



MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION  
Federal state autonomous educational institution  
of higher education  
«Far Eastern Federal University»  
(FEFU)

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**SCHOOL OF BIOMEDICINE**

«AGREED»

Head of education program  
«General medicine»

  
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(signature) Khotimchenko Yu.S.  
(Full name)  
«09» of July 2019

«APPROVED»

Director of the Department of Clinical  
Medicine



  
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(Full name)  
«09» of July 2019

**WORKING PROGRAM OF ACADEMIC DISCIPLINE (WPAD)**

**« Histology, Cytology, Embryology»**

Educational program

Specialty 31.05.01 «General medicine»

**Form of study: full time**

year 1,2 semester 2,3  
lectures 36 hours  
practical classes 108 hours  
laboratory works not provided  
total amount of in-classroom work 144 hours  
independent self-work 108 hours  
including exam preparation 27 hours  
control works ()  
credit 2 semester  
exam 2 year, 3 semester

The working program is drawn up in accordance with the requirements of the Federal state educational standard of higher education (level of training), approved by the order of the Ministry of education and science of the Russian Federation from 09.02.2016 № 95.

The working program of the discipline was discussed at the meeting of the Department of fundamental and clinical medicine. Protocol No. 8, 09 of July 2019

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## ANNOTATION

The discipline "Histology, Cytology, Embryology" is implemented in the basic part of the curriculum of training a specialist for students in the direction (specialty) 31.05.01 Medicine.

In developing the work program of the discipline, the Federal State Educational Standard of Higher Education, approved by the Ministry of Education and Science of the Russian Federation of February 9, 2016 No. 95, for the specialty 31.05.01 Medical business (specialty level) and the curriculum for the medical specialty approved by FEFU Academic Council.

The complexity of the discipline is 252 hours (7 credits), 144 hours - classroom work, of which, 36 hours - lectures, 108 hours - practical exercises, 108 hours - independent work of students and 27 hours control over the independent work of students.

The discipline "Histology, Cytology, Embryology" is a discipline related to the B1 block of the basic part of the educational program in the structure of the general education program of higher education in the specialty 31.05.01 Medicine; studied in the second and third semesters. This discipline is an obligatory and important link in the system of biomedical sciences, providing fundamental theoretical knowledge, on the basis of which the training of the future doctor is based. To master the discipline, students use the knowledge, skills and activities mastered in the study of the preceding disciplines: "Biology", "Latin". Knowledge of the discipline "Histology, cytology, embryology" serve as a theoretical and practical basis for mastering a number of basic disciplines: normal physiology, pathological anatomy, pathological physiology, clinical and laboratory diagnostics, immunology, ophthalmology, forensic medicine, obstetrics and gynecology, etc.

### **Course purpose:**

Formation of students' fundamental knowledge, skills and practical skills in cytology, general and private histology and human embryology, necessary for the successful development of other medical, biological and clinical disciplines and the

acquisition of professional competencies that contribute to the formation of a specialist.

**Tasks:**

- study of the basic laws of development and vital activity of the human body based on the structural organization of cells, tissues and organs; anatomical and physiological, age-sex and individual characteristics of the structure and development of the human body;
- training in the most important methods of studying morphological structures, allowing to identify organs and determine their tissue elements at the microscopic and ultramicroscopic levels; recognize changes in the structure of cells, tissues and organs in connection with various biological and protective-adaptive reactions of the body;
- teaching students the most important methods of histological research in order to provide a basis for studying clinical disciplines;
- formation of skills of analytical work with information (educational, scientific, regulatory and reference books and other sources), with information technology, diagnostic methods of research.

Code and skill description	Stages of skill development	
the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	<b>Know</b>	The basic laws of development and vital activity of the organism are based on the structural organization of cells, tissues and organs; histo-functional characteristics of tissue elements; methods of their research; structure, topography and development of cells, tissues, organs and body systems in conjunction with their function in the norm; age characteristics of cells, tissues, organs and body systems.
	<b>Able</b>	To give a histophysiological assessment various cellular, tissue and organ structures, analyze pathological processes in the human body
	<b>Master</b>	The ability to compare morphological changes in health and disease

In order to form these skills during "Histology, Cytology and Embryology" course, the following methods of learning will be used:

Lectures:

1. Lecture with visual aids
2. Lecture-discussion

Practical training

**I. STRUCTURE AND CONTENT OF THE THEORETICAL PART OF THE  
COURSE (36 HOURS)  
SECOND SEMESTER (18 HOURS)**

**Lecture 1: Cell structure (2 hours).**

1. Cell. Cell theory. Organelle classification.
2. Chemical composition of the cell.
3. Cell membrane, its functions and role.
4. Structure and functions of the nucleus. The cell cycle. DNA replication. Cell division.
5. Mitochondrion: functions and structure.
6. Paraneurosis, especially physiological and pathological cell degeneration.
7. Cell differentiation. Cell death (necrosis, apoptosis).

**Lecture 2: Tissue classification. Epithelial tissue. Connective tissue (2 hours).**

1. General characteristics and classification of tissue.
2. Epithelial tissue. General features of epithelial tissue.
3. Functions of epithelial tissues.
4. Development of epithelial tissue.
5. Classification of epithelial tissues.
6. Glandular epithelium; two types of glands.
7. General characteristics of connective tissue. Mesenchyme.
8. Functions and classification of connective tissue.
9. The structure of the loose connective tissue - cell composition and organization of the intercellular substance.
10. Structure and function of tendon.
11. Structure and function of the ligament.

**Lecture 3. Blood. Hematopoiesis (4 hours).**

1. Blood as a tissue.

2. Characteristics of red blood cells.
3. White blood cells, their classification and function.
4. Origin and function of platelets (thrombocytes).
5. The hemogram and its clinical significance.
6. The role of histology in hematology development, hematopoiesis theory.
7. Fetal (primary) hematopoiesis.
8. The definitive (secondary) hematopoiesis.
9. Types of stem cells and stages of their development.
10. Stages of erythropoiesis.
11. Stage of granulocytogenesis.
12. Regulation of hematopoiesis by humoral factors and neurons.

#### **Lecture 4. Immune system (2 hours).**

1. Characteristics of the immune system.
2. What is the "immunity"? Types of immunity.
3. The term "antigen", "antibody", "complement", "major histocompatibility complex".
4. Immunoglobulins. Classification of immunoglobulins.
5. T lymphocytes features and functions.
6. B lymphocytes features and functions.
7. Macrophages and their role in the immune response.
8. Immune system organization at the tissue level.

#### **Lecture 5. Bone tissue. Cartilage tissue (2 hours).**

1. The cellular elements of bone tissue.
2. Structure of intercellular substance of bone tissue.
3. Classification of bone tissue.
4. Development and regeneration of bone tissue: types of osteogenesis.
5. Histological structure of a tubular bone.
6. Factors that influence on bone structure.

7. Age-related changes in bone tissues.
8. General characteristics of the cartilage, cellular element of cartilage.
9. Intercellular substance of cartilage.
10. Types of cartilage.
12. Cartilage growth and development. Cartilage regeneration.

### **Lecture 6. Muscle tissue (2 hours).**

1. The development, structure and function of muscle tissue.
2. Sarcomere structure.
3. Theory of muscle contraction.
4. The regeneration of muscle tissue.

### **Lecture 6. Nervous tissue (2 hours).**

1. Cells of nervous system.
2. Neurons: their morphology, neurochemical and functional characteristics.
3. Macroglia and microglia, types and origins.
4. Classification of nerve endings, their morphological differences.
5. Structure and types of nerve fiber.
6. Types and organization of synapses.
7. Neural theory.
8. Reflex arc.

### **Lecture 7. Organs of nervous system (2 hours).**

1. Spinal ganglion.
2. Organization of the gray matter and white matter in the spinal cord.
3. Structure of the cerebellum and cerebral cortex of the brain.
4. Morphological and functional characteristics of neurons of the cerebellar cortex and cerebral cortex

### **Lecture 8. Organs of sense. Eye. Organ of smell (2 hours).**

1. Analyzers.
2. Morphofunctional characteristic of primary and secondary sensory senses.
3. Development of the structural components of sight and smell organs.
4. Structure and function of the eye layers.
5. The structure of the receptors and accommodative apparatus of the eye.
6. Characteristic of the olfactory system receptors.

**Lecture 9. Organs of sense. Organs of taste, equilibrium and hearing (2 hours).**

1. Morphological and functional features of the senses with secondary sensory cells.
2. Components of the cochlea membranous labyrinth.
3. Structure and ultrastructure of the receptor cells in the spiral organ, organs of equilibrium and taste.

**THIRD SEMESTER (18 HOURS)**

**Lecture 1: Cardiovascular system. Blood vessels (2 hours).**

1. Formation of cardiovascular system organs during human development.
2. Classification of the arteries, veins, anastomoses.
3. Structure of the artery and vein walls.
4. Structure and function of arterioles, venules, capillaries.
5. Angiogenesis, development of endocardium, myocardium and epicardium.
6. The history of the circulation study.
7. Types of arteries: arteries structure of muscular and elastic type.
8. Structure of the veins.
9. Arterio-venous anastomoses.

**Lecture 2: Cardiovascular system. Heart (2 hours).**

1. Structure of the heart wall.
2. Heart development and layers of the heart wall.

3. The structure of the endocardium and epicardium.
4. Myocardium, its structure and function, types of cardiomyocytes.
5. Conduction system of the heart, types of cardiomyocytes.

**Lecture 3: Hematopoiesis and immune defense organs (2 hours).**

1. Development of hematopoiesis and immune organs.
2. Common features in structural organization of hematopoiesis and immune organs.
3. Structure and function of red bone marrow, thymus, lymph nodes, spleen and tonsils.

**Lecture 4: The skin and skin derivatives. Respiratory system (2 hours).**

1. Skin development.
2. Skin structure.
3. The epidermis and dermis of the skin.
4. Receptors in skin. Receptor`s classification.
5. Skin derivatives: sweat glands, sebaceous glands, hair.
6. Organization of the respiratory system.
7. Functions of the respiratory system.
8. Development of the respiratory system and respiratory epithelium.
9. The structure of the bronchial tree.
10. Acinus structure.
11. The cellular elements of the alveoli and the structure of the air-blood barrier.
12. Features of the circulation and respiratory system innervation.

