

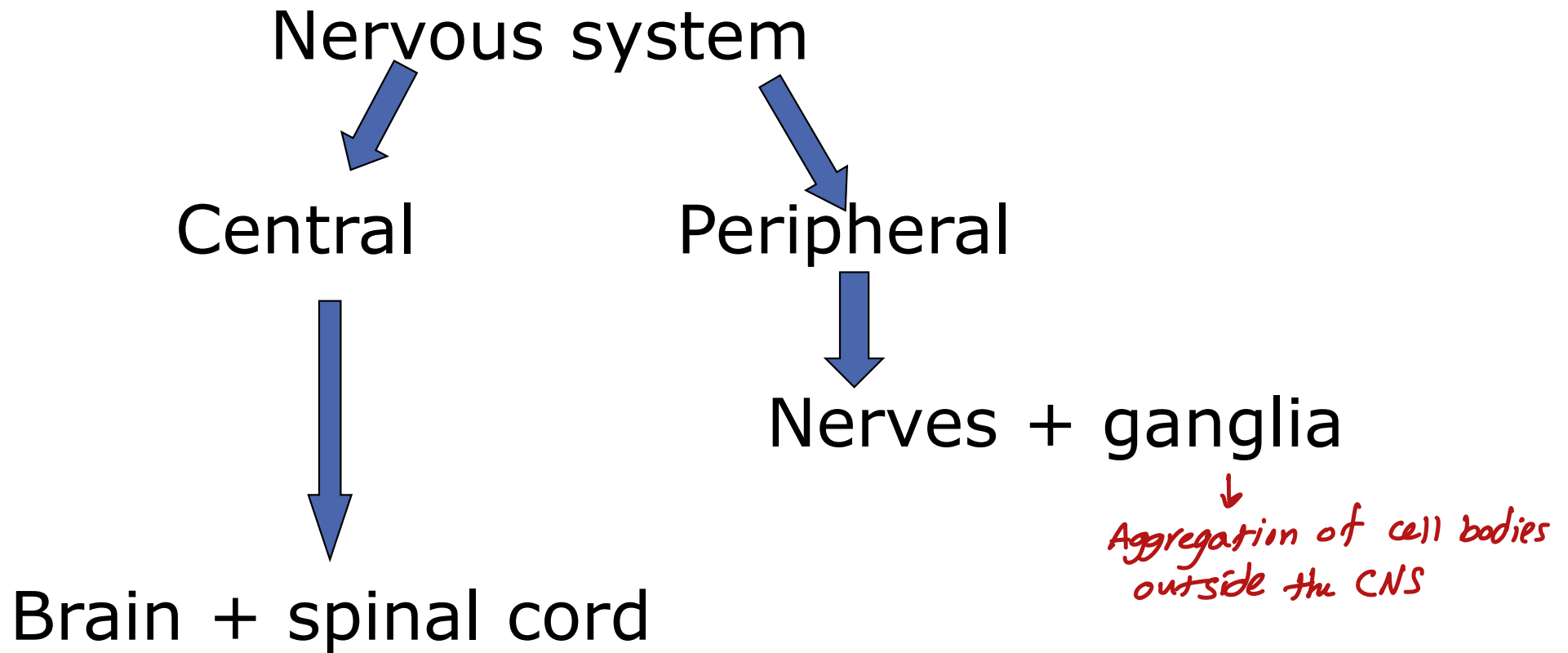
Histology of The Nervous System



Functions

- Response to external and internal changes
- Keeps vital conditions within normal range
 - Control and integration → of impulses coming either from inside or outside the body
- Behavior & personality
- This is accomplished by high level analysis & integration of information

Anatomy

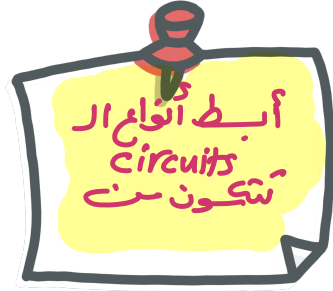


Neurons

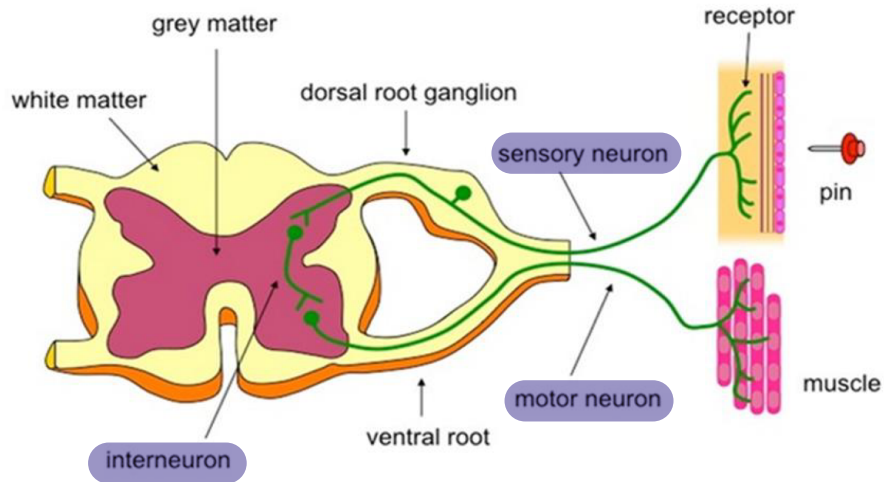
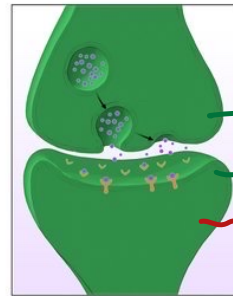
- Cell bodies
 - Inside the CNS → Called **nucleus**
 - Outside the CNS → Called **ganglion**
- Axons

Introduction

- Highly complex, highly organized
- 10 billion neurons
- 1000's connection for each neuron → = Synapse
- Chain like arrangement integrated communications network
 - several “electronic circuits” → هيا Basic unit تسمى ال Brain اليه من طريقها يقوم بوظائفه المختلفة
 - Elementary circuits may form higher order systems α
- Fine coordination for a definite result → Circuits فربطان تكون في كثير من مظهره
- Synapses → Connection between 2 neurons or between the neuron and the effector organ



- ① Afferent (sensory) neuron → Reception → *مخاطبة*
- ② Efferent (effector) neuron → the neuron performing the function
- ③ Interneuron → In between the aff. & eff.
→ Assessment and making direction to the impulse and deciding what type of response should be performed



Synaptic space

Postsynaptic cleft

هو الجزء الذي جايه الاشارة

Signals are transmitted in this space by already deposited neurotransmitters "are produced previously"



Synapse

Overview

- Neural pathways/reflex arcs

- Functionally

- Somatic nervous system

- Conscious, voluntary → از سیستمی بنحویه داخدا مدکن
- From simple to complex responses

- Autonomous nervous system

- Involuntary
- Control the function of internal organs
 - In cooperation with the endocrine system
- Smooth muscle, heart, glands, and afferent sensory
- Sympathetic, parasympathetic and enteric → اُستاد از Autonomous nervous system



The autonomous nervous system
of the GIT

من کنتر ماهو منظمه بارما یصلوه
Parasympathetic, Sympathetic عن

Composition of nerve tissue

- Neurons → *The basic structure of the nervous system*
- Supporting cells (neuroglial cells) → *يمكن نكحى cells glial لخال*
 - Oligodendrocytes
 - Astrocytes
 - Microglia
 - Ependymal cells
- Peripheral supporting cells
 - Schwann cells
 - Satellite cells; in the ganglia
- Enteric neuroglial cells

Functions of the neuroglial cells

- Physical support → Neurons are very fragile cells and consuming large amounts of O_2 and nutrition, so should be supported physically & chemically
- Isolation, thus rapid transmission
- Repair of neuron → *embryology* *برجئه الهادور أشتادار* Neuroglia
- Regulation of the microenvironment
- Clearance of the neurotransmitter → *ماتانكون جهرين نيقبل* another signals
- Metabolic exchange → e.g. No direct contact between the neurons and the BVs

Action potential *نقل عن طريق* Nervous system
هو بخصيص عبارة عن *electric* *درين في*
isolation *electrical current*
ماتنقل بالكل الصبح

→ So the contact is mediated by the neuroglia "هي الوسيط" in order to exchange metabolites

Composition of nerve tissue

- Vasculature

- Blood-brain barrier → *The neuroglia constitute the entire system of BBB*

The neuron

→ Neurons are very very heterogenous group of cells
منه يمكن يكون بأشكال مختلفة

- **Sensory neurons** → Receive the signals
 - Impulse from receptors to CNS
 - Afferent fibers; somatic and visseral
- **Motor neurons** → Response to the stimulus
 - Efferent; somatic or visseral
- **Interneurons**
 - 99.9% !
 - Communicating and integrating

The neuron

- The cell body (perikaryon)

- Axon

 - Mostly only one

يمكن شكل limited
قرب از organ
حوية تغذيات

از مكان برصه يعطي Recurrent branch
يشتغل كنوع من feedback لـ Cell
انه هو الوضع هو الـ signals الي وحيات

- Dendrites

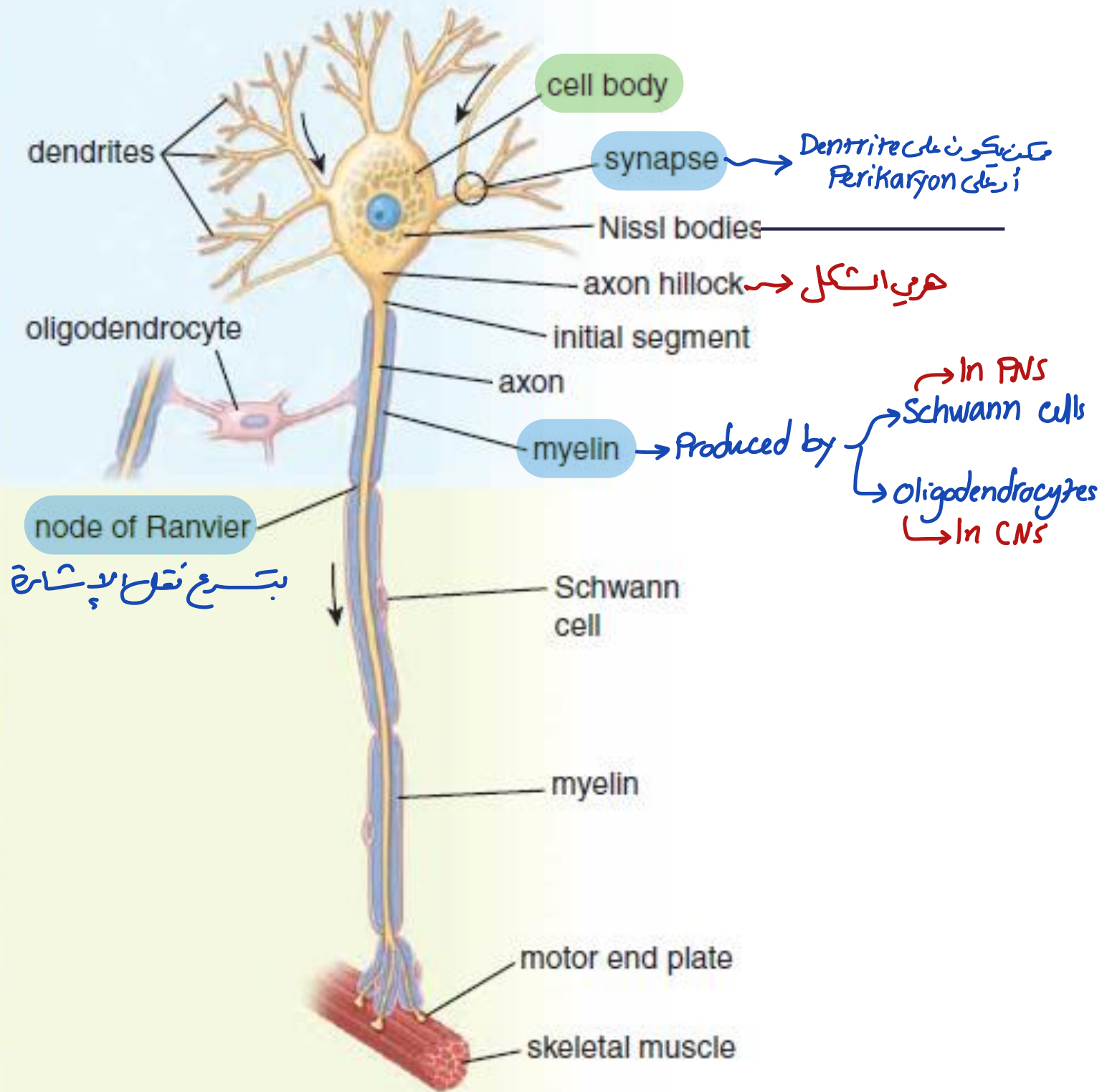
 - Usually many

- Plasma membrane extensions

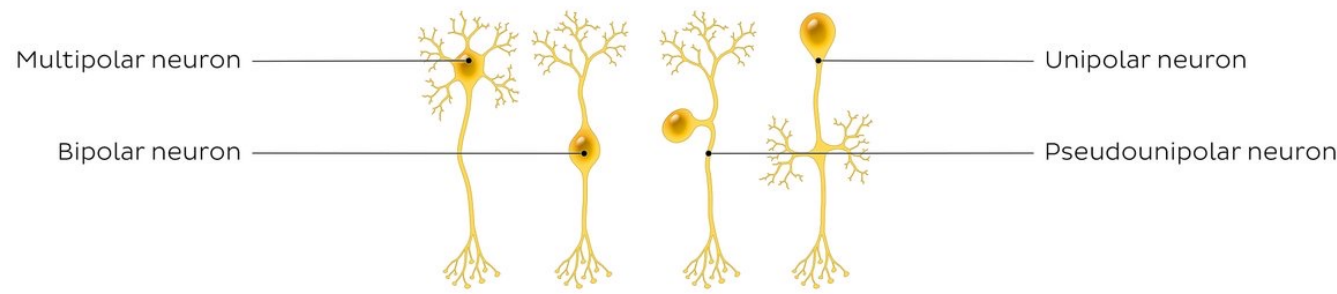
- It is the site for receiving multiple synapses coming from other neurons

CENTRAL NERVOUS SYSTEM

PERIPHERAL NERVOUS SYSTEM



The neuron



□ Multipolar

- Motor neurons and interneurons

→ *Constitute 99% of neurons* → *So the majority of neurons are multipolar*

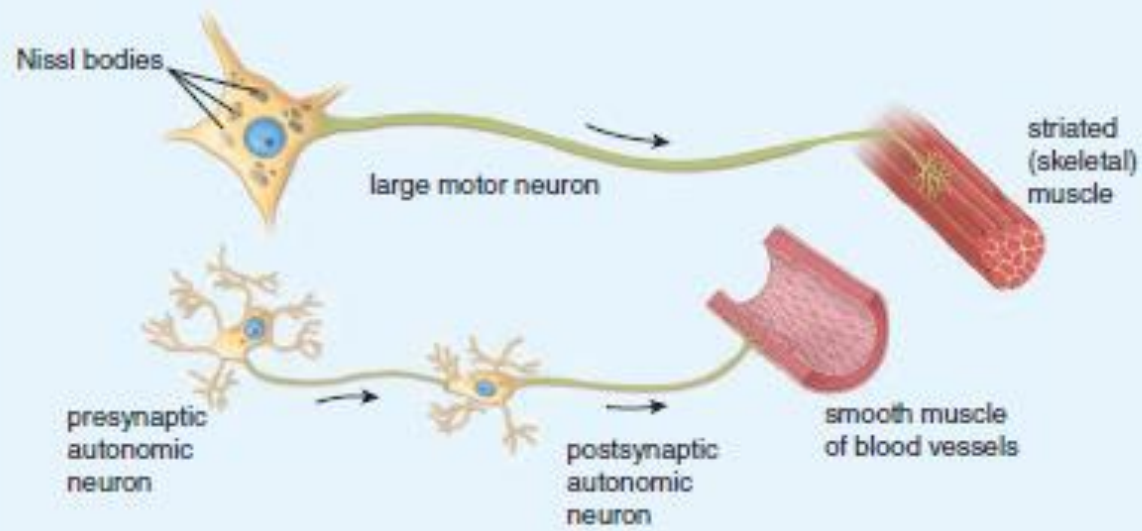
□ Bipolar

- Rare → *Vestibulocochlear system (CN VIII) + Retina*
- Associated with receptor of special senses

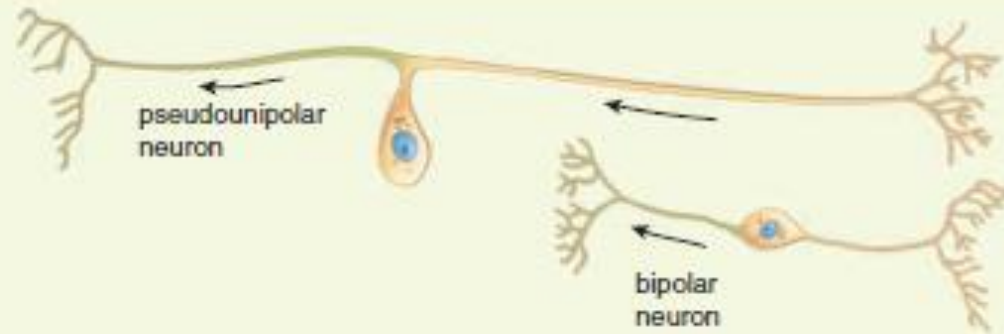
□ Pseudounipolar

- one process
- The majority are sensory neurons
- Located close to the CNS
- Cell bodies in the dorsal root and cranial nerve ganglia
↳ *'Spinal ganglia'*

MOTOR



SENSORY



INTEGRATIVE



محل ↓
nucleus

Cell body

Chromatin in the nucleus is of euchromatin type

► Prominent large nucleolus

- Very rich in mitochondria

Dispersed & light in
chromatin

محادثة لينة active وسفاحل على طول

Production of ribosomes
 Ribosomes are made of protein and RNA
 Protein is made of amino acids

- Morphology LM and TEM

- Nissl bodies
- Axon hillock → Neck of the axon
- Axonal transport → Axons do not contain organelles
- Neural stem cells → Regenerative capacity in the neuro

لها يحتاج طاقة كثير وبسرعة
 لا يقدر تتغذى عن
 Aerobic energy
 (مصدرها الصيد)

→ should be performed
يُنْتَمِ عَنْ خُرْبِيعَة Cytoskeleton تبعه

Recent studies
تحقیق‌های اخیر
نموده‌اند که

Cytoplasm are rich in rough ER & Golgi apparatus

ريبوزوم ER وال Ribasomus الي عليها ممكن سينا في
cytoplasm على شكل bodies في ال light microscope

light microscope

Nessel bodies بنسیر

لے مابینہ رشتوں اور
علاقہ منہ علاقہ

(نُتَظَرُ مِنْهُ عَنْ طَرِيقَةِ EM)

لكن لأنظمة الـ *organisms* موجودة بكثرة في كل مكان

Dendrites and axons

□ Dendrites

- Greater diameter than axons
- Unmyelinated
- Usually tapered
- Extensive arborization (dendritic tree)
- Similar cytoplasmic composition with the perikaryon (with the exception of Golgi)

→ Axons عکس

تفرعات

↳ while axons are devoid of any organelles

Dendrites and axons

□ Axons

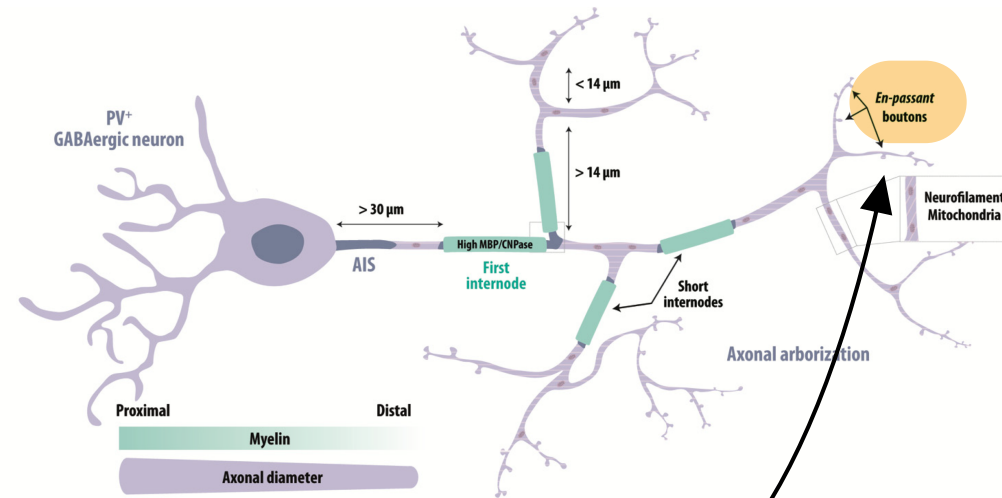
- Only one
- May be extremely long
- Branching → *limited and usually in the distal part near the effector organ*
- Originate from the axon hillock
- No large organelles
- The initial segment → *The part between the axon hillock and the first schwann cell*
→ *It's the space where the action potential starts*
→ *Under control and modification of various coming signals*
- Periaxoplasmic plaques/memory??

حجودة بنو يار axons على شكل swellings
تتجمع فيها aggregations of ribosomes
معتقد انه لها علاقة بـ memory

↓
some are excitatory
others are inhibitory
ربائلي بهذا المكان
Summation جمع
of coming signals

Synapses

- Axodendritic
 - Dendritic spines/memory
- Axosomatic
- Axoaxonic



Axon مادة بيضاء على طول الـ Perikaryon بعيد
 multiple points of contact (synapses)
 هو ناسخ بعيد multiple Synapses على الـ Cell

- Boutons en passant (buttons in passing)
- Bouton terminal (terminal bouton/end bulb)
- From few to tens of thousands

الجزء الأضيق إلى فيه Swelling

electrical synapses ← عبارة عن Gap junction

- Anastomosing openings between 2 cells
- Maintain continuous contact between the 2 cells
- Present in cardiac and smooth muscles

Synapses

لكن في CNS في بيانه chemical synapses

□ Chemical synapse

- Presynaptic membrane
- Synaptic space
- Postsynaptic membrane
- neurotransmitter ✓✓

في الفقاريات
(vertebrates)

□ Electrical synapses

- In invertebrates الفقاريات
- Gap junctions
- Mammalian equivalent: smooth and cardiac muscle

انما في الفقاريات في vertebrates
الى يحتوي على electrical synapses

The neuroglia

- Oligodendrocytes
- Astrocytes
- Microglia
- Ependymal cells
- Central
- Peripheral → found in peripheral ganglia
 - Schwann cells → Produce myelin
 - Satellite cells
 - Others
 - Terminal neuroglia (teloglia) in the motor end plate
 - Enteric neuroglia
 - Müller's cells in the retina

Schwann cells

- Neural crest/SOX-10 → the transcription factor that induce differentiation of neural crest into schwann cells
- Produce myelin sheath + Isolation of the axons from each other
- In both myelinated and unmyelinated axons
- Rapped concentrically around the axon → ملففان axon على حدة
- The node of Ranvier/the internodal segment
- Unmyelinated axons
 - Also enveloped by schwann cells ✓✓

Internodal segment → The space between 2 Nodes of Ranvier
= 1 schwann cell



Myelin →

→ Node of
Ranvier

→ Axon

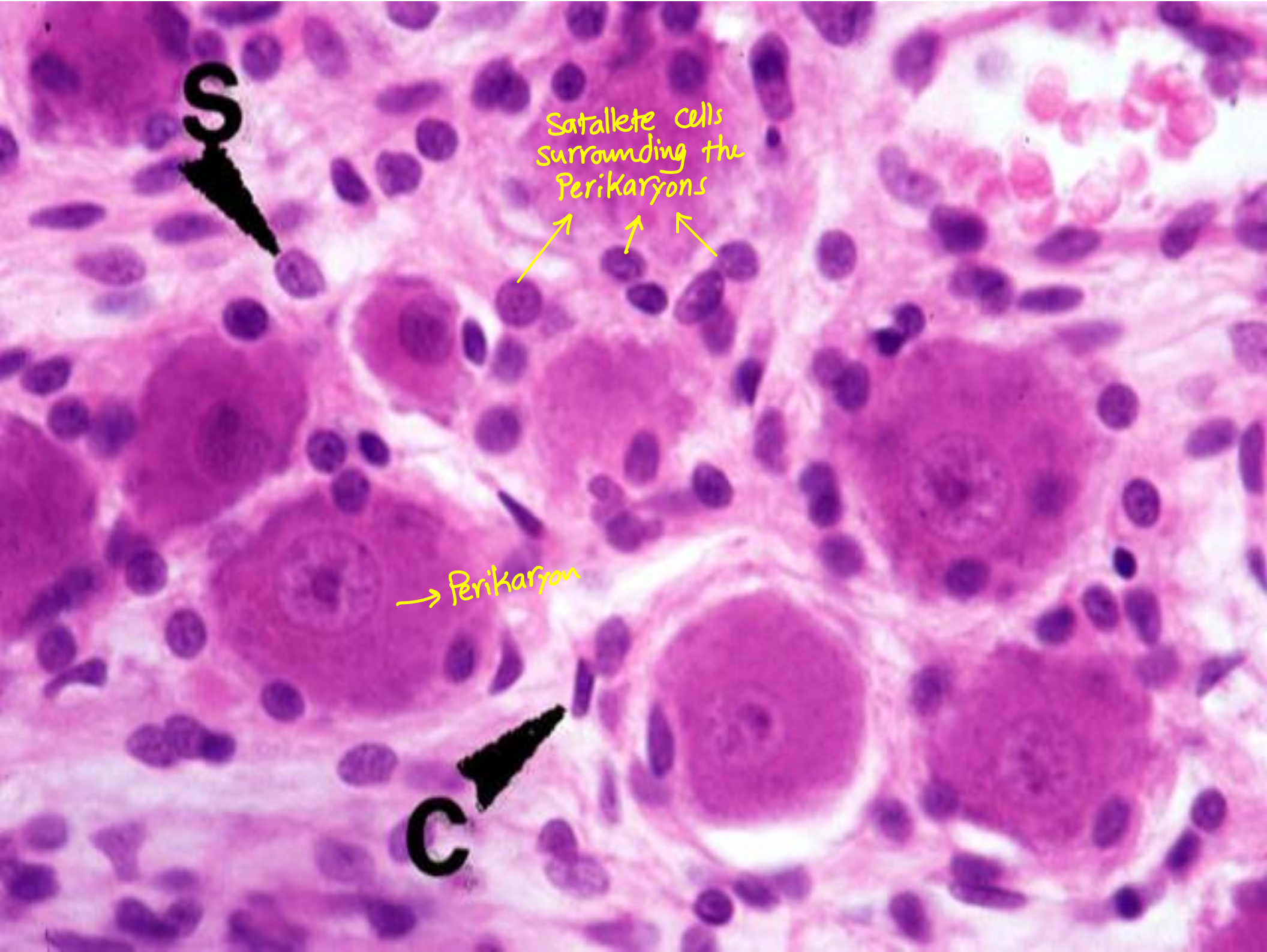
Satellite cells

- Complete layer around the perikaryon
- Processes penetrate between them
- Electrical insulation and controlled microenvironment

نماذج الخلايا في المادة الرمادية
في ANS (Ganglia)

مقطع من spinal ganglia بـو حنج تكل
Pseudounipolar axons





Satellite cells
surrounding the
Perikaryons

→ Perikaryon

→ Present around the cell bodies in the digestive system

Enteric neuroglial cells

- Morphologically and functionally identical to astrocytes

Muscularis propria of GI mucosa

- longitudinal layer
- Circular layer

Between them there is the **Aurbach's plexus** (Intermuscular plexus)

enteric neuroglia بیکون نیریا



Astrocytes

- The largest
- Support, control of metabolism and modulation of activity
- Scaffolding during embryology → *تعمل إطاراً حيوياً على تطور الخلايا العصبية*
development
- Processes from vessel to neuron → *Interphase (رابط) between the vessels and neurons*
- Types
 - Protoplasmic
 - More common in the gray matter
 - Numerous short branching processes
 - Fibrous
 - Common in the white matter
 - Relatively straight with fewer processes

perivascular
feet

axon

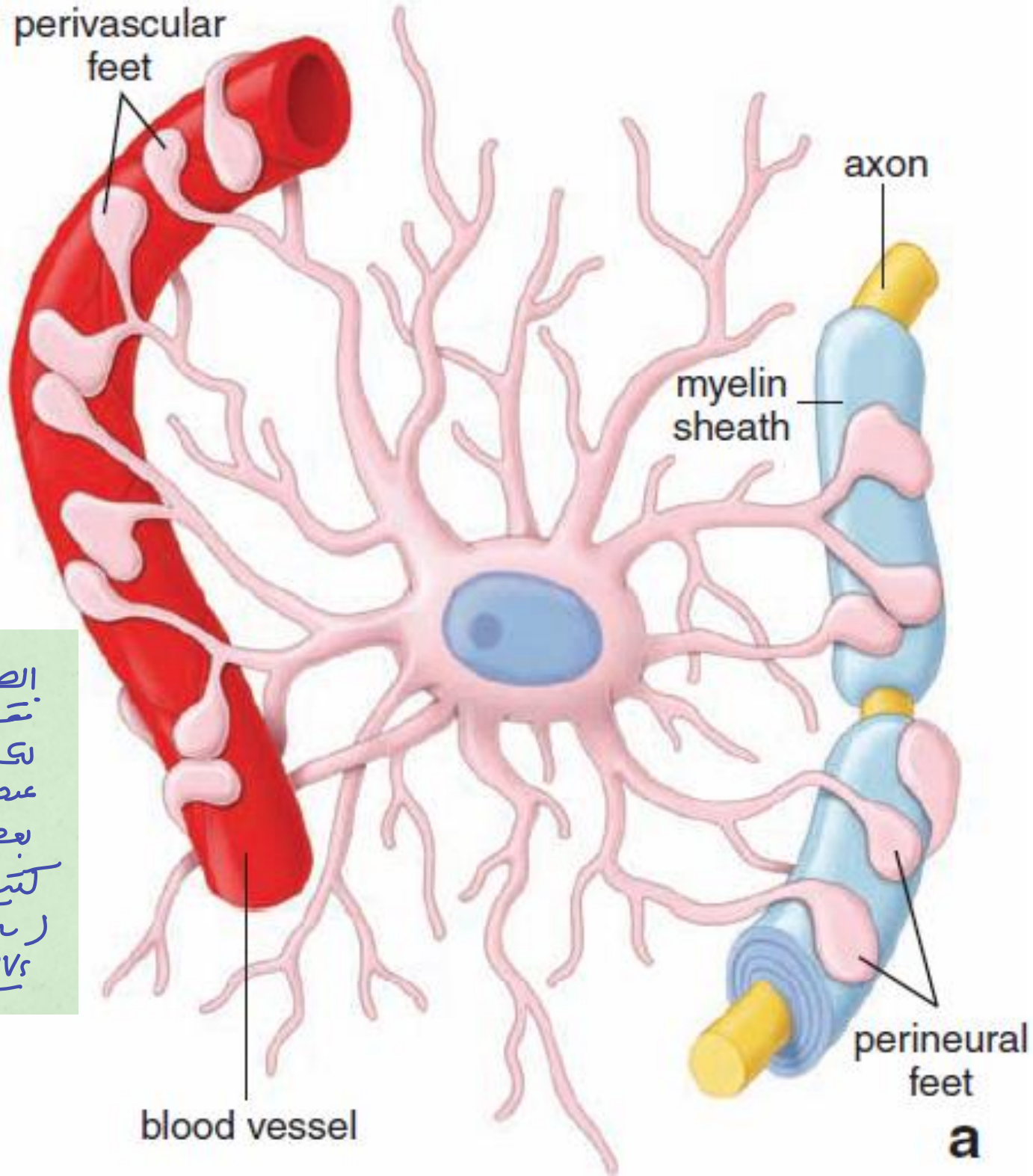
myelin
sheath

perineural
feet

blood vessel

a

الصورة هاي سوخنة
نقطه 1 astrocyte
لكن فعليا بيكون
عدد هم كثير وفنوم
بعض ال branches
كثيره فبيعملوا عزل
(isolation) لـ
neurons عن BVs



Astrocytes

- GFAP *Intermediate filament*
Glial fibrillary acidic protein
- Maintain the BBB
- Covering for Ranvier nodes and synapses ✓
- NT removal
- Glia limitans (impermeable)
 - ↳ *Cell processes of astrocytes extend from the outermost surface of CNS to the pia matter (nearest structure to CNS)*

Oligodendrocyte

- Produces CNS myelin

- Few processes

- CNS in contrast to PNS

The unmyelinated axons are also surrounded by schwann cells

- No supporting cells around unmyelinated axons

- And no BL → 'Oligodendrocytes'

*ایک سے
بہت
PNS*

Microglia

- ❑ Origin → Hematopoietic system 'mesoderm not ectoderm as other neurons'
- ❑ Phagocytic
- ❑ 5% of glial cells
- ❑ Morphology
 - Elongated cell
 - Elongated nucleus
 - Has cell processes

- full circumferential tight junctions

- Tightly isolated (sealed off) *مغلقة بإحكام* → يعني مانعة مرور لـ fluid من حوائط الخلية

Ependymal cells

- Localization → lining the cavities or spaces of the CNS *ventricles*
central canal of spinal cord
- Morphology of the fluid transporting cells
- Tightly bound by junctional complexes at the apical surfaces
- Lack external lamina (unlike epithelium)
- The basal cell surface → *Rich in mitochondria*
- The apical surface

Contains *microvilli* to increase the surface area thus performing more effective absorption

Interdigitations of the basal surface

this also increase the surface area and perform more functions

هذه اى Cells تكل عام بيكون الهم شكل خاص زي انه بيكون الهم microvilli وكذا معث الافلية عليهم برضه خلايا mucosa of GI

وماي Cells تحت LM مابشرين تقاصيلها بيبين انها قنطرة برضه بنسبة striated cells

Ependymal cells

□ Tanycytes *→ Subtype of ependymal cells*

- Floor of III ventricle
- No cilia
- Long process into the brain parenchyma

□ Choroid plexus

- Modified ependymal cells and the associated capillaries

Choroid plexus is closely related with capillary structures

Peripheral nerves

- Nerve fibers held together by CT
- Endoneurium
 - Loose CT
 - Secreted by Schwann cells
 - Mast cells and macrophages
- Perineurium
 - Metabolically active diffusion barrier α
 - Contribute to the formation of blood nerve barrier α
 - No lymphocytes or plasma cells in both the endo and α perineurium

The neuron itself can be subdivided into multiple fascicles (bundles)

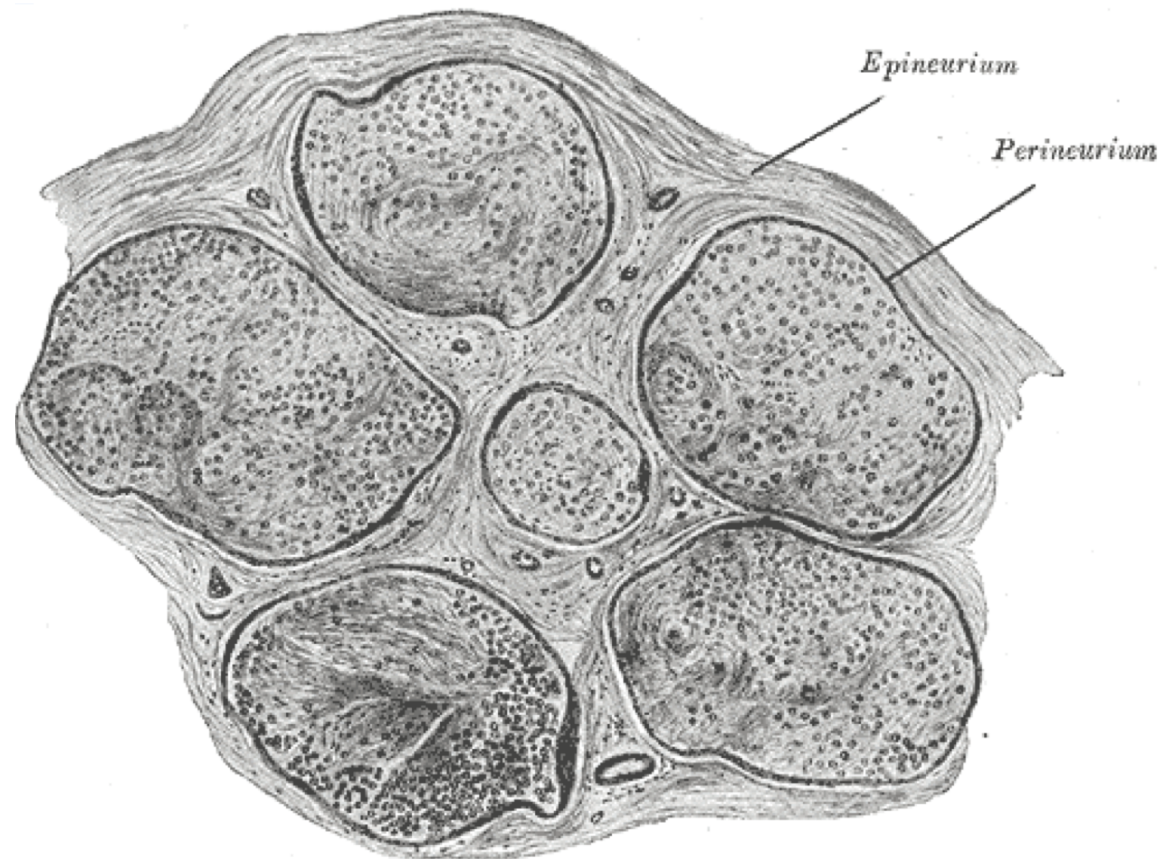
each one of these fascicles is surrounded by the perineurium

Peripheral nerves

□ Epineurium

- Dense irregular connective tissue
- Fat in large nerves
- Blood vessels inside

بجھٹ بار nerve من کل
الجھات

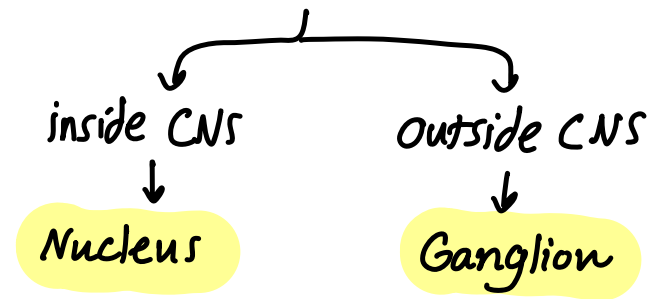


Organization

- Anatomy
- Gray matter → *cell bodies of the neurons* → may present

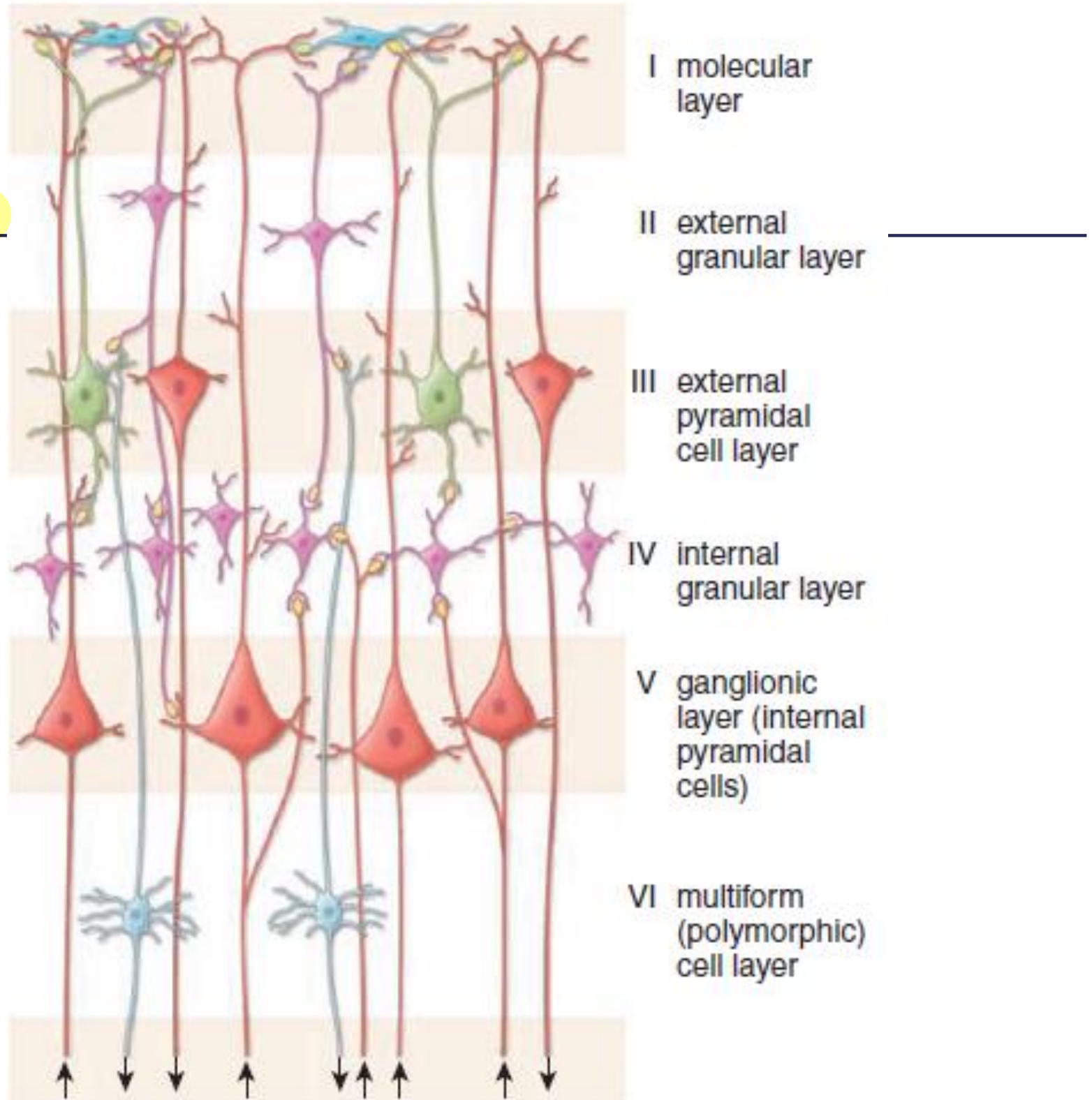
- Neuropil

- White matter
↳ *Neuronal axons (fibers)*



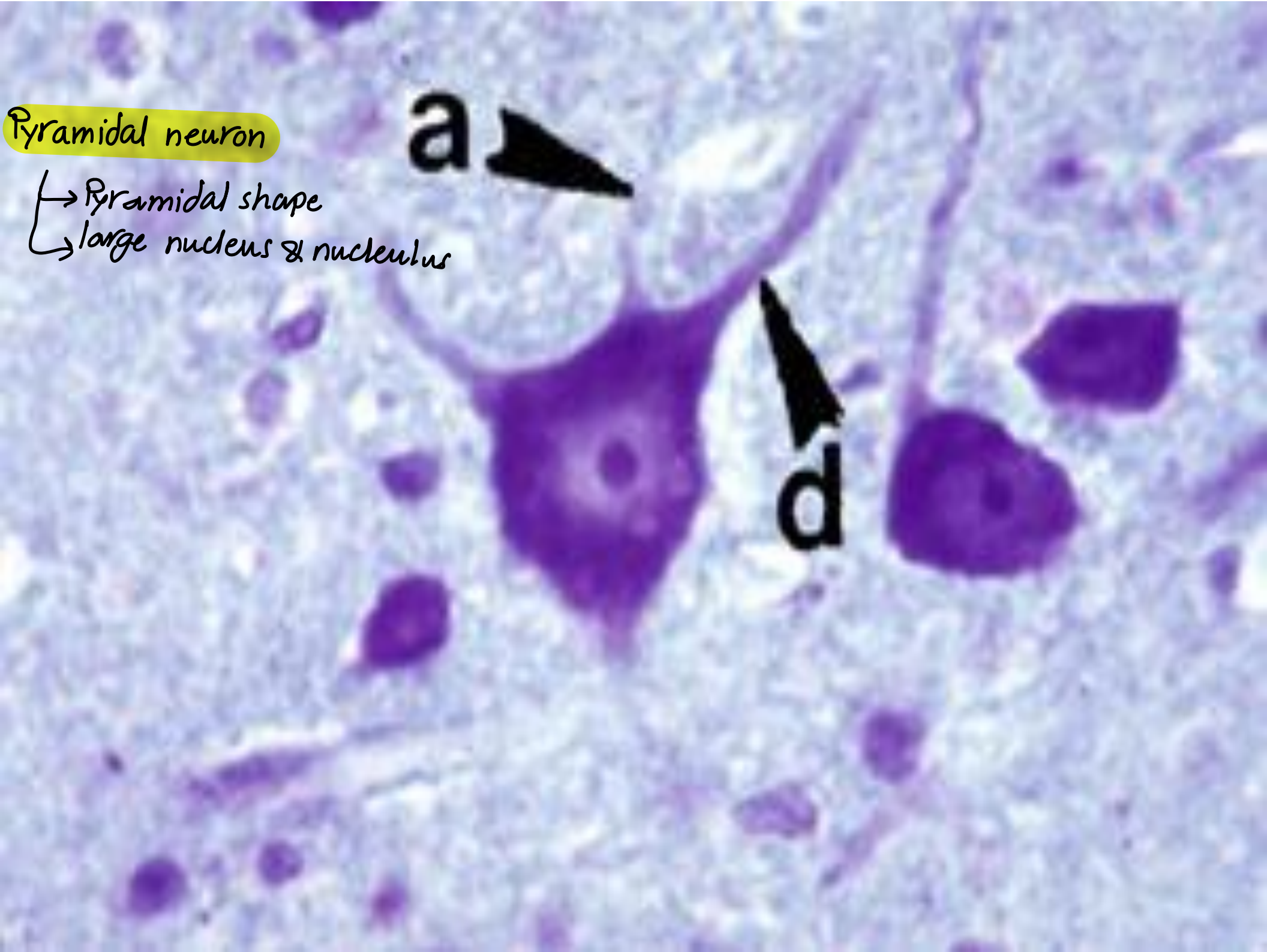
The layers of the cerebral cortex

↓
6 layers



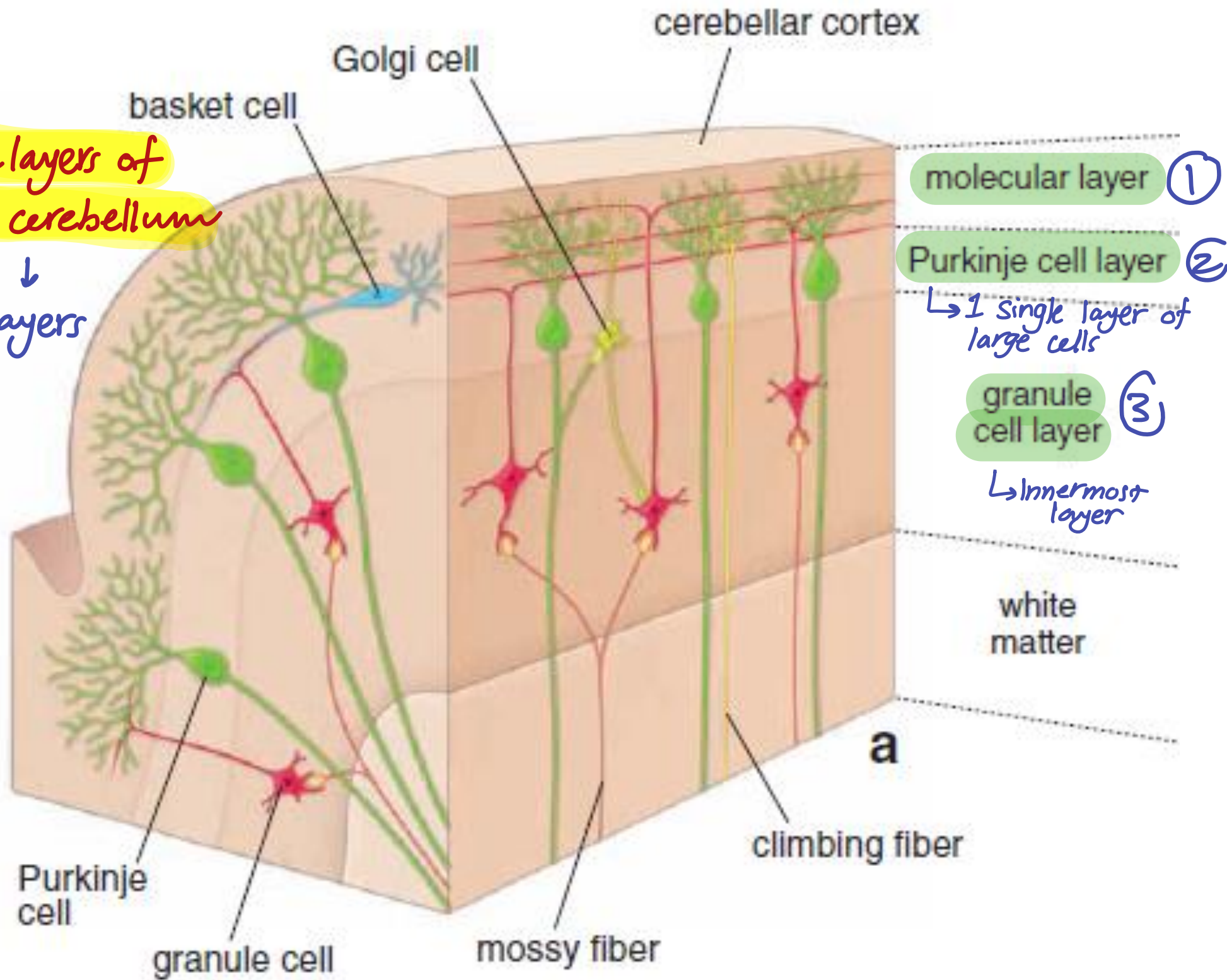
Pyramidal neuron

- Pyramidal shape
- large nucleus & nucleolus



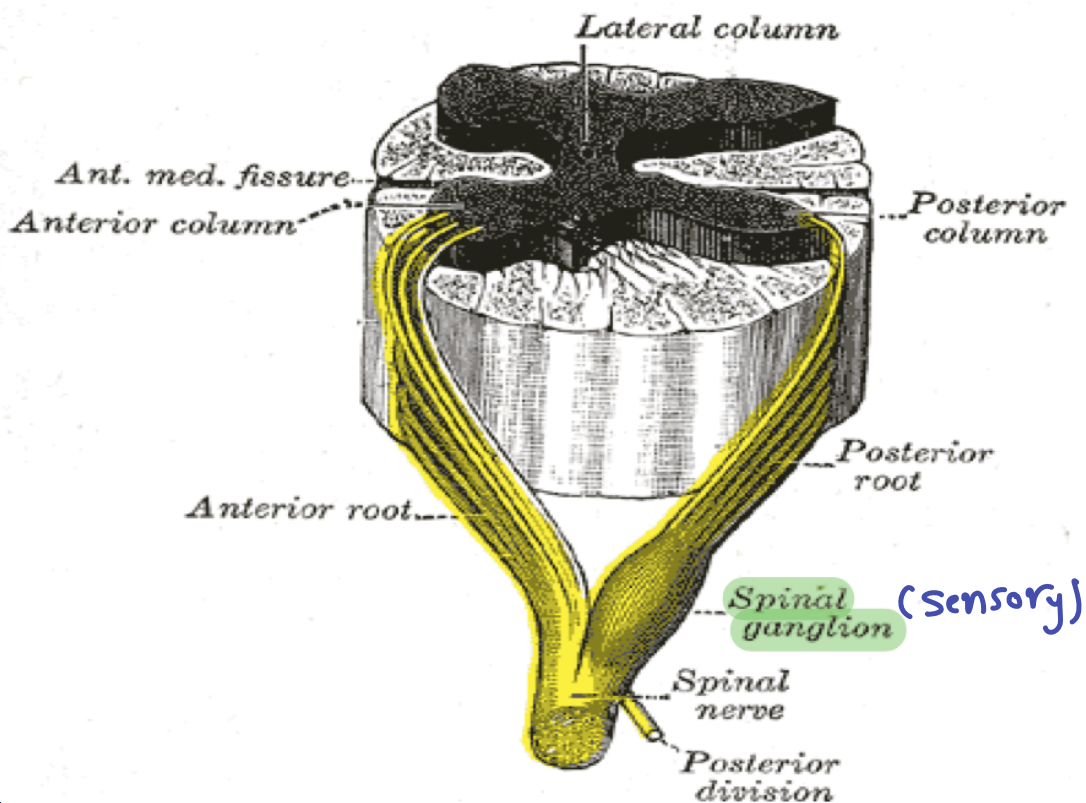
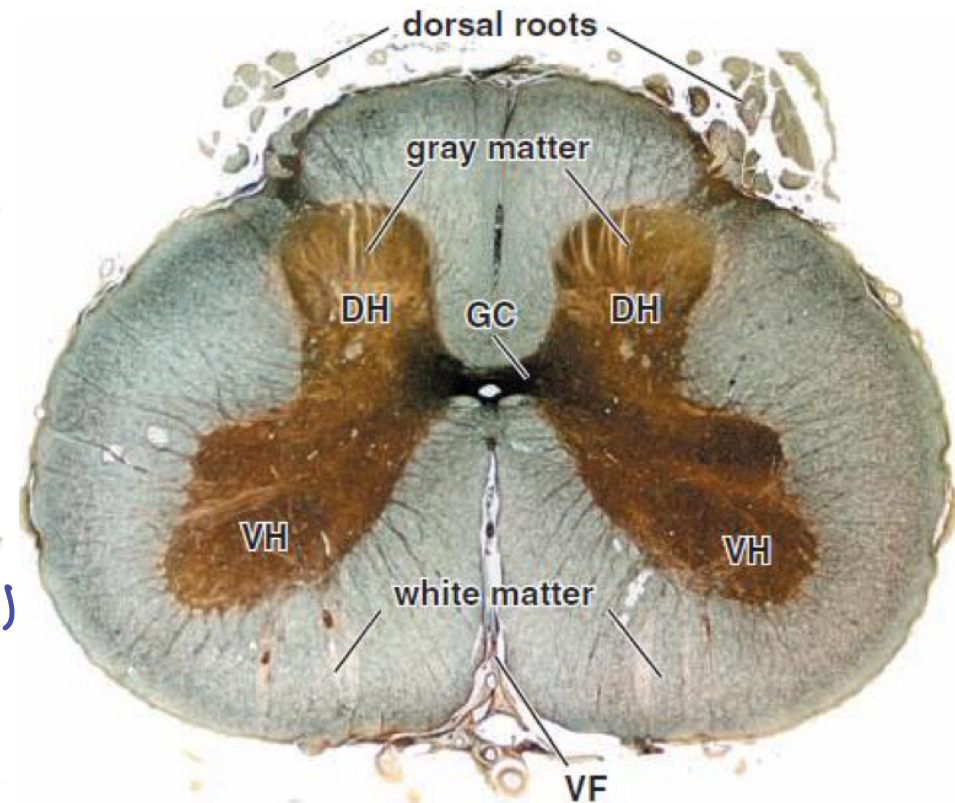
The layers of the cerebellum

↓
3 layers



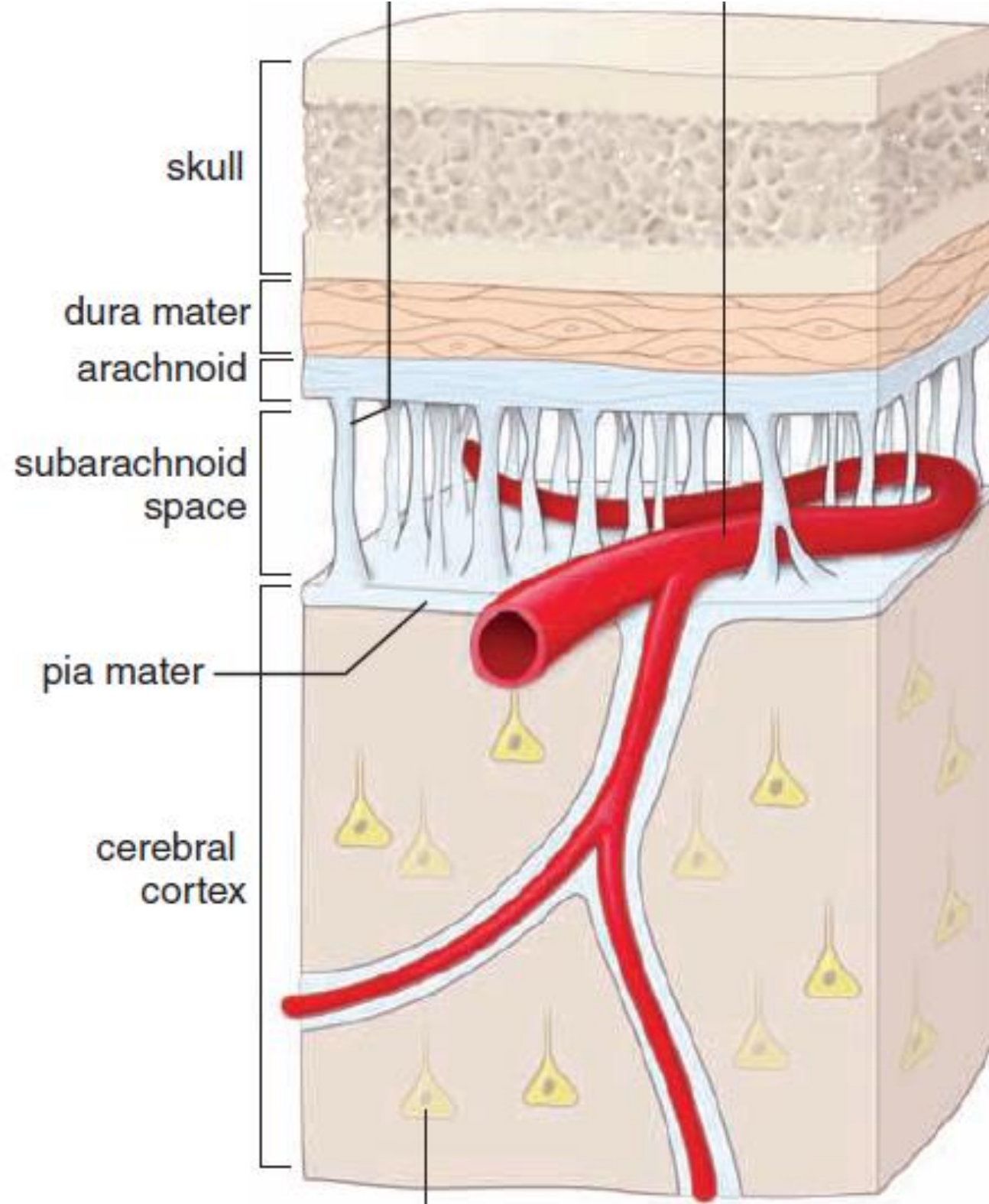
The spinal cord

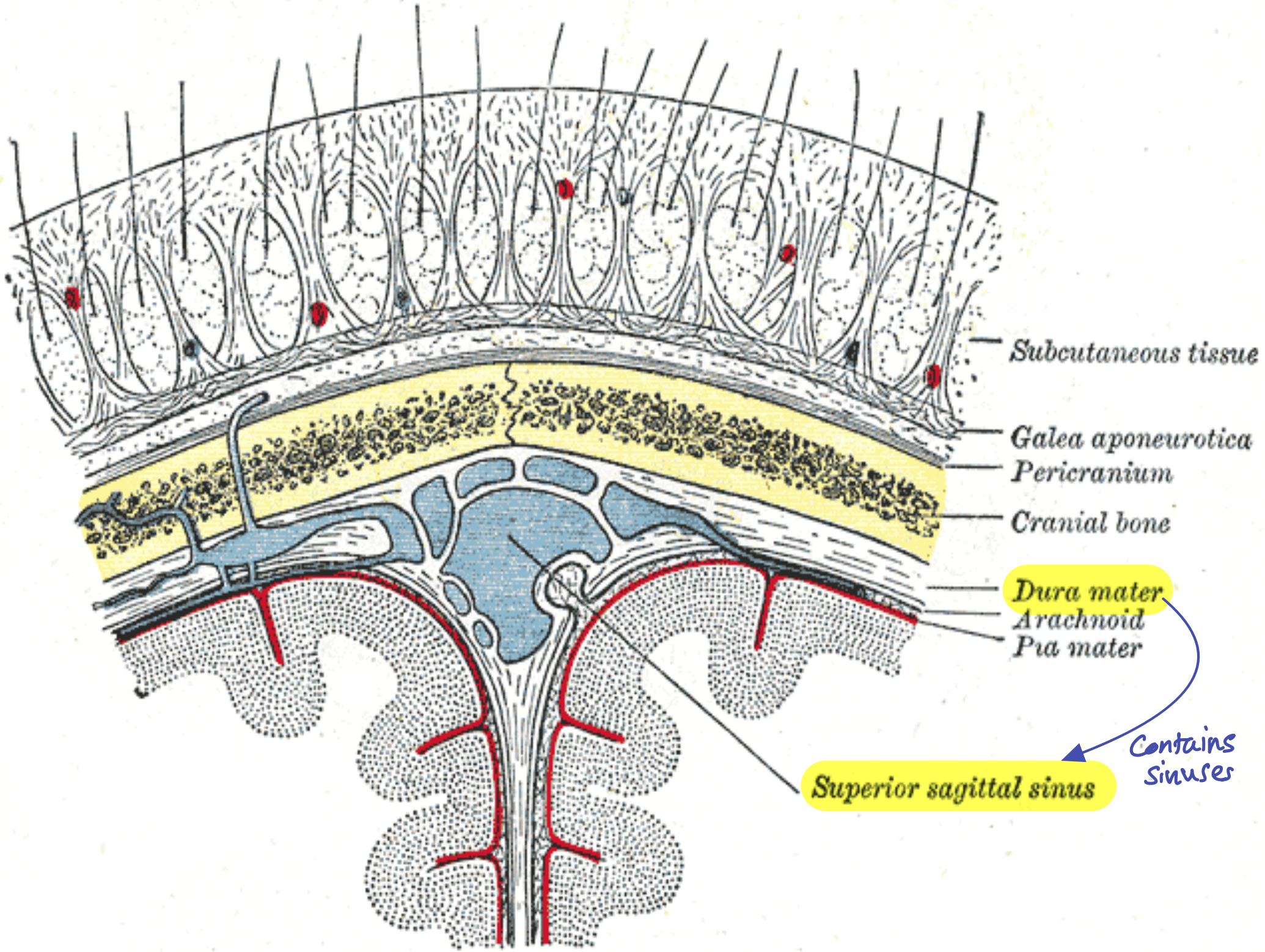
- Overview
- Ventral motor neurons
- Dorsal root ganglia/sensory neurons



Meninges

- Dura matter هي الأبعد
 - Dense connective tissue
 - Continuous with the periosteum
 - Sinuses → Venous sinuses
- Arachnoid
 - Arachnoid trabeculae of loose CT → Contains cavities
 - Subarachnoid space/CSF
- Pia matter
 - Loose CT
 - Continuous with the perivascular connective tissue
→ Contains
سكان ينطس مع BVs لجوار brain





Subcutaneous tissue

Galea aponeurotica

Pericranium

Cranial bone

Dura mater

Arachnoid

Pia mater

Superior sagittal sinus

Contains
Sinuses