

Dear students,

congratulations! At this very moment, you have come across material that we believe will be beneficial to you in your study of (not only) the subject of histology and embryology.

We have compiled in a comprehensive form all the topics of general and special histology that you may encounter during your studies in the first and second year. No topic has been left out, so you can be sure that the material presented will prepare you well for the examination in our subject but will also serve you well in higher years in preparation for subsequent subjects.

We have endeavored to help you effectively acquire the key knowledge in our subject, but our main aim remains that you not only learn, but more importantly understand and are able to apply the knowledge you have acquired. Therefore, even to answer some of the more difficult questions, you need to combine several pieces of knowledge. Of course, to really understand why an answer is right or wrong, you need to study from the recommended literature, to which you are hereby referred.

You have in front of you a set of questions divided into 24 chapters exactly according to the topics covered in the lectures and practical exercises of the summer and winter semesters. Each topic contains approximately 40 to 50 questions, which are didactically divided into approximately two equal halves. We recommend that you start with the first half first, as this will teach you to focus on the essentials, creating a sort of solid outline on which you can "stick" more and more knowledge. You will recognize these questions by the longer, more explicative answers and by the wording of the questions themselves, starting with "Decide whether...". You can then continue with the second half, where you will find questions often discussing particular problems and details. You will recognize these by the precise focus of the question and the (usually) shorter answer. The chapters on special histology also always include 10 questions directed at the development and congenital developmental defects of particular organ systems. For your better orientation, these questions are highlighted in

brown. At the end of each chapter, on a separate page, you will find the key to the correct answers. In this way you will be able to test yourself; the correct answers are not marked directly next to the options.

We are aware that most of you will spend time with the questions because they will be part of the final exam. However, we hope that at the end you will understand for yourselves that these questions were not created to torment you with new responsibilities, but to make your study of our admittedly difficult but beautiful subject as easy as possible.

The team of authors

Summer semester: histology as  
a subject, cytology, histological  
technique, and general histology

## Chapter One: Microscope. Histological technique

**1. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) We use an inverted microscope to observe common histological slides.
- b) The eyepiece is an optical component of a light microscope.
- c) We use a coarse focus for sharpening at the highest magnifications.
- d) The condenser is an illuminating and optical component of a light microscope.

**2. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) The resolving power of a light microscope is limited by the wavelength of photons of light in the visible spectrum.
- b) The inverted microscope is used to observe cell cultures.
- c) The immersion objective is used to observe blood smears.
- d) The resolving power of a light microscope is 0.2 nm.

**3. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) The stage of a microscope can be moved in two parallel planes.
- b) The fully open iris aperture increases the contrast of structures on a histological slide.
- c) The inverted microscope has a condenser above and objectives below the slide stage.

d) The lenses of a light microscope are only in objectives.

**4. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) We start to microscope at the highest magnification.
- b) The final magnification of the image is calculated by multiplying the magnification of an eyepiece by the magnification of an objective lens.
- c) The arm and fine coarse represent mechanic parts of a microscope.
- d) In a common light microscopy, we use ultraviolet light.

**5. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) A binocular light microscope contains one tube and one eyepiece.
- b) We start to microscope with the stage in the lowest position.
- c) The eye observes the primary image shown by the eyepiece.
- d) Brightfield microscopy is the most used method for observing common histological slides.

**6. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) The resolving power of an electron microscope is 0,05 - 0,2 nm.
- b) The electron microscope allows higher resolution than the light microscope because electrons have a significantly shorter wavelength compared to the wavelength of photons in the visible spectrum.

- c) The scanning electron microscope makes it possible to visualize the sample's surface, for example, the microvilli surface of absorptive cells.
- d) We can observe the inner structure of cilia axonemes with a scanning electron microscope.

**7. Decide whether the following statements about the electron microscopy are true T or false F:**

- a) The role of lenses in electron microscopy is fulfilled by a series of electromagnets.
- b) The resulting image of the sample examined in the electron microscope is observed in shades of gray.
- c) The maximum useful magnification of an electron microscope is one thousand times.
- d) The image from the electron microscope is called a photomicrograph.

**8. Decide whether the following statements about the electron microscopy are true T or false F:**

- a) The beam of accelerated electrons passes through ground glass lenses.
- b) When observing a sample in a scanning electron microscope under high vacuum conditions, it is desirable for the sample to be conductive, in other words coated with a layer of precious metal, such as gold.
- c) The resolving power of a scanning electron microscope is  $1 - 10$  nm.
- d) Prior to observation in the electron microscope, the slides must be stained in a similar way to light microscopy.

**9. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) A beam of electrons is emitted from the anode and is accelerated by a high voltage applied to the cathode.
- b) A transmission electron microscope is used to observe the ultrastructure of cells.
- c) The recorded image from an electron microscope is called an electron micrograph.
- d) The electron microscopy was invented by Max Knoll and Antonie van Leeuwenhoek.

**10. Decide whether the following statements about the electron microscopy are true**

**T or false F:**

- a) Ultrathin sections are used in electron microscopy.
- b) An objective and eyepiece are considered to be electromagnetic lenses.
- c) The principle of transmission electron microscopy is the reflection of electrons from the surface of a sample.
- d) The chromatin structure can be observed with a scanning electron microscope.

**11. Decide whether the following statements about the special microscopic techniques are true T or false F:**

- a) Dark-field observation is one of the most routine and common techniques for tissue microscopy.
- b) Light rays that do not interact with the specimen are excluded from image formation in dark-field observation.

- c) Polarization microscopy exploits the ability of some tissues and structures to change the plane of polarization of light.
- d) Polarizing microscopy enables studying for example the orientation of hydroxyapatite crystals in the bone matrix.

**12. Decide whether the following statements about the special microscopic techniques are true T or false F:**

- a) Slides stained with hematoxylin and eosin are observed with a polarizing microscope.
- b) Phase contrast microscopy allows visualization of living cells in cell culture.
- c) To observe the sample in phase contrast, the sample must first be stained.
- d) In phase contrast, we observe fixed slides that have been impregnated with heavy metal salts.

**13. Decide whether the following statements about the special microscopic techniques are true T or false F:**

- a) Fluorescence microscopy uses the ability of the sample to rotate the plane of polarized light.
- b) Fluorochromes (fluorophores) are characterized by excitation by light of shorter wavelengths and subsequent emission of light of longer wavelengths.
- c) Hemoglobin, for example, has an intrinsic fluorescence ability.
- d) A fluorescence microscope is a type of electron microscope.



**14. Decide whether the following statements about the special microscopic techniques are true T or false F:**

- a) Confocal microscopy allows the reconstruction of a three-dimensional image.
- b) A confocal microscope is a type of light microscope.
- c) The principle of confocal microscopy is to use confocal apertures to outline a specific plane interval of the sample.
- d) Confocal microscopy is most used in combination with fluorescence microscopy.

**15. Decide whether the following statements about the special microscopic techniques are true T or false F:**

- a) Observation in the dark field exploits the natural fluorescence of some molecules.
- b) Light polarization is the phenomenon of excitation of structures with shorter wavelengths of light followed by emission of long-wavelength light.
- c) Phase contraction is useful, for example, for the observation of vital spermatozoa.
- d) In a dark field, we can observe structures that are below the resolution of a light microscope.

**16. Decide whether the following statements about histologic techniques are true T or false F:**

- a) Removing tissue from a dead donor is called a biopsy.
- b) Tissue fixation is used to facilitate slicing of the specimen on the microtome.
- c) The most used chemical fixative is 10% formol (formalin).

- d) Basophilic structures are chemically acidic in nature, such as DNA in the nucleus.

**17. Decide whether the following statements about histologic techniques are true T or false F:**

- a) Eosinophilia indicates that the structure has an affinity for alkaline dyes.
- b) The frozen section method is faster than the traditional paraffin section method.
- c) While the paraffin section method is more time-consuming yet produces better image quality and the resulting slide is permanent in comparison to the frozen sectioning method.
- d) Preparation of slides using the paraffin technique is routinely used in fast perioperative biopsy diagnostics.

**18. Decide whether the following statements about histologic techniques are true T or false F:**

- a) The paraffin section technique uses a physical method of fixation.
- b) Cryomicrotome is used to cut paraffin blocks.
- c) Staining of the paraffin section of the sample is possible immediately after cutting.
- d) A series of alcohols in increasing concentration is used to dehydrate the sample.

**19. Decide whether the following statements about histologic techniques are true T or false F:**

- a) Argyrophilia and argentaphilia are related phenomena that refer to the ability of a structure to stain with silver salts.
- b) Impregnation involves revealing certain structures by reducing metal salts on their surface.
- c) A common method of impregnation is the use of hematoxylin and eosin.
- d) Hematoxylin stains collagen fibers purple.

**20. Decide whether the following statements about histologic techniques are true T or false F:**

- a) Eosin stains the nucleus pink.
- b) Paraffin sections are cut with a microtome to a standard thickness of 2-7 micrometers.
- c) Paraffin is used to embed the specimen, which can be sliced once it has become solid.
- d) Xylene is used to brighten the samples.

**21. Decide whether the following statements about the histochemistry are true T or false F:**

- a) Histochemistry involves staining of immunocomplexes.
- b) Histochemistry is the staining of chemical substances, such as enzymes, in cells.
- c) Glycogen in the liver can be histochemically proved using the PAS method.

- d) We can use histochemistry to demonstrate the presence of alkaline phosphatase, for example in the brush border in epithelial cells of the proximal tubule of kidney nephron.

**22. Decide whether the following statements about the histochemistry are true T or false F:**

- a) The PAS method is a combination of Schiff's reagent and periodic acid.
- b) We histochemically visualize for example DNA in the nucleus using hematoxylin.
- c) We classify the detection of alkaline phosphatase as an enzyme histochemical method.
- d) The PAS reaction is used to demonstrate substances of a fatty nature.

**23. Decide whether the following statements about the immunohistochemistry are true T or false F:**

- a) Immunohistochemistry is used to demonstrate specific epitopes of antigens.
- b) The most used chromogen in immunohistochemistry is diaminobenzidine (DAB).
- c) Monoclonal antibodies are directed against multiple epitopes of antigens.
- d) Immunization of laboratory animals produces exclusively monoclonal antibodies.

**24. Decide whether the following statements about the immunohistochemistry are true T or false F:**

- a) Immunohistochemistry is of fundamental importance not only in research, but also in the clinical diagnosis of for example tumors.
- b) Conventional paraffin blocks can be used for immunohistochemistry.
- c) Secondary antibodies are used in direct immunohistochemistry.
- d) Polyclonal antibodies are produced by a specific clone of plasma cells.

**25. Decide whether the following statements about the immunohistochemistry are true T or false F:**

- a) Cytokeratin tonofilaments as markers of cells of epithelial origin can be visualized by immunohistochemistry.
- b) Estrogen receptor displays nuclear positivity with immunohistochemical staining.
- c) There are three main types of positivity in immunohistochemistry - nuclear, cytoplasmic, and membrane.
- d) Immunohistochemistry is used to differentiate cell populations that cannot be distinguished by conventional staining, such as T and B lymphocytes.

**26. What is the correct chronological order of steps in the routine processing of histologic specimens?**

- a) sectioning, 2. embedding, 3. clearing, 4. mounting
- b) fixation, 2. embedding, 3. rehydration, 4. mounting
- c) dehydration, 2. clearing, 3. embedding, 4. sectioning
- d) deparaffinization, 2. rehydration, 3. staining, 4. mounting
- e) fixation, 2. dehydration, 3. clearing, 4. embedding

f) clearing, 2. fixation, 3. dehydration, 4. staining

**27. Which dyes are acidophilic?**

- a) eosin
- b) hematoxylin
- c) aniline blue
- d) methylene blue
- e) picric acid

**28. Which of the following approaches to visualizing specimens use a histochemical approach?**

- a) periodic acid-Schiff reagent (PAS)
- b) silver impregnation
- c) Sudan stain
- d) acid phosphatase
- e) Masson stain
- f) Pappenheim stain

**29. Could the following couples have theoretically met in the past?**

- a) Camillo Golgi - Andreas Vesalius
- b) Santiago Ramón y Cajal - Camillo Golgi
- c) Rudolf Virchow - Jan Evangelista Purkyně
- d) Antonie van Leeuwenhoek - Robert Hooke
- e) Ernst Abbe - Carl Zeiss
- f) Xavier Bichat - Albert Coons

**30. What optical parts does the beam pass through in Köhler illumination?**

- a) condenser lens
- b) magnetic coil
- c) objective
- d) ocular lens

**31. What chemicals are used in transmission electron microscope specimen preparation during fixation and postfixation?**

- a) hematoxylin
- b) glutaraldehyde
- c) formaldehyde
- d) ethanol
- e) osmium tetroxide

**32. What determines the resolution?**

- a) wavelength of particles used
- b) numerical aperture of objective
- c) refractive index of the medium between specimen and objective
- d) intensity of beam of light or electrons
- e) extent to which aperture is closed

**33. Which of the following statements about the eosin are true?**

- a) it is a basic dye
- b) it can stain the cytoplasm of the vast majority of cells pink

- c) it was developed to stain collagen green
- d) it serves as a chemical agent during fixation

**34. The following can be said about hematoxylin:**

- a) it is a basic dye
- b) can stain the cytoplasm of most cells pink
- c) was developed to stain collagen green
- d) can be used to visualize cell nuclei

**35. Which of the following statements about the microscope are true?**

- a) objective lenses magnify and project the illuminated image of the object toward the eyepiece
- b) the ocular lens further magnifies the image and projects it onto the viewer's retina
- c) the maximum resolution of the light microscope is approximately 0.2 nm
- d) the total magnification of an optical microscope is obtained by multiplying the magnification of the condenser and objective
- e) numerical aperture for microscope lenses typically ranges from 0.10 to 1.25, corresponding to focal lengths of about 40 mm to 2 mm

**36. Which of the following dye-biological structure pairs are correct?**

- a) Sudan – sugars
- b) aniline blue – elastin
- c) orcein – elastin
- d) hematoxylin – mitochondria



- e) silver - reticular fibers
- f) osmium tetroxide – lipids

**37. Which of the following statements about the term "resolution" are true?**

- a) is the degree to which an object appears enlarged in the image
- b) is a degree of separation between two adjacent points in the specimen
- c) depends mainly on the objective
- d) the resolution of the naked eye is approximately 0,2 mm
- e) the resolution of the electron microscope is approximately 0,2  $\mu\text{m}$

**38. Replace the incorrect word with the correct one in the following sentence: The principle of fluorescent microscopy is that specimen is illuminated with light of a specific wavelength which is absorbed by the fluorophores, causing them to emit light of shorter wavelengths (i.e., of a different color)**

- a) fluorescent  $\rightarrow$  darkfield
- b) absorbed  $\rightarrow$  reflected
- c) shorter  $\rightarrow$  longer
- d) color  $\rightarrow$  saturation

**39. What microscopy technique uses visible light as a radiation source?**

- a) atomic force microscopy
- b) transmission electron microscopy
- c) confocal microscopy
- d) phase-contrast microscopy
- e) fluorescence microscopy

**40. What is used for antigen retrieval in immunohistochemistry protocols?**

- a) trypsin
- b) formaldehyde
- c) X-rays
- d) heat

**41. Who coined the term "cell"?**

- a) Marcello Malpighi
- b) Antoni van Leeuwenhoek
- c) Karl Mayer
- d) Robert Hooke

**42. What are some of the routine clearing agents used in histology?**

- a) paraffin
- b) xylene
- c) methyl salicylate
- d) hematoxylin
- e) ethanol

**43. What is the name of the histological device used to slice thin sections from blocks of tissue?**

- a) dermatome
- b) myotome

- c) histotome
- d) microtome
- e) sclerotome

**44. What is an antigenic determinant of known structure - the part of an antigen recognized by a specific immunoglobulin - called?**

- a) chromophore
- b) antibody
- c) epitope
- d) immunocomplex

**45. Which of the following statements about the staining are true?**

- a) when stained with H&E, nuclei are generally stained pink
- b) hematoxylin stains mitochondria well
- c) Cresyl Violet is one of the dyes used in Nissl staining
- d) in H&E staining, the two visible compartments of the cell - nucleus and cytoplasm - are usually stained in contrast

## Chapter One answers:

- |         |          |          |         |
|---------|----------|----------|---------|
| 1) bd   | 13) bc   | 25) abcd | 37) bcd |
| 2) abc  | 14) abcd | 26) bcde | 38) c   |
| 3) c    | 15) cd   | 27) ace  | 39) cde |
| 4) bc   | 16) cd   | 28) abcd | 40) ad  |
| 5) bcd  | 17) bc   | 29) bcde | 41) d   |
| 6) abc  | 18) d    | 30) acd  | 42) bc  |
| 7) ab   | 19) ab   | 31) be   | 43) d   |
| 8) bc   | 20) bcd  | 32) abc  | 44) c   |
| 9) bc   | 21) bcd  | 33) b    | 45) cd  |
| 10) a   | 22) ac   | 34) ad   |         |
| 11) bcd | 23) ab   | 35) abe  |         |
| 12) b   | 24) ab   | 36) cef  |         |

## Chapter Two: Cell

**1. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) Euchromatin is the term for dark condensed chromatin.
- b) The predominance of heterochromatin is typical of cells with low transcriptional activity.
- c) A dark heterochromatic nucleus is typical of a proteosynthetically active cell.
- d) Pyknosis indicates a state of maximal condensation of nuclear chromatin.

