بسم الله الرحمن الرحيم

DOPAMINE SCIENTIFIC TEAM

Neurology

FINAL | Lecture 2

﴿إِنِّي تَوَكَّلْتُ عَلَى اللَّهِ رَبِّي وَرَبِّكُمْ ۚ مَّا مِن دَابَّةٍ إِلَّا هُوَ آخِذٌ بِنَاصِيَتِهَا ۚ إِنَّ رَبِّي عَلَىٰ صِرَاطٍ مُّسْتَقِيمٍ﴾

Written by: Sadeel Al-hawawsheh
Raya Al Weshah

CLINICAL

رحلة اليقين مع سورة يس

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

أَوَلَيۡسَ ٱلَّذِي خَلَقَ ٱلسَّمَٰوَٰتِ وَٱلۡأَرۡضَ بِقَٰدِرٍ عَلَىٰٓ أَن يَخۡلُقَ مِثۡلَهُمۚ بَلَىٰ وَهُوَ ٱلۡخَلَّٰقُ ٱلۡعَلِيمُ (٨١) إِنَّمَآ أَمۡرُهُۥٓ إِذَآ أَرَادَ شَيۡـًٔا أَن يَقُولَ لَهُۥ كُن فَيَكُونُ (٨٢) فَسُبۡحَٰنَ ٱلَّذِي بِيَدِهِۦ مَلَكُوتُ كُلِّ شَيۡءٖ وَإِلَيۡهِ تُرۡجَعُونَ (٨٣)

أو ليس الذي خلق السموات والأرض وما فيهما بقادر على أن يخلق مثلهم، فيعيدهم كما بدأهم؟ بلى، إنه قادر على ذلك، وهو الخلاق لجميع المخلوقات، العليم بكل ما خلق ويَخْلُقُ، لا يخفى عليه شيءإنما أمره سبحانه وتعالى إذا أراد شيئًا أن يقول له: «كن» فيكون، ومن ذلك الإماتة والإحياء، والبعث والنشور.

{فَسُبۡحَٰنَ ٱلَّذِي بِيَدِهِۦ مَلَكُوتُ كُلِّ شَيۡءٖ وَإِلَيۡهِ تُرۡجَعُونَ} فتنزه الله تعالى وتقدس عن العجز والشرك، فهو المالك لكل شيء، المتصرف في شؤون خلقه بلا منازع أو ممانع، وقد ظهرت دلائل قدرته، وتمام نعمته، وإليه تُرجعون للحساب والجزاء.

الحمدلله، اللهم تقبّل منّا هذا العمل، واجعلنا من الذين يستمعون القول فيتبعون أحسنه.

Introduction to The Nervous System

Neurology Division

The University of Jordan

المحاضرة جدا سهلة وممتعة واغلبها أشياء مكررة

لا تنسوا الصلاة والدعاء لأهلنا المستضعفين

وبسم الله نبدأ :)

Central Nervous System (CNS)

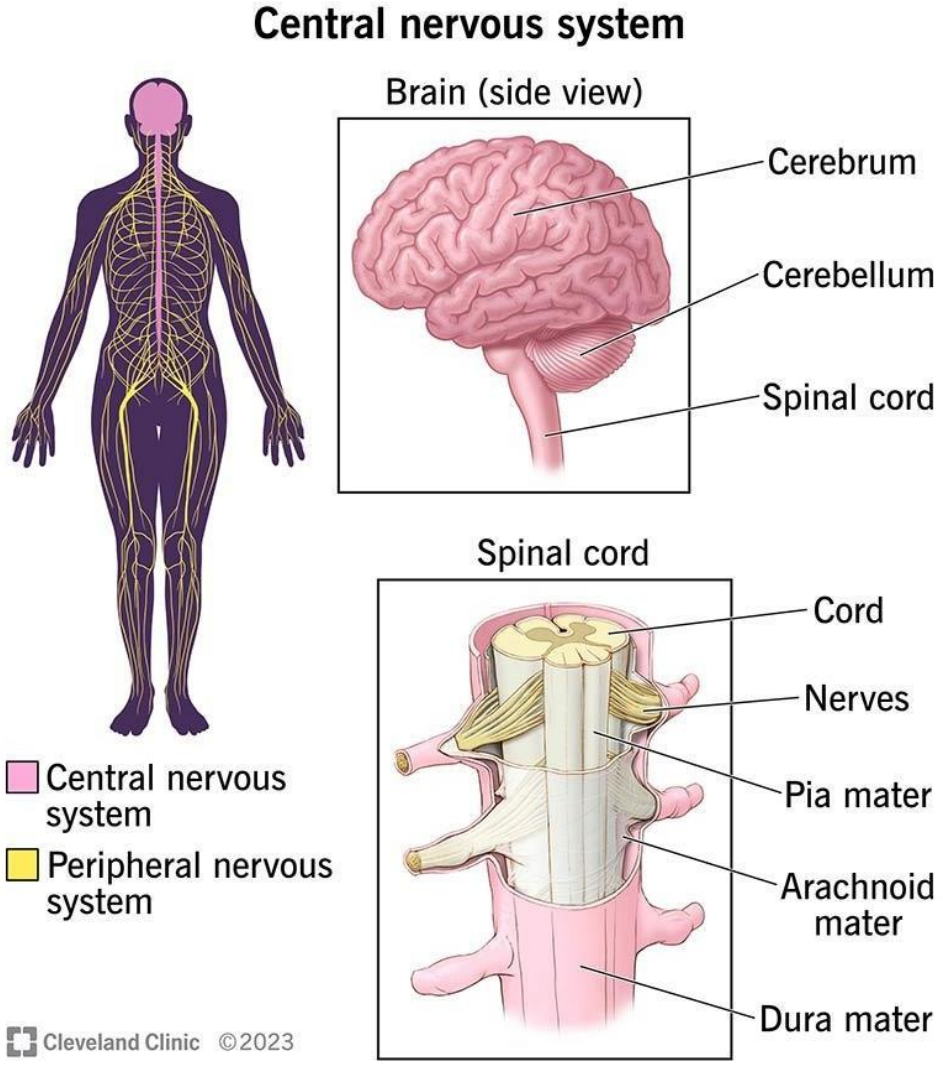
The nervous system is classified into two main parts: the **central nervous system** (CNS) and the **peripheral nervous system** (PNS). Regarding the **CNS**:

- **Brain** and **spinal cord**
- **Integration** and **processing** center
- Protected by **skull (brain)** & **vertebrae (spinal cord)**

Central Nervous System (CNS)

The brain is composed of several major parts:

- **Cerebrum (Cerebral Cortex):** The cerebrum consists of **two** hemispheres; **the right and left cerebral hemispheres.**
- **Cerebellum**: The cerebellum is located beneath the cerebrum. It plays a crucial role in maintaining **balance** and **coordination**. Therefore, if a patient presents with **imbalance**, one possible cause could be **cerebellar involvement**, such as a **cerebellar mass, disease, or lesion.**
- **Brainstem**: The brainstem is a small structure located anterior to the cerebellum. It consists of three parts: **Midbrain, Pons and Medulla oblongata.** It is responsible for controlling **the level of consciousness** and contains the **nuclei of most cranial nerves**. It is particularly important in conditions such as **coma** and **cranial nerve abnormalities.**

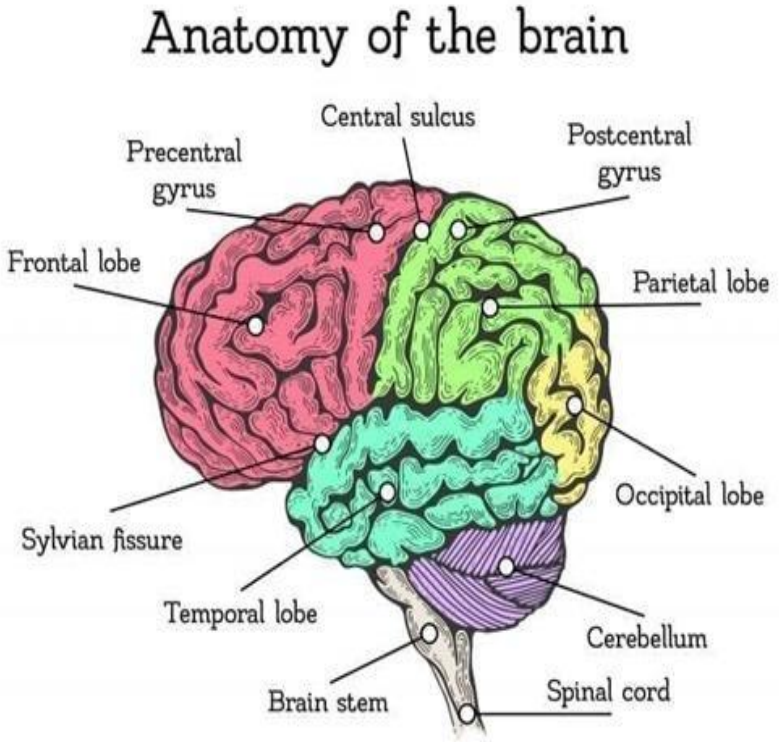


Spinal Cord

The spinal cord gives rise to **spinal nerves**. It is covered **Pia mater**, **Arachnoid mater** and **Dura mater**

