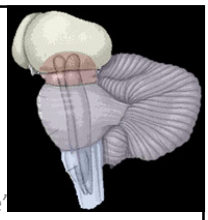
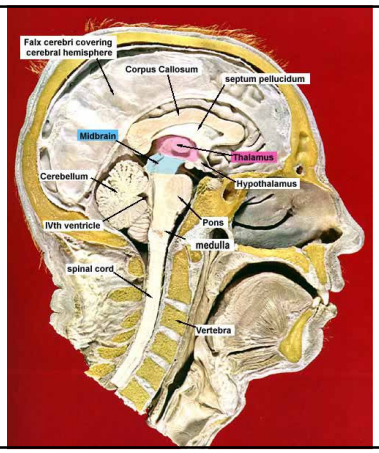
The Brainstem (or brain stem)



Like spinal cord, it is part of the "cable" connecting brain to body, and also has "local functions".

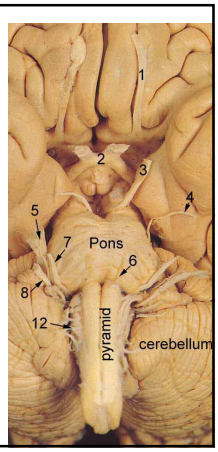
Like spinal cord, dorsal structures are usually sensory, ventral structures usually motor in function.



Book Fig. 9.3

Ventral Surface

- Corticospinal/pyramidal pathway "pyramids"
- Transverse fibers of the pons linking to cerebellum
- Both of these are motor in function

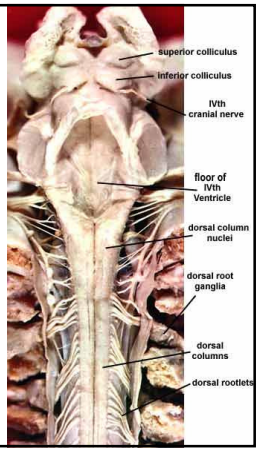


Book Figure 9.1

Dorsal Surface

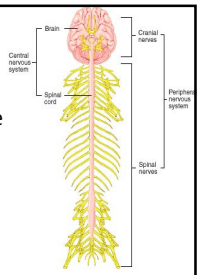
(cerebellum removed)

- Dorsal column sensory pathway
- Superior and inferior colliculi of midbrain (visual & auditory reflexes, respectively)
- Both of these are sensory in function



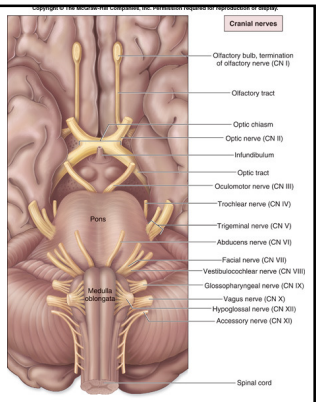
Review: Spinal Nerves

- Incoming sensory axons of dorsal roots synapse in the dorsal gray matter of the cord or medulla.
- Motor neurons located in the ventral horns send their axons out to muscle fibers via the ventral roots. ANS axons also exit via the ventral roots
- Although there are sensory nerves and motor nerves that enter and exit the **brainstem** there are no "dorsal or ventral horns" in the brainstem.



The Cranial Nerves

12 pairs of peripheral nerves that enter/exit brain rather than cord



Cranial Nerves vs Spinal Nerves

- 31 pairs of spinal nerves all share similar sensory, motor and autonomic functions - just for different levels of the body.
- 12 pairs of cranial nerves are more variable & specialized in function - they do **not** all have sensory, motor and autonomic functions.

