



PHYSIOLOGY

FACULTY OF PHARMACEUTICAL SCIENCES

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LECTURE 3, PART (2): INTRODUCTION OF THE NERVOUS SYSTEM

Objectives

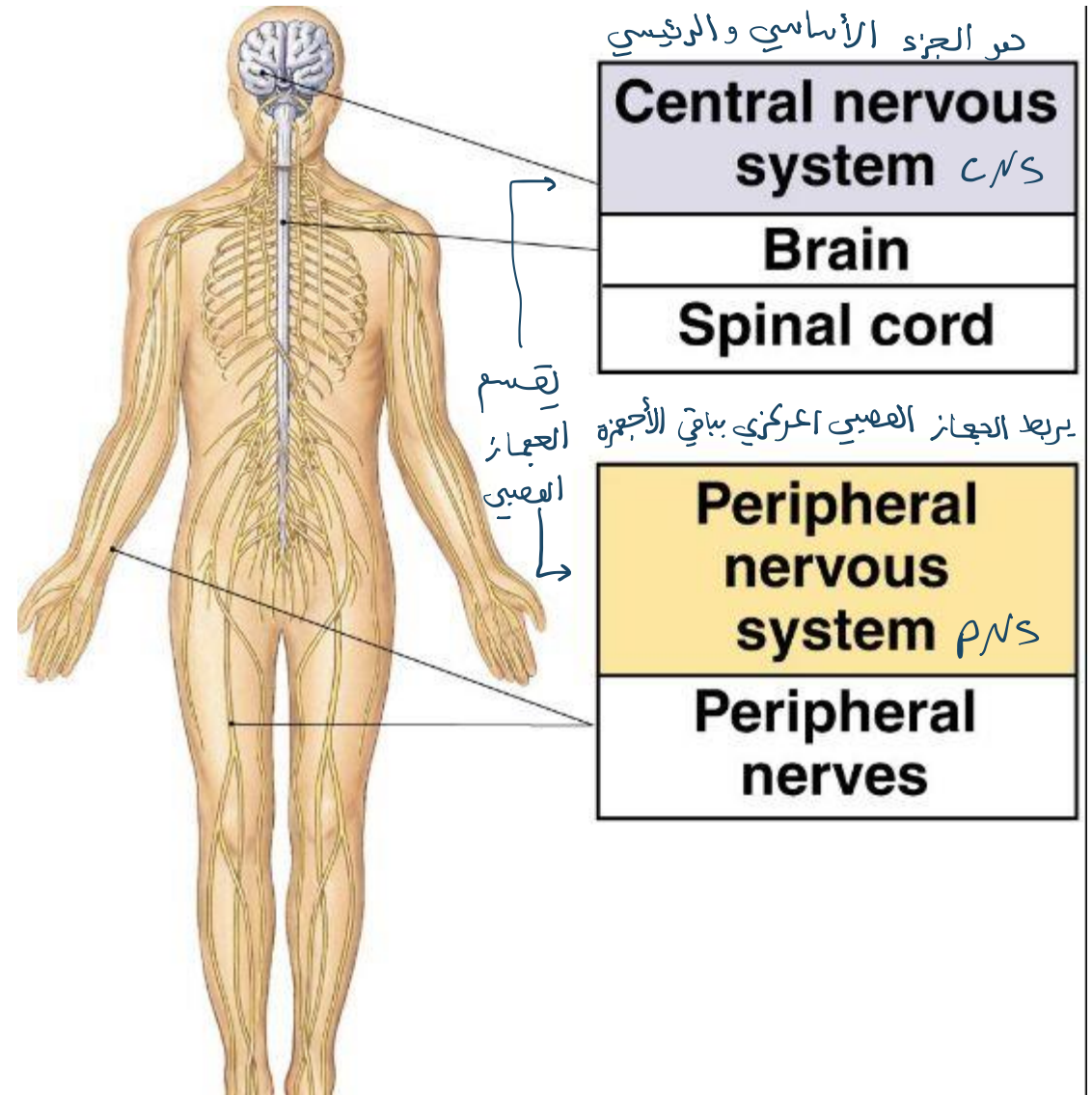
1. Discuss **central nervous system (CNS)** as well as **peripheral nervous system (PNS)**.
2. Describe **functions of the nervous system**.
3. Explore **classification of neurons**.

(Pages 400- 408 of the reference)

General Overview

The nervous system is one of the smallest (3% of the total body weight) but the most complex of the 11 body systems.

