

AL-FARABI KAZAKH NATIONAL UNIVERSITY
Faculty of Medicine and Healthcare
Higher School of Medicine
Department of Fundamental Medicine

6BM10201 Dentistry Mechanisms of Defense and Health

Instructions for practical lessons on Mechanisms of Defense and Health

FOUNDATION OF IMMUNOLOGY

Practical lesson 1.

Topic: Introduction to Immunology. Historical background of Immunology.

Maximum score: 2.

Learning outcomes:

1. *List the main historical stages in the development of immunology.*
2. *Define the science of immunology.*
3. *Define the subject of study of immunology.*
4. *List the main areas of immunology: general immunology and private immunology.*
5. *Discuss the place of the discipline of immunology in individual specialties.*
6. *Describe the task of general immunology.*

Practical lesson 2.

Topic: Innate Immunity.

Maximum score: 2.

Learning outcomes:

1. *List and discuss components of innate immunity.*
2. *Justify external barriers against infection.*
3. *Identify and classify cells of the immune system.*
4. *Classify the types of pattern recognition receptors.*
5. *Explain initiation of an immune response.*
6. *Know how do the innate immune system instigates adaptive immunity .*
7. *Explain collaboration between innate and adaptive immune responses.*
8. *Draw and describe interaction between innate and adaptive immune responses.*

WRITING TASK

Anatomical barriers play a large role in preventing the entrance of a pathogen into the body. They provide a critical first line of defense. Think about what a potential pathogen like a bacteria or a virus would have to overcome in order to get into your body, and then into the target tissue to untimely make you sick. List several (at least three) of these critical barriers and how they help to eliminate pathogens. Describe how these mechanisms are or could be related to the symptoms you often get when someone falls ill (for example with the cold).

Practical lesson 3.

Topic: Adaptive Immunity.

Maximum score: 2.

Learning outcomes:

1. *List and describe the central and peripheral organs of the immune system.*
2. *Explain the patterns of clonal selection.*
3. *Explain the importance of antigen-independent differentiation of lymphocytes.*
4. *Explain the importance of antigen-dependent differentiation of lymphocytes.*
5. *List the main types of lymphatic tissue cells and indicate their functions.*
6. *Name and explain types of immune response.*

7. *Discuss primary and secondary immune response.*
8. *Describe and explain the interaction of immune cells in the immune response.*
9. *Describe the interaction between innate and adaptive immunity*
10. *Explain the differences between innate and adaptive immunity.*
11. *Compare the functional characteristics of cells of innate and adaptive immunity.*
12. *Perform the "ADAPTIVE IMMUNITY" test.*

Practical lesson 4.

Topic: Major histocompatibility complex and its general organization.

Maximum score: 2.

Learning outcomes:

1. *Describe and explain the structure of the major histocompatibility complex.*
2. *Describe the structure and function of the MHC I and MHC II molecules.*
3. *Explain the principle of MHC inheritance*
4. *Explain the role of major histocompatibility complex gene products in the immune response.*
5. *Give examples of associations between HLA antigens and diseases.*

Practical lesson 5.

Topic: Antigens.

Maximum score: 2.

Learning outcomes:

1. *Define the terms: antigen, haptan, carrier.*
2. *Describe the chemical properties of antigens.*
3. *List the main features of antigens;*
4. *Explain role of antigenic determinants and carrier in the induction of immune response;*
5. *Describe the thymus-dependent and thymus-independent antigens.*
6. *Explain mechanisms of formation of the immune response to thymus-dependent and thymus-independent antigens.*
7. *Compare and contrast thymus-dependent and thymus-independent antigens.*
8. *Contrast primary and secondary self-antigens. Give examples of each.*
9. *Complete test quiz "Antigens".*

Practical lesson 6.

Topic: Humoral factors of Immunity B-cell maturation.

Maximum score: 2.

Learning outcomes:

1. *Describe development of B-lymphocytes.*
2. *Explain the ability of B lymphocytes to the immune response in the process of differentiation.*
3. *Explain how B cells recognize and respond to an antigen*
4. *List the markers of B-cells.*
5. *Describe B-cell receptor.*
6. *Summarize role of humoral immunity in immune reactions.*

Practical lesson 7.

Topic: B cell development.

Maximum score: 2.

Learning outcomes:

1. *Discuss the role bone marrow in development of B cells*
2. *Describe antigen-dependent differentiation of B-lymphocytes.*
3. *Define antigen-independent differentiation of B-lymphocytes*
4. *Compare differences between antigen-independent and antigen-dependent differentiation of B-lymphocytes.*

5. List key components of humoral immune response

Practical lesson 8.

Topic: Structure and functions of antibodies.

Maximum score: 2.

Learning outcomes:

1. Describe the structure and five types of antibodies.
2. Describe the structure of an antibody monomer and state what part of it binds to antigens.
3. Name and explain the functions of the Fab and Fc fragments of immunoglobulins.
4. Complete test quiz "HUMORAL IMMUNITY" (mark true or false).
5. List and describe features of the structure and functions of the major classes of immunoglobulins.
6. Describe ways in which an antibody acts against an antigen.
7. Provide examples of using monoclonal antibodies in therapy.

WRITING TASK "The major classes of antibodies, structural features, functions"

Practical lesson 9.

Colloquium I on FOUNDATION OF IMMUNOLOGY

Maximum score: 14.

Practical lesson 10.

Topic: The complement system.

Maximum score: 1.

Learning outcomes:

1. Describe the immune roles of the complement system.
2. Explain how do the complement system protect against disease .
3. List general characteristics of the complement system and its role in immune reactions.
4. Draw and explain classical and alternative pathway activation of the complement system.
5. Compare and contrast classical and alternative pathway.
6. Name and describe factors that contribute to the initiation of classical and alternative pathways.
7. Draw the mechanism of activation of the complement system by the classical pathway.
8. Draw the mechanism of activation of the complement system via the alternative and lectin pathways.
9. Identify the biological role of intermediate fragments of the complement system.
10. Explain role of the complement system in immunopathological processes.
11. Complete test quiz "THE ROLE OF THE COMPLEMENT SYSTEM IN THE IMMUNE RESPONSE".

Practical lesson 11.

