كلية الطب البشري
Faculty of Medicine

CNS Module-Spring 2021

Physiology Lectures (L6&7)

Topic 3: Brain Stem
Beginning of Topic 4: Basal Ganglia

Presented by:

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The Brain Stem

The brain stem is a complex extension of the spinal cord, which performs sensory, motor and reflex functions.

- It also contain centers that:

1- Regulate cardiovascular, respiratory and gastrointestinal functions.

2- Play major role in control of eye movements.

3- Support the body against gravity.

4- Control complex reflex movements.

2

The reticular formation of the brain stem

- **The reticular formation is a large structure occupying the core of the brain stem.**
- **It consists of areas of diffuse neurons of 2 types:**

-Sensory neurons:

which are greater in number and which make multiple connections within the reticular formation itself.

-Motor neurons:

which are larger in size and receive impulses from sensory neurons.

3

Motor neurons give rise to axons, which divide into:

1- Ascending branches (Reticular Activating System = RAS) → non-specific thalamic nuclei→ basal ganglia→ thalamus → cerebral cortex.

(B) Factors that decrease the ARAS activity

(1) Reduction of signals from the sensory pathways or the cerebral cortex.
(2) Stimulation of the sleep centres (see below).
(3) Extensive damage of the ARAS (e.g. by tumours).
(4) General anesthetic drugs : These drugs lead to unconsciousness through ***depressing the ARAS activity*** (by inhibiting the synaptic transmission between its neurons).

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2- Descending branches → **Pass to the spinal cord to supply the anterior motor neurons. These are the lateral and ventral reticulospinal tracts.**

divided into:

A- The pontine reticular system

B- The Medullary Reticular System

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A- The pontine reticular system "facilitatory reticular formation":

- **Has spontaneous intrinsic activity which is enhanced by impulses from:**
  - **Motor area 4 of the cerebral cortex.**
  - **The vestibular nucleus.**
  - **The neocerebellum.**
  - **The classical sensory pathways.**

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B- The Medullary Reticular System"inhibitory reticular formation“:

- **It does not discharge spontaneously, but driven by impulses from the:**
  - **Suppressor area of the motor cortex.**
  - **Basal ganglia.**
  - **Paleocerebellum.**

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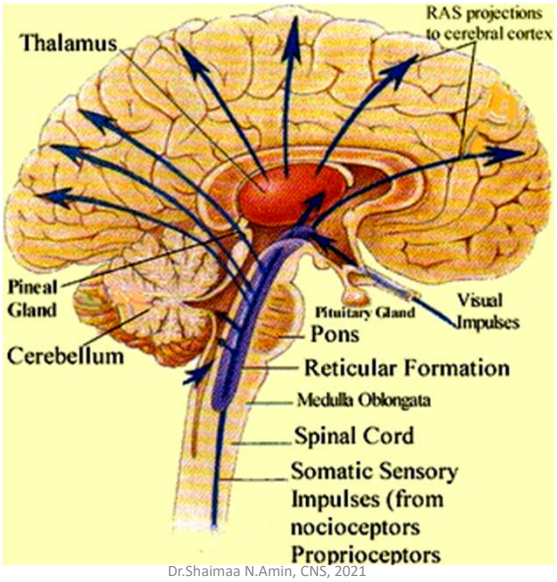
The reticular formation of the brain stem



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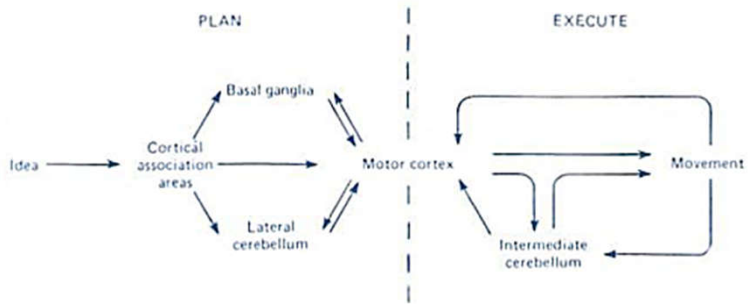

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Basal Ganglia

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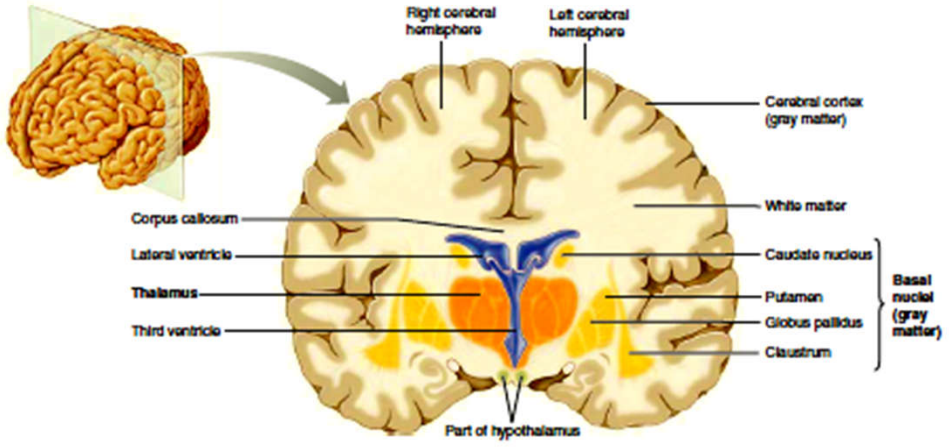
Anatomical considerations



