

Author(s): Peter Hitchcock, PH.D., 2009

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Basal Ganglia

M1 – CNS Sequence
Peter Hitchcock, Ph.D.

Winter, 2009



The topic of today's lecture is the basal ganglia.

I. Fundamental concepts of basal ganglia structure and function.

II. Nuclei of the basal ganglia

III. Axonal connections of the basal ganglia.

a. afferent connections

b. intrinsic connections

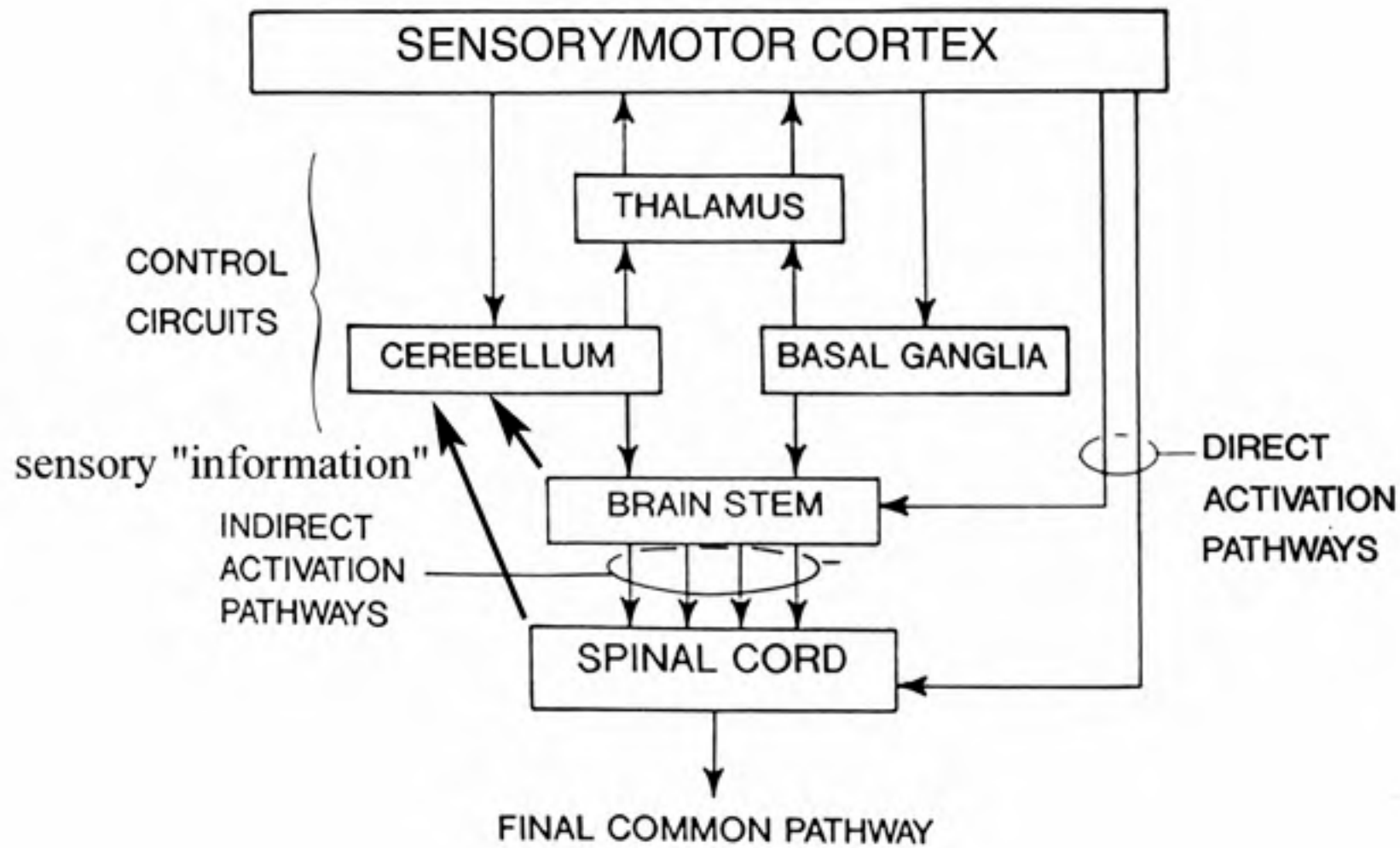
c. efferent connections

d. direct and indirect pathways

IV. Neurotransmitters of the basal ganglia

V. Diseases of the basal ganglia

VI. Models of anatomy and function of basal ganglia



The basal ganglia: organizing principles.

