

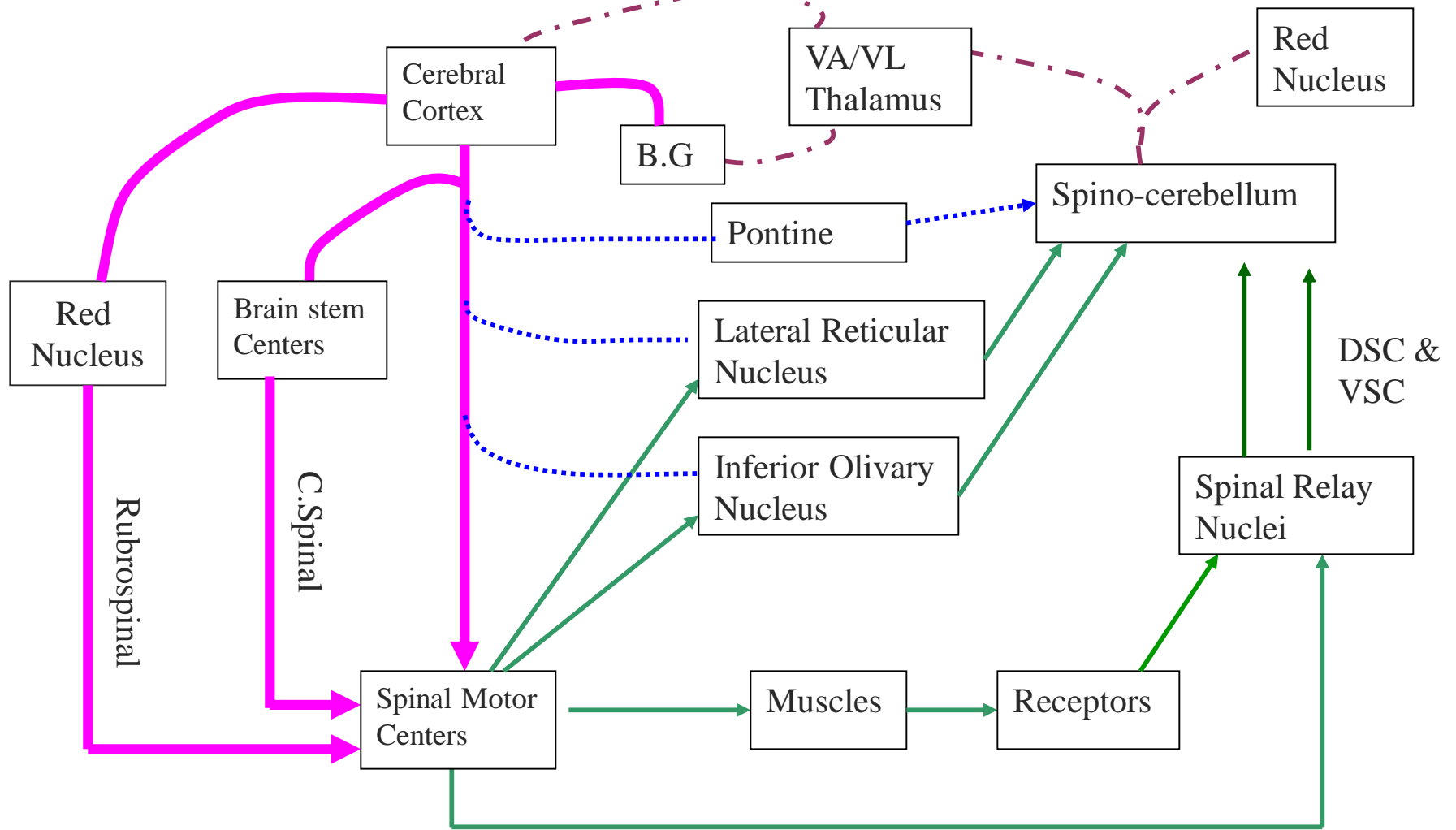


Basal Ganglia and Motor Control

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[Objectives]

- ☺ Recognize the basal ganglia system and name its parts
- ☺ Describe how the basal ganglia system works toward control of motor movements
- ☺ Identify basal ganglia abnormalities