Topic: Cells of innate immunity.

Maximum score: 1.

Learning outcomes:

1. Describe the defensive functions of various types of leukocytes and macrophages.
2. List the main types of antigen presenting cells.
3. Name the main functions of macrophages.
4. Explain what macrophages are? Give examples and state where they are found.
5. Describe the process of antigen presentation and T cell activation.
6. Explain what role does an antigen-presenting cell play in the activation of T cells.
7. Complete test "CELL-MEDIATED IMMUNITY PART I".

Practical lesson 12.**Topic: Cell-mediated immunity.****Maximum score: 1.****Learning outcomes:**

1. *Identify the three distinguishing characteristics of adaptive immunity.*
2. *List contrast cellular and humoral immunity.*
3. *Explain what role does the thymus play in the life history of a T cell*
4. *List the types of lymphocytes involved in cellular immunity and describe the roles they play.*
5. *Explain antigen-independent differentiation of T lymphocytes.*
6. *Explain the processes of positive and negative selection in the thymus.*
7. *Draw and explain polarization of T-helper cells.*
8. *Complete test "CELL-MEDIATED IMMUNITY PART II".*

Practical lesson 13.**Topic: Cell-mediated cytotoxic response.****Maximum score: 1.****Learning outcomes:**

1. *Explain how is a cytotoxic T cell like a natural killer (NK) cell.*
2. *List and discuss how CTL and NK-cells different.*
3. *Describe mechanism of action of the CD8 + CTL.*
4. *Explain what do NK, T, and B cells have in common? How do their functions differ?*
5. *List specialized lymphocytes.*

Practical lesson 14.**Topic: Cytokines.****Maximum score: 1.****Learning outcomes:**

1. *List main groups of cytokines.*
2. *Outline the immune roles of interferons.*
3. *Describe the process of inflammation and explain what accounts for its cardinal signs.*
4. *Describe the general roles played by lymphocytes, antigen presenting cells, and interleukins in the immune response.*

WRITING TASK

Cytokines are of critical importance for communication. Indicate a role for the following cytokines during an infection and which cells can produce that cytokine: IFN a/b, IFN-g, TNF-a, IL-12, IL-6 and IL-10. Based on what you find, can you briefly comment on how cells interact together to produce this cytokine network?

Practical lesson 15.**Topic: Immune response. Immunity and oral cavity****Maximum score: 1.****Learning outcomes:**

1. *Describe structure and features of the immune system.*
2. *Explain the relationship in the immune response.*
3. *Identify some of the characteristics of the main components of the immune system.*
4. *List the main components of immunity in the oral cavity.*
5. *Define the role of local oral immunity.*
6. *Identify some of the characteristics of the main components of the immune system.*

Practical lesson 16.

Topic: Antiviral immune response

Maximum score: 1.

Learning outcomes:

1. *Characterize the role innate immune system against viruses*
2. *Discuss the importance of adaptive immune response in antiviral immunity*
3. *Define the mechanism of action of interferons against viruses*
4. *Describe the role of immunological memory is an important mechanism that protects the organism from viruses*
5. *Explain the collaboration of innate and adaptive immune systems against viruses*

Practical lesson 17.

Topic: Antibacterial immune response

Maximum score: 1.

Learning outcomes:

1. *Explain the role innate immune system against bacterial infection*
2. *Define the protective mechanism of innate immunity components against bacteria.*
3. *Outline the importance of adaptive immune response in antibacterial immunity*
4. *Describe the role of immunological memory as an important mechanism that protects the organism from bacterial agents.*
5. *Explain the collaboration of innate and adaptive immune systems against bacterial pathogens.*

ISW

Maximum score: 3.

Case study that includes the concept of discipline - immunology.

Practical lesson 18.

Colloquium II on FOUNDATION OF IMMUNOLOGY.

Maximum score: 15.

FOUNDATION OF MICROBIOLOGY

Practical lesson 1.

Topic: Introduction to microbiology. Historical background.

Maximum score: 2.

Learning outcomes:

1. *Apply microbiological concepts and basic research findings through description, interpretation, and analysis*
2. *Name the main historical stages of the development of microbiology.*
3. *Define correctly characteristic features related to microorganisms.*
4. *Describe specialized language and knowledge relevant to microbiology.*
5. *Consider the contributions of major scientists and their contributions to the development of Microbiology*
6. *Utilize microbiological concepts to summarize, analyze, and synthesize scientific and microbiology-related literature*
7. *Describe some of the various activities of microorganisms that are beneficial to humans (in food, environment, prevention of disease, agriculture, energy, wastewater treatment)*
8. *Define the general methods used in the study of microorganisms*
9. *Discuss the importance of the field of microbiology to other areas of biology and to general human welfare*
10. *Interpret in the form of essay the role of microbiology in medicine*

Practical lesson 2-3.

Topic: Morphology of bacteria.

Maximum score: 2+2 .

Learning outcomes:

1. *Identify major prokaryotic cell structures in a drawing or photomicrograph.*
2. *Describe the various sizes, shapes, and cellular arrangements exhibited by prokaryotes.*
3. *Describe the appearance, composition, and function of the various internal structures found in prokaryotic organisms (such as inclusion bodies, ribosomes, and the nucleoid).*
4. *Compare the structure of gram-positive and gram-negative bacterial cell walls and explain how the differences between the two contribute to their gram reaction.*
5. *Describe external structures such as capsules, fimbriae and flagella diagram and describe the various arrangements of bacterial flagella.*
6. *Consider the main principles of taxonomy and microorganisms classification.*
7. *Explain the characteristic structures and chemical nature of cellular constituents that distinguish eukaryotic and prokaryotic cells.*
8. *Draw a neat labeled diagram of bacterial cell, types of bacterial cell wall, flagella, capsule and bacterial spore.*
9. *Explain how the structure of LPS confers antigenic specificity and toxicity.*
10. *Define how specialized structures (e.g., pili/fimbriae, capsules, lipopolysaccharides, spores, or flagella) enable a microbe to survive in a given environment .*
11. *Identify correctly bacterial toxins and find differences between them.*
12. *Describe the production of the bacterial endospore and how it enables endospore-forming bacteria to survive harsh environmental conditions and renew growth when the environment becomes conducive to growth.*
13. *Describe in a broad range the metabolic and physiological diversity among bacteria*
14. *Complete 2 parts of ELVIS case.*

Practical lesson 4-5.

