom of the pyramid.



Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, activation energy; activator; active site; allosteric regulation; catalysis; catalyst; coenzyme; cofactor; competitive inhibitor; effector; energy diagram; enzyme; enzyme-substrate; complex; glycolysis; induced fit; inhibitor; kinetics; reaction rate; substrate; transition state; feedback inhibition; fermentation; glycolytic; glycolysis; isomerization; chemiosmosis; electrochemical gradient; oxidative phosphorylation; proton motive force; reduction potential; and uncoupler.

Direct Instruction:

- Principles of Bioenergetics
  - Cellular Energy Currency
  - Enzymes and Metabolism
- Central Catabolic Pathways
  - An Overview of Metabolism
  - Glycolysis
  - The TCA Cycle
- Electron Transport and Cellular Respiration
  - Electron Transport, ATP Synthesis, and Chemiosmosis

UNIT 8 – Animal Structure, Reproduction, and Development

This unit opens by examining the structural organization of animals. It describes the tissue, organs, and organ systems of the vertebrate body as well as the regulation and control of oxygen. Students then learn about reproduction and different methods of fertilization. They will also review the development of a human embryo from conception to birth.

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 40, 46, and 47

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, adipose tissue; axon; cardiac muscle; cartilage; circulatory system; columnar epithelium; connective tissue; control center; cuboidal epithelium; effector; endocrine system; epithelial tissue; excretory system extracellular matrix; fibroblast; glandular epithelium; goblet cell; homeostasis; hormone; hypothalamus; immune system; integumentary system; lymphatic system; lymphocyte; macrophage; muscular system; negative feedback; nervous system; neuron; organ; organ system; receptor; reproductive system; respiratory system; skeletal muscle; skeletal system; smooth muscle; squamous epithelium; stratified epithelium; tissue; acrosome; allantois; amnion; amniote; amniotic fluid; animal hemisphere; animal pole; anterior; blastocoel; blastocyst; blastula; cell differentiation; chorion; cleavage; development; dorsal; ectoderm; endoderm; embryogenesis; fetus; gastrula; gastrulation; germ layers; implantation; invagination; mesoderm; morphogenesis; neural tube; organogenesis; placenta; posterior; stem cell; umbilical cord; vegetal hemisphere; vegetal pole; ventral; vitelline layer; yolk; yolk sac; and zygote.

Direct Instruction:

- Structural Organization of Animals
  - Animal Form and Function
- Reproduction and Development in Animals
  - Animal Reproduction
  - Animal Development

UNIT 9 – Circulation, Body's Defenses, and Nutrition

This unit discusses the circulatory system and how it relates to the respiratory system. Students will study the increase in complexity of the heart and examine the human heart function in a virtual lab. They will then go on to learn about the body's external and internal defenses to protect us from infections from harmful bacteria, viruses, and fungi. The unit closes with an exploration of the digestive system and excretion process of animals.

In this unit, students will explore important concepts found in three of the four Big Ideas: Big Idea 2: biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis; Big Idea 3: living systems store, retrieve, transmit, and respond to information essential to life processes; and Big Idea 4: biological systems interact, and these systems and their interactions possess complex properties. Essential knowledge is addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work will provide students opportunities to draw conclusions about the relationships of the big ideas to one another. This unit exposes students to the enduring understandings that "many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination (2.E);" "cells communicate by generating transmitting and receiving chemical signals (3.D);" and "interactions within biological systems lead to complex properties (4.A)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 41, 42 (Concepts 42.1–42.7), 43, and 44 (Concepts 44.1–44.5)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Virtual Lab:

Cardiovascular Health — Understand the function of a normal heart, the types of cholesterol and their roles in relation to cardiovascular disease, and recognize several different types of congenital heart defects.

- Describe how blood pressure is measured, and state what readings indicate high blood pressure
- Explain the relationship between the segments of an electrocardiograph and the heart cycle
- Describe a "normal" ECG
- Explain why an exercise stress test is used to help diagnose heart conditions
- Describe an angiogram and how it is performed
- Explain the angioplasty procedure

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Lab:

Blood Typing — Explore the blood types of four patients by performing blood clotting tests.

- Use or simulate a blood typing kit to perform negative and positive control tests
- Use or simulate a blood typing kit to perform blood tests of patients with varying blood types and Rh factors
- Determine blood compatibility for each patient

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Lab:

Disease Spread — Explore the spread of a communicable disease using a simulation.

