COURSE DATA

DATA SUBJECT

Code: 36834
Name: Genetics
Cycle: Undergraduate Studies
ECTS Credits: 10.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1106 - Degree in Biology	Facultat de Ciències Biològiques	2	Annual

SUBJECT-MATTER

Degree	Subject-matter	Character
1106 - Degree in Biology	Bases moleculares y genéticas de los seres vivos	COMPULSORY

COORDINATION

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SUMMARY

The course of Genetics is taught in the second year of the curriculum of the Degree in Biology of the University of Valencia. It is part of the subject **Molecular and Genetic Bases of Living Beings**, which is made up of three subjects. Two are of 10.5 ECTS each, **Biochemistry** and **Genetics**, while the third, **Molecular Methods in Biology** is of 6 ECTS. The subject **Genetics** is theoretical-practical and will be taught throughout the two semesters that make up the academic year.

The teaching of molecular genetics / molecular biology has been coordinated with the other two subjects, paying special attention to developing a coordinated program of activities and contents in order to avoid overlaps. The objectives related to the acquisition of practical skills will be especially shared and complemented with those of the subject of **Molecular Methods in Biology** since this subject aims to integrate in a multidisciplinary way various molecular and cellular techniques, many of which have a clear connection with our area of knowledge.

In addition, continuing with the process of coordinating content between subjects, some aspects of evolutionary genetics have been included in the subjects **Tree of Life** (6 ECTS), in the first year, and

Evolutionary processes and mechanisms (4.5 ECTS) taught during the first semester of the second year, and therefore they do not appear among the contents of the subject of **Genetics**.

The general objectives of the subject **Genetics** are to provide the student, on the one hand, with the basic knowledge related to the study of biological variability and the mechanisms that regulate its inheritance, and to the structure and function of genes and genomes and, on the other hand, the conceptual and methodological tools that enable them to carry out any type of genetic analysis in their professional work.

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

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.

Interpret the functioning of the mechanisms of biological inheritance and the applications in recombinant DNA technology and genetic engineering.

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

Understand and relate the structure and function of biomolecules and interpret the functioning of the mechanisms of replication, transcription, translation and mutation. Be familiar with the techniques, methodologies and basic instruments of the molecular biology laboratory.

DESCRIPTION OF CONTENTS

1. Introduction to Genetics

Definition and objectives of genetics.
Basic concepts: genotype, phenotype and standard reaction.
Phenocopies.
Pleiotropy.
Genetic analysis.
Mutation: definition and type.
Relationships between alleles.

2. Inheritance patterns

Cytological basis of inheritance: mitosis and meiosis.
Genetic consequences of meiosis.
Gregor Mendel: the reasons for a success.
Monohybrid crossbreeding: law of segregation.
The testcross.
Dihybrid analysis: law of transmission.
Genetic notation.
The use of branching diagrams and double-entry tables.
The chi-square test.
Analysis of polyhybridism.
The study and calculation of probabilities in genealogies.

3. Extensions of Mendelian analysis

The AB0 blood group system, an example of multiple allelism.
How to establish dominance between alleles series. Lethality.
Relationships between genes: interaction and epistasis. Penetration and expressiveness.
Influence of the environment on gene expression.

4. Gene function and complementation

A. Garrod and the congenital errors of metabolism.
G. Beadle, E. Tatum and the beginning of biochemical genetics.
The genetic dissection of a biochemical pathway.
Sickle-cell anaemia: each gene encodes a polypeptide. Gene complementation.
The flow of hereditary information.

5. Genetics of quantitative traits

The multiple factors.
Standard reaction and phenotypic distribution. Dismembering phenotypic variance.
When is it worth making selection?
Heritability.
How to calculate the heritability of a character.

6. Population genetics

Genetic pool.
Frequency of genes and genotypes.
The Hardy-Weinberg law.
Extensions of the Hardy-Weinberg law.
How to know if a population is in equilibrium.
Use of the Hardy-Weinberg law to estimate gene frequencies.

7. Chromosomes, sex and heredity

Establishment of the chromosomal theory of heredity.
Linked inheritance of sex chromosomes.
Dosage compensation.
Sex determination systems.
Role of X and Y chromosomes in Drosophila and humans.
Influence of sex on inheritance and gene expression.
Influence of the environment on gene expression

8. Genetic linkage

The transmission of linked genes.
Meiotic recombination.
Detection of linkage.
Recombination, genetic distance and linkage map.
Mitotic recombination.
Intragenic recombination.

