Basal Ganglia

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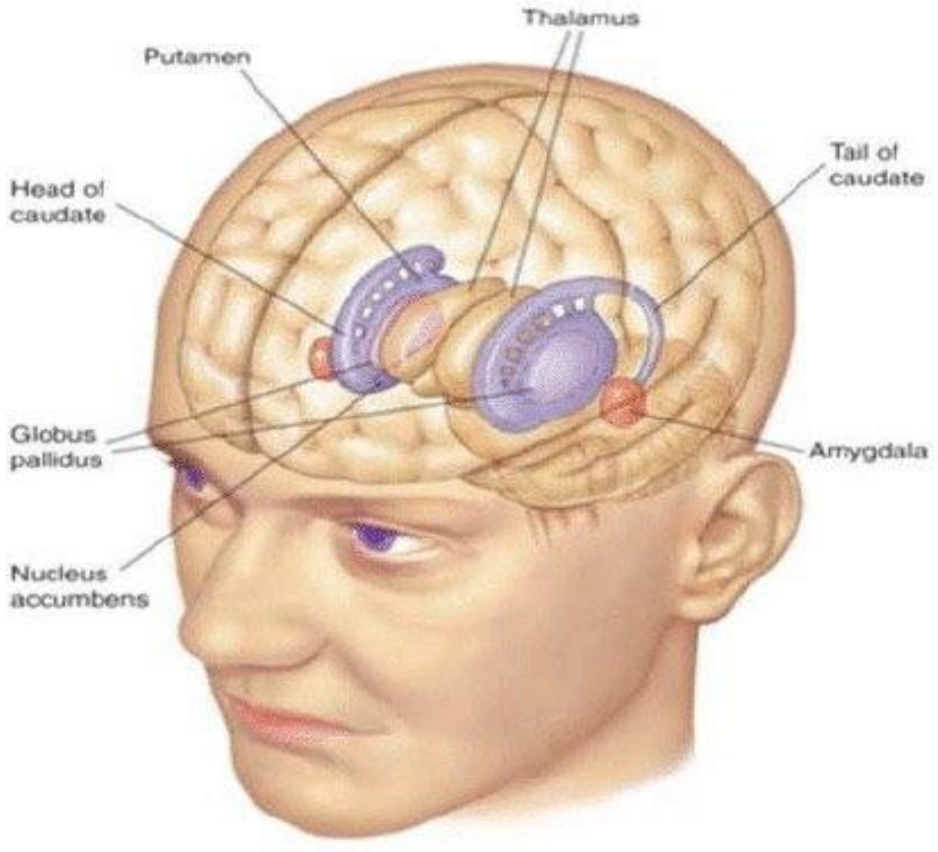
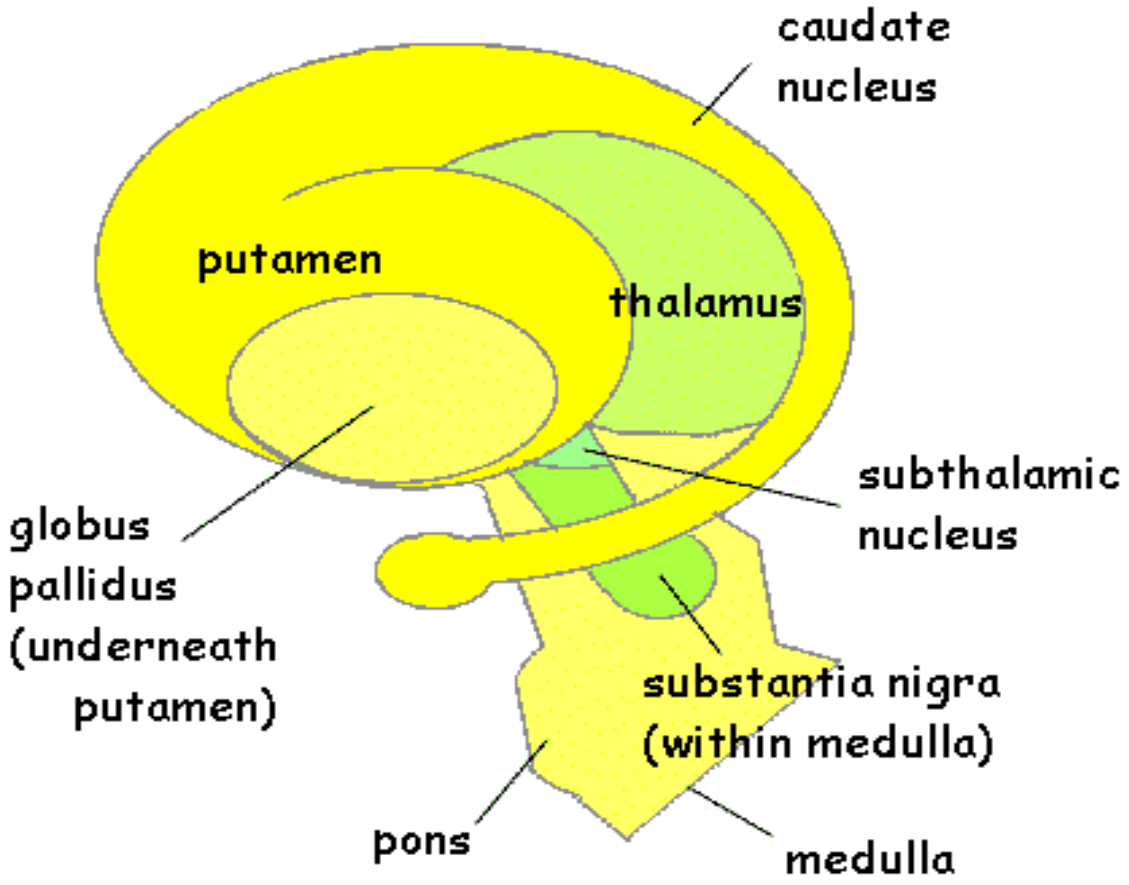
Objectives