أصغر جهاز كوزن بالنسبة لباقي الأجهزة ولكنه
الأهم



12 Cranial Nerves

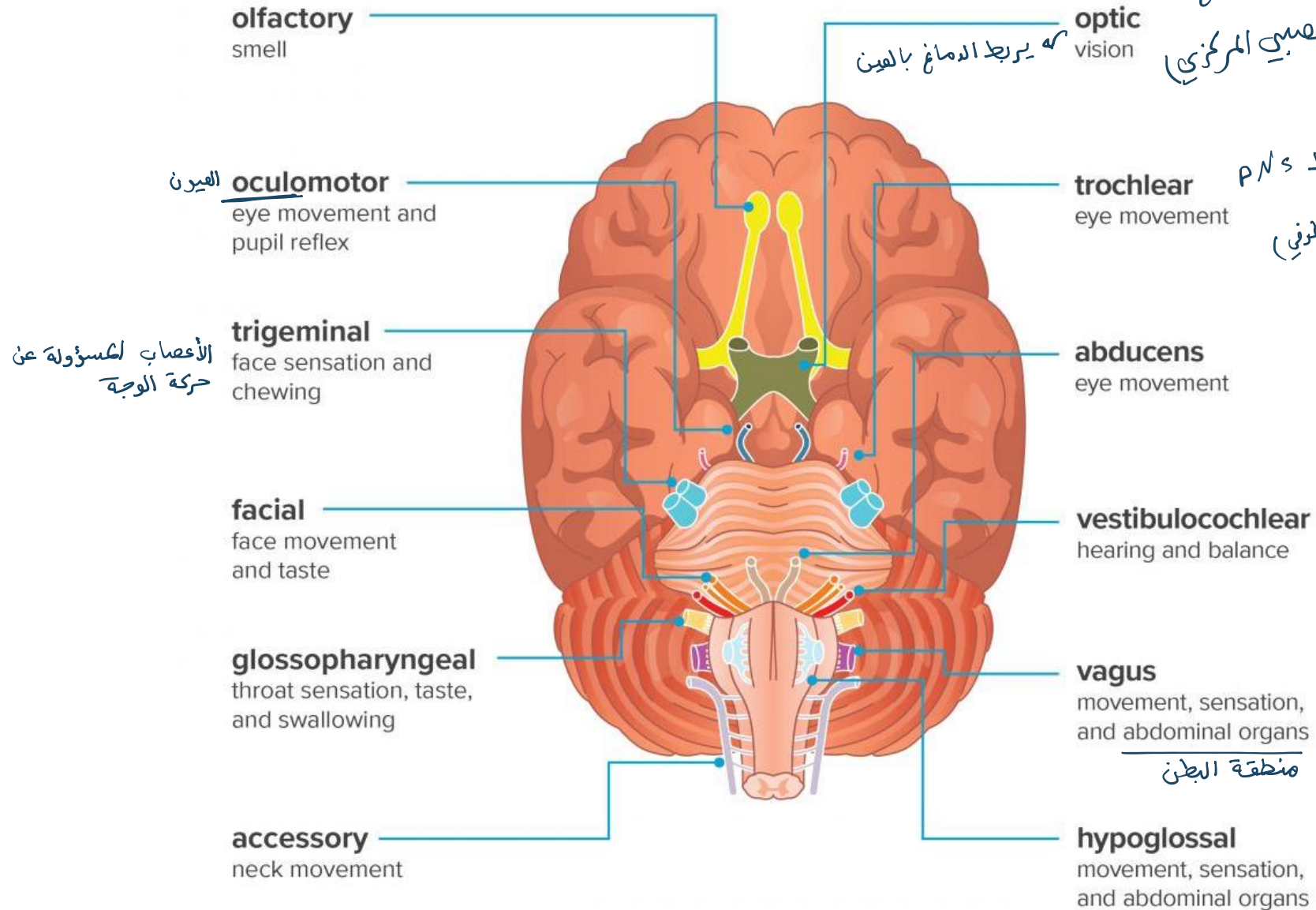
الأعصاب التي تخرج من
منطقة الدماغ

الجهاز العصبي المركزي



تتصل بالأعضاء

الجهاز العصبي الطرفي



الأعصاب المسؤولة عن
حركة الوجه

منطقة البطن

Spinal Nerve Function

Every Cell of Your Body Has a Nerve Component

تخرج هذه الأعصاب من الجبل الشوكي

VERTEBRAL LEVEL	NERVE ROOT*	INNERVATION	POSSIBLE SYMPTOMS
C1	C1	Intracranial Blood Vessels	Headaches • Migraine Headaches
C2	C2	• Eyes • Lacrimal Gland	• Dizziness • Sinus Problems
C3	C3	• Parotid Gland • Scalp	• Allergies • Head Colds • Fatigue
C4	C4	• Base of Skull • Neck	• Vision Problems • Runny Nose
C5	C5	Muscles • Diaphragm	• Sore Throat • Stiff Neck
C6	C6	• Neck Muscles • Shoulders	• Cough • Croup • Arm Pain
C7	C7	• Elbows • Arms • Wrists	• Hand and Finger Numbness
C8	C8	• Hands • Fingers • Esophagus • Heart • Lungs • Chest	or Tingling • Asthma • Heart Conditions • High Blood Pressure
T1	T1	Arms • Esophagus	Wrist, Hand and Finger Numbness or Pain • Middle Back Pain • Congestion • Difficulty Breathing • Asthma • High Blood Pressure • Heart Conditions
T2	T2	• Heart • Lungs • Chest	• Bronchitis • Pneumonia
T3	T3	• Larynx • Trachea	• Gallbladder Conditions
T4	T4		• Jaundice • Liver Conditions
T5	T5	Gallbladder • Liver	• Stomach Problems • Ulcers
T6	T6	• Diaphragm • Stomach	• Gastritis • Kidney Problems
T7	T7	• Pancreas • Spleen	
T8	T8	• Kidneys • Small Intestine	
T9	T9	• Appendix • Adrenals	
T10	T10		
T11	T11	Small Intestines • Colon • Uterus	
T12	T12	Uterus • Colon • Buttocks	
L1	L1	Large Intestines	Constipation • Colitis • Diarrhea
L2	L2	• Buttocks • Groin	• Gas Pain • Irritable Bowel
L3	L3	• Reproductive Organs	• Bladder Problems • Menstrual Problems • Low Back Pain
L4	L4	• Colon • Thighs • Knees	• Pain or Numbness in Legs
L5	L5	• Legs • Feet	
S1	S1	Buttocks • Reproductive Organs • Bladder	Constipation • Diarrhea • Bladder Problems • Menstrual Problems
S2	S2	• Prostate Gland • Legs	• Lower Back Pain • Pain or Numbness in Legs
S3	S3	• Ankles • Feet • Toes	

REFERENCES:
C.J. D., Ph.D., *Neuroanatomy*, 4th Edition, Lippincott Williams & Wilkins, 2002.

Undel, E. R., Schwartz, J. H., Russell, T. M., *Principles of Neural Science*, Appleton & Lange, 1999.

Oppenfeld, S. M.D., *Physical Examination of the Spine and Extremities*, Appleton-Century-Crofts, 1976.

Netter, K. H., D., *The Ciba Collection of Medical Illustrations*, Vol. 1, *Anatomy and Physiology*, Ciba Pharmaceutical Division, New York, 1991.

إلى أين يصل السيال العصبي (المناطق التي يصلها)

Cervical Nerv

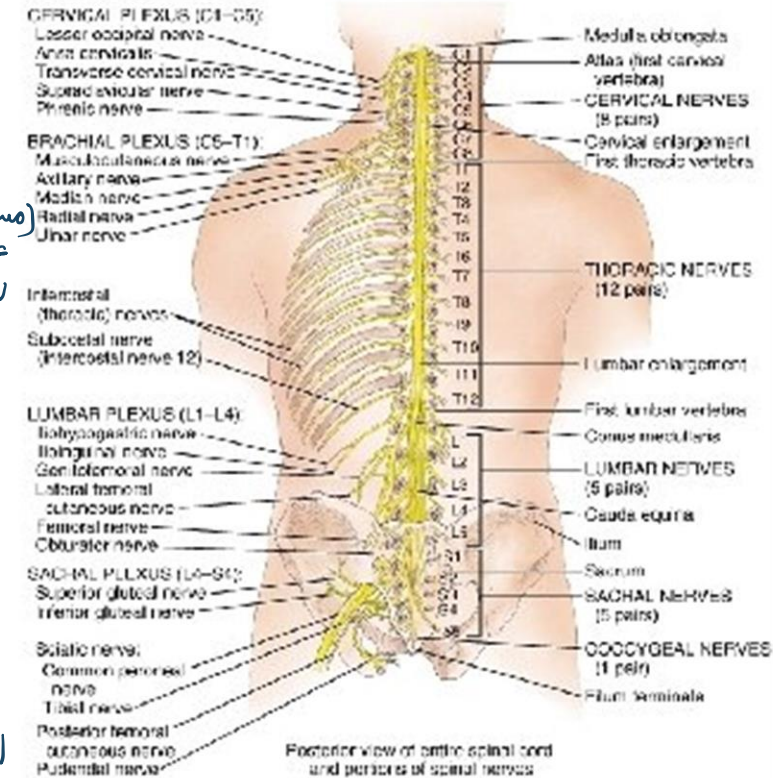
يعني لاحظت مشكلة أو عطل لهذا العصب ما هي الأعراض التي تنتج من تعطله

thoracic nerve

lumber nerve

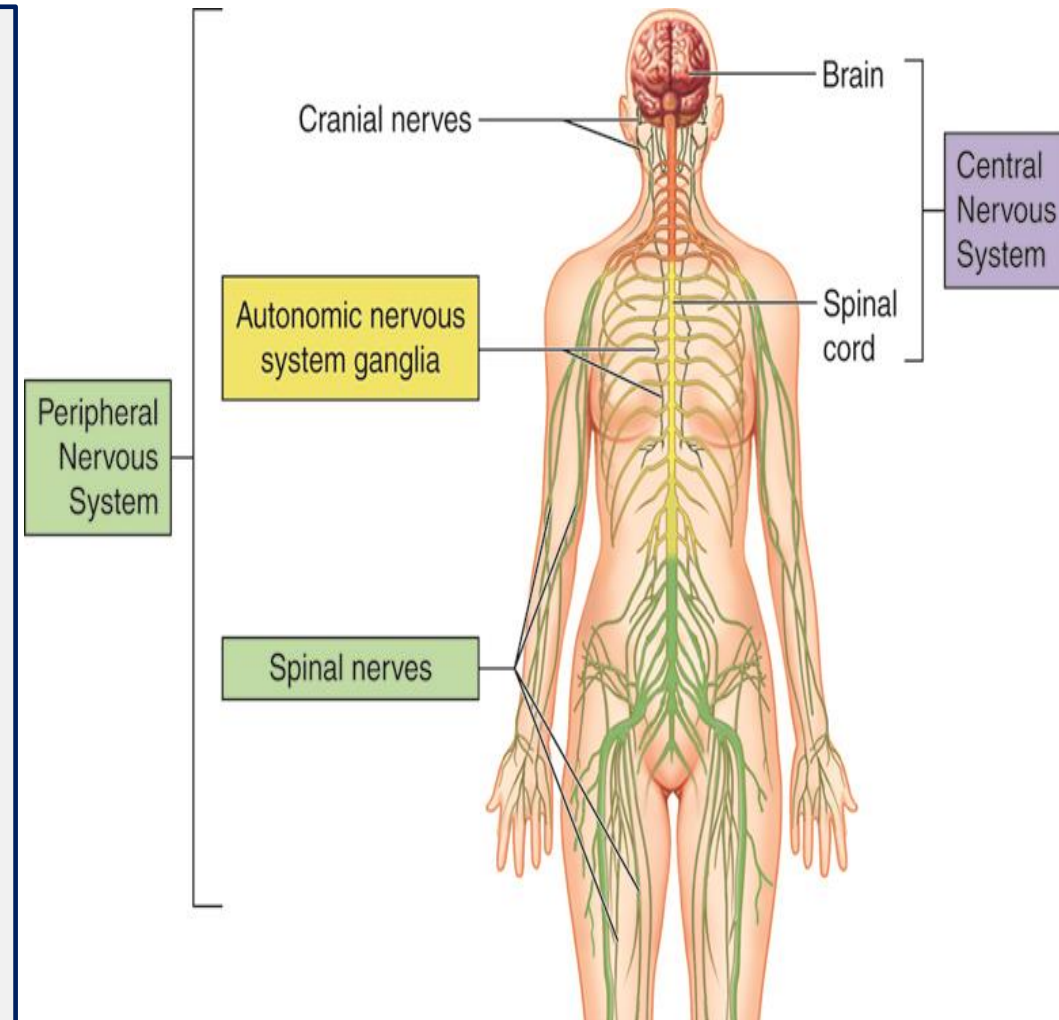
Spinal Nerves

- 31 Pairs of spinal nerves
- Named & numbered by the cord level of their origin
 - 8 pairs of cervical nerves (C1 to C8) ^{المنطقة}
 - 12 pairs of thoracic nerves (T1 to T12)
 - 5 pairs of lumbar nerves (L1 to L5) ^(الأرجل legs)
 - 5 pairs of sacral nerves (S1 to S5) ^(الأقدام feet)
 - 1 pair of coccygeal nerves ^{الوصف}
- Mixed sensory & motor nerves



NERVOUS SYSTEM

- It consists of **central nervous system (CNS)** and **peripheral nervous system (PNS)**.
- The **CNS** consists of brain (85 billion neurons) and spinal cord (100 million neurons).
خلية عصبية
- The **PNS** consists of all nervous tissue outside the CNS, which include nerves, ganglia, enteric plexuses, and sensory receptors.



