YU - MEDICINE
PASSION ACADEMIC TEAM

Central Nervous System

Sheet# 7 - Physiology

Lec. Title : Motor Systems (Part 2)

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kindly report it to
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تفريغ محاضرة فسيولوجي 7
motor neurophysiology 2

الدكتورة اعتبرت انو هدول السلايدات هما مادة اناتومي لذلك كان معظم المحاضرة هي قراءة سلايدااااتتتت لاااا غيييييررررر

aseel ababneh

3. Flexor withdrawal reflex

- is **polysynaptic.**

- results in **flexion on the ipsilateral side** and **extension on the contralateral side.**

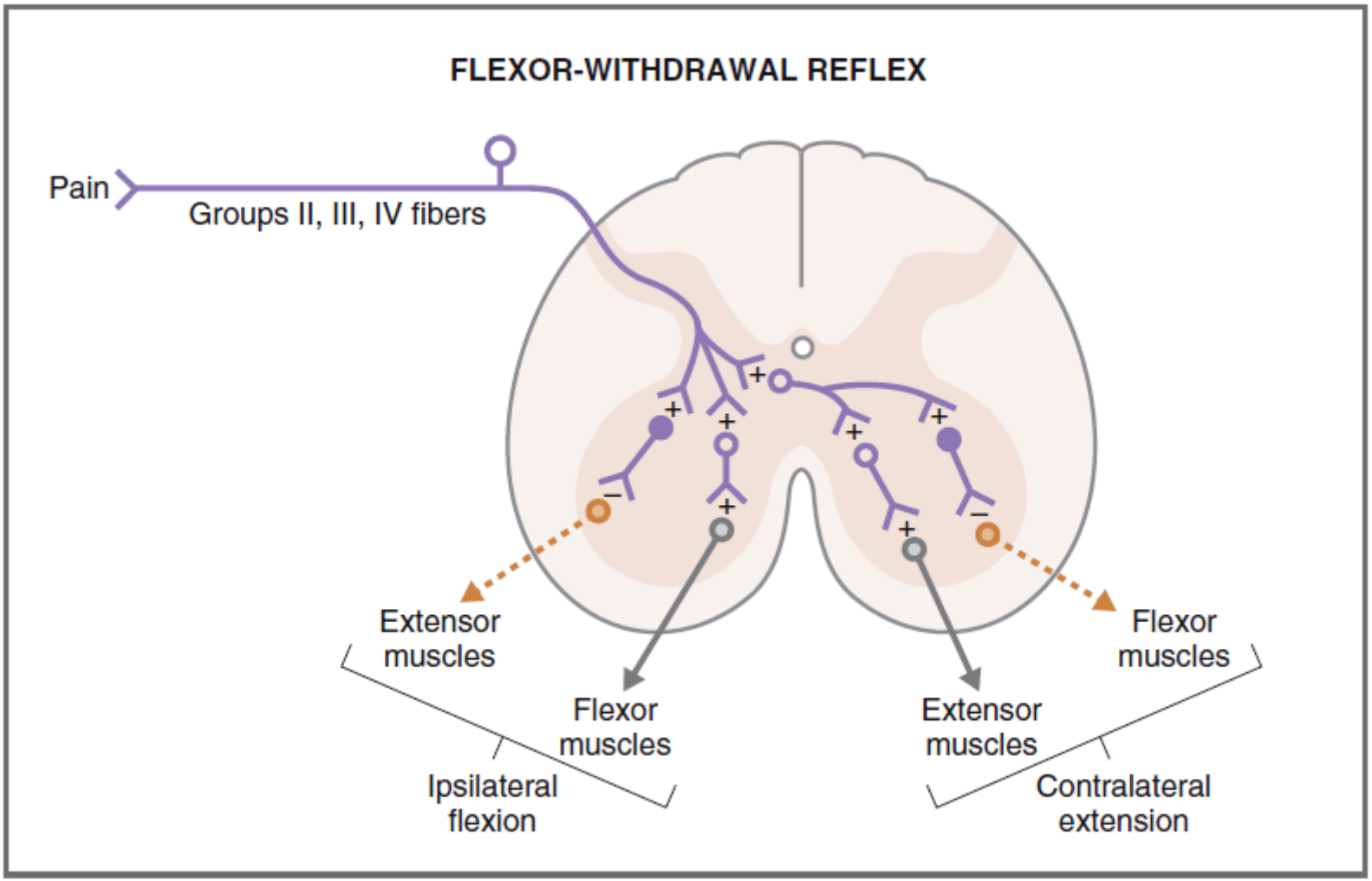
  Somatosensory and pain afferent fibers elicit withdrawal of the stimulated body part from the noxious stimulus.

