

Vagus nerve

<i>Nerve: Vagus nerve</i>	
Plan of upper portions of glossopharyngeal, vagus, and accessory nerves.	
Course and distribution of the glossopharyngeal, vagus, and accessory nerves.	
Latin	<i>nervus vagus</i>
Gray's	<i>subject #205 910</i> ^[1]
Innervates	Levator veli palatini, Salpingopharyngeus, Palatoglossus, Palatopharyngeus, Superior pharyngeal constrictor, Middle pharyngeal constrictor, Inferior pharyngeal constrictor, viscera
MeSH	<i>Vagus+Nerve</i> ^[2]

Cranial Nerves
CN 0 - Cranial nerve zero
CN I - Olfactory
CN II - Optic
CN III - Oculomotor
CN IV - Trochlear
CN V - Trigeminal
CN VI - Abducens
CN VII - Facial
CN VIII - Vestibulocochlear
CN IX - Glossopharyngeal

CN X - Vagus
CN XI - Accessory
CN XII - Hypoglossal

The **vagus nerve** (pronounced /'veɪɡəs/, us dict: vā'·gəəs), also called **pneumogastric nerve**, **cranial nerve X**, **the Wanderer** or sometimes **the Rambler**, is the tenth of twelve (excluding CN0) paired cranial nerves. Upon leaving the medulla between the olivary nucleus and the inferior cerebellar peduncle, it extends through the jugular foramen, then passing into the carotid sheath between the internal carotid artery and the internal jugular vein down below the head, to the neck, chest and abdomen, where it contributes to the innervation of the viscera. Besides output to the various organs in the body the vagus nerve conveys sensory information about the state of the body's organs to the central nervous system. 80-90% of the nerve fibers in the vagus nerve are afferent (sensory) nerves communicating the state of the viscera to the brain.^[3]

The medieval Latin word *vagus* means literally "Wandering" (the words *vagrant*, *vagabond*, and *vague* come from the same root). Sometimes the branches are spoken of in the plural and are thus called **vagi** (pronounced /'veɪdʒaɪ/, us dict: vā'·jī). The vagus is also called the *pneumogastric* nerve since it innervates both the lungs and the stomach.

Branches

- Auricular nerve
- Pharyngeal nerve
- Superior laryngeal nerve
- Superior cervical cardiac branches of vagus nerve
- Inferior cervical cardiac branch
- Recurrent laryngeal nerve
- Thoracic cardiac branches
- Branches to the pulmonary plexus
- Branches to the esophageal plexus
- Anterior vagal trunk
- Posterior vagal trunk
- herring breuer reflux in alveoli

The vagus runs posterior to the common carotid artery and internal jugular vein inside the carotid sheath.

Innervation

Both right and left vagus nerves descend from the brain in the carotid sheath, lateral to the carotid artery.

The right vagus nerve gives rise to the right recurrent laryngeal nerve which hooks around the right subclavian artery and ascends into the neck between the trachea and esophagus. The right vagus then crosses anteriorly to the right subclavian artery and runs posterior to the superior vena cava and descends posterior to the right main bronchus and contributes to cardiac, pulmonary and esophageal plexuses. It forms the posterior vagal trunk at the lower part of the esophagus and enters the diaphragm through the esophageal hiatus.

The left vagus nerve enters the thorax between left common carotid artery and left subclavian artery and descends on the aortic arch. It gives rise to the left recurrent laryngeal nerve which hooks around the aortic arch to the left of the ligamentum arteriosum and ascends between the trachea and esophagus. The left vagus further gives off thoracic cardiac branches, breaks up into pulmonary plexus, continues into the esophageal plexus and enters the abdomen as the anterior vagal trunk in the esophageal hiatus of the diaphragm.

The vagus nerve supplies motor parasympathetic fibers to all the organs except the suprarenal (adrenal) glands, from the neck down to the second segment of the transverse colon. The vagus also controls a few skeletal muscles,

namely:

- Cricothyroid muscle
- Levator veli palatini muscle
- Salpingopharyngeus muscle
- Palatoglossus muscle
- Palatopharyngeus muscle
- Superior, middle and inferior pharyngeal constrictors
- Muscles of the larynx (speech).

This means that the vagus nerve is responsible for such varied tasks as heart rate, gastrointestinal peristalsis, sweating, and quite a few muscle movements in the mouth, including speech (via the recurrent laryngeal nerve) and keeping the larynx open for breathing (via action of the posterior cricoarytenoid muscle, the only abductor of the vocal folds). It also has some afferent fibers that innervate the inner (canal) portion of the outer ear, via the Auricular branch (also known as Alderman's nerve) and part of the meninges. This explains why a person may cough when tickled on their ear (such as when trying to remove ear wax with a cotton swab).