Central Nervous System (CNS)

- **The brain** is divided into different lobes, each with specific functions. The **frontal lobe** is mainly responsible for **motor activity.**
- Behind it lies the **parietal lobe**, which is concerned with **somatosensory function**.
- **Frontal and parietal lobes** are separated by **the central sulcus**. Just in front of this sulcus is the **precentral gyrus**, while just behind it is the **postcentral gyrus**. Therefore, the central sulcus separates the **motor area** from the **somatosensory area**.
- **The lateral (Sylvian) fissure**, which separates the **frontal** and **parietal lobes** (located superiorly) from the **temporal lobe** (located inferiorly).
- The **occipital lobe** is responsible for vision.
- It is important to remember that each of these lobes exists in **both the right and left cerebral hemispheres.**



Central Nervous System (CNS)

The **cerebellum**, which also has **right and left hemispheres**, plays a major role in **balance**, **coordination**, and **fine motor coordination.** Proper execution of fine movements requires **precise coordination**, so when the **cerebellum is affected**, the patient develops **loss of coordination and balance**. This is especially noticeable during clinical examination.

One common test is the **finger-to-nose test**, where the patient is asked to **touch their nose and then the examiner's finger repeatedly**. In cerebellar disease, the movement becomes **irregular** and **uncoordinated**. The patient may show **intention tremor and dysmetria,** meaning they either **overshoot** or **undershoot the target.** The movement is **not smooth** and **varies in speed**, reflecting impaired coordination.

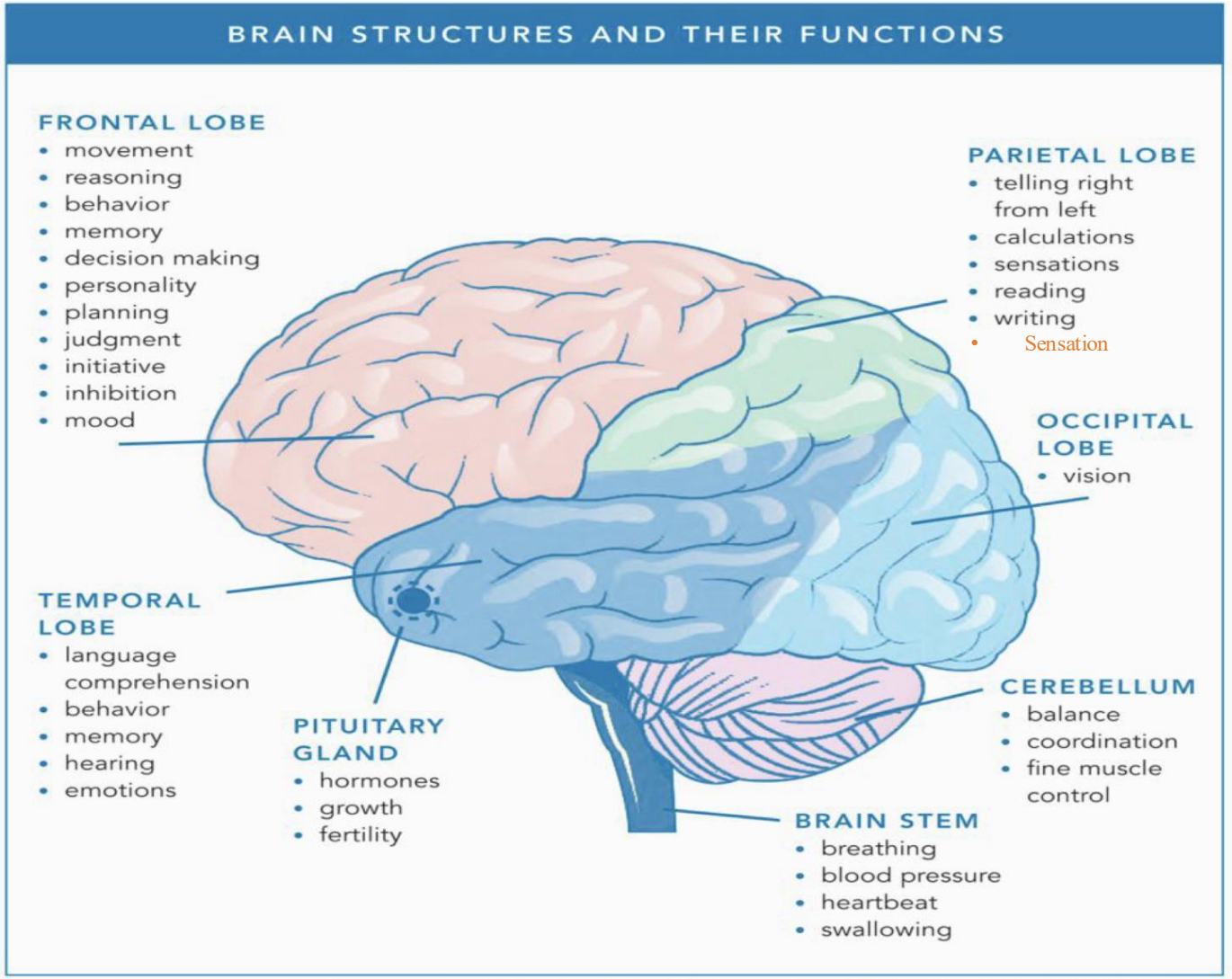
This idea is sometimes described clinically as **"listening to the cerebellum"** meaning observing the **regularity and rhythm of movement.** Normally, movements are **smooth** and **coordinated**, but in cerebellar dysfunction, they become **irregular** and **inconsistent**.

Another important test is **rapid alternating movements**, used to assess coordination. The patient may struggle to perform these movements quickly and smoothly, a condition known as **dysdiadochokinesia**. This test is performed on **both sides** because each **cerebellar hemisphere controls coordination on the same (ipsilateral) side of the body.** Finally, **the heel-to-shin test** can also be used to assess lower limb coordination.

Central Nervous System (CNS)

In **frontotemporal dementia,** the **frontal** lobe is affected, leading to **disinhibition** and **poor judgment - inappropriate behavior** (listening to loud music at a funeral, urinating in public, or making socially unacceptable decisions).

The **temporal lobe** is responsible for **language comprehension** (understanding spoken and written language), whereas **language expression**—including fluency and speech production—**is controlled by the frontal lobe**. In other words, damage to the **temporal lobe** affects **understanding** while damage to the **frontal lobe** affects speech **production and fluency.**



Based on an illustration from National Brain Tumor Society's *The Essential Guide to Brain Tumors*

Damage to the **parietal lobe** can cause **neglect**, where the patient may **ignore one side of the body or environment.**

Exam questions on this slide will be presented as **clinical scenarios rather than direct questions. Take your time to understand the precise function of each lobe thoroughly*

Central Nervous System (CNS)

What are common conditions that affect the central nervous system?

- Alzheimer's disease (brain)
- Multiple Sclerosis (brain and spinal cord)
- Epilepsy (brain)
- Dementia (brain)
- Stroke (brain)
- Inflammation (transverse myelitis – inflammatory lesions in the spinal cord)
- Spinal cord trauma (spinal cord)
- Traumatic brain injury (brain)

Central Nervous System (CNS)

What are the signs or symptoms of central nervous system conditions?

- Loss of consciousness. (brainstem)
- Upper limb or lower limb weakness. (cerebral cortex)
- Dizziness/Imbalance. (Sensory or cerebellar)
- Confusion and/or memory loss.
- Involuntary movements. (Basal Ganglia)
- Headache. (cerebral cortex)
- Pain, tingling or numbness in upper limbs or lower limbs.
- Seizures —also called **fits** in patient language— involuntary movements (cortical neurons)

Therefore, patients with these symptoms should undergo brain imaging (such as MRI or CT scans) to determine which specific brain region is affected.

