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Radnor High School
Course Syllabus

Honors Biology
320

Credits:
Weighted:
Length:
Format

Grades:
Prerequisite:

Overall Description of Course

Honors Biology
1.0Credit Weighted

Length: Year
Format: Meets daily
Prerequisite: 8th Grade Science
Co-requisites: Advanced Geometry or Higher

Biology Honors is a course where learning is focused on enriched content and offered at an accelerated pace. Honors Biology provides students with a rigorous and comprehensive study of biological themes. Laboratory investigations with accompanying detailed written reports form a framework for the development of critical thinking skills. Emphasis is placed on the ability of students to learn independently outside the classroom. Students who have successfully completed Honors Biology are able to cover all the material in Biology 322 in addition to being able to: describe the organizing schemes of classification keys, explain how cells store and use information to guide their functions, understand the relationship among DNA, genes and chromosomes as well as different types of inheritance patterns, distinguish between different reproductive patterns in living things, and describe the factors affecting gene frequency in a population over time and the related consequences. Students taking Honors Biology are expected to remain on the honors track, taking Honors Chemistry and Honors Physics in the subsequent years.

FROM existing syllabus

Common Core Standards

3.3.9.A-Explain the structural and functional similarities and differences found among living things.
3.3.9.B-Describe and explain the chemical and structural basis of living organisms.
S11.B.1.1-Explain structure and function at multiple levels of organization. (Reference: 3.3.10.A, 3.3.10.B, 4.6.10.A, 4.7.10.B)
3.2.9.A-Apply knowledge and understanding about the nature of scientific and technological knowledge.
3.2.9.A-Apply knowledge and understanding about the nature of scientific and technological knowledge.
3.2.9.B-Apply process knowledge and organize scientific and technological phenomena in varied ways.
3.2.9.C-Apply the elements of scientific inquiry to solve problems.
3.2.9.D-Identify and apply the technological design process to solve problems.
S11.A.2.1-Apply knowledge of scientific investigation or technological design to develop or critique aspects of the experimental or design process. (Reference: 3.2.10.B)
3.7.9.A-Identify and safely use a variety of tools, basic machines, materials, and techniques to solve problems and answer questions.
3.7.9.B-Demonstrate the use of appropriate instruments to study processes.
3.8.9.C-Predict the consequences and impacts of scientific and technological solutions.
S11.A.1.1-Analyze and explain the nature of science in the search for understanding the natural world and its connection to technological systems. (Reference: 3.1.10.A, 3.2.10.A)
S11.A.1.2-Identify and analyze the scientific or technological challenges of societal issues; propose possible solutions and discuss implications. (Reference: 3.2.10.A, 4.3.10.B)
S11.A.2.2-Evaluate appropriate technologies for a specific purpose, or describe the information the instrument can provide. (Reference: 3.7.10.B, 3.8.10.B)
3.3.9.A-Explain the structural and functional similarities and differences found among living things.
S11.B.1.1-Explain structure and function at multiple levels of organization. (Reference: 3.3.10.A, 3.3.10.B, 4.6.10.A, 4.7.10.B)
S11.B.3.2-Analyze patterns of change in natural or human-made systems over time. (Reference: 3.1.10.C, 4.2.10.D, 4.3.10.B, 3.1.10.E, 4.3.10.C)
3.3.9.A-Explain the structural and functional similarities and differences found among living things.
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3.3.9.B-Describe and explain the chemical and structural basis of living organisms.
S11.A.3.1-Analyze the parts of a simple system, their roles, and their relationships to the system as a whole. (Reference: 3.1.10.A, 3.1.10.E, 4.3.10.C)
S11.A.3.3-Compare and analyze repeated processes or recurring elements in patterns. (Reference: 3.1.10.C, 3.2.10.B)
S11.B.1.1-Explain structure and function at multiple levels of organization. (Reference: 3.3.10.A, 3.3.10.B, 4.6.10.A, 4.7.10.B)
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S11.A.3.3-Compare and analyze repeated processes or recurring elements in patterns. (Reference: 3.1.10.C, 3.2.10.B)
S11.B.1.1-Explain structure and function at multiple levels of organization. (Reference: 3.3.10.A, 3.3.10.B, 4.6.10.A, 4.7.10.B)

Keystone Connections:

Student Objectives:

Materials & Texts

MATERIALS

TEXTS

Activities, Assignments, & Assessments

ACTIVITIES

ASSIGNMENTS

.