1. What is basal ganglia?
2. Neural circuitry of basal ganglia
   - putamen circuit.
   - caudate circuit.
3. Functions.
4. Basal Ganglia neurotransmitter.
5. Clinical abnormalities.

Basal Ganglia



Basal Ganglia



- subcortical multinucleated structure, located deeply occupying a large portion of the interior regions of both cerebral hemispheres
- It is considered as an accessory motor system that functions usually not by itself but in close association with the cerebral cortex and corticospinal motor control system.
- the basal ganglia receive most of their input signals from the cerebral cortex and also return almost all their output signals back to the cortex.

NEURONAL CIRCUITRY OF THE BASAL GANGLIA

The anatomical connections between the basal ganglia and the other brain elements that provide motor control are complex,

- 2 anatomical connections within BG

One with motor cortex, thalamus, and associated brain stem and cerebellar circuitry.

And the second is the major circuitry of the basal ganglia system, showing the tremendous interconnections among the basal ganglia plus extensive input and output pathways between the other motor regions of the brain and the basal ganglia

Two major circuits:

- putamen circuit
- caudate circuit

Neural Pathways of the Putamen Circuit

premotor and supplementary areas of the motor cortex and in the somatosensory areas of the sensory cortex.

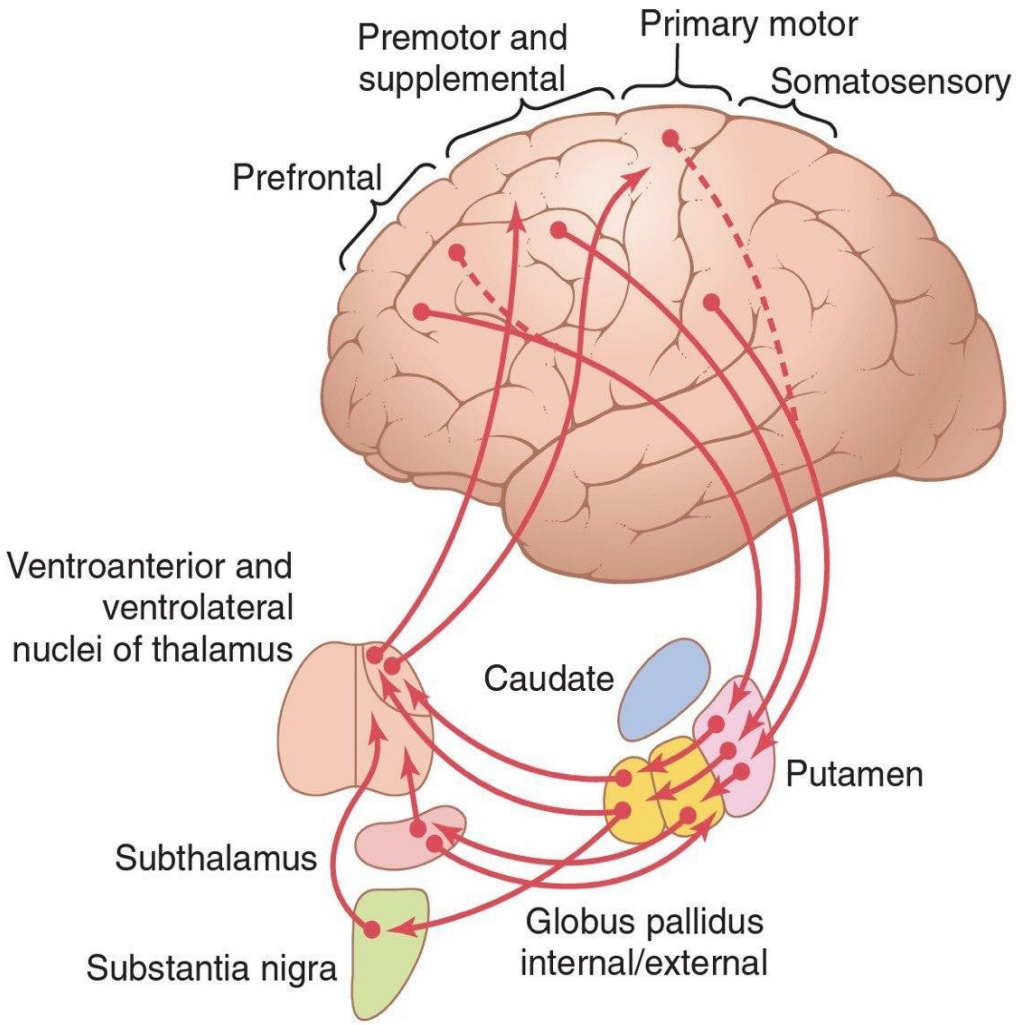
Putamen nucleus

Internal portion of the globus pallidus,

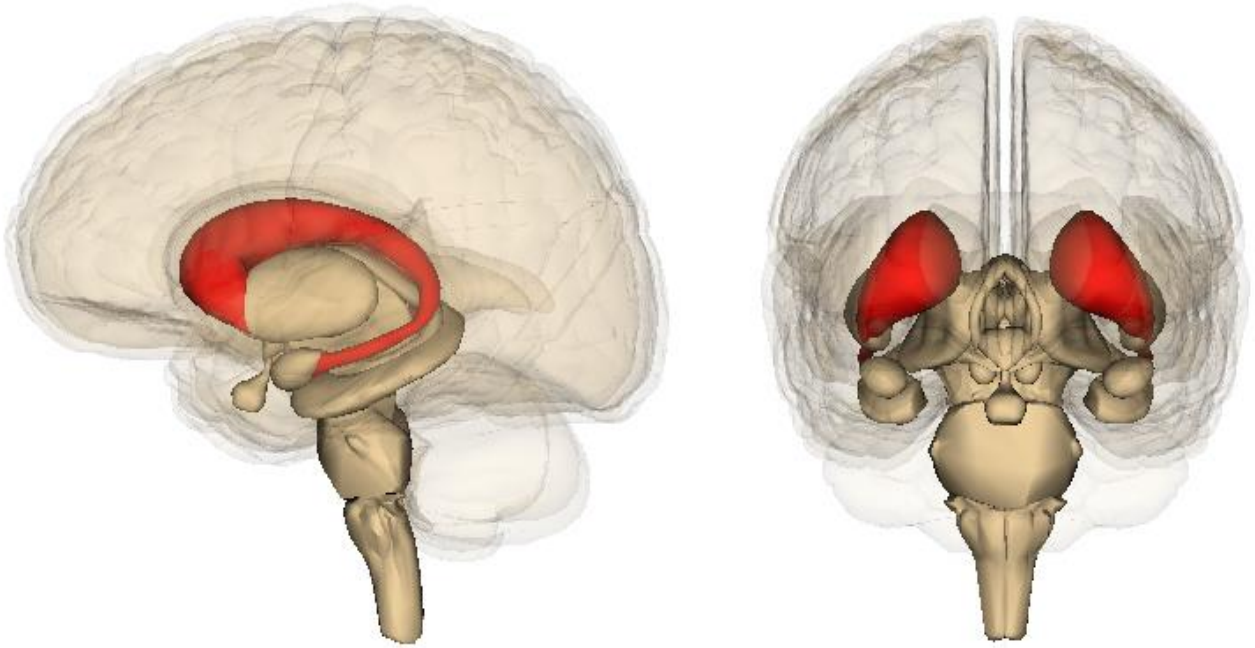
ventroanterior and ventrolateral relay nuclei of the thalamus

cerebral primary motor cortex to portions of the premotor and supplementary cerebral areas

Putamen circuit

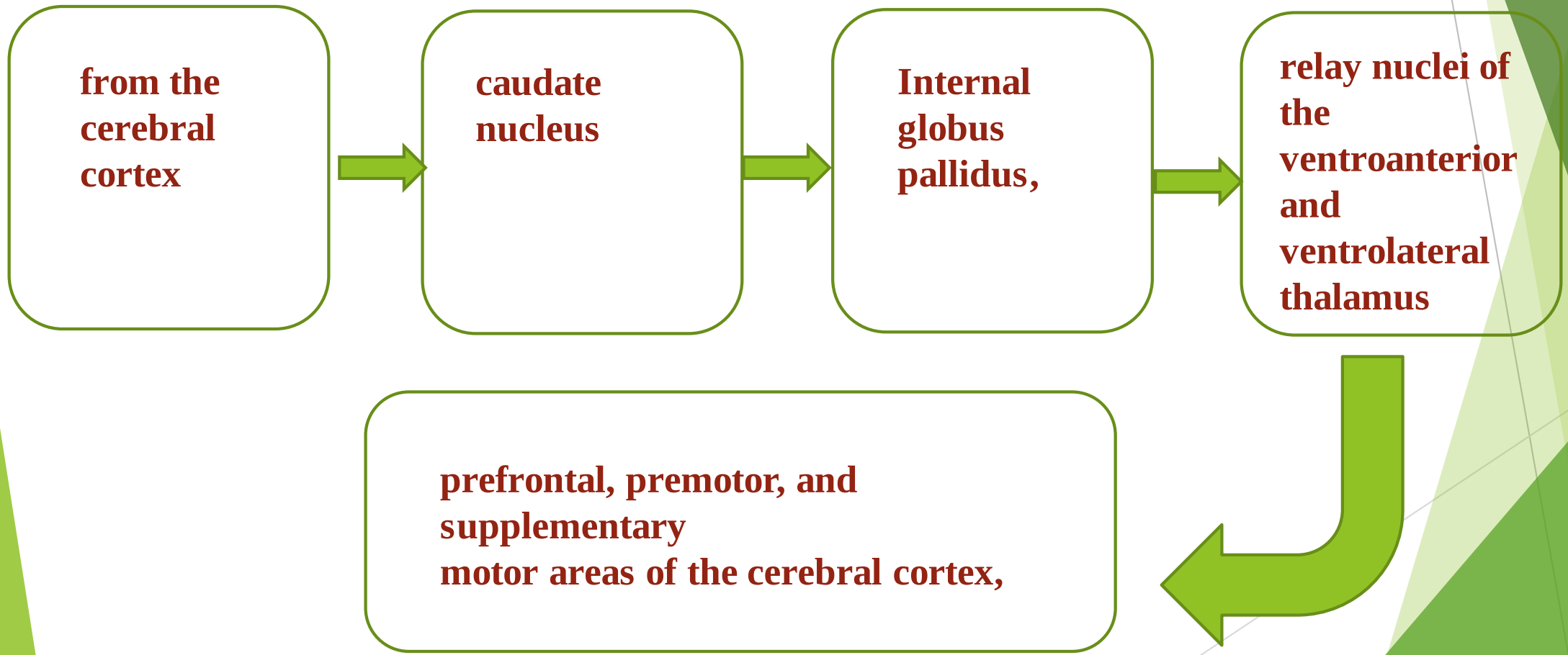


Caudate Nucleus

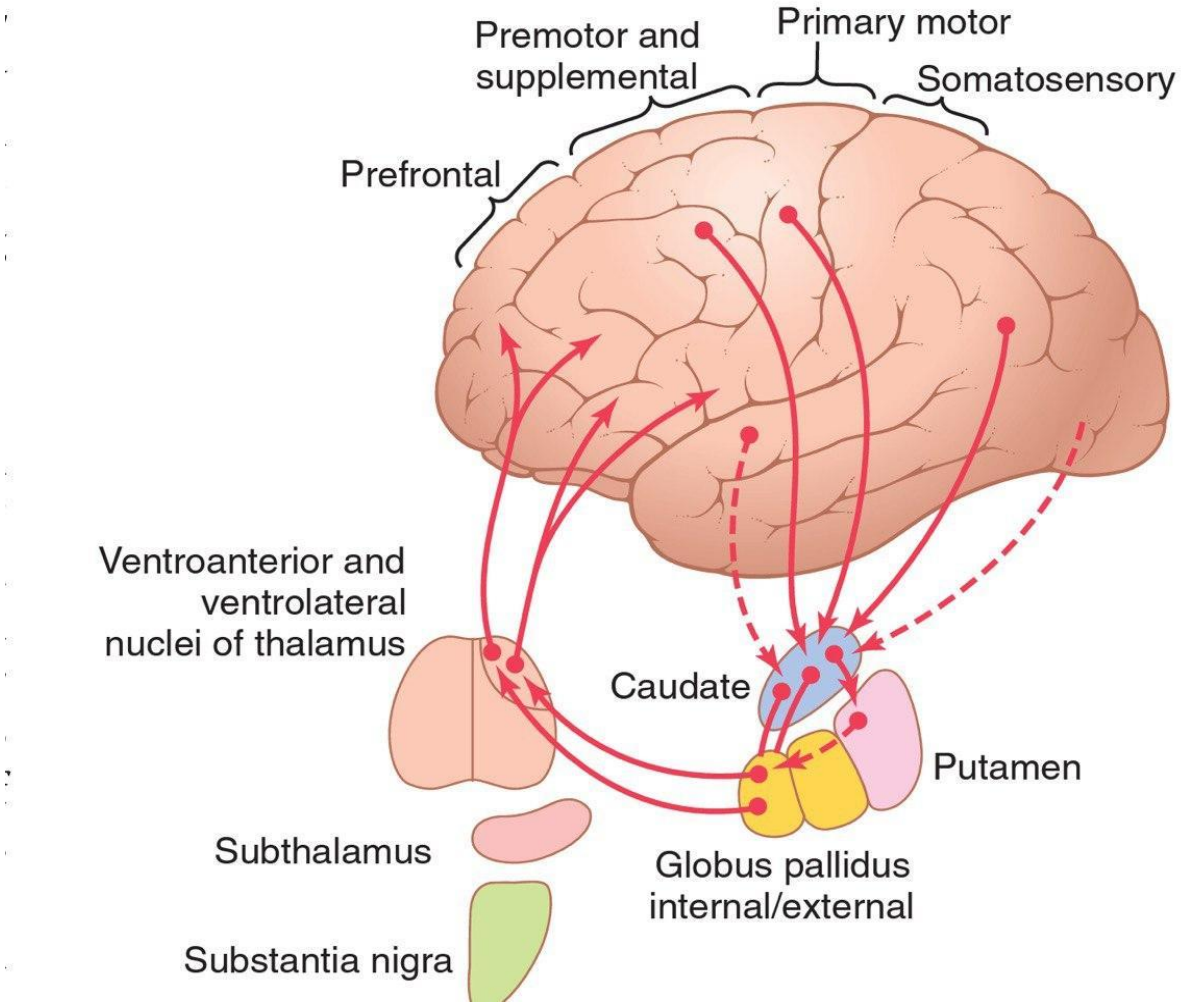


- caudate nucleus, extends into all lobes of the cerebrum, beginning anteriorly in the frontal lobes, then passing posteriorly through the parietal and occipital lobes, and finally curving forward again like the letter “C” into the temporal lobes.

Caudate circuit



Caudate Circuit



- The caudate nucleus plays a major role in the cognitive control of motor activity.

- The term cognition means the thinking processes of the brain, using both sensory input to the brain plus information already stored in memory.
- Most of our motor actions occur as a consequence of thoughts generated in the mind, a process called cognitive control of motor activity.

Basal Ganglia (Change Timing and Scale Intensity of Movements)

- Brain is capable to control movement by:

I. Determine how rapidly movement is to be performed

II. Control how large movement will be.

- **Example**: a person may write letter "a" slowly or rapidly. Also, may write a small "a" on a piece of paper or a large "a" on a chalkboard. Regardless of choice, proportional characteristics of letter remain nearly same.

- An example is the writing of letters of the alphabet. When the basal ganglia sustain serious damage, the cortical system of motor control can no longer provide these patterns. Instead, one's writing becomes crude, as if one were learning how to write for the first time.

- Other patterns that require the basal ganglia are cutting paper with scissors, hammering nails, shooting a basketball through a hoop, passing a football, throwing a baseball.

Basal Ganglia neurotransmitter

A. Dopamine pathway from substantia nigra to caudate nucleus & putamen **(inhibitory)**.

B. GABA pathway from caudate nucleus and putamen to globus pallidus and substantia nigra **(inhibitory)**.

A. ACh pathway from cortex to caudate nucleus and putamen.

D. Multiple general pathways from brainstem (secrete norepinephrine, serotonin, enkephalin and several other neurotransmitters).

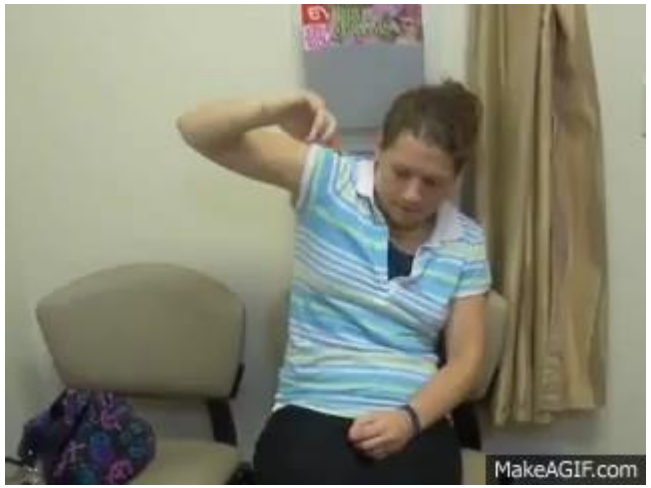
E. Multiple glutamate pathways provide most of **excitatory** signals.

Clinical abnormalities

- **Chorea** is an abnormal involuntary movement derived from the Greek word "dance". It is characterized by brief, abrupt, irregular, unpredictable, non-stereotyped movements.
- Due to lesion in caudate nucleus

- Athetosis: slow, involuntary, convoluted, writhing movements of the fingers, hands, toes, and feet and in some cases, arms, legs, neck and tongue.
- Due to lesion in Globus pallidus

- Hemiballismus it is flailing, ballistic, undesired movements of the limbs.
- lesion in subthalamic nucleus



Lesion in substantia nigra

- Parkinson's disease, which is also known as paralysis agitans, results from destruction of the portion of the substantia nigra that sends dopamine-secreting nerve fibers to the caudate nucleus and putamen. The disease is characterized by

(1) rigidity of much of the musculature of the body.

(2) involuntary tremor

- (3) difficulty in initiating movement, called Hypokinesia or Akinesia.

Recap

1. subcortical multinucleated structure, located deeply occupying a large portion of the interior regions of both cerebral hemispheres

2. the basal ganglia receive most of their input signals from the cerebral cortex and also return almost all their output signals back to the cortex.

putamen circuit

caudate circuit

3. Its act by Change Timing and Scale Intensity of Movements

4. Multiple types of neurotransmitter (excitatory, inhibitory

5. Clinical abnormalities.

Thank You