CENTRAL NERVOUS SYSTEM. SENSE ORGANS

STUDY GUIDE

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Medical Institute

CENTRAL NERVOUS SYSTEM. SENSE ORGANS

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This study gnide is intended for the students of medical higher educational institutions of IV accreditation level, who study human anatomy in the English language.

Навчальний посібник рекомендований для студентів вищих медичних навчальних закладів IV рівня акредитації, які вивчають анатомію людини англійською мовою.

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INTRODUCTION

Human anatomy is a scientific study of human body structure taking into consideration all its functions and mechanisms of its development.

Studying the structure of separate organs and systems in close connection with their functions, anatomy considers a person's organism as a unit which develops basing on the regularities under the influence of internal and external factors during the whole process of evolution.

The purpose of this subject is to study the structure of organs and systems of a person, features of the body structure in comparison with animals, revealing the anatomic frames of the age, sexual and individual variability, to study the adaptation of the form and structure of the organs to varying conditions of functioning and existence. Such functional and anatomic, evolutionary and causal treatment of the information about morphological features of the human sustem has a huge value for clinical manifestation in the anatomy course as it promotes comprehension of the nature of a healthy and sick person.

This educational and methodical practical work is based on the models of educational and working programs on human anatomy according to the credit–modular system of organization of the educational process. It is directed toward the assistance to the students and teachers in the organization and realization of the most effective methods of studying and teaching this subject.

GENERAL PART

LECTURE PLAN

1) An Introduction to the Nervous System.The Spinal Cord.
2) The Structure of the Brain Stem. The Rhomboid Fossa.
3) The Structure of the Diencephalon and Telencephalon.
4) Conducting Tracts of the Brain and the Spinal Cord.
5) The Cranial and Spinal Nerves.
6) The Autonomic Nervous System.
7) The Organ of Vision.
8) The Organ of Hearing. The Organ of Gravitation and Balance.

SCHEDULE OF THE PRACTICAL CLASSES

CNS

Theme 1. An overview of the nervous system. The external structure of the spinal cord. The meninges of the spinal cord.

Theme 2. The internal structure of the spinal cord.

Theme 3. General survey of the brain. Embryogenesis of the brain. The medulla oblongata.

Theme 4. The rhomboid fossa. The fourth ventricle. The pons and cerebellum.

Theme 5. The mesencephalon. The cerebral aqueduct. The isthmus of the rhombencephalon. The diencephalon. The third ventricle. The rhinencephalon. The basal nuclei. The internal capsule. The lateral ventricles. The corpus callosum. The fornix.

Theme 6. The surfaces of the cerebral hemispheres (pallium). Cerebral cortex areas and functions.

Theme 7. The association, commissural and projection fibers of the white matter of the hemispheres. The ascending and descending conduction pathways.

Theme 8. The meninges of the brain. The cerebrospinal fluid. The vessels of the brain.

Theme 9. The test in CNS

SENSE ORGANS

Theme 1. The structure of the eyeball. The accessory structures of the eye. The optic, oculomotor, trochlear and abducent cranial nerves. The visual tract.

Theme 2. The external and middle ear. The internal ear. The vestibulocochlear nerve. Hearing and balance tracts. The skin. The organ of smell. The olfactory nerves. The organ of taste. The taste tract.

PART 1. THE CENTRAL NERVOUS SYSTEM

I. OVERVIEW OF THE NERVOUS SYSTEM. THE EXTERNAL STRUCTURE OF THE SPINAL CORD. THE MENINGES OF THE SPINAL CORD

The nervous system consists of central and peripheral parts.

1. **The central nervous system (CNS)** consists of the brain and the spinal cord. The central nervous system is made up of grey and white matter. The white matter is aggregations of myelinated and unmyelinated axons of matter its name. The gray matter of the nervous system contains neuronal cell bodies and dendrites.

2. **The peripheral nervous system (PNS)** includes the cranial and spinal nerves, their branches, ganglia, and plexuses.

The nervous system is made up of tissue that has special property to conduct impulses rapidly from one part of the body to another. The nervous system controls and regulates all functions of the body, its activity as a single whole. In the living organism, the nervous system is concerned with the introduction of information. Branching into all organs and tissues, the nervous system binds and integrates all parts of the organism into a single, unified whole. Its activity is based on the reflex. The nervous receptor receives a signal from an agent of the exterior or interior of the organism, which transforms into electrochemical impulse and, by a nerve fibers, passes to the central nervous system.

Nervous tissue consists of two types of cells: ***neurons and neuroglia***. Neurouns provide most of the unique functions of the nervous system, such as sensing, thinking, remembering, controlling, muscle activity, and regulating glandular secretions. Neuroglia support, nourish, and protect the neurons and maintain homeostasis in the interstitial fluid that bathes neurons.

The basic anatomical element of the nervous system is the nerve cell, which is called the *neuron.* Neuron is the functional unit of the nervous system (Fig.1). Most neurons have three parts:

1. cell body
2. dendrites
3. axon

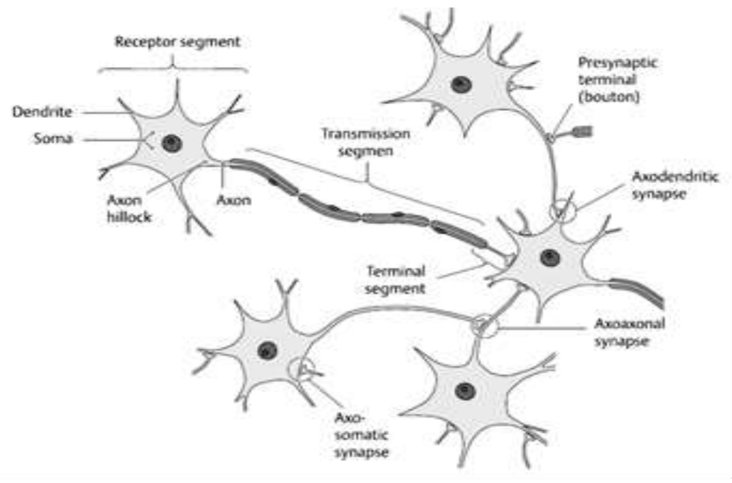


Figure 1 – Neurons

A long axial process, axon or neurite, arises from the cell body in one direction. Short branched processes, dendrites, are in a different direction. Nervous impulses inside the neuron run from the dendrites to the cell body and from there to the axon. The axons convey the nervous impulses away from the cell body. The site of communication between two neurons or between a neuron and an effector cell is called a *synapse*.

The synapses may be of various types depending upon the parts of the neurons that come in contact.

1. *Axodendritic synapse* is the most common type of synapse, when axon terminal establishes contact with the dendrite of a receiving neuron.
2. *Axosomatic synapse* – the axon terminal may synapse with the cell body.
3. *Axoaxonal synapse* is less common than others, when axon terminal may synapse the axon of the receiving neuron.
4. *Dendro–dendritic synapse* – the dendrites of one neuron may synapse with the dendrites of another neuron.

Structurally, neurons are classified according to the number of processes extending from the cell body.

1. *Multipolar neurons* usually have several dendrites and one axon. Most neurons in the brain and spinal cord are of this type.
2. *Bipolar neurons* have one main dendrite and one axon.
3. *Unipolar neurons* are sensory neurons that begin in the embrio as bipolar neurons. During the course of development, the axon and dendrite fuse into a single process that splits into two branches a short distance from the cell body. Both branches have the characteristic structure and function of an axon. However, the axon branch that extends into the periphery has dendrites at its distal tip, whereas the axon branch that extends into the CNS ends in synaptic end bulbs.

The neurons are generally classified into the three main categories:

1. *Sensory neurons*, which convey impulses from receptors to the central nervous system. Sensory neurons are unipolar. The cell body of these neurons is situated in ganglia close to the central nervous system: one axonal branch extends to the periphery and another extends to the central nervous system.

2. *Motor neurons*, which convey impulses from the central nervous system to effector cells.

3. *Interneurons* (internuclear neurons, intercalated neurons) – a great intermediate network interposed between the sensory and the motor neurons.

The connection between organs through the neurons is provided by the **reflex arc**. Reflex arc forms the basis of the reflex, the simplest and sometimes most fundamental reaction of the nervous system. A reflex is a fast, involuntary, unplanned sequence of actions that occurs in response to a particular stimulus.

According to number of neurons they are divided into:

1. The simple reflex arc that consists of two neurons, one of which is sensory and another – motor.

2. The simple reflex arc consists of three neurons: the first–order of which is sensory, the second one is interneuron and serves as a transmitting station from the sensory neuron to the third, motor, neuron.

3. The complex multineural reflex arc, sometimes, contains more than three neurons passing through different levels of the brain, including the cerebral cortex.

The reflex arc includes the following five functional components (Fig. 2):

1. **Sensory receptor.** The distal end of a sensory neuron (dendrite), or an associated sensory structure, serves as a sensory receptor. Receptors transform the energy of the external stimulus into a nerve impulse and transmit it toward the center. These receptors are from tree sensory surfaces, or receptor fields, of the organism:

a) *exteroceptive receptors* (exteroceptors) are located at or near the external surface of the body; they are sensitive to stimuli originating outside the body and provide information about the external invironment. The sensations of hearing, vision, smell, taste, touch, pressure, vibration, temperature, and pain are conveyed by exteroceptors

b) *interoceptive receptors* (interoceptors) are located in blood vessels, visceral organs, and monitor conditions in the internal environment

c) *proprioceptive receptors* (proprioceptors) are located in muscles, tendons, joints, and the inner ear. They provide information about body position and movement of our joints.

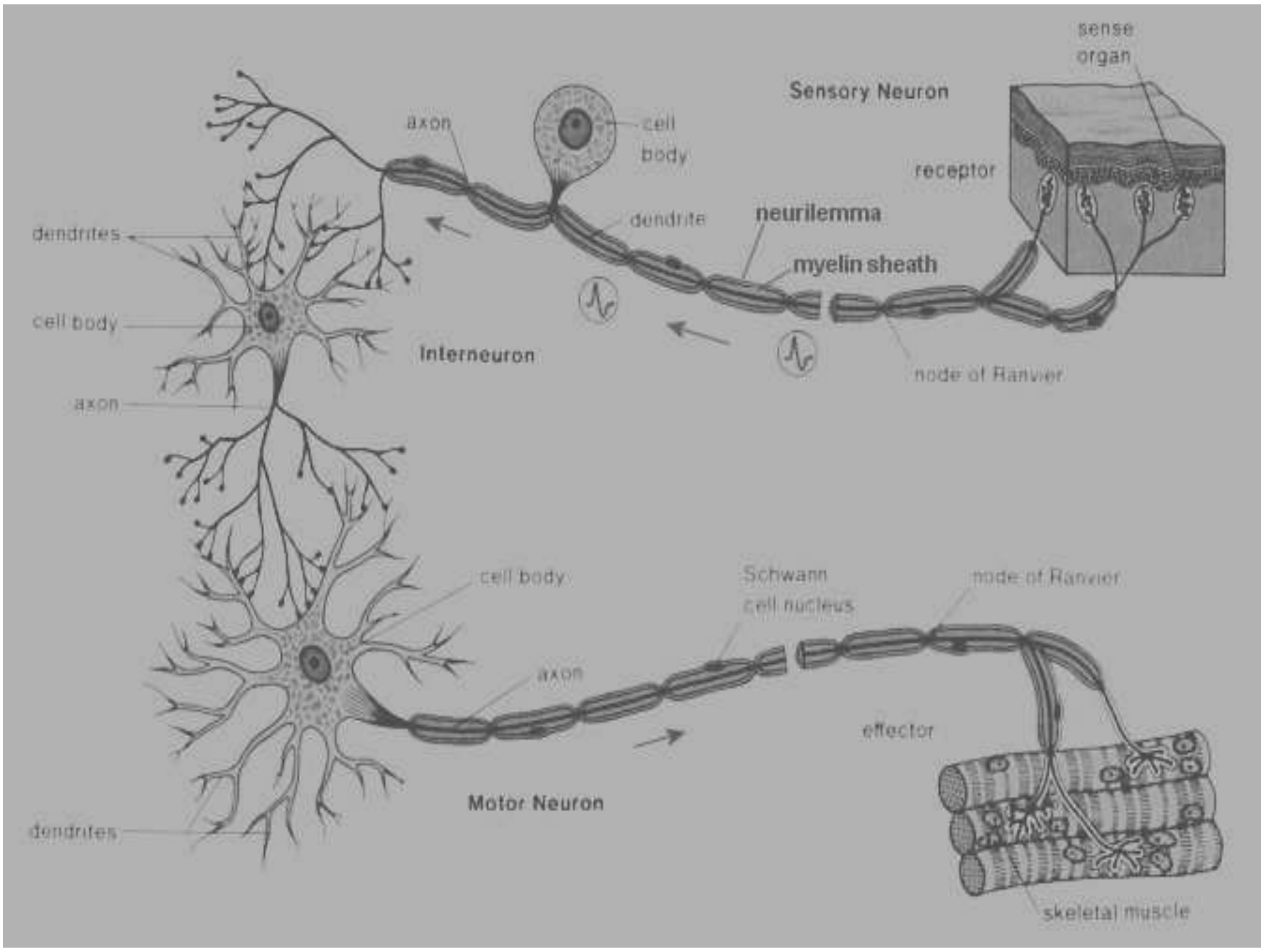


Figure 2 – The simple reflex arc

2. **Sensory neuron** (afferent, affector neuron). The nerve impulses propagate from the sensory receptor along the axon of the sensory neuron to the axon terminals, which are located in the gray matter of the spinal cord or brain stem.

3. **Integrating center** (conductor). One or more regions of gray matter within the CNS arc act as an integrating center.

4. **Motor neuron** (efferent or centrifugal neuron). Impulses triggered by the integrating center propagate out of the CNS along a motor neuron to the part of the body that will respond.

5. **Effector.** The part of the body that responds to the motor nerve impulse, such as a muscle or gland, is the effector. Its action is called a reflex. If the effector is skeletal muscle, the reflex is a *somatic reflex*. If the effector is smooth muscle, cardiac muscle, or gland, the reflex is an *autonomic (visceral) reflex*.

SPINAL CORD (Medulla Spinalis). EXTERNAL FEATURES

Spinal cord is the oldest part of CNS. It is cylindrical in shape, slightly flattened from front to the back. It occupies approximately the upper two thirds of the vertebral canal – about 40−45 cm long. The spinal cord runs in the vertebral canal from the foramen magnum to the level of the 1st to 2nd lumbar vertebra. It has a conical end, the *conus medullaris*, which terminates at the level of L2. Spinal cord has cervical and lumbar enlargements which correspond to the roots of the nerves of the upper and lower limbs (Fig. 3).

The space between L3 and L4 be used for safe puncturing of vertebral canal for collecting the cerebrospinal fluid or for producing spinal anaesthesia (Fig. 4).

The deep **anterior median fissure** runs along the anterior aspect of the spinal cord.

The posterior median sulcus is not deep. The posterior median septum arises from posterior median sulcus and separates right and left halves of the spinal cord.

The anterolateral sulcus is pared. It passes anterior roots of spinal nerves that exit spinal cord.

The posterolateral sulcus is paired. It marks the site of dorsal root entry into spinal cord.

31 paired spinal nerves extend through the intervertebral foramina laterally from C1 to S5.

Spinal nerves include:

- 8 pr. Cervical (C1–C8)
- 12 pr. Thoracic (T1–T12)
- 5 pr. Lumbar (L1–L5)
- 5 pr. Sacral (S1–S5)
- 1 pr. Coccygeal (Co)

Because the spinal cord is shorter than the vertebral canal, nerve roots run horizontally in the cervical region only. The lower roots descend along the spinal cord to the corresponding intervertebral foramina and in the lumdar region join the filum terminale to form the **cauda equina**, like a thick sheaf.

The **segment of spinal cord** is a portion of spinal cord that gives rise to one pair of spinal nerves. Segments are defined as regions where root fibers pass through the intervertebral foramina. The boundaries are not determinable in the isolated spinal cord (Fig. 5, 6).

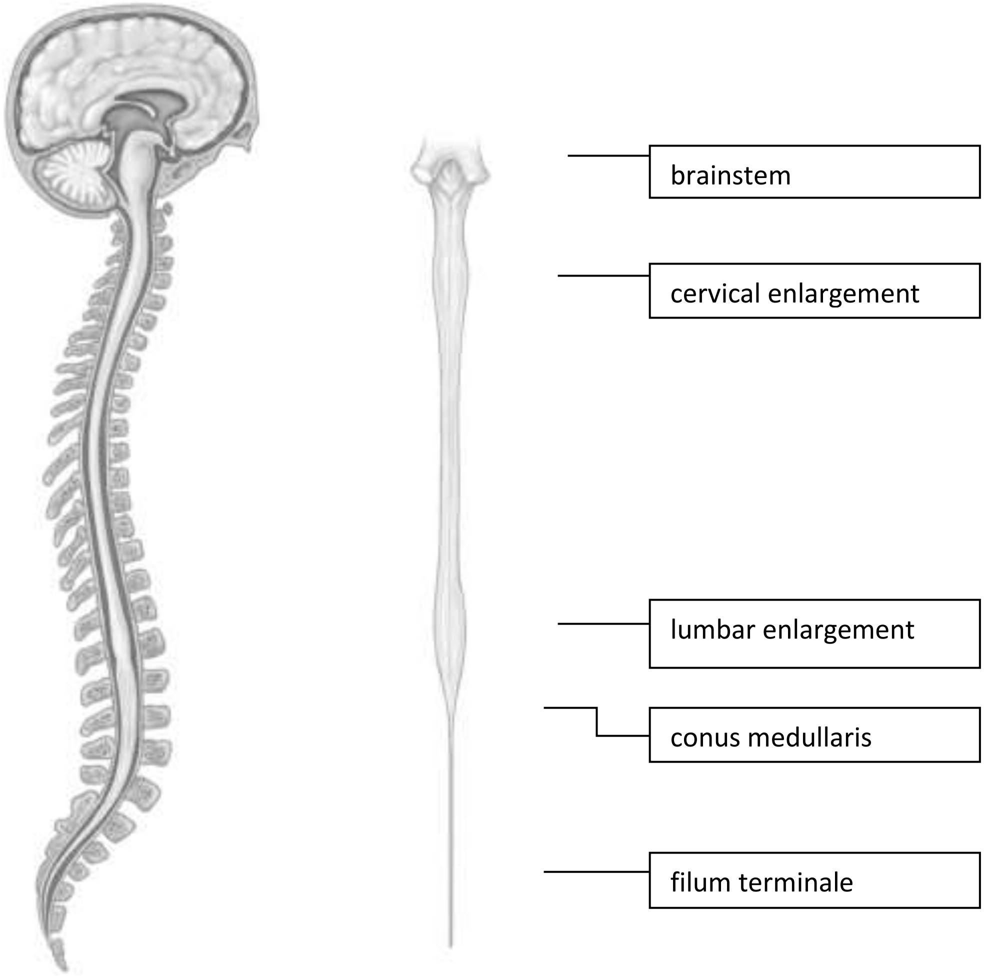


Figure 3 – External features of spinal cord

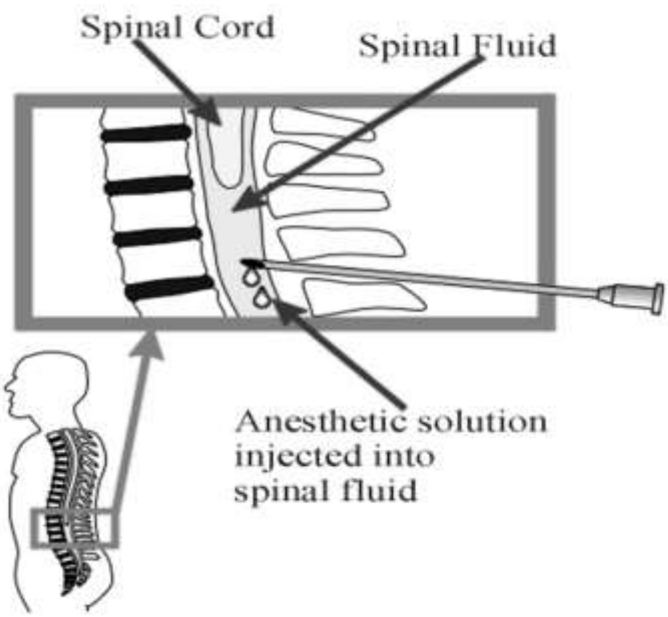


Figure 4 – Spinal anaesthesia

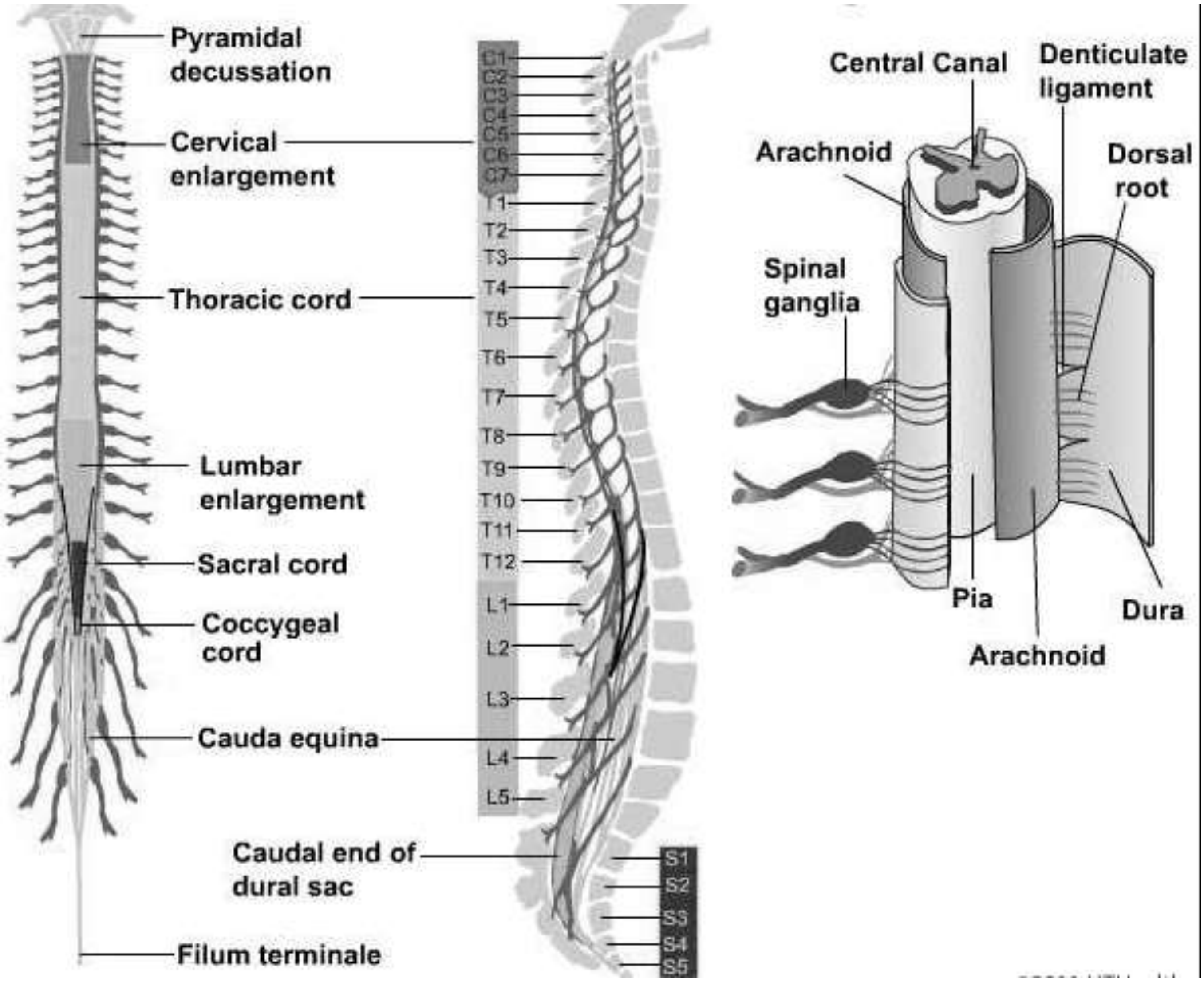


Figure 5 – The spinal cord segments

There are 31 spinal segments:

• 8 cervical segments; upper four segments are related to vertebrae C1–C4 and lower four segments – to C4– C7 (to one vertebra above)

• 12 thoracic segments; upper four segments are related to C7–Th3 (to one vertebra above), middle four segments are related to Th3–Th6 (to two vertebra above), lower four segments are related to Th6–Th9 (to three vertebra above)

• 5 lumbar segments are related to Th10–Th11 vertebrae

• 5 sacral segment are related to Th12–L1

• 1 coccygeal segments; is related to lower border of L1

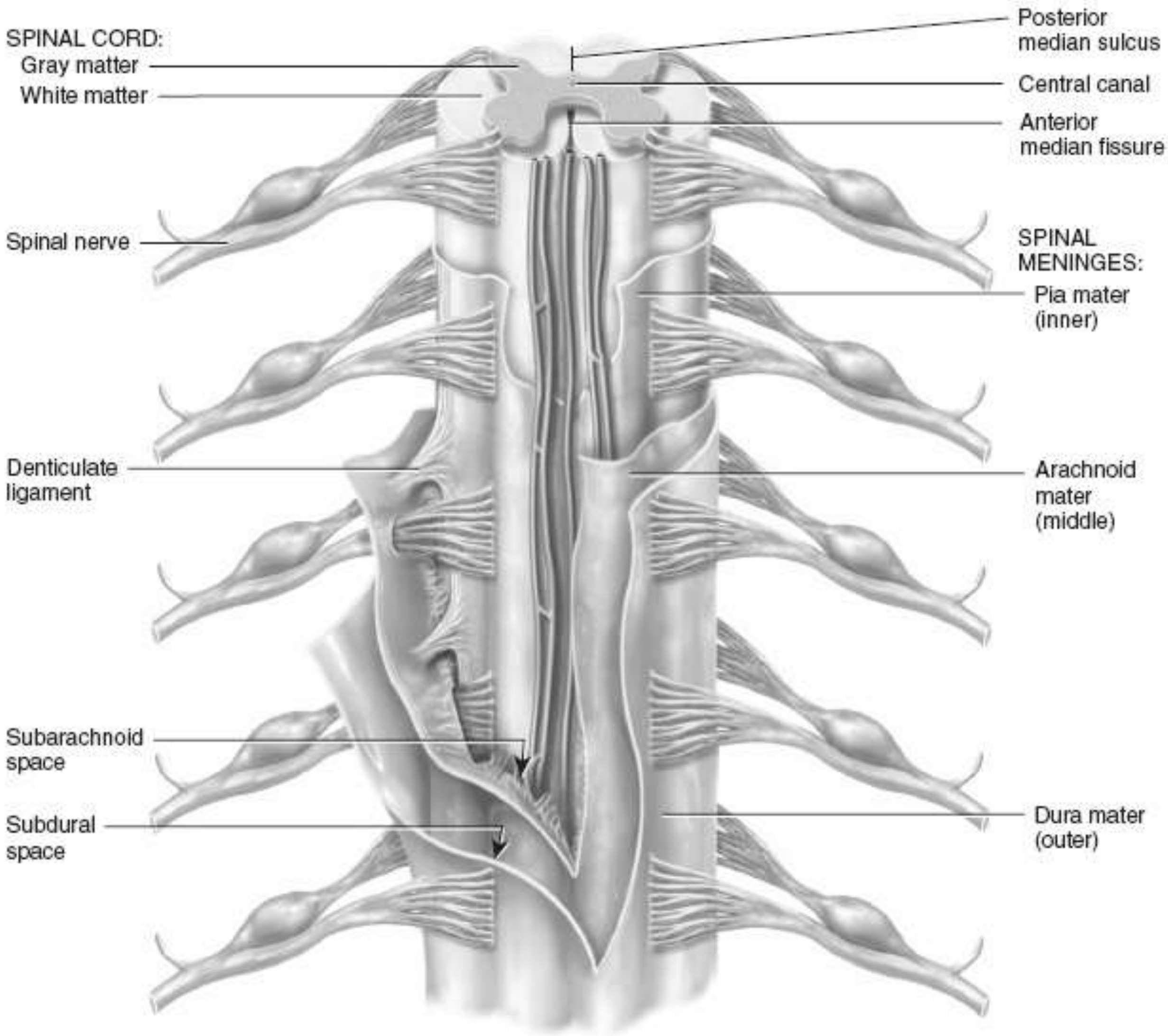


Figure 6 – Anterior view and transverse section through spinal cord

The spinal cord is surrounded and protected by bones and spinal meninges (Fig. 7):

- **Dura mater** is the outermost layer of dense connective tissue. The outer dural layer continues as the periosteum of the spinal canal, while the inner layer forms the dural sac, enclosing the spinal cord. The space between the two layers is called the *epidural space*. It contains loose connective tissue, fat, and the internal venous plexus. The two layers of the spinal dura matter join together where the spinal nerve roots emerge from the spinal canal through the intervertebral foramina. The lower end of the dural sac encloses the cauda equina and terminates at the S2 level. Its continuation below this level is the filum terminale of the dura mater, which is anchored to the sacral periosteum by the fibrous coccygeal ligament. A thin subdural space containing interstitial fluid is located between the dura mater and arachnoid mater.

- **Arachnoid** is the middle meninx – a delicate, netlike membrane that spreads over the CNS. A *subarachnoid space* is found between this layer and the innermost pia mater layer. This space contains the cerebrospinal fluid**.**
- **Pia mater** is the innermost meninx, is composed of loose connective tissue and tightly bound to the contours of the brain and spinal cord. It is highly vascular, supporting the vessels that nourish the underlying spinal cord cells.

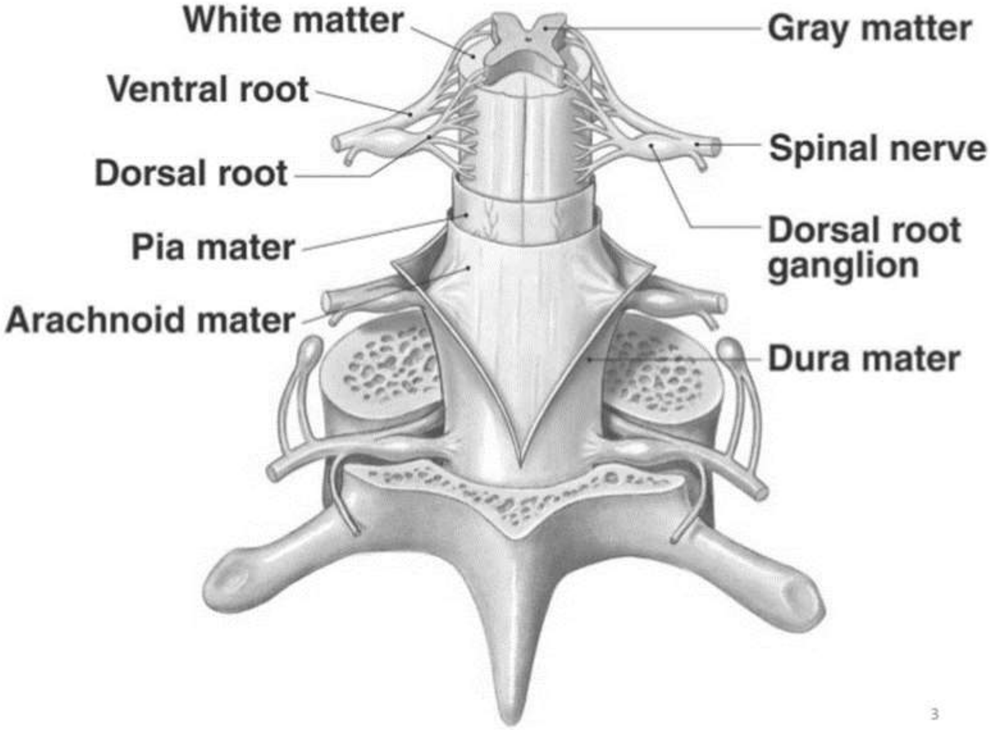


Figure 7 – Meninges of the spinal cord

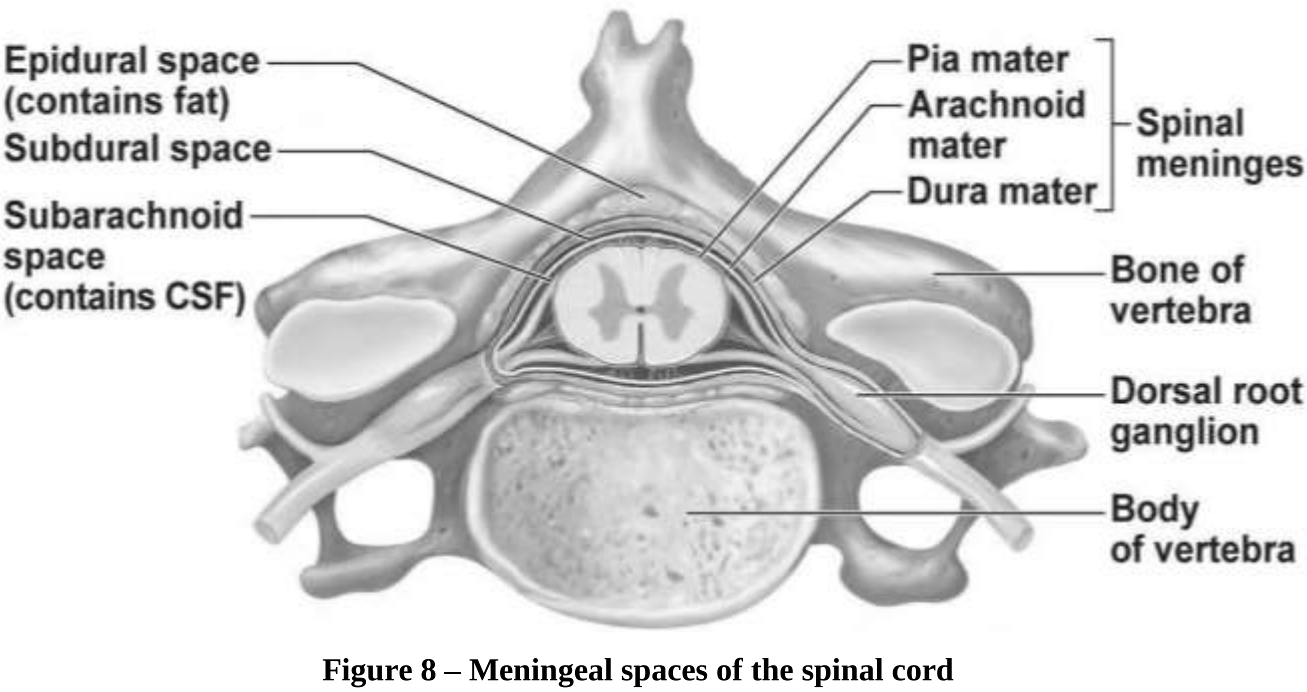


Figure 8 – Meningeal spaces of the spinal cord

II. THE INTERNAL STRUCTURE OF THE SPINAL CORD

The spinal cord is composed of centrally located *gray matter* that is surrounded by *white matter*.

The **gray matter** core resembles an "H" on cross–section (Fig. 9*)* and is composed of nerve cell bodies, neuroglia, and unmyelinated association neurons (interneurons).

It forms:

1. Paired **posterior horns** that extend dorsally and contain **sensory** neurocell bodies.
2. Paired **anterior horns** that extend ventrally and contain somatic **motor** neurocell bodies, whose axons extend out to muscles.
3. Paired **lateral horns** between posterior and anterior horns that extend laterally and contain **autonomic** motor neuron cell bodies. They are present at the spinal cord level from C8 to L2.
4. The **central canal** in the middle; it communicates with the brain ventricles and contains the cerebrospinal fluid.

Along the spinal cord, the *gray matter* forms three paired columns – *anterior, lateral and posterior.*

The **white matter** surrounds gray matter and forms 3 paired (right and left) funiculi:

- *the anterior funiculus* is located between anterior median fissure and anterolateral sulcus
- *the lateral funiculus* is delimited by anterolateral and posterolateral sulci
- *the posterior funiculus* resides between posterolateral and posterior median sulci

The white matter consists of bundles, or **tracts,** ascending and descending myelinated nerve fibers.

Ascending tracts conduct sensory impulses to the brain.

Descending tracts conduct motor impulses from the brain.

Fasciculi proprii.

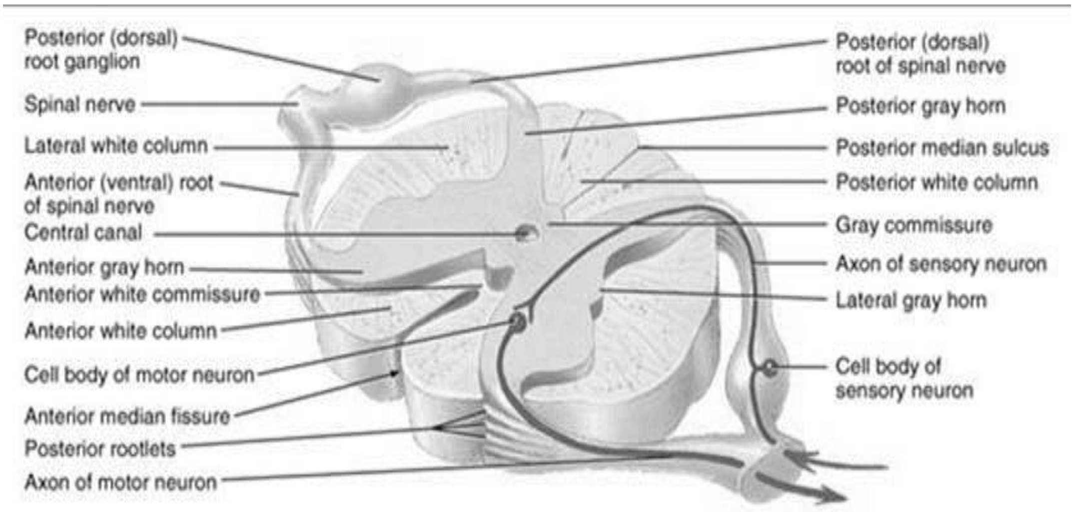


Figure 9 – Cross–section of the spinal cord

The **posterior column** is composed of sensory neurons (Fig. 10). The **posterior horn** is seen in transverse section of the spinal cord. The **apex** of posterior horn consists of **gelatinous substance** and **spongy zone**, primarily consisting of glia and small ganglion cells.

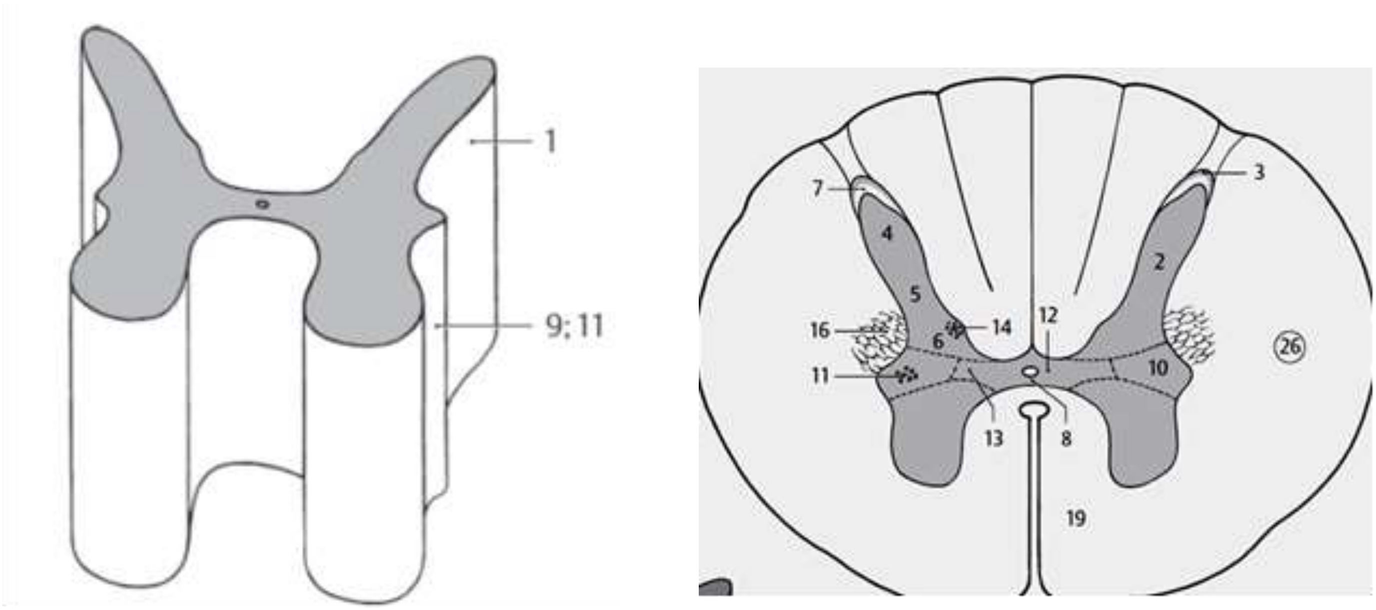


Figure 10 – Posterior horn. Lateral horn: 1 – posterior column; 2 – posterior horn; 3 – apex; 4 – head; 5 – cervix; 6 – base; 7 – gelatinous substance; 9 – lateral column; 10 – lateral horn; 11 – intermediolateral nucleus; 12 – intermediomedial zone; 14 – thoracic column (Stilling–Clarke)

The **head** is a thickened middle part of posterior horn; it contains the **nucleus proprius.** The **cervix** is a thinner segment of posterior horn between the head and base. The **base** is a broadened attachment of the posterior horn to the middle part of the gray matter. The **thoracic nucleus** (Stilling–Clarkes) is located here.

The **lateral column** is the gray matter between the anterior and posterior columns. It extends from C8 to L2. It contains the cells of the sympathetic nervous system forming intermediolateral nucleus.

The **thoracic column (**Stilling–Clarke) lies at the base of the posterior horn and usually extends from C8 –L2.

Cells of the sacral parasymphathetic nervous system are situated between the anterior and posterior horns in the spinal segments S2–S4.

The reticular formation is netlike mixture of gray and white matter in the angle between the lateral and posterior horns.

The **anterior column** comprises predominantly motor neurons (anterior horn cells). The **anterior horn** is seen in transverse section of the spinal cord (Fig. 11). It contains anterolateral, anteromedial, posterolateral, posteromedial and central nuclei.

The nucleus of the accessory nerve lies in segments Cl–C6 in the area of the anterolateral nucleus and provides the spinal root fibers of the accessory nerve. The **nucleus of phrenic nerve** lies in the middle of the anterior horn and extends from segments C4–C7.

The white matter (substantia alba) comprises the fasciculi of nerve fibers that form various tracts (tractus). It enfolds the gray matter and is divided into anterior, lateral and posterior funiculi.

The tracts of the spinal cord (Fig. 12) can be subdivided as follows:

1) *the fasciculi proprii* that associate the segments of spinal cord. They begin from the interneurons of the gray matter and run close to it because they are phylogenetically older than the rest. Together with nearby gray matter, the proper fasciculi form the segmental apparatus of spinal cord;

2) the two–way association apparatus of the brain and the spinal cord comprises the bundles that run from the spinal centers and the spinal ganglia to the brain (*sensory or afferent tracts*) and the bundles that run in opposite direction (*motor or descending tracts*).

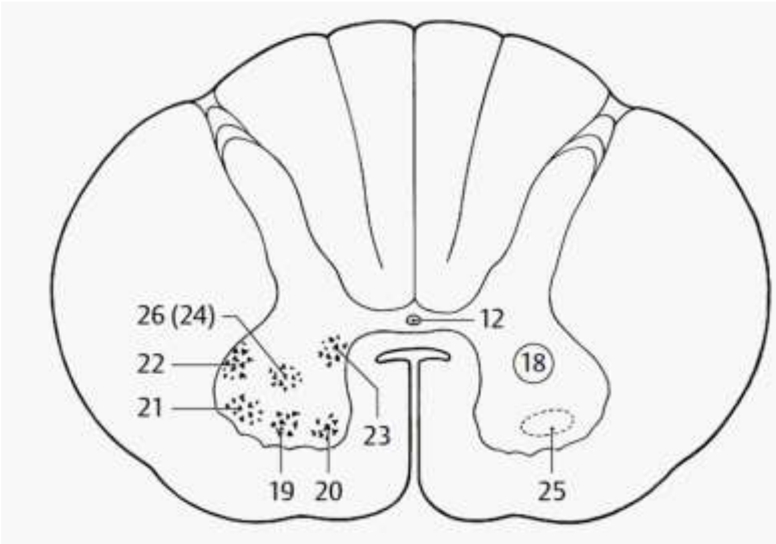


Figure 11 – Anterior horn of the spinal cord: 19 – anterolateral nucleus; 20 – anteromedial nucleus; 21 – posterolateral nucleus; 23 – posteromedial nucleus; 24 – central nucleus; 25 – nucleus of accessory nerve; 26 – nucleus of phrenic nerve

The anterior funiculus contains the fasciculi as follows:

- **the anterior fasciculus proprius**
- **the anterior corticospinal (pyramidal) tract** , that runs from the cerebral cortex to the motor neurons of the anterior columns
- **the vestibulospinal tract** that runs from the vestibular nuclei of the brainstem to the motor neurons of anterior columns
- **the anterior spinothalamic tract,** that arises from the cells of the gelatinous substance at the apex of the posterior horn and ascends to reach the thalamus; it transmits the impulses of tactile sensitivity
- **the tectospinal tract,** that arises from the tectum of midbrain (tectum mesencephali), namely from the proper nuclei of superior and inferior colliculi and reaches the motor neurons of anterior columns
- **the reticulospinal fibers,** that arises from the reticular formation of the brainstem to autonomic neurons of the lateral columns and the motor neurons of the anterior columns

The **lateral funiculus** contains the following fasciculi:

- **the lateral fasciculus proprius**
- **the lateral corticospinal tract** that arises from the cerebral cortex to the motor neurons of the anterior columns. This tract is the largest in the area: it occupies the central portion of the funiculus
- **the rubrospinal tract** that arises from the red nucleus or nucleus ruber of the midbrain and descends to motor neurons of anterior horns; it is adjacent to the previous tract
- **the olivospinal tract** that arise from the inferior olive of the brainstem omoard to the motor neurons of the anterior columns

- **the lateral spinothalamic tract** arises from the cells located within the head of the posterior horn and ascends to the thalamus; it transmits the impulses of pain and temperature sensitivity
- **the anterior (ventral) spinocerebellar tract, (Gower's tract)** that arises from the cells of intermediomedial nucleus and ascends to the cerebellum; it occupies the ventral peripheral portion of funiculus. The tract transmits impulses of proprioceptive sensitivity
- **the posterior (dorsal) spinocerebellar tract (Flechsig's tract)** that arises from the thoracic nucleus of the posterior horn and runs along the ventral peripheral part of the funiculus to the cerebellum; the tract also transmits impulses of proprioceptive sensitivity

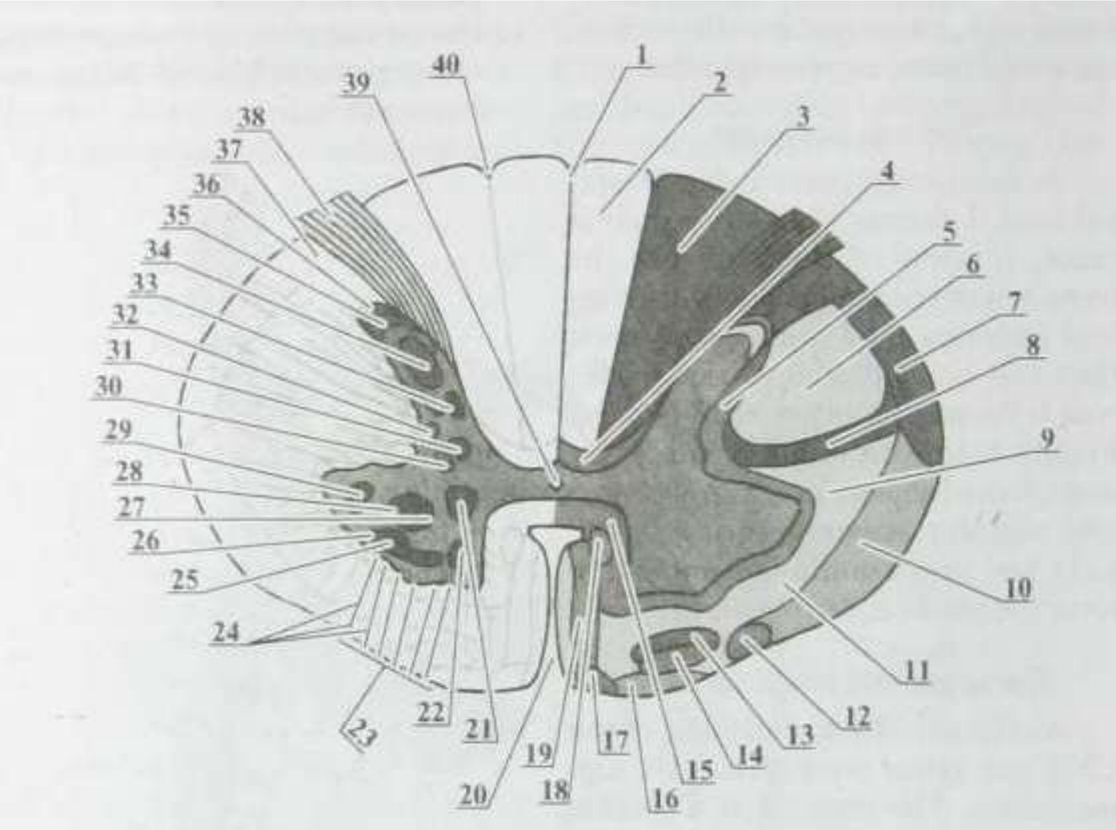


Figure 12 – The cross section of the spinal cord (topography of tracts): 1 – posterior median sulcus; 2 – fasciculus graciis; 3 – fasciculus cuneatus; 4 – posterior fasciculus proprius; 5 – lateral fasciculus proprius; 6 – lateral corticospinal tract; 7 – posterior spinocerebellar tract; 8 – rubrospinal tract; 10 – anterior spinocerebellar tract; 11– lateral spinothalamic tract; 12 – olivospinal tract; 13 – reticulospinal tract; 14 – anterior spinothalamic tract; 15 – anterior fasciculus proprius; 16 – vestibulospinal tract; 17 – tectospinal tract; 19 – anterior corticospinal tract; 20 – anterior median fissure.

The posterior funiculus contains the following fasciculi:

- **the posterior fasciculus proprius**
- **the gracile fasciculus (Goll's tract).** It resides medially and is represented by the central processes of sensory pseudounipolar cells. It ascends to the medulla oblongata and transmits the proprioceptive impulses from the lower limbs and the lower portion of trunk

- **the cuneate fasciculus, (Burdach tract)** that resides laterally from the previous one. It is also represented by the central processes of sensory pseudounipolar neurons located within the spinal ganglia; it ascends to the medulla oblongata as well and functions identically to the previous but collects the impulses from the upper limbs and upper portion of the trunk. Both bundles are evident at the level of Th4 and over; below this level, only gracile fasciculus is present

Spinal Cord Functions

1. Impulse conduction to and from the brain via peripheral white matter tracts:
   a) **ascending tracts** conduct impulses from peripheral sensory receptors to the brain
   b) **descending tracts** conduct impulses from the brain to the motor neurons that affect muscles and glands

2. Reflex integration – centrally located gray matter is involved in spinal reflexes, when nervous system links sensors and effectors (muscles and glands) via a reflex arc.

The spinal reflex arc

All activities of CNS are based on reflexes both conditioned and unconditioned. Reflex is a response of an organism to external or internal stimuli that involves CNS.

During evolution, the spinal cord is the first–order to appear as a solid structure and simple reflex reactions, exterior and interior stimuli, synapse within it (Fig.13).

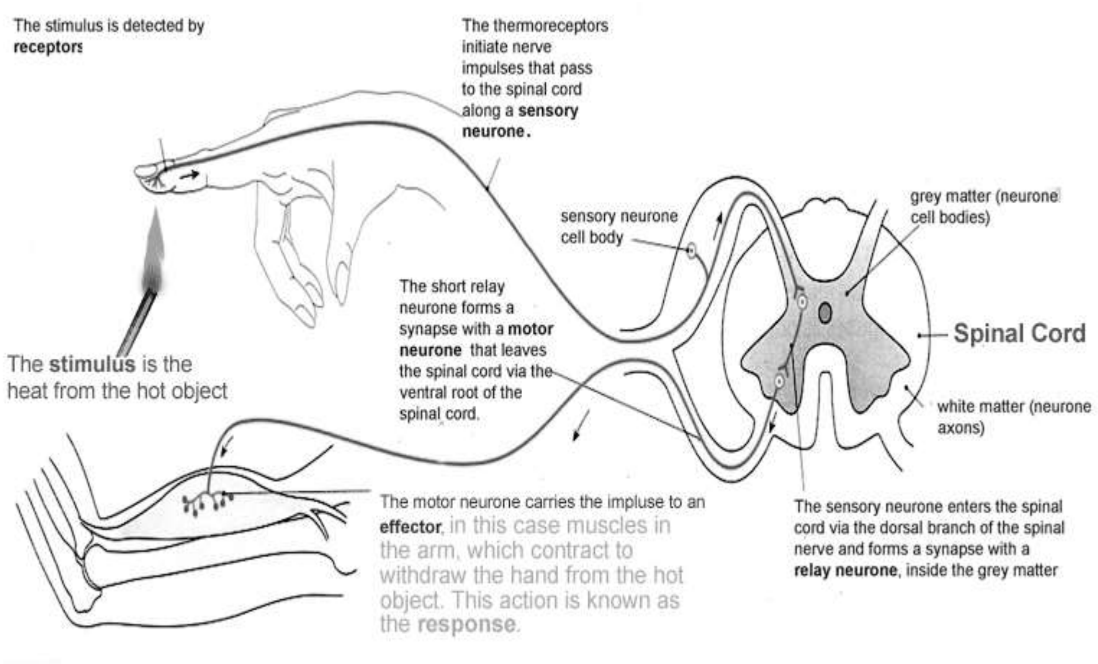


Figure 13 – The reflex arc

Typically, the reflex arc comprises three neurons:

1) the sensory neurons are located in the spinal ganglia. The peripheral processes of sensory pseudounipolar neurons project to the receptors of the trunk and extremities (the receptors are located within the skin, mucous membranes and tendons) that accept stimuli and generate nerve impulses.

The impulses eventually reach the posterior horn of spinal cord via posterior root and proceed to the interneurons

2) the interneurons of simple reflex arc are located within the nuclei of the posterior horns. Some of their axons project directly to the motor nuclei of the anterior gray columns, and some branch off where they ascend and descend and then synapse with the motor nuclei of the upper and lower segments. These branches run 5–6 segments up 5–6 segments down and form the fasciculi proprii adherent to grey substance. Thus, even a small number of stimulated receptors involves nearly a half of spinal segments and related muscles

3) the motor neurons of the anterior gray columns; their axons quit the spinal cord through the anterior root and run within the spinal nerves to reach the respective muscles and set them to motion

Thus, the gray matter with related roots and fasciculi proprii form the proper or segmental apparatus responsible for unconditioned reflexes.

III. EMBRYOGENESIS OF THE BRAIN. A GENERAL SURVEY OF THE BRAIN. THE MEDULLA OBLONGATA

Embryogenesis of the brain. Development of the nervous system begins in the third week with a thickening of the ectoderm called the neural plate. The plate folds inward and forms a longitudinal groove, the *neural groove*. The raised edges of the neural plate are called *neural folds*. As development continues, the neural folds increase in height and meet to form a tube called the *neural tube*.

During the fourth week of embryonic development, the anterior part of the neural tube develops into three enlarged areas called **primary brain vesicles** (Fig. 14). These are the *prosencephalon or forebrain, mesencephalon or the midbrain*, and *rhombencephalon, or the hindbrain*.

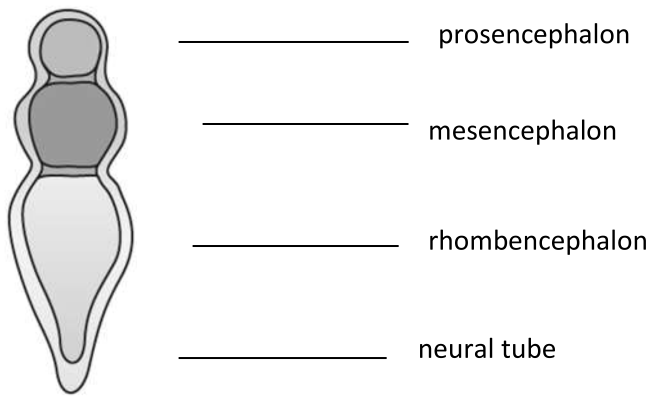


Figure 14 – Primary vesicles

During the fifth week of defelopment, the prosencephalon develops into two **secondary brain vesicles** called the *telencephalon* and the *diencephalon*. The rhombencephalon also develops into two secondary brain vesicles called the *metencephalon* and the *myelencephalon* (Fig. 15).

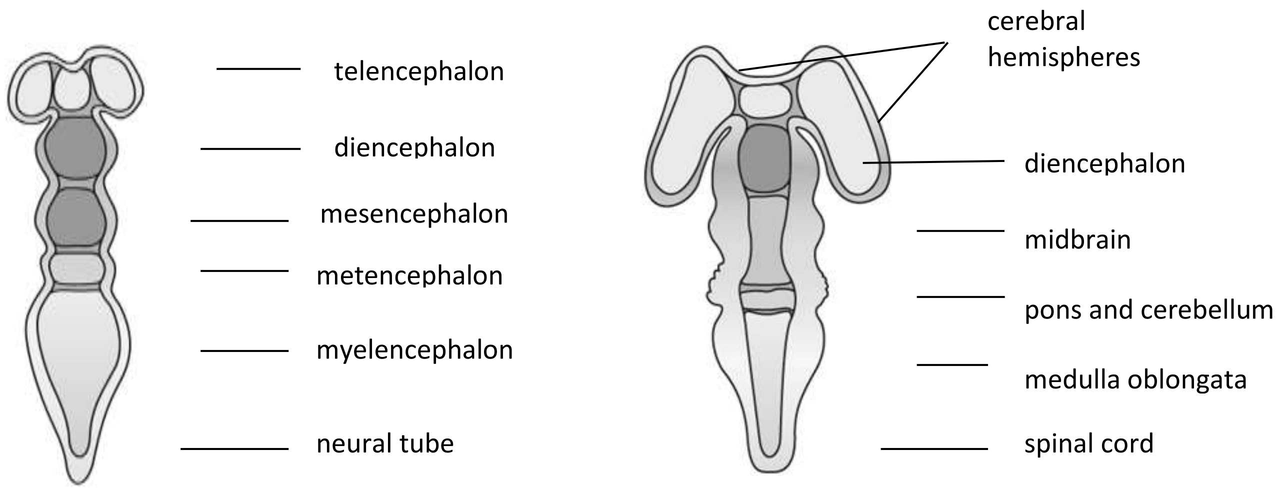


Figure 15 – Secondary vesicles

During this period the brain also develops two major bends, or flexures – a midbrain flexure and a cervical flexure (Fig. 16).

Each secondary brain vesicle develops rapidly to produce the major structures of the adult brain. The greatest change occurs in the telencephalon.

The diencephalon develops three main divisions: the thalamus, the hypothalamus, and the epithalamus.

The mesencephalon forms the midbrain.

Farther caudally, the ventral part of the metencephalon becomes the pons, and the cerebellum develops from the metencephalon's dorsal roof.

The myelencephalon is now called the medulla oblongata (medula oblongata).

The midbrain, pons, and medulla together constitute the brain stem.

Finally, the central cavity of the neural tube enlarges in certain regions to form the hollow ventricles of the brain. Lateral ventricles (I and II) are cavities of telencephalon, the cavity of diencephalon is III ventrice, the cerebral aqueduct is the cavity of midbrain, the IV ventricle is the cavity of the rhombencephalon.

During the late embryonic and the fetal periods, the brain continues to grow rapidly, and changes occur in the relative positions of its parts. Space restrictions force the cerebral hemispheres to grow posteriorly over the rest of the brain, and soon these hemispheres completely envelop the diencephalon and midbrain. As each cerebral hemisphere grows, it bends into a horseshoe shape.

By week 26, the continued growth of the cerebral hemispheres causes their surfaces to crease and fold, until at birth the hemispheres are wrinkled like a walnut. This infolding allows more neurons to fit in the limited space.

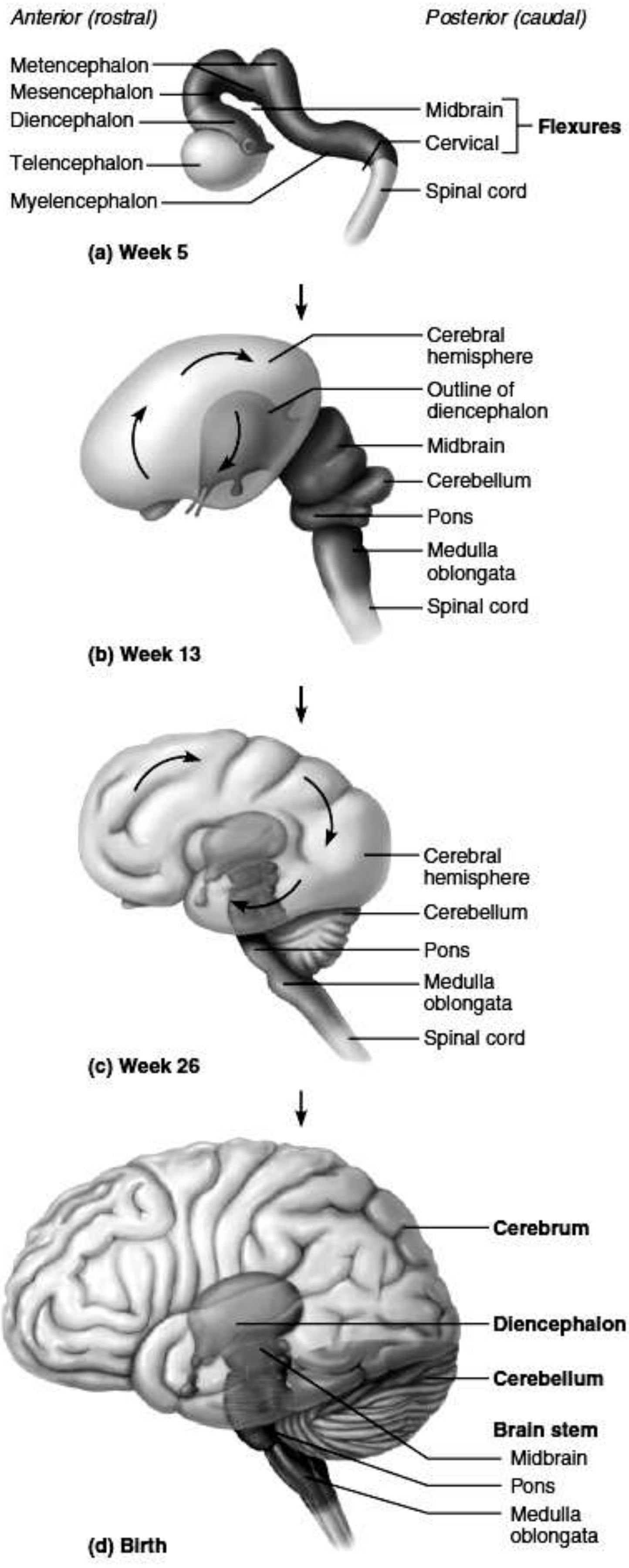


Figure 16 – Embryogenesis of the brain

A GENERAL SURVEY OF THE BRAIN (ENCEPHALON)

The term 'encephalon' originates from two Greek words: 'en' — 'within', and 'kephale' — 'head'.

The brain consists of three large principal parts:

- **the cerebral hemispheres**
- **the cerebellum**
- **the brainstem**

The brain comprises five compartments that develop from secondary vesicles:

1) the telencephalon
2) the diencephalon
3) the midbrain
4) the mesencephalon
5) the medulla oblongata that becomes continuous with the spinal cord at the level of foramen magnum

Right and left cerebral hemispheres are separated by deep **longitudinal cerebral fissure.** It lodges the falx cerebri. Posteriorly, it joins the **transverse cerebral fissure** that separates the cerebral hemispheres from the cerebellum.

The surface of hemispheres features numerous cerebral sulci. The deeper interlobar sulci delimit the cerebral lobes. The smaller and shallower sulci delimit the cerebral gyri on respective lobes (Fig. 17).

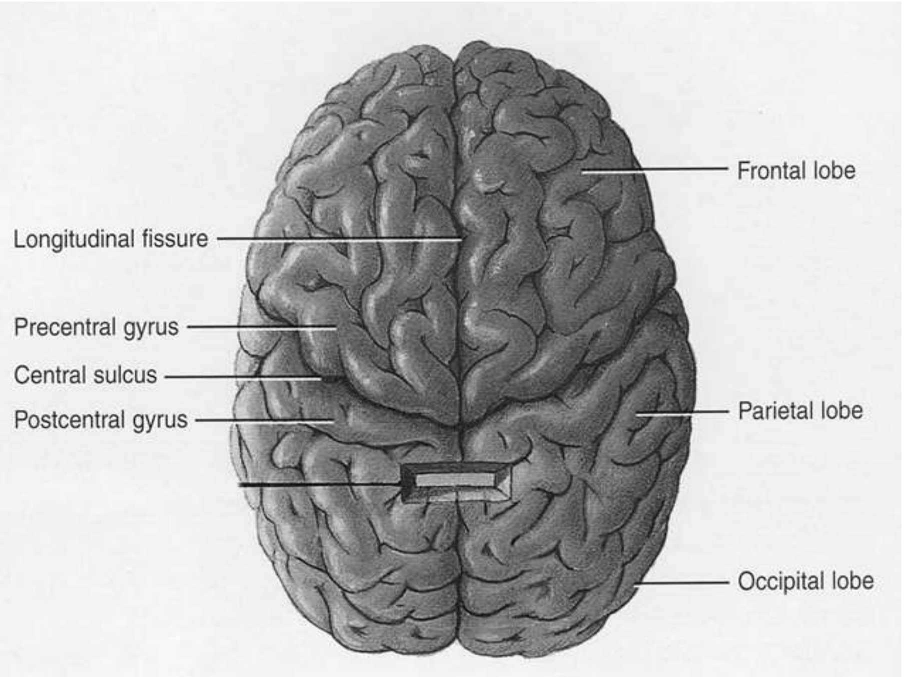


Figure 17 – Cerebral hemispferes, superior view

Superior (superomedial) margin of a hemisphere separates the superolateral and medial surface.

Inferolateral border of a hemisphere is located between the superolateral and inferior surfaces.

Medial (inferomedial) margin of either hemisphere is located between the inferior and medial surfaces.

Each cerebral hemisphere has three surfaces:

Superolateral surface

It follows the concavity of the cranial vault, upper and lateral surface of the hemisphere (Fig. 18). There are four lobes of the cerebrum: *frontal*, *parietal*, *temporal* and *occipital*. *Lateral fossa* of cerebrum is a deep space within the lateral sulcus.

