BIOL 203 Eukaryotic Microbiology

Calendar Entry

BIOL 203 (4) Eukaryotic Microbiology

Introduction to the origin and diversity of protists (protozoa and algae) at both cellular and genomic levels, including the role of endosymbiosis in evolution.
[3-3-0]

Prerequisite: All of BIOL 140 and one of BIOL 121 or SCIE 001. BIOL 200 recommended.

Instructor Patrick Keeling. To be offered in Winter 2011.

Course Description

Protists represent the majority of eukaryotic diversity, and include a number of ecologically important groups (such as diatoms, major primary producers in the marine environment), parasitic groups (such as parasites causing malaria, sleeping sickness, and amoebic dysentery), and organisms where important processes and systems have been discovered and studied (for example, catalytic RNAs and lateral gene transfer). Moreover, the more familiar animals, fungi, and plants have all evolved independently from protist ancestors, so to have a meaningful grasp of eukaryotic evolution or context of these more familiar groups, a view of the whole tree of eukaryotes is essential. This course helps fill the second year 'diversity' requirements for a biology degree. At the end of the course, students should have an appreciation for the depth of eukaryotic diversity, where familiar animals plants and fungi fit into this diversity, and be able to evaluate current views on the evolutionary processes that gave rise to eukaryotic diversity.

Course Outline

BIOL 203 will be a one-term four-credit course with three lecture hours and a three-hour lab each week. The lab will focus on microscopy and observing and documenting diverse microbial eukaryotes, and will follow the course lecture material. There will be six main units:

Unit 1. Discovery of Microbial World.
This unit will introduce students to the history of microscopy and why the discovery of the microbial world challenged our fundamental views about the diversity of life, which was generally divided into plants and animals.

Unit 2. Endosymbiosis and the Origin of Eukaryotes.
This unit will follow up the historical view with the modern view of the tree of life and hypotheses for the origin of eukaryotes. The unit will also address how endosymbiosis has transformed eukaryotic evolution with the origin of mitochondria and plastids.

Unit 3. The Tree of Eukaryotes.

This short unit will summarise the modern view of the tree of eukaryotes, and will outline the way such phylogenetic relationships are inferred & evidence for the major groups of eukaryotes.

Unit 4. The Major Groups of Eukaryotes.
This large unit will summarise the main features of the six main groups of eukaryotes, Opisthokonts, Amoebozoa, Archaeplastids, Chromalveolates and Rhizaria. The emphasis will be on the main cellular features of these organisms, as well as their evolutionary origin, ecological impact, and exceptional genomic or molecular features. In each case examples will also be introduced where these have impacted human history or technology, or where there is a special interest in a particular species.

Unit 5. Diversity and Evolution of Eukaryotic Genomes.
A number of major 'rules' are broken by various protist groups, most glaringly at the molecular level (e.g. RNA editing, autocatalytic RNA, non-canonical genetic codes, etc.). Protists will be used to exemplify the possible diversity of such processes, with an emphasis on how they might evolve and what they tell us about the origin of related systems.

Lab topics and exercises:
- Lab 1 + 2: van Leeuwenhoek microscope, elaboration of keys
- Lab 3: Amoebozoa (live amoebae and slime moulds)
- Lab 4: Excavates 1: Termite guts (parabasalids and oxymonads)
- Lab 5: Excavates 2: Euglenids and kinetoplastids
- Lab 6: Green algae, red algae and glaucophytes
- Lab 7: Rhizaria (chlorarachniophytes, Forams and Rad skeleton-sorting)
- Lab 8: 1 Cryptophytes, Haptophytes, Oomycetes, Ochrophytes
- Lab 9: Diatoms (exercises in 3-D) and Dinoflagellates
- Lab 10: Gregarines (live earthworm combined with prepared slides)
- Lab 11: Coccidians (*Eimeria* and *Plasmodium*)
- Lab 12: Ciliates

Textbook, Primary Literature & Library Impact
There is no appropriate textbook for this field: comprehensive books at the undergraduate level are 20 years out of date; books that are up to date are highly technical and written for researchers. We will therefore rely on review articles, primary scientific literature and the updated Tree of Life Webpage Project resource (http://tolweb.org/Eukaryotes/3).

Learning Outcomes

Foundational knowledge
- Discuss the relationship between historical and current views of eukaryotic diversity
- Evaluate competing hypotheses on the origin of eukaryotes
- Evaluate the evidence available regarding the endosymbiotic origin of mitochondria and chloroplasts
- Evaluate the validity of the current supergroups of eukaryotes based on published evidence

- Discuss the variability of genetic systems in protists (e.g. RNA editing, trans-splicing, miniaturization/atomization of genomes, scrambled genes, etc.)
- Discuss the evolution of key features of eukaryotic cells in the different lineages:
    *nuclei and genomes
    *flagella
    *cytoskeleton
    *mitochondria
    *plastids
- Explain life strategies of protists (e.g. regarding food gathering, types of movement, reproduction, life cycle stages, metabolism, genetic systems) in light of the environmental conditions they live in
- Compare the processes through which the different multicellular eukaryotic lineages (animals, fungi, red algae, land plants and brown algae) attained multicellularity
- Discuss the significance of protists for the functioning of the world's major ecosystems (terrestrial, marine and freshwater)
- Assess the significance of protists on the history of humanity based on punctual examples (oil production, pathogenic organisms to humans, other animals or crops, harmful algal blooms, plankton and coral reefs and their relationship to fisheries and world climate)

Applications, skills

- Make their own microscope using the technology available when microbes were discovered
- Operate modern light microscopes effectively
- Visualize and draw living organisms in the light microscope by studying and comparing series of microscopic images in different focal planes
- Find protists in most environments and identify a variety of protists to major group
- Find reference material on protists using the web (Google Scholar), UBC on-line reference databases, or print databases
- Make an effective oral presentation on protistological issues

Evaluation

Evaluation will be based on a combination of mid-term, final exam, lab reports and lab exam. Lab reports will include observations and interpretation, and will emphasize the ability to write clearly. The lab exam will evaluate the students ability to interpret live cells and effectively use the light microscope. The exams will test all of the learning outcomes, and will evaluate the students' ability to synthesise information on different groups of organisms to address common themes.

Tentative Evaluation scheme:

Mid-Term	25%
Final Exam	50%
Lab Reports (8 reports)	15%
Lab Exam	10%