

Foundations of Biology

History of Biology and Impacts on Society **FB.1**

Conceptual Understanding: The history of science is a compilation of the works of many people. To understand science and its applications, the history of scientific experiments and developments must be understood. The needs of society have been the driving force behind numerous advances in science and technology. Advances in science and technology have forever changed and will continue to change society.

- A** Students will relate the importance of significant historical biological experiments and their impact of these on research, development, and society. **FB.1A**
- 1** Identify and communicate the contributions of famous scientists and their experiments that formed fundamental scientific principles (e.g., Robert Hooke, Schleiden/ Schwann/Virchow, Griffith, Avery/MacLeod/McCarty, Hershey/Chase, Rosalind Franklin, Gregor Mendel, Watson/Crick, Pasteur, and Charles Darwin). **FB.1A.1**
 - 2** Trace and model the historical development of scientific ideas and theories (e.g., creation of the microscope, discovery of cells/cell theory, discovery of DNA/RNA, double helical shape of DNA, evolution/natural selection, endosymbiosis) through the development of a timeline. **FB.1A.2**
 - 3** Research, analyze, explain, and communicate how scientific enterprise relates to society and classic inventions (e.g., microscope, blood typing, gel electrophoresis equipment, DNA sequencing technology). **FB.1A.3**
 - 4** Enrichment: Research, analyze, explain, and communicate the influence of society, including cultural components, on the direction and progress of science and technology (e.g., medical treatments, emerging viruses, antibiotic resistance, vaccinations and re-emergent diseases, alternative energy development, and/or biomimicry). **FB.1A.4**

The Chemistry of Life **FB.2**

Conceptual Understanding: Living and non-living things are composed of elements. Elements have the unique ability to form compounds and molecules based on their atomic structures. Water has unique properties that allow it to form solutions with a variety of compounds. Living organisms are composed of biological molecules that interact with water and through chemical reactions, help to maintain homeostasis.

- A** Students will demonstrate an understanding of the structure and interactions of matter and how the organization of matter supports living organisms. **FB.2A**
- 1** Develop and use simple atomic models to describe the components of elements (e.g., relative position, charges of protons, neutrons, and electrons). **FB.2A.1**
 - 2** Obtain and use information about elements (e.g., chemical symbol, atomic number, atomic mass, and group or family) to describe the organization of the periodic table. **FB.2A.2**
 - 3** Relate chemical reactivity to an element's position on the periodic table. Use this information to determine what type of bond will form between elements (ionic, covalent, hydrogen). **FB.2A.3**
 - 4** Analyze and interpret data to classify common solutions such as acids, bases, or neutral. Communicate the importance of pH in living systems. **FB.2A.4**
 - 5** Investigate how the properties of water (e.g., cohesion, adhesion, heat capacity, solvent properties) contribute to the maintenance of living cells and organisms. **FB.2A.5**
 - 6** Explain the role of the major biomolecules (carbohydrates, proteins -including enzymes, lipids, and nucleic acids) to the survival of living organisms. **FB.2A.6**
 - 7** Enrichment: Explore the structure of biomolecules using molecular models. Relate the structure of biomolecules to their function in living things (discuss types bonding, importance of the strength and weakness of the bond in function, energy in bonds, enzyme function). **FB.2A.7**
-

**Organization and Energy
in Living Systems** **FB.3**

Conceptual Understanding: Cells are the basic unit of any living organism. All organisms are composed of one (unicellular) or many cells (multicellular). Living things use their cells to acquire energy from their environment to grow and reproduce, and then they respond and adapt to that environment for survival.

- A** Students will demonstrate an understanding of how the structure of living organisms supports the essential functions of life. **FB.3A**
- 1** Compare and contrast prokaryotic/eukaryotic and plant/animal/bacteria cells. **FB.3A.1**
 - 2** Use models to investigate and explain structures within living cells that support life (e.g., cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, Golgi, vacuoles, ER, ribosomes, chromosomes, centrioles, cytoskeleton, nucleolus, nuclear membrane). **FB.3A.2**
 - 3** Compare and contrast active and passive cellular transport. Analyze the movement of water across a cell membrane in hypotonic, isotonic, and hypertonic solutions. **FB.3A.3**
 - 4** Analyze the relationship between photosynthesis and cellular respiration and explain that relationship in terms of the need for all living things to acquire energy from their environment. **FB.3A.4**
 - 5** Use models to explain how ADP and ATP cycle to store and release chemical energy using inorganic phosphate. **FB.3A.5**
 - 6** Compare and contrast the processes and results of mitosis and meiosis. **FB.3A.6**
 - 7** Enrichment: Research and orally communicate the possible outcomes of a failure of mitosis (cancer) or meiosis (nondisjunction). **FB.3A.7**
-

Molecular Basis of Heredity **FB.4**

Conceptual Understanding: One strand of DNA creates a chromosome. Chromosomes have genes, which are simply segments of DNA. The information stored in DNA (in genes on chromosomes) determines the unique characteristics of an individual. DNA is the blueprint for RNA through transcription, which in turn, allows for the creation of a protein through translation. Modern technologies allow humans to manipulate DNA, RNA, and proteins to solve human dilemmas. Using technology to manipulate genetic information is controversial.

