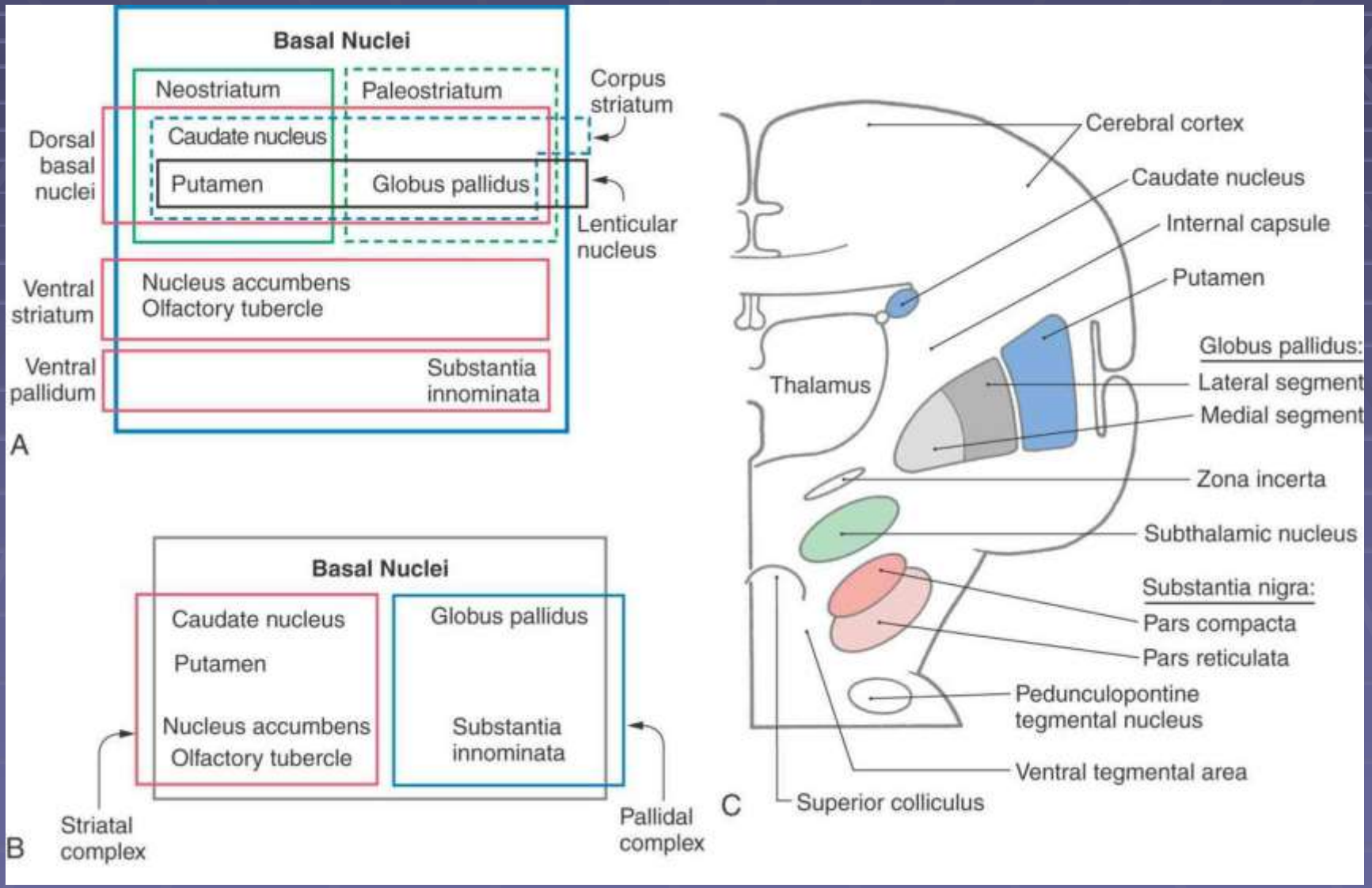
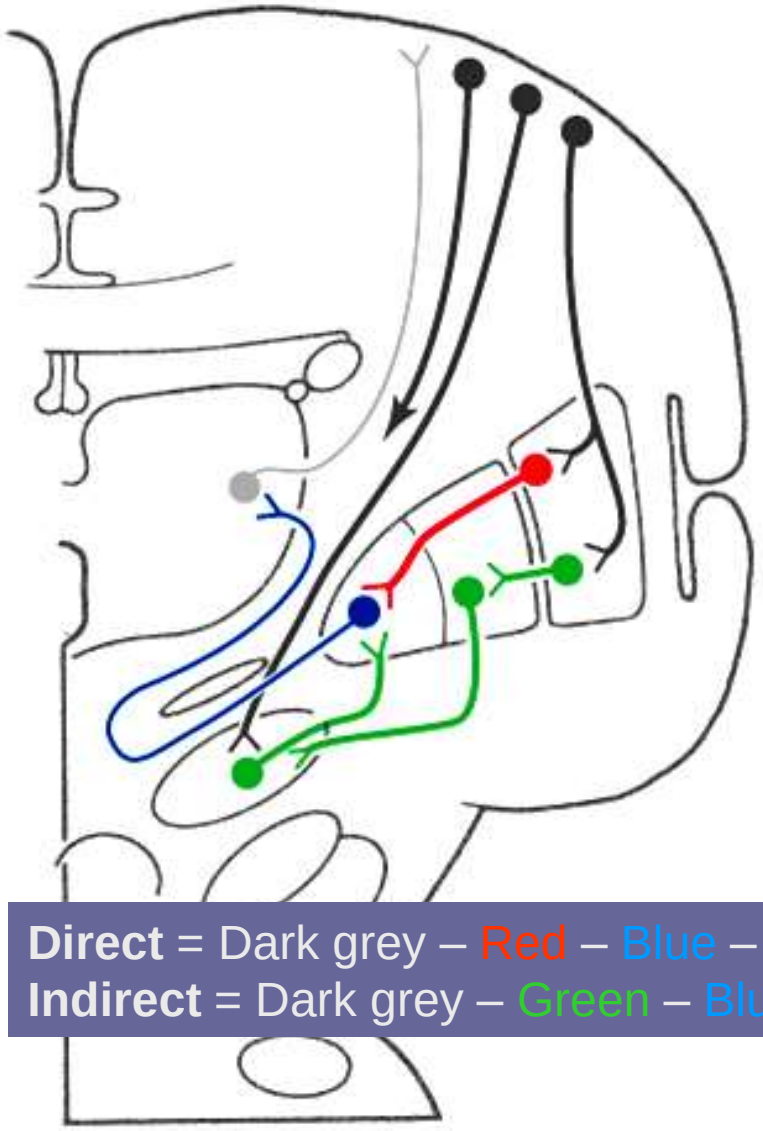
Basal ganglia/nucleus

Parts


Basal Nuclei
Neostriatum
Paleostriatum
Corpus striatum
Dorsal basal nuclei
Caudate nucleus
Putamen
Globus pallidus
Lenticular nucleus
Ventral striatum
Nucleus accumbens
Olfactory tubercle
Ventral pallidum
Substantia innominata
A
Basal Nuclei
Caudate nucleus
Putamen
Globus pallidus
Nucleus accumbens
Olfactory tubercle
Substantia innominata
Striatal complex
Pallidal complex
B
Cerebral cortex
Caudate nucleus
Internal capsule
Putamen
Thalamus
Globus pallidus:
Lateral segment
Medial segment
Zona incerta
Subthalamic nucleus
Substantia nigra:
Pars compacta
Pars reticulata
Pedunculopontine tegmental nucleus
Ventral tegmental area
Superior colliculus
C