Case 1

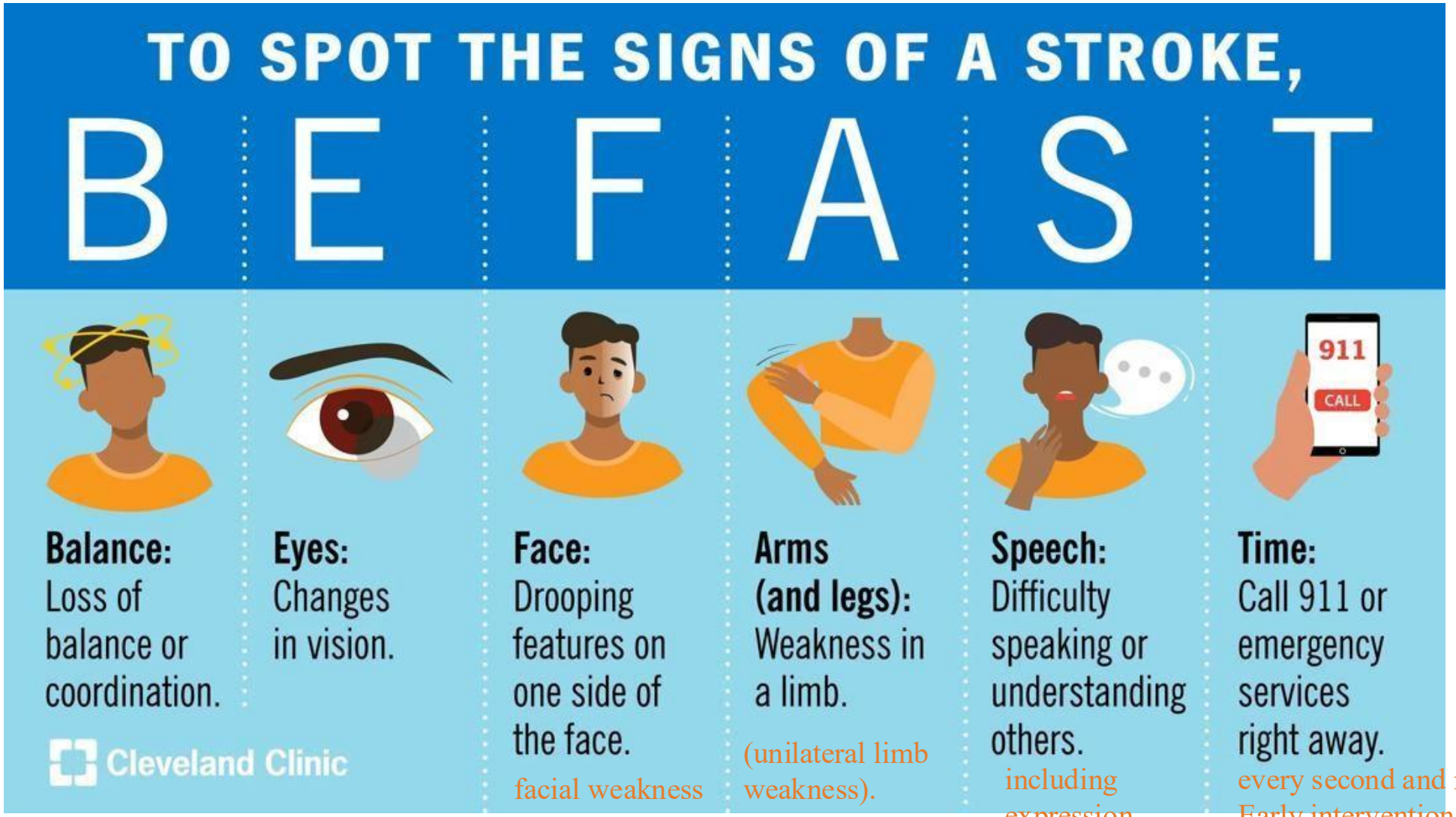
A 68-year-old male with a history of hypertension and diabetes presents to the ED with sudden onset **tongue heaviness** and **right-sided facial drooping, occurring 90 minutes ago.** He shows **right-sided weakness and a left gaze preference.**

This sign is called **pronator drift**. It is tested by asking the patient to raise both arms forward as if in a "praying" position. If one arm slowly drifts downward, the patient cannot maintain it in the air.

Case 1 / Stroke

- The most likely diagnosis for this patient is a **stroke**, given the presence of **tongue heaviness**, **speech difficulties**, **right-sided facial weakness**, and **left gaze preference.**
- The stroke affected this patient is most likely located in the **left cerebral cortex**, specifically in **the left middle cerebral artery (MCA)**, because the **right side** of the face and body is **affected**.
- **The mouth deviates to the left** due to **right facial weakness**, which causes the lips to pull toward the left side.
- The **left gaze preference** occurs because the **left cerebral cortex normally directs the eyes to the right.** When the **left cortex is damaged**, the eyes tend to **deviate toward the left.**
- The rapid onset within **90 minutes** indicates **an acute stroke**
- This patient should be assessed using **BEFAST**, a **screening tool** designed to quickly identify stroke symptoms. (SEE THE NEXT SLIDE)

This screening method is sometimes taught to the general population for rapid recognition of stroke. As doctors, we use more detailed systems to evaluate patients, which we will learn in our clinical years Insha'Allah.



facial weakness

(unilateral limb weakness).

including expression, comprehension, or repetition.

every second and minute matters. Early intervention improves the chance of revascularization and reduces long-term deficits.

Important Investigations

- Brain CT scan, Brain MRI, vessel MRA
- Blood work up: RBS, HBA1C, CBC, KFT, Lipid profile
- Echo, cardiac evaluation

Management

- Acute management: Aspirin 300 mg PO **after excluding hemorrhage**, thrombolytics and thrombectomy
- Secondary prevention: Dual APT vs Single APT, Statins, carotid endarterectomy

A **brain CT scan** serves to localize the stroke lesion, as well as determine whether the stroke is ischemic or haemorrhagic.

Blood tests are important because most of the patients presenting with a stroke have comorbidities such as diabetes, hypertension, hyperlipidaemia, etc.

An **echo**, ultrasound test of the heart and blood vessels, is ordered in cases of embolic strokes, as the embolus would have formed in the heart and then migrated to the brain via blood circulation.

Recall that thrombolytics may only be given if the patient presents within the window period (normally around 4.5 hours after the **onset of the last symptom**). Administering thrombolytics after this window period may cause haemorrhage.

Secondary prevention includes

- advising the patient on how to keep their sugar, lipids (statins), & blood pressure in check
- ordering a dual/single anti-platelet, depending on the stroke size, age, health status. Dual APT is given for a 3-week period. However, single APT is life-long therapy. **A stroke patient <u>cannot</u> be taken off single APT.**

Case 2

55-year-old male patient presented to emergency room with **imbalance of 2 days** duration. Upon examination, he has **dysarthria, nystagmus, right sided weakness, intentional tremor and past pointing when finger-nose and heel to shin are tested.**

- Question: Which structure is affected?
- Hint: Think **right side of cerebellum**

Case #2: Cerebellar Stroke

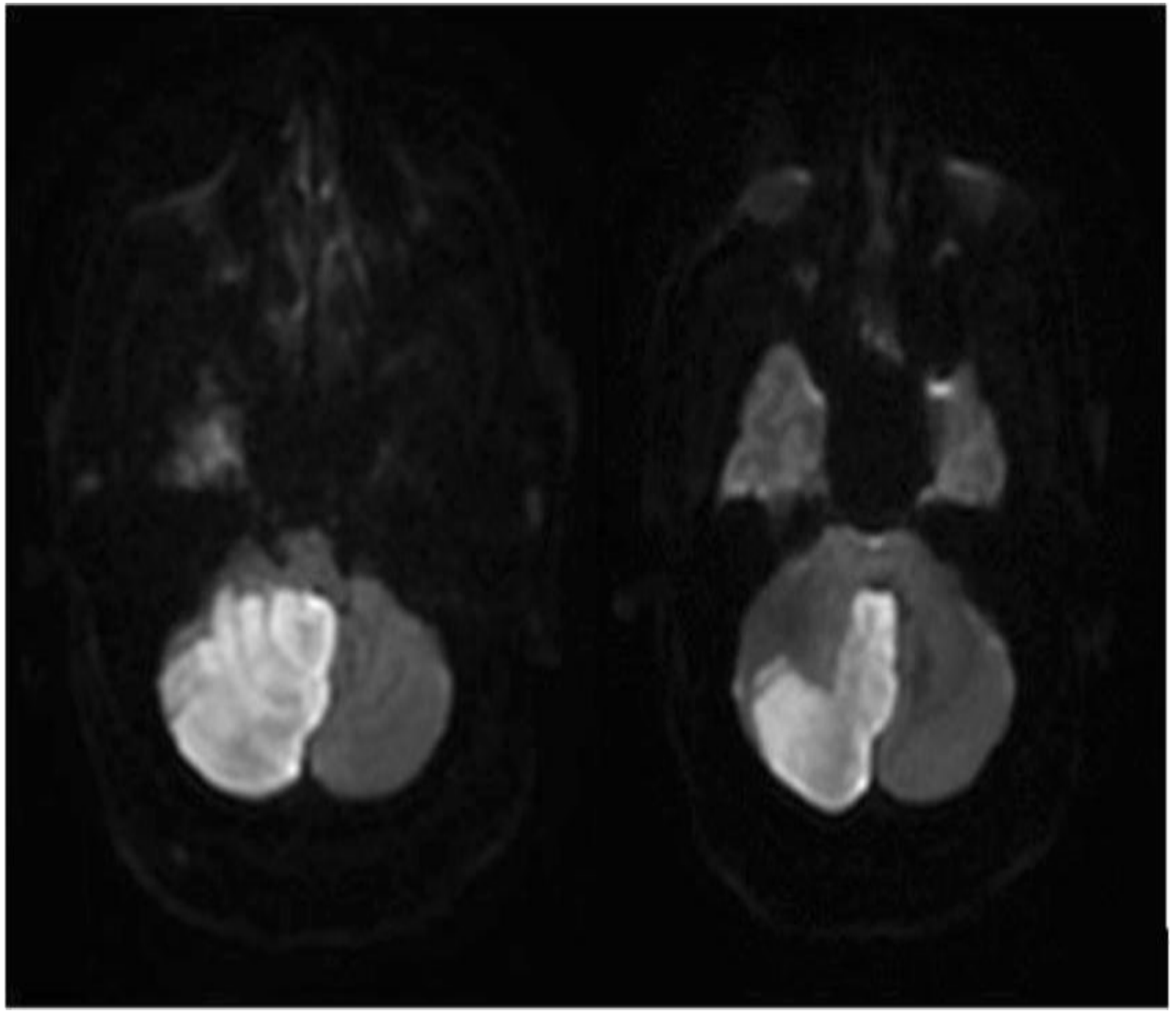
The location of a stroke can be localized by analyzing its symptoms.