**Lecture 5. The digestive system. The organs of the anterior part of digestive system (2 hours).**

1. Structure of the digestive tube.
2. Development of the anterior part of the digestive system



3. Mucous membrane of the skin and intestinal type. The area of esophagus and stomach connection, their development.
4. Tissues of the tooth, sources of their development.
5. Layers of the esophagus wall, tissues composition of the upper, middle and lower thirds of the esophagus.

**Lecture 6. The digestive system. Structure of middle and posterior parts. The salivary and pancreatic glands. Liver (2 hours).**

1. Development of the stomach and intestines.
2. The structure of the stomach wall layers.
3. Cells of the fundic, cardiac and pyloric glands of the stomach.
4. Endocrine cells of the stomach.
5. Differences in the structure of the small intestine wall.
6. The structure of the villi. Histophysiology of digestion.
7. The structure of the colon wall.
8. Endocrine cells of the intestine.
9. Development, structure and functions of salivary glands.
10. Features of the pancreas structure. Exocrine part, acinus organization.
11. Features of the pancreas. Types of Langerhans islet endocrine cells, and importance of its hormones.
12. Liver. Liver functions. Theories of the liver structure.
13. Characteristic of hepatocytes.
14. Sinusoids of the liver and the space of Disse.
15. The vascular system of the liver, the role of the portal vein and hepatic artery.

**Lecture 7. The endocrine system. The central organs. Peripheral organs (2 hours).**

1. Structure and functions of the endocrine glands.
2. Classification of the endocrine glands.
3. Development of the endocrine system.

4. Structure and function of neurosecretory nuclei of the hypothalamus.
5. The structure and cells of the pineal gland and pituitary gland.
6. The hormones of the endocrine glands and their role.
7. Diffuse endocrine system.
8. Development of the endocrine system.
9. Common features of the endocrine glands.
10. Structure and function of the adrenal, thyroid and parathyroid glands.
11. Role of glandular cells and hormone secretion and its role.

**Lecture 8. The urinary system. Male reproductive system. Female reproductive system (2 hours).**

1. Urinary system structure, development of urinary system.
2. Kidney, structure and functions. Nephron as a structural and functional unit of the kidney.
3. Structure and blood supply of nephrons.
4. Endocrine regulation of the kidneys.
5. Anatomy of the male reproductive system.
6. Embryogenesis of the male reproductive system.
7. Structure and function of the testis.
8. The structure and function of the prostate gland.
9. Spermatogenesis.
10. The development of the ovary.
11. Cyclical changes in the ovary.
12. Ovogenesis.

**Lecture 9. Germ cells. Introduction to developmental biology. Human embryonic development. Extraembryonic membranes (provisional organs). The ontogeny and ecology (2 hours).**

1. Features of germ cells.
2. Principles of classification of eggs.

3. Hormonal regulation of ovarian-menstrual cycle.
4. Stages of embryogenesis.
5. The phases of meiosis.
6. Chromosomal disorders and related disease.
7. Fertilization and cleavage, zygote formation.
8. The blastula and gastrula, types of gastrulation.
9. Early organogenesis. Germ layers and their derivatives.
10. Provisional organs and their role in human development.
11. Formation of the placenta, its structure and functions.
12. The most sensitive stages in the human development.
13. The concept of embryogenesis, ontogeny and phylogeny.

## **II. STRUCTURE AND CONTENT OF PRACTICAL PART OF THE COURSE (108 HOURS) SECOND SEMESTER (54 HOURS)**

### **Practical 1. Methods in histology. Preparation of the slide. Types of microscopy (4 hours).**

Aim of this lesson is to describe the content of the subject and general biological bases of histology and general principles of microscopic methods. After this class students will be able to work with the light microscope and will know how to prepare a histological slide.

Tasks:

Task 1. Understand features of light, fluorescent and laser scanning microscopy (confocal) microscopy. Structure of transmission electron microscope and scanning electron microscope, how and why researchers use them.

Task 2. Staining methods in histology: staining with hematoxylin-eosin, Romanovsky-Giemsa and Van Gieson. Principles and stages of histochemical and immunohistochemical staining.

Task 3. Students will study how to work with a light microscope, with low and high magnification lens. Objects of study are different microscopes.

## **Practical 2. Cell structure (4 hours).**

Objective is to study the basic forms of life, the structure of the cytoplasm and cell nucleus, their chemical composition of the cell; classification, structure and function of different cell organelles. Origin and classification of cytoplasmic inclusions. Stages of cell cycle, the morphology of the mitosis phases, structure and functional significance of chromosomes.

Tasks:

Task 1. Study the symplast structure. Object of study is muscle fibers (hematoxylin-eosin staining). Students should draw and mark the muscle fibers, sarcoplasm, sarcolemma, nucleus (big magnification).

Task 2. The intercellular substance. Object of the study is hyaline cartilage (hematoxylin-eosin staining). Students should find and mark the cartilage cells and intercellular substance (small magnification).

Task 3. Students learn to distinguish mitochondria. Object of study is kidney slides (Altman staining). With using small magnification find the cells of the kidney epithelium, then with using big magnification find and mark nucleus, the nucleolus, mitochondria.

Task 4. Students learn to distinguish the Golgi apparatus. Object of study is spinal ganglion (osmic acid staining). With small magnification find round cells, on a big magnification find the cell nucleus, the nucleolus, the Golgi apparatus.

Task 5. Mitosis in animal cells (hematoxylin-eosin staining). The task is to find the mitotic cells (small magnification) then draw and note chromosomes location in all phases of mitosis.

## **Practical 3. Seminar "Cytology" (4 hours).**

1. Histology as a science, its features.
2. Histology as an university course, its main sections.
3. History of histology.
4. The cell theory, main points of it.

5. Cell is the main form of protoplasm organization.
6. Symplasts and syncytia is adaptive forms of protoplasm organization.
7. Intercellular substance.
8. The size and shape of cells.
9. Classification of cellular organelles.
10. The cell surface, its properties and functions.
11. The main functions of the cell.
13. Regulation of protein synthesis in the cell.
14. Mitochondria and its functions.
15. Cell reproduction (mitosis, endomitosis).
16. The cell cycle.
17. Chromosomes and its structure and functions. Kariotype.
18. Paraneerosis and cell death (apoptosis and necrosis).
19. Levels of cell adaptation.

#### **Practical 4. Epithelial tissue (2 hours).**

The aims of this practical are: to know the classification of tissues; know the structure of epithelial tissues and their development, classification and structure of glandular epithelium.

Tasks:

Task 1. To study the structure of the keratinizing stratified squamous epithelium. Object of study is keratinizing stratified squamous epithelium (epidermis) of skin (hematoxylin-eosin staining). Find epidermis of the skin (small magnification). At Then find and mark: stratum basale, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum (big magnification).

Task 2. To study the structure of the nonkeratinizing stratified squamous epithelium. Object of study is stratified squamous epithelium of the cornea (hematoxylin-eosin staining). Find the epithelial layer (small magnification). Find and mark: the basal layer, prickly layer, a layer of flat cells (big magnification).

Task 3. To study the structure of a single layer squamous epithelium. Object of study is: mesothelium (simple squamous epithelium) (slides were stained with silver impregnation by Ramon y Cajal's staining technique, than slides were stained with hematoxylin). Find the epithelial cells of polygonal shape. At high magnification find and mark: polygonal cells, the boundaries between the cells, the nucleus, cytoplasm.

Task 4. To study the structure of a pseudostratified columnar ciliated epithelium. Object of the study is a pseudostratified columnar ciliated epithelium of the trachea (hematoxylin – eosin staining). Find the epithelial layer. At high magnification find and mark goblet cells, ciliated epithelial cells.

Task 5. Draw the table “Transitional epithelium of the bladder”.

Task 6. Draw the table “Simple pseudostratified ciliated epithelium”.

### **Practical 5. Mesenchyme. Connective tissues (4 hours).**

Objective: To study the structure of the mesenchymal tissue; cellular structure and organization of the intercellular substances in the loose and dense connective tissue.

Tasks:

Task 1. Study the structure of the mesenchyme. Object of study is mesenchyme (hematoxylin-eosin staining). Find the mesenchyme localization in embryo (small magnification). Draw and note star-shaped mesenchymal cells (big magnification).

Task 2. Study the structure of loose connective tissue. Object of study is loose connective tissue slide (iron hematoxylin staining). Find the lightest slide area At high magnification Draw and noted: fibroblast, mast cell, macrophage, collagen fibers, elastic fibers, ground substance.

Task 3. Study the structure of the tendon. Object of study is cross-section of tendon (hematoxylin – eosin staining) Draw and note: paratenon, epitenon, endotenon, collagen fibers, fibrocytes nucleus, primary fiber bundle (subfacicle), secondary fiber bundle (facicle).

Task 4. Study the structure of the ligaments. Object of study is longitudinal section of the ligament (hematoxylin-eosin staining). Draw and note: elastic fibers, fibrocytes nucleus, collagen fibers, connective tissue.

### **Practical 6. Blood and blood formation (4 hours).**

Aim is to learn morphology and functions of blood as a tissue; be able to distinguish different blood cell types on blood slides; know the stages of embryonic and postembryonic hematopoiesis.

Tasks:

Task 1. Table “Hemogram”.

Task 2. Study human blood. Object of study is human blood (hematoxylin-eosin staining). Draw and note: erythrocytes, neutrophil, eosinophil, lymphocyte, monocyte (big magnification).

Task 3. Study blood of the frog. Object of study is frog blood (hematoxylin-eosin staining). Draw and note: red blood cells, neutrophil, eosinophil, lymphocyte, platelet.

Task 4. Table “Hematopoiesis stages”.

### **Practical 7. Immune system (4 hours).**

Aim of this practical is understand the role of the immune system and function of the cells in the formation of humoral and cellular immunity; understand the difference between structures of different lymphoid organs.

Tasks:

Task 1. Study the tonsils. Object of study is palatine tonsil (hematoxylin-eosin staining). Draw and note the squamous epithelium, follicles, the follicles centers, the crypt.

Task 2. Study the lymph node. Object of study is lymph node (hematoxylin-eosin staining). Draw and note capsule, B-dependent zone, lymph follicles, the breeding center in the follicle (B-dependent zone), T-dependent zone.

Task 3. Study the spleen. Object of study is spleen slide (hematoxylin-eosin staining). Draw and mark the capsule, white pulp, the central artery, red pulp (small magnification).

Task 4. Study the thymus. Object of study is thymus slide (hematoxylin-eosin staining). Draw and mark the fibrous capsule of the thymus, trabeculae, cortex and medulla, lymphocytes (small magnification).