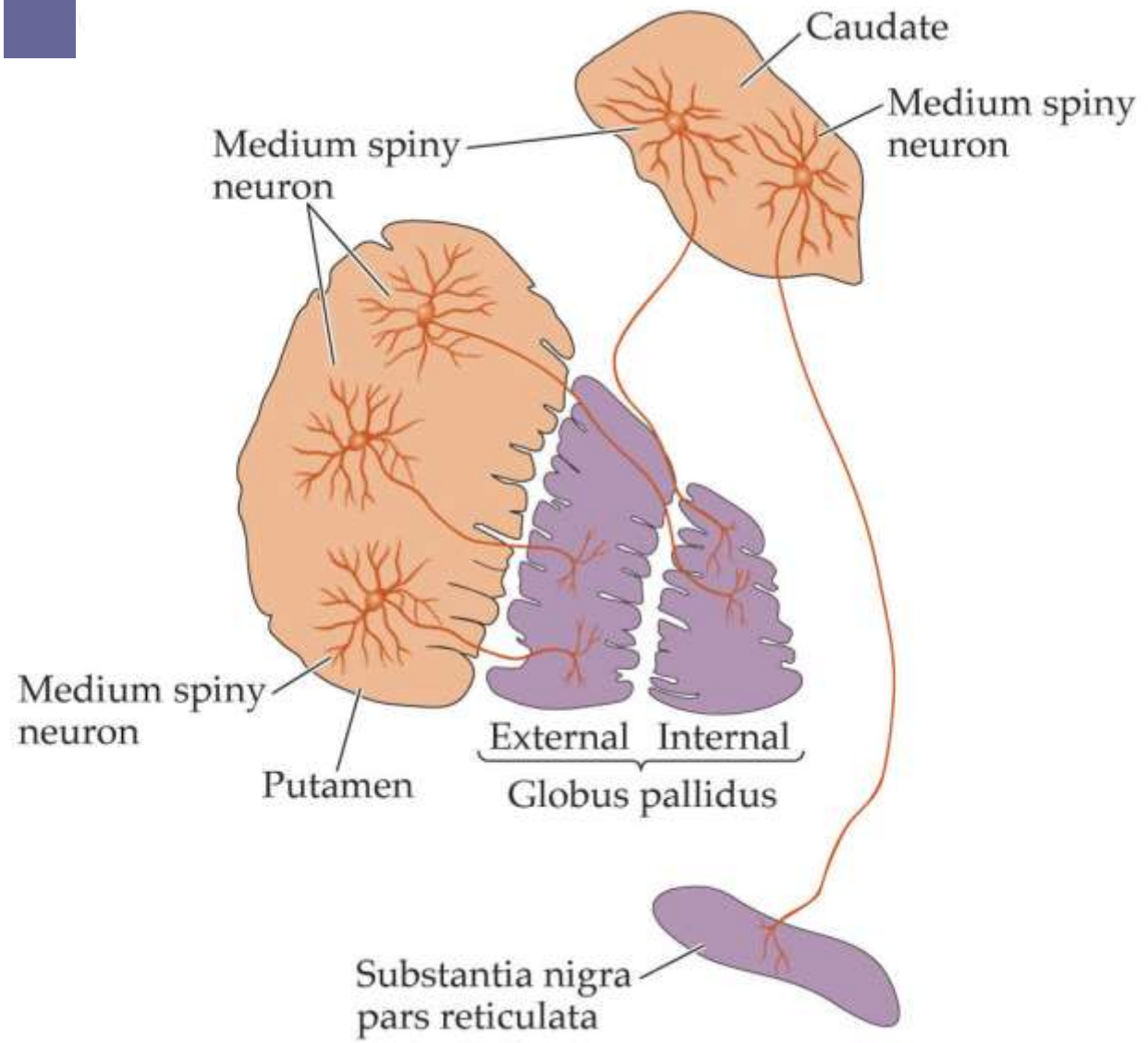
Function of the basal ganglia



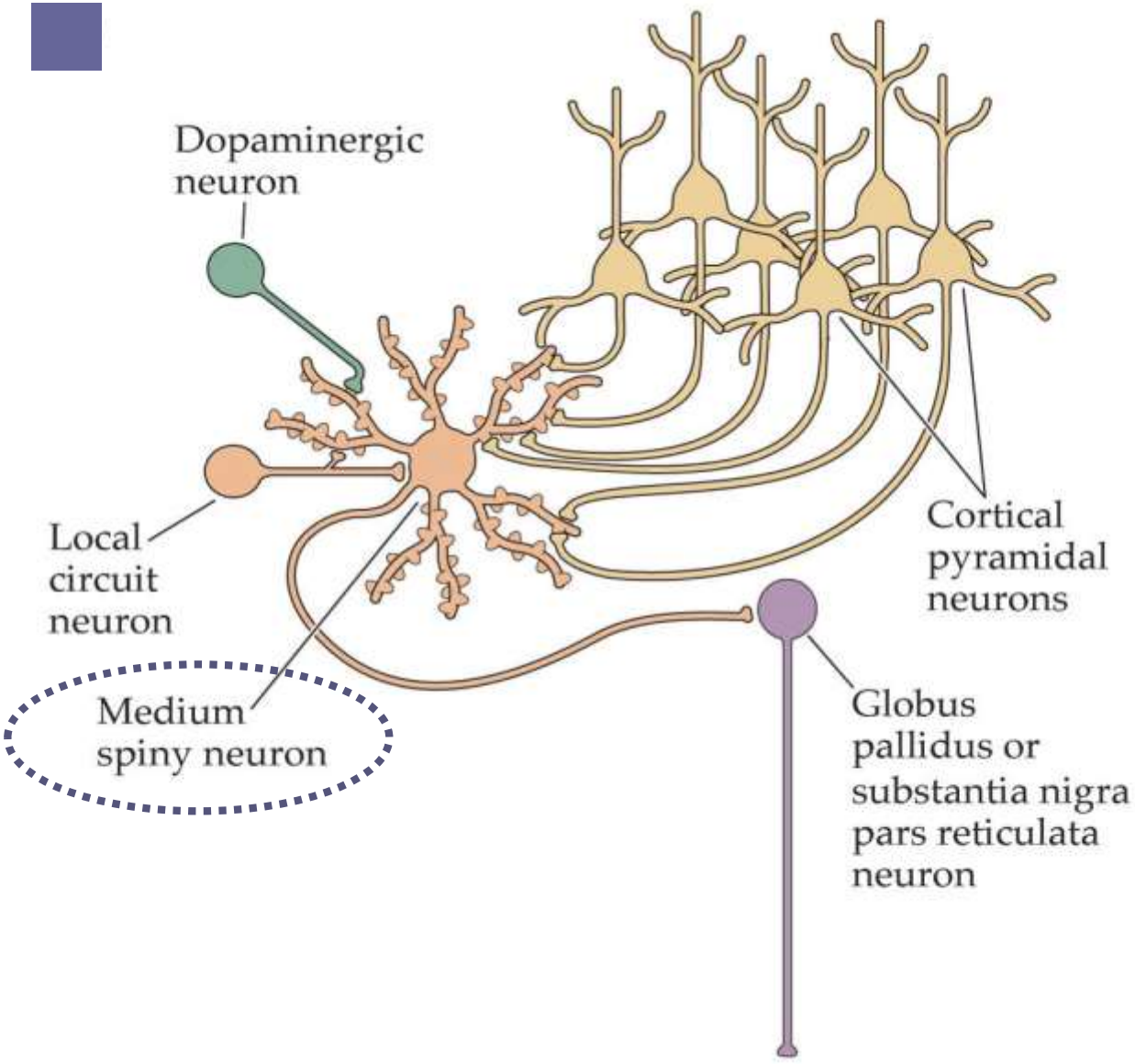
Direct = Dark grey – Red – Blue – Light grey
Indirect = Dark grey – Green – Blue – Light grey

