

NEUROVASCULAR STRUCTURES IN THE NECK

BASIC TOPOGRAPHY OF THE NECK

- Can be thought of as a tube through which structures pass between head and trunk.
- Upper parts of both respiratory and digestive pathways both pass through the neck
- Contains arteries to the head and veins returning from the head.
- Several cranial nerves pass through foramina in the base of the skull and then run down through the neck.

- Must have a strong musculoskeletal framework but also be mobile.
- 7 cervical vertebrae allow both stability & motility
- Pairs of spinal nerves leave through the intervertebral foramina
- Although there are 7 cervical vertebrae, there are 8 pairs of cervical spinal nerves
 - Because the first pair of cervical spinal nerves leaves the column above the first cervical vertebra.
- First 4 pairs of cervical spinal nerves supply the neck muscles and cutaneous sensation to the neck.
- The lower pairs are involved in the brachial plexus → axilla → upper limb.

- Cervical vertebral column is surrounded & protected by muscle:
 - Posteriorly – extensor muscle mass
 - Must be particularly powerful, as the head naturally falls onto the neck in the upright position.
 - Anteriorly – flexor prevertebral muscles
 - Weak, as assisted by gravity

- Muscles from the cervical column also suspend the scapula on the back of the rib-cage

- Also gives the **scalene muscles** which insert into the first 2 ribs of the thoracic inlet.

- Each of the muscles which surround the cervical vertebral column are covered with fascia
- This fascia is esp. well defined over the prevertebral muscles – the **prevertebral fascia**
- Also thick in the midline posteriorly between the extensor muscles – the **ligamentum nuchae**

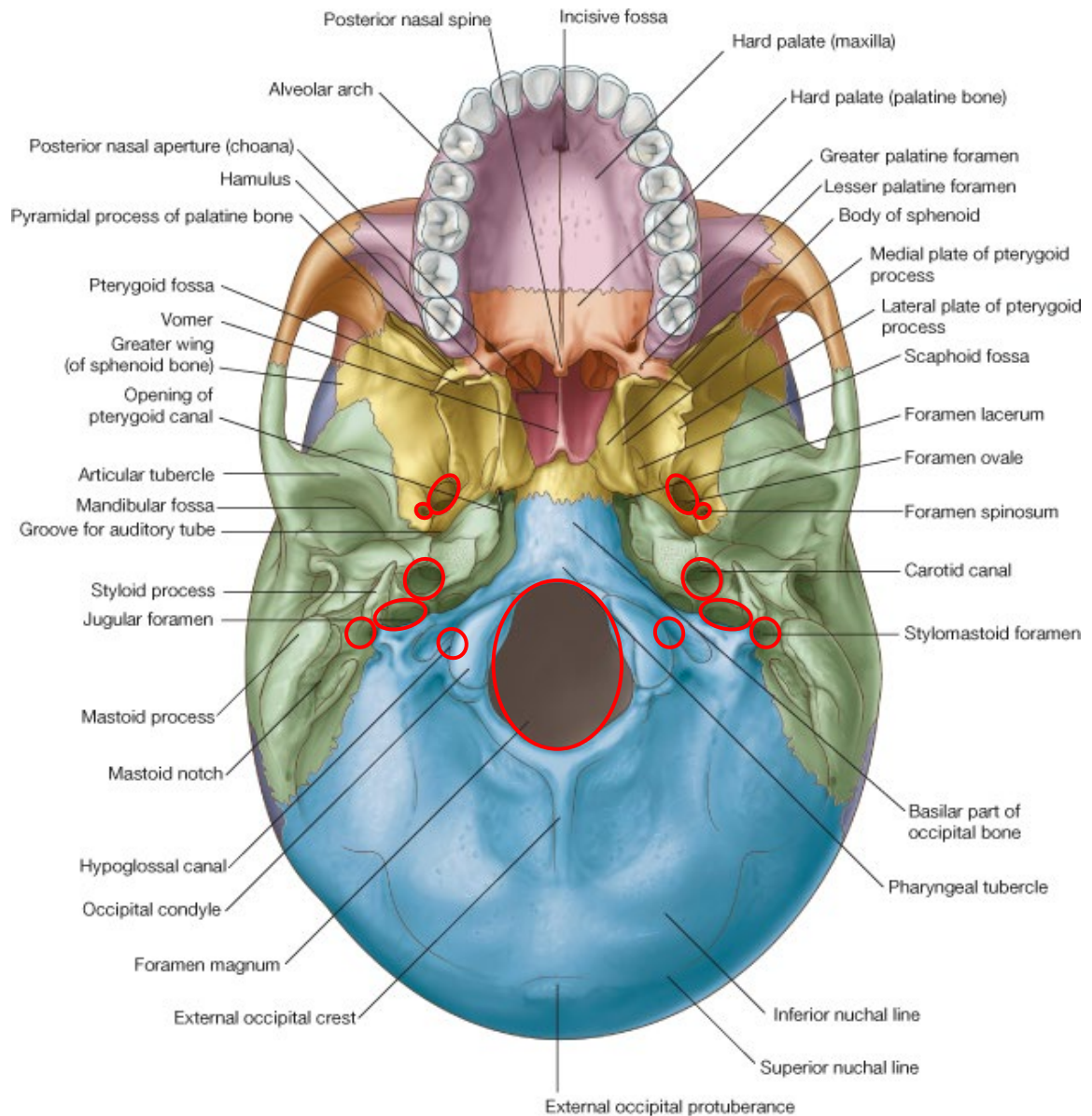
- Thus the neck can be divided into 2 compartments:
 - **Anterior compartment:**
 - Upper parts of respiratory & digestive tracts (trachea & oesophagus)
 - Neurovascular structures & lymph nodes
 - **Posterior compartment:**
 - Cervical vertebral column
 - Surrounding musculature

- Both compartments are surrounded on the outside by sheath of **investing** or **deep cervical fascia** – encircles the neck like a stocking.

