COURSE DATA

DATA SUBJECT

Code: 33071
Name: Development biology
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1100 - Degree in Biology	Facultat de Ciències Biològiques	2	Second quarter
1106 - Degree in Biology	Facultat de Ciències Biològiques	2	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1100 - Degree in Biology	Development biology	COMPULSORY
1106 - Degree in Biology	Biología del Desarrollo	COMPULSORY

COORDINATION

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SUMMARY

The compulsory course entitled ¿Developmental Biology¿ is taught in the second semester of the second year of the Degree in Biology. This course aims that undergraduate students reach a comparative vision of gametogenesis, fertilization and embryonic and postnatal development of different groups of metazoans. Various animal models of morphogenesis, specification of embryonic axes, organogenesis, migration of primordial germ cells, primary and secondary sex determination, limb development, and tissue regeneration are analyzed. Likewise, special mention is made of the role that programmed cell death plays in animal development.

Thus, this course collects, rethinks, expands and questions previous knowledge acquired by students about the genesis of new organisms.

FOR STUDENTS ENROLLED WITH THE 2010 STUDY PLAN (OLD STUDY PLAN, IN THE PROCESS OF EXTINCTION): DUE TO THE IMPLEMENTATION OF THE NEW PLAN OF STUDIES FOR THE DEGREE IN BIOLOGY, THIS SUBJECT IS IN THE PROCESS OF EXTINCTION AND, THEREFORE, IT IS OFFERED ONLY WITHOUT TEACHING (SD). THIS MEANS THAT THERE WILL NOT BE ANY ASSOCIATED TEACHING

ACTIVITY AND THAT THE EVALUATION OF THE SUBJECT WILL BE CARRIED OUT ONLY THROUGH A THEORETICAL-PRACTICAL EXAM.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

COMPETENCES / LEARNING OUTCOMES

1106 - Degree in Biology

Apply principles of physics, chemistry and geology to the field of biology.

Interpret and apply basic legislation to manage professional tasks within the field of biology.

Organise, plan and manage information in a manner that allows the individual to analyse, synthesise and develop critical reasoning that can be applied to solve problems, make decisions and carry out work.

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

Understand the main stages and patterns of development of various groups of metazoans and the molecular, genetic and cellular bases for developmental changes in the embryo, including programmed cell death.

Use scientific language, both oral and written, and be able to adapt the register to the target audience and/or readers. Use the most common foreign languages in each discipline as a vehicle for communication in a globalised system.

DESCRIPTION OF CONTENTS

Topic 1. Definition and Objectives of Developmental Biology. Origins and Evolution of Developmental Biology: Hippocrates, Aristotle, Malpighi, Schleiden and Schwann, Weismann, Mendel, Roux, Driesch, Spemann and Mangold, Johannsen.

Topic 2. Comparative animal gametogenesis. Germ plasm and primordial germ cell determination: Primordial germ cell migration in mammals. Sexual dimorphism in mammalian meiosis. Spermatogenesis in mammals, birds, reptiles, fish, amphibians, and insects. Oogenesis in mammals, fish, and insects.

Topic 3. Comparative fertilization. Sperm and oocyte morphology. Function of the oocyte coat(s). Molecular mechanism of sperm capacitation. Sperm binding to the oocyte coat(s). Acrosome reaction Sperm binding and fusion with the oocyte plasma membrane. Oocyte activation: Changes in oocyte membrane potential, Increased $[Ca^{2+}]_I$, Exocytosis of cortical granules or alveoli, Cytoplasmic segregation Increased pH_i, Resumption of the cell cycle, Development of the male pronucleus, Centrosome inheritance, Pronuclear apposition and karyogamy.

Topic 4. Obtaining multicellularity. Determination of embryonic axes. Characteristics of the cell cycle during cleavage: Transition from fertilization to cleavage, Mid-blastula transition. Cleavage patterns: Radial cleavage of sea urchin isolecytic oocytes, Displaced radial cleavage of frog mesolecytic oocyte, Rotational cleavage of mammalian isolecytic oocytes, Discoid cleavage of avian telolecytic oocytes, Superficial cleavage of *Drosophila* centrolecytic oocytes.

