

Nervous system

By studying this topic, you will find out about the basic structure of nerves, synapses, central and peripheral nervous systems, supporting cells of nervous tissue and the special senses. The following content will be studied in this topic:

<p>Neurons:</p> <ol style="list-style-type: none"> 1. Cell bodies <ol style="list-style-type: none"> 1. Multipolar 2. Pseudo-unipolar 2. Processes <ol style="list-style-type: none"> 1. Myelinated 2. Unmyelinated 3. Nerve endings <ol style="list-style-type: none"> 1. Central nervous system <ol style="list-style-type: none"> 1. Synapse 2. Peripheral nervous system <ol style="list-style-type: none"> 1. Motor units <ul style="list-style-type: none"> • Motor muscle end plate 2. Sensory endings <ul style="list-style-type: none"> • Pacinian corpuscle • Meissner's corpuscle 	<p>Neuroglia:</p> <ol style="list-style-type: none"> 1. Astrocytes 2. Ependyma <p>Special sense:</p> <ol style="list-style-type: none"> 1. Eye 2. Ear 3. Touch <ul style="list-style-type: none"> • Pacinian corpuscle • Meissner's corpuscle 	<p>Nervous system:</p> <ol style="list-style-type: none"> 1. Ganglia <ul style="list-style-type: none"> • Spinal • Sympathetic • Parasympathetic 2. Cerebrum 3. Cerebellum 4. Spinal cord
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Nervous tissues

You should be able to:

Describe the major divisions of the nervous system.

Describe the functional and structural differences between grey and white matter.

Describe the basic structure of a neuron.

Identify neurons, neuroglia and neuropil.

Identify the different types of neurons.

Identify and describe the differences between axons and dendrites.

Identify and describe myelinated and nonmyelinated nerve axons.

Identify and explain the connective tissue arrangements in nervous tissue.

Describe the components and organisation of the central and peripheral nervous systems.

Describe and identify the supporting cells in the central and peripheral nervous system.

Describe the functions of the various cells and structures of the nervous system.

Describe the structure of synapses.

Nervous system

You should be able to:

Distinguish cerebellum from cerebrum in histological sections.
 Identify the layers of the grey matter in the cerebellum and their constituent cells.
 Describe and explain the organization and structure of the spinal cord in cross-section.
 Distinguish and explain the differences between ganglia and nerves.

Sensory system

You should be able to:
 Describe different types of sensory receptors
 Identify different encapsulated sensory receptors.
 Describe the structures involved in the special senses of taste, smell, hearing, balance, and vision.
 Describe the means of mechano-reception for hearing and balance.

Eye

You should be able to:
 Describe the overall organization of the eye.
 Describe the structural organization and functions of the components of the eyelid and conjunctiva.
 Describe the components of the three layers of the eye.
 Explain the relation between structure and function of the layers in the eye.
 Recognize and describe the retina, fovea, optic disk, and layout of blood vessels in the retina.
 Recognize and describe the structures of the cornea, iris, lens, vitreous body and ciliary body.
 Understand the relationship among the choroid and the pigmented and sensory layers of the retina.
 Understand and describe the sensory cells of the retina and the rest of the optical sensory pathway.

Ear

You should be able to:
 Describe the overall organisation of the ear, middle ear and inner ear.
 Recognise the ear drum, cochlea and its components.
 Describe and explain the functions of the components of the ear.

Slides: Nervous tissues and systems

Slide name	Slide number	Stain
Nervous tissues		
Neuron: Cell bodies		
Multi-polar: spinal cord	26 & 82	H/E and silver
Multi-polar: cerebellum	60	Silver
Pseudo-unipolar: spinal ganglion	26	H/E
Neuron: fibres		
Myelinated: peripheral nerve	32	H/E
Myelinated: myelin sheath	59	Osmium
Nerve endings		

Central nervous system		
Synapse	82	Sliver
Peripheral nervous system		
Motor endings		
Motor end plate	44	Gold
Sensory endings		
Pacinian corpuscles	93	H/E
Meissner's corpuscles	24	Silver
Neuroglia		
Astrocytes: cerebrum	61	Silver
Ependyma: choroid plexus	98	H/E
Nervous system		
Ganglia: Spinal	26 & 82	H/E and silver
Ganglia: Sympathetic	103	H/E
Ganglia: Parasympathetic	37, 41, or 42	H/E
Cerebrum	61	Silver
Cerebellum	60	Silver
Spinal cord	26	H/E
Neuromuscular bundle	69	H/E
Eye		
Eyelid	96	H/E
Lacrimal gland	99	H/E
Eye	29	H/E
Optic nerve	105	H/E
Ear		
Pinna	87	H/E
Eardrum		H/E
Auditory tube	39	H/E

Cochlea		H/E
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This is a section through skin from the palm, illustrating sensory nerve endings of the peripheral nervous system.

Identify:

A Macroscopic

- Orientate yourself with regard to the three layers of the skin. Look for Meissner's corpuscles in the papillary layer of the dermis.

B Microscopic

- Stratified squamous keratinising epithelium
- Loose connective tissue
- Meissner's corpuscles

Draw and annotate a Meissner's corpuscle.

Questions:

1. Describe a Meissner's corpuscle.
2. What is the difference between a Meissner's and Pacinian corpuscle?

This is a cross section through the spinal cord and spinal ganglion. The spinal cord serves as an example of multipolar neuron cell bodies.

Identify:

A Macroscopic

- The orientation of the spinal cord, identifying the H-shaped grey matter, the white matter and the spinal ganglion.

B Microscopic

- The multipolar neuron cell bodies found in the grey matter. (i) Cell body.
- Nucleus
- Nissl-substance
- Axon hillock
- Nuclei of the neuroglia

Draw and annotate a multipolar neuron cell body. Indicate the components of the neuron in detail.

Questions:

1. What characteristic of the cell bodies is used in the identification of multipolar neurons?
2. What is characteristic of the nuclei of the neurons?
3. How does the Nissl-substance appear and what is it in reality?
4. What is characteristic of the axon hillock?

This is a cross section through the spinal cord and spinal ganglion. The spinal cord serves as an example of multipolar neuron cell bodies.

Identify:

A Macroscopic

- The orientation of the spinal cord, identifying the H-shaped grey matter, the white matter and the spinal ganglion.

B Microscopic

- The multipolar neuron cell bodies found in the grey matter. (i) Cell body.
- Nucleus
- Nissl-substance
- Axon hillock
- Nuclei of the neuroglia

Draw and annotate:

A multipolar neuron cell body. Indicate the components of the neuron in detail.

Question:

1. What characteristic of the cell bodies is used in the identification of multipolar neurons?
2. What is characteristic of the nuclei of the neurons?
3. How does the Nissl-substance appear and what is it in reality?
4. What is characteristic of the axon hillock?

This is a cross section through the spinal cord and spinal ganglion. The spinal ganglion is used as an example to demonstrate pseudo-unipolar neuron cell bodies.

Identify:

A Macroscopic

- The orientation of the spinal ganglion identifying the spinal ganglion next to the spinal cord. The pseudo-unipolar neurons are found in the spinal ganglion.

B Microscopic

- Cell bodies
- Nuclei
- Nissl-substance

Draw and annotate:

A pseudo-unipolar neuron.

Question:

1. What is characteristic of the shape of a pseudo-unipolar neuron in comparison to that of multipolar neurons?
2. How do the granules of the Nissl-substance of pseudo-unipolar neurons differ from those of the multipolar neurons?

This specimen is a section through the eye. The thin stratified squamous unkeratinizing epithelium is found on the outside of the cornea. Stratified epithelia occur where there are high levels of friction.

Identify:

A Macroscopic

- The eyeball and the cornea situated anteriorly.

B Microscopic

- The different layers comprising the epithelium.
- The shape of the cells in the different layers.

Draw and annotate:

A few epithelial cells of each layer showing the different cell shapes.

Questions:

1. How many cell layers form this epithelium and how thick is each one of these layers in relation to one another?
2. How does the shape of the cells in each layer change?
3. What is characteristic of the junction between this epithelium and the underlying support structures (connective tissue)? Are papillae present?

This is a sagittal section through the eye. The lens may or may not be present.

Identify:

A Orientate yourself macroscopically with respect to the eye by identifying the following structures:

- Cornea
- Limbus
- Sclera
- Choroid
- Ciliary body
- Iris - anterior and small posterior chambers
- Lens [if present]
- Retina
- Large posterior chamber and vitreous body
- Optic nerve [if present]

B Microscopic

- (a) The cornea
 - The different layers of the cornea
- (b) The Limbus
 - The different layers of this area
 - The Canal of Schlemm
 - Pectineal ligament
- (c) The Sclera
- (d) The conjunctiva
 - Epithelium
 - Connective tissue
- (e) The Choroid
 - The different layers of the choroid
- (f) The Ciliary Body
 - The different structures of the ciliary body
- (g) The Iris
 - The different layers of the iris
- (h) The Retina
 - The different layers of the retina
 - The ora serrata

Draw and annotate:

A line diagram of the eye, including detail of a small part of each of the different elements that make up the eye.

Questions:

1. What types of epithelium are found in the cornea?
2. What membranes and types of support tissue are connected to the cornea?
3. How do the layers of the limbus of the cornea differ from those of the sclera and conjunctiva?
4. What type of epithelium forms the Canal of Schlemm?
5. What are the characteristic features of the ciliary zonule of lens?
6. What type of support tissue is associated with the sclera?
7. What type of epithelium covers the conjunctiva?
8. What type of support tissue is associated with the conjunctiva?

9. What are the layers of the choroid?
10. What is the membrane of Bruch and what cells make up this membrane?
11. What structures does the ciliary body consist of?
12. What is characteristic of the epithelium of the ciliary body?
13. What types of muscle forms the iris?
14. How is the ora serrata identified?
15. What are the layers of the fovea?
16. What structures connect to the optic disk?

This is a cross section through a peripheral nerve.

Identify microscopically:

1. Epi-, peri- and endoneurium
2. Axon
3. Neurilemma
4. Schwann cell nuclei

Draw and annotate:

A line diagram of the nerve in which the connective tissue components and nerve bundles are indicated. Draw a few cross sectional axons with their sheaths.

Questions:

1. How do the axons appear?
2. How do the myelin sheaths appear?
3. How does one distinguish between Schwann cell and fibroblast nuclei?
4. How do unmyelinated fibers appear?

This slide is a cross section through the fundus of the stomach.

Identify:

A Macroscopic

- The rugae with the naked eye.

B Microscopic

- Foveolae
- Mucosa
- Gastric glands
- Submucosa
- M. externa
- Serosa
- Ganglia

Draw and annotate:

A line sketch of the stomach where the detail of a number of foveolae and gastric glands are shown.

Questions:

1. How deep do the foveolae extend into the mucosa?
2. Which layers comprise the mucosa?
3. What are the identifying characteristics of the epithelium which lines the foveolae and surface?
4. What is typical of the extent, areas and types of cells of the gastric glands?
5. What is typical of the submucosa?
6. What are the identifying characteristics of the M. externa?
7. What does the serosa comprise of, and how does it differ from the adventitia?
8. Where are the ganglia found, and of what do they form a part of?

The pharyngeal tube or the tip of the tongue (slide 7) is used as examples to study serous, mucinous and mixed secretory units.

Identify:

A Macroscopic

- Identify with the naked eye the J-shaped cartilage of the pharyngeal tube. The glandular tissue can be found on the inside of the J-shaped cartilage. The glandular tissue of the tongue can be found between the bundles of muscle fibers.

B Microscopic

- Serous units
- Mucinous units
- Mixed units - serous demilunes

Draw and annotate:

The three types of units. Clearly indicate the differences in morphology.

Questions:

1. Tabulate the differences between mucinous and serous units.

	Mucinous	Serous
Shape of unit		
Staining of cells in unit		
Shape of nucleus		
Lumen		

2. Where do the secretions of the serous demilunes go?

This slide is a section through the auditory tube.

Identify:

A Macroscopic

- Orientate yourself with respect to the J-shaped cartilage.

B Microscopic

- The lumen of the auditory tube
- The epithelium that lines the tube
- The laminal propria with mixed glands
- Muscle

Draw and annotate:

A diagram of the auditory tube and its surrounding tissue:

Questions:

1. What is the shape of the lumen?
2. What type of epithelium is found here?
3. What type of cartilage is found here?
4. What is characteristic of the glands?
5. What type of muscle is found here, and what is the anatomical name of this muscle?

This specimen serves as an example of endothelium as seen in a section. The specimens that are used are sections through the skin of the palm or a section through the ileum. The blood vessels can be found in the dermis/hypodermis of the skin or in the submucosa of the ileum.

Identify:

A Macroscopic

Hold the slide against a white background and look at it with the naked eye. Identify the three coloured layers seen in the section:

- A dark pink to red scalloped area - the epidermis.
- A central light pink area - the dermis.
- A thick very light pink area - the hypodermis.

The blood vessels can be found under low magnification in the dermis.

B Microscopic

- Lumen of the blood vessel
- Endothelial cells against the lumen
- Nuclei of the endothelial cells
- Cytoplasm
- Layers of the blood vessel wall

Draw and annotate:

A line diagram of the blood vessel and endothelial cells.

Questions:

1. What is characteristic of the endothelial cells?
2. What is characteristic of the cytoplasm of these endothelial cells? And the nuclei?
3. What is sometimes seen in the lumen?

This slide is a longitudinal section through the ileum.

Identify microscopically:

1. Mucosa
2. Submucosa
3. M. externa
4. Serosa
5. Lymphocyte infiltration

Draw and annotate:

A line drawing of the ileum.

Questions:

1. What are the similarities and differences between the ileum and duodenum?

This specimen is a longitudinal section through the large intestine.

Identify:

A Macroscopic

- The longitudinally sectioned colon
- The luminal surface

B Microscopic

- Single cell gland or goblet cell (pale staining)
- Simple tubular gland. Note that the simple tubular gland is the whole test tube shaped structure and that it is lined with goblet cells and columnar epithelial cells.

Draw and annotate:

A goblet cell as well as a simple tubular gland (with goblet cells and columnar epithelial cells), as seen in longitudinal section.

Questions:

1. What are the characteristics of a goblet cell?
2. What cells form a simple tubular gland?

This specimen is a section through the colon and is a good example of the different types of connective tissue cells.

Identify:

A Macroscopic

- (i) A thin dark pink coloured line, the mucosa.
- (ii) A central light pink coloured area with fine pink coloured structures, the submucosa.
- (iii) An outer pink coloured irregular area, the outer muscle layer.

B Microscopic

C In the lamina propria of the mucosa, which comprises an epithelial layer and a loose connective tissue layer, the lamina propria, the following cells must be identified:

- Fibroblasts
- Plasma cells
- Macrophages
- Mast cells
- Eosinophils
- Lymphocytes
- Smooth muscle fibers

Draw and annotate:

The different cell types. List with each cell type, their distinguishing characteristics.

This slide is a longitudinal section through the colon.

Identify microscopically:

1. Mucosa
2. Submucosa
3. M. externa
4. Serosa

Draw and annotate:

A line diagram of the colon.

Questions:

1. What are the distinguishing characteristics of the crypts as far as their structure and arrangement are concerned?
2. What is typical of the outer layer of M. externa?
3. What are the similarities and differences between the colon, appendix, vermiformis, ileum and duodenum?

This is a slide of separated skeletal muscle fibers illustrating the motor end plates of the peripheral nervous system.

Identify microscopically:

1. (i) Separated skeletal muscle fibers
2. (ii) Nerve fibers
3. (iii) Motor end plates

Draw and annotate:

A motor end plate.

Questions:

1. What is the difference between an end plate and a motor end plate?
2. What is a motor unit?

This is a cross-section through a peripheral nerve that has been stained for myelin.

Identify microscopically:

1. Myelin sheath
2. Axon

Draw and annotate:

A number of myelin sheaths in detail.

Reflection:

1. Are all the axons and myelin sheaths sectioned the same?
2. Why can't the structure of the axons be seen?

This slide is a sagittal section through the cerebellum.

Identify:

- A Macroscopic
 - The grey and white matter
- B Microscopic
 - The different layers of the cerebellar cortex
 - White matter

Draw and annotate:

The neurons of the different layers of the cerebellar cortex.

Questions:

1. What type of neurons are seen in the grey matter?

This is a section through the cerebrum illustrating neuroglia of the central nervous system.

