BIO-151H: HONORS PRINCIPLES OF BIOLOGY II

Cuyahoga Community College

Viewing: BIO-151H : Honors Principles of Biology II

Board of Trustees:
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Academic Term:
Fall 2023

Subject Code
BIO - Biology

Course Number:
151H

Title:
Honors Principles of Biology II

Catalog Description:
Honors course designed for science majors. The diversity of life, animals, plants, and ecology are explored in both lecture and laboratory settings. Topics include the origin and evolution of life, systematics, classifications, structural and functional variations in animals and plants, populations, communities, and ecosystems. Emphasis on evolution as the unifying theory in biology. Strong focus on inquiry-based learning.

Credit Hour(s):
4

Lecture Hour(s):
3

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
BIO-150H Honors Principles of Biology I or BIO-1500 Principles of Biology I.

Outcomes

Course Outcome(s):
1. Diversity: Evaluate evidence for the diversity of life on Earth resulting from evolution.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
a. Evaluate evidence for the origin of life and the key events in evolution of life on Earth, including evolution of photosynthesis, eukaryotic cells, multicellularity, and land adaptations.
b. Explain how systematics and classification are used to categorize and describe the unity and diversity of life.
c. Design cladograms using shared derived characteristics and/or gene sequences and the Basic Local Alignment Search Tool (BLAST) available through the U.S. National Library of Medicine and National Center for Biotechnology Information (NCBI).
d. Compare and contrast the biological species concept to the phylogenetic species concept.
e. Evaluate the scientific evidence for the three-domain theory of life and explore the evolutionary relationship among Archaea, Bacteria, and Eukarya.
f. Research the evolution of primate genomes, including humans and great apes.
g. Describe prokaryotic diversity and investigate recent discoveries and interpretations of prokaryotic phylogenies.
h. Describe the diversity of unicellular eukaryotes and investigate recent discoveries and interpretation of eukaryotic phylogenies.
i. Interpret evidence for multiple independent origins of multicellular eukaryotes.

j. Describe the diversity of multicellular eukaryotes.
k. Evaluate evidence for the role of homeobox genes in the Cambrian explosion.
l. Demonstrate safe and proper use of lab equipment when observing specimens and performing experiments and procedures, and respond appropriately to instructor feedback as it is given.
m. Use lab equipment to collect and analyze data pertaining to the growth and/or behavior of living organisms.

Course Outcome(s):

2. Animals: Interpret how the structural organization of animal bodies evolved to maintain physiological homeostasis.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

a. Analyze and explain the organization of the animal body, including evolution of body plans, tissues, symmetry, body cavities, developmental patterns, and segmentation.
b. Predict and explain the adaptations required for the evolution of terrestrial vertebrates.
c. Describe how animals have adapted to maintain homeostasis of physiological parameters through conformation or regulation.
d. Compare and contrast the nervous and endocrine systems as a means of multicellular communication and maintenance of homeostasis in the animal body.
e. Formulate examples of negative feedback and positive feedback as it relates to physiological regulation.
f. Differentiate between ectotherms and endotherms and their temperature regulation mechanisms and explain the adaptations required for the evolution of endothermy.
g. Differentiate and describe the divisions of the vertebrate nervous system.
h. Dissect a vertebrate brain, and/or use anatomical models, to discover the structural features of the vertebrate brain and spinal cord.
i. Compare and contrast vertebrate brains to predict the functional significance of similar and/or unique brain structures in the context of evolutionary history.
j. Apply ethological principles to study animal behavior.
k. Hypothesize how a behavior is an adaptive trait tied to the vertebrate brain structure.
l. Explain the physiology of neuronal communication and muscle contraction.
m. Predict the impact of a neurotoxin on the function of nervous and muscle tissue.
n. Describe the traits of muscle and nervous tissue that allow the transmission of electrical impulses along cellular membranes to communicate and/or contract.
o. Describe neural and hormonal control of digestion, respiration, circulation, osmoregulation, and reproduction.
p. Explain the interdependence of the muscular and skeletal systems for movement, support, and locomotion.
q. Describe the different types of animal digestive systems.
r. Explore the digestion, absorption and elimination in the vertebrate digestive tract and the evolutionary adaptations to accommodate different diets through dissection and/or literature review on animals of interest.
s. Explore the respiratory adaptations for gas exchange in aquatic and terrestrial environments through dissection and/or literature review on animals of interest.
t. Compare and contrast the composition and function of blood and hemolymph.
u. Describe evolutionary changes in the heart and circulation in vertebrates and explain the physiological significance of those changes.
v. Differentiate between an osmoconformer and osmoregulator, and describe the various osmoregulatory structures of invertebrates and vertebrates.
w. Describe the vertebrate urinary system and explain the role of the kidney nephron in the process of filtration, reabsorption, and secretion.
x. Distinguish between sexual and asexual methods of reproduction in animals.
y. Compare external and internal fertilization, and explain different strategies for embryonic and fetal development.
z. Describe how sexual selection has led to the evolution of secondary sexual characteristics.