- 1) The basal ganglia is a collection of interconnected subcortical nuclei that functions as a central link in the part of the motor system that translates the desire to move (mentation) into action**
- 2) The basal ganglia integrates representations of sensory inputs, motor programs and 'internal states' and selects the appropriate, context -dependent learned behavior**
- 3) The basal ganglia are involved in higher order movements, particularly those with a cognitive component and damage to or disorders of the basal ganglia result in disruption of movements and may also cause significant deficits in other neural function such as cognition, perception and mentation**
- 4) The basal ganglia do not make direct or indirect connections with the motor neurons in the spinal cord or brainstem; rather it regulates the output of the cerebral cortex**
- 5) The basal ganglia contains 4 parallel, anatomically separate loops that originate in cortex, pass through the basal ganglia and project back to cortex via the dorsal thalamus. Each loop corresponds to a particular behaviorally relevant movement. The four loops are:
somatic motor loop: somatomotor control of voluntary movements
occulomotor loop: control of eye movements
frontal loop: cognitive functions
limbic loop: emotional and visceral functions**

The basal ganglia: organizing principles, cont'd.

- 6) The basal ganglia receive inputs from all of the cerebral cortex and may be involved in all cortical functions**

- 7) The basal ganglia function primarily through disinhibition (release from inhibition) of thalamocortical circuits.**

- 8) Diseases of the basal ganglia can be described as disruptions of the neurotransmitter interactions between components of the basal ganglia.**

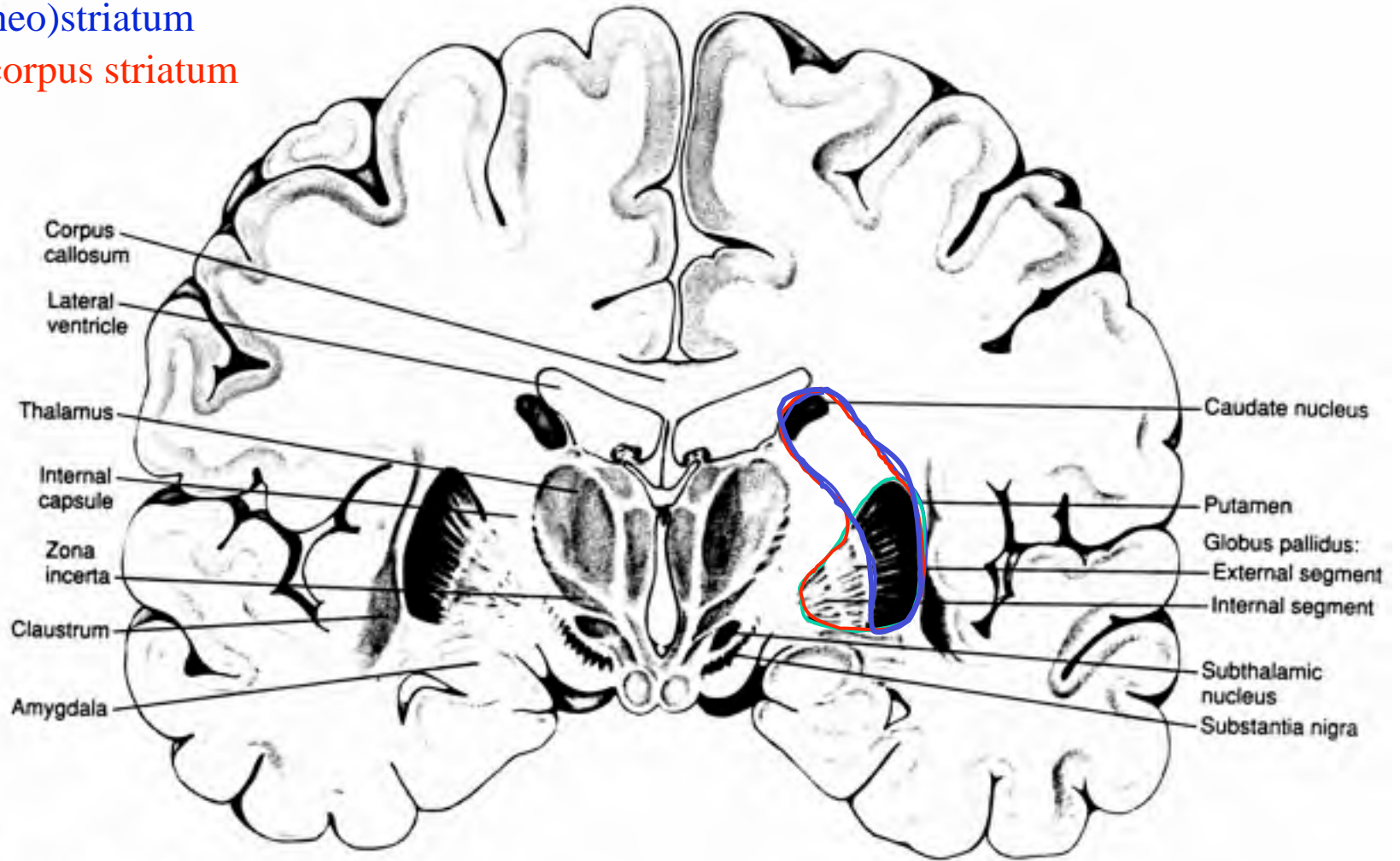
This lecture will deal only with the somatic-motor loop (motor channel) of the basal ganglia that is involved in regulating voluntary, somatic movements

