SCIENCE DEPARTMENT **BIOLOGY (H): COURSE #421**

The Department's Educational Philosophy

We believe that students should be exposed to the process of scientific inquiry so they can acquire and interpret scientific knowledge, and begin to realize the wider applicability of scientific problem-solving methods. By making the laboratory the focal point of learning, we seek to foster students' appreciation for the experience of doing science.

Guiding Principles

- Students must be able to collect and analyze data and formulate hypotheses.
- Inductive and deductive problem-solving skills are central to science education.
- An effective program in science addresses the limitations of data and conclusions.
- Students should be able to use or design a strategy for testing scientific concepts.
- A comprehensive science program will emphasize the delicate checks and balances in man's abiotic and biotic environments and the stresses upon these ecosystems, which could affect the destiny of the world.
- Science is integrally related to mathematics.
- An effective science program builds students' ability to communicate accurately and precisely.
- An effective science program stresses both cooperative and independent learning.

BIOLOGY (H): COURSE #421

Course Frequency: Full-year course, five times per week; six times in a six-day cycle
Credits Offered: 5 credits
Prerequisites: By Recommendation of the Department

Background to the Curriculum

Biology 421 (H) is a rigorous course designed to provide students with a sophisticated understanding of the major topics in biology. The following topics will be covered: ecology, biochemistry, cellular biology, genetics, natural selection, classification, a survey of major kingdoms, and human biology.

Core Topics/Questions/Concepts/Skills

Core Topics	Questions	Concepts
I. Ecosystems	• How do organisms in New England ecosystems and other ecosystems interact? • How do matter and energy move through ecosystems?	Niches, habitats, biomes, biosphere, Ecological succession, competition, predator-prey, symbiosis, food web, energy pyramid
II. Matter and Energy	• How does life utilize energy? • How does life utilize matter?	general chemistry, conservation of matter and energy, photosynthesis and cellular respiration, enzymes, ATP, macromolecules
III. Cells	• What are the basic structures of cells and their functions? • How have complex cells evolved from simpler cells?	characteristics of life, cell structure and function, prokaryotes/eukaryotes, surface area/volume, proteins (channel, receptor, marker) diffusion, osmosis, active/passive transport, mitosis, cancer, endosymbiotic theory
IV. Photosynthesis and Cellular Respiration	• How do plants convert abiotic energy to biotic energy? • Biochemically, how do plants use water, carbon dioxide and sunlight? • Biochemically, how do plants produce glucose and oxygen?	photosynthesis, thylakoid, stroma, grana, light reaction, light-independent reaction, Calvin cycle, cellular respiration, mitochondria, lactic acid fermentation, alcoholic fermentation, Krebs Cycle, electron transport chain

	• Biochemically, how do organisms use glucose and oxygen? • Biochemically, how do organisms produce water and carbon dioxide?	
V. Heredity	• How is hereditary information housed in your cells? • How is the hereditary information passed on from parent to offspring? • How does variation in a species increase?	Mendel's experiments, inheritance, genotype vs. phenotype, probability, laws of segregation and independent assortment, pedigree, asexual and sexual reproduction.
VI. Molecular Genetics	• What is the structure of DNA and where is it located? • How are proteins made? • How do mutations relate to the structure of chromosomes and DNA?	Chromosomal theory of inheritance, meiosis, mutations, DNA and RNA structures, inversions, translocations, deletions, substitutions, point mutations.
VII. Evolution	• How do species evolve over time? • How does variation in a species relate to evolution? • Can an organism adapt?	Darwin vs. Lamarck, variation, reproduction, environmental influence, adaptation, homologous/analogous structures, adaptive radiation
VIII. Earth History and Classification	• How did life evolve from inorganic matter? • What is the timeline of the history of life on Earth? • How do scientists categorize the diversity of life? • How are organisms classified based on evolutionary relationships?	Miller – Urey experiment, endosymbiotic theory, protenoid microsphere, cyanobacteria, properties of RNA, mass extinction, biodiversity, taxonomy phylogeny, convergent and divergent evolution, patterns of evolution
IX. Bacteria and Viruses	• What is the structural diversity of bacteria? • What roles do bacteria play in ecosystems? • How are bacteria classified? • What are the general characteristics of viruses?	bacteria (distribution, structure, diversity, nutrition, pathogens, antibiotic resistance), viruses (structure, reproduction, pathogens, HIV), vaccines

