

VEIN BATCH 2027



Sub: Histology المادة:

Lecture: 5 المحاضرة:

By: Mohammad alomari إعداد:

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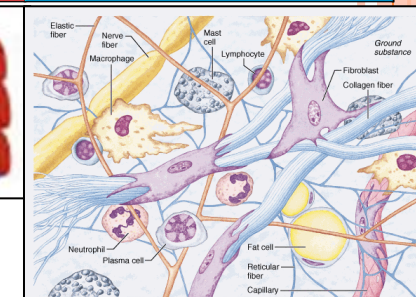
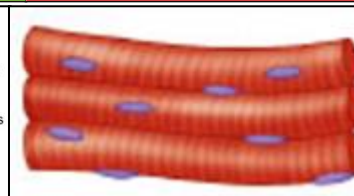
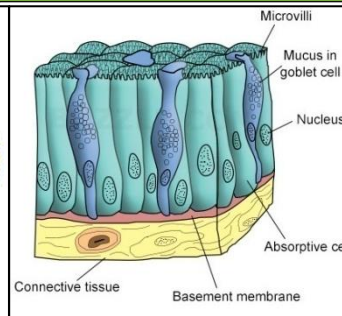
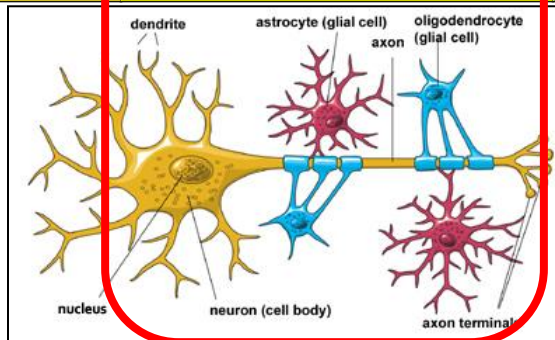
THE NERVOUS TISSUE

Dr. Mustafa Saad
(2022)
part 1

تفريغ : محمد العمري

Table 1: Types of tissues and their characteristics

<i>Tissue</i>	<i>Nervous</i>	<i>Epithelial</i>	<i>Muscular</i>	<i>Connective</i>
<i>Cells</i>	Have intertwining elongated processes طويلة ومتداخلة	Aggregated polyhedral cells	Elongated contractile cells الخلايا نفسها طويلة وقابلة للتقلص	Several types of fixed and wandering cells
<i>Amount of ECM</i>	Very small	Small	Moderate	Abundant
<i>Main Function</i>	Transmission of nerve impulse	Lining, Secretion	Movement	Support, protection

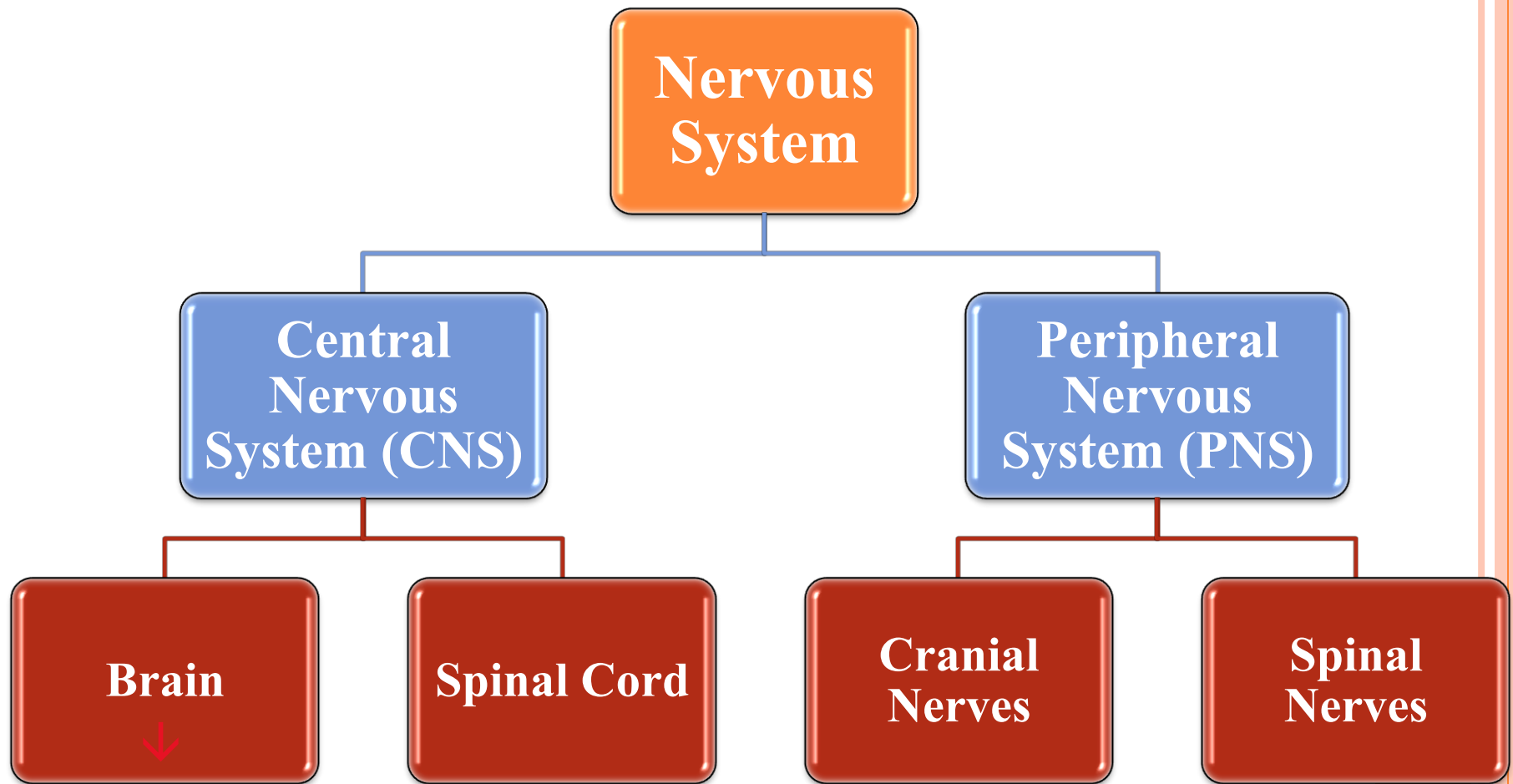


The Nervous System

- ❑ The nervous system is **the most complex system** in the body. It performs several functions that include:
 1. Reception and perception of sensory information.
 2. Controlling muscular action (**motor commands**) and glandular activity.
 3. Thinking, learning, memory, emotions, behavior and decision making. **الfunctions بنقطة 3 تسمى the higher functions**

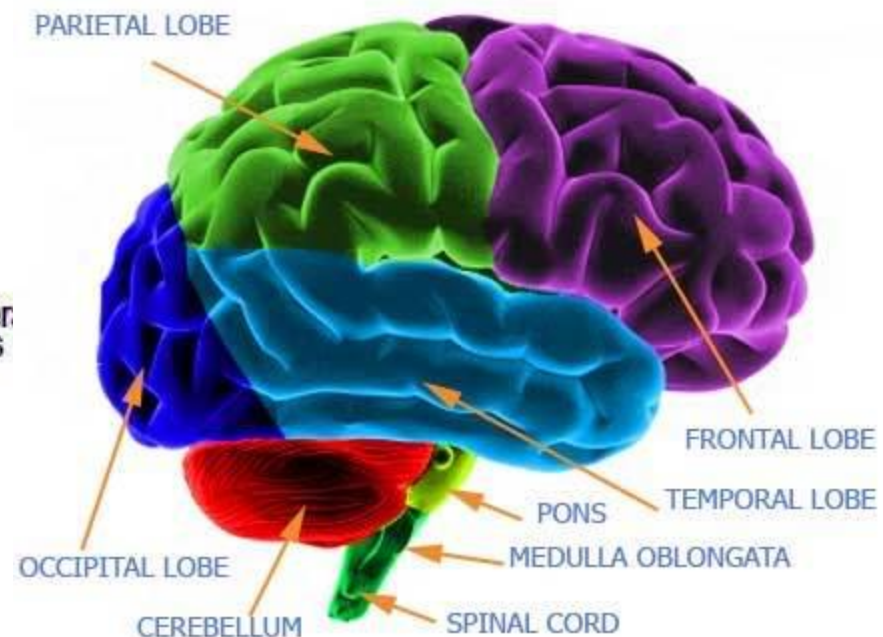
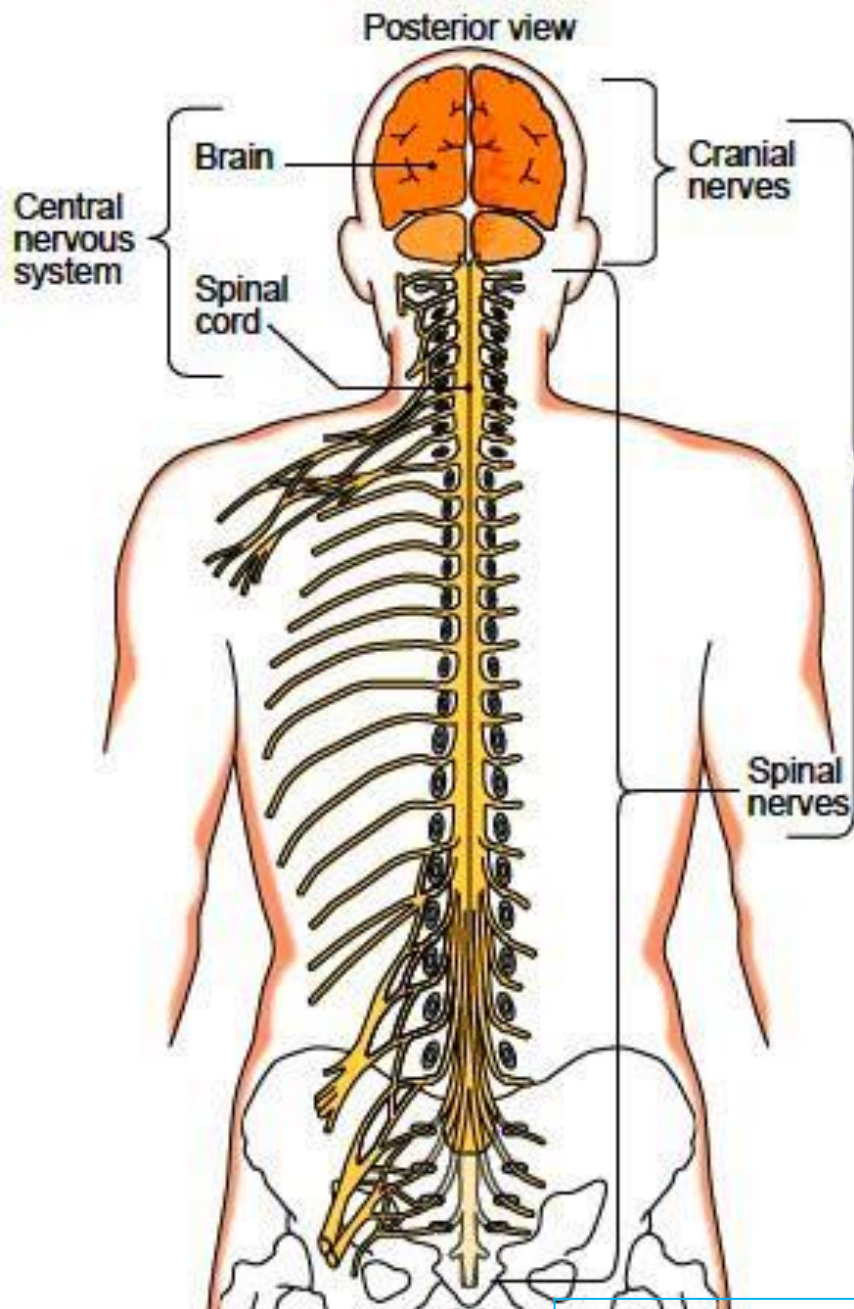
- ❑ **These functions** and others **are performed by** millions of specialized cells called **Neurons** which are **supported by** other types of cells called **Glia cells**.

Divisions of the Nervous System



يتكون من cerebrum ,cerebrum
brainstem ,cerebellum

In addition to the
Dorsal Root Ganglion



سبحان الله, والحمد لله, ولا إله إلا الله, والله أكبر

THE NEURON

- Neurons are **the structural** and **functional** units of the nervous system.
- They are *Excitable cells*, which means that **they can generate and conduct electrical impulses**.
- They're connected with other neurons and with other structures in the body like muscles and glands.

Neurons are the main cells (the functional cells), so the function of the NS is performed by them, and the glia cells are only supporting not functioning

- Neurons are formed of a cell body (somata, soma, perikaryon) and cell processes.

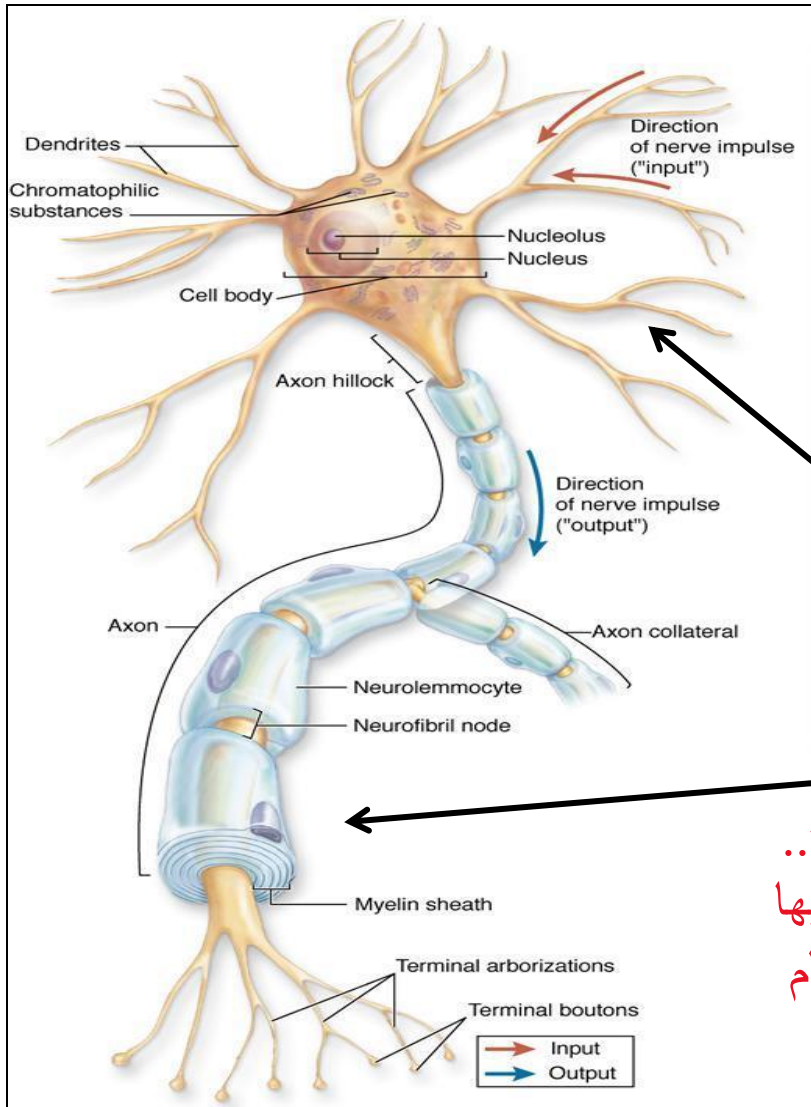
أسماء مختلفة بس كلها

تعبّر عن ال body

6

Somata (also soma) = body. Perikaryon = peri = around + karyon = nucleus.

Features of the Neurons



1. **Cell Body:** It contains the **nucleus** and **cytoplasm** (with its contents) and covered by plasma membrane.

2. **Processes:** which include the **dendrites** and the **axon**.

*ال neurons يطلق عليها مصطلح ال typical cells .. لأنها بتحتوي على كل ال organelles اللي ممكن نلاقها بخلية حيوانية , لأنه ال organelles هاي مطلوبة للقيام بال functions of the neurons

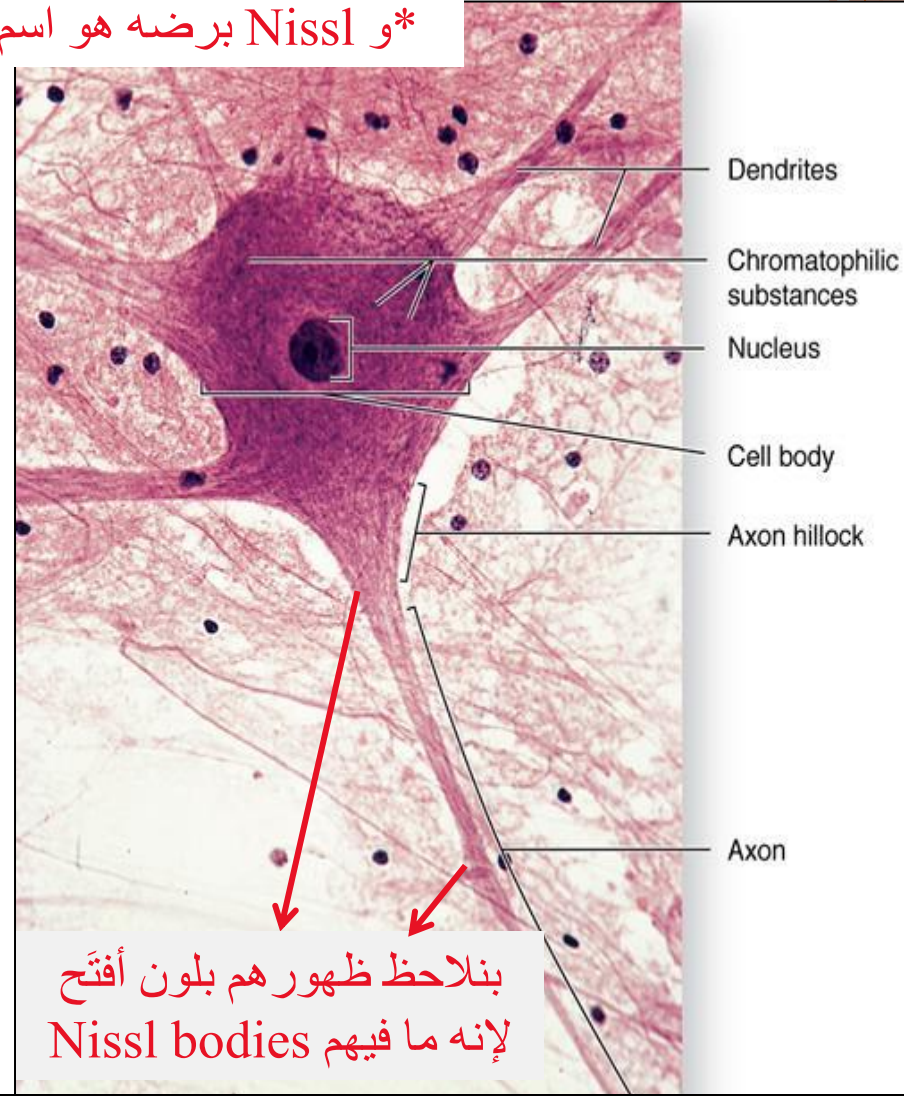
وحسب ما قلنا سابقا.. فهاي الصفة (اللي تحتها خط) من صفات الخلايا اللي بتصنع بروتين, وهاض معناه انه ال neurons برضه بتعمل synthesis لأحد البروتينات وهي ال neurotransmitters

The cell body:

- 1) **Nucleus:** Round and centrally located. It's [↑] pale staining with a prominent nucleolus. Barr bodies (condensed inactive X-Chromosomes) are present in females. للتذكير.. موضوع ال inactive X حكيما عنه بنهاية ال CT, واللي بصير بال females انه عنّا two X's بحملوا نفس الصفات, فالجسم بلغي تفعيل واحد منهم لأنه ما في داعي لوجوده (و Barr هو اسم العالم المُكتَشِف)
 - 2) **Cytoplasm:** contains (contains the organelles)
 - Δ Golgi complex: found around the nucleus.
 - Δ Mitochondria: found in cell body, dendrites and axon. (Found everywhere in the neuron)
 - Δ Lysosomes.
 - Δ Centrioles: these play a role in cell division only in the immature neurons. وبما انها فقط موجودة بال immature فهاض معناه لو يصير مشكلة او ضرر لل mature neurons ما رح تتجدد أو تتبدل
- Mature neurons do not divide.***

Δ ***Nissl Bodies***: these are aggregates of RER with free ribosomes. And that's why **These bodies are basophilic. It's a characteristic feature of neurons.** They are present in the **cytoplasm** of cell body and proximal part of the dendrites, **but not in the axon hillock or axon.** When there's neuronal damage, these bodies move towards the periphery of the soma giving the impression that they have disappeared – this is called ***Chromatolysis***.