**2. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) Nuclear pores allow bidirectional communication between the cytoplasm and nucleoplasm.
- b) The nuclear envelope consists of two membranes, each about 8nm thick.
- c) 2:1 is the typical nucleocytoplasmic ratio in immature progenitor cells.
- d) A nucleocytoplasmic ratio of 4:1 is typical of immature cells, but can also be observed in mature cells, for example lymphocytes.

**3. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) The basic functional and regulatory structure of chromatin is the nucleosome.
- b) Heterochromatin is strongly basophilic when stained with hematoxylin.

- c) Euchromatin is a transcriptionally active chromatin that appears slightly basophilic when stained with hematoxylin.
- d) In an electron microscope image, heterochromatin is electron dense.

**4. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) The arrangement of heterochromatin and euchromatin allows us to distinguish, for example, a B lymphocyte from a plasma cell.
- b) The nuclear pore complex consists of an outer and inner ring and a central channel.
- c) The perinuclear compartment is located between the cytoplasm and the outer nuclear membrane.
- d) Nuclear pore can be identified at the light-microscopic level.

**5. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) The pyknotic nucleus can be seen in sperm or in the surface epithelial cells of the skin.
- b) Karyolysis is typically described in cell division.
- c) Stem cells usually have a bright, optically empty nucleus.
- d) Most cells have a very dark pyknotic nucleus.

**6. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) Ribosomes are the site of post-translational modification of proteins.

- b) Basophilia is a typical property of ribosomes due to the abundance of acidic molecules.
- c) mRNA is the only type of RNA found in ribosomes.
- d) Basophilia is a typical feature of ribosomes due to the abundance of molecules that are basic in nature.

**7. Decide whether the following statements about the cell nucleus are true T or false F:**

- a) rRNA, tRNA and mRNA are integral parts of ribosomes.
- b) Ribosomes are membrane organelles.
- c) Ribosomes are also found in mitochondria.
- d) Ribosomes are synthesized in the cell nucleolus.

**8. Decide whether the following statements about the rough endoplasmic reticulum are true T or false F:**

- a) The smooth endoplasmic reticulum has ribosomes attached to the membrane and is used for protein synthesis.
- b) Accumulation of rough endoplasmic reticulum and polyribosomes in the cytoplasm of neurons is called a Nissl substance.
- c) The smooth endoplasmic reticulum is used, for example, in the synthesis of steroid hormones.
- d) The rough endoplasmic reticulum is stained pink with eosin.

**9. Decide whether the following statements about the rough endoplasmic reticulum are true T or false F:**

- a) Cells with high proteosynthetic activity have a predominance of smooth endoplasmic reticulum.
- b) The endoplasmic reticulum is a double membrane organelle.
- c) Post-translational modification of proteins takes place in the inside of the rough endoplasmic reticulum.
- d) The rough endoplasmic reticulum is a reservoir of calcium cations needed for muscle contraction.

**10. Decide whether the following statements about the nucleolus are true T or false F:**

- a) A dark basophilic nucleolus is observed, for example, in plasma cells or fibroblasts.
- b) The nucleolus is the site of mRNA synthesis.
- c) The nucleolus is surrounded by a double membrane.
- d) Both subunits of the ribosome are synthesized in the nucleolus.

**11. Decide whether the following statements about the cells are true T or false F:**

- a) The shape of the nucleus usually copies the shape of the whole cell.
- b) Mitochondria with cristae are the most common type of mitochondria.
- c) A phagolysosome is a type of primary lysosome.
- d) The Golgi apparatus is used for post-translational modification of proteins.



**12. Decide whether the following statements about the cells are true T or false F:**

- a) Lysosomes are non-membrane organelles.
- b) Mitochondria can be observed at the light microscopic level after staining with a specific method, otherwise it is difficult to identify them.
- c) The mitochondria's own DNA comes exclusively from the mother.
- d) Cells that synthesize steroid hormones contain tubular mitochondria.

**13. Decide whether the following statements about the cells are true T or false F:**

- a) Mitochondria are surrounded by a single membrane.
- b) The smooth endoplasmic reticulum is used, for example, for protein synthesis.
- c) Most cells have one nucleus.
- d) The syncytium refers to cells with two nuclei, for example cardiomyocytes.

**14. Decide whether the following statements about the cells are true T or false F:**

- a) Most cells in the human body have a single nucleus.
- b) Syncytium is a common feature of muscle fibers and osteoclasts.
- c) Microtubules are membrane organelles.
- d) Mitochondria have their own ribosomes in addition to their own circular DNA molecule.

**15. Decide whether the following statements about the cells are true T or false F:**

- a) The high content of mitochondria in the cytoplasm of a cell gives it a strong affinity for acidic dyes, such as eosin.

- b) Primary lysosomes contain phagocytosed material.
- c) Residual body is a synonym for tertiary lysosome.
- d) Microtubules are part of the cytoskeleton and form the inner skeleton of cilia.

**16. Decide whether the following statements about the inclusions are true T or false**

**F:**

- a) Lipofuscin is found in long living cells, such as cardiomyocytes or neurons.
- b) Reinke's crystalloids in Leydig cells of the testis are cellular inclusions.
- c) Steatosis refers to the physiological storage of fat droplets in hepatocytes.
- d) Pheomelanin is responsible for the black coloration of skin and hair.

**17. Decide whether the following statements about the inclusions are true T or false**

**F:**

- a) Glycogen granules are PAS positive structures.
- b) Fat droplets are clearly visible when stained with hematoxylin and eosin.
- c) Skin color is not determined by the number of melanocytes but by the total number of melanosomes.
- d) The accumulation of exogenous carbon particles in alveolar macrophages is the basis of anthracosis.

**18. Decide whether the following statements about the inclusions are true T or false**

**F:**

- a) Hemosiderin is an exogenous pigment.
- b) Neuromelanin is a synonym for pigment of aging.

- c) Colored particles injected into the subcutaneous tissue during tattooing are endogenous pigments.
- d) We use Sudan III stain to show fat droplets.

**19. Decide whether the following statements about the inclusions are true T or false**

**F:**

- a) Albinism is an inherited disorder characterized by a deficiency in the production of lipofuscin.
- b) Glycogen granules in hepatocytes are easily visible when stained with hematoxylin and eosin.
- c) Large amounts of neuromelanin are found, for example, in the substantia nigra.
- d) Hemosiderin is a hematogenous endogenous pigment.

**20. Decide whether the following statements about the inclusions are true T or false**

**F:**

- a) Lipofuscin is also known as the aging pigment.
- b) Lipofuscin accumulation is typical of epithelial cells in the small intestine.
- c) Myoglobin is a hematogenous pigment typical of muscle tissue.
- d) Inclusions are cell organelles.

**21. Which of the following statements about the cell nucleus are true?**

- a) contains the genome
- b) contains enzymes for RNA transcription
- c) is the site of ribosomal RNA synthesis

- d) chromatin is responsible for its characteristic eosinophilia
- e) in gametes, contains a set of 46 chromosomes
- f) is a double-membrane limited organelle

**22. Where is it possible to find the nuclear lamina?**

- a) in perinuclear cisternal space
- b) next to outer nuclear membrane
- c) adjacent to the inner nuclear membrane
- d) around the granular material of nucleolus

**23. Which of the following statements about the nucleolus are true?**

- a) is a membrane-bound region within the nucleus
- b) is a primary site of ribosome production and assembly
- c) is involved in regulation of cell cycle
- d) does not contain a genome
- e) is well visible when stained with acidic dyes

**24. What is typical of a dying cell?**

- a) karyolysis
- b) shutdown of endonucleases
- c) karyorrhexis
- d) pyknosis
- e) cell blebbing

**25. What does a nucleosome consist of?**

- a) hexamer (six histone molecules)
- b) octamer (eight histone molecules)
- c) six loops of DNA
- d) two loops of DNA

**26. In the nuclei of which cells would you see a predominance of euchromatin?**

- a) cells producing antibodies
- b) cells producing testosterone
- c) cells producing collagen
- d) phagocytic cells
- e) cells carrying respiratory gases

**27. In which cells would you see a well-developed smooth ER?**

- a) cells carrying respiratory gases
- b) male germ cells
- c) lipid storing cells
- d) cells producing sebum
- e) cells with detoxification function
- f) cells producing testosterone

**28. Which cells have retained their mitotic potential?**

- a) cells that transmit nerve impulses
- b) cells carrying respiratory gases

- c) malignant cells
- d) stem cells

**29. What do mitosis and meiosis have in common?**

- a) two daughter cells have the same DNA content as the parent cell
- b) both occur in a cleavage of the zygote
- c) preceding S-phase
- d) crossing-over
- e) both have metaphase
- f) both have pachytene stage of prophase

**30. What are some of the diseases that appear to be caused by losing cells?**

- a) Parkinson's disease
- b) AIDS
- c) cancer
- d) proliferative glomerulonephritis
- e) muscular dystrophies

**31. Where in the body can apoptosis be observed?**

- a) follicular atresia
- b) in the uterus after childbirth
- c) during a tumor formation
- d) on cells damaged beyond repair

**32. What are non-membranous organelles?**

- a) mitochondria
- b) ribosomes
- c) rough endoplasmic reticulum
- d) centriole
- e) acrosome
- f) cytoskeleton

**33. What can be found in the plasma membrane?**

- a) cerebrosides
- b) cholesterol
- c) integral proteins
- d) connexons
- e) clathrin
- f) sphingomyelin

**34. In the following statement, correct the word to make this statement correct: The production of proteins by the cell begins within the nucleus with translation, in which the genetic code is encoded to mRNA.**

- a) proteins → lipids
- b) nucleus → nucleolus
- c) translation → transcription
- d) mRNA → tRNA

**35. Which of the given pairs are correct?**

- a) Golgi - cytochrome c
- b) smooth ER – cardiolipin
- c) mitochondria - SNARE proteins
- d) plasma membrane – cholesterol
- e) microtubules – dynein
- f) nucleus – lamins
- g) basal body – actin

**36. What is it glycocalyx?**

- a) polysaccharide coating of cells
- b) type of sphingolipid in plasma membrane
- c) positively charged pericellular matrix
- d) voltage-gated channel at the apical surface of cell

**37. Which of the following statements about the endocytosis are true?**

- a) is the passive transfer of substances across the cytoplasmic membrane
- b) is the opposite of pinocytosis
- c) one of its type is phagocytosis
- d) can be mediated by specific receptors

**38. Which of the following statements about the cell cycle are true?**

- a) cell cycle interphase can be divided into G<sub>1</sub>, S and G<sub>2</sub> phases
- b) DNA duplication occurs during the G<sub>1</sub> phase



- c) during the G<sub>2</sub> phase the cell is prepared for mitotic division
- d) the length of the cell cycle is independent of external conditions

**39. Which of these statements about different organelles are true?**

- a) secondary lysosomes do not comprise digested material
- b) intermediate filament proteins include vimentin
- c) mitochondria are basophilic organelles
- d) microvillus is approximately 10 μm wide
- e) the cell nucleus is round regardless of the cell shape
- f) Golgi complex is functionally and structurally related to the endoplasmic reticulum

**40. What could be a different function of the smooth ER in different cells?**

- a) production of steroid hormones
- b) post-translational modification and sorting of proteins
- c) intracellular transport
- d) detoxification
- e) lipid metabolism
- f) phosphate anions storage
- g) protein synthesis

## Chapter Two answers:

- |         |         |          |           |
|---------|---------|----------|-----------|
| 1) bd   | 11) abd | 21) abcf | 31) abd   |
| 2) abd  | 12) bcd | 22) c    | 32) bdf   |
| 3) abcd | 13) c   | 23) bc   | 33) abcdf |
| 4) ab   | 14) abd | 24) acde | 34) c     |
| 5) ac   | 15) acd | 25) bd   | 35) def   |
| 6) b    | 16) ab  | 26) ac   | 36) a     |
| 7) acd  | 17) acd | 27) cdef | 37) cd    |
| 8) bc   | 18) d   | 28) cd   | 38) ac    |
| 9) c    | 19) cd  | 29) ce   | 39) bf    |
| 10) ad  | 20) ac  | 30) abe  | 40) ade   |

## Chapter Three: Covering and lining epithelia

**1. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The endothelium is a simple columnar epithelium lining the vessels and cavities of the heart.
- b) The basal labyrinth is typical of cells with significant active transport, for example in the lining epithelial cells of the proximal tubules of the kidney.
- c) The apical part of epithelial cells is characterized by the presence of adhesive intercellular junctions.
- d) In simple epithelia, all cells contact the basal lamina.

**2. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Lamina fibroreticularis is a product of epithelial cells.
- b) Lamina basalis and membrana basalis are synonyms.
- c) Zonula occludens is a cohesive intercellular junction.
- d) The nexus consists of two connexons synthesized by two adjacent epithelial cells to communicate with each other.

**3. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Nexuses are one of the communicating junctions through which neighboring epithelial cells exchange signaling molecules.

- b) Both zonula adherens and a desmosome are band-type of adherent intercellular junctions.
- c) Desmosomes are associated with intermediate filaments of epithelial cells known as cytokeratin tonofilaments.
- d) Zonula adherens consists of E-cadherin, a transmembrane protein to which actin filaments attach.

**4. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Simple columnar epithelium is typical for the mucosa of small intestine.
- b) Simple epithelia are generally more mechanically resistant than stratified epithelia.
- c) The proximal tubules of nephrons are lined by a simple squamous epithelium.
- d) Lamina densa and lamina lucida are components of a basal lamina that are commonly observed with a light microscope.

**5. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The basement membrane lies at the border between the epithelial cells and the free surface.
- b) The major type of collagen in lamina basalis is the collagen type IV.
- c) The basement membrane consists of two sublayers, lamina basalis, which is synthesized by epithelial cells and lamina fibroreticularis produced by connective tissue cells.
- d) Lamina fibroreticularis is part of the blood-air barrier in lung alveoli.

**6. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) It is typical for pseudostratified epithelia that only cells with nuclei in the uppermost rows reach the basement membrane.
- b) The trachea is lined by a pseudostratified columnar epithelium with cilia and goblet cells.
- c) Zonula occludens is a lateral tight intercellular junction located closest to the apical pole of the epithelial cell.
- d) Nexus is a communicating junction formed by two connexins.

**7. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The transitional epithelium (urothelium) is an example of a pseudostratified epithelium.
- b) The umbrella cells of the urothelium attach to the basement membrane.
- c) Transitional epithelium means that a different number of epithelial layers can be observed depending on the functional state of an organ (for example filling of the bladder).
- d) Pseudostratified epithelia are characterized by all epithelial cells reaching the free surface.

**8. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Pseudostratified epithelia are formed by a single layer of cells with nuclei located at one level.
- b) The lateral domain of epithelial cells contains hemidesmosomes.

- c) Pseudostratified columnar epithelium lines for example the esophagus.
- d) Cytokeratin tonofilaments are anchored into desmosomal plaques formed by desmoglein and desmoplakin.

**9. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) E-cadherin is an integral part of the communicating intercellular junctions (nexuses).
- b) Claudin and occludin are transmembrane proteins of desmosomes.
- c) Hemidesmosomes connect epithelial cells to the basement membrane via integrins.
- d) The trachea is lined by a pseudostratified squamous epithelium.

**10. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The basal labyrinth contains large numbers of mitochondria.
- b) The junctional complex of the lateral domain of epithelial cells is formed by intercellular junctions in the following order from the free surface towards the basement membrane - zonula occludens, zonula adherens, desmosome.
- c) The junctions are part of the apical domain of epithelial cells.
- d) Cytokeratin tonofilaments of epithelial cells are part of the microtubules.

**11. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The epidermis is formed by a stratified squamous keratinized epithelium.

- b) Only the basal layer of a stratified epithelium attaches to the basement membrane.
- c) Stratified squamous keratinized epithelium is also known as epithelium of mucosa.
- d) Stratified epithelia are mechanically more resistant than simple epithelia.

**12. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) A stratified squamous epithelium means that all its cells are flat.
- b) The most common type of a stratified epithelium is the stratified columnar.
- c) Stratified columnar epithelium is the typical epithelium of transitional zones.
- d) Ducts of a larger exocrine gland may be lined with a stratified cuboidal epithelium.

**13. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The esophagus is lined by a mechanically resistant, stratified squamous non-keratinized epithelium.
- b) The shape of stratified epithelia is determined by the shape of their surface epithelial layers.
- c) The epithelium of the epidermis is sometimes called the parakeratinized epithelium.
- d) In stratified epithelia, the mitotically most active cells are closest to the free surface.

**14. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Orthokeratinization is the so-called "true" keratinization that is observed within the epithelium forming the epidermis.
- b) The boundary of stratified epithelia with a connective tissue is usually undulated to facilitate the nourishment of epithelial cells.
- c) All cells of stratified epithelia attach to the basement membrane.
- d) Stratified columnar epithelium of the epidermis undergoes keratinization.

**15. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The most common type of stratified epithelium in the human body is the stratified squamous epithelium.
- b) Stratified squamous epithelium lines the bladder.
- c) Keratinization is typical for the lining epithelium of the digestive tract.
- d) Stratified non-keratinized epithelium is characterized by the presence of living cells with typical organelles, including nuclei, even in the most superficial layers.

**16. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Lining epithelia are usually avascular, except for stria vascularis of the inner ear.
- b) Epithelial tissue is characterized by a well-developed extracellular matrix.
- c) Epithelial cells have multiple domains with different structure and function; hence they are polarized.



- d) Covering and lining epithelia are found throughout the organism at the interface with the external environment.

**17. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Stereocilia are motile projections.
- b) The inner skeleton of cilia consisting of 9 peripheral pairs and 1 central pair of microtubules is referred to as the axoneme.
- c) Both microvilli and stereocilia have an internal skeleton composed of actin microfilaments.
- d) The common feature of microvilli, stereocilia, and cilia is that they all belong to the apical specializations of epithelial cells.

**18. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) The axoneme has the same internal structure as the basal body.
- b) Large number of microvilli are found on the surface of epithelial cells with high absorptive activity, for example enterocytes.
- c) Brush border is a term for a set of stereocilia on the surface of epithelial cells of the small intestine.
- d) Kartagener syndrome affects organs in which epithelial cells have stereocilia on their surface.

**19. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Stereocilia are found, for example, on the surface of epithelial cells of the epididymis, but also as part of the hair cells of the inner ear.
- b) All covering and lining epithelia are derivatives of a single germ layer, the ectoderm.
- c) Differentiation of epithelial cells into cells of a connective tissue is referred to as epithelial-mesenchymal transition (transformation).
- d) Change from one type of epithelium to another is referred to as metaplasia.

**20. Decide whether the following statements about the covering and lining epithelia are true T or false F:**

- a) Motility of cilia is mediated by motor protein dynein bound to microtubules.
- b) Cilia have an internal skeleton composed of 9 peripheral and 1 central pair of actin microfilaments.
- c) Epithelia are avascular and therefore have a low capacity for regeneration.
- d) The basement membrane is crucial for epithelial regeneration.

**21. Which intermediate filaments are the most characteristic of epithelial cells?**

- a) vimentin intermediate filaments
- b) keratin intermediate filaments
- c) desmin intermediate filaments
- d) glial fibrillary acidic protein

**22. What are typical characteristics of epithelial cells?**

- a) their polar orientation
- b) are bound to adjacent cells by cell junctions
- c) low rate of renewal
- d) they can be terminally differentiated postmitotic cells (e.g. keratinocytes in stratum corneum of the epidermis)
- e) some specialized cells may be contractile
- f) they are closely aggregated cells that cover most body surfaces, cavities, and tubes

**23. What are the apical specializations of epithelial cells?**

- a) tight junctions
- b) microvilli
- c) basal labyrinth
- d) stereocilia
- e) kinocilia

**24. What intercellular junction is said to contain cadherins as transmembrane proteins and their intracellular segment binds to intermediate filaments instead of actin?**

- a) adhering junction, or zonula adherens
- b) tight junction, or zonula occludens
- c) desmosome, or macula adherens
- d) gap junction, or nexus
- e) hemidesmosomes

**25. What type of lining epithelium is typical of the small intestine?**

- a) simple squamous non keratinized
- b) simple cuboidal with stereocilia
- c) simple columnar with microvilli
- d) simple columnar with interspersed goblet cells
- e) simple columnar with stereocilia
- f) stratified columnar

**26. What type of lining epithelium is typical of the conducting portion of the airways?**

- a) simple columnar with interspersed goblet cells
- b) simple columnar with stereocilia
- c) stratified columnar
- d) pseudostratified columnar with goblet cells
- e) pseudostratified columnar with kinocilia
- f) stratified columnar with kinocilia

**27. What type of lining epithelium is found on the absorptive surfaces of the digestive tube?**

- a) simple squamous
- b) simple columnar
- c) pseudostratified
- d) transitional

**28. Replace the incorrect word with the correct one in the following sentence: Actin microfilaments are vital for the maintenance of epithelial cell shape and polarity.**

- a) are vital → are lethal
- b) Actin microfilaments → Keratins
- c) shape → adhesion
- d) Actin → Myosin

**29. What are the characteristics of the basement membrane?**

- a) appears as a PAS-positive layer under a light microscope
- b) its basal lamina (product of epithelial cells) is detectable with impregnation with  $\text{AgNO}_3$
- c) its lamina fibroreticularis contains reticular fibers
- d) collagen type VIII is creating anchoring loops in its lamina fibroreticularis
- e) laminin is a major glycoprotein component of the basal lamina

**30. Which of the word pairs are correct?**

- a) integrins – nexus
- b) dynein – stereocilia
- c) cadherins – desmosomes
- d) mitochondria - basal labyrinth
- e) actin – microvillus

**31. How would you define transitional epithelium?**

- a) a stratified epithelium with flat cells covered by keratin

- b) a simple epithelium with tall cells possessing cilia
- c) an epithelium with cells that change shape in response to internal pressure
- d) a specific type of pseudostratified epithelium

**32. Which intercellular junctions of epithelial cells provide the "non-leakiness" of the epithelial layer?**

- a) zonulae occludentes
- b) zonulae adherentes
- c) basal labyrinth
- d) hemidesmosomes

**33. What is a typical intercellular junction that maintains cell polarity, prevents paracellular penetration of substances?**

- a) zonula adherens
- b) zonula occludens
- c) nexus
- d) desmosome

**34. Which of the following statements are typical of epithelial tissue?**

- a) lies on the basal lamina
- b) usually has good innervation
- c) is highly vascularized
- d) is not visible in the light microscope

**35. Where is simple cuboidal epithelium seen?**

- a) in the thyroid follicles
- b) in the ducts of some glands
- c) in the distal tubule of the nephron
- d) in the jejunum

**36. What is true about the goblet cell?**

- a) is characterized by the presence of large, light-colored granules
- b) has a narrowed base
- c) is present in the epithelium found in the small intestine
- d) play a significant role in the synthesis and secretion of digestive enzymes in stomach
- e) are capable of differentiating into various cell types, including neurons and muscle cells

**37. How does the lining epithelium in the respiratory tract contribute to lung function?**

- a) regulating body temperature
- b) producing mucus to trap foreign particles and pathogens
- c) providing structural support to the respiratory system
- d) providing cilia for ciliary transport of substances

**38. Pseudostratified epithelium lines the lumen of which structures/organs?**

- a) duct of epididymis

- b) duodenum
- c) urinary bladder
- d) trachea
- e) paranasal sinuses
- f) loop of Henle
- g) uterine tubes

**39. Simple squamous epithelium lines the lumen of which structures/organs?**

- a) lymphatic vessels
- b) vagina
- c) loop of Henle
- d) blood capillaries
- e) esophagus

**40. Which of the following criteria is used to classify lining epithelia?**

- a) shape of the cells in the basal layer
- b) number of layers of epithelial cells
- c) size of cell nuclei
- d) presence of cytokeratins
- e) presence of lamina basalis



## Chapter Three answers:

- |        |         |           |          |
|--------|---------|-----------|----------|
| 1) bd  | 11) abd | 21) b     | 31) cd   |
| 2) d   | 12) cd  | 22) abdef | 32) a    |
| 3) acd | 13) ab  | 23) bde   | 33) b    |
| 4) a   | 14) ab  | 24) c     | 34) ab   |
| 5) bc  | 15) ad  | 25) cd    | 35) abc  |
| 6) bc  | 16) acd | 26) de    | 36) abc  |
| 7) abc | 17) bcd | 27) b     | 37) bd   |
| 8) d   | 18) b   | 28) b     | 38) acde |
| 9) c   | 19) acd | 29) ace   | 39) acd  |
| 10) ab | 20) ad  | 30) cde   | 40) b    |

## Chapter Four: Glandular epithelia

**1. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Goblet cell is intraepithelial unicellular gland.
- b) Large salivary glands are multicellular endocrine glands.
- c) Secretory products of multicellular exocrine glands are called hormones.
- d) Extraepithelial exocrine glands are always in contact with the surface through one or more ducts.

**2. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Parotid gland is a purely compound serous exocrine gland.
- b) Serous cell has typical features of a proteosynthetically active cell - an euchromatic nucleus, a dark prominent nucleolus, and a basophilic cytoplasm.
- c) Example of a simple tubular gland is a crypt of Lieberkühn in the colon.
- d) Sublingual gland is a compound tubulo-acinar gland with a predominance of mucous tubules.

**3. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Striated ducts are a type of intercalated ducts.
- b) Mucus in goblet cells is easily seen when stained with hematoxylin and eosin.
- c) Serous acini usually have a lumen which is well visible on histologic slide.
- d) Mucous cells display PAS positivity.

**4. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Each exocrine gland with branched secretory units is also a compound gland with a branched duct system.
- b) All types of ducts of exocrine gland are lined by a simple cuboidal epithelium.
- c) Alveoli are secretory units characterized by a broad well-visible lumen.
- d) Each compound exocrine gland with a branched duct system also has a branched system of secretory units.

**5. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Interlobar ducts of major salivary glands are lined by stratified cuboidal to columnar epithelium.
- b) Intercalated ducts open at the body surface or into the lumen of a hollow organ.
- c) Exocrine glands secrete their product directly into the blood.
- d) Myoepithelial cells around secretory units of a mammary gland help to discharge the secretory product.

**6. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) The apocrine mechanism of secretion is observed in the lactating mammary gland.
- b) The typical feature of holocrine secretion is that a secretory product is released by exocytosis.
- c) In the apocrine mechanism of secretion, the cell loses the apical part of the cytoplasm.

d) An example of a holocrine secreting gland is a parotid gland.

**7. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Holocrine secretion is characterized by apoptosis of secretory cells.
- b) Pancreatic enzymes are secreted from serous cells by a merocrine mechanism.
- c) In eccrine secretion, there is no change in cell shape.
- d) Substances of a lipid nature, for example milk fat, are secreted by apocrine mechanism.

**8. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Eccrine secretion is typical for sweat glands.
- b) If a cell disappears and becomes part of the secretion, it is a holocrine type of secretion.
- c) In apocrine secretion, different cell heights are observed depending on the phase of secretion.
- d) A mammary gland secretes all the components of breast milk by the apocrine mechanism.

**9. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Hormones are secreted from endocrine glands via apocrine, merocrine, and holocrine mechanism.
- b) Dominant type of secretion in the major salivary glands is merocrine secretion.

- c) Autocrine secretion means that a cell produces substances for its own use.
- d) Paracrine secretion is when the secreted substance only affects the surrounding environment.

**10. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Goblet cells secrete mucus by exocytosis, which is apocrine mode.
- b) When a single cell secretes both hormones and exocrine products, this is called homotypic amphicrine secretion, as in hepatocytes.
- c) Pancreas is a heterotypic amphicrine gland because it contains separate exocrine and endocrine components.
- d) Insulin as well as pancreatic enzymes are secreted by holocrine mechanism.

**11. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Endocrine glands secrete hormones into the duct system.
- b) Pancreas is a purely endocrine gland.
- c) Follicles are epithelial structures typical for a thyroid gland.
- d) Endocrine glands secrete hormones into the interstitium and from there directly into the blood.

**12. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Epithelial cells of zona fasciculata of the adrenal gland cortex have a foamy appearance due to their high cholesterol content.
- b) Cords of epithelial cells of the adrenal gland cortex are surrounded by a rich network of blood capillaries.

- c) Zona glomerulosa is arranged in cords while zona fasciculata is formed by follicles.
- d) Thyroid gland is one of the exocrine glands because hormones are stored in the follicle cavity before secretion.

**13. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) DES (diffuse endocrine system) cells form macroscopically recognizable endocrine glands.
- b) Endocrine and exocrine glands differ morphologically only in the arrangement of their secretory units.
- c) Endocrine and exocrine glandular epithelia always share a common embryonic origin.
- d) Thyroid follicles are surrounded by a network of capillaries with a fenestrated endothelial lining.

**14. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) The adrenal cortex is characterized by the presence of striated ducts.
- b) Exocrine epithelia retain their connection with the covering or lining epithelium, whereas endocrine epithelia have secondarily lost this connection.
- c) Unlike exocrine epithelia, endocrine epithelia do not attach to the basement membrane.
- d) All zones of the adrenal cortex have cells arranged in morphologically identical cords.

**15. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) In addition to glandular epithelia, endocrine secretion is also observed in other types of tissue, such as the heart or thymus.
- b) The adrenal cortex is divided by septa into lobules, within which the interlobular ducts run.
- c) The adrenal cortex is an example of the follicular arrangement of endocrine epithelia.
- d) A colloid is a specific form of glucocorticoid storage in the follicles of zona fasciculata of the adrenal cortex.

**16. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Autocrine secretion requires a system of ducts.
- b) Epithelial cells of ducts have the same morphology as serous cells of secretory compartments.
- c) A mucous cell has a large round euchromatic nucleus.
- d) Serous cells have a cuboidal or pyramidal shape.

**17. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) The goblet cell is an example of a serous cell.
- b) All multicellular glands are connected to the external environment by a duct.
- c) The goblet cell is found only as part of simple tubular glands.
- d) Eccrine sweat glands are simple coiled glands.

**18. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Sebaceous glands have a tree-like branching system of ducts.
- b) A combination of merocrine and apocrine secretion is observed in sebaceous glands.
- c) Serous lunules are artefacts of histological processing of specimens.
- d) The difference between tubulo-acinar and purely acinar glands is mainly the morphology of their duct system.