X. Protists and Fungi	• What is the structural diversity of protists? • What roles do protists play in ecosystems? • How are protists classified? • What is the structural diversity of fungi? • What roles do fungi play in ecosystems? • How are fungi classified?	protists (characteristics, diversity, pathogens), reproduction, examples fungi (characteristics, diversity, reproduction, examples, symbiosis, lichens, mycorrhizae)
XI. Plants	• What is the structural diversity of plants? • What roles do plants play in ecosystems? • How are plants classified? • What were the survival strategies that plants evolved and what evidence supports this?	Evolution, biodiversity, reproduction, plant structure/function
XII. Animals	• What is the structural diversity of animals? • What roles do animals play in ecosystems? • How are animals classified? • What were the survival strategies that animals evolved and what evidence supports this? • What were the major changes in body plan that evolved?	evolution, structure, development, body plan, phyla characteristics
XIII. Human Body Systems (Nervous, Skeletal, Muscular, Endocrine, Circulatory, Respiratory, Digestive, Excretory, and Immune Systems) and Cell Respiration.	• How do structure and function relate in the human body systems? • What is homeostasis and how is it disrupted in each of the human body systems?	structure versus function, major bones, bone formation, types of muscle, movement, cellular respiration (glycolysis, Krebs cycle, electron transport, mitochondria), microscopic anatomy, nerve impulse, neuron structure, synapse, hormones, glands, cardiovascular, pulmonary and systemic circuits, immune response, disease

Course-End Learning Objectives

Students will:

Ecosystems

1] Explain how organisms interact in New England ecosystems and other ecosystems.
2] Describe how matter and energy move through ecosystems.

Matter and Energy

1] Describe how living organisms utilize energy.
2] Explain the composition and functions of the different molecules within living organism.

Cells

1] Describe the basic structures of cells and their functions.
2] Explain how complex cells have evolved from simpler cells.
3] Explain the role of enzymes and identify factors which have an effect on enzymes
4] Describe the cell cycle and the process of mitosis
5] Describe how the process of meiosis results in the formation of haploid cells

Photosynthesis and Cellular Respiration

1] Discuss how plants convert abiotic energy to biotic energy.
2] Discuss how animals process energy.

Heredity

1] Distinguish among observed inheritance patterns caused by several types of genetic traits
2] Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance
3] Use a Punnett Square to determine the probabilities for genotype and phenotype combinations.

Genetics

1] Identify how and where hereditary information is housed in cells.
2] Explain how hereditary information is passed from parent to offspring.
3] Identify how variation in a species increases over time.
4] Describe the structure of DNA and where it is located.
5] Describe how proteins are made.

Natural Selection

1] Explain how species evolve over time.
2] Describe the role that variation plays in the evolution of a species.
3] Explain what is meant by the term adaptation as it relates to natural selection.

Earth History and Classification

1] Describe how life evolved from inorganic matter.
2] Explain the timeline of the history of life on Earth.
3] Explain how scientists categorize the diversity of life.
4] Describe the impact that the evolutionary relationships of organisms plays in classification.

Bacteria and Viruses

1] Describe the structural diversity of bacteria.
2] Explain the diverse roles bacteria play in ecosystems.
3] Explain how bacteria are classified
4] Describe the general characteristics of viruses

Protists

1] Describe the structural diversity of protists.
2] Explain the diverse roles protists play in ecosystems.
3] Explain how protists are classified.

Fungi

1] Describe the structural diversity of fungi.
2] Explain the diverse roles fungi play in ecosystems.
3] Explain how fungi are classified.

Plants and Photosynthesis

1] Describe the structural diversity of plants.
2] Explain the role plants play in ecosystems.
3] Explain how plants are classified
4] Describe the survival strategies that plants evolved and the evidence that supports this.

Animals

1] Describe the structural diversity of animals.
2] Explain how animals are classified.
3] Describe the survival strategies that animals evolved and the evidence that supports this.
4] Discuss the major changes in body plan that evolved in the animal kingdom.

Human Body Systems

1] Explain the structures and functions of the organ systems in the human body.
2] Describe how homeostasis is maintained and how it can be disrupted in each of the human body systems

Scientific Inquiry Skills (II) and Mathematical Skills (III) are addressed throughout the course through a variety of labs and activities.

Assessment

- Tests: written based on curriculum covered. Students are required to interpret and solve application-oriented questions using fundamental biological concepts covered in each unit.
- Quizzes: vocabulary and basic concepts in a multiple-choice format.
- Formal lab reports: typed with hypotheses, procedure, materials, data, discussion and conclusion.
- Lab practicals: Students observe prepared lab specimens or use laboratory skills to answer graded questions.
- Thematic essay: a two-page essay addressing a core topic question such as evolution or the movement of energy and matter.
- Projects: done individually or sometimes in a group. May be presented to class.
- Homework: questions from the chapter review, vocabulary work, and work sheets.

Materials and Resources

Student text: Campbell, Williamson & Heyden. Biology: Exploring Life. Pearson Prentice-Hall, 2004.

Numerous audio-visual, web sites, and lab materials to supplement the material taught in this course.