COURSE DATA

DATA SUBJECT

Code: 36839
Name: Integrated Experimentation in Biology
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1106 - Degree in Biology	Facultat de Ciències Biològiques	3	Annual, Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1106 - Degree in Biology	Experimentación Integrada en Biología	COMPULSORY

COORDINATION

GARRIDO BENAVENT ISAAC

FLORES TORNERO MARIA

SUMMARY

Integrated Experimentation in Biology is a four-month subject of 6 ECTS credits that is taught in the third year of the Degree in Biology with obligatory character, conceived as an agglutination of the specificities of the biological subjects considered so far in the training of students, by showing the interdisciplinary and integrated character of modern biology through the design and analysis of the experimental results obtained. Nowadays, in biological studies, the final objective does not remain in simply descriptive aspects, but shows an increasingly greater synthetic and applied tendency, which requires the consideration of different points of view.

In any of the biological disciplines, questions arise that require the design of one or more experiments, the results of which allow for the testing or refutation of the underlying hypotheses, since as branches of science they have to apply the scientific method. Each biologist approaches the question posed from the perspective of his discipline and at the biological level that concerns him, but what if he were to work with another biologist from a different discipline doing research at a different level? The answer is clear. The synergy of working together (as a team) would result in highly designed and interconnected experimental approaches, with valid results for both disciplines.

The starting point to understand the approach of the subject Integrated Experimentation in Biology is that different experiments that arise in different biological disciplines, with subjects in the Degree in Biology, are solved with the same statistical methods, as it has been tried to convey since the first course. But what we are now trying to convey is that, in addition to the fact that the same statistical method can be applied to the resolution of different biological problems, there are more specific methods for more complex questions arising from the synergistic effect of interdisciplinary work.

The course contemplates the theoretical aspects in its initial moment in the second quarter in classroom sessions in a conventional classroom and / or computer classroom, the contents of which do not necessarily have to follow a sequential order according to their arrangement in proposed topics. The practices, which integrate different perspectives, will be carried out in face-to-face sessions in the field, laboratory and / or computer classroom.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

It is essential to have passed the subjects of the first course:

1. Biology (Code. 33041),
2. Tree of Life (Code. 33053),
3. Cellular Biology (Code. 36828),
4. Mathematics (Code. 36829), and

it is recommended to have passed the second-year subjects:

5. Botany II (Code. 36833)
6. Paleontology (Code. 36835)
7. Biostatistics (Code. 36837).

These prerequisites and recommendations would guarantee an overview of biological aspects and basic numerical calculations for the logical pursuit of Integrated Experimentation in Biology.

COMPETENCES / LEARNING OUTCOMES

1106 - Degree in Biology

(CB4) Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Assimilate the process of constructing scientific knowledge: experimentation in the laboratory and field studies, gathering, handling and analysis of data and preparation of scientific documents. Use of information and communication technology (ICT) in biology.

Be able to analyse the data obtained in different biological experiments by using appropriate statistical software.

Design and conduct experiments by using scientific techniques and instruments appropriately and complying with laboratory safety regulations.

Interpret, analyse, evaluate, process and synthesise biological data and information by applying mathematical and statistical methods.

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 communicate information, ideas, problems and solutions to both expert and lay audiences.

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.

Understanding the process of constructing scientific knowledge: laboratory experimentation and field studies, data acquisition, management and analysis, and writing scientific documents. Use of information and communication technologies (ICTs) in biology.

Use ICTs, apps and other computer tools to manage and disseminate information in both educational and professional environments.

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

1. SUBJECT¿S PRESENTATION

The professors, their profile; how to contact them. Teaching organization of the course: location of the teaching guide. Teaching materials on the web. Other information.

2. THEORY.

Statistics

Topic 1: Multiple linear regression

Simple and multiple linear regression models. Estimation and interpretation of the multiple linear regression model. Study of interactions between variables. Model diagnosis. Variable selection.

Topic 2: ANOVA of one way

Variance decomposition. F distribution. One-way analysis of variance. ANOVA table. Representation of ANOVA models as linear models.

Topic 3: ANOVA of two and more ways

Factorial designs with two factors. Fixed and random factors. Nested designs with two factors.

