COURSE DATA

Data Subject	
Code	33155
Name	Human genetics
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Faculty of Biological Sciences	4	First term

Subject-matter

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	12 - Biomedicina molecular	Obligatory

Coordination

Name	Department
MOLTO RUIZ, MARIA DOLORES	194 - Genetics

SUMMARY

Human Genetics is a subject belonging to the fourth year of the Degree in Biochemistry and Biomedical Sciences (University of Valencia, Plan 2009). It is a theoretical and practical subject of the first semester of the course, containing 6 ECTS credits. It is part of the subject "Molecular Biomedicine" along with "Clinical Biochemistry and Molecular Pathology", and the optional subjects "Microbial Pathogenesis", "Molecular Pharmacology" and "Molecular and Public Health Parasitology”.

Human genetics studies heredity and variation of biological traits in human, being one of the cornerstones of Biomedicine. Knowledge of the language, concepts and methods of Human genetics and the assessment of genetic and genomic perspective of health and disease, provide a learning framework which is essential in the professional practice within the Health Sciences at the present time.

This subject provides a comprehensive and integrated application of genetics to the study of heredity in human's beings, with emphasis on specific methods and techniques that have allowed the isolation of genes and characterization of mutations causing many hereditary diseases. In keeping with the theoretical development of the subject, will be experimentally developed some of the methods used currently in the implementation of Genetic counseling and Genetic diagnosis in its different facets, complemented with the discussion and resolution of specific clinical cases.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

OUTCOMES

1101 - Degree in Biochemistry and Biomedical Sciences

- Have capacity for analysis, synthesis and critical reasoning in the application of the scientific method.
- Desarrollo de habilidades para la aplicación de los conocimientos adquiridos al mundo profesional.
- Capacidad para el trabajo multidisciplinar en equipo y la cooperación.
- Be able to use new information and communication technologies.
- Know how to use the different bibliographic sources and biological databases and be able to use bioinformatic tools.
- Know the usual procedures used by scientists in the area of molecular biosciences and biomedicine to generate, transmit and disseminate scientific information.
- Know the common and differential molecular and cellular elements of the different types of living organisms with special emphasis on the human being and model organisms for their study.
- Understand experimental approaches and their limitations and interpret scientific results in molecular biosciences and biomedicine.
- Know how to design multidisciplinary experimental strategies in the field of molecular biosciences to solve complex biological problems, especially those related to human health.
- Acquire skills to use the methodologies of molecular biosciences and to keep an annotated record of activities.
- Know how to work responsibly and rigorously in the laboratory, considering the safety aspects in experimentation as well as the legal and practical aspects of the handling and disposal of waste.
- Know and understand the molecular bases of genetic information and the mechanisms of its transmission and variation.

- Know how to apply the knowledge gained in the diagnosis, prevention and treatment of human diseases.
- Tener una visión integrada de las técnicas y métodos utilizados por las ciencias Biomédicas.
- Capacidad para trabajar correctamente en los laboratorios de Biomedicina incluyendo seguridad, manipulación, eliminación de residuos y registro anotado de actividades.
- Utilización de terminología específica de la biomedicina.
- Conocer los principales métodos y técnicas experimentales aplicadas al estudio de la salud y enfermedad humanas, su etiología y la efectividad de los tratamientos.
- Conocimiento de las enfermedades y disfunciones más frecuentes.
- Capacidad para utilizar la instrumentación básica en los laboratorios de Biomedicina.
- Diferenciar entre enfermedades cromosómicas, de transmisión mendeliana y multifactoriales.
- Conocer las estrategias genéticas para la prevención de enfermedades hereditarias como son el consejo y el diagnóstico genético.
- Conocer el papel de los genes en el cáncer y su seguimiento mediante marcadores tumorales.
- Conocer los fundamentos de terapia génica.
- Conocer las aplicaciones de los análisis genéticos en la identificación de individuos y la determinación de relaciones de parentesco.

LEARNING OUTCOMES

About knowledge

1. Knowing and applying correctly the vocabulary and terminology specific to Human Genetics.

2. Acquisition of essential knowledge about genetic and molecular bases of inherited diseases.

3. Acquisition of basic knowledge about the origin of karyotypic alterations and its application in clinical cytogenetics.

4. Acquisition of knowledge and its application about the methodology developed for identification of Mendelian genes and genetic risk factors in multifactorial diseases and cancer.

5. Acquisition of basic knowledge of strategies to address the prevention and treatment of genetic diseases.

6. Acquisition of knowledge about the genetic basis of interindividual differences in response to different drugs and its application in the context of personalized medicine.

About procedure

7. Identification of the different Mendelian inheritance patterns, as well as the factors that can alter them, based on the study of genealogies and assignment of genotypes.

