CIEE Global Institute – Monteverde

Course name: Introductory Biology II (Lab course)
Course number: (GI) BIOL 2402 MOCR
Programs offering course: Monteverde Open Campus Block: STEM and Society
Open Campus track: STEM and Society
Language of instruction: English
U.S. semester credits: 4
Contact hours: 45 lecture and 45 laboratory
Term: Spring 2020

Course Description

Introductory Biology II covers the second semester sequence requirements of a typical two-semester biology course for science majors. The course provides comprehensive coverage of foundational research and core biology concepts through an evolutionary lens. This second semester will include a survey of biological diversity, plant structure and function, animal morphology and physiology, and ecology.

Learning Objectives

By the end of this course, students will be able to,
Develop problem-solving skills by approaching biological phenomena mathematically, chemically and with physics, as well as intuitively
Explore how life is expressed, from viruses through all major biological taxa
Describe the life of plants: plant form and physiology, soil and plant nutrition, as well as plant reproduction
Detail the life of animals: basic form and function
Investigate all major organ systems: digestive, nervous, sensory, endocrine, musculoskeletal, respiratory, circulatory, excretory and reproductive
Apply genetic and evolutionary information to ecological processes
Explain basic ecological processes at many scales, from biosphere through ecosystems to populations, including terrestrial and aquatic environments
Know and follow proper laboratory safety practices
Collect and report data effectively: Use correct laboratory notebook skills, spreadsheets, graphing software and regression analysis
Assess how Biology impacts their lives and the lives of local people

Course Prerequisites

None

Methods of Instruction

The course will be taught using lectures, class discussions, lecture activities, reading assignments, problem sets, presentations, laboratory activities and experiments. In addition, students will visit national universities and industrial facilities, conducting interviews with local biologists and conservationists. Students will work individually and in groups in laboratory and on assigned problem sets. Students are expected to read portions of the textbook before lectures and review laboratory manual instructions before labs. Students will work in groups to present current applications of biology in their lives and in the lives of those in the local community. Students should take full advantage of generous online resources associated with the texts.

Assessment and Final Grade

Weekly Exams (Five)	25 %
Problem Sets	10 %
Laboratory	30 %
Group Presentation	10 %
Participation	5 %
Final Exam (Comprehensive)	20 %

Course Requirements

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to- peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities**.**

Weekly Exams

Each week, students will take an exam based upon the previous week's material. These exams will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. Each exam will take approximately 30 minutes and comprise 5% of the final course evaluation.

Problem Sets

Problems located at the end of each chapter of the textbook will be assigned to individuals or groups by the instructor. Student solutions to these problems will be collected and discussed in review sessions. The instructor will work through or give solutions to all problems. Similar problems will appear on weekly quizzes and the final exam. Assessment for problem sets will include timely and correct completion of problems.

Laboratory
Each lab will begin with a short quiz assessing student preparedness. This will cover material in the laboratory manual related to the lab assigned for that day. Each lab will end with a report sheet which must be turned in at the end of the lab period. All lab report sheets must be completed in ink. Report protocol will be covered in the first lab period. Points will be deducted for failing to follow these procedures or if the lab sheet is not neatly presented. A laboratory notebook will be kept, in addition to the manual, and will contain all changes to protocols, data collected and interpretation of data. Some labs will require written lab reports. The style and content of written lab reports will be given in the first lab period.

Group Presentations
Students will investigate how Biology impacts their daily lives and the lives of local people. This will be done in groups using information from various sources, including interviewing each other, local people and online resources. A 15-minute presentation with a demonstration using biological principles will be graded on the overall quality and information in the presentation as well as each student's part in it.

Final Exam
The final exam is comprehensive. As with quizzes, this exam will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. It will include material from both lecture and laboratory.

Class Attendance
Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**
More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1 Survey of Biological Diversity: Viruses and Single-Celled

Session 1.1: Viruses, Prokaryotes and Protists. Students explore the evolution of life from viruses through unicellular organisms. They begin with viral evolution, morphology and classification, viral infections and hosts, prevention of viral infections and other acellular entities, like prions and viroids. Students will continue with prokaryotes, describing their diversity, structure and metabolism. They will apply these concepts to bacterially caused human disease and beneficial prokaryotes. Students will also explore eukaryotic origins with protists, their morphological characteristics, classification and ecology.

Readings: Chapter 1 The Study of Life, Chapter 21 Viruses, Chapter 22 Prokaryotes: Bacteria and Archaea and Chapter 23 Protists, plus assigned problems at ends of chapters, and Olivero, J. et al. 2017. Recent loss of closed forests is associated with Ebola virus disease outbreaks. *Scientific Reports*, *7*(1), p.14291.

