Universitat Autònoma de Barcelona

2021/2022

Evolution

Code: 100770
ECTS Credits: 9

Degree	Type	Year	Semester
2500250 Biology	OB	3	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: No

Some groups entirely in Spanish: No

Teachers

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Prerequisites

All biology converges in evolution. Evolutionary analysis integrates and requires knowledge of all disciplines of biology. For an adequate follow-up of the subject it is VERY IMPORTANT to start from the following previous knowledge:

1) Understanding of transversal concepts of mathematics and biometrics (chance, random variable, discrete and continuous variables, mathematical model, distribution functions, Poisson distribution, binomial distribution, multinomial distribution, chi-square distribution, normal distribution, samples and populations, statistics and parameters, measures of central tendency and dispersion, measures of relationship, correlation and causality, statistical inference, sampling error, bias and dispersion, null hypothesis, hypothesis test, confidence interval, level of significance, experimental error, experimental design, replication, nonparametric approximation, pseudo replication, simulation, Bayesian approach). These concepts are taught in Mathematics (1st year) and Biostatistics (1st year).

2) Understanding of the metabolism, physiology, anatomy and taxonomy of prokaryotic and eukaryotic organisms. Fundamental concepts of classical genetics (gene, allele, homozygote and heterozygote, genotype and phenotype, asexual and sexual reproduction, somatic and germinal lines, mitosis and meiosis, gametes and genotypes, principles of allelic segregation in the same locus and in different loci, recombination and linkage), molecular genetics (molecular characters, structure of nucleic acids, concept of gene, structural and functional categories of genomic sequences, types of genetic changes, structure of regulatory genetic regions, physicochemical properties of amino acids, structure of proteins, genetic codes, levels of regulation of gene expression, mechanisms of pattern formation and morphogenesis, genetic bases of the development and control of gene expression, feedback loops, epigenetics), population genetics (individuals and populations,

variability, Hardy-Weinberg equilibrium, departures from random mating, sources of genetic variation, effective population size, migration, genetic drift, natural selection, sexual selection, adaptation, biological efficacy and components, polymorphism and substitution, linkage disequilibrium, gene interaction, epistasis, adaptive landscape, genetic ballast), quantitative genetics (similarity among relatives, monogenic and polygenic inheritance, components of phenotypic variance, additive and dominant genetic variance, heritability, selection differential, response to selection, genotype-environment interaction, genetic background, reaction norm, conflicts and "trade-offs") and ecology (environment, energy flow, ecological niche and habitat, life cycle, reproductive strategies, demographic structure, growth models, carrying capacity, survival curve, acclimatization, competitive exclusion, competition and types, symbiosis and types, trophic level, dispersion, metapopulation, community, ecosystem, ecological network, homeostasis, resilience, ecotone, spatial patterns of diversity). This knowledge is taught in the scientific-technical subjects of Genetics (1st year), Structure and Function of Biomolecules (1st year), Botany (1st year), Zoology (1st year), Cellular Biology Extension (2nd year), Biosignaling and Metabolism (2nd year), Molecular Genetics (2nd year), Advanced Histology (2nd year), Advanced Zoology (2nd year), Microbiology (2nd year), Plant Nutrition and Metabolism (2nd year) and Animal Physiology (2nd year).

Most training resources are in English. To be able to benefit from these resources it is necessary to understand written and spoken discourses in English.

Objectives and Contextualisation

The concept of evolution by natural selection of Charles Darwin is one of the most revolutionary ideas of Western thought.

GLOBAL OBJECTIVES:

a) To raise a vital concern for evolution as a conceptual framework of explanation capable of providing a synthetic view of nature, and of exerting a decisive influence on the understanding of oneself, and one's position in the future of our planet.

b) To provide a solid and integrated knowledge of the core of modern evolutionary theory and its most relevant implications - anthropological, sociological, philosophical. To appreciate how this knowledge comes about and continues to expand through the creativity, the rigorous scientific method, and the cooperation among researchers, within the cultural and social context of each moment.

c) To face the uncertainty associated with change and the multiple perspectives of knowledge and reality.

d) Promotion of intellectual autonomy and personal creative independence in the search and acquisition of knowledge.

e) To transfer theoretical approaches to concrete situations, demonstrating the applicability of evolutionary theory (e.g. in health sciences, agriculture and conservation), and the positive impact that a citizen with a solid knowledge of this subject can have in society.

