

Comparative and Environmental Animal Physiology

Code: 100834
ECTS Credits: 10

Degree	Type	Year	Semester
2500251 Environmental Biology	OB	2	1

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

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Prerequisites

It is recommended to review topics about animal diversity (zoology) and general concepts such as ecology, evolution and cell biology.

Objectives and Contextualisation

In this subject, the introduction to the study of the morphological diversity of the various animal groups, is complemented with the description and analysis of comparative physiology in vertebrates and invertebrates. It is intended that the student be able to place each animal group in an ecophysiological context, evaluating it in relation to different aspects such as: the number of species, habitat, life cycle, adaptation to the environment, position within the ecosystems and finally their importance in relation to their particular interest in applied sciences and economic interest.

Targets:

- (1) Acquire the formal knowledge in animal physiology, which include:
 - (I) The general concepts of adaptation, acclimatization and evolution,
 - (II) The concepts and foundations of physiological analysis (homeostasis of perception, integration and response; feedback, amplification and control mechanisms)
 - (III) The general description of the main integrative systems (nervous, immune and endocrine systems) including their interactions
- (2) Apply the formal knowledge in animal physiology to ecological and symbiotic relationships among several species:

(I) The physiology of thermoregulation and osmoregulation.

(II) Differential adaptations between the aquatic and terrestrial environments (respiration, circulation, osmoregulation).

(III) The physiology of reproduction.

(IV) The physiology of symbiotic interactions in the digestive system.

(V) The evolutionary physiology of the immune relationships between host and parasite.

(3) Be able to diagnose the advantages and problems of the physiological adaptations in the environment. That is why the necessary materials and knowledge are provided to evaluate the physiological adaptations of a specific species in an environment with

specific biotic and abiotic conditions.

Competences

- Carry out functional tests and determine, assess and interpret vital parameters.
- Communicate efficiently, orally and in writing.
- Describe, analyse and interpret the vital adaptations and strategies of the principal groups of living beings.
- Integrate knowledge of different organisational levels of organisms in their functioning.
- Manage information
- Reason critically.
- Recognise and interpret the development, growth and biological cycles of the principal groups of living beings.
- Solve problems.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Understand the bases of regulation of vital functions of organisms through internal and external factors, and identify environmental adaptation mechanisms.

Learning Outcomes

1. Actuar en l'àmbit de coneixement propi avaluant les desigualtats per raó de sexe/gènere.
2. Apply tests and indexes to assess the functioning and development of animals.
3. Communicate efficiently, orally and in writing.
4. Interpret animals' mechanisms of adaptation to the medium.
5. Interpret the origin and functioning of organic structures in the different groups of animals.
6. Interpret the physiological processes that regulate animals' growth and reproduction.
7. Manage information
8. Reason critically.
9. Recognise and interpret the different phases in the biological cycles of all animal groups.
10. Recognise the characteristics of the environment that determine the distribution of the principal animal groups.
11. Solve problems.

Content

MASTER CLASS MODULES

MODULE I: Foundations of comparative physiology

Ecophysiological adaptation: key concepts. Proximate and ultimate explanations, adaptation, adaptation and acclimatization. Feedback, homeostasis, alostasis and allostatic load. Coping strategies: proaction and

reaction; conformists, regulators and avoiders; euriotics and stenotics. Reaction norms and phenotypic plasticity. Advantages and problems of physiological models: sex-based differences in physiological studies.

Regulation of physiological systems: the physiology of processes of perception, integration and response in the nervous system. Evolutionary trends in the emergence and complexity of nervous systems: tropisms, neural networks, bilateral nerve systems, encephalisation. Summary of the vertebrate brain. Characteristics of the synapses, action potential and transmission of the nervous signal. General characteristics of sensory systems, synaptic plasticity and multisensory integration, cortical representation and interpretation. The axes of emotions, stress and reticular activation. Memory formation: synaptic plasticity and long-term potentiation.

Case study. Evolutionary ecophysiology of echolocation, electrolocation, magnetolocation and thermolocation.

MODULE II: the imprint of the environment

Thermal regulation

Physiological regulation of body temperature in the human species. Mechanisms of heat exchange. Central and peripheral receptors, feedback. Factors influencing the control of basal metabolic rate. Fever and sweat. Homeotherms and poikilotherms. Endotherms and ectotherms. Taquimetabolic and bradimetabolic organisms. Temporary and regional heterotherms. Thermal inertia and body size. Thermal ecophysiology in the deserts: thermal regulation and water balance. Thermal ecophysiology in polar environments: hibernation and freezing.

Case study (I). Aestivation and the ontogenic plasticity in desert toads.

Case study (II). Evolutionary ecophysiology of polar fish.

