Teaching Guide				
Identifying Data				2023/24
Subject (*)	Paleobiology		Code	610G02043
Study programme	Grao en Bioloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optional	6
Language	SpanishEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Física e Ciencias da Terra			
Coordinador	Bao Casal, Roberto	E-mail	roberto.bao@udc.es	
Lecturers	Bao Casal, Roberto Blanco Calvo, Luis Alejandro Gonzalez Fortes, Gloria Maria Grandal D`Anglade, Aurora Moncunill Solé, Blanca	E-mail	roberto.bao@udc.es alejandro.blancoc@udc.es g.gfortes@udc.es aurora.grandal@udc.es blanca.moncunill@udc.es	
Web	campusvirtual.udc.es/moodle/			
General description	Paleobiology studies biological processes occurring at geological time scales. After introducing the main features of the fossil record, other aspects, such as the analysis of organic form, the role of the fossil record on the development of modern Evolutionary Theory, or the analysis of paleoecological and paleobiogeographical processes from an evolutionary perspective, are considered. An specific section is reserved for an overview of the evolution of biodiversity over geologic time, establishing the different relationships that allow us to understand our planet as a system. The subject has a strong conceptual focus, leaving more descriptive issues (Systematic Paleontology) for the workshops and laboratory sessions.			

Study programme competences	
Code	Study programme competences
A1	Recoñecer distintos niveis de organización nos sistemas vivos.
A2	Identificar organismos.
A3	Recoñecer, obter, analizar e interpretar evidencias paleontológicas.
A4	Obter, manexar, conservar e observar especímenes.
A29	Impartir coñecementos de Bioloxía.
B1	Aprender a aprender.
B2	Resolver problemas de forma efectiva.

Learning outcomes			
Learning outcomes	Study programme competences		
To understand the concept of deep (geologic) time	A3 A29	B1	
To understand the processes of fossilization and the biases of the fossil record as an indicator of ancient biospheres	A2	B1	
To understand how biological processes occurring at geological time scales, such as evolution or mass extinctions, cannot always be understood as simple extrapolations of processes taking place at shorter time scales	A2	B1 B2	
To expand our understanding of Evolutionary Theory from a multidisciplinary perspective	A3	B1 B2	
To know the fossil groups that make up the fossil record and their practical uses	A1 A2 A3 A4	B1 B2	

To identify the main bioevents in the history of the Earth, their causes and aftermath	A2 A3	B1 B2	
To synthesize knowledge from a long array of subjects such as Geology, Ecology, Microbiology, Biochemistry, Botany or Zoology in the framework of an ever changing Earth	A2 A3 A29	B1 B2	

Contents	
Topic	**Sub-topic**
SECTION-1.	HISTORY AND CONCEPT OF PALEOBIOLOGY
Lesson 1. An introduction to Paleobiology	1.1 Introduction 1.2 Theoretical and methodological aspects 1.3 Divisions of Paleobiology
SECTION-2.	TAPHONOMY
Lesson 2. The concept of fossil. Taphonomy	2.1 Introduction 2.2 The concept and types of fossils 2.3 Biostratinomy 2.4 Diagenesis of fossils 2.5 Ichnofossils 2.6 Time-averaging 2.7 Fossil-lagerstätten 2.8 The quality of the fossil record
SECTION-3.	MORPHOLOGICAL ANALYSIS
Lesson 3. Size and Shape in Fossils	9.1 Introduction 9.2 The analysis of morphometrical variability 9.3 Types of growth 9.4 Population variability 9.5 Ecophenotypic variability 9.6 Sexual dimorphism 9.7 Taphonomical variability
Lesson 4. Ontogeny and Heterochrony	10.1 Introduction 10.2 Biogenetic and von Baer's Law 10.3 Heterochrony and its types 10.4 Heterochrony and allometry 10.5 Heterochronoclines 10.6 Dissociated heterochrony 10.7 Evolutionary consequences of heterochrony
Lesson 5. Morphodynamics and the Evolution of Form	11.1 Introduction 11.2 Constructional morphology. Phylogenetic factor. Functional factor. Fabricational factor. Other factors 11.3 Research methods in morphodynamics. Biomechanical analysis. Theoretical morphology
SECTION-4.	EVOLUTIONARY PALEONTOLOGY
Lesson 6. Classification and Phylogeny	12.1 Introduction 12.2 Methods of classification. Essentialism, evolutionary, phenetic, and cladistic classification 12.3 Fossils and Phylogeny. Stratocladistics. Phylogenetic trees
Lesson 7. Speciation	13.1 Introduction 13.2 Species concepts 13.3 Modes of speciation 13.4 The problem of species concept in Paleontology

