كلية المستقبل الجامعة قسم هندسة الطب الحياتي

المرحلة الثانية

HEAD & NECK

ANATOMY

(L4)

Head and Neck Vessels

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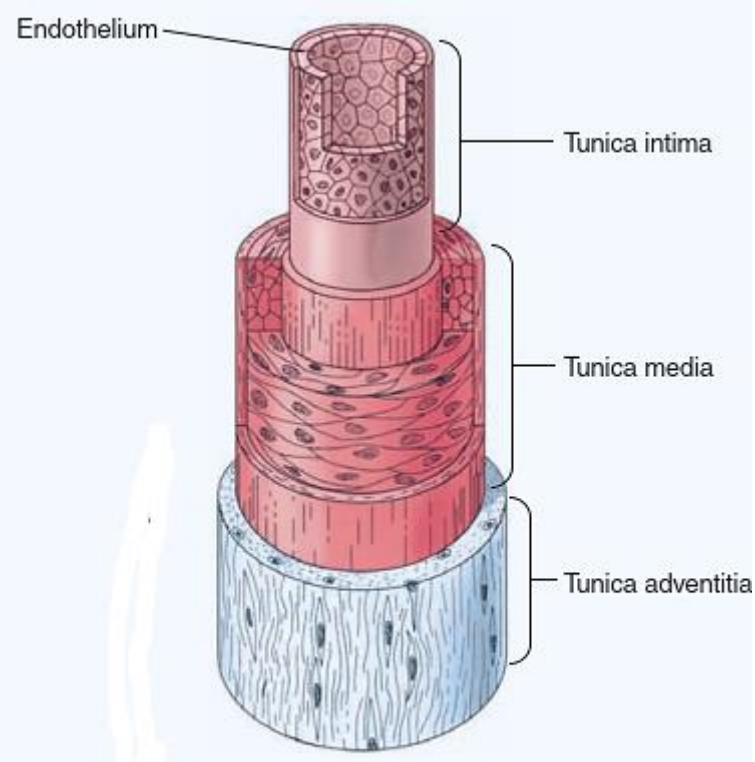
Head and Neck Vessels

The head and neck region obtain the majority of its blood supply via the carotid and also vertebral arteries. The carotid arteries are the primary vessels supplying blood to the brain and face.

Like most of the vascular system throughout the body, histologically, the carotid arteries are made up of three layers – the inner layer "tunica intima," the middle layer "tunica media," and the outer layer "tunica adventitia." The tunica intima consists of endothelium supported by a fragile elastic and also a collagenous layer of variable thickness. Smooth muscle comprises the tunica media, and it is responsible for changing the diameter of the blood vessel to regulate blood flow and blood pressure. The tunica adventitia attaches the carotid vessel to the surrounding tissue.



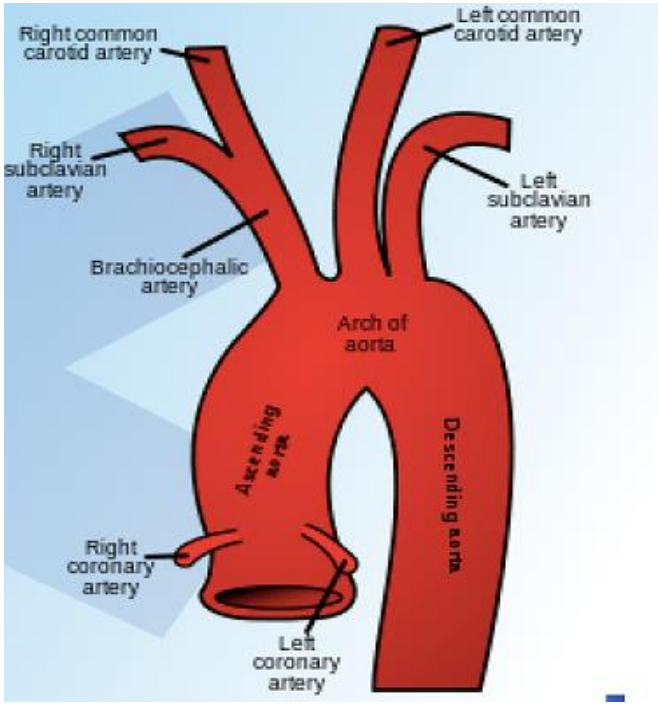
General structure of the blood vessel. The artery shown here consists of three major layers, the tunica intima, tunica media, and tunica adventitia.