**19. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Intercalated ducts are lined by two layers of cuboidal epithelium.
- b) Serous cells do not display cell polarity, unlike lining epithelial cells.
- c) The secretory compartments of the parotid gland and the exocrine portion of the pancreas have an identical morphology.
- d) Serous cells are characterized by secretion of substances of a fatty nature.

**20. Decide whether the following statements about the glandular epithelia are true**

**T or false F:**

- a) Mucus in goblet cells is PAS negative.
- b) Aromatic glands use exclusively eccrine mechanism of secretion.
- c) Serous acini secrete their products directly into the blood.
- d) Parenchyma cells of endocrine glands are surrounded by a rich network of fenestrated capillaries or sinusoids.



**21. Which exocrine gland has the form of simple tubular gland?**

- a) the one that is located in the mucosa of the ileum
- b) submandibular gland
- c) sebaceous gland
- d) lactating mammary gland
- e) eccrine sweat gland in skin

**22. Apart from the smooth endoplasmic reticulum, what typical organelles will also contain adult Leydig cells?**

- a) numerous free ribosomes
- b) mitochondria of tubular type
- c) extensively developed Golgi apparatus
- d) non-motile primary cilium
- e) well-staining basophilic cytoplasm

**23. Which is true of holocrine secretion?**

- a) occurs in endocrine glands
- b) the apical part of the cytoplasm is being shredded during secretion
- c) involves secretion of chlorine ions
- d) occurs in sebaceous glands

**24. Which cell type is best characterized as having abundant rough ER?**

- a) mucus-secreting cells
- b) peptide-secreting cells

- c) protein-secreting cells
- d) steroid-secreting cells
- e) ion-transporting cells

**25. What is typical for cells with mitochondria of tubular type?**

- a) are protein-secreting cells
- b) are located in the adrenal cortex
- c) are located in the testicular interstitium
- d) these mitochondria are located between infoldings of the basal plasma membrane
- e) are steroid-secreting cells

**26. What is typical of the glandular epithelium?**

- a) polar orientation of the (exocrine) cells
- b) presence of lamina basalis
- c) low rate of renewal
- d) high cellularity
- e) derived from former lining/covering epithelium

**27. What is typical of the mucous cell?**

- a) forms a dense secretion with hydrophilic glycoprotein
- b) merocrine secretion
- c) its typical example is a myoepithelial cell
- d) the basal compartment shows considerable basophilia due to local accumulation of polyribosomes

- e) its typical example is a goblet cell
- f) its apical pole is PAS-positive

**28. In the following statement, correct the word to make this statement correct:  
Endocrine cells frequently form plates or cords, interspersed with abundant,  
large-bore, continuous capillaries.**

- a) large-bore → narrow
- b) endocrine → exocrine
- c) frequently → infrequently
- d) continuous → fenestrated

**29. Which of the word pairs are correct?**

- a) tubulus - mucous cells
- b) parotid gland - serous cells
- c) sebaceous gland - holocrine secretion
- d) rough ER - serous cell

**30. What is true about myoepithelial cells?**

- a) they are contractile epithelial cells that facilitate the expulsion of secretions from exocrine glands
- b) they lie just below the epithelial basal lamina
- c) they are present in the secretory portion and ducts of the mammary gland
- d) structurally resemble epithelial cells and cardiomyocytes
- e) these are undifferentiated cells that are the precursors of future muscle fibers

**31. What is part of the intralobular duct system?**

- a) intercalated ducts
- b) main duct (e.g., Wharton's duct of submandibular gland)
- c) striated duct
- d) ducts that are not involved in any further modification of the product

**32. Where is the glandular epithelium located in the cords?**

- a) in the thyroid gland
- b) in the adenohypophysis
- c) in the neurohypophysis
- d) in adrenal gland cortex
- e) in the large intestine, where forms the tubular glands

**33. What is true about the DES (diffuse endocrine system)?**

- a) its cells are able to uptake monoamine precursors
- b) are found in clusters as glands in lamina propria of several organs
- c) its cells produce biogenic amines (e.g. somatostatin)
- d) its cells are distributed as unicellular glands within the epithelia of the respiratory and GIT systems
- e) its cells are regularly distributed in the nuclei of the hypothalamus

**34. Which of the following statements about the glandular epithelium are true?**

- a) secretory portions of apocrine sweat glands are wrapped in myoepithelial cells

- b) during the secretion cycle in glands with holocrine secretion, cells release secretory granules by exocytosis
- c) all three major salivary glands contain serous cells
- d) the cytoplasm of the serous secretory cell is pale pink (eosinophilic) on hematoxylin and eosin staining
- e) the mammary gland is a simple tubular-alveolar gland
- f) alveolus (acinus) is a synonym for the ductal part of the exocrine glandular epithelium

**35. What do exocrine and endocrine glands have in common?**

- a) both developed from superficial covering/lining epithelium
- b) both have their version of a duct system
- c) both are producing hormones
- d) their cells lie on lamina basalis

**36. Which of the following statements about the serous cell is true?**

- a) has the same shape as a mucous cell
- b) here is an accumulation of rough ER around the nucleus
- c) contains a large number of zymogen granules
- d) has a round nucleus

**37. What is typical of glandular epithelium?**

- a) is made up of cells specialized in the production of liquid secretions
- b) is located in the pancreas

- c) the substances produced are stored in the cells in the form of membrane-bound vesicles - secretory granules
- d) is located in the sweat gland
- e) always has direct contact with the body surface or body cavity

**38. The following applies to apocrine secretion:**

- a) the secretory product accumulates within the maturing cell, which simultaneously undergoes programmed cell death
- b) it is the most common mechanism of secretion and is found, for example, in pancreatic acinar cells
- c) secretory product is released along with a small amount of apical cytoplasm
- d) can be found in the lactating mammary gland or in the ceruminous glands of the external auditory canal

**39. Identify the correct pair!**

- a) sebaceous gland - merocrine secretion
- b) fatty component of lactating mammary gland product - apocrine secretion
- c) sweat gland - holocrine secretion
- d) tubulo-alveolar gland - lactating mammary gland

**40. What cell populations are not part of the microscopic image of the parotid gland?**

- a) serous cells
- b) adipocytes
- c) myoepithelial cells
- d) epithelial cuboidal cell of striated duct

e)  $\beta$ -cells

## Chapter Four answers:

- |         |        |          |          |
|---------|--------|----------|----------|
| 1) ad   | 11) cd | 21) ae   | 31) ac   |
| 2) abcd | 12) ab | 22) b    | 32) bd   |
| 3) d    | 13) d  | 23) d    | 33) acd  |
| 4) cd   | 14) b  | 24) bc   | 34) ac   |
| 5) ad   | 15) a  | 25) bce  | 35) ad   |
| 6) ac   | 16) d  | 26) abde | 36) bcd  |
| 7) abcd | 17) d  | 27) abef | 37) abcd |
| 8) abc  | 18) c  | 28) d    | 38) cd   |
| 9) bcd  | 19) c  | 29) abcd | 39) bd   |
| 10) bc  | 20) d  | 30) ac   | 40) e    |



## Chapter Five: Connective tissue proper

- 1. Decide whether the following statements about the connective tissue proper are true T or false F:**
  - a) Fibroblasts have a basophilic cytoplasm.
  - b) The nucleus resembling a clock face is found in mast cells.
  - c) Plasma cells display metachromasia.
  - d) A fibrocyte is a quiescent form of a spindle-shaped basic connective tissue cell that differentiates from a fibroblast.
  
- 2. Decide whether the following statements about the connective tissue proper are true T or false F:**
  - a) An adipocyte with one large lipid vacuole is typical for brown adipose tissue.
  - b) A reticular cell is a variant of a fibroblast and produces type III collagen.
  - c) A typical feature of unilocular adipocytes is the absence of thermogenesis.
  - d) Wandering cells of a connective tissue proper are usually derived from a hematopoietic stem cell.
  
- 3. Decide whether the following statements about the connective tissue proper are true T or false F:**
  - a) Effector cell of T lymphocytes is a plasma cell.
  - b) Metachromatic granules of mast cells contain histamine and heparin.
  - c) A fibroblast is a star-like cell that produces all components of the extracellular matrix of a loose connective tissue.

- d) A fibroblast has typical features of a proteosynthetically active cell - a large euchromatic nucleus, prominent nucleolus/nucleoli, and a basophilic cytoplasm.

**4. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Fixed connective tissue cells usually differentiate directly from the mesenchyme and remain in place in connective tissue throughout life.
- b) Wandering connective tissue cells include adipocytes and myofibroblasts.
- c) In general, wandering connective tissue cells have a predominantly immune function.
- d) Both fixed and wandering connective tissue cells are polarized similarly to epithelial cells.

**5. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Fibroblasts and fibrocytes are morphologically and functionally identical.
- b) A plasma cell has a lower nucleocytoplasmic ratio than its progenitor cell (B lymphocyte).
- c) Macrophages belong to fixed cells of connective tissue proper.
- d) Fixed connective tissue cells are characterized by recirculation between the bloodstream and the interstitium.

**6. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) The most common type of collagen is type I collagen.
- b) Type III collagen is well visible with hematoxylin and eosin staining.
- c) Elastic fibers are composed of the amorphous protein elastin that surround microfibrils of fibrillin (oxytalan fibers).
- d) Reticular fibers are argyrophilic.

**7. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Collagen is the most abundant protein in the human body.
- b) Collagen microfibrils are made up of a triple helix of tropocollagen.
- c) Histology uses special techniques to visualize elastic fibers, such as orcein or resorcin-fuchsin.
- d) Reticular fibers display PAS positivity in addition to argyrophilia.

**8. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Components of a ground substance are well distinguishable by light microscopy.
- b) The amorphous ground substance with a high content of hyaluronic acid is well hydrated.
- c) Laminin is a multi-adhesive glycoprotein that mediates adhesion of epithelial cells to the basal lamina through the binding of integrins to type IV collagen.
- d) Proteoglycans are aggregates composed of a core protein to which sulfated glycosaminoglycans are covalently attached.

**9. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Ground substance and fibers form the extracellular matrix of a connective tissue.
- b) Hyaluronic acid is a nonsulfated glycosaminoglycan that is abundant in well-hydrated connective tissue proper.
- c) Fibronectin is a fibrous component of the extracellular matrix of connective tissue proper.
- d) The primary function of multiadhesive structural glycoproteins is to mediate binding between epithelia and connective tissue proper components.

**10. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Ground substance is PAS positive due to its high carbohydrate content.
- b) The fibrous component of the extracellular matrix of connective tissue proper is produced by fibroblasts, whereas the ground substance is a product of wandering cells.
- c) Dermatan sulfate is a sulfated glycosaminoglycan found, for example, in dermis.
- d) Ground substance is crucial in regulating hydration of connective tissue proper and therefore has a major influence on, for example, immune processes.

**11. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Loose connective tissue is composed mainly of cells and ground substance; fibers are less numerous.
- b) Loose connective tissue is a key site of immune processes in the body.
- c) One of the functions of the highly vascularized loose connective tissue is to nourish the lining epithelia which are almost always avascular.
- d) Loose connective tissue contains only collagen fibers.

**12. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Fascia is a typical example of loose connective tissue.
- b) Collagen fibers predominate over cells and amorphous material in dense connective tissue.
- c) Tendons consist of a dense irregular connective tissue.
- d) Ligaments or aponeuroses are typical examples of a dense regular connective tissue.

**13. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Dense irregular connective tissue is found mainly in places where external forces act in one direction.
- b) Thick parallel bundles of type I collagen fibers with few flat fibrocytes are observed in tendons.
- c) Dense connective tissue contains more cells than fibers.
- d) Stratum reticulare of the dermis is a dense irregular connective tissue.

**14. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Although, histologically, ligaments are a dense regular connective tissue type, they may contain elastic fibers as well, for example in ligamenta flava.
- b) Tendinocytes are a specific type of fibrocytes found in tendons.
- c) Trichrome staining is used to visualize collagen fibers in a connective tissue.
- d) Dense and loose connective tissue differ mainly in composition and amount of ground amorphous substance.

**15. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Dense connective tissue contains mainly type III collagen.
- b) Capsules of parenchymal organs are formed by a dense irregular connective tissue.
- c) The wavy arrangement of bundles of collagen fibers in tendons provides some capacity to stretch.
- d) Thick bundles of type I collagen fibers in tendons, ligaments, and aponeuroses are highly resistant to tension.

**16. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Brown adipose tissue serves mainly as an energy reservoir.
- b) Adipocytes may be isolated within a loose connective tissue, but when they are the dominant cell type, it is called an adipose tissue.
- c) Mucous connective tissue in the umbilical cord contains a high content of hyaluronic acid.

- d) Reticular connective tissue forms the fine supporting stroma in the secondary lymphoid organs.

**17. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Reticular tissue is best visualized by trichrome staining.
- b) Brown adipose tissue is highly vascularized.
- c) Brown adipose tissue is particularly important in neonates for its thermoregulatory function.
- d) For the specific demonstration of white adipose tissue, hematoxylin-eosin staining is most illustrative.

**18. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) All types of connective tissue contain many cells and few fibers.
- b) Elastic tissues make up the majority of tendons and aponeurosis.
- c) In addition to brown and white adipose tissue, there is also beige adipose tissue.
- d) Reticular tissue is formed by reticular cells and argyrophilic reticular fibers.

**19. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) Adipocytes in adipose tissue form their own outer lamina, which is structurally like the basal lamina of epithelia.
- b) White adipose tissue does not contain blood vessels.

- c) Mucous connective tissue is found in the umbilical cord or dental pulp before tooth eruption.
- d) Mucous connective tissue has a minimum amount of amorphous ground substance.

**20. Decide whether the following statements about the connective tissue proper are true T or false F:**

- a) In addition to its storage function, white adipose tissue also has a very important endocrine function.
- b) Conventional techniques dissolve lipids during sample processing, so we use special methods such as orcein staining to visualize adipose connective tissue.
- c) White adipose tissue may change to brown and vice versa.
- d) Reticular fibers form a fine stroma, for example around epithelial cells of the adrenal cortex.

**21. What is typical of loose connective tissue?**

- a) in the form of lamina propria layer is located beneath the avascular epithelium
- b) is rich in blood and lymphatic vessels
- c) forms the internal network in majority of the lymphoid organs (e.g. lymph node)
- d) fibers predominate over amorphous ground substance



**22. What is typical of fibroblast?**

- a) is the spindle-shaped cell with more processes and ovoid / fusiform nucleus
- b) contains granules with heparin and histamine
- c) as a chief cell of connective tissue proper, produces antibodies
- d) as a chief cell of connective tissue proper, produces all components of the extracellular matrix
- e) has a large pale ovoid / fusiform nucleus and a prominent nucleolus
- f) is a fixed cell in the connective tissue proper with pale-stained nucleus, prominent nucleolus and basophilic cytoplasm
- g) is typical of the content of mitochondria of tubular type
- h) belongs to group of free (wandering) cells of connective tissue proper

**23. What is the type of tissue that you would find in a tendon?**

- a) reticular tissue
- b) (white) adipose tissue
- c) loose connective tissue
- d) dense connective tissue irregular
- e) dense connective tissue regular

**24. Which tissue is selectively stained with orcein?**

- a) loose connective tissue with mast cells
- b) elastic connective tissue
- c) reticular connective tissue
- d) adipose tissue
- e) mucous connective tissue

**25. What is typical of elastic fibers?**

- a) are produced by both fibroblasts and smooth muscle cells in blood vessels
- b) form elastic lamellae (membranes) in the aortic wall
- c) can be visualized by aniline blue and exhibit wavy course
- d) are argyrophilic
- e) include proteins elastin, elauinin and oxytalan deposited onto fibrillin microfibrillar scaffolds

**26. The nucleus of which of the cell resembles a clock face or a braided wheel?**

- a) fibroblast
- b) plasma cell
- c) mast cell
- d) multilocular adipocyte

**27. What are the differences between white and brown adipose tissue?**

- a) the size of the cells that make them up
- b) heat production capability
- c) brown one is specialized in storage of excess energy
- d) different number of mitochondria in the cells of one of them

**28. What is the difference between a dense connective tissue and a mucous tissue?**

- a) dense connective tissue is more abundant in the adult body
- b) mucous tissue contains more amorphous ground substance with a predominance of hyaluronate

- c) mucous tissue cannot be stained with trichrome stain
- d) dense connective tissue contains less collagen fibers

**29. What is true about the brown adipose tissue?**

- a) contains multilocular adipocytes with high mitochondrial content
- b) can generate heat
- c) is richly vascularized
- d) is formed by cells that have the shape of a sealing ring, while the flat nucleus is pushed to the periphery in the narrow rim of the cytoplasm

**30. Which of the pairs are correct?**

- a) elastic tissue - orcein stain
- b) reticular tissue - trichrome stain
- c) adipose tissue - Sudan stain
- d) dense connective tissue - silver salt impregnation

**31. Which statements about the amorphous ground substance of connective tissue are true?**

- a) its basis is glycosaminoglycans and structural glycoproteins
- b) hyaluronic acid is an unsulfated glycosaminoglycan
- c) fibronectin and laminin are sulphated glycosaminoglycans
- d) due to its hydrophobic properties, it contains only a minimum of water

**32. Which statements about the functions of connective tissue cells are correct?**

- a) mast cell degranulation is associated with allergic reactions
- b) plasma cells have abundant basophilic cytoplasm and their function is phagocytosis
- c) macrophages can fuse together to form huge multinucleated cells
- d) unilocular adipocytes are able to generate heat
- e) dead neutrophils co-create pus

**33. In the following statement, correct the word to make this statement correct:**

**Glycosaminoglycans are not part of the extracellular matrix of loose connective tissue.**

- a) Glycosaminoglycans → Proteoglycans
- b) are not → are
- c) loose → mucous
- d) Glycosaminoglycans (are) → Hyaluronate (is)

**34. Which statements about the collagen molecule are true?**

- a) the collagen protein is composed of a double helix
- b) contains mainly the amino acids glycine and proline
- c) a long-term deficiency of vitamin C results in its impaired synthesis
- d) hydroxylation of its amino acids does not occur under physiological circumstances during synthesis
- e) the fibroblast is the most common cell that creates collagen

**35. Which statements about the hyaluronic acid are true?**

- a) it is strongly hydrophobic (water repellent)
- b) hyaluronidase cleavage of invading bacteria reduces the viscosity of hyaluronic acid and facilitates the penetration of microorganisms into the tissue
- c) is abundant e.g. in vitreous humor, synovial joint fluid or Wharton's jelly
- d) it is only non-sulphated glycosaminoglycan of the amorphous ground substance of connective tissue
- e) it is a polymer of disaccharides

**36. What can connective tissue cells do?**

- a) produce intercellular matrix
- b) store fat
- c) phagocytose
- d) provide immunological response
- e) convey nerve impulses

**37. Which statements about mast cells are true?**

- a) they are derived from blood-borne monocytes
- b) are spindle- to stellate-shaped cells
- c) contain the extensive rough endoplasmic reticulum and Golgi apparatus
- d) are produced in the bone marrow
- e) contain a single large lipid droplet that compresses the nucleus and cytoplasm to the periphery of the cell
- f) their cytoplasm is filled with numerous granules that contain mediators of the inflammatory response

- g) are related, but not identical, to basophils

**38. Which statements about reticular tissue are true?**

- a) forms the connective tissue capsule (capsula fibrosa) of the spleen, kidney and liver
- b) forms the hematopoietic bone marrow stroma
- c) is characterized by the absence of phagocytic cells
- d) its reticular cells produce and envelop the reticular fibers with their processes
- e) its reticular fibers are PAS negative

**39. Which general statements about connective tissue proper are true?**

- a) belongs to the same tissue type as bone
- b) arises ontogenetically from the mesenchyme
- c) in contrast to the epithelium is avascular
- d) is mainly composed of cells with very little extracellular matrix

**40. What are the substances in mast cell granules?**

- a) mucinogen
- b) heparin
- c) histamine
- d) hemoglobin
- e) antibodies
- f) metalloproteinases

## Chapter Five answers:

- |         |         |          |          |
|---------|---------|----------|----------|
| 1) ad   | 11) abc | 21) ab   | 31) ab   |
| 2) bd   | 12) bd  | 22) adef | 32) ace  |
| 3) bcd  | 13) bd  | 23) e    | 33) b    |
| 4) ac   | 14) abc | 24) b    | 34) bce  |
| 5) b    | 15) bcd | 25) abe  | 35) bcde |
| 6) acd  | 16) bcd | 26) b    | 36) abcd |
| 7) abcd | 17) bc  | 27) abd  | 37) dfg  |
| 8) bcd  | 18) cd  | 28) ab   | 38) bd   |
| 9) abd  | 19) ac  | 29) abc  | 39) ab   |
| 10) acd | 20) acd | 30) ac   | 40) bc   |

## Chapter Six: Cartilage

**1. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) The most common type of cartilage in the human body is hyaline cartilage.
- b) The tissue of cartilage is richly vascularized.
- c) The presence of type II collagen is typical for extracellular matrix of cartilage.
- d) Type II collagen fibrils of the cartilage extracellular matrix form distinct bundles that are easily seen by conventional staining.

**2. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) Perichondrium is the connective tissue layer providing nutrition to the cartilage.
- b) Hyaline cartilage including articular cartilage is covered by the perichondrium.
- c) Elastic cartilage contains only elastic fibers in the extracellular matrix.
- d) Type I collagen is the predominant collagen type in fibrocartilage.

**3. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) Formation of isogenous groups is most typical for fibrocartilage.
- b) Territorial matrix is basophilic due to the high content of acidic sulfated glycosaminoglycans.



- c) Chondrogenic layer of the perichondrium allows appositional growth of cartilage.
- d) The auricle and epiglottis are supported by elastic cartilage.

**4. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) Articular cartilage is nourished by synovial fluid.
- b) Fibrocartilage contains distinct bundles of type I collagen fibers.
- c) Chondrocytes of fibrocartilage are arranged either individually or in rows.
- d) Fibrocartilage is surrounded by a well distinct perichondrium.

**5. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) Elastic cartilage has more cells and less isogenous groups than hyaline cartilage.
- b) Hyaline cartilage provides a model for future bones that will ossify in a chondrogenic/endochondral manner.
- c) Isogenous groups are always formed by a single pair of chondrocytes.
- d) Chondroblasts that differentiate within the perichondrium are responsible for interstitial cartilage growth.

**6. Decide whether the following statements about the cartilage are true T or false**

**F:**

- a) Interterritorial matrix of a cartilage is more basophilic than territorial.
- b) Cartilage has an excellent regenerative capacity due to its rich vascularity.

- c) Fibrocartilage is a structure at the interface between cartilage and dense connective tissue.
- d) Collagen fibrils of articular cartilage are arranged in arches in superficial layers.

**7. Decide whether the following statements about the cartilage are true T or false F:**

- a) Type II collagen fibrils are masked in the extracellular matrix because their size is below the level of resolution of a light microscope.
- b) Cartilage is resistant to compression because of high water content.
- c) Chondrocytes of cartilage are embedded in lacunae.
- d) Cartilage and perichondrium are morphologically identical, the only difference is the level of vascularization.

**8. What molecules make up the organic portion of the extracellular amorphous matrix of cartilage?**

- a) aggrecan
- b) heparin
- c) chondroitin sulphate
- d) hydroxyapatite

**9. What is typical of hyaline cartilage?**

- a) periosteum
- b) basophilic territorial matrix
- c) absence of isogenous groups

d) collagen type III

**10. Which of the following statements about the elastic cartilage are true?**

- a) has no perichondrium
- b) forms the skeleton of the epiglottis
- c) chondrocytes are arranged in larger isogenous groups
- d) does not calcify with age
- e) forms part of the intervertebral disc
- f) can be selectively stained with orcein

**11. Which general statements about cartilage are true?**

- a) is avascular
- b) interior cells receive nutrients by diffusion
- c) have abundant, flexible, semi-rigid extracellular matrix
- d) of all the types, elastic cartilage is the most common
- e) has a very high turnover of its extracellular matrix
- f) is formed from condensed mesenchyme during prenatal development

**12. Where in the body is fibrocartilage found?**

- a) discus interpubicus
- b) nucleus pulposus disci intervertebralis
- c) meniscus
- d) cartilago cricoidea
- e) symphysis manubriosternalis

**13. What is the role of the perichondrium?**

- a) produces synovial fluid on the surface of articular cartilage
- b) is a source of cells for appositional growth of cartilage
- c) prevents excessive stretching of cartilage
- d) by its avascular nature isolates the cartilage from harmful substances
- e) surrounds the capsular matrix around the lacunae

**14. Which statements about hyaline cartilage are true?**

- a) is flexible due to the binding of water to negatively charged glycosaminoglycan chains
- b) chondronectin conditions the attachment of chondrocytes to the collagen of the intercellular matrix
- c) the capsular zone around chondrocytes is more basophilic than the surrounding matrix
- d) in this type of cartilage, chondrocytes do not form isogenous groups
- e) is covered by perichondrium except for joints
- f) its chondrocytes are arranged in strings between parallel bundles of collagen fibers

**15. Which features are typical of chondrocytes?**

- a) are spherical in shape, often flattened at the points of contact
- b) often contain glycogen granules
- c) inhabit cavities called lacunae
- d) are found in the inner layer of the perichondrium
- e) as terminally differentiated cells are not subject to mitosis

**16. In the following statement, correct the word to make this statement correct: If the cartilage cells grow from the chondrocytes within the cartilage, it is called appositional growth.**

- a) chondrocytes → chondroblasts
- b) cells → glycosaminoglycans
- c) appositional → interstitial
- d) appositional → tumorous

**17. The intense basophilia of the capsular matrix in hyaline cartilage is caused mainly by the synthetic activity of which chondrocyte organelle?**

- a) rough ER
- b) smooth ER
- c) Golgi
- d) mitochondria

**18. What cells are found in the synovial membrane?**

- a) fibrocytes
- b) phagocytic synovial cells
- c) chondroblasts
- d) chondrocytes
- e) secretory synovial cell

**19. Which zones of articular cartilage can be identified?**

- a) tangential zone

- b) zone of apposition growth
- c) zone of hypertrophy
- d) calcified zone
- e) perichondral zone
- f) deep (radial) zone

**20. Where in the body is elastic cartilage found?**

- a) auricle
- b) Eustachian tube
- c) nucleus pulposus disci intervertebralis
- d) anulus fibrosus disci intervertebralis
- e) epiglottis

**21. Which of the following statements about the perichondrium are true?**

- a) is made of dense connective tissue
- b) stains more basophilic due to increased glycosaminoglycan content
- c) is a source of blood vessels important for nutrition of the avascular cartilage
- d) is essential for growth and maintenance of the cartilage and comprises precursors for chondroblasts

**22. Which is the earliest of the steps in cartilage formation?**

- a) appositional growth
- b) perichondrium histogenesis
- c) interstitial growth
- d) mesenchymal condensation

**23. In the following statement, correct the word to make this statement correct: The inability of cartilage to respond to injury is due to cartilage avascularity, chondrocyte hypermobility and a low rate of their renewal.**

- a) inability → ability
- b) chondrocyte → chondroblast
- c) hypermobility → immobility
- d) low → high

**24. Which of the following statements about calcification of the cartilage matrix are true?**

- a) once calcified, diffusion is impeded and the chondrocytes are dying
- b) it is one of the basic processes of intramembranous ossification
- c) aging elastic cartilage tends to calcify over time
- d) it is always a pathological process

**25. Which of the following structures are typical of hyaline cartilage?**

- a) isogenous groups
- b) mast cells
- c) capsular matrix
- d) collagen type III
- e) versican

**26. What is the molecular basis for the shock-absorbing capacity of articular cartilage?**

- a) attachment of chondrocytes to collagen type II
- b) cushioning effect of hydrated glycosaminoglycans in the matrix
- c) chondroitinsulphate polycationic property
- d) cross-linking of collagen type I fibers in the perichondrium

**27. Which of the pairs are correct?**

- a) auricle – orcein
- b) hyaline cartilage – aggrecan
- c) symphysis pubis – fibrocartilage
- d) collagen type VI - capsular matrix

**28. What molecules/structures impart resilience to the cartilage?**

- a) aggrecan
- b) collagen molecule type III
- c) collagen molecule type IV
- d) hyaluronan
- e) chondrocytes within the lacunae
- f) anchorin CII
- g) secreted metalloproteinases from chondrocytes

**29. What are the glycosaminoglycans found in significant amount in cartilage?**

- a) hyaluronic acid



- b) dermatan sulphate
- c) heparin
- d) chondroitin 6-sulphate
- e) decorin
- f) keratan sulphate
- g) chondroitin 4-sulphate
- h) heparan sulphate

**30. What are typical features of cartilage?**

- a) avascular character
- b) high rate of renewal
- c) dense connective tissue capsule called perichondrium (with exception of articular cartilage and fibrocartilage)
- d) dominance of extracellular matrix
- e) aggrecan being typical proteoglycan
- f) isogenous groups
- g) uniform composition of extracellular matrix
- h) eosinophilic character of extracellular matrix (due to sulphated ground substance)

**31. What are the layers one can find in articular cartilage?**

- a) tangential zone
- b) germinative zone
- c) intermediate (transitional) zone
- d) fibrous perichondrium
- e) deep (radial) zone
- f) zone of hypertrophy

g) calcified zone

h) tidemark - undulating, heavily calcified line

## Chapter Six answers:

- |        |          |         |           |
|--------|----------|---------|-----------|
| 1) ac  | 9) b     | 17) c   | 25) ac    |
| 2) ad  | 10) bdf  | 18) abe | 26) b     |
| 3) bcd | 11) abcf | 19) adf | 27) abcd  |
| 4) abc | 12) ace  | 20) abe | 28) ad    |
| 5) ab  | 13) bc   | 21) acd | 29) adfg  |
| 6) cd  | 14) abce | 22) d   | 30) acdef |
| 7) abc | 15) abc  | 23) c   | 31) acegh |
| 8) ac  | 16) c    | 24) a   |           |

## Chapter Seven: Bone tissue

**1. Decide whether the following statements about the bone are true T or false F:**

- a) Bone does not contain blood vessels.
- b) Rich vascularization contributes to bone's excellent regenerative capacity.
- c) The periosteum covers the bone and contains osteoprogenitor cells in stratum osteogenicum.
- d) The endosteum is a thin fibrous layer consisting of reticular fibers and osteoprogenitor cells lining the inner cavities and canals of bone.

**2. Decide whether the following statements about the bone are true T or false F:**

- a) Osteoprogenitor cells differentiate into osteoclasts.
- b) Primary bone is divided into spongiosa and compact bone.
- c) The basic morphological unit of a compact bone is the Haversian system (osteon).
- d) Periosteum is richly vascularized and innervated.

**3. Decide whether the following statements about the bone are true T or false F:**

- a) Woven bone is arranged in osteons.
- b) Both spongy bone and compact bone are types of secondary bone arranged in lamellae.
- c) Cortical bone is the term for spongy bone on the surface of the diaphysis.
- d) Volkmann's canals connect adjacent osteons.

**4. Decide whether the following statements about the bone are true T or false F:**

- a) The diploe, a layer of spongy bone between two layers of compact bone, forms flat bones of the cranial vault.
- b) Osteocytes have long processes that run in canaliculi ossium.
- c) Bone remodeling is carried out by bone-forming osteoblasts and bone-resorbing osteoclasts.
- d) Fibrous bone is the first formed during bone formation and fracture healing.

**5. Decide whether the following statements about the bone are true T or false F:**

- a) Type I collagen is a major organic component of bone's extracellular matrix.
- b) Interstitial lamellae of compact bone are remnants of previous generations of osteons after their remodeling.
- c) Sharpey's fibers are perforating collagen fibers of stratum osteogenicum of the periosteum that attach the periosteum to the bone.
- d) Osteoblasts can be distinguished microscopically as cells arranged in an epithelioid pattern on the surface of an osteoid during the bone formation.

**6. Decide whether the following statements about the bone are true T or false F:**

- a) Osteoclasts are the only bone cells that do not originate from osteoprogenitor cells.
- b) Osteoclasts are part of the mononuclear phagocyte system.
- c) Haversian canals contain only blood vessels.
- d) Circumferential lamellae of a compact bone are formed by the process of interstitial growth.

**7. Decide whether the following statements about the bone are true T or false F:**

- a) Ground bone preparation involves the process of demineralization of bone tissue.
- b) Thicker trabeculae of spongy bone may contain complete osteons.
- c) Spongy bone is a primary bone and compact bone is a secondary bone.
- d) The basic morphological unit of a compact bone is the Volkmann system.

**8. Decide whether the following statements about the bone ossification are true T or false F:**

- a) Endochondral ossification relies on the model of connective tissue proper.
- b) A line of erosion is seen in intramembranous ossification.
- c) Most bones in the human body ossify on a hyaline cartilage model.
- d) A multipotent mesenchymal stem cell is the initial cell population for both types of ossification.

**9. Decide whether the following statements about the bone ossification are true T or false F:**

- a) Apoptosis of chondrocytes is observed in the process of desmogenous/intramembranous ossification.
- b) In chondrogenic/endochondral ossification, chondrocytes undergo differentiation into osteocytes.
- c) One of the steps in chondrogenic/endochondral ossification of the diaphysis of future long bones is the formation of the periosteal bony collar, which is formed by the process of desmogenous/intramembranous ossification.
- d) A key process in chondrogenic/endochondral ossification is the synthesis of vascular growth factors (VEGF) by chondrocytes undergoing apoptosis.

**10. Decide whether the following statements about the bone ossification are true T or false F:**

- a) Desmogenous/intramembranous ossification involves proliferation and hypertrophy of chondrocytes.
- b) Bone spicules of an osteoid contain osteocytes that are arranged in an epithelioid pattern on the surface.
- c) The epiphyseal growth plate (cartilage) is essential for bone growth in length.
- d) Ossification takes place in an avascular environment.

**11. Decide whether the following statements about the bone ossification are true T or false F:**

- a) A zone of calcified cartilage is observed in the epiphyseal growth plate.
- b) Bones of the stylopodium, zeugopodium and autopodium ossify in a chondrogenic/endochondral manner.
- c) Chondrocyte proliferation on one side and cartilage degradation on the opposite side ensures that the thickness of the epiphyseal growth plate remains constant throughout bone growth.
- d) Desmogenous/intramembranous ossification creates ossification centers directly in the thickened mesenchyme.

**12. Decide whether the following statements about the bone ossification are true T or false F:**

- a) The entire axial skeleton ossifies from the mesenchyme template.
- b) A necessary part of ossification is the breakdown of bone by osteoclasts.
- c) In desmogenous/intramembranous ossification, secondary bone forms directly from the mesenchyme.

- d) It is essential for normal ossification that the ossification centers are well vascularized.

**13. Decide whether the following statements about the bone ossification are true T or false F:**

- a) Osteoid is present within the zone of hypertrophic cartilage.
- b) In desmogenous/intramembranous ossification, osteocytes arise directly in the thickened mesenchyme.
- c) Bone-forming cells reach the primary ossification centers in the diaphysis of long bones via the bloodstream.
- d) Osteoprogenitor cells differentiate directly within cartilage tissue during chondrogenic/endochondral ossification.

**14. What are the typical characteristics of compact bone?**

- a) there is a rich network of capillaries around its osteons
- b) forms the diaphysis of the long bones
- c) has osteocytes embedded between the lamellae
- d) it is an immature stage of what will later become spongy bone

**15. What are the general roles of bone tissue in the human body?**

- a) storage of iodine
- b) to provide mechanical protection
- c) storage of calcium
- d) to serve as an embryonic skeleton



**16. What are the various hollow spaces that can be found in bone tissue called?**

- a) canaliculi ossium
- b) Volkmann's canals
- c) spicules
- d) osteonal (Haversian) canal
- e) medullary cavity
- f) canals of Hering

**17. What is on the outer surface of bones?**

- a) perichondrium
- b) Sharpey's fibers
- c) metaphysis
- d) periosteum

**18. Which of the following statements about osteoclasts are true?**

- a) make up the bone matrix
- b) are acidophilic
- c) give rise to osteoblasts
- d) are located in lacunae
- e) are bone-resorbing cells

**19. Which of the following statements about osteoclasts are true?**

- a) are phagocytic cells
- b) are multinucleated

- c) possess RANK receptors
- d) estrogens trigger their activity

**20. In the following statement, correct the word to make this statement correct:**

**With the formation of the periosteal bony collar, the chondrocytes in the underlying cartilage become hypotrophic.**

- a) periosteal → perichondral
- b) chondrocytes → chondroblasts
- c) cartilage → woven bone
- d) hypotrophic → hypertrophic

**21. Which cells on the surface of bone tissue are directly involved in bone remodeling?**

- a) periosteal cells
- b) hemopoietic stem cells
- c) osteoprogenitor cells
- d) osteoclasts
- e) osteocytes
- f) osteoblasts

**22. Why alkaline phosphatase (ALP) secreted from osteoblasts is important?**

- a) ALP binds extracellular  $\text{Ca}^{2+}$
- b) ALP is basic enzyme present in Howship's lacuna
- c) ALP is responsible for extracellular polymerization of collagen type I

- d) ALP is important for mineralization by increasing the local concentration of  $\text{PO}_4$  ions

**23. Which of the following statements about osteocytes are true?**

- a) are a circular bone cell with more nuclei
- b) are responsible for the production of bone matrix
- c) arise from osteoblasts and its body is located in the bone lacuna
- d) have many processes located in canaliculi
- e) in the cytoplasm, they have many lysosomes with proteolytic enzymes

**24. Which of the following terms are associated with active osteoclasts?**

- a) ruffled border
- b) Howship lacuna
- c) syntitium
- d) alkaline phosphatase

**25. Os frontale, clavícula and os zygomaticum. What do these bones have in common?**

- a) osteoclast activity in them
- b) their hyaline cartilage precursors form part of the embryonic skeleton
- c) the presence of a perichondral bony collar at the stage of their development
- d) growth plates
- e) origin in desmal osteogenesis

**26. What zones can be differentiated in the epiphyseal growth plate?**

- a) of proliferation
- b) of mineralization
- c) resting zone
- d) of hypertrophy
- e) tangential zone

**27. Which of the following statements applies to chondral osteogenesis (enchondral ossification)?**

- a) is a mode of origin of the clavicle and flattened bones of the skull
- b) epiphyseal plate is responsible for the bone growth in width
- c) occurs in cartilaginous diaphysis of future long bone
- d) during which hypertrophied chondrocytes change to osteoblasts by transdifferentiation

**28. What can be said about the woven bone?**

- a) its collagen fibers are arranged in lamellae
- b) is temporary, in adults it is replaced by secondary bone
- c) has irregularly arranged collagen fibrils
- d) usually is less mineralized than Haversian bone
- e) has no osteocytes

**29. What can be said about the osteoid?**

- a) is non-mineralized bone matrix

- b) is tissue within stratum cambium of the perichondrium
- c) is free of collagen fibrils
- d) is synthesized by osteoblasts

**30. Which description is true of intramembranous ossification?**

- a) is the process of periosteal bone collar formation
- b) forms most of the bony skeleton
- c) involves osteoid formation by osteoclasts
- d) involves zones of proliferation, hypertrophy and calcification

**31. Which of the following statements about the secondary bone are true?**

- a) Haversian system (osteon) is a basic morphological unit of secondary spongy bone
- b) Haversian system (osteon) is a basic morphological unit of secondary compact bone
- c) can be found as compact bone or spongy bone
- d) can be found as compact bone or woven bone

**32. How do the following hormones affect the bone?**

- a) parathormone indirectly stimulates osteoclast activity
- b) thyroxine stimulates bone growth
- c) estrogen activates apoptosis of osteocytes
- d) calcitonin inhibits osteoclast activity
- e) growth factor stimulates osteoprogenitor cell differentiation

**33. Which of the given pairs are correct?**

- a) dense connective tissue – endosteum
- b) osteocytes - gap junctions
- c) Sharpey fibers - collagen type I
- d) cambium layer - osteoprogenitor cells
- e) acid phosphatase – osteoclasts

## Chapter Seven answers:

- |         |          |          |          |
|---------|----------|----------|----------|
| 1) bcd  | 10) c    | 19) abc  | 28) bcd  |
| 2) cd   | 11) abcd | 20) d    | 29) ad   |
| 3) bd   | 12) bd   | 21) df   | 30) a    |
| 4) abcd | 13) c    | 22) d    | 31) bc   |
| 5) abd  | 14) bc   | 23) cd   | 32) abde |
| 6) ab   | 15) bc   | 24) abc  | 33) bcde |
| 7) b    | 16) abde | 25) ae   |          |
| 8) cd   | 17) d    | 26) abcd |          |
| 9) cd   | 18) be   | 27) c    |          |

## Chapter Eight: Blood

**1. Decide whether the following statements about the blood are true T or false F:**

- a) An erythrocyte contains all typical organelles, including a nucleus.
- b) The most common blood cell is an erythrocyte.
- c) The average erythrocyte is about 7,5 micrometers in size.
- d) The typical shape of an erythrocyte is a biconvex disc.

**2. Decide whether the following statements about the blood are true T or false F:**

- a) The average lifespan of an erythrocyte is 120 days.
- b) The center of an erythrocyte is the thinnest part, only about 0,8 micrometers thick.
- c) A normocyte is an erythrocyte with a normal size of about 7,5 micrometers.
- d) Acidic hemoglobin causes eosinophilia of an erythrocyte cytoplasm.

**3. Decide whether the following statements about the blood are true T or false F:**

- a) Erythrocyte is sometimes called a histological ruler.
- b) Spectrin and ankyrin are part of the hemoglobin molecule.
- c) Erythrocytes are shaped like a biconcave disc.
- d) The most abundant type of hemoglobin in adults is type F hemoglobin.

**4. Decide whether the following statements about the blood are true T or false F:**

- a) Thrombocytes contain typical cell organelles, including the nucleus.



- b) A megakaryocyte is a giant bone marrow cell, fragments of which are called platelets.
- c) Thrombocytes are about 12 micrometers in size.
- d) Thrombocytes contain a darker central granulomere and a lighter peripheral hyalomere.

**5. Decide whether the following statements about the blood are true T or false F:**

- a) Platelets are about 2-3 micrometers in size making them the smallest formed blood elements.
- b) The granulomere of platelets contains alpha granules in which coagulation factors are found.
- c) Platelets have a lifespan of about 10 days.
- d) Platelets are found individually or in clumps in a blood smear.

**6. Decide whether the following statements about the blood are true T or false F:**

- a) The most numerous types of leukocytes are neutrophilic granulocytes.
- b) Granulocytes are also known as polymorphonuclear granulocytes.
- c) Arnett classes determine the average number of segments in the nucleus of eosinophilic granulocytes.
- d) Bands or stabs is the term for old neutrophilic granulocytes.

**7. Decide whether the following statements about the blood are true T or false F:**

- a) In the blood smear, an eosinophilic granulocyte contains brick-red specific granules.
- b) Specific granules of basophilic granulocytes show metachromasia.

- c) Basophilic granulocytes normally make up approximately 30% of all white blood cells.
- d) Barr body is an inactivated Y chromosome in males that can be observed on one of the segments of a neutrophilic granulocyte.

**8. Decide whether the following statements about the blood are true T or false F:**

- a) The average neutrophilic granulocyte is about 10-12 micrometers in size.
- b) A neutrophilic granulocyte has no specific granules in the cytoplasm.
- c) Granulocytes are classified as neutrophilic, eosinophilic, and basophilic granulocytes according to the staining ability of azurophilic granules.
- d) 60-70% of leukocytes are neutrophilic granulocytes.

**9. Decide whether the following statements about the blood are true T or false F:**

- a) The older the neutrophil, the more segmented is its nucleus.
- b) Neutrophils are also known as microphages.
- c) Eosinophilic granulocytes have a bilobed nucleus that resembles eyeglasses.
- d) The nucleus of a basophilic granulocyte consists of 4-5 segments.

**10. Decide whether the following statements about the blood are true T or false F:**

- a) The main function of eosinophils is to fight parasites, but they are also involved in allergic reactions.
- b) The dense crystalloid is part of the specific granules of basophilic granulocytes.
- c) Only about 0.5-1% of all circulating leukocytes are basophilic granulocytes.
- d) The smallest leukocytes are neutrophilic granulocytes.

**11. Decide whether the following statements about the blood are true T or false F:**

- a) Agranulocytes do not have granules in the cytoplasm.
- b) The characteristic feature of agranulocytes is an unsegmented nucleus, hence the name mononucleus.
- c) The largest agranulocytes are monocytes.
- d) B and T lymphocytes can be distinguished in a normal blood smear by nuclear morphology.

**12. Decide whether the following statements about the blood are true T or false F:**

- a) Monocytes differentiate into macrophages in tissues.
- b) Monocytes are about 20 micrometers in size.
- c) Up to 90% of all lymphocytes are small lymphocytes, measuring 6-8 micrometers.
- d) Lymphocytes have a nucleocytoplasmic ratio of 1:1.

**13. Decide whether the following statements about the blood are true T or false F:**

- a) The staining method used for blood smears is Pappenheim staining.
- b) Monocytes have a centrally located round nucleus.
- c) Monocytes circulate in the blood for only 1-3 days.
- d) Lymphocytes are the second most abundant type of leukocyte in peripheral blood after neutrophils.

**14. Decide whether the following statements about the blood are true T or false F:**

- a) The nucleus of monocytes is eccentrically located and kidney shaped.

- b) Monocytes are sometimes called naked nuclei.
- c) Both lymphocytes and monocytes have a similar nucleocytoplasmic ratio.
- d) Both lymphocytes and monocytes have a basophilic cytoplasm.

**15. Decide whether the following statements about the blood are true T or false F:**

- a) Monocytes, as part of the mononuclear phagocyte system, differentiate into different populations of cells after entering a tissue.
- b) Monocytes circulate in the blood for about 120 days.
- c) Monocyte is the largest and most numerous type of leukocyte in the peripheral blood.
- d) B lymphocytes and T lymphocytes can be distinguished from each other in a conventionally stained blood smear by the staining ability of their CD markers.

**16. Decide whether the following statements about the blood are true T or false F:**

- a) T lymphocytes develop from the myeloid lineage.
- b) All formed blood elements are derived from one common multipotent hematopoietic stem cell.
- c) A reticulocyte is an immature form of erythrocyte that still contains a nucleus.
- d) A polychromatophilic erythroblast stains only with basic dyes.

**17. Decide whether the following statements about the blood are true T or false F:**

- a) All formed blood elements except lymphocytes are part of the myeloid lineage.

- b) The mesoblastic period of hematopoiesis is characterized by extramedullary hematopoiesis that begins in the wall of the yolk sac.
- c) The myeloid progenitor cell is unipotent.
- d) The orthochromatic erythroblast has an eosinophilic cytoplasm like that of mature erythrocytes.

**18. Decide whether the following statements about the blood are true T or false F:**

- a) Blood plasma without clotting factors is called serum.
- b) Water forms about 90% of blood plasma.
- c) Blood plasma makes up about 45% of blood volume.
- d) Blood plasma contains formed blood elements.

**19. Decide whether the following statements about the blood are true T or false F:**

- a) In adults, hematopoiesis always takes place only in the bone marrow.
- b) All agranulocytes develop from the lymphoid lineage, whereas all granulocytes originate from the myeloid lineage.
- c) A basophilic erythroblast has a nucleus.
- d) A myeloblast differentiates from a promyelocyte.

**20. Decide whether the following statements about the blood are true T or false F:**

- a) Hematopoiesis occurs exclusively in the bone marrow from the beginning of intrauterine development.
- b) Extramedullary hematopoiesis takes place in the yellow bone marrow.
- c) Precursor cells of hematopoiesis are always more differentiated than progenitor cells.

- d) Megakaryoblast, promegakaryocyte, and megakaryocyte are developmental stages of thrombopoiesis.

**21. What is the average size of leukocytes?**

- a) around 15  $\mu\text{m}$
- b) 7,5  $\mu\text{m}$
- c) around 35  $\mu\text{m}$
- d) around 350 nm

**22. Where in the blood do we find the largest percentage of transported carbon dioxide?**

- a) bound to erythrocyte hemoglobin as a carbamino compound
- b) bound to blood plasma albumin
- c) freely dissolved  $\text{CO}_2$  in blood plasma
- d) in plasma in the form of bicarbonate

**23. Which cells are the result of myelopoiesis?**

- a) megakaryocytes
- b) reticulocytes
- c) mast cells
- d) NK cells

**24. Which cells are the result of myelopoiesis?**

- a) eosinophils
- b) macrophages
- c) T-lymphocytes
- d) monocytes
- e) plasma cells

**25. Which of the leukocytes is generally the largest?**

- a) neutrophil
- b) monocyte
- c) basophil
- d) matured B-lymphocyte

**26. What substances do specific granules of basophil contain?**

- a) major basic protein
- b) histamine
- c) heparin
- d) proteolytic enzymes

**27. Which of the following statements about erythrocytes are true?**

- a) their average lifespan is 120 days
- b) are capable of ameboid movement
- c) contain  $\text{Fe}^{2+}$

- d) have a desmin cytoskeleton
- e) do not have a developed glycocalyx
- f) their concentration is approximately 5 million in 1  $\mu\text{m}$  of blood

**28. What do erythrocyte and thrombocyte have in common?**

- a) common myeloid progenitor cell
- b) that they contain no mitochondria
- c) presence of actin molecule
- d) biconcave shape

**29. Which of the given erythrocyte developmental stages is the least mature?**

- a) polychromatophilic normoblast/erythroblast
- b) orthochromatic normoblast/erythroblast
- c) reticulocyte
- d) basophilic normoblast/erythroblast

**30. Which of the following is most abundant in peripheral blood?**

- a) monocyte
- b) platelet
- c) eosinophil
- d) neutrophil



**31. In the following statement, correct the word to make this statement correct: The metamyelocyte is the stage at which neutrophil, eosinophil and basophil lines can be clearly identified by the presence of numerous azurophilic granules.**

- a) metamyelocyte → promyelocyte
- b) basophil → monocyte
- c) azurophilic → specific
- d) granules → inclusions

**32. Which of the following statements about neutrophils are true?**

- a) their granules contain metalloproteinases
- b) can differentiate into macrophages
- c) have a polymorphic nucleus divided into 1-5 segments (lobules)
- d) are the most numerous type of leukocytes in blood

**33. Which of the following statements about neutrophils are true?**

- a) make up 13-40 % of all leukocytes
- b) makes up 55-70 % of leukocytes
- c) are induced by microbial inflammation
- d) become microphages in tissues
- e) their specific granules contain histamine and heparin

**34. What is most likely to indicate an elevated differential lymphocyte count?**

- a) an early sign of arterial bleeding
- b) possible leukemic process in the bone marrow

- c) bone marrow suppression
- d) advanced HIV infection with manifestations of AIDS
- e) the presence of an influenza infection in the body

**35. Which of the following statements about T-lymphocytes are correct?**

- a) participates in acquired (specific) cellular immunity
- b) mature and gain their immunocompetence in the bone marrow
- c) some of them can retain information about the antigen, i.e. the infection, for many years
- d) most measure between 8 and 10  $\mu\text{m}$
- e) against B lymphocytes, they are best distinguished by identification of surface CD markers (cluster of differentiation markers)
- f) are slightly larger than B-lymphocytes
- g) are several times more abundant in the peripheral blood than are B lymphocytes

**36. Which of the following statements about basophils are correct?**

- a) are least numerous of the leukocytes
- b) their euchromatin is chiefly centrally located in nuclei
- c) possess receptors for IgE antibodies
- d) do not contain azurophilic granules

**37. Which of the following statements about eosinophils are correct?**

- a) make up 60-70% of leukocytes
- b) are proliferated in allergy sufferers and patients with parasitic diseases

- c) their nuclei are typically bilobed
- d) contain MBP (major basic protein)
- e) their products multiply the effects of histamine on tissues

**38. The concentration of which hormone is increased in the blood of an athlete who is training at a high altitude?**

- a) thrombopoietin
- b) thymopoietin
- c) erythropoietin
- d) somatostatin

**39. Which of the following statements about the erythrocytes are correct?**

- a) survive for hours to days at most
- b) mitochondria are the only type of organelle present in their cytoplasm
- c) cannot normally pass through an intact vessel wall from the bloodstream into the connective tissue
- d) have a form of biconvex discs
- e) has a disk diameter of approximately 6.2–8.2  $\mu\text{m}$

**40. Which of the pairs are correct?**

- a) hyalomere - platelet
- b) bean-shaped nucleus - monocyte
- c) nucleus - reticulocyte
- d) hematopoietic stem cell - red bone marrow

## Chapter Eight answers:

- |         |         |         |           |
|---------|---------|---------|-----------|
| 1) bc   | 11) bc  | 21) a   | 31) c     |
| 2) abc  | 12) abc | 22) d   | 32) acd   |
| 3) ac   | 13) acd | 23) abc | 33) bcd   |
| 4) bd   | 14) ad  | 24) abd | 34) be    |
| 5) abcd | 15) a   | 25) b   | 35) acdeg |
| 6) ab   | 16) b   | 26) bcd | 36) abc   |
| 7) ab   | 17) abd | 27) acf | 37) bcd   |
| 8) ad   | 18) ab  | 28) ac  | 38) c     |
| 9) abc  | 19) c   | 29) d   | 39) ce    |
| 10) ac  | 20) cd  | 30) b   | 40) abd   |

## Chapter Nine: Muscle tissue

**1. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) The basic morphological unit of skeletal muscle is the striated muscle cell.
- b) The sarcoplasmic reticulum is a smooth endoplasmic reticulum that serves as a reservoir for calcium cations.
- c) Skeletal muscle exhibits transverse striations because of parallel arrangement of myofibrils in sarcomeres.
- d) The sarcolemma is the name given to a triad of structures - the cytoplasmic membrane, the basal lamina, and a fine network of reticular fibers.

**2. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) Muscle fiber is a syncytium with centrally located nuclei.
- b) Individual muscle fibers are surrounded by an epimysium.
- c) Skeletal muscle has cross-striations.
- d) Striated skeletal muscle is also found in the wall of some internal organs, for example the cervical part of the esophagus.

**3. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) High mitochondrial content makes muscle fiber cytoplasm basophilic.
- b) The basis of muscle fiber contraction is the shortening of sarcomeres.
- c) Myofibrils are made up of contractile myofilaments - titin and alpha-actinin.

- d) Triads are formed by single terminal cisterna of the sarcoplasmic reticulum and a T-tubule.

**4. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) T-tubules are invaginations of sarcolemma conducting the action potential to the depth of the muscle fiber thus ensuring synchronized contraction of all myofibrils at the same time.
- b) A muscle fiber is a syncytium that may contain tens to hundreds of nuclei located just below the sarcolemma.
- c) Anchoring of actin myofilaments to the Z-line by alpha-actinin is observed by conventional light microscopy staining.
- d) Actin and myosin myofilaments interact with the troponin-tropomyosin complex during muscle contraction.

**5. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) Slow oxidative muscle fibers have lots of myoglobin, mitochondria, and a rich capillary network.
- b) The basis of the transverse striation of skeletal muscle fibers is the alternation of A- and I-bands, which are clearly visible when stained for example with iron hematoxylin.
- c) The A stripe is made up exclusively of thick myosin myofilaments.
- d) The triad is a combination of a single T-tubule and a pair of terminal cisternae of the sarcoplasmic reticulum.

**6. Decide whether the following statements about the cardiac muscle tissue are true T or false F:**

- a) The cardiac muscle is striated and, like the skeletal muscles, can be controlled by will.
- b) Cardiomyocytes are single- to double-nucleated cells that branch in an X- or Y-shape.
- c) The sarcoplasm of cardiomyocytes contains dyads - combinations of one terminal cisterna of the sarcoplasmic reticulum and one T-tubule.
- d) Cardiomyocytes have most myofibrils in the vicinity of the cell nucleus.

**7. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) Intercalated discs of cardiomyocytes consist entirely of gap junctions.
- b) Cardiac muscle is richly vascularized - it contains capillaries of continuous type.
- c) Cross-striations of cardiomyocytes are best seen in their transverse section.
- d) The endomysium around the cardiomyocytes is formed by dense connective tissue.

**8. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) Cardiomyocytes have a less developed sarcoplasmic reticulum than skeletal muscle.
- b) The intercalated disc contains desmosomes and fasciae adherentes in addition to communicating junctions.
- c) The sarcoplasm of cardiomyocytes is basophilic.

d) The nucleus of cardiomyocytes is located just below the sarcolemma.

**9. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) The cardiac muscle is capable of automatic, lifelong, tireless contraction.
- b) Cardiomyocytes cannot be controlled at will because they have no striations.
- c) Cardiomyocytes form a morphological syncytium.
- d) Gap junctions of intercalated discs ensure synchronized contraction of the cardiac muscle.

**10. Decide whether the following statements about the skeletal muscle tissue are true T or false F:**

- a) Cardiomyocytes require lots of energy and therefore up to 40% of their sarcoplasmic content consists of mitochondria.
- b) The intercalated discs can be observed at the level of light microscopy in longitudinal sections of cardiomyocytes.
- c) A lighter part around the nucleus of a cardiomyocyte which is devoid of myofibrils is called an endoplasm.
- d) Unlike skeletal muscle fibers, the sarcolemma of cardiomyocytes is not invaginated in the form of T-tubules.

**11. Decide whether the following statements about the smooth muscle tissue are true T or false F:**

- a) Smooth muscle cells form both morphological and functional syncytia.



- b) Smooth muscle cells do not show striations because they do not contain actin and myosin myofilaments.
- c) A smooth muscle cell has a single nucleus in the center.
- d) The nucleus of a smooth muscle cell copies its shape - it is round.

**12. Decide whether the following statements about the smooth muscle tissue are true T or false F:**

- a) The smooth muscle cell is found together with the striated muscle cell in the thoracic part of the esophagus.
- b) Smooth muscle cells have a more developed sarcoplasmic reticulum than skeletal muscle.
- c) The T-tubules and L-cisternae of the sarcoplasmic reticulum of smooth muscle cells form triads.
- d) Actin myofilaments of smooth muscle cells are anchored into dense bodies.

**13. Decide whether the following statements about the smooth muscle tissue are true T or false F:**

- a) Sarcolemma of smooth muscle cells does not invaginate in the form of T-tubules.
- b) Smooth muscle cells are normally about 20 to 50 micrometers long.
- c) Smooth muscle cells are surrounded by an endomysium.
- d) Smooth muscle of a blood vessel wall can be controlled by will.

**14. Decide whether the following statements about the smooth muscle tissue are true T or false F:**

- a) Smooth muscle cells transport calcium from the extracellular space via pinocytosis.
- b) Myofibrils of smooth muscle cells are arranged in sarcomeres.
- c) Calcium cations bind to troponin C, as in skeletal muscle.
- d) Smooth muscle cells usually have two nuclei.

**15. Decide whether the following statements about the smooth muscle tissue are true T or false F:**

- a) Calcium cations bind to calmodulin in smooth muscle.
- b) Smooth muscle cells have more mitochondria than cardiomyocytes.
- c) Smooth muscle sarcomeres are about 2,5 micrometers long.
- d) The nucleus of a smooth muscle cell is cigar shaped – it copies the spindle shape of the cell.

**16. Decide whether the following statements about the muscle tissue are true T or false F:**

- a) The muscle spindle is innervated by alpha motoneurons.
- b) A motor unit is a group of muscle fibers innervated by the axon of a single alpha motoneuron.
- c) The neuromuscular synapse of a muscle fiber is called a motor end plate.
- d) Muscle spindles are responsible for proprioception.

**17. Decide whether the following statements about the muscle tissue are true T or false F:**

- a) Energy is only needed for muscle contraction, the release of the actin-myosin complex occurs passively.
- b) Titin is a giant protein ensuring the integrity of the entire sarcomere.
- c) The bundles of muscle fibers are surrounded with endomysium.
- d) The epimysium is made up of a fine layer of reticular fibers.

**18. Decide whether the following statements about the muscle tissue are true T or false F:**

- a) The troponin-tropomyosin complex is bound to myosin myofilaments.
- b) Troponin I exposes the binding site for myosin on the actin filament in the presence of calcium bound to troponin C, which is essential for muscle fiber contraction.
- c) In the muscle fiber, calcium cations are bound to calmodulin.
- d) Fast glycolytic type II B muscle fibers are pale because of low myoglobin content.

**19. Decide whether the following statements about the muscle tissue are true T or false F:**

- a) The major protein of muscle tissue intermediate filaments is myomesin.
- b) Alpha-actinin is essential for binding actin myofilaments to the Z lines of sarcomeres.
- c) Striation of muscle fibers is caused by repeating alternation of H-bands and M-lines.
- d) Muscle cells are the only cell type capable of contraction.

**20. Decide whether the following statements about the muscle tissue are true T or false F:**

- a) In addition to muscle cells and fibers, other cells such as myofibroblasts or pericytes have a system of contractile myofilaments.
- b) Dense bodies are typical components of cardiomyocytes.
- c) Sarcoplasm is the cytoplasm of a muscle cell or muscle fiber.
- d) The perimysium is a connective tissue that surrounds bundles of muscle fibers.