PERIPHERAL NERVOUS SYSTEM

1. **Nerve** is a ^{حزمة} bundle of hundreds to thousands of axons plus associated ^{مكمية} connective tissue and blood ^{تغذية} vessels that lies outside the brain and spinal cord (i.e., **cranial nerves** emerge from the brain and **spinal nerves** emerge from the spinal cord). ^{تظهر}

2. **Ganglia** are small masses of nervous tissue, that are located outside of the brain and spinal cord. ^{عقدة عصبية}

3. **Enteric plexuses** are extensive ^{اعنطقة الحشوية} networks of neurons ^{لوجود في بداية آخر عصب} located in the walls of ^{يوصل المعلومات إلى effector} organs of the gastrointestinal tract ^{العضو الذي يقوم بالاستجابة} (regulating the digestive system). ^{واحدة النظام}

4. **Sensory receptor** refers to a structure of the nervous system that monitors changes in the external or internal environment. ^{مجموعة أعصاب تقع ضمن الجهاز الهضمي}

Nervous system

central nervous system

brain

spinal cord

peripheral nervous system

Somatic

Autonomic

Enteric

effector: skeletal muscle

cardio, glands

digestive system

smooth muscles
توجد في جدران الأعضاء الداخلية المعوية

control: involuntary
لا إرادي

involuntary controlled
لا إرادي

voluntary
إرادي

في أجزاء معينة من الجهاز و إرادي في أجزاء أخرى

semi-conscious
controlled

sympathetic

fight & flight

يُعمل على الشعور
بالحرق والفرقة
الغضب، التوتر

parasympathetic

rest & digest

يُعمل على
الراحة
والعض
يُخزن الطاقة

يختلف تأثيرهم بحسب المعنى

PERIPHERAL NERVOUS SYSTEM

كل واحد فيهم يحتوي على sensory and motor neurons

Somatic nervous system (SNS)

Autonomic nervous system (ANS)

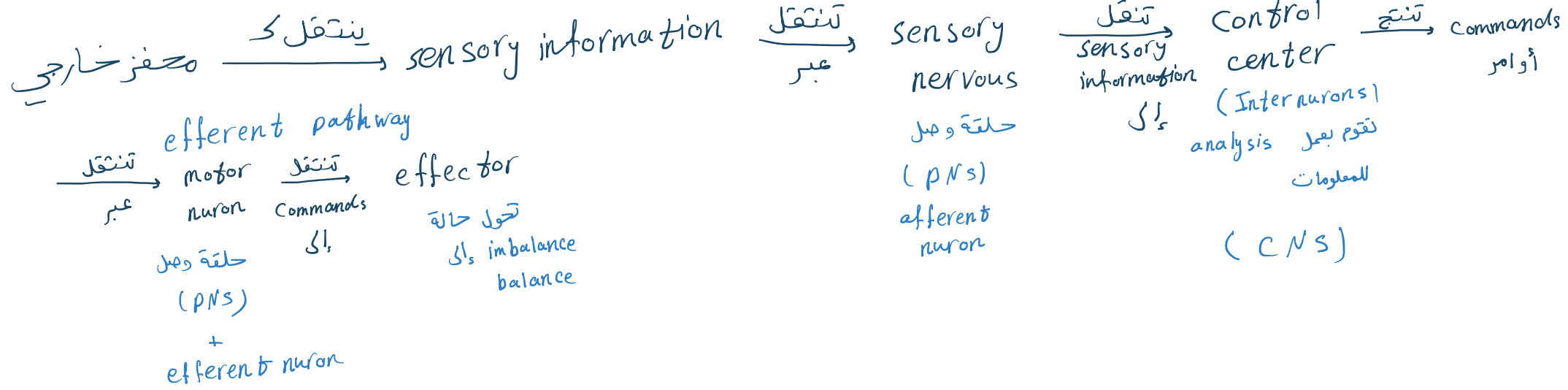
Enteric nervous system (ENS)

من
GI system
يتأثر بالجهاز الهضمي
حتى يقيم هضم الطعام
بحاجة إلى
انقباضات وإفرازات
والأعصاب

SOMATIC NERVOUS SYSTEM (SNS) (CONSCIOUSLY CONTROLLED)

من الطرفي إلى المركزي

1. **Sensory neurons** that convey information to CNS from somatic receptors in the head, body wall, and limbs and from receptors for the special senses of vision, hearing, taste, and smell.
2. **Motor neurons** that conduct impulses from the CNS to skeletal muscles only.



AUTONOMIC NERVOUS SYSTEM (ANS) (INVOLUNTARY)

1. **Sensory neurons** that convey information to CNS from autonomic sensory receptors, located primarily in visceral organs such as the stomach and lungs.

الأعضاء الحشوية

2. **Motor neurons** that conduct nerve impulses from the CNS to smooth muscle, cardiac muscle, and glands.

Note: The motor part of the ANS consists of two branches, the **sympathetic division** and the **parasympathetic division**.

fight & flight
تحفيز

rest & digest
تقليل

ENTERIC NERVOUS SYSTEM (ENS) (THE BRAIN OF THE GUT) (INVOLUNTARY)

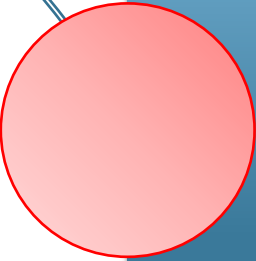
القناة الهضمية

1. **Sensory neurons** of the ENS monitor chemical changes within the GI tract as well as the stretching of its walls.
gastrointestinal *نَمْد*
2. **Motor neurons** govern contractions of GI tract smooth muscle to propel food through the GI tract, secretions of GI tract organs (such as acid from the stomach and hormones from GI tract endocrine cells).
تَدَكُم بِالْقَلْبَلَات
يَدْفَعُ الْأَكْلَ خِلَالِ الْقَنَاةِ الْهَضْمِيَّةِ

مثل
الإنزيمات
الهاضمية

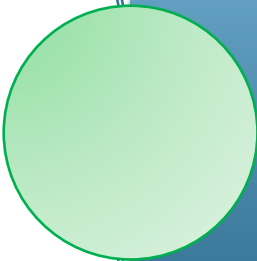
FUNCTIONS OF THE NERVOUS SYSTEM

تصنيف الأعصاب بناء على وظائفهم



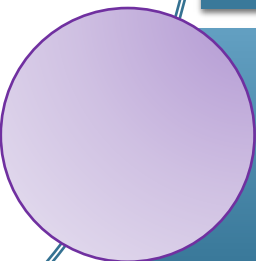
Sensory function (detecting internal stimuli or external stimuli through cranial and spinal nerves).

بالجهاز العصبي المركزي



Integrative function (analyzing sensory information and making decisions for appropriate responses).

استجابة



Motor function (eliciting an appropriate motor response by activating effectors (muscles and glands) through cranial and spinal nerves).

العنصر الذي يتأثر
ويقوم بالاستجابة

NERVOUS TISSUE

وظيفتها: إنتاج السائل العصبي والعمل على إنتقاله (propagation)

Neurons (provide most of the unique functions of the nervous system, such as sensing as they connect all regions of the body to the brain and spinal cord). No ability to undergo dividing throughout an individual's lifetime.

