

Hello Everyone

Hope You Are Having
A Wonderful Physiological Day





ARE YOU
READY ?

LET'S GET STARTED!



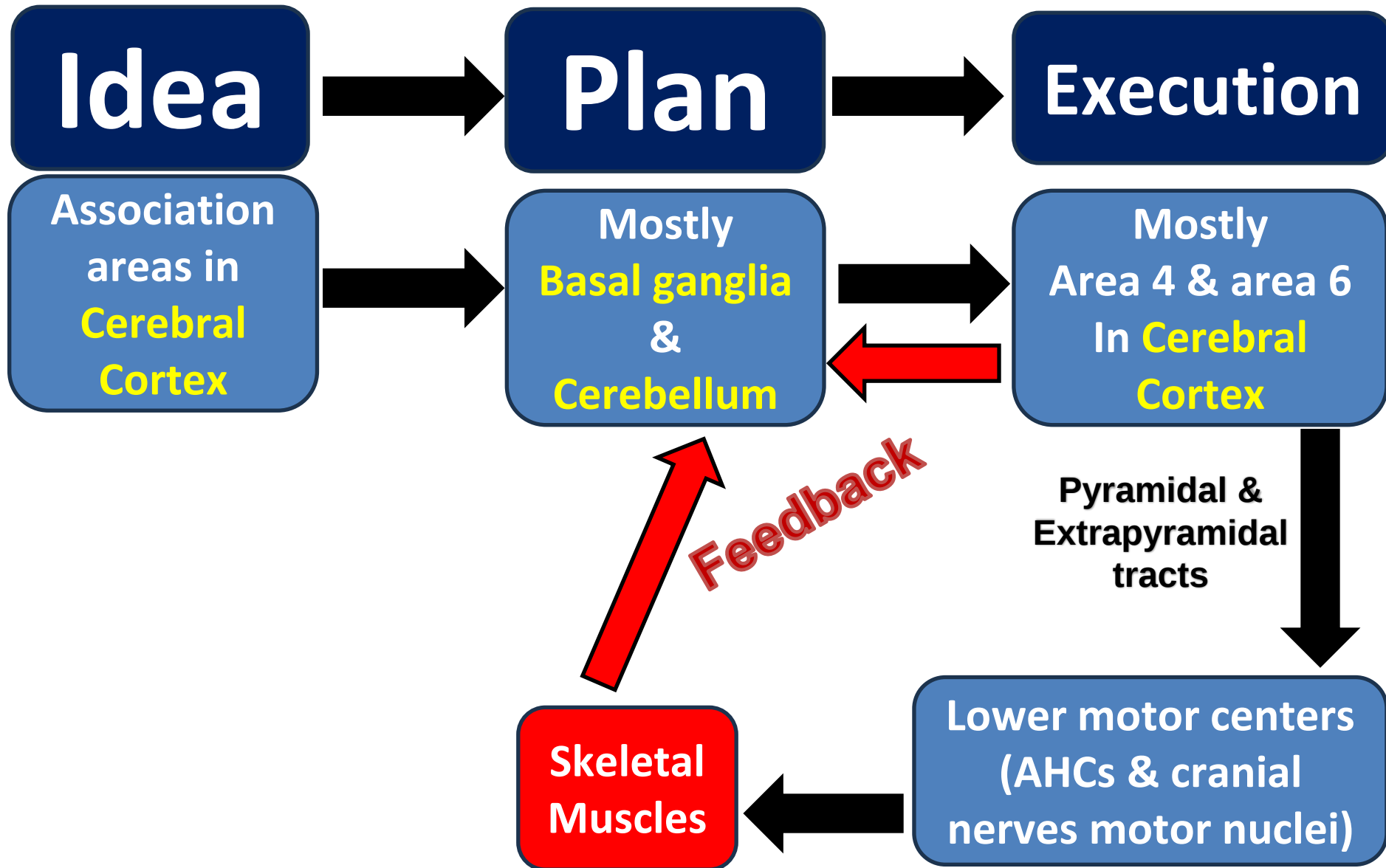
Basal Ganglia

Sem 4

Medical Physiology Department

Faculty of Medicine, MU

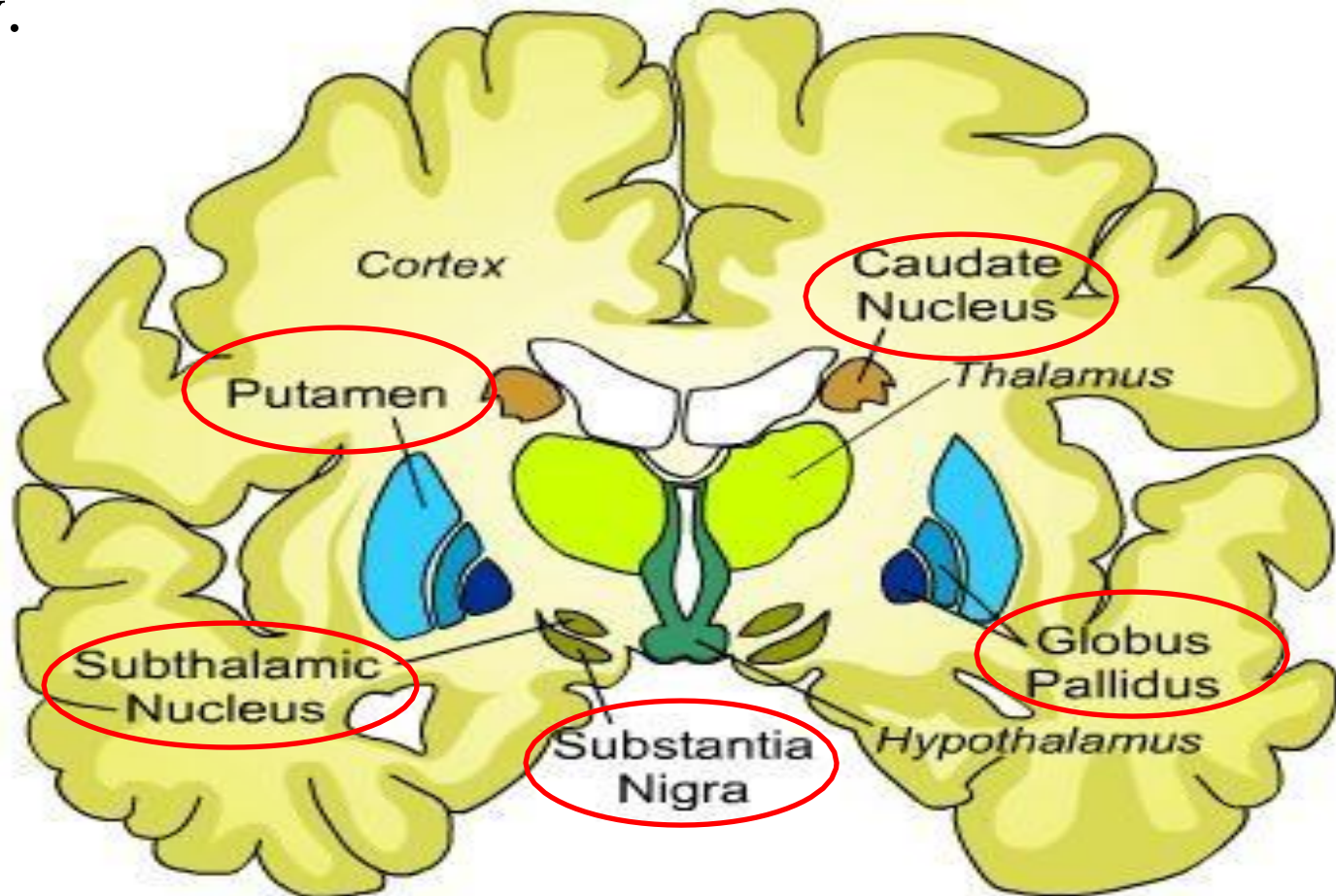
Voluntary Motor Activity



Basal Ganglia

Def,

- The BG are elements of the **motor system ??** that play a principal role in the **initiation and regulation** of motor activity.



Basal Ganglia