* و Nissl برضه هو اسم العالم



بما انه ال Nissl bodies بتحتوي على RER هاض معناه انها هي برضه بتصنع بروتين, بس بما انها موجودة بال body ف هاض معناه انه لو صار عندي ضرر بال body رح يتوقف انتاج البروتينات وبالتالي رح تموت الخلية, بس لو اللي تضرر كان axon ف رح يتم إصلاحه عادي.. وعشان هيك الضرر عال peripheral nerves يمكن معالجته, لأنها عبارة عن axons

Fig.2: Nissl bodies take up basic dyes rendering the cell body basophilic.

بكمال هون عشان ما ضل وسع.. هسا لما يصير ضرر بالaxon الNissl bodies رح تترك الcell body وتتحرك باتجاه مكان الضرر عشان تعالجه ووصول البروتينات اله يكون اسرع, وبهاي الحالة لما نيجي نشوف الneuron رح نشوف إنه الصبغة اللي بالbody اختفت بسبب إنه الNissl bodies طلعت منه, هاي الحالة اسمها Chromatolysis وهي مؤشر (indicator) من خلالها بعرف إنه الneuron فيه ضرر

- △ *The Cytoskeleton*: similar to other cells. However, neurons contain a **specific type of intermediate filaments called *Neurofilaments***. These are present in the body and processes. When stained with **silver**, these filaments become cross-linked to form thicker neurofibrils that are visible under the light microscope.
- الcytoskeleton مشابه للموجود بجميع الخلايا, بس اللي بميزه هون إنه بحتوي على neurofilaments واللي عشان أشوفها بضيف الsilver, اللي رح يخلي الfilaments تتحد مع بعض وتعمل neurofibrils بنقدر نشوفها بالLM.. والsilver هون بتحد مع كل أجزاء الneuron لأنه الfilaments موجودة بكل أجزاءه
3. **Inclusion bodies**: these include

△ Lipofuscin granules: which result from the action of lysosomes.

△ Glycogen and lipid granules. → The source of nutrients for neurons

كل المناطق الظاهرة بلون غامق أو أسود عبارة عن neurons مصبوغة بالsilver

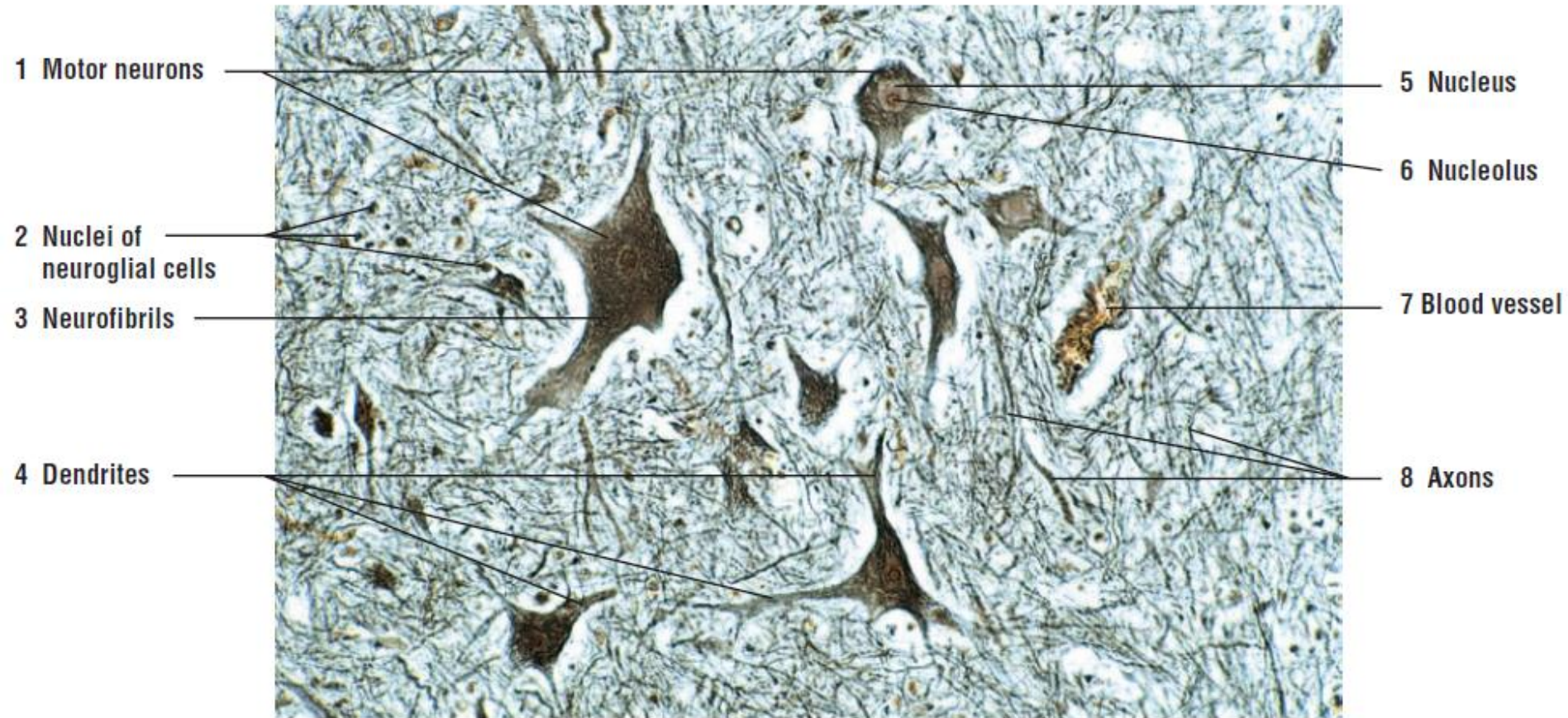
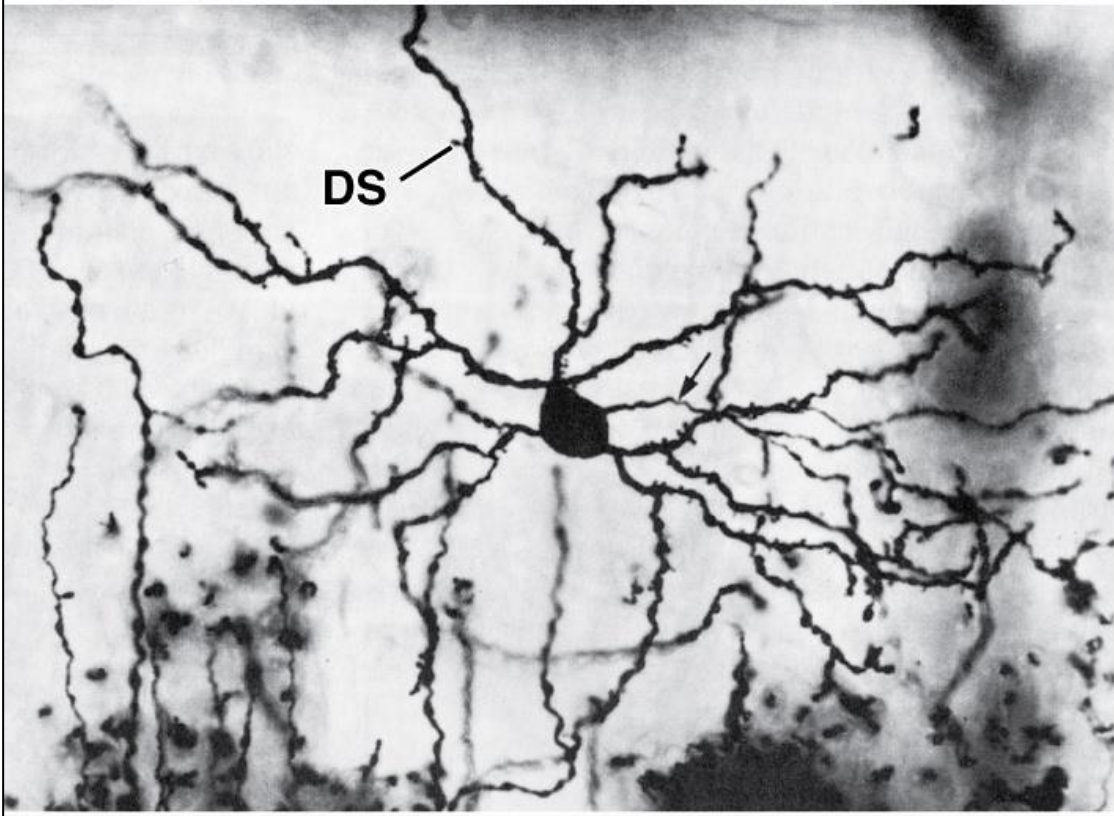


Fig.3: By using silver impregnation, the neurofilaments will be cross-linked to form neurofibrils visible by light microscope. Note how the cell body and processes are stained black by this method.

و dendrites من كلمة dendro الإغريقية وتعني شجرة، لأنها تتفرع على شكل شجرة

Cell processes – Dendrites:

- ❖ These are usually short, profusely branching processes of the neurons. (numerous branching)
- ❖ Their diameter decrease as they extend away from cell body. (They are thin, and become thinner as they extend away)
- ❖ They possess small projections called **Dendritic Spines** that form synapses.
- ❖ Their cytoplasm is similar to that of the cell body. (الفرق بس إنه ال cytoplasm بال cell body يحتوي على Golgi وهون مش موجود)
- ❖ Their function is to conduct impulses towards cell body. (وظيفته يحمل ال actin potential لل cell body)

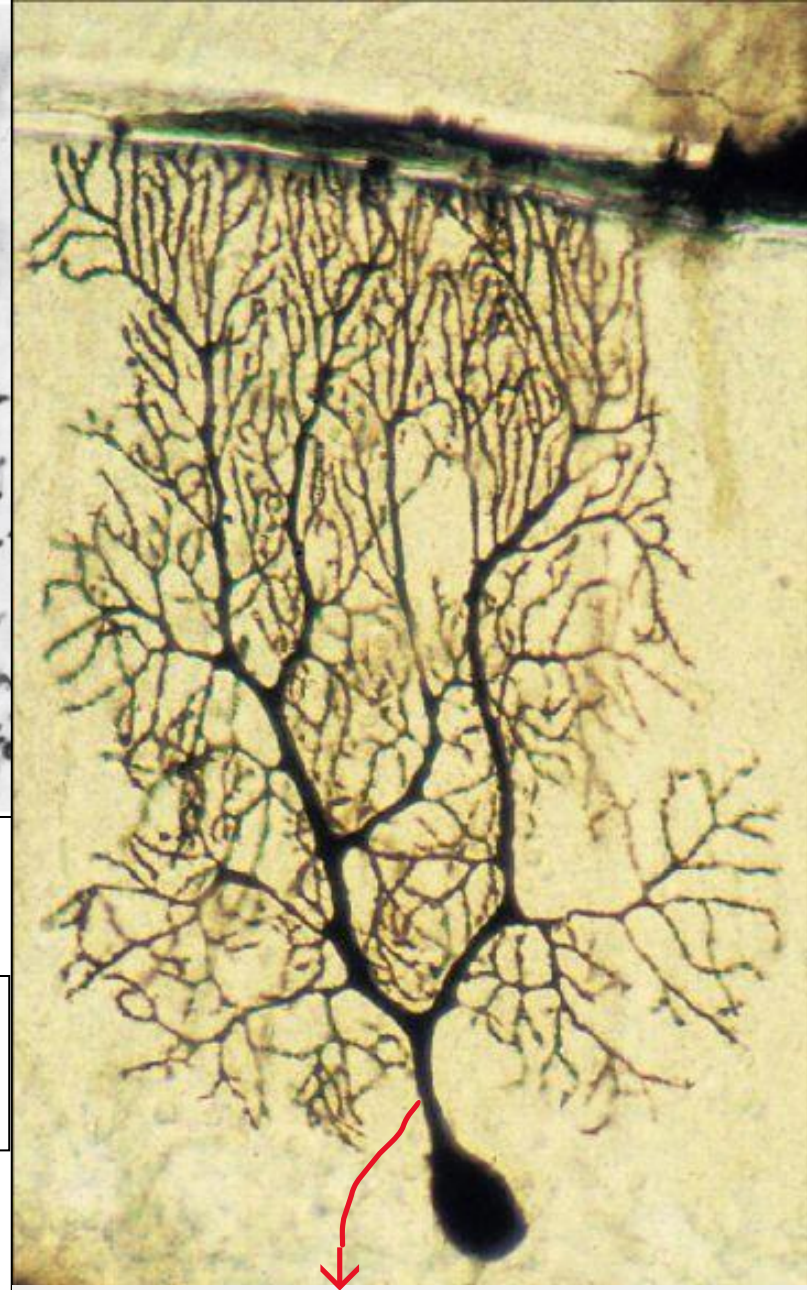


بالصورة هون بنشوف ال dendrites وبنلاحظ بعض الأشياء الصغيرة جدا البارزة منها, اللي بتمثل ال dendritic spines

Fig.4: To the right, the profusely branching dendrites of a Purkinje cell is evident. Above, dendritic spines (DS) are seen. In both these preparations, silver impregnation was used.

*ال Purkinje cells ما الها علاقة بال Purkinje fibers, القصة بس إنه اكتشفهم نفس العالم

*ال Purkinje cells موجودة بال Cerebellum وهي أول خلايا عصبية تمت دراستها نظرا لحجمها وسهولة الحصول عليها





ال dendrites بلشت من هون, وكل ما بعدنا عن ال body بتتفرع أكثر وبتصير أصغر

Cell processes – Axon:

- A single branch that arises from a conical projection of the cell body called the ***Axon Hillock***. The axon is usually longer than the dendrites and is **therefore called *nerve fiber***.
*مثال على طول الaxon.. ف في axon بال lumbar region of the spinal cord بتوصل لل little toe, يعني Axon واحد طوله أكثر من متر !
- They are tubular with a **fixed diameter**.
- Their plasma membrane is called ***Axolemma***. Their cytoplasm is called ***Axoplasm***. The axoplasm is devoid of Nissl bodies and Golgi complex.
خالية من
- The ***Initial Segment*** is the first part of the axon close to the hillock at which the action potential is generated.

➤ The axon doesn't give branches near the cell body. It may give ***collateral branches*** along its course.

➤ Shortly before their termination, axons commonly branch profusely. The distal ends of these ***terminal branches*** are often enlarged and are called axon terminal bulbs.  وهي مكان لتكوين الsynapsis برضه

➤ Some axons (especially those of autonomic nerves) near their termination show a series of swellings resembling a string of beads; these swellings are called ***varicosities***.  وهاض بنشوفه أكثر اشي بالautonomic nervous system

➤ Axons conduct impulses away from cell body.

Table 1: Differentiation between dendrites and axons.

	Dendrites	Axon
1	Mostly multiple branches	A single branch
2	Usually short	Usually the longest branch
3	Taper as they extend away from cell body	Has a fixed diameter
4	Branch profusely	<ul style="list-style-type: none"> No branches near cell body Collateral branches along course Terminal branches
5	Cytoplasm similar to the that in cell body	Axoplasm lacks Nissl bodies and Golgi complex
6	Not covered by a myelin sheath	Some are covered by a myelin sheath
7	Conduct impulse towards cell body	Conducts impulse away from cell body

Classification of Neurons

According to Number of Branches

- Multipolar.
- Bipolar.
- Pseudounipolar.

According to Termination of Axon

- Projection neurons.
- Local circuit (interneurons).

According to Function

- Motor.
- Sensory.

And others...*Like shape*

According to Number of Branches: (it's the most important classification)

1) **Multipolar neurons:** have 1 axon and at least 2 dendrites. **Most common type of neuron.** Example: anterior horn cells of the spinal cord.