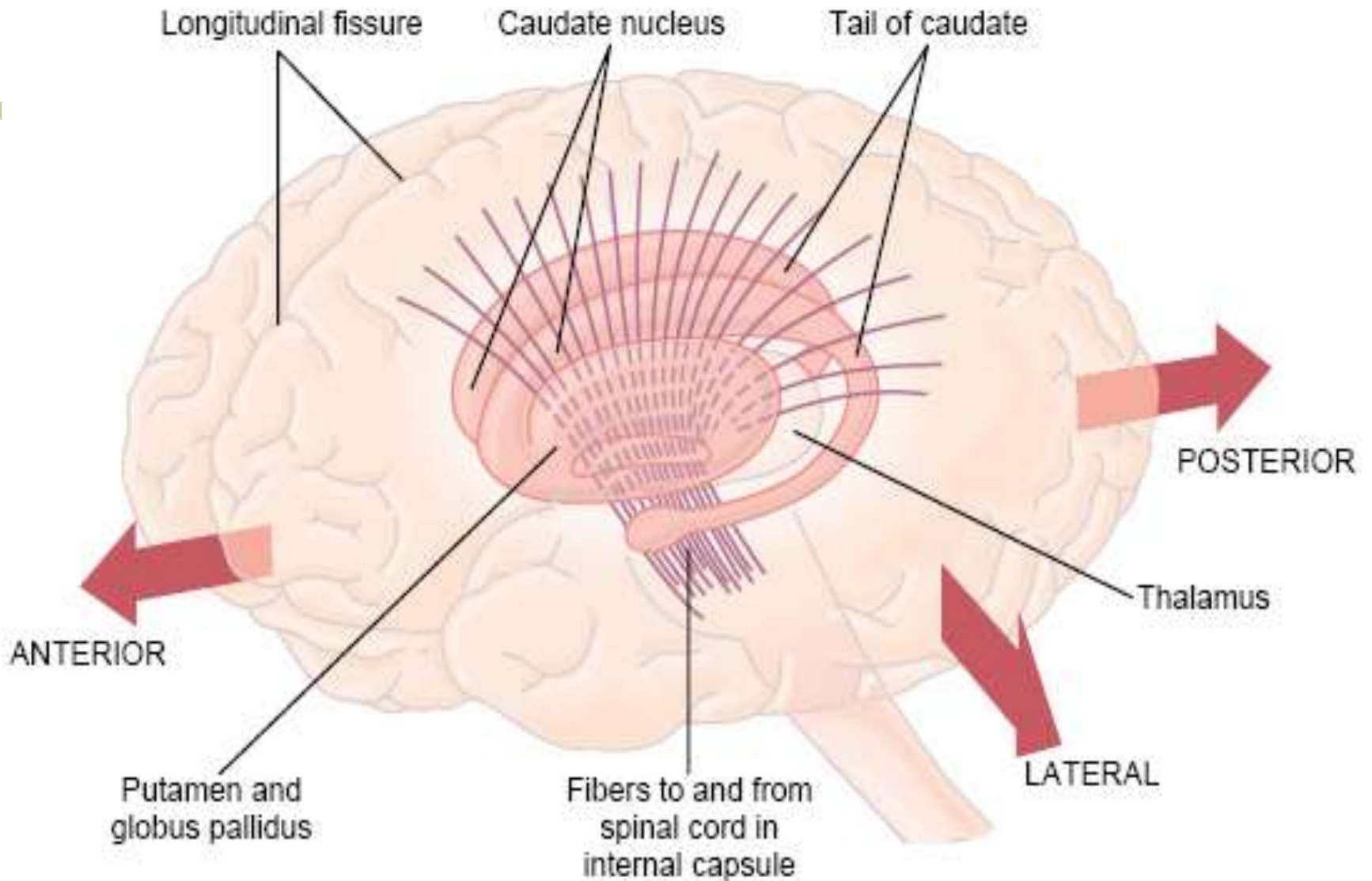


-  Motor Command
-  Feed Back
-  Command Monitor
-  Corrective Command

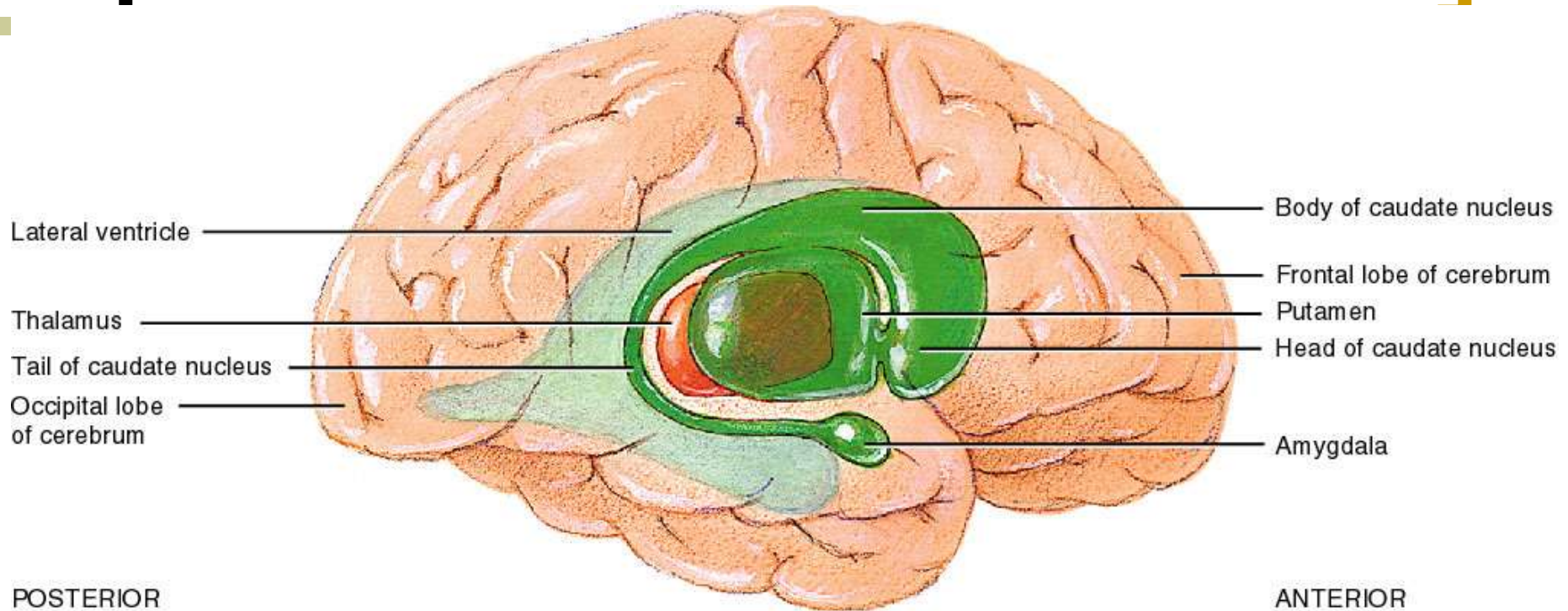
Motor System

[Basal Ganglia System]

- Consist of Four Nuclei
- striatum
 - caudate and putamen
- globus pallidus
- substantia nigra
- subthalamus



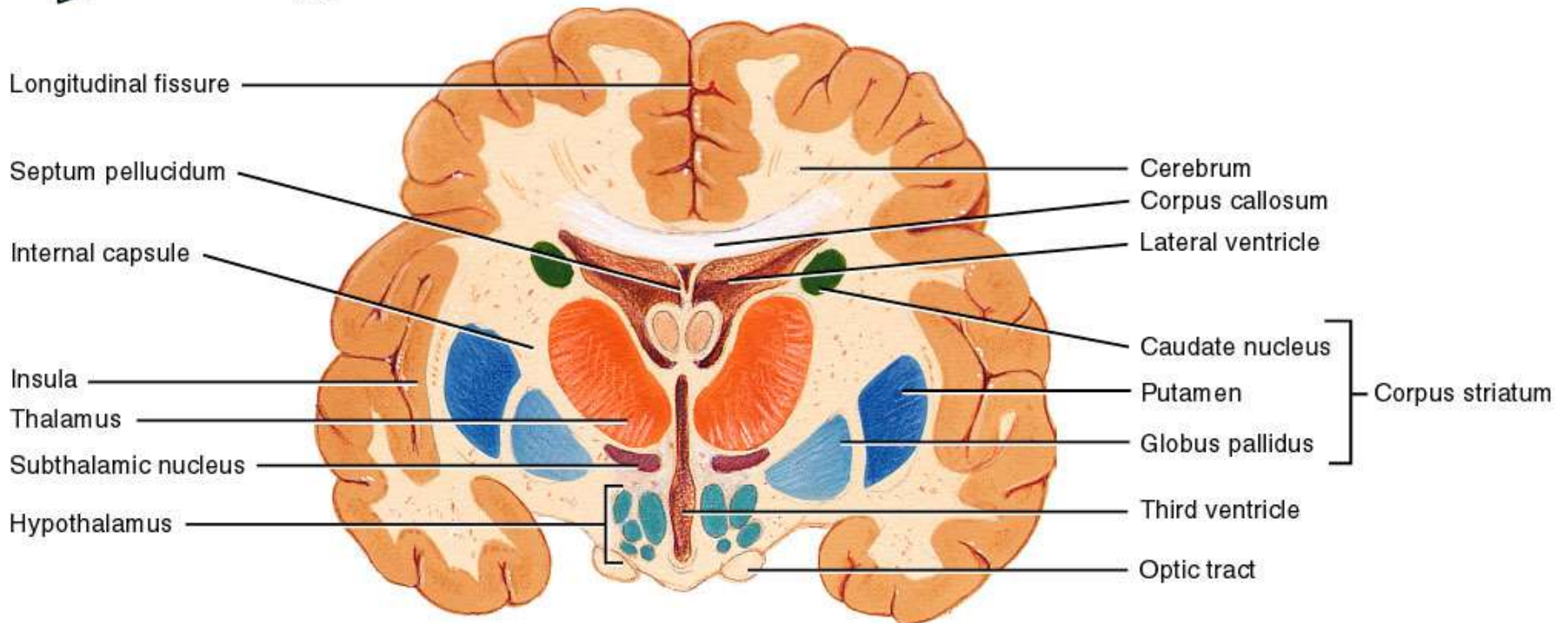
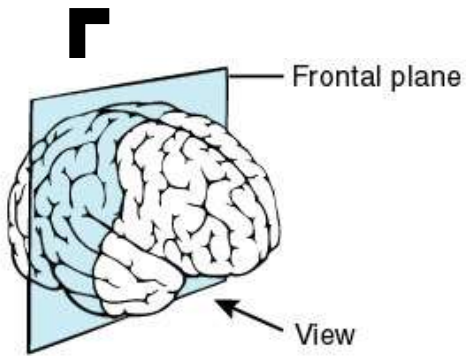
Basal Ganglia



