COURSE DATA

Data Subject	
Code	33053
Name	The tree of life
Cycle	Grade
ECTS Credits	6.0
Academic year	2017 - 2018

Study (s)

Degree	Center	Acad. year	Period
1100 - Degree in Biology	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
1100 - Degree in Biology	5 - Biology	Basic Training
1100 - Degree in Biology	13 - Biology	Basic Training

Coordination

Name	Department
ATIENZA TAMARIT, M.VIOLETA	25 - Plant Biology
BOTELLA SEVILLA, HÉCTOR	200 - Geology
PASCUAL CALAFORRA, LUIS FCO.	194 - Genetics

SUMMARY

"The tree of life" (AV) is a basic course belonging to the matter of Biology included in the "Degree in Biology" of the University of Valencia. This course is taught during the first semester of the first year, at the very beginning of the students' formative process, and provides a phylogenetic perspective of Biology.
The main objective is to familiarize students with the most basic concepts of the theory of evolution and phylogenetics, as well as with the implications of the evolutionary process in the classification of living beings. These basic concepts should enable them to understand biological phenomena as a result of the evolutionary process that determines the phylogenetic relationships among organisms. The student should be able, therefore, to recognize the role of descent from common ancestors and the evolution of change in establishing patterns of similarity and difference between groups of organisms, to know the hierarchical structure of Systematics and the different classification systems, as well as the methodologies and basic tools for the classification of living things. The fundamental rules governing the designation of different groups of organisms and their relationships are also studied. Finally, the student should be familiar with

the timeline of life on earth, and the major events in the history of life.
The course combines both theoretical and practical aspects. This is reflected in the time devoted to active discussion on controversial aspects of evolution, as well as to solve different types of problems.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

1100 - Degree in Biology

- Situar la Biología en el contexto de la ciencia a través del conocimiento de algunos de sus grandes temas y problemáticas en el mundo actual.
- Manejo de material para la experimentación en el laboratorio y en el campo.
- Conocer las normas de seguridad e higiene en el laboratorio.
- Manejo de recursos informáticos de utilidad en Biología.
- Capacidad de análisis, síntesis, trabajo metódico y riguroso.
- Capacidad de análisis crítico de textos científicos.
- Develop the capacity for organisation and planning.
- Capacidad de presentación escrita y oral de datos científicos.
- Habilidad para el trabajo en equipo.
- Conocimiento y respeto de la diversidad cultural humana.
- Capacidad de valoración de los riesgos medioambientales y de las crisis de biodiversidad.
- Compromiso con la conservación y con el desarrollo sostenible.
- Compromiso con la defensa y práctica de las políticas de igualdad.
- Compromiso ético en el manejo de animales para experimentación.
- Compromiso ético en el ejercicio de la profesión de biólogo/a.
- Identificar relaciones entre la ciencia y la sociedad.
- Analizar los valores culturales implícitos en los saberes y prácticas de la ciencia.
- Asimilar la dimensión histórica del conocimiento.
- Asimilar el proceso de construcción del conocimiento científico.

- Capacidad para divulgar la ciencia.

LEARNING OUTCOMES

- Understanding the theory of evolution, its principles and its scope and its impact on the development of Biology.
- Understanding the time dimension of the origin and evolution of life and its implications.
- Understanding the different types of classification systems.
- Understanding the historical nature of the evolutionary process in its aspects of uniqueness, contingency and / or need.
- Understanding the major taxonomic groups and their position in the universal phylogenetic reconstruction.
- Learning about the history and chronology of the life to locate major evolutionary events in the geologic time scale.
- Discriminating between scientific and pseudoscientific explanations in development.
- Interpreting social and cultural influences in the development of the theory of evolution.
- Applying statistical methods in evaluating scientific hypotheses.
- Discriminating between homologies and homoplasies
- Recognizing the taxonomic categories and use the rules of biological nomenclature.
- Understanding the rules to establish groups of organisms.
- Recognizing adaptations of organisms to the environment as a result of natural selection.
- A basic knowledge of the common origin of all living beings.
- Differentiating between natural selection and evolution.
- Relating environmental diversity, organizational diversity and the evolutionary process.
- Identifying the evolutionary relationships among major groups of organisms.
- Constructing and interpreting phylogenetic trees.
- The application of the scientific method and the comparative method to establish theories and to interpret data and experimental and observational evidences.

DESCRIPTION OF CONTENTS

1. THE DISCOVERY AND THE CONCEPT OF EVOLUTION

What do we mean by evolution? Evolutionary theories before Darwin. The theory of evolution by natural selection: Darwin and Wallace. The evolutionary hypothesis: questions and answers. Common origin and descent with modification. The new synthesis. The current evolutionary theory.

2. NATURAL SELECTION: ADAPTATION AND DIVERSIFICATION

Natural selection in action. The postulates of Darwin. Natural selection as explanations to evolution and adaptation. The nature of natural selection. Types of selection.