The neostriatum is the primary afferent-receiving structure of the basal ganglia.

lenticular nucleus

(neo)striatum

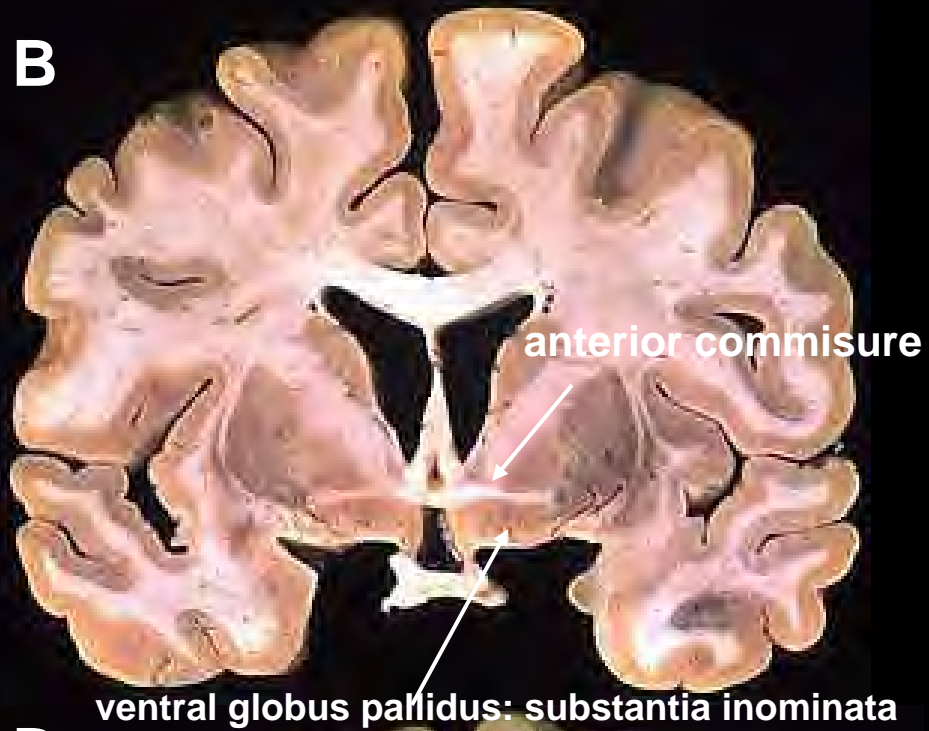
corpus striatum



Coronal section through the forebrain illustrating the components of the basal ganglia