8. Assessment of genetic prediction and recurrence risk in hereditary diseases.

9. Recognition of loss of function vs gain of function mutations in hereditary diseases.

10. Learning the protocol for obtaining human karyotype and chromosomal abnormalities identification.

11. Learning different genotyping techniques as ASO (*Allele Specific Oligonucleotide) hybridization*.

12. Interpretation and presentation of genetic association studies results as "case-control".

13. Interpretation and presentation of genetic analysis results form different types of samples and tests applied in the genetic diagnosis.

14. Management of bibliographic sources related to human genetics from books, journals and database

DESCRIPTION OF CONTENTS

1. Introduction

The role of Human Genetics in Biomedicine and Health Sciences. Technical and scientific advances in Human Genetics. The Human genoma Projects. Largest international projects in genomics. Genomic databases. Medical genetics. Genetic and hereditary diseases. Disease Prevalence and Incidence.

2. The genetic and molecular bases of inherited diseases

Rare diseases Mendelian inheritance. Gain and loss of function mutations. Genealogy studies. Inbreeding coefficient. Autosomal and sex chromosome-linked inheritance patterns. Examples Atypical patterns of inheritance. Multiple alleles: Blood groups.

3. Extensions and exceptions to Mendelian inheritance I

Factors affecting basic patterns of inheritance: Penetrance. Expressivity. De novo mutations. Gonadal mosaicism. Lethality. Genetic heterogeneity. Pleiotropy.

4. Extensions and exceptions to Mendelian inheritance II

Dynamic mutations. Mechanisms and classification of microsatellites. Anticipation. Fragile sites.

5. Extensions to Mendelian Inheritance III

Epigenetics Epimutations Genes with imprinting. Epigenetic and epigenomic diseases. Characteristics of mitochondrial inheritance. Diseases with mitochondrial inheritance. Mitochondria replacement therapy.

6. Genetic diseases with complex inheritance

Genes and Environment. The norm of reaction. Continuous multifactorial inheritance. Discontinuous multifactorial inheritance. Alleles of genetic vulnerability. Study of complex diseases: studies of family clustering; studies of twins: rates of concordance and heritability; adoption studies.

7. Cloning disease genes

Principles and strategies in identifying disease genes. Functional cloning. Candidate gene approaches. Positional cloning: cloning of chromosomal breakpoints, linkage analysis. Autozygosity. Mutation screening: confirming a candidate gene. Genomic methodology: exome and genome sequencing, Gene Panels. Ethics issues.

8. Identification of genetic risk factors in complex diseases

Linkage analyses in complex diseases. Linkage disequilibrium. Candidate gene association studies. Genome wide association studies (GWAS). Haplotype map: HapMap project. GxE association studies. PHEnome-Wide Association Studies (PHEWAS).

9. The genetics of cancer

Genetic basis of cancer. Familial and sporadic cancer. Environmental risk factors. Oncogenes and tumor suppressor gene mutations. Tumor loss of heterozygosity. Alterations in DNA repair. Chromosomal instability. Tumor progresión.

10. Genetic Counselling

Genetic counseling. Determining recurrence risks. Genetic diagnosis: preimplantation, prenatal and presymptomatic. Diagnostics and laboratory tests. Population genetic screening.

11. Genetic diseases treatment

Treatment strategies. Gene therapy: types. Therapeutic genes and constructs. Transfer vectors and methods. Candidate diseases. Applying genomics to individualize cancer therapy. Pharmacogenetics and personalized medicine. Ethical issues in human genetics.

12. Human Genetics Laboratory: Detection of polymorphisms in the ADH3 gene using filter hibridization and ASO probes.

Amplification of ADH3 exon 8 by PCR from gDNA samples. Dot blot. Hybridization with dUTP-digoxigenin-labeled allele-specific oligonucleotides (ASO probes). Deteccion of hybrids by colorimetry. Analysis of resuls.

13. Human Genetics Laboratory: Karyotyping

Extraction of 2 ml of peripheral blood. Lymphocyte culture. Accumulation of cells in metaphase and dispersion of chromosomes. Fixation, extension and staining of the samples. Observation under the optical microscope and photographed. Ordering and classification of chromosomes.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	36,00	100
Laboratory practices	16,00	100
Classroom practices	8,00	100
TOTAL	**60,00**	

TEACHING METHODOLOGY

14:57:431. **Theory classes.** A total of 23 one-hour sessions will be needed to cover this teaching activity, developed in the format of lectures. The teacher will present the most relevant contents for the subject, using audiovisual equipment for agile development. The material necessary for proper monitoring of the lectures will be previously available in Aula Virtual.

2. **Laboratory**. The program of laboratory classes will be developed in coordination with the lectures. The duration of each laboratory session is 4 hours. Attendance is compulsory for these classes.

