BIOL108

Introduction to Biological Diversity

3 Credits

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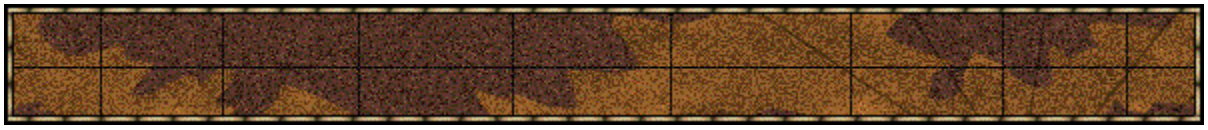

Introduction to Biological Diversity

Calendar Description

Examines the major lineages of life on Earth. Overview of evolutionary principles and classification, the history of life, and the key adaptations of prokaryotes, protists, fungi, plants, and animals. Laboratories survey the diversity of biological form and function, and introduce students to data collection and scientific writing.

Rationale

BIOL108 is an introduction to the mechanisms of evolution of organisms, and it provides an overview over the diversity of life forms. This course introduces the taxonomic techniques and viewpoints. Based on the domain and kingdom concepts, the evolutionary lineages of prokaryotic bacteria and archaeans, eukaryotic protistans, fungi, plants, and animals are reconstructed. General topics are phylogeny, natural selection, fitness, speciation, population genetics, the origin of life, nutritional types, biogeochemical cycles, endosymbiosis, evolution of photosynthesis, binary fission, mitosis and meiosis, alternation of sexual and asexual generations in life cycles, multicellularity, body plans and organ function.

BIOL108 is intended as an introductory biology course for first year university transfer students. The course builds a foundation for students in agriculture, forestry, arts, elementary and secondary education, human and veterinary medicine, pharmacy, and science.

Prerequisites

Biology 30

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to (cognitive skills)

1. indicate the hierarchy of study object sizes or scopes, and recognize the hierarchy of taxa in biological systems.

2. apply the criteria which distinguish life from dead matter.
3. itemize the unique properties of water and carbon, which make life possible on Earth.
4. distinguish biological classification schemes: 2 kingdoms based on nutrition and motility (Linnaeus), 3 domains based on ribosomal RNA sequences (Woese), 5 or 6 kingdoms based on presence of nucleus, cell wall, membrane lipids, and body plans (Whittaker).
5. quote the rules of taxonomy: binomial nomenclature, typology, cladism, evolutionism, pheneticism, and the biological species concept based on reproductive barriers and population genetics, the use of morphological versus molecular data.
6. describe the importance of genotype and phenotype in natural selection, mutation rates, orthologs and paralogs, sympatric speciation, sexual reproduction and meiosis, genetic recombination, and the alternation of generations in the life cycle.
7. discuss the origin of life, the change in atmospheric composition due to photosynthesis, the effect of plate tectonics and continental drift on allopatric speciation.
8. explain the foundations of archaean and bacterial taxonomy, lithotrophy, methanogenesis, carbon, nitrogen and sulfur biogeochemical cycles, and the endosymbiotic theory of mitochondrial and chloroplast evolution.
9. outline the tenets of protistan taxonomy, the evolution of sexual reproduction, the rise of colonial and multicellular forms, the origin of organelles, modes of cell division, acquisition of photosynthetic pigments, locomotion and symbiosis.
10. specify the basics of fungal taxonomy, the evolution of parasitic and saprotrophic life styles, separation of plasmogamy and karyogamy in the dikaryon, cell connections, air borne sexual and asexual spores, and symbiosis with algae in lichens.
11. epitomize the arguments for relating green algal and plant taxonomies, importance of genome duplications, the rise of the sporophyte, and its alternation with the gametophyte, the evolution of air borne asexual spores, pollination, seeds, fruit, and flowers.
12. rationalize the principles of animal taxonomy, the evolution of embryonic cleavage types, germ layers, body polarity and symmetry, DNA-sequencing based concepts of lophotrochozoans and ecdysozoans, animal body plans and the success of mollusks, arthropods, and vertebrates.
13. list the unique features of sequentially evolved clades of deuterostomes, chordates, craniates, vertebrates, gnathostomes, pharyngopnoi, amniotes, and placentals.

Upon successful completion of this course, students will be able to (applied skills)

14. work safely in a biology lab, wearing a lab coat, tying long hair, reporting accidents, cleaning spills, washing hands, disinfecting lab benches, avoiding cuts and burns by keeping a neat work space. Safe waste disposal.
15. adjust compound and dissecting light microscopes for the study of live and preserved specimens, and prepare wet-mounts on slides of live cultures of three cyanobacterial species.
16. draw specimens viewed under the microscope, estimate and calculate their sizes using the ocular micrometer, the magnification of the image, and calculate the resolution of the objective lens in use.
17. find peer-reviewed primary research articles on a given topic using databases, such as Biological and Agricultural Index, Agricola, Biological Abstracts, J-Store, and to make interlibrary loan requests.

