Universitat Autònoma de Barcelona

**2019/2020**

# Virology

Code: 100951
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2500253 Biotechnology | OB | 3 | 2 |

## Contact

Name: Esther Vazquez Gomez
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## Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

## Other comments on languages

50% of classes are in spanish and 50% in catalan

## Teachers

Antonio Villaverde Corrales

Neus Ferrer Miralles Ferrer Miralles

## Prerequisites

A good knowledge of Microbiology, Biochemistry and Cell Biology and interest in Virology.

## Objectives and Contextualisation

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The teaching objectives of the course are the acquisition by the students of basic knowledge about biology, structure, genetics and evolution of viruses within the framework of its pathogenesis and pharmacological possibilities and research opportunities that 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.
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 the nucleic acid. The viral cycle: extracellular and intracellular phases. Virus multiplication:

productive and non-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 andbiotechnology. Bioterrorism.

3. Viral multiplication

Cell recognition. Nature and function of receptors. Internalization. Uncoating. The cellular shutdown. Stimulation of cellular functions: papovavirus and adenovirus. Synthesis of RNA, DNA and viral proteins: temporal sequences. Cytopathic effects. Exit of viral particles with and without lysis. Apoptosis. Cellular transformationin 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.

4. Viral structure

Morphology of viral particles. Architectonic study of viral particles: electron microscopy and three-dimensional reconstructions. The X-ray diffraction: requirements and level of crystallographic resolution. Molecular architecture 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.

5. Viral genomes and genetics

Principles of economy and complexity of the viral genome, overlapping genes. Segmented and multipartite genomes. Sequencing of viral genomes and function prediction. Recombination, rearrangement and phenotypic mixing. Types of viral mutants. Defective viruses: integrated 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.

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. Evolutionand evolutionary potential. Darwinian selection and Darwinian mutations. Founding effects and bottlenecks. Genetic and antigenic divergence, the influenza virus. Analysis of the 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 virus and others.

8. 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.

9. 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.

10. 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 encephalopaty. 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.

11. 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.

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

Non-specific 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. Types of artificial viruses and used biomolecules. Modular strategies. Selection of functional domains. Examples and applications of artificial viruses.

## Competences

- Identify the structural and functional elements of viruses and other useful microorganisms for the design of new strategies for molecular diagnosis of infectious diseases.
- Read specialised texts both in English and ones own language.
- Search for and manage information from various sources.
- Work individually and in teams

## Learning Outcomes

1. Apply the methods used for the detection and quantification of viral material and antiviral immune response material.
2. Explain the properties of viruses and viral particles useful for the design of vaccines and antivirals.
3. Identify the viral and viral-cycle components that are key to antiviral immune response.
4. Read specialised texts both in English and ones own language.
5. Search for and manage information from various sources.
6. Work individually and in teams

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## Methodology

The subject will be taught through lectures and active learning with activities and scientific cases, in which students acquire skills in bibliographic research, experimental approaches and problem solving. Students will do oral presentations derived from practical work, and teamwork will be encouraged, as well as activities' coordination and rational presentation of work projects and results. It will be focused on methodological aspects as well as in biomedical, biotechnological, pharmacological and nanotecnology applications of virus and derived structures.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Classroom classes | 42 | 1.68 | 1, 2, 3 |
| Type: Supervised | | | |
| Preparing public presentation of projects | 50 | 2 | 5, 4, 6 |
| Type: Autonomous | | | |
| Study | 20 | 0.8 | 5, 4, 6 |
| Texts reading | 30 | 1.2 | 5, 4, 6 |

## 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 exam. 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 and resolution of classroom problems or presentation of written exercices. For these activities (30%) no remedial test is programmed.
The remedial exam will be multiple choice and only students who have failed in the global qualification of the subject, but have at least 3.5 in the overall mark, will have to access to it. 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 |
|---|---|---|---|---|
| Final exam: third partial + synthesis exam. Multiple choice | 40% | 2 | 0.08 | 2, 3 |
| Midterm exams multiple choice | 30% | 3 | 0.12 | 1, 2, 3 |
| Oral presentations and written projects | 30% | 3 | 0.12 | 5, 4, 6 |

## Bibliography


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