Topic 5. Gastrulation models. Types of cell movement during gastrulation. Gastrulation patterns in amphibians (anurans and urodeles), echinoderms, birds, mammals, and insects.

Topic 6. Cell differentiation and morphogenesis. Cellular differentiation: Gene expression in differentiated cells, Conflict between cell division and differentiation, Methylation patterns and the control of transcription, Inheritance and stabilization of DNA methylation patterns. Genomic imprinting, Cellular foundations of morphogenesis, Mechanisms of cell specification, Cell

morphogenesis and adhesion, The extracellular matrix and cell integrins, Epithelial-mesenchymal transition, Cell migration.

Topic 7. Proximal cellular interactions. Induction and Competence. Cascade Inductions: Reciprocal and sequential. Instructive and Permissive Interactions. Epithelial-mesenchymal Interactions: Regional specificity of induction, Genetic specificity of induction. Mechanisms of inductive interactions: paracrine and juxtracrine interactions. Gradients of Paracrine Factors (morphogens).

Topic 8. Specification of embryonic axes in vertebrates. Formation of the dorsal-ventral axis and neural tube in amphibians. Molecular mechanisms of axis formation in amphibians: Induction of neural ectoderm and dorsal mesoderm: BMP inhibitors, regional specificity of neural induction along the anterior-posterior axis. Autonomous specification of the endoderm. Specification of the left-right axis. Formation of the anterior-posterior axis in *Drosophila* and mammals

Topic 9. Organogenesis I. Formation and modelling of the neural plate: Mechanisms of neurulation, Primary neurulation, Secondary neurulation, Neurulation at the junctional zone or transition zone. Differentiation of the neural tube: Antero-posterior axis, Dorsal-ventral axis. Histogenesis of the central nervous system. Differentiation of the germinal neuroepithelium in different regions of the CNS: Organization of the spinal cord and medulla oblongata, Organization of the cerebellum, Organization of the brain. Neural crest and its derivatives

Topic 10. Organogenesis II. Endodermal derivatives: The pharynx, The digestive tract and its derivatives, Specification of the different parts of the digestive tract, The liver, gallbladder, and pancreas, The respiratory tract. Paraxial mesoderm derivatives: Head mesoderm, Somites and their derivatives. Somitogenesis or somite formation: Periodicity, Separation, Epithelialization, Axial specification, Differentiation. Derivatives of the intermediate mesoderm: Progression of the 3 stages of kidney development. Derivatives of the lateral Mesoderm: Development of the heart, Specification of the cardiogenic mesoderm in vertebrates, Development of the heart in birds. Blood vessel formation: Vasculogenesis and angiogenesis, Sites of vasculogenesis. Development of blood cells.

Topic 11. Migration of primordial germ cells in mammals. Primary sex determination in mammals. Development of the gonads. Secondary sex determination in mammals. Development of the external genitalia.

Topic 12. Formation of the limb pattern. Limb development in tetrapods: Formation of the limb buds, Specification of the proximal-distal limb axis, Specification of the forelimbs and hindlimbs, Specification of the anterior-posterior limb axis. Specification of the dorso-ventral limb axis. Limb development in *Drosophila*: Specification of the proximal-distal axis of the imaginal discs of the legs, Eversion and differentiation of the imaginal discs of the legs, Specification of the antero-posterior axis of the imaginal discs of the wings, Specification of the dorso-ventral and proximal-distal axes of the imaginal discs of the wings.

Topic 13. Regeneration and renewal. Mechanisms of tissue regeneration in animals: Stem cell-mediated regeneration, Epimorphic limb regeneration in salamanders, Morphallactic, epimorphic, and stem cell-mediated regeneration in species of the genus *Hydra*, Compensatory regeneration in the mammalian liver.

Topic 14. Programmed cell death and development. Programmed cell death in animal development: Sculpting/molding structures, Removal of structures, Regulation of cell number, Elimination of abnormal and/or potentially dangerous cells, Role of caspases in cell differentiation and stimulation of proliferation, wound healing, and tissue regeneration.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	5,00
Theory	30,00
Laboratory	10,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	8,00
Independent study and work	59,50
Preparation of lessons	0,00

Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The acquisition of knowledge and skills by the students is based on five types of activities:

Theoretical classes: The teacher will present the essential contents of each topic, using the appropriate audiovisual resources, guiding students in the use of bibliographic material, as well as encouraging discussion and debate of problems raised in the classroom.