الخلايا العصبية لا تتجدد + لا تنقسم

الخلايا الدبقية

Neuroglia (support and protect neurons, and maintain the interstitial fluid that bathes them) (they outnumber neurons). It has a continuous ability to divide throughout an individual's lifetime.

neuroglia تنقسم وتتجدد ولكن لا تنتج سيلات عصبية أو تعمل على إنتقالها

(تتجاوز عدد neurons)

- تكون موجودة حول neurons

الوظائف:

- توفر بيئة مناسبة لإنتاج السائل العصبي

- تحافظ على neuron من المواد السامة

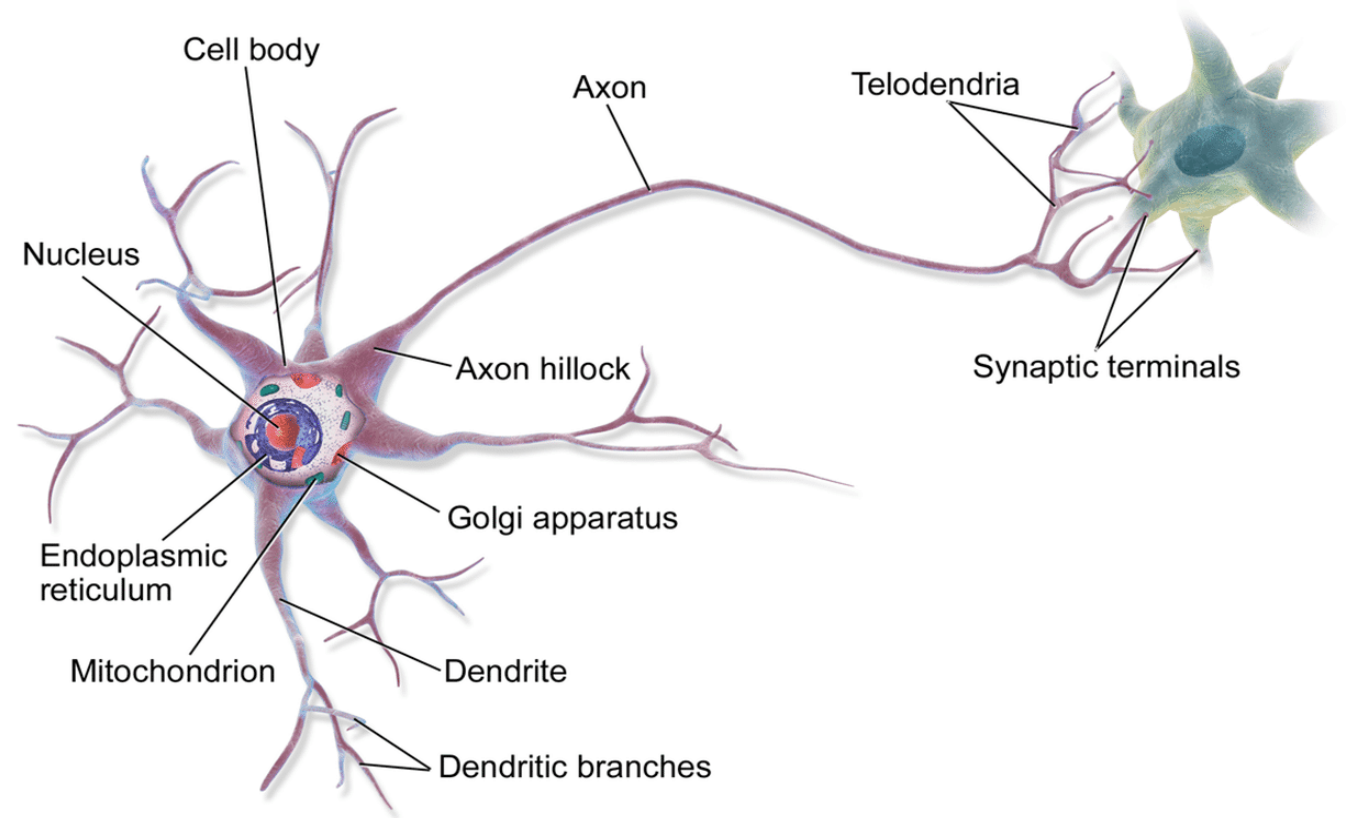
- تحافظ على الإستقرار الداخلي

- تسرع انتقال السائل العصبي من خلال إنتاج myelin sheath

The neuron has the ability to respond to a stimulus and convert it into an action potential (nerve impulses).

The cell body contains free ribosomes and rough endoplasmic reticulum for synthesizing new proteins. .

Neuron



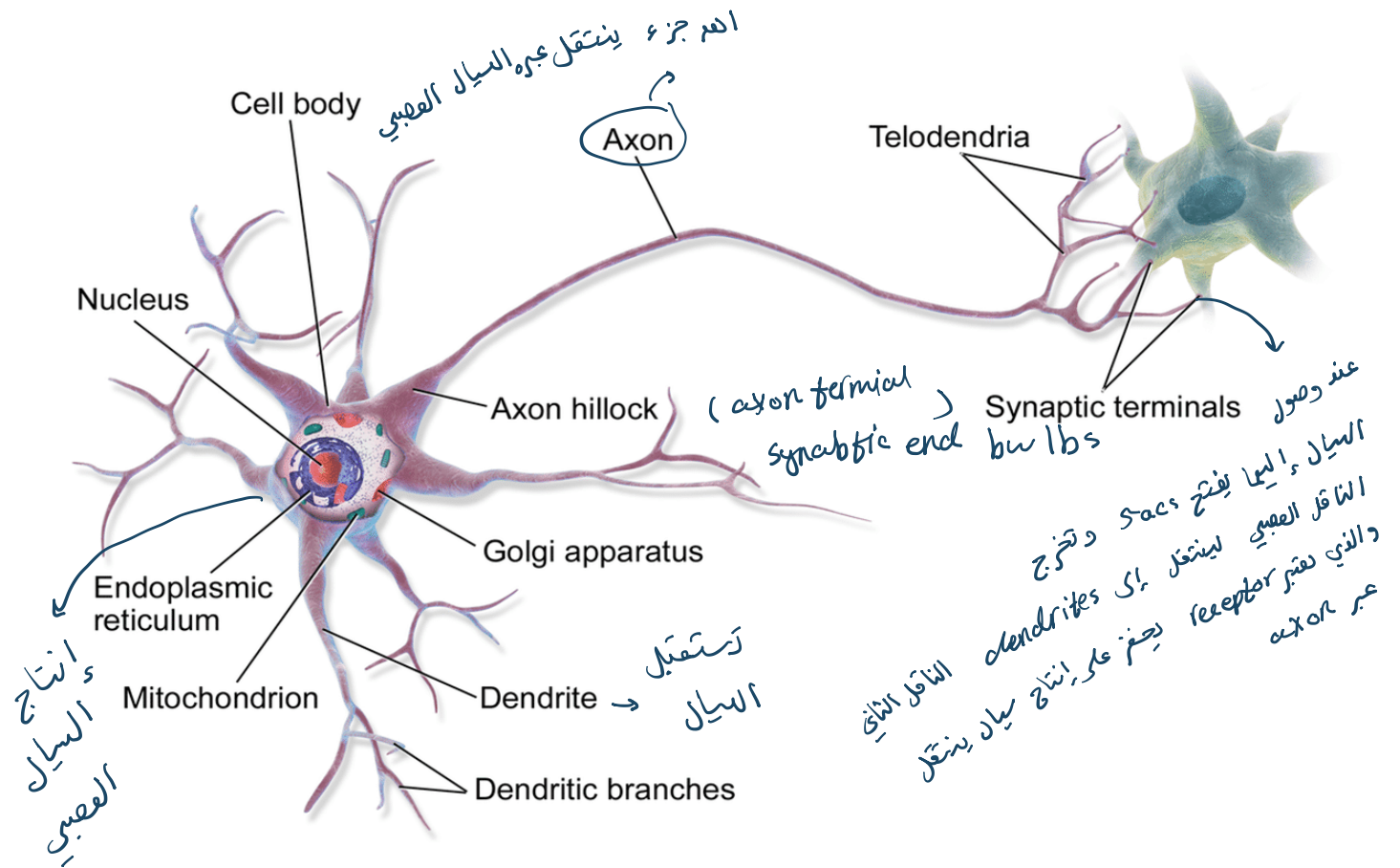
المركز الحسي في العصب أول من يستقبل
stimulus

The dendrites (like little trees) are the receiving or input portions of a neuron because they contain numerous receptor sites for binding chemical messengers from other cells.

