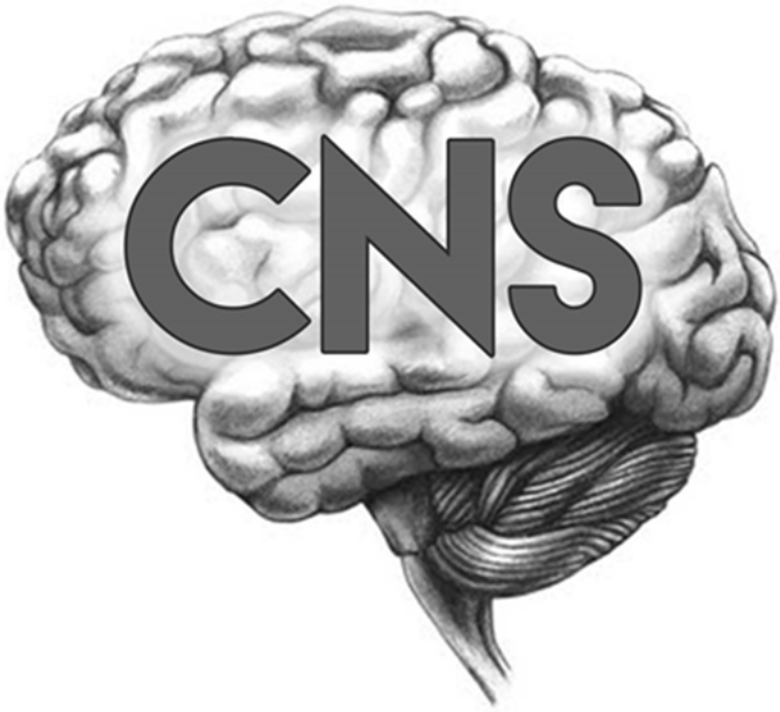


PHYSIOLOGY

☑ Sheet ○ Slide ○ Handout

Number

2

Subject

Done By

tala ashoor

Corrected by

Doctor

Faisal Mohammed

Date: **00/00/2016**

Price:

- This sheet was written according to the record that belongs to sec2.
- This sheet is easy and it illustrates many anatomic topics .
- The sheet was 10 pages before the figures :p

- As mentioned before , we will start our long long very long CNS discussion with the motor pathway.
- The command starts from the cerebral cortex "the leader" to other areas that might be regulatory or effectors .

Cortical Control of Motor Function

- The cerebral cortex is sub divided into areas that are either motor or sensory, or special for auditory and vision.
- Any motor command is initiated in the cortex , or from other nuclei in the brain stem under the supervision of the cortex ,thus we have tracts that transmit these commands .
- A tract is a group of nerve fibers that have the same origin, termination ,and function.
- The main motor tracts are :
    1. To the spinal cord : cortico-spinal tract .
    2. To brain system centers :
        - Cortico-ponto-cerebelar .
        - Cortico-reticular.
        - Cortico-rubral.
        - Cortico-olivery.
- The cortico-spinal tract:
  This starts in the cerebral cortex, and the commander neurone is called upper motor neurone, this descends down to the spinal cord .
  Within the spinal cord it synapses with other neurons like alpha motor neurones .
  Alpha and gamma neurones are called lower motor neurones.
  But the cortex never sends one command to one area ,the motor command must be regulated and monitored
  So the same command that reach the spinal cord through the cortico-spinal tract also reaches the cerebellum via another tract called the cortico-Ponto-cerebelar.
  But why? This is to tell our cerebellum about the intention (the movement we want to accomplish) and the reason behind that is that our cortex never send exact impulses ,there is certain errors ,so the impulse might be more or less than the intended (it's okay if you don't understand this, there is an illustrative example on this) .

Other commands might reach other areas via the tracts mentioned above ,such as reaching the reticular formation in the brain stem (we have pontine reticular formation in the pons , and medullary reticular formation in te medulla)

Back to the story , the impulse reach the alpha neuron in the spinal cord, the impulse is transmitted to the muscle via the axon of the alpha neuron , then the muscle either contracts or relaxes, as said before the action on the muscle could be higher or lower than the intended .

So the signal has to be corrected

But how does that happen?

- In the muscle we have receptors called muscle spindle ,other receptors are Golgi tendons, these receptors sense the changes in the muscle (its length,tention and so on) so they end an impulse via feedback fibers called spino-cerebellar tract (sensory of course) to the cerebellum to tell it how the muscle is contracted .

We have two spino-cerebellar tracts : dorsal spino-cerebellar and ventral.

In the cerebellum the magic occurs! Remember the cortico-ponto-cerebellar tract that reached the cerebellum? O the cerebellum has a copy of the intended command , when the feedback of the actual movement from the spino-cerebellar reaches the cerebellum , a comparession between the two info is made .

So it compares the actual to the intended movement ,if they match that's fine, if not then it sends info back to the cortex but **never direct** only through the thalamus .

Remember that anything goes back to the cortex either motor or sensory,it has to synape in the thalamus .

But in CNS whenever you study any thing you should ask: where?? ,thus where in does the synapse occur in the thalamus?

- The thalamus has many areas ,some are sensory and some are motor, the motor areas are : ventro-lateral and ventro-anterior .

So the cerebellum corrects the commands,and send it back to the cortex via the thalamus to give orders all over again .

The cortex sends another command, close to the corrected one (because it never gives exact) and the previous story is repeated over and over until we reach the intended movement.

Why don't we sense this correction?

- The amazing feature of this mechanism is that it happens so fast to the extent that we don't see it (please cherish this moment and say سبحان اللهhow amazing the organization is).
- We see the movement smooth and sharply directed toward the target

like when you watch a movie ,pictures are ordered one after another but run so fast and we see movement.

Clinical correlation :

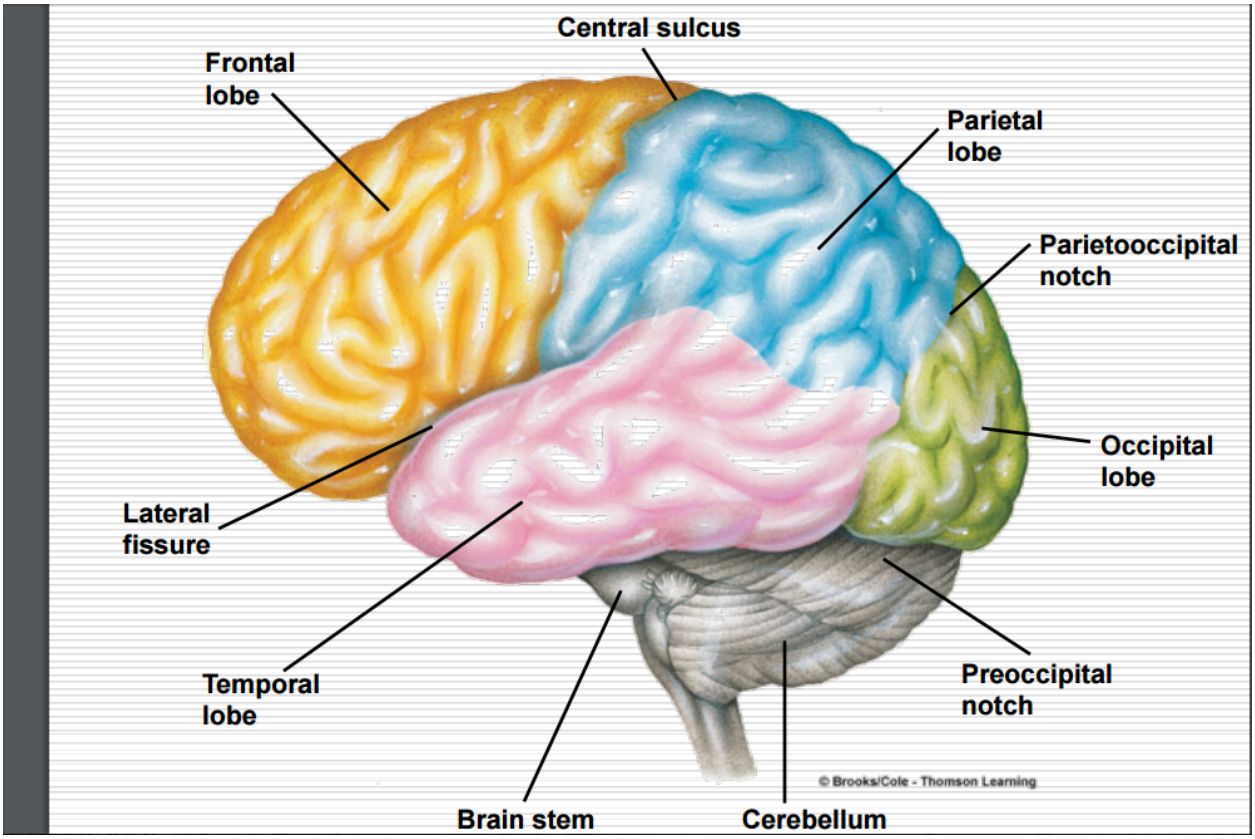
If there's a damage in the way, like in the cerebellum, the movement becomes slow, broken down, and with tremor when , we call this tremor intention/action tremor (because it occurs only when the patients moves) .

There are of course other types of tremor like in case of basal ganglia diseases(Parkinson:resting tremor).

To understand the whole previous story follow this :

"you have this sheet infront of you ,you want to hold it , your cortex initiate a command "this medical student wants to hold the sheet "and sends one copy to the spinal cord and another to the cerebellum , the one that reaches the spinal cord synapses with alpha and thus the muscles contracts , your hand move toward the sheet , but doesn't reach it for example ☹ a feedback is then transmitted to the cerebellum "the hand is not on the sheet", but the cerebellum has strict command that you hold the sheet , so it sends correction to the thalamus and the thalamus tells the cortex to fire again ,until you hold the sheet :p "

cerebral cortex:



the anatomy of the cerebral cortex ,: on the lateral view of the cerebral hemispheres we see grooves called sulcii, and ridges called gyri

we also have three main features :

1- Central sulcus : divides the cerebral hemisphere into frontal and parietal lobes .
2- Lateral fissure : divides the cerebral hemisphere into temporal and parietal
3- Prieto-occipital : divides it into parietal and occipital.

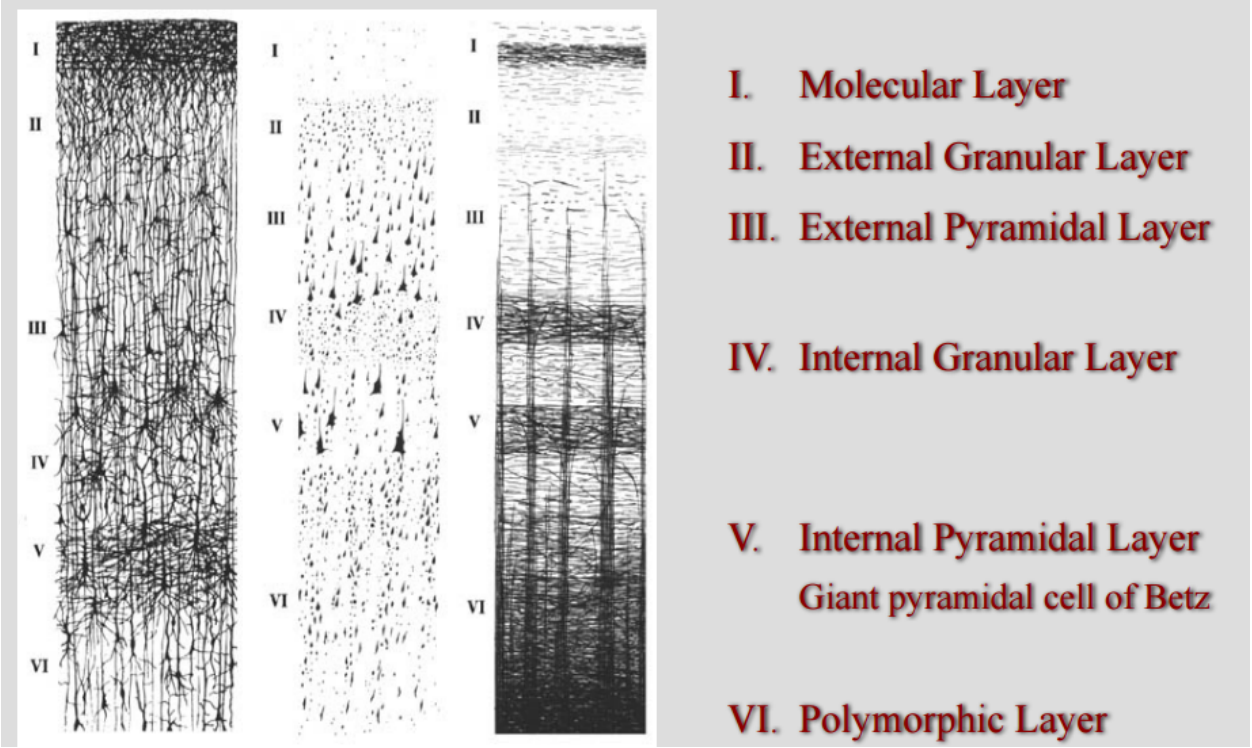
Anterior to central sulcus we have :precentral- primary motor area 4.

Stimulation of this area doesn't give you coordinated movements , only simple movements .

Posterior to the central sulcus we have :postcentral area that is sensory .

Histological preview of the cortex :

- The doctor doesn't care about the histology, but in the course you might hear that a certain efferent neuron originate from a certain layer , so you have to know them .



betz cells in layer 5

in general fibers are either :

1- Afferent fibers : nerve fibers that come back to the cortex (to remember it I say that afferent is Ahlan :p).
2- Efferent fibers : nerve fibers that go out of the cortex .

Afferent fibers : that come to the cortex

1. corticocortical fiber :
   nerves that run within the corteces themselves and are either :
   - association fibers : that run within the same cortex in one side .
   - commissural fibers that run from one side to the other , and these are important for integration and coordination .

2. thalamocortical fiber - specific and non-specific

3. extrathalamic subcortical fiber

Efferent : that go out of the cortex

1- Corticofugal Fiber - Projection Fiber : To sharpen the movement , fibers to sharpen the signal .
2- corticostriate fiber to basal gaglia : Basal ganglia has putamen and caudate both are called corpus striatum because they are striated
3- corticothalamic fiber
4- corticorubral fiber
5- corticotectal fiber : to the Tectum , the tectum has 4 coliculi Superior from vision and inferior from hearing .
6- corticopontine fiber
7- cortico-olivary fiber
8- corticobulbar fiber to nuclei of cranial nerves
9- corticospinal fiber : the main one, the motor tract
10- Corticocortical Fiber :Association fiber, Commissural fiber

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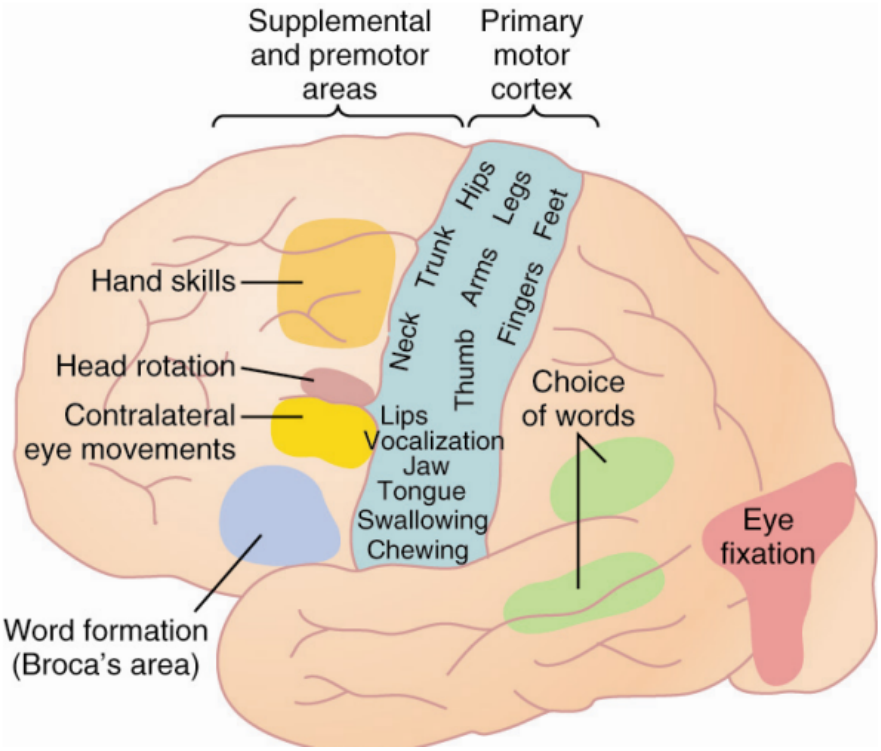
The cortex is divided into 3 sub areas :

1- Primary motor area :
    - Located on the precentral gyrus
    - Has unequal topographic representation of the body : this means that ech part of our body is represented on the area , but not equally in size that it occupies .
    - The area that represents any part of our body is proportional to the number of motor units in that area , and the numbers of motor neurons determines how fine the movement is .
    - Movement can be elicited by eternal experimental stimulation on the cortex .
2- Premotor area:

Motor Areas of the Cortex

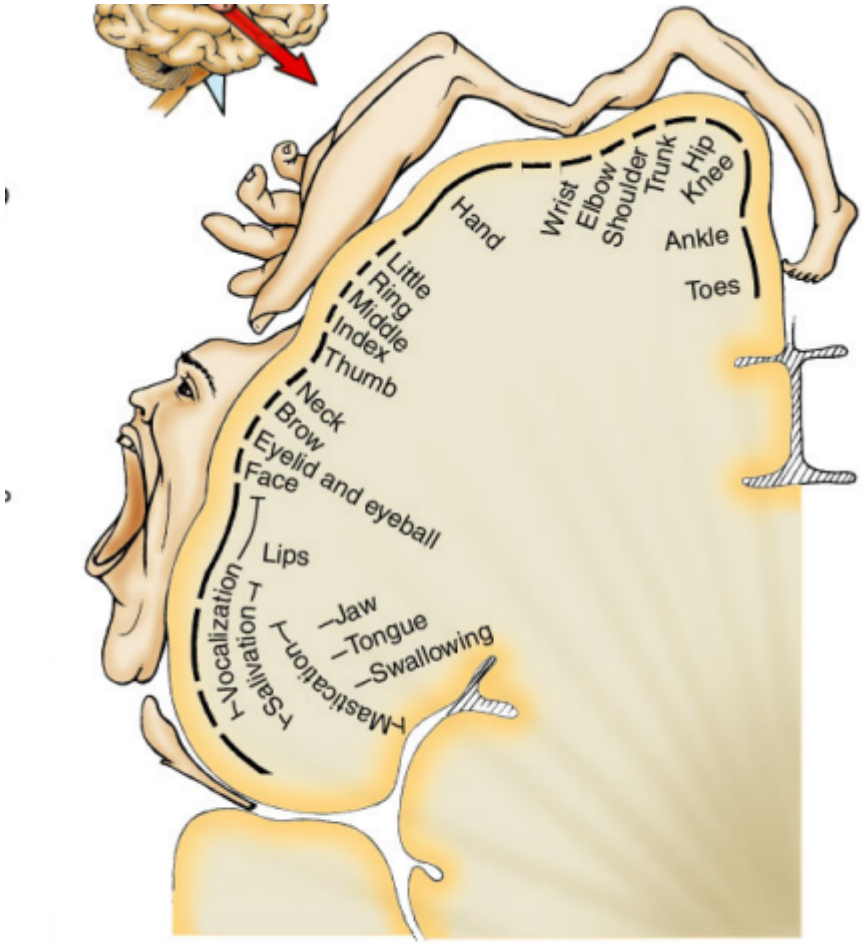


- Has topographical organization similar to primary motor cortex
- stimulation results in movement of **muscle groups** to perform a specific task
- works in concert with other motor areas
-

3- supplemental motor area:

- topographically organized
- simulation often elicits **bilateral** movements.
- functions in concert with premotor area to provide attitudinal, fixation or positional movement for the body
- it provides the background for fine motor control of the arms and hands by premotor and primary motor cortex

so our body is represented on the cerebral cortex and the representation is **upside down** and contralateral (the right controls the left and vice versa)



(b) Frontal section of primary motor area in right cerebral hemisphere

Rule :

"Any area of our body is represented by area in the cerebral cortex ,and how much is representing that area in the cerebral cortex depends on the number of motor unit in that area"

Motor units : a motor unit is a neuron and the muscle fiber/s it supplies , a large motor unit is thus a neurone that supplies a large muscle (many muscle fibers) , while a small motor unit is a neuron that supplies small number of muscle fibers .

If we say that the fine movements (like writing and playing the guitar etc) needs a high number of motor units, then the units are small.

For example : our hand has very precise movements so the number of motor units that supply our hand distal muscles is too much compared to the size of our hand , and we say it has large topographical representation on the cortex.

The legs are supplied by much less motor units , less precise movement

- **so the representation is relative to the function**

insurance area haa thumb 50%

- ❖ Premotor and supplementary areas :

Stimulation of their areas gives u a sequence of movements ,so stimulation of the primary motor area doesn't give you coordinated movements it rather gives , simple single muscle contraction. While , stimulation of the premotor area gives you coordinated movements.

Areas of the Premotor area :

- Broca's area of speech gives you the sentence you want to say , and coordinate the movements of you tongue and face to express the sentence via coordinated stimulation of area 4.
- contra lateral eye movements
- hand skills

In the Premotor area the representation is not single representation , rather we have programmes .

In the supplementary area , representation is a little bit bilateral , and the representation is not equal.

- ❖ Some people divide the cortex into only primary and Premotor areas ,and then sub divide the Premotor area into : lateral and supplemantory areas .

Functional organization of the primary Motor Cortex

- Located in the precentral gyrus of the frontal lobe.
- More cortical area is devoted to those muscles involved in skilled, complex or delicate movements, that have more motor units i.e the cortical representation is proportional to the No. of motor units

- ❖ Characteristics of the PMC:

1. It has predominant influence on the opposite side of the body (except some portions of the face).

2. It is organized in a homunculus pattern (small human being) with inversed order .

3. The degree of representation is proportional to the discreteness (fines of the movement) (number of motor unit) of movement required of the respective part of the body. (Face and fingers have large representative).

4. Stimulation of a certain part of PMC can cause very specific muscle contractions but not coordinate movements.

Fibers from the primary motor area either :

- ❖ Project directly –from the cerebral cortex to the spinal cord to regulate movement
  - Via the Corticospinal Tract . (this originate from the cortex , mainly from area 4 and 6 , but could be from other areas , it passes through the internal capsule)

- It reaches the medulla and cross to the other side (from lef to right and vice versa) this is called medullary decussation .
- More than 90% of fiber cross
- Less than 10% don't
- The pyramidal system.(it passes through the pyramid of the medulla)
- Affect more distal flexors .
- Most of the direct fibers synapse with interneurons (others synapse with alpha)
- It's refered to as direct because it reaches the spinal cord directly and synapses there.

❖ Projects indirectly

- Via the Brain stem to regulate movement
- Either corticorubral ,or cortico-reticular .
- Extrapyramidal system
- affect extensors mainly (except the rubral that affects flexors).

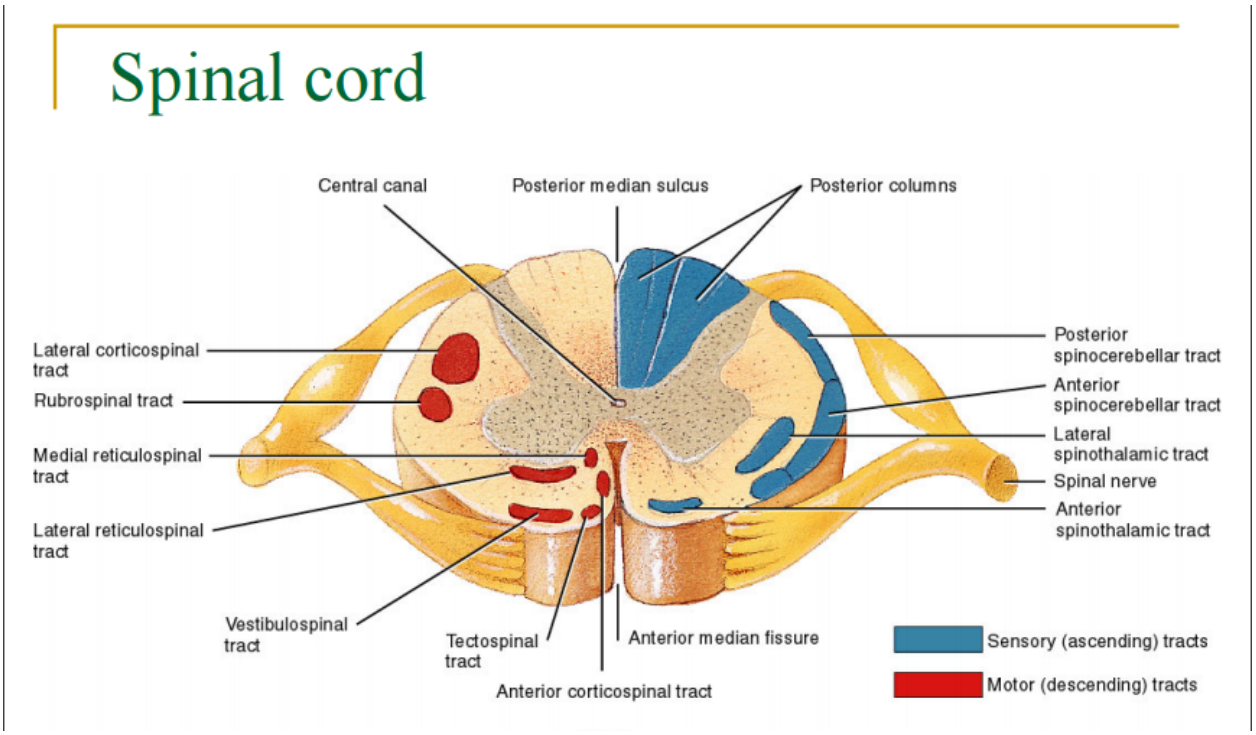
We said that fibers reach the spinal cord , but again WHERE exactly in the spinal segment they pass?

- The spinal cord segments have white matter and grey matter
- The grey matter is H shaped and is divided into horns : 2 anterior (ventral horns) ,2 posterior (dorsal horns) , and in some segments we have lateral horns .

The white matter (myelinated)axons is divided into three columns by theses horns : posterior (dorsal column) ,Lateral column ,Medial (anterior column).

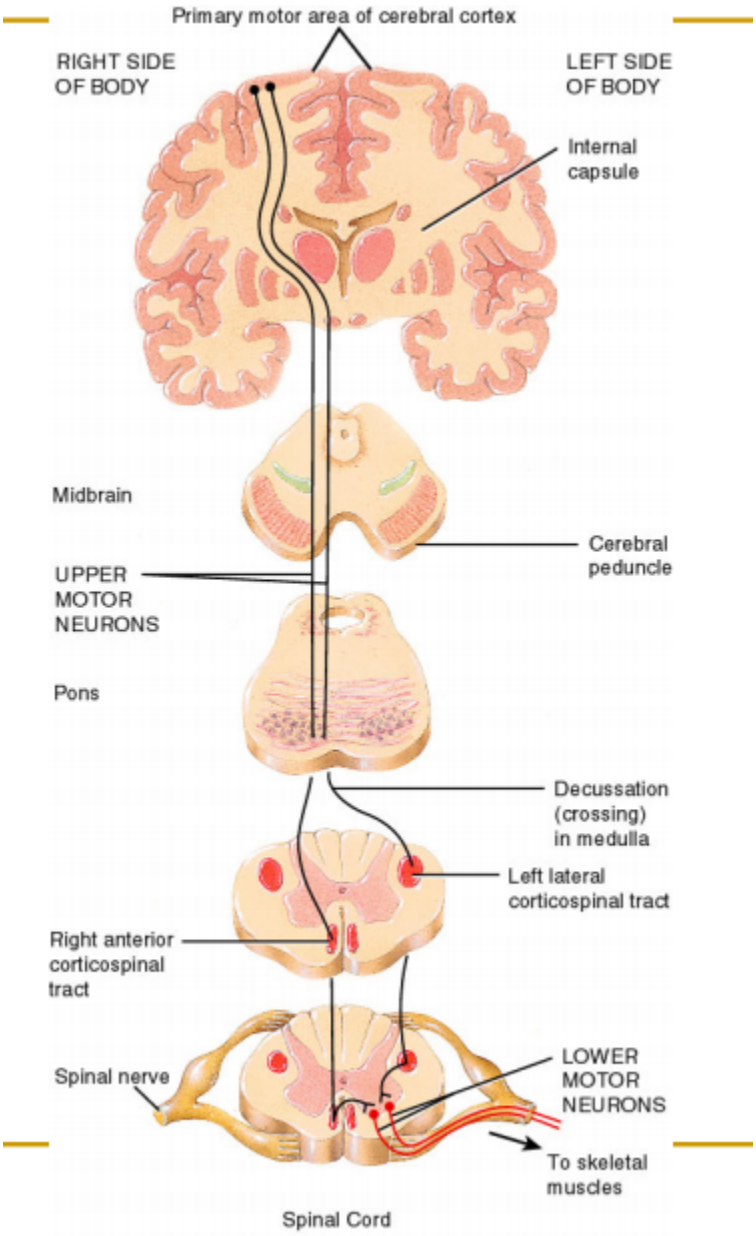
The cortico-spinal and the rubro-spinal tracts pass through the lateral column and hence they are called lateral system pathway .

Medial system pathway passes through the medial column.



(The lateral corticospinal once reaches its final destination :p synapses with alpha neurons or interneuron and alpha send impulses for the muscle to contract.(Alpha is called final common pathway because it receive many synapses)

Now we said that 10% of the fibers don't decussate , these are anterior cortico-spinal fibers , most of the fibers cross at the level of the segment in the spinal cord .



Conclusion :

Descending Spinal Pathways

- **pyramidal system :**
- Direct
- Control muscle tone and conscious skilled movements (other tracts control the subconscious and the unconscious)
- Direct synapse of upper motor neurons of cerebral cortex with lower motor neurons in brainstem or spinal cord
- **extrapyramidal system:**
- synapses in brain stem areas

- Indirect
- coordination of head & eye movements,.
- coordinated function of trunk & extremity musculature to maintaining posture and balance n Synapse in some intermediate nucleus rather than directly with lower motor neurons

- Both rubro-spinal and cortico-spinal control the function of the flexors and they both form lateral system pathway .
- Medial system pathway control the extensors ,the antigravity muscles, important for balance and posture .

Antigravity muscles : extensors +shoulder and hip girdle.

The lateral controls the flexors for voluntary skilled movement.

Rubro-spinal controls large muscles of the wrest and the elbows .

(sometimes when you want to write , you want to fix the wrest , by stimulation of the rubro-spinal , and move the hand by the cortico-spinal)

cortico thus controls distal muscles .

- The following is from the slide
- Transmission of Cortical Motor Signals :
    - Direct pathway :
    - Via corticospinal tract
    - for discrete detailed movement for distal muscles flexor
    - Indirect pathway :
    - signals to basal ganglia, cerebellum, and brainstem nuclei

some features about the cortico-spinal fibers :

- they are 34,000 Betz cell fibers, make up only about 3% of the total number of fibers
- Go from betz and synape directly with alpha
- 97% of the 1 million fibers are **small diameter fibers**

Other Pathways from the Motor Cortex :

- Betz collaterals back to cortex to sharpen the boundaries of the excitatory signal (these are the corticofugal) conduct feedback signals from the cortex to control intensity of the various sensory signals to the brain to sharpen the signal

- Fibers to caudate nucleus and putamen of the basal ganglia corticostrietor
- Fibers to the red nucleus rubral , which then sends axons to the cord in the rubrospinal tract
- Reticular substance, vestibular nuclei and pons then to the cerebellum
- Therefore the basal ganglia, brain stem and cerebellum receive a large number of signals from the cortex.

Premotor Areas

•Receive information from parietal and prefrontal areas association

•Project to primary motor cortex and spinal cord

•For planning and coordination of complex planned movements

" If you believe in yourself ,have dedication and pride, and never quit, you wil be a winner.the price of victory is high, but so are the rewards" :D

Paul Bryant