# Introduction to neurology. Principles of structure and functions of the nervous system. Movement disordes. Extrapyramidal syndrome and its neurochemical mechanisms.

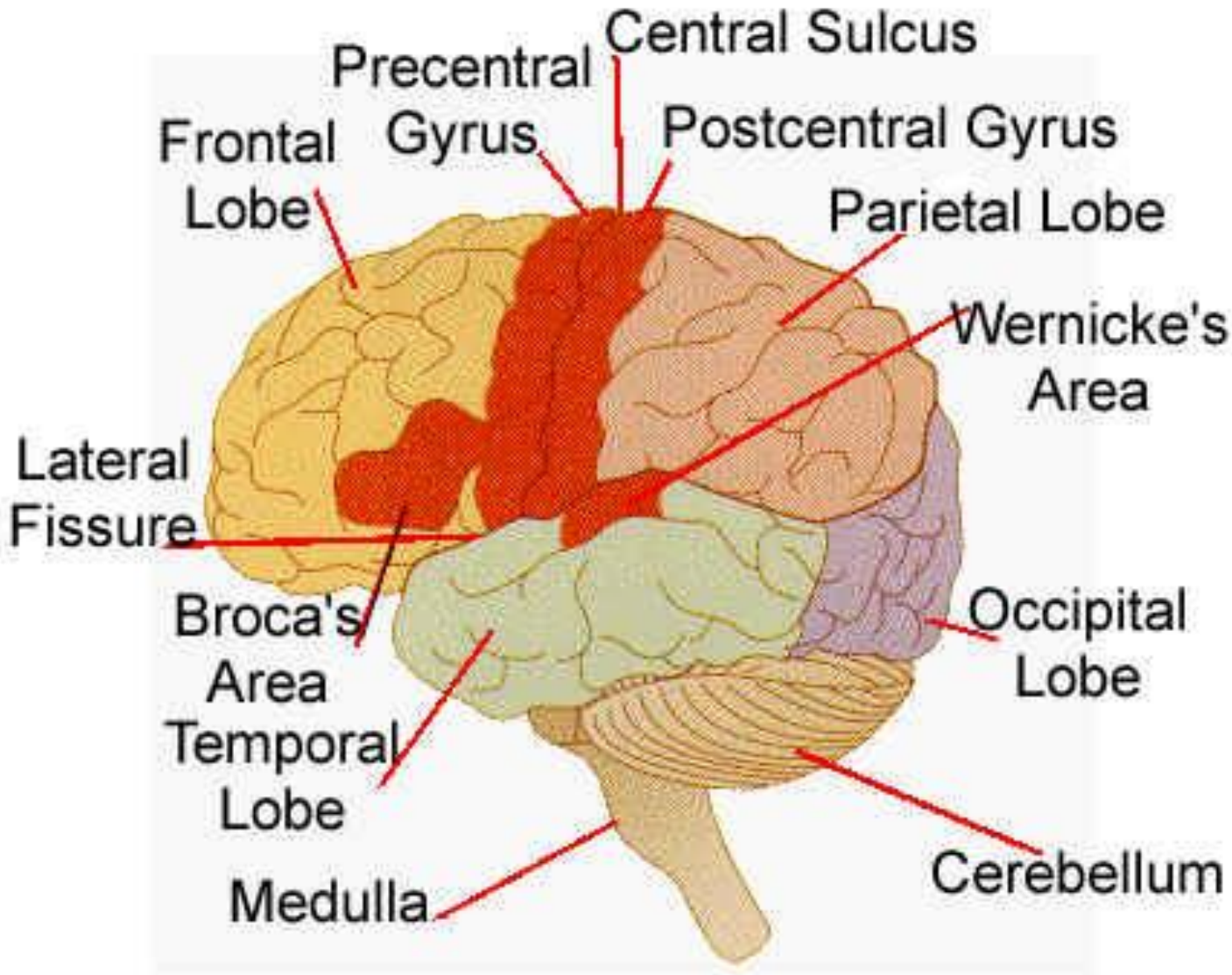
# Nervous System Functions

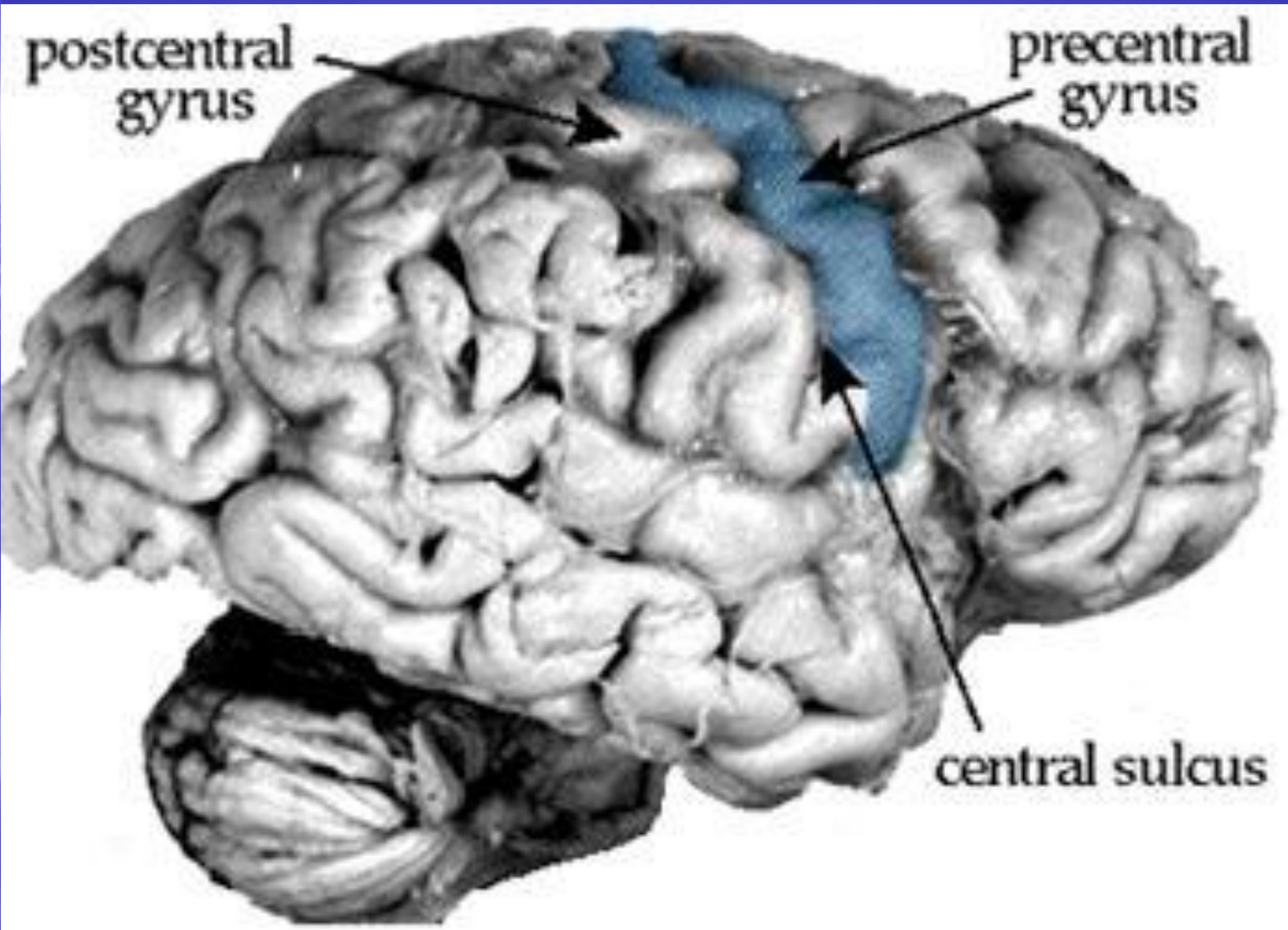
**Three basic functions:**

- **Sensory**
  - **Receptors monitor internal and external environment**
- **Integrative**
  - **Processes sensory information and makes decisions for appropriate responses**
- **Motor**
  - **Responds to integration decisions by signalling effectors**

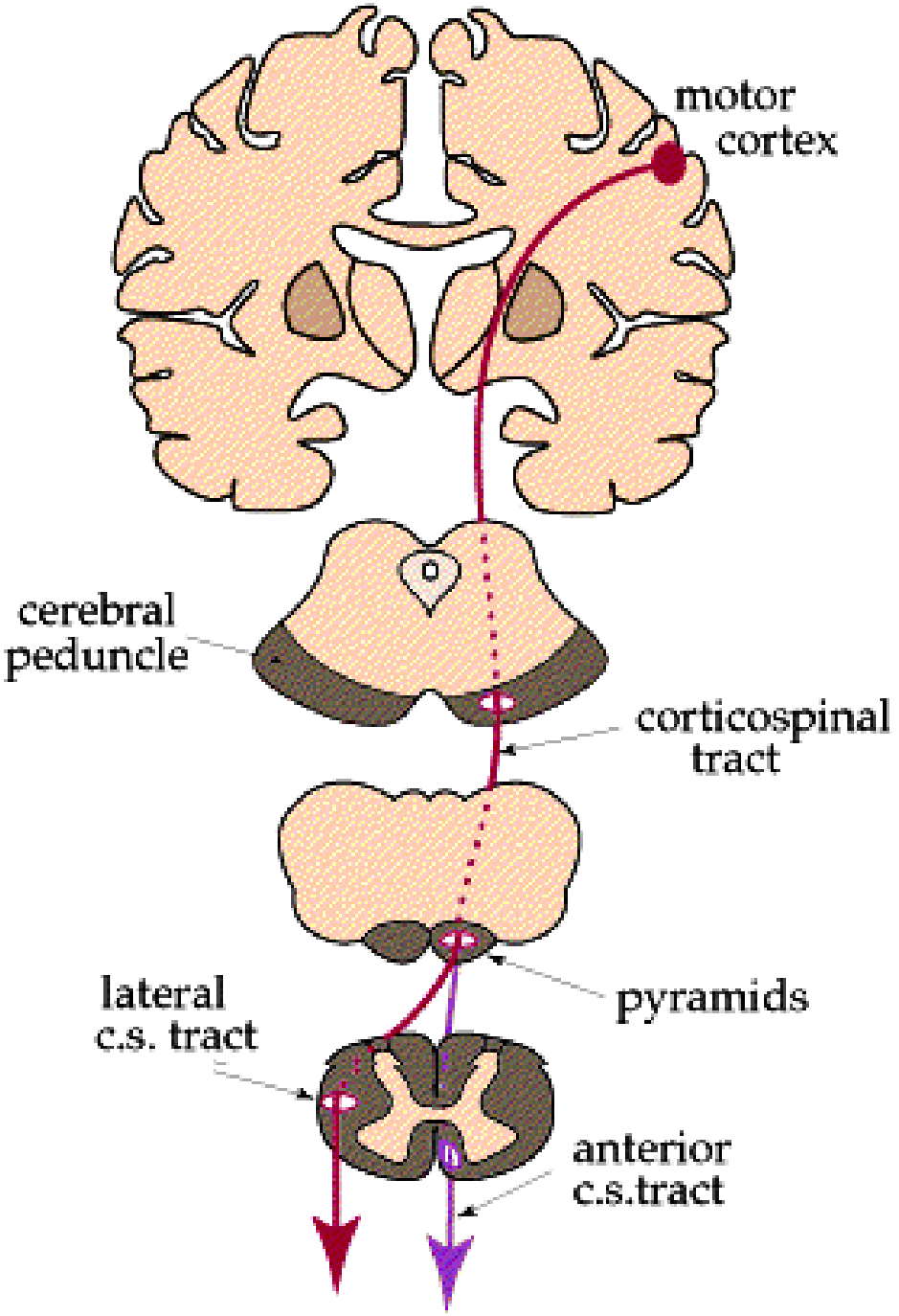
# MOTOR SYSTEM

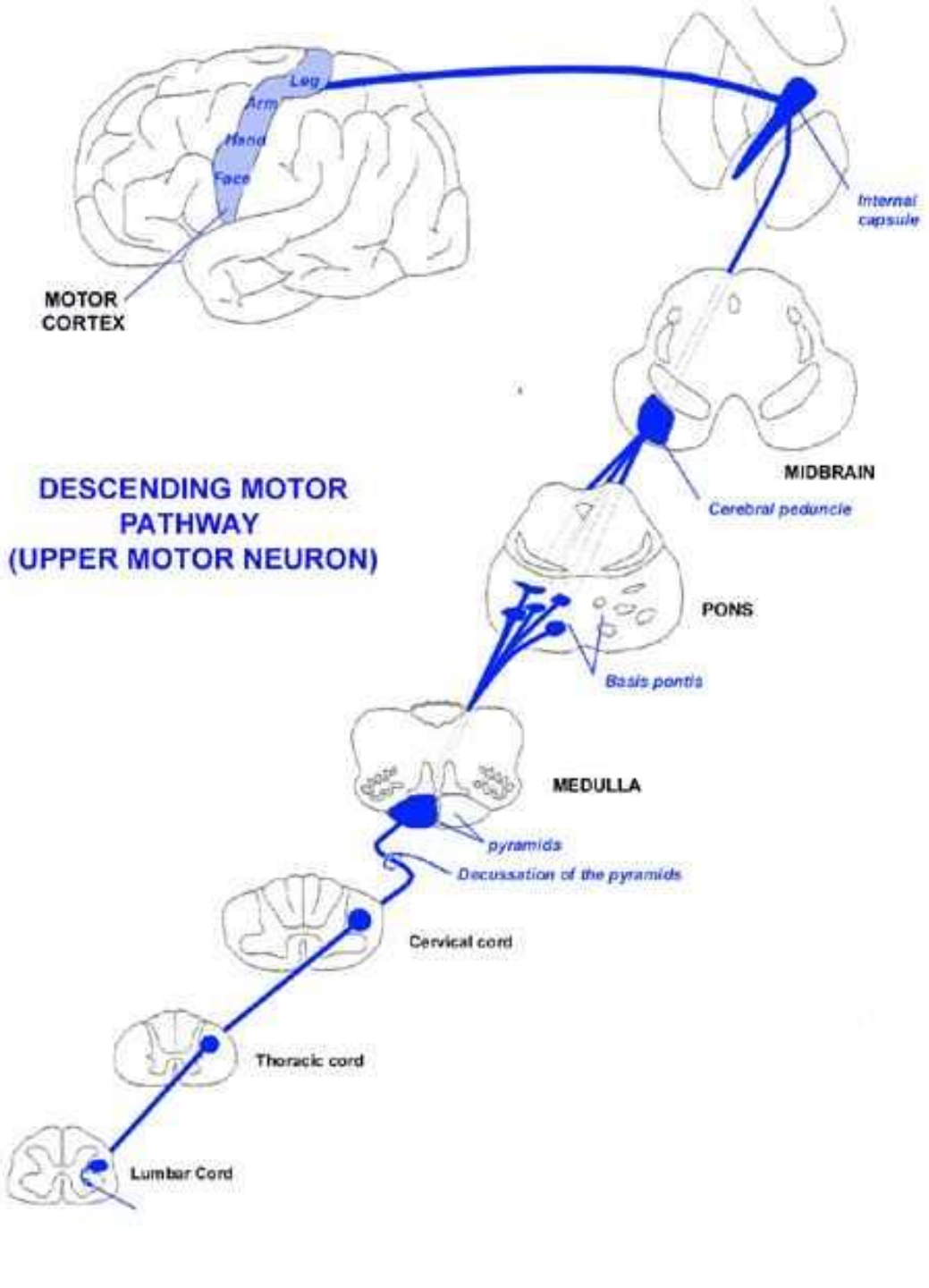
**The realization and control of movement is effected by the interaction of the pyramidal, cerebellar and extrapyramidal systems interconnecting with each others as well as projecting to the anterior horn region or cranial nerve motor nuclei.**


Central Sulcus
Precentral Gyrus
Postcentral Gyrus
Frontal Lobe
Parietal Lobe
Wernicke's Area
Lateral Fissure
Broca's Area
Occipital Lobe
Temporal Lobe
Cerebellum
Medulla

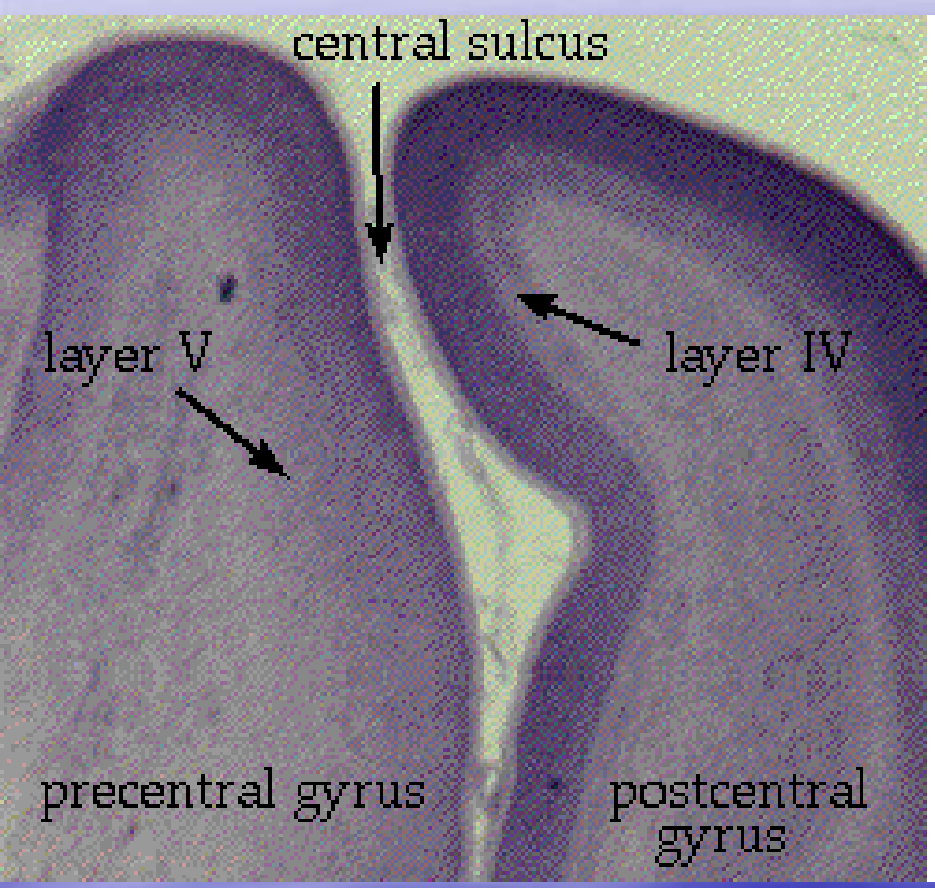

postcentral gyrus
precentral gyrus
central sulcus

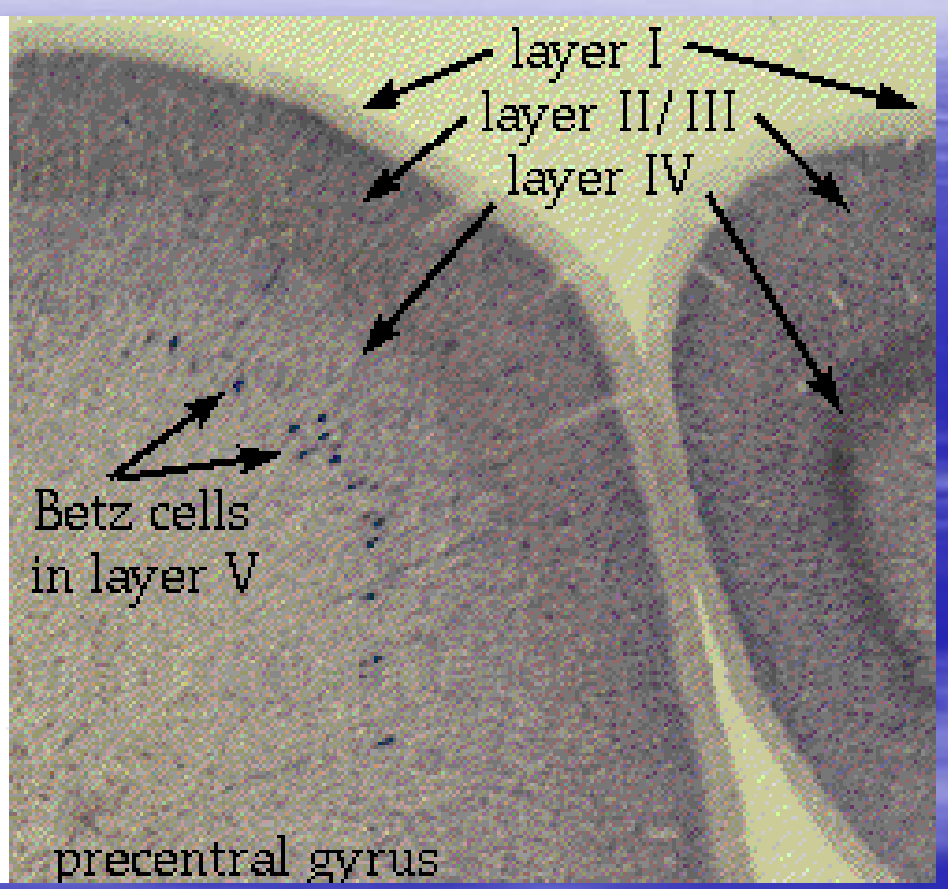
E.


motor
cortex
cerebral
peduncle
corticospinal
tract
pyramids
lateral
c.s. tract
anterior
c.s.tract




## DESCENDING MOTOR PATHWAY (UPPER MOTOR NEURON)


central sulcus
layer V
layer IV
precentral gyrus
postcentral gyrus

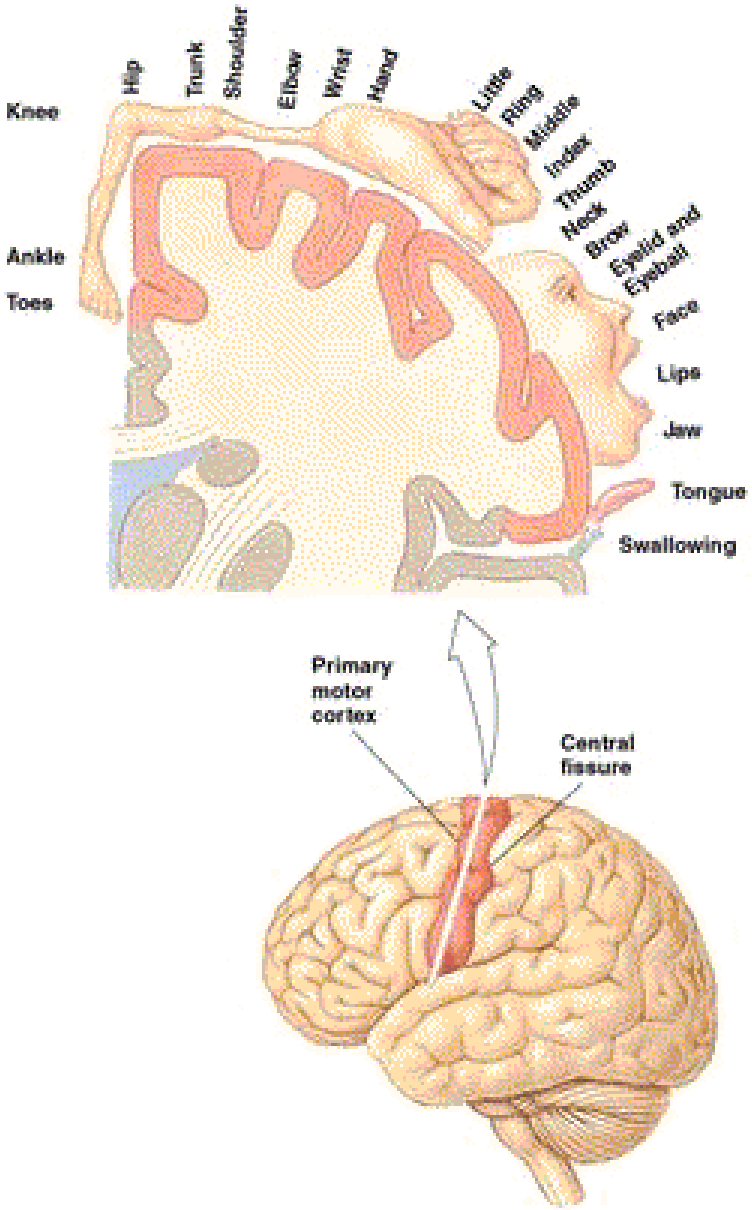

layer I
layer II/ III
layer IV
Betz cells
in layer V
precentral gyrus

The corticospinal tract originates as the axons of pyramidal neurons in layer V of motor cortex.

In the precentral gyrus exist neurons which are called Betz cells, and they are the source of the corticospinal tract.

It is just a morphological name for large neurons that are triangular in shape, pointing a long apical dendrite toward the surface of the brain.

## ▶ The Motor Homunculus




Source: Adapted from Penfield & Rasmussen, 1950.

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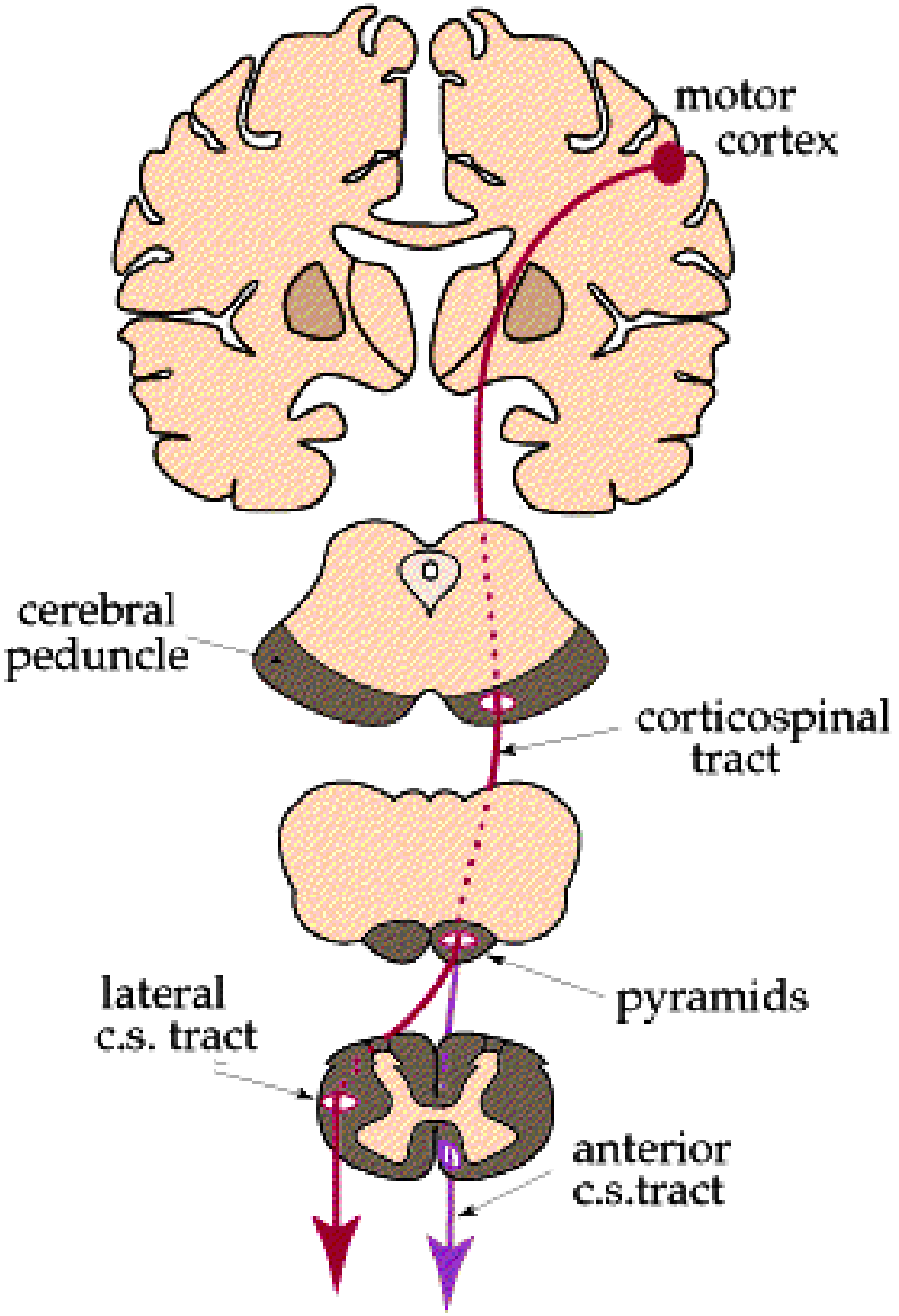
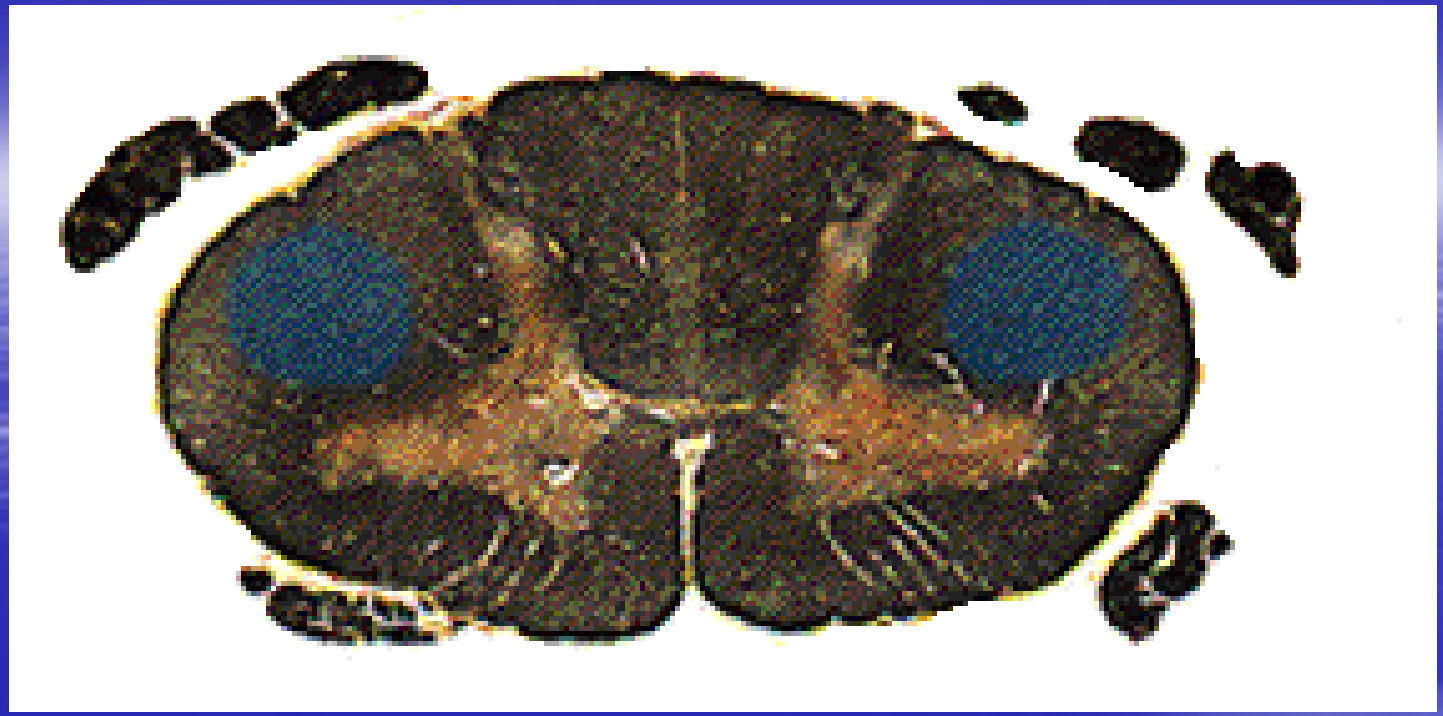
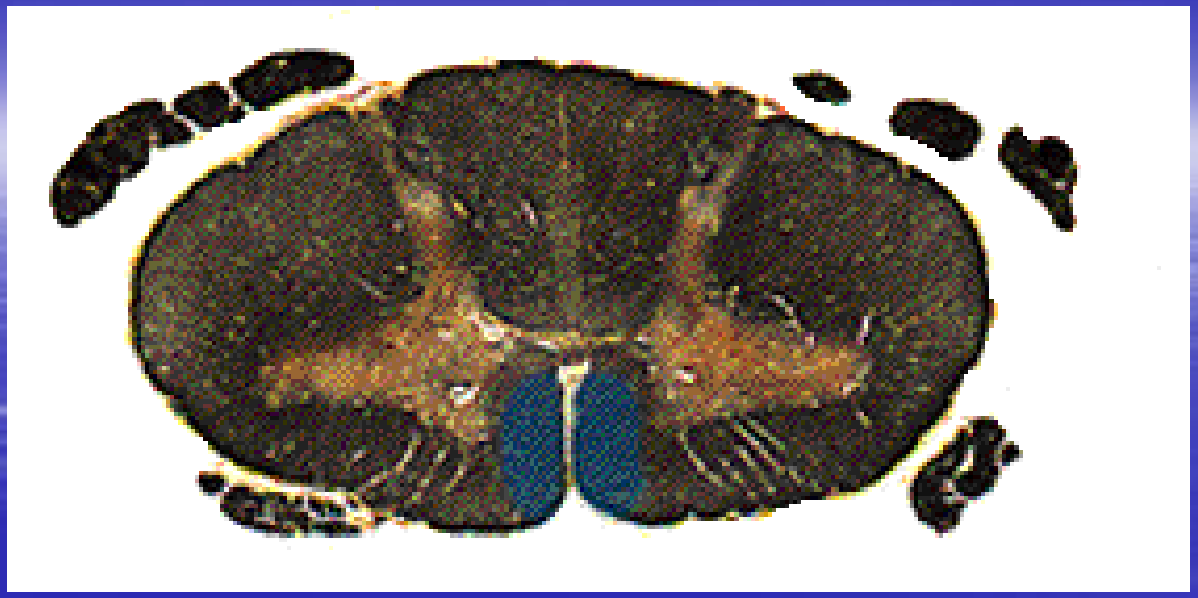

motor
cortex
cerebral
peduncle
corticospinal
tract
pyramids
lateral
c.s. tract
anterior
c.s.tract



**By the time**
**the decussation is completed, the corticospinal fibers reside in this new location, now called the lateral corticospinal tract.**



**Anterior corticospinal tract.**
**These fibers were part of the original corticospinal tract, and made up**
**15-20% of the pyramids, but at the decussation, they did not cross.**

**These fibers also dive into the ventral horns at appropriate levels, and they tend to innervate the muscles of the trunk.**

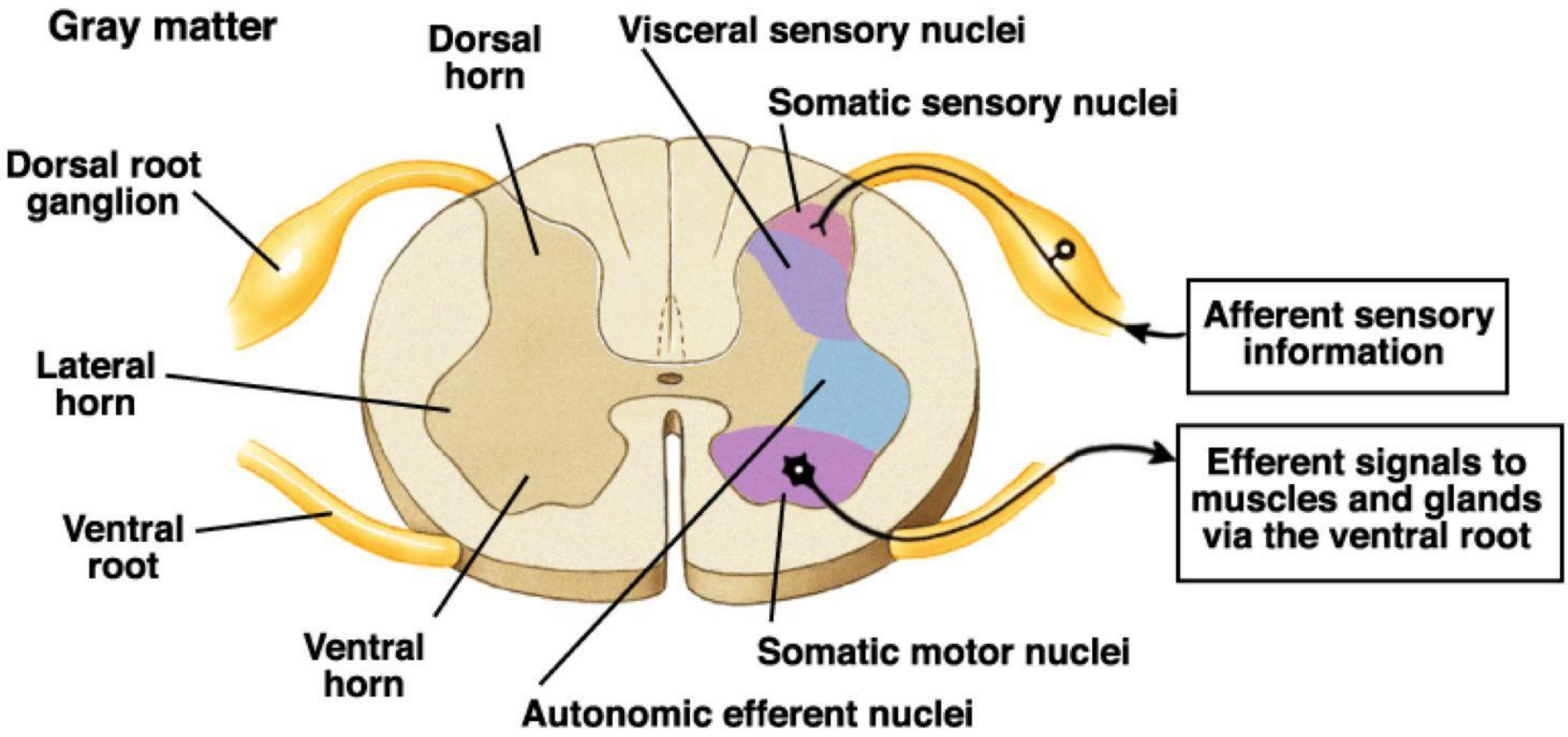
# Lower Motor Neuron

Skeletal (striated) muscle contraction is initiated by "lower" motor neurons in the spinal cord and brainstem.

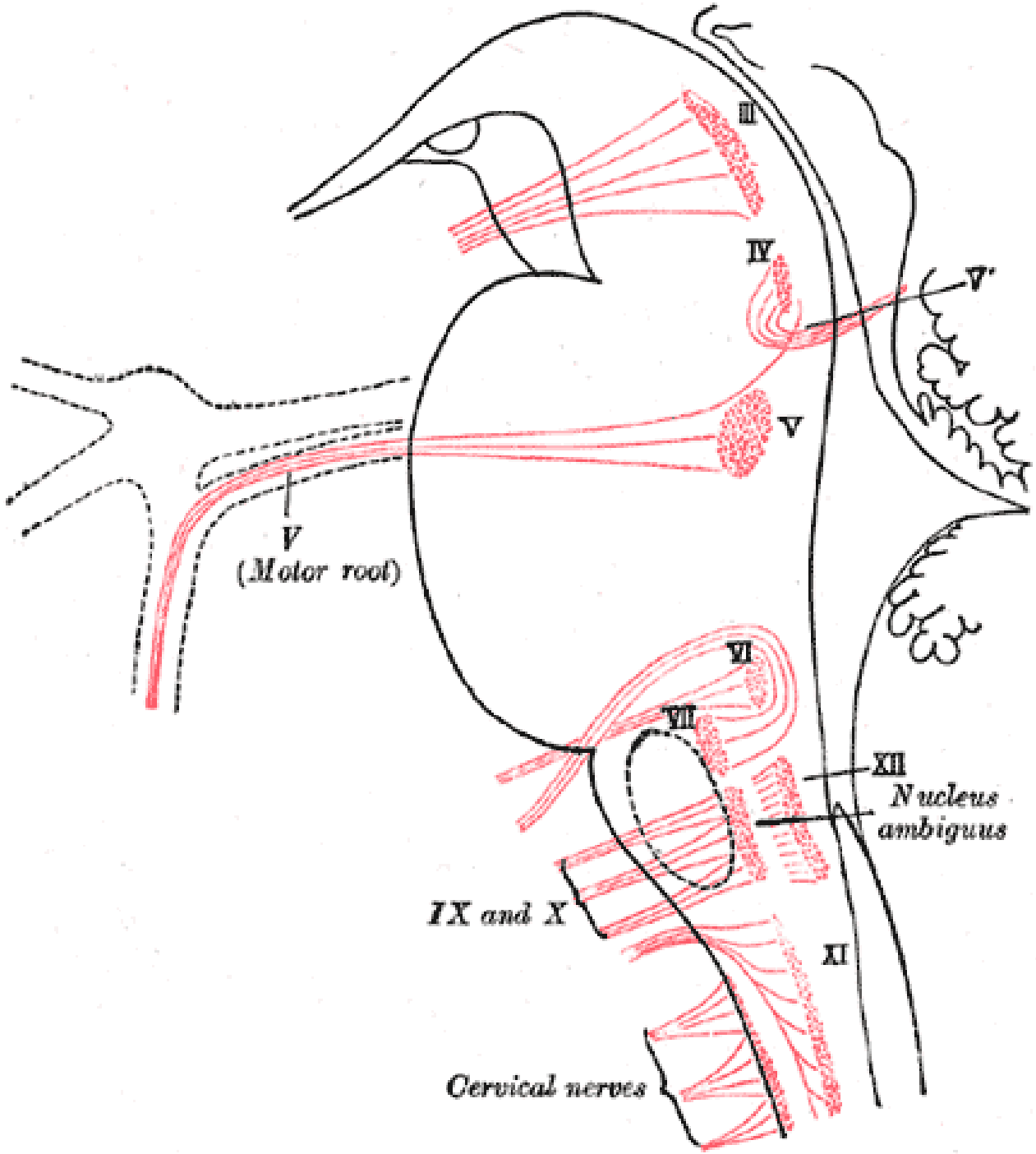
The cell bodies of the lower neurons are located in the ventral horn of the spinal cord gray matter and in the motor nuclei of the cranial nerves in the brainstem.

These neurons send axons directly to skeletal muscles via the ventral roots and spinal peripheral nerves, or via cranial nerves in the case of the brainstem nuclei.

Lower motor neurons are the final common pathway for transmitting neural information from a variety of sources to the skeletal muscles.


Gray matter
Dorsal horn
Visceral sensory nuclei
Somatic sensory nuclei
Dorsal root ganglion
Afferent sensory information
Lateral horn
Efferent signals to muscles and glands via the ventral root
Ventral root
Ventral horn
Somatic motor nuclei
Autonomic efferent nuclei

**The lower motor neurons for the control of muscles in the head and neck are located in the brainstem and distributed in the eight motor nuclei of the cranial nerves in the medulla, pons, and midbrain.**


III
IV
V'
V
V
(Motor root)
VI
VII
XII
Nucleus
ambiguus
IX and X
XI
Cervical nerves

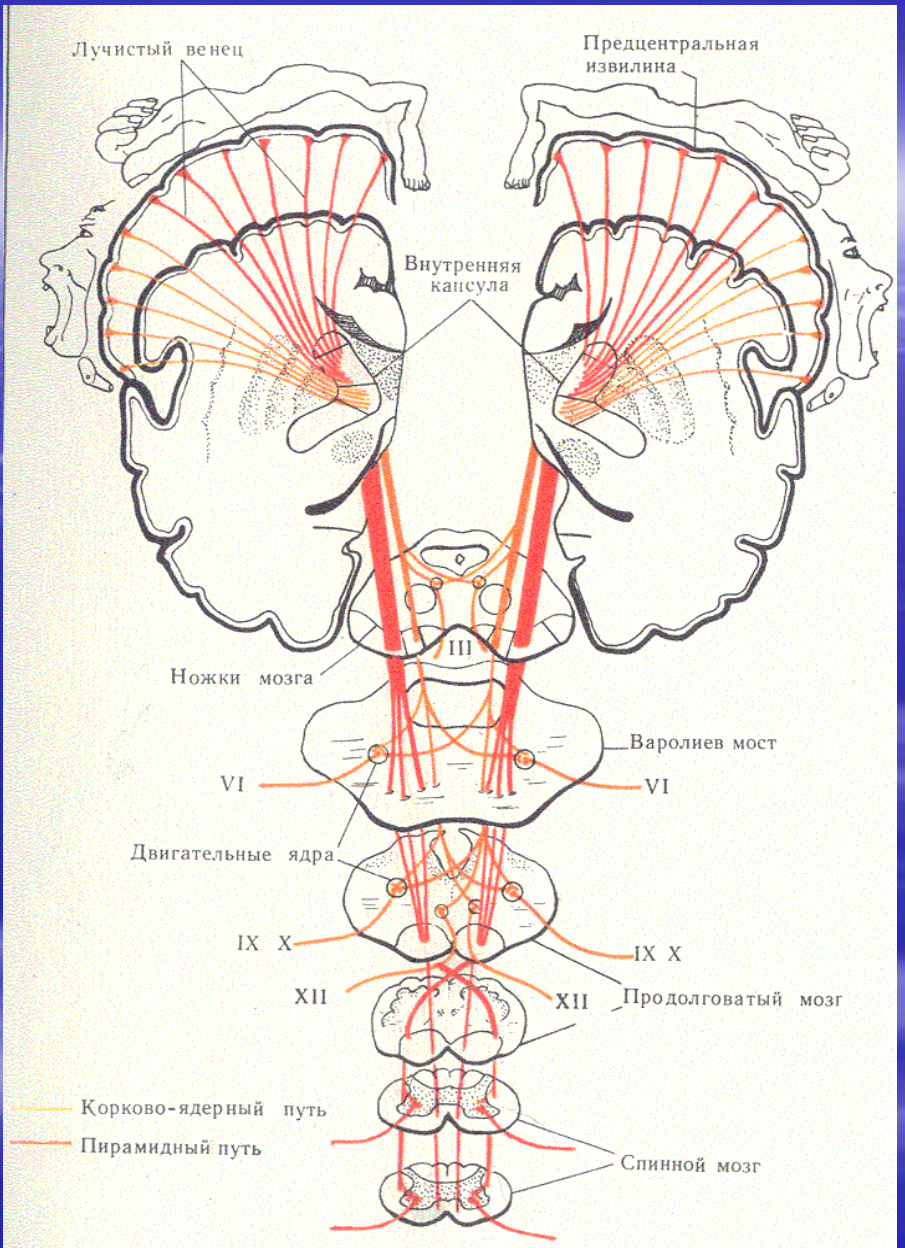
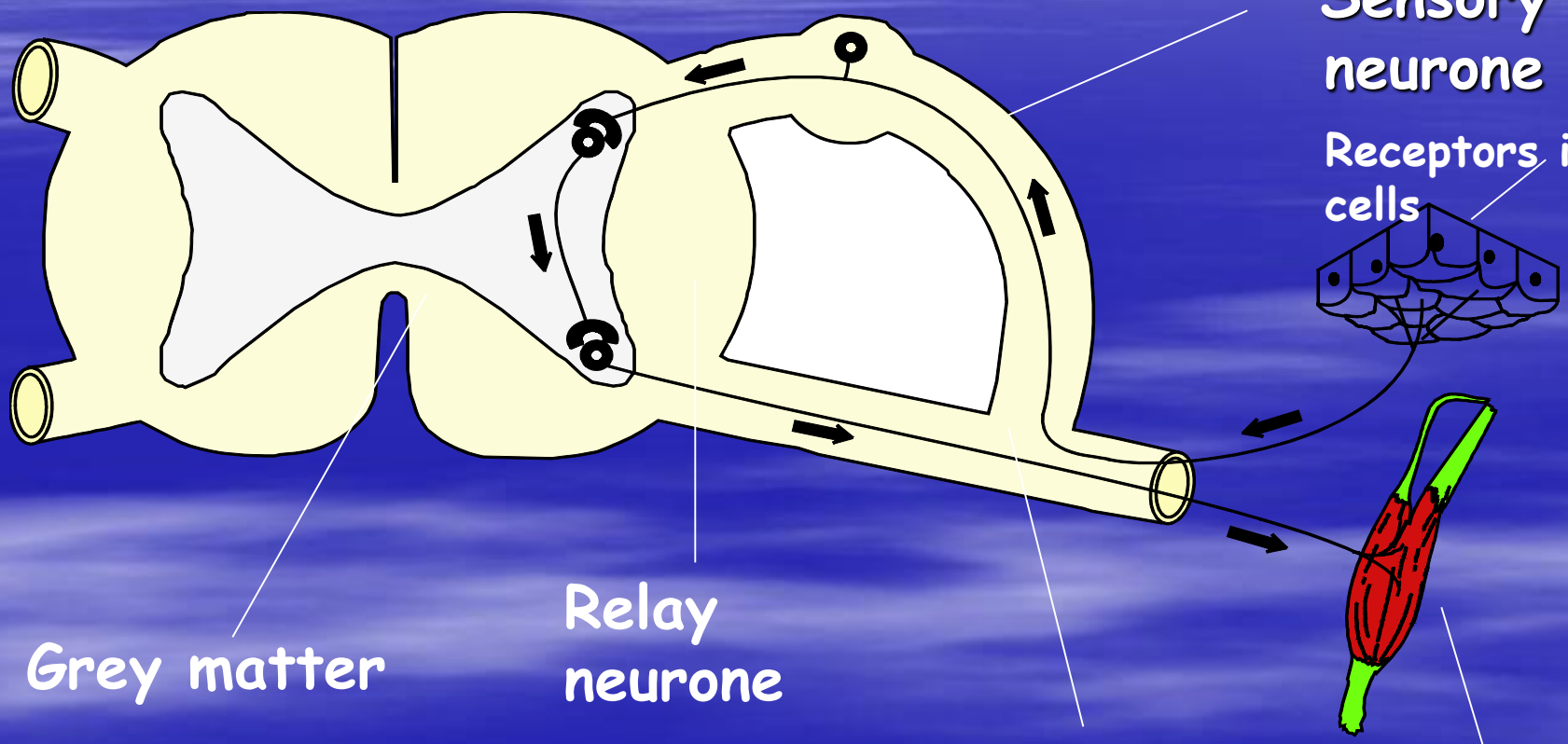



*Таблица 37.* Корково-спинномозговой (пирамидный) и корково-ядерный двигательные пути.

A **reflex** is involuntary, stereotyped pattern of response brought about by a sensory stimulus.

# Reflex arc


Sensory neurone
Receptors in skin cells
Grey matter
Relay neurone
Motor neurone
Effector (muscle)

**The different reflex responses may be grouped into 2 categories on the basis of their clinical significance.**

**1) Normal (physiological) reflexes – present during normal functioning of motor pathways.**

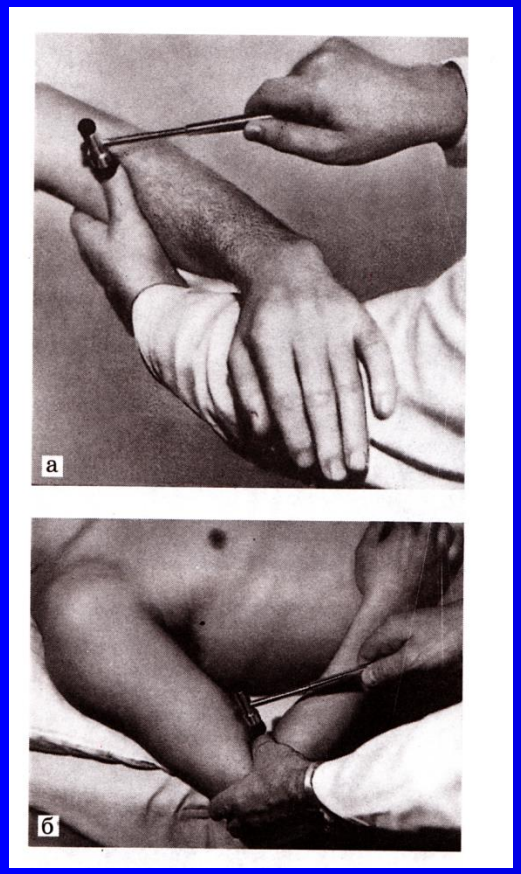
**2) Abnormal (pathological) reflexes – appear if upper motor neurone are damaged.**

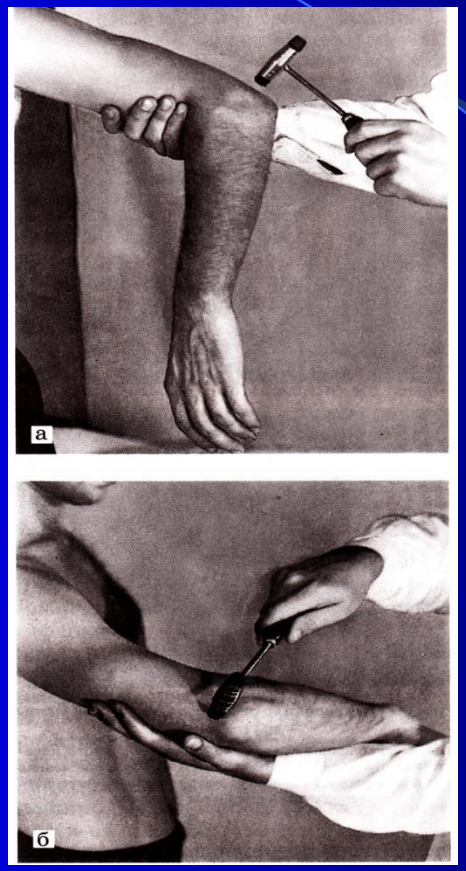
**The normal reflexes are classified on two categories**

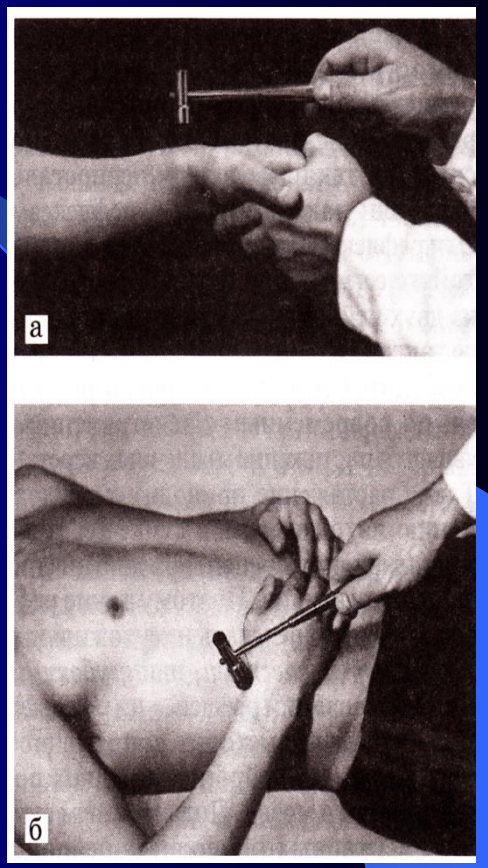
**1) Superficial reflexes.**
**a) cutaneos;**
**b) mucous.**

**2) Deep reflexes.**
**a) tendons**
**b) periostal.**

# Deep reflexes



# Clinical classification

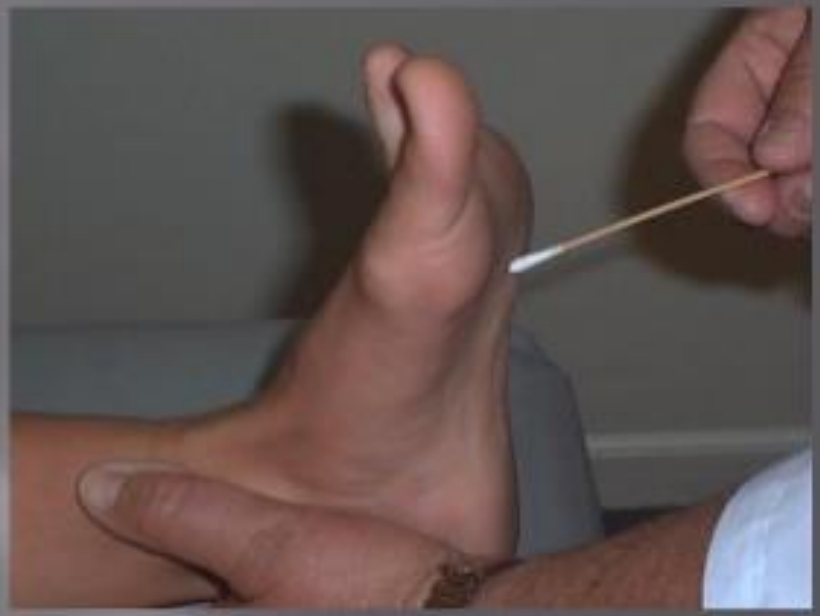
## 1- Superficial reflexes:

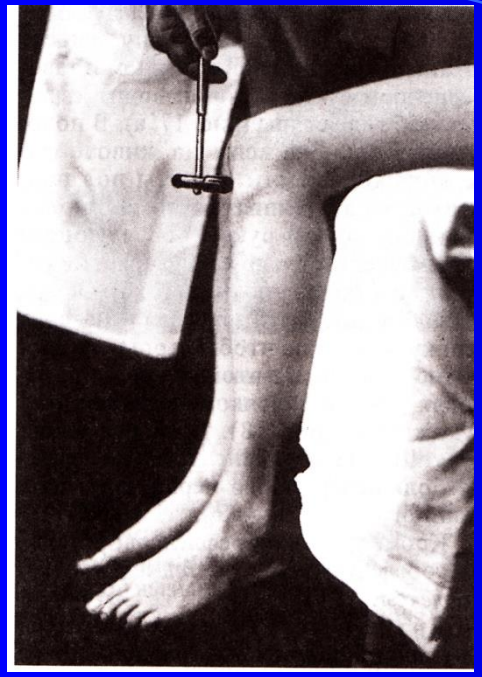
* initiated by stimulating appropriate receptors of skin or mucous membrane.

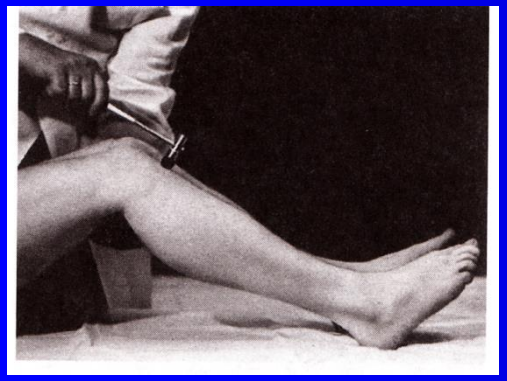
* Are usually multisynaptic .

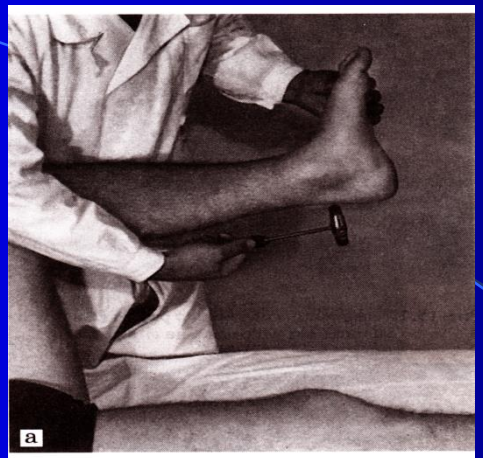
* Are usually involving moving away from stimulus

* E.g. plantar response, corneal and conjunctival reflexes.





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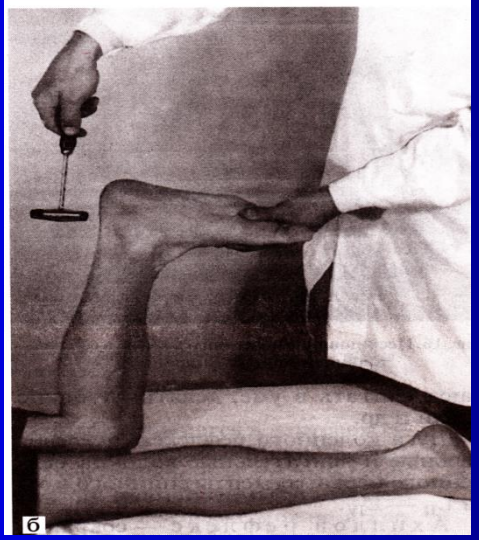
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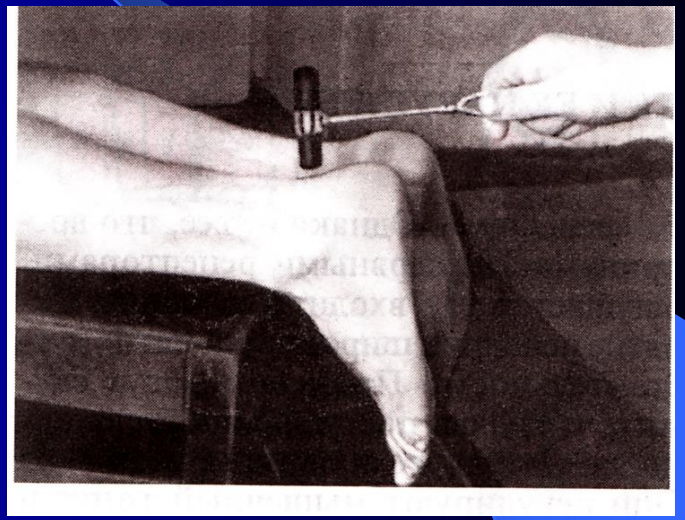
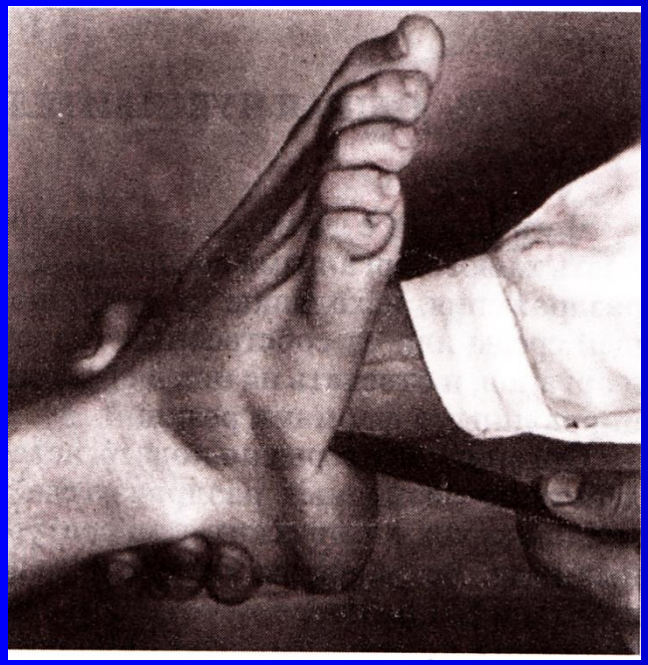
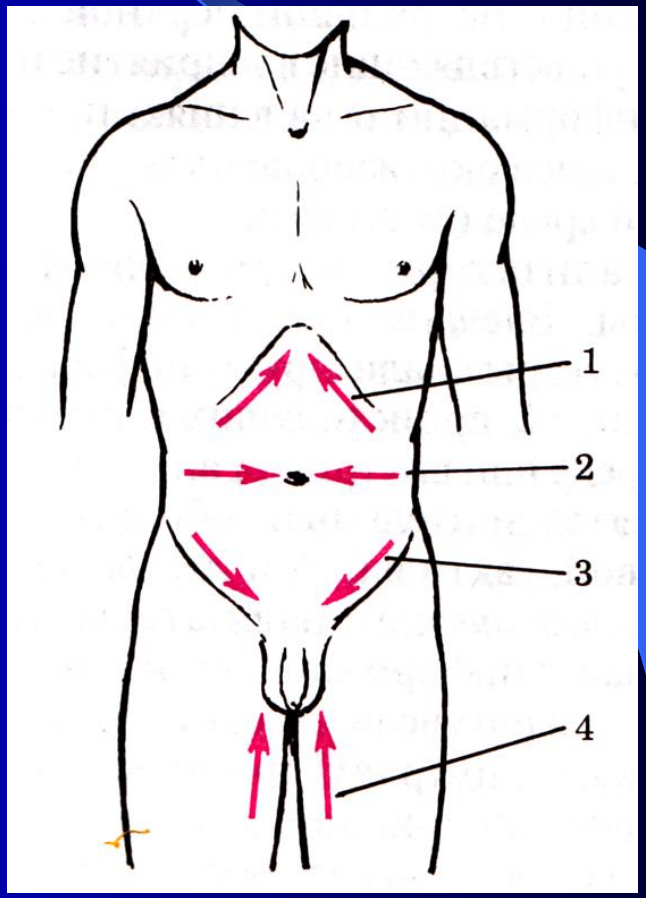


# Superficial reflexes





**Paresis - partial loss of voluntary movements; weakness.**

**Paralysis - complete loss of voluntary movements.**

***Monoparesis*** - weakness limited to a single arm or leg.

***Hemiparesis -*** weakness on one side of the body so that the arm and leg on that side are both weak.

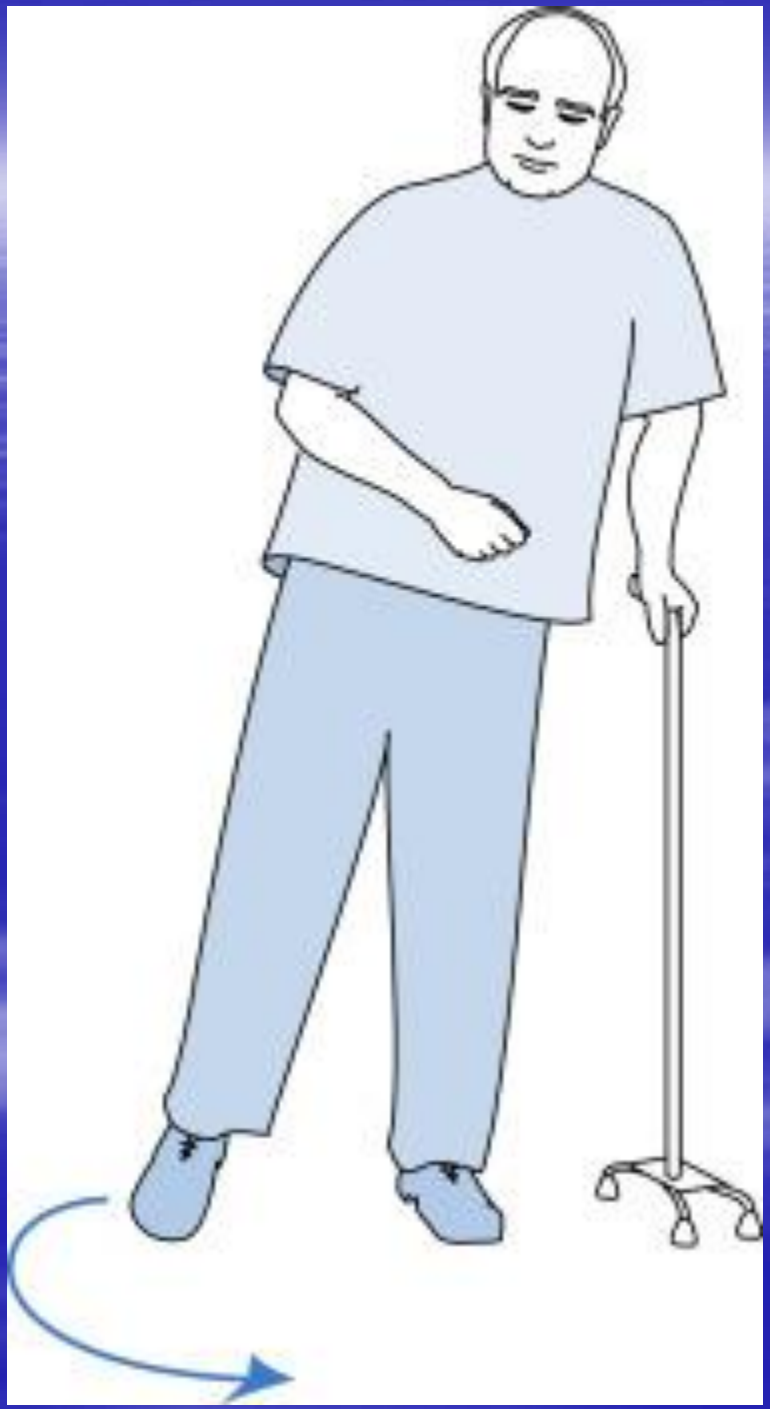
***Paraparesis*** - weakness limited to the arms or legs.

**Tetraparesis** – weakness of all extremities.

**Muscle tone - normal, ongoing tension in a muscle; measured by resistance of a muscle to passive stretching.**

# Upper motor neuron lesions

- **Symptoms :**
  1. **Paralysis :**
  2. **Spasticity :**
     - **Exaggerated tendon reflex resulting in increases resistance .**
     - **More in flexor of arm and extensor of leg (antigravity muscle).**
     - **Clasp-knife**



3. Hyperreflexia:

- Clonus
- Spread reflexes
- Explained like the spasticity.

4. Pathological reflexes.

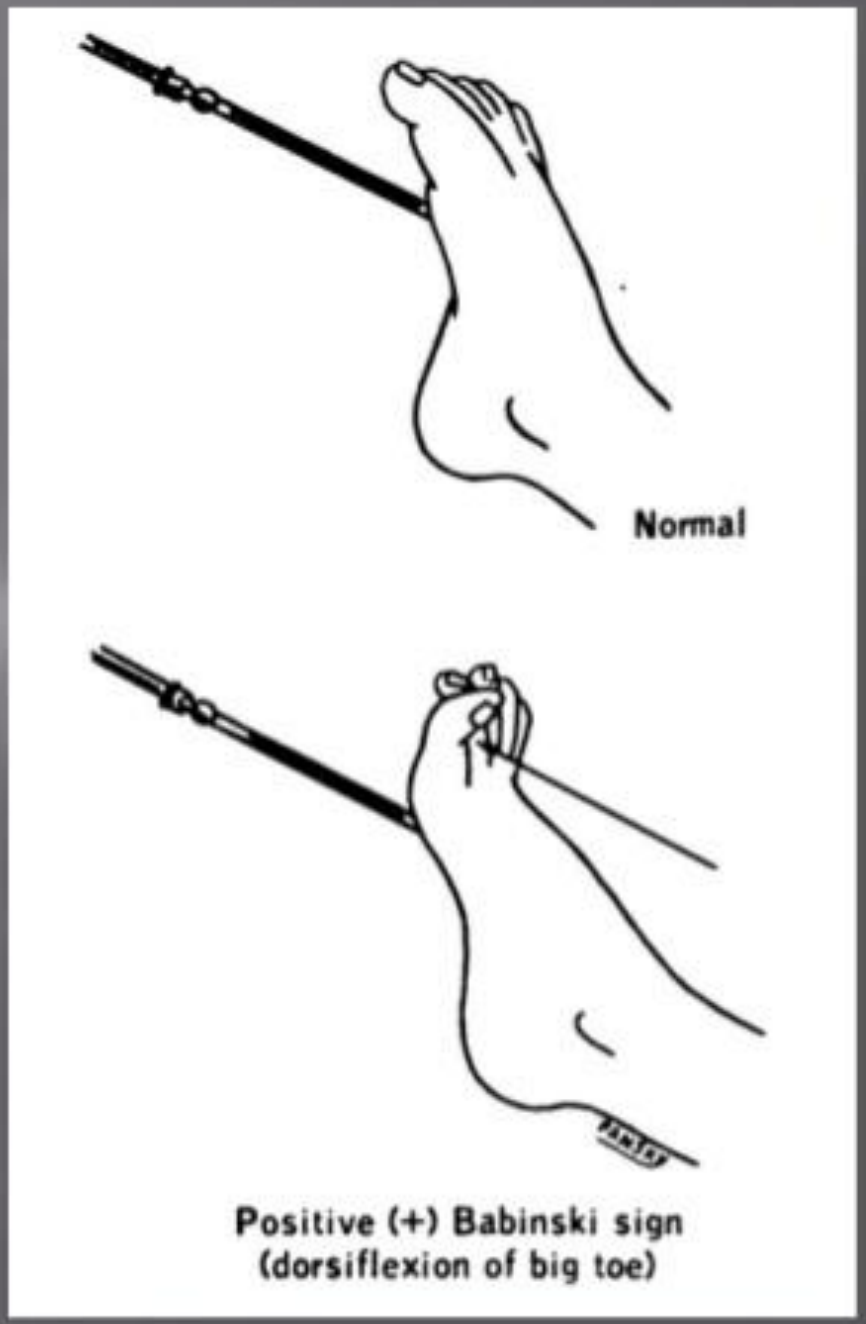
5. Hyporeflexia of superficial reflexes.

# 4- Pathological reflexes:

* Are not found normally

* Presence indicates pathological condition within the body

* E.g., Babiniski's sign.



# Lower motor neuron lesions

- **Symptoms:**
  1. **Paresis or plegia.**
  2. **Hypotonia.**
  3. **Muscle Atrophy. (denervation atrophy).**
  4. **Areflexia.**
  5. **Flaccidity :**
     - **No tone**
  6. **Fasciculation.**

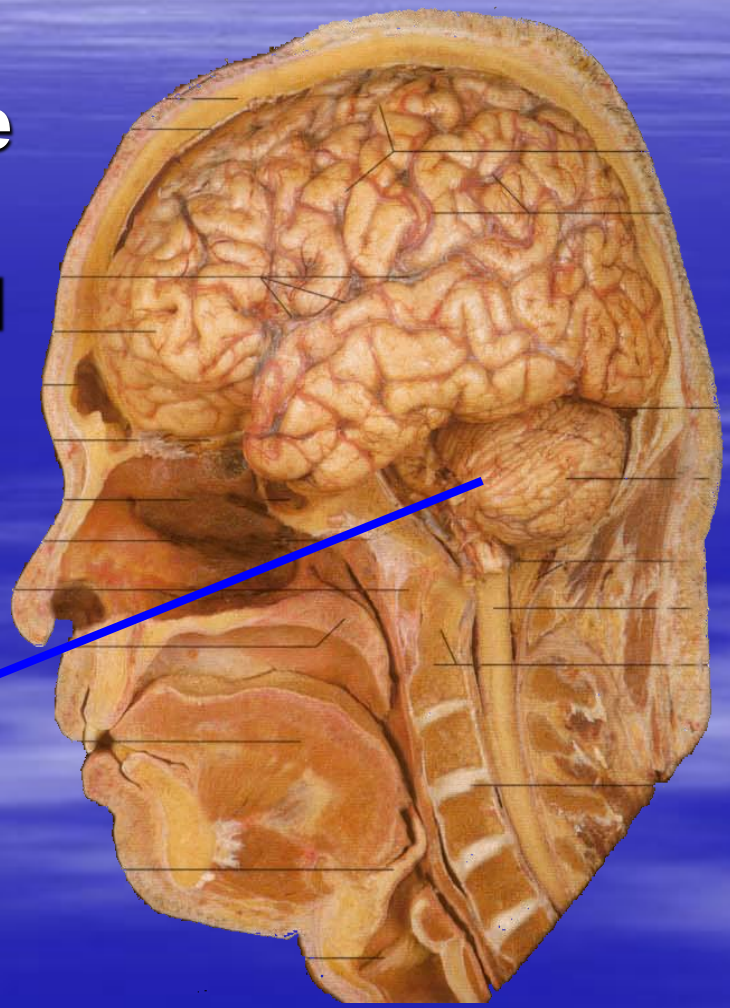
# CEREBELLUM

**Functions:**

- **motor coordination**
- **posture, balance**
- **influences muscle tone**
- **synergia (the interplay between agonist and antagonist muscle groups).**

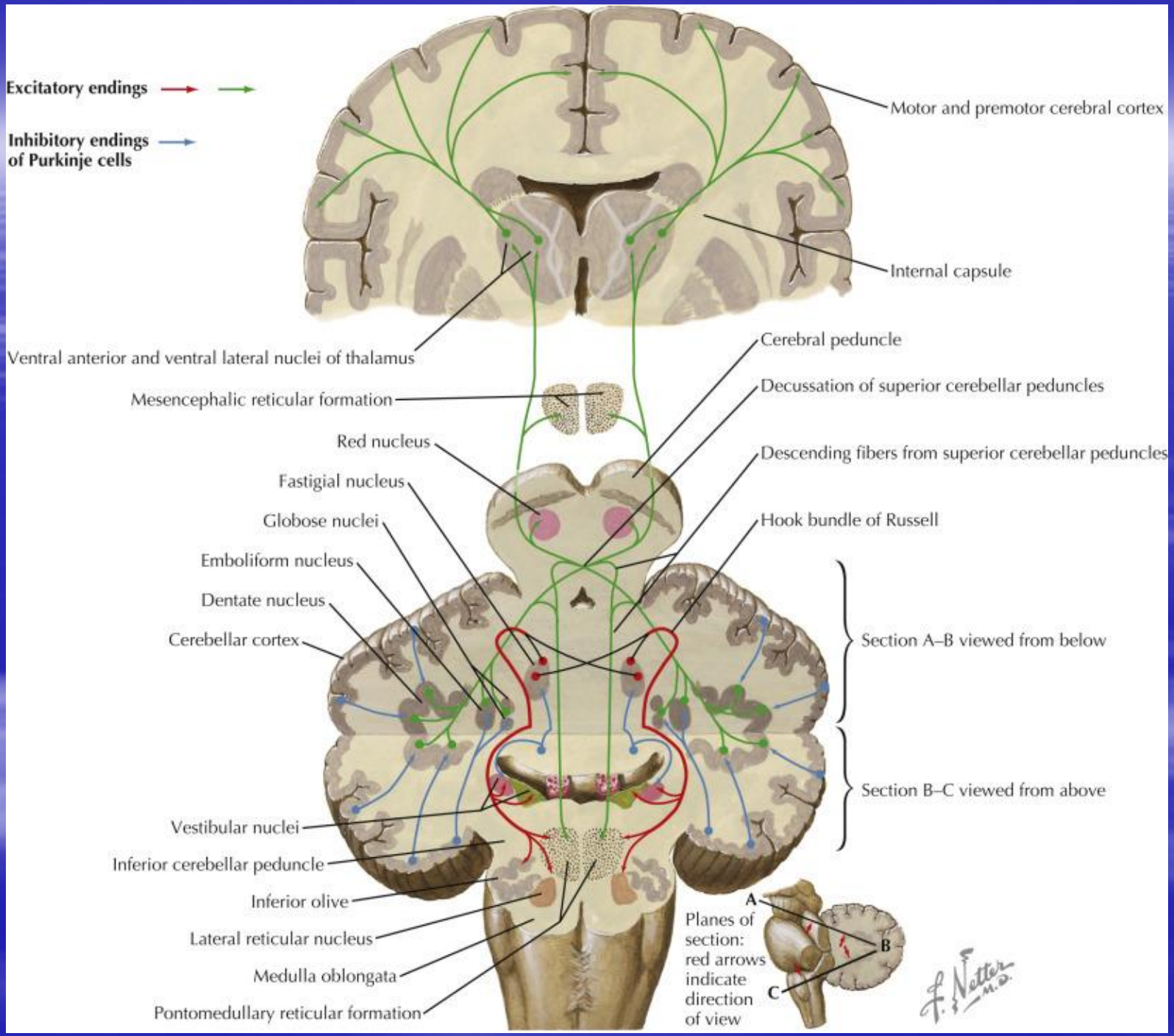
# Position

- Lies above and behind the medullar and pons and occupies posterior cranial fossa

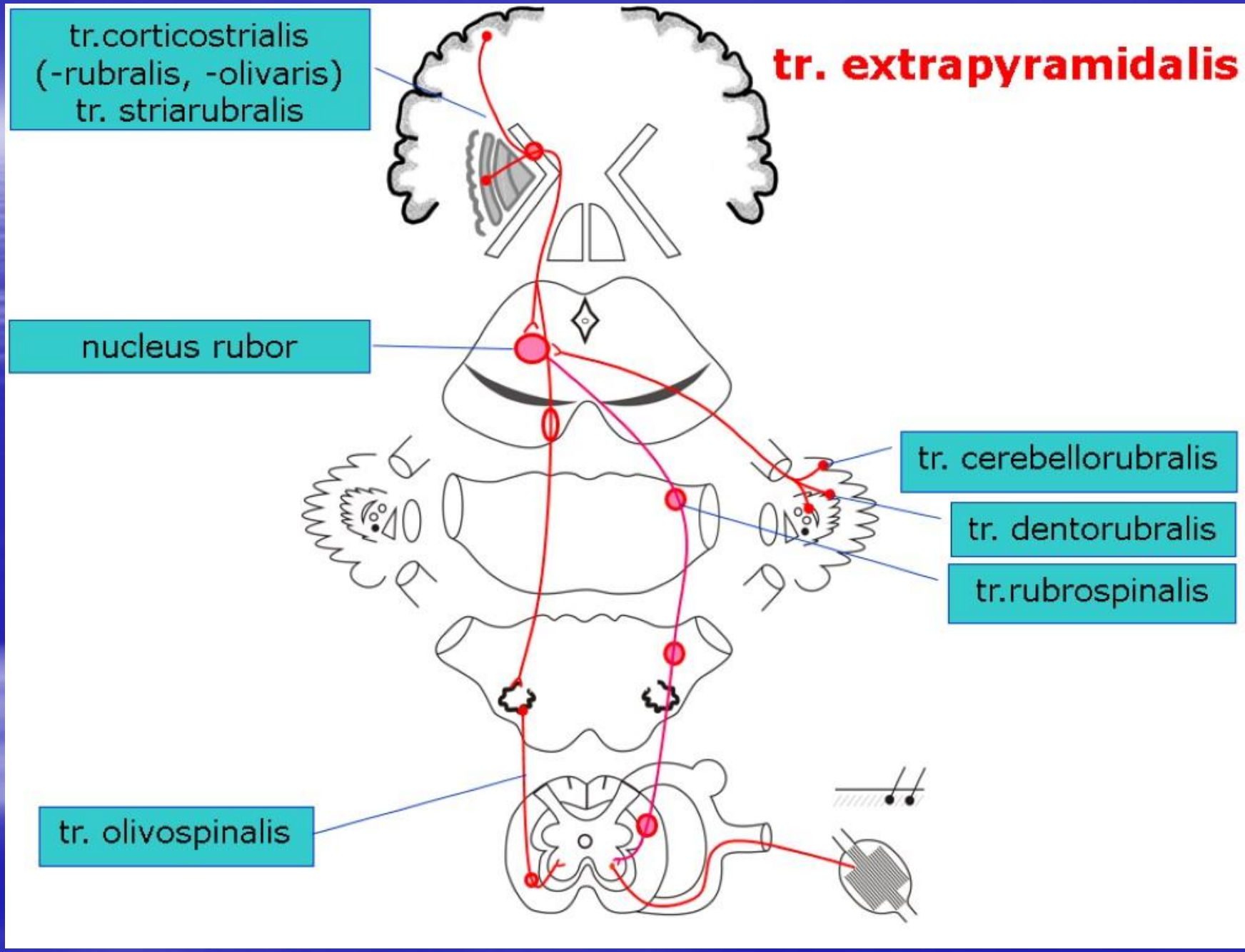


# External features

Consists of two **cerebellar hemisphere** united in the midline by the **vermis**


Excitatory endings
Inhibitory endings of Purkinje cells
Motor and premotor cerebral cortex
Internal capsule
Ventral anterior and ventral lateral nuclei of thalamus
Cerebral peduncle
Mesencephalic reticular formation
Decussation of superior cerebellar peduncles
Red nucleus
Descending fibers from superior cerebellar peduncles
Fastigial nucleus
Globose nuclei
Hook bundle of Russell
Emboliform nucleus
Dentate nucleus
Cerebellar cortex
Section A–B viewed from below
Section B–C viewed from above
Vestibular nuclei
Inferior cerebellar peduncle
Inferior olive
Lateral reticular nucleus
Medulla oblongata
Pontomedullary reticular formation
A
B
C
Planes of section: red arrows indicate direction of view
F. Netter M.D.

# tr. extrapyramidalis



Damage to hemisphere structures of cerebellum always produces signs to the side of lesion (on the same side of the body as the damage to the cerebellum).

# Dyssynergia.

**Incoordination results in loss of smoothness of execution of a motor activity.**

## Rebound Reflex

**The patient is unable to stop flexion of the arm on sudden release so the arm may strike the chest and doesn't recoil to the initial position. This is most likely due to failure of timely triceps contraction.**

# Dysmetria.

**Inaccurate movements due to faulty judgment of distance (results in overshooting or undershooting of a target while attempting to reach an object) .**

**Error in Judgment of Range and Distance of Target**

## Dysequilibrium.

**It is a results in balance problems, and the patient falls to the affected side.**

**Romberg Test perform by having the patient stand still with their heels together. Ask the patient to remain still and close their eyes. If the patient loses their balance, the test is positive.**

## Dysdiadochokinesis.

**Inability to perform rapid alternating movements (a disturbance of the normal ability to make repeated supinations and pronations of the lower arms).**

## Intention tremor.

**Tremor that occurs while performing a voluntary motor act and accelerates in pace on approaching the target.**

**There are next probes for examinations of tremor:**

**Toe-to-finger**

**Finger-to-nose**

**Heel-to-shin**

## Scanning speech.

**It is characterized by poor modulation of the volume and pitch of the speech (speech is slow and slurred) with occasionally sudden unexpected force (explosive speech).**

**Nystagmus.**

**It is involuntary movements of the eyeballs around their natural position (may be horizontal, vertical, rotational).**

**Handwriting increases in size (macrographia).**

# CEREBELLAR GAIT

**A drunken gait is the style of walking that is seen in a patient with a cerebellar lesion.**
**It is characterized by:**

**- the feet are separated widely;**

**- steps are jerky and unsure, varying in size;**

**-the trunk sways forward;**

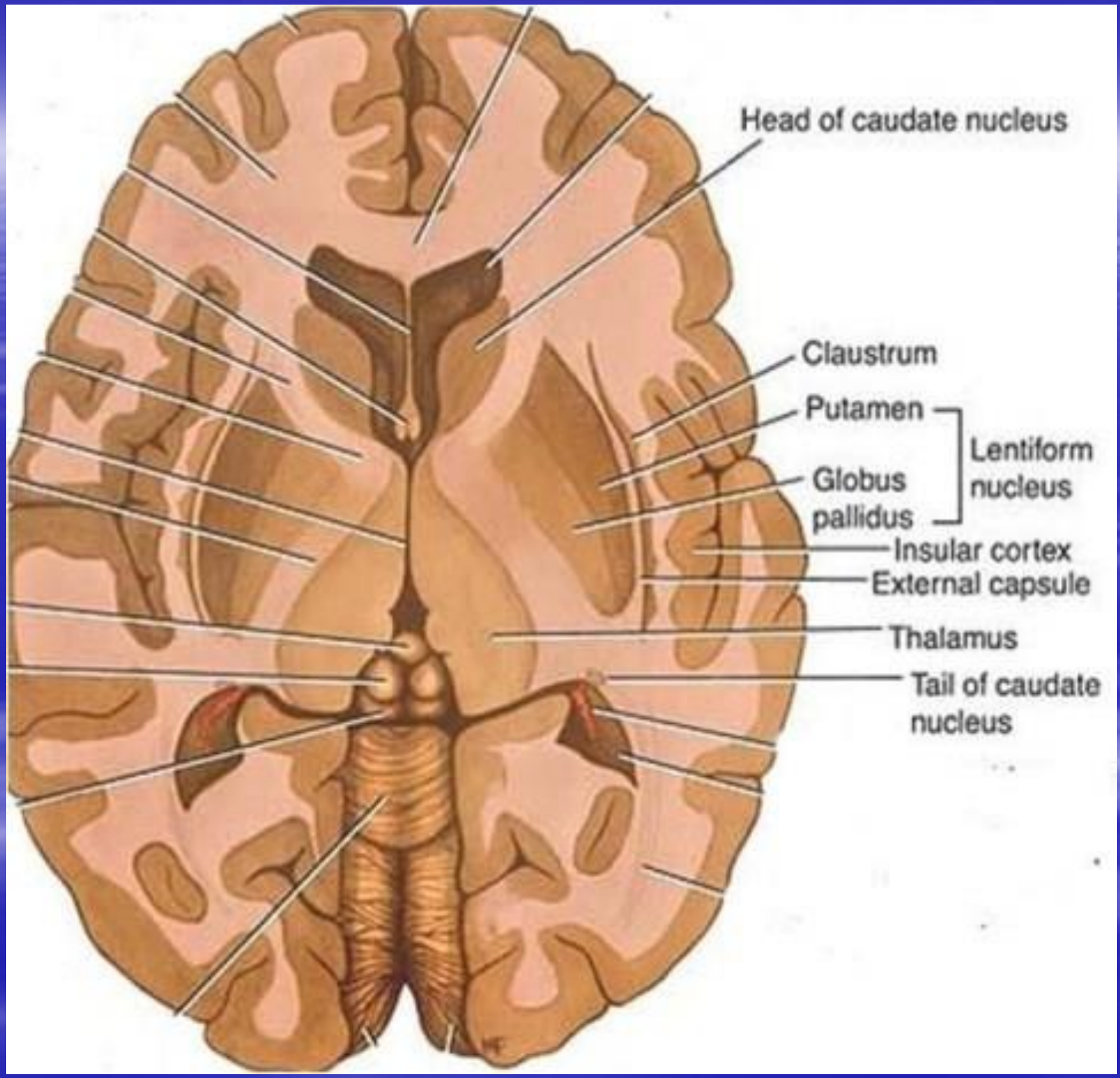
**- patient may fall to the side of the lesion.**

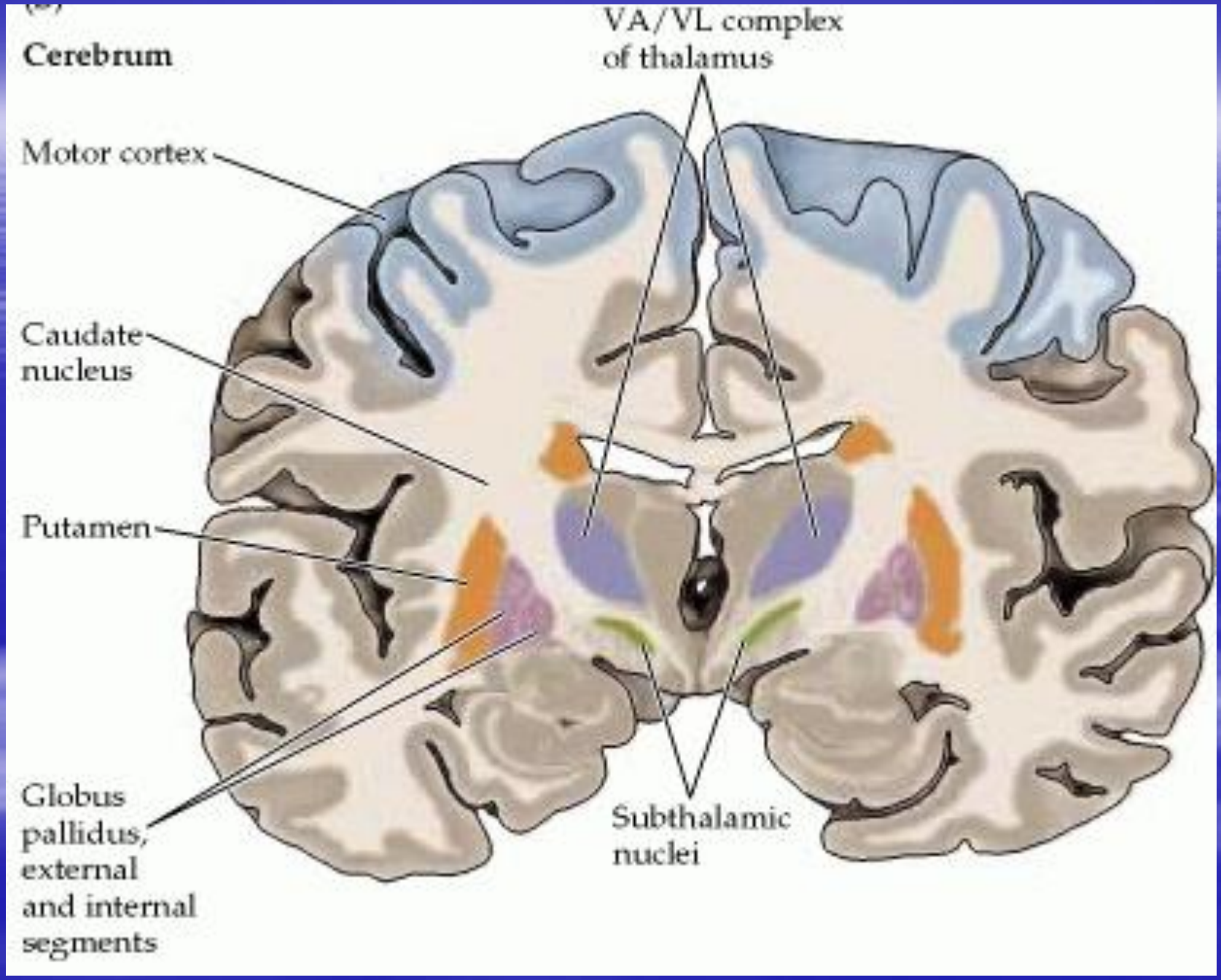
# Basal Ganglia

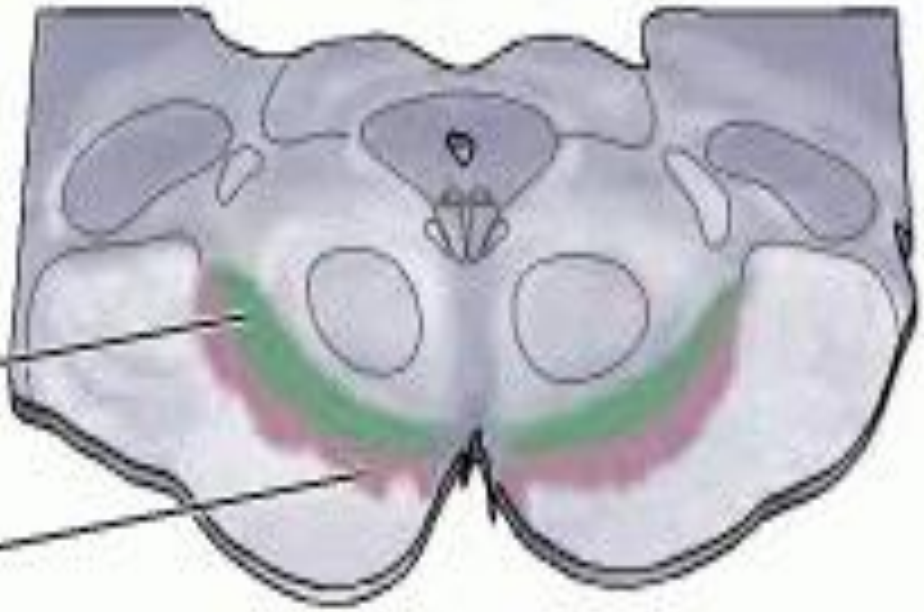
Masses of gray matter found deep within the cortical white matter.

- **The main nuclei of the basal ganglia are, the caudate and putamen (together called the "striatum" or “neostriatum”), the substantia nigra, the globus pallidus (divided into internal and external portions), and the subthalamic nucleus (together called the “pallidum" or “paleostriatum”).**

- **Topographically the putamen and globus pallidus constitute the lentiform nucleus.**


Head of caudate nucleus
Claustrum
Putamen
Globus pallidus
Lentiform nucleus
Insular cortex
External capsule
Thalamus
Tail of caudate nucleus


Cerebrum
VA/VL complex of thalamus
Motor cortex
Caudate nucleus
Putamen
Globus pallidus, external and internal segments
Subthalamic nuclei


Midbrain
Substantia nigra
pars compacta
Substantia nigra
pars reticulata

# Functions of Basal Ganglia

- **The main function of the basal ganglia is to initiate, correcting and stop movements, control of posture, controls muscle tone between different muscles' group.**
- **The basal ganglia also contribute to cognitive (i.e., intelligence, knowledge, motor behavior and motor learning), affective (i.e., emotional) and autonomic functions.**

There are several neurotransmitters in basal ganglia (acetylcholine, dopamine, γ-aminobutyric acid, glutamate, substance P, encephalin so on).

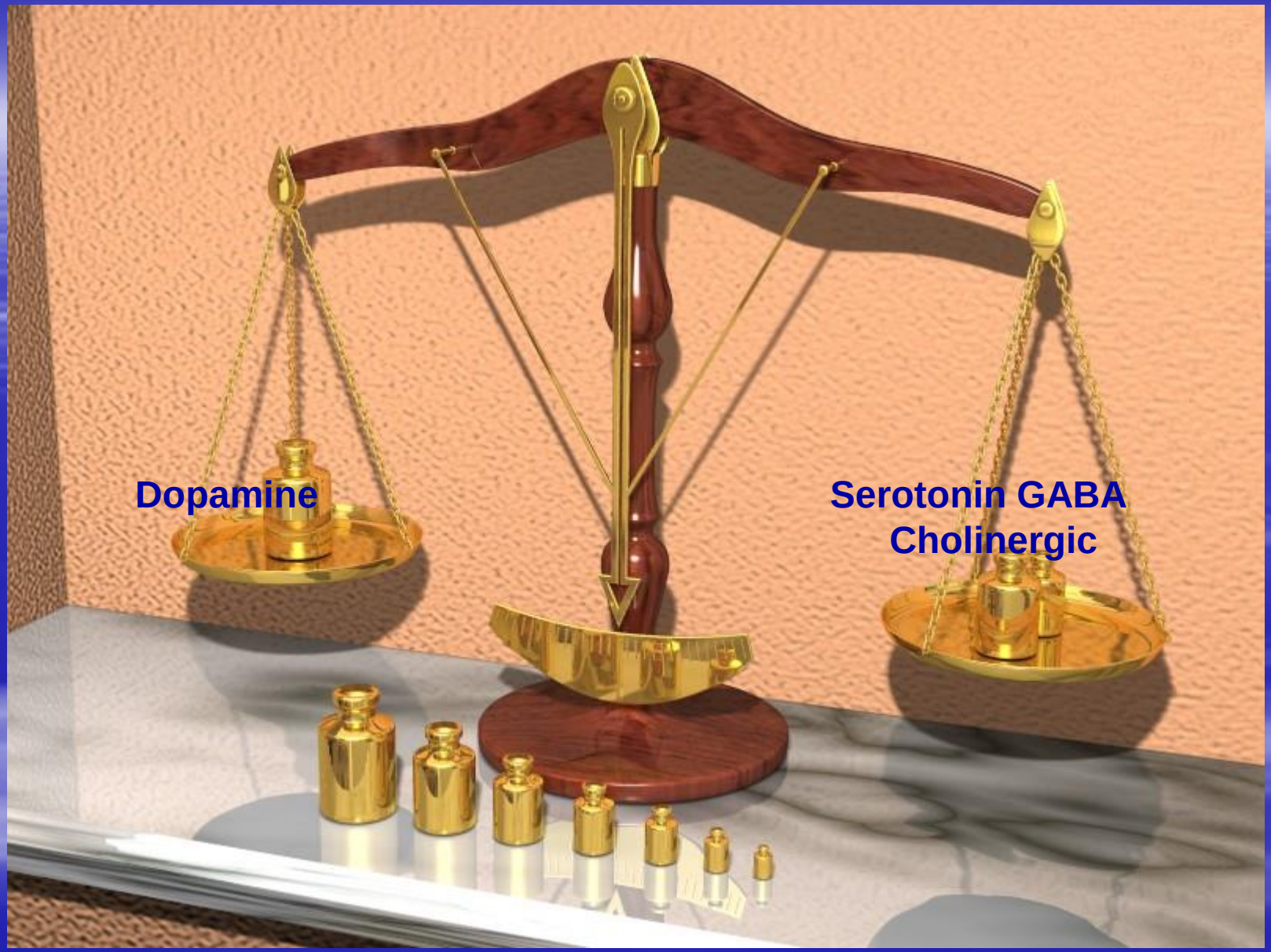
The most important are acetylcholine and dopamine.

ACETYLCHOLINE

- synthesized by small striatal cells
- greatest concentration in striatum
- excitatory moving effect.

DOPAMINE

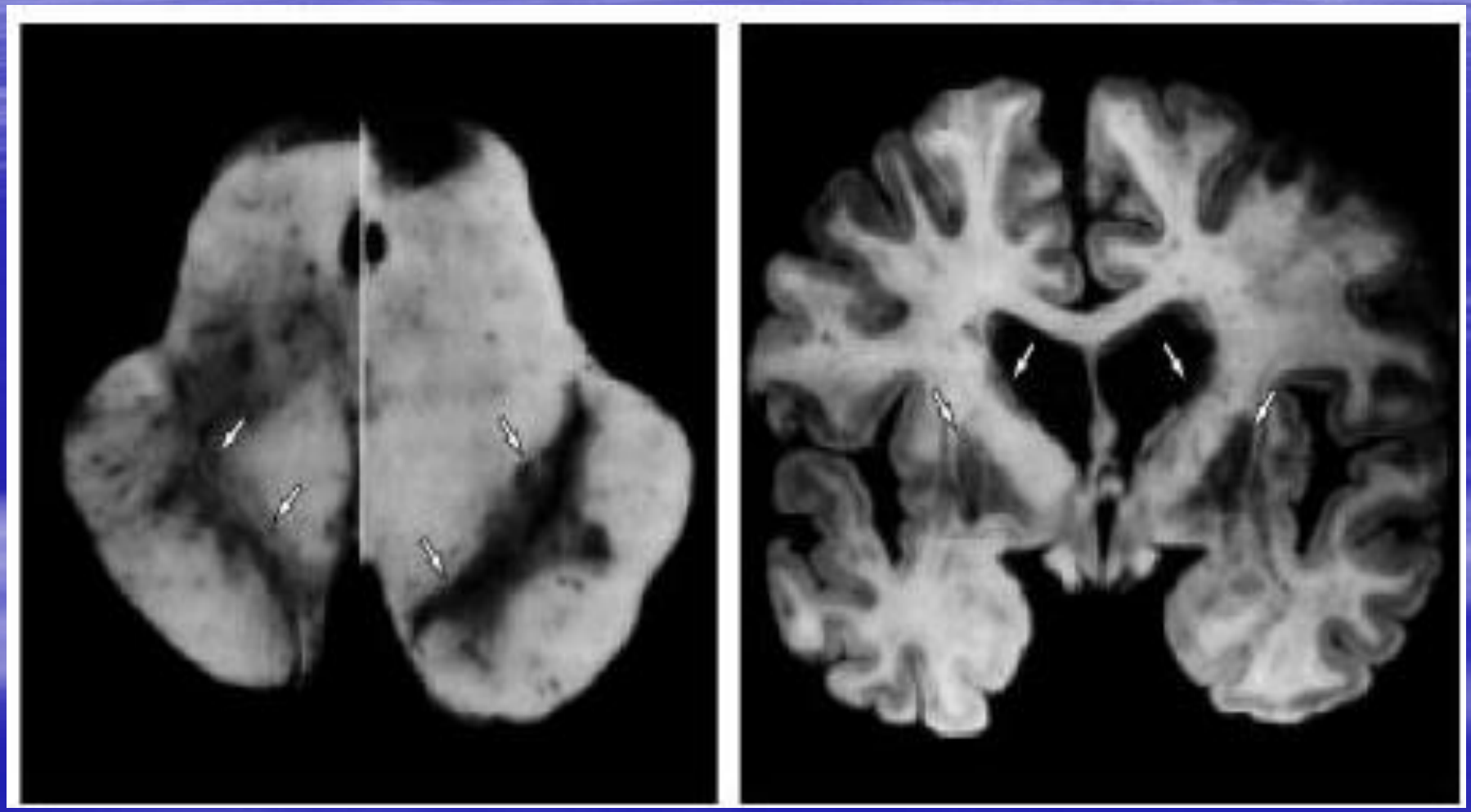
- synthesized by cells of substantia nigra
- greatest concentration in substantia nigra
- inhibiting moving effect.


Dopamine
Serotonin GABA
Cholinergic

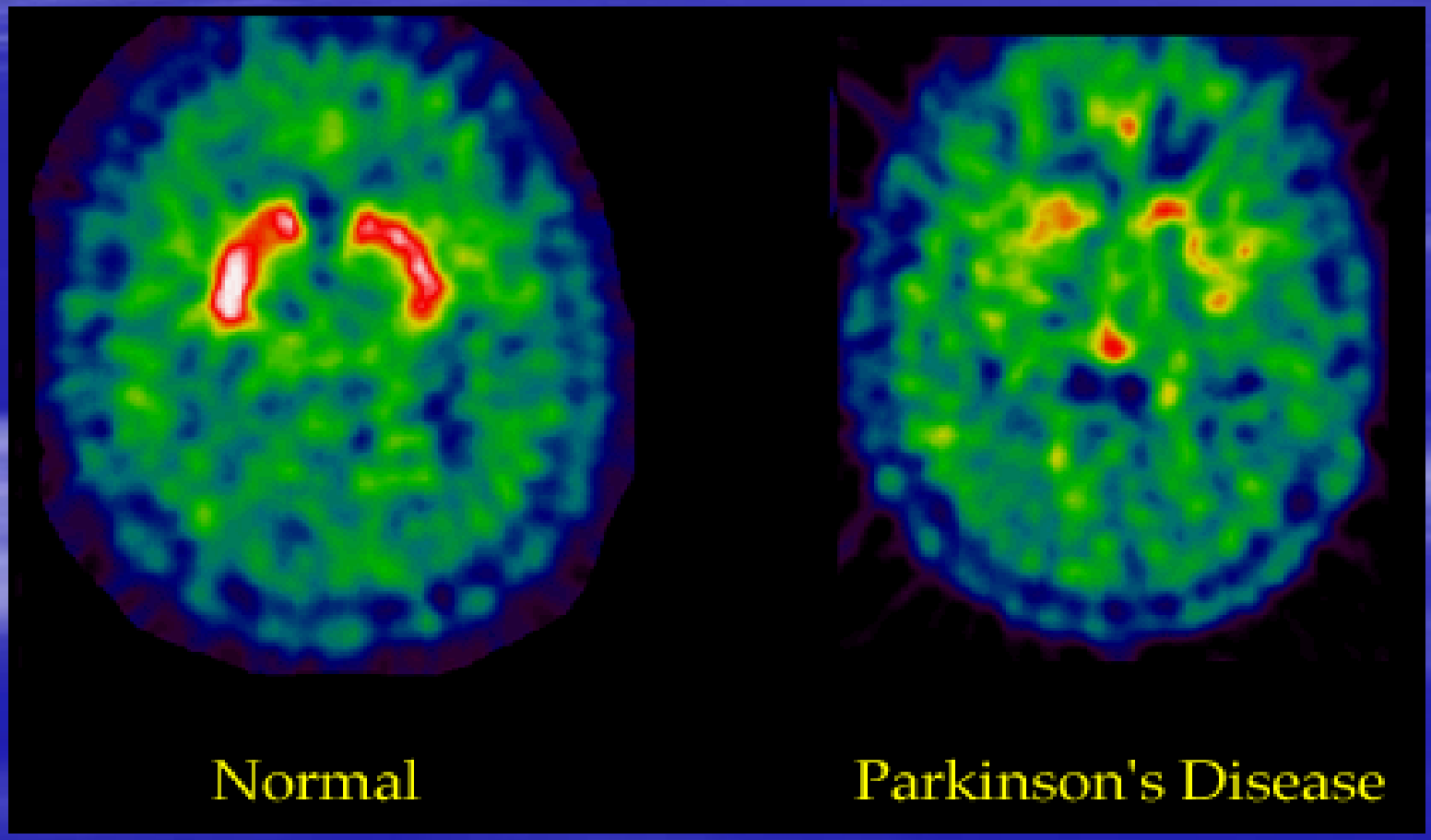
# Hypertonic-hypokinetic syndrome
# Parkinson's syndrome

The defects in motor function are due to the progressive loss of dopaminergic neurons in the substantia nigra (and loss of dophamine respectively) called hypertonic-hypokinetic syndrome

- **Degeneration of DA neurons within the substantia nigra.**
- **Examination of a PD brain reveals loss of substantia nigra cells.**



# PET Scan Images



**Bradykinesia**: pathologically slow movement, it produces:

- reduced facial expression (mask-like)
- reduced blinking
- reduced adjustment of posture when seated.

**Kinesia paradoxica** – when agitated the patient will move swiftly.

**Postural disturbance** – flexion of limbs and trunk is associated with a failure to make quick postural adjustments to correct imbalance.

The patients falls whilst turning or if pushed.

## Tremor.

at rest («pill-rolling», the thumb moving rhythmically backwards and forwards on the palm of the hand), decreasing with movements and disappears during sleep.

## Rigidity.

Stiffness felt by examinator when passively moving a limb.

This resistance is present to the same degree throughout the full range of movement, affecting flexor and extensor muscle groups equally and described as PLASTIC or LEAD PIPE rigidity. When tremor superimposed upon rigidity it produce a COGHWHEEL quality.

**Handwriting** reduces in size (micrographia).

**Autonomic features occur** – excessive sweating, greasy skin (seborrhoea), postural hypotension.

**Depression**, dementia.

Bradiphrenia.

# Parkinsonian gait.

**A parkinsonism gait is the manner of walking that is seen in patients with parkinsonism.**
**Characteristics of this gait are:**

**1) hesitation in starting: akinesia**

**2) small, shuffling, hurried steps**

**3) lack of normal arm swing**

**5) kinesia paradoxica**

The clinical syndromes of striatum's impairment are associated with hyperkinetic (involuntary movements.)

There are conditions that consist of excessive and involuntary movement of the body's parts.

## 1.Chorea.

**The term chorea means dance.**
**It refers to rapid, irregular, relatively small amplitude, random-appearing, rather continuous, non-stereotyped jerks, usually of the distal limbs.**

## 2. Athetosis.

**A wormlike, writhing, twisting movement, typically of the limbs.**

## 3.Choreo-Athetosis.

**A mix of 1 and 2.**

## 4. Tremor:

**Rhythmic, oscillatory movements of distal parts of body, usually of the limbs.**

## 5. Dystonia:

**Involuntary, sustained, patterned, and often repetitive muscle contractions of opposing muscles. Results in twisting, spasmodic or other abnormal postures of many body parts. Dystonias may be generalized (torsion dystonia) or partial (focal), for example, involuntary turning of the head by neck muscle contraction is referred to as Torticollis.**

## 6. Tics:

**These are semi-involuntary, (often compulsive), repetitive, stereotyped movements (e.g., facial grimace, eye squint, head flip, etc).**

## 7. Hemiballismus:

**is a violent flinging movement of half of the body. It is associated with lesions of the subthalamic nucleus (ie, body of Louis).**

## 8. Myoclonus:

**is a muscle jerk; it is a brief, generalized body-jerk, which is sometimes asymmetric.**

## 9. Asterixis:

**is momentary loss of tone and flapping of the hand are seen when the patient extends his arms in front with the wrists dorsiflexed.**