3. Problems and questions. The concepts presented in the lectures will be reinforced in these sessions. Active participation of students through discussion and problem-solving will be stimulated. The teacher will prepare a series of exercises for each subject block taking into account the most relevant aspects of the agenda**.** Students will work individually (through personal preparation) and collectively (through exposure and discussion in the group class).

4. Seminars, conferences or other activities. Seminars will be held by researchers in molecular Biomedicine. Students will have the opportunity to make contact with current research on the subjects of their studies.

5. Personalized tutoring. Students will be encouraged to use this resource for advice and discussion with the teacher of any topic about the program, the course, or degree studies.

EVALUATION

1. Evaluation of the knowledge of theory

The evaluation of the theory knowledge will represent **60%** of the final mark. It will be performed by the resolution of multiple-choice tests and written tests with short answer questions.

2. Evaluation of practical classes.

The value of this part will be **40%** of the final mark for the course.

1.1 An assessment of the student's ability to deal with and solve problems of a genetic nature will be done, by means of a written test that will be done together with the theory at the end of the course. The value of this test will be **20%** of the final grade of the subject.

1.2 Evaluation of laboratory. It will be assessed taking into account the presentation of practical results and discussion, 15 days after the end of these classes (**10%** of final mark) and a written test (**10%** of final grade) to be carried out in the last session of the laboratory classes. Attendance to the lab sessions is a prerequisite to pass the course.

The final mark will be the sum of the marks achieved in the different sections. To pass the course, it will be necessary to obtain a global mark equal to or greater than 5 out of 10, as long as the mark for theoretical and practical knowledge (both problems and laboratory) is independently equal to or greater than 4 out of 10.

For students who have not passed the subject in the first call, the marks of the knowledge of theory, problems and of the laboratory skills will be saved for the second call if the mark is equal to or greater than 4 out of 10.

The laboratory mark will be saved for the next course if it is equal to or greater than 5 points out of 10.

Students, who do not assist to any part of the final exam (theory or problems), will have NOT EVALUATED in the records.

To request the advancement of the call for this subject, the mandatory activities indicated in this teaching guide must have been carried out.

REFERENCES

Basic

- JORDE LB, CAREY JC y Bamshad MJ. Genética Médica. 2021 (6ª ed). Editorial Elsevier España SL. ISBN 978-84-9113-797-9; eISBN: 978-84-9113-880-8.

- NUSSBAUM R.L., McINNES R.R., WILLARD H.F. Genética en Medicina. 2016 (8ª Ed). Elsevier España. ISBN: 9788445826423

- PIERCE B.A. Genetics: A Conceptual Approach. 2018 (5ª Ed.). WH Freeman. ISBN 1319187811. La cuarta edición tiene traducción al castellano: Genética: un enfoque conceptual. 2016 (4ª ed). Editorial Médica Panamericana.

- PRITCHARD D.J. / KORF B.R. Genética Médica. 2015 (3ª ed). Editorial Médica Panamericana. ISBN 9788479033958

- STRACHAN T, GOODSHIP J, and CHINNERY P. 2015. Genetics and Genomics in Medicine. Garland Science, Taylor & Francis Group, LLC. ISBN 978-0-8153-4480-3

- STRACHAN and READ. Human Molecular Genetics. 2019 (5ª ed, ISNB 0815345895); 2010 (4ª ed, ISBN 9780815341499) Garland Science/Taylor & Francis Group. La tercera edición tiene traducción al castellano (2006, Mc.Graw-Hill Interamericana, ISBN970-10-5135-1).

-TURNPENNY P. and ELLARD S. Emery. Elementos de genética médica. 2018 (Ed. 15). Elsevier. ISBN 9788491132066

-Textos electrònics:
(1) Relació de llibres electrònics sobre temes de biomedicina. https://www.ncbi.nlm.nih.gov/books/

Additional

- DELGADO RUBIO A., GALÁN GÓMEZ E., GUILLÉN NAVARRO E., LAPUNZINA BADÍA PABLO D.,PENCHASZADEH VICTOR B., ROMEO CASABONA CARLOS MARÍA, EMALDI CIRIÓN AITZIBER.Asesoramiento Genético en la práctica médica. 2012. Editorial Médica Panaméricana.

- WEBS recomanades:
ENCODE www.nature.com/encode/#/threads
GeneCards: http://www.genecards.org/
Gene Names: www.genenames.org
Genetic Diagnosis: http://www.gendia.net/index.html
GeneReviews: http://www.genereviews.org/
OMIM - Online Mendelian Inheritance in Man: https://omim.org/
Orphanet (portal europeo de información de referencia en enfermedades raras y medicamentos huérfanos):
https://www.orpha.net/consor/cgi-bin/index.php?lng=ES