Basal Ganglia & Cerebellum

Lab 6

October 14, 2025 - Dr. Stiver *(mikaela.stiver@ubc.ca)*

Objectives:

1. Describe the main functions of the thalamus
2. Identify the basal ganglia and associated tracts on brain specimens and micrographs
3. Relate the net effect of the direct and indirect pathways on the thalamus to their role in movement
4. Describe how motor, association, and limbic areas of the cortex interact with the basal ganglia
5. Explain the consequence of lesions to the basal ganglia
6. Identify the three different functional areas of the cerebellum (vestibulocerebellum, spinocerebellum, cerebrocerebellum) and correlate these with the surface landmarks of the cerebellum
7. Describe how the three functional areas of the cerebellum influence central nervous system (CNS) function, in particular the control of movement
8. Describe the major tracts travelling in the cerebellar peduncles
9. Explain the consequence of lesions to the cerebellum

Use the following resources to help meet the lab objectives:

Basal Ganglia (Video)

Basal Ganglia (Module)

Whole Brain (3D)

Cerebellum (Video)

Cerebellum (Module)

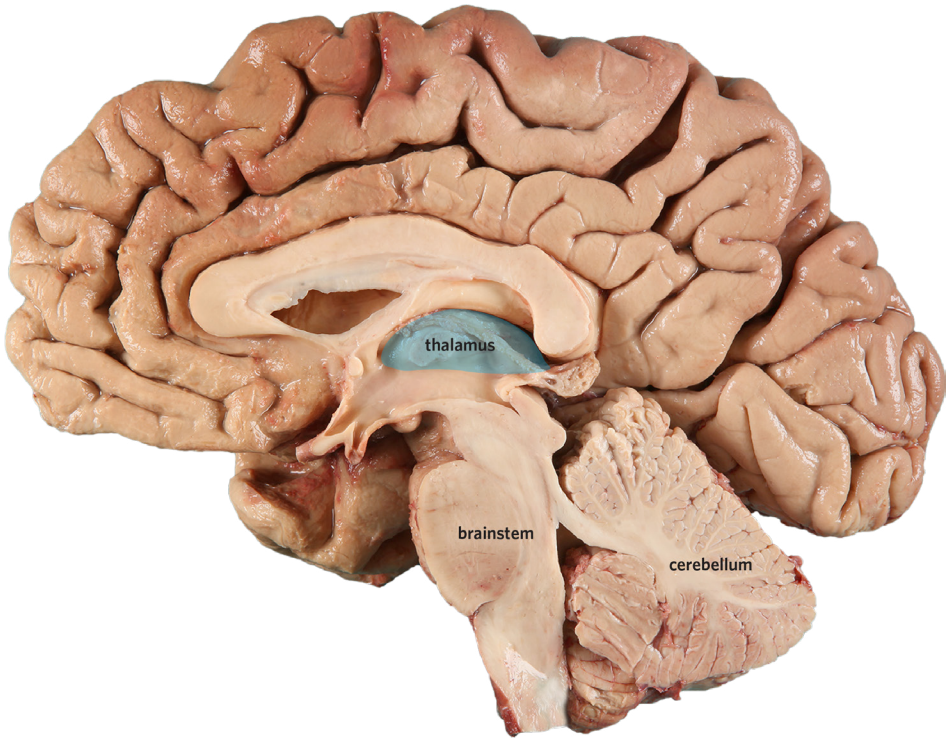
Basal Ganglia (3D)

Basal ganglia tab

Cortex (Module)

Sagittal Head (3D)