- Simulate the spread of a communicable disease using liquids in cups
- Measuring the number of people infected after four points of contact

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Online Discussion:

Circulation and Gas Exchange

Larger animals tend to have lower breathing and heart rates. They also have lower blood pressures. A mouse has a heart rate of about 650 beats a minute. A large whale may have a heart beat as low as 8 beats a minute.

This forum will give you a chance to discuss why you think these differences exist. The metabolic rate, or the rate at which animals use energy, is important. Smaller animals tend to have higher metabolic rates, although there are exceptions: Birds tend to have a higher metabolic rate than mammals of similar size.

Other areas that you might like to investigate are how animal size affects the relative sizes of the organs involved and the length of the blood vessels. For example, a blue whale has a heart the size of a small car, and blood may have to travel several hundred feet between visits to the heart. A mouse heart is smaller than a fingernail, with blood vessels only a few inches long.

The whole size of the animal is also important. Smaller animals have much larger body surfaces relative to their mass.

An animal's activity level is also related to the energy that the animal needs to generate: A hummingbird is much more active than a soaring albatross.

Explain to your classmates why you feel the way you do. Respond to the views presented by your classmates, and explain why you agree or disagree with their opinions.

Remember, in discussions like this, each person may have a different view. There are no right or wrong answers. It's important to think about what your classmates have said and keep an open mind. A discussion about your viewpoint may lead you to keep your original view, change it slightly, or even change your mind completely!

Free-response Essay: Respond to the exam prompt from the 2006 exam concerning the evolution of circulatory systems.

Circulatory systems allowed larger and more complex animals to arise.

a. Describe the respiratory and digestive systems' specialized structure that facilitate the movement of the oxygen and glucose into the circulatory system of mammals.

b. Explain how oxygen and glucose are transported within the circulatory system of mammals.

c. Explain the transfer of oxygen and glucose from the blood and into the active cells of mammals.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, respiratory system and cellular respiration; respiratory mechanisms and structures in simple and complex animals; the human respiratory system; concept of gas diffusion and partial pressure; how gases are exchanged across the alveoli; how oxygen and carbon dioxide are transported in blood; the purposes of the lymphatic system and how it works with the circulatory system; the role of lymph nodes; noncellular components of blood and their roles; how blood clots; the cellular components of blood and their role; how blood cells develop; the difference between intracellular and extracellular digestion; components of a complete digestive system; structural adaptations of teeth; the major organs of the human digestive system and their functions; the structure of the small intestine; and how the structure facilitates absorption of nutrients.

Direct Instruction:

- Circulation and Gas Exchange
  - The Circulatory System
  - The Respiratory System
  - Cardiovascular Health
  - Blood Typing
- The Body's Defenses
  - Disease Spread
  - The Lymphatic System and the Blood
  - Nonspecific Immune Defenses
  - Specific Immune Defenses
- Nutrition and Excretion
  - Diet and Feeding Mechanisms
  - The Digestive System
  - Osmoregulation and Excretion

UNIT 10 – Nervous System and Internal Controls

This unit introduces the structure of the nervous system and details how nerve cells work. It also covers chemical signals in animals. Students will learn that animals must sense and respond to external signs and internal signs. They will also explore the different types of skeletons and how they allow organisms to move using muscle contractions.

In this unit, students will explore important concepts found in Big Idea 2: "biological system utilize free energy and molecular building blocks to grow, to reproduce, and maintain dynamic homeostasis," and Big Idea 3: "living systems store, retrieve, transmit, and respond to information essential to life processes." Several enduring understandings are addressed through direct instruction, writing activities, interactive exercises, and exploration activities. Students are exposed to the essential knowledge that "organisms use feedback to regulate growth and reproduction and to maintain dynamic homeostasis (2.C);" and "cells communicate by generating, transmitting, and receiving chemical signals (3.D)"

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapter 11, 45 (Concepts 45.1–45.5), 48 (Concepts 48.1–48.7), and 49 (Concepts 49.1–49.7)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam

Online Discussion:

Nervous System, Internal Controls

Our five traditional senses—sight, smell, taste, touch, and hearing—don't really represent all the senses humans possess. For other animal species, the list extends even further. For example, structures in our inner ear allow us to sense our position and movement, thereby helping us maintain balance. Special chambers within the ear have an internal lining of sensory hair cells. A gelatinous material containing mineral particles coats the hair cells, and shifts in response to a change in position. The pulling or bending of the "hairs" of the hair cells causes them to initiate a nerve impulse. Many animals possess sensory systems like this.

