Teaching guide

IDENTIFICATION DETAILS

Degree:	Biotechnology
Scope	Biology and Genetics
Faculty/School:	Experimental Sciences
Course:	MICROBIOLOGY II
Type:	Compulsory
ECTS credits:	6
Year:	2
Code:	2029
Teaching period:	Fourth semester
Subject:	Biologics
Module:	Fundamental Sciences
Teaching type:	Classroom-based
Language:	Spanish
Total number of student study hours:	150

SUBJECT DESCRIPTION

The subject Microbiology II is complementary to Microbiology I. This course begins with the study of the microbial genome, the mechanisms of gene expression and its regulation, focusing mainly on viruses and bacteria. In addition, the molecular mechanisms that produce genetic variability and their implications are studied. Next, the importance of the interactions of microorganisms with other living beings and with the environment is discussed, the mechanisms of microbial pathogenicity and how the immune response to microbial infections is triggered are studied in depth. Finally, the usefulness of some microorganisms in industrial processes and the new possibilities that exist thanks to microbial biotechnology are analyzed.

Microbiology is the science that deals with the study of microorganisms and was consolidated as a scientific discipline during the last decades of the 19th century. Until the middle of the 20th century, microbiologists' main

interests were the characterization of infectious agents, the study of immunity and its role in preventing and curing diseases, the search for chemotherapeutic agents and the analysis of the chemical activity of microorganisms. The development of the first Genetic Engineering tools in the second half of the 20th century gave rise to the era of Molecular Microbiology or Microbial Biotechnology, in which the first genetically modified microorganisms were created. Throughout history, Microbiology has made great contributions to the world of Science, which have allowed the development of new disciplines and technologies for application in a multitude of fields of socio-economic activity such as medicine, agriculture, industry, food, bioenergetics, ecology, etc. We will begin by talking about the research carried out during the second half of the 20th century that allowed the development of basic tools for the genetic modification of microorganisms. From this moment on, the era of Molecular Biotechnology emerged, which has helped to create organisms and molecules that have made it possible to improve the quality of life of today's man and to generate great social optimism in everything related to the biotechnology field. This is also what has promoted a change in the current conception of the world and of man, something that needs to be deepened in order to establish the limits of what Biotechnology in general and Microbial Biotechnology in particular can and must create. Nowadays, industrial development and social changes have brought us to the current situation in which the sustainability of life is threatened. This has motivated the United Nations to set out a series of sustainable development objectives included in the 2030 Agenda, in order to ensure the viability of life on the planet and the well-being of people. In addition, this and other international organizations call on the university institution as one of the engines for the training and awareness of professionals who must contribute to the achievement of these objectives. In this sense, the Francisco de Vitoria University, with its comprehensive student education model and specifically from the subject of Microbiology, we want to get directly involved and make our students aware of the importance of sustainability. In Microbiology-II we will study how gene expression occurs in viruses and bacteria and the mechanisms that regulate it, how the cell cycle is regulated, what mechanisms produce the variability of genomes, the mechanisms that allow them to infect other cells and reproduce, etc. Knowledge of all these processes at the molecular level is essential to be able to control diseases of microbial origin or to design industrial processes and products of interest to today's society. The interaction of microorganisms with other living beings will also be studied, focusing mainly on the mechanisms that induce microbial pathogenicity and ways to combat it. An overview will be given of how the immune system responds to the presence of an infectious agent and also how microorganisms are able to evade this response. Next, we will study the fundamental role of microorganisms in nature as a whole and how they are responsible for many essential processes for the rest of the living beings to inhabit the planet. Finally, the usefulness that many microorganisms have in different industrial and technological sectors will be analyzed. In addition, in the practical classes included in this subject, the student will work with different types of microorganisms that he will isolate and manipulate, in order to learn the techniques that allow the identification and quantification of microorganisms as well as carrying out gene expression and molecular biology studies.

GOAL

The objective is for students to understand the molecular bases that direct the growth and behavior of microorganisms in their different habitats, as a basis for biotechnological development, always keeping in mind the ethical, social and anthropological implications of their genetic manipulation.

The specific aims of the subject are:

- Understand the fundamentals of bacterial genetics at the molecular level and its importance

- Know the basic characteristics of viruses and identify their applications

- Understand the molecular basis of infectious diseases

- Discovering the relationship between microbiota and human health

- Know the adaptation of microorganisms to their habitat and identify their potential application

- Identify the applications of molecular microbiology in current science

- Reflect on the applications of microbiology to society's challenges in terms of sustainable development

PRIOR KNOWLEDGE

To take the subject Microbiology II, it is advisable to have good knowledge in Cell Biology, Biochemistry, Genetics, and to have previously taken the subject Microbiology I.