cell body
تستقبل المعلومات
وتنقلها إلى axon
وتساعد على إنتاج سائل عصبي

يعني تستقبل المعلومات
أو الإشارات العصبية
وتدخلها إلى الخلية
العصبية

Neuron

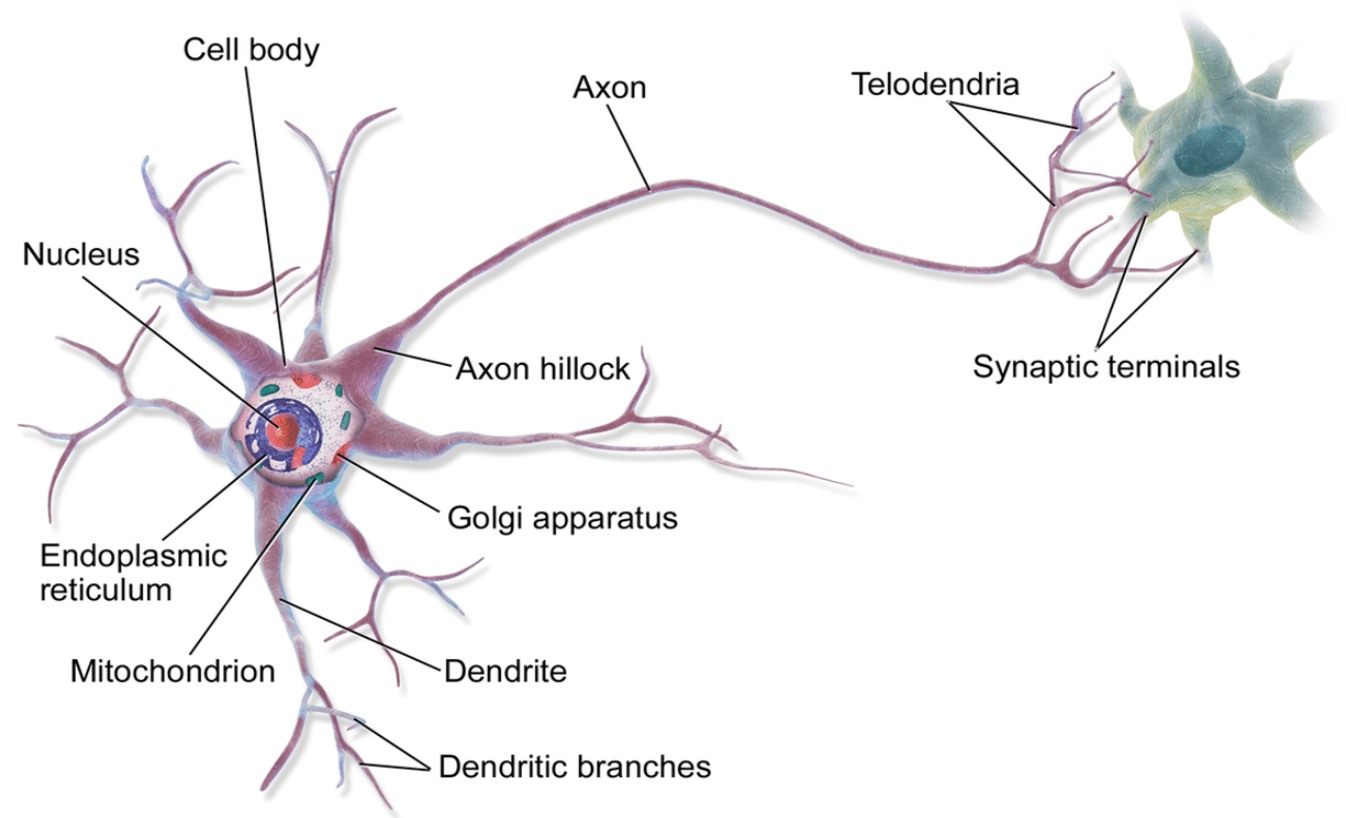


The single axon (long and thin projection) of a neuron ^{انتقال مستمر} propagates nerve impulses toward another neuron, a muscle fiber, or a gland cell.

The axon ends by dividing into many fine processes called axon terminals.

له ينتهي التفرع بالعديد من النهايات
الدقيقة التي تقوم بإرسال الإشارات العصبية
إلى خلايا عصبية أخرى أو الخلايا العضلية أو الغدد

Neuron

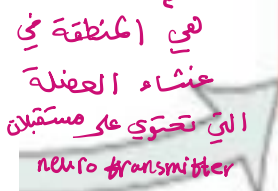


SYNAPSE

- **Synapse** is the site of communication between two neurons or between a neuron and an effector cell.

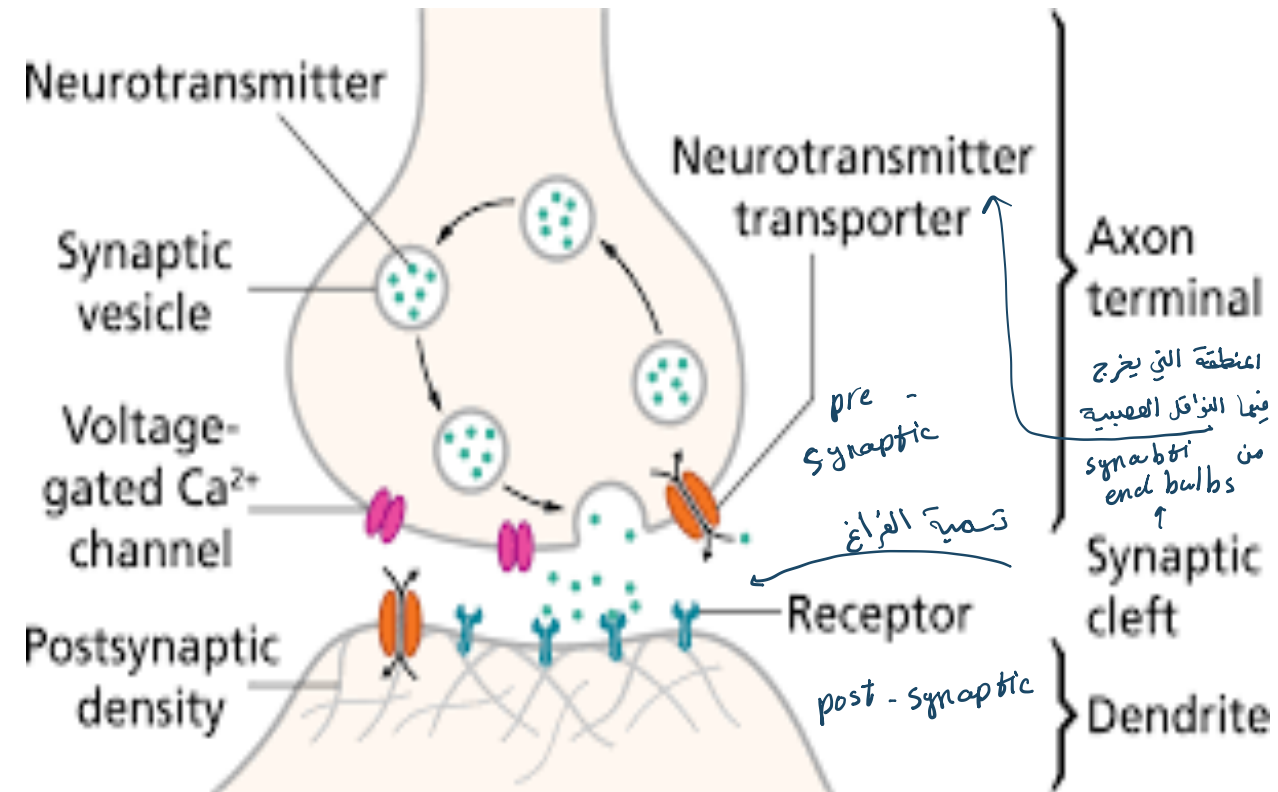
- Some axon terminals swell into bulb-shaped structures called **synaptic end bulbs**.

ناقل عصبی



SYNAPSE

- **Neurotransmitter** is a molecule released from a synaptic vesicle to excite or inhibit another neuron, muscle fiber, or gland cell.
- Many neurons have two or even three types of neurotransmitters, each with different effects on the **postsynaptic cell**.



موجود قبل نهاية الأعصاب قبل → ganglion
ما يوجد effector

ارتباط ناقل عصبي بالمستقبل يؤدي إلى
إحداث تغييرات في الخلية مثل تغير التراكيب

CLASSIFICATION OF NEURONS

1. **Structural Classification** (according to the number of processes extending from the cell body).

التي تخرج

2. **Functional Classification** (according to the direction in which the nerve impulse (action potential) is conveyed with respect to the CNS).

sensor, motor, entry

نسبة إلى

STRUCTURAL CLASSIFICATION

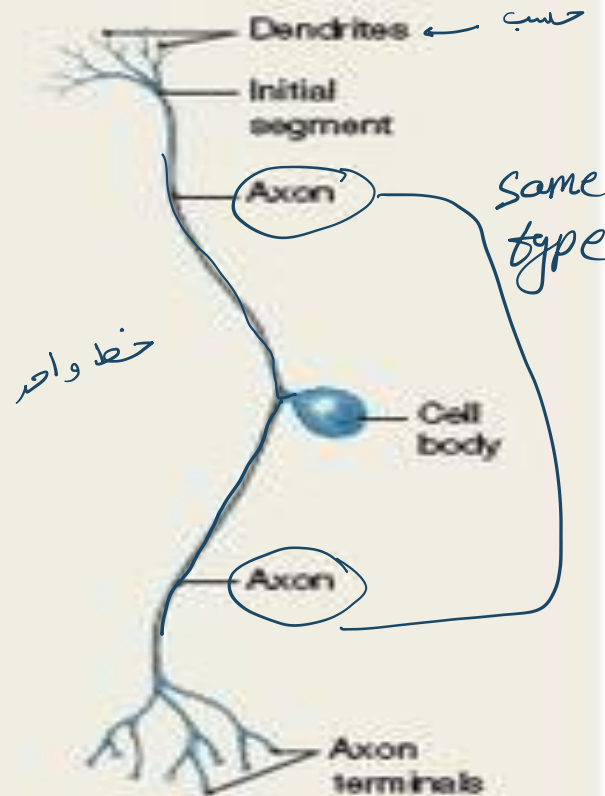
b Bipolar neuron

Bipolar neurons have two processes separated by the cell body.