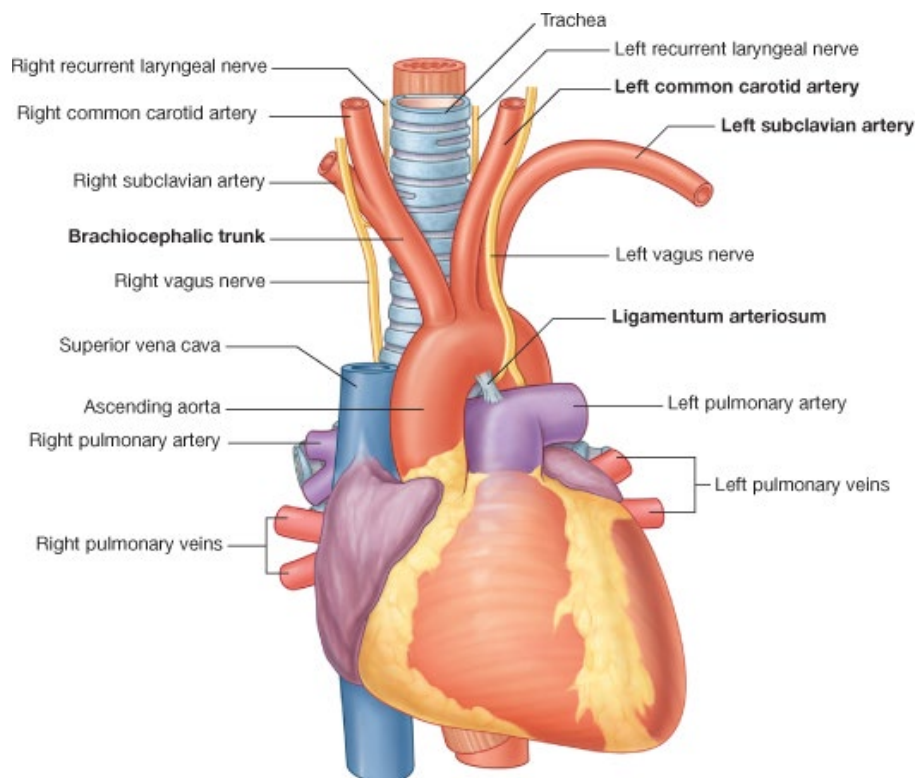
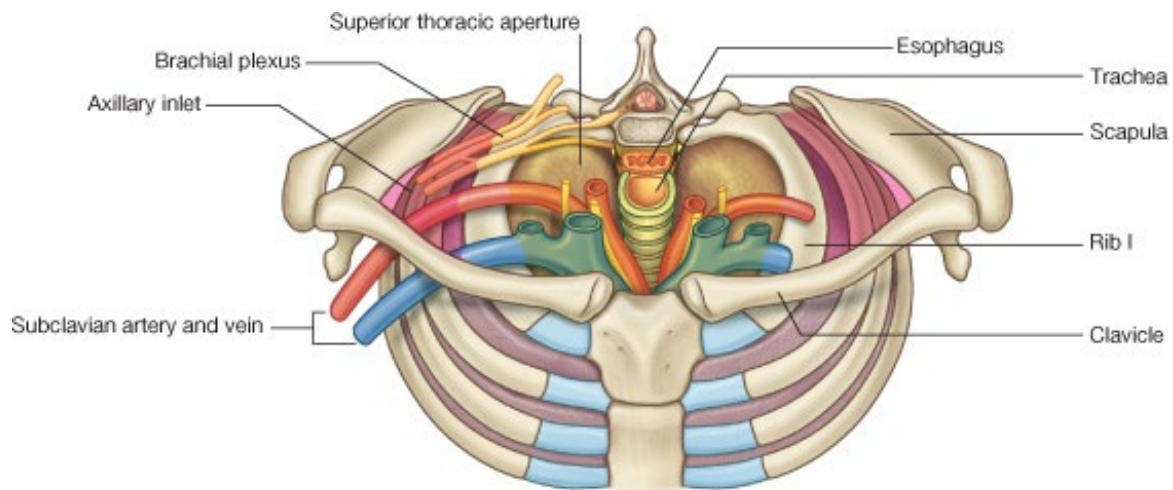
- Neurovascular structures and LNs lie either side of the structures of the anterior compartment.
- **THYROID** gland straddles the structures across the root of the neck.

NEUROVASCULAR STRUCTURES IN THE NECK:

- Arteries, veins & nerves all pass through neck.
- Skull base is full of holes to allow structures to pass from neck into the head & vice-versa



- **Carotid canal:** round entrance
- **Jugular foramen:** irregular outline
- **Styloid process:** positioned between the styloid process & mastoid process
- **Anterior condyloid foramen / hypoglossal canal:** in line with C1, just above occipital condyle.
- At the root of the neck there is only one hole – the **thoracic inlet**
- The thoracic inlet is bounded by:
 - T1
 - The first ribs
 - Manubrium
- Trachea, oesophagus and neurovascular structures pass through this inlet.

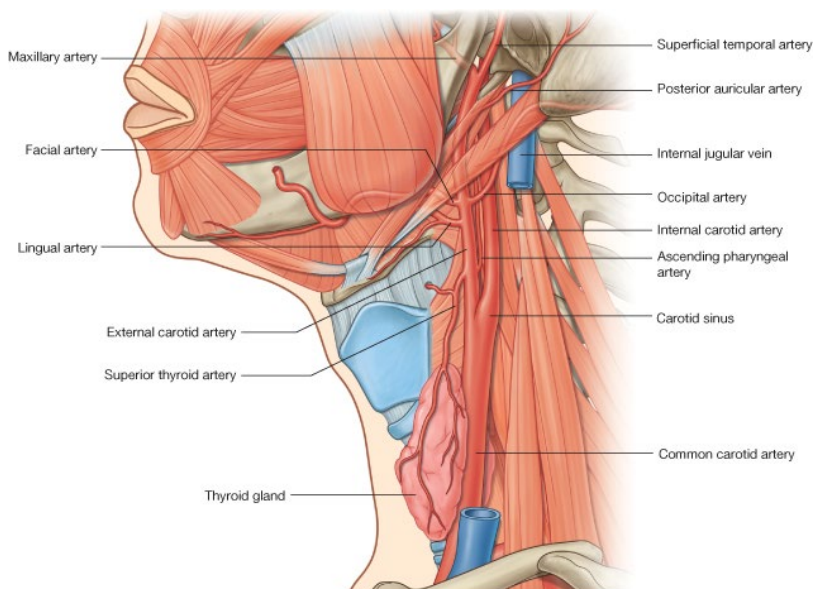
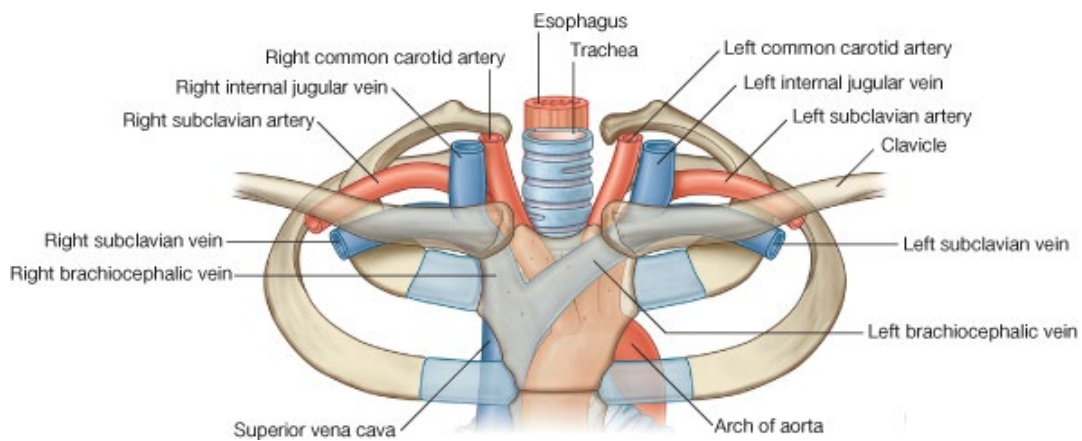


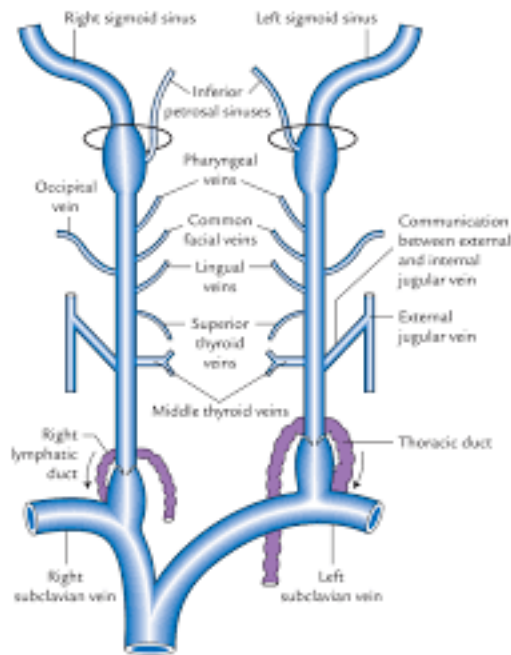
- The aortic arch gives off the:
 - **Brachiocephalic trunk** on the right
 - **Left common carotid & left subclavian artery** on the left
- **Brachiocephalic** on the right splits into right common carotid and right subclavian artery.
- Both **right and left common carotids ascend the neck on the either side of the midline tubes**
- On reaching the upper border of the thyroid cartilage (C4), each common carotid bifurcates:
 - **Internal carotid artery**
 - **External carotid artery**
- **Internal carotid artery:**
 - Destined to supply much of the brain
 - Gives no branches in the neck during its ascent to the skull

- Enters the skull through the **carotid canal**
- Eventually emerges through the top of the cavernous sinus close to the pituitary fossa

- **External carotid artery:**

- Supplies much of:
 - Neck
 - Head
 - Face
 - Skull
- Δ gives many branches in the neck – the **carotid tree**