COURSE SYLLABUS

SECTION I. INTRODUCTION.
Topic 1.- Microbiology in 21st century society. Importance of Microbiology in the development of other sciences. From Microbiology to Microbial Biotechnology. Contributions of Microbiology to the science of the moment and to the current conception of the world and of man. UN Sustainable Development Goals (2030)
SECTION II. MICROBIAL MOLECULAR BIOLOGY AND GENETICS
Theme 2. The bacterial genome: gene structure, replication and expression. The E. coli genome: genetic map. Chromosomes and extrachromosomal elements. Structure and function of genes and regulatory sequences. Replication, transcription and translation.
Theme 3. Regulation of gene expression. Levels of regulation. Regulation of transcription. Regulation of translation. Global regulation systems. Cell cycle control.
Topic 4. Mechanisms of genetic variation. Horizontal gene transfer methods: conjugation, transduction and transformation. Mutation and mutation repair. Transposable genetic elements. Plasmids. Bacterial transformation mechanism. Generalized and specialized transduction. Bacterial conjugation. The F factor.
SECTION III. VIROLOGY
Topic 5. General characteristics of viruses. General properties of viruses. Structure and classification. Cultivation.
Theme 6. Bacterial and archaic viruses. Structure and classification. Virulent bacteriophages. Tempered bacteriophages and lysogeny. Phages from different Baltimore groups. Phage therapy and other biotechnological uses of bacteriophages
Topic 7. Eukaryotic viruses and other acellular infectious agents. Classification of eukaryotic viruses. Types of infections in vertebrates. Viruses and cancer. Antivirals. Plant viruses. Defective viruses. Viroids and virusoids. Prions.
SECTION IV. MICROORGANISM-HUMAN INTERACTION
Topic 8. Human microbiota. Positive or neutral symbiosis between microorganisms and humans. Importance of the microbiota. Gastrointestinal microbiota: relationship with health status. Antibiotic effect. Probiotics and prebiotics.
Topic 9. Immune response. Nonspecific and specific immunity: cells and processes against infections. Different forms of immunization.
Topic 10. Microbial pathogenicity. Host-parasite relationships. Bacterial pathogenesis. Virulence factors associated

with adhesion and invasion. Toxigenicity. Escape the host's defenses. Role of biofilm and QS. Regulation of virulence factors. Pathogenicity islands and HGT.
SECTION V. ENVIRONMENTAL AND INDUSTRIAL MICROBIOLOGY
Topic 11. Microbial ecology. Introduction to the analysis of microbial communities. Metagenomics and its application. Extreme habitats. Microbial bioremediation. Bioplastics. Biofuels. Interactions with other living beings.
Topic 12. Industrial, food and pharmaceutical microbiology. Microorganisms of industrial interest and their products. Types of metabolites. Industrial fermentations. Scaling. Applications: some examples of food industries, food analysis, pharmaceuticals, etc.
Topic 13. Applications of Microbiology in Genetic Engineering and Biotechnology.
SECTION VI. LABORATORY PRACTICES
Block 1. Microbial genetics. Obtaining spontaneous and induced mutants. Auxotroph selection. Gene transfer in gram-negative bacteria by conjugation. Regulation of the lac operon in Escherichia coli: effect of the presence of glucose or lactose in an E. coli culture.
Block 2. Virology. Bacterial virus titration: infection of E. coli with Lambda phage. Observation of lysis plaques and determination of the number of infectious viral particles.
Block 3. Environmental and health microbiology. Microbiological analysis of contaminated water. Count the number of microorganisms in water samples and analysis of the type of microorganisms present. Detection of potential pathogens. Identification of bacteria in different anatomical areas by growing on plates of enriched, selective and differential media
Block 4. Industrial Microbiology. Application of microorganisms in food processing. Selection of microorganisms with activities of industrial interest

EDUCATION ACTIVITIES

- Participatory exhibition classes. They will be taught by the teacher of the subject with computer support: the schemes designed by the teacher of the different subjects are projected, including figures obtained from books and publications. Questions will be asked in class about what has been explained and doubts will be resolved. In addition, in some sessions, the inverted class methodology or 'flipped classroom' will be used, in which the teacher will direct the session based on the materials sent previously and that the students have worked individually or in groups prior to the session.
- Carrying out group work: IMA2030 Project This activity was created with the objective of involving our students in the call made by the UN to universities to achieve the objectives of the 2030 agenda. From the Microbiology and Social Responsibility subjects of the Biotechnology degree, we understand that our students must acquire competencies that involve them, not only personally, but as professionals, in these sustainability challenges. For this reason, we have developed the IMA2030 project (Implication of the Microbiologist in the 2030 Agenda). Students will carry out group work in which they will study the possible applications of genera or microbial species of biotechnological and/or clinical relevance and will identify their usefulness in the face of the sustainable development challenges of the UN 2030 agenda. The project will be developed and evaluated in the subjects of Microbiology II and Social Responsibility. In the subject of Microbiology-II, each team will study and propose a biotechnological application, related to microbiology, useful in one of the sustainable development objectives proposed by the UN and studied in the subject of Social Responsibility. The student will wake up to global problems and will discover, at the molecular level, the genetic and biotechnological characteristics of the selected microorganism or group of microorganisms, with the objective of deciding the biotechnology-based project they want to develop to provide knowledge or solutions that alleviate the problem.
- Continuous evaluation. Evaluation tests will be carried out throughout the course so that the student can self-evaluate the degree of knowledge of the subject continuously over time. These tests do not release subject matter