18. transfer C-fern spores as well as *Arabidopsis* plant seeds, from sterilized water to solid agar medium under aseptic conditions, by using sterile packaging, and dousing and flaming forceps on alcohol lamps.
19. identify cyanobacteral species by their cell shape, cell arrangement, cell size, and cell differentiation, and by use of a dichotomous key. Later on, a more elaborate dichotomous key aids in lichens identification.
20. evaluate 5 hypothetical phylogenetic trees of 5 ungulates and the aardvark outgroup, based on a morphological data matrix, when applying the parsimony principle.
21. document genetic drift in small fragmented populations of the quokka, and the molecular clock, using random draws of poker chips and substitutions of colored interlocking necklave beads at the DNA and protein levels.
22. calculate genetic distance among the 5 ungulate species and aardvark outgroup, based on the multiple DNA sequence alignment (MSA) of mitochondrial cytochrome B, translated into 380 amino acids.
23. label the organs of a live sunflower (*Helianthus*) seedling, the primary tissues in a prepared *Helianthus* stem cross-section, and tissues in a prepared lilac (*Syringa*) leaf cross-section.
24. measure the root growth in phosphate-starved roots compared to control roots with normal phosphate levels; also, calculate the germination rates of *Arabidopsis thaliana* seeds in low and normal phosphate media.
25. compare root growth at two phosphate concentrations by the t-test, by formulating the null hypothesis, calculating means, variances, degrees of freedom, and t-statistic, at confidence level, determine significance.
26. write lab reports and make poster presentations in scientific format: experimental data analysis and graphing, alternative hypothesis, statistical tests, evaluation and interpretation of results, and citation in APA format.
27. observe the plant life cycle of the cultured *Ceratopteris* fern: homospores, gametophytes, sperms, eggs (1n), and later sporophytes (2n); graph male and hermaphroditic gametophyte percentage against overall density.
28. test habitat preferences, light, temperature, and pH, of newly hatched brine shrimp (*Artemia franciscana*) larvae in 1m gradient tubes; at the end, shrimp numbers are counted separately in 4 clamped-off sections.
29. perform a statistical goodness of fit Chi^2-test on the shrimp count data, calculating Chi^2 from expected and observed counts, compare it to the critical Chi^2, and discuss significance based on the null hypothesis.
30. recognize basidiomycetes by mushroom and basidia, deuteromycetes by conidiophores, yeasts as single cells, impact on humans, symbiosis in arbuscular and ecto-mycorrhiza, symbiosis in lichens (dichotomous key).
31. design and run experiments to study the life of an invertebrate animal (hydra, planarian, earthworm, nematode, pond snail, slug, mealworm, bean beetle, brine or fairy shrimp); read about classification, anatomy, food.
31. create and group-present a laminated scientific poster with title, author names and institutional address, abstract, introduction, results in graphs, pictures, tables, calculations, discussion, references; peer review.

32. dissect a vertebrate (perch fish) for the study of its internal anatomy (mounted rat), name the bones on a perch and cat skeleton, name external features of sea star, urchin, and sea cucumber, their locomotion, their canals.

Resource Materials

Required Texts:

Urry L. A., Cain M. L., Wasserman S. A., Minorsky P. V., Reece J. B., Rawle F. E., Durnford D. G., Moyes C. D., and Scott K. (2021). *Campbell Biology* (3rd Canadian ed.). Don Mills, Ontario, Canada.: Pearson Canada Inc.

Hagen, M. (2020/2021). *Biology 108. Introduction to biological diversity. Laboratory manual*. Edmonton, AB: Department of Biological Sciences, University of Alberta.

Cuny, R. (2020). *BIOL108. Introduction to biological diversity. Course notes.* Lloydminster, AB: Lakeland College.

Cuny, R. (2020). *BIOL108. Introduction to biological diversity.* Online. Desire-to-Learn, Lloydminster, AB: Lakeland College.

Reference Text:

Pechenik, J. A. (2016). *A short guide to writing about biology* (9th ed.). Hoboken, New Jersey: Pearson.

Conduct of Course

This is a 3 credit course with 3 hours of lecture and 3 hours of lab per week. (3-0-3).

Lectures - Three hours per week

The lectures are supported by PowerPoint projection, whiteboard, and occasionally by a short movie. The textbook, printed course notes and electronic files placed on Desire-2-Learn must be supplemented by notes taken by the students. The library can be used to access the biological literature and on-line databases. Students are expected to do the assigned readings in the textbook and lab manual on a weekly basis.