Course Outcome(s):

3. Plants: Interpret how the structural organization of plants evolved to maintain physiological homeostasis.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

a. Evaluate evidence for the evolution of land plants from green algae.
b. Classify plants into their major evolutionary lineages.
c. Describe the successive adaptations to terrestrial environments that characterize land plant evolution.
d. Evaluate the evidence for co-evolution with respect to plant-animal interactions and angiosperm diversity.
e. Differentiate between the characteristics of monocots and eudicots.
f. Explain the significance of monocots for the human food supply.
g. Analyze and explain the functions of the major plant cells and tissues through dissection and/or a review of relevant literature.
h. Describe primary and secondary growth in plants and calculate the age of woody stems using anatomical features.
i. Compare the tissue organization of roots and stems in monocots and eudicots.
j. Explain how tissue type and organization determines the potential height of plants.
k. Compare the tissue organization of leaves in monocots, eudicots, and conifers.
l. Evaluate evidence on the responses of plants to light, gravity, mechanical stimuli, water, and temperature.
m. Evaluate the roles of plant hormones on plant physiology.
n. Formulate examples of plant chemical and physical defenses and explain the influence on herbivore evolution.
o. Explain the role of secondary compounds in plant defenses.
p. Summarize the nutrients required by plants and describe the adaptations for acquiring these nutrients.
q. Predict the direction of water flow between soil and plant root vasculature using the concept of water potential.
r. Draw the three potential pathways of water from the soil to the plant root vasculature.
s. Compare and contrast capillary action, root pressure, and the transpiration-cohesion theory to explain water movement in plants.
t. Explain mass-flow transport of carbohydrates in plants.
u. Explain the haplodiplontic life cycle of plants and compare variations in the life cycles of major plant lineages.
v. Explain the unique reproductive structures in the major plant lineages.

Course Outcome(s):

4. Ecology: Evaluate how relationships and interactions between living things and their environment influence populations, communities, and ecosystems.

Essential Learning Outcome Mapping:

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

a. Define the major levels of organization in ecology including population level, community level, ecosystem level and biosphere level.
b. Differentiate between biotic and abiotic factors in an ecosystem and describe how these factors impact population abundance and distribution.
c. List the major biomes on Earth and describe how the biotic and abiotic factors in each biome factor into their unique ecosystems.
d. Apply mathematical models to describe a population's demographic properties and estimate a population's growth.
e. Interpret survivorship curves and basic models of population dynamics.
f. Compare and contrast the interactions between populations within a community.
g. Explain the evolution of symbiotic relationships among species.
h. Describe the effects of competition and predation on the evolution of a species.
i. Formulate and explain examples of invasive, dominant, foundation, and keystone species in specific habitats.
j. Measure the growth, interaction of species, or diversity of an ecosystem, under specific environmental conditions, or in the wild, using quantitative techniques in the laboratory.
k. Explain how chemicals cycle through the various compartments of an ecosystem.
l. Explain how energy flows through the trophic levels in an ecosystem.
m. Describe the link between primary productivity, biodiversity, and ecosystem stability.
n. Discuss the impact of human activities on biodiversity and ecosystem health.
o. Examine the role of human activity on eutrophication of aquatic ecosystems.
p. Explore natural and technological solutions for climate change and its impact on biodiversity and ecosystem health.

Course Outcome(s):

5. Independent Research: Apply scientific methods of inquiry to gather data and draw evidence-based conclusions. Disseminate the results in written and/or oral form.

Essential Learning Outcome Mapping:

Information Literacy: Acquire, evaluate, and use information from credible sources in order to meet information needs for a specific research purpose.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

a. Develop an independent research project by compiling primary literature and making qualitative and/or quantitative observations on a relevant scientific question.
b. Construct a hypothesis and design an experiment to test the hypothesis using appropriate statistical methods.
c. Revise experimental designs based on peer and instructor feedback.
d. Disseminate the results of an experiment through written laboratory reports and/or oral presentations.
e. Discuss the limitations and reproducibility of scientific data as it relates to an independent research project.