Topic: Physiology and biochemistry of bacteria.

Maximum score: 2+2.

Learning outcomes:

1. *Consider the main physiological differences among the domains Eukarya, Archaea and Bacteria .*
2. *Define aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation.*
3. *Describe conceptual role of enzymes in physiology and biochemistry of bacteria.*
4. *Explain the importance of the nitrogen and carbon cycles, and the role of microbes in their maintenance.*
5. *Describe the different phases of the bacterial growth curve. Predict the effect of different environmental conditions on microbial growth and death curves.*
6. *Characterize the various ways bacterial growth is measured, and explain the advantages and disadvantages of each method.*
7. *Discuss the diverse nutritional needs that support the growth of bacteria.*
8. *Draw neat labeled diagram of bacterial growth curve.*
9. *Explain the factors affecting bacterial growth curve.*
10. *Explain how nutrients are transported and how energy is spent to drive transport through the cell membrane. Focus on major groups of molecules.*
11. *Compare heterotrophy and autotrophy.*
12. *List different classes of microbes based on their preferred environmental niches (pH, temperature, and salt).*
13. *Describe the biological properties that allow different classes of microbes to grow in extreme environments.*

14. *Describe the different groups of organisms based on their oxygen requirements.*
15. *Discuss the role of the major biomolecules- carbohydrates, lipids, proteins, amino acids, nucleic acids, classification, structure, function of the above-mentioned biomolecules.*
16. *Explain in detail peptidoglycan synthesis according to the scheme*
17. *Complete remaining parts of ELVIS case .*

Practical lesson 6-7.

Topic: Normal microbiota of oral cavity.

Maximum score: 2+2.

Learning outcomes:

1. *Describe general characteristics of oral microbiota.*
2. *Give the meaning of microbiota, microbiome, metagenomics .*
3. *Reveal how oral cavity acquires its microbiota .*
4. *Outline biological role of normal oral microbiota.*
5. *Analyze about the biological impact of the oral microbiota on human health.*
6. *Explain microflora of saliva, tongue, dental plaque, and gingival crevices.*
7. *Describe dysbiosis of oral cavity.*
8. *Reveal microbiological features of oral cavity.*

Practical lesson 8.

Topic: Genetics of bacteria.

Maximum score: 2.

Learning outcomes:

1. *Specify how DNA is rearranged within a bacterium.*
2. *Give the meaning of bacterial gene transfer, mechanisms of bacterial DNA exchange and conjugal crosses.*
3. *Explain the mechanism of genetic recombination in bacteria.*
4. *Describe the function of plasmids and transposons.*
5. *Explain how chromosome structure differs in Bacteria, Archaea, and Eukaryotes.*
6. *List one example in medicine or in agriculture when bacteria acquired new genes that resulted in an altered cell function.*
7. *Explain what a plasmid is, and describe the role of plasmids in the spread of antibiotic resistance genes.*
8. *Explain the relationship between transcription and translation in bacteria.*
9. *Describe the ribosomal steps of initiation, elongation, and termination.*

Practical lesson 9.

Topic: Colloquium I on FOUNDATION OF MICROBIOLOGY.

Maximum score: 14.

Practical lesson 10.

Topic: Mycology .

Maximum score: 1.

Learning outcomes:

1. *Outline the unique characteristics of fungi.*
2. *Label key features of mycology and fungal morphology.*
3. *Define the importance of fungi to the environment.*
4. *Characterize the common structures of fungi.*
5. *Reveal the structure of the fungal cell wall and overview of compounds that target components.*
6. *Classify fungi into unique categories.*
7. *Compare the major groups of fungi and give examples of each.*

8. *Describe the mechanisms of reproduction in fungi.*
9. *Explain fungal growth morphology and kinetics of growth.*
10. *Define fungal fermentation system.*
11. *Complete test quiz "Mycology".*

Practical lesson 11.

Topic: Isolation, classification and identification of oral microorganisms

Maximum score:1 .

Learning outcomes:

1. *Describe a variety of oral microflora.*
2. *Explain molecular methods of oral bacteria identification.*
3. *Characterize microscopy of bacteria in oral microflora.*
4. *Define bacteria cultivation in oral microflora.*

Practical lesson 12.

Topic: Introduction to virology .

Maximum score: 1.

Learning outcomes:

1. *Indicate how viruses were discovered and characterized.*
2. *Describe the unique characteristics of viruses.*
3. *Identify the origin and importance of viruses.*
4. *Characterize the general structure and size range of viruses.*
5. *Explain the structure and functions of capsids, envelopes, and spikes.*
6. *Classify the different viral groups based on their basic structure.*
7. *Relate the stages in the multiplication cycle of animal viruses, and summarize what is happening in each stage.*
8. *Comprehend three ways in which animal viruses enter into a host cell.*
9. *Summarize two ways in which animal viruses are released by a host cell.*
10. *Discuss cytopathic effects of viruses and the possible results of persistent viral infections.*
11. *Distinguish the bases of viral genetic variability and the principles of viral evolution*
12. *Describe the stages in the multiplication cycle of bacteriophages.*
13. *Compare the major stages in multiplication of animal viruses and bacteriophages.*
14. *Explain what is meant by lysogeny, prophage, lysogenic induction, and lysogenic conversion.*
15. *Explain the classification scheme used for viruses.*
16. *Describe the bases of viral genetic variability and the principles of viral evolution.*
17. *Explain the use of vaccines and delivery systems to control viral infections.*
18. *Complete the whole case about Influenza virus.*

Practical lesson 13.

Topic: Prions.

Maximum score:1 .