Type of Vessel	Vessel Wall	Actions
Artery	Three-layer thick wall (endothelial lining, middle smooth muscle and elastic connective tissue layer, and outer connective tissue layer)	Carries relatively high-pressure blood from the heart to the arterioles
Arteriole	Three-layer thinner wall (smaller arterioles have an endothelial lining, some smooth muscle tissue, and a small amount of connective tissue)	Helps control blood flow from arteries to capillaries by vasoconstriction or vasodilation
Capillary	One layer of squamous epithelium	Has a membrane allowing nutrients, gases, and wastes to be exchanged between blood and tissue fluid
Venule	Thinner wall than arterioles, with less smooth muscle and elastic connective tissue	Connects capillaries to veins
Vein	Thinner wall than arteries but similar layers; poorly developed middle layer; some have flaplike valves	Carries relatively low-pressure blood from venules to the heart; valves prevent blood backflow; veins serve as blood reservoirs

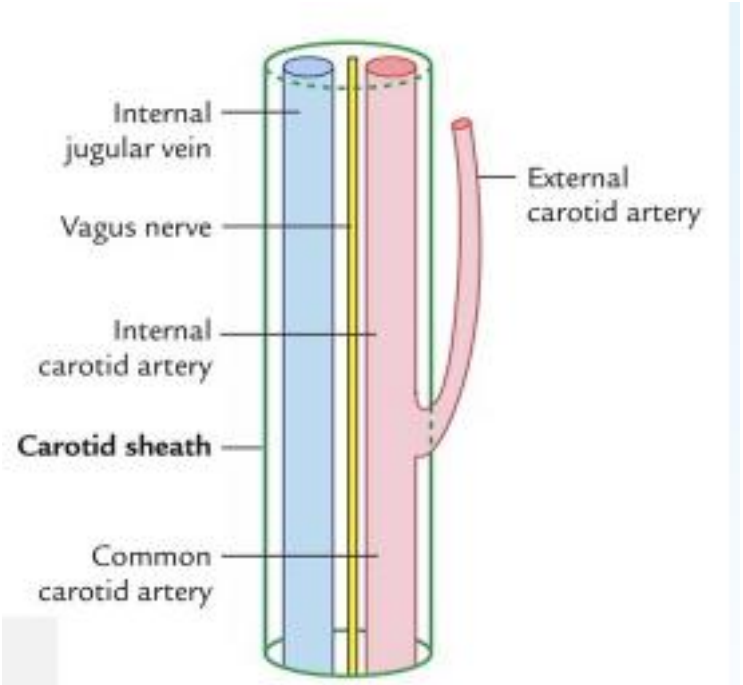
The **right common** carotid artery arises from a **bifurcation** of the **brachiocephalic trunk** (the right subclavian artery is the other branch).

The left common carotid artery branches directly from the **arch of aorta**. The left and right common carotid arteries ascend up the neck, **lateral** to the trachea and the oesophagus. They do not give off any branches in the neck.

(The Origin of CCAs)



The common carotid arteries originate posterior to the sternoclavicular joints and in the neck, they are contained within the carotid sheath posterior to the sternocleidomastoid muscle. At the location of the upper border of the thyroid cartilage (typically at the level of the fourth or fifth cervical vertebra), the common carotid arteries bifurcate into the ECA and ICA. This bifurcation point is clinically significant as it serves as a point for the location of the "carotid body," a chemoreceptor, and the "carotid sinus," a baroreceptor. The carotid body chemoreceptor is sensitive to decreased PO2, increased PCO2, and decreased pH of blood, and is responsible for alerting the brain to change the respiratory rate. The carotid sinus baroreceptors respond to changes in the stretch of the blood vessel and are responsible for detecting changes and maintaining blood pressure. After its division, the ECA exits the sheath to provide oxygenated blood to the face and neck, while the ICA continues in the carotid sheath to enter the carotid canal within the temporal bone.



(Carotid Sheath Contents)

The **external carotid artery** supplies the areas of the head and neck external to the cranium.

The artery ends within the **parotid gland** by dividing into the superficial temporal artery and the maxillary artery. It gives rise to six branches in total:

- Superior thyroid artery
- Lingual artery
- Facial artery
- Ascending pharyngeal artery
- Occipital artery
- Posterior auricular artery

The facial, maxillary and superficial temporal arteries are the major branches of note..