### **Practical 8. Bone. Cartilage and muscle tissue (4 hours).**

The aim of practical is to understand the development, structure and function of bone tissue. Understand difference in structure of different bone tissue. Study development, structure and function of cartilage and muscle tissues.

Tasks:

Task 1. Study the structure of a long bone. Object of study is a cross section of compact bone (Shmorl method). Find and mark: periosteum, circumferential lamellae, interstitial lamellae, central canal, perforating canal, concentric lamellae, osteon.

Task 2. Hyaline cartilage (hematoxylin-eosin staining). Find and draw the perichondrium, young cartilage zone, chondroblasts, zone of mature cartilage, chondrocytes, isogenic groups.

Task 3. Elastic cartilage (staining with orsein). Find and mark: perichondrium, chondroblasts, chondrocytes, elastic fibers, amorphous substance.

Task 4. Smooth muscle tissue (hematoxylin-eosin staining). Find and draw: muscle cells, nuclei of muscle cells, zones of loose irregular connective tissue.

Task 5. Striated muscle tissue (iron hematoxylin staining). Find and draw: sarcolemma, sarcoplasm, nuclei, myofibrils, loose connective tissue, muscle fibers.

### **Practical 9. Seminar "Epithelial, connective and muscle tissue. Immune system" (4 hours).**

1. Positional information: determination, differentiation and cell specialization.
2. Constitutive and inducible genes; cell fate determination.



3. The origin of tissues. Evolution theory of tissue.
4. Definition of tissue and tissue classification.
5. General characteristics of epithelial tissue.
6. Classification of epithelial tissue.
7. Glandular epithelium. Two types of glands.
8. Structure and functions of mesenchyme.
9. Classification of connective tissue.
10. Intercellular substance: collagen, reticular and elastic fibers.
11. Loose connective tissue: localization, structure and functions.
12. Cells of loose connective tissue.
13. A dense connective tissue.
14. Blood as a tissue.
15. Characteristics of erythrocytes.
16. Leukocytes: classification, structure and function.
17. The platelets (thrombocytes), their origin and function.
18. The hemogram and its clinical significance.
19. The role of histology in the hematology development: theory of blood formation.
20. Embryonic (primary) hematopoiesis.
21. The definitive (secondary) hematopoiesis.
22. Stem cell: types and stages of development.
23. Erythropoiesis: stage and cell shape.
24. Humoral and nervous regulation of hematopoiesis.
25. Integrative system of the body.
26. General features of immune cells.
27. The antigen-independent differentiation of B-lymphocytes.
28. The antigen-independent differentiation of T lymphocytes.
29. The interaction of T and B lymphocyte responses in infectious immunity and transplantation.
30. Two types of bone tissue: cells and intercellular substance.

31. The development, growth and regeneration of bone.
32. Classification of muscle tissue and the types of motor activity.
33. Characteristics of mion.
34. Sarcomere structure. Theory of muscle contraction.
35. Transmission of nerve impulses to the muscle fiber.
36. The development and regeneration of muscle tissue.
37. The origin, structure and types of cartilaginous tissue.

### **Practical 10. Nervous System (4 hours).**

Aim is understand the development, structure and function of cells in the nervous system; also as development, structure and function of organs, that form spinal cord system (spinal cord and spinal ganglions). Know the development, structure and function of the cerebellar cortex, the cortex of the brain.

Tasks:

Task 1: The object of study is cross-section of the spinal cord (Nissl staining). Find in the anterior horns of the spinal cord gray matter and draw multipolar neurons, basophilic substance, nucleus and nucleolus.

Task 2. The object of study is nerve fiber (hematoxylin-eosin staining). Find and draw the nerve fibers and nucleus.

Task 3. Spinal ganglion (hematoxylin-eosin staining). Draw and note: capsule, anterior root, dorsal root, nerve (small magnification). Draw and note with usind big magnification: psevdounipolyarnye nerve cells, satellite cells, myelinated nerve fiber, loose connective tissue.

Task 4. The object of study is spinal cord (silver impregnation methods by Cajal). Draw and note: the gray matter of the spinal cord, the dorsal horn, ventral horn, lateral horn, white matter, multipolar neurons.

Task 5. Study the structure of the cerebellum and identify the layers of the cerebellum and cerebellum cellular composition. Object of study is cerebellum (impregnation by silver nitrate, Cajal method). With using small magnification find the cerebellum gyri (longitudinal section). Draw and note: molecular layer,

Purkinje cell layer, granular layer; white matter. With using big magnification find and draw the pear-shaped cell.

Task 6. Examine the structure of the cerebral cortex. Learn how to identify the layers of the cerebral cortex and its cell types. Object of study is cerebral cortex preparations (silver nitrate impregnation, Cajal method). Search, draw and note: molecular layer, the external granular layer, pyramidal layer, the internal granular, ganglionic layer, polymorphic layer, pyramidal cells.

### **Practical 11. Eye. Organ of smell (4 hours).**

Aim is to study development, structure and functions of the organs of sight and smell.

Tasks:

Task 1. Identify the cornea layers. Object of study is cornea (hematoxylin-eosin). Find, draw and label: anterior epithelium (non-keratinized stratified squamous epithelium), basement membrane of non-keratinized stratified squamous epithelium, stroma, Bowman`s membrane, Descemet`s membrane, endothelium.

Task 2. Study wall of the eye and identify retina layers. Object of the study is eye layers preparation (hematoxylin-eosin). Find, draw and label: sclera, choroid, the visual part of the retina (small magnification). Find and mark in the retina: pigment layer, the layer of photoreceptors (rods and cones), outer limiting membrane, outer nuclear layer, outer plexiform layer, inner nuclear layer, inner plexiform layer, ganglion cell layer, the layer of nerve fibers, the inner boundary layer (big magnification).

Task 3. Identify the olfactory receptors, supporting cells and their structures. Object of study is scheme "Olfactory receptors and supporting cells".

### **Practical 12. Organs of taste, equilibrium and hearing (4 hours).**

Aim is to study development, structure and function of hearing, balance and taste organs.

Tasks:

Task 1. The object of study is preparation of an axial slice of the cochlea (hematoxylin - eosin). Find and mark: bony labyrinth, that contains the cochlear duct, vestibular canal and tympanic canal. In the cochlear duct find and mark: organ of Corti, outer hair cells, inner hair cells, supporting Deiters cells (also called phalangeal cells), on the tops of the hair cells find stereocilia.

Task 2. Identify the structural components of the taste organ. Object of study is tongue preparation with foliate lingual papillae (hematoxylin-eosin staining). Find and mark: non-keratinized stratified squamous epithelium of papillae, taste buds, the taste pores, taste cells, supporting cells (big magnification).

**Practical 13. Seminar "Cell elements of the nervous system. Nervous system" (4 hours).**

1. Neural theory.
2. Structure and function of the neuron.
3. Neuron classifications based on their function and morphology.
4. Neuromediators, cytochemical classification of neurons.
5. Synapse, nerve endings, their classification.
6. Classification of macroglial cells.
7. Microglia.
8. Development of neurons and histogenesis of the nervous system.
9. Regeneration of neurons and glia.
10. Spinal system structure.
11. Organization of the spinal cord gray matter.
13. The reflex arc: monosynaptic and polysynaptic reflex arc.
14. The main types of spinal cord neurons. Nociceptive, visceral and proprioceptive sensitivity centers.
15. Spinal cord: command neurons and central control of movements.
16. The spinal cord white matter.
17. Cortical column is the functional unit of the cerebral cortex.
18. The cell composition of the cortical column.

19. The concept of modules and distribution systems.
20. Cytoarchitectonics of the cortex.
21. Homo- and heterotypic cortex.
22. Myeloarchitectonics of the cerebral cortex.
23. Cerebellum: layers, neural structure and function.

### **THIRD SEMESTER (54 HOURS)**

#### **Practical 1. Cardiovascular system (4 hours).**

Aim is to know the development, structure and function of the cardiovascular system, students should be able recognize different structures on preparations.

Tasks:

Task 1. Identify capillaries, venules and arterioles. The object of studying is preparation of pia mater (hematoxylin-eosin). Find: small arteries and small veins (small magnification); arterioles, venules, capillaries (big magnification).

Task 2. Study the structure of muscular artery wall. Identify the layers of the vessel and its composition. Object of study is a cross section of muscular artery (hematoxylin - eosin). Find and note: inner, middle and outer artery layers (small magnification); endothelium, internal and external elastic membrane (big magnification).

Task 3. Study the structure of muscular vein wall. Identify the layers of the vessel and its composition. Object of study is cross section of muscular vein (hematoxylin - eosin). Find three layers of vein wall: the inner, middle and outer. Then find and draw the endothelium and smooth muscle cells.

Task 4. Study the structure of the elastic artery. Identify the layers of the vessel and its composition. Object of study is aorta (orsein staining). Find and draw the inner, middle and outer shell. In the inner and outer layers find, draw and label elastic fibers, in the middle layers mark wavy sheets of elastic fibers.

Task 5. Study the structure of the heart wall. Identify the wall layers. Object of study is heart wall preparation (hematoxylin-eosin). Find and draw the endocardium and myocardium. With using big magnification in the endocardium

find endothelium, the layer of connective tissue, which contains abnormal myocytes; in the myocardium find cardiomyocytes and capillaries between them.

## **Practical 2. Hematopoiesis and immune system organs (4 hours).**

Aim is to know the development, structure and function organs of hematopoiesis and immune defense. Students should be able distinguish different organs based on preparations.

Tasks:

Task 1. Study the tonsil. Object of study is palatine tonsil (hematoxylin - eosin). Find, draw and note: mucous membranes, lymph follicles, follicle breeding centers, crypt, mucosal fold.

Task 2. Study the lymph node. Object of study is a preparation of lymph node (hematoxylin-eosin). Find, draw and note: capsule of lymph node, outer and an inner cortex, lymphatic follicle, the germinal centres, deep cortical, and medullary cords.

Task 3. Study the spleen. Object of study is spleen preparation (hematoxylin-eosin). Find, draw and mark: capsule, trabeculae, red pulp, white pulp, Malpighian body, the central artery.

Task 4. Study the thymus. Object of study is thymus preparation (hematoxylin - eosin). Find, draw and mark the capsule of the thymus, in the lobules of the thymus, find interlobular connective tissue with blood vessels.

## **Practical 3. Respiratory system and skin (4 hours).**

Aim is to study the development, structure and function of the skin and its derivatives; study the development, structure and function of the respiratory system.