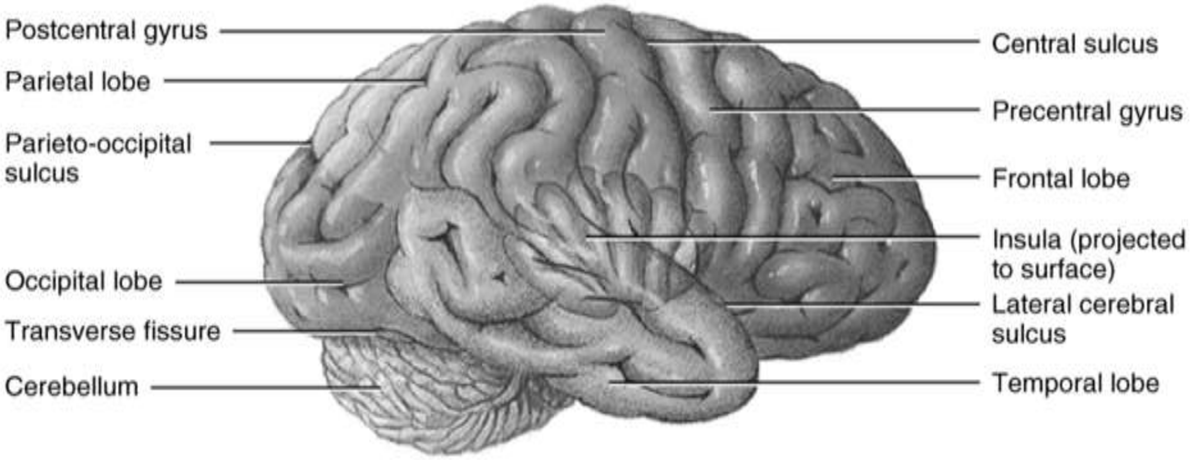


Figure 18 – The superolateral surface of the cerebral hemisphere

Inferior surface

Inferior surface is formed of cerebral hemispheres, cerebellum and brainstem (Fig. 19). In the order from front to back, there are visible *olfactory bulbs*, which are continuous with the *olfactory tracts* that run backward and terminate at the *olfactory trigone*. Behind the latter, there is an *anterior perforated substance*, which is bounded medially by the *optic chiasm* formed by the decussation of the *optic nerves* (2nd pair of cranial nerve). The optic chiasm gives rise to the right and left *optic tracts*.

To the back of chiasm, there is the tuber cinereum with the *infundibulum*, where the *pituitary gland (hypophysis)* attaches.

Posterior to the tuber cinereum, there are *mammilary bodies*, *interpeduncular fossa*, which is filled with the *posterior perforated substance*. The oculomotor nerve (3d pair of cranial nerves) arises from the medial surface of each cerebral peduncle. The trochlear nerve (CN–IV) is visible laterally the cerebral peduncles.

The *pons* is situated behind the cerebral peduncles. Its lateral narrowed portions form the *middle cerebellar peduncles*. The trigeminal nerve (CN–V) exits laterally the pons. Behind the pons is the *medulla oblongata*. The groove between the pons and the medulla oblongata passes the *abducent nerve* (CN–VI). Still father laterally, at the posterior margin of the middle cerebellar peduncles, on each side, there are other two nerves located closer to each other. They are the *facial* (CN–VII) and *vestibulo–cochlear* (CN–VIII) nerves. The *hypoglossal nerve* (CN–XII) roots emerge between the *pyramid* and the *olive* of the medulla oblongata. The roots of glossopharyngeal (CN–IX), vagus (CN–X) and accessory (CN–XI) nerves emerge behind the olive.

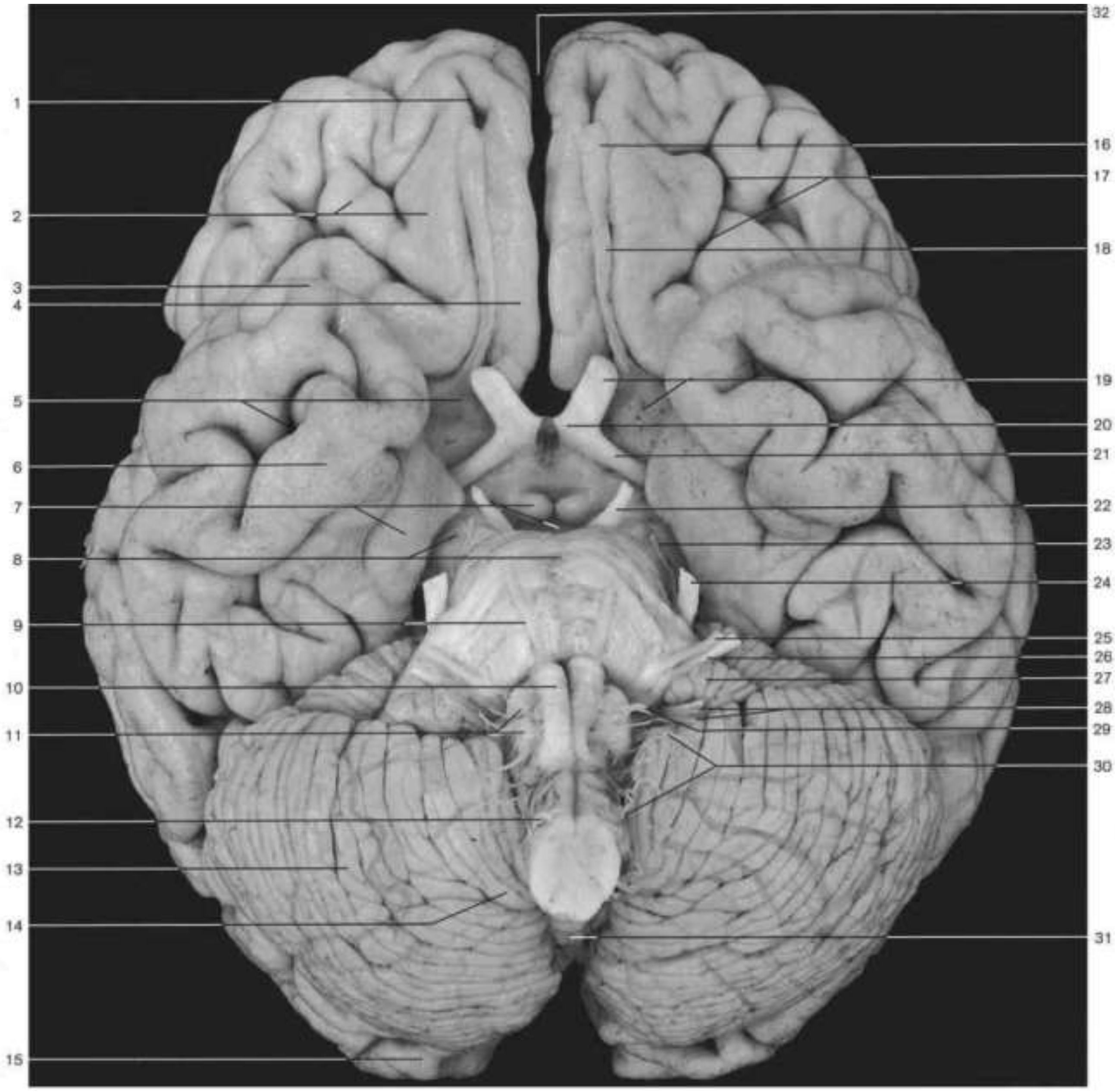


Figure 19 – Inferior surface of the brain: 1– olfactory sulcus (termination); 2 – orbital gyri; 3 – temporal lobe; 4 – straight gyrus; 5 – olfactory trigone and inferior temporal sulcus; 6 – medial occipitotemporal gyrus; 7 – parahippocampal gyrus, mamillary body, and interpeduncular fossa; 8 – pons and cerebral peduncle; 9 – abducent nerve (CN VI); 10 – pyramid; 11 – inferior olive; 12 – cervical spinal nerves; 13 – cerebellum; 14 – tonsil of cerebellum; 15 – occipital lobe (posterior pole); 16 – olfactory bulb; 17 – orbital sulci of frontal lobe; 18 – olfactory tract; 19 – optic nerve (CN II) and anterior perforated substance; 20 – optic chiasma; 21 – optic tract; 22 – oculomotor nerve (CN III); 23 – trochlear nerve (CN IV); 24 – trigeminal nerve (CN V); 25 – facial nerve (CN VII); 26 – vestibulocochlear nerve (CN VIII); 27 – flocculus of cerebellum; 28 – glossopharyngeal nerve (CN IX) and vagus nerve (CN X); 29 – hypoglossal nerve (CN XII); 30 – accessory nerve (CN XI); 31 – vermis of cerebellum; 32 – longitudinal fissure.

It is flat and seperated from its congener by the great longitudinal fissure and the falx cerebri. In the center, there is the *corpus callosum,* which associates the hemispheres. The middle portion of the corpus callosum is called the *trunk*; the posterior thickened portion is called *splenium* and the anterior portion is called the *genu*. The genu continuous with the *rostrum*. The *lamina terminalis* runs from the rostrum to the inferior surface of the brain and adheres to the optic chiasm. Below the corpus calosum there is the *fornix*. The *corpus of the fornix* adheres to the corpus callosum. Its anterior portion, the *column*, reaches the mammillary bodies. The *anterior commissure* is located between the fornix and the lamina terminalis. A thin plate between the corpus callosum and the fornix is called the *septum pellucidum*. It closes anterior horns of lateral ventricles. The *thalamus* resides below the fornix. The medial surfaces of the right and left thalami form the lateral walls of the third ventricle placed vertically. A passage between the column of the fornix and the anterior thalamic tubercle is called the *interventricular foramen* that communicates the lateral ventricle with the third ventricle.

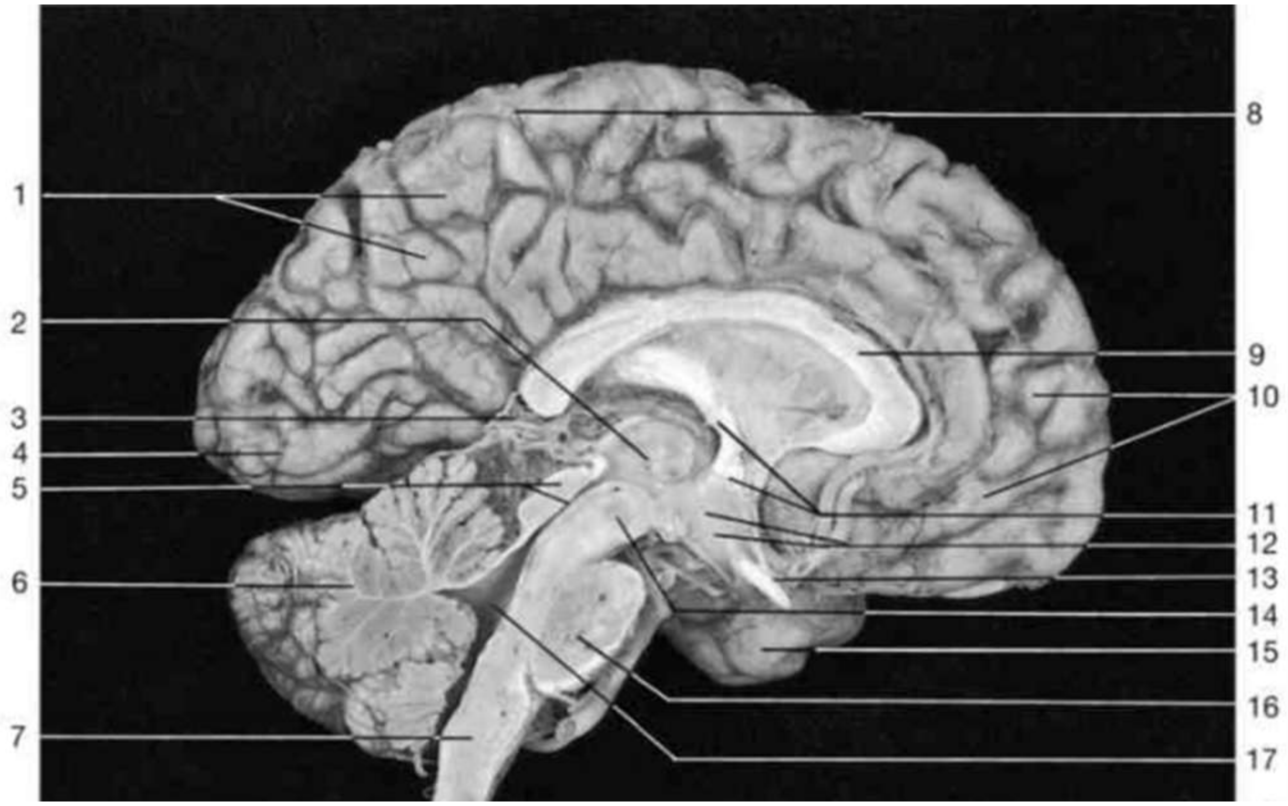


Figure 20 – The medial surface of the cerebral hemisphere: 1 – parietal lobe; 2 – thalamus, the third ventricle; 3 – great cerebral vein; 4 – occipital lobe; 5 – colliculi of the midbrain and cerebral aqueduct; 6 – cerebellum; 7 – medulla oblongata; 8 – central sulcus; 9 – corpus callosum; 10 – frontal lobe; 11 – fornix and anterior commissure; 12 – hypothalamus; 13 – optic chiasma; 14 – midbrain; 15 – temporal lobe; 16 – pons; 17 – fourth ventricle

The *hypothalamic sulcus* arises from the interventricular foramen and runs backward, delimiting the thalamus from the *hypothalamus*.

The pineal gland (epiphysis) is located above and behind the thalamus. Below the epiphysis, there is the *posterior commissure*. *The tectal plate* resides below the posterior commissure, it is a part of the midbrain. The *cerebral aqueduct*, the cavity of the midbrain, communicates the third and the fourth ventricles.

The superior medullary velum is stretched between the tectal plate and cerebellum.

The medulla oblongata is continuous below, through the foramen magnum, with the spinal cord, and above, with the pons; posteriorly, it is connected with the cerebellum by inferior cerebellar peduncles.

External features of the medulla oblongata.

The anterior surface of the medulla is grooved by the ***anteromedian fissure***, on either side of which there are longitudinal elevations, ***pyramids*** (Fig. 21). Both pyramids continue with anterior funiculi of the spinal cord. The ***decussation of pyramids*** resides below the pyramids. Here, the most of motor fibers cross before the spinal cord entry.

Pyramids are separated from the lateral surface by the ***anterolateral sulcus,*** along which the rootlets of the XII–th cranial nerve emerge. The lateral surface of the medulla oblongata is represented by ***olives***.

The ***posterolateral sulcus*** separates the olives and ***posterior (dorsal) surface*** of the medulla oblongata. It passes the roots of cranial nerves IX, X and XI. The posteromedian sulcus of the cord is continued half–way up the medulla, where it widens out to form the posterior part of the IVth ventricle. On either side of the posteromedian sulcus, the posterior columns of the spinal cord expand to form ***gracile and cuneate tubercles***.

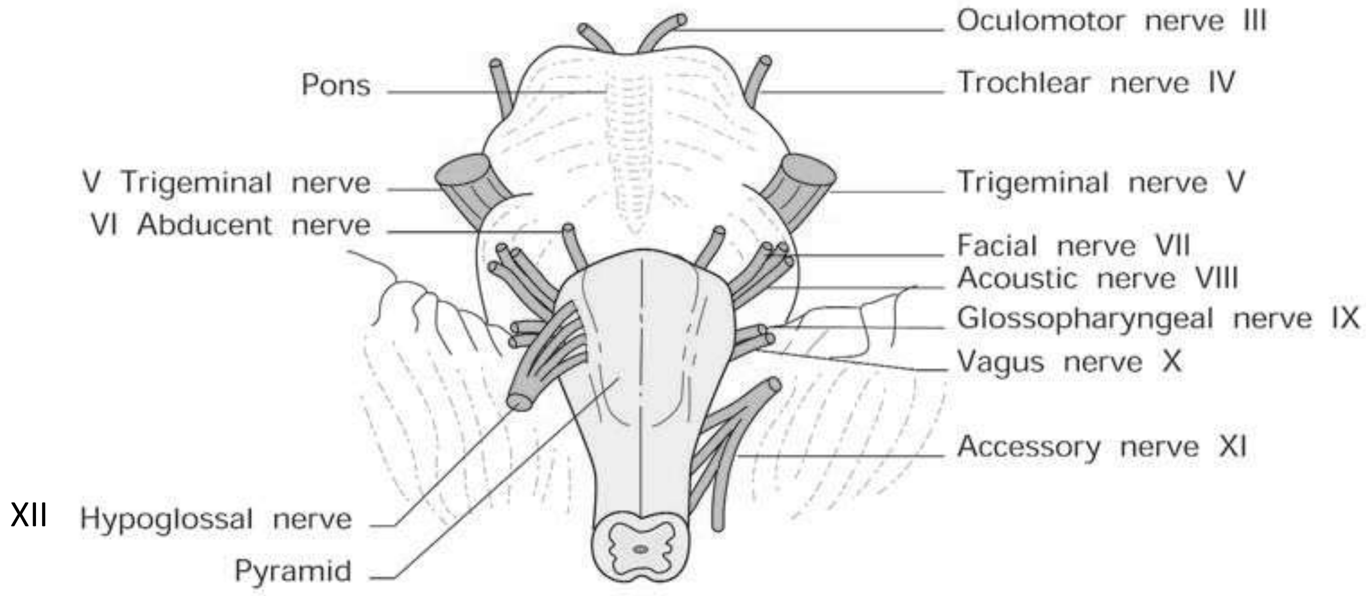


Figure 21 – Anterior (ventral) surface of the medulla oblongata and the pons

Internal structure of medulla oblongata (Figs. 22, 23 and Table 1).

The grey matter is represented by:

- **the inferior olivary nucleus**, which resides within the olives. It communicates with the cerebellum via the olivocerebellar tract and with spinal cord via the olivospinal tract. The olivary nucleus controls body equilibrium
- the reticular formation. It comprises small and large neurons with well–branched processes that form wide networks. It is connected with spinal cord via reticulospinal tract

- the nuclei of cranial nerves IX, X, XI, and XII are located within the dorsal portion of the medulla oblongata
- the respiratory, cardiac and vasomotor centres are the ‘vital centres’. The respiratory centre is particularly vulnerable to compression, injury or poliomyelitis with consequent respiratory failure
- the cuneate and gracile nuclei are found within respective tubercles

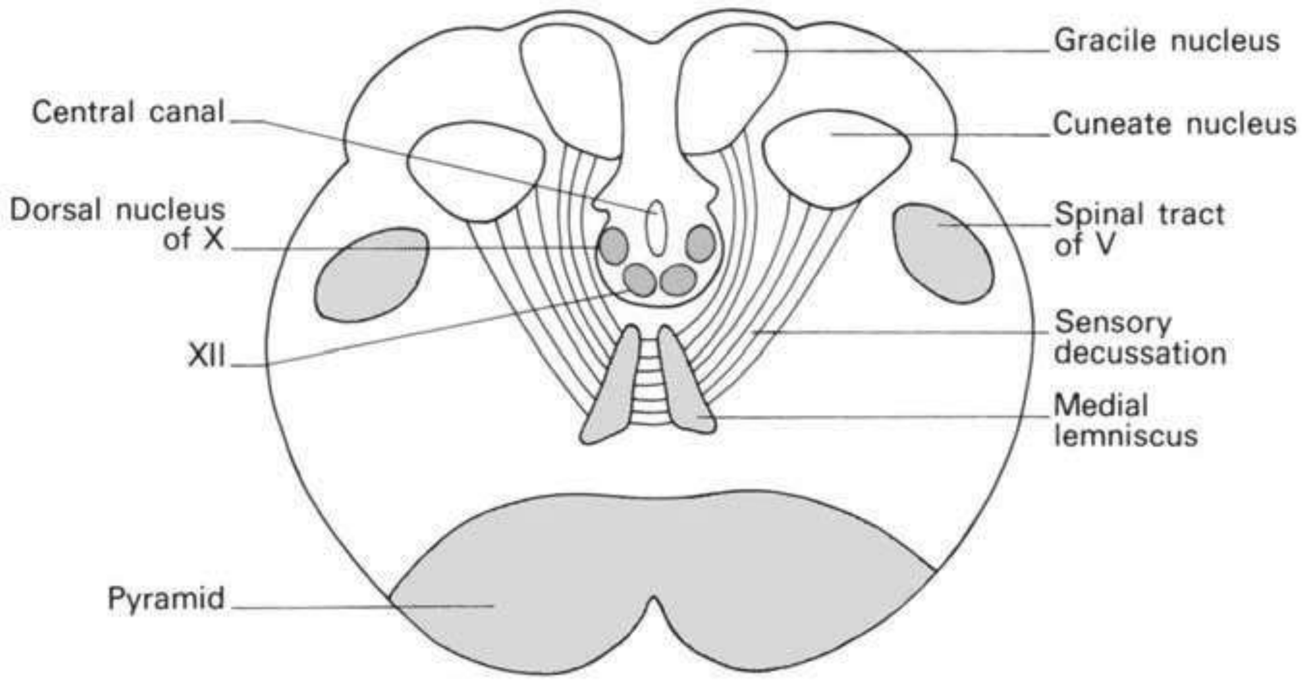


Figure 22 – Cross–section of the medulla at the level of the sensory decussation

The white matter of the medulla oblongata forms the following tracts:

- **the pyramidal tract** (descending, motor) is formed by corticospinal fibers that transit the medulla oblongata. About 80 % of fibers decussate below pyramids and proceed to the lateral funiculus of the spinal cord forming the lateral corticospinal tract. Fibers that bypassed decussation (about 20 %) descend to the anterior funiculus of the spinal cord and run as the anterior corticospinal tract. These fibers decussate within the respective segments
- **the medial lemniscus** pathway is a bundle of neurofibers that arises from the cuneate and gracile nuclei on each side and ascends to the thalamus, forming the bulbothalamic tract. Upon arising, the fibers arch in ventral direction and enter the depth of the medulla oblongata, forming the decussation of the medial lemniscus between the inferior olives.

Thus, the white matter forms two decussations in the medulla oblongata, namely the ventral, motor, pyramidal decussation and the dorsal, sensory decussation, also known as the medial lemniscus.

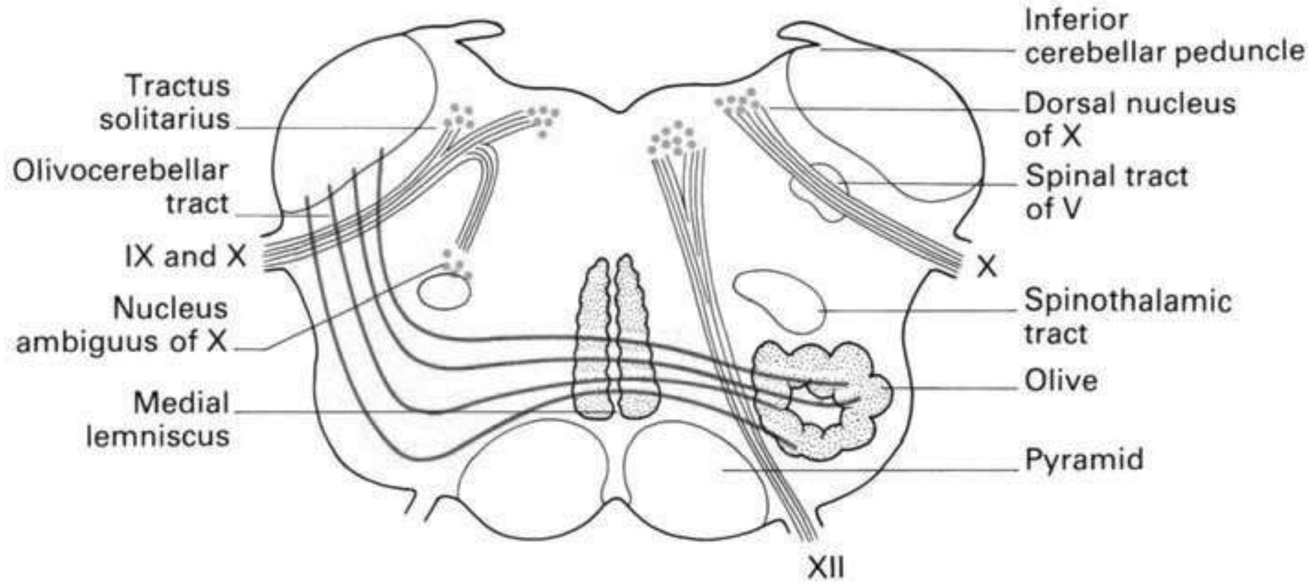


Figure 23 – Cross–section of the medulla at the level of the caudal part of the 4th ventricle

Table 1 – Medulla oblongata

Region/Nucleus	**Functions**
GRAY MATTER	
Nucleus gracilis **Nucleus cuneatus**	Relay somatic sensory information to the ventral posterior nuclei of the thalamus
Olivary nuclei	Relay information from the spinal cord, the red nucleus, other midbrain centers, and the cerebral cortex to the vermis of the cerebellum
Reflex centers Cardiac centers Vasomotor centers Respiratory rhythmicity centers	Regulate heart rate and force of contraction Regulate distribution of blood flow Set the pace of respiratory movements
Other nuclei/centers	Sensory and motor nuclei of four cranial nerves (IX, X, XI, XII) Nuclei relaying ascending sensory information from the spinal cord to higher centers
WHITE MATTER	
Ascending and descending tracts	Link the brain with the spinal cord

IV. THE PONS AND CEREBELLUM. THE RHOMBOID FOSSA. THE FOURTH VENTRICLE

The pons (Fig. 21) lies between the medulla and the midbrain and is connected to the cerebellum by the middle cerebellar peduncles. Its ***ventral surface*** presents a ***basilar sulcus*** which houses the basilar artery and numerous transverse ridges. ***The dorsal surface*** of the pons forms the upper part of the floor of the IVth ventricle. Its junction with the medulla is marked close to the ventral midline by the emergence of the VIth cranial nerves. In the angle between the pons and the cerebellum there are roots of VIIth and VIIIth cranial nerves. Both the motor and sensory roots of Vth cranial nerve leave the lateral part of the pons near its upper border.

Internal structure

Like the medulla, the pons consists of both nuclei and tracts (Table 2). As its name implies, the pons is a bridge that connects the parts of the brain with one another. These connections are provided by bundles of axons. Some axons of the pons connect the right and left sides of the cerebellum. Others are part of ascending sensory tracts and descending motor tracts. The pons has two major structural components: a *basilar part* and a *dorsal part*, which are delimited by the ***trapezoid body***. The trapezoid body is represented by the fibers and nuclei that belong to the auditory tract.

Table 2 – The pons

Region/Nucleus	Functions
GRAY MATTER	
Respiratory centers	Modify output of respiratory centers in the medulla oblongata
Other nuclei/centers	Nuclei associated with four cranial nerves (V, VI, VII, VIII) and the cerebellum
WHITE MATTER	
Ascending and descending tracts	Interconnect other portions of CNS
Transverse fibers	Interconnect the cerebellar hemispheres; interconnect the pontine nuclei with the cerebellar hemispheres on the opposite side

The basilar part of the pons forms a large synaptic relay station consisting of scattered gray centers called ***the pontine nuclei***. Entering and exiting these nuclei are numerous white matter tracts (***pontocerebellar tracts***), each providing a connection between the cortex of a cerebral hemisphere and that of the opposite hemisphere of the cerebellum. This complex circuitry plays an essential role in coordinating and maximizing the efficiency of voluntary motor output throughout the body.

The basilar part transmits the following descending tracts:

- corticospinal (pyramidal) tracts;
- corticonuclear tracts that synapse with the motor nuclei of the cranial nerves;
- corticopontine tracts that connect the cerebral cortex with the pontine nuclei.

The dorsal part of the pons contains ascending tracts which are represented by the medial lemniscus. It also contains nuclei of the cranial nerves V–VIII.

The **cerebellum** is the secondlargest part of the brain; it occupies the inferior and posterior aspects of the cranial cavity. Like the cerebrum, it has a highly folded surface that greatly increases the surface area of its outer gray matter cortex, allowing for a greater number of neurons. A deep groove between the cerebrum and cerebellum, known as the transverse fissure, is occupied by the tentorium cerebelli which supports the posterior part of the cerebrum and separates it from the cerebellum. The tentorium cerebelli is a tentlike fold of the dura mater. The central constricted area is called ***the vermis***, and the lateral lobe – the ***cerebellar hemispheres*** (Figs. 24, 25).

The ***horizontal fissure*** separates ***superior and inferior parts*** of each hemispheres.

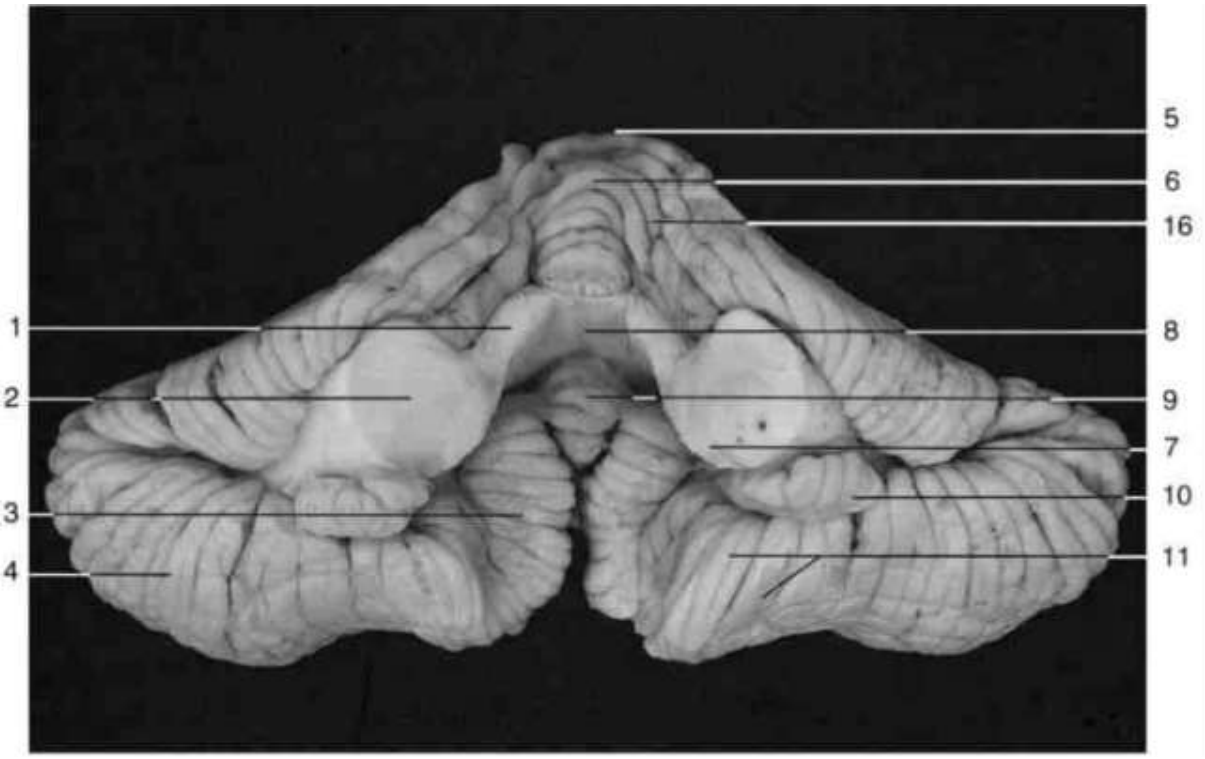


Figure 24 – Ventral aspect of the cerebellum: 1 – superior cerebellar peduncle; 2 – middle cerebellar peduncle; 3 – cerebellar tonsil; 4 – inferior semilunar lobule; 5 – vermis; 6 – central lobule of vermis; 7 – inferior cerebellar peduncle; 8 – superior medullary velum; 9 – nodule of vermis; 10 – flocculus of cerebellum

Phylogenetic divisions of cerebellum are:

- **archicerebellum**, the oldest part; it is involved into body equilibrium control and is represented with ***flocculonodular lobe*** (paired lateral flocculi with midline nodulus)
- **paleocerebellum**, ***the anterior lobe***, cotrols muscle tone, coordinates the movements and controls body equilibrium
- **neocerebellum**, ***the posterior lobe***, is the largest anatomical subdivision of the cerebellum in humans. It is separated from the anterior lobe by ***primary fissure***. The posterior lobe controls both voluntary and automated movements

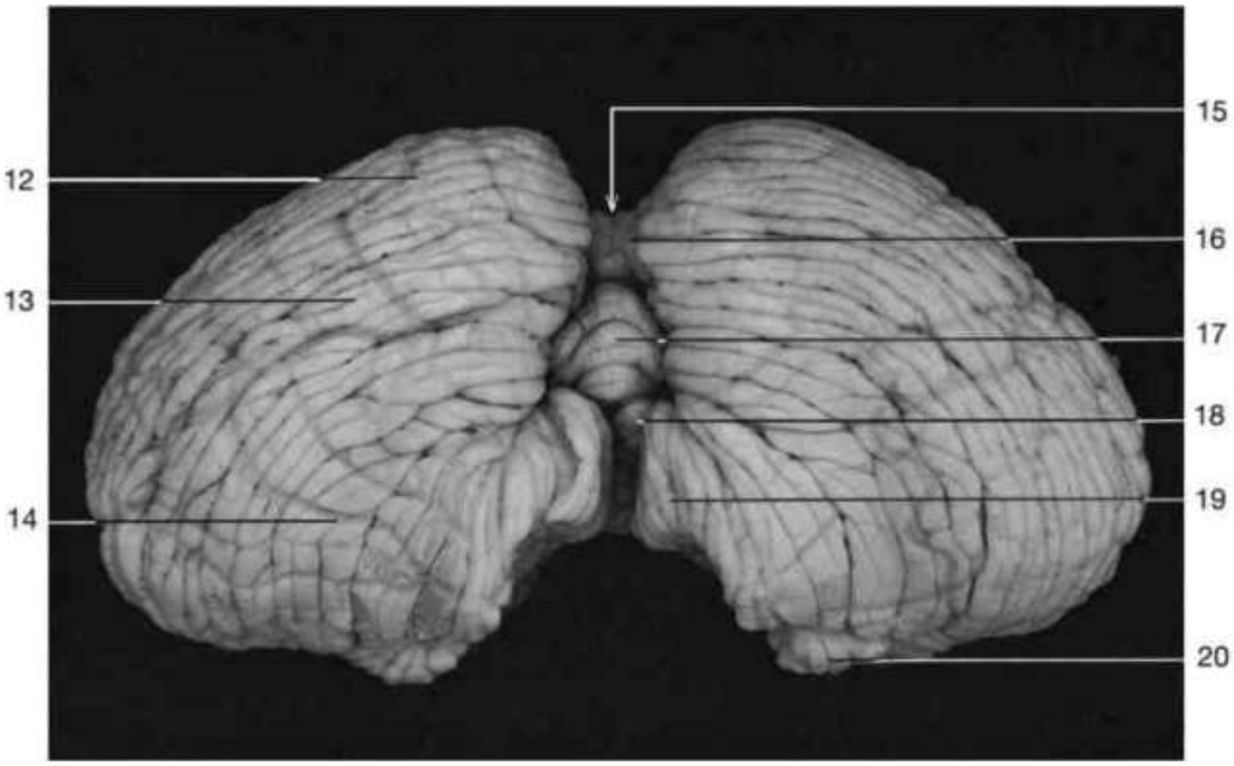


Figure 25 – The dorsal aspect of the cerebellum: 12 – left cerebellar hemisphere; 13 – inferior semilunar lobule; 14 – biventral lobule; 15 – vermis of cerebellum; 16 – tuber of vermis; 17 – pyramid of vermis; 18 – uvula of vermis; 19 – tonsil of cerebellum; 20 – flocculus of cerebellum

The superficial layer of the cerebellum, called ***the cerebellar cortex***, consists of grey matter in a series of slender, parallel ridges called folia. Saggital section (Fig. 26) resembles branches of a tree, formed by arrangement of white and grey matter and is called the ***arbor vitae*** (tree of life). Even deeper, within the white matter, there are the cerebellar nuclei, regions of gray matter that give rise to axons carrying impulses from the cerebellum to other brain centers and to the spinal cord (Fig. 27).

The cerebellar nuclei are as follows:

- ***the dentate nucleus***
- ***the emboliform nucleus***
- ***the globose nucleus***
- ***the fastigial nucleus***

Three paired cerebellar peduncles attach the cerebellum to the brain stem (Fig. 24). These bundles of white matter consist of axons that conduct impulses between the cerebellum and other parts of the brain.

The ***inferior cerebellar peduncles*** associate the cerebellum with medulla and contain the posterior spinocerebellar, olivocerebellar and vestibulocerebellar tracts.

The ***middle cerebellar peduncles*** are the largest peduncles. They associate cerebellum with the pons passing pontocerebellar fibers.

The ***superior cerebellar peduncles*** contain axons that extend from the cerebellum to the red nuclei of the midbrain (dentatorubral tract) and to several nuclei of the thalamus (dentatothalamic tract). Also the anterior spinocerebellar tract passes through the superior cerebellar peduncle.

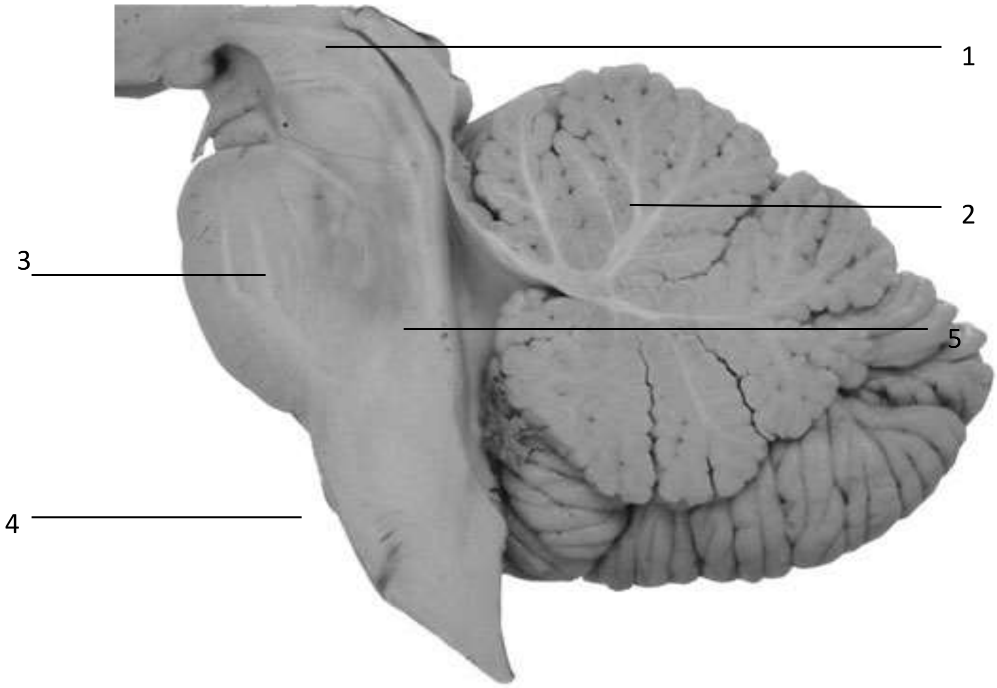


Figure 26 – The saggital section of the cerebellum and brainstem: 1 – midbrain; 2 – arbor vitae; 3 – pons; 4 – medulla; 5 – IVth ventricle

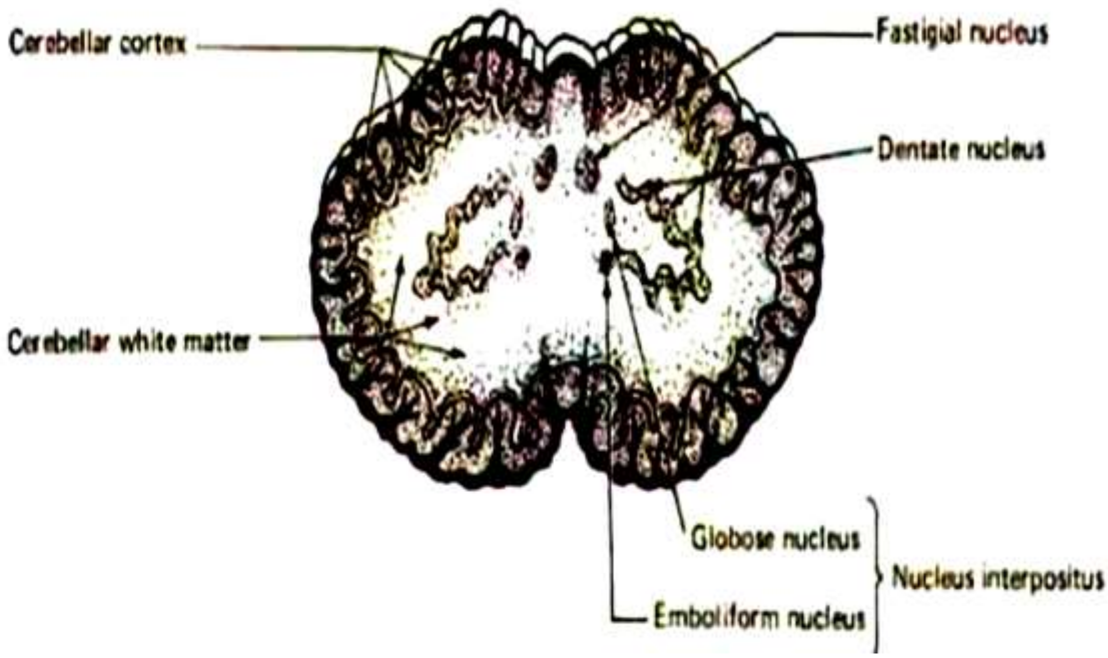


Figure 27 – Nuclei of the cerebellum

The primary function of the cerebellum is to evaluate how well movements initiated by motor areas in the cerebrum are actually being carried out. When movements initiated by the cerebral motor areas are not being carried out correctly, the cerebellum detects the discrepancies. Then it sends inhibitory feedback signals to motor areas of the cerebral cortex via its connections to the red nucleus and thalamus. The feedback signals help to correct the errors, smooth the movements, and coordinate complex sequences of skeletal muscle contractions. The cerebellum is also the main brain region that regulates posture and balance. These aspects of cerebellar function make it possible to perform all kinds of skilled muscular activities.

THE FOURTH VENTRICLE

The fourth ventricle is a roughly tent–shaped cavity filled with cerebrospinal fluid, situated beneath the cerebellum, above the pons and above the dorsal part of the medulla. Laterally, the ventricle is bounded by the superior and inferior cerebellar peduncles.

The roof or dorsal surface of the fourth ventricle consists of a sheet of white nonnervous tissue called the superior and inferior medullary velum. The ***superior medullary velum*** is stretched between the superior cerebellar peduncles, and the ***inferior medullary velum*** – between the floccular peduncles. A layer of pia mater covers the inner lining. An opening, situated at the caudal part of the roof, is called the ***foramen of Magendie***; it connects the subarachnoid space and the interior of the ventricle. The ventricle communicates with the subarachnoid space also through two lateral openings called the ***foramen of Luschka***. Situated caudally above the ventricular roof, there is a double layer of pia mater, called the *tela choroidea*, which lies between the cerebellum and the ventricular roof. The tela choroidea is highly vascularized, and its blood vessels project through the roof of the caudal part of the ventricle to form the choroid plexus. The choroid plexus produces the cerebrospinal fluid.

The floor or ***rhomboid fossa*** of the fourth ventricle is formed by the dorsal surfaces of the medulla and pons.

The fossa rhomboidea extends from the aqueduct of the midbrain superiorly and to the spinal cord inferiorly.

The ***sulcus medianus*** stretches on the midline of the fossa. On either side of the sulcus medianus, there are two ***medial eminences***. The motor nuclei of the cranial nerves lie in the depth of these eminences. In the upper portion of the eminentia medialis there is the ***facial colliculus***. The eminentia medialis are bounded laterally by the ***sulcus limitans***.

The eminentia medialis gradually narrows downward and continuous with the ***hypoglossal triangle;*** the nucleus of the hypoglossal nerve is located within it. Laterally to the lower part of this triangle, there is the ***vagal triangle***.

In the region of the lateral angles, at both sides, there is the ***vestibular area***; the nuclei of the eight pair of nerves lie here.

Some of the fibres, emerging from them pass across the rhomboid fossa from the lateral angles to the median sulcus. There are the ***stria medullaris*** or stria acustica. These stria divide the rhomboid fossa into two triangles, inferior and superior, and correspond to the junction of the medulla oblongata and pons.

There is bluish depressed area, the locus caeruleus, above the superior fovea. Its colour is due to the presence of pigmented cells.

Topography of the rhomboid fossa grey matter

The nuclei of the V–XII cranial nerves are locted in the depth of the rhomboid fossa. The somatic motor nuclei of the CN lie in the medial row (within the medial eminence), the autonomic nuclei – in the middle row, and the somatic sensory nuclei located laterally (Fig. 28).

Projection of the CN nuclei in the rhomboid fossa are as follows:

1. The Vth cranial nerve, or **trigeminal nerve,** has one motor and three sensory nuclei:

- the pontine nucleus
- the mesencephalic nucleus
- the nucleus of the spinal tract

2. The VIth cranial nerve, or **abducent nerve,** has one motor nucleus. It corresponds to the facial colliculus.
3. The VIIth cranial nerve, or **facial nerve**, has following nuclei:

- the motor nucleus. The nerve fibres arising from it form a loop in the deepth of the pons, which protrudes in the rhomboid fossa as the facial colliculus
- the autonomic nucleus – the ***superior salivary nucleus***
- the sensory nucleus – the ***nucleus of the solitary tract***

4. The VIIIth cranial nerve, or auditory, or **vestibulocochlear nerve,** has six sensory nuclei projected in the vestibular area. The nuclei are divided into two groups. Pars cochlearis, or the cochlea nerve, has two nuclei:

- ***the dorsal cochlear nucleus***
- ***the ventral cochlear nucleus***

Pars vestibularis, or the vestibular nerve, has four nuclei:

- ***the medial vestibular nucleus or Schwalbe's nucleus***
- ***the lateral vestibular nucleus or Deiter's nucleus***
- ***the superior vestibular nucleus or Bechterew's nucleus***
- ***the inferior vestibular nucleus or Roller's nucleus***

5. The IXth cranial nerve or **glossopharyngeal nerve**. It contains the following three nuclei:

- the sensory nucleus of the solitary tract; it is common with the VIIth, IXth and Xth cranial nerves
- the autonomic – the inferior salivary nucleus
- the ambiguus nucleus is common with the IXth, Xth and XIth cranial nerves

6. The Xth cranial nerve, or **vagus nerve**, has the following three nuclei:

- the sensory nucleus of the solitary tract
- the autonomic – dorsal nucleus of the vagus nerve, located in the vagal triangle
- the motor nucleus ambiguus

7. The XIth cranial nerve, or **accessory nerve**, has two motor nuclei:

- the spinal nucleus of the accessory nerve
- the nucleus ambiguous

8. The XIIth cranial nerve, or **hypoglossal nerve**, has one motor nucleus, which is located in the region of the hypoglossal triangle.

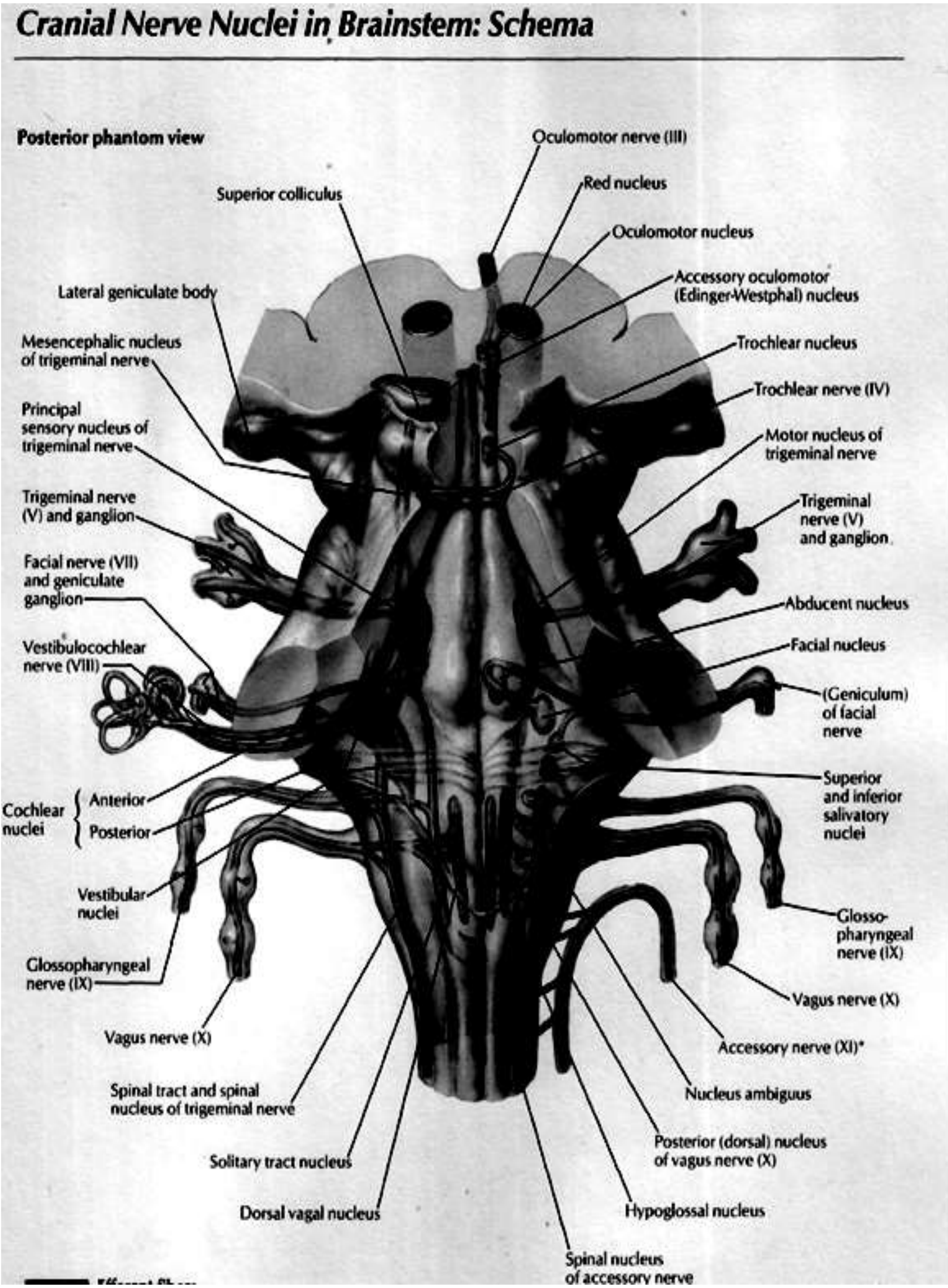


Figure 28 – Rhomboid fossa

V. THE MESENCEPHALON. THE CEREBRAL AQUEDUCT. THE ISTHMUS OF THE RHOMBENCEPHALON. THE DIENCEPHALON. THE THIRD VENTRICLE. THE RHINENCEPHALON. THE LIMBIC SYSTEM. THE BASAL NUCLEI. THE INTERNAL CAPSULE. THE LATERAL VENTRICLES. THE CORPUS CALLOSUM. THE FORNIX

The **midbrain** (mesencephalon) is the smallest part of the brain. It extends from the pons to the diencephalon (Fig. 29).

The midbrain consists of the following parts:

- *the tectal plate;*
- *cerebral peduncles.*

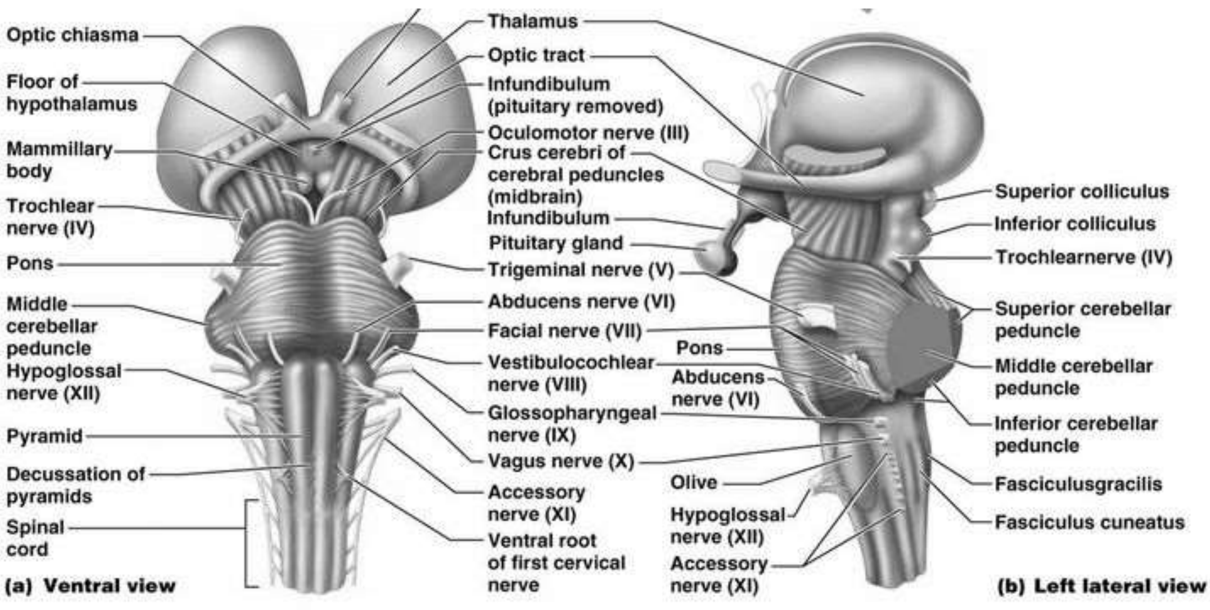


Figure 29 – The brainstem

The tectal plate ("roof") is the dorsal surface of the midbrain. It is composed of four rounded elevations – the colliculi ("little hills"). The posterior pair, called the *inferior colliculi*, has an auditory function: it continuous with the *brachium of inferior colliculi*. The anterior pair, called the *superior colliculi*, has a visual function. The pineal body (epyphisis) is located between the superior colliculi. The superior colliculus continuous with the *brachium of superior colliculi*. The brachii are directed to diencephalon.

The **cerebral peduncles** are the part of the midbrain that link the remainder of the brainstem to the thalami and thereby, the cerebrum. They are the most anterior structure in the midbrain and contain the large ascending and descending tracts that run to and from the cerebrum.

The **aqueduct of the midbrain** (cerebral aqueduct) passes through the midbrain (Fig. 30), connecting the third ventricle above with the fourth ventricle below. It is bounded by tectal plate above and cerebral peduncles below. It is surrounded by the central grey substance, which contains autonomic regulatory cells.

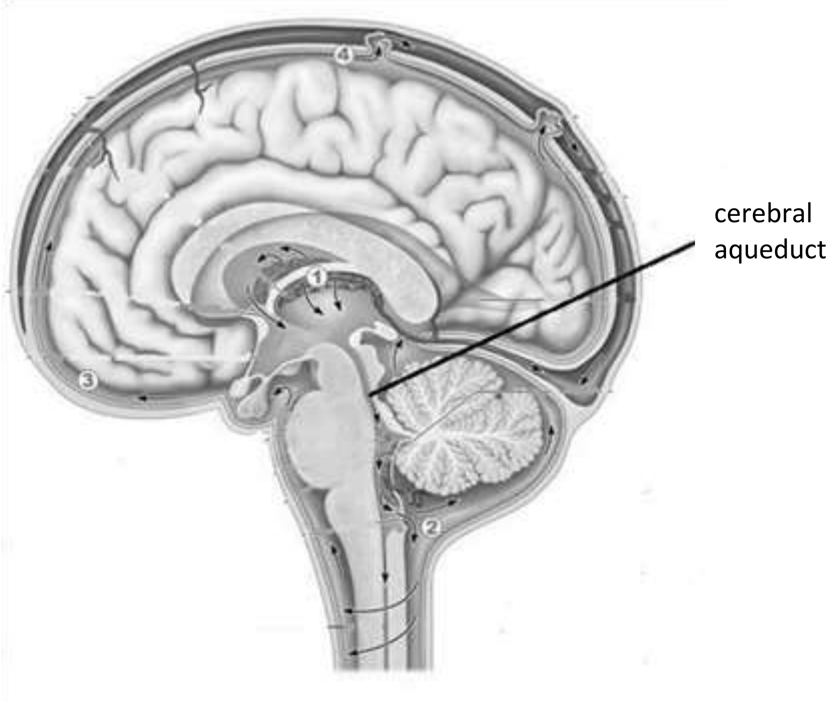


Figure 30 – Saggital section of the brain

INTERNAL FEATURES OF THE MIDBRAIN

Like the medulla and the pons, the midbrain contains both tracts and nuclei (Table 3).

The **substantia nigra** is located within the cerebral peduncles and separates them on **the tegmentum** and **the ventral part** (Fig. 31).

Neurons that release dopamine extend from the substantia nigra to the basal nuclei and help to control subconscious muscle activities. The loss of these neurons is associated with Parkinson`s disease.

The midbrain *tegmentum* is a part of the midbrain extending from the substantia nigra to the cerebral aqueduct in a horizontal section of the midbrain. It forms the floor of the midbrain that surrounds the cerebral aqueduct. The left and right red nuclei (**nucleus ruber**) are located within the tegmentum (Fig. 32). They extend from hypothalamus to inferior colliculi. Nucleus ruber looks reddish due to its rich blood supply and an iron–containing pigment in its neuronal cell bodies. Axons from the cerebellum and cerebral cortex form synapses in the red nuclei which function with the cerebellum to coordinate muscular movements.

The rubrospinal tract was formed by axons of red nuclei, which decussate in the ventral part of cerebral peduncles (*Forrel`s decussation*).

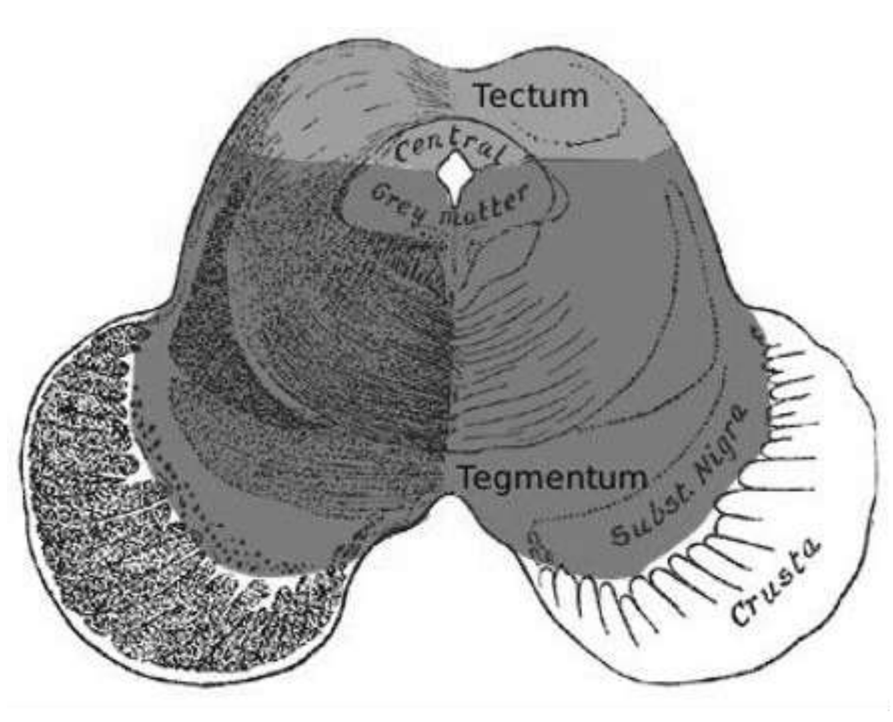


Figure 30 – Cross section of the midbrain

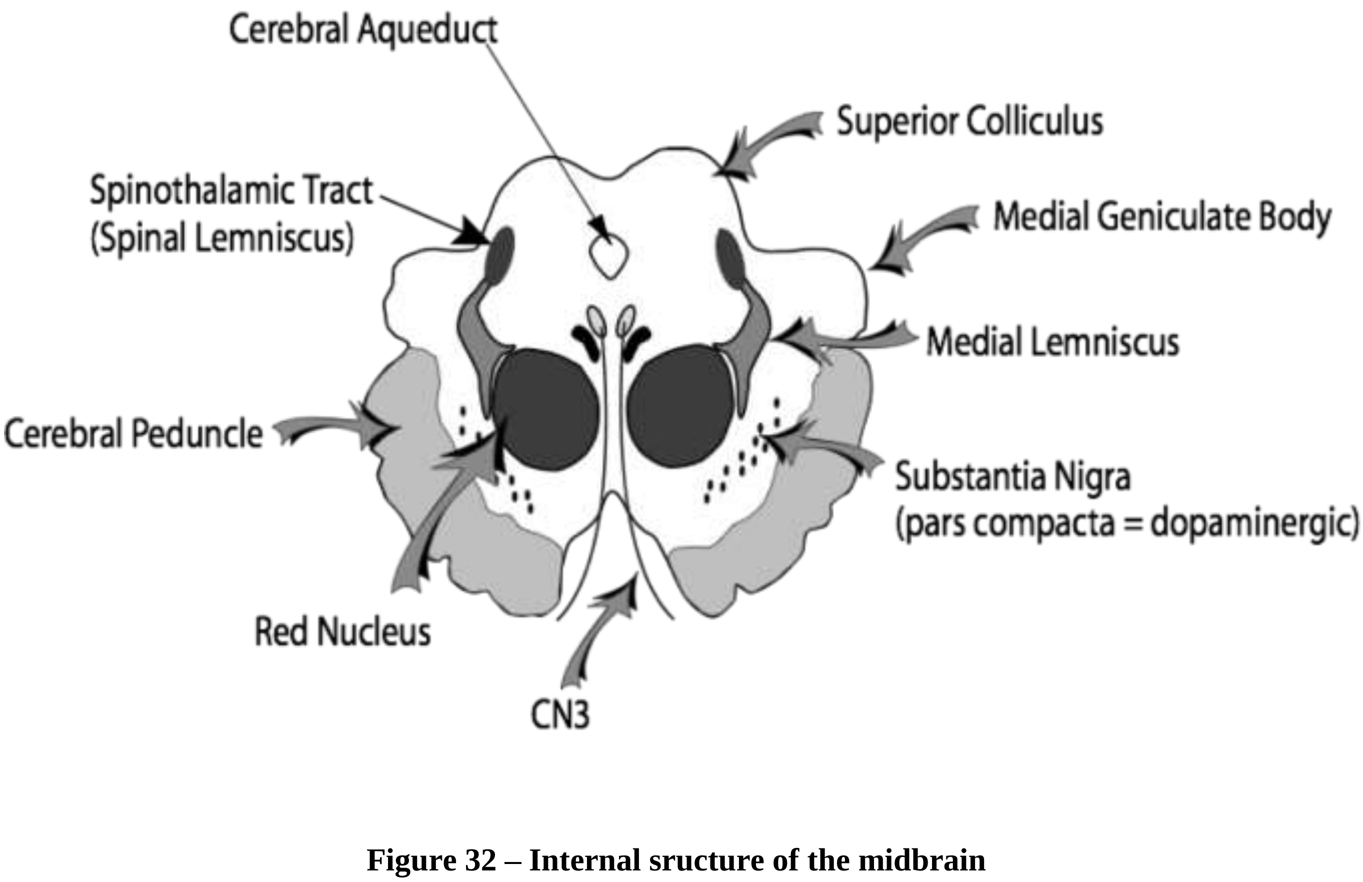


Figure 32 – Internal sructure of the midbrain

Table 3 – The mesencephalon

Region/Nucleus	Functions
GRAY MATTER	
Tectum (roof)	
Superior colliculi	Integrate visual information with other sensory input; initiate reflex responses to visual stimuli
Inferior colliculi	Relay auditory information to medial geniculate nuclei; initiate reflex responses to auditory stimuli
Walls and floor	
Red nuclei	Involuntary control of background muscle tone and limb position
Substantia nigra	Regulates activity in the basal nuclei
Reticular formation	Automatic processing of incoming sensations and outgoing motor commands; can initiate motor responses to stimuli; helps maintain consciousness
Other nuclei/centers	Nuclei associated with two cranial nerves (III, IV)
WHITE MATTER	
Cerebral peduncles	Connect primary motor cortex with motor neurons in brain and spinal cord; carry ascending sensory information to thalamus

Nuclei in the midbrain are associated with two pairs of cranial nerves.

1. Oculomotor (III) nerves: *oculomotor nuclei* in the midbrain provide motor impulses that control movements of the eyeball, while parasympathetic *accessory oculomotor nuclei (Yacubovich`s nucleus)* provide motor control to the smooth muscles that regulate constriction of the pupil and changes in shape of the lens via the oculomotor nerves. Oculomotor nuclei are located at the level of superior colliculi of the tectal plate.

2. Trochlear (IV) nerves: the motor nuclei are located at the level of inferior colliculi and control movements of the superior oblique muscle of the eyeball.

The tegmentum also contains axons of sensory neurons that extend from the medulla to the thalamus (lemniscus medialis).

The ventral portion of the cerebral peduncles contains motor tracts: corticospinal, corticobulbar, and corticopontine, which conduct nerve impulses from the cerebrum to the spinal cord, medulla, and pons, respectively.

The tectum of mesencephalon contains two pairs of sensory nuclei within superior and inferior colliculi. These nuclei are relay stations concerned with the processing of visual and auditory sensations. Each superior colliculus receives visual input from the lateral geniculate body of the thalamus on that side. The inferior colliculus receives auditory data from nuclei in the medulla oblongata; some of this information may be forwarded to the medial geniculate body on the same side. Axons of these nuclei form *tectospinal tract* that decussates in the tegmentum of cerebral peduncles (*Meynert`s decussation*).

THE DIENCEPHALON

The diencephalon together with the telencephalon (cerebrum) comprise the two major divisions of prosencephalon (forebrain).

The diencephalon relays sensory information between brain regions and controls many autonomic functions of the peripheral nervous system. It also connects structures of the endocrine system with the nervous system and works in conjunction with limbic system structures to generate and manage emotions and memories.

Location:

Directionally, the diencephalon is situated between the cerebral hemispheres, superior to the midbrain (Fig. 33).

