

BIOL 201

Diversity of Life I

Fall Term (2017)

CALENDAR DESCRIPTION

A survey of bacteria, algae, fungi and plants, their internal organization and their relationships to their environment. Organismal biology is discussed in a phylogenetic context and the evolution of organizational complexity and the relations between structure and function are stressed.

LEARNING HOURS 120 (36L;33Lb;48P)

SCHEDULE

Lectures: Mon 3:30 pm, Wed 2:30 pm and Thurs 4:30 pm – Biosciences Auditorium

Please refer to SOLUS for the lab schedule.

| | |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Instructors | Drs. P. Grogan and L. Aarssen |
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| Instructor Office Hours | TBA |
| Lab Coordinator | Dale Kristensen |
| Lab Coordinator Contact | drk1@queensu.ca – ph 613-533-6151 Biosciences room 5603 (best to arrange appointment by email) |

Learning Objectives

The goals of Biology 201 are to provide students with the background knowledge and interpretive skills needed to recognize and study the diversity of life as a product of Darwinian evolution, based largely on the process of natural selection. Students will be able to:

1. Describe and discuss the diversity of living organisms across the 'tree of life' from both evolutionary and ecological perspectives
2. Explain the primary and secondary mechanisms that generate biological diversity across the 'tree of life'
3. Recognise, describe, and compare the principal unique features of a wide range of organisms including bacteria, algae, fungi and plants in order to be able to identify and taxonomically classify these organisms
4. Describe the timeline of major advances in the evolutionary history of higher plants (embryophytes)
5. Identify the phylogenetic relationships of the major groups (phyla) of higher plants and distinguish their key characteristics using conventional botanical terminology and taxonomic nomenclature.
6. Interpret the relative success and diversity of the major groups (phyla) of higher plants in the modern flora in terms of adaptations for growth, survival and reproduction.

Learning Hours

| <i>Teaching method</i> | | <i>Average hours per week</i> | <i>Number of weeks</i> | <i>Total hours</i> |
|------------------------|------------|-------------------------------|------------------------|--------------------|
| ≡ | Lecture | 3 | 12 | 36 |
| | Seminar | | | |
| | Laboratory | 3 | 11 | 33 |

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|---------------------|------------------------|---|----|-----|
| | Tutorial | | | |
| | Practicum | | | |
| | Group learning | | | |
| | Individual instruction | | | |
| Other | Online activity | | | |
| | Off-campus activity | | | |
| | Private study | 4 | 12 | 48 |
| Total hours on task | | | | 117 |

Course Outline

1. Introduction to the Diversity of Life

The three domains of life; Historical developments in the Tree of Life concept; Why is an understanding of the diversity of life important? Course learning outcomes; Course logistics; Characteristics of living organisms; Early life on earth, and possible origins; Genetic diversity differs from species diversity

2. Systematics and Viruses

Differing concepts of 'species'; Systematics (Taxonomy plus Phylogenetics); Hierarchical classification system. Viruses – Characteristics, Origins, Impacts on living organisms, Structure, Bacteriophage life cycle, Development of virus defence strategies (vaccines etc.). Case study: Influenza virus (antigenic drift, shift).

3. Video and Discussion

Bacteria, Archaea and the Eukaryotic Domains

4. Prokaryotes: Bacteria (I)

Why study prokaryotes? Biological characteristics; What are the implications of being microscopically small? Prokaryotic lifestyles; Fundamentals of nutrition and energetics; Reproduction; Population growth in cultures; Mechanisms driving genetic variability

5. Prokaryotes: Bacteria (II) and Archaea

What are the principal differences between Bacteria and Archaea? Gram's stain. Archaea - structural features and functional groups; Bacteria – dormancy phases (endospores). Chemoheterotrophs (decomposers); Respiration vs. Fermentation; Bacterial roles in food production; Symbionts, Parasites and Pathogens; Photoautotrophs (e.g. cyanobacteria); Chemoautotrophs (e.g. methanogens). The fundamental roles of prokaryotes in whole Earth biogeochemistry. Photoheterotrophs.

6. Eukaryotes: Structure and Origin

Prokaryotes versus Eukaryotes: Differences in cellular structure, similarities in biochemistry; Distinctive characteristics of eukaryotes (cell and gene structural features in relation to function). The origin of eukaryotes; Evidence to support the endosymbiosis theory. Endosymbiosis and prokaryotic gene transfer mechanisms (e.g. plasmids) indicate that the 'tree of life' is actually a web containing many lateral gene transfers at its ancestral base.

7. Eukaryotes: Reproduction, and Introduction to the Protists

Sexual reproduction; Mechanisms by which sexual reproduction enhances diversity; Distinctive speciation mechanisms in eukaryotes (ploidy and life stage metamorphoses); Zygotic, Sporic and Gametic meiosis; Why have these different life cycles evolved?; Protists – a paraphyletic group; Light energy and implications for aquatic photosynthetic organisms (Algae). Ecology and physiology of algae parallels that of terrestrial plants.