As you probably know, the planet Earth is a giant magnet, with north and south poles at its ends. Biologists have discovered that many animals seem able to use Earth's magnetic field for navigation, although just how they do it is still a scientific mystery. For example, some birds use the magnetic field (in addition to other sensory clues) to guide the direction of their migration.

What is the mechanism of this sensation? One explanation hinges on the mineral magnetite, a magnetic iron compound. Microscopic crystals of magnetite exist in the tissues of many animal species.

A magnetic field can orient these crystals as if they were tiny compasses.

Another explanation offered by some biologists depends on the sensitivity of certain pigment molecules to magnetic fields. These pigment molecules absorb light to different degrees depending on the direction of the magnetic field around them.

Discuss how magnetite crystals or special pigment molecules might work as part of a sensory receptor to allow an animal to detect the direction of a magnetic field. In your discussion, include experiments or careful observations you could do to test your ideas. Remember that biologists are working on this very problem too!

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, function of the nervous system; the structure of the nervous system in several invertebrates; categories and functions of nerves of the peripheral nervous system, spinal cord, structure and function of the human brain, and the functional roles of some of its major parts; examples of sensory receptors; neural signaling and hormonal signaling; hormone receptors; local regulators; characteristics of amino acid-based and lipophilic hormones; environmental and internal cues that trigger hormonal signaling, organization of skeletal muscle; structure of a sarcomere; how energy is stored in a muscle cell; and muscle contraction.

Direct Instruction:

- Nervous System, Internal Controls
  - Nervous Systems and Sensation
  - How Nerves Work
- Chemical Signals in Animals
  - Hormones
  - The Endocrine System
- The Musculoskeletal System
  - Skeletons
  - Muscle Structure and Contraction

UNIT 11 – Plants: Form and Function

This unit explores the basic structures and functions of plant cells and tissues. Students will learn about the nutritional requirements of plats and how modern technology meets the challenge of feeding a growing population. They will also learn about how plants convert light energy into chemical energy and then use the chemical energy to drive the assimilation of carbon in the process of photosynthesis. The unit then describes plant reproduction.

In this unit students will explore important concepts found in Big Idea 2: "biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis." Several enduring understandings are addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab-work in this unit exposes students to the essential knowledge that "growth, reproduction, and maintenance of the organization of living systems require free energy and matter (2.A);" and "organisms use feedback to regulate growth and reproduction, and to maintain dynamic homeostasis (2.C)."

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 36, 37, 10 (Concepts 10.1–10.4), 38, and 39

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Virtual Lab:

Transpiration in Plants — Discuss how and why transpiration rates are affected by high temperature, dry air, and wind, and discuss the roles that adhesion and cohesion play in transpiration.

- Define water potential
- Describe how water loss is measured in transpiring plants using a potometer
- Calculate transpiration rates using recorded potometer readings collected over time

This is a virtual lab only. Students will complete a reflection assignment after completing the lab work.

Online Discussion:

Plant Energetics

Plant cells contain both chloroplasts and mitochondria. These organelles have many things in common and also some very important differences. This discussion will give you a chance to identify the similarities and differences between chloroplasts and mitochondria, as well as to discuss the significance of their similarities and differences.

Discuss ways in which these organelles are alike in energy transforming processes. Discuss ways in which similarities in their physical structures aid them in these processes.

Discuss ways in which these organelles differ in energy transforming processes. Discuss ways in which the differences in their physical structures enable them to do different things.

Discuss the challenges that plant cells have had to overcome because they contain both chloroplasts and mitochondria. Think about the purpose and regulatory issues associated with the processes of photosynthesis and cellular respiration.

Free-response Essay: Respond to the exam prompt from the 2005 exam concerning flowering plants.

Angiosperms (flowering plants) have wide distribution in the biosphere and the largest number of species in the plant kingdom.

a. Discuss the function of FOUR structures for reproduction found in angiosperms and the adaptive (evolutionary) significance of each.

b. Mosses (bryophytes) have not achieved the widespread terrestrial success of angiosperms. Discuss how the anatomy and reproductive strategies of mosses limit their distribution.

c. Explain alternation of generations in either angiosperms or mosses.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, essential macronutrients and micronutrients that plants require; composition of the three soil horizons, physical and chemical properties of soil; free-living and symbiotic; nitrogen-fixing bacteria; symbiotic relationship between legumes and nitrogen-fixing bacteria; crop rotation and fertilizers; photophosphorylation; noncyclic and cyclic electron flow; photosynthesis; asexual reproduction and sexual reproduction; natural selection in plant reproduction; mitosis; and meiosis occur.

