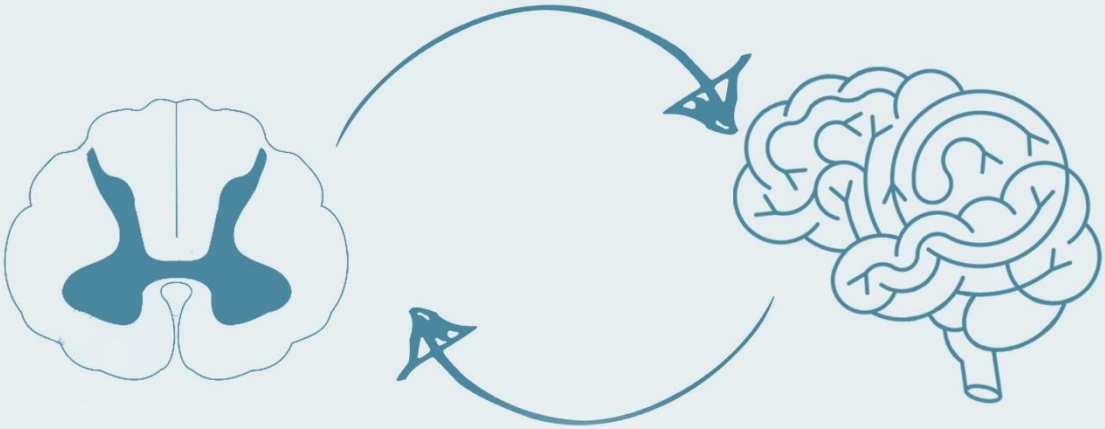

CNS

Anatomy

0 slides 0 sheets

number	5
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This sheet will discuss three topics:

- Arterial blood supply and venous drainage of spinal cord.
- Introduction to the Motor descending tracts.
- Muscle spindle.

❖***Arterial Blood supply of spinal cord***

The spinal cord got its arterial supply by two ways:

- ✓ Longitudinal arteries
- ✓ Segmental arteries

1- Longitudinal arteries:

In order to understand longitudinal arteries, we must give a short brief about blood supply of brain, here we go ☺

- Brain is supplied by pairs of internal carotid artery and vertebral artery.

- Internal carotid artery arises from common carotid artery, which on the left side arises directly from aortic arch and on the right side from brachiocephalic trunk. On upper border of thyroid cartilage common carotid bifurcates into an external carotid and internal carotid arteries.

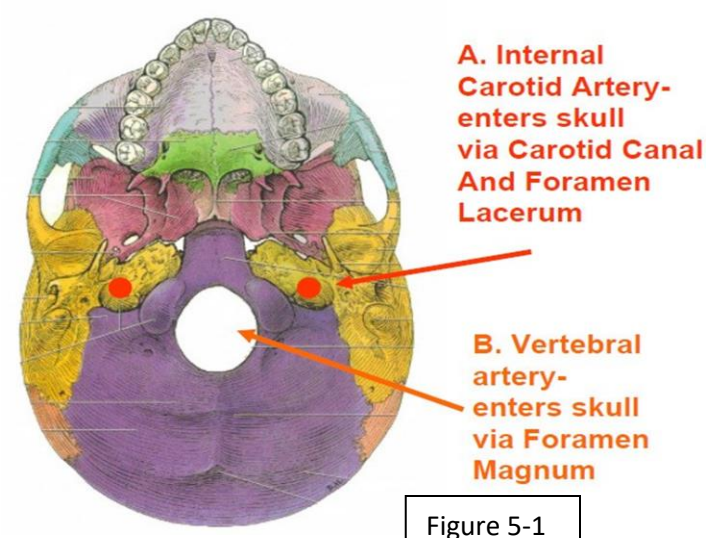

Figure 5-1

- External carotid gives off number of branches which we have already covered in MSS: (superior thyroid,lingual,fascial,maxillary,superficialtemporal,occipital,ascending pharyngeal and posterior auricular).

- Internal carotid artery enters the skull via carotid canal and foramen lacerum (on the base of the skull). Figure5-1. It gives three important branches:

- Anterior cerebral artery
- Middle cerebral artery

- Posterior communicating artery

- Vertebral artery is a branch from **Subclavian** artery, and again left subclavian arises directly from aortic arch and right one from brachiocephalic trunk, it ends at the outer border of first rib by becoming axillary artery.

