

March 27, 2024 - Dr. Krebs (claudia.krebs@ubc.ca)

Objectives:

1. Apply the neuroanatomy of the facial nerve (CN VII) to common manifestations of facial palsy.
2. Apply the neuroanatomy of the trigeminal nerve (CN V) to common manifestations of trigeminal nerve lesions (trigeminal neuralgia).
3. Describe the pain pathways from the spinal cord through the brainstem to the cortex, and their integration with the modulation of the pain experience.
4. Integrate peripheral nociception with the central experience and modulation of the pain experience.

Resources

Here are the e-tutorials, videos and web resources for this lab - click the green buttons to access them.

Videos:

Modules:



Use today's lab to review all of your neuroanatomy from previous labs. Make sure you take advantage of looking at all of the specimens we have studied over the past term.



*This icon located throughout the lab manual indicates **checklist items!***

** NOTE: Interactive PDFs are best viewed on desktop/laptop computers - functionality is not reliable on mobile devices **

Facial Nerve (CN VII)



Identify CN VII on gross specimens

Modality	Associated Nucleus	Function
Motor (SVE)	Facial nucleus	Motor to muscles of facial expression & stapedius muscle
Parasympathetic (GVE)	Superior salivatory nucleus	Parasympathetic innervation to lacrimal, submandibular & sublingual glands
Somatic Sensory (GSA)	Chief sensory nucleus of V Spinal nucleus and tract of V	General sensation from outer ear
Taste (SVA)	Solitary nucleus and tract	Taste from anterior 2/3 of tongue

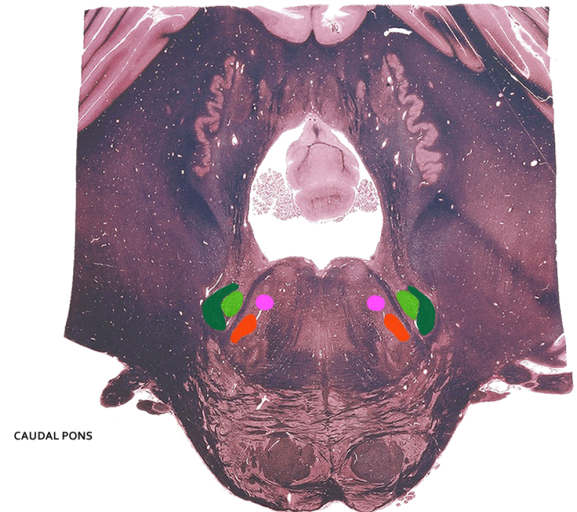
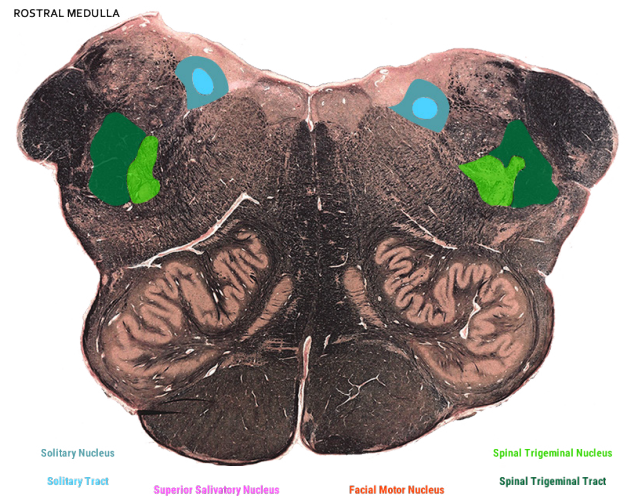
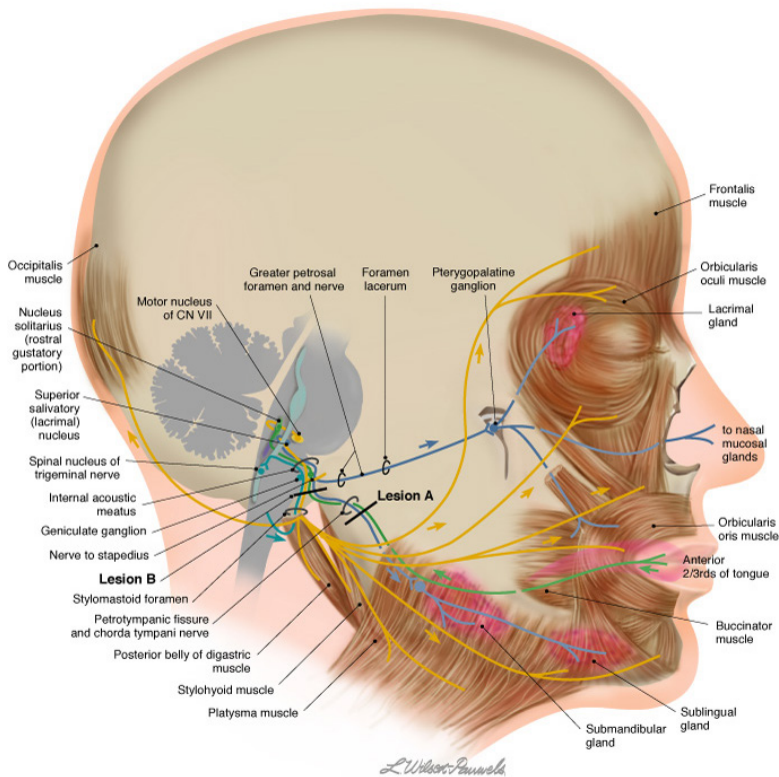
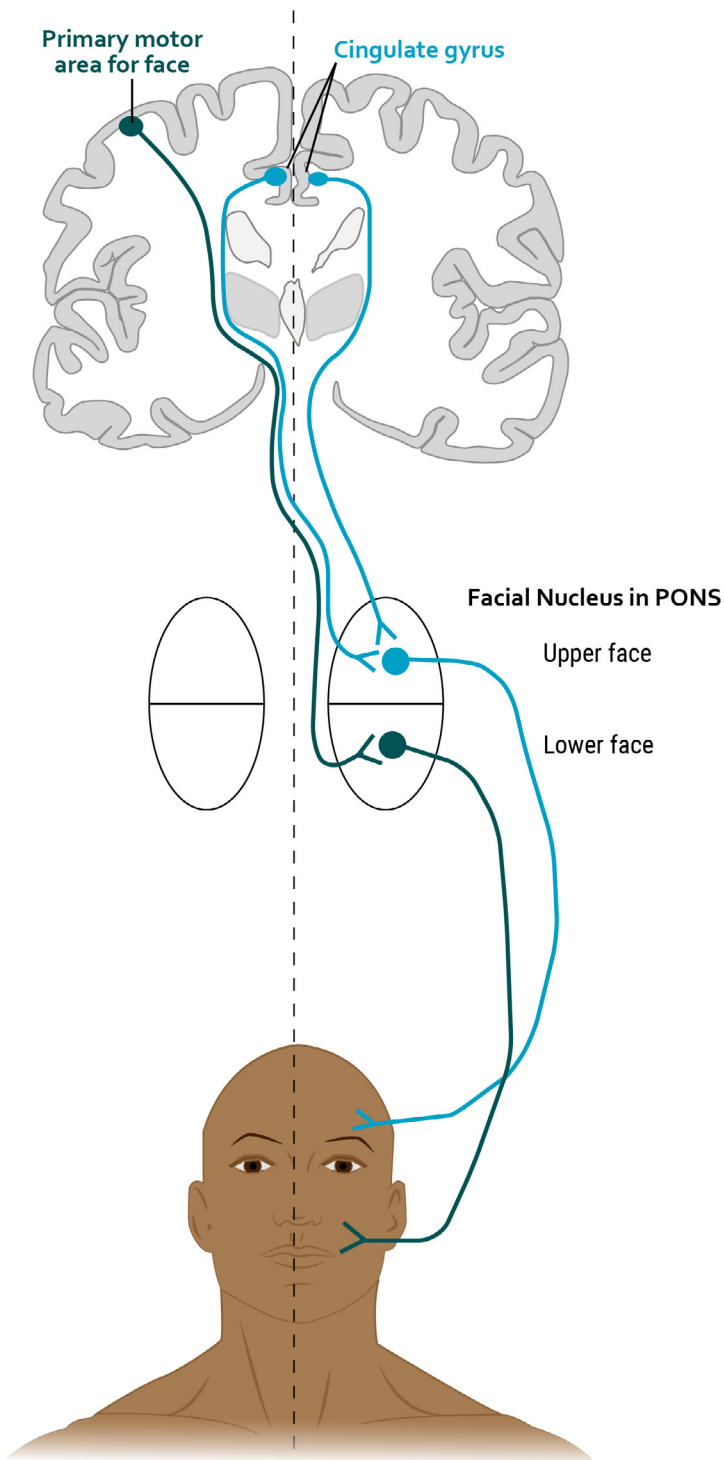


