



Teaching Guide

Teaching Guide				
Identifying Data				2020/21
Subject (*)	Population Genetics and Evolution		Code	610G02021
Study programme	Grao en Bioloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Third	Obligatory	6
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Bioloxía			
Coordinador	Naveira Fachal, Horacio	E-mail	horacio.naveira.fachal@udc.es	
Lecturers	Martinez Lage, Andres Naveira Fachal, Horacio Vila Sanjurjo, Antón Vila Taboada, Marta	E-mail	andres.martinez@udc.es horacio.naveira.fachal@udc.es anton.vila@udc.es marta.vila.taboada@udc.es	
Web				
General description	Introductory course to population genetics and evolution, dealing with the forces that act on gene frequencies in populations, the interactions between genotypes and environment that shape phenotypes, and the patterns of evolution of populations and species.			



Contingency plan	1. Modifications to the contents
	No modification.
	2. Methodologies
	- Teaching of the theory topics and exercises will make use of videoconferencing, using TEAMS, at the same dates and times scheduled in the official timetable for the classes in person. The two groups (English and Spanish language) will stay separate. Teacher in charge: Dr. Horacio Naveira.
	- Practical exercises of bioinformatics will be carried out using both synchronous and asynchronous assignments. The different groups will stay separate, and receive instructions to work at the same dates and times scheduled in the official timetable for the classes in person. Indications on how to proceed in each case will be supplied by the teacher in charge, Dr. Antonio Vila-Sanjurjo.
	- Seminars will be carried out exclusively by asynchronous assignments (in principle, students should not expect to be invited to join any kind of activity at the precise times indicated in the official timetable for seminars in person). Students will no longer be separated into different groups. Teacher in charge: Dr. Marta Vila-Taboada.
	3. Mechanisms for personalized attention to students
	Although meetings, per force, can not take place in person, and will be carried out by TEAMS, it is advisable to refer to office hours for the benefit of work organization. Previous appointments by email will be enforced.
	4. Modifications in the evaluation
	The assessment of the subject will remain the same (no changes, neither in the contribution from the different concepts, nor in their description).
	5. Modifications to the bibliography or webgraphy
	No modification

Study programme competences	
Code	Study programme competences
A7	Reconstruír as relacións filoxenéticas entre unidades operacionais e pór a proba hipóteses evolutivas.
A12	Manipular material xenético, realizar análises xenéticas e levar a cabo asesoramento xenético.
A18	Levar a cabo estudos de produción e mellora animal e vexetal.
A21	Deseñar modelos de procesos biolóxicos.
A24	Xestionar, conservar e restaurar poboacións e ecosistemas.
A27	Dirixir, redactar e executar proxectos en Bioloxía.
B1	Aprender a aprender.
B2	Resolver problemas de forma efectiva.
B3	Aplicar un pensamento crítico, lóxico e creativo.
B4	Traballar de forma autónoma con iniciativa.
B5	Traballar en colaboración.
B6	Organizar e planificar o traballo.
B7	Comunicarse de maneira efectiva nunha contorna de traballo.



Learning outcomes			
Learning outcomes	Study programme competences		
Capacity to interpret and to analyze the biological problems, as well as the human nature itself, from an evolutionary perspective	A7 A12 A18 A21	B1 B2 B3 B4 B5 B6 B7	
Choice of the techniques and methods more adequate to tackle the study of a specific evolutionary problem	A7 A12 A18 A24	B1 B2 B3 B4 B5 B6 B7	
Use of the genetic information to manage, to preserve and to restore populations.	A7 A12 A18 A21 A24 A27	B1 B2 B3 B4 B5 B6 B7	

Contents	
Topic	Sub-topic
1.- GENERAL INTRODUCTION.	Genetic variation and its quantification. Genotype and phenotype. Evolutionary units: domains, supradomains and multiprotein factories. Adaptations, exaptations and spandrels.
2.- QUANTITATIVE GENETICS.	Continuous, discontinuous and threshold characters. Breeding value and genotypic value of a genotype. Environmental value. Environmental sensitivity of a genotype. Components of phenotypic variance. Heritability. Estimation of the minimum number of loci underlying a quantitative trait (QTL). Mapping of QTLs.
3.- CONSEQUENCES OF REPRODUCTIVE SYSTEMS AND TYPES OF MATING ON THE ORGANIZATION OF GENETIC VARIATION.	Maintenance of genetic variation in populations with sexual reproduction and random mating: Hardy-Weinberg law (H-W); deviations from H-W expectations. Effects of asexual reproduction and non-random mating on genotype frequencies: parthenogenesis; self-fertilization; inbreeding and relatedness coefficients; regular systems of inbreeding; phenotypic assortative mating.
4.- RANDOM DRIFT OF GENE FREQUENCIES IN SMALL POPULATIONS.	Sampling of gametes and random walk of gene frequencies. Wright-Fisher model. Dispersion of gene frequencies among subpopulations. Rate of fixation within subpopulations and genomes. Effective population size. Founder effects and population bottlenecks. Wahlund's effect.
5.- MUTATION AND GENE FLOW.	Classes of mutations: nucleotide substitutions; insertions and deletions; duplications; chromosome rearrangements. Mutation rates. Change in gene frequency due to mutation. The fate of a single mutant. Models of mutation in molecular population genetics. Migration and gene flow. Change in gene frequency due to migration; the island model. Mutation and migration in finite populations.