and will include multiple-choice questions and development questions. In addition to summative tests, diagnostic and formative tests will be performed throughout the course.
- Experimental work in the laboratory. In laboratory practices, students carry out simple experiments that allow them to become familiar with techniques for manipulating and studying microorganisms.
- Tutoring. Through tutoring (individual or group), the teacher, at his own request or the student and at the established time for this purpose, will answer questions or discuss the questions posed by the student, in order to guide him in learning the subject.
- Other training activities: Horizons of Open Reason conferences and the cycle “An Encounter with...”. Seminars given by researchers from other institutions will be recommended to delve into topics of interest and that serve to bring our science into dialogue with other disciplines that study life and man.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
60 Horas	90 Horas

SKILLS

Basic Skills

Students must have demonstrated knowledge and understanding in an area of study that is founded on general secondary education. Moreover, the area of study is typically at a level that includes certain aspects implying knowledge at the forefront of its field of study, albeit supported by advanced textbooks

Students must be able to apply their knowledge to their work or vocation in a professional manner and possess skills that can typically be demonstrated by coming up with and sustaining arguments and solving problems within their field of study.

Students must have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgments that include reflections on pertinent social, scientific or ethical issues

Students must be able to convey information, ideas, problems and solutions to both an expert and non-expert audience

Students must have developed the learning skills needed to undertake further study with a high degree of independence

To be familiar with the applications of biotechnology in the healthcare, food, agrobiotechnological, environmental and chemical fields.

Capacity for teamwork and group management.

To be able to plan time effectively.

To recognize the mutual influence existing between science, society and technological development in order to strive for a sustainable future.

To develop an ability to search for, take in, analyze, sum up and relate information.

To acquire the skills needed for experimental work: design, preparation, the compilation of results and the obtainment of conclusions, understanding the limitations of an experimental approach.

General Skills

To be familiar with the applications of biotechnology in the healthcare, food, agrobiotechnological, environmental and chemical fields.

Capacity for teamwork and group management.

To be able to plan time effectively.

To recognize the mutual influence existing between science, society and technological development in order to strive for a sustainable future.

To develop an ability to search for, take in, analyze, sum up and relate information.

To acquire the skills needed for experimental work: design, preparation, the compilation of results and the obtainment of conclusions, understanding the limitations of an experimental approach.

Specific skills

Know and apply the ability to handle microorganisms in bioremediation, bioremediation and pest control.

Apply the ability to manipulate microorganisms for the production of biotechnological products.

Know how to use microorganisms, cells and enzymes in the industrial production of chemicals, biopolymers, antibiotics, etc.

Define the characteristics, properties and methods of studying viruses.

To know the molecular mechanisms of viral infections and the pathologies produced.

Know the procedures and strategies for the development of biotechnological tools based on certain viral genera.

Understand the principles of bacterial genetics necessary for the development of microbial biotechnology.

Identify the main causes of microbial pathogenesis and ways to combat it.

Organize and plan the work in the laboratory correctly.

Know how to describe, quantify, analyze and critically evaluate the results obtained from experimental work carried out in the laboratory.

Develop habits of rigorous thinking.

Ability to communicate the knowledge acquired orally and in writing.

Know how to work as a team in an effective and coordinated way.

LEARNING RESULTS

Recognize the main groups of viruses of clinical and biotechnological interest

Understand the basis of microbial pathogenicity and ways to combat microbial diseases.

Use knowledge obtained through basic research to design new biotechnology-based processes and products.

Develop protocols for manipulating microorganisms

Formulate experiments that generate new knowledge for biotechnological application.

Detect properties of microorganisms that may be useful for industrial, environmental, clinical use, etc.

Understand the fundamentals of the immune response and the molecular mechanisms that direct their activation against infectious diseases.