Labs - Three hours per week

The laboratory enables the students to have direct contact with living and preserved organisms of most kingdoms. Safety procedures must be followed and **lab coats must be worn when in the lab.** Key experiments teach the students the process of scientific deduction: A hypothesis is formulated, tested experimentally, and the results are evaluated and compared with the theoretical values predicted by the hypothesis.

In addition to the 8 worksheets, three lab activities are submitted: *Arabidopsis* root length (Lab 3) with t-test statistics, *Artemia* habitat preferences (Lab 5) with Chi^2 statistics, and a graph of *Ceratopteris* gametophyte density versus sex ratio (Lab 4). There is a lab safety quiz (Lab 2) on lab and biosafety (Orientation and Lab 1). All students must pass the lab safety quiz before continuing with the labs. Although some laboratory work is performed in groups of up to 4 students, each student is responsible for an independent data analysis, and individual interpretation of the results. Citation follows a scientific format (APA).

The WHMIS Workplace Hazardous Materials Information System requires the safe handling and storage of chemicals as specified in the MSDS Materials Safety Data Sheets. Live animals must be handled in accordance with the Guidelines of the Canadian Council on Animal Care, and cruelty or neglect is not tolerated. Microorganisms on Schedule 2 of the Human Pathogens and Toxins Act fall under the regulations of the Pathogens Regulation Directorate of the Public Health Agency of Canada and can only be studied in the Level 2 approved lab BK110. All laboratory equipment is operated as specified in the Operation Manuals.

Evaluation Procedures

The student's performance is evaluated in terms of percentage points that reflect the weighted number of correct answers on exams, the quality of lab reports, worksheet entries, and practical work. The final mark is the aggregate of the evaluations. However, students must achieve a mark of 50% or higher in the laboratory component, which includes the safety quiz, lab reports, worksheets, databases literature search, group presentation, practical work, and the final lab exam combined to pass the course.

The weighting of the course components are as follows:

Lecture:		
Lecture Quiz (1)	5%	
Lecture Midterm Exam (1)	20%	
Lecture Final Exam (1)	35%	
(Lecture Total)		**60%**

Laboratory:		
Laboratory Safety Quiz (1) (you must pass)	5%	
Library database search, citation (3)	2% (+ 1% bonus)	
Laboratory worksheets (8)	4.5%	
Data analysis, table, graph: C-fern (1)	1%	
Half Report: Arabidopsis root growth (½)	1.5%	
Lab Report: Artemia habitat preference (1)	3%	
Group poster (1), poster peer review (1)	3% (+0.5% bonus)	
Final Laboratory Exam (1)	15%	
Laboratory practical work	5%	
(Laboratory Total)		**40%**
Total		**100%**

No supplemental assignments or exam re-writes are allowed in the University Transfer Department. The lecture exams are composed of a 2:1 mixture of multiple choice questions and short answer questions. The laboratory exam may present any living or preserved material that the students studied in the labs; question stations are set up, and students will take turns (5 minutes per station) answering questions at each station. The lab reports do not exceed 2 pages single spaced, excluding tables or graphs. They follow a scientific format: Title, author's name and address, abstract, a brief introduction and hypothesis, methods, results, a discussion, reference list (APA), and answers to questions asked in the lab manual or on worksheets. Late submissions of assignments will suffer a 5% deduction per day late, except under documented extraordinary circumstances.

Cheating, falsifying of laboratory data, plagiarism, and non-compliance with class procedures, safety regulations, copyright, or the code of conduct are academic and professional offenses. Depending on the severity of the offence, a student may be reminded, sent out of the class room, reported to the department head, may have marks deducted, assigned a failing grade in the course, or may be expelled from the college.

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Attendance is recorded by the instructors, and lab attendance is mandatory. If more than 2 labs are missed, excused or unexcused, the student is required to withdraw (RW) or is assigned a failing grade (F) for the entire course. If you do not meet the lecture attendance requirement of 80%, the Registrar may withdraw you from the course (RW). If you are absent due to illness or due to a critical family situation, please provide the documentation. In any case, it is the responsibility of the student to acquire the missing information, and to complete missed course work.

Students are only allowed to submit lab reports or worksheets for labs that they have attended. If the student's absence is excusable, the missed lab is not counted. If the absence is inexcusable, the lab assignment will be assigned a mark of 0.

Make-up labs are difficult or impossible to set up in biology. Only students with an excused absence may be granted a make-up lab.

Course Units/Topics

Week	Type	Lecture and Lab Titles
		I. CLASSIFICATION AND EVOLUTION
1	Lec -	(LABOUR DAY), registration, orientation
	Lab -	Biology laboratory safety and biosafety orientation
	Lec 1	Overview of the course, criteria for life, subdividing biology by size or by taxon
	Lec 2	Importance of water for life: physical and chemical properties
2	Lec 3	Importance of carbon for life: inorganic versus organic carbon, macromolecules
	Lab 1	Lab safety; microscopy, cyanobacteria, *Arabidopsis* and *Ceratopteris cultures*
	Lec 4	Binomial nomenclature, taxonomic hierarchy, typology
	Lec 5	Pheneticists, evolutionists, cladists; homology and synapomorphy
3	Lec 6	Classification: 2 or 5 kingdom systems, 3 domain system, endosymbiosis
	Lab 2	**Lab Safety Quiz**; phylograms of ungulates, cytochrome b; library databases
	Lec 7	Schools of biological thought: Plato to Darwin, *Scala Naturae*
	Lec 8	Lamarck and Darwin's work:: Galápagos and the Darwin finches
4	Lec 9	Evidence of evolution by natural selection
	Lab 3	Kingdom Plantae: plant shoot and root; *Arabidopsis* root and phosphate, t-test
	Lec 10	Biological species concept, reproductive barriers, fitness
	Lec 11	**Lecture Quiz 1**; allopatric speciation, continental drift, adaptation, gradualism

5	Lec 12	Sympatric speciation, allopolyploidy, translocations, inversions, punctualism
	Lab 4	Kingdom Plantae: *Ceratopteris* fern life cycle; density and gametophyte sex ratio
	Lec 13	Asexual versus sexual reproduction, life cycles, meiosis, recombination
	Lec 14	Mendelian genetics, pedigrees, mutations, allele frequencies, gene pool
6	Lec -	(THANKSGIVING DAY)
	Lab -	(THANKSGIVING WEEK)
	Lec 15	Population genetics, Hardy-Weinberg binomial expansion, 5 criteria for evolution
	Lec 16	Genetic drift, polymorphism, modes of selection, neutral variation, bottlenecks
		II. DIVERSITY OF LIFE, DOMAINS AND KINGDOMS
7	Lec 17	Origin of life, abiotic synthesis of biomolecules, protobionts, stromatolites, BIF
	Lab 5	Kingdom Animalia: habitat selection by Artemia shrimp hatchlings; Chi^2-tests
	Lec 18	Prokaryotes: Domains Bacteria and Archaea, cell shape, size, Gram stain
	Lec 19	Prokaryotes: Bacteria and Archaea, kingdoms, pathogens, symbionts
8	Lec 20	**Midterm Lecture Exam**
	Lab 6	Kingdom Fungi: Zygo-, Glomo-, Asco-, Basidiomycota, lichens, mycorrhiza
	Lec 21	Prokaryotes: nutritional types, photoheterotrophs, fermentation types
	Lec 22	Prokaryotes in biogeochemical cycles of C, N, S, Fe, evolution of photosynthesis
9	Lec 23	Eukaryotes: Kingdom Protista is paraphyletic, endosymbiosis, mitosis, meiosis
	Lab 7	Overview over Animalia: Radiata to Protostomia; design invertebrate experiments
	Lec 24	Kingdom Protista: single-celled to colonial zooflagellates, amoebas, ciliates
	Lec 25	Protista: slime molds, water molds, phytoflagellates
10	Lec 26	Protista: brown, red, and green algae, including Charophyta
	Lab 8	Group experiment, investigation into the biology of a living invertebrate
	Lec 27	Kingdom Plantae: green algal origin, strategies on land, life cycles, gametophytes
	Lec -	(REMEMBRANCE DAY)
11	Lec 28	Plantae: nonvascular to vascular, life cycles of mosses and ferns, embryophytes
	Lab 9	Kingdom Animalia: Deuterostomia, including Vertebrata, anatomy, dissection
	Lec 29	Plantae: vessels, seeds, strobili, to flowering plants, double fertilization, fruits
	Lec 30	Kingdom Fungi: opistokont rear-flagellum or no flagellum, dikaryon

12	Lec 31	Fungi: Chytridio-, Zygo-, Glomo-, Asco-, Basidiomycota, lichens, mycorrhiza
	Lab 10	**Group Poster Presentation** on the assigned invertebrate animal
	Lec 32	Kingdom Animalia: body symmetry and polarity, germ layers, gastrulation, coelom
	Lec 33	Animalia: Parazoa: sponges, Metazoa: Radiata, Bilateria, Pseudocoelomata
13	Lec 34	Animalia: Acoelomata, Coelomata, Protostomia, Mollusca, Annelida
	Lab 11	**Final Lab Exam**
	Lec 35	Phylum Arthropoda; Lophophorata; Deuterostomia, Echinodermata - features
	Lec 36	Phylum Chordata: neurulation, notochord, neural crest, somites, pharyngeal gills
14	Lec 37	Subphylum Vertebrata: jaws, girdles, amniote egg, skull openings, milk glands
14/15		**Final Lecture Exam Period**

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