Tasks:

Task 1. Study the skin structure. Object of study is skin of the toe (hematoxylin-eosin). Find and note: epidermis, papillary dermis, reticular dermis, sweat glands

and sweat gland ducts (small magnification). Use bigger magnification in order to study epidermis layers: basal layer, prickly layer, granular.

Task 2. Study the lung. Object of study is lung preparation (hematoxylin - eosin). Use small magnification to find and note: middle bronchus, small bronchus and blood vessels. Use bigger magnification to find in the middle bronchus: mucosa, submucosa, fibro-cartilaginous layer, protein and mucous glands. Use bigger magnification to find and note in small bronchi: mucosa, lamina muscularis mucosae, adventicia.

#### **Practical 4. Seminar "Cardiovascular System. Organs of hematopoiesis and immune system. Respiratory system and skin" (4 hours).**

1. The history of the doctrine of the circulation.
2. Classification and function of blood vessels, their structure.
3. Capillaries, their types, structure and function; concept of microcirculation.
4. Types of arteries: the structure of muscular and elastic arteries.
5. Features and structure of the veins.
6. Circulatory anastomosis.
7. Development of the heart.
8. The structure of the endocardium and epicardium.
9. Structure and function of myocardium, types of cardiomyocytes.
10. The conductive system of the heart, cardiac pacemaker cells.
11. The central and peripheral organs of hematopoiesis. Common features.
12. Bone marrow and its types.
13. Red bone marrow, its structure and functions.
14. The thymus, thymic involution.
15. Functions of the lymph node.
16. Spleen. Features of the structure and blood supply.
17. The structure of the palatine tonsil.
18. Characteristic of the skin and its functions.
19. The origin and structure of the epidermis.

20. The origin and structure of the dermis.
21. The skin as an organ of sensitivity.
22. The hair structure and their types.
23. The main functions of the respiratory system.
24. Conducting zone: trachea and bronchi.
25. Respiratory zone.
26. Acinus structure and air-blood barrier structure.

### **Practical 5. The digestive system (4 hours).**

Aim is to study the development, structure and functions of the organs of digestive system anterior part. Know the development and structure of the stomach and intestines.

Tasks:

Task 1. Study to identify the structural elements of the tongue. Object of study is tongue papillae (hematoxylin-eosin). With using small magnification find and mark: the upper tongue surface, a bottom surface of the tongue, mucous membrane of the upper surface of the tongue, filiform papillae, stratified squamous epithelium, lamina propria mucosæ, muscles of tongue, submucosa, mucosa of the tongue lower surface.

Task 2. Study the structure of the enamel and dentin. Object of study is preparation of the late stage of tooth development (enamel and dentin) (hematoxylin-eosin). Find and mark: the enamel organ, dentin and enamel (small magnification); with using bigger magnification find odontoblasts.

Task 3. Define the boundaries and tissue composition of the esophagus layers. Object of study is esophagus preparation (hematoxylin-eosin). Find and note: mucous membrane, stratified squamous epithelium, lamina propria mucosæ, muscularis mucosa, submucosa, muscle layer, adventitia (small magnification).

Task 4. Study the structure of the stomach wall. Understand how to identify stomach layers. Object of study is preparation of the fundus of the stomach (staining with the Congo red). Find small part of the stomach, draw it and note:



mucosa, the gastric pits, submucosa, muscle layers, serous membrane. Using big magnification find and note: columnar epithelium, lamina propria, fundic gland (inside this structure find gastric chief cell and parietal cells, muscularis mucosa, submucosa with blood vessels and serosa with mesothelial cell nucleus.

Task 5. Study the structure and tissue composition of the duodenum wall. Object of study is duodenum preparation (hematoxylin-eosin staining). Find draw and label: mucosa, villi, crypts, submucosal layer of duodenal glands, muscle layer, serosa (small magnification). Using bigger magnification find and label: simple limbic columnar epithelium, goblet cells, lamina propria, muscularis mucosa.

### **Practical 6. Large digestive glands (4 hours).**

Aim is to know the development, structure and functions of large digestive glands (salivary glands: parotid, sublingual, submandibular), liver, pancreas.

Tasks:

Task 1. Identify ducts, terminal units and cells of the parotid gland. Object of study is preparation of parotid gland (hematoxylin-eosin). Find the lobules and interlobular ducts (small magnification). At high magnification find - protein ends of sections, striated ducts, intralobular ducts, connective capsule, connective septum, intercalated ducts, interlobular ducts.

Task 2. Study the structure of the terminal parts of the sublingual gland. Object of study is sublingual gland preparation (hematoxylin-eosin staining). Find the lobules and interlobular ducts (small magnification); intralobular ducts, acini (big magnification).

Task 3. Study the ultrastructure of the exocrine and endocrine parts of the pancreas. Object of study is the pancreas preparation (hematoxylin-eosin staining). Find, draw and label: lobules, interlobular connective tissue, interlobular ducts (small magnification); secretory units, endocrine islets, intercalated ducts (big magnification).

Task 4. Study the structure of liver lobules. Object of study is pig liver (Van Gieson staining). Find, draw and label: liver lobules, interlobular connective tissue, central vein (small magnification).

### **Practical 7. The endocrine system (4 hours).**

Aim is to learn how to identify the endocrine system organs and their components at the tissue level of organization.

Tasks:

Task 1. Draw the scheme of gipotalyamo-pituitary system and influence of hormones on the target organs.

Task 2. Study the structure of the pituitary gland. The object is the pituitary gland preparation (hematoxylin-eosin staining). Find and mark the anterior, middle, and posterior parts of the pituitary (small magnification); pituitary cell types: acidophil cells, basophil cell, chromophobe cell, sinusoidal capillaries (big magnification).

Task 3. Study the thyroid gland. The thyroid (hematoxylin-eosin staining). Find, draw and mark: capsule, follicles, colloid, interfollicular islands (small magnification).

Task 4. Study the parathyroid gland. The object of the study is the parathyroid gland preparation (hematoxylin-eosin staining). Find, draw and mark: capsule, epithelial cells, connective tissue, blood vessels (small magnification).

Task 5. Study adrenal gland. The object of the study is adrenal preparation (hematoxylin-eosin staining). Find, draw and mark: capsule, cortex, zona glomerulosa, zona fasciculate, zona reticularis, adrenal medulla, capillaries (small magnification).

### **Practical 8. Urinary system (4 hours).**

Objective is to know the development, structure and function of the urinary system, be able to distinguish preparations of different organs.

Tasks:

Task 1. Learn to distinguish between renal cortical and cerebral substance, the main part of the nephron, the collecting ducts, blood vessels. Object of study is kidney preparation (hematoxylin-eosin). Find and draw: capsule, cortex, medulla, tubules of the nephron.

Task 2. Ureter wall structure. Object of study is preparation of the ureter (hematoxylin-eosin). Find and mark: mucous membrane with transitional epithelium, lamina propria, submucosa, muscle layer, adventitia.

Task 3. Structure of the bladder (hematoxylin-eosin staining). Find and mark: mucous membrane with transitional epithelium and lamina propria, submucosa, muscle layer, serous.

**Practical 9. Seminar "Digestive System. Endocrine System. Urinary system" (4 hours).**

1. General characteristics of the digestive system.
2. Two types of mucous membrane.
3. Tongue. Taste papillae and taste organ.
4. Tooth structure. Tooth development.
5. Esophagus. Features of the structure in the connection of the esophagus and stomach.
6. Stomach. The structure and function of the mucosa.
7. The glands of the stomach. Types and topography.
8. Fundic glands of the stomach, local endocrine regulation.
9. Small intestine. The structure and function of the mucosa.
10. Intestinal villi. Structure histophysiology of intestinal villi.
11. Colon. The structure and function.
12. Stomach and gut endocrine cells. Their hormones and function.
13. The salivary glands, structure and function.
14. Characteristics of the pancreas: exocrine part, structure of acinus.
15. Characteristics of the pancreas: endocrine part, the types of endocrine cells, hormones and their role.

16. Functions of the liver. Theories of liver structure.
17. Hepatocyte characterization.
18. Liver sinusoid and Disse space.
19. The vascular system of the liver. The role of the portal vein and hepatic artery.
20. General characteristics, structure and functions of the endocrine system.
21. Hypothalamic nuclei, their hormones.
22. Adenohypophysis. The cells and the hormones of the anterior pituitary.
23. Neurohypophysis.
24. Epiphysis. Structure, two main groups of hormones.
25. Thyroid. Follicular and parafollicular cells. Hormones and their functions.
26. Parathyroid. Structure, hormones, function.
27. Adrenal glands: cortex, medulla, the hormones and their roles.
28. Anatomy of the kidney and urinary tract.
29. The structure and role of the brush border cells.
30. Structure of the kidney epithelium.
31. The structure of the fenestrated capillaries.
32. Features of the urinary system, the sources of its development.
33. Kidney, structure and functions. Nephron as a structural and functional unit of the kidney.
34. Structure and blood supply to the different nephron types.
35. Endocrine regulation of kidney function.

### **Practical 10. Male reproductive system (4 hours).**

Aim is to know the development, structure and function of the male reproductive system.

Tasks:

Task 1. Study the structure of the testis. Object of study is testicles preparation (hematoxylin-eosin). Find, draw and mark segments of the testis, Sertoli cells,

spermatogonia, spermatocytes order I, spermatocytes order II, spermatids, spermatozoon, Leydig cells.

Task 2. Identify the structure of the prostate gland. Object of study is prostate preparation (hematoxylin-eosin). Find, draw and note: glandular cells, smooth muscle cells, urethra.

### **Practical 11. Female reproductive system (4 hours).**

Aim is to know the development, structure and function of the female reproductive system.

Tasks:

Task 1. The object of study is ovary preparation (hematoxylin-eosin). Find and draw: capsule, cortex and medulla; primordial follicles, growing follicles, mature follicles, corpus albicans, corpus luteum.

Task 2. To study the structure of the uterus. Object of the study is uterus preparation (hematoxylin-eosin). Find and note: endometrium, which consists of a single-layered prismatic epithelium and lamina propria, crypt, myometrium, perimetrium.

Task 3. To study the structure of the mammary gland. Object of study is mammary gland preparation (hematoxylin-eosin). Find and draw: interlobular connective tissue, milk duct, acinus, lobules, squamous epithelium.

### **Practical 12. Human development (4 hours).**

Aim is to know the stages of the human development and the influence of internal and external factors on this process.