Figure VII-1 Overview of facial nerve components (parotid gland removed).
From "Cranial Nerves in Health and Disease" 2002, © Wilson-Pauwels, Akesson, Stewart, Spacey, B C Decker Inc.

In addition to their location, you also need to know the **function** and the consequences of a **lesion** to the nuclei.



Notes:

- Upper motor neuron (UMN) input to the lower motor neurons (LMNs) for the upper face comes from both sides of the cortex.
- UMN input to the LMNs for the lower face comes only from the contralateral cortex.

Considering this innervation pattern, what is the consequence for the innervation of the muscles of facial expression when CN VII is severed as it exits the brainstem? (this would be a lower motor neuron, peripheral nerve lesion)

What is the consequence of a stroke affecting the corticobulbar tract - an upper motor neuron lesion?

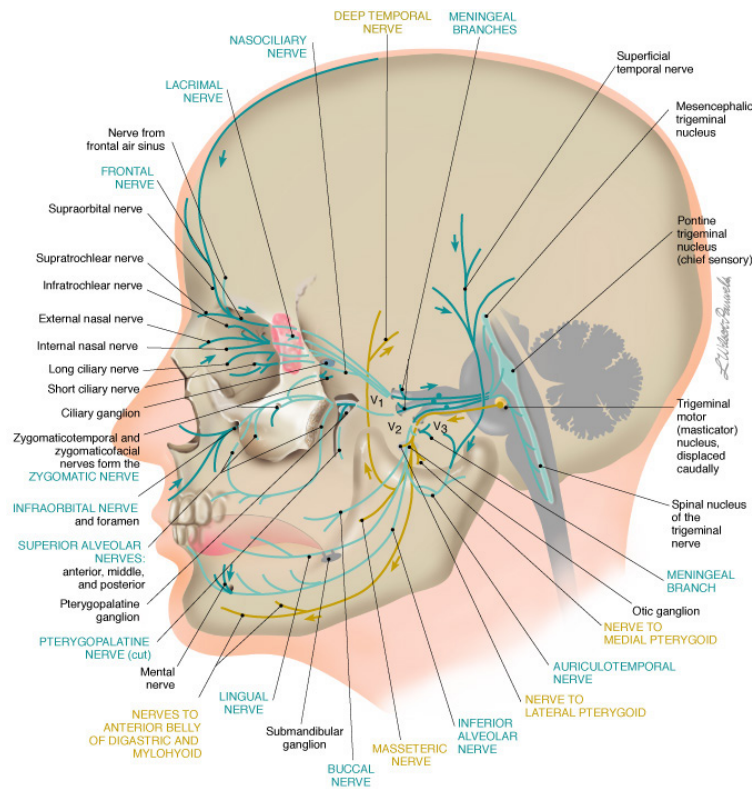
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Trigeminal Nerve (CN V)