3. EVIDENCE OF EVOLUTION

Geological evidence: the fossil record. Biogeographic evidence. The concept of homology in biology. Homologies as evidence for evolution. Structural evidence and vestigial organs. Biochemical and genetic evidence. Ontogeny. Homoplasy, convergent evolution. Direct observations of evolution.

4. PHYLOGENETIC RECONSTRUCTION

Homology as a guide to recognize the phylogenetic relationships. Types of characters and character states. The phylogenetic approach to biology. What is a phylogenetic tree? Inference and interpretation of phylogenetic trees. Basic methods of phylogenetic reconstruction. Molecular phylogenies. Challenges and applications of phylogenetic reconstruction.

5. CLASSIFICATION IN BIOLOGY

Requirement, logics and objectives. Related concepts: classification, systematics and taxonomy. Hierarchy in biological classification. Taxonomic categories: their use and application. The species as a basic unit. The use of intermediate categories. Artificial and natural classifications. Phenetic, cladistic and evolutionary systematic schools: their principles and methodologies.

6. BIOLOGICAL NOMENCLATURE

Nomenclature codes. Purpose and principles of nomenclature. Forming scientific names. Names of hybrids. Operating principles of nomenclature: Priority, Synonymy, Homonymy, The types in Systematic Biology. Particularities of specific groups. The case of domestic animals and cultivated plants.

7. THE TREE OF LIFE: MAJOR GROUPS

Life domains: Archaea, Bacteria and Eukaryotes. The last universal common ancestor of all cellular organisms. An overview of the major kingdoms and phyla.

8. LIFE HISTORY

Timeline of life on earth, the geological scale. Reconstructing and dating of the tree of life: molecules and fossils. Origin and phylogenetic relationships among major groups of organisms. Key events in the history of life. Major historical changes in diversity: evolutionary explosions, mass extinctions and adaptive radiations.

9. PRACTICAL SESSIONS 1

1. Evolution and biodiversity: the problem of biological classification, the use of simple characters: constructing binary matrices. 2 hours (lab).
2. The use of complex characters. Extraction of complex traits useful for classification. Development of characters x individual matrices. 2 hours (lab).
3. Phenetic methods I. Algorithms for measuring similarities and distances among individuals. Quantitative data processing. Clustering algorithms. Construction of dendrograms of taxonomic hierarchy. Delimitation of groups. 3 hours (classroom).
4. Phenetic methods II. Software application to real data matrices of different groups of organisms. Consensus trees and evaluation of results. 3 hours (computer room)
5. Cladistic methods I. Application of parsimony in phylogenetic hypothesis testing. Selection and polarization of characters. The use of fossil organisms in the cladistic analysis and phylogenetic reconstruction. 3 hours (classroom).
6. Cladistic methods II. Application of software for phylogenetic reconstruction by parsimony. 3 hours (computer room).

10. PRACTICAL SESSIONS 2

7. Molecular phylogenetics I. Molecular markers and their treatment as characters. Transformation of molecular characters into distances. 2 hours (classroom)
8. Computing resources for evolution, phylogenetics and systematics. Databases and information sources on the Internet. The 'The Tree of Life project. 1 hour (computer room).
9. Molecular phylogenetics II. Phylogenetic reconstruction from molecular data. Use of software for phylogenetic analysis of sequences. Simple methods of contrasting phylogenetic reconstructions. 3 hours (computer room)
10. Comparison of phylogenetic reconstructions. Comparison of methods. Congruence between data types. 2 hours (classroom)
11. Biological nomenclature. A series of exercises to apply the principles of biological nomenclature. 2 hours (classroom)
12. The tree of life: evolution and biodiversity. Guided tour through the history of life using this scientific and educational resources of the Museum of Natural Sciences in Valencia. 2 hours (external activity).

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	29,00	100
Classroom practices	12,00	100
Computer classroom practice	10,00	100
Laboratory practices	6,00	100
Tutorials	3,00	100
Attendance at events and external activities	3,00	0
Development of group work	20,00	0
Development of individual work	1,00	0
Study and independent work	10,00	0
Readings supplementary material	1,00	0
Preparation of evaluation activities	40,00	0
Preparing lectures	8,00	0
Preparation of practical classes and problem	5,00	0
Resolution of case studies	1,00	0
Resolution of online questionnaires	1,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course is based on the use of different learning methods including:

• Lectures. The teacher will present the fundamental concepts of each topic, using appropriate audiovisual resources, that will be accessible to students through the platform to support the teaching of the university (virtual classroom). During these sessions, students will focus on appropriate literature and resources to study and understand the key concepts. These concepts will be reinforced by attending conferences and seminars as part of the course.

• Practical classes. Practical sessions of 2/3 hours. The students will follow a guide which must be read before each practice. These practical sessions will be scheduled as lab sessions (2), problem resolution sessions (7) and computer sessions (5). During the practical sessions the professor will introduce the main objective of the practice and the basic methods to solve the proposed exercises. During the rest of the session the students will practice or solve exercises under the supervision of the professor. And at the end, the professor will propose additional exercises to reinforce the basic concepts treated. One of the practical sessions is a external visit to the Museum of Natural Sciences of Valencia, after which students will answer a questionnaire to determine if the student has achieved an adequate understanding of key concepts developed.