THE CAROTID SYSTEM

- Bifurcation of the common carotid takes place at the upper border of the thyroid cartilage (C4).
- The thyroid cartilage is easily palpated
- The **superior thyroid artery** also emerges at the level of the thyroid cartilage

- Hyoid bone is the next landmark
- Palpable in the neck just above the thyroid cartilage
- **Lingual artery** to the tongue arises at this level

- **Facial artery** arises just above the lingual ligament
- But at this level the mandible (lower jaw) overlaps the carotid tree – such that the facial artery has to curl around the lower border of the mandible (can be felt as a pulse)

- Remainder of external carotid continues up, but to expose it, the side of the mandible must be removed.
- Deep to the mandible, & within substance of parotid salivary gland, the external carotid divides into 2 terminal branches:
 - **Superficial temporal:**
 - Curls behind the neck of the mandible
 - Supplies superficial structures of temple & scalp
 - **Maxillary artery:**
 - Passes inwards towards midline → partner on the other side
 - In its course it supplies:
 - Upper jaw
 - Back of nose
 - Upper pharynx

- Anterior from the top downwards: **Super Man Fancies Lisa Simpson**

- **Ascending pharyngeal** artery arises opposite the superior thyroid artery
- Supplies blood to the pharyngeal wall
- **Occipital artery** arises opposite the facial artery
- Passes to the back of the neck, deep to sternocleidomastoid muscle
- **Posterior auricular branch** runs out of parotid gland near the back of the mandible, prior to the terminal division of the external carotid
- Supplies the gland, skin and muscles here.
- Posterior from the top downwards: **Posterior Of Artery**

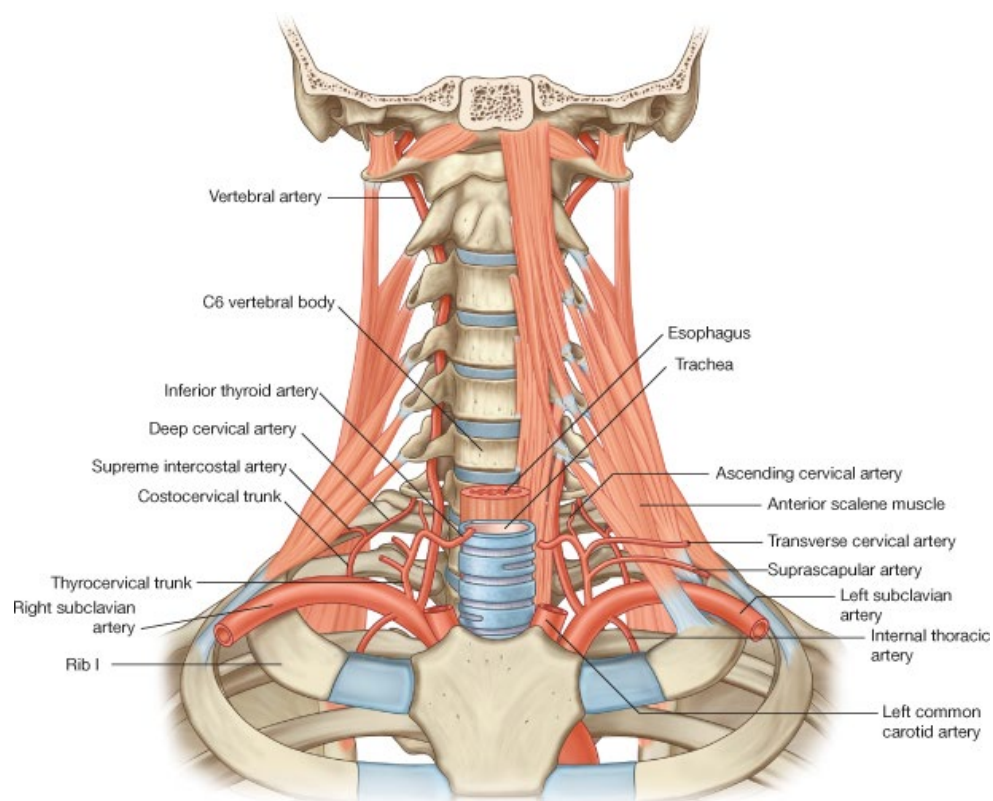
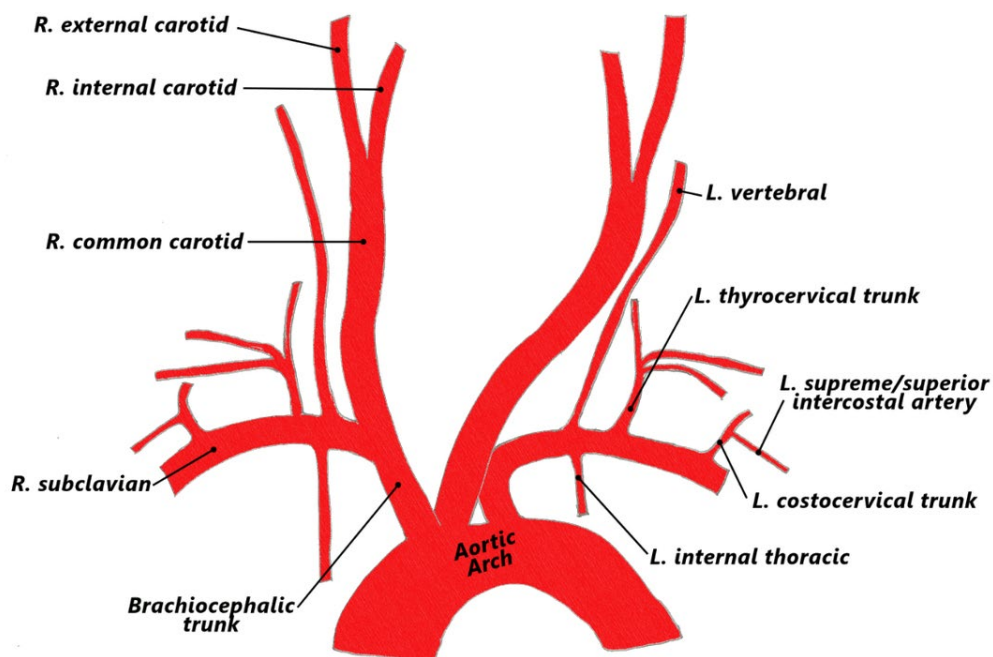
External carotid:

		S
P		M
O		F
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SUBCLAVIAN ARTERIES

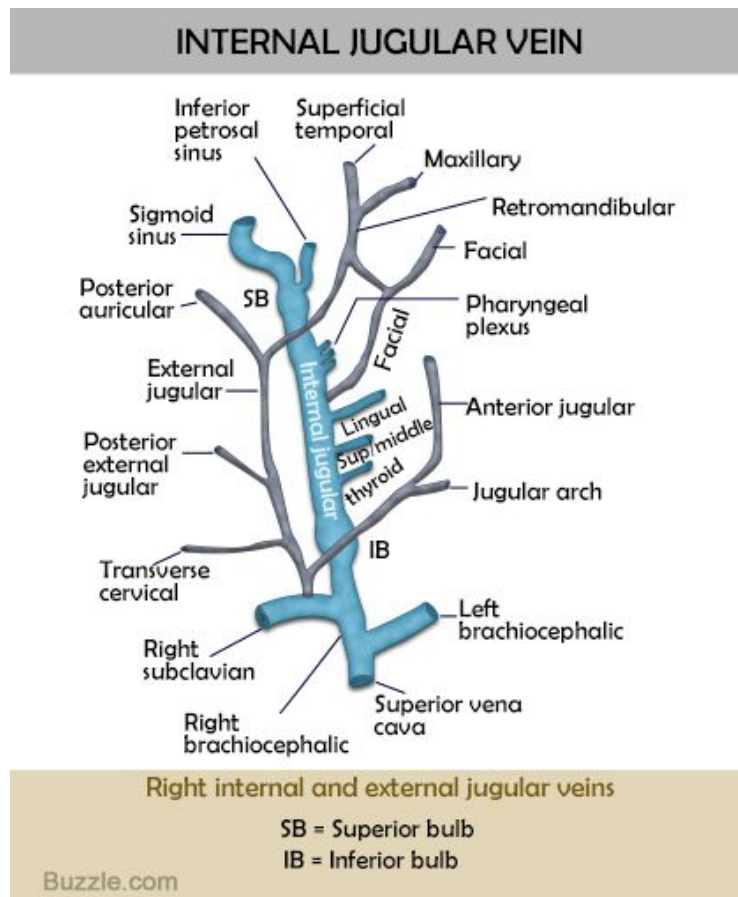
- Carry blood into the upper limb, but also carry some blood to the neck.
- Branches are best seen from the front at the root of the neck
- One of the branches of the subclavian artery – the **vertebral artery** – supplies the brain
- Runs to vertebral column in neck
- Climbs neck in **foramina transversarium** of the cervical vertebrae
- Enters the cranial cavity through the **foramen magnum**
- **Costocervical trunk** arises from subclavian
- Gives branches to:
 - Deep muscles in back of neck