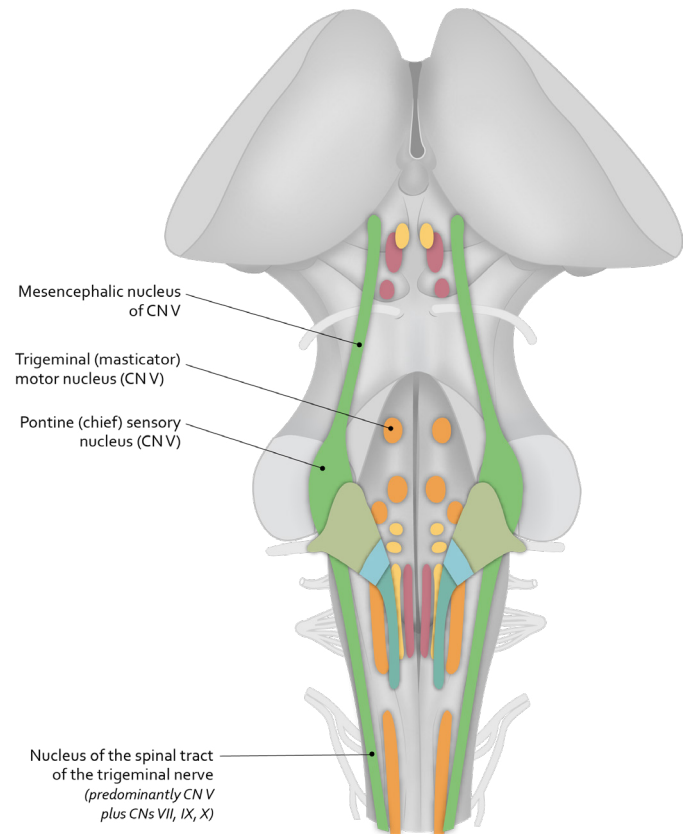
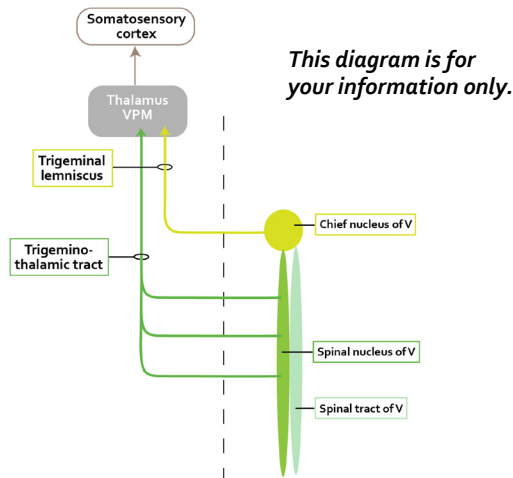
Identify CN V on gross specimens

Modality	Associated Nucleus	Function
Motor (SVE)	Motor nucleus of V	Motor to muscles of mastication
Somatic Sensory (GSA)	Chief sensory nucleus of V Spinal nucleus and tract of V	General sensation from head and neck: <ul style="list-style-type: none"> • Discriminative touch, vibration • Pain & temperature



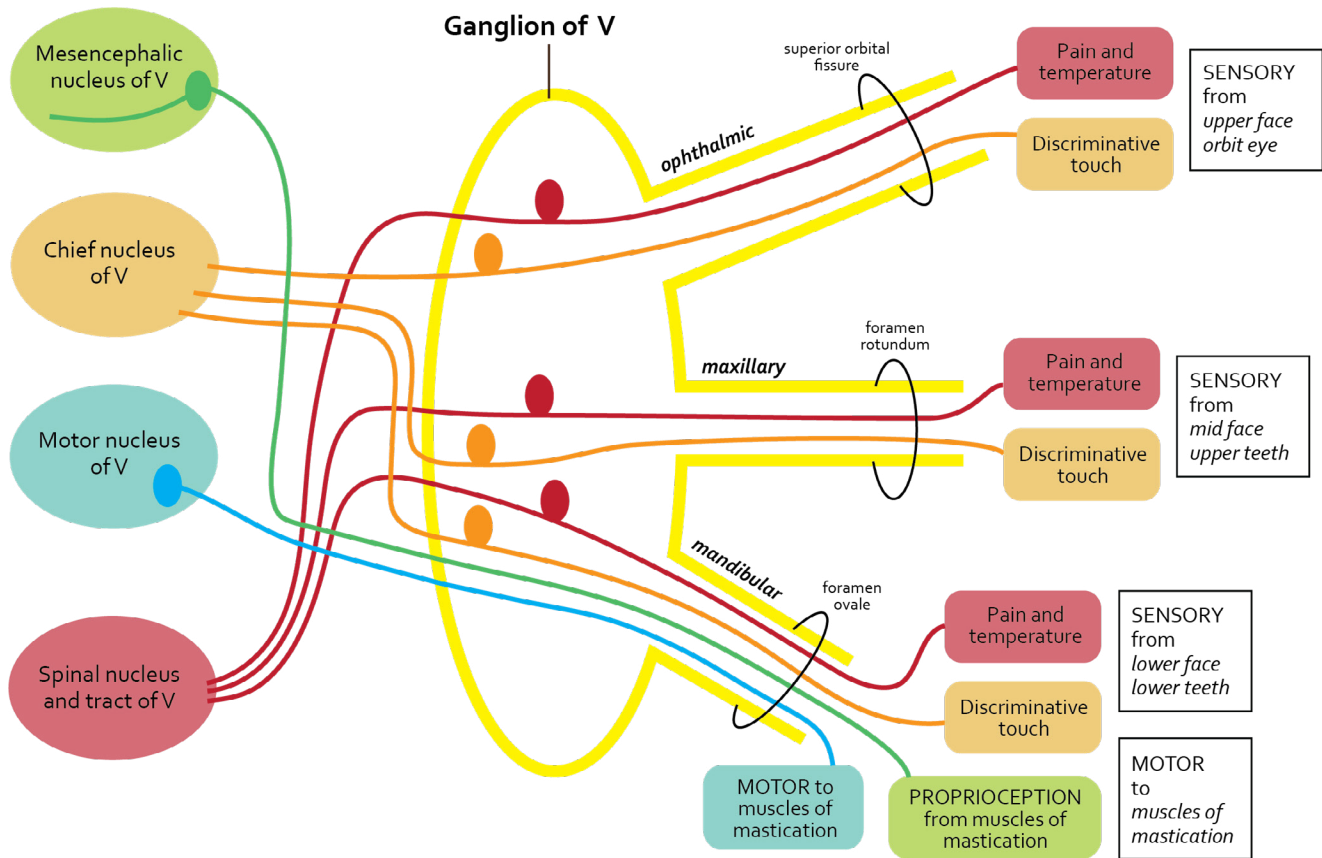
In addition to their location, you also need to know the **function** and the consequences of a **lesion** to the nuclei.

