Science/Biology 2010.04 Plant Biology

3 credits lecture (3 hours/week; 12 weeks); 1 credit laboratory (3 hours/week; 12 weeks)
Current advances in plant biology research, highlighting plant structure, physiology, development and diversity. Three lecture hours, three laboratory hours. One term. Four credits. Prerequisite: SC/BIOL 1010 6.0 or SC/BIOL1000 3.0 and SC/BIOL1001 3.0.

Textbook

Evert RF and SE Eichorn 2012 Raven Biology of Plants. Eighth Edition. WH Freeman. (Table of Contents[1]).

Lecture Topics

Photosynthesis, Light and Life (Chapter 7) (*ca 3 hours*)

light properties and physics of light absorption, pigments (porphyrin structure and function), light reactions (electron transfer, ATP and NADPH production), and dark reactions (carbon fixation, carboxylase reactions)

The mechanisms of photosynthesis are presented with especial emphasis on the remarkable geological changes that occurred due to 1–2 billion years of oxygenic photosynthesis, creating the currently high oxygen levels in the atmosphere (and very low carbon dioxide levels). The juxtaposition of photosynthetic 'terra-forming' and carbohydrate production that support heterotrophic organisms are key elements in the evolution of biological diversity.

Systematics: The Science of Biological Diversity (Chapter 12) (*ca 0.5 hour*)

classification, phylogeny and major organismal groups

A brief overview of the 'evolution' of classification schemes is presented, including the initial ones proposed by Linnaeus and others 300-400 years ago, culminating in the evolution-based classification schemes now used.

Procaryotes and Viruses (Chapter 13) (*ca 1 hours*)

procaryotic classification and major procaryotic groups

Morphological and functional classifications of bacteria are presented, with special reference to diagnostics and the central role of wall structure in the ubiquitous Gram-staining.

Protista (Chapter 15) (*ca 4 hours*)

Autotroph unicellular: Euglenoids, Cryptomonads, Haptophytes, Dinoflagellates. Major characteristics, life cycles and biology

Heterokonts (Stramenopiles): Diatoms, Chrysophytes, Phaeophytes (multicellular) and the heterotroph Oomycota.

Multicellular: Rhodophytes, Green Algae (Chlorophyceae, Ulvophyceae and Charophycea) and the heterotroph Slime Molds. Major characteristics, life cycles and biology

The unicellular and multicellular phyla of the protists represent an evolutionary bridge to the animal, fungal and plant kingdoms, especially the complexities of cellular architecture (anticipating cellular differentiation in multicellular organisms) and patterns of multicellular development. The phylogenetic sequence is very obscure. We will explore them thematically, beginning with the unicellular groups, the multicellular groups and the heterotrophic groups.

Fungi (Chapter 14) (*ca 2 hours*)

major fungal groups, life cycles and fungal biology

The heterotrophic decomposers of the fungal kingdom are presented with emphasis on life cycle, characteristics and ecology. Emphasis will be placed on the major groups (Chytridiomycota, Zygomycota, Ascomycota and Basidiomycota) and the symbionts (Glomeromycota, other mycorrhiza and lichens)

Bryophytes (Chapter 16) (*ca 2 hours*)

major characteristics, life cycles and biology

The major characteristics of Bryophytes are presented in the context of adaptations to the rigors of life on land, where water is scarce and protection of offspring –until they can survive on their own– is crucial

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Seedless Vascular Plants (Chapter 17) (*ca 2 hours*)

major characteristics, life cycles and biology

Adaptive vasculature, including architectural complexities of stelar anatomy to support photosynthetic leaves are emphasized, as well as life cycles.

Gymnosperms (Chapter 18) (*ca 1.5 hours*)

major characteristics, life cycles and biology

The three major extant phyla (Cycadophyta, Ginkgophyta and Coniferophyta) are emphasized.