(a) Lateral view of right side of brain

14.13a

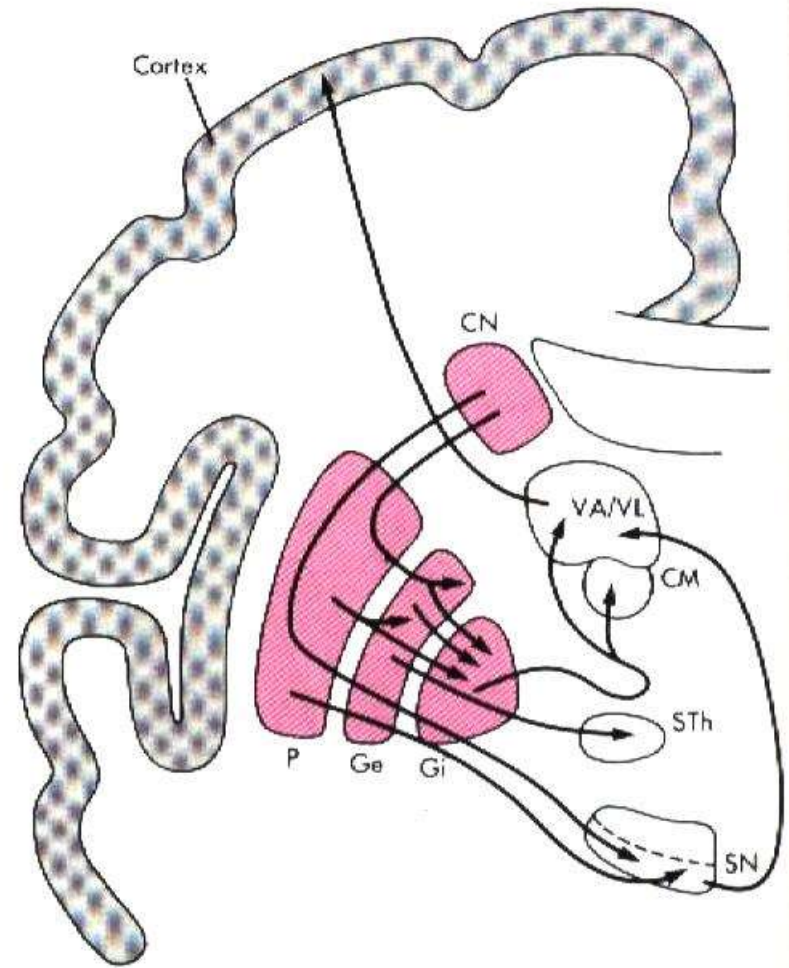
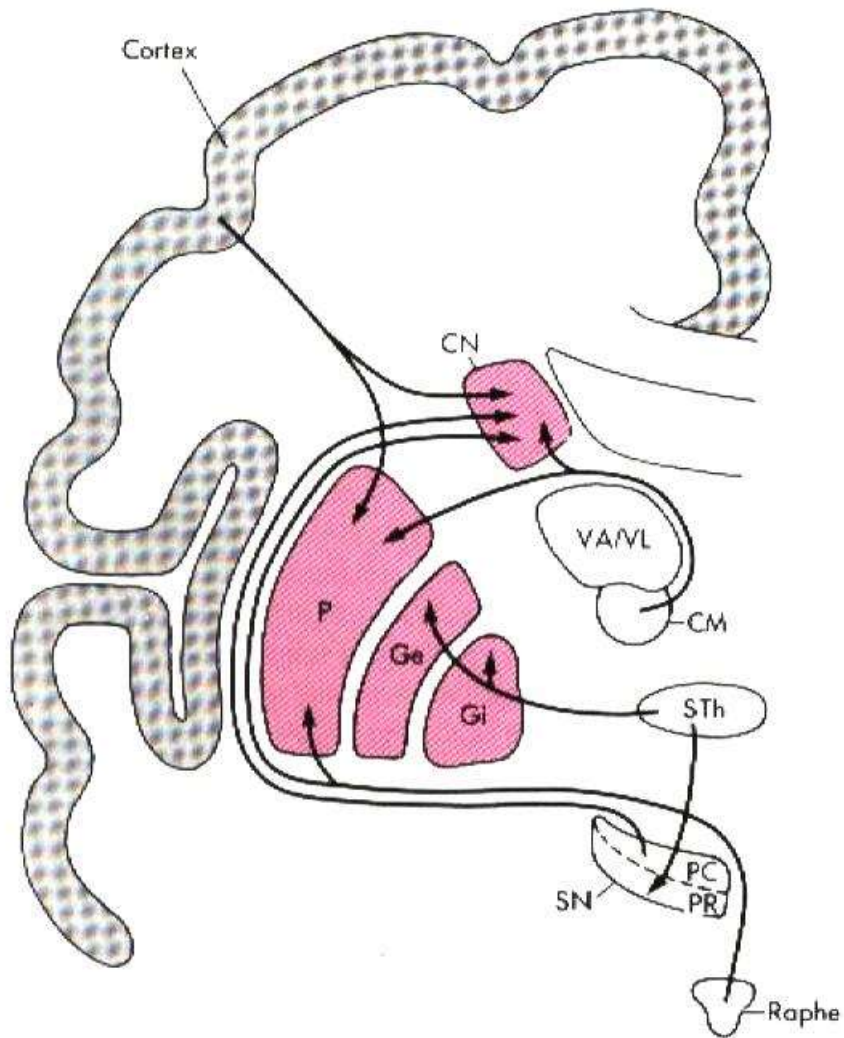
Basal Ganglia