- Upper 2 intercostal spaces
- **Internal thoracic artery** is branch of subclavian
- Supplies:
 - Upper intercostal space
 - Small muscles of neck
- Descends into thorax to supply thoracic wall
- **Thyrocervical trunk** is a short thick branch
- Divides into the **inferior thyroid artery** to supply the thyroid
- Also gives off branches to the back of shoulder and scapular muscles.



VENOUS DRAINAGE OF THE HEAD & NECK:

- The **internal jugular vein** drains the brain via the intracranial venous sinuses – sigmoid sinus runs out of jugular foramen and joins the lesser petrosal sinus to form the **IJV**
- At the level of the jugular foramen is the superior jugular bulb
- Runs down the neck lateral to:
 - Initially: internal carotid artery
 - Then: common carotid artery
- In its descent the IJV receives superficial venous drainage from:
 - Scalp
 - Face
 - Neck
- Also receives deep venous tributaries – from structures like the thyroid gland
- In the root of the neck the **internal jugular vein** joins with **subclavian vein** to give the **brachiocephalic vein**
- Just above the point where they join is the inferior jugular bulb, which has valves to prevent backflow of blood when intrathoracic pressure is raised (e.g. lifting / straining)
- The brachiocephalic vein from each side run down behind the manubrium & join to form the **superior vena cava**

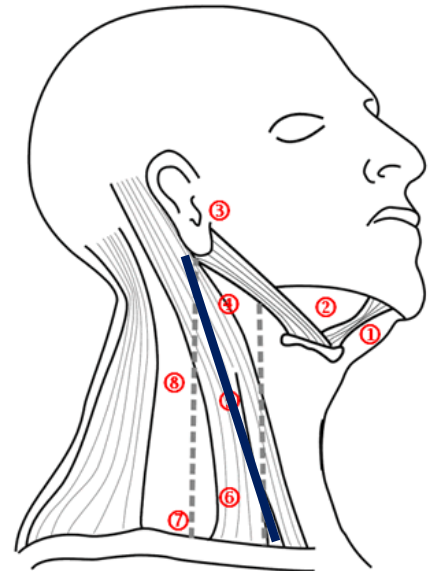
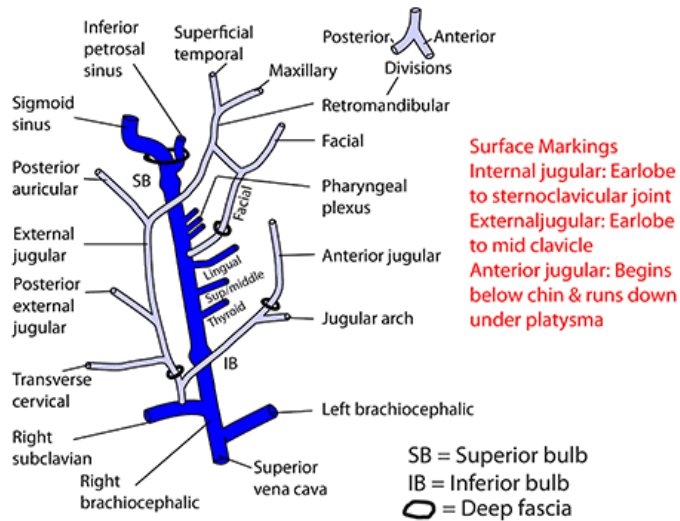


Surface markings of the IJV:

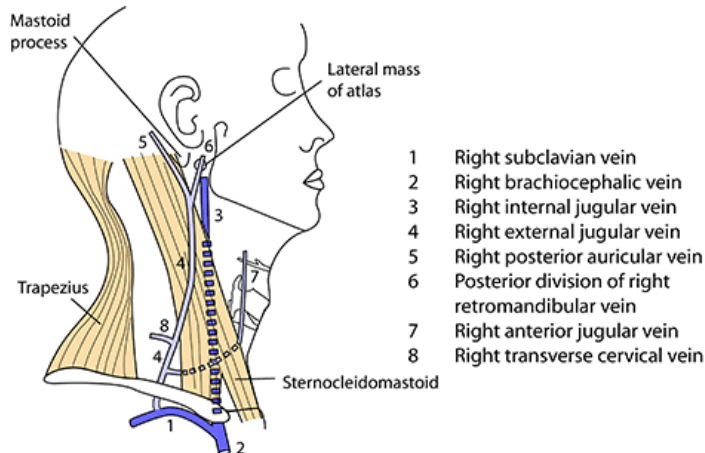
- Important to be able to locate IJV, as often the vein used to put catheters into the heart.
- Jugular foramen lies in front of the arch of the atlas at the base of the skull:
 - This point is between the **mastoid process** and the **tragus** of the ear when head is turned to the side.
- Vein then passes directly towards and behind the sternoclavicular joint

- At the level of the sternoclavicular joint, it lies in the groove between the 2 heads of the sternocleidomastoid.
- **Lymphatics** run along the vascular pathways in the neck
- LNs are interspersed along the lymphatics, especially those in association with the IJV

RIGHT INTERNAL & EXTERNAL JUGULAR VEINS



JUGULAR VEINS IN NECK



EXTERNAL JUGULAR VEIN

- Posterior division of the retromandibular vein + posterior auricular vein → EJV
- EJV is joined by:
 - Posteriorly: transverse cervical vein
 - Anteriorly: anterior jugular vein

CRANIAL NERVES IN THE NECK

- Several cranial nerves enter the neck through foramina in the base of the skull
- **Trigeminal nerve (V)** has 3 divisions
- The **mandibular division** passes down towards the mouth and mandible
- **Facial nerve (VII)** runs to the muscles of fascial expression
- Other cranial nerves leaving the skull base → neck include:
 - **Glossopharyngeal (IX)**
 - **Vagus (X)**
 - **Accessory (XI)**
 - **Hypoglossal (XII)**

Mandibular division (V)

- Division of trigeminal (V)
- Passes through **foramen ovale**
- Runs deep to the mandible
- Innervates structures in the mouth

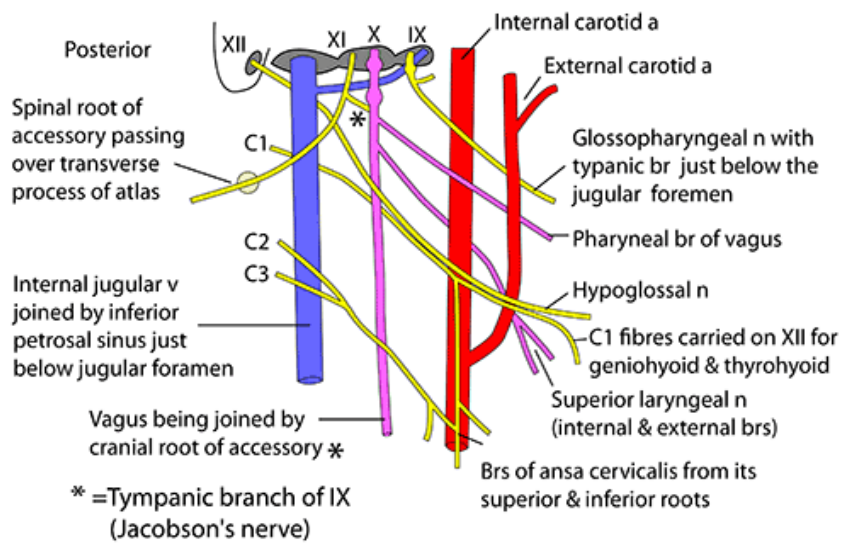
Facial nerve (VII)