Functionally, the basal ganglia consist of the following nuclei ;

1) Telencephalic nuclei:

a) Caudate Nucleus

b) Putamen

c) Globus Pallidus

- *The caudate and putamen* → together are called *corpus striatum*.
- *Globus Pallidus* is subdivided into **internal (Gpi)** and **external (Gpe)** segments

Basal Ganglia

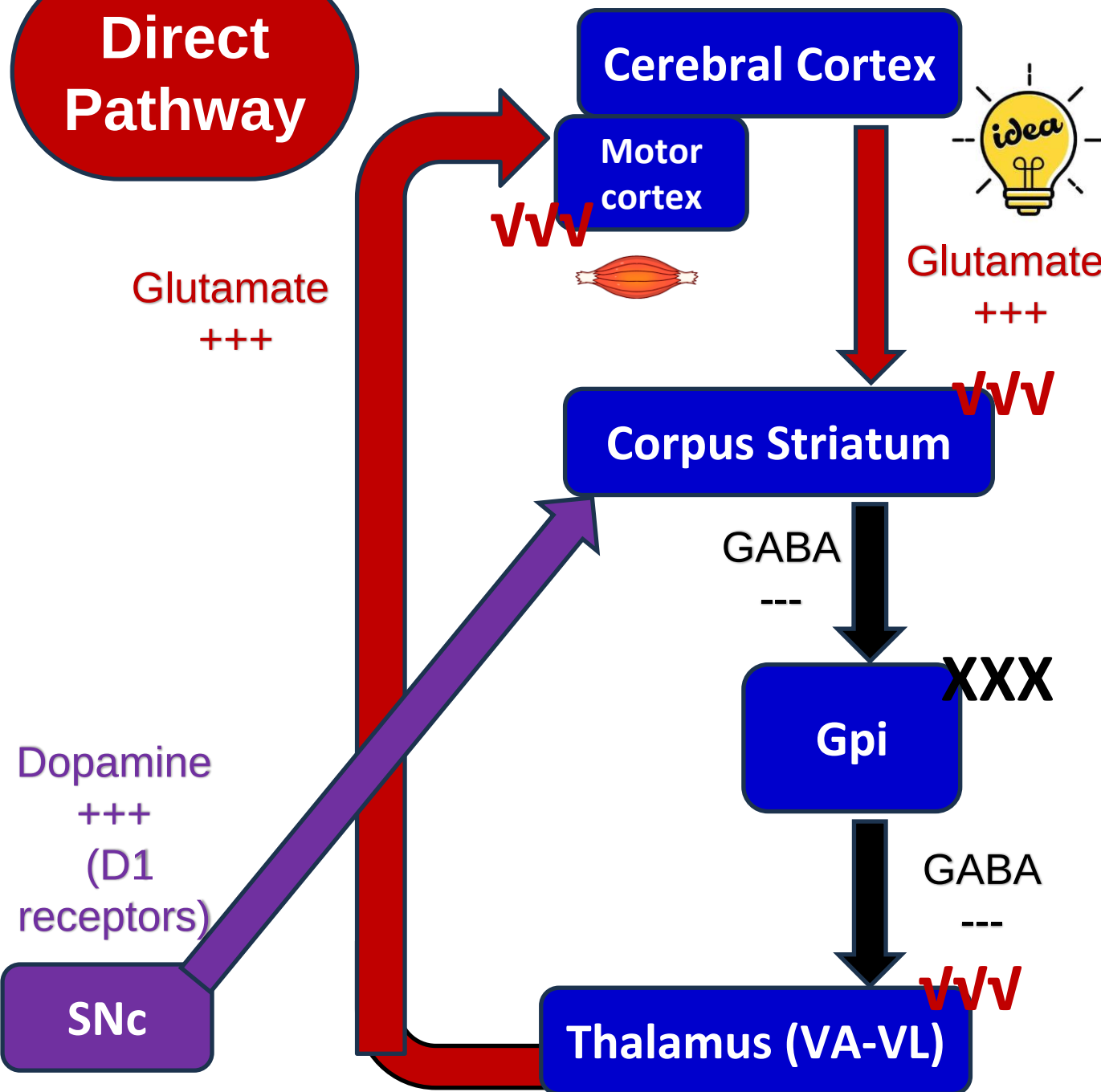
2) Diencephalic nuclei:

Subthalamic Nucleus is located in the diencephalon below the thalamus.