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Laboratory 1: Students will review lab protocols, use the scientific method, graphing and statistics to approach a biological investigation. They will then describe distinguishing features of members of Kindoms Archaebacteria and Bacteria. Students will describe differences between bacteria and cyanobacteria, identifying examples using compound microscopes and agar plate colony characteristics. Students will then use gram stains to separate gram positive from gram negative bacteria with oil immersion. Students go on to examine green algae, protists and slime molds. A prelab quiz and post lab worksheet will be due.

Watch: What is Biology? The Characteristics of Life. The Science Classroom. https://www.youtube.com/watch?v=7nKKoxnmTEA

Homework: Read 10 Applications of Biology in Everyday Life https://www.lifepersona.com/10-applications-of-biology-in-everyday-life and, using internet resources, come up with three additional examples.

Week 2 Survey of Biological Diversity: Multicellular

Session 2.1: Fungi and Plants. Students will list characteristics of fungi, describe the composition of the mycelium, describe the mode of nutrition of fungi and explain sexual and asexual reproduction in fungi. They will identify fungi and place them into the five major phyla according to current classification. They will also describe the role of fungi in various ecosystems, describe the mutualistic relationship of fungi with plant roots and describe beneficial relationships between some fungi and insects. Students will explore some fungal parasites and pathogens of plants, insects and humans. They will explain with antifungal therapy is hampered by similarities between fungal and animal cells. Students will discuss the challenges to plant life on land, describe adaptations allowing plants to colonize land, the timeline of plant evolution and the impact of land plants on other living things. They will delineate traits shared by green algae and land plants from those that differ, explain why charophytes are considered the closest algal relative to land plants and explain how current phylogenetic relationships are reshaped by comparative analyses of DNA sequences. Students will then go onto identify characteristics and plant divisions and describe their life cycles. They will discuss the ecological importance of seeds and flowers.

Readings and Problem Sets: Chapter 24 Fungi, Chapter 25 Seedless Plants, Chapter 26 Seed Plants with select end of chapter problems, and Hijri, M. and Bâ, A., 2018. Mycorrhiza in Tropical and Neotropical Ecosystems. *Frontiers in plant science*, *9*, p.308.

Laboratory 2: Fungal Diversity. Students will work with examples of fungi to describe characteristics of the Kingdom Fungi and basic fungal morphology. They will discuss variation in structures and sequence of events of sexual and asexual reproduction. They will examine hyphae from prepared slides using compound microscopes and stain mycorrhizal hyphae from fine root samples. They will construct life cycle diagrams for major fungal groups. Students will then go to a nearby park and look for examples of fungal fruiting bodies, examining and describing their morphologies, including lichens. A prelab quiz will be taken and a lab report on fungi will be due the next lab period.

Session 2.2: Plant Structure and Function. Students describe the shoot and root organ systems, distinguish between meristematic and permanent tissue, identify and describe the three regions where plant growth occurs, summarize the roles of dermal tissue, vascular tissue and ground tissue and compare simple plant tissue with complex plant tissue. They then examine stem morphology and function, describing the main function and basic structure, compare roles of dermal, vascular and ground tissue, distinguish between primary and secondary growth,

detail how growth rings form and describe a list of modified stems. Students then move to roots, identifying the two types of root systems, describing three zones of the root tip and modifications to the basic root form. They also identify leaf layers, compare simple to compound leaves and describe leaf modifications. They describe how water and nutrients move around a plant, describe plant sensory systems and responses and how plants defend themselves from herbivores. They will explain how plants interact with soils to extract nutrients. Students will also identify different modes of plant reproduction and discuss the importance of pollination and seed dispersal for flowering plants.

Readings and Problem Sets: Chapter 30 Plant Form and Physiology, Chapter 31 Soil and Plant Nutrition, Chapter 32 Plant Reproduction, and assigned problems.

Laboratory 3: Plant Ecophysiology. Plant systematics, structures and ecophysiology. Students will visit the local botanical garden. They will closely examine plants by Division and note unique and shared characteristics of each. Students will consider which plants use spores, seeds and flowers, how these changes evolved and how they changed plant habitat and diversity. Students will then explore how morphology is related to function by examining plants in different habitats. Here, the focus will be on convergent evolution and the diversity of plant adaptations to environmental stress. Back in the laboratory, students will use prepared slides to compare internal morphology of major plant groups. There will be a pre-lab quiz and full laboratory report due the following lab period.

