Syllabus

Advanced Biology - Semester B

Course Overview

Biology is presented as one form of scientific inquiry, the process of channeling human curiosity into purposeful exploration, discovery, and exploration of observable natural phenomena. Biology is the study of life, but it is most important as a shared method of asking questions all humans have about life and living things, and communicating responses to the questions in clear and understandable forms.

In this online course, students will be taught and encouraged to continually pose questions about the subject matter. Through exploration and discovery of the phenomenon at the core of each lesson, students will be guided to answer their own questions and be able to discuss the phenomenon in ways that reflect sound scientific practices. Biology is presented as a living process, one that carries a body of current understandings and a method of building on those understandings to either deepen them or replace them with better explanations. In particular, we will explore these eight themes identified as the focus for AP-level Biology instruction:

- Science as a Process
- Evolution
- Energy Transfer
- Continuity and Change
- Relationship of Structure to Function
- Regulation
- Interdependence in Nature
- Science, Technology, and Society

Course Goals

- Foster a love of science, especially in terms of Biology.
- Provide learners with chances to inquire about natural phenomena, asking natural and well-formed questions.
- Expose learners to how the scientific method is applied in studying living things.
- Empower learners to explore natural phenomena in order to answer their own questions.
- Train learners to draw conclusions from observations in order to construct their own understanding of biological concepts.
- Build skills for learners to communicate their questions, observations, findings and conclusions to others interested in similar questions about living things.

- Expose learners to significant concepts and themes in Biology.
- Tie lessons together in terms of the eight themes which structure AP Biology.
- Assess learners' ability to ask and answer questions about nature.
- Reinforce an interest in nature and the living things that make up our common environment.
- Provide learners with a set of tools for solving problems that relate to nature and impact the daily lives of learners.

Teaching Strategies

Structure

This blended online course is organized into units and lessons. Each lesson incorporates multiple learning activities designed to develop, apply, and assess specific learning objectives. (See *Course Outline*, below.)

Concept Development Activities

In order to generate skills for lifelong learning and to employ the most appropriate learning approach for each topic, twenty-five percent of the lessons will use student-driven, constructivist approaches for concept development. For example, the lesson on Mendelian Genetics from Unit 4 of Semester A provides multiple opportunities for learners to take on-screen instruction about Mendel's discoveries and produce Punnett Squares that exemplify each of his discoveries. The experience of going from explanation of the concept to constructing an illustration of it themselves will move learners' understanding of those discoveries to a deeper level.

The remaining lessons will employ direct instruction approaches. Regardless of the approach, students will take full advantage of the online learning environment, linking to rich online, multimedia, and interactive resources. Developing critical of 21st century skills is an important secondary goal of this course.

Application and Inquiry Work Products

Application and inquiry will be an integrated part of the lessons, requiring higher-level cognitive work. Students will submit written work online for review, comment, and grading.

Discussions

Students will also have the opportunity to engage in online (asynchronous) discussions during this course. Discussion topics provide the chance to dig deeper into specific scientific and STEM concepts and applications.

Science Pedagogy

This course will be grounded in inquiry learning and will make special effort to integrate the study of biology in a broader STEM perspective.

- **Inquiry** – As often as possible, lessons will include inquiry-based approaches to new material. In particular, the 5 Es approach will be adapted for use in this course, asking learners to Engage, Explore, Explain, Elaborate, and Evaluate. The lesson "Water: An Essential for Life" in Unit 1 of Semester A provides a good example of this strategy. The lesson is structured around a series of short hands-on experiences with water in the form of short lab-like activities. This approach provides learners with a chance to experience the properties of water and form their own sense of the central ideas in the lesson.

- **STEM:** In today's global economy, employers are looking for skilled workers who are innovative problem solvers and critical thinkers. Such skills encompass what STEM education is. It fuses science, technology, engineering, and mathematics into one cohesive discipline. STEM education is designed to open students' minds to the exciting and fulfilling opportunities in STEM-related careers.