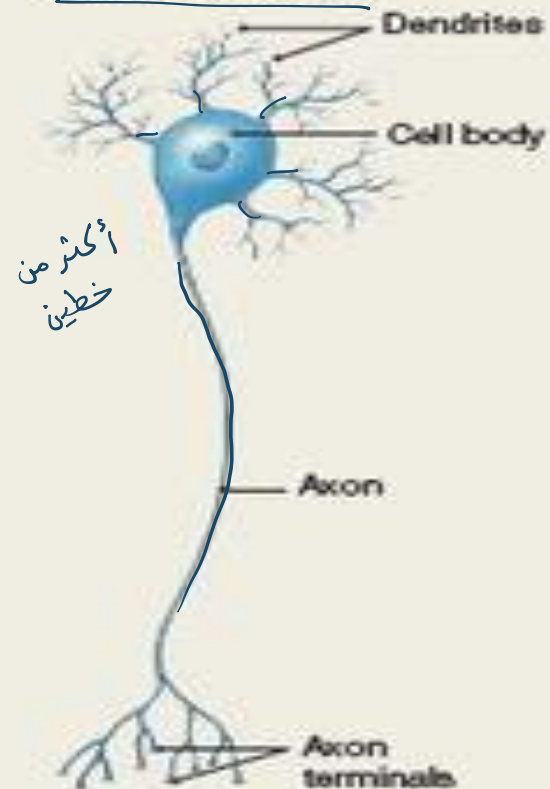
c Unipolar neuron

Unipolar neurons have a single elongated process, with the cell body located off to the side.



d Multipolar neuron

Multipolar neurons have more than two processes; there is a single axon and multiple dendrites.



متعدد
الأقطاب

لا نقوم بعد
axons أو dendrites
نقوم بعد عدد الخطوط
التي تخرج من cell body

STRUCTURAL CLASSIFICATION

- A **multipolar neuron** has many processes extending from the cell body, a **bipolar neuron** has two, and a **unipolar neuron** has one.
- **Multipolar neurons** have several dendrites and one axon (i.e., neurons in the brain and spinal cord). They are found as motor neurons (all) and interneurons (many).

الحبل الشوكي

STRUCTURAL CLASSIFICATION

- **Bipolar neurons** have one main dendrite and one axon (i.e., neurons in the retina of the eye, the inner ear, and the olfactory area of the brain. Some of them are found as sensory neurons. ^{الشم}
- **Unipolar neurons** have ~~dendrites~~ and one axon that are fused together to form a continuous process that emerges from the cell body. They are found as most of the body's sensory neurons.

Sensory neurons (most) ~~leaves~~ unipolar

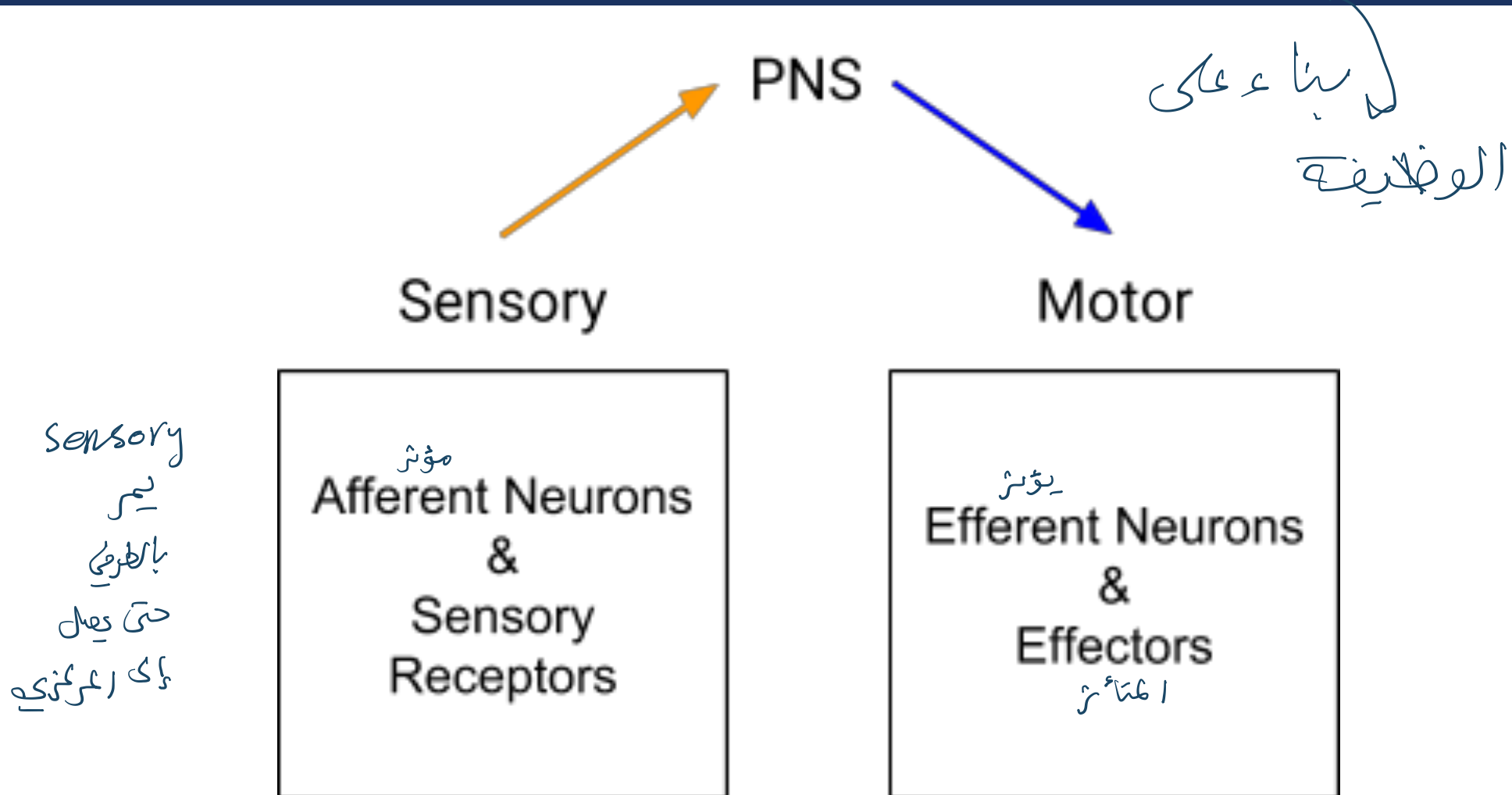
جزء منها → Bipolar

motor neurons $\xrightarrow{\text{Levea}}$ multipolar

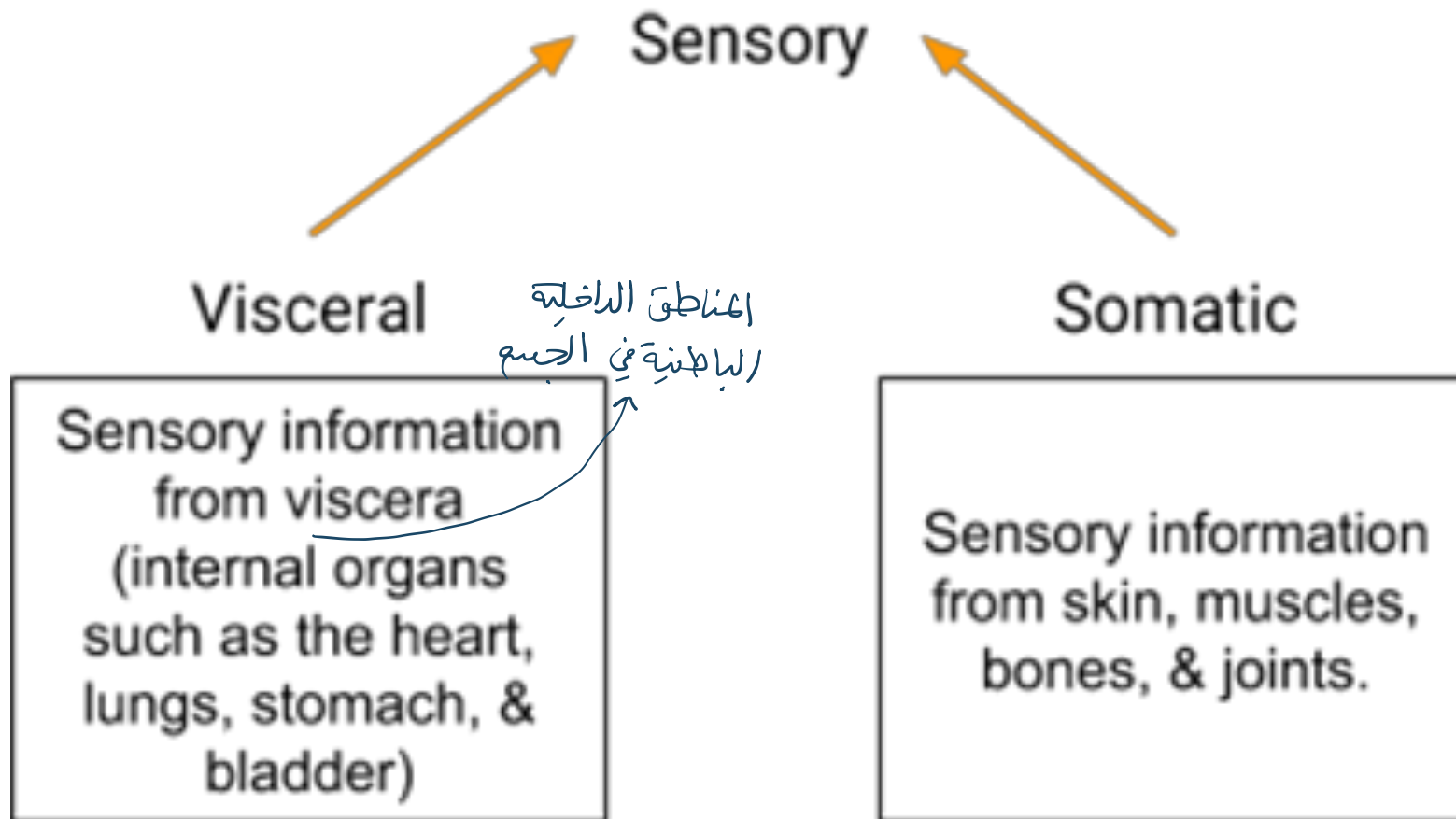
Inter neurons $\xrightarrow{\text{Labels}}$ multipolar

