COURSE GUIDE

Systems Ecology

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Grado (Bachelor's Degree)	Bachelor's Degree in Biology	Branch	Sciences
Module	Ecología	Subject	Ecología

Year of study	3º	Semester	2º	ECTS Credits	6	Course type	Compulsory course

PREREQUISITES AND RECOMMENDATIONS

- Physical environment, Biostatistics and Population and Community Ecology
- Statistics knowledge is recommended

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- System theory
- Physical support
- Flow of energy and matter
- Pyramids, chains, and trophic networks. Regulation
- Complexity and stability of food webs.
- Global biogeochemical cycles: C, O, N, P and S.

SKILLS

GENERAL SKILLS

- CG01 - Capacidad de organización y planificación
- CG02 - Trabajo en equipo
- CG04 - Capacidad de análisis y síntesis
- CG05 - Conocimiento de una lengua extranjera
- CG06 - Razonamiento critico
- CG08 - Aprendizaje autónomo para el desarrollo continuo profesional
- CG09 - Comunicación oral y escrita en la lengua materna
- CG12 - Sensibilidad por temas de índole social y medioambiental
- CG13 - Habilidades en las relaciones interpersonales

- CG17 - Capacidad de gestión de la información
- CG18 - Trabajo en equipo interdisciplinar
- CG19 - Compromiso ético
- CG22 - Reconocimiento a la diversidad y multiculturalidad

SUBJECT-SPECIFIC SKILLS

- CE01 - Reconocer distintos niveles de organización en el sistema vivo.
- CE05 - Identificar organismos
- CE07 - Catalogar, evaluar y gestionar recursos naturales
- CE09 - Identificar y utilizar bioindicadores
- CE18 - Obtener, manejar, conservar y observar especimenes
- CE25 - Diseñar modelos de procesos biológicos
- CE27 - Diagnosticar y solucionar problemas ambientales
- CE28 - Muestrear, caracterizar y manejar poblaciones y comunidades
- CE29 - Gestionar, conservar y restaurar poblaciones y ecosistemas
- CE30 - Desarrollar y aplicar técnicas de biocontrol
- CE32 - Evaluar el impacto ambiental
- CE33 - Obtener información, diseñar experimentos e interpretar los resultados
- CE35 - Dirigir, redactar y ejecutar proyectos en Biología
- CE43 - Saber los tipos y niveles de organización
- CE68 - Comprender las adaptaciones funcionales al medio
- CE69 - Conocer los ciclos biológicos
- CE70 - Conocer el medio físico: hídrico, atmosférico y terrestre
- CE71 - Conocer la estructura y dinámica de poblaciones
- CE72 - Conocer las Interacciones entre especies
- CE73 - Entender la estructura y dinámica de comunidades
- CE74 - Conocer los flujos de energía y ciclos biogeoquímicos en los ecosistemas

LEARNING OUTCOMES

The student will know/understand:

- The principles and use of the scientific method, understanding its capabilities and limitations.
- The methods and techniques commonly used in the discipline.
- The structure and functioning of ecosystems and the Biosphere.
- The idea of globality and interconnectedness among the components of ecological systems.
- Realistic perception of human action on the environment and the need for environmental protection and conservation

The student will be able:

- To develop a critical spirit, sustained equally by a thirst for knowledge and curiosity on the one hand, and skepticism in the face of answers on the other. This will allow him/her to evaluate the hypotheses, generate alternative explanations, and suggest procedures to test them.
- To develop an inquiring mind that allows him/her to evaluate and take sides for different explanations, theories and hypotheses for a given ecological phenomenon.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