ASSESSMENTS

Terminology

Media, Technology, Web Resources

FROM CURRICULUM CONNECTOR
UNIT: Quarter 1
Units 1,2,&3

Common Core Standards

Keystone Connections:

Student Objectives:

KNOWLEDGE

Unit 1:Unity within Diversity

Ch. 1 Biology: Exploring Life and Ch.15.15 Classification

- Common themes help to organize the study of life
- Evolution accounts for the unity and diversity of life and the evolutionary adaptations of organisms to their environment.
- In studying nature, scientists make observations, form hypotheses, and test predictions with experiments.
- Learning about biology helps us understand many issues involving science, technology and society.
- The evolutionary history of species is reconstructed using fossils, homologies and molecular systematic.

Unit 2:The Chemistry of Life

Ch 2. The Chemical Basis of Life and Ch.3 The Molecules of Cells

- Living organisms are made of atoms of certain elements, mostly combined into compounds.
- The structure of an atom determines what types of bonds it can form with other atoms
- The unique properties of water derive from the polarity of water molecules.
- The Carbon-containing compounds are the chemical building blocks of life.
- Carbohydrates serve as a cell's fuel and building material.
- Lipids are hydrophobic molecules with diverse functions.
- Proteins are essential to the structures and functions of life.
- Nucleic acids store, transmit and help express hereditary information

Unit 3: Cellular Organization

Ch 4. A Tour of the Cell and Ch. 5 The Working Cell

- Microscopes reveal the structures of cells- the fundamental units of life.
- A cell's genetic instructions are housed in the nucleus and carried out by the ribosome.
- The endomembrane system participates in the manufacture, distribution and breakdown of materials.

- Mitochondria in all cells and chloroplasts in plant cells function in energy processing.
- The cytoskeleton and extracellular components provide support, motility and functional connections.
- The phospholipids and protein structure of cell membranes enables their many important functions.
- A cell's metabolic reactions transform energy, producing ATP, which drives cellular work.
- Enzymes speed up a cell's chemical reactions and provide precise control of metabolism.

SKILLS

Themes in the Study of Biology

1.1 Describe seven properties common to all life.
1.2 Describe the levels of biological organization from molecules to the biosphere, noting the interrelationships between levels.
1.2 Define the concept of emergent properties and describe an example of it.
1.3 Explain why cells are a special level in biological organization. Compare prokaryotic and eukaryotic cells.
1.4 Compare the dynamics of nutrients and energy in an ecosystem.

Evolution, the Core Theme of Biology

1.5 Explain how DNA encodes a cell's information.
1.6 Compare the three domains of life. Distinguish between the three multicellular kingdoms within Eukarya.
1.7 Describe the process and products of natural selection. Explain why individuals cannot evolve.

The Process of Science

1.8 Distinguish between quantitative and qualitative data. Compare the definitions and use of inductive and deductive reasoning in scientific investigations.
1.8 Distinguish between a scientific theory and a hypothesis.
1.8 Distinguish between the scientific definition and common use of the word *theory*.
1.9 Describe the structure of a controlled experiment and give an example.

Biology and Everyday Life

1.10 Compare the goals of science and technology. Explain why an understanding of science is essential to our lives.
1.11 Explain how evolution impacts the lives of all humans.

Elements, Atoms, and Compounds

2.1 Define matter, an element, a compound, and a trace element.
2.2 Explain how and why iodine, fluoride, and iron are added to the human diet.
2.3 Distinguish between the size, location, and properties of protons, electrons, and neutrons.
2.3 Define the atomic number and mass number of an atom.
2.3 Define an isotope and explain what makes some isotopes radioactive.
2.4 Describe the uses and dangers of radioactive isotopes.

Chemical Bonds

2.5 Explain how the electron configuration of an atom influences its chemical behavior.
2.6–2.8 Distinguish between covalent bonds, nonpolar polar covalent bonds, polar covalent bonds, hydrogen bonds, and ionic bonds, noting their relative strengths and how and where they form.
2.9 Explain the significance of chemical reactions. Identify the reactants and products of photosynthesis.