**21. Why is striated muscle striated?**

- a) because of regular parallel arrangement of two kinds of myofilaments
- b) because sarcomeres in adjacent myofibrils are in register
- c) because of regular altering of myosin heavy and light chains
- d) because of absence of calmodulin in striated cells

**22. Which of the following statements about the cardiac muscle cells are true?**

- a) are called cardiomyocytes
- b) are called leiomyocytes
- c) contain one or two centrally located nuclei
- d) are united in form of morphological syncytium
- e) contain a few mitochondria

**23. Which of the following statements about the cardiac muscle cells are true?**

- a) their euchromatic nucleus is peripherally located

- b) cytoplasm is basophilic due to intensive protein-synthetic organelle content
- c) their cytoplasm is eosinophilic due to high amount of mitochondria
- d) display irregular shape of the cell (X, Y or Z-shaped cell) due to cell branches
- e) contain triads (T-tubule and two cisternae of the sarcoplasmic reticulum)

**24. Which of the following statements about the cardiac muscle cells are true?**

- a) are always uninuclear
- b) is characterized by a significant regenerative ability due to presence of stem cells close to each cell
- c) their cross striation is obvious especially in longitudinal section through the cardiac muscle tissue
- d) contain dyads (T-tubule and one small cisterna of the sarcoplasmic reticulum)
- e) their sarcomeres extend from one Z-line to the other

**25. Which of the following statements about the intercalated discs are true?**

- a) are composed of fascia adherens, desmosomes and gap junctions
- b) are composed of transverse and lateral components
- c) co-create dyads
- d) are found only among the cardiomyocytes of the conduction system
- e) gap junctions are found on their lateral component

**26. Which of the following statements about the cells of skeletal muscle tissue are true?**

- a) are called muscle fibers
- b) are multinucleated syncytium

- c) are formed by the fusion of myoblasts
- d) can be several centimeters long
- e) are a typical unit for myometrium in uterus

**27. Which of the following statements about the microscopic anatomy of cells of skeletal muscle tissue are true?**

- a) have one or two centrally located nuclei
- b) deep invaginations of sarcolemma are their typical ultrastructural features
- c) stain basophilic in basic HE stain
- d) their myofilaments form a spatial network (free arrangement)
- e) the nuclei of these cells are located directly under the sarcolemma
- f) are invested in the perimysium
- g) contain well developed smooth endoplasmic reticulum called sarcoplasmic reticulum

**28. Where to look for striated visceral muscle tissue?**

- a) in the tongue
- b) in the uterus
- c) in the pharynx
- d) in the trachea

**29. Which of the following statements about the thin myofilaments are true?**

- a) in smooth muscle cell are anchored to the dense bodies
- b) their F-actin are double-stranded helices
- c) their troponin consist of complex of four globular subunits

d) is composed of four light and two heavy chains

**30. Which of the pairs are correct?**

- a) satellite cells - cardiac muscle
- b) smooth muscle cell - calmodulin
- c) cardiomyocytes - caveolae
- d) sarcoplasmic reticulum - storage of  $\text{Ca}^{2+}$

**31. In the following statement, correct the word to make this statement correct:**

**Attachment is the initial stage of the contraction cycle; the myosin head is tightly bound to troponin molecule of the thin filament.**

- a) initial → final
- b) head → tail
- c) troponin → actin
- d) thin → thick

**32. Which of the following statements about the smooth muscle are true?**

- a) its basic morphological unit is a spindle-shaped cell enclosed in basal lamina and reticular fibers sheath
- b) typically can be found in the tongue
- c) is innervated by autonomous nervous system
- d) forms the arrector muscle of hair
- e) typically can be found in the wall of muscle artery

**33. Which of the following statements about the smooth muscle cells are true?**

- a) are connected by special cell connections called intercalated discs
- b) do not show striations because they do not contain actin and myosin myofilaments
- c) their sarcoplasmic reticulum participates in the formation of triads
- d) are interconnected by gap junctions
- e) their intermediate filaments contain protein desmin

**34. What do cardiac and smooth muscle have in common?**

- a) mitotic potential
- b) afferent innervation
- c) absence of striation
- d) deep and wide T-tubules

**35. Which of the following proteins are creating part of Z-disc (Z-line) in sarcomere?**

- a) myomesin
- b)  $\alpha$ -actinin
- c) troponin complex
- d) filamin-C

**36. Which of the following statements about the I-band are true?**

- a) defines the contractile unit of muscle fiber
- b) is the site of interaction of tropomyosin and troponin M
- c) comprises an overlap between actin and myosin filaments



- d) shortens during muscle contraction
- e) consists entirely of thin filaments

**37. Which of the following statements about the motor end plate are true?**

- a) it is the neuroeffector synapse between Golgi type I motoneuron and skeletal muscle fiber.
- b) the basal lamina of the muscle fiber is absent in the synaptic cleft
- c) the neurotransmitter used here is acetylcholine
- d) there are always several of these synapses on the surface of twitch muscle fiber

**38. Which feature of skeletal muscle is directly proportionate to the strength of contraction?**

- a) size of motor units
- b) thickness of endomysium
- c) fiber diameter
- d) number of T-tubules

**39. Which of the following statements about the sarcomere are true?**

- a) myosin myofilaments are anchored to the M lines
- b) H-band is not visible at maximal contraction
- c) its length changes during contraction
- d) actin filament shows ATPase activity

**40. Which of the following statements about the endomysium of the skeletal muscle are true?**

- a) is argyrophilic
- b) is made of dystrophin and desmin proteins
- c) wraps individual muscle fibers
- d) plays a role in the mechanical transmission of force

## Chapter Nine answers:

- |         |         |          |          |
|---------|---------|----------|----------|
| 1) bcd  | 11) c   | 21) ab   | 31) c    |
| 2) cd   | 12) ad  | 22) ac   | 32) acde |
| 3) b    | 13) abc | 23) cd   | 33) de   |
| 4) abd  | 14) a   | 24) cde  | 34) b    |
| 5) abd  | 15) ad  | 25) abe  | 35) bd   |
| 6) bc   | 16) bcd | 26) abcd | 36) de   |
| 7) b    | 17) ab  | 27) beg  | 37) ac   |
| 8) ab   | 18) bd  | 28) ac   | 38) c    |
| 9) ad   | 19) b   | 29) ab   | 39) abc  |
| 10) abc | 20) acd | 30) bd   | 40) acd  |

## Chapter Ten: Nervous tissue

1. **Decide whether the following statements about the nerve tissue are true T or false F:**

- a) The gray matter represents the accumulation of neuron bodies and glial cells.
- b) Cranial nerves are part of the central nervous system.
- c) Nerve ganglia are an example of neuron bodies located outside the central nervous system.
- d) Spinal and cranial nerves are classified as peripheral nerves.

2. **Decide whether the following statements about the nerve tissue are true T or false F:**

- a) The endoneurium encloses each individual nerve fiber.
- b) Individual peripheral nerves usually contain only one type of nerve fiber.
- c) The endoneurium is synonymous with myelin sheath.
- d) We can represent myelin sheaths by impregnation with  $\text{OsO}_4$ .

3. **Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Neurofibrils are best represented by conventional histological stains.
- b) Myelin sheaths can be stained black using the Holmes method.
- c) The endoneurium is a fine connective tissue with a predominance of reticular fibers.
- d) Peripheral nerves contain the bodies of neurons.

**4. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Most peripheral nerves contain Schwann cells.
- b) Myelinated nerve fibers of a peripheral nerve are surrounded by a sheath of astrocytes.
- c) Unmyelinated nerve fibers allow saltatory conduction of nerve impulse.
- d) A single Schwann cell forms a myelin sheath around a portion of a nerve fiber.

**5. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) A peripheral nerve contains dendrites of pseudounipolar neurons of spinal ganglia.
- b) Most fibers in a peripheral nerve are not myelinated.
- c) The perineurium envelops bundles of nerve fibers in the peripheral nerve.
- d) Peripheral nerves have their own vascular supply and innervation in the form of vasa nervorum and nervi nervorum.

**6. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) The body of a neuron is also called the perikaryon or soma.
- b) Alpha motoneurons of the anterior horns of the spinal cord are classified as pseudo-unipolar neurons.
- c) Neurons have a basophilic cytoplasm in the form of Nissl substance.
- d) Nissl substance is present in the body of a neuron as well as in all processes, including axons.

**7. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) The most common type of neurons are multipolar neurons.
- b) Pseudounipolar neurons share a common dendraxon that branches in a T-shape.
- c) Axon can be identified by basic hematoxylin and eosin staining in the light microscope.
- d) Axons are devoid of Nissl substance.

**8. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) A tigroid can be visualized with Luxol blue.
- b) All neurons of the human body have an axon.
- c) The plasma membrane of a neuron is also called the neurilemma.
- d) Neurofibrils are visualized by Holmes' impregnation.

**9. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Motoneurons are unipolar star-shaped neurons with a round, pale stained nucleus.
- b) An example of neurons that do not have an axon are amacrine cells of the retina.
- c) An axon is a centrifugal or efferent process.
- d) When a neuron has an axon, there is always an axon coming out of its body, which may branch.

**10. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) A multipolar neuron has one dendrite and several axons.
- b) A unipolar neuron has only one process.
- c) An example of a multipolar neuron is a Purkinje cell of cerebellar cortex.
- d) As a long living cell, a neuron may contain lipofuscin in its cytoplasm.

**11. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Microglia are part of the mononuclear phagocyte system.
- b) Astrocytes are responsible for myelination in the central nervous system.
- c) Gray matter contains protoplasmic astrocytes.
- d) Neuroglia include satellite cells around pseudounipolar neurons of the spinal ganglia.

**12. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Microglia can be demonstrated using impregnation according to Rio del Hortega.
- b) Membrana limitans glialis perivascularis is the term for blood-brain barrier formed by pedicles of astrocytes and continuous capillaries.
- c) Oligodendrocytes form a myelin sheath around several nerve fibers.
- d) Ependymal cells rest on the basal lamina.

**13. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Ependymocytes line the central canal of the spinal cord and cerebral ventricles.
- b) Fibrillary astrocytes are found in the white matter of the central nervous system.
- c) Tanycytes are a special type of ependymal cells that are in contact with the capillaries of the brain.
- d) The ependyma is a type of simple cuboidal epithelium.

**14. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Golgi impregnation shows astrocytes in black color.
- b) Schwann cells form myelin sheaths in the central nervous system.
- c) Satellite cells line the central canal of the spinal cord.
- d) Astrocyte processes on the surface of the central nervous system form membrana limitans glialis superficialis.

**15. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) We can show microglia by Golgi impregnation.
- b) Neuroglial cells are much less numerous than neurons.
- c) Fibrillary astrocytes are responsible for myelination within the central nervous system.
- d) Satellite cells are neuroglial cells in the spinal ganglia.



**16. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Myelinated nerve fibers transmit impulses more slowly than unmyelinated ones.
- b) Schwann cells form a Schwann sheath around unmyelinated nerve fibers.
- c) Nodes of Ranvier are found on unmyelinated nerve fibers.
- d) The epineurium surrounds the whole nerve, the perineurium surrounds bundles of nerve fibers, and the endoneurium surrounds individual nerve fibers.

**17. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Nerve tissue has an excellent regenerative capacity.
- b) The same cell population is responsible for myelination in both the CNS and PNS.
- c) Myelinated nerve fibers can transmit impulses at 100-120 m/s due to their saltatory mechanism.
- d) Myelin sheaths are best visualized using hematoxylin and eosin.

**18. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Nerve fibers in the human body can be tens of meters long.
- b) Purkinje neurons are among the largest cells in the human body.
- c) Nissl substance is a term used exclusively to describe alpha motor neurons in the anterior horns of the gray matter of the spinal cord.
- d) Neurons have no nucleus.

**19. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) The neuropil is part of the brain gray matter.
- b) White matter of the central nervous system is made up of neuronal processes, their sheaths, and glial cells.
- c) The perineurium contains fibroblasts arranged in an epithelioid pattern.
- d) A peripheral nerve contains a mixture of sensory and motor nerve fibers.

**20. Decide whether the following statements about the nerve tissue are true T or false F:**

- a) Visceromotor and viscerosensory fibers always run separately outside the peripheral nerves, providing somatomotor and somatosensory innervation.
- b) The epineurium surrounds the entire peripheral nerve.
- c) The ability of the nervous system to change its activity by reorganizing synaptic connections is called plasticity.
- d) Perineurium consists of elastic tissue.

**21. What are the types of glial cells in the CNS?**

- a) Bergmann glia
- b) satellite cells
- c) pituicytes
- d) astroglial cells
- e) Schwann cells

**22. What is the name of the glial cell that act as phagocyte to aid in protecting CNS neurons?**

- a) microglia
- b) oligodendrocyte
- c) Schwann cell
- d) ependymal cell

**23. Fill in the two blanks with the correct option: When a neuron is depolarized, the gated channels of the membrane open to allow \_\_\_\_\_ to enter the neuron. A neuron becomes hyperpolarized when the gated channels of the membrane open thus allowing \_\_\_\_\_ to exit the neuron.**

- a)  $K^+$ ;  $Na^+$
- b)  $Na^+$ ;  $K^+$
- c)  $Mg^{2+}$ ;  $Ca^{2+}$
- d)  $Ca^{2+}$ ;  $K^+$

**24. When a neuron is hyperpolarized, it means that:**

- a) becomes more sensitive to new stimuli
- b) responds as normal as it is its resting period
- c) cannot respond to new stimuli
- d) positive ions are entering into the neuron

**25. Which of the following statements about the neurons are true?**

- a) many neurons have a basophilic cytoplasm due to their intense protein synthetic activity
- b) neurons have generally an euchromatic nucleus and a highly basophilic nucleolus
- c) neurons may contain lipofuscin granules
- d) neuron nucleus is usually large, round, and pale
- e) the body of the neuron is also called axoplasm

**26. Which of the following statements about the peripheral nerve are true?**

- a) contains bipolar neurons surrounded by satellite cells
- b) is composed of fascicles of nerve fibers (axons), myelin sheaths and connective tissue coverings
- c) comprises Schwann cells
- d) comprises bodies of neurons

**27. What does the cerebellar cortex contain?**

- a) pyramidal cells
- b) Purkinje cells
- c) has three layers
- d) Purkinje fibers
- e) granular neurons

**28. Which of the following statements about the neuronal Nissl bodies are true?**

- a) extend into axon hillock
- b) are accumulations of rough ER
- c) are prominent cisterns of Golgi
- d) can extend into the dendrites

**29. Which of the following statements about the neuronal dendrites are true?**

- a) convey information away from the cell
- b) in bipolar neurons, there must be at least two
- c) carry information centripetally
- d) are unmyelinated
- e) usually are tapered
- f) are terminated with an enlarged tip - bouton terminal
- g) at their bases, they are generally wider than the axons

**30. What is the role of kinesin in axonal transport?**

- a) is involved in retrograde transport
- b) is microtubule-associated protein motor
- c) is important in polymerization of microtubules
- d) can hydrolyze ATP
- e) carries material to the periphery

**31. Which structures are closely related to the myelin sheath?**

- a) mesaxon

- b) Schmidt-Lanterman clefts
- c) nodes of Ranvier
- d) Nissl bodies
- e) paranodal loops

**32. Which general statements about various neuronal types are true?**

- a) Purkinje neurons are among the smallest neurons in the CNS
- b) multipolar neuron is found in the anterior horns of gray matter of the spinal cord
- c) pseudounipolar neuron has a single process that bifurcates close to the perikaryon
- d) great pyramidal neurons are principal sensitive neurons

**33. Which of the following statements about the oligodendrocytes are true?**

- a) form the myelin sheaths in PNS
- b) are responsible for the phagocytosis
- c) are mainly found in the gray matter of the CNS
- d) originate from a hematopoietic stem cell
- e) participate in the formation of the blood-brain barrier
- f) form myelin sheaths around multiple axons at once

**34. Which of the following statements about the protoplasmic astrocytes are true?**

- a) are mainly found in the white matter of the CNS
- b) originate from a hematopoietic stem cell
- c) participate in the formation of the blood-brain barrier

- d) provide physical and metabolic support for neurons
- e) possess pedicles (vascular feet)
- f) form a glial scar in the site of neuronal injury

**35. Which of the following statements about the microglia are true?**

- a) originate from a hematopoietic stem cell
- b) participate in the formation of the blood-brain barrier
- c) are responsible for the phagocytosis
- d) are found within the dorsal root ganglia

**36. In the following statement, correct the word to make this statement correct:**

**Regeneration of an axon distal to an injury site is called anterograde or Wallerian and occurs within hours of injury.**

- a) Regeneration → Degeneration
- b) axon → dendrite
- c) distal → proximal
- d) anterograde → retrograde
- e) hours → days

**37. Which of the following cellular structures gives rise (origin) to the cell projection that conducts impulses away from the cell body?**

- a) Nissl bodies
- b) axon hillock
- c) centrosome
- d) axoplasm

**38. Which of the following statements about the ependymal cells are true?**

- a) are involved in the formation of cerebrospinal fluid
- b) lining the blood vessels of the brain
- c) may have cilia
- d) lie on the basement membrane
- e) are involved in the formation of blood-brain barrier

**39. What are functions of the various glia?**

- a) repair of neuronal injury
- b) physical support
- c) clearance of neurotransmitters from synaptic clefts
- d) synthesis of neurotransmitters
- e) phagocytosis of cellular debris

**40. What are the common excitatory neurotransmitters?**

- a) glutamate
- b) serotonin
- c) GABA ( $\gamma$ -aminobutyric acid)
- d) norepinephrine



## Chapter Ten answers:

- |         |          |          |          |
|---------|----------|----------|----------|
| 1) acd  | 11) acd  | 21) acd  | 31) abce |
| 2) ad   | 12) abc  | 22) a    | 32) bc   |
| 3) c    | 13) abc  | 23) b    | 33) f    |
| 4) ad   | 14) ad   | 24) c    | 34) cdef |
| 5) acd  | 15) d    | 25) abcd | 35) ac   |
| 6) ac   | 16) bd   | 26) bc   | 36) a    |
| 7) abcd | 17) c    | 27) bce  | 37) b    |
| 8) d    | 18) ab   | 28) bd   | 38) ac   |
| 9) bcd  | 19) abcd | 29) cdeg | 39) abce |
| 10) bcd | 20) bc   | 30) bde  | 40) abd  |

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