- **Unit 1. Systems theory.** General Theory of Systems. Definitions. Characteristics: structure and function. The ecosystem as a system. Relationships among the elements of a system. Simple vs. complex relationships. Tools: stable isotopes, satellites. Compartment models. Renewal rate and residence time. Ecosystem services. Biomes and biogeographic regions.
- **Unit 2. The physical environment: atmosphere, hydrosphere.** The atmosphere. Earth's energy balance.
  Planetary temperature. Atmospheric circulation on a global scale. Climate. Ocean circulation. Global water cycle. Water balance in an ecosystem.
- **Unit 3. Primary production.** Gross and net primary production. Methods of measuring primary production: local and global scales. Relationship between production and biomass. Factors limiting primary production in terrestrial and aquatic ecosystems. Explanatory hypotheses. Latitudinal patterns in primary production.
- **Unit 4. Secondary production.** Concept of secondary production and approaches. Functional feeding forms: phagotrophs and saprotrophs. Methods for measuring Secondary production. Metabolic costs. Limiting factors.
- **Unit 5. Dead organic matter and decomposition.** The deposit of dead organic matter or detritus. Forms of dead organic matter in terrestrial and aquatic ecosystems. Measurements of decomposition rates. Decomposition: immobilization vs. mineralization. Factors controlling decomposition. Accumulation of detritus in different ecosystems.
- **Unit 6. Flow of matter and energy: trophic networks.** Energy transfer efficiencies: consumption, assimilation and production efficiencies. Biomass and energy pyramids. Trophic and food webs: grazing chains and detritus chains. Energy flow in the food web: differences between ecosystems. Regulation of trophic levels (bottom-up vs. top-down).
- **Unit 7. Ecological succession and stability.** Explanatory models of succession. Description of regularities. Succession, regression and exploitation. Succession, diversity and stability. Models of succession.
- **Unit 8. Biogeochemical cycles (C, O).** Redox potential. Coupling between biogeochemical cycles. Transformation of C and O in the atmospheric, aquatic and terrestrial compartments. Time scales. Sources and sinks. Global carbon cycle balances. Anthropic alterations.
- **Unit 9. Biogeochemical cycles (N, P, S).** Global cycle of nitrogen, phosphorus and sulfur. Main metabolic transformations. Sources and sinks. Particularities of the cycles in terrestrial and aquatic compartments. Climate regulation. Anthropic alterations.
- **Unit 10. Human-biosphere relationships.** Human demography. Ecological footprint. Biocapacity. Ecological deficit and surplus. Anthropocene. Ecological thresholds and planetary boundaries.

PRACTICAL SYLLABUS

Laboratory practice

- **Practice 1. NOAA databases: atmospheric monitoring of greenhouse gases and their relation to climate change.** This practice requires the use of several web tools to analyze the concentrations of greenhouse gases (CO_2, CH_4, CFCs, N_2O) in different parts of the planet, as measured by NOAA. By analyzing short- and long-term trends of gases the student learns how the atmosphere and climate is changing and determines the causes responsible for the ongoing climate change.

Field Practicum (2-day camp)

- **Practice 1. Acid neutralizing capacity in aquatic ecosystems.** Determination of inorganic carbon. Proportion of different forms of inorganic carbon. Relationship with pH. Evaluation of the capacity to neutralize acids in different aquatic ecosystems.
- **Practice 2. Measurements of primary production and respiration in lakes.** Measurement of the oxygen concentration (Winkler Method). Light and dark bottle method. Net primary production and respiration. Monitoring of daily changes in oxygen concentration. Daily estimates.
- **Practice 3. Analysis of the macroinvertebrate food web in a river system.** Characterization of the macrobenthic community: identification of organisms at family level. Quantification of macroinvertebrate diversity in two sections of the same stream (upstream and downstream of the reservoir). Estimation of ecological attributes from functional feeding groups.
- **Practice 4. Determination of CO2 exchange in the ecosystem as a function of environmental parameters**. Quantification of CO2 emission from soils by manipulating the type of plant community, substrate type, and soil moisture. Effect of temperature on daily CO2 emission.
- **Practice 5. Organisms as ecosystem engineers: evaluation on the role of seed dispersers in pine-forest reforestation.** The interaction of woody plants with seed dispersers as engineers for vegetation regeneration. Estimation of the economic budgets of ecosystem services.

The use of gown, goggles, gloves and closed footwear is mandatory in practices with chemical reagents.

RECOMMENDED READING

ESSENTIAL READING

- Krebs, C. (2001-2009) Ecology: The experimental analysis of distribution and abundance, Addison Wesley Longman.
- Smith, R. L. & T.M. Smith (2009) Elements of Ecology. Pearson, 9th Edn.
- Chapin III, P.; Matson, P.A.; Mooney, H.A. (2002) Principles of Terrestrial Ecosystem Ecology. Springer
- Schlesinger, W. H. (2002-2013) Biogeochemistry: An Analysis of Global Change. Academic Press. Nueva York.
- Molles, M. (2006) Ecología. Conceptos y aplicaciones. McGraw-Hill, Interamericana.
- Rodríguez, J. (2001-2010) Ecología. Edn. Pirámide, Madrid.
- Piñol, J. & Martínez-Vilalta, J (2006) Ecología con números. Lynx Edn.

