Universitat Autònoma de Barcelona

2017/2018

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 Vazquez Gomez

Prerequisites

Is essential to have a good level of spoken and written English and 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.

Skills

- 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. An introduction to viruses and Virology

The world of viruses. Strict parasitism, multiplication and transmission. The viral disease and the concept of "iceberg". Viral diversity. The viral particle: size, 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 nucleic acid. The viral cycle: extracellular and intracellular phases. Virus multiplication: productive and not productive infection. Sequential expression of viral genes. Viruses, mobile genetic elements and living beings.

2. Historical overview of virology

Hypotheses about the maintenance of life and spontaneous generation. The work of Pasteur. Microscopic infectious agents and Koch's postulates. The nineteenth century: the discovery of viruses. The tobacco mosaic virus: the concept of "filtrable infectious agent". Discovery of animal viruses. The twentieth century: characterization, chemical and genetic structure of viruses. Significant events in the history of virology. The eradication of smallpox and the risk of re-emergence. Clinical aspects of virology and biotechnology. Bioterrorism.

3. Viral structure

Morphology of viral particles. Architectural study of viral particles: electron microscopy and three-dimensional reconstructions. The X-ray diffraction: requirements and level of crystallographic resolution. Architecture molecular of helical and icosaedrical symmetry. Trans-membrane proteins in viral envelopes. Receptor binding sites. The viral antigens and epitopes B and T. The neutralization and evasion of antibody neutralization. Genetic and epitopic variability.

4. Viral genomes and genetics

Principle of economy and complexityof the viral genome, overlapping genes. Segmented and multipartite genomes. Sequencing of viralgenomes and function prediction. Recombination, rearrangement and phenotypic mixing. Types of viral mutants. Defective viruses: integrated genomes, satellite virus and defective interfering particles. Complementation. The infectious clone. Gene expression in different types of viruses, temporary regulation strategies. Principles of reverse genetics. Tools for viral gene transfer and gene therapy. Presentation of antigen and peptides in recombinant viruses. Gene cloning and expression vectors of viral origin.

5. Viral multiplication

Cell recognition. Nature and function of receptors. Internalization. Uncoating. The cellular shutdown. Stimulation of cellular functions: papovavirusand adenovirus.Synthesis of RNA, DNA and viral proteins: temporal sequences. Cytopathic effects. Exit of viral particles with and withoutlysis. Apoptosis. Cellular transformation in RNA virus: cellular oncogenes,activation and transduction. Cellular transformation in DNA virus: viral oncogenes and oncoproteins. Processing of viral proteins. Targets for antiviral drugs. RNA interference.

6. Origin and evolution of viruses

Origin of viruses and regressive theories for a cellular origin. Mechanisms of generation of diversity. Mutation frequencies and relative abundance of mutants. Fixation of mutations. Viral replicases and copying fidelity. Variability and evolution in RNA viruses and retroviruses. The viral quasispecies. Evolution and evolutionary potential. Darwinian selection and Darwinian mutations. Founding effects and bottlenecks. Genetic and antigenic divergence, the influenza virus. Analysis of viral phylogeny

7. Emerging viruses and viral diseases

Emergence of new viral diseases. Host jump and viral reservoirs. Viral emergence and viral re-emergence. Environmental factors, social and technological factors. Importance of arthropod vectors. The human species as a terminal host. New emerging viruses and human viruses. Hemorrhagic fevers. The Ebola virus and human immunodeficiency virus. The new hepatic viruses. The continuing re-emergence of influenza virusand others.

8. Prions and viroids

Infectious proteins: the prion. Development of the prion concept. The amyloid. Synthesis and processing of PrPc. PrPsc formation and propagation of prions. Spongiform encephalopathies: inheritance and contagion. Phenotypic diversity of prions; strains. The "scrapie" and bovine spongiform encephalopathy. Interspecific barriers. The human spongiform encephalopathies: Kuru, Creutzfeldt-Jakob disease and hereditary diseases. Prions in yeast. Viroids: structure and consistency of domains. Possible pathogenetic mechanisms. The hepatitis delta.

9. 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. Systems of selection of antiviral drugs: the case of protease inhibitors.

10. Methods in Virology

Obtaining viral particles. The cell culture. Small and medium scale cell culture. Purification. Quantitative analysis of viral particles. Detection of viral components and applications in the diagnostic methodology. The virology laboratory: areas and distribution. The biological safety levels of containment: P1 to P4. Air treatment. Tributary treatment. Vaccine factories: industrial-scale up production of viral particles.

11. Viral taxonomy

Early classifications of viruses: Baltimore classification of animal viruses. The International Committee on Taxonomy of Viruses and the classification system. Properties used in viral taxonomy. Families of animal viruses and viruses not classified. The major human pathogens and their diseases.

12. Viral pathogenesis

Characteristics of viral infections. Entry routes. Localized and systemic infections. Invasiveness. Viremia. Nerve transmission. Target tissues: tropism. Virulence. Role of organic response in the pathogenesis. Infection: transmission routes. Vectors and reservoirs. Persistent viral infections, mechanisms of persistence. The measles virus. The Epstein-Barr virus.Viral hepatitis. HIV infection; dynamic aspects of persistence. The movement of plant viruses.

13. Responses to viral infection

Nonspecific antiviral mechanisms. Induction and activity of interferons. Induction and evolution of the immune response. Role of antibodies and T cells. Prophylaxis of viral infections: vaccination. Types of vaccines: attenuated and inactivated. Polio vaccines. Molecular basis of attenuation. New generation vaccines. Antigens and immunogens. Recombinant proteins and peptides. Pseudo-capsid vaccine. The vaccine against hepatitis B and papilloma viruses. Vaccination with DNA.

14. Artificial viruses

Viral gene therapy; important features and biological risks. Artificial viruses as alternatives to viral gene therapy. Type of artificial viruses and used biomolecules. Modular strategies. Selection of 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.

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			
Literature search	28	1.12	10, 12
Personal study	45	1.8	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 13
Reading	20	0.8	10, 14

Evaluation

The evaluation will be done through one midterm exam and one final exam. The sum of the marks obtained in the evaluation of all written exams will represent 70 % of the final grade (10 % and 60 %respectively). Remedial exam will be scheduled for the final exam. 30 % of the grade will be obtained by oral and written presentations of assignments and classroom problem-solving activities. The mark obtained in the final exam (or remedial exam) must be higher than 4.5 to be used in the final mark calculation. In the case of obtaining a lower mark than 4.5 in the final exam (remedial exam), the maximum mark would be 4.
Evaluation of classroom lecture competencies (70 % of final grade)
-During the course two written tests will be scheduled for this evaluation form. The first test will have a weight of 10% and the second a weight of 60 %.
Evaluation of oral and written presentations (30 % of the final grade)
-Students will present the reports of the assigned active learning exercises in classroom sessions. Oral presentations will be evaluated on content, organization and communicative skills. Additional written reports will be evaluated on content and organization.
Delay in the delivery of activity assignments will represent a 100 % reduction in the mark obtained in the evaluated activity.
We consider that a student will be graded as "NO AVALUABLE" if the assessment of all conducted evaluation activities does not allow students to achieve the overall grade of 5 on the assumption that they had obtained the highest grade in all of them.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Final exam	60 %	3	0.12	11, 9, 8, 6, 7, 4, 5, 1, 2, 3, 13
First midterm exam	10 %	2	0.08	9, 7, 1, 2, 3
Oral and written presentation of reports	30 %	5	0.2	10, 14, 12

Bibliography

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