- الهدف ابعد الجزء من الجسم عن المادة اللي سببت وجع مثل ابعد ايدي عن الصوبا

3. Flexor withdrawal reflex

A. **Pain** (e.g., touching a hot stove) stimulates the flexor reflex afferents **of groups II, III, and IV.**
B. The afferent fibers synapse polysynaptically (via interneurons that do processing) onto motoneurons in the spinal cord.
C. On the **ipsilateral side** of the pain stimulus, flexors are stimulated (they contract) and extensors are inhibited (they relax), and the arm is jerked away from the stove. On the **contralateral side**, flexors are inhibited and extensors are stimulated (crossed extension reflex) to maintain balance.

3. Flexor withdrawal reflex



Operation of the flexor-withdrawal reflex. *Solid lines* show excitatory pathways; *dashed lines* show inhibitory steps. *Open* neurons are excitatory; *filled* neurons are inhibitory.

Brain stem control of posture

two motor or pyramidal pathways :

Motor centers and pathways

- **Pyramidal tracts** (corticospinal and corticobulbar) pass through the medullary pyramids and descend directly onto lower motoneurons in the spinal cord.

- All others are **extrapyramidal tracts** and originate primarily in the following structures of the brain stem:

Extrapyramidal tracts

1. Rubrospinal tract

- originates in the red nucleus and projects to interneurons in the lateral spinal cord.
- Stimulation of the red nucleus produces **stimulation of flexors and inhibition of extensors.**

Extrapyramidal tracts

2. Pontine reticulospinal tract

- originates in the nuclei in the pons and projects to the ventromedial spinal cord.

- Stimulation has a general **stimulatory effect on both extensors and flexors,** with the predominant effect on extensors.

Extrapyramidal tracts

3. Medullary reticulospinal tract

- originates in the medullary reticular formation and projects to spinal cord interneurons in the intermediate gray area.

- Stimulation has a general **inhibitory effect on both extensors and flexors,** with the predominant effect on extensors.

Extrapyramidal tracts

4. Lateral vestibulospinal tract

- originates in Deiters nucleus and projects to ipsilateral motoneurons and interneurons.

- Stimulation causes a powerful **stimulation of extensors** and **inhibition of flexors.**
- **i.e. intercostal and back muscles, as well as the extensors of the limbs**