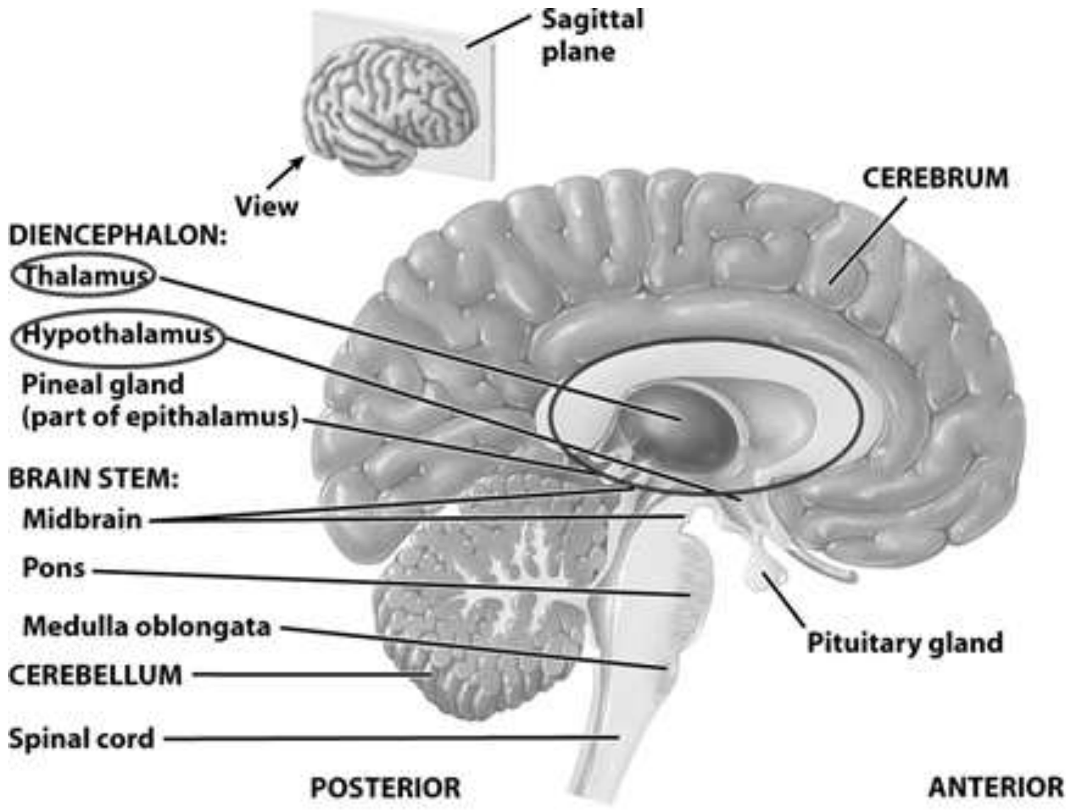


Figure 33 – Saggital section of the hemisphere

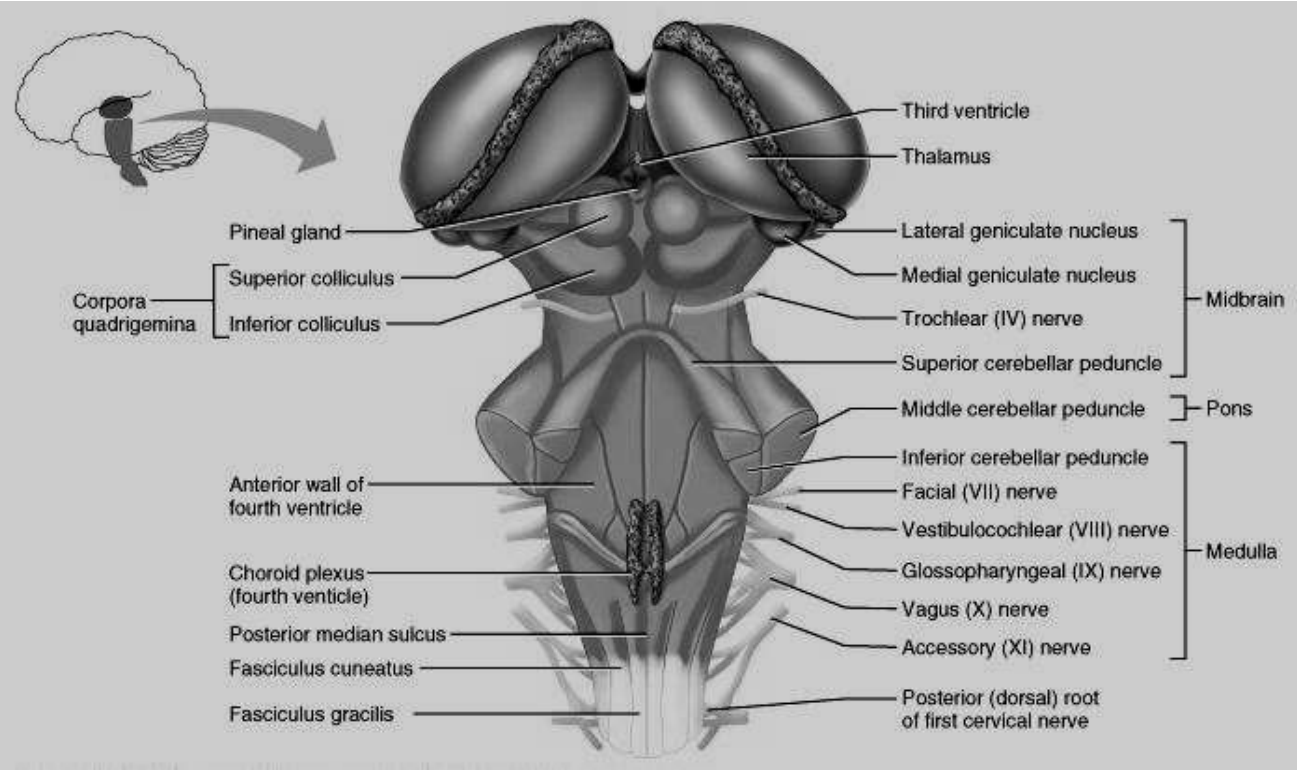


Figure 34 – Dorsal surface of the hindbrain

Structure:

- dorsal thalamus
- ventral thalamus
- hypothalamus
- epithalamus
- metathalamus

The *dorsal thalamus* is the subcortical sensory center. It is critically involved in a number of functions including relaying sensory and motor signals to the cerebral cortex, and regulating consciousness, sleep, and alertness. Either of two large, ovoid structures of grey matter within the forebrain that relay sensory impulses to the cerebral cortex. Its features are as follows:

- anterior thalamic tubercle
- pulvinar (thiker posterior portion of the thalamus)
- sulcus terminalis (it separates the thalamus from the caudate nucleus)
- hypothalamic sulcus (it delimits the dorsal thalamus from the ventral thalamus)
- interthalamic adhesion (it connects the right and left thalami)
- stria medullaris of the thalamus (it runs between the superior and medial surfaces of the thalamus).

The nuclei of dorsal thalamus are divided into the anterior, medial, ventral, and posterior groups (See Table 4, Fig. 35).

Table 4 – Nuclei of thalamus

STRUCTURE / NUCLEI	FUNCTIONS
Anterior Group	Part of the limbic system
Medial Group	Integrates sensory information and other data arriving at the thalamus and hypothalamus for projection to the frontal lobes of the cerebral hemispheres
Ventral Group	Projects sensory information to the primary sensory cortex of the parietal lobe; relays information from cerebellum and basal nuclei to motor areas of cerebral cortex
Posterior Group	
Pulvinar	Integrates sensory information for projection to association areas of cerebral cortex
Lateral geniculate nuclei	Project visual information to the visual cortex of occipital lobe
Medial geniculate nuclei	Project auditory information to the auditory cortex of temporal lobe
Lateral Group	Forms feedback loops involving the cingulate gyrus (emotional states) and the parietal lobe (integration of sensory information)

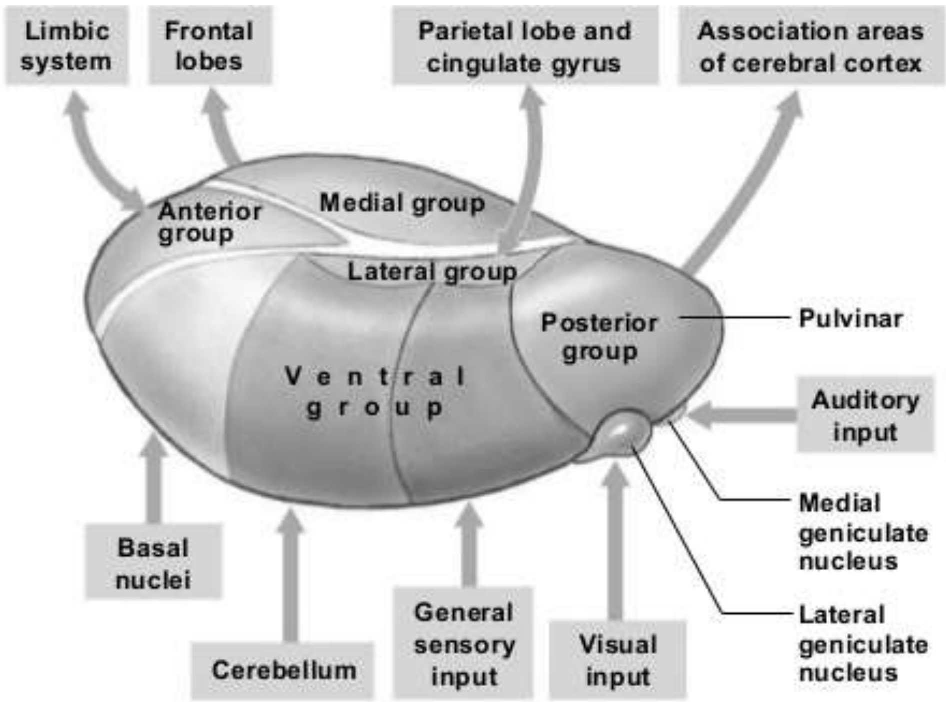


Figure 35 – An enlarged view of the thalamic nuclei of the left side

The *venral thalamus* (subthalamus) resides between the hypothalamic sulcus and the hypothalamus. It is a continuation of the midbrain tegmentum and contains the following nuclei:

- subthalamic nucleus (nucleus of Luys) – a component of the extrapyramidal system
- reticular nuclei
- red nucleus
- substantia nigra

The **methatalamus** is composed of *the medial and lateral geniculate bodies*. The fibres of the optic nerve end on the nuclei of the lateral geniculate body. The fibres of the auditory portion of the vestibular–cochlear nerve end on the nuclei of the medial geniculate body.

The **epithalamus** (Fig. 34) functions as a connection between the limbic system and other parts of the brain. Some functions of its components include the secretion of melatonin by *the pineal gland* (involved in circadian rhythms) and regulation of motor pathways and emotions. It includes such structures as:

- pineal gland
- habenula (it connects the pineal gland and the dorsal thalamus)
- habenular commissure (it connects right and left habenulae)
- habenular trigone (the expansion of habenula next to thalamus)
- posterior commisure (it associates right and left pulvinars and colliculi of tectal plate)

The hypothalamus is the ventral–most part of the diencephalon. The ventral aspect of the hypothalamus is exposed on the base of the brain. It extends from the rostral limit of the optic chiasm to the caudal limit of the mammillary bodies. The hypothalamus acts as an autonomic nervous center in accelerating or decelerating certain body functions. It secretes several hormones, including oxytocin and antidiuretic hormone (vasopressin) which are transported to the posterior lobe of pituitary gland via hypothalamo–hypophyseal tract (Figs. 36, 37).

The principal autonomic and limbic (emotional) functions of the hypothalamus are as follows:

1. **Cardiovascular regulation.** Although the heart has an innate pattern of contraction, impulses from the hypothalamus cause autonomic acceleration or deceleration of the heart rate. Impulses from the posterior hypothalamus produce a rise in arterial blood pressure and an increase of the heart rate. Impulses from the anterior portion have the opposite effect. Rather than traveling directly to the heart, impulses from these regions pass first–order to the cardiovascular centers of the medulla oblongata.

2. **Body–temperature regulation.** Specialized nuclei within the anterior portion of the hypothalamus are sensitive to changes in body temperature. If the arterial blood flowing through this portion of the hypothalamus is above normal temperature, the hypothalamus initiates impulses that cause heat loss through sweating and vasodilation of cutaneous vessels of the skin. A below–normal blood temperature causes the hypothalamus to relay impulses that result in heat production and retention through shivering, contraction of cutaneous blood vessels, and cessation of sweating.

3. **Regulation of water and electrolyte balance.** Specialized osmoreceptors in the hypothalamus continuously monitor the osmotic concentration of the blood. An increased osmotic concentration resulting from lack of water causes the production of antidiuretic hormone by the hypothalamus and its release from the posterior pituitary. At the same time, a *thirst center* within the hypothalamus produces feelings of thirst.

4. **Regulation of hunger and control of gastrointestinal activity.** The *feeding center* is a specialized portion of the lateral hypothalamus that monitors blood glucose, fatty acid and amino acid

levels. Low levels of these substances in the blood are partially responsible for a sensation of hunger elicited from the hypothalamus. When enough food has been eaten, the *satiety center* in the midportion of the hypothalamus inhibits the feeding center. The hypothalamus also receives sensory impulses from the abdominal viscera and regulates glandular secretions and the peristaltic movements of the gastrointestinal tract.

5. **Regulation of sleeping and wakefulness.** The hypothalamus has both a *sleep center* and a *wakefulness center* that function with other parts of the brain to determine the level of conscious alertness.

6. **Sexual response.** Specialized *sexual center* nuclei within the superior portion of the hypothalamus respond to sexual stimulation of the tactile receptors within the genital organs. The experience of orgasm involves neural activity within the sexual center of the hypothalamus.

7. **Emotions.** A number of nuclei within the hypothalamus are associated with specific emotional responses, including anger, fear, pain, and pleasure.

8. **Control of endocrine functions.** The hypothalamus produces neurosecretory chemicals that stimulate the anterior and posterior pituitary to release various hormones.

The anterior hypothalamic area houses *the supra–optic* and *paraventricular nuclei.* The posterior hypothalamic area comprises *nuclei of mammillary bodies*. Also hypothalamus includes the dorsal hypothalamic area and the intermediate hypothalamic area.

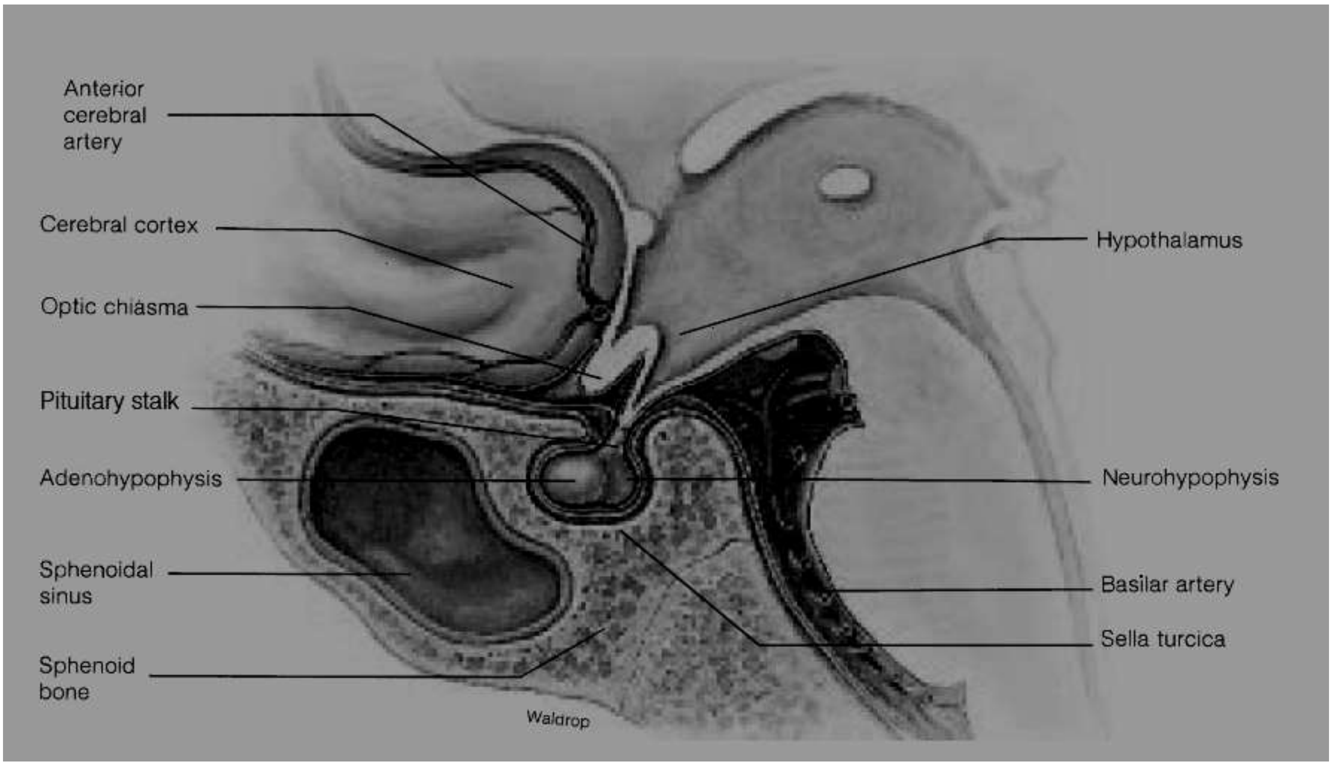


Figure 36 – The hypothalamo–hypophyseal system

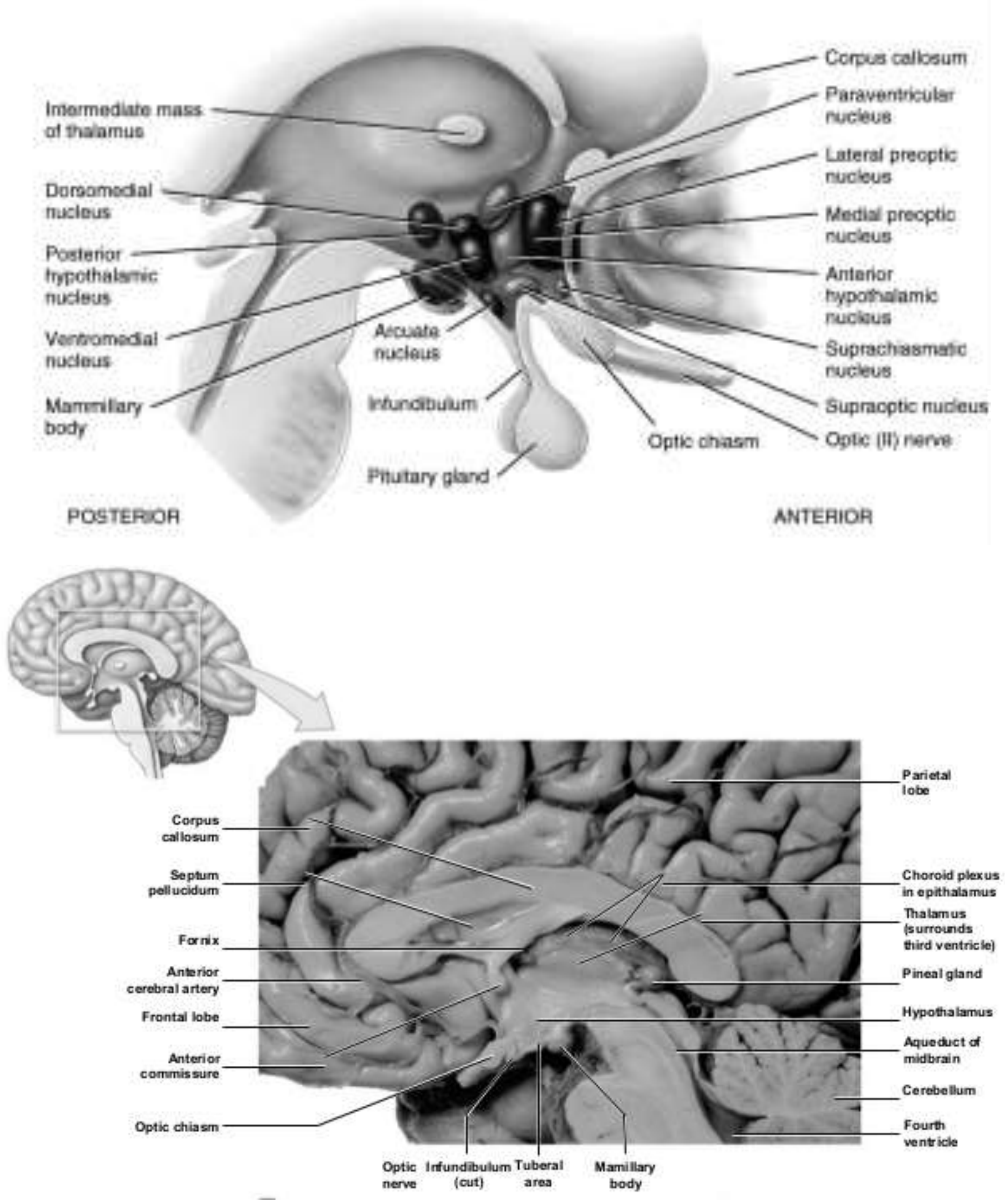


Figure 37 – The saggital section of hypothalamus

The **third ventricle** (*ventriculus tertius*) is one of four connected fluid–filled cavities, comprising the ventricular system within the human brain. It is a median cleft in the diencephalon between the two thalami and filled with cerebrospinal fluid. It is in the midline, between the left and right lateral ventricles. Running through the third ventricle is the interthalamic adhesion, which contains thalamic neurons and fibers that may connect the two thalami (Fig. 38).

Structure

The third ventricle communicates with the lateral ventricles anteriorly by the interventricular foramina (of Monro). It also communicates with the fourth ventricle posteriorly by the cerebral aqueduct (of Sylvius).

Development

The third ventricle, like other parts of the ventricular system of the brain, develops from the central canal of the neural tube. Specifically, it originates from the portion of the tube that is present in the developing prosencephalon, and subsequently in the developing diencephalon.

Boundaries

The third ventricle is bounded by the thalamus and hypothalamus on both the left and right sides. The lamina terminalis forms the anterior wall. The floor is formed by hypothalamic structures. The roof is formed by the ependyma, lining the undersurface of the tela choroidea of the third ventricle.

Protrusions

There are two protrusions on the anterior aspect of the third ventricle:

- the supra–optic recess (above the optic chiasma)
- the infundibular recess (above the pituitary stalk)

Additionally, there are two protrusions on the posterior aspect, above the cerebral aqueduct:

- the suprapineal recess (above the pineal gland)
- the pineal recess (protruding into the stalk of the pineal gland)

Clinical significance

The floor of the third ventricle is formed by hypothalamic structures, and this can be opened surgically between the mamillary bodies and the pituitary gland in a procedure called an endoscopic third ventriculostomy. An endoscopic third ventriculostomy can be performed in order to release extra fluid caused by hydrocephalus.

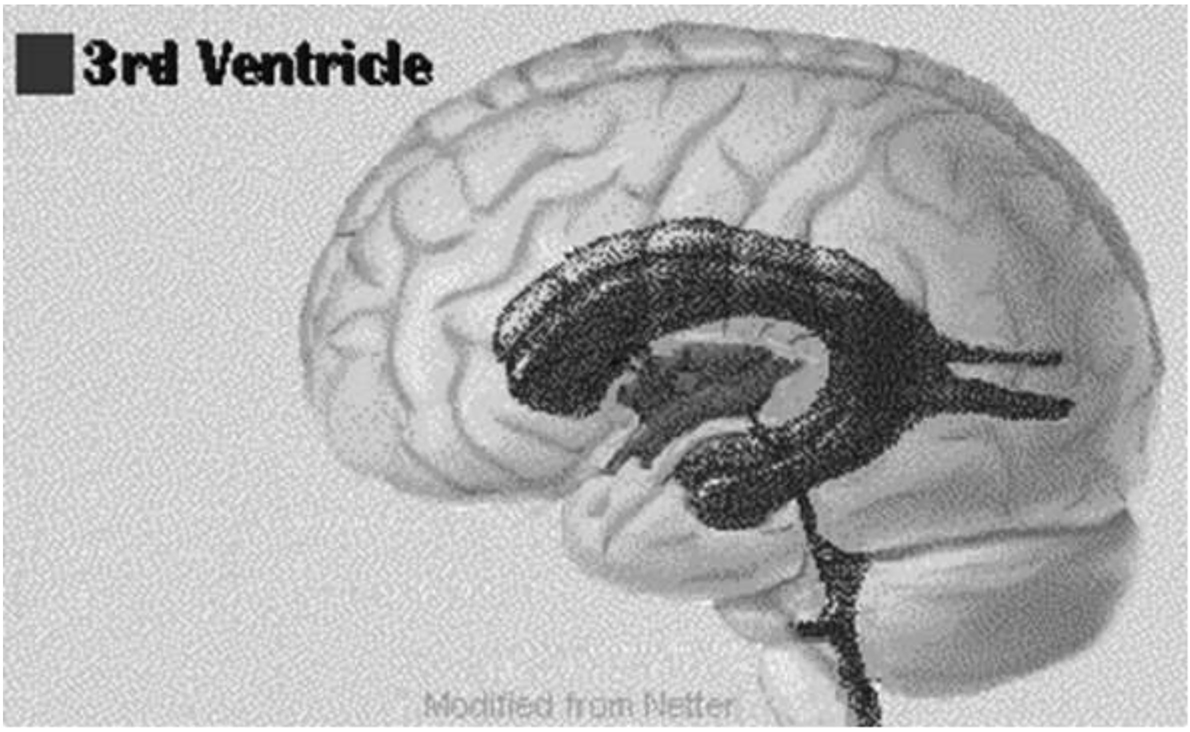


Figure 38 – The third ventricle

The **telencephalon (endbrain)** consists of two cerebral hemispheres. The following groups of centres are distinguished in the telencephalon in the order of their historical development:

1) the rhinencephalon – the part of the brain concerned with the act or function of smelling, olfaction, which is the oldest and at the same time the smallest part located ventrally;

2) the palaeencephalon – the basal, or ventral, ganglia of the hemispheres in the subcortical area, the old part of the endbrain hidden at the depth;

3) the neoencephalon – the cortex composed of grey matter, the youngest part, and at the same time the largest part, covering all other parts like a cloak or mantle: hence its other name – the pallium.

The rhinencephalon is a center of expressive sensitivity. It consists of 2 compartments – peripheral and central.

The peripheral compartment includes:

- the olfactory bulbs
- the olfactory tract
- the olfactory trigone
- the anterior perforated substance
- the olfactory striae (they associate the olfactory trigone and anterior perforated substance with the parahippocampal gyrus and the subcallosal area)

The central compartment includes:

- the limbic lobe (it is a rim of the cerebral cortex on the medial surface of each hemisphere. It includes the cingulate gyrus, which lies above the corpus callosum, and the parahippocampal gyrus, which is burried deep in the temporal lobe. The hippocampus is a portion of the parahippocampal gyrus that extends into the floor of the lateral ventricle)

- the hippocampus (it is located on the medial wall of the inferior horn of the lateral ventricle)

- the dentate gyrus (in the depth of the hippocampal sulcus)

- subcallosal area (under the rostrum of the corpus callosum)

The rhinencephalon is a part of the limbic system.

The **limbic system** (Fig. 39) plays a central role in basic survival functions such as memory, reproduction, and nutrition. It is also involved in the emotional interpretation of sensory input and emotions in general. Limbus means border, and the term limbic refers to deep portions of the cerebrum that form a ring around the diencephalon.

The main components of the limbic system are as follows:

- the rhinencephalon
- the amygdaloid body – a basal nucleus located close to the tail of the caudate nucleus
- the septum pellucidum
- the mammillary bodies
- the fornix
- the thalamus and hypothalamus

The limbic system is sometimes called the "emotional brain" because it plays a primary role in a range of emotions, including pain, pleasure, docility, affection, and anger. It also is involved in olfaction (smell) and memory. Together with parts of the cerebrum, the limbic system also functions in memory; damage to the limbic system causes memory impairment.

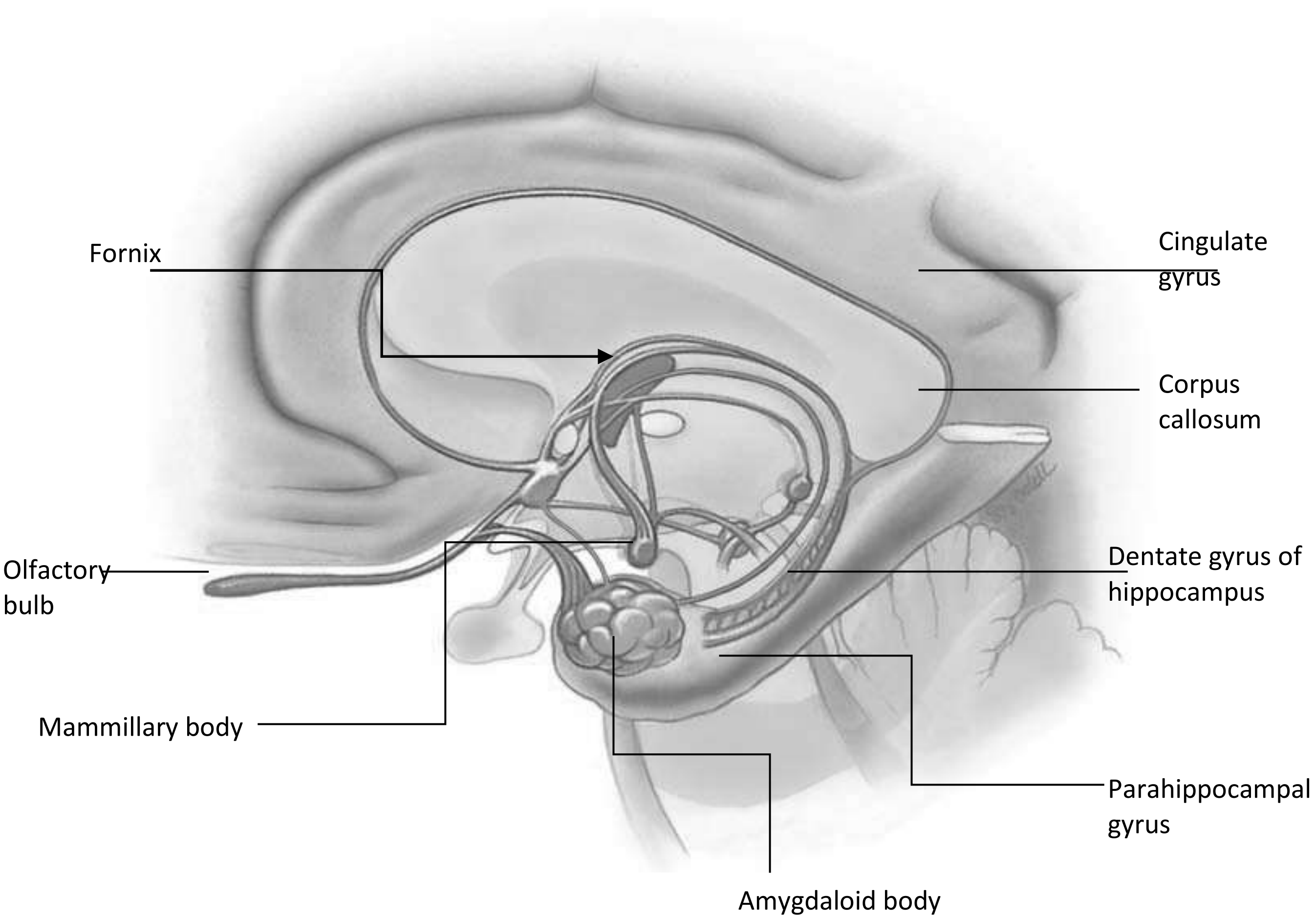


Figure 39 – The limbic system

The corpus callosum is a thick band of nerve fibers that connects the left and right hemispheres of the brain allowing for communication between both hemispheres. The corpus callosum transfers motor, sensory, and cognitive information between the brain hemispheres.

Structure:

The posterior portion of the corpus callosum is called the ***splenium***; the anterior is called the ***genu*** (or "knee"); between the two is the ***truncus***, or "body", of the corpus callosum. The part between the body and the splenium is often markedly narrowed and thus referred to as the "***isthmus***". ***The rostrum*** is the part of the corpus callosum that projects posteriorly and inferiorly from the anteriormost genu, as can be seen on the sagittal image of the brain displayed on the right. The rostrum is so named for its resemblance to a bird's beak.

On either side of the corpus callosum, the fibers radiate in the white matter and pass to the various parts of the cerebral cortex; those curving forward from the genu into the frontal lobe constitute the *forceps anterior*, and those curving backward into the occipital lobe – the *forceps posterior*.

Location:

Directionally, the corpus callosum is located underneath the cerebrum at the center of the brain (Fig. 40).

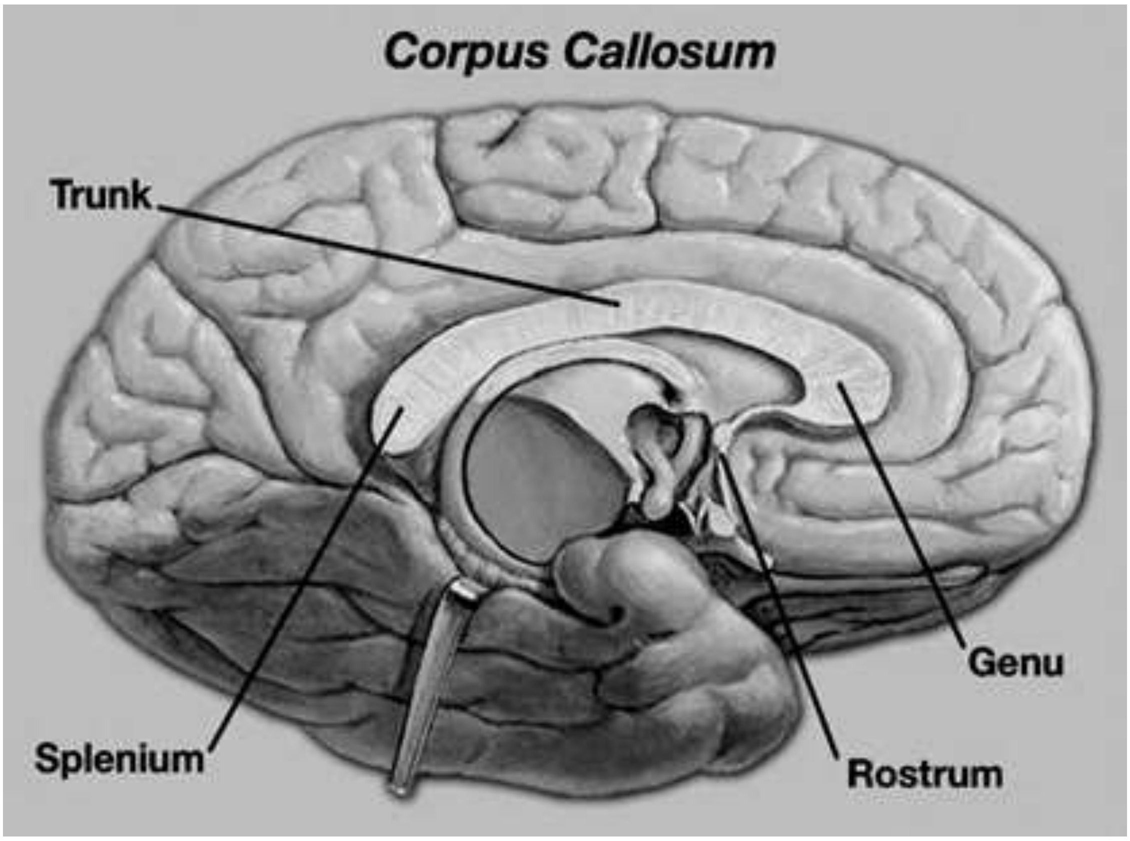


Figure 40 – The corpus callosum

The **fornix** (Fig. 41) is a longitudinal, arch–shaped lamella of white substance, situated below the corpus callosum, and continuous with it behind, but separated from it in front by the septum pellucidum. It may be described as consisting of two symmetrical bands, one for either hemisphere. The two portions are not united to each other in front and behind, but their central parts are joined together in the middle line. The anterior parts are called the **columns** of the fornix; the intermediate united portions, the **body;** and the posterior parts, the **crura.**

The **columns** (**anterior pillars**; **fornicolumns**) of the fornix arch downward in front of the interventricular foramina and behind the anterior commissure, and each descends through the grey matter in the lateral wall of the third ventricle to the base of the brain, where it ends in the mamillary bodies.

The **crura** of the fornix are prolonged backward from the body. They are flattened bands and, at their commencement, are intimately connected with the under surface of the corpus callosum. Diverging from one another, each curves around the posterior end of the thalamus and passes downward and forward into the temporal horn of lateral ventricle. Here they are continued as a narrow white band, ***the fimbria of hippocampus***, which is prolonged into the uncus of the parahippocampal gyrus.

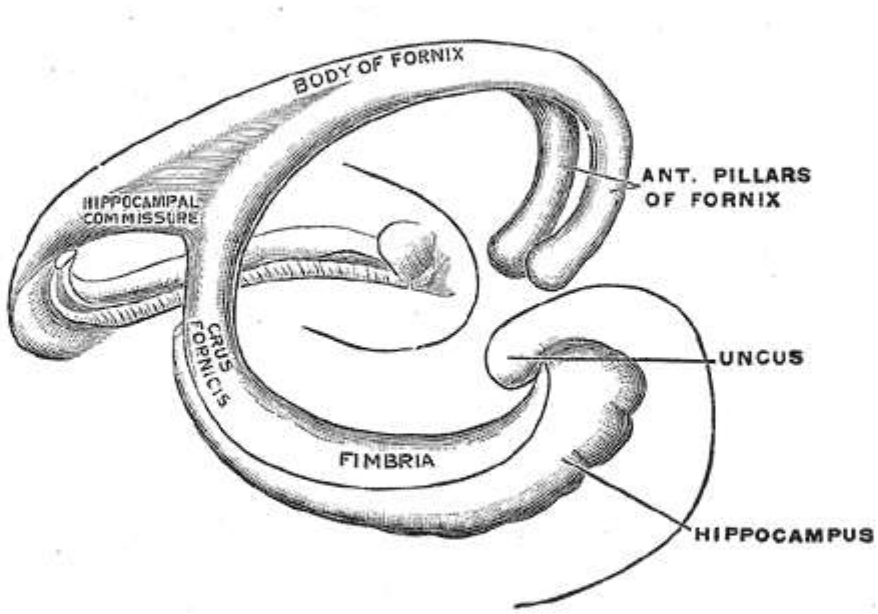


Figure 41 – The fornix

The **septum pellucidum** is a thin layer of grey matter that expands between the columns of fornix and the corpus callosum. It is triangular in form, broad in front, and narrow behind; its inferior angle corresponds with the upper part of the anterior commissure. The lateral surface of each lamina is directed toward the central part and anterior horn of the lateral ventricle.

The basal nuclei (Fig. 42) are paired masses of gray matter within the cerebral hemispheres. These nuclei lie within each hemisphere inferior to the floor of the lateral ventricle. They are embedded within the central white matter, and the radiating projection and commissural fibers travel around or between these nuclei.

The basal nuclei consist of the *amygdaloid body,* situated in the temporal lobe, the *claustrum* and *corpus striatum*.

The corpus striatum lies laterally to the thalamus and is divided phylogenetically into the *neostriatum*, which consists of *the caudate nucleus* and the *putamen,* and the *paleostriatum*, which consists of *the globus pallidus***.** The caudate nucleus and the putamen are separated almost completely by a band of fibers called *the internal capsule***.**

The corpus striatum is split by the internal capsule, a band of nerve fibers, into the *caudate nucleus* and *lentiform nucleus*.

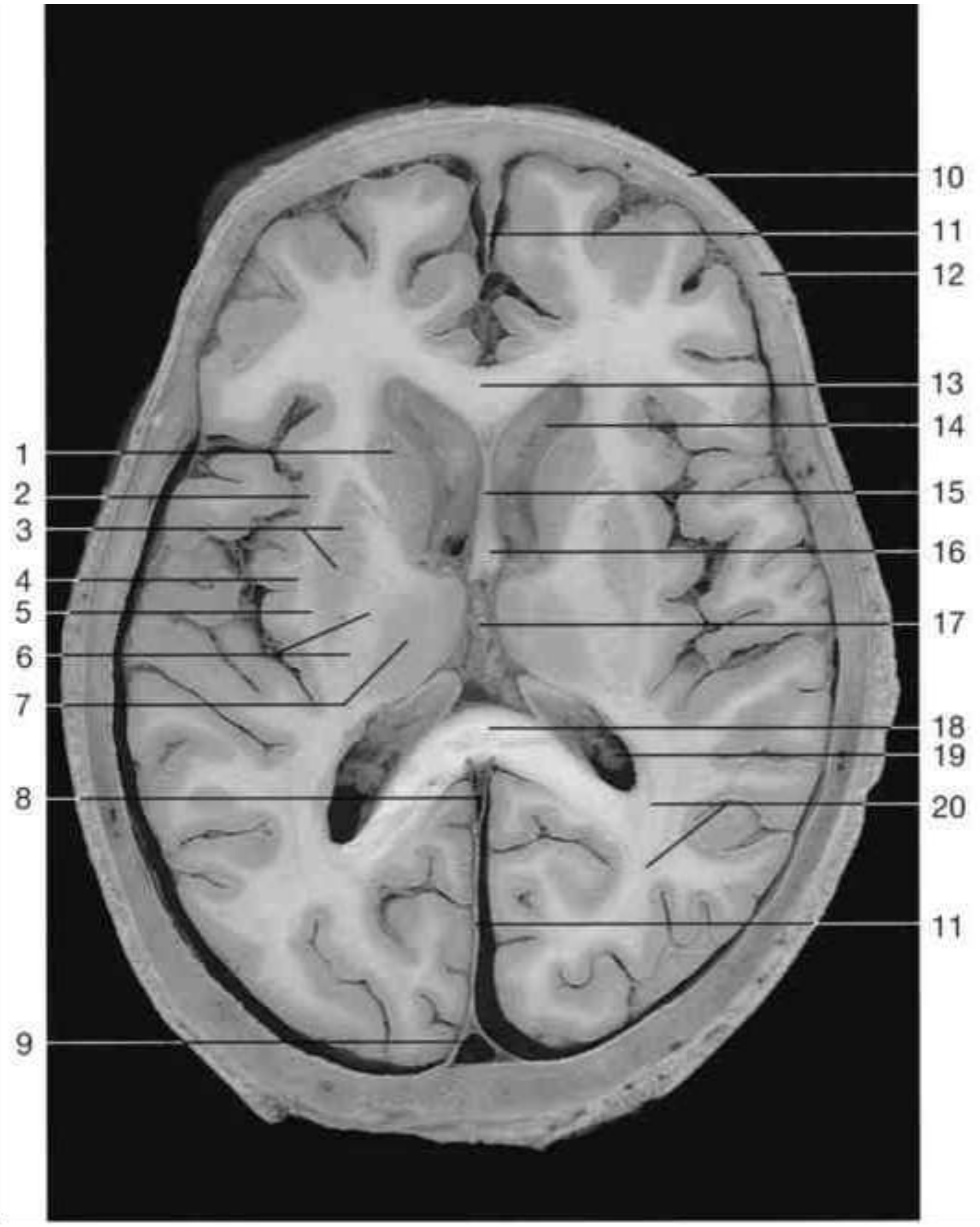


Figure 42 – Horizontal brain section: 1 – caudate nucleus; 2 – lobus insularis (insula); 3 – lentiform nucleus; 4 – claustrum; 5 – external capsule; 6 – internal capsule; 7 – thalamus; 8 – inferior sagittal sinus; 9 – superior sagittal sinus; 10 – skin of scalp; 11 – falx cerebri; 12– calvaria (diploe of skull); 13 – genu of corpus callosum; 14 – anterior horn of lateral ventricle; 15 – septum pellucidum; 16 – column of fornix; 17 – choroid plexus of third ventricle; 18 – splenium of corpus callosum; 19 – entrance to inferior horn of lateral ventricle with choroid plexus; 20 – optic radiation; 21 – third ventricle

The caudate nucleus has a massive head, body and a slender, curving tail that follows the curve of the lateral ventricle. At the tip of the tail is a separate nucleus, the amygdaloid body. Three masses of gray matter lie between the bulging surface of the insula and the lateral wall of the diencephalon. These are *the claustrum, the putamen*, and *the globus pallidus*. The putamen and globus pallidus are often considered to be subdivisions of a larger *lentiform nucleus* because when they exposed in a gross anatomy dissection, they form a rather compact, rounded mass. The lentiform nucleus is separated from the caudate nucleus by the anterior limb of the internal capsule.

The claustrum is a thin sheet of gray matter situated lateral to the putamen. It is separated from the lentiform nucleus by external capsule and from the insula – by the extreme capsule.

The term *corpus striatum* refers to the striated appearance of the internal capsule as it passes among the basal nuclei. Nearby structures that are functionally linked to the basal nuclei are the substantia nigra of the midbrain and the subthalamic nuclei of the diencephalon. Axons from the substantia nigra terminate in the caudate nucleus and putamen. The subthalamic nuclei interconnect with the globus pallidus.

The basal nuclei are involved with the subconscious control and integration of skeletal muscle tone; the coordination of learned movement patterns; and the processing, integration, and relay of information from the cerebral cortex to the thalamus. Under normal conditions, these nuclei do not initiate particular movements. But once a movement is under way, the basal nuclei provide the general pattern and rhythm, especially for movements of the trunk and proximal limb muscles. When a person is walking, the caudate nucleus and putamen control the cycles of arm and leg movements that occur between the time the decision is made to “start walking” and the time the “stop” order is given.

The claustrum appears to be involved in the processing of visual information at the subconscious level. Evidence suggests that it focuses attention on specific patterns or relevant features.

The amygdaloid body is an important component of the limbic system. The functions of other basal nuclei are poorly understood.

Nuclei	**Function**
Amygdaloid body	Component of limbic system
Claustrum	Plays a role in the subconscious processing of visual information
Caudate nucleus **Lentiform nucleus (putamen and globus pallidus)**	Subconscious adjustment and modification of voluntary motor commands

The internal capsule (Fig. 43) is a deep subcortical structure that contains a concentration of white matter projection fibres. These fibres form the corona radiata. Anatomically, this is an important area because of the high concentration of both motor and sensory projection fibres.

The internal capsule is found between lentiform nucleus on one side and thalamus and the head of caudate nucleus on the other. It is made up of three parts. These are the anterior limb, genu, and posterior limb.

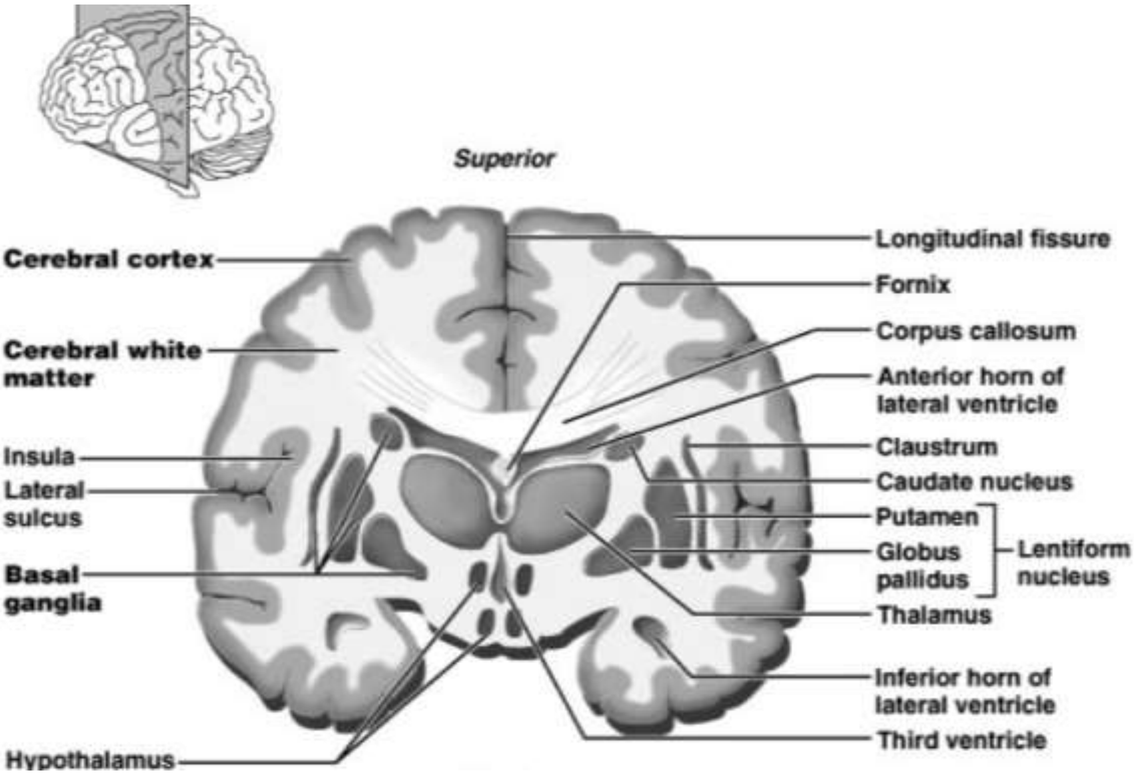


Figure 43 – The internal capsule

- *the anterior limb* lies between the head of the caudate nucleus medially and the lentiform nucleus laterally; it contains motir fibers that associate the cortex of the frontal lobe with the thalamus and pons (frontopontine and frontothalamic tracts)
- *the genu* lies medial to the apex of the lentiform nucleus, it contains corticonuclear fibres (previously called corticobulbar fibres)
- *the posterior limb* lies between the thalamus medially and the lentiform nucleus laterally; it contains the corticospinal fibres lying in the anterior two–thirds of the posterior limb, thalamocortical tract, which contains somatosensory fibres from the ventral posterior thalamic nucleus, optic radiation, and auditory radiation.

Therefore, the injury to the internal capsule may cause both sensory and motor disturbances.

The lateral ventricles (Fig. 44) are two curved openings (shaped like a horseshoe) located deep within the top section of the brain that provide a pathway for cerebrospinal fluid. There is one lateral ventricle on each side of the brain. The two lateral ventricles are the largest of ventricles of the brain.

Lateral ventricles are surrounded by periventricular white matter. They communicate with the third ventricle though two ***interventricular foramina, or foramina of Monro***. These are apertures between the anterior end of the thalamus and the column of the fornix. On each side, there are ***anterior***, ***posterior, and inferior horns,*** and a ***central part*** (Table 5).

The roof of the anterior horns is formed by the corpus callosum and its medial wall by the septum pellucidum. Each lateral wall and the floor are supplied by the head of the caudate nucleus. They extends rostrally from the interventricular foramina to the splenium of the corpus callosum.

The corpus callosum forms the roof of the central part, and the floor is contributed to by a number of structures such as caudate nucleus, stria terminalis, thalamus, choroid plexus, and fornix.

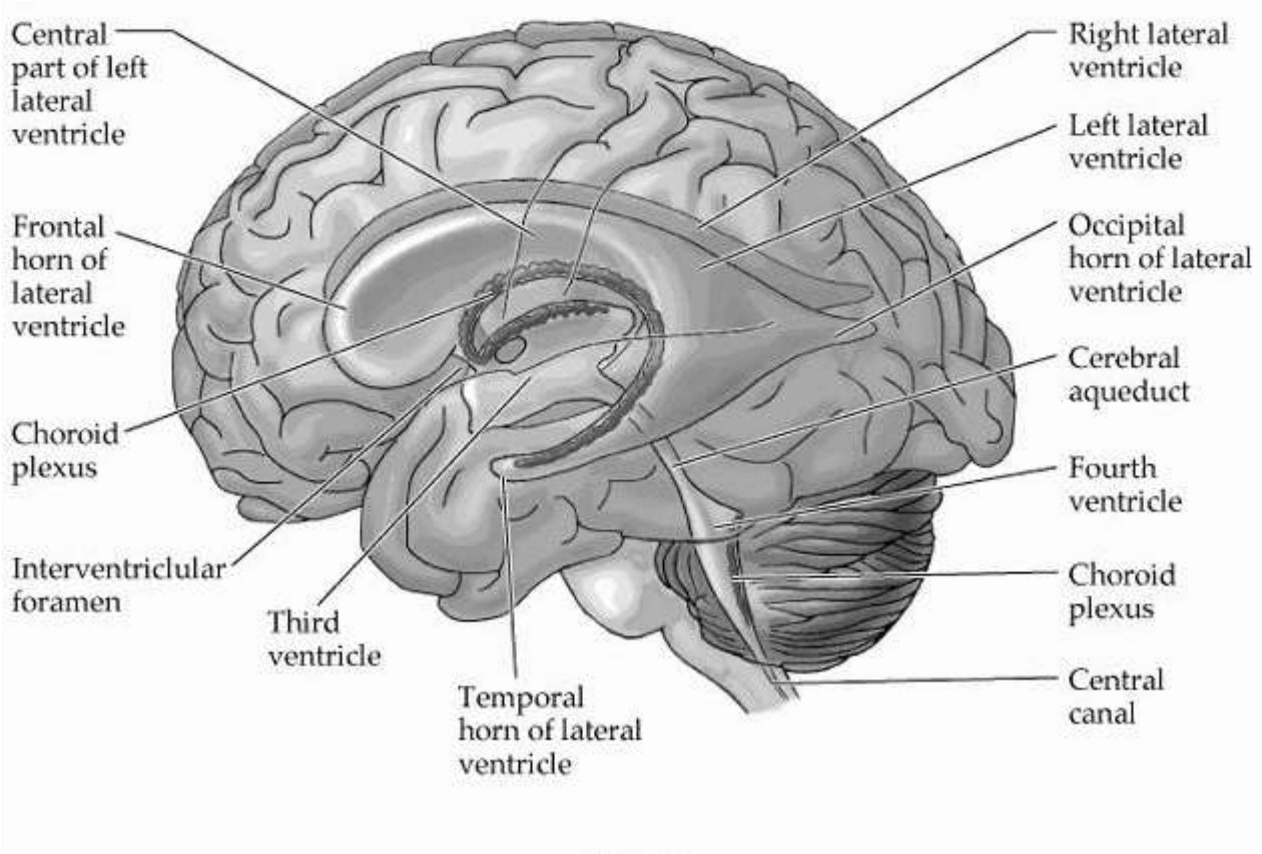


Figure 44 – Lateral ventricle

Table 5 – Parts of the lateral ventricles

Parts of the Lateral Ventricle	Lateral ventricles are the largest of the ventricles. They are irregular in shape. Each consists of a central part, with anterior, posterior, and inferior horns
Anterior horn	**It is anterior to the interventricular foramen. Its roof and anterior border are formed by the corpus callosum: its vertical medial wall – by the septum pellucidum. The floor is formed by the head of the caudate nucleus**
Central part	**It extends from the splenium of the corpus callosum; medially it is bounded by the posterior part of the septum pellucidum, and below – by parts of the caudate nucleus, thalamus, choroid plexus, and fornix**
Posterior horn	**It extends into the occipital lobe. Its roof is formed by fibers of the corpus callosum**
Inferior horn	**It traverses the temporal lobe. Its roof is formed by the white substance of the cerebral hemisphere. Along the medial border, there are the stria terminalis and the tail of the caudate nucleus. The amygdaloid nucleus bulges into the terminal part of the inferior horn. The floor and the medial wall are formed by the hippocampus**

The posterior horn extends caudally into the occipital lobe; its roof is formed by a part of the corpus callosum.

The inferior horn resides within the temporal lobe. The medial portion of the superior wall is formed by the tail of the caudate nucleus. Hippocampus is located on the medial wall. The anterior thickened extremity of the hippocampus, pes hippocampi, has several projections called the ***hippocampal digitations.*** Medially, hypocampus fuses with the fimbria which arises from the crus of the fornix.

The coroid plexus resides in the central part and in the inferior horn of the lateral ventricle.

VI. THE SURFACES OF THE CEREBRAL HEMISPHERES (PALLIUM). CEREBRAL CORTEX AREAS AND FUNCTIONS

The cerebral cortex is phylogenetically the youngest part of the brain. In external appearance, the cerebral cortex has a convoluted, corrugated appearance. The surface of the cortex is deeply folded, which greatly increases its surface area. The crest of a fold is called a **gyrus**, and the depression between folds is called a **sulcus**. One of the main landmark sulci of the brain is **the central sulcus** (or sulcus of Rolando). The fissure that runs approximately horizontally along the lateral surface of the brain is called **the lateral fissure** (or fissure of Sylvius). The hemisphere is composed of four lobes: the frontal lobe, the parietal lobe, the temporal lobe, and the occipital lobe (Fig. 45).

The **frontal lobe** is the largest of the cortex and extends from the central sulcus to the front. Several gyri can be distinguished on the frontal lobe surface. These are **the precentral gyrus**, which is defined by the central and precentral sulci, and which holds within itself the motor cortex**.** In front of the precentral sulcus are **the superior, middle, and inferior frontal gyri.**

The parietal lobe is the area immediately behind or caudal to the central sulcus and it runs caudally. It is bounded ventrally by the lateral fissure. The somatosensory cortex is contained within the postcentral gyrus in the parietal lobe, just caudal to the central sulcus. Caudal to the postcentral gyrus is **the superior parietal lobule**, and ventral to that is **the inferior parietal lobule.**

The temporal lobe lies ventral to the lateral fissure and includes the inferior, middle, and superior temporal gyri. These run approximately parallel to the lateral fissure. The superior temporal gyrus holds the area of the primary auditory cortex.

The occipital lobe occupies the most caudal end of the brain and may be considered to lie caudal to a line drawn through **the parieto–occipital sulcus**, wich is visualised on the medial surface.

The area of the cerebral cortex, called **the insula**, is buried deep in the lateral fissure. Its borders are defined by the frontal, parietal, and temporal cortex. The rostral end of the insula is a poorly understood part of the limbic system, and the caudal end of the insula is involved in somatosensory processing.

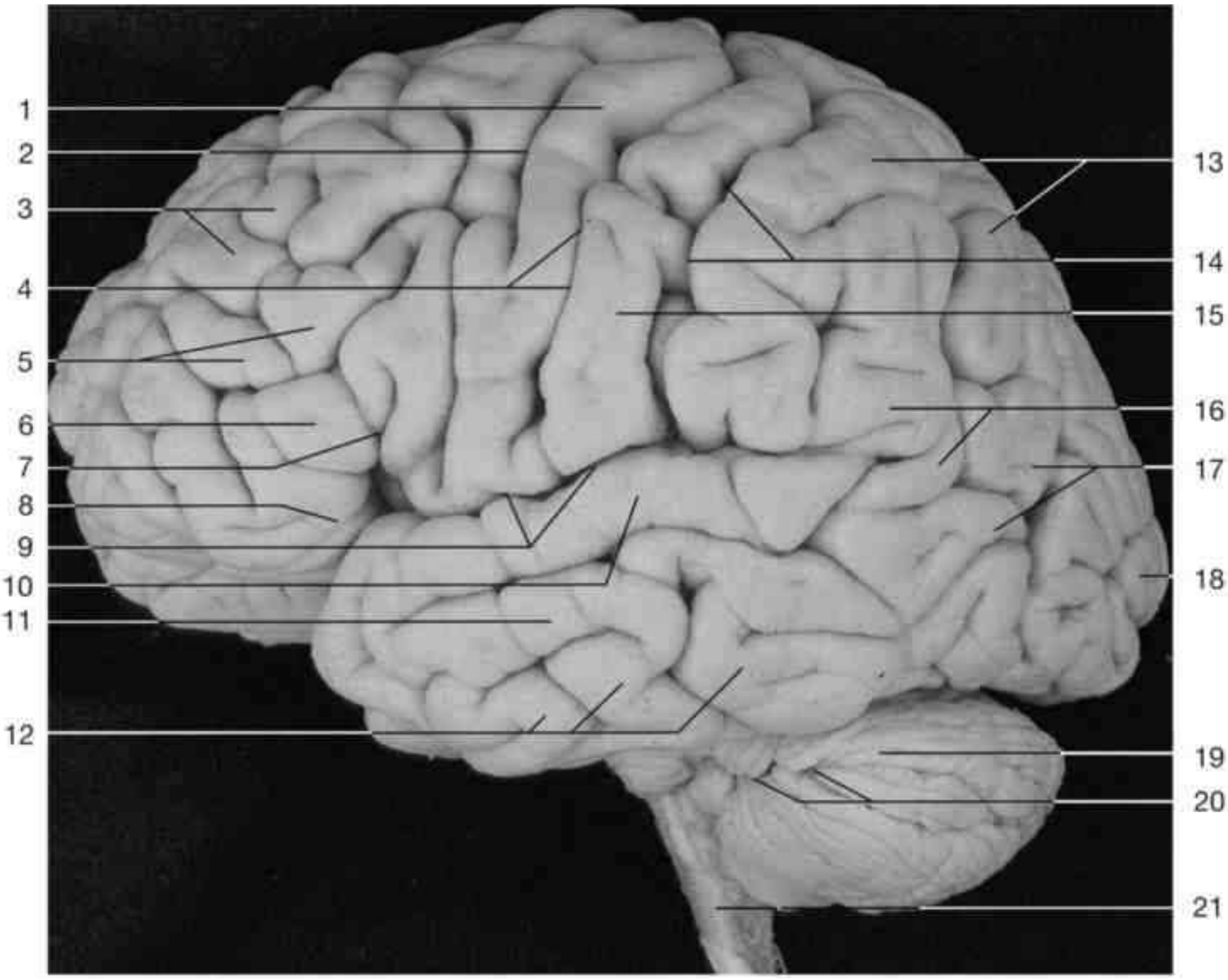


Figure 45 – Dorsolateral surface of the left hemisphere: 1 – precentral gyrus; 2 – precentral sulcus; 3 – superior frontal gyrus; 4 – central sulcus; 5 – middle frontal gyrus; 6 – inferior frontal gyrus; 7– ascending ramus of lateral; 8 – anterior ramus; 9 – lateral sulcus; 10 – superior temporal gyrus; 11– middle temporal gyrus; 12 – inferior temporal gyrus; 13 – parietal lobe; 14 – postcentral sulcus; 15 – postcentral gyrus; 16 – supramarginal gyrus; 17 – angular gyrus; 18 – occipital lobe; 19 – cerebellum; 20 – horizontal fissure of cerebellum; 21– medulla oblongata

The relief of frontal lobe:

- **precentral gyrus –** it is between the central and precentral sulci
- **superior frontal gyrus** – between the superior margin of the hemisphere and ***superior frontal sulcus***
- **middle frontal gyrus** – between the superior and inferior frontal sulci
- **inferior frontal gyrus** – below the ***inferior frontal sulcus.***

The ***anterior*** and ***ascending rami*** run upward from the lateral sulcus and separate the inferior temporal gyrus into three parts:

– ***orbital part*** – it is situated below the anterior ramus
– ***triangular part*** – it is situated between the anterior and ascending rami
– ***opercular part*** – it is situated behind the ascending ramus

The relief of parietal lobe:

- **postcentral gyrus** – between the central and postcentral sulci
- **superior parietal lobule** – it is enclosed between the superior margin of the hemisphere and the intraparietal sulcus
- **inferior parietal lobule** – it is located below the intraparietal sulcus. These are 2 gyri:
  – ***supramarginal gyrus*** (it closes the posterior edge of the lateral sulcus)
  – ***angular gyrus*** (it closes the posterior edge of the superior temporal sulcus)

The relief of temporal lobe:

- **superior temporal gyrus** – it is located between the lateral and superior temporal sulci, on its upper surface, in the depth of the lateral sulcus, one can see the **transverse temporal gyri** (Heschl`s gyrus)
- **middle temporal gyrus** – between **the** superior and inferior temporal sulci
- **inferior temporal gyrus** – below the inferior temporal sulcus

Gyri of the **occipital lobe** on the dorsolateral surface are small and variable.

The medial surface (Fig. 46) is formed by all lobes exept the insula. The **cingulate gyrus** lies immediately above the corpus callosum and resides between the sulcus of corpus callosum and the cingulate sulcus. It narrows to form the isthmus that continuous with the parahippocampal gyrus.

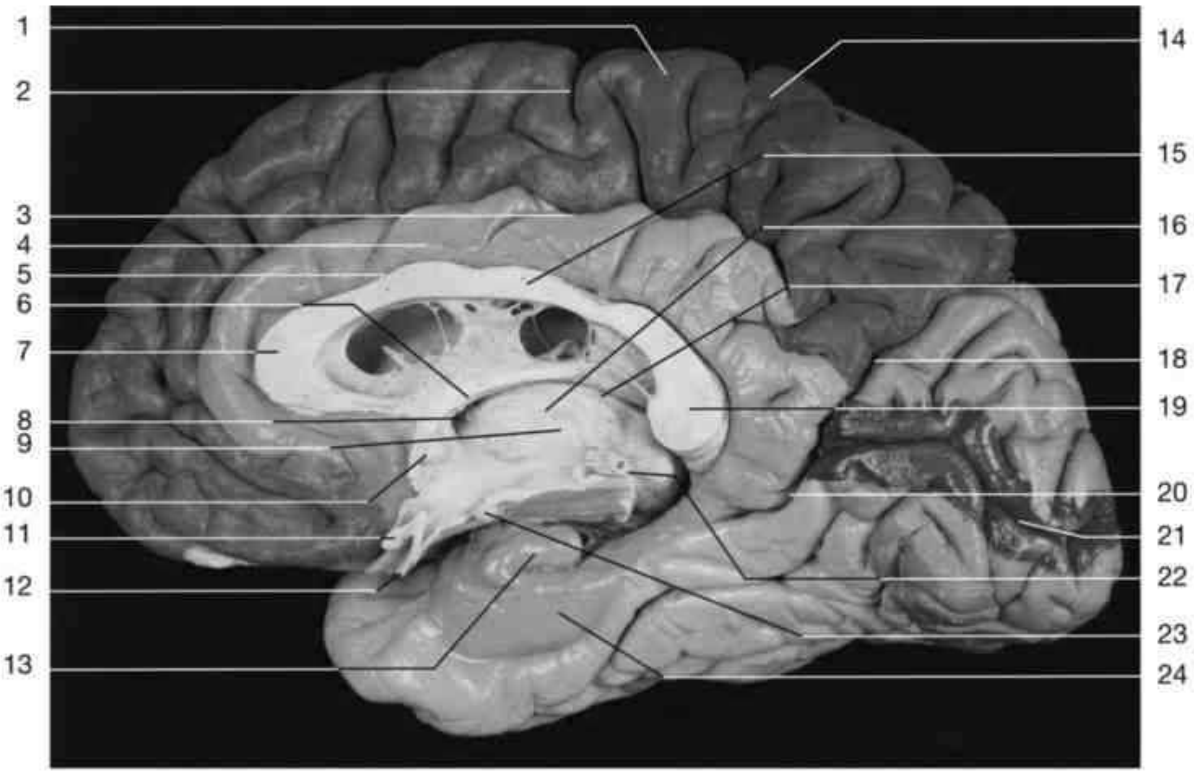


Figure 46 – Medial surface of the left hemisphere: 1 – precentral gyrus; 2 – precentral sulcus; 3 – cingulate sulcus; 4 – cingulate gyrus; 5 – sulcus of corpus callosum; 6 – fornix; 7 – genu of corpus callosum; 8 – interventricular foramen; 10 – anterior commissure; 11 – optic chiasma; 12 – infundibulum; 13 – uncus; 14 – postcentral gyrus; 15 – body of corpus callosum; 16 – third ventricle and thalamus; 17 – stria medullaris; 18 – parieto–occipital sulcus; 19 – splenium of corpus callosum; 20 – communication of calcarine and parieto–occipital sulcus; 21 – calcarine sulcus; 22 – pineal body; 23 – mamillary body; 24 – parahippocampal gyrus

The **medial frontal gyrus** is located above the cingulate gyrus. The **paracentral lobula** is bounded by the precentral sulcus in front and the marginal branch of the cingulate sulcus behind. The **precuneus** is situated between the marginal branch of the cingulate sulcus in front and the parieto–occipital sulcus behind. The **cuneus** is located between the parieto–occipital and calcarine sulci.