A

ventral striatum: olfactory tubercle, nuc. accumbens

B**C****D**

E



substantia nigra
-pars compacta
-pars reticulata

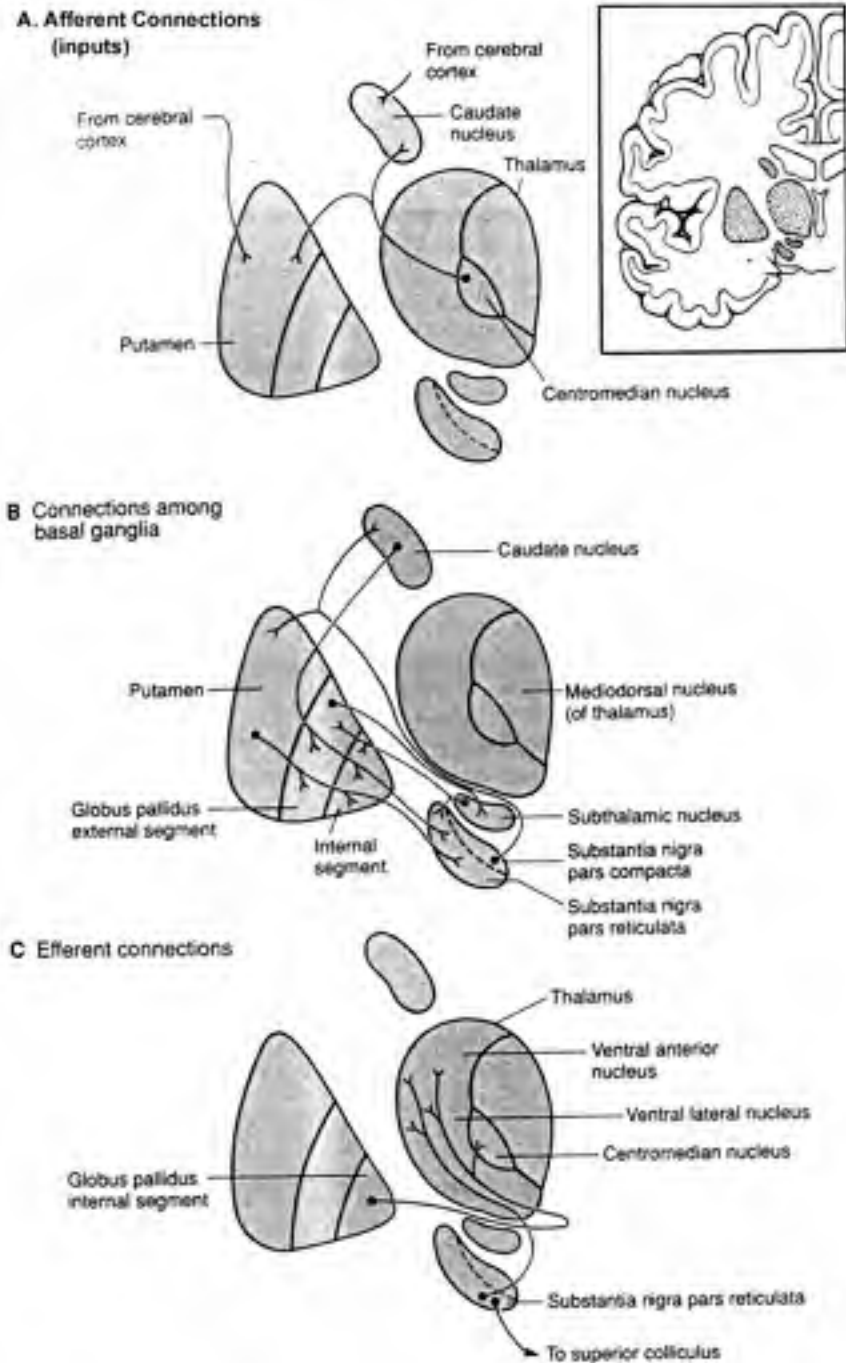
dorsal thalamus

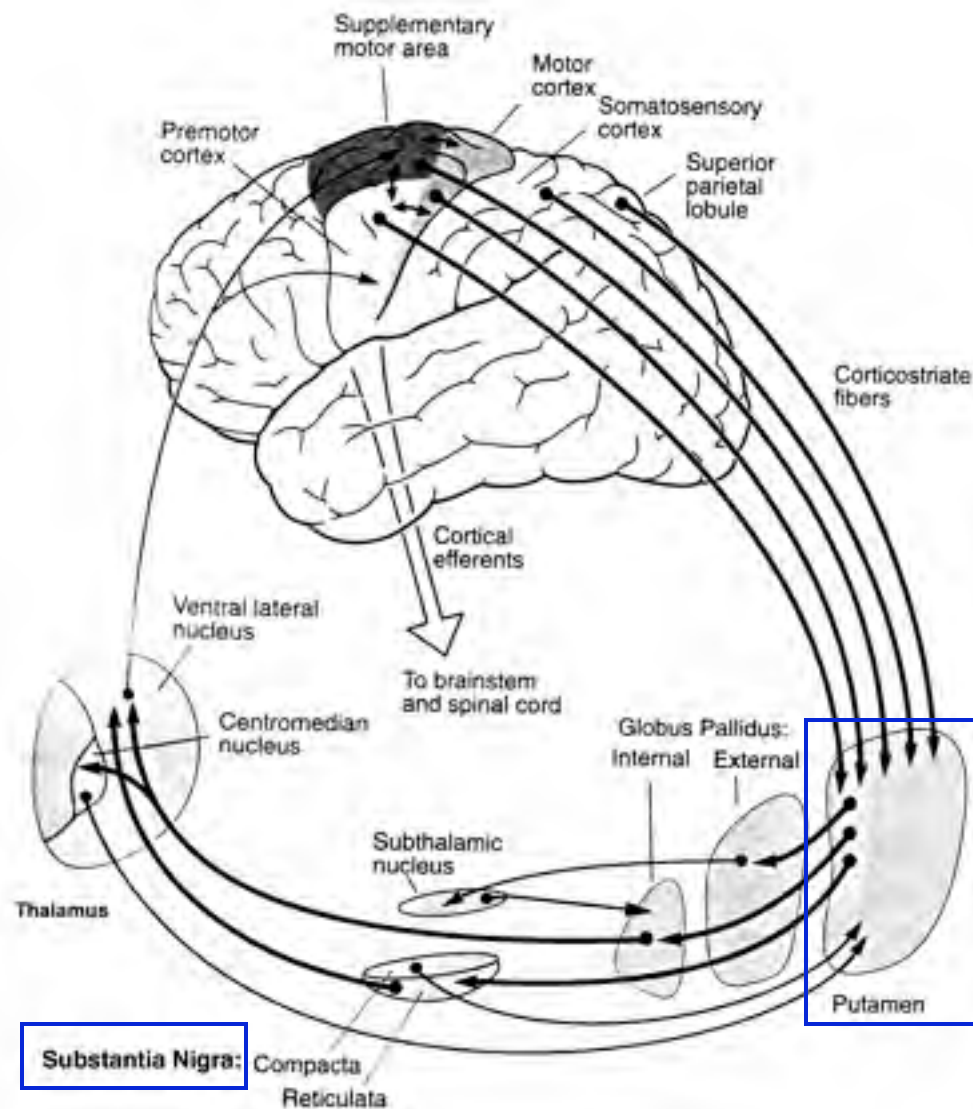
caudate
putamen
globus pallidus



internal capsule
-posterior limb

This schematic diagram illustrates the nuclei of the basal ganglia and the three components of the major anatomical connections: afferent connections, intrinsic connections, efferent connections