  Many guidelines have been integrated into the course design and lessons that embody the Goals of a STEM education. Lessons will use real-world scenarios that that will illustrate to students to how math, science, engineering, and technology are applied in professional and everyday lives. Students will leverage technologies such as graphing calculators, spreadsheets, and the Internet to help them solve difficult and complex problems. Students will also be given culminating activities that will require them to solve open-ended, complex problems.

  For example, the lesson on Gene Frequencies in Unit 6 of Semester A starts with a young high school student finding she has an interest in genetics. Through a school mentoring program, she finds a mentor who is a practicing scientist in this field. The high school student has some misconceptions about certain genetic principles and, through the lesson, has a chance to overcome them with the help of her mentor. This structure models the STEM career paths open to students, as

well as a method for students to explore and discover their own path to a STEM career.

Lab Components

Purpose

The lab activities for science subjects provide learners with hands-on exposure to the scientific concepts they are studying and exploring. Science instruction is as much about learning how to do science, as it is about developing a conceptual understanding – labs bring those two elements together.

- **Informal labs:** Sometimes called “kitchen sink” labs, these activities use materials readily available at home or in non-lab facilities within a school. They will provide true hands-on exposure to phenomena without the use scientific experimental equipment. For example, the lesson “Water: An Essential of Life” described above includes a series of such informal hands-on experiences that do not require lab equipment to carry out.

- **Simulated labs:** Using various media, such as videos and microscope slides, learners will observe experiments virtually and then carry out analysis and interpretation of that experience as if they had performed the steps themselves. The lesson “The Cell Cycle” in Unit 3 of Semester A, provides an example of this alternate approach to labs. It uses a series of photographs of microscope slides to simulate the experience of taking onion skin cell samples. The microscope slides are presented for the learner to identify the cell cycle phases and then put the phases in the right sequence.

- **Interactive simulations**: These rich, interactive simulations are open-ended and multi-dimensional. They allow learners to adjust various factors in a simulated experimental situation to see how the outcome of the procedure changes in reaction to their inputs. The simulations allow for open-learner exploration, as well as more structured and guided inquiry into various phenomena. For the topic Evolution in Unit 6 of Semester A, an online simulation on Natural Selection provides learners with the chance to change certain variables and observe successive generations of species as the population adapts to the environmental conditions.

- **Analysis of experimental data:** Experiencing the practice of science need not involve doing every step of the gathering of data by hand. Many scientists share data sets from observations or experiments, and the questions posed, calculations performed, and the analysis and interpretation of the results can be quite a powerful lab experience. The tasks included in this course will point learners to existing data sets, show them an analytical approach, then ask them to perform calculations, graph, analyze, and report back on that data using solid principles of scientific inquiry.

Student Evaluation

Multiple evaluation tools will be used to assess understanding at all appropriate cognitive levels and to reflect AP assessment methodology:

- **Lesson-Level Mastery Tests:** Each lesson will be accompanied by an AP-style multiple-choice mastery test to assess mastery of the basic lesson concepts.
- **Self-Assessment Lesson Activities:** Especially useful in constructivist/inquiry lessons, self-assessment activities will provide sample responses against which learners can assess their own learning.
- **Teacher-Graded Lesson Activities:** These lesson activities will require teacher assessment, employing AP-style objective rubrics. Students will be provided with the rubrics for each assignment.
- **Unit-Level Posttests:** Each unit will have a multiple-choice assessment to confirm that all the material within the unit has been retained and can be applied in a larger context than a single-lesson format.
- **Unit-Level Culminating Activities:** Learners will have the chance to apply their knowledge of the concepts that cut across the lessons within a unit. Most of the units will include this teacher-graded activity for evaluation of higher order thinking skills.
- **End-of-Semester Tests:** At the end of each of the two semesters, learners will take a multiple-choice test to assess mastery of lesson concepts and provide additional practice for a long-form exam like the AP exam.