Figure V-2 Overview of the trigeminal nerve. From "Cranial Nerves in Health and Disease" 2002, © Wilson-Pauwels, Akesson, Stewart, Spacey, B C Decker Inc.



CNV Nuclei on Brainstem

The three branches of the trigeminal nerve and their associated modalities and nuclei:

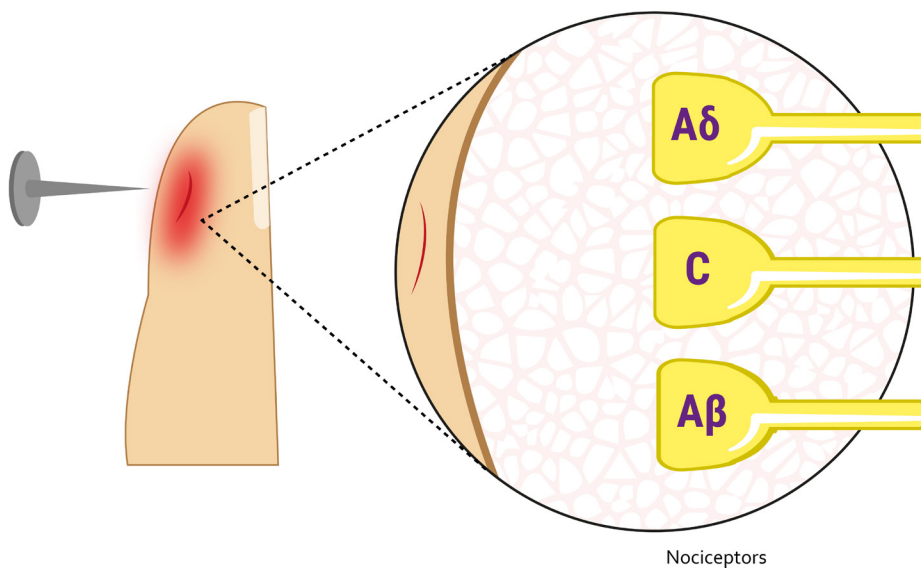


Pain

"Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage."

- International Association for the Study of Pain

A noxious stimulus not only leads to a perception of where it occurred, but also to things such as a rapid increase in level of attention, emotional reactions, autonomic responses, and a tendency to remember the event and its circumstances. Multiple pathways convey nociceptive information rostrally from the spinal cord (and brainstem, for information from head).



Nociceptors

- A δ and C fibers
- cell body in spinal ganglion
- large receptive field

Categories of Pain Perception

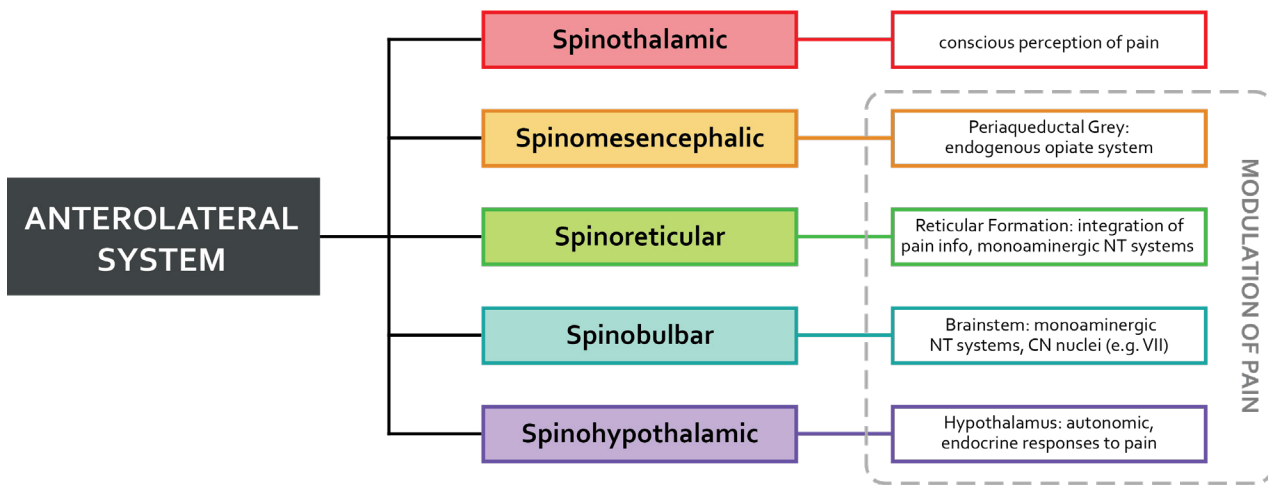
- first pain: sharp, fast
 - conveyed by A δ myelinated fibers (conduction velocity 20 m/s)
- second pain: dull, throbbing, slow
 - conveyed by unmyelinated C fibers (conduction velocity 2 m/s)

Pain Detection with Increasing Stimulus

- light activation of A δ fibers → tingling
- increased activation of A δ fibers → sharp pain

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Overview of the Anterolateral System

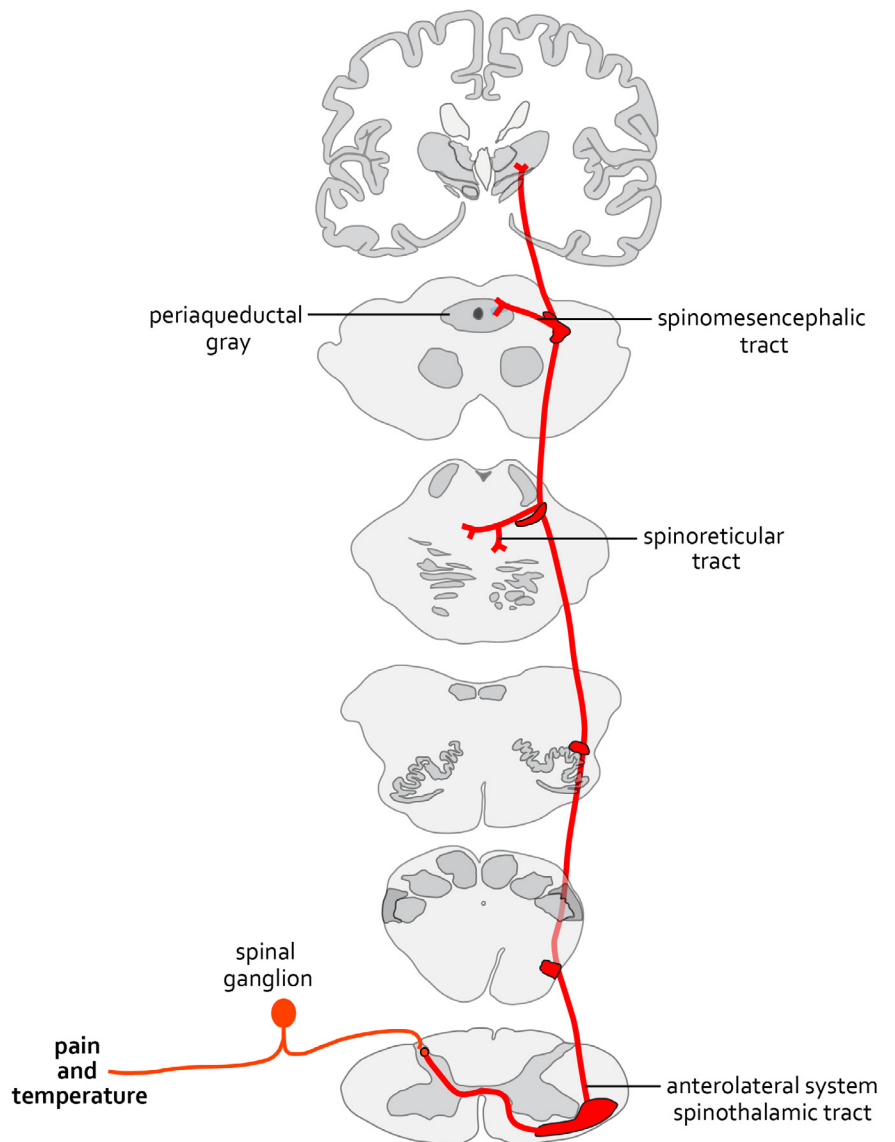


Review the anterolateral system.



Be sure you can identify:

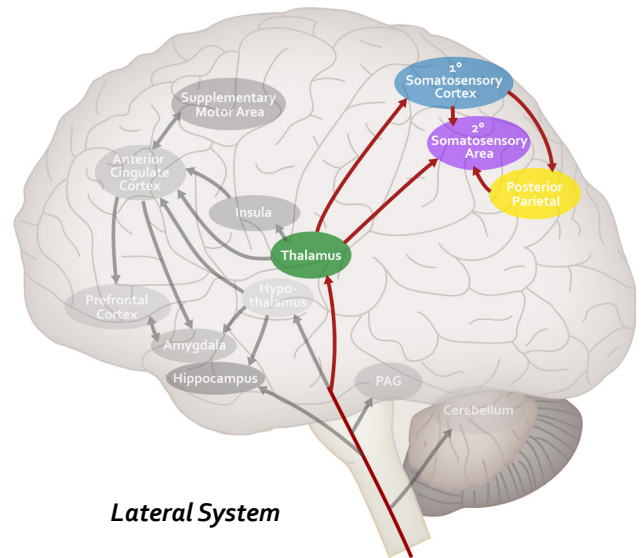
the position of this tract in micrographs, from spinal cord through brainstem



Major Components of Pain

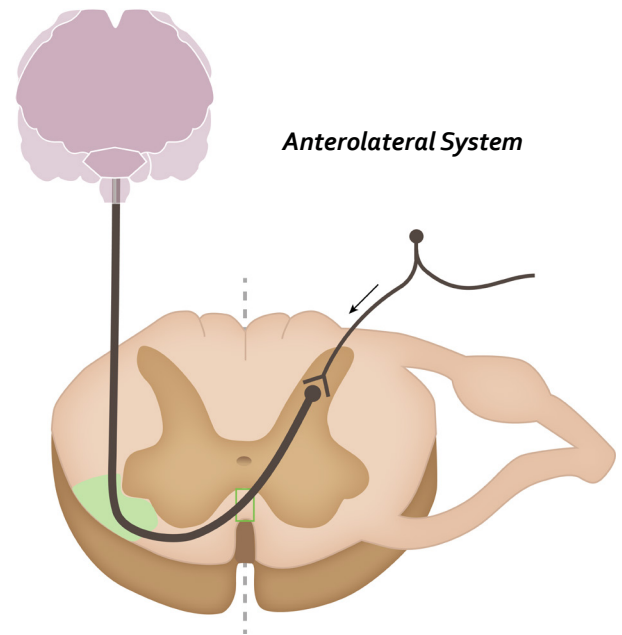
Sensory, Discriminative Component

- Location, intensity and quality of pain (e.g. sharp pain in foot)



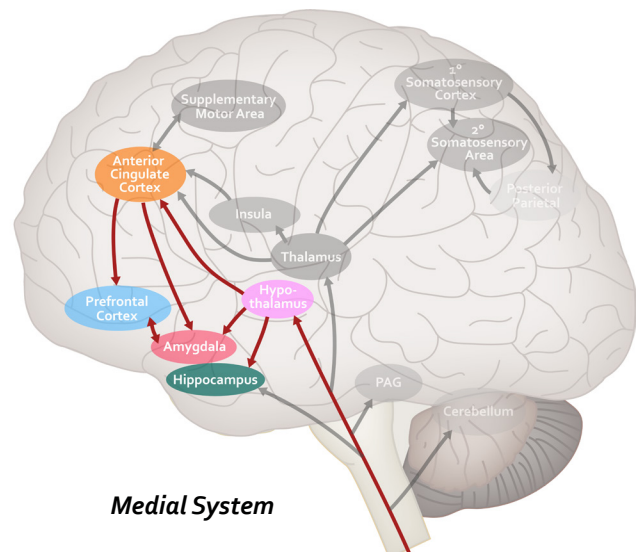
Spinothalamic Tract

- Arises from laminae I and IV-V, crosses midline in anterior white commissure, projects to VPL (and some adjacent thalamic nuclei) in a somatotopic pattern, and then projects to primary somatosensory cortex
- Thought to have a role in appreciation of sharp, pricking, well-localized pain (input from A δ fibers)



Affective-Motivational Component

- Signals the unpleasant quality of experience (ouch!)
- Enables autonomic activation (**fight-or-flight**)
- These tracts are thought to have a role in the sensation of dull, aching, poorly localized pain related to that mediated by C fibers
- Also have a role in affect and cortical arousal associated with pain
- Fibers project to limbic structures (via the thalamus) and to pain modulating centers in the brainstem



Modulation of Pain Processing

Spinal Cord Level

- Interneurons in substantia gelatinosa (SG) (laminae II) of dorsal horn play a major role. Act on incoming pain and temperature information to modulate both fast and slow pain. These interneurons receive descending inhibition.
- Efferents from periaqueductal gray project to reticular formation nuclei in the rostral medulla/caudal pons which send descending input to the posterior horn (SG) of the spinal cord.
- Large diameter afferents conducting touch can also modulate pain through connections with SG and other dorsal horn laminae.

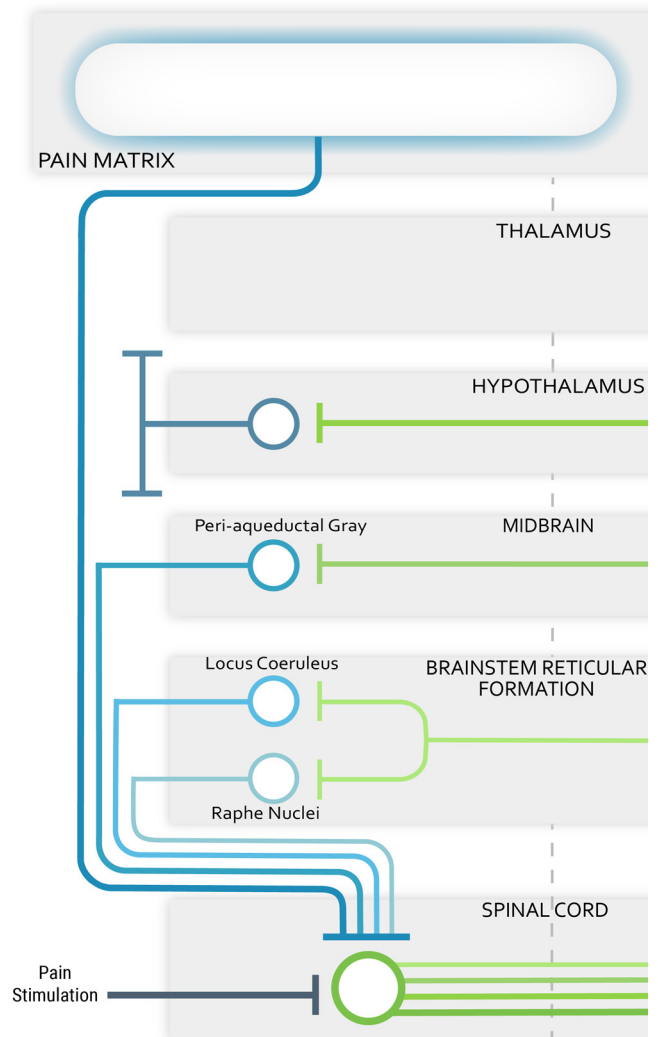
Spinomesencephalic Tract and Spinoreticular Tract

- A subset of fibers synapses in midbrain reticular formation and periaqueductal gray (PAG).
- PAG region has reciprocal connections with limbic system through hypothalamus. PAG also sends a descending projection to posterior horn (substantia gelatinosa [SG], lamina II).
- The tract also receives input from cortex, hypothalamus and limbic system structures.

Central Modulation

- Opiate receptors and endogenous opiate peptides
 - found diffusely throughout the brain
 - higher concentrations in PAG, rostral medulla, spinal cord posterior horn, areas of hypothalamus that project to PAG

Information on pain from the head is carried by the trigeminal system. The spinal tract and nucleus of V correspond to the spinothalamic tract, and mediate fast pain. Information on cranial paths for slow pain is meager, but it is reasonable to assume that they are similar to the indirect pathways of the spinal cord. (i.e. to reticular formation, medial thalamus, widespread areas of cerebral cortex)



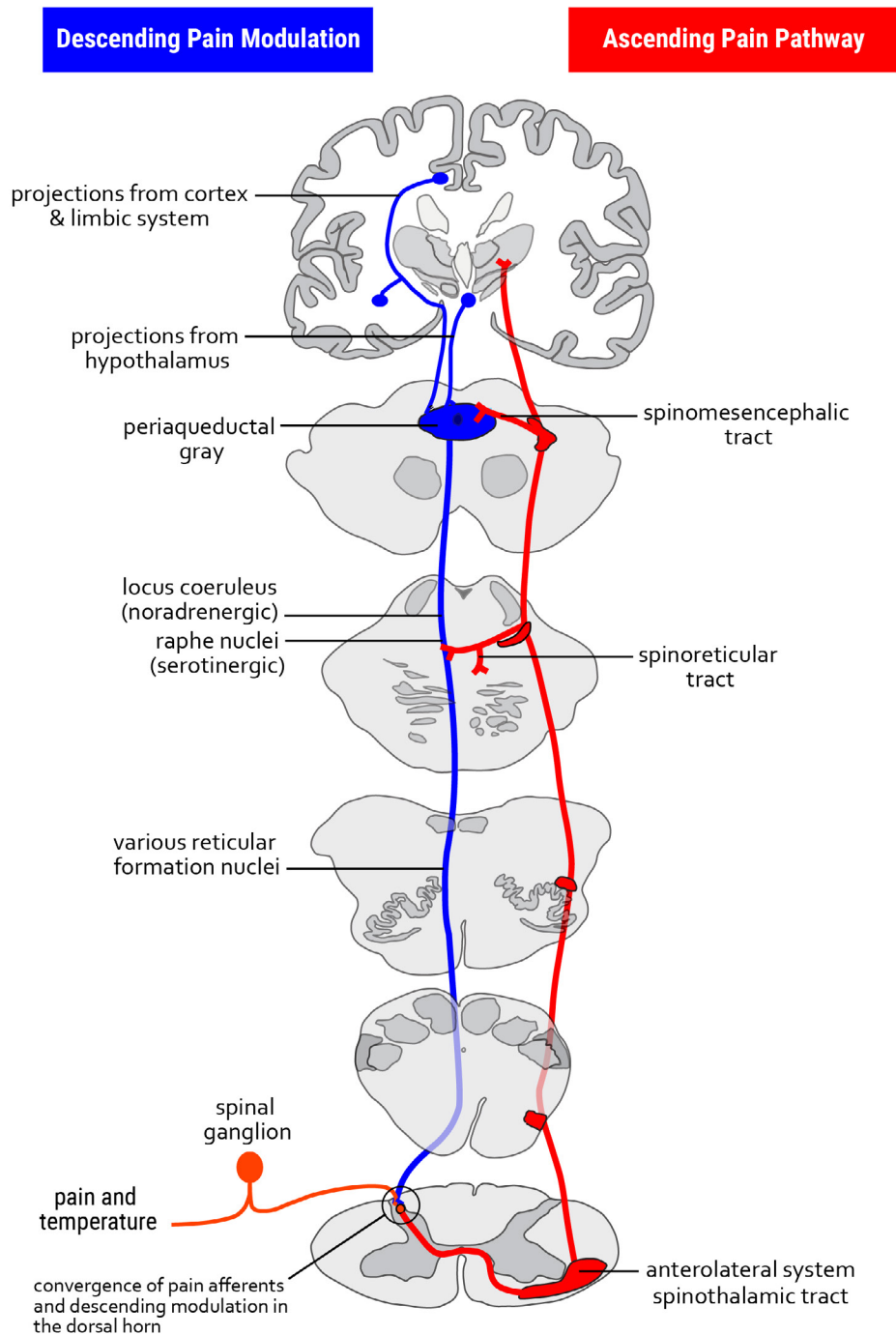
Conceptual Overview of Pain Modulation Networks

- Section 5 -



Identify on micrographs:

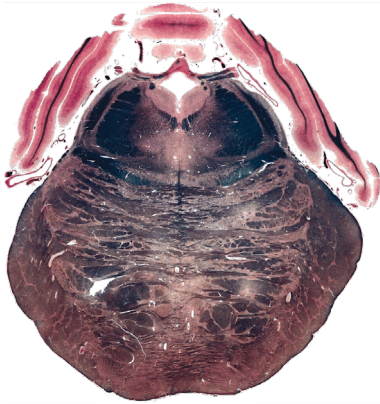
- substantia gelatinosa (spinal cord)
- periaqueductal gray (midbrain)
- raphe nuclei (throughout brainstem)
- locus ceruleus (midbrain/pons)



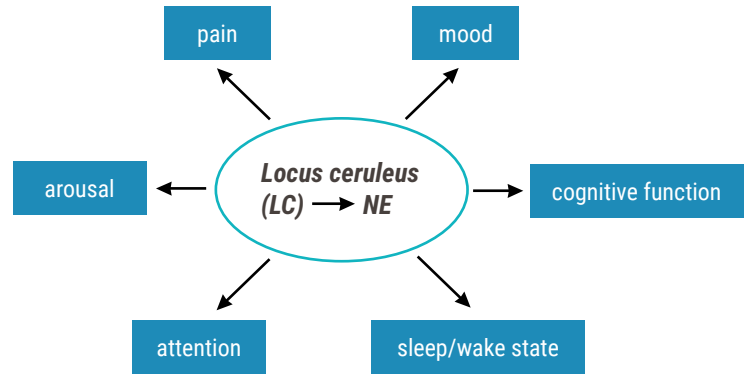
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Monoaminergic Nuclei of the Reticular Formation * REVIEW *

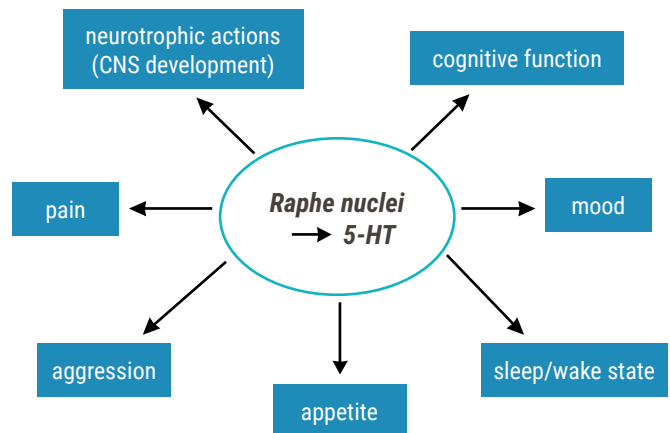
These nuclei have widespread projections to the entire brain.
 Drugs that influence these systems will have widespread effects.



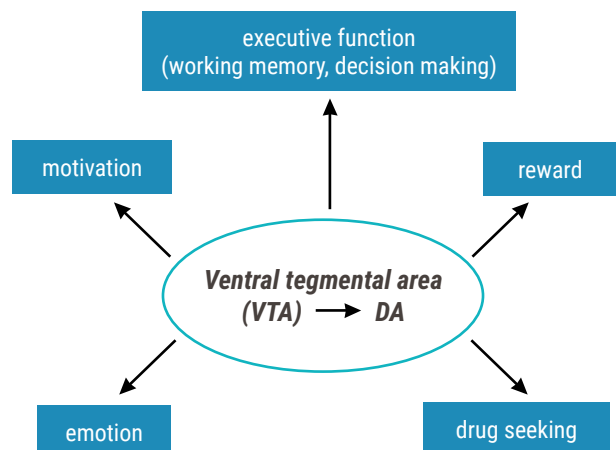
Locus Ceruleus (#9)
 noradrenergic neurons



Raphe Nuclei (#10)
 serotonergic neurons



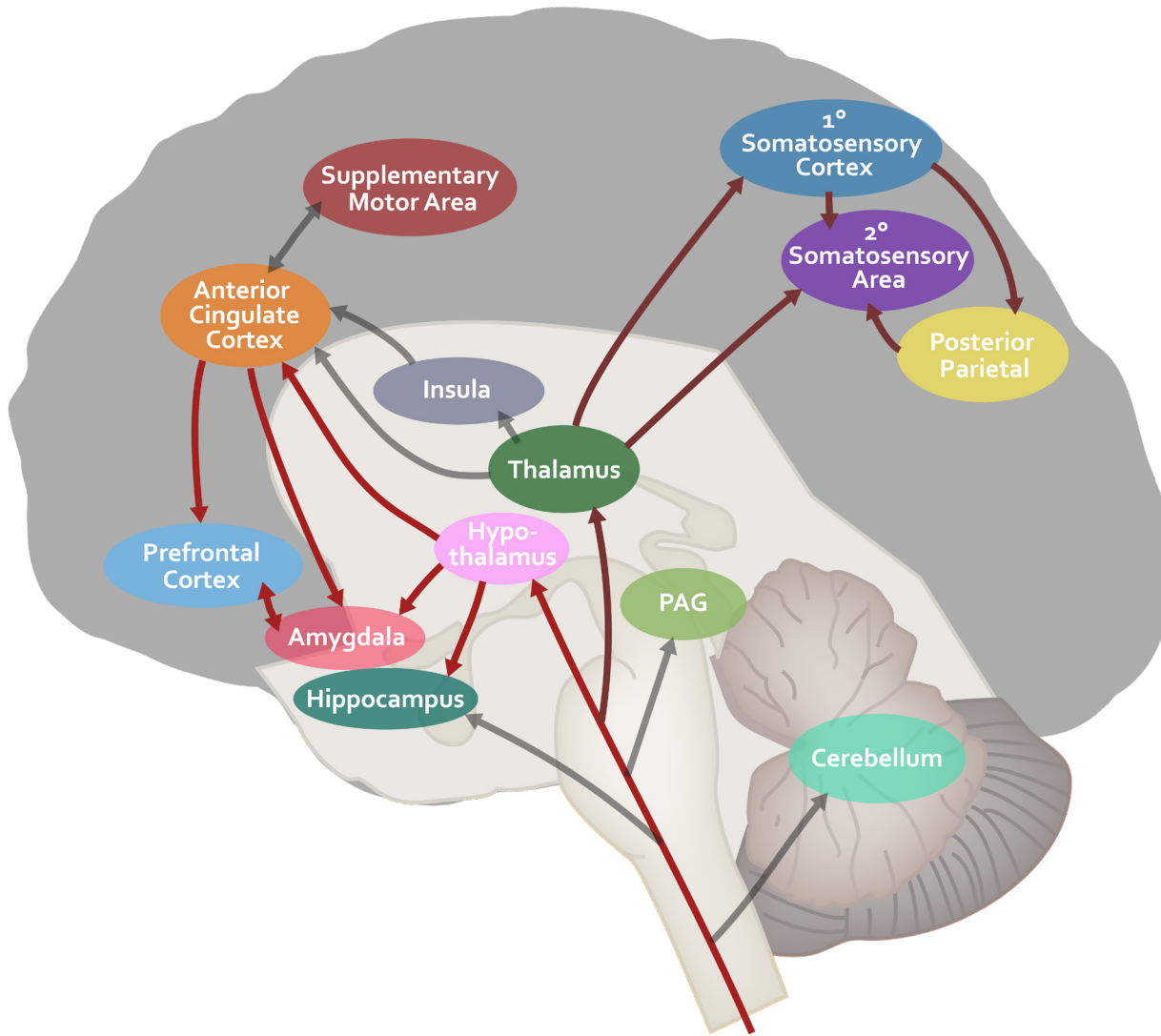
Ventral Tegmental Area (#11)
 dopaminergic neurons



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Cortical Pain Processing

- Section 4 -



What does the concept of a cortical pain matrix imply for the experience of pain?

What is the cortical pain matrix?



Micrograph Checklist

CNV

- motor nucleus of V
- spinal trigeminal nucleus and tract
- chief sensory nucleus of V
- mesencephalic nucleus

CN VII

- motor nucleus
- solitary nucleus and tract
- spinal nucleus and tract of V
- superior salivatory nucleus
(difficult to see)

Tracts

- spinothalamic tract throughout the brainstem
- other tracts of the anterolateral system
(only conceptually)

Other Nuclei

- substantia gelatinosa
- periaqueductal gray
- raphe nuclei
- locus ceruleus

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RESOURCES

Websites:

Neuroanatomy | Entrada

Recommended Textbooks:

Lippincott Illustrated Reviews: Neuroscience

By: Claudia Krebs, Joanne Weinberg, Elizabeth J. Akesson, Esma Dilli

Lippincott Williams & Wilkins

ISBN 978-1-4963-6789-1

Neuroanatomy Through Clinical Cases

By: Hal Blumenfeld

Sinauer

ISBN 978-0-8789-3613-7

Neuroanatomy in Clinical Context: An Atlas of Structures, Sections, Systems, and Syndromes

By: Duane E. Haines

Wolters kluwer Health

ISBN 978-1-4511-8625-3

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