Direct Instruction:

- The Structure of Plants
  - Plant Nutrition
  - Plant Tissues and Organs
  - Transpiration in Plants
- Plant Energetics
  - Introduction to Photosynthesis
  - The Light Reactions
- Plant Reproduction, Development, and Control
  - Plant Reproduction and Development
  - Control Systems in Plants

UNIT 12 – Ecology

This unit introduces students to ecology, the study of the interaction between organisms and their environments. Students will look at Earth's major ecological systems and learn about populations and their dynamics including the interactions between species. Students will be able to define an ecosystem and look at how energy, water, and chemical elements move through and between ecosystems. The unit closes with a study of the different levels of behavior and how animals interact with others of the same species.

In this unit, students will explore important concepts found in Big Idea 4: "biological systems interact, and these systems and their interactions possess complex properties." Several enduring understandings are addressed through direct instruction, writing activities, interactive exercises, and exploration activities. In particular, lab work in this unit exposes students to the essential knowledge that "interactions within biological system lead to complex properties. (4.A)"

Readings

- *Biology* (Benjamin-Cummings Publishing Company), Chapters 50–55 (Concepts 51.1–51.6 and 54.1–54.5)

Key Activities

Vocabulary: Review key terms necessary for the AP Biology exam.

Online Discussion:

Populations and Ecosystems
All living things, including you, are part of an ecosystem. Depending on where you live, you will have several different ecosystems close to you. You may live close to the coast, with both marine and terrestrial ecosystems nearby. You may live in an agricultural region, where grassland has been replaced by cultivated crops. You may also live in a big city, where the natural ecosystems of your region have given way to concrete and asphalt.

What kinds of ecosystem can you identify within a 50-mile radius of your home? What are the major species of animals and plants that you associate with each ecosystem? How has each ecosystem changed since the area has been inhabited?

Discuss these questions with your classmates. Do you all agree, or are there alternative ideas proposed? If particular species have changed their distribution as a result of human settlement, try to propose theories as to why the changes have taken place. For example, has the food source been reduced, have nesting sites or ground cover disappeared, or have the animals been hunted and killed?

Explain to your classmates why you feel the way you do. Respond to the views presented by your classmates, and explain why you agree or disagree with their opinions.

Remember, in discussions like this, each person may have a different view. There are no right or wrong answers. It's important to think about what your classmates have said and keep an open mind. A discussion about your viewpoint may lead you to keep your original view, change it slightly, or even change your mind completely!

Lab:

Interdependence of Organisms — Explore the effect on plant growth of the presence of worms in soil.

- Prepare, maintain, and observe trays of lima bean plants for one week
- Add worms and examine the effects each week for four additional weeks

This lab consists of both a virtual and a wet lab component. Students need to follow proper laboratory procedure and adhere to the safety requirements of their school when conducting the wet lab. Students are required to complete both a reflection assignment and a laboratory report for this lab.

Free-response Essay: Respond to the exam prompt from the 2012 exam concerning carbon and life.

The element carbon is contained in all organic compounds.

a. Discuss the role of photosynthesis and cellular respiration in carbon cycling in the biosphere.

b. For THREE of the following predict and explain the effect on the carbon cycle if:

- decomposers were absent
- deforestation occurred
- volcanic dust accumulated in the atmosphere
- the average ocean temperature increased

c. Explain how increased CO2 in the atmosphere results in great acidification of oceans and describe the effect on marine organisms. Include in your discussion TWO examples of how human activity can increase atmospheric CO2.

Unit and Chapter Tests: AP style questions review key concepts

Content

Important concepts covered in this unit, include, but are not limited to, abiotic factors that act on organisms in the biosphere; global climate patterns and atmospheric circulation; how altitude affects temperature; rain shadow phenomenon; characteristics of terrestrial biomes; characteristics of freshwater habitats; five major zones of the oceanic biome; difference between a food chain and a food web; primary productivity; water cycle; animal behavior; ethology and behaviorism; fixed action pattern; cognition; four different kinds of learning; and classical and operant conditioning.

Direct Instruction:

- Populations and Ecosystems
  - The Natural Setting
  - Population Ecology
  - Community Ecology
- Ecosystems
  - Energy Flow and the Water Cycle
  - Chemical Element Cycles
  - Conservation Biology
  - Primary Productivity
  - Dynamic Ecosystems
  - Interdependence of Organisms
- Behavioral Ecology
  - Basics of Behavior
  - Social Behavior
  - Animal Behavior