MICROBIOLOGY

Course volume: 12 lecture classes, 5 seminars.

Lectures: Maria BAYLIAK

Seminars: Maria BAYLIAK, Oleksandra ABRAT

Lectures

1. Introduction to Microbiology.

Microbiology and its disciplines. The role of microorganisms in the environment and human life. The history of microbiology. The place of microorganisms among living organisms. General principles of taxonomy of microorganisms. Phylogenetic taxonomy of bacteria.

2. Morphology of microorganisms.

Sizes of microorganisms. The shapes of bacteria. Unicellular mycelial fungi. Yeast.

3. The structure of a prokaryotic cell.

The main differences between prokaryotes and eukaryotes. The general structure of a bacterial cell. Structure and chemical composition of cell walls of prokaryotes. Surface structures of the cell wall: fimbriae, F-pili, and flagella. Movement of bacteria. Taxis. Capsules and mucus. Membrane and its derivatives. Cytoplasm and cytoplasmic inclusions. Genetic apparatus of bacteria. Dormant forms in bacteria.

4. Growth and reproduction of microorganisms.

Individual growth of bacterial cells. Reproduction of bacteria. Growth of microbial population. Methods of estimating growth and viability of microorganisms. Continuous bacterial cultures. Synchronous bacterial cultures.

5. Environmental factors affecting growth of microorganisms.

Physical factors - temperature, humidity, osmotic pressure, hydrostatic pressure, light, electricity, ultrasound. Chemical factors - pH, oxygen, and chemical compounds.

6. Types of nutrition. **Energy production in microorganisms: fermentation**.

Nutrient requirements of microorganisms. Nutritional types of microorganisms. Energy-producing pathways in microorganisms. Carbohydrate metabolism in microorganisms: initial stages of conversion of carbohydrates. Types of fermentation: alcoholic, lactic acid, propionic acid, and butyric acid fermentation. The application of fermentation in industry.

7. Energy production in microorganisms: respiration.

Aerobic respiration during assimilation of organic substrates. Incomplete aerobic oxidation of organic substrates. Anaerobic respiration. Use of energy of inorganic substrates. Use of light energy (photosynthesis).

8. Biosynthetic processes in microorganisms.

Biosynthesis of carbohydrates. Biosynthesis of amino acids. Biosynthesis of lipids. Biosynthesis of secondary metabolites.

9. Transformation of nitrogen by microorganisms.

The role of microorganisms in the nitrogen cycle. Ammonification of organic nitrogen-containing compounds. Nitrification. Denitrification. Fixation of atmospheric nitrogen. Symbiotic and free-living nitrogen fixers. Mechanism of biological nitrogen fixation.

10. Genetics of microorganisms.

Basic terms in the genetics of microorganisms. Genetic material: bacterial chromosome and plasmids. Non-hereditary and heritable variability (mutations and genetic recombinations) and its importance for microorganisms. Genetic engineering of microorganisms.

11. Antibiotics and antibiotic resistance.

General characteristics and classification of antibiotics. Characteristics of the main groups of antibiotics according to the mechanism of action. Natural and acquired resistance to antibiotics. Methods of determining sensitivity to antibiotics.

12. Pathogenicity of microorganisms. Pathogenicity of bacteria. Ways by which microorganisms escape the immune system. Bacterial exotoxins and endotoxins. Forms of infection. Periods of the infectious process. Antimicrobial immunity: overview.

Practicals (Seminars)

1. Safety rules of work in a microbiological laboratory. Methods of sterilization.

2. Preparation of nutrient media for microorganisms. Principles of nutrient media selection. Types of nutrient media. Cultivation, inoculation techniques and storage of microorganisms.

3. Light microscope and microscopy technique. Preparation of slides of microorganisms. Gram staining of bacteria.

4. Ecology of microorganisms: air, water and soil microbiota. Analysis of air and water microbiota.

5. Human microbiome. Composition of human microbiome. Methods to study human microbiome. Microbiome and gut-brain axis. Microbiome and obesity. Pathogenic microorganisms.

VIROLOGY

Course volume: 10 lectures, 4 seminars

Lectures: Maria BAYLIAK, Dmytro GOSPODARYOV

Seminars: Maria BAYLIAK, Dmytro GOSPODARYOV

Lectures

1. Introduction to virology.

The spread of viruses on the Earth. Reasons for studying viruses. Discovery of viruses. The nature and properties of viruses. Naked and enveloped viruses. Bacteriophages.

2. Components of viral particles and classification of viruses.

Viral nucleic acids. Viral proteins. Persistence of viruses in the environment. General principles of virus classification. Main DNA and RNA viruses.

3. Virus reproduction cycle.

Virus transmission. The main aspects of the reproduction of viruses. Lytic and lysogenic cycle of viruses. Attachment and entry of viruses into cells. Transcription of viral genomes. Translation of viral mRNAs. Virus genome replication. Assembly and exit of virions from cells. Lysogeny of phages.

4. Genetics of viruses.

Genomes of viruses. Compactness of the viral genome and diversity of coding strategies. Proteins encoded by the viral genome. Interactions between viral genomes (complementation, interference, recombination, reassortment).