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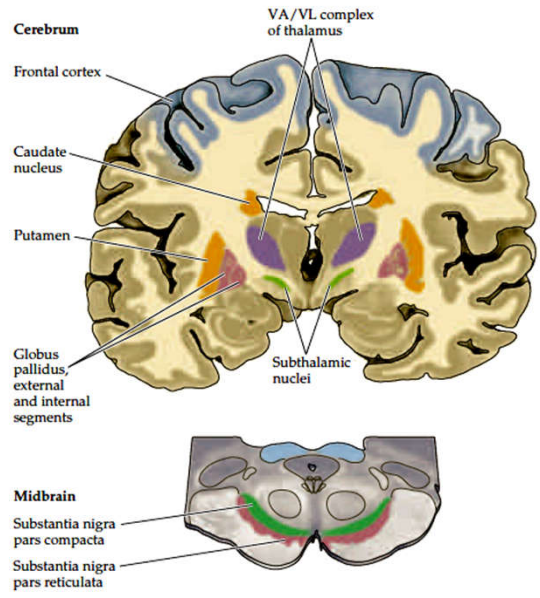

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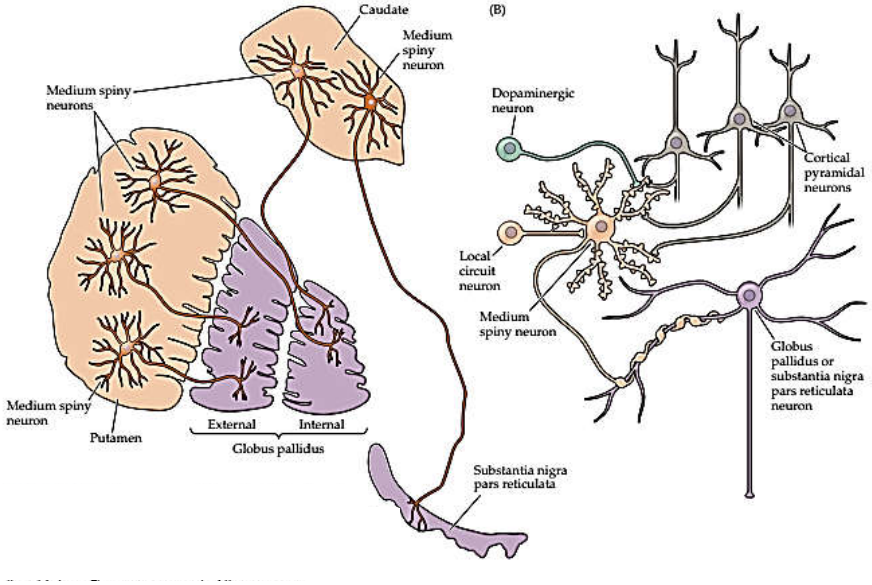
Caudate
Medium spiny neuron
Medium spiny neurons
(B)
Dopaminergic neuron
Cortical pyramidal neurons
Local circuit neuron
Medium spiny neuron
Globus pallidus or substantia nigra pars reticulata neuron
Medium spiny neuron
Putamen
External
Internal
Globus pallidus
Substantia nigra pars reticulata

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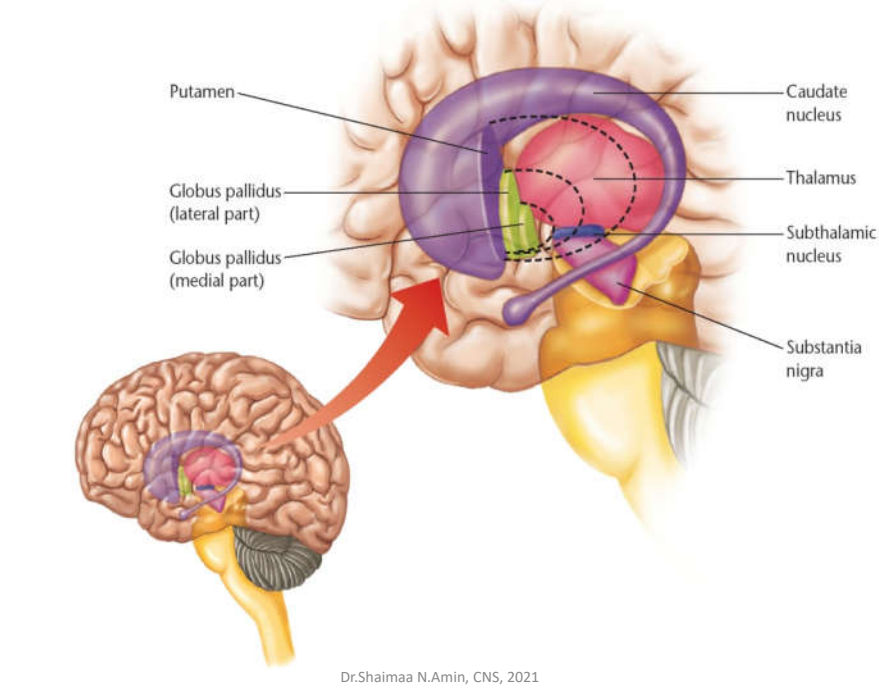
Putamen
Caudate nucleus
Thalamus
Globus pallidus (lateral part)
Subthalamic nucleus
Globus pallidus (medial part)
Substantia nigra