(b) Anterior view of frontal section

14.13b

Basal ganglia Afferents and Efferents



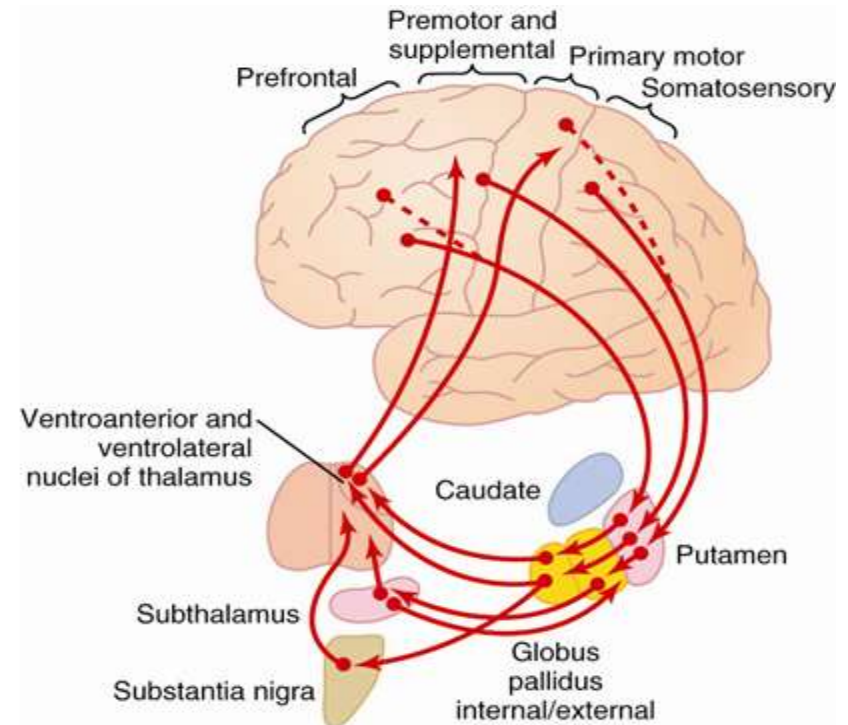
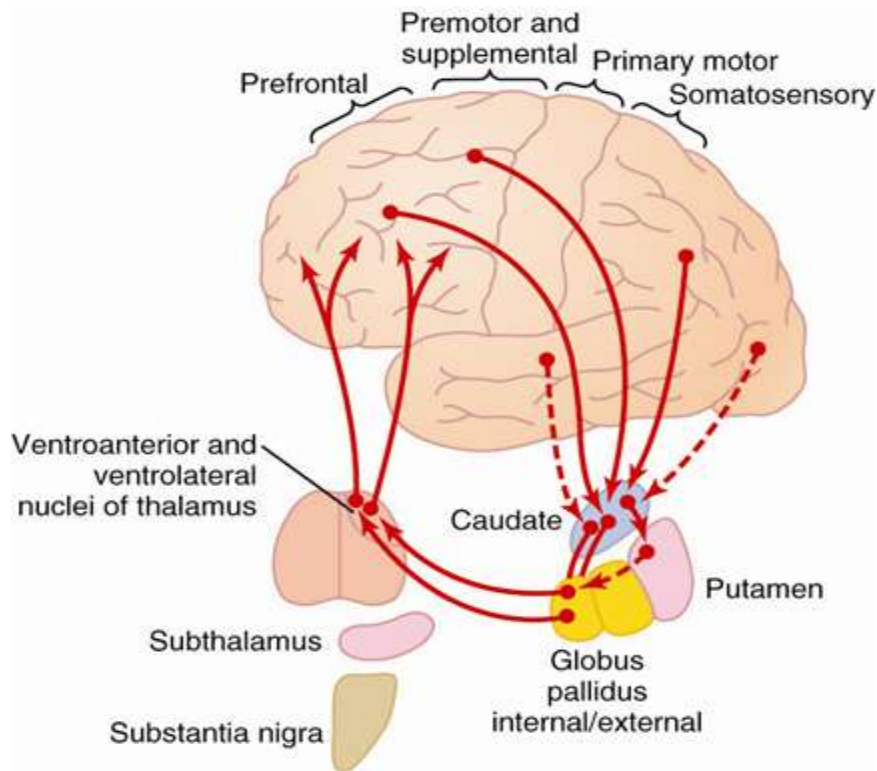
Basal ganglia Afferents

- Afferents:
 - Cerebral cortex to caudate and putamen
 - Substantia nigra pars compacta to putamen and caudate
 - Subthalamic nucleus to globus pallidus and to substantia nigra pars reticulata
 - Centromedial nucleus of the thalamus to putamen and caudate
 - Raphe magnus nucleus to putamen and caudate

Basal ganglia Efferents

- Efferents:
 - Putamen and caudate to globus pallidus
 - Putamen and caudate to substantia nigra pars reticularis
 - Globus pallidus to subthalamic nucleus
 - Globus pallidus to ventroanterio and ventrolateral nuclei of the thalamus

The basal ganglia are the principle subcortical components of a family of parallel circuits linking the thalamus with the cerebral cortex