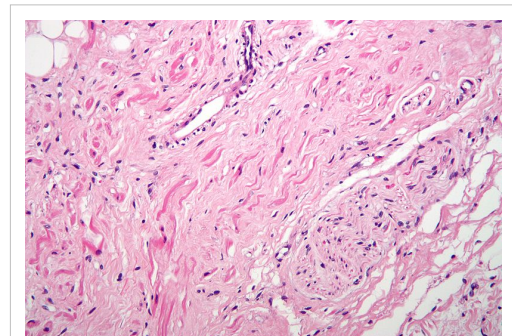
The vagus nerve and the heart

Parasympathetic innervation of the heart is mediated by the vagus nerve. Specifically, the vagus nerve acts to lower the heart rate. The right vagus innervates the sinoatrial node. Parasympathetic hyperstimulation predisposes those affected to bradyarrhythmias. The left vagus when hyperstimulated predisposes the heart to atrioventricular (AV) blocks.

At this location neuroscientist Otto Loewi first proved that nerves secrete substances called neurotransmitters which have effects on receptors in target tissues. Loewi described the substance released by the vagus nerve as vagusstoff, which was later found to be acetylcholine.

The vagus nerve has three nuclei in the CNS associated with cardiovascular control, the dorsal motor nucleus, the nucleus ambiguus and the solitary nucleus. The parasympathetic output to the heart comes mainly from neurons in the nucleus ambiguus and to a lesser extent from the dorsal motor nucleus.^[4] The solitary nucleus receives sensory input about the state of the cardiovascular system, being an integrational hub for the baroreflex.

Drugs that inhibit the muscarinic cholinergic receptor (anticholinergics) such as atropine and scopolamine are called vagolytic because they inhibit the action of the vagus nerve on the heart, gastrointestinal tract and other organs. Anticholinergic drugs increase heart rate and are used to treat bradycardia (slow heart rate) and asystole, which is when the heart has no electrical activity.



Fibres of the **vagus nerve** (right/bottom of image) innervate the sinoatrial node tissue (central and left of image). H&E stain.

Medical treatment involving the vagus nerve

Vagus nerve stimulation (VNS) therapy using a pacemaker-like device implanted in the chest is a treatment used since 1997 to control seizures in epilepsy patients and has recently been approved for treating drug-resistant cases of clinical depression.^[5] A non-invasive VNS device that stimulates an afferent branch of the vagus nerve is also being developed and will soon undergo trials.

VNS may also be achieved by one of the *vagal maneuvers*: holding the breath for a few seconds, dipping the face in cold water, coughing, or tensing the stomach muscles as if to bear down to have a bowel movement (Valsalva maneuver).^[6] Patients with supraventricular tachycardia,^[6] atrial fibrillation, and other illnesses may be trained to perform vagal maneuvers (or find one or more on their own).

Vagus nerve blocking (VBLOC) therapy is similar to VNS but only used during the day. In a six month open-label trial involving three medical centers in Australia, Mexico, and Norway, vagus nerve blocking has helped 31 obese participants lose an average of nearly 15 percent of their excess weight. A year long 300 participant double-blind, phase II trial has begun.^[7]

Vagotomy (cutting of the vagus nerve) is a now-obsolete therapy that was performed for peptic ulcer disease. Vagotomy is currently being researched as a less invasive alternative weight loss procedure to gastric bypass surgery.^[8] The procedure curbs the feeling of hunger and is sometimes performed in conjunction with putting bands on patients' stomachs, resulting in average weight loss of 43% at six months with diet and exercise.^[9]

One serious side effect of a Vagotomy is a Vitamin B12 deficiency later in life - i.e. 10 years - that is similar to Pernicious Anaemia. As one gets older, the stomach produces less acid. The acid, and one of its components called Intrinsic Factor, is needed to metabolized B12 from food. The vagotomy reduces the acid that ultimately leads to the deficiency which, if left untreated, causes nerve damage, tiredness, dementia, paranoia and ultimately death.^[10]

Physical and emotional effects

Activation of the vagus nerve typically leads to a reduction in heart rate, blood pressure, or both. This occurs commonly in the setting of gastrointestinal illness such as viral gastroenteritis or acute cholecystitis, or in response to other stimuli, including carotid sinus massage, Valsalva maneuver, or pain from any cause, particularly having blood drawn. When the circulatory changes are great enough, vasovagal syncope results. Relative dehydration tends to amplify these responses.

