

Basal Ganglia & Cerebellum

November 21, 2023 - Dr. Krebs (claudia.krebs@ubc.ca)

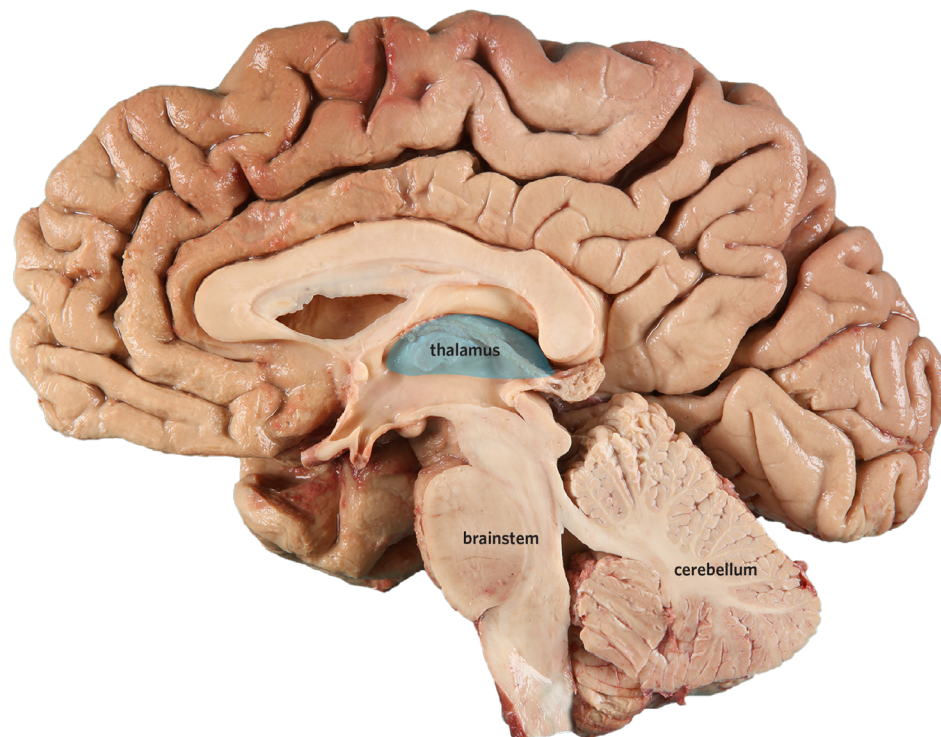
Objectives:

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 tab

To view position and brainstem connections of cerebellum



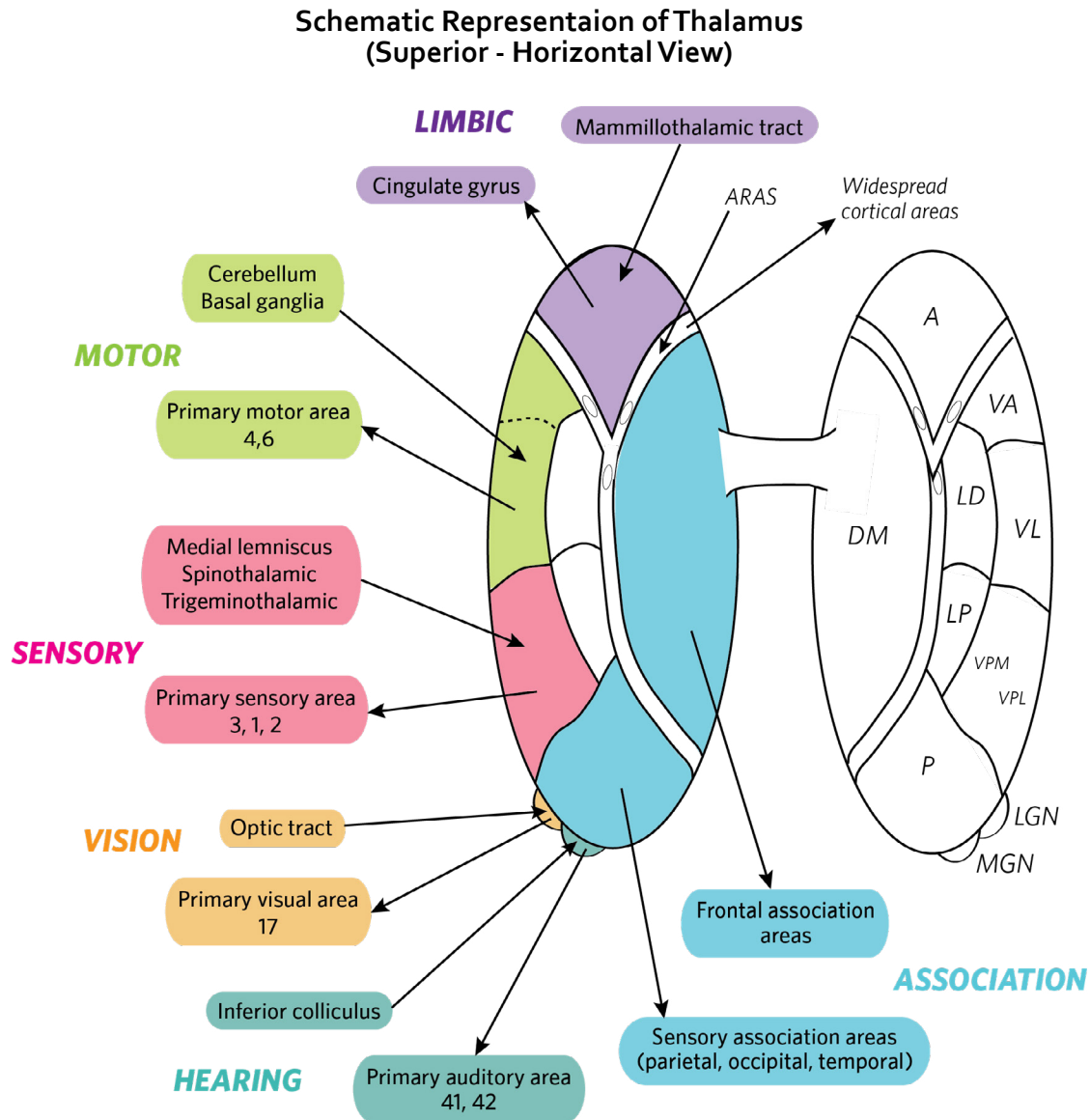
Medial view of brain

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Overview of Thalamus:

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



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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.

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Overview of Basal Ganglia:

Glossary and Abbreviations:

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

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.

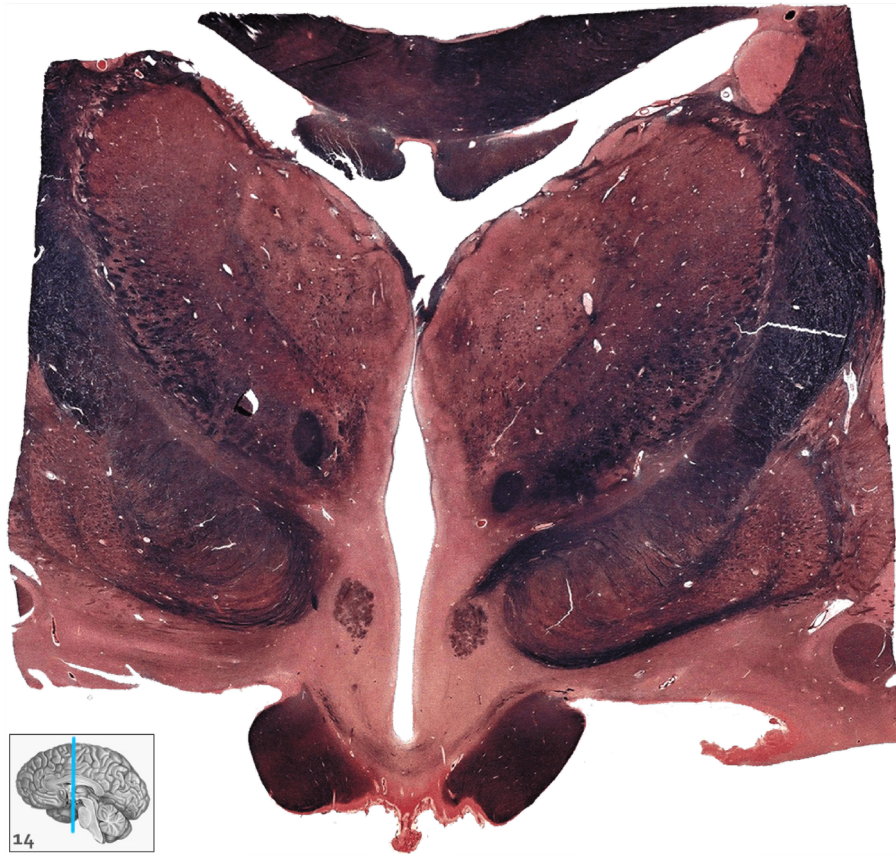
Find this structure in your micrographs.

Which neurotransmitter is used by this projection?

Coronal section of brain

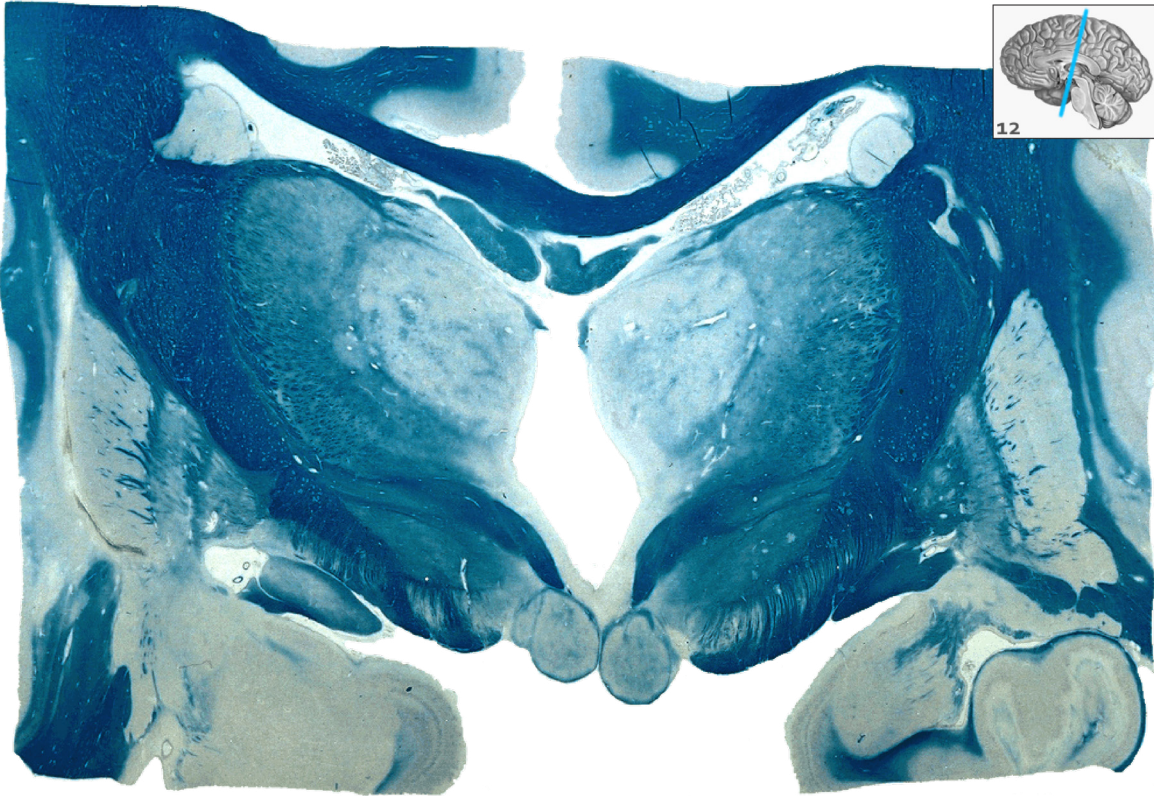
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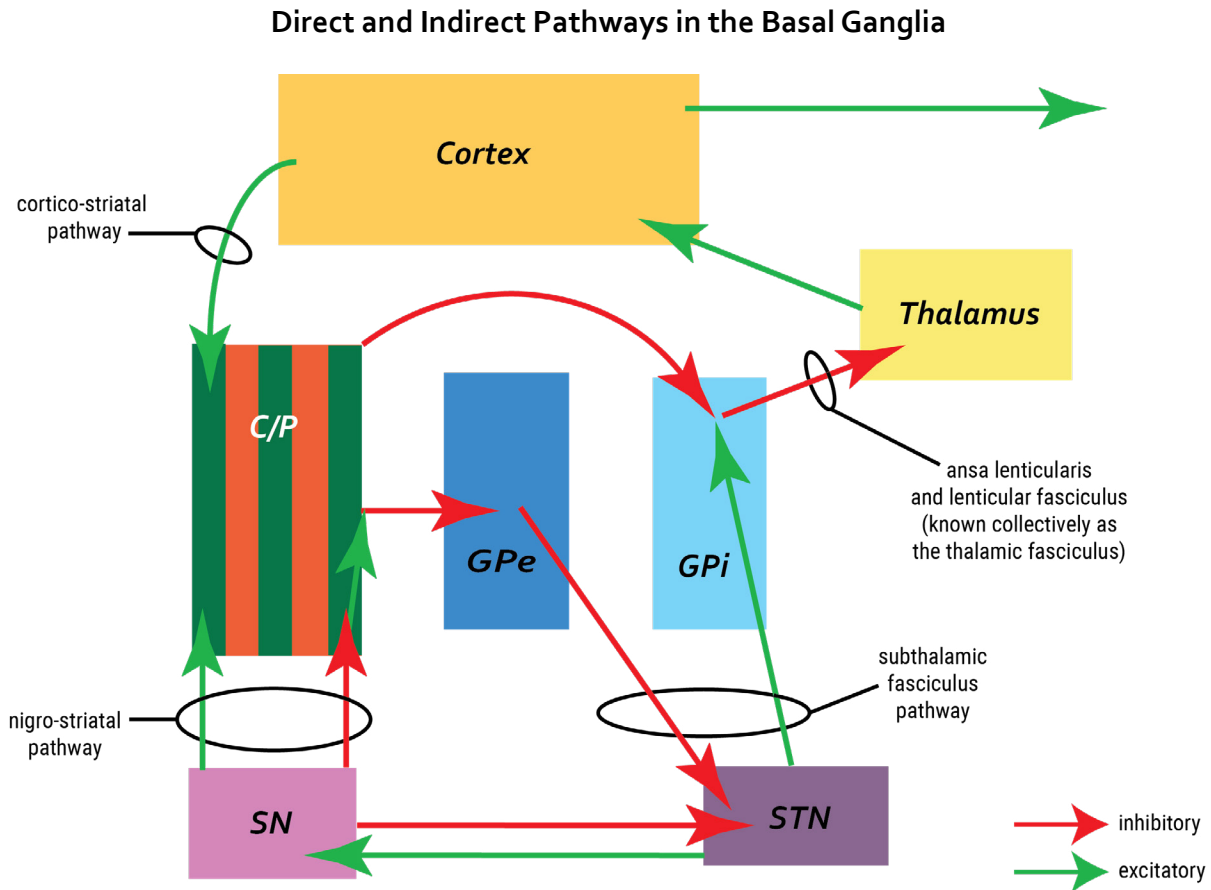
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C/P = Caudate and Putamen; GPe = external segment of Globus Pallidus; GPi = internal segment of Globus Pallidus; SN = Substantia Nigra; STN = Subthalamic Nucleus

- The **thalamus** is under chronic inhibition - GABAergic neurons from the GPi to the thalamus, traveling in the thalamic fasciculus.
- The **direct pathway** releases the thalamus from its chronic inhibition by inhibiting the GPi output. This inhibition comes through a direct projection from the striatum (C/P). This leads to an increased output from the thalamus to the cortex.
The direct pathway facilitates target oriented, efficient movement.
- The **indirect pathway** increases the inhibition of the thalamus by stimulating the GPi. This stimulation of the inhibition of the thalamus comes from the subthalamic nucleus (STN). This leads to reduced output from the thalamus to the cortex.
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).

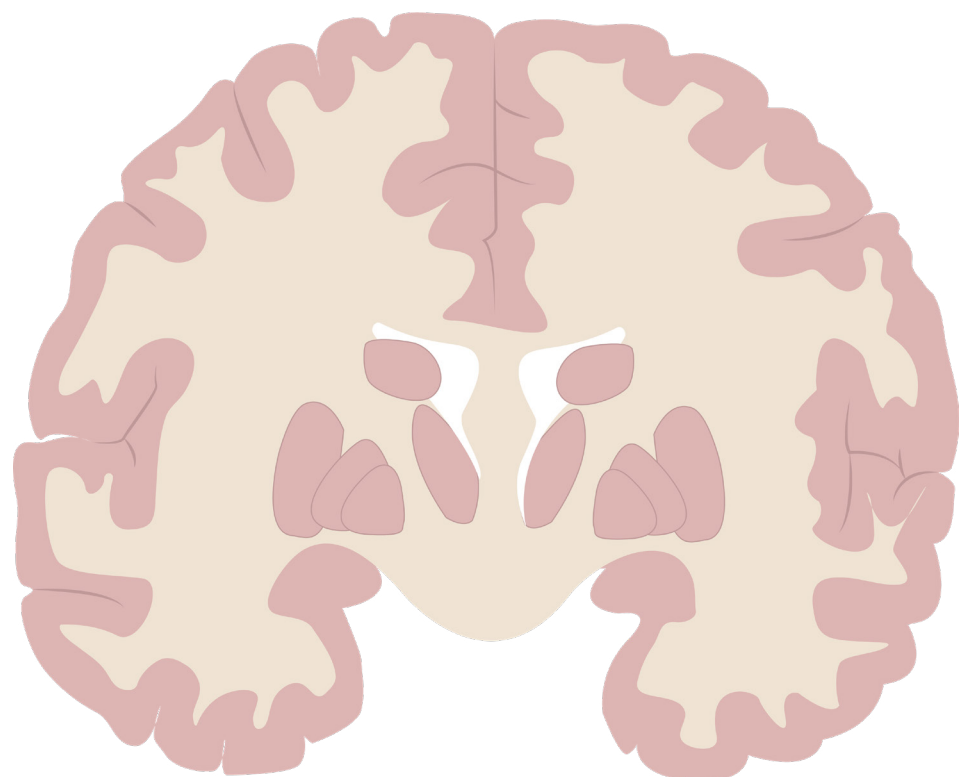
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Use these templates to draw in nuclei of the basal ganglia as seen in horizontal & coronal cross-sections.



Horizontal



Coronal

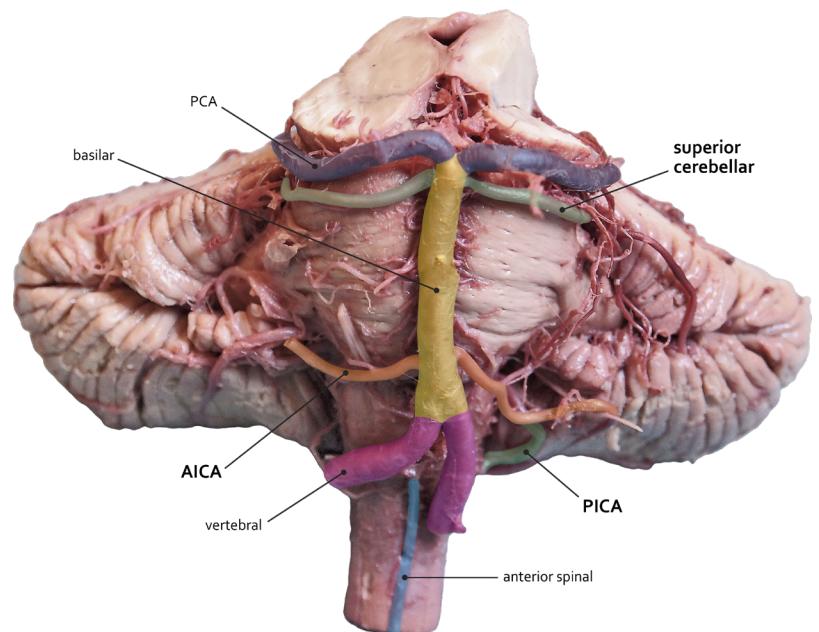
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The Cerebellum

On gross specimens & micrographs, identify:

- Cerebellar hemispheres
- Cerebellar lobes
- Flocculus, nodulus, vermis, cerebellar tonsils
- Dentate nucleus (micrographs only)
- Cerebellar peduncles
- Blood supply:
 - PICA
 - AICA
 - Superior cerebellar artery



Vessels of posterior brainstem and cerebellum

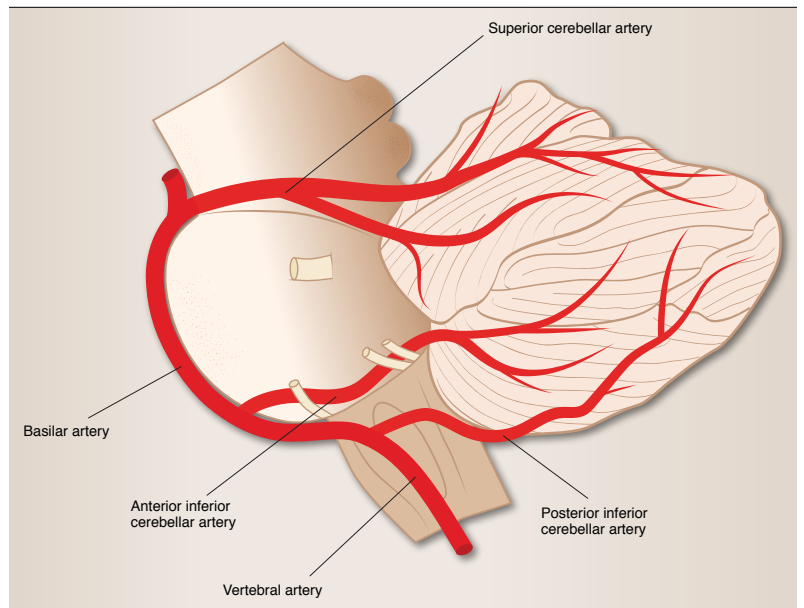
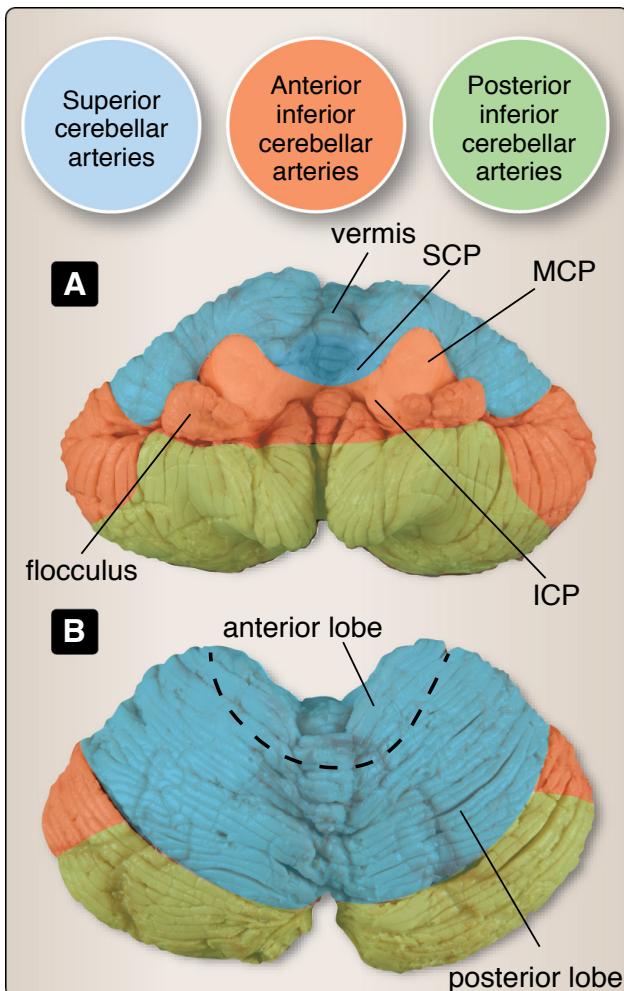
Cerebellum

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Blood Supply to the Cerebellum

| | |
|-------------|---|
| AICA | Cerebellar peduncles Flocculus, nodule (floconodular 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 provide supply to SCP, rostral parts of MCP |



Krebs et al., *Lippincott's Illustrated Reviews - Neuroscience, 2nd ed.*
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CASE 1

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

You have been seeing him in regards to **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 is slow for the past 6 years.

He has also noticed that he is slower with the 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 I get this 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.

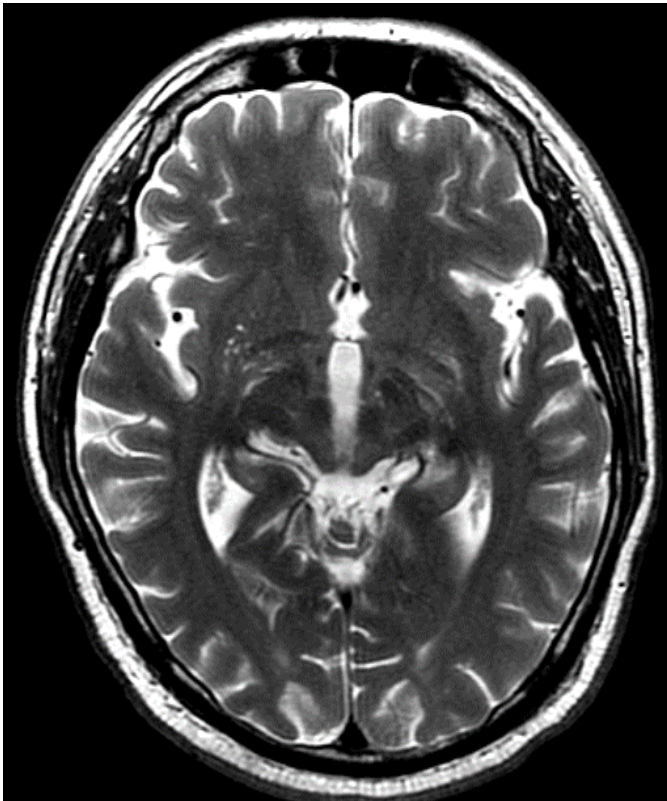
He has slow small amplitude movement of the right >>> left hand.

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

He turns slowly.

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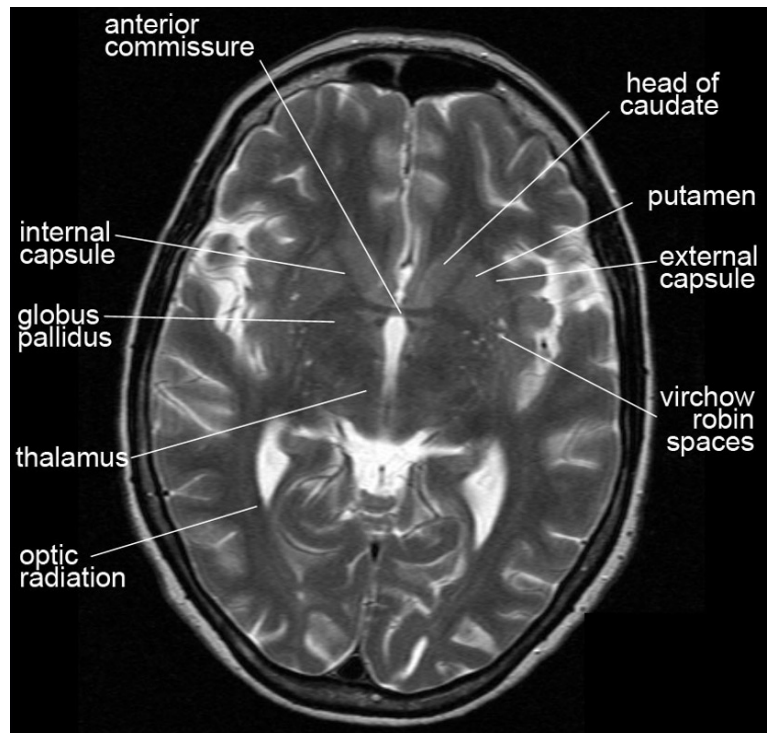


What is this patient's medical condition?

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?



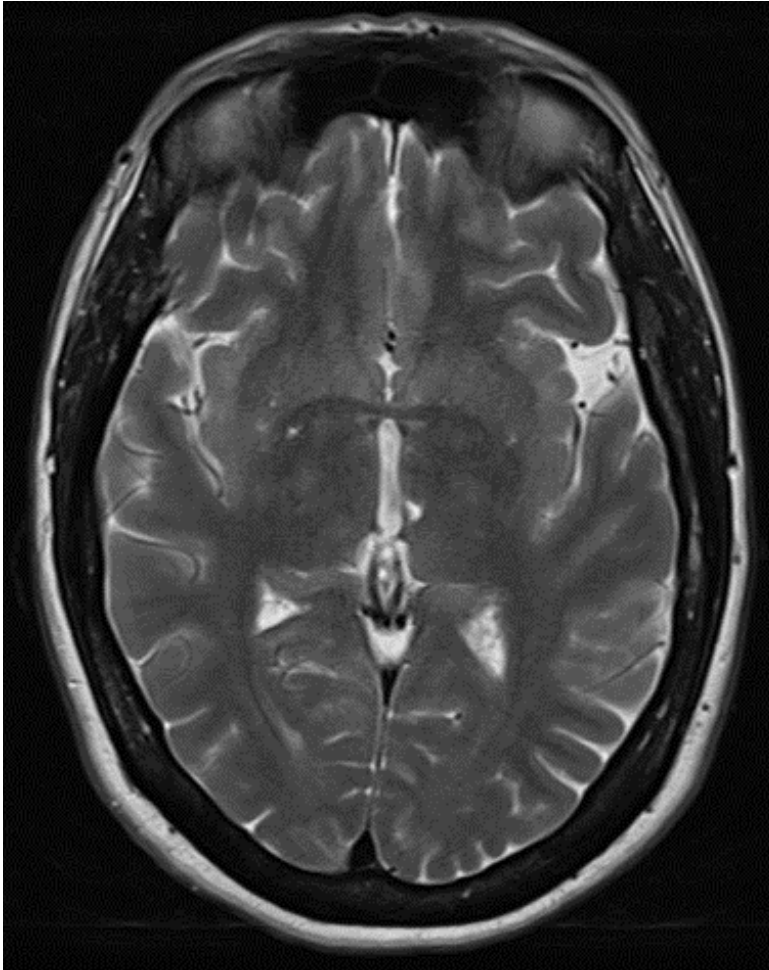
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CASE 2

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?

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

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RESOURCES

Websites:

[Clinical Anatomy](#) | [Entrada](#) | [Neuroanatomy](#) | [Web Syllabus](#)

Recommended Textbooks:

Gray's Anatomy for Students

By: Drake, Vogl, Mitchell
Elsevier Inc. Churchill Livingstone
ISBN 978-0-7020-5131-9

** OR **

Essential Clinical Anatomy

By: Moore and Agur
Lippincott Williams & Wilkins
ISBN 0-7817-6274-X

One of the Following Atlases:

Gray's Atlas of Anatomy

By: Drake, Vogl, Tibbits, Richardson, Mitchell
Elsevier
ISBN 978-1-4557-4802-0

Atlas of Anatomy

By: Gilroy, MacPherson, Ross
Thieme
ISBN 978-1-60406-062-1

Atlas of Human Anatomy

By: Frank Netter
Icon Learning Systems
ISBN 1-929007-11-6

Before We Are Born

By: Moore and Persaud
Saunders
ISBN 978-1-4160-3705-7

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