Learning outcomes:

1. *Define and describe prions, including their replication process.*
2. *Compare and contrast prions and viruses.*
3. *List four diseases caused by prions.*
4. *Explain the pathogenesis, transmission, and epidemiology of prion disease.*
5. *Understand how prion infection is diagnosed, treated, and prevented.*

Practical lesson 14.**Topic: Introduction to parasitology.****Maximum score:1 .****Learning outcomes:**

1. Summarize the main characteristics of protozoan form, nutrition, and locomotion.
2. Describe the general life cycle and mode of reproduction in protozoans.
3. Explain how protozoans are identified and classified.
4. Outline a classification scheme for protozoans, and provide examples of important members of each group.
5. Explain some biological properties of parasites, and list some common protozoan pathogens.
6. Recall the identifying attributes of the four commonly recognized groups of protozoa.
7. Identify the amoebas generally seen as human pathogens and the portals of entry for each.
8. Depict the life cycle seen in *Entamoeba histolytica* infection.
9. Contrast the pathogenesis, treatments, and common outcomes of *Entamoeba*, *Naegleria*, and *Acanthamoeba* infections.
10. Classify and describe the important characteristics of *Balantidium coli*.
11. Understand the importance of cysts to the transmission of *Giardia*.
12. Describe the four developmental stages of hemoflagellates, and identify those stages that are infectious.
13. Compare the types of vector-borne diseases and associated pathologies.
14. Recall the most important apicomplexan parasites.
15. Diagram the life cycle of *Plasmodium*.
16. Describe the life cycle of *Toxoplasma gondii*.
17. Explain the occasional presence of *Cryptosporidium* in domestic water sources.

Practical lesson 15.**Topic: Type Flatworms (Platyhelminthes). Class Tapeworms (Cestoda).****Maximum score: 1.****Learning outcomes:**

1. Describe the three categories of parasitic helminths.
2. Distinguish between intermediate hosts and definitive hosts.
3. Describe the four basic helminth transmission cycles.
4. Identify the intermediate and definitive hosts in trematode infestation.
5. Recall the stages of the *Schistosoma* life cycle.
6. Describe the strategies used to diagnose and control helminth infection.
7. Set out the morphological and physiological characteristics of tapeworms.
8. Outline the life cycle of the parasite in steps.
9. Complete the whole case about parasitology - "Coping with infection - resistance and tolerance of parasites on soay sheep".
10. Discuss the anatomical adaptation of tapeworms to their intestinal habitat.
11. Describe the major morphological and physiological characteristics of *Taenia saginata* and *Taenia solium*.
12. Describe the major morphological and physiological characteristics of *Diphyllobothrium latum*.

Practical lesson 16.**Topic: Type Roundworms (Nemathelminthes) .****Maximum score: 1.****Learning outcomes:**

1. Specify the common morphological and physiological characteristics of nematodes.

2. *Identify the transmission cycle of each of the most common intestinal nematodes*
3. *Differentiate between tissue nematodes and intestinal nematodes.*
4. *List the vectors associated with each of the common filarial worms.*
5. *Recognize significant morphological characteristics for identification of parasites to taxonomic groups and the life history stage.*
6. *Outline the life cycle of the parasite in steps.*
7. *Complete case about roundworms - "A 2 year old boy from Chad was referred urgently to the district hospital after presenting with bilious vomiting (regurgitation of bile from the small intestines) and abdominal distension (expansion of the stomach and waist beyond its normal circumference)".*
8. *Summarize the mode of infestation and pathology of Necator, Strongyloides, and Trichinella.*
9. *Identify risk factors for contracting trichinellosis, and list several preventative measures.*
10. *Describe the signs and symptoms associated with the most common tissue nematodes.*

Practical lesson 17.

Topic: Type Arthropods (Arthropoda).

Maximum score:1 .

Learning outcomes:

1. *Explain the morphological and physiological characteristics of Arthropods.*
2. *Describe the general life cycle and mode of reproduction in Arthropods.*
3. *Explain the morphology and physiological characteristics of Acarina.*
4. *Distinguish between parasitiform and sarcoptiform (acariform) ticks.*
5. *Describe the general life cycle and mode of reproduction in Acarina.*
6. *Outline the common characteristics of Insecta.*
7. *Depict the structure of of Insecta .*
8. *Describe the morphology and life cycle of Insecta.*
9. *Differentiate among the arthropod vectors of disease.*
10. *Describe the relationship between arthropod vectors and the parasites they carry.*

ISW

Maximum score: 3

Case study that includes the concept of disciplines - microbiology and parasitology.

Practical lesson 18.

Topic: Colloquium II on FOUNDATION OF MICROBIOLOGY.

Maximum score: 15.

FOUNDATION OF BIOCHEMISTRY

Practical lesson 1.

Topic: The foundations of biochemistry.

Maximum score: 3.

Learning outcomes:

1. *History of the development of Biological Chemistry.*
2. *Discuss the types of chemical bonds and name the functional groups and their functions.*
3. *Explain stereoisomers and cis-trans configurations.*
4. *Evaluate the properties of thermodynamics and chemical kinetics.*
5. *Articulate on anabolism and catabolism.*
6. *Explain biochemical hierarchy from monomers to polymers and then to the cell.*

Practical lesson 2.**Topic: Water. Amino acids, peptides, and proteins.****Maximum score: 3.****Learning outcomes:**

1. *Define the interactions in water and how it shapes its properties as: solvent, buffer, and catalyst.*
2. *Explain the formation of hydrophobic aggregates in water.*
3. *Explain how weak acids and bases behave in water: to be able to solve weak acid problems with the Henderson-Hasselbalch equation.*
4. *Discuss the function of water in biochemical reactions and buffer.*
5. *Explain pH and it can be calculated.*
6. *Articulate on enantiomers of amino acids and draw the structure.*
7. *Explain the diversity of functional groups and their interaction with other molecules.*
8. *Compare the amino acid functions and buffering points.*
9. *Differ three chromatography techniques (size-exclusion, ion-exclusion, and affinity).*
10. *Explain SDS-PAGE (2D and 3D).*

Practical lesson 3.**Topic: The three-dimensional structure of proteins. Protein function.****Maximum score: 3****Learning outcomes:**