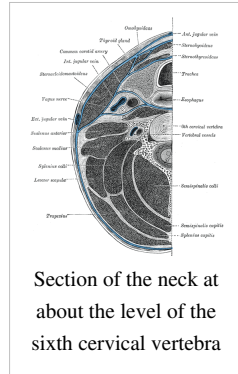
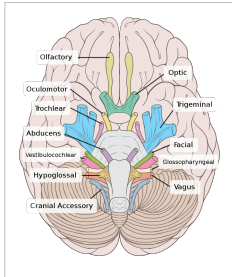
Excessive activation of the vagal nerve during emotional stress, which is a parasympathetic overcompensation of a strong sympathetic nervous system response associated with stress, can also cause vasovagal syncope because of a sudden drop in blood pressure and heart rate. Vasovagal syncope affects young children and women more often. It can also lead to temporary loss of bladder control under moments of extreme fear.

Research has shown that women who have complete transection of the spinal cord can experience orgasms through the vagus nerve, which can go from the uterus, cervix and probably the vagina to the brain.^{[11] [12]}

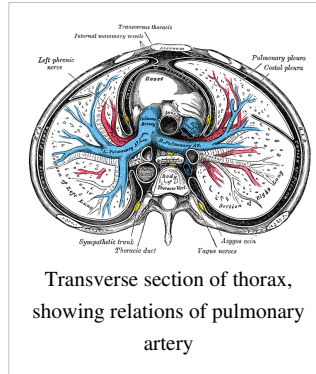
Effects of vagus nerve lesions

The patient complains of hoarse voice, difficulty in swallowing (dysphagia) and choking when drinking fluid. There is also loss of gag reflex. Uvula deviates away from the side of lesion and there is failure of palate elevation.

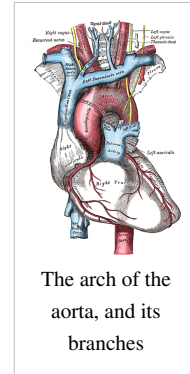
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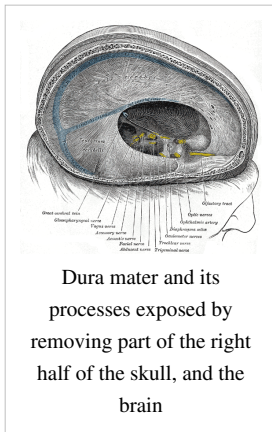
Section of the neck at about the level of the sixth cervical vertebra



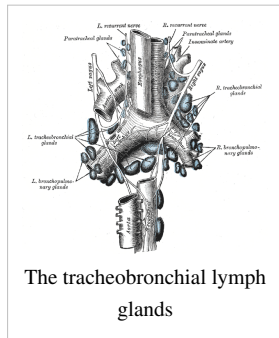
Transverse section of thorax, showing relations of pulmonary artery



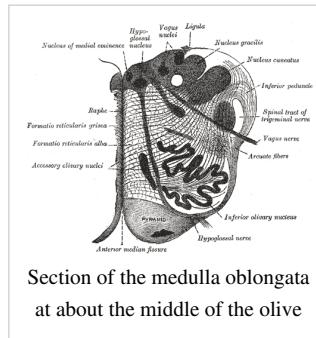
The arch of the aorta, and its branches



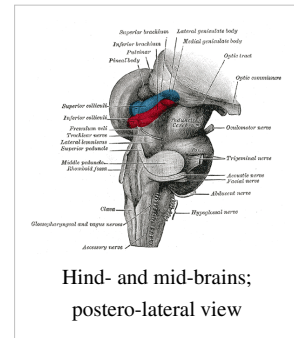
Dura mater and its processes exposed by removing part of the right half of the skull, and the brain



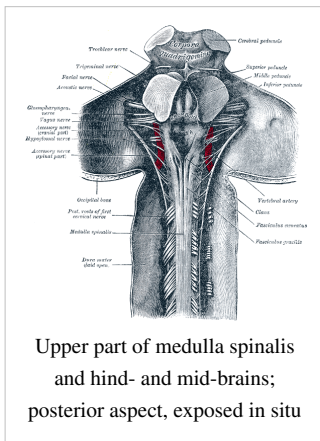
The tracheobronchial lymph glands



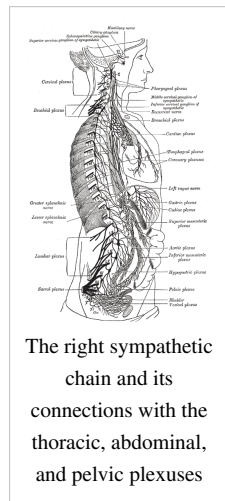
Section of the medulla oblongata at about the middle of the olive