To view position and brainstem connections of cerebellum



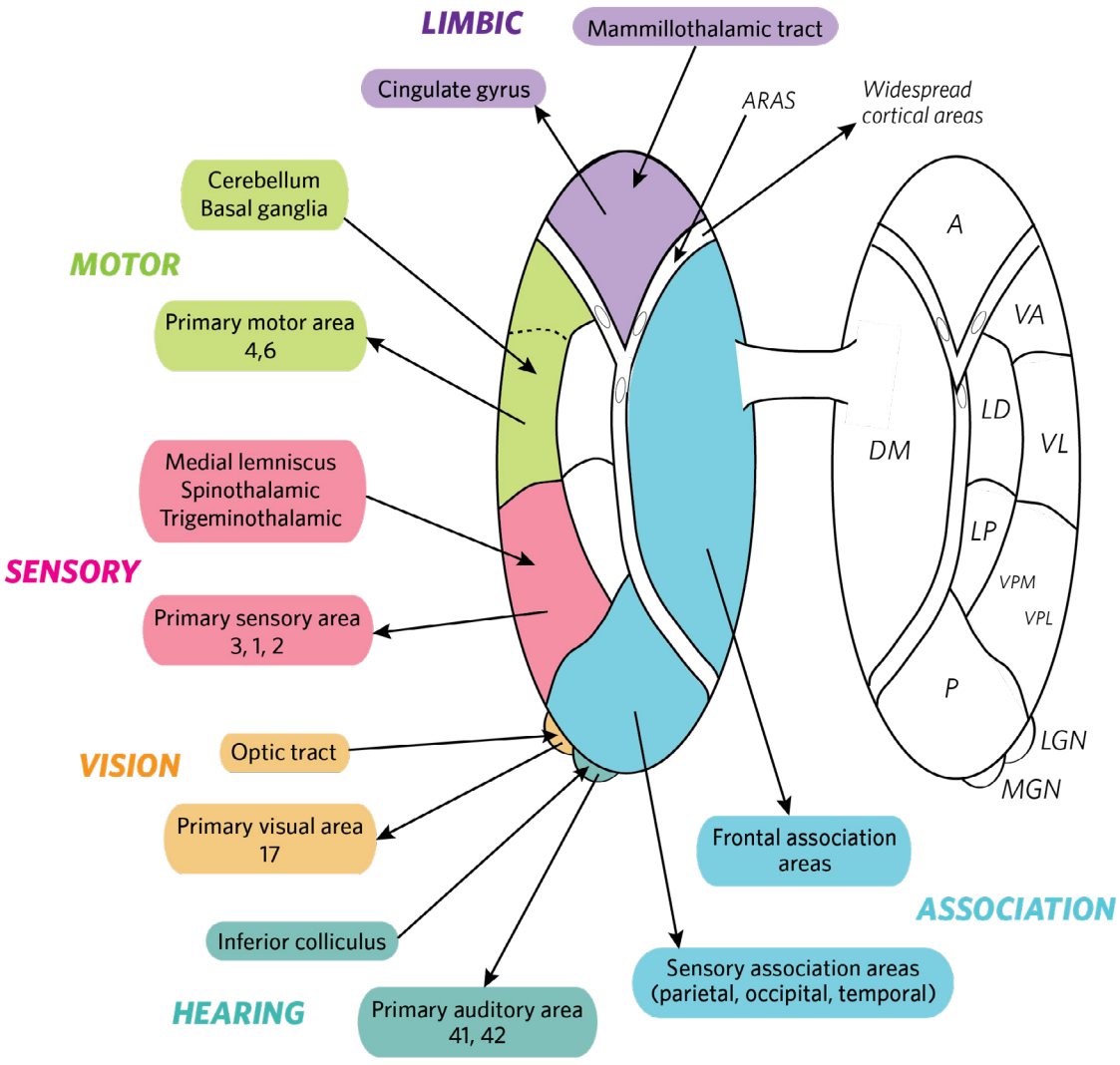
Medial view of brain

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

Overview of Thalamus:

- Describe the main functions of the thalamus
- Identify the basal ganglia and associated tracts on brain specimens and micrographs

Schematic Representaion of Thalamus
(Superior - Horizontal View)



On gross specimens & micrographs, identify:

Relationship of thalamus to:

- ◯ Ventricles
- ◯ Internal capsule

Clinical Note
A small lesion in the thalamus can mimic a larger cortical or subcortical (fiber tract) lesion.

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

Overview of Basal Ganglia:

Glossary and Abbreviations:

- caudate nucleus + putamen = neostriatum or (dorsal) striatum
- putamen + globus pallidus = lentiform or lenticular nucleus
- globus pallidus, external segment (GPe)
- globus pallidus, internal segment (GPi)
- substantia nigra (SN)
- subthalamic nucleus (STN)

Micrographs

Coronal Sections

Horizontal Sections

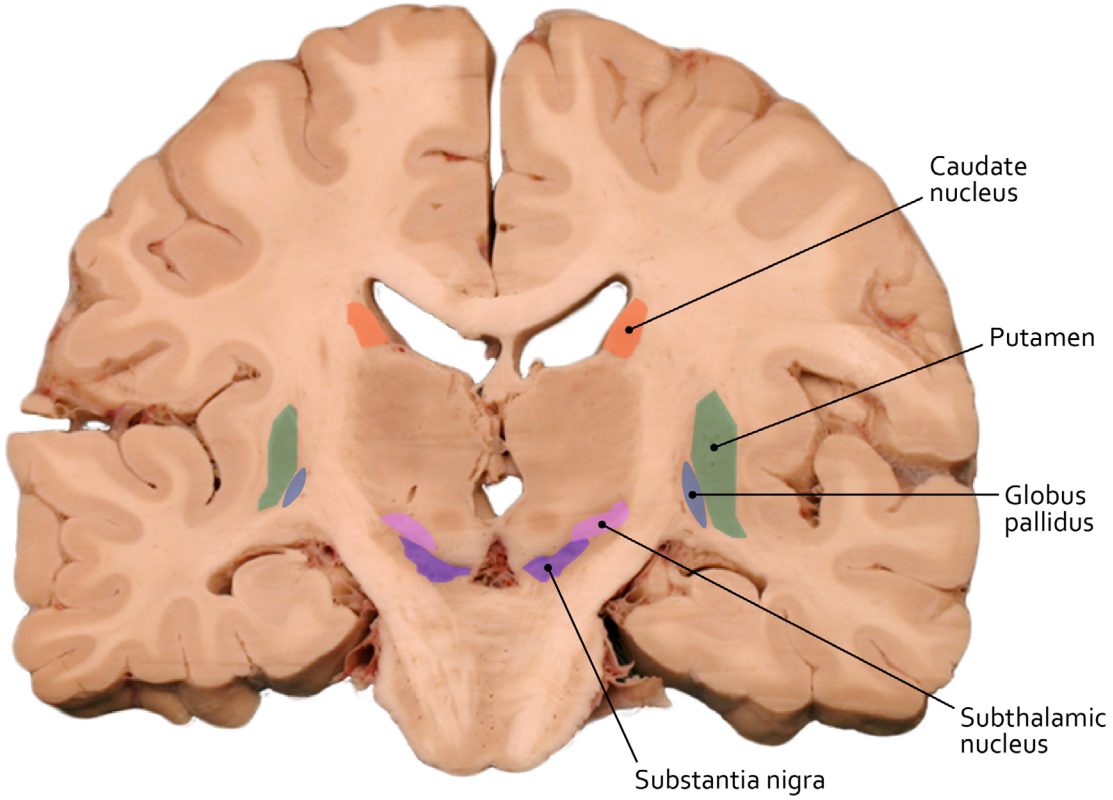
On gross specimens & micrographs, identify:

- ◯ Putamen
- ◯ Globus pallidus (external & internal)
- ◯ Caudate nucleus
- ◯ Nucleus accumbens
- ◯ Substantia nigra
- ◯ Subthalamic nucleus *(micrographs only)*
- ◯ Ansa lenticularis & subthalamic fasciculus *(micrographs only)*
- ◯ Relationship of basal ganglia to internal capsule & thalamus

The inhibitory projection from the GPi to the thalamus is called ansa lenticularis. ***Find this structure in your micrographs.***

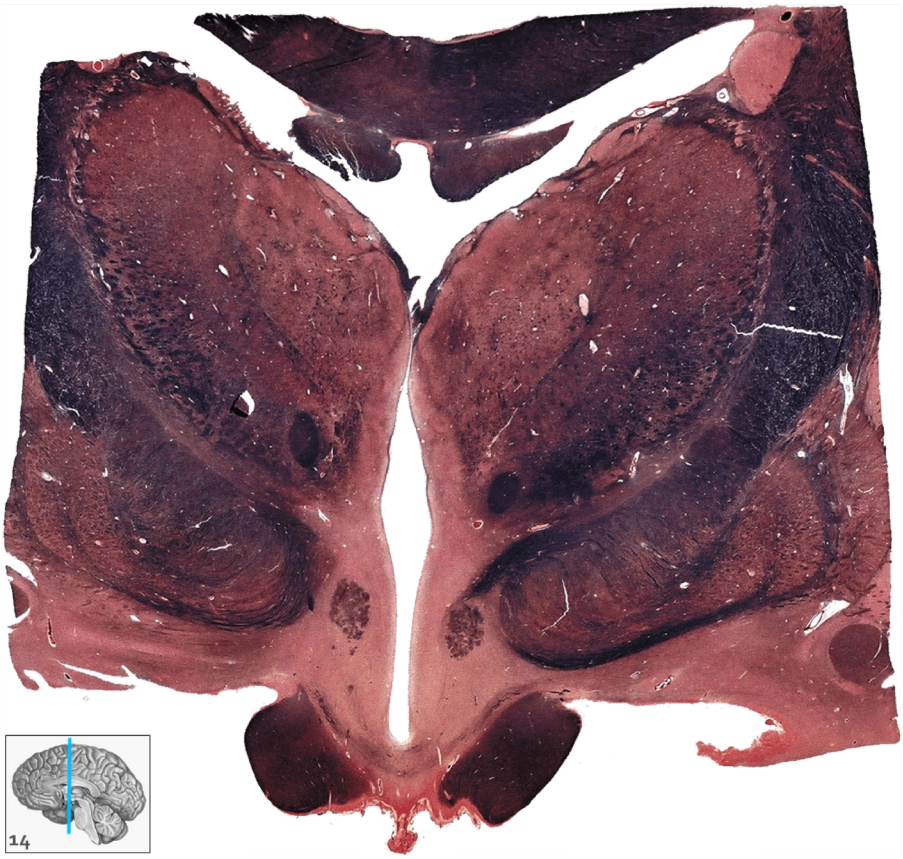
Which neurotransmitter is used by this projection?

Hide Labels



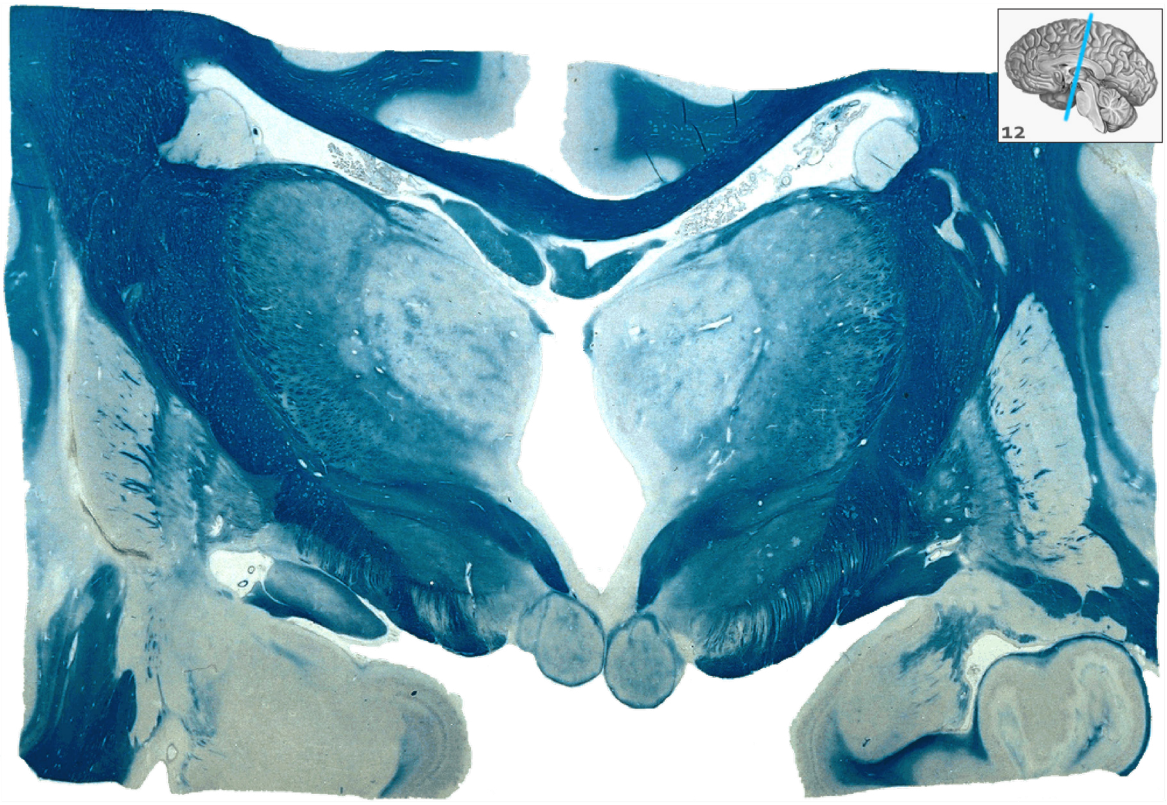
Coronal section of brain

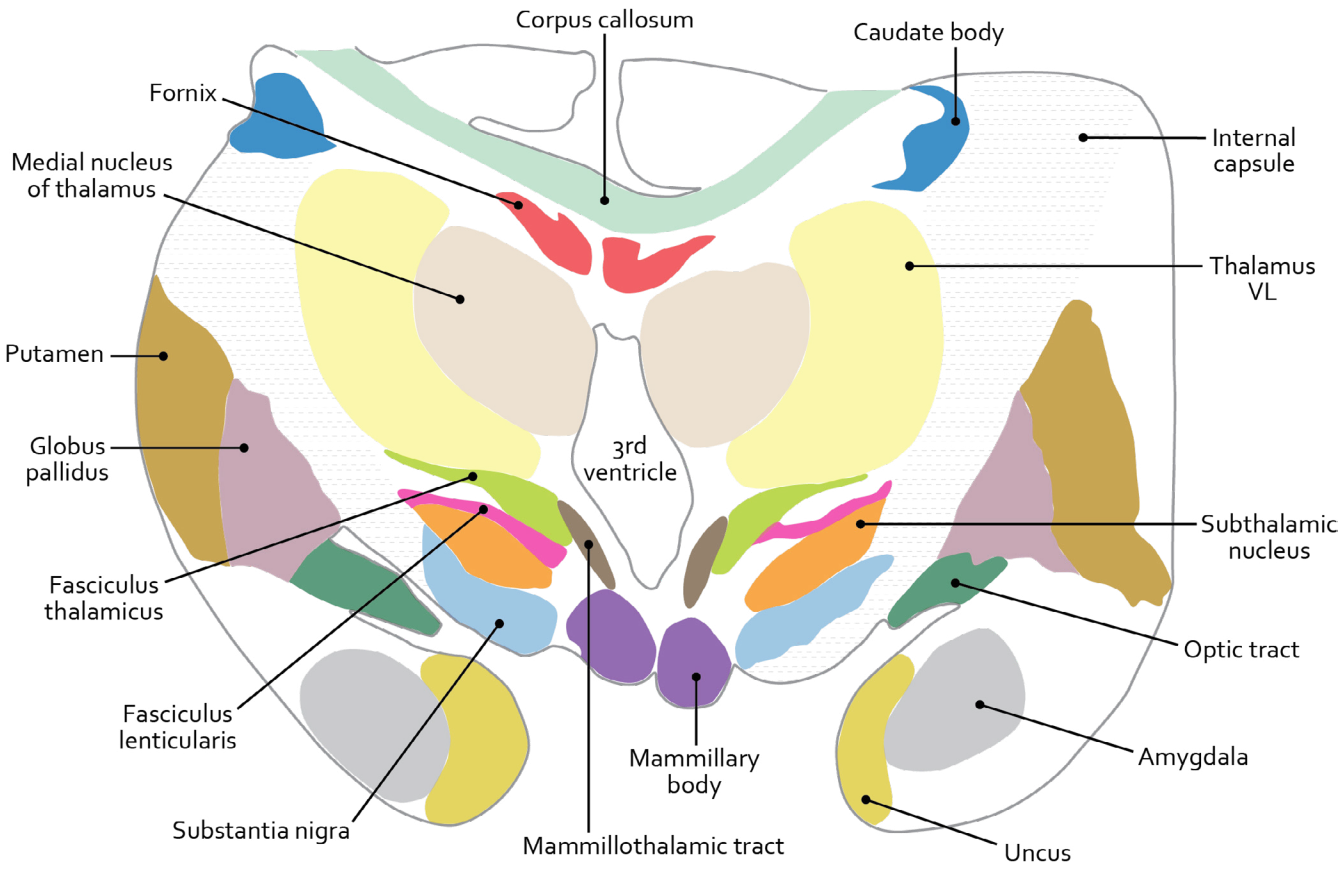
October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)



Hide Labels

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

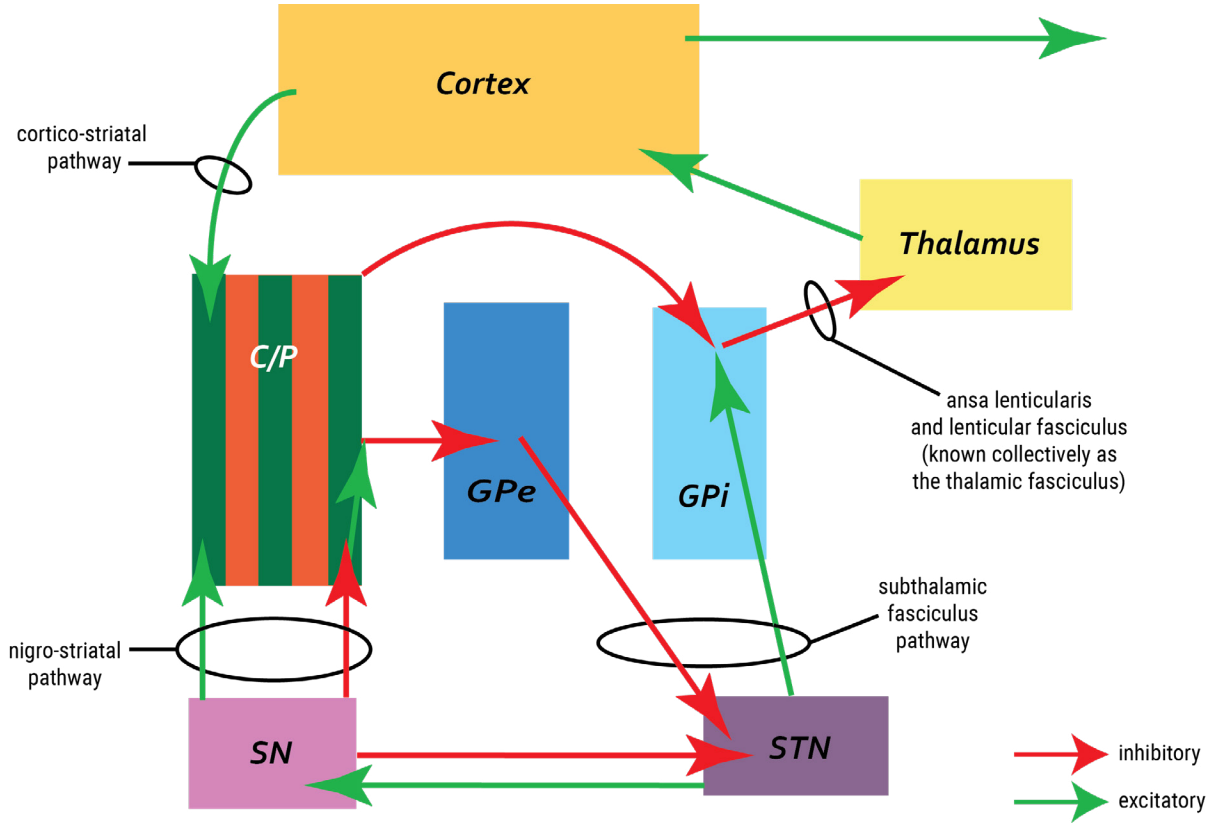




Hide Labels

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

Direct and Indirect Pathways in the Basal Ganglia



C/P = Caudate and Putamen; GPe = external segment of Globus Pallidus; GPi = internal segment of Globus Pallidus; SN = Substantia Nigra; STN = Subthalamic Nucleus

- The **thalamus** is under tonic inhibition — GABAergic neurons from the GPi to the thalamus, traveling in the thalamic fasciculus.
- The **direct pathway** releases the thalamus from its tonic inhibition by inhibiting the GPi output. This inhibition comes through a direct projection from the striatum (C/P). This leads to increased output from the thalamus to the cortex and subsequently an increase in cortical output.

  The direct pathway facilitates target oriented, efficient movement.
- The **indirect pathway** increases the inhibition of the thalamus by stimulating the GPi. The subthalamic nucleus (STN) stimulates the GPi, which in turn inhibits the thalamus. This leads to reduced output from the thalamus to the cortex and subsequently a decrease in cortical output.

  The indirect pathway inhibits superfluous and potentially competing movements.
- **Dopamine** facilitates cortical output and movement. It strengthens the direct pathway and weakens the indirect pathway. Dopaminergic projections come from the substantia nigra (SN).

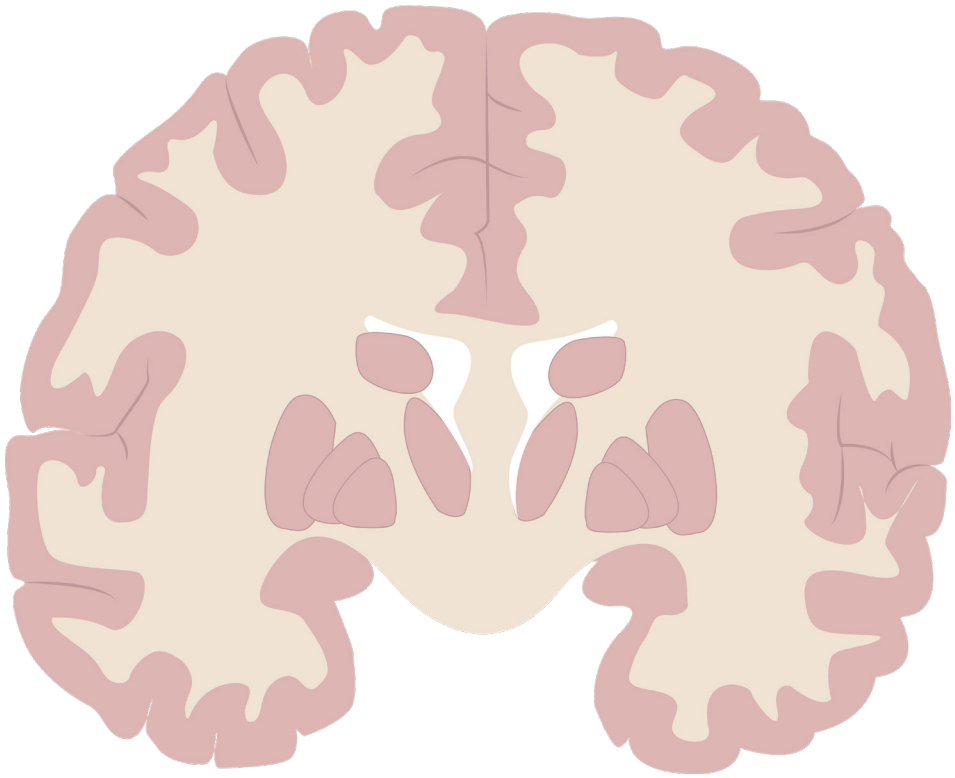
October 14, 2025 - Dr. Stiver *(mikaela.stiver@ubc.ca)*

Use these templates to draw in nuclei of the basal ganglia as seen in horizontal & coronal cross-sections.

Coronal Sections

Horizontal Sections

Horizontal



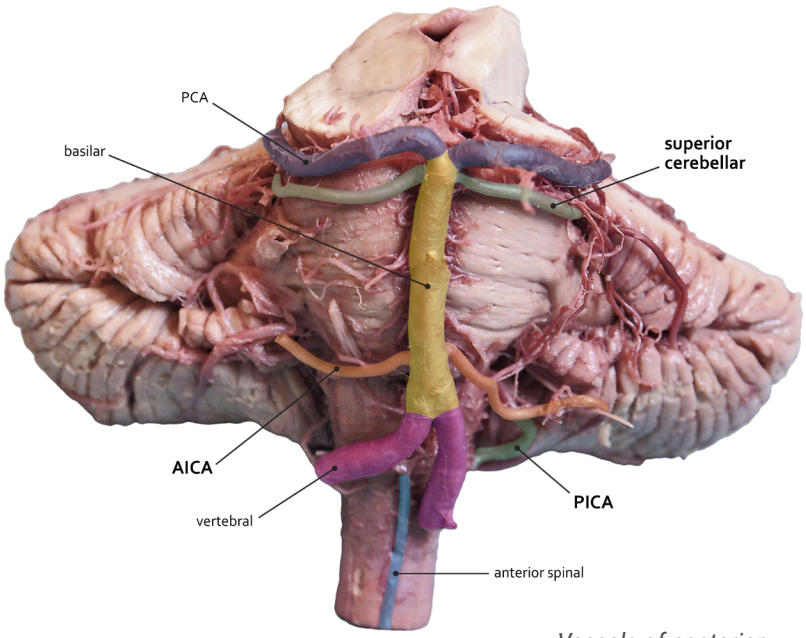
Coronal

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

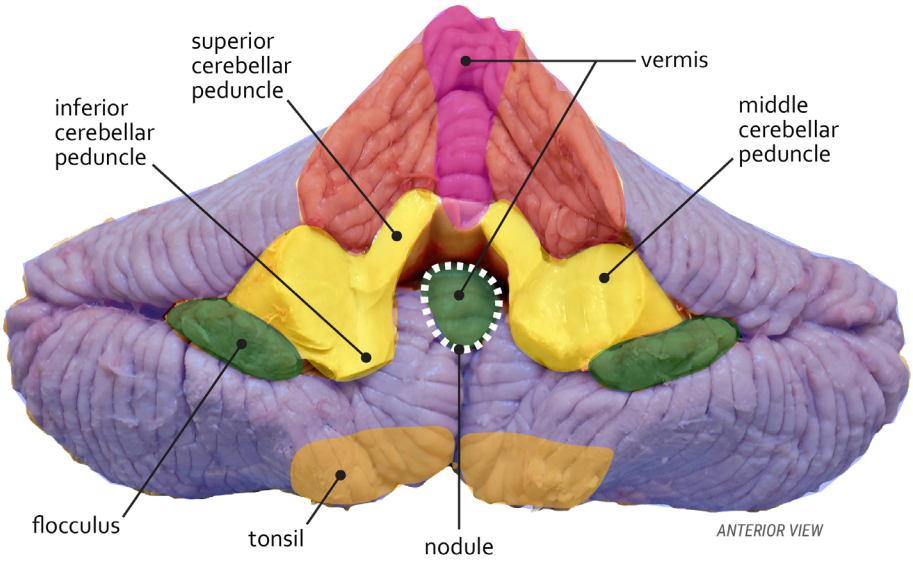
The Cerebellum

On gross specimens & micrographs, identify:

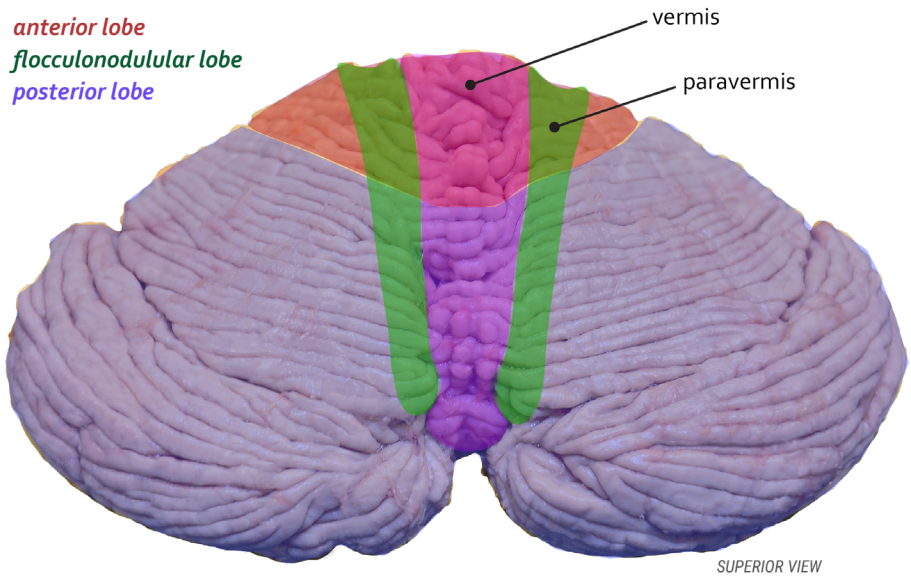
- Cerebellar hemispheres
- Cerebellar lobes
- Flocculus, nodule, vermis, cerebellar tonsils
- Dentate nucleus (micrographs only)
- Cerebellar peduncles
- Blood supply:
  - Posterior inferior cerebellar artery (PICA)
  - Anterior inferior cerebellar artery (AICA)
  - Superior cerebellar artery (SCA)



Vessels of posterior brainstem and cerebellum



anterior lobe
flocculonodulular lobe
posterior lobe



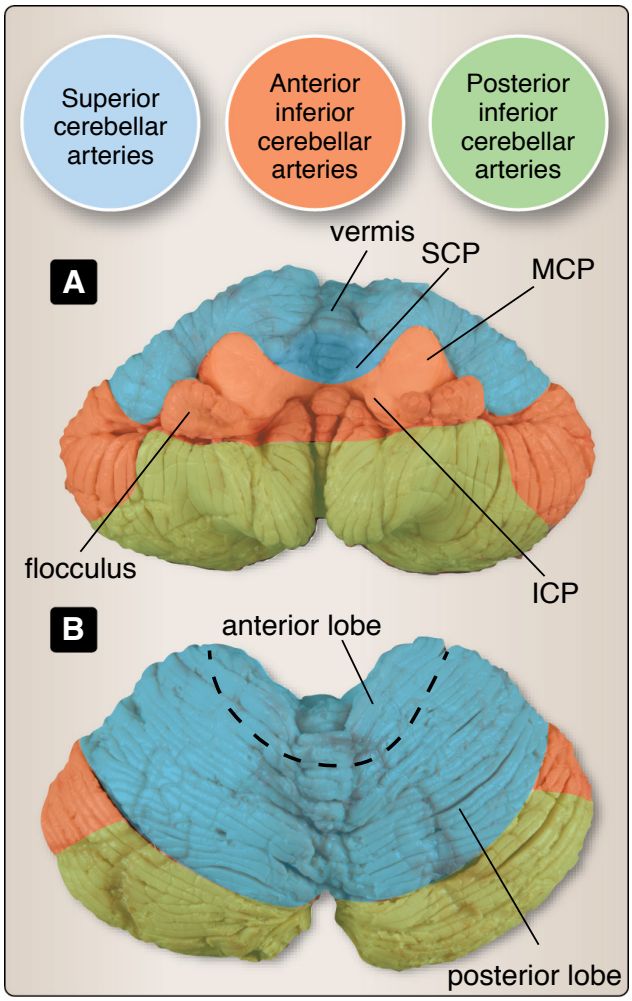
Hide Labels

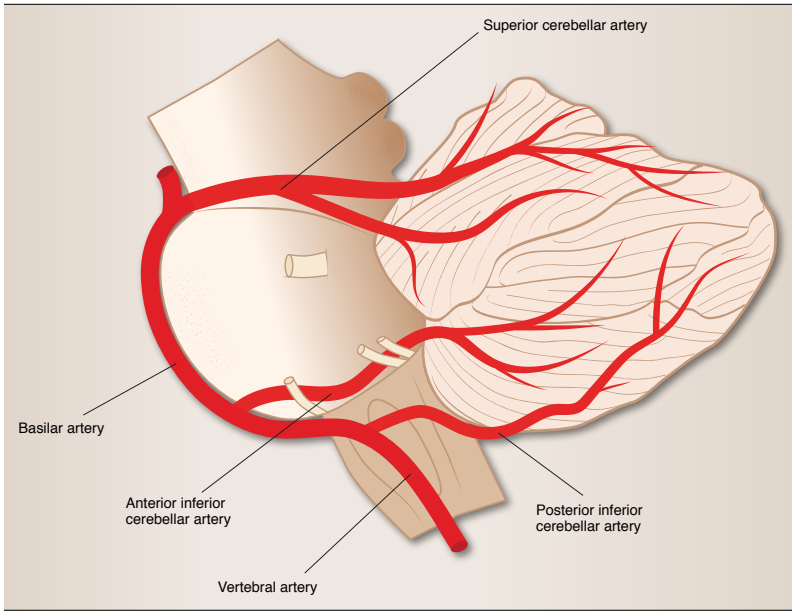
Cerebellum

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

Blood Supply to the Cerebellum

AICA	• Cerebellar peduncles • Flocculus, nodule (flocconodular lobe) • Lateral aspect of posterior lobe on inferior surface • Assists with supply to deep cerebellar nuclei
PICA	• Posterior lobe: inferior surface, extending onto superior surface • Tonsils • Inferior part of vermis
SCA	• Anterior lobe • Posterior lobe: superior aspect, strip adjacent to anterior lobe • Vermis on superior surface • Major supply to deep cerebellar nuclei • Can assist with supply to superior cerebellar peduncle (SCP), rostral parts of middle cerebellar peduncle (MCP)





Krebs et al., Lippincott's Illustrated Reviews - Neuroscience, 2nd ed.

October 14, 2025 - Dr. Stiver *(mikaela.stiver@ubc.ca)*

CASE 1

A **72-year-old man** presents to your office for a 6-month follow-up appointment.

You have been seeing him in regard to a **right hand tremor with slowness in movement on the right**.

He has had these symptoms for 9 years.
He is on medication for this concern.

He tells you that the tremor is getting worse and that is it more prominent when he is sitting at rest or walking.
His wife has noticed that his gait has been slow for the past 6 years.
He has also noticed that he is slower with movement in his right hand despite the medications that he is taking for this medical condition.
He denies any weakness or sensory changes.
He denies any unsteadiness except occasionally when he turns quickly he can lose his footing.

On review of his records, you recall the following trouble:

Smell: Yes, my food tastes bland, occurring for the past 10 years
Sleep: Yes, my wife tells me that I kick around in my sleep and appear distressed during this period
Urination: Yes, I am getting up 3-5 times in the middle of the night but no trouble during the day
Bowel function: Yes, I am constipated at times
Lightheadedness when standing: Occasionally, but only in the morning

Today you ask the same questions and find out that all the above positive symptoms have worsened in the past 6 months.
He is frequently lightheaded when standing and he is constipated all the time.

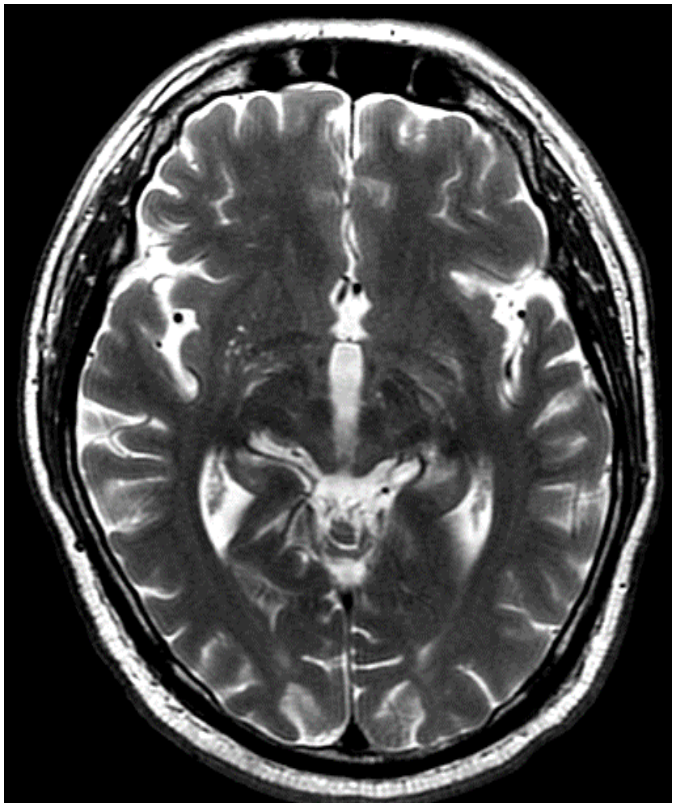
In addition you ask the following:

Behaviour changes: No
Mood concerns: He denies a low mood but his wife later tells you that she is concerned about his mood; he is less interactive, socially withdrawn, but there is no suicidal ideation.
Cognitive symptoms: He has noticed trouble with his ST memory of the past few months. He is not as quick to recall information and has word finding difficulties. He denies any geographic disorientation or impairment in judgement, insight or planning. He is able to do his ADL and IADLs. His friends have noticed this change.

On examination, his blood pressure lying down is 130/78 and standing is 104/72.
He has less animation in his face with reduced blinking.
He has rigidity on the right >> left arm with cogwheeling at both wrists.
There is a resting tremor in the right hand.
His strength, reflexes, sensation, and coordination is normal.
He has slow small amplitude movement of the right >>> left hand.

He has reduced arm swing on the right and slow gait with slight stooped posture.
He turns slowly.

October 14, 2025 - Dr. Stiver (mikaela.stiver@ubc.ca)

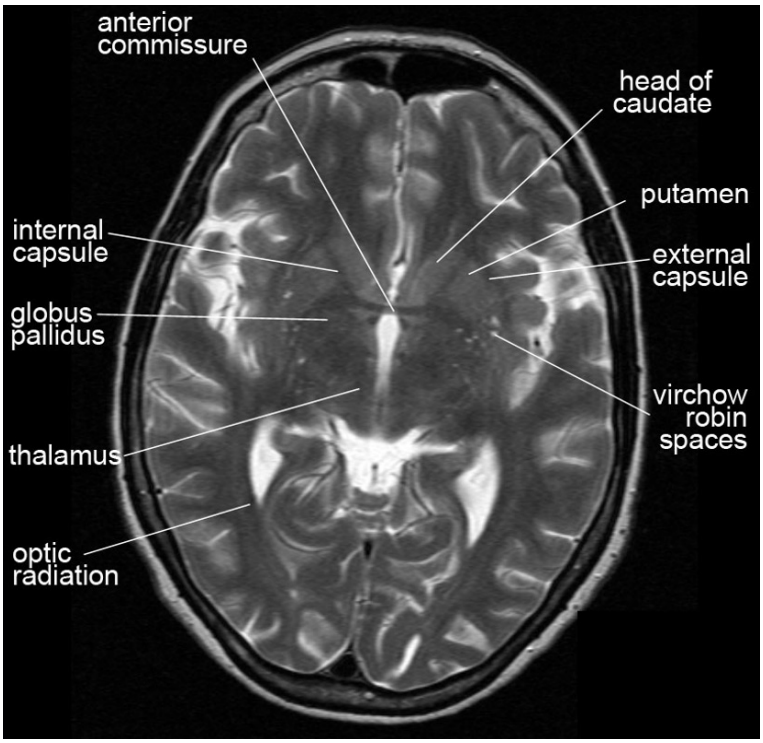


What is this patient's medical condition?

Where is the pathology to explain why the right side is more involved?

What is the reason for the constipation and nocturia?

Why are his cognition and mood changing?

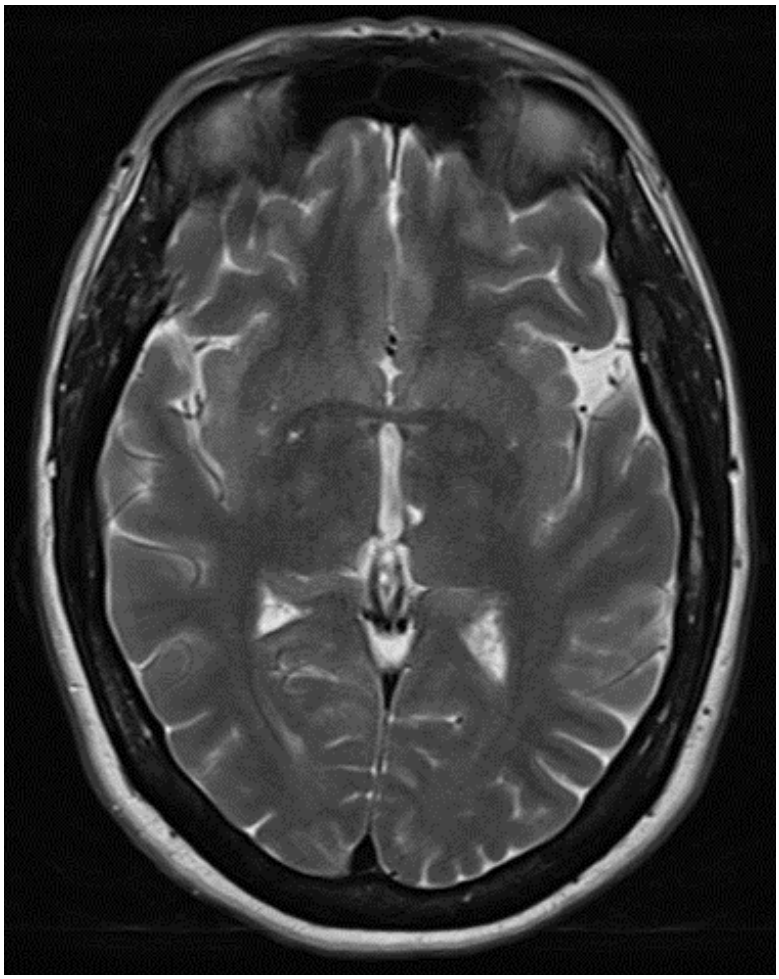


October 14, 2025 - Dr. Stiver *(mikaela.stiver@ubc.ca)*

CASE 2

A **78-year-old man** with a history of **hypertension and diabetes** presents to your office for follow-up 2 months after his **stroke**.

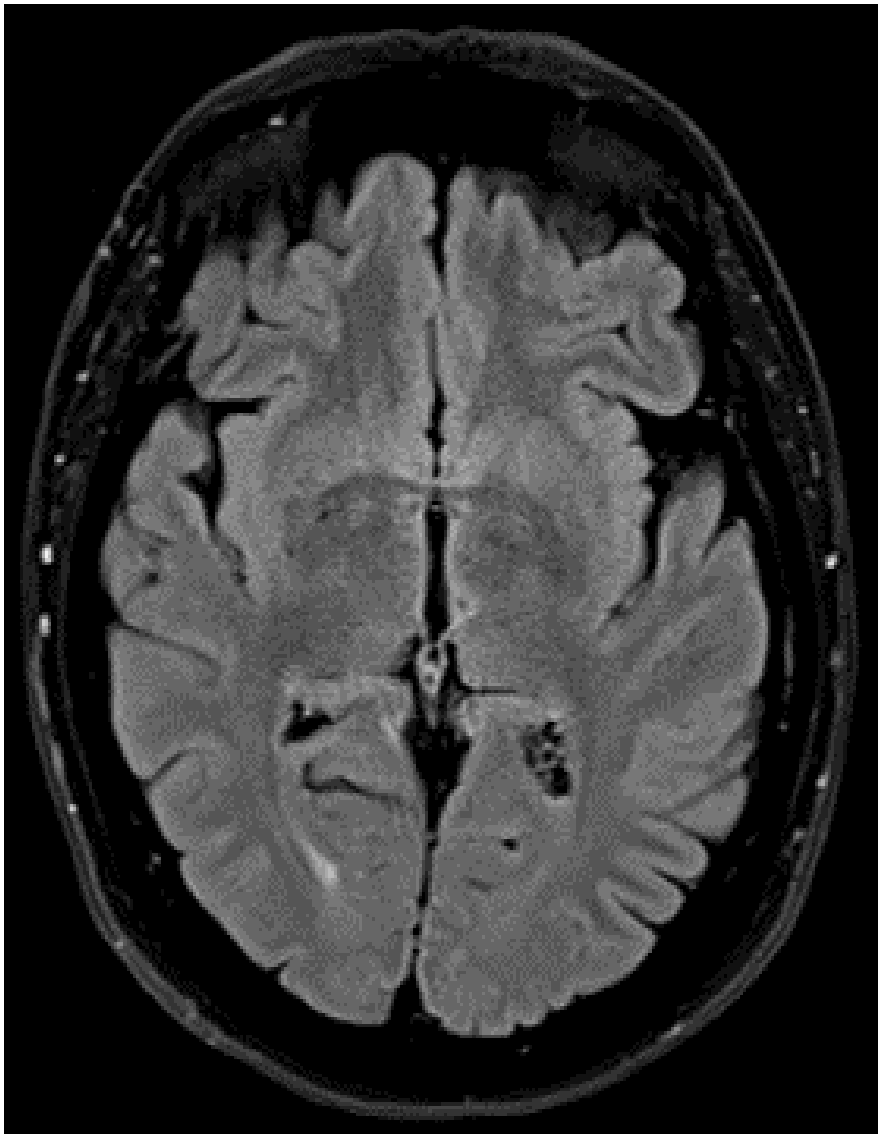
You review the imaging and see that the stroke affected the **left subthalamic nucleus**.



Which vessel was likely involved in this stroke?

What type of movement disorder will this patient have? Why?

October 14, 2025 - Dr. Stiver *(mikaela.stiver@ubc.ca)*



On which side will the movement disorder present? Explain why.