9. Genetic mapping in eukaryotes

The three-point map.
How to proceed when we do not know the order of genes.

Genetic distance and physical distance.
The phenomenon of interference.
Double crossovers and map functions.
Distance from the dihybrid.
Linkage analysis in pedigrees: lod score.
Segregation and recombination in haploids: tetrad analysis.

10. Transfer, recombination and maps of hereditary material in bacteria and viruses

Maps by transformation and cotransformation.
Bacterial conjugation.
Characteristics of the factor F.
Interrupted mating maps.
Taking advantage of bacteriophages: transduction.
Maps by cotransduction.
Recombination in viruses.
Intragenic recombination.

11. The Nature of Hereditary Material: Nucleic Acids and Heredity

Features to be met by hereditary material.
The transforming principle by F. Griffith.
Establishing the nature of the transforming principle.
RNA is the hereditary material of some viruses.
Interactions between DNA and proteins.

12. The chromosome: vehicle of inheritance

Chromatin: composition and organization.
From the nucleosome to the metaphase chromosome.
Centromere, telomere and nucleolar organizer.
Morphology and number of chromosomes. The karyotype.
Chromosome staining.
"In situ" hybridization as a technique for chromosomal identification.
Euchromatin, heterochromatin and position effect.

13. Chromosomal mutations

A classification of chromosomal mutations.
Structural changes.

Duplications and deletions affect the number of genes present on chromosomes.
Inversions and translocations change the physical location of genes.
Numerical changes.
Chromosomal fusion and fission: Robertsonian translocations.
Aneuploidy: a partial change in chromosomal sets.
Polyploids: a variation of euploidy.

14. Physical Maps

Maps by deletions.
The use of balancing chromosomes in genetic analysis.
Use of deletions to map mutations.
Maps by somatic cell hybridization.
Maps by irradiated hybrids.
Maps by hybridization "in situ".

15. Gene expression and genetic code

Gene expression.
Coding genes and non-coding RNA genes.
Characteristics of the genetic code.
Deciphering the genetic code.
Anticodons and the wobble hypothesis.
Universality of the genetic code.
Effect of the use of codons.

16. Molecular basis of gene mutation

How mutation affects genetic material.
Basic characteristics of the mutational phenomenon.
The molecular basis of spontaneous mutation.
Induced mutations: chemical mutagens and ionizing radiation.

17. DNA repair and recombination

A look at repair systems.
The molecular mechanism of recombination. The process of homologous recombination.
The breakage and reunion model proposed by Holliday.
Hybrid DNA, repair of mismatches and gene conversion.

18. Molecular analysis of genetic variation

Concept of DNA polymorphism.
DNA polymorphisms analysis by minisatellite probes.
Analysis of DNA polymorphisms by PCR.
The interpretation of biological evidence: the fallacies of the prosecutor and the defense.
Bayesian analysis.
Pharmacogenetics: an example of genetic individuality.

19. Control of gene expression in prokaryotes

Regulated and constitutive genes.
An overview of regulation in prokaryotes.
Global circuits of control of gene expression.
Inducible systems: gene regulation of lactose metabolism in E. coli.
The lac operon model of Jacob and Monod.
Catabolic repression: control by positive induction in the lac operon.
Repressible and negative control: the trp operon. Regulation by attenuation of the trp operon.
Gene regulation by RNAs.

20. Control of gene expression in eukaryotes

An overview of gene regulation levels in eukaryotes.
How to activate a eukaryotic gene.
The role of enhancers and activators of transcription factors.
A model for transcription activation.
Gene regulation in the maturation of mRNA.
Coordinated control of transcription: the role of hormones. Other levels of regulation

21. Developmental genetics

Genetic bases of differentiation.
Binary cell fate decisions: sex determination.
Specification of the anteroposterior axis in Drosophila.
Floral development in A. Thaliana.
Development and evolution processes.

22. Cancer Genetics

Cancer as a genetic disease.

Cell cycle control.
Programmed cell death
Genetic bases of cancer: oncogenes and tumour suppressor genes.
Hereditary predisposition to cancer.

23. Epigenetics

Epigenetic alterations of the genome.
Epigenetics and genomic printing.
Epigenetics and cancer
Epigenetics and behaviour
Epigenetics and the environment

24. Introduction to Genomics: transposable elements

Genomics: definition and types.
C value paradox: genome sizes.
The complexity of eukaryotic DNA.
Genomes of prokaryotes.
Eukaryotic nuclear genomes: genetics
Genomes of eukaryotic organelles.
Comparative genomics.
The dynamic genome: transposable elements. Mechanisms of transposition.
Mutagenic effect of transposition. Transposable elements of bacteria. Transposable elements of eukaryotes.