Session 2.3: Animals: Invertebrates. Students will list the features that distinguish the animal Kingdom, explain the processes of animal reproduction and embryonic development and describe the roles that Hox genes play in development. They will explain the differences in animal body plans that support basic animal classification and compare the embryonic development of protostomes and deuterostomes. Students will interpret the Metazoan phylogeny and describe features that characterized the earliest animals. They will then survey the invertebrate phyla, examining changes in body plan and organ systems.

Readings and Problem Sets: Chapter 27 Introduction to Animal Diversity, Chapter 28 Invertebrates and assigned problems.

Weekly Exam 1

Week3 Animal Morphology and Physiology

Session 3.1: Animals: Vertebrates. Students continue with their survey of animal diversity by exploring vertebrates. They list the distinguishing characteristics of chordates, identify the derived characteristics of craniates that sets them apart from other chordates and describe the developmental fate of the notochord in vertebrates. They then examine morphology and physiology of the major vertebrate groups.

Students give special emphasis to how different vertebrate groups evolved from common ancestors.

Readings: Chapter 29 Vertebrates and assigned problems, with Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J. and Collen, B., 2014. Defaunation in the Anthropocene. *science*, *345*(6195), pp.401-406.

Laboratory 4: Invertebrates: Students will use morphological characters to identify different invertebrates to Phylum. For insects, students will key out to Order. Representatives of each major invertebrate Phylum and Insect Orders will be on display for students to study and ID, as well. Students will describe how structures specific to a given phylum help increase their evolutionary fitness. They will consider major body plans, their advantages and disadvantages, and how body plan has evolved over evolutionary time. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

Session 3.2: Animal Structure and Function: Basics and Digestive System. Students will compare different animal body plans, describe limits on animal size and shape and relate bioenergetics to body size, levels of activity, homeo/poikilothermy, endo/ectothermy, and environment. They will discuss different types of animal tissues, how they are composed and their functions. Students will investigate homeostasis and discuss positive and negative feedbacks to maintain it. They will then explore animal nutrition and the digestive system. They will explain the process of digestion and absorption, compare different digestive systems, explain specialized organs and their involvement in digestion and describe ways organs work together to digest and absorb food, as well as eliminate solid waste.

Readings: Chapter 33 The Animal Body: Basic Form and Function, Chapter 34 Animal Nutrition and the Digestive System, and assigned problems.

Laboratory 5: Vertebrates. Using prepared slides, students will examine animal cell division and distinguish early embryological differences between protostomes and deuterostomes. Beginning with the Phylum Chordata, students will use morphological characters to determine why vertebrates are placed with other Chordates. They will then explore all major vertebrate Classes. Students will list characteristics of each vertebrate Class, using both external and internal morphological characteristics. and discuss their relevance to where and how the animal lives. Within Classes, students will also explore diversity of form and function and link this to the habitats where these animals are found. There will be a pre-lab quiz and post-lab notebook check.

Session 3.3: Nervous and Sensory Systems. Students will list and describe the functions of the structural components of a neuron, list and describe the four main types of neurons and compare the functions of different glial cell types. They will describe the basis of the resting membrane potential, explain stages of an action potential including how they are propagated, contrast chemical and electrical synapses and describe long-term potentiation and long-term depression. Students will

identify the spinal cord, cerebral lobes and other areas of the brain, describing their basic functions. They will compare the organization and functions of the sympathetic and parasympathetic nervous systems and describe the organization and function of the sensory-somatic nervous system. Finally, they will explore the symptoms, potential causes and treatment of several human nervous system disorders. They will go onto study sensory system processes, somatosensation, and the morphology and function of all major sense organ systems.

Readings: Chapter 35 The Nervous System, Chapter 36 Sensory Systems, with assigned problems.

Weekly Exam 2

Week 4 **Animal Physiology: Endocrine, Musculoskeletal, Circulatory and Respiratory**

Session 4.1: Endocrine System. Students begin by examining the role of different hormones in maintaining homeostasis, explaining how hormones work and the role of different types of hormones in the excretory, reproductive and digestive systems. They will explain how hormones are regulated and discuss the different stimuli that control hormone levels in the body. Students will also explore human diseases involving hormonal dysfunction.

Readings and Problem Sets: Chapter 37 Endocrine System and assigned problems.

Laboratory 6: Invertebrate Anatomy. Students learn major invertebrate body plans and organ systems by dissecting (virtually or actually, by student choice) a jellyfish, earthworm, squid, crab or crayfish and sea star. Groups of two will work together on two organisms and then show other students in the class the basic physiological principles of circulatory/cardiovascular, respiratory, urinary, endocrine, reproductive, digestive, lymphatic and integumentary systems of their organisms. Labelled diagrams of all organisms will be handed in before leaving the laboratory.