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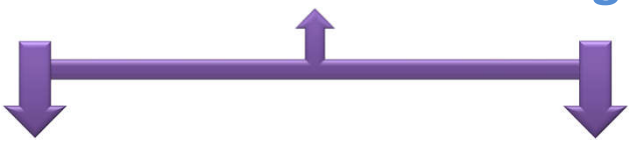
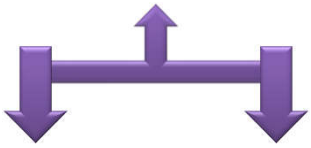
Connection of the Basal Ganglia



I-Afferent Fibers
(Cortical connections)

II-Efferent Pathway
from basal ganglia



a-Caudate
Circuit

b-Putamen
Circuit

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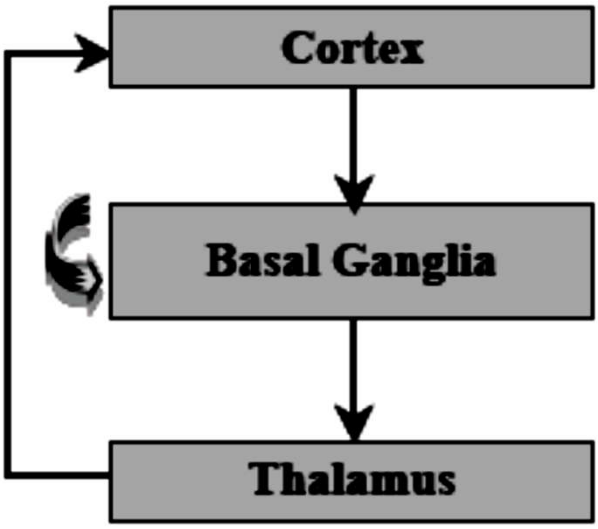

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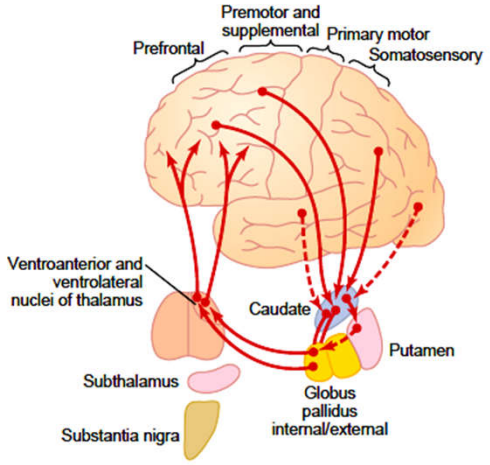
I-Afferent Fibers
(Cortical connections)

a-Caudate Circuit



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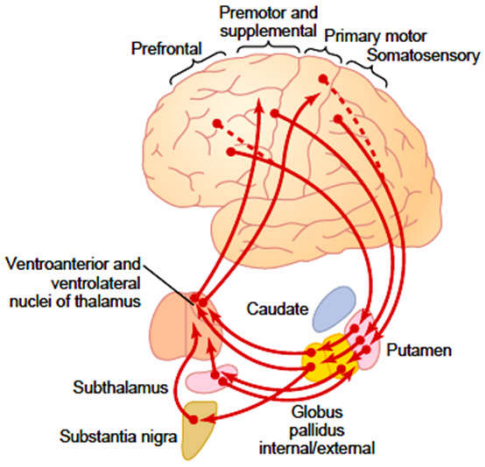
I-Afferent Fibers
(Cortical connections)

b-Putamen Circuit



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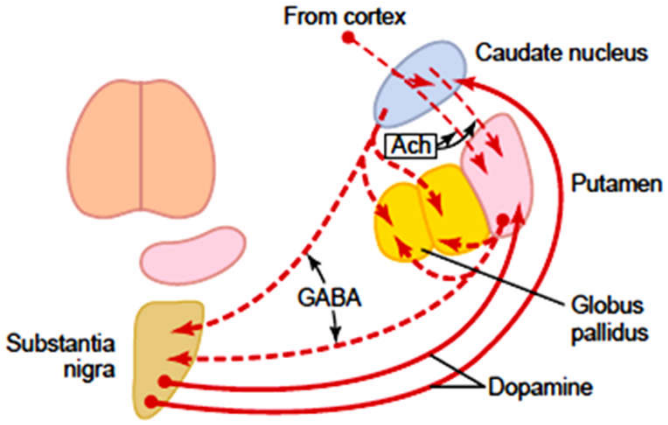
Pathways between the neostriatum and substantia nigra