Course Outcome(s):

6. Integration of Science and Society: Discuss how scientific research may be used and/or misused in a global society.

Essential Learning Outcome Mapping:

Civic Responsibility: Analyze the results of actions and inactions with the likely effects on the larger local and/or global communities.

Objective(s):

a. Participate in discussions on the limitations and reproducibility of scientific data and how the process of science is interpreted in society.
b. Evaluate how scientific advances impact the contemporary world.
c. Practice science communication through peer-teaching and reframing of primary literature in everyday language.
d. Reflect on historical examples of scientific breakthroughs causing societal shifts.
e. Investigate the scientific contributions of individuals from under-represented populations and consider the value of diversity and inclusion in science.
f. Predict how biological research can contribute to the resolution of ethical, social, and environmental issues.

Methods of Evaluation:

a. Required research paper and/or project
b. Quizzes
c. Exams
d. Laboratory practicals
e. Written reports
f. Presentations (individual or group)
g. Poster Presentations
h. Article discussions/reviews/summaries
i. Discussion boards
j. Homework assignments
k. Case studies

Course Content Outline:

a. Concepts:
    i. Phylogenetic systematics
    ii. Classification and taxonomy using the Linnaean hierarchy
    iii. Origin of life hypotheses
    iv. Key events in the evolutionary history of life on Earth
    v. Evolutionary tree of life
    vi. Lateral gene transfer

vii. Hox genes
viii. Major domains of life (Bacteria, Archaea, and Eukarya)
ix. Extremophiles
x. Modes of nutrition
xi. Endosymbiosis
xii. Diversity of eukaryotes, including unicellular and multicellular forms
xiii. Major phyla of Animalia, Fungi, and Viridiplantae
xiv. Plant adaptations to land
xv. Life cycles of plants and fungi
xvi. Ecological roles of fungi
xvii. Key innovations in animal evolution (symmetry, tissues, body cavity, developmental patterns, and segmentation)
xviii. Organization of the animal body
xix. Animal tissues (epithelium, connective, muscle, nervous)
xx. Homeostasis and feedback regulation (positive and negative)
xxi. Temperature regulation (endothermic and ectothermic)
xxii. Evolution of animal nervous systems
xxiii. Nerve impulse transmission (resting potential and action potential)
xxiv. Saltatory and continuous conduction
xxv. Synapses and neurotransmitters
xxvi. Reflex arc
xxvii. Organization of the vertebrate nervous system (central, peripheral, autonomic, somatic, sympathetic, and parasympathetic)
xxviii. Evolution of the vertebrate brain
xxix. Sensory-motor integration
xxx. Link between nervous and endocrine systems
xxxi. Endocrine glands and major animal hormones
xxxii. Skeletal systems (endoskeleton, exoskeleton, hydroskeleton)
xxxiii. Bone structure
xxxiv. Skeleton and muscle interaction
xxxv. Sliding filament theory of muscle contraction
xxxvi. Role of calcium ions in muscle contraction
xxxvii. Modes of animal locomotion (terrestrial, aerial, aquatic)
xxxviii. Comparative animal digestive systems
xxxix. Structures and functions of vertebrate digestive organs
xl. Mechanical and chemical digestion
xli. Absorption of nutrients
xlii. Roles of accessory organs in digestion
xliii. Factors affecting the rate of diffusion across a membrane.
xliv. Comparative animal respiratory structures
xlv. Mechanisms for breathing in amphibians, reptiles, birds, and mammals
xlvi. Countercurrent exchange
xlvii. Transport of respiratory gases and regulation of breathing
xlviii. Open and closed circulatory systems
xlix. Organization of vertebrate cardiovascular system
l. Composition of blood
li. Evolution of the chambered heart
lii. Structure and function of vessels (arteries, veins, and capillaries)
liii. Connection between cardiovascular and lymphatic system
liv. Comparative animal excretory systems
lv. Osmolarity and osmotic balance
lvi. Osmoregulatory organs (flame cells, nephridia, Malpighian tubules, kidneys)
lvii. Nephron structure and function
lviii. Nitrogenous wastes (ammonia, urea, uric acid)
lix. Hormonal control of osmoregulation
lx. Sexual and asexual reproduction in animals
lxi. Sex determination in animals
lxii. Structure and function of reproductive organs
lxiii. Strategies for embryonic and fetal development (oviparity, ovoviviparity, viviparity)

