Universitat Autònoma de Barcelona

2019/2020

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.
- Understand the bases of regulation of vital functions of organisms through internal and external factors, and identify environmental adaptation mechanisms.

Learning Outcomes

1. Apply tests and indexes to assess the functioning and development of animals.
2. Communicate efficiently, orally and in writing.
3. Interpret animals' mechanisms of adaptation to the medium.
4. Interpret the origin and functioning of organic structures in the different groups of animals.
5. Interpret the physiological processes that regulate animals' growth and reproduction.
6. Manage information
7. Reason critically.
8. Recognise and interpret the different phases in the biological cycles of all animal groups.
9. Recognise the characteristics of the environment that determine the distribution of the principal animal groups.
10. Solve problems.

Content

MODULE I: Foundations of comparative physiology

-Ecophysiological adaptation

Initial and complex causes of adaptation, adaptation and acclimatization. Ecophysiological characteristics and temporal scope of the different environments: biotic and abiotic; genomic and phenotypic, biogeographic and historical. Homeostasis, alostasis and allostatic load. Coping strategies: proaction and reaction; conformists, regulators and avoiders; eurioics and estenoics. Rules of reaction and phenotypic plasticity.

-The organization of physiological systems

Concept and mechanisms of perception, integration and response. Feedback. The main regulatory systems. The levels of study of physiological adaptations: connectivity, phenotypic diversity, evolution. Advantages and problems of physiological models.

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.

Case study (I): fever and sweat.

The range of thermal regulation strategies in animals. 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 in evasive species, evaporators and resistant. Thermal ecophysiology in polar environments: hibernation and freezing.

Case study (II). The estivation and the ontogenic plasticity in the amphibians.

Case study (III): The evolutionary physiology of over-cooling in polar fish.

Case study (IV): Adaptive strategies in hydrothermal fumaroles.

The respiration-circulation coupling

General characteristics and regulation of the cardiovascular and respiratory physiology in the human species. Gas exchange. Factors influencing the changes in hemoglobin. Respiration and acid-base balance.

Case study (I): Respiratory height adaptations.

Respiratory and cardiovascular adaptations in animals. The aquatic condition and the transition to terrestrial environment. The diversity of respiratory pigments. Gastrovascular circulatory systems, open and closed. Ecophysiology of external respiratory surfaces (skin and gills) and internal (air and lung sacks): (i) the flow in the fish; (ii) skin respiration in the amphibians, (iii) respiratory adaptations in the reptiles, (iv) the respiration in the estuarine invertebrates, (v) efficiency and physiological regulation of the tracheal system of insects

Case study (II): respiratory ecophysiology of pulmonary fish.

Case study (III): Evolutionary ecophysiology of flight in birds. Anatomy and physiology of the breathing-movement coupling in the birds and implications for the evolution of the flight.

The management of water and waste

Osmoregulation in humans. Physiological anatomy of the renal function. Mechanisms and regulation of urine concentratio. Homeostasis of plasma concentration, blood volume, sodium levels and acid-base balance.

Case study (I): Osmoregulation of the castaway.

Osmoregulation and metabolism of nitrogen in terrestrial animals.Strategies of nitrogenous waste management: amoniotelia, ureotelia and uricelia. Secretors vs. filterers. Physiological anatomy of osmoregulation and excretion in terrestrial insects: uricotelism, regulation of water and osmolites in the Malpighi tubules. The management of large volumes of water in hematophage insects and saponers. Primitive filtration systems in terrestrial invertebrates: flame cells and nefridia.

Case study (II): Adaptative specializations of insects in dry environments: cryptographic systems and hyperconcentrators.

Osmoregulation and metabolism of nitrogen in aquatic animals. Osmoconformists strategies in marine invertebrates. Adapted 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 (III): smoltification in salmon, environmental conditions, anatomical and physiological aspects of anadromy in migratory salmonids and osmotic adaptation to environmental salinity changes.

The trophic conflict

Digestive processes in the human species. 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

Case study (I): Where and how are fats, proteins and carbohydrates digested?

The human Intestinal biota. Characteristics of the microbial symbiotic intestinal communities. Structural, digestive, metabolic and immune functions.

Case study (II): The hypothesis of the cephalic-intestinal axis. Communication and influence bidirectional homeostasis between the intestine and the brain in situations of stress, pain and altered behaviors.

Digestive processes in animals. Adaptive solutions to the environmental conditions: compartmentalizations and functional and morphological specializations of the digestive tract, reservoirs, extracorporeal digestion, agastria. Models of foraging, palatability, digestion and detoxification of food. Insect digestion: functional structure of the digestive tube, peritrophic matrix and greasy bodies; digestive symbiosis of xylophagous insects and saba suckers. Energy efficiency and physiology of digestion in birds.

Case study (III): Digestive specialities of hematophagic insects.

Case study (IV): digestive ecophysiology of large herbivores. Digestive specializations of cranial and caudal fermentation. Conditioners of the evolution of ruminants.

The integrating perception

The physiology of processes of perception, integration and response in the nervous system. Evolutionary trends in the emergence and complexity of nervous systems: tropism, neural networks, bilateral nerve systems, encephalisation. Summary of the vertebrate encephal. Characteristics of the synapses, action potential andtransmission 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.

Case study (I): memory in humans. Types of memory, synaptic plasticity and long-term empowerment

Case study (II): the influence of the environment on sensory perception. Evolutionary ecophysiology of echocalization, electrolocation, magnetolocalization and thermolocation.

The interaction with pathogens

Characteristics of innate and adaptive immunity in vertebrates. Mechanisms of cellular and humoral immunity. Maturation, reactivity and cellular recirculation. Immune synapsis. PAMPs and PRRs. Presentation of antigens. The immune response in the gut. The acute and inflammatory phase reactions.

Case study: Parasitic ecophysiology. Zoonoses. Adaptive general physiology of the parasites: feeding, osmoregulation, thermoregulation, respiration and reproduction. Mechanisms of immune evasion The hypothesis of behavioral manipulation.

Reproduction

Physiology of human reproduction. Hormonal control and cycles. Factors influencing the reproductive strategies of animals. Sexual selection and its impact on the anatomy, physiology and behavior of both sexes.

Hormone handling and control of sexual behavior. Environmental conditiones: biological cycles, photoperiods, similarity vs. iteroparity, nutritional environment, induced ovulation, social structure, sequential hermaphroditism.

Case study (I): the pheromone attraction. Influence of the vomeronasal organ in the sexual behavior of vertebrates.

Case study (II): evophysiology of milk production. Proximal and distal causes of the milk production in mammals.

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 behavioralpatternsin 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.

Activities

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

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 assessment activities 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	1, 2, 6, 3, 5, 8, 4, 7, 9, 10
First exam (individual)	25%	3	0.12	1, 2, 6, 3, 5, 8, 4, 7, 9, 10
Lab sessions	15%	4	0.16	1, 2, 6, 7
Second exam (individual)	25%	3	0.12	1, 2, 6, 3, 5, 8, 4, 7, 9, 10

Bibliography

Essential references of general, comparative and environmental physiology.

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Supplementary references

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Carlson, Neil A. Fisiologia de la conducta. Pearson.

Guyton, A.C. Hall,J.E. Tratado de Fisiología Médica. Elsevier.

Hickman, C.P. et al. Principios integrales de zoologia, McGraw-Hill

Kandel, E.R. et al. Principles of neural science. McGraw-Hill.

Moyes, C.D., i Schulte, P.M. Principios de fisiología animal. Pearson.

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