Practices classes: During the laboratory sessions, the teacher will present the objective and the guidelines of each laboratory exercise. Thereafter, the student will observe, analyze and interpret the respective histological slides.

Group tutorials: Dedicated to the expansion and review of different parts of the theory syllabus to delve into the contents that, due to time constraints, cannot be covered in theory classes.

Personal tutorials: Students¿ individual doubts will be clarified using the time assigned by the University regulations. Optionally, at the discretion of each teacher, tutorials may be interactive and/or on-line.

Interdisciplinary works: The activities of the subject are completed and complemented with the transversal activity "Interdisciplinary Seminars" directly focused on the work on competences.

This is a cross-disciplinary activity common to all subjects in the second year of the degree in Biology (Histology, Evolutionary Processes and Mechanisms, Zoology II, Botany II, Biochemistry, Genetics, Paleontology, Developmental Biology, and Biostatistics). It consists of the preparation and presentation, by a working group (3 students), of a seminar, which will consist of a written text and an oral presentation. The activity is compulsory for all students enrolled in the second year, except for those who have done it before. Each working group prepares a seminar on a topic proposed by the teachers of the participating subjects. The assignment of each group to the subjects will be randomly done. Each interdisciplinary work will thus be linked to the corresponding subject resulting from the draw. A tutor will be assigned to each of the projects, who will supervise the completion of the project and supervise its presentation. To this end, a series of regular meetings will be held with the tutor throughout the course. A co-tutor will also be assigned, who will review the final version of the work submitted. Each interdisciplinary work will be presented orally by all members of the group for 20-30 minutes. The presentation will be attended by all students on the course, as attendance is compulsory, and by two lecturers: the tutor and a second lecturer. Both students and teachers will take part in the presentation.

NOT APPLICABLE FOR STUDENTS ENROLLED WITH THE 2010 STUDY PLAN (OLD STUDY PLAN, 1100, IN THE PROCESS OF EXTINCTION) DUE TO THE IMPLEMENTATION OF THE NEW STUDY PLAN: SEE THE SUMMARY SECTION.

EVALUATION

In proportion to the ETCS allocated to each activity, theory will have a relative weight of 80% of the final mark. This relative weight of 80% will be calculated by assigning 75% to the syllabus taught in the theory classes and 5% to the topics covered in the group tutorial sessions, which will be dedicated to expanding and clarifying some concepts introduced in the theory classes. To pass the subject, it will be an essential requirement to achieve a score of 5.00 out of 10.00 in the overall theory/group tutorial mark. The laboratory practices will represent 10% of the final mark, with the same conditions as the theoretical evaluation. In other words, the two parts of the subject (theory/group tutorials and laboratory practices) will be evaluated independently and it will be necessary to have passed each of the two parts separately to pass the subject. The elaboration of the interdisciplinary work will represent the remaining 10% of the final mark.