1. *Compare and contrast primary, secondary, tertiary, and quaternary structures.*
2. *Outline the classification of proteins.*
3. *Compare alpha-helix, beta-sheets, and beta-turns.*
4. *Discuss scurvy based on collagen formation.*
5. *Define ligands and ligand binding kinetics.*
6. *Explain the importance of iron and heme.*
7. *Outline the interaction of myoglobin and hemoglobin with heme and oxygen gas, cyanide, and carbon monoxide.*
8. *Explain the interaction between carbon dioxide and globins.*
9. *Compare and contrast hemoglobin and myoglobin structure and function.*
10. *Explain how hemoglobin transports oxygen considering partial pressure of gases, allosteric regulation and pH.*
11. *Outline the key differences of sickle cell anemia.*

Practical lesson 4.**Topic: Enzymes.****Maximum score: 3.****Learning outcomes:**

1. *Describe the general properties of enzymes.*
2. *Define an enzyme and ligand.*
3. *Define coenzyme and cofactor: give examples.*
4. *Describe the nomenclature and enzyme classification.*
5. *Explain the function of an enzyme based on kinetics and thermodynamics.*
6. *Define K_m and V_{max} . Calculate K_m .*
7. *Compare several enzymes based on their K_m , K_{cat} , V_{max} , and V_0 .*
8. *Clinical significance of the determination of individual enzymes in dentistry*

Practical lesson 5.**Topic: Regulation of enzyme activities.****Maximum score: 3.****Learning outcomes:**

1. *Enlist the factors affecting the enzyme activity.*
2. *Characterize the mechanism of enzymatic catalysis.*
3. *Explain the mechanism of inhibitors working on enzyme catalytic activity.*
4. *Competitive and non-competitive inhibition.*
5. *Explain the regulation enzyme function based on allosteric inhibition, competitive inhibition, and phosphorylation.*

Practical lesson 6.

Topic: Vitamins.

Maximum score: 3.

Learning outcomes:

1. *Describe the Nomenclature of vitamins.*
2. *Explain water-soluble vitamins: structure, role.*
3. *Explain fat-soluble vitamins.*
4. *Discuss the avitaminosis and hypervitaminosis of water-soluble and fat-soluble vitamins.*
5. *Differ vitamin-like substances and antivitamin.*

Practical lesson 7.

Topic: Bioenergetics of the cell. Respiration.

Maximum score: 3.

Learning outcomes:

1. *Describe stages of energy metabolism.*
2. *Explain specific pathways for the breakdown of nutrients.*
3. *Explain biological oxidation.*
4. *Characterize respiratory chain.*
5. *Understand oxidative phosphorylation.*
6. *Regulation of tissue respiration.*

Practical lesson 8.

Topic: Metabolism of carbohydrates & Glycogen

Maximum score: 3

Learning outcomes:

1. *Define carbohydrates.*
2. *Draw the structure of a glucose.*
3. *Explain how the structure of a glucose makes it soluble in water and highly reactive.*
4. *Explain the function and classification of carbohydrates.*
5. *Give five examples of monosaccharides and three examples of disaccharides.*
6. *Explain their metabolic activity.*
7. *Outline polysaccharides - Glycoconjugates: Proteoglycans, Glycoproteins, and Glycosphingolipids.*
8. *Discuss carbohydrates as informational macromolecules: the sugar code working with carbohydrates.*
9. *Discuss glycogen metabolism and the concept of its impairment.*

Practical lesson 9.

Topic: Colloquium I on FOUNDATION OF BIOCHEMISTRY.

Maximum score: 16.

Practical lesson 10.

Topic: Glycolysis, gluconeogenesis, and pentose phosphate pathway.

The citric acid cycle and catabolism.

Maximum score: 3.

Learning outcomes:

1. *Understand the meaning of each step in glycolysis: energetics, enzymes.*
2. *Know the difference between aerobic and anaerobic pathways.*
3. *Explain main points of Pentose Phosphate Pathway.*
4. *Explain features of each step of TCA: energetics, enzymes.*
5. *Explain regulation principles.*
6. *Understand roles of water and CoA.*

Practical lesson 11.**Topic: Lipid & Fatty acids metabolism.****Maximum score: 3.****Learning outcomes:**

1. *Define storage lipids.*
2. *Outline structural lipids in membranes.*
3. *Discuss lipids as signals, cofactors, and pigments.*
4. *Expound working with lipids.*
5. *Characterize the biosynthesis of triacylglycerols, phospholipids and cholesterol.*
6. *Describe fatty acid oxidation.*

Practical lesson 12.**Topic: Biological membrane. Membrane transport.****Maximum score: 3.****Learning outcomes:**

1. *Describe a biological membrane.*
2. *Characterize membrane transport.*
3. *Explain how intracellular channels are arranged.*
4. *Discuss the fluidity of the membrane.*

Practical lesson 13.**Topic: Signal transduction and biochemical reaction types.****Maximum score: 3.****Learning outcomes:**

1. *Give a definition of intracellular organization (signal transduction).*
2. *Classify and characterize membrane cell receptors, give specific examples.*
3. *Give examples of secondary intermediaries.*
4. *Predict signaling pathways when exposed to insulin cell and thyroid hormone, steroid hormones.*
5. *Characterize cytoplasmic and nuclear receptors.*
6. *Give examples of signal transmission paths for the effect on the cell of steroid hormones.*
7. *Explain how temperature, entropy, enthalpy determines spontaneity of reaction.*

Practical lesson 14.**Topic: Metabolism of proteins and amino acids****Maximum score: 3.****Learning outcomes:**

1. *Explain the breakdown of proteins to amino acids.*
2. *Explain that the first step in amino acid degradation is nitrogen removal.*
3. *Explain why the carbon atoms of degraded amino acids become major metabolic intermediates.*
4. *Realize that amino acids are the precursors of many molecules.*
5. *Understand the biosynthesis and breakdown of amino acids.*

Practical lesson 15.**Topic: Nucleotides and nucleic acids.****Maximum score: 3.****Learning outcomes:**

1. *Explain Basics of the Living system.*
2. *Outline Nucleic Acid Structure and chemistry.*
3. *Describe Functions of Nucleotides.*

Practical lesson 16.**Topic: Biosynthesis and functions of nucleic acids.****Maximum score: 3.****Learning outcomes:**

1. *Explain how the pyrimidine ring is formed from bicarbonate, aspartate and glutamine.*
2. *Learn how bicarbonate and other oxygenated carbon compounds are activated by phosphorylation.*
3. *Understand how the glutamine side chain can be hydrolyzed to form ammonia.*
4. *Explain DNA replication.*
5. *Understand the chemical nature of the gene.*