Extrapyramidal tracts

5. Tectospinal tract

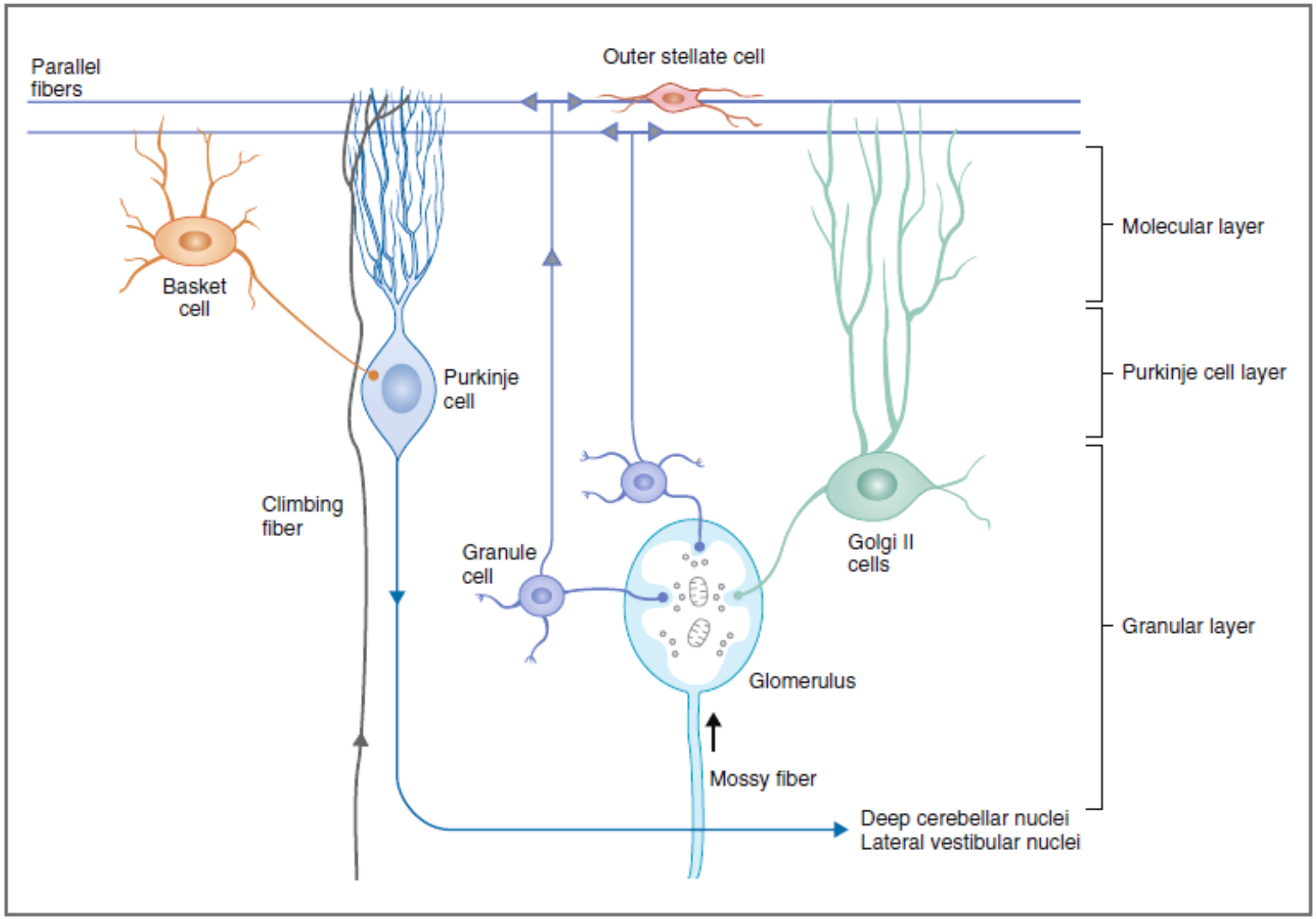
- originates in the superior colliculus and projects to the cervical spinal cord.

- is involved in the **control of neck muscles.**

Cerebellum – central control of movement

- **Functions of the cerebellum**
  - **Vestibulocerebellum** - control of balance and eye movement
  - **Pontocerebellum -** planning and initiation of movement
  - **Spinocerebellum** - synergy, which is control of rate, force, range, and direction of movement

Layers of the cerebellar cortex



Structures of the cerebellar cortex shown in cross-section.