25. Evolution of genomes

Acquisition of new genes.
Genomics and gene duplication.
Duplication of domains and domain shuffling.
Horizontal gene transfer.
Introgression and allopolyploidy.
Non-coding DNA and genome evolution.
Effect of transposable elements on the evolution of genomes.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	5,00
Theory	62,00

Laboratory	10,00
Computer classroom practice	6,00
Classroom practices	22,00
Total hours	**105,00**

NON PRESENCIAL ACTIVITIES

Activity	**Hours**
Attendance at other activities	0,00
Individual or group project	20,00
Independent study and work	52,50
Preparation of lessons	50,00
Preparation for assessment activities	35,00
Resolution of case studies	0,00
Total hours	**157,50**

TEACHING METHODOLOGY

For the development of the theoretical activities, the expository method or master lesson is used, but encouraging the participation of students with questions about specific cases or problems.

For practical work, the methodology of solving exercises and problems is used (exercise, rehearsal and implementation of previous knowledge). Teamwork is strongly encouraged, since both the activities carried out in the laboratory, in problems, and in the computer lab are carried out in groups.

The activities of the subject are completed and complemented by the transversal activity "Interdisciplinary Seminars" directly focused on the work on competences. As an alternative to this activity, some other transversal activity may be carried out, endorsed by the CAT, within the framework of an educational innovation project.

The development of the course is structured in:

Class work:

1.- Two or three weekly sessions of one-hour theory classes. In these sessions it is intended to present and analyse the basic concepts of the subject with a special interest in highlighting the practical aspects of them. It is highly recommended to read the topics beforehand. In total, 62 one-hour sessions are necessary to cover this teaching facet.

2.- A weekly two-hour practical class session. This includes five laboratory sessions (10 hours), eleven problem sessions (22 hours) and three practical sessions in the computer room (bioinformatics) (6 hours).

3.- The availability of five one-hour sessions of group tutoring. These sessions appear in the work agenda distributed throughout the teaching period and allow us to deepen -in an eminently practical and participatory way- in conceptual aspects of the subject through group work.

Independent work:

Interdisciplinary work: realization and oral presentation of a seminar. This is an interdisciplinary activity with a transversal character common to all the subjects of the second year of the degree in Biology (Histology, Evolutionary Processes and Mechanisms, Zoology II, Botany II, Biochemistry, Genetics, Palaeontology, Developmental Biology and Biostatistics). The activity is compulsory for all students who are enrolled in the second year, except for those who have done it previously (and have had their grade saved). Each working group, made up of three students, will carry out a seminar (which will consist of a written work and an oral presentation) on a topic assigned by public draw among those proposed by the teachers of the subjects participating in this activity.

Alternatively, students may propose a topic of their interest with the approval of their tutor. Each interdisciplinary work will be considered linked (see impact on the evaluation of the activity) to the subject on which the assigned topic directly depends. Each of the works will be assigned a tutor, who will direct the realization of the same and supervise its presentation. To this end, a series of periodic meetings will be held with the tutor throughout the course.

At the beginning of the course, the dates on which these follow-up meetings must be held will be published, as well as the date on which the final project must be presented and the documents that must be included. A co-tutor will also be assigned who will review the final version of the work presented. Each work will be presented orally by all members of the group for 30 minutes. The presentation will be attended by all the students of the course, since attendance is compulsory, and two teachers: the tutor of the project and a second teacher. Both students and teachers will participate in the selection of the works that, due to their quality and originality, will be presented at the Biology Congress, carried out jointly between the first and second years of the degree in Biology.

EVALUATION

The evaluation of the learning of the knowledge and skills acquired by the students will consider all facets of it and will be carried out, fundamentally, continuously throughout the course in order to detect in time the possible shortcomings of the student and thus be able to advise and help them in their task. Therefore, the student-teacher relationship and the student's knowledge of the degree of learning achieved by the student will be very important, which will be facilitated by personalized tutorials.