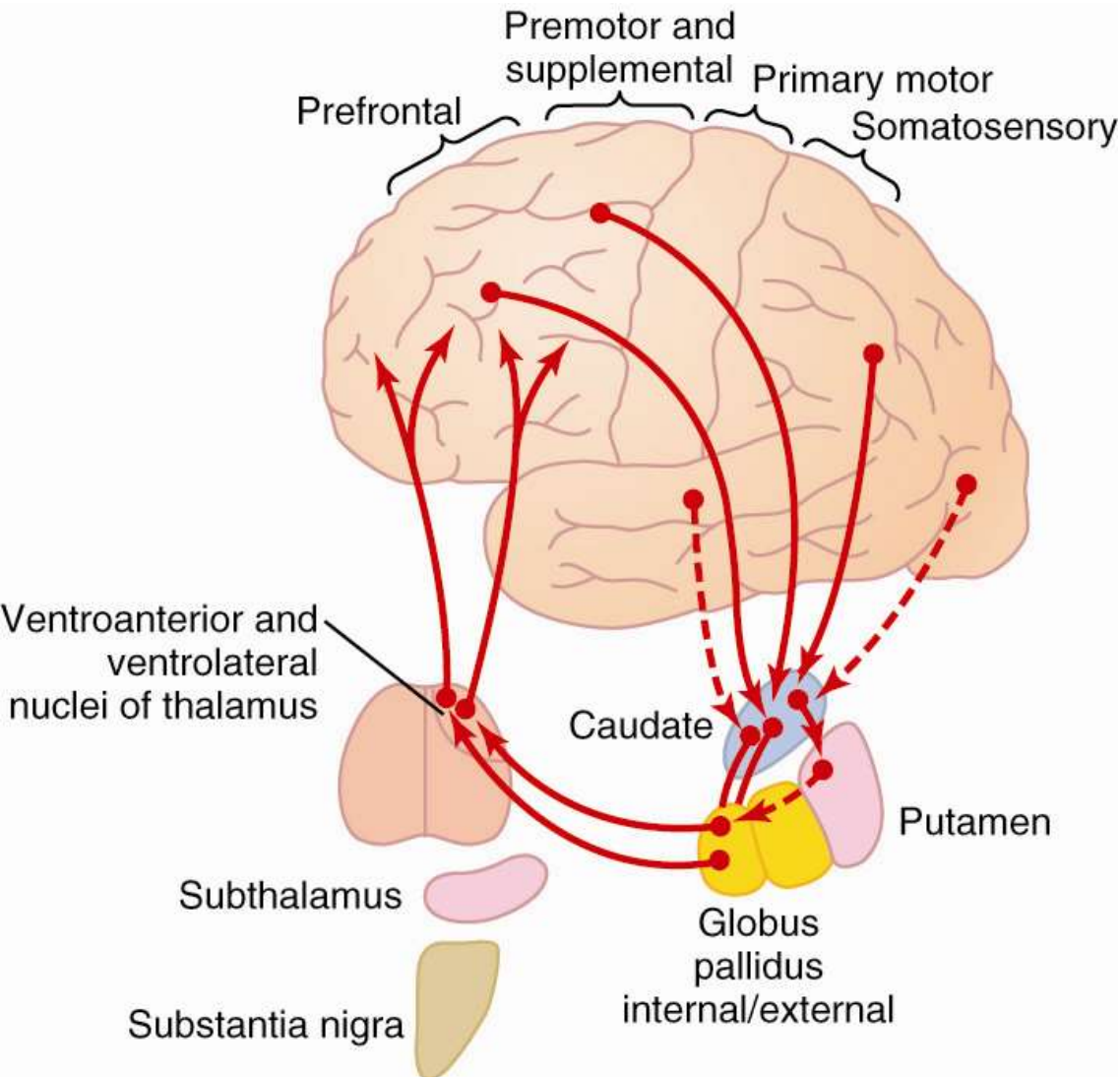
Motor Function of the Basal Ganglia

- control of *complex patterns* of motor activity
 - writing
 - using scissors
 - throwing balls
 - shoveling dirt
 - some aspects of vocalization

Function of the Basal Ganglia?

- not much is known about the specific functions of each of these structures
- thought to function in *timing and scaling* of motion and in the **initiation of motion**
- most information comes from the result of damage to these structures and the resulting clinical abnormality

Caudate Circuit

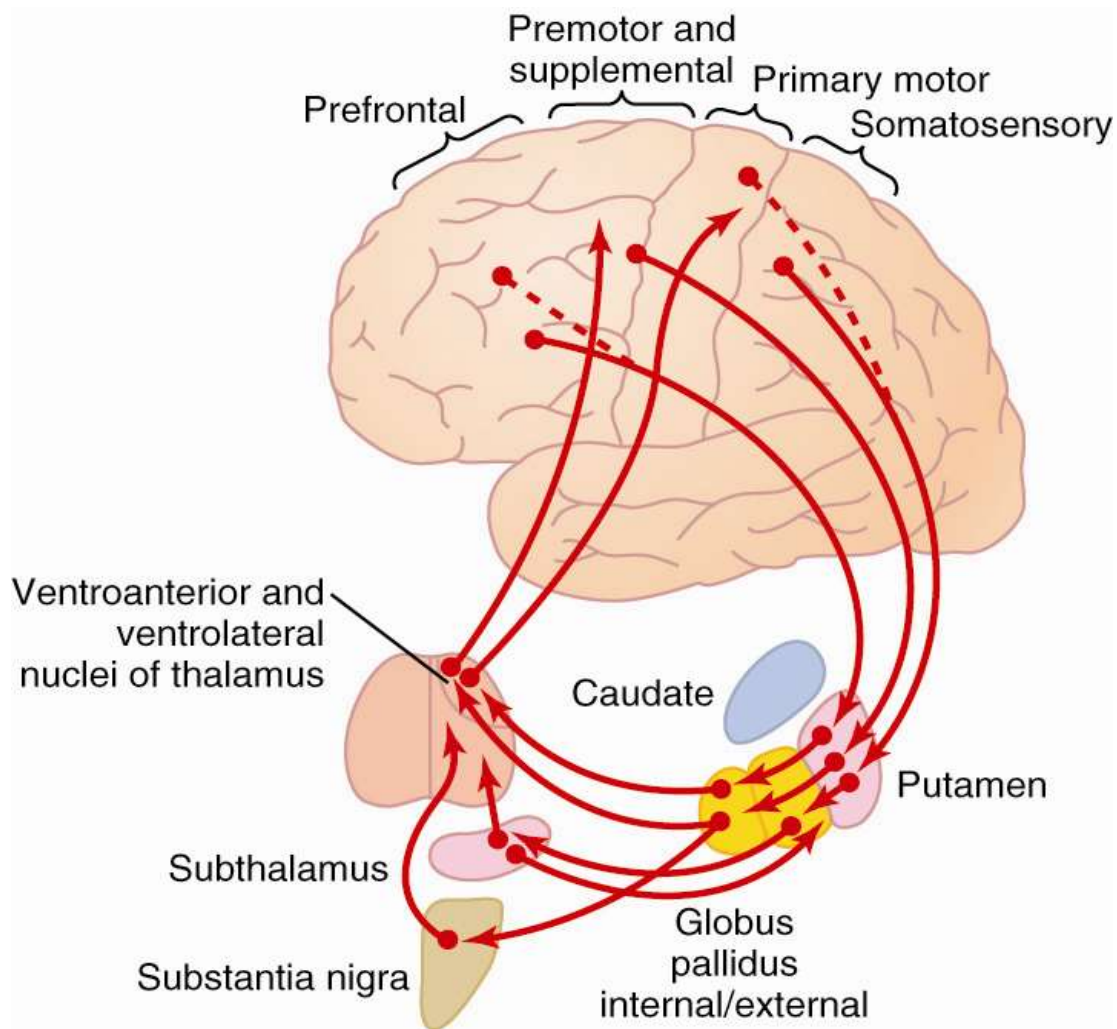


Caudate extends into all lobes of the cortex and receives a large input from association areas of the cortex

Mostly projects to globus pallidus, no fibers to subthalamus

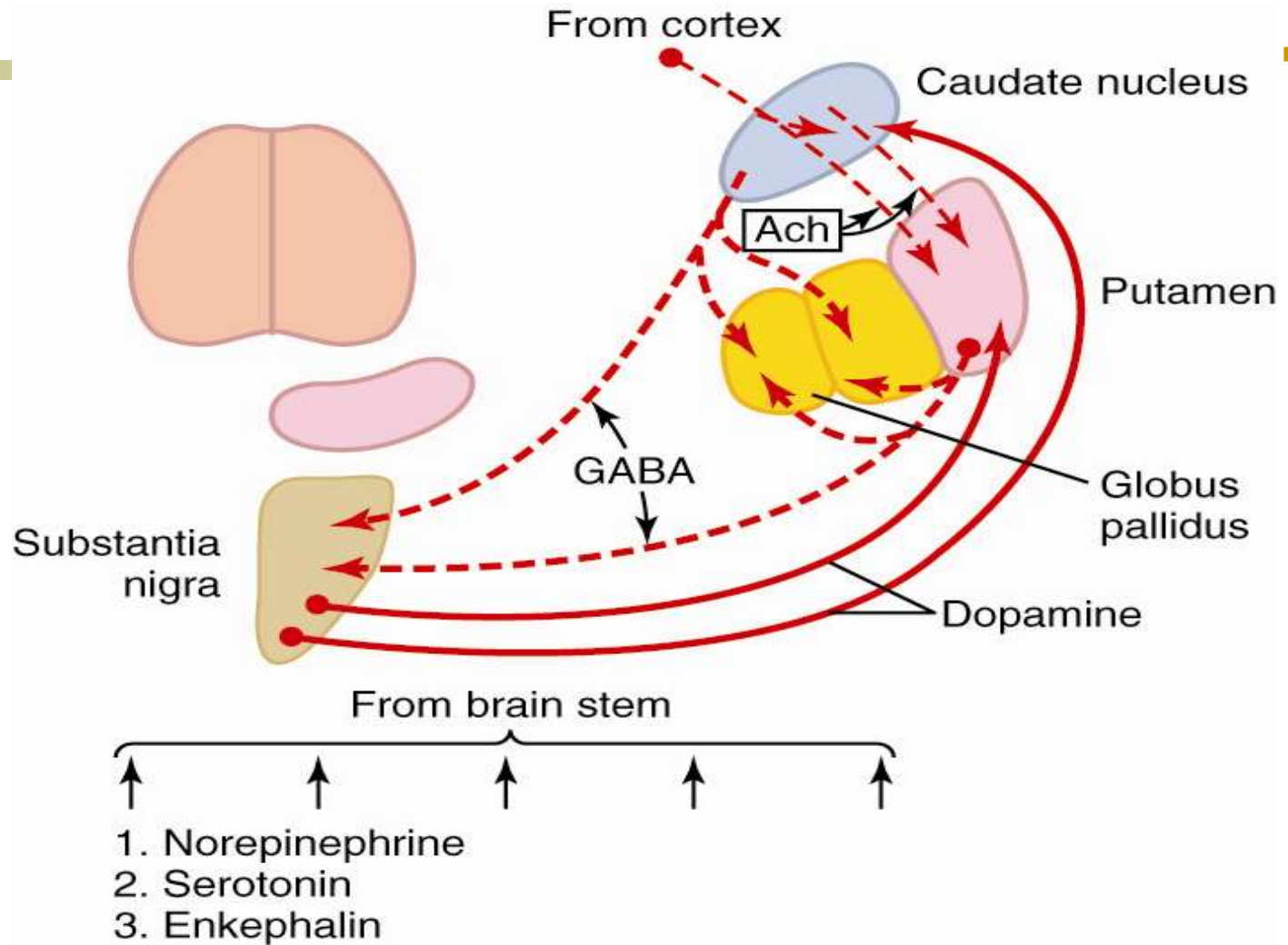
Most motor actions occur as a result of a **sequence of thoughts**. Caudate circuit may play a role in the **cognitive control of motor functions**

Putamen Circuit

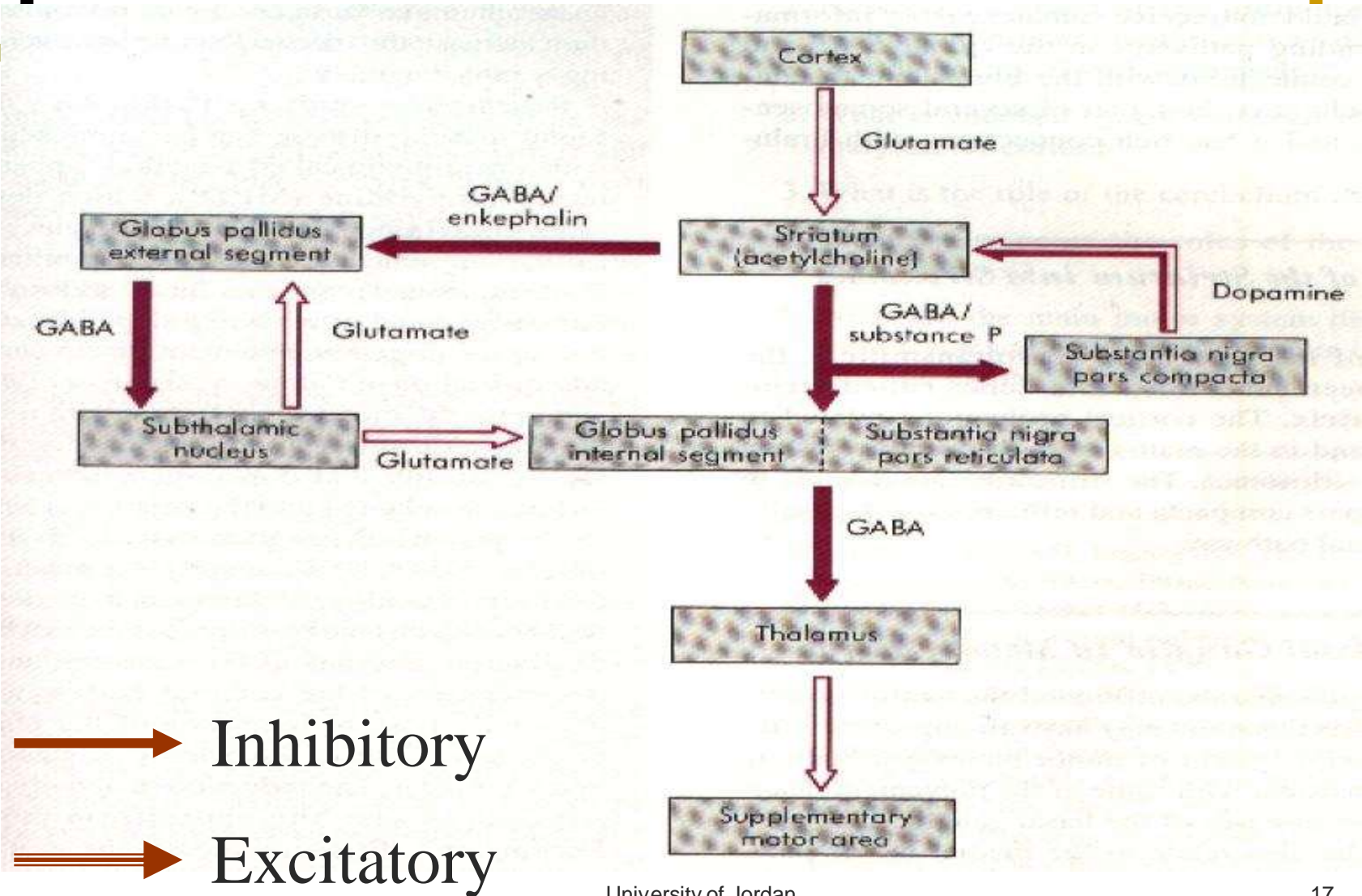


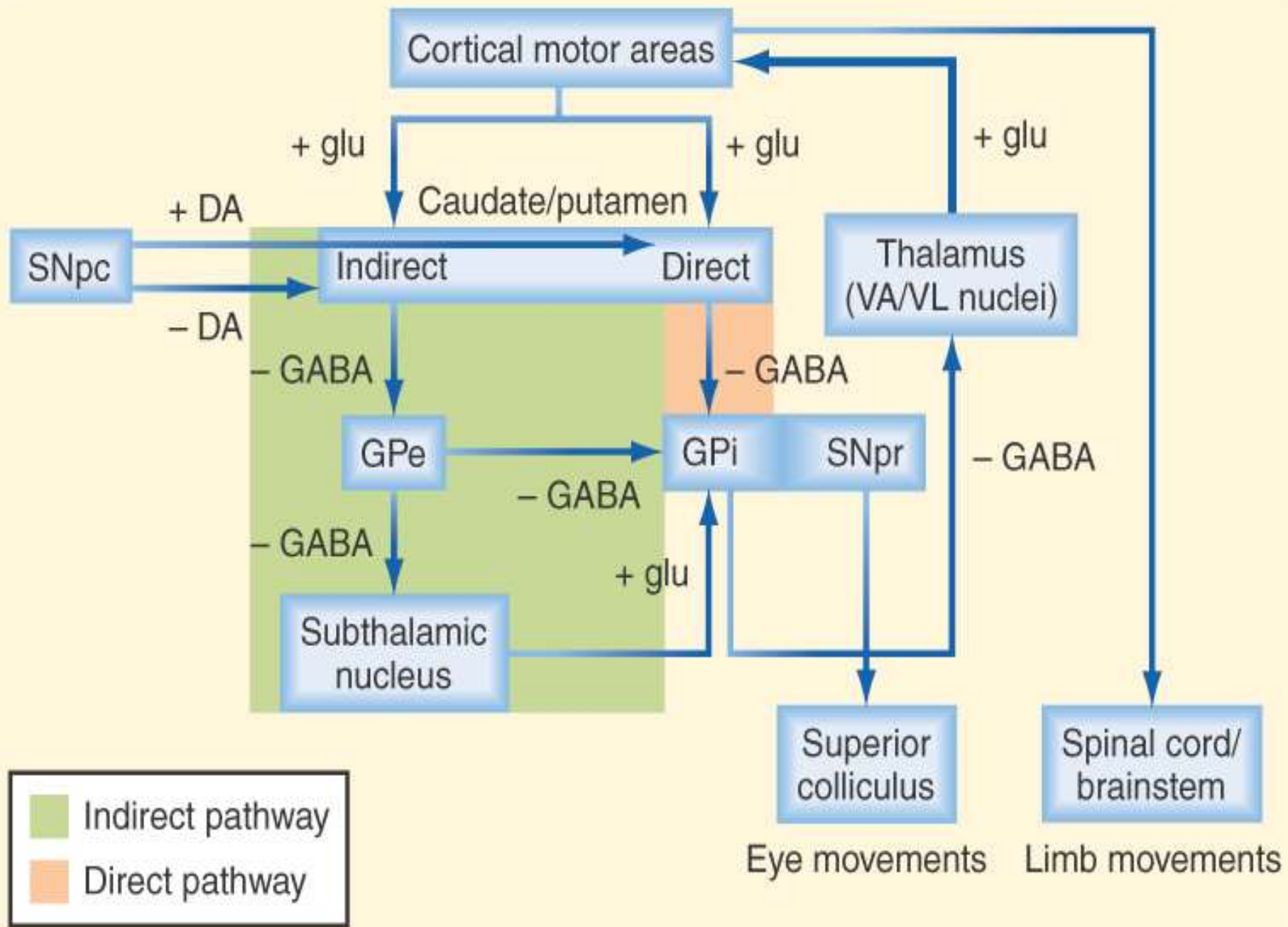
Mostly from premotor and supplemental motor cortex to putamen then back to motor cortex.

Neurotransmitters in the Basal Ganglia



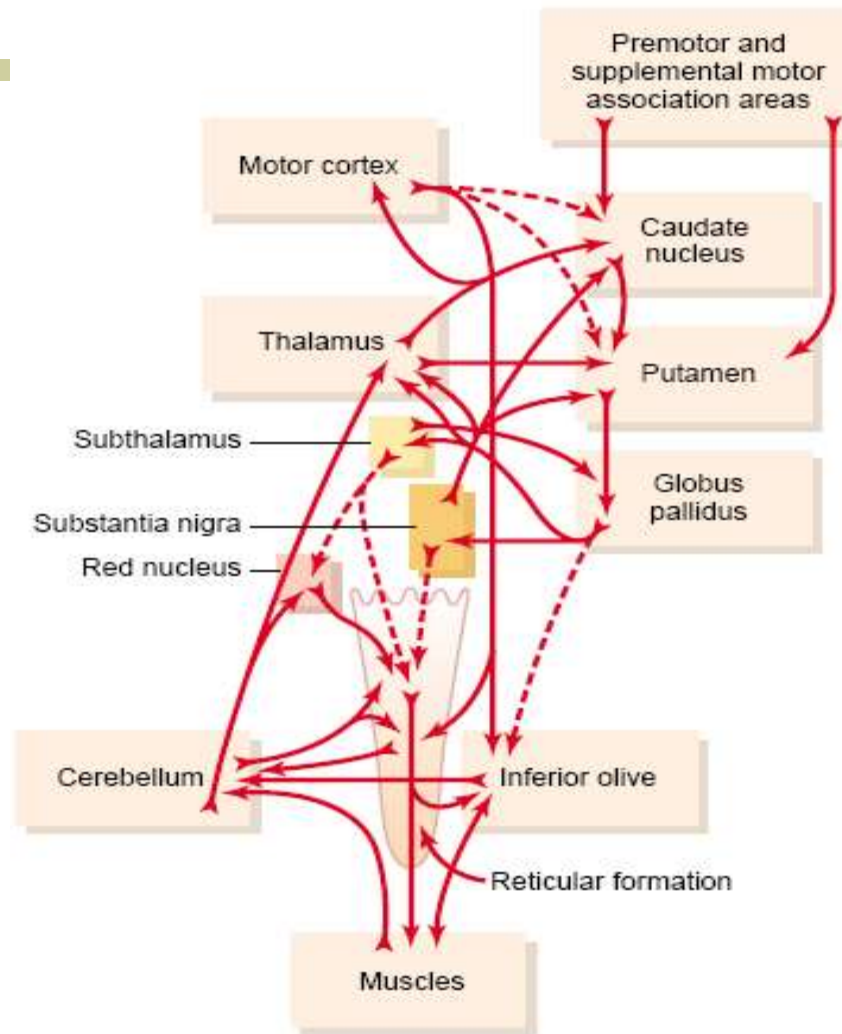
Basal Ganglia circuits and Neurotransmitters





A

Motor control of the Basal Ganglia



Lesions of Basal Ganglia

- Globus pallidus
 - athetosis - spontaneous writhing movements of the hand, arm, neck, and face
- Putamen
 - chorea – involuntary flicking movements of the hands, face, and shoulders
- Substantia nigra
 - Parkinson's disease - **rigidity, resting tremor** and **akinesia**
 - loss of dopaminergic input from substantia nigra to the caudate and putamen

Lesions of Basal Ganglia

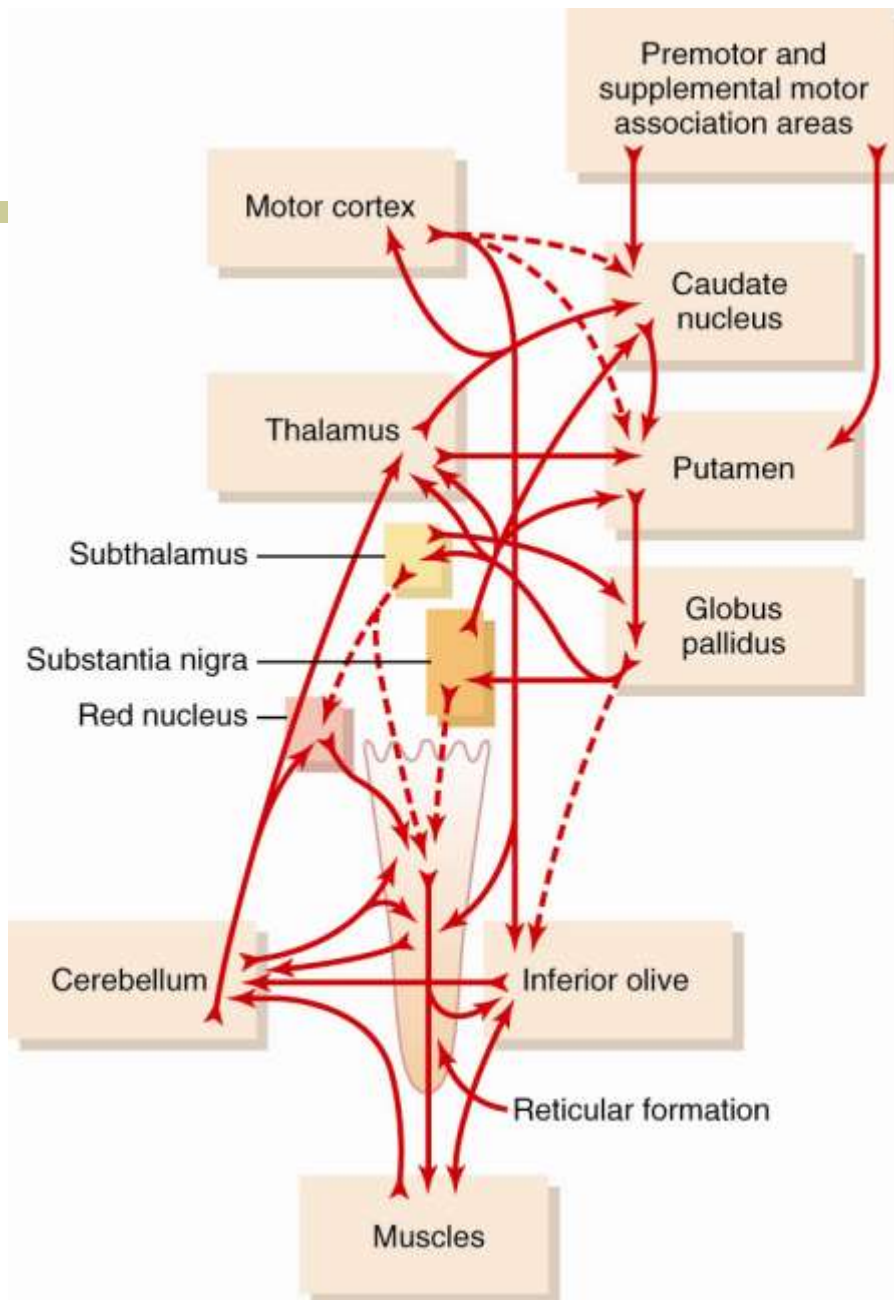
- Subthalamus
 - hemiballismus - sudden flailing movements of the entire limb
- Caudate nucleus and Putamen
 - huntington's chorea - loss of GABA containing neurons to globus pallidus and substantia nigra
- All signs and symptoms of basal ganglia diseases are **contralateral** to the lesion in contrast to cerebellar lesions which are **ipsilateral**

Integration of Motor Control

- Spinal cord level
 - preprogramming of patterns of movement of all muscles (i.e., withdrawal reflex, walking movements, etc.).
- Brainstem level
 - maintains equilibrium by adjusting axial tone
- Cortical level
 - issues commands to set into motion the patterns available in the spinal cord
 - controls the intensity and modifies the timing

Integration of Motor Control (cont'd)

- Cerebellum
 - function with all levels of control to adjust cord motor activity, equilibrium, and planning of motor activity
- Basal ganglia
 - functions to assist cortex in executing subconscious but learned patterns of movement, and to plan sequential patterns to accomplish a purposeful task



Overall scheme for integration of motor function

Thank You