The **cerebellum** is the structure most concerned with **balance** (recall the vestibulocerebellar pathway). Therefore, issues regarding imbalance and loss of movement coordination would most likely point to a cerebellar dysfunction. **Dysarthria, nystagmus, and intentional (active) tremor** are also characteristic of cerebellar strokes, as the cerebellum is responsible for these functions normally.

The **right side** of the cerebellum is affected because **cerebellum** controls the **ipsilateral side** of the body. Remember, pathways from the cerebellum undergo **double-crossing**.

Dr. Eman said that there will be no pictures like this on the exam, and that we are not required to know this, but it would be helpful to be familiar with it for clinical rotations.

A stroke in the right cerebellum can be clearly seen by the hyperintense, white color predominating the area.



Right Left

Case 3

A 32-year-old woman presents to the emergency room with a **4 weeks history of right eye pain** and **blurring of vision**. She states that **three episodes** have occurred during the past 6 months. She reported an attack of **numbness in the left side of her body 1 year ago**. She states she has not observed any **gait disturbance**, fever, or **urinary incontinence.**

Upon evaluation, she has mild spasticity, generalized hyperreflexia, upgoing plantar response and clonus.

Case #3: Multiple Sclerosis

Hyperreflexia, positive Babinski sign, and clonus are all signs of an **upper motor neuron lesion.**

The possibility of these UMN lesions being caused by a **stroke** is eliminated due to:

1. the **long period** that the symptoms have been taking place,
2. the **nature** of these symptoms (episodes instead of continuous & progressive), as well as
3. the **age** of the patient, where she is assumingly too young for atherosclerosis, A-fib, or any predisposing factors.

This patient has **multiple sclerosis** affecting **the spinal cord**, causing the numbness, and the **optic nerve**, which is responsible for the right eye pain, blurry vision, red-color desaturation (patient can't see red properly), central scotoma (center of visual field is lost).

Multiple sclerosis flare-ups may last days-weeks, depending on the episode, before going back into the remission period.

Additional picture of central scotoma.

These white lesions present in the paraventricular, subcortical, and cortical areas of the brain, as well as the spinal cord point to a high susceptibility of the patient having MS.

Important Investigations

- Brain MRI, Spinal MRI with **contrast**
- Visual studies (optic nerve)
- Lumbar puncture

Management

- Acute management: IV methylprednisolone
- Long term therapy: disease modifying agents

A brain CT scan is not important for the diagnosis of multiple sclerosis.

Images in multiple sclerosis must be taken with **contrast**, so that active lesions can be easily identified.

Lesions that take in the contrast are active lesions.

Lumbar punctures are crucial to identify protein and cell components in the CSF.

Case 4

A 72-year-old gentleman presents to the neurology clinic with his family because they noticed he has **difficulty in initiating movements, abnormal posture with short steps while walking and abnormal shaking of his right-hand during rest.**

Case #4: Parkinson's Disease

The patient has an issue **initiating movement** and presents with a **resting tremor,** both of which point to Parkinson's.

Parkison's disease is caused by the depletion of **dopaminergic** neurons in the **substania nigra** (basal ganglia).

In movement disorders, whether the patient is **hypo**kinetic or **hyper**kinetic, the basal ganglia are a prime suspect of the underlying disease etiology.

People with Parkinson's disease normally present with resting tremor, postural instability, hypokinesia, orthostatic hypotension, and issues with initiating movement.

PD treatment is **Levodopa + Carbidopa**.

Case #4: Parkinson's Disease

The patient has an issue **initiating movement** and presents with a **resting tremor,** both of which point to Parkinson's.

Parkison's disease is caused by the depletion of **dopaminergic** neurons in the **substania nigra** (basal ganglia).

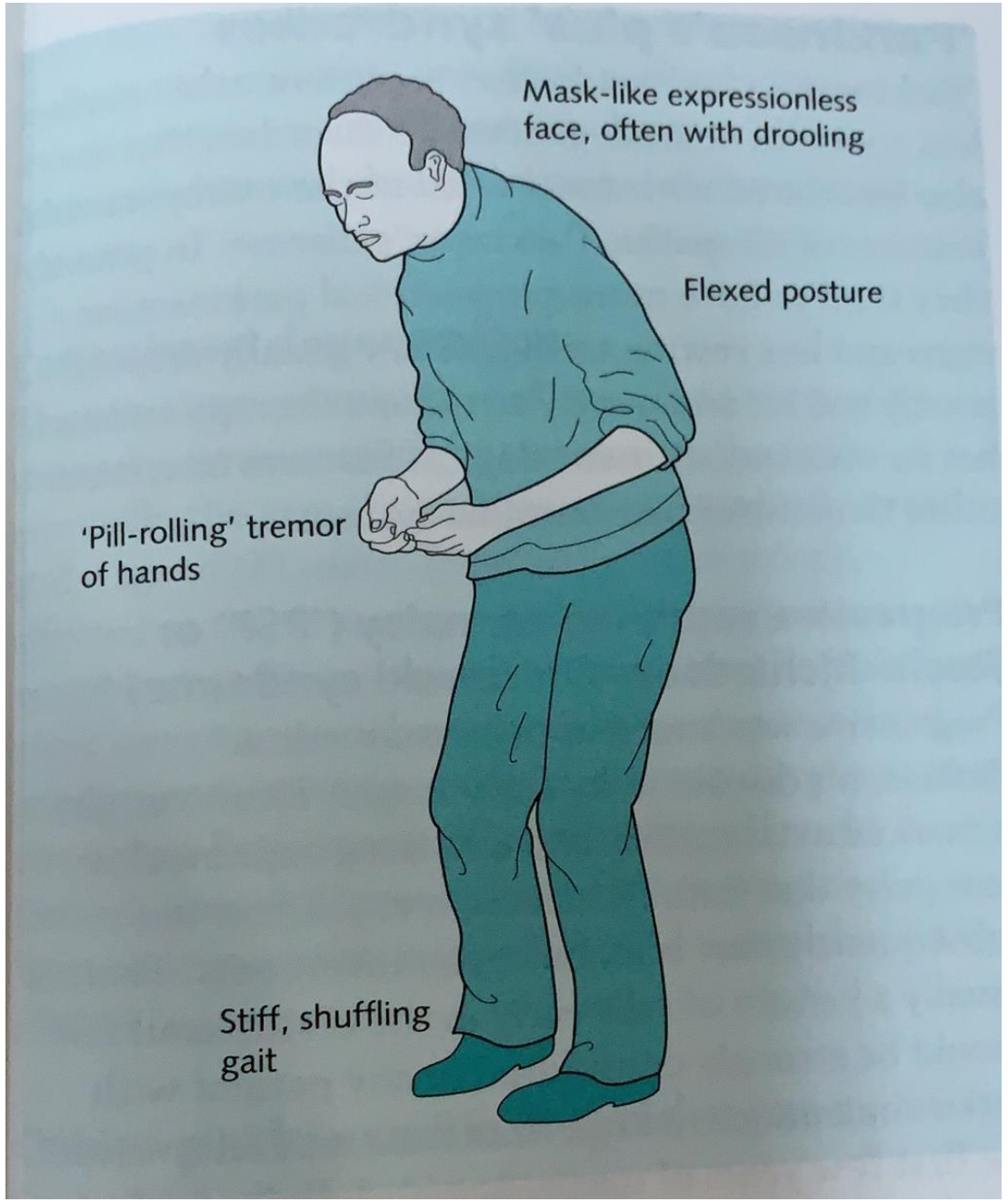
In movement disorders, whether the patient is **hypo**kinetic or **hyper**kinetic, the basal ganglia are a prime suspect of the underlying disease etiology.