الباقي $\rightarrow$ Bipolar

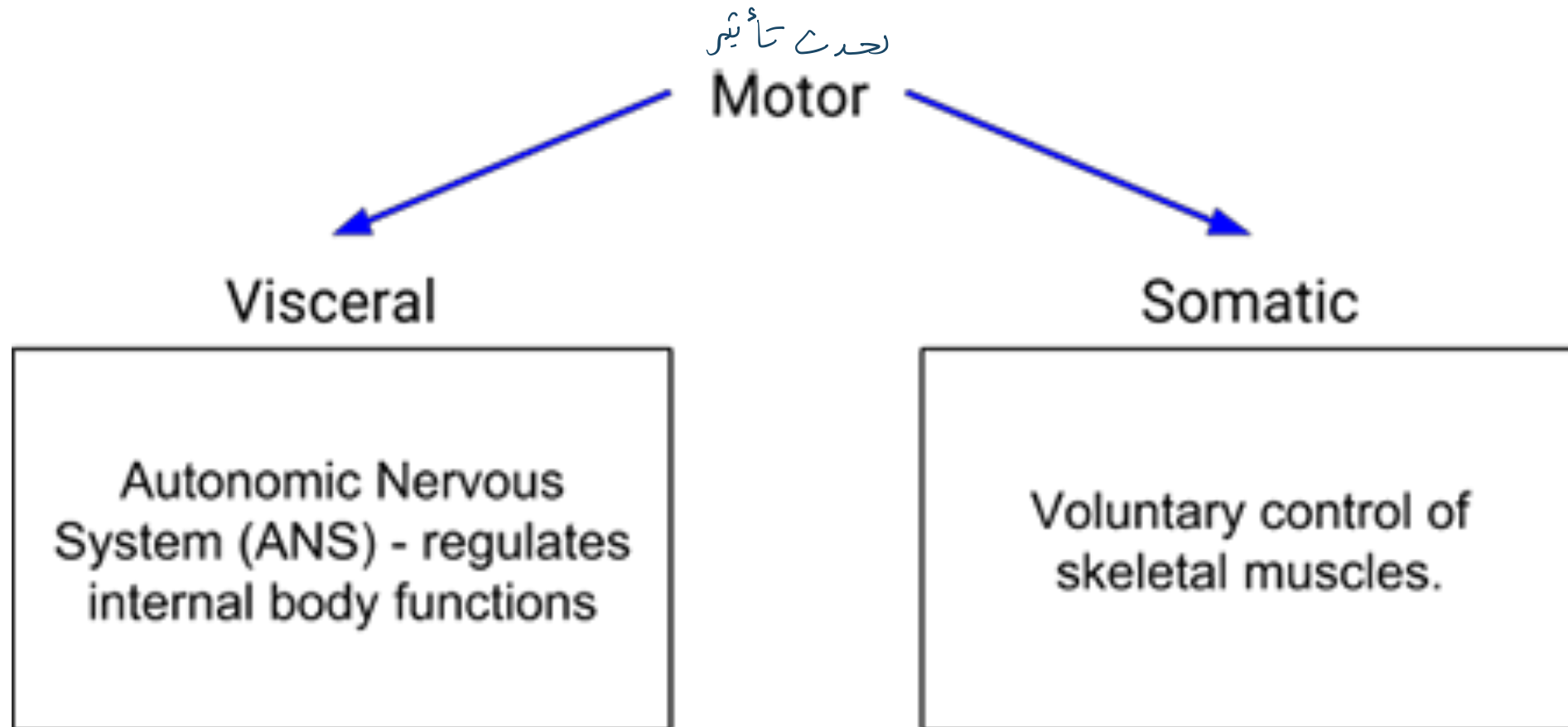
FUNCTIONAL CLASSIFICATION



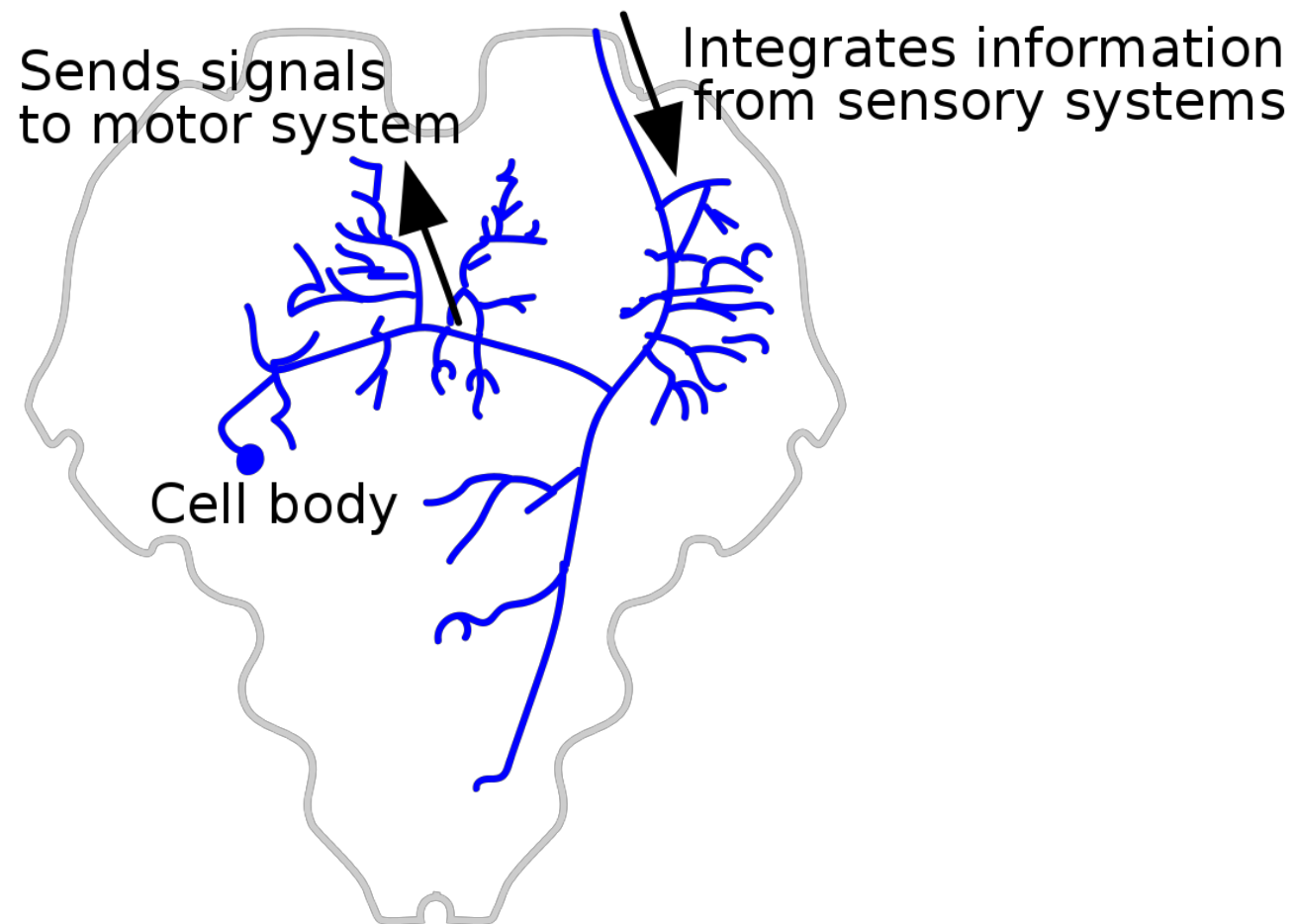
SENSORY OR AFFERENT NEURONS



MOTOR OR EFFERENT NEURONS



INTERNEURONS OR ASSOCIATION NEURONS



(تحليل)

FUNCTIONAL CLASSIFICATION

- **Sensory or afferent neurons (most are unipolar):** appropriate stimulus activates a sensory receptor; the sensory neuron forms an action potential in its axon and the action potential is conveyed into the CNS through cranial or spinal nerves. Most sensory neurons are unipolar in structure.
- **Motor or efferent neurons (most are multipolar):** convey action potentials (commands) away from the CNS to effectors (muscles and glands) through cranial or spinal nerves.