Angiosperms (Chapters 19 and 20) (*ca 3 hours*)

evolutionary biology of flowering plants

The reproductive peculiarities of flowering plants are presented, and the remarkable world of coevolution as a major effecter of the explosion of speciation

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Plant Development and Physiology (Chapters 22, 23, 24 and 25) (*ca 16 hours)*

a detailed examination of the life cycle of a flowering plant

The life of a plant –from dormant seed through germination and mature plant form– is presented in the context of the environmental and hormonal cues that trigger each developmental stage. At this point, the lectures will have evolved to being more central to the course, supplanting the textbook.

Lecture examinations (60% of final grade): two term tests and a final exam

The lecture and laboratory components are integrated (and usually synchronized). The final grade of the student is compiled from the combination of lecture and laboratory.

Laboratory Exercises

The majority of the material presented in laboratory exercises focuses on developing the observational skills of the students: observation and recording of gross form and structure (including the life cycle of a fern), and microscopic form and structure. Opportunities to identify material using keys –from algae, conifers to pollen– test and hone the student's observational skills. When appropriate, students will be introduced to statistical techniques for analyzing data obtained in laboratory exercises.

Photosynthesis

Oxygen evolution (effect of different wavelengths of light and CO_2 availability).

Algae and Fern Life Cycles

Identification of algae using keys, observation of fern life cycle (4 week exercise).

Fungi

Diverse life cycles and unique forms and patterns of fungi are examined and documented; the major role of fermentation is examined experimentally; a complete fungal life cycle is observed (4 week exercise).

Bryophytes
Seedless Vascular Plants
Gymnosperms

Diverse life cycles and unique forms and patterns of lower land plants are examined and documented; keys are used to identify gymnosperm species.

Pollen Identification I
Pollen Identification II

The angiosperm life cycle relies upon fertilization of the flower by pollen; both identification of pollen (in the context of its use in documenting pre-historic vegetation and climate) and observation of the dynamics of the pollination process are examined.

Angiosperm Anatomy Project I
Angiosperm Anatomy Project II

A flowering plant is dissected to examine structure and anatomy using various staining techniques and microscopic observation; the culmination of the student's developing adeptness in observation.

Fruit and Vegetable Anatomy Project

An extra credit opportunity for students to explore the nutritional value and anatomy of a fruit or vegetable they select.

Laboratory marks (40% of final grade): quizzes (keying) and lab write-ups.

Learning Objectives

DIVERSITAS

Students will learn the major characteristics of biological groupings commonly compiled together in a plants course: Prokaryotic heterotrophs and autotrophs, Eukaryotic Protist groups emphasizing the autotrophs, the heterotrophic Fungi, and Land Plants. The Learning Objective is fulfilled by integration of lecture and lab components. In Lecture, the students learn the characteristics, economic importance, and evolutionary significance of the various groups. In Lab, students are given the opportunity to observe life cycles of these organisms, from both prepared and living material. The Observational Skills that the students acquire in Lab (including microscopic observation and documentation with drawings) are crucial for their ability to integrate their understanding of biotic diversity in the context of Lecture presentation.

Achievement of the *Diversitas* Learning Objectives is documented by term tests that challenge the student to apply and integrate their knowledge of biotic diversity, and by lab quizzes and write-ups that document their ability to observe and identify major biotic groups.

FORMA VITAE

Students will explore that form and development of an angiosperm, from seed to seed in the context of environmental and physiological cues that control each life stage transition. The Learning Objective is fulfilled by integration of lecture and lab components. In Lecture, the students learn about environmental cues that regulate each life stage transition of a flowering plant and how the plant achieves that transition. In Lab, students are given the opportunity to dissect a plant and explore its internal structures that support survival at each life stage. The Learning Objectives include a transition to independent learning in which analytical thinking is emphasized.

Achievement of the *Forma Vitae* Learning Objectives is documented by term test and final exam that challenge the student to apply and integrate their knowledge of the life cycle of a flowering plant with analytical thinking, and by write-ups that document their ability to observe and explore the plant structures that support survival of the plant.

Roger R. Lew, Professor of Biology, York University, Toronto, Ontario, Canada
Course Director, SC/BIOL 2010.040, 2 December 2013

[i] Table of Contents (Evert RF and SE Eichorn 2012 Raven Biology of Plants. Eighth Edition. (chapters covered are in bold font).