Layers of the cerebellar cortex

1. **Granular layer**

- is the innermost layer.
- contains granule cells, Golgi type II cells, and glomeruli.
- In the **glomeruli,** axons of mossy fibers form synaptic connections on dendrites of granular and Golgi type II cells.
- Mossy fibers are the most appendant here

Layers of the cerebellar cortex

2. Purkinje cell layer

- is the middle layer.
- contains Purkinje cells.
- **output is always inhibitory.**
- **It regulates the function of cerebellum**

Layers of the cerebellar cortex

3. Molecular layer

- is the outermost layer.
- contains stellate and basket cells, dendrites of Purkinje and Golgi type II cells, and parallel fibers (axons of granule cells).
- The **parallel fibers** synapse on dendrites of Purkinje cells, basket cells, stellate cells, and Golgi type II cells.

  Parallel fibers are the most appendant here

Connections in the cerebellar cortex

Input to the cerebellar cortex

1. ***Climbing fibers***

- originate from a **single region of the medulla (inferior olive).**
- make multiple synapses onto Purkinje cells, resulting in high-frequency bursts, or **complex spikes.**
- "condition" the Purkinje cells.
- play a role in cerebellar **motor learning.**

Input to the cerebellar cortex

2. *Mossy fibers*

- originate from **many centers in the brain stem and spinal cord.**
- include vestibulocerebellar, spinocerebellar, and pontocerebellar afferents.
- make multiple synapses on Purkinje fibers via interneurons. Synapses on Purkinje cells result in **simple spikes.**

Output of the cerebellar cortex

- **Purkinje cells** are the ***only output of the cerebellar cortex.***

- Output of the Purkinje cells is **always inhibitory;** the neurotransmitter is **(GABA).**

- The output projects to deep cerebellar nuclei and to the vestibular nucleus. This inhibitory output **modulates** the output of the cerebellum and regulates rate, range, and direction of movement.