• Scientific communication. Students will prepare a scientific communication as a poster. This is a transversal activity for all courses of the 1st year of degree.

• Small group tutorial sessions. These tutorials will be used to discuss papers read by students, or current issues related to the subject, as part of the continuous evaluation of students. Students should prepare and pose questions during the course, which may be answered by other students or the professor it appropriate.

• Individual tutorials. These personal interviews will be used to solve specific questions or personal problems related to the course. E-mail maybe also used for this purpose.

EVALUATION

An ongoing assessment of the achievements of each student will be performed on the basis of the different activities described in the Methodology section, such as attendance, the completion and submission of all homework and the active participation and the degree of involvement in the learning process. The specific aspects to be evaluated are:

- **An objective test on the contents of the course**. It consists of an examination of both theoretical and practical issues (problems, laboratory and computer). The score of the theory concepts will represent 40% of the final score and the practical problems, 35%. This exam will focus on the understanding of basic concepts for the development of their knowledge and skills to achieve the main goals of the course. It is mandatory to pass the exam with a minimum score of 5 out of 10.
- **Evaluation of the interdisciplinary scientific communication**. The evaluation of this activity will test the ability of the student to obtain scientific information and to provide criteria for assessing its validity, the capacity to disseminate scientific knowledge, the ability for deal with a teamwork and the ability to present their results. This activity will represent a 10% of the final score.
- **Assessment of participation in classroom activities, group tutorials and other activities**. Among other things, this section will evaluate the ability to ask questions, propose answers and lead the group discussion, as part of the evaluation of the student. The score of this section will contribute to a 15% of the final score.

REFERENCES

Basic

- Barton N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D. B., y Patel, N.H. 2007. Evolution. CSHL Press.
- Fontdevila, A., y Moya, A. 2004. Evolución. Editorial Síntesis, Madrid.
- Freeman, S., y Herron, J.C. 2002. Análisis evolutivo. Prentice Hall, Madrid.
- Freeman, S., y Herron, J.C. 2007. Evolutionary analysis. 4th edition. Prentice Hall.
- Futuyma, D.J. 2009. Evolution. 2nd edition. Sinauer.

- Ridley, M. 2004. Evolution. 3rd edition. Blackwell.
- Stearns, S.C., y Hoekstra, R.F. 2005. Evolution: An introduction. 2nd edition. Oxford University Press, Oxford.
- Vargas., P. & Zardoya, R. 2012. El árbol de la vida: sistemática y evolución de los seres vivos.

Additional

- Avise J.C. (2000) Phylogeny: The history and formation of species. Harvard University Press, Cambridge, Massachusetts.
- Carrión, J.S. 2003. Evolución Vegetal. Diego Marín, Murcia.
- Cowen, R. 2005. History of Life. 4th Edition. Oxford, Blackwell Publishing.
- DeSalle, R., Giribet, G. & Wheeler W. (2001) Molecular Systematics and Evolution: Theory and Practice. Birkhauser.
- DeSalle, R., Giribet, G. & Wheeler W. (2002). Techniques in Molecular Systematics and Evolution. Springer Verlag
- Felsenstein J. (2004). Inferring phylogenies. Sinauer Associates, Sunderland, Massachusetts.
- Hall, B.G. 2000. Phylogenetics Trees Made Easy: A How-To Manual for Molecular Biologists. Sinauer Assoc. Inc.
- Majerus, M., Amos, W. y Hurst, G. 1996. Evolution. The four billion year war. Longman.
- Mayr, E. & P. D. Ashlock (1991). Principles of Systematic Zoology. 2nd Edition. McGraw-Hill, Inc., Singapore. 475pp.
- Nei, M. & S. Kumar. (2000). Molecular Evolution and Phylogenetics. Oxford University Press.
- Niklas, K.J. (1997). The Evolutionary Biology of Plants. Univ. Chicago Press
- Quicke, D. L. J. (1993). Principles and Techniques of Contemporary Taxonomy. Tertiary Level Biology. Blackie Acad. & Professional, Chapman & Hall,Glosgow. 311 pp.
- Stuessy, T. F. 1990. Plant Taxonomy. The Systematic Evaluation of Comparative Data. Columbia University Press, New York. 514 pp.
- Wheeler, Q. & Meier, R. (2000). Species Concepts and Phylogenetic Theory. Columbia University Press.
- Wiens, J.J. (2000). Phylogenic Analysis of Morphological Data. Smithsonian Institution Press.
- Wiley, E.O., Siegel-Causey, D., Brooks, D.R. and Funk, V.A. (1991). The complet cladist. A primer of phylogenetic procedures. The University of Kansas, Museum of Natural History, special publication, Lawrence.