However, to be able to give a numerical rating of the degree of knowledge and skills achieved by the student, different tests will be carried out that will try to measure them from the different teaching activities developed. Like that:

A. Evaluation of knowledge of theory.

An evaluation of the concepts worked on in the theoretical sessions will be carried out by carrying out two independent written tests and eliminatory subjects. These tests correspond to:

A1. First test. The theoretical aspects, and their practical application, corresponding to the first 14 topics of the program will be evaluated. It will be held during the exam period in January.

A2. Second test. The theoretical aspects, and their practical application, corresponding to topics 15 to 25 of the program will be evaluated. It will be held during the May-June exam period.

Students who do not attend, or do not pass with a 5 either of these two tests (A1 and/or A2) in the first call may recover it in the second call.

Students who do not pass the subject in the first exam session but have passed (minimum 5/10) any of the theory parts (A1 or A2), will have the grade of the theory part approved for the second exam session of the course kept.

The combined value of these tests **represents 54% of the final grade of the subject (27% each test).**

Section A together with section B can be passed, **within the call**, with at least an average of 5 between the grades of A1, A2 and section B as long as all three grades are equal to or greater than 4. That is, grade (A1 > 4 + A2 > 4 + B > 4) / 3 > 5 out of 10.

B.- Evaluation of knowledge and skills in problem solving.

The grade in section B (problems) will be obtained from two types of activities: a) active participation in problem classes (presentation of some of the problems that will be carried out during the class and carrying out learning controls) and b) taking a written test after the end of the classroom sessions (January exam period). Students who are not present or do not pass the written test may retake it in the May-June exam period (second call for the subject).

The participation grade will be worth 4 points and the written exam will be worth 16 points. The combined value of the tests referred to this aspect represents 20% of the final grade of the subject.

For the grade in section B to be saved for the second call, a minimum grade of 5 must be obtained.

We remind you that section A together with section B can be approved, **within each call**, with at least an average of 5 between the grades of A1, A2 and section B as long as all three grades are equal to or greater than 4. That is, grade (A1 > 4 + A2 > 4 + B > 4) / 3 > 5 out of 10.

C.- Evaluation of the work and the capacity developed during the practical laboratory and bioinformatics.

The work developed in the laboratory (laboratory practices) and in the practical sessions in the bioinformatics lab will be evaluated. The assessment of this aspect will be made according to the skills shown by the student to work in the laboratory or with the sequence analysis program and the report that he/she presents on the work carried out. For laboratory work, a report will be presented, while for work in the bioinformatics lab, a questionnaire will be filled out and sent to the teacher at the end of the last session. The value of this section will be **16 points in the final grade of the subject (10 in the laboratory and 6 in the bioinformatics lab),** which represents 16% of the final grade of the subject. To pass this section, it is necessary to obtain a minimum grade of 5 out of 10, both in the laboratory part and in the bioinformatics part.

Attendance at the laboratory and bioinformatic sessions is a mandatory requirement to pass the subject.

D.- Evaluation of the interdisciplinary seminar.

The grade obtained in the interdisciplinary work will account for 10% of the grade of the subject. The tutor and an assistant teacher (co-tutor) will participate in the oral presentation of the work (with a relative weight corresponding to 60% and 40%, respectively). The assessment of this activity will consider both the scientific contents dealt with and the way in which they have been presented, especially valuing the ability to communicate and transmit ideas and concepts. The works selected for presentation at the Biology Congress will have an extra grade, corresponding to 10% of the grade of the activity.

If the subject is failed, the grade of the interdisciplinary work will be saved for the next academic year.

If the interdisciplinary work (of a compulsory nature) is not carried out, this subject will be suspended, if it is the subject linked to this interdisciplinary work (i.e., the one that proposed the topic and of which the tutor of the project is a teacher), regardless of the grade obtained in the rest of the subject.

In the case of failing the subject for not having carried out the interdisciplinary activity linked to it, the grade obtained in the rest of the subject will be kept if it is considered approved (i.e., with a grade equal to or greater than 5 out of a maximum of 9, in addition to meeting the rest of the criteria necessary to pass the subject, and which are detailed in this teaching guide). This grade will be kept only until the next academic year and will be added to the grade obtained in the interdisciplinary activity at the time it is carried out.

In the event that this subject is not the subject linked to the interdisciplinary work, if the interdisciplinary work is not carried out, in order to pass the subject it will be necessary to obtain a grade equal to or greater than 5 out of a maximum of 9, as they have not scored in the interdisciplinary activity (in addition to meeting the rest of the criteria necessary to pass this subject, and which are detailed in this course guide).

E.- Student's portfolio.