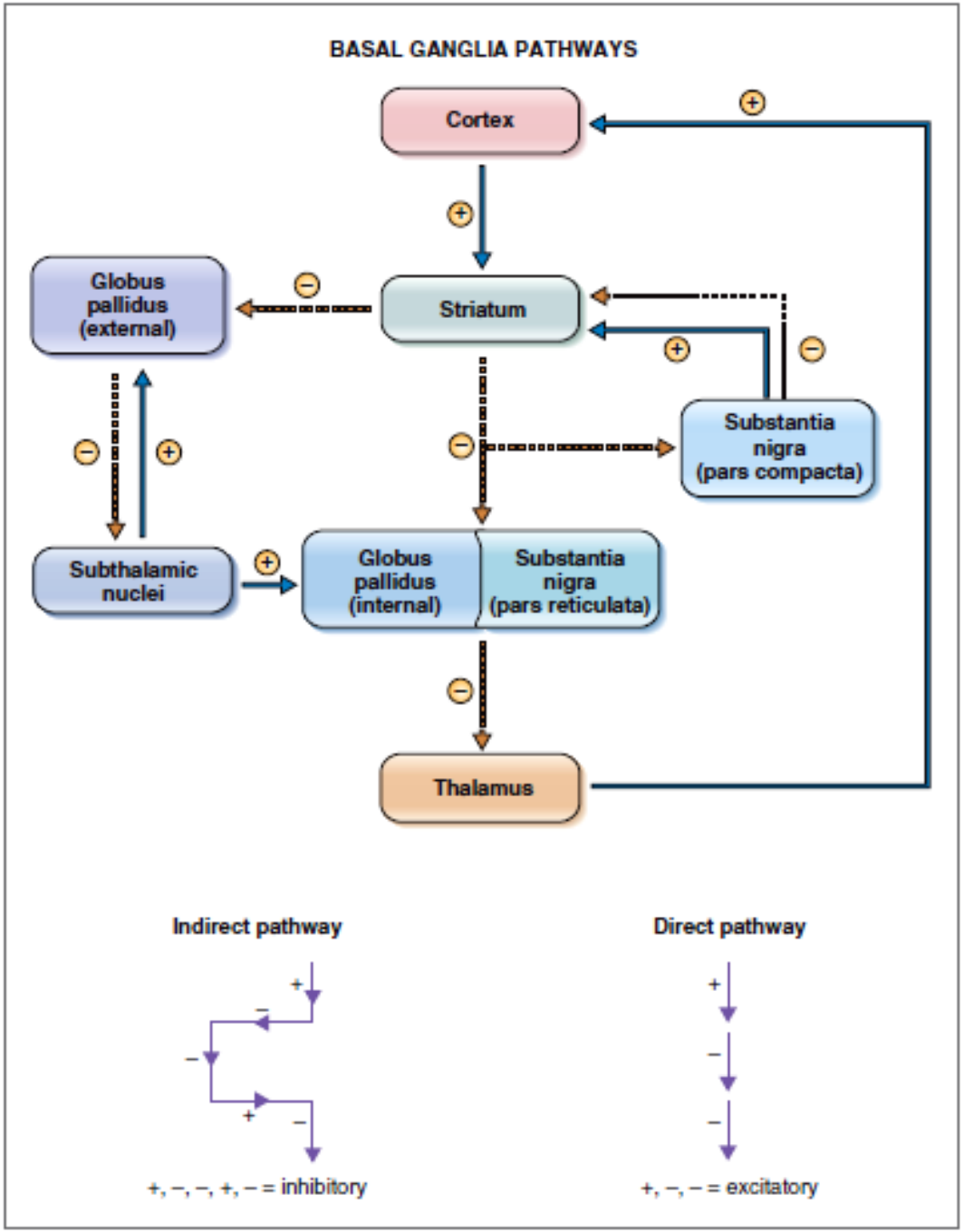
Basal ganglia – control of movement

- consists of the striatum, globus pallidus, subthalamic nuclei, and substantia nigra.
- modulates thalamic outflow to the motor cortex to **plan and execute smooth movements.**
- Many synaptic connections are inhibitory and use **GABA as their neurotransmitter.**
- The striatum communicates with the thalamus and the cerebral cortex by two opposing pathways.

  - **Indirect pathway is, overall, inhibitory.**
  - **Direct pathway is, overall, excitatory.**

Q1 is this related to the firing rate ?
Yes - its related to the summation of firing rates to decide if it is excitatory or inhibitory
q2 are these pathways related to the type of movement that goes through them
yes > wanted movement goes through the direct pathway because it is excitatory pathway and the unwanted goes throw the indirect

so the indirect prevents unwanted movement and direct triggers the wanted movement


BASAL GANGLIA PATHWAYS
Cortex
Striatum
Globus pallidus (external)
Substantia nigra (pars compacta)
Subthalamic nuclei
Globus pallidus (internal)
Substantia nigra (pars reticulata)
Thalamus
Indirect pathway
+, −, −, +, − = inhibitory
Direct pathway
+, −, − = excitatory

Basal ganglia – control of movement

- Connections between the striatum and the substantia nigra use **dopamine** as their neurotransmitter.

- Dopamine is inhibitory on the indirect pathway (**D_2** receptors) and excitatory on the direct pathway (**D_1** receptors).
- Thus, the action of dopamine is, overall, excitatory.

Motor cortex

1. Premotor cortex and supplementary motor cortex (area 6)

- are responsible for **generating a plan for movement,** which is transferred to the primary motor cortex for execution. Palnning to inatiate the movment

- The supplementary motor cortex programs complex motor sequences and is active during **"mental rehearsal"** for a movement.

2. Primary motor cortex (area 4)

- is responsible for the **execution of movement.** Programmed patterns of motoneurons are activated in the motor cortex. Excitation of upper motoneurons in the motor cortex is transferred to the brain stem and spinal cord, where the lower motoneurons are activated and cause voluntary movement.

- is somatotopically organized **(motor homunculus).** Epileptic events in the primary motor cortex cause **Jacksonian seizures,** which illustrate the somatotopic organization.
- It's the result of defect of the motor homunculus which cause this disease