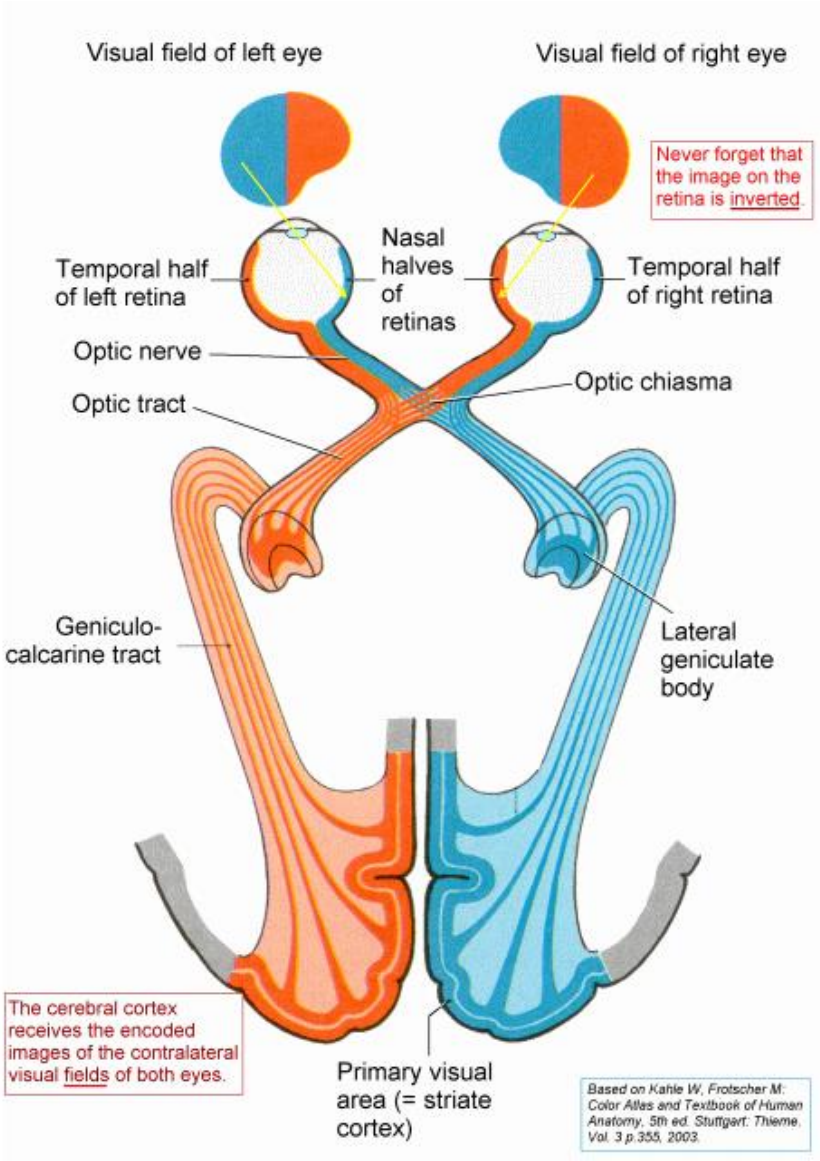
The Special Senses

NS201C
2017

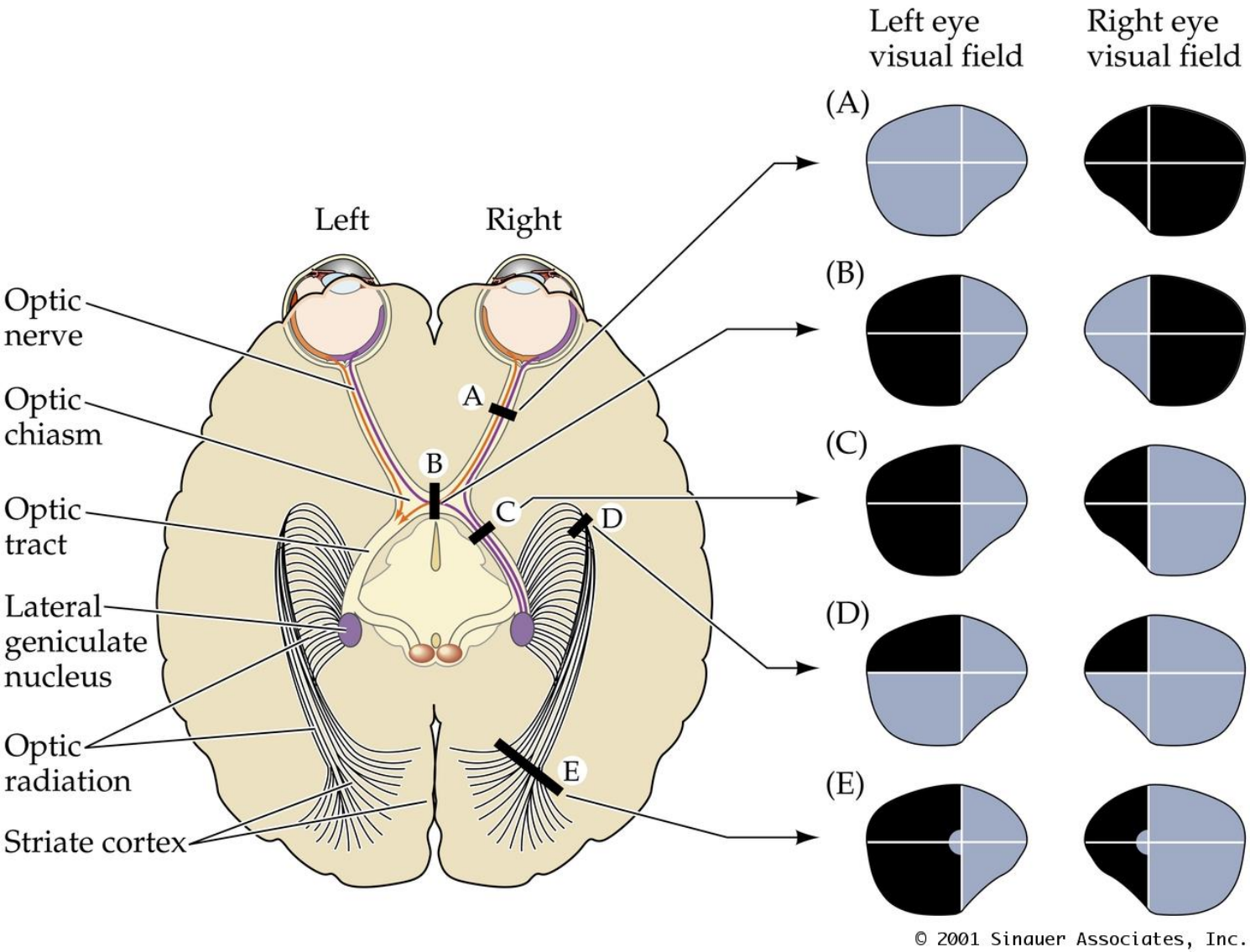
Peter Ohara
Department of Anatomy

The Visual System

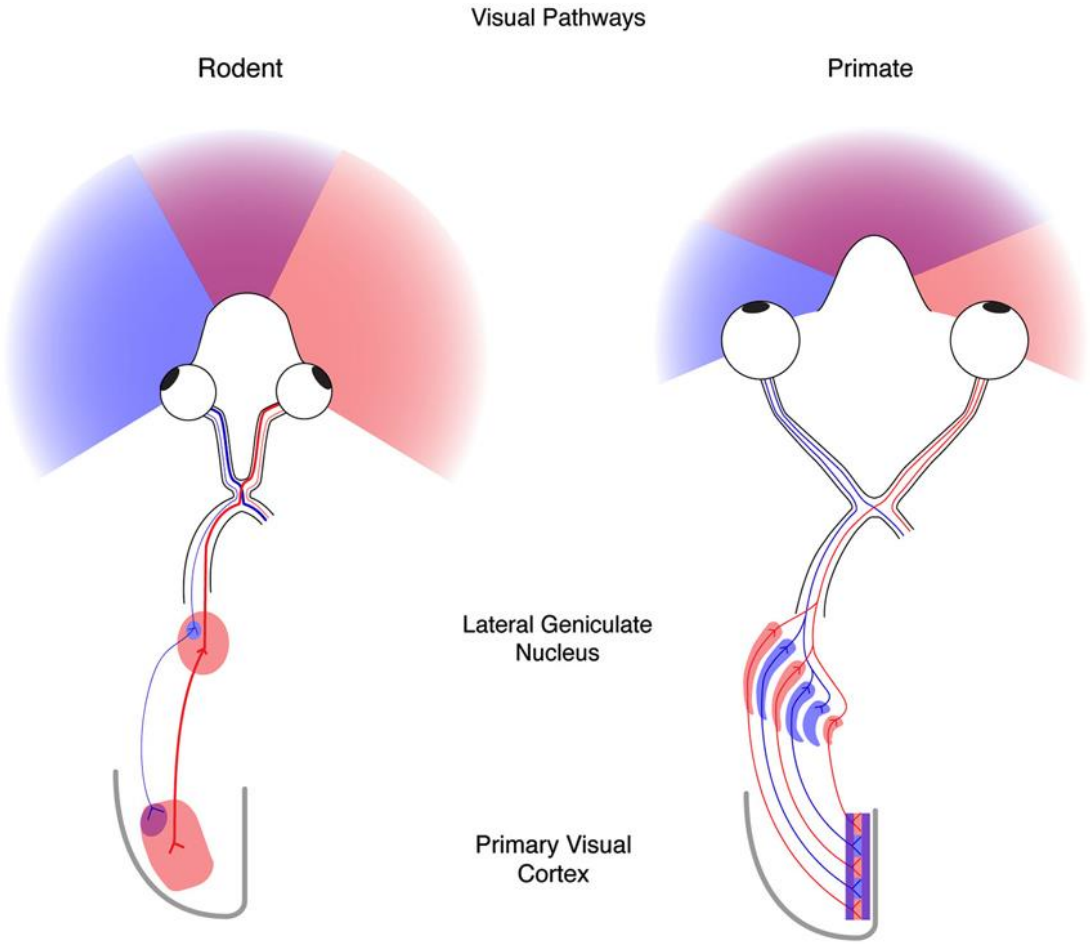
Visual pathway



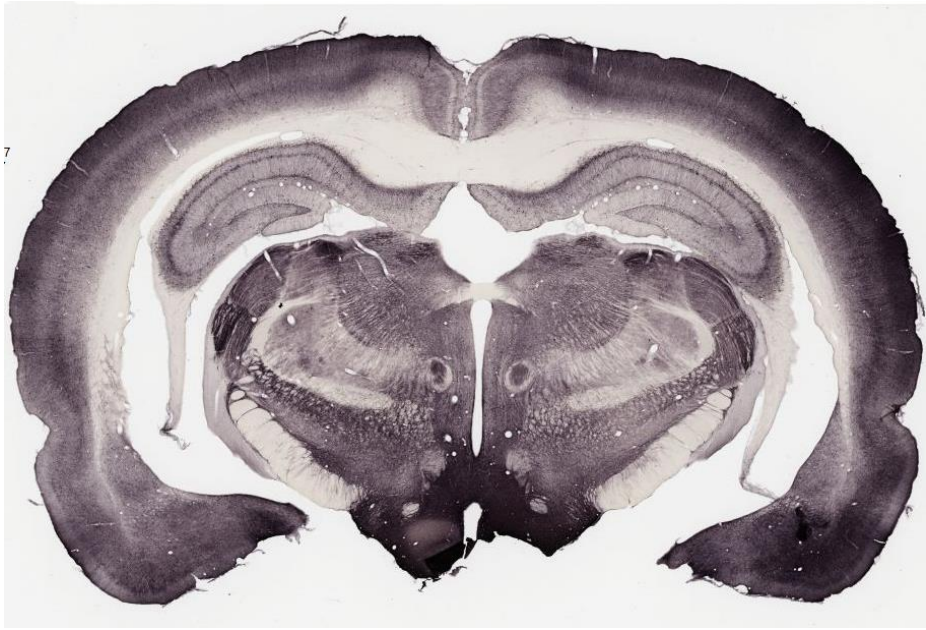
Visual field defects

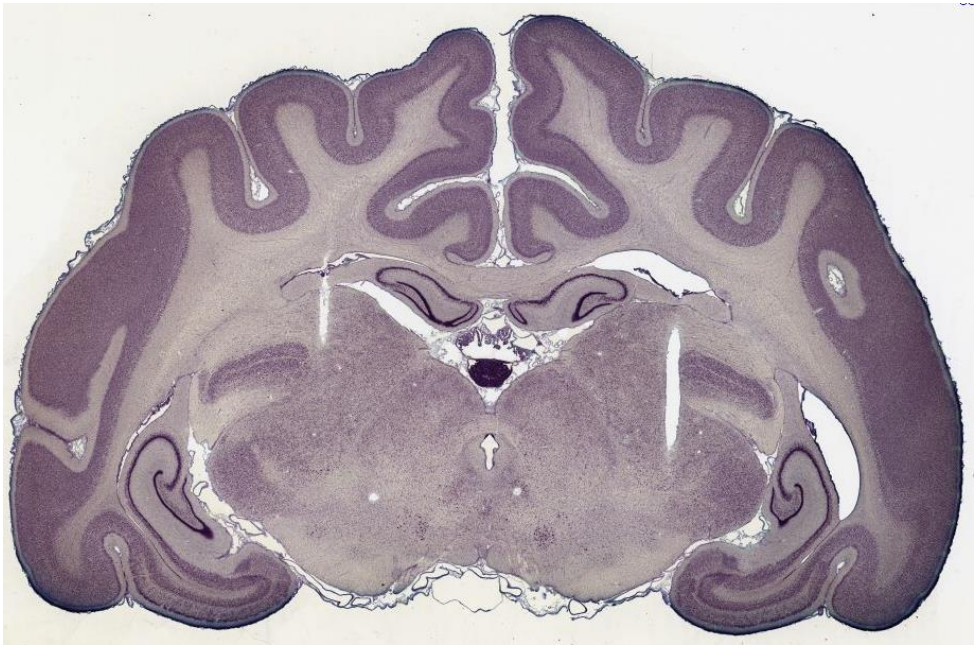


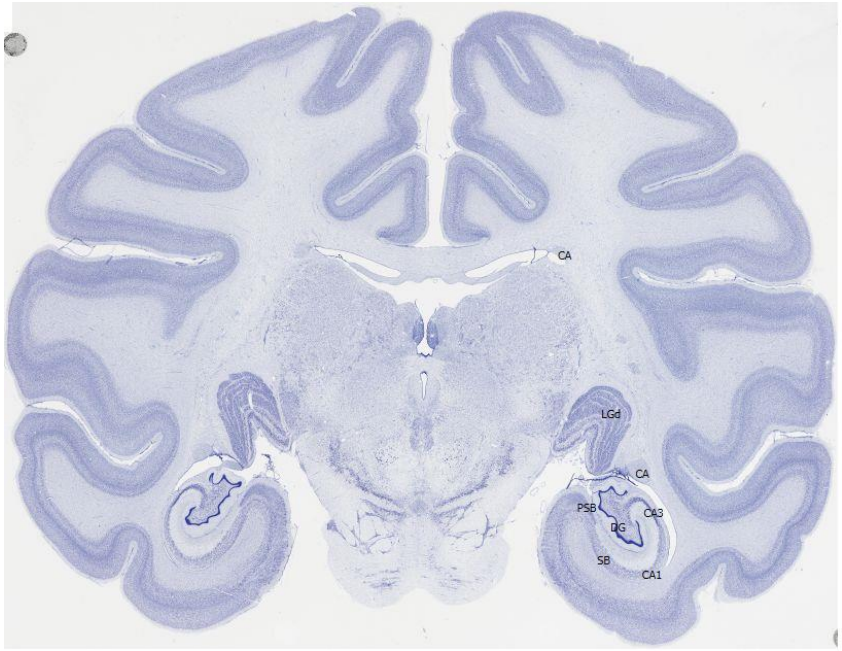
Binocular vision



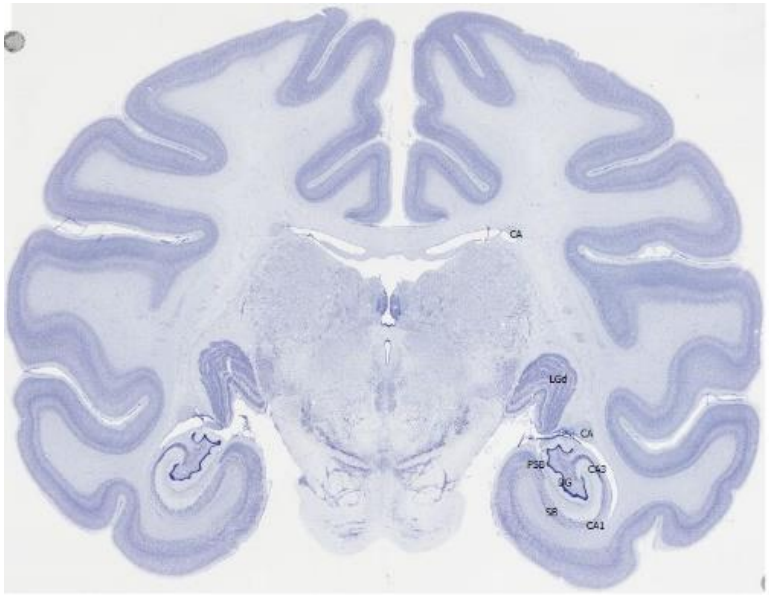
Lateral geniculate nucleus

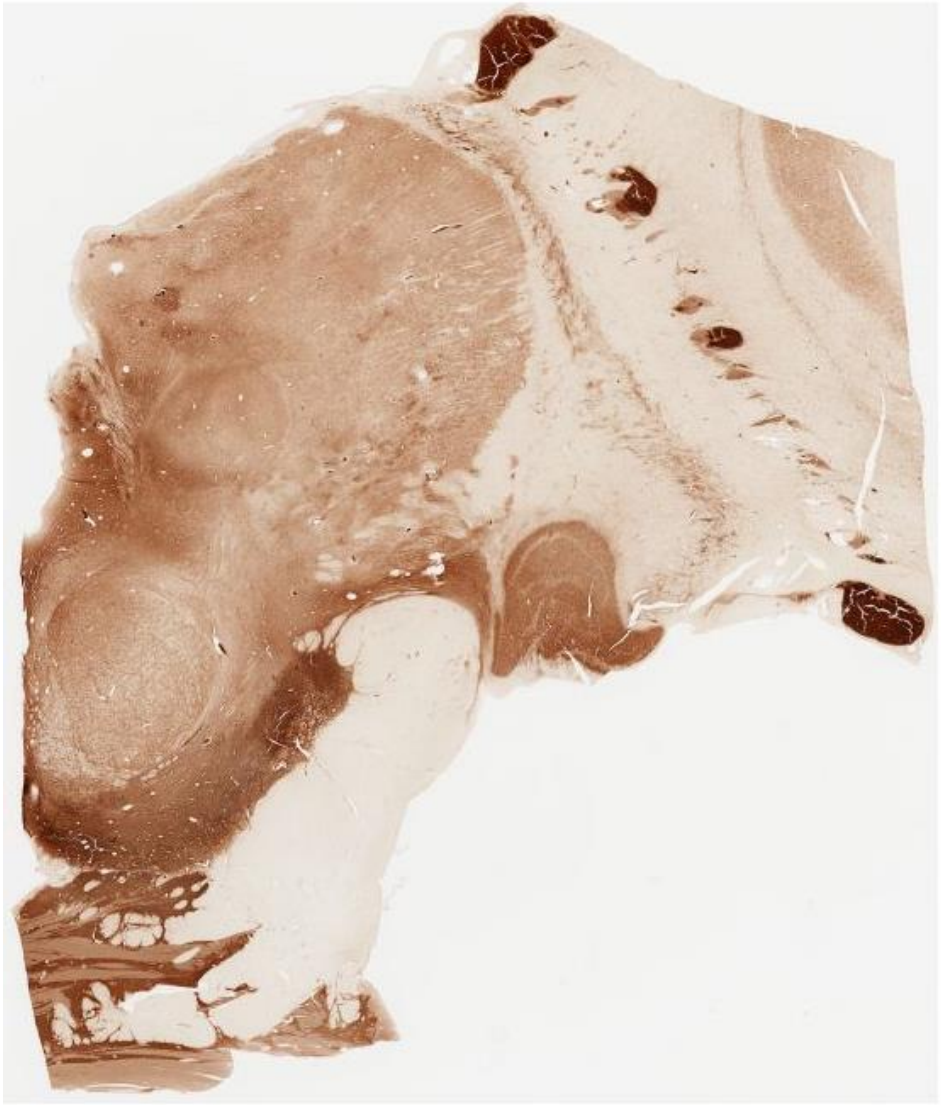




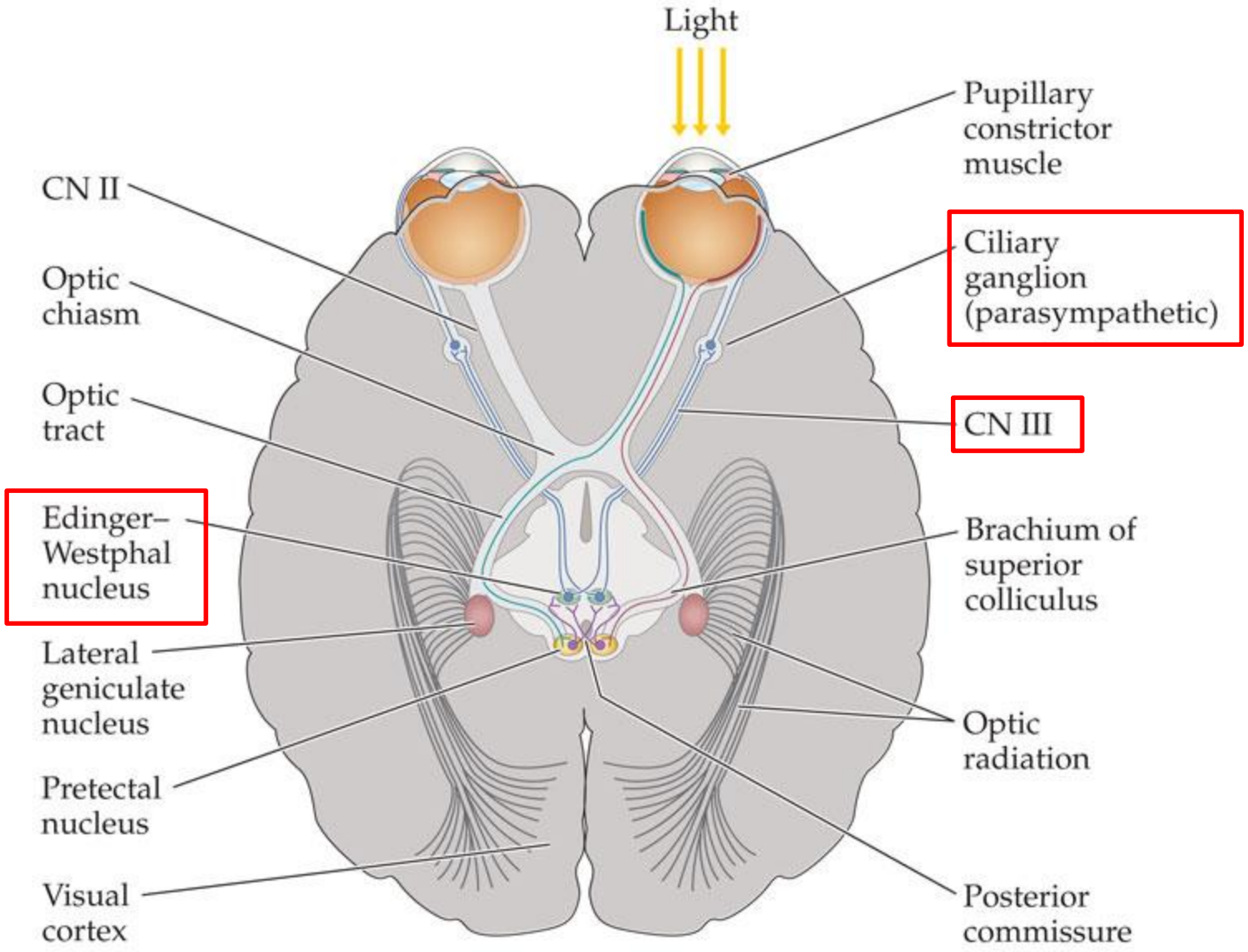


Human LGN



