COURSE DATA

Data Subject	
Code	44695
Name	Omics technologies
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2224 - M.U. Investigación y Desarrollo en Biotecnología Biomedicina	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2224 - M.U. Investigación y Desarrollo en Biotecnología Biomedicina	1 - New technology	Obligatory

Coordination

Name	Department
PEREZ ORTIN, JOSE ENRIQUE	30 - Biochemistry and Molecular Biology
SANCHEZ DEL PINO, MANUEL MATEO	30 - Biochemistry and Molecular Biology

SUMMARY

Omics technologies hold since late last century a leading role in many of the scientific discoveries in the fields of biology covered by this Master. Genomics The term was coined 25 years ago to refer to the sub-discipline of Genetics dedicated to the study of mapping, sequencing and analysis of the functions of whole genomes. Subsequently has extended the "omics" suffix to many other disciplines have in common being globalizing and used in all fields of Current Biology. Since much of the content of these omics is methodological and most prospective students must already possess basic concepts about them this subject focuses mainly on the study of methodologies and applications that have at this time research in Molecular and Cellular Biology, Genetics and Microbiology.

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

2224 - M.U. Investigación y Desarrollo en Biotecnología Biomedicina

- Students can apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- Students are able to integrate knowledge and handle the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflection on social and ethical responsibilities linked to the application of their knowledge and judgments.
- Students can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences, clearly and unambiguously.
- Students have the learning skills that will allow them to continue studying in a way that will be largely self-directed or autonomous.
- Students have the knowledge and understanding that provide a basis or an opportunity for originality in developing and/or applying ideas, often within a research context.
- Be able to integrate new technologies in their professional and/or research work.
- Ser capaces de analizar de forma crítica tanto su trabajo como el de su compañeros.
- Capacidad de seleccionar y gestionar los recursos disponibles (instrumentales y humanos) para optimizar resultados en investigación.
- Ser capaces de realizar una toma rápida y eficaz de decisiones en situaciones complejas de su labor profesional o investigadora, mediante el desarrollo de nuevas e innovadoras metodologías de trabajo adaptadas al ámbito científico/investigador, tecnológico o profesional en el que se desarrolle su actividad.
- Ser capaces de acceder a la información necesaria en el ámbito específico de la materia (bases de datos, artículos científicos, etc.) y tener suficiente criterio para su interpretación y empleo.
- Aplicar el razonamiento crítico y la argumentación desde criterios racionales.
- Capacidad para preparar, redactar y exponer en público informes y proyectos de forma clara y coherente, defenderlos con rigor y tolerancia y responder satisfactoriamente a las críticas que pudieren derivarse de su exposición.
- Ser capaces de trabajar en equipo, sin discriminación entre hombres y mujeres, con eficiencia en su labor profesional o investigadora adquiriendo la capacidad de participar en proyectos de investigación y colaboraciones científicas o tecnológicas.

- Capacidad para desarrollar los resultados científicos obtenidos por uno mismo o por otros científicos a las aplicaciones prácticas de rentabilidad social y/o económica.
- Ser capaz de aplicar los conocimientos adquiridos en la identificación de salidas profesionales y yacimientos de empleo.
- Adquirir las habilidades personales que faciliten la inserción y desarrollo profesional.
- Conocer y usar las técnicas y herramientas de búsqueda de empleo.
- Considerar el emprendimiento como alternativa profesional.
- Motivación por la calidad y la mejora continua, actuando con rigor, responsabilidad y ética profesional.
- Respeto a los derechos fundamentales y de igualdad entre hombres y mujeres.
- Capacidad de proyectar los conocimientos, habilidades y destrezas adquiridos para promover una sociedad basada en los valores de la libertad, la justicia, la igualdad y el pluralismo.
- Aprendizaje en la redacción de artículos científicos en los campos de la Biomedicina y la Biotecnología.
- Manejar adecuadamente las fuentes de información científica y poseer la habilidad de hacer una valoración crítica de las mismas, integrando la información para aportar conocimientos a grupos de investigación multidisciplinares.
- Utilizar adecuadamente las herramientas informáticas, métodos estadísticos y de simulación de datos, aplicando los programas informáticos y la estadística a los problemas biomédicos y biotecnológicos.
- Dominar el método científico, el planteamiento de protocolos experimentales y la interpretación de resultados en el ámbito biomédico y biotecnológico.
- Ser capaces de aplicar la experiencia investigadora adquirida tanto en la empresa privada como en organismos públicos.
- Saber diseñar estrategias experimentales multidisciplinares en el ámbito de las biociencias moleculares para la resolución de problemas biológicos complejos, especialmente los relacionados con salud humana.
- Adquirir destrezas en el manejo de las metodologías avanzadas empleadas en las biociencias moleculares y en el registro anotado de actividades.
- Mejorar la capacidad para trabajar de manera autónoma, responsable y rigurosa en el laboratorio, aplicando los conocimientos sobre los aspectos legales y prácticos en la manipulación y eliminación de agentes de riesgo.
- Mejorar la capacidad de trabajar con seres vivos o muestras biológicas.
- Tener una visión integrada del funcionamiento de los sistemas vivos utilizando el enfoque que proporcionan las ciencias ómicas.
- Aprendizaje del uso de la instrumentación y equipamientos empleados en los laboratorios de biotecnología y biomedicina.

- Saber utilizar un lenguaje integrador y no discriminatorio en todos los ámbitos de la comunicación anteriormente mencionados.

LEARNING OUTCOMES

1) Understand how omics sciences, approaches and interpetración of the results generated
2) Knowing the capabilities, the implications and limitations of omics techniques.
3) Practical realization of identifying a protein by analyzing its peptide fingerprint.
4) Discuss the future of these technologies as well as the resources / information obtained relationship.
5) Understanding what relevant biomedical information that can be obtained from these and what is their scope.

DESCRIPTION OF CONTENTS

1. General concepts of omics technologies

The era of omics. functional genomics and other omics. Subject of study, globalizers approaches and analysis of results.

2. Methods for DNA sequencing whole genomes.

Historical description of genome sequencing. Current methodologies of high-trouhgput sequencing (HTS). Third generation HTS methodologies and the future of technology. Assembly of complete genomes. Annotation of genomes. Metagenomics

3. Methods for global gene expression analysis.

Methods of analysis of global gene expression. Comparison of individual analysis methods and global analysis. The serial analysis of gene expression (SAGE) and derived methods. DNA Chips or microarrays: fundamentals and applications. transcriptomic studies with DNA chips. Ultrasequencing for transcriptome studies: RNAseq and other techniques. Analysis of the results. Study of other parameters of gene expression. Metatranscriptomics.

4. Interactomics, Epigenomics and Phenomics.

Interactions between DNA and proteins: ChIP-chip and ChIP-seq. Three-dimensional organization of the genome. Epigenomics. RNA-protein interactions and RNA structure. Global phenotypic studies: phenomics. Collections of deletion mutants of genes. Essential genes. Collections of gene fusions. Analysis techniques phenotypic studies.

5. Sample preparation and separation in Proteomics

Preparation of samples for analysis by proteomic techniques. Separation techniques peptides and proteins. Proteomics Bottom-up and Top-down.

6. Mass spectrometry: instrumentation and procedures.

Ionization techniques biological samples. Types of mass analyzers and its application in proteomics. Fragmentation and de novo sequencing of peptides. Experiments LC-MS / MS. dependent and independent data acquisition.

7. Protein identification.

Protein identification methods. Using search engines. Analysis of macromolecular complexes.

8. Protein quantitation

Protein quantitation methods using fluorescent and isotopic labeling. Quantification techniques without marking. Directed proteomics (SRM / MRM). Analysis of interaction networks and metabolic pathways.

9. Metabolomics

Analysis techniques in metabolomics. Identification and quantification of metabolites.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	50,00	100
Development of group work	10,00	0
Development of individual work	25,00	0
Study and independent work	30,00	0
Readings supplementary material	10,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

The following teaching methodologies will be used for the activities of this module: 1) Theoretical classes. Based on the lecture / lecture method and case studies 2) Seminars prepared by the students tutored by the teacher 3) Seminars given by experts on current issues. 4) Personal tutorials. Help and guide students in relation to problems that arise during the development of face-to-face and non-face-to-

face activities.

EVALUATION

The evaluation will be based on an examination of the two parts of the subject: proteomics / metabolomics (value 40%) and genomics (value 60%). To pass, it will be necessary to exceed 30% of the grade for each part in order to average the two grades. The exam will constitute 90% of the final grade. The other 10% will be based on seminars given by the students that will be evaluated by the corresponding professor based on the content of the seminar, quality of the presentation and the answers to the questions that are asked about its content.

REFERENCES

Basic

- - Chee-Seng, K. et al. (2010). Next generation sequencing technologies and their applications. In: Encyclopedia of Life Sciences (ELS). John Wiley & Sons.
- Metzker, ML (2010). Sequencing technologies the next generation. Nat. Rev. Genet., 11: 31-46.
- Brent, M. R. (2006). Genome annotation past, present, and future: How to define an ORF at each locus. Genome Res., 15:1777-1786.
- Handelsman, J. (2004). Metagenomics: application of genomics to uncultured microorganisms. Microbiol. Mol. Biol. Rev., 68: 669-685.
- Xu, Y., and Gogarten, J. P. (2008). Computational Methods for Understanding Bacterial and Archaeal Genomes. Series on Advances in Bioinformatics and Computational Biology, vol. 7. Imperial College Press, London.
- Pérez-Ortín, J.E.; Alepuz, P. y Moreno; J. (2007). Genomics and gene transcription kinetics in yeast. Trends Genet. 23, 250-257.
- Eidhammer, I., Flikka, K., Martens, L., and Mikalsen, S.-O. (2008). Computational Methods for Mass Spectrometry Proteomics (Wiley-Interscience).
- Bar-Even A. et al. (2006). Noise in protein expression scales with natural protein abundance. Nat. Genet. 38: 636-643.
- Myers, C. L., et al., 2005. Discovery of biological networks from diverse functional genomic data. Genome Biology, 6: R114.
- Fernando Corrales y Juan J. Calvete (2014) Manual de proteómica. Sociedad Española de Proteómica

Additional

- - Biological database compilation at NAR: http://nar.oupjournals.org/content/vol29/issue1
  - EMBL (European Molecular BIology Laboratory), Bioinformatics. http://wwwdb.embl.de/jss/servlet/de.embl.bk.emblGroups.EmblGroupsOrg/serv_0?t=0
  - ExPASy (Expert Protein Analysis System). http://us.expasy.org/
  - GenomeNet (Kyoto University Bioinformatics Center). http://www.genome.jp/
  - Gene Ontology Consortium. http://www.geneontology.org/GO.consortiumlist.shtml
  - GOLD (Genomes Online Database). http://www.genomesonline.org/
  - KEGG (Kyoto Encyclopedia of Genes and Genomes). http://www.genome.jp/kegg/kegg2.html
  - MINT: Molecular Interaction Database. http://mint.bio.uniroma2.it/mint/Welcome.do
  - NCBI (National Center for Biotechnology Information). http://www.ncbi.nlm.nih.gov/
  - Saccharomyces Genome Database. http://www.yeastgenome.org/