Session 4.2: Musculoskeletal System. Students compare skeletal systems in different phyla with special attention on vertebrates. They classify the different types of vertebrate bones, explain the role of different cell types in bone and how bones form during development. Students classify different types of joints and analyze the role of joints in skeletal movement. They also delineate different types of muscle tissue and the role of muscles in locomotion.

Readings and Problem Sets: Chapter 38 The Musculoskeletal System and related end of chapter questions.

Laboratory 7: Vertebrate Anatomy. Students learn the vertebrate body plans and organ systems by dissecting (virtually or actually, by student choice) a frog and a fetal pig (virtual only). Students will draw, label and answer questions related to the basic physiological principles of circulatory/cardiovascular, respiratory, urinary, endocrine, reproductive, digestive, lymphatic and integumentary systems of their organisms. Labelled diagrams and answers to questions will be handed in before leaving the laboratory.

Session 4.3: Circulatory and Respiratory Systems. Students describe how different animal phyla respire and circulate fluids. For vertebrates, they describe the passage of air from the outside to the lungs (when present) and explain how the lungs are protected from particulate matter. They describe lung volume and lung capacity and articulate how gas pressure influences how much gas moves into and out of body. They describe how the structures of the lungs and thoracic cavity control the mechanics of breathing, explain the importance of compliance and resistance in the lungs and discuss problems that may arise due to a V/Q mismatch. They describe how oxygen is bound to hemoglobin and transported to body tissues and how carbon dioxide is transported to the lungs. For circulation, students describe both open and closed circulatory systems, interstitial fluid and hemolymph, and contrast circulatory systems in invertebrates and vertebrates. They list the basic components of the blood, comparing red and white blood cells and describe blood plasma and serum. Students then describe the human circulatory system, the cardiac cycle and the structures of arteries, veins, capillaries and how blood flows through the body, including blood pressure and its importance.

Readings and Problem Sets: Chapter 39 The Respiratory System, Chapter 40 the Circulatory System, and assigned problems

Weekly Exam 3

Week 5 Animal Physiology: Osmotic Regulation, Immunity and Reproduction

Session 5.1: Osmotic Regulation and Excretion. Students define osmosis and explain its role within molecules, explain why osmoregulation and osmotic balance are importance body functions, describe active transport mechanisms and explore osmoregulators or osmoconformers and how they allow animals to adapt to different environments. They explain how kidneys serve as the main osmoregulatory organs in mammals, the structure of kidneys, how the nephron is the functional unit of the kidney and how it works and detail the three steps in the formation of urine. They explain how vacuoles in microorganisms work to excrete waste as well as the way flame cells and nephridia work in invertebrates, including Malpighian tubules in terrestrial insects. Students compare ways aquatic and terrestrial animals eliminate ammonium and the role of hormones in excretion.

Readings and Problem Sets: Chapter 41 Osmotic Regulation and Excretion, with end of chapter problems and questions assigned.

Laboratory 8: Functions of Tissues and Organs. Through a series of laboratory activities, students will explore the epidermis, dermis and hypodermis, touch sensitivity and muscle fatigue. Students will use online resources to further investigate other tissues and organ systems, highlighting human diseases affecting each. Groups of students will present on causes and treatments of diseases for one major human organ system. There will be a pre-lab quiz and post-lab worksheet as well as a short group presentation.

Session 5.2: Immune System and Animal Reproduction. Students describe physical and chemical barriers for immunity, explain immediate and induced innate immune responses, discuss natural killer cells, describe major histocompatibility complexes and summarize how proteins in a complement system function to destroy extracellular pathogens. They explain adaptive immunity, compare adaptive and innate immunity, describe cell-mediate immune response, humoral immune response and immune tolerance. Students explore antibodies, as well, explaining cross-reactivity, the structure and function of antibodies and antibody production. They explore disruptions in the immune system, including hypersensitivity and autoimmunity. Students compare reproductive methods across phyla, describe fertilization in different taxa, human reproductive anatomy, gametogenesis and hormonal control of human reproduction.

Readings and Problem Sets: Chapter 42 Immune System, Chapter 43 Animal Reproduction and assigned problems.

Laboratory 9: The Cardiovascular System. Students examine the circulation of blood around the body, taking a closer look at the heart using online resources as well as measuring heart rate and pulse rate in themselves and others. They will also measure and understand the source and importance of blood pressure, applying changes in blood pressure to different first aid scenarios. They will measure lung capacity in different contexts. There will be a pre-lab quiz and post-lab worksheet.