- Passes through cavity of the ear and eventually leaves the skull through the **stylomastoid foramen** (between styloid process and mastoid process)
- Facial nerve then runs superficial to the mandible (through parotid)
- Innervates structures of the face

CN IX, X, XI, XII

- Cranial nerves **IX, X & XI** emerge together through the jugular foramen:
 - **Glossopharyngeal (IX)**
 - **Vagus (X)**
 - **Accessory (XI)**
- **Hypoglossal nerve (XII)** emerges from posterior cranial fossa through the anterior condylar fossa / hypoglossal canal
- The means of exit of all the above cranial nerves through the skull base ensures that they emerge close to the internal carotid artery and internal jugular vein.
- The nerves spread out from these vessels to reach their destinations as they move down the neck.
- Form relationships with the:
 - Carotid tree
 - Subclavian artery & branches
- → form **neurovascular bundles**

EXPLODED VIEW OF RIGHT JUGULAR FORAMEN



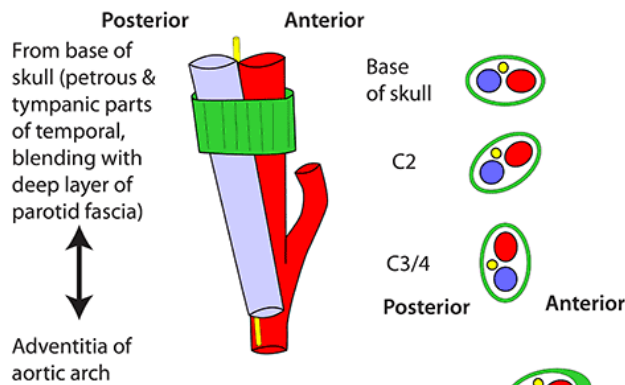
Note:

1. Hypoglossal nerve passes lateral to internal & external carotid arteries
2. Superior laryngeal nerve passes medial to both arteries
3. Glossopharyngeal & pharyngeal branch of vagus pass between them

Relation of jugular foramen cranial nerves to the carotids (ICA + ECA)

- **CN12 – outside both**
- **CN10 superior laryngeal – inside both**
- **CN9 + CN10 pharyngeal (i.e. the two (pharyngeal')) – between them**
- **CN10 then continues down in the carotid sheath**

CAROTID SHEATH



- It fuses with pretracheal fascia and the investing fascia under sternocleidomastoid
- The ansa cervicalis is in the carotid sheath over the internal jugular vein
- Escaping from the upper sheath are: Glossopharyngeal (IX), superior laryngeal Branch of vagus (X), spinal root of accessory (XI) and hypoglossal (XII) nerves

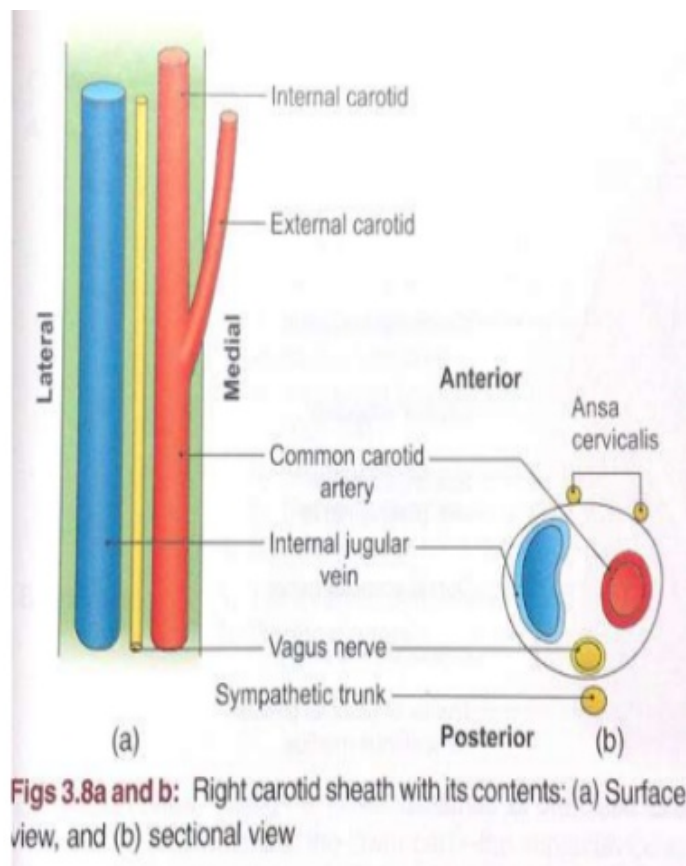


CONTENT

Internal jugular vein
laterally, common carotid artery (in the lower part) & internal carotid artery (in the upper part) medially, vagus nerve in b/w them in a posterior plane

Relations-

Anteriorly- ansa cervicalis
Posteriorly – sympathetic trunk



Figs 3.8a and b: Right carotid sheath with its contents: (a) Surface view, and (b) sectional view

- **Glossopharyngeal (IX)**

Motor:

- Stylopharyngeus

Sensory:

- Middle ear
 - Oropharynx
 - Posterior 1/3 of tongue (both general sensation and taste) – *not vallecula*
 - Baroreceptors and chemoreceptors of carotid body & sinus
 - Parasympathetic to the otic ganglion via lesser petrosal nerve
- Runs to the pharynx & posterior tongue Δ aims for the wall of the pharynx
 - 1. Leaves through jugular foramen
 - 2. Passes between internal and external carotid arteries
 - 3. Arrives at **middle constrictor muscle** of pharynx
 - Sensory nerve supply to oropharynx
 - 4. Continues lateral to the palatine tonsil in wall of oropharynx → tongue
 - Supplies posterior 1/3 of tongue
 - Fine branch of glossopharyngeal also travels down to bifurcation of the common carotid to supply the **carotid sinus & carotid body** (monitor BP and blood gas)

- **Vagus (X)**

- Enters neck through jugular foramen
- Down the neck it closely follows path of:
 - Internal carotid artery
 - Common carotid artery
 - Internal jugular vein
- Creates a great neurovascular bundle with these vessels
- The bundle is surrounded by loose CT – the **carotid sheath**
- Vagus runs down the sheath
- → runs in front of subclavian
- → enters thorax through superior aperture of thorax

Pharyngeal branch:

- Soon after leaving the skull the vagus gives off the **pharyngeal branch** – forms a meshwork on the front of the pharyngeal muscles.
 - Motor supply to the pharynx
 - Motor supply to the soft palate muscles (*except tensor palati*)
- Note that this vagus is actually a mixture of vagus and cranial accessory fibres (see below).
- The vagoaccessory pharyngeal branch contributes to the **pharyngeal plexus** on pharyngeal wall:
 - **Glossopharyngeal nerve CN9 – sensory**
 - **Pharyngeal branch (vagus + cranial accessory) CN10+11 – motor**
 - **Few sympathetic fibres**

Superior laryngeal branch:

- Given off by the vagus
- Superior laryngeal branch divides into:

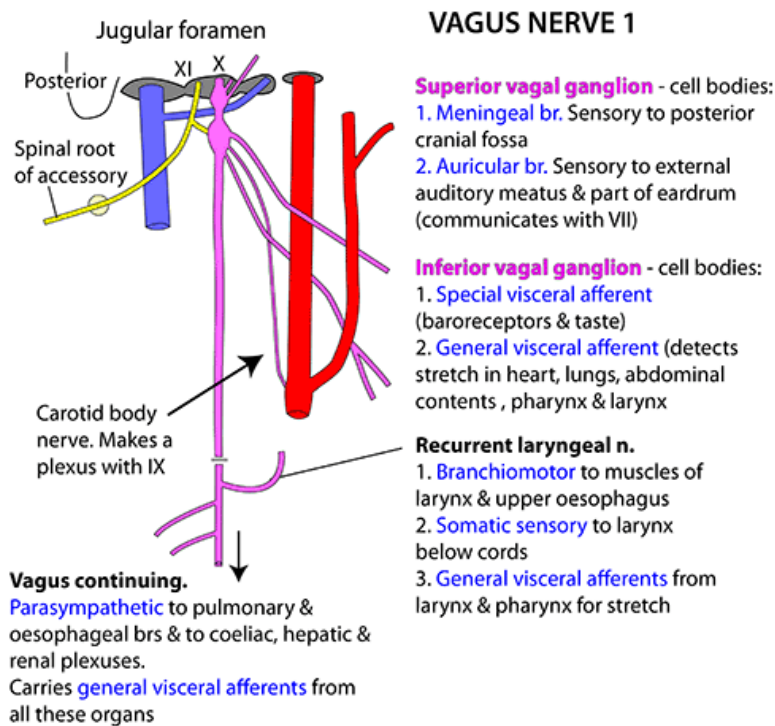
- **Internal laryngeal branch** – sensory: enters larynx by piercing membrane, sensory above cords.
 - **External laryngeal branch** – motor: supplies only the cricothyroid
- The superior laryngeal nerve follows the superior thyroid artery – forming a neurovascular bundle.

Right recurrent laryngeal nerve:

- Hooks around the subclavian artery
- Ascends with the inferior thyroid artery – another neurovascular bundle
- Enters larynx to supply the remainder of the laryngeal musculature + sensory below cords

Left recurrent laryngeal nerve:

- Arises in the thorax – hooks around the arch of the aorta
- Ascends into the neck
- Terminal portion of the left recurrent laryngeal nerve has the same relationship to the inferior thyroid artery as the right does.



Vagus arises from 8-10 rootlets on medulla. Associated nuclei are:

1. Dorsal nucleus of vagus.

General visceral efferent (parasympathetic) to smooth muscle of bronchi, heart, oesophagus, intestine to transverse colon.

General visceral afferent (sensory) from above organs.

2. Nucleus ambiguus. **Branchiomotor** supply to striated muscle of palate, pharynx, larynx & upper oesophagus (these fibres originate from the cranial root of accessory).

3. Nucleus solitarius. **Sensory** for baroreceptors and taste.

4. Spinal nucleus of trigeminal nerve. All **somatic sensory** fibres in vagus end here.

- **Accessory (XI)**

- Arises from 2 roots:

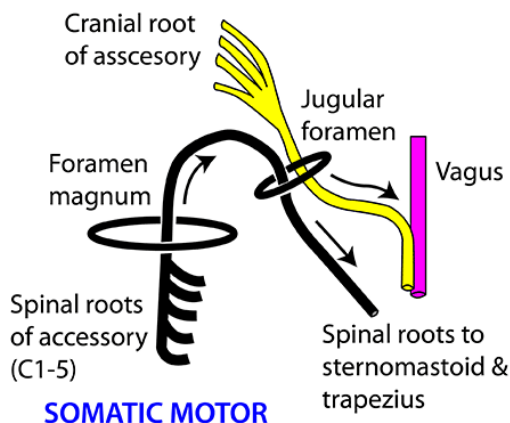
- **Cranial root** (from brain just above vagus – joins vagus)
- **Spinal root** (from upper spinal cord)
- The 2 roots converge next to vagus just before they leave the skull through jugular foramen.
- Having exited the skull the cranial and spinal roots once again separate.
- The cranial root fibres join the vagus
- The spinal root fibres carry on as a separate nerve
 - Enters 2 large muscles:
 - **Sternocleidomastoid**
 - **Trapezius**

- ✚ It is Δ clear that the vagus nerve reaching the neck & larynx are actually a mixture of **vagoaccessory fibres** – vagal and cranial accessory fibres
- ✚ However, by the time the vagus reaches the thorax, all the cranial accessory fibres have been used up (in supplying pharynx, larynx & soft palate).
- ✚ Δ vagus in the thorax is 'true' vagus (not a mixture as in the neck)

XI ACCESSORY NERVE

(Accessory to vagus)

BRANCHIOMOTOR



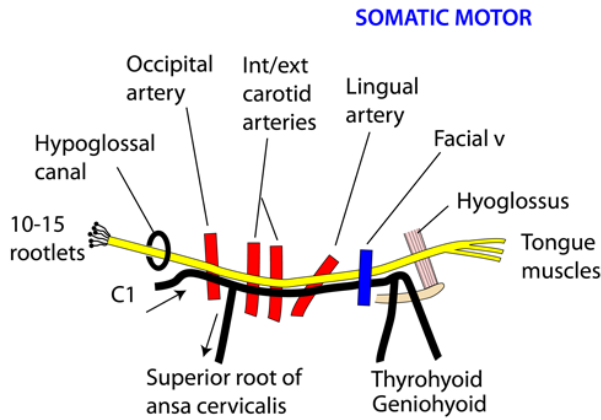
SOMATIC MOTOR

Branchiomotor = motor to muscles of head + neck

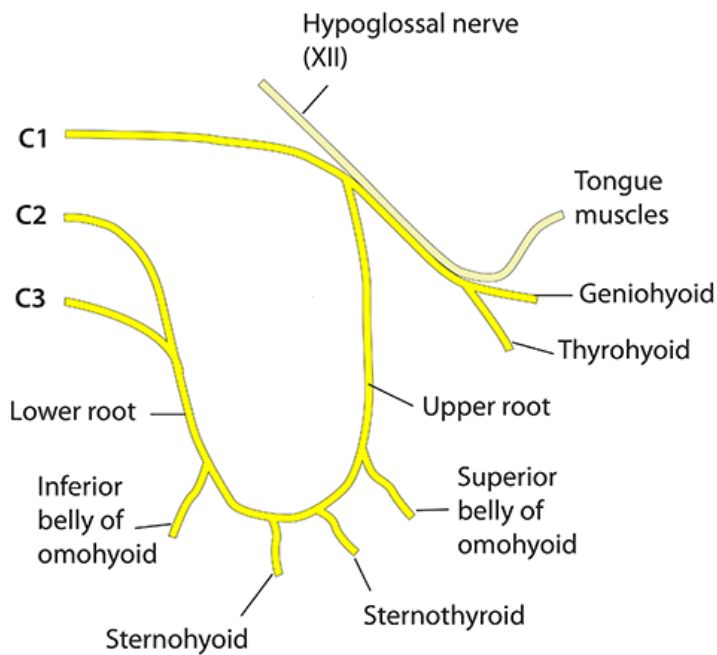
- **Hypoglossal nerve (XII)**
 - Supplies nearly all musculature of the tongue (except palatoglossus)
 - Δ passes deep to the muscles of the floor of the mouth.
 - Travels in a neuromuscular bundle with lingual artery
 - Begins as the *most medial* cranial nerve exiting the skull – passing through the hypoglossal canal.
 - But then takes a wide sweeping course, outside both internal, external carotids & the lingual artery.
 - A few fibres of C1 ventral ramus 'hitch-hike' along the hypoglossal nerve for a short while – before leaving it as a slender filament, the **superior root of the ansa cervicalis**.
 - Fibres from C2 & C3 ventral rami form a separate **inferior root of ansa cervicalis**

- The superior and inferior roots of the ansa cervicalis join and form a delicate U-shaped loop on the common carotid and IJV.
- Supplies some of muscles of front of neck.

XII HYPOGLOSSAL NERVE



ANSA CERVICALIS



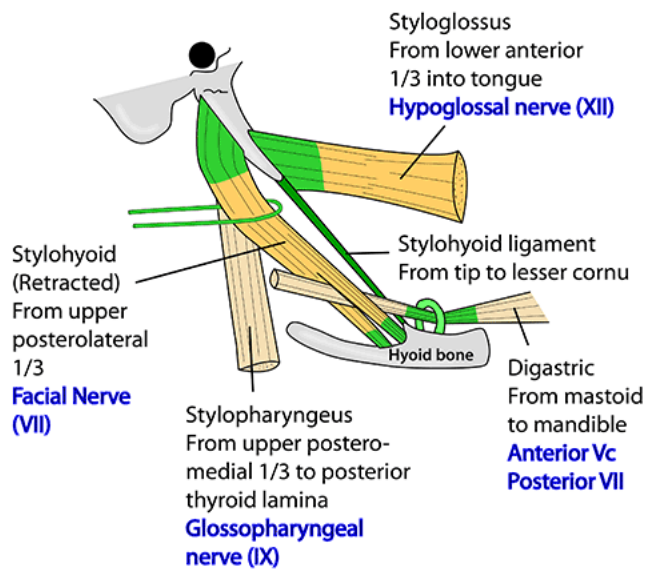
Nerve	Foramen	Vessel accompanying	Innervation
Mandibular (V)	Foramen ovale		Structures in mouth
Glossopharyngeal (IX)	Jugular foramen	(stylopharyngeus muscle)	Sensory to oropharynx Posterior 1/3 of tongue Carotid body & sinus
Vagus (X)	Jugular foramen	Coarotid sheath (IC, CC, IJV)	

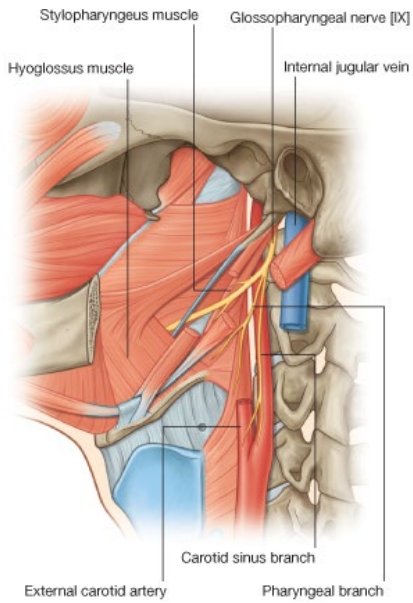
<i>Pharyngeal branch</i> (vagoaccessory) <i>Superior laryngeal:</i> <ul style="list-style-type: none"> • Internal laryngeal • External laryngeal <i>Recurrent laryngeal</i>		 Superior thyroid artery Inferior thyroid artery	Motor to pharynx & soft palate (pharyngeal plexus) Sensory above cords Motor to cricothyroid Sensory below cords Motor to larynx
Accessory (XI) <i>Cranial root</i> <i>Spinal root</i>	Jugular foramen		Joins vagus Motor to sternocleidomastoid & trapezius.
Hypoglossal (XII)	Hypoglossal canal	Lingual artery	Motor to nearly all musculature of the tongue (not pg)

Muscles of the deep side of the neck:

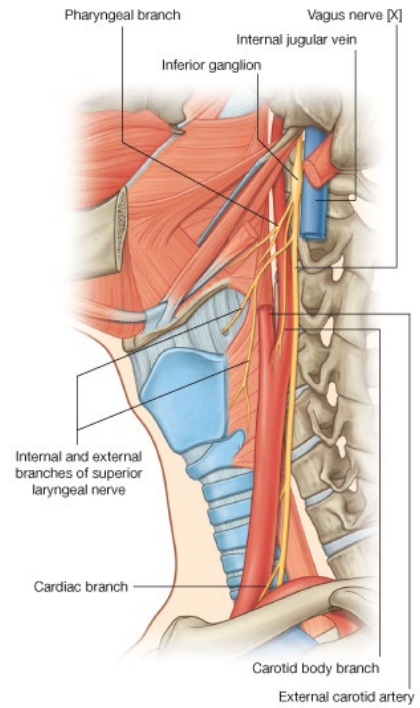
- **3 small styloid muscles** weave through the carotid tree
- Their origin is the **styloid process** on the base of the skull
 - **Styloglossus** is destined for the tongue and is the deepest muscle
 - **Stylopharyngeus** passes with glossopharyngeal nerve (IX)
 - Passes between external and internal carotids
 - → passes over upper border of middle constrictor
 - Becomes a longitudinal muscle of the pharynx
 - **Stylohyoid** is most superficial
 - Runs around outside of carotid tree (like hypoglossal nerve) to insert into hyoid bone.

**RIGHT STYLOID PROCESS
MUSCLE AND LIGAMENT ATTACHMENTS
LATERAL VIEW**

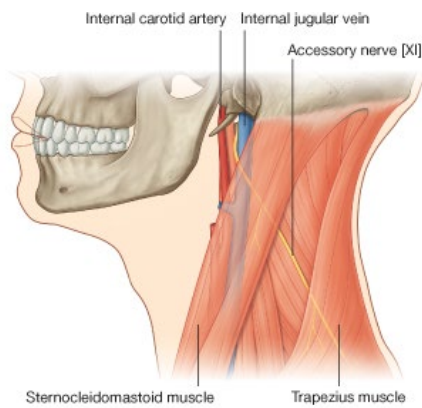




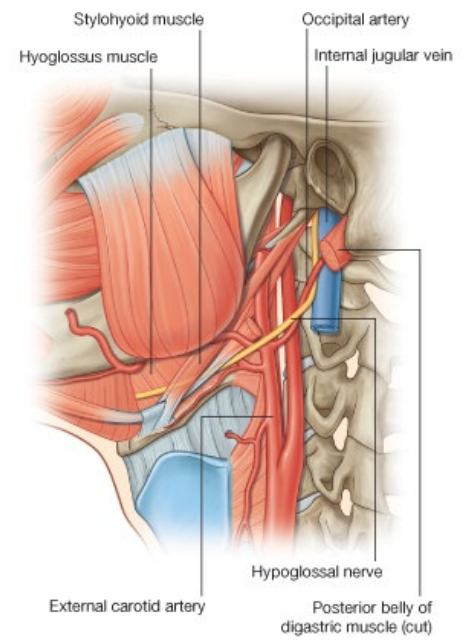
Glossopharyngeal (IX)



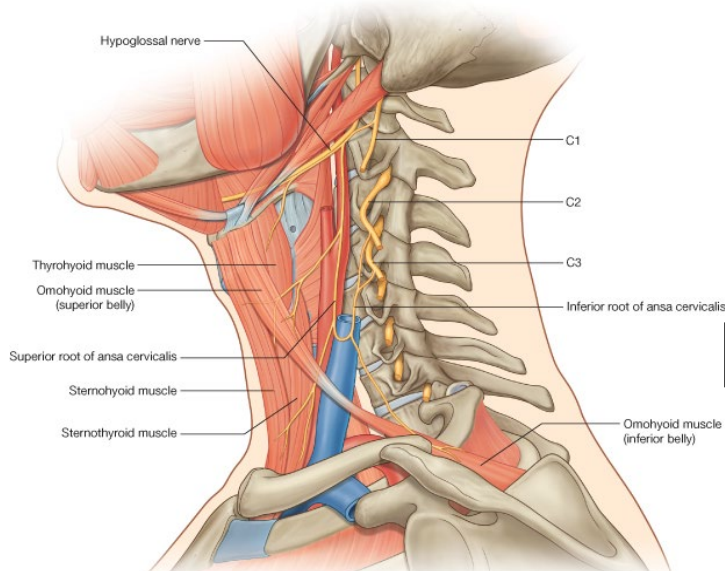
Vagus (X)



Accessory (XI)