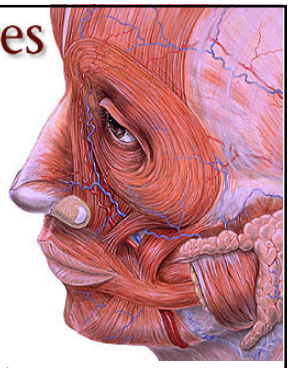
- In the brain stem, the **clusters of neurons** which either
  - 1) receive the incoming sensory messages of cranial nerves OR
  - 2) send the outgoing motor/autonomic messages of cranial nerves
- are known as **"cranial nerve nuclei".**

Location of Cranial Nerves

- 2 enter the forebrain (I and II)
- 2 exit the midbrain (III and IV)
- 3 enter/exit the pons (V, VI and VII)
- 1 enters at pons/medulla junction (VIII)
- 4 enter/exit the medulla (IX, X, XI, XII)

Cranial Nerves

I	Olfactory
II	Optic
III	Oculomotor
IV	Trochlear
V	Trigeminal
VI	Abducens
VII	Facial
VIII	Vestibulocochlear
IX	Glossopharyngeal
X	Vagus
XI	Accessory
XII	Hypoglossal



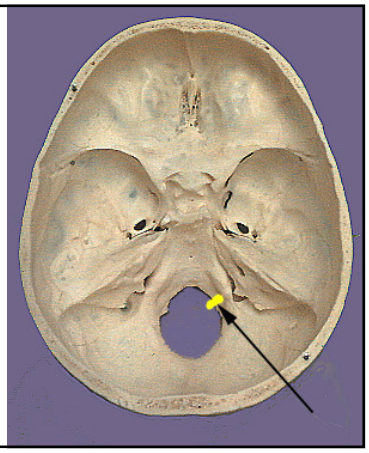
- VIII aka **Auditory-vestibular** or acoustic-vestibular
- XI aka **Spinal accessory**

Mnemonics to Help Your Memory

- On Old Olympus's towering tops a Fin and German vend snowy hops.
- Oh oh oh - to touch and feel a guy(girl) - very sexy and hot.

- Is the nerve sensory, motor or both?
- **S**ome **s**ay **m**ake **m**erry **b**ut **m**y **b**rother **s**ays **b**ad **b**usiness **m**aking **m**erry.

Cranial nerves must pass through small holes in skull

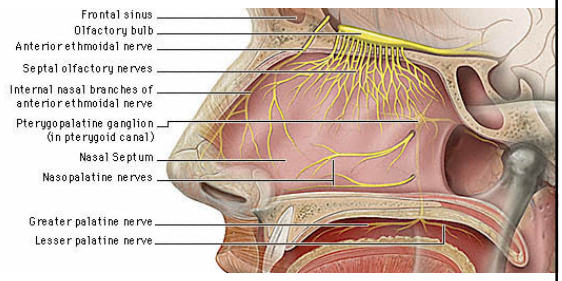


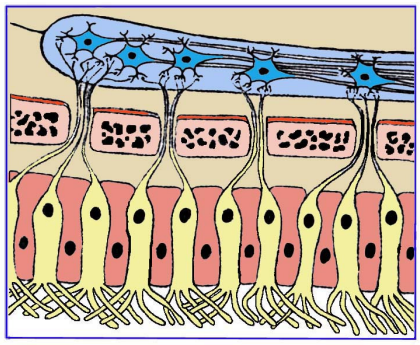
Purely Sensory Cranial Nerves

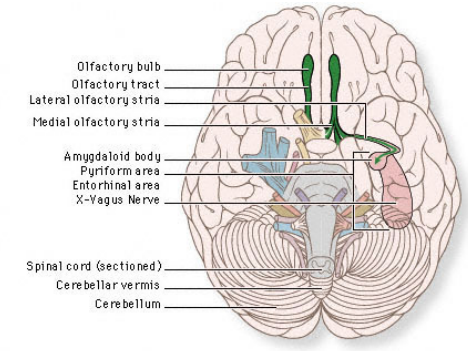
- Olfactory (I)- smell
- Optic (II)- vision
- Auditory/Vestibular (VIII) - hearing & vestibular input