Text Fig. 26-9

Medium spiny neuron projections

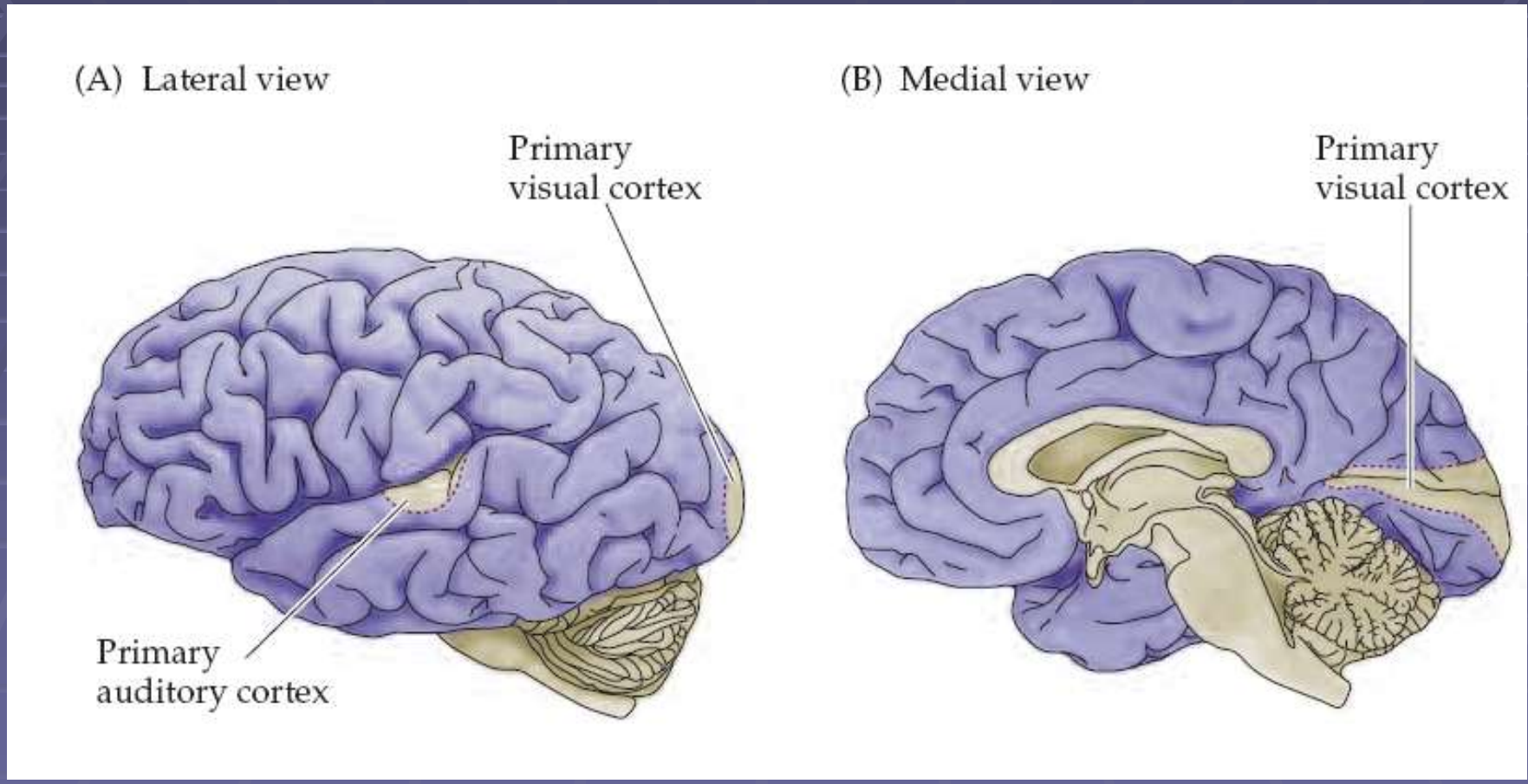


Neurons of the basal ganglia

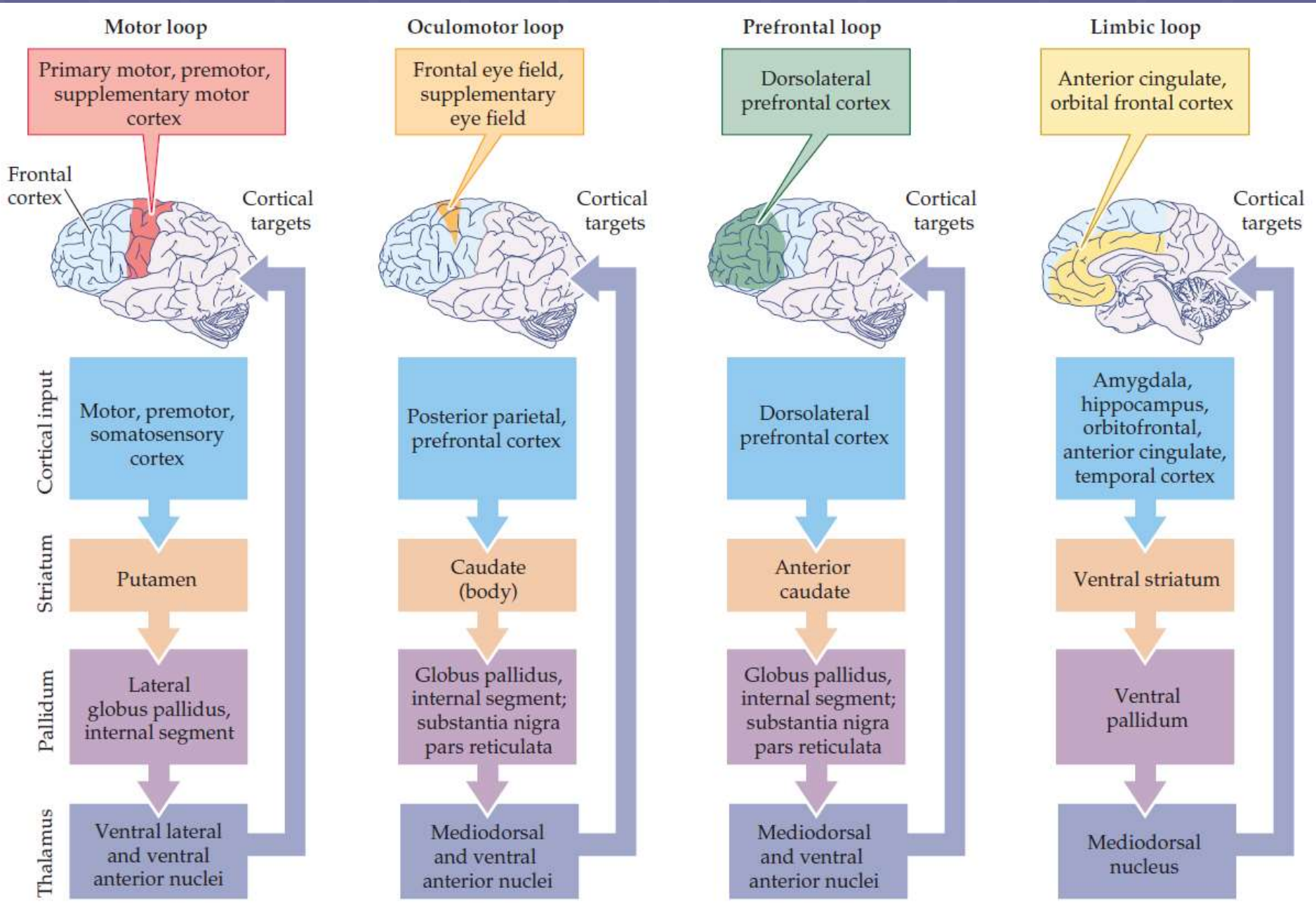


NEUROSCIENCE, Third Edition, **Figure 17.3 (Part 2)**

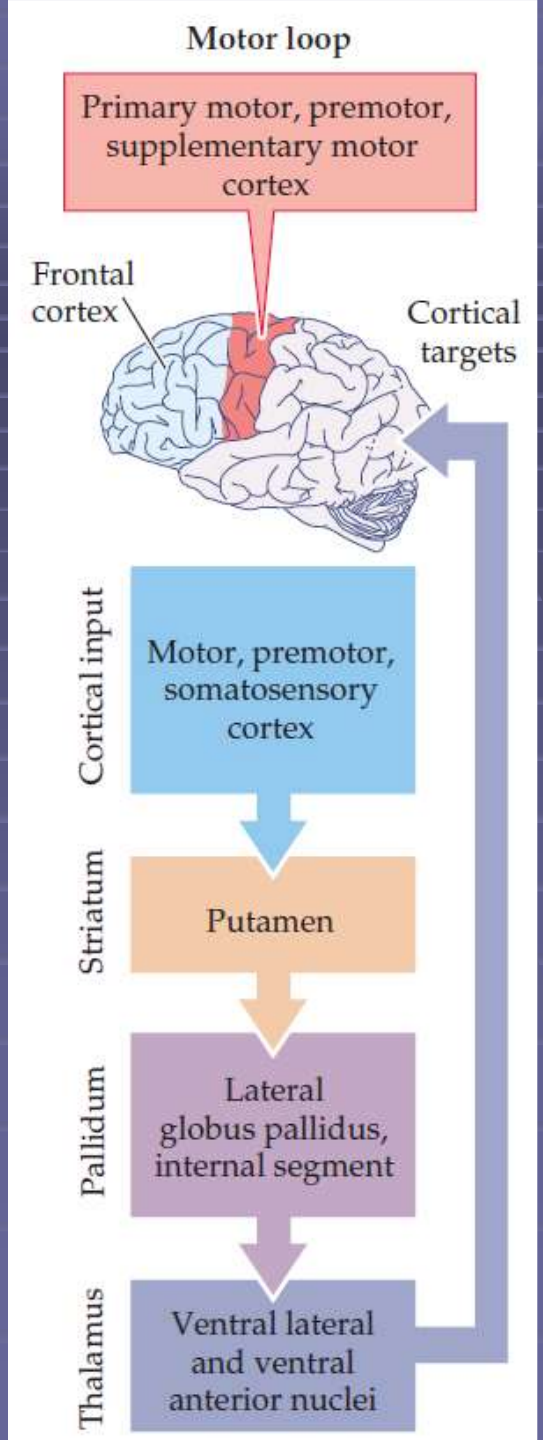
Connections and circuits

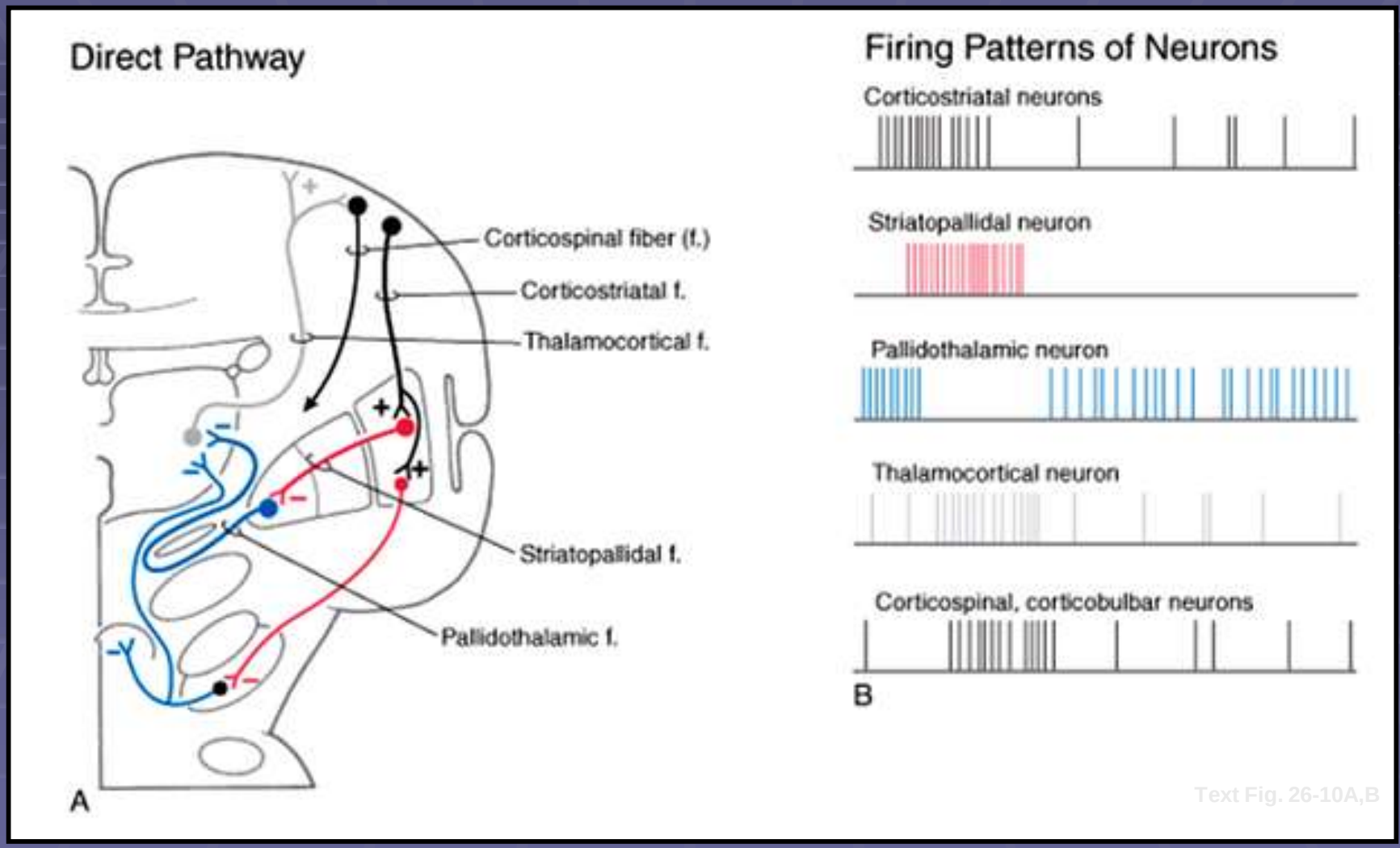


Functional loops

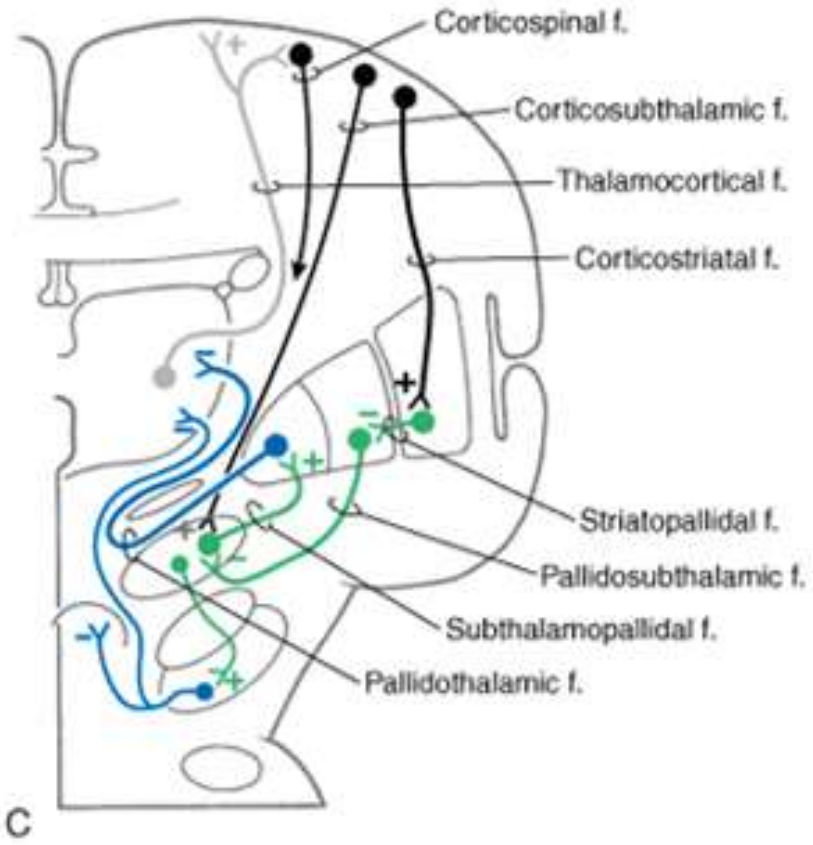

Motor loop
Primary motor, premotor, supplementary motor cortex
Frontal cortex
Cortical targets
Cortical input
Motor, premotor, somatosensory cortex
Striatum
Putamen
Pallidum
Lateral globus pallidus, internal segment
Thalamus
Ventral lateral and ventral anterior nuclei
Oculomotor loop
Frontal eye field, supplementary eye field
Cortical targets
Posterior parietal, prefrontal cortex
Caudate (body)