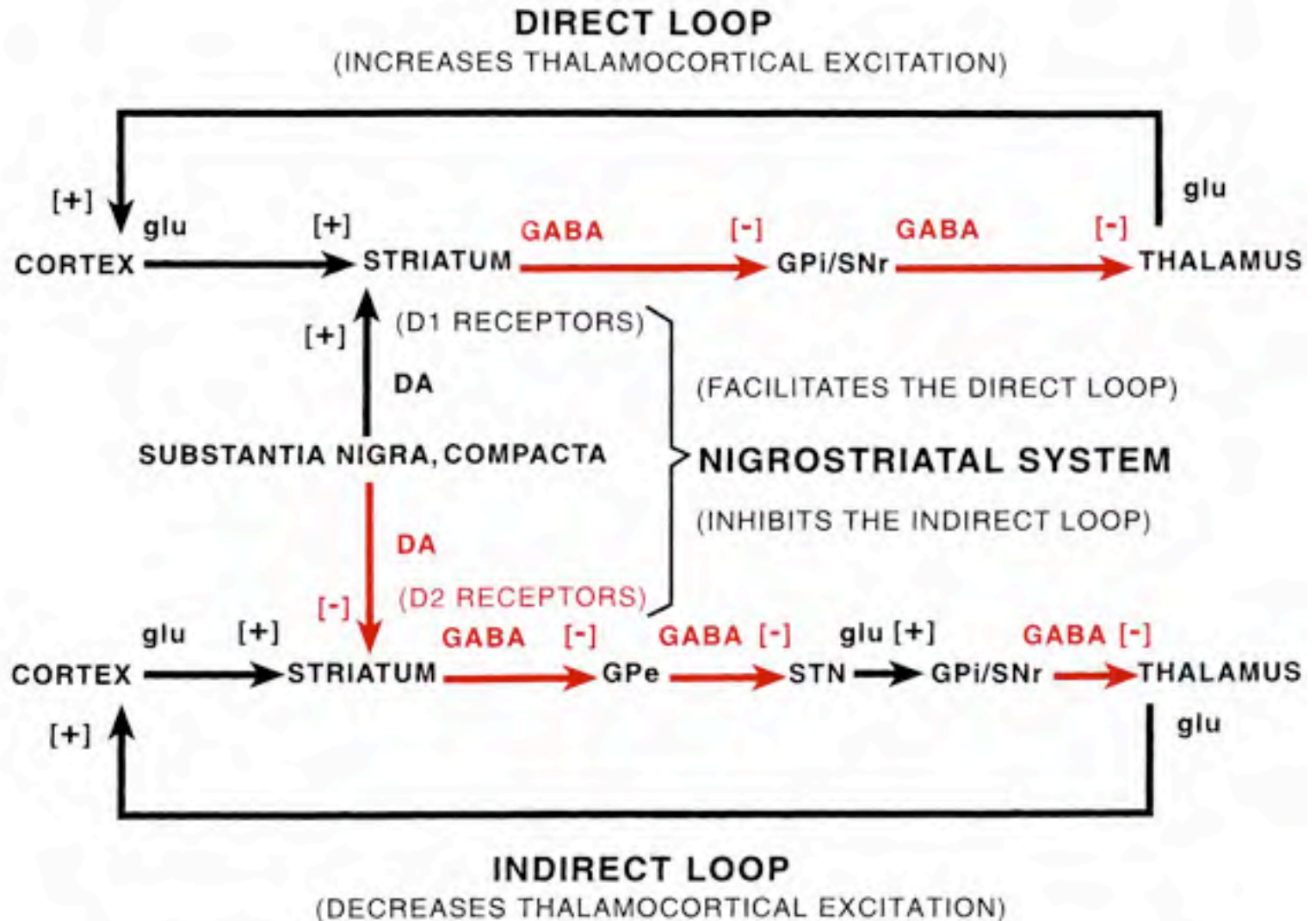




PD results from the degeneration of neurons in the substantia nigra

HD results from the degeneration of neurons in the neostriatum

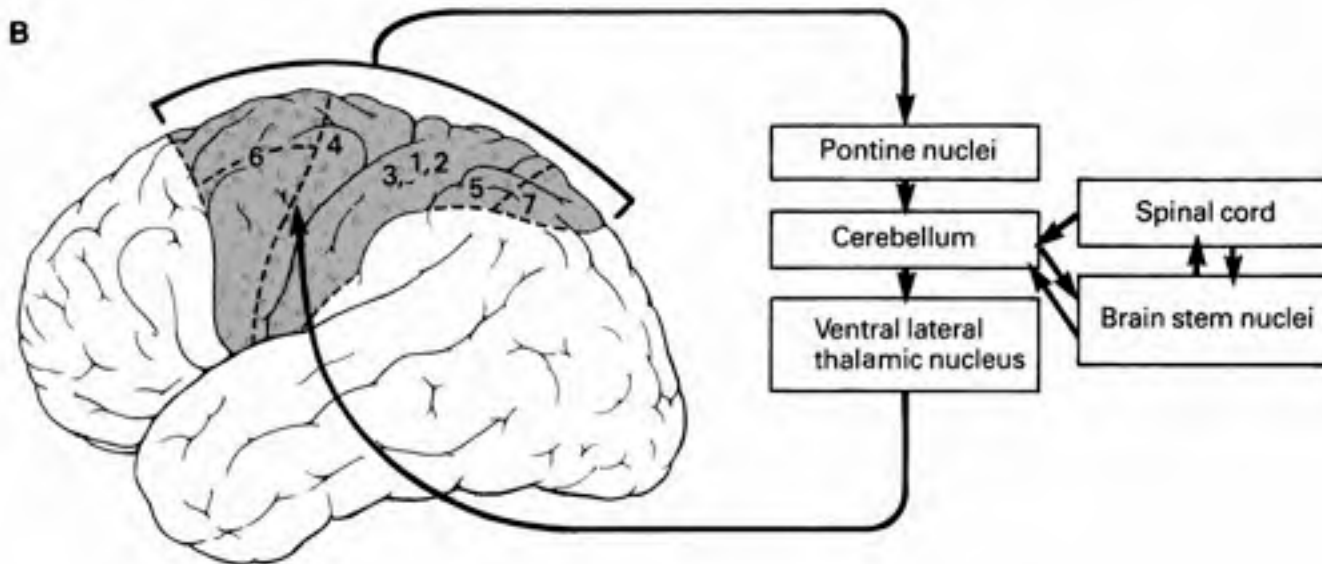
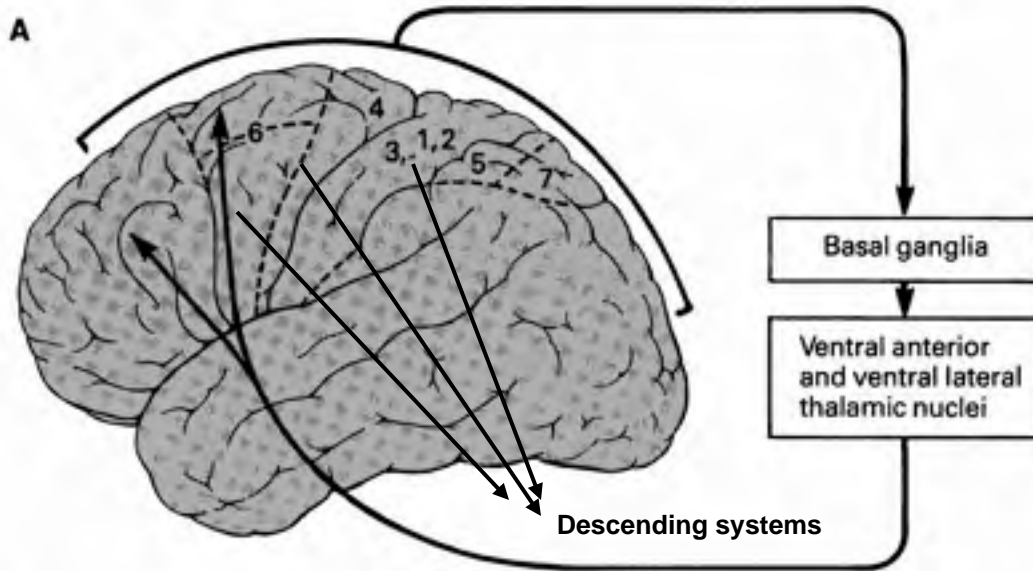
Function of indirect and direct pathways in the BG



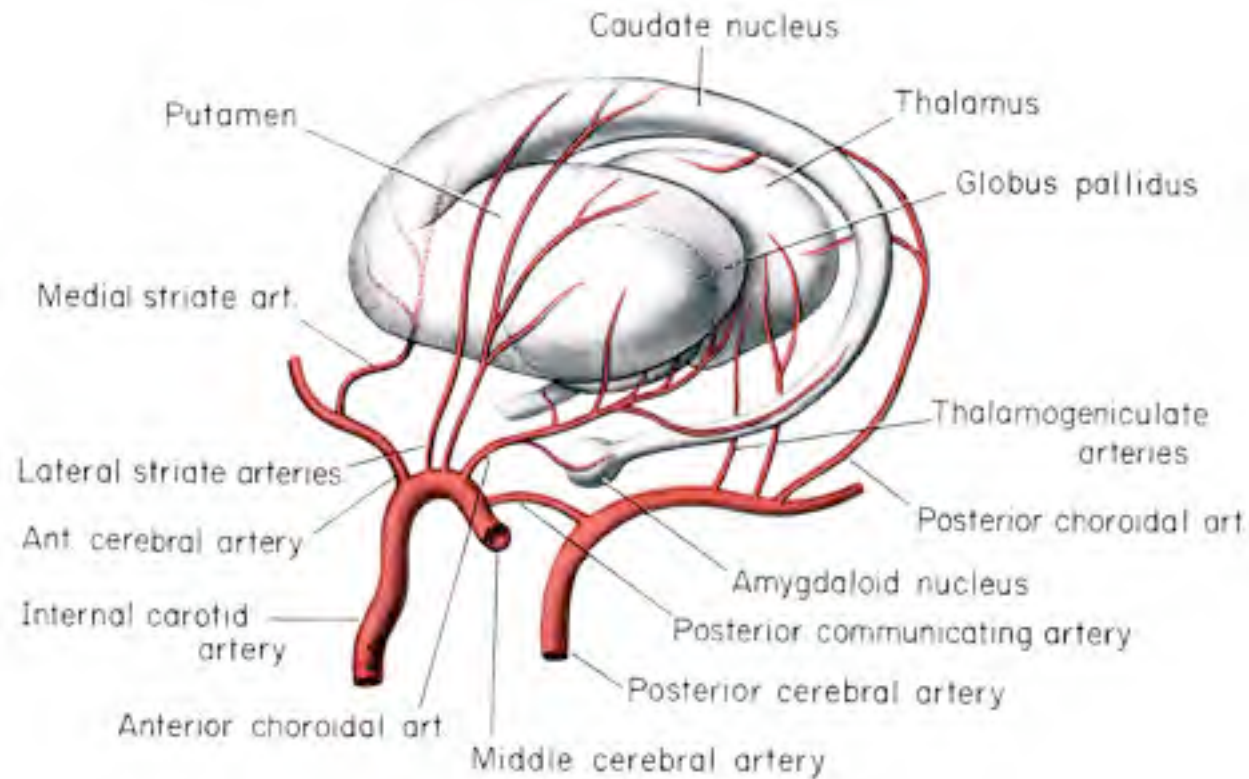
Summary diagrams of the control circuits of the motor system.

A: basal ganglia

B: cerebellum



Blood supply to the basal ganglia



branches of anterior and middle cerebral artery

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