Water's Life-Supporting Properties

2.10–2.13 Describe the special properties of water that make it vital to living systems. Explain how these properties are related to hydrogen bonding.
2.10 Define and distinguish between cohesion, adhesion, and surface tension.
2.11 Define and distinguish between heat and temperature. Explain how sweating helps to cool your body.
2.12 Explain why ice floats.
2.13 Define a solute, a solvent, and a solution.
2.14 Explain how acids and bases directly or indirectly affect the hydrogen ion concentration of a solution.
2.14 Explain the basis of the pH scale.
2.14 Explain how buffers function.
2.15 Describe the causes and consequences of acid precipitation and ocean acidification.
2.16 Explain why the search for extraterrestrial life centers on the search for water.

Introduction to Organic Compounds

3.1 Explain why carbon is unparalleled in its ability to form large, diverse molecules.
3.1 Define organic compounds, hydrocarbons, a carbon skeleton, and an isomer.
3.2 Describe the properties of and distinguish between the six chemical groups important in the chemistry of life.
3.3 List the four main classes of macromolecules important to life. Explain the relationship between monomers and polymers. Compare the processes of dehydration synthesis and hydrolysis.

Carbohydrates

3.4–3.7 Describe the structures, functions, properties, and types of carbohydrate molecules common in the human diet.
3.6 Explain how and why high-fructose corn syrup is produced.

Lipids

3.8–3.10 Describe the structures, functions, properties, and types of lipid molecules.
3.10 Describe the health risks associated with the use of anabolic steroids.

Proteins

3.11–3.13 Describe the structures, functions, properties, and types of proteins.
3.12 Explain how a protein's shape determines its functions.

Nucleic Acids

3.14–3.15 Compare the structures and functions of DNA and RNA, noting similarities and differences.
3.16 Describe the adaptive advantage of lactose tolerance in people of East African decent.

Materials & Texts

MATERIALS

TEXTS: Holt BiologyJohnson and Raven 2004

Activities, Assignments, & Assessments

ACTIVITIES Classroom lecture and discussion per chapter, Film clips relevant to topic, Lab

ASSIGNMENTS Assigned Reading from Text per chapter, Study Guide Packets per chapter, Supplemental Reading per Unit, Current Events Reading , Lab reports

ASSESSMENTS
Unit Test, Vocab Quizzes, Lab Reports Essays, Formative Assessments

Terminology

Unit 1: Unity within Diversity: Archaea, Bacteria, biology, biosphere, cell, community, controlled experiment, dependent and independent variable, deductive reasoning, domains ecosystem, emergent properties, Taxonomy, binomial, Eukarya, eukaryotic cells, evolution, genes, hypothesis, inductive reasoning, molecule, naturals election, organ system, organelle, organism, organs, Population, prokaryotic cells, systems biology, technology, theory, tissues, phylogenetic tree, cladogram.

Unit 2: Chemistry of Life acid, acid precipitation, adhesion, aqueous solution, atom, atomic mass, atomic number,base, buffer, chemical bond, chemical reaction, cohesion, compound, covalent bond, electron, electron shell, electronegativity, element, evaporative cooling, heat, hydrogen bond, ion, ionic bond, isotope, mass number, matter, molecule, neutron, nonpolar covalent bond, nucleus, ocean acidification, pH scale, polar covalent bond, polar molecule, product, proton, radioactive isotope, reactant, salt, solute Solution, solvent, surface tension, temperature, trace element, amino acid, amino group, anabolic steroid Carbohydrate, carbon skeleton, carbonyl group, carboxyl group, cellulose, chitin, cholesterol, dehydration reaction, denaturation, deoxyribonucleic acid (DNA), disaccharide, double helix, enzyme, fat functional group, gene, glycogen, hydrocarbon, hydrolysis, hydrophilic, hydrophobic, hydroxyl group isomers, lipid, macromolecule, methyl group, monomer, monosaccharide, nucleic acid, nucleotide,

organic compound, peptide bond, phosphate group, phospholipid, polymer,polypeptide
polysaccharide
primary structure
protein
quaternary structure
ribonucleic acid (RNA)
saturated fatty acid
secondary structure
starch
steroid
tertiary structure
trans fat
unsaturated fatty acid

Media, Technology, Web Resources

Enduring Understandings

Essential Questions

FROM CURRICULUM CONNECTOR
UNIT: Quarter 2
Units 3,4,&5

Common Core Standards

Keystone Connections:

Student Objectives:

KNOWLEDGE

Unit 3: (see above) unit 3 spans both the 1st and 2nd quarter

Unit 4:Utilization of Energy

Ch. 6 How Cells Harvest Chemical Energy and Ch. 7 Photosynthesis: Using Light to Make Food