Topic 4: More complex statistical designs

Unbalanced designs. ANOVA with three and more ways. ANCOVA.

3. PRÁCTICAS

Session A1. Geometric morphometry: identification of phylogenetic and adaptive load in the evolution of organic form**.**

The present practice the structures to be characterized are a set of dental pieces of micromammals from different taxonomic groups and from different periods, to determine if the differences between each group are due to phylogenetic factors or an adaptation to a particular type of diet. The practice structure would allow parallel analyses such as: variations in the diet of different raptors, or variations in the size of different groups (rodents, insectivores); or in the composition of micromammal communities in recent times for the same area. For the analysis of the data obtained in the field sampling, multivariate analysis techniques will be used (Discriminant Analysis and Principal Component Analysis), although the use of Multiple regression and/or chi-square tests could also be considered for possible parallel considerations.

Session A2. Comparative study of the effect of different concentrations of chemicals on reproductive parameters in individuals of the freshwater invertebrate *Daphnia magna*.

In this practical, we propose to perform a comparative study of the effect of exposure to sublethal concentrations of chemical compounds in invertebrates of the species *Daphnia magna* (Crustacea, Cladocera). The invertebrates will be kept for a specific period of time and a semi-static exposure and, subsequently, different individual parameters will be recorded. The data obtained will be used to perform the relevant statistical analyses to answer the pre-test hypotheses. In addition, a study of the size/sex/presence of possible external morphological malformations in the offspring will be carried out.

Session B1. Freezing as a procedure to preserve microorganisms.

The objective of this practical is for the student to understand and analyze the different factors

that can influence the survival of microorganisms preserved by freezing at -20 °C. Throughout this activity, the following key aspects will be discussed in depth:

1. How the incorporation of cryoprotectants affects the viability and preservation of microbial cells will be evaluated, analyzing their ability to protect microorganisms during the freezing process.
2. The impact of freezing on the viability of prokaryotic (e.g., bacteria) and eukaryotic (e.g., yeast) microorganisms will be studied, comparing their resistance and capacity of recovery after the process.
3. It will be analyzed how freezing differentially affects gram-positive and gram-negative bacteria, considering the particularities of their cellular structures.

In all cases, the technique used to determine microbial viability will be the plate count of viable bacteria. This method will consist of the preparation of successive decimal dilutions of the samples, followed by sowing on the surface of plates with solid culture medium. Subsequently, the colony forming unit (CFU) count will be performed to evaluate the survival of microorganisms behind freezing.

Session B2. Ecophysiological and molecular study of C3 and C4 plants.

The biological material will consist of C3 (pea, *Pisum sativum* L.) and C4 (maize, *Zea mays* L.) plants grown under controlled conditions, at 20 °C and 35 °C. The effect of temperature on growth rate, photosynthetic pigment content, as well as leaf anatomy will be determined, paying attention to stomatal density and the measurement of stomatal guard cells.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	5,00
Theory	16,00
Laboratory	25,00
Computer classroom practice	14,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	20,00
Independent study and work	70,00
Preparation of lessons	0,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

In the present subject, different methodologies are applied and some activities are proposed for the achievement of its objectives. The face-to-face activities correspond to:

Lectures. This type of activity is planned for the exposition of the theoretical topics, where the teacher will present the basic concepts of each topic with the help of available resources (blackboard and information and communication technologies). The students will be oriented on other possible resources (bibliographic, Internet) for the study of the concepts. Attendance is not compulsory, but it is recommended. The total number of hours dedicated to this activity is 16 hours / course.

Practical classes. The environment in which these activities are developed will be the computer classroom, the field and the laboratory. The purpose of the practical classes in the computer classroom is to support the theoretical sessions with the use of general and/or specific statistical programs, and to serve as a resource for the processing of data obtained in the field and laboratory practices. The activities developed in the field and / or laboratory are aimed at the execution of the experiences that are programmed.

Group tutorials. This activity is designed for students to raise their doubts and questions in relation to the subject, to be solved and answered by the students themselves, or by the teacher if he/she deems it appropriate. It also serves to guide the group on the possible steps to follow in the proper execution of the experiments proposed, as well as in the preparation of the scientific article.

Individual tutorials. This activity allows to solve specific questions of one or more students, that may appear punctually throughout the course, during the attention schedule established by the teacher, or by means of consultation by e-mail.

