Universidad Zaragoza

Academic Year/course: 2022/23

66859 - Omics tools in the study of health

Syllabus Information

Academic Year: 2022/23
Subject: 66859 - Omics tools in the study of health
Faculty / School: 105 - Facultad de Veterinaria
Degree: 617 - Master's in Global Health: Integration of Environmental, Human and Animal Health
ECTS: 3.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The course and its expected results meet the following aims:

The overall objective of the course is the basic management and integration of various Omics techniques (genomics, transcriptomics, proteomics, metabolomics, epigenomics and metagenomics) and their application to the search for biomarkers and disease resistance factors. The theoretical classes will introduce the student to the bases of the tools and their applications. The theory will be interspersed with practical classes, where the obtained knowledge will be reinforced and applied to the practical use of bioinformatics tools and the interpretation of results.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment), in such a way that the acquisition of the subject learning goals provides training and competence to contribute to some extent to its achievement:

- Objective 3: Good Health and Well-being (targets 3.3 and 3.4)
- Objective 4: Quality education (target 4.4)
- Goal 8: Decent work and economic growth (target 8.6)
- Objective 9: Industroes, innovation and infrastructure (target 9.5)
- Goal 12: Responsible consumption and production (target 12.2)
- Goal 16: Peace, justice and strong institutions (target 16.6)

1.2. Context and importance of this course in the degree

This course is framed within the Master's in Global Health: Integration of Environmental, Human and Animal Health, a degree that contemplates an interdisciplinary approach to the study of health. The aim of this degree is to integrate epidemiological, environmental and molecular tools to understand the dynamics of diseases. The speciality course "Omics Tools in the Health Studies" is optional within the Translational Research specialty that provides basic and essential knowledge to use, interpret and design current diagnostic and prevention tools. It complements other specialty courses such as "Advanced Tools for Diagnosis and Prevention" or "Experimental Models of Disease", and also provides knowledge of bioinformatic tools for obtaining and analysing omics data in order to search for biomarkers in identification of the genetic basis of disease resistance and resilience. Finally, basic statistical knowledge highly relevant for the analysis of omics data will be obtained.

1.3. Recommendations to take this course

It is convenient for the student to have previous knowledge on Genetics, Biochemistry and/ or Molecular Biology, Microbiology and Statistics.

2. Learning goals

2.1. Competences

By passing the course, the student will be more competent to:

· Understand the methodological bases and use of omics tools.

· Use computer tools and specific web applications to analyse omics results.

· Design and interpret experiments based on the use of omics tools.

· Know how to apply omics tools in various areas of health study and research.

2.2. Learning goals

To pass this course, the student will have to demonstrate the following results:

· Understand the bases of omics studies.

· Be able to interpret omics analysis results.

· Know how to design a study using omics tools.

· To be able to critically evaluate scientific articles that use omics tools.

· Know how to perform basic analysis of results obtained with omics tools.

2.3. Importance of learning goals

The course provides skills on the bases, the analysis and the interpretation of results of the data obtained by omics methodologies. These skills are of increasing importance for the development of activities of health professionals for the critical interpretation of results obtained through their own work or by other published works, for the experimental design and for the development of biomarkers. The tools learned can be applied to other more basic aspects of health research, such as the study of their molecular mechanisms or the search for therapeutic targets.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student will have to demonstrate that s/he achieved the intended learning results through the following assessment activities:

ACTIVITY 1: WRITTEN TEST FOR THE THEORETICAL ASSESSMENT

There will be a final written test based on the answer and 20 test questions. The test will evaluate the acquisition of basic theoretical knowledge of the lectures of the course. The qualification of this final written test will be from 0 to 10 and will represent 20% of the final grade for the course.

ACTIVITY 2: WRITTEN TEST FOR THE PRACTICAL ASSESSMENT

At the end of each of the practices, the student will have to fill out a questionnaire in which it will be evaluated whether they have acquired the desired skills. The evaluation of the set of practices will be from 0 to 10 and will represent 30% of the final grade for the course.

ACTIVITY 3: ACADEMIC/WRITTEN WORK

In order to pass this activity, at the end of the course the student needs to present a bibliographic review omics tools of his/her choice to illustrate how it has been used in the diagnosis and/or prevention of a disease. The work will be evaluated by two teachers of the course. The qualification of this activity will be from 0 to 10 and will represent 30% of the final grade for the course. This rating will take into account the following aspects:

- Originality of the work (30%)

- Knowledge and demonstrated understanding of the described methodologies (30%)

- Bibliographic review: search, understanding and interpretation (40%).

ACTIVITY 4: TROUBLESHOOTING AND CASES

In groups, students need demonstrate their ability to interpret results of different problems based on omics data by solving a specific case. They will have to justify and reason their resolution in a written report that will be presented at the end of the course. The qualification of this activity will be from 0 to 10 and will represent 20% of the final grade for the course.

Summary table of the evaluation activities and their reflection in the student's final grade:

Assesment Task	**Content evaluated**	**% Final score**
Written test 1	Lectures	20 %
Written test 2	Practical sessions	30%
Academic work	Autonomous search for information and writing reports	30%

Resolution of cases	Group work for the resolution of practical cases	20%

Global assessment: Students who have not chosen the continuous assessment or who have not passed the subject by this procedure, will have the right to sit for a global assessment that will consist of a written test that assesses the theoretical and practical contents of the subject and the on-site resolution of a practical case. This test will have a score between 0 and 10 points. Assessment criteria: the written test will suppose 60% of the final grade and the resolution of the case 40%. The test will take place in the official exam period of the University of Zaragoza.

Grading system: according to the Regulation of Learning Assessment Standards of the University of Zaragoza (Agreement of the Governing Council of December 22, 2010), the results obtained by the student will be graded based on the following numerical scale of 0 to 10, with expression of a decimal, to which its corresponding qualitative qualification may be added:

0-4.9: Suspense (Suspenso, SS).

5.0-6.9: Approved (Aprobado, AP).

7.0-8.9: Notable (Notable, NT).

9.0-10: Outstanding (Sobresaliente, SB).

The mention of "Matricula de Honor" will be awarded to students who have obtained a grade higher than 9.0. Their number may not exceed five percent of the students enrolled in the corresponding academic year.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process designed for this course is based on the following issues:

The course is structured in four thematic blocks that comprise 14 theoretical topics and four practical sessions. A total of 20 theoretical classroom lectures (presential) will include as much as possible, practical examples. For the preparation of the theoretical examination, 34 hours of remote (non-presential) work of the student will be required.

The student will also take 10 hours of practical sessions divided into four practices with a variable duration depending on the theme. The student will need to fill out a questionnaire at the end of each practical session to demonstrate that s/he has acquired the intended skills.

Finally, the student shall carry out academic assignments that will entail a 10-hour autonomous work.

Summary table of the time distribution in the different teaching activities

Exercise	Classroom (h)	Remote (h)
Theoretical master class	20	0
Practical classes	10	0
Teaching tasks	0	10
Autonomous work of the student	0	34
Assessment test	1	0

4.2. Learning tasks

The program offered to the student to help her/him to achieve the intended results includes the following tasks:

Participatory master classes will be taught in the classroom. Before the start of the same, students will be provided, with sufficient time, the teaching material to use. The master classes will be held in a single group.

The practical sessions will be divided into 4 sessions and will have a variable duration depending on their nature. These sessions will take place in the computer rooms. In principle, this activity will be carried out in a single group.

Academic assignments will be carried out individually or in groups. For their realization, the teaching staff will provide the necessary documentation and will tutor the students. The student will need to carry out work autonomously for the study of the theoretical subjects of the course, as well as the literature search and assignment. There will also be a 2-hour session to solve problems and cases.

Finally, there will be an evaluation of the teaching work by at least two teachers, and of the theoretical content through a written exam. These will be prepared and evaluated by the teachers who participate in the course.

4.3. Syllabus

The course will address the following topics:

LECTURES:

BLOCK I: INTRODUCTION TO OMICS ANALYSIS: GENOMIC, TRANSCRIPTOMIC, PROTEOMIC, METABOLOMIC, METAGENOMIC.

Topic 0: Introduction

- Presentation of the course.

Estimated duration: 1 hour in person.

Topic 1: Genomics

- Definition and concepts.
- Sequencing, mapping, annotation and applications.
- Tools based on the use of new sequencing technologies. Estimated duration: 1 hour in person.

Topic 2: Transcriptomics (in English)

- Definition and concepts.
- Transcriptomic analysis tools (pilot techniques [ESTs, SAGE], microarrays, RNA sequencing.

Estimated duration: 1 hour in person.

Topic 3: Proteomics

- Fundamental concepts about proteins (composition, structure, properties, post translational modifications) and proteomics (challenges, strategies)
- High performance liquid chromatography (HPLC) and mass spectrometry (MS) applied to proteomics.
- Computer resources and protein databases. Estimated duration: 1 hour in person.

Topic 4: Metabolomics

- Metabolomics. Concept, development, tools used.
- Application in Pharmacology. Pharmacometabolomics. Estimated duration: 1 hour in person.

Topic 5: Epigenomics: mechanisms, tools and applications in the study of diseases

- Definition and concepts.
- Mechanisms of epigenetic gene regulation.
- Epigenetics in nature: examples.
- Experimental tools for epigenetic analysis.
- Application of epigenomics in the study of molecular mechanisms, diseases and treatments. Estimated duration: 2 hours in person.

Topic 6: Metagenomics: Microbiota analysis

- Analysis of microbiota by study of 16S rRNA amplicons
- Tools for analysis of microbiota
- Applications in the investigation of intestinal diseases Estimated duration: 1 hour in person.

BLOCK II: STATISTICAL METHODS FOR THE ANALYSIS OF OMIC DATA

Topic 7: Statistical methods for the analysis of "omics" data (I): Preprocess.

- Normalization and transformation methods.
- Transformation for compositional data.
- Clustering and dimensional reduction.

Estimated duration: 1 hour in person.

Topic 8: Statistical methods for the analysis of "omics" data (II): Analysis.

- Statistical tests.
- Lineal models.
- Generalized lineal models.

Estimated duration: 1 hour in person.

Topic 9: Statistical methods for the analysis of "omics" data (III): Interpretation.

- Multiple comparison problem.
- Bonferroni correction and False Discovery Rate.
- Enrichment methods.

Estimated duration: 1 hour in person.

BLOCK III: APPLICATIONS OF THE "OMIC" TOOLS FOR THE DISCOVERY OF BIOMARKERS

Topic 10: General introduction to biomarkers (in English)

- Revision of the general properties of biomarkers.
- Clinical development (phases, regulatory agencies)
- Non-coding RNAs in neurodegenerative diseases and aging.

Estimated duration: 2h in person.

Topic 11: Transcriptomic tools to search for biomarkers (in English)

- Principal steps for RNA sequencing.
- Galaxy platform: biomarker search through analysis of RNA-Seq data.

Estimated duration: 2h in person.

Topic 12: Proteomic tools to search for biomarkers

- Tools for the discovery phase (2D electrophoresis, DIGE, iTRAQ, Label-free)
- Tools for the confirmation / validation phase (ELISA, WesternBlot, SRM)
- Examples of proteomic tests

Estimated duration: 1h in person.

BLOCK IV: GENOMIC ANALYSIS FOR THE IDENTIFICATION OF THE GENETIC BASIS OF RESISTANCE TO DISEASES AND RESILIENCE

Topic 13: Genetic variation of the host in disease resistance (quantification) GWAS

- Definition and concepts.
- Experimental designs and phenotyping.
- Genomic tools for genome wide association studies (GWAS): low, medium and high density arrays; association programs and imputation of genotypes; use of new generation sequencing genotypes.
- Annotation and analysis of functional enrichment.

Estimated duration: 2h in person.

Topic 14: Selection for genetic resistance to diseases

- Introduction to quantitative genetics.
- Similarity between relatives and heritability.
- Objectives and criteria of selection.
- Biomarkers, molecular genetics, and genomic selection.
- Selection for immune response and selection for resilience.

Estimated duration: 2h in person.

PRACTICAL SESSIONS

Practice I. Exploring RNAseq data

Estimated duration: 2 h in person. Space required: Bioinformatic room.

Contents: Analysis of small RNA sequencing data in Galaxy platform.

Activities carried out by the student:

- Data import.
- Quality control (FastQC).
- Read trimming (Trimmomatic).
- Alignment of reads with a reference genome (HISAT2)
- Read count (FeatureCounts).
- Creation and implementation of computational workflow (Workflow)
- Differential expression (DESeq2) and export of normalized data.
- Data analysis in Excel
- Written test: practice questionnaire.

Observations: This practice will be carried out in combination with the theoretical classes of Topic 11.

Practice II. Proteomic analysis: Identification of proteins by peptide fingerprint and MS / MS with MALDITOF / TOF technology

Estimated duration: 2 hours in person. Space needed: Bioinformatics room.

Contents: Identification of a protein by MALDITOF / TOF mass spectrometry. Use of search engine and protein databases. Interpretation of the results.

Activities carried out by the student:

- Analysis by MALDI TOF / TOF mass spectrometry
- Search in databases
- Interpretation of the result
- Written test: practice questionnaire.

Observations: This practice will be done in combination with the theoretical classes of Topics 3 and 12.

Practice III: Genetic variation of the host in disease resistance (quantification) GWAS

Estimated duration: 2h in person. Space required: Bioinformatics room.

Contents: Identification of genomic regions associated with resilience and resistance to infections by gastrointestinal parasites in sheep. Use of basic tools for filtering massive genotyping data, and genome-wide association studies (GWAS). Interpretation of results and functional enrichment analysis.

Activities carried out by the student:

- Import and quality filtering of genotyping data.
- Imputation of missing genotypes.
- Full genome association analysis.
- Gene annotation and functional enrichment analysis.
- Written test: practice questionnaire.

Observations: This practice will be carried out in combination with the theoretical classes of Unit 13.

Practice IV: Metagenomics: Analysis of the intestinal microbiota

Estimated duration: 4 hours in person. Space required: Bioinformatics room. Activities carried out by the student:

- Visualization and import of sequencing data.
- Analysis of the quality of the sequences obtained.
- Filtering of the sequences, elimination of chimeras and replication. Obtaining OTUs.
- Taxonomic annotation of the sequences.
- Analysis of bacterial composition and different taxonomic levels.
- Written test: practice questionnaire.

Observations: This practice will be done in combination with the lectures of Topic 6.

ACADEMIC WORKS

Individual work: Biomarkers for a disease and how they have been detected (Bibliographic Review)

Each student will choose a disease or a group of diseases and on it will carry out a bibliographic review that compiles the different Omics tools used for their diagnosis and prevention, explaining each of them and the results obtained with them.

Group problem solving and cases

Problem solving and cases will show teamwork, discussion and skills with information sources. Students must work in groups and solve the questions posed in problems related to the course.

4.4. Course planning and calendar

Calendar of classroom sessions and task delivery

The calendar of the Master?s and the programming of the theoretical and practical sessions of the course will appear in the month of September on the website of the Veterinary Faculty: http://veterinaria.unizar.es/

The dates for the theoretical assignment will be scheduled each year based on the schedule of the Master's in Global Health and will be available for the student at the time of enrolment. Teaching assignments will be delivered no later than one week after the end of the other teaching activities.

Tutorials

Tutorials will be held upon previous appointment by e-mail.

Coordinator

Janne M. Toivonen email: toivonen@unizar.es

4.5. Bibliography and recommended resources

The list of updated bibliography, presentations and recommended resources will be displayed in the ADD and, as far as possible, will be available before the theoretical and practical sessions, so that students can consult them beforehand to encourage understanding and more active participation.