Lesson 8. Modes of evolution	14.1 Introduction 14.2 Darwinism and the Synthetic Theory of Evolution 14.3 Modes of evolution and the fossil record. Phyletic gradualism and punctuated equilibria 14.5 Evolutionary trends 14.6 Species selection 14.7 Coordinated stasis
Lesson 9. Paleobiogeography	16.1 Introduction 16.2 Dispersal biogeography 16.3 Paleogeography and paleoclimatology 16.4 Vicariance biogeography 16.5 Biogeographic patterns and extinctions
Lesson 10. Evolutionary Paleoecology	17.1 Introduction 17.2 Phanerozoic trends in global diversity. Explanatory hypotheses 17.3 Law of constant extinction. Red Queen Hypothesis and alternative explanatory hypotheses 17.4 Clade interactions
SECTION-5.	BIOSTRATIGRAPHY
Lesson 11. Time and Geology	4.1 Dating methods 4.2 The geologic time scale
SECTION-6.	HISTORY OF LIFE
Lesson 12. The origin and early evolution of Earth and Life	5.1 Origins of the Solar System and Earth. 5.2 Origin and evolution of the Atmosphere. 5.3 Origin of the Hidrosphere. 5.4 Origin and evolution of the continents. 5.5 The first life forms.
Lesson 13. The diversification of Life	6.1 The Ediacaran Fauna and other life forms. 6.2 The Cambrian Explosion. 6.3 Evolution of life forms during the Paleozoic. 6.4 Terrestrialization.
Lesson 14. Mass extinction events	7.1 Mass extinctions. Causes and their aftermath. 7.2 The end-Permian extinction. 7.3 The end-Cretaceous extinction.
Lesson 15. Climate and Life	8.1 Climatic evolution of the planet Earth. 8.2 Global glaciations. Methods of study. 8.3 The Snowball Earth hypothesis. 8.4 The influence of climatic change on the Quaternary faunas and floras.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A3 A29 B1 B2	21	63	84
Laboratory practice	A1 A2 A3 A4 A29 B1 B2	14	21	35
Workshop	A1 A2 A3 A4 A29 B1 B2	7	10.5	17.5
Mixed objective/subjective test	A1 A2 A3 A4 A29 B1 B2	4.5	7	11.5
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Guest lecture / keynote speech	Lectures will be devoted to topics related to principles and problems in Paleontology, as well as to the history of life on Earth. Students are expected to prepare their own handouts, as well as complete reading assignments from specific topics.
Laboratory practice	Laboratory sessions will be devoted to the recognition of the basic morphological features of the main fossil groups, as well as to the identification of important taxa from the Iberian Peninsula. Students will be required to take their own notes and answer the lab quizzes. Unjustified changes in scheduled lab groups will not be allowed. Attendance to the lab sessions, as well as the delivery of quizzes to the lecturers, are mandatory to pass the subject.
Workshop	The workshops ("clases de grupo reducido") are intended to introduce the basic concepts of taphonomy and systematics to the students by means of the direct observation of fossils. The students will prepare their own handouts and solve specific quizzes. Unjustified changes in scheduled workshop groups will not be allowed. Attendance to the workshops ("clases de grupo reducido"), as well as the delivery of quizzes to the lecturers, are mandatory to pass the subject
Mixed objective/subjective test	Grading is primarily based on the idea of continuous assessment and so, the final exam IS NOT REQUIRED for those students being successful during this continuous assessment. Students failing specific parts or the whole subject are required to make the final exam for the parts they failed (see the ?Assessment? section).

Personalized attention	
Methodologies	**Description**
Workshop Mixed objective/subjective test Laboratory practice Guest lecture / keynote speech	Tutoring is expected, especially for those aspects showing greater difficulty, such as quizzes solving, tests, or workshop/laboratory observations. Part-time students not capable of attending to the workshops and/or lab sessions (i. e., those having an official academic waiver) are eligible to get an exemption of these mandatory tasks in the scheduled programme. They will be required to perform adapted specific tasks to pass the subject

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Workshop	A1 A2 A3 A4 A29 B1 B2	Continuous assessment using quizzes involving multiple choice, matching, true-false questions, fill in the blank questions or short answer and essay questions. These quizzes make up 7% of the final grade	7
Mixed objective/subjective test	A1 A2 A3 A4 A29 B1 B2	As stated in Step 5, grading is primarily based on the idea of continuous assessment and so, the FINAL EXAM IS NOT REQUIRED for those students being successful during this continuous assessment. For the rest of students, a final exam will be carried out for the specific parts of the subject (i. e., lectures=65%, workshops + laboratory sessions= 35%) that they failed.	0
Laboratory practice	A1 A2 A3 A4 A29 B1 B2	Continuous assessment using quizzes involving multiple choice, matching, true-false questions, fill in the blank questions, short answer, essay questions and/or fossil identifications with real specimens. Quizzes make up 28% of the final grade	28
Guest lecture / keynote speech	A3 A29 B1 B2	Continuous assessment will take place using in-class quizzes and participation during classes. All quizzes can involve multiple choice, matching, true-false questions, fill in the blank questions or short answer and essay questions. Quizzes make up 65% of the final grade	65
Others			