- We divide subclavian artery into three parts according to scalenus anterior muscle (which arise from upper cervical vertebrae down to the first rib):

- ✓ 1st part : lies before scalenus anterior
- ✓ 2nd part : lies behind scalenus anterior
- ✓ 3rd part : lies after scalenus anterior

Now look at figure 5-2, from which part vertebral arteries arise?!

Yes, from the ***first part***☺.They proceed superiorly and enter transverse foramina of cervical vertebrae then they enter foramen magnum in the occipital bone (figure 5-3)

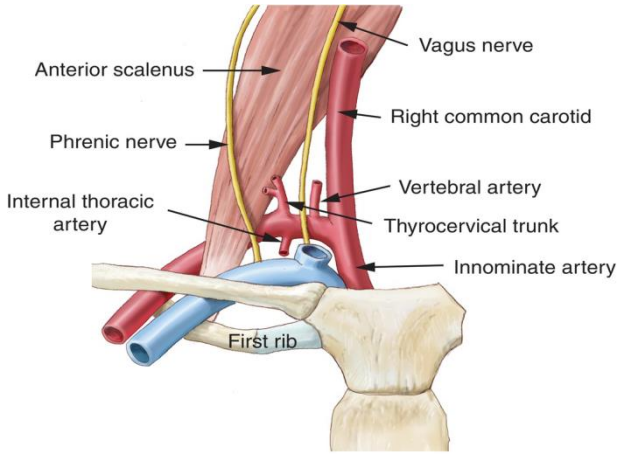

Figure 5-2

Note: ***Spinal*** accessory nerve also passes through foramen magnum.

Remember: Accessory nerve has two roots: spinal and cranial.

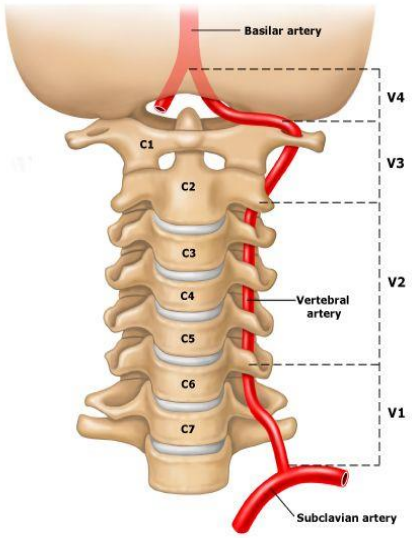

Figure 5-3

-After right and left vertebral arteries pass through foramen magnum they run medially and meet each other on the lower border of pons (pontomedullary junction) forming ***basilar artery*** which run superiorly in the basilar groove on anterior border of pons, on upper border of pons it divides into two ***posterior cerebral arteries***.

Remember: anterior cerebral, middle cerebral and **posterior communicating** arteries are branches from ***internal carotid artery***.

-Posterior communicating artery-from internal carotid- communicates with posterior cerebral artery-terminal branch of basilar- on each side. Figure 5-4

وبذلك تكتمل ال Circle of Willis

-This circle is found in subarachnoid space and it is responsible for the blood supply of brain.

وبعد كل هالقصة شو دخل Spinal cord؟

Here is the answer ☺

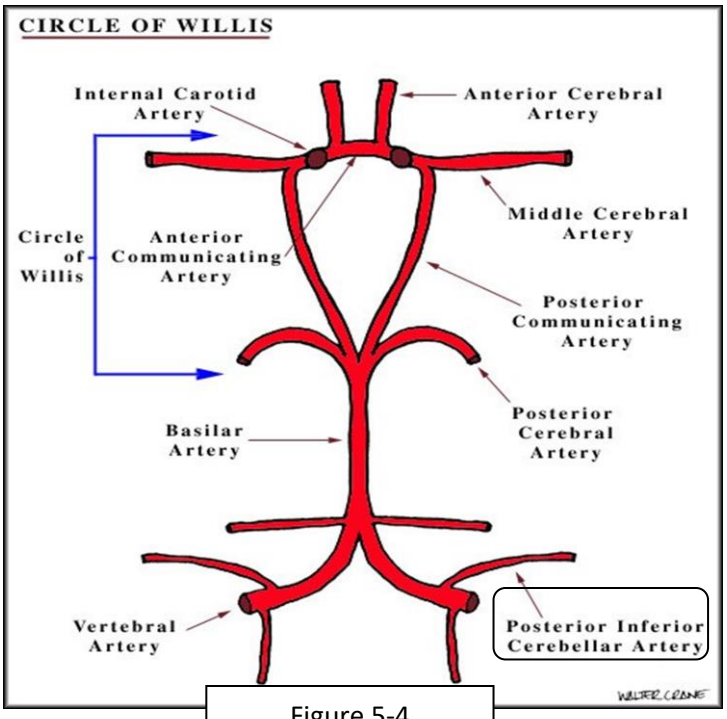

Figure 5-4

- As we said before, Right and Left vertebral arteries meet each other on the lower border of pons to make basilar artery, but before that they give branch on anterior aspect of spinal cord and they meet each other on anterior median fissure to form ***anterior spinal artery***, which descends along the spinal cord.