الspinal cord يحتوي على جزي يسمى الgray matter وهو جزئين anterior و posterior والanterior part هو المسؤول عن حركة العضلات

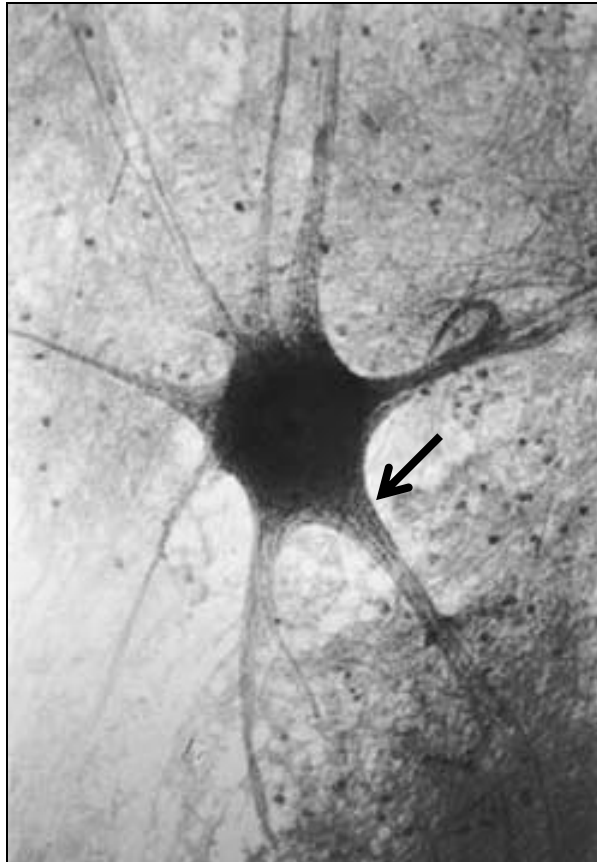
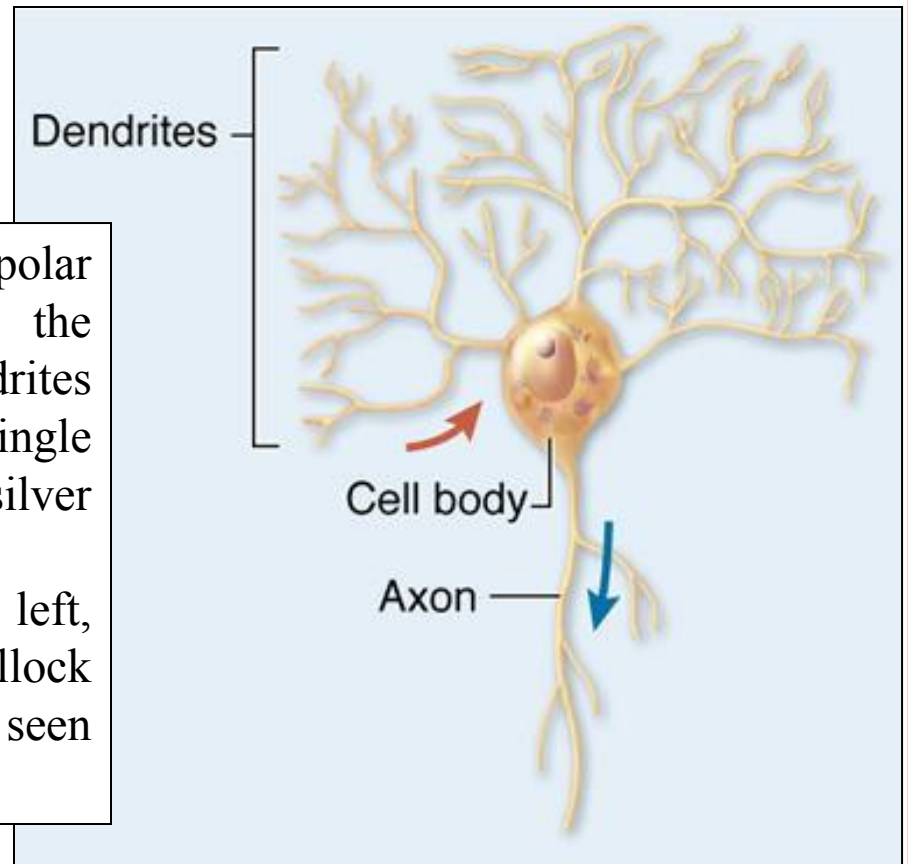
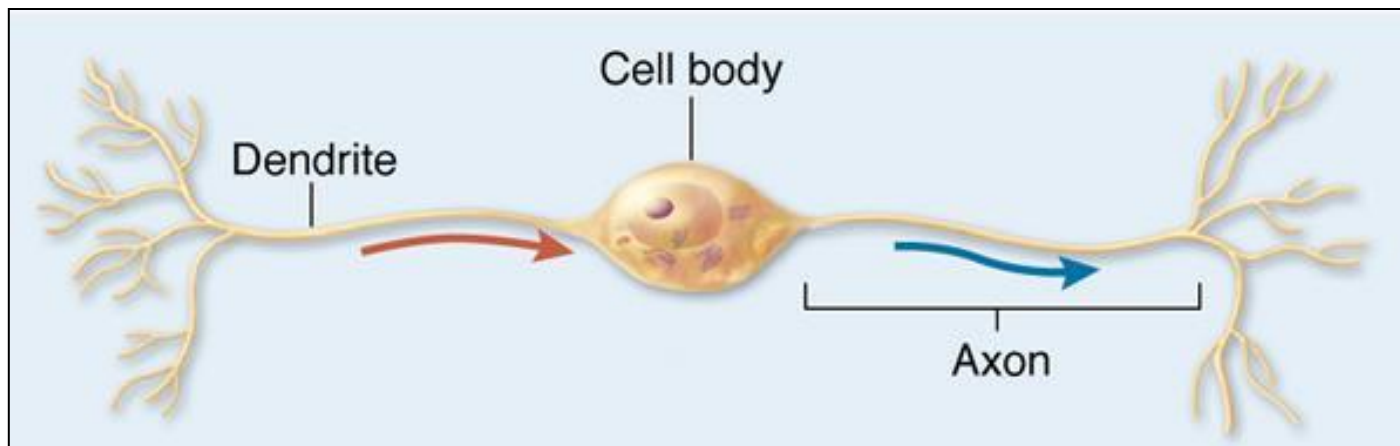


Fig.5: Multipolar neuron. Note the several dendrites and the single axon. In the silver impregnation image on the left, the axon hillock can be seen (arrow).



2) **Bipolar neurons**: has an elongated body from one end of which arises **a single axon** and from the other end arises **a single dendrite**. Example: Cells of the sensory ganglia of the Vestibulocochlear nerve, Bipolar cells of the Retina and the Olfactory neurons.

Many bipolar cells are specialized sensory neurons for the transmission of sense.
(مخصصة للحواس)



الخلايا المسؤولة عن حاسة الشم تسمى
the olfactory cells

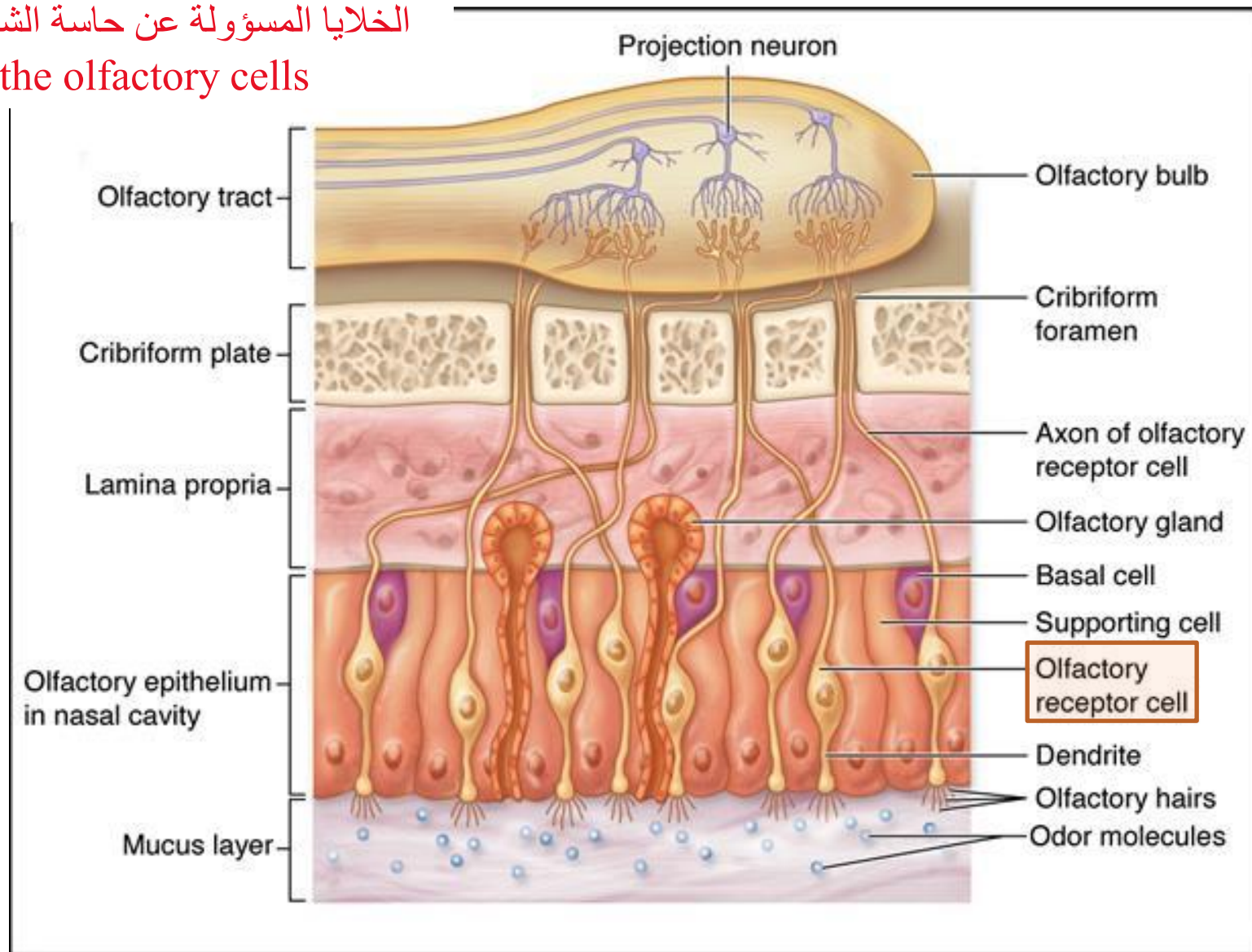


Fig.6: The Olfactory epithelium. The olfactory receptor cells are bipolar neurons.

3) **Pseudounipolar neurons**: A single process arises from the cell body that soon divides into a central branch and a peripheral branch. They are located in the PNS, Example: neurons in the sensory ganglia of some cranial nerves and neurons in the dorsal root ganglia of the spinal nerves.

مسؤولة عن الإحساس في

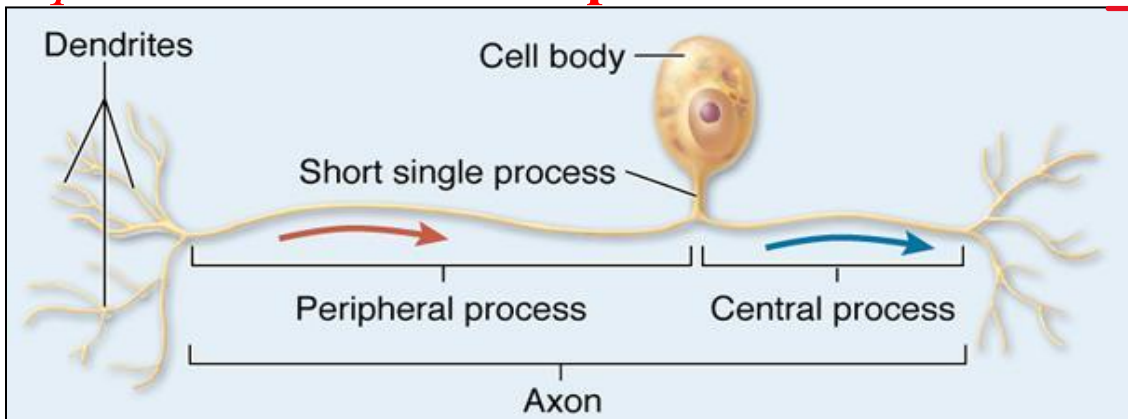
ال head and neck region

عبارة عن branch وحيد بطلع من ال cell body وينقسم ل two branches.. واحد بروح لل Central NS والثاني لل Peripheral NS.

The peripheral will end up in sensory receptors all around the body, and central process will end up in sensory areas in the CNS..

وهاض معناه إنه ال pseudounipolar إليه دور بال sensation, وبشكل أدق بال somatic sensation الموجود بال skin مثلا, ويشمل ال touch, pressure, cold, warmth, and pain

❖ **The only place in the CNS in which pseudounipolar neurons are present is the mesencephalic nucleus of the trigeminal nerve.**



المسؤول عن الإحساس في الوجه

*في ال CNS الجزء الخارجي من ال brain والمسمى بال cortex يكون عبارة عن cell bodies of neurons والجزء الداخلي (ال white matter) يكون عبارة عن ال processes اللي طالعة من ال body, بس برضه بداخل ال white matter عندي منطقة يكون فيها تجمع من ال cell bodies of neurons بسميها ال nucleus (موقعها موضح بالصورة بسلايد 41) →

According to Termination of axon:

- 1) **Projecting Neurons:** Here the Axon extends beyond the area where the cell body is located. Example: anterior horn cells. ال cell body تاها موجود بال spinal cord بينما ال axon بنتهي في إحدى ال muscles بعيدا عن ال body
- 2) **Local Circuit Neurons (Interneurons):** The Axon terminates in the same area as the cell body. Because all the branches are short, the cell usually have a stellate appearance. Example: some of the smaller cells of the cerebral and cerebellar cortex.

According to Function:

1. **Motor neurons:** Carry impulses from the CNS to the body. Example: anterior horn cells and the autonomic neurons.

مسؤولة عن إعطاء الأوامر لل skeletal muscles للإنقباض
بتعطي أوامر (commands) لل smooth muscles للإنقباض, أو لل glands عشان تفرز

2. **Sensory neurons:** Carry sensory information from the body to the CNS. Example: Neurons of the dorsal root ganglia.

According to Size:

- The cell bodies are variable in size. They could be large, like the Pyramidal cells of the cerebral cortex, Purkinje cells of the cerebellar cortex, and the anterior horn cells of the spinal cord; or they could be small, like the Granular cells of the cerebellar cortex.

According to Shape:

❑ Neurons have various shapes. They could be:

(Star like)

1. **Stellate**: as the stellate cells of the cerebellum. These cells are oval with two or more processes radiating from the cell body in all directions giving the cell a star shape.

(pear like (إجاص))

2. **Pear shaped**: as the **Purkinje cell** of the cerebellum.

↪ involved in the movement of the muscles برضه

3. **Granular**: these are small, round and numerous like the granules of sand. Example: Granular cells of the cerebellum.

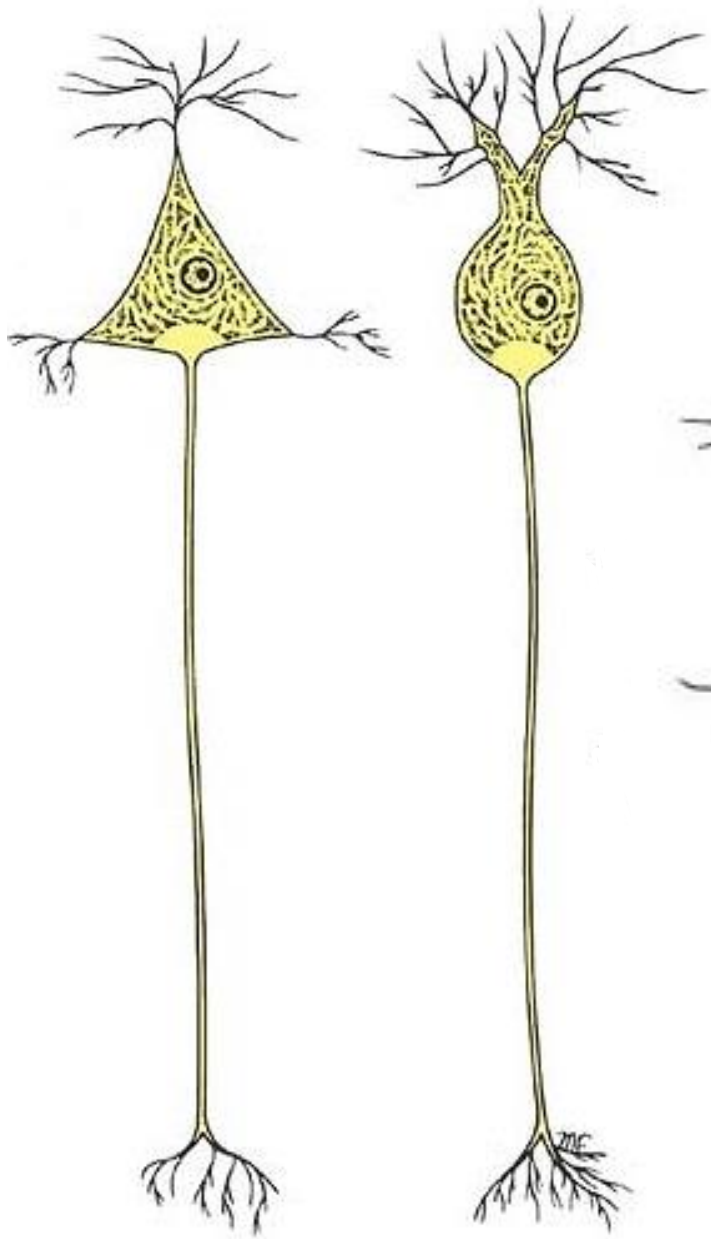
ال axon بطلع من القاعدة وال dendrites بالغالب من الزوايا

4. **Pyramidal**: these are triangular cells. Example: the **Pyramidal cells of the cerebral cortex**.



خلايا مهمة جدا لل movement of muscles فأول أمر بوصل للعضلة عشان تتحرك بكون منها

Fig.7: Various shapes of neurons.

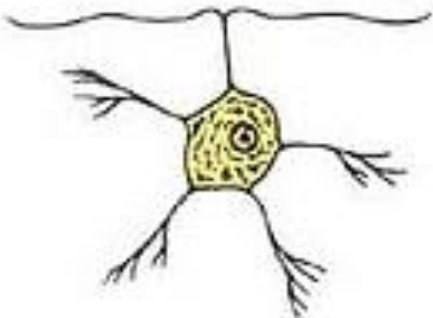


Pyramidal cell
(upper motor neuron)—
cerebral cortex

Purkinje cell—
cerebellar cortex



Stellate cell—
cerebellar cortex



Granule cell—
cerebellar cortex

Example of Neurons



Purkinje Cells	Feature	Pyramidal Cells
Cerebellar cortex	Location	Cerebral cortex
Large Pear shaped	Cell Body	Large Pyramidal
Multipolar	Type	Multipolar
Motor	Function	Motor
Projection	Termination of Axon	Projection





THE NERVOUS TISSUE

Dr. Mustafa Saad
(2022)
part 2

تفريغ : محمد العمري

GLIA CELLS

- Glia cells, also called Neuroglia, are a group of supporting non-excitabile cells that perform various functions in the nervous system.

Glia cells can't generate nerve impulse, and not involved in performing the functions of the nervous system, but they play a lot of supportive functions and support the neurons

(الglia cells ما بتقوم بأي من وظائف الNS هي بس بتوفر له الدعم)

- These cells are much smaller than neurons, but they outnumber them. So the glia cells comprise up to half the volume of the brain and spinal cord.

