Science Outcomes: Ecology

The intention of the Biology II: Ecology course is to build on the concepts outlined in the Biology I Standards of Learning. The second level biology course outcomes are designed to provide students with a more intensive look at ecological concepts. Students are expected to have had instruction in biology and Earth science content prior to taking the course (although Earth Science is not a pre-requisite for the course, students will need understanding of basic Earth processes that underlie ecological concepts). Concepts include the flow of matter and energy in biotic and abiotic components of an ecosystem, geochemical processes (carbon, nitrogen, phosphorus, and oxygen cycles), chemical and biochemical processes essential for life, water chemistry and the impact of water on life processes, and processes and interactions of Earth systems. The use of performance assessment to include field experiences and MWEEs (Meaningful Watershed Education Experience) should be used as support for Ecology instruction.

Science Skills and Processes

The student will demonstrate an understanding of scientific skills and processes by

- asking questions and defining problems
  - ask questions that arise from careful observation of phenomena and/or organisms or from examining models and theories, or unexpected results, and/or to seek additional information
  - determine which questions can be investigated within the scope of the school laboratory or field to determine relationships between independent and dependent variables
  - make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated
- planning and carrying out investigations
  - individually and collaboratively plan and conduct observational and experimental investigations
  - plan and conduct investigations or test design solutions in a safe and ethical manner including considerations of environmental, social, and personal impacts
  - determine appropriate sample size and techniques
  - select and use appropriate tools and technology to collect, record, analyze, and evaluate data
- interpreting, analyzing, and evaluating data
  - construct and interpret data tables showing independent and dependent variables, repeated trials, and means
  - construct, analyze, and interpret graphical displays of data, including scatterplots and line plots and consider limitations of data analysis
  - apply mathematical concepts and processes to scientific questions
  - use data in building and revising models, supporting explanation for phenomena, or testing solutions to problems
  - analyze data using tools, technologies, and/or models to make valid and reliable scientific claims or determine an optimal design solution
- constructing and critiquing conclusions and explanations

        - make quantitative and/or qualitative claims regarding the relationship between dependent and independent variables
        - construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including students' own investigations, models, theories, simulations, peer review
        - apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and design solutions
        - compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence
        - construct arguments or counterarguments based on data and evidence
        - differentiate between a scientific hypothesis and theory
    - developing and using models
        - evaluate the merits and limitations of models
        - develop, revise, and/or use models based on evidence to illustrate or predict relationships
        - develop and/or use models to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems
    - obtaining, evaluating, and communicating information
        - compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem
        - gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and credibility of each source
        - communicate scientific and/or technical information about phenomena in multiple formats

Science Content

I. The Individual

The student will investigate and understand that Life History Theory allows for the prediction of an organisms development and behaviors. Key concepts include

- an organisms life history includes patterns of growth, development and reproduction; and
- patterns of life history (K-selection, r-selection)

The student will understand that the individual is the basic unit of ecology. Key ideas include

- classification is based on molecular phylogenetics, structural, and biochemical characteristics;
- organisms can be classified based on how they use energy; and
- systemics, the science of grouping and categorizing organisms, is adaptable to new scientific discoveries.

The student will investigate and understand that plants have evolved a variety of adaptations to survive, grow, and reproduce in the wide range of environmental conditions on Earth. Key environmental conditions include:

- quantities of reactants for photosynthesis;
- temperature;

- nutrient availability; and
- predators.

The students will investigate and understand that animals have evolved a variety of adaptations to survive, grow, and reproduce in the diversity of environments existing on earth. Adaptations include:

- body size;
- acquiring and digesting food;
- oxygen absorption;
- maintaining temperature and water balance; and
- variations to light and temperature.

II. Populations

Students will investigate that different factors influence population density, dispersion, and demographics and use models as predictors of population growth. Key concepts include

- basic structure of ecological populations includes population distribution and population abundance;
- factors that regulate population growth include intraspecific competition in population growth and population density;
- limits to population growth include limiting factors, population density, and carrying capacity;
- population growth can be described as geometric or exponential;
- models are used to predict population growth; and
- the impact of rapid growth of human population is a source of environmental problems.

Students will investigate and understand that intraspecific interactions and natural selection have an impact on a population. Key ideas include

- there is intraspecific and interspecific competition;
- predation includes cryptic coloration, aposematic, Batesian mimicry, Mullerian mimicry herbivory; and
- organisms have symbiotic relationships.

III. Communities

Students will explore and analyze community structures and interactions. Key concepts include

- species interactions (e.g. predation, parasitism, mutualism, commensalism, and competition) and adaptations have evolved in response to interspecific selective pressures;
- ecological niches and resource partitioning impact interactions;
- dominant, keystone, foundation, and endangered species have roles in ecosystems and communities, locally and globally;
- species diversity relates to the stability of ecosystems and communities; and
- ecological succession changes communities over time and may have an impact of disturbance on community composition.

IV. Ecosystems

The students will understand the that energy flow through an ecosystem. Key concepts include

- food chains, webs and pyramids model energy flow in ecosystems; and
- primary productivity is important in ecosystems;
- efficiency of energy use is important;
- thermodynamic principles apply in an ecological system; and
- the stability of an ecosystem is related to the biodiversity.

The students will investigate and understand that dead organic matter is crucial to the internal cycling of nutrients in an ecosystem. Key concepts include

- climate impacts the type of decomposers in an ecosystem; and
- rate of decomposition varies by organism and climate.

The students will investigate and understand the effect of human influence on an ecosystem. Key concepts include

- Humans influence the pattern of natural changes such as primary/secondary succession and desertification;

V. Biomes

Students will analyze how biotic and abiotic factors interact to affect the distribution of species and the diversity of life on Earth. Key concepts include

- the biotic and abiotic components that define various biomes and aquatic life zones;
- global climate patterns and biogeography impact diversity;
- different factors lead to the species richness of an ecosystem and the importance of biodiversity; and
- natural selection has a role in organismal adaptations that are specific to their habitats.

VI. Global Issues

Students will assess the impact of human activities on the natural world, and research how ecological theory can address current issues facing our society, both locally and globally. Key issues include

- major primary and secondary pollutants;
- sustainable and non-sustainable use of resources, including soil, timber, fish and wild game, mineral resources, and nonrenewable energy;
- natural and anthropogenic climate change;
- habitat fragmentation and habitat loss on biodiversity in relation to island biogeography, and apply island biogeography theory to the design of parks and nature preserves; and
- the ecological impact of agriculture (historical and modern) in the environment and its implications for feeding the world's population.