AP Biology Semester B Course Outline

Units

This course will be structured in 18-week semester with the following unit:

Semester B
Diversity of Life, Part 1
Diversity of Life, Part 2
Plant Structure and Function
Animal Structure and Function, Part 1
Animal Structure and Function, Part 2

Advanced Biology - Semester B

Unit 1 – Diversity of Life, Part 1 (3 Weeks, 6 Lessons)

The Tree of Life - Explain our modern system of biological taxonomy and how it is hierarchical in nature

- Describe binomial nomenclature and apply it to living things
- List in descending order the major taxonomic levels employed by biologists today

Phylogeny and Evolution - Describe how taxonomy reflects evolutionary relationships

- Relate the branching pattern of phylogenetic trees to the taxonomic hierarchy
- Relate a cladistic analysis of a species evolution to branch points on its phylogenetic tree

Prokaryotes - Demonstrate knowledge of the biology, diversity, evolution, and importance of the prokaryotes

- Differentiate between archeabacteria and eubacteria, including their evolutionary history
- Describe diversity within kingdom monera
- Describe the modes of nutrition and reproduction within the prokaryotes
- Discuss the prevalence and importance of the prokaryotes to all other life

Protozoa - Demonstrate knowledge of the biology, diversity, evolution, and importance of the protozoa within kingdom Protista

- Describe the diversity of the protozoans
- Survey the biology of a representative of each major group of protozoans

Algae - Demonstrate knowledge of the biology, diversity, evolution, and importance of the major algae types within kingdom Protista

- Describe the diversity of the algae
- Discuss the origin of multicellularity in algae
- Describe evidence for the evolutionary link between green algae and land plants

Fungi - Demonstrate knowledge of the biology, diversity, evolution, and importance of the Fungi

- Describe the basic structures of a fungal organism
- Illustrate diversity in the fungi by outlining the characteristics of the major fungal divisions
- Discuss both positive and negative roles of fungi in nature

Unit 2 – Diversity of Life, Part 2 (2 Weeks, 5 Lessons)

Moss and Other Bryophytes - Demonstrate knowledge of the biology, diversity, evolution, and importance of the nonvascular plants

- Discuss alternation of generations as seen in the bryophytes
- Discuss the evolutionary history of plants moving from water to land
- Describe the adaptive problems that plants faced moving onto land
- Show how bryophytes are partially but not completely adapted to life on land

Vascular Plants - Demonstrate knowledge of the biology, diversity, evolution, and importance of vascular plants

- Discuss the importance of the evolution of vascular tissues in land plants
- Discuss how ferns and horsetails improved upon bryophyte biology but are not still fully land adapted plants
- Describe the evolution of the seed and pollen grain as land adaptations
- Describe how the gymnosperms and angiosperms have completed the evolution of plants to land
- Discuss the importance of vascular plants to life

Lower Invertebrate Animals - Demonstrate knowledge of the biology, diversity, evolution, and importance of the lower invertebrates

- Draw a phylogenetic tree of animal kingdom evolution
- List and explain the characteristics used to classify animals
- Discuss the linear evolutionary nature of the lower invertebrates

- Compare the anatomy of the parazoa, radiata, acoelomates, and pseudocoelomates showing increasing complexity

Higher Invertebrate Animals - Demonstrate knowledge of the biology, diversity, evolution, and importance of the higher invertebrates

- Explain why the higher invertebrates have evolved into two distinct pathways: protostomes (annelids, mollusks, and arthropods) and deuterostomes (echinoderms)
- Compare the evolution of major body systems in the higher invertebrates
- Illustrate the diversity seen within these animal phyla
- Discuss reasons for the overwhelming dominance of the arthropods on Earth

Chordates - Demonstrate knowledge of the biology, diversity, evolution, and importance of the chordates