Types of Neuroglia

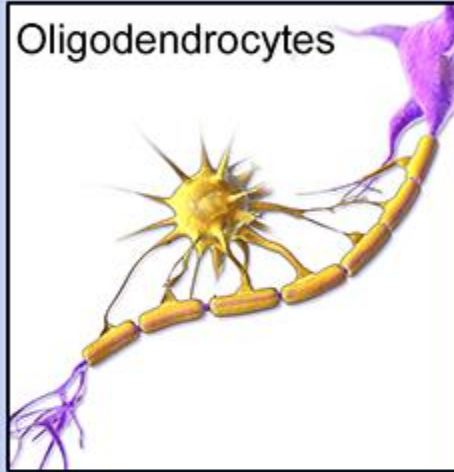
Central Nervous System

Peripheral Nervous System

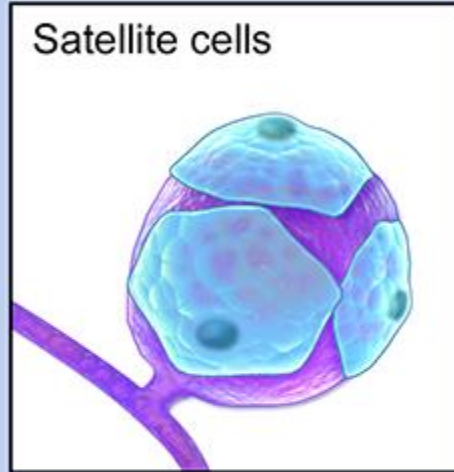
Ependymal cells



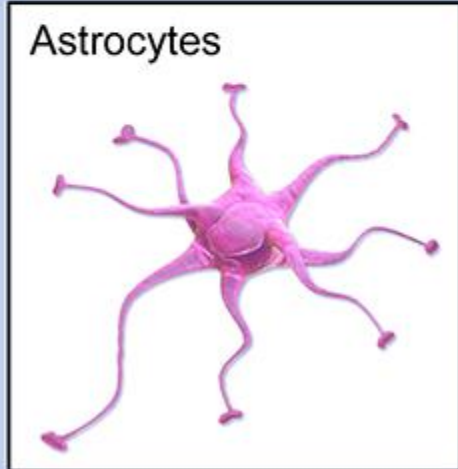
Oligodendrocytes



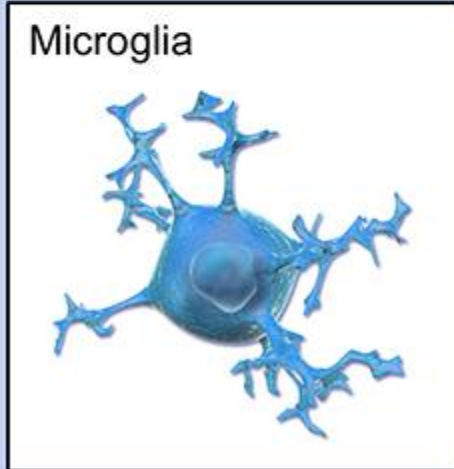
Satellite cells



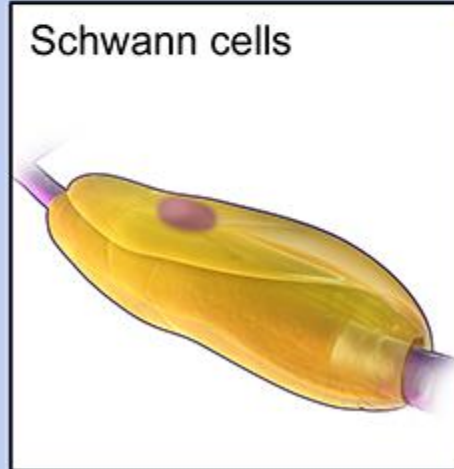
Astrocytes



Microglia



Schwann cells



Types of Glia Cells

1) Astrocytes: found in the CNS

- Fibrous Astrocytes: are found mainly in the white matter. They have long, slender processes with few branches.
- Protoplasmic Astrocytes: are found mainly in the gray matter. Their processes are short, thick and more branched.
- Astrocytes have a specific type of intermediate filaments that can be stained to identify these cells.

بما انه هاي ال filaments مخصصة لل astrocytes فهي تستخدم ك marker لتميزهم وإلها أهمية برضه بتشخيص الأمراض والأورام المتعلقة بهاض النوع من الخلايا.. يعني لو كان عندي ورم بالدماغ بقدر عن طريقها أحدد اذا ال astrocytes هي مصدره ولا خلايا ثانية

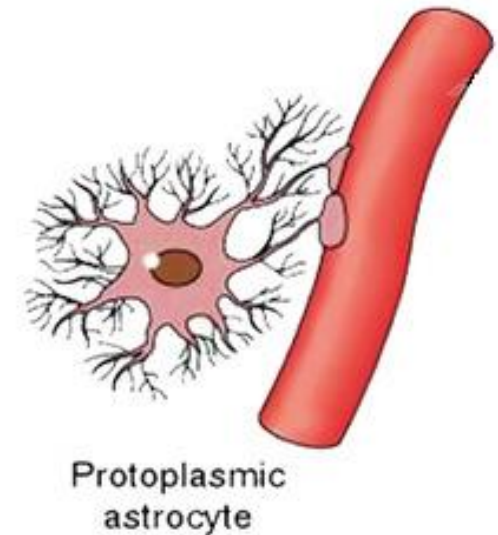
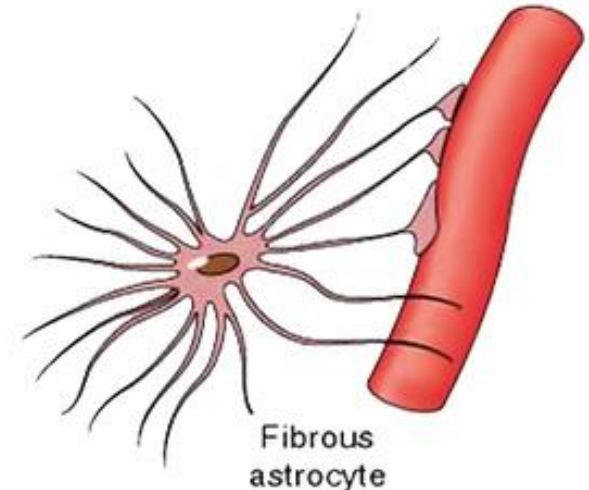


Fig.8: Astrocytes.

Functions of Astrocytes:

- بنهاية ال processes لما ترتبط بال blood capillaries بتصير expanded
- 1) Some processes of astrocytes end in an expansion around blood capillaries. **These are called *perivascular feet*** and they form part of the Blood-Brain Barrier.
 - 2) Form the External and Internal Glial Limiting Membrane. These membranes protect the nervous tissue. → ال processes الخارجة من ال astrocytes يكون الها expansions بتعمل على تغطية وتبطين ال brain من الداخل والخارج وظيفتها ال protection
 - 3) Provide nutrients for neurons. زي ما مرّ بالفسيو ال neurotransmitters بس يخلص شغلها عنا 3 طرق للتعامل معها
 - 4) Recycle neurotransmitters. → وإيقاف ال synapse, والمسؤول عنهم هي
 - 5) Replace damaged tissue by a scar. ال astrocytes

و زي ما ذكرنا برضه فال neurons ما عندها القدرة عالانقسام والتجدد, ف لما تتضرر أحد المناطق يتم استبدال ال neurons المتضررة ب CT يتم تكوينه عن طريق ال astrocytes

2) Oligodendrocytes:

found in the CNS

- They have small cell bodies with few processes.

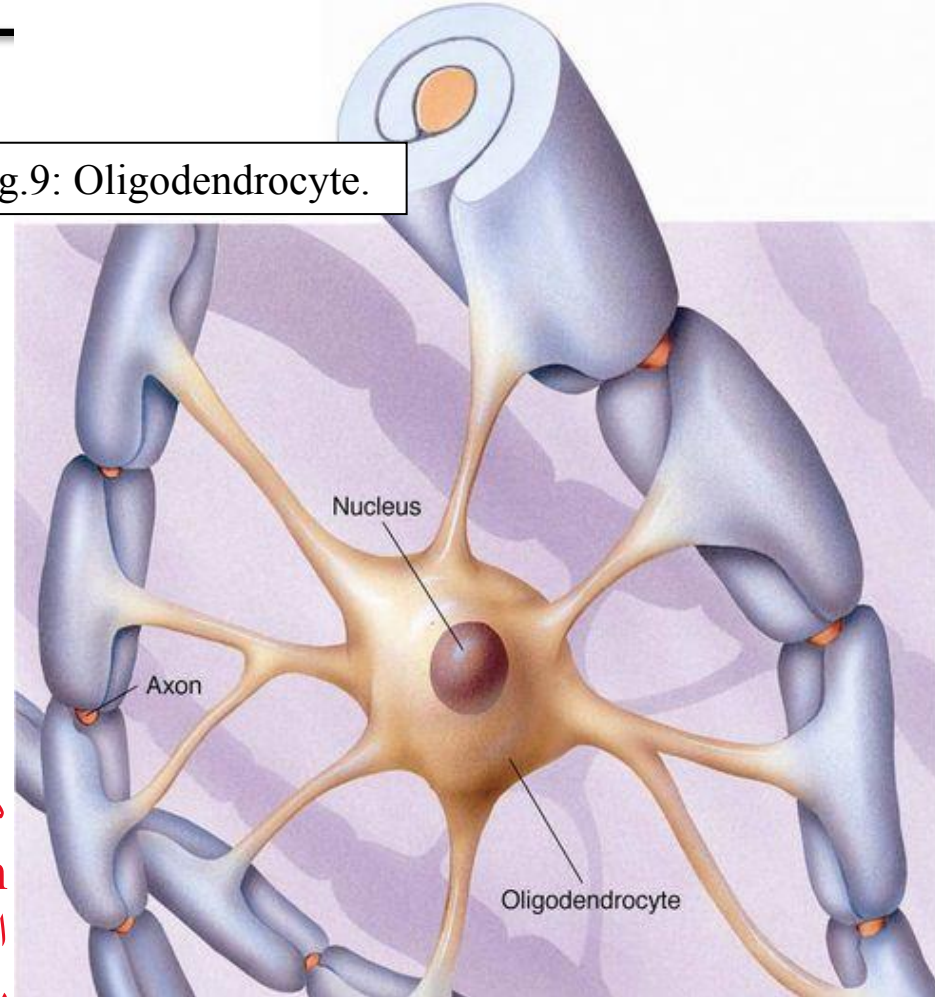
- They form the Myelin sheath around the myelinated axons in the CNS.

هي المسؤولة عن تكوين الmyelin sheath حول الaxons بالCNS، وبما انها متواجده حول الnerve fibers بالCNS فهاض معناها انها بنتواجد بكثرة فالwhite matter (موجودة بالgray بس أقل)

- A single process of an oligodendrocyte forms the myelin sheath around a part of a single axon. An oligodendrocyte forms the myelin sheath around parts of several axons.

الآن خلية الoligodendrocytes الواحدة بتكون مرتبطة بعدة axons عن طريق الprocesses اللي طالعة منها.. وكل process بكون myelin sheath حول قطعة واحدة فقط

Fig.9: Oligodendrocyte.



3) Microglia: in the CNS

- They have elongated cell bodies with several short, branched processes.
- They are the Phagocytic cells of the CNS. Found equally in both white and gray matter
- They are derived from Monocytes.

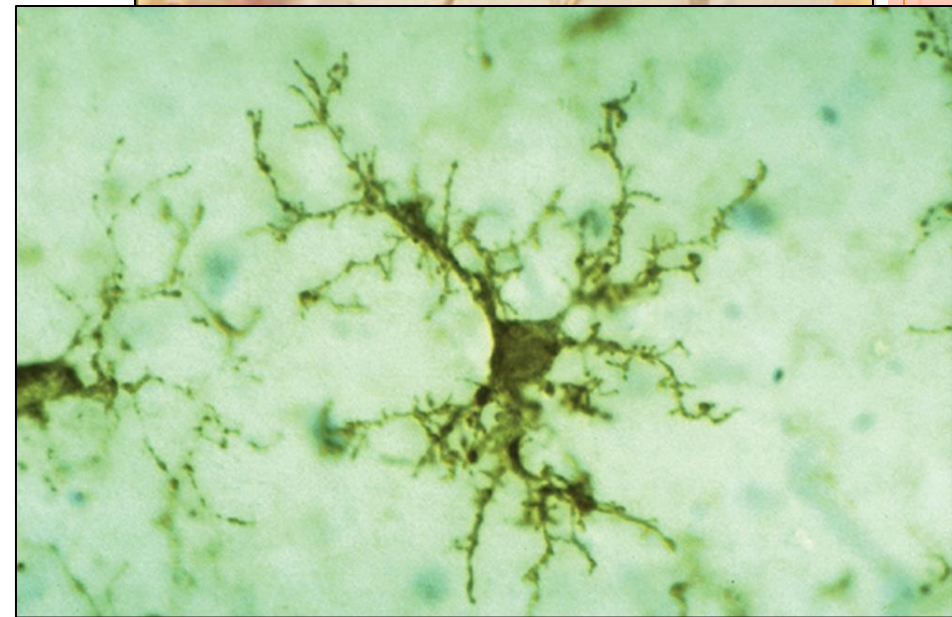
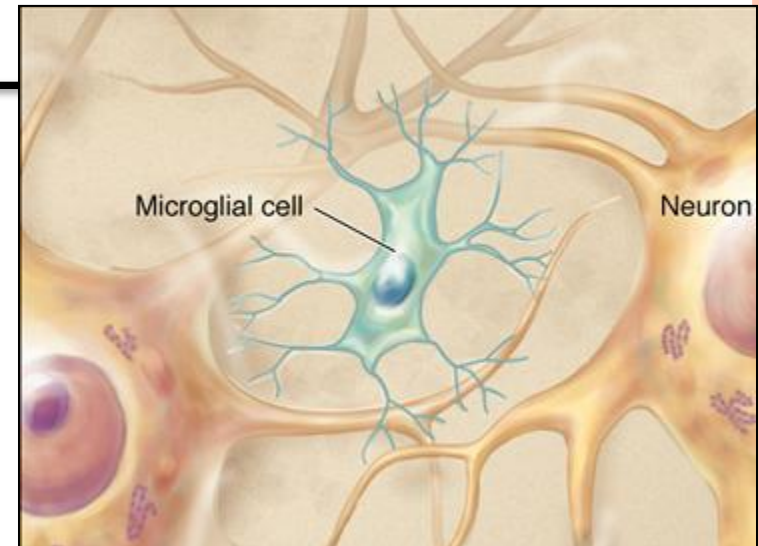


Fig.10: Microglia cells. Note the numerous branched processes. Immunohistological study.

* للتذكير.. قلنا سابقا إنه ال monocytes بتتحول ل phagocytic cells واسمها بختلف من tissue للثاني, بال CT كان اسمها macrophages وهون اسمها microglia, بس كلها الها نفس الخصائص

4) Ependymal Cells: in the CNS

بنقدر نعتبرها ال epithelial cells للNS
لتشابه صفاتها مع صفات ال epithelial T

- Cuboidal or low columnar cells that line the ventricles of the brain and the central canal of the spinal cord. They have cilia, microvilli, tight junctions and basal appendages.

ال brain يحتوي على تجاويف وقنوات بتكون
filled with Cerebrospinal fluid
و lined with ependymal cells

- There are several types of ependymal cells. They're all related to cerebrospinal fluid production and circulation. جميع أنواع ال ependymal cells الها نفس الوظيفة, وهي تكوين ال fluid أو بتدخل بال circulation اله بين ال cavities وال NT

وال fluid بتواجد داخل ال ventricles, داخل ال central canal of spinal cord, وداخل ال suberecinoid space (حول ال brain وال spinal cord) ويكون في حركة دائمة داخل هاي المناطق وبينها برضه, بحيث يكون في حركة دائمة بين الاجزاء هاي

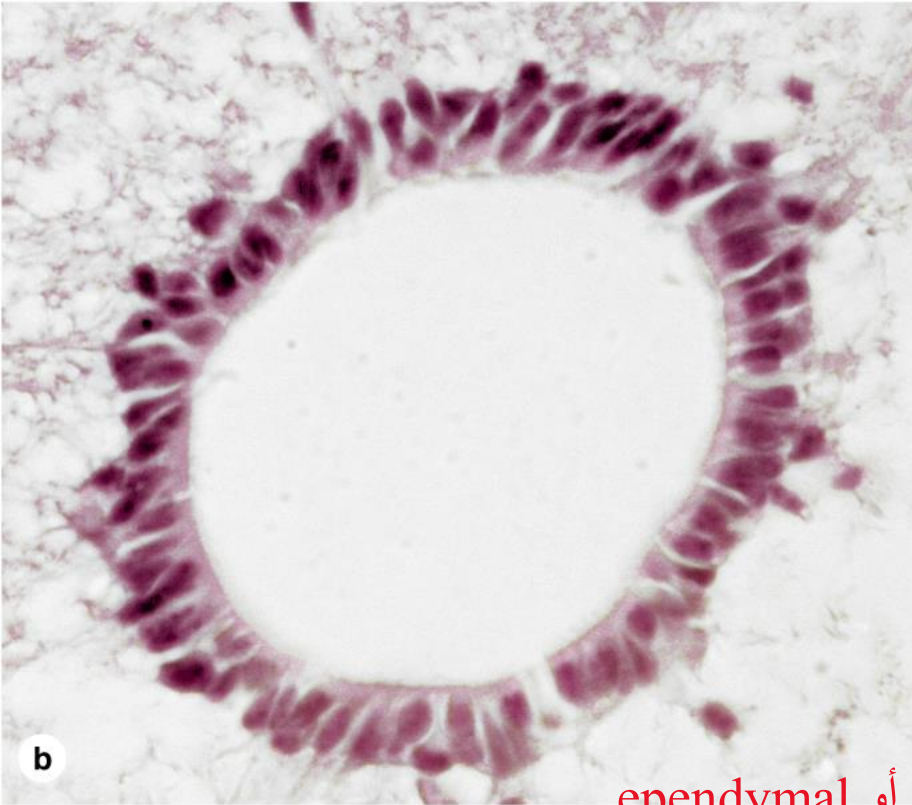
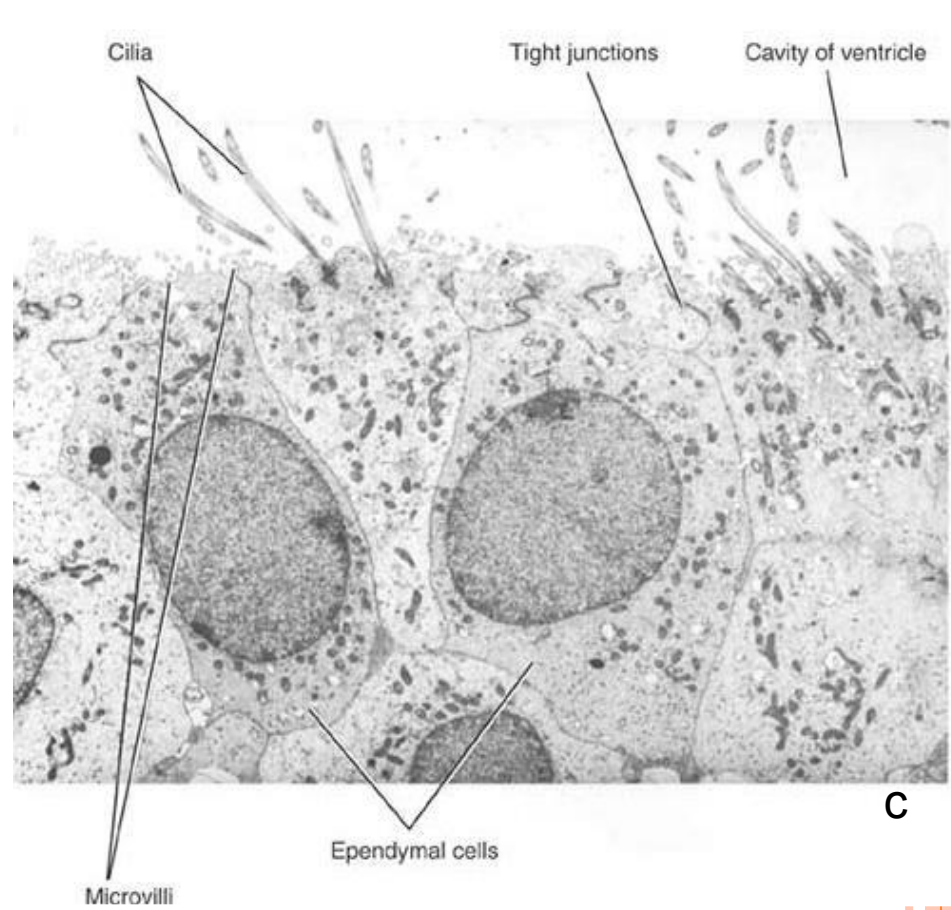
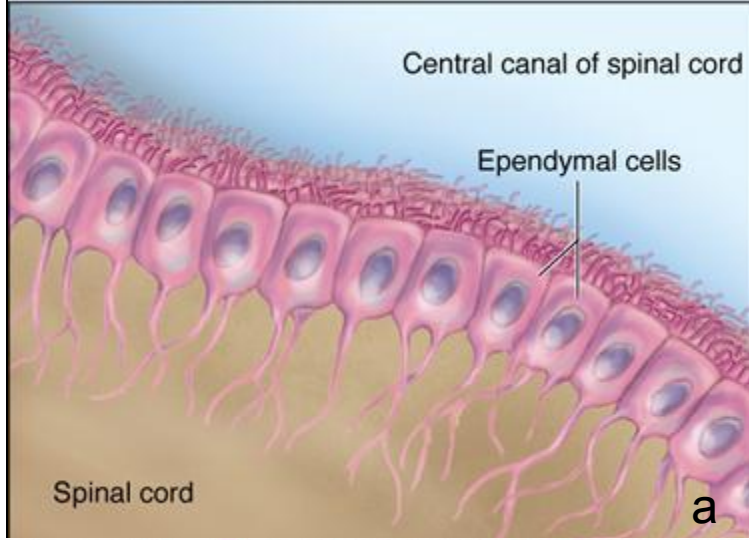


Fig.11: Ependymal cells.

