COURSE DATA

DATA SUBJECT

Code: 43465
Name: Genetic pathology
Cycle: Master's Degree
ECTS Credits: 3
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2210 - Master's Degree in Research in Molecular, Cellular and Genetics Biology	Facultat de Ciències Biològiques	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2210 - Master's Degree in Research in Molecular, Cellular and Genetics Biology	Genetic pathology	ELECTIVES

COORDINATION

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SUMMARY

Increased awareness of the role of genetics in the etiology of the disease and its impact on individuals, families and society, has led to the Molecular Genetics at the head of biomedical research. Indeed, in recent years there have been major advances in the understanding of molecular and patho-physiological of many hereditary diseases, clearly genetic diseases, but also in the study of the genetic basis of susceptibility to common diseases such as osteoporosis, Alzheimer's disease, diabetes, cancer or heart disease, or multifactorial complex diseases called because they meet both genetic and environmental factors.

The main objective of this elective course in the Master of Research in Molecular and Cellular Biology and Genetics is to provide the basic knowledge necessary for understanding the genetic basis of both monogenic diseases and complex diseases as well as know current technology and methodology for genetic and molecular characterization of these genetically based diseases.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

The subject "Genetic Pathology" is taught in the Master in Research in Molecular and Cell Biology, and Genetics as an elective. Students who enrol in it should have general knowledge in Molecular Biology and Molecular and Human Genetics.

COMPETENCES / LEARNING OUTCOMES

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Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.

Be able to access to information tools in other areas of knowledge and use them properly.

Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.

Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.

Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.

Students should demonstrate self-directed learning skills for continued academic growth.

Students should possess and understand foundational knowledge that enables original thinking and research in the field.

To be able to assess the need to complete the scientific, historical, language, informatics, literature, ethics, social and human background in general, attending conferences, courses or doing complementary activities, self-assessing the contribution of these activities towards a comprehensive development.

DESCRIPTION OF CONTENTS

1. Initial theme: The Human genome. Chromosomes. Mutation and polymorphism.

The human nuclear genome. Results derived from the genome project. HapMap and 1000 genomes projects. Mutation and polymorphism. General nomenclature and types of mutations. Distinctive features of diseases due to mitochondrial DNA alteration.

In this block karyotyping and the main techniques for its realization such as traditional banding are studied.

2. Block 1: Chromosomal Abnormalities.

In addition, other cytogenetic techniques such as FISH or those of current routine use such as CGH-Array or SNP array or the newest ones such as genomic optical mapping are also discussed. The objective is to understand the different techniques currently available and their diagnostic application in daily clinical practice. This will enable us to select the appropriate technique for the diagnosis, both prenatal and postnatally, of a specific patient and to obtain a fast, accurate and economic diagnosis. Several numerical and structural chromosomal pathologies are studied, analyzing the causes that provoke them. Euploidies and aneuploidies. Down's syndrome, Turner's syndrome, Klinefelter's syndrome. Structural anomalies. Translocations. Microdeletion/microduplication syndromes.

3. Block 2: Monogenic Pathologies.

Inheritance types and disease models: Autosomal dominant inheritance: Marfan syndrome, Neurofibromatosis and Achondroplasia. Autosomal recessive inheritance: Cystic Fibrosis, Tay-Sachs disease and Spinal Muscular Atrophy. X-linked inheritance: Hemophilia and Rett syndrome. Y-linked inheritance: Auricular hypertrichosis. Pseudoautosomal inheritance: Leri-Welli syndrome.
Phenomena that complicate the interpretation of Mendelian inheritance patterns: Pleiotropy, penetrance and expressivity. Phenocopy and genocopy. Genetic heterogeneity. Allelic diseases. Chimeras and Mosaicism. Founder mutation. Pseudodominance. Hypomorphic alleles. Uniparental disomy. X chromosome inactivation. Genetic modifiers.
Identification of genes responsible for monogenic pathologies: Polymorphism and its types. Genetic mapping and linkage. Strategies for gene identification. Genetic analysis methods. New approaches based on massive sequencing. Case studies of identification of genes involved in hereditary diseases.
Phenotypic effects of mutations: point mutation: missense, Nonsense Mediated Decay (NMD), insertion/deletion/indel. Non-exonic mutation. Deleterious, lethal, and beneficial mutation. Loss of function or gain of function mutation. Negative dominant mutation. Novel mutations, how to demonstrate that they are pathological?

4. Block 3: Non-classical Mendelian inheritance and mitochondrial inheritance

Pathologies caused by nucleotide expansions: General; Friedreich's Ataxia (GAA expansion in FXN gene); Myotonic dystrophy type I (CTG trinucleotide in DMPK gene) and Myotonic dystrophy type II (CCTG tetranucleotide in CNBP gene); Huntington's disease (CAG expansion in the IT15 gene); Pathologies caused by CGG triplet expansions in the FMR1 gene (Fragile X syndrome, FXTAS, Premature ovarian failure).
Epigenetic diseases (Beckwith-Wiedemann syndrome) and epigenomic diseases (Rett syndrome or ICF syndrome (Immunodeficiency/centromeric instability/facial anomalies), among others.
Pathologies due to mitochondrial DNA alteration: due to point mutations (Leber hereditary optic neuropathy, Leigh syndrome or MERRF disease), rearrangements in the mtDNA molecule (Pearson and Kearns-Sayre syndromes), and depletion syndromes.

