Universitat Autònoma de Barcelona

2022/2023

Virology

Code: 101002
ECTS Credits: 6

Degree	Type	Year	Semester
2500502 Microbiology	OB	2	2

Contact

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Use of Languages

Principal working language: english (eng)
Some groups entirely in English: Yes
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Other comments on languages

Classes are given in English

Teachers

Antonio Villaverde Corrales
Esther Vázquez Gómez

Prerequisites

Is essential to have a general background in Biochemistry, Molecular Biology, Cell Biology, Microbiology and Immunology.

Objectives and Contextualisation

The teaching objectives of the course are the acquisition by students of basic knowledge about the biology, structure, genetics and evolution of viruses within the framework of its pathogenesis and pharmacological possibilities and research opportunities virology can offer in those fields. It will be also focused on emerging applications of the viruses in biotechnology and nanotechnology, and the need for constant updating of information through bibliographic databases.

Competences

- Apply microorganisms or their components to the development of products of interest in health, industry and technology.
- Apply suitable methodologies to isolate, analyse, observe, cultivate, identify and conserve microorganisms.
- Characterise the causal agents of microbial diseases in humans, animals and plants in order to diagnose and control them, perform epidemiological studies and be aware of present-day problems with these diseases and strategies to combat them.

- Identify the molecular mechanisms of pathogenesis and relate them to the response to infection in order to design and develop strategies for diagnosing and combating diseases caused by microorganisms.
- Obtain, select and manage information.
- Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
- Work individually or in groups, in multidisciplinary teams and in an international context.

Learning Outcomes

1. Identify and describe the microorganisms used in bioterrorism.
2. Identify the techniques used in the conservation and storage of microorganisms.
3. Identify the techniques used in the multiplication, detection and identification of viruses.
4. Identify viral elements that are useful for the design of antigens, immunogens and vaccines.
5. Identify viral elements that are useful for the design of diagnostic reagents.
6. Know and identify the biotechnological and nanomedical applications of viruses in microelectronics, as biosensors and for controlled drug delivery.
7. Know the molecular bases of viral invasiveness and virulence and recognise the value of attenuated viral variants in vaccine design.
8. Know the molecular processes of the viral cycle and identify the potential targets of antiviral drugs.
9. Know the most important groups of pathogenic microorganisms.
10. Obtain, select and manage information.
11. Understand the microbiological bases that are used to develop products of interest in healthcare.
12. Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
13. Use omics techniques for identifying target genes and proteins related to pathogenicity and virulence, and usable in the design of vaccines and antimicrobial compounds.
14. Work individually or in groups, in multidisciplinary teams and in an international context.

Content

1. Nature and multiplication of viruses

The world of viruses. Strict parasitism, multiplication and transmission. Viral disease and the iceberg concept. Viral diversity and virome. The viral particle: dimensions, chemical composition, morphology and nomenclature. Functions of the capsid; stability and recognition. Chemical composition, structure and organization of the viral genome: structural and non-structural genes. The polarity of the nucleic acid. The viral cycle: extra- and intracellular phases. Viral multiplication: productive and non-productive infections. Sequential expression of viral genes. Viruses, mobile genetic elements and living things.

2. Origins of Virology

The hypotheses about the maintenance of life and spontaneous generation. Pasteur's work. Microscopic infectious agents and Koch postulates. The nineteenth century: the discovery of viruses. The tobacco mosaic: the concept of filterable poison. Discovery of animal viruses. 20th century: chemical, structural and genetic characterization of viruses. Relevant facts in the history of Virology. Smallpox eradication and the risk of re-emergence. Clinical and biotechnological aspects of Virology. Bioterrorism.

3. Structure of viral particles

Morphology of viral particles. Architectural study of viral particles: electron microscopy and three-dimensional reconstructions. X-ray diffraction: resolution level. Molecular architecture in helical and icosahedral symmetries. Trans-membrane proteins in viral envelopes. Receptor- binding sites. Viral antigens and epitopes B and T. Neutralization and evasion of neutralization. Genetic and epitopic variability.

4. Viral genetics and viral genomes

Diversity of viral genomes. Principle of economics and complexity of viral genomes; gene overlapping. Segmented and split genomes. Information encoding the viral genome. Viral genome types and gene

expression and replication strategies; time-regulation strategies. The infectious clone. Principles of reverse genetics. Defective viruses.

5. Methods in Virology

Obtaining viral particles. Cell culture at small and medium scale. Purification. Quantitative and qualitative analysis of viral particles. Detection of viral components and applications in diagnostic methodology. The Virology laboratory: areas and distribution. Biological safety. Containment levels: P1 to P4. Air treatment. Effluent treatment.

6. Principles of viral taxonomy

First virus classifications: Baltimore classification of animal viruses. The International Committee on Taxonomy of Viruses and the classification system. Viral properties used in taxonomy. Families of animal viruses and unclassified viruses. Nomenclature changes. Main human pathogens and their diseases.

7. Viral multiplication

Cell recognition. Nature and function of receptors. Internalization. Disassembly. Biosynthetic shutdown. Stimulation of cellular functions: papovaviruses and adenoviruses. RNA, DNA and viral protein synthesis: time sequences. Cytopathic effects. Exit of viral particles with and without lysis. Apoptosis. Cell transformation into RNA viruses: cellular oncogenes; activation and transduction. Cell transformation into DNA viruses: oncogenes and viral oncoproteins. Viral protein processing. Antiviral drug targets. Interfering RNA.