In (a), note the basal appendages.

In (b), note how they line the central canal of the spinal cord.

In (c), the EM image shows the cilia, microvilli and tight junctions.

هسا كصورة زي هيڪ لا يمكن التمييز اذا كانت epithelial أو ependymal,

ف باللاب لما بييجي صورة بحكيلنا من وين مأخوذة، عشان هيڪ لازم نكون عارفين مواقع وجود الtissues باللاب

5) Satellite Cells: in the PNS

❖ They're small cells that form a covering layer around the cell bodies of the neurons in the peripheral ganglia.

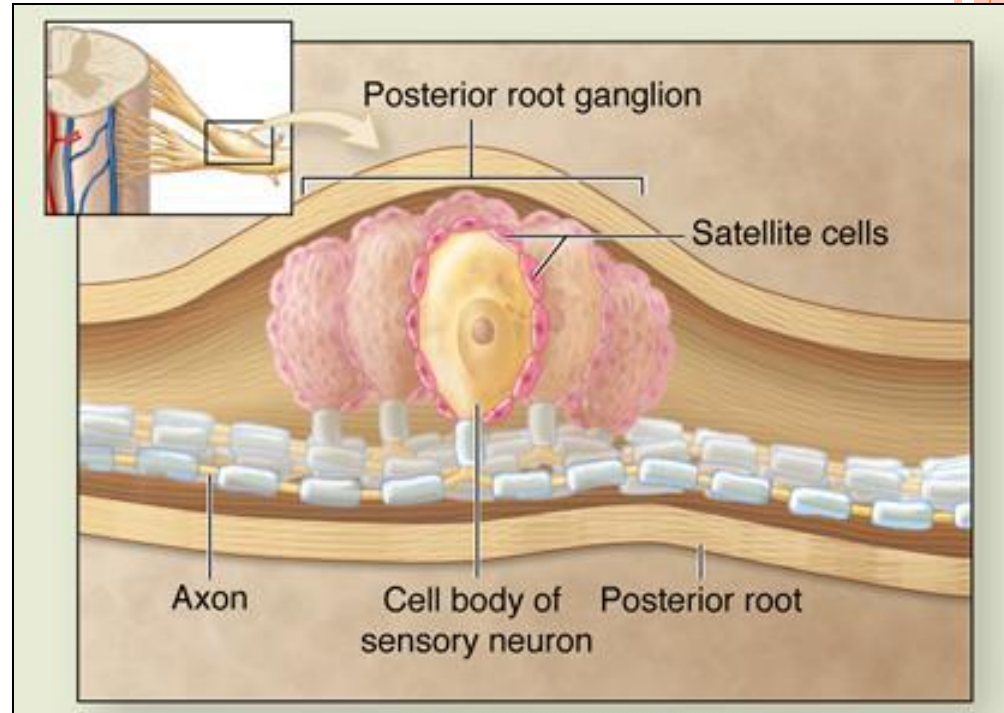


Fig.12: Satellite cells surrounding the pseudounipolar neurons of the dorsal root ganglia.

❖ They support the neurons in the ganglia.

↓
Support, protection, cleaning transmitters, provision of nutrients

6) Schwann Cells (Neurolemmocytes): in the PNS

△ These cells form the myelin sheath around the myelinated axons in the PNS. Each cell forms the myelin sheath around a part of a single axon.

بالoligodendrocytes كانت الprocesses هي اللي بتكوّن الmyelin.. بينما هون الخلية بنفسها هي اللي بتكوّنه

△ They also envelope the unmyelinated axons.

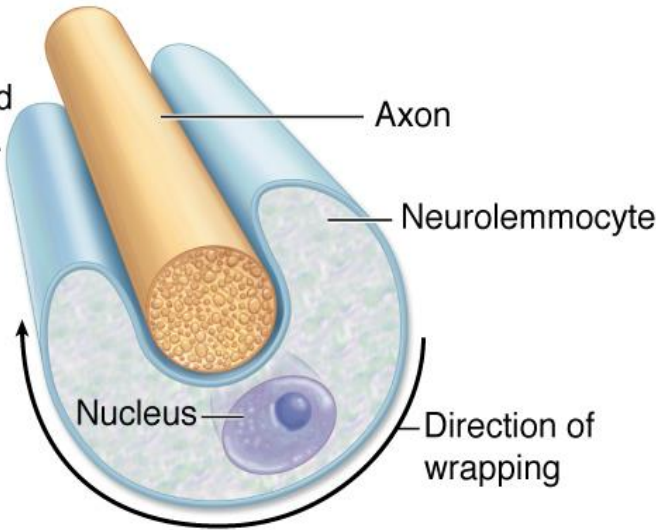
△ Schwann cells produce a layer around it called the **External lamina** that's similar to the epithelial basal lamina. *للتذكير.. الadipocytes برضه بتفرز حولها مادة تشبه الbasal lamina.

△ They play a role in the regeneration of nerve fibers.

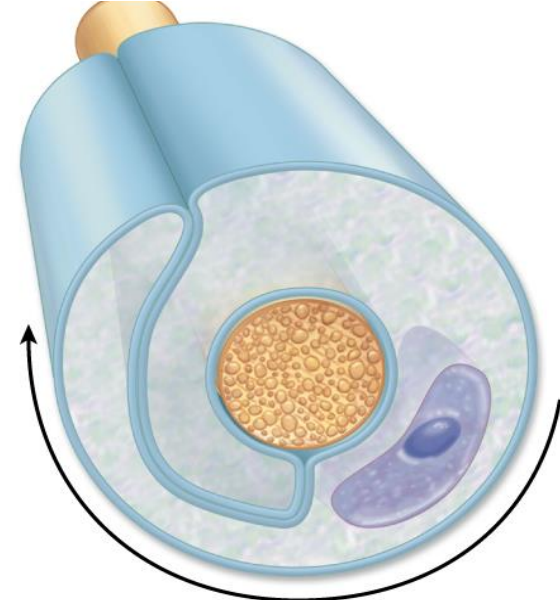
Processes of Myelination

والعملية هائي نفسها بتصير بال CNS بس الفرق انها عن طريق ال processes لل oligodendrocytes

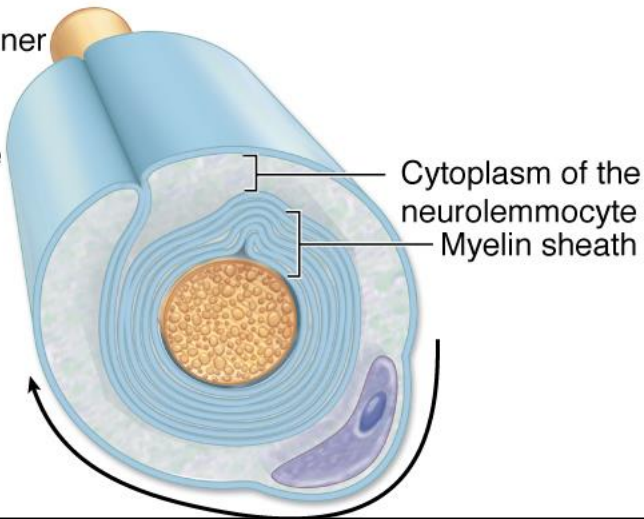
① Neurolemmocyte starts to wrap around a portion of an axon.



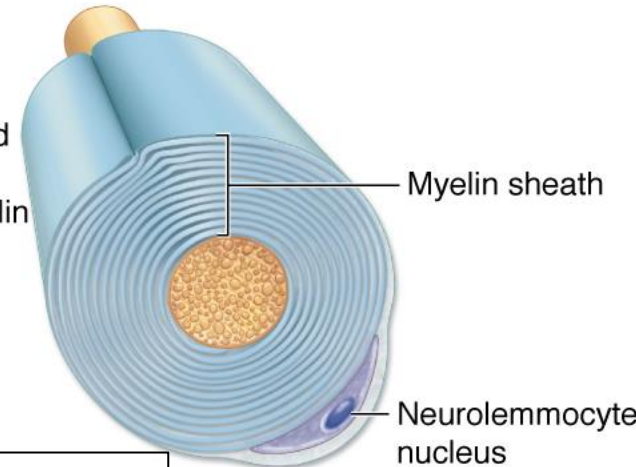
② Neurolemmocyte cytoplasm and plasma membrane begin to form consecutive layers around axon.



③ The overlapping inner layers of the neurolemmocyte plasma membrane form the myelin sheath.



④ Eventually, the neurolemmocyte cytoplasm and nucleus are pushed to the periphery of the cell as the myelin sheath is formed.



Myelin sheath = multiple layers of cell membrane

الآن ال cell membrane مكوّن من lipids واللي لونها الإجمالي أبيض, عشان هيك ال nerves بالعين المجردة بتظهر باللون الأبيض (معظم ال PNS nerves بتكون myelinated) (ال unmyelinated ما بظهر بكون شفاف)

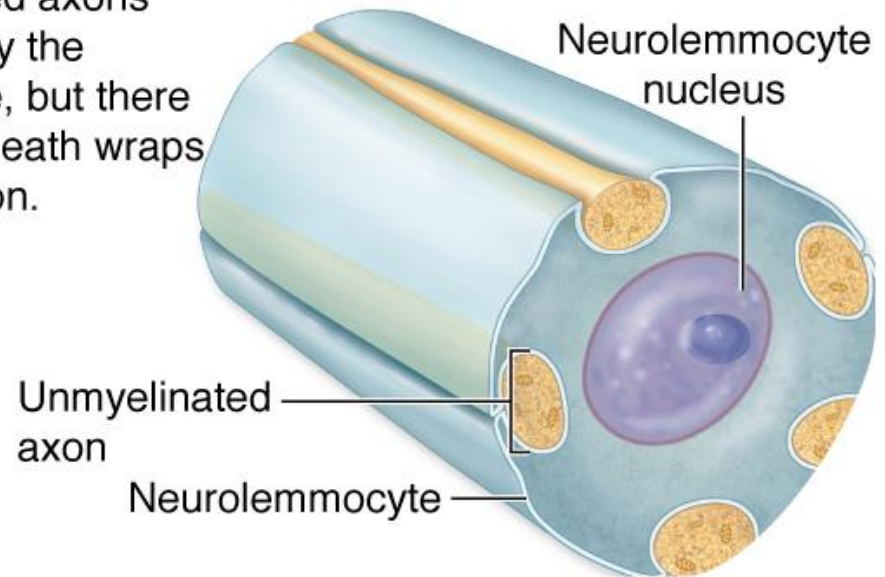
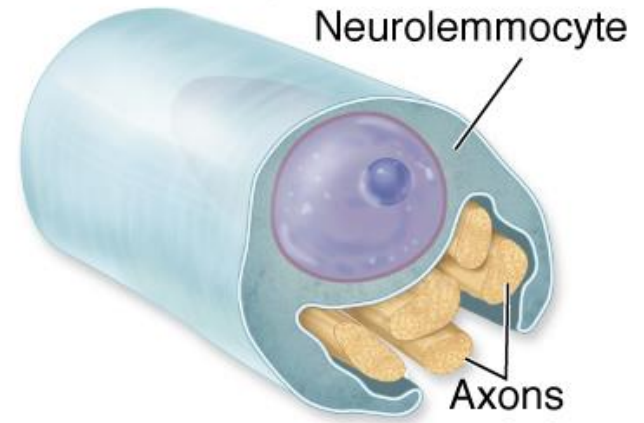
Schwann cells and the unmyelinated fiber

Unmyelinated axons

- ① Neurolemmocyte starts to envelop multiple axons.
- ② The unmyelinated axons are enveloped by the neurolemmocyte, but there are *no* myelin sheath wraps around each axon.

الaxons بتضل محاطة
بالcell membrane
تاع الSchwann cells
بس ما بسميه myelin
sheath لأنه مش عدة
طبقات

The unmyelinated axons in the CNS are surrounded by nothing and run free in the nervous tissue.



هسا بالPNS الunmyelinated يكون مُحاط بالcell membrane للSchwann cells
بينما بالCNS الunmyelinated ما بتكون محاطة بأي اشي, فالoligodendrocytes
بتكون بس متصلة بالmyelinated

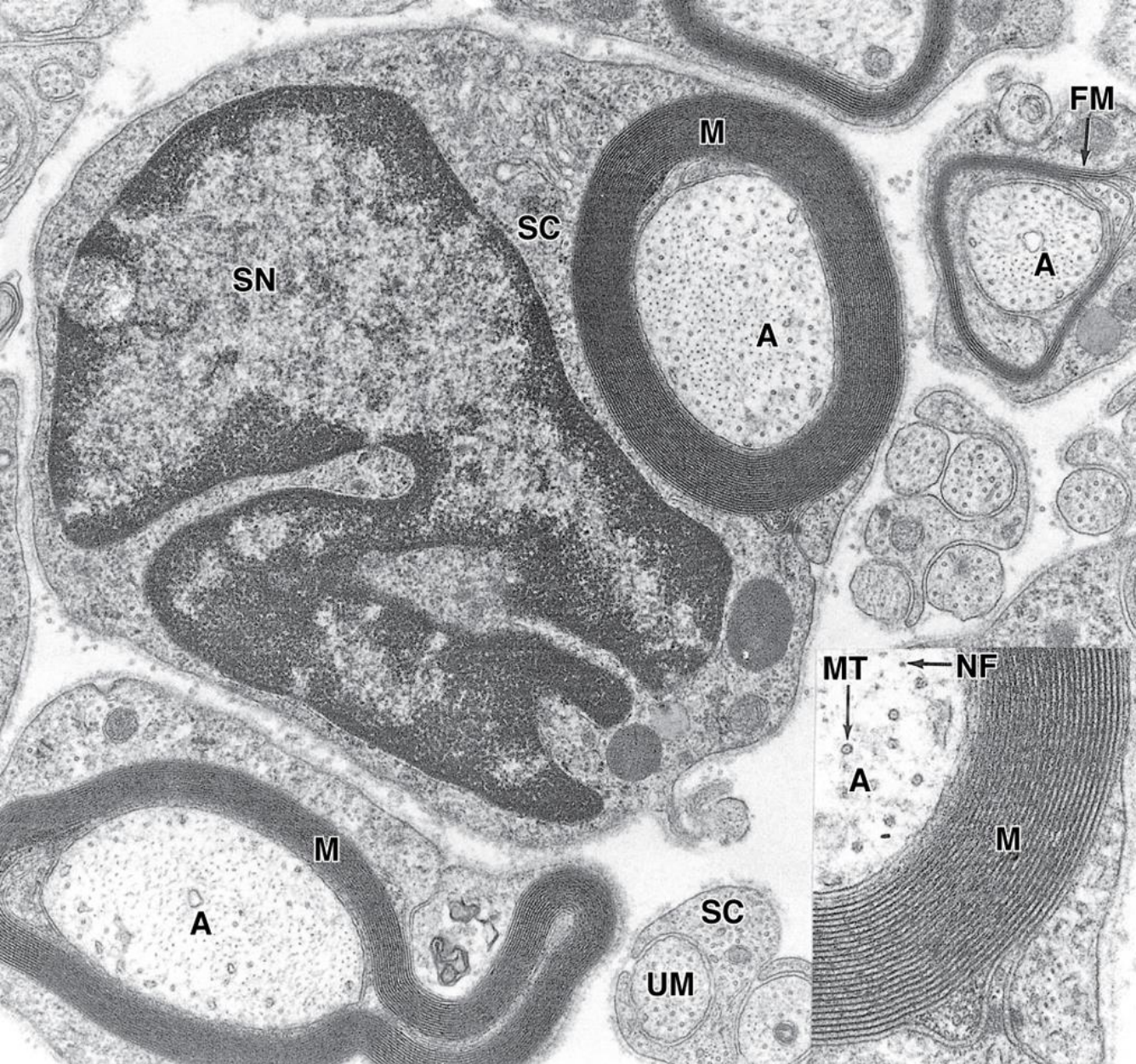
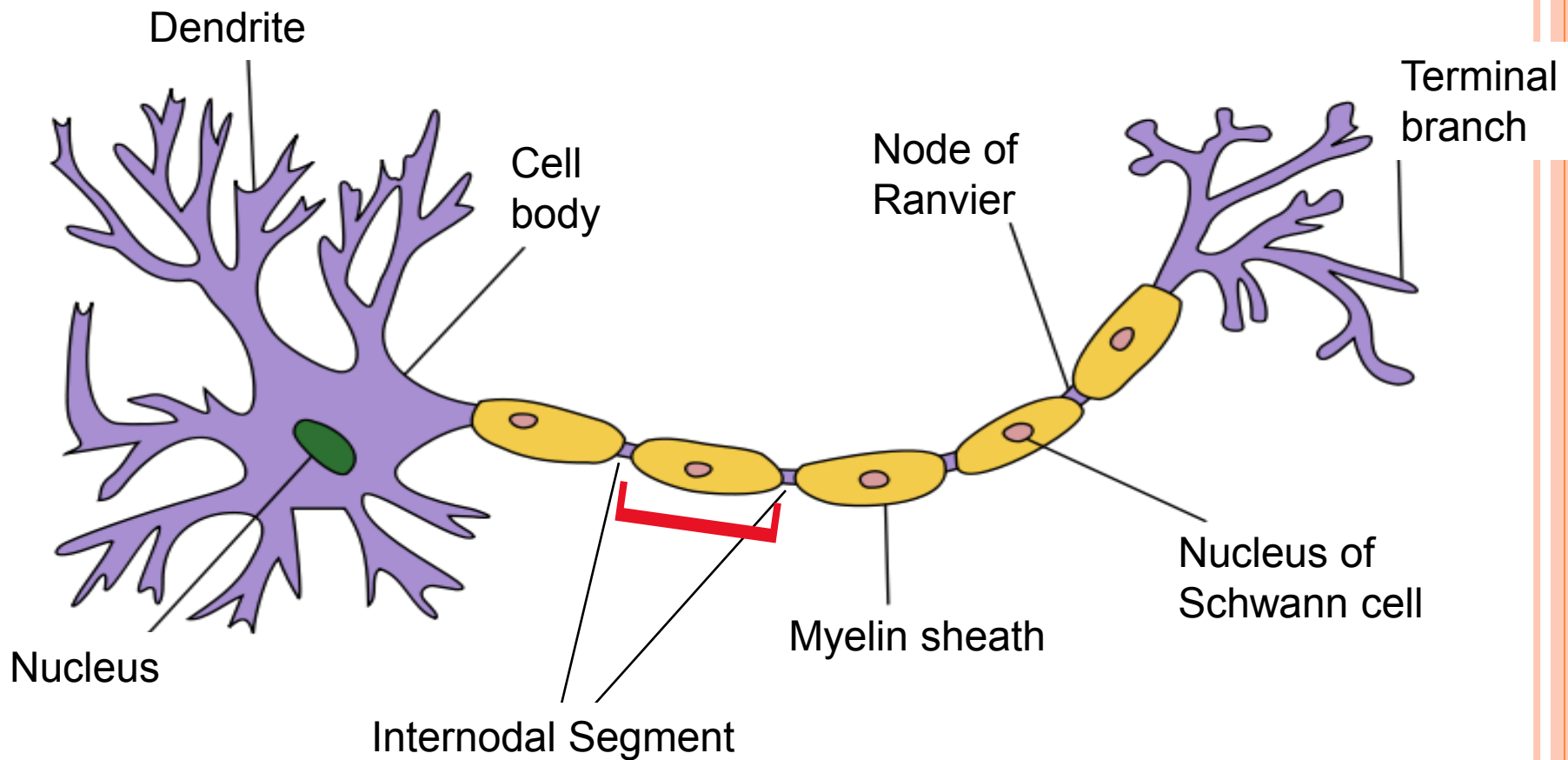


