Sparta Area School District

Good people, great schools.

Course Outcome Summary

Course Information: Advanced Biology

Description: This course is designed based on the three overarching topics of Molecules and Cells, Heredity and Evolution, and Organisms and Populations. The recurring thread throughout the text is evolution as the foundation of modern biological models and thought. The course is taught to constantly review the themes and relate the biological concepts to real world examples and explanations to the students and society. Advanced Biology is designed to actively engage students in the process of science through class assignments and discussions which inform their laboratory experiences. This course is equivalent of an introductory college-level biology course, and it is designed to prepare students for the second year Biology course.

Instruction Level: 11-12

Total Credits: 2 (dual credit with UW-Richland Center)

Prerequisites: Successful completion of Biology /Chemistry /Physics

Textbooks: Biology, Concepts and Connections, Reece, Campbell, 978-0321696816)

Course Standards:

Content:

- The process of evolution drives the diversity and unity of life.
- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Living systems store, retrieve, transmit and respond to information essential to life processes.
- Biological systems interact, and these systems and their interactions possess complex properties.

Science Practices:

- The student can use representations and models to communicate scientific phenomena and solve scientific problems.
- The student can use mathematics appropriately.
- The student can engage in scientific questioning to extend thinking or to guide investigations with the context of Advanced Biology.
- The student can plan and implement data collection strategies appropriate to a particular scientific question.
- The student can perform data analysis and evaluation of evidence.

- The student can work with scientific explanations and theories.
- The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

Unit

1. **Chemical Basis of Life**
2. **Cellular Energy**
3. **Cell Structure and Transport**
4. **Cell Anatomy**
5. **Molecular Genetics**
6. **Heredity**
7. **Evolution**
8. **Ecology**

Unit Outlines

1. Chemical Basis of Life

Standards:

- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Biological systems interact, and these systems and their interactions possess complex properties.

Essential Question:

Students will be able to answer the following question(s):

- How are the characteristics of life manifested by the cell?
- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?
- How do living things use energy and matter to survive in an ecosystem?

Essential Knowledge:

- **Water and Chemistry**
  - Provide evidence that life requires a highly ordered system.
  - Model how organisms use free energy to maintain organization, grow and reproduce.
  - Describe how changes in free energy availability can result in changes in population size and disruptions to an ecosystem.
  - List the properties of water and explain their importance to life.
- **Macromolecules**
  - Describe how molecules and atoms from the environment are necessary to build new molecules.

    - Model how the subcomponents of biological molecules and their sequence determine the properties of that molecule.
    - Explain why carbon in the backbone of all organic molecules.
- **Homeostasis and Metabolism**
    - Explain how organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
    - Understand that alternation in the mechanisms of feedback often results in deleterious consequences.
    - Explain the role of enzymes in chemical reactions
    - Identify the factors that affect enzymes
    - Compare and contrast competitive vs. non-competitive inhibition.
    - Describe what is occurring during competitive inhibition
    - Differentiate between the active site and allosteric site of the enzyme-substrate complex
    - Explain how interactions between molecules affect their structure and function.

2. Cellular Energy

Standards:

- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

Essential Question:

Students will be able to answer the following question(s):

- What are the relationships between structure and function of cell organelles?
- How are the characteristics of life manifested by the cell?
- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?
- How is energy stored in biological systems?
- How do living things use energy and matter to survive in an ecosystem?

Essential Knowledge:

- **Cellular Respiration and Photosynthesis**
    - Describe how energy-related pathways in biological systems are sequential and may be entered at multiple points in pathway.
    - Model how organisms capture and store free energy for use in biological processes.
    - Describe how autotrophs capture free energy from physical sources in the environment.
    - Describe how heterotrophs capture free energy present in carbon compounds produced by other organisms.
    - Reason how different energy-capturing processes use different types of electron acceptors.
    - Summarize the light-dependent reactions of photosynthesis in eukaryotes.

- Summarize cellular respiration in eukaryotes and the series of coordinated enzyme-catalyzed reactions that harvest free energy from simple carbohydrates.
- Model how free energy becomes available for metabolism by the conversion of ATP→ADP, which is coupled to many steps in metabolic pathways.

3. Cellular Structure and Transport

Standards:

- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Living systems store, retrieve, transmit and respond to information essential to life processes.

Essential Question:

Students will be able to answer the following question(s):

- How do materials enter and leave the cell?
- What role does the cell membrane play in cellular homeostasis?
- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?
- How is energy stored in biological systems?
- How are external signals converted into cellular responses?

Essential Knowledge:

- **Cell membrane**
  - Describe how cell membranes are selectivity permeable due to their structure.
  - Construct models that connect the movement of molecules across membranes with membrane structure and function.
- **Homeostasis**
  - Use data collected to justify that surface area-to-volume ratios affect a biological system's ability to obtain necessary resources or eliminate waste products.
  - Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination.
  - Describe how growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
- **Cell communication**
  - Explain how signal pathways mediate gene expression, including how this process can affect protein production.
  - Use representations and appropriate models to describe features of a cell signaling pathway.
  - Describe a model that expresses the key element of signal transduction pathway by which a signal is converted to a cellular response.
  - Describe how changes in the signal transduction pathways can alter cellular response.

