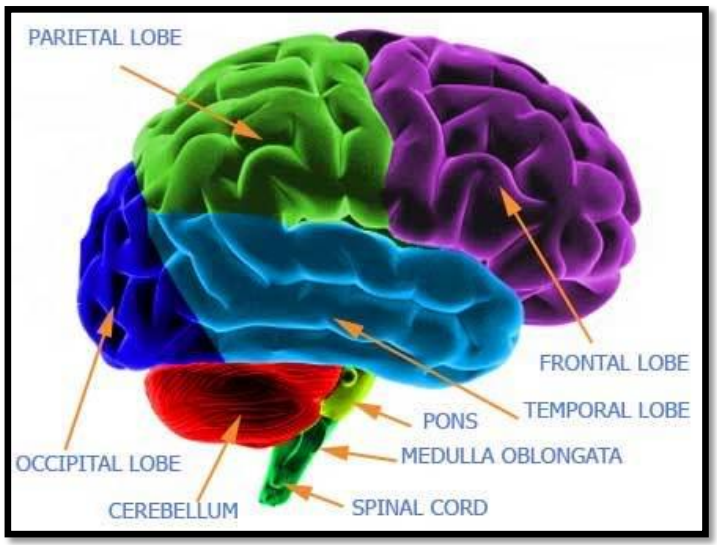
لجان الدفعات

ANATOMY

MORPHINE ACADEMY

The Nervous System

Dr. Mustafa Saad
(2021)



Overview

- *The nervous system is the system that **controls** the various functions of the body by the means of **electrical impulses**.*

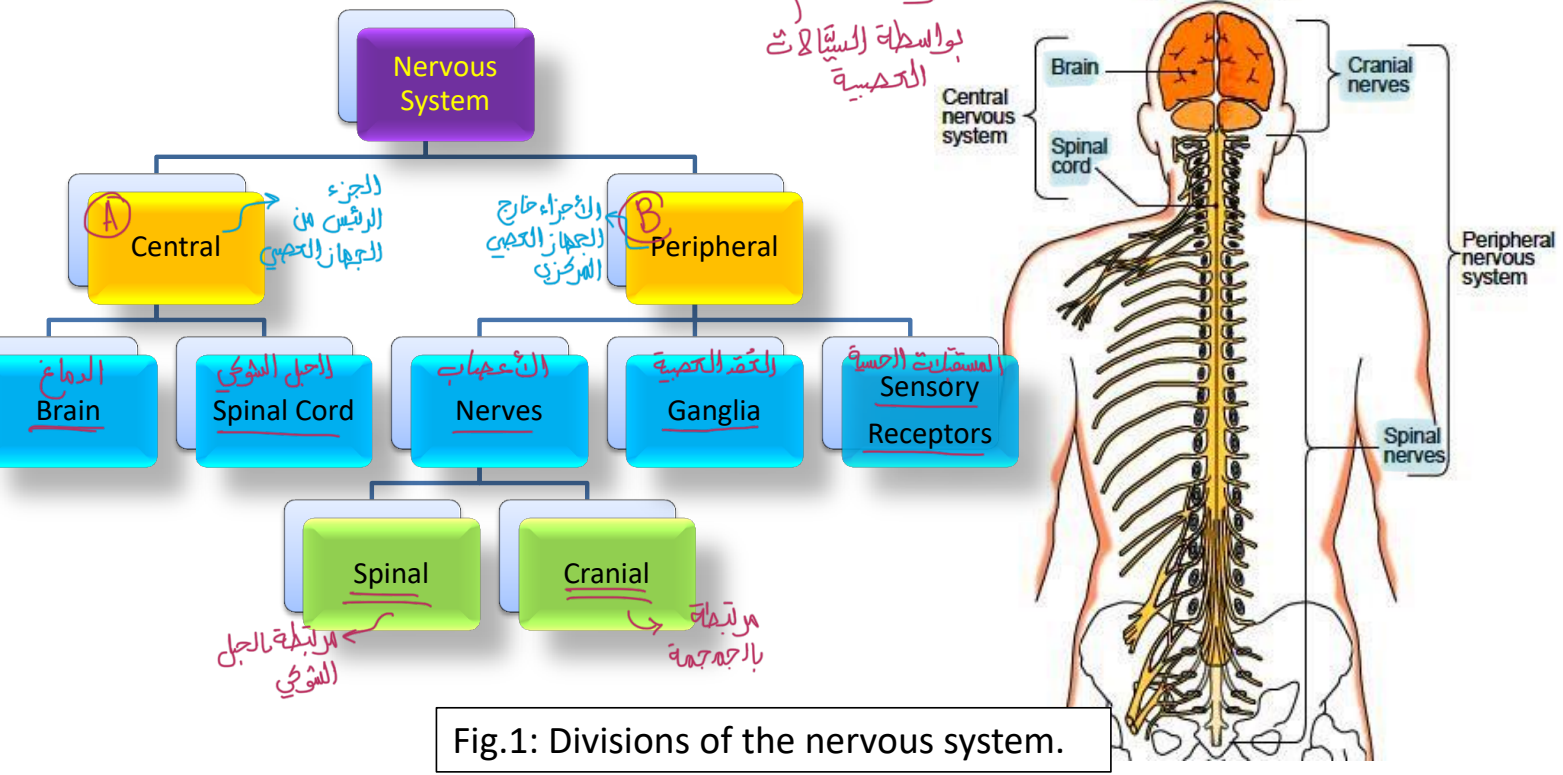


Fig.1: Divisions of the nervous system.

The Central Nervous System (CNS)

- Formed of the brain and spinal cord
- Formed of millions of nerve cells (neurons) and supporting cells (glia cells).
- Well protected within the skull and vertebral column.
- **Functions:**

1. **Initiates motor commands (movement and secretions).**
2. **Receives and perceives sensory information.**
3. **Responsible for our emotions, personality, behavior, memory and others.**

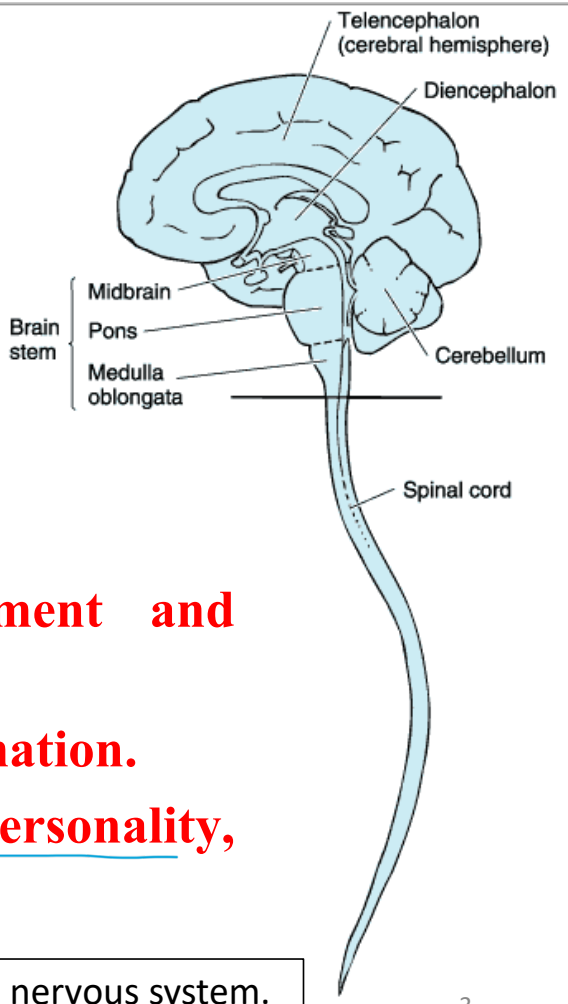


Fig.2: The central nervous system.

The Peripheral Nervous System (PNS)

- Formed of the peripheral nerves (cranial and spinal), the ganglia, and the sensory receptors.
- The nerves may be sensory (carry information to CNS) or motor (carry orders from the CNS)
- **Ganglia** are collection of neurons outside the central nervous system.
- **Sensory receptors** are parts of neurons or specialized structures that can detect changes in the internal or external environment. The skin, for example, contains several types of receptors that detect pain, touch and heat.

- Functionally, the PNS can be divided into:

1. **Somatic part**: connected to skin, muscles, joints and the special senses. We are fully conscious of this part. Our voluntary movements and our sensation of pain and touch are controlled by this part.

2. **Autonomic Nervous System**: this part usually operates without conscious control, as it controls all of our involuntary actions, like our heart rate, respiratory rate and blood pressure.

3. **Enteric part**: controls the secretions and movements of the various parts of the digestive system unconsciously.

Histology Of The Nervous System

- The nervous tissue is formed of two types of cells:

1. The nerve cell – Neurons
2. Supporting cells –Neuroglia or Glia cells

- In the nervous tissue, there is ***a very small amount of extracellular matrix*** found around the blood vessels.
- The space between the cells is filled with **neuropil** which is formed of the processes of both neurons and glia cells and some fluid.

Neurons

- Functional unit of nervous system.
- Have capacity to produce action potentials.
- ***Cell body:***
  - Single nucleus with prominent nucleolus
  - *Nissl bodies* formed of rough endoplasmic reticulum & free ribosomes for protein synthesis.
  - Neurofilaments give cell shape and support
- ***Cell processes*** = dendrites & axons
  تشعبات

- ***Mature neurons cannot divide. A damaged neuron cannot be repaired and is replaced by fibrous tissue.***

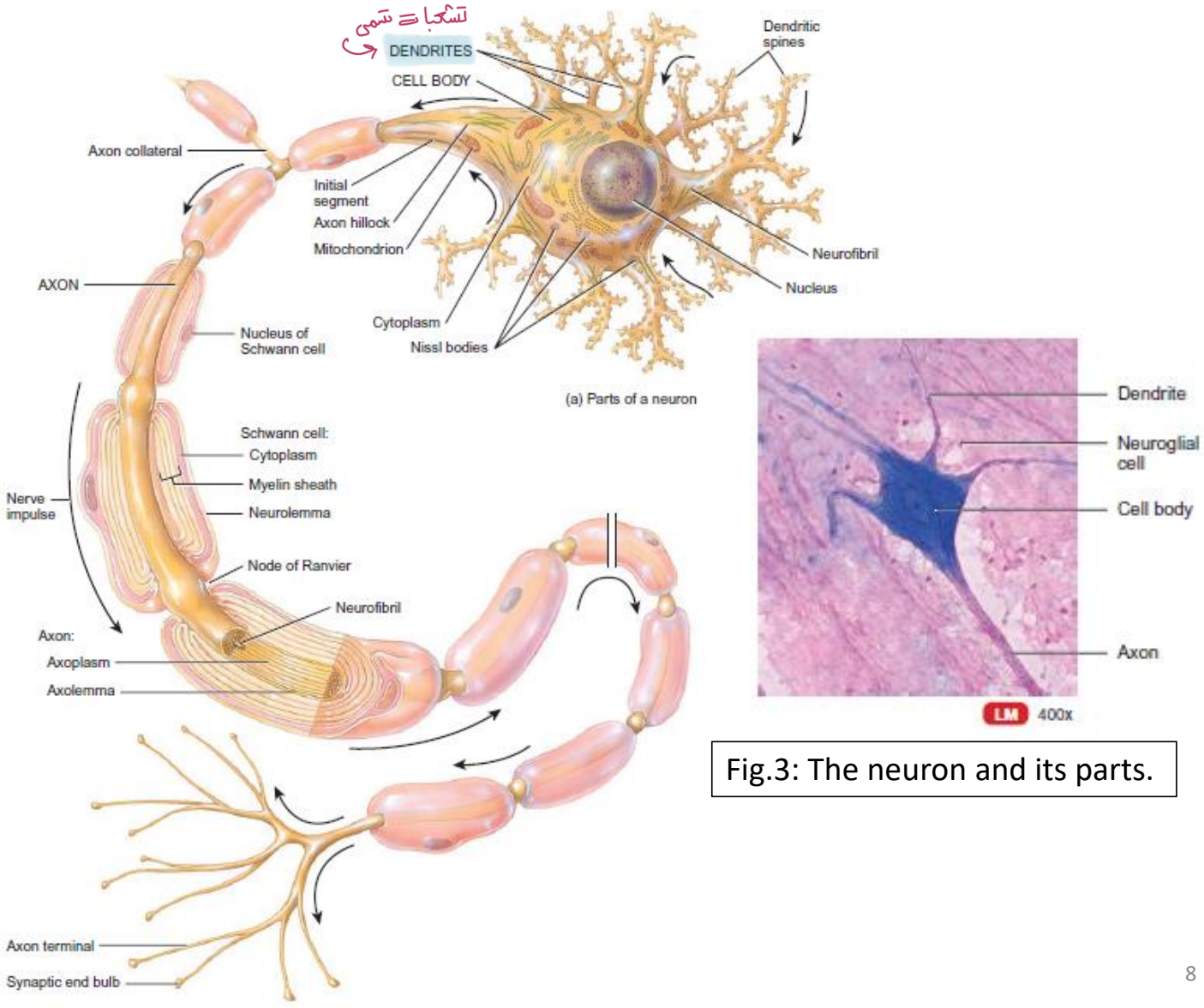


Fig.3: The neuron and its parts.

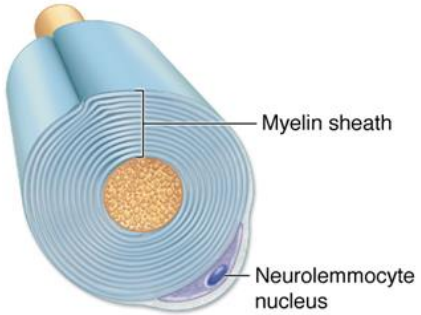
	Dendrites	Axon
1	Mostly multiple branches	A Single branch
2	Usually short	Usually the longest branch and is called ***nerve fiber***
3	Taper as they extend away from cell body	Has a fixed diameter
4	Branch profusely	▪ No branches near cell body ▪ Collateral branches along course ▪ Terminal branches
5	Not covered by a myelin sheath	Some are covered by a myelin sheath
6	Conduct impulse towards cell body	Conducts impulse away from cell body

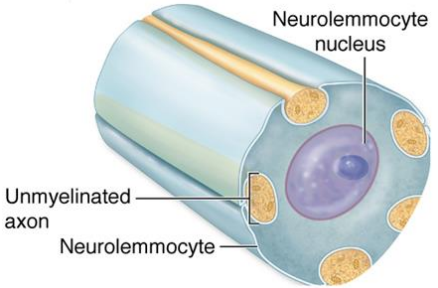
Glia cells

Location	Cell	Function
CNS	① Astrocytes	• Part of blood-brain barrier (bbb) • Provide nutrients for neurons • Form scar tissue after injury
	② Oligodendrocytes	Form myelin sheath
	③ Microglia cells	Defense (by phagocytosis)
	④ Ependymal cells	Line cavities
PNS	① Schwann cells (Neurolemmocytes)	Form myelin sheath
	② Satellite cells	Support neurons in dorsal root ganglia

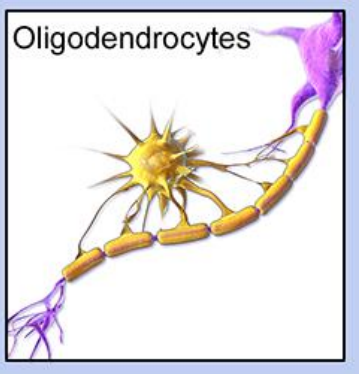
Myelination (تغليف axon)

- The process by which a nerve fiber (axon) is surrounded by multiple layer of cell membrane (myelin sheath)





PNS	CNS
مسؤول عنهم Done by Schwann cells	Done by oligodendrocyte نواة داخلية
الخلية تفتهم هي الي تلف حوالين الـ axon The entire cell wraps around the axon	The process of the cell wraps around the axon
Unmyelinated axons are also surrounded by cell membrane of Schwann cell	Unmyelinated fibers are not surrounded by anything



Histology of a nerve

- **Nerve**: a group of bundles of nerve fibers and their covering connective tissue layers.

طبقي epineurium

- The whole nerve is surrounded by the **epineurium.**
- Each bundle is surrounded by the **perineurium,** which forms a blood-nerve barrier.
- Each nerve fiber (axon) is surrounded by myelin sheath and an areolar connective tissue **endoneurium.**

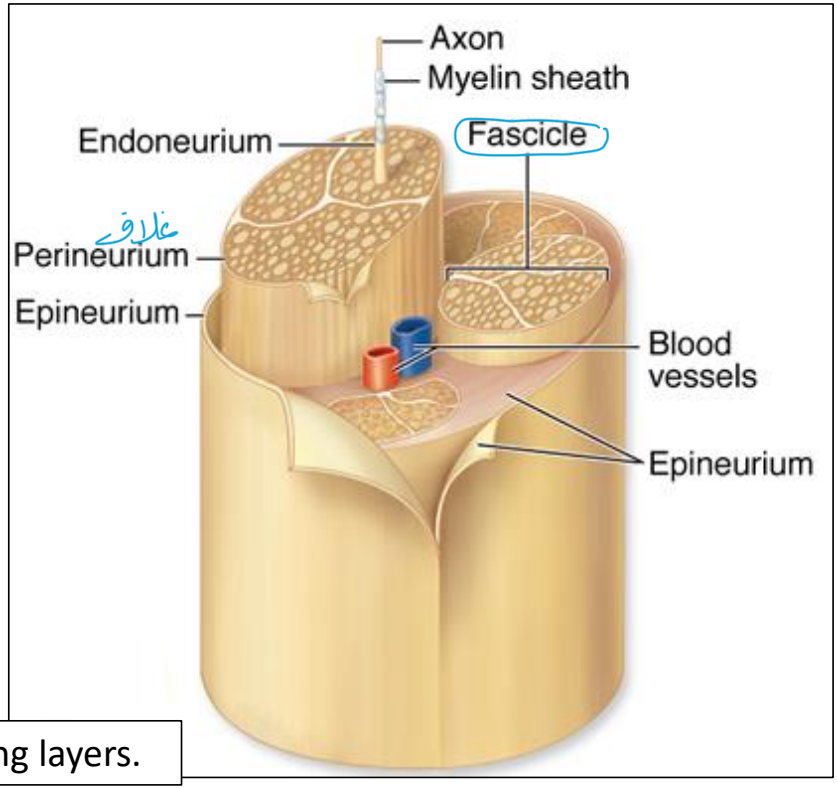
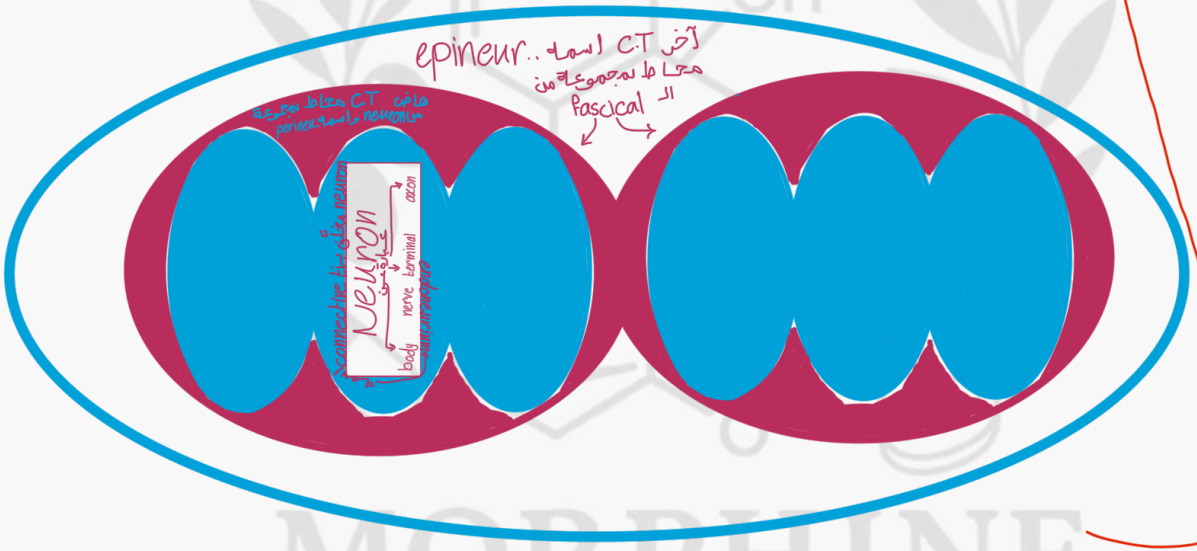


Fig.4: Peripheral nerve and its covering layers.



كُلّه حبار اسمه nerve

هاذا الوحدة الصغيرة اللي بتكوّن منها الـ nerve اسمها neuron .

The Central Nervous System - The Brain

- The brain is the part of the nervous system present within the skull. It's covered by protective layers called the meninges.

- The brain is formed of:

1) The Cerebrum (الجزء الكبير) المخ
2) The Diencephalon المخ المتوسط
3) The Cerebellum المُخيخ
4) The Brainstem جذع الدماغ

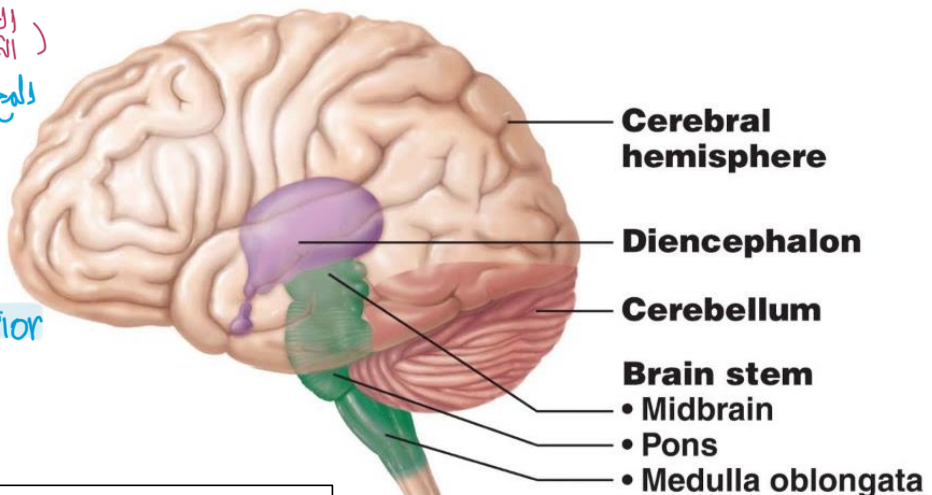


Fig.5: Parts of the brain.

- locate the cerebellum according to the Brainstem Posterior
- locate the Brainstem according to the cerebellum Inferior
- locate the Brainstem according to the cerebrum Anterior.
- locate the cerebellum according to the diencephalon Superior

Ventricular system

عبارة عن تجاويف

- Within the different parts of the brain, there are several cavities lined by ependymal cells and filled with cerebrospinal fluid.

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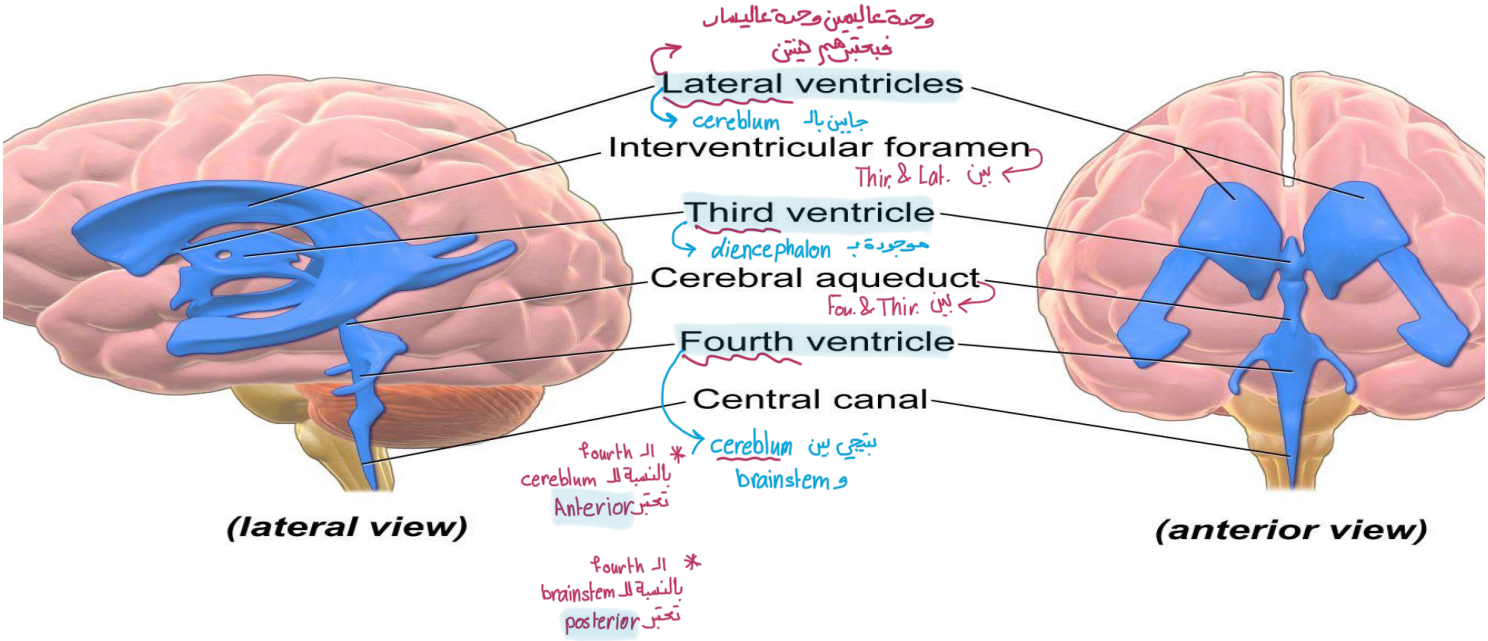


Fig.6: Ventricles of the brain.

Cranial meninges

السحايا

وهي عبارة عن ٣ طبقات بتغطي الـ Brain الـ meni..

1. **Dura mater**: the hard outermost layer. Separated from the skull bones by the epidural space. The venous sinuses of the brain are located within the dura mater.

الطبقة الخارجية الصلبة — فوق — الجيوب الأنفية

2. **Arachnoid mater** : the thin middle layer. Separated from the dura by the subdural space. Beneath the arachnoid, we have the large subarachnoid space.

تحت — تحت — المسافة إلي بين الـ Dura و.. Ara.. سو اسمها؟ — subdural

3. **Pia mater**: thin innermost layer. Directly covers the brain.

ملزقة بـ Brain

ترتيب الطبقات :

skull
epidural space
Dura mater
subdural space
Arachnoid mater
subarachnoid space
Pia mater
Brain

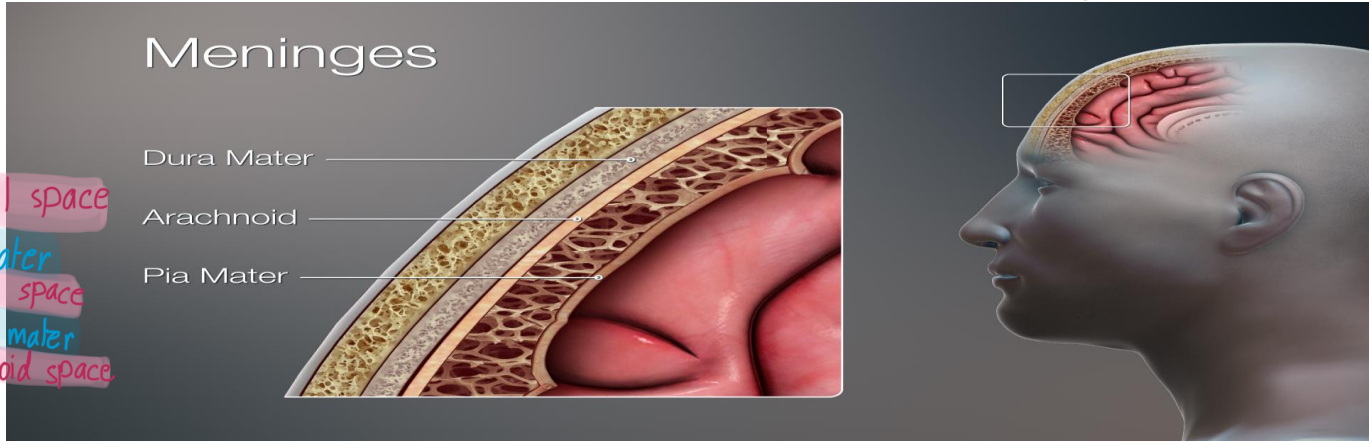
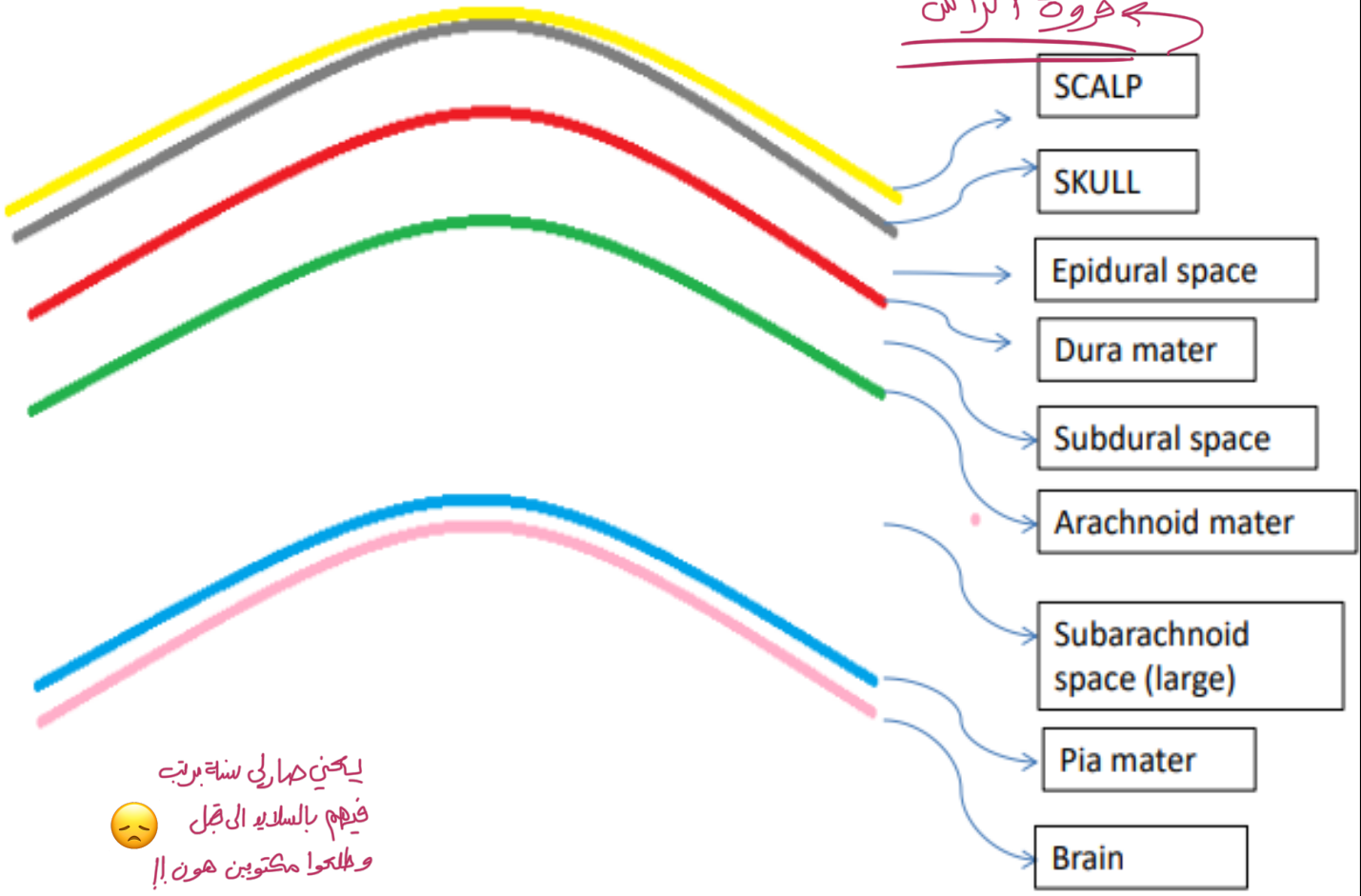


Fig.7: The cranial meninges.



يكفي صار لي سنة برتب
فيهم بالسلايد اللي قبل
وطلعوا مكتوبين هون !!

The Cerebrospinal Fluid (CSF)

سائل الحبل الشوكي

- Clear fluid. سائل شفاف
- Circulates through cavities in the brain (ventricles) and the spinal cord (central canal) and also in the subarachnoid space.

الى هي اكبر space

- ***Functions:***

1. ***Absorbs shock and protects the brain and the spinal cord.***
2. ***Helps transport nutrients and wastes between the blood and the nervous tissue.***

The Blood-Brain Barrier

- This include a number of structures that control the passage of substances from blood to the nervous tissue to protect it against harmful agents.

- It's formed of:
  1) Endothelium of capillaries
  2) Pericytes: cells present around the capillaries beneath its basal lamina
  3) Basal lamina
  4) Processes of astrocytes

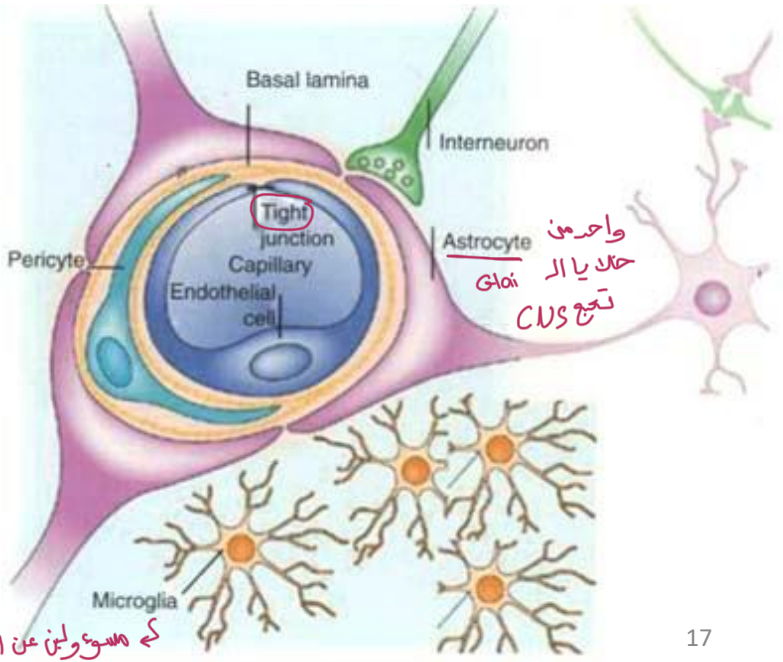
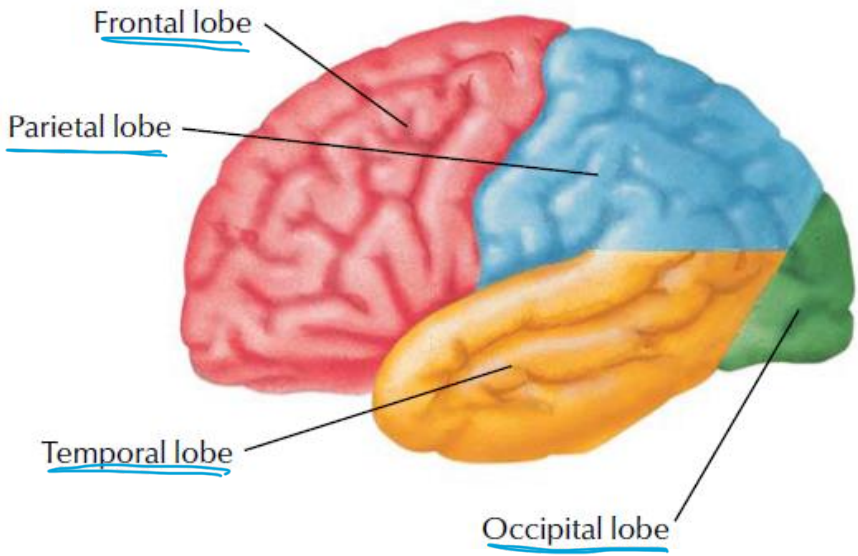


Fig.8: The blood-brain barrier.

The Cerebrum

إلى هو أكبر جزء

Fig.9: The Cerebrum (lateral view).



- All motor commands issue from the cerebrum. All sensations are perceived here. In addition, this part is responsible for emotions, behavior and memory.

مقسوم نصين وكل نص مقسم لأربعة

- The cerebrum is the largest part of the brain. It's formed of two parts (called hemispheres) each of which is formed of four lobes: frontal lobe, parietal lobe, temporal lobe, and occipital lobe.
- It's characterized by the presence of fissures called sulci and protrusions called gyri (Fig.11). The cavity within it is the lateral ventricle.

- The outer layer of the cerebrum is called the **cerebral cortex**. It's formed mainly of the body of neurons and therefore it's called the **gray matter**. Deep to it, we have the **white matter,** formed mainly of nerve fibers.
- In the spinal cord, the arrangement is reversed.

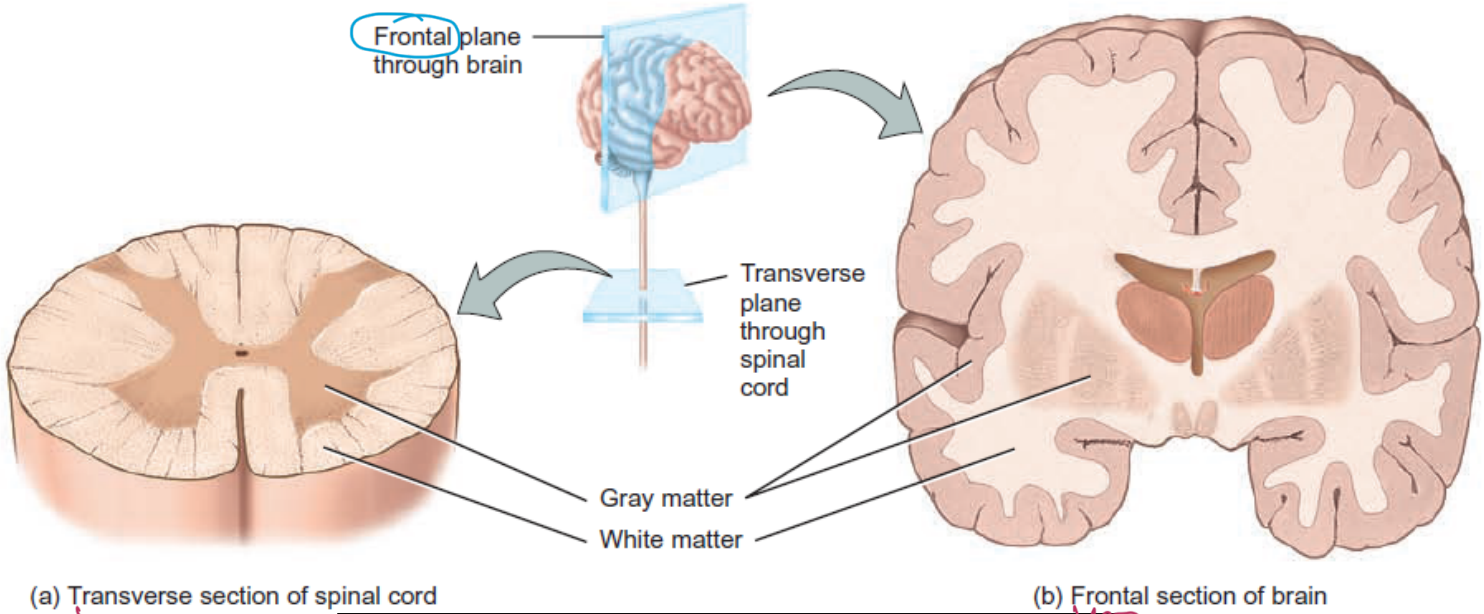


Fig.10: The arrangement of the gray and white matter in the cerebrum and spinal cord.

The Diencephalon الدماغ المتوسط

- This part of the brain is located on the medial aspect of the cerebrum. The cavity here is the 3rd ventricle.

- It's formed of the:

1. Thalamus
2. Hypothalamus
3. Epithalamus

مقسوم إلى ٣ أقسام

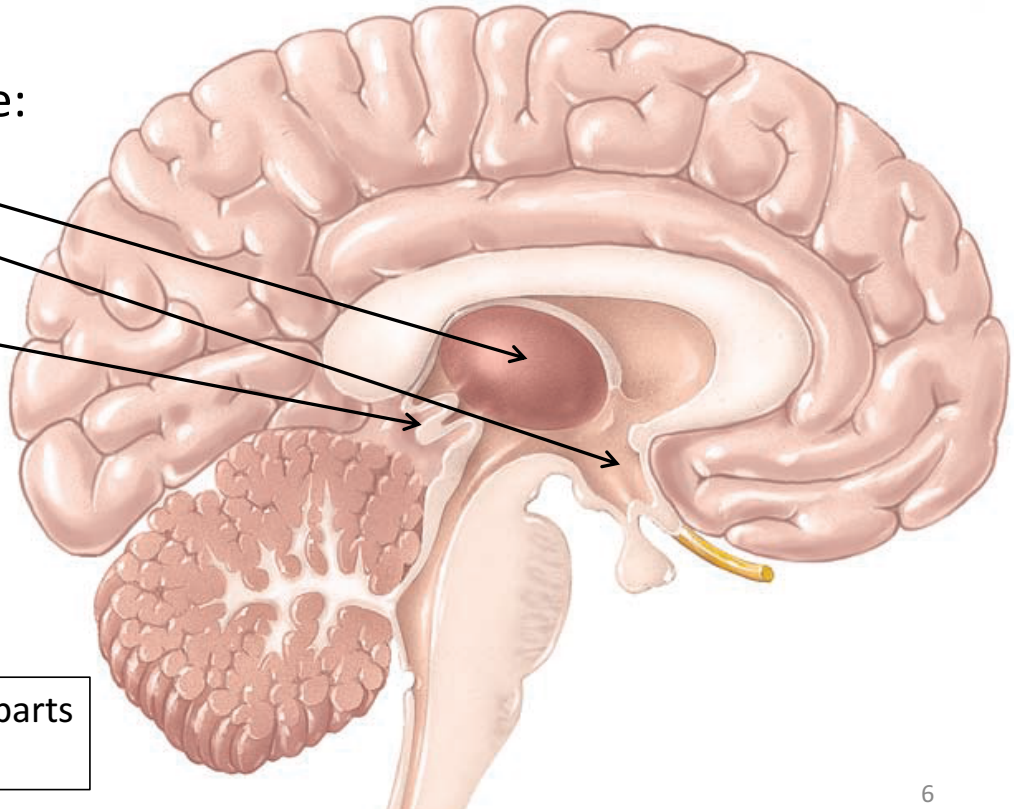


Fig.12: The location and parts of the diencephalon.

Part	Main Function
Thalamus	Relay station for most sensation
Hypothalamus	1. Controls hormone secretions of all endocrine glands in the body 2. Control body temperature 3. Control eating and drinking
Pineal gland of the epithalamus	Secrete melatonin hormone which regulates diurnal (day-night) cycles

The Cerebellum

- Second largest part of the brain.
- The central constricted area is the **vermis**. On each side of the vermis, we have the expanded **cerebellar hemispheres.**
- The cerebellum is located inferior to the occipital lobe and posterior to the brainstem. It's separated from the brainstem by the 4th ventricle.
- ***The function of the cerebellum is the coordination of movement and the maintaining of balance.***

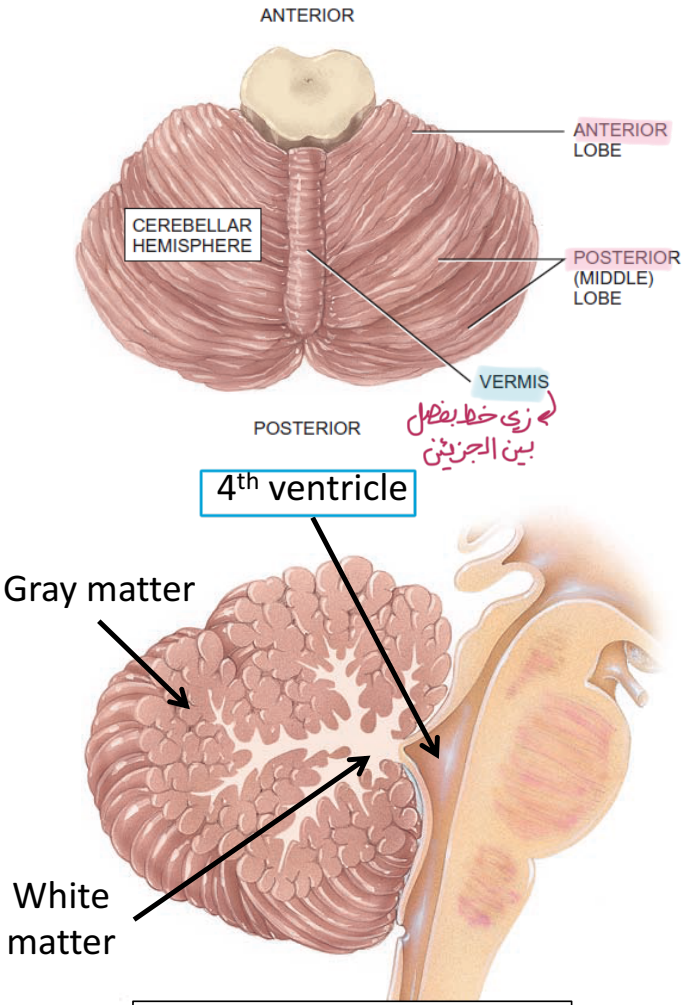


Fig.13: The cerebellum.

The Brainstem

جذع الدماغ

- The part of the brain that connects the diencephalon with the spinal cord.
- Formed of 3 parts:
  - Midbrain (MB) والجزء العلوي
  - Pons – connect several parts of the CNS together. Contains respiratory centers.
  - Medulla oblongata
- The brainstem contains several important control centers and the attachment of several cranial nerves.
- Also in the brainstem is the ***Reticular Formation*** which is related to consciousness and muscle tone.

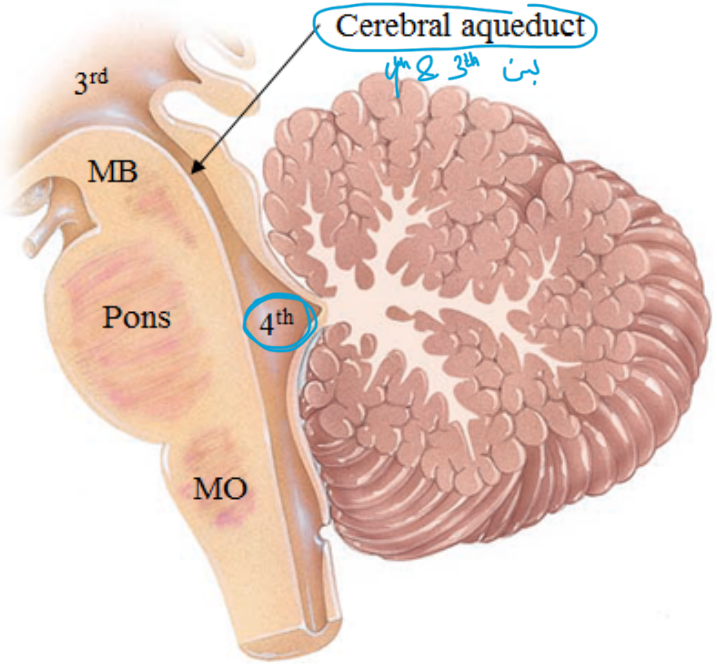
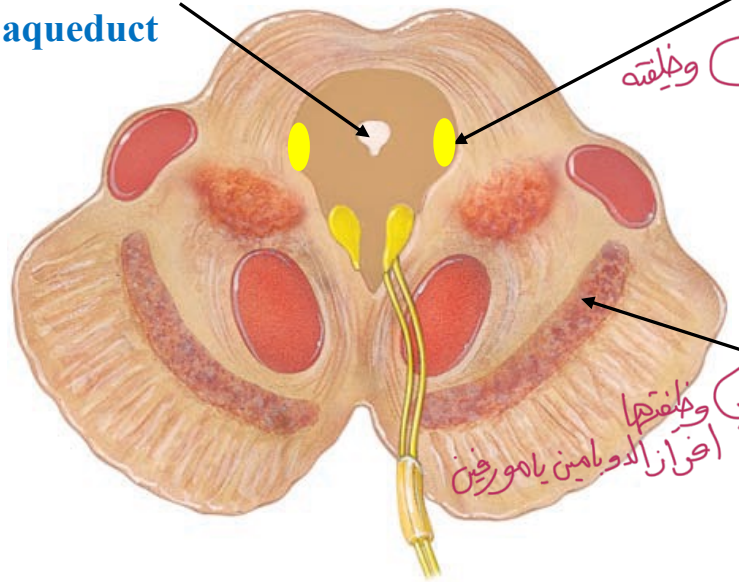


Fig.14: Location and parts of the brainstem.

The Midbrain



Mesencephalic nucleus – contains pseudounipolar neurons that carry sensations from the face. The only place in the CNS with such neurons; all other pseudounipolar neurons are located in peripheral ganglia.

Substantia nigra – neurons here release Dopmaine and is involved in muscular activity. Lesion in this area is associated with Parkinson's disease.

Fig.15: Section through the midbrain.

The Medulla Oblongata

آخر قطعة من قطع الـ Brainstem
إلي بتربط الـ Brain بـ spinal cord

- Contains important control centers:
  - Cardiovascular center
  - Respiratory center

وهم نازلين بتعلى لقي اسمه decussation (تقاطع)

- Anteriorly, near the midline, are ***the pyramids*** which are formed by the descending motor tracts (group of nerve fibers in the CNS).
- At a certain point in the medulla, the majority of the fibers in these tracts will cross to the opposite side forming the ***decussation of the pyramid***.
- This is why each half of the brain controls the opposite side of the body.

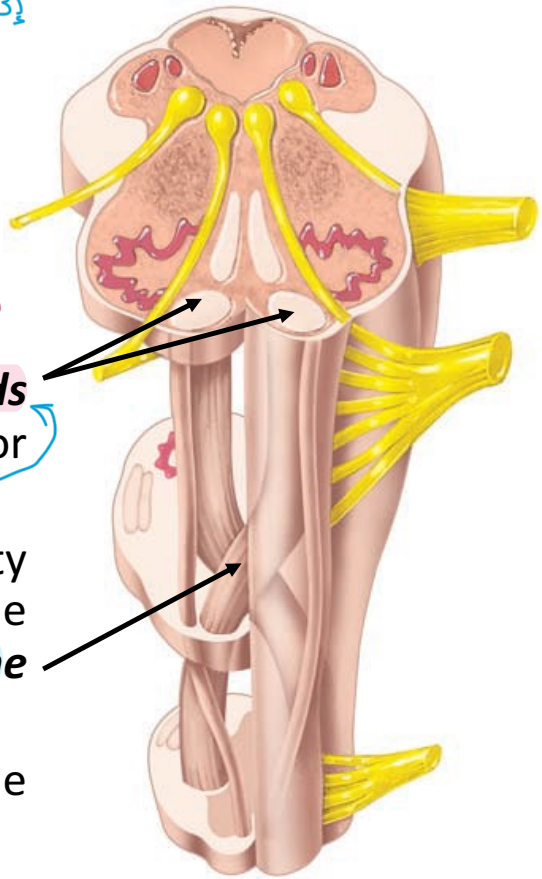


Fig.16: The medulla oblongata.

بسم الله نبدأ على قولة الدكتور هاي أسوء محاضرة

The Central Nervous System - The Spinal Cord

- A grayish-white cylindrical structure.
- Starts at the foramen magnum and ends at lower border of L1 in adults. In children, it ends at L3.
- Protected by the vertebral column and the three layers of meninges.
- The pia matter will continue after the termination of the spinal cord as a thin thread called the filum terminale.

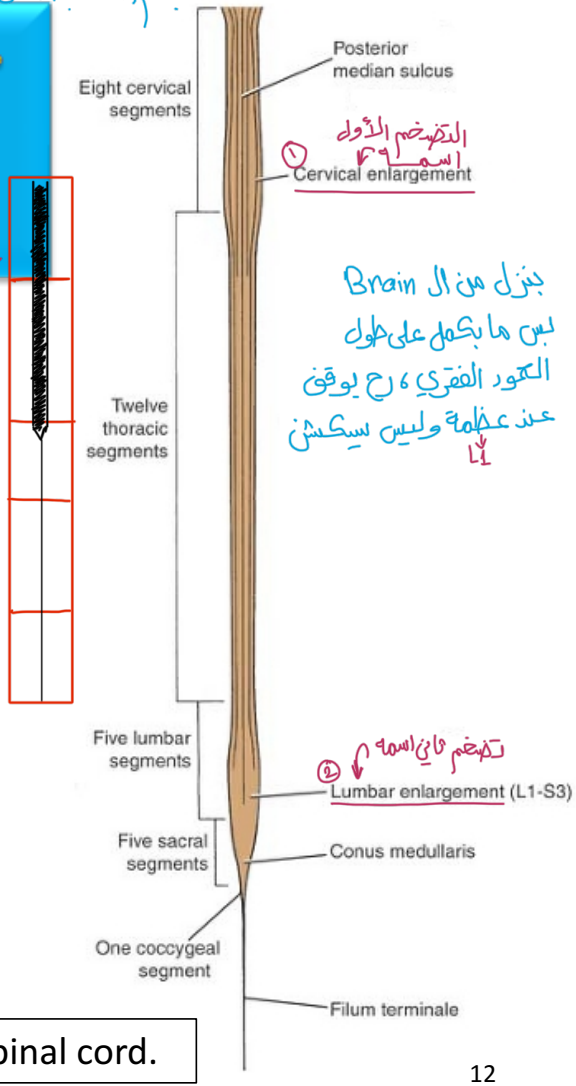


Fig.17: The spinal cord.

External features of the spinal cord

- It has two enlargements: cervical and lumbar. The cervical enlargement is the origin of the cervical and brachial plexuses. The lumbar enlargement is the origin of the lumbar and sacral plexuses.

- The terminal part of the spinal cord is cone shaped and called the **Conus medullaris.**

Fig.18: The conus medullaris.

- The spinal cord is divided into segments: 8 Cervical, 12 Thoracic, 5 Lumbar, 5 Sacral and 1 Coccygeal. From each segment arises a pair of spinal nerves. Thus, we have a total of 31 pairs of spinal nerves.

- The nerves pass laterally to exit the vertebral column. The spinal cord is shorter than the spine. Therefore the lower nerves must pass down for a distance before exiting. These will form a structure like a wisp of hair around the filum terminale called the **Cauda Equina.**

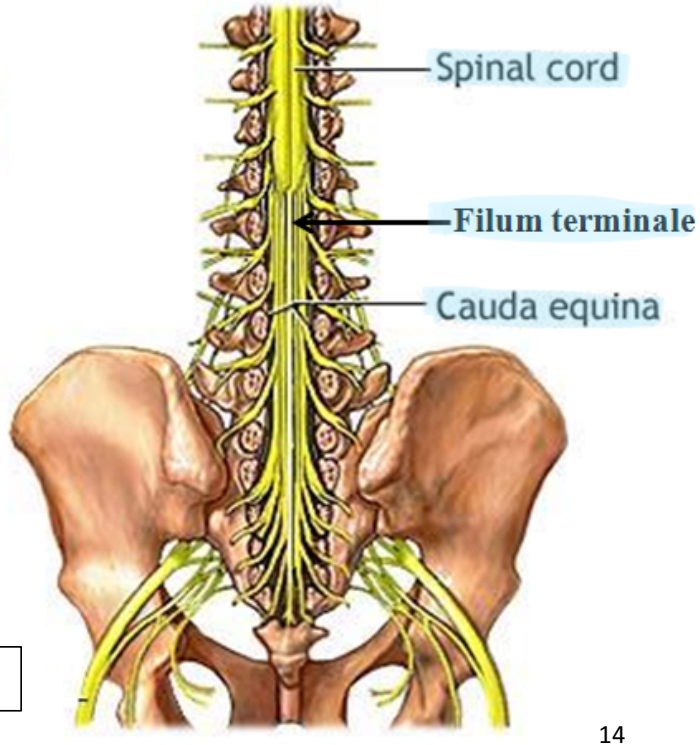


Fig.19: The cauda equina.

Internal features of the spinal cord :-

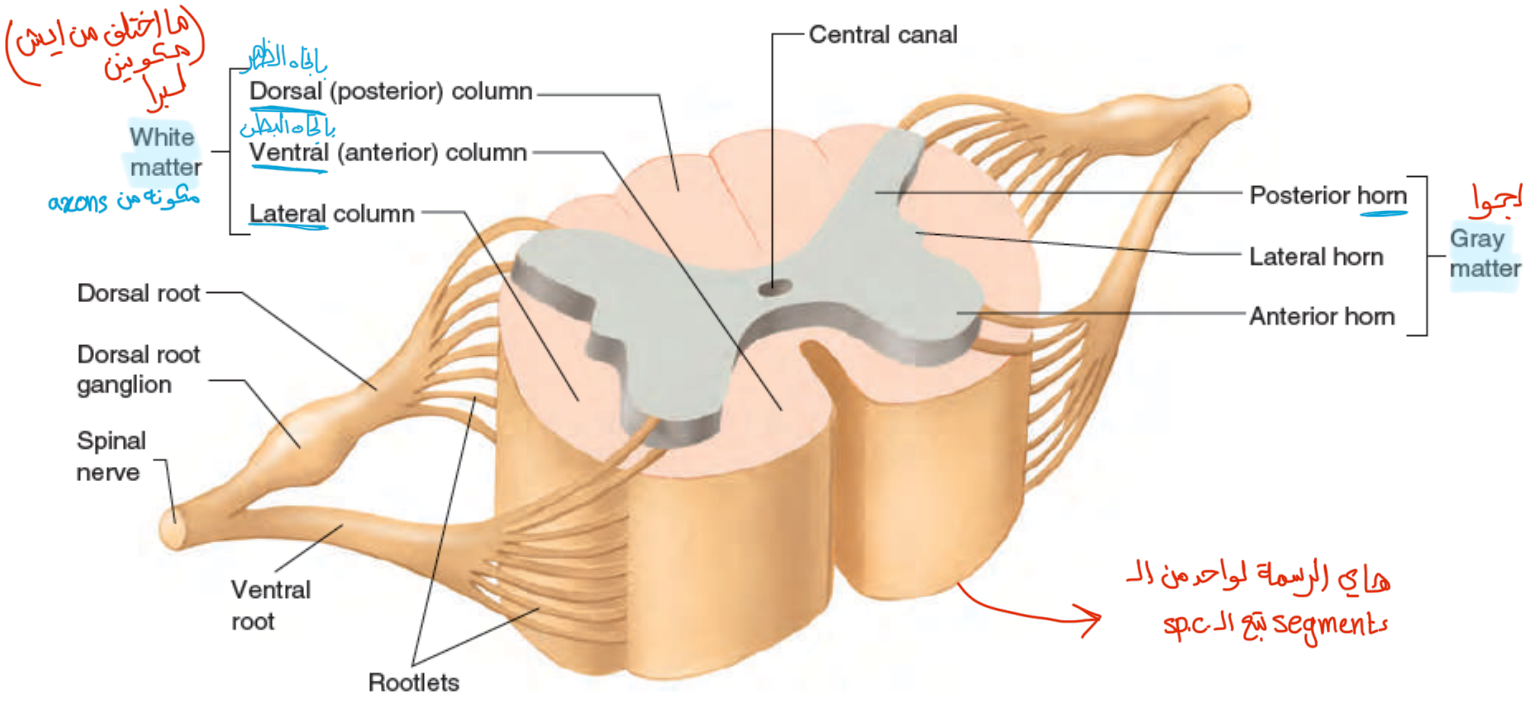


Fig.20*: Cross section through the spinal cord showing important internal features.

The Peripheral Nervous System - The Cranial Nerves

عندي طريقة ربط الإسم مع الفنكشن بس مسحتها اكتبها

هاظ اكيد حاكي منه

Cranial Nerve	Main Functions
I – Olfactory	Olfaction (Smelling)
II – Optic	Vision النظر
III – Oculomotor	Supplies extrinsic muscles of eye
IV - Trochlear	
V – Trigeminal	1. Carries sensation from face 2. Supplies muscles of mastication
VI – Abducent	Supplies extrinsic muscles of eye

ح يجيب الرسم والرقم وبسأل عن الفنكشن

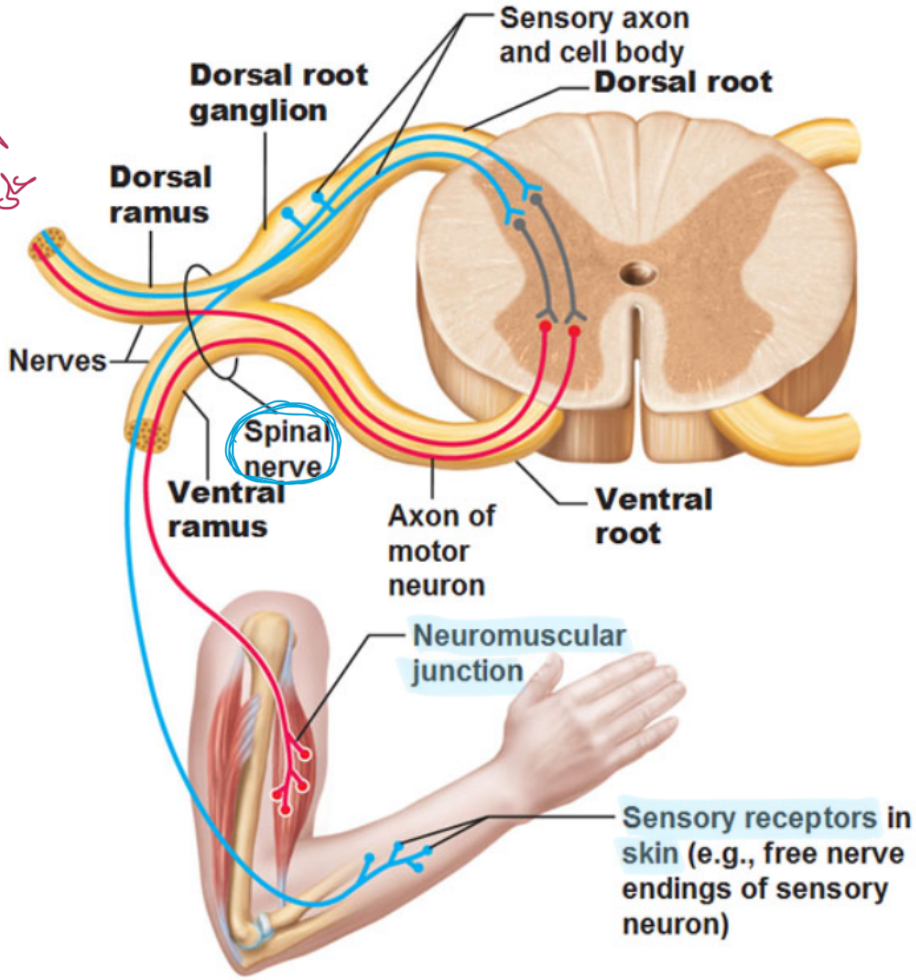
Cranial Nerve	Main Functions
VII – Facial	1. Supplies muscles of facial expression 2. Carries taste sensations from anterior 2/3 of tongue
VIII - Vestibulocochlear	Hearing and equilibrium
IX - Glossopharyngeal	1. Supplies some muscles 2. Carries taste sensation from posterior 1/3 of tongue
X – Vagus	1. Supplies various muscles 2. Carries various sensation 3. Supplies internal organs
XI – Accessory	Supplies the sternocleidomastoid and trapezius muscles
XII – Hypoglossal	Supplies all muscles of the tongue (except palatoglossus)

The Peripheral Nervous System - The Spinal Nerves

- 31 pairs of mixed nerves (sensory and motor): Cervical (C1-C8), thoracic (T1-T12), lumbar (L1-L5), sacral (S1-S5) and coccygeal (Co).
- A spinal nerve gives off two main branches: anterior ramus and posteior ramus. Anterior rami of spinal nerves are usually arranged in groups called plexuses.

Plexus	Main Branches
Cervical	Phrenic
Brachial	Axillary, Musculocutaneous, Radial, Median, Ulnar
Lumbar	Obturator, Femoral
Sacral	Sciatic (Largest nerve in the body)

Spinal Nerves



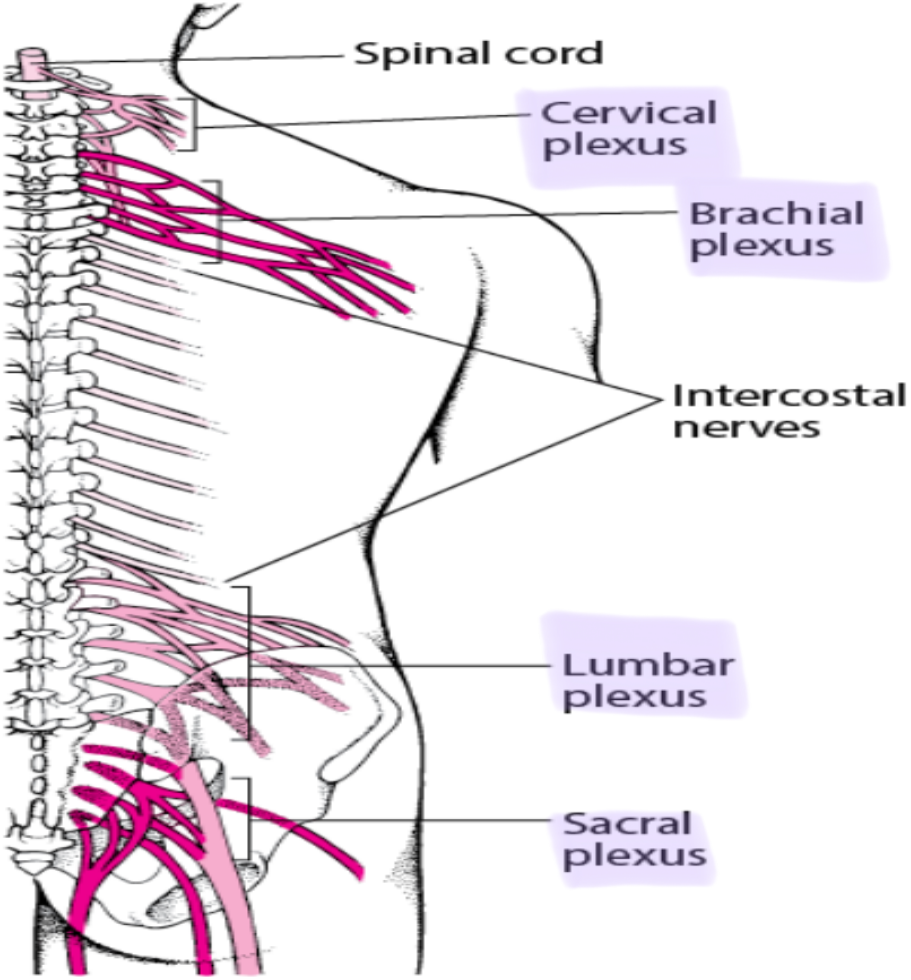
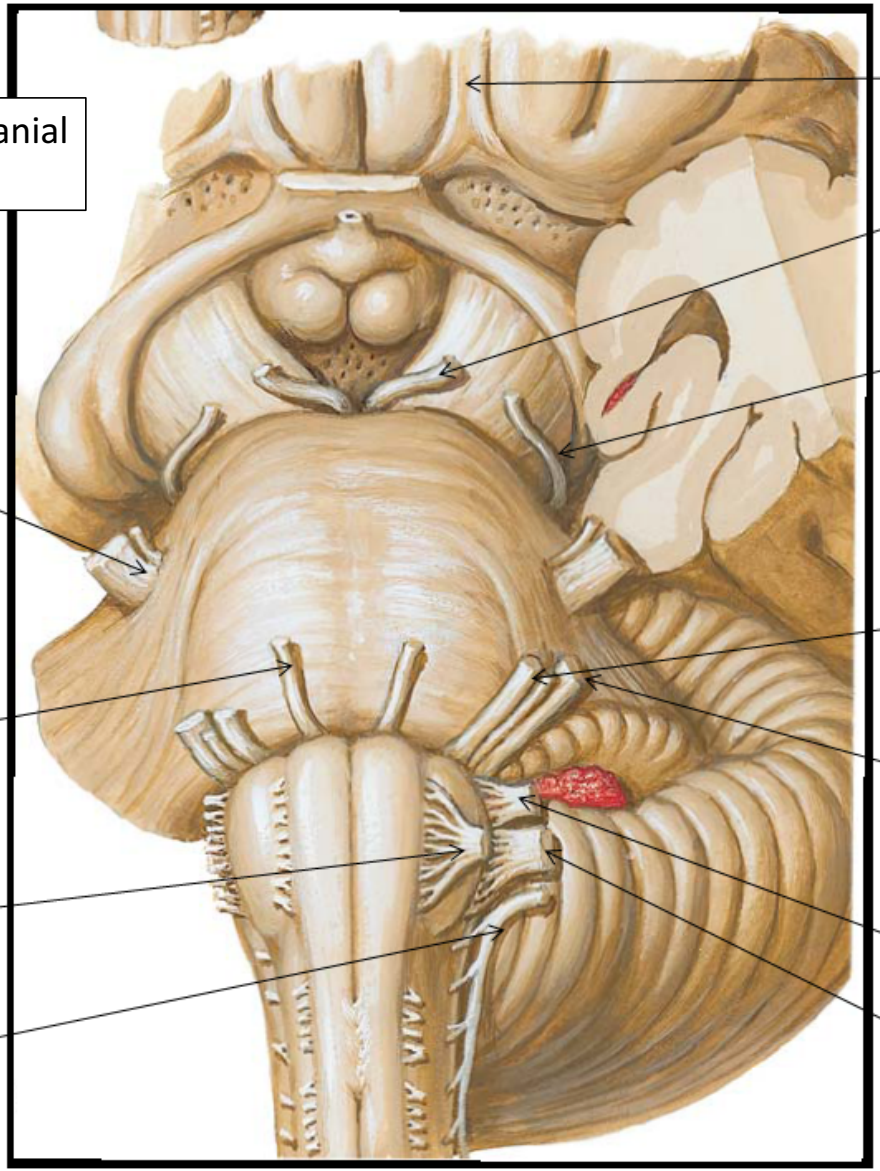

Spinal cord
Cervical plexus
Brachial plexus
Intercostal nerves
Lumbar plexus
Sacral plexus

Fig.21: The cranial nerves.



The Autonomic Nervous system

- The autonomic nervous system (ANS) is part of the peripheral nervous system. It operates unconsciously to control involuntary muscles (cardiac and smooth) and glands. It's formed of two divisions: The Sympathetic and Parasympathetic.
- The ANS is formed of Preganglionic and Postganglionic fibers. The preganglionic fibers arise from autonomic centers in the CNS and pass through cranial and spinal nerves to autonomic ganglia outside the CNS. The postganglionic fibers arise from the autonomic ganglia to supply the involuntary muscles and glands.
- The autonomic centers are controlled by the ***Hypothalamus.***

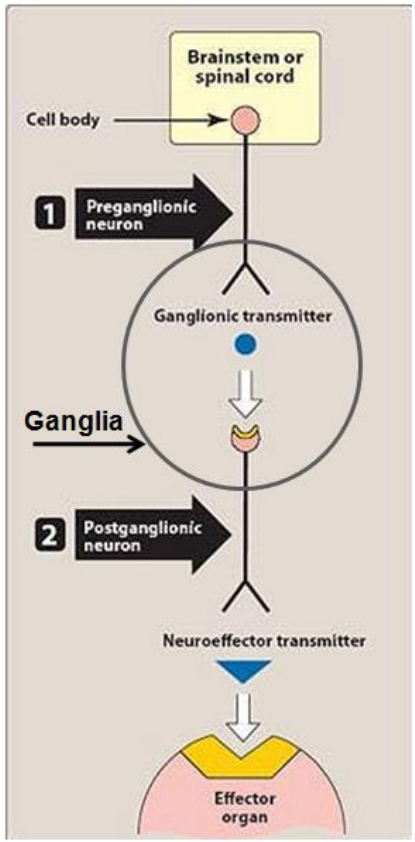


Fig.22: The two-neuron pathway of the ANS.

The Sympathetic (Thoracolumbar) Division

- The gray matter of the ***T1-L2 segments*** of the spinal cord possess a ***lateral horn*** in which are located the cell bodies of the sympathetic preganglionic neurons.
- The myelinated axons of these neurons leave the spinal cord through the anterior root of the spinal nerves.
- They pass through the white ramus to enter the sympathetic trunk.
- *Sympathetic trunk* is a chain of ganglia located on each side of the vertebral column.

Internal features of the spinal cord

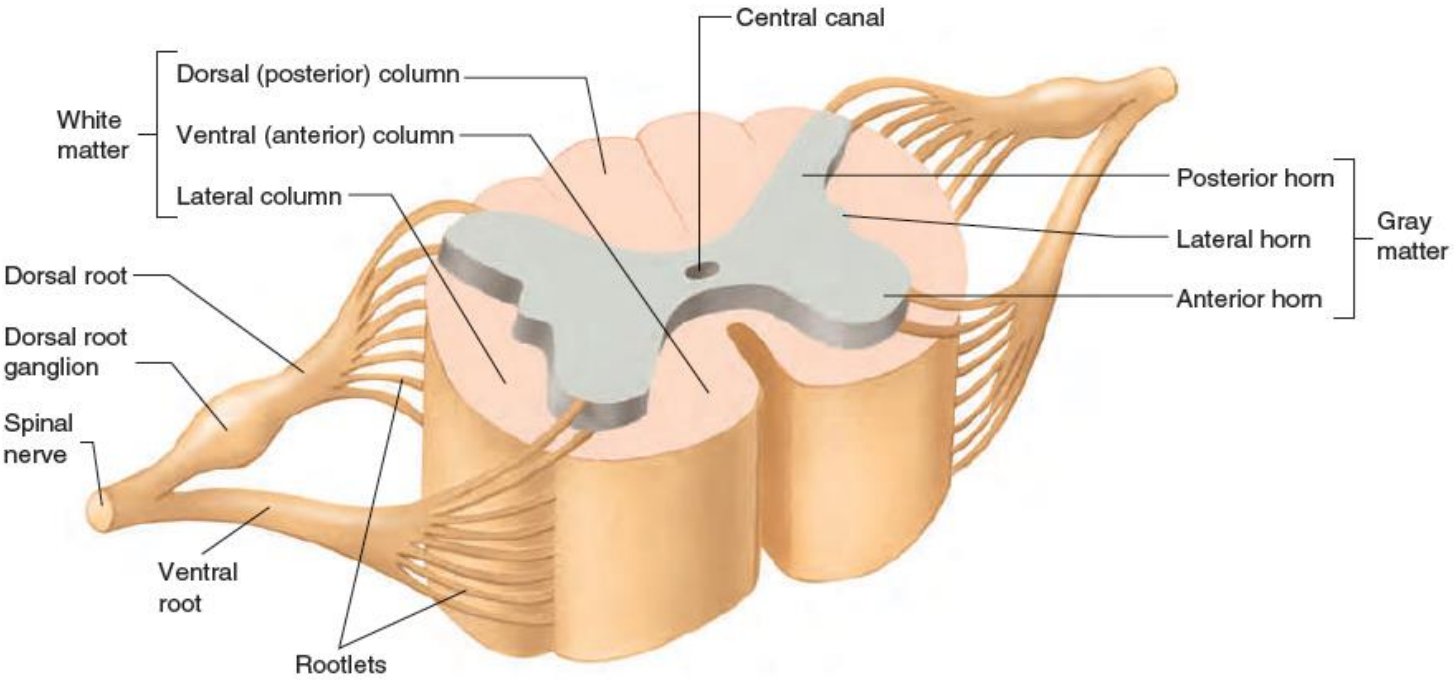


Fig.20*: Cross section through the spinal cord showing important internal features.

- In the sympathetic trunk, the preganglionic neuron may either:

1. *Synapse* with the postganglionic neurons in the ganglia at the *same level* on the same side. In this case, the unmyelinated postganglionic fibers exit the trunk through the gray ramus to re-enter the spinal nerves where they pass to supply the smooth muscles of blood vessels, sweat glands, and the arrector pili muscles of the skin.
2. Pass up/down in the sympathetic trunk to *synapse* with postganglionic neurons at a *different level* to supply skin.

→ Some postganglionic fibers will supply various organs in the head, chest, abdomen and pelvis.

3. *Leave* the trunk *without synapsing*. Here preganglionic fibers will form the Splanchnic nerves and they will eventually synapse with postganglionic neurons in the preaortic ganglia (celiac, superior mesenteric, inferior mesenteric and renal). The postganglinic fibers will then pass to supply the viscera.

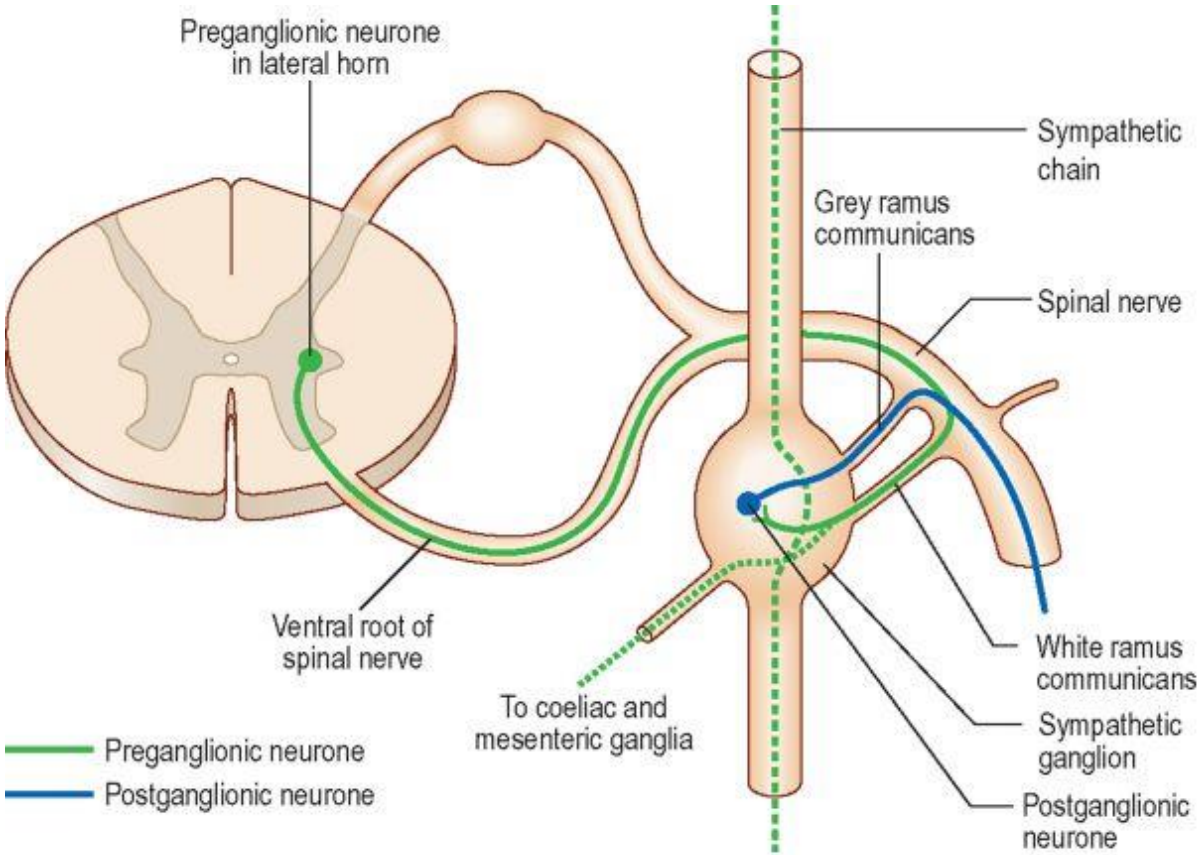


Fig.23: The pathway of the sympathetic neurons.

2 The Parasympathetic Division

- Also called Craniosacral division.
- Preganglionic neurons pass through:
  - The cranial nerves III, VII, IX and X
  - Sacral spinal nerves S2-S4 (form the Pelvic Splanchnic nerves)
- A preganglionic neuron usually synapses with 4-5 postganglionic neurons all of which supply a single visceral effector. So the effect is limited.

General and Special Sensations

General and Special Senses

General Senses

- Include:
  - Somatic sensations (tactile, thermal, pain, and proprioceptive – sense of position) from body and joints
  - Visceral sensations from the organs.
- Scattered throughout the body.
- Simple structures.

Special Senses

- Include
  - Smell
  - Taste
  - Vision
  - Hearing and equilibrium.
- Concentrated in specific locations in the head.
- Anatomically distinct structures.
- Complex neural pathway.

The General Sensory Structures

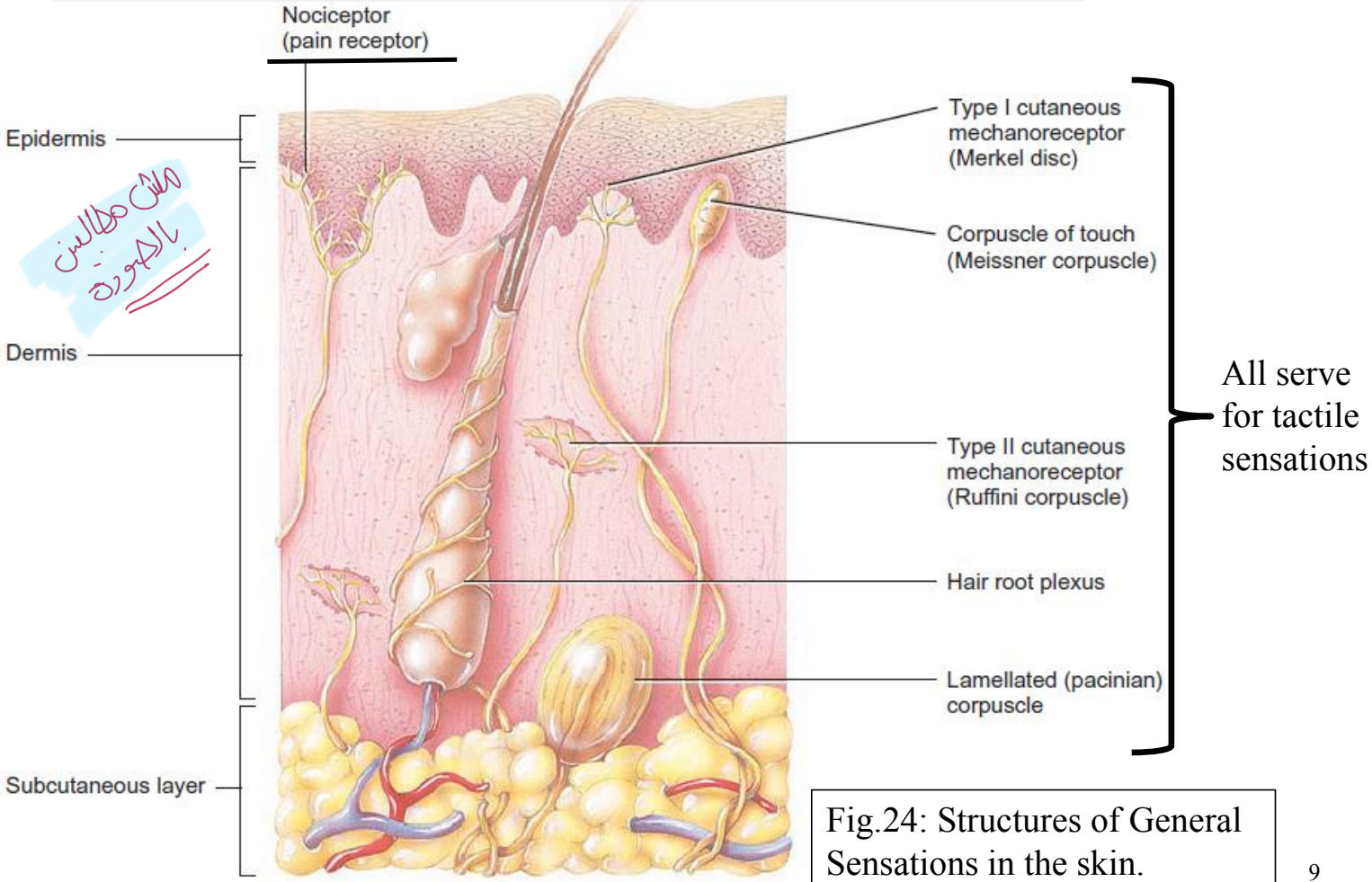


Fig.24: Structures of General Sensations in the skin.

Special Senses – Olfaction = Smell

- The olfactory epithelium is located in the roof of the nasal cavity.

- The olfactory epithelium is formed of:

1. ***Olfactory receptors*** - bipolar neurons with cilia called olfactory hairs
2. ***Supporting cells***- provide support and nourishment.
3. ***Basal cells***- replace olfactory receptors.

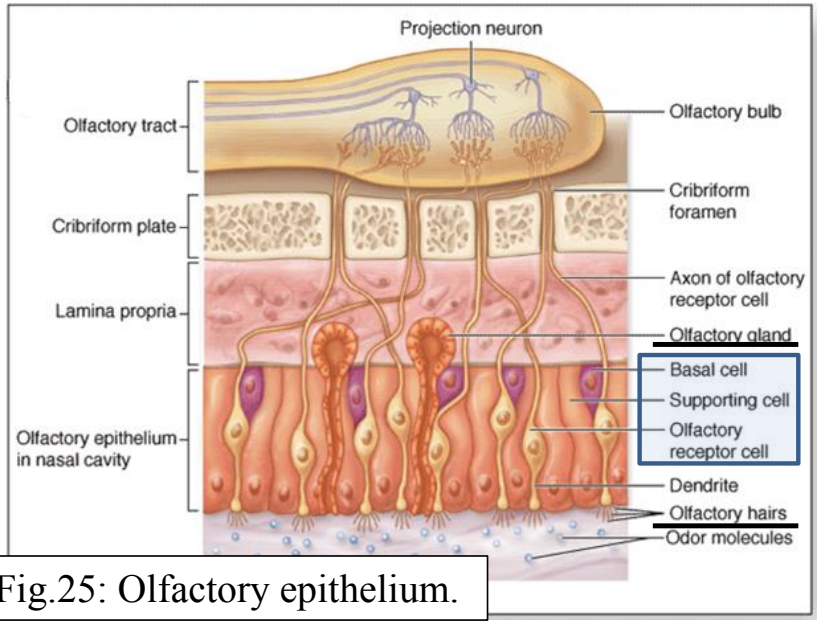


Fig.25: Olfactory epithelium.

- Olfactory glands produce a secretion that helps in moistening the surface of the epithelium

Special Senses – Gustation = Taste

- Gustation is performed by specialized structures called ***Taste Buds*** that are mainly present in the papillae of the tongue.

- Taste buds are oval structures formed of:

1. ***Gustatory cells***- Each one has a gustatory hair (a long microvillus) that projects through an opening in the bud called the taste pore.

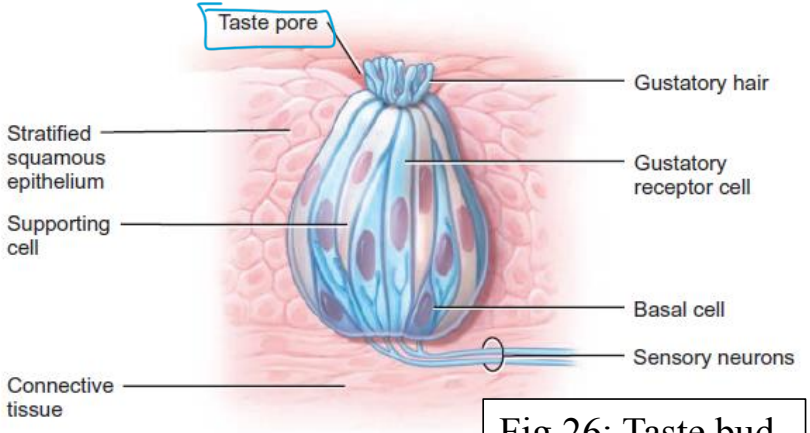


Fig.26: Taste bud.

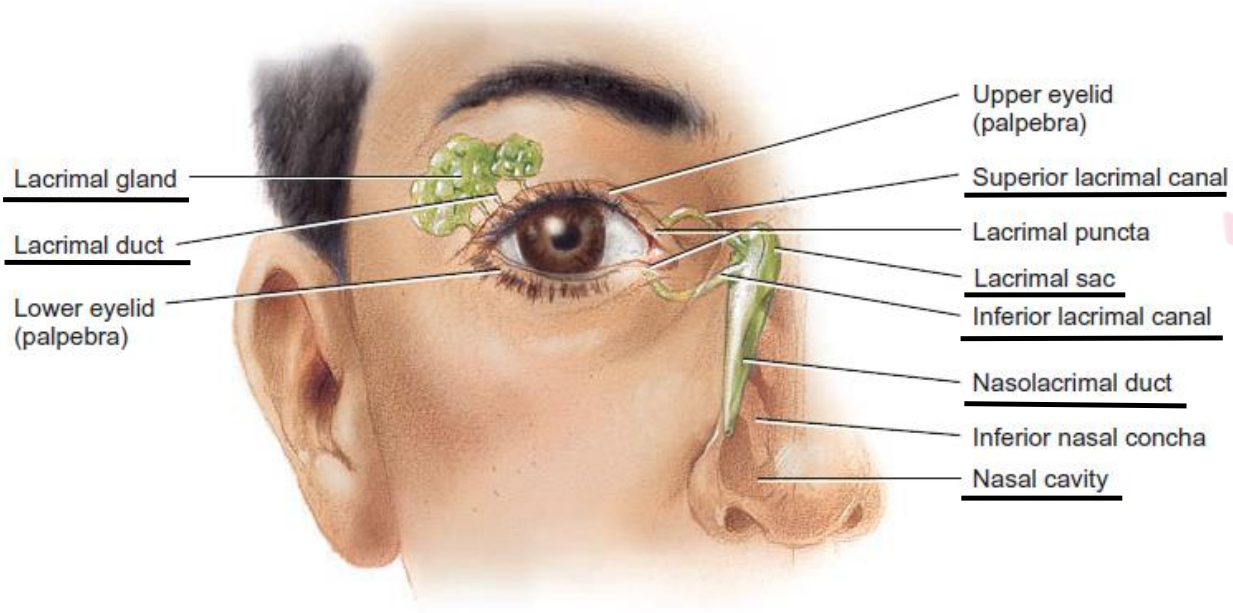
2. ***Supporting cells***- provide support and nourishment.
3. ***Basal cells***- replace the other cells.

Special Senses – Vision

- Vision is the function of the eye.
- The eyeball is located in the orbital cavity of the skull.
- Accessory structures of the eye include:
  1. The eyelids الجفون
  2. The lacrimal apparatus
  3. The extrinsic muscles of the eye

- The two eyelids (palpebrae) (1)protect eye from light, (2)shade eye during sleep, and (3)spread tear.
- The space between the eyelids that exposes the eyeball is called the ***palpebral fissure***.
- The ***levator palpebrae superioris*** muscle raises the upper eyelid.

The Lacrimal Apparatus



FLOW OF TEARS

Lacrimal gland

↓

Lacrimal ducts

↓

Superior or inferior lacrimal canal

↓

Lacrimal sac

↓

Nasolacrimal duct

↓

Nasal cavity

Fig.27*: Components of the lacrimal apparatus.

Extrinsic Eye Muscles

- Six **extrinsic** eye muscles control movements of each eyeball. They are called extrinsic because they originate outside the eyeball in the bony orbit and insert on the outer surface of the sclera. These muscles are supplied by cranial nerve III, IV, and VI.

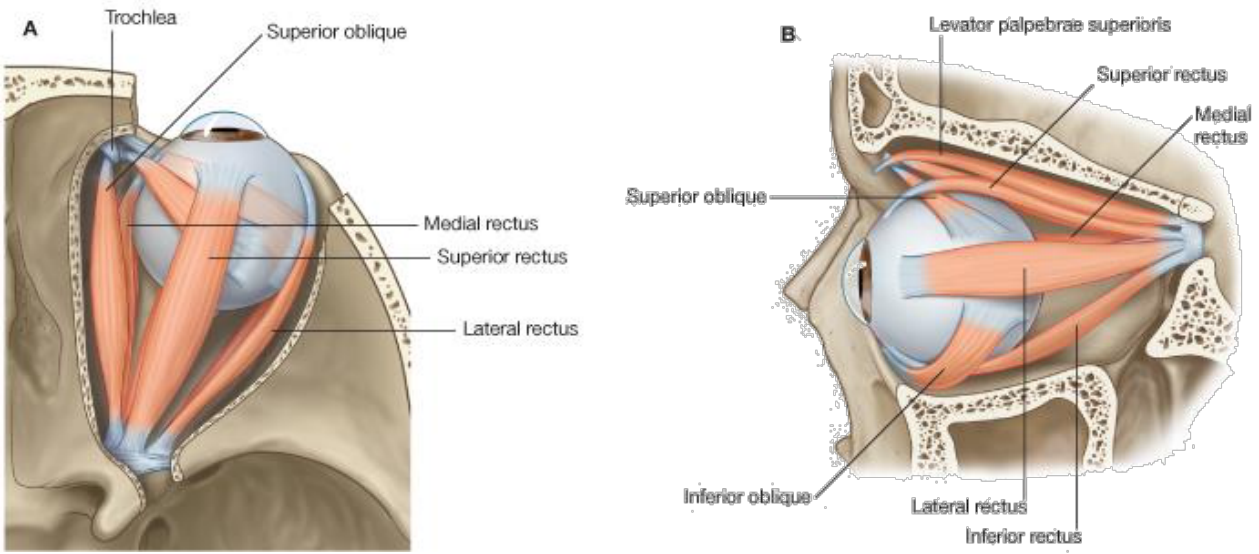


Fig.28: Extrinsic muscles of the eye. (A) superior view. (B) lateral view.

Anatomy of the Eyeball

The Wall of the eyeball

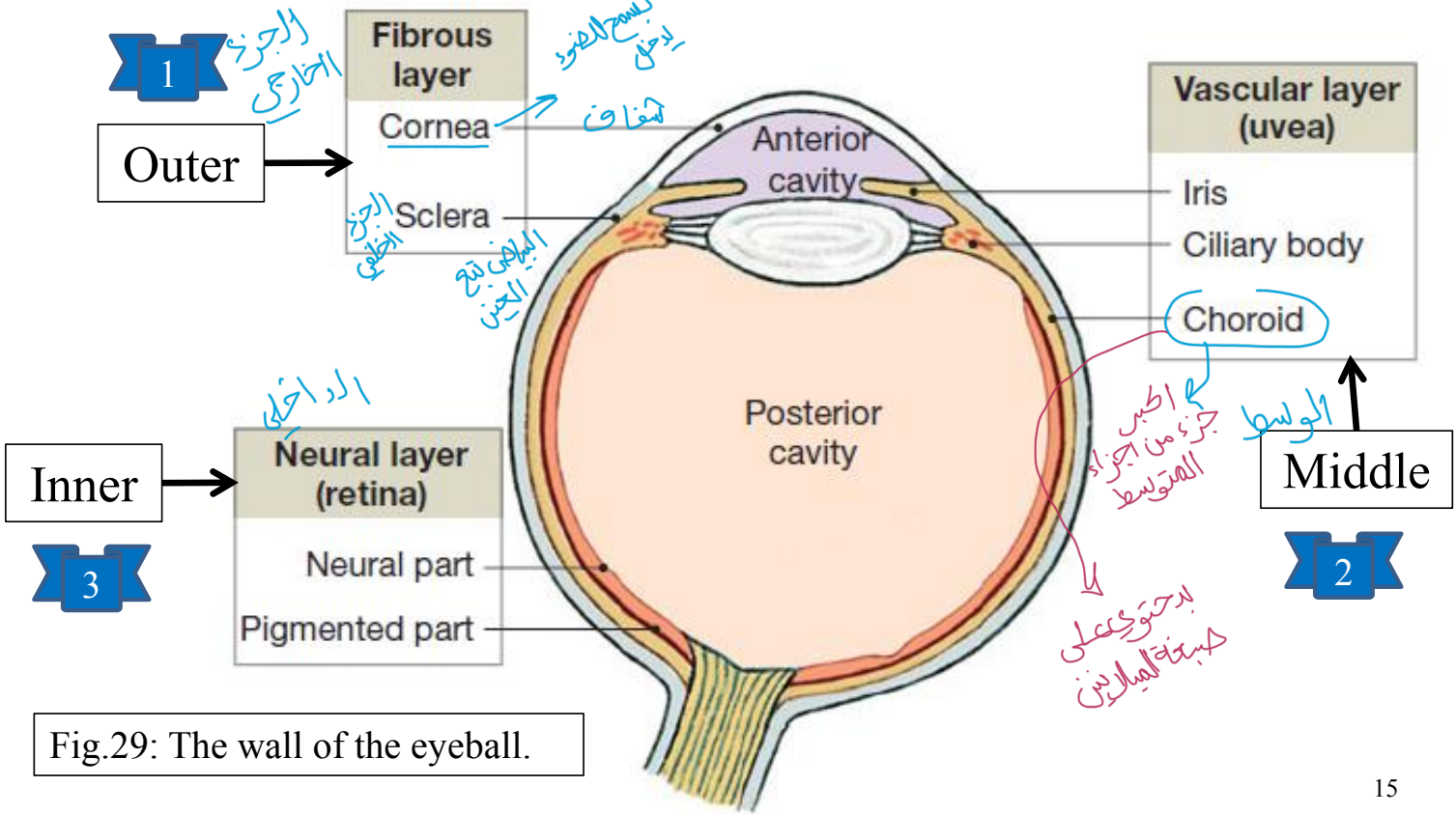


Fig.29: The wall of the eyeball.

1. *Fibrous tunic (layer)*

a) **Sclera** "white" of the eye

- The larger posterior part.
- A strong fibrous layer.
- Functions:
  1. Protect the eye.
  2. Help maintain shape of the eye.
  3. Site of attachment of extrinsic eye muscles.

b) **Cornea**

- The smaller anterior part. Located in front of the iris.
- Transparent.
- Function: it allows light to enter the eye and it's the major refractory structure in the eye.

2. *Vascular tunic*

a) Choroid

- The large posterior part. It's highly vascular layer with numerous melanin-producing melanocytes.
- Functions: (1)supply nutrients to the retina, (2)melanin pigment absorbs any stray lights, thus, making the image sharp.

b) Ciliary body

- The middle part of the vascular tunic.
- Located just posterior to the junction of the cornea and sclera.
- Has numerous protrusions called the ***ciliary processess***. These produce the aqueous humor. From them extend the ***zonular fibers*** (suspensory ligaments) that are attached to the lens.
- The ***ciliary muscle*** is a smooth muscle within the ciliary body. It's responsible for changing the shape of the lens.

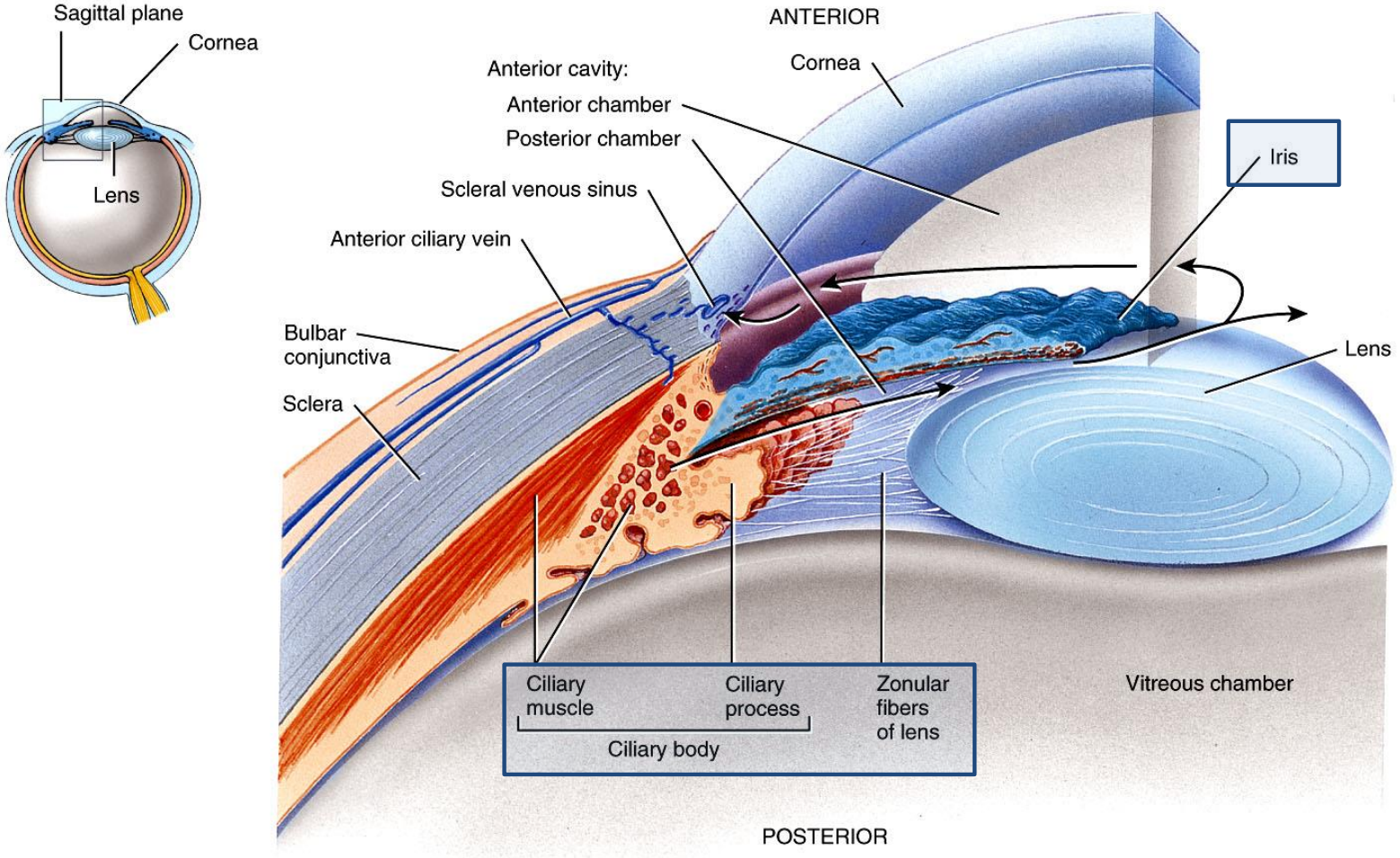


Fig.30: The ciliary body and the iris.