Respiration-circulation coupling

General characteristics and regulation of the cardiovascular and respiratory physiology. Gas exchange. Factors influencing the changes in hemoglobin. Respiration and acid-base balance. Respiratory height adaptations. Respiratory transitions: from aquatic to terrestrial environment. The diversity of respiratory pigments. Gastrovascular circulatory systems, open and closed. Ecophysiology of external (skin and gills) and internal (air sacs and lungs) respiratory surfaces: (i) countercurrent flow in fish; (ii) skin respiration in the amphibians, (iii) respiratory adaptations in the reptiles, (iv) respiration in estuarine invertebrates, (v) efficiency and physiological regulation of the tracheal system of insects.

Case study (I). Respiratory ecophysiology of respiration in lungfish.

Case study (II). Evolutionary ecophysiology of respiration in birds.

The management of water and waste

Osmoregulation and metabolism of nitrogen in terrestrial animals. Physiological anatomy of the renal function. Mechanisms and regulation of urine concentration. Homeostasis of plasma concentration, blood volume, sodium levels and acid-base balance. Strategies of nitrogenous waste management: ammonotelism, ureotelism and uricotelism. Secretors vs. filterers. Physiological anatomy of osmoregulation and excretion in terrestrial insects: uricotelism, regulation of water and osmolites in the Malpighian tubules. The management of large volumes of water in hematophage insects and saponers. Primitive filtration systems in terrestrial invertebrates: flame cells and nephridia. Adaptive specializations of insects in dry environments: cryptonephric systems and hyperconcentrators.

Osmoregulation and metabolism of nitrogen in aquatic animals. Osmoconformist strategies in marine invertebrates. Adaptive ecophysiology of osmoregulation and management of metabolic waste in fish: iono-osmoconformers and regulators. Physiological gill models, kidney and gut in ionic and water transport in marine and freshwater fish. Saline glands and rectal reabsorption in birds and marine reptiles.

Case study. Evolutionary ecophysiology of smoltification in migrating salmon.

The trophic conflict

Digestive processes. Physiological anatomy of the digestive function. The perception of taste. The regulation and control of the digestion, secretion, absorption and motility in the digestive system. Where and how are fats, proteins and carbohydrates digested? The human Intestinal biota: characteristics of the symbiotic intestinal communities, structural, digestive, metabolic and immune functions. The brain-gut axis: Communication and bidirectional homeostasis between the intestine and the brain in situations of stress, pain and altered behaviors.

Adaptive solutions to the environmental constraints: compartmentalization, functional and morphological specializations of the digestive tract, reservoirs, extracorporeal digestion, agastria. Insect digestion: functional structure of the digestive tube, peritrophic matrix and fat bodies; digestive symbiosis of xylophagous insects and saba suckers. Energy efficiency and physiology of digestion in birds.

Case study. Digestive evolutionary ecophysiology of large herbivores.

The interaction with pathogens

Characteristics of innate and adaptive immunity in vertebrates. Mechanisms of cellular and humoral immunity. Inflammation, cell maturation, reactivity and cellular recirculation. Immune synapsis and antigen presentation: PAMPs and PRRs.

Case study. Evolutionary ecophysiology of hematophagous insects.

Reproduction

Physiology of reproduction. Hormonal control and cycles. Factors influencing the reproductive strategies of animals. Sexual selection, biological cycles, photoperiods, semelparity vs. iteroparity, nutritional environment, induced ovulation, social structure, sequential hermaphroditism. Pheromones: reproductive synchrony, influence of the vomeronasal organ in the sexual behavior of vertebrates. Evolutionary ecophysiology of milk production.

Case study. Ecophysiology of mammalian diapause.

PRACTICAL CLASSES

To be able to attend it, it is necessary for the student to justify having passed the biosafety and security tests that you will find in the Virtual Campus, to know and accept the operation rules of the laboratories of the Faculty of Biosciences.

P1. Comparative hematology of vertebrates.

P2. Cardiorespiratory adaptations to exercise.

P3. Assessment of the immersion reflex in humans.

P4a. Behavioral patterns in fish.

P4b. Elaboration of an experimental design based on behavioral patterns in fish and response to temperature

SEMINARS

(1) Analysis of the physiology and biology of the conservation of one particular species in relation to its habitual and / or artificial environment.

(2) Reasoned evaluation of a scientific article related to animal physiology.

Methodology

The methodology used in this subject to achieve the learning process is based on stimulating the students for working on the information that is provided. The function of the Professor is to give them the information or tell

them where they can get it and help tutor them, so that the learning process can be carried out effectively. To achieve this goal, the subject is based on the following activities*:

Master classes:

With these classes the student acquires the basic scientific and technical knowledge of the subject that must be complemented with the personal study of the topics explained.

Seminars:

The mission of the seminars is to promote the capacity for analysis and synthesis, the critical reasoning, and the ability to solve problems. Seminars work on the scientific-technical knowledge previously exposed in the master classes to complete their comprehension and deepen in them, developing various activities: analysis and discussion of cases and articles published in the field of physiology, oral and written assessment of physiological adaptations to specific environments, resolution of questions related to the specific subjects and research and analysis of ecophysiological information.

Practices:

The objective of the practical classes is to complete and reinforce, through controlled experimentation in the laboratory, the physiological knowledge acquired in the theoretical classes and seminars, following a specific guideline. In practical sessions empirical skills such as the ability for observation will be stimulated and developed by the student, together with the analysis and evaluation of problems in the usual physiological experimentation. To be able to attend the practicals, it is necessary for the student to justify having passed the biosafety and security tests that can be find in the Virtual Campus and also to know and accept the rules of operation of the Faculty of Biosciences laboratories.

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			
Seminars	10	0.4	2, 3, 7, 4, 6, 9, 5, 8, 10, 11
Theory	57	2.28	1, 2, 3, 4, 6, 9, 5, 8, 10, 11
Type: Supervised			
Laboratory	20	0.8	2, 3, 7, 9, 11
Type: Autonomous			
Study	120	4.8	2, 3, 7, 4, 6, 9, 5, 8, 10, 11
Work preparation, solving questions	32	1.28	2, 3, 7, 4, 6, 9, 5, 8, 10, 11

Assessment

The evaluation consists of 4 tests to assess the knowledge obtained by the student in the subject, as well as its capacity for analysis, synthesis and critical reasoning:

(1) Individual assessment (50% of the final grade). There will be 2 written partial exams, compulsory and eliminatory of matter. The minimum grade to pass each partial exam is 5. Students who do not pass one of the two partial examinations will be able to retrieve them to the final exam To pass the final exam the grade must be equal to or greater than 5.

Group evaluation on:

(2) the physiological adaptations to the environment in a specific organism (20% of the final grade).

(3) the written, critical and reasoned analysis of a scientific article published in the field of ecophysiology. (15% of the final grade).

(4) the practices, by means of the delivery of a group report (15% of the final note). To be able to attend it, it is necessary for the student to justify having passed the biosafety and security tests that can be find in the Virtual Campus and to know and accept the rules of operation of the laboratories of the Faculty of Biosciences.

To pass the course the student must:

(1) have passed the individual exam and (2) the final global grade be equal to or greater than 5.

To participate in the recuperation, the students must have been previously evaluated in a set of activities whose weight equals to a minimum of two thirds of the total grade of the subject or module. Therefore, the students will obtain the qualification of "No Valuable "when the assessment activities carried out have a weighting of less than 67% in the final qualification. It will be considered that a student will obtain the qualification of Non-Valuable if the valuation of all assessmentactivities performed do not allow to achieve the overall rating of 5 in the assumption that the student had obtained the highest note in all of them. If forjustified reasons (paid work, illness, etc.) the students can not attend any of the tests and / or evaluation seminars, they can retrieve the tests by doing them another day (in the case of the individual examination) or a written work of equivalent evaluation based on a subject matter that will be discussed with the teaching staff.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Dossier submission	35%	1	0.04	2, 3, 7, 4, 6, 9, 5, 8, 10, 11
First exam (individual)	25%	3	0.12	1, 2, 3, 7, 4, 6, 9, 5, 8, 10, 11
Lab sessions	15%	4	0.16	2, 3, 7, 8
Second exam (individual)	25%	3	0.12	1, 2, 3, 7, 4, 6, 9, 5, 8, 10, 11

Bibliography

Essential references of general, comparative and environmental physiology.

- Fox, S.I. Fisiología humana. Mcgraw-hill interamericana. (*e-book*)
- Hill, R.W. i Wyse, G.A. Animal Physiology. Sinauer.
- Moyes, C.D., i Schulte, P.M. Principios de fisiología animal. Pearson. (*e-book*)
- Willmer, P., Stone, G, i Johnston, I. Environmental physiology of animals. Blackwell. (*e-book*)

Supplementary references

- Carlson, Neil A. Fisiología de la conducta. Pearson. (*e-book*)
- Cooper, E.L. Advances in Comparative Immunology. Springer. (*e-book*)
- García Sacristán, A. Fisiología veterinaria. Editorial Tébar. (*e-book*)
- Hickman, C.P. et al. Principios integrales de zoología, McGraw-Hill. (*e-book*)

- Kandel, E.R. et al. Principles of neural science. McGraw-Hill. (*e-book*)
- Losos, J. The Princeton Guide to Evolution. Princeton University Press. (*e-book*)
- Murphy, K. Immunobiología de Janeway. McGraw-Hill. (*e-book*)
- Scanes, C. Sturkie's Avian Physiology. Academic Press. (*e-book*)

PubMed, browser for papers in physiology and biomedicine: <http://www.ncbi.nlm.nih.gov/sites/entrez>

Software

No specialized software packages are required