People with Parkinson's disease normally present with resting tremor, postural instability, hypokinesia, orthostatic hypotension, and issues with initiating movement.

PD treatment is **Levodopa + Carbidopa**.

- Tremor
- Rigidity
- Akinesia
- Postural Instability

Treatment is Levodopa-Carbidopa



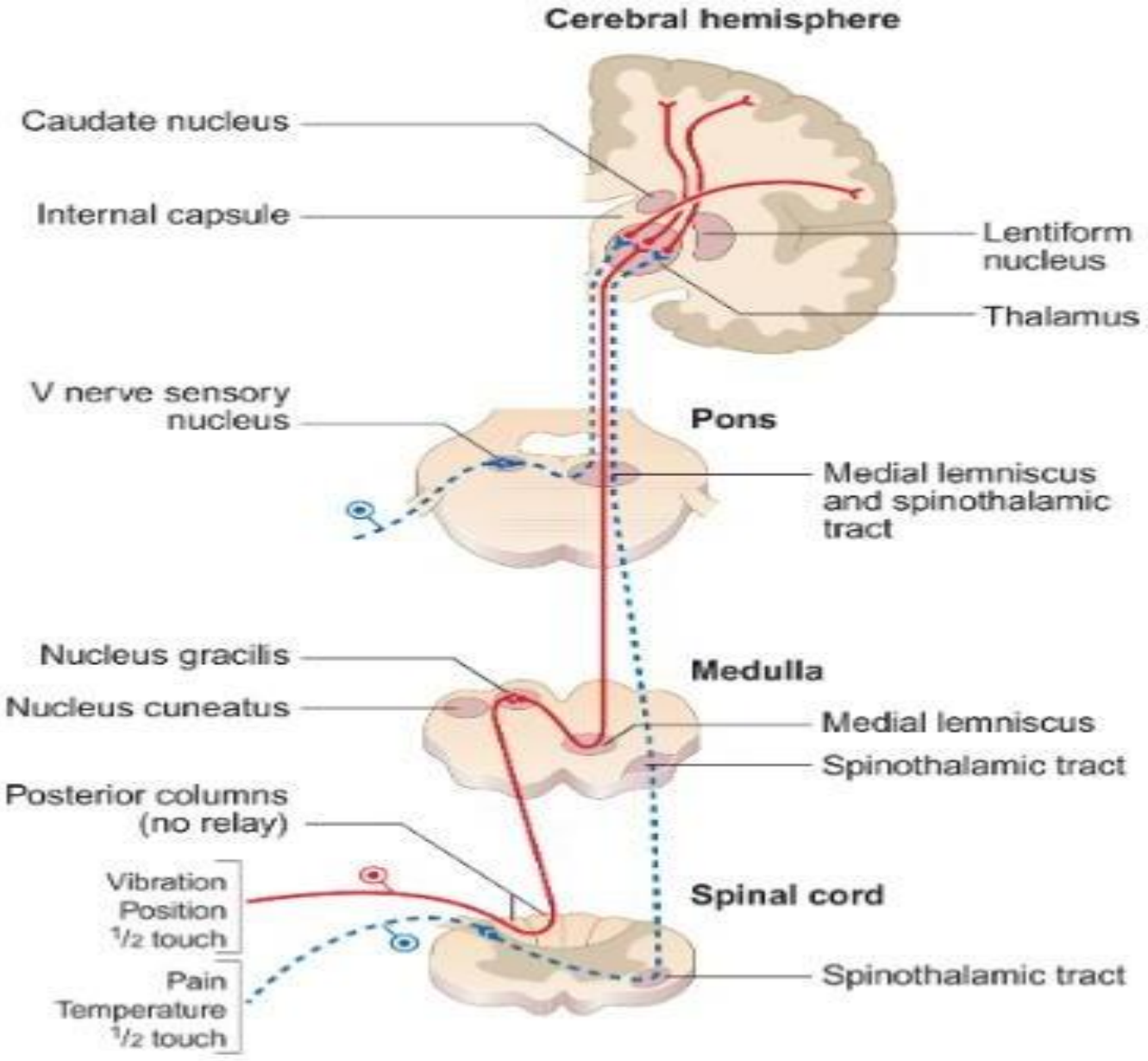
Spinal Cord

Traumatic and compressive spinal cord lesions cause loss or impairment of sensation in a dermatomal distribution below the level of the lesion.

A zone of **hyperesthesia** may be found immediately above or at the level of sensory loss.

General recap of tracts:

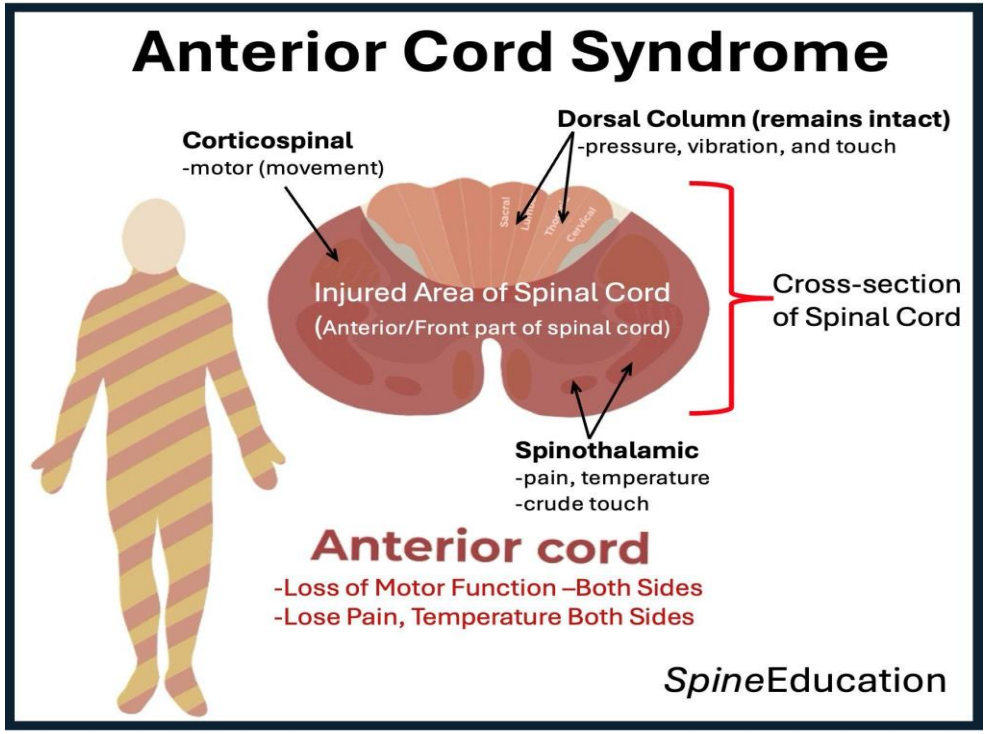
- **Spinothalamic**: pain, temperature, crude touch.
- **Dorsal column**: fine touch, vibration, proprioception.
- **Corticospinal**: motor function.



Anterior Spinal Artery Syndrome:

Results in loss of **spinothalamic** sensation and motor function (corticospinal), with sparing of dorsal column sensation.