- Cellular respiration oxidizes fuel molecules and generates ATP for cellular work.
- The main stages of cellular respiration are glycolysis, the citric acid cycle, and oxidative phosphorylation.
- Fermentation regenerates NAD+, allowing glycolysis and ATP production to continue without oxygen.
- The breakdown pathways of cellular respiration intersect with biosynthetic pathways.
- Plants and other photoautotrophs use the energy of sunlight to convert CO2 and H2O to sugar and O2.
- In the thylakoids of chloroplast, the light reactions generate ATP and NADPH.
- The Calvin Cycle, which takes place in the stroma of the chloroplast, uses ATP and NADPH to reduce CO2 to sugar.
- Photosynthesis provides the energy and building material for ecosystems. It also affects global climate and ozone layer.

Unit 5: Cellular Reproduction

Ch. 8 The Cellular Basis of Reproduction and Inheritance

- Cell division underlies many of life's important processes.
- Cells produce genetic duplicates through an ordered, tightly controlled series of steps.
- The process of meiosis produces genetically varied haploid gametes from diploid cells.
- Errors in cell division can produce organisms with abnormal number of chromosomes.

SKILLS

Introduction to the Cell

4.1 Compare the designs of and images produced by a light microscope, a scanning electron microscope, and a transmission electron microscope. Distinguish between magnification and resolving power.

4.1 Describe the two parts of cell theory.

4.2 Explain why there are upper and lower limits to cell size.
4.2 Describe the hydrophobic and hydrophilic components of a plasma membrane and relate these regions to the functions of the plasma membrane.
4.3 Distinguish between the structures of prokaryotic and eukaryotic cells.
4.4 Explain why compartmentalization is important in eukaryotic cells.
4.4 Compare the structures of plant and animal cells. Note the function of each cell part.
4.4 Describe the structures and functions of the four compartments of eukaryotic cells.

The Nucleus and Ribosomes

4.5 Describe the structure and functions of the nucleus and nucleolus. Explain how DNA is packaged inside of the nucleus.
4.6 Describe the functions of ribosomes. Explain why some ribosomes are free in the fluid of the cytoplasm while others are bound to the endoplasmic reticulum or nuclear envelope.

The Endomembrane System

4.7–4.12 Describe the structures and functions of the components of the endomembrane system, including smooth and rough endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, and peroxisomes.

Energy-Converting Organelles 4.13–4.15

4.13–4.14 Compare the structures and functions of chloroplasts and mitochondria.
4.15 Describe the evidence that suggests that mitochondria and chloroplasts evolved by endosymbiosis.

The Cytoskeleton and Cell Surfaces 4.16–4.22

4.16 Compare the structures and functions of microfilaments, intermediate filaments, and microtubules.
4.17 Relate the structure of cilia and flagella to their functions.
4.18 Describe examples of environmental and genetic causes of infertility in men.
4.19 Relate the structure of the extracellular matrix to its functions.
4.20 Compare the structures and functions of tight junctions, anchoring junctions, and gap junctions.
4.21 Relate the structures of plant cell walls and plasmodesmata to their functions.
4.22 Describe the four functional categories of organelles in eukaryotic cells.
4.22 Describe the fundamental features of all organisms.

Membrane Structure and Function

5.1 Describe the fluid mosaic structure of cell membranes.
5.1 Describe the diverse functions of membrane proteins.
5.2 Relate the structure of phospholipid molecules to the structure and properties of cell

membranes.

5.2 Explain how the properties of phospholipids spontaneously form membranes.
5.3 Define diffusion and describe the process of passive transport.
5.4 Explain how osmosis can be defined as the diffusion of water across a membrane.
5.5 Distinguish between hypertonic, hypotonic, and isotonic solutions.
5.5 Explain how animal and plants cells change when placed into hypertonic or hypotonic solutions.
5.6 Explain how transport proteins facilitate diffusion.
5.7 Describe the function of aquaporins in cell membranes.
5.8 Compare the processes of facilitated diffusion and active transport.
5.9 Distinguish between exocytosis, endocytosis, phagocytosis, pinocytosis, and receptor-mediated endocytosis.

Energy and the Cell

5.10 Define and compare kinetic energy, potential energy, chemical energy, and heat.
5.10 Define the first and second laws of thermodynamics. Explain how these laws of thermodynamics relate to energy use in a cell.
5.11 Define and compare endergonic and exergonic reactions. Explain how cells use cellular respiration and energy coupling to survive.
5.12 Describe the three main types of cellular work.
5.12 Explain how ATP functions as an energy shuttle.

