**SHORT DESCRIPTION AND JUSTIFICATION** (of the meaning of the course in relation to the studies. Between 100 and 200 words)

Omic sciences aim the characterization and quantification of the global pool of biomolecules, to understand the structure, function and dynamics of cells and organisms. The exponential growth of these sciences is closely linked to the capacity to sequence the genomes, together with the development of methodologies that allow the global measurement of the biomolecules present in a biological sample. The impact of these sciences in the current and future biotechnology is undisputed, since global understanding of a biological system facilitates optimization of biotechnological processes and the identification of new biotechnological targets.

The aim of the course is to provide students with basic knowledge of the different "omic" sciences, and it is divided into three parts: (1) GENOMICS: Fundamentals for understanding and analysing the structure, function and diversity of genomes. (2) PROTEOMICS: Techniques for the analysis of proteomes (set of proteins of a cell or organism). (3) METABOLOMICS: Techniques for the study of the metabolome (set of metabolites in a cell or organism).

**COMPETENCES** (of the course placed in relation to the pre-assigned competences in the subject matter)

- That students know how to apply their knowledge to their work or vocation in a professional manner, and have acquired the competencies that allow them to elaborate and defence arguments as well as to solve problems within their area of study (CB2)
- That students develop those learning skills necessary to undertake further studies with a high degree of autonomy (CB5)
- Be able to assess the impact of their professional activity on the sustainable development of society (T3)
- Be able to understand and apply advanced knowledge of Biosciences and Engineering to the field of Biotechnology (E3)
- Be able to use tools, systems or processes to carry out the activities in the field of Biotechnology according to the established requirements (E4)

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• Be able to integrate the knowledge and tools of biotechnology for their application to different industrial sectors that use, develop or produce biotechnological products or processes (E6)

PREVIOUS REQUIREMENTS * (modules, subject matters, courses or knowledge necessary for the follow-up of the subject. State previous courses required to be completed)

Students must have completed the following courses of the basic module: Cell Biology and Genetics, Animal and Plant Biology, and Microbiology. In addition, students must have completed the following courses of the second year: Molecular Biology, Recombinant DNA technology, Structure and function of biomolecules, Metabolism and regulation. Finally, students must have also completed the following courses of the third year: Bioinformatics and Protein Engineering.

CONTENTS (List the content of the course, with up to two level detail)

PART I. GENOMICS.

1. Introduction to genomics.
   1.1. Structure and organization of genomes.
   1.2. Comparative genomics.

2. Genome mapping.
   2.1. Genetic markers.
   2.2. Linkage analysis and genetic mapping.
   2.3. Development of physical maps.

3. Genome sequencing.
   3.2. Genome sequencing strategies: Hierarchical sequencing and whole-genome shotgun sequencing.
   3.3. Deep sequencing (next-generation sequencing).

   4.1. Whole-genome gene expression analysis.
   4.2. Microarrays: platforms, experimental design, and data analysis.
   4.3. Deep sequencing RNA (RNA-seq).
   4.4. Determination of the genomic binding sites of transcription factors: ChIP-chip and ChIP-seq.

5. Functional genomics.
   5.1. Genome mutagenesis: chemical and insertional mutagenesis.
   5.2. Genetic screening for the identification of new gene functions.

PART II. Proteomics.

6. Introduction to Proteomics.

7. Mass spectrometry.
   7.1. MALDI and ESI ionization.
   7.2. Types of analyzers, instruments and basic concepts of MS.

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7.3. Tandem mass spectrometry MS-MS.
8. **Identification and characterization of proteins by MS.**
   8.1. Identification of proteins by Peptide Mass Fingerprint.
   8.2. Identification of proteins on MSMS spectra.
   8.3. De Novo sequencing. Databases search engines.
   8.4. Characterization of posttranslational modifications.
9. **Proteomic analysis based on Two-dimensional gel electrophoresis.**
   9.1. Two-dimensional electrophoresis of proteins.
   9.2. DIGE.
10. **Proteomic analysis by liquid chromatography coupled to MS.**
    10.1. Coupling nano-LC-MS.
    10.2. Label-free Quantitative Proteomics.
    10.3. Quantitative proteomics based on isotopic labeling. SILAC, ITRAQ.
    10.4. Targeted quantitative analysis. SRM.
11. **Functional proteomics. Interactomics.**
12. **Protein arrays.**
    12.1. Analytical, functional and reverse phase arrays.
    12.2. Antibody arrays.
    12.3. Bead Arrays.
13. **Clinical Proteomics.**
    13.2. Microbiological identification.
    13.3. MALDI-imaging.
14. **Bioinformatic tools in proteomics.**
    14.1. Protein and peptide databases