Fig.13: Myelinated and unmyelinated nerve fibers. In the center of the image, (A) is an axon surrounded by a myelin sheath (M) and (SN) is the nucleus of Schwann cell. Note the multiple layers of the sheath in the inset. (UM) is an unmyelinated axon.



- **Node of Ranvier**: the part of the axon that's not covered by a myelin sheath.
- **Internode**: the segment between 2 adjacent nodes of Ranvier.

Gray vs White matter

في الدماغ ال gray من الخارج وال white بالداخل, بس
بال spinal cord العكس

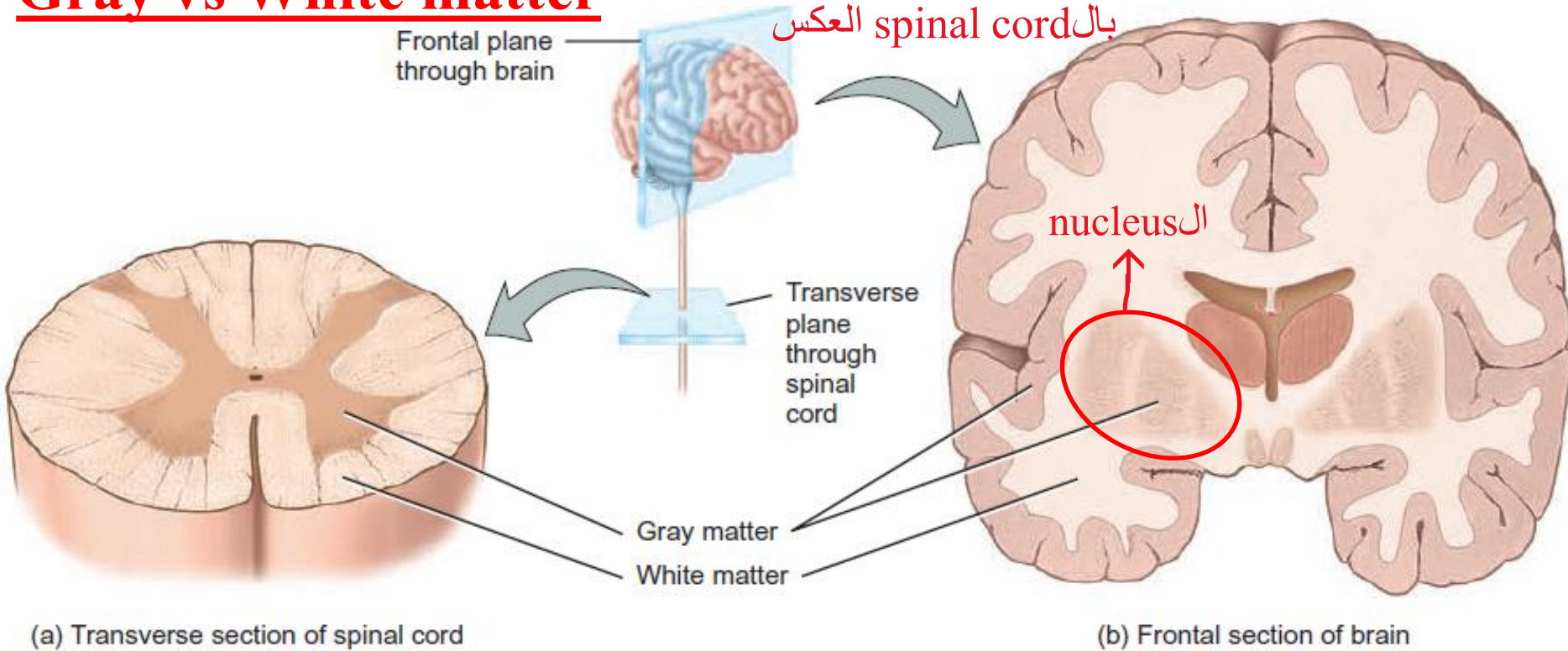


Fig.14: Gray matter is generally the outer layer in the brain and the white matter is deep. In the spinal cord, the arrangement is opposite.

(Made of)

- Gray matter = cell bodies of neurons (mostly) + initial part of the axons + dendrites + glia cells.

(Made of)

(mainly)

- White matter = myelinated and unmyelinated nerve fibers + glia cells.

THE EXTRACELLULAR SPACE

- ✓ Is a very small space that fills the gap between neurons and glia cells. It's filled with fluid.

*Important for providing nutrients for neurons → Cerebral Spinal Fluid

- ✓ It's continuous with the CSF in the subarachnoid space externally and ventricles and central canal internally. *A very small amount of extracellular matrix surrounds the blood vessels.*

هسا ال extracellular space ما بقدر اسميها ECM زي ال tissues اللي قبل, والسبب إنها ما بتحتوي على fibers و molecules زي الموجودة بال ECM, بس ممكن نلاقي كميات صغيرة جدا في المنطقة المحيطة بال vessels بشكل مباشر

- ✓ Provides a pathway for the passage of ions and molecules.
- ✓ It contains a network of the processes of neurons and glia cells which is called the **Neuropil**.

*بشكل عام.. الجزء الخارجي للorgan يُطلق عليه cortex والداخلي medulla
(بس بالbrain اسمها white matter)

THE CEREBRAL CORTEX

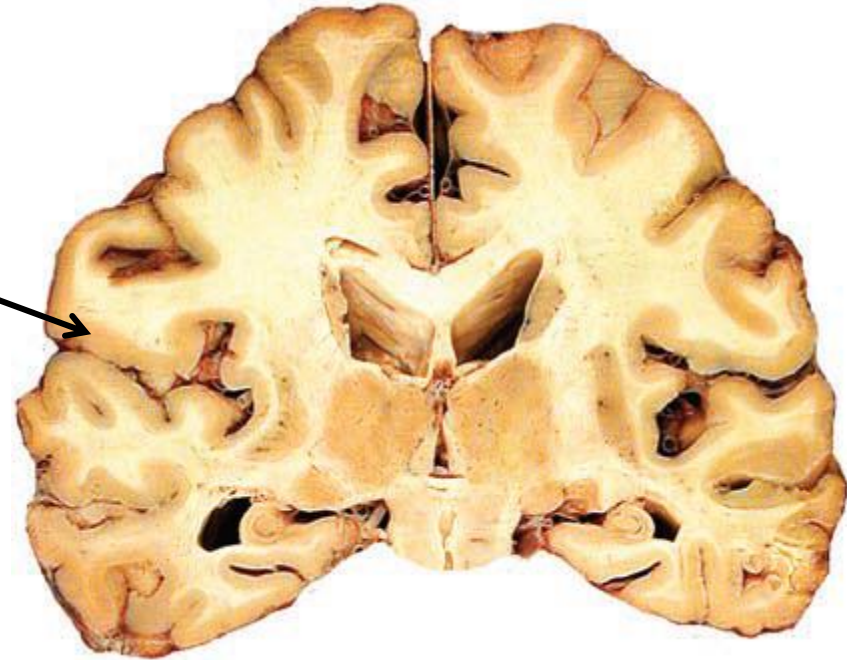
- The outer gray matter of the cerebrum is called the *Cerebral Cortex*.

- It's formed of several types of neurons usually arranged in layers.

في كل طبقة عندي neurons مختلفة بتقوم بوظائف مختلفة

- In addition to neurons, the cortex also contains dendrites, parts of axons and glia cells.

- The largest neurons in the cerebral cortex are the multipolar Pyramidal cells.



مصبوغة بالsilver.. يعني كل اللي بالأسود neurons

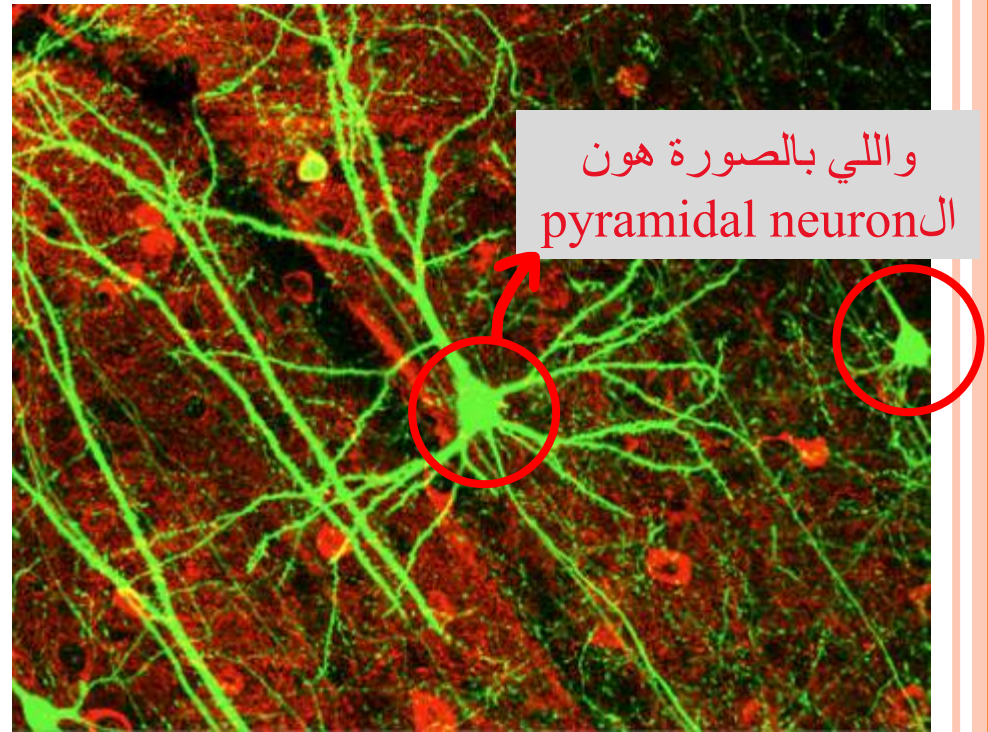
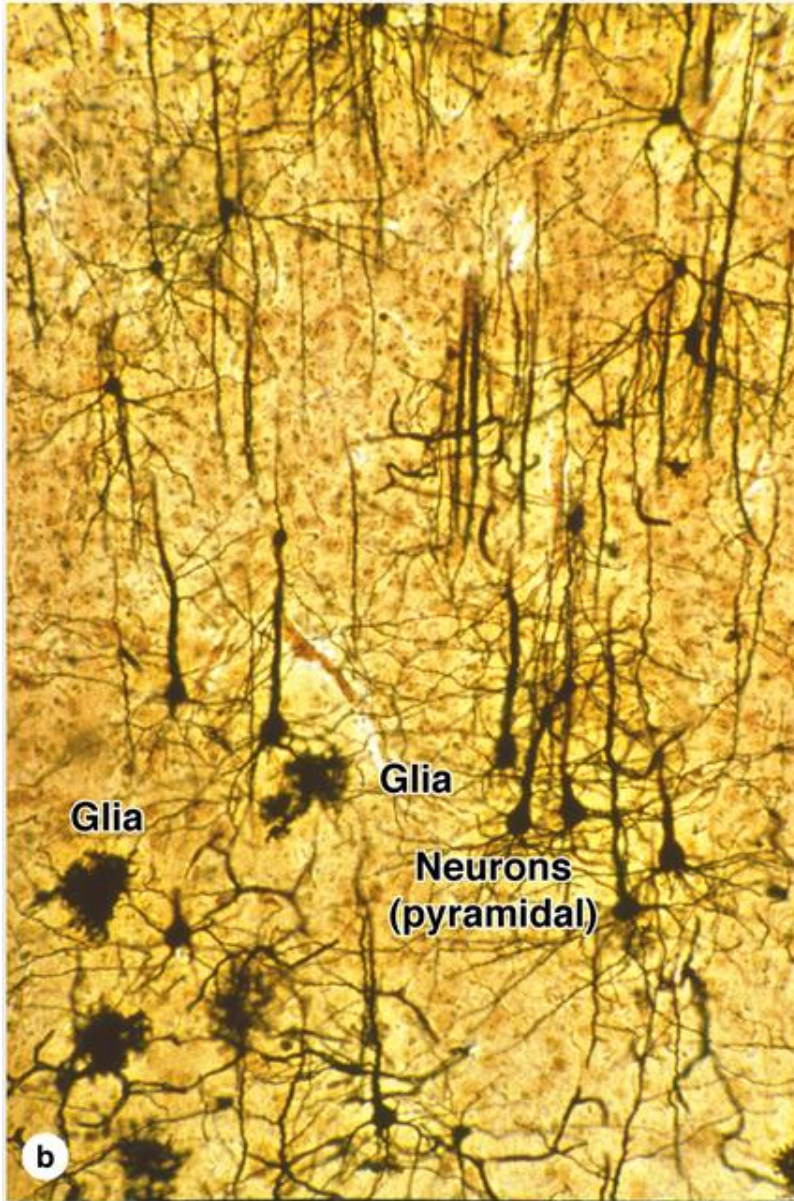
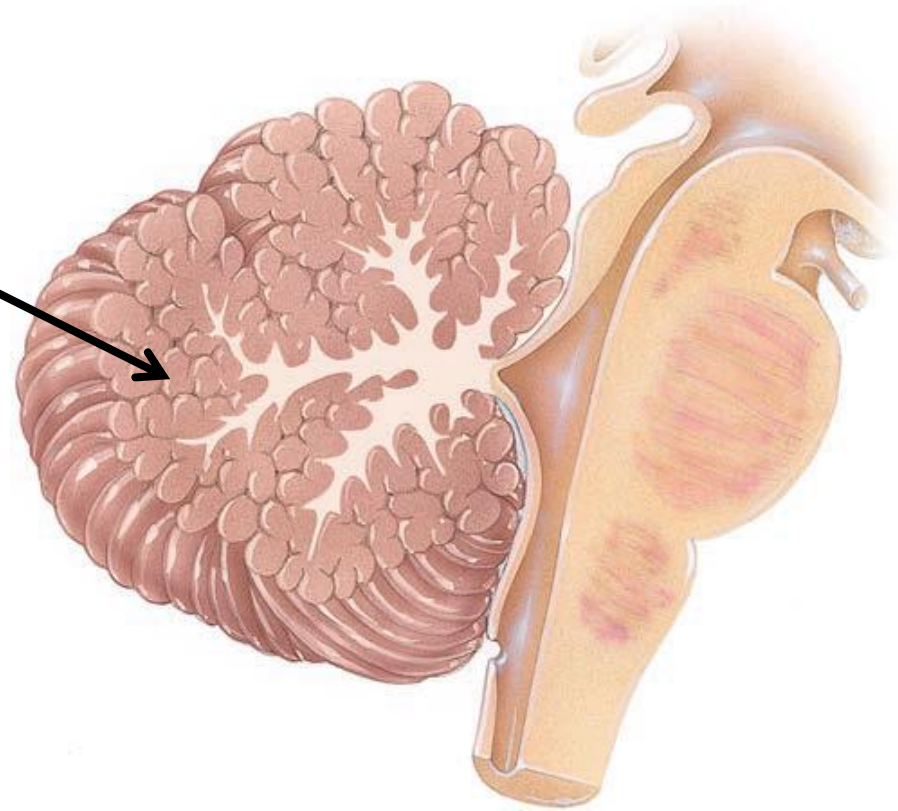