How Enzymes Function

5.13 Define activation energy and explain how enzymes speed up chemical reactions.
5.14 Describe the structure of an enzyme-substrate interaction.
5.14 Explain how the cellular environment affects enzyme activity.
5.15 Explain how competitive and noncompetitive inhibitors alter an enzyme's activity.
5.15 Describe the process of feedback inhibition.
5.16 Explain how certain drugs, pesticides, and poisons can affect enzymes.

Materials & Texts

MATERIALS

TEXTS

Activities, Assignments, & Assessments

ACTIVITIES
ASSIGNMENTS

ASSESSMENTS

Terminology

Media, Technology, Web Resources

Enduring Understandings

Essential Questions

FROM CURRICULUM CONNECTOR
UNIT: Quarter 3
Units 6 & 7

Common Core Standards

Keystone Connections:

Student Objectives:

KNOWLEDGE

Unit 6 Genetics

Ch. 9 Patterns of Inheritance

- A few simple and long established rules explain many aspects of heredity.
- Some inheritance patterns are more complex than the ones described by Mendel.
- Hereditary rules can be understood by following the behavior of chromosomes.
- Genes found on sex chromosomes display unique patterns of inheritance.

Unit 7 Nucleic Acids and Protein Synthesis

Ch. 10 Molecular Biology of the Gene

- A series of experiments established DNA as the molecule of heredity.
- Each DNA strand can serve as a template for another.
- Genotype controls phenotype through the production of proteins.
- Viruses and bacteria are useful model systems for the study of molecular biology.

SKILLS

Cellular Respiration: Aerobic Harvesting of Energy

6.1 Compare the processes and locations of cellular respiration and photosynthesis. Explain why it is accurate to say that life on Earth is solar-powered.

6.2 Explain how breathing and cellular respiration are related.

6.3 Provide the overall chemical equation for cellular respiration. Compare the efficiency of this process in cells to the efficiency of a gasoline automobile engine.

6.4 Explain how the human body uses its daily supply of ATP.

6.5 Explain how the energy in a glucose molecule is released during cellular respiration.

6.5 Explain how redox reactions are used in cellular respiration.

6.5 Describe the general roles of dehydrogenase, NADH, and the electron transport chain in cellular respiration.

Stages of Cellular Respiration

6.6 List the cellular regions where glycolysis, the citric acid cycle, and oxidative phosphorylation occur. Note whether substrate-level phosphorylation or chemiosmosis occur at each of these sites.

6.7–6.12 Compare the reactants, products, and energy yield of the three stages of cellular respiration.

6.11 Explain how rotenone, cyanide, carbon monoxide, oligomycin, and uncouplers interrupt critical events in cellular respiration.

Fermentation: Anaerobic Harvesting of Energy

6.13 Compare the reactants, products, and energy yield of alcohol and lactic acid fermentation. Distinguish between strict anaerobes and facultative anaerobes.

6.14 Describe the evolutionary history of glycolysis.

Connections Between Metabolic Pathways

6.15 Explain how carbohydrates, fats, and proteins are used as fuel for cellular respiration. Explain why a gram of fat yields more ATP than a gram of starch or protein.

6.16 Explain how nutrients are used in biosynthesis.

An Overview of Photosynthesis

7.1 Define autotrophs, heterotrophs, producers, and photoautotrophs.

7.2 Describe the structure of chloroplasts and their location in a leaf. Identify specifically where most light energy is converted to chemical energy.

7.3 Explain how plants produce oxygen. Describe the experiments that revealed the source of the oxygen produced during photosynthesis.

7.4 Describe the role of redox reactions in photosynthesis and cellular respiration.

7.5 Compare the reactants and products of the light reactions and the Calvin cycle. Explain how photosynthesis relates to these reactions.

The Light Reactions: Converting Solar Energy to Chemical Energy

7.6 Describe the properties and functions of the different photosynthetic pigments.

7.7 Explain how photosystems capture solar energy.

7.8–7.9 Explain how the electron transport chain and chemiosmosis generate ATP, NADPH, and oxygen in the light reactions.

7.9 Compare photophosphorylation and oxidative phosphorylation.

The Calvin Cycle: Reducing CO_2 to Sugar

7.10 Describe the reactants and products of the Calvin cycle. Explain why this cycle is dependent upon the light reactions.