The inferior surface (Fig. 47) features the following sulci and gyri:

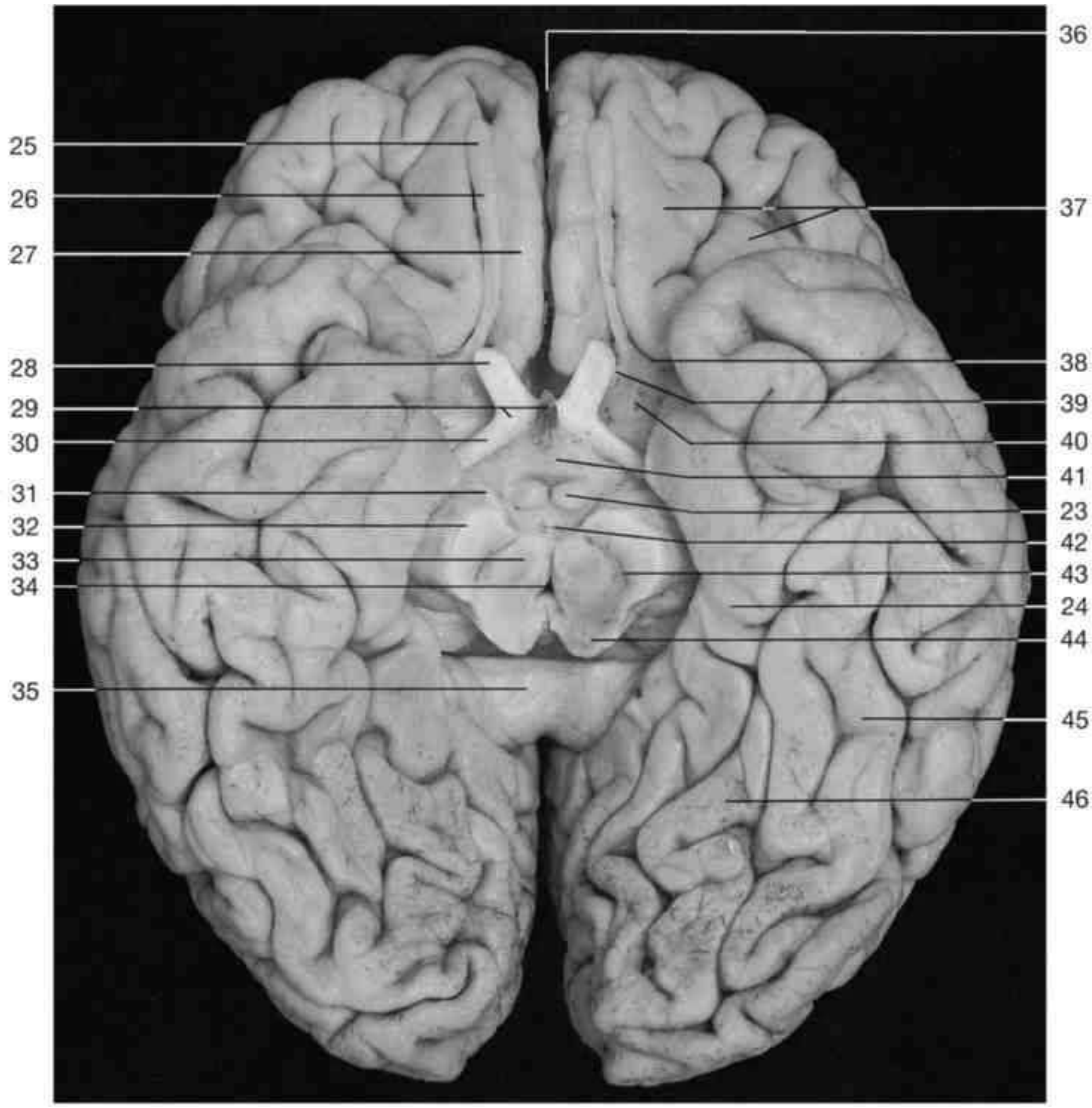


Figure 47 – Inferior surface of the left hemisphere: 25 – olfactory bulb; 26 – olfactory tract; 27 – gyrus rectus; 28 – optic nerve; 29 – infundibulum and optic chiasma; 30 – optic tract; 31 – oculomotor nerve; 32 – pedunculus cerebri; 33 – red nucleus; 34 – cerebral aqueduct; 35 – corpus callosum; 36 – longitudinal fissure; 37 – orbital gyri; 38 – lateral root of olfactory tract; 39 – medial root of olfactory tract; 40 – olfactory tubercle and anterior perforated substance; 41 – tuber cinereum; 42 – interpeduncular fossa; 43 – substantia nigra; 44 – colliculi of the midbrain; 45 – lateral occipitotemporal gyrus; 46 – medial occipitotemporal gyrus

- **the straight gyrus** is bounded by the longitudinal fissure and the olfactory sulcus
- **the orbital gyri** are located laterally the straight gyrus
- **the parahippocampal gyrus** is a continuation of the cingulate gyrus; it is bounded by the hippocampal sulcus medially and the rhinal sulcus laterally; it runs forward and terminates with the **uncus**
- **the lingual gyrus –** between calcarine and collateral sulci; the collateral sulcus runs along the occipital and temporal lobes and continuous with the rhinal sulcus
- **the medial occipitotemporal gyrus –** between the collateral and occipitotemporal sulci
- **the lateral occipitotemporal gyrus –** between the occipitotemporal sulcus and the inferior margine of the hemisphere.

DYNAMIC LOCALIZATION OF FUNCTIONS IN THE CEREBRAL CORTEX

To know functional divisions of the cerebral cortex is of great importance for theoretical studies because it gives an idea of the nervous regulation of all processes in the body and its adaptation to the environment. It is also of great practical importance for identifying the sites of lesions in the cerebral hemispheres.

The idea of the areas responsible for specialized functions in the cerebral cortex is primarily linked with the concept of the cortical center. Each cortical area differes in structure from other parts of the brain.

According to Pavlov, the center is the cerebral end of an analyser. The analyser is a nervous mechanism whose function is to decompose the intricacy of the outer and inner worlds into their separate elements and components, i.e., the analysis.

From Pavlov’s point of view, the brain centre, or the cortical end of the analyser, has no strictly demarcated boundaries but consists of a nuclear and scattered parts.

The nucleus is a detailed and exact projection in the cortex of all elements of the peripheral receptor and is necessary for accomplishing the highest analysis and synthesis.

The scattered elements are on the periphery of the nucleus and can be found at a far distance from it; they are concerned with a simple and elementary analysis and synthesis.

At a lesion of the nuclear part, the scattered elements can compensate, to some extent, for the lost function of the nucleus, which is very important in the clinical practice for the restoration of the function.

The cortical ends of the analysers are located in definite areas of the cerebral cortex.

Signals from the organising inner and outer worlds reach the cortex through the analysers. According to Pavlov, these signals compose the first–order signaling or alarm system of reality, expressed as concrete and visually aided, through the complexes of sensations to perceptions. A human being and animals have the first–order signaling system. Even in defferent living organisms, the centers of the first–order signaling system are on the higher level of development then in the human being.

The first–order signaling system consists of two main parts – the cortical ends of the internal analyser, which carry the nerve impulses from the internal environment, and the cortical ends of the external analysers, which carry the nerve impulses from the external environment.

The first–order signaling system, which excludes the spoken or written word, is common to both humans and animals. But speech and later the written word make up a secondary signaling system of reality which serves as a set of symbols or signs for the first–order system. This use of the word, which is specifically human, is exactly what distinguishes humans from animals.

Two cortical systems are distinguished:

- **projective system** (the first–order signaling system)
- **associative system** (the second sygnaling system)

The projective system is two–sided: the right area is connected with the left half of the body and the left area is connected with the right half of the body.

Projective centers:

- **the nucleus of the motor analyser**, or the analyser of the proprioceptive stimuli, arising in the bones, joints, and the skeletal muscles and their tendons; it is located in the **anterior central gyrus** and in the **paracentral lobule**. The body is projected in this gyrus headforemost, whereby the lower limb receptors are projected in the upper part of the gyrus and the head receptors in its lower part (Fig. 48)

- **the nucleus of the skin analyser (**sense touch, pain, and temperature) is in the **posterior central gyrus**. The body is projected in the gyrus headforemost (Fig. 48)

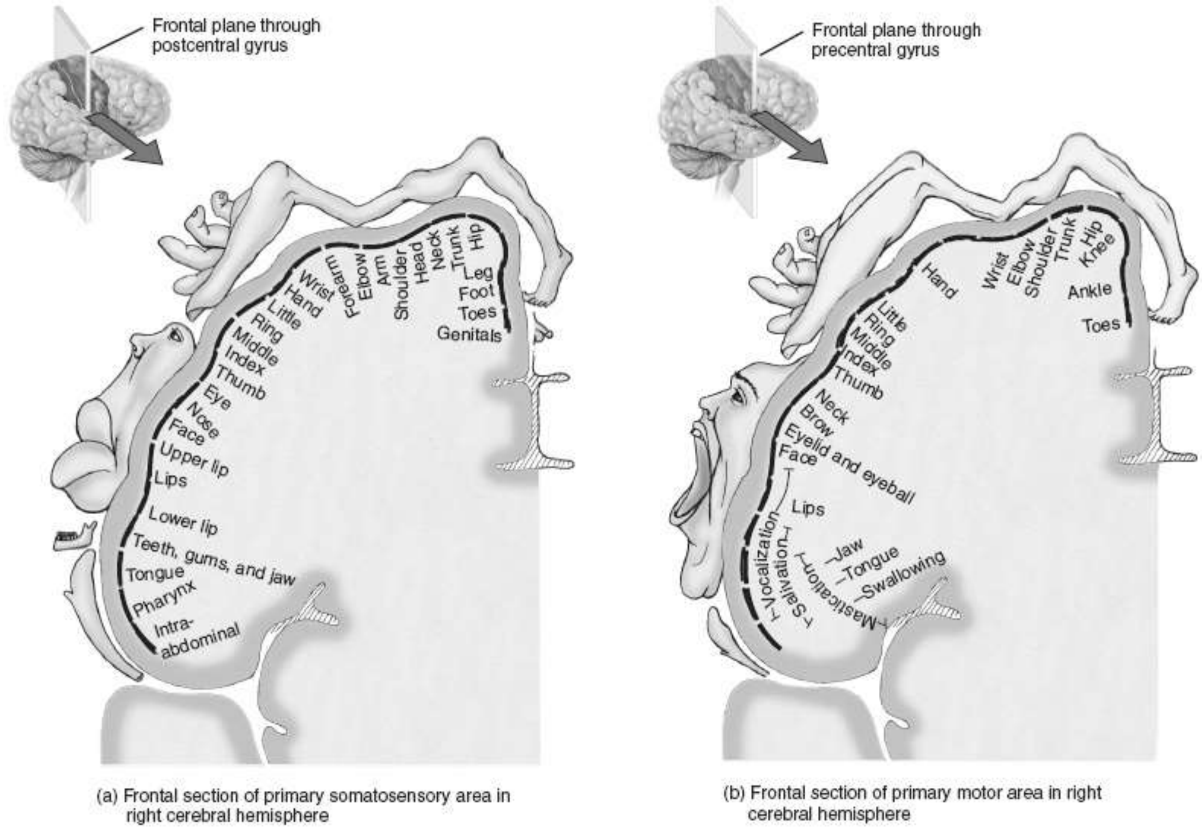


Figure 48 – Somatic sensory and somatic motor maps in the cerebral cortex

- **the nucleus of the auditory analyser** lies in the **middle part of the superior temporal gyrus (transverse temporal gyri –** Heschl's gyri) on the surface facing the insula. It interprets the basic characteristics of sound such as pitch and rhythm. Its injury results in cortical deafness

- **the nucleus of the visual analyser** is located on the medial surface of the occipital lobe **on the margins of the calcarine sulcus.** A lesion in the nucleus of the visual analyser leads to blindness

- **the nucleus of the olfactory analyser,** which receives smell impulses and **the nucleus of the taste analyser** are situated in the **uncus**

Associative centers:

- **the nucleus of the motor** analyser, by means of which the combined habitual purposeful movements are synthesized, is located in the inferior parietal lobule, in the **supramarginal gyrus.** This is the center of praxia. In affection the ability to move in general is preserved, but purposeful movements and actions cannot be performed: this is apraxia

- **the center of stereognosis,** or recognition of objects by touch, is located in the **superior parietal lobule**

- **the center of body scheme** is on the **margins of the intraparietal sulcus**

- **the nucleus of the motor analyser with regard to coordinate eye–head turning in the opposite direction** is situated in the **middle frontal gyrus**

Associative centers of the speech. All speech analysers (Fig. 49) are located in both hemispheres but develop only on one side (on the left in a right–handed person, and on the right in a left–handed person). All analysers are functionally asymmetric.

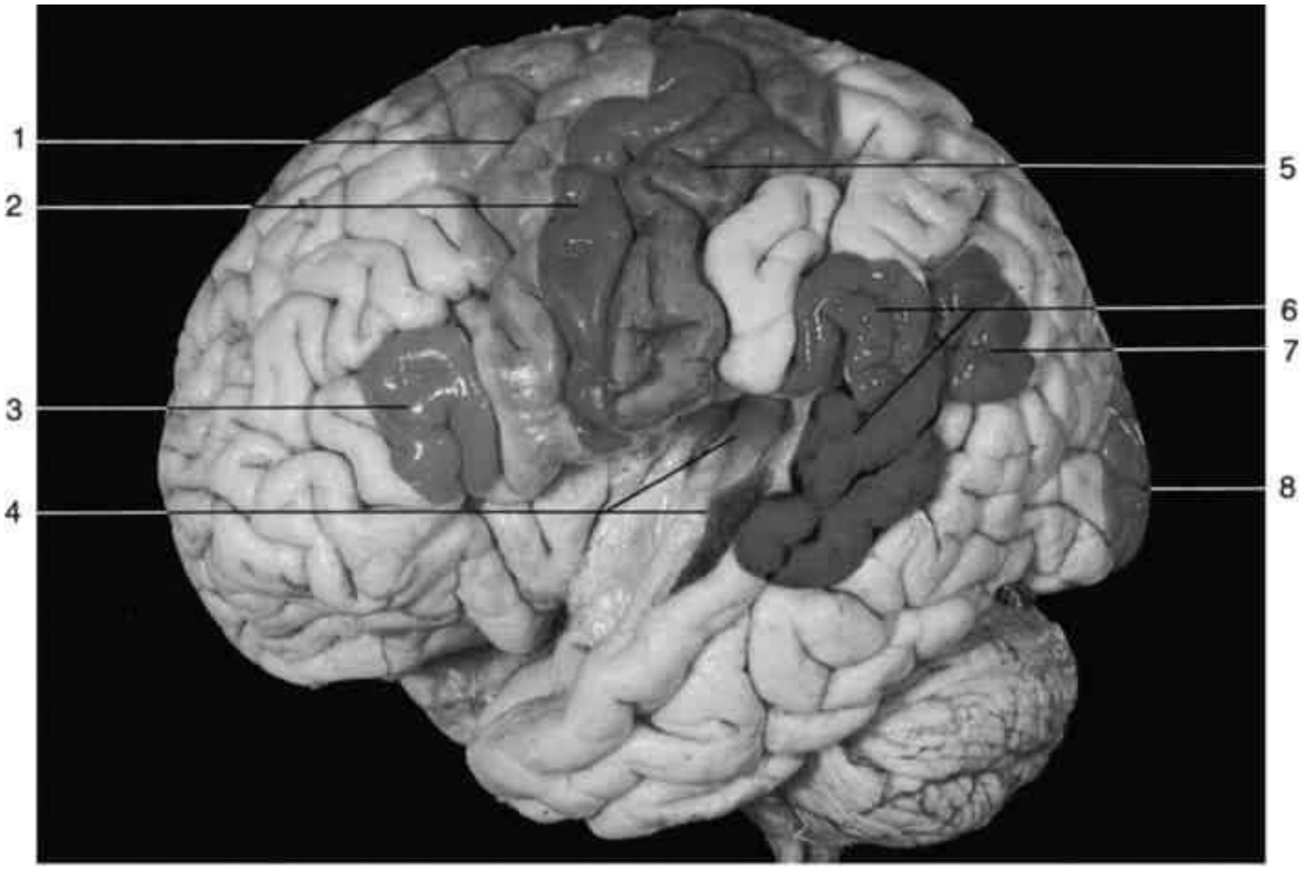


Figure 49 – Brain, left hemisphere (lateral aspect). Main cortical areas:
1 – motor analyser of written speech; 2 – somatomotor area; 3 – motor speech area of Broca; 4 – acoustic area; 5 – somatosensory area; 6 – sensory speech area (Wernicke's area); 7 – reading comprehension area; 8 – visuosensory area

The motor analyser of speech articulation (speech motor analyser, or **Broca's** speech area) lies in the posterior part of the **inferior frontal gyrus (opercular part).** Its injury results in motor aphasia.

The auditory analyser of spoken speech is located in the posterior part of the **superior temporal gyrus (Wernicke's area).** It is being damaged, retains the ability to hear sounds, but the meaning of both written and spoken word is not understood; this condition is called pure word deafness, or sensory aphasia.

The motor analyser of written speech is located in the posterior part of the **middle frontal gyrus**. The activity of this analyser is associated with the analyser of hand movements necessary in writting. Its injury results in agraphia.

The visual analyser of written speech is located in the inferior parietal lobule, in the **angular gyrus.** Vision is preserved in damage to this area, but the ability to read, i.e. to analyse written letters and form words and sentences from them, is lost (alexia).

VII. THE ASSOCIATION, COMMISSURAL AND PROJECTION FIBRES OF THE WHITE MATTER OF THE HEMISPHERES. THE ASCENDING AND DESCENDING CONDUCTION PATHWAYS

The **white matter** occupies the whole space between the grey matter of cerebral cortex and basal ganglia. It consists of a great number of nerve fibres stretching in different directions and forming the conduction pathways of the telencephalon.

Structure

White matter is composed of bundles of myelinated nerve cell processes (or axons), which connect various grey matter areas (the locations of nerve cell bodies) of the brain to each other, and carry nerve impulses between neurons. Myelin acts as an insulator, increasing the speed of transmission of all nerve signals

Location

White matter forms the bulk of the deep parts of the brain and the superficial parts of the spinal cord. Aggregates of gray matter such as the basal ganglia (caudate nucleus, putamen, globus pallidus, subthalamic nucleus) and brain stem nuclei (red nucleus, substantia nigra, cranial nerve nuclei), are spread within the cerebral white matter.

The following three systems of nerve fibres are distinguished (Fig. 50):

1. The association fibres connect different cortical areas of one hemisphere. Short and long fibres are distinguished. The association fibers connect different areas of the cerebral cortex. Some are relatively large, such as the *superior longitudinal fasciculus*, which connects the occipital and frontal lobes. Part of the fasciculus, the *arcuate fasciculus* connects temporal and frontal lobes, and is important for language. The *inferior longitudinal fasciculus* connects the temporal and occipital lobes and is involved in visual recognition function.

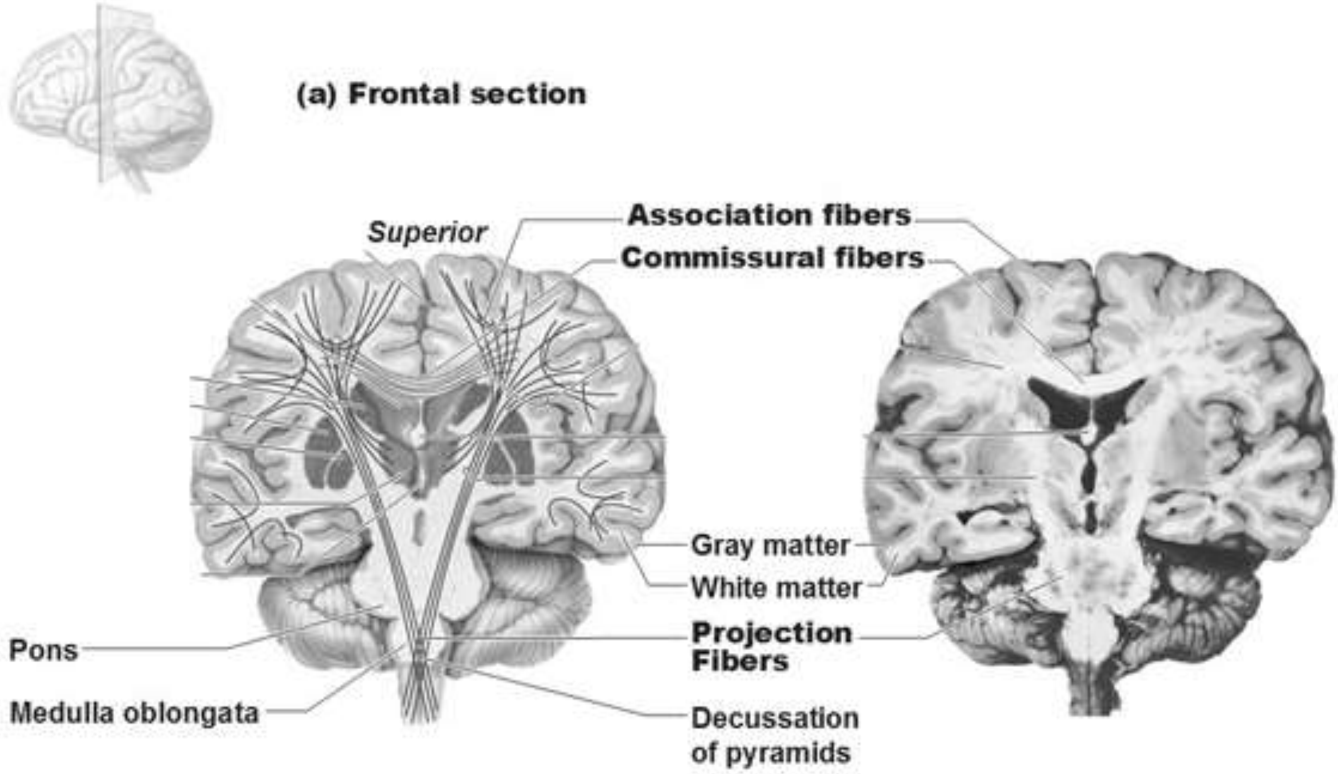


Figure 50 – Types of conducting pathways

2. The commissural fibres, components of the cerebral commissures, connect symetrical parts of both hemispheres. The largest commissure is the corpus callosum, which lies superior to the lateral ventricles, deep within the longitudinal fissure. Less prominent examples are the anterior and posterior commissures.

3. The projection fibres connect the cerebral cortex partly with the thalamus and the geniculate bodies and partly with the distally located parts of the nervous system, the spinal cord among others. Some of these fibres conduct stimuli centripetally, i.e. toward the cortex, and other, on the contrary, centrifugally.

The projection pathways are divided into centripetal, or afferent, and centrifugal, or efferent neural pathways, according to the direction of the conducted stimuli. The centripetal neural pathways conduct information in the ascending direction, from the receptors to the brain formation, while the centrifugal neural pathways convey it in the opposite, descending direction, from the brain structures to the effector organs.

By the type of impulses, the ascending (sensory, afferent) pathways are divided into exteroceptic, proprioceptic, and interoceptic ones.

The exteroceptic pathways conduct impulses that are formed under external action on the skin (pain, temperature, pressure sense and the sense of touch), sense organs (organs of vision, smell, hearing, and taste). Proprioceptic pathways conduct impulses from the organs of the locomotor apparatus (muscles, ligaments, tendons, and joint capsules), convey information about the body position or amplitude of movements. Interoceptic pathways conduct impulses from entrails and vessels, where chemo–, baro– and mechanoreceptors «sense» the condition of internal medium, intensity of metabolism, chemical compositiion of tissue fluid, and blood pressure in vessels.

EXTEROCEPTIVE CONDUCTIVE PATHWAYS

The conductive pathway for temperature and pain sense – lateral spinothalamic tract. The receptor is situated in the skin. The conductor consists of three neurons.

The cell body of the ***first–order–rder neuron*** (pseudounipolar cells) is located in the spinal ganglion. The process arising from the cells of this ganglion splits into two branches: the peripheral one runs in the skin nerve to the receptor, while the central branche runs as a component of the posterior root into the spinal cord, and fibres end in the posterior horn.

The cell body of the ***second–order neuron*** is situated in the nucleus proprius of the posterior horns. The axons of the secondary neurons continue through the anterior grey commissure into the funiculus lateralis of the opposite side.

Fascicle of these neurons (axons of secondary neurons) ascends medulla oblongata, pons, and midbrain and terminates in the thalamus, forming synapses on bodies of the third–order neurons.

Bodies of the ***third–order neurons*** are situated in the dorsal lateral nucleus of the thalamus, and their axons continue through the posterior part of the internal capsule. Then they fan out taking part in forming the radiate crown end with neuron synapses of the fourth layer of the cortex of the postcentral gyrus.

The lateral spinothalamic pathway is completely cotralateal, it means that all the fibres of the secondary neurons pass to the opposite side. Therefore a lesion affecting the half of the spinal cord results in loosing pain and temperature sensation in the opposite side under the place of the lesion.

The conductive pathway for touch and pressure sensitivity – the anterior spinothalamic tract – differs from lateral spinothalamic pathway only by second–order neurons. The cell bodies of the ***second–order*** neurons are located in the substantia gelatinosa of the posterior horn of the spinal cord. All axons of the second neurons continue through the anterior grey commissure into the anterior funiculus of the opposite side. As a part of the anterior funiculus, axons of the second–order neurons ascend to the cerebellum.

Cell bodies of the ***third–order neurons*** are situated in the dorsal lateral nucleus of the thalamus. Axons of the third–order neurons along with fibres of the lateral spinothalamic pathway intersect the posterior crus of the internal capsule and reach the posterior central gyrus.

The fibres of the first–order–order neurons that conduct senses of touch and pressure pass as a part of the posterior funiculus of their side with cell axons of the pathway conducting proprioceptive sensitivity to the cortex. Therefore a lesion affecting the half of the spinal cord causes just a decrease but not a total disappearance of skin sensitivity to touch and pressure.

PROPRIOCEPTIVE CONDUCTIVE PATHWAYS convey impulses from locomotor system to the cerebral cortex of the hemispheres and to the cerebellum.

The conductive pathway for proprioceptive sensitivity to cortex – tractus bulbothalamicus. Receptor of the first–order–order neurons are situated in the muscles, tendons, joint capsules, and ligaments. Bodies of the ***first–order–order neurons*** are situated in the spinal ganglia. Axons of these neurons, as a part of the posterior root of spinal nerves, continue to the posterior funiculus of the spinal cord. The lateral section of the posterior funiculus (wedge–shaped fascicle, Burdach's fascicle) is formed of the axons that convey information from the upper body, neck, and upper extremities. The medial part of the posterior funiculus (slender fascicle, Goll's fascicle) conveys impulses of proprioceptive sensitivity from the lower part of the body and the lower extremity.

Then axons of the first–order–order neurons ascend to the medulla oblongata and terminate by synapsing with the second neurons.

Cell bodies of the ***second–order neurons*** are situated in the nucleus gracilis (slender) and cuneatus nucleus (cuneate). Axons of the second–order neurons come out of these nuclei, arcuate forward and medially in the interolivial layer as internal acuate fibres (medial lemniscus), pass on the opposite side. Here, at axons of the second–order neurons, occurs the sensory decussation of the medulla oblongata. Then fibres of the medial loop (fillet) ascend in the pons, midbrain and synapses with the neurons of the dorsal lateral nucleus of the thalamus (***third neurons***). Axons of the third–order neurons intersect the posterior part of the internal capsule. These fibres reach the postcentral gyrus as a part of the radiate crown.

A part of fibres of the second–order neurons of the proprioceptive pathway to the cortex come out of the cuneate nucleus and nucleus gracilis and continue to the cerebellum. Among these fibres they distinguish the anterior and posterior external arcuate fibres.

Posterior external arcuate fibres end on the neurons of the cerebellar cortex of the vermis of their side. Anterior external arcuate fibres go straight opposite to the vermal cortex.

The conductive pathways for proprioceptive sensitivity to the cerebellum are related to the involuntary coordination of movement.

The dorsal spinocerebellar tract or Flechsig`s fasciculus conveys impulses from muscles, tendons and ligaments to the cerebellum. Bodies of the ***first–order–order neurons*** are situated in the spinal ganglia. Central processes of these cells go to the posterior horn as a part of the dorsal root of a spinal nerve. These axons end up on the neurons of the thoracic nucleus (Clarke`s column) in which the bodies of the ***second–order neurons*** are located. The axons of the second–order neurons pass to the posterior part of the funiculus lateralis of their side. Then they ascend to the medulla oblongata. These axons proceed to the cerebellum through the inferior cerebellar peduncle and terminate by synapsing with neurons of the vermal cortex, where the tract ends up.

The anterior spinocerebellar tract or Gowers` tract is more complicated than Flechsig’s tract.

Bodies of the ***first–order–order neurons*** are located in spinal ganglia. Bodies of the ***second–order neurons*** are in the nucleus intermedius medialis. Axons of the second–order neurons intersect the anterior grey commissure and pass into the anterior part of the funiculus lateralis of the opposite side (first–order decussation). Then the axons of the second–order neurons ascend to the level of the rhombencephalic ishtmus and return to their side (second decussation), procceding through the superior cerebellar peduncle towards the cerebellum. Here, they end up in the cortex of vermis. In the vermal cortex there are bodies of the third neurons. Axons of the ***third–order neurons,*** from the vermal cortex, run to the dentate nucleus and form the *vermodentate tract*. In the dentate nucleus the bodies of the ***fourth neurons*** are located.

Axons of the dentate nucleus neurons go as a *dentorubral tract* to the red nucleus of the opposite side. In the red nucleus there are the bodies of the ***fifth neurons***. Axons of this nucleus form the descending *rubrospinal tract* which is a part of the involuntary coordination of movement.

DESCENDING PROJECTION (motor, efferent) pathways conduct impulses from the cortex, subcortical centers, and nuclei of the brainstem to the motor nuclei of the brainstem and the spinal cord. They include pyramidal (voluntary) and extrapyramidal (involuntary) motor tracts.

Pyramidal tract includes corticonuclear, anterior, and lateral corticospinal conductive tracts.

Extrapyramidal conductive tracts are philogenetically older then pyramidal. They include rubrospinal tract, reticulo–, tecto–, and olivospinal tracts, etc.

Corticonuclear tract starts from the giant pyramidal cells (Betz cells) that are situated in the fifth layer of the cortex of the precentral gyrus, in its lower one third. Axons of these neurons descend through the genu of the internal capsule, intersect the base of the cerebral peduncles and the basal part of the pons up to the medulla oblongata. Axons of the first–order neurons proceed contraversal to the level of the midbrain and terminate on neurons of motor nuclei of the cranial nerves III and IV. At the level of the pons, the fibres proceed to the motor nuclei of the cranial nerves V, VI, VII of the opposite side. At the level of the medulla oblongata, the fibres pass to the motor nuclei of the cranial nerves IX, X, XI, XII of the opposite side. The bodies of the second neurons are located in the motor nuclei of the cranial nerves. Axons of the second neurons, as a part of branches of the cranial nerves, proceed to the striated muscles of the head and the neck and innervate them.

Lateral and anterior corticospinal tracts arise from the giant pyramidal cells of the upper two thirds of the precentral gyrus. The bodies of the first–order neurons are located in these cells. Axons of these cells descend through the posterior crus of the internal capsule behind the corticonuclear tract. Then fibres of these tracts descend through the base of the cerebral peduncle, the basal part of the pons and form the pyramids of the medulla oblongata. In the lower part of the medulla oblongata, a part of fibres crosses the opposite side, forming the decussation of the pyramid (motor decussation). Then these fibres enter funiculus lateralis of the opposite side of the spinal cord, named the lateral corticospinal tract. This conductive tracts descend in the funiculus lateralis and gradually enters the anterior horn of the grey substance of the spinal cord and terminates with synapses on motor neurons in which the bodies of the second neurons are situated.

A part of nerve fibres in the corticospinal tracts do not take part in forming the decussation of the pyramids. They descend as a part of the anterior funiculus of the spinal cord of their side. This is the anterior corticospinal tract. Its fibres gradually cross to the opposite side of the spinal cord through the anterior white commissure and terminate on motor nuclei of the anterior horn of the opposite side in which the bodies of the second neurons are located.

The axons of the second neurons pass from the anterior roots of the spinal nerve and innervate the skeletal musculature of the trunk and limbs.

As a consequence, the cortex of each hemisphere innervates the muscles on the opposite side of the body. The corticonuclear and the corticospinal tracts form a single pyramidal system concerned with conscious control of the whole skeletal musculature.

Several centers in the cerebrum, diencephalon, and brain stem may issue somatic motor commands as a result of the processing performed at a subconscious level. These centers and their conducting pathways are known as the **extrapyramidal system**. The vestibulospinal, tectospinal, and reticulospinal tracts help control gross movements of the trunk and proximal limb muscles, whereas the rubrospinal tracts help control the distal limb muscles that perform more precise movements. The axons of the upper–motor neurons in these pathways synapse on the same lower motor neurons innervated by the corticospinal tracts.

Control of muscle tone and gross movements of the neck, trunk, and proximal limb muscles is primarily transmitted by vestibulospinal, tectospinal, and reticulospinal tracts. The upper motor neurons of these tracts are located in the vestibular nuclei, the superior and inferior colliculi, and the reticular formation, respectively (Table 6).

The vestibular nuclei receive information, over the vestibulocochlear nerve (N VIII), from receptors in the inner ear that monitor the position and movement of the head. These nuclei respond to changes in the orientation of the head, sending motor commands that alter the muscle tone, extension, and position of the neck, eyes, head, and limbs. The primary goal is to maintain posture and balance. The descending fibers in the spinal cord constitute the **vestibulospinal tracts**.

The superior and inferior colliculi are located in the tectum, or roof, of the mesencephalon. The colliculi receive visual (superior) and auditory (inferior) sensations, and these nuclei are involved in coordinating or directing reflexive responses to these stimuli. The axons of upper–motor neurons cross to the opposite side immediately, before descending to synapse on lower–motor neurons in the brain stem or spinal cord. Axons in the **tectospinal tracts** direct reflexive changes in the position of the head, neck, and upper limbs in response to bright lights, sudden movements, or loud noises.

Table 6 – Principal motor pathways

Tract	**First–order neuron**	**Second neuron**	**Site of crossover**	**Action**
CORTICOSPINAL TRACTS				
Corticonuclear tracts	Precentral gyrus	Motor neurons of cranial nerve nuclei in brain	Brain stem	Conscious motor control of skeletal muscles
Lateral corticospinal tracts	Precentral gyrus	Motor neurons of anterior horns of spinal cord	Pyramids of medulla oblongata	Conscious motor control of skeletal muscles
Anterior corticospinal tracts	Precentral gyrus	Motor neurons of anterior horns of spinal cord	Level of lower–motor neuron	Conscious motor control of skeletal muscles
SUBCORTICAL (SUBCONSCIOUS) MOTOR PATHWAYS				
Vestibulospinal tracts	Vestibular nuclei	Motor neurons of anterior horns of spinal cord	uncrossed	Subconscious regulation of balance and muscle tone
Tectospinal tracts		Motor neurons of anterior horns of spinal cord (cervical spinal cord only)	mesencephalon	Subconscious regulation of eye, head, neck, and upper limb position in response to visual and auditory stimuli
Reticulospinal tracts		Motor neurons of anterior horns of spinal cord	uncrossed	Subconscious regulation of reflex Activity
Rubrospinal tracts		Motor neurons of anterior horns of spinal cord	mesencephalon	Subconscious regulation of upper limb muscle tone and movement

The reticular formation is a loosely organized network of neurons that extends throughout the brain stem. The reticular formation receives input from almost every ascending and descending tract. It also has extensive interconnections with the cerebrum, the cerebellum, and brain stem nuclei. Axons of upper motor neurons in the reticular formation descend in the reticulospinal tracts without crossing to the opposite side. The effects of reticular formation stimulation are determined by the region stimulated. For example, the stimulation of upper motor neurons in one portion of the reticular formation produces eye movements, whereas the stimulation of another portion activates respiratory muscles.

Control of muscle tone and the movements of distal portions of the upper limbs is the primary information transmitted by the **rubrospinal tracts**. The commands carried by these tracts typically facilitate flexor muscles and inhibit extensor muscles. The upper motor neurons of these tracts lie within the red nuclei of the mesencephalon. Axons of upper motor neurons in the red nuclei cross to the opposite side of the brain and descend into the spinal cord in the rubrospinal tracts. In humans, the rubrospinal tracts are small and extend only to the cervical spinal cord. There they provide motor control over distal muscles of the upper limbs; normally, their role is insignificant compared with that of the lateral corticospinal tracts. However, the rubrospinal tracts can be important in maintaining motor control and muscle tone in the upper limbs if the lateral corticospinal tracts are damaged.

The descending tracts of the cerebral cortex to the cerebellum

The cerebral cortex which is in charge of all body processes also governs the cerebellum, the most important proprioceptive center concerned with body movement. This is achieved due to the presence of a special tract descending from the cortex of the brain to that of the cerebellum.

The corticopontine tract. The first–order neurons of this tract consist of neurons which cell bodies are located in the cerebral cortex, while the axons descend to the nuclei of the pons – ***proper pontine nuclei***, where the bodies of the second neurons are located. This tract is divided into two bundles,according to the different lobes of the brain:

- The **frontopontine tract** passes through the internal capsule and the base of the cerebral peduncle.

- The **occipito–temporo–parieto–pontine tract** passes through the internal capsule and the base of the cerebral peduncle.

The pontine nuclei give rise to the second neuron which axons form the **pontocerebellar tract** passing to the opposite side of the pons and reaching the cerebellar cortex as components of the middle cerebellar peduncles.

VIII. THE MENINGES OF THE BRAIN. THE CEREBROSPINAL FLUID. THE VESSELS OF THE BRAIN

The cranium and the cranial meninges surround and protect the brain, acting as shock absorbers that prevent contact with surrounding bones. The cranial meninges are continuous with the spinal meninges you learned about in the last chapter. The outer layer of the meninges is the **dura mater**, the middle – the **arachnoid mater,** and the inner layer is the **pia mater**.

The dura mater splits to form **dural venous sinuses**, where venous blood passes. The veins of the brain open into these sinuses which, in turn, deliver that blood to the internal jugular vein. Four processes of the dura mater separate parts of the brain (Fig. 51).

1. **The falx cerebri** separates two hemispheres of the cerebrum. It projects between the cerebral hemispheres in the longitudinal fissure. Its inferior portions attach to the crista galli (anteriolly) and the internal occipital crest and tentorium cerebelli (posteriolly). Two large venous sinuses, **the superior sagittalsinus** and **the inferior sagittal sinus**, pass within this dural fold.

2. **The tentorium cerebelli** separates the cerebrum from the cerebellum. It supports and protects the two occipital lobes of the cerebrum. It extends across the cranium at right angles to the falx cerebri. **The transverse sinus** lies within the tentorium cerebelli.

3. **The falx cerebelli** separates the two hemispheres of the cerebellum. It extends in the midsagittal line inferior to the tentorium cerebelli. Its posterior margin, which is locked in position, contains the **occipital sinus**.

4. **The diaphragma sellae** is a continuation of the dural sheet that lines the sella turcica of the sphenoid. It expands between the clinoid processes of the sphenoid bone and passes infundibulum to the pituitary gland.

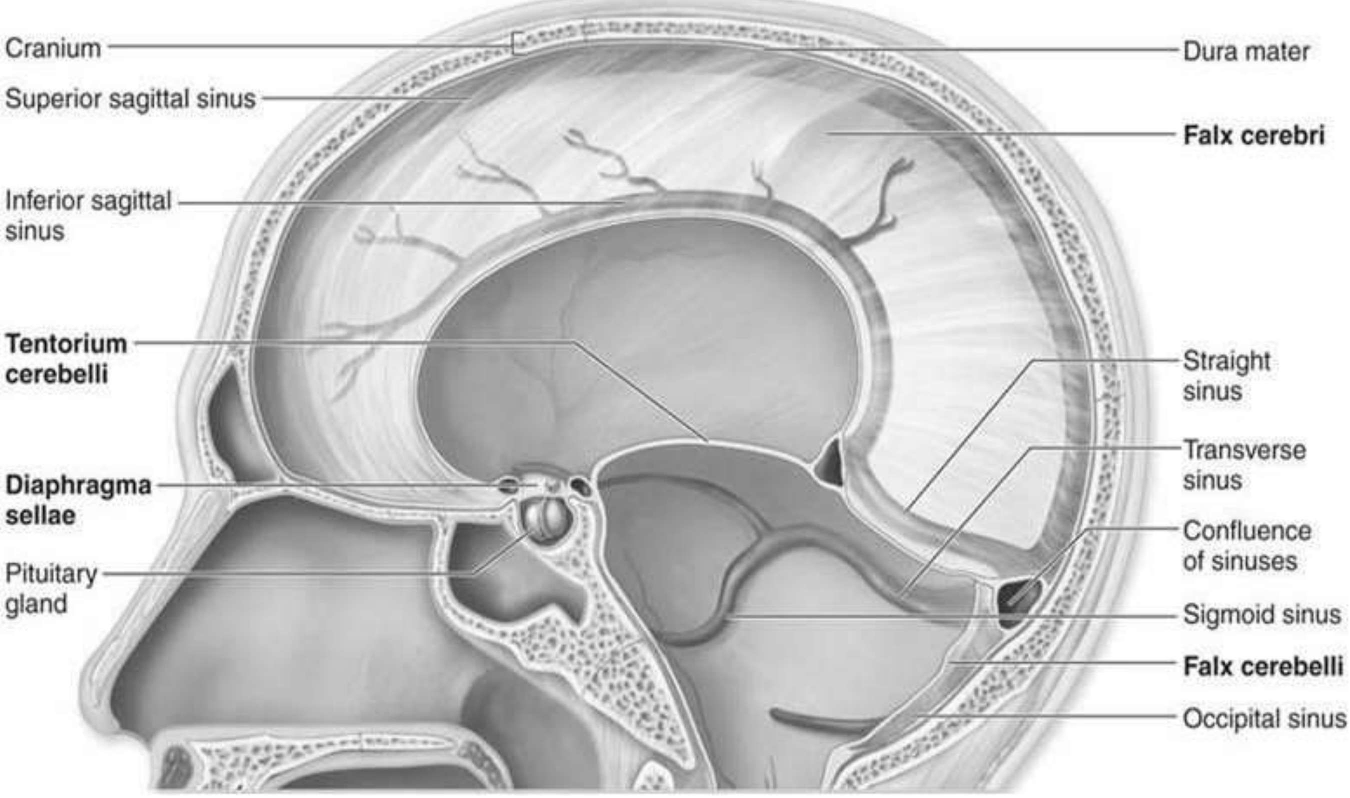
The arachnoid mater is located between the superficial dura mater and the deeper pia mater.

The subdural space is a potential space that exists between the dura mater and the arachnoid mater. The meningeal layer of the dura mater is usually adherent to the underlying arachnoid mater via a series of tight junctions. The subdural space does not exist under normal conditions and is appreciable only when there is an underlying pathology. Bleeding from bridging veins may strip the dura from the arachnoid mater. This collection of blood is known as a subdural haematoma. The arachnoid mater does not follow the underlying cerebral sulci. Deep to the arachnoid mater is the **subarachnoid space**, which contains a cerebrospinal fluid. In certain areas the subarachnoid space is considerably enlarged to form distinct cisterns. The most important of these are:

– the **posterior cerebromedullary cistern**, or cisterna magna: between the cerebellum and the dorsum of the medulla;
– the **cistern of lateral cerebral fossa**;
– the **interpeduncular cistern**: between the two cerebral peduncles;
– the **chiasmatic cistern:** around the optic chiasma.

Externally, along the axis of the superior sagittal sinus, extensions of the arachnoid mater penetrate into the dura mater and project into the venous sinuses. At these projections, called **arachnoid granulations**, cerebrospinal fluid flows past bundles of fibers (the arachnoid trabeculae), crosse the arachnoid mater, and enter the venous circulation.

The pia mater is tightly attached to the surface contours of the brain, following its contours and lining the sulci. The cranial pia mater is a highly vascular membrane that acts as a floor to support the large cerebral blood vessels as they branch over the surface of the brain.



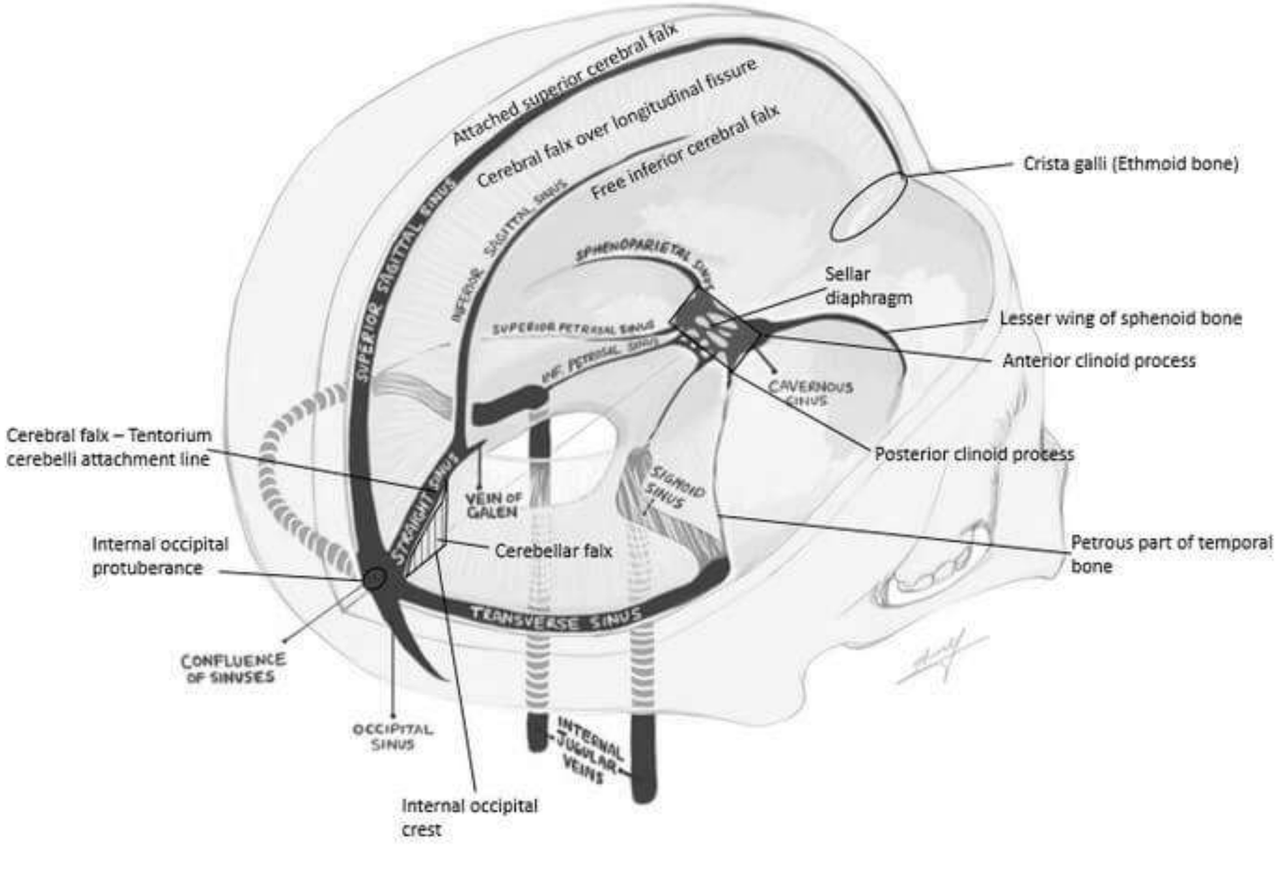


Figure 51 – Dura mater and venous sinuses of the dura mater

All of the ventricles contain choroid plexus, which consists of a combination of specialized ependymal cells and highly permeable capillaries. Two extensive folds of the choroid plexus originate in the roof of the third ventricle and extend through the interventricular foramina into the lateral ventricles. These folds cover the floors of the lateral ventricles. In the lower brain stem, a region of the choroid plexus in the roof of the fourth ventricle projects between the cerebellum and the pons. The choroid plexus is responsible for the production of cerebrospinal fluid.

Cerebrospinal fluid is a clear, colorless liquid comprised primarily of water that protects the brain and spinal cord against chemical and physical injuries. It also carries small amounts of oxygen, glucose, and other needed chemicals from the blood to neurons and neuroglia. Cerebrospinal fluid circulates slowly and continuously through cavities in the brain and spinal cord and around the brain and spinal cord in the subarachnoid space. The total volume of the cerebrospinal fluid is 80 to 150 mL (3 to 5 oz) in an adult.

The cerebrospinal fluid functions in three main ways:

1. Mechanical protection. The primary function of the cerebrospinal fluid is to serve as a shock–absorbing medium. It protects the delicate tissues of the brain and spinal cord from jolts that would otherwise cause them to hit the bony walls of the cranial cavity and vertebral canal.

2. Chemical protection. Cerebrospinal fluid provides an optimal chemical environment for efficient neuronal signaling.

3. Circulation. Cerebrospinal fluid is a medium for the minor exchange of nutrients and waste products between the blood and the adjacent nervous tissue.

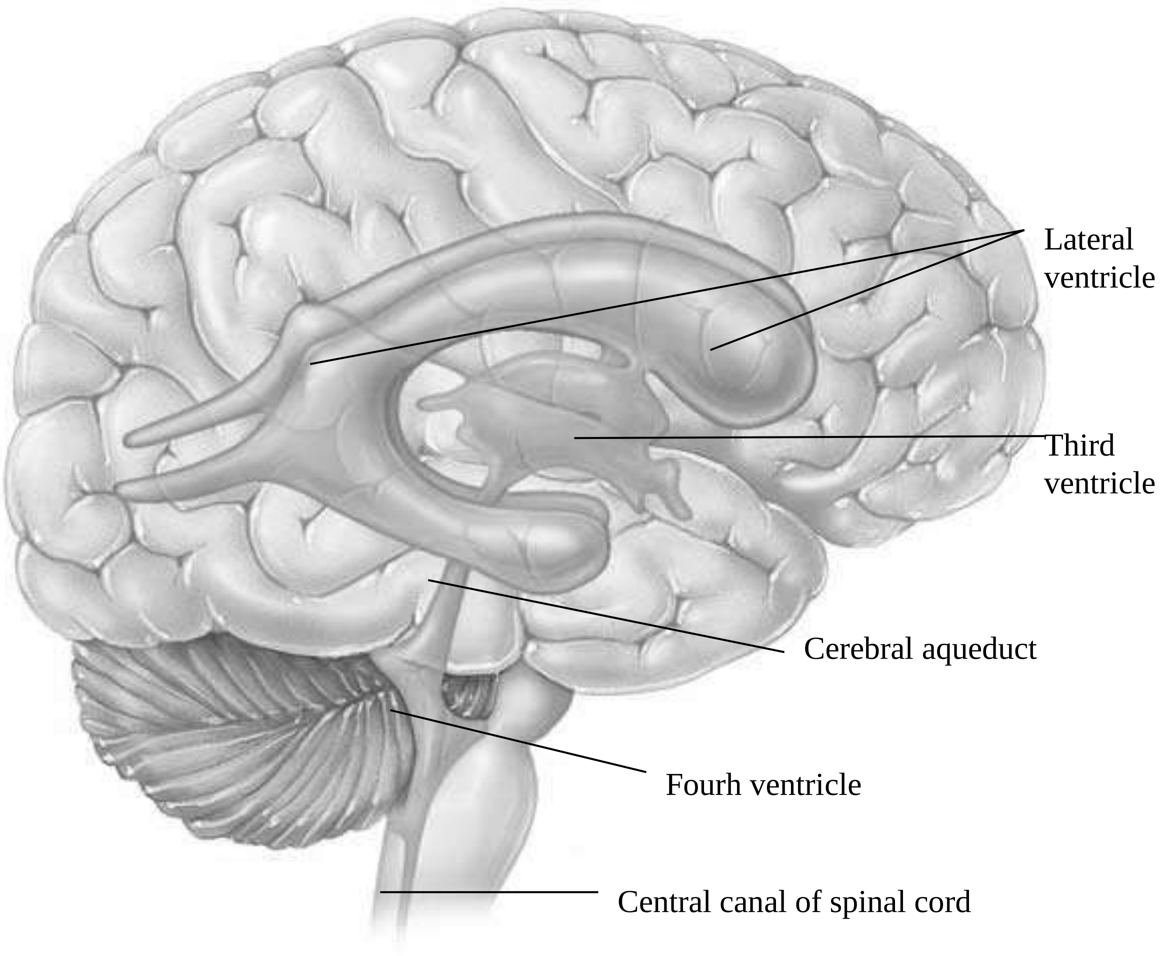
Circulation of cerebrospinal fluid

Cerebrospinal fluid (CSF) produced in the lateral ventricles flows into the third ventricle through the interventricular foramen (foramen of Monro). From there, cerebrospinal fluid flows into the aqueduct of the midbrain (Fig. 52).

Most of the cerebrospinal fluid reaching the fourth ventricle enters the subarachnoid space by passing through the paired lateral apertures (foramen of Luschka) and a single median aperture (foramen of Magendie) in its membranous roof.

A relatively small quantity of cerebrospinal fluid circulates between the fourth ventricle and the central canal of the spinal cord. Cerebrospinal fluid continuously flows through the subarachnoid space surrounding the brain, and movements of the vertebral column move it around the spinal cord and cauda equina CSF is gradually reabsorbed into the blood through the arachnoid villi, which are fingerlike projections from the arachnoid matter (the Pachionian granulations), into the dural venous sinuses, especially the superior sagittal sinus.

The flow of cerebrospinal fluid must be regulated to prevent the build–up of too much fluid in the brain that creates abnormally high pressure on brain tissue. If the normal circulation of CSF is interrupted, a variety of clinical problems may appear.



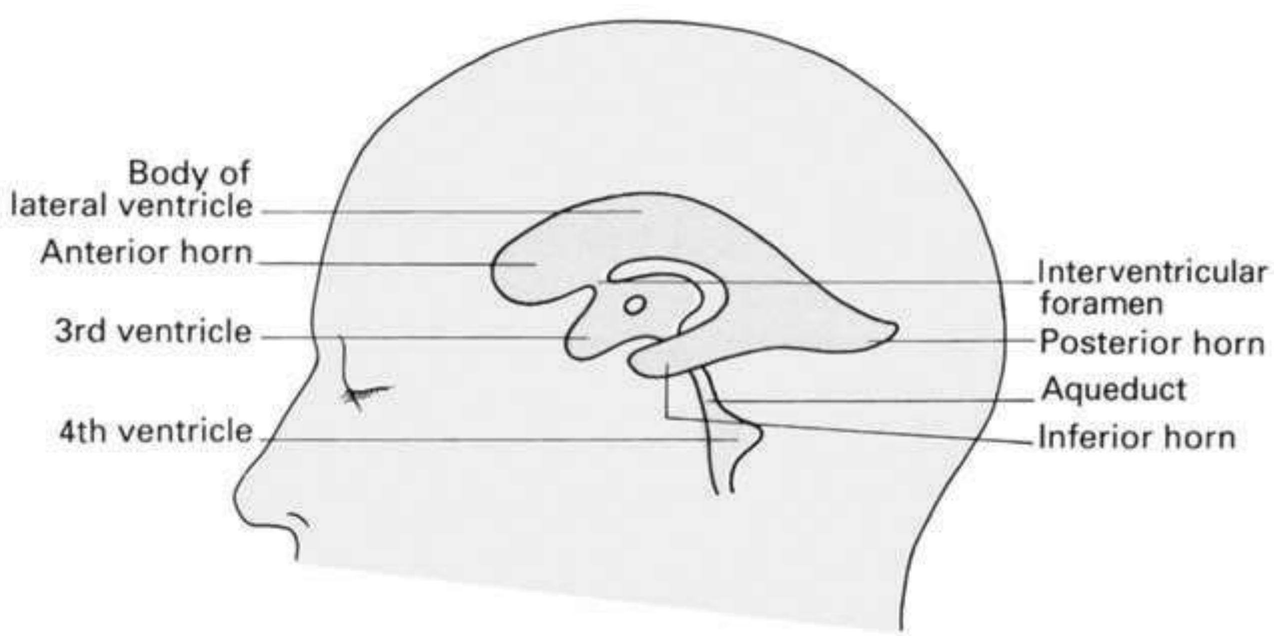


Figure 52 – Ventricular system of the brain

IX. VESSELS OF THE BRAIN AND SPINAL CORD

The internal carotid artery gives rise to the anterior and middle cerebral arteries.

The anterior cerebral artery runs medially above the optic chiasm and then between the frontal lobes in the longitudinal fissure. This artery supplies the medial surface of the parietal and frontal lobes. It is linked to the opposite anterior cerebral artery by the anterior communicating artery.

The middle cerebral artery, which is the largest of the cerebral arteries, divides and branches to supply most of the lateral surfaces of the frontal, parietal, and temporal lobes.

The vertebral arteries arise from the subclavian artery and enter the cranium cavity via the foramen magnum. As they rise rostrally, the vertebral arteries give off, among others, the posterior and anterior spinal arteries, which feed the spinal cord and the medulla. The largest of these branches is the posterior inferior cerebellar artery, which supplies the inferior part of the cerebellum.

The arterial circle of Willis (Fig.53) is completed in front by the anterior communicating artery, which links the two anterior cerebral arteries, and behind by a posterior communicating artery on each side, passing backwards from the internal carotid to anastomose with the posterior cerebral, a branch of the basilar artery, the latter being formed by the junction of the two vertebral arteries.

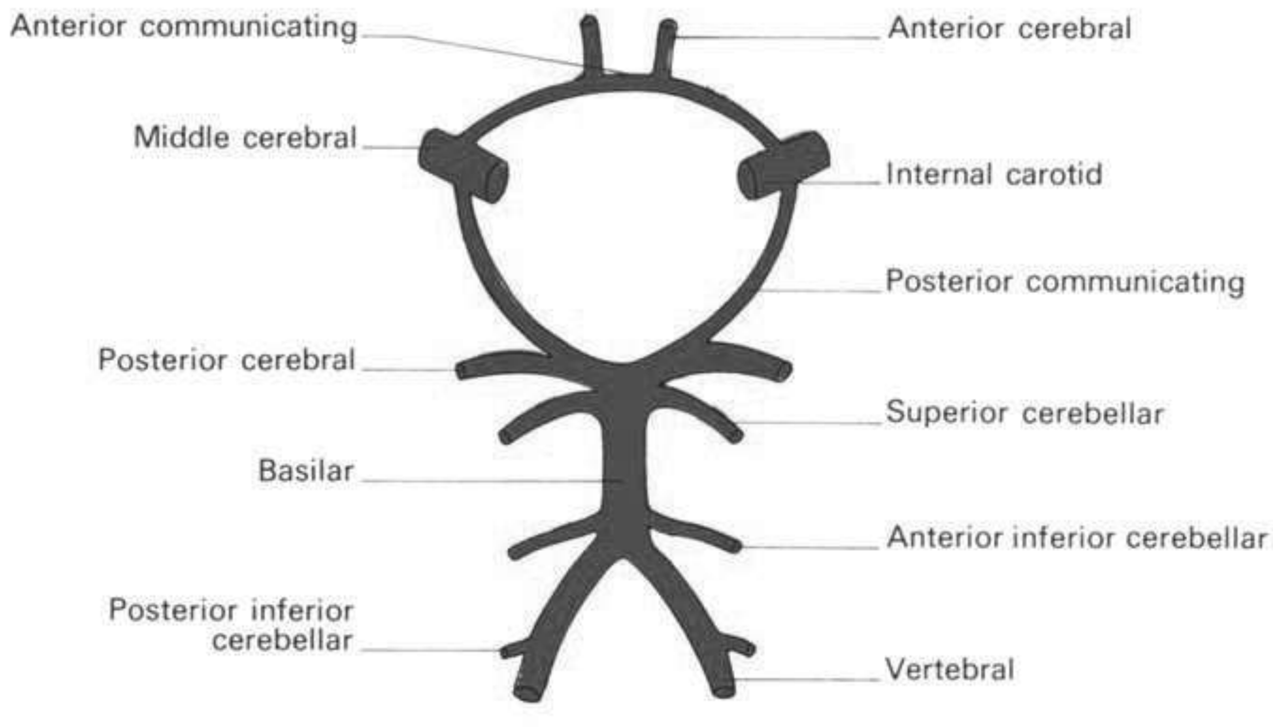


Figure 53 – The circle of Willis

The venous drainage of the brain follows two pathways:

1) the superficial structures, e.g., the cerebral and cerebellar cortices, drain to the nearest available dural sinus by superficial veins;

2) the deep structures drain through the internal cerebral vein on each side, which is formed at the interventricular foramen by the junction of the choroid vein (draining the choroid plexus of the lateral ventricle) with the thalamostriate vein (draining the basal ganglia).

The two internal cerebral veins unite to form the *great cerebral vein* (the vein of Galen) which emerges from under the splenium of the corpus callosum to join the inferior sagittal sinus in the formation of the straight sinus.

The venous sinuses (Fig. 54) lie between the layers of the dura.

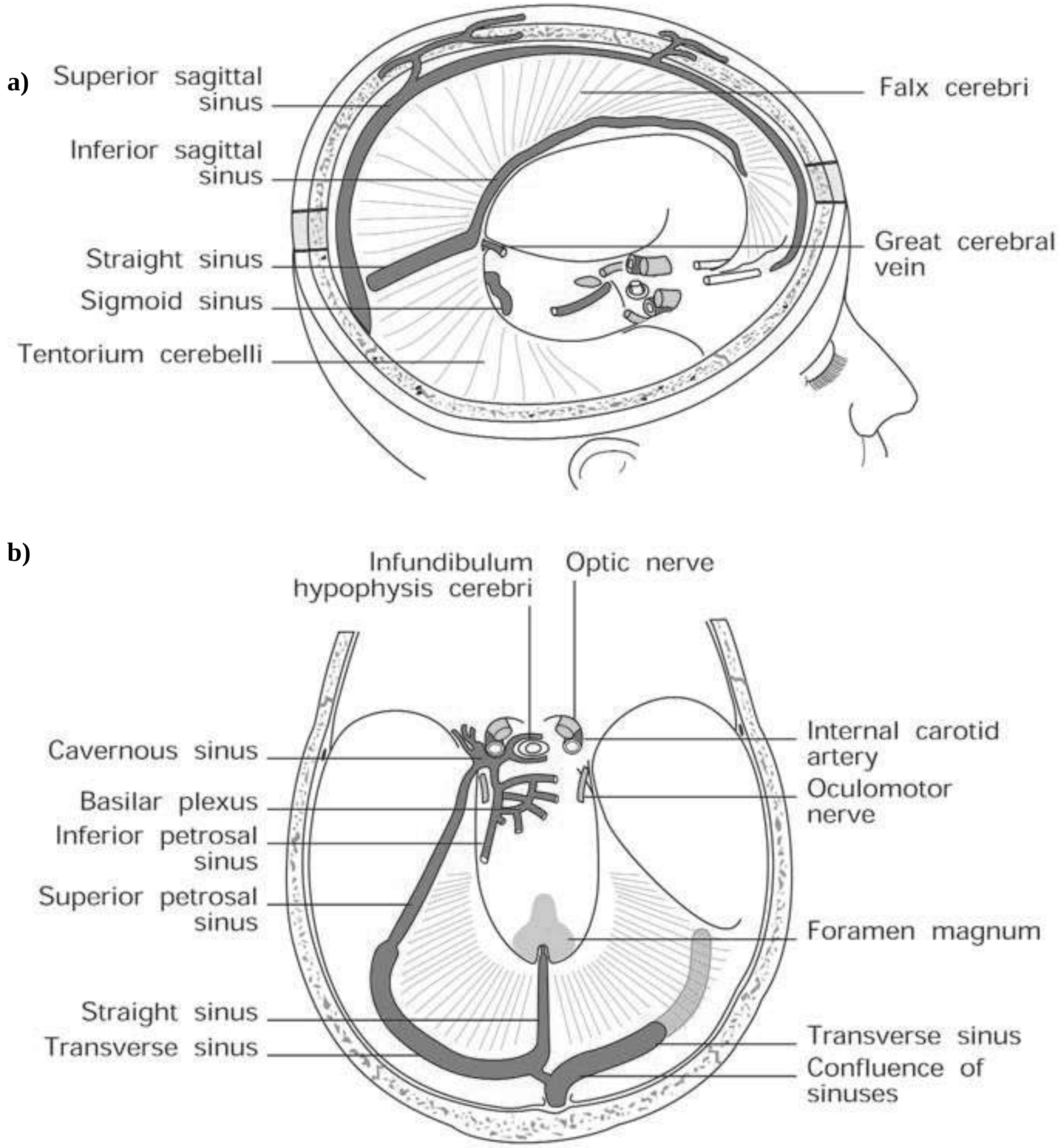


Figure 54 – The venous dural sinuses: (a) lateral and (b) superior view

They receive the venous drainage of the brain and of the skull (the diploic veins) and disgorge ultimately into the internal jugular vein. They also communicate with the veins of the scalp, face and neck via emissary veins which pass through a number of the foramina in the skull.

The superior sagittal sinus lies along the attached edge of the falx cerebri and ends up posteriorly (usually) in the right transverse sinus. Connecting with it, there is a number of venous lakes (lacunae laterales) into which the Pacchionian granulations of arachnoid project, filtering cerebrospinal fluid back into the blood.

The inferior sagittal sinus lies in the free margin of the falx cerebri and opens into the straight sinus.

The straight sinus lies in the tentorium cerebelli along the attachment of the falx cerebri. It is formed by the junction of the great cerebral vein of Galen with the inferior sagittal sinus and runs backwards to open (usually) into the left transverse sinus.

The transverse sinuses commence at the internal occipital protuberance and run in the tentorium cerebelli on either side along its attached margin. On reaching the mastoid part of the temporal bone, each sinus passes downwards, forwards and medially terminating in the sigmoid sinus emerges through the jugular foramen into the internal jugular vein.

The cavernous sinuses (Fig. 54) lie one on either side of the body of the sphenoid bone against the fibrous wall of the pituitary fossa and rest inferiorly on the greater sphenoid wing. They communicate freely with each other via *the intercavernous sinuses*.

The ophthalmic veins drain into the anterior aspect of the cavernous sinus which also links up, through these veins, with the pterygoid venous plexus and the anterior facial vein. The cavernous sinus also receives venous drainage from the brain (the superficial middle cerebral vein) and from the dura matter (*the sphenoparietal sinus*).

Posteriorly, *the superior and inferior petrosal sinuses* drain the cavernous sinus into *the sigmoid sinus* and into the commencement of the internal jugular vein respectively.