8. Algae (Dinoflagellates and Euglenoids)

Dinoflagellate structural and metabolic characteristics; reproduction. Biological features underlying dinoflagellate 'red tides', and impacts on food webs including humans. Coral reefs: structure, ecology and critical role of dinoflagellate symbionts. Euglenoids: structure, reproduction, ecology.

Phylogenetics/Evolution conundrum: How come Dinoflagellates photosynthesize but evolved as a separate group prior to primary endosymbiosis event? Likewise, how come Euglenoids have the same chlorophyll pigments as higher plants? - Secondary endosymbiosis as a major pathway generating algal diversity.

9. Algae (Heterokonts: Diatoms, and Brown seaweeds)

Origins of each group: multiple endosymbiotic events. Diatoms: Structure, Life cycle, Ecological significance, Uses by humans including palaeoecology. Brown algae: Habitat and morphology; Structural features that relate to functional needs (internal translocation, large size) with particular emphasis on evolved traits that parallel those of higher plants. Novel adaptations required for diversification of algae toward shoreline and ultimately onto land. Reproduction: Heteromorphic alternation of generations, and discussion of possible selective forces giving rise to same. Ecology and human uses of brown algae.

10. Algae (Reds and Greens)

Red algae: Major ecological and structural features; Photosynthesis characteristics. Reproduction – asexual, alternation of generations (isomorphic and heteromorphic). Why has sporic meiosis (alternation of generations) evolved? Economic importance of red algae. Green algae: Structural features of major groups demonstrating complexity (e.g. Volvox). Structural, biochemical, and developmental linkages to traits found in higher plants.

11. Introduction to the Fungi

Fungi: Phylogeny; General distinguishing features; Structural forms; Hyphae: What are the implications of being small *and filamentous*? Nutrient acquisition; Human uses of fungi. Why are the Fungi so species-rich (second only to insects in species number)? Fungal reproduction and genetics (cytoplasmic and nuclear fusion stages in the life cycle). Why might the dikaryotic phase have evolved? Zygomycota: Major features; Life cycle of a bread mould. What triggers transition from asexual to sexual reproduction?

12. Fungi (Ascos and Basidios)

Ascomycota (sac fungi): Major biological features. Reproduction: Ploidy and the life cycle of an Ascomycota; Diseases. Basidiomycota (gill fungi): Major features. Reproduction: Life cycle of a mushroom. Fruit body diversity. Spore production and dispersal. Pathogenic, parasitic and nematode-trapping fungi. Case study: Stinkhorns.

13. Fungal symbioses

The symbiosis concept. Lichens: Polyphyletic origins. Structural features. Reproduction. The mutualism/parasitism enigma; Lichen ecology and uses. Mycorrhizae: Functional impacts on soil-plant relationships. Major features of Arbuscular and Ectomycorrhizae. The 'wood-wide web': implications for forest community ecology below- and aboveground ecology. The potential role of lichens and mycorrhizae in enabling ancestral algae to colonise land, leading to the evolution and diversification of all land plants.

14. Synthesis and Review

Reflection on the learning outcomes for this section of the course. An overview perspective on the mechanism of evolution by natural and sexual selection in the context of the course themes: Diversity begets diversity – but only up to a point; Evolution as a progressive, convergent, predictable process or as a random, contingent, unpredictable process; review of queries from students.

15. Origin, evolution, and classification of land plants

The link between life and non-life. Invasion of the land. Early thalloid land plants. Diversity from unity. Alternation of generations. Stages in the evolutionary series from algae to early land plants. Land plant classification.

16. Bryophytes

Classification of Bryophytes. General characteristics and life cycles. Liverworts; thallose, leafy, spore discharge. Hornworts. Mosses; classes, growth forms, structure, spore discharge.

17. Vascular Plants: Origin, Evolution, and Structure

Algal origin. Anthoceros origin. The first vascular plants. Extinct Phyla. Major evolutionary trends; roots, evolution of the axis (height, girth); evolution of vascular tissue (stele, tracheids, vessels, secondary growth); bark (periderm); evolution of the leaf (microphyll, megaphyll); reduction in size and life span of gametophyte generation and increasing dependence on sporophyte; loss of sperm cell motility; homosporous/heterosporous.

18. Seedless Vascular plants: Introduction, Whisk Ferns and Club Mosses

Classification. Whisk ferns: origin, structure; life cycle; interpretation of Psilotum sporangium. Club mosses: structure; life cycle; interpretation of Lycopodium sporangium; extinct lycophytes; coal age plants; heterosporous; gametophytes.

19. Seedless Vascular Plants: Horsetails and Ferns

Horsetails: structure; life cycle; interpretation of Equisetum sporangiophore; extinct taxa. Ferns: classification; structure; life cycle; origin of megaphyll and sporangial position; spore dispersal; tree ferns; age of the ferns.

20. Evolution of the Seed Plants

The race to the canopy. Progymnosperms. The seed habit compared with Pteridophytes. Heterosporous and retention of reduced endosporous female gametophyte. Indehiscent megasporangium. Integumentation of megasporangium. Seed versus ovule. Interpretation of integument. Evolution of the pollen grain/male gametophyte. Major advantages of the seed habit. Introduction to gymnosperms: female gametophyte; polyembryony. Cycads: structure; strobili; gametophytes; pollination and fertilization; similarities with ferns.

21. Gymnosperms (continued): Ginkgophyta and Coniferophyta

Ginkgo: structure. Conifers: classification; shoots and leaves; strobili and cones; gametophytes; life cycle.

22. Origin and Evolution of Angiosperms

Gnetophyta: gymnosperms with similarities to angiosperms. Evolutionary trend in the separation of the sexes (hermaphroditism, monoecy, dioecy). The flower: the carpel. Origin. Stages in the evolution of the carpel. Interpretation of flower parts. Evolutionary trends in flowers. Evolution of insect pollination.

23. Angiosperms: Reproduction

Pollen development: microsporogenesis; microgametogenesis. Embryo sac development: megasporogenesis, megagametogenesis. Androeceum and gynoecium. Pollination. Fertilization. Seed development: interpretation of endosperm; comparison with gymnosperms. The Fruit. Summary characteristics of angiosperms. Advantages of angiosperms over gymnosperms.

24. On Sizes, Numbers, and Trade-offs in Higher Plants I.

Death without sex: the problem of the small. Why are most species relatively small? Evolutionary time hypothesis; Left wall hypothesis; Extinction rate hypothesis; Habitat availability hypothesis.

25. On Sizes, Numbers, and Trade-offs in Higher Plants II.

Selection for reproductive economy hypothesis. Evolution of clonality and selfing. Relationship between functional plant size and zygote product longevity in the evolution of plant strategies. Physical-space-niche hypothesis.

26. Overview: Evolutionary Trends**Textbooks/Readings**

Textbook: Raven Biology of Plants, 8th Edition. 2013. Evert and Eichhorn. Freeman Press.

Grading Scheme

| Component | Weight (%) | Date |
|--------------------------------|------------|---------------------------------------------|
| Lecture midterm exam | 20% | week of October 16 th (in class) |
| Final lecture exam | 30% | December exam period |
| Lab quizzes | 5% | |
| Lab exam 1 | 10% | Oct 24-28 |
| Lab exam 2 | 10% | Nov 21-25 |
| Group Projects and assignments | 25% | TBA |

Grading Method

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale.

Your course average will then be converted to a final letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

| Grade | Numerical Course Average (Range) |
|-------|----------------------------------|
| A+ | 90-100 |
| A | 85-89 |
| A- | 80-84 |
| B+ | 77-79 |
| B | 73-76 |
| B- | 70-72 |
| C+ | 67-69 |
| C | 63-66 |
| C- | 60-62 |
| D+ | 57-59 |
| D | 53-56 |
| D- | 50-52 |
| F | 49 and below |

Academic Integrity and Queen's Code of Conduct

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and conduct conform to the principles of academic integrity. Information is available in the Arts and Science Calendar (see Academic Regulation 1 - <http://www.queensu.ca/artsci/academic-calendars/regulations/academic-regulations>, on the Arts and Science website (see <http://www.queensu.ca/artsci/academics/undergraduate/academic-integrity>), and at Biology's website (<http://biology.queensu.ca/academics/undergraduate/prepare-yourself/>) and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's.

Given the seriousness of these matters, actions which contravene the regulations on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

Accommodation Policy, Exam Conflicts, and Other Conflicts

Students who feel they need accommodations for disabilities or extenuating circumstances, or have a conflict between exams or other commitments should consult the Biology Department's website for details about how to proceed (<http://biology.queensu.ca/academics/undergraduate/prepare-yourself/>). In general, the earlier a course coordinator is apprised of an extenuating circumstance, the more likely an accommodation can be made. Students are encouraged to be proactive in anticipating difficulties, when it is possible to do so.

Students may apply to write a make-up or deferred exam if they have an exam conflict as defined in the Academic Regulations of the Faculty (See Arts and Science Calendar Regulation 8 - <http://www.queensu.ca/artsci/academic-calendars/regulations/academic-regulations>). In this case, the student should report to the Exams Office first to verify that there is a genuine exam conflict. Biology professors will not consider your situation to be a conflict unless it meets the criteria set out by the Faculty of Arts and Sciences.

Students may request a make-up or deferred exam if they have an exam conflict with off-campus travel associated with a field course (e.g BIOL-307/3.0 or 407/3.0) that is held during the fall or winter terms.

Accommodation of Disabilities

Queen's University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact the Student Wellness Services Office and register as early as possible. For more information, including important deadlines, please visit the website at: <http://www.queensu.ca/studentwellness/>

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