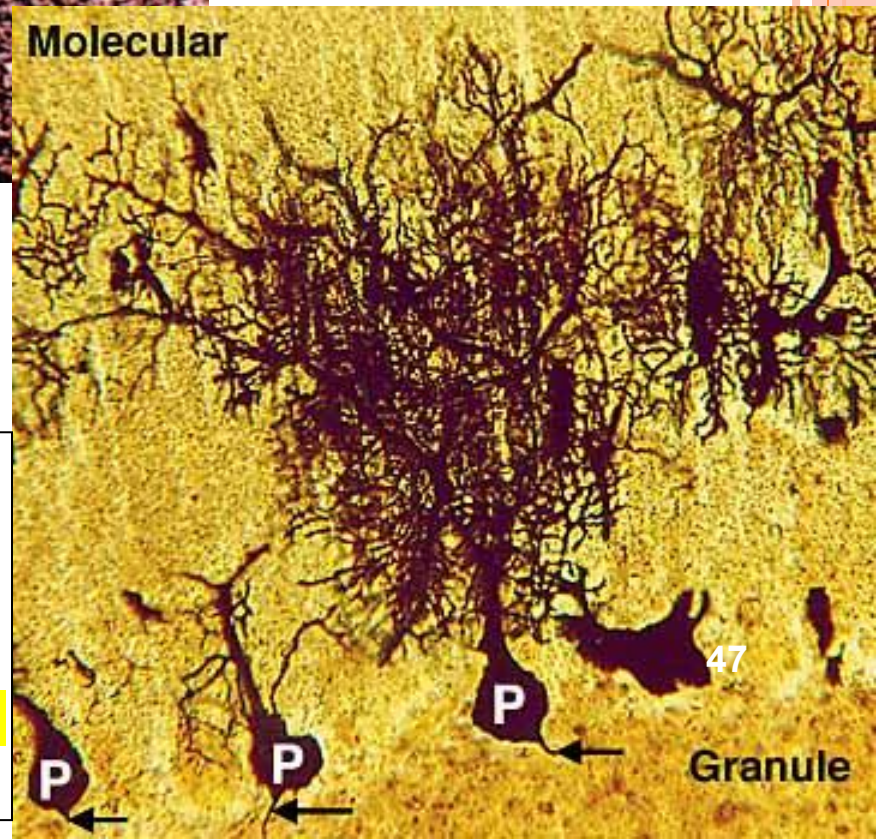
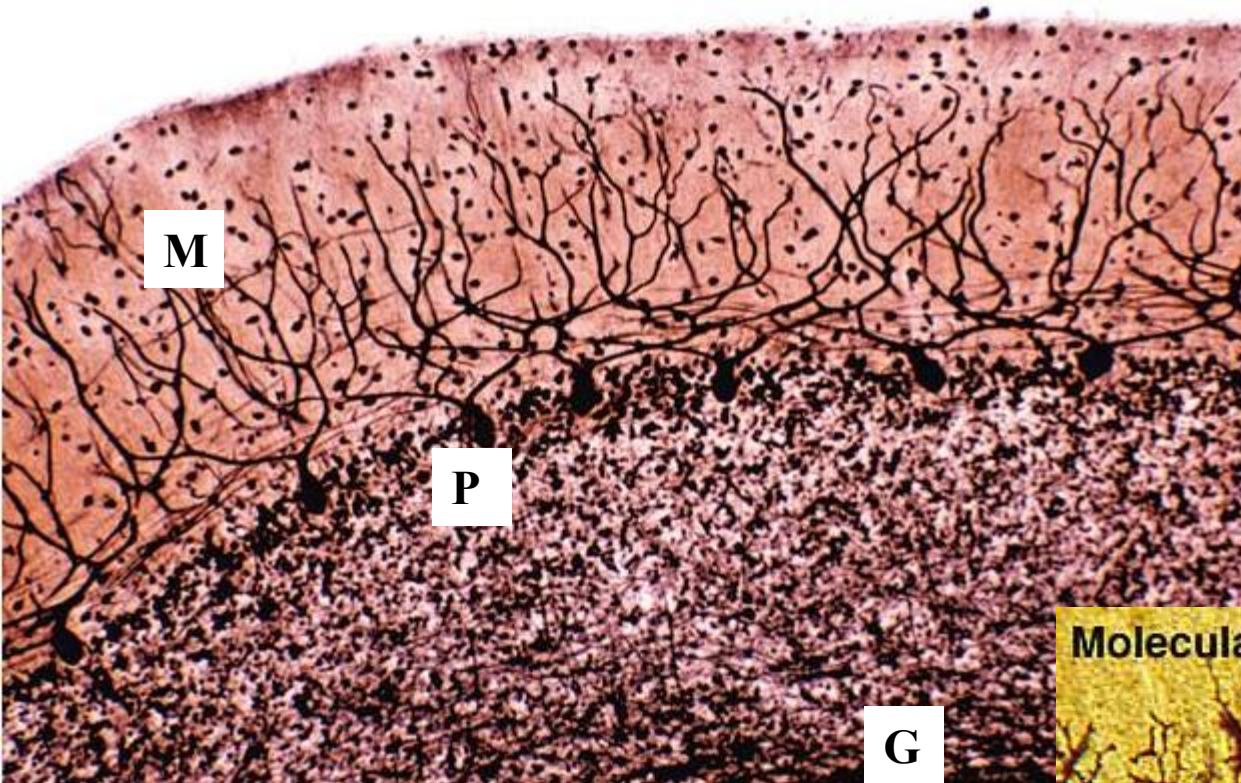
Fig.15: To the left, the cerebral cortex (silver impregnation). Image above, a Pyramidal neuron (fluorescent stain). Note the dendrites of the cell (one going up and two going to the sides) and the axon (passing down).

THE CEREBELLAR CORTEX

- The outer gray matter of the cerebellum is called the *Cerebellar Cortex*.
- The cortex is formed of three layers: Molecular, Purkinje and Granular (from outside in).



*في الcerebrum عدد الطبقات مش ثابت بختلف من مكان لآخر, بس بالcerebellum عدد الطبقات دايمًا 3



ال P layer بتحتوي على ال cell bodies of Purkinje cells ال dendrites طالعة باتجاه ال M layer, وال axons نازلة لل G layer

Fig.16: Cerebellar cortex. The image above shows the three layers: M=molecular, P=Purkinje, G=Granular. Image to the right is a Purkinje cell. Note the extensive tree-like branching of the dendrite of this cell (arrows indicate the axons). Both images, silver staining.

BLOOD-BRAIN BARRIER

- ✓ A series of structures that control the passage of substances from the blood to the nervous tissue to protect it from any adverse effect.

طبعا ممنوع لأي مادة تعبر إلى داخل ال NT, لأنه المواد بالداخل بتتواجد بنسب محددة ودقيقة جدا

- ✓ It's present in all parts of the brain except:

- a) Choroid plexuses, where CSF is produced.

ال CSF حقيقةً يتم تصنيعها (تشتق) من الدم.. عشان هيك لازم يصير تبادل لبعض

المواد عشان تقدر ال choroid plexuses تصنع ال CSF

- b) In hypothalamus, where plasma contents are monitored.

وبرضه ما بتكون موجودة بال hypothalamus عشان تقدر تعرف

مكونات ال blood وتتحكم وتغير فيها اذا كان فيها أي مشكلة

- ✓ Disruption of this barrier by drugs or microorganisms may damage the nervous tissue of the brain.

لأنه ممكن يعبر مواد مختلفة من toxins وغيرها

BBB is composed of:

1) Capillary endothelium: these are connected by tight junctions.

Formed of simple squamous epithelium and has numerous TJ, means that the intercellular space is closed of

2) Pericytes: cells with contractile ability that surround the endothelial cells. Located beneath basal

lamina. Found around capillaries in certain organs (like brain) these cells can contract, pushing the blood away

3) Basal lamina: this is unfenestrated. غير متقبة (قطعة واحدة)

4) Perivascular feet of Astrocytes. وحول ال vessels بنلاقي

كميات كبيرة من ال microglia cells للاحتياط في حال عبور بعض المواد بالخطا او اذا صار خلل يعني

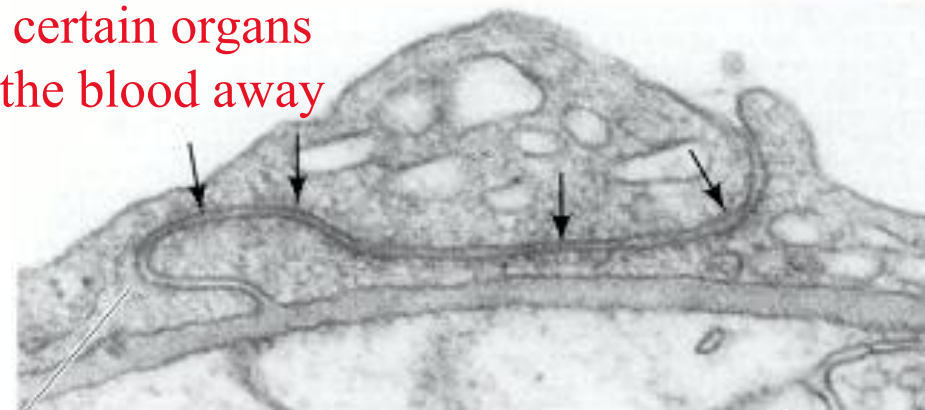
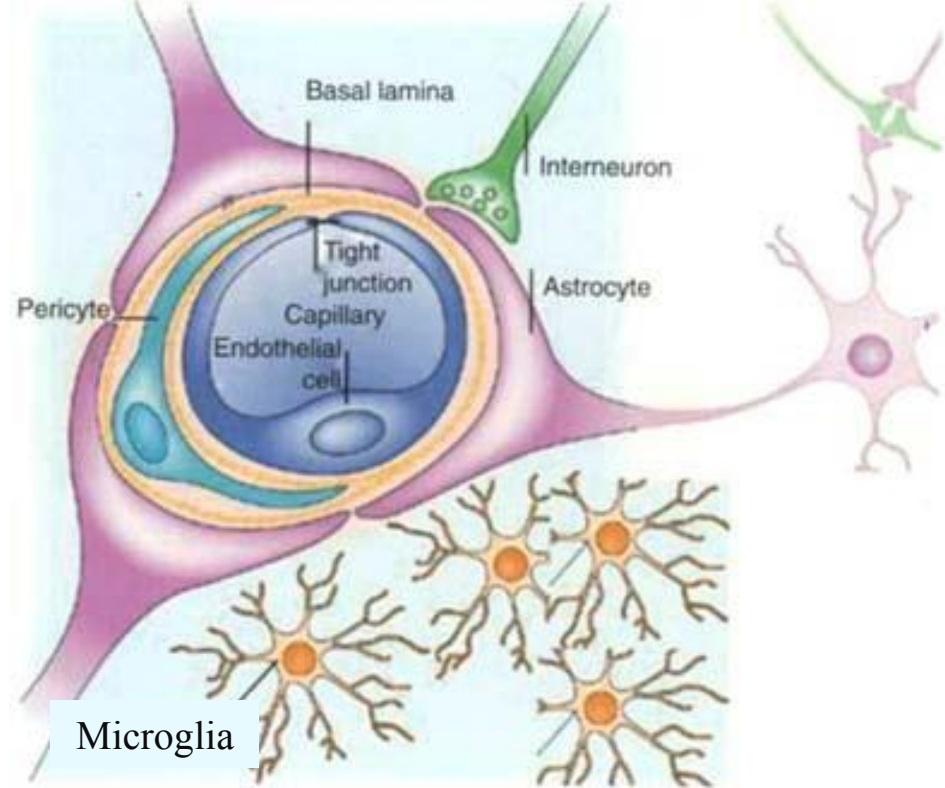


Fig.17: Blood brain barrier. The EM image shows the tight junctions between two endothelial cells (arrows).

PERIPHERAL NERVES

△ Each nerve is formed of several fascicles (bundles) of many nerve fibers (axons).

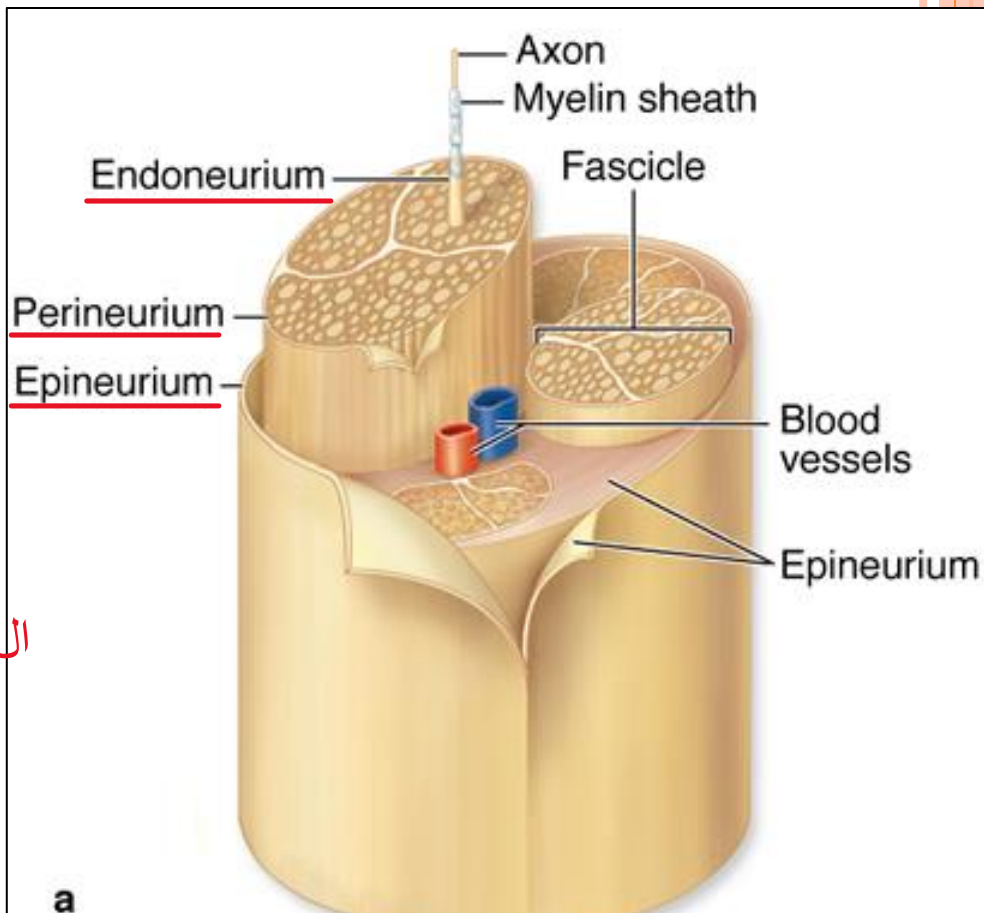
△ Each axon is surrounded by Schwann cell myelin sheath. Then the fiber is surrounded by the *Endoneurium*.

الفascicle) bundle ال nerve fibers بتتجمع وبتعمل

△ The fascicle is ensheathed by the *Perineurium*.

ال nerve bundles بتتجمع وبتعمل

△ The whole nerve is surrounded by the *Epineurium*.



اذا كان ال myelinated axon ف رح يكون مغطى
أولا بال myelin sheath, واذا كان unmyelinated
رح يكون حوله Schwann cell, وكلاهما مُحاط
بال endoneurium

△ *Endoneurium*: is formed of loose areolar connective tissue that merges with the external lamina produced by Schwann cells.

Surrounds every single nerve fiber, and connected to the external lamina

△ *Perineurium*: is formed of several layers of closely packed cells with tight junction between them. It protects the fascicles and acts as an insulator and a *blood-nerve barrier*.

△ *Epineurium*: formed of a dense irregular collagenous connective tissue. It passes into the nerve between the fascicles. And covers the entire nerve

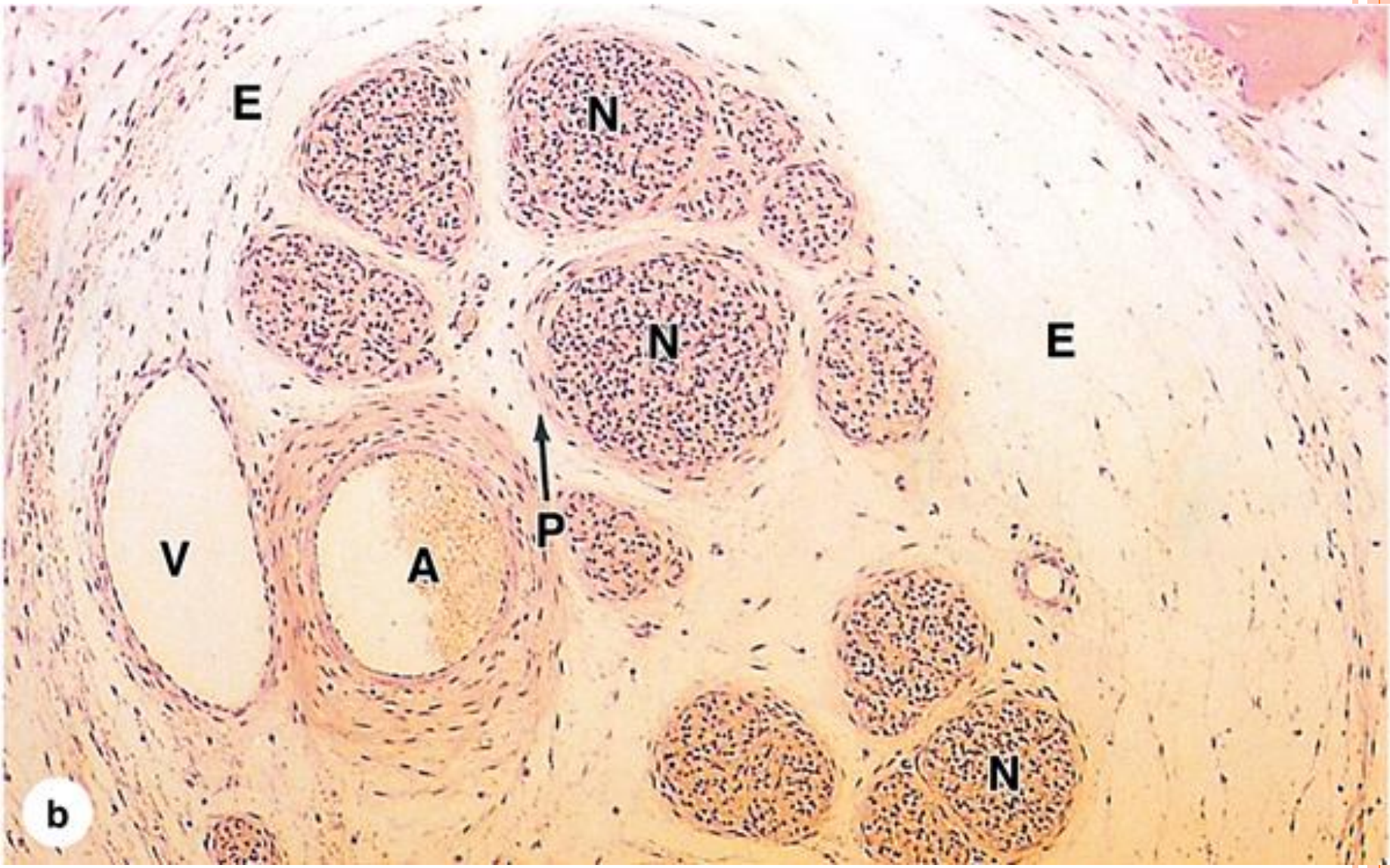


Fig.18: Peripheral nerve. E=Epineurium, an artery (A) and a vein (V) are present in this layer. P=Perineurium (note how it's formed of several layers of cells). N=fascicle of nerve fibers (each black dot in the fascicle is an axon).