3) Mesencephalic nuclei:

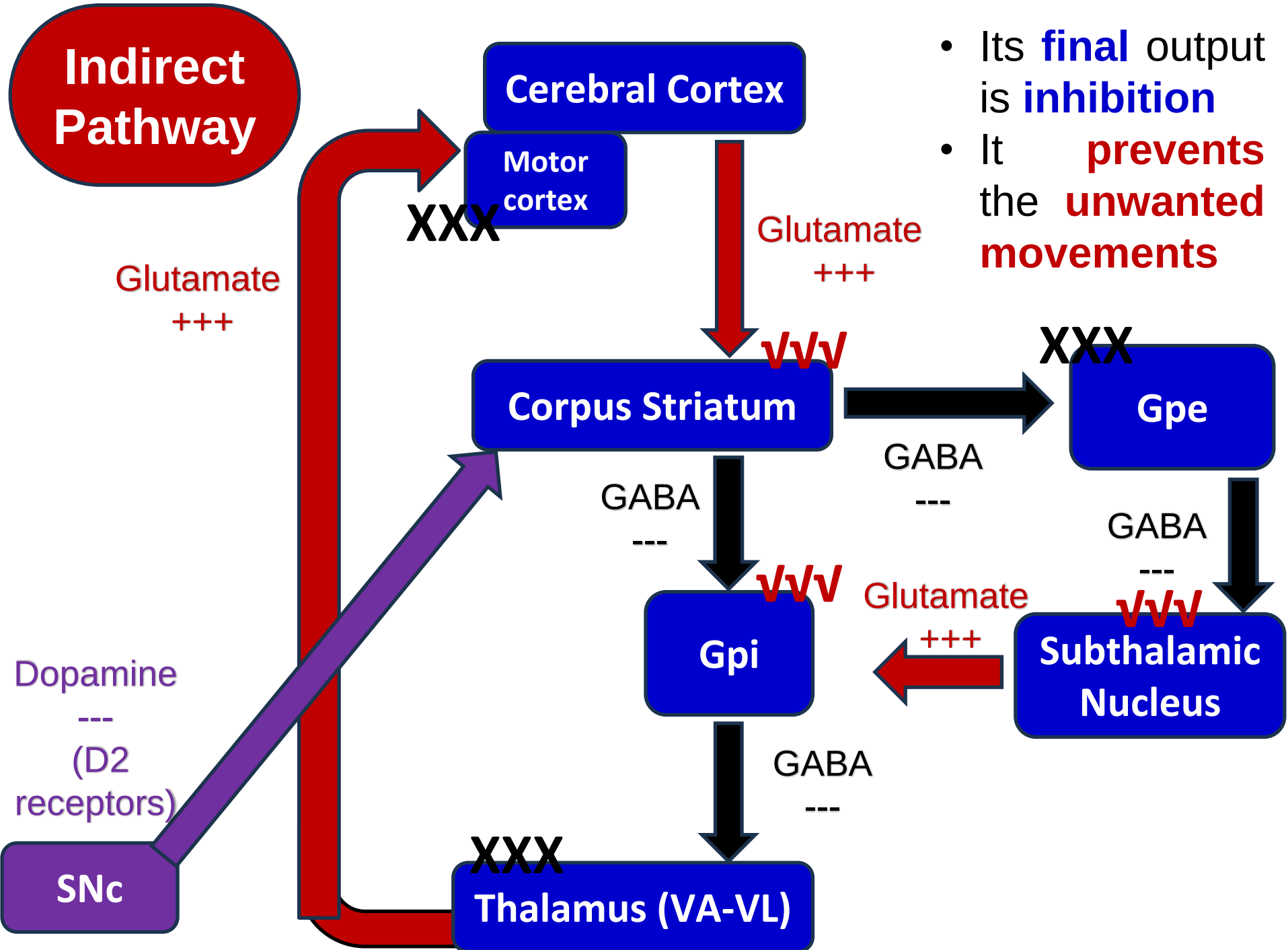
- *Substantia nigra*; is located in the mesencephalon (midbrain)
- *Histologically*, it is subdivided into 2 regions,
 - a) *Substantia nigra pars compacta (SNc)*
 - b) *Substantia nigra pars reticulata (SNr)*