COMPLEMENTARY READING

- Allaby, M. (2010). A dictionary of ecology (4th ed.). Oxford University Press, Oxford.
- Cain, M., Bowman, W., Hacker, S., Allen, J., Pizer, M. y Kohorn, L. (2008) Ecology. Sunderland, Mass: Sinauer Associates
- Colinvaux, P. (1993) Ecology 2. Wiley & Sons, Inc.
- Collin, P. (2011). Dictionary of environment y ecology (5th Edn.). Bloomsbury, London.
- Calow, P. (1999) Blackwell's Concise Encyclopedia of Ecology. Blackwell Science Ltd.

- Jørgensen, S.E. (2009) Ecosystem Ecology. Academic Press-Elsevier.
- Mackenzie F.T. Our changing planet: An introduction to Earth System Science and Global Environmental Change. Prentice Hall.
- Ricklefs, R.E. (1998) Invitación a la Ecología. La Economía de la Naturaleza. 4ª Edn. Editorial Médica Panamericana. Madrid.
- Smith, R. L. y T. M. Smith (2009) Elements of Ecology (7th Edition). Pearson International Edn.
- Schultz, J. (2005). The Ecozones of the World: The Ecological Divisions of the Geosphere. Springer Berlin Heidelberg.
- Stiling, P.D. (1992) Introductory Ecology. Prentice Hall, Inc., New Jersey.
- Stiling P- D. (2012) Ecology. Global Insights & Investigations. Mc. Graw Hill.
- Townsend, C., Harper, J. L. and M. Begon (2002-2009) Essentials of Ecology. Blackwell Science. Oxford.
- Weathers, K.C., Strayer, D.L. y Likens, G.E. (2013) Fundamentals of Ecosystem Science. Elsevier/AP, Amsterdam.

TEACHING METHODS

- MD01 Lección magistral/expositiva
- MD02 Sesiones de discusión y debate
- MD03 Resolución de problemas y estudio de casos prácticos
- MD04 Prácticas de laboratorio y/o clínicas y/o talleres de habilidades
- MD05 Prácticas de campo
- MD06 Prácticas en sala de informática
- MD07 Seminarios
- MD08 Ejercicios de simulación
- MD09 Análisis de fuentes y documentos
- MD10 Realización de trabajos en grupo

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

The assessment of the students' level of acquisition of the general and specific competencies will be carried out continuously throughout the academic period by means of the following procedures:

- **Theory (55%).** A final examination of theoretical knowledge and problem solving provides 45% of the final grade. It is necessary to obtain a minimum of 5 points out of 10 to succeed. There will be three complementary tests (10-20 quiz questions) throughout the course representing 10% of the final grade.
- **Practices (20%).** All results gathered in practical activities (laboratory, field or computer simulation) will allow students to complement a scientific work in a poster format. The work will be evaluated in a class presentation to the rest of students. A minimum grade of 5 out of 10 is required to succeed. Any problem associated with practical classes must be communicated to the class supervisor.
- **Debates (10%).** The clarity and quality of the arguments presented in the debate sessions will be particularly taken into consideration.
- **Attendance, attitude and participation in all the formative activities (5%).**

Grades from theoretical and practice evaluations will be hold until the extraordinary assessment session of the same academic year.

EXTRAORDINARY EXAMINATION DIET

- The final grade will result from a **theoretical (80%) and practice (20%) examination.**
- The student may participate in the continuous activities throughout the course, and this might be taken into account for the evaluation if this is explicitly indicated by the student in writing.
- The student will have to take the extraordinary exam he/she fail to take or pass the theoretical or practice exam in the ordinary assessment session.
- The professor may chose to carry out oral examinations.
- The calendar of ordinary and extraordinary exams for the academic year can be view at the Biology website: http://grados.ugr.es/biologia/pages/infoacademica/convocatorias

SINGLE FINAL ASSESSMENT (evaluación única final)