5. Pathogenesis of viral infections.

Pathogenicity and virulence of viruses. Classification of viral infections at the cellular level. Cytopathic effect of viruses. Classification of viral infections at the level of the organism.

6. Methods of study of viruses.

Cultivation of viruses. Structural investigations of cells and virions. Biochemical methods: electrophoretic techniques and PCR. Identification of viruses using antibodies.

7. Antiviral immunity.

Innate and adaptive antiviral immunity. Cells of the immune system involved in virus neutralization. Interferons, their types, induction and role in antiviral immunity. Antiviral antibodies. Primary and secondary immune response. Ways of evasion by viruses of the immune systems

8. Viruses and cancer.

Oncogenic viruses and virus-linked cancers. Integration of viral and cellular genomes. Properties of cancer cells. Overview of mechanisms of viral carcinogenesis. Mechanisms of transformation of proto-oncogenes into oncogenes.

9. The most common viral infections, caused by RNA viruses.

Influenza virus. Coronavirus infections. Poliovirus and hepatitis A virus. Human immunodeficiency virus.

10. The most common viral infections, caused by DNA viruses. Herpesviruses. Adenovirus infections. Hepatitis B virus.

Practicals (Seminars)

1. Origin and evolution of viruses.

Hypothesis of origins of viruses. Evolution of viruses. New viruses.

2. **Vaccines and antiviral drugs**.

Types of vaccines and their effectiveness and safety. Examples of live, killed, peptide and genetically engineered vaccines. Problems in the development of vaccines. Introduction to antiviral drugs. Abnormal nucleosides as antiviral drugs. Drug resistance.

3. **Prions**.

Prions as infectious protein agents. Prion diseases. Potential mechanisms of prion formation. Prion transmission. Biological role of prions.

4. Use of viruses for biomedical research.

Anti-bacterial agents. Sources of enzymes. Gene vectors for protein production. Recombinant viruses as gene therapy vectors and anti-cancer agents.

IMMUNOLOGY

Course volume: 10 lectures, 4 seminars

Lectures: Maryna SKOK, Denys KOLYBO

Seminars: Oleksandra ABRAT

Lectures

1. Main concepts of immunology. The history of immunology.

Immunology as a science about immunity. General terms of immunology. Primary and secondary lymphoid organs. Mechanisms of non-self recognition. Main theories of up to date immunology. Establishment of fundamental and applied immunological trends.

2. Mechanisms of nonspecific resistance. Inflammation.

Non-specific resistance and the ways to ensure it. Humoral means of innate immunity, cytokines. Pattern recognition receptors, their role in defense and pathology. Inflammatory reaction, its types, development, physiological regulation and biological significance.

3. Structure and evolution of mammalian immune system.

The origin of immune organs and cells. Primary and secondary lymphoid organs: structure and functions. Diffuse lymphoid tissue, MALT and SALT.

4. The cells of the immune system.

Effector cells of innate immunity and mechanisms of their functioning. Lymphopoiesis. B lymphocytes, their subpopulations, localization and recirculation. Plasma and memory cells. B cell receptor and antigen recognition by B lymphocytes. T cell receptor and antigen recognition by T lymphocytes. The role of thymus microenvironment for T lymphocyte development, positive and negative selection. Subpopulations of T lymphocytes, mechanisms of target recognition and cytolytic activity.

5. The general scheme of the immune response.

Antigen transportation to lymph nodes. Dendritic cells, lymphocyte recruiting, their post-activation maturation, effector and memory cells formation. Effector mechanisms of specific immune reactions: opsonization, phagocytosis enhancement, cytolysis, antibody-dependent cellular cytotoxicity.

6. Antigens.

Antigens: classification, structure and main definitions. Antigenic determinant and epitope. T and B epitopes. Conformational and linear B epitopes. General ideas about exciter antigens.

7. MHC biosynthesis and antigen presentation.

Antigen processing and presentation, biological role of main histocompatibility complex for adaptive cellular immune reaction development. Presentation of endogenous and exogenous antigens to CD4+ and CD8+T cells.

8. Structure and functions of immunoglobulins.

Structure, synthesis and isotypic diversity of immunoglobulins. Antigen-antibody interaction. Immune complex. Antibody functions in the organism: antigen neutralization, precipitation, agglutination. Effector antibody functions: antibody-dependent cellular and humoral immune reactions.

9. Genetics of antibodies and T cell receptors.

Initial theories of the antibody diversity. Genetic mechanisms of the antibody and T cell receptor diversity formation. Somatic hypermutagenesis. Alternative splicing. The antibody isotype switch. Development and differentiation of B and T lymphocytes, formation of their receptors.

10. Immunological methods.

General characteristics of immunological methods. The ways to evaluate the immune reactivity of the organism. Immunochemical analysis: areas of application. Polyclonal and monoclonal antibodies, their use for diagnostics and therapy.

Practicals (seminars)

1. Mammalian lymphoid system. Structure of organs and vessels.
2. Cells of the immune system. Morphology and methods of analysis.
3. Antibodies. Diagnostic significance of different antibody classes. Immunological methods.
4. Immunobiological products. Antibodies, sera, vaccines, immunomodulators.