- Explain why phylum chordata are on the deuterostome line of animal evolution
- List the identifying characteristics of a chordate
- Describe the characteristics that identify chordates in each of the three chordate subphyla
- Describe the evolution of the vertebrates to land
- Systemically, compare the seven classes of vertebrates
- Illustrate the diversity seen among the vertebrates
- Discuss the importance of the vertebrates to life on Earth

Unit 3 – Plant Structure and Function (4 Weeks, 8 Lessons)

Angiosperms - Describe the organization of an angiosperm

- Identify and give the function of the seven major plant tissues (collenchyma, sclerenchyma, parenchyma, xylem, phloem, meristems, and epidermis)
- Identify and give the function of the four major organs (leaves, stems, roots, and flowers)

Leaves - Describe the structure and function of leaves

- In a drawing of a leaf cross section, identify each tissue present and give its role in photosynthesis
- Distinguish between monocot and dicot leaves
- Describe the diversity in leaf shape, arrangement, and venation patterns

Stems - Describe the structure and functions of stems

- Identify the major functions of stems (conduction, support, storage, sometimes photosynthesis)
- Distinguish between monocot and dicot stem cross sections

Growth in Stems - Describe the process of primary and secondary growth in stems

- In a longitudinal section through the apical bud, identify the mitotic zone, the zone of elongation, and the zone of differentiation and describe how each are involved in the primary growth of a stem
- In a cross section through a herbacious dicot stem, identify each tissue in the vascular bundle and relate that tissues to a stem’s secondary growth
- Relate secondary growth in a vascular bundle to the annual growth in a woody stem

Roots - Describe the structure and functions of roots

- List the functions of roots in plants
- From root cross section diagrams, identify a monocot from a dicot
- Identify the different types of roots and their function

Transportation in Plants - Describe how materials necessary for plant metabolism are absorbed and transported by plants

- Describe how plants are able to selectively control root-hair absorption by the Carparian Strip
- Describe mechanisms and energy sources that plants use to transport water in xylem from foots to leaves
- Discuss how the rate of water transport is controlled by stomata in leaves through transpiration
- Investigate and discuss factors that affect the rate of transpiration in plants
- Describe how the products of photosynthesis produced in leaves are transported in phloem to non-photosynthetic parts of the plant
- Compare the structure and tissues of a monocot and dicot root cross section and relate them to primary and secondary root growth

Plant Reproduction - Describe sexual and asexual methods of plant reproduction

- Describe the structure of a flower and discuss how it is adapted for reproduction on land
- Describe the double fertilization that occurs after pollination
- Explain how a seed develops and how it is adapted for reproduction on land
- Discuss fruit formation in a plant and methods of seed distribution in plants
- Describe asexual methods of reproduction in plants

Plants in their Environment - Describe hormonal and other behavioral responses of plants to their environment

- List and describe the effects of the following plant hormones: auxin, gibberelins, cytokinins, ethylene
- Describe plant responses of phototropism and geotropism
- Describe how plants are able to determine seasons and length of day

Unit 4 – Animal Structure and Function, Part 1 (2 Weeks, 5 Lessons)

Animal Bodies - Describe how an animal body is organized as represented by a mammal

- Describe the structural and functional differences among tissues within the four basic tissue groups: epithelial, connective, muscular, and nervous
- Identify the major organ systems of a mammal and their basic functions
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The Digestive System - Describe the structures and functions of the digestive system in a mammal

- Identify all the organs (and accessory organs) of the digestive system and their function in digestion
- Describe how food is mechanically and chemically digested, including all digestive enzymes, the substrate they act upon, products produced, and required pH
- Describe the hormonal control of the digestive system
- Explain where and how digested molecules are absorbed from the digestive system into the blood stream
- Explain the role of symbiotic bacteria in digestion

Circulatory and Respiratory Systems - Describe the structures and functions of the circulatory and respiratory systems in a mammal