Globus pallidus, internal segment; substantia nigra pars reticulata
Mediodorsal and ventral anterior nuclei
Prefrontal loop
Dorsolateral prefrontal cortex
Cortical targets
Dorsolateral prefrontal cortex
Anterior caudate
Globus pallidus, internal segment; substantia nigra pars reticulata
Mediodorsal and ventral anterior nuclei
Limbic loop
Anterior cingulate, orbital frontal cortex
Cortical targets
Amygdala, hippocampus, orbitofrontal, anterior cingulate, temporal cortex
Ventral striatum
Ventral pallidum
Mediodorsal nucleus

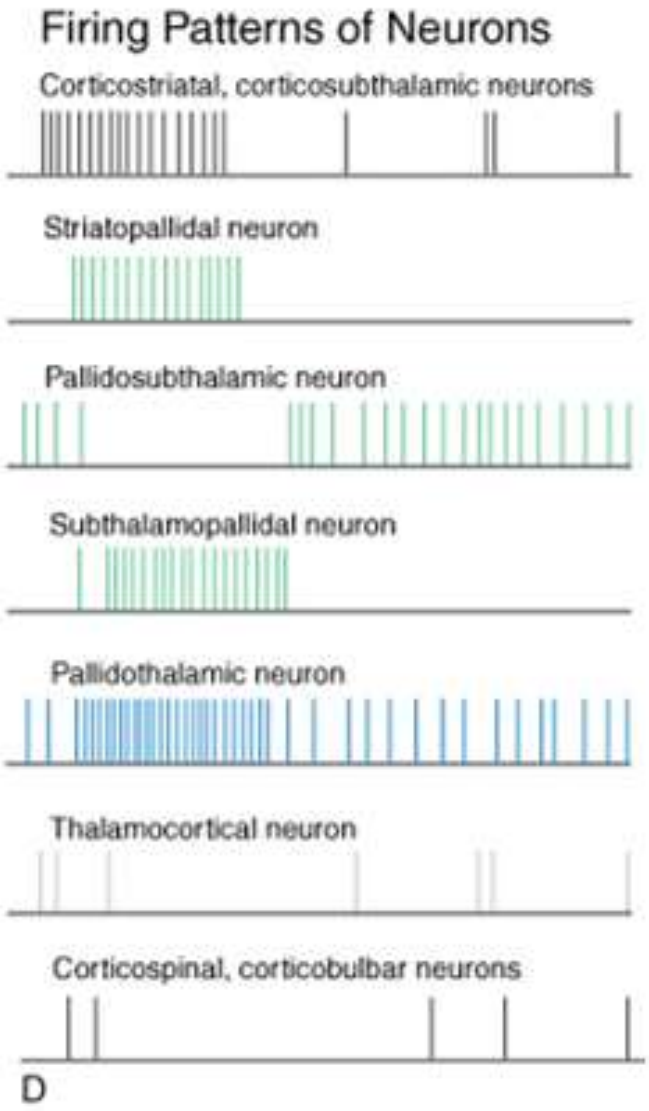
Motor Loop


Motor loop
Primary motor, premotor, supplementary motor cortex
Frontal cortex
Cortical targets
Cortical input
Motor, premotor, somatosensory cortex
Striatum
Putamen
Pallidum
Lateral globus pallidus, internal segment
Thalamus
Ventral lateral and ventral anterior nuclei

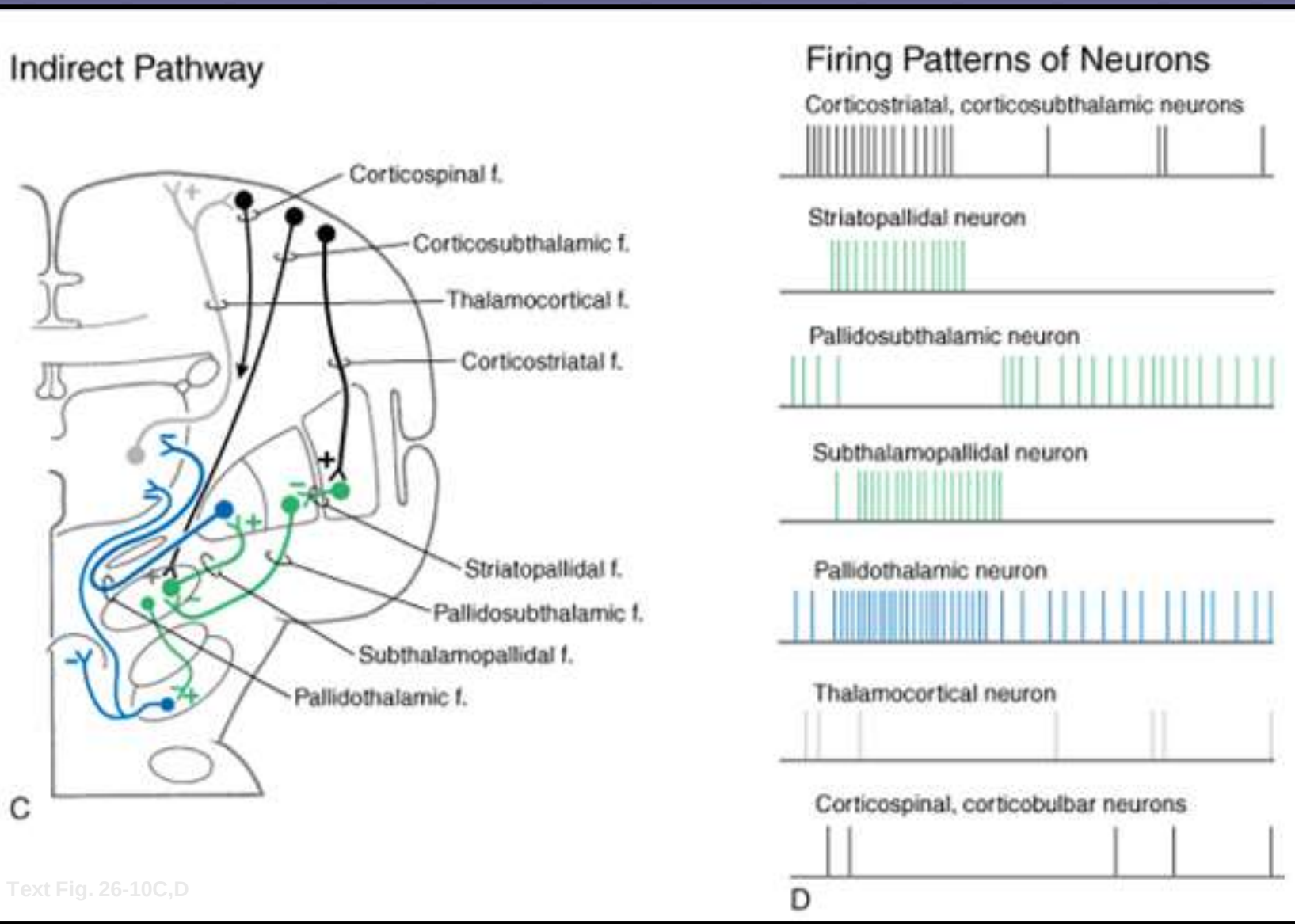


Text Fig. 26-10A,B





Text Fig. 26-10C,D



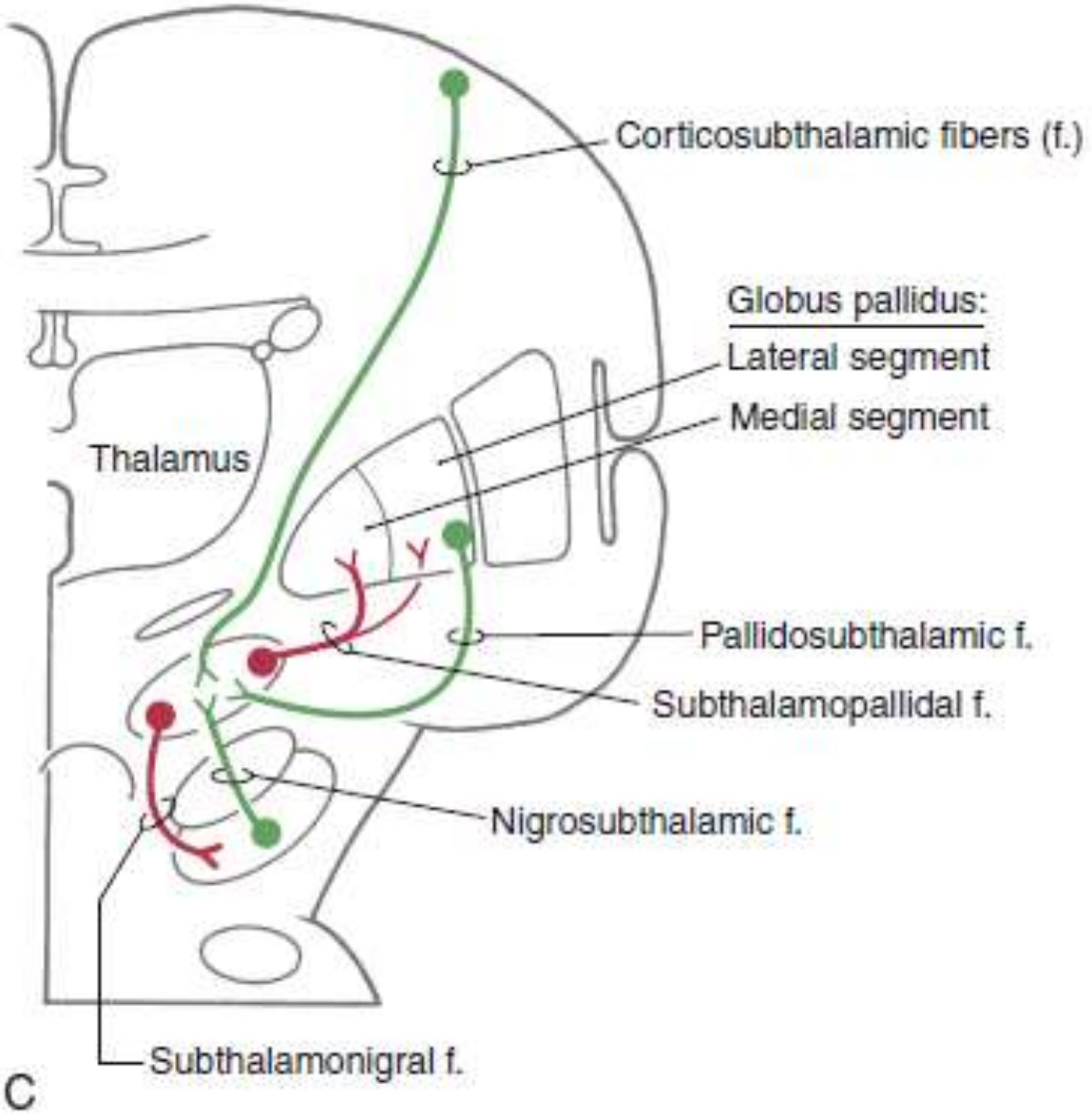
Text Fig. 26-10C,D

Modulators (associated nuclei)

Modulators (associated nuclei)

- Subthalamic Nucleus ?????
- Nigral Complex (Dopamine)
- Pedunculo-pontine nucleus (Acetylcholine)