Tasks:

Task 1. Study the structure of the fetal part of the placenta. Object of study is preparation of the fetal part of human placenta (hematoxylin-eosin). Search, draw and label: amniotic membrane, epithelium, connective tissue; chorionic plate; fibrinoid; blood lacunae; chorionic villi, cytotrophoblast, blood vessels.

Task 2. To study the structure of the maternal part of the placenta. Object of the study is preparation of the human placenta (hematoxylin-eosin). Find, draw and label: basal lamina, decidual cells, connective tissue, chorionic villi, fibrinoid.

**Practical 13. Seminar "Reproductive system. Human development" (4 hours).**

1. Development of the male reproductive system.
2. The structure of the testicle.
3. The generative and endocrine function of the testis. Stages of spermatogenesis.
4. Regulation of spermatogenesis.
5. Prostate, structure and function.
6. The development of the ovary.
7. Cyclical changes in the ovary: folliculogenesis, structural features of different follicles.
8. Corpus albicans.
9. Ovogenesis.
10. Development of the female reproductive system organs.
11. Structure of fallopian tube, uterus and vagina walls.
12. The structure of the mammary glands and their functional connection with the female reproductive system organs.
13. Germ cells.
14. Egg classifications.
15. Hormonal regulation of the menstrual cycle.
16. Fertilization and factors influence on it.
17. Zygote.
18. Structure and implantation of the blastocyst.
19. Types and stages of gastrulation.
20. Characteristics of the early organogenesis.
21. Extraembryonic organs and their role during human development.
22. Placenta formation, structure and functions.

23. The most sensitive stages during human development.

### **III. EDUCATIONAL-METHODOLOGICAL SUPPORT OF STUDENT'S INDEPENDENT WORK**

Methodical support of student independent work during the course "Histology. Cytology. Embryology" includes (see Supplementary 1):

- schedule for independent work, including the approximate time for each task;
- description of the tasks for independent work and methodical recommendations for its implementation;
- requirements for the presentation of the results of independent work;
- criteria for independent work evaluation.

### **IV. CONTROL OF COURSE GOAL ACHIEVEMENT**

№	Course topics	Codes and stages of skill development		Evaluation tools	
				Control during the course	Midterm control / exam
1	Section 1. Cytology	the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	know	Interview	Exam questions 1-80; questions of “Cell biology and general histology” part of the exam
	Section 2. General Histology		can	Test	
	Section 3. Private Histology		master	Test	Test
	Section 4. Embryology				

Typical tests and other teaching materials, also as materials for knowledge and skills assessment, as well as criteria and indicators are needed to evaluate the knowledge, skills and stages, that are characterized skill formation during the course, are provided in Appendix 2.

### **V. LIST OF TEXTBOOKS AND OTHER EDUCATIONAL LITERATURE AND INFORMATIONAL SOURCES OF THE COURSE**



## **Basic literature**

*(Electronic and print media)*

1. Compendium of Histology, Anders Rehfeld, Malin Nylander, Kirstine Karnov 2017 <https://link.springer.com/book/10.1007/978-3-319-41873-5>
2. Histology with Regional and Ethnic Variation, Michael B. Morgan 2018 [https://link.springer.com/chapter/10.1007/978-3-319-74847-4\\_3](https://link.springer.com/chapter/10.1007/978-3-319-74847-4_3)
3. Histology, Stefan Dirnhofer 2017 [https://link.springer.com/chapter/10.1007/978-3-319-76879-3\\_3](https://link.springer.com/chapter/10.1007/978-3-319-76879-3_3)

## **Additional literature**

*(Electronic and print media)*

1. Sinonasal Tract – Anatomy and Histology, Margaret S. Brandwein 2016 [https://link.springer.com/chapter/10.1007/978-3-319-33323-6\\_1](https://link.springer.com/chapter/10.1007/978-3-319-33323-6_1)
2. Colon, Anatomy and Histology, Sibel Erdamar 2016 [https://link.springer.com/referenceworkentry/10.1007/978-3-319-40560-5\\_1446](https://link.springer.com/referenceworkentry/10.1007/978-3-319-40560-5_1446)

## **The list of Internet resources**

1. <http://elibrary.ru/> - Scientific Library.
2. <http://macroevolution.narod.ru/> - electronic resource for evolutionary biology.
3. [http://www.bu.edu/histology/m/t\\_electr.htm](http://www.bu.edu/histology/m/t_electr.htm) - histology learning system (database of different cell structure images and tissue images).
4. <http://histologyguide.org> - Histology Guide (virtual microscope slides and electron micrographs for learning human histology).
5. <http://www.anatomyatlases.org/MicroscopicAnatomy/MicroscopicAnatomy.shtml> - Atlas of Microscopic Anatomy - A Functional Approach: Companion to Histology and Neuroanatomy: Second Edition

6. <https://www.ouhsc.edu/histology/> - University of Oklahoma Health Sciences Center Interactive Histology Atlas.

7. <http://histologyatlas.wisc.edu> - database of different cell structure images and tissue images.

## LIST OF INFORMATION TECHNOLOGIES AND SOFTWARE

The location of the computer equipment on which the software is installed, the number of jobs	List of licensed software
Multimedia auditorium Vladivostok Russian island, Ayaks 10, building 25.1, RM. M723 Area of 80.3 m2 (Room for independent work)	Windows Seven enterprise SP3x64 Operating System Microsoft Office Professional Plus 2010 office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.); 7Zip 9.20 - free file archiver with a high degree of data compression; ABBYY FineReader 11 - a program for optical character recognition; Adobe Acrobat XI Pro 11.0.00 - software package for creating and viewing electronic publications in PDF; WinDjView 2.0.2 - a program for recognizing and viewing files with the same format DJV and DjVu.

In order to provide special conditions for the education of persons with disabilities all buildings are equipped with ramps, elevators, lifts, specialized places equipped with toilet rooms, information and navigation support signs.

## VI. METHODOICAL INSTRUCTIONS ON SUBJECT STUDYING

During the course "Histology. Cytology. Embryology" a variety of methods and tools are used: lectures, practicals, tests, independent work of students.

Lecture is the main form of activity in the classroom, which involves intense mental activity of the student, and it may be difficult for first-year students. Lectures help to assimilate the theoretical material of the discipline. During the lecture it is necessary for students to note the most important points in their own words in order to better remember the material.

During the lecture teacher gives only a small proportion of material, which is described in more detailed in textbooks. Therefore, it is always necessary to use the

basic textbook while student works with lecture notes and additional literature. Such a serious work with the lecture notes and textbook allows to reach success in subject memorization.

During the course "Histology. Cytology. Embryology" the following forms of active learning are used: lecture, discussion, lecture – visualization. Lecture material is based on the knowledge of «Biology», "Chemistry" and "Physics" courses.

To illustrate the verbal information teachers, use presentations, spreadsheets and diagrams.

### **Lecture - visualization**

Lecture is accompanied by any types of visual aids, that contributes to better and easier understanding of the material. During lecture - visualization verbal presentation of the material must be accompanied by visual aids. The information should be present in the form of diagrams on the blackboard, tables, slides. This allow you to create the problematic issues, and contribute to the development of professional thinking of future specialists.

### **Lecture - conversation**

Lecture- conversation (or dialogue with the audience) it is the most common form of active learning; it allows students to be engaged in the learning process, as there is direct contact between the teacher and students. Such contact is achieved during the lecture, when students ask questions on different issues. Questions are asked by entire audience, and any of the students can answer it, other students can make some comments and add additional information. In this way we can identify active students and try to involve students who do not participate in the work. This form of lectures allows students to be engaged in work, increases their attention, thinking, get an experience of collective work, give understanding on how to form questions. The main advantage of lecture-conversation is that it allows to attract

the students' attention to the most important issues of the theme and to determine the content and speed of educational material presentation.

### **Practicals**

Practical training is a collective form of education. It includes seminars, which are also one of the main types of work for deep study of practical discipline. Each practical related to one of the topics and includes quiz for students in order to exam their knowledge and discussion, which is aimed at formation of skills to debate, develop independence and critical thinking, the student ability to work with large information flows, to develop and defend their own position on issues. Other active learning methods includes press conference and debate.

Press conference. For this type of activity 3-4 students prepare reports on different topics, that are related to the topic of current practical. Each students makes a presentation. After this, other students asked questions, and based on these questions and answers creative discussion appers, guided by the teacher.

### **MATERIAL AND TECHNICAL EQUIPMENT OF SUBJECT**

For performing practical work, as well as for organizing independent work, students have access to the following laboratory equipment and specialized classrooms that meet applicable sanitary and fire regulations, as well as safety requirements for educational and research and production work:

For performing practical work, as well as for organizing independent work, students have access to the following laboratory equipment and specialized classrooms that meet applicable sanitary and fire regulations, as well as safety requirements for educational and research and production work:

<b>Name of equipped premises and rooms for independent work</b>	<b>List of equipment;</b>
Computer class of the School of Biomedicine room M723, 15 seats	Screen with an electric drive 236 * 147 cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x800, 2000: 1 EW330U Mitsubishi; The subsystem of specialized fixing equipment CORSA-2007 Tuarex; Video switching subsystem: DVI DXP 44

	<p>DVI Pro Extron matrix switcher; DVI extension cable for twisted pair DVI 201 Tx / Rx Extron; Audio switching and sound reinforcement subsystem; ceiling speaker system SI 3CT LP Extron; DMP 44 Extron digital audio processor; extension for the control controller IPL T CR48; Wireless LANs for students are provided with a system based on 802.11a / b / g / n access points 2x2 MIMO (2SS).</p> <p>Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty</p>
Multimedia auditory	<p>Monoblock HP ProOne 400 G1 AiO 19.5 "Intel Core i3-4130T 4GB DDR3-1600 SODIMM (1x4GB) 500GB; Projection Screen Projecta Elpro Electrol, 300x173 cm; Multimedia Projector, 4000 Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded Interface, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded, Embedded, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded; TLS TAM 201 Stan cables; Avervision CP355AF Document Camera; Sennheiser EW 122 G3 Microphone UHF-band microphone system as part of a wireless microphone and receiver; LifeSizeExpress 220-Codeonly-Non-AES video conferencing codec; Multipix MP-HD718 Network Video Camera; Dual LCD Panels 47 ", Full HD, LG M4716CCBA; Audio switching and sound reinforcement subsystem; central uninterrupted power supply</p>
Reading rooms of the FEFU Scientific Library with open access to the book collection (Building A - Level 10)	<p>HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty Internet access speed 500 Mbit / s. Jobs for people with disabilities are equipped with braille displays and printers; equipped with: portable devices for reading flat-printed texts, scanning and reading machines with a video optimizer with the ability to adjust color spectra; magnifying electronic loops and ultrasonic markers</p>
690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax Village, 10, room M628  Multimedia-equipped room	<p>Microscope light Alto BIO4 (20 pieces);</p> <p>Light microscope with digital camera BIO8 Altos (1 pc);</p> <p>Monoblock Lenovo C360G-I34164G500UDK (1 pc);</p> <p>LED TV Samsung UE40D6510WS (1 pc).</p> <p>A set of histological preparations (basics of cytology, cell structure of various types, main types of living tissues, embryology basics,</p>