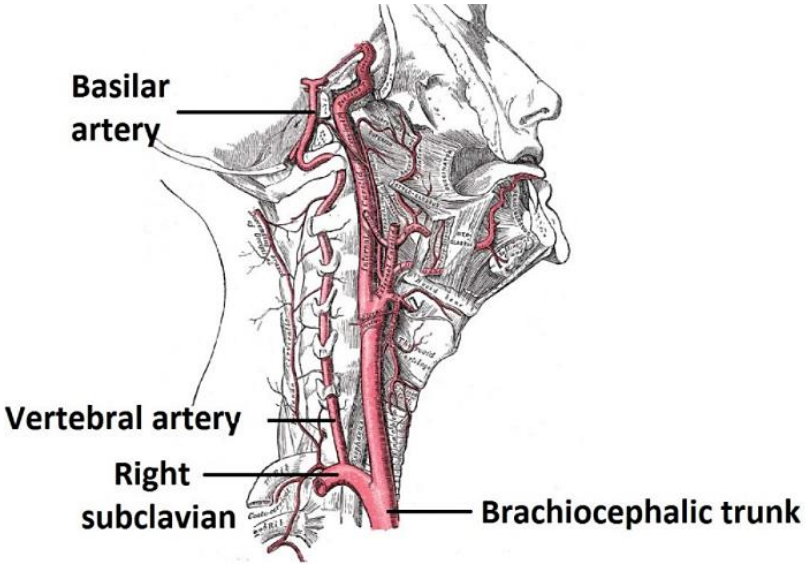
Internal Carotid Artery

The internal carotid arteries do not supply any structures in the neck, entering the cranial cavity via the **carotid canal** in the petrous part of the **temporal bone**. Within the cranial cavity, the internal carotid artery supplies:

- The brain
- Eyes
- Forehead

The **vertebral arteries** are paired vessels which arise from the subclavian arteries.They ascend the posterior aspect of the neck, passing through holes in the transverse processes of the cervical vertebrae (known as foramen transversarium).

The vertebral arteries enter the cranium via the **foramen magnum** and converge to form the basilar artery – which continues to supply the brain. The vertebral arteries do not supply any branches to the neck or other extra-cranial structures.



Other Arteries of the Neck

The neck is supplied by arteries other than the carotids. The right and left subclavian arteries give rise to the **thyrocervical trunk.** From this trunk, several vessels arise, which go on to supply the neck.

- The first branch of the thyrocervical trunk is the **inferior thyroid artery.** It supplies the thyroid gland
- The **ascending cervical artery** arises from the inferior thyroid artery.
- The **transverse cervical artery** is the next branch off the thyrocervical trunk.
- Lastly, the **suprascapular artery** arises. It supplies the posterior shoulder area.

The central nervous system, like any system of the body, requires constant oxygenation and nourishment. The brain has a particularly high oxygen demand – at rest it represents one fifth of the body's total oxygen consumption. It

is also very sensitive to oxygen deprivation, with ischemic cell death resulting within minutes.

There are two paired arteries which are responsible for the blood supply to the brain; the **vertebral arteries**, and the **internal carotid arteries.** These arteries arise in the neck, and ascend to the cranium.

Within the cranial vault, the terminal branches of these arteries form an anastomotic circle, called the **Circle of Willis**. From this circle, branches arise which supply the majority of the cerebrum.

Internal Carotid Arteries

The internal carotid arteries (ICA) originate at the bifurcation of the left and right **common carotid arteries**, at the level of the fourth cervical vertebrae (C4).

They move superiorly within the carotid sheath, and enter the brain via the **carotid canal** of the temporal bone. They do not supply any branches to the face or neck.

Once in the cranial cavity, the internal carotids pass anteriorly through the **cavernous sinus**. Distal to the cavernous sinus, each ICA gives rise to:

- **Ophthalmic artery** – supplies the structures of the orbit.
- **Posterior communicating artery** – acts as an anastomotic 'connecting vessel' in the Circle of Willis (see 'Circle of Willis' below).
- **Anterior choroidal artery** – supplies structures in the brain important for motor control and vision.
- **Anterior cerebral artery** – supplies part of the cerebrum.

The internal carotids then continue as the **middle cerebral artery,** which supplies the lateral portions of the cerebrum.

The right and left vertebral arteries arise from the **subclavian** arteries, medial to the anterior scalene muscle. They then ascend the posterior aspect of the neck, through holes in the **transverse processes** of the cervical vertebrae, known as **foramen transversarium**.

The vertebral arteries enter the cranial cavity via the **foramen magnum.** Within the cranial vault, some branches are given off:

- **Meningeal branch.**
- **Anterior and posterior spinal arteries**.
- **Posterior inferior cerebellar artery**.

After this, the two vertebral arteries converge to form the **basilar artery**. Several branches from the basilar artery originate here, and go onto supply the cerebellum and pons. The basilar artery terminates by bifurcating into the posterior cerebral arteries.