- Identify all the organs of the circulatory system and their function
- Identify all the different functions of the circulatory system
- Differentiate between the structure and function of arteries, veins, and capillaries
- Distinguish between systemic and pulmonary circulation
- Discuss the roles of blood pressure, velocity, and surface area upon metabolic exchange
- Describe the structure of a mammalian heart and how blood circulates through it
- Explain how an intrinsic heartbeat occurs and how nervous and hormonal factors change the heartbeat rate
- Identify by structure and function the cellular and plasma components of blood
- Explain human blood types for the ABO and Rh systems
- Explain the anatomical modifications in a fetus's circulatory system
- Identify all the organs of the respiratory system and their function
- Describe how breathing occurs and is controlled in a mammal
- Discuss how oxygen and carbon dioxide are transported in blood
- Explain how internal and external respiration occur and how they are controlled

The Immune System - Describe the structures and functions of the immune system in a mammal

- Describe the series of reactions that occur at the site of a wound.

- Describe various non-specific external barriers to potential pathogens of the human body
- Describe the non-specific internal defenses of the body (white blood cells and fever) and their role in the inflammation reaction
- Describe the specific internal defenses of the body including humoral and cell mediated responses
- Explain how long-term immunity is established and maintained (clonal selection)

The Excretory System - Describe the structures and functions of the excretory system in a mammal

- Identify the waste products of metabolism that must be excreted and their source
- Describe the various mechanisms and controls for body temperature regulation
- Identify all the excretory organs of the body and what they excrete
- Identify all the organs of the urinary system and their functions
- Explain how metabolic wastes are removed and concentrated by the urinary system
- Explain how urine production is controlled and regulated

Unit 5 – Animal Structure and Function, Part 2 (3 Weeks, 6 Lessons)

The Endocrine System - Describe the structures and functions of the endocrine system in a mammal

- Differentiate between the structure and functions of endocrine and exocrine glands
- Explain what a hormone is and what it does
- Describe the two different classes of hormones and how each causes a target cell to react

- Identify and discuss how the glands of the brain regulate and control all other glands
- Identify the location and hormones produced by all the major glands of the body
- For all major hormones of the body, identify their target organ(s) and effect
- Show how blood glucose levels are maintained at homeostatic levels by hormone action
- Discuss how prostaglandins are unique hormones that target both organs of self and organs in other people

The Nervous System - Describe the structures and functions of the nervous system in a mammal

- Describe the structure of a typical neuron
- Explain how an impulse is transmitted along a nonmyelinated and myelinated axon
- Explain how a nerve impulse is transmitted across a neural and a muscle synapse
- Identify some common neurotransmitters and state their function
- Describe the organization of the vertebrate nervous system
- Explain the reflex arc and its role in vertebrates
- Explain how the two divisions of the autonomic nervous system work to maintain homeostasis of vertebrate internal organs
- Discuss the structures of the brain and their functions
- Discuss the structure and function of the body's major internal and external sense organs

The Skeletal and Muscular Systems - Describe the structures and functions of the skeletal and muscular systems in a mammal

- Describe the structures seen in a long bone cut longitudinally and the function of each structure
- Differentiate between the axial and appendicular skeleton
- Describe the structure of a Haversian system in compact bone
- Describe how bones grow in length and width
- Name and describe the common types of joints in the vertebrate skeleton
- Discuss the role of calcium storage and release from bones
- Describe the structure and function of the three different types of muscle cells
- Explain the physiology of skeletal muscle contraction
- Explain the role of calcium ions in muscle contraction

Animal Reproduction - Describe the structures and functions of the reproductive system in a mammal

- Identify and give the function(s) of all structures composing the male and female reproductive system
- Explain the hormonal control and feedback systems of the male reproductive system
- Explain the interactions of the pituitary gland, ovaries, and uterus in initiating and regulating the menstrual cycle
- Describe the hormone-initiated sequence of events that occur in a woman’s body after fertilization occurs
- Explain the relationship between maternal and fetal blood streams during pregnancy and how metabolic exchange between mother and fetus occur
- Explain the hormonal controls in the mother that initiate and complete the birth process