	<p>cell multiplication, fundamentals of parasitology), slides, coverslips, immersion medium, Pasteur pipette, Romanovsky-Giemsa dye, glycerin, Petri dishes, test tube Falcon type 50 ml, container for samples of biomaterials</p>
<p>690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax Village, 10, room M627</p>	<p>Light microscope Carl Zeiss GmbH Primo Star 3144014501 (13 pcs.);</p> <p>Microscope light with a digital camera BIO8 Altos (2 pieces).</p> <p>A set of histological preparations (basics of cytology, cell structure of various types, main types of living tissues, embryology basics, cell multiplication, fundamentals of parasitology), slides, coverslips, immersion medium, Pasteur pipette, Romanovsky-Giemsa dye, glycerin, Petri dishes, test tube Falcon type 50 ml, container for samples of biomaterials</p>
<p>690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax Village, 10, room M625</p>	<p>Microscope light Carl Zeiss GmbH Primo Star 3144014501 (11 pcs.)</p> <p>A set of histological preparations ((basics of cytology, cell structure of various types, main types of living tissues, embryology basics, cell reproduction, basics of parasitology), slides, coverslips, immersion medium, Pasteur pipette, Romanovsky-Giemsa dye, glycerin, Petri dishes, test tube of Falcon type 50 ml, container for samples of biomaterials</p>



MINISTRY OF EDUCATION AND SCIENCE OF RUSSIAN FEDERATION  
The Federal state autonomous educational institution  
higher education  
**"Far Eastern Federal University"**  
(FEFU)

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SCHOOL OF BIOMEDICINE

**EDUCATIONAL AND METHODOLOGICAL SUPPORT OF STUDENTS  
INDEPENDENT WORK**  
on the subject "Histology. Cytology. Embryology"  
Speciality 31.05.01 General Medicine  
Full-time training

Vladivostok  
2016

Independent student work includes:

- 1) work with textbooks, educational literature and lecture notes in library or at home,
- 2) preparation for practicals,
- 3) preparation for test and interview in the end of semester.

Independent work of students is determined by the schedule of independent work implementation during the course.

### Schedule of independent work during the course

№	Date / deadlines	Type of independent work	Estimated time to complete	Form of control
<b>2 semester</b>				
1	1-3 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	20	Work on practicals with preparations and microscope, discussion or written quiz, computer test
2	4-6 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	22	Work on practicals with preparations and microscope, discussion or written quiz, computer test
3	7-11 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	10	Work on practicals with preparations and microscope, discussion or written quiz, computer test
4	12-14 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	20	Work on practicals with preparations and microscope, discussion or written quiz, computer test
<b>3 semester</b>				
1	1-10 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	3	Work on practicals with preparations and microscope, discussion or written quiz,



				computer test
2	1-12 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	3	Work on practicals with preparations and microscope, discussion or written quiz, computer test
3	12-14 weeks	Work with preparations, textbook and lecture notes, preparing for the seminar	9	Work on practicals with preparations and microscope, discussion or written quiz, computer testing
	17-18 week	Prapairing to exam	27	

Control of independent work is realized during the practicals, written quizzes, oral interviews, solving of practical tasks, tests.

### **Topics for essays and presentations**

Academic plan of “Histology. Cytology. Embryology” includes 81 hours of independent work, within this time at least one oral presentation should be performed by the student on one of the following topics (or student can proposed their topic).

1. The gray and white matter of the brain.
2. The optic nerve.
3. The vegetative (autonomic) nervous system.
4. Histology of cardiovascular system.
5. Histological characteristic of the junction place of esophagus into the stomach.
6. The structure of the organ of vision.
7. Cells and structure of the spinal cord.
8. Muscle cells.
9. The history of cell biology and histology.
10. Human ontogenesis stages.
11. The trachea and main bronchi: structure, cells, blood supply, and innervation.
12. Heart structure: layers of the wall and cell types.

13. The structure of the wall of the heart and pericardium.
14. Structural elements, age features and functions of the immune system.

### **Oral presentation evaluation criteria**

Oral report on the subject "Histology. Cytology. Embryology" is estimated by the following point scale: 5, 4, 3.

"5" - student expressed his own opinion on the issue, defined content and components precisely, he can analyze, synthesize the material and make the right conclusions from the basic and additional literature, answered all questions.

"4" - student presented the material on a selected topic coherently and consistently, resulting in arguments to prove one or the other position in the report, demonstrated the ability to analyze basic and additional literature, despite some inaccuracies.

"3" - student had an independent analysis of basic and additional literature, however, student made mistakes in presenting the material and not always fully respond to the questions about the material.

### **Methodical instructions for preparation of presentations**

For presentation preparation students can use PowerPoint. To prepare the presentation, student must understand information and included it the essay.

The sequence of presentation preparation:

1. Define the purpose of the presentation.
2. Determine the presentation format.
3. Select all content part of the presentation and put them in the logical order.
4. Determine the key points in the text and highlight them.
5. Determine the visualization aids (images) to display them on the slides according to the logic, purpose and specificity of the data.
6. Choose design and format of the slides (the number of images and text, their location, color and size).

## 7. Check the visual perception of the presentation.

The methods of visualization are illustrations, images, charts and tables. The purpose of images is to induce emotion and create a relationship to it, to influence on audience. With the help of appropriate images, information can be stored longer in memory of the person.

Diagram is visualization of quantitative and qualitative relations. It is used to demonstrate the convincing data for thinking in addition to the logical thinking.

Table is concrete, visual and accurate data display. The main purpose of table using is to structure the information, which sometimes facilitates the perception of data by the audience.

### **Methodical instructions for the practical class preparation**

1. Student should be prepared for each practical; in order to be prepared before practical student should repeat the lecture material, read the appropriate section in the textbook on the subject.
2. Practical begins with a verbal questioning or written quiz.
3. In the classroom students work with a collection of preparations and atlases.
4. For practicals students should have a notebook to write the theoretical material, album for drawing and set of pencils.
5. Students study preparations, draw and mark main parts of each preparation in album.
6. At the end of class teacher gives homework for the next time.
7. Verbal questioning or written quiz is evaluated on each practical.

### **Methodical instructions for report preparation**

1. Student choose the theme of the report by themselves.
2. Selection of the literature on the topic of the report among recommended basic and additional literature and work with the resources in the "Internet".

3. Work with the literature includes reading and analyzation, comparison of data from different sources for the presentation.
4. Students should recapitulate the most important thing from analyzed material, but it is not rewriting from the source without any commentary and analysis.
5. Student writes a plan of the report, based on analysis of the literature.
6. The report should be logical; moreover, student should express his opinion on discussed issue.
7. Duration of the report is 7-10 minutes; student should tell it, not read it.

### **Methodical instructions for working with literature**

1. It is necessary to build a list of literature sources. The basis of this list can be literature that was recommended in the working program of the course. You can make your own list of selected sources (author's name, title, year of publication and other) on the computer. The main advantage of it that it will allow you to add new sources, remove some and replace them when you need. The initial list of references can be completed with using of FEFU library electronic catalog. Also you should not hesitate to ask for help library staff.
2. During the work with the literature, it is necessary to read and learn new material with on of the following method of study: make a brief summary or scheme. That makes it easier to understand and remember. It is not recommended to rewrite the text.



MINISTRY OF EDUCATION AND SCIENCE OF RUSSIAN FEDERATION  
The Federal state autonomous educational institution  
higher education  
**"Far Eastern Federal University"**  
(FEFU)

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**SCHOOL OF BIOMEDICINE**

**FUND OF ASSESSMENT TOOLS**  
**on the subject "Histology. Cytology. Embryology"**  
**The basic educational program (specialty) 31.05.01 General Medicine**  
**Full-time training**

Vladivostok  
2016

## Fund of assessment tools passport

This part of the program is filled in accordance with the Regulations on the Funds of assessment tools of educational programs of higher education - undergraduate, specialist's and master's programs of Far Eastern Federal University, approved by order of the rector of 12.05.2015 №12-13-850.

Code and skill description	Stages of skill development	
the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	<b>Know</b>	The basic laws of development and vital activity of the organism are based on the structural organization of cells, tissues and organs; histo-functional characteristics of tissue elements; methods of their research; structure, topography and development of cells, tissues, organs and body systems in conjunction with their function in the norm; age characteristics of cells, tissues, organs and body systems.
	<b>Able</b>	To give a histophysiological assessment various cellular, tissue and organ structures, analyze pathological processes in the human body
	<b>Master</b>	The ability to compare morphological changes in health and disease

### CONTROL OF COURSE GOAL ACHIEVEMENT

№	Course topics	Codes and stages of skill development		Evaluation tools	
				Control during the course	Midterm control / exam
1	Section 1. Cytology	the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	know	Interview	Exam questions 1-80; questions of “Cell biology and general histology” part of the exam
	Section 2. General Histology		can	Test	
	Section 3. Private Histology		master	Test	
	Section 4. Embryology				

### Scale of course achievements

Code and formulation of competence.	Stages of formation of competence		Criteria	Indicators	Points
GPC-9 the capacity for the assessment of	Knows (entry level)	Basic methods of human histology, cytology and embryology	Knowledge of the basic terminology of histology,	The ability to define the basic concepts	65-71

morphological and physiological states and pathological processes in the human body for solving professional tasks			cytology and embryology	of histology, cytology and embryology	
	Able (advanced level)	To use educational, scientific, popular scientific literature, the Internet for professional activities	The use of basic concepts on research methods; confident use of information sources	The ability to list and reveal the essence of the methods applied in histology, cytology and embryology	71-84
	Master (high level)	simple research tools (microscope, slides)	Ability to work with tools	The ability to work with simple research tools and its correct application	85-100

### **Methodical recommendations for the final evaluation of the subject**

During the exam as an assessment tool is used interview and the decision of situational issues. In the case of cheating, the examiner has the right to remove the student from the examination.

