Fairfield Public Schools
Science Curriculum

Draft Units

AP Biology

Course: Description

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:

Disciplinary Core Ideas: Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

Science and Engineering Practices: These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

Cross-cutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

CROSS CUTTING CONCEPTS

Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

AP Biology: Overview

Enduring Understandings
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Course Essential Questions
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Course: Year-at-a Glance

Unit	Title	Unit Essential Questions
1	The process of evolution drives the diversity and unity of life.	● Why is the change in the genetic makeup of a population over time considered evolution? ● Why are organisms considered linked by lines of descent from a common ancestor? ● Why does life continue to evolve within a changing environment? ● Why are the origins of living systems explained by natural processes?
2	Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.	● Why do the growth, reproduction, and maintenance of the organization of living systems require free energy and matter? ● Why do the growth, reproduction, and dynamic homeostasis of cells require that cells create and maintain internal environments that are different from their external environments? ● Why do organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis? ● Why are growth and dynamic homeostasis of a biological system influenced by changes in the system's environment? ● Why do many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination?
3	Living systems store, retrieve, transmit and respond to information essential to life processes.	● Why does heritable information provide for the continuity of life? ● Why does the expression of genetic information involve cellular and molecular mechanisms? ● Why is the processing of genetic information imperfect and a source of genetic variation? ● Why do cells communicate by generating, transmitting and receiving chemical signals? ● Why does the transmission of information result in changes within and between biological systems?
4	Biological systems interact, and these systems and their interactions possess complex properties.	● Why do interactions within biological systems lead to complex properties? ● Why are competition and cooperation important aspects of biological systems? ● Why does naturally occurring diversity among and between components within biological systems affect interactions with the environment?

The Process of Evolution Drives the Diversity and Unity of Life

Overview

Evolution is a change in the genetic makeup of a population over time, with natural selection as its major driving mechanism. Naturally occurring and human induced events as well as random environmental changes can result in alteration in the gene pools of populations. A diverse gene pool is vital for the survival of species because environmental conditions change. Scientific evidence supports the idea that both speciation and extinction have occurred throughout Earth's history and that life continues to evolve within a changing environment, thus explaining the diversity of life.

Unit Content Objectives

At the conclusion of this unit, students will be able to evaluate why:

- Natural selection is a major mechanism of evolution.
- Natural selection acts on phenotypic variations in populations.
- Evolutionary change is also driven by random processes.
- Biological evolution is supported by scientific evidence from many disciplines, including mathematics.
- Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
- Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
- Speciation and extinction have occurred throughout the Earth's history.
- Speciation may occur when two populations become reproductively isolated from each other.
- Populations of organisms continue to evolve.
- There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
- Scientific evidence from many different disciplines supports models of the origin of life.

Unit Essential Questions

- Why is the change in the genetic makeup of a population over time considered evolution?
- Why are organisms considered linked by lines of descent from a common ancestor?
- Why does life continue to evolve within a changing environment?
- Why are the origins of living systems explained by natural processes?

Crosscutting Concepts

- Use representations and models to communicate scientific phenomena and solve scientific problems.
- Use mathematics appropriately.
- Engage in scientific questioning to extend thinking or to guide investigations.
- Plan and implement data collection strategies appropriate to a particular scientific question.
- Perform data analysis and evaluation of evidence.
- Work with scientific explanations and theories.
- Connect and relate knowledge across various scales, concepts and representations in and across domains.

NGSS Unit Standards
DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards:

Biological systems utilize free energy & molecular building blocks to grow, to reproduce & to maintain dynamic homeostasis

Overview

Living systems require free energy and matter to maintain order, grow and reproduce. Organisms employ various strategies to capture, use and store free energy and other vital resources. Energy deficiencies are not only detrimental to individual organisms, they also can cause disruptions at the population and ecosystem level.

Unit Content Objectives

At the conclusion of this unit, students will be able to evaluate why:

- All living systems require constant input of free energy.
- Organisms capture and store free energy for use in biological processes.
- Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
- Cell membranes are selectively permeable due to their structure.
- Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
- Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.
- Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
- Organisms respond to changes in their external environments.
- All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
- Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.
- Biological systems are affected by disruptions to their dynamic homeostasis.
- Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.
- Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.
- Timing and coordination of physiological events are regulated by multiple mechanisms.
- Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

Unit Essential Questions

- Why do the growth, reproduction, and maintenance of the organization of living systems require free energy and matter?
- Why do the growth, reproduction, and dynamic homeostasis of cells require that cells create and maintain internal environments that are different from their external environments?
- Why do organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis?