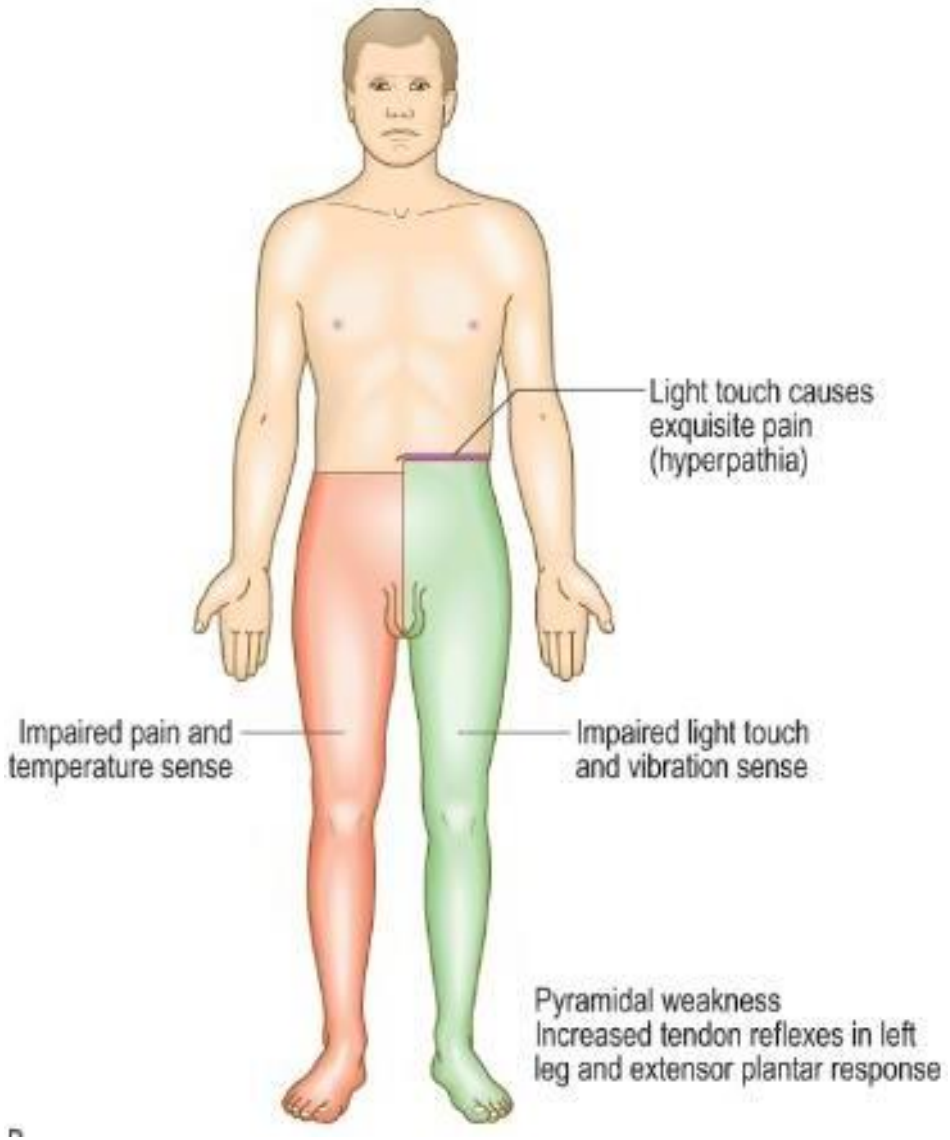
Bilateral loss of pain and temperature sensation and motor function at the levels below the lesion.



Brown-Séquard syndrome:

When one-half of the spinal cord is damaged.

This is characterized by **ipsilateral motor** weakness and **loss of vibration and joint position sense**, with **contralateral** loss of **pain and temperature**.



Peripheral Nervous System (PNS)

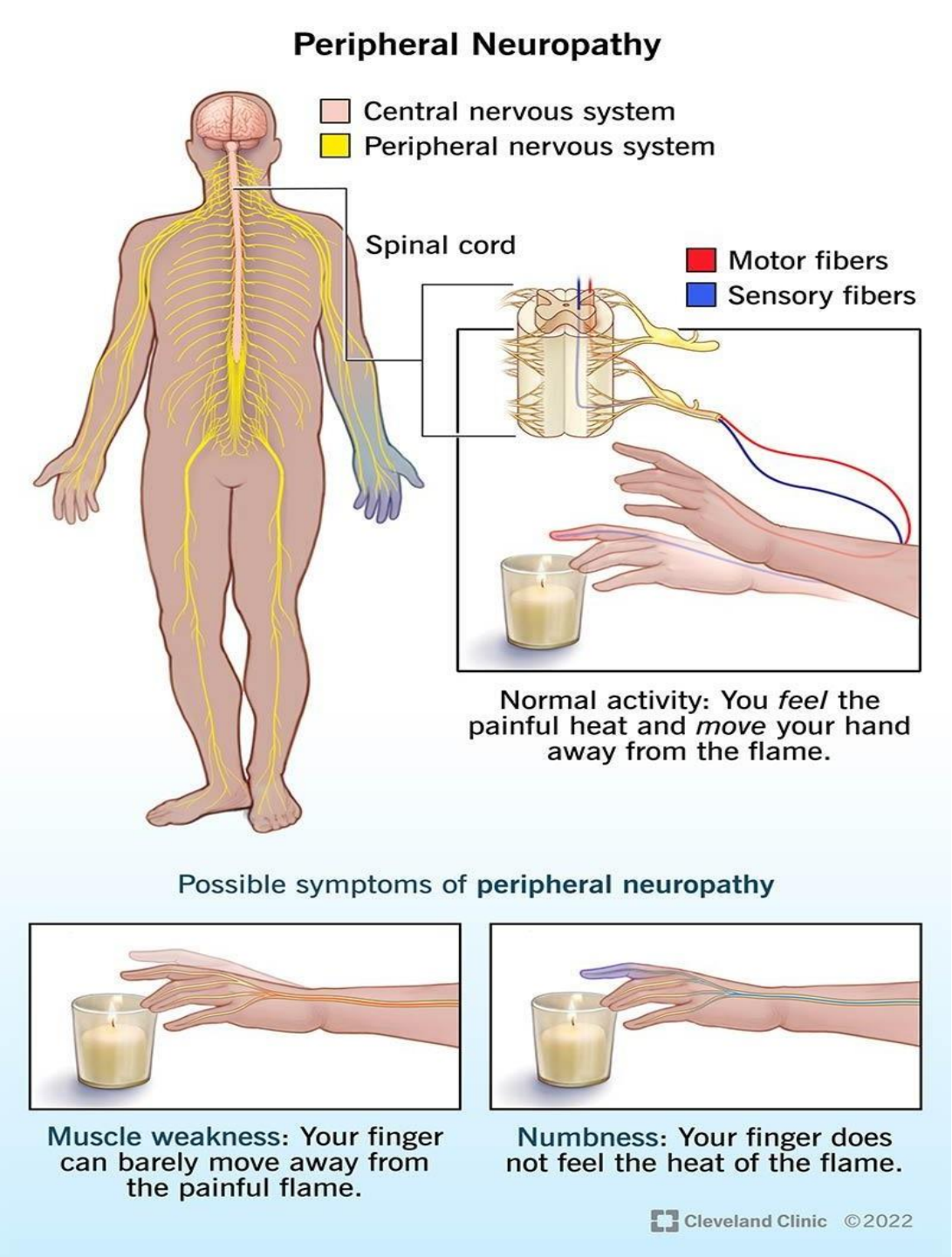
- Cranial and spinal nerves
- Connects CNS to body

The symptoms are:

- Motor.
- Sensory and pain.
- Autonomic.

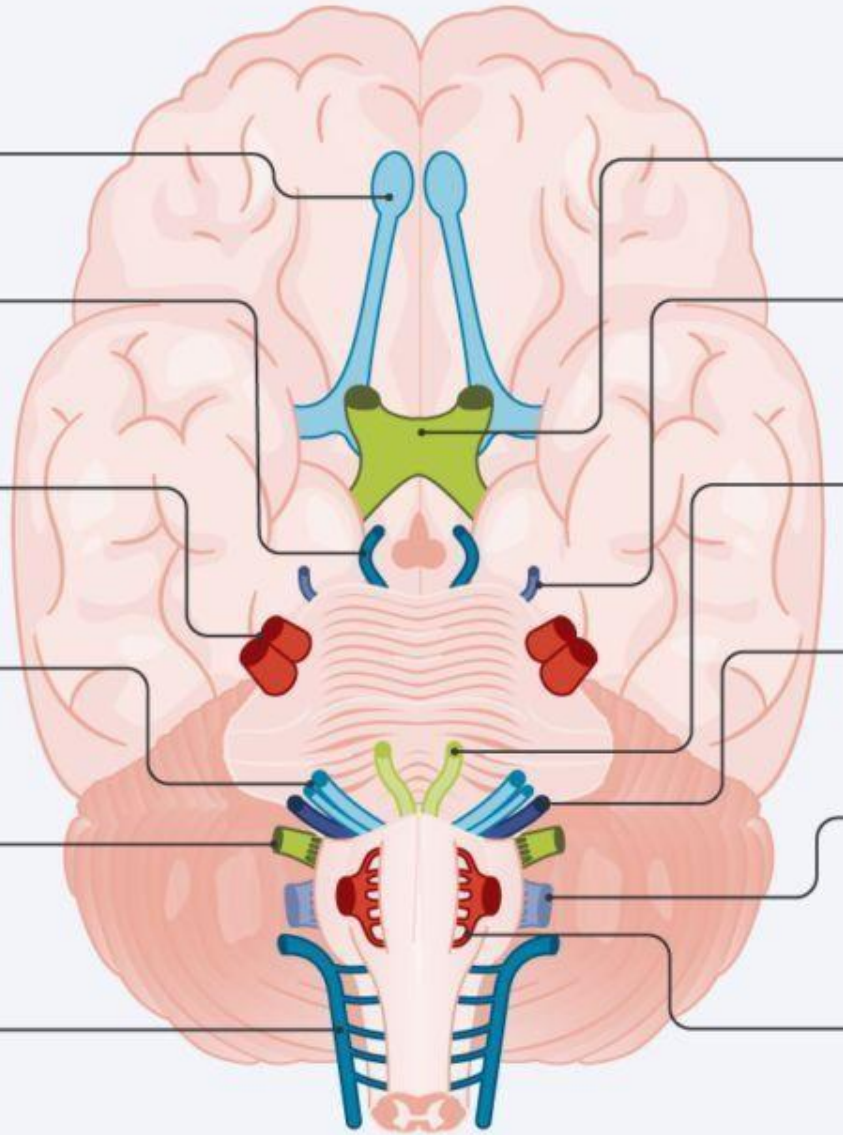
Peripheral neuropathy happens in two main ways:

- Demyelinating neuropathy
- Axonal degeneration



Dr. Eman said that these next slides regarding the PNS are not required for exam purposes.

12 cranial nerves



olfactory
smell

oculomotor
eye movement and pupil reflex

trigeminal
face sensation and chewing

facial
face movement and taste

glossopharyngeal
throat sensation, taste, and swallowing

accessory
neck movement

optic
vision

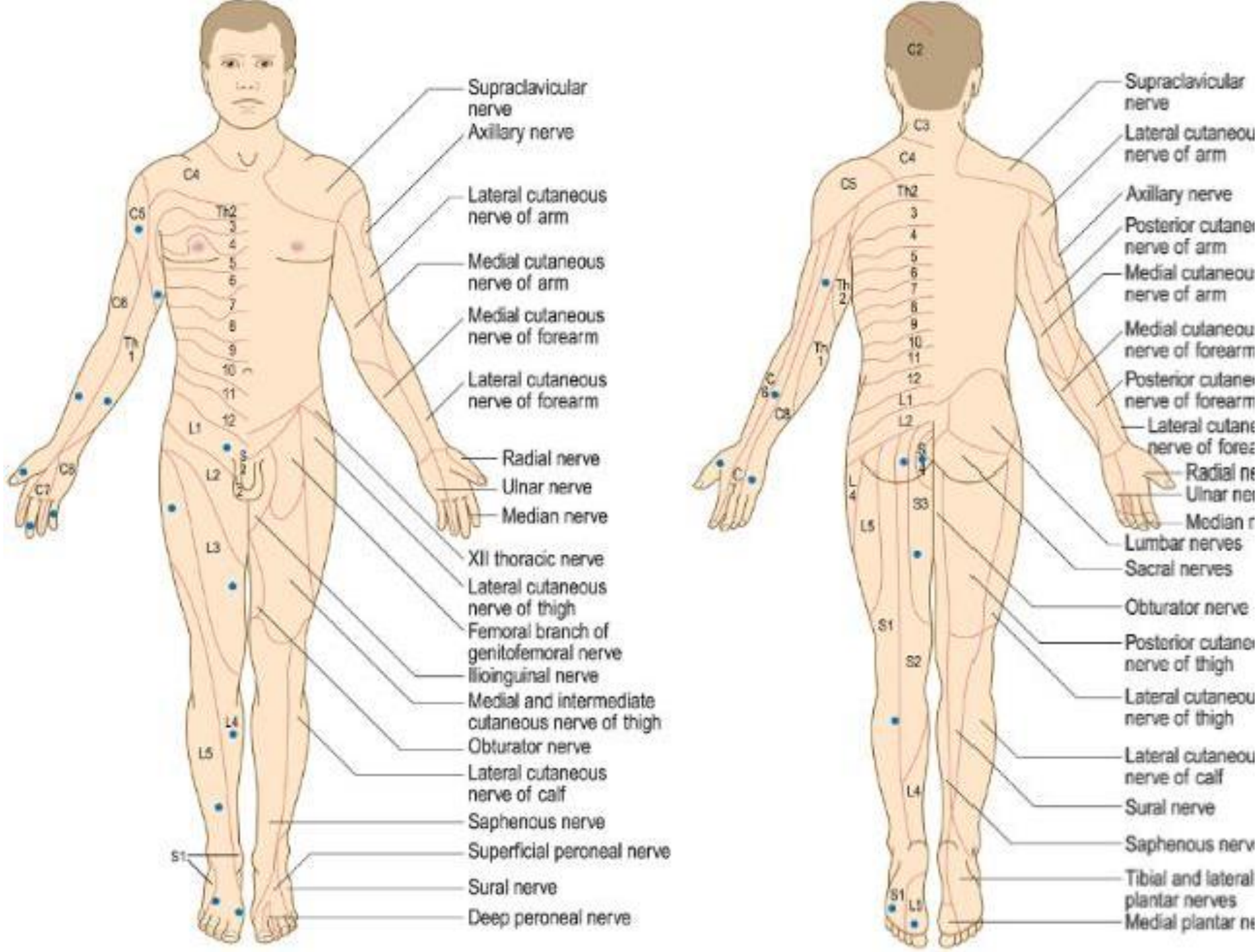
trochlear
eye movement

abducens
eye movement

vestibulocochlear
hearing and balance

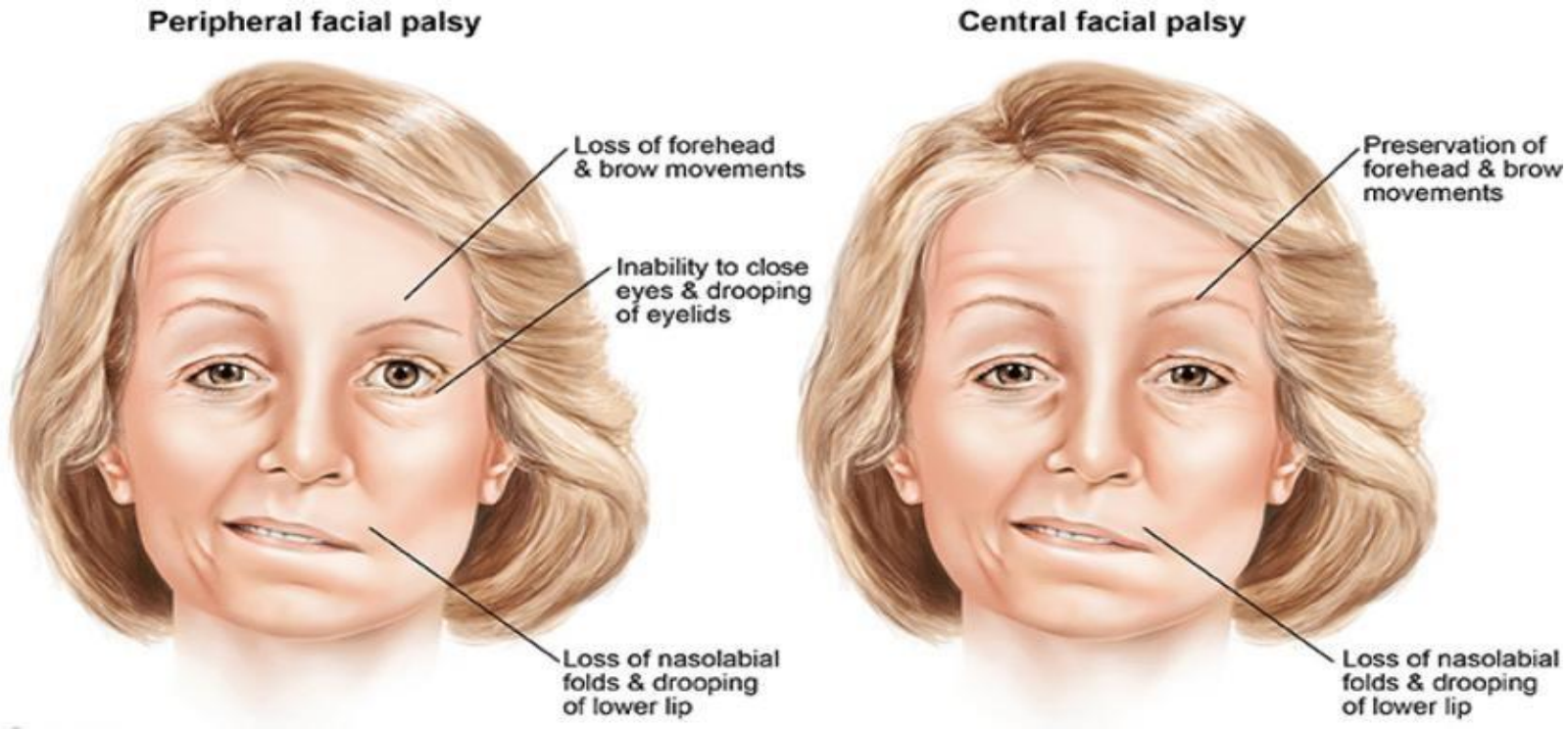
vagus
movement, sensation, and abdominal organs