6.- EFFECTS OF NATURAL SELECTION ON GENE FREQUENCIES AND PHENOTYPES.	Natural selection. Biological fitness. Types of selection. Haploid and diploid basic models of selection. Hard vs soft selection. Balanced polymorphisms kept by constant selection coefficients. Selection on quantitative traits. Correlated response to selection.
7.- GAMETIC DISEQUILIBRIUM AND RECOMBINATION.	Linkage groups. Quantifying linkage disequilibrium. Randomization effect of recombination. Factors that influence disequilibrium. Evolutionary advantages of recombination. Interactions between non-allelic genes in the determination of fitness. Genetic coadaptation. Horizontal transmission. Promiscuous proteins. Gene duplications. Recruitment. Modular evolution.
8.- EQUILIBRIUM BETWEEN SELECTION AND OTHER FORCES THAT CHANGE GENE FREQUENCIES.	Mutation-selection balance. The distribution of fitness effects of new mutations. Mutation load: Haldane-Muller principle. Hill-Robertson effect. Muller's ratchet. The degeneration of Y chromosomes. Segregation load. Equilibrium between selection and gene flow.
9.- MEASURING FITNESS IN CONTEMPORARY POPULATIONS.	Fitness components. Changes in gene frequencies over several generations. Changes in gene frequencies within the life cycle. Differences in the distribution of genetic variation before and after the action of selection. Chromosome extraction techniques. Frequent errors and spurious results in the estimation of fitness. Major difficulty faced by attempts to estimate fitness differences among genotypes in natural populations.
10.- VARIATION IN SELECTION COEFFICIENTS.	Evolutionary constraints. Environmental mosaicism. Spatial and/or temporal variation in fitness. Selection, gene flow and clines. Frequency-dependent selection. Antagonistic pleiotropy. Genetic conflicts. Sexual selection. Cooperation, altruism and kin-selection: inclusive fitness.
12.- MOLECULAR FOOTPRINTS OF NATURAL SELECTION AND STATISTICAL METHODS FOR TESTING THE NEUTRAL HYPOTHESIS.	Models of DNA evolution. Limits of nucleotide divergence. Estimates of the number of nucleotide substitutions. Substitution rates. Pseudogenes. Direct effects of selection on nucleotide polymorphism and divergence. The importance of recombination: selective sweep and background selection. Estimators of the population mutation parameter. Statistical tests.
13.- MOLECULAR PHYLOGENIES.	Cladograms and phylograms. Coalescence theory. Monophyletic, paraphyletic and polyphyletic taxa. Gene trees and species trees. Methods of molecular phylogenetics. The human evolutionary tree.
TEMA 13.- FILOXENIAS MOLECULARES.	Cladogramas e filogramas. Teoría da coalescencia. Relacións monofiléticas, parafileticas e polifiléticas. Árbores de xenes e árbores de especies. Métodos de filoxenética molecular. A árbore evolutiva da especie humana.
14.- ORIGINS OF SPECIES.	Concepts of species. Why are there so many species? Modes of speciation. Speciation and structure of fitness topographies. Evolution of genetic incompatibilities of hybrids. Rules of speciation. Punctuated equilibria: an alternative to phyletic gradualism
15.- MACROEVOLUTION	The history of biodiversity. Rates of species origination and extinction. Biogeography. The species concept in paleontology. Using phylogeny to reconstruct the deep past. Adaptive radiations. The origin of animal body plans: Ediacaran biota. Mass extinctions. Human-driven extinctions (the "Sixth Mass Extinction";).

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student's personal work hours	Total hours
Introductory activities	B1 B4 B5 B6	1	0	1
Guest lecture / keynote speech	A7 A12 A18 A24 B1 B3 B4 B6	15	45	60
Problem solving	B2	6	6	12



ICT practicals	A7 A21 B2 B4	15	15	30
Directed discussion	B1 B2 B3 B7	1	0	1
Collaborative learning	A27 B1 B3 B5 B7	7	35	42
Objective test	A7 A12 A18 A21 A24 B1 B2	3	0	3
Personalized attention		1	0	1

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	Description
Introductory activities	Profesor.- Presenta a guía docente da materia, aclara dúbidas, organiza os alumnos para as actividades. Alumno.- Toma notas, formula dúbidas e cuestións.
Guest lecture / keynote speech	Profesor.- Explica os fundamentos teóricos Alumno.- Observa, asimila e toma notas. Formula dúbidas e cuestións. Memoriza. Le os textos recomendados.
Problem solving	Profesor.- Formula problemas e orienta para a súa resolución. Alumno.- Traballa individualmente ou en grupo, busca información e resolve as cuestións formuladas
ICT practicals	Profesor. - Presenta os obxectivos, prepara o material e o equipo, expón os métodos, proporciona un guión, asiste aos alumnos. Alumno. - Experimenta, analiza e elabora unha memoria
Directed discussion	Discusión de textos asignados a principio do curso e resolución de exercicios relacionados.
Collaborative learning	(profesor) Asigna traballos. Instrúe sobre ferramentas. Orienta e resolve dúbidas. (alumno) Traballa cos seus compañeiros na realización das tarefas asignadas polo profesor.
Objective test	Profesor. - Formula preguntas e valora as respostas dos alumnos Alumno. - Consulta os seus materiais de apoio e responde ás preguntas