Optionally, students may choose to split the evaluation of the theory syllabus/group tutorials, or take the entire theory syllabus/group tutorials in the first official call of the Faculty. Class attendance will be mandatory for those students who choose to divide the evaluation of the theory syllabus/group tutorials into several tests. Specifically, these students will take two partial theory exams that will evaluate the syllabus taught in the theory classes and a third exam that will assess the learning achieved in the topics covered in the group tutorial sessions. The three exams will be test type, using the computer resources of the Virtual Classroom. Each one of the two partial theory exams will evaluate approximately half of the theory syllabus. The final mark for the two exams will be obtained by calculating the arithmetic mean of the marks obtained in the two partial exams, regardless of the mark obtained in each of them. Students who take the two partial theory exams and the group tutorial exam, as well as those students who choose the option of taking the entire theory/group tutorial syllabus in the first official call of the Faculty, who do not achieve a minimum overall grade of 5.00 in theory/group tutorials, will have the option of taking the entire theory/group tutorial syllabus in the second official call of the Faculty. To calculate the overall mark for the three theory exams/group tutorials, the arithmetic mean obtained in the two partial theory exams will be weighted with a value of 95% and the mark achieved in the group tutorial exam with a weight of 5%. Similarly, the overall mark for the theory/group tutorials of those students who take the entire theory/group tutorial syllabus in the first or second official call of the Faculty will be calculated by weighting with a value of 95% the mark obtained in the only exam that will be carried out on the entire theory syllabus and 5% to the mark achieved in the group tutorial exam. The calculation of the global or joint grade for theory/group tutorials has the ONLY OBJECTIVE of knowing if the theory/group tutorials part of the subject has been passed by the students. In fact, as we have mentioned previously, the final mark of the entire subject, that will appear in the Official Record, will be calculated by giving a relative weight of 75% (85% in the case of being exempt from carrying out the interdisciplinary work) to the arithmetic mean of the two partial theory exams, or to the only theory exam in those students who take the entire theory syllabus in the official calls of the Faculty, 5% to the exam that will assess the group tutorials, 10% to the laboratory practices exam and 10% remaining to interdisciplinary work.

Students who choose to divide the evaluation of the theory syllabus/group tutorials through three exams may also take a practice exam, multiple choice, using the computer resources of the Virtual Classroom. This exam will coincide with the day and time of the second partial exam of the theory syllabus. Those students who do not follow the option of dividing the evaluation of the theory syllabus/group tutorials into three exams or who, despite taking the two partial theory exams and the group tutorial exam, do not wish to take the laboratory practice exam on the same day that they take the second partial exam of the theory syllabus, they may take the laboratory practices exam in the first official call of the Faculty. Students who, after taking the laboratory practices exam following one of the two evaluation options mentioned above, who do not achieve a minimum grade of 5.00, may take the laboratory practices exam in the second official call of the Faculty. The mark obtained in the laboratory practices exam, in the event of passing, but failed in the theory /group tutorials exams, will remain valid during the current academic year. However, this mark

will not be maintained or saved in successive academic years.

The tutor and an assistant lecturer (cotutor) will participate in the grading of the interdisciplinary work and will take into account both the oral presentation of the work and the written text. In these assessments, the relative weight of the tutor's and co-tutor's marks will be 60% and 40%, respectively. The evaluation of this activity will take into account both the scientific content and the way in which it has been presented, especially the ability to communicate and transmit ideas and concepts. The works selected for presentation at the Biology Congress will receive an extra mark, corresponding to 10% of the mark for the activity.

In the event of not passing the entire subject, that is, the syllabus of the theory classes/group tutorial sessions and the laboratory practices, each one separately, the mark of the interdisciplinary work will be saved for the following year.

In the event that the interdisciplinary work (of a compulsory nature) is not carried out, the subject linked to the interdisciplinary work will be failed, regardless of the grade obtained in the rest of the subject.

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REFERENCES

Basic references

- -Barresi, M.J. and Gilbert, S.F. (2020). Developmental Biology. 12th ed. Sinauer Associated, Inc.
- -Tarín, J.J., Cano, A. (2000). Fertilization in Protozoa and Metazoan Animals. Cellular and Molecular Aspects. Springer.

Complementary references

- -Aeckerle N, Drummer C, Debowski K, Viebahn C, Behr R. Primordial germ cell development in the marmoset monkey as revealed by pluripotency factor expression: suggestion of a novel model of embryonic germ cell translocation. Mol Hum Reprod. 2015 Jan;21(1):66-80. doi: 10.1093 /molehr/gau088. Epub 2014 Sep 18. Erratum in: Mol Hum Reprod. 2015 Jun;21(6):552.
- -Callebaut M. Origin, fate, and function of the components of the avian germ disc region and early blastoderm: role of ooplasmic determinants. Dev Dyn. 2005 Aug;233(4):1194-216.
- -Kaneda T, Motoki JY. Gastrulation and pre-gastrulation morphogenesis, inductions, and gene expression: similarities and dissimilarities between urodelean and anuran embryos. Dev Biol. 2012 Sep 1;369(1):1-18. doi: 10.1016/j.ydbio.2012.05.019.