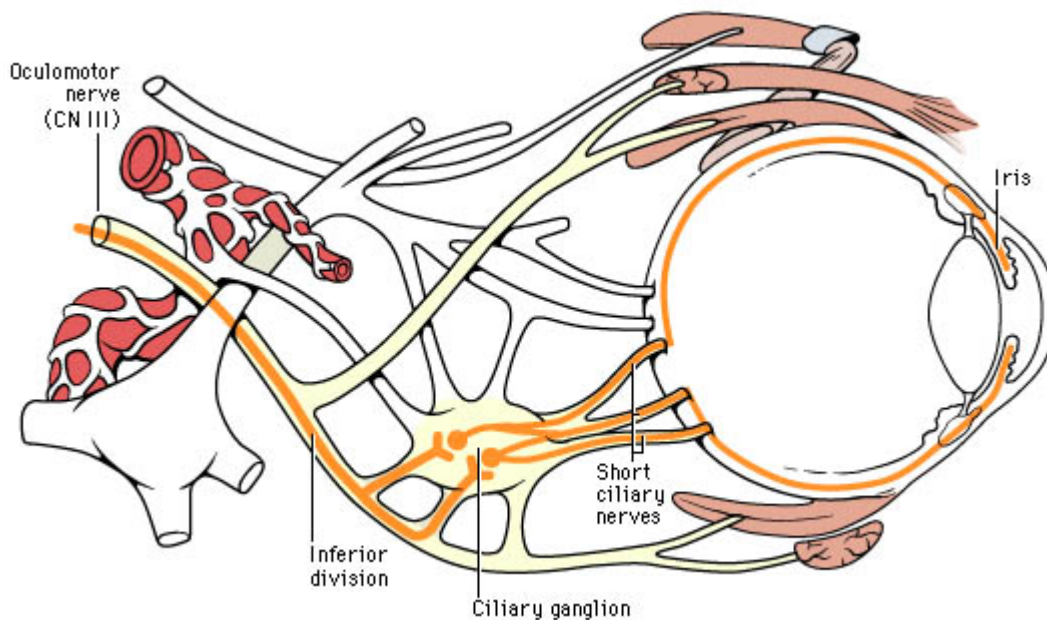


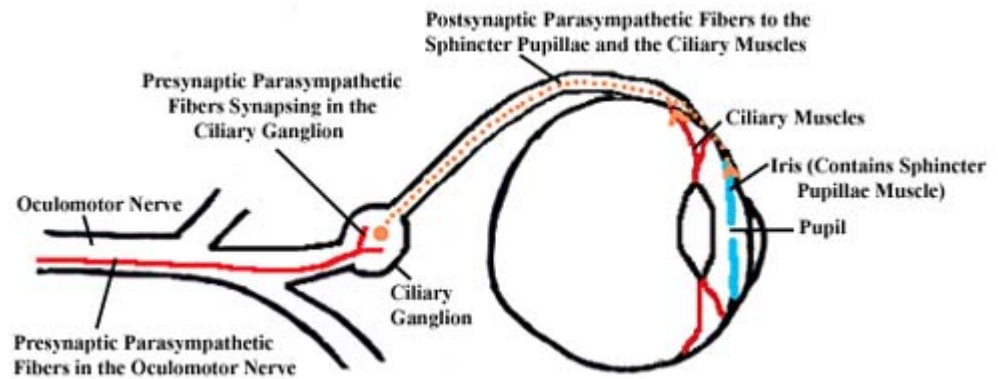
The ciliary ganglion story – prelude to synapse

The oculomotor nerve carries preganglionic parasympathetic fibers into the orbit. These fibers follow the inferior division of the oculomotor nerve, and branch anterosuperiorly as a short (2-4 mm) motor root of the ciliary ganglion, which lies on the lateral side of the optic nerve, near the apex of the orbit. A sensory root passes from the nasociliary nerve (from V1) to the ciliary ganglion, but of course its fibers pass right through. And, just to spice things up, a sympathetic root passes from the cavernous sinus to the ganglion, and it also passes through it. (all sympathetics past the superior cervical ganglion are postsynaptic).

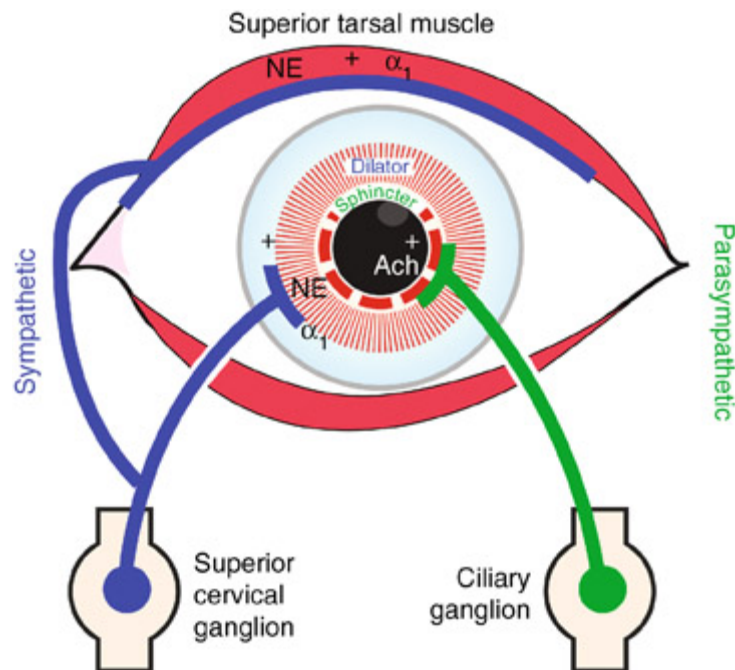


The ciliary ganglion story – after the synapse

The presynaptic parasympathetic fibers in the motor root synapse, and then the postsynaptic parasympathetic fibers unite with the fibers in the other two roots, sensory and sympathetic, to form short ciliary nerves. These short ciliary nerves travel anteriorly to reach the back of the eyeball, pierce it, and pass forward within the walls of the eyeball to reach the smooth muscle of the eyeball. The parasympathetic fibers innervate 2 muscles: the ciliary muscle, which relaxes the suspensory ligaments of the lens and allows the lens to thicken for close-up vision, and the sphincter pupillae, circularly oriented fibers in the iris that constrict the pupil to allow less light to enter the eye. The sympathetic fibers innervate one muscle: dilator pupillae, radially oriented fibers in the iris that open the pupil to allow more light into the eye.

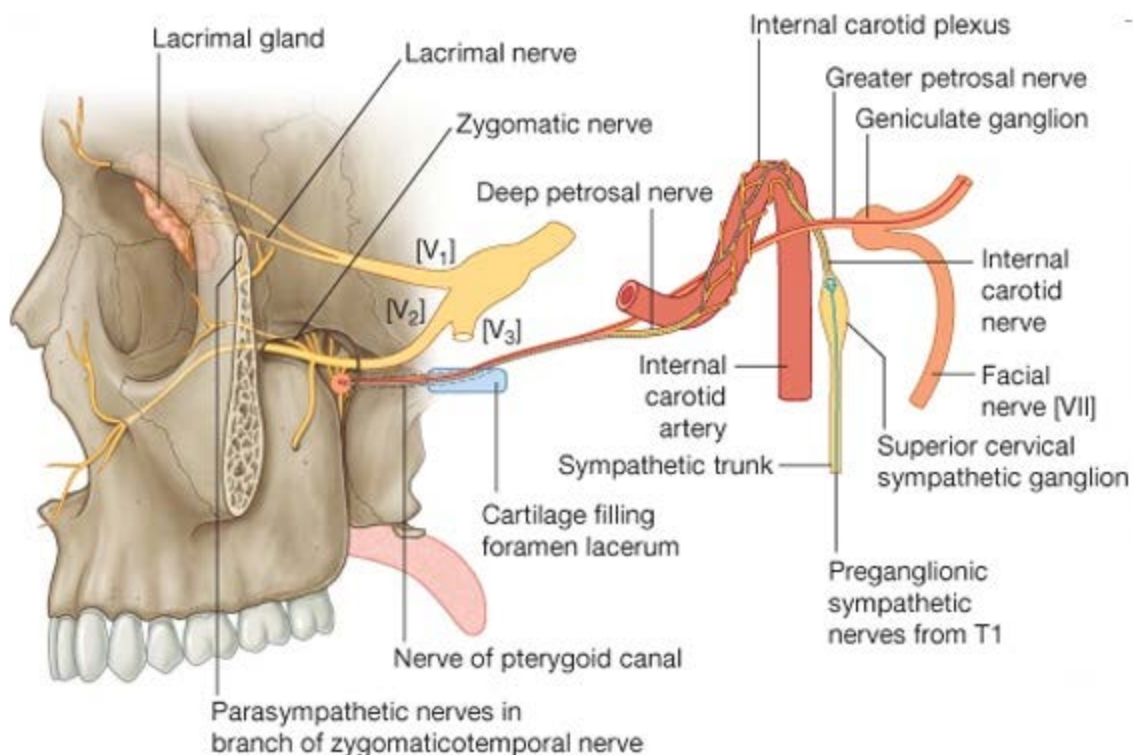


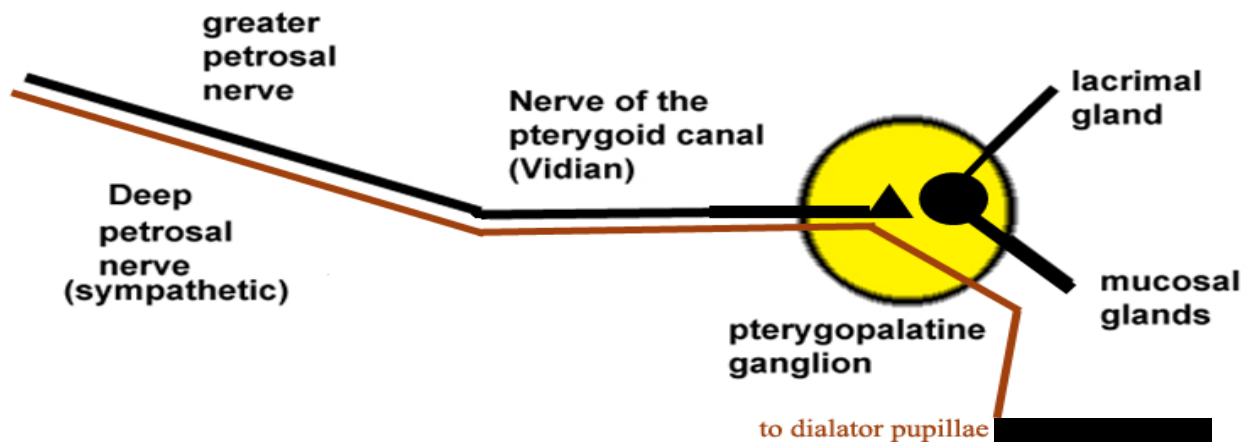
There is one more muscle in the orbit that receives sympathetic innervation: the superior tarsal muscle, which is smooth muscle near the anterior attachment of the levator palpebrae superioris muscle to the superior tarsal plate. This muscle is innervated by sympathetic fibers from the internal carotid plexus, and it holds the eyelid up. Horner's syndrome, loss of sympathetic innervation in the head, will cause ptosis, or a drooping eyelid, along with a constricted pupil and a flushed, dry face on the affected side.



The pterygopalatine ganglion story – until we synapse again

Facial nerve gives off preganglionic fibers in the form of 2 nerves: the greater petrosal and the chorda tympani. Greater petrosal nerve branches from facial at the geniculate ganglion, a sensory ganglion (not to be confused with an autonomic ganglion) along the beginning of the course of the facial nerve within the petrous temporal bone. Greater petrosal exits the anterior slope of the petrous bone to run anteromedially toward the foramen lacerum. It passes through a bit of the cartilage blocking this foramen to enter a canal hidden in its anterior margin, the pterygoid canal (because it lies at superior to the pterygoid plates of the sphenoid bone). Greater petrosal is joined by some fibers from the internal carotid plexus (postganglionic sympathetic, of course) called the deep petrosal nerve – they united to form the nerve of the pterygoid canal. The nerve of the pterygoid canal runs forward to reach the pterygopalatine ganglion that lies within the pterygopalatine fossa.



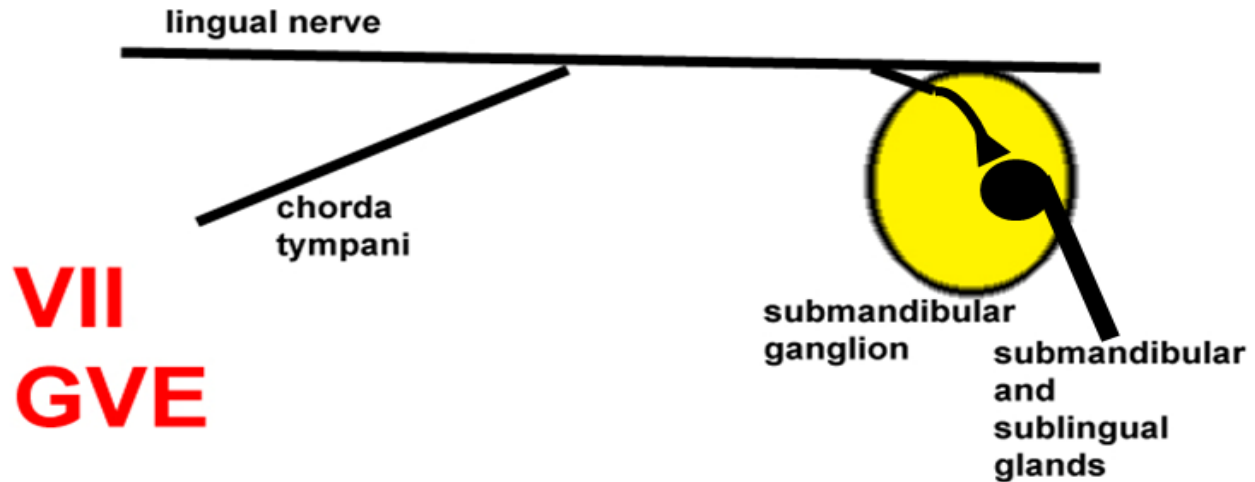


The pterygopalatine ganglion story – after the synapse

Postganglionic fibers leave the pterygopalatine ganglion within branches of the maxillary division of trigeminal nerve (V2). Some of these branches go to mucous membranes in the nose, paranasal sinuses, palate, and upper pharynx. One branch, the zygomatic nerve, passes through the inferior orbital fissure into the orbit. It runs superiorly up the lateral wall of the orbit, and splits into zygomaticotemporal and zygomaticofacial branches. The postganglionic parasympathetic fibers continue with the zygomaticotemporal nerve, then leave as a communicating branch to reach the lacrimal nerve, a branch of ophthalmic division of trigeminal nerve (V1). Lacrimal nerve carries these secretomotor fibers the last millimeters to reach the lacrimal gland, and then continues on to innervate skin of the upper eyelid laterally.

The submandibular ganglion story – before the synapse

Toward the end of its course through the petrous temporal bone, the facial nerve gives off a branch, the chorda tympani nerve, immediately before exiting the skull at the stylomastoid foramen. Chorda tympani recurs back into the middle ear cavity, and then passes anteriorly across the lateral wall of the middle ear, which happens to be the tympanic membrane. It crosses the handle of the malleus, and ultimately leaves the middle ear anteriorly to exit at the base of the skull through the petrotympanic fissure. This leads chorda tympani into the infratemporal fossa, in which it passes anteroinferiorly to join the lingual nerve from behind. It then runs with the lingual nerve to the submandibular ganglion, located in the paralingual space near the deep portion of the submandibular gland.



The submandibular ganglion story – synapsing, and beyond.

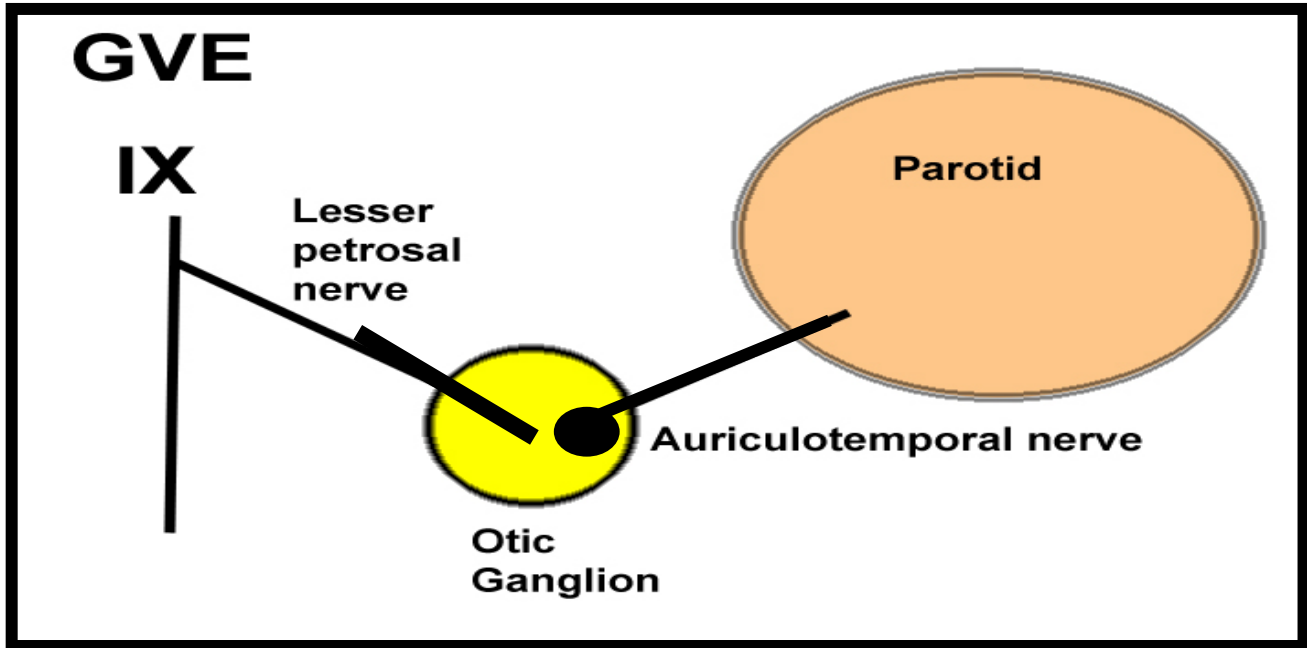
Chorda tympani carries preganglionic parasympathetic fibers that pass to the submandibular ganglion. There, some of these fibers synapse and return to the lingual nerve to travel anteriorly to reach the sublingual gland, to be secretomotor there. Other fibers synapse in the submandibular ganglion then reach the submandibular gland, to be secretomotor to this gland.

Chorda tympani not only carries preganglionic parasympathetic fibers, but it also carries sensory fibers for taste for the anterior two-thirds of the tongue. These fibers travel into the tongue with the lingual nerve to reach the taste buds on the dorsum and sides of the tongue.

The otic ganglion story – until the synapse happens

As the glossopharyngeal nerve (CN IX) passes inferiorly through the jugular foramen, it gives off a tympanic branch, carrying preganglionic parasympathetic fibers, that passes upward through the inferior tympanic canaliculus to pass into the middle ear. There, it forms a tympanic plexus on the promontory, an eminence on the medial wall of the middle ear cavity. Stretching anteromedially from the promontory, and piercing the anterior wall of the middle ear cavity, is the lesser petrosal nerve. Lesser petrosal nerve travels anteromedial on the anterior surface of the petrous temporal bone, just lateral to the greater petrosal nerve (more on that one later). Lesser petrosal passes inferiorly through the skull base, usually through foramen ovale. Immediately below the skull, it passes into the otic ganglion,

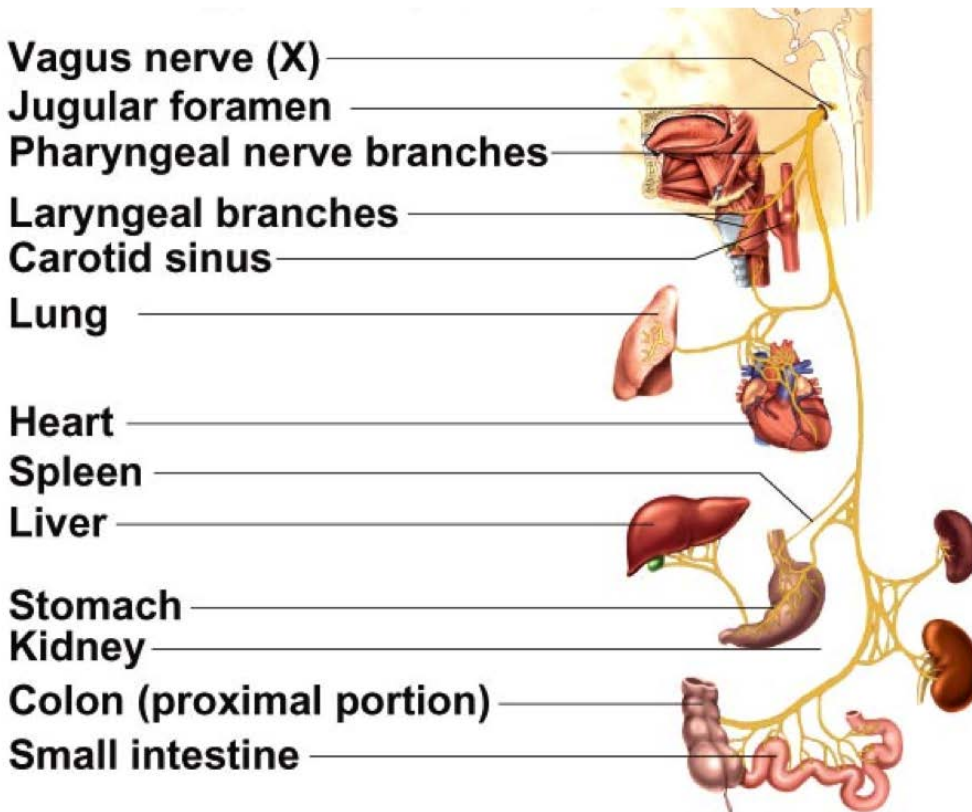
located on the medial surface of the mandibular division of trigeminal nerve (CN V3) below its exit through foramen ovale. And, to paraphrase a bumper sticker, synapse happens.



The otic ganglion story – after the synapse

Postganglionic fibers from the otic ganglion pass into the auriculotemporal nerve, a cutaneous sensory branch of V3. The auriculotemporal nerve passes posteriorly on the medial side of the temporomandibular joint capsule, encircles the middle meningeal artery as it ascends to pass through foramen spinosum, and then curves laterally behind the TMJ capsule to reach the parotid gland. The postganglionic parasympathetic fibers distribute to the parotid gland, where they are secretomotor, causing saliva production.

One fact that may help you remember this: glossopharyngeal nerve innervates the posterior one-third of the tongue AND the third salivary gland, the parotid (the other two are the sublingual and submandibular glands).



The vagus story – look, ma – no ganglion.

The vagus carries preganglionic fibers everywhere it travels. In the head, it also delivers skeletal motor fibers to most of the soft palate (except tensor veli palatine muscle), most of the pharynx (except stylopharyngeus muscle), all of the larynx, and the upper esophagus (which is skeletal muscle). These skeletal motor fibers travel in the pharyngeal branches, external branches of superior laryngeal nerve, and the recurrent laryngeal nerves.

Preganglionic parasympathetic fibers accompany the branches of vagus, synapsing as always within the viscera wall, to innervate mucous glands in the lining of the structures innervated – pharynx, larynx, and esophagus. This is most of the mucous membranes in the head and neck, with the exception being the nasal cavity, paranasal sinuses, palate, and upper pharynx. This region is serviced by branches from the pterygopalatine ganglion.

In the neck, the vagus also gives off 2 cervical cardiac nerves that pass inferiorly into the chest, often uniting with the sympathetic cardiac branches on the way.

Autonomic innervation of the head – summary (14 plus pages of crap plus a million powerpoint slides and the damn test questions will probably all come from the following facts☺)

Sympathetic – internal & external carotid nerves/plexuses – innervate blood vessels, sweat glands, superior tarsal dilator pupillae muscles.

Parasympathetic –

1. Oculomotor n. (CN III) > inferior division > motor root > ciliary ganglion > short ciliary nn. > sphincter pupillae & ciliary muscles
2. Facial n. (CN VII) > greater petrosal n. > deep petrosal n. > pterygopalatine ganglion > zygomatic n. (V2) > zygomaticotemporal n. > lacrimal n. (V1) > lacrimal gland
3. Facial n. (CN VII) > chorda tympani > lingual n. (V3) submandibular ganglion > submandibular & sublingual glands
4. Glossopharyngeal n. (CN IX) > tympanic n. > tympanic plexus > lesser petrosal n. > otic ganglion > auriculotemporal n. (V3) > parotid gland
5. Vagus n. (CN X) > pharyngeal, superior laryngeal, and recurrent laryngeal nn. > terminal ganglia > mucous glands----plus slows heart and speeds up digestion