The **non-face-to-face activities** represent a very important part of the time of the course in which the dedication of the students has to be invested in order to achieve the proposed objectives. In this activity, the elaboration of a scientific article in group is contemplated with the teachings received and the materials used in the practices, and where the purpose is to apply all the formal aspects acquired to the previous transversal activities and the knowledge integrated in the subject.

EVALUATION

The subject will be evaluated through different tests:

Objective test (40%)

It will consist of a written exam on the contents of statistics (topics 1 to 4), which will include theoretical-practical questions and problems (32% of the final grade) and the continuous evaluation in practical sessions (8% of the final grade). In order to compensate this part of the evaluation (contents on statistics) it will be necessary to achieve at least 45% percentage of the maximum joint grade of this part, as well as 40% of the maximum possible grade of the exam."

Scientific article (40%)

Writing of a scientific article of one of the practices carried out, where the knowledge of statistics received is applied to the interpretation of the experimental results. The authorship of this work is the team, consisting of a maximum of four students who have developed the practices (field-laboratory, computer classroom). As such, it is governed by editing rules (division into parts, extension, figures and tables) that will be indicated at the beginning of the practices, being the accepted languages for its presentation Valencian, Spanish and English. The grade of this activity represents 40% of the final grade. This part of the evaluation will be compensable when a minimum percentage of 45% of the corresponding maximum grade has been achieved.

Summaries, reports and/or questionnaires (20%)

Evaluation of practical activities from the resolution of questionnaires, regular attendance to face-to-face activities, participation and degree of involvement in the teaching-learning process. These aspects correspond to 20% of the final grade, which is divided equally between the two practices that the student enrolls (10% of each), compensating when a minimum percentage of 45% of the maximum grade is reached in each practice.

Considerations for passing the course.

The course cannot be passed in any of the academic year if the student has not attended each and every one of the scheduled sessions (including laboratory sessions, field trips, computer classes and tutorials) in the practices (A1, A2, B1 or B2) assigned to each student.

- **1st call.** To pass the course it is enough to achieve the minimum compensable required in all the evaluable activities in the first call of the academic year. Those activities that have not achieved these minimums will remain pending until the next call of the course.

- **2nd call.** In order to pass the course, it will be necessary to achieve the required compensable minimums in those activities that were pending in the first call. Failure to pass these pending activities will imply the repetition of all the activities in a subsequent course.

REFERENCES

BASIC

Azcón-Bieto & Talón. Fundamentos de Fisiología Vegetal. 2ª edición. McGraw-Hill¿ Interamericana de España, S.L.

Evert R.F. & S. E. Eichhorn (2013). Raven Biology of Plants. 8ª ed. W.H. Freeman and Company. New York, 727 pp.

Izco J. (2004) Botánica. McGraw-Hill Interamericana de España, S.L.

Legendre, P. & L. Legendre (1998). Numerical Ecology. 2nd Edition. Elsevier Science B. V., Amsterdam.

Manley, B. F. J. (1994). Multivariate Statistical Analysis. A Primer. 2nd Edition.Chapman & Hall, London.

Quinn, G. P. y Keough, M.J. (2002). Experimental Design and Data Analysis for Biologists. Cambridge University Press.

Sokal, R.R. & Rohlf, F.J. (1995). Biometry. 3ª edición. W.H.Freeman, New York.

Strasburger E. (2002). Tratado de Botánica. 35ª Edición. OMEGA.

Taiz L., Møller I.M., Murphy A. & Zeiger E. (2022). Plant Physiology and Development. Seventh Edition. Sinauer Associates.

Zar, J.H. (2009). Biostatistical Analysis, 5th Edición. Prentice Hall, Upper Saddle River, NJ.

COMPLEMENTARY

Podani, J. (2000). Introduction to the Exploration of Multivariate Biological Data. Backhuys Publishers, Leiden.

Reyment, R. A. (1991). Multidimensional Paleobiology. Pergamon Press, Oxford

https://exa.unne.edu.ar/biologia/fisiologia.vegetal/FundamentosdeFisiologiaVegetal2008Azcon.pdf

https://www.scribd.com/document/718875846/E-Strasburger-Tratado-de-Botanica.