Identify microscopically:

1. Astrocytes
2. Blood vessels

Draw and annotate:

An astrocyte in detail.

Questions:

1. What type of astrocyte is visible in this slide, and with which structure are they in contact?
2. Where are these astrocytes found?
3. What is distinctive of astrocytes?
4. Describe the perivascular feet?

This slide is a section through the cerebrum.

Identify:

A Macroscopic

- The white and grey matter

B Microscopic

- The different layers of the cerebral cortex.
- White matter

Draw and annotate:

The different types of neurons found in the different layers of the cerebrum.

Questions:

1. What types of neuron are seen here?
2. What other structures are also visible in this slide?

This slide is a cross-section through a medium artery and vein.

Identify microscopically:

1. The three layers of the vessels, and their subdivisions

Draw and annotate:

A diagram of the artery and vein showing a portion of detail of each layer.

Questions:

1. What is the relative thickness of the three layers of the artery and vein with respect to each other?
2. What is characteristic of each layer seen in the artery and the vein?
3. What are the identifying features of the artery and the vein. Tabulate the differences and similarities of these arteries and veins.

This is a cross section through the spinal cord and spinal ganglion. The spinal cord is used as an example of multipolar neuron cell bodies.

Identify microscopically:

1. Cell bodies
2. Nuclei
3. Neurofibrils
4. Meshwork
5. Nuclei of neuroglia

Draw and annotate:

A multipolar neuron.

Questions

1. Is the neuron nuclei visible?
2. How do the neurofibrils appear and what are they in reality?
3. What is the meshwork surrounding the cell bodies in reality?

Slide 82: Spinal cord: synapse

Silver

This is a cross-section through the spinal cord showing the nerve ends (synapses) of the central nervous system, which are situated on the neuron cell bodies of the large anterior horn of the spinal cord.

Identify microscopically:

1. Neuron bodies
2. End plates

Draw and annotate:

A neuron cell body with end plates included.

Questions:

1. How are the end plates presented under the light microscope?

This slide is a longitudinal section through the pinna of the ear.

Identify microscopically:

1. The different layers of the pinna

Draw and annotate:

A diagram of the pinna showing the different components:

Questions:

1. What type of cartilage is found in the pinna?
2. How can one distinguish between the lateral and medial surfaces of the pinna?

This specimen serves as an example of endothelium as seen in a section. The specimens that are used are sections through the skin of the palm or a section through the ileum (slide 41) can also be used. The blood vessels can be found in the dermis/hypodermis of the skin or in the submucosa of the ileum.

Identify:

A Macroscopic

Hold the slide against a white background and look at it with the naked eye. Identify the three coloured layers seen in the section:

- A dark pink to red scalloped area - the epidermis.
- A central light pink area - the dermis.
- A thick very light pink area - the hypodermis.

The blood vessels can be found under low magnification in the dermis.

B Microscopic

- Lumen of the blood vessel
- Endothelial cells against the lumen
- Nuclei of the endothelial cells
- Cytoplasm
- Layers of the blood vessel wall

Draw and annotate:

A line diagram of the bloodvessel and endothelial cells.

Reflection:

1. What is characteristic of the endothelial cells?
2. What is characteristic of the cytoplasm of these endothelial cells? And the nuclei?
3. What is sometimes seen in the lumen?

This specimen is a section through the skin of the palm of the hand.

Identify:

A Macroscopic

Hold the slide against a white background and look at it with the naked eye. Identify three coloured layers seen in the section:

- A dark pink to red scalloped area – the epidermis
- A central light pink area – the dermis
- A thick very light pin area – the hypodermis

B Microscopic

- The different layers of the epithelium which form the epidermis
- The shape of the cells in the different layers

Draw and annotate:

A few epithelial cells of each layer to show the different cell shapes.

Questions:

1. How many cell layers are present?
2. How does the shape of the cells in each layer change?
3. How does the junction between this epithelium and the underlying support structures (connective tissue) appear?

This is a section through the hypodermis of thick skin to demonstrate fatty connective tissue.

Identify:

A Macroscopic

- The different textures and intensity of stained layers of thick skin.

B Microscopic

- Fat cells
- Connective tissue septa.

Draw and annotate:

A line diagram of a few lobules of fatty tissue. In one of the lobules draw fat cells as well as the surrounding connective tissue septa.

Questions:

1. How does the appearance of these fat cells differ from those that were stained with Sudan IV?

This is a section through skin from the palm, illustrating sensory nerve endings of the peripheral nervous system.

Identify:

A Macroscopic

- Orientate yourself with regard to the three visible primary layers of the skin of the palm. Look for the Pacinian corpuscles which are found in the subcutaneous fat tissue.

B Microscopic

- Adipose tissue
- Pacinian corpuscles

Draw and annotate:

A Pacinian corpuscle.

Questions:

1. Describe the Pacinian corpuscle.
2. What is the capsule made from?

This slide is a section through the skin of the palm of the hand.

Identify:

A Macroscopic

- Orientate yourself with respect to the two layers of the skin, as well as the subcutaneous tissue.

B Microscopic

- The two layers of the skin
- The subcutaneous tissue
- Sweat glands

Draw and annotate:

The layers of the skin, including the subcutaneous tissue and sweat glands.

Questions:

1. What type of epithelium is seen here?
2. What are the different layers of the dermis, and what type of support tissue is found here?
3. What is characteristic of the subcutis (hypodermis)?
4. What is characteristic of the ducts of the sweat glands?
5. How does one distinguish between the secretory part and the tubular part of sweat glands?

This slide is a sagittal section through the eyelid.

Identify:

A Macroscopic

- Orientate yourself with regard to inner and outer surfaces of the eyelid.

B Microscopic

- The different layers that make up the eyelid
- The different structures seen in the eyelid

Draw and annotate:

A line diagram of the eyelid, including details of the conjunctiva and Meibomian glands.

Questions:

1. How can one distinguish between the inner and outer surfaces of the eye?
2. What type of connective tissue forms the tarsal plates?
3. What type of gland is the Meibomian gland?
4. What is the anatomical name of the muscle seen, and what type of muscle is it?
5. What are the glands of Moll and Zeiss otherwise known as?

This is a section through the choroid plexus illustrating neuroglia of the central nervous system.

Identify microscopically:

1. Ependyma
2. Connective tissue and blood vessels

Draw and annotate:

A few ependymal cells, including the underlying blood vessels and connective tissue.

Questions:

1. Where is the choroid plexus located?
2. What is the difference between ependyma and simple cuboidal epithelium?

This slide is a section through the lacrimal gland.

Identify microscopically:

1. Acini (secretory unit)
2. Ducts, connective tissue and blood vessels

Draw and annotate:

A line diagram of the lacrimal gland, including details of a number of secretory units, ducts and connective tissue:

Questions:

1. What are the characteristics of the lacrimal gland?
2. What type of epithelium are the ducts lined with?
3. What type of gland is the lacrimal gland classified as?

This slide is a cross section through the optic nerve.

Identify microscopically:

1. The connective tissue
2. Nerve fibers

Draw and annotate:

A diagram of the connective tissue layers and the nerve fibers:

Questions:

1. What layers of support tissue surround the optic nerve?
2. What types of cells are found between the nerve fibers?
3. Is this a myelinated nerve or not? Explain.
4. How can one differentiate between the optic nerve and a peripheral nerve?

Revision Questions

What are the 3 layers of the sclera?

Name and discuss the 5 layers of the cornea.

Name the 4 layers of the iris.

What determines eye colour?

Name the 8 layers of the retina and what forms them.

What is the lens composed of?

Name the 3 chambers of the eye.

Explain the histological basis of glaucoma.

Describe the flow of liquid in the posterior and anterior chambers of the eye.

What separates the external and middle ear?

Name the three auditory ossicles.

What type of joint articulates the ossicles?

How is movement detected in the inner ear?

How is sound detected in the inner ear?

What is the organ of Corti composed of?

Name 3 types of neurons.

What is a synapse?

Name the types of cells which form myelin in the CNS & PNS.

Name the 4 specialized support cells of the central nervous system.

Name and define the 3 meningeal layers.

What is the function of the choroid plexus?

Name the 4 components of a peripheral nerve.

Where are the endoneurium, perineurium and epineurium located?

Which autoimmune disease attacks the myelin of the CNS?