- A** Students will demonstrate an understanding of how genetic information is transferred from parent to offspring. **FB.4A**
- 1** Compare and contrast the basic structure and function of nucleic acids (e.g., DNA, RNA). **FB.4A.1**
 - 2** Obtain and communicate information illustrating the relationships among DNA, genes, chromosomes, and proteins to the basis of life. **FB.4A.2**
 - 3** Use models (e.g., Punnett squares) and mathematical reasoning to describe and predict patterns of inheritance of single genetic traits from parents to offspring (e.g., dominant, and recessive traits, incomplete dominance, codominance, multiple alleles, sex- linkage). **FB.4A.3**
 - 4** Obtain and communicate information to describe how mutations may affect genetic expression and provide examples. **FB.4A.4**
 - 5** Research and report on genetic technologies that may improve the quality of life (e.g., genetic engineering, cloning, gene splicing, DNA testing). **FB.4A.5**
 - 6** Enrichment: Debate the pros and cons of using biotechnology to manipulate genetic information for human purposes (society). **FB.4A.6**

Biological Evolution **FB.5**

Conceptual Understanding: The geologic time scale interpreted from rock strata and fossil evidence provides a way to organize major historical events in Earth's history. Rock strata can document the existence, diversity, extinction, and changes in many life forms. Adaptation by natural selection acting over generations is one important process by which species gradually change to respond to environmental pressures.

- A** Students will demonstrate an understanding of Earth's fossil record and its indication of the diversity of life over time. **FB.5A**
- 1** Investigate through research the contributions of scientists to the theory of evolution and evolutionary processes (e.g., Needham, Spallanzani, Redi, Pasteur, Lyell, Lamarck, Malthus, Wallace, Darwin). **FB.5A.1**
 - 2** Analyze and interpret data to support claims that different types of fossils provide evidence of the diversity of life that has existed on Earth and of the relationships between past and existing life on Earth. **FB.5A.2**
 - 3** Obtain and communicate information to explain how DNA evidence and fossil records support Darwin's theory of evolution. **FB.5A.3**
 - 4** Investigate how biological adaptations and genetic variations of traits in a population enhance the probability of survival in an environment (natural selection). **FB.5A.4**
 - 5** Enrichment: Create and analyze models that illustrate the relatedness between all living things (cladograms/phylogenetic trees). **FB.5A.5**
-

**Ecological
Principals** **FB.6**

Conceptual Understanding: Ecosystems are dynamic in nature, full of complex interactions that affect the numbers and types of organisms that can survive. Biotic and abiotic factors affect ecosystems, allowing them to sustain only a limited number of organisms and populations, known as a carrying capacity. There is a delicate balance that exists between the living and non-living things in an ecosystem. Humans can interrupt this balance, causing both local and global environmental issues.

- A** Students will understand the interdependence of living organisms and their environment. **FB.6A**
- 1** Compare and contrast biotic and abiotic factors. **FB.6A.1**
 - 2** Use models to analyze the cycling of matter in an ecosystem (e.g., water, carbon dioxide/oxygen, nitrogen). **FB.6A.2**
 - 3** Obtain, evaluate, and communicate information to explain relationships that exist between abiotic and biotic components of an ecosystem. Explain how changes in biotic and abiotic components affect the balance of an ecosystem over time. **FB.6A.3**
 - 4** Develop and use models to discuss the climate, flora, and fauna of the terrestrial and aquatic biomes of the world. **FB.6A.4**
 - 5** Use models to analyze the flow of energy through food chains, webs, and pyramids. **FB.6A.5**
 - 6** Engage in scientific argument from evidence to distinguish organisms that exist in symbiotic (mutualism, parasitism, commensalism) or co-evolutionary (predator-prey, cooperation, competition, and mimicry) relationships within ecosystems. **FB.6A.6**
 - 7** Enrichment: Design solutions to reduce the impact of human activity on the ecosystem. **FB.6A.7**