Practical lesson 17.**Topic: Protein biosynthesis. Types of mutations.****Maximum score: 3.****Learning outcomes:**

1. *Explain the stages of the process of protein biosynthesis.*
2. *Describe the regulation of protein biosynthesis.*
3. *Understand the causes and mechanisms of the appearance of a mutation.*

Practical lesson 18.**Topic: DNA-based information technologies.****Maximum score: 3.****Learning outcomes:**

1. *Describe the methods for determining DNA.*
2. *Explain steps of DNA amplification by PCR.*
3. *Explain recombinant DNA cloning using viruses.*
4. *Explain recombinant DNA cloning using bacterial artificial chromosome.*
5. *Know the strategy of DNA purification.*

ISW**Maximum score: Case study that includes the concept of discipline - biochemistry.****Practical lesson 15.****Topic: Colloquium II on FOUNDATION OF BIOCHEMISTRY****Maximum score: 20.****Methodical instruction for practical lessons**

Aim: The goal is to form a holistic view of the characteristics of the molecular organization and metabolism of the most important organs and tissues of the body and their regulation; about the structure of the immune system, its role in maintaining homeostasis, the mechanisms of immunoregulation, the basic biological properties of microorganisms of medical importance, the interaction of macro and microorganisms in the process of normal life and during the infectious process.

Learning outcomes:

1. Describe the main biochemical processes and metabolism at the molecular level with an understanding of the principles of maintaining the stability of the internal environment of the body.
2. Apply knowledge of normal metabolism and its regulation under different physiological conditions.
3. Apply knowledge of molecular genetic mechanisms to maintain homeostasis, gene expression and epigenetics.
4. Describe the components of the immune system, the mechanisms of immune defense are normal and the adaptive immune response, the development of the immune system; genes responsible for the functioning of the immune system and immunoregulation;
5. Describe the morphology and physiology of bacteria, viruses, fungi of medical significance, recognize them, know their properties, reproduction, antigenic composition, factors of pathogenicity and virulence; formation of sustainability.
6. Describe the properties, characteristics, life cycle of parasites of medical value.
7. Apply knowledge of the normal immune response to various types of infections (viral, bacterial, fungal, parasitic)
8. Apply knowledge of the normal microbiota and its interaction with the human immune system
9. Demonstrate the ability to apply the language and knowledge of each discipline to discuss and solve fundamental scientific and clinical problems.
10. Demonstrate the ability to identify learning gaps and create strategies to enhance one's own knowledge and skills.
11. Effectively communicate with other students and teachers regarding medical and scientific information, articulate their opinions clearly when discussing and work effectively as a member of the team

Plan of preparation work for each lessons

1. Familiarize yourself with the basic and additional literature, use textbooks, the syllabus and present directions, Internet resources to prepare for seminars.
2. Be prepared for class and participate actively on case-discussion and problem solving group activities.
3. Use the examples (in this number cases and your own experience studied before) for illustration of theoretic material.
4. Use different tools for studying, discussion and visualisation of thoughts - drawing, mind maps, 3d-modelling.
5. Use the group work with cases for the development of team work skills, communication, problem solving and self-studying.

SOME TIPS ON TEAMWORK AND LEARNING ¹

The medical profession involves working in multidisciplinary teams, so these skills are identified as key in the competence of the doctor and other health professionals in all countries.

Therefore, group work is included as an essential component in the practical exercises of our course. In addition, it aims to provide a safe environment in which you can try out new ideas and practices and acquire relevant group skills. These can be tasks for performance in pairs, triples or small groups of 4-6 people (work with cases, tasks of the ISW, etc.).

When you are working on a project or task in a team, you have the opportunity to use the various strengths of the group members to create a wider and better project or task than if you were working independently.

Group training means you need to share your knowledge and ideas with other students. There are two benefits to this: you need to think carefully about your own ideas in order to explain

¹ adapted from UNSW Guide to Group Work <https://student.unsw.edu.au/groupwork>)

them to others, and you expand your own understanding, taking into account the knowledge and ideas of others.

Interpersonal Communication and Discussion

Take some time to chat and get to know each of your group mates. The better you know each other and the more convenient you communicate, the more effective you can work together.

Create a culture of mutual respect in your group. You probably had little choice or no choice at all when forming training groups and small teams in the classroom. Therefore, you will have to learn to overcome the differences between people. In addition, you will not have the opportunity to choose employees in the workplace, and at work, you will experience much greater pressure to be a productive member of the team.

For effective communication and discussion in a team: you should not be shy to express your opinion and it is important to feel that these opinions will be heard; it is necessary to feel that all members of the group make a feasible contribution to solving problems, observing agreed rules and plans, performing work efficiently and on time; it is important to know that everyone's feelings are taken into account by team members, but the goals and objectives of the group are not compromised, in favor of the whims or desires of individual members;

Try to express your opinion and listen to others. There is nothing wrong with disagreeing with your classmates, no matter how confident they are. When you disagree, be constructive and focus on the problem, not the person. Similarly, when someone disagrees with you, respect what he says and the risk that he takes upon himself to express his opinion. Try to find a way that everyone can agree with, and this is not necessarily the opinion of the loudest or smartest member of the team.

Below we provide some examples of constructive and destructive group behavior²

Constructive group behavior - a person who:

Unites - interest in the views and opinions of others and willingness to adapt to interest

Clarifies - clearly defines the problems for the group by listening, summarizing, focusing the discussion

Inspires - encourages the group, stimulates participation and progress

Harmonizes - stimulates group unity and teamwork. For example, uses humor as a relaxation after difficult situations.

Take the risk - willingness to take risks at the expense of oneself for the success of the group or project

Manages the process - organizes a group on the issues of the process: for example, plan, schedule, timeline, topic, solution methods, and use of information

Destructive group behavior:

Domination - takes a lot of time expressing your opinion and views. Trying to take control by capturing energy, time, etc.

Fussiness - hastens the group to move quickly before the task is completed. Impatient in listening to other opinions and working together.