Direct Pathway



- Its **final** output is **excitation**
- It **initiates** the **movements**

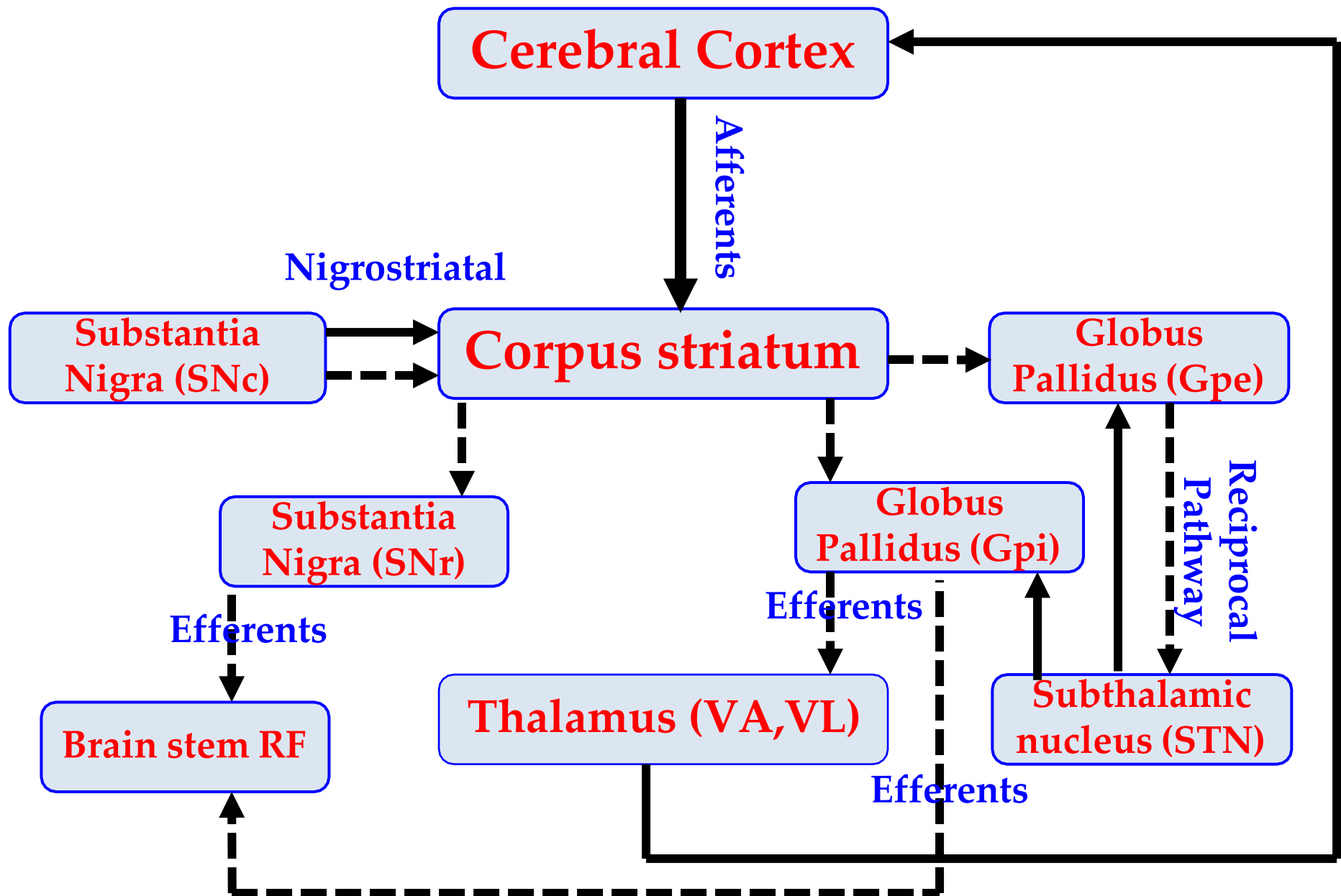
Indirect Pathway



Neural connections of the Basal Ganglia

	From	To
Afferent connections	Cerebral cortex	Corpus striatum (the principal entry gate) → Corticostriatal pathway
Efferent connections	i) Main efferent pathway → from internal segment of the globus pallidus (GPi) ii) Efferent pathways from the GPi and SNr	i) To the VA and VL nuclei of the thalamus → in turn project to the frontal motor areas and the prefrontal region of the CC. ii) To brain stem reticular formation
Internal connections	i) A pathway from the Striatum ii) A reciprocal pathway () the globus pallidus & the subthalamic nucleus. iii) A nigrostriatal pathway → from the substantia nigra	i) To the globus pallidus ii) A reciprocal pathway () the globus pallidus & the subthalamic nucleus. iii) To the striatum

Neural connections of the Basal Ganglia



Neurotransmitters of BG

Transmitter	Source	Action
Glutamate	Secreted from; i) <u>Neurons</u> which arise from the CC and terminate in striatum ii) <u>Neurons</u> from subthalamic nucleus that terminate in the GPi and SNr	Excitatory transmitter
Dopamine	Secreted from neurons of the SNc that terminate mainly in the corpus striatum → the nigrostriatal pathway	Has 2 different actions (modulatory): i) Is excitatory to neurons having D1 receptors → potentiate the effect of cortical glutamatergic input to the striatum. ii) Is inhibitory to striatal neurons having D2 receptors → antagonize the effect glutamatergic input to the striatum

Neurotransmitters of BG

Transmitter	<u>Source</u>	<u>Action</u>
Acetylcholine	Found mainly in interneurons in the striatum (inhibit D1 neurons via M4 receptors and stimulate D2 neurons via M1 receptor)	modulatory
GABA	Found in striatal neurons that project to the GPe and GPi and the SNr	Inhibitory
Substance P	Co-transmitter with GABA from striatal GABA-ergic neurons	Inhibitory
Enkephalins	Co-transmitter with GABA from striatal GABA-ergic neurons	Inhibitory