- Right and left vertebral arteries also give ***posterior inferior cerebellar arteries*** which give two posterior spinal arteries.(in the posterolateral sulcus)

  Now we have ***one anterior spinal artery*** and ***two right and left posterior spinal arteries***.

  (They are the **longitudinal arteries** of spinal nerve)

2- Segmental arteries:

Longitudinal blood supply must reinforce by segmental arteries (they run horizontally) and enters intervertebral foramina, segment by segment.

- They arise from :
  - ✓ Vertebral arteries: on cervical region

- ✓ Deep cervical arteries: they help vertebral arteries in cervical region (neck), they are branches of costocervical trunk which is the only branch of **SECOND** part of subclavian artery.
  REMEMBER: Vertebral artery is branch of the **FIRST** part of subclavian.
- ✓ Posterior intercostal arteries (11) and subcostal (number12) in the thorax.
- ✓ Lumber arteries which arise from abdominal aorta (they are 4 in number on either side) in the abdomen.

- Branches of segmental arteries after they pass through the intervertebral foramena:
  - ✓ Anterior radicular arteries (جذري): they run with ventral roots of spinal nerves.
  - ✓ Posterior radicular arteries: they run with dorsal root of spinal nerve.
  - ✓ Segmental medullary arteries: they run anteriorly and anastomose with anterior spinal artery.Figure 5-5

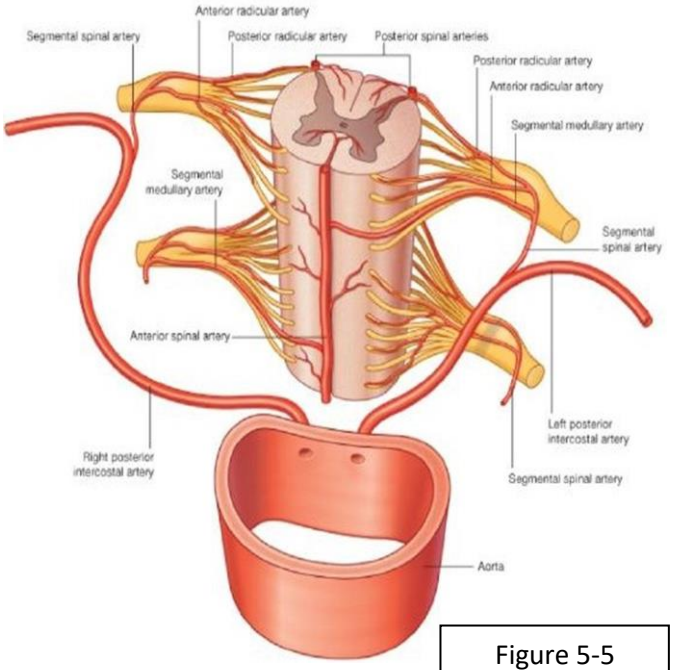

Figure 5-5

Artery of Adamkiewicz:

Figure5-6

- ☒ Branch from segmental artery.
- ☒ In most people it arise from left side (70%), from left posterior intercostal artery at the level of 9th to 12th intercostal artery, which branches from aorta, and supplies the lower two thirds of spinal

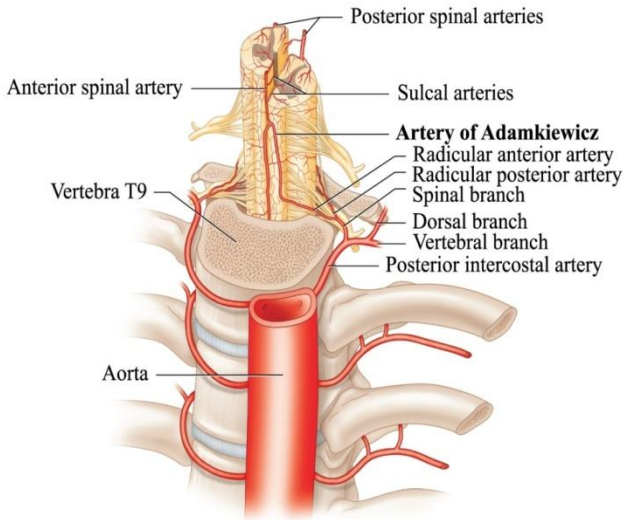

Figure 5-6

cord-reinforcement of blood supply to lower segments - (from slides).

- ☒ Anastomose with anterior spinal artery.
- ☒ If there is an obstruction in it, the blood supply to the lower segments will decrease and anterior **spinal artery syndrome** will happen.It affects the motor activity of the lower segments which affects sphincters (external anal and urinary sphincters), this will result in incontinency (inability to control urination and defecation).

Extra: about artery of adamkiewicz

Some radicular arteries, mainly situated in the lower cervical, lower thoracic and upper lumbar regions, are large enough to reach the anterior median sulcus where they divide into slender ascending and large descending branches. These are the anterior medullary feeder arteries. They anastomose with the anterior spinal arteries to form longitudinal vessel along the anterior median sulcus. The largest anterior medullary feeder, the great anterior segmental medullary artery of Adamkiewicz, varies in level, arising from a spinal branch of either one of the lower posterior intercostal arteries (T9–11), or of the subcostal artery (T12), or less frequently of the upper lumbar arteries (L1 and L2). It most often arises on the left side. **Source: Grays anatomy**

❖ ***Venous drainage of spinal cord***

- ✓ two pairs of veins on each side.
- ✓ One midline channel parallels the anterior median fissure.
- ✓ One midline channel passes along the posterior median sulcus.
    - All of them drain into an extensive ***internal vertebral plexus*** in the **extradural(epidural)** space of the vertebral canal. Figure 5-7
    - Eventually they will drain into ***azygous system*** (azygous vein on the right side and two hemiazygous,superior and inferior,

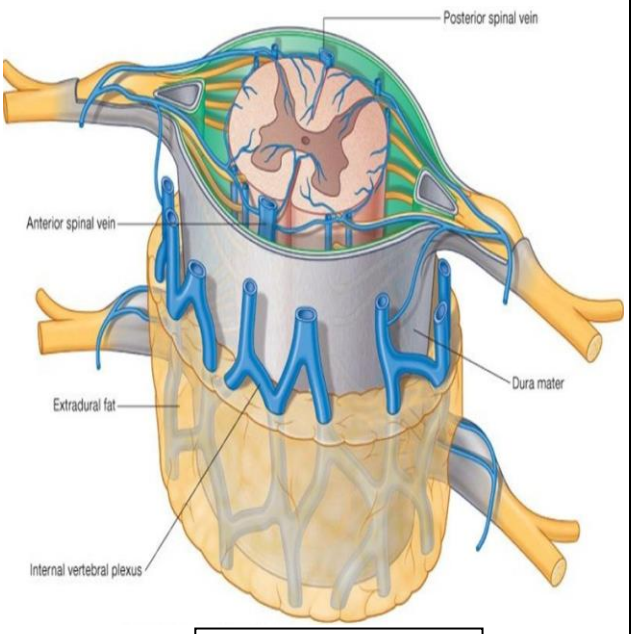

Figure 5-7

on the left side), but the upper cervical may drain into ***intracranial veins***. (we will talk about them when we discuss venous drainage of the brain).

Remember: most of arterial supply is found in **subarachnoid space**, so when there is a rupture in spinal artery, there will be blood in CSF

❖ *Motor descending tracts*

The *upper motor neuron* starts form the cortex, but from which areas of the cortex?! In general we have two areas: Figure5-8

- Primary motor cortex: anterior to central sulcus we have frontal lobe, the first area of frontal lobe is precentral gyrus, this is the anatomical name, but the functional name is primary motor cortex (Area #4)

- Premotor cortex
- supplementary cortex

} Area #6

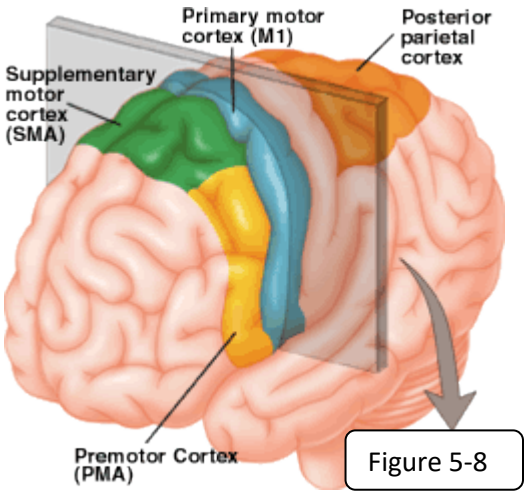

Figure 5-8

- In case of spinal nerves, the *upper motor neuron*descend down to the **anterior horn** of spinal cord (corticospinal fibers), then it will synapse indirectly through interneuron with the *lower motor neuron.*
- In case of cranial nerves, the *upper motor neuron*descend down to the **nucleus** in brain stem(corticonuclear or corticobulbar), then it will synapse with the *lower motor neuron.* We have nucleus for every motor cranial nerve like oculomotor, trochlear, fascial etc.…

-We have two important motor tracts:

✓ ***Pyramidal tracts:***

We call it pyramidal because the fibers descend from cortex to internal capsule to midbrain to pons and when they reach the anterior aspect of medulla,they pass through the pyramids of the medulla oblongata.

When we say pyramidal tracts this means corticospinal(anterior &lateral) and corticonuclear fibers, although corticonuclear fibers don't reach the pyramid anatomically, but functionally we considered them with pyramidal tracts.

- ☒ Funtion: **conscious** control of skeletal muscles movement.

'**From Wikipedia**The pyramidal tracts include both the corticobulbar tract and the corticospinal tract. These are aggregations of efferent nerve fibers from the upper motor neurons that travel from the cerebral cortex and terminate either in the brainstem (corticobulbar) or spinal cord (corticospinal) and are involved in the control of motor functions of the body"

- ✓ ***Extrapyramidal tracts:***

1- **Vestibulospinal tract:**Vestibular nucleus in brain stem receives sensory information through the vestibular nerve (part of vestibulocochlear nerve السمعي التوازني, which is the 8th cranial nerve) about balance and orientation of the head from the inner ear. The nuclei relay motor commands through vestibulospinal tract.

2- **Reticulospinal tract:** It starts from reticular formation which is found in the core of brain stem.

3- **Rubrospinal tract:** Rubro means red, so it starts from red nucleus which is found on superior aspect of midbrain down to anterior horn system.

4- **Tectospinal tracts:**It starts from tectum which is found in midbrain down to anterior horn system.

This naming is somehow misleading because it indicates that these tracts starts from structures in brain stem down, but in reality these tracts are under direct control from the cortex. If we want to name **precisely**, we put cotico- before the previous names.

- ☒ Function: **subconscious** control of ***skeletal muscle*** movement, **Neither** smooth muscle nor glands. What do we mean by this? Fine tuning and modification of skeletal muscle on subconscious level.

Pyramidal tracts: mainly area #4 (primary motor cortex), not only area #4 but mainly.

Extrapyramidal tracts: area #6 (premotor and supplementary areas).

❖ Rexed laminae

-Dorsal horn from lamina 1 to 7 is sensory.

-Ventral horn is motor and it's made from lamina 8 and 9, but mainly lamina 9 because it contains cell bodies of lower motor neurons while lamina 8 contains motor interneurons

- Lamina 9 is divided into nuclei: Figure 5-9

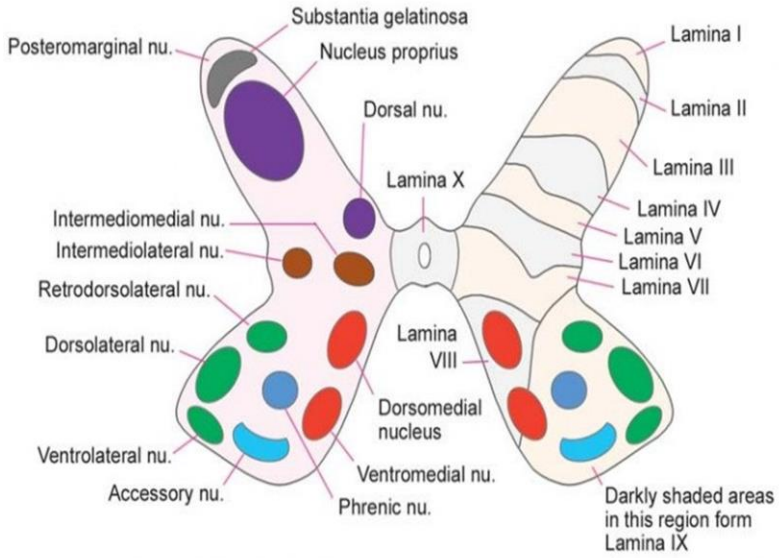

Figure 5-9 he grey matter of the spinal cord. The left half of the figure shows the cell described. The right half shows the newer concept of laminae.