Suspension - removes itself from a discussion or decision. Opt out

Ignoring - does not respect or belittle the ideas and suggestions of the team or individuals. An extreme manifestation of ignoring is an insult in the form of ridicule.

Distraction - excessive talkativeness, tells stories and leads groups away from the goal

Blocking - prevents group progress by denying all ideas and suggestions. "It will not work because ..."

Effective group work does not arise by itself. A conscious and planned effort is needed, and since many people participate in it, one cannot rely on memory; need to make notes. **The following steps** will help you and your team work together effectively.

² adapted from Brunt (1993): <https://tle.wisc.edu/solutions/engagement/constructive-and-destructive-groupbehaviors>

1. Define clear objectives. At each stage, you should try to coordinate the tasks. They include a timeline for the project, as well as more specific tasks (such as “agree on an approach to the task before Friday”). Each meeting or discussion should also begin with a specific goal (for example, make a list of tasks that need to be completed). Tasks should be broken down into smaller parts and planned. Sometimes one part cannot be started until the other part is finished, so you may need to draw a simple temporary map.

- discuss the resources that you have and those that you will need to find.
- formulate the desired result.
- consider how you know when you did it well enough?
- split tasks between the team and
- set deadlines for subtasks and time for future meetings.

2. Set the basic rules. Discussions can become erratic and can prevent more modest group members from participating if you do not have rules to stimulate discussion, resolve disagreements, and make decisions without repetition. Set the rules from the start and change them as needed. For example: an interesting rule that was developed by one group - anyone who missed a meeting would buy the rest of the group coffee in a coffee shop. No one ever missed a meeting after that.

3. Communicate effectively. Make sure you regularly communicate with group members. Try to be clear and positive in what you say without repeating.

4. Find consensus. People work together most effectively when they work towards a goal with which they have agreed. Make sure everyone has their own opinion, even if you need time to get more participants to say something. Make sure you listen to everyone’s ideas and then try to come to an agreement that everyone shares and everyone has contributed.

5. Define the roles. Divide the work that needs to be done into separate tasks, for which you can use the strengths of individual team members. Define roles for both fulfilling your tasks and for meetings / discussions (for example, Arani is responsible for summarizing the discussions, Joseph is for everyone to express their opinions and make decisions, etc.).

Examples of roles and functions:

Facilitator or leader (depending on context) - to clarify the goals of the meeting and to summarize the discussions and decisions; ensures that the meeting takes place, continues and the basic rules are respected.

Secretary - keep a record of the ideas discussed and decisions made and who does what.

Time Manager - to make sure that you discuss everything that you need in the time allotted for the meeting.

Controller - to ensure that work is completed by an agreed time, and to solve problems if they are not being performed.

A process observer is someone who monitors the process, not the content, and can bring problems to the attention of the team. In this role, it is important to be positive, not condemning.

Editor - bring all materials together, identify gaps or matches and ensure consistency in the final presentation.

6. Make it clear. When a decision is made, it should be explained in such a way that it is absolutely clear to everyone that it was decided, including the time frame.

7. Keep good notes. Always summarize the discussions and document the decisions and publish them (for example in WhatsApp chat) so you can always get back to them. This includes lists of those who agreed what to do.

8. Stick to the plan. If you agreed to do something as part of the plan, do it. Your group relies on you to do what you agreed to do, and exactly in this way, not in the way you would like. If you think the plan should be reviewed, discuss it.

9. Keep track of progress and keep up to date. Discuss progress together regarding your schedule and deadlines. Make sure you meet deadlines personally so you do not let your group down.

Co-writing a document/report

Joint writing is one of the most difficult parts of group work. There are many ways to do this, and your group must decide how to separate the work of writing, comparing, editing, and finalizing your work. Writing in a group (six people crowd around the keyboard) is a recipe for conflict and lack of progress. The other extreme - when one person assumes all responsibility and ultimately does most of the work - is also unproductive and contributes to conflict.

Three approaches are possible when working on a common document:

1 - One person writes the most part - this means that a narrow circle of ideas is used, and the rest of the team does not learn (and will not learn) to write reports and documents.

2 - Each person writes one section - then it is difficult to make a single consistent report, and you will not know about the rest, except for your own section.

3- Co-writing. This is the most productive way to solve group problems and provides the greatest benefit from collaboration. For example: in each section, there is a writer and at least one reviewer, and each team member is the author of a section and a reviewer of another one.

All team members before finalization by **the editor** must review the final product. Alternatively, you can have one author with others, editors, add and review, and someone tidies the finished report.

Try to divide the writing of source documents into tasks and solve them individually or in pairs. After the first draft of the sections are written, send out all the components and read them. You will probably need to come together to discuss how to combine them so that they fit together. Any participants who were not involved in preparing the drafts can do part of this work. Then edit, improve and polish the draft. It's convenient to collaborate on documents in Google documents.

When preparing a report / final document, regularly check the following:

- Is the purpose of the project clear from the report?
- Are the conclusions or recommendations clear?
- Do conclusions follow from the main part of the report?
- Do sections fit well?
- Does the report achieve goals (and evaluation criteria)?
- Are the necessary components sufficiently covered?

Whatever method you use, all group members must agree on the process and how they are going to maximize the collaborative approach to writing the final document.

Monitoring team performance and coping

Below is a checklist that includes a list of common problems that arise in a group work. Use it regularly to identify problems before they get out of hand. If serious problems and tensions arise, use it to determine where something might go wrong. First answer each question about yourself, and then give answer to this **question** about the group as a whole. Then gather a group and discuss where, in your opinion, problems may arise, and think about how you can overcome these problems.

Each participant must complete this checklist. You should do this exercise regularly to track and improve your team's performance.

1. Answer each question regarding your teamwork.
2. Answer each question regarding the rest of the team.
3. Get together with your entire team and discuss where, in your opinion, any problems arise.
4. Discuss what you are going to do to overcome these problems.

Checklist for self-assessment of team effectiveness.