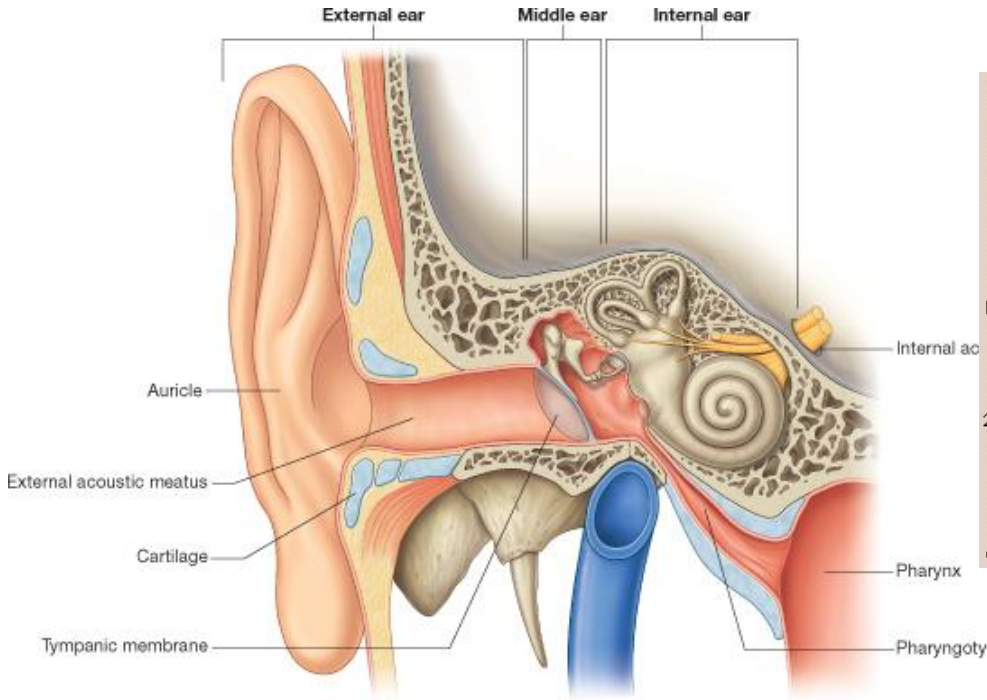


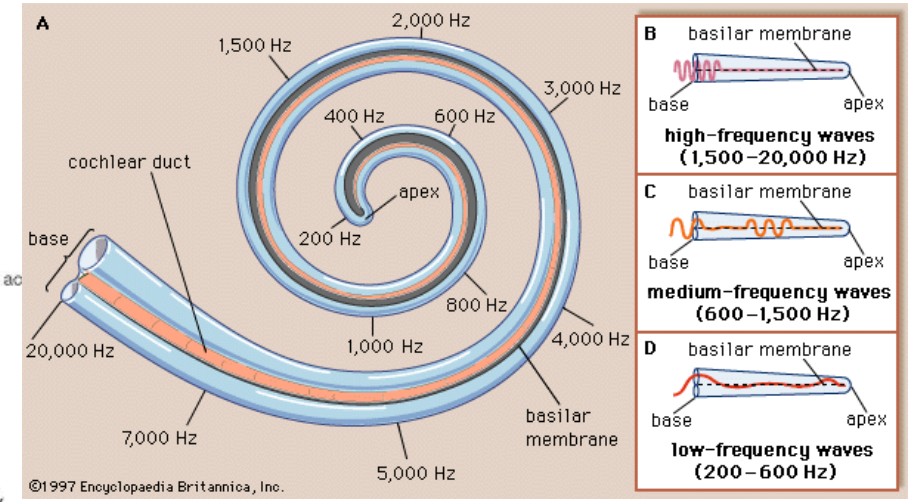
Pupillary light reflex



Auditory System

Auditory overview





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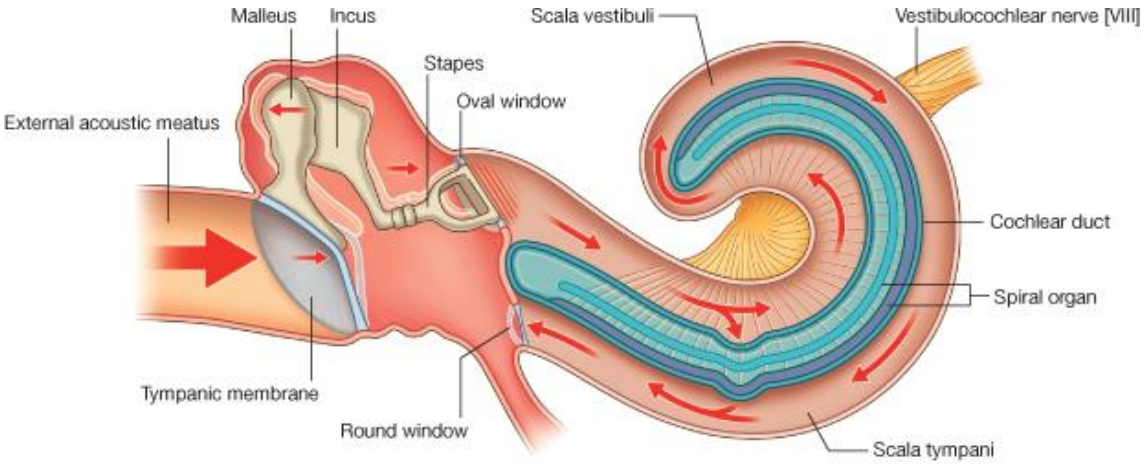

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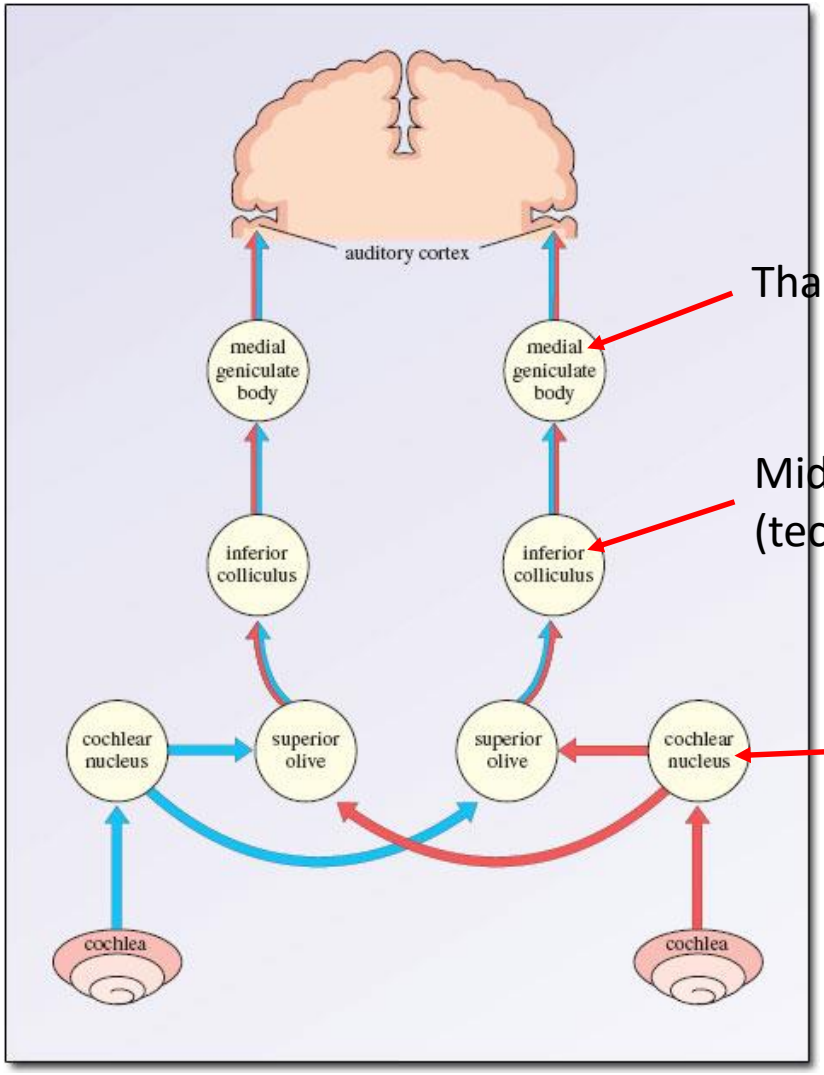
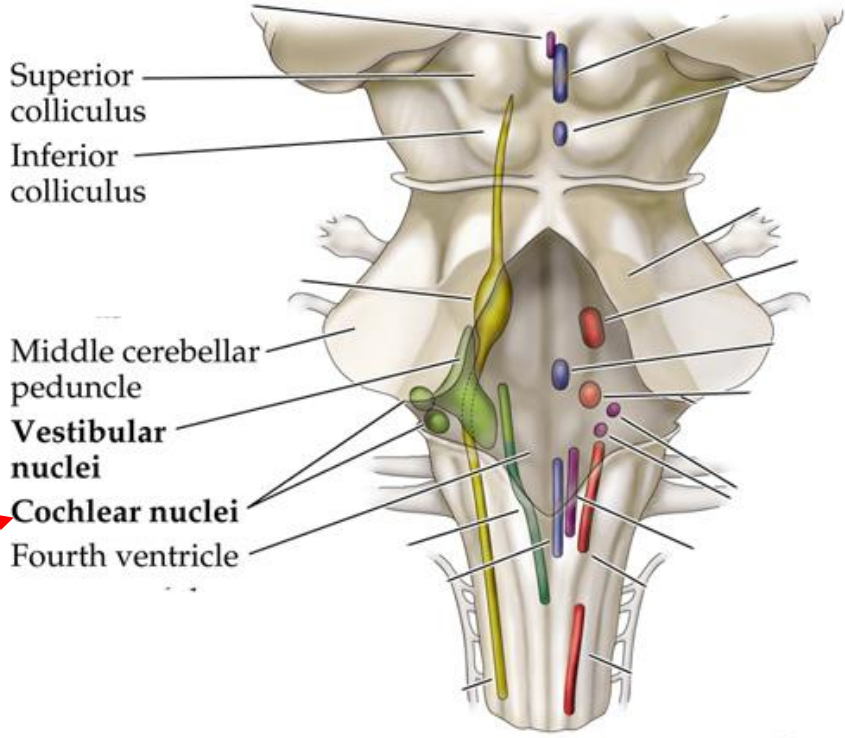
Auditory pathway (1)



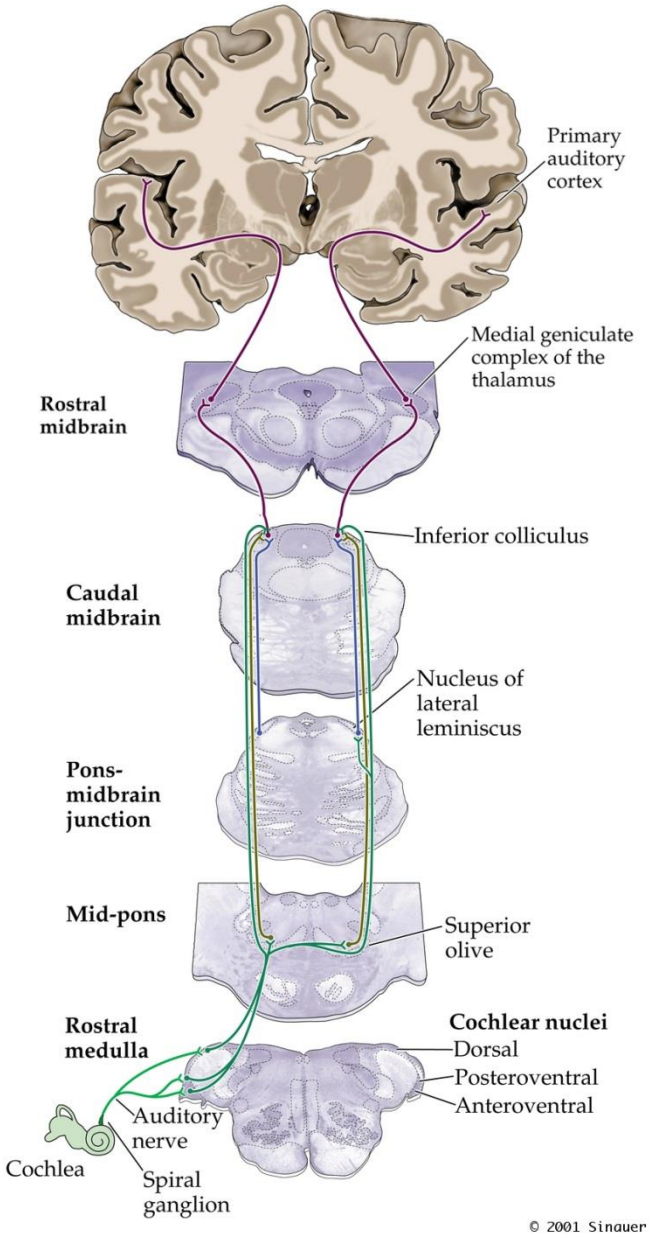
Thalamus

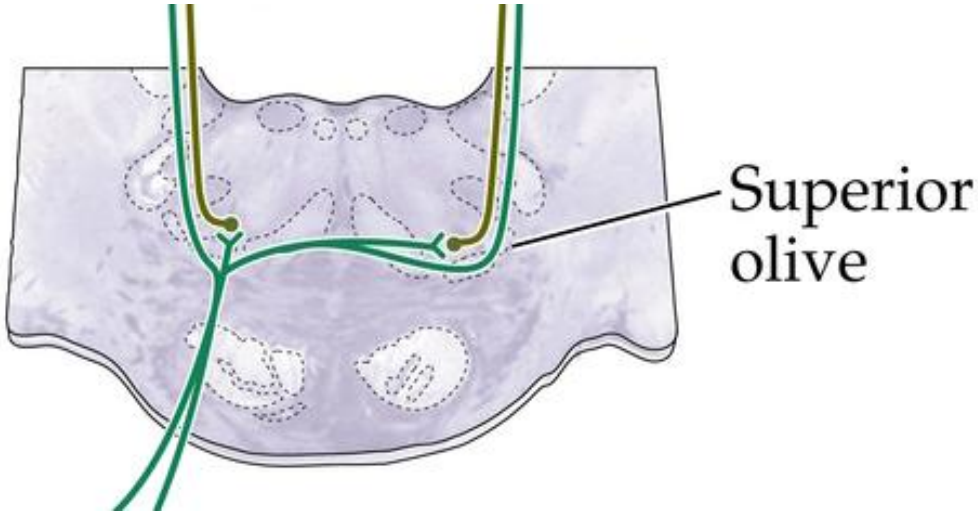
Midbrain (tectum)

Pons

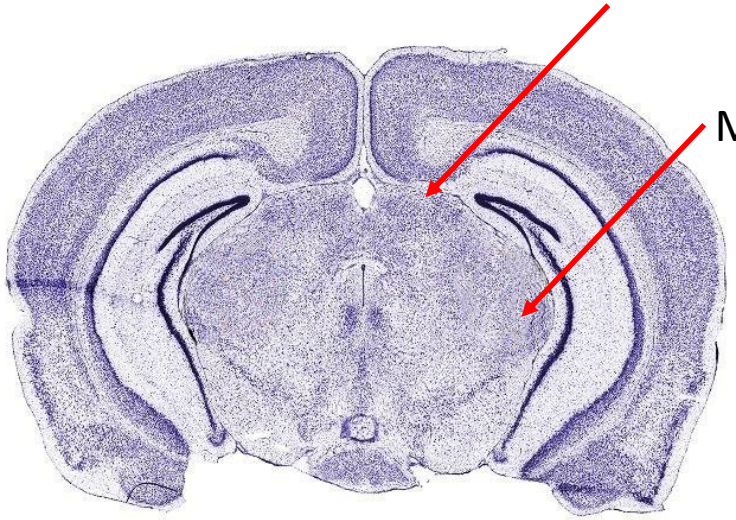


Auditory pathway (2)



