Basal Ganglia

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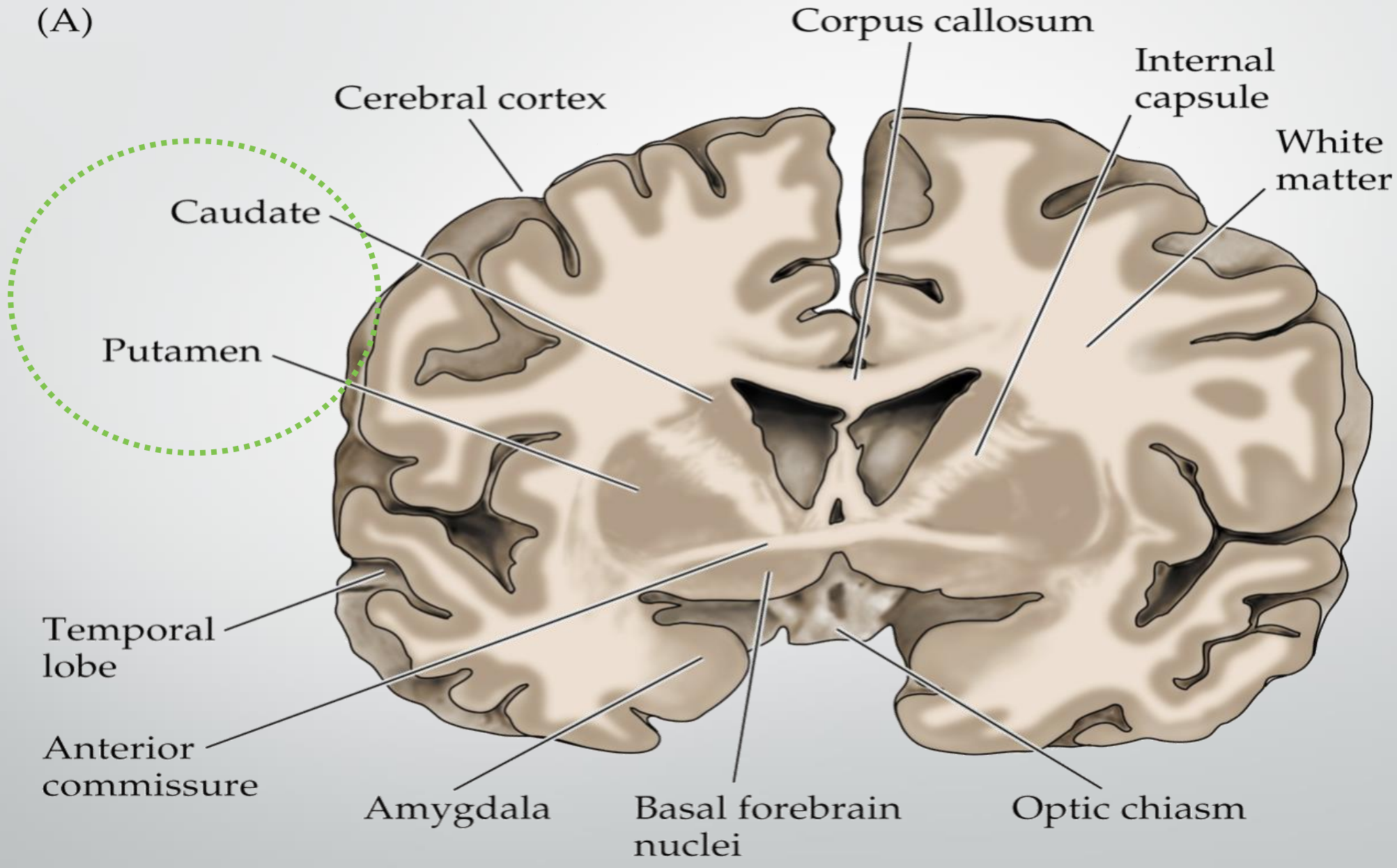
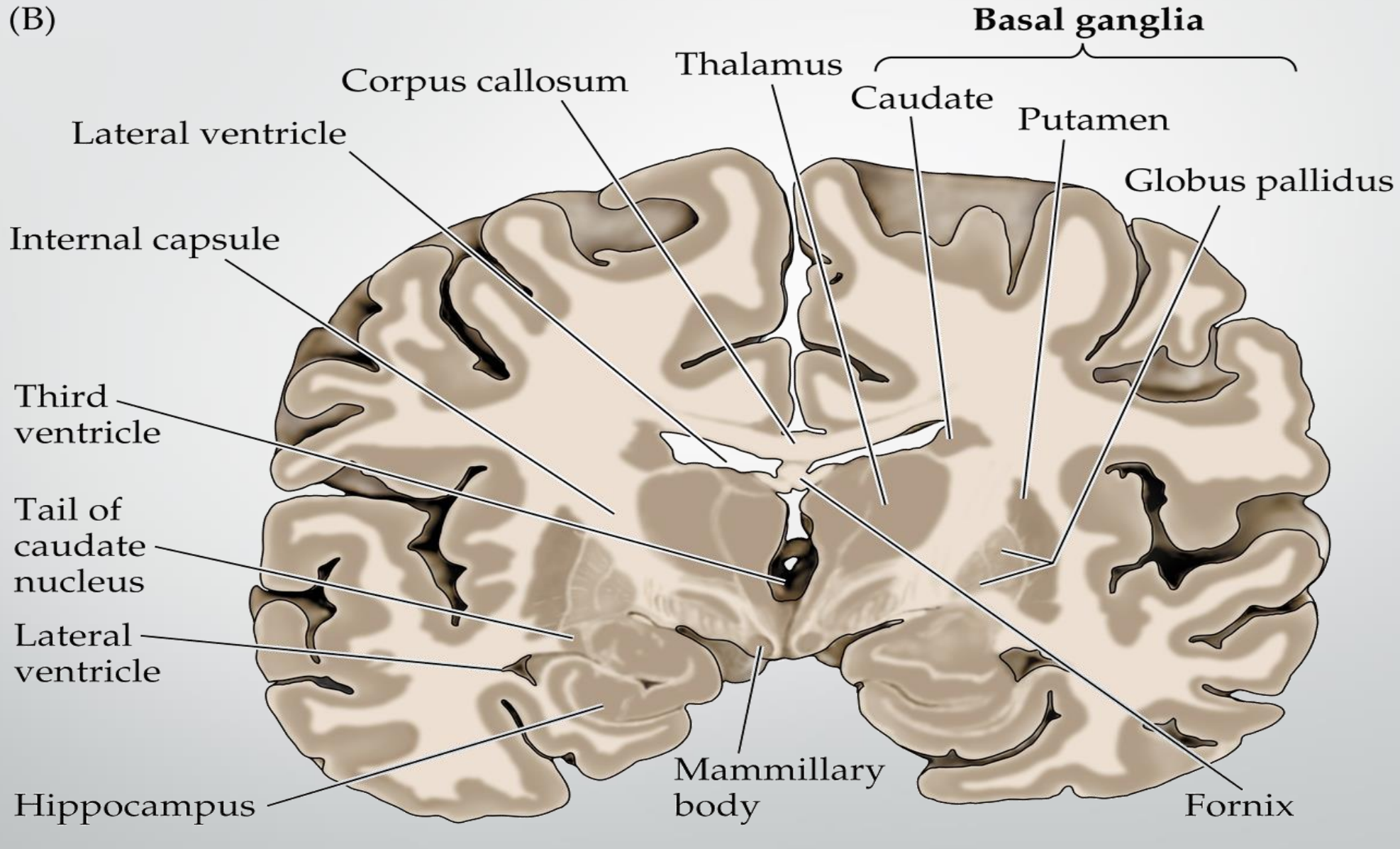
VMCH&RI