Assessment comments

The continuous assessment consists of: 1) Tests on the contents of lectures, making up 65% of the final grade2) Tests on laboratory sessions + workshops, making up 35% of the final grade (tests on Systematic Paleontology, 20% + test on fossil identification ?de visu?, 15%). Non-attendance to lab sessions or workshops will be penalized as follows: 1 unjustified missing lab/workshop = 1 out of 10 in the Systematic Paleontology test2 unjustified missing lab/workshops = 2.5 out of 10 in the Systematic Paleontology test3 or more unjustified missing lab/workshops carries failing the entire subject (this includes the grading opportunities of January and July)3) Besides the tests, all students are required to know the chronostratigraphic chart with 0% value in the final grade. This is therefore considered a key question to pass the subject. Students are required to obtain a final grade (lectures, and workshops + lab sessions = 100%) of at least 5.0 out of 10 to pass this subject. However, all the activities making up the continuous assessment (lectures, and workshops + lab sessions) can be compensated among them getting a grade of at least 4.0.The two Final Exams (grading opportunities of January and July) are only required for those students who have not passed the aforementioned continuous assessment. Students passing any of the parts of the continuous assessment (lectures, and workshops + lab sessions) are given the opportunity to keep their marks for the two Final Exams (grading opportunities of January and July), being only examined of those parts which they failed. However, all the teaching-learning process of this subject is based on the idea of being developed in the current term. This means that for successive terms the student will be required to fullfill all the assignments scheduled for those specific terms.Under exceptional justified reasons, such as part-time learning, or students with special educational needs, specifically adapted assessments could be undertaken.The grade ?no show? will be given only to those students who have not participated in more than 20% of the assessed activities during the term.All the aforementioned instructions also apply to part-time students.Students from former terms, if attending the December?s advance call, will be examined under the rules of the 2022/2023 academic year (please check the corresponding syllabus).If academic fraud is detected in any of the activities included in the continuous assessment program, the student/s involved will be subject to the current UDC regulations on this topic.

Sources of information	
Basic	- BENTON, M. J. & HARPER, D. A. T. (2020). Introduction to Paleobiology and the Fossil Record. Wiiey-Blackwell - FOOTE, M. & MILLER, A.I. (2007). Principles of Paleontology. W. H. Freeman, New York - PROTHERO, D. R. (2013). Bringing Fossils to Life. An Introduction to Paleobiology. Columbia University Press, New York - BENTON, M.J. (2020). Cowen?s History of Life. Wiley - PROTHERO, D. R. (2020). The Evolving Earth. Oxford University Press - BRIGGS, D. E. G. & CROWTHER, P. R. (2003). Palaeobiology II. Blackwell Science - DOMÈNECH, R. & MARTINELL, J (1996). Introducción a los Fósiles. Masson - MILSOM, C. & RIGBY, S. (2010). Fossils at a Glance. Wiley-Blackwell - MARTÍNEZ-CHACÓN, M. & RIVAS, P. eds. (2009). Paleontología de Invertebrados. Sociedad Española de Paleontología - CLARKSON, E. N. K. (2001). Invertebrate Palaeontology and Evolution. Blackwell Science, Oxford <u>RECURSOS WEB</u>http://www.palaeos.comhttp://www.ucmp.berkeley.edu/exhibit/geology.htmlhttp://tolweb.org/tree/phylogeny.htmlRECURSOS WEBhttp://www.palaeos.comhttp://www.ucmp.berkeley.edu/exhibit/geology.htmlhttp://tolweb.org/tree/phylogeny.html
Complementary	- (). Digital Atlas of Ancient Life. https://www.digitalatlasofancientlife.org - (). Museo Virtual de Paleontología de la Universidad de Huelva . https://www.uhu.es/museovirtualpaleontologia/index.html - (). Paleo3D: La Colección de Prácticas Virtual del Área de Paleontología de la Universitat de València. http://paleo3d.uv.es - (). Paleobiology Database (PDBD). https://paleobiodb.org

Recommendations

Subjects that it is recommended to have taken before
Geology/610G02004 Physical Geography/610G02006 Genetics/610G02019 Population Genetics and Evolution/610G02021 Plant Systematics: Cryptogamia/610G02024 Plant Systematics: Phanerogamia/610G02025 Zoology I/610G02031 Zoology II/610G02032 Ecology I: Individuals and Ecosystems/610G02039 Ecology II: Populations and Communities/610G02040
Subjects that are recommended to be taken simultaneously
Animal Biodiversity and the Environment/610G02033
Subjects that continue the syllabus
Developmental Biology/610G02010 Functional Adaptations of Animals in the Environment/610G02037
Other comments
Students having specific inquiries or wanting to discuss class materials are always welcome during the lecturer's office hours. It is highly recommended that they communicate any kind of problem affecting their class performance, ability to take tests or class attendances, especially in the case of foreign students.This subject follows the Green Campus Faculty of Sciences program on sustainability (https://ciencias.udc.es/images/Facultade/Green_Campus/Declaraci%C3%B3n_Ambiental_FCiencias.pdf)

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.