Anatomy 1

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BUNA (emergency medical services)

- BUNA of anatomy exercises is valid only for RM majors.
- The prerequisite for passing is to solve the tasks at the end of each presentation (link will be provided later).
- Nursing students are also encouraged to solve assignments (this can be useful for passing the credit at the end of the class).

Why do we need anatomy?

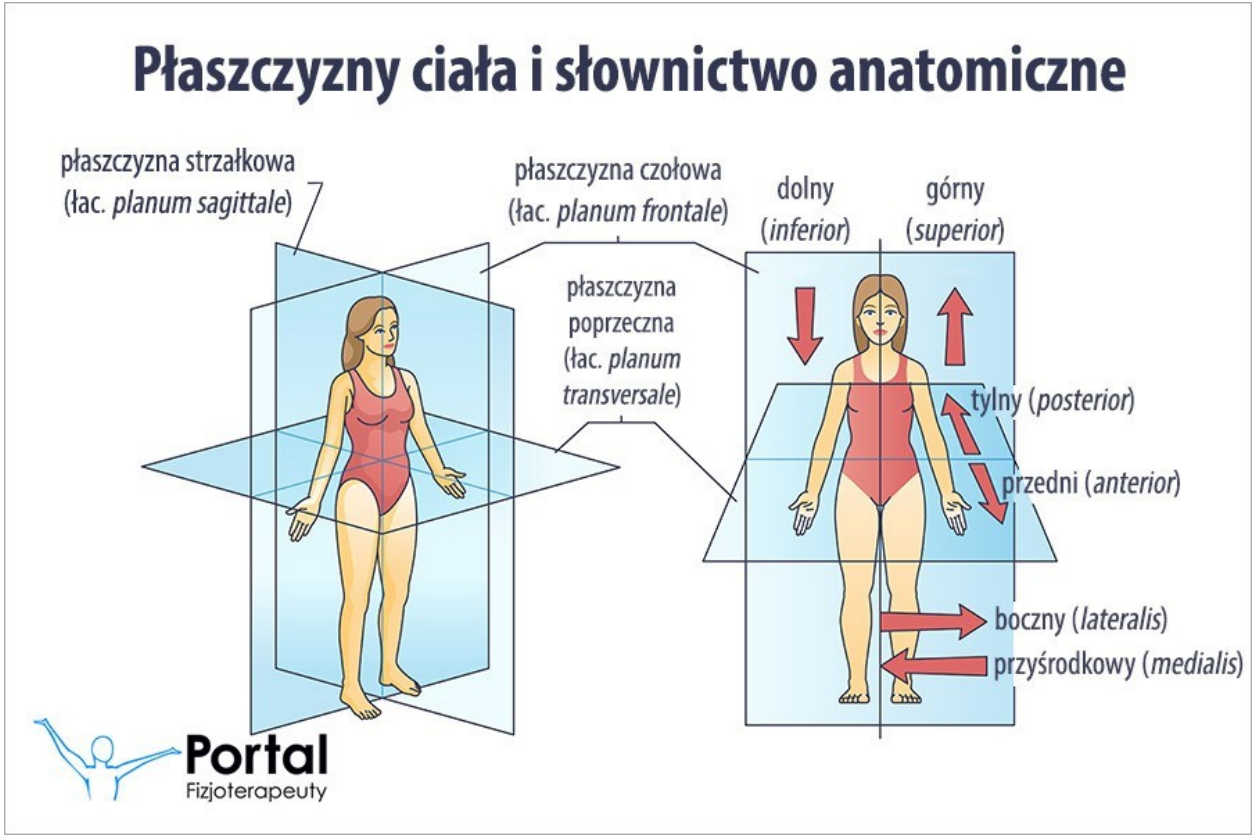
Anatomical position

- Provides a basis for describing the position of organs in relation to each other
- Standing, upright position, upper limbs hanging loosely
- Palms facing forward, thumbs to the side

https://fizjoterapeuty.pl/anatomia/position-anatomical-axes-planes-and-movements.html

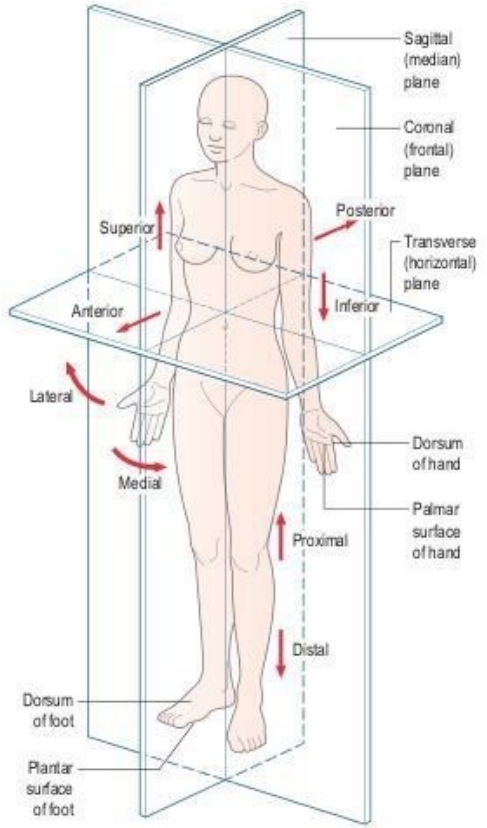
Axes and planes of the body

- Coats:
  - front
  - sagittal
  - horizontal
- Axes:
  - vertical
  - transverse
  - sagittal



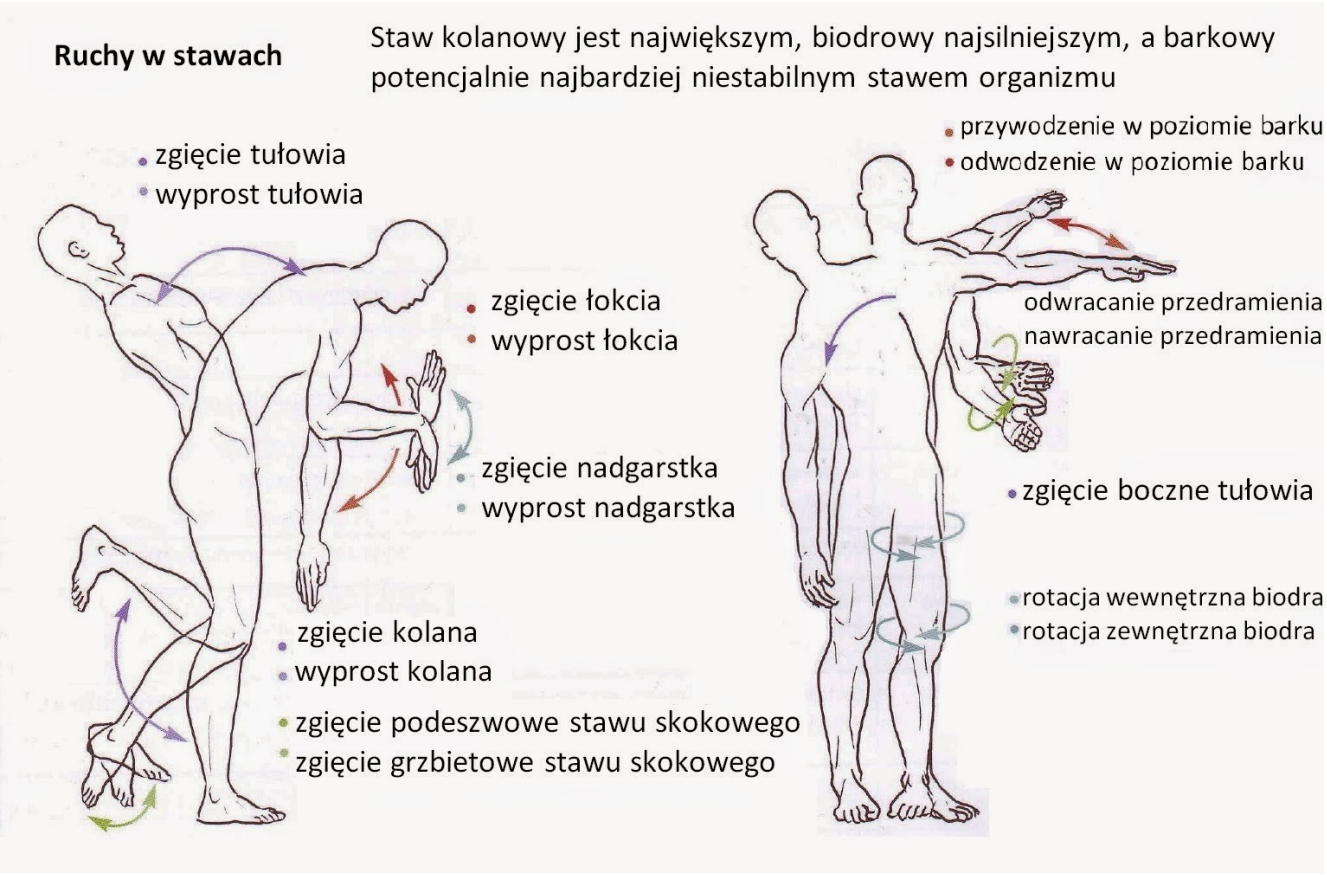
Position descriptions

- Closer = proximal (proximal)
- Further = distal (distal)
- Front = anterior
- Rear = posterior
- Top = superior
- Lower = inferior
- Lateral = lateral
- Medial = medial



https://docplayer.pl/89905042-Biomechanika-inzynierska.html

Movement descriptions

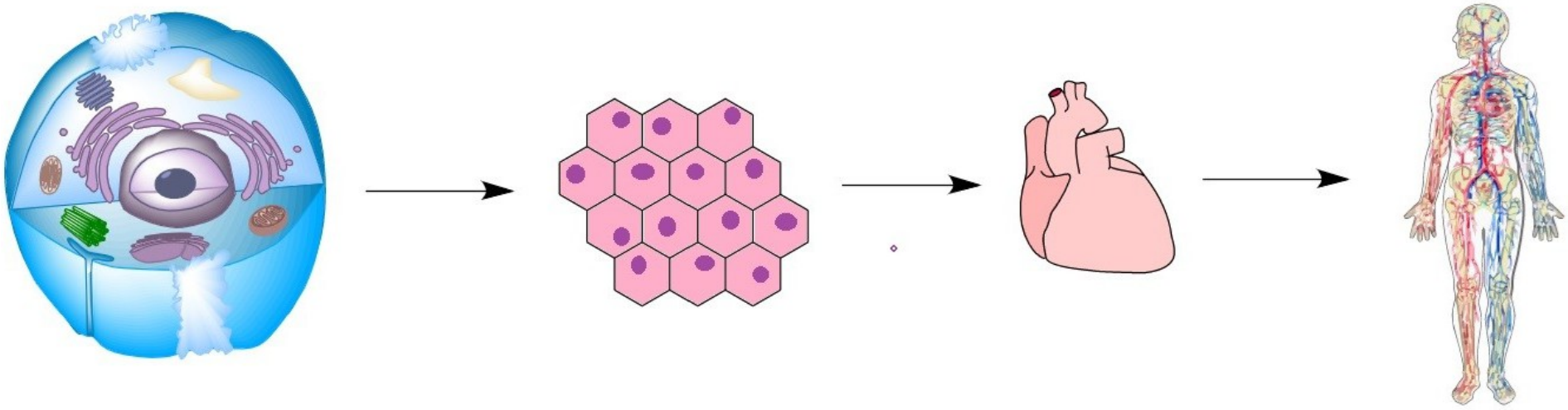


- **Bend**
- **Straightening out**
- **Visit**
- **Bringing**
- **Internal rotation**
- **External rotation**

https://trener-bytomski.blogspot.com/2014/12/ruchy-w-stawach.html

Histology or microscopic anatomy

Cell → tissue → organ → system → organism

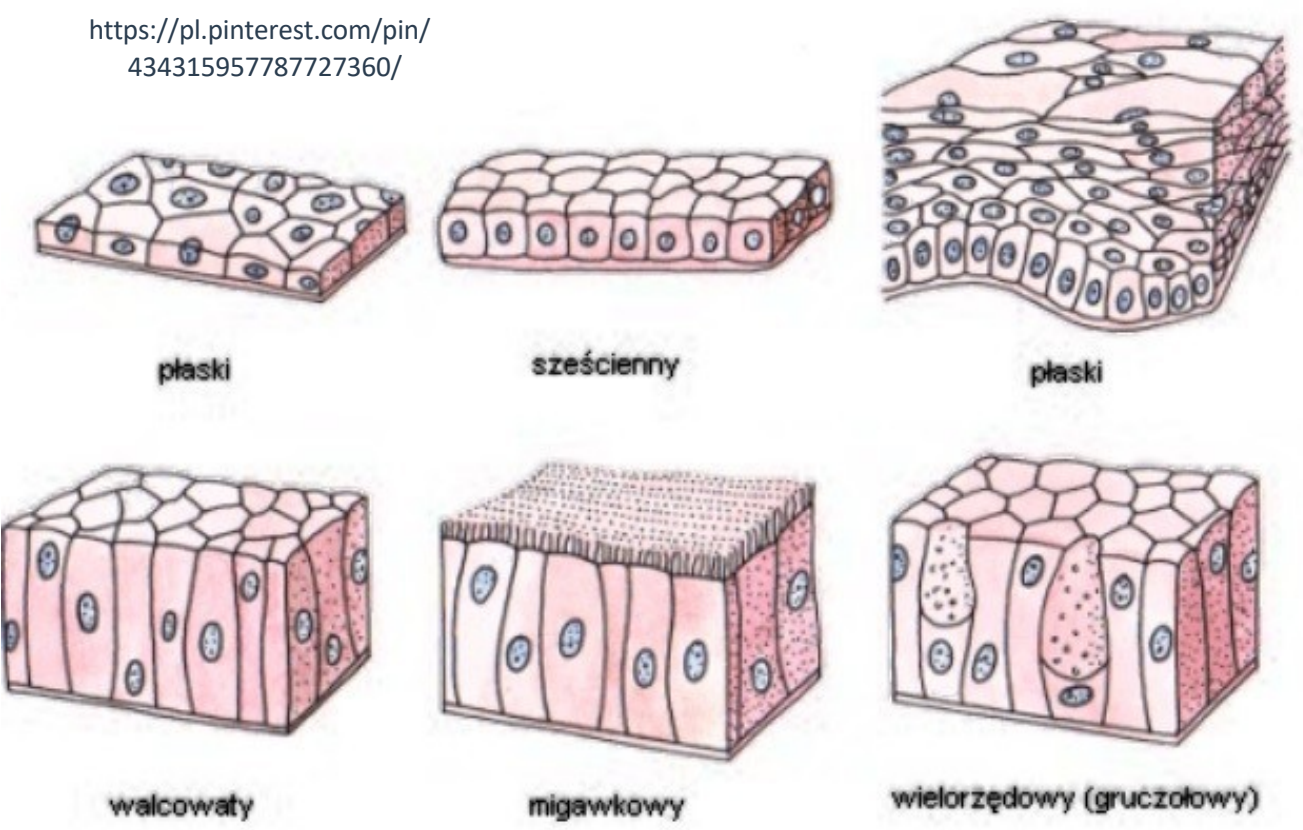


Types and functions of tissues in the human body

- Epithelial: protection, lining cavities and organs having a lumen
- Muscular: generating movement
- Nervous: transmission of nerve impulses
- Combined: support function, filling spaces between other tissues and numerous special functions

Epithelial tissue

https://pl.pinterest.com/pin/434315957787727360/



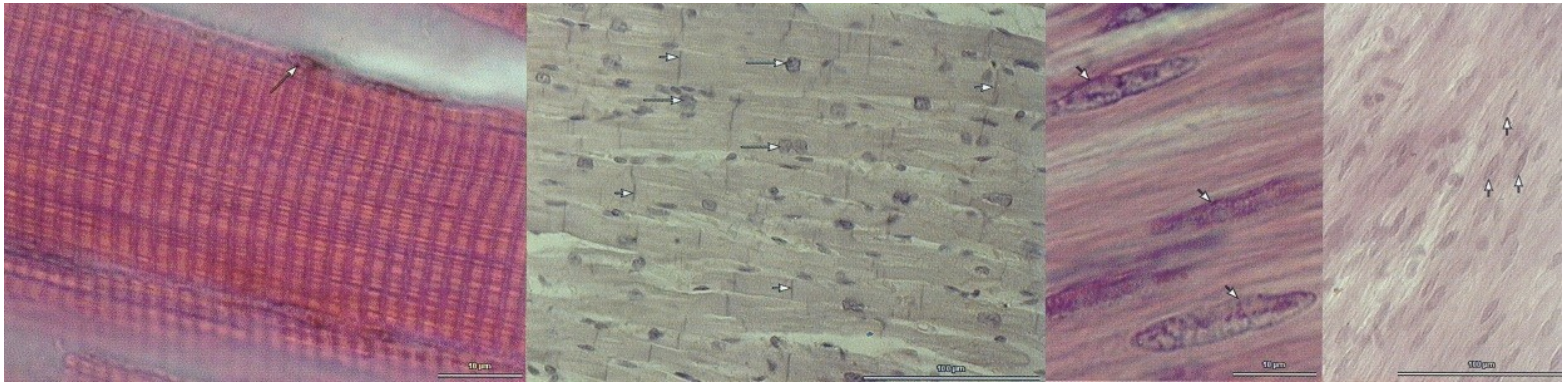
In the human body, different types of epithelia perform different functions. Epithelia can have only 1 layer of cells or have multiple layers.

Shutter epithelium - possesses special protuberances, the movement of which allows clearing the airways (the shutters stop working properly when exposed to inhaled pollutants, including tobacco smoke).

Monolayer squamous epithelium lining the vascular walls from the inside (endothelium) - its proper function is essential for uninterrupted blood flow.

Muscle tissue

- Transversely striated skeletal
- Transverse striated cardiac
- Smooth (urinary tract, gastrointestinal tract, blood vessels...) → contraction / diastole slowest.



A. Mysliwski, P. Trzonkowski et al, Histological Atlas, Operon Pedagogical Publishing House 2002.

Connective tissue

https://www.google.com/url?sa=i&url=https%3A%2F%2Fzpe.gov.pl%2Fpdf%2FP4EXp3BMu&psig=AOvVaw2V4M36qotaBrZ0w8LHE3Y6&ust=1699266885501000&source=images&cd=vfe&opi=89978449&ved=0CBEQjRxqFwoTCJDvtsvUrIIDFQAAAAAdAAAAABAV

- **Liquid: blood and lymph**
- **Resistant: bone and cartilage**
- **Connective tissue: flaccid, compact (e.g., dermis, tendons), fatty tissue**

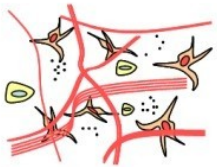
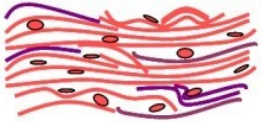
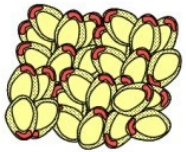
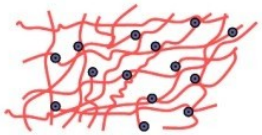
Connective tissue

BUDOWA, ROZMIESZCZENIE I FUNKCJE TKANEK W ORGANIZMIE CZŁOWIEKA

TKANKA ŁĄCZNA WŁAŚCIWA

Komórki tej tkanki są bardzo zróżnicowane tak morfologicznie, jak i pod względem wykonywanych czynności. Mogą mieć różne kształty – od owalnych po gwiaździste i pełnić różne funkcje.

rodzaje tkanki łącznej właściwej

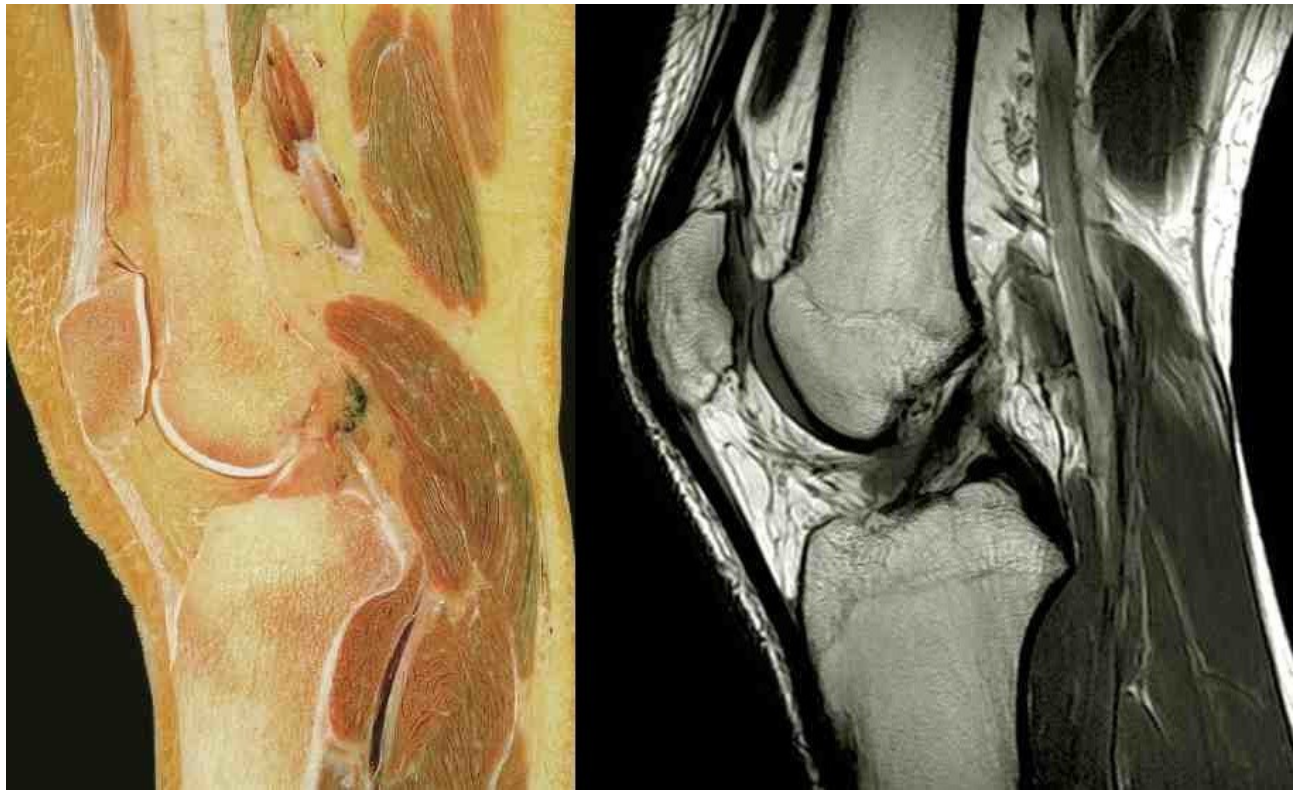
TKANKA ŁĄCZNA WŁÓKNISTA LUŹNA	TKANKA ŁĄCZNA WŁÓKNISTA ZWARTA	TKANKA TŁUSZCZOWA	TKANKA SIATECZKOWA
			
Zawiera włókna kolagenowe oraz różnego typu komórki. Występuje we wszystkich narządach w przestrzeniach międzykomórkowych. Pośredniczy w wymianie substancji między naczyniami włosowatymi a komórkami	Zawiera pęczki włókien kolagenowych i sprężystych. Tworzy więzadła i ścięgna	W jej skład wchodzą komórki tłuszczowe z materiałem zapasowym. Poza magazynowaniem substancji energetycznych pełni również funkcję izolacyjną i ochronną	Włókna i komórki, które się na nią składają tworzą siateczkę w której oczkach leżą limfocyty. Występuje w szpiku kostnym i narządach limfatycznych

TKANKA ZARODKOWA

Buduje ciało zarodków. Jej komórki są zdolne do różnicowania się i przekształcania w różnego rodzaju komórki tkanki łącznej

Layered construction

- Leather
- Subcutaneous tissue
- Muscles
- Bones

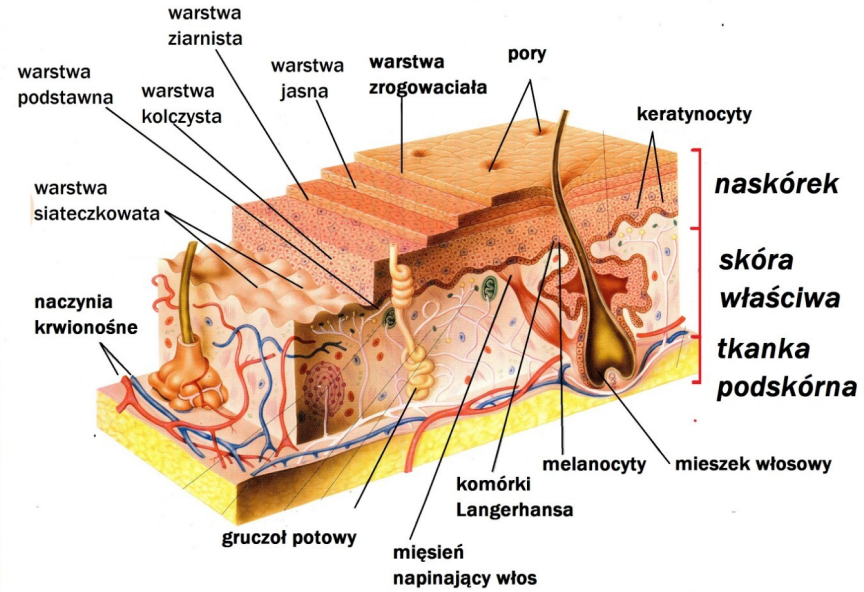


Rohen et al. Color Atlas of Anatomy.
A Photographic Study Of The Human Body.
Seventh Edition, 2011 by Schattauer GmbH.

Skin and subcutaneous tissue

- Skin = epidermis (cornified squamous epithelium) + dermis (connective tissue)

A. Mysliwski, P. Trzonkowski et al, Histological Atlas, Operon Pedagogical Publishing



http://holicos.pl/2017/01/16/budowa-skory/

Peripheral blood

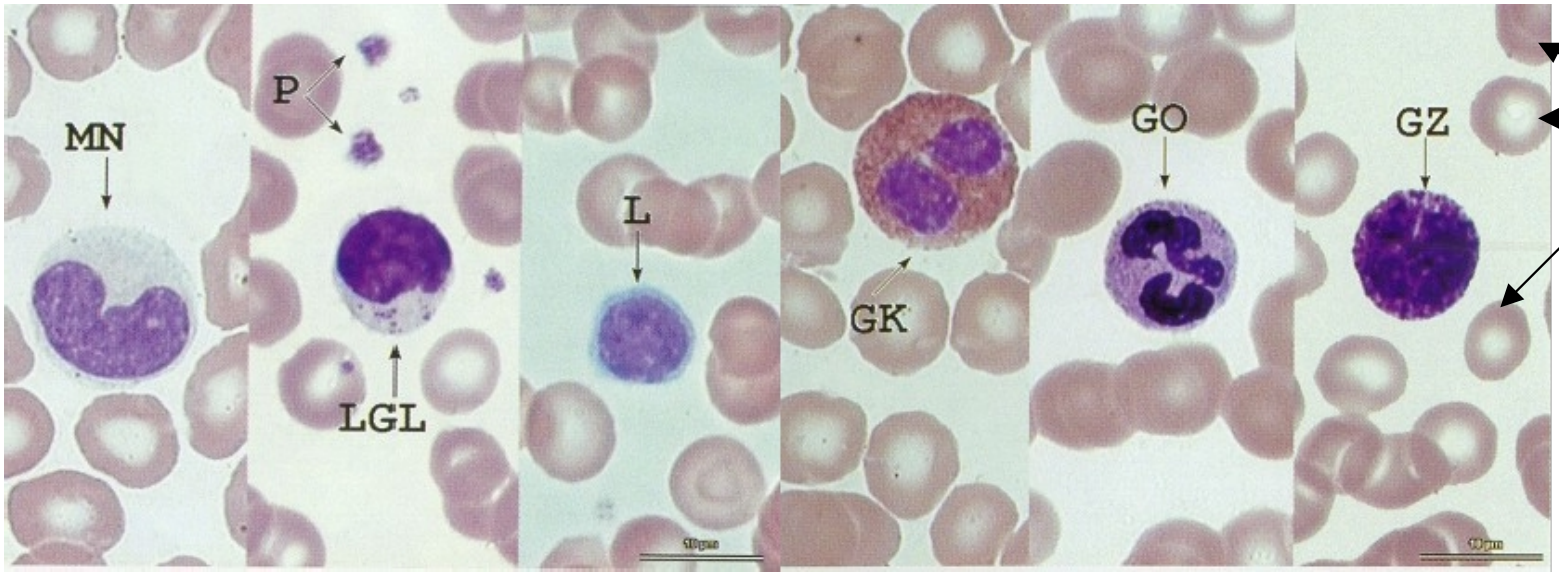
- Blood = plasma + morphotic elements (cells)
- After blood centrifugation:
  - plasma
  - leukocyte dross
  - erythrocytes

- Hematocrit = percentage of red blood cell volume after centrifugation
- ESR = Passer's Reaction = rate of fall of blood cells (mm/h)

Peripheral blood

- Blood morphology - abundance of morphotic elements
- The 3 main morphotic elements of blood are blood cells:
  - white (WBC) = leukocytes → immune function
  - Red (RBC) = erythrocytes → contain hemoglobin = oxygen transport
  - Platelets (PLT) → coagulation (primary hemostasis)
- White blood cells are divided into subgroups:
  - granulocytes: neutrophils, eosinophils, basophils
  - agranulocytes: lymphocytes, monocytes

Blood under the microscope



What are these cells and why do they have translucency in the center?

Photo source:
A. Mysliwski, P. Trzonkowski et al, Histological Atlas, Operon Pedagogical Publishing House 2002.

P - Platelets (participate in primary hemostasis)

Agranulocytes: MN - monocyte (phagocytosis), L - lymphocytes (B and T; antibody production, memory cells, antigen presentation)

Granulocytes: GO - neutrophil = neutrophilic granulocyte (phagocytosis, antimicrobial immunity), GZ - basophil = basophilic granulocyte

Blood under the microscope

Peripheral blood morphology

BADANIE	WYNIK		JEDNOSTKI	WARTOŚCI REFER.
Hemoglobina	**14.7**		g/dl	(13.0 - 17.0)
Krwinki czerwone	**4.50**		x10^12/l	(4.5 - 5.5)
Hematokryt	**39.4**	L	**%**	**(40 - 50)**
MCV	**87.6**		fl	(80 - 96)
MCH	**32.7**	H	**pg**	**(27 - 32)**
MCHC	**37.3**	H	**g/dl**	**(31.5 - 34.5)**
RDW	**12.2**		%	(11.6 - 14.0)
Płytki krwi	**260**		x10^9/l	(150 - 410)
MPV	**9.8**		fl	(8.0 - 11.0)
Wskaźnik anizocytozy płytek krwi	**11.3**		fl	(9.0-14.0)
Płytkokryt	**0.25**		%	(0.19-0.39)
Odsetek dużych płytek krwi	**23.2**		%	(15-35)
Krwinki białe	**4.56**		x10^9/l	(4 - 10)
Liczba neutrocytów	**2.39**		x10^9/l	(2.0 - 7.0)
% neutrocytów	**52.4**		%	(40 - 80)
Liczba limfocytów	**1.64**		x10^9/l	(1.0 - 3.0)
% limfocytów	**36.0**		%	(20 - 40)
Liczba monocytów	**0.44**		x10^9/l	(0.2 - 1.0)
% monocytów	**9.6**		%	(2 - 10)
Liczba eozynocytów	**0.04**		x10^9/l	(0.02 - 0.5)
% eozynocytów	**0.9**	L	**%**	**(1 - 6)**
Liczba bazocytów	**0.05**		x10^9/l	(0.0 - 0.1)
% bazocytów	**1.1**		%	(=< 2)
Liczba niedojrzałych granulocytów	**0.01**		x10^9/l	(0.00 - 0.03)
% niedojrzałych granulocytów	**0.2**		%	(0.0 - 0.5)
Erytroblasty	**0.00**		G/l	
% erytoblastów	**0.0**		%	

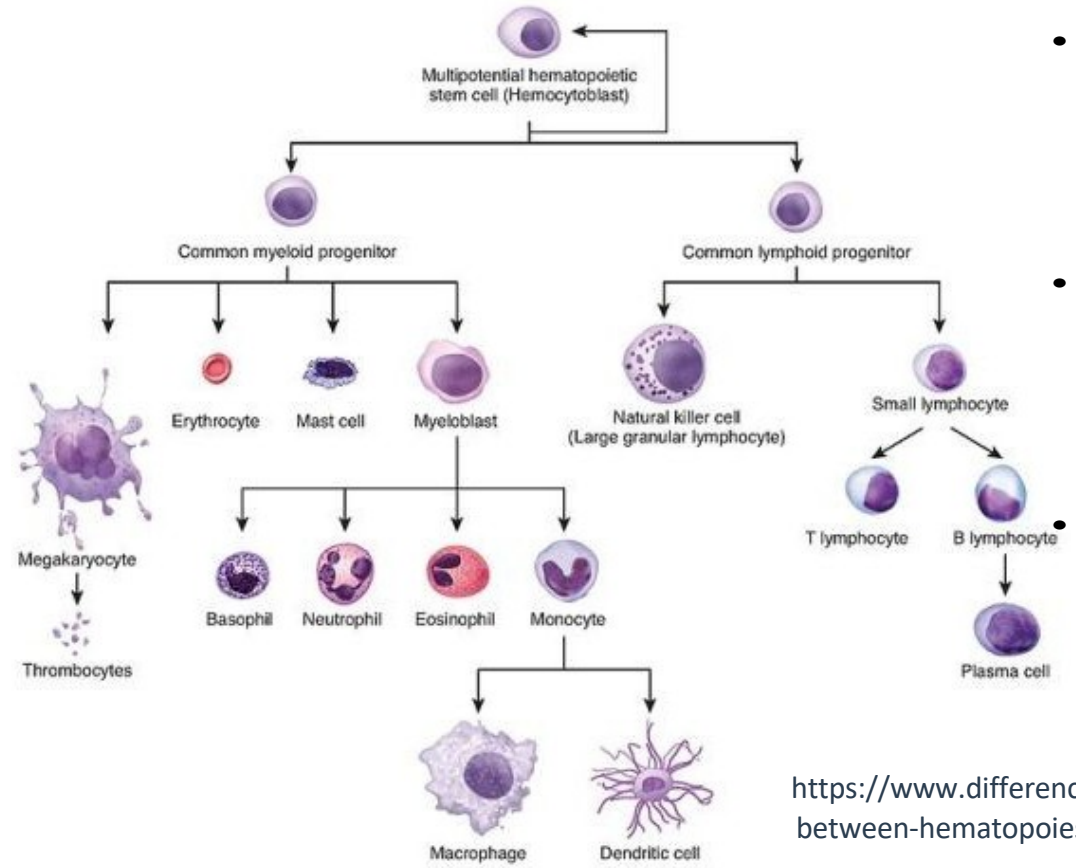
Bone marrow

- Bone marrow fills the marrow cavities inside the bone
- The red marrow produces the morphotic elements of the blood (hematopoietic function)
- Yellow marrow shows no hematopoiesis
- Red marrow in children is found in all bones, and in adults only in the flat bones (skull, sternum, pelvic bones)

https://www.youtube.com/watch?v=FsjsSsGo1ZQ&ab_channel=ME%D0%94%D0%A4%D0%98%D0%9B%D0%AC%D0%9C

https://www.youtube.com/watchv=Fd3aUkdQTtI&ab_channel=S.A.B.Impex%2Cs.r.o

Hematopoiesis - "blood production"



- 2 Basic lines:
  - myeloid → platelets, erythrocytes, monocytes and granulocytes
  - lymphoid → lymphocytes
- Typical for the bone marrow are blastic cells ("blasts"), the appearance of which in the peripheral blood is a sign of sepsis or leukemia
- There are 2 basic types of leukemia based on the type of cells from which the "pathological blasts" originate - lymphoblastic/lymphocytic leukemia and myeloblastic/splenic leukemia

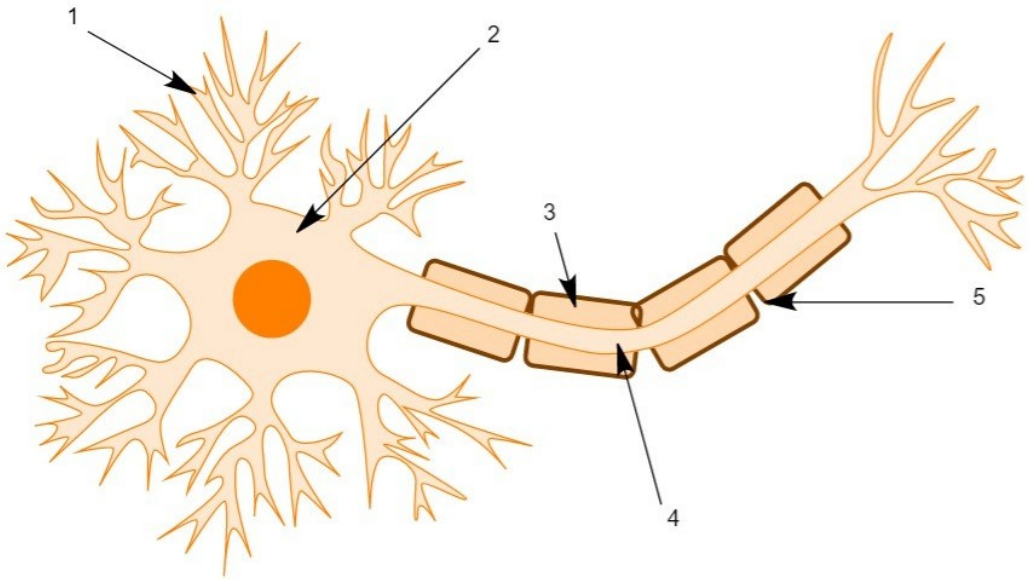
https://www.differencebetween.com/difference-between-hematopoiesis-and-vs-erythropoiesis/

Lymph = lymph

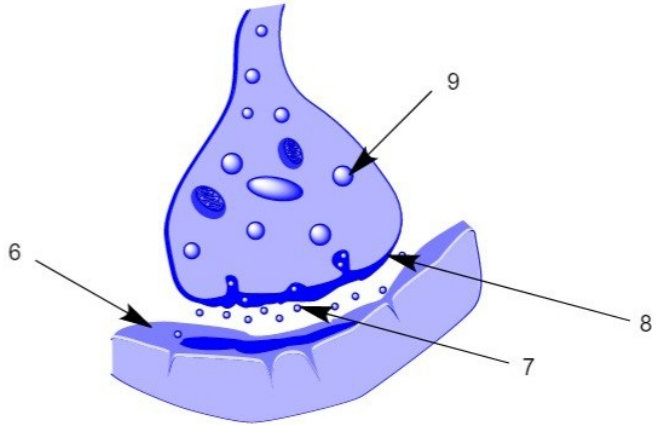
- Intercellular fluid and immune cells that have left the blood vessels and ended up in the tissues.
- Lymph flow from tissues allows fluid and leukocytes to return to the bloodstream
- In the path of the lymph vessels are the lymph nodes
- What happens if the lymph vessels are destroyed (for example, during the removal of lymph nodes during cancer surgery or after radiation therapy)?

Basics of neuroanatomy

Neuron and synapse



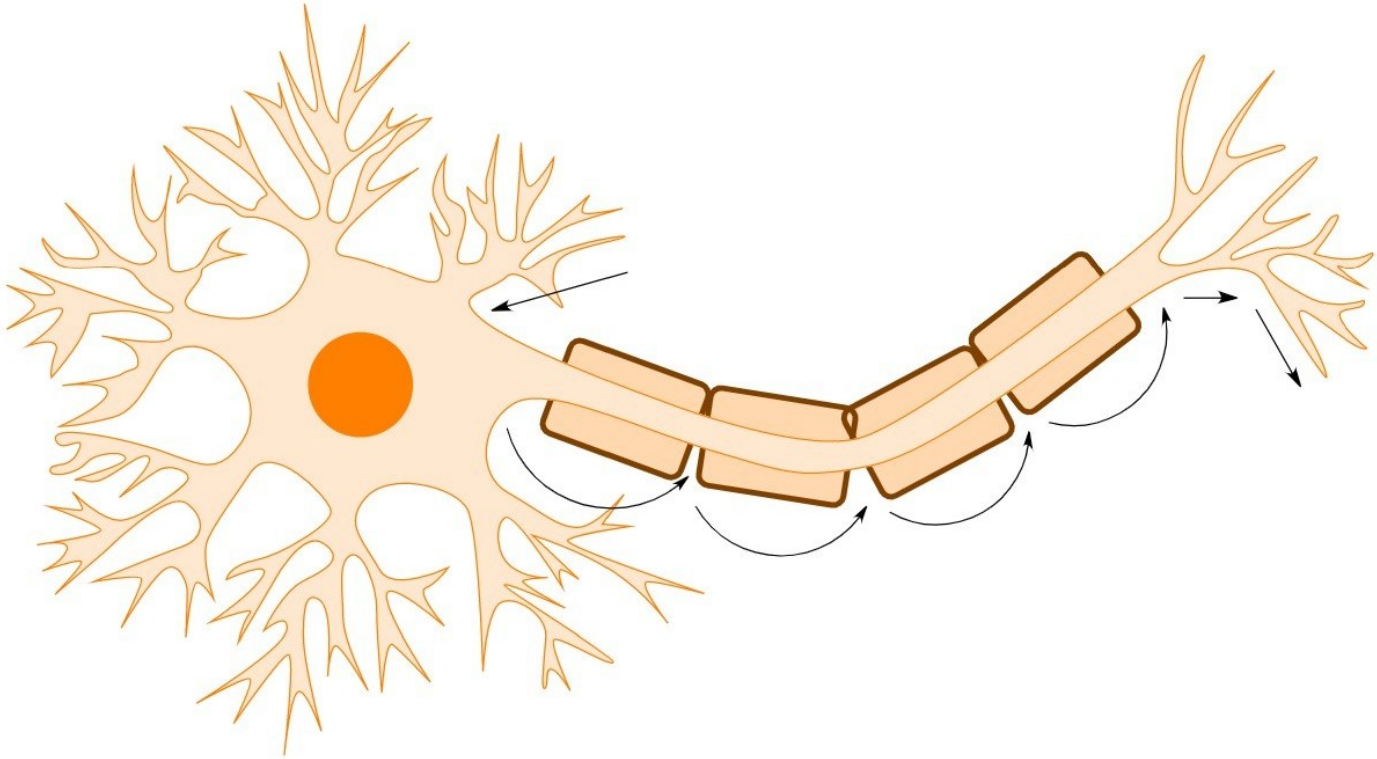
Synapse - connection site 2 nerve cells or a nerve cell with an effector cell.

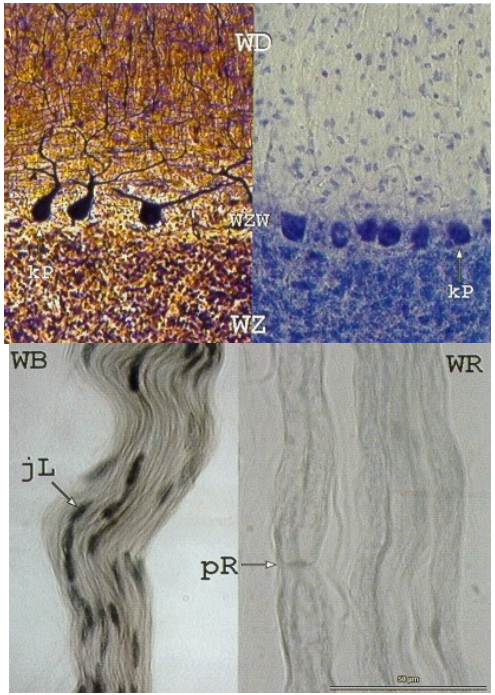


1	
2	
3	
4	
5	
6	
7	
8	
9	

A - Schwann cell producing myelin sheath, B - synaptic vesicle, C - postsynaptic membrane, D - dendrite, E - neurotransmitter molecule, F - axon, G - neuron body, H - presynaptic membrane, I - Ranvier's constriction

The course of a nerve impulse in a neuron





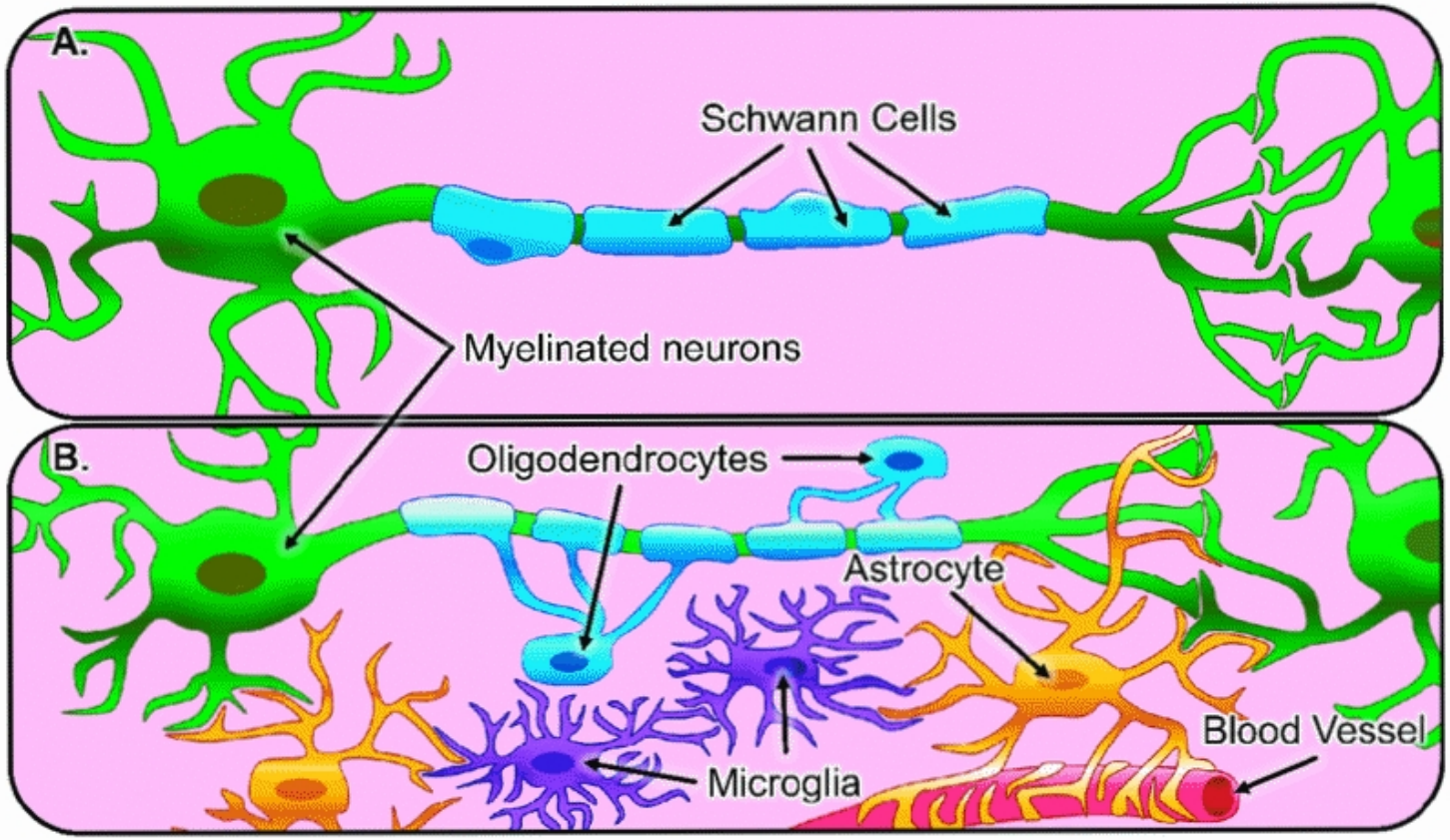
Does the myelin sheath slow down or speed up the course of the pulse?

The course of a nerve impulse in a neuron

Gliu
m

- Cells with a protective, supportive and nutritional function to neurons
- There are the following types of glial cells:
  - Microglia → immune function, phagocytosis
  - oligodendrocytes → myelinize neurons in the central nervous system
  - Schwann cells (lemocytes) → myelinize neurons in the peripheral nervous system
  - Astrocytes (stellate cells) → form the blood-brain barrier by surrounding vessels, surround synapses and form glial scars (in areas where nerve tissue has been destroyed - such as after strokes or injuries)
  - Ependymocytes (lining cells) → lining the ventricles of the brain

Gliu
m



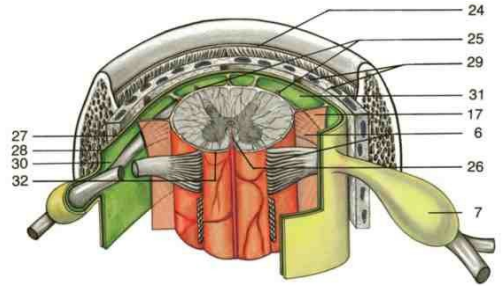
Is the peripheral nerve picture A or B?

Puhl, Devan & Funnell, Jessica & Nelson, Derek & Gottipati, Manoj & Gilbert, Ryan. (2020). Electrospun Fiber Scaffolds for Engineering Glial Cell Behavior to Promote Neural Regeneration. Bioengineering. 8. 4. 10.3390/bioengineering8010004.

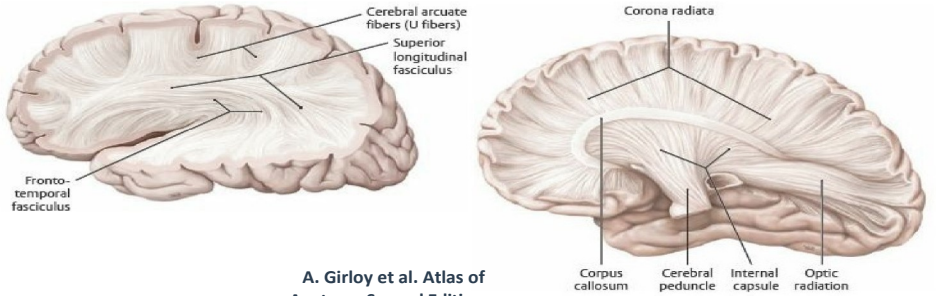
White and gray being

- "Gray cells" → gray matter are nerve cell bodies
- White matter is fibers of nerve cells (axons)
- In the brain, the gray matter is on the outside, while in the spinal cord it is on the inside

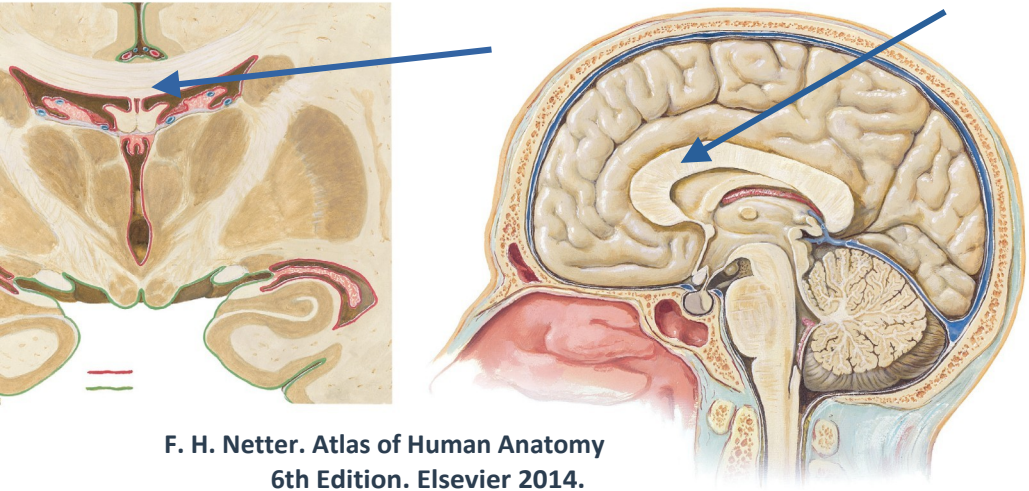
Rohen et al. Color Atlas of Anatomy.
A Photographic Study of The Human Body.
Seventh Edition, 2011 by Schattauer GmbH.



White matter of the brain and corpus callosum



A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

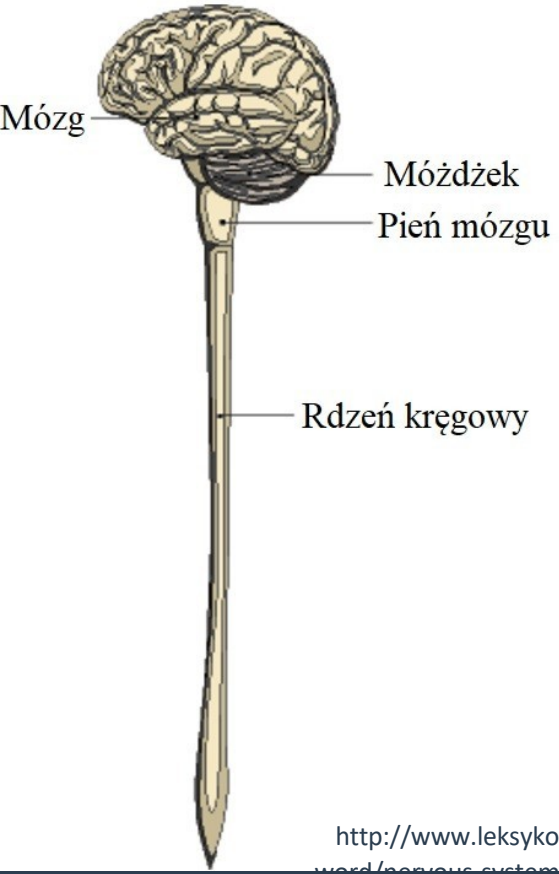
- The white matter (nerve fibers) connects different areas of the brain within the same hemisphere, communicates between the two hemispheres (via the corpus callosum), and reaches the brainstem, cerebellum and spinal cord
- The corpus callosum (dark blue arrow) connects the white matter of both hemispheres!

White matter of the brain and corpus callosum

Central and peripheral nervous system

- Central nervous system: brain + spinal cord
- Peripheral nervous system: cranial and spinal nerves and ganglia (ganglion = cluster of nerve cell bodies outside the central nervous system)
- Brain - "contents of the cerebrum"
- Spinal cord - "contents of the spinal canal"
- Where is the boundary between the brain and the spinal cord?

Central nervous system



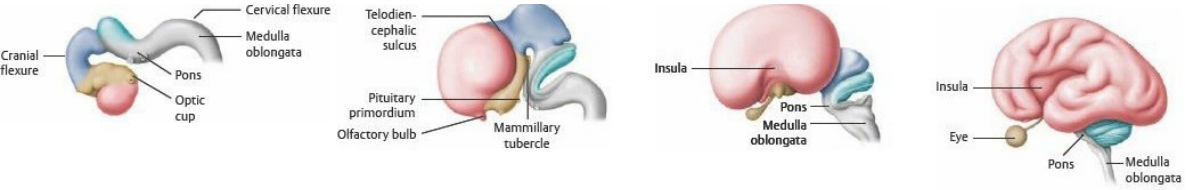
http://www.leksykonmasazu.pl/word/nervous-system-central/1378

- Cerebrum = brain + brainstem + cerebellum
- Brain = cerebral hemispheres + intercerebrum (thalamus and hypothalamus)
- Brain stem = midbrain + bridge + medulla oblongata
- Spinal cord - cervical, thoracic, lumbar, sacral and nodal segments

Central nervous system

Structure of the central nervous system

Storey structure of the central nervous system



A. Girloy et al. Atlas of Anatomy Second Edition.
Thieme Stuttgart, New York 2012.

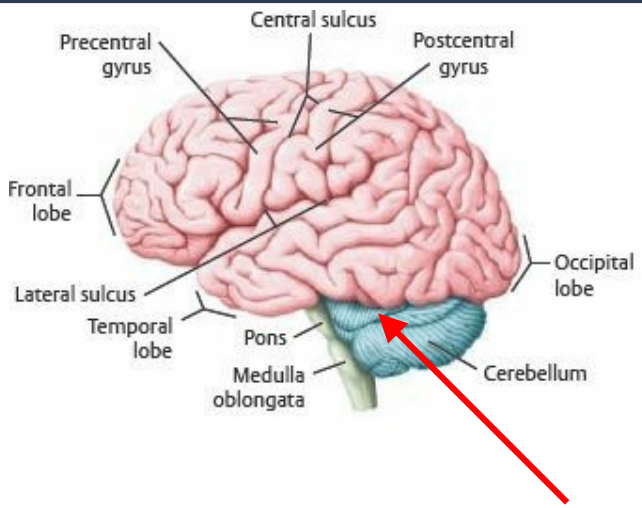
Table 40.1 Development of the brain

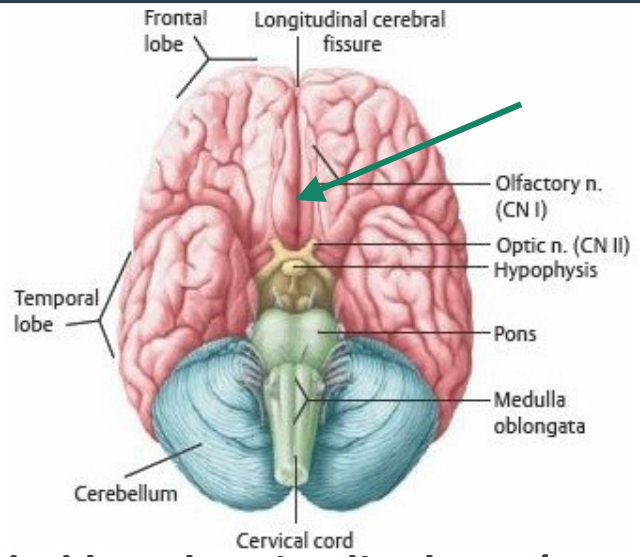
	Primary vesicle	Region		Structure
Neural tube	Prosencephalon (forebrain)	Telencephalon (cerebrum)		Cerebral cortex, white matter, and basal ganglia
		Diencephalon		Epithalamus (pineal), dorsal thalamus, subthalamus, and hypothalamus
	Mesencephalon (midbrain)*			Tectum, tegmentum, and cerebral peduncles
	Rhombencephalon (hindbrain)	Metencephalon	Cerebellum	Cerebellar cortex, nuclei, and peduncles
			Pons*	Nuclei and fiber tracts
		Myelencephalon	Medulla oblongata*	

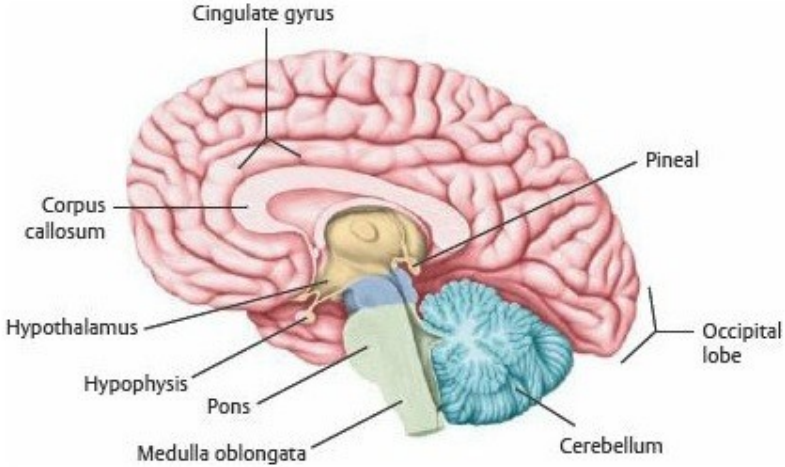
* The mesencephalon, pons, and medulla oblongata are collectively known as the brainstem.

- The central nervous system has a storied structure
- This is due to embryological development from 5 bubbles
- The highest floor is the cerebral hemispheres with the cortex, and the lowest floor is the spinal cord

Hemispheres and cortex of the brain







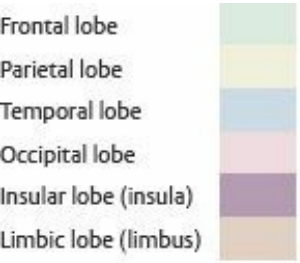
- The hemispheres are divided by a longitudinal gap (green arrow).
- The hemispheres are separated from the cerebellum by the transverse fissure (red arrow)
- The individual curves between them are separated by furrows.

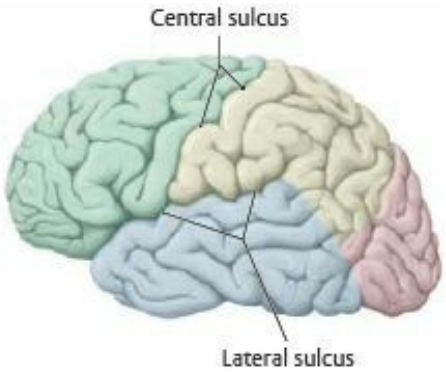
A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

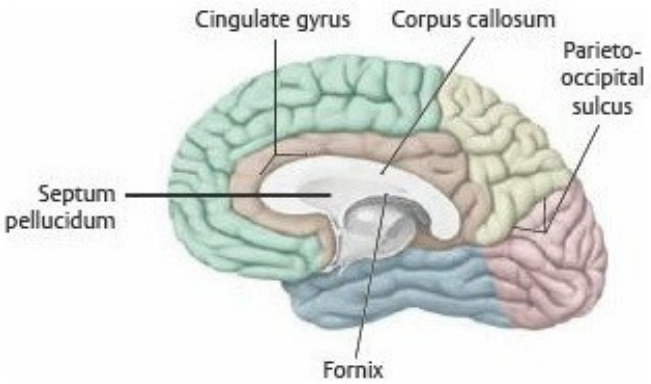
Hemispheres and cortex of the brain

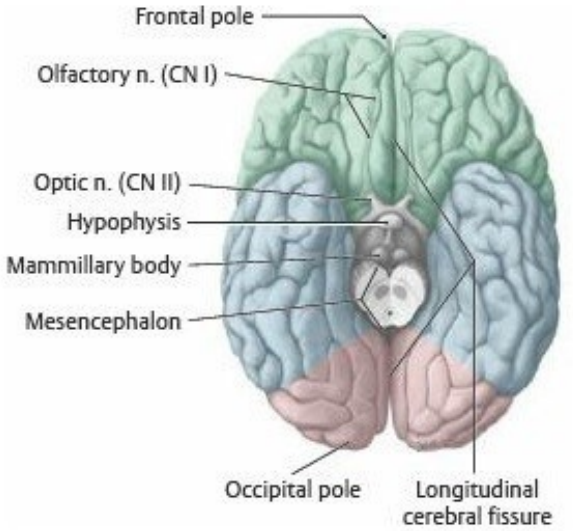
- is located?

Brain lobes









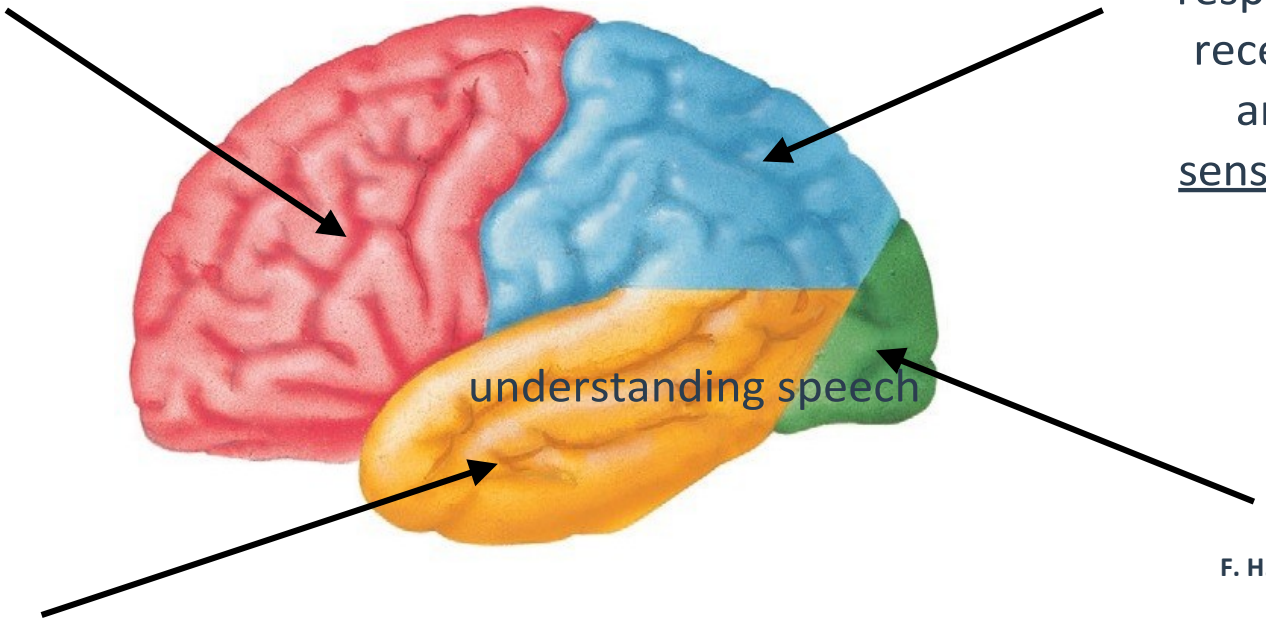
A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

Green: ? **Yellow: ?** **Red: ?** **Blue: ?Blue: ?**

Brain lobes

Frontal: responsible for initiating movement, speech, personality

Parietal: responsible for receiving and analyzing sensory stimuli



Temporal: responsible for receiving and analyzing auditory stimuli,

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

Brain lobes

receiving and analyzing visual stimuli

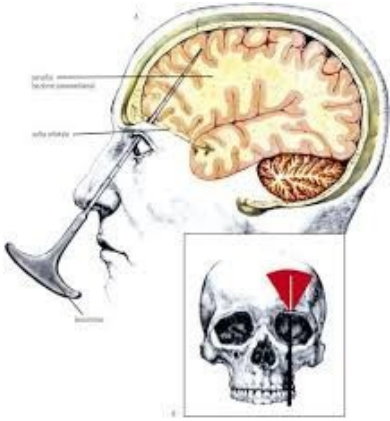
Sensory and motor aphasia

- Motor aphasia - damage to the frontal lobe → the patient finds it difficult to generate speech, it loses its fluency. There are difficulties in constructing a correct sentence, the patient makes grammatical errors, forgets words. The patient knows what he wants to say, but it "doesn't work out" for him.
- Sensorineural aphasia - damage to the temporal lobe → the patient does not understand what is said to him (even if he can hear). The patient utters many words fluently, although they do not always form a correct utterance.

https://www.youtube.com/watch?v=7ZZVLiH53hQ&ab_channel=TelewizjaNaukowaPIONIERTV

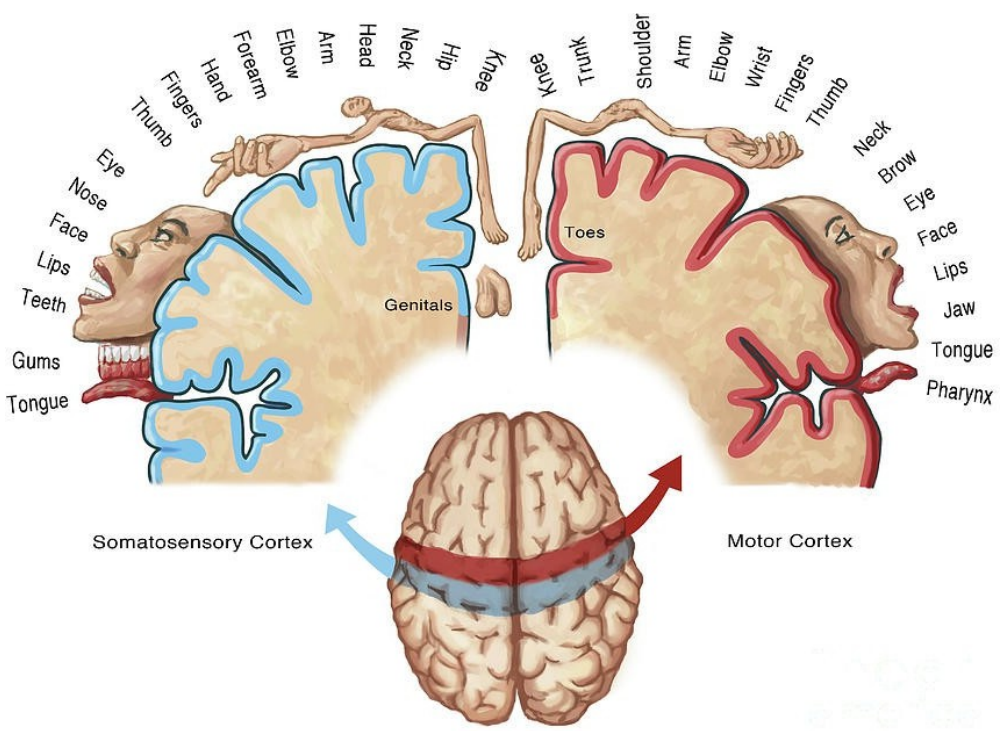
Lobotomy

- A procedure performed in the past to "treat" mental illnesses (e.g., Schizophrenia).
- It involved mechanically disrupting the pathways that connect the prefrontal cortex (the portion of the frontal lobe forward from the motor cortex, responsible for personality) to the rest of the brain.
- Patients afterwards experienced dementia, "loss of personality," lack of interest, initiative, motivation, empathy, or loss of inhibition; they were
  Unable to function independently in society.



https://notgonnafakeit.wordpress.com/2016/10/18/surgery-soul-lobotomy/

Motor and sensory humunculus



https://pixels.com/featured/homunculus-map-spencer-sutton.html

- Humunculus ("man") is a graphic representation of the areas in the cortex of the brain responsible for a particular part of the body.
- Both the sensory and locomotor humunculus have disproportionately large hands and face, which means that sensation in these areas is most sensitive, and movement is most perfect (the greatest possibility for precise movement).
- The area responsible for the lower limb is located medially, and the face is most

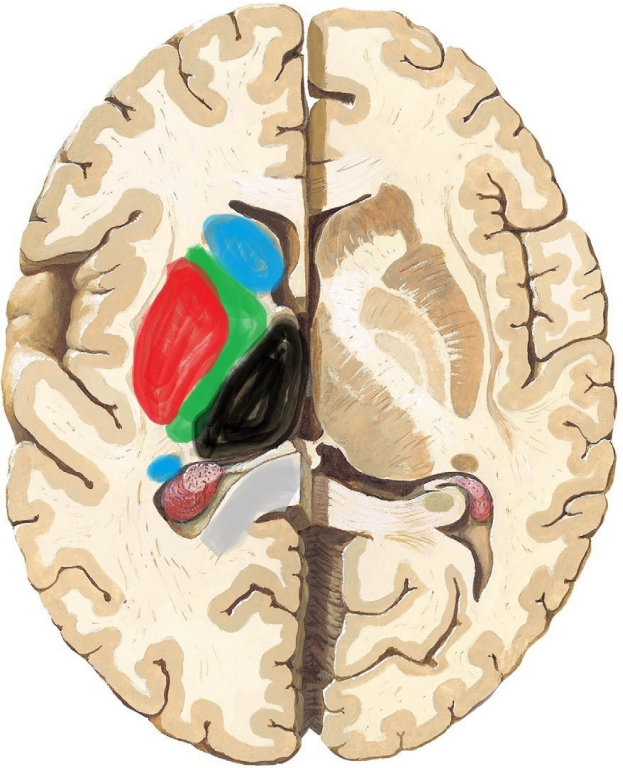
Motor and sensory humunculus

laterally.

Base nuclei

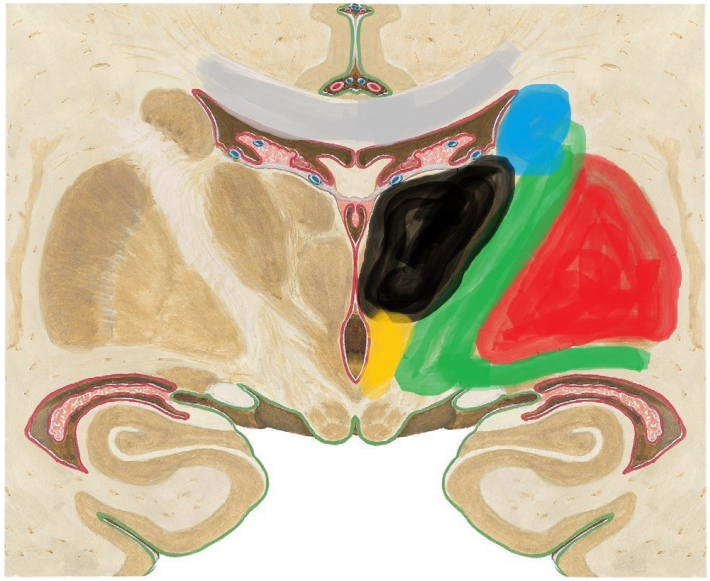
- Concentrations of gray matter located deep within the brain hemispheres.
- Among the most important are the lentiform nucleus, caudate nucleus, which are part of the extrapyramidal system (involved in motor control), and the amygdala (part of the limbic system).
- The basal nuclei are separated from each other and the thalamus by the internal capsule (white matter), in which fibers running from the cortex to the spinal cord are concentrated (damage to even a very small area of the internal capsule yields numerous neurological deficits).

Basal nuclei and inner pouch



przekrój poziomy

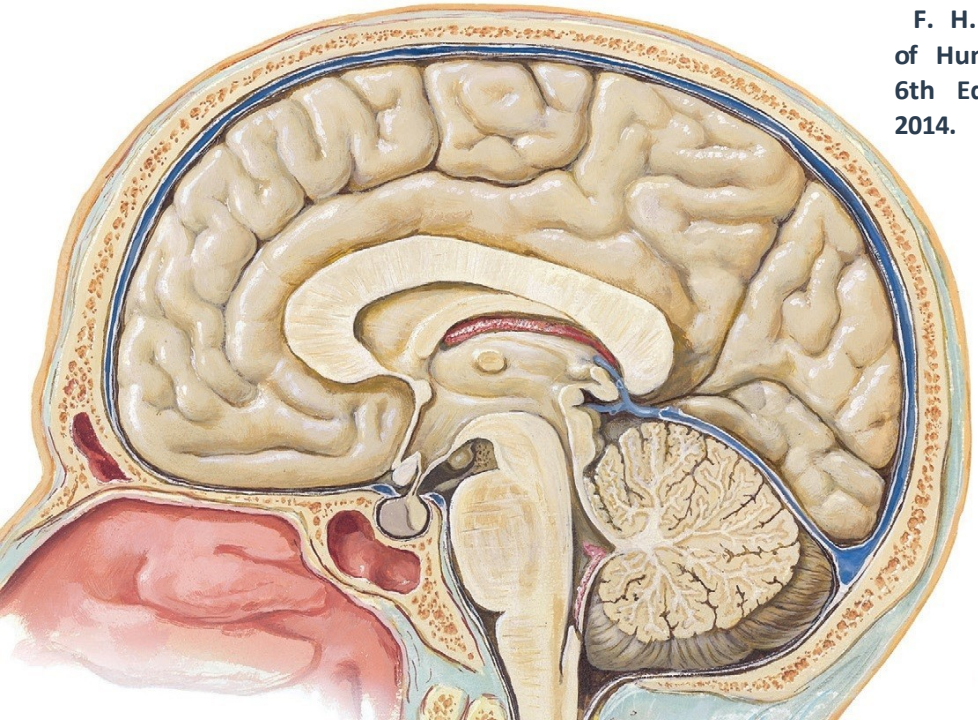
F. H. Netter. Atlas of Human Anatomy
6th Edition. Elsevier 2014.



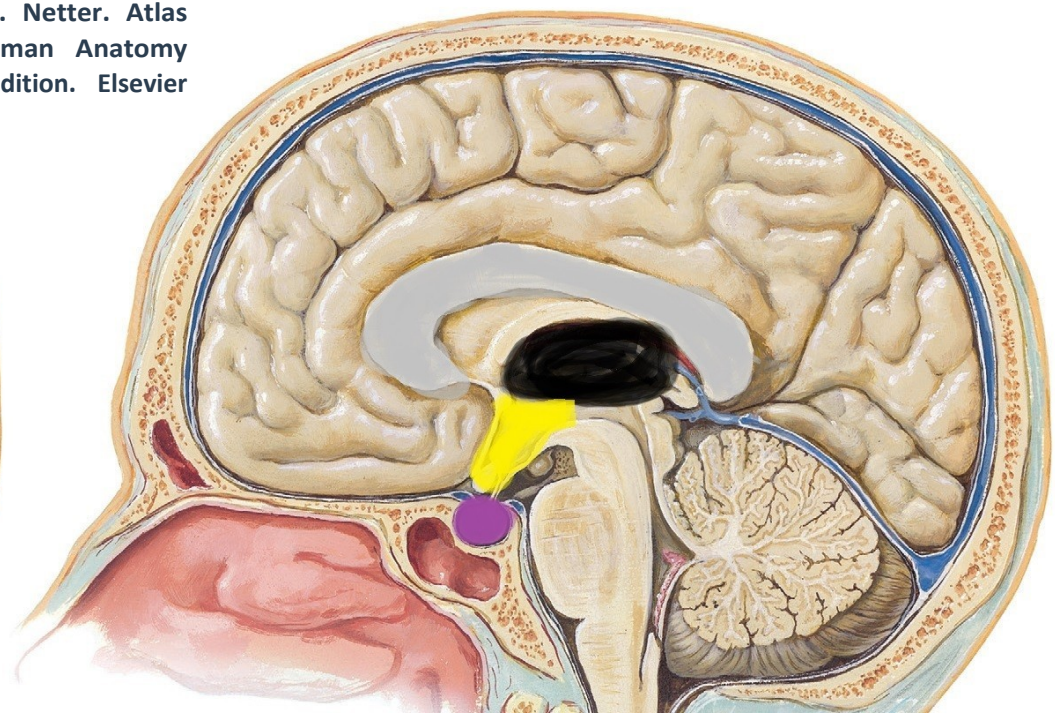
przekrój czołowy

- Hill
- Hypothalamus
- Corpus callosum
- Inner bag
- Lenticular nucleus
- Caudal nucleus

Interbrain - thalamus and hypothalamus



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.



Interbrain - thalamus and hypothalamus

Hill Hypothalamus Corpus callosum Pituitary gland

Hill

- It serves as a "relay station" for signals running from the body to the cerebral cortex - it reduces the excessive "bombardment" of the cerebral cortex (i.e. our consciousness) with unnecessary information.
- It is an essential component of the sensory system.
- From the middle it borders the ventricle III of the brain.
- It serves as an anastomosing element between the cortex and subcortical structures (extrapyramidal system, limbic system).

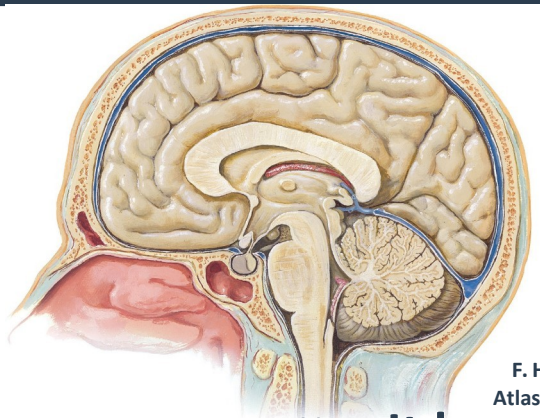
Hypothalamus

- It is the center of regulation of the autonomic nervous system and hormonal economy.
- It is important in regulating body temperature, diurnal rhythm, appetite, and sexual function.
- It has a close connection with the limbic system (responsible for memory and emotions).

Pituitary gland and hypothalamic-pituitary axis

- The pituitary gland is connected by a funnel to the hypothalamus, where the hormones of the posterior pituitary lobe (oxytocin and vasopressin) are synthesized, which are transported to it and released into the bloodstream.
- The frontal lobe produces (tropic) hormones independently and releases them into the blood (gonadotropins, somatotropin, adrenocorticotropin thyrotropin, prolactin) - this happens under the control of the hypothalamus, which secretes: -liberins and -statin.

Brain stem



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- It consists of the midbrain, the bridge and the medulla oblongata.
- The brainstem contains the nuclei of cranial nerves III through XII.
- It has a significant importance, thanks to the existence of the armature reticular, for the control of many vital processes (heart rate, respiratory drive, hunger), the lack of brainstem activity prevents the higher floors from functioning.
- At the level of the (occipital) great aperture in the skull, it passes into the spinal cord

Reticular formation

- Along the entire length of the brainstem are scattered cells and nerve fibers that form the reticular formation.
- It contains neurons that produce transmitters (catecholamines, serotonin, acetylcholine).
- It is responsible for autonomic functions (independent of our will): circulation, breathing, hunger and food intake (chewing, swallowing, vomiting).
- Through descending pathways, it influences the action of the spinal cord (regulating muscle tone), while ascending pathways stimulate the cerebral

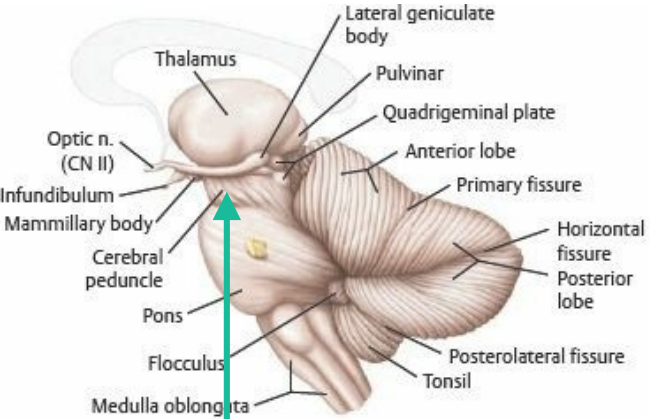
Reticular formation

cortex (responsible for the
"on" and "off" consciousness, including control of the diurnal rhythm).

Midbrain

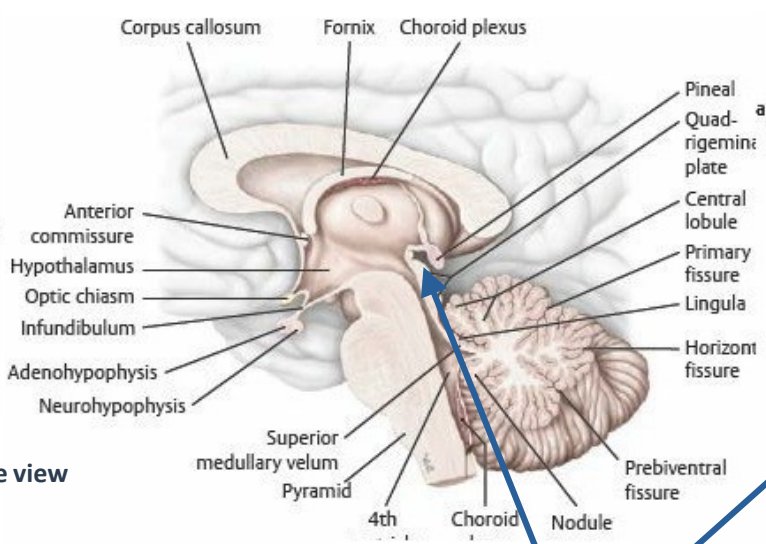
- It consists of the brain branches and the lid lamina, also known as the quadrate lamina (along with the thalamus: upper - part of the visual pathway and lower - of the auditory pathway).
- White matter fibers descending from the cerebral cortex through the radial rim, inner pouch go to the brain branches.
- In addition, the midbrain contains black matter, which is the source of dopamine for the extrapyramidal system (dopamine deficiency caused by degeneration of this area is responsible for the development of Parkinson's disease).
- Inside the midbrain runs the midbrain water supply.

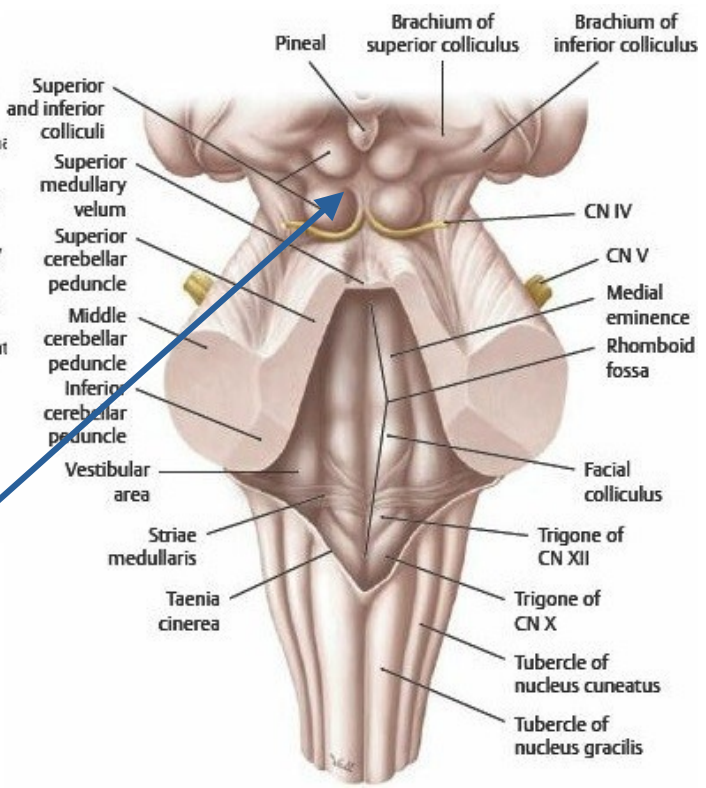
Midbrain



Brain stem - side view

Cerebral limb (left)



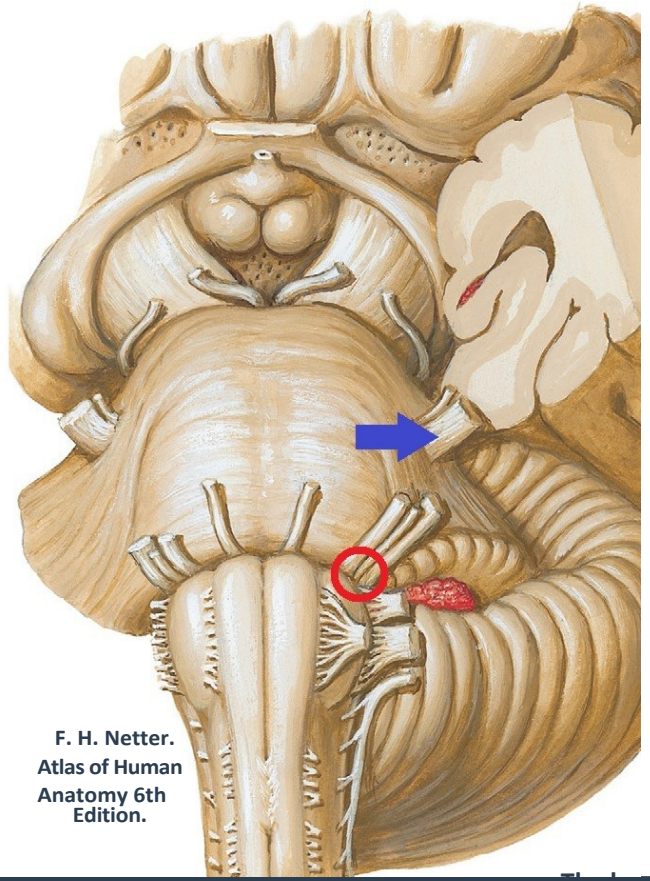


Brain stem - posterior view (after removal of the cerebellum)

Cover plate = = quadrilateral plate

A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

Bridge

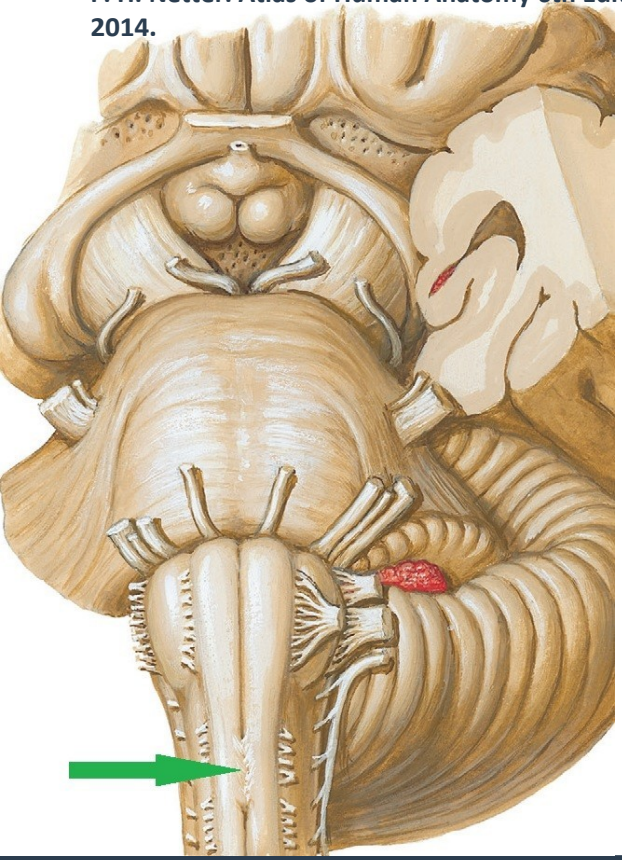


F. H. Netter. Atlas of Human Anatomy 6th Edition.

- Between the midbrain and the medulla oblongata is an elevation - a bridge.
- The bridge towards the back passes into the middle cerebellar branches.
- The V cranial nerve has its origin in the bridge, and VII and VIII in the sternocerebellar angle.
- Tumors of the sternocerebellar angle cause damage to precisely these nerves.

Extended medulla = pons

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.



- It descends from the bridge downward, and at the height of the
  The (occipital) great aperture passes into the spinal cord.
- Many cranial nerves emerge from its surface.
- In its lower, anterior part, the intersection of pyramids - the place where motor fibers cross - is marked.

Extended medulla = pons

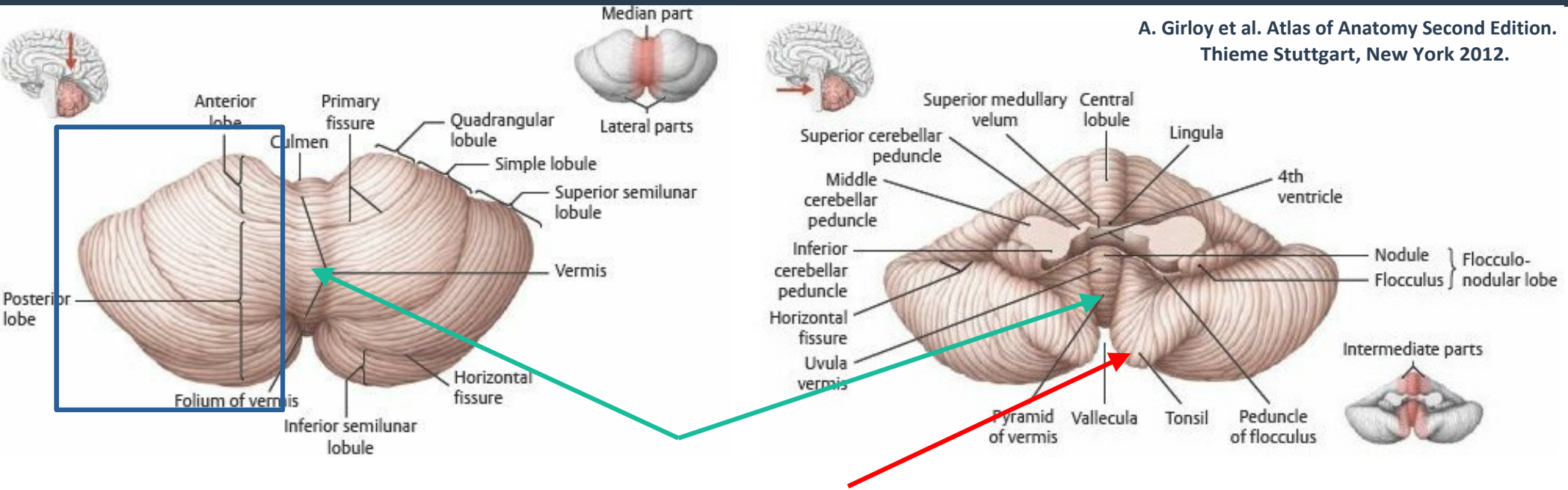
Cerebellum

- It is made up of the worm and cerebellar hemispheres (with the amygdala protruding into the brainstem), forward of the cerebellum is the IV ventricle.
- It participates in motor coordination, fluidity of movement and maintaining balance.
- Cerebellar dysfunction (cerebellar ataxia) is characterized by tremors, imprecise movement (dysmetria), and a wobbly gait on a wide base.
- The cerebellum connects to the brainstem via the branches: upper (runs to the midbrain), middle (to the bridge) and lower (to the

Cerebellum

pons).

Cerebellum



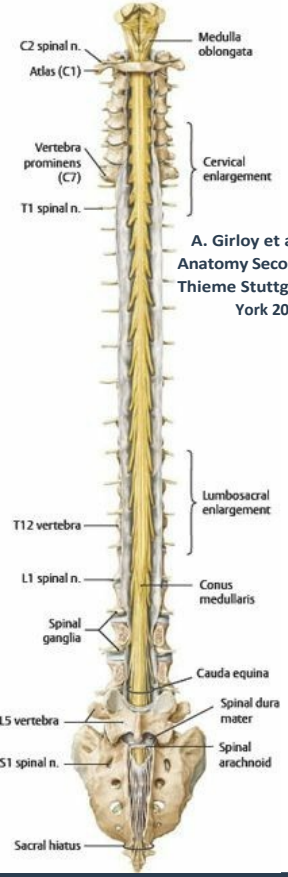
A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

Cerebellum -

top viewCerebellum - front view

Cerebellar worm, cerebellar hemisphere, cerebellar amygdala

Spinal cord



A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

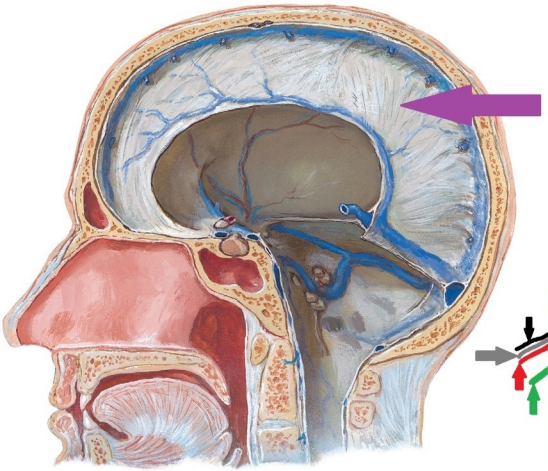
- It has C (cervical) - cervical, Th (thoracic) - thoracic, L (lumbar) - lumbar, S (sacral) - sacral and Co (coccygeal) - button.
- It begins at the level of the great aperture and ends by passing into the spinal cone and cauda equina (bundle of spinal nerves) at the level of the L1 vertebra.
- It has gray matter in the form of anterior horn (motor) and posterior horn (sensory) and indirectly - lateral (sympathetic at C8 – L2)

Meninges of the central nervous system

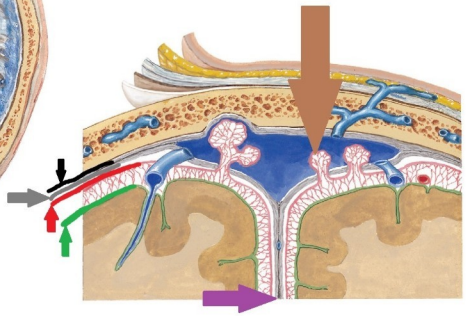
- The protective apparatus of the central nervous system.
- The outermost element is the dura mater (in the skull it adheres to the periosteum of the bones of the cranial lid).
- Adjacent to the dura is the arachnoid membrane, underneath it is a fluid-filled space (subarachnoid).
- The brain tissue is covered by the soft meninges.
- In addition, the dura forms protuberances: the sickle of the brain, the tentorium of the cerebellum, the sickle of the cerebellum and the saddle diaphragm.

Meninges of the central nervous system

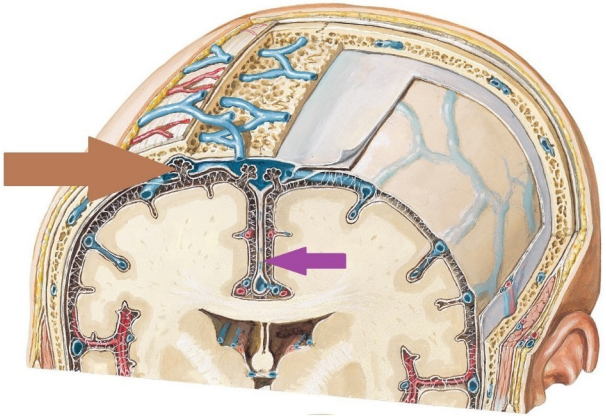
F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

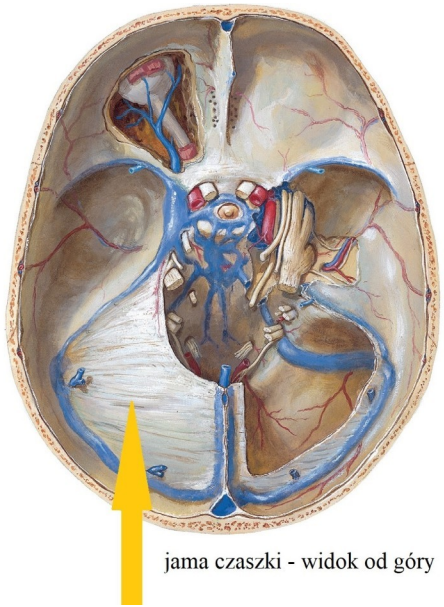


przekrój strzałkowy



przekrój czołowy





jama czaszki - widok od góry

Soft tire

spider tire

hard tire

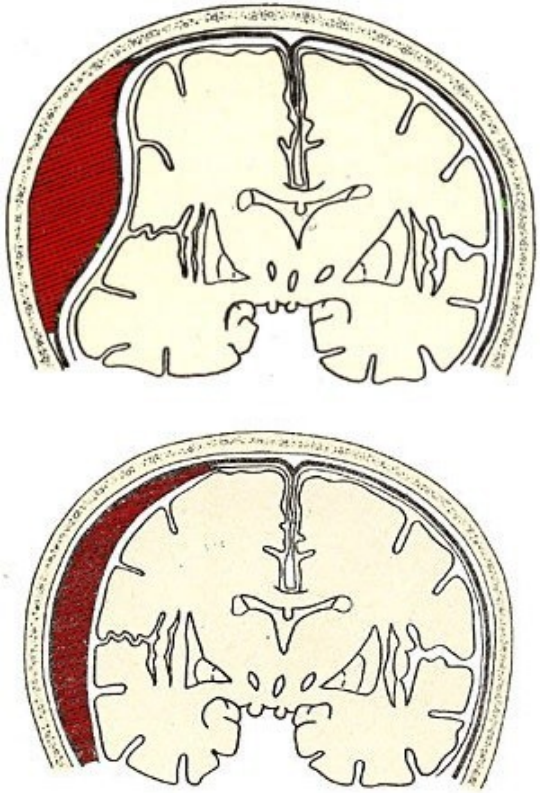
periosteum

sickle

tent of the cerebellum

arachnoid granules

Spaces between tires



http://www.kryminalistyka.fr.pl/forensic_czacha_02.php

- Due to the presence of 3 layers of meninges, it is possible to distinguish a subarachnoid space filled with cerebrospinal fluid and 2 potential spaces: subdural and supratentorial.
- Between what structures are these spaces distinguished?
- After head injuries, they can be the site of blood accumulation (hematoma).

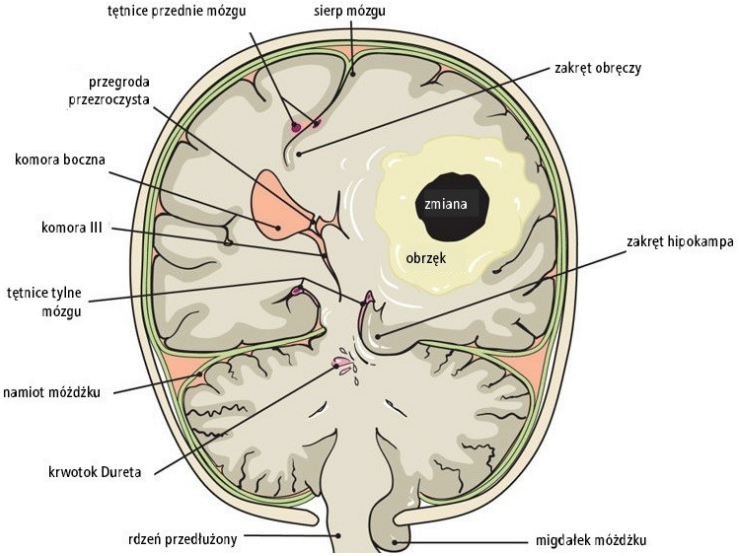
Intrusions in the central nervous system

- If there is an increase in intracranial pressure as a result of the disease process, some elements of the brain may intrude (move) into spaces previously unoccupied by the structure in question.
- Indentations:

  - The cingulate curve under the sickle of the brain → slowi down;

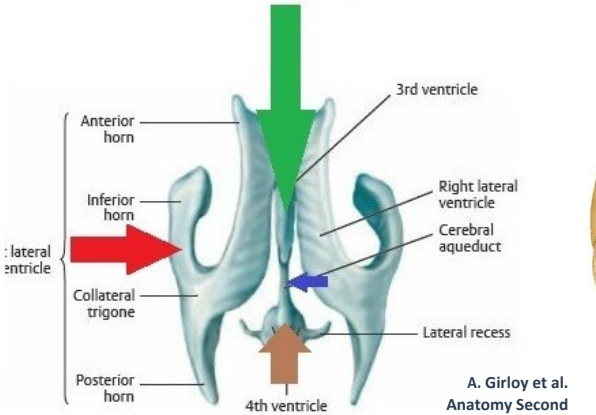
  - Hippocampal bend under the tentorium of the cerebellum → pressure on the ne III (pupil dilation) and pressure on the cerebellar conus (limb paresis); rw

  - cerebellar amygdala into the spinal canal → compression of the medulla oblongata and death occurs.

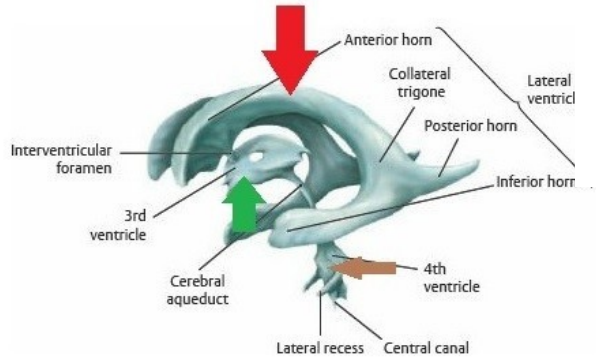


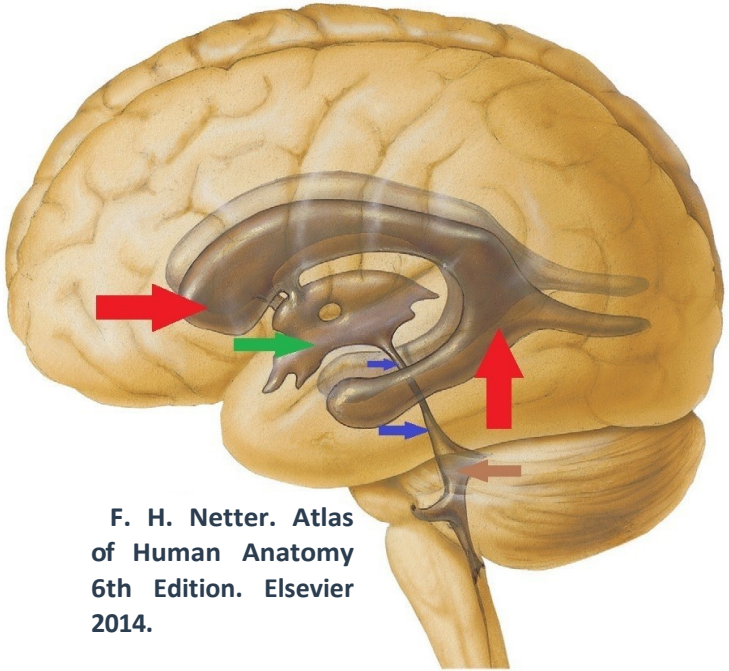
https://www.mp.pl/neurologia/choroby/inne-diseases/220455,hypertension-internal-cranial-patient-with-cancer-disease,1

Brain chambers



A. Girloy et al. Anatomy Second Thieme Stuttgart, 2012.





F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

Lateral ventricle Ventricle III Midbrain water supply Ventricle IV

- The subarachnoid space is connected to the 4 ventricles located "inside" the brain.
- The paired lateral ventricles drain into ventricle III, which communicates via the midbrain water supply with ventricle IV (between the brainstem and cerebellum).

Circulation of subarachnoid fluid

- In the lateral ventricles are the choroid plexuses, which "produce" cerebrospinal fluid, which flows into ventricle III, and through the hydrocele into ventricle IV and further into the subarachnoid space, where it is absorbed into the bloodstream thanks to the arachnoid granules.
- Cerebrospinal fluid from the cranial cavity also drains from the spinal cord.
- Blockage in the outflow of fluid from the ventricles (e.g., by clogging the midbrain water supply can cause hydrocephalus).

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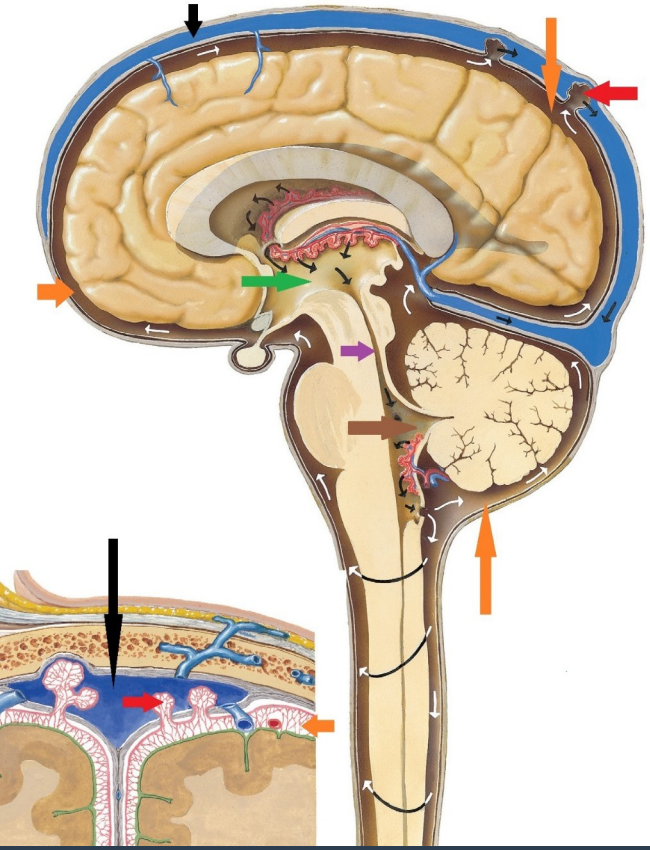
Chamber III Subarachnoid space Arachnoid granulations Superior sagittal sinus

Circulation of subarachnoid fluid

Midbrain water supply

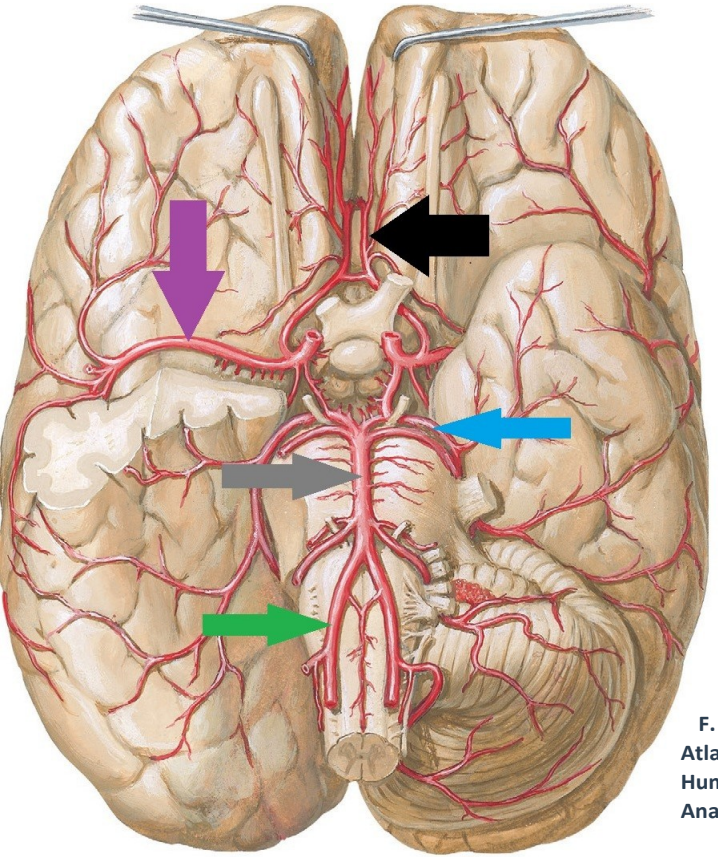
Chamber IV



Arterial vascularization of the central nervous system

- Arterial blood is supplied to the cranial cavity by 2 internal carotid arteries and 2 vertebral arteries.
- The vertebral arteries unite to form 1 vessel - the basilar artery (which runs on the anterior surface of the bridge).
- The brain is vascularized by the anterior, middle and posterior arteries.
- Arteries on the basal side of the brain branch and connect to form the arterial circle of Willis (which is fully developed in only about 1/3 of the population).
- The anterior artery vascularizes the medial part of the cortex, the middle artery the lateral part and deep structures, and the posterior artery mainly the occipital lobe.
- Ischemic stroke from anterior artery area will cause paresis of which limb (upper or lower)? The effect of closing the posterior artery will be?

Arterial vascularization of the central nervous system



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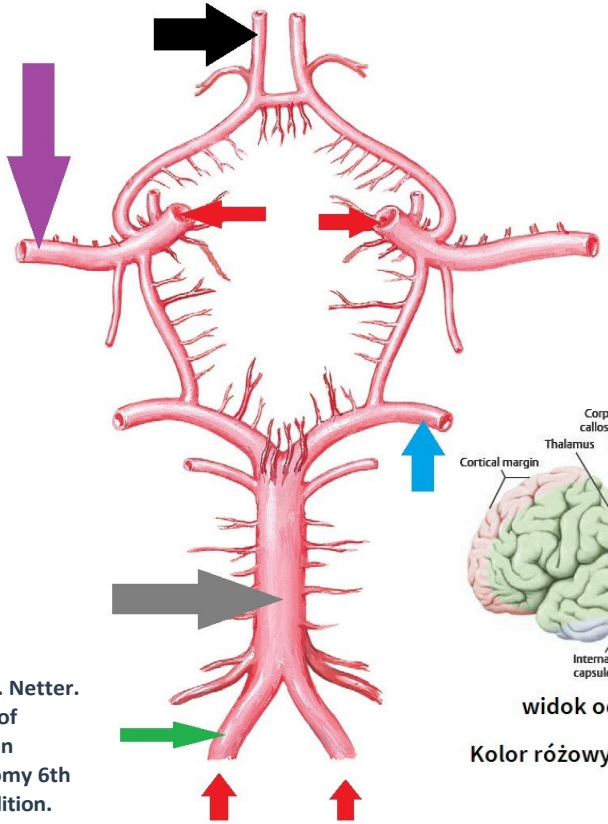
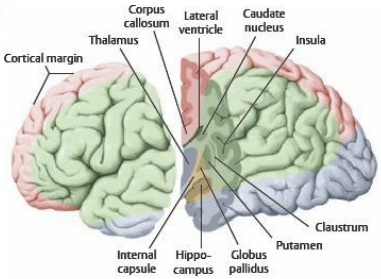


Direction of arterial blood inflow (from internal carotid and vertebral arteries)

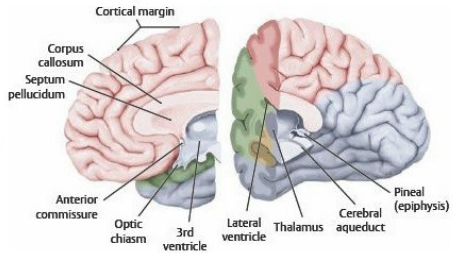
Vertebral artery Basilar artery Anterior cerebral artery

Middle cerebral artery

Posterior cerebral artery



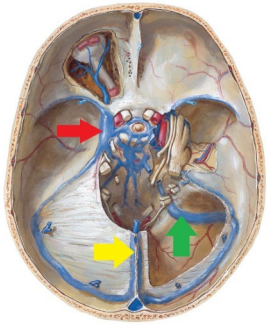
widok od boku



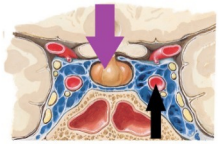
widok od przyśrodka

Kolor różowy - unaczynienie tętnicy przedniej; zielony - środkowej; niebieski - tylnej.

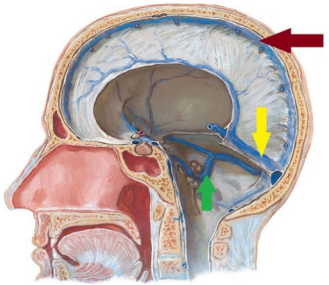
Venous vascularization of the central nervous system



jama czaszki widok od góry



Przekrój czołowy przez zatoki jamiste



Przekrój strzałkowy

- Instead of the classic venous system accompanying the arteries, inside the skull, venous blood flows through superficial veins into the sinuses of the dura and from them into the internal jugular vein (4 arteries supply blood to the cranial cavity and 2 veins drain it).
- The most important sinuses are the superior and inferior sagittal, straight, transverse, sigmoid, and cavernous (inside which many structures, including the internal carotid artery and nerves, run).
- The inferior sagittal sinus connects to the great vein of the brain to form the straight sinus.
- The straight sinus and the superior sagittal sinus join in the sinus drainage, where the even transverse sinuses begin, which pass into the sigmoid sinuses (and these pass into the internal jugular veins).

Cavernous sinus Simple sinus Sinus sigmoidalis Pituitary gland

Internal carotid artery Superior sagittal sinus

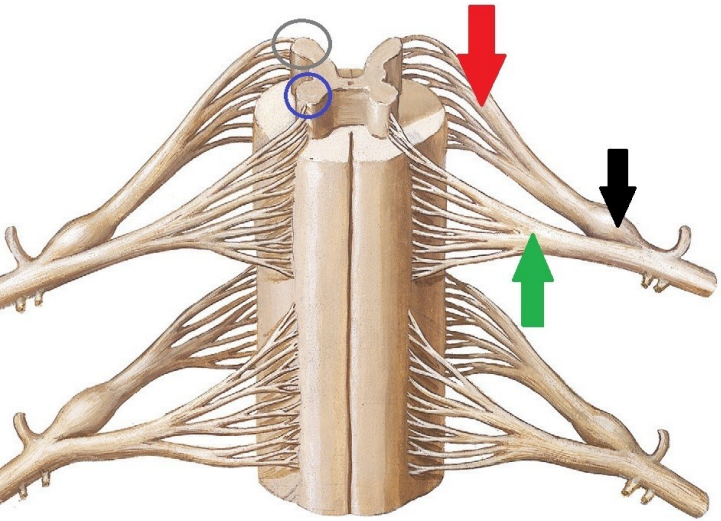
Venous vascularization of the central nervous system

Structure of the peripheral nervous system

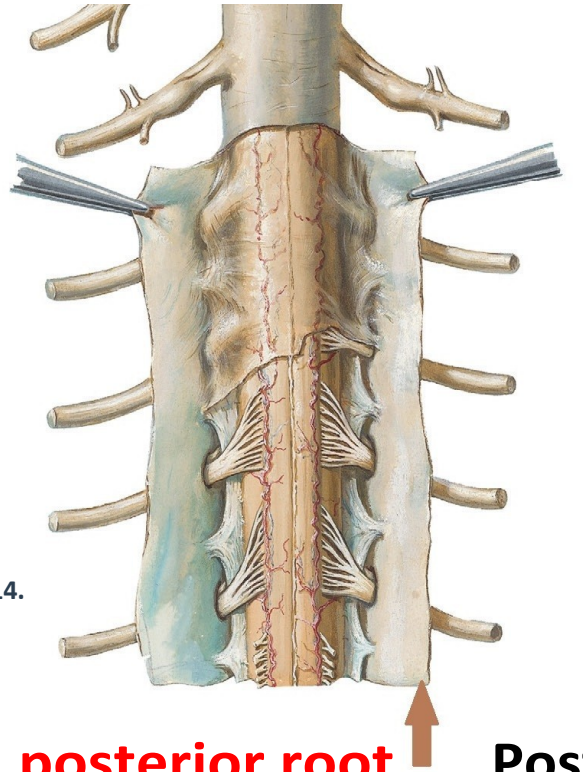
Peripheral nerves - cranial and spinal

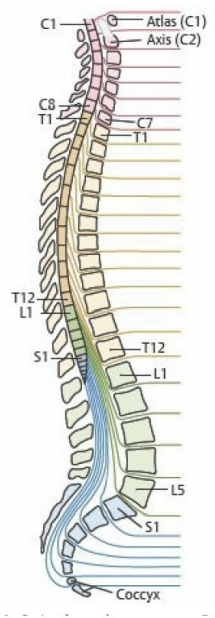
- The peripheral nervous system consists of peripheral nerves and their ganglia.
- The cranial nerves (12 pairs) have their nuclei and leave the central nervous system at the level of the brainstem.
- Spinal nerves (31 pairs) leave the spinal cord with 1 pair for each segment (8 cervical C, 12 thoracic Th, 5 lumbar L, 5 sacral S and 1 nodal Co).
- Spinal nerves consist of anterior (motor) and posterior sensory (ganglion) roots.

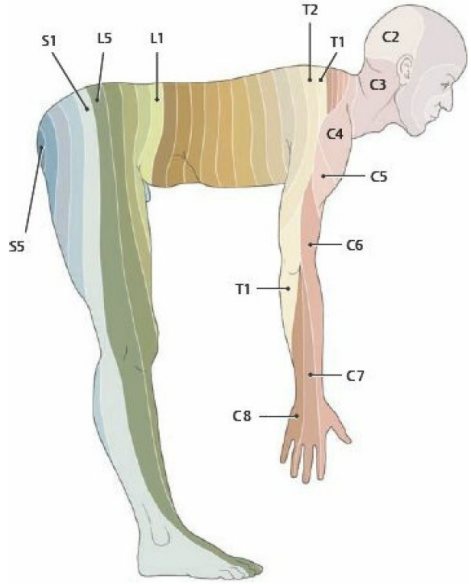
Spinal nerves



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.





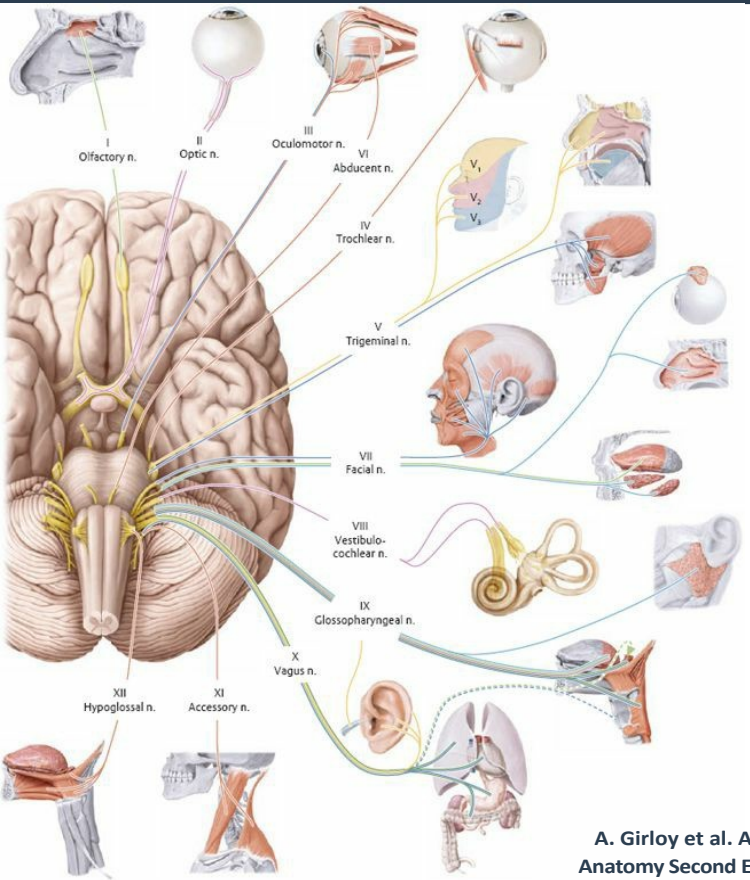


Front root posterior root Posterior root coil

anterior horn posterior horn

Spinal nerves

Cranial nerves

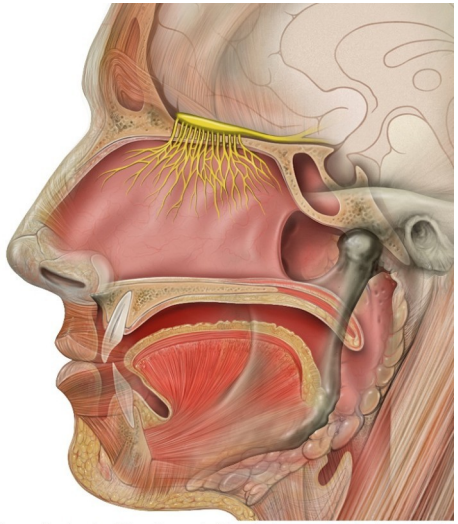


A. Girloy et al. Atlas of Anatomy Second Edition.

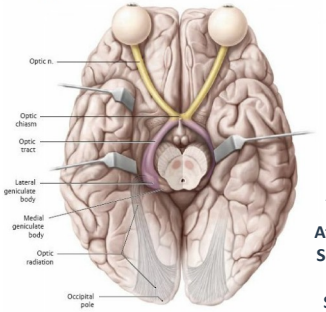
- I → olfactory nerve
- II → optic nerve
- Nerves III, IV and VI → responsible for eye movement
- V → trigeminal nerve (facial sensation and masticatory muscles)
- VII → facial nerve (facial muscles)
- VIII → vestibulocochlear nerve (hearing and balance)
- X → vagus nerve (parasympathetic innervation of the thorax and abdomen)
- Nerves IX, XI and XII → innervation of throat, tongue, salivary glands
  parotid and some neck muscles

2012.

Nerves I and II



https://upload.wikimedia.org/wikipedia/commons/3/3a/Head_olfactory_nerve.jpg

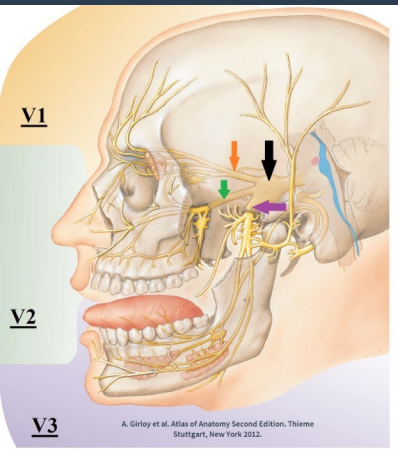


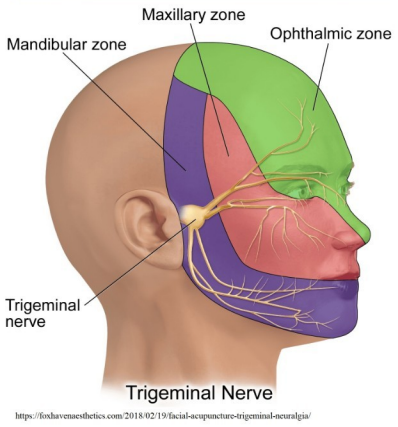
A. Girloy et al.

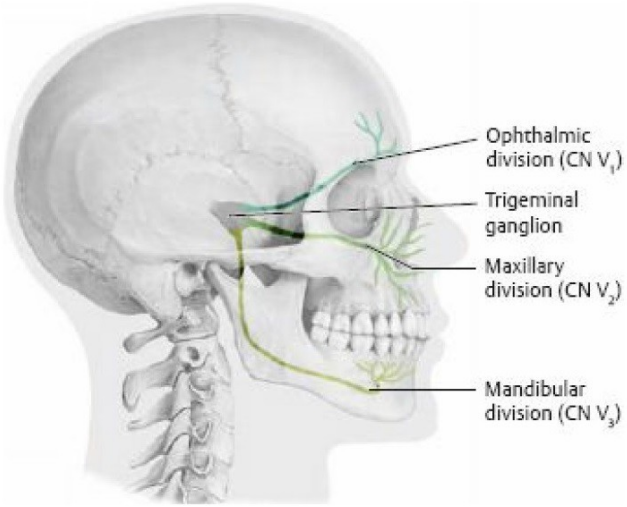
Atlas of Anatomy Second Edition. Thieme Stuttgart, New

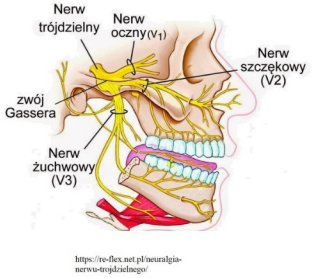
- These nerves are not real nerves just protrusions of the interbrain (which is why increased intracranial pressure manifests as swelling of the optic nerve disc at the bottom of the eye).
- The olfactory nerve is a short protuberance that terminates in the olfactory bulb, from which the olfactory threads exit to enter the nasal cavity through the sieve lamina.
- The optic nerve runs from the optic chiasm to the The eyeball (passing into the orbit through the optic canal).

V nerve - trigeminal



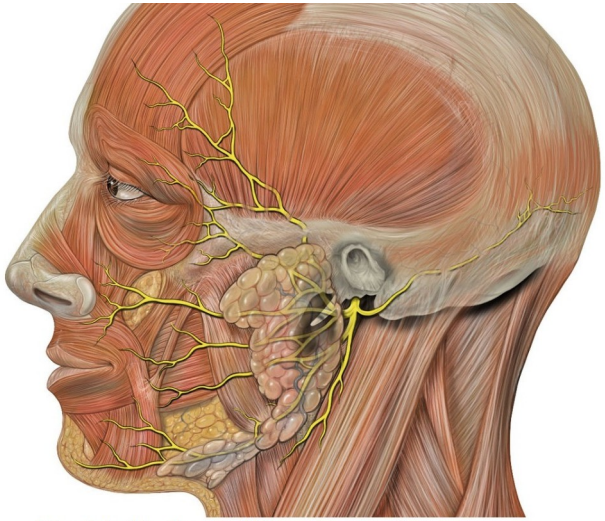




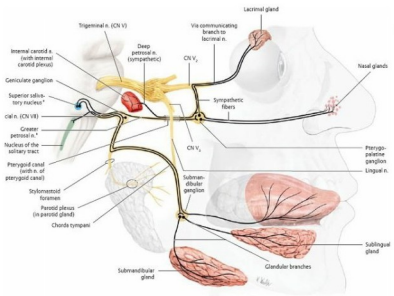


- The nerve exits the bridge and divides into 3 branches: the ocular (V1), maxillary (V2) and mandibular (V3) nerves.
- It sensory innervates the face, nasal cavity, front part of the tongue (2/3) and motor muscles responsible for the movement of the mandible (chewing).
- Due to the sensory nature of the fibers, it has a ganglion - Gasser's ganglion.
- If any of the branches is compressed, there is hemifacial pain in the area innervated by the branch in question (trigeminal neuralgia).

VII - facial nerve



https://pl.wikipedia.org/wiki/Nerw_twarzowy#/media/Plik:Head_facial_nerve_branches.jpg



A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

- It provides motor innervation to the facial muscles and parasympathetic to the lacrimal, nasal, submandibular and sublingual salivary glands.
- The nerve exits the brainstem at the sternocerebellar angle and enters the internal auditory aperture along with the VIII nerve, then runs in the facial nerve canal (in the scala part of the temporal bone), where the knee ganglion is located, through the eardrum and the greater scala nerve the VII nerve leaves the parasympathetic fibers. After the VII nerve (only motor fibers) leaves the skull, it runs and branches inside the parotid gland, but does not innervate it!
- With paralysis of this nerve and in strokes (when the area of the brain responsible for the action of the facial muscles is damaged), the corner of the mouth drops and the eyelid is unable to close.

VII - facial nerve

VIII - vestibulospinal nerve

Nerve VIII Nerve VII Nerve VII knee ganglion

Vestibular organ

Cochle

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

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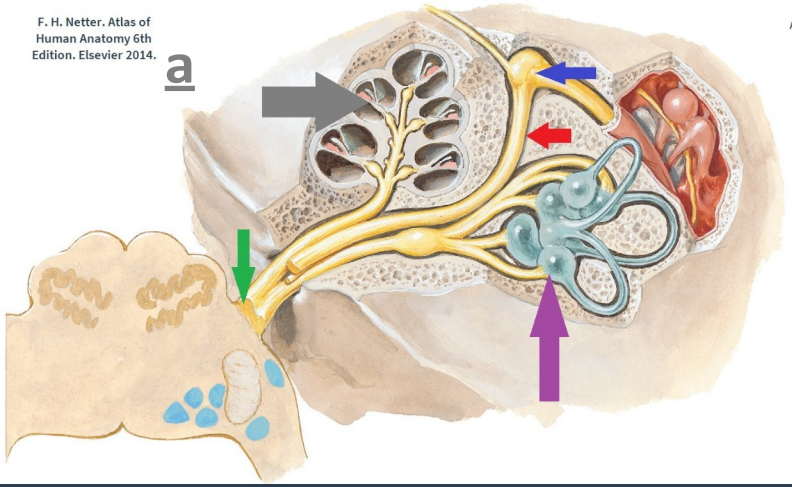
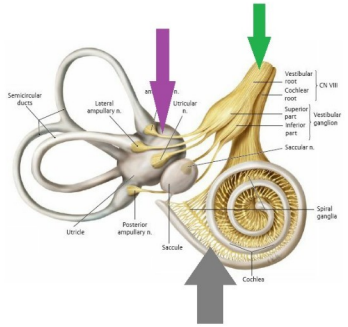


A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.



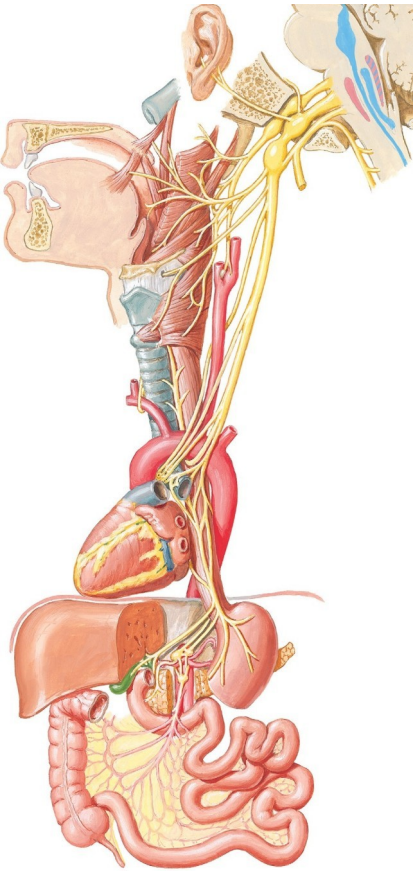
- It emerges from the brainstem at the sternocerebellar angle and enters the scalene part of the temporal bone through the internal auditory aperture. It branches into the vestibular part, which is responsible for innervating the organ of balance, and the cochlear part, which is responsible for hearing.
- Irritation of this nerve manifests as tinnitus and dizziness.

X nerve - vagus

- It innervates parasympathetically the organs of the neck, chest and abdomen (except the small pelvis!), locomotionally the pharynx and larynx, sensory the outer ear and posterior cranial fossa.
- It is the longest cranial nerve.
- Latin for vagus (in the past, a vagotomy procedure was performed - cutting this nerve to reduce the secretion of hydrochloric acid in the stomach to treat peptic ulcer disease).
- Stimulation of this nerve slows heart rate, reduces respiratory rate and increases secretion in the digestive tract (stimulates digestion).

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

X nerve - vagus



Functional systems

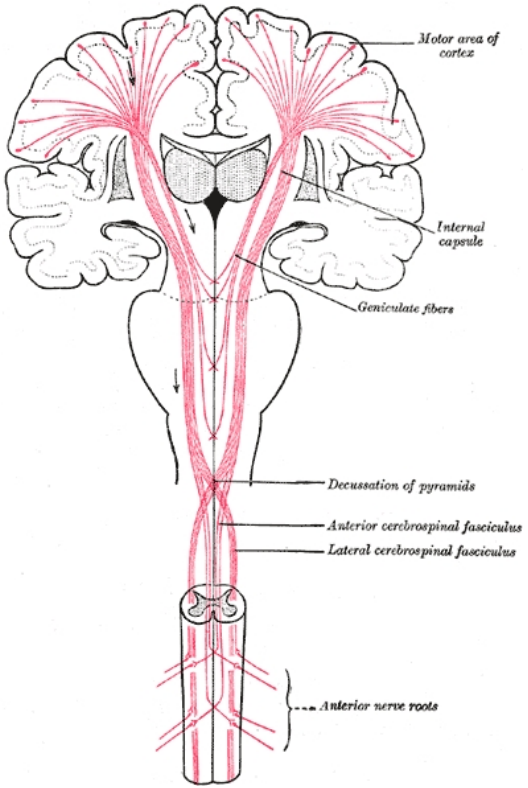
Traffic initiation and control

- The pyramidal system is responsible for initiating movement (information passes through 2 neurons - the 1st in the frontal lobe cortex, which discharges the white matter axon to the 2nd neuron in the anterior horn of the spinal cord or cranial nerve nucleus). This is a crossed system (at the junction of the pyramids in the medulla oblongata, the fibers descending into the medulla go to the 2nd side).
- The extrapyramidal and cerebellar systems control and coordinate the fluidity and precision of movement, the distribution of muscle tension, and nullify tremor. They are

Traffic initiation and control

multi-neuronal systems.

Initiation of movement - pyramid system



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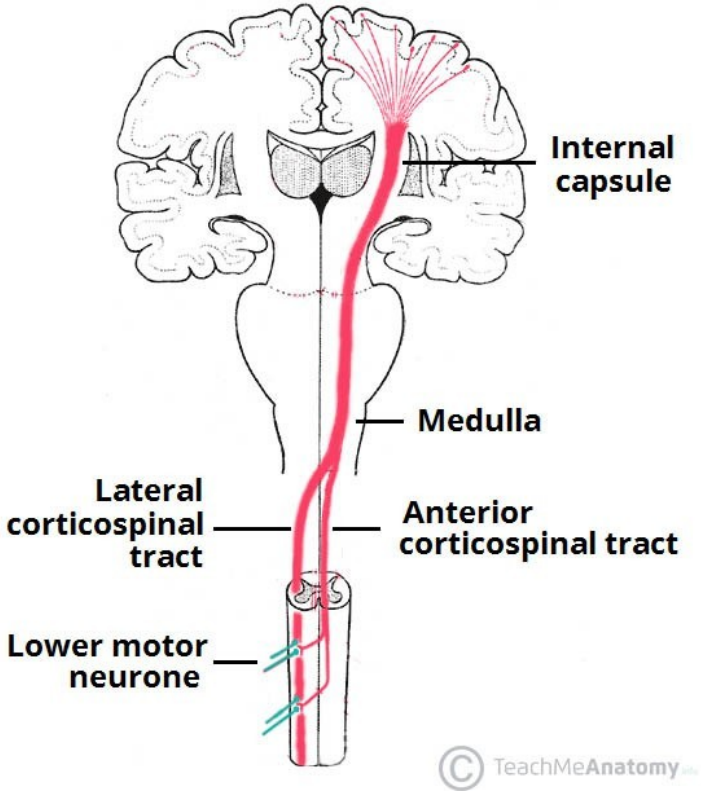
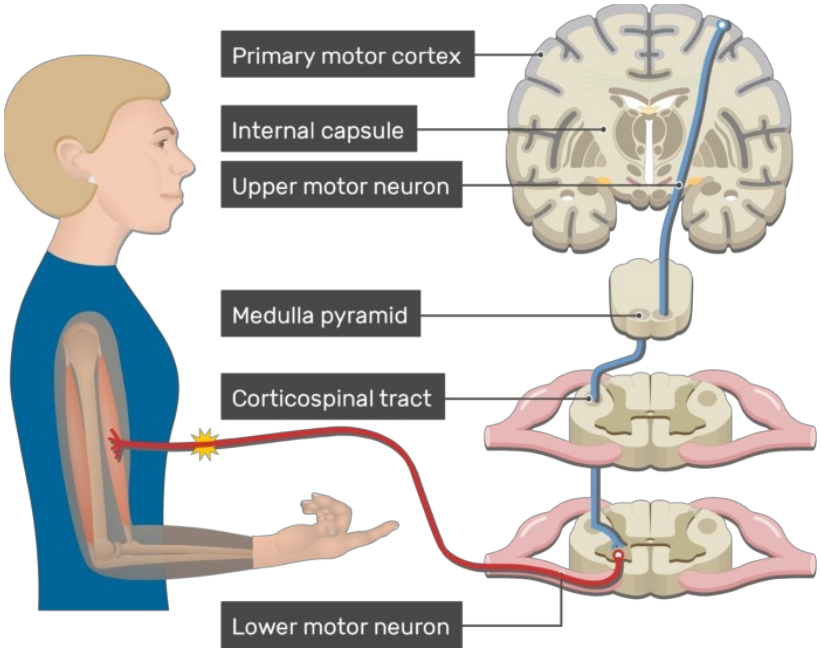


http://www.examnnotes.com/Pyramidal%20Tracts.html



https://www.getbodysmart.com/motor-system/pyramidal-tract-pathway

Level of damage to the pyramidal tract

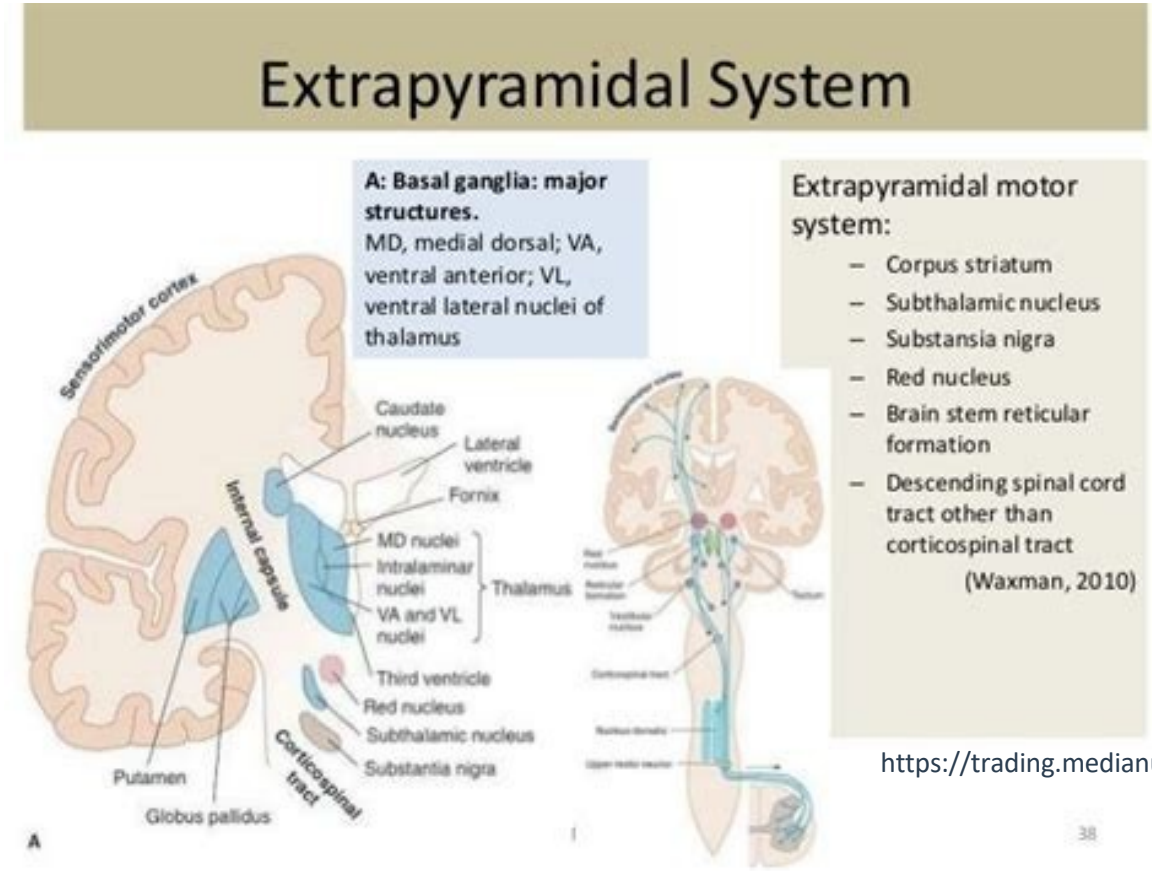
Spastic paresis / pseudobulbar syndrome	Flaccid paresis / pad syndrome
- weakened strength muscle - increased tension muscular (spasticity) - exorbitance reflexes tendons - manifestation pathological symptoms (e.g. Babinski, clonus)	- weakened strength muscle - weakening voltage muscle (limpness) - weakening reflexes tendons - muscles undergo atrophy

- Damage to the 1st neuron of the pyramidal pathway (the upper one, i.e. from the level of the cerebral cortex to the cranial nerve nucleus or anterior horn of the spinal cord) results in spastic paresis (for spinal nerves) or pseudobulbar syndrome (for cranial nerves). Symptoms result from a lack of inhibition of the lower neuron by the upper neuron (the lower neuron is "overactive")
- Damage to the 2nd neuron of the pyramidal pathway (inferior, that is, from the level of the cranial nerve nucleus or anterior horn of the spinal cord) results in flaccid paresis or palsy syndrome.

https://www.youtube.com/watch?v=2C9-r82I3e8&ab_channel=FizjoTerapiaHD

Extrapyramidal system

- The extrapyramidal system consists of the basal nuclei in the cerebral hemispheres and their connections to the black matter of the midbrain, thalamus, cerebral cortex and spinal cord.
- This system primarily takes care of the correct distribution of muscle tension (when we contract the flexor muscle, the extensor relaxes, but we don't think about it).
- It operates independently of our will.



Cerebellar system

- Functionally, we distinguish between the cerebellum: vestibular, medullary and new cerebellum.
- The vestibular cerebellum receives information about head position from the VIII nerve and corrects eye alignment and postural muscle tension (responsible for posture).
- The spinal cerebellum (cerebellar worm) receives information about the movement being made from the spinal cord by which it can correct it.
- The new cerebellum (cerebellar hemispheres) receives information about planned movement from the cerebral cortex and sends corrective feedback to it.
- The cerebellum takes care of the precision of movement, compensates for tremors, prevents falls, and allows you to fix your eyes on 1 point while moving your head.
- Cerebellar syndrome (damage) manifests as: nystagmus (involuntary, rhythmic eye movements), dizziness, difficulty maintaining balance, ataxia (awkwardness of movement), dysmetria (difficulty stopping movement), tremor when moving a limb.

Types of sensing

- Sensory is divided into superficial (skin) and deep (muscles, tendons, ligaments).
- From a neurobiological point of view, a distinction can be made between sensing:
  - pain and temperature,
  - touch,
  - proprioception (position sensing) conscious,
  - unconscious proprioception.
- In addition, sensation is divided into somatic and visceral. Somatic is conducted by peripheral nerves from the skin, subcutaneous tissue, muscles, tendons, ligaments, bones. This sensation is well localized, accurate. Visceral sensation (from internal organs) conducted by nerves of the autonomic nervous system, is mainly limited to pain (to stretch, ischemia) and temperature. It is poorly localized, and sensations can be projected (e.g., shoulder pain can be a symptom of cholecystitis).

Sensory (somatic) pathways

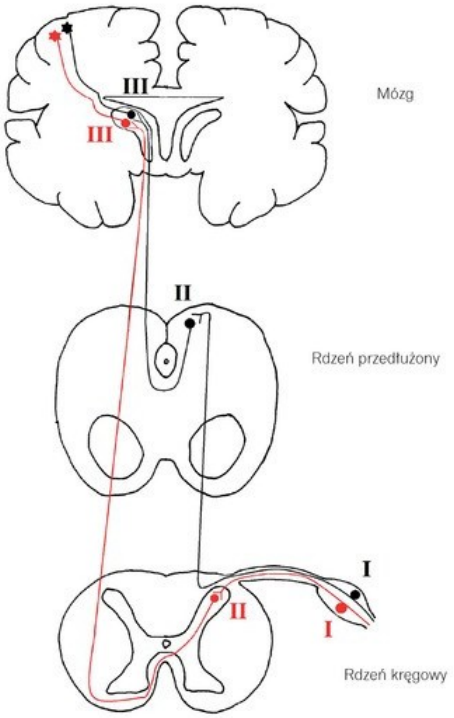
- Consists of 3 neurons (1. in the spinal or cranial nerve ganglia, 2. in the posterior horns of the spinal cord or nucleus accumbens or cuneus and 3. in the thalamus)
- The fiber of the 2nd neuron is crossed!
- Pathways for pain, temperature and touch have 2nd neuron bodies in the posterior horn and cross at the level of the entrance to the spinal cord
- The pathways of conscious proprioception cross only in the brainstem, because there is the 2nd neuron of the sensory pathway for this type of

Sensory (somatic) pathways

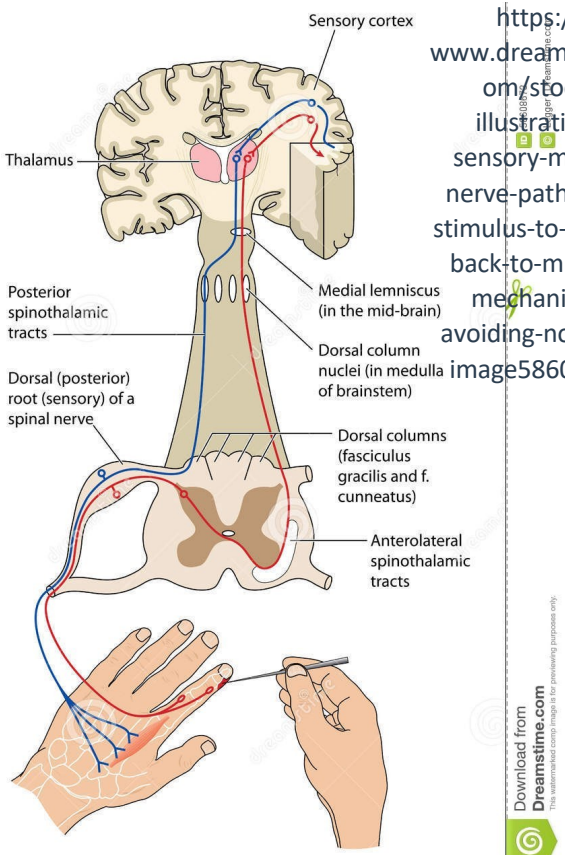
sensation.

- Unconscious proprioception pathways do not cross!

Sensory pathways



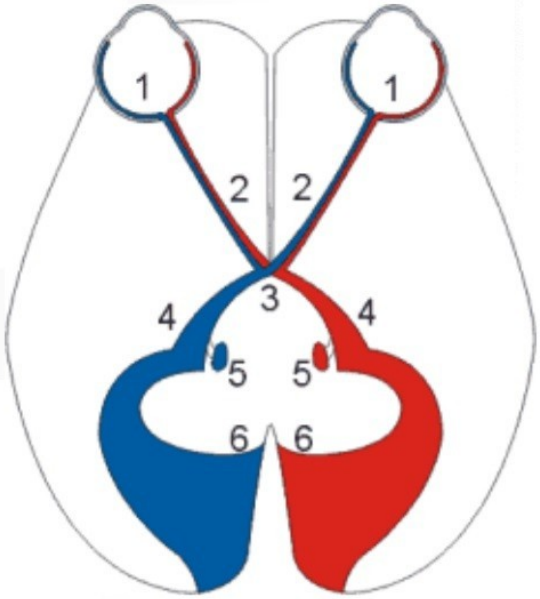
https://podyplomie.pl/neurologia/13519,diagnostic-diagnosis-disturbances-feeling-disturbances

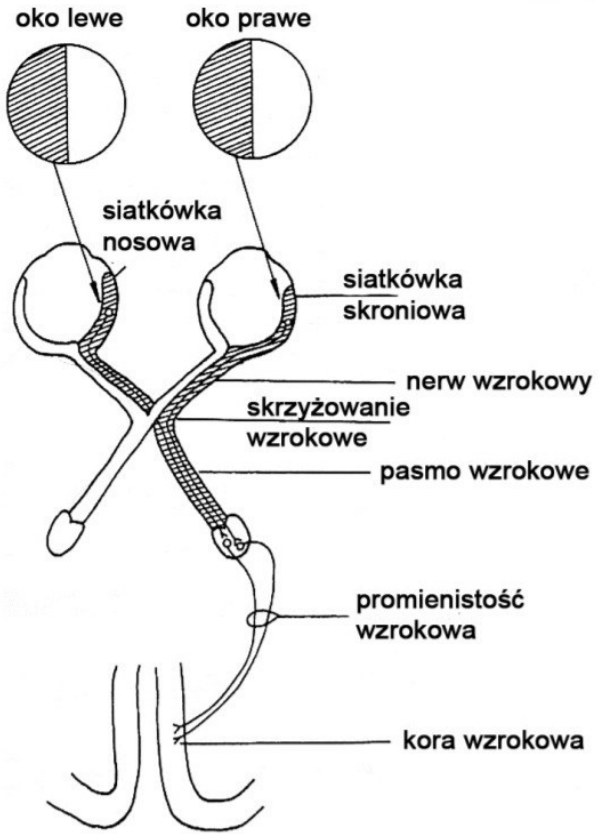


https://www.dreamstime.com/stock-illustration-sensory-motor-nerve-pathways-stimulus-to-cortex-back-to-muscle-mechanism-avoiding-noxious-image58608673

- **The red color (in both figures) indicates surface sensation (pain, touch, temperature), whose pathway crosses at the level of the entrance to the core.**
- **The color black or blue represents deep sensation (conscious proprioception), or position sensation, whose pathway is crossed at the level of the brainstem.**

Visual pathway

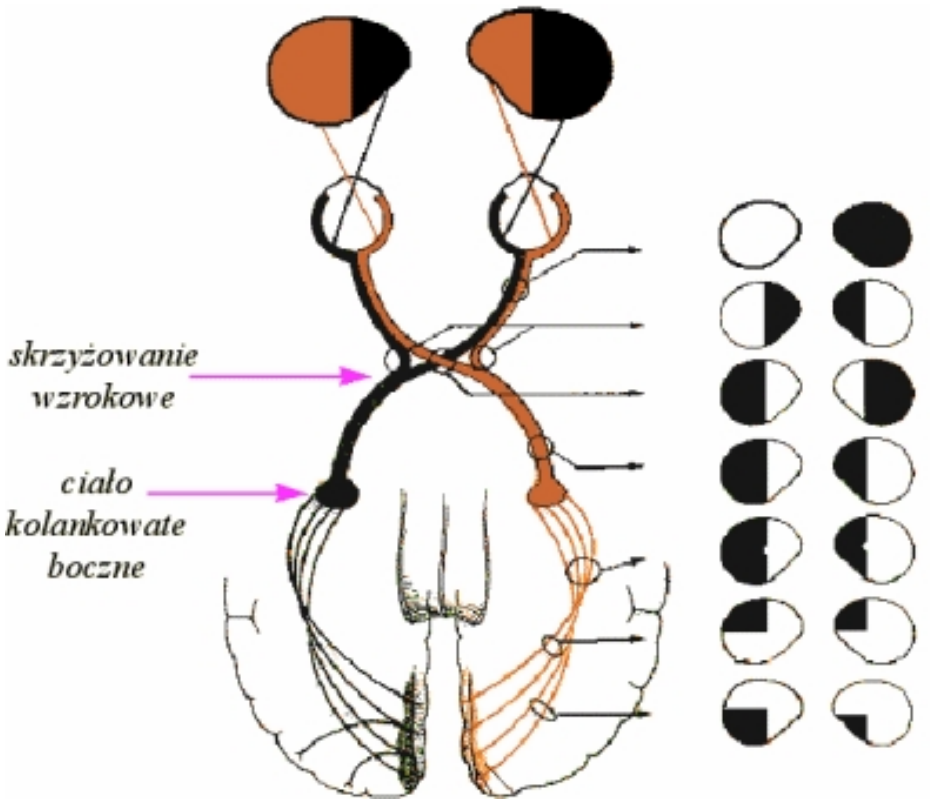




http://www.swiatlo.tak.pl/1/index.php/principle_action_eye-process-seeing/

- An inverted image falls on the retina (1) (the image from the nasal region to the temporal part and vice versa). From the eyeball to the optic junction (3) runs the optic nerve (2).
- In the visual crossroads (3), fibers from the medial (nasal) part of the retina cross, and those from the lateral (temporal) part go to the occipital cortex uncrossed.

Visual pathway - damage



- Depending on the location of the damage to the visual pathway, the visual field restriction proceeds differently.
- Tunnel vision → loss of lateral visual fields due to pressure on the visual junction.
- Damage behind the optic chiasm (optic chiasm, optic radius) leads to a loss of visual field on the same side for each eye.

Limbic system

- Emotional-memory system.
- It has numerous connections to numerous elements of the central nervous system, including the cortex, hypothalamus, thalamus, and olfactory nerve.
- It is located in parts of the basal nuclei and temporal lobe (in the deeper structures of the brain, involving relatively few structures of the cerebral cortex).
- Among the main structures of this system are the hippocampus, the cingulate nerve, the amygdala and amygdala bodies, and the olfactory cortex.
- Responsible for remembering (whether a piece of information will remain in short- or long-term memory), the strongest emotions are experienced at this level (especially those that strongly interact with the autonomic nervous system through connections with the hypothalamus): fear, euphoria, elation, pleasure; it also participates in the regulation of urges (sex, food, sleep).

Autonomic nervous system

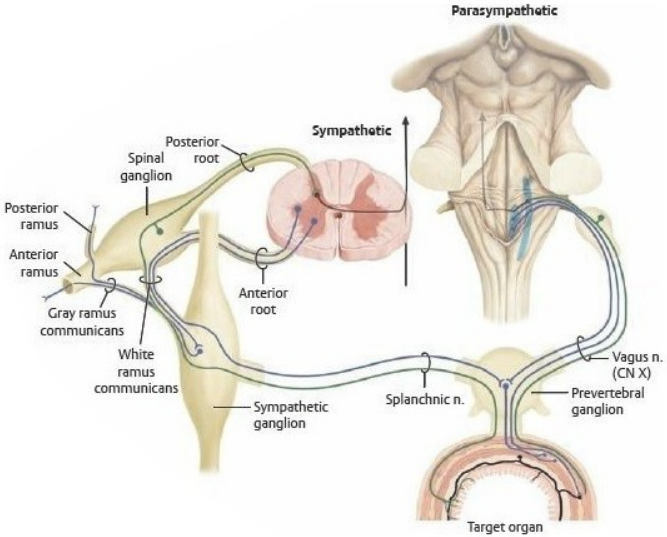
- **A system independent of our will that regulates the work of organs crucial to life, the operation of which we do not make conscious decisions about. It conducts visceral sensation. It is divided into 2 components: sympathetic and parasympathetic autonomic systems.**

A. Girloy et al.

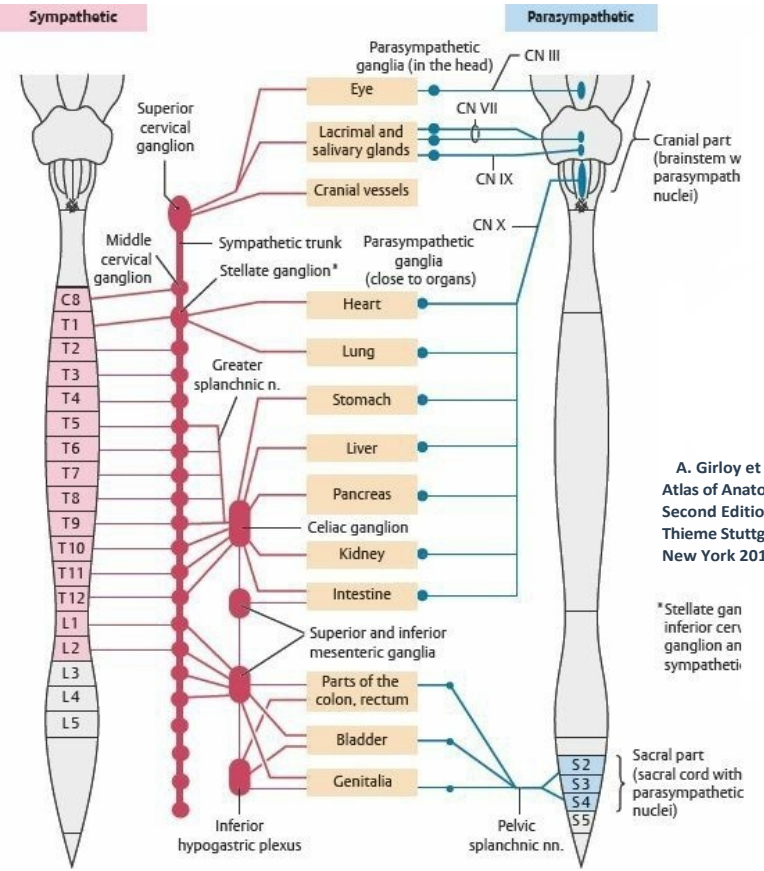
Atlas of Anatomy
Second Edition.
Thieme Stuttgart,
New York 2012.

- **It remains under the control of the hypothalamus and reticular formation of the brainstem, and its primary centers are the nuclei of nerves III, VII, IX and X and the S2 - S4 section of the spinal cord (parasympathetic system) and the anterolateral horns of the spinal cord C8 - L2 (sympathetic system).**
- **Sympathetic nervous system - stimulates fight, flight (sweating, acceleration of heart rate, breathing, increase in blood pressure, directing blood to skeletal muscles, and draining it, for example, from the gastrointestinal tract, constriction of the pupil).**
- **Parasympathetic system - rest, digestion (slows heart rate, breathing, increases digestion, blood is directed to the gastrointestinal tract, pupil dilation).**

Autonomic nervous system



Autonomic nervous system

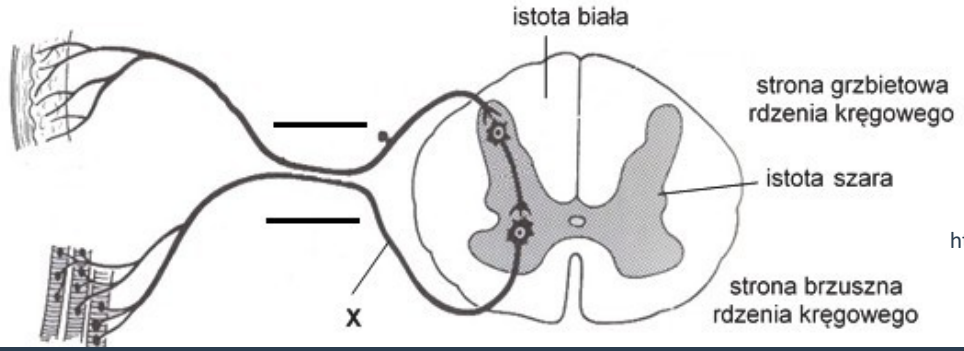


A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

- Associated with the autonomic system is the existence of ganglia (where information is switched to the 2nd neuron of the autonomic pathway).
- The sympathetic nervous system begins in the spinal cord (C8-L2) in the anterolateral horn, through the anterior roots of the spinal nerves, the fibers enter the spinal ganglia, which are connected to each other and form the sympathetic trunk, from which the fibers depart to various organs (often around blood vessels).
- The parasympathetic system begins in the nuclei of cranial nerves III (eyeball), VII (sublingual and submandibular salivary glands, lacrimal glands), IX (parotid gland) and X (organs of the neck, thorax and abdomen). The pelvic organs are innervated from nerves originating in the S2-4 segment of the spinal cord. Parasympathetic ganglia are usually located in the walls of the organs.

Reflex

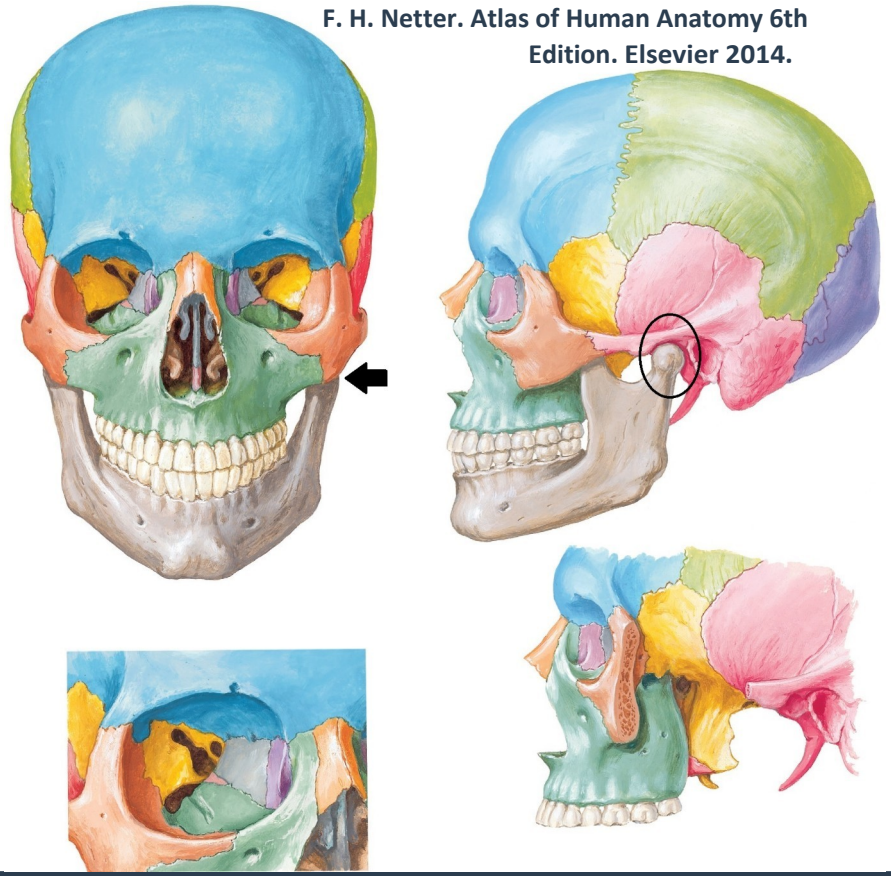
- **An automatic (without our will) response to a stimulus occurring with the involvement of the central nervous system. By examining the reflex, we can determine the level of damage to the nervous system. For the occurrence of a correct reflex, the efficiency of all elements of the reflex arc is required: receptor → afferent pathway → reflex center → efferent pathway → effector.**



https://biologhelp.pl/matura/matura-may-2019-elementary-level-standard/task-19

Anatomy of the head

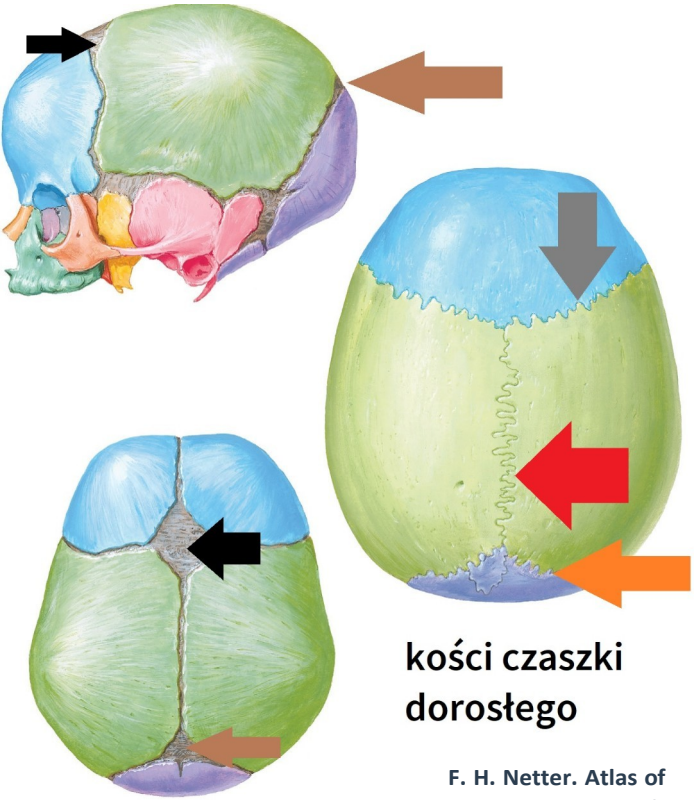
Skull



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- A complex of multiple even and odd flat bones.
- It is divided into the facial part (which is the support for the face) and the cerebral part (which is the bony protection of the brain).
- The most important facial bones include the mandible, maxilla, zygomatic bone, nasal bone, and nasal cavity bones.
- The most important bones of the cerebrum include the temporal, cuneiform, frontal, parietal and occipital bones.
- The only movable connection between the bones of the skull is the temporomandibular joint.

Sutures and fontanels



kości czaszki dziecka

kości czaszki dorosłego

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The bones of the skull in an adult are connected by sutures (cranial adhesions): the nodal, sagittal and coronal.
- In infants, the bones of the skull do not fully fuse together and there are fontanelles at the joints of the bones: anterior, posterior, wedge and mastoid.
- Through the bones of the skull run the spur veins, which connect the venous sinuses of the dura with the superficial venous system of the skull (in the subcutaneous tissue). They form

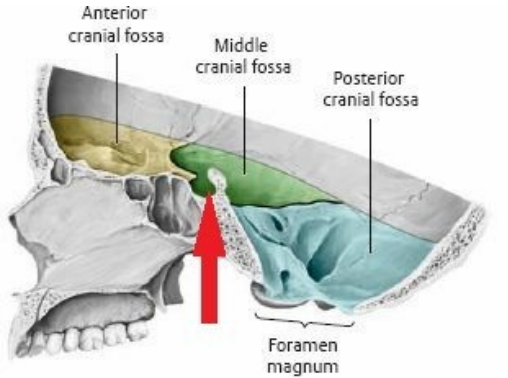
Sutures and fontanels

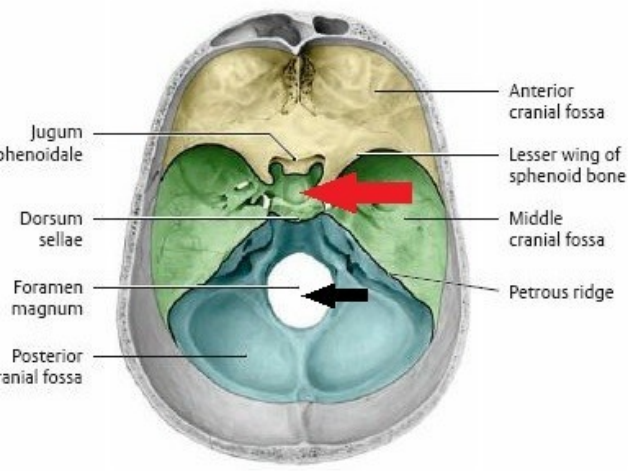
Skull pits

A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

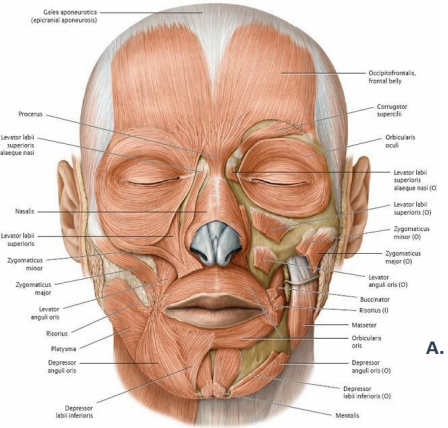
- Looking from above at the open cranial cavity, 3 cranial pits can be distinguished: anterior (under the frontal lobes), middle (under the temporal lobes) and posterior (under the cerebellum).
- Part of the middle fossa is the Turkish saddle, into which the pituitary gland protrudes.
- In the posterior fossa of the skull is the great opening, through which the spinal

Skull pits

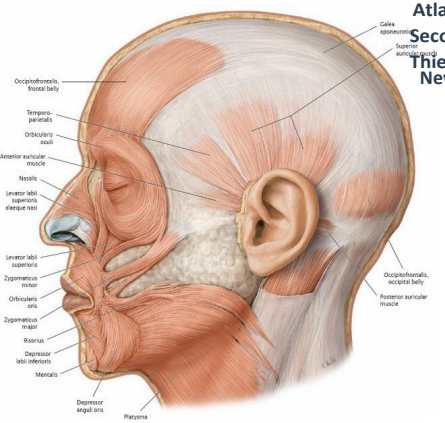

Anterior cranial fossa
Middle cranial fossa
Posterior cranial fossa
Foramen magnum


Jugum
phenoidale
Dorsum sellae
Foramen magnum
Posterior
anial fossa
Anterior cranial fossa
Lesser wing of sphenoid bone
Middle cranial fossa
Petrous ridge

Head muscles



A. Girloy et al.



Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

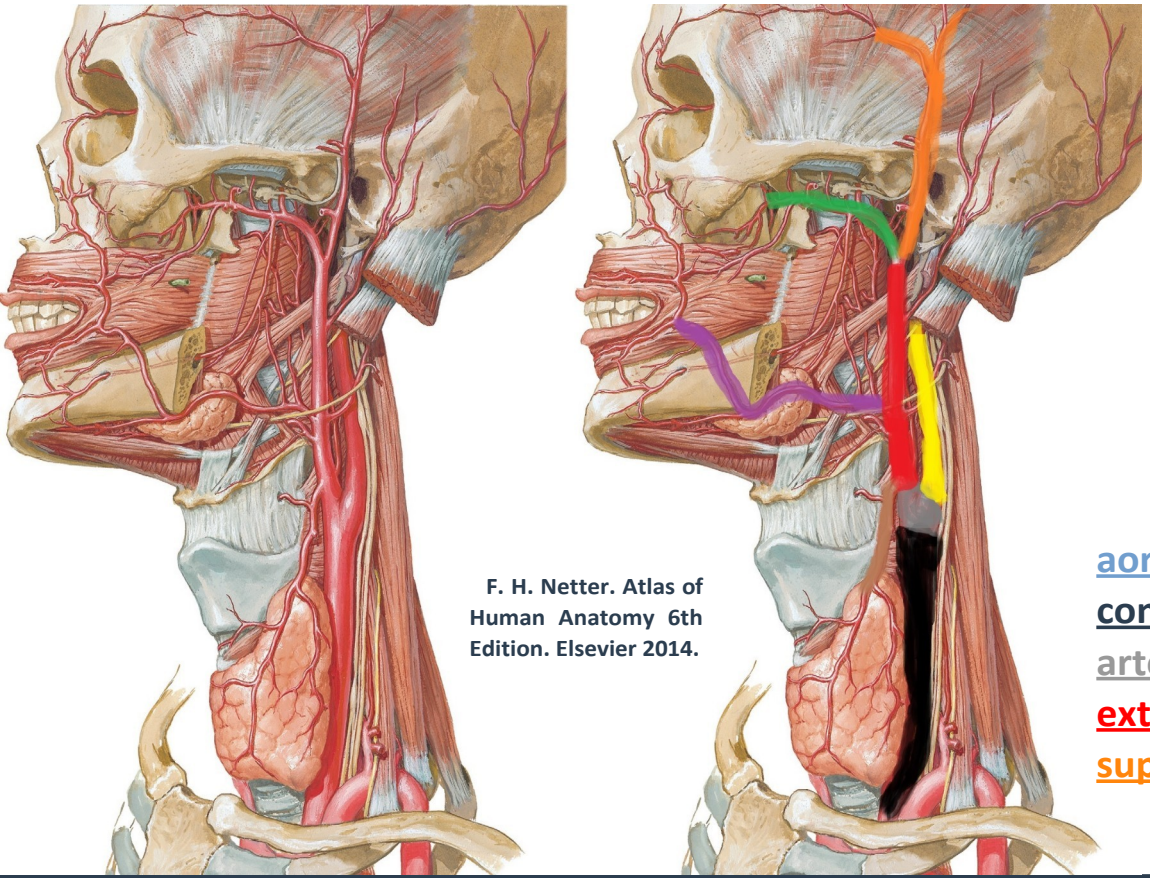
- The head has 2 primary muscle groups: facial (innervated by the facial nerve) and masticatory (innervated by the trigeminal nerve).
- The muscles of mastication are responsible for the movement of the jaw (especially its closing and side-to-side movements).
- Facial muscles are responsible for all facial movements (especially forehead creasing, eyebrow lifting, eye closing, nose lobe movements, mouth movements, smiling, lip clenching, cheek movements).
- The circular muscles close the given opening (mouth or

Head muscles

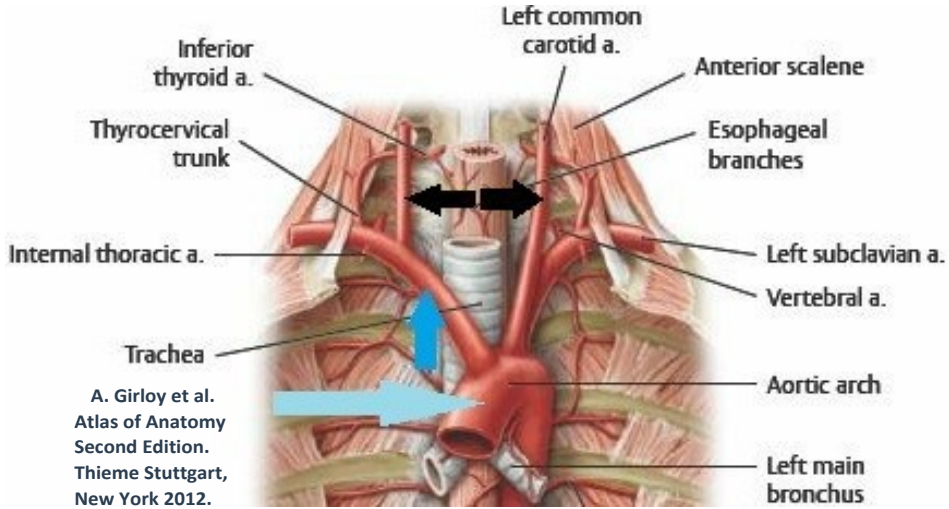
Arterial vascularization of the head

- The brachiocephalic trunk, from which the right common carotid artery branches, and the left common carotid artery branches directly from the aortic arch.
- The internal carotid artery is divided into internal and external. At the branch is the carotid sinus, which is a key element in regulating blood pressure.
- The internal carotid artery does not give off any branches in the neck and enters the cranial cavity, where it participates in the vascularization of the brain.
- The external carotid artery vascularizes the facial skull (in addition to the orbital contents), and is divided into the superior thyroid, facial, maxillary and superficial temporal arteries.
- The superficial temporal artery lies very shallowly and does not vascularize any important areas - it is a good vessel for diagnostic biopsy in cases of vasculitis.
- From the maxillary artery comes the middle meningeal artery (vascularizes the dura mater), it is its damage that leads to the formation of a rapidly growing supratentorial hematoma.

Arterial vascularization of the head



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.



A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.

aortic arch

brachiocephalic trunk

common carotid artery

sinus of the carotid artery

internal carotid artery

external carotid artery

facial artery

superficial temporal artery

maxillary artery

Head innervation

- The head is innervated mainly by the cranial nerves, parasympathetic innervation accompanies the other fibers in the cranial nerves: III (eyeball), VII (lacrimal gland, nose, oral cavity, submandibular and sublingual salivary glands), IX (parotid gland, pharynx), X (pharynx, organs of the neck, chest and abdomen). Sympathetic innervation reaches the head from the sympathetic trunk by wrapping around the carotid artery (damage to the carotid artery can cause pupillary constriction).
- Motor innervation of mimic muscles: nerve VII
- Motor denervation of masticatory muscles and facial sensation: nerve V

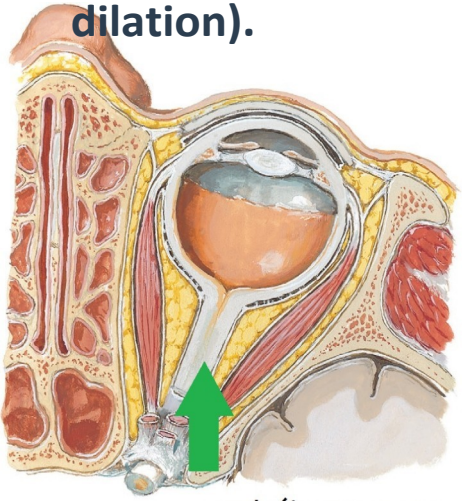
The eye socket and its contents

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

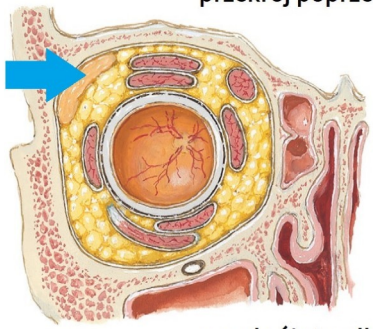
- The orbit is a bony cavity at the border of the facial and cerebral skull, which houses the eyeball along with the surrounding tissues.
- In addition to the eyeball, the orbit contains a large amount of adipose tissue, the lacrimal gland and the muscles that lift the upper eyelid.
- The arterial vascularization of the orbital contents (including the eyeball) is mainly from the internal carotid artery, the orbit being the site of connection between the venous system of the cranial cavity (cavernous sinus) and the facial venous system.
- Motor innervation of the eyeball comes from the cranial nerves: III, IV and VI, sensory innervation of the orbital contents comes from the V1 nerve, and visual information is conducted by the II (optic) nerve. In addition, nerve III conducts parasympathetic fibers to the eye (pressure on this nerve during insertion under the sickle of the brain causes pupil

The eye socket and its contents

dilation).

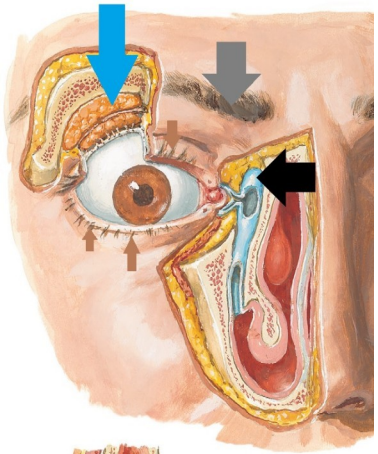


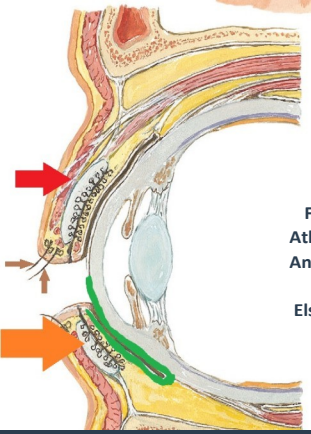
przekrój poprzeczny



przekrój strzałkowy

Eye protection apparatus



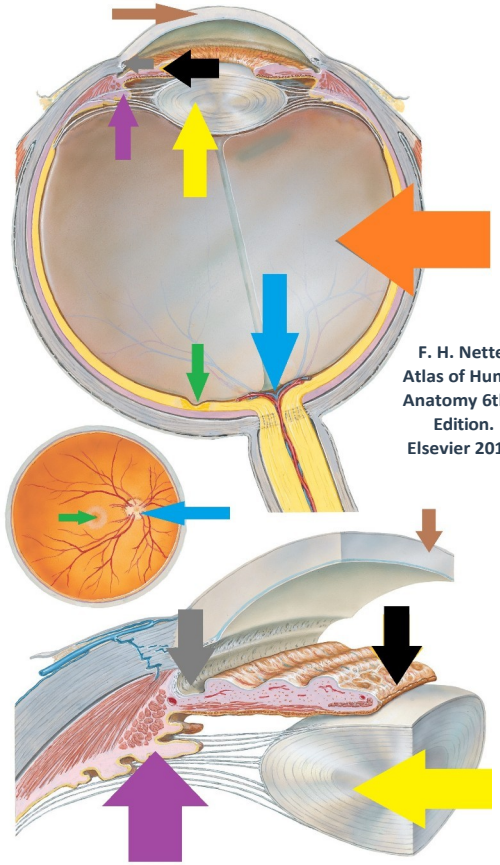


F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The protective apparatus of the eye includes eyebrows, eyelashes, eyelids (upper and lower, each containing a disc), conjunctiva (the membrane lining the inside of the eyelids and the outside of the eyeball to form the conjunctival sac) and the lacrimal gland.
- The lacrimal gland is located in the lateral-upper part of the orbit, tears wash over the conjunctival sac and enter the medial part of the orbit, from where they flow down the nasolacrimal duct into the nasal cavity (under the inferior nasal auricle).

Eye protection apparatus

The eyeball and the fundus of the eye



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The wall of the eyeball is made up of 3 fused membranes: the sclera (the outermost, at the front it becomes the cornea), the choroid membrane (which consists of the choroid, ciliary body and iris) and the retina (the inner).
- Clinically, the eye is divided into anterior (up to and including the lens) and posterior sections.
- Backward from the lens, the eyeball is filled with a gelatinous vitreous body. In the anterior section there is fluid - aqueous fluid produced by the ciliary body, flows through the pupil (the opening in the iris) and is absorbed at the angle of the isthmus (between the cornea and iris).
- Looking at the fundus of the eye, one can observe the macula (the place of greatest concentration of cells that receive visual stimuli) and the optic nerve disc (macula), which is the origin of the optic nerve, and through the disc the central vessels of the retina (artery and vein) enter the retina, which branch to vascularize the retina.

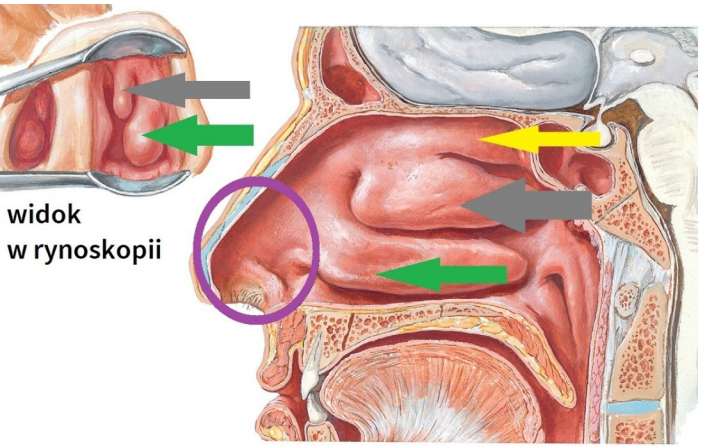
The eyeball and the fundus of the eye

Nose and nasal cavity

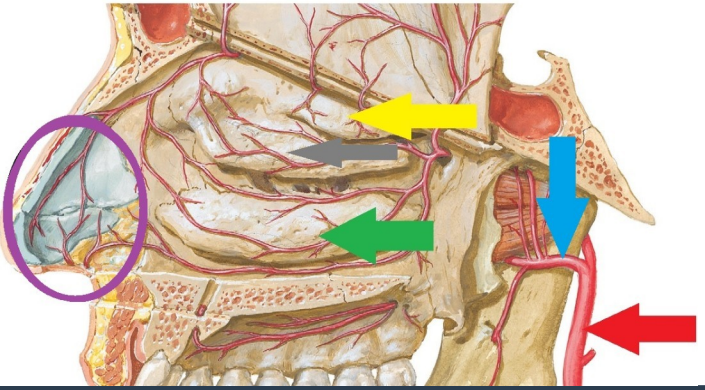
F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The nose is built from a bony and cartilaginous scaffold.
- The nasal cavity is bounded from the front by the front nostrils and from the back by the rear nostrils, where it passes into the nasal part of the pharynx.
- The nasal cavities (left and right) are separated by a nasal septum, which consists of a bony part and a cartilaginous part.
- The nasal cavity consists of the nasal vestibule and nasal passages (upper, middle and lower), which are located under the nasal auricles (upper, middle and lower).
- The nasal vestibule is a particularly richly vascularized area, where the Kiesselbach's plexus is located (the place where vascularization from the maxillary and facial arteries, both of which are branches of the external carotid artery).
- Sensitively, the nose innervates mainly the V2 nerve and parasympathetically the VII nerve (mucosal wetting glands), while olfactory information is transmitted by the I nerve.

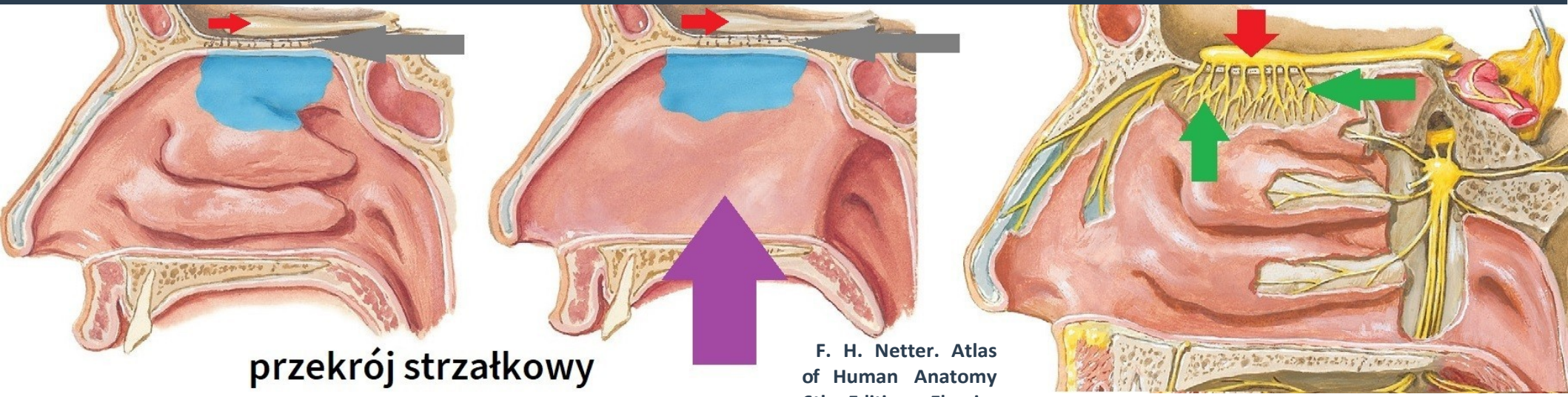
Nose and nasal cavity



przekroje strzłkowe



Sniff



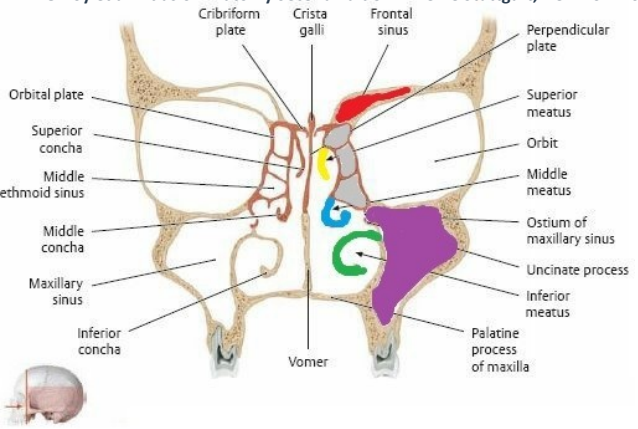
przekrój strzałkowy

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

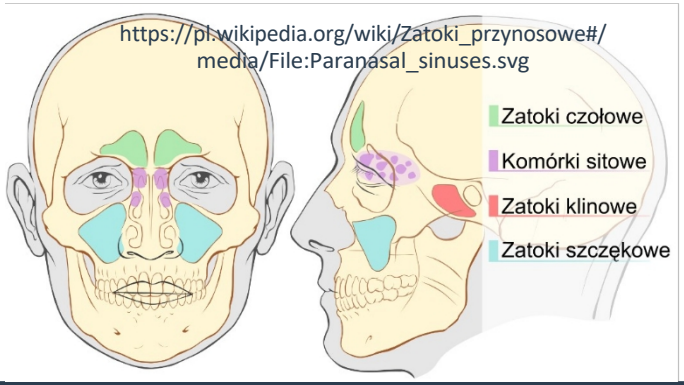
- The olfactory threads exit the olfactory bulb and pass through the sieve lamina, innervating the olfactory epithelium at the top of the nasal cavity. The purple arrow marks the nasal septum.
- Fracture of the sieve lamina (which is a portion of the skull base) leads to leakage of cerebrospinal fluid through the nasal cavity (watery nasal leakage after injury).

Nasal sinuses

A. Girloy et al. Atlas of Anatomy Second Edition. Thieme Stuttgart, New York 2012.



https://pl.wikipedia.org/wiki/Zatoki_przynosowe#/media/File:Paranasal_sinuses.svg

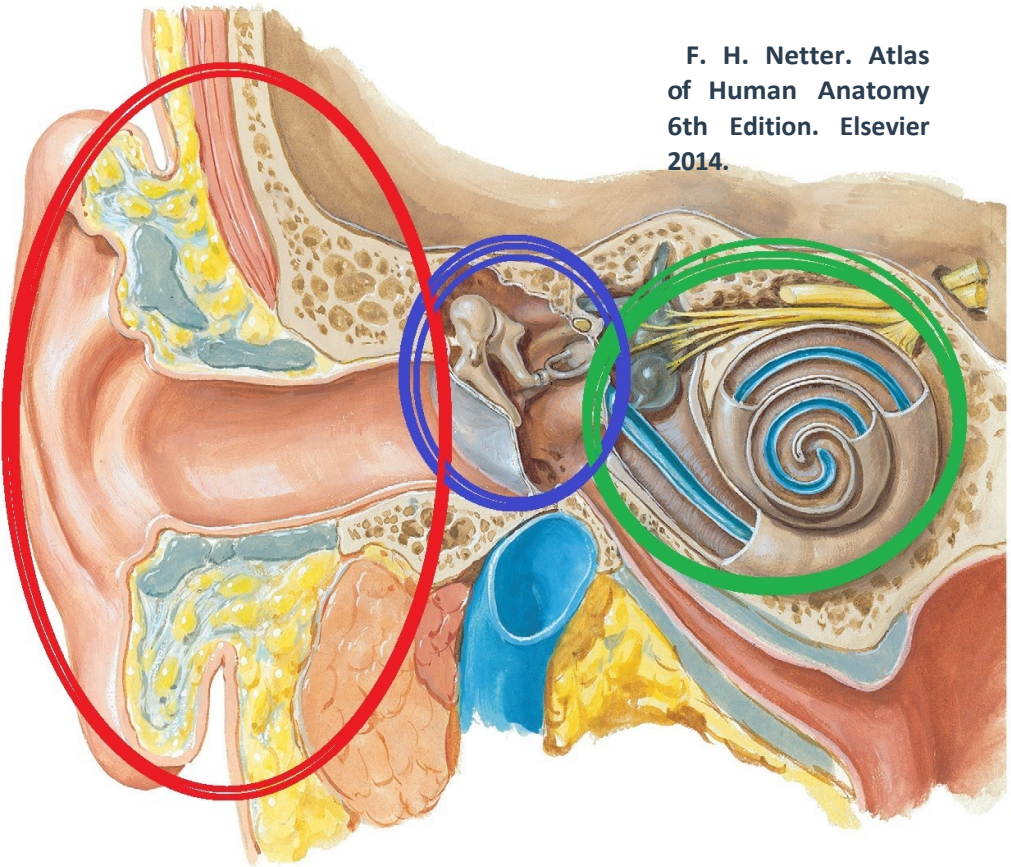


- The child is born with only the sinus appendages, their development takes years (their full development is achieved in adulthood).
- The nasal sinuses and the nasolacrimal duct pass under the nasal auricles (upper, middle and lower).
- The function of the nasal cavity is to humidify, purify, and warm the air, while the sinuses are to

  The purpose is to reduce the weight of the skull and give color to our voice.
- The sinuses of the nose are: sieve cells (between the orbit and nasal cavity), maxillary, frontal and wedge sinuses.

Nasal sinuses

Ear

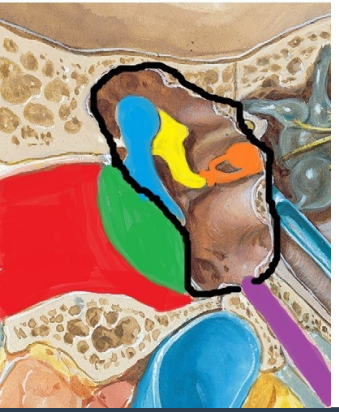


F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The ear is divided into 3 parts: outer, middle and inner.
- Most of the structures of the ear are located in the temporal bone (the eardrum, scala, mastoid process of this bone).
- The outer ear directs sound to the eardrum.
- The middle ear amplifies and transmits sound to the inner ear.
- The inner ear is responsible for receiving auditory stimuli and changes in head position, and converting these stimuli into a nerve impulse.

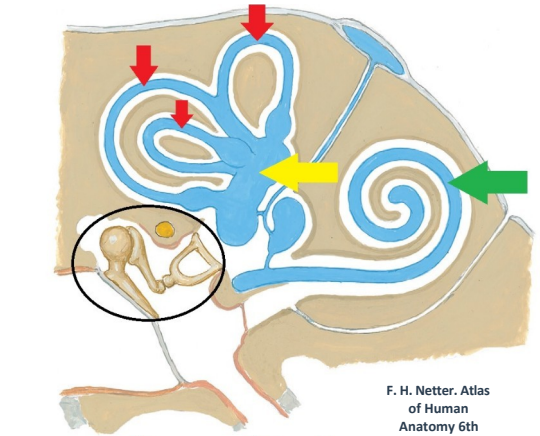
Outer and middle ear

F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.



- The outer ear consists of the auricle and the external ear canal.
- Middle ear: the tympanic cavity (the air space where vibrations of the eardrum are transmitted by the ossicles - malleus, anvil and stirrup - to the middle ear) and the connected mastoid cavity in the mastoid process of the temporal bone, and the Eustachian tube (which escapes into the nasal part of the pharynx, its function is to equalize pressure in the middle ear).
- There are 2 muscles in the eardrum cavity (tympanic membrane tensioner and stirrup), the tension of which protects the inner ear from high sound frequencies (those with high energy).
- Obstruction of the auditory trumpet (common in respiratory tract infections) is a contraindication to diving, as there is a large pressure difference after immersion, which can lead to pressure injury to the ear.

Inner ear



F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

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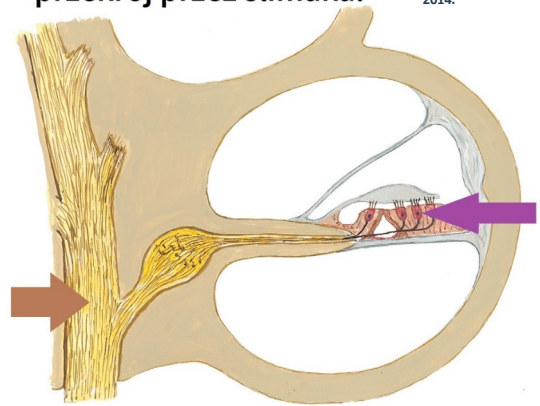


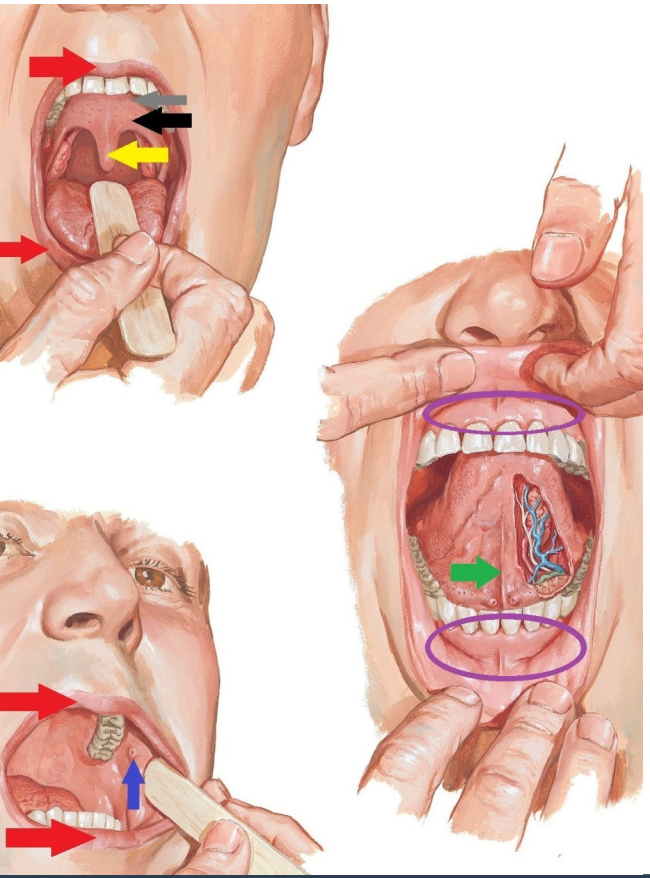
- The inner ear ("vestibule"), or vestibulocochlear organ, is responsible for converting auditory stimuli and changes in head position into nerve impulses.
- It consists of an atrium, cochlea and semicircular canals (each located in a different plane). They are filled with endolymph, and perilymph flows around them.
- Vibrations from the ossicles are transmitted through the oval window to the vestibule and further along the cochlea, where vibrations of the endolymph lead to stimulation of the organ of Corti, which produces a nerve impulse (conducted to the brain via the VIII nerve).
- Head movements cause the flow of endolymph and otoliths (pebbles suspended in the endolymph) in the semicircular canals and atrium.

Oral cavity

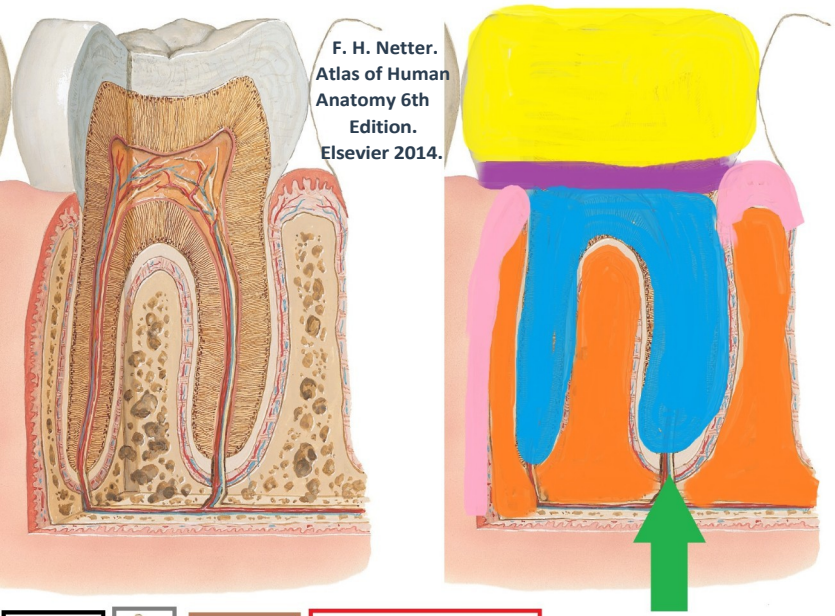
F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier 2014.

- The palate separates the oral cavity from the nasal cavity, and is divided into the hard palate (immobile, having bony support) and the soft palate (which is movable) located posteriorly, ending in the uvula.
- From the front, the mouth is bounded by the lips (upper and lower - each topped by a red lip), and from the side by the cheeks. Between the lips and teeth is the oral vestibule.
- The floor of the mouth consists of muscles that span between the mandible and the hyoid bone. Attached to the floor of the mouth is the tongue. A frenulum of the tongue runs between the tongue and the lower gum.
- The outlets of the sublingual and submandibular salivary glands exit under the tongue. The duct of the parotid gland enters on the inner side of the cheek at the level of the 2nd upper molar.
- Posteriorly, the mouth passes into the oral part of the pharynx.

Oral cavity



Teeth



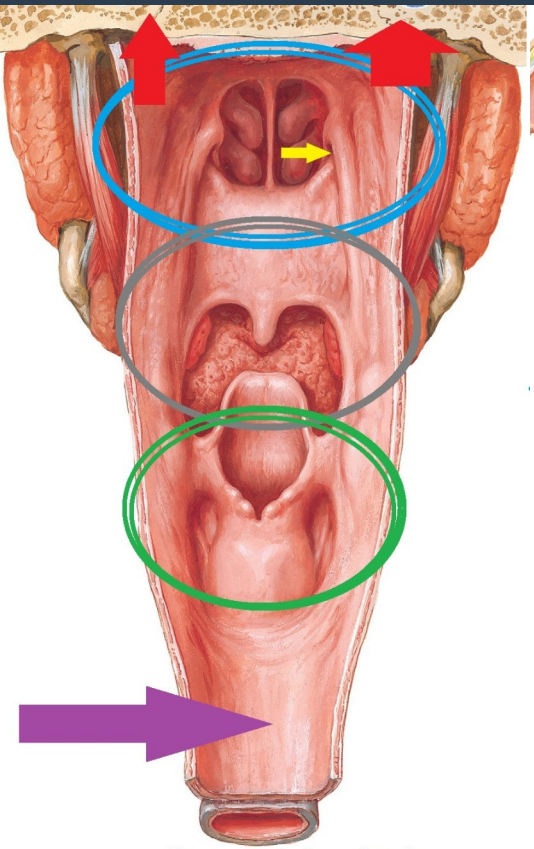
- The first teeth erupt from about 6 months of age and last until the end of the 2nd year. The eruption of permanent teeth begins around age 6 and continues until about age 20.
- The baby has 20 teeth: 4 x 5 (2 incisors, a fang, 2 molars).
- The adult has 32 teeth: 4 x 8 (2 incisors, a fang, 2 premolars and 3 molars).
- Teeth have a crown, a neck and a root. At the top of the root there are apex openings through which innervation and vascularization reach the tooth.
- Teeth are attached to the alveolar processes of the mandible and maxilla, which are covered with mucous membranes - forming the gums

Teeth	10

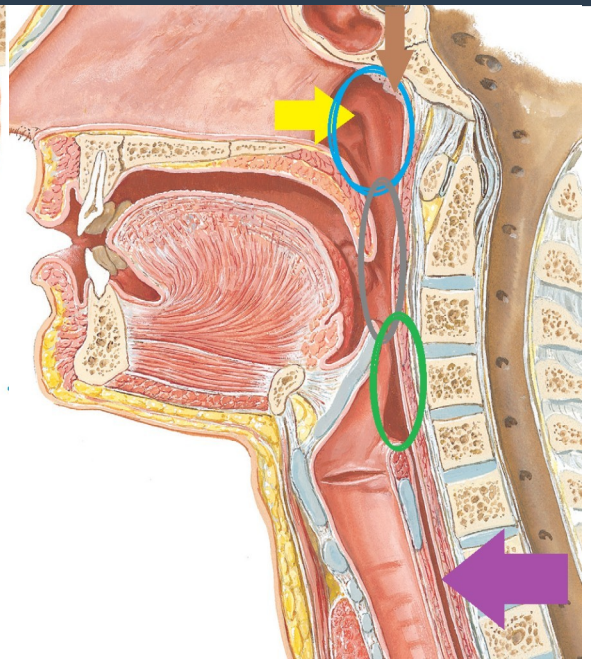
F. H. Netter.
Atlas of Human
Anatomy 6th
Edition.
Elsevier 2014.

- A muscular tube attached to the base of the skull and ending at the level of the neck passing into the esophagus.
- It is divided into nasal, oral and laryngeal parts according to the name of the cavity with which the part communicates.
- Into the nasopharynx escapes the auditory trumpet.
- The throat is a common part of the respiratory and digestive systems.

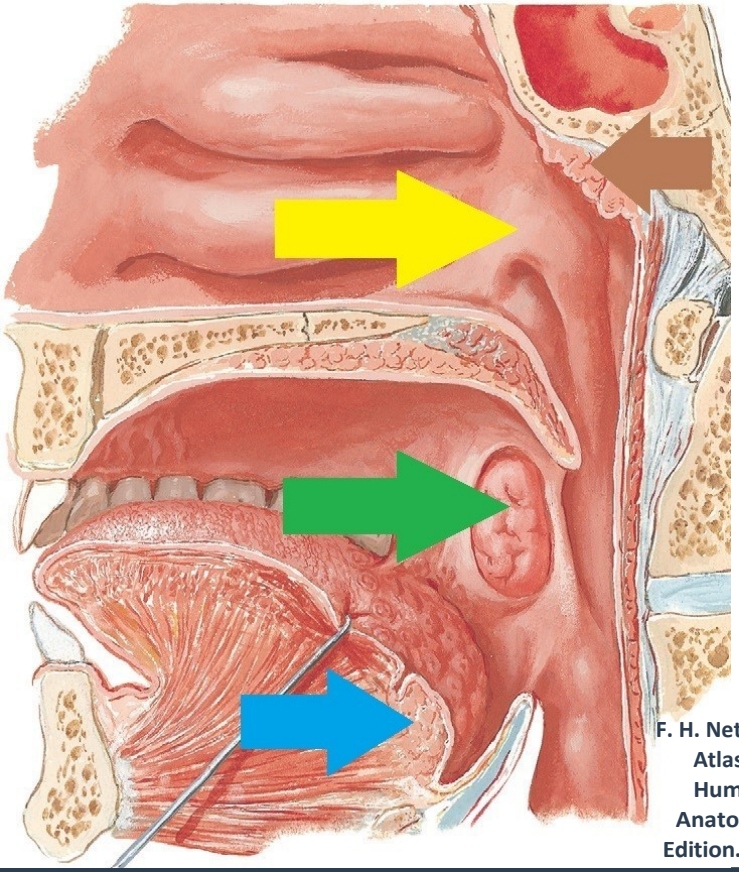
tonsil



gardło - widok od tyłu



The tonsils and the lymph ring



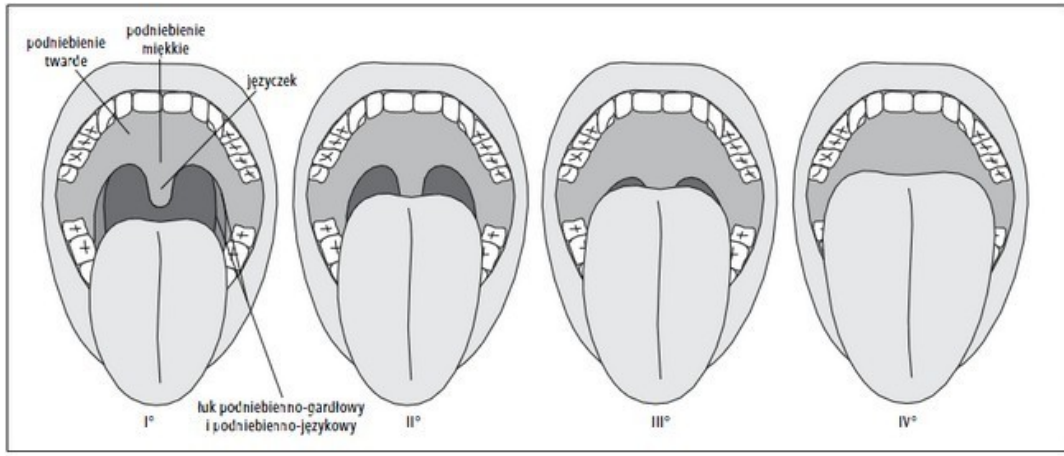
F. H. Netter. Atlas of Human Anatomy 6th Edition. Elsevier

- The pharyngeal mucosa contains clusters of lymphoid tissue (extravascular "leukocyte stores"). These clusters include diffuse lymph nodules and macroscopically visible tonsils.
- There are 6 tonsils: 1 lingual, 2 palatine (right and left), 2 trumpet (right and left at the mouth of the ear trumpets) and 1 pharyngeal (at the top of the nasopharynx).
- The above tissues form the so-called Waldeyer's lymph ring.
- The function of the pharyngeal lymph tissue is to protect against infections. In childhood, hypertrophy of lymph tissue often occurs as a result of recurrent or chronic infections

upper respiratory tract, which may require removal of the tonsils (e.g., the pharyngeal tonsil or so-called 3rd tonsil).

Mallampati scale

- The Mallampati scale is used to predict the difficulty of endotracheal intubation by assessing the visibility of palatal and pharyngeal structures after wide opening of the mouth.



https://www.mp.pl/pulmonologia/praktyka-kliniczna/przypadki/118536,36-letni-otyly-man-with-breathing-disturbance-while-sleeping

- The higher the grade on this scale, the greater the risk that endotracheal intubation will be difficult and may require additional forces and resources (e.g., guidewire, videolaryngoscope, fiberoptic...).

Clinical cases (BUNA for RM)

1) Isolated spastic paresis of the lower limb results from closure of which central nervous system vessel?

2) As a result of the increase in intracranial pressure, there was an intussusception under the tentorium of the cerebellum of the right hippocampal bend with compression of the right III nerve and the cerebellar conus. Which side will develop pupillary dilation and which side will develop limb paresis?

3) What tonsils are visible when the mouth is opened?

4) A red and swollen eardrum without changes in the external auditory canal is indicative of inflammation of which part of the ear

(external/central/internal)?

5) What visual field loss will occur as a result:

- embolism of the central retinal artery
- pressure on the optic chiasm
- visual band defects

6) What tires are punctured during the collection of cerebrospinal fluid for diagnostic purposes?

7) Name the structures in question:

A. It is responsible for the appearance of watery nasal discharge after crying.

B. Degeneration of this joint makes chewing difficult, causes pain when eating, and can lead to dislocation of the jaw.

C. Damage to this gland can cause facial muscle paresis.

D. The only odd artery reaching the arterial circle of Willis.

E. It allows the infection to pass from the throat to the middle ear.

F. A fracture within this bone that results in a tear in the meninges will lead to leakage of cerebrospinal fluid from the ear.

8) Link the symptoms to the location of the nervous system damage (a given location can be used multiple times!):

A. Tremors of limbs during movement, shaky gait, nystagmus, dizziness

B. Foot sagging, muscles atrophied, flaccid, no tendon reflexes

C. Deep disturbance of consciousness, respiratory and circulatory disturbances

D. Personality disorders after brain contusion

E. The patient does not understand speech, uttering a stream of words that is not a logical and coherent utterance.

F. The patient speaks slowly, loses words, has difficulty saying his thoughts, and does not follow grammatical rules.

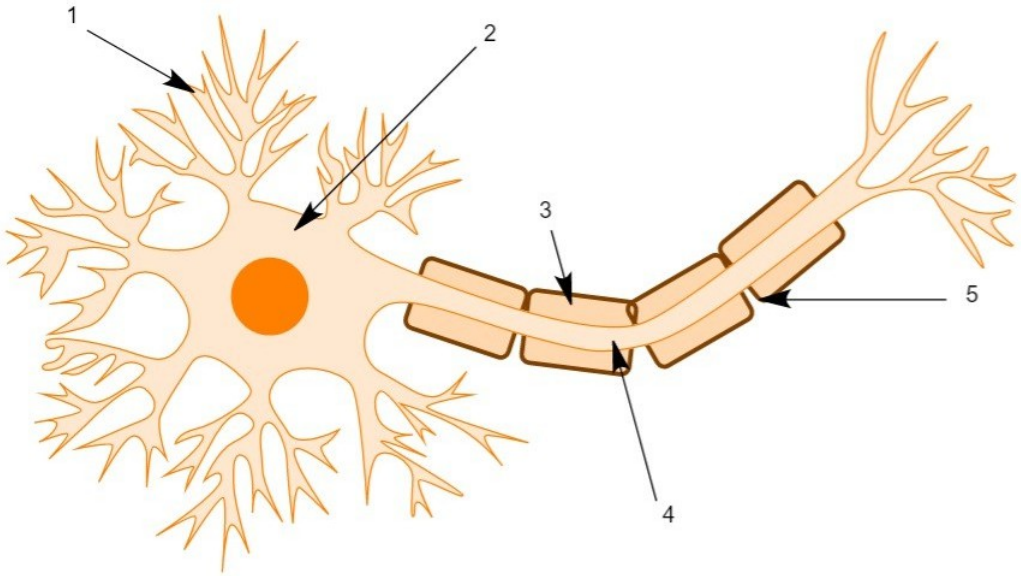
H. The patient has impaired strength but increased muscle tone on the side of the damage , there is no deep sensation on the same side, and sensation of touch, pain and temperature is impaired on the other side.

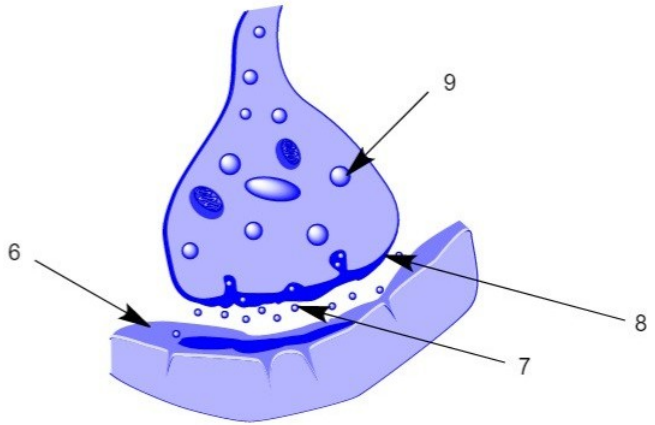
I. The patient reports tinnitus and dizziness, there is nystagmus and hearing loss.

J. Paresis of the upper limb, lower limb and facial muscles on the side opposite the injury

I → frontal lobe II → parietal lobe III → occipital lobe IV → temporal lobe V → spinal peripheral nerve VI → cranial nerve VII → spinal cord VIII → brain stem IX → cerebellum X → thalamus XI → hypothalamus

9)





1	
2	
3	
4	
5	
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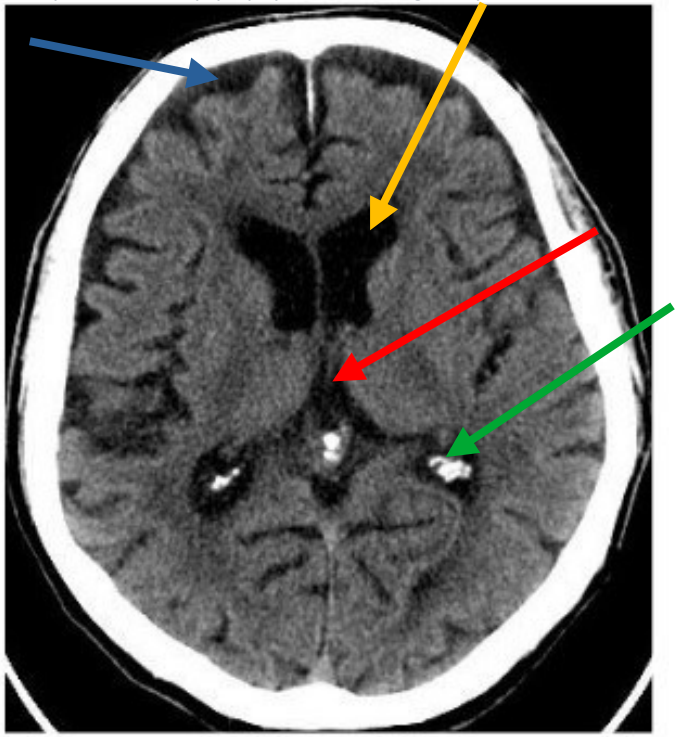
8	
9	

A - Schwann cell producing myelin sheath, B - synaptic vesicle, C - postsynaptic membrane, D - dendrite, E - neurotransmitter molecule, F - axon, G - neuron body, H - presynaptic membrane, I - Ranvier's constriction

10)

https://www.mp.pl/psychiatria/diagnostyka/48170,zanik-mozgu

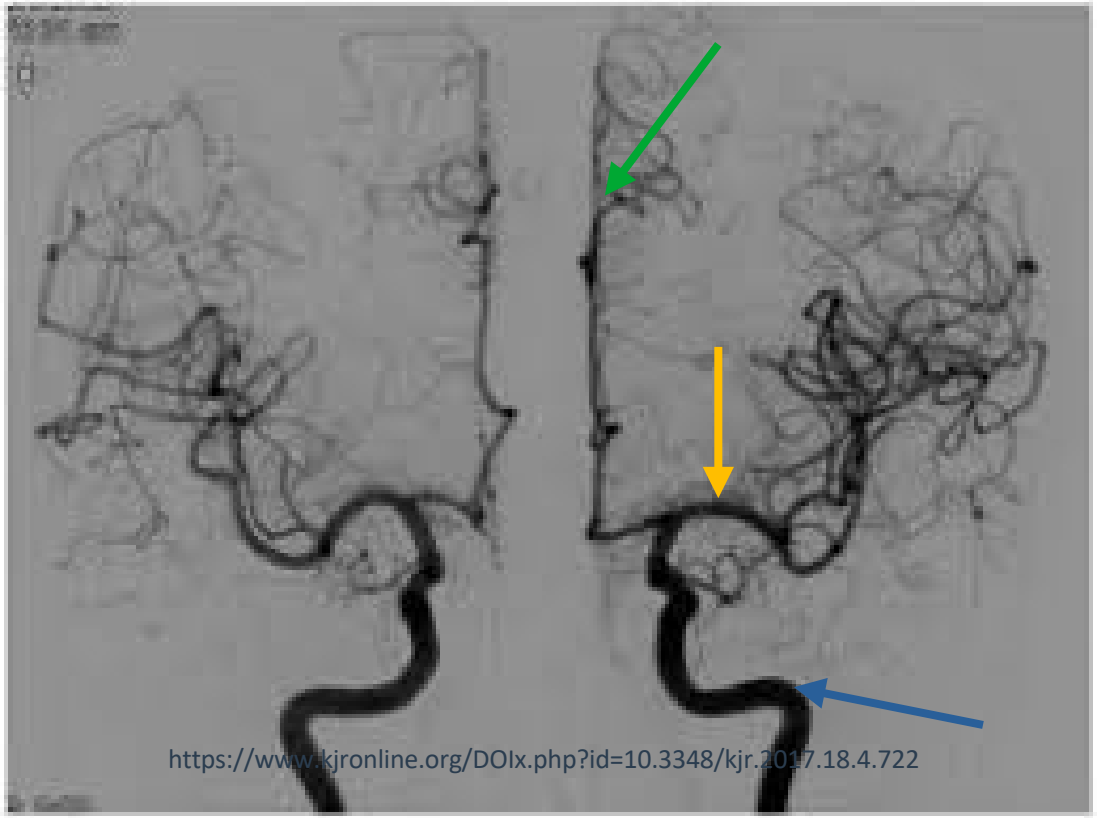


Ryc. 1. Uwidoczniona na obrazie TK poszerzona przestrzeń płynowa nad płatami czołowymi

Knowing that cerebrospinal fluid and air are "dark" in CT scans, give the colors of the arrows for the structures:

- **Side chamber**
- **Chamber III**
- **Choroid plexus**
- **Subarachnoid space**

11)



Name the arteries in the brain angiography: