
بسم الله الرحمن الرحيم

GROSS ANATOMY OF VAGUS NERVE

By

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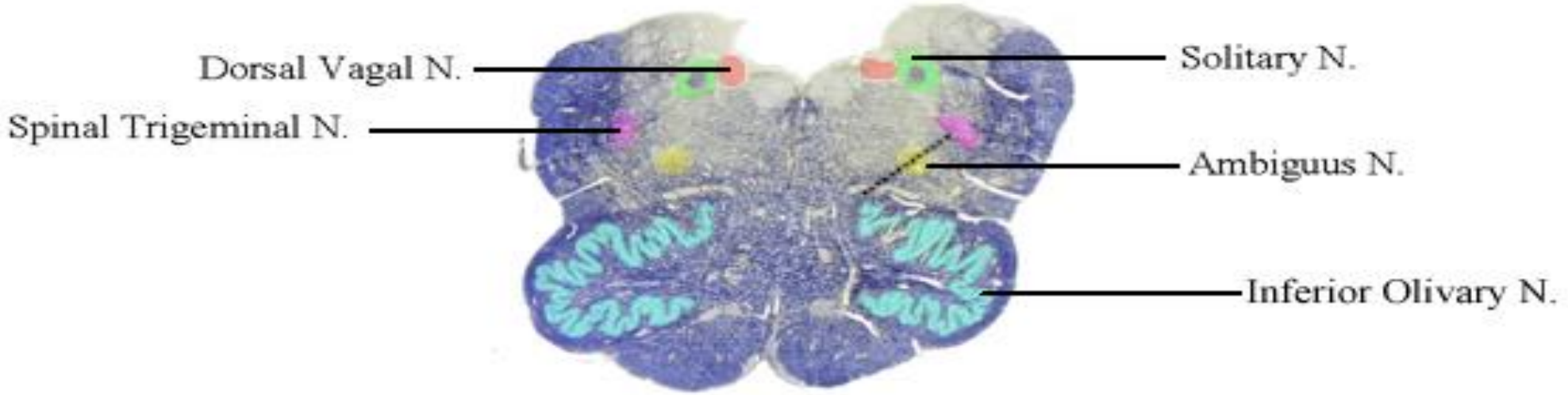
THE VAGUS NERVE (CN X)

- The **vagus nerve** is the 10th cranial nerve (CN X).MIXED NERVE
- It is a functionally diverse nerve, offering many different modalities of innervation. It is associated with the derivatives of the fourth and sixth **pharyngeal arches**.

OVERVIEW

- **Sensory:** Innervates the skin of the external acoustic meatus and the internal surfaces of the laryngopharynx and larynx. Provides visceral sensation to the heart and abdominal viscera.
- **Special Sensory:** Provides taste sensation to the epiglottis and root of the tongue.
- **Motor:** Provides motor innervation to the majority of the muscles of the pharynx, soft palate and larynx.
- **Parasympathetic:** Innervates the smooth muscle of the trachea, bronchi and gastro-intestinal tract and regulates heart rhythm.

Vagal Component	Associated Nucleus	Innervated Structures
Parasympathetic	Dorsal Vagal N.	Autonomic ganglia of thorax and abdomen
Motor	Ambiguus N.	Pharynx, larynx, palate
Viscerosensory	Solitary N.	Pharynx, larynx, esophagus, thoracic and abdominal viscera
Chemosensory	Solitary N.	Taste buds of epiglottis
Somatosensory	Spinal Trigeminal N.	Outer ear canal, pinna, dura



Function

Nerve	Modality	Nucleus	Position	Distribution
Vagus nerve	SVE**	Nucleus ambigius	Medulla	Motor to constrictor muscles of pharynx, intrinsic muscles of larynx, muscles of palate (except tensor veli palatini), and striated muscle in superior two thirds of esophagus
	GVE	Dorsal vagus nuclei	Medulla	Smooth muscle of trachea, bronchi, and digestive tract, cardiac muscle
	GVA	Solitary nucleus	Lower medulla	Visceral sensation from base of tongue, pharynx, larynx, trachea, bronchi, heart, esophagus, stomach, and intestine
	SVA			Taste from epiglottis and palate
	GSA	Sensory nucleus of trigeminal nerve	Pons – C2	Sensation from auricle, external acoustic meatus, and dura mater of posterior cranial fossa

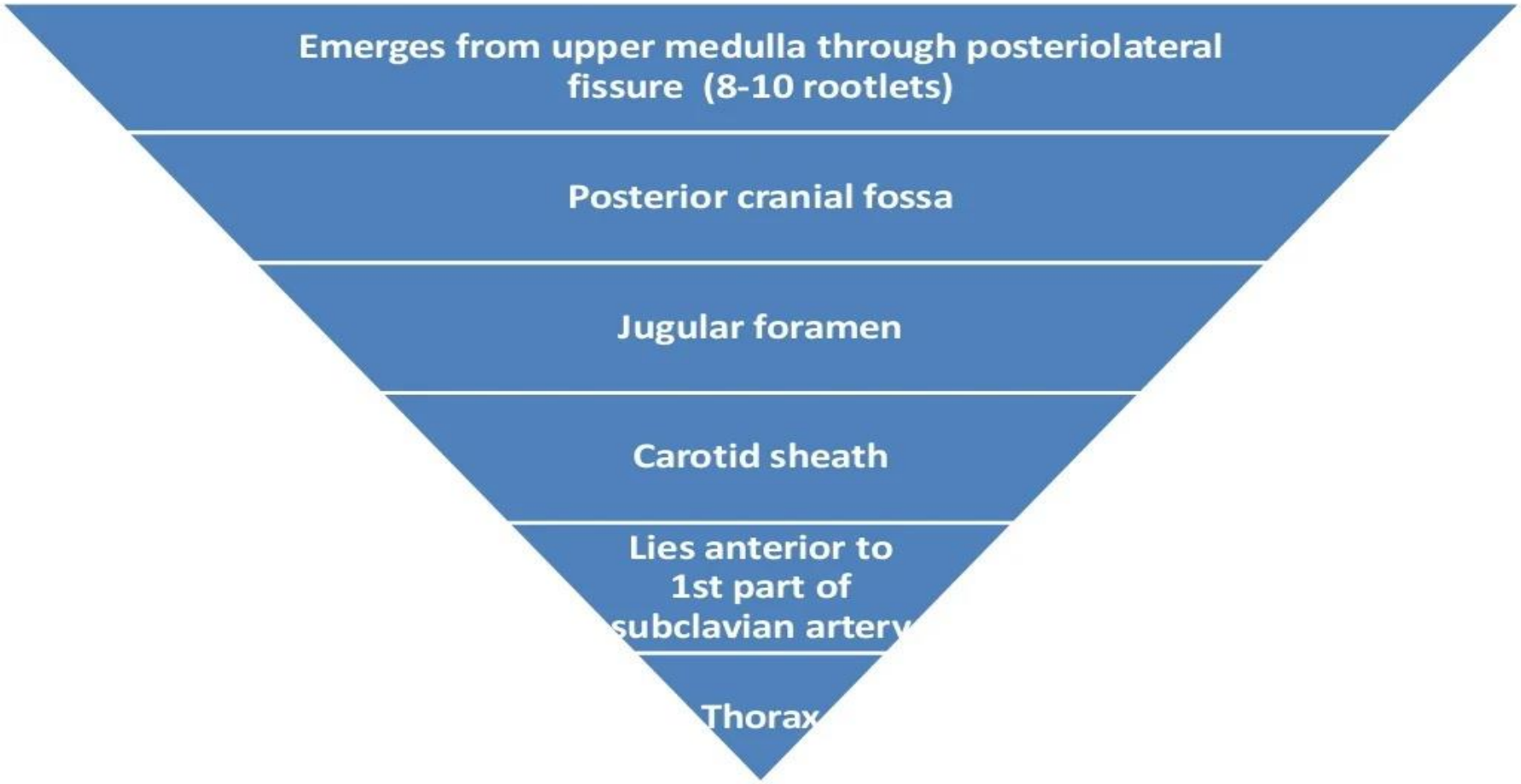
ANATOMICAL COURSE

- The vagus nerve has the longest course of all the cranial nerves, extending from the head to the abdomen. Its name is derived from the Latin '*vagary*' – meaning wandering. It is sometimes referred to as the wandering nerve.

IN THE HEAD

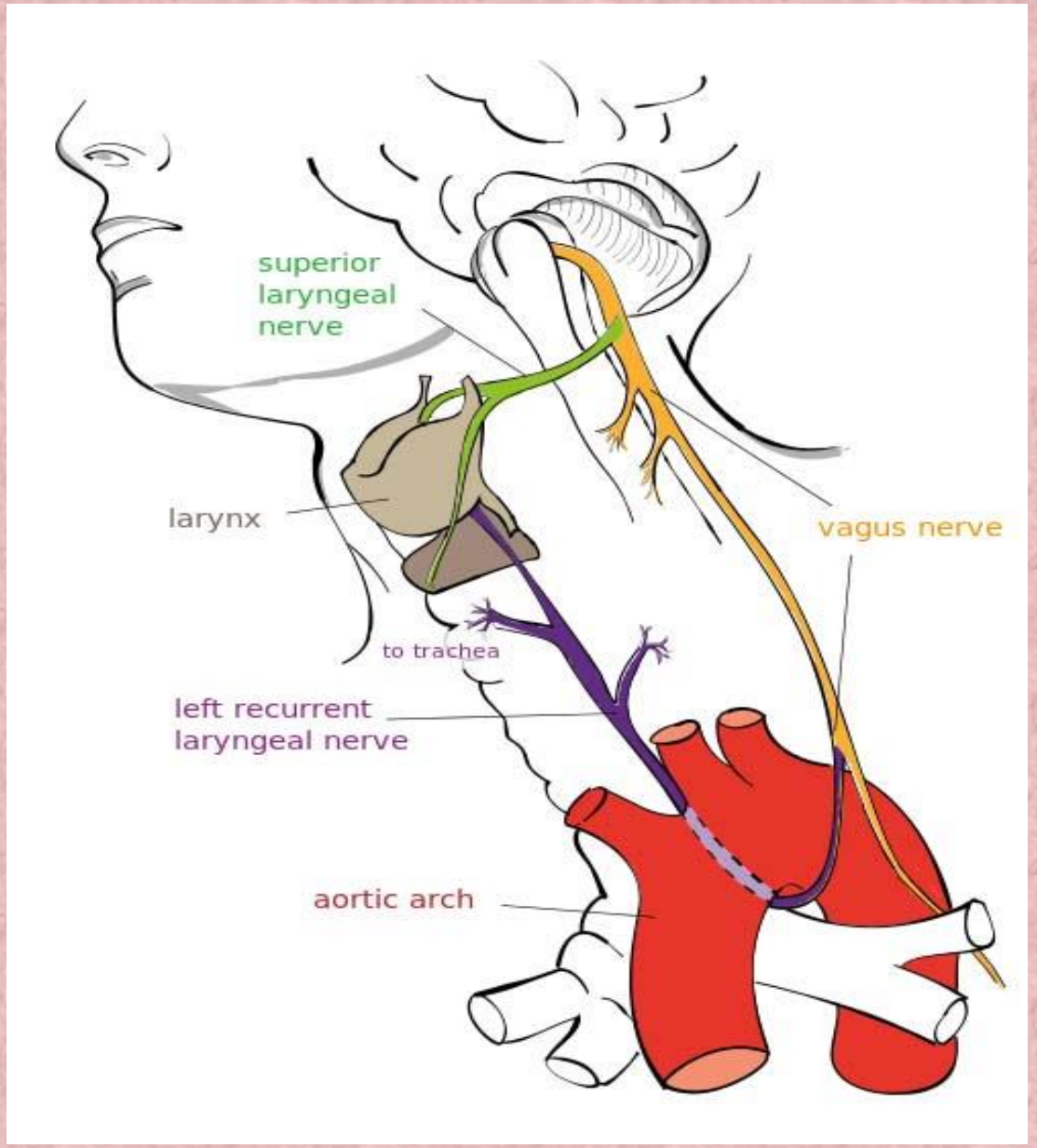
- The vagus nerve originates from the medulla of the brainstem. It exits the cranium via the **jugular foramen,** with the glossopharyngeal and accessory nerves (CN IX and XI respectively).
- Within the cranium, the **auricular branch** arises. This supplies sensation to the posterior part of the external auditory canal and external ear.

The Vagus Nerve (CN X)



ANATOMICAL COURSE CONTD

- In the neck, the vagus nerve passes into the carotid sheath, travelling inferiorly with the internal jugular vein and common carotid artery. At the base of the neck, the right and left nerves have differing pathways:
- The **right vagus nerve** passes anterior to the subclavian artery and posterior to the sternoclavicular joint, entering the thorax.
- The **left vagus nerve** passes inferiorly between the left common carotid and left subclavian arteries, posterior to the sternoclavicular joint, entering the thorax.



Overview of the major branches of the vagus nerve

Right vagus

- In thorax first posterolateral to brachiocephalic artery
- Between trachea (laterally) azygos vein (medially)
- Behind root of lung(pulmonary plexus)
- Posterior to esophagus (esophageal plexus)
- Esophageal opening of diaphragm at T10
- Posterior surface of stomach to form posterior vagal trunk
- Branches to celiac & superior mesenteric plexuses

Left vagus nerve

- X • Descends in thorax between left common carotid artery & left subclavian artery
- X • Crosses left side of aortic arch (phrenic nerve crosses left vagus)
- X • Behind root of left lung (pulmonary plexus)
- X • Anterior to esophagus (esophageal plexus)
- X • Esophageal opening of diaphragm at T10
- X • Anterior surface of stomach to form anterior vagal trunk

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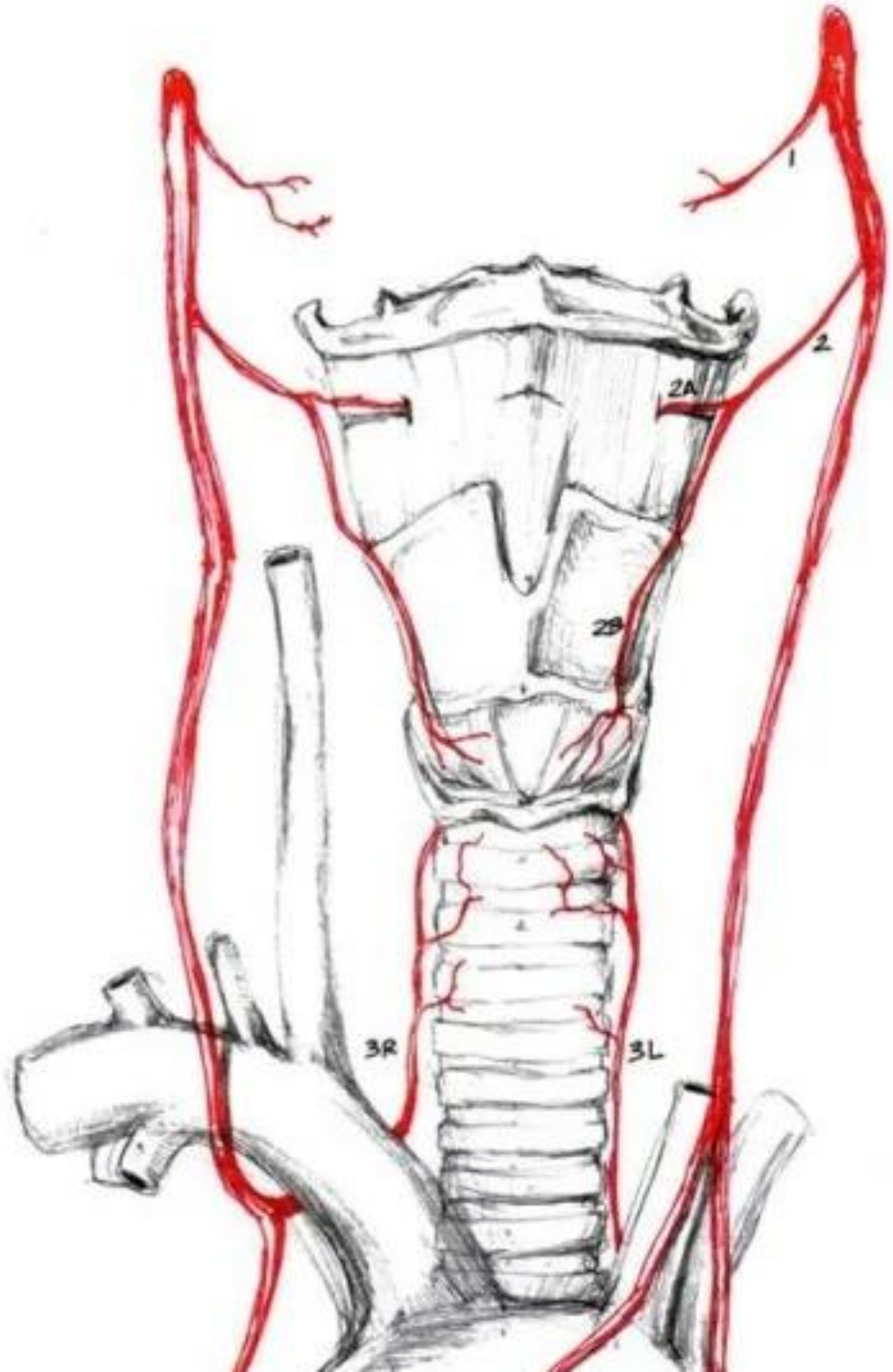
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2
2A
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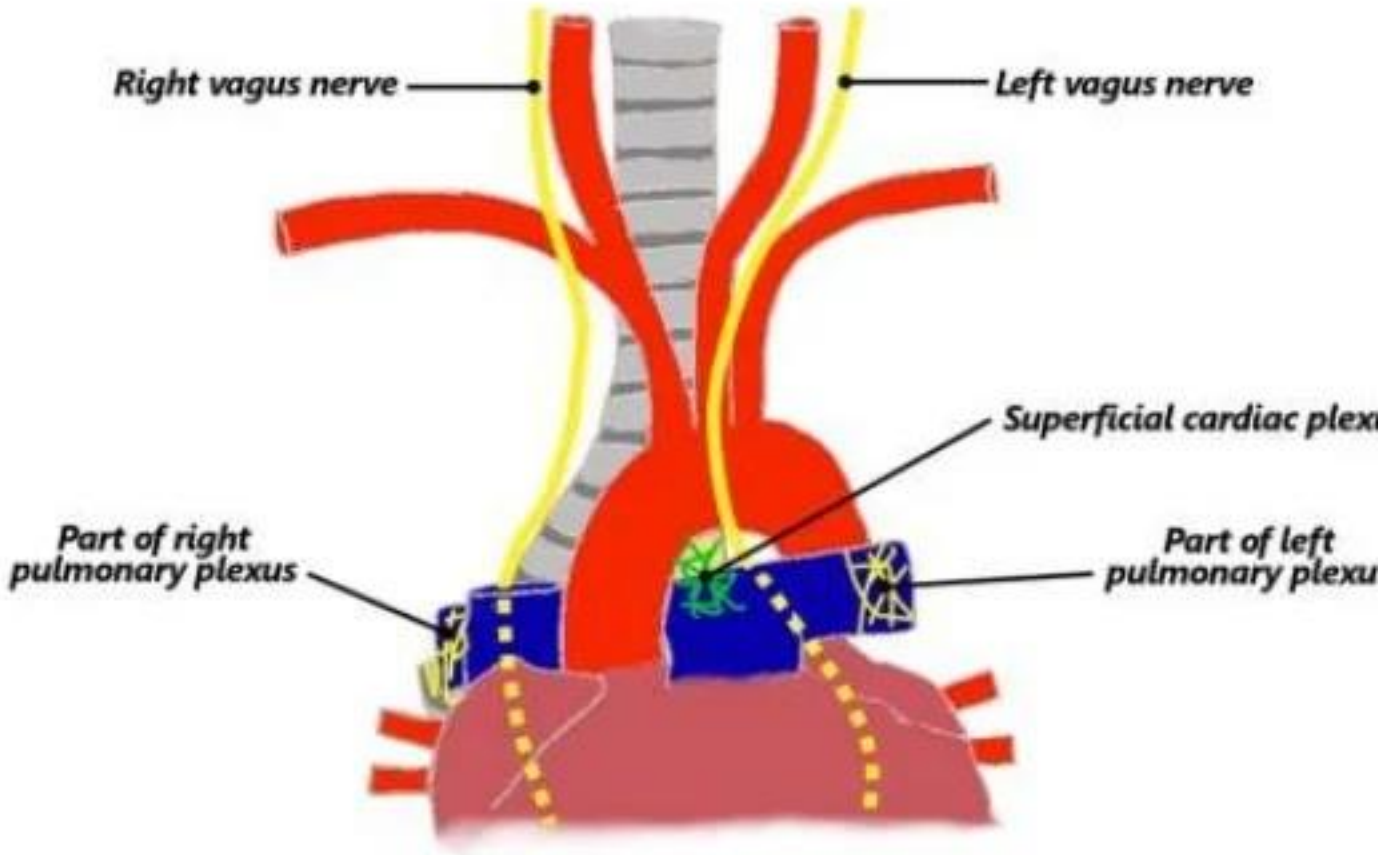
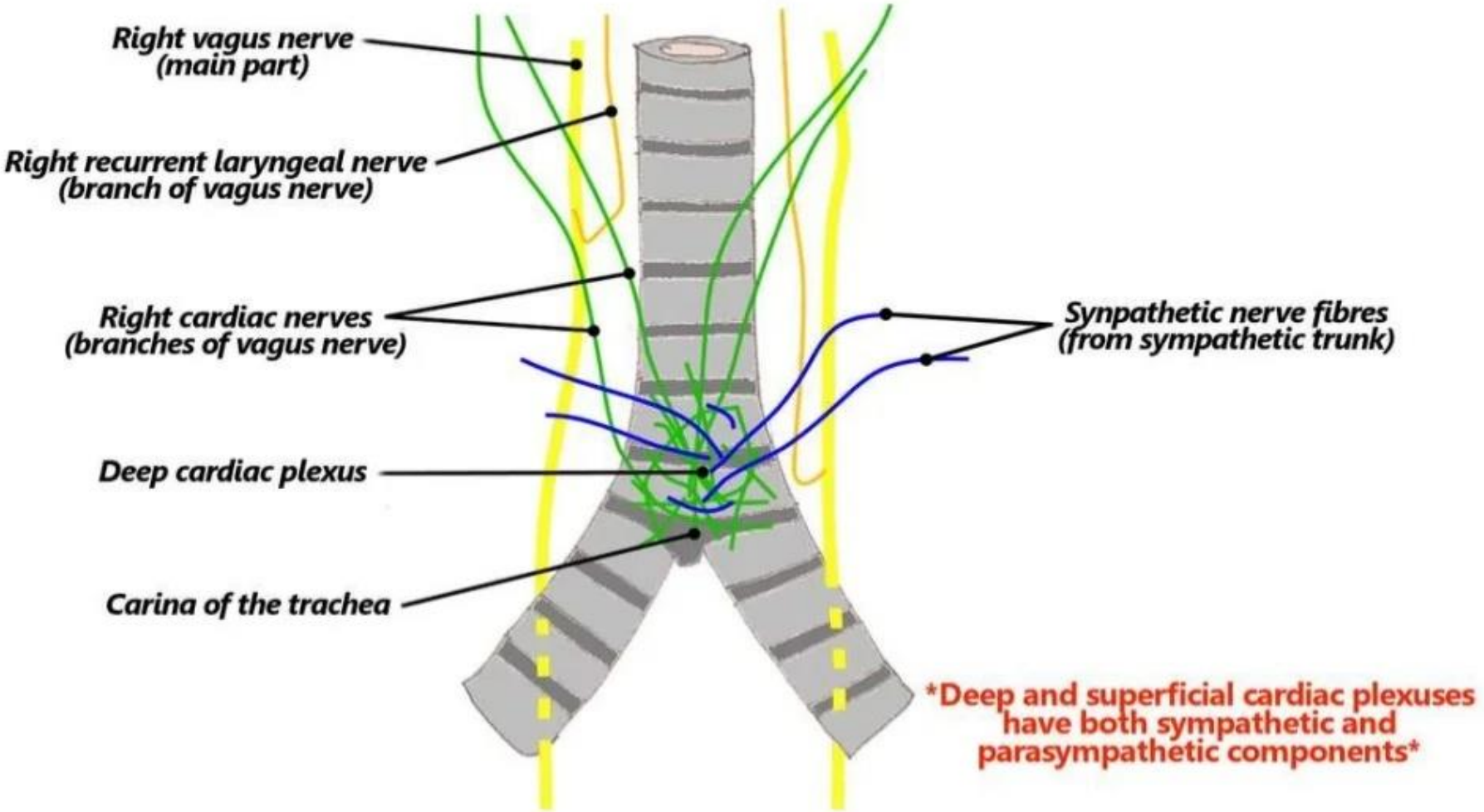
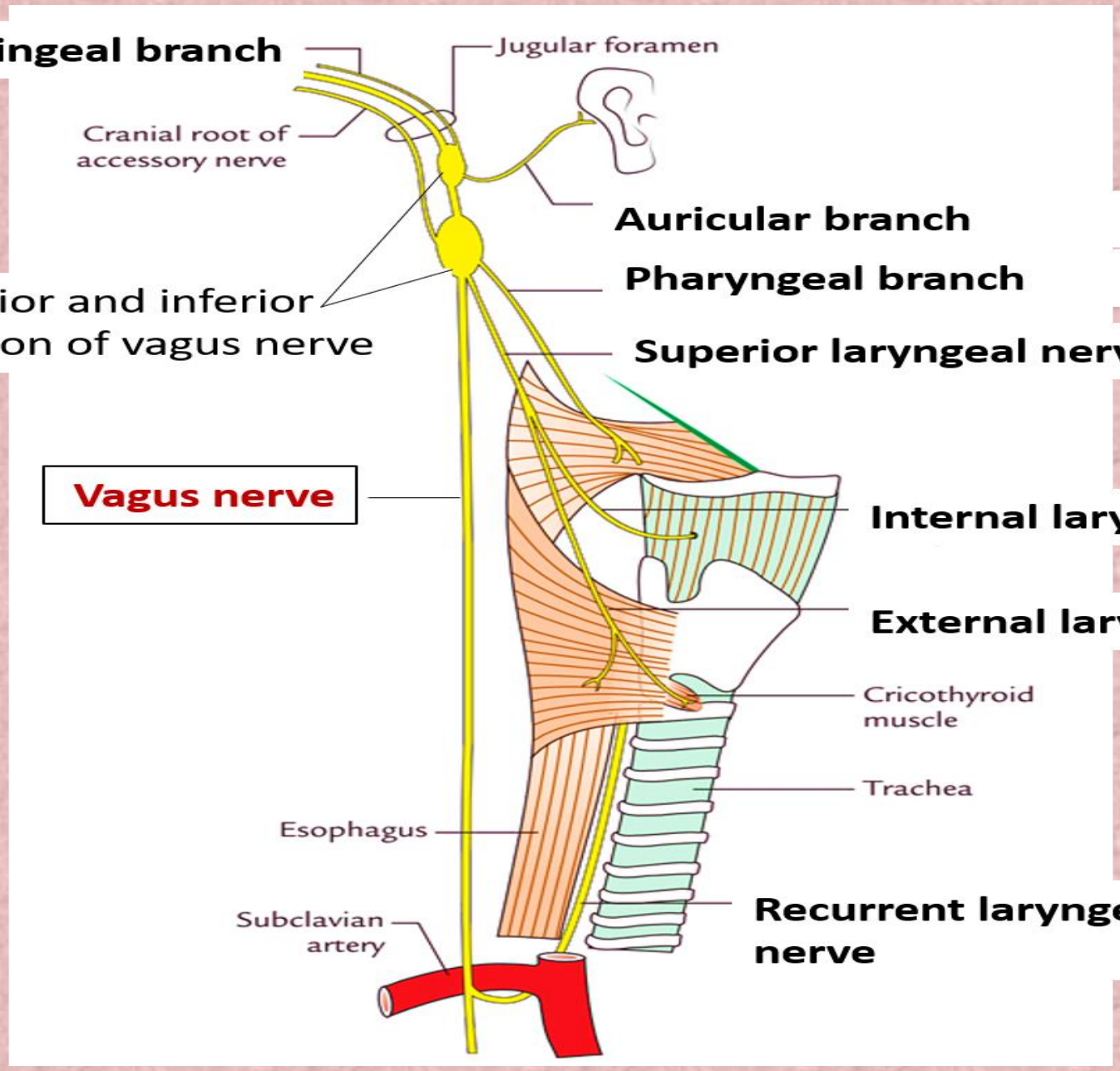

Right vagus nerve
Left vagus nerve
Superficial cardiac plexu
Part of right
pulmonary plexus
Part of left
pulmonary plexu


Right vagus nerve
(main part)
Right recurrent laryngeal nerve
(branch of vagus nerve)
Right cardiac nerves
(branches of vagus nerve)
Deep cardiac plexus
Carina of the trachea
Sympathetic nerve fibres
(from sympathetic trunk)
Deep and superficial cardiac plexuses have both sympathetic and parasympathetic components

SEVERAL BRANCHES ARISE IN THE NECK

- **Pharyngeal branches** – Provides motor innervation to the majority of the muscles of the pharynx and soft palate.
- **Superior laryngeal nerve** – Splits into internal and external branches. The external laryngeal nerve innervates the cricothyroid muscle of the larynx. The internal laryngeal provides sensory innervation to the laryngopharynx and superior part of the larynx.
- **Recurrent laryngeal nerve** (right side only) – Hooks underneath the right subclavian artery, then ascends towards to the larynx. It innervates the majority of the intrinsic muscles of the larynx.(below vocal cord)


Meningeal branch
Jugular foramen
Cranial root of accessory nerve
Auricular branch
Pharyngeal branch
Superior and inferior ganglion of vagus nerve
Superior laryngeal nerve
Vagus nerve
Internal laryngeal nerve
External laryngeal nerve
Cricothyroid muscle
Trachea
Esophagus
Subclavian artery
Recurrent laryngeal nerve

IN THE THORAX

- In the thorax, the right vagus nerve forms the **posterior vagal trunk**, and the left forms the **anterior vagal trunk**. Branches from the vagal trunks contribute to the formation of the oesophageal plexus, which innervates the smooth muscle of the oesophagus.
- Two other branches arise in the thorax:
- **Left recurrent laryngeal nerve** – it hooks under the arch of the aorta, ascending to innervate the majority of the intrinsic muscles of the larynx.
- **Cardiac branches** – these innervate regulate heart rate and provide visceral sensation to the organ.

IN THE THORAX

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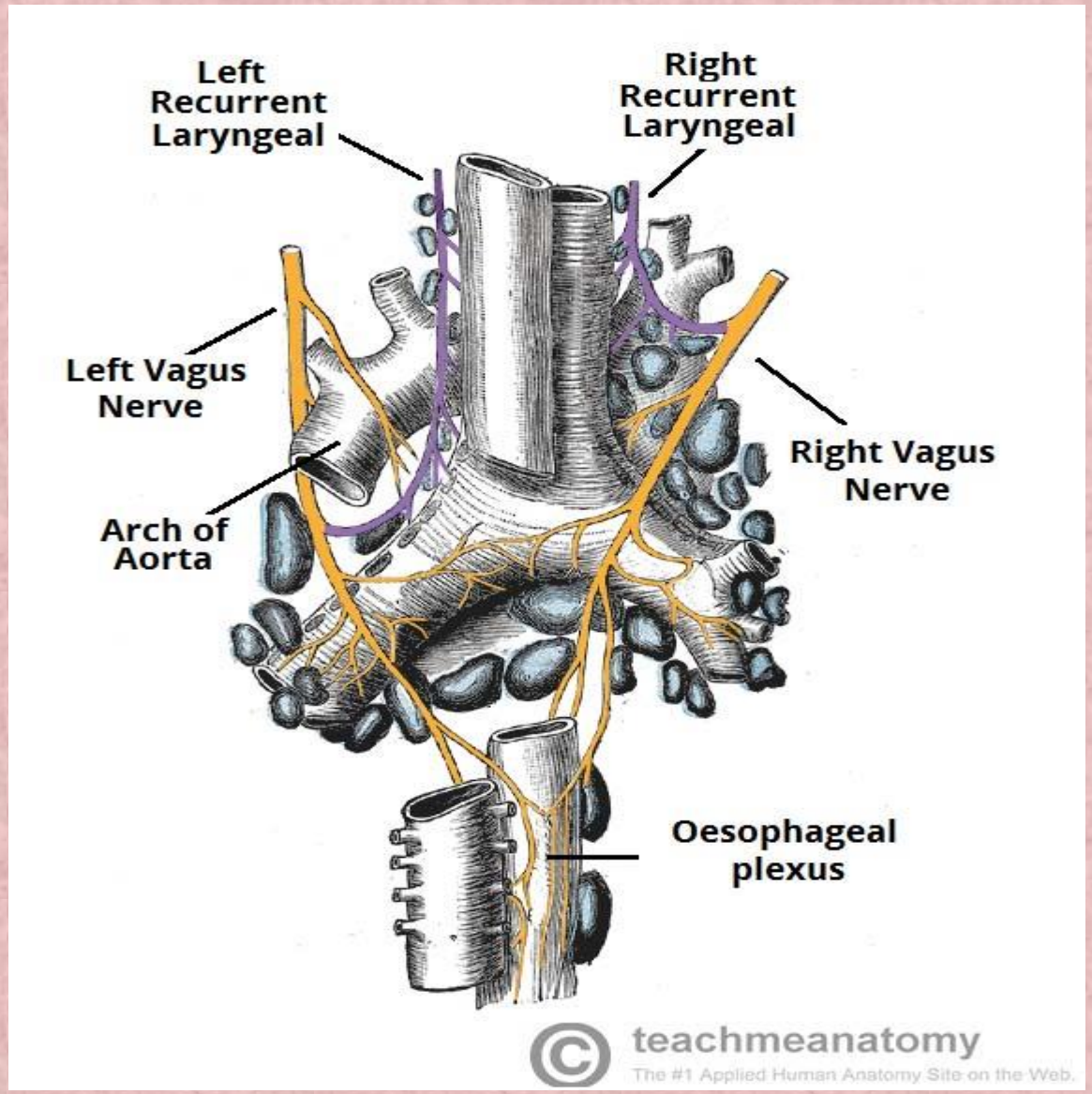
- The vagal trunks enter the abdomen via the oesophageal hiatus, an opening in the diaphragm.



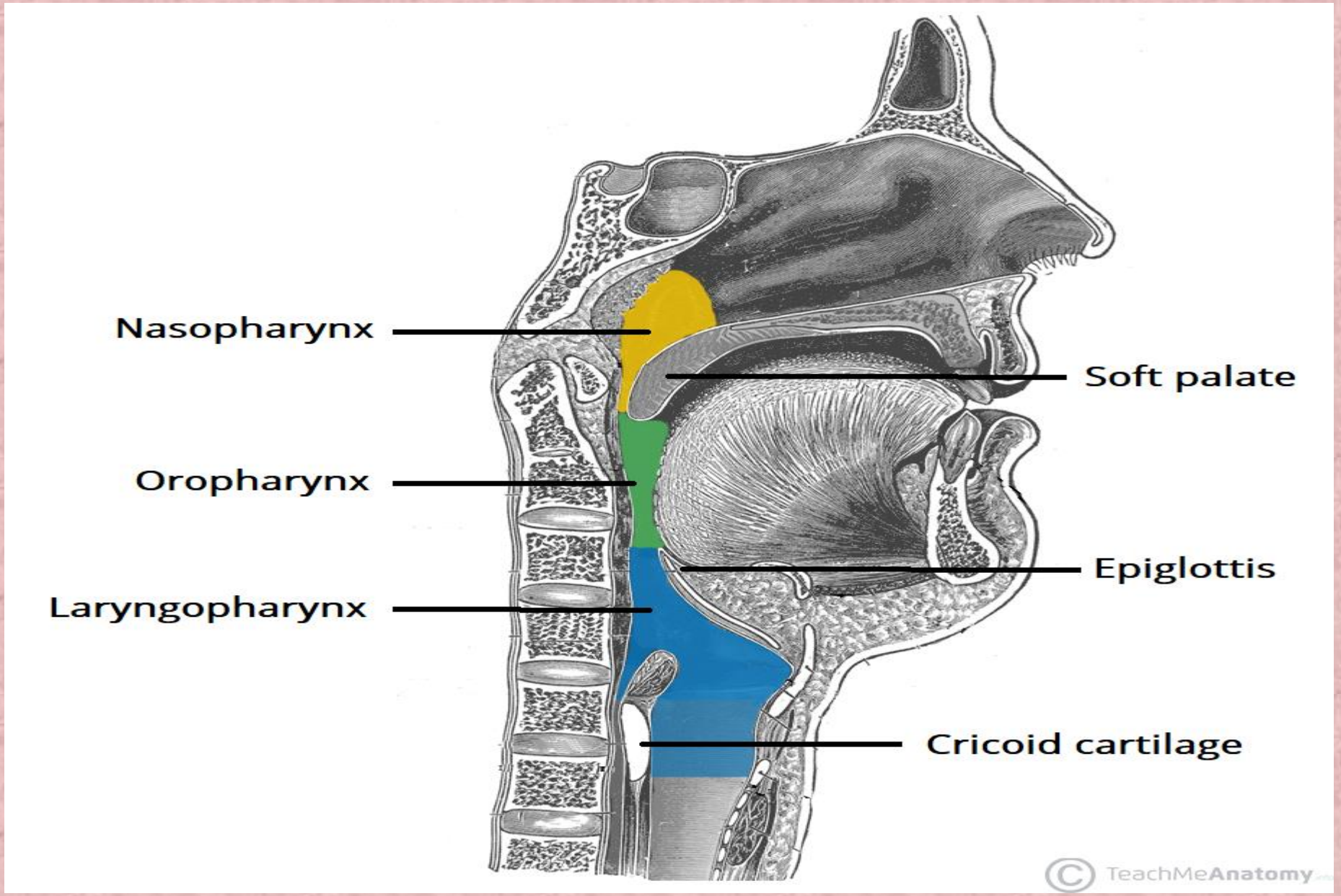
The origin of the recurrent laryngeal nerves

IN THE ABDOMEN

- In the abdomen, the vagal trunks terminate by dividing into branches that supply the oesophagus, stomach and the small and large bowel (up to the splenic flexure).

SENSORY FUNCTIONS

- There are **somatic** and **visceral** components to the sensory function of the vagus nerve.
- Somatic refers to sensation from the skin and muscles. This is provided by the auricular nerve, which innervates the skin of the posterior part of the external auditory canal and external ear.
- Viscera sensation is that from the organs of the body. The vagus nerve innervates:
- **Laryngopharynx** – via the internal laryngeal nerve.
- Superior aspect of **larynx** (above vocal folds) – via the internal laryngeal nerve. Below vocal cord –via recurrent laryngeal nerve
- **Heart** – via cardiac branches of the vagus nerve.
- **Gastro-intestinal tract** (up to the splenic flexure) – via the terminal branches of the vagus nerve.



THE THREE PARTS OF THE PHARYNX, AND THEIR BORDERS.
THE LARYNGOPHARYNX IS INNERVATED BY THE VAGUS NERVE.

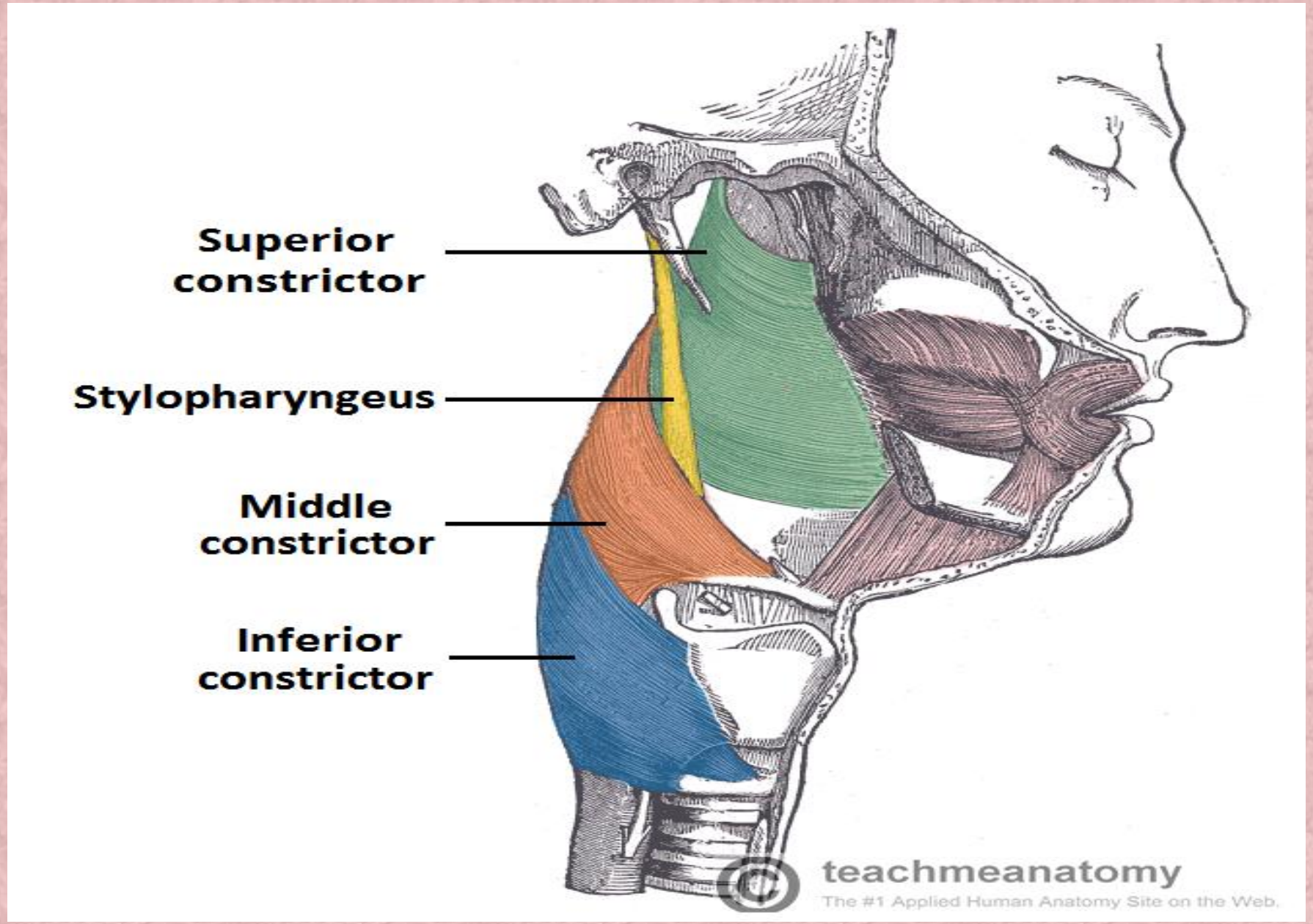
SPECIAL SENSORY FUNCTIONS

- The vagus nerve has a minor role in taste sensation. It carries afferent fibres from the **root of the tongue** and **epiglottis**.
- *(This is not to be confused with the special sensation of the glossopharyngeal nerve, which provides taste sensation for the posterior 1/3 of the tongue).*

MOTOR FUNCTIONS

The vagus nerve innervates the majority of the muscles associated with the pharynx and larynx. These muscles are responsible for the initiation of swallowing and phonation.

- **Pharynx**
- Most of the muscles of the pharynx are innervated by the **pharyngeal branches** of the vagus nerve:
- Superior, middle and inferior pharyngeal constrictor muscles
- Palatopharyngeus
- Salpingopharyngeus
- An additional muscle of the pharynx, the **stylopharyngeus**, is innervated by the glossopharyngeal nerve.



Lateral view of the deep structures of the pharynx. Visible are the circular muscles of the pharynx, and the stylopharyngeus.

LARYNX

Innervation to the intrinsic muscles of the larynx is achieved via the recurrent laryngeal nerve and external branch of the superior laryngeal nerve.

- **Recurrent laryngeal nerve:**
- Thyro-arytenoid
- Posterior crico-arytenoid
- Lateral crico-arytenoid
- Transverse and oblique arytenoids
- Vocalis
- **External laryngeal nerve:**
- Cricothyroid
- **Other Muscles**

In addition to the pharynx and larynx, the vagus nerve also innervates the **palatoglossus** of the tongue, and the majority of the muscles of the **soft palate**.

PARASYMPATHETIC FUNCTIONS

In the thorax and abdomen, the vagus nerve is the main parasympathetic outflow to the heart and gastro-intestinal organs.

- **The Heart**
- Cardiac branches arise in the thorax, conveying parasympathetic innervation to the sino-atrial and atrio-ventricular nodes of the heart.
- These branches stimulate a reduction in the resting heart rate. They are constantly active, producing a rhythm of 60 – 80 beats per minute. If the vagus nerve was lesioned, the resting heart rate would be around 100 beats per minute.

PARASYMPATHETIC FUNCTIONS

GASTRO-INTESTINAL SYSTEM

- The vagus nerve provides parasympathetic innervation to the majority of the abdominal organs. It sends branches to the oesophagus, stomach and most of the intestinal tract – up to the splenic flexure of the large colon.
- The function of the vagus nerve is to stimulate smooth muscle contraction and glandular secretions in these organs. For example, in the stomach, the vagus nerve increases the rate of gastric emptying, and stimulates acid production.

CLINICAL RELEVANCE
DISORDERS OF THE VAGUS NERVE

C A R D I O V A S C U L A R

- Many pharmacological agents can be used to potentiate vagal tone on the heart therefore slowing the heart rate. Beta-blockers, muscarinic agonists and cardiac glycosides such as Digoxin are just a few that can be used.
- Vasovagal syncope can ensue during a period of emotional stress for example causing a sudden drop in blood pressure and heart rate. Further to this a carotid massage can compress the carotid sinus leading to the perception of a high blood pressure. This will cause CN X to increase its firing leading to a decreased activity of the SA node and AV node. Overall a decreased rate and strength of contraction will ensue and the person may experience syncope.
- Many congenital heart defects such as a **patent ductus arteriosus** can irritate the left recurrent laryngeal nerve, leading to dysphonia (hoarse voice).

CLINICAL RELEVANCE
DISORDERS OF THE VAGUS NERVE

GASTRO-INTESTINAL

- Lesions to the CN X are rare. A lesion to the pharyngeal branches can lead to dysphagia (difficulty swallowing) due to the involvement with the muscles of the pharynx. As CN X innervates the Palatopharyngeus and Salpingopharyngeus muscles a lesion here will cause the Palatoglossal arch to drop leading to Uvula deviation away from the affected side. The CN IX is sensory to the oropharynx and laryngopharynx with CN X being the motor efferents involved in the Gag reflex therefore a lesion in this area will cause a loss of the Gag reflex.
- Once upon a time a vagotomy could be done to reduce excess stomach acid production. However with advancements in pharmacological therapy this is no longer necessary.

CLINICAL RELEVANCE
DISORDERS OF THE VAGUS NERVE

OTHER

- As shown above a lesion to one of the RLN's will cause dysphonia. A lesion to both RLN's will cause aphonia (loss of voice) and a stridor (inspiratory wheeze). Paralysis of the RLN's usually occur due to cancer of the larynx or thyroid gland or due to surgical complications.

CLINICAL TESTING OF VAGUS NERVE

- The vagus nerve can be analyzed medically by requesting the patient to open his mouth and say ‘ah’ and after that comparing the palatal arches of the 2 sides. If the vagus is undamaged, the soft palate rises (is elevated) in the midline. In bilateral lesions, the soft palate falls. In the unilateral lesion, there’s flattening (drooping) of palate arch on the side of paralysis and uvula pulled to the normal side.

VAGUS NERVE

- The vagus nerve is associated with the derivatives of the fourth pharyngeal arch.
- **Sensory:** Innervates the skin of the external acoustic meatus and the internal surfaces of the laryngopharynx and larynx. Provides visceral sensation to the heart and abdominal viscera.
- **Special Sensory:** Provides taste sensation to the epiglottis and root of the tongue.
- **Motor:** Provides motor innervation to the majority of the muscles of the pharynx, soft palate and larynx.
- **Parasympathetic:** Innervates the smooth muscle of the trachea, bronchi and gastro-intestinal tract and regulates heart rhythm.

KEY FACTS	
NUCLEI	Dorsal nucleus - sends parasympathetic fibers to the intestines Nucleus ambiguus - sends efferent motor and parasympathetic fibers to the heart Solitary nucleus - receives special gustatory afferent from the tongue and visceral afferent fibers from organs Spinal trigeminal nucleus - receives general sensory afferent fibers
BRANCHES	In the jugular fossa: meningeal, auricular branches In the neck: pharyngeal, superior laryngeal, recurrent laryngeal nerves; superior cardiac branches In the thorax: inferior cardiac nerve, anterior bronchial branches, posterior bronchial branches, esophageal branches In the abdomen: gastric, celiac and hepatic branches
FIELD OF INNERVATION	General sensory afferent fibers - sensory information from larynx, auricle, external acoustic meatus, dura mater of the posterior cranial fossa General visceral afferent - information from the aortic body, esophagus, lungs, bronchi, heart, intestines Special afferent - information about taste General visceral efferent - parasympathetic division that simulates smooth muscle and glands of the pharynx, larynx, thoracic and abdominal organs
CLINICAL RELATIONS	Vagotomy, unilateral and bilateral lesions


Thank you