Personalized attention	
Methodologies	Description
Directed discussion Collaborative learning Guest lecture / keynote speech Problem solving ICT practicals	Every student will have 1 hour of obligatory tuition, with the objective of detecting possible dysfunctions of the teaching program and designing appropriate corrective actions.

Assessment			
Methodologies	Competencies	Description	Qualification
Directed discussion	B1 B2 B3 B7	O alumnado realizará unha proba mixta (test + problemas) sobre os contidos tratados nos catro seminarios anteriores.	15
ICT practicals	A7 A21 B2 B4	Realización de varios exercicios de xenética evolutiva cun ordenador persoal, empregando os programas informáticos utilizados nas prácticas. É imprescindible obter acumulativamente polo menos 15 puntos nesta proba, que se realizará ao final das sesións prácticas, para aprobar a materia. Nesta actividade avaliarase a adquisición das competencias A7, A21, A24 e A27.	25



Objective test	A7 A12 A18 A21 A24 B1 B2	Conxunto de preguntas de distinto tipo (alternativa múltiple, resposta breve, completar, asociación, etc) relacionadas con calquera dos contidos do temario. A proba desenvólvese en dúas fases. A primeira delas non é presencial, e consiste en unha serie de cuestionarios na plataforma Moodle, aos que se debe dar resposta en datas e horas prefixadas ao longo do curso. A contribución desta fase á proba é de un máximo de 25 puntos. A segunda fase é un exame presencial con preguntas test de alternativa múltiple, e correspóndese co exame oficial da materia. A contribución acumulada das dúas fases á nota final da materia é de un máximo de 60 puntos. É imprescindible obter polo menos 35 puntos nesta proba para aprobar a materia. Nesta actividade avalíase a adquisición das competencias A7, A12, A18, A21, A24 e A27.	60
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Assessment comments

Se considerarán PRESENTADOS en las actas de la asignatura todos los alumnos que se hayan presentado al examen práctico o a la segunda fase de la prueba objetiva (examen final de la asignatura).

La nota final en actas de los alumnos que no alcanzaran en las prácticas o en la prueba objetiva la nota mínima para aprobar la asignatura, pero cuya puntuación acumulativa fuese superior a 50, será un 4,9 (SUSPENSO).

En la segunda oportunidad se empleará la misma metodología de evaluación que en la primera.

En el caso de que algún estudiante, por razones debidamente justificadas, no pudiera realizar las pruebas de evaluación continua, el profesorado de la materia adoptará las medidas correctoras que considere oportunas a fin de garantizar la igualdad de oportunidades.

Sources of information

Basic	- Caballero, A. (2017). Genética Cuantitativa. Síntesis - Hedrick, P.W. (2011). Genetics of Populations.. Jones & Bartlett - Herron, J. D., and Freeman, S. (2014). Evolutionary Analysis. . Pearson - Zimmer, C. and Emlen, D. (2015). Evolution: Making sense of life. Roberts and Company Publishers - Cutter, A. D. (2019). A primer of molecular population genetics. OUP Oxford - DeSalle, R. (2013). Phylogenomics: A primer. Routledge - Hahn, M. W. (2018). Molecular Population Genetics. OUP USA - Shubin, N. (2015). Tu pez interior. Capitán Swing - Hartl, D. L. (2020). A primer of population genetics and genomics. OUP Oxford
Complementary	- Avise, J. C. (2006). Evolutionary Pathways in Nature. A Phylogenetic Approach. . Cambridge Univ. Press. - Barton, N. (2007). Evolution. Cold Spring Harbor Lab. Press. - Bromham, L. (2008). Reading the Story in DNA: A Beginners Guide to Molecular Evolution. . Oxford Univ. Press. - Coyne, J. A. (2009). Why Evolution is True. Viking - Ridley, M. (2004). Evolution. Blackwell - Sampedro, J. (2007). Deconstruyendo a Darwin: Los Enigmas de la Evolución a la Luz de la Nueva Genética.. Síntesis - Fontdevila, A., y Moya, A. (2003). Evolución. Origen, adaptación y divergencia de las especies.. Síntesis - Fontdevila, A., y Moya, A. (1999). Introducción a la genética de poblaciones. Síntesis

Recommendations

Subjects that it is recommended to have taken before

Statistics/610G02005

Genetics/610G02019

Molecular Genetics/610G02020

Subjects that are recommended to be taken simultaneously

Subjects that continue the syllabus



Other comments

(*)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.