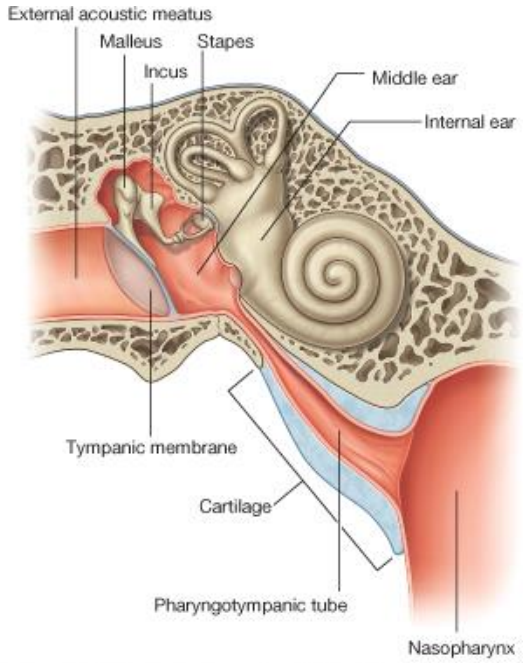


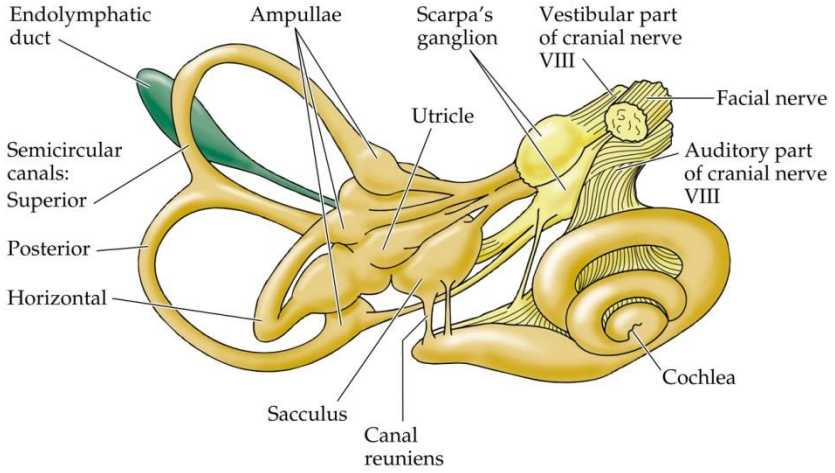
Inf Colliculus



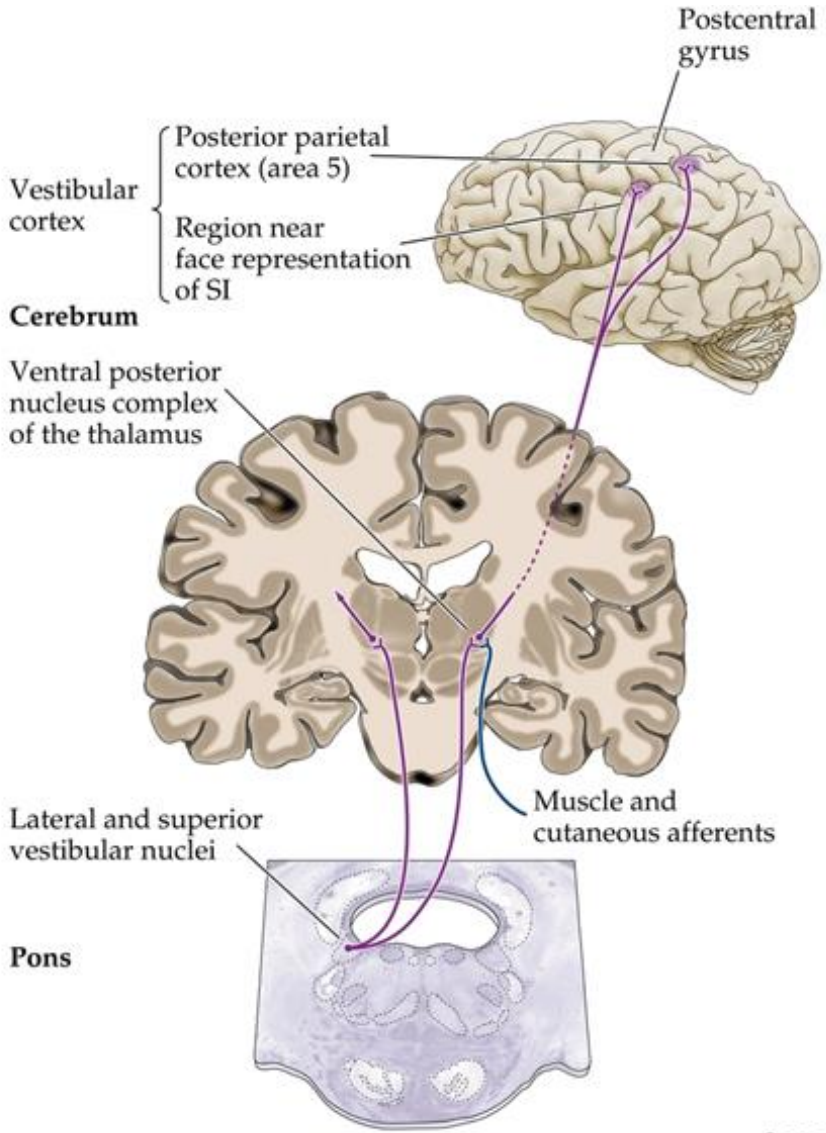
Vestibular system

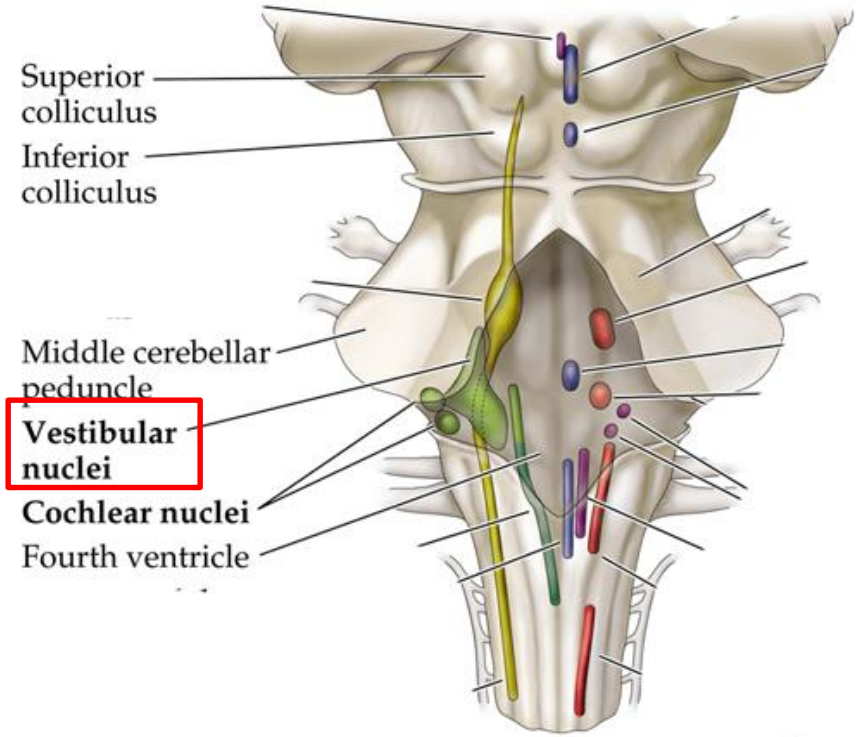
Vestibular system: sensory organ



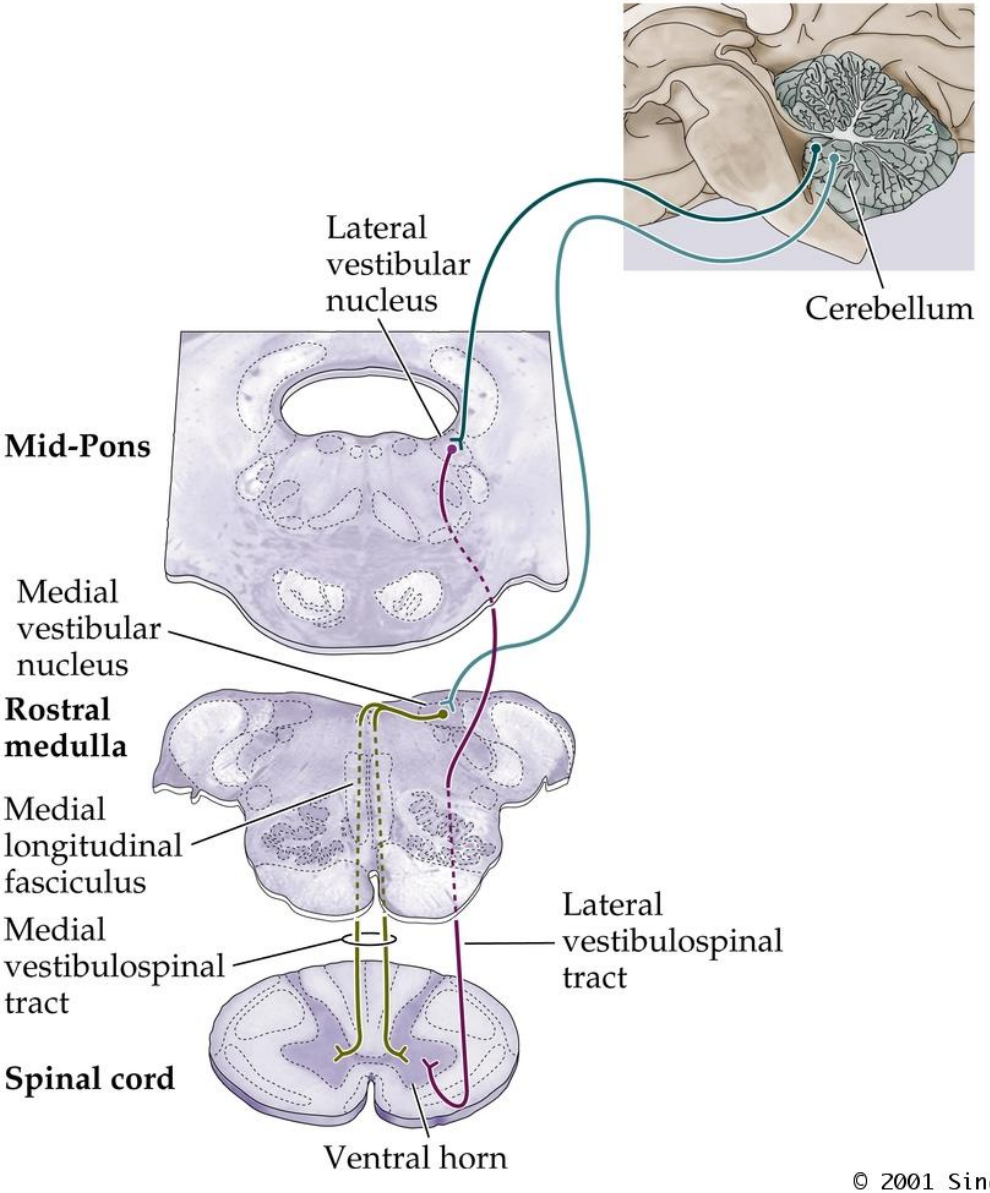


Vestibular system: Pathway 1





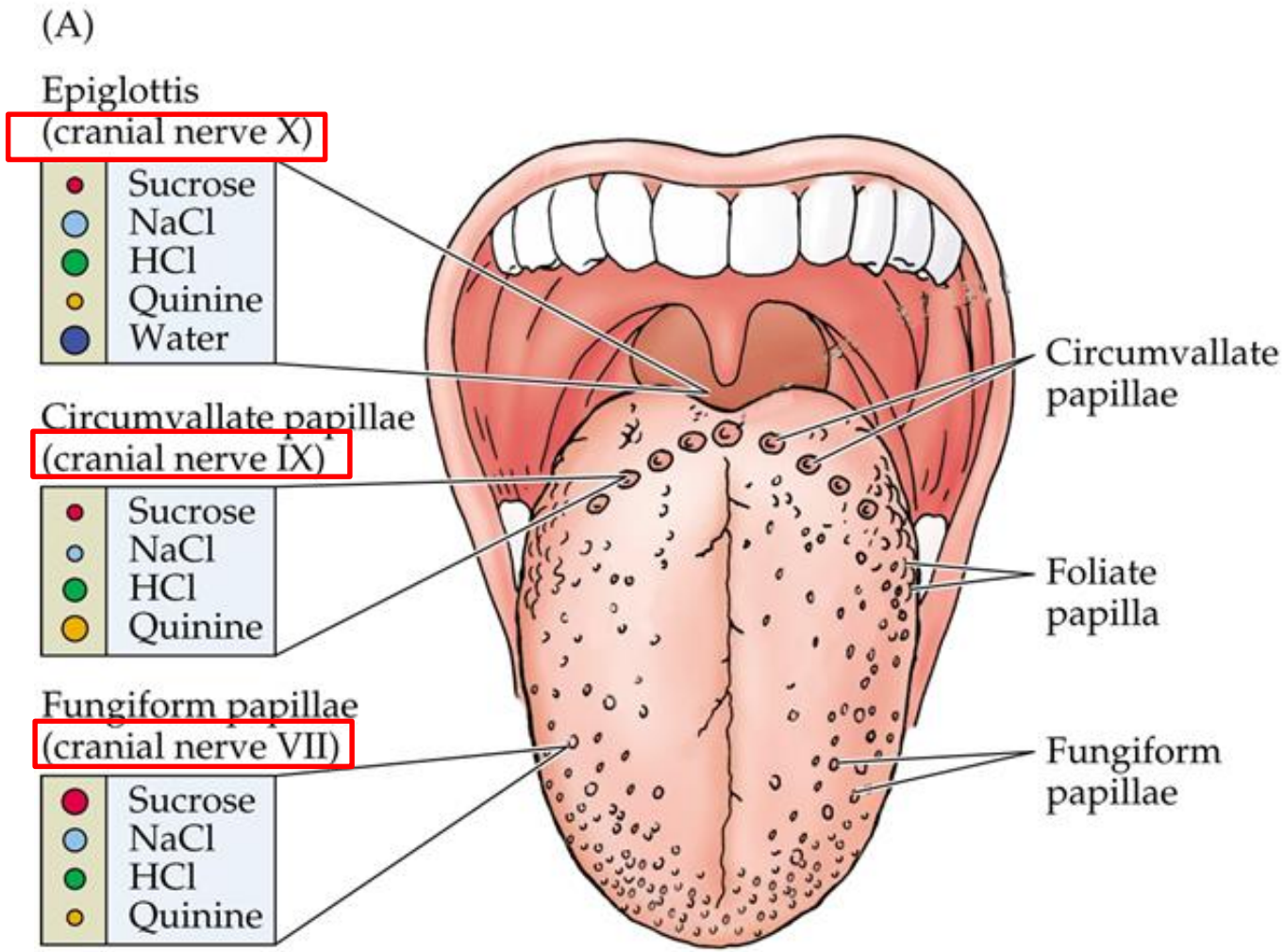
Vestibular system: Pathway 2



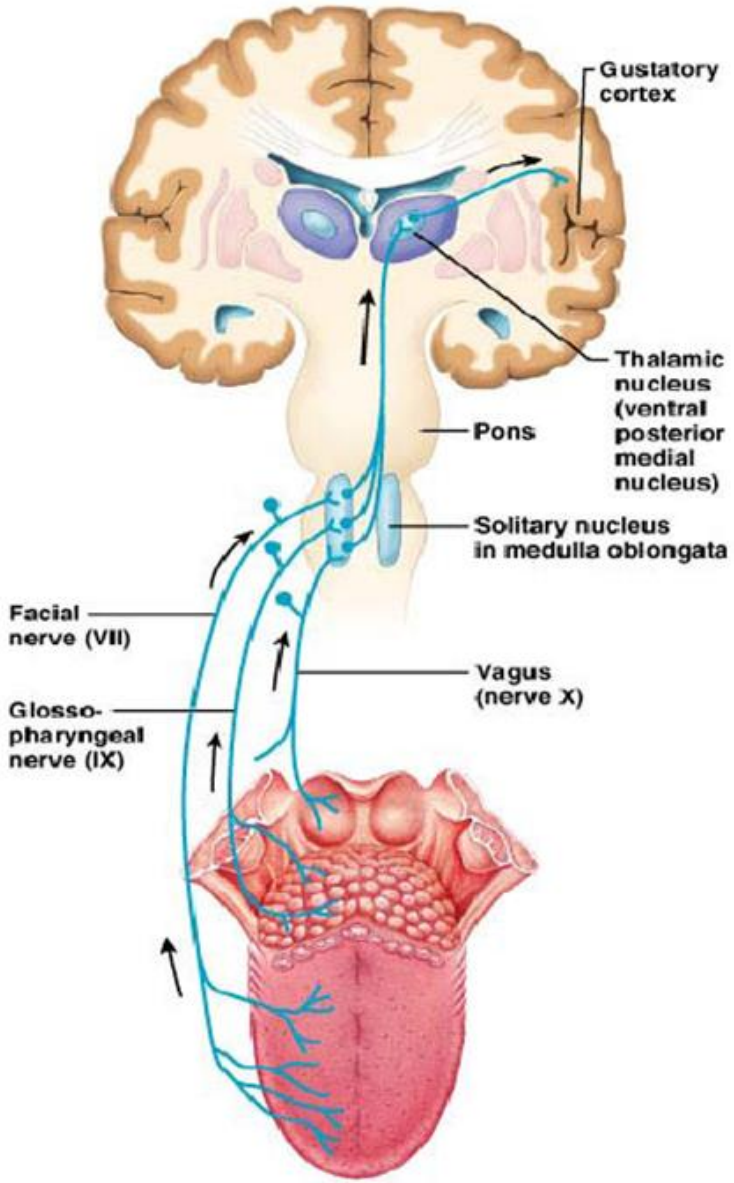
Chemical Senses

1) Gustatory
2) Olfaction
3) ?

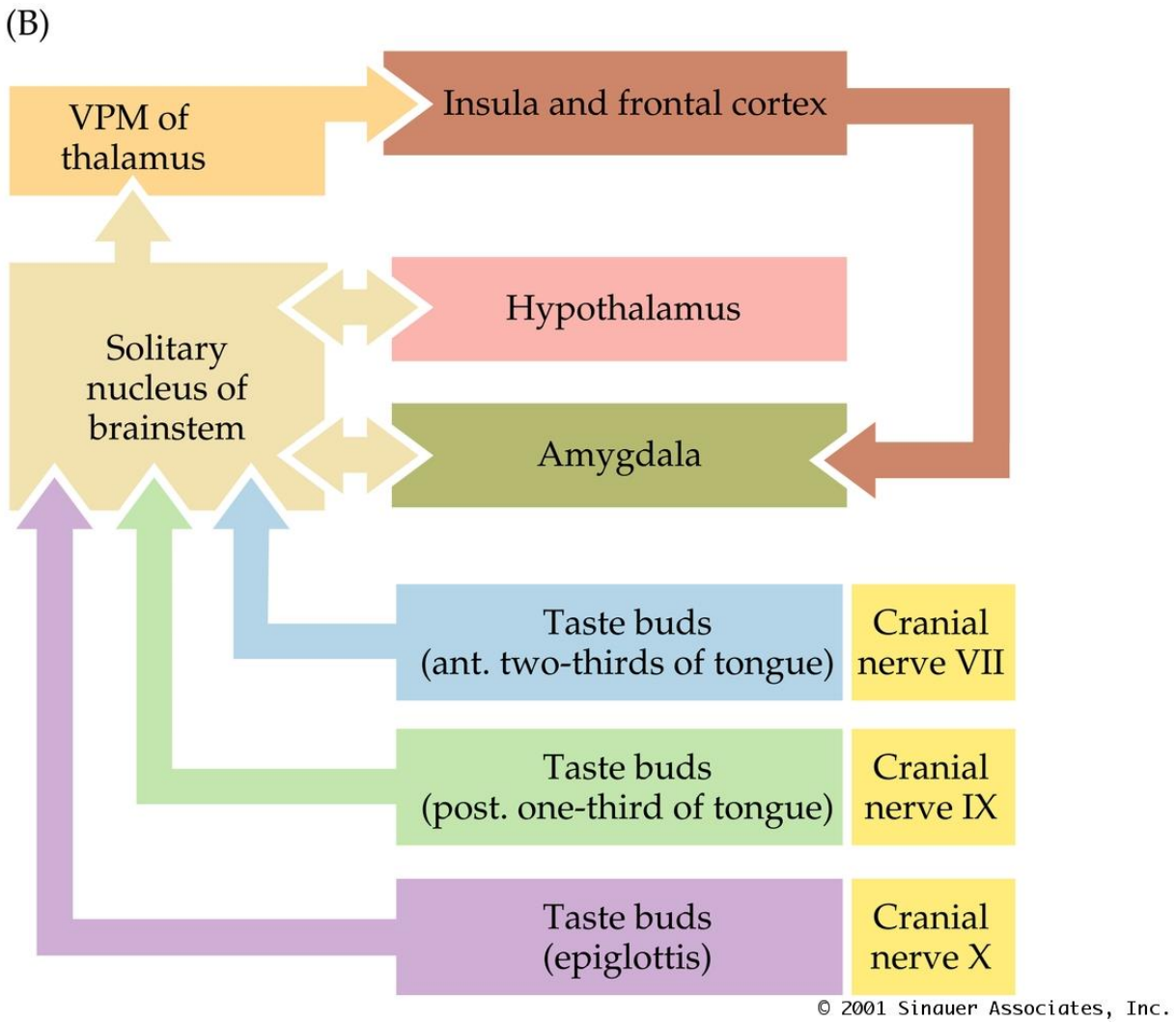
Taste: Receptors



Taste: Pathway

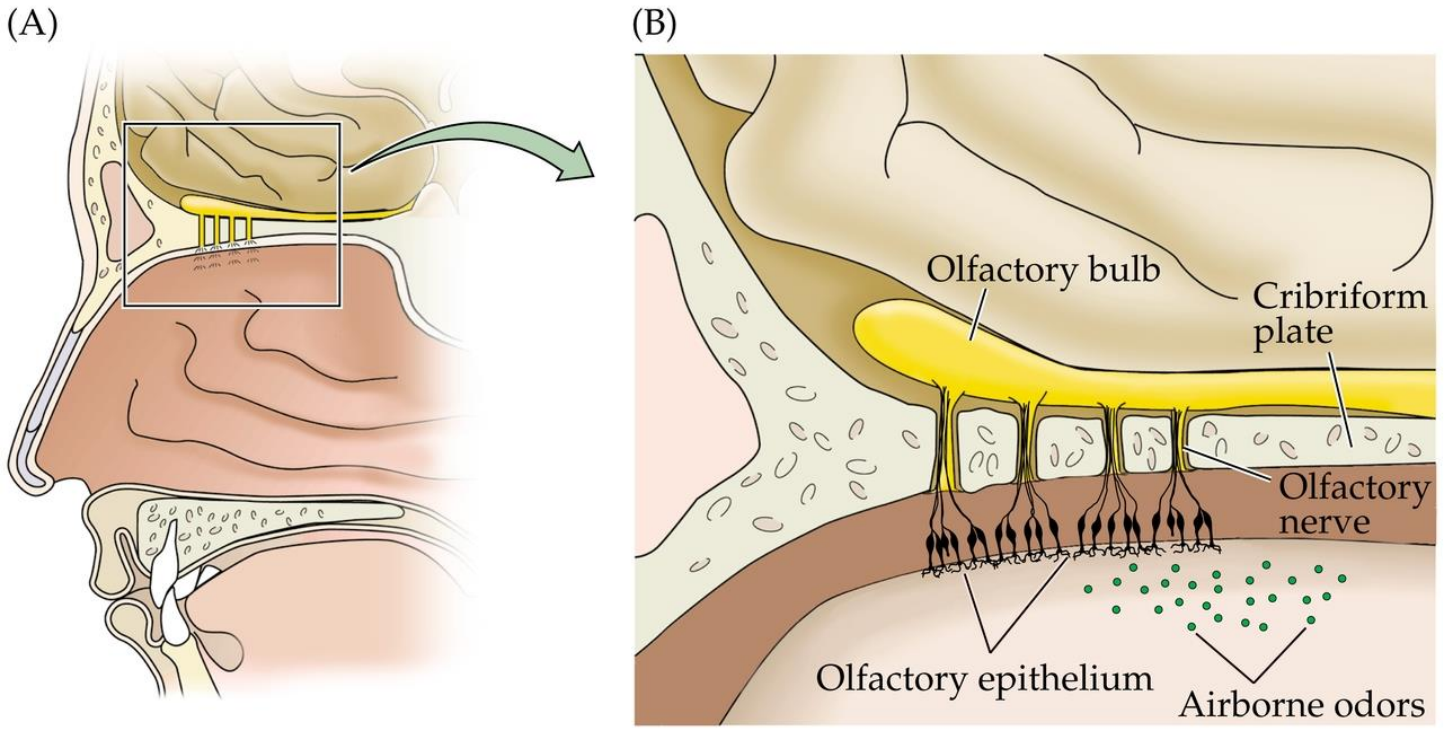


Taste: Targets

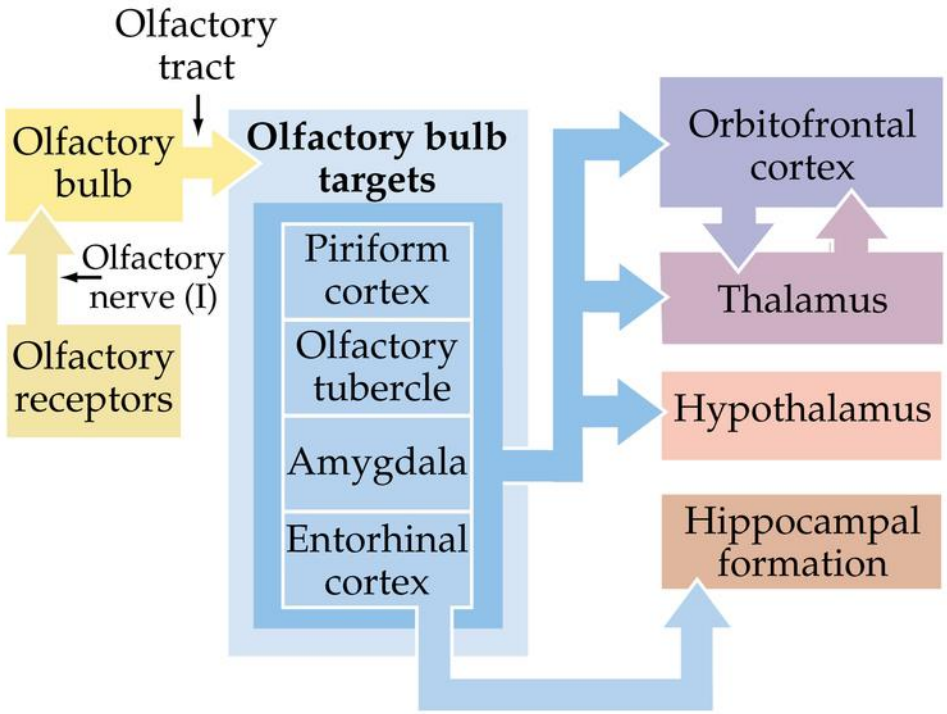


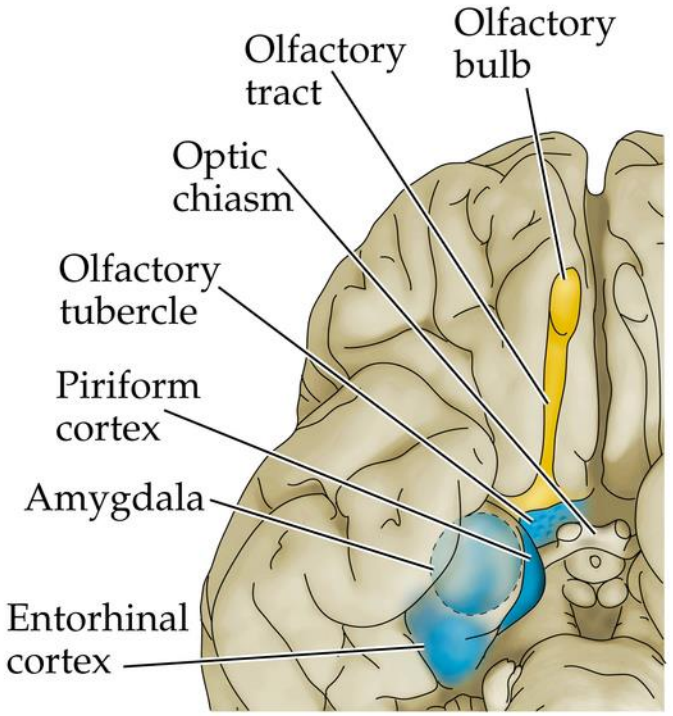
Olfaction:

Olfaction: Nerve

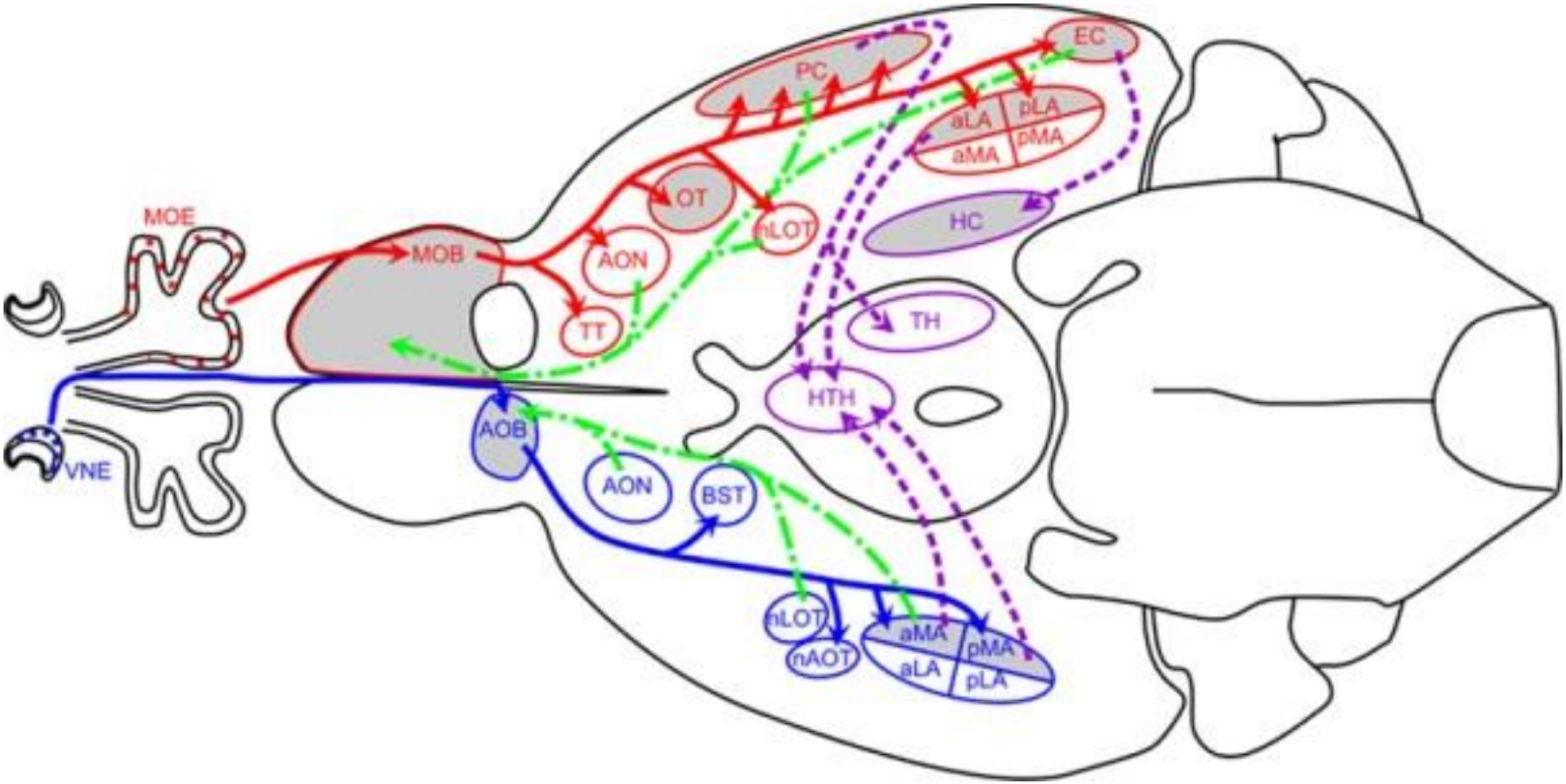


Olfaction: Targets

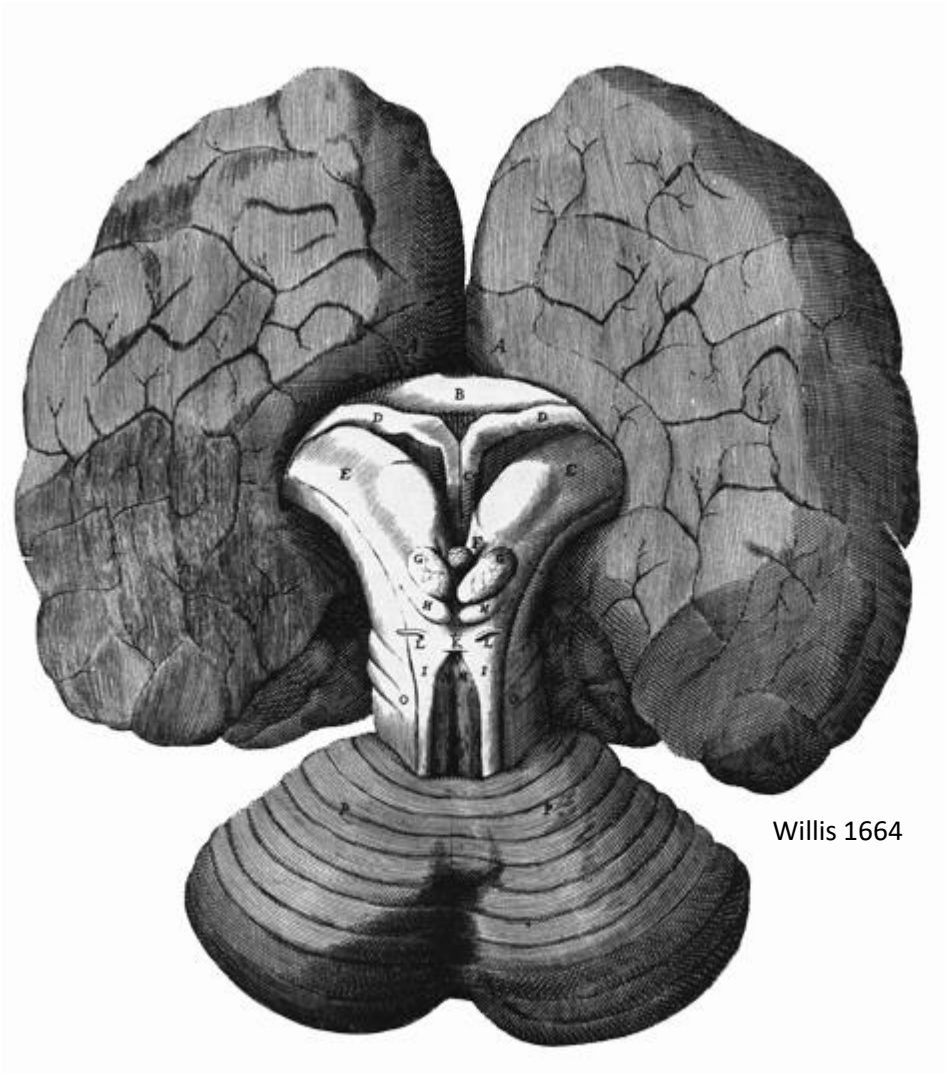




Vomeronasal System



Thalamus



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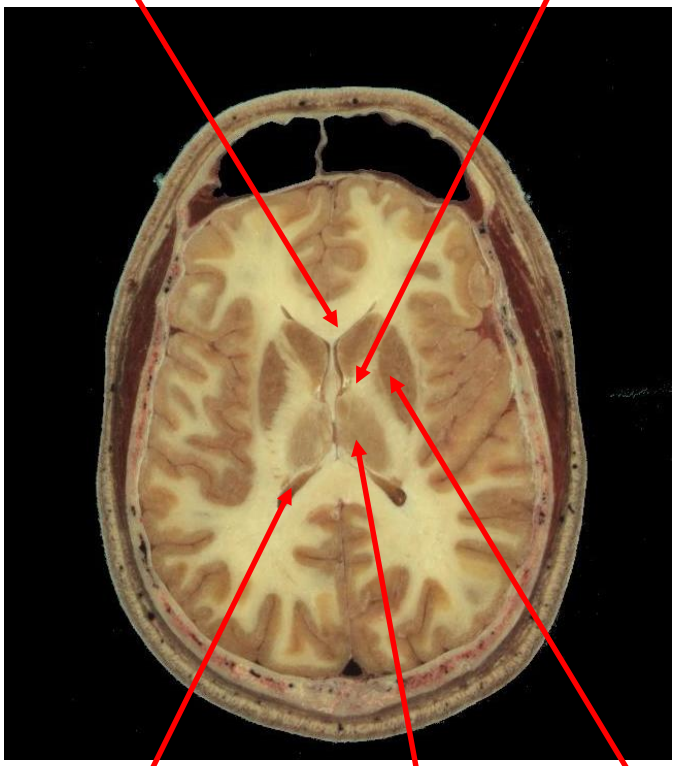
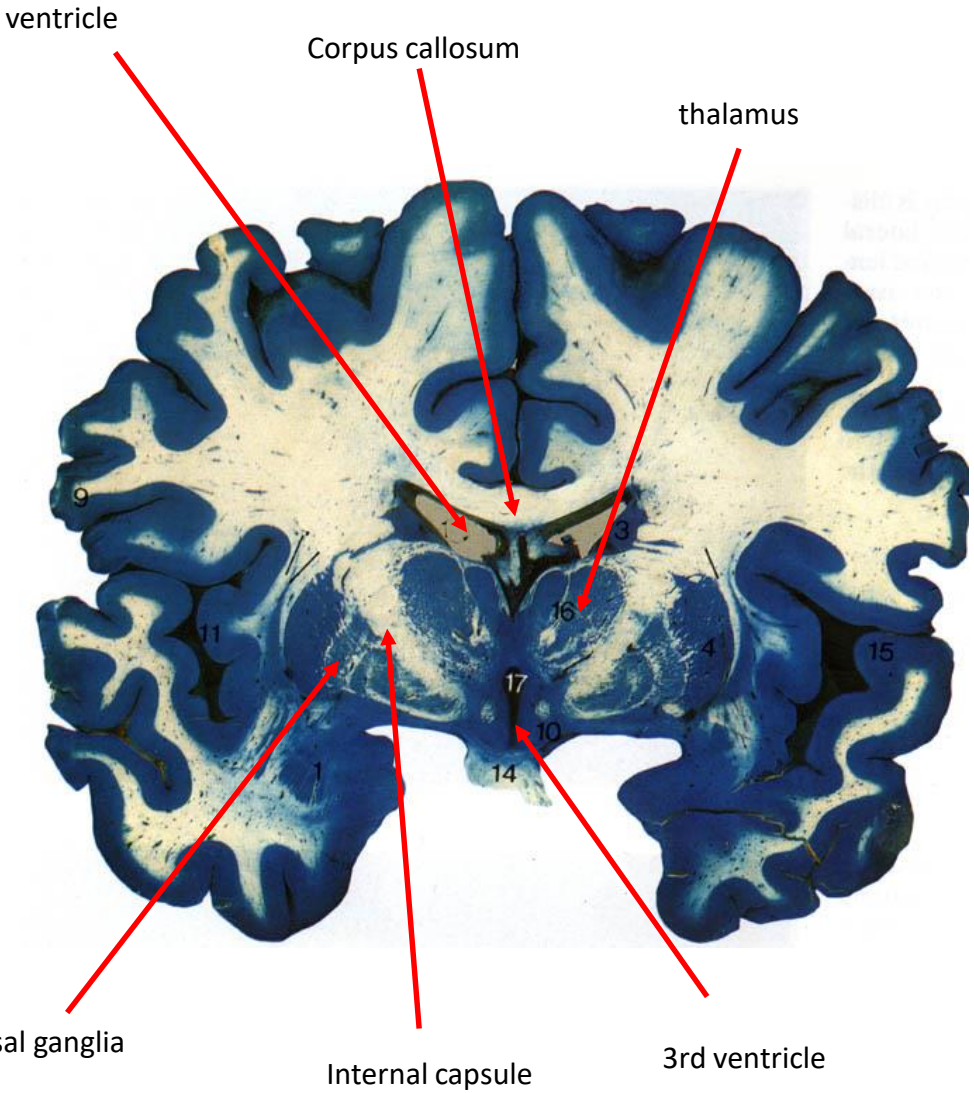
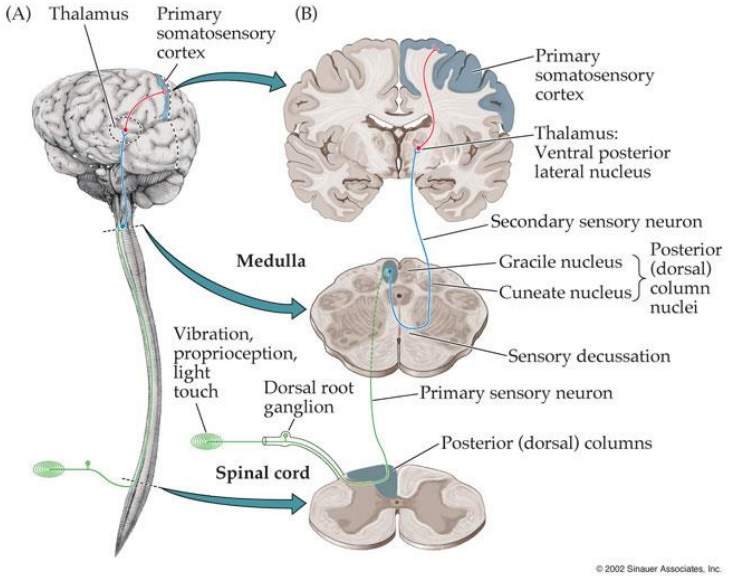
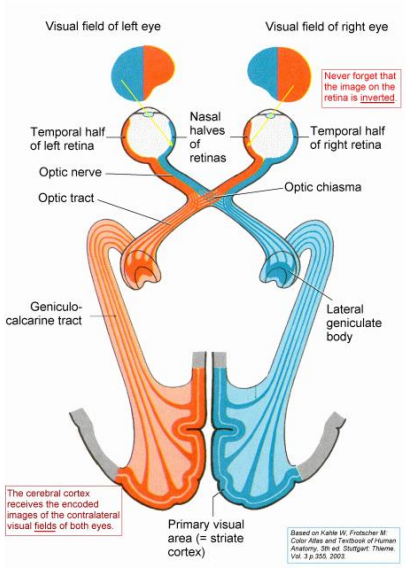
Thalamus: Horizontal and coronal sections

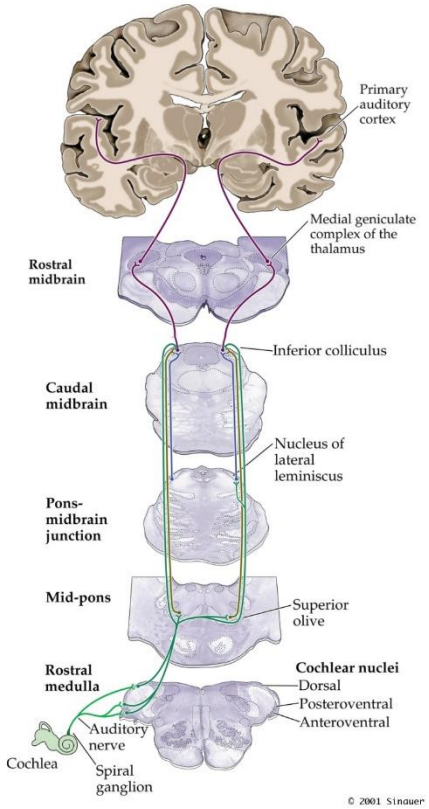


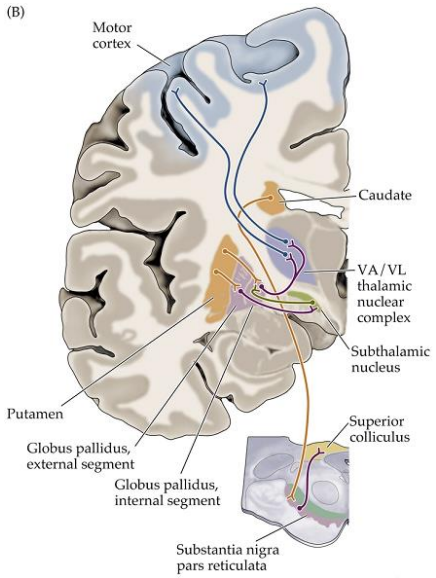


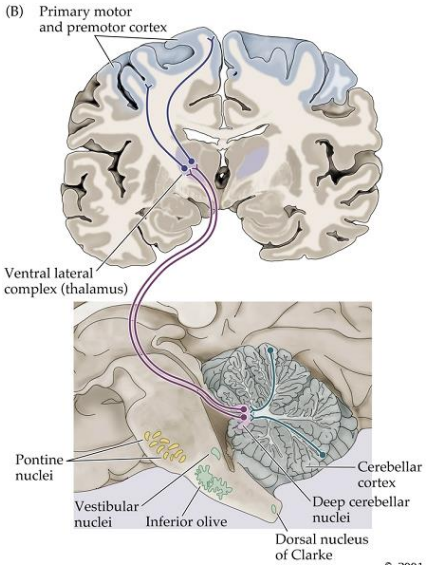
Thalamus in sensory and motor pathways



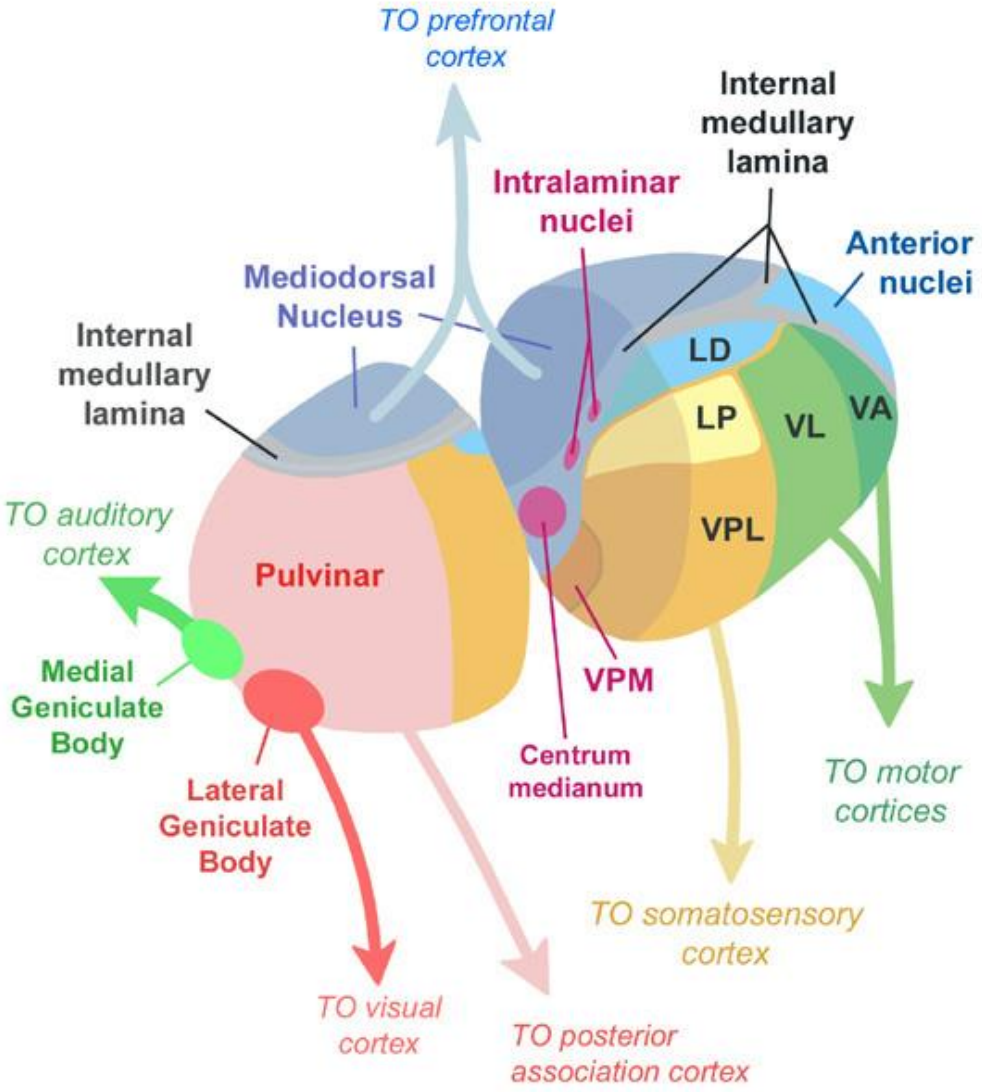








Thalamic nuclei can be categorized on their location within the thalamus



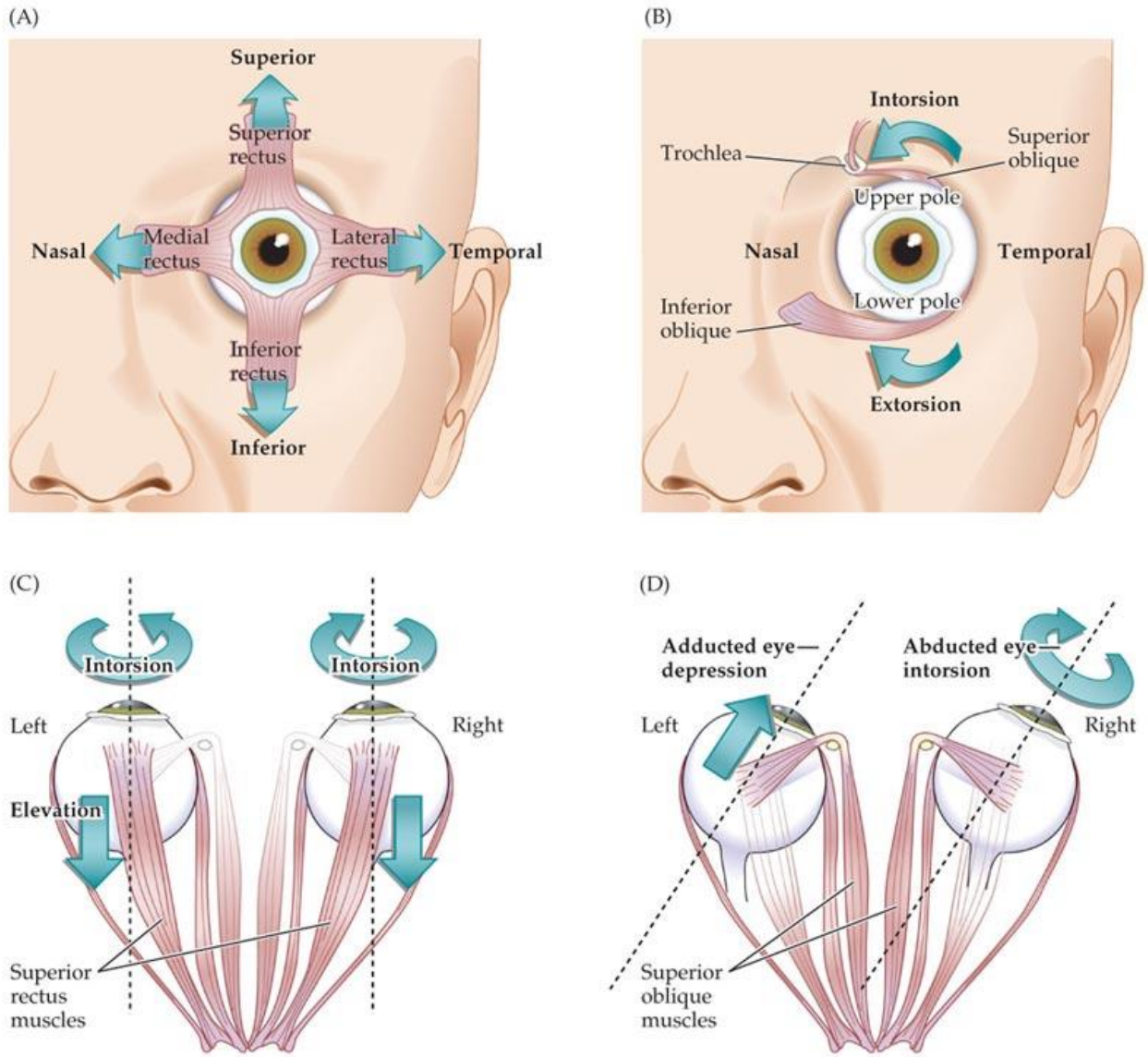
Representative thalamic nuclei

Name	Afferents	Cortical target
Lateral geniculate (LGd)	Retina	Visual cortex (Brodmann area 17)
Ventroposterior lateral (VPL)	Medial lemniscus (Dorsal columns) Spinothalamic tract	Primary somatosensory cortex. (Brodmann areas 3, 1, 2)
Ventroposterior medial (VPM)	Trigeminal nuclear complex	Primary somatosensory cortex (Brodmann areas 3, 1, 2)
Ventrolateral (VLp)	Deep cerebellar nuclei Vestibular nuclei Globus pallidus	Primary motor cortex (Brodmann area 4)
Medial Geniculate	Inferior colliculus	Auditory cortex (Brodmann areas 41, 42)

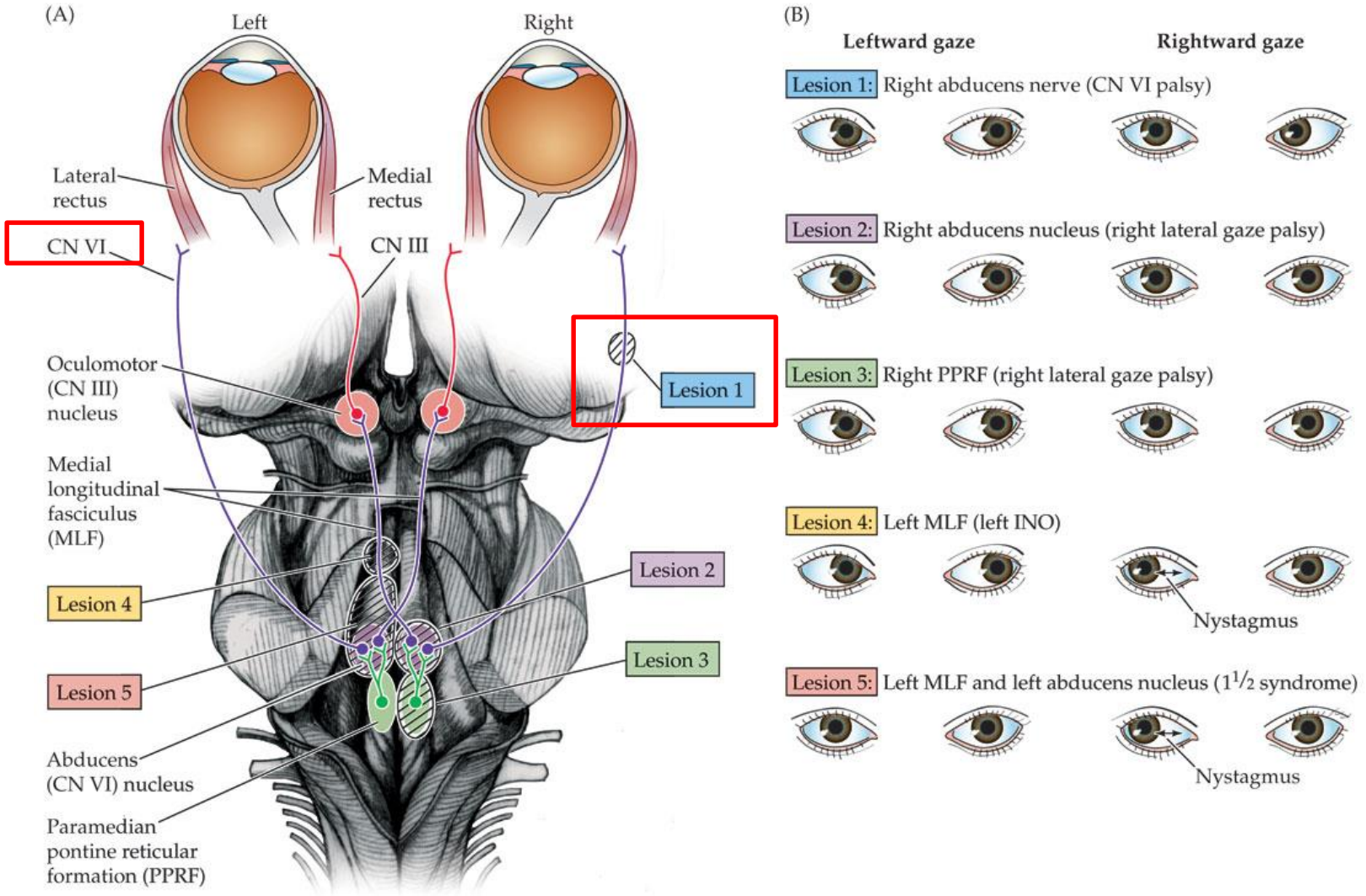
Brainstem

What’s going on?