8. Pathogenesis of viral infections

"Good" viruses. Virus-host coexistence. Asymptomatic infections. Characteristics of viral infections. Entrance gates. Transmission routes: horizontal and vertical. Localized and systemic infections. Dissemination. Viremia. Nerve transmission. Target tissues: tropism. Acute and persistent infections. Dissemination. Viremia. Nerve transmission. Target tissues: tropism. Acute and persistent infections. Latent infections. Viral and non-viral factors influencing pathogenesis. Virulence. Evasion of the immune response by viruses. Immunopathology.

9. Response to viral infections and vaccines.

Types of vaccines; attenuated and inactivated. Molecular basis of attenuation. New generation vaccines. Recombinant vaccines and synthetic peptides. Vaccination with nucleic acids. New vectors in vaccines. SARS-CoV-2 vaccines. Herd immunity. Innate and adaptive immune response. Sentinel cells, complement, inflammation, interferons. Communication between innate and adaptive response. Adaptive immune response: humoral and cellular. The importance of the antiviral cellular immune response. The bacterial immune system CRISPR / Cas.

10. Origin and evolution of viruses

Origin of viruses; regressive theories and those in favor of a cellular origin. Mechanisms for the generation of diversity. Mutation frequencies and relative abundance of mutants. Fixation of mutations. Viral replicases and fidelity of copy. Variability and evolution in RNA and retrovirus viruses. Viral quasi-species. Evolution and evolutionary potential. Darwinian and non-Darwinian selection of mutations. Foundational effects and bottlenecks.

11. New viral diseases and emerging viruses

Emergence of new viral diseases. Host jump and viral reservoirs. Viral emergency and re-emergence. Determining environmental, social and technological factors. Importance of arthropod vectors. The human species as a terminal host. New viruses and emerging viral diseases. Hemorrhagic fevers. Ebola virus and human immunodeficiency virus. The continuous re-emergence of the influenza virus.

12. The virome

The concept of virome and methods for its study. Viruses in the planet. The iceberg concept and the Global Virome Project. Acquisition of viruses in humans. Horizontal transmission of the viruses. The horizontal transmission of phenotypes. The human holobiont. The role of the virome in biology of the holobiont, in health and disease. Virome and sexuality.

13. Peculiar infectious agents

Prions: Infectious proteins. Development of the concept of prion. The amyloid. PrPc synthesis and processing. PrPsc formation and prion propagation. Spongiform encephalopathies:inheritance and infection. Phenotypic diversity of prions; the strains. "Scrapie" and bovine spongiform encephalopathy. Interspecific barriers. Human spongiform encephalopathies: Kuru, Creutzfeldt-Jakob syndrome and hereditary diseases. Prions in yeast. Viroids: structure and constancy of domains. Possible mechanisms of pathogenesis. The Satellites. The delta hepatitis virus. Virophages.

14. Bacteriophages

Use of bacteriophages in molecular genetics and biotechnology. The "phage display". The generation of antibodies without immunization and the search for new ligands. Directed molecular evolution. Drug selection systems.

15. Artificial viruses

Viruses as new editable nanomaterials. Viral gene therapy; important features and biological risks. Gene therapy products on the market. Artificial viruses as alternatives to viral gene therapy. Types of artificial viruses and used biomolecules. Modular strategies. Selection of virus-inspired functional domains. Examples and applications of artificial viruses.

Methodology

The course will comprise classroom lectures and active learning activities with scientific problems and cases by which students will acquire skills necessary to perform literature research, propose experimental approaches and design problem solving strategies. Oral presentations of active learning activities will encourage teamwork, coordination of activities and rational presentation of work plans and results. Active learning activities will be focused on methodological aspects and biomedical, biotechnology, pharmaceutical and nanotechnological applications of virus as well as derived viral structures. Personal tutorial guidance sessions will be available by email appointment and will be held in the office C3/331. In those sessions, students will have the opportunity to receive individual guidance according to their needs.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Active learning activities	15	0.6	10, 14, 12
Lectures	30	1.2	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 13
Type: Supervised			
Personal tutorial guidance sessions	2	0.08	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 10, 14, 12, 13
Type: Autonomous			

Group work: preparation of written reports	2	0.08	10, 14, 12
Literature search	28	1.12	10, 12
Personal study	44	1.76	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 13
Preparation of oral and written presentation of reports	2	0.08	10, 14, 12
Reading	23	0.92	10, 14

Assessment

The evaluation will be done through 3 exams, two non-eliminatory partials and a final exam that will include the third partial and a synthesis part. The exams will be distributed during the course, with a total weight over the final qualification of 70% (15%, 15% and 35 + 5% respectively). Furthermore, 30% of the qualification will be obtained through oral presentations of problems, resolution of classroom problems or presentation of written exercices (in teams). For these activities (30%) no remedial test is programmed.

The remedial exam will be a multiple-choice test and will have questions from the entire syllabus. The exam will be open to students who have failed in the global score of the subject, but also to those who want to improve their scores. Prior registration is required. Separate remedial exams for each part examination cannot be made. The remedial will cover the whole subject and the score obtained will be that of the recovery exam (70%), regardless of the scores obtained in the previous exams. In compliance with article 112 ter point 2 of the current Academic Regulations of the UAB, to be eligible for the remedial test, students must have been previously evaluated in a set of activities equaling at least two thirds of the final qualification of the course. Therefore, the students will obtain the "No Avaluable" qualification when the evaluation activities carried out have a weight lower than 67% in the final score.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation of 3 group assignements: written report and oral presentation	30 %	0	0	10, 14, 12
Final exam: multiple choice	40 %	2	0.08	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 13
First midterm exam: multiple choice	15 %	1	0.04	9, 7, 1, 2, 3
Second Midterm exam: multiple choice	15 %	1	0.04	11, 9, 8, 7, 4

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Software

No specific software is foreseen