You	I personally	Group as a whole	Comments
Effectively clarify your tasks and tasks at each stage?			
Evaluate the progress of work?			
We clarify and document everything that the group decided?			
We clarify who will do what and how?			
We clarify by what date each task should be done?			
Setting meeting management rules?			
Adhere to agreed rules?			
Listening to each other?			
Allow some team members to dominate?			
Allow some team members to refuse / withdraw?			
We sacrifice personal desires for the success of the team?			
Recognize the feelings of other team members?			
Making equal contributions to team progress?			
Adhere to agreed rules for writing and naming files?			

Points and Grade

Group tasks and assignments mean that grades are given to the whole group based on the results of the work of the whole group. Everyone should be interested in ensuring the effective contribution of all members of the group and ensuring the high quality of the assignment. Sometimes, to assess the relative contribution of each to the group process, a form of peer-to-peer or peer review and a team assessment form will be used. This can be used to moderate assignment grades, or simply as a way to give feedback on your work in a group. The following are examples of student assessment criteria for team training.

№	Student assessment criteria in practical classes
1	<i>Preparation for classes:</i> He studies information focused on the case and problematic issues, uses various sources, and supports the statements with relevant links.
2	<i>Group skills and professional attitude:</i> Demonstrates excellent attendance, reliability, responsibility Takes the initiative, takes an active part in the discussion, helps the teammates, willingly takes on tasks

3	<i>Communication skills:</i> Actively listens, shows emotions according to the situation, is susceptible to non-verbal and emotional signals, shows respect and correctness in relation to others, helps to resolve misunderstandings and conflicts
4	<i>Feedback Skills:</i> Demonstrates a high level of introspection, critically evaluates oneself and colleagues, provides constructive and objective feedback in a friendly manner, accepts feedback without opposition
5	<i>Skills of critical thinking and effective learning:</i> Effectively participates in generating hypotheses and formulating problematic questions, gives relevant examples from life, skillfully applies knowledge to the problem / case under consideration, critically evaluates information, draws conclusions, explains and substantiates statements, draws diagrams and drawings, demonstrates a constant interest in the material being studied
6	<i>Theoretical knowledge and skills on the topic of the lesson:</i> All key aspects are presented logically; accuracy, relevance of answers to the questions posed without redundancy; integration of theoretical issues; Use of relevant examples proper use of professional terminology

Basic literature:

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2. Warren Levinson. Review of Medical Microbiology and Immunology (13th Edition) 2014, - McGraw Hill, 2014. - 1950 p. - ISBN 978-0-07-181812-4.
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5. Rodwell Victor W. Harper's Illustrated biochemistry - 31st edition. McGraw-Hill, 2018, 693 p. ISBN-10:1260288420.
6. Roitt's Essential Immunology [Electronic resource] : textbook / P. J. Delves, S. J. Martin, D. R. Burton [et al.]. - 13th ed. - Pondicherry : Garamond by SPi Global, 2017. - 576 p. - ISBN 978-1-118-41577-1.
7. Abul K. Abbas; Andrew H. Lichtman; Shiv Pillai Basic Immunology, Edition: 6th, 2019, 336 p, - ISBN: 9780323549431, 0323549438.

Additional literature

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2. Maheshwari N. Clinical Microbiology and Pathology [Text] : for DMLT Students; Damyanti DMLT Institute. - 3rd ed. - New Delhi ; London ; Philadelphia: Jaypee, 2016. - 498 p. : il. - ISBN 978-93-5250-018-5 : Ind.: p. 489-498.
3. Kumar.S. Essentials of Microbiology [Electronic resource] : monograph / - [S.l.] : Jaypee, 2016. - 627 p. - ISBN 978-93-5152-380-2.
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5. Toy E. C. , Skinner C. R. Debord Case files : microbiology [Electronic resource] : textbook/- 3th ed. - Electronic text data 5.42 Mb. - New York : Medical publishing division, 2015. - 365 p. - The Main Page Title. - ISBN 978-0-07-182022-6
6. Sastry, Apurba Sankar. Essentials of Medical Microbiology [Text] : [monogr.] /A. S. Sastry, S. B. K ; Jawaharial Institute of Postgraduate Medical Education and Research (JIPMER) [et al.]. - New Delhi ; London ; Philadelphia : Jaypee, 2016. - 638 p. : il. - Ind.: p. 631-638. - ISBN 978-93-5152-987-3
7. Moscatello, Kim, Immunology and Microbiology. USMLE Step 1 [Electronic resource] : lecture Notes. / K. Moscatello. - Electronic text data 15.2 Mb. - New York : Kaplan Medical, 2017. - 502 p. - The Main Page Title. - ISBN 978-1-5062-0873-2
8. SenGupta, Manideepa. Practicals in Microbiology [Text] : [practical notebook] /M. SenGupta, M. Sengupta ; Medical Colledge, Kolkata [et al.]. - New Delhi; London ; Philadelphia : Jaypee, 2016. - 184 p. - Ind.: p. 181-184. - ISBN 978-93-5250-133-5
9. Zubay's Principles of Biochemistry [Text] : textbook / V. B. Rastogi, K. R. Aneja; Gargi College [et al.]. - 5th ed. - New Delhi ; Guwahati ; Thiruvananthapuram : MEDTECH, 2017. - 675 p. : il. - Ind.: p. 669-675. - ISBN 978-93-84007-49-2
10. Rodwell V.W., Bender D.A., Botham K.M., Kennelly P.J., Weil P.A. Harper's Illustrated Biochemistry, 31th Edition. — McGraw-Hill Education, 2018. — 2023 p.ISBN-13: 978-1259837937

WWW resources

1. Lecturio.com
<https://www.lecturio.com>
2. Microbiology online
https://microbiologyonline.org/teachers/resources?resource_type=fact-files
3. MicroBEnet: the microbiology of the Built Environment network
<https://microbe.net/resources/microbiology-web-resources/>
4. Microbiology society <https://microbiologysociety.org/members-outreach-resources.html>
5. BioEd Online <http://www.bioedonline.org/lessons-and-more/resource-collections/micromatters-microbiology/>
6. Microbiology Resource Announcements <https://mra.asm.org>
7. A Portal for Three-dimensional Structural Information about Nucleic Acids
<http://ndbserver.rutgers.edu>
8. Biochemistry handbook
<https://library.med.utah.edu/NetBiochem/titles.htm>
9. Biochemical journal
<https://portlandpress.com/biochemj>
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