1- C .Cortex→ Glutamate → Neostriatum
2- Neostriatum → GABA → Substantia nigra
3- Substantia nigra → dopamine → Neostriatum

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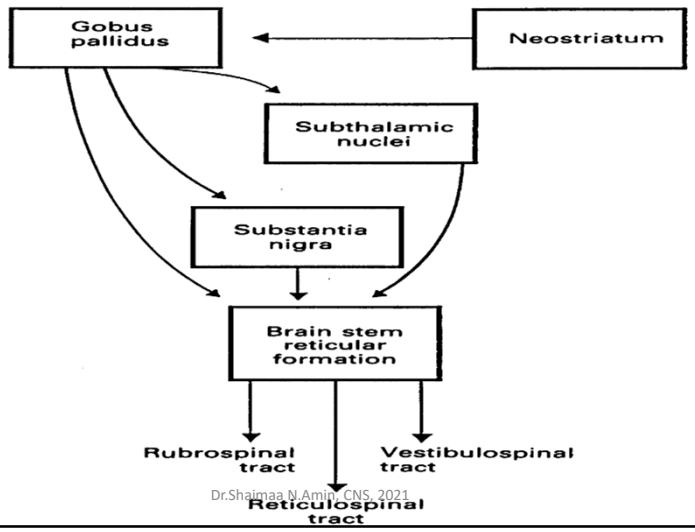
II-Efferent Pathway from basal ganglia