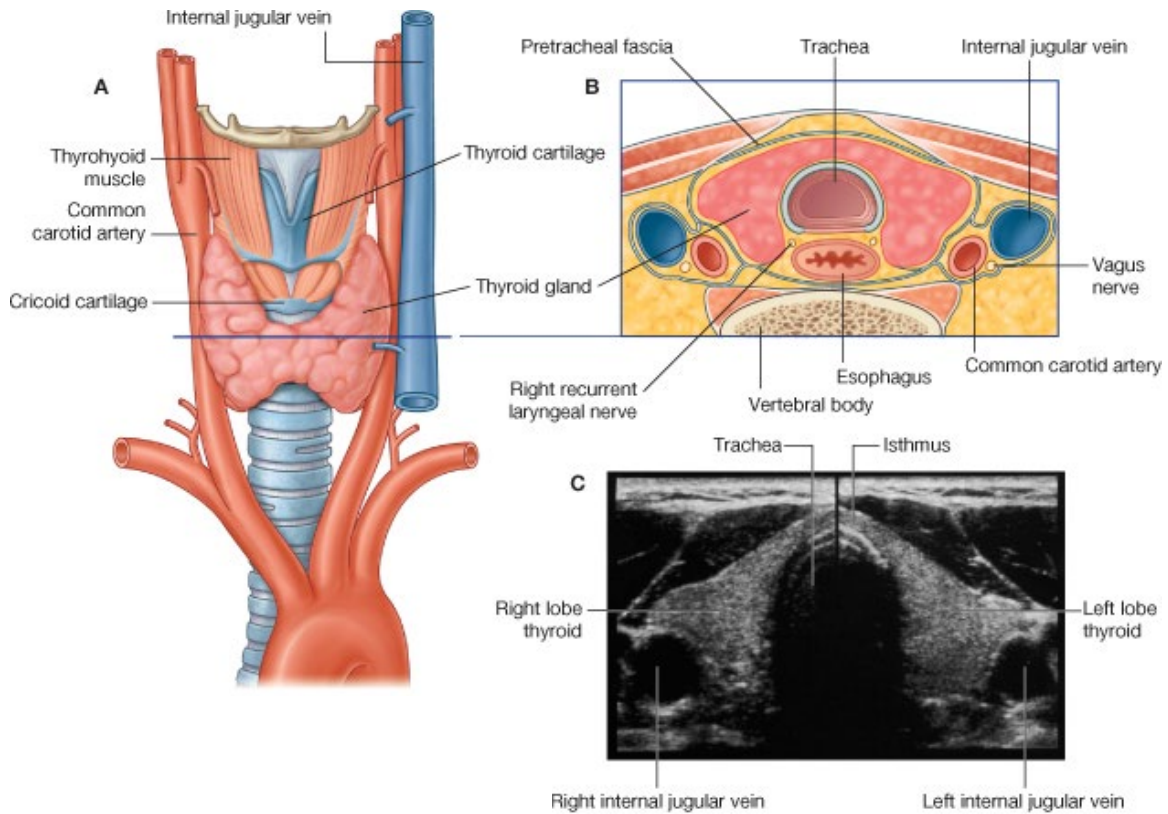
Hypoglossal (XII)



Ansa cervicalis

THYROID GLAND

- Important endocrine gland
- Composed of 2 **lateral lobes**
- Lies on each side of the larynx and upper tracheal cartilages
- Overlaps the carotid sheaths
- Each lobe is conical in shape
- The 2 lobes of the thyroid are joined in front of the trachea by an **isthmus** of thyroid tissue.
- The lower medial surface of each lobe is moulded against the trachea and oesophagus
- The recurrent laryngeal nerve lies in the groove between these structures.
- The upper medial surface of each lobe is placed against the **cricoid** and **thyroid cartilages**

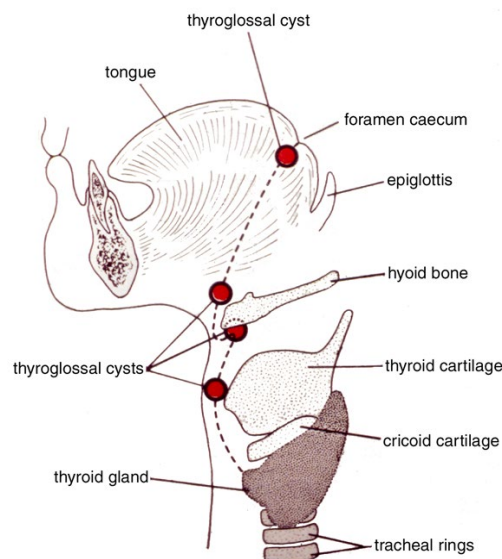


- 2 small **parathyroid glands** are embedded in the posterior surface of each lobe (i.e. 2 in each lobe).
- Ductless endocrine glands
- Responsible for maintenance of body calcium levels
- **Superior parathyroid gland** has a relatively constant position in the middle of the posterior surface of thyroid lobe.

- **Inferior parathyroid gland** lies near the inferior pole of the gland or even amongst structures below the lobe
 - Because the inferior parathyroid develops in the **thymus gland**
 - As the thymus descends into the anterior mediastinum during development, it drags the inferior parathyroid with it.
 - Δ final position of inferior parathyroid can be anywhere along the descent.

Embryological origins of parathyroid glands:

- Superior parathyroid: 4th pharyngeal pouch
 - Inferior parathyroid: 3rd pharyngeal pouch
 - **Isthmus** of the thyroid lies over the 3rd & 4th tracheal rings
 - **Pyramidal lobe** is a tongue of thyroid tissue which often extends upwards from the upper border of the isthmus towards the hyoid bone.
 - The pyramidal lobe may be attached to the hyoid bone by a small muscular slip – **levator glandulae thyroidae** – although this muscle is sometimes no more than a strand of fibrous tissue (it is a developmental remnant).
 - The thyroid develops from the floor of the embryological pharynx
 - Site of origin can be seen in an adult at the back of the tongue as a small depression – **foramen caecum**.
 - Cells from the foramen caecum multiply → descend into neck → pass in front of hyoid bone → loop up behind the hyoid bone → descend to final position.
 - Sometimes small clusters of thyroid cells are found in the midline of the adult in the pathway of this descent – presenting as small midline swellings in neck.
 - If glandular thyroid tissue develops in foramen caecum of tongue, known as **lingual thyroid**.
- See D&P page 54*



- Lobes of thyroid + isthmus are enclosed in a sheet of fascia – the **pretracheal fascia**
- The pretracheal fascia is attached to the thyroid cartilage and cricoid cartilage of larynx.
 - Because of this, the thyroid gland moves up and down with the larynx on swallowing.
- Pretracheal fascia binds at the sides with the carotid sheaths

- Below, the pretracheal fascia binds with the fascia of the arch of aorta

Blood supply to thyroid gland:

- **Superior thyroid artery:**
 - Branch of external carotid
 - Runs in close relation with external superior laryngeal nerve
- **Inferior thyroid artery:**
 - Branch of subclavian artery
 - Passes deeply, *behind* the carotid sheath, before dividing into the thyroid gland.
 - Runs in close relation with the recurrent laryngeal nerve.
- In thyroid surgery, care must be taken:
 - When ligating superior thyroid artery – not to damage external laryngeal nerve
 - When ligation inferior thyroid artery – not to damage recurrent laryngeal nerve.
- **Thyroid ima:**
 - A vessel which only arises occasionally (rare)
 - May arise from any of:
 - Arch of aorta
 - Brachiocephalic artery
 - Left common carotid
- All 3 of these thyroid arteries freely anastomose on the surface of the thyroid in the space between the pretracheal fascial sheath and the true capsule of the gland.

Venous drainage:

- Blood is collected in a venous network on the surface of the gland
- → drain through 3 pairs of veins
 - **Superior thyroid vein**
 - **Middle thyroid vein**
 - **Inferior thyroid vein(s)**
- Superior and middle → internal jugular vein
- Inferior thyroid vein descends through superior aperture of the thorax → brachiocephalic veins behind the manubrium

Superior thyroid artery = external carotid

Superior + middle thyroid veins = internal jugular

- **Lymphatics** along the thyroid follow the blood vessels and drain into LNs around:
 - Carotid sheath
 - Root of neck
 - Upper mediastinal LNs in thorax (a few)