The arterial blood supply to the spinal cord is derived from both vertical and horizontal components. The vertical system consists of the unpaired anterior spinal artery and the paired posterior spinal arteries. The spinal arteries typically arise intracranially from the vertebral arteries.

The descending spinal arteries are reinforced from the anterior and posterior segmental medullary arteries. These segmental medullary vessels arise from spinal branches of the vertebral, ascending cervical, deep cervlcal, posterior intercostal, lumbar, and lateral sacral arteries.

The distribution of the spinal veins is similar in general to that of the spinal arteries. The interior of the spinal cord drains through venous plexuses (Fig. 55).

The internal vertebral venous plexus drains into ***the external vertebral venous plexus*** and from there into the vertebral veins which open into ascending lumbar, azygos, and hemiazygos veins, which are tributaries of the superior vena cava.

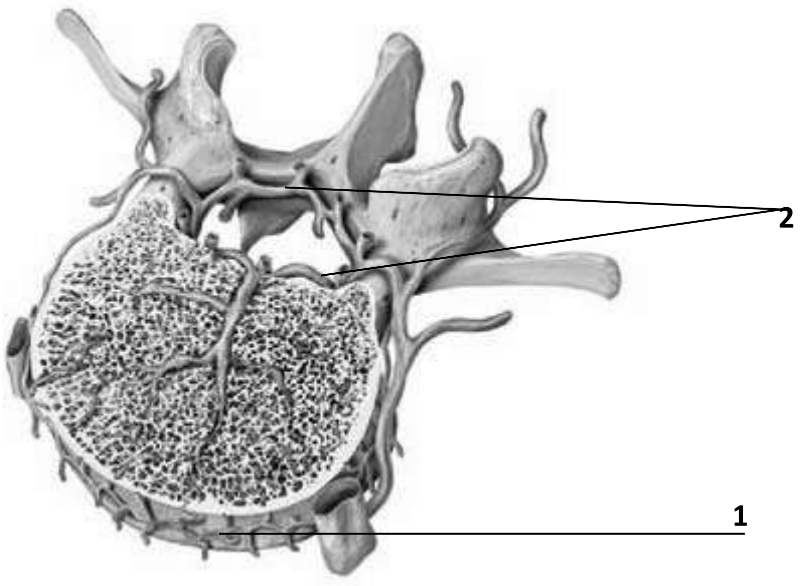


Figure 55 – Vertebral venous plexuses
1 – external vertebral venous plexus; 2 – internal vertebral venous plexus

PART 2. SPECIAL SENSES

The general senses include somatic senses (tactile, thermal, pain, and proprioceptive) and visceral sensations. Receptors for the general senses are scattered throughout the body and are simple in structure. They are mostly modified dendrites of sensory neurons.

Receptors for the special senses – smell, taste, vision, hearing, and equilibrium – are anatomically distinct from one another and are concentrated in specific locations in the head. They are usually embedded in the epithelial tissue within complex sensory organs such as the eyes and ears. Neural pathways for the special senses are more complex than those for the general senses.

The special senses include smell, taste, sight, hearing, and balance. Some special senses detect physical phenomena such as light, sound, or gravity. Because two of the special senses require the interaction of chemicals with sensory receptors – olfaction (smell) and gustation – they are sometimes referred to as the chemical senses. Also, because the nose and mouth are connected, the senses of smell and taste are associated. For example, when you have a stuffy nose and cannot smell, you often cannot taste foods.

I. THE ORGAN OF VISION

The eye consists of the eyeball and the auxiliary apparatus (Fig.56).

The bulb of the eye is spherical in shape and is contained in the cavity of the orbit, where it is protected from injury and moved by the ocular muscles. The term anterior pole is applied to the central point of the anterior curvature of the eyeball, and that of the posterior pole to the central point of its posterior curvature. The line connecting both poles is called the *external optic axis* of the eye. The part lying between the posterior surface of the cornea and the retina is called the *internal axis of the eye*. Optic axis passes from the anterior pole of the eye to the place of the best vision in the central pit of the retina.

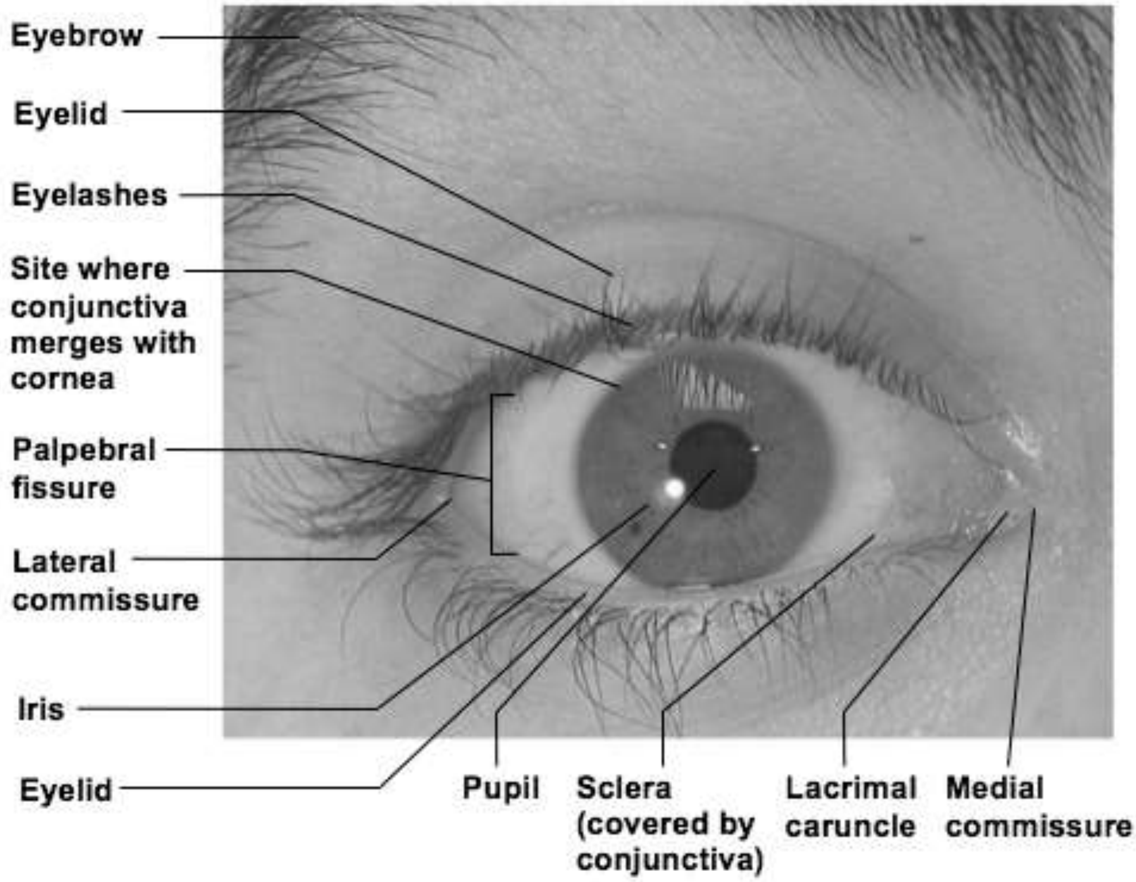


Figure 56 – Surface anatomy of the right eye

The eyeball is composed of three refracting media, and has three investing tunics surrounding its inner nucleus (Figure 57).

These tunics are:

- an external or fibrous tunic
- a middle or vascular tunic
- an internal coat or retina

The fibrous tunic comprises the **sclera** and the **cornea**. The sclera has received its name from its extreme density and hardness. It is a firm, fibrous membrane, serving to maintain the form of the globe. At the junction with the cornea in the thickness of the sclera, there is a circular venous canal, *the sinus venosus sclerae*, called **Schlemm's canal**.

The cornea is the projecting transparent part of the external tunic. It is responsible for refraction of the light that enters the eye. It is avascular and sensitive to touch.

The vascular tunic of the eye is formed from behind forward by the following:

- the choroid
- the ciliary body, and
- the iris

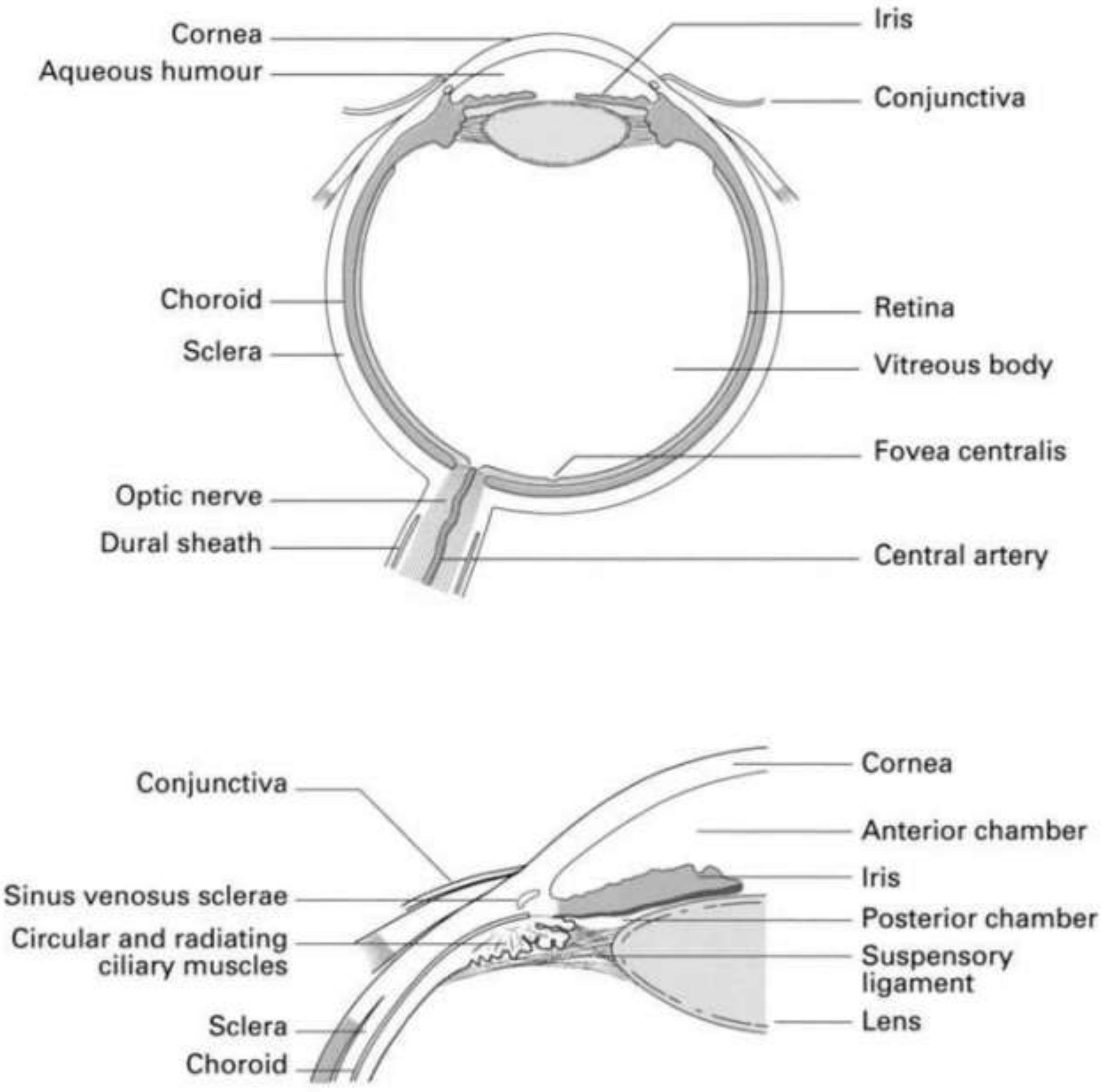


Figure 57 – The tunics of the eyeball

The choroid extends as far forward as the ora serrata of the retina. Posteriorly, it is pierced by the optic nerve, and anteriorly, it is connected to the iris by the ciliary body.

The ciliary body consists chiefly of interlacing smooth muscle bundles called *ciliary muscles*, which act to control lens shape and is supplied by parasympathetic fibres transmitted in the oculomotor nerve (III). Near the lens, its posterior surface is thrown into radiating folds called *ciliary processes*, which secrete the fluid that fills the cavity of the anterior segment of the eyeball. The *ciliary zonule* (zonule of Zinn, or suspensory ligament) extends from the ciliary processes to the lens.

The iris, the visible colored part of the eye, is the most anterior portion of the vascular layer. It lies between the cornea and the lens and is continuous with the ciliary body posteriorly. Its round central opening, **the pupil**, allows light to enter the eye. The iris is made up of two smooth muscle layers. Its muscle fibers allow it to act as a reflexively activated diaphragm to vary pupil size. In close vision and bright light, **the sphincter pupillae** (circular muscles) contract and the pupil constricts. In distant vision and dim light, **the dilator pupillae** (radial muscles) contract and the pupil dilates, allowing more light to enter. Sympathetic fibers from the internal carotid plexus control pupillary dilation, and parasympathetic fibers from the oculomotor nerve control constriction.

Although irises come in different colors, they contain only brown pigment. When they have a lot of pigment, the eyes appear brown or black. If the amount of pigment is small and restricted to the posterior surface of the iris, the unpigmented parts simply scatter the shorter wavelengths of light and the eyes appear blue, green, or gray. Most newborn babies' eyes are slate gray or blue because their iris pigment is not yet developed.

The iris divides the space between the lens and the cornea into an anterior and a posterior chamber.

The neural coat. The retina (Fig. 58) consists of two layers: an outer *pigmented layer* and an inner *neural layer*.

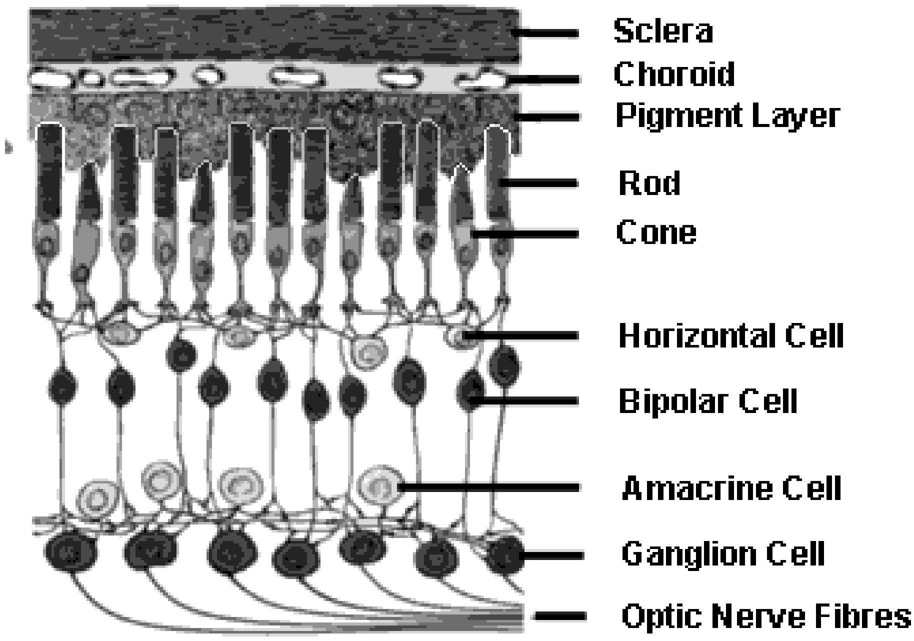


Figure 58 – Microscopic structure of the retina

Anteriorly, it presents an irregular edge, the *ora serrata*, while posteriorly, the nerve fibres on its surface collect to form the optic nerve.

Exactly in the center of the posterior part of the retina, corresponding to the axis of the eye, and at a point in which the sense of vision is most perfect, there is an ovale yellowish area, the macula lutea; in the macula is a central depression, the fovea centralis. At the fovea centralis the retina is exceedingly thin, and the dark color of the choroid is distinctly seen through it. About 3 mm to the nasal side of the macula lutea, there is the entrance of the optic nerve, called an optic disk; the arteria centralis retinae pierces the center of the disk. This is the only part of the surface of the retina which is insensitive to light, and it is termed the blind spot.

The outer pigmented layer extends anteriorly to cover the ciliary body and the posterior face of the iris. These pigment cells absorb light and prevent it from scattering in the eye. They also act as phagocytes, participating in photoreceptor cell renewal and store vitamin A needed by the photoreceptor cells.

The neural layer is composed of three main types of neurons: photoreceptors, bipolar cells, and ganglion cells. Signals are produced in response to light and spread from the photoreceptors to the bipolar cells and then to the innermost ganglion cells, where action potentials are generated. The ganglion cell axons leave the posterior aspect of the eye as the thick optic nerve.

The photoreceptors are of two types: rods and cones.

- Rods are dim–light and peripheral vision receptors. They are more numerous and far more sensitive to light than cones, but they do not provide sharp images or color vision.

- Cones are vision receptors for bright light and provide high–resolution color vision.

Components of the eyeball

Within the eyeball, there are found:
- the lens
- the aqueous humour
- the vitreous body

The lens enclosed in its capsule is situated immediately behind the iris, in front of the vitreous body. Like the cornea, the lens is avascular. The lens is a transparent, biconvex body: the convexity of its anterior surface being less than that of its posterior surface. The lens is held in a position by the special suspensory ligament called the *ciliary zonule*, or *zonular ligament of Zinn*, which is running from the capsule of the lens to the ciliary body. The zonular fibers are separated by interstices (zonular spaces) with aqueous humor. These interstices form, behind the suspensory ligament, a sacculated canal, *the spacia zonularis* (*canal of Petit*), which encircles the equator of the lens. The lens easily changes its curvature depending upon whether the object we are looking at is far (Zinn ligament pulls on the lens, flattening it) or at a near distance (the ciliary muscle contracts, relaxing Zinn ligament together with the capsule around the equator of the lens, bulging the lens). This event is called **accommodation**.

A cataract (“waterfall”) is a clouding of the lens that causes the world to appear distorted, as if seen through frosted glass. Some cataracts are congenital, but most result from age–related hardening and thickening of the lens or are a secondary consequence of diabetes mellitus.

The lens and its ciliary zonule divide the eye into two segments, the anterior segment in front of the lens and the larger posterior segment behind it.

The posterior segment is filled with a vitreous body. The vitreous body fills the concavity of the retina and is hollowed anteriorly, forming a deep concavity, the hyaloid fossa, for the reception of the lens. It is perfectly transparent, jelly–like substance.

The main functions of vitreous body are:

- Transmit light

- Support the posterior surface of the lens and hold the neural layer of the retina firmly against the pigmented layer. It contributes to intraocular pressure

The iris divides the anterior segment into the **anterior chamber** and the **posterior chamber**, which are filled with **aqueous humor**, secreted by the ciliary processes. The anterior chamber of the eye is the space bounded in front by the posterior surface of the cornea and behind by the front of the iris. The anterior and posterior surfaces of the anterior chamber meet along its circumference at the angle formed by the junction of the cornea and the iris. This is the **iridocorneal angle.** Within the iridocorneal angle, there is a meshwork of fine trabeculae, forming the ***pectinate ligament***. Between the trabeculae of the ligament there are the slit–like ***Fontana spaces***. The aqueous humor drains through the Fontana's spaces into the Schlemm's canal to reach the sinus venosus sclerae.

The posterior chamber is a narrow chink behind the iris, and in front of the lens. The posterior chamber communicates with anterior chamber through the pupil.

Normally, aqueous humor forms and drains at the same rate, maintaining a constant intraocular pressure of about 16 mm Hg, which helps to support the eyeball internally. Aqueous humor supplies nutrients and oxygen to the lens and cornea, and to some cells of the retina, and it carries away their metabolic wastes.

Pressure within the eye may increase to dangerous levels and compress the retina and optic nerve – a condition called glaucoma. The eventual result of glaucoma is blindness unless the conditions of the disease have been identified on time.

The refracting media

There are three refracting media of the eye:

- aqueous humor
- vitreous body
- lens

Light passing from air into the eye moves sequentially through the cornea, aqueous humor, lens, and vitreous humor, and then passes through the entire neural layer of the retina to excite the photoreceptors.

Extraocular structures

The accessory organs of the eye include:

- **The ocular muscles**:
  - rectus superior
  - rectus inferior
  - rectus lateralis
  - rectus medialis
  - obliquus superior
  - obliquus inferior

- **The fasciae**:
  - periorbit
  - fatty tissue
  - the capsule of Tenon (Tenon's capsule)

- **The eyebrows**

- **The eyelids**

- **The conjunctiva** lines the inner surfaces of the eyelids and is reflected over the forepart of the sclera and cornea. The conjunctiva forms a sac, the conjunctival sac, which is open at the palpebral fissure.

- **The lacrimal apparatus** consists of:
  - the lacrimal glands, which secret lacrimal fluid
  - the excretory ducts
  - the lacrimal rives
  - the lacrimal lake
  - the lacrimal punctum
  - the lacrimal canaliculi
  - the lacrimal sac
  - the nasolacrimal duct

Bony orbits protect the eyes from trauma.

The eyelids (or palpebrae) and eyelashes protect the eyes from injury, dust, and foreign bodies.

Conjunctivae guard against invasion by foreign matter.

The structures of the lacrimal apparatus lubricate and protect the cornea and conjunctivae by producing and absorbing tears.

The ocular muscles (Table 7) are represented with orbital and extra–ocular muscles. Extraocular muscles hold the eyes in place and control movement, helping create binocular vision. The orbital muscles are the levator palpebrae superioris and orbicularis oculi; the extra–ocular muscles are the medial, lateral, superior and inferior recti and the superior and inferior obliques.

Table 7 – Muscles Associated with the Eyelids and Eyes

Name	Innervation	Function
Muscles of the eyelids		
Orbicularis oculi	Facial nerve (VII)	Closes eye
Levator palpebrae superioris	Oculomotor nerve (III)	Opens eye
Extrinsic muscles of the eyes		
Superior rectus	Oculomotor nerve (III)	Rotates eye upward and toward midline
Inferior rectus	Oculomotor nerve (III)	Rotates eye downward and toward midline
Medial rectus	Oculomotor nerve (III)	Rotates eye toward midline
Lateral rectus	Abducens nerve (VI)	Rotates eye away from midline
Superior oblique	Trochlear nerve (IV)	Rotates eye downward and away from midline
Inferior oblique	Oculomotor nerve (III)	Rotates eye upward and away from midline

The four recti arise from a tendinous ring around the optic foramen and the medial part of the superior orbital fissure and are inserted into the sclera anterior to the equator of the eyeball (Fig. 59). The lateral rectus is supplied by the abducent nerve, the others – by the oculomotor nerve. The superior oblique arises just above the tendinous ring and is inserted by means of a long tendon which loops around a fibrous pulley on the medial part of the roof of the orbit into the sclera just lateral to the insertion of the superior rectus. It is supplied by the trochlear nerve. The inferior oblique passes like a sling from its origin on the medial side of the orbit around the undersurface of the eye to insert into the sclera between the superior and lateral recti; it is supplied by oculomotor nerve. Both the oblique muscles insert behind the equator of the eyeball.

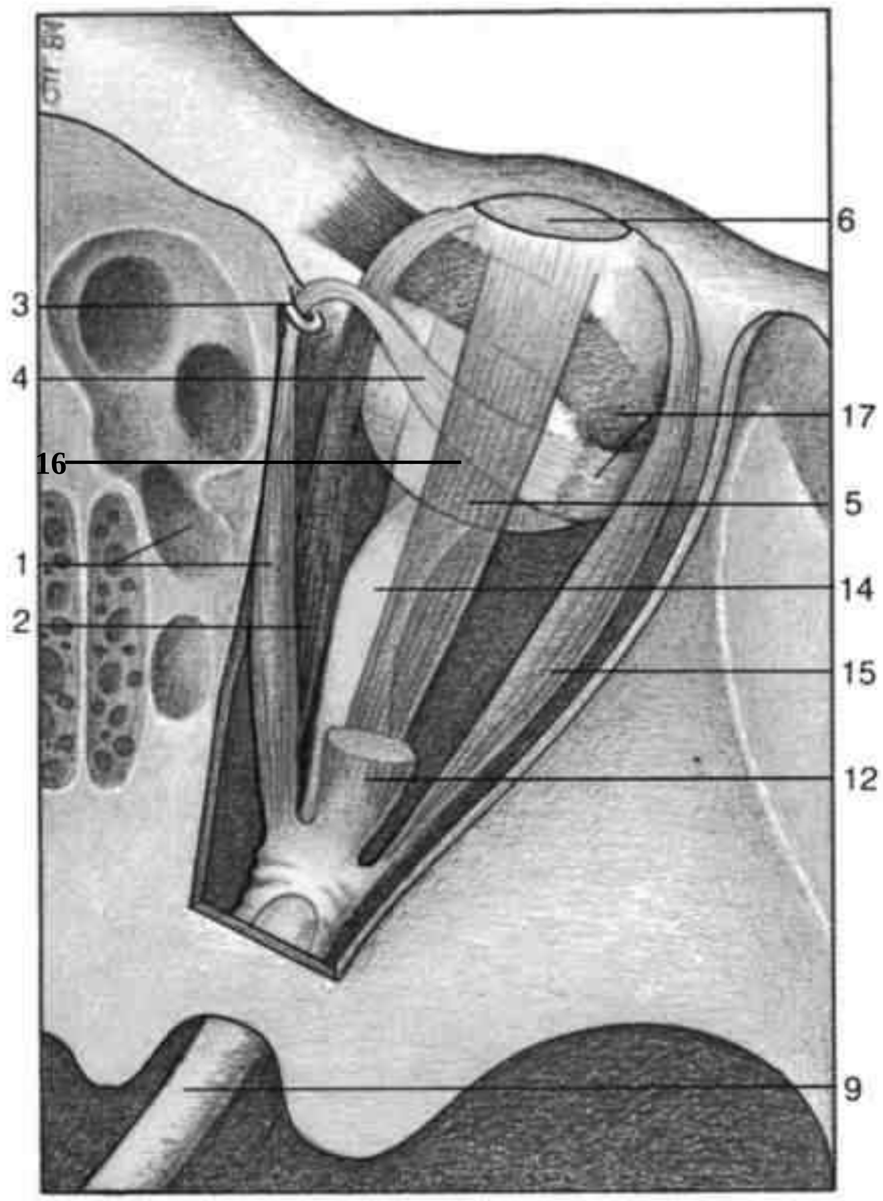


Figure 59 – Extra–ocular muscles. 1 – superior oblique muscle and ethmoid air cells; 2 – medial rectus muscle; 3 – trochlea; 4 – tendon of superior oblique muscle; 5 – superior rectus muscle; 6 – cornea; 9 – optic nerve (intracranial part); 12 – levator palpebrae superioris muscle; 14 – optic nerve (extracranial part); 15 – lateral rectus muscle; 16 – inferior rectus muscle; 17–inferior oblique muscle

The fascial sheath of the eye (Tenon's capsule) is the membranous socieet that envelopes external surpace of the sclera. It extends from the optic nerve to the sclerocorneal junction in front. It is pierced by the vessels and nerves of the eye and by the tendons of the extra–ocular muscles. It is thickened inferiorly, where it forms the suspensory ligament.

The eyelids and conjunctiva. Each eyelid consists of the following layers, from without inwards: skin, loose connective tissue, fibres of the orbicularis oculi muscle, the tarsal plates, tarsal glands and conjunctiva. The eyelashes arise along the mucocutaneous junction, and immediately behind the lashes, there are the openings of the tarsal (Meibomian) glands. These are large sebaceous glands whose secretion helps to seal the palpebral fissure when the eyelids are closed and forms a thin layer over the exposed surface of the open eye; if blocked, they distend into Meibomian cysts.

The conjunctiva is the delicate mucous membrane lining the inner surface of the eyelids from which it is reflected over the anterior part of the sclera to the cornea. Over the lids it is thick and highly vascular, but over the sclera it is much thinner and over the cornea it is reduced to a single layer of epithelium. The line of reflection from the lid to the sclera is known as the conjunctival fornix; the superior fornix receives the openings of the lacrimal glands.

Movements of the eyelids are brought about by the contraction of the orbicularis oculi and levator palpebrae superioris muscles.

The lacrimal apparatus (Fig. 60)

The lacrimal gland is situated in the upper, lateral part of the orbit known as the lacrimal fossa. The gland is drained by a series of 8–12 small ducts which open into the lateral part of the superior conjunctival fornix, whence its secretion is spread over the surface of the eye by the action of the eyelids.

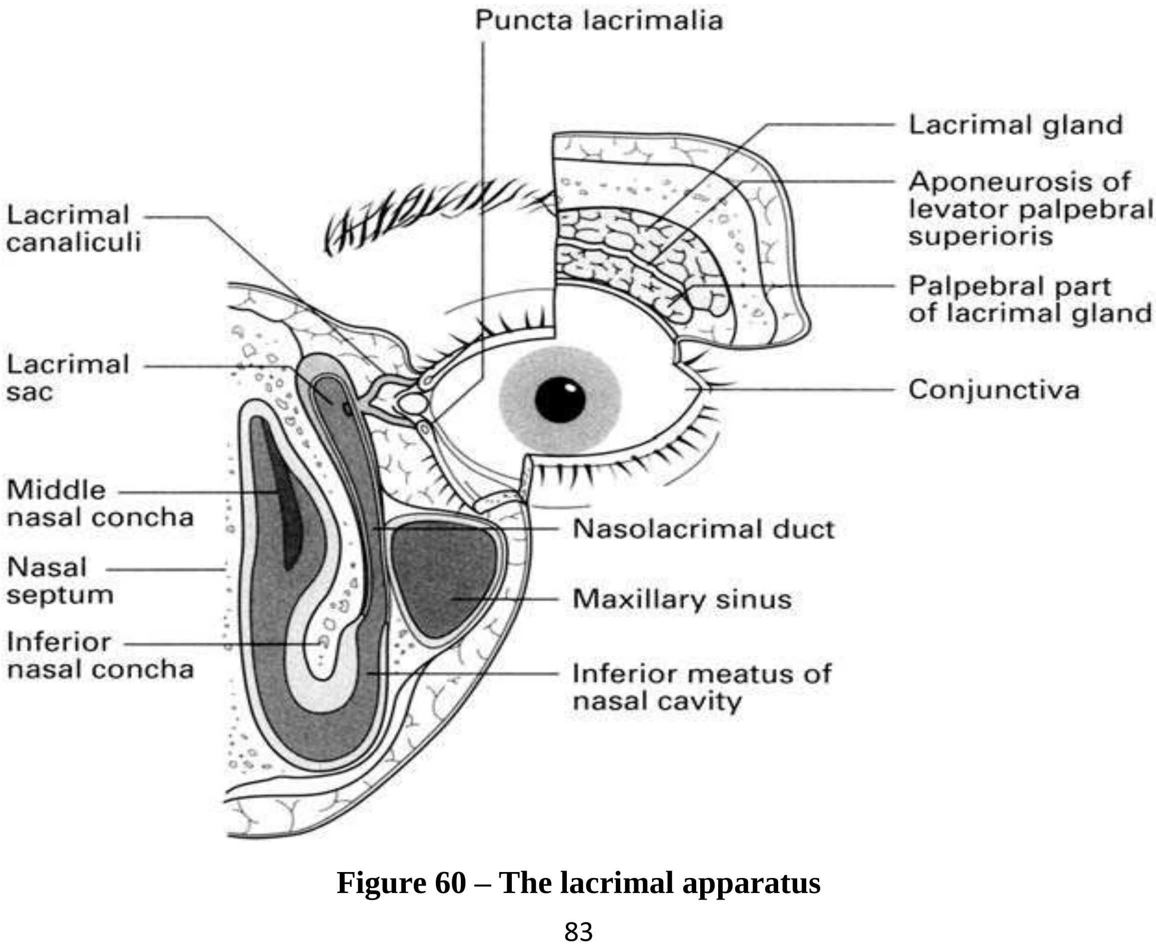


Figure 60 – The lacrimal apparatus

The tears are drained by way of the lacrimal canaliculi whose openings, the lacrimal puncta, can be seen on the small elevation near the medial margin of each eyelid known as the lacrimal papilla. The two canaliculi, superior and inferior, open into the lacrimal sac, which is situated in a small depression on the medial surface of the orbit. This in turn drains through the nasolacrimal duct into the anterior part of the inferior meatus of the nose. The nasolacrimal duct, is about 12 mm in length and lies in its own bony canal in the medial wall of the orbit.

Basic visual pathways

The bodies of the first–order three neurons are located in the retina (Fig. 61):

- first–order neurons: the light – sensitive cells – rods and cones
- second neurons: the bipolar cells
- third neurons: the multipolar cells, whose processes continue into the nerve fibres of the optic nerve

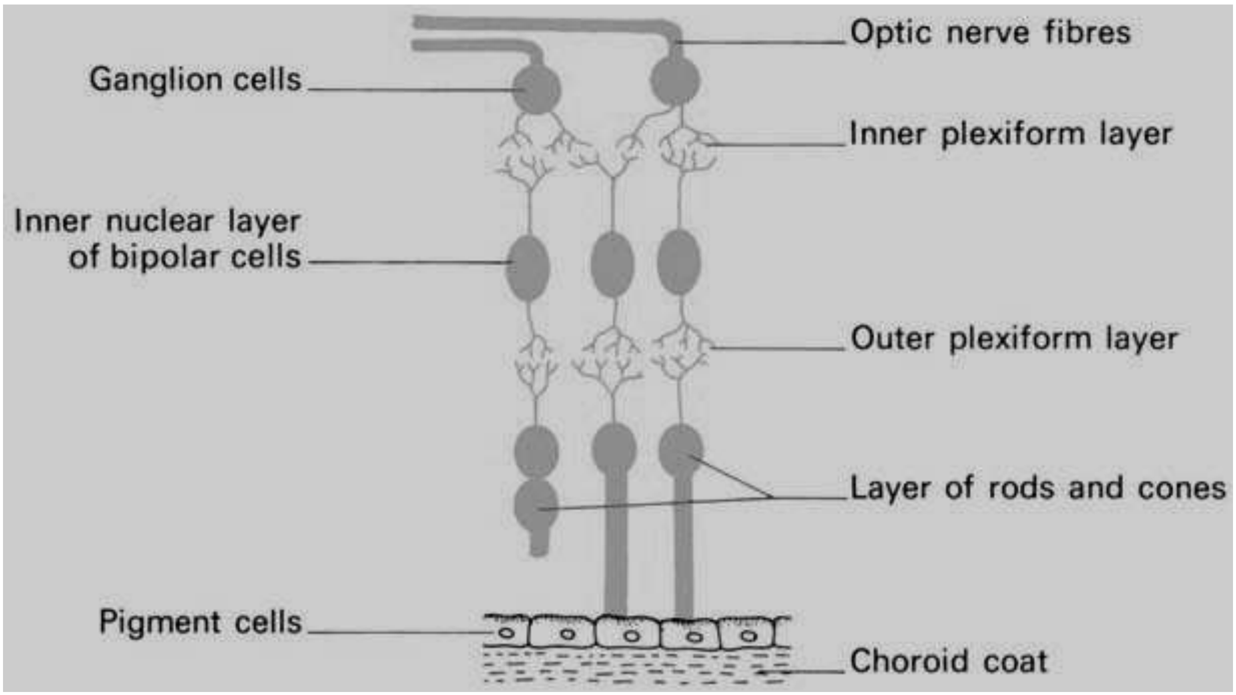


Figure 61 – The layers of the retina

The axons of the retinal ganglion cells exit the eye in the optic nerves. After exit from the orbit through the optic canal, the optic nerve passes to the inferior surface of the brain. At the X–shaped optic chiasma, fibers from the medial aspect of each eye cross over to the opposite side and then continue on via the optic tracts. As a result, each optic tract:

– contains fibers from the lateral (temporal) aspect of the eye on the same side and fibers from the medial (nasal) aspect of the opposite eye, and

– carries all the information from the same half of the visual field

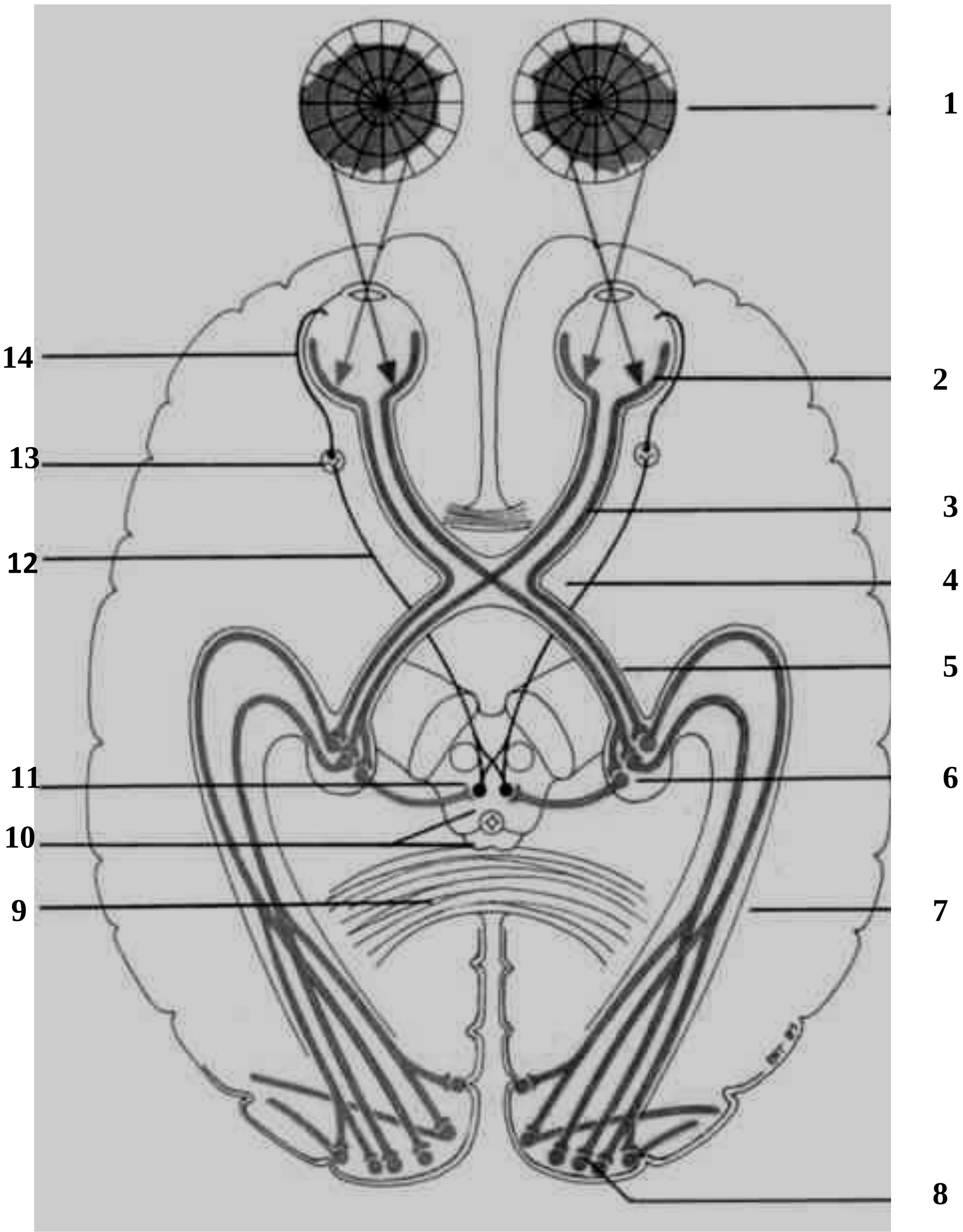


Figure 62 – The visual pathway: 1 – visual field; 2 – retina; 3 – optic nerve; 4 – optic chiasma; 5 – optic tract; 6 – lateral geniculate body; 7 – optic radiation; 8 – visual cortex (area calcarina); 9 – corpus callosum; 10 – colliculi of midbrain; 11 – accessory oculomotor nucleus; 12 – oculomotor nerve; 13 – ciliary ganglion; 14 – ciliary nerves (long and short)

Both the crossed and uncrossed fibres of the visual pathways end in two bundles in the subcortical visual centers, in which the cell bodies of the fourth neuron of the optic tract rest. They are:

1. The first–order bundle ends in the pulvinar of the thalamus and in the lateral geniculate body. The axons of fourth neuron pass through the dorsal part of the posterior crus of the internal capsula and then form the optic radiation in the white matter of the cerebral hemispheres, which reaches the cortex of the occipital lobe of the brain. The visual pathways from the light–sensitive receptors to the cortex constitute the conductor of the visual analyzer.

2. The second bundle ends in the superior colliculi of the midbrain.

The axons of the fourth neuron of the superior colliculi pass to the accessory nucleus of the oculomotor nerve, where the bodies of the fifth neuron are located. The axons of the fifth neuron pass to the ciliary ganglion, where the bodies of the sixth neuron are located. The axons of the sixth neuron pass to the smooth muscle of the eye: ciliary and sphincter pupillae muscles. This connection helps the visual apparatus to provide convergence, accommodation, and papillary reflex to certain light stimuli (Fig. 62).

II. THE EXTERNAL AND MIDDLE EAR. THE INTERNAL EAR. THE VESTIBULOCOCHLEAR NERVE. AUDITORY AND VESTIBULAR PATHWAYS. THE ORGAN OF SMELL. THE OLFACTORY NERVES. THE ORGAN OF TASTE. THE TASTE TRACT

The auditory and vestibular apparatus are located deep in the petrous part of the temporal bone. The auditory apparatus consists of the external ear couferear, middle ear, and internal car (inner ear) (Fig. 63).

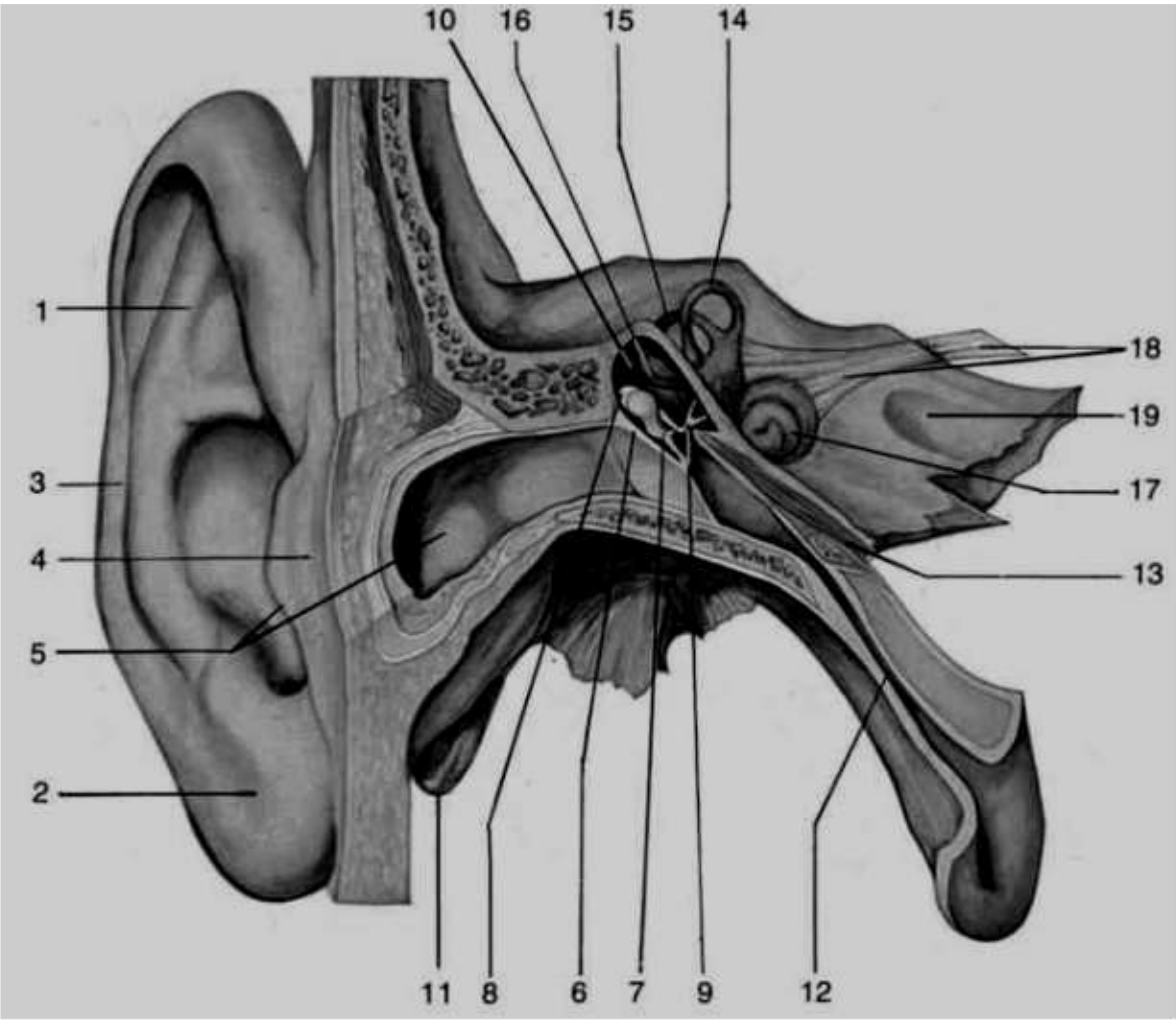


Figure 63 – Human ear: Outer ear: 1 – auricle; 2 – lobule of auricle; 3 – helix; 4 – tragus; 5 – external acoustic meatus. **Middle ear**: 6 – tympanic membrane; 7 – malleus; 8 – incus; 9 – stapes; 10 – tympanic cavity; 11 – mastoid process; 12 – auditory tube; 13 –tensor tympani muscle. **Inner ear**: 14 – anterior semicircular duct; 15 – posterior semicircular duct; 16 – lateral semicircular duct; 17 –cochlea; 18 – vestibulocochlear nerve; 19 – petrous part of the temporal bone

The external ear (outerear) comprises *the auricle* and *the external auditory meatus*. The auricle (Fig. 64), for the most part, consists of a cartilaginous framework to which the skin is closely applied. The intrinsic and extrinsic muscles are not significant for describtion of the human ear.

The external auditory meatus extends inwards to the tympanic membrane. It is about 37 mm long. The outer third of the canal is cartilaginous and somewhat wider than the medial osseous portion. The whole canal is lined by skin, which is closely adherent to the osseous portion but is separated from the cartilaginous part by the ceruminous glands in the subcutaneous tissue. Sound waves are captured by the external ear and pass through the external auditory meatus to the tympanic membrane, which markes the lateral boundary of the middle ear.

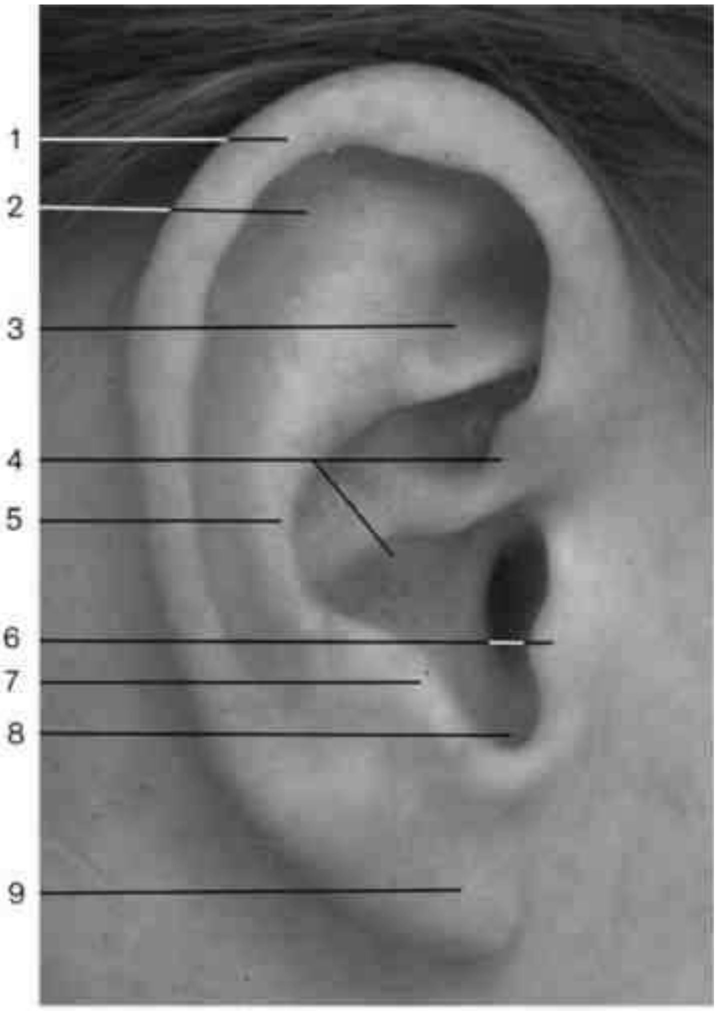


Figure 64 – Right auricle: 1 – helix; 2 – scaphoid fossa; 3 – triangular fossa; 4 – concha; 5 –antihelix; 6 – tragus; 7 – antitragus; 8 – intertragic notch; 9 – lobule

The tympanic membrane, or ear drum, separates the middle ear from the external auditory meatus (Fig. 65). It is made up of an outercutaneous layer, continuous with the skin of the external auditory meatus, a middle fibrous layer and an inner mucous layer continuous with the mucoperiosteum of the rest of the tympanic cavity.

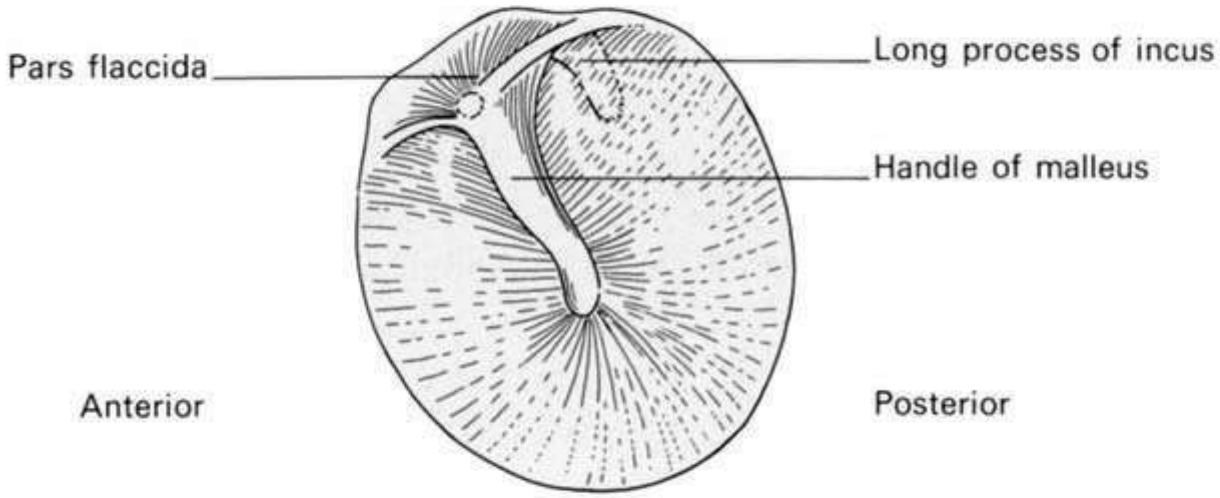


Figure 65 – The tympanic membrane

The greater part of the membrane is taut and is known as the *pars tensa*, but above the lateral process of the malleus there is a small triangular area where the membrane is thin and lax— the *pars flaccida*. This area is bounded by two distinct malleolar folds which reach down to the lateral process of the malleus. The point of greatest concavity of the membrane is known as the *umbo*; this marks the attachment of the handle of the malleus to the membrane.

The middle ear, *or tympanic cavity*, is the narrow slit–like cavity in the petrous part of the temporal bone containing the three auditory ossicles (Fig. 66).

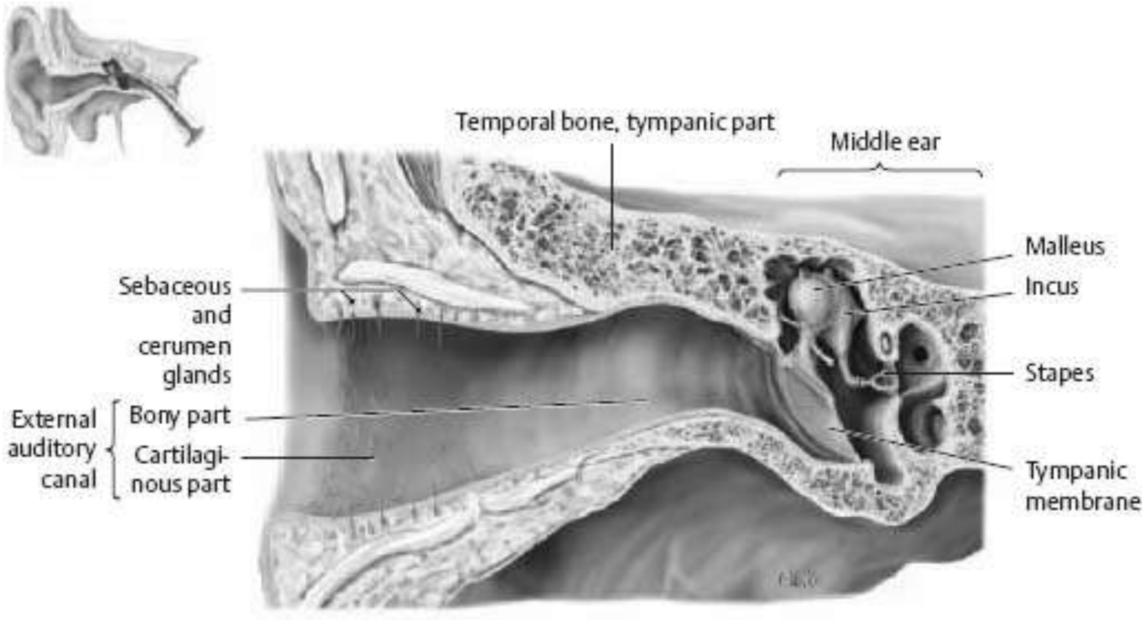


Figure 66 – External acoustic meatus and middle ear

The walls of the tympanic cavity and its important relations are as follows:

- *The lateral (membranous) wall* is formed mainly by the tympanic membrane, which divides it from the external auditory meatus, and above this by the squamous part of the temporal bone.
- *The medial (labyrinthine) wall* separates the cavity from the internal ear, presents the fenestra cochleae (*round window*), closed by the secondary tympanic membrane; the fenestra vestibuli (*oval window*), occupied by the base of the stapes; the *promontory*, formed by the first–order turn of the cochlea; and the prominence caused by the underlying canal for the facial nerve.
- *The inferior (jugular) wall* is a thin plate of bone separating the cavity from the bulb of the jugular vein.
- *The superior (tegmental) wall* is formed by the thin sheet of bone known as the tegmen tympani, which separates it from the middle cranial fossa and the temporal lobe of the brain.
- *The anterior (carotid) wall*, related to the carotid canal communicates the tympanic cavity with the pharynx by the auditiry or the Eustachian tube.
- *The posterior (mastoid) wall* communicates with the mastoid or tympanic antrum and the mastoid air cells. Infection may spread to these spaces from the middle ear and it is intimately related posteriorly to the sigmoid sinus and the cerebellum both of which may be affected by the middle ear infection.

The auditory (Eustachian) tube runs downwards, forwards and medially from the anterior part of the tympanic cavity to the lateral walls of the nasopharynx. The first–order 1/3 is bony while the rest is cartilaginous. Near the pharyngeal orifice of the tube, there is a considerable collection of lymphoid tissue termed the tubal tonsil. Tubal tonsil may become infected and swollen, producing blockage of the tube. The tube is the widest at its pharyngeal end and narrowest at the junction of the bony and cartilaginous portions.

The *malleus*, *incus* and *stapes* form a short chain that crosses the middle ear and transmits vibrations caused by sound waves to the inner ear (Figs.67, 68).

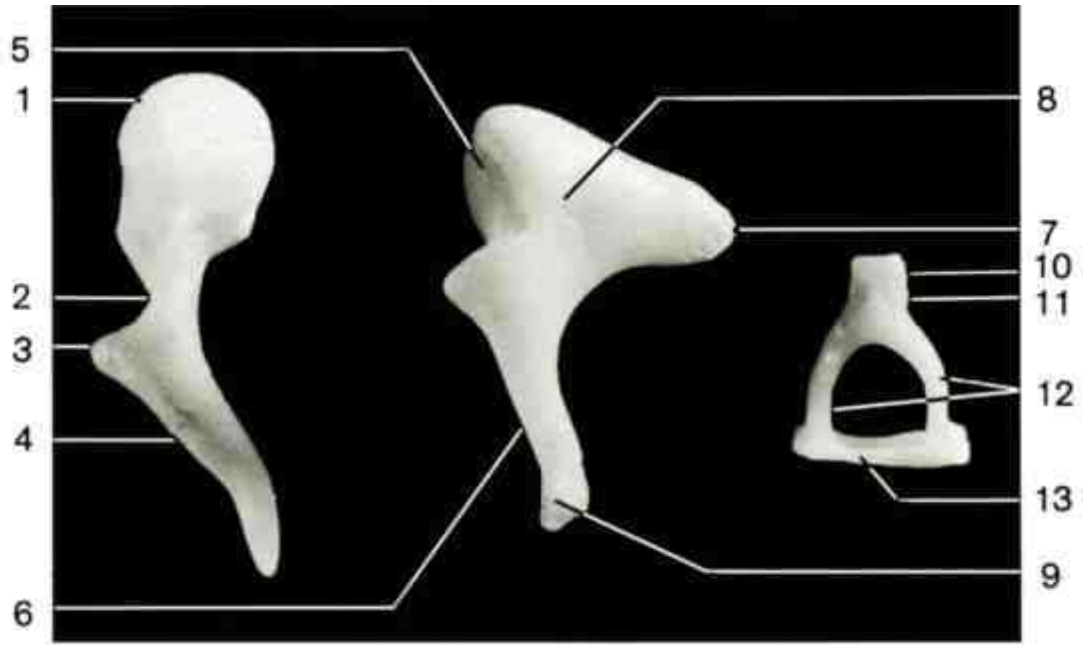


Figure 67 – Isolated auditory ossicles: Malleus: 1 – head; 2 – neck; 3– lateral process; 4 – handle. Incus: 5 – articular facet for malleus; 6 – long crus; 7 – short crus; 8 – body; 9 – lenticular process. Stapes: 10 – head; 11 –neck; 12 – anterior and posterior crura; 13 – base

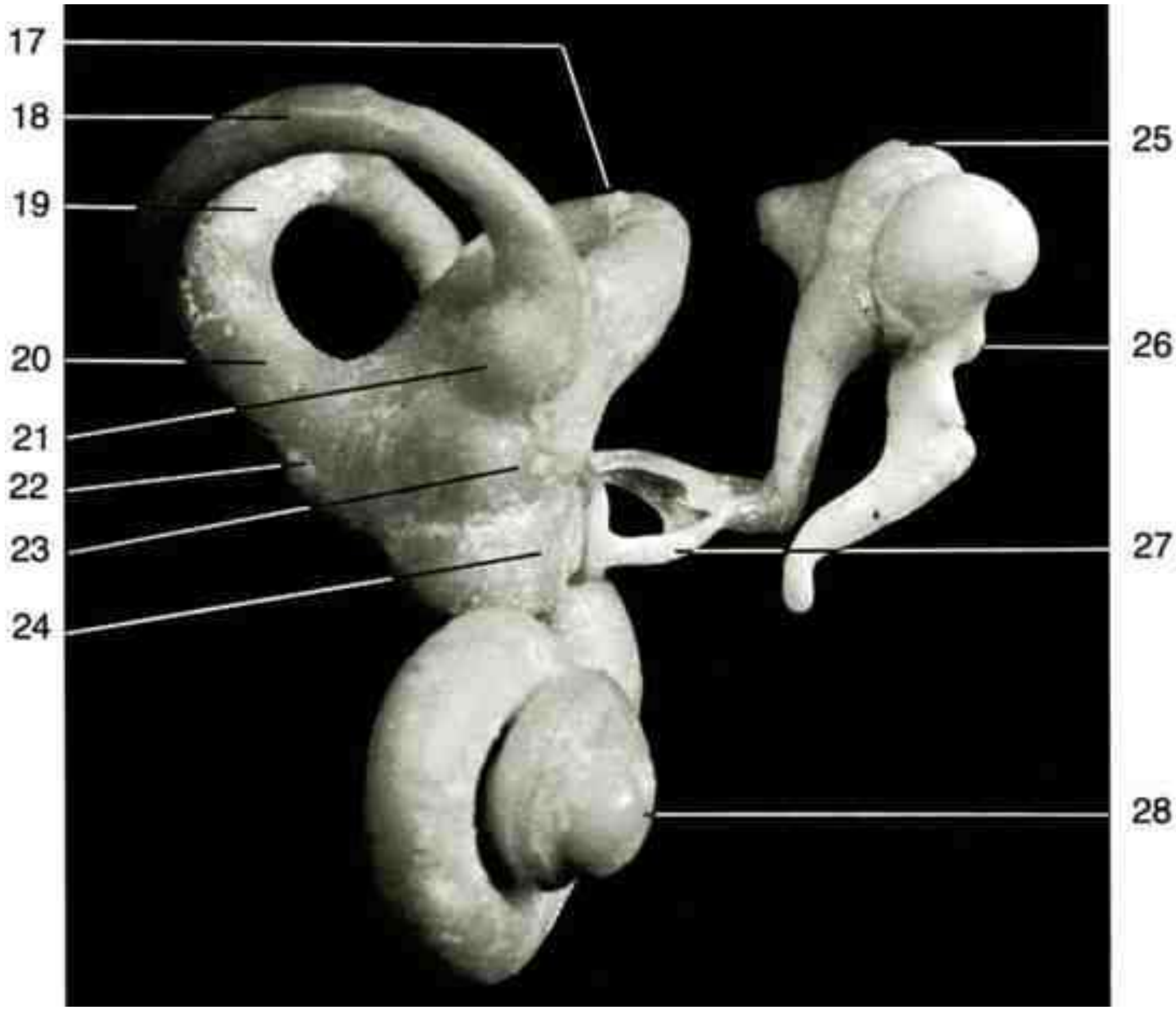


Figure 68 – Chain of auditory ossicles in connection with the inner ear: 17– lateral semicircular duct; 18 – anterior semicircular duct; 19 – posterior semicircular duct; 20 – common crus; 21 – ampulla; 22 – beginning of endolymphatic duct; 23 – utricular prominence; 24 – saccular prominence; 25 – incus; 26 – malleus; 27 – stapes; 28 – cochlea

The malleus is the outermost and the largest of the three small bones and is described as having a handle, attached to the tympanic membrane, a rounded head, which articulates with the incus, and a lateral process, which can be seen through the tympanic membrane and from which the malleolar folds radiate.

The incus comprises a body, which articulates with the malleus, forming the *incudomallear joint*, and two processes, long and short. A short process attaches to the posterior wall of the middle ear and a long process articulates with the stapes, forming the *incudostapedial joint*.

The stapes has a head that articulates with the incus, a neck, two limbs, and a base which is firmly attached to the fenestra vestibuli (the oval window).

Two small muscles are associated with these ossicles: *the stapedius,* which is attached to the neck of the stapes and is supplied by the facial nerve, and *the tensor tympani*, which is inserted into the handle of the malleus and is supplied by the mandibular division of the trigeminal nerve. Both muscles serve to damp high–frequency vibrations.

The internal ear (Fig. 69, Tab. 8) consists of a ***bony labyrinth*** divided into 3 parts: *vestibule*, which communicates posteriorly with *three semicircular canals* and anteriorly with the *cochlea*.

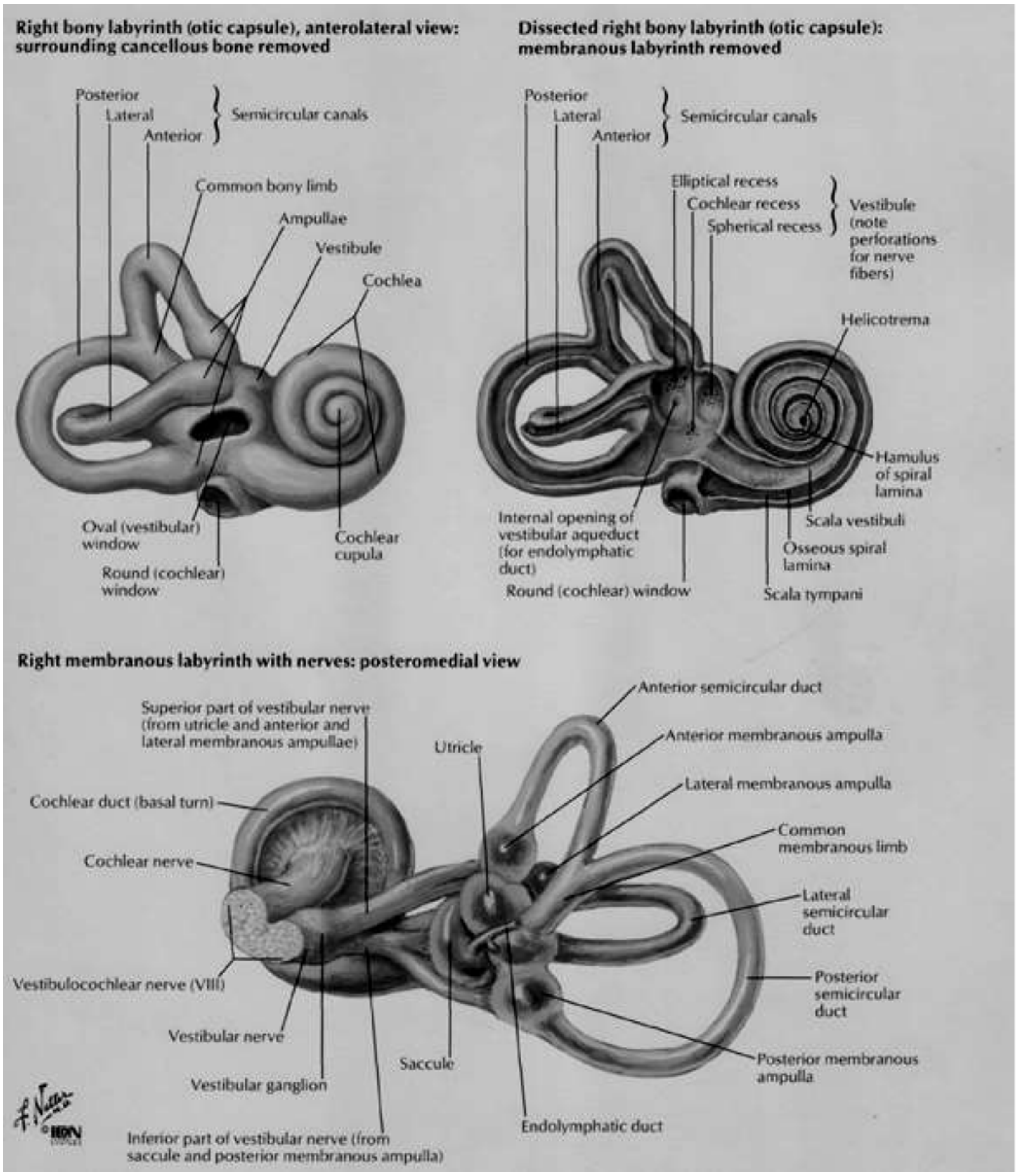


Figure 69 – The internal ear

This cavity contains a fluid known as *perilymph* and encloses the ***membranous labyrinth*** (Fig. 70), comprising the *utricle* and *saccule*, which communicate respectively with the *semicircular ducts* and the *cochlear duct*.

The duct system is filled with *endolymph*. In each component of the membranous labyrinth, there are specialized sensory receptor areas known as the *macula of the utricle* and saccule, the *ampullary crests* of the semicircular ducts and the *spiral organ of Corti* in the cochlea.

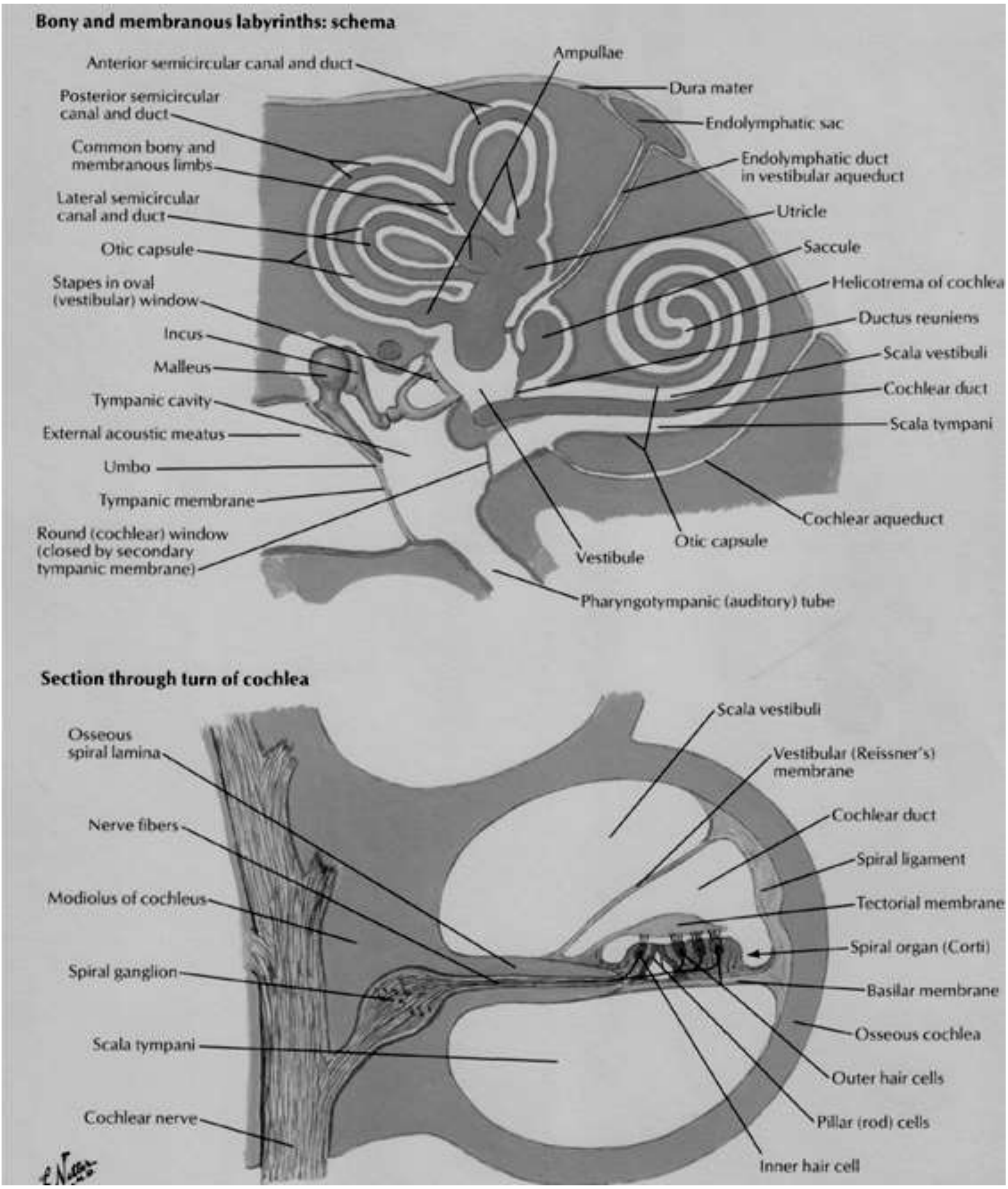


Figure 70 – The membranous labyrinth

The disposition of the semicircular canals in three planes at right angles to each other renders this part of the labyrinth particularly well suited to signal changes in position of the head.

The organ of Corti is adapted to record the sound vibrations transmitted by the stapes at the oval window.

Table 8 – Summary of the Internal Ear

Bony labyrinth	Membranous labyrinth	Function	Receptor region
Semicircular canals	Semicircular ducts	Equilibrium: rotational (angular) acceleration	Crista ampullaris
Vestibule	Utricle and saccule	Equilibrium: head position relative to gravity, linear acceleration	Macula
Cochlea	Cochlear duct (scala media)	Hearing	Spiral organ

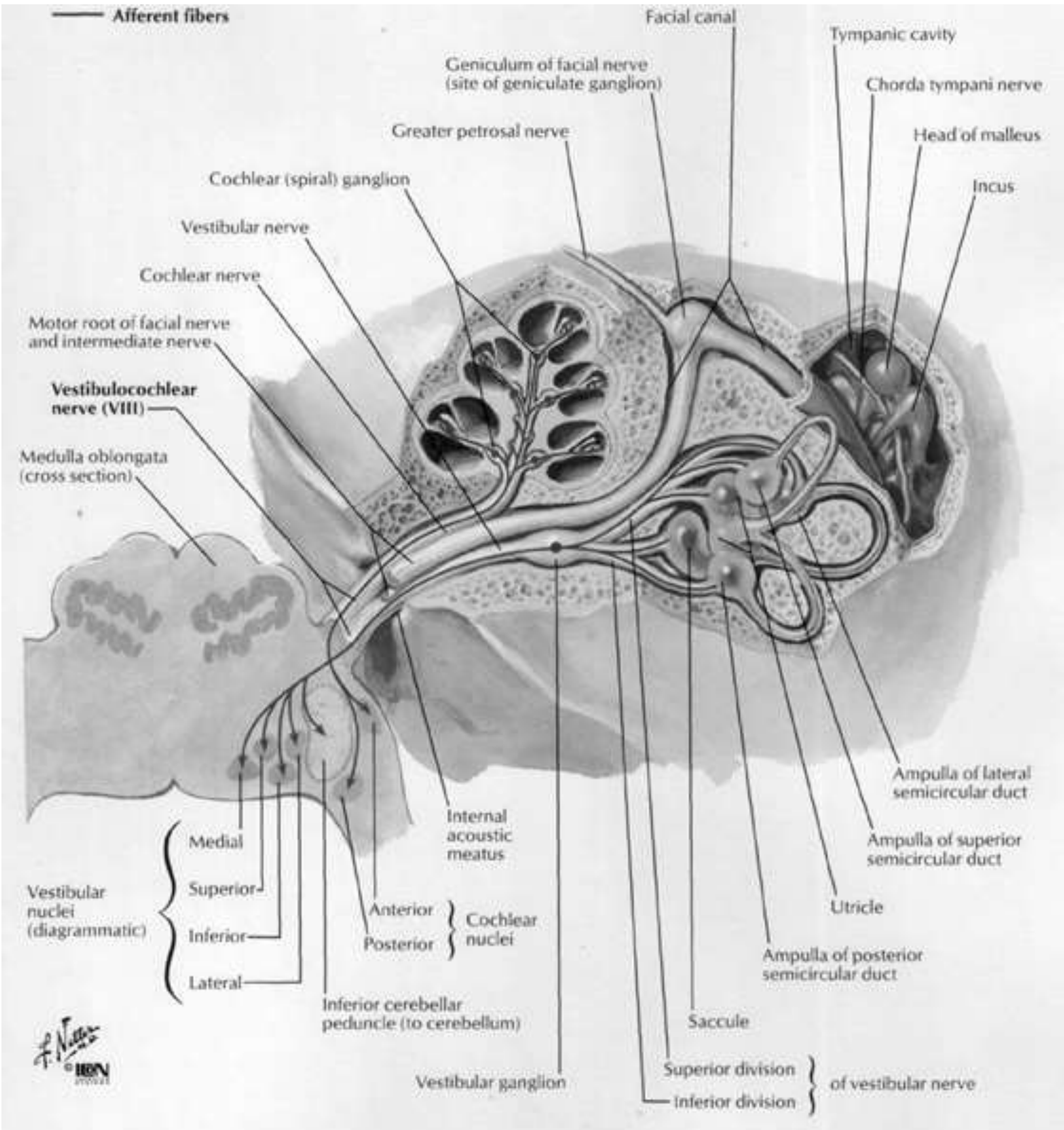


Figure 71 – Vestibulocochlear nerve

Sound waves enter external acoustic meatus

↓

Waves of changing pressures cause eardrum to reproduce vibrations coming from sound wave source

↓

Auditory ossicles amplify and transmit vibrations to end of stapes

↓

Movement of stapes at oval window transmits vibrations to perilymph in scala vestibuli

↓

Vibrations pass through the vestibular membrane and enter endolymph of cochlear duct

↓

Different frequencies of vibration in endolymph stimulate different sets of receptor cells

↓

Neurotransmitter stimulates ends of nearby sensory neurons.

↓

Sensory impulses are triggered on fibers of the cochlear branch of vestibulocochlear nerve

↓

Auditory cortex of temporal lobes interpret sensory impulses

Figure 72 – Auditory Sensation

The nerve fibers

The nerve fibers associated with hearing enter the auditory nerve pathways, which pass into the auditory cortices of the temporal lobes of the cerebrum, where they are interpreted. On the way, some of these fibers cross over, so that impulses arising from each ear are interpreted on both sides of the brain (Fig. 71, 72). Consequently, damage to a temporal lobe on one side of the brain does not necessarily cause complete hearing loss in the ear on that side.

Many older people have some degree of hearing loss. One possible cause is a gradual buildup of cerumen. Another cause is a slow, progressing deafness called presbycusis or senile deafness. This irreversible, bilateral sensorineural hearing loss usually starts at middle age, slowly worsens, and affects more men than women.

SENSE OF EQUILIBRIUM

The sense of equilibrium actually consists of two senses – static equilibrium and dynamic equilibrium –that come from different sensory organs. The organs of static equilibrium sense the position of the head, maintaining stability and posture when the head and body are still. When the head and body suddenly move or rotate, the organs of dynamic equilibrium detect such motion and maintai balance.

Static Equilibrium. The organs of static equilibrium are located inside the vestibule. The membranous labyrinth inside the vestibule consists of two expanded chambers – *an utricle* and *a saccule*. Each of these chambers has a tiny structure called a *macula* (Fig.73). Maculae have many hair cells, which serve as sensory receptors. The hairs of the hair cells project into a mass of gelatinous material, which has grains of calcium carbonate (otoliths) embedded in it. The head bending forward, backward, or to one side stimulates hair cells. Such movements tilt the gelatinous masses of the maculae, and as they sag in response to gravity, the hairs projecting into them bend. This action stimulates the hair cells, and they signal the neurons associated with them in a manner similar to that of hearing receptors. The resulting action potentials travel into the central nervous system on the vestibular branch of the vestibulocochlear nerve, informing the brain of the head's new position. The brain responds by sending motor impulses to skeletal muscles, which contract or relax to maintain balance.

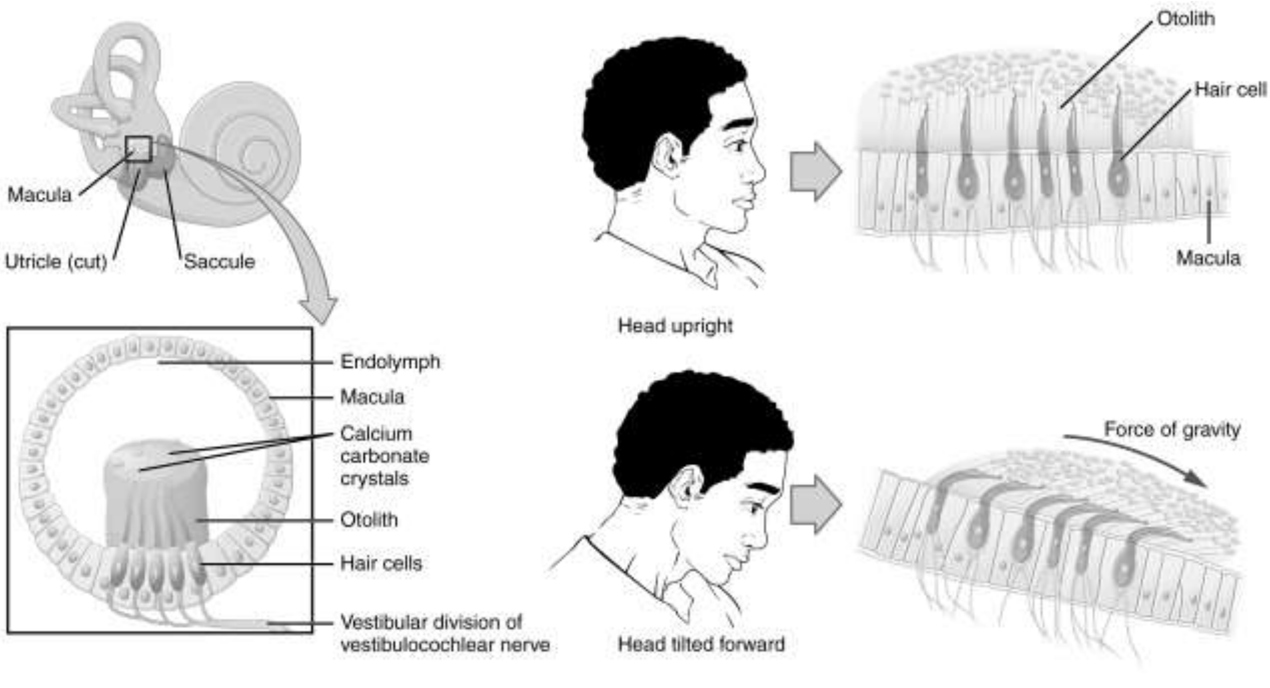


Figure 73 – Location and structure of receptors in the maculae of the right ear

Dynamic Equilibrium. The organs of dynamic equilibrium are the three semicircular canals in the labyrinth. They detect motion of the head and aid in balancing the head and body during sudden movement. These canals lie at right angles to each other, and each corresponds to a different anatomical plane. Suspended in the perilymph of the osseous portion of each semicircular canal is a membranous canal that ends in a swelling called an *ampulla*, which houses the sensory organs of the semicircular canals. Each of these organs called a *crista ampullaris*, contains a number of sensory hair cells and supporting cells. Like the hairs of the maculae, the hair cells extend upward into a dome–shaped gelatinous mass called the cupula. Rapid turns of the head or body stimulate the hair cells of the crista ampullaris. At the same time, the semicircular canals move with the head or body, but the fluid inside the membranous canals remains stationary. This bends the cupula in one or more of the canals in a direction opposite that of the head or body movement, and the hairs embedded in it also bend. The stimulated hair cells signal their associated nerve fibers, sending impulses to the brain. The brain interprets these impulses as a movement in a particular direction (Fig. 74).

Parts of the cerebellum are particularly important in interpreting impulses from the semicircular canals. Analysis of such information allows the brain to predict the consequences of rapid body movements, and by modifying signals to appropriate skeletal muscles, the cerebellum can maintain balance.

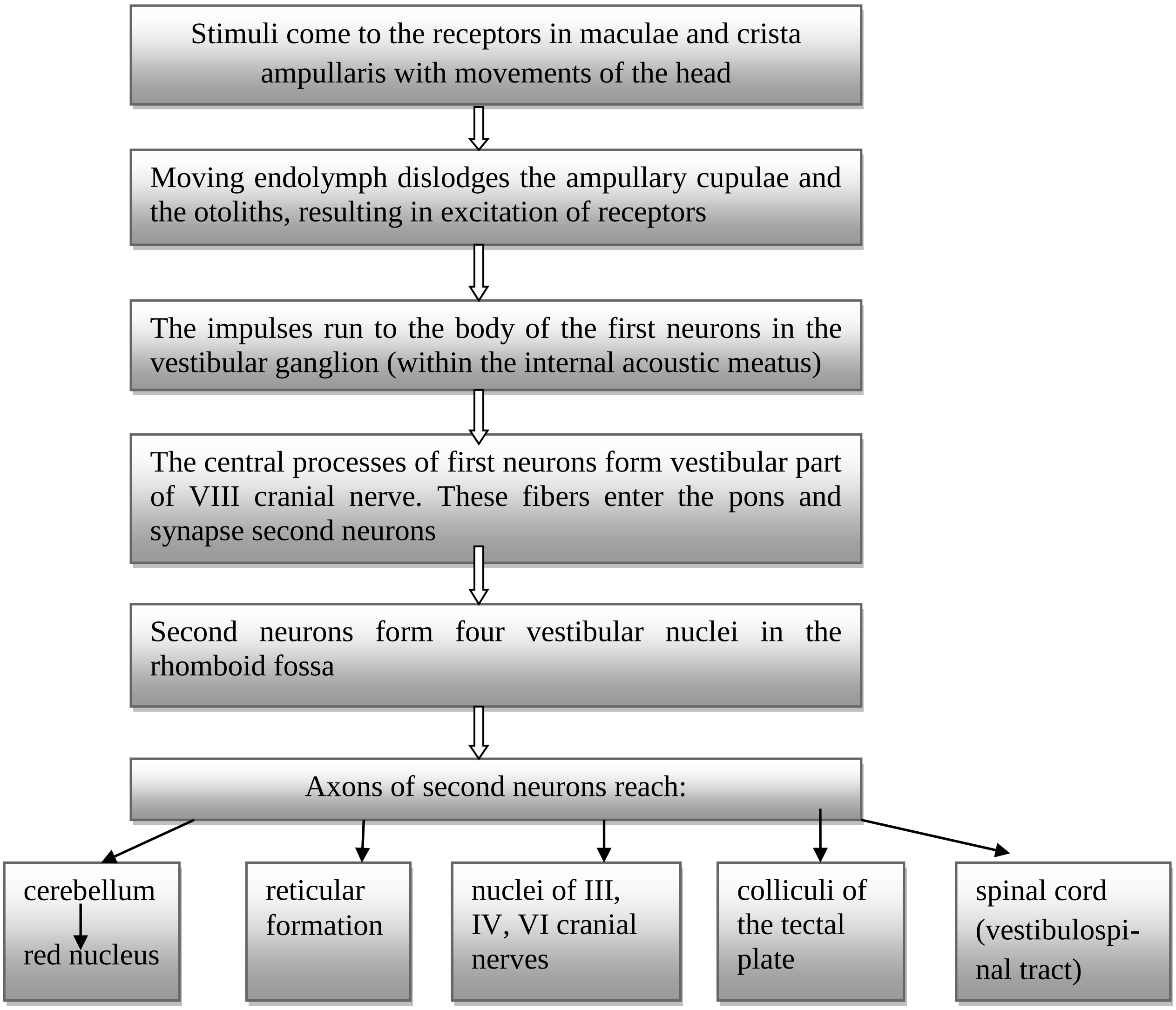


Figure 74 – Vestibular apparatus

THE OLFACTORY APPARATUS

The nose is the sense organ for smell. The mucosal epithelium that lines the upper parts of the nasal cavity, the superior nasal conchae, and a part of the nasal septum houses receptors for fibers of the olfactory nerve (cranial nerve I). These receptors, called olfactory (smell) receptors, consist of hair cells that are highly sensitive. The nose contains 10 – 100 million receptors for the sense of smell. These olfactory receptors are bipolar neurons and are surrounded by other cells, including supporting cells and basal cells (Fig. 75).

Olfactory receptors bind and recognize almost 10,000 different molecules, which are collectively called odorants. The odorants elicit action potentials within the receptors, and the information is sent via the olfactory nerves (cranial nerve I) to the olfactory areas of the brain (temporal and frontal lobes of the cerebrum, the limbic system, and the hypothalamus). Because some of the nerve impulses are passed to the limbic system, certain odors and tastes evoke strong emotional responses and memories (Fig. 76).

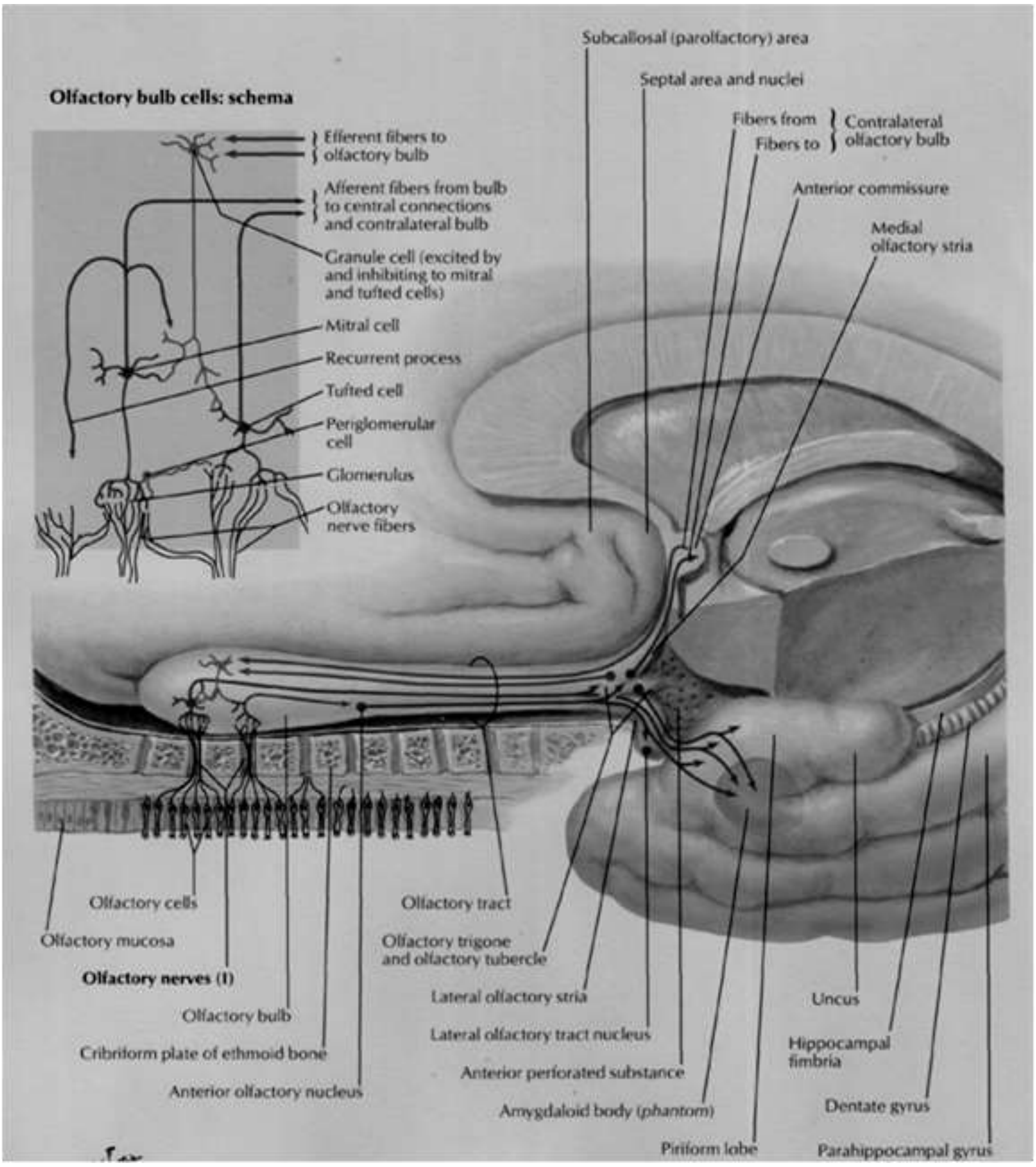


Figure 75 – Schematic drawing of olfactory nerve pathway

Stimulated olfactory receptor cells send impulses along their axons

⇓

These axons, forming the first cranial nerves, synapse with second neurons located in olfactory bulbs

⇓

In the olfactory bulbs the impulses are analyzed, and additional impulses travel along the olfactory tracts to the limbic system

Figure 76 – Olfactory Nerve Pathways

THE ORGAN OF TASTE

Gustation involves receptors from both the oral and nasal cavities.

The roof of the mouth and the tongue contain most of the receptors for the taste nerve fibers (Fig. 77).

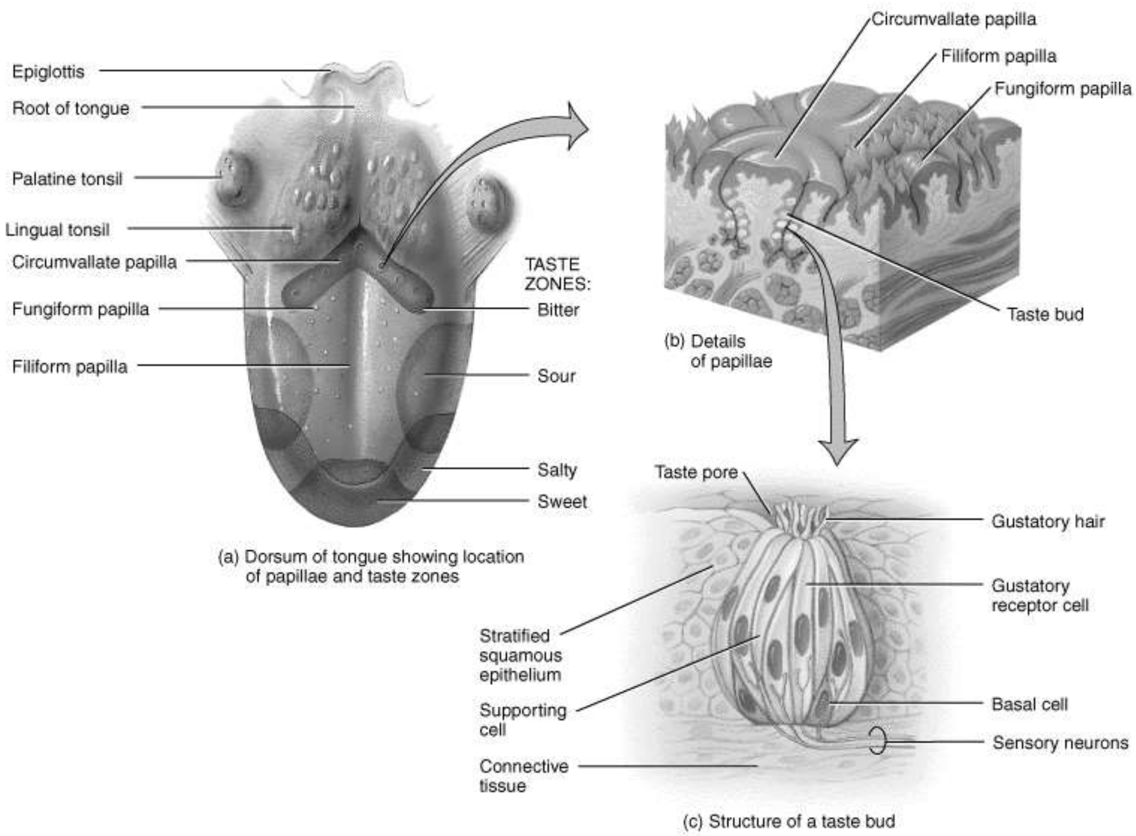


Figure 77 – The gustatory system: taste receptor cells in taste buds of papillae

Receptors called taste buds are stimulated by chemicals and respond to four taste sensations:

- sweet (on the tip of the tongue)
- sour (along the sides of the tongue)
- bitter (on the back of the tongue)
- salty (on the tip and sides of the tongue)

All other taste sensations result when air passing through the nose stimulates olfactory receptors and taste buds. Unlike the nose, the tongue has no “sticky” mucus to trap tastant molecules. Instead, the tastants dissolve in saliva, enter taste pores, and contact the hairs of gustatory receptors on the tongue. The gustatory receptors transmit their information via several cranial nerves (VII, IX, X) to the primary gustatory area in the parietal lobe of the cerebrum, the limbic system, and the hypothalamus (Fig. 78). Because gustatory information is sent to the limbic system, some tastes may evoke strong memories.

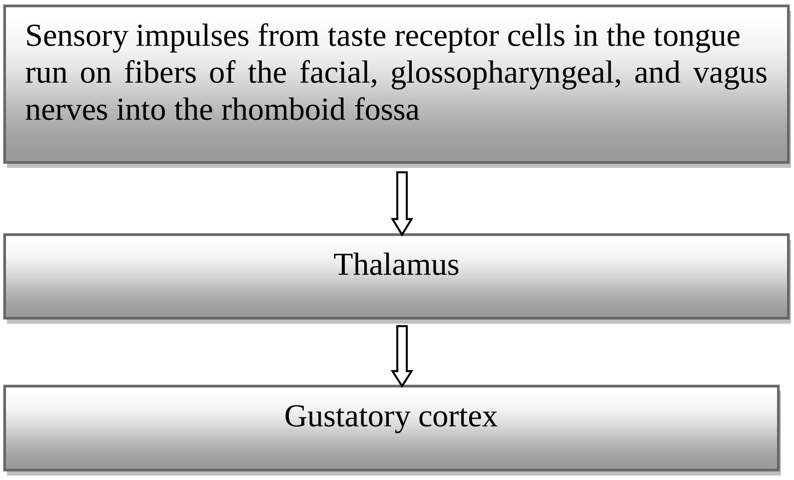


Figure 78 – Taste nerve pathways

TEST QUESTIONS (COMPUTER)

External features of the human spinal cord

The structural and functional unit of the nervous system*:*
+neuron
– nephron
– island
– nerve

The neuron with 1 process is called as follows:
+unipolar
–bipolar
–multipolar
–heksapolar

The neuron with many processes is called as follows:
+multipolar
–unipolar
–bipolar
–heksapolar

The sensory (afferent) neurons reside as follows:
+in the spinal ganglia
–in the spinal cord
–in muscles
–in the brain

The motor (efferent) neurons reside as follows:
+in the spinal cord and brain
–in spinal ganglia
–exclusively in the spinal cord
–in muscles and skin

The assosiative neurons reside as follows:
+in the spinal cord and brain
–in spinal ganglia
–exclusively in the spinal cord
–in muscles and skin

The simplest reflex arc is made up with the following:
+ 2 neurons
– 1neuron
–4 neurons
–from 5 to 10 neurons

The caudal end of the spinal cord terminates as follows:
+at the level of LI–II vertebrae
–at the level of S II vertebral body
–at the level of Th I vertebral body
–at the level of Th XII vertebral body

The receptors receiving stimuli from external environment are called as follows:
+exteroceptors
–proprioceptors
–assosiative neurons
–motor neurons

Where are exteroceptors located?
+in the skin, mucous membranes, and organs of sense
–in muscles, tendons, and joint capsules
–in vessels
–in the internal organs

The receptors that are stimulated by intestinal chemical are called as follows:
+interoceptors
–proprioceptors
–assosiative neurons
–motor neurons

Where are proprioceptors located?
+in muscles, tendons, and joint capsules
–in the skin, mucous membranes, and organs of sense
–in vessels
–in the internal organs

The receptors which reside in muscles, tendons, fasciae, and joint capsules are called as follows:
+proprioceptors
–interoceptors
–assosiative neurons
–motor neurons

The central nervous system comprises:
+the spinal cord and brain
–only the brain
–the gray matter of the brain
–the spinal cord, nerves, and ganglia

What is the grey matter of the brain and the spinal cord formed of?
+the bodies of the neurons

–nerve fibers and nerves
–conductive tracts of the spinal cord
–neural ganglia

The peripheral nervous system is formed by the following structures:
+nerves, nodes and nerve plexuses
–the bodies of the neurons
–the grey and white matter of the spinal cord
–exteroceptors and interoceptors

What does the somatic nervous system innervate?
+skin and skeletal muscles
–all internal organs
–vessels and the heart
–endocrine glands and internal ograns

The vegetative (autonomic) nervous system innervates the following structures:
+glands and smooth muscles
–skeletal muscles
–cerebrum
–organs of sensation

Where do the anterior (motor) roots of spinal nerve arise from?
+the anterolateral groove
–the posterolateral groove
–the anterior median fissure
–the posterior median groove

Where do the posterior (sensory) roots enter the spinal cord?
+ posterolateral groove
– anterolateral groove
– anterior median fissure
– posterior median groove

How many roots of spinal nerves are there?
+31 pair on each side
–12 pairs on each side
–28 pairs
–38 pairs

How many spinal nerves are there?
+31 pair
–38 pairs
–20 pairs
–12 pairs

How many segments of the spinal cord are there?
+31
–30
–12
–5

The number of cervical segments is as follows:
+8
–12 pairs
–5
–31

The number of lumbar segments is as follows:
+5
–5 pairs
–12
–8

The upper cervical segments of the spinal cord are located as follows:
+at the level of the corresponding vertebrae
–at the level of Th–X and Th–XI vertebral bodies
– 1 vertebra above than the corresponding vertebral bodies
–3 vertebrae higher than the corresponding vertebral bodies

The lower cervical and upper thoracic spinal segments are located as follows:
+1vertebrae above than the corresponding vertebral bodies
–at the level of the corresponding vertebrae
–2 vertebrae higher than the corresponding vertebrae bodies
–at the level of the Th–X and Th–XII vertebrae

The middle thoracic segments of the spinal cord are located as follows:
+2 vertebrae higher than the corresponding vertebral bodies
–1 vertebra above than the corresponding vertebral bodies
–2 vertebrae lower than the corresponding vertebral bodies
–at the level of the Th–X and Th–XII vertebrae

The lower thoracic segments of the spinal cord are located as follows:
+3 vertebrae higher than the corresponding vertebral bodies
–1 vertebra above than the corresponding vertebral body
–2 vertebrae lower than the corresponding vertebral bodies
–at the level of the Th–X and Th–XII vertebrae

The lumbar segments of the spinal cord are located:
+at the level of the 10th and 11th thoracic vertebrae
–at the level of lumbar vertebrae
–1 vertebra above the corresponding vertebral body
–2 vertebrae lower than the corresponding vertebral bodies

The sacral and coccygeal segments of the spinal cord are located as follows:
+at the level of the 12th thoracic and 1st lumbar vertebrae
–1 vertebra above the corresponding vertebral body
–2 vertebrae lower than the corresponding vertebral bodies
–at the level of the Th X and Th XII vertebrae

The epidural space of the spinal cord lies between the following structures:
+ periostium and the dura mater of the spinal cord
– the dura mater and arachnoid mater of the spinal cord
– the pia mater and arachnoid mater of the spinal cord
– the pia mater and dura mater of the spinal cord

The subdural space lies between the following structures:
+ the dura mater and arachnoid mater of the spinal cord
– the pia mater and arachnoid mater of the spinal cord
– the pia mater and dura mater of the spinal cord
– periostium and the dura mater of the spinal cord

The subarachnoid space lies between the following structures:
+ the pia mater and arachnoid mater of the spinal cord
– the dura mater and arachnoid mater of the spinal cord
– the pia mater and dura mater of the spinal cord
– the periostium and dura mater of the spinal cord

The subarachnoid space contains the following structures:
+the cerebrospinal fluid
–the adipose tissue
–the venous plexus
–only connective tissue

The epidural space contains the following structures:
+the adipose tissue and venous plexus
–the cerebrospinal liquid
–only connective tissue
–only adipose tissue

The cauda equina is formed by the following structures:
+the roots of the lower segments of the spinal cord
–the connective tissue
–the roots of all segments of the spinal cord
–the lower spinal nerves

The thoracic segments of the spinal cord are numbered as follows:
+ThI – ThXII
–CI–CVIII
–LI–LV
–SI–SV

The sacral spinal cord segments are numbered as follows:
+SI–SV
–ThI–ThXII
–CI–CV
–LI–LV

The lumbar segments are numbered as follows:

+LI–LV
–ThI–ThV
–LI–LVIII
–C I – C VIII

The cervical segments are numbered as follows:
+C I – C VIII
–C I – C V
–S I – S V
–Th I – Th VIII

Microscopic Structure of the Spinal Cord

The anterior horns of the spinal cord are distinguished as follows:
+throughout the whole spinal cord
–at the level of C8 – L 2 segments
–only in the cervical segments
–only in the thoracic segments

The posterior horns of the spinal cord are distinguished as follows:
+throughout the whole spinal cord
–to the level of C8 – L2 segments

The lateral horns of the spinal cord are located as follows:
+at the level of C8 – L2 segments
–throughout the whole spinal cord
–only in the cervical segments
–only in the thoracic segments

The central canal of the spinal cord is located as follows:
+inside the grey matter
–in the terminal ventricle
–inside the white matter
–outside the spinal cord

Motor (efferent) neurons are located as follows:
+in the anterior horns of the spinal cord
–in the posterior horns of the spinal cord
–in the lateral horns of the spinal cord
–in the spinal ganglia

How many nuclei are located in the anterior horn of the spinal cord?
+5
–3
–1
–9

What is the function of the nuclei of the anterior horns of the spinal cord?
+motor
–vegetative
–sensitive
–mixed

What is located in the lateral horns of the spinal cord?
+the intermediolateral nucleus
–the anterior and posterior lateral nuclei
–the thoracic nucleus
–the spongy zone

What is the function of the nuclei of the lateral horns?
+vegetative
–motor
–sensory
–mixed

What is the type of neurons is found in the lateral horns?
+associative
–mixed
–motor
–sensory

***Assosiative neurons form the following structure*:**
+posterior horn
–ganglia
–anterior horn
–posterior funiculus

Thoracic nucleus is situated as follows:
+in the posterior horns
–in the lateral horns
–in the lateral funiculus
–in the reticular formation of the spinal cord

The reticular formation of the spinal cord is located in the following structure :
+in the white matter
–in ganglia
–in anterior horns
–in lateral horns

The white matter of the spinal cord is made up of the following structures:

+the nerve processes
–the nerve cell bodies
–the nuclei
–the ganglia

What is the name of the anterior tract, facilitating voluntary movements?
+the anterior corticospinal tract
–the tectospinal tract
–the anterior spinocerebellar tract
–the rubrospinal tract

What is the function of the tectospinal tract?
+ involuntary movements
– voluntary movements
– tactile sensitivity
– proprioceptive sensitivity

The anterior spinothalamic tract carries impulses:
+of tactile sensitivity
–pain and temperature sensitivity
–proprioceptive sensitivity
–from visual and auditory centers

The anterior spinotalamic tract is characterized as follows:
+the tract of tactile sensitivity
–the tract of proprioceptive sensitivity
–the motor tract of the voluntary movements
–the motor tract of the involuntary movements

Flechsig's tract is is characterized as follows:
+the posterior spinocerebellar tract
–the lateral spinothalamic tract
–the fasciculus gracilis tract
–the anterior corticospinal tract

What type of sensitivity does the posterior spinocerebellar tract hold?
+proprioceptive sensitivity
–tactile sensitivity
–pain sensitivity
–visual sensitivity

Which tract holds proprioceptive sensitivity for the cerebellum?
+the posterior spinocerebellar tract
–the anterior spinothalamic tract
–the fasciculus gracilis tract
–the olivospinal tract

What type of sensitivity does the anterior spinocerebellar tract hold?
+proprioceptive sensitivity
–tactile sensitivity
–pain sensitivity
–visual sensitivity

What is another name for Gowers' tract?
+the anterior spinocerebellar tract
–the fasciculus cuneatus
–the anterior corticospinal tract
–the anterior spinothalamic tract

What tract transmits pain and temperature?
+the lateral spinothalamic tract
–the anterior spinothalamic tract
–the anterior corticospinal tract
–the reticulospinal tract

The lateral spinothalamic tract carries the following impulses:
+pain and temperature sensitivity
–proprioceptive sensitivity
–visual and auditory sensitivity
–tactile sensitivity

The lateral corticospinal tract is characterized as follows:
+the tract of voluntary movement
–the tract of involuntary movement
–the proprioceptive tract
–the tactile sensitivity tract

The rubrospinal tract is characterized as follows:
+the tract of involuntary movement
–the tract of voluntary movement
–the proprioceptive tract
–the tactile sensitivity tract

The nerve fibers from 19 lower spinal segments pass in the following structure:
+the fasciculus gracilis
–the fasciculus cuneatus
–the posterior spinocerebellar tract
–the rubrospinal tract

The nerve fibers from 12 upper spinal cord segments pass in the following structure:
+the fasciculus cuneatus
–the fasciculus gracilis

–the tectospinal tract
–the vestibulospinal tract

What is the function of the fasciculus gracilis?
+the pathway of proprioceptive sensitivity
–the pathway of tactile sensitivity
–the tract of involuntary movement
–the tract of voluntary movement

What is the function of the fasciculus cuneatus?
+the pathway of proprioceptive sensitivity
–the pathway of tactile sensitivity
–the tract of involuntary movement
–the tract of voluntary movement

What tract carries the proprioceptive impulses to the cortex of the brain?
+the fasciculus cuneatus
–the anterior spinocerebellar tract
–the rubrospinal tract
–the anterior corticospinal tract

What tract carries the proprioceptive impulses to the cerebellum?
+the posterior spinocerebellar tract
–the fasciculus cuneatus
–the fasciculus gracilis
–the anterior reticulospinal tract

The white matter of spinal cord is divided into:
+anterior, posterior and lateral funiculi
–anterior and posterior funiculi
–anterior, posterior and lateral horns
–anterior, posterior and lateral funiculi at the level C8–L2

Overview of the Brain. Medulla Oblongata

The following structures are primary vesicles:
+ prosencephalon, mesencephalon, rhombencephalon
– telencephalon, diencephalon, mesencephalon, methencephalon, myelencephalon
–prosencephalon, diencephalon, methencephalon
–telencephalon, mesencephalon, rhombencephalon

The following structures are secondary cerebral vesicles:
+telencephalon, diencephalon, mesencephalon, methencephalon, myelencephalon
–prosencephalon, diencephalon, methencephalon
–telencephalon, mesencephalon, rhombencephalon
–prosencephalon, mesencephalon, rhombencephalon

Prosencephalon is divided as follows:
+telencephalon and diencephalon
–methencephalon and myelencephalon
–diencephalon and methencephalon
–telencephalon and mesencephalon

Rhombencephalon is divided as follows:
+methencephalon and myelencephalon
–diencephalon and methencephalon
–telencephalon and mesencephalon
–prosencephalon and mesencephalon

Mesencephalon is divided as follows:
+not divided
–diencephalon and methencephalon
–telencephalon and myelencephalon
–methencephalon and myelencephalon

What divisions of the brain originate from the forebrain?
+telencephalon and diencephalon
–mesencephalon
–pons and cerebellum
–medulla oblongata

What divisions of the brain originate from the middle primary vesicle?
+mesencephalon
–mesencephalon and medulla oblongata
–pons and cerebellum
–telencephalon and diencephalon

What divisions of the brain originate from the hindbrain?
+pons, cerebellum and medulla oblongata
–mesencephalon and medulla oblongata
–diencephalon and medulla oblongata
–telencephalon and diencephalon

What divisions of the brain originate from the methencephalon?
+pons and cerebellum
–mesencephalon and medulla oblongata
–diencephalon and medulla oblongata
–telencephalon and diencephalon

What divisions of the brain originate from the myelencephalon?
+medulla oblongata
–mesencephalon and medulla oblongata
–telencephalon and diencephalon
–pons and cerebellum

The brain consists of the following principal parts:
+cerebral hemispheres, cerebellum, brainstem
–mesencephalon and medulla oblongata
–telencephalon and diencephalon
–cerebral hemispheres, cerebellum, pons

The brainstem consists of the following parts:
+diencephalon, mesencephalon, pons and medulla oblongata
–mesencephalon and cerebellum
–telencephalon and diencephalon
–cerebral hemispheres and cerebellum

The newest part of the brain is represented as follows:
+cerebral hemispheres
–brainstem
–diencephalon
–cerebellum

The following strucnure is the oldest part of the brain:
+brainstem
–diencephalon
–cerebellum
–cerebral hemispheres

The longitudinal cerebral fissure separates the following structures:
+cerebral hemispheres
–mesencephalon and cerebellum
–telencephalon and diencephalon
–cerebral hemispheres and cerebellum

The transverse cerebral fissure separates the following structures:
+cerebral hemispheres and cerebellum
–mesencephalon and cerebellum
–telencephalon and diencephalon
–cerebral hemispheres

The 1st pair of cranial nerves is called as follows:
+olfactory nerve
–optic nerve
–trigeminal nerve
–accessory nerve

How many cranial nerves are there?
+12
–31
–10
–7

The 2nd pair of cranial nerves is called as follows:
+optic nerve
–olfactory nerve
–trigeminal nerve
–accessory nerve

The 3rd pair of cranial nerves is called as follows:
+oculomotor nerve
–optic nerve
–trigeminal nerve
–accessory nerve

The 4th pair of cranial nerves is called as follows:
+trochlear nerve
–optic nerve
–trigeminal nerve
–accessory nerve

The 5th pair of cranial nerves is called as follows:
+trigeminal nerve
–optic nerve
–facial nerve
–accessory nerve

The 6th pair of cranial nerves is called as follows:
+abducent nerve
–optic nerve
–facial nerve
–accessory nerve

The 7th pair of cranial nerves is called as follows:
+facial nerve
–optic nerve
–abducent nerve
–accessory nerve

The 8th pair of cranial nerves is called as follows:
+vestibulocochlear nerve
–optic nerve
–facial nerve
–vagus nerve

The 9th pair of cranial nerves is called as follows:
+glossopharyngeal nerve
–vestibulocochlear nerve
–facial nerve
–vagus nerve

The 10th pair of cranial nerves is called as follows:
+vagus nerve
–glossopharyngeal nerve
–vestibulocochlear nerve
–facial nerve

The 11th pair of cranial nerves is called as follows:
+accessory nerve
–glossopharyngeal nerve
–vestibulocochlear nerve
–facial nerve

The 12th pair of cranial nerves is called as follows:
+hypoglossal nerve
–glossopharyngeal nerve
–vestibulocochlear nerve
–facial nerve

What structure is a component of CN I?
+olfactory tract
–optic chiasm
–tuber cinereum
–posterior perforated substance

What structure is a component of CN II?
+optic chiasm
–olfactory tract
–tuber cinereum
–anterior perforated substance

Where does the oculomotor nerve emerge from in the brain?
+from medial surface of the cerebral peduncle
–from lateral surface of the cerebral peduncle
–between pons and middle cerebellar peduncle
–between pons and medulla oblongata

Where does the trochlear nerve arise from im the brain?
+from lateral surface of the cerebral peduncle
–from medial surface of the cerebral peduncle
–between pons and middle cerebellar peduncle
–between pons and medulla oblongata

Where does the trigeminal nerve arise from in the brain?
+between pons and middle cerebellar peduncle
–from medial surface of the cerebral peduncle
–from lateral surface of the cerebral peduncle
–between posterior border of the pons and pyramids of medulla oblongata

Where does the abducent nerve arise from in the brain?
+between posterior border of the pons and pyramids of medulla oblongata
–from medial surface of the cerebral peduncle
–from lateral surface of the cerebral peduncle
–between pons and middle cerebellar peduncle

Where does the facial nerve from brain?
+between posterior border of the pons and olive of medulla oblongata
–from lateral surface of the cerebral peduncle
–between pons and middle cerebellar peduncle
–between posterior border of the pons and pyramids of medulla oblongata

Where does the vestibulocochlear nerve arise from in the brain?
+between posterior border of the pons and olive of medulla oblongata
–from lateral surface of the cerebral peduncle
–between pons and middle cerebellar peduncle
–between posterior border of the pons and pyramids of medulla oblongata

Where does the glossopharyngeal nerve arise fromin the brain?

+from posterolateral sulcus of medulla oblongata
–from anterolateral sulcus of medulla oblongata
–between posterior border of the pons and pyramids of medulla oblongata
–between posterior border of the pons and olive of medulla oblongata

Where does the vagus nerve arise from in the brain?
+from posterolateral sulcus of medulla oblongata
–from anterolateral sulcus of medulla oblongata
–between posterior border of the pons and pyramids of medulla oblongata
–between posterior border of the pons and olive of medulla oblongata

Where does the accessory nerve arise from in the brain?
+from posterolateral sulcus of medulla oblongata
–from anterolateral sulcus of medulla oblongata
–between posterior border of the pons and pyramids of medulla oblongata
–between posterior border of the pons and olive of medulla oblongata

Where does the hypoglossal nerve arise from in the brain?
+from anterolateral sulcus of medulla oblongata
–from posterolateral sulcus of medulla oblongata
–between posterior border of the pons and pyramids of medulla oblongata
–between pons and middle cerebellar peduncle

The olfactory nerve is the following nerve:
+1st pair of cranial nerves
–2nd pair of cranial nerves
–4th pair of cranial nerves
–6th pair of cranial nerves

The optic nerve is the following nerve:
+2nd pair of cranial nerves
–1st pair of cranial nerves
–5th pair of cranial nerves
–4th pair of cranial nerves

The oculomotor nerve is the following nerve:
+3rd pair of cranial nerves
–2nd pair of cranial nerves
–6th pair of cranial nerves
–4th pair of cranial nerves

The trochlear nerve is the following nerve:
+4th pair of cranial nerves
–6th pair of cranial nerves
–3rd pair of cranial nerves
–5th pair of cranial nerves

The trigeminal nerve is the following nerve:
+5th pair of cranial nerves
–2nd pair of cranial nerves
–7th pair of cranial nerves
–6th pair of cranial nerves

The abducent nerve is the following nerve:
+6th pair of cranial nerves
–2nd pair of cranial nerves
–3rd pair of cranial nerves
–6th pair of cranial nerves

The facial nerve is the following nerve:
+7th pair of cranial nerves
–8th pair of cranial nerves
–5th pair of cranial nerves
–4th pair of cranial nerves

The vestibulocochlear nerve is the following nerve:
+8th pair of cranial nerves
–9th pair of cranial nerves
–11th pair of cranial nerves
–7th pair of cranial nerves

The glossopharyngeal nerve is the following nerve:
+9th pair of cranial nerves
–10th pair of cranial nerves
–11th pair of cranial nerves
–7th pair of cranial nerves

The vagus nerve is the following nerve:
+10th pair of cranial nerves
–11th pair of cranial nerves
–5th pair of cranial nerves
–8th pair of cranial nerves

The accessory nerve is the following nerve:

+11th pair of cranial nerves
–12th pair of cranial nerves
–9th pair of cranial nerves
–7th pair of cranial nerves

The hypoglossal nerve is the following nerve:
+12th pair of cranial nerves
–9th pair of cranial nerves
–11th pair of cranial nerves
–4th pair of cranial nerves

On inferior surface of the brain, from medial side of the cerebral peduncle,e arise roots of the following nerves:
+3rd pair of cranial nerves
–4th pair of cranial nerves
–5th pair of cranial nerves
–9th pair of cranial nerves

On inferior surface of the brain, from lateral side of the cerebral peduncle, arise roots of the following nerves:
+4th pair of cranial nerves
–3rd pair of cranial nerves
–5th pair of cranial nerves
–6th pair of cranial nerves

On inferior surface of the brain, between pons and middle cerebellar peduncle, arise roots of the following nerves:
+5th pair of cranial nerves
–4th pair of cranial nerves
–6th pair of cranial nerves
–7th pair of cranial nerves

On inferior surface of the brain, between posterior surface of the pons and pyramids of medulla oblongata, arise roots of the following nerves:
+6th pair of cranial nerves
–4th pair of cranial nerves
–7th pair of cranial nerves
–5th pair of cranial nerves

The borders of the interpeduncular fossa are called as follows:
+cerebral peduncles
–superior cerebellar peduncles
–inferior cerebellar peduncles
–middle cerebellar peduncles

The floor of the interpeduncular fossa features the following structure:
+posterior perforated substance
–anterior perforated substance
–olfactory trigone
–optic chiasm

The inferior narrowed portion of the tuber cinereum forms the following structure:
+infundibulum
–mammillary body
–olfactory bulb
–corpus callosum

The central portion of corpus callosum is called as follows:
+trunk
–splenium
–rostrum
–lamina terminalis

The anterior portion of corpus callosum is called as follows:
+genu
–trunk
–splenium
–body

The posterior portion of corpus callosum is called as follows:
+splenium
–trunk
–rostrum
–genu

The fornix consists of the following components:
+crus, body and column
–body, trunk and genu
–crus, body and rostrum
–column, body and splenium

The cavity of the rhombencephalon is called as follows:
+4th ventricle
–1st ventricle
–3rd ventricle
–2nd ventricle

The rhombencephalon comprises the following structure:
+medulla oblongata and metencephalon

–medulla oblongata and mesencephalon
–pons and mesencephalon
–cerebellum and telencephalon

The 4th ventricle is the cavity of the following structure:
+medulla oblongata and metencephalon
–mesencephalon
–diencephalon
–cerebral hemisphere

The boundary between medulla oblongata and spinal cord is called as follows:
+the first–order pair of spinal nerve or foramen magnum
–medullary stria of 4th ventricle
–medullopontine sulcus
–the roots of 12th pair of cranial nerve

The boundary between medulla oblongata and pons ventrally is called as follows:
+medullopontine sulcus
–medullary stria of 4th ventricle
–the roots of the 12th pair of cranial nerves
–the first–order pair of spinal nerve or foramen magnum

The medulla oblongata has the following surfaces:
+ventral, dorsal and lateral
–superior and inferior
–medial and lateral
–anterior, posterior and inferior

The features of the ventral surface of the medulla oblongata as following:
+anterior median fissure, pyramids and decussation of pyramids
–oliva, anterolateral and posterolateral sulci
–posterior median sulcus, gracile and cuneate tubercles
–pyramids, oliva, anterolateral and posterolateral sulci

The lateral surface of the medulla oblongata comprises the following structures:
+oliva, anterolateral and posterolateral sulci
–posterior median sulcus, gracile and cuneate tubercles
–pyramids, oliva, anterolateral and posterolateral sulci
–anterior median fissure, pyramids and decussation of pyramids

The dorsal surface of the medulla oblongata features the following structures:
+posterior median sulcus, gracile fascicle and cuneate fascicle
–pyramids, oliva, anterolateral and posterolateral sulci
–anterior median fissure, pyramids and decussation of pyramids
–oliva, anterolateral and posterolateral sulci

The following nuclei are the nuclei of medulla oblongata:
+gracile and cuneate nuclei, inferior olivary nucleus, nuclei of 9th–12th cranial nerves
–superior olivary nucleus, nuclei of the 5th–8th cranial nerves, red nucleus
–dentate, emboliform and globose nuclei
–red nucleus, nuclei of the 5th–8th cranial nerves, superior and inferior olivary nuclei

The inferior olivary nucleus function as following:
+ it controls body equilibrium
–it controls voluntary and involuntary movements
– it is a center of extrapyramidal system
–it transmits proprioceptive impulses

The medial lemniscus is a bundle of axons that arises from the following nuclei:
+gracile and cuneate nuclei
–inferior olivary nucleus
–superior olivary nucleus
–emboliform and globose nuclei

The medial lemniscus transmits the following impulses:
+proprioceptive and partly tactile sensitivity
–pain and temperature sensitivity
–voluntary movement
–voluntary and involuntary movement

The sensory decussation of the medulla oblongata is formed by the following structures:
+fibers of medial lemniscus
–fibers of corticospinal tract
–fibers of lateral lemniscus
–fibers of trapezoid body

The motor decussation of the medulla oblongata is formed by the following structures:
+fibers of corticospinal tract
–fibers of medial lemniscus
–fibers of lateral lemniscus
–fibers of trapezoid body

The metencephalon comprises the following structures:
+pons and cerebellum
–medulla oblongata and pons
–medulla oblongata and cerebellum
–medulla oblongata, pons and cerebellum

Pons and Cerebellum. Romboid Fossa and the 4th Ventricle

The pons has the following surfaces:
+ventral and dorsal
–superior and inferior
–medial and lateral
–anterior, superior and inferior

The dorsal surface of the pons features the following structures:
+medullary stria of the 4th ventricle
–pyramids and oliva
–middle cerebellar peduncle
–medullopontine and basilar sulci

The ventral surface of the pons features the following structures:
+medullopontine and basilar sulci
–medullary stria of the 4th ventricle
–pyramids and oliva
–gracile and cuniate fascicles

What structure delimits the basilar part of the pons and the pontine tegmentum?
+trapezoid body
–medullary stria of the 4th ventricle
–middle cerebellar peduncle
–basilar sulcus

The fibers of the trapezoid body belong to the following structures:
+auditory pathways
– proprioceptive sensitivity pathways
– pyramidal pathways
– pain and temperature sensitivity pathways

The trapezoid body delimits pons into two parts:
+basilar part and tegmentum of the pons
–lateral and medial parts
–pyramids and oliva
–tectum and tegmentum of the pons

The ventral part of pons comprises the following nuclei:
+pontine nuclei
–nuclei of 5th–8th cranial nerves
–superior olivary nucleus
–inferior olivary nucleus

The dorsal part of the pons comprises the following nuclei:
+nuclei of 5th–8th cranial nerves and superior olivary nucleus
–nuclei of 9th–12th cranial nerves and superior olivary nucleus
–superior olivary nucleus and inferior olivary nucleus
–pontine nuclei

The ventral (basilar) part of the pons contains the following fibers:
+pontocerebellar, corticopontine and pyramidal fibers
–medial and trigeminal lemniscus, rubrospinal and tectospinal tracts
–corticospinal and corticonuclear tracts, medial lemniscus
–pyramidal fibers and medial lemniscus

The cerebellum has the following surfaces:
+superior (dorsal) and inferior (ventral)
–superior, inferior, anterior and posterior
–medial and lateral
–anterior, posterior and lateral

The cerebellum has the following borders:
+anterior and posterior borders
–superior and inferior borders
–medial and lateral borders
–two lateral borders

The cerebellum comprises the following parts:
+two hemispheres and vermis
–flocculonodular lobe, anterior and posterior parts

–cerebellar cortex and arbor vitae
–two hemispheres and cerebellar peduncle

What is the phylogenetically oldest part (archicerebellum) of the cerebellum?
+flocculonodular lobe
–hemispheres of cerebellum
–vermis
–vallecula of cerebellum

What is a phylogenetically old part (paleocerebellum) of the cerebellum?
+vermis
–cerebellar hemispheres
–vallecula of cerebellum
–flocculonodular lobe

What is a phylogenetically new part (neocerebellum) of the cerebellum?
+ cerebellar hemispheres
–vermis
–vallecula of cerebellum
–flocculonodular lobe

The following nuclei are the nuclei of the cerebellum:
+dentate, emboliform, globose and fastigial
–nuclei of 5th–8th cranial nerves, superior and inferior olivar nuclei
–red nucleus and nuclei of 9th–12th cranial nerves
–gracile and cuneate nuclei, inferior olivar nucleus and nuclei of 9th–12th cranial nerves

The inferior cerebellar peduncles contain the following fibers:
+posterior spinocerebellar tract, olivocerebellar tract, external arcuate fibers, and vestibulocerebellar fibers
–pontocerebellar fibers
–dentorubral and anterior spinocerebellar tracts
–anterior and posterior spinocerebellar tracts

The middle cerebellar peduncles contain the following fibers:
+pontocerebellar fibers
–posterior spinocerebellar tract, olivocerebellar tract, external arcuate fibers, and vestibulocerebellar fibers
–dentorubral and anterior spinocerebellar tracts
–anterior and posterior spinoceebellar tracts

The superior cerebellar peduncles contain the following fibers:
+dentorubral and anterior spinocerebellar tracts
–posterior spinocerebellar tract, olivocerebellar tract, external arcuate fibers, and vestibulocerebellar fibers
–pontocerebellar fibers
–anterior and posterior spinocerebellar tracts

Where is the superior medullary velum located?
+between superior cerebellar peduncles
–between inferior cerebellar peduncles
–between middle cerebellar peduncles
–between peduncles of floculus

The superior cerebellar peduncles connect the cerebellum to the following structures:
+midbrain
–pons
–medulla oblongata
–cerebral hemisphere

The inferior cerebellar peduncles connect the cerebellum to the following structures:
+medulla oblongata
–pons
–midbrain
–cerebral hemisphere

The middle cerebellar peduncles connect the cerebellum to the following structures:
+pons
–medulla oblongata
–cerebral hemisphere
–midbrain

The pons is connucted to the cerebellum by the following structures:
+middle cerebellar peduncles
–inferior cerebellar peduncles
–superior cerebellar peduncles
–peduncles of flocculus

The medulla oblongata is connected with the cerebellum by the following structures:
+inferior cerebellar peduncles
–middle cerebellar peduncles
–superior cerebellar peduncles

–peduncles of flocculus

The midbrain is connected to the with cerebellum by the following structures:
+superior cerebellar peduncles
–inferior cerebellar peduncles
–middle cerebellar peduncles
–peduncles of flocculus

The superior part of rhomboid fossa is limited by the following structure:
+superior cerebellar peduncle
–midle cerebellar peduncle
–inferior cerebellar peduncle
–cerebral peduncle

The lower part of the rhomboid fossa is limited by the following structure:
+inferior cerebellar peduncle
–midle cerebellar peduncle
–superior cerebellar peduncle
–cerebral peduncle

The inferior angle of the rhomboid fossa is continued as follows:
+central canal of the spinal cord
– the 3rd ventricle
–cerebral aqueduct
–subarachnoid space

The superior angle of the rhomboid fossa is continued as follows:
+cerebral aqueduct
–central canal of spinal cord
–the 3rd ventricle
–subarachnoid space

In the superior part of the rhomboid fossa medial eminence has the following structure:
+facial tubercle
–triangle of the vagus nerve
–caudal fossa
–triangle of the hypoglossal nerve

In the lower part of the rhomboid fossa the medial eminence forms the following structure:
+triangle of the hypoglossal nerve
–vestibular field
–facial tubercle
–caudal fossa

The border between the medulla oblongata and the pons, on the rhomboid fossa, is demarcated as follows:
+medullary striae
–medial eminence
–median sulcus
–vestibular field

The anterior part of the rhomboid fossa is formed as follows:
+dorsal surface of the pons
–dorsal surface of the medulla oblongata
–dorsal surface of the midbrain
–triangle loop

The posterior part of the rhomboid fossa is formed as follows:
+dorsal surface of the medulla oblongata
–dorsal surface of the pons
–ventral surface of the medulla oblongata
–dorsal surface of the midbrain

The roof of the 4th ventricle is formed as follows:
+superior and inferior medullary velum
–pons
–roof of midbrain
–superior and inferior cerebellar peduncles

Choroid plexus of the 4th ventricle is located in the following region:
+inferior medullary velum
–floor of the 4th ventricle
–superior medullary velum
–cerebral aqueduct

The Magendie`s aperture is located as follows:
+on the inferior medullary velum
–on the superior medullayr velum
–floor of the 4th ventricle
–in the region of the upper angle of the rhomboid fossa

The lower angle of the 4th ventricle has the following foramen:
+foramen of Magendie
–foramen of Luschka
–cerebral aqueduct
–vestibular area

The lateral angles of the 4th ventricle have the following foramen:
+foramen of Luschka
–foramen of Magendie
–cerebral aqueduct
–vestibular area

Apertures of Magendie and Lyushka connect cavity of the 4th ventricle as follows:
+subarachnoid space
–the central canal of the spinal cord
–cerebral aqueduct
–subdural space

Superior medullary velum is stretched between the following structures:
+superior cerebellar peduncle
–inferior cerebellar peduncle
–middle cerebrallar peduncle
– median aperture of Magendie

Inferior medullary velum is stretched between the following structures:
+inferior cerebellar peduncle
–superior cerebellar peduncle
–middle cerebrallar peduncle
– median aperture of Magendie

The nuclei of the fallowing cranial nerves are located in the rhomboid fossa:
+5th–12th
–5th–8th
– 9th–12th
– 3rd–4th

The nuclei of the following cranial nerves are located in the region of the upper triangle of the rhomboid fossa:
+5th–8th
–9th–12th
–5th–10th
–5th–12th

The nuclei of the following cranial nerves are located in the region of the lower triangle of the rhomboid fossa:
+9th–12th
–5th–8th
–5th–12th
–4th–6th

How many nuclei does the trigeminal nerve have?
+4
–2
–1
–3

What is the name of the motor nucleus of the trigeminal nerve in Latin?
+nucleus motorius n. trigemini
–nucleus salivatorius
–nucleus ambiguus
–nucleus pontinus n. trigemini

The following function is the function of the mesencephalic nucleus of trigeminal nerve:
+sensory
–motor
–vegetative
–mixed

The following function is the function of the spinal nucleus of the trigeminal nerve:
+sensory
–motor
–vegetative
–mixed

The following function is the function of the pontine nucleus of the trigeminal nerv:
+sensory
–motor
–vegetative
–mixed

The 6th cranial nerve has the following nuclei:
+nucleus n. abducentis
–nucleus ambiguus
–nucleus solivatorius
–nucleus n. accessorii

The following function is common for the CNVI nucleus:
+motor
–sensory
–vegetative
–mixed

How many nuclei does the facial nerve have?
+3
–4

–1
–6

The following function is the function of the facial nerve nucleus:
+motor
–sensory
–vegetative
–an initial

The following function is the function of the solitary nucleus:
+sensory
–motor
–vegetative
–mixed

Sensory facial nerve nucleus is called as follows:
+solitary nucleus
–ambiguus nucleus
–salivatorius inferior nucleus
–nucleus pontinus

The solitary tract nucleus is common for the following cranial nerves:
+CNVII, CNIX, CNX
– CNVII, CNX
– CNV, CNVII
– CNVII, CNXI, CNXII

The superior salivatory nucleus is a part of the following nerves:
+ CNVII
– CNV
– CNIX
– CNXI

The following function is the function of the superior salivatory nucleus:
+vegetative
–sensory
–motor
–mixed

How many nuclei does the CNVIII have?
+6
–2
–4
–3

The nuclei of the CNVIII project as follows:
+vestibular area
–median eminence
–facial tubercle
–caudal fossa

The anterior and posterior cochlear nuclei belong to the following structure:
+cochlear part of the CNVIII
–vestibular part of the CNVIII
–facial nerve
–vagus nerve

The lateral vestibular nucleus is called as follows:
+Deiter`s nucleus
–Schwalbes nucleus
–Bechterew`s nucleus
–Roller nucleus

The medial vestibular nucleus is called as follows:
+Schwalbe`s nucleus
–Deiter`s nucleus
–Bechterew`s nucleus
–Roller nucleus

The superior vestibular nucleus is called as follows:
+Bechterew`s nucleus
–Schwalbe`s nucleus
–Deiter`s nucleus
–Roller nucleus

The inferior vestibular nucleus is called as follows:
+Roller nucleus
–Bechterew`s nucleus
–Schwalbe`s nucleus
–Deiter`s nucleus

The followingfunction is the function of ambiguous nucleus:
+motor
–sensory
–vegetative
–mixed

Where does the ambiguous nucleus project on the rhomboid fossa:
+into the caudal region of rhomboid fossa
–into the medial eminence

–into the triangle of hypoglosal nerve
–into the vestibular area

The inferior salivatory nucleus is a part of the following nerve:
+CNIX
–CNV
–CNIII
–CNX

The following function is the function of the inferior salivatory nucleus:
+vegetative
–sensory
–motor
–mixed

The function of the dorsal nucleus of the vagus nerve is as follows:
+vegetative
–sensory
–mixed
–motor

The dorsal nucleus of the vagus nerve is a part of the following nerve:
+CNX
–CNIX, and CNX
–CNVIII
–CNIX, CNX, and CNXI

The 11th cranial nerve has the following nuclei:
+ambiguous and spinal nuclei
–pontine nucleus
–anterior and posterior vestibular nuclei
–nucleus of the solitary tract

The function of the nuclei of the accessory nerve is as follows:
+motor
–sensory
–mixed
–vegetative

The 12th cranial nerve has the following nucleus:
+nucleus of hypoglossal nerve
–ambiguous nucleus
–pontine nucleus
–solitary nucleus

The function of the nuclei of the hypoglossal nerve is as follows:
+motor
–sensory
–vegetative
–mixed

Midbrain. Diencephalon. The 3rd Ventricle. Telencephalon

The midbrain consists of the following structures:
+the tectum and the cerebral peduncles
–the thalamus, the epithalamus, the metathalamus, and the hypothalamus
–the thalamus and the cerebral peduncles
–the tectum, pyramids, and olives

The diencephalon consists of the following structures:
+the thalamus, the epithalamus, the metathalamus, and the hypothalamus
–the thalamus and the cerebral peduncles
–pyramids, olives and the tectum
–the tectum and the cerebral peduncles

The thalamus, the epithalamus, the metathalamus and the hypothalamus are parts of the following structure:
+the diencephalon
–the mesencephalon
–the medulla oblongata
–the pons
The tectum and the cerebral peduncles are parts of the following structure:
+the midbrain
–the diencephalon
–the cerebellum
–the medulla oblongata

The midbrain cavity is represented by the following structure:
+cerebral aqueduct (aqueduct of Sylvius)
–the 3rd ventricle
–the 4rh ventricle
–the central canal

The cavity of the diencephalon is represented by the following structure:
+the 3rd ventricle
–the 4th ventricle

–the aqueduct of Sylvius
–the 1st and the 2nd ventricles

The cerebral aqueduct (the aqueduct of Sylvius) is the cavity of the following structure:
+the midbrain
–the diencephalon
–the medulla oblongata
–the cerebellum

The 3rd ventricle is reffered to as the cavity of the following structure:
+the diencephalon
–the mesencephalon
–the metencephalon
–the rhombencephalon

The aqueduct is bounded as follows:
+the tectal lamina and the cerebral peduncles
–the tegmentum of cerebral peduncles
–the superior and inferior colliculi of the tectal lamina
–the medial surfaces of two thalami

The cerebral aqueduct connects the following structures:
+the 4th ventricle to the 3rd ventricle
–the 3rd ventricle to the 1st and the 2nd ventricles
–the 1st ventricle to the 2nd ventricle
–the 4th ventricle to the central canal of the spinal cord

The cerebral aqueduct is surrounded by the following structures:
+the central grey substance
–the white matter
–the substantia nigra
–the habenulae

What is the ventral part of the midbrain?
+the cerebral peduncles
–the tectal plate
–the hypothalamus
–the metathalamus

What is the dorsal part of the midbrain?
+the tectal plate
–the cerebral peduncles
–the epithalamus
–the thalami

The substantia nigra divides the cerebral peduncle into the following parts:
+ventral part (base) and dorsal part (tegmentum)
–left and right parts
–medial and lateral parts
–medial and lateral geniculate bodies

What divides the cerebral peduncle into ventral and the dorsal parts?
+the substantia nigra
–the white matter
–the cerebral aqueduct
–the red nucleus

The substantia nigra acts as follows:
+subcortical center of the extrapyramidal system
–subcortical visual center
–subcortical auditory center
–autonomic regulatory center

The substantia nigra is located as follows:
+between the base and tegmentum of the cerebral peduncle
–between the tectal plate and the cerebral peduncles
–at the level of the superior colliculi
–anteriorly from the tectal plate below the fornix and the corpus callosum

The central grey substance of the midbrain is located found as follows:
+around the aqueduct of the midbrain
–between the cerebral peduncles
–between the superior and inferior colliculi of the tectal plate
–between the base and the tegmentum of the cerebral peduncle

The substantia perforata posterior resides as follows:
+between the cerebral peduncles of the midbrain
–around the aqueduct of the midbrain
–between the superior and inferior colliculi of the tectal plate
–between the base and the tegmentum of the cerebral peduncle

What is located between the cerebral peduncles?
+the interpeduncular fossa and the posterior perforated substance
–the substantia nigra
–the central grey substance of the midbrain
–the aqueduct of the midbrain (the aqueduct of Sylvius)

Roots of what cranial nerves emerge from the interpeduncular fossa of the midbrain?
+the roots of CNIII
–the roots of CNIV
–the roots of CNV
–the roots of CNVI

What nuclei are located in the dorsal part of the cerebral peduncle (in the midbrain tegmentum)?
+the red nucleus, the nucleus of the oculomotor nerve, the accessory nucleus of the oculomotor nerve, and the nucleus of the trochlear nerve
–the red nucleus, the substantia nigra, the subthalamic nucleus, and the pulvinar nuclei
–the anterior nuclei, the pulvinar nuclei, the ventral lateral nuclei, and the medial nuclei
–the nuclei of the oculomotor, and the trochlear and the abducent cranial nerves

The red nucleus, the nucles of the oculumotor nerve, the accessory nucleus of the oculomotor nerve, and the nucleus of the trochlear nerve are located in the following parts of the brain:
+dorsal part of the cerebral peduncle (midbrain tegmentum)
–the ventral part of the cerebral peduncle (the base of the cerebral peduncle)
–the dorsal thalamus
–the ventral thalamus

What are the most important groups of the nuclei of the dorsal thalamus?
+the anterior, pulvinar, ventrolateral and medial nuclei
–the red nucleus, the substantia nigra, the reticular nuclei and the subthalamic nucleus
–the nucleus of the oculumotor nerve, and the trochlear and the abducent nerves
–the red nucleus, the nucleus of the oculomotor nerve, and the accessory nucleus of the oculomotor nerve, the nucleus of the trochlear nerve

Which of the following nuclei are the nuclei of the ventral thalamus?
+the subthalamic nucleus, the red nucleus, the substantia nigra and the reticular nuclei
–the anterior, pulvinar, ventrolateral and medial nuclei
–the nuclei of the oculomotor nerve, the trochlear and the abducent nerves
–the infundibular, the lateral tuberal, the dorsomedial and ventromedial nuclei

The red nucleus, the substantia nigra, the subthalamic nucleus and the reticular nuclei of the thalamus are contained inside the following part of the brain:
+the ventral thalamus
–the ventral part of the cerebral peduncles (base of peduncles)
–the dorsal thalamus
–the dorsal part of the cerebral peduncles (the midbrain tegmentum)

The anterior, pulvinar, ventrolateral, and medial nuclei are situated inside the following part of the brain:
+the dorsal thalamus
–the ventral thalamus
–the dorsal part of the cerebral peduncle (the tegmentum)
–the hypothalamus

What is the function of the red nucleus?
+it is the subcortical center of the extrapyramidal system
–it is the subcortical visual center
–it is the subcortical auditory center
–it is the superior autonomic regulatory center

What is the function of the subthalamic nucleus (nucleus of Luys)?
+it is the subcortical center of the extrapyramidal system
–it is the extrapyramidal auditory center
–it is the extrapyramidal sensory center
–it is the extrapyramidal motor center

Which of the following are the subcortical centers of the extrapyramidal system?
+the red nucleus, the substantia nigra, the subthalamic nucleus (nucleus of Luys)
–the nuclei of the oculomotor nerve, the trochlear and abducent nerves
–the red nucleus, the nucleus of the oculomotor nerve, the accessory nucleus of the oculomotor nerve and the nucleus of the trochlear nerve
–the anterior, the pulvinar, the ventrolateral and medial nuclei of the thalamus

What is the function of the nucleus of the oculomotor nerve?
+motor
–sensory
–sympathetic
–parasympathetic

Which of the following is the parasympathetic nucleus of the midbrain?
+the accessory nucleus of the oculomotor nerve
–the nucleus of the trochlear nerve
–the red nucleus
–the subthalamic nucleus

What is the function of the accessory nucleus of the oculomotor nerve?
+parasympathetic
–sympathetic
–motor
–sensory

What is the function of the nucleus of the trochlear nerve?
+motor
–sensory
–sympathrtic
–parasympathetic

What nuclei of the cranial nerves are there in the tegmentum of the cerebral peduncle?
+nuclei of CNIII and CNIV
–nuclei of CNIV and CNVI
–nuclei of CNV
–nuclei of CNIII and CNVI

The roots of the following pair of cranial nerves are visible lateral to the cerebral peduncle:
+the fourth pair
–the third pair
–the fifth pair
–the sixth pair

The thinest of cranial nerves, the trochlear nerve, is seen on the base of the brain:
+lateral to the cerebral peduncle
–medial to the cerebral peduncle
–lateral to the thalamus
–between the medulla and the posterior border of the pons

The roots of the 3rd pair of cranial nerves emerge from the brain as follows:
+on the medial surface of each cerebral peduncle
–between the pyramid and the olive
–between the medulla and the posterior border of the pons
–on the lateral surface of each cerebral peduncle

What is the function of the red nucleus?
+it regulates muscle tonus and automated movements’ precision
–it is the subcortical visual center
–it is the subcortical sensory center
–it regulates autonomic functions

What nuclei of cranial nerves are situated on the level of the superior colliculi of the midbrain tegmentum?
+the nuclei of the oculomotor nerve
–the red nuclei
–the nuclei of the trochlear nerve
–the subthalamic nuclei (nuclei of Luys)

What nuclei of cranial nerves are situated on the level of the inferior colliculi of the midbrain tegmentum?
+the nuclei of the trochlear nerve
–the red nuclei
–the pulvinar nuclei
–the nuclei of the oculomotor nerve

The nuclei of the trochlear nerves are situated as follows:
+in the midbrain tegmentum on the level of the inferior colliculi
–in the midbrain tegmentum on the level of the superior colliculi

–in the base of the cerebral peduncles on the level of the inferior colliculi
–in the base of the cerebral peduncles on the level of the superior colliculi

The nuclei of the oculomotor nerves are situated as follows:
+in the midbrain tegmentum on the level of the superior colliculi
–in the midbrain tegmentum on the level of the inferior colliculi
–in the base of the cerebral peduncles on the level of the inferior colliculi
–in the base of the cerebral peduncles on the level of the superior colliculi

What descending nerve tracts run through the base of the cerebral peduncle?
+corticospinal, corticonuclear, and the corticopontine tracts
–the medial longitudinal fasciculus, the medial lemniscus and the spinothalamic tracts
–the rubrospinal tract, the lateral lemniscus and the medial lemniscus
–the corticopontine fibers, the rubrospinal tract, the lateral and the medial lemniscus

The fibers of the lateral lemniscus transmit the following impulses:
+auditory sensitivity
–visual sensitivity
–pain and temperature sensitivity
–proprioceptive and partly tactile sensitivity

The medial longitudinal fasciculus is a pathway that interconnects the following structures:
+the axons of motor nuclei of CNIII, CNIV, and CNVI
–the axons of red nucleus
–the corticospinal fibers
–the axons from cochlear nuclei

The function of the medial longitudinal fasciculus is as follows:
+accurate coordination of eyes and head movements
–regulation of muscle tones and automated movements' precision
–transmition of auditoty impulses
–transmition of visual impulses

What structure transmits the auditory impulses?
+the fibers of the lateral lemniscus
–the fibers of the medial lemniscus
–the medial longitudinal fasciculus
–the rubrospinal tract

An extremely good coordination of eyes and head movements is fulfilled as follows:
+the medial longitudinal fasciculus
–the fibers of the medial lemniscus
–the rubrospinal tract
–the fibers of the lateral lemniscus

The two transecting grooves divide the tectal plate of the midbrain into the following structures:
+four colliculi – two superior and two inferior
–four colliculi – two lateral and two medial
–two colliculi – one superior and one inferior
–the medial and the lateral geniculate bodies

The following nuclei are the nuclei of the superior colliculi:
+the subcortical visual centers
–the subcortical auditory centers
–the subcortical sensory centers
–the autonomic regulatory centers

The following nuclei are the nuclei of the inferior colliculi:
+the subcortical auditory centers
–the subcortical visual centers
–the subcortical sensory centers
–the autonomic regulatory centers

Where are the subcortical visual centers situated?
+in the superior colliculi of the midbrain, the lateral geniculate body of the metathalamus and the pulvinar of the thalamus
–in the inferior colliculi of the midbrain and the medial geniculate body of the metathalamus
–in the mammillary bodies
–in the red nuclei and the reticular nuclei of the thalamus

Where are the subcortical auditory centers situated?

+in the inferior colliculi of the midbrain and the medial geniculate body of the metathalamus
–in the superior colliculi of the midbrain and the lateral geniculate body of the metathalamus
–in the mammillary bodies
–in the red nuclei and the reticular nuclei of the thalamus

Each superior colliculus is continuous with a brachium of the midbrain passing to:
+the lateral geniculate body of the metathalamus
–the medial geniculate body of the metathalamus
–the nuclei of the hypothalamus
–the thalamus

Each inferior colliculus is extended by the brachium of the midbrain, passing to the following structure:
+the medial geniculate body of the metathalamus
–the lateral geniculate body of the metathalamus
–the nuclei of the hypothalamus
–the thalamus

The nuclei housed by the superior and inferior colliculi give rise to the following tract:
+the tectospinal tract
–the rubrospinal tract
–the vestibulospinal tract
–the reticulospinal tract

What parts does the thalamus comprise?
+the ventral and the dorsal thalami
–the lateral and medial compartments
–the right and left thalami
–the subthalamus and the epithalamus

What delimits the thalamus into two partts?
+the hypothalamic sulcus
–the substantia nigra
–the terminal sulcus
–the thin layer of white matter

What function do the anterior nuclei of the dorsal thalamus fulfil?
+They are related to the olfactory pathways
–They are related to the autonomic center
–It is the subcortical sensory center
–It is the subcortical visual center

What function do the pulvinar nuclei of the dorsal thalamus fulfil?
+They are related to the optic pathways
–They are related to the autonomic center
–It is the subcortical sensory center
–It is the subcortical auditory center

What function do the ventrolateral nuclei of the dorsal thalamus fulfil?
+They accept the fibers from the medial lemniscus
–They are related to the autonomic center
–They are related to the subcortical sensory center
–It is the subcortical auditory center

What is the function of the dorsal thalamus?
+a subcortical center of all types of sensitivity
–a center of extrapyramidal system
–an autonomic regulatory center
–a subcortical auditory center

What structures does the metathalamus comprise?
+the medial and lateral geniculate bodies
–the pineal gland, the habenula, the habenular commissure, the habenular trigone, and the posterior commissure
–the preoptic area, the optic chiasm, the optic tract, the tuber cinereum, the infundibulum, the neurohypophysis, and the mammillary body
–four colliculi – two superior and two inferior

What structures does the dorsal thalamus comprise?
+the anterior tubercle, the pulvinar, the hypothalamic sulcus, the interthalamic adhesion, and the stria medullaris
–the medial and the lateral geniculate bodies
–the pineal gland, the habenula, the habenular commissure, the habenular trigone, and the posterior commissure
–the preoptic area, the optic chiasm, the optic tract, the tuber cinereum, the infundibulum, the neurohypophysis, and the mammillary body

What structures does the epithalamus comprise?
+the pineal gland, the habenula, the habenular commissure, the habenular trigone, and the posterior commissure
–the anterior tubercle, the pulvinar, the hypothalamic sulcus, the interthalamic adhesion, and the stria medullaris
–the medial and the lateral geniculate bodies
–the preoptic area, the optic chiasm, the optic tract, the tuber cinereum, the infundibulum, the neurohypophysis, and the mammillary body

What structures does the hypothalamus comprise?
+the preoptic area, the optic chiasm, the optic tract, the tuber cinereum, the infundibulum, the neurohypophysis, and the mammillary body
–the pineal gland, the habenula, the habenular commissure, the habenular trigone, and the posterior commissure
–the anterior tubercle, the pulvinar, the hypothalamic sulcus, the interthalamic adhesion, and the stria medullaris
–the medial and the lateral geniculate bodies

The preoptic area, the optic chiasm, the optic tract, the tuber cinereum, the infundibulum, the neurohypophysis, and the mammillary body are structures of the following part of the brain:
+the hypothalamus
–the epithalamus
–the metathalamus
–the cerebral peduncles

The medial and the lateral geniculate bodies are structures of the following part of the brain:
+the metathalamus
–the epithalamus
–the hypothalamus
–the tectal plate

The anterior tubercle, the pulvinar, the hypothalamic sulcus, the interthalamic adhesion, and the stria medullaris are structures of the following part of the brain:
+the dorsal thalamus
–the ventral thalamus
–the epithalamus
–the hypothalamus

The pineal gland, the habenula, the habenular commissure, the habenular trigone, and the posterior commissure are the structures of the following parts of the brain:
+the epithalamus
–the hypothalamus
–the cerebral peduncles
–the dorsal thalamus

The nuclei of the lateral geniculate bodies belong to the following centers:
+the subcortical visual centers
–the subcortical sensory center
–the subcortical auditory centers
–the centers of the extrapyramidal system

The nuclei of the medial geniculate bodies belong to the following centers:
+the subcortical auditory centers
–the subcortical sensory center
–the subcortical visual centers
–the centers of the extrapyramidal system

What is the function of the pineal gland?
+internal secretion
–external secretion
–autonomic regulation
–the center of the extrapyramidal system

The pineal gland is also called as follows:
+the cerebral epiphysis
–the neurohypophysis
–the hypothalamus
–the epithalamus

Name the nuclei of the hypothalamus:
+the supra–optic and paraventricular nuclei, the nuclei of mammillary bodies, the dorsal nuclei, the numerous small nuclei of the intermediate area
–the red nucleus, the substantia nigra, the reticular nuclei of thalamus, the subthalamic nucleus
–the red nucleus, the nucleus of the oculomotor nerve, the accessory nucleus of the oculomotor nerve, the nucleus of the trochlear nerve
–the anterior nuclei, the pulvinar nuclei, the ventrolateral nuclei, the medial nuclei

What nuclei of the hypothalamus have an ability to secrete hormones?
+the supra–optic and paraventricular nuclei
–the subthalamic nucleus
–the nuclei of the mammillary bodies
–the pulvinar nuclei and the ventrolateral nuclei

The nuclei of the mammillary bodies constitute the following centers:
+the subcortical olfactory center
–the subcortical visual center
–the autonomic regulatory center
–the extrapyramidal center

What function do the supra–optic and paraventricular nuclei fulfil?
+neurosecretion
–autonomic regulation
–related to the olfactory center
–related to the extrapyramidal center

Name the function of the hypothalamus:
+It is the superior autonomic (vegetative) regulatory center
–It is the extrapyramidal center
–It is the subcortical auditory center
–It is the subcortical sensory center

Which of the following is the superior autonomic (vegetative) regulatory center?
+the hypothalamus
–the dorsal thalamus
–the substantia nigra
–the epithalamus

Which of the following is the subcortical sensory center?
+the dorsal thalamus
–the hypothalamus
–the red nucleus
–the metathalamus

The third ventricle is the cavity of the following parts of the brain:
+the diencephalon
–the midbrain
–the rhombencephalon
–the spinal cord

The third ventricle is situated between the following parts of the brain:
+the two thalami
–the cerebral peduncles
–the superior and the inferior colliculi of the tectal plate
–the cerebral prduncles and the tectal plate

Which of the following structures are the walls of the third ventricle?
+the anterior, posterior, superior, and inferior walls and two lateral walls
–the anterior, posterior, and two medial and two lateral walls
–the floor and the roof
–the medial, lateral and inferior walls

The anterior wall of the third ventricle is formed by the following structures:
+the columns of fornix, the anterior commissure and the lamina terminalis
–the posterior commissure and the habenular commissure
–the medial surfaces of the thalami
–the duplicated pia matter

The posterior wall of the third ventricle is formed by the following structures:
+the posterior commissure and the habenular commissure
–the medial surfaces of the thalami
–the duplicated pia matter
–the tectal plate with four colliculi

What forms the inferior wall of the third ventricle?
+the optic chiasm, the optic tracts, the tuber cinereum with the infundibulum, and the mammillary bodies
–the medial surfaces of the thalami
–the duplicated pia matter
–the tectal plate with four colliculi

The lateral walls of the third ventricle are formed as follows:
+the medial surfaces of the thalami
–the duplicated pia matter
–the tectal plate with four colliculi
–the optic chiasm, the optic tracts, the tuber cinereum with the infundibulum, and the mammillary bodies

The superior wall of the third ventricle is formed by the following structures:

+the duplicated pia matter
–the tectal plate with four colliculi
–the optic chiasm, the optic tracts, the tuber cinereum with the infundibulum, and the mammillary bodies
–the posterior commissure and the habenular commissure

What is the function of the choroid plexus of the third ventricle?
+it produces the cerebrospinal fluid
–it produces the endolymph
–it serves for drainage of the cerebrospinal fluid
– it produces the perilymph

Which wall of the third ventricle is the duplication of the pia matter?
+the superior wall
–the inferior wall
–the anterior wall
–the posterior wall

Which wall of the third ventricle is formed by the columns of fornix, the anterior commissure and the lamina terminalis?
+the anterior wall
–the superior wall
–the inferior wall
–the posterior wall

Name the wall of the third ventricle wich is made of the posterior commissure and the habenular commissure:
+the posterior wall
–the medial wall
–the lateral wall
–the inferior wall

The optic chiasm, the optic tracts, the tuber cinereum with the infundibulum and the mammilary bodies are formed by the following structures:
+the inferior wall of the 3rd ventricle
–the superior wall of the 3rd ventricle
–the posterior wall of the 3rd ventricle
–the medial wall of the 3rd ventricle

The medial surfaces of the thalami is formed by the following structures:
+the lateral walls of the 3rd ventricle
–the anterior and the posterior walls of the 3rd ventricle
–the superior and the inferior walls of the 4th ventricle
–the medial walls of the 3rd ventricle

The cavity of the third ventricle contains the following structures:
+the cerebrospinal fluid
–the fat and the internal vertebral venous plexus
–the endolymph
–the perilymph

Through the interventricular foramina (foramina of Monro,) the third ventricle is connected to the following structure:
+the lateral ventricles
–the fourth ventricle
–the cerebral aqueduct (aqueduct of Sylvius)
–the subarachnoid space

The cerebral aqueduct connects the third ventricle with the following structure:
+the fourth ventricle
–the lateral ventricles
–the subarachnoid space
–the subdural space

Where is the pineal gland situated?
+between the superior colliculi of the tectal plate
–between the inferior colliculi of the tectal plate
–at the region of the tuber cinereum
–at the anterior hypothalamic area

The habenula connects the pineal gland to the following structures:
+the dorsal thalamus
–the ventral thalamus
–the tuber cinereum
–the posterior perforated substance

The posterior (epithalamic) commissure connects the following structures:
+the pulvinars and the colliculi of the tectal plate
–the ventral and the dorsal thalami
–the tuber cinereum and the neurohypophysis
–two habenulae anterior to the pineal gland

What is the optic chiasm formed by?
+ the optic nerves
– the rubrospinal tracts
– the lateral lemnisci
– the lateral geniculate bodies

What is the optic tract formed by?
+ the fibers of the optic chiasm
– the fibers of the rubrospinal tracts
– the fibers of the accessory nucleus of the oculomotor nerves
– the fibers of the optic nerve

The tuber cinereum is situated as follows:
+posterior to the optic chiasm, it is continuous with the infundibulum
–anterior to the optic chiasm, it is continuous with the lamina terminalis
–within the sella turcica
–between the superior colliculi of the tectal plate

What does the infundibulum connect?
+the tuber cinereum with the neurohypophysis
–the ventral and the dorsal thalami
–the two thalami
–the superior colliculi of the tectal plate

Where is the neurohypophysis situated?
+within the hypophysial fossa
–between the superior colliculi of the tectal plate
–between the optic chiasm and the lamina terminalis
–within the third ventricle

Corpus callosum is formed by the following conductive pathways:
+commissural
–ascending
–descending
–associative

The neuron fibers in the genu of the corpus callosum connect the following structures:
+the frontal cortex between the left and right cerebral hemispheres
– the insula cortex
–the occipital lobes of the cerebral cortex
–crura of the fornix

The frontal lobes of both hemispheres are connected by neuron fibers which pass through the following structures:
+the genu of corpus callosum
–the splenium of the corpus callosum
–the crura of the fornix
–the interventricular foramen

The fibers of the corpus callosum in the splenium connect the following structures:
+the occipital lobes of the left and right cerebral hemispheres
– the frontal lobes of the left and right cerebral hemispheres
–the brain and the spinal cord
–the centers of the same hemisphere

The cortex of occipital lobes of hemispheres is connected by fibers which pass through:
+the Splenium of corpus callosum
–the Genu of corpus callosum
–the Commissure of fornix
–the Body of fornix

The body of the fornix is continued downward in front by the following structure:
+the column of the fornix
–the crus of the fornix
–the anterior cerebral commissure
–the fmbria hippocampi

What structure ends in the mammillary body?
+the column of the fornix
–the crus of the fornix
–the genu of the corpus callosum
–the tail of the caudate nucleus

The fimbria hippocampi are formed by the following structures:
+the crura of the fornix
–the tail of the caudate nucleus
–the lamina of the septum pellucidum
–the column of the fornix

Where is the central part of the lateral ventricle located?
+in the parietal lobe
–in the occipital lobe
–in the frontal lobe
–in the insular

Where is the anterior horn of the lateral ventricle located?
+in the frontal lobe
–in the occipital lobe
–in the parietal lobe
–in the temporal lobe

Where is the posterior horn of the lateral ventricle located?
+in the occipital lobe
–in the temporal lobe
–in the insular
–in the parietal lobe

Where is the inferior horn of the lateral ventricle located?
+in the temporal lobe
–in the occipital lobe
–in the frontal lobe
–in the parietal lobe

The following structure is found in the temporal lobe of the brain:
+ the inferior horn of the lateral ventricle
– the posterior horn of the lateral ventricle
– the anterior horn of the lateral ventricle
– the central part of the lateral ventricle

The following structure is found in the parietal lobe of the brain:
+ the central part of the lateral ventricle
– the posterior horn of the lateral ventricle
–the anterior horn of the lateral ventricle
–the inferior horn of the lateral ventricle

The following structure is found in the occipital lobe of the brain:
+the posterior horn of the lateral ventricle
–the anterior horn of the lateral ventricle
–the inferior horn of the lateral ventricle
–the central part of the lateral ventricle

The following structure is found in the frontal lobe of the brain:
+the anterior horn of the lateral ventricle
–the inferior horn of the lateral ventricle
–the central part of the lateral ventricle
–the posterior horn of the lateral ventricle

The body of the caudate nucleus and the dorsal surface of the thalamus form the following structures:
+the floor of the central part of the lateral ventricle
–the medial wall of the anterior horn
–the superior wall of the posterior horn
–the inferior wall of the inferior horn

The superior wall of the central part of the lateral ventricle is formed by the following structures:
+fibers of corpus callosum
–head of caudate nucleus
–septum pellucidum
–dorsal surface of the thalamus

The medial wall of the central part of the lateral ventricle is formed by the following structures:
+body of the fornix
–septum pellucidum
–hippocampus
–white matter of the brain

The medial wall of the anterior horn of the lateral ventricle is formed by the following structures:
+septum pellucidum
–body of the fornix
–hippocampus
–column of the fornix

The lateral wall of the anterior horn of the lateral ventricle is formed by the following structures:
+head of the caudate nucleus
–body of the fornix
–white matter of the cerebral hemisphere
–tail of the caudate nucleus

The anterior, superior and inferior walls of the anterior horn of the lateral ventricle are formed by the following structures:
+fibers of the corpus callosum
–body of the caudate nucleus
–septum pellucidum
–hippocampus

The white matter of the cerebral hemisphere and the tail of the caudate nucleus form the following structure:
–superior wall of the inferior horn in the lateral ventricle

–medial wall of the central part in the lateral ventricle
–medial wall of the anterior horn in the lateral ventricle
–superior wall of the central part in the lateral ventricle

Where is the collateral eminence situated?
+on the inferior wall of the inferior horn in the lateral ventricle
–on the medial wall of the posterior horn in the lateral ventricle
–on the lateral wall of the posterior horn in the lateral ventricle
–on the inferior wall of the anterior horn in the lateral ventricle

The medial wall of the inferior horn in the lateral ventricle is formed by the following structure:
+hippocampus
–septum pellucidum
–body of the fornix
–head of the caudate nucleus

The calcarine spur islocated in the lateral ventricle on the following wall:
+medial wall of the posterior horn
–medial wall of the inferior horn
–superior wall of the inferior horn
–superior wall of the posterior horn
The collateral trigone is located in the posterior horn of the lateral ventricle on the following wall:
+inferior wall
–medial wall
–superior wall
–lateral wall

Choroid plexus of the lateral ventricle is found as follows:
+in the central part and in the inferior horn
–in all parts of the lateral ventricle
–in the posterior and inferior horns
–in the central part and in the posterior horn

Relief of the Cerebral Cortex. Localisation of Function in the Cerebral Cortex

The superior margin of the cerebral hemisphere is found between the following surfaces:
+medial and superolateral
–medial and inferior
–inferior and superolateral
–superior and medial

The following region is located between the lateral and central sulci of the cerebral hemisphere:
+frontal lobe
–frontal pole
–parietal lobe
–temporal lobe

Precentral gyrus is located in the following lobe of the cerebral hemisphere:
+frontal
–parietal
–temporal
–insula

What sulcus is called "Rolando's fissure"?
+the central sulcus
–the lateral sulcus
–the parietooccipital sulcus
–the hippocampal sulcus

What sulcus is called "Sylvian sulcus"?
+the lateral sulcus
–the rhinal sulcus
–the cingulated sulcus
–the central sulcus

The following region is located between the central and parietooccipital sulci:
+the parietal lobe
–the frontal lobe
–the occipital lobe
–the insula

Where is the insula situated?
+deep within the lateral sulcus
–within the central sulcus
–on the inferior surface of the cerebral hemisphere
–within the longitudinal cerebral fissure

Where is the precentral gyrus located?
+in the frontal lobe
–in the temporal lobe
–in the occipital lobe
–in the parietal lobe

What area is located between the central and precentral sulci?
+the precentral gyrus
–the postcentral gyrus
–the angular gyrus
–the triangular gyrus

Ascending and anterior rami are branches of the following sulcus:
+the lateral sulcus
–the central sulcus
–the inferior frontal sulcus
–the superior frontal sulcus

A part of the inferior frontal gyrus that lies between the inferior part of precentral sulcus and ascending ramus is called as follows:
+the opercular part
–the triangular part
–the uncus
–the dentate sulcus

A part that lies between the ascending and anterior rami is called as follows:
+the triangular part
–the orbital part
–the angular gyrus
–the fornicate gyrus

Where is the postcentral gyrus located?
+in the parietal lobe
–in the frontal lobe
–in the insular
–in the temporal part

What part of the cortex is located between the central and postcentral sulci?
+the postcentral gyrus
–the superior parietal lobule
–the supramarginal gyrus
–the opercular part

The following structure is found on the medial surface of the cerebral hemisphere between the precentral and postcentral sulci:
+the paracentral lobule
–the angular gyrus
–the triangular part
–the cuneus

Where are the angular and supramarginal gyri located?
+in the inferior parietal lobule
–in the inferior frontal gyrus
–in the superior temporal gyrus
–in the insula

The supramarginal gyrus closes the following sulcus:
+lateral
–inferior temporal
–central
–cingulate

What structure arches over the posterior end of the lateral sulcus?
+the supramarginal gyrus
–the uncus
–the paracentral lobule
–the angular gyrus

The angular gyrus closes the following sulcus:
+superior temporal
–inferior temporal
–central
–rhinal

The posterior end of the superior temporal sulcus is closed by the following structure:
+the angular gyrus
–the paracentral lobule
–the lingual gyrus
–the uncus

What sulcus is located between the superior and inferior parietal lobules?
+intraparietal
–cingulate
–calcarine
–postcentral

The insula is separated from the neighboring lobes by:
+the circular sulcus
–the long sulcus of insular
–the central sulcus of insula
–the lateral sulcus

The following gyrus is located between the lateral and superior temporal sulci:
+the superior temporal gyrus

–the middle temporal gyrus
–the lateral occipitotemporal gyrus
–the angular gyrus

Where are transverse temporal (Heschl's) gyri located?
+on the superior temporal gyrus
–on the inferior temporal gyrus
–on the middle temporal gyrus
–on the cingulated gyrus

The sulcus of corpus callosum is continued by the following sulcus:
+the hippocampal sulcus
–the cingulate sulcus
–the calcarine sulcus
–the rhinal sulcus

There is the following structure between the sulcus of corpus callosum and cingulated sulcus:
+the cingylate gyrus
–the cuneus
–the lingual gyrus
–the parahippocampal gyrus

The cingulate gyrus, the isthmus of cingulated gyrus and the parahippocampal gyrus form the following structure:
+the fornicate gyrus
–the paracentral lobule
–the dentate gyrus
–the precuneus

There is the following structure between the parietooccipital and calcarine sulci:
+the cuneus
–the precuneus
–the lingual gyrus
–the paracentral lobule

The following structure is located between the marginal part of the cingulated sulcus and the parietooccipital sulcus:
+the precuneus
–the cuneus
–the cingulate gyrus
–the lingual gyrus

Where is the dentate gyrus located?
+within the hippocampal sulcus
–within the lateral sulcus
–within the circular sulcus of insula
–within the cingulated gyrus

What is located within the hippocampal sulcus located?
+the dentate gyrus
–the lingual gyrus
–the Heshl's gyri
–the uncus

The following structure is located between the calcarine and collateral sulci:
+the lingual gyrus
–the precuneus
–the parahippocampal gyrus
–the uncus

The following structure is located between the longitudinal cerebral fissure and the olfactory sulcus:
+the straight gyrus
–the orbital gyri
–the cingulate gyrus
–the parahippocampal gyrus

The parahippocampal gyrus terminates as the the following structure:
+the uncus
–the cuneus
–the lingual gyrus
–the angular gyrus

The following structure is located between the medial and lateral occipitotemporal gyri:
+the occipitotemporal sulcus
–the olfactory sulcus
–the hippocampal sulcus
–the cingulate sulcus

The following structure is located between the collateral and occipitotemporal sulci:
+the medial occipitotemporal gyrus
–the parahippocampal gyrus
–the lingual gyrus
–the fornicate gyrus

The following structure is located between the medial occipitotemporal and parahippocampal gyri:
+the collateral sulcus
–the cingulate sulcus
–the olfactory sulcus

–the calcarine sulcus

Where is the center of the skin analyzer located?
+the postcentral gyrus
–the inferior parietal lobule
–the uncus
–the posterior part of middle frontal gyrus

Where is the center of the proprioceptive sensitivity located?
+the postcentral gyrus
–the precentral gyrus and paracentral lobule
–the superior parietal lobule
–the posterior part of inferior frontal gyrus

The postcentral gyrus of each hemisphere is associated with the following part of the body:
+the opposite half of the body
–the half of the body of the same side
–the opposite upper limb
–the inferior limb of the same side

Where is the center of the motor analyzer located?
+precentral gyrus and paracentral lobule
–postcentral gyrus
–supramarginal gyrus
–uncus

The gigantic pyramidal cells (cells of Betz) are situated in the following structure:
+the fifth layer of the cortex
–the sixth layer of the cortex
–the third layer of the cortex
–the second layer of the cortex

The upper part of the precentral gyrus and the paracentral lobule are associated with muscles of the following part of the body:
+lower limbs
–upper limbs
–neck
–head

Where is the center of the motor analyser related to the concord turning of the head and eyes in the opposite direction located?
+in the middle frontal gyrus
–in the posterior part of inferior frontal gyrus
–in the Heschl's gyri
–in the superior parietal lobule

The center of motor analyser, by means of which the habitual, purposeful, combined movements are synthesized (the center of praxia), is located as follows:
+in the supramarginal gyrus
–in the angular gyrus
–in Heschl's gyri
–in the superior parietal lobule

The affection of the cortical center of motor analyser, by means of which habitual purposeful combined movements are synthesized (the center of praxia), is called as follows:
+apraxia
–motor aphasia
–agraphia
–sensory aphasia

Where is the center of stereognosis or recognition of objects by touch located?
+the superior parietal lobule
–the middle frontal gyrus
–the supramarginal gyrus
–the superior temporal gyrus

Where is the center of the auditory analyzer located?
+Heschl's gyri
–the uncus
–the supramarginal gyrus
–the inferior frontal gyrus

The injury of the center of the auditory analyzer results in the following disoder:
+cortical deafness
–blindness
–sensory aphasia
–agraphia

Where is the center of the visual analyzer located?
+on the margins of the calcarine sulcus
–uncus and hippocampus
–middle frontal gyrus
–Heschl's gyri

Where is the center of the olfactory analyzer located?
+the uncus

–the angular gyrus
–Heschl's gyri
–the inferior frontal gyrus

Where is the center of the taste analyzer located?
+the uncus
–Heschl's gyri
–the supramarginal gyrus
–the superior parietal lobule

Where is the motor analyzer of written speech located?
+the posterior part of the middle frontal gyrus
–the posterior part of inferior frontal gyrus
–the superior parietal lobule
–the angular gyrus

Where is the auditory analyzer of spoken speech located?
+the superior temporal gyrus
–the inferior frontal gyrus
–the cortex of hippocamp
–the inferior parietal lobule

Where is the motor analyzer of speech articulation located?
+the posterior part of inferior frontal gyrus (opercular part)
–the posterior part of the middle frontal gyrus
–the precentral gyrus
–the supramarginal gyrus

Broca's area is the center of the following cortical analyzer:
+motor analyzer of speech articulation
–motor analyzer of written speech
–auditory analyzer of spoken speech
–visual analyzer of written speech

Where is the visual analyzer of written speech located?
+the angular gyrus
–the supramarginal gyrus
–the middle frontal gyrus
–the superior parietal lobule

The damage to the motor analyzer of written speech results in the following disoder:
+agraphia
–apraxia
–motor aphasia
–sensory aphasia

The affection of the area of the speech auditory analyzer results in the following disoder:
+sensory aphasia
–agraphia
–apraxia
–alexia

The injury of the visual analyzer of the written speech results in the following disoder:
+alexia
–sensory aphasia
–agraphia
–apraxia

The injury of the motor analyzer of speech articulation results in the following disoder:
+motor aphasia
–sensory aphasia
–alexia
–agraphia

Wernicke's center is the area of the following cortical analyzer:
+auditory analyzer of spoken speech
–motor analyzer of speech articulation
–motor analyzer of written speech
–visual analyzer of written speech

Association, commissural, and projection pathways

The following nerve fibers connect different areas of the same hemisphere:
+association fibers
–commissural fibers
–efferent fibers
–afferent fibers

The following nerve fibers interconnect neighboring gyri of the same hemisphere:
+short association fibers
–long association fibers
–commissural fibers
–projection fibers

The following nerve fibers interconnect different lobes of the same hemisphere:
+long association fibers
–short association fibers

–commissural fibers
–projection fibers

The following fasciculus connects the cortex of the frontal lobe with parietal and occipital lobes:
+superior longitudinal fasciculus
–inferior longitudinal fasciculus
–uncinate fasciculus
–frontal forceps (minor)

The following fasciculus connects the temporal and occipital lobes:
+inferior longitudinal fasciculus
–superior longitudinal fasciculus
–uncinate fasciculus
–frontal forceps (minor)

Fasciculus which connects the frontal, parietal and temporal lobes is called as follows:
+uncinate fasciculus
–superior longitudinal fasciculus
–inferior longitudinal fasciculus
–frontal forceps (minor)

The fibers of the genu and rostrum of the corpus callosum connect the following lobes:
+frontal
–parietal
–occipital
–insular

Frontal forceps (minor) is formed by fibers of the following structures of the brain:
+genu and rostrum of corpus callosum
–splenium of corpus callosum
–anterior cerebral commissure
–posterior cerebral commissure

The fibers in the trunk of the corpus callosum connect the following lobes:
+parietal and temporal
–frontal
–occipital
–insula

The fibers, which connect the cortex of the occipital lobes pass through the following structures:
+splenium of corpus callosum
–trunk of corpus callosum
–genu of corpus callosum
–posterior cerebral commissure

The occipital forceps (major) is formed by the fibers of the following structures:
+splenium of corpus callosum
–rostrum of the corpus callosum
–commissure of fornix
–epithalamical commissure

Name the pathways which transmit the impulses from the skin receptors and sense organs:
+exteroceptive
–proprioceptive
–interoceptive
–pyramidal

Name the pathways which transmit the signals from the locomotor apparatus:
+proprioceptive
–exteroceptive
–interoceptive
–extrapyramidal

Name the pathways which transmit the impulses from the internal organs and vessels:
+interoceptive
–proprioceptive
–exteroceptive
–pyramidal

Name the pathways which transmit the impulses from the cortex of the brain to the nuclei of the brainstem and motor nuclei of the spinal cord:
+efferent
–exteroceptive
–interoceptive
–proprioceptive

What pathways transmit nerve impulses for coordination of targeted voluntary movements?
+pyramidal
–extrapyramidal
–exteroceptive
–interoceptive

What pathways transmit nerve impulses from subcortical centers to motor nuclei of the cranial and spinal nerves?
+extrapyramidal
–pyramidal
–interoceptive
–proprioceptive

What name is given to the pathways that carry information about pain and temperature sensitivity?
+lateral spinothalamic tract
–anterior spinothalamic tract
–anterior spinocerebellar tract
–bulbothalamic tract

How many neurons has the pathway that carries pain and temperature sensation?
+3
–2
–5
–6

Where is the first neuron of the lateral spinothalamic tract located?
+in the spinal ganglion
–in proper nucleus of the spinal cord
–in gracile and cuneate nuclei
–in the cortex of the postcentral gyrus

Where are the receptors of the first–order neuron of the lateral spinothalamic tract located?
+in the skin and mucosa
–in the muscles, tendons, ligaments, and capsules of the joints
–In the retina
–In the precentral gyrus

Where is the second neuron of the lateral spinothalamic tract located?
+in the proper nucleus of the spinal cord
–in the spinal ganglion
–in the anterior horn of the spinal cord
–in the lateral intermediate nucleus of the spinal cord

Where does the axon of the third–order neuron of the lateral spinothalamic tract terminate?
+at the cortex of the postcentral gyrus
–at the cortex of the precentral gyrus
–at the thalamus
–at the cortex of the vermis

The central process of the first–order neuron of the lateral spinothalamic tract runs to the following structure:
+the posterior horn of the spinal cord
– skin receptors and mucosa
–the thalamus
–the postcentral gyrus

The axon of the second–order neuron of the lateral spinothalamic tract runs to the following structure:
+lateral funiculus of the opposite side
–lateral funiculus of the same side
–spinal ganglion
–cortex of the vermis

Where does the axon of the second–order neuron of the lateral spinothalamic tract teerminate?
+at the nuclei of the thalamus
–within the cortex of the postcentral gyrus
–at the cortex of the vermis
–at the gracile and cuneate nuclei

Where is the thrid–order neuron of the lateral spinothalamic tract located?
+in the dorsolateral nuclei of the thalamus
–in the cortex of the postcentral gyrus
–in the gracile and cuneate nuclei
–in the cortex of the vermis

The axons of the thrid–order neuron of the lateral spinothalamic tract pass through the following structures:
+posterior limb of the internal capsule
–anterior limb of the internal capsule
–anterior cerebellar peduncle
–posterior cerebellar peduncle

What is the name of the pathways that carry information about tactile sensitivity?
+anterior spinothalamic tract
–lateral spinothalamic tract
–bulbothalamic tract
–anterior spinocerebellar tract

Where are the receptors of the first–order neuron of the anterior spinothalamic tract located?

+in the skin
–in the muscles and tendons
–in the capsule of joints
–in the postcentral gyrus

Where does the axon of the thrid–order neuron of the pathways for tactile sensitivity terminate?
+at the postcentral gyrus
–at the precentral gyrus
–at the cortex of the vermis
–at the cortex of the cerebellar hemisphere

The body of the first–order neuron of the anterior spinothalamic tract is located as follows:
+in the spinal ganglion
–in the proper nucleus of the spinal cord
–in the thoracic column
–in the gracile and cuneate nuclei

Where is the second–order neuron of the pathways that carry information about the tactile sensitivity located?
+in the gelatinous substance
–in the proper nucleus of the spinal cord
–in the thoracic nucleus of the spinal cord
–in the spinal ganglion

The axons of the second–order neuron of the pathways that carry information about the tactile sensitivity run to the following structure:
+the anterior funiculus of the spinal cord of the opposite side
–the lateral funiculus of the spinal cord of the same side
–the posterior funiculus of the same side
–the spinal ganglion

Where does the axon of the second–order neuron of the pathways that carry information about the tactile sensitivity terminate?
+at the thalamus
–at the spinal ganglion
–at the thoracic nucleus of the spinal cord
–at the postcentral gyrus

The body of the thrid–order neuron of the anterior spinothalamic tract is located as follows:
+in the dorsolateral nuclei of the thalamus
–in the cortex of the vermis
–in the gracile and cuneate nuclei
–in the postcentral gyrus

The axons of the thrid–order neuron of the anterior spinothalamic tract pass through the following structurres:
+posterior limb of the internal capsule
–anterior limb of the internal capsule
–inferior cerebellar peduncle
–superior cerebellar peduncle

What is the name of the proprioceptive pathway of the cortical direction?
+bulbothalamic tract
–posterior spinocerebellar tract
–anterior spinocerebellar tract
–anterior spinothalamic tract

The receptors of the first–order neuron of the proprioceptive pathway of the cortical direction are located as follows:
+in the muscles, tendons, ligaments, and capsules of the joints
–in the skin and mucosa
–in the spinal ganglia
–in the thoracic nuclei

The body of the first–order neuron of the proprioceptive pathway of the cortical direction is located as follows:
+in the spinal ganglion
–in the postcentral gyrus
–in the proper nuclei of spinal cord
–in the gracile and cuneate nuclei

The axon of the first–order neuron of the proprioceptive pathway of the cortical direction runs to the following structure:
+posterior funiculus of the spinal cord of the same side
–lateral funiculus of the spinal cord of the opposite side
–anterior funiculus of the spinal cord of the same side
–posterior funiculus of the spinal cord of the opposite side

Where is the second–order neuron of the proprioceptive pathway of the cortical direction located?

+in the gracile and cuneate nuclei
–in the thoracic nucleus
–in the spongious zone
–in the intermediomedial nucleus

The gracile fasciculus (Goll's tract) carries the impulses from the following structures:
+lower limbs and lower body
–upper limbs
–upper thoracic and cervical parts of the body
–head

The cuneate fasciculus (Burdach's tract) carries impulses from the following sttructures:
+upper body, upper limbs and neck
–lower limbs
–lower body
–head

What is the initial part of the medial lemniscus?
+internal arcuate fibers
–dorsal external arcuate fibers
–ventral external arcuate fibers
–fibers of the trapezoid body

The external arcuate fibers run to the following structures:
+cortex of vermis
–thalamus
–postcentral gyrus
–precentral gyrus

Where do the fibers of the medial lemniscus terminate?
+at the dorsolateral nuclei of the thalamus
–at the cortex of the vermis
–at the postcentral gyrus
–at the gracile and cuneate nuclei

The bodies of the thrid–order neurons of the proprioceptive pathway of the cortical direction are located as follows:
+in the dorsolateral nuclei of the thalamus
–in the cortex of the vermis
–in the postcentral gyrus
–in the gracile and cuneate nuclei

What is the name of the posterior spinocerebellar tract?
+Flechsig's tract
–Gower's tract
–Goll's tract
–Burdach's tract

The bodies of the first–order neurons of the posterior spinocerebellar tract are located as follows:
+in the spinal ganglion
–in the cortex of the vermis
–in the postcentral gyrus
–in the thoracic nucleus

Where are the bodies of the second–order neurons of the posterior spinocerebellar tract located?
+in the thoracic nucleus
–in the proper nucleus of spinal cord
–in the thalamus
–in the postcentral gyrus

The axon of the second–order neuron of the posterior spinocerebellar tract runs to the following structure:
+lateral funiculus of the same side
–lateral funiculus of the opposite side
–anterior funiculus of the same side
–posterior funiculus of the opposite side

Where does Flechsig's tract end?
+in the cortex of the vermis
–in the postcentral gyrus
–in the dorsal nucleus of the thalamus
–in the cortex of the cerebellar hemisphere

What is the name of the anterior spinocerebellar tract?
+Gower's tract
–Flechsig's tract
–Goll's tract
–Burdach's tract

The bodies of the first–order neurons of the anterior spinocerebellar tract are located as follows:
+in the spinal ganglion
–in the medial intermediate nucleus
–in the postcentral gyrus
–in the thoracic nucleus

Where are the bodies of the second–order neurons of the anterior spinocerebellar tract located?

+in the intermediomedial nucleus
–in the thoracic nucleus
–in the proper nucleus of the spinal cord
–in the thalamus

The axon of the second–order neuron of the anterior spinocerebellar tract runs to the following structures:
+lateral funiculus of the opposite side
–lateral funiculus of the same side
–anterior funiculus of the same side
–posterior funiculus of the opposite side

Where does Gower's tract end?
+in the cortex of the vermis of the same side
–in the postcentral gyrus
–in the dorsal nucleus of the thalamus
–in the cortex of the vermis of the opposite side

The pyramidal tracts start from the cortex of the following structure:
+precentral gyrus
–postcentral gyrus
–cerebellar vermis
–inferior frontal gyrus

The part of the pyramidal tracts between the precentral gyrus and the motor nuclei of the cranial nerves is called as follows:
+corticonuclear tract
–anterior corticospinal tract
–lateral corticospinal tract
–reticulospinal tract

The pyramidal tract, which ends in the motor nuclei of the cranial nerve, starts from the following structure:
+precentral gyrus
–postcentral gyrus
–red nucleus
–thalamus

The corticonuclear tract originates from the cortex of the following structure:
+inferior third of the precentral gyrus
–upper third of the precentral gyrus
–postcentral gyrus
–cortex of the cerebellar vermis

The corticonuclear tract passes through the following part of the internal capsule:
+genu
–anterior limb
–inferior third of the posterior limb
–superior third of the posterior limb

The following tract passes through the genu of the internal capsule:
+corticonuclear tract
–anterior spinothalamic tract
–anterior corticonuclear tract
–rubrospinal tract

Where does the corticonuclear tract end in the midbrain?
+on the motor nuclei of CNIII and IV
–on the motor nuclei of CNXI and XII
–on the motor nuclei of CNV, VI and VII
–on the motor nuclei of CNIX, X and XI

Where does the corticonuclear tract end in the pons?
+on the motor nuclei of CNV–VII
–on the motor nuclei of CNIII and IV
–on the motor nuclei of CNV–XII
–on the motor nuclei of CNIX–XII

Where does the corticonuclear tract end in the medulla oblongata?
+on the motor nuclei of CNIX–XII
–on the motor nuclei of CNIII and IV
–on the motor nuclei of CNIII–V
–on the motor nuclei of CNX

Processes of the motor cells originate from the nuclei as a component of the corresponding cranial nerves and reach the following muscles:
+skeletal muscles of the head and neck
–skeletal muscles of the upper limb
–skeletal muscles of the trunk
–skeletal muscles of the lower limb

Where are the first–order neurons of the corticonuclear tract located?
+in the gigantic pyramidal cells (cells of Betz)
–in the motor nuclei of the cranial nerves
–in the cortex of the postcentral gyrus
–in the nuclei of the anterior horn of the spinal cord

Where are the second–order neurons of the corticonuclear tract located?

+in the motor nuclei of the cranial nerves
–in the nuclei of the anterior horn of the spinal cord
–in the gigantic pyramidal cells (cells of Betz)
–in the spinal ganglion

Where are the first–order neurons of the lateral corticospinal tract located?
+in the upper 2/3 of the precentral gyrus
–in the inferior 1/3 of the precentral gyrus
–in the postcentral gyrus
–in the spinal ganglion

Where are the first–order neurons of the lateral corticospinal tract located?
+in the gigantic pyramidal cells (cells of Betz)
–in the motor nuclear of the cranial nerves
–in the cortex of the postcentral gyrus
–in the nuclei of anterior horn of the spinal cord

The lateral corticospinal tract passes through the following part of the internal capsule:
+anterior part of the posterior limb
–genu
–anterior limb
–posterior part of the posterior limb

Where does the lateral corticospinal tract decussate?
+in the inferior part of the medulla oblongata
–in the upper part of the pons
–in the midbrain
–in the spinal cord

The decussation of the pyramids is formed by the following tract:
+the lateral corticospinal tract
–the anterior corticospinal tract
–the rubrospinal tract
–the tectospinal tract

Where are the second–order neurons of the lateral corticospinal tract located?
+in the nuclei of the anterior horns of the spinal cord
–in the gracile and cuneate nuclei
–in the motor nuclei of cranial nerves
–in the gigantic pyramidal cells

Where are the first–order neurons of the anterior corticospinal tract located?
+in the upper 2/3 of the precentral gyrus
–in inferior 1/3 of the precentral gyrus
–in the postcentral gyrus
–in the spinal ganglion

Where are the first–order neurons of the anterior corticospinal tract located?
+in the gigantic pyramidal cells (cells of Betz)
–in the motor nuclei of the cranial nerves
–in the cortex of the postcentral gyrus
–in the nuclei of the anterior horn of the spinal nerves

The anterior corticospinal tract passes through the following part of the internal capsule:
+anterior part of the posterior limb
–genu
–anterior limb
–posterior part of the posterior limb

Where does the anterior corticospinal tract decussate?
+in the spinal cord
–in the inferior part of the medulla oblongata
–in the upper part of the pons
–in the cerebral peduncle

Where are the second–order neurons of the anterior corticospinal tract located?
+in the nuclei of the anterior horns of the spinal cord
–in the red (ruber) nucleus
–in the motor nuclei of the cranial nerves
–in the gigantic pyramidal cells

Where does the rubrospinal tract originate?
+in the red nucleus
–in the nuclei of colliculi
–in the cells of Betz
–in the motor nuclei of cranial nerves

The Forel's decussation is formed by the following tracts:
+rubrospinal tracts
–tectospinal tracts
–lateral corticospinal tracts
–reticulospinal tracts

The rubrospinal tract runs to the opposite side and forms the following structure:
+Forel's decussation

–Monakov's decussation
–pyramidal decussation
–medial lemniscus

Axons of the nucleus ruber (red nucleus) synapse in the following structures:
+motor nuclei of spinal cord
–cells of Betz
–motor nuclei of the cranial nerves
–proper nuclei of the pons

The vestibulospinal tract originates in the following structure:
+Deiters' nucleus
–nucleus ruber
–motor nuclei of spinal cord
–cells of Betz

Which tract originates in the lateral vestibular nucleus (Deiters' nucleus)?
+vestibulospinal tract
–reticulospinal tract
–tectospinal tract
–corticopontocerebellar tract

Axons of the nucleus of the vestibulospinal tract synapse in the following structure:
+motor nuclei of the spinal cord
–motor nuclei of the cranial nerves
–proper nuclei of the pons
–gigantic pyramidal cells (cells of Betz)

The following descending tract originates from the subcortical visual and auditory centers:
+tectospinal tract
–reticulospinal tract
–corticopontocerebellar tract
–vestibulospinal tract

The following descending tract originates from the nuclei of the reticular formation:
+reticulospinal tract
–tectospinal tract
–vestibulospinal tract
–rubrospinal tract

Where are the second–order neurons of the tectospinal tract located?
+in the anterior horn of the spinal cord
–in the spinal ganglion
–in the posterior horn of the spinal cord
–in the reticular formation

Where are the second–order neurons of the reticulospinal tract located?
+in the motor nuclei of the spinal cord
–in the proper nuclei of the pons
–in the motor nuclei of the cranial nerves
–in the reticular formation

Where are the first–order neurons of the corticopontocerbellar tract located?
+in the cortex of the frontal, parietal, temporal and occipital lobes
–in the cortex of precentral gyrus
–in the proper nuclei of pons
–in the cortex of cerebellar hemispheres

The fibers of the corticopontocerebellar tract, which originate from the cortex of the frontal lobe, pass though the following part of the internal capsule:
+the anterior limb
–the genu
–the anterior part of the posterior limb
–the posterior part of the posterior limb

The fibers of the corticopontocerebellar tract, which originate from the cortex of the parietal, temporal and occipital lobes pass through the following part of the internal capsule:
+the posterior part of the posterior limb
–the genu
–the anterior part of the posterior limb
–the anterior limb

The axons of the first–order neurons of the corticopontocerebellar tract synapse in the following structures:
+the proper nuclei of the pons
–the motor nuclei of the spinal cord
–cells of the cortex of the cerebellar hemispheres
–cells of the cerebellar vermis

Where are the second–order neurons of the corticopontocerebellar tract located?
+in the proper nuclei of the pons
–in the motor nuclei of the spinal cord
–in the cells of the cortex of the cerebellar hemispheres

–in the cells of the cortex of the cerebral hemispheres

The axons of the proper nuclei of the pons run to cerebellar hemisphere through the following structures:
+the middle cerebellar peduncle
–the anterior limb of the internal capsule
–the anterior grey commissure of the spinal cord
–the medial part of the base of the cerebral peduncle

Meninges of the Brain and the Spinal Cord

The epidural space is located between the following structures:
+periosteum of the vertebrae and dura mater spinalis
–dura mater spinalis and pia mater spinalis
–dura mater spinalis and arachnoid mater spinalis
–arachnoid mater spinalis and pia mater spinalis

The subdural space is located between the following structures:
+dura mater spinalis and arachnoid mater spinalis
–periosteum of the vertebrae and dura mater spinalis
–dura mater spinalis and pia mater spinalis
–arachnoid mater spinalis and pia mater spinalis

The subarachnoid space is located between the following structures:
+arachnoid mater spinalis and pia mater spinalis
–dura mater spinalis and arachnoid mater spinalis
–dura mater spinalis and pia mater spinalis
–pia mater spinalis and spinal cord

The subarachnoid space is filled with the following structure:
+cerebrospinal fluid
–adipose tissue
–venous plexuses
–connective fibers

The epidural space houses the following structures:
+vertebral venous plexuses and adipose tissue
–cerebrospinal fluid
–connective fibers
–only adipose tissue

The meninges of the spinal cord are continues with the cranial meninges at the following level:
+foramen magnum
–Turkish saddle
–jugular foramen
–clivus

What mater closely lines the cranial cavity?
+the cranial dura mater
–the cranial arachnoid mater
–the cranial pia mater
–the epidural space

What mater invests the brain?
+cranial pia mater
– cranial dura mater
–subarachnoid space
–subdural space
The cranial arachniod mater lies between the following structures:
+cranial dura mater and the cranial pia mater
–bones of the skull and cranial dura mater
–cranial pia mater and the brain
–bones of the skull and the cranial pia mater

The cranial dura mater fixes firmly to the following structures:
+bones of the cranial base
–pia mater
–bones of the vault
–arachnoid mater

The cranial dura mater splits to form the following structures:
+dural venous sinuses
–processes of the dura mater
–ligaments of the dura mater
–venous plexuses

The dura mater dublication that runs along the longitudinal fissure of the brain is called as follows:
+the falx cerebri
–the falx cerebelli

–the denticulate ligaments
–the tentorium cerebelli

The process of the dura mater that runs along the transverse fissure of the brain is called as follows:
+the tentorium cerebelli
–the falx cerebri
–the falx cerebelli
–the denticulate ligaments

The process of the dura mater that runs between the cerebellar hemispheres is called as follows:
+the falx cerebelli
–the tentorium cerebelli
–the falx cerebri
–the diaphragma sellae

The portion of the dura mater that expands over the hypophysial fossa is called as follows:
+diaphragma sellae
–falx cerebelli
–tentorium cerebelli
–falx cerebri
The dural sinuses are canals for the following substance:
+venous blood
–arterial blood
–cerebrospinal fluid
–connective tissue

Where is the superior sagittal sinus located?
+along the upper border of the falx cerebri
–along the lower border of the falx cerebri
–along the origination of the falx cerebelli
–along free margin of the the falx cerebelli

Which of the following sinuses is involved in the confluence of sinuses?
+the sphenoparietal sinus
–the occipital sinus
–the straight sinus
–the superior sagittal sinus

Where is the inferior sagittal sinus located?
+along the lower free border of falx cerebri
–along the upper border of falx cerebri
–along the origination of falx cerebelli
–along free margin of the falx cerebelli

The inferior sagittal sinus drains into the following sinuses:
+the straight sinus
–the transverse sinus
–the sigmoid sinus
–the cavernous sinus

Where is the transverse sinus located?
+along the base of the tentorium cerebelli
–along the lower free border of the falx cerebri
–along the upper border of the falx cerebri
–on the base of the skull on the sides of the Turkish saddle

Where is the occipital sinus located?
+along the origination (base) of the falx cerebelli
–along the lower free border of the falx cerebri
–along the upper border of the falx cerebri
–along free margin of the falx cerebelli

The transverse sinus is continuous with the following structure:
+the sigmoid sinus
–the internal jugular vein
–the straight sinus
–the occipital sinus

The sigmoid sinus is continuous with the following structure:
+the internal jugular vein
–the external jugular vein
–the anterior jugular vein
–the basal vein

Where is the cavernous sinus located?
+on both lateral sides of the Turkish saddle
–at the base of the falx cerebelli
–along the lower free border of the falx cerebri
–along the upper border of the falx cerebri

The right and left cavernous sinuses communicate via the following structure:
+the anterior and posterior intercavernous sinuses
–the inferior and superior communicating veins
–the diploic veins
–the emissary veins

Where is the sphenoparietal sinus located?