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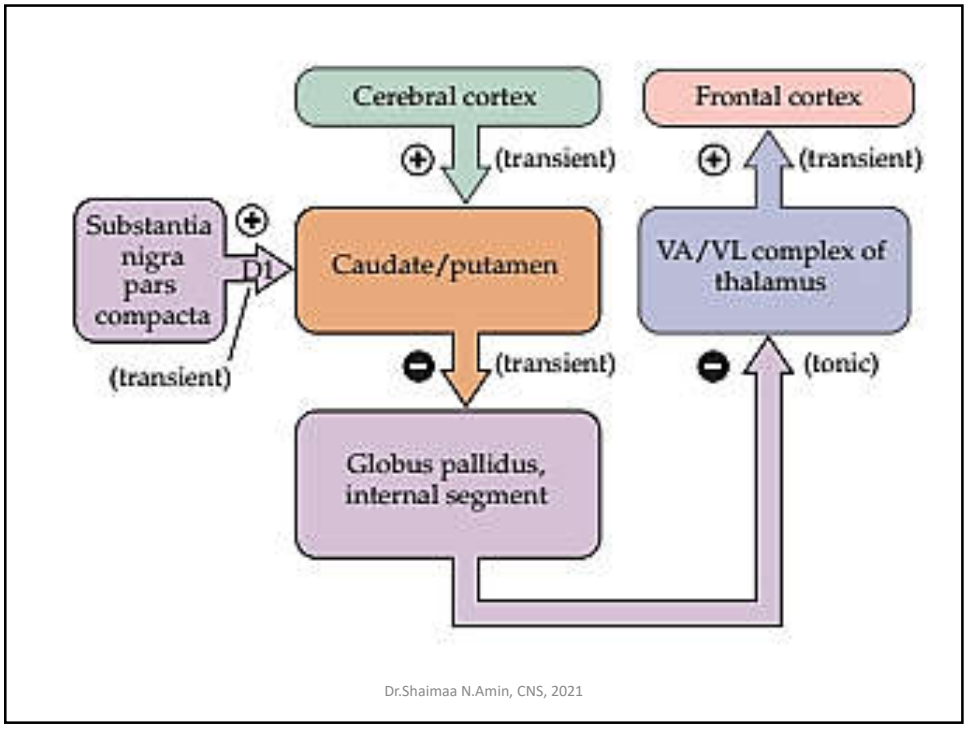
Cerebral cortex
Frontal cortex
(transient)
(transient)
Substantia nigra pars compacta
D1
Caudate/putamen
VA/VL complex of thalamus
(transient)
(transient)
(tonic)
Globus pallidus, internal segment
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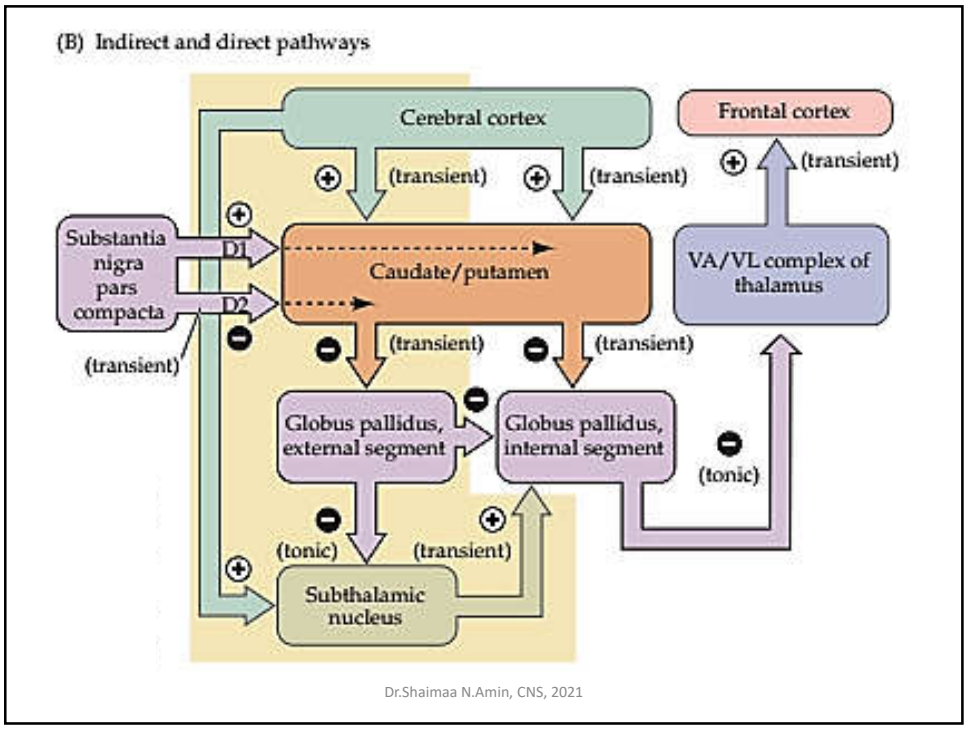
(B) Indirect and direct pathways
Cerebral cortex
Frontal cortex
(transient)
(transient)
(transient)
Substantia nigra pars compacta
D1
D2
Caudate/putamen
VA/VL complex of thalamus
(transient)
(transient)
(transient)
Globus pallidus, external segment
Globus pallidus, internal segment
(tonic)
(tonic)
(transient)
Subthalamic nucleus
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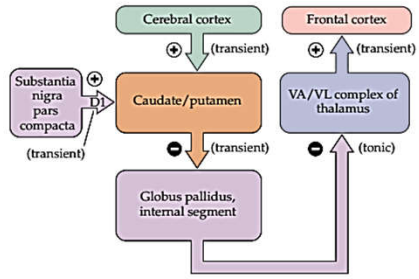
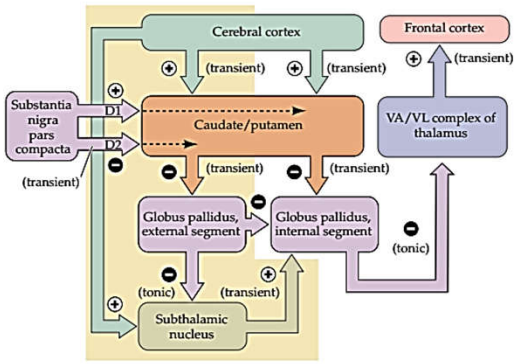
FIGURE 18.7 Disinhibition in the direct and indirect pathways through the basal ganglia. (A) In the direct pathway, transiently inhibitory neurons in the caudate and putamen project to tonically active inhibitory neurons in the *internal* segment of the globus pallidus, which project in turn to the VA/VL complex of the thalamus. Transiently excitatory inputs to the caudate and putamen from the cortex and substantia nigra are also shown, as is the transiently excitatory input from the thalamus back to the cortex. (B) In the indirect pathway (shaded), transiently active inhibitory neurons from the caudate and putamen project to tonically active inhibitory neurons of the *external* segment of the globus pallidus. Note that the influence of nigral dopaminergic input to neurons in the indirect pathway is inhibitory. The globus pallidus (external segment) neurons project to the subthalamic nucleus, which also receives a strong excitatory input from the cortex. The subthalamic nucleus in turn projects to the globus pallidus (internal segment), where its transiently excitatory drive acts to oppose the disinhibitory action of the direct pathway. In this way, the indirect pathway modulates the effects of the direct pathway.



(B) Indirect and direct pathways



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Diseases of the basal ganglia in human

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Diseases of the basal ganglia in human

1-Chorea.

2-Parkinsonism.

3-Athetosis.

4-Ballism.