The student will be able to get up to 10% extra in the final grade of the subject through the assessment that, of the interest shown by the student in the subject as well as his degree of maturity in this field of Biology, can be made by the teachers valuing the attendance of the student to the personal tutorials and the realization of individual activities that have previously been consulted with the teachers. As and example, we can cite reading and critical analysis of books on genetic aspects; carrying out tasks proposed to improve certain theoretical aspects, attending seminars or conferences, etc.

Summary of the evaluation system:

Section	Punctuation over 100	It is saved for second call only if the grade in first call (out of 10) is greater than or equal to:
A1. Theory. Lectures 1 to 14	up to 27 points	**5**
A2. Theory. Lectures 15 to 25	up to 27 points	**5**
B. Problems	up to 20 points	**5**
C. Practical work (laboratory and bioinformatics)	up to 16 points (10 laboratory and 6 bioinformatics)	**5**
D. Interdisciplinary seminar	up to 10 points	**5**
E. Student's portfolio (volunteer)	up to 10 points (extra)	**0**

FINAL CONSIDERATIONS:

To pass the subject, it will be necessary to obtain an overall grade equal to or greater than 5 out of 10 (50 points). Specifically, in addition to being necessary to obtain grades greater than or equal to the equivalent of 5 points in sections C and D. It is recalled that you must also achieve at least an average of 5 between the grades of A1, A2 and section B **within the call** as long as all three grades are equal to or greater than 4. That is, grade (A1 > 4 + A2 > 4 + B > 4) / 3 > 5 out of 10.

The portfolio grade will be considered once the subject has been passed.

In the exam of the second call, the grade of sections A1, A2 and/or B cannot be improved if they have already been approved (minimum 5/10) in the first call.

The grades of the practical work (section C, joint grade of the laboratory and bioinformatics) equal to or greater than 5 (out of 10) obtained during an academic year will be kept for the calls of the following three academic years.

Those students who do NOT show up to any of the parts of the final exam (theory and / or problems), will appear with the grade of **NOT PRESENTED** in the records.

It is recalled that **it is NOT possible to renounce** grades equal to or greater than 5 obtained, both in the assessment of the different assessment tests and the documents delivered for it (exams, reports, etc.), as well as in the assessment of participation in face-to-face teaching activities (laboratory, problems, seminars, etc.).

Second call:

Students who do not pass the subject in the first call of the course, will have their grade saved for the second call, either in the sections corresponding to knowledge of theory independently (A1 and/or A2), problem solving (B), practical work (C) and/or interdisciplinary activity (D), **if they have passed it** (5/10).

It should be note that to pass the subject in the second call of the course it is necessary to have passed the practical work (section C).

REFERENCES

Basic references

- - Benito, C. 141 Problemas de Genética. (2015). 1ª edición. Ed. Síntesis. ISBN 9788490772195
- - Benito, C. and Espino, F.J. (2015) Genética: conceptos esenciales. 5ª edición. Ed.Médica Panamericana. ISBN : 9788498356014
- - Brown, T.A. (2008). Genomas. 3ª ed. Ed. Médica Panamericana. ISBN: 978-950-06-1448-1
- - Griffiths, A.J.F.; Wessler, S.R.; Carroll, S.B. and J. Doebley (2012). Introduction to Genetic Analysis. 10th Edition. Ed. W.H. Freeman. ISBN-10: 1-4292-2943-8 ISBN-13: 978-1-4292-2943-2
- - Griffiths, A.J.F., Wessler, S.R. and Lewontin, R.C. (2008). Genética, 9ª edición. McGraw-Hill-Interamericana. ISBN: 8448160916
- - Klug, W., Cummings, M.R., Spencer C. A. and Palladino M.A.(2013). Conceptos de Genética. 10ª edición. Pearson. ISBN: 9788415552499
- - Ménsua, José L. (2003). Genética. Problemas y ejercicios resueltos. Ed. Pearson. ISBN: 9788420533414
- - Pascual, L and Silva, F. (2018). Principios básicos de genética. 1ª edición. Ed. Síntesis. ISBN 9788491711063
- - Pierce B. (2016) Genética. Un enfoque conceptual. 5ª edición. Ed. Médica Panamericana. ISBN: 978- 84-

Complementary references

- - Departament de Genètica https://www.uv.es/genetica
- - DNA from the beginning. En inglés. https://www.dnaftb.org/
- - Sociedad Española de Genética https://segenetica.es/