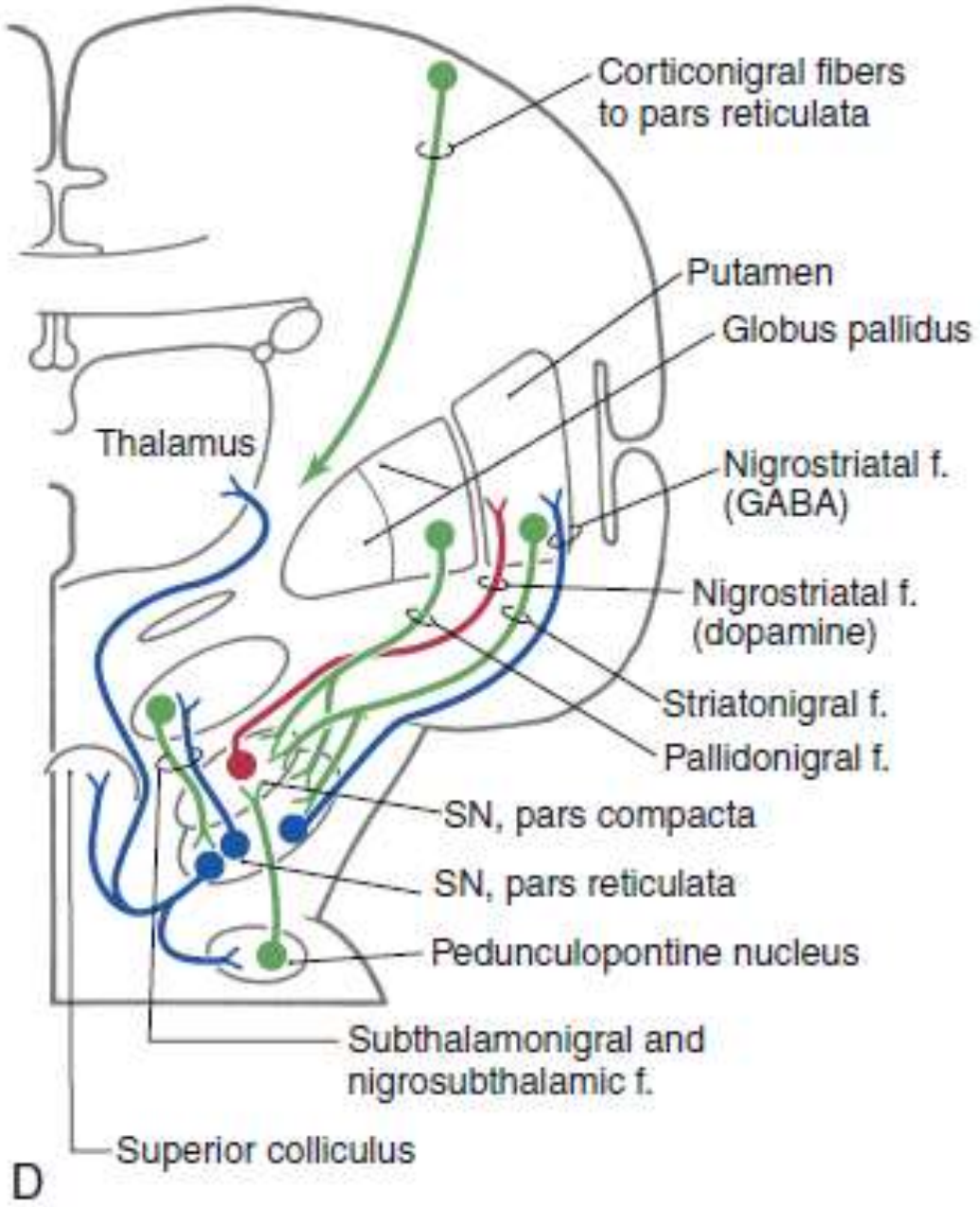
Connections of Subthalamus



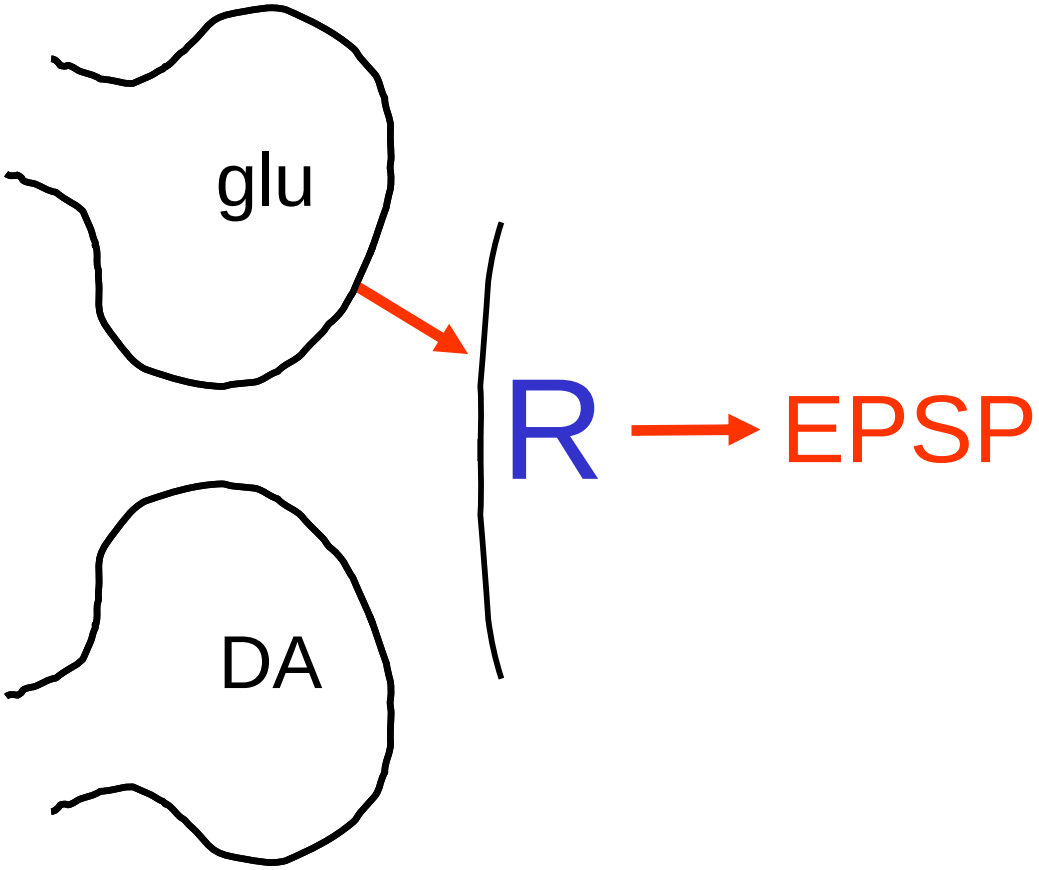
Modulators (associated nuclei)

- Subthalamic Nucleus ?????
- Nigral Complex (Dopamine)
- Pedunculo-pontine nucleus (Acetylcholine)

Connections of Substantia Nigra

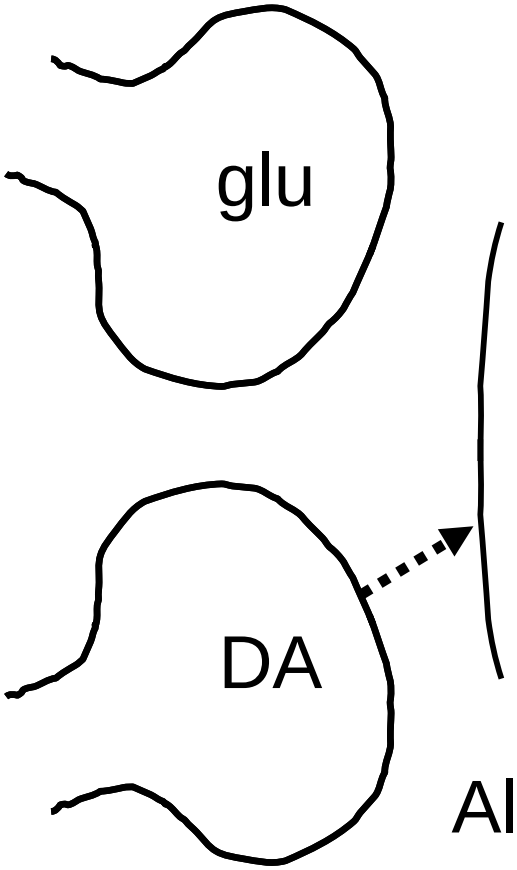


Nigral modulation



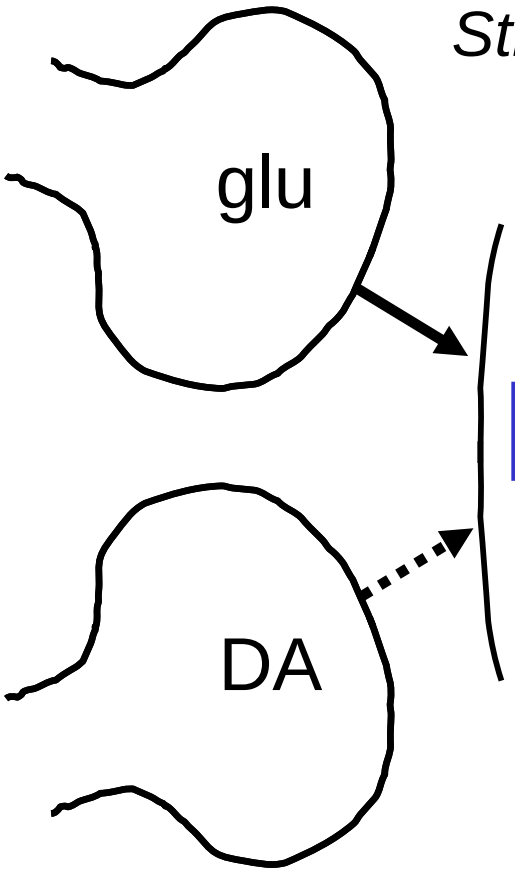
Direct transmission

Direct transmission *vs.* modulation



Almost No direct effect of DA

Direct transmission *vs.* modulation



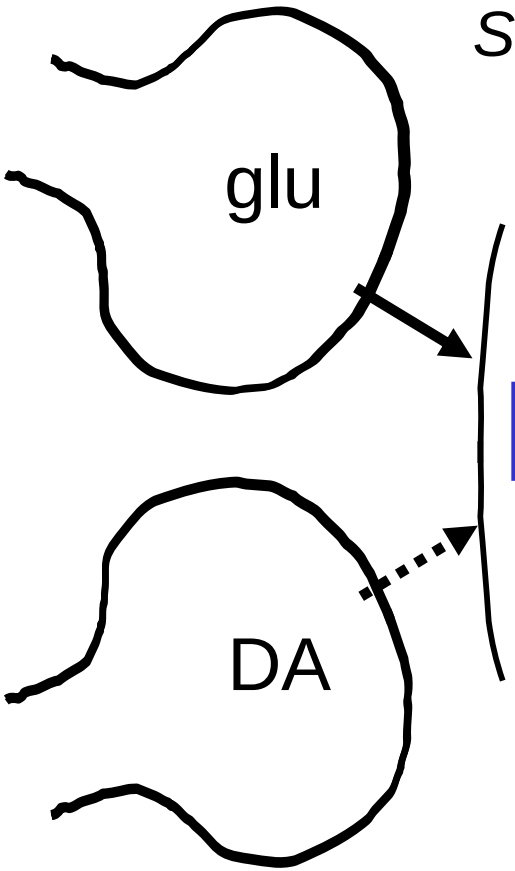
Striatal medium spiny neuron

enhanced
or diminished
response

D1-Rs in the direct pathway:
Excitatory effect on the pathway, hence
Increase cortical activity

Modulation

Direct transmission *vs.* modulation

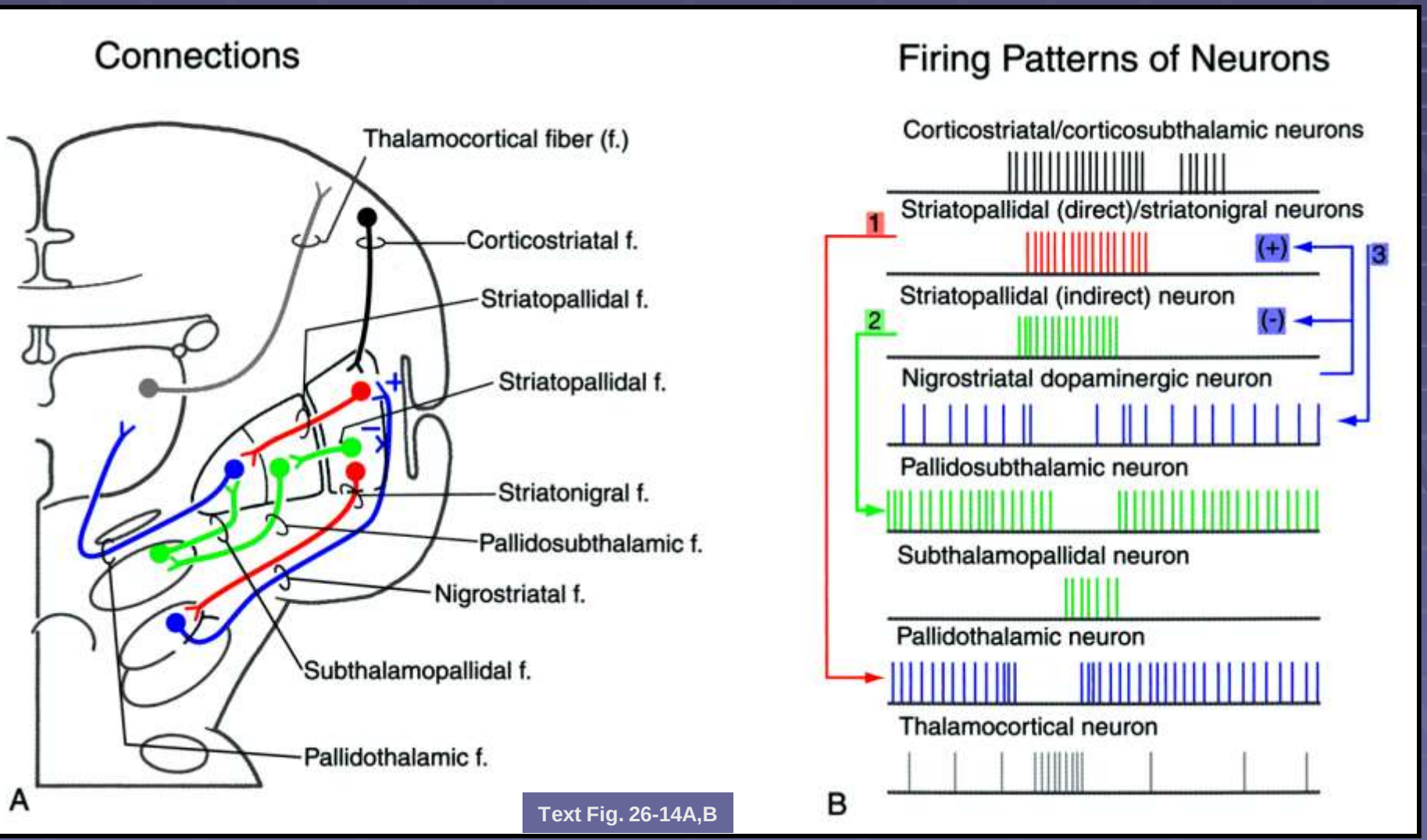


Striatal medium spiny neuron

enhanced
or ***diminished***
response

D2-Rs in the indirect pathway:
Inhibitory effect on the pathway, hence
Increase cortical activity
Modulation

Direct and Indirect Pathways (Including the Substantia Nigra

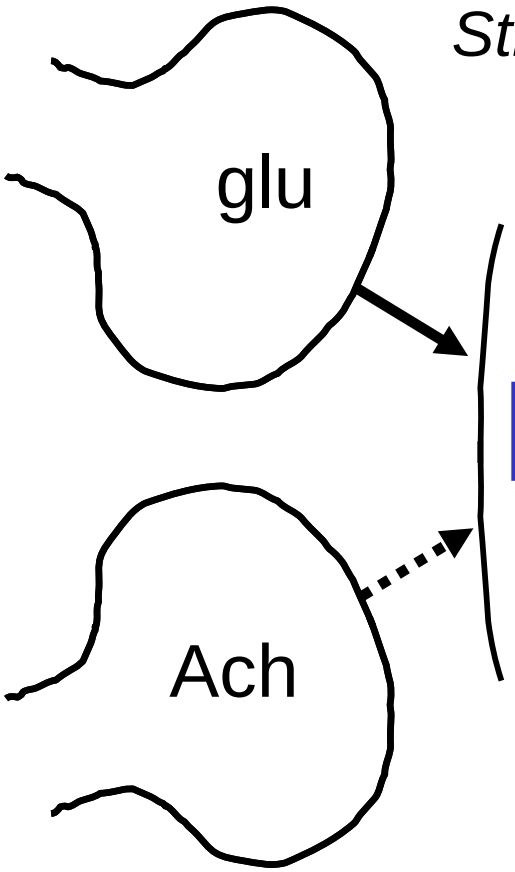


Text Fig. 26-14A,B

Modulators (associated nuclei)

- Subthalamic Nucleus ?????
- Nigral Complex (Dopamine)
- Pedunculo-pontine nucleus (Acetylcholine)

Direct transmission *vs.* modulation



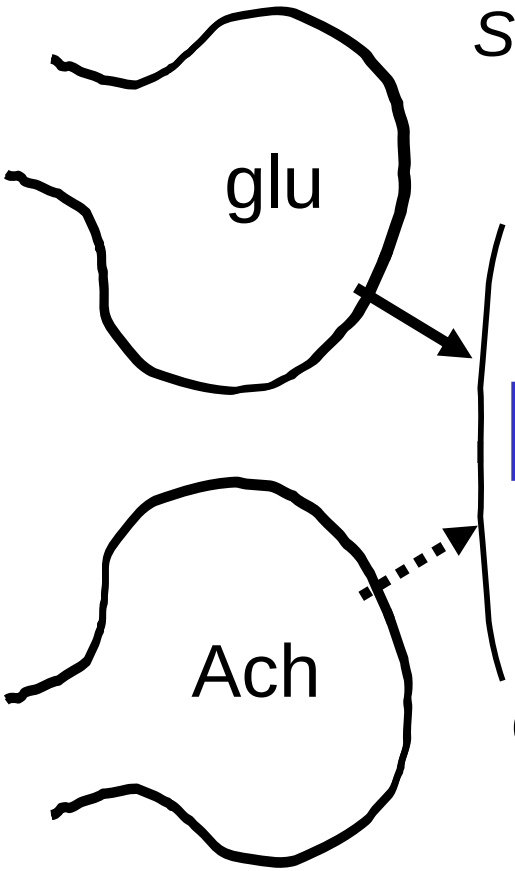
Striatal medium spiny neuron

enhanced
or diminished
response

M4-Rs in the direct pathway:
1) Inhibitory, hence decrease cortical activation

Modulation

Direct transmission *vs.* modulation



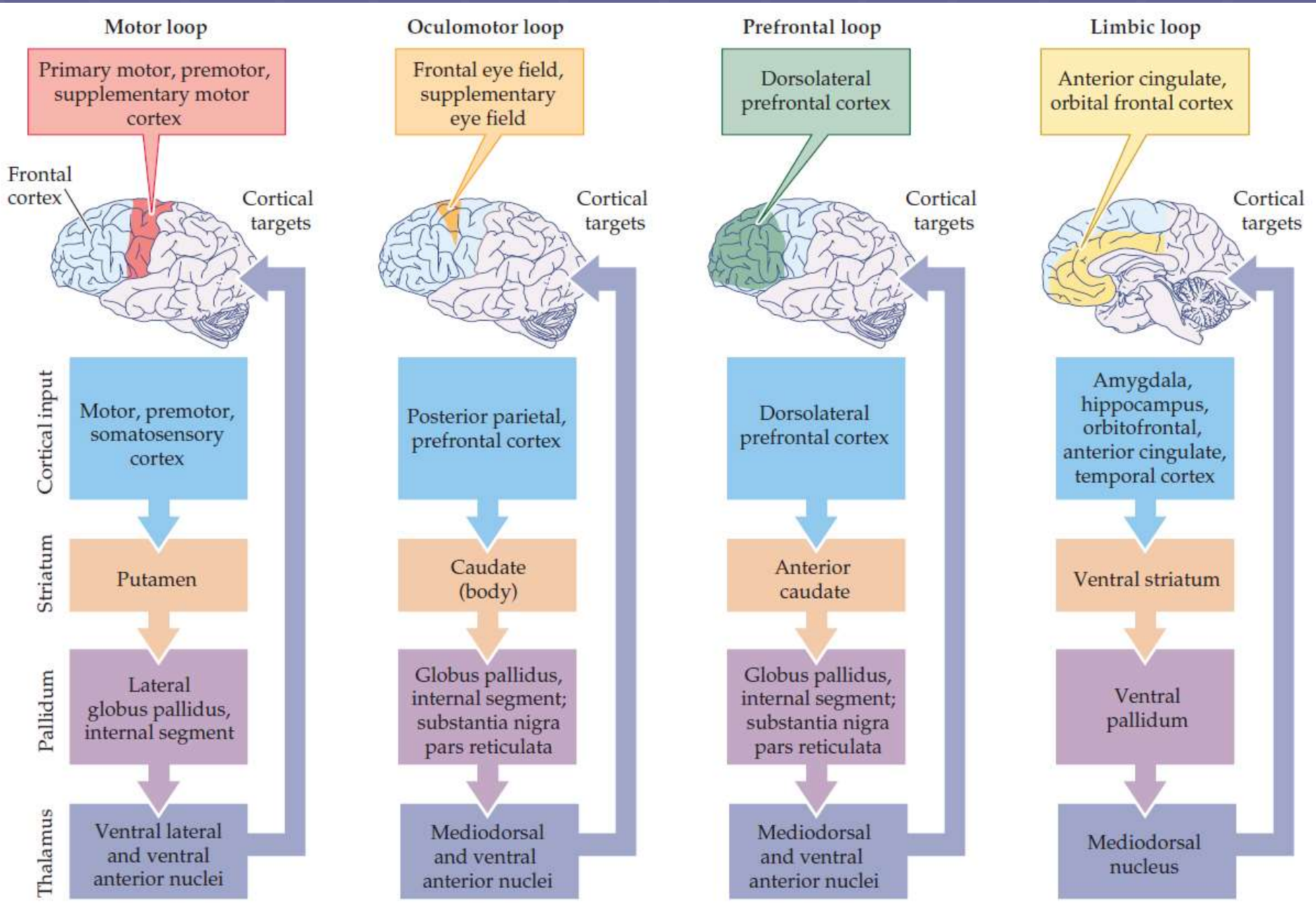
Striatal medium spiny neuron

R

enhanced
or ***diminished***
response

M1-Rs in the indirect pathway:
excitatory, hence
Decrease cortical activity

Modulation


Motor loop
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Frontal cortex
Cortical targets
Cortical input
Motor, premotor, somatosensory cortex
Striatum
Putamen
Pallidum
Lateral globus pallidus, internal segment
Thalamus
Ventral lateral and ventral anterior nuclei
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Frontal eye field, supplementary eye field
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Dorsolateral prefrontal cortex
Cortical targets
Dorsolateral prefrontal cortex
Anterior caudate
Globus pallidus, internal segment; substantia nigra pars reticulata
Mediodorsal and ventral anterior nuclei
Limbic loop
Anterior cingulate, orbital frontal cortex
Cortical targets
Amygdala, hippocampus, orbitofrontal, anterior cingulate, temporal cortex
Ventral striatum
Ventral pallidum
Mediodorsal nucleus

Motor behavior is determined by the balance between direct/indirect striatal outputs

Hypokinetic disorders

- **insufficient direct** pathway output
- **excess indirect** pathway output

Hyperkinetic disorders

- **excess direct** pathway output
- **insufficient indirect** pathway output

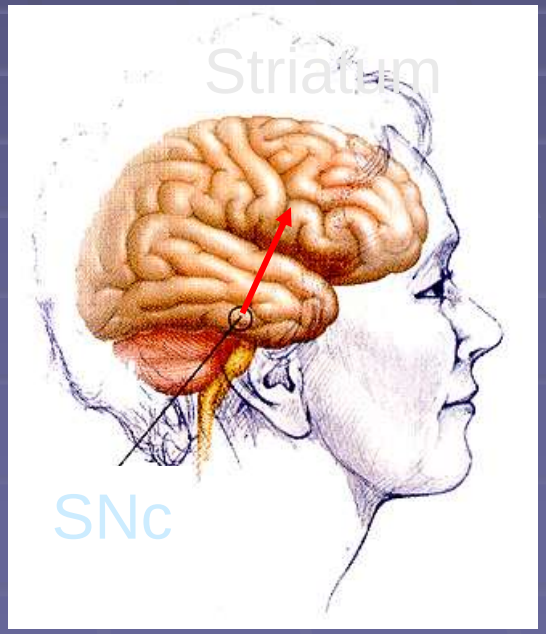
Parkinson's disease

Michael J. Fox

Muhammad Ali

Pathophysiology

- Primary: loss of nigrostriatal DA projection



Parkinson's disease

Treatment

↑ Dopamine

↓ Acetylcholine

Deep brain stimulation

subthalamic nucleus (STN)/ globus pallidus interna (GPi)

high frequency stimulation inactivates the STN or GPi.

Motor behavior is determined by the balance between direct/indirect striatal outputs

Hypokinetic disorders

- **insufficient direct** pathway output
- **excess indirect** pathway output

Hyperkinetic disorders

- **excess direct** pathway output
- **insufficient indirect** pathway output

Hyperkinetic symptoms

Involuntary (unwanted) movements

- Chorea
- Ballismus
- Dystonia
- Athetosis

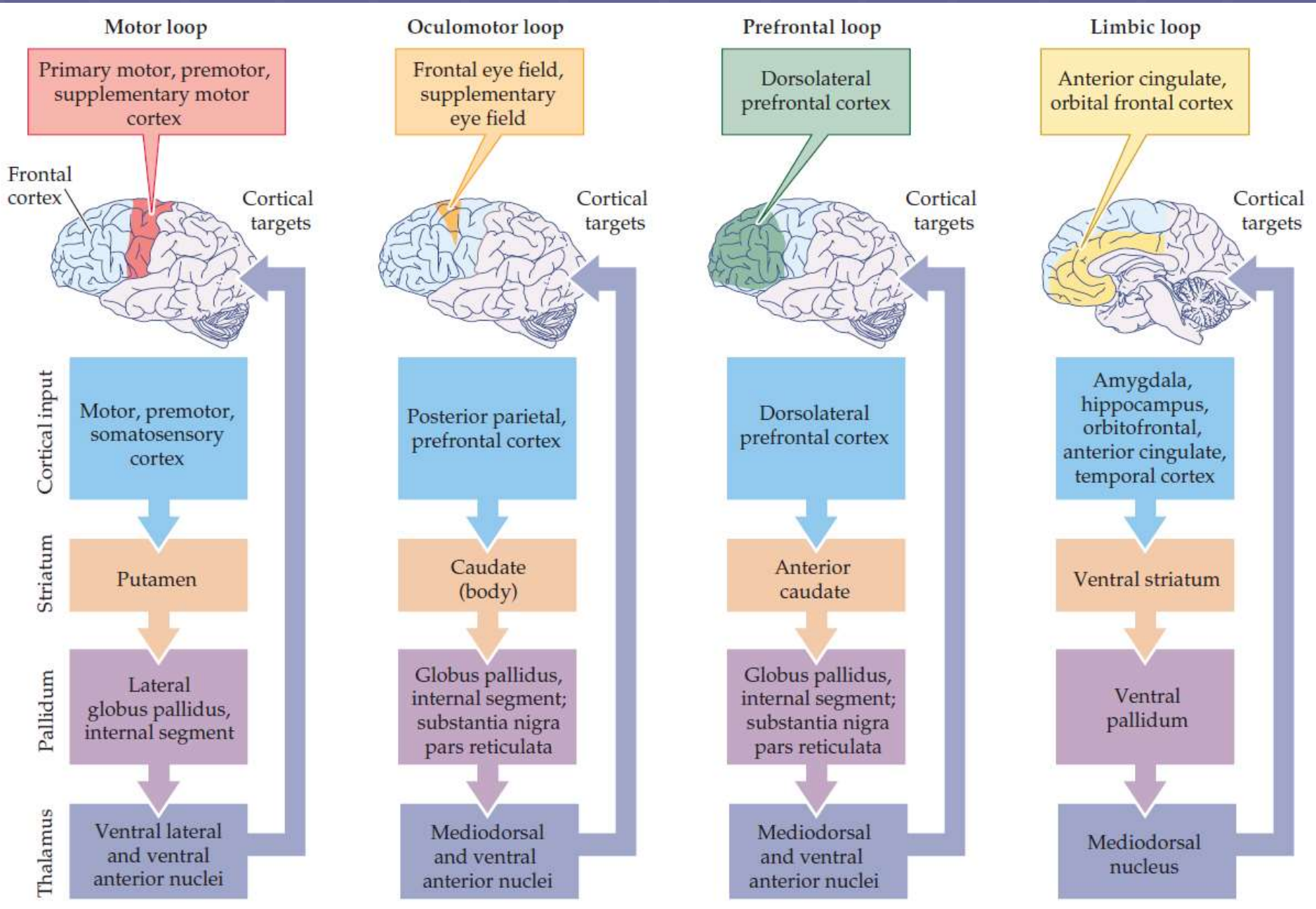
Hyperkinetic disorders: choreatic syndromes

1. Huntington's Chorea
2. Sydenham Chorea
3. Dystonia
4. Tardive dyskinesia
5. DOPA-induced dyskinesia
6. Hemiballismus
7. Tourette's syndrome

Huntington's disease

Pathophysiology

- Atrophy of striatum
- Loss of striatal neurons
- Neuropathological sequence
- start , rostral and medial then caudal and lateral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Anterior cingulate, orbital frontal cortex
Cortical targets
Amygdala, hippocampus, orbitofrontal, anterior cingulate, temporal cortex
Ventral striatum
Ventral pallidum
Mediodorsal nucleus

Huntington's disease

Symptoms

Early motor signs

- chorea (brief, involuntary movements)
- later have dystonia episodes

Choreatic gait

Dystonic movements

Hyperkinetic disorders:

1. Huntington's Chorea
2. Sydenham Chorea
3. Dystonia
4. Tardive dyskinesia
5. DOPA-induced dyskinesia
6. Hemiballismus
7. Tourette's syndrome

Hyperkinetic disorders: choreatic syndromes

Huntington's disease

Dystonia

Tardive dyskinesia

DOPA-induced dyskinesia

Hemiballismus

Tourette's syndrome

Cervical dystonia

After botulinum toxin

Hyperkinetic disorders: choreatic syndromes

Huntington's disease

Dystonia

Tardive dyskinesia

DOPA-induced dyskinesia

After treatment with the D2-R blocker sulpiride

Hemiballismus – unilateral
STN stroke

Tourette's syndrome

Hyperkinetic disorders:

1. Huntington's Chorea
2. Sydenham Chorea
3. Dystonia
4. Tardive dyskinesia
5. DOPA-induced dyskinesia
6. Hemiballismus
7. Tourette's syndrome

Hyperkinetic disorders:

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5. LDOPA-induced dyskinesia
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Hyperkinetic disorders:

1. Huntington’s Chorea
2. Sydenham Chorea
3. Dystonia
4. Tardive dyskinesia
5. LDOPA-induced dyskinesia
6. Hemiballismus
7. Tourette’s syndrome

Hyperkinetic disorders:

Tourette’s syndrome

https://www.youtube.com/watch?v=e8HtTb0Vk_o

https://www.youtube.com/watch?v=jYRa-fpNonY