+along the posterior border of the lesser wing of sphenoid bone
–along the squamous border of the greater wing of the sphenoid bone
–along the sphenofrontal suture
–along the coronal suture

The superior and inferior petrosal sinuses communicate with the following sinuses:
+the cavernous and sigmoid sinuses
–the superior and inferior cavernous sinuses
–the right and left cavernous sinuses
–the sigmoid and superior sagittal sinuses

Where is the sigmoid sinus located?
+in the sigmoid sulcus
–laterally the Turkish saddle
–at the base of the falx cerebelli
–at the base of the falx cerebri

What sinus runs along the junction of the cerebral falx and the tentorium cerebelli?
+the straight sinus
–the inferior sagittal sinus
–the cavernous sinus
–the transverse sinus

The dilated point which is formed by junction of the superior sagittal, transverse, straight and occipital sinuses is called as follows:
+the confluence of sinuses
–the sigmoid sinus
–the cavernous sinus
–the sphenoparietal sinus

The posterior end of the superior sagittal sinus opens into the following structure:
+the transverse sinus
–the internal jugular vein
–the sphenoparietal sinus
–the sigmoid sinus

The great cerebral vein (vena cerebri magna) empties into the following sinus:
+the straight sinus
–the occipital sinus
–the superior sagittal sinus
–the transverse sinus

The straight sinus opens into the following structure:
+the transverse sinus
–the cavernous sinus
–the internal jugular vein
–the sphenoparietal sinus

The posterior ends of the superior and inferior sagittal sinuses communicate by the following structures:
+the straight sinus
–the basilar venous plexus
–the cavernous sinus
–the transverse sinus

The superior end of the occipital sinus opens into the following sinus:
+the transverse sinus
–the straight sinus
–the cavernous sinus
–the superior petrosal sinus

What sinus folks and then runs along the borders of the foramen magnum?
+the occipital sinus
–the cavernous sinus
–the transverse sinus
–the sigmoid sinus

The sphenoparietal sinus opens into the following sinus:
+the cavernous sinus
–the sigmoid sinus
–the straight sinus
–the confluence of sinuses

What sinus runs along the posterior border of the lesser wing of the sphenoid bone?
+the sphenoparietal sinus
–the superior petrosal sinus
–the cavernous sinus
–the transverse sinus

The posterior cerebellomedullary cistern is situated between the following structures:
+the cerebellum and the medulla oblongata
–in the lateral fossa of the brain
–in front of the optic chiasm
–between the medulla oblongata and the pons

The cistern of the lateral cerebral fossa is located as follows:
+in the same fossa
–in the interpeduncular fossa
–between the medulla oblongata and the pons

–in front of the optic chiasm

The interpeduncular cistern is located as follows:
+between the cerebral peduncles
–in the lateral fossa
–in front of the optic chiasm
–between the medulla oblongata and the pons

The cerebrospinal fluid is produced by the following structure:
+the choroid plexuses of all ventricles of the brain
–the arachnoid granulations
–the veins of the brain
–the diploic veins

The cerebrospinal fluid produced within the lateral ventricles drains into the following structures:
+the 3rd ventricle
–the 4th ventricle
–the cerebellomedullary cistern
–the arachnoid granulations

From the 3rd ventricle the cerebrospinal fluid drains into the following structure:
+the 4th ventricle
–the lateral ventricle
–the interpeduncular cistern
–through the arachnoid granulations to venous blood

From the 4th ventricle the cerebrospinal fluid drains directly into the following structure:
+the cerebellomedullary cistern
–the interpeduncular cistern
–the 3rd ventricle
–the dural venous sinuses

The 4th ventricle communicates with subarachnoidal space via the following structures:
+the lateral apertures (Luschka's foramina) and the median aperture (foramen of Majendie)
–the cerebral aqueduct
–the subarachnoid cisterns
–the diploic veins

The choroid plexuses of the cerebral ventricles are formed by the following structure:
+the pia mater
–the arachnoid granulations
–the basilar venous plexus
–the deep cerebral veins

What artery supplies the medial surface of the cerebral hemisphere?
+the anterior cerebral artery
–the middle cerebral artery
–the anterior choroid artery
–the posterior communicating artery

What branch of the internal carotid artery is the biggest one located in the lateral sulcus of the brain?
+the middle cerebral artery
–the anterior cerebral artery
–the posterior cerebral artery
–the basilar artery

What arteries of the brain are connected by the anterior communicating artery?
+the anterior cerebral arteries
–the middle cerebral arteries
–the posterior cerebral arteries
–the anterior inferior cerebellar arteries

The basilar artery is formed by the following arteries:
+the fusion of the vertebral arteries
– the fusion of the spinal arteries
–the fusion of the posterior cerebral artery and internal carotid artery
–the fusion of the posterior cerebral artery and middle cerebral artery

The arterial circle of the brain is located:
+at the base of the brain
–within lateral sulcus of the brain
–in the ventricles of the brain
–on the medial surface of the hemisphere

The Organ of Vision

More than half of sensory receptors in the human body are located as follows:
+in the eyes
–in the nose
–in the taste bubs of the tongue
–in the ears

The visual organ perceives:

+the light
–the sound
–the odor
–the taste

What is the most prominent portion of the cornea called?
+the anterior pole of the eyeball
–the posterior pole of the eyeball
–the fovea centralis
–the optic disc

An imaginary longitudinal line that runs through both poles is called as follows:
+the external axis of the eyeball
–the internal axis of the eyeball
–the vertical diameter of the equator of the eyeball
–the optic axis

What is the line that expends between the internal surface of the cornea and the retina called?
+the internal axis of the eyeball
–the external axis of the eyeball
–the optic axis
–the equator of the eyeball

The length of the internal axis of the eyeball of a normal eye is as follows:
+21.5 mm long
–24 mm long
–28 mm long
–20.5 mm long

When the internal axis of the eyeball is longer than 21.5 mm and the focus of converging rays is in front of the retina, it is called as follows:
+the myopia or nearsightedness
–the hypermetropia or farsightedness
–the accommodation
–the color blindness

When the internal axis of the eyeball is shorter than 21.5 mm and the focus of converging rays is behind the retina, it is called as follows:
+the hypermetropia or farsightedness
–the myopia or nearsightedness
–the accommodation
–the night blindness

An imaginary line, that corresponds to the route of light rays from the anterior pole of the cornea to the fovea centralis of the retina, is called as follows:
+the optic axis
–the external axis of the eyeball
–the internal axis of the eyeball
–the equator of the eyeball

What is the site of the sharpest visual acuity?
+the fovea centralis of the retina
–the depression of the optic disc
–the anterior pole of the eyeball
–the hyaloid fossa of the vitreous body

What tunic is not the layer of the wall of the eyeball?
+the muscular tunic
–the fibrous tunic
–the vascular tunic
–the retina

Which of the following parts is not the part of the nucleus (the internal media) of the eyeball?
+the cornea
–the lens
–the aqueous humor
–the vitreous body

The anterior transparent portion of the fibrous tunic of the eyeball is called as follows:
+the cornea
–the ciliary body
–the retina
–the lens

The posterior portion of the fibrous tunic of the eyeball is called as follows:
+the sclera
–the cornea
–the iris
–the macula lutea

The following structure is located at the junction of the sclera and cornea in the thickness of the sclera:
+the scleral venous sinus (Schlemm`s canal)
–the ciliary ring
–the ciliary zonule (Zinn`s zonule)

–the pectinate ligament

Which of the following parts is not the part of the vascular tunic of the eyeball?
+the cornea
–the choroid
–the ciliary body
–the iris

The following structure is the posterior portion of the vascular tunic of the eyeball:
+the choroid
–the retina
–the iris
–the cornea

In the anterior portion of the vascular tunic, the choroid becomes the following structure:
+the ciliary body
–the iris
–the sclera
–the scleral venous sinus (Schlemm’s canal)

What is the function of the ciliary muscle of the eyeball?
+accommodation of the eye
–light and dark adaptation
–convergence
–refraction

The anterior portion of the vascular tunic of the eyeball is called as follows:
+the iris
–the cornea
–the retina
–the lens

What is the hole in the center of the iris called?
+the pupil
–the lens
–the ciliary ring
–the ciliary zonule (zonule of Zinn)

The following tunic is the innermost of the three tunics of the eyeball:
+the retina
–the iris
–the sclera
–the choroid

The anterior surface of the iris is of different color in different people and determines the color of their eyes. This depends on the following conditions:
+the amount of pigment (melanin) in the superficial layers of the iris
–the presence of vessels in the stroma of the iris
–the presence of muscles within the stroma of the iris
–the thickness of the iris

What is the border between the optic part of the retina and the nonvisual retina?
+the ora serrata
–the ciliary zonule (Zinn`s zonule)
–the ciliary ring
–the optic axis

The blind spot of the retina is also called as follows:
+the optic disc
–the macula lutea
–the central fovea of the macula lutea
–the hyaloid fossa

What is the area of the highest visual acuity or resolution?
+the central fovea of the macula lutea
–the depression of the optic disc
–the pigmented layer of the retina
–the ora serrata of the retina

The central fovea of the macula lutea contains the following structures:
+only cones
–only rods
–the rods and cones
–the pigmented cells

An area where the axons of the retinal ganglion cells leave the eyeball is called as follows:
+the optic disc
–the macila lutea
–the ora serrata
–the ciliary ring

The space between the posterior surface of the cornea and the anterior surface of the iris is called:
+the anterior chamber of the eyeball

–the posterior chamber of the eyeball
–the scleral venous sinus (Schlemm’s canal)
–the perichoroidal space

The iridocorneal angle is rounded off by the following structure:
+the pectinate ligament
–the scleral venous sinus (Schlemm’s canal)
–the ciliary ring
–the macula lutea

Between the trabeculae of the pectinate ligament are the following structures:
+the endothelium–lined spaces of the iridocorneal angle (Fontana’s spaces)
–the smooth muscle fibers of the ciliary muscle
–the zonular spaces (Petit’s canal)
–the ciliary processes

The posterior chamber of the eyeball communicates with the anterior chamber through the following structure:
+the pupil
–the scleral venous sinus (Schlemm’s canal)
–the spaces of the iridocorneal angle (Fontana’s spaces)
–the zonular spaces (Petit’s canal)

What is the space behind the iris and in front of the zonular fibers and lens called?
+the posterior chamber of the eyeball
–the anterior chamber of the eyeball
–the scleral venous sinus (Schlemm’s canal)
–the perichoroidal space

The aqueous humor continually filters out of the following structures:
+the blood capillaries in the ciliary processes
–the blood vessels in the iris
–the fibers of the ciliary zonule (Zinn`s zonule)
–the vitreous body

What shape has the transparent lens?
+like a lentil or a biconvex glass
–like a biconcave glass
–like a convex–concave glass
–like a ball

The capsule of the lens attaches to the following eye structure by means of the ciliary zonule (Zinn`s zonule):
+the ciliary body
–the vitreous body
–the iris
–the choroid

What fills the space between the lens and the retina?
+the vitreous body
–the posterior chamber of the eyeball
–the ciliary body
–the aqueous humor

How many voluntary (striated) muscles are attached to the eyeball?
+6
–4
–7
–8

What muscles arise from the common tendinous ring in the area of the optic canal and attach to the sclera?
+all rectus muscles and the superior oblique muscle
–the inferior oblique muscle
–all rectus muscles
–all oblique muscles

What muscle rotates the eyeball laterally?
+the lateral rectus muscle
–the superior rectus muscle
–the superior oblique muscle
–the inferior oblique muscle

What muscle rotates the eyeball medially?
+the medial rectus muscle
–the lateral rectus muscle
–the superior oblique muscle
–the inferior oblique muscle

The superior oblique muscle rotates the eyeball and the pupil:
+downward and laterally
–upward and laterally
–upward and medially
–downward and medially

The inferior oblique muscle rotates the eyeball and the pupil:
+upward and laterally

–upward and medially
–downward and laterally
–downward and medially

What nerve supplies the superior oblique muscle of the eyeball?
+the trochlear nerve (CNIV)
–the oculomotor nerve (CNIII)
–the ophthalmic nerve (the 1st branch of the CNV)
–the facial nerve (CNVII)

What nerve supplies the inferior oblique muscle of the eyeball?
+the oculomotor nerve (CNIII)
–the trochlear nerve (CNIV)
–the abducent nerve (CNVI)
–the optic nerve (CNII)

What nerve supplies the lateral rectus muscle of the eyeball?
+the abducent nerve (CNVI)
–the ophthalmic nerve (the1st branch of CNV)
–the oculomotor nerve (CNIII)
–the trochlear nerve (CNIV)

What nerve supplies the medial rectus muscle of the eyeball?
+the oculomotor nerve (CNIII)
–the abducent nerve (CNVI)
–the optic nerve (CNII)
–the ophthalmic nerve (the1st branch of CNV)

What nerve supplies the superior rectus muscle of the eyeball?
+the oculomotor nerve (CN III)
–the trochlear nerve (CN IV)
–the trigeminal nerve (CN V)
–the abducent nerve (CN VI)

What nerve supplies the inferior rectus muscle of the eyeball?
+the oculomotor nerve (CN III)
–the trochlear nerve (CN IV)
–the maxillaty nerve (the 2nd branch of CN V)
–the ophthalmic nerve (the1st branch of CN V)

What nerve supplies the levator palpebrae superioris muscle?
+the oculomotor nerve (CNIII)
–the trigeminal nerve (CNV)
–the facial nerve (CNVII)
–the trochlear nerve (CNIV)

What is the 2nd cranial nerve called?
+the optic nerve
–the oculomotor nerve
–the ophthalmic nerve
–the trochlear nerve

The transparent light–refracting media of the eyeball are called as follows:
+the cornea, the aqueous humor, the lens, the vitreous body
–the cornea, the pupil, the lens, the retina
–the iris, the pupil, the lens, the vitreous body
–the cornea, the pupil, the iris, the retina

The rays of the light pass through the light–refracting media of the eye to the area of the highest visual acuity:
+the central fovea of the macula lutea
–the optic disc
–the depression of the optic disc
–the ciliary and irideal parts of the retina

The curvature of the lens changes depending on the distance to the object we are looking at. This phenomenon is called as follows:
+accommodation
–astigmatism
–convergence
–albinism

When object is examined at a close distance, the eye muscles rotate the eyes medially because the light rays from the object strike the same points on both retinas. Such coordinate movement of two eys is called as follows:
+convergence
–accommodation
–myopia (nearsightedness)
–astigmatism

The retina comprises the following three layers of the neurons that accept light stimuli and transmit them to the brain:
+the rods and cones, the bipolar neurons, the ganglionic neurons
–the ganglionic neurons, the bipolar neurons, the rods and cones

–the bipolar neurons, the ganglionic neurons, the rods and cones
–the rods and cones, the ganglionic neurons, the bipolar neurons

The optic nerve is formed by the following structures:
+the axons of the ganglionic neurons
–the axons of the rods and cones
–the processes of the bipolar neurons
–the processes of all neurons of the retina

The optic nerve passes out of the orbit through the following structure:
+the optic canal
–the superior orbital fissure
–the inferior orbital fissure
–the nasolacrimal canal

The optic chiasm is formed by decussation of the following nerves:
+the medial parts of both optic nerves
–the lateral parts of both optic nerves
–the medial fibers of the right opric nerve and the lateral fibers of the left optic nerve
–the medial fibers of the left optic nerve and the lateral fibers of the right optic nerve

Each optic tract consists of the following structures:
+the lateral fibers of the optic nerve of the same side and the medial fibers of the optic nerve of the opposite side
–the lateral parts of both optic nerves
–the medial parts of both optic nerves
–the completely decussated fibers of both optic nerves

Which of the following structures is not the subcortical visual center?
+the hypothalamus
–the thalamus
–the lateral geniculate bodies
–the superior colliculi of the tectum of the mesencephalon

What structures form the first–order neurons of the visual pathway?
+the rods and the cones of the retina
–the ganglionic cells of the retina
–the cells of the thalamus
–the cerebral cortex lying along the banks of the calcarine sulcus

What part of the internal capsule of the hemispheres do the fibers of the optic tract pass through?
+the posterior part of the posterior limb
–the anterior limb
–the anterior part of the posterior limb
–the genu

Where is the cortical visual center located?
+within the cerebral cortex lying along the banks of the calcarine sulcus
–within the thalamus
–within the postcentral gyrys
–within the supramarginal gyrus of the inferior parietal lobule

The oculomotor nerve (CNIII) emerges from the brain as follows:
+along the medial edge of the peduncle of the brain
–laterally the superior medullary velum
–at the posterior edge of the pons
–on the line separating the pons from the middle cerebellar peduncle

The oculomotor nerve (CNIII) enters the orbit through the following structures:
+the superior orbital fissure
–the inferior orbital fissure
–the optic canal
–the infraorbital canal

The 4th pair of cranial nerves is called as follows:
+the trochlear nerve
–the optic nerve
–the trigeminal nerve
–the abducent nerve

The 4th pair of cranial nerves emerges from the brain as follows:
+laterally the superior medullary velum
–on the line separating the pons from the middle cerebellar peduncle
–behind the olive of the medulla oblongata
–along the medial edge of the peduncle of the brain

The trochlear nerve (CNIV) enters the orbit through the following structure:
+the superior orbital fissure
–the inferior orbital fissure
–the optic canal
–the infraorbital canal

What muscle is located in the upper and lower eyelids?
+the palpebral part of the orbicularis oculi muscle
–the levator palpebrae superioris muscle
–the superior and inferior oblique muscle of the eyeball
–the superior and inferior rectus muscle of the eyeball

What muscle inserts a plate of dense connective tissue in the upper eyelid?
+the levator palpebrae superioris muscle
–the superior oblique muscle of the eyeball
–the superior rectus muscle of the eyeball
–the orbital part of the orbicularis oculi muscle

Embedded in each tarsal plate are the modified sebaceous glands, known as tarsal or Meibomian glands. They are located as follows:
+along the free margins of the eyelids
–within the conjunctival sac
–within the lacrimal lacus (lake)
–in the nasolacrimal duct

A slit–like cavity formed of the palpebral and the orbital conjunctivae is called as follows:
+the conjunctival sac
–the lacrimal lacus (lake)
–the palpebral fissure
–the episcleral space

Where does the lacrimal gland reside?
+in the superolateral angle of the orbit
–in the superomedial angle of the orbit
–within the conjunctival sac
–within the superior eyelid

Where do the excretory ducts of the lacrimal gland open?
+into the conjunctival sac
–into the lacrimal lacus (lake)
–into the nasolacrimal duct
–along the free margins of the eyelids

From the lacrimal lacus (lake) the tears pass into the following structures:
+the superior and inferior lacrimal canaliculi
–the lacrimal sac
–the nasolacrimal duct
–the lacrimal caruncle

From the superior and inferior canaliculi the tears pass into the following structures:
+the lacrimal sac
–the lacrimal lacus (lake)
–the nasolacrimal duct
–the fascial sheath of the eyeball (the Tenon's capsule)

Where does the nasolacrimal duct open?
+into the inferior nasal meatus
–into the lacrimal lacus (lake)
–into the conjunctival sac
–into the superior nasal meatus

The Organ of Hearing and Equilibrium. The Olfactory and Gustatory Organs

The following structure comprises theauricle and the external auditory meatus:
+the external ear
–the middle ear
–the internal ear
–the anterior ear

The following structure comprises tympanic cavity with the auditory ossicles and the auditory tube (the Eustachian tube):
+the middle ear
–the external ear
–the internal ear
–the posterior ear

The auricle (pinna) is formed as follows:
+by the elastic cartilage
–by the connective tissue
–by the hyaline cartilage
–by the osseous tissue

The inferior portion of the auricle is called as follows:
+the lobule
–the helix
–the external acoustic meatus
–the tympanic membrane

The thickened curved rim of the auricle is called as follows:
+the helix
–the tragus
–the lobule of the ear
–the concha of the auricle

What eminence is located anterior and parallel to the helix?
+the anthelix
–the lobule of the auricle
–the scapha
–the external acoustic meatus

What eminence is situated anterior to the external acoustic meatus?
+the tragus
–the helix
–the lobule of the auricle
–the concha of the auricle

An eminence situated in the inferior part of the antihelix opposite to the tragus is called as follows:
+the antitragus
–the helix
–the tympanic membrane
–the concha of the auricle

The concha of the auricle leads to the following anatomical structure:
+the external acoustic meatus
–the tympanic cavity
–the auditory tube
–the membranous labyrinth

The middle ear is separated from the external ear by the following structure:
+the tympanic membrane (the eardrum)
–the lobule of the auricle
–the labyrinthine wall of the tympanic cavity
–the mastoid antrum

Near the exterior opening, the skin of external auditory canal contains a few hairs and specialized sebaceous glands called as follows:
+the ceruminous glands
–the tarsal glands (Meibomian glands)
–the sweat glands
–the endocrine glands

The lower part of the tympanic membrane (the eardrum) is called as follows:
+the tense part
–the flaccid part
–the free part
–the triangular part

The upper part of the tympanic membrane (the eardrum) is called as follows:
+the flaccid part
–the tense part
–the free part
–the cribriforme plate

The centee of the tympanic membrane (the eardrum) which is drawn in like a shallow funnel, is called as follows:
+the umbo
–the tubercle
–the promontory
–the round window

The substance of the tympanic membrane (the eardrum) between the two epithelial layers consists of the following structures:
+the fibrous connective tissue
–the muscular tissue
–the hyolin cartilage
–the elastic cartilage

Where does the tympanic membrane not contain fibrous connective tissue?
+in the flaccid part
–in the tense part
–in the umbo area
–in the posterior area

How many walls are distinguished in the tympanic cavity?
+6
–4
–8
–3

What wall separates the tympanic cavity from the cranial cavity?
+the tegmental wall (the roof)
–the labyrinthine wall
–the membranous wall
–the jugular wall (the floor)

The superior wall of the tympanic caviry is called as follows:
+the tegmental wall (the roof)
–the mastoid wall
–the membranous wall
–the carotid wall

The wall of the tympanic cavity which faces the inferior surface of the pyramid of the temporal bone is called as follows:
+the jugular wall (the floor)
–the tegmental wall (the roof)
–the mastoid wall
–the membranous wall

The inferior wall of the tympanic cavity is called as follows:
+the jugular wall (the floor)
–the carotid wall
–the tegmental wall
–the labyrinthine wall

What wall of the tympanuc cavity belongs to the bony labyrinth of the internal ear?
+the labyrinthine wall
–the carotid wall
–the tegmental wall
–the membranous wall

The medial wall of the tympanic cavity is called as follows:
+the labyrinthine wall
–the mastoid wall
–the carotid wall
–the membranous wall

The medial wall of the tympanic canity has the opening leading into the vestibule of the internal ear. The base of the stapes which is inserted in this opening is called as follows:
+the fenestra vestibuli (the oval window)
–the fenestra cochleae (the round window)
–the tympanic opening of the auditory tube
–the aditus to the mastoid antrum

The fenestra vestibuli (the oval window), leading from the tympanic cavity into the vestibule of the internal ear, is located as follows:
+on the medial wall of the tympanic cavity
–on the inferior wall of the tympanic cavity
–on the lateral wall of the tympanic cavity
–on the posterior wall of the tympanic cavity

The opening of the medial wall of the tympanic cavity, leading into the cochlea and being closed with the secondary tympanic membrane, is called as follows:
+the fenestra cochleae (the round window)
–the fenestra vestibuli (the oval window)
–the tympanic opening of the auditory tube
–the aditus of the mastoid antrum

The fenestra cochlea (the round window), leading from the tympanic cavity into the cochlea, is located as follows:
+on the medial wall of the tympanic cavity
–on the anterior wall of the tympanic cavity
–on the superior wall of the tympanic cavity
–on the lateral wall of the tympanic cavity

The mastoid antrum is a small cavity protruding toward the mastoid process from the tympanic cavity. It is located as follows:
+on the posterior wall of the tympanic cavity
–on the anterior wall of the tympanic cavity
–on the medial wall of the tympanic cavity
–on the lateral wall of the tympanic cavity

What is the posterior wall of the tympanic cavity called?
+the mastoid wall
–the carotid wall
–the jugular wall
–the membranous wall

What wall of the tympanic cavity hauses the pyramidal eminence from within which the stapedius muscle arises?
+the posterior wall
–the superior wall
–the inferior wall
–the anterior wall

What wall of the tympanic cavity is related to the carotid canal?
+the carotid wall
–the labyrinthine wall
–the membranous wall
–the tegmental wall

What is the anterior wall of the tympanic cavity called?
+the carotid wall

–the jugular wall
–the mastoid wall
–the tegmental wall

Where can one distinguish the tympanic opening of the auditory tube (the Eustachian tube)?
+on the anterior wall of the tympanic cavity
–on the posterior wall of the tympanic canity
–on the umbo of the tympanic membrane
–on the superior wall of the tympanic cavity

What wall of the tympanic cavity is formed by the tympanic membrane?
+the lateral wall
–the posterior wall
–the medial wall
–the inferior wall

What is the lateral wall of the tympanic cavity called?
+the membranous wall
–the carotid wall
–the mastoid wall
–the tegmental wall

Which of the following structures is not the auditory ossicle?
+the cochlea
–the incus
–the stapes
–the malleus

What opening does the base of the stapes close?
+the oval window (the fenestra vestibuli)
–the round window (the fenestra cochlea)
–the tympanic opening of the auditory tube
–the mastoid antrum

The head of the malleus articulates with:
+the body of the incus
–the long limb of the incus
–the base of the stapes
–the head of the stapes

Where does the handle of the malleus attaches to?
+the umbo of the tympanic membrane
–the body of the incus
–the secondary tympanic membrane
–the head of the stapes

Where does the inferior cartilaginous part of the auditory tube open?
+on the lateral wall of the pharynx
–on the anterior wall of the tympanic cavity
–on the medial wall of the tympanic cavity
–on the secondary tympanic membrane

Which cranial nerve supplies the stapedius muscle?
+the facial nerve (CNVII)
–the trigeminal nerve (CNV)
–the vestibulocochlear nerve (CNVIII)
–the vagus nerve (CNX)

The innervation of the tensor tympani muscle is provided by the following nerve:
+the trigeminal nerve (CNV)
–the vestibulocochlear nerve (CNVIII)
–the facial nerve (CNVII)
–the glossopharyngeal nerve (CNIX)

The lymphatic follicles accumulate in large amount at the pharyngeal ostium of the auditory tube to form the following structures:
+the tubal tonsil
–the palatine tonsil
–the pharyngeal tonsil
–the tubal elevation (torus tubarius)

The muscles, which strain and elevate the soft palate and open the pharyngeal orifice of the auditory tube, arise from the following structure:
+the cartilaginous part of the auditory tube
–the bony part of the auditory tube
–the tympanic membrane
–the mastoid process of the temporal bone

What is not the part of the bony labyrinth of the internal ear?
+the tympanic cavity
–the vestibule
–the cochlea
–the semicircular canals

Two openings (the oval window and the round window) are located on the following structure:
+the lateral vestibular wall
–the posterior vestibular wall

–the base of the cochlea
–the cochlear cupula

The oval window, enclosed by the base of the stapes, opens into the following structure:
+the vestibule
–the cochlear duct
–the spiral canal of the modiolus
–the anterior semicircular canal

The round window, enclosed by the secondary tympanic membrane, opens into the following structure:
+the cochlear duct
–the vestibule
–the posterior semicircular canal
–the spiral canal of the midiolus

The following structures are located on the posterior wall of the vestibule:
+5 openings of the semicircular canals
–the opening of the cochlear duct
–the oval and round windows
–the openings of the spiral canal of modiolus

The following structure is located on the anterior wall of the vestibule:
+the opening of the cochlear duct
–the round window
–the oval window
–the opening of the spiral canal of modiolus

The vestibular crest that delimits the elliptical and the spherical recesses is located as follows:
+on the medial wall of the vestibule
–on the posterior wall of the vestibule
–on the anterior wall of the vestibule
–on the lateral wall of the vestibule

What portion of the bony labyrinth is called «the cochlea»?
+the anterior portion
–the posterior portion
–the medial portion
–the lateral portion

The central portion of the bony labyrinth is called as follows:
+the vestibule
–the cochlea
–the lateral semicircular canal
–the anterior semicircular canal

The posterior portion of the bony labirinth is composed of the following structures:
+the semicircular canals
–the cochlea
–the vestibule
–the auditory tube

The spiral bony canal of the cochlea winds up around the central bony core as follows:
+for two and a half coils
–for two coils
–for one coil
–for four and half coils

Where does the base of the cochlea face?
+medially, towards the internal acoustic opening
–laterally, towards the tympanic cavity
–superiorly, towards the tegmen tympani
–inferiorly, towards the jugular fossa
Where does the cochlear cupula face?
+laterally, towards the tympanic cavity
–medially, towards the internal acoustic meatus
–superiorly, towards the tegmen tympani
–inferiorly, towards the jugular fossa

A bony spiral canal of the cochlea makes two and a half turns around the central bony core which is called as follows:
+the modiolus
–the vestibular crest
–the osseous spiral lamina
–the helicotrema

Where does the spiral ganglion found?
+within the spiral canal of modiolus
–within the spherical (saccular) recess
–within the ampullary crestst
–within the cochlear aqueduct

The perilymph flows to the subarachnoid space via the following structures:
+the cochlear aqueduct
–the vestibular canaliculus
–the helicotrema
–the utriculosaccular duct

Three bony semicircular canals open into the vestibule by means of the following number of openings:
+5 openings
–6 openings
–4 openings
–3 openings

How many ampullary bony limbs do the bony semicircular canals form?
+3
–1
–6
–5

How many simple bony limbs do the bony semicircular canals form?
+1
–6
–3
–5

The walls of the membranous labyrinth are formed by the following structures:
+the connective tissue
–the muscular tissue
–the cartilaginous tissue
–the bony tissue

The perilymphatic space is filled with the following content:
+the perilymph
–the endolymph
–the aqueous humor
–the lymph

The perilymph flows through the cochlear aqueduct towards the following structure:
+the subarachnoid space
–the endolymphatic sac
–the venous vessels of the brain
–the cavernous sinus of the dura mater

The cavities of the membranous labyrinth are filled with clear fluid, called as follows:
+the endolymph
–the perilymph
–the aqueous humor
–the connective tissue

The endolymph flows through the endolymphatic duct towards the following structure:
+the endolymphatic sac
–the subarachnoid space
–the venous vessels of the brain
–the inferior petrosal sinus of the dura mater

Which of the following structures is not the part of the membranous labyrinth?
+the spiral canal of the modiolus
–the utricle and the saccule
–three semicircular ducts
–the cochlear duct

The small canal joining the utricle with the saccule is called as follows:
+the utriculosaccular duct
–the endolymphatic duct
–the perilymphatic duct
–the ductus reuniens

What opens into the utricle?
+5 openings of the semicircular ducts
–the ductus reuniens
–the cochlear duct
–the cochlear canaliculus

The maculae of the utricle and saccule and the ampullary crests of the semicircular duct contain the following structures:
+the receptor areas of the vestibular analyzer
–the auditory receptors
–the bodies of the first–order neurons of the auditory pathways
–the bodies of the second–order neurons of the equilibrium pathways

Where do the bodies of the first–order–order sensory neurons of the equilibrium pathways reside?
+within the bipolar neurons of the vestibular ganglion
–within the maculae of the utricle and saccule
–within the ampullary crests of the semicircular ducts
–within the vestibular nuclei of the brain

Where does the vestibular ganglion reside?
+within the internal acoustic meatus
–within the spiral canal of the modiolus
–within the utricle

–under the dura mater on the posterior surface of the pyramid of the temporal bone

Where are the second–order neurons of the neural pathways of the vestibular analyzer located?
+within the vestibular nuclei of the brain
–within the vestibular ganglion
–within the maculae of the utricle and saccule
–within the ampullary crests of the semicircular ducts

What shape has the cochlear duct on cross section?
+triangle
–oval
–ellipse
–quadrangle

The external surface of the cochlear duct is formed by connective tissue, attached to the following structure:
+the bony wall of spiral canal of the cochlea
–to the osseous spiral lamina of the modiolus and the wall of the spiral canal
–to the helicotrema
–to the base of the osseous spiral lamina and the helicotrema

The vestibular (superior) surface of the cochlear duct (Reissner's membrane) expands between the following structures:
+the osseous spiral lamina of the modiolus and the wall of the spiral canal passing obliquely
–the wall of the spiral canal and the base of the osseous spiral lamina
–the base of the osseous spiral lamina and helicotrema
–the helicotrema and the floor of the internal acoustic opening

At the cupula of the cochlea the scala vestibuli and the scala tympani communicate through the following structure:
+the helicotrema
–the endolymphatic duct
–the ductus reuniens
–the cochlear aqueduct

The spiral organ (the organ of Corti) is situated as follows:
+within the cochlear duct
–within the utricle
–within the sacculus
–within the perilymphatic duct

Where are the receptors of the auditory pathways situated?
+in the sensory cells of the spiral organ (the organ of Corti)
–in the spiral ganglion
–in the cochlear nuclei of the pons
–in the cerebellar nuclei

The bodies of the first–order–order sensory neurons of the auditory pathways are located within the following structures:
+the spiral ganglion
–the medial geniculate bodies
–the cochlear nuclei
–the cortex of the superior temporal gyrus (Heschl's convolution or gyrus)

Where are the second–order neurons of the auditory pathways situated?
+in the ventral and dorsal cochlear nuclei
–in the spiral ganglion
–in the superior temporal gyrus of the cerebral cortex (Heschl's convolution)
–in the superior colliculi in the midbrain

Axons, carrying auditory signals from the neurons of the ventral cochlear nuclei, decussate to form the following structure:
+the trapezoid body
–the medial lemniscus
–the pyramids
–the external arcuate fibers

Axons, carrying auditory signals from the neurons of the dorsal cochlear nuclei, leave the pons and, on the rhomboid fossa, they form the following structure:
+the medullary stria of the fourth ventricle
–the medial eminenses
–the lateral recesses
–the superior cerebellar peduncles

Where are the third–order neurons of the auditory pathways located?
+in the inferior colliculi of the midbrain and the medial geniculate bodies
–in the trapezoid body
–in the lateral geniculate bodies

–in the superior temporal gyrus of the cerebral cortex (Heschl's gyri)

Axons, carrying auditory signals from the third–order neurons, run to the internal capsule and pass through the following structure:
+the posterior part of the posterior limb of the internal capsule
–the anterior part of the posterior limb of the internal capsule
–the genu of the internal capsule
–the anterior part of the anterior limb of the internal capsule

The fibers of the auditory pathways terminate in the primary auditory cortex of the following structures:
+the transverse temporal gyri or Heschl's gyri
–the precentral gyrus
–the angular gyrus
–the marginal portions of the calcarine sulcus

The olfactory organ perceives the following sensations:
+odors
– light
–sounds
–taste

Where are the receptors of the olfactory organ situated?
+in the nasal mucosa of the superior nasal conchae and the contralateral areas of the nasal septum
–in the nasal mucosa of the middle nasal conchae and the contralateral areas of the nasal septum
–in the nasal mucosa of the inferior nasal conchae
–in the nasal mucosa of the nasal septum

Where are the bodies of the first–order neurons of the olfactory pathway located?
+in the nasal mucosa of the superior nasal conchae and the adherent portion of the nasal septum
–in the nasal mucosa of the middle and inferior nasal conchae
–in the olfactory bulbs
–in the parahippocampal gyrus

Where are the bodies of the second–order neurons of the olfacrory pathway located?
+in the olfactory bulbs
–in the nasal mucosa of the superior nasal conchae and the adherent portion of the nasal septum
–in the parahippocampal gyrus
–in the olfactory trigone

Where are the bodies of the third–order neurons of the olfactory pathway located?
+in the olfactory trigone, the anterior perforated substance and the septum pellucidum
–in the olfactory bulbs
–in the parahippocampal gyrus
–in the olfactory cells of the nasal mucosa of the middle and inferior nasal conchae

Where is the olfactory cortex located?
+in the uncus of the parahippocampal gyrus
–in the superior temporal gyrus
–in the postcentral gyrus
–in the cerebral cortex lying along the banks of the calcarine sulcus

The olfactory nerves enter the skull cavity through the following structures:
+the cribriform plate of the ethmoid bone
–the foramen rotundum of the sphenoid bone
–the foramen caecum of the frontal bone
–the mastoid canaliculus of the temporal bone

What cranial nerves are the olfactory nerves?
+CNI
–CNII
–CNVI
–CNIV

The receptors for gustatory perception (taste receptor cells) are located on the following structures:
+the taste buds
–the lingual tonsil
–the oral mucosa of the floor of the oral cavity
–the filiform and conical papillae

Which of the following structures has no taste buds?
+the filiform papillae
–the fungiform papillae

–the vallate papillae
–the foliate papillae

Where are the first–order neurons of the gustatory pathway located?
+in the sensory ganglia of the facial, glossopharyngeal and the vagus nerves
–in the sensory nucleus of the solitary tract (the common nucleus for CNVII, and CNIX, CNX)
–on the taste buds
–in the sensory ganglion of the trigeminal nerve (the Gasserian ganglion)

Where are the second–order neurons of the gustatory pathway located?
+in the neurons of the nucleus of solitary tract (the common nucleus for CNVII, CNIX, and CNX)
–on the taste buds
–in the sensory ganglia of the CNIVII CNix and CNX
–in the uncus of the parahippocampal gyrus

Where are the third–order neurons of the gustatory pathway located?
+in the thalamic neurons
–in the neurons of the nucleus of solitary tract (the common nucleus for CNVII, and CNIX, CNX)
–in the sensory ganglion of the trigeminal nerve (gasserian ganglion)
–in the taste papillae of the tongue

Where is the primary taste cortex located?
+in the uncus of the parahippocampal gyrus
–in the postcentral gyrus
–in the thalamic neurons
–in the transverse temporal gyri (Heshl's gyri)

Which nerve carries the taste sensation from the anterior two thirds of the tongue?
+the chorda tympani, a branch of the facial nerve
–the greater petrosal nerve that branches from the facial nerve
–the lingual nerve that branches from the vagus nerve
–the lingual nerve that branches from the hypoglossal nerve

Which nerve carries the taste sensation from the posterior third of the tongue, the soft palate and the palatal arches?
+the lingual nerve that branches from the glossopharyngeal nerve
–the chorda tympani of the facial nerve
–the lesser petrosal nerve of the glossopharyngeal nerve
–the lingual nerve that branches from the hypoglossal nerve

Which nerve carries the taste sensation from the root of the tongue and epiglottis?
+the superior laryngeal nerve of the vagus nerve
–the chorda tympani of the facial nerve
–the greater petrosal nerve that branches from the facial nerve
–the lesser petrosal nerve of the glossopharyngeal nerve

CLINICAL TASKS (KROK–1)

CENTRAL NERVE SYSTEM

A patient has meningitis. A lumbar puncture of the subarachnoid space is prescribed. Between what formations is it located?
+arachnoid and pia mater
–periosteum and arachnoid
–dura mater and arachnoid
–periosteum and dura mater
–dura mater and pia mater

A patient has epidural abscess (epiduritis) – an accumulation of pus in the epidural space of the spinal cord. Define the localization of the pathological process.
+between periosteum and dura mater
–between arachnoid and pia mater
–between dura mater and arachnoid
–between pia mater and spinal cord
–between dura mater and pia mater

A patient has a damage of the 5th thoracic vertebra as a result of an accident. Which segment of the spinal cord can be damaged?
+7th thoracic segment
–3rd thoracic segment
–5th thoracic segment
–4th thoracic segment
–6th thoracic segment

It is necessary to carry out a lumbar puncture to confirm the diagnosis of meningitis. The inferior border of which lumbar vertebrae is a safe place for the manipulation?
+L 3
–L 4
–L 2
–L 5
–L l

The hemorrhage in anterior horns of the spinal cord is diagnosed in the 65–year–old patient. What are the anterior horns according to function?
+motor
–parasympathetic
–sensory
–sympathetic
–mix

Many leucocytes in the liquid received from the space between the arachnoid and pia maters of the spinal cord is determined. What formation was punctured?
+spatium subarachnoidale
–cavum trigeminale
–spatium subdurale
–spatim epidurale
–cisterna cerebellomedullaris posterior

A patient has coordination impairment and loss of balance. What structures of the central nervous system are affected?
+cerebellum and its conducting tracts
–the area of the precentral gyrus
–motor nuclei of the spinal cord
–anterior funiculi of the spinal cord
–red nucleus of mesencephalon

A patient has trauma in an occipital region of the skull. Gait and balance disoders were detected during examination. What part of the brain is damaged?
+cerebellum
–spinal cord
–medulla oblongata
–pons
–diencephalon

The absence of the pupillary reflex due to anesthesia was diagnosed in patient during surgery. What brainstem structure is affected?
+mesencephalon
–cerebellum
–diencephalon
–medulla oblongata
–metencephalon

A patient has dysfunction of the brain cortex. It is caused by neurological disorders in a brain stem supporting cortex activity. What is the structure of the brain stroke?
+reticular formation
–basal ganglia
–nuclei of cerebellum
–caudate nucleus
–nuclei of hypothalamus

The red nucleus syndrome can be found as a result of the posterior cerebral artery damages. What part of the brain is damaged from the stroke?

+mesencephalon
–thalamus
–metayhalamus
–epithalamus
–hypothalamus

A patient has double vision (diplopia), paralysis of accommodation, ptosis, and mydriasis (dilatated pupil). What mesencephalon nuclei are affected?
+nuclei of oculomotor and trochlear nerve
–nuclei of inferior colliculus
–nuclei of superior colliculus
–red nucleus
–substantia nigra

A 60-year–old patient has a prolonged sleep after a hemorrhage in the brain. What structure has being damaged most probably?
+reticular formation
–hippocampus
–cranial nerves' nuclei
–substantia nigra
–cortex of brain hemispheres

A changein the form of the Turkish saddle has been revealed in the patient. Doctors have suspected a pituitary gland tumour. What part of the brain does the pituitary gland relate to?
+diencephalon
–mesencephalon
–telencephalon
–rhombencephalon
–metencephalon

A patient with diencephalic damage has a hearing disorder. What nuclei are damaged?
+medial geniculate body
–lateral geniculate body
–red nucleus
–anterior nuclei of the hypothalamus
–posterior ventral nucleus

The patient has a strong feeling of hunger. Disfunction of receptors that maintain carbohydrate level in blood are revealed in subthalamic region. What part of the brain is damaged from stroke?
+diencephalon
–medulla oblongata
–mesencephalon
–pons
–medulla oblongata

A patient has exophthalmos, caused by excessive secretion of thyrotropic hormone by a pituitary gland. What part of the diencephalon does the pituitary body belong to?
+hypothalamus
–thalamus
–mesencephalon
–metethalamus
–epithalamus

Pathological changes have been revealed in the telencephalon of the patient with Parkinson's disease. What has changed in particular?
+lentiform nucleus
–angular gyrus
–supramarginal gyrus
–uncus of the hypocampal gyrus
–amygdaloid body

A metal nail has pierced the squamous part of the temporal bone and has penetrated into the substance of the left temporal lobe closer to the temporal pole. Which of the basal nuclei is damaged?
+amygdaloid body
–lentiform nucleus
–caudate nucleus
–claustrum
–pallidum

Chorea is diagnosed in a patient. Chorea is characterized by jerky uncontrolled movements. What brain structures are involved?
+substantia nigra and corpus striatum
–pulvinar thalamicus
–fasciculus longitudinalis medialis
–fasciculus longitudinalis posterior
–nucleus ruber

The damage to the striopallidar system has resulted in the development of athetosis (rhythmic involuntary movements of extremities). What nucleus is damaged?
+corpus striatum
–anterior nucleus of the hypothalamus
–medial geniculate body

–lateral geniculate body
–posterior nucleus of the hypothalamus

A patient has a hemorrhage in the right hemisphere. Thus associative fibers bridging the cortex of the frontal pole with the temporal pole have suffered. What fascicle it?
+uncinate fascicle
–inferior longitudinal fascicle
–superior longitudinal fascicle
–arcuate fibers
–cingulum

A patient has tumor of the right hemisphere, which has squeezed associative fibers of the white matter, connecting the cortex of the temporal and occipital lobes. Name these fibers.
+inferior longitudinal fascicle
–superior longitudinal fascicle
–uncinate fascicle
–arcuate fibers
–cingulum

The corpus callosum was cut out in the surgical treatment of epilepsy. What fibers were cut out?
+commissural
–projection
–associative
–pyramidal
–extrapyramidal

The loss of sight was observed after a head trauma in the occipital regione. What was found during examination?
+pathologic process is located in cortical end of the visual analyzer (area of calcarine sulcus)
–pathologic process is located in the parietal lobe of a brain
–pathologic process is located in the medial geniculate body
–pathologic process is located in the cerebellum
–pathologic process is located in the medulla oblongata

A patient has lost the ability to write letters after problems with cerebral blood supply. The damage of which lobe of the brain can result in such pathology?
+frontal lobe
–insula
–parietal lobe
–occipital lobe
–temporal lobe

A patient has unilateral paralysis of the left inferior extremity. What area of the cerebral cortex is the center of the lesion?
+the right precentral gyrus
–the superior parietal lobule
–the postcentral gyrus
–the left precentral gyrus
–the middle temporal gyrus

A patient has disoder of superficial and deep sensitivity on circumscribed sites of the body. What gyrus defeat was diagnosed by the doctor?
+postcentral gyrus
–precentral gyrus
–superior temporal gyrus
–middle temporal gyrus
–gyrus fornicatus

A patient has a hemorrhage in the postcentral gyrus. In what kind of sensory processing disoder at the opposite side of the body will it result?
+skin and proprioceptive
–olfactory and gustatory
–auditory and visual
–auditory
–visual

A patient has lost an ability to pronounce words distinctly after an injury of the brain. What area of the cerebral cortex has been affected?
+frontal lobe
–occipital lobe
–parietal lobe
–temporal lobe
–insula

A patient has an acute hearing impairment. There is no pathology in sound conducting and perceiving structures. What gyrus of the cerebral cortex has been affected by pathological changes?
+superior temporal
–middle temporal
–superior frontal

–supramarginai
–angular

A patient has muscle paralysis of the left upper and lower extremities. What gyrus of the cerebral cortex has suffered a stroke?
+precentral
–postcentra.
–middle frontal
–inferior frontal
superior frontal

A patient does not understand the sense of words and his native language (verbal deafness). What gyrus of the cerebral cortex has suffered a stroke?
+superior temporal
–postcentral
–inferior frontal
–superior parietal lobule
–inferior parietal lobule

A patient complains of impossibility to recognize objects through touch. Which cortical area has to be damaged to cause astereognosis?
+in the cortex superior parietal lobule
–in the cortex of middle frontal gyrus
–in the cortex of the superior temporal gyrus
–in the cortex of occipital lobe
–in the cortex of inferior parietal lobule

A patient has signs of sensory aphasia, that is the patient hears sounds but has lost ability to understand words. Which cortical areas have to be damaged?
+in the temporal lobe
–in the frontal lobe
–in the occipital lobe
–in the parietal lobe
–in the insula

A patient is experiencing a true taste loss. The clinical examination has established cortical localization of the pathological process. Where is it located?
+in the uncus and hippocampus
–in the uncus and the inferior part of the precentral gyrus
–in the angular gyrus and the hippocampal gyrus
–in the inferior frontal gyrus and the subcallosal area
–in the subcallosal area and the cingulate gyrus

A hemorrhage in the cortical area between calcarine and parietooccipital sulci was found in the patient. What is that cortical area called?
+cuneus
–uncus
–precuneus
–cingulum
–paracentral lobule

A patient has ceased recognizing the relatives after a serious closed craniocerebral trauma. What cortical center is damaged?
+cortex above the calcarine sulcus
–cortex of the supramarginal gyrus
–cortex of the superior temporal gyrus
–cortex of the precentral gyrus
–cortex of the postcentral gyrus

A patient has complained of the loss of the abiliity to write words. The diagnosis of a written aphasia was put by a doctor. What cortical analyzer is damaged?
+cortical center of the motor analyzer of written speech
–cortical center of the sensitive analyzer
–cortical center of the motor analyzer of spoken speech
–cortical center of the motor analyzer
–cortical center of the visual analyzer

A patient has lost the ability to carry out complex coordinated movements (apraxia) after traumatic event. Where is the corresponding cortical center located?
+ in the supramarginalis gyru
–in the parahipocampalis gyrus
– in the angularis gyrus
– in the paracentralis gyrus
– in the lingualis gyrus

A patient has lost the ability to coordinated turning of the head and eyes in the opposite direction after traumatic brain injury. Where is the corresponding cortical center located?
+posterior part of the middle frontal gyrus
–frontal pole

–posterior part of the superior frontal gyrus
–angular gyrus
–inferior parietal lobule

A patient has lost the ability to carry out complex combined movements (apraxia) after traumatic brain injury. Where is the corresponding cortical center located?
+inferior parietal lobule
–posterior part of the superior frontal gyrus
–frontal pole
–paracentral lobule
–posterior part of the middle frontal gyrus

A patient has motor neuron disorder which affects facial muscles. Where is the corresponding cortical center located?
+inferior part of the precentral gyrus
–superior part of the precentral gyrus
–supramarginal gyrus
–superior parietal lobule
–angular gyrus

A patient has a motor aphasia. What part of the brain is damaged?
+inferior frontal gyrus
–superior temporal gyrus
–hypoglossal nerve
–middle frontal gyrus
–angular gyrus

Visual perception is broken in the person after traumatic brain injury. What area of the cerebral cortex has been damaged?
+occipital area of the cortex
–postcentral gyrus
–parietal area of the cortex
–temporal area of the cortex
–precentral gyrus

Sound perception is broken in the person after traumatic brain injury. What area of the cerebral cortex has been damaged?
+temporal lobe of the cortex
–parietal lobe of the cortex
–occipital a lobe of the cortex
–precentral gyrus
–postcentral gyrus

The brain injury has resulted in motor speech disoder. What area of the cerebral cortex has been damaged?
+inferior frontal gyrus
–superior temporal gyrus
–middle temporal gyrus
–supramarginal gyrus
–precentral gyrus

A patient has disoders of pain and temperature sensation after a spinal cord injury. Fibers of what conducting tract were destroyed?
+lateral spinothalamic tract
–aterior spinocerebellar tract
–lateral spinocortical tract
–medial spinocortical tract
–posterior spinocerebellar tract

Pain and temperature sensations on the left half of the trunk are absent after injury. Damage to which conducting tract can cause this phenomenon?
+tractus spinothalamicus lateralis on the right
– tractus spinothalamicus anterior on the right
– tractus spinothalamicus lateralis on the left
– tractus spinothalamicus anterior on the left
–fascicles of Goll and Burdach on the left

Damage to the posterior funiculus of the spinal cord at the level of the 1st thoracic vertebrae has deen revealed in the victim. What conducting tracts have suffered?
+tactile and proprioceptive sensitivity
–pain and temperature sensitivity
–corticospinal
–spinocerebellar
–extrapyramidal

The posterior funiculi of the spinal white matter have been damaged as a result of the knife wound. What neurologic disoders can be observed in this case?
+disoders of proprioceptive, tactile sensitivity, and stereognosis
–disoders of pain sensitivity and thermoesthesia
–disoders of touch and pressure sensitivity
–disoders of conscious and voluntary movements
–disoders of unconscious and involuntary movements

Following an injury of spinal cord, the victim lost tactile sensitivity, sense of body position

and vibration sense. What conducting tracts have been damaged?
+Goll's and Burdach's fascicles
–Flechsig's and Gowers' tracts
–rubrospinal tract
–reticulospinal tract
–tectospinal tract

The pyramids of the medulla oblongata are damaged in the patient with tumour. What conducting tracts carrying out nerve impulses are damaged?
+tractus corticospinalis
–tractus corticopontinus
–tractus corticonuclearis
–tractus dentatorubralis
–tractus spinocerebellaris

In a patient with local defeat of the brainstem, the conducting tracts of crus cerebri are damaged. What conducting tract is forming the ventral tegmental decussation?
+ tractus rubrospinalis
– tractus tectospinalis
– tractus corticospinalis anterior
– tractus corticospinalis lateralis
– tractus corticonuclearis

Appreciably expanded the lateral and the third ventricles were revealed at the patient. The doctor diagnosed a blockage of cerebrospinal fluid pathways. Define an area of the occlusion:
+cerebral aqueduct
–interventricular foramen
–median aperture of the fourth ventricle
–lateral aperture of the fourth ventricle
–arachnoidal [pacchionian] granulations

A patient complains of a pain in the lumbar region. The doctor diagnosed the lumbar radiculitis. Where was a compression of spinal roots most likely?
+in the intervertebral foramens of the lumbar vertebral column
–in the vertebral canal
–in the nutrition foramens of the lumbar vertebrae
–in the foramena of transverse processes of the cervical vertebrae
–in the matter of lumbar segments of the spinal cord

A patient has ceased to feel pain from a prick during injections after a hemorrhage. What structures of the nervous system may be damaged?
+nucleus of the thalamus
–medial geniculate bodies
–lateral geniculate bodies
–red nucleus
–basal nuclei of the cerebral hemispheres

Between what vertebrae is the lumbar puncture made in adults?
+L3–L4
–L1–L2
–L2–L3
–L4–L5
–L5–S1

A patient after trauma to the spinal cord, has lost deep sensitivity and movements in the right lower limb. What part of the spinal cord is injured?
+the right half of the spinal cord
–the anterior part of the spinal cord
–the posterior part of the spinal cord
–the left half of the spinal cord
–a complete transversal break of the spinal cord

An injury of the posterior funiculi of the spinal cord at the level of the first–order thoracic vertebra is revealed in the victim. What conducting tracts are damaged?
+tactile and proprioceptive sensitivity
–pain and thermoesthesia
–corticospinal
–spinoserebellar
–extrapyramidal

A patient, after a head injury, hears and understands speech, but cannot correctly name an object. What gyrus is damaged?
+inferior frontal gyrus
–superior frontal gyrus
–anterior frontal gyrus
–middle frontal gyrus
–middle temporal gyrus

A patient, working as a mechanic, has suddenly lost the ability to carry instruments

during hes work. In what lobe of the brain is a center of injury located?
+in the supramarginal gyrus
–in the angular gyrus
–in the superior temporal gyrus
–in the superior parietal lobule
–in the occipital lobe

A patient has suddenly lost the ability to read a text. He sees letters, but not able to make words of them. In what lobe of the brain is the injury located?
+in the anglular gyrus
–in the middle temporal gyrus
–in the supramarginal gyrus
–in the superior parietal lobule
–in the occipital lobe

The loss of tactile sensitivity is revealed during medical examination of the patient with damage to cerebral hemispheres. What region of the cerebral cortex has been damaged?
+postcentral gyrus
–frontal lobe
–occipital lobe
–parietal lobe
–precentral gyrus

Cerebellar ataxy (the loss of body equilibrium) is observed in a patient after poisoning by an unknown pesticid. What cerebellum nucleus is damaged in this case?
+nucleus fastigii
–nucleus emboliformis
–nucleus dentatus
–nucleus globosus
–all nuclei

Involuntary movements and muscle tone derangement in the trunk were developed in the patient after the brain disease. What conductive tract is damaged?
+tractus rubrospinalis
–tractus corticospinalis
–tractus corticonuclearis
–tractus olivospinalis
–tractus tectospinalis

A patient cannot read and understand written words (alexia), but visual function is not broken. What analyzer nucleus has been injured?
+nucleus of the visual analyzer of written speech
–nucleus of the motor analyzer of written speech
–nucleus of the acoustic analyzer of oral speech
–nucleus of the visual analyzer
–nucleus of the motor analyzer of oral speech

A patient has complete demyelination of ascending conductive tracts. What kind of sensitivity will persist under these conditions?
+vision
–thermoesthesia
–vibratory sensitivity
–sensation of pressure
–proprioception

The expansion of the third brain ventricle is marked in the patient. What structure takes part in formation of its anterior wall?
+lamina terminalis
–septum pellucidum
–corpus fornicis
–pedunculi fornicis
–stria medullaris

After having meningoencephalitis a patient suffers from a spinal fluid accumulation in ventricles of the brain. What could cause this phenomenon?
+obturation of apertures in the 4th ventricle
–obturation of interventricular foramen on the left side
–obturation of the interventricular foramen on the right side
–obturation of the cerebral aquiduct
–obturation of the central canal of the spinal cord

Voluntary movements of the head and neck muscles and the hematoma at the genu of the internal capsule are observed in the patient. What conducting tract is injured?
+tractus corticonuclearis
– tractus cprticofrontopontinus
– tractus corticospinalis
– tractus corticothalamicus
– tractus thalamocorticalis

A test of a pupillary reflex in the patient has demonstrated retardation of of the left eye reaction to the light. The function of what vegetative nucleus is implied?

+parasympathetic nucleus of CNIII (Yakubovich nucleus)
–nucleus of the trochlear nerve
–red nucleus
–nucleus of the superior colliculi of the lamina qudrigemina
–nucleus of inferior colliculi of the lamina quadrigemina

In the patient, the pathological defect of the right and left lateral ventricles has formed. What anatomic structure of the brain was damaged?

+septum pellucidum
–a falx cerebri
–anterior cerebral comissure
–posterior cerebral comissure
–a corpus callosum

A student has asked the anatomy teacher the name of the part of the lobe that is posed between the cingulate sulcus and the parieto-occipital sulcus of the hemisphere. What is it called?

+precuneus
–cuneus
–insula
–cingulum
–uncus

A patient has ceased to understand speech after a hemorrhagic stroke. Where is the pathological center located?

+posterior parts of the superior temporal gyrus
–a medial surface of the superior temporal gyrus
–posterior parts of the middle temporal gyrus
–superior parietal lobule
–posterior parts of the inferior frontal gyrus

Dilated 1–3 ventricles were revealed in the patient with brain tumour after special x–ray examination. Specify the most probable localization of the tumour:

+mesencephalon
–telencephalon
–pedulla oblongata
–Pons
–cerebellum

SENSE ORGANS

In the patient, suffering from diabetes mellitus, inflammation of the sebaceous glands (glands of Zeis) of the upper eyelids occurs periodically. What nerve supplies the upper eyelid?

+n. ophtalmicus
–n. oculomotorius
–n. abducens
–n. trochlearis
–n. infraorbitalis

A patient has stable strabismus of the right eye, the ability to abduct the eye is lost after a cerebral hemorrhage. What nucleus of the cranial nerve is damaged by hemorrhage?

+n. abducens dexter
–n. facialis dexter
–n. oculomotorius
–n. abducens sinister
–n. trochlearis

A patient has a convergent strabismus of the right eye after a craniocerebral trauma. What cranial nerve damage has resulted in such visual consequence?

+n. abducens
–n. oculomotorius
–n. trochlearis
–n. trigeminu
–n. facialis

A patient has signs of loss of the vision and optic reflex. What nuclei of the brainstem are damaged?

+nuclei of the superior colliculi of the tectal lamina
–nuclei of the third cranial nerve
–nuclei of the inferior colliculi of the tectal lamina
–nuclei of the trochlear nerve
–nuclei of the abducent nerve

A patient has accommodation disorder of the eyes, bilateral ptosis (drooping of the upper eyelids), and divergent strabismus. Pupils are expanded. Nuclei of which cranial nerves are affected?

+CNIII

–CNIV
–CNV
–CNVI
–CNVII

Damage to the external wall of the orbit is detected in a patient. The victim can not abduct the eyeball on the injured side. What nerve could be affected in this case?
+n. abducens
–n. trochlearis
–n. oculomotorius
–n. ophthalmicus
–chorda tympani

A patient has drooping eyelids, inability to turn eyes upwards and inwards, expanded pupils which do not react to light. What nerve is damaged?
+oculomotor
–trochlear
–abducent
–optic
–trigeminal

A patient has accommodation disoders of the eyes and expanded pupils, which do not react to light. Function of which muscles is disturbed?
+m. sphincter pupillae, m. ciliaris
–m. dilatator pupillae, m. ciliaris
–m. oliquus superior, m. ciliaris
–m. rectus lateralis, m. sphincter pupillae
–m. sphincter pupillae, m. dilatator pupillae

Loss of medial visual fields caused by a tumour of the hypophysis is revealed in a patient. What part of visual pathways is compressed by tumour?
+chiasma opticum
–n. opticus
–tractus opticus
–corpus geniculatum mediale
–corpus geniculatum laterale

A three–year–old child has entered a hospital with the diagnosis of a divergent squint. What nerve is damaged?
+oculomotor
–optic
–trochlear
–abducent
–ophthalmic

A patient has a drooping upper eyelid (ptosis) and strabismus. Dysfunction of what nucleus is assumed by the doctor?
+motor nucleus of the oculomotor nerve
–motor nucleus of the trigeminal nerve
–subcortical visual nuclei
–motor nucleus of the facial nerve
–cortical visual center

A patient complains of a strong headache, pain in eyes after excessive close work and blurred vision during reading. What eye muscle is defeated?
+sphincter muscle of pupil
–dilator muscle of pupil
–superior oblique muscle
–inferior oblique muscle
–orbital muscles

During clinical examination of the patient, a deviation of the left eyeball medially and inability of abduction is revealed. What muscle is affected?
+lateral rectus muscle
–superior rectus muscle
–medial rectus muscle
–inferior oblique muscle
–levator palpebrae muscle

Accommodation disorder of the eyes and pathology of the ligament, running from the lens capsule to the ciliary body, were observed in the patient. What ligament is affected?
+zonula ciliaris
–ligamentum lentis
– ligamentum capsularis
– ligamentum pectinatum iridis
–corpus vitreum

The diagnosis of coloboma (cleft) was made after clinical examination of the patient. What tunic of an eyeball is affected?
+iris
–ciliary body
–cornea
–retina
–sclera

The diagnosis of cataract was made after clinical examination of the patient. What structures of an eyeball can be affected by such pathology?
+lens
–corpus ciliare
–corpus vitreum
–iris
–cornea

A patient complains of abnormal accommodation. What structure is responsible for an accommodation and is injured in the patient?
+lens and a ciliary body
–anterior chamber of an eye
–iris
–vitreous body
–posterior chamber of an eye

Dysfunction of receptors which are responsible for color perception was revealed after the retina examination of the patient. What receptors are damaged?
+cones
–rods
–bipolar cells
–multipolar cell
–ganglionic cells

Eye examination of the patient has revealed intraocular pressure increase. What liquid outflow disoder has evoked that condition?
+aqueous humor
–perilymph
–endolymph
–lymph
–tear

Fast dilation (widening) of the pupil (mydriasis) has occured following the application of atropine eye drops. What muscle stops working?
+pupil sphincter muscle
– pupil dilator muscle
–ciliary muscle
–all rectus muscles
–all oblique muscles

The pupillary reflex is broken in the patient. The pupils are small, the patient badly orientates himself in the dark. What muscle of an eyeball function is broken?
+m. dilatator pupillae
–m. obliquus bulbi inferior
–m. sphincter pupillae
–m. ciliares
–m. obliquus bulbi superior

A patient has hearing loss. What anatomical structure does not participate in conduction of mechanical vibrations to Corti's organ?
+scala vestibuli
–ossicula auditus
–membrana tympani
–scala tympani
–tuba auditiva

A patient complains of giddiness, nausea, and balance disoder after trauma to the head. What structure of inner ear produces such symptoms?
+vestibular apparatus
–membrana tympani
–labyrinthus osseu
–organum spirale
–canalis longitudinalis modioli

A child has an increase of the pharyngeal tonsil closing-the pharyngeal aperture of the auditory tube. What wall of the tympanic cavity does the auditory tube open?
+paries caroticus
–paries jugularis
–paries labyrinthicus
–paries mastoideus
–paries tegmentalis

A child complains of cold in the head and pain in the ear. Through what aperture of the pharynx the infection has got to the tympanic cavity and caused its inflammation?
+pharyngeal opening of auditory tube
–tympanic opening of auditory tube
–choanae
–fauces
–aperture of larynx

A child has signs of inflammation of the cranial dura mater after otitis media with purulent effusion (inflammation of the middle ear). What way could the infection be distributed?

+through the vestibular aqueduct
–through the cochlear fenestra
–through canaliculus tympanicus
–through the vestibular fenestra
–through the cohlear canaliculus

A child has enlarged tubal tonsil, blocking pharyngeal opening of the auditory tube. What does the auditory tube connect the cavity of pharynx with?
+ tympanic cavity
– laryngeal cavity
– internal ear
– nasal cavity
– mouth

The superior wall of the tympanic cavity is destroyed by pus because of otitis media with purulent effusion. Which cranial fossa distributes pus from tympanic cavity?
+middle cranial fossa
–posterior cranial fossa
–anterior cranial fossa
–orbit
–pterygopalatine fossa

Inflammation of the tympanic cavity is complicated by an inflammation of the dura mater. What wall of the tympanic cavity can the infection penetrate into a cranial cavity?
+superior wall
–inferior wall
–lateral wall
–medial wall
–posterior wall

A patient has tonsillitis which is complicated by an acute otitis media (inflammation of the tympanic mucosa). What are the anatomic preconditions for this process?
+eustachian tube
–Waldayer`s–Pirogov tonsillar ring
–fallopian tubes
–congenital anomalies of the pharynx
–piriform sinus

Inflammation of the middle ear was complicated by mastoiditis. Later on, there was a threat of a purulent clotage of the nearest venous sinus. What sinus was affected?
+sigmoid sinus
–inferior petrosal sinus
–superior sagittal sinus
–transverse sinus
–sinus rectus

Inflammation of the middle ear of a child began from nasopharyngeal inflammation. What canal of the temporal bone allows the infection to penetrate to the tympanic cavity?
+musculotubal canal
–carotid canal
–canaliculus of chorda tympani
–canaliculus tympanicus
–caroticotympanic canaliculi

A patient has worsened olfaction after traumatic injury of the temporal area of the head. What anatomic structure is injured?
+uncus
–fila olfactoria
–trigonum olfactorium
–buldus olfactorius
–tractus olfactorius

The olfactory fibers leaving a nasal cavity were broken because of trauma. What bone do these fibers pass through?
+ethmoid bone
–sphenoid bone
–maxilla
–inferior nasal concha
–nasal bone

A patient recuires a nail plate of the right thumb to be removed. What pecularities of the anatomic structure of the nail the surgeon should take into account during operation?
+the nail is an epidermal derivative
–the nail is an osteal tissue growth
–the nail is a cartilaginous plate
–the nail is a growth of tendons
–the nail is a dermal derivative

The sebaceous glands have not been revealed in the skin test during medicolegal investigation. What part of the body does the delivered material belong to?
+sole of the foot
–transitional zone of the lips
–glans of penis
–skin of the mammary gland

–skin of the scrotum

The diagnosis of gynecomastia was made to a young man during medical examination in the recruiting office. What are symptoms and causes of this disoder?
+development of mammary glands due to high estrogen level as in female
–absence of hair
–development of the additional mammary glands
–diminution of working sweat glands
–formation of false pudendal lips

A young woman has addressed to a beauty clinic. She considers her mammary glands to be posed too low. What level are the mammary glands should be located to be normal?
+ ribs 3 – 6
– ribs 4 – 7
– ribs 2 – 5
– ribs 3 – 4
– ribs 4 – 6

The surgeons prefer radial incisions in the surgery of mammary glands. What anatomical features underlie such surgical technique?
+the apices of the lobules converge on the nipple of the breast
–the bases of the lobules are inverted nipples
–the lobules are placed transversely
–the lobules are placed vertically
–the lobules are placed horizontally

A 42 year–old woman addressed to the surgeon concerning an induration in the right mammary gland. What normal amount of lobules should be in mammary glands?
+15–20 lobules
–25–30 lobules
–4–6 lobules
–6–8 lobules
–10–12 lobules

A patient has taste disturbance. But the tongue still has tactile, pain and temperature sensitivity. What papillae of the tongue are not gustatory?
+filiform papilla
–vallate papilla
–fungiform papilla
–foliate papilla

A young mother complained on absence of tears when her 2–week–old baby was crying. When do the lachrymal glands start to work in newborn babies?
+since 3 weeks old
–about 2 months old
–about 6 months old
–since 8 weeks old
–right after birth

A brain tumor, which is located in the site of the left optic tract, is found in the patient. What vision disorder can be observed in the patient?
+loss of vision in the lateral half of the visual field of the left eye and in the medial half of the visual field of the right eye
–loss of vision in the left half of the visual field of both eyes
–loss of vision in the right half of the visual fields of both eyes
–loss of vision in both halves of the visual fields of the left eye
–loss of vision in both halves of the visual fields of the right eye

Due to trauma, the different diameter of pupils (anisocoria) is observed in the patient. What muscle activity is blocked?
+musculus sphincter pupillae
–musculus ciliaris
–musculus dilatator pupillae
–musculus rectus superior
–musculus rectus inferior

A 50–year–old patient complains of narrow vision getting worse. Which muscle fibres become worse?
+meridional fibers of the ciliary muscle
–circular fibers of a ciliary muscle
–radial fibers of the iris
–circular fibers of the iris
–sceletal muscles of the eye

A patient has a tumor of the superior nasal meatus. What symptoms can we recognize?
+olfactory disorders
–taste disorder
–respiratory disorders

–swallowing disorders
–disorders of salivation

A patient has glaucoma. The damage of what structure in the wall of an eyeball causes permanent obstruction of aqueous outflow from the anterior chamber?
+venous sinus
–vascular coat
–posterior corneal epithelium
–ciliary body
–ciliary muscle

The diagnosis of a right–hand mastoiditis was made to the patient. Specify the most probable source of purulence in the mastoid air cells:
+from the tympanic cavity
–from sterno–cleido–mastoid muscles
–from spongy substance of the occipital bone
–from subcutaneous fatty tissue
–from middle cranial fossa

A doctor diagnosed hidradenitis suppurativa (inflammation of sudoriferous sweat glands located in the axillary fossa). In what skin layer are the sudoriferous glands located?
+in the reticular dermis
–on the border between the epidermis and derma
–in the papillary derma
–in the epidermis
–in the subcutaneous adipose tissue

An anaesthesiologist monitors pupillary light response during anaesthesia. What nuclei in the brainstem are responsible for pupillary reaction to light?
+nucleus of the superior collicuus
–nucleus ambigus
–nucleus of the lateral geniculate body
–accessory nucleus of the oculomotor nerve
–motor nucleus of the trigeminal nerve

A diagnosis of chronic rhinitis (inflammation of the nasal mucosa) was made to a patient. Derangement in olfaction was detected. What nervous structures are damaged?
+ olfactory nerve receptors
–olfactory bulb
–olfactory tract
–cingulate gyrus
–septum pellucidum

A victim has lost the abiliuty to lift the right eyelid and the right eye after trauma to the superior wall of the right orbit. What nerve is damaged?
+superior ramus of the oculomotor nerve
–inferior ramus of the oculomotor nerve
–trochlear nerve
–abducens nerve
–ophthalmicus nerve

Loss off vision of the right halves of both eyes retina is detected in a patient. The patient has no ocular pathology. Where can the damage be located most probably?
+at the right cortical end of the visual analyzer
–at the left cortical end of the visual analyze
–at the optic chiasm
–in an optic nerve
–in the retina

Loss of vision in the medial half of the vision field of both eyes is detected in the patient. What part of the visual pathway is damaged?
+chiasma opticus
–nervus opticus
–tractus opticus
–sulcus calcarinus
–retina

Divergence insufficiency is detected in the patient. What muscles of the eyeball are damaged?
+ rectus lateralis
–rectus medialis
–rectus superior
–rectus inferior
–obliqus oculi superior

A patient has loss of hearing in the left ear. Where are nuclei of the damaged nerve located?
+vestibular area of the rhomboid fossa
–hypothalamus
–diencephalon
–midbrain
–pedunculi cerebri

A patient has dysfunction of postural orientation and equilibrium. What nuclei of the brainstem are damaged?

+vestibular nuclei
–nucleus of the facial nerve
–nuclei of the medial geniculate body
–motor nucleus of the eleventh cranial nerve
–nuclei of the lateral geniculate body

A patient has hearing loss because of CN VIII damage. Where are the first–order neuron of the auditory pathway located?
+ganglion spirale
–ganglion trigeminale
–ganglion vestibulare
–ganglion geniculi
–ganglion ciliare

A patient complains of giddiness and loss of hearing in the right ear. What nerve is damaged?
+right vestibulocochlear nerve
–left vestibulocochlear nerve
–hypoglossal nerve
–vagus nerve
–trochlear nerve

A patient has hearing loss because of the CNVIII damage. Where are the second-order neuron of the auditory pathway located?
+nucleus cochlearis ventralis et dorsalis
–nucleus cochlearis lateralis et medialis
–nucleus cochlearis accessorius
–nucleus vestibularis lateralis et medialis
–nucleus vestibularis ventralis et dorsalis

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