hypoglossal
movement, sensation, and abdominal organs


Supraclavicular nerve
Axillary nerve
Lateral cutaneous nerve of arm
Medial cutaneous nerve of arm
Medial cutaneous nerve of forearm
Lateral cutaneous nerve of forearm
Radial nerve
Ulnar nerve
Median nerve
XII thoracic nerve
Lateral cutaneous nerve of thigh
Femoral branch of genitofemoral nerve
Ilioinguinal nerve
Medial and intermediate cutaneous nerve of thigh
Obturator nerve
Lateral cutaneous nerve of calf
Saphenous nerve
Superficial peroneal nerve
Sural nerve
Deep peroneal nerve
C2
C3
C4
C5
C6
C7
C8
Th1
Th2
L1
L2
L3
L4
L5
S1
S2
S3
Supraclavicular nerve
Lateral cutaneou nerve of arm
Axillary nerve
Posterior cutane nerve of arm
Medial cutaneou nerve of arm
Medial cutaneou nerve of forearm
Posterior cutane nerve of forearm
Lateral cutane nerve of forea
Radial ne
Ulnar ner
Median n
Lumbar nerves
Sacral nerves
Obturator nerve
Posterior cutane nerve of thigh
Lateral cutaneou nerve of thigh
Lateral cutaneou nerve of calf
Sural nerve
Saphenous nerv
Tibial and lateral plantar nerves
Medial plantar ne

Case 5

60-year-old female patient presented to neurology clinic with history of **left sided facial weakness, mouth deviation to the right, inability to close the left eye of 1 day duration.**



Case 6

A 50-year-old female patient known to have **diabetes and hypothyroidism** presented to clinic with history of **unpleasant tingling sensation in both hands especially at night** of three months duration. Upon examination, you noticed **weak thumb abduction and no muscle weakness.**

Carpal Tunnel Syndrome

- is the most common entrapment neuropathy
- This may be compressed as it passes between the flexor retinaculum and the carpal bones at the wrist
- initially produces sensory symptoms

Case #5: Bell's Palsy

Central palsy is caused by a stroke. Central palsy normally doesn't affect the eyes and the eyebrows, only the lower half of the face. However, in unilateral facial nerve palsy, the entire side of the face is affected, while the other is completely fine.

Case #6: Carpel Tunnel Syndrome

Issues in thumb abduction = **median nerve injury.**
Carpel Tunnel affects females more than males, more likely in those patients with existing comorbidities such as **diabetes, hypothyroidism, and rheumatoid arthritis**. Sensory symptoms include numbness and tingling.

Common Peroneal Nerve

- This typically presents with foot drop.

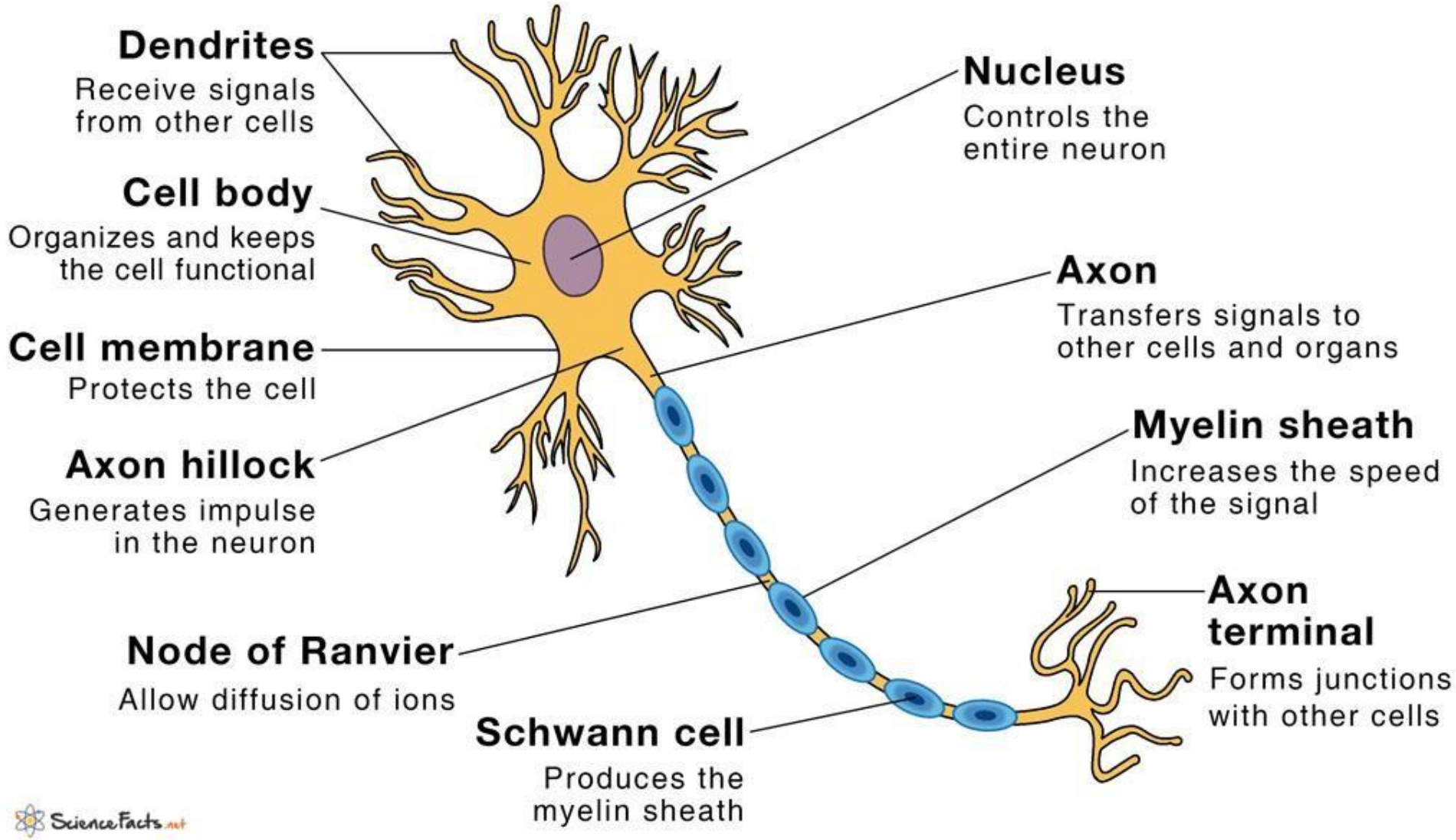
- It may be damaged in fibular head fractures, or compressed particularly in immobile patients, or because of repetitive kneeling or squatting.

Patients with common peroneal nerve injury are unable to walk on their heels, can't dorsiflex. They may stomp while walking due to the knee flexion.

Neuron Structure

- Cell body
- Dendrites receive signals
- Axon transmits signals
- Synapse = communication

Parts of a Neuron with Functions



Clinical Correlations

Multiple Sclerosis → demyelination

Parkinson's → basal ganglia

Stroke → blood supply interruption

Quick Quiz

1) Which is part of PNS?

A. Brain

B. Spinal cord

C. Cranial nerves

2) Which is of the following is a PNS disease?

A. Multiple Sclerosis

B. Dementia

C. Trigeminal Neuralgia

3) Which of the following is not considered as parietal lobe function?

A. Calculation

B. Vision

C. Sensation

4) What happens if myelin is lost?

A. Faster conduction

B. Slower conduction

C. No change

Quick Quiz

1) Which is part of PNS?

A. Brain

B. Spinal cord

C. Cranial nerves

2) Which is of the following is a PNS disease?

A. Multiple Sclerosis

B. Dementia

C. Trigeminal Neuralgia

3) Which of the following is not considered as parietal lobe function?

A. Calculation

B. Vision

C. Sensation

4) What happens if myelin is lost?

A. Faster conduction

B. Slower conduction

C. No change

External Resources

رسالة من الفريق العلمي

اللهم إن عمر عطية في ذمتك وحبل جوارك، فقِه من فتنة القبر وعذاب النار،
أنت أهل الوفاء والحق، فاغفر له وارحمه إنك أنت الغفور الرحيم.

Scan the QR code or click it for FEEDBACK

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			