(Arteriogram of the arterial supply to the CNS)

Arterial Circle of Willis

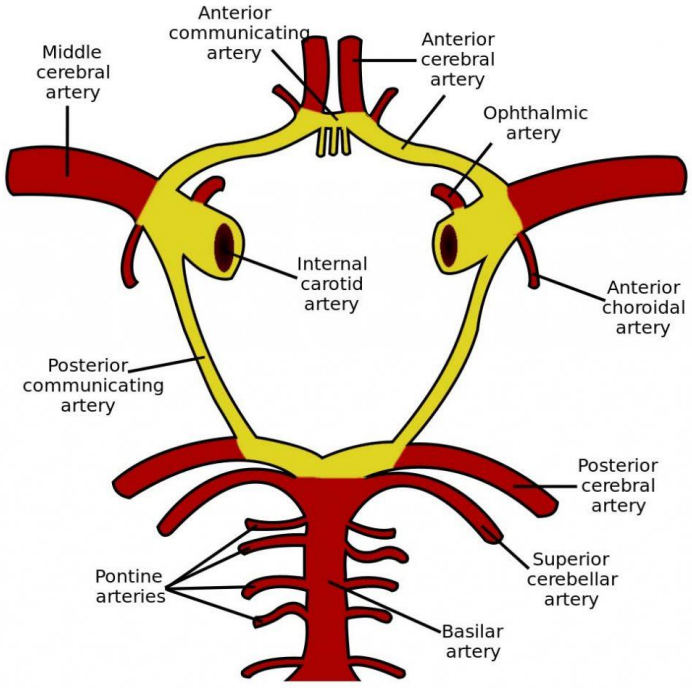
The terminal branches of the vertebral and internal carotid arteries all anastomose to form a circular blood vessel, called the **Circle of Willis**.

There are three main (paired) constituents of the Circle of Willis:

- **Anterior cerebral arteries** – terminal branches of the internal carotid arteries.
- **Internal carotid arteries** – located immediately proximal to the origin of the middle cerebral arteries.
- **Posterior cerebral arteries** – terminal branches of the basilar artery

To complete the circle, two 'connecting vessels' are also present:

- **Anterior communicating artery** – connects the two anterior cerebral arteries.
- **Posterior communicating artery** – branch of the internal carotid, this artery connects the ICA to the posterior cerebral artery



(Circle of Willis)

Venous Drainage of the Head and Neck

The veins of the head and neck collect deoxygenated blood and return it to the heart. Anatomically, the venous drainage can be divided into three parts:

- **Venous drainage of the brain and meninges**: Supplied by the dural venous sinuses.
- **Venous drainage of the scalp and face**: Drained by veins synonymous with the arteries of the face and scalp. These empty into the internal and external jugular veins.
- **Venous drainage of the neck**: Carried out by the anterior jugular veins.

Jugular Veins

There are three main jugular veins – external, internal and anterior. They are ultimately responsible for the venous drainage of the whole head and neck.

External Jugular Vein

The external jugular vein and its tributaries supply the majority of the external face. It is formed by the union of two veins:

- Posterior auricular vein – drains the area of scalp superior and posterior to the outer ear.
- Retromandibular vein (posterior branch) – itself formed by the maxillary and superficial temporal veins, which drain the face.

These two veins combine immediately posterior to the angle of mandible, and inferior to the outer ear, forming the external jugular vein.