- ✓ ***Ventromedial:*** found in all segments (extensors of vertebral column).
- ✓ ***Dorsomedial:*** from T1 to L2 (intercostals and abdominal muscles)
- ✓ ***Ventrolateral:*** from C5 to C8 (arm) and from L2 to S2 (thigh). For example, C5 deltoid, C6 biceps and C7 triceps.
- ✓ ***Dorsolateral:*** from C5 to C8 (forearm) and from L3 to S3 (leg)
- ✓ ***Retrodorsolateral:*** C8-T1 (small muscles of the hand) responsible for the sophisticated movements of the hand like writing and drawing. S1-S2 (foot).
- ✓ ***Central:*** phrenic nerve (C3-C5) motor innervation of diaphragm.

    - ***General rule:*** medial motor system (nuclei which are located medially in ventral horn **in all** segments generally) is responsible for proximal muscles which are related to posture (walking, running, sitting), while lateral motor system (nuclei which are located laterally in cervical and lumbar enlargements **only**) is responsible for distal muscles (skilled movements like writing, drawing, etc...). Figure 5-10

When there is a lesion in upper motor neuron, we call it *upper motor neuron lesion* while in lower motor neuron; we call it *lower motor neuron lesion*. Anybody will say that the net effect of two lesions is paralysis, but this is not the case!! Actually sometimes we will see that symptoms of the upper lesions are hyperreflexia and rigidity, while in the lower lesions are hyporeflexia and flaccidity, completely the opposite!! But why?

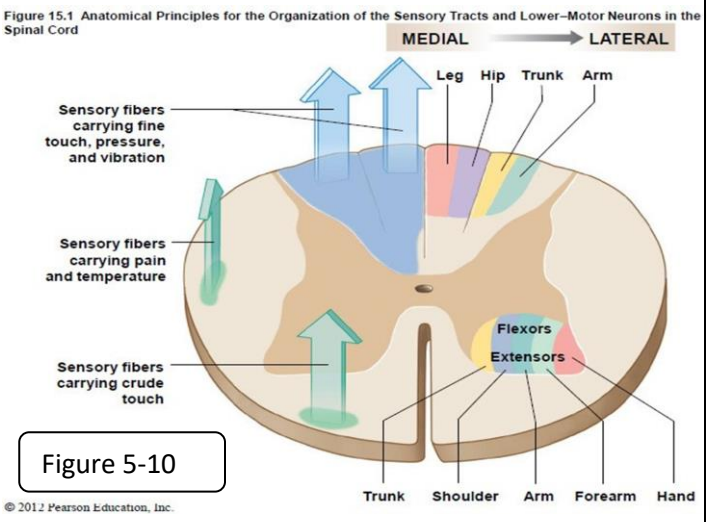

Figure 5-10

In order to understand this, we must discuss the histology of skeletal muscle. Figure 5-11

-The skeletal muscle is composed of:

- ✓ ***Extrafusal fibers (99%):*** which are the regular fibers we took before. Innervated by alpha motor neuron (big cell body in lamina 9 and large diameter, so higher velocity).
- ✓ ***Intrafusal fibers (1%):*** they are encapsulated and fusiform (spindle) in shape. Innervated by gamma motor neuron, smaller cell body, smaller diameter, so lower velocity.

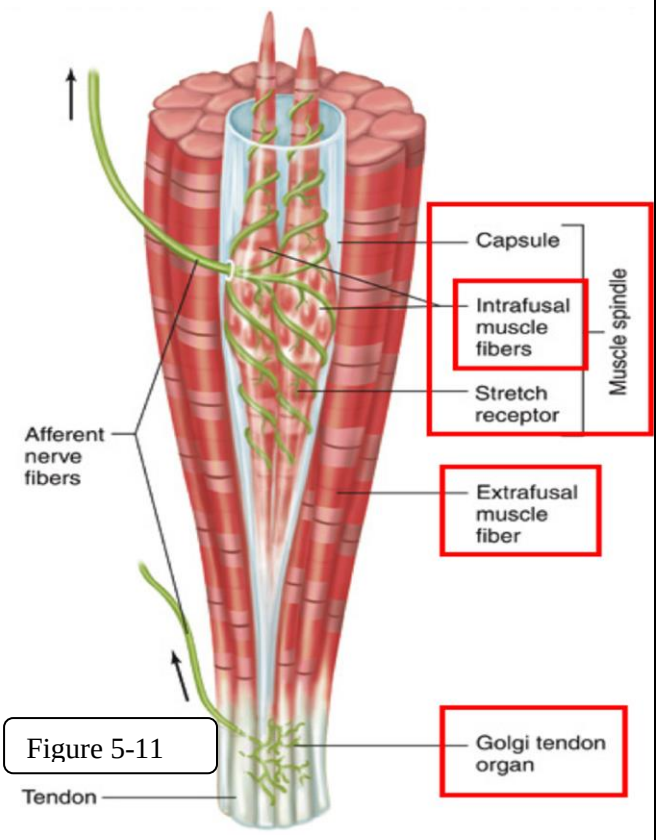

Figure 5-11

-In order to contract the muscle, you must activate it through lower motor neuron. But how to activate the lower motor neuron?! We have two ways:

- ✓ 1st way: through upper motor neuron indirectly through interneuron.
- ✓ 2nd way: through stretch reflex, there are sensory fibers in intrafusal muscle fibers (muscle spindle), and these sensory fibers pass through dorsal root then they activate alpha motor neuron directly without interneuron (monosynaptic).

Muscle spindles: are sensory receptors within the belly of a muscle that primarily detect changes in the length of this muscle.

But, how to activate muscle spindle?!

Figure 5-12

1- Muscle spindle is sensitive to **stretch** which means that when the length of the muscle increases it gets activated then it will synapse directly with the lower motor neuron that goes to the same muscle then the muscle will contract. Why we have such reflex? To preservemuscle tone.

Muscle tone indicates that the muscle is always in partial state of contraction because all muscles are shorter than the distance between origin and insertion. Muscle tone mainly preserves posture, for example: when you stand up, the partial state of contraction of antigravity muscles like extensors of lower limbs preserves your posture.

لو في عندك كبسة بتوقف ال Tone.. **:P**....العضلات رح ترتخي ورح تُفرُط وتِقع من طولك.

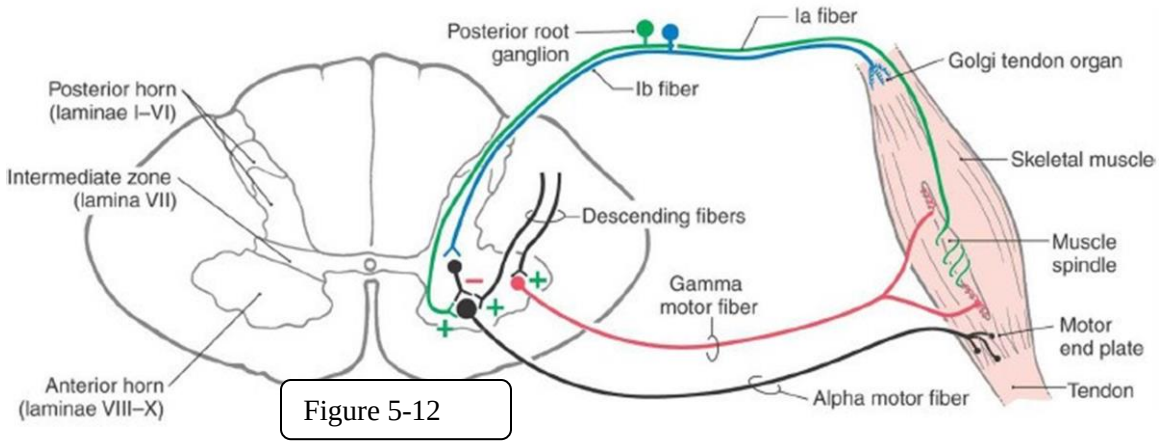

Figure 5-12

We call the part of the muscle which is innervated by one axon **motor unit**, the number of motor units increase in muscles of skilled movement. For example: muscles of the hand and eye.

2- **Gamma loop:** Descending tracts activate alpha motor neuron and gamma motor neuron which supply muscle spindle at the same time. Why? If we want to understand well,

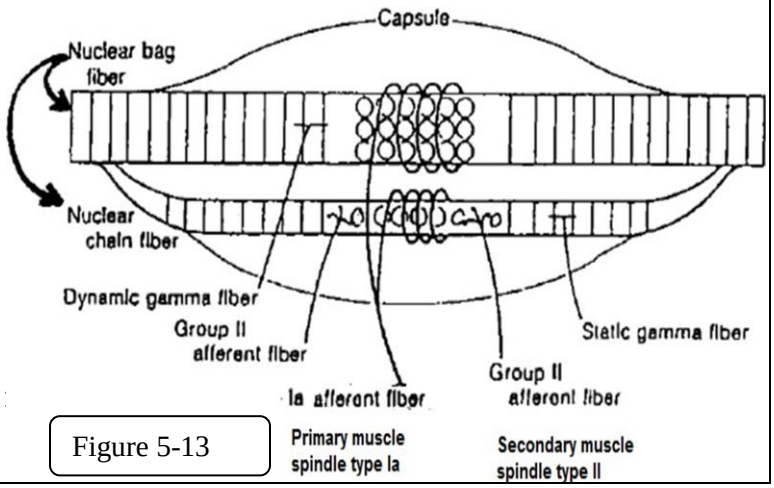

Figure 5-13

we must have a closer look at muscle spindle. Figure 5-13
-We have two types of intrafusal fibers:

- *Nuclear bag:*the nuclei converge in the center like a bag.
- *Nuclear chain:* the nuclei converge in the center like a chain.

In both of them, the sarcomeres are located in the periphery while the central area is free of sarcomeres. When they get activated through gamma,the tips will contract while the central area (which has sensory fibers) will stretch→activation of muscle spindle → activation of alpha motor neuron→ contraction of extrafusal fibers. This happens in case of sustained contraction.

- *Gamma fibers activate the muscle fibers indirectly, while alpha fibers do it directly.*

When we look at muscle spindle, we will find two types of afferent fibers:

- ***Primary afferent fibers***: take sensation from both nuclear bag and chain, type 1a fibers according to the old classification, Aα according to the newest one. They have large diameter and high velocity (rapidly adapting) and is responsible for dynamic stretch reflex which happens in jerks. When you hit a tendon with hammer, the primary afferent will get activated then the reflex will result.**Hint:** type 1b is found in golgi tendon organ.
- ***Secondary afferent fibers:*** take sensation from nuclear chain only, type 2 fibers (Aβ). They have smaller diameter and lower velocity (slowly adapting) and is responsible for static stretch reflex which is important in muscle tone. You want the tone to be sustained, so whenever you have a signal you will have a response. In this way we preserve the tone.

Regulation of α motor neuron:

Figure 5-14

α motor neuron tend to be over active, so there must be away to inhibit it. α motor neuron give a collateral fiber which goes to Renshaw cells in lamina 7. These cells are inhibitory cells which go back to α motor and secrete glycine which inhibit the neuron.

- ***Strychnine poisoning:***

- It is a drug which was used to treat sexual dysfunction, but now it is considered a poison.
- It inhibits renshow cells and prevents them from secreting glycine
- α motor neuron will cause excessive firing (contractions and convulsions)

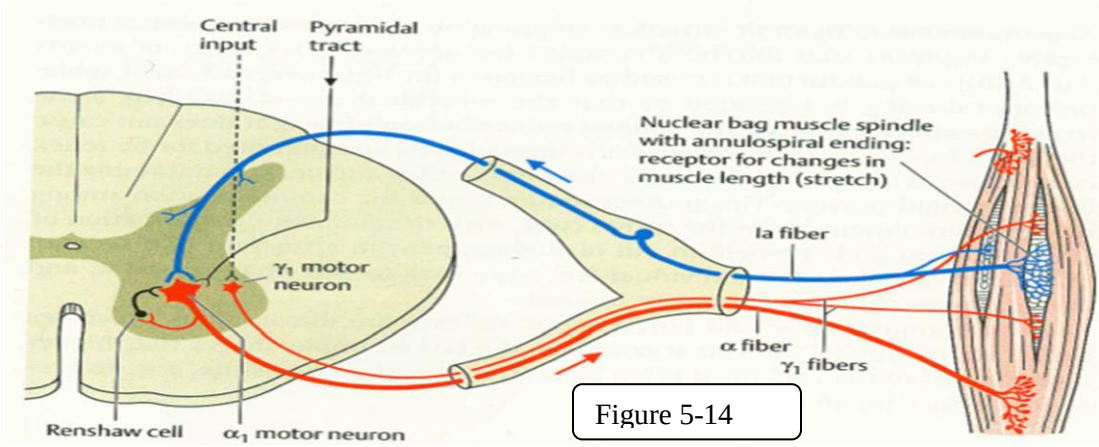

Figure 5-14

But still we didn't answer our question, which is why in sometimes upper motor neuron lesions have completely opposite symptoms of that in lower motor neuron lesions?!

The answer precisely is not in this sheet :P, it will be discussed in sheet #7 but briefly, pyramidal tracts tend to be excitatory and extrapyramidal tend to be inhibitory, so when we cut pyramidal only (which is very very rare) the result will be hypotonia, but when we cut both of them (in most of times) the result will be hypertonia. Because when you cut the inhibitory, gamma loop tend to be overactive!

Figure 5-15 :p