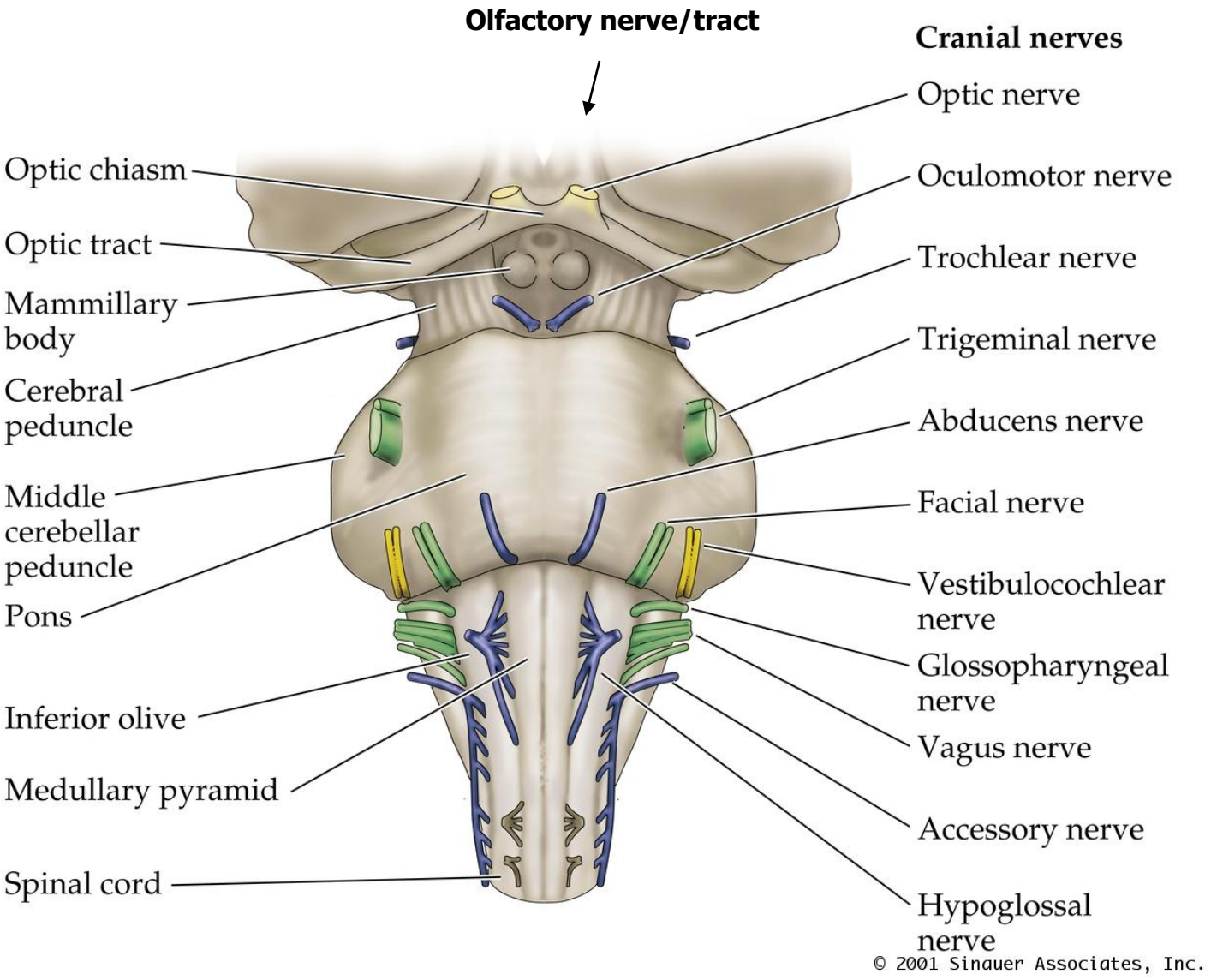
Extraocular muscles (1)



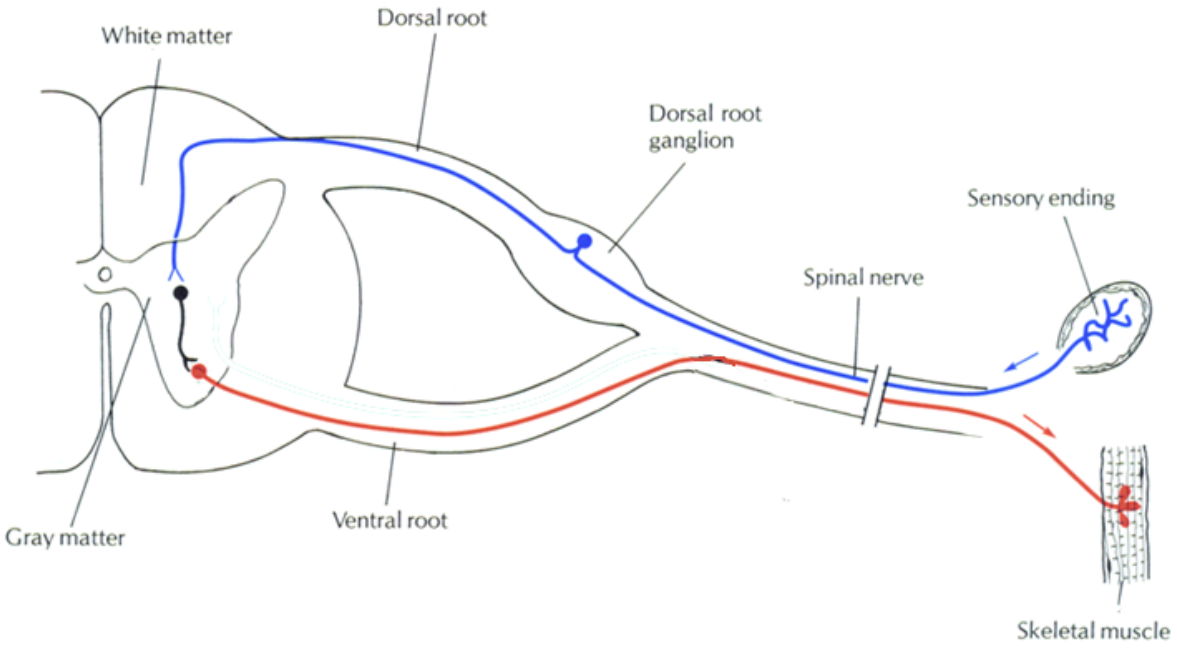
Extraocular muscles

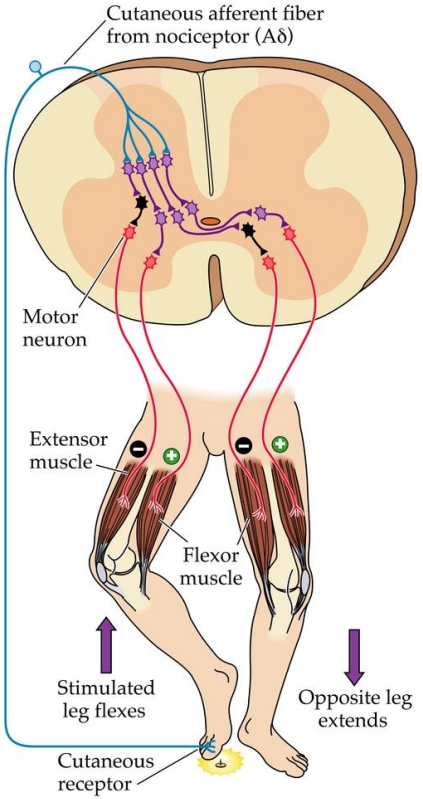


The Cranial nerves



Spinal cord and peripheral nerves: a review

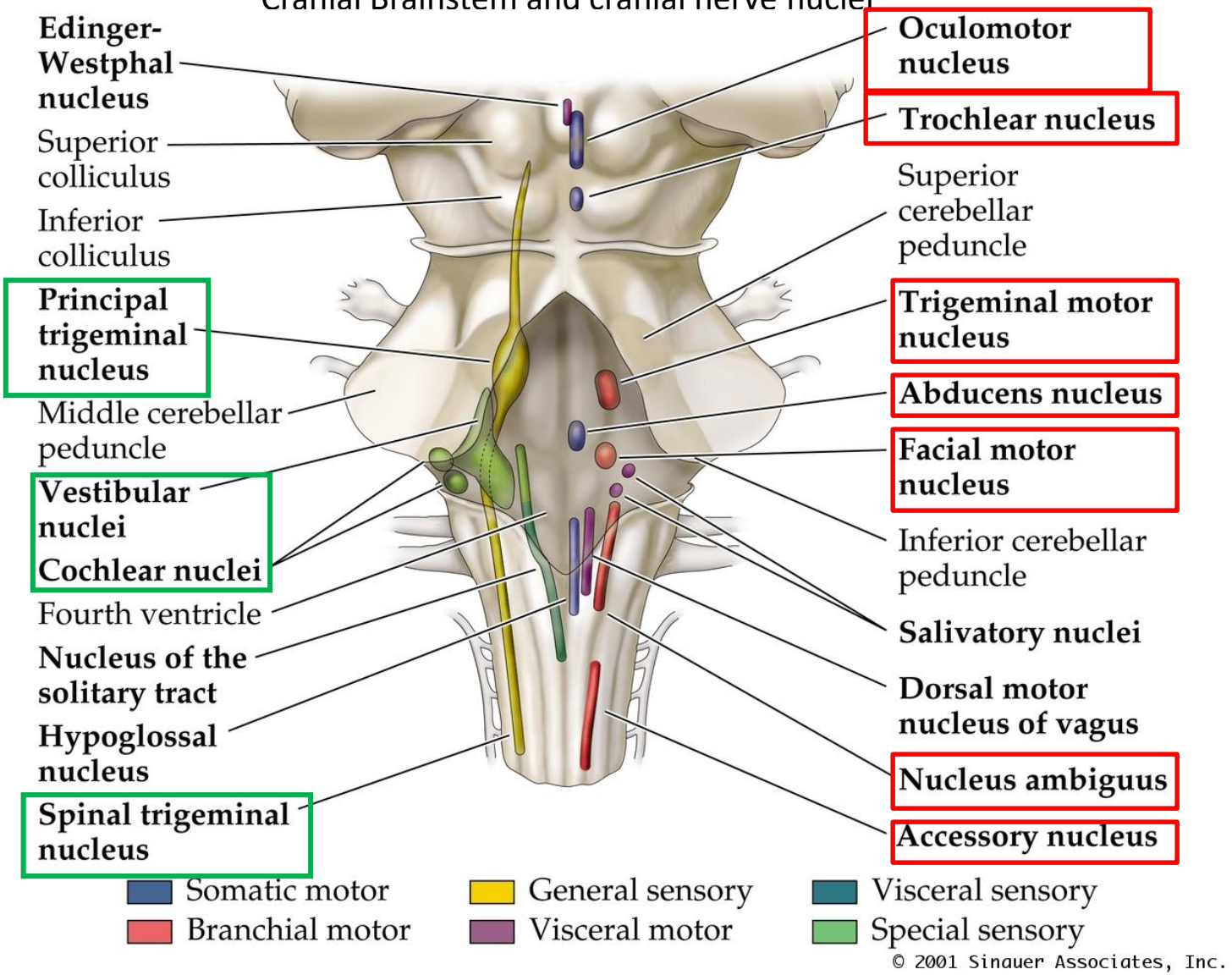




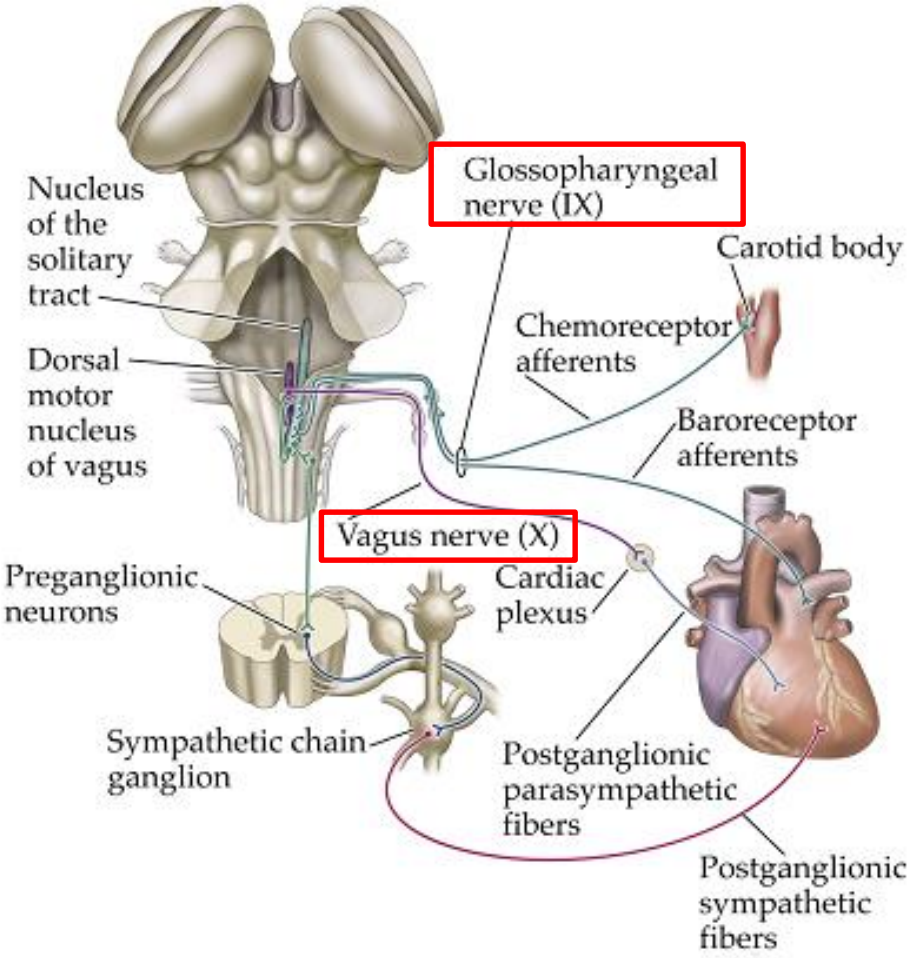
SENSORY

MOTOR

Cranial Brainstem and cranial nerve nuclei



Cardiovascular circuit



Summary: Brainstem Aminergic Pathways

Noradrenergic pathways

Dopaminergic pathways

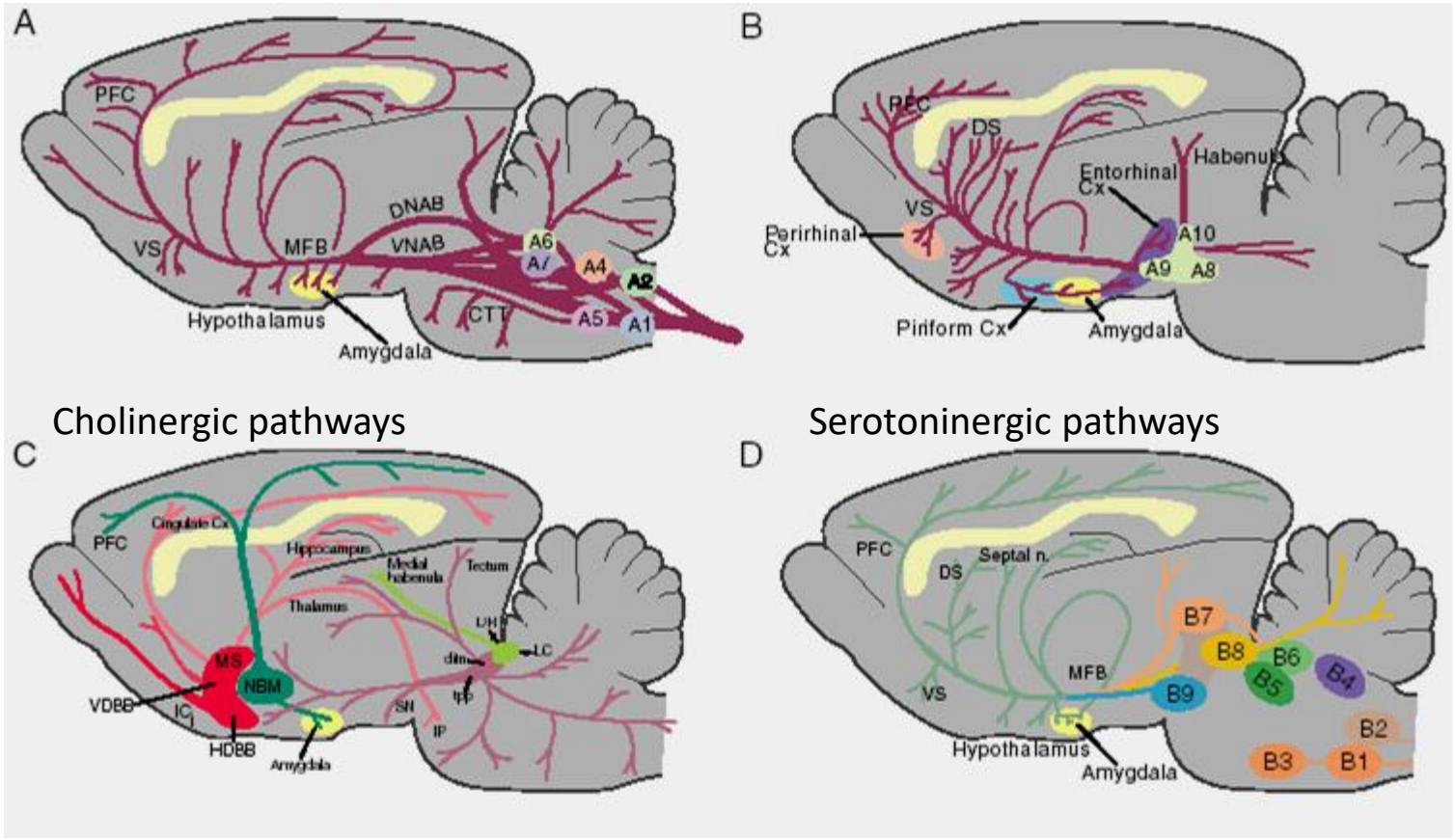


FIGURE 2 Ascending monoamine neurotransmitter systems. Figure shows schematic sagittal (A–D) and coronal (E) sections through the lateral hypothalamus of a rat brain. (A) Origin and distribution of central noradrenergic pathways. Note noradrenergic cell groups A1–A7, including the locus ceruleus (A6). DNAB, dorsal noradrenergic ascending bundle; VNAB, ventral noradrenergic ascending bundle. (B) Origin and distribution of central dopamine pathways. Note dopaminergic cell groups A8–A10. (C) Origin and distribution of central cholinergic pathways. Note rostral cell groups. NBM, nucleus basalis magnocellularis (Meynert in primates); MS, medial septum; VDBB, vertical limb nucleus of the diagonal band of Broca; HDBB, horizontal limb nucleus of the diagonal band of Broca. (D) Origin and distribution of central serotoninergic pathways. Note cell groups in the raphe nucleus, B4–B9. MFB, medial forebrain bundle; PFC, prefrontal cortex; VS, ventral striatum; DS, dorsal striatum.

Autonomic nervous system

Sympathetic function

The Sympathetic Human
(Rage or Fear)

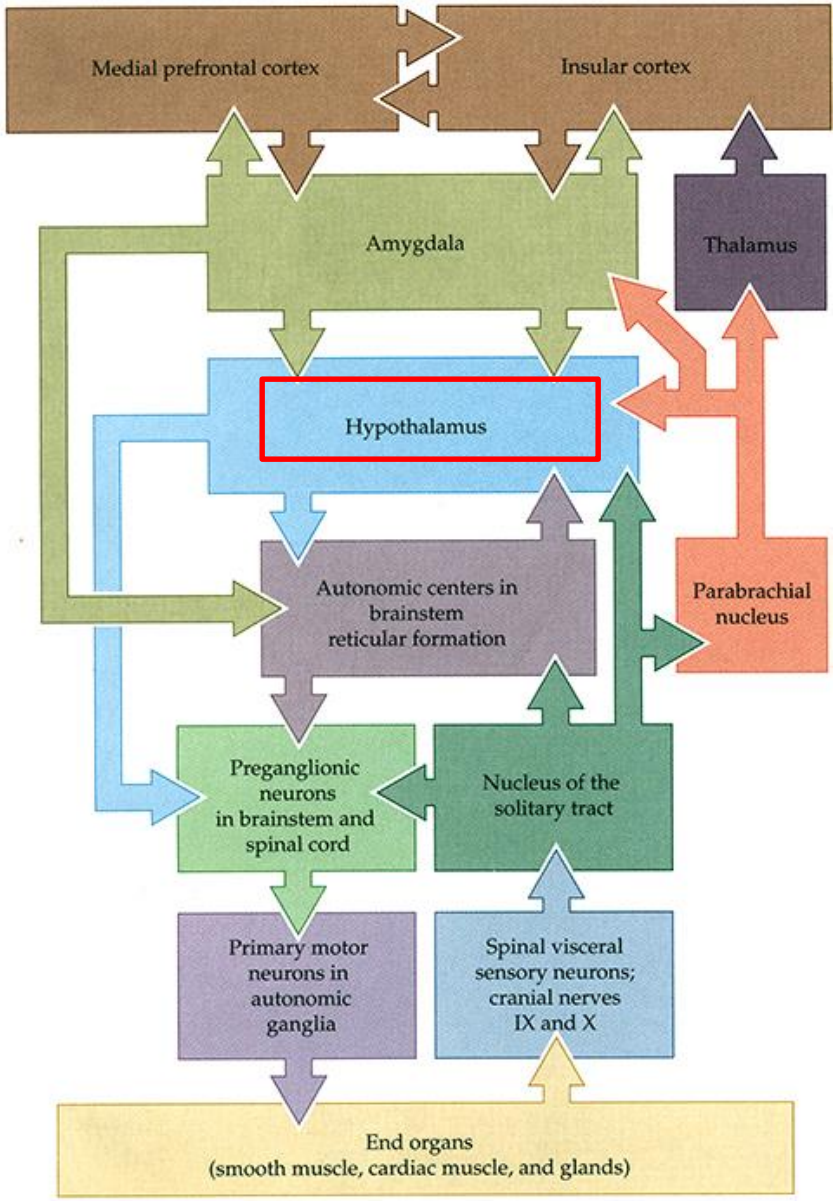
1. Blood Pressure increases
2. Pupils dilated
3. Saliva decreases
4. Peripheral vessels constrict
5. Bronchioles dilate
6. Gut activity inhibited
7. Piloerection.

Parasympathetic function

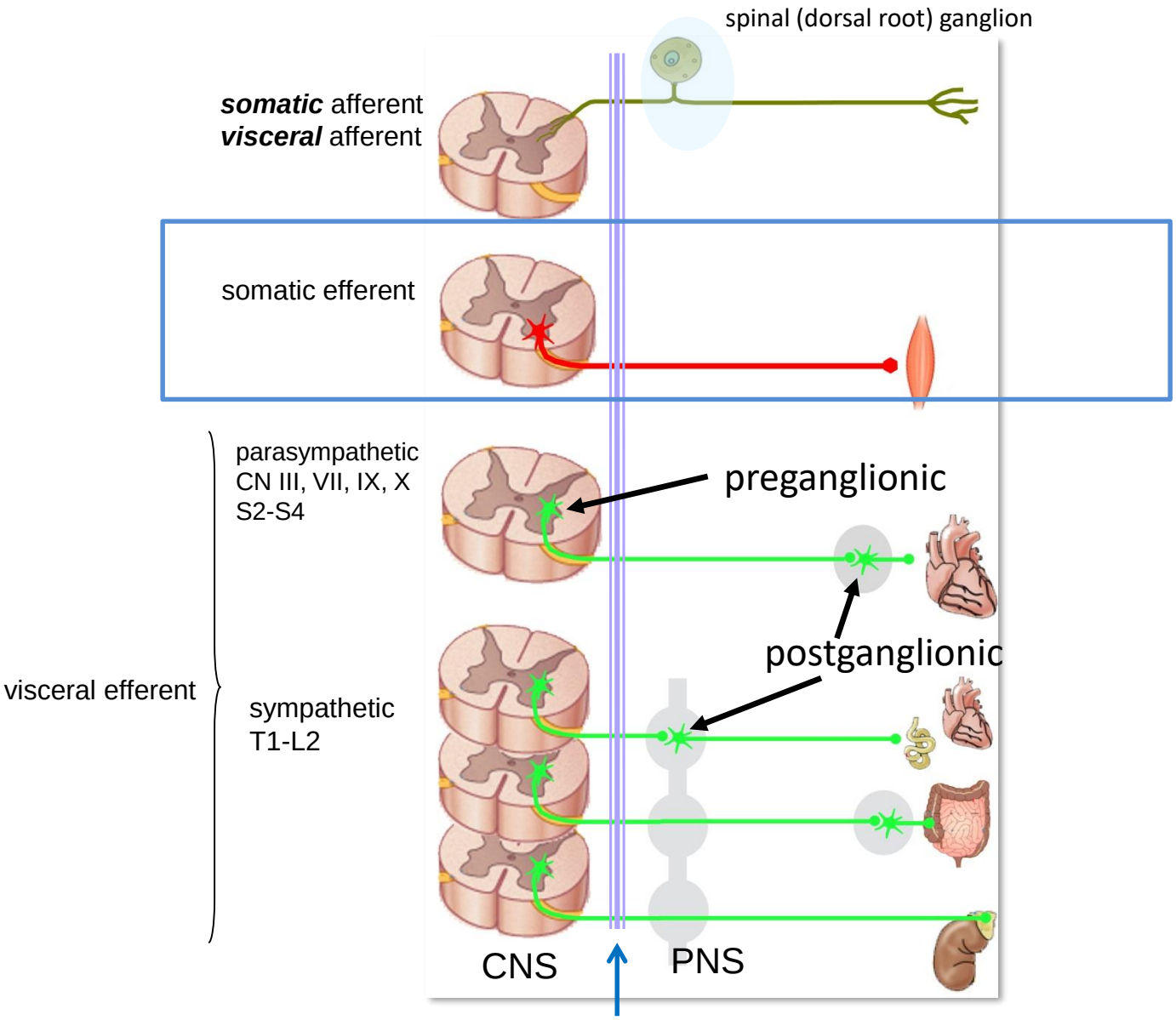
The Parasympathetic Human
(The Big Lunch)

1. Heart rate slow and steady
2. Pupils constricted
3. Salivary glands secreting
4. Gut peristalsis
5. Bladder contracts
6. Rectum contracts
7. Sphincters relax

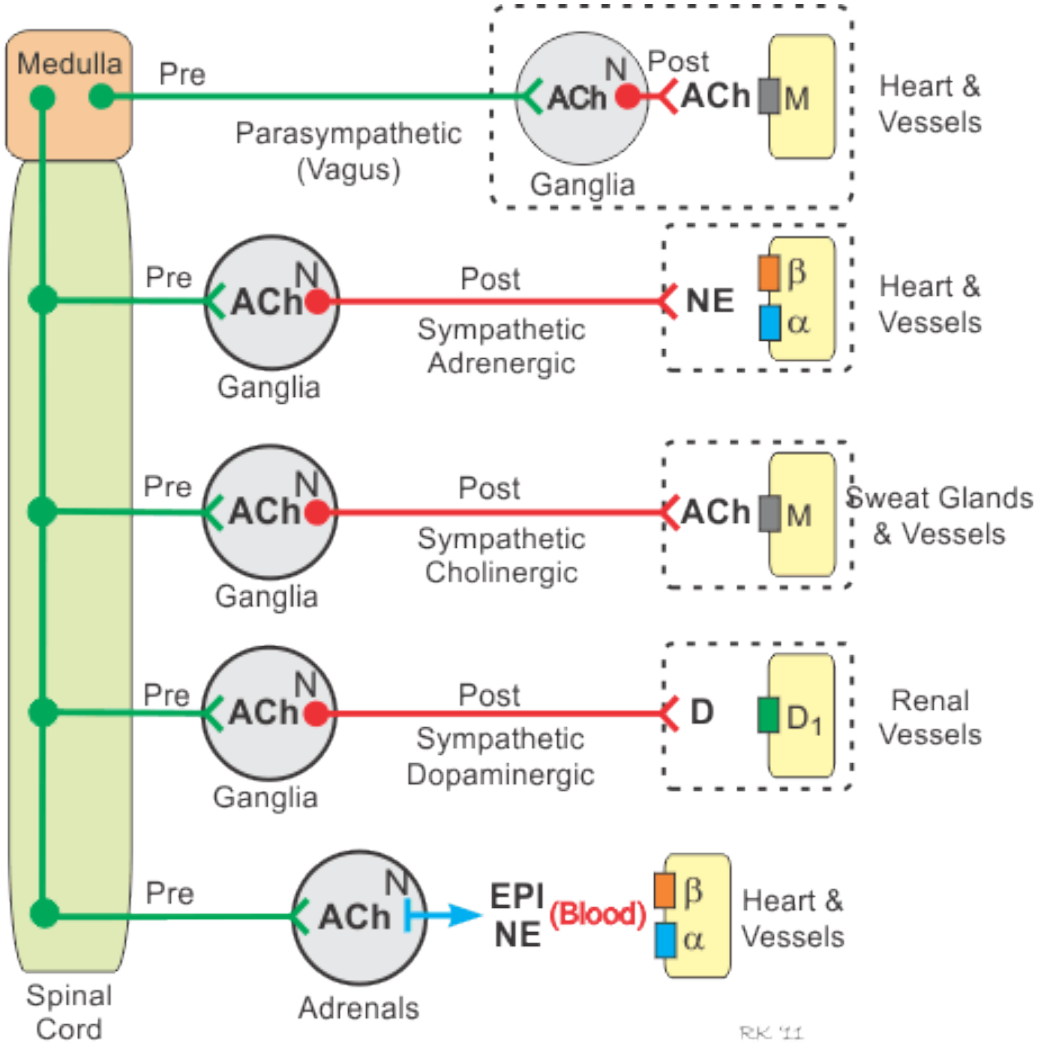
Central control of Autonomic Nervous system



Comparison of peripheral somatic and autonomic sensory and motor systems.



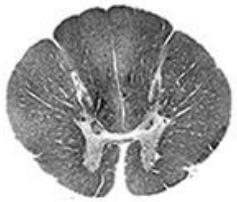
Neurotransmitters

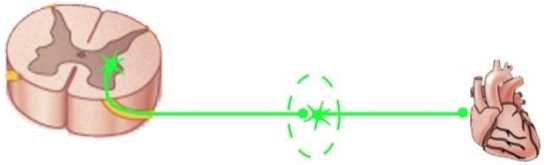


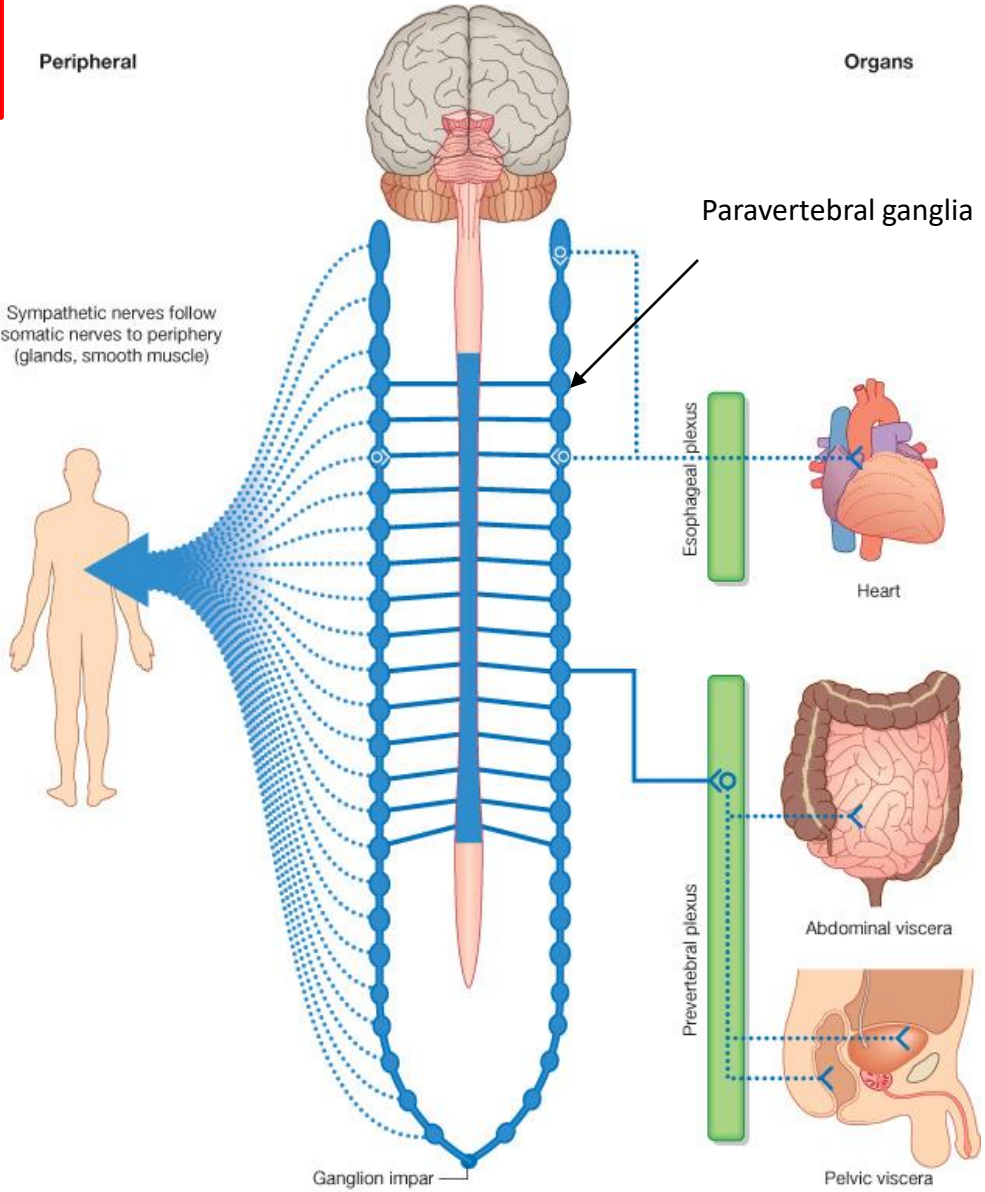
CNS = central nervous system; Pre = preganglionic; Post = postganglionic;
ACh = acetylcholine; N = nicotinic receptor; NE = norepinephrine; EPI = epinephrine;
D = dopamine; M = muscarinic receptor; β = β-adrenoceptor; α = α-adrenoceptor;
D_1 = dopaminergic receptor

Sympathetic efferents

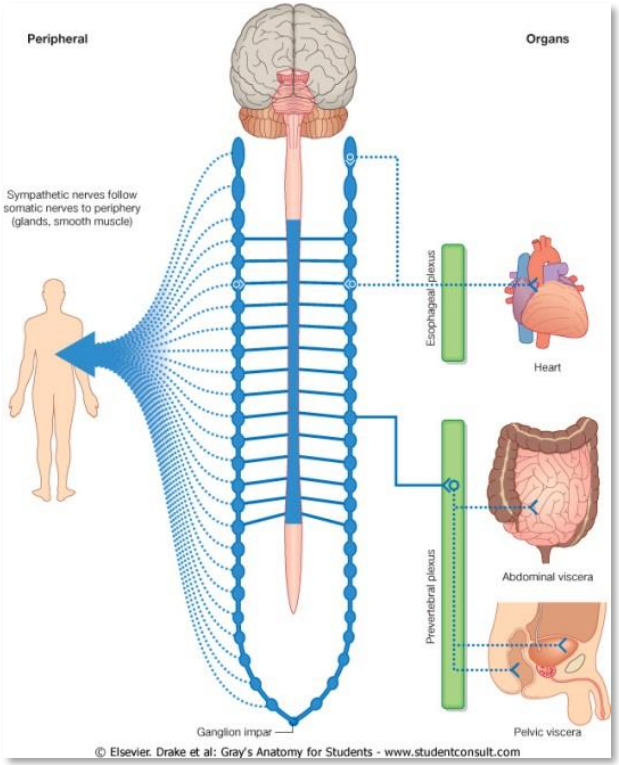
preganglionic
T1-L2

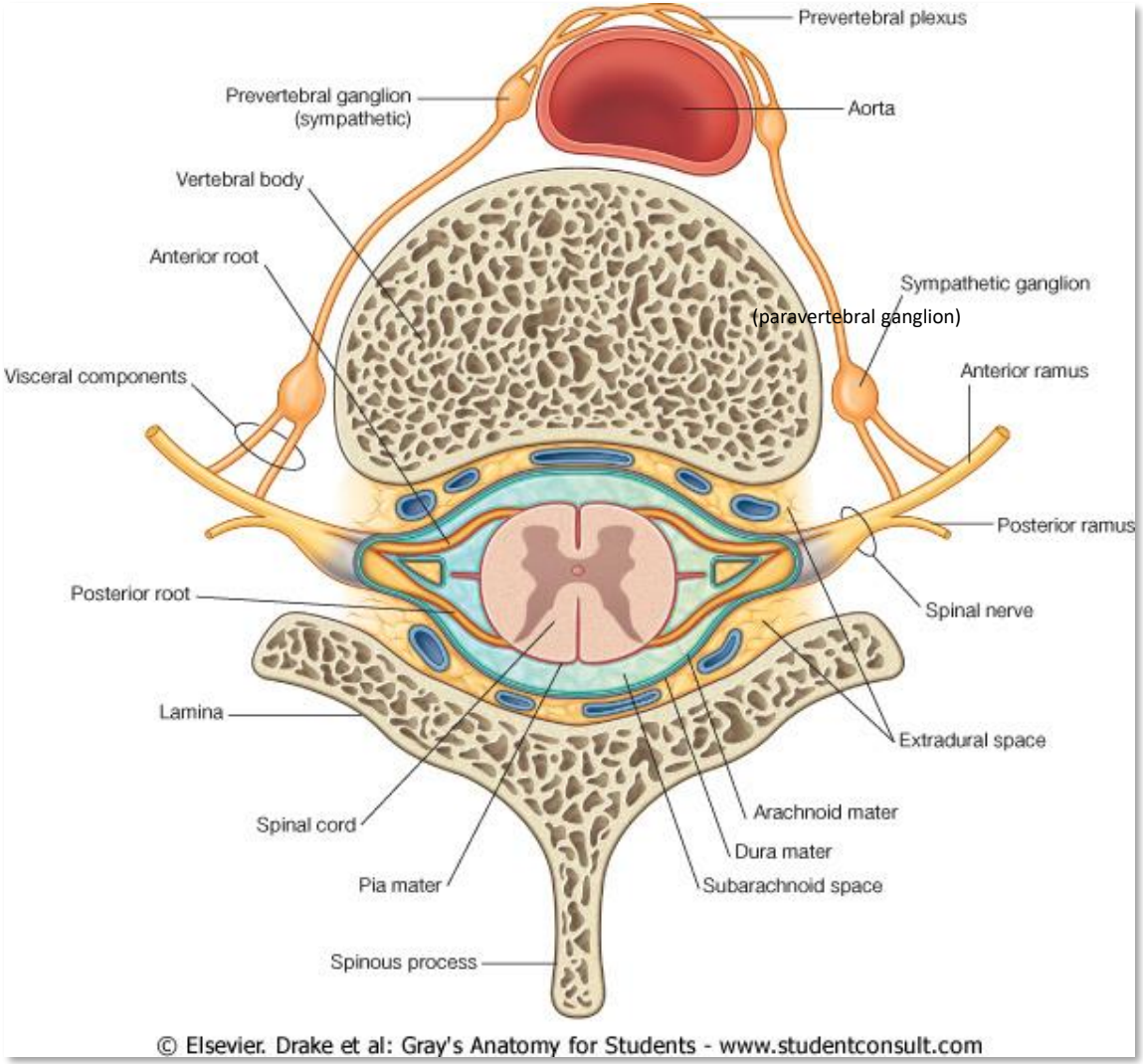






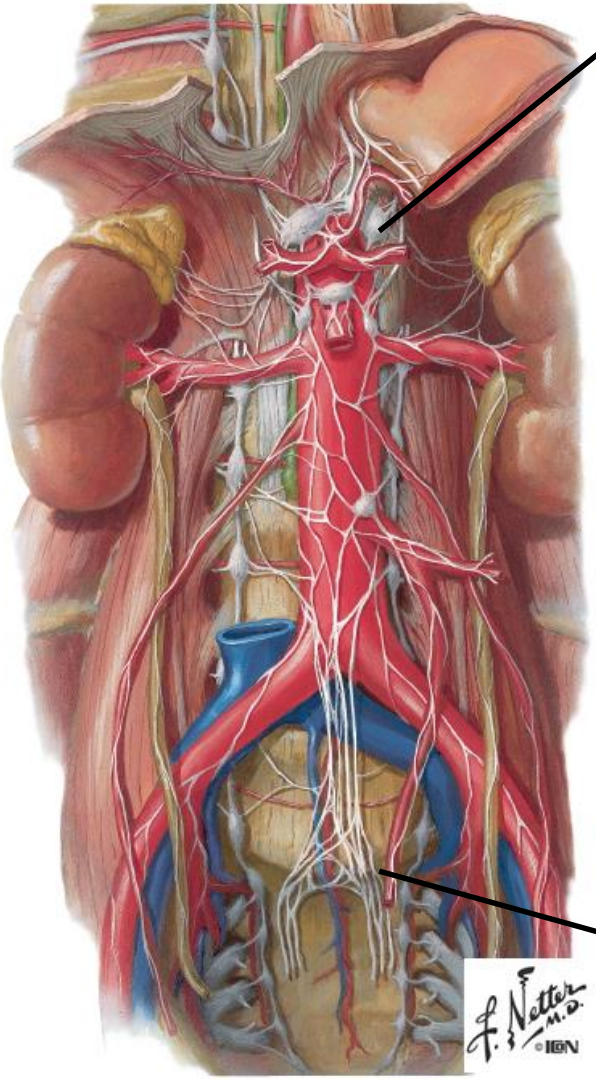
Autonomic ganglia





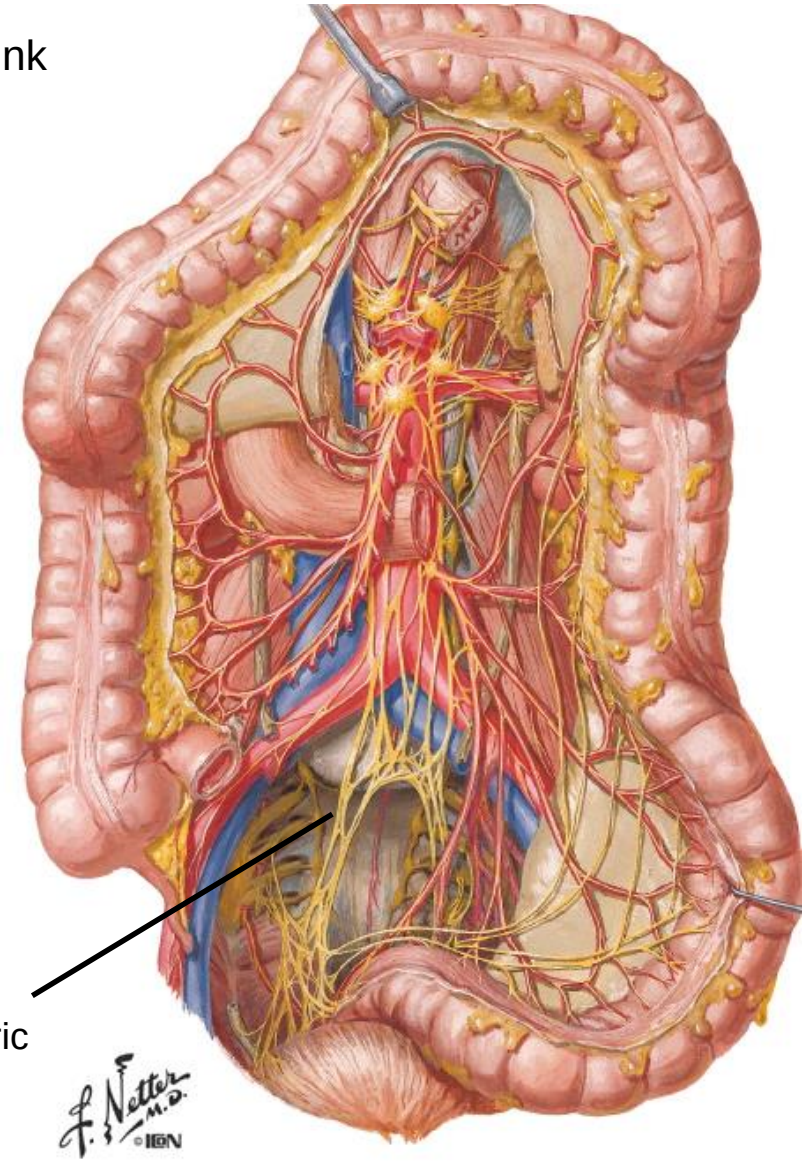
Plexuses

Greater and lesser
Splanchnic nerves

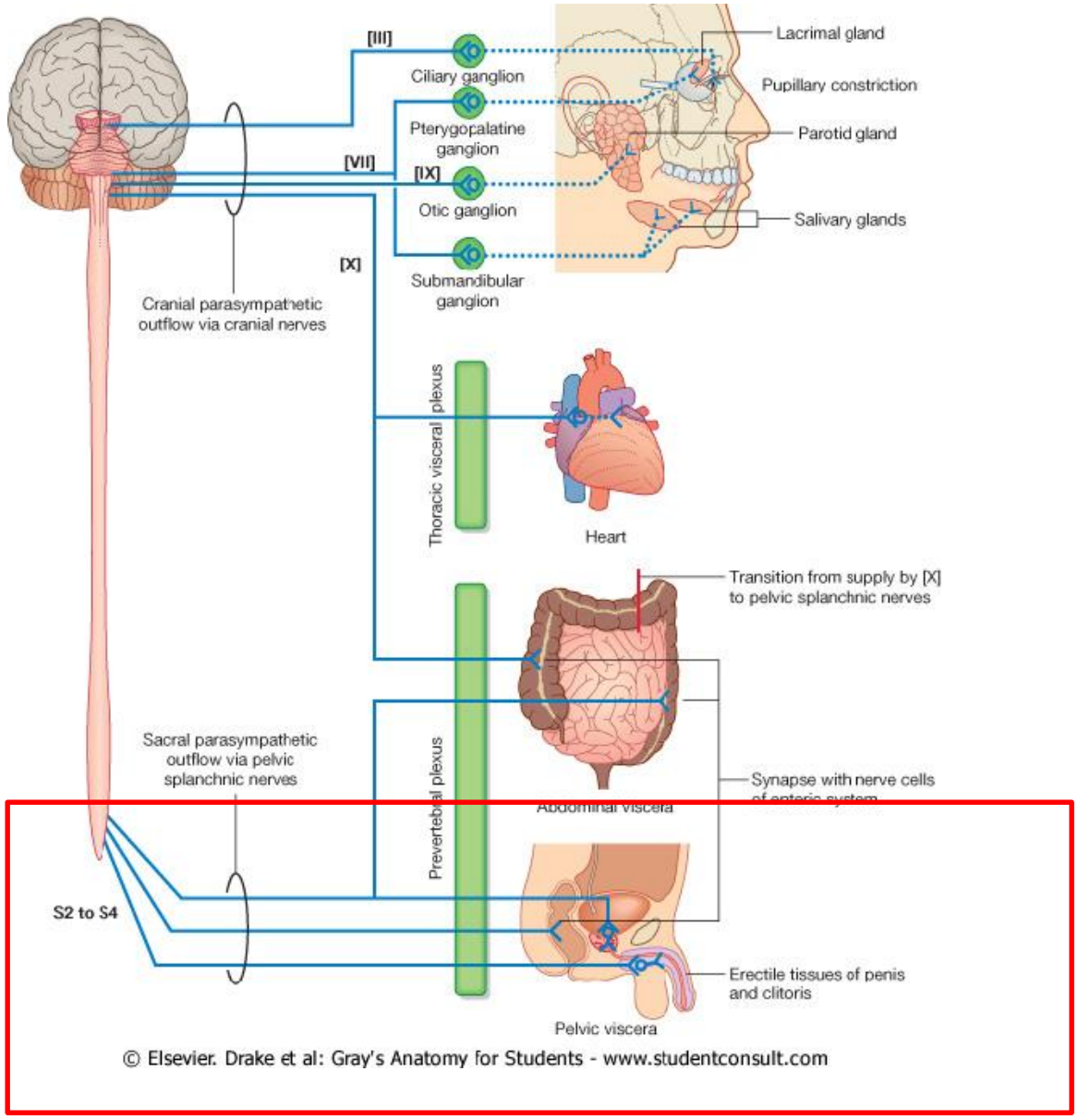


Celiac trunk

Superior
hypogastric
plexus



Parasympathetic efferents



NEURODEVELOPMENT

The sacral autonomic outflow is sympathetic

I. Espinosa-Medina,[1*] O. Saha,[1*] F. Boismoreau,[1] Z. Chettouh,[1] F. Rossi,[1] W. D. Richardson,[2] J.-F. Brunet[1]†

A kinship between cranial and pelvic visceral nerves of vertebrates has been accepted for a century. Accordingly, sacral preganglionic neurons are considered parasympathetic, as are their targets in the pelvic ganglia that prominently control rectal, bladder, and genital functions. Here, we uncover 15 phenotypic and ontogenetic features that distinguish pre- and postganglionic neurons of the cranial parasympathetic outflow from those of the thoracolumbar sympathetic outflow in mice. By every single one, the sacral outflow is indistinguishable from the thoracolumbar outflow. Thus, the parasympathetic nervous system receives input from cranial nerves exclusively and the sympathetic nervous system from spinal nerves, thoracic to sacral inclusively. This simplified, bipartite architecture offers a new framework to understand pelvic neurophysiology as well as development and evolution of the autonomic nervous system.

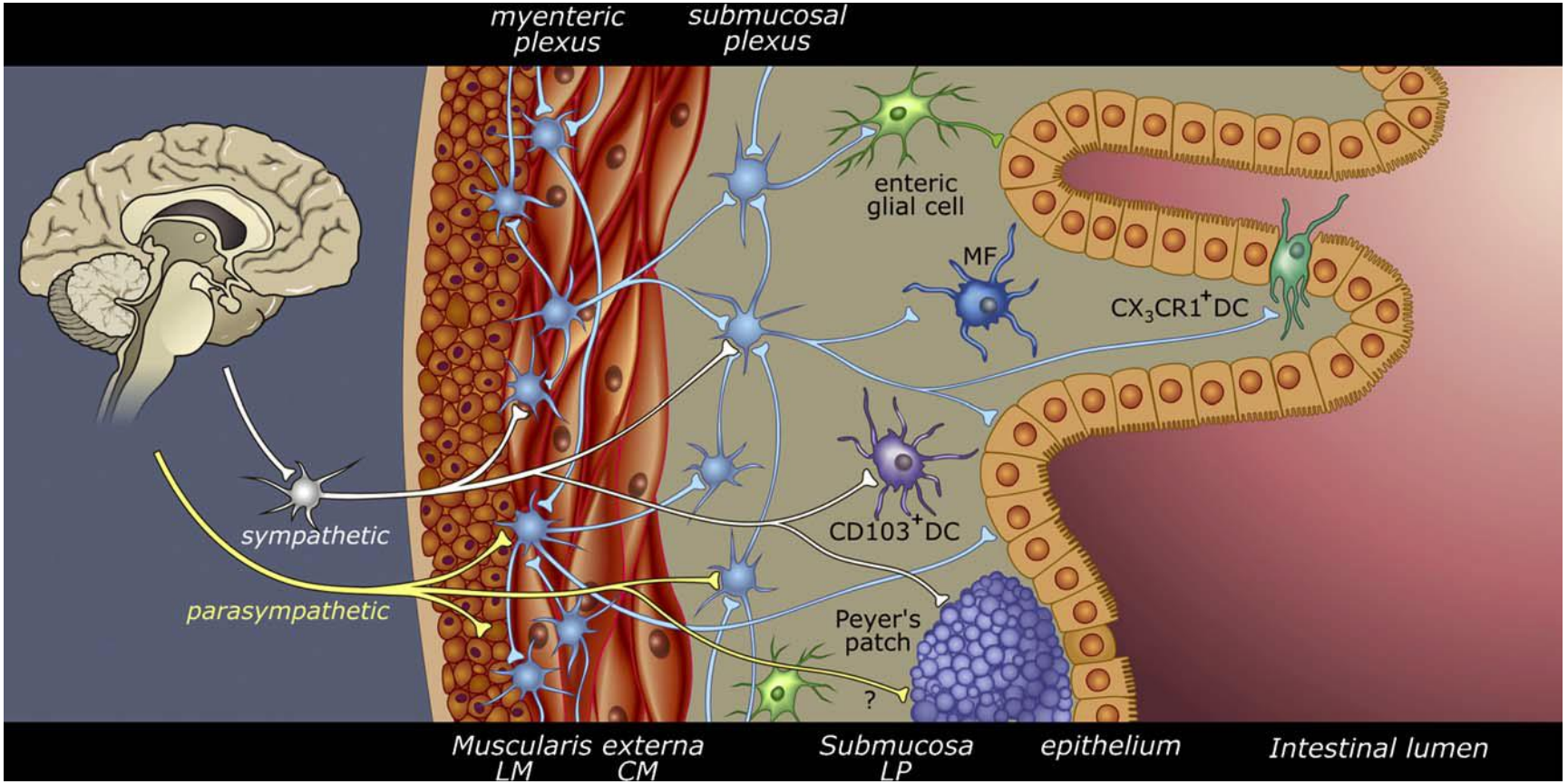
Science, 355, p893. Nov 2016

Targets

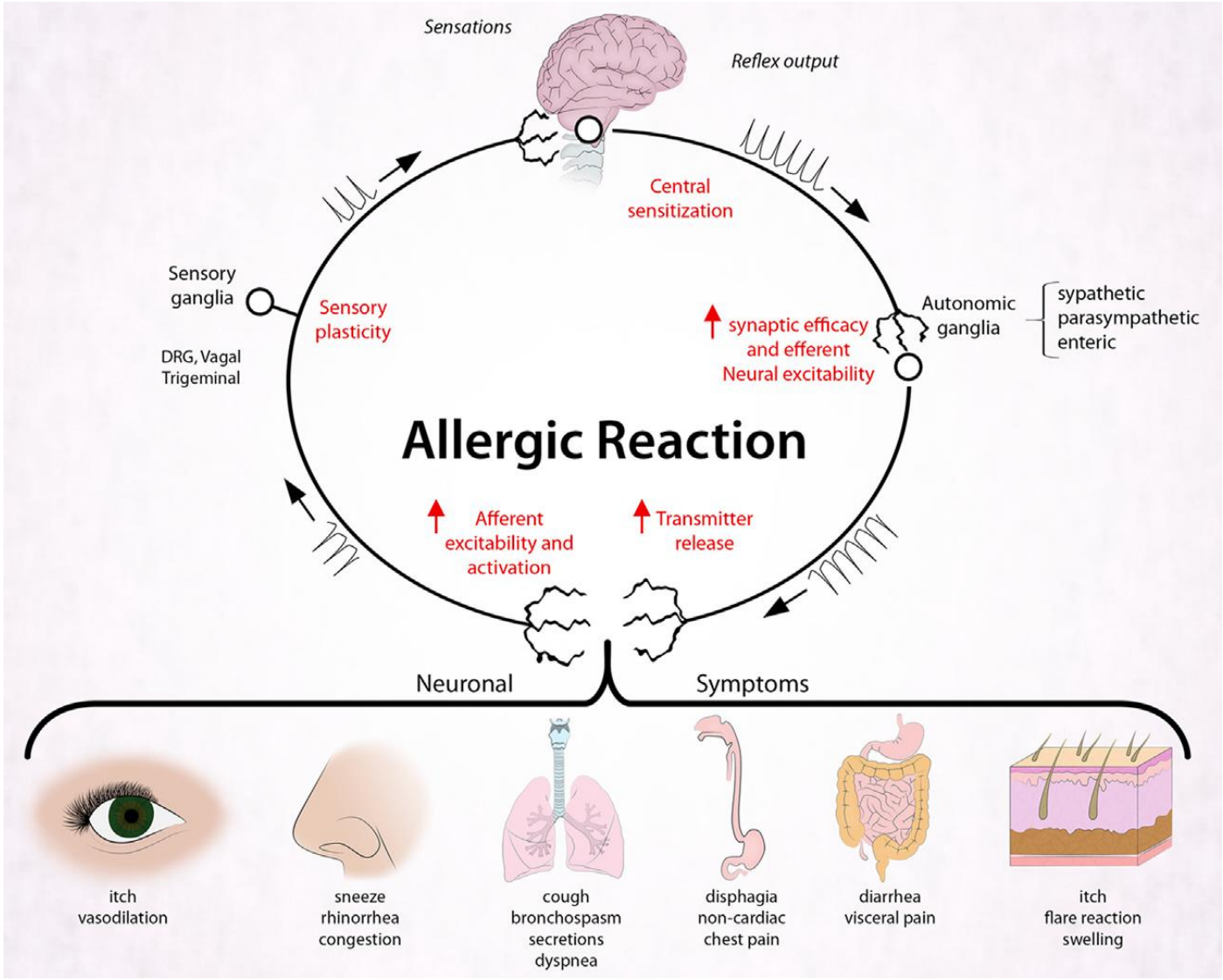
Function	Sympathetic	Parasympathetic	
Iris	Dilates pupil	Constricts pupil	Operates on different targets
Salivary glands	Reduced secretion (α receptors)	Watery secretion (muscarinic receptors)	Same target
Lacrimal glands	No effect	Stimulates	Only one innervation
Sweat glands	stimulates secretion	No effect	Only one innervation

Tonic and phasic activity in autonomic pathways	
Tonic activity	Phasic Activity
Sympathetic pathways	
Skin Vasoconstriction Muscle vasoconstriction Gut vasoconstriction inhibition of gut motility inhibition of gut secretions Detrusor relaxation internal urethral sphincter contraction	Sweating (thermal or emotional) Piloerection increased cardiac output Mucous saliva production pupil dilation Sexual activity (ejaculation)
Parasympathetic pathways	
Reduced cardiac output at rest pupil constriction Basal saliva secretion Basal tear production	Accommodation Tear production in crying Salivation (during speech, eating) Receptive relaxation of stomach Stomach emptying pancreatic secretion urination Sexual activity (erection)

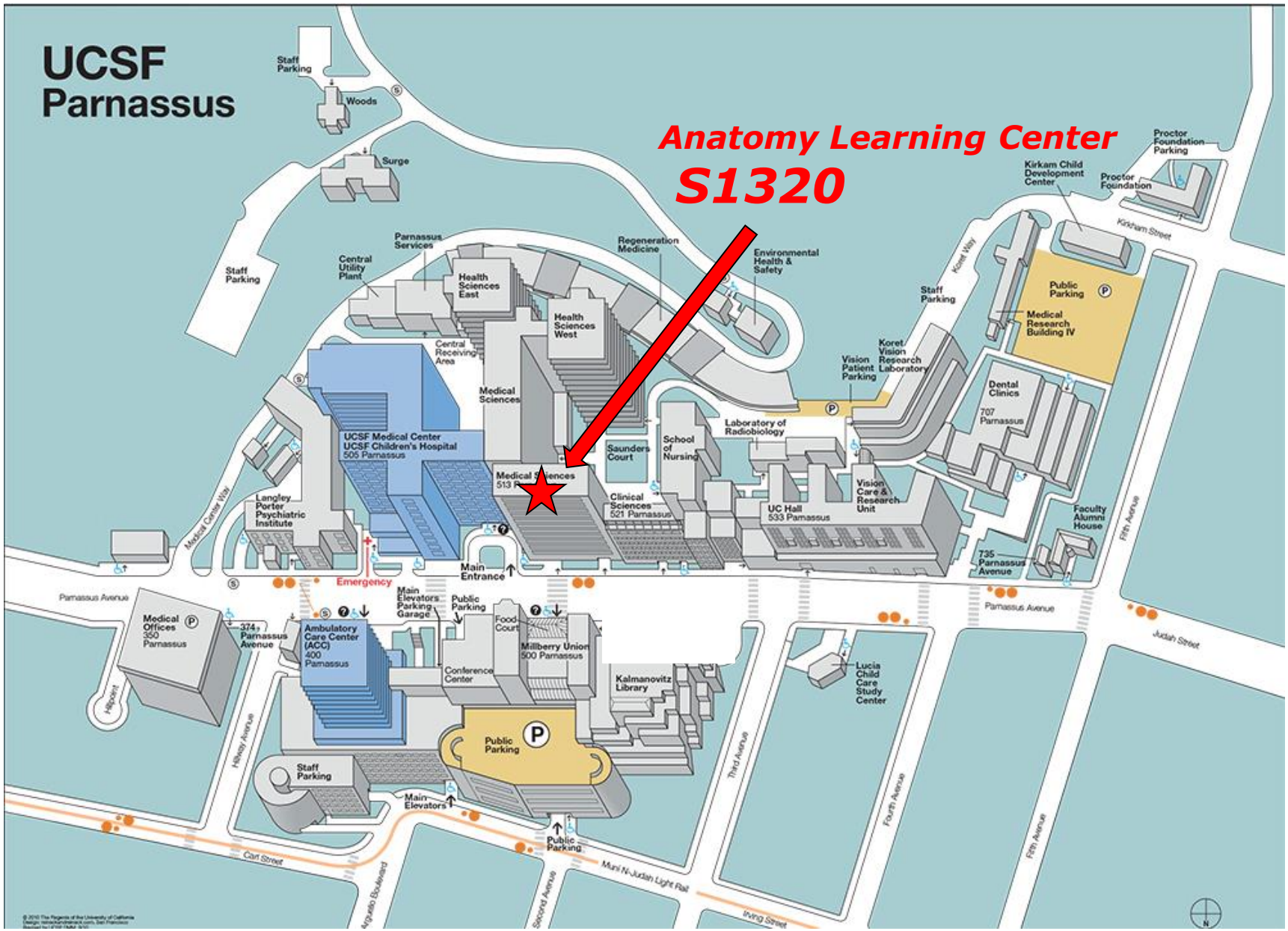
Autonomic innervation of the enteric nervous system



Autonomic NS and the immune system



Where is the lab?



There is a buzzer to the right of the main entrance. Buzz for entry.

Bring a lab coat

I will provide gloves