Function of Basal Ganglia

1. Planning and programming of voluntary movements

2. Execution of learned patterns of movements

3. Regulation of posture

4. Regulation of muscle tone

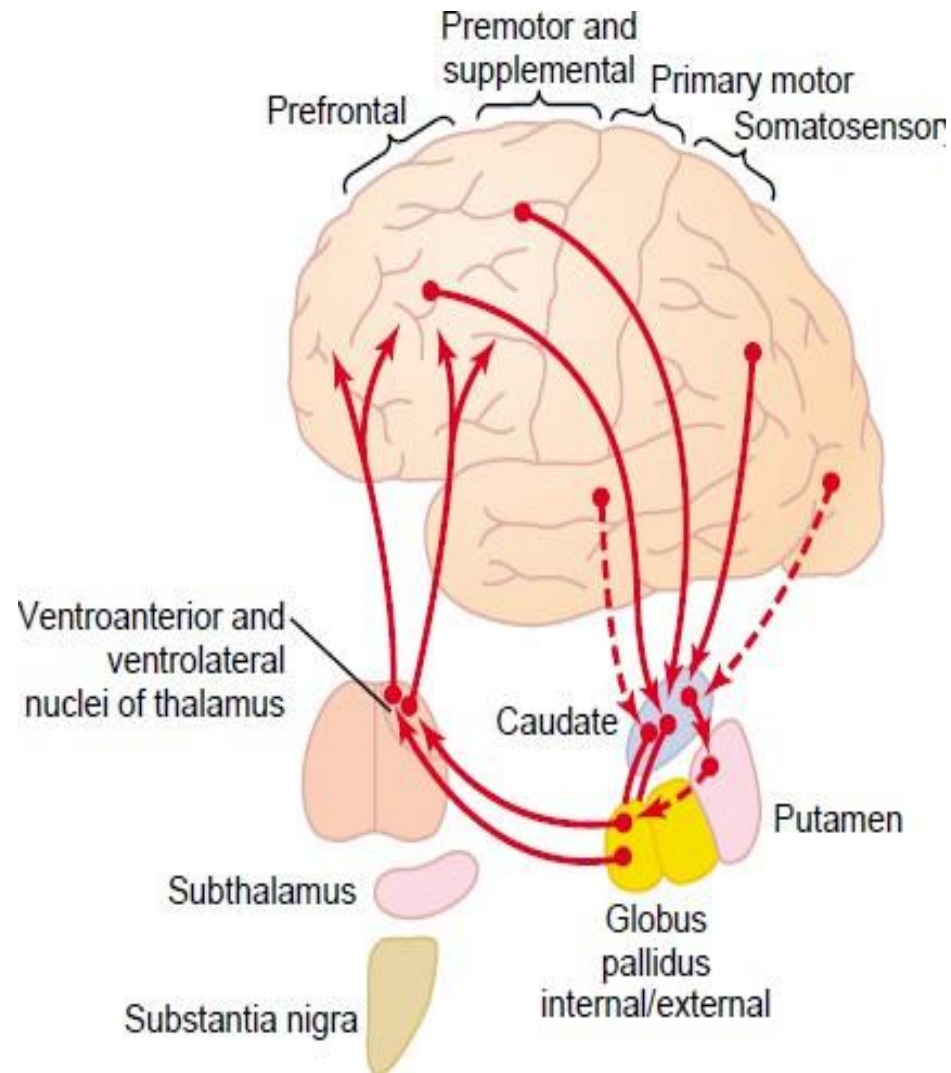
5. Initiation of automatic movements

1. Planning and programming of voluntary movements

- The BG plays a major role in **converting thoughts into voluntary motor acts**;
- This is done by determining:
 1. When move
 2. Where to move
 3. What ms to use for moving
 4. What is the direction of the movement
- The BG does not function alone, but in close association with;
 - a) **Cortical motor areas**: provide a preliminary plan of motor act
 - b) **Cortical association areas**: provide information about the **spatial relationship** of the different part of the body relative to each other and the **spatial orientation** of the body to the surrounding environment

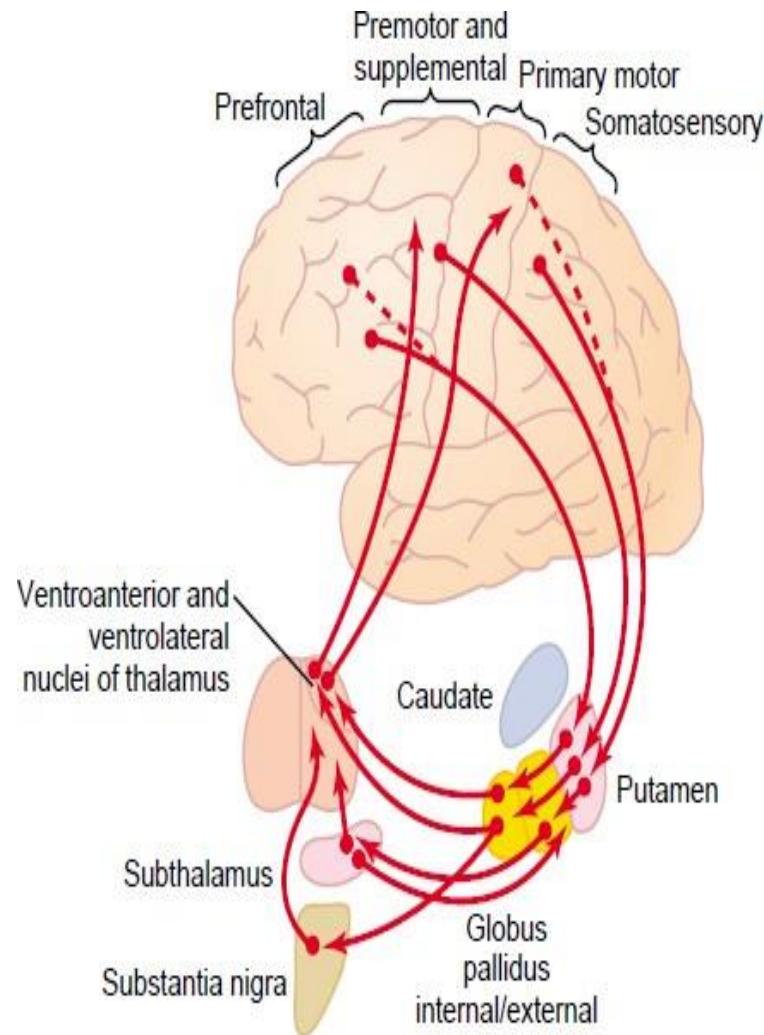
1. Planning and programming of voluntary movements

- This function is usually performed via **caudate circuit**
- Loss of this cognitive function of the BG makes the person **unable to make the proper decisions** about planning his motor acts under different circumstances



2. Execution of learned patterns of movements

- Many patterns of learned or skilled movements such as writing , typing , and many hand skills in addition to certain aspects of speech are performed so rapidly that it **could not allow for sensory feed-back control**.
- The patterns of these **rapid skilled movements** are established, after several trials (**training period**), in the motor system, then **stored in the BG**.
- **Execution of these movements** are controlled by BG through **putamen circuit**
- Damage of **BG** make **these movements crude** and as they done for the **first time**