- Group of deep sub cortical nuclei located in the base of forebrain
- Consists of nuclear groups
  - Caudate nucleus
  - Putamen
  - Globus Pallidus – external & internal segment
  - Substantia Nigra – pars compacta & pars reticularis
  - Subthalamic nucleus


(A)
Corpus callosum
Internal capsule
Cerebral cortex
White matter
Caudate
Putamen
Temporal lobe
Anterior commissure
Amygdala
Basal forebrain nuclei
Optic chiasm


(B)
Basal ganglia
Thalamus
Corpus callosum
Caudate
Putamen
Lateral ventricle
Globus pallidus
Internal capsule
Third ventricle
Tail of caudate nucleus
Lateral ventricle
Hippocampus
Mammillary body
Fornix
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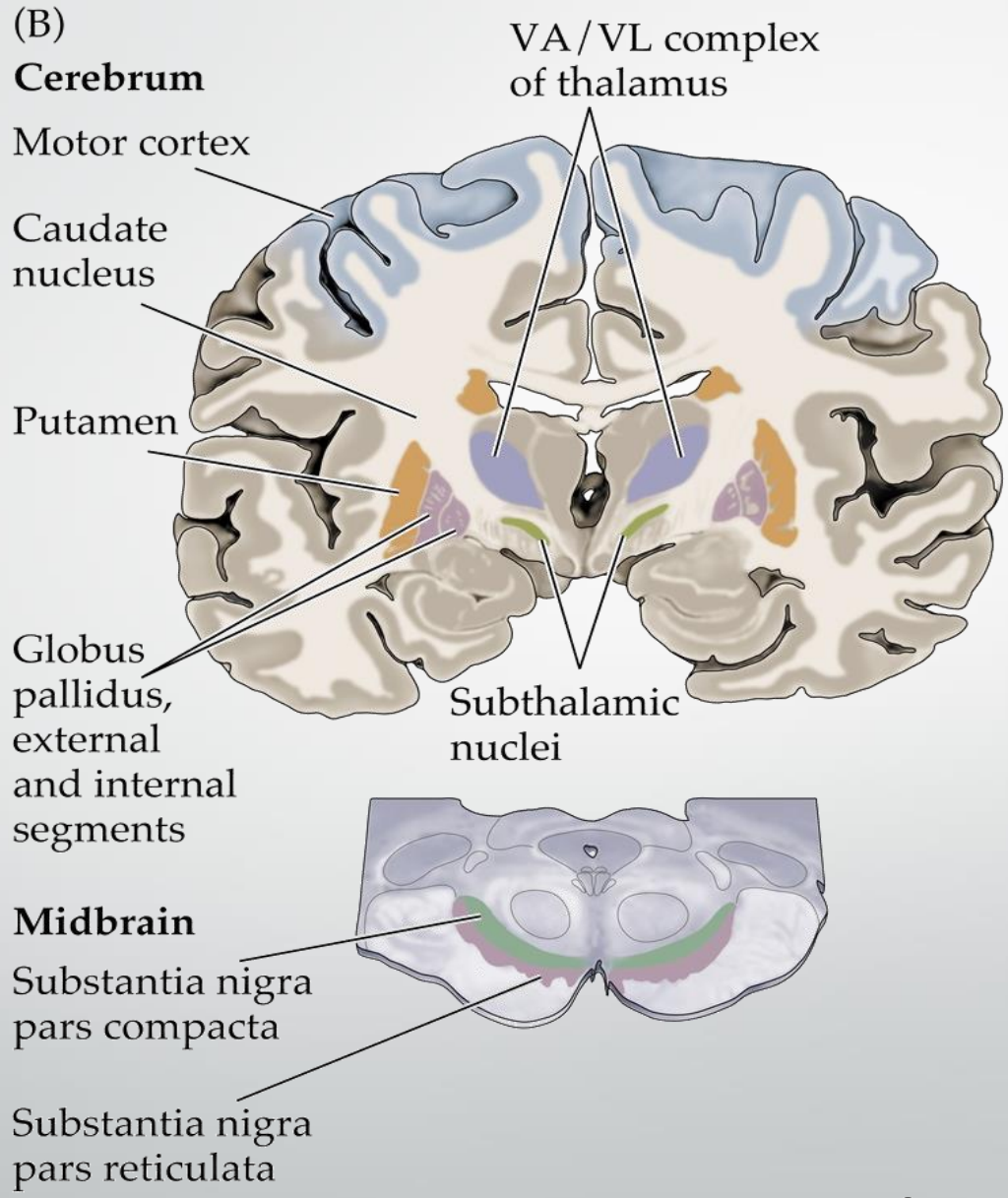


- Caudate nucleus + Putamen = Striatum
- Putamen + Globus pallidus = Lenticular nucleus
- Neural transmitters
  - Dopamine
  - GABA
  - Acetyl choline

Internal Connections

- Pars compacta of Substantia nigra to Striatum
- Striatum to Pars reticularis of Substantia nigra
- Caudate Nucleus & putamen (Striatum) to globus pallidus
- Ext Segment of Globus pallidus to Subthalamic nucleus
- Sub thalamic nucleus to Ext & Int segment of Globus pallidus

Inputs

Mainly from cerebral cortex and also from thalamus, dorsal raphe nucleus, pedunculopontine region

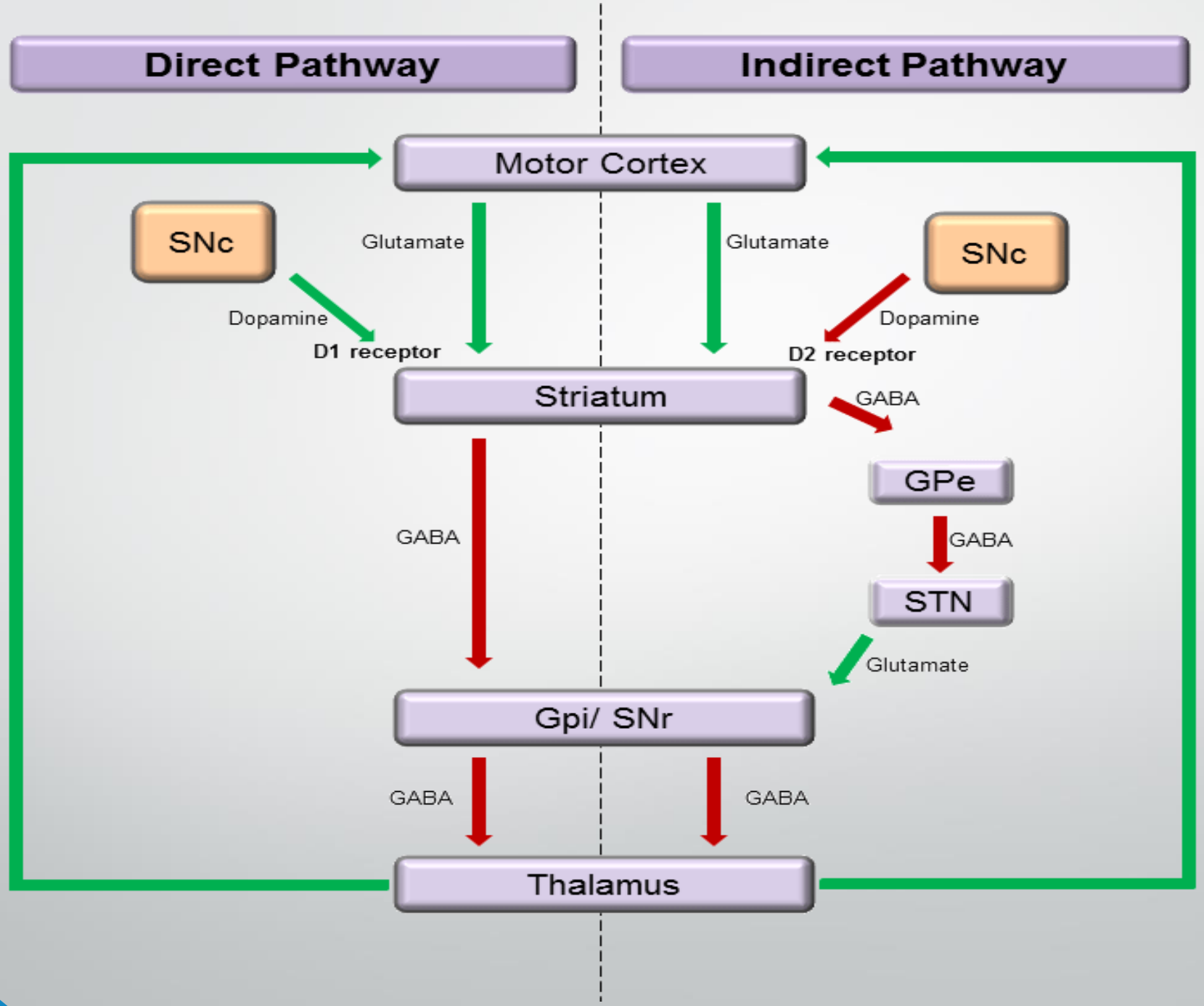
- Corticostriate projection
- Thalamo striate projection
- Raphestriate projection
- Pedunculostriate projection