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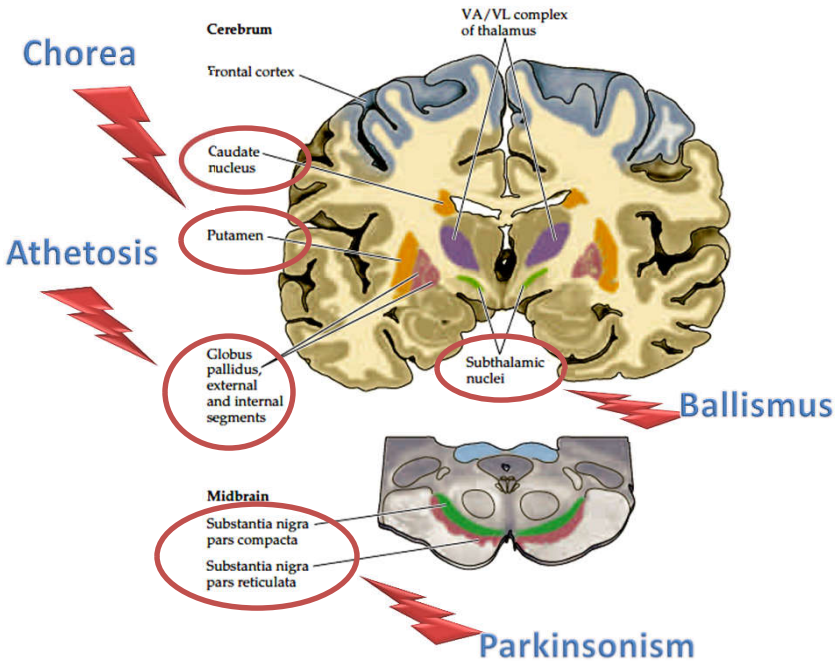

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Chorea

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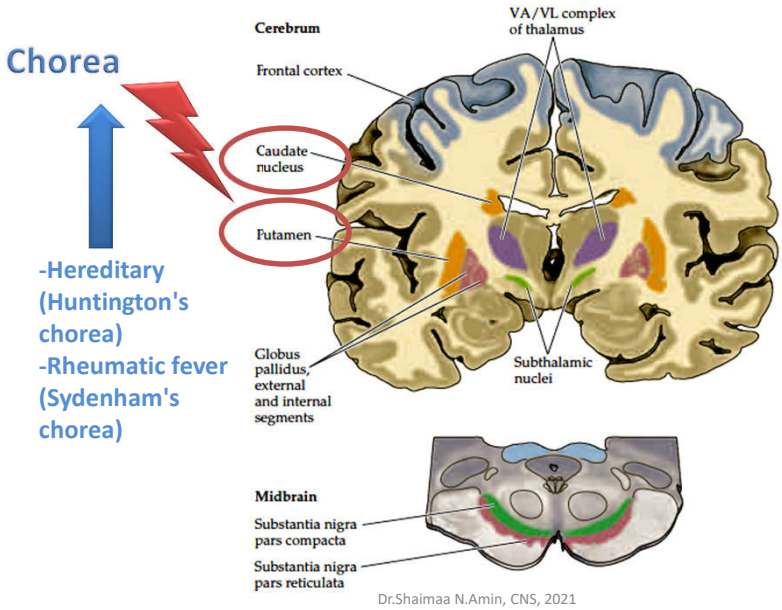
Diseases of the basal ganglia in human

Chorea

-Hereditary (Huntington's chorea)
-Rheumatic fever (Sydenham's chorea)



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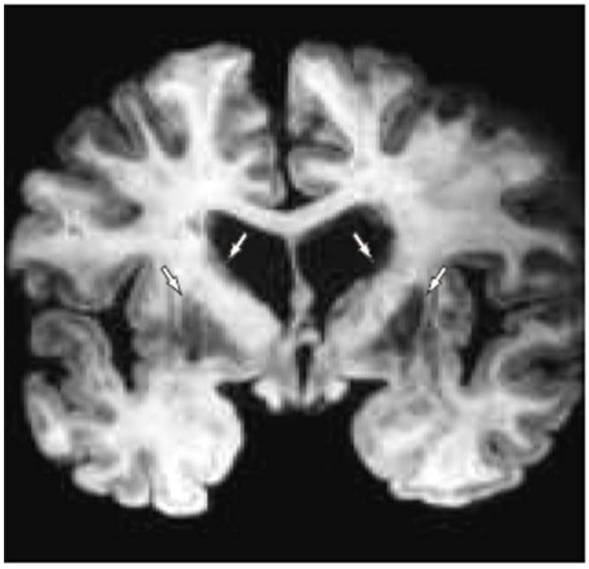
Huntington's disease



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Parkinsonism

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FAMOUS PEOPLE WITH PARKINSON'S DISEASE

Muhammad Ali was one of America's favorite boxers of all times

Mao Zedong - (1893-1976) Chinese military and political leader

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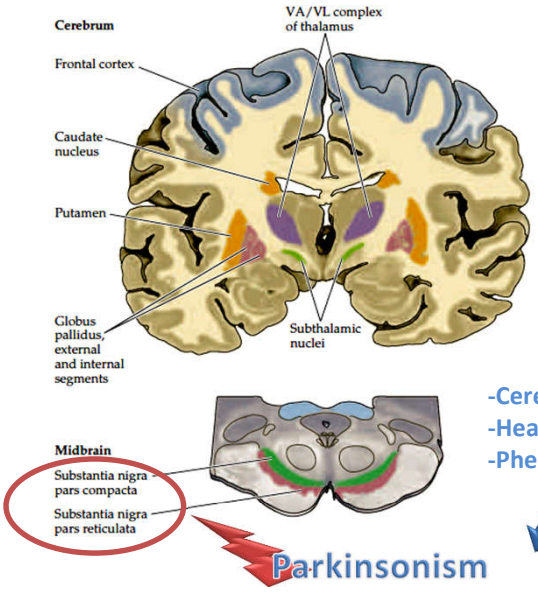
Diseases of the basal ganglia in human



-Cerebral atherosclerosis.
-Head Trauma.
-Phenothiazine drugs

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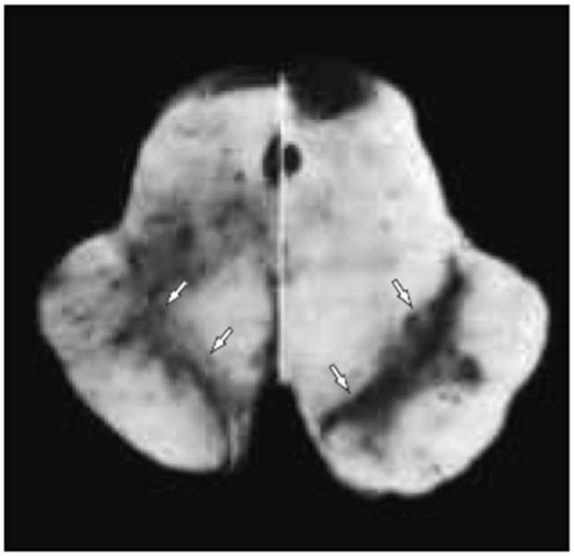
Parkinson's disease



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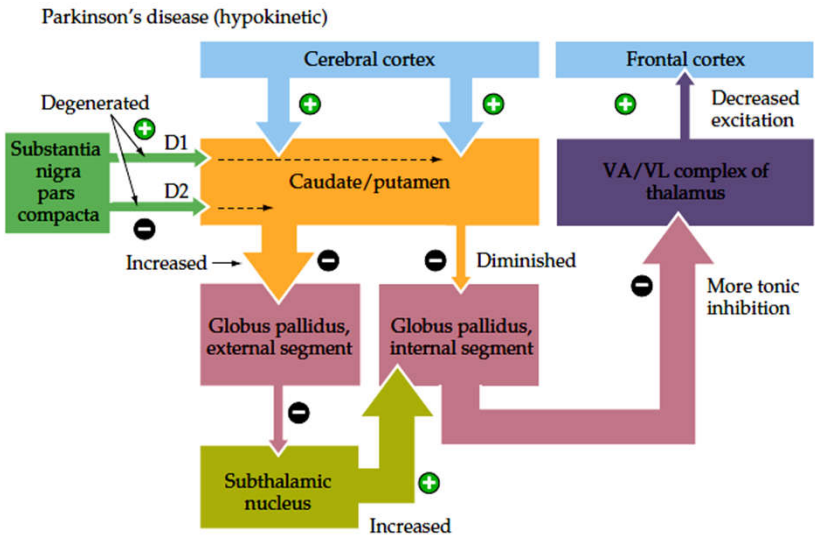

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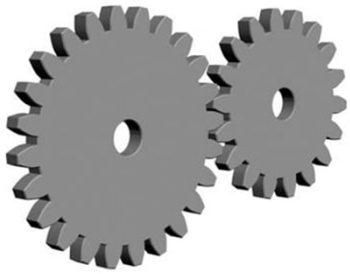
Characters of Parkinson's disease

- Rigidity (Cogwheel or lead pipe rigidity)



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Cogwheel rigidity

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Lead pipe rigidity

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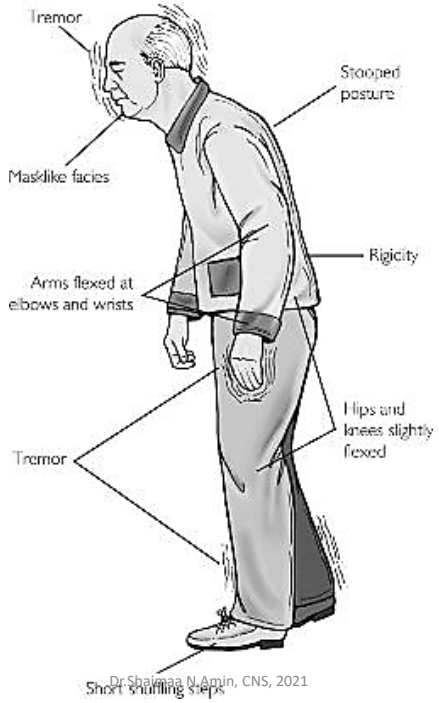

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Treatment of Parkinson's disease

- L-dopa.
- Anticholinergic drugs.
- Surgical treatment.
- High frequency stimulation of sub thalamic nucleus

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Athetosis

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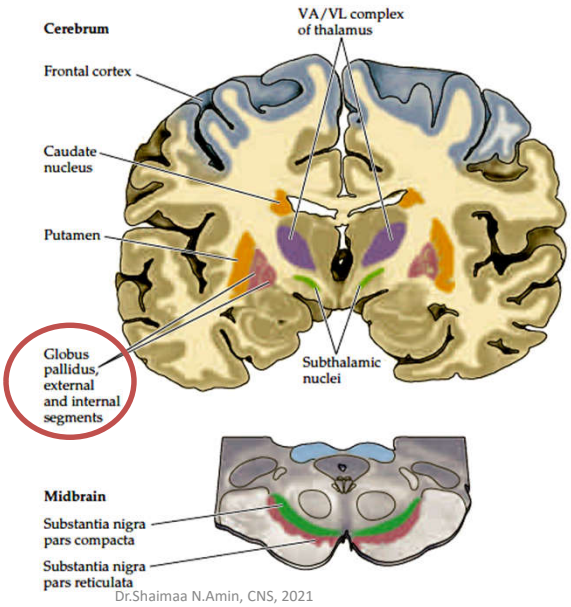
Diseases of the basal ganglia in human

Wilson's disease

Athetosis



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Ballism

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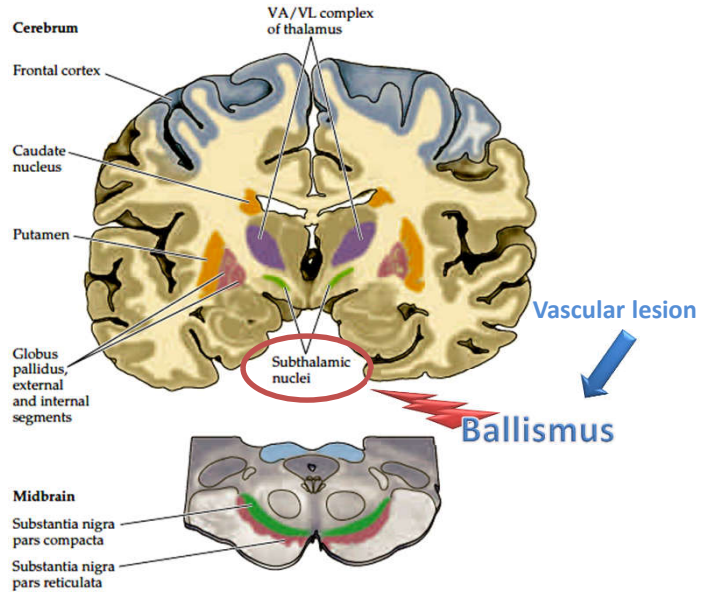
Diseases of the basal ganglia in human



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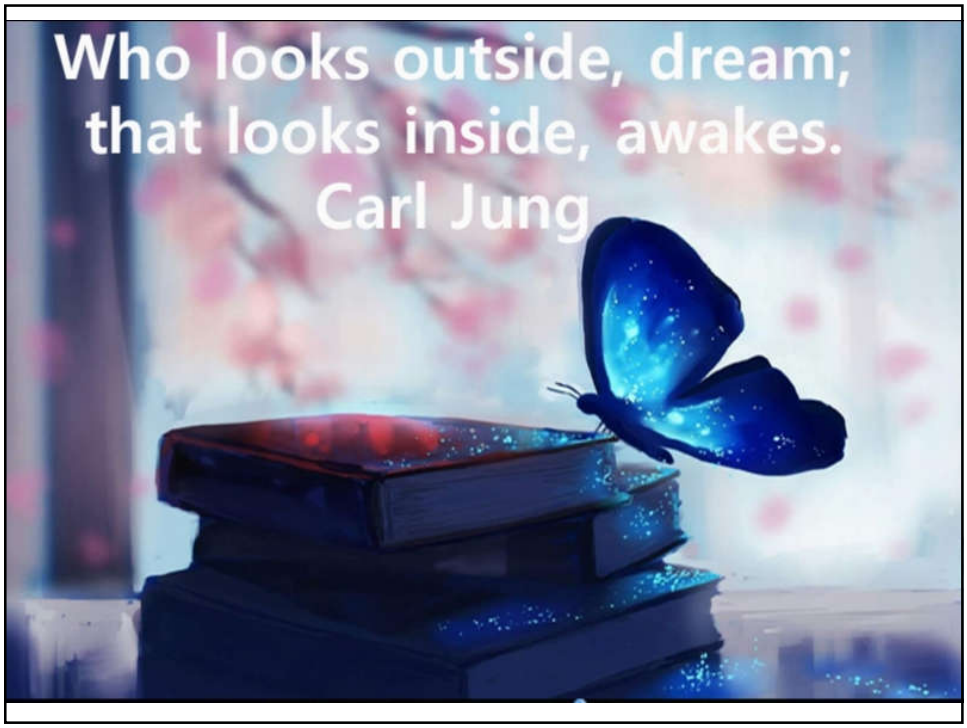

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