This block studies different methodological approaches for the identification of susceptibility genes for complex diseases such as twin studies, parametric and non-parametric linkage studies and association studies with and without prior hypotheses. Linkage disequilibrium and haplotypes: the HapMap project.

5. Block 4: Multifactorial diseases

Other approaches to association studies (Phewas, Transmission Distortion Test (TDT), and Haplotype Risk Test (HRR)). Common disease common variant hypothesis. Where to look for missing heritability? Rare variants and complex disease. Identification of genotype x environment (GxE) interactions. Epigenetics and complex disease. Postmenopausal osteoporosis as an example of multifactorial disease.

6. Block 5: Cancer as a genetic disease

This block studies cancer as a genetic disease. To this end, the genomics of cancer is addressed by differentiating between adult tumors and pediatric tumors. In this topic we will study examples of pathologies associated with mutations in proto-oncogenes and activation mechanisms, in tumor suppressor genes and in genes involved in the detection, signaling and repair of DNA damage. Examples: Hirschsprung's disease, Retinoblastoma, and Li-Fraumeni syndrome among others.

7. Block 6: Clinical genetics

This block is mainly dedicated to comment on genetic counseling and the estimation of the risk of recurrence as the main item of this block. As far as possible, we dedicate minutes to current treatments for genetic pathologies, with emphasis on hereditary diseases and the study of Pharmacogenetics and Pharmacogenomics

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	7,00
Theory	21,00
Other activities	2,00
Total hours	**30,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	0,00
Preparation of lessons	15,00
Preparation for assessment activities	30,00
Resolution of case studies	0,00
Total hours	**45,00**

TEACHING METHODOLOGY

The course is structured into three weekly one-hour sessions. In each session, the professor will present the program topics for approximately 50-55 minutes, and the remaining hour will be devoted to questions and discussion of what has been covered in class or in previous classes. The concepts studied in the lectures will serve as a basis for students' reading and understanding of scientific articles.
The professor will provide a series of articles representing all the pathologies studied. The objective is to reinforce what has been learned in the course regarding the basic principles of inheritance, diagnosis, the technology used, and genetic counseling, and to familiarize students with this type of study.

EVALUATION

Student learning will be assessed by evaluating the following sections:
Final Exam: A single in-person written exam will be administered after classes have concluded, during the month of January. This exam will account for 70% of the final grade and may include multiple-choice questions, short-answer questions, and/or essay questions.
Continuous Assessment: This mandatory assessment will represent the remaining 30% of the final grade. It will include critical reviews of the articles provided by the faculty, as well as assessment of other indicators of engagement in the subject, such as regular attendance, active participation in class, and attendance at tutorials.

REFERENCES

- -COHN R, SCHERER S and HAMOSH A. Thompson & Thompson Genetics and Genomics in Medicine. 2023 (9ª Ed). Editorial Elsevier. ISBN: 978-0323547628. -Solari AJ (2011) Genética humana: fundamentos y aplicaciones en medicina. Buenos Aires. Editorial Médica Panamericana, 4a ed. -Strachan T and Read A (2019). Human Molecular Genetics. 4ª edición, CRC Press, Taylor & Francis Group. ISBN-978-0815345893 -Jorde LB, Carey JC, Bamshad MJ (2021). Genética médica. 6ª Edición. Elsevier. Barcelona. ISBN: 978-84-9113-797-9. -Turnpenny P and Ellard S (2017). Emerys Elements of Medical Genetics. 15 Edition. Academic Press. Elsevier ISBN: 9780702066917. -Strachan T, Goodship J, Chinnery P (2015). Genetics and Genomics in Medicine. 1ª edición. Garland Science. Taylor & Francis Group. New York. ISBN 978-0-8153-4480-3. -Mckusick VA (1998). Mendelian inheritance in man. Catalogue of human genes. 1998. Johns Hopkins -Uhlmann WR, Schuette JL, Yashar B (2009). A Guide to Genetic Counselling. 2009 (2nd edition). -Allis CD, Jenuwein TH, Reinberg D, and Caparros ML (2006). Epigenetics. Cold Spring Harbor Laboratory. -William K. Scott and Marylyn D. Ritchie (2022). Genetic Analysis of Complex Disease, 3rd ed. Newark: John Wiley & Sons, Incorporated. -Gardner, RJM (2012). Chromosome Abnormalities and Genetic Counseling. Oxford: Oxford University Press, cop, 4th ed. -Steven L. Gersen, Martha B. Keagle (2013) The Principles of Clinical Cytogenetics. 3rd ed, New York, NY: Springer New York.