lxiv. Intersexual and intrasexual selection
lxv. Parental investment and mate choice
lxvi. Polygynous, polyandrous, and monogamous mating systems
lxvii. Altruism, kin selection, and reciprocity
lxviii. Plant adaptations to land
lxix. Haplodiplontic life cycle of plants
lxx. Heterosporous life cycle of seed plants
lxxi. Bryophytes
lxxii. Ferns and fern allies
lxxiii. Gymnosperms
lxxiv. Angiosperms (monocots & eudicots)
lxxv. Sexual and asexual reproduction in seedless and seed plants
lxxvi. Vascular tissue (xylem and phloem)
lxxvii. Ground tissue (parenchyma, collenchyma, sclerenchyma)
lxxviii. Dermal tissue (epidermal, trichomes, root hairs, guard cells)
lxxix. Meristem tissue (apical and lateral)
lxxx. Primary and secondary growth in plants
lxxxi. Leaf, stem, and root structure (internal and external) and function
lxxxii. Modified leaves, stems, and roots
lxxxiii. Flower, fruit, and seed structure, function, and diversity
lxxxiv. Transpiration
lxxxv. Guard cell regulation of stomata
lxxxvi. Casparian strip
lxxxvii. Absorption and movement of water, minerals, and nutrients in plants
lxxxviii. Plant dormancy and life span (evergreen, deciduous, annual, perennial)
lxxxix. Pollination (self-pollination & cross-pollination)
xc. Double fertilization of angiosperms
xci. Fruit and seed dispersal
xcii. Adaptive advantage of seeds
xciii. Germination in plants
xciv. Major plant hormones
xcv. Tropisms in plants (photo-, thigmo-, and gravitropism)
xcvi. Reversible sensory reactions in plants (circadian clocks, solar tracking, leaf action)
xcvii. Plant nutrients and special nutritional strategies (nitrogen fixation, mycorrhizae, carnivorous plants, parasitic plants)
xcviii. Plant physical and chemical defenses
xcix. Secondary compounds in plants
c. Levels of ecological organization (populations, communities, ecosystems, and the biosphere)
ci. Population growth models
cii. Factors affecting population growth rates
ciii. Population distribution
civ. Carrying capacity
cv. Survivorship curves
cvi. r-selected and k-selected life history models
cvii. History of and predictions for human population growth
cviii. Ecological footprints
cix. Ecological niche
cx. Competition
cxi. Competitive exclusion principle
cxii. Predator/prey relationships
cxiii. Batesian and Mullerian mimicry
cxiv. Symbiotic relationships, including commensalism, mutualism, and parasitism
cxv. Coevolution
cxvi. Community disturbances and the Intermediate disturbance hypothesis
cxvii. Keystone species
cxviii. Primary and secondary succession
cxix. Biogeochemical cycles: water, carbon, nitrogen, phosphorus
cxx. Energy flow through trophic levels

cxxi. Trophic cascade
cxxii. Productivity (primary and secondary) and biomass
cxxiii. Species richness and relative abundance
cxxiv. Climate (latitude, atmospheric circulation, altitude, ocean currents, etc.)
cxxv. Terrestrial biomes and aquatic ecosystems
cxxvi. Anthropogenic pollution
cxxvii. Point vs. nonpoint source pollution
cxxviii. Eutrophication
cxxix. Biological magnification
cxxx. Invasive species
cxxxi. Current environmental issues
cxxxii. Climate change
cxxxiii. Watershed

b. Skills:
i. Prepare a wet mount for examination under a compound light microscope.
ii. Construct or use dichotomous keys.
iii. Construct or interpret phylogenies or cladograms.
iv. Evaluate evolutionary hypotheses.
v. Sample the environment for microorganisms.
vi. Distinguish among representative bacteria and protists using a microscope.
vii. Distinguish among plant phyla and identify representatives of each group.
viii. Distinguish among fungal phyla and identify representatives of each group.
ix. Distinguish among animal phyla and identify representatives of each group.
x. Distinguish among chordate clades and identify representatives of each group.
xi. Identify basic types of animal tissues and key cells.
xii. Identify the type of skeleton in various animal specimens.
xiii. Dissect and identify the major components of the following animal systems: digestive, respiratory, circulatory, urinary, nervous, and reproductive.
xiv. Assign representative plant specimens as nonvascular, seedless vascular, gymnosperm, or angiosperm.
xv. Identify the internal and external anatomy of leaves, stems, and roots, using live, preserved, and microscopic specimens.
xvi. Differentiate between monocots and eudicots, based on their anatomy.
xvii. Dissection of flowers, seeds, and fruits.
xviii. Determine the mechanism of seed dispersal based on the fruit of an angiosperm.
xix. Identify the parts of a flower and describe their roles in reproduction.
xx. Trace the path of water through vascular plants, starting in the soil and exiting the stomata.
xxi. Construct a population growth curve.
xxii. Analyze population pyramids.
xxiii. Estimate population size using mark-recapture and/or quadrat sampling.