- You are probably familiar with these 3 so the following are just provided as a refresher

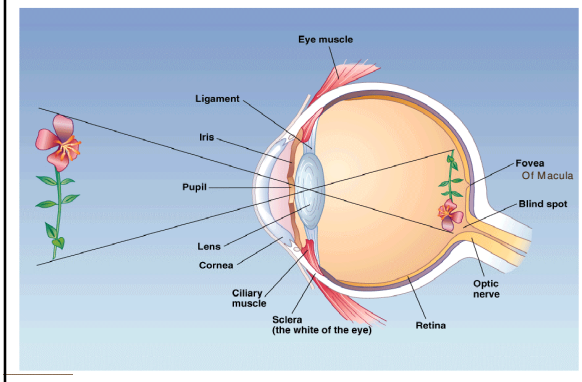
Olfactory Nerves



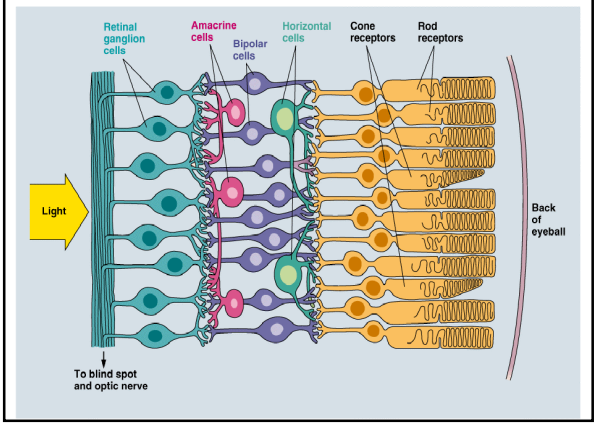




► Section of the Human Eye

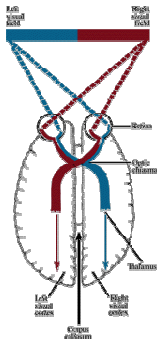


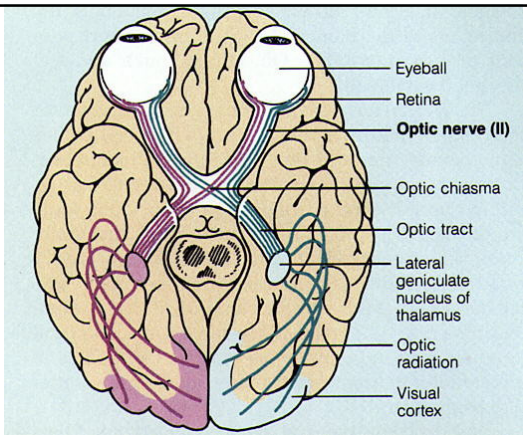
► Cellular Structure of the Mammalian Retina



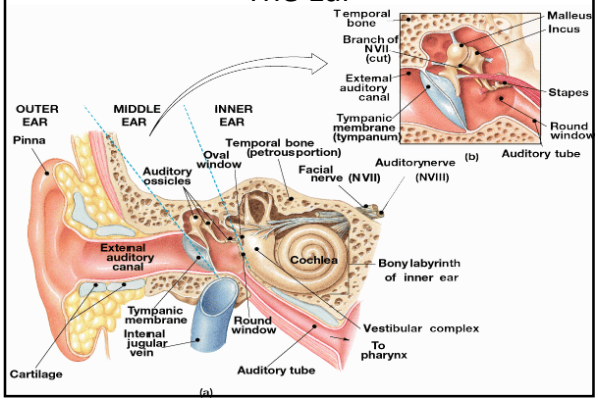
Visual Fields

- Each half of your brain sees the opposite half of your visual world

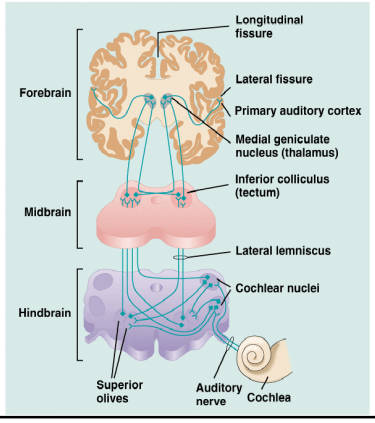




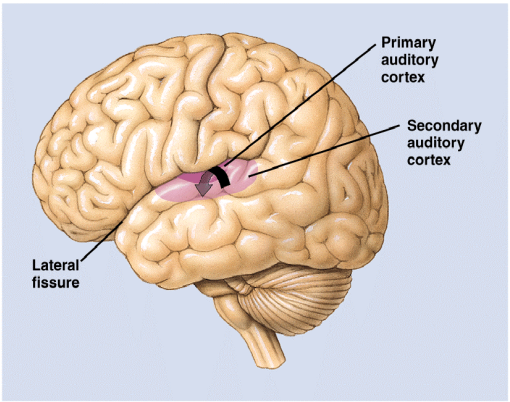
The Ear



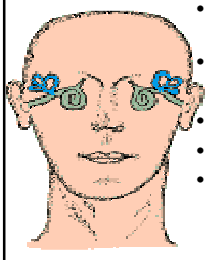
Pathways of the Auditory System



Primary and Secondary Auditory Cortex



Vestibular System (in blue)



- Senses position & movement of head & alerts:
- Spinal cord LMNs
  Cerebellum
- III,IV, VI, X
- Thalamus/cortex
- http://www.youtube.com/watch?v=mmBB2bu1gEQ&feature=related

Meniere's Disease (~200/100,000)

- Episodic attacks of spinning sensation (rotational vertigo) & sensations of movement causing dysequilibrium, nausea and vomiting.
- During attacks, patients are usually unable to perform normal activities.
- Auditory portion of VIII also usually affected (episodic hearing loss, tinnitus (a roaring, buzzing, or ringing sound in the ear), and sensation of fullness in the affected ear). Hearing loss tends to be progressive.
- http://www.youtube.com/watch?v=a0JiByEcwt8

Meniere's Disease

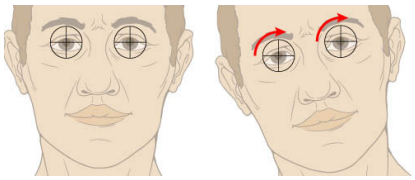
- Most often to be due to an imbalance in fluids of inner ear.
- 1st treatment: diuretics, low salt, sugar, caffeine, alcohol diet and anti-motion sickness/anti-nausea drugs. Sometimes anti-allergy & anti-inflammatory meds
- Maintain a food/drink diary to look for associations
- If unsuccessful, shunting canals to decrease endolymph
- Most extreme cases – administer an ototoxic drug to the vestibular system, cutting vestibular nerve, or labrinthectomy.

http://www.youtube.com/watch?v=8-b91ughElY

Purely Motor Cranial Nerves

- Trochlear (IV) – rotates eyes when head tilts; look down & to side (e.g. going down stairs)
- Abducens (VI) - moves eyes to side
- Accessory (or spinal accessory) (XI)– pulls shoulders back; turns head to opposite side; helps with speech muscles
- Hypoglossal (XII) - move tongue

Trochlear (IV)



Trochlear Palsy – eye doesn't rotate when head tilts

- Abducens Nerve Palsy – muscle can't pull eye outwards

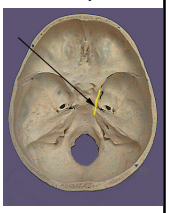
Told to "look to the right" Told to "look straight ahead"

Hypoglossal Palsy

- When asked to stick tongue out, weakness of half of tongue makes it point toward the side XII is damaged on.