7.11 Compare the mechanisms that C_3, C_4, and CAM plants use to obtain and use carbon dioxide. Note examples of plants that use each of these systems.

Photosynthesis Reviewed and Extended

7.12 Review the overall process of the light reactions and the Calvin cycle, noting the products, reactants, and locations of every major step.

7.13 Describe the greenhouse effect. Explain how deforestation and the use of fossil fuels contribute to global warming.

7.14 Explain how the ozone layer forms, how human activities have damaged it, and the consequences of the destruction of the ozone layer.

Materials & Texts

MATERIALS

TEXTS

Activities, Assignments, & Assessments

ACTIVITIES

ASSIGNMENTS

ASSESSMENTS

Terminology

Media, Technology, Web Resources

Enduring Understandings

Essential Questions

FROM CURRICULUM CONNECTOR
UNIT: Quarter 4
Units 8,9 &10

Common Core Standards

Keystone Connections:

Student Objectives:

KNOWLEDGE

Unit 8: Evolution

Ch. 13 How Populations Evolve and Ch. 15 Tracing Evolutionary History

- Darwin's theory of evolution explains the adaptations of organisms and the unity and diversity of life,
- Genetic variation makes evolution possible within a population.
- Natural selection, genetic drift and gene flow can alter gene pools; natural selection leads to adaptive evolution.
- Scientific experiments can test the four-stage hypothesis of how life originated on early Earth.
- The fossil record and radiometric dating established a geological record of key events in life's history.
- Continental drift, mass extinctions, adaptive radiation, and changes in developmental genes have all contributed to macroevolution.
- The evolutionary history of a species is reconstructed using fossil, homologies, and molecular systematic.

Unit 9: Ecology

Ch. 34 The Biosphere and Ch.37 Communities and Ecosystems

- The distribution and the abundance of life in the biosphere is influenced by living and nonliving components of the environment.
- In marine biomes, the salt concentration is generally around 3%. In freshwater biomes, the salt concentration is typically less than 1%.
- The distribution of terrestrial biomes is primarily determined by temperature and rainfall.
- Community ecologists examine factors that influence the species composition and distribution of communities and factors that affect community stability.
- Ecosystem ecology emphasizes energy flow and chemical cycling.

Unit 10:Defense Against Pathogens

Ch. 24 The Immune System and Ch. 16 Microbial Life and reflection on Ch.10.18-10.20

- Innate Immunity: all animals have immune defenses that are always ready.
- Adaptive Immunity: vertebrates custom-tailor the immune responses to specific pathogens.
- Malfunctions of the immune response can cause problems that range from mild to severe.

- Prokaryotes, the smallest organisms known, are extraordinarily diverse.
- Protists are eukaryotes. Though most are unicellular, microscopic organisms, some protists are multicellular.
- Many viruses cause disease in animals and plants.
- Emerging viruses threaten human health.
- The AIDS virus makes DNA on an RNA template.
- Viroids and prions are formidable pathogens in plants and animals.

If time Permits:

Unit 11: Human Body Systems
Ch. 20 Unifying Concepts of Animal Structure and Function

Unit 12: Comparative Anatomy

SKILLS

Darwin's Theory of Evolution

13.1 Briefly summarize the history of evolutionary thought by characterizing the views of early Lamarck, Darwin, and Greek philosophers.
13.1 Explain how Darwin's voyage on the Beagle influenced his thinking.
13.1 Describe the ideas and events that led to Darwin's 1859 publication of *The Origin of Species*.
13.2 Explain how the work of Thomas Malthus and the process of artificial selection influenced Darwin's development of the idea of natural selection.
13.2 Describe Darwin's observations and inferences in developing the concept of natural selection.
13.2 Explain why individuals cannot evolve and why evolution does not lead to perfectly adapted organisms.
13.3 Describe two examples of natural selection known to occur in nature. Note two key points about how natural selection works.
13.4 Explain how fossils form, noting examples of each process.
13.4 Explain how the fossil record provides some of the strongest evidence of evolution.
13.5 Explain how biogeography, comparative anatomy, and molecular biology support evolution.
13.6 Explain how evolutionary trees are constructed and used to represent ancestral relationships.

The Evolution of Populations

13.7 Define the gene pool, a population, and microevolution.
13.8 Explain how mutation and sexual reproduction produce genetic variation.

13.8 Explain why prokaryotes can evolve more quickly than eukaryotes.
13.9 Describe the five conditions required for the Hardy-Weinberg equilibrium.
13.9–13.10 Explain the significance of the Hardy-Weinberg equilibrium to natural populations and to public health science.

Mechanisms of Microevolution

13.11 Define genetic drift and gene flow. Explain how the bottleneck effect and the founder effect influence microevolution.
13.11 Explain how genetic bottlenecks threaten the survival of certain species.
13.12 Explain why natural selection is the only mechanism that consistently leads to adaptive evolution.
13.13 Distinguish between stabilizing selection, directional selection, and disruptive selection. Describe an example of each.
13.14 Define and compare intrasexual selection and intersexual selection.
13.15 Explain how antibiotic resistance has evolved.
13.16 Explain how genetic variation is maintained in populations.
13.17 Explain why natural selection cannot produce perfection.

Early Earth and the Origin of Life

15.1 Describe the conditions on the surface of the early Earth. Describe the evidence that life on Earth existed at least 3.5 billion years ago.
15.1 Describe the four stages that might have produced the first cells on Earth.
15.2 Describe the experiments of Stanley Miller and others in understanding how life might have first evolved on Earth.
15.3 Describe the significance of protocells and ribozymes in the origin of the first cells.

Major Events in the History of Life

15.4 Describe the key events in the history of life on Earth.
15.5 Explain how radiometric dating and the relative position of a fossil within rock strata are used to determine the age of rocks.
15.6 Briefly describe the history of life on Earth, noting the major eras, their time range, and which types of life were most abundant. Describe the key events that serve to divide these eras.

Mechanisms of Macroevolution

15.7 Describe how Earth’s continents have changed over the past 250 million years. Explain the consequences of these changes for life on Earth.
15.8 Explain how volcanoes and earthquakes result from plate tectonics.
15.9 Describe the causes, frequency, and consequences of mass extinctions over the last 500 million years.
15.10 Explain how and why adaptive radiations occur.
15.11 Explain how genes that program development function in the evolution of life.
15.11 Define and describe examples of paedomorphosis.
15.12 Define exaptation and describe two examples in birds.
15.13 Explain why evolutionary trends do not reflect “directions” or “goals.”

Phylogeny and the Tree of Life

15.14 Distinguish between homologous and analogous structures and provide examples of each. Describe the process of convergent evolution.

15.15 Describe the goals of systematics. List the progressively broader categories of classification used in systematics in order, from most specific to most general.

15.16 Define the terms clade, monophyletic groups, shared derived characters, shared ancestral characters, ingroup, outgroup, phylogenetic trees, and parsimony.

15.17 Explain how molecular biology is used as a tool in systematics. Describe examples used to study panda and human evolution. Explain why some studies use DNA coding for ribosomal RNA (rRNA) and other studies use mitochondrial DNA (mtDNA).

15.18 Explain how molecular clocks are used to track evolutionary time. Describe the limits of this process.

15.19 Explain why a diagram of the tree of life is difficult to construct.

The Biosphere

34.1 Define and distinguish between the different levels within ecosystems. Distinguish between the biotic and abiotic components of an ecosystem.

34.2 Summarize the subject and impact of Rachel Carson's influential book *Silent Spring*.

34.3 Describe the abiotic factors that influence life in the biosphere.

34.4 Describe the adaptations that enable pronghorns to survive in the open plains and shrub deserts of North America.

34.5 Explain how global climate patterns are influenced by solar energy input as well as the movement of Earth through space. Explain how landforms affect local climate.

34.5 Explain why the seasons of the year, prevailing winds, and ocean currents exist.

Aquatic Biomes

34.6 Describe the abiotic and biotic characteristics of the different ocean zones and adjacent aquatic biomes.

34.7 Describe the different types of freshwater biomes.

34.7 Explain how the properties of a river change between its source and its outlet, and how this impacts the biotic components of this biome.

Terrestrial Biomes

34.8 Explain why species in widely separated biomes may have similar features.

34.8 Explain why storms and fire are crucial factors in some biomes.

34.8–34.17 Describe the characteristics used to define terrestrial biomes. Then use these characteristics to define the major terrestrial biomes: tropical forests, savannas, deserts, chaparral, temperate grasslands, temperate forests, coniferous forests, tundra, and polar ice.

34.18 Explain how all parts of the biosphere are linked by the global water cycle.

Community Structure and Dynamics

37.1 Define a biological community. Explain why the study of community ecology is important.
37.2 Define interspecific competition, mutualism, predation, herbivory, and parasitism, and provide examples of each.
37.3 Define an ecological niche. Explain how interspecific competition can occur when the niches of two populations overlap.
37.4 Describe the mutualistic relationship between corals and dinoflagellates.
37.5 Define predation. Describe the protective strategies potential prey employ to avoid predators.
37.6 Explain why many plants have chemical toxins, spines, or thorns. Define coevolution and describe an example.
37.7 Explain how parasites and pathogens can affect community composition.
37.8 Identify and compare the trophic levels of terrestrial and aquatic food chains.
37.9 Explain how food chains interconnect to form food webs.
37.10 Describe the two components of species diversity. Explain why large fields of a single crop are vulnerable to devastating disease.
37.11 Define a keystone species. Explain why the long-spined sea urchin is considered a keystone species.
37.12 Explain how disturbances can benefit communities. Distinguish between primary and secondary succession.
37.13 Explain how invasive species can affect communities.

Ecosystem Structure and Dynamics

37.14 Compare the movement of energy and chemicals within and through ecosystems.
37.15 Compare the primary production of tropical rain forests, coral reefs, and open ocean. Explain why the differences between them exist.
37.16–37.17 Describe the movement of energy through a food chain. Explain why there are more producers than consumers and why eating meat counts as a great luxury.
37.18–37.21 Explain how carbon, nitrogen, and phosphorus cycle within ecosystems.
37.22 Explain how rapid eutrophication of aquatic ecosystems affects species diversity and oxygen levels.
37.23 Explain how human activities are threatening natural ecosystems.

Innate Immunity

24.1 Describe the nature of innate defenses in invertebrates and vertebrates.
24.2 Describe the steps of the inflammatory response and explain how they help to prevent the spread of disease.
24.3 Describe the structure and functions of the lymphatic system.

Adaptive Immunity

24.4 Describe the specific nature of adaptive immune system responses. Define the terms antigen, antibody, passive immunity, and active immunity.
24.5 Describe the development and functions of B lymphocytes and T lymphocytes. Define

and distinguish between the humoral immune response and the cell-mediated immune response.

24.6 Describe the nature of antigens. Explain how an antigen and an antibody interact.

24.7 Describe the process of clonal selection and compare a primary immune response to a secondary immune response.

24.8 Describe the specific structure of an antibody and relate its shape to its functions.

24.9 Describe four effector mechanisms of the humoral immune system. Explain how antibodies work with innate defenses to form a complete defense system.

24.10 Describe the production and uses of monoclonal antibodies.

24.11 Describe the specific functions of helper T cells and how they interact with other cells.

24.12 Explain how cytotoxic T cells destroy infected body cells.

24.13 Explain how HIV infects cells, multiplies, and causes disease.

24.14 Explain why it has been difficult to develop a successful treatment for AIDS.

24.15 Explain how the immune system identifies the body's own molecules and how this system complicates organ transplantations.

Disorders of the Immune System

24.16 Describe how the malfunction or failure of the immune system can cause disease.

24.17 Explain why allergies occur and what causes anaphylactic shock.

Prokaryotes

16.1 Describe the diverse roles and abundance of prokaryotic life.

16.2 Compare the different shapes, cell walls, and projections of prokaryotes.

16.3 Explain how bacteria can evolve quickly and how bacteria can survive stressful environments.

16.4 Describe the nutritional diversity of prokaryotes.

16.5 Explain why biofilms are unique and potentially dangerous to human health.

16.6 Explain how prokaryotes are employed to address the needs of human society.

16.7 Compare the three domains of life based upon differences in cellular and biochemical traits. Explain why biologists consider Archaea to be more closely related to Eukarya than to Bacteria.

16.8 Describe the diverse types of Archaea living in extreme and more moderate environments.

16.9 Distinguish between the subgroups of the domain Bacteria, noting the particular structure, special features, and habitats of each group.

16.10 Describe some of the diseases associated with bacteria. Distinguish between exotoxins and endotoxins, noting examples of each.

16.11 Describe the four parts of Koch's postulates. Explain why this method is used and how it relates to our new understanding of the cause of most peptic ulcers.

16.12 Describe the recent U.S. attacks using bacteria and the effectiveness of anthrax as a weapon.

Protists

16.13 Describe the basic types of protists. Explain why biologists currently think that they represent many clades.

16.14 Explain how primary endosymbiosis and secondary endosymbiosis led to further cellular diversity.

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