c. Issues:
i. Origin of life hypotheses
ii. The nature of viruses
iii. Defining species
iv. Natural vs. unnatural taxonomic groups
v. Inherent anthropocentric bias in classification systems
vi. Fluctuating nature of classification
vii. Complexity is not necessarily better than simplicity
viii. Modern challenges to taxonomy
ix. Separation of cytogamy and karyogamy
x. Ancestral vs. derived characteristics
xi. Not all animals are mammals
xii. Majority of animals are invertebrates
xiii. Common misconceptions about plants
xiv. Plants respond to internal and external stimuli
xv. Oxygen requirement of plants
xvi. Photosynthesis is not unique to plants
xvii. Plant mass is derived from carbon dioxide
xviii. Human population growth and sustainability

xix. Human impacts on biodiversity
xx. Interconnectedness of terrestrial and aquatic ecosystems
xxi. Global warming

Resources

Dolphin, W., Vleck, D., Colbert, J.T., and Westgate, L.M. *Biological Investigations: Form, Function, Diversity, & Process*. 12th ed. New York: McGraw-Hill, 2019.

Carroll, S.B. *Endless Forms Most Beautiful.* WW Norton Co., 2005.

Raven, P.H., Johnson, G.B., Mason, K.A., Losos, J.B., and Singer, S.R. *Biology*. 12th ed. New York: McGraw-Hill, 2020.

Vodopich, D.S. and Moore, R. *Biology Laboratory Manual*. 12th ed. New York: McGraw-Hill, 2019.

Brooker, R.J., Widmaier, E.P., Graham, L.E., and Stiling, P.D. *Biology*. 5th ed. New York: McGraw-Hill, 2019.

Futyuma, D. *Evolution*. 4th ed. Sinauer Associates, 2017.

Pollan, M. *The Botany of Desire: A Plant's-Eye View of the World.* Thorndike Press, 2001.

Elizabeth Kolbert. (2015) *The Sixth Extinction: An Unnatural History*, New York: Picador.

Resources Other

a. NOVA - http://www.pbs.org/wgbh/nova/
b. McGraw-Hill Virtual Laboratory - http://www.mhhe.com/biosci/genbio/virtual_labs/
c. Action Bioscience: Bringing Biology to Informed Decision Making - http://www.actionbioscience.org/
d. Encyclopedia of Life – http://eol.org (http://eol.org/)
e. Tree of Life Web Resource - www.tolweb.com (http://www.tolweb.com/)
f. Howard Hughes Medical Institute Biointeractive - http://www.hhmi.org/biointeractive/
g. Digital morphology at the University of Texas - http://digimorph.org/
h. International Union for the Conservation of Nature, Biodiversity - http://www.iucn.org/what/tpas/biodiversity/
i. Smithsonian National Museum of Natural History, Biodiversity - http://www.mnh.si.edu/explore/diversity.htm
j. The University of California Berkeley, Museum of Paleontology online exhibits - http://www.ucmp.berkeley.edu/exhibits/index.php (http://www.ucmp.berkeley.edu/exhibits/)
k. Tom Volk's Fungi: Dept. of Biology, Univ. of Wisconsin-LaCrosse - http://botit.botany.wisc.edu/toms_fungi/
l. Plants in Motion - http://plantsinmotion.bio.indiana.edu/plantmotion/starthere.html
m. American Society of Plant Biologists, Education - http://my.aspb.org/?page=Education
n. ChloroFilms: Plant Videos on YouTube: http://www.chlorofilms.org/index.php?module=Pages&func=display&pageid=16 (http://www.chlorofilms.org/?module=Pages&func=display&pageid=16)
o. Global Invasive Species Database - http://www.issg.org/database/welcome/
p. Environmental Literacy Council - http://www.enviroliteracy.org/
q. U.S. Census Bureau: International Database - http://www.census.gov/idb/ranks.html
r. CIA World Factbook - https://www.cia.gov/library/publications/the-world-factbook/

Instructional Services

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