FUNCTIONAL CLASSIFICATION

- **Interneurons or association neurons (most are multipolar):**

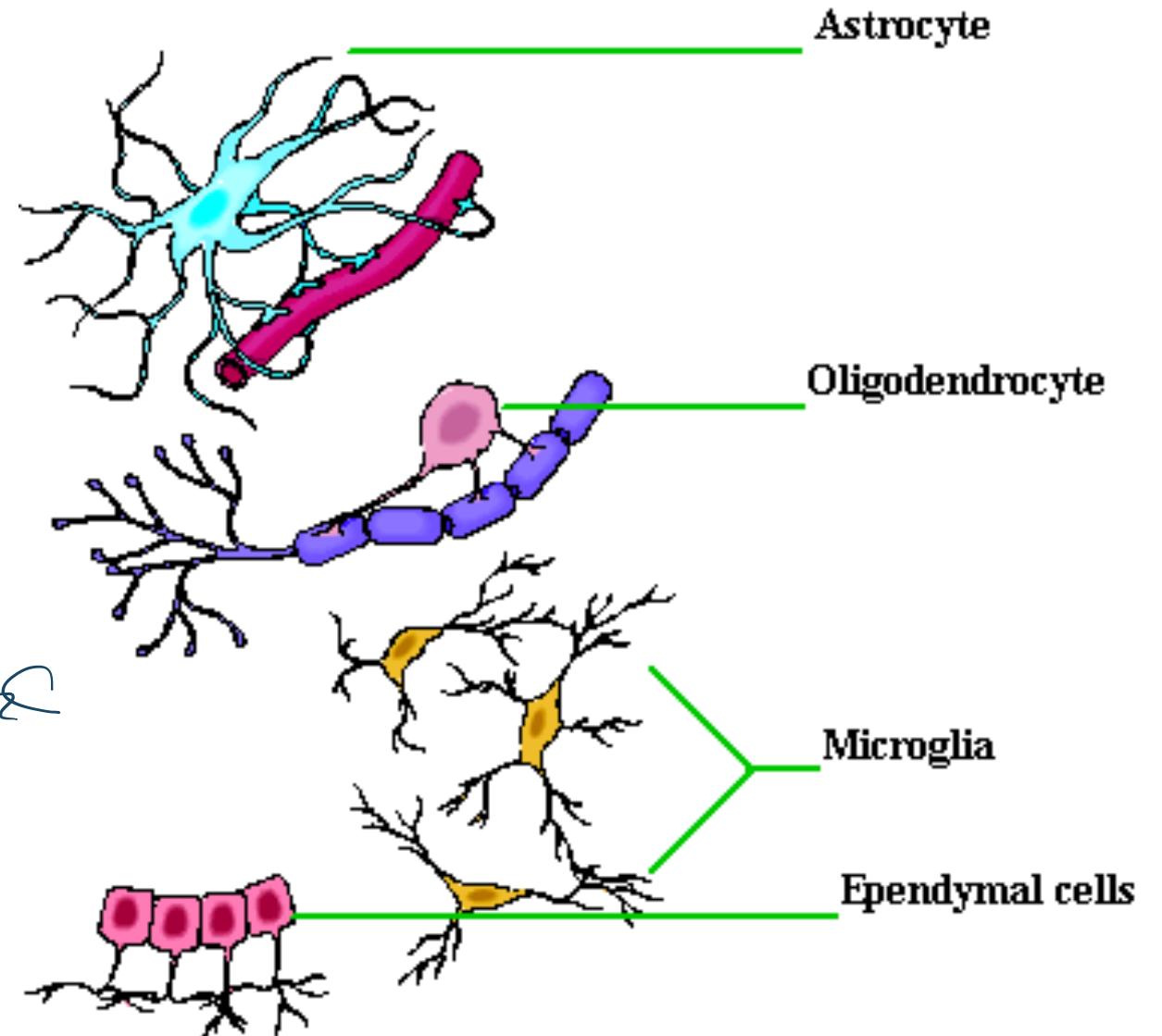
- They are located within the CNS (brain and spinal cord) between sensory and motor neurons.
- They integrate the incoming sensory information from sensory neurons (transmit action potential from one neuron to another) and then elicit a motor response by activating the appropriate motor neurons.
- Main functions are thinking, memory, decision making.

في الجهاز العصبي
المركزي

NEUROGLIA

- In contrast to neurons, neuroglia **do not generate** or propagate **action potentials**, and they **can multiply and divide** in the mature nervous system.
- Neuroglia of the CNS can be classified into four types: astrocytes, oligodendrocytes, microglial cells, and ependymal cells.

Neuroglial Cells of the CNS



ASTROCYTES

1. **Support neurons.**
2. **Isolate neurons** of the CNS from various potentially **harmful substances** in blood.
تحمي من الخطر
3. **Regulate** the growth, migration, and interconnection among **neurons** in the brain.
4. **Maintain** ^{محافظة} the appropriate chemical environment for the generation of **nerve impulses**.
لن يسمح إنتاج سيال بدون تدخل الأيونات
5. Play a role in **learning and memory** by influencing the formation of neural synapses.
من خلال التأثير على تكوين السيلات العصبية

OLIGODENDROCYTES

- They are forming and maintaining the myelin sheath which increases the speed of nerve impulse conduction around CNS axons. (containing interneurons)

نقل ما
من pre-ganglion neuron على myelin sheath (myelinated pre-ganglion neuron)

MICROGLIA

الخلايا / الأنسجة الميتة / الضام

- They remove cellular debris formed during normal development of the nervous system and phagocytize microbes and damaged nervous tissue.

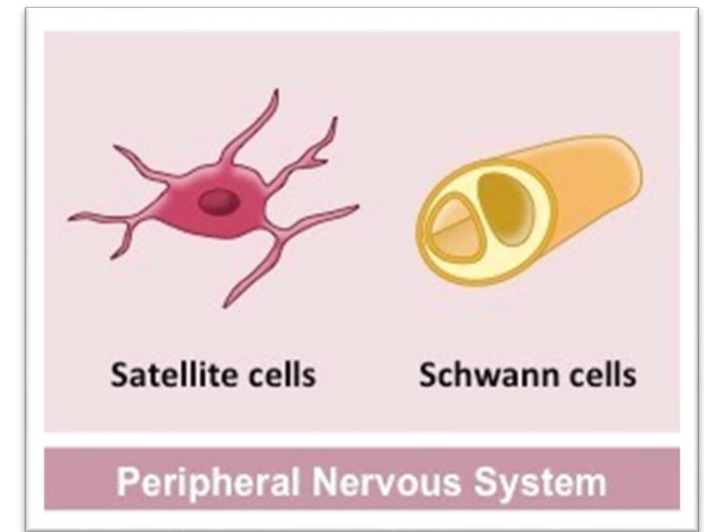
EPENDYMAL CELLS

تدوير السائل حتى يتم توزيعه بشكل فعال لضمان حماية الدماغ والحبل الشوكي

- They produce and assist in the circulation of cerebrospinal fluid.

السائل تحت الجمجمة لحماية الدماغ

NEUROGLIA OF THE PNS



- The two types of glial cells in the PNS are **Schwann cells and Satellite cells.**

شوان

SCHWANN CELLS

- They form the myelin sheath around axons and participate in axon regeneration. (containing sensory and motor neurons).

خلايا شوان تساعد في تكوين غمد مياليني حول المحاور العصبية في الجهاز العصبي المحيطي ، مما يزيد من سرعة نقل الإشارات العصبية ، وتساهم أيضاً في إصلاح وتجديد الأعصاب إذا تعرضت للتلف .

SATELLITE CELLS

- They provide structural support and regulate the exchanges of materials between neuronal cell bodies and interstitial fluid.

تساعد على نقل المواد الغذائية للخلية العصبية والدماغ



THANK YOU

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