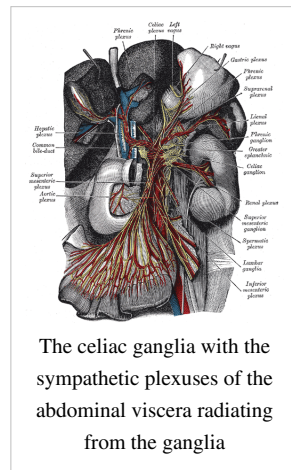
Hind- and mid-brains; postero-lateral view



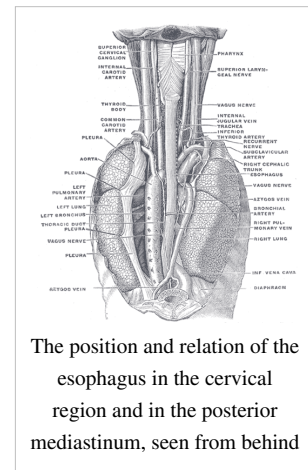
Upper part of medulla spinalis and hind- and mid-brains; posterior aspect, exposed in situ



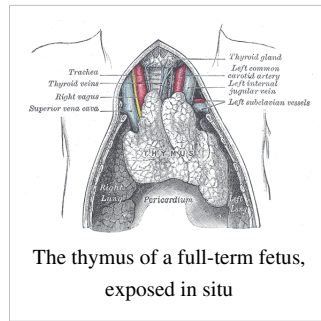
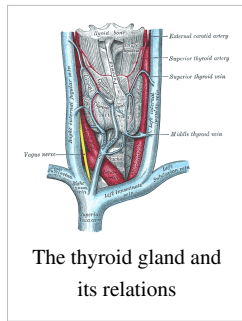
The right sympathetic chain and its connections with the thoracic, abdominal, and pelvic plexuses



The celiac ganglia with the sympathetic plexuses of the abdominal viscera radiating from the ganglia



The position and relation of the esophagus in the cervical region and in the posterior mediastinum, seen from behind



See also

- Porphyria — This rare disorder can cause seizures and damage to the vagal nerve. Diagnosis, in some cases, may require DNA testing.
- Vagovagal reflex
- Vagus nerve stimulation

External links

- MedEd at Loyola *grossanatomy/h_n/cn/cn1/cn10.htm* ^[13]
- Cranial Nerves at Yale *10-1* ^[14]
- Human anatomy at Dartmouth *figures/chapter_24/24-7.HTM* ^[15]
- *cranialnerves* ^[16] at *The Anatomy Lesson* ^[17] by Wesley Norman (Georgetown University) (*X* ^[18])

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- [2] http://www.nlm.nih.gov/cgi/mesh/2007/MB_cgi?mode=&term=Vagus+Nerve
- [3] Functional and chemical anatomy of the afferent vagal system. Berthoud HR and Neuhuber WL ([http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VT5-41TN409-2&_user=10&_coverDate=12/20/2000&_rdoc=2&_fmt=high&_orig=browse&_srch=doc-info\(#toc#6281#2000#999149998#220094#FLA#display#Volume\)&_cdi=6281&_sort=d&_docanchor=&view=c&_ct=23&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=540993eae7f65c7a08bcabc6693627c1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VT5-41TN409-2&_user=10&_coverDate=12/20/2000&_rdoc=2&_fmt=high&_orig=browse&_srch=doc-info(#toc#6281#2000#999149998#220094#FLA#display#Volume)&_cdi=6281&_sort=d&_docanchor=&view=c&_ct=23&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=540993eae7f65c7a08bcabc6693627c1))
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- [7] Mayo Clinic. Device Blocking Stomach Nerve Signals Shows Promise in Obesity (<http://www.mayoclinic.org/news2008-rst/4892.html>)
- [8] Ulcer surgery may help treat obesity - Diet and nutrition - MSNBC.com (<http://www.msnbc.msn.com/id/19563617/>)
- [9] <http://www.cnn.com/2007/HEALTH/conditions/07/09/obesity.nerve.ap/index.html>
- [10] <http://www.pernicious-anaemia-society.org>
- [11] (<http://www.wired.com/medtech/health/news/2007/01/72325>)
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- [15] http://www.dartmouth.edu/~humananatomy/figures/chapter_24/24-7.HTM
- [16] <http://mywebpages.comcast.net/wnor/cranialnerves.htm>
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