3. Regulation of posture

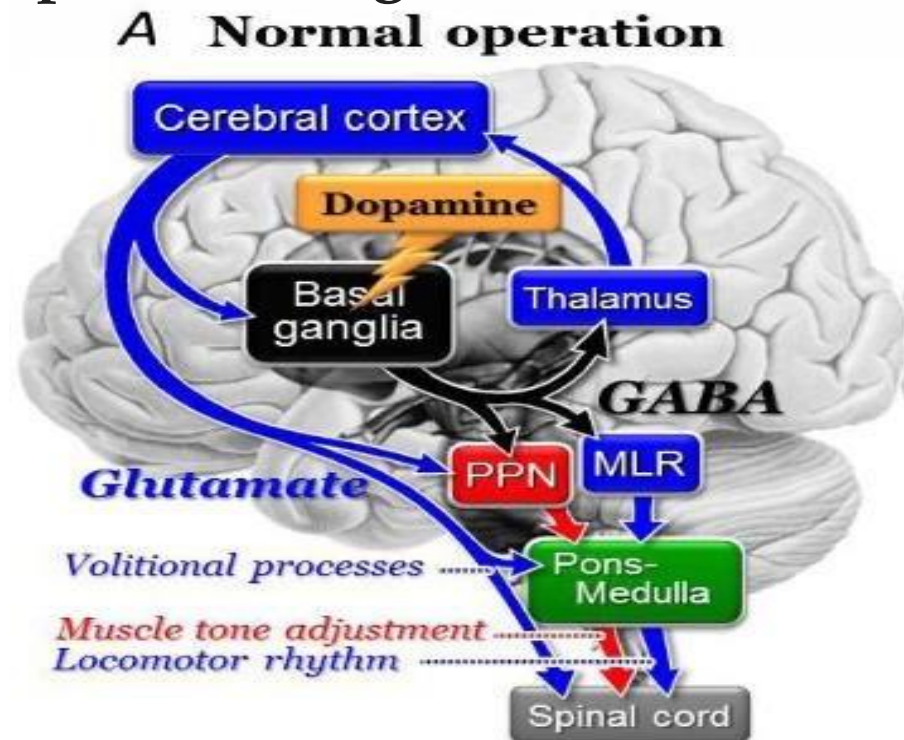
- **BG provides a *postural background***, which is **necessary** for the performance of voluntary **movements** by the **distal parts** of the limbs.
- That is, if the person wishes to perform *a skilled movement* by the hand, initiated by motor impulses mediated through the *corticospinal tract*, then the BG adjust the tone of the *trunk ms and proximal limb ms*, by way of its controlling influence on the *reticulospinal tracts*, to provide appropriate positioning of the shoulder and elbow as a **stable basis** for voluntary movements of the hand
- So, the **BG** constitute an ***important bridge that link*** the **lateral motor system**, with the **medial motor system????**

4. Regulation of muscle tone

- Normally, B.G. stimulate the motor cortex (premotor area, inhibitory is powerful than area 4 on ms tone) via activation of VA and VL thalamic nuclei, so **inhibit the ms tone**
- The BG send also **inhibitory** output to the brain stem **facilitatory RF** via pedunculopontine tegmental nucleus (PPN) → **inhibits ms tone**

N.B.

- Also, it control the gait via activation of mesencephalic locomotor region (MLR) in midbrain



5. Initiation of automatic movements

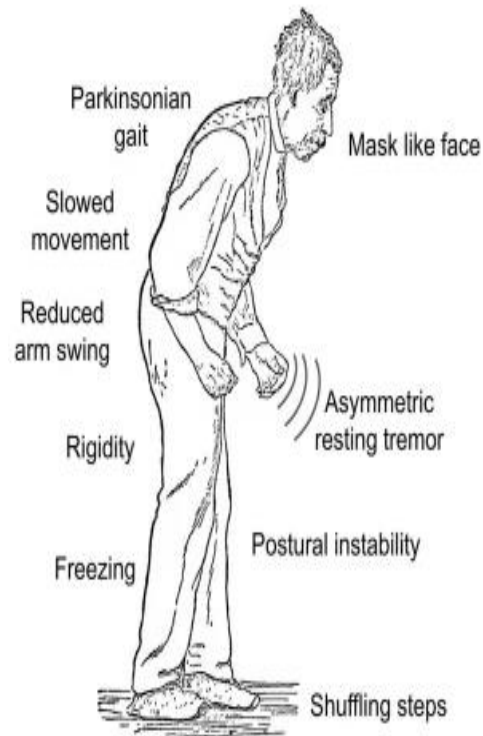
- The BG seems to initiate and regulate several patterns of **automatic movements** that are usually performed subconsciously.

-Such movements include e.g.

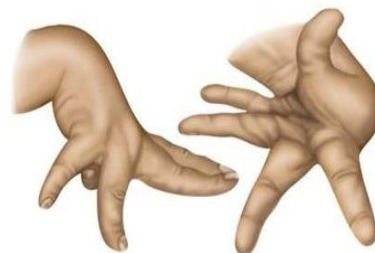
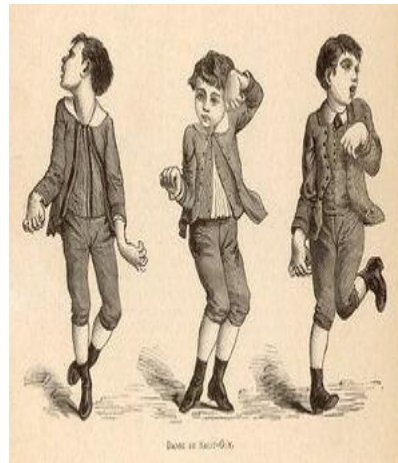
1. **Swinging movements** of the arms **during walking**,
2. **Facial expression** that reflect the **emotional state** of the subject.

Disorders of Basal Ganglia

Parkinsonism



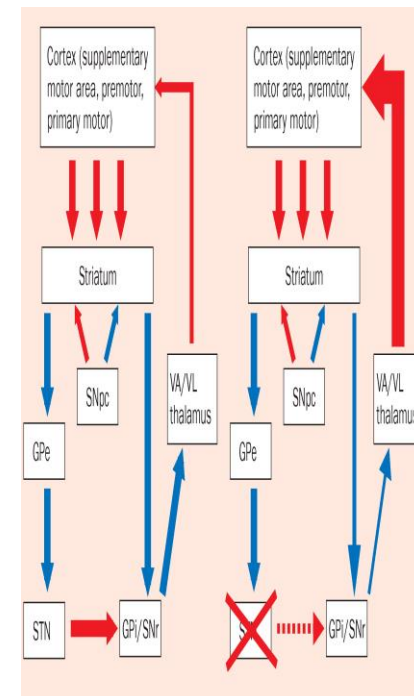
Chorea



Athetosis



Ballismus



Parkinsonism

- It is a **common degenerative disease** of the brain caused by a lesion in **nigrostriatal pathway** that characterized by

- a) **Tremors**
- b) **Akinesia**
- c) **Rigidity**

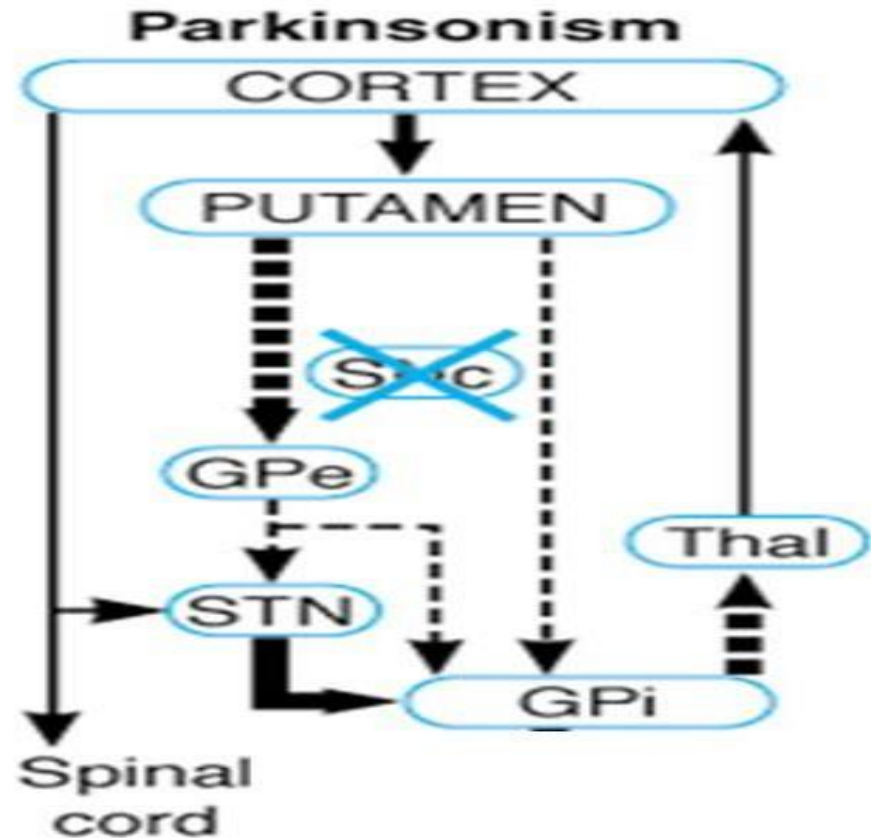
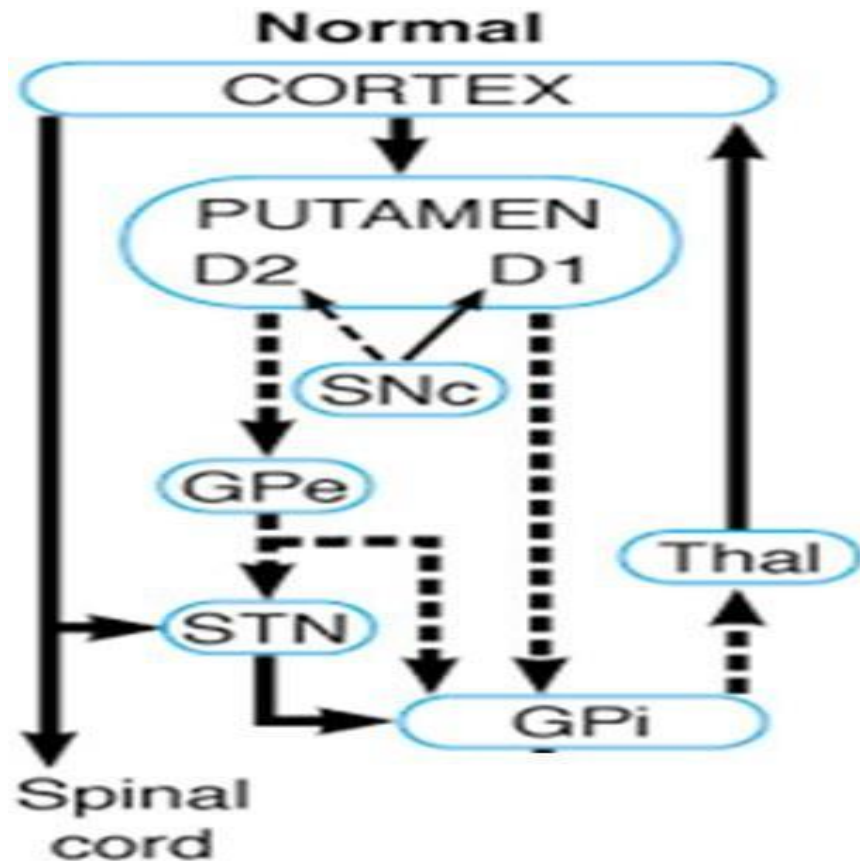
Causes:

- Caused by **degeneration of the dopaminergic nigrostriatal neurons** → marked ↓ of dopamine release
- It may be;
 - a) **Idiopathic (spontaneous)** → more common in old age.
 - b) **Non -idiopathic Parkinsonism** → Viral encephalitis, CO and manganese poisoning, repeated head trauma and tranquilizers that block D2 receptors

Parkinsonism

Mechanism

- Degeneration of SNc will result in loss of dopamine and activation of inhibitory pathway and **inhibition of the motor cortex** resulting in **difficulty to initiate the movements** (hypokinesia) and **increased muscle tone**.



Clinical signs of Parkinsonism

1) Tremors:

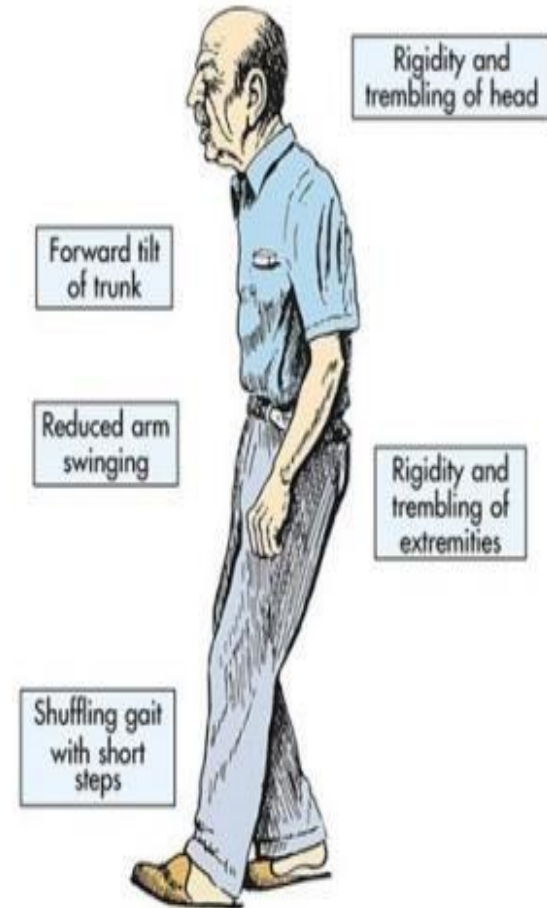
- Occur at rest i.e. **static tremors**
- ↑ by emotional excitement.

2) Akinesia and Bradykinesia:

- a) The voluntary movements show difficulty in initiating them, when initiated become slow, of limited range stiff, and exhausting.
- b) The automatic movements are absent e.g. facial expression lost (a **mask-like face**).
- c) **Speech** becomes **slow and monotonous**.
- d) The gait becomes **short shuffling**

3) Rigidity: (lead pipe and cogwheel)

- It is due to hypertonia of all skeletal ms (**alpha rigidity**)
- Rigidity affects flexors than extensors → **flexion attitude or gorilla like attitude**

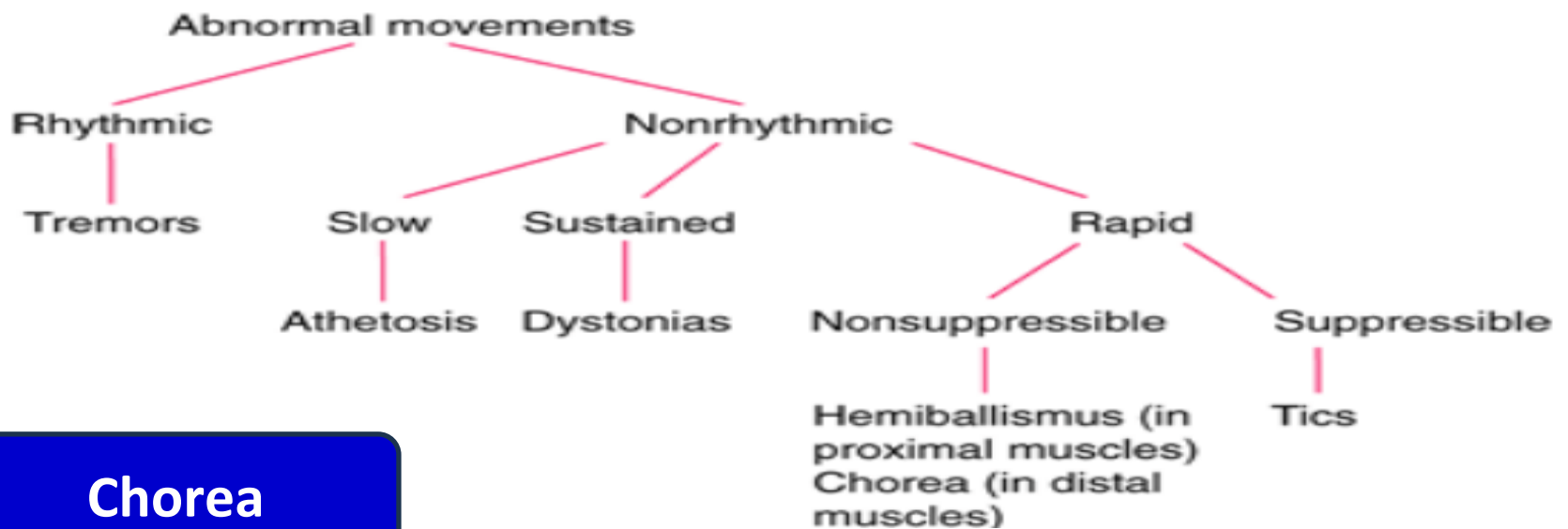


Clinical signs of Parkinsonism



Disorders of Basal Ganglia

	B)Chorea	C)Athetosis	D) Ballismus
Def.	Rapid uncontrolled shaking or jerky (dancing) movements, which may involve distal parts of the body , e.g. hand & face i) Sydenham's Chorea occurs in children with rheumatic fever ii) Huntington's Chorea : inherited disease occurs at the age of 30-50 years	Continuous slow writhing (twisting) movements which are particularly evident in the hands and fingers.	Spontaneous attacks of violent involuntary movements involving large areas of the body
Cause	Atrophy and degeneration of the caudate nucleus	Traumatic damage to the basal ganglia at birth (cerebral palsy)→involves the striatum and globus pallidus	Damage of the subthalamic nucleus

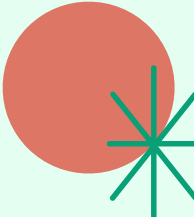


Chorea

Athetosis

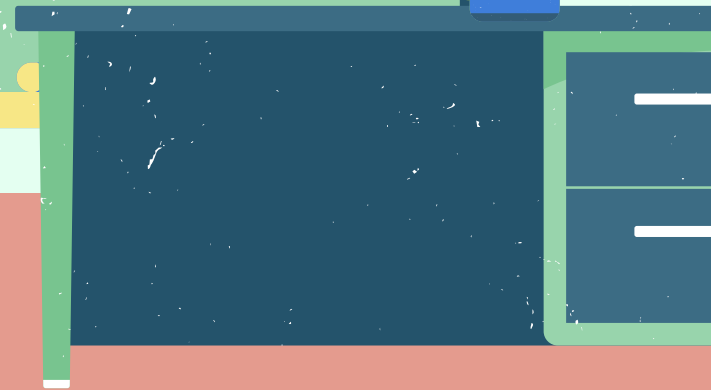
Ballismus





Any Questions

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Thank

You