VIRAL GENETICS

Viruses

OUTLINE

- Viruses - characteristics and structure
- Replication of viruses
- Classification of viruses
- Viruses and their system/hosts

LEARNING OBJECTIVES

The student becomes familiar with the concepts of viruses, their function and structure, and the organization of the viral genome. He/she learns about the evolutionary theories on the origin of viruses, as well as their classification systems, and understands the life cycle and latent phase of viruses and the ways in which a virus is transmitted, infected and released.

Viral Genome

OUTLINE

- Organization and structure of the viral genome
- DNA viral genome
- RNA viral genome

LEARNING OBJECTIVES

The student learns about the structure and organization of the viral genome, the special features and the differentiations between single-stranded and double-stranded viral genomes, as well as positive-sense and negative-sense RNA viruses.

Viral Proteome

OUTLINE

- Viral polyprotein
- Structural and non-structural viral proteins
- Post-translational modifications of viral proteins in host cell

LEARNING OBJECTIVES

The student learns about the organization of the proteins in the viral polyprotein. He/she learns on protein composition of viruses and the structural and non-structural proteins of viruses. The student

familiarizes with the three-dimensional structure of proteins and learns about the mechanisms of interaction with the host cells. In addition, he/she learns about post-translational modifications of viral proteins in the host cell and how viruses hijack the hosts' machinery to replicate themselves.

Viral mutagenesis – Drug resistance

OUTLINE

- Viral mutation mechanisms
- Viral mutation rates
- Drug resistance

LEARNING OBJECTIVES

The student becomes familiar with the concept of mutagenesis in viral genomes. He/she learns about the mechanisms and rates of mutation in different types of viruses. The student understands the resistance of viruses to drugs based on their high mutability rates and the obstacles in viral drug design.

Viruses and evolution

OUTLINE

- Viral evolution
- Virocentric evolution

LEARNING OBJECTIVES

The student becomes familiar with the concept of evolution. He/she learns at greater depth about the origin of viruses and the viral evolution per virus type. He/she learns about the virocentric evolution of species by understanding how the integration of viral genetic material in the DNA of their hosts has had a pivotal effect on the course of evolution.

Virus infection and viral disease and pathogenesis

OUTLINE

- Virus transmission
- Susceptibility and resistance to viral disease
- Mechanisms of antiviral immunity
- Localized and systemic infections

- Acute, chronic and latent infections
- Epidemiology
- Emerging and re-emerging viral infections

LEARNING OBJECTIVES

The student learns on virus transmission in a population, the inborn and genetic resistance to viral disease, as well as the mechanisms of antiviral immunity. He/she familiarizes with the concepts of localized and systemic infections and their differences, and the acute, chronic and latent infections. He/she becomes aware of the fundamental principles of epidemiology, the patterns of disease occurrence and patterns of spread, the viral reservoir and virgin-soil epidemics, and learns about the current methods on epidemiological studies. Finally, he/she learns about the factors leading to the emergence of new infectious diseases and re-emergence of viral diseases.

Principles of viral diagnosis

OUTLINE

- The laboratory diagnosis of viral infections: introduction and principles
- The laboratory diagnosis of viral infections: detection of virus-specific immunity
- The laboratory diagnosis of viral infections: detection of viral nucleic acid

LEARNING OBJECTIVES

The student understands the fundamental principles and methods of viral diagnosis. He/she is aware on the methods of viral detection through direct and/or indirect diagnosis, the detection of viral antigens, and the methods to test for virus-specific antibodies and nucleic acid testing as therapeutic and/or prognostic markers.

Prevention and treatment of viral infections

OUTLINE

- Disinfection and sterilization
- Transfusion and transplant safety
- Antiviral drugs: history and obstacles
- Antiviral drugs – modes of action
- Immunotherapy and immunoprophylaxis: passive and active immunity
- Post-exposure prophylaxis for viral infections

LEARNING OBJECTIVES

The student learns the basic principles and methods of viral diagnosis and prevention and treatment against viral infections. He/she recognizes the importance of disinfection and sterilization as preventive methods and the modes of transfusion and transplant safety modes. Through on overview of the history and an understanding of the modes of action of antiviral drugs, he/she can address the obstacles that occur on viral therapeutics. He/she is able to understand and explain passive and active immunity against viral infections and the modes of post-exposure prophylaxis.

Specific Viruses

OUTLINE

- DNA viruses
- RNA viruses
- Subviral agents

LEARNING OBJECTIVES

The student familiarizes with specific types of viruses. Examples of DNA viruses (Adenoviruses, Herpesviruses, Poxviruses, Human papillomaviruses, Hepadnaviruses), RNA viruses (Retroviruses, Orthomyxoviruses, Paramyxoviruses, Filoviruses, Coronaviruses, Flaviviruses) and subviral agents help the student recognize the differences of specific viral infection in terms of their genetic material and function.

Gene therapy

OUTLINE

- Principles of gene therapy
- Viral delivery systems – Lentiviruses, adenoviruses and adeno-associated viruses
- Applications and obstacles

LEARNING OBJECTIVES

The student becomes familiar with the basic principles of gene therapy. He/she learns about the modern developments in the therapeutic approaches of genetic engineering for the transfer and expression of genes with specific emphasis on viral delivery systems. In particular, he/she learns about specific types of viral delivery systems, such as lentiviruses, adenoviruses, and adeno-associated viruses. He/she is updated on recent gene therapy applications and understands the barriers as well as the ethical dilemmas that arise for gene editing.

Viral diseases and clinical scenarios

OUTLINE

- Neurological disease with a viral etiology
- Gastrointestinal illness
- Respiratory viruses
- Hepatitis viruses
- Viral infections of skin and mucosal membranes
- Viral infections and pregnancy
- Viruses and cancer
- Human immunodeficiency virus
- Viral hemorrhagic fevers
- Sexually transmitted viral infections
- Opportunistic viral infections
- Eradication of viral diseases

LEARNING OBJECTIVES

The student expands his/her knowledge on specific viral diseases through several clinical scenarios and understands the differences in clinical outcomes and research methods used for antiviral drug design and the corresponding antiviral therapies. He/she learns the association of cancer and viruses, is informed on sexually transmitted viral infections and opportunistic viral infections and the concept of eradication of viral diseases.

Laboratory Exercises

OUTLINE

- Multiple sequence alignment of viral genomes
- Phylogenetic analysis of viral genomes
- Analysis of SNPs in viral sequences
- Viral genomes metanalysis
- Sequence feature variants in viral proteins
- Final assignment

LEARNING OBJECTIVES

The student, through the laboratory exercises, has the opportunity to apply the knowledge from the theory of the course to a modern bioinformatics analysis. He/she is learning to use the most specialized database in viral data Vipr (Virus Pathogen Resource, https://www.viprbrc.org/brc/home.spg?decorator=vipr), which includes a collection of annotated viral genes and proteomes and their metadata, where applicable, and a set of tools for mining and analyzing available information. The student learns to apply multiple sequence alignments to a given set of viral strains, to construct phylogenetic trees, to apply SNPs analysis on viral sequences, and learns methods of metanalysis of viral genomes as well as sequence feature variant analysis in viral

proteins. Finally, in his/her final assignment he/she has the opportunity to sum up and present the acquired knowledge in viral genetics and the application of computational analysis on viral genomes.