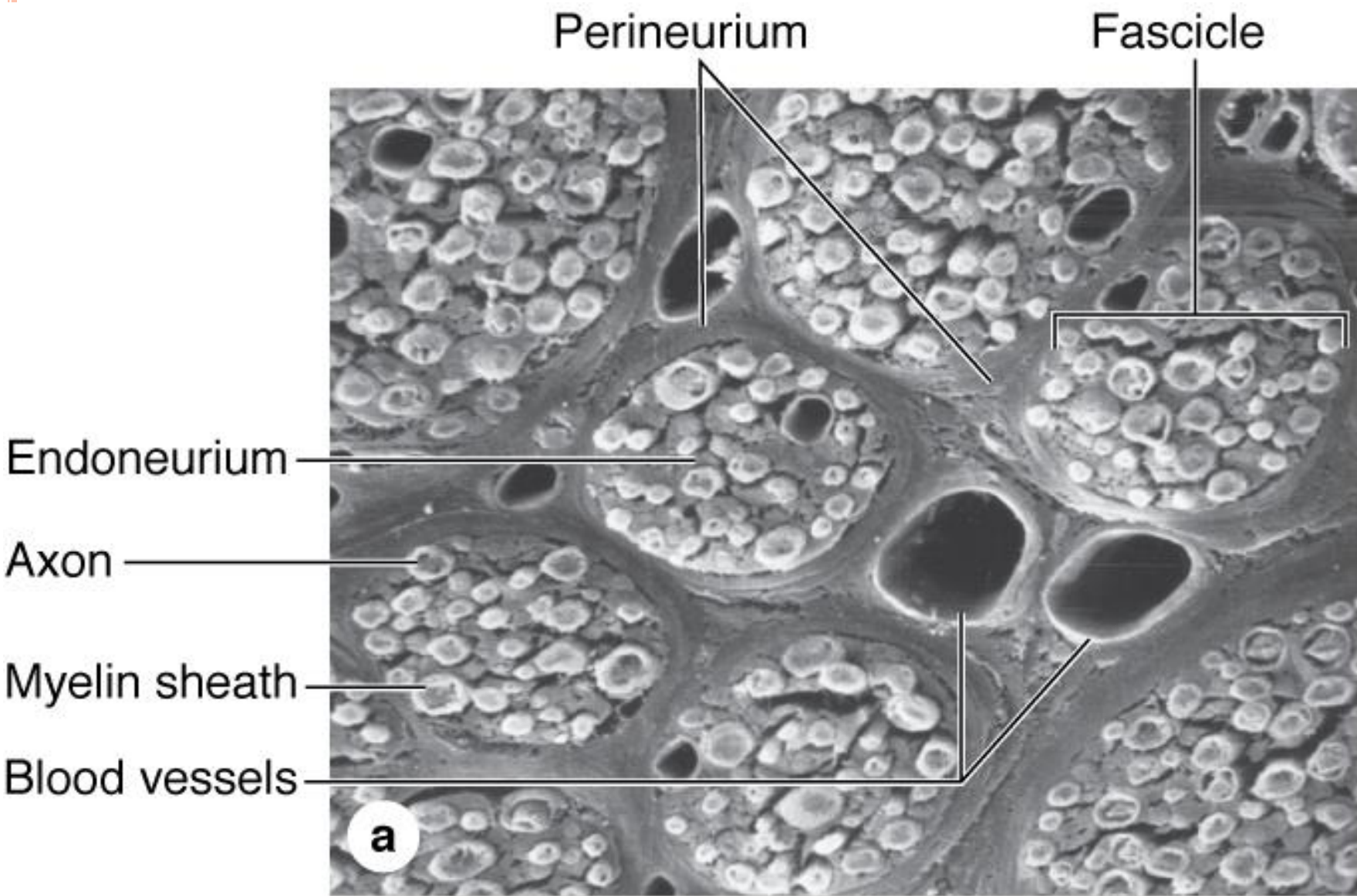
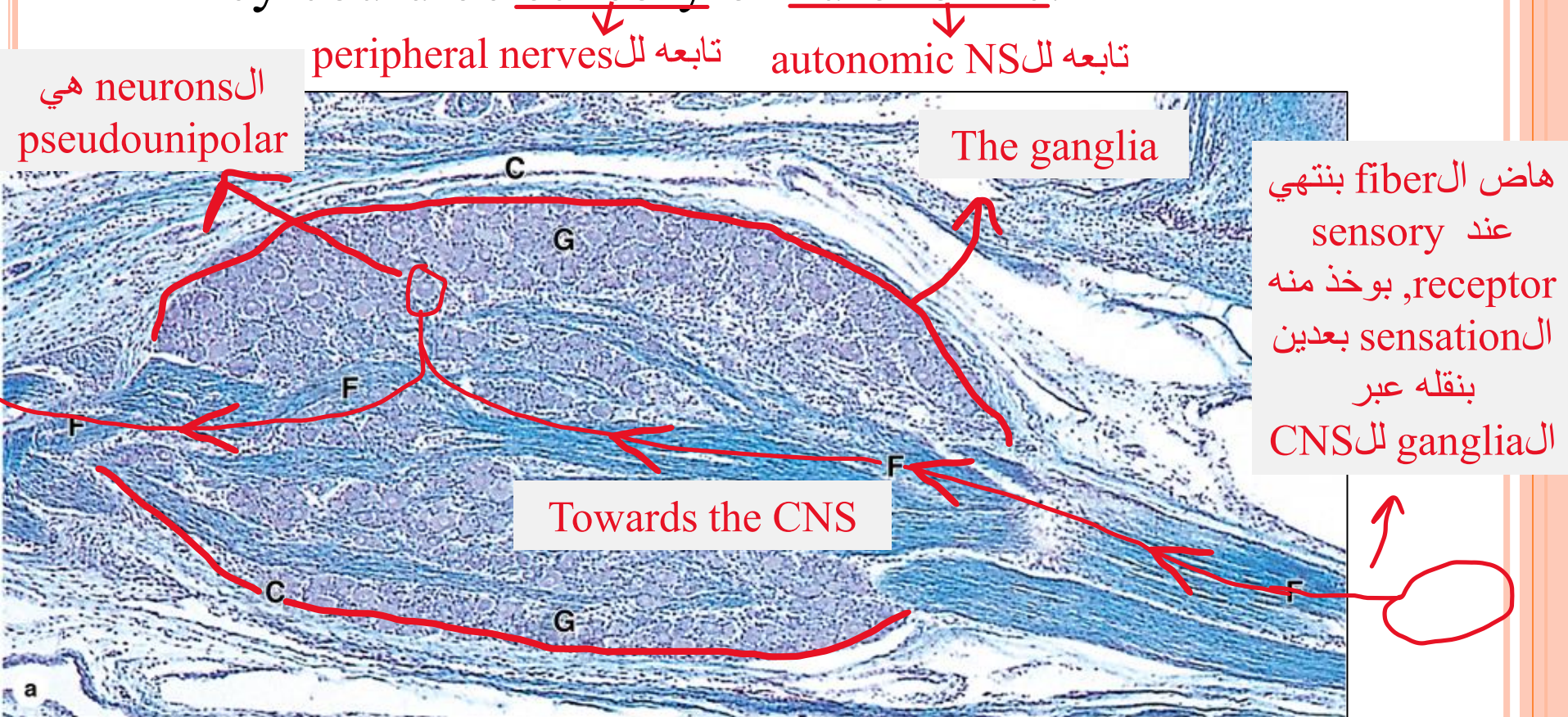


Fig.19: A SEM image of a nerve.

PERIPHERAL GANGLIA

- Ganglia are a **collection of neurons outside the CNS**. They could be sensory or autonomic.



وال ganglia بتتكون من cell bodies of neurons و nerve fibers و مُحاطة ب CT capsule

Fig.20: A section through a peripheral sensory ganglion. Note the well **distinct capsule** (C). The nerve fibers (F) enter from one end of the ganglion and exit from the other.

Both sympathetic and parasympathetic

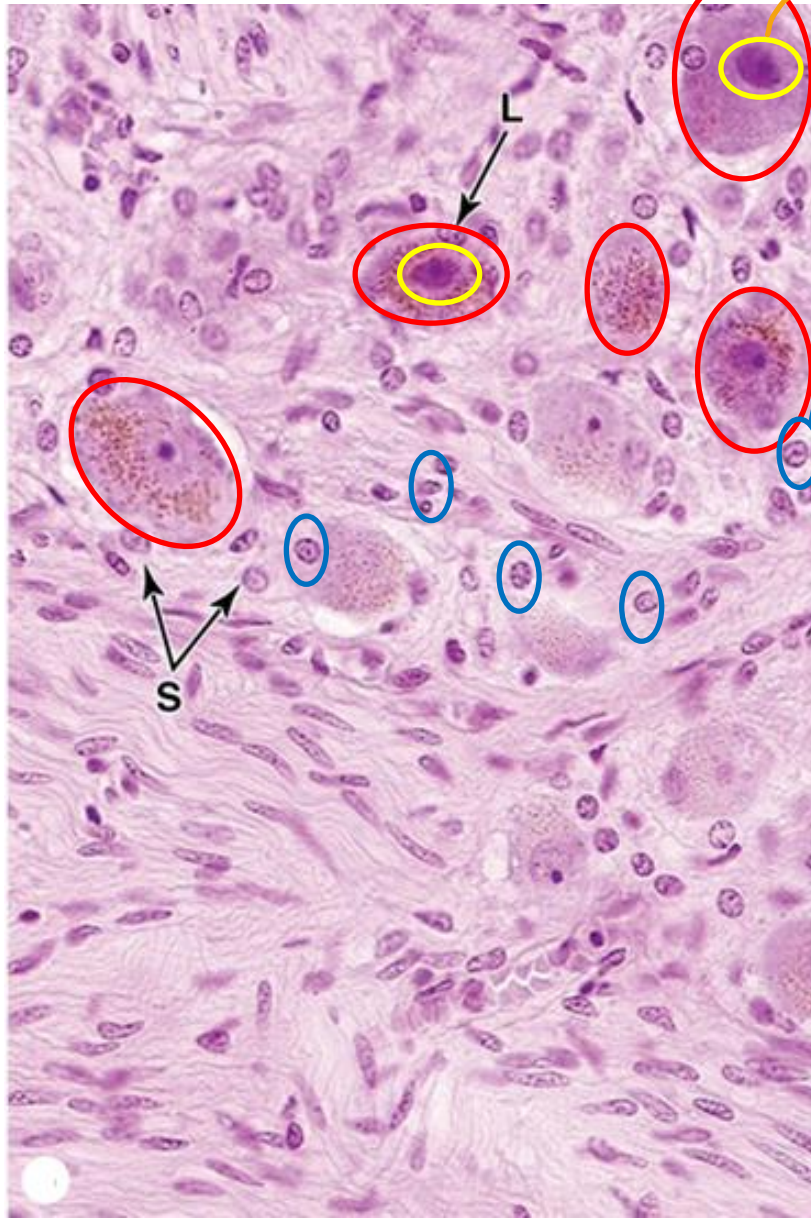
	Sensory	Autonomic
Location	(Posterior root) Dorsal root ganglia of the spinal nerves and some cranial nerves.	Small dilation in autonomic nerves and within the wall of some organs. <i>داخل العضو نفسه</i>
Capsule	Distinct.	Not well developed. May merge with CT of the organ in which it's contained.
Type of neuron	Pseudounipolar.	Multipolar.
Function	Receives sensory nerves and sends sensory information to CNS.	Relay station for autonomic stimuli.

يعني لما تكون داخل
organ فال CT المحيط
فيها ممكن يندمج مع
ال CT للorgan

نقطة التقاء ال preganglionic neuron
مع ال postganglionic neuron

اللهم إنك عفوٌّ تحب العفو فاعفُ عنا

The cell bodies of neurons

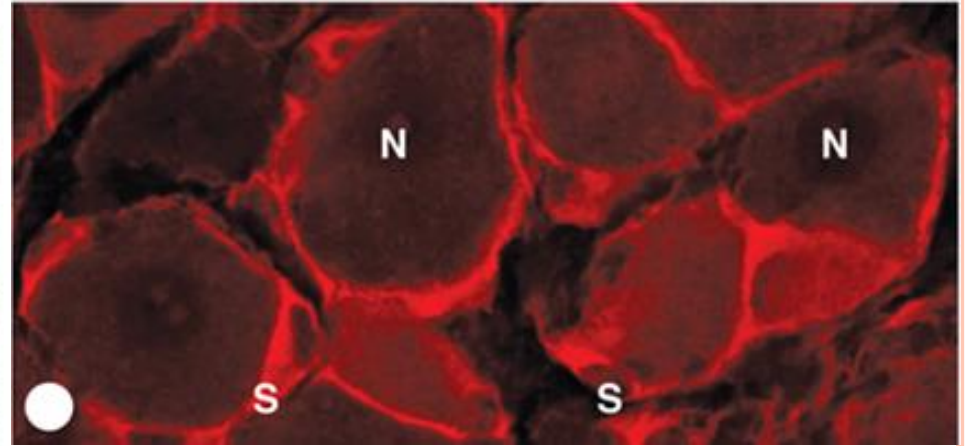


والنقاط الغامقة داخلها هي الnuclei..
أما النقاط المصبوغة بلون بني تقريبا داخل

ال body فهي الnissl bodies

أما بالنسبة للنقاط الغامقة المحيطة بال cell body
فهي ال satellite cells, والتي قلنا سابقا إنها
بتحيط بال neurons وبتدعمها

Fig.21: To the left, sensory ganglion.
Note the satellite cells (S) surrounding
the larger neurons. Below, a fluorescent
stain was used for the satellite cells.



بالصورة هاهي تم استخدام صبغة fluorescent
مخصصة لل satellite cells, فاللون الغامق يمثل
ال bodies الغير مصبوغة, بينما كل اللي بظهر باللون
الأحمر حول ال body عبارة عن satellite cells

REPAIR OF NERVE INJURY

- **Mature neurons do not divide.** Stem cells that can form new neurons are present in the nervous system.

What's their role???

* ما بتنقسم, ولا ال stem cells بتساعدها تتجدد

ال stem cells لو نحفزها داخل المختبر رح تكوّن neurons جديدة.. بينما داخل الكائن الحي ما بتتحول لneurons.. So their role in human body is still not completely understood ..

- A cut peripheral nerve **can be repaired**, however.
- All debris from the site of injury are removed, except the CT layers that surround Schwann cells.

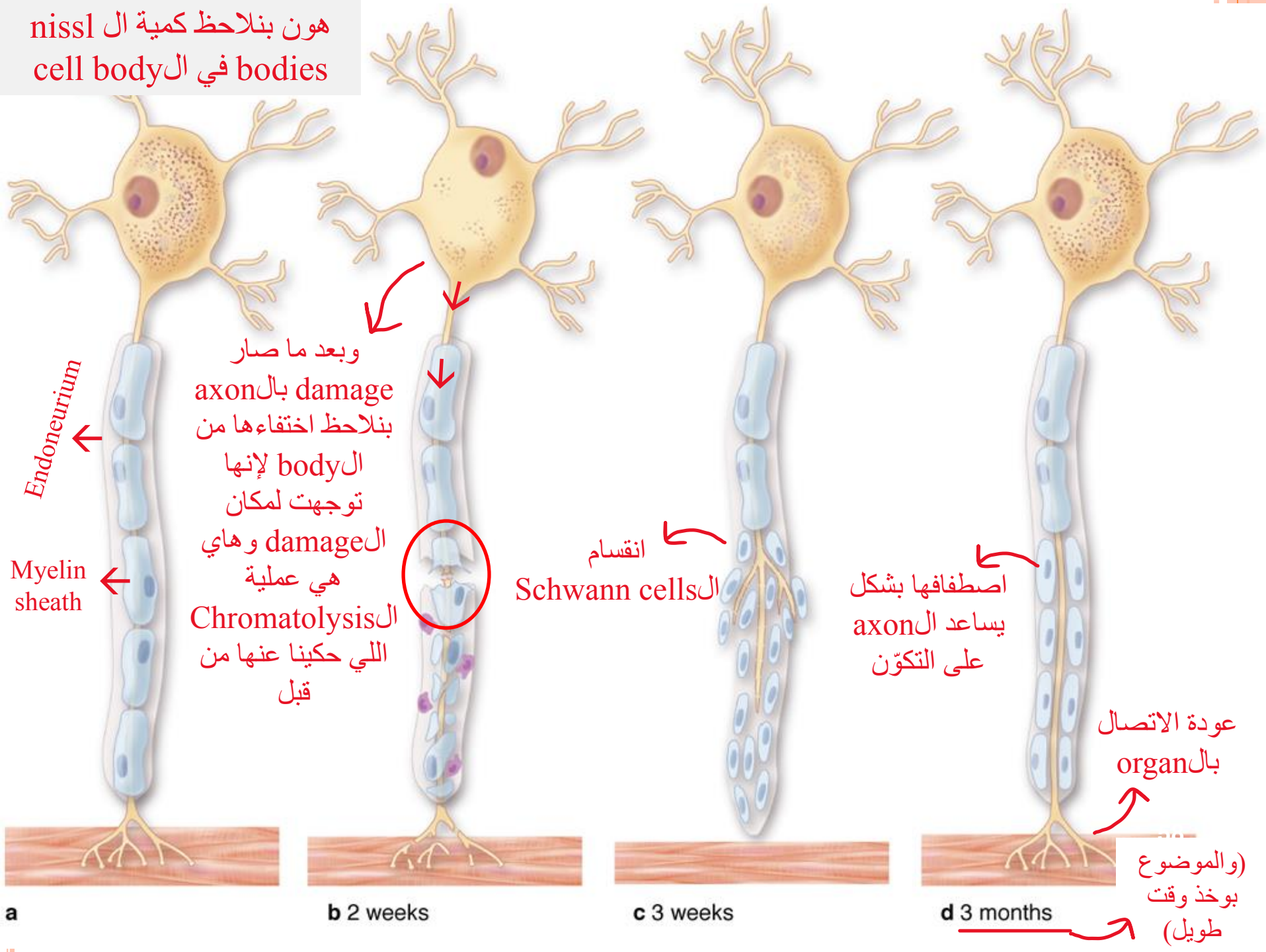
بتم تنظيف مكان ال damage من أي اشي موجود باستثناء ال CT المحيط بال axon

- Schwann cells proximal to the injury will proliferate within the CT layers to form rows of cells that act as a guide for the forming axon.

بعدين ال Schwann cell المجاورة لمكان ال damage بتبدأ تنقسم, ووجود ال CT حولها بساعدها عالانقسام, بعدين القطع بتبلس تترتب بحيث تعمل قناة في وسطها عشان يتكون بداخلها axon جديد, وبالنهاية يرجع ال axon يرتبط بال organ

** هسا في حال كان unmyelinated ف برضه بصير له repair بس الموضوع أصعب

هون بنلاحظ كمية ال nissl
bodies في ال cell body



Thank
You

اللهم إني أستودعك ما درست
وقرأت وحفظت وفهمت..
فرُدّه لي عند حاجتي إليه

دعواتكم

**It dazzled his brain from
cerebrum to cerebellum.**