Biology I

Core Ideas/Crosscutting Concepts:

Introduction to Biology, Characteristics of Life, the Scientific Method
Biological knowledge applies directly to an individual's life, and is important in making personal decisions.

Biology is studied by using the scientific method.

Biology is the study of life. In order to distinguish living from nonliving, a series of life determine characteristics must be confirmed.

Laboratory investigations require attention to safety precautions

1. How can living organisms be distinguished from nonliving matter?

2. What are the major themes in Biology and how do they apply to everyday life?

3. How can the scientific method be used to solve a problem?

4. What procedures should be taken to assure safety in the lab? Where is safety equipment located?

Learning Targets:

Science Inquiry and Application
All students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models; and

Communicate and support a scientific argument.

Core Ideas/Crosscutting Concepts:

TAXONOMY
Classification systems are frameworks created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms.

This classification system is continually undergoing modification as it accommodates the enormous diversity of living things.

Recent molecular evidence sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.

1. What basic criteria should a classification system meet?

2. Why is a classification system important?

Ecology
The great diversity of organisms and ecological niches they occupy result from more than 3.5 billion years of evolution.

Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium.

Ecosystems change as geological or biological conditions vary.

Energy flows from "eaten" to "eater" and this restricts the number, mass and energy at higher trophic levels.

Food webs are affected if any trophic level is severely altered, and producers, keystone species, predators and decomposers all have special effects on the web.

Populations are controlled by density dependent and density independent limiting factors.

Population growth can take many forms, and overpopulation develops when carrying capacity is exceeded.

Nutrients cycle in predictable ways throughout the atmosphere, hydrosphere, earth and biota.

Living organisms fall into rhythms based on their biologic needs and the habitat in which they live.

Biotic relationships such as predator/prey, symbiosis, and competition determine population size and growth.

Ecosystems change over time in successional patterns based on the severity of disruption and the habitat's abiotic characteristics

Learning Targets:

Biology
Diversity and Interdependence of Life

Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.

Ecosystems

Homeostasis

Carrying capacity

Equilibrium and disequilibrium

Diversity and Interdependence of Life

Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.

Core Ideas/Crosscutting Concepts:

BIOCHEMISTRY/ CELL STRUCTURE
A living cell is composed of a number of smaller elements - mainly carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.

Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules.

The essential functions of cells involve chemical reactions that involve water and carbohydrates, proteins, lipids, and nucleic acids.

Atomic structure and types of chemical bonds are described and related to physical properties.

The progress of chemical reactions can be diagrammed properly, and the role of enzymes and energy can be assessed within chemical reactions.

The processes of condensation and hydrolysis, monomers and polymers are applied to the types of organic molecules.

The 4 major categories of biological molecules (lipid, carbohydrate, nucleic acid and protein) are identified in terms of structure, function, nutritional value and dietary sources.

Most cells function within a narrow range of temperature and pH. At low temperatures, reaction rates

are slow. High temperatures and/or extremes of pH can irreversibly change the structure of most protein molecules.

1. What distinguishes the chemical molecules associated with life?

2. How are the 4 organic molecule categories similar/different in structure and function?

3. How do lipids, proteins, nucleic acids, and carbohydrates contribute to the total nutrition and structure of organisms?

4. How is the American diet balanced/unbalanced in major food categories?

5. What constitutes the recommended nutrition pyramid?

CELL STRUCTURE
The cell is the basic unit of structure and function of all living organisms.

This topic focuses on the cell as a system itself (single-celled), and as part of a larger system (multicellular).

1. How can the microscopic world be studied?

2. How can microscopic evidence be used to solve a crime?

3. How are plant and animal cells organized, and how do they carry out life activities?

4. How is a cell membrane constructed, and how does it enable a cell to communicate with its environment?

5. What distinguishes prokaryotic and eukaryotic cells? How did eukaryotic cells evolve?

6. What is the cell theory and how was it developed?

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Biology
Cells

Cell structure and function

Structure, function and interrelatedness of cell organelles

Eukaryotic cells and prokaryotic cells

Cellular processes

Characteristics of life regulated by cellular processes

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Core Ideas/Crosscutting Concepts:

CELL TRANSPORT
Fluid transport model of cell membrane is related to activities such as diffusion, osmosis, active transport and immunity.

Transport needs can be analyzed based on daily cell activities.

Predictions can be made for diffusion and osmosis events given concentration gradients.

Active and passive transport methods can be differentiated.

Given solutions that are hypotonic, hypertonic or isotonic, predictions can be made for diffusion and osmosis.

Sodium potassium pump activities can be related to nerve and muscle functioning.

Bulk transport is related to Golgi, water vacuole and lysosomal functioning.

Osmosis is related to turgor pressure in plants and food preservation.

1. Why is cell size limited?

2. How do cells control, through the structure of their cell membranes, what enters and exits through their membranes?

3. Why do cells need to use energy to move some things in/out, and don't need to use energy to move other things in/out?

4. How do concentration gradients affect osmosis and diffusion?

5. How do plant and animal cells handle problems with osmolality differently?

6. How do active transport methods relate to the development of membrane potentials, and why are membrane potentials useful in nerve and muscle activity?

Learning Targets:

Biology
Cells

Characteristics of life regulated by cellular processes

ENERGY: PHOTOSYNTHESIS AND CELLULAR RESPIRATION
Energy flows through the living world.

Plants capture energy from the sun and convert it to usable energy.

Animals obtain energy from plants when they eat the plants.

1. How is the anatomy of a chloroplast related to photosynthesis?

2. What is the role of various plant pigments in photosynthesis?

3. How are oxygen and ATP involved in the breakdown of glucose?

4. What are the products of fermentation and respiration?

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Biology
Cells

Cellular processes

Photosynthesis, chemosynthesis, cellular respiration

DNA, Protein Synthesis & Cell Division
DNA's structure comprised of a double helix with strong/weak bonds allows it to open up easily to replicate and transcribe, but prevents changes in the sequence of nitrogen bases (mutations).

The genetic code involves a sequence of nitrogen bases which converts to a sequence of amino acids in the resulting protein. The sequence of amino acids determines the 3D structure which orchestrates the behavior of an individual protein.

The discovery of DNA came about due to several sequential experiments which built on each other. (Ex. Griffiths, Avery, Thompson, Franklin, Watson, Crick)

Cell differentiation is the means by which a multicellular organism can divide labor to provide for the greater energy needs of a large organism.

Learning Targets:

Biology
Heredity

Cellular genetics

Structure and function of DNA in cells

Genetic mechanisms and inheritance

Mutations

Cells

Cellular processes

Cell division and differentiation

CELL REPRODUCTION
Chromosomes consist of thousands of genes, which are segments of DNA, each relating to a specific trait.

The majority of cells in an organism contain the diploid number of chromosomes, but gametes contain the haploid number of chromosomes.

When cells divide, the genetic information in the chromosomes must be passed on to each new cell.

Somatic cells produce identical diploid daugher cells by the process of mitosis; Germ cells produce haploid gametes by the process of meiosis

Mistakes can occur during the process of meiosis. Chromosomal errors are often visible through karyotyping.

Interphase and mitosis make up the cell cycle. Malfunctions in the cell cycle can result in cancer.

Mitosis is the method by which cells replicate themself identically to create more mass. Meiosis, on the other hand, creates diversity among gametes, and ensures that the chromosome number says constant from one generation to the next.

Learning Targets:

Biology
Heredity

Cellular genetics

Genetic mechanisms and inheritance

Mutations

Core Ideas/Crosscutting Concepts:

GENETICS & Biotechnology
DNA contains the genetic code that determines what characteristics are inherited by offspring from their parents.

Mendel's classic experiment uncovered three principles that govern the inheritance of characteristics.

If the genetic code of two parents is known, the genotypes and phenotypes of their offspring can be predicted.

Changes in DNA will result in changes in the characteristics of the organism.

Genetic modifications by man can result in organisms that have traits beneficial to man's purposes. These changes can, however, spread to other species or affect the modified organism and its ecosystem in ways not originally anticipated by man.

Genetic mechanisms include incomplete dominance, sex-linked traits, goodness of fit test, and dihybrid crosses.

Genes that affect more than one trait (pleiotropy), traits affected by more than one gene (epistasis), and polygenetic traits are explored with real world examples.

1. Given what you know about meiosis, how do you think a child inherits traits form both parents?

2. How do you think that chromosomes transmit a genetic disorder?

3. What do you think might happen if a mistake in replication occurs in the DNA of a cell that produces gametes?

4. Why do males express sex-linked characteristics more often than females?

Learning Targets:

Biology
Heredity

Genetic mechanisms and inheritance

Modern genetics

Core Ideas/Crosscutting Concepts:

EVOLUTION
Evolution is the change in the genetic makeup of organisms through time.

Scientific evidence for evolution comes from the fossil record as well as from living organisms. Recent molecular sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.

From a long term perspective, evolution is the descent with modification of different lineages from common ancestors.

From the short term perspective, evolution is the ongoing adaptation of organism to environmental challenges and changes.

Punctuated equilibrium proposes that evolution occurs in geologically rapid spurts, followed by long periods of stability.

The study of Evolution is focused around Modern Synthesis - the unification of genetics and evolution, and the historical perspectives of evolutionary theory.

The study of Evolution includes the ideas of gene flow, mutation, speciation, natural selection, genetic drift, sexual selection, and Hardy Weinberg's law.

Different phenotypes result from new combinations of existing genes or from mutations of genes in reproductive cells.

Populations evolve over time.

Evolution is the consequence of interactions of: 1) the potential for a population to increase its numbers, 2) the genetic variability of offspring due to mutation and recombination of genes, 3) a finite supply of its numbers, and 4) the differential survival and reproduction of individuals with the specific phenotype.

Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When and environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment.

1. Why is diversity in a population important?

2. What cellular mechanism forms the basis for evolutionary change?

3. What critical cellular evolutionary changes have been replicated in labs?

Learning Targets:

Biology
Evolution

Mechanisms

Natural selection

Mutation

Genetic drift

Gene flow (immigration, emigration)

Sexual selection

History of life on Earth

Diversity of Life

Speciation and biological classification based on molecular evidence

Variation of organisms within a species due to population genetics and gene frequency

Core Ideas/Crosscutting Concepts:

PLANTS
Plants are the providers of food for all other organisms.

Plants are capable of growth, reproduction, photosynthesis, and transport of materials.

Plants have critical impacts on our lives, for food and nonfood uses.

In order to grow plants successfully, plant needs for water, nutrients, soil, temperature, and light must be identified.

1. What are the major plant taxonomic groups?

2. What is the structure of plant roots, leaves, stems, flowers, and fruits?

3. How does reproduction occur in spore and seed producing plants?