Outputs

- Mainly to thalamus from globus pallidus
- Substantia nigra to thalamus
- Also basal ganglia projects to pedunculopontine nucleus & superior colliculus

Functions

- Planning and programming the voluntary motor activity
- Stretch reflex regulation
- Controls the transfer of information from sensory & associated areas to the motor cortex
- Initiation , control and cessation of muscular activity
- Provides necessary muscle tone for skilled movements
- Co-ordinates impulses for skilled motor activity
- Regulates sub conscious gross movements
- Controls associated movements that happen normally & automatically
- Cognitive functions


Direct Pathway
Indirect Pathway
Motor Cortex
SNc
Glutamate
Glutamate
SNc
Dopamine
D1 receptor
Dopamine
D2 receptor
Striatum
GABA
GPe
GABA
GABA
STN
Glutamate
Gpi/ SNr
GABA
GABA
Thalamus
Excitatory
Inhibitory
©M Gibson

Parkinsonism

James Parkinson first to identify paralysis agitans – named as parkinsonism

Degeneration of nigro-striatal pathway

With age progressive loss of dopamine & dopaminergic receptors in basal ganglia

Causes

- Idiopathic
- Drugs – phenothiazine & D2 receptor blockers
- Methyl Phenyl pyridinium accumulation destroys basal ganglia

Features

1.Hypokinetic movements
- Akinesia
- Bradykinesia
- Decreased associated Movements – mask like face

2.Hyperkinetic movements
- Rigidity(lead pipe /cog wheel)
- Tremor (resting)
- Gait(festinant)

Treatment

- Replacement of dopamine - L Dopa
- Dopamine agonists – Bromocriptine
- Anticholinergics
- Deprenyl – monoamine oxidase inhibitors
- Transplantation of adrenal gland into basal ganglia
- Implantation of some tissues of fetal basal ganglia
- Transplantation of glomus cells from carotid body

Huntington's disease

- Autosomal dominant disease
  - Defect in chromosome 4
  - Gene that codes for huntingtan – an abnormal protein
- Causes
  - Degeneration of GABAergic fibres
- Features
  - Chorea , Dimentia & Slurred speech
- Treatment
  - No Treatment – progressively fatal

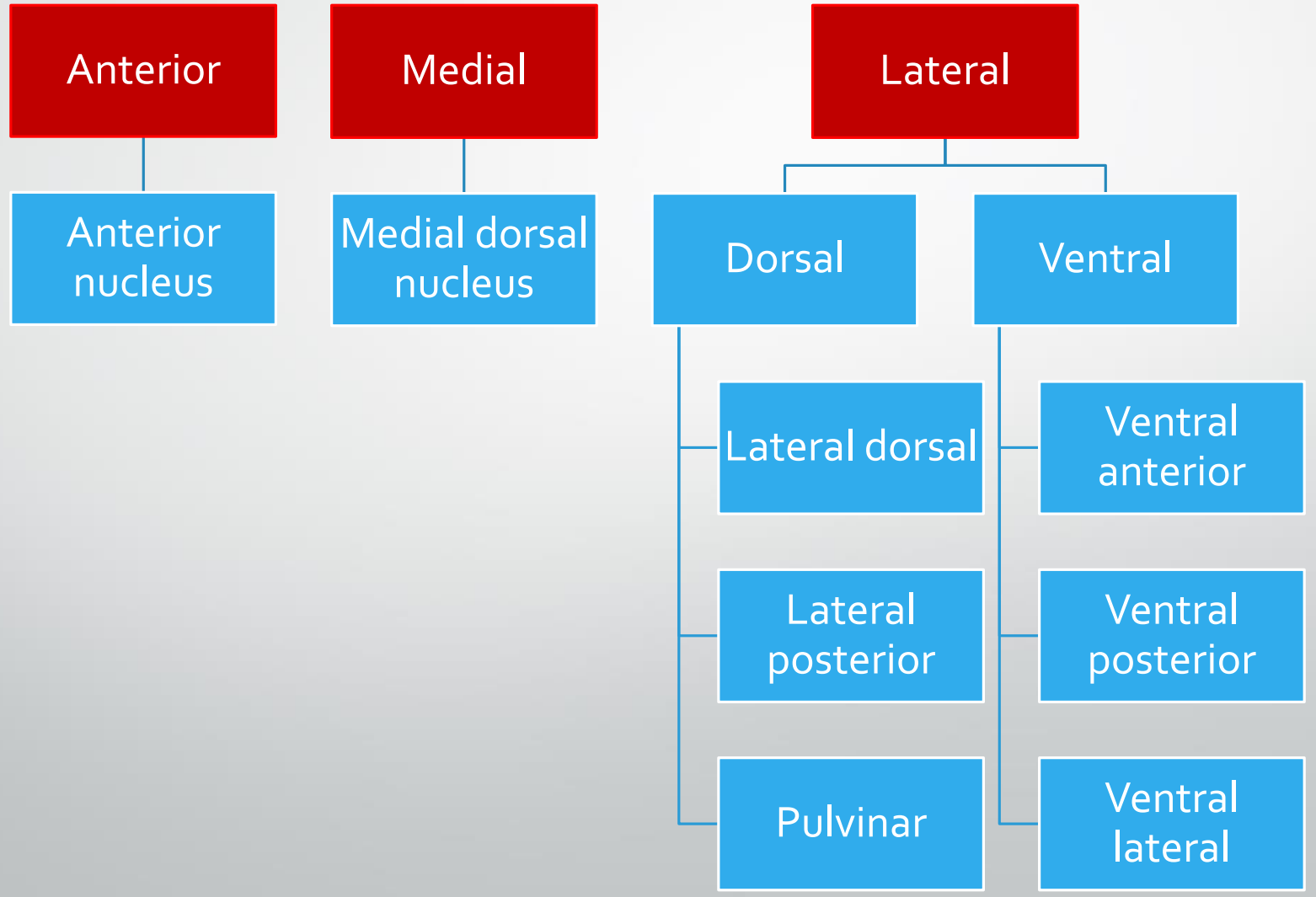
Other Dysfunctions

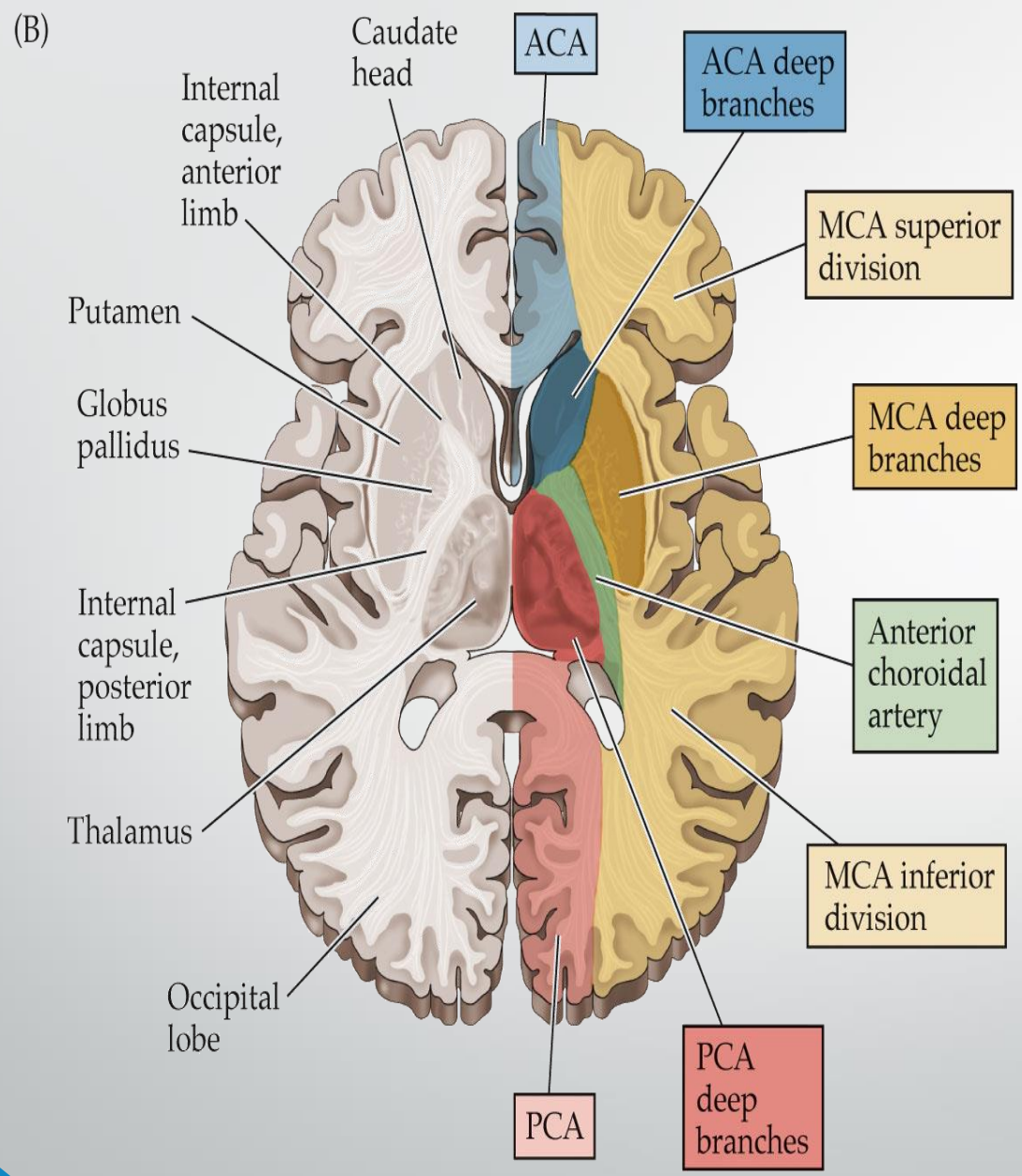
Ballism	• Involuntary movements – flailing, intense & violent in Nature • Caused by sub thalamic nuclear damage
Hemiballism	• Caused due to haemorrhage in sub thalamic nuclei
Athetosis	• Continuous but slow writhing movements • Damage to striatum
Chorea	• Damage to caudate nucleus

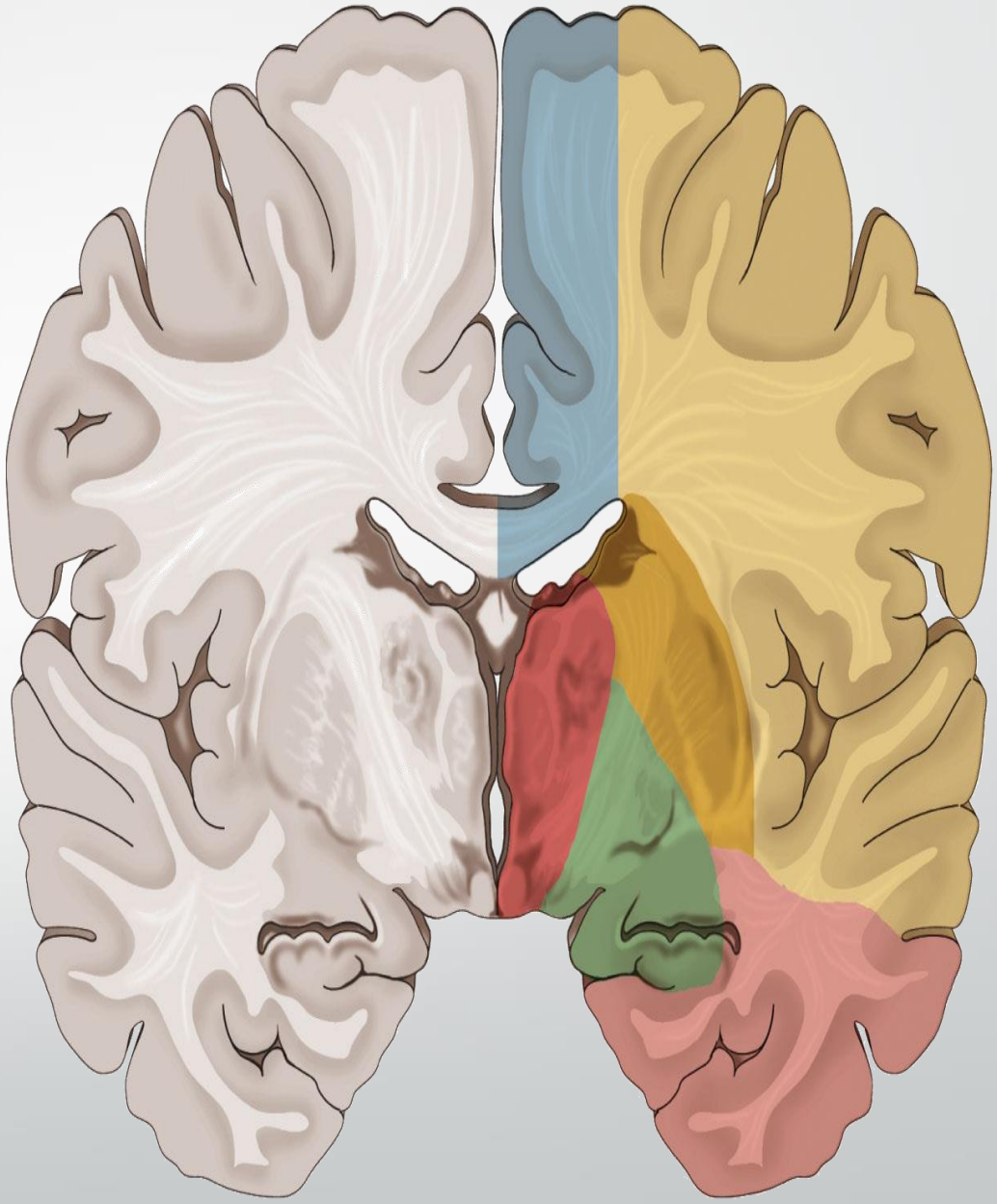
Thalamus

- Egg shaped nuclear structure – on the top of brain stem
- Sensory relay station – receives ascending inputs & projects to the sensory cortex
- Afferent fibres of reticular formation also projects to thalamus
- Thalamus also receives input from cortex

Thalamus nuclei group







Connections

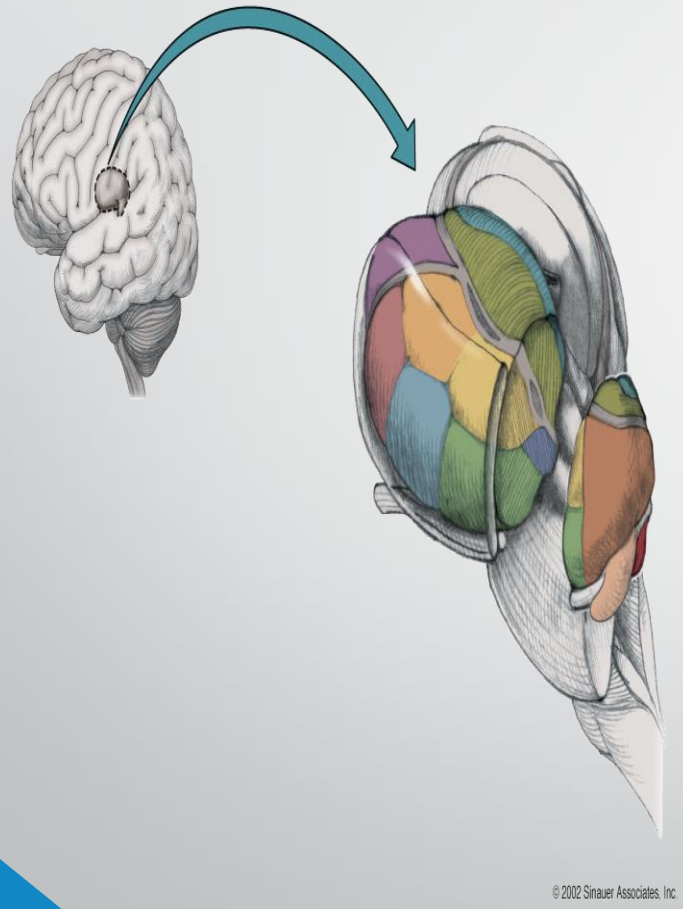
Efferent connections

- Cerebral cortex
- Caudate nucleus
- Globus pallidus
- Intra thalamic connections
- Hypothalamus & Mid brain

Afferent connctions

- Medial lemniscus – ventral postero lateral nucleus
- Spinal lemniscus - postero lateral
- Trigeminal lemniscus – ventral postero medial nucleus
- Hypothalamus – medial part of thalamus
- Cerebellum – ventral lateral nucleus
- Red nucleus – ventral lateral nucleus
- Cerebral cortex

Functions



- Sensory relay (ex Smell)
- To perform voluntary motor activity
- Storage & short term memory
- Regulates autonomic functions associated with emotions
- Responsible for consciousness,sleep and wakefulness
- Pain perception
- Genesis & synchronization of EEG waves
- Execution of speech
- Forms a link between cerebellum, basal ganglia & cerebral cortex

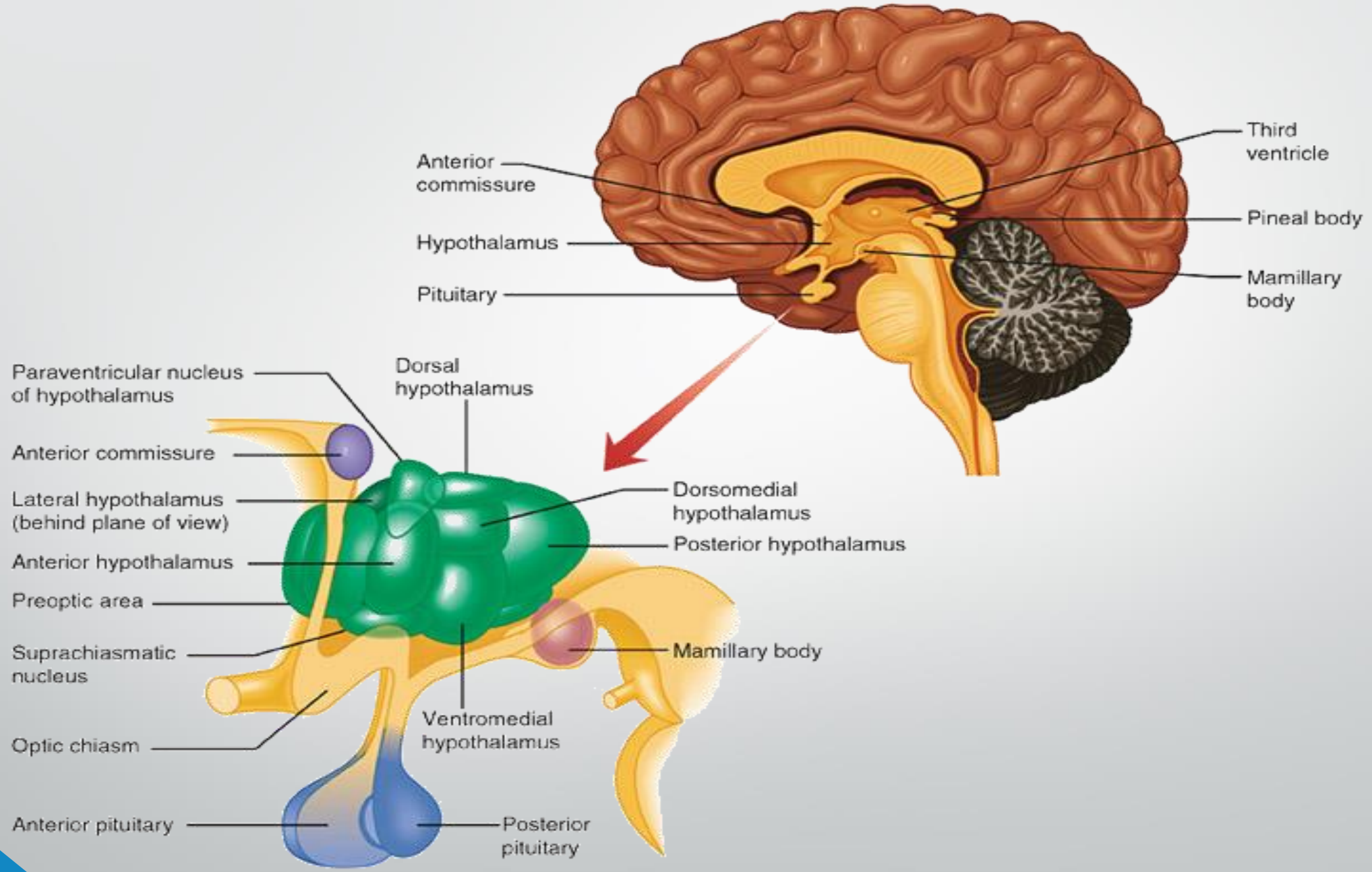
Thalamic syndrome

Ischemic damage to the postero ventral part of thalamus

Characteristic features

- Loss or alteration in different sensations
- Ataxia
- Astereognosis
- Hypotonia & muscle weakness
- Emotional disturbances
- Increased pain perception

Hypothalamus


Anterior commissure
Hypothalamus
Pituitary
Third ventricle
Pineal body
Mamillary body
Paraventricular nucleus of hypothalamus
Dorsal hypothalamus
Anterior commissure
Lateral hypothalamus (behind plane of view)
Anterior hypothalamus
Preoptic area
Suprachiasmatic nucleus
Optic chiasm
Anterior pituitary
Dorsomedial hypothalamus
Posterior hypothalamus
Mamillary body
Ventromedial hypothalamus
Posterior pituitary

Anterior hypothalamus

- Preoptic nucleus
- Paraventricular nucleus
- Supra optic nucleus
- Supra chiasmatic nucleus
- Anterior hypothalamic nucleus

Posterior hypothalamus

- Posterior hypothalamic nucleus
- Mamillary body

Medial hypothalamus

- Dorso medial nucleus
- Ventro medial nucleus
- Arcuate nucleus

Lateral hypothalamus

- Lateral hypothalamic nucleus

Afferent connections

- Cerebral cortex
- Globus pallidus
- Olfactory area
- Amygdala
- Limbic system
- Hippocampus
- Midbrain
- Reticular formation

Efferent connection

- Anterior hypothalamic nucleus
- Tegmentum of mid brain
- Brainstem reticular formation
- Frontal lobe of cerebral cortex
- Posterior pituitary
- Limbic system
- Lateral horn of spinal tract

Functions

- Control of food intake
- Regulation of water balance
- Control of anterior pituitary
- Control of posterior pituitary
- Regulation of body temperature
- Control of autonomic functions
- Control of sleep and wakefulness
- Control of circadian rhythm
- Control of behaviour

Thank you