To pass the oral exam in the audience to 6-8 students are invited at the same time. Leaving the audience during the preparation to the answers without the permission of the examiner is prohibited. The time for preparation must not be more than 30 minutes.

For exams and differentiated test the following marks are used: "excellent", "good", "satisfactory" and "unsatisfactory". "Failed to appear" is used if a student did not go the exam without any reasonable excuse. Student, who does not agree with the mark, has the right to submit an application to the Director of the School. Director of the School can create a commission consisting of three teachers of appropriate department; their mark is final.

### **Questions for exam on "Histology. Cytology. Embryology" (2 semester)**

1. Histology as a science, its features.
2. Histology as an university course, its main sections.

3. History of histology.
4. The cell theory, main points of it.
5. Cell is the main form of protoplasm organization.
6. Symplasts and syncytia is adaptive forms of protoplasm organization.
7. Intercellular substance.
8. The size and shape of cells.
9. Classification of cellular organelles.
10. The cell surface, its properties and functions.
11. The main functions of the cell.
13. Regulation of protein synthesis in the cell.
14. Mitochondria and its functions.
15. Cell reproduction (mitosis, endomitosis).
16. The cell cycle.
17. Chromosomes and its structure and functions. Karyotype.
18. Paraneurosis and cell death (apoptosis and necrosis).
19. Levels of cell adaptation.
20. Positional information: determination, differentiation and cell specialization.
21. Constitutive and inducible genes; cell fate determination.
22. The origin of tissues. Evolution theory of tissue.
23. Definition of tissue and tissue classification.
24. General characteristics of epithelial tissue.
25. Classification of epithelial tissue.
26. Glandular epithelium. Two types of glands.
27. Structure and functions of mesenchyme.
28. Classification of connective tissue.
29. Intercellular substance: collagen, reticular and elastic fibers.
30. Loose connective tissue: localization, structure and functions.
31. Cells of loose connective tissue.
32. A dense connective tissue.
33. Blood as a tissue.



34. Characteristics of erythrocytes.
35. Leukocytes: classification, structure and function.
36. The platelets (thrombocytes), their origin and function.
37. The hemogram and its clinical significance.
38. The role of histology in the hematology development: theory of blood formation.
39. Embryonic (primary) hematopoiesis.
40. The definitive (secondary) hematopoiesis.
41. Stem cell: types and stages of development.
42. Erythropoiesis: stage and cell shape.
43. Humoral and nervous regulation of hematopoiesis.
44. Integrative system of the body.
45. General features of immune cells.
46. The antigen-independent differentiation of B-lymphocytes.
47. The antigen-independent differentiation of T lymphocytes.
48. The interaction of T and B lymphocyte responses in infectious immunity and transplantation.
49. Two types of bone tissue: cells and intercellular substance.
50. The development, growth and regeneration of bone.
51. Classification of muscle tissue and the types of motor activity.
52. Characteristics of myon.
53. Sarcomere structure. Theory of muscle contraction.
54. Transmission of nerve impulses to the muscle fiber.
55. The development and regeneration of muscle tissue.
56. The origin, structure and types of cartilaginous tissue.
57. Neural theory.
58. Structure and function of the neuron.
59. Neuron classifications based on their function and morphology.
60. Neuromediators, cytochemical classification of neurons.
61. Synapse, nerve endings, their classification.

62. Classification of macroglial cells.
63. Microglia.
64. Development of neurons and histogenesis of the nervous system.
65. Regeneration of neurons and glia.
66. Spinal system structure.
67. Organization of the spinal cord gray matter.
68. The reflex arc: monosynaptic and polysynaptic reflex arc.
69. The main types of spinal cord neurons. Nociceptive, visceral and proprioceptive sensitivity centers.
70. Spinal cord: command neurons and central control of movements.
71. The spinal cord white matter.
72. Cortical column is the functional unit of the cerebral cortex.
73. The cell composition of the cortical column.
74. The concept of modules and distribution systems.
75. Cytoarchitectonics of the cortex.
76. Homo- and heterotypic cortex.
77. Myeloarchitectonics of the cerebral cortex.
78. Cerebellum: layers, neural structure and function.

**Questions for exam on "Histology. Cytology. Embryology" (3 semester)**

1. The history of the doctrine of the circulation.
2. Classification and function of blood vessels, their structure.
3. Capillaries, their types, structure and function; concept of microcirculation.
4. Types of arteries: the structure of muscular and elastic arteries.
5. Features and structure of the veins.
6. Circulatory anastomosis.
7. Development of the heart.
8. The structure of the endocardium and epicardium.
9. Structure and function of myocardium, types of cardiomyocytes.
10. The conductive system of the heart, cardiac pacemaker cells.

11. The central and peripheral organs of hematopoiesis. Common features of central and peripheral organs.
12. Bone marrow and its types.
13. Red bone marrow, its structure and functions.
14. The thymus, thymic involution.
15. Functions of the lymph node.
16. Spleen. Features of the structure and blood supply.
17. The structure of the palatine tonsil.
18. Characteristic of the skin and its functions.
19. The origin and structure of the epidermis.
20. The origin and structure of the dermis.
21. The skin as an organ of sensitivity.
22. The hair structure and their types.
23. The main functions of the respiratory system.
24. Conducting zone: trachea and bronchi.
25. Respiratory zone.
26. Acinus structure and air-blood barrier structure.
27. General characteristics of the digestive system.
28. Two types of mucous membrane.
29. Tongue. Taste papillae and taste organ.
30. Tooth structure. Tooth development.
31. Esophagus. Features of the structure in the connection of the esophagus and stomach.
32. Stomach. The structure and function of the mucosa.
33. The glands of the stomach. Types and topography.
34. Fundic glands of the stomach, local endocrine regulation.
35. Small intestine. The structure and function of the mucosa.
36. Intestinal villi. Structure histophysiology of intestinal villi.
37. Colon. The structure and function.
38. Stomach and gut endocrine cells. Their hormones and function.

39. The salivary glands, structure and function.
40. Characteristics of the pancreas: exocrine part, structure of acinus.
41. Characteristics of the pancreas: endocrine part, the types of endocrine cells, hormones and their role.
42. Functions of the liver. Theories of liver structure.
43. Hepatocyte characterization.
44. Liver sinusoid and Disse space.
45. The vascular system of the liver. The role of the portal vein and hepatic artery.
46. General characteristics, structure and functions of the endocrine system.
47. Hypothalamic nuclei, their hormones.
48. Adenohypophysis. The cells and the hormones of the anterior pituitary.
49. Neurohypophysis.
50. Epiphysis. Structure, two main groups of hormones.
51. Thyroid. Follicular and parafollicular cells. Hormones and their functions.
52. Parathyroid. Structure, hormones, function.
53. Adrenal glands: cortex, medulla, the hormones and their roles.
54. Anatomy of the kidney and urinary tract.
55. The structure and role of the brush border cells.
56. Structure of the kidney epithelium.
57. The structure of the fenestrated capillaries.
58. Features of the urinary system, the sources of its development.
59. Kidney, structure and functions. Nephron as a structural and functional unit of the kidney.
60. Structure and blood supply to the different nephron types.
61. Endocrine regulation of kidney function.
62. Development of the male reproductive system.
63. The structure of the testicle.
64. The generative and endocrine function of the testis. Stages of spermatogenesis.
65. Regulation of spermatogenesis.

66. Prostate, structure and function.
67. The development of the ovary.
68. Cyclical changes in the ovary: folliculogenesis, structural features of different follicles.
69. Corpus albicans.
70. Ovogenesis.
71. Development of the female reproductive system organs.
72. Structure of fallopian tube, uterus and vagina walls.
73. The structure of the mammary glands and their functional connection with the female reproductive system organs.
74. Germ cells.
75. Egg classifications.
76. Hormonal regulation of the menstrual cycle.
77. Fertilization and factors influence on it.
78. Zygote.
79. Structure and implantation of the blastocyst.
80. Types and stages of gastrulation.
81. Characteristics of the early organogenesis.
82. Extraembryonic organs and their role during human development.
83. Placenta formation, structure and functions.
84. The most sensitive stages during human development.

### **Questions for final exam on "Histology. Cytology. Embryology"**

1. Histology as a science, its features.
2. Histology as an university course, its main sections.
3. History of histology.
4. The cell theory, main points of it.
5. Cell is the main form of protoplasm organization.
6. Symplasts and syncytia is adaptive forms of protoplasm organization.
7. Intercellular substance.

8. The size and shape of cells.
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48. The interaction of T and B lymphocyte responses in infectious immunity and transplantation.
49. Two types of bone tissue: cells and intercellular substance.
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140. The structure of the testicle.
141. The generative and endocrine function of the testis. Stages of spermatogenesis.
142. Regulation of spermatogenesis.
143. Prostate, structure and function.
144. The development of the ovary.
145. Cyclical changes in the ovary: folliculogenesis, structural features of different follicles.
146. Corpus albicans.

147. Oogenesis.
148. Development of the female reproductive system organs.
149. Structure of fallopian tube, uterus and vagina walls.
150. The structure of the mammary glands and their functional connection with the female reproductive system organs.
151. Germ cells.
152. Egg classifications.
153. Hormonal regulation of the menstrual cycle.
154. Fertilization and factors influence on it.
155. Zygote.
156. Structure and implantation of the blastocyst.
157. Types and stages of gastrulation.
158. Characteristics of the early organogenesis.
159. Extraembryonic organs and their role during human development.
160. Placenta formation, structure and functions.
161. The most sensitive stages during human development.

### **Criteria for exam evaluation**

For exams evaluation the following marks are used: "excellent", "good", "satisfactory" and "unsatisfactory".

**"5":**

- Complete and accurate answers to all exam questions;
- Fluency in the basic terms and concepts of the course;
- logical presentation of the course material.

**"4":**

- Complete and accurate answers to all exam questions;
- Knowledge of the basic terms and concepts of the course;

**"3":**

- Complete and accurate answers to 2 of 3 exam questions;
- Satisfactory knowledge of basic terms and concepts of the course;

- Lack of consistent presentation of course material;
  - Ability to formulate some conclusions and generalizations on questions;
- "2" suggests:
- answer to one exam question.

### **Test examples**

What structures are associated with the rough endoplasmic reticulum?

- a. Golgi apparatus
- b. ribosomes
- c. lysosomes
- d. chromosomes

Which of the following is a function of the rough endoplasmic reticulum?