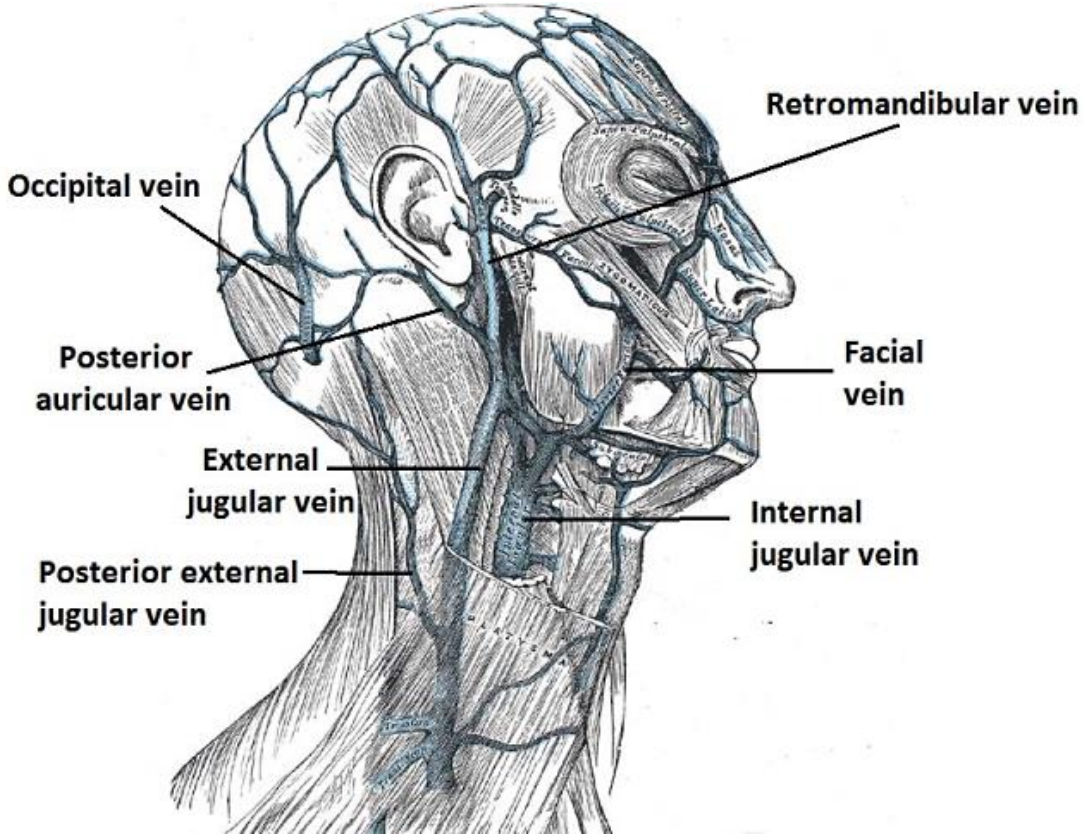
After formation, the external jugular vein descends down the neck within the superficial fascia.

In the root of the neck, the vein passes underneath the clavicle, and terminates by draining into the subclavian vein. Along its route down the

neck, the EJV receives tributary veins – posterior external jugular, transverse cervical and suprascapular veins.

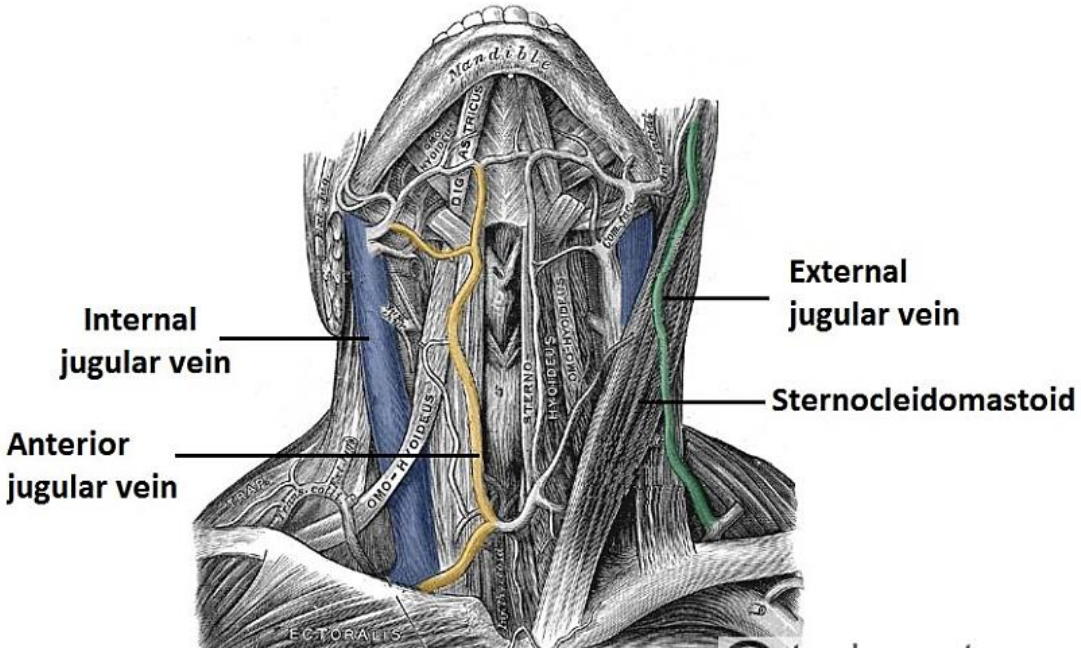
Anterior Jugular Veins

The anterior jugular veins vary from person to person. They are paired veins, which drain the anterior aspect of