Session 5.3: Ecology. Students define ecology and delineate four basic levels of ecological research. They give examples of how ecology often requires integration of different disciplines, distinguish and recognize the relationship between abiotic and biotic components of the environment. They define biogeography, listing abiotic factors affecting global species distributions, compare the impact of abiotic forces on aquatic and terrestrial environments and summarize effects of abiotic factors on net primary productivity. They use abiotic factors to define the eight major terrestrial biomes, aquatic biomes, compare ocean habitats and explore freshwater habitats. Students will define global climate change, summarize its source and describe at least three biological impacts of global warming.

Readings and Problem Sets: Chapter 44 Ecology and the Biosphere and assigned problems.

Weekly Exam 4

Week 6 Ecology and Biodiversity Conservation

Session 6.1: Population and Community Ecology, Ecosystems. Students explore the ecology of populations, life histories and natural selection, limits to population growth, human population growth, communities, ecosystems, energy flow through ecosystems and major biogeochemical cycles. Specifically, students will describe how ecologists measure population size, contrast three patterns of population distribution, use life tables to calculate mortality and describe three types of survivorship curves and relate them to specific populations. They will relate population growth curves to natural selection and how environmental adaptation led to the evolution of particular life history patterns and how this applies to the human population. Students will then explore major species interactions: predation, competition and mutualism. They will also describe community structure, function and how it changes successively. They will extend this to ecosystems, also characterizing food webs and how matter and energy move through ecosystems. Finally, students explore biogeochemical cycles of water, carbon, nitrogen, phosphorus and sulfur, and how humans are changing each.

Readings and Problem Sets: Chapter 45 Population and Community Ecology and assigned problems.

Laboratory 10: Ecology: Diversity and Interaction in Plant Communities. Students will observe the physical factors, plant dominance and interactions among organisms in a nearby park or nature preserve. They will characterize the ecological community through a series of careful observations and measurements. Students will quantify the distribution and abundance of an easy to recognize and abundant plant in this community using statistical methods. They will look for evidence of allelopathy and competition between plants. They will also explain four different ways of quantifying the importance of different plant species in a plant community using transect data. Students will summarize and statistically analyze data, reporting their findings to other groups at the end of the lab period using PowerPoint. The lab will conclude with a thorough laboratory clean up.

Group Presentations

Session 6.2: Ecosystems and Conservation Biology. Students define biodiversity as species diversity and relative abundance, describe biodiversity as the equilibrium of naturally fluctuating rates of extinction and speciation and identify historical causes of biodiversity loss. Students will discuss the importance of biodiversity

to human happiness and standard of living. They will identify human caused threats to biodiversity and discuss ways to conserve it.

Readings and Problem Sets: Chapter 47. Conservation Biology and Biodiversity.

Weekly Exam 5

Laboratory 11: The Effects of Chemical, Thermal and Acid Pollution. Students will describe how chemical pollution, thermal pollution and acid rain affect the growth and reproduction of select organisms. They will visit a nearby stream and use both chemical tests, presence of algae and macroinvertebrate diversity to assess stream water quality. Students will statistically use biological indicator scores for major benthic macroinvertebrates and use them to compare diversity indices and explain differences in species diversity with contamination in a lab report. A formal lab report will be due at the end of the laboratory period.

Session 6.3: Comprehensive Review, Problem Set Workshop and Final Exam

Course Materials

Textbooks

Biology, Second Edition. 2018. M.A. Clark, J. Choi and M. Douglas, OpenStax College

Thinking about Biology: An Introductory Laboratory Manual 2015. M. Bres and A. Weisshaar, Pearson Education, Inc.

Biology Laboratory Manual 7th ed. 2005. D.S. Vodopich and R. Moore. McGraw Hill.

Readings

Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J. and Collen, B., 2014. Defaunation in the Anthropocene. *science*, *345*(6195), pp.401-406.

Hijri, M. and Bâ, A., 2018. Mycorrhiza in Tropical and Neotropical Ecosystems. *Frontiers in plant science*, *9*, p.308.

Online Resources

Biology Student Resources. 2018. Openstax. Rice University
https://d3bxy9euw4e147.cloudfront.net/oscms-

prodcms/media/documents/openstax_getting_started_guide_student.pdf

Virtual Crayfish Dissection
https://www.biologyjunction.com/crayfish_dissection.htm

Virtual Earthworm Dissection
http://www.mhhe.com/biosci/genbio/virtual_labs/BL_14/BL_14.html

Virtual Fetal Pig Dissection
http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html

Virtual Frog Dissection
http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html

Virtual Squid Dissection
https://www.biologycorner.com/worksheets/squid_virtual.html