- a. production of proteins
- b. detoxification of certain substances
- c. synthesis of steroid hormones
- d. regulation of intracellular calcium concentration

Which of the following organelles produces ATP?

- a. mitochondria
- b. peroxisomes
- c. lysosomes
- d. ribosomes

What features are common for nucleus and mitochondria?

- a. the same genes
- b. a double cell membrane
- c. ribosome synthesis
- d. ATP production

Which of the following structures could be found within the nucleolus?

- a. chromatin
- b. histones
- c. ribosomes
- d. nucleosomes

Which of the following sequences on a DNA molecule would be complementary to GCTTATAT?

- a. TAGGCGCG
- b. ATCCGCGC
- c. CGAATATA
- d. TGCCTCTC

Place the following structures in order from least to most complex organization:

chromatin, nucleosome, DNA, chromosome

- a. DNA, nucleosome, chromatin, chromosome
- b. nucleosome, DNA, chromosome, chromatin
- c. DNA, chromatin, nucleosome, chromosome
- d. nucleosome, chromatin, DNA, chromosome

Which of the following is *not* a difference between DNA and RNA?

- a. DNA contains thymine whereas RNA contains uracil
- b. DNA contains deoxyribose and RNA contains ribose
- c. DNA contains alternating sugar-phosphate molecules whereas RNA does not contain sugars
- d. RNA is single stranded and DNA is double stranded

Transcription and translation take place in the \_\_\_\_\_ and \_\_\_\_\_, respectively.

- a. nucleus; cytoplasm

- b. nucleolus; nucleus
- c. nucleolus; cytoplasm
- d. cytoplasm; nucleus

How many “letters” of an RNA molecule, in sequence, does it take to provide the code for a single amino acid?

- a. 1
- b. 2
- c. 3
- d. 4

Arrange the following terms in order of increasing specialization: oligopotency, pleuripotency, unipotency, multipotency.

- a. multipotency, pleuripotency, oligopotency, unipotency
- b. pleuripotency, oligopotency, multipotency unipotency
- c. oligopotency, pleuripotency, unipotency, multipotency
- d. pleuripotency, multipotency, oligopotency, unipotency

Which type of stem cell gives rise to red and white blood cells?

- a. endothelial
- b. epithelial
- c. hematopoietic
- d. mesenchymal

Which of the following is not a type of tissue?

- a. muscle
- b. nervous
- c. embryonic
- d. epithelial

The process by which a less specialized cell matures into a more specialized cell is called \_\_\_\_\_.

- a. differentiation
- b. maturation
- c. modification
- d. specialization

Differentiated cells in a developing embryo derive from \_\_\_\_\_.

- a. endothelium, mesothelium, and epithelium
- b. ectoderm, mesoderm, and endoderm
- c. connective tissue, epithelial tissue, and muscle tissue
- d. epidermis, mesoderm, and endothelium

Which of the following lines the body cavities exposed to the external environment?

- a. mesothelium
- b. lamina propria
- c. mesenteries
- d. mucosa

In observing epithelial cells under a microscope, the cells are arranged in a single layer and look tall and narrow, and the nucleus is located close to the basal side of the cell. The specimen is what type of epithelial tissue?

- a. columnar
- b. stratified
- c. squamous
- d. transitional

Which of the following is the epithelial tissue that lines the interior of blood vessels?

- a. columnar

- b. pseudostratified
- c. simple squamous
- d. transitional

The \_\_\_\_\_ exocrine gland stores its secretion until the glandular cell ruptures, whereas the \_\_\_\_\_ gland releases its apical region and reforms.

- a. holocrine; apocrine
- b. eccrine; endocrine
- c. apocrine; holocrine
- d. eccrine; apocrine

Connective tissue is made of which three essential components?

- a. cells, ground substance, and carbohydrate fibers
- b. cells, ground substance, and protein fibers
- c. collagen, ground substance, and protein fibers
- d. matrix, ground substance, and fluid

Under the microscope, a tissue specimen shows cells located in spaces scattered in a transparent background. This is probably \_\_\_\_\_.

- a. loose connective tissue
- b. a tendon
- c. bone
- d. hyaline cartilage

Which connective tissue specializes in storage of fat?

- a. tendon
- b. adipose tissue
- c. reticular tissue
- d. dense connective tissue



In adults, new connective tissue cells originate from the \_\_\_\_\_.

- a. mesoderm
- b. mesenchyme
- c. ectoderm
- d. endoderm

In bone, the main cells are \_\_\_\_\_.

- a. fibroblasts
- b. chondrocytes
- c. lymphocytes
- d. osteocytes

Which of the following statements about blood is true?

- a. Blood is about 92 percent water.
- b. Blood is slightly more acidic than water.
- c. Blood is slightly more viscous than water.
- d. Blood is slightly more salty than seawater.

Which of the formed elements arise from myeloid stem cells?

- a. B cells
- b. natural killer cells
- c. platelets
- d. all of the above

Which of the following statements about erythropoietin is true?

- a. It facilitates the proliferation and differentiation of the erythrocyte lineage.
- b. It is a hormone produced by the thyroid gland.
- c. It is a hemopoietic growth factor that prompts lymphoid stem cells to leave the bone marrow.
- d. Both a and b are true.

Which of the following statements about mature, circulating erythrocytes is true?

- a. They have no nucleus.
- b. They are packed with mitochondria.
- c. They survive for an average of 4 days.
- d. All of the above.

A molecule of hemoglobin \_\_\_\_\_.

- a. is shaped like a biconcave disk packed almost entirely with iron
- b. contains four glycoprotein units studded with oxygen
- c. consists of four globin proteins, each bound to a molecule of heme
- d. can carry up to 120 molecules of oxygen

The production of healthy erythrocytes depends upon the availability of \_\_\_\_\_.

- a. copper
- b. zinc
- c. vitamin B<sub>12</sub>
- d. copper, zinc, and vitamin B<sub>12</sub>

Aging and damaged erythrocytes are removed from the circulation by \_\_\_\_\_.

- a. myeloblasts
- b. monocytes
- c. macrophages
- d. mast cells

The process by which leukocytes squeeze through adjacent cells in a blood vessel wall is called \_\_\_\_\_.

- a. leukocytosis
- b. positive chemotaxis

- c. emigration
- d. cytoplasmic extending

Which of the following describes a neutrophil?

- a. abundant, agranular, especially effective against cancer cells
- b. abundant, granular, especially effective against bacteria
- c. rare, agranular, releases antimicrobial defensins
- d. rare, granular, contains multiple granules packed with histamine

T and B lymphocytes \_\_\_\_\_.

- a. are polymorphonuclear
- b. are involved with specific immune function
- c. proliferate excessively in leukopenia
- d. are most active against parasitic worms

Thrombocytes are more accurately called \_\_\_\_\_.

- a. clotting factors
- b. megakaryoblasts
- c. megakaryocytes
- d. platelets

The first step in hemostasis is \_\_\_\_\_.

- a. vascular spasm
- b. conversion of fibrinogen to fibrin
- c. activation of the intrinsic pathway
- d. activation of the common pathway

Prothrombin is converted to thrombin during the \_\_\_\_\_.

- a. intrinsic pathway
- b. extrinsic pathway

- c. common pathway
- d. formation of the platelet plug

The process in which antibodies attach to antigens, causing the formation of masses of linked cells, is called \_\_\_\_\_.

- a. sensitization
- b. coagulation
- c. agglutination
- d. hemolysis

People with ABO blood type O \_\_\_\_\_.

- a. have both antigens A and B on their erythrocytes
- b. lack both antigens A and B on their erythrocytes
- c. have neither anti-A nor anti-B antibodies circulating in their blood plasma
- d. are considered universal recipients

Hemolytic disease of the newborn is a risk during a subsequent pregnancy in which \_\_\_\_\_.

- a. a type AB mother is carrying a type O fetus
- b. a type O mother is carrying a type AB fetus
- c. an Rh<sup>+</sup> mother is carrying an Rh<sup>-</sup> fetus
- d. an Rh<sup>-</sup> mother is carrying a second Rh<sup>+</sup> fetus

Which of the following cells is phagocytic?

- a. plasma cell
- b. macrophage
- c. B cell
- d. NK cell

Which of the following cells is important in the innate immune response?

- a. B cells
- b. T cells
- c. macrophages
- d. plasma cells

Which of the lymphoid nodules is most likely to see food antigens first?

- a. tonsils
- b. Peyer's patches
- c. bronchus-associated lymphoid tissue
- d. mucosa-associated lymphoid tissue

Which of the following is *not* important in the antiviral innate immune response?

- a. interferons
- b. natural killer cells
- c. complement
- d. microphages

Enhanced phagocytosis of a cell by the binding of a specific protein is called

\_\_\_\_\_.

- a. endocytosis
- b. opsonization
- c. anaphylaxis
- d. complement activation

T cells that secrete cytokines that help antibody responses are called \_\_\_\_\_.

- a. Th1
- b. Th2
- c. regulatory T cells
- d. thymocytes

The taking in of antigen and digesting it for later presentation is called \_\_\_\_\_.

- a. antigen presentation
- b. antigen processing
- c. endocytosis
- d. exocytosis

Why is clonal expansion so important?

- a. to select for specific cells
- b. to secrete cytokines
- c. to kill target cells
- d. to increase the numbers of specific cells

The elimination of self-reactive thymocytes is called \_\_\_\_\_.

- a. positive selection.
- b. negative selection.
- c. tolerance.
- d. clonal selection.

Which type of T cell is most effective against viruses?

- a. Th1
- b. Th2
- c. cytotoxic T cells
- d. regulatory T cells

Removing functionality from a B cell without killing it is called \_\_\_\_\_.

- a. clonal selection
- b. clonal expansion
- c. clonal deletion
- d. clonal anergy

Which class of antibody crosses the placenta in pregnant women?

- a. IgM
- b. IgA
- c. IgE
- d. IgG

Which class of antibody has no known function other than as an antigen receptor?

- a. IgM
- b. IgA
- c. IgE
- d. IgD

When does class switching occur?

- a. primary response
- b. secondary response
- c. tolerance
- d. memory response

Which class of antibody is found in mucus?

- a. IgM
- b. IgA
- c. IgE
- d. IgD

Test evaluation:

"5" – more than 86% answers are correct.

"4" - 76-85% answers are correct.

"3" - 62-75% answers are correct.

"2" - less than 61% answers are correct.