- Why are growth and dynamic homeostasis of a biological system influenced by changes in the system's environment?
- Why do many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination?

Crosscutting Concepts

- Use representations and models to communicate scientific phenomena and solve scientific problems.
- Use mathematics appropriately.
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
- Plan and implement data collection strategies appropriate to a particular scientific question.
- Perform data analysis and evaluation of evidence.
- Work with scientific explanations and theories.
- Connect and relate knowledge across various scales, concepts and representations in and across domains.

NGSS Unit Standards
DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards:

Living systems store, retrieve, transmit and respond to information essential to life processes.

Overview

The transmission of genetic information from parent to offspring allows for the continuity of life. Repair enzymes maintain the integrity of these processes, although replication is imperfect and errors occur through a variety of impacts. Cell products are the result of expression of the genetic material of the cell and these products determine the metabolism of the cell. The long term survival and evolution of a species is often due to advantageous genetic variation. Also essential to life processes, is successful communication amongst cells as well as responses to their external environment.

Unit Content Objectives

At the conclusion of this unit, students will be able to evaluate why:

- DNA, and in some cases RNA, is the primary source of heritable information.
- In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.
- The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring
- The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
- Gene regulation results in differential gene expression, leading to cell specialization.
- A variety of intercellular and intracellular signal transmissions mediate gene expression.
- Changes in genotype can result in changes in phenotype.
- Biological systems have multiple processes that increase genetic variation
- Viral replication results in genetic variation and viral infection can introduce genetic variation into the hosts.
- Cell communication processes share common features that reflect a shared evolutionary history.
- Cells communicate with each other through direct contact with other cells or from a distance via chemical
- Signal transduction pathways link signal reception with cellular response.
- Changes in signal transduction pathways can alter cellular response.
- Individuals can act on information and communicate it to others.
- Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce response

Unit Essential Questions
● Why does heritable information provide for the continuity of life? ● Why does the expression of genetic information involve cellular and molecular mechanisms? ● Why is the processing of genetic information imperfect and a source of genetic variation? ● Why do cells communicate by generating, transmitting and receiving chemical signals? ● Why does the transmission of information result in changes within and between biological systems?

Crosscutting Concepts

NGSS Unit Standards
DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards:

Biological systems interact, and these systems and their interactions possess complex properties

Overview

All biological systems are composed of parts that interact with each other from the molecular level to the ecosystem level and exhibit properties of biocomplexity and diversity. Variations in components within biological systems provide a greater flexibility to respond to changes in its environment.

Unit Content Objectives

At the conclusion of this unit, students will be able to evaluate why:

- The subcomponents of biological molecules and their sequence determine the properties of that molecule.
- The structure and function of subcellular components, and their interactions, provide essential cellular processes.
- Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
- Organisms exhibit complex properties due to interactions between their constituent parts.
- Communities are composed of populations of organisms that interact in complex ways.
- Interactions among living systems and with their environment result in the movement of matter and energy.
- Interactions between molecules affect their structure and function.
- Cooperative interactions within organisms promote efficiency in the use of energy and matter.
- Interactions between and within populations influence patterns of species distribution and abundance.
- Distribution of local and global ecosystems changes over time.
- Variation in molecular units provides cells with a wider range of functions.
- Environmental factors influence the expression of the genotype in an organism.
- The level of variation in a population affects population dynamics.
- The diversity of species within an ecosystem may influence the stability of the ecosystem.

Unit Essential Questions

- Why do interactions within biological systems lead to complex properties?
- Why are competition and cooperation important aspects of biological systems?
- Why does naturally occurring diversity among and between components within biological systems affect interactions with the environment?

Crosscutting Concepts

NGSS Unit Standards
DISCIPLINARY CORE IDEAS (DCI): **SCIENCE AND ENGINEERING PRACTICES (SEP):**
Corresponding CT Core Standards: