



The Nervous System Histology

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مجموعة من الخلايا المتخصصة في استقبال المعلومات من العالم الخارجي ونقلها إلى الجهاز العصبي المركزي.
 الجهاز العصبي المركزي: الدماغ، النخاع، الحبل الشوكي.
 الجهاز العصبي المحيطي: الأعصاب، العقد العصبية.

- Highly complex, highly organized.
- 10 billion neurons.
- 1000's connection for each neuron.
- Chain like arrangement integrated communications network.
 - Several "electronic circuits".
 - Elementary circuits may form higher order systems.
- Fine coordination for a definite result.
- Synapses.

تكون هناك دوائر كهربائية مختلفة لتصل إلى مركز التحكم في الجسم.
 من أجل أن يتم نقل المعلومات إلى المركز.

الاتصال بين الخلايا العصبية

Synapses: the site of transmission of electric nerve impulses between two nerve cells (neurons) or between a neuron and a gland or muscle cell (effector).

Complex nervous system in more complex creatures is not a summation of simple neurons (it's not

Functions

about the number of neurons present).

- Response to external and internal changes.
- Keeps vital conditions within normal range.
 - Control and integration. → there is control and need high level of integration.
- Behavior & personality. ✓ * in human the behavior and personality under control of NS.
- This is accomplished by high level analysis & integration of information.

the response → reflex at the spinal cord level
 → voluntary

Anatomy

Nervous system:

Central: brain + spinal cord. inside the skull → inside the spinal canal [arrangement of vertebral canal]

Peripheral: nerves + ganglia (aggregation of neuron cell bodies).

Fibers

مجموعة من الخلايا العصبية...

arrangement → تخرج [axons] من الجهاز العصبي المركزي.
 - nerves are long.

* there is sensation of problem → the arch between sensory and motor neuron lead to make the response
بدون الرجوع للمركز العليا.

Overview

Neural pathways/reflex arcs.

Reflex happens at the level of the spinal cord (or medulla oblongata) without being influenced by the higher centers.

Functionally:

- Somatic nervous system. *مركزية له راحة متجاوئة تتم بعد تغيير الاداء*

Conscious, voluntary.

From simple to complex responses.

- Autonomous nervous system *Automatic*

Involuntary.

Control the function of internal organs (in cooperation with the endocrine system).

*منه 1 metabolic events
بمئة تكون خلافة و متلازمة از maintenance of organism*

Smooth muscle, heart, glands, and afferent sensory.

1 Sympathetic, 2 parasympathetic and 3 enteric.

* What is the enteric nervous system and where is it located?

in GIT

The enteric nervous system (ENS) is a web of sensory neurons, motor neurons, and interneurons embedded in the wall of the gastrointestinal system, stretching from the lower third of the esophagus right through to the rectum.

Submucosal plexus and intermuscular (Auerbach) plexus between the circular and longitudinal muscle cells.

It is the brain of the gut and does many of its functions without referring to the CNS.

Composition of nerve tissue

Neurons. *الخلاية العصبية*

Supporting cells/neuroglial cells (of central NS):

called

تختلف في CNS من PNS

- in CNS
- Oligodendrocytes.
 - Astrocytes.
 - Microglia.
 - Ependymal cells.

Peripheral supporting cells:

- in PNS
- Schwann cells.
 - Satellite cells; in the ganglia.

Enteric neuroglial cells (in GIT).

Vasculature:

- Blood-brain barrier between the capillary system and the NS.

The neuron

Sensory neurons:

- Impulse from receptors to CNS.
- Afferent fibers; somatic and visceral (from the internal organs).

Motor neurons:

- Efferent; somatic or visceral.

Interneurons:

- 99.9% of neurons. vast majority
- Between sensory and motor
- Communicating and integrating. and information analysis.

واختيار الجواب المناسب

Neurons consist of three part:

- The cell body (perikaryon). the cytoplasm surrounding the nucleus.
- Dendrites: cytoplasmic membrane extensions/ usually many. receives
- Axon: plasma membrane process/ mostly only one. sends.

Neurons could also be:

Multipolar:

Majority.

ribosome

[well developed [prominent] nucleolus - 1 Azo chromatin - large nucleus]

من تتفرع القفا ببطيئة باستحقاق الصغ.

باستقرار سطح يتم إنتاج protein مبركود تكون cell غنية بار rough endoplasmic reticulum...

هذه العضيات اللازمة لتفريع البروتين...

* Chromatin يكون - Eno chromatin

transcription [active] باستقرار

transcription [active] باستقرار

* there is aggregation inside the cytoplasm of neuron cells → in L.M. we can see it [dense, heavy blue basophilic color].
 ↳ rich in rough ER.

- Characterized by many dendrites that can originate from different regions of a perikaryon.
- Motor neurons and interneurons.

axon of other neuron & synaps in the dendrite surface or in the perikaryon surface.

Bipolar:

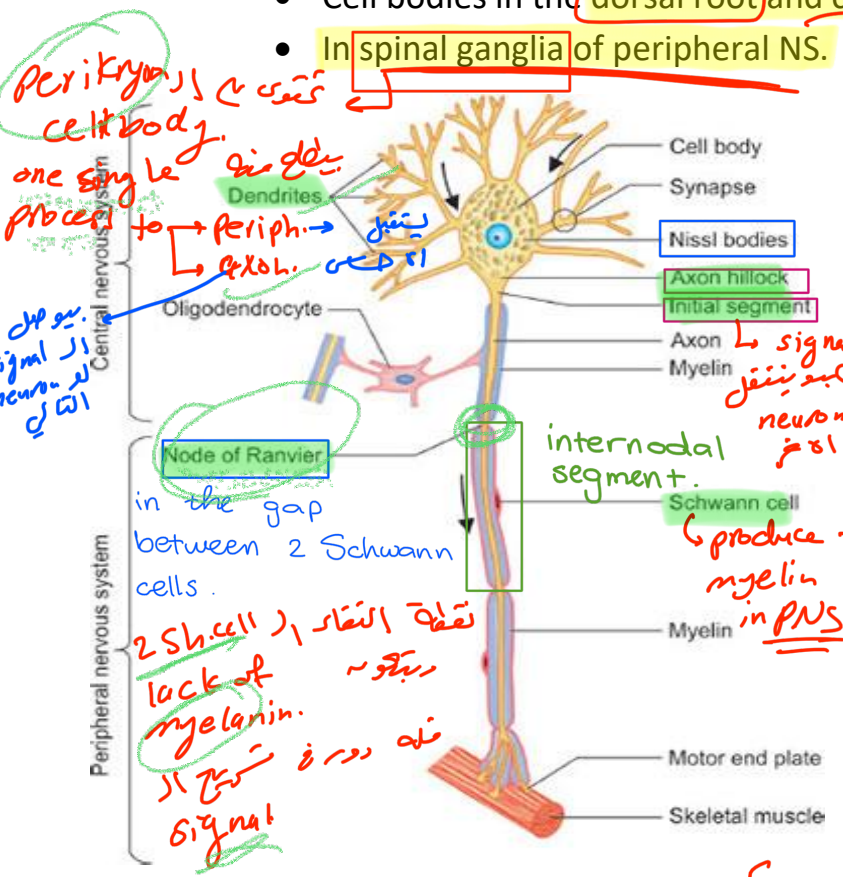
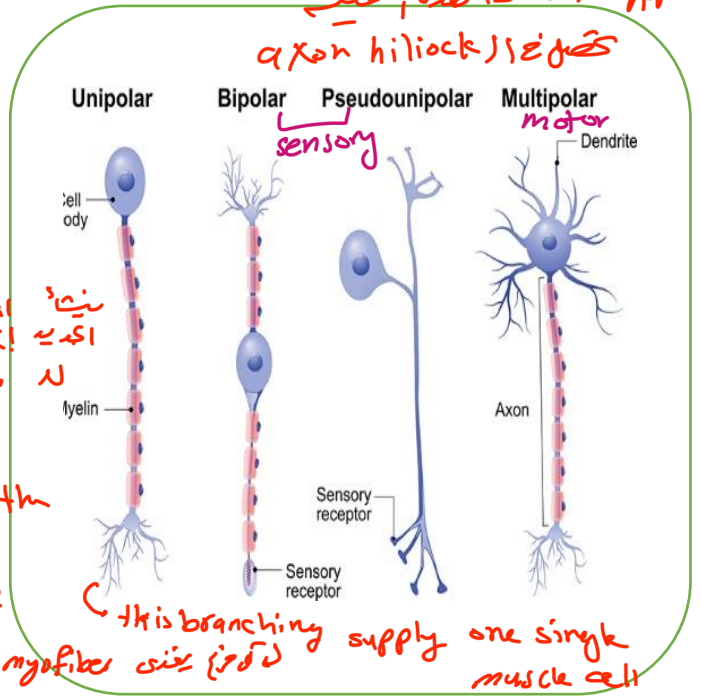
- One single axon and one single dendrite.
- Rare.
- Associated with receptor of special senses.

retina + internal ear.

Pseudounipolar: common

- One process.
- The majority are sensory neurons.
- Located close to the CNS.
- Cell bodies in the dorsal root and cranial nerve ganglia.
- In spinal ganglia of peripheral NS.

neuron يربط بين سطح ما يقارب ألف synaps neuronal connection
 راجع عن excitation to the neurons
 موجع depolarization
 neuron و inhibition
 Sum of this various signals
 مع هذا او مع يتم اتخاذ
 او كما انه، لعينة AI



* depolarization → the mem.
 axons فتفتح القنات - ينقل في axons
 Schwann كانت تنقل أيضا في بعض المرات
 او charging في هذا الحيز

Axon
 myelinated
 lipid غشاء
 خاصية النقل لا axon
 IS/CT
 غير الخلية
 non myelinated
 نقل في axons
 بالعقز و بوجه اشكال
 شجرة + موج

* the initial segment:- axon hillock
 و بانه انتاج 1 myelin في Schwann
 axon hillock في Sum.

هذا الحيز في شرج ال signals
 relatively lack of myelin
 Schwann cell تحت ال cytoplasm
 في axon و بوجه شرج ال myelin
 انتاج Schwann cell و بانه راحة ال [نقطة التقاء] راجع في

Cell body

*Morphology LM and TEM:

*Cytoplasm of cell body has abundant RER, Golgi apparatus and other organelles needed for protein synthesis including the neurotransmitters, enzymes and receptors.

* Nucleus is large and has euchromatin, which is lightly-packed, evenly-dispersed, active chromatin.

* Nucleolus is prominent and well developed for the synthesis of ribosomal RNA, which has a major role in protein synthesis.

تسكيميا *حصة مخاضة* *ال (لوفن فوف)* *Tschemia*
 * **Rich in mitochondria** hence neurons are very vulnerable to hypoxia.

- **Nissl bodies**: granules in the cytoplasm (mostly ribosomes) of nerve cell bodies that are strongly stained by basic dyes and appear as basophilic clumps on light microscopy.
- **Axon hillock**: a specialized part of the cell body (or soma) of a neuron that connects to the axon/ where the summation of signals occur.

- **Axonal transport**: transport material to the terminal bulb.
- **Neural stem cells**: in limited areas.

نواة سيتوبلازم
cyto-
skeleton. [organelles
التالفة.

علاوة على regeneration مجرور بتكوين، والفرق
أخرى.. [بنية نصية] هذا لأن الـ neuralgia
لا تتجلب.

inside the axon
transport material to the terminal bulb.
limited areas.

↓
secretory vesicle..

at the cytoskeleton component

- microtubule
- microfilament
- intermediate filament.

Dendrites and axons

Dendrites:

- Greater diameter than axons.
- Unmyelinated.
- Usually tapered. *کدام حالت بهتری*
- Extensive arborization (dendritic tree). *شعبه های*
- Similar cytoplasmic composition with the perikaryon (with the exception of Golgi). *Similar to the component in the first part*
especially at the beginning near the perikaryon

Axons:

- Only one (mostly).
- May be extremely long.

initial segment:- between the axon hillock and the first sch. cell
↳ forming the depolarization [wave]

e.g. each skeletal muscle fiber is innervated by a branch of the axon.

- Branching at the end (near the effector organ).
- In the initial segment where the depolarization wave starts, the axon can give a branch after a short distance, this branch synapses with the same perikaryon for feedback function.

- Originate from the axon hillock.

- No large organelles.

- The initial segment.

- Periaxoplasmic plaques: aggregation of proteins in the dendrites and axons thought to have a connection with memory and learning especially the ones in the dendrites called dendrite

- dendritic spikes. The proteins change their configuration when they receive signals.

* Synapses could be at the cell body or dendrites.

* Neurons have up to a 1000 synapses/ connection, some of which are excitatory while others are inhibitory.

* The total is a summation of these various signals. This is thought to happen at the axon hillock.

* Axon hillock and the beginning of the myelin (from the first Schwann cell) is called the initial segment. After the summation has happened, the new signal starts at the initial segment.

* Along the axon, Schwann cells rap the cytoplasm and produce myelin. The space between two Schwann cells lack myelin to increase the speed of signal transduction.

* Schwann cells produce myelin in the peripheral and oligodendrocytes produce it in the CNS.

Synapses

Axodendritic: Dendritic spines/memory.

Axosomatic: between the axon/perikaryon

Axoaxonic: between the axon and other axon.

skipped Boutons en passant (buttons in passing).

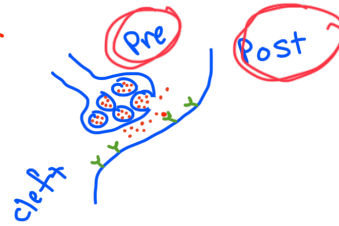
skipped Bouton terminal (terminal bouton/end bulb).

From few to tens of thousands.

types of the synaps:-

① Chemical synapse:

- Presynaptic membrane.
↳ release neurotransmitter
- Synaptic space. [cleft]
- Postsynaptic membrane. ↳ has R. for NT. ↳ neuron ↳ muscle.
- Neurotransmitter.



Neurotransmitter is released at the presynaptic membrane into the synaptic cleft and it has a receptor on the postsynaptic membrane. Their binding leads to new action potential in the next cell or muscle.

② Electrical synapses:

- In invertebrates.
- Gap junctions. open in the cytoplasm, post synaptic, pre synaptic forming channel.
- Mammalian equivalent: smooth and cardiac muscle.



Charged molecules pass directly from one cell to another through the gap junction.

The neuroglia

Central: astrocytes, microglial cells, ependymal cells, and oligodendrocytes. microglial cell

Peripheral:

- Schwann cells.
- Satellite cells.
- Others: ↳ خلائیات عصبانی
- Terminal neuroglia (teloglia).
- Enteric neuroglia.
- Müller's cells.

Peripheral neuroglia

Schwann cells

neural tube ↓ origin for CNS
 origin of sch. cell
Neural crest/SOX-10 (transcription factor/ help in identifying the origin of a tumor).
 using IHC
 to give the start signal for transcription to form protein and make differentiation.
 Produce myelin sheath.

In both myelinated and unmyelinated axons.

cytoplasm axon. ↓
 Rapped concentrically around the axon.

The node of Ranvier/ the internodal segment: the segment between 2 Schwann cells.
 ↳ between 2 Ranvier node.

electrical signals
 ↓
 Unmyelinated axons are also enveloped by Schwann cells.

*Myelin is lipid.

↳ appears as vacuole when there is processing.

② Satellite cells

Complete layer around the perikaryon.

Processes penetrate between them.

Function: Electrical insulation and controlled microenvironment.

Enteric neuroglial cells

Morphologically and functionally identical to astrocytes.

Central neuroglia

Astrocytes neuroglial cell in the CNS

The largest. compartment →

Support, control of metabolism and modulation of activity.

Scaffolding during embryology.

Scaffolding: to encourage the migration, differentiation, attachment, and development of regrowing cells.

Processes from vessel to neuron.

Perivascular feet from multiple astrocytes cover the vessel completely.

Anatomy: spinal nerves from vertebra on each side
 ↳ dorsal root
 ↳ lateral/anterior bundle (motor) → S.N.
 ↳ ventral root
 ↳ sensory
 ↳ spinal ganglion
 ↳ dorsal root
 ↳ ventral root

physical
 chemical
 mechanical
 metabolic
 ↓
 neuron migration

①
 ②
 ↳ new
 [function]

[no direct connection]
 process

* Basal ganglia → part of gray matter inside the white matter.

Types:

Protoplasmic.

- More common in the gray matter. ^{millimeter} ^{perikaryon}
- Numerous short branching processes so we called it Astrocyte

Fibrous.

- Common in the white matter. ^{axons} ^{called it axon.}
- Relatively straight with fewer processes. ^{elongated.}

Cytoskeleton: microtubules, microfilaments, intermediate filaments.

GFAP (a protein/ an intermediate filament/ marker for neuroglial origin).

^{glial fibrillary acidic protein}
↳ if it (+ve) so the origin of tumor from Astrocyte mainly.
Maintain the BBB.

Covering for Ranvier nodes and synapses. ^{نظرة}

NT (neurotransmitter) removal. ^{إزالة الناقل العصبي}

Glia limitans (impermeable). ^{الحائل}

② Oligodendrocyte

^{صارية / صائجة}
The counter part of Schwann cells in the periphery.

Produces CNS myelin.

Few processes.

CNS in contrast to PNS:

- No supporting cells around unmyelinated axons. ^{in CNS}
- And no BL (basal lamina).

In general brain has little connective tissue.

CT: cells (fibroblasts) + extracellular matrix (ground substance and fibers).

^{poor}
↳ collagen
↳ reticulin
↳ elastic fibers

↳ elongated fibers.

③ Microglia

Origin: monocyte.

^{blood cell can leave the circulation and enter the tissue}
↳ neural crest, tube.

Phagocytic. ^{inside the Brain}
^{waste product}
5% of glial cells, higher in inflammation.

Morphology:

Elongated nucleus, less process.

④ Ependymal cells

Localization: line the ^{2nd, 3rd & 4th} ventricles and the central canal. ^{inside the spinal cord. filled by CSF.}

Has the same morphology of the fluid transporting cells like the cells in the salivary gland. ^{or kidney}

- The basal part has foldings rich in mitochondria. ^{to give the energy}
- Tightly bound by junctional complexes at the apical surfaces (zonula occludens). ^{to prevent fluid leak.}

Arranged like epithelium but lack external lamina (unlike epithelium).

The apical surface: has cilia (movement) and microvilli (more surface area). ^{not motile}

Types: special type:-

① Tanycytes

- Floor of III ventricle. ^{3rd V}
- No cilia. ^{one single}
- Long process into the brain parenchyma.

② Choroid plexus

- Modified ependymal cells and the associated capillaries. ^{rich in blood vessels [capillary]}
- Produce CSF. ^{+ folds}

Peripheral nerves

Nerve fibers held together by CT.

Nerve fibers: the axon on its own or the axon with its associations (Schwann cells, myelin,...).

bundle of nerve fibers
nerve
axon

*dense CT → collagen fibers, bundle..

Endoneurium.

- Surrounds a single axon
- Loose CT (rich in ground substance, poor in fibers).
- CT is secreted by Schwann cells. and not fibroblast.
- Mast cells and macrophages. → CT
- No blood vessels/diffusion.

Perineurium.

- Surrounds a group of axons
- Metabolically active diffusion barrier.
- Contribute to the formation of blood nerve barrier.
- No lymphocytes or plasma cells in both the endo and perineurium.

Epineurium

- Surrounds the whole nerve.
- Dense irregular connective tissue.
- Has fat in large nerves.
- Blood vessels inside (also in peri).

Organization

Anatomy.

Gray matter: cell bodies with neuropil (dendrites, axons, synapses, glial cell processes, and microvasculature).

White matter.

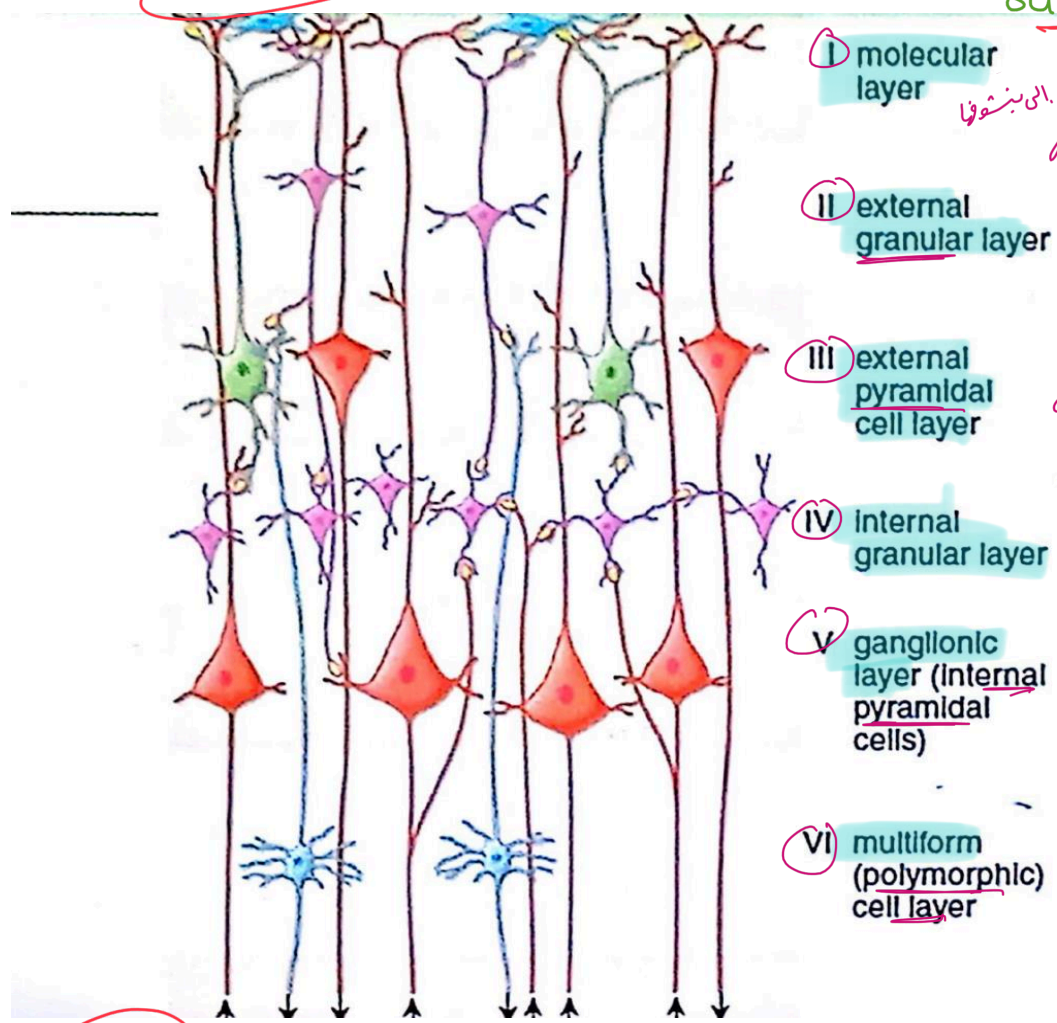
[cerebrum, cerebellum, brain stem.] → Brain Parts

other part of neuropil

* high level of organization [nerve, Brain] ..

6 parts of Gray matter in cerebellum:-

superfascial.

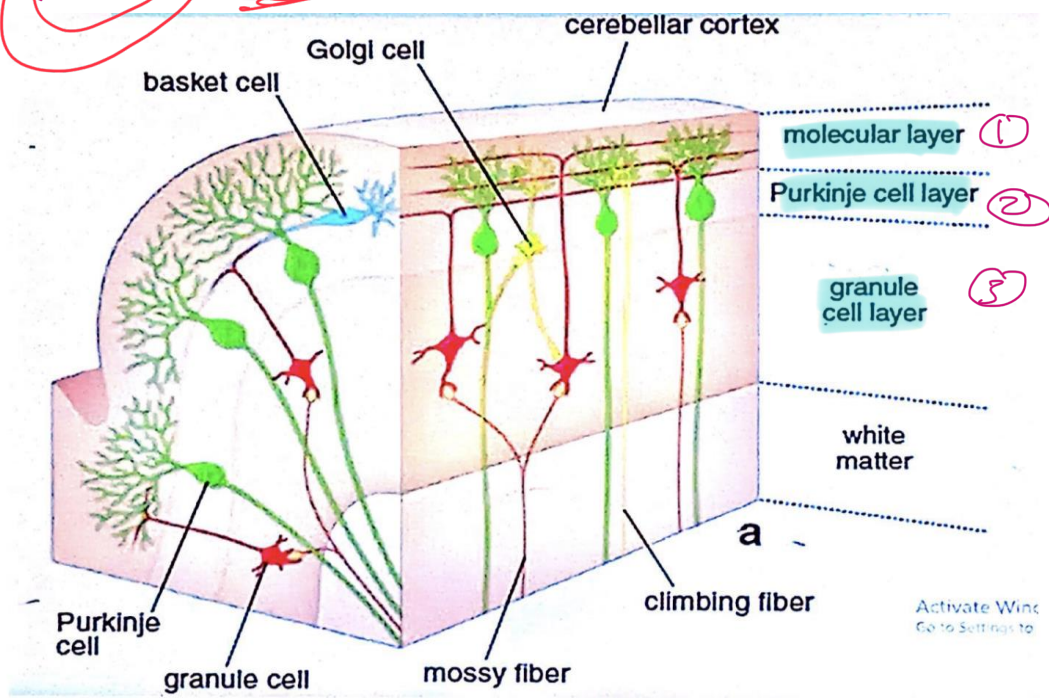


حجرات perikaryons الى بنيتها
قسمت الى 6 اجزاء

حجرات

deep.

The 3 layers of cerebellum cortex:



Activate Windows
Go to Settings to activate Windows.

Brain في كس في The spinal cord

Gray matter on the ^{inside} ~~outside~~ and white matter on the ^{outside} ~~inside~~ unlike the brain.

forming H shape there is → ant. horn → in 3D appear as column.
Spinal ganglia is pseudounipolar.

Ant. Ventral motor neurons.

post. Dorsal root ganglia/sensory neurons.

called anti column.

Anterior column has the secondary motor neurons. of motor tract

↳ has large motor neurons, [2nd] motor cortex JS as as circle in the brain

mechanical protection. ↳ 3 layer of C.T

Meninges

Dura matter:

- Dense connective tissue.
- Continuous with the periosteum in the skull.
- Separated from the spinal canal by the epidural space.
- Sinuses for draining venous blood.

Arachnoid:

- Arachnoid trabeculae of loose CT.
- Subarachnoid space/CSF.

connection of pia matter and Arachnoid...

Pia matter:

- Loose CT.
- Continuous with the perivascular connective tissue.

Brain 1, 2, 3 BV 1, 2 مع 3
supply 3 BV

Done ✓