**PART III. METABOLOMICS.**
15. **Introduction.**
    15.1. Role of metabolomics in systems biology.
16. **Acquisition and analysis of the metabolome.**
    16.1. Stop and extraction metabolites.
        16.2.1. Nuclear magnetic resonance.
        16.2.2. Mass spectrometry.
    16.3. Absolute quantitation based on IDMS.
17. **Applications.**
    17.2. Hierarchical and metabolic regulation.
    17.3. $^{13}$C-Metabolic flux analysis.

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**METHODOLOGY**

**LEARNING ACTIVITIES** *(Complete the table relating activities, workload in ECTS credits, and competences.)*

<table>
<thead>
<tr>
<th>Learning Activities</th>
<th>ECTS Credits</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>1,4</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Case and Problem-Solving Sessions</td>
<td>0,1</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Seminars</td>
<td>0,1</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Practical and Lab Work</td>
<td>-</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Presentations</td>
<td>-</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Personal Study</td>
<td>3,3</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Assessment Tasks (Exams, Continuous Assessment...)</td>
<td>0,1</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,0</strong></td>
<td><strong>CB2, CB5, T3, E3, E4, E6</strong></td>
</tr>
</tbody>
</table>

**TEACHING METHODOLOGY** *(justify the teaching methodology in relation to the competences and course contents. Between 100 and 200 words)*

The course includes lectures, case and problem-solving sessions and seminars. Student attendance to sessions is mandatory.

- **Lectures**: Presentation and explanation of contents by a teacher (possibly including demonstrations).
- **Case and Problem-Solving Sessions**: Resolution of exercises and problems, and exposition / discussion of cases by a teacher with the active participation of students.
- **Seminars**: Period of instruction carried out by a teacher with the aim of reviewing, discussing and resolving doubts about the materials and topics presented in the lectures and in the case and problem-solving sessions.

The course is divided into three blocks: Genomics, Proteomics and Metabolomics. Each block is organized into chapters. The weight of each part is: 40% Genomics, 40% Proteomics, and 20% Metabolomics. In each of these blocks different continuous assessment activities will be conducted, and at the end of the semester a final exam will be taken.

Personal study activities by the student serve to (i) prepare the other activities; (ii) acquire the skills and competences; and (iii) assimilate the knowledge presented in lectures and in case and problem-solving sessions.

The IQS virtual campus will be used to provide students with teaching materials (presentations, articles and quizzes) and maintain continuous communication.

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ASSESSMENT

ASSESSMENT METHODS * (Complete the table relating assessment methods, competences, and weight percentage in the course qualification)

<table>
<thead>
<tr>
<th>Assessment methods</th>
<th>Weight</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Exam</td>
<td>40%</td>
<td>CB2, CB5, T3, E3, E4, E6</td>
</tr>
<tr>
<td>Midterm Exam/s</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Continuous Assessment Activities</td>
<td>35%</td>
<td>E3, E4, E6</td>
</tr>
<tr>
<td>Reports and Presentations</td>
<td>20%</td>
<td>E3, E4, E6</td>
</tr>
<tr>
<td>Lab or Field Work</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Host Student Evaluation</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>5%</td>
<td>E3, E4, E6</td>
</tr>
</tbody>
</table>

LEARNING OUTCOMES (Explanation of the student’s achievements that allow the assessment of competences, relating them to the competences and the assessment methods)

- Students must know how to apply their knowledge on genomics, proteomics and metabolomics to their work or vocation in a professional manner, and must have acquired the competencies that allow them to elaborate and defence arguments as well as to solve problems within the area of the course (CB2)
- Students must develop those learning skills necessary to undertake further studies with a high degree of autonomy (CB5)
- Students must be able to understand the impact of omic sciences in Biotechnology, and to assess the impact of their professional activity on the sustainable development of society (T3)
- Students must understand the fundamentals of omic sciences (structure and analysis of a genome, and basic methodologies used in genomics, proteomics, Metabolomics). Students must be able to apply this advanced knowledge in biosciences and Engineering to the field of Biotechnology (E3)
- Students must be able to use tools, systems or processes to carry out the activities in the field of Biotechnology according to the established requirements (E4)
- Students must be able to integrate the acquired knowledge and tools from omic sciences in the context of Biotechnology, for their application to different industrial sectors that use, develop or produce biotechnological products or processes (E6)

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QUALIFICATION (Explanation of the qualification system)

The qualification of the course (final grade, CF) will consider the marks obtained in the final exam (EF), the continuous assessment (AS), reports and presentations (TP), and participation (P). Each of these grades will be over 10 and have a maximum value of 10.

The qualification of the continuous assessment activities (AS) is calculated as a weighted average of the various activities. The qualification of the reports and presentations (TP) is calculated as a weighted average of the various activities. The participation grade (P) is assigned at the end of the course after weighing the level of student participation in global activities.

The final exam (EF) is to evaluate the synthesis of the course. It will consist of three parts corresponding to the thematic blocks, which have the following weight: Genomics (40%); Proteomics (40%); and Metabolomics (20%). Each mark of the 3 parts will be over 10 and have a maximum value of 10. In order to pass the course, you must meet two requirements:
(I) The grade of each of the three parts of the EF should be equal or greater than 4,5.
(II) The grade of the EF should be equal or greater than 4,5. The EF grade is calculated as:

\[ EF = 0.4 \times \text{Genomics} + 0.4 \times \text{Proteomics} + 0.2 \times \text{Metabolomics} . \]

In the event that the mark of one of the three parts of the EF is less than 4,5, or that the grade of the EF is less than 4,5, then this mark will be the final grade (CF) of the course. In this case, the student can keep the marks of the blocks that are greater than or equal to 4,5 for the retake exam.

If the grade of the EF is equal or higher than 4,5, then the final grade (CF) of the subject is calculated as a weighted average of the marks obtained in the final exam (EF, 40%), the continuous assessment activities (AS, 35%), the reports and presentations (TP, 20%), and participation (P, 5%), following the formula:

\[ CF = 0.4 \times EF + 0.35 \times AS + 0.20 \times TP + 0.05 \times P \]

The course is passed when this final grade (CF) is equal to or greater than 5.

To pass the course, student must attend a minimum of 75% of the classes of each of the three parts of the subject (genomics, proteomics, metabolomics).

ASSESSMENT OF THE COMPETENCES (Describe the grading system for each competence in relation with the assessment tasks)

For the evaluation of the competences CB2, CB5 and T3, the grade of the EF will be used as an indicator.
For the evaluation of the competences E3, E4 and E6, the grades of the EF, the AS, the TP and the P will be used as an indicator.

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COURSE: GENOMICS, PROTEOMICS, AND METABOLOMICS

SUBJECT MATTER: Omics Technologies

MODULE: Biotechnology for Health

PROGRAM: Degree in Biotechnology

BIBLIOGRAPHY (Recommended and accessible to the student.)

GENOMICS:

PROTEOMICS:
- **Recursos on-line:**
  - [http://www.embl.de/proteomics/proteomics_services/links_tutorials/index.html](http://www.embl.de/proteomics/proteomics_services/links_tutorials/index.html)
  - [http://www.broadinstitute.org/scientific-community/science/platforms/proteomics/proteomic-mass-spectrometry-intro](http://www.broadinstitute.org/scientific-community/science/platforms/proteomics/proteomic-mass-spectrometry-intro)

METABOLOMICS:

DOCUMENT HISTORY

PREVIOUS REVISIONS (Indicate date and author / s, first the most recent one)

CURRENT REVISION (Indicate date and author / s)
March 20th 2019, Dr. Pau Leivar, Dr. Francesc Canals, Dr. Marc Carnicer

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