Mixed Function Cranial Nerves: Oculomotor (III)

- Motor to 4 eye muscles to move eyes medially and upwards
- Motor to muscle that opens eye
- Parasympathetic to constrict pupil
- Parasympathetic to ciliary muscle focus lens for near vision



- Look at a case of unilateral damage to III:

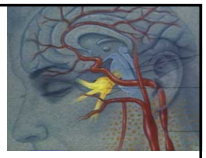
Oculomotor Palsy

- Damage to Oculomotor- can't open eye

Oculomotor Palsy

- If we lift that eyelid we can see that in that eye the pupil "fixed and dilated" (can't constrict pupil)
- Eye can't move medially or up so it is stuck in "wall-eyed" position (eye turned laterally)

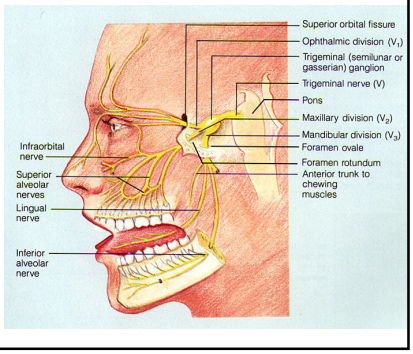
Trigeminal Nerves (V)



- Sensory from face, cornea, mouth, nasal passages, teeth, tongue, meninges & their vessels, sinuses, eardrum, TMJ
- Motor to muscles of mastication (bite, chew)
- *Recent evidence that V axons from blood vessels may cause migraine pain

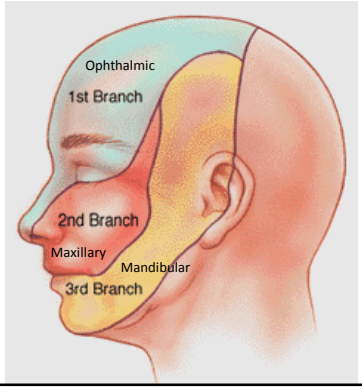
The Trigeminal Nerve (V)-"tri" refers to its 3 branches

- Collects touch, temp, pain sensations from front of head



Trigeminal Dermatomes

Book Fig. 10-10

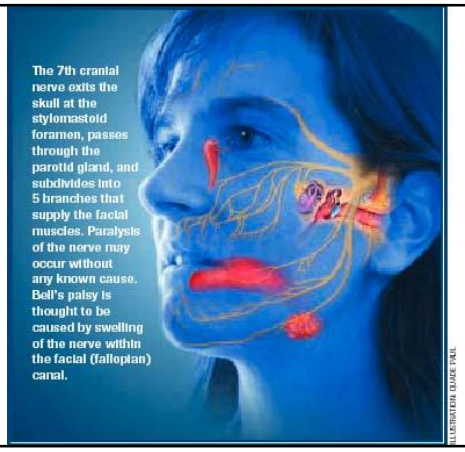


Trigeminal Neuralgia or "Tic Douloureux" (~15/100,000)

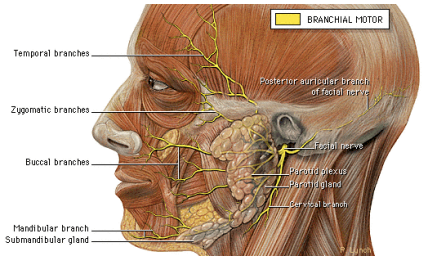
- Sudden excruciating electric shock or stabbing unilateral facial pain, usually in one region of V's distribution
- Pain causes muscle spasm or grimace
- May be triggered by facial sensation (a breeze, shaving, chewing)
- May be caused by pressure on the nerve causing it to fire, damage during dental procedure
- Treated with Tegretol or other anticonvulsant drugs or surgery
- http://www.youtube.com/watch?v=YfKEvlqR14Y&feature=related
- http://www.youtube.com/watch?v=BdufoO96jsg&feature=related

Facial Nerves (VII)

- Sensory from taste receptors of front 2/3 of tongue and from palates
- Motor to muscles of facial expression and to stapedius muscle of middle ear
- Parasympathetic to salivary glands, lacrimal (tear) glands & mucous membranes

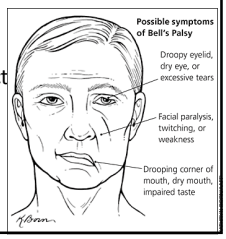


Facial Nerves to Facial Muscles & Parotid Gland



Bell's Palsy or Facial Paralysis

- Unilateral partial or complete paralysis of half the face, typically with decreased taste sensation and increased sensitivity to sound on that side.
- May be an autoimmune reaction to recent infection causing inflammation & swelling of the nerve
- May accompany Lyme's disease caused by Herpes Zoster infect nerves
- Up to 250/100,000 cases; recovery



Bell's Palsy ("Facial Paralysis")

- She can't smile or crinkle eyes on paralyzed side

Bell's Palsy

- This girl is being told to close her eyes tightly but can't fully close eye on paralyzed side

Glossopharyngeal (IX)

- Mostly a sensory nerve sensing
  - taste from rear 1/3 of tongue
  - Eustachian tube & middle ear
  - upper throat (touch, pain, etc.
  - chemoreceptors (oxygen/carbon monoxide balance and acid/base balance of blood) located in the carotid body and baroreceptors of carotid sinus
- Motor to swallowing muscle of the throat
- Parasymp. to parotid salivary gland

Vagus (X)

- Sensory from
  - external ear, canal & eardrum
  - taste receptors in throat
  - viscera & chemo- and baroreceptors in aortic arch
- Motor to muscles of larynx and pharynx for speech and swallowing
- Parasympathetic to all organs of chest and abdomen

Receptors Involved in Cardiovascular and Respiratory Reflexes

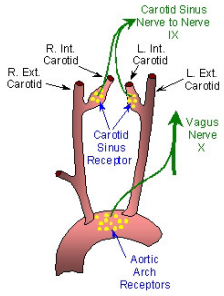
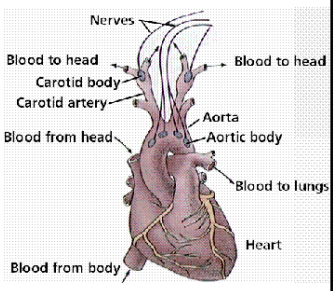


Figure 1. Location and innervation of arterial baroreceptors



Location of chemoreceptors

Reflex/Processing Centers of the Midbrain

- Eye movement reflexes (III & IV)
- Pupillary reflexes (III)
- Auditory & visual reflexes of the superior and inferior colliculi

Reflex/Processing Centers of the Pons

- Corneal reflex & blinking (V & VII)
- Chewing (V) & salivating (VII)
- Facial expression (VII)
- Eye movements (VI)
- Auditory/vestibular processing

Reflex Centers of Medulla

- Glossopharyngeal - needed for gag, swallowing reflexes, respiratory and BP reflexes
- Vagus - main parasympathetic nerve (slows HR and breathing, triggers peristalsis, digestion, elimination, vomiting). Motor portion necessary for swallowing and voice.
- Hypoglossal – tongue movements

- Dysphagia – difficulty swallowing
- Dysarthria – impaired articulation of speech
- Dysphonia – impairment of voice
- Stroke involving the medulla can be lethal.

- Remember- brainstem is part of those long ascending and descending pathways, so can suffer from the same kinds of problems that affected the spinal cord, e.g.:
  - Shingles of dermatomes of V
  - "Syringobulbia" (abnormal brainstem cavity)
  - Could have LMN or UMN problems affecting the muscles controlled by cranial nerves.

Brainstem Motor Neurons Just Like Spinal Motor Neurons

- If cranial nerve with motor function is damaged→ LMN symptoms in affected muscles ("bulbar palsy")
- If connections between UMN and cranial nerve are damaged→ UMN symptoms in affected muscles ("pseudobulbar palsy")