Stages of Development - Describe the stages occurring during animal development

- Describe the mechanism that a sperm uses to enter an egg
- Describe the changes in the zygote as it undergoes embryological development through early cleavage, blastula, gastrula, and neurula

Variation in Development - Describe the controls occurring during animal development

- Describe the mechanism that a sperm uses to enter an egg and the changes that entry has upon the egg
- Explain the difference between determinate and indeterminate eggs and how each affects differentiation
- Explain how qualitative difference in blastomere cytoplasm triggers different transcription and, therefore, differentiation
- Explain how different extracellular environments may trigger differentiation of blastomeres
- Discuss how neighboring embryonic cells can send messengers to nearby cells, directing differentiation

Unit 6 – Ecology (4 Weeks, 8 Lessons)

Energy in an Ecosystem - Describe how energy flows through an ecosystem

- Describe the basic trophic relationships common in any ecosystem
- Explain how food chains and webs can be used to show trophic relationships in ecosystems
- Describe the efficiency of energy transfer between trophic levels
- Explain how measuring ecosystem productivity shows an ecosystem's efficiency at transferring energy between trophic levels

- Show how productivity and efficiency can be illustrated in biomass and productivity pyramids

Ecosystem Productivity - Describe how productivity can be measured and used to measure the efficiency of an ecosystem

- Explain how measuring ecosystem productivity shows an ecosystem's efficiency at transferring energy between trophic levels
- Measure the productivity of an aquatic ecosystem

Cycles of an Ecosystem - Describe the major biogeochemical cycles of an ecosystem

- Show how the paired reactions of photosynthesis and respiration continuously cycle carbon between the atmosphere and organisms
- Describe the nitrogen cycle and the role of nitrifying bacteria
- Describe the phosphate cycle and the role of decomposing bacteria
- Describe the water cycle and factors that affect it

Balance in Nature - Describe how population numbers and distribution are kept in balance in nature

- Define a niche and the principle of exclusion
- Explain the roles that natality, mortality, immigration, and emigration have on populations
- Describe three patterns of individual spacing in a population and factors that determine each pattern
- Describe the two common growth patterns observed in populations (S-curve and J-curve) and factors that produce each
- Relate life history strategies of species (R and K strategists) to growth patterns

- Explain how the concepts of biotic potential and environmental resistance relate to population dynamics.
- Explain the effects that density-dependent or density-independent limiting factors have upon growth curves

Community Structure - Discuss factors that determine community structure in ecosystems

- Describe several types of interspecies interactions and evaluate their effect on both species (symbiosis, predation, competition)
- Describe how intra-species interactions affect community structure (intra-species competition, herds, societies)
- Describe how natural and human-made disturbances can alter community structures

Ecological Succession - Describe how ecological succession can change environments and lead to the formation of new biomes

- Describe a succession sequence that would begin at bare rock and climax at a deciduous hardwood forest
- List five conclusions about the nature of community changes during the course of ecological succession
- Outline a general description of the world's major land and water biomes and state what environmental conditions are necessary to result in them

Ecological Issues and Crises - Discuss the major global ecological issues facing humanity today

- Students will be prepared to use information learned from this course to explain and discuss regional and global ecological issues, including the following topics:
    - The causes and potential effects of global climate change

- The causes, types, and effects of pollution on ecosystems
- The role human population growth has on global ecology
- The effects of loss of biodiversity in habitats

Adaptability in Nature- Explain how an animal's behavior patterns affect its adaptability in nature

- List and explain, with examples, the common forms of innate behavior in animals (taxis, instinct)
- Discuss the role of behavioral releasers in initiating specific behaviors and how these behaviors could increase an animal's chances of survival in nature
- List and explain the common forms of learned behavior seen in animals (habituation, imprinting, conditioning, reasoning)
- Discuss examples of how animals communicate by sound, chemicals (pheromones), and displays
- Discuss the advantages and disadvantages of social behavior in animals
- Describe social behaviors seen in bees, birds, and primates