4. Cellular Anatomy

Standards:

- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Living systems store, retrieve, transmit and respond to information essential to life processes.
- Biological systems interact, and these systems and their interactions possess complex properties.

Essential Question:

Students will be able to answer the following question(s):

- How is the cell the basic unit of life?
- What are the relationships between structure and function of cell organelles?
- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?

Essential Knowledge:

- **Endomembrane System**
  - Describe how organisms share many conserved core processes and features that evolved and are widely distributed among organisms today using structural evidence.
  - Explain how internal membranes and organelles contribute to cell functions.
  - Use representations and models to describe differences in prokaryotic and eukaryotic cells.
  - Identify the structure and function of subcellular components, and their interactions, provide essential cellular processes.
- **Mitosis**
  - Describe the events that occur in the cell cycle.
  - Explain how in eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis.
- **Cancer**
  - Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.

5. Molecular Genetics

Standards:

- The process of evolution drives the diversity and unity of life.
- Living systems store, retrieve, transmit and respond to information essential to life processes.

Essential Question:

Students will be able to answer the following question(s):

- How are external signals converted into cellular responses?
- How does gene expression control the cell and determine its metabolism?
- How does genotype affect phenotype?
- How are genotype and human disorder related?

Essential Knowledge:

- **Replication and DNA/RNA**
  - Use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information.
  - Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.
  - Describe representations and models that illustrate how genetic information is copied for transmission between generations.
  - Model how changes in genotype can result in changes in phenotype.
- **Central Dogma**
  - Describe representations and models illustrating how genetic information is translated into polypeptides.
  - Explain how viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.
- **Gene Expression**
  - Describe how 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.
  - Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.
  - Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.
  - Use representations to describe how gene regulation influences cell products and function.

6. Heredity

Standards:

- The process of evolution drives the diversity and unity of life.
- Living systems store, retrieve, transmit and respond to information essential to life processes.

Essential Question:

Students will be able to answer the following question(s):

- How are traits passed from one generation to the next?
- How do eukaryotic cells store, retrieve, and transmit genetic information?
- What are the current trends in genetic engineering techniques that guide manipulation of genetic information?
- What social and ethical issues are raised by advances in genetic engineering?

Essential Knowledge:

- **Meiosis**
  - Construct a representation that connects the process of meiosis to the passage of traits from parent to offspring.
  - Explain how meiosis, a reduction division, followed by fertilization ensures genetic diversity in sexually reproducing organisms.
- **Mendelian Genetics**
  - Explain how the chromosomal basis of inheritance provides an understanding of the pattern of passage of genes from parent to offspring.
  - Justify how the inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
  - Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets.
  - Pose questions about ethical, social, or medical issues surrounding human genetic disorders.
  - Discuss how environmental factors influence the expression of the genotype in an organism.

7. Evolution

Standards:

- The process of evolution drives the diversity and unity of life.

Essential Question:

Students will be able to answer the following question(s):

- What role does evolution play in the organization of living things?
- What evidence supports our current models of the origin of life?
- How does the process of evolution drive diversity and the unity of life?
- How does life evolve in changing environments?

Essential Knowledge:

- Use evidence to defend how natural selection is a major mechanism of evolution.
- Model how natural selection acts on phenotypic variations in populations.
- Describe how evolutionary change is also driven by random processes.
- Explain how biological evolution is supported by scientific evidence from many disciplines, including mathematics.
- Use phylogenetic trees and cladograms as graphical representations of evolutionary history that can be tested.
- Identify how speciation and extinction have occurred throughout Earth's history.
- Discuss speciation and how it may occur when two populations become reproductively isolated from each other.
- Evaluate given data sets that illustrate evolution as an ongoing process.
- Evaluate several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
- Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.
- Justify scientific claims about the effects of variation within populations on survival and fitness.

8. Ecology

Standards:

- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Biological systems interact, and these systems and their interactions possess complex properties.

Essential Question:

Students will be able to answer the following question(s):

- How is free energy used in biological systems to facilitate growth, reproduction, and homeostasis sustainability?
- How do interactions between and within populations influence patterns of species distribution and abundance?
- How do living things use energy and matter to survive in an ecosystem?
- How do humans impact the biodiversity of ecosystems?
- What role does the environment play in sustaining homeostasis in biological systems?

Essential Knowledge:

- Predict the effects of a change in the community's population on the community.
- Describe how interactions among living systems and with their environment result in the movement of matter and energy.
- Analyze effects of population interactions on patterns of species distribution and abundance.
- Predict consequences of human actions on both local and global ecosystems.
- Explain how the diversity of species within an ecosystem may influence the stability of the ecosystem.