Distinguish the different virus study techniques

Identify the main mechanisms of viral infection

Select the appropriate microorganisms for the production of biotechnological products

Recognize the main viral pathologies

Develop protocols to develop biotechnological tools using appropriate virus generas||Identify the main mechanisms of bacterial genetics

Select the appropriate technique for genetic modification of bacteria

Select the most suitable microorganisms for carry out bioremediation, bioremediation and pest control processes

Recognize the properties of microorganisms that make them suitable for the biotechnology industry

Discriminate between existing sources of information

Appropriately argue the results obtained from experimental processes||Identify the appropriate methodology for oral and written communication||Evaluate the ethical and social impact of technical advances and biological discovery||Relate knowledge of different subjects

Know the cause of main infectious diseases and ways to combat them

LEARNING APPRAISAL SYSTEM

The final grade for this subject will be obtained based on the grades obtained in the evaluation of the following modules and it will be necessary to obtain at least 50% of the total grade to consider the subject approved. Plagiarism, as well as the use of illegitimate means in evaluation tests, will be sanctioned in accordance with those established in the Evaluation Regulations and the University's Coexistence Regulations
ORDINARY EVALUATION SYSTEM (this is the default evaluation system for students in this subject)
1- Theoretical block (65% of the subject grade). It is mandatory to pass this block with at least half the grade to apply the rest of the 1.1 percentages. Final theoretical exam. 80% of this block will be worth and you must obtain at least 50% of the score in the two different parts of the exam to pass it and be able to apply the rest of the percentages. The exam will include multiple-choice questions and short questions to be developed. 1.2. Follow-up tests for continuous evaluation. Throughout the course, 3 written tests will be taken that do not release subject matter. These will be short tests that will be taken in the classroom in no more than 20 minutes. Of the 3 notes, the 2 highest grades will be chosen to make an average that will calculate 20% of the grade of the theoretical block. In case of unexcused absences, that day's evaluation test will be rated as 0.
2- Practical block (20% of the grade of the subject). Attendance at laboratory practices is mandatory, where students carry out simple experiments that allow them to become familiar with techniques for manipulating and studying microorganisms. The evaluation of this block will be done as explained below 2.1 Exploitation and interest shown during the internship: it will be evaluated by a specific rubric (15%) 2.2 Delivery of a report and/or written exercises on the practices: it will also be evaluated by a specific rubric (25%) 2.3 Final practice exam that will be carried out on the same day as the final theory exam and which will evaluate the understanding of the practices (60%). It is mandatory to pass this exam with at least 50% of the grade to apply the rest of the percentages.
3- IMA2030 teamwork (15% of the subject). Through face-to-face tutoring and other tests, the dedication, study and rigor of the members of the group will be evaluated during the preparation of the work, as well as the individual work.
* In blocks where the contrary has not been specified, it will not be necessary to obtain a minimum grade. However, if after applying all the percentages, the subject is suspended, the continuous evaluation items can be recovered, optionally, by asking some extra questions to assess these competencies in the extraordinary call.
** The blocks passed will be saved for the extraordinary call of the same academic year but not for the following.
ALTERNATIVE EVALUATION SYSTEM. Only in the case of students in the second call and later, and students with an academic exemption, who request it in a reasoned manner by email from the teachers of the subject. If not reported, continuous evaluation will be assumed, with all that this implies. Students in second or subsequent enrollment should contact the teaching team to request to take advantage of this system during the first week of class.
In the alternative evaluation system, the following percentages will be applied:
- Final theory exam (65%). You have to get at least 50% of the grade to apply the rest of the percentages
- Final internship exam (20%). You have to get at least 50% of the grade to apply the rest of the percentages
- IMA2030 work (15%): similar to that developed by continuous evaluation students.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:
a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.
b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.
c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(https://www.ufv.es/gestion-de-la-informacion_biblioteca/).
d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.
2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the Guide for the Responsible Use of Artificial Intelligence in Studies at UFV. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.
3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

PRESCOTT, Lansing M. Prescott, Harley and Klein: Microbiology/7th ed. Madrid:McGraw-Hill, 2009.

Michael T. Madigan... [et al.]. Brock [Electronic Resource]: Biology of Microorganisms/16th ed. Madrid:Pearson, 2021.

Black, Jacquelyn G. Microbiology: principles and explorations/[S. l.] :John Wiley & Sons, 2008.

Slonczewski, Joan. Microbiology: an evolving science/5th ed. New York: W.W. Norton & Company, 2020.

Additional

Tortora, Gerard J. Microbiology: an introduction/13th ed. Boston: Pearson, 2019.

Berenguer, José. Questions in microbiology/Madrid:Hélice, 2003.

Murray, Patrick R (1948-) Basic Medical Microbiology [Electronic Resource]/1st ed. Barcelona:Elsevier, 2018. (Murray, Patrick R (1948-) Basic Medical Microbiology [Electronic Resource]/1st ed. Barcelona:Elsevier, 2018. , ||Larry Snyder... [et al.]. Molecular Genetics of Bacteria/4th ed. Washington, DC:ASM Press,2013.)