TRAINING OBJECTIVES:

a) Development of syntactic-semantic competences for the transmission of evolutionary ideas with rigor, avoiding teleologism of language. Evolution is a contingent historical process, without purpose or direction.

b) Acquisition of a perspective of all the biological disciplines articulated in a coherent conceptual framework of the evolution of life on Earth.

c) Knowledge of the history and social relations of evolutionary thought, including the most recent discussions about the need to review the New Synthesis. The theory of biological evolution is usually identified only with the figure of Charles Darwin.

d) Knowledge of the main empirical evidence on which modern evolutionary theory is based. Biological evolution is such a solid scientific theory that in practice it can be considered as a fact.

e) Knowledge of the main theories about the origin of life, the nature of the last common ancestor and the history of its diversification (extinction) in the present forms of life, emphasizing the great evolutionary transitions, in connection with the dynamics of the planet. The purpose of evolutionary biology is to interpret phenomena that cannot be understood without knowing the past.

f) Understanding of basic concepts and methodological approaches (based on tacit premises, based on explicit models) for the inference of evolutionary relationships (genealogies, phylogenies) between organisms at different taxonomic levels (populations, species, higher order categories), and its dating (molecular clocks), from characters of diverse nature (genetic sequences, molecular markers, physiological or anatomical properties).

g) Understanding of the method of evolutionary analysis. In a broad sense, evolution is descent with modification. Related organisms tend to have similar biological properties. Through the evolutionary approach, it is possible to predict the biology of an organism by comparison with related organisms.

h) Understanding the genetic basis of evolution (structural variants vs. regulatory variants) and the connections between evolution and development.

i) Understanding of the causes and mechanisms of the evolutionary process in its two dimensions: Anagenesis and cladogenesis, integrating the classical approaches to the study of evolution with modern techniques of genetic analysis (genetic sequences, molecular markers, genetic manipulation) and bioinformatics (analysis comparative of sequences).

j) Understanding of human nature and diversity, and the connections and interrelationships of our species in the evolutionary scheme of life on Earth.

k) Understanding of evolutionary biology not as a discipline of exclusively formal interest, but as fundamental knowledge with practical implications in multiple areas. The rapid advance of evolutionary biology has triggered the development of powerful technologies for health monitoring, law enforcement, agriculture, ecology, and the treatment of all kinds of design and optimization problems.

Skills

- To analyse and interpret the origin, evolution, diversity and behaviour of living beings.
- To understand the processes that determine the functioning of living beings in each of their levels of organization.
- To understand the biological characteristics of human nature.
- To develop independent learning strategies.
- To develop a critical thinking and reasoning. To communicate them effectively.
- To develop a historical vision of biology.
- Respect towards the diversity and plurality of ideas, people and situations.
- To be able to analyse and synthesize.
- Capacity for organization and planning.

Learning outcomes

1. Combine historical thinking with scientific thinking.

2. Develop autonomous learning strategies.

3. Develop a critical thinking and reasoning.

4. State in a clear way the difference between patterns and process in evolution.

5. Explain the conflicts that are generated between the different levels of biological organization.

6. Explain the importance of models in biology.

7. Explain the old dichotomy between nature and environment.

8. Explain what makes us different from the rest of the species and why.

9. Identify and enunciate the problems associated with the answer to the big question: how did life on our planet emerge and evolve?

10. Identify fallacies in non-evolutionist discourses.

11. Interpret phylogenetic reconstruction.

12. Justify the importance of phylogenetic relationships in data analysis.

13. Justify the relative importance of contingent and functional aspects in the history of life.

14. Justify why biology is an autonomous science.

15. Respect the diversity and plurality of ideas, people and situations.

16. Summarize the historical development of evolutionary theories.

17. Summarize evolutionary thinking and integrate the different levels of biological organization under a coherent perspective.

18. Be able to analyze and synthesize.

19. Have the capacity for organization and planning.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Analyse and interpret the origin, evolution, diversity and behaviour of living beings.
- Be able to analyse and synthesise
- Be able to organise and plan.
- Develop a historical vision of biology.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Understand the biological characteristics of human nature.
- Understand the processes that determine the functioning of living beings in each of their levels of organisation.

Learning Outcomes

1. Analyse a situation and identify its points for improvement.
2. Analyse the sex- or gender-based inequalities and the gender biases present in one's own area of knowledge.

3. Be able to analyse and synthesise.
4. Be able to organise and plan.
5. Clearly present the difference between evolutionary patterns and processes.
6. Combine historical thought with scientific thought.
7. Critically analyse the principles, values and procedures that govern the exercise of the profession.
8. Explain the conflicts generated between the different levels of biological organisation.
9. Explain the importance of models in biology.
10. Explain the importance of phylogenetic relations in data analysis.
11. Explain the old dichotomy between nature and environment.
12. Explain what makes us different to the other species and why.
13. Explain why biology is a separate science.
14. Identify and present the problems associated with the answer to the big question: how did life arise and evolve on our planet?
15. Identify the fallacies in non-evolutionary discourse.
16. Interpret phylogenetic reconstruction.
17. Justify the relative importance of the contingent and functional aspects in the history of life.
18. Propose new methods or well-founded alternative solutions.
19. Propose projects and actions that incorporate the gender perspective.
20. Propose viable projects and actions to boost social, economic and environmental benefits.
21. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
22. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
23. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
24. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
25. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
26. Summarise evolutionary thought and integrate the different levels of biological organisation into a coherent approach.
27. Summarise the historical development of theories of evolution.

Content

Theme 1: Introduction to the phenomenon of evolution. -Definitions and basic concepts: Evolution, lineage, philogeny, reproduction, phenotype, genotype, development, genotype-phenotype relationship, -The existence, magnitude and directionof evolution

Theme 2: Introduction to evolutionary processes.

Theme 3 : Natural selection -Terminology, what is selected. -Ecological bases. -Spacial variation and temporal variation. -Classical mathematical model. -Selection for biotic and abiotic factors. -Frequency-dependent selection -The cost of selection. -Sexual selection -Selection in social groups and cooperation -Selection levels in conflicts.

Theme 4: Drift -Definition of levels -Relation to population size and selection. -Classical mathematical models. -The molecular clock -The neutralist theory

Theme 5: Generators of genetic variation. -Genetic variation. -Mutation. -Recombination, "Standing genetic variation". -Types of genetic variation -Mutation and substitution rates. -Quantification of genetic variation. -Coalescence. -Mathematical models: mutation and selection.

Theme 6: Generators of variation at the molecular level. - RNA secondary models. -Evolution of proteins. -Evolution of ribosomes. -Evolution of cells.

Theme 7: Processes generating variation at the morphological levels. -Evolutionary explanations: selection and phenotypic variation -Pattern formation and morphogenesis -Gene networks -Relation between genetic variation and morphological variation. -Theories of embryonic development in morphological evolution. -Evolution of complexity.

Theme 8: Evolution of the processes that generate variation. -Variation in mutation rates. -Theories and concepts on the evolution of development. -Evolution of phenotypic complexity in «seascapes»

Theme 9: Structure of populations.

Theme 10: History of Evolutionary Biology. -History of pre-evolution. -The ideas before Charles Darwin. -Darwin and Wallace. -Re-discovery of Mendelism. -The modern synthesis. -Problems with the synthesis in the 80s. -Evo-devo and other new directions.

Theme 11: Origin of life -Definitions of life and evolutionary systems -RNA-first hypotheses -Metabolism-first hypotheses -Membrane-first hypotheses -Experimental approximations

Theme 12: Cultural evolution. -The other evolutionary revolution of the 19th century -The phenomenon -Models based on the classical approximation -Newer approaches

Theme 13: Speciation.

Theme 14 Speciation through chromosomal variation.

Theme 15 Phylogenetic reconstruction

Themec 16: History of life I. Geologic history I.

Theme 17: History of life II. Evolution of prokaryotes
Theme 18: History of life III. The fossil record.

-Introduction to taphonomy.

-Diversity patterns over time.

-Punctuated equilibrium vs gradualism.

-Trends or they lack.
Theme 19: Radiations.
Theme 20: Extinctions and diversifications.
Theme 21: Human evolution.

Theme 22: Evolution taxes.

Theme 23: Recurrent errors in the study of evolution compensation. "
* Restrictions imposed may be imposed by the sanitary authorities.

Methodology

The contents of the subject will allow students to receive a general introduction to the basic concepts of evolutionary theory.

Theory classes: The student acquires the scientific knowledge of the subject by attending theory classes that will complement the personal study of the topics discussed.

Master seminars: The theory classes will be complemented by seminars taught by several specialists in various disciplines.

seminars: where the students and professor will discuss classical articles in evolutionary biology.

Optional work on the simulation of evolution.

Teaching Practices: Essential module to understand and put into practice the knowledge acquired in theory classes. Various concepts and methods studied are reviewed.

Optional work on the simulation of evolution

Tutorials: They aim to provide guidance and personalized help to the student by clarifying doubts about the subjects, the direction and orientation of the proposed seminars, and the comment and discussion of the results of the evaluations.

"*The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities."

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lab Practicum	20	0.8	9, 16, 10, 3
Theory lectures	45	1.8	6, 5, 8, 9, 11, 12, 14, 15, 16, 10, 17, 13, 27, 26, 3
Type: Supervised			
Tutorials	5	0.2	3
Type: Autonomous			
Reading and discussion of articles	30	1.2	6, 5, 8, 9, 11, 12, 14, 15, 16, 10, 17, 13, 27, 26, 3
Literature search	26	1.04	3
Studying	90	3.6	3

Assessment

First partial exam, 50% of themes, 35% of the final grade.

Second partial exam, 50% of themes, 35% of the final grade.

Practicum, 15% of the final degree. Small exercies will be done during the practium itself or slightly later.

Seminars, 15% of the degree. For each student, the seminars will be graded based on his/her answers to the questions that will be posed to them during the seminars about the topics of the seminars.

The students that chose to would work on a simulation project that can add up to 1,5 points to the final grade.

To pass the subject a student should obtain a 5 or more in each partial exam. Each student that fails in a partial examen can participate in a second chance exam for such partial (even for both if the student fails in both).

To take part in the final exam the student needs to have been taken place in the two partial exams (on in 2/3 of the gradeable activities).

"*Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities."

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial exam 1	35% de la nota global	3	0.12	6, 5, 8, 9, 14, 15, 17, 13, 27, 26, 3
Partial examen 2	35%	3	0.12	6, 5, 8, 9, 11, 12, 14, 15, 16, 10, 17, 13, 27, 26
Participación en los seminarios	15% de la nota global	1	0.04	2, 19, 20, 25, 24, 23, 21, 22, 26, 3, 4
Prueba práctica	15% de la nota global	2	0.08	7, 1, 16, 10, 18, 3

Bibliography

General

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Futuyma, D. J., and M. Kirkpatrick. Evolution, 4th ed. 2017. Sinauer Associates, Sunderland, Massachusetts.

Ridley, M. 2004. Evolution, 2nd ed. Oxford University Press.

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-Evolutionary Developmental Biology: A Reference Guide. Editors: Nuno de la Rosa, Laura, Müller, Gerd (Eds.) 2021. Springer.

-Arthur, W. Understanding Evo-devo. Cambridge University Press. 2021.

Specific

Boy, R., Silk, J. B. 2001. Cómo evolucionaron los humanos. Ariel.

King, M. 1993. Species evolution. The role of chromosome change. Cambridge Univ. Press.

Raven, H., R. F. Evert, S. E. Eichhorn. 1999. Biología Vegetal. Ediciones Omega.

Stahl, D.A. Brock. Biologia de los microorganismos (12th edition). Pearson Education S.A. 2015.

Willis, K. J., McElwain, J. C. 2014. The Evolution of Plants (2nd edition). Oxford.

Software

-Arlequin http://cmpg.unibe.ch/software/arlequin35/

-Network https://www.fluxus-engineering.com/sharenet.htm

-Neighbor (Phylip) https://evolution.gs.washington.edu/phylip/doc/neighbor.html

-Populus: https://cbs.umn.edu/populus

-FigTree http://tree.bio.ed.ac.uk/software/figtree/

-Gblocks http://molevol.cmima.csic.es/castresana/Gblocks.html

-raxmlGUI https://antonellilab.github.io/raxmlGUI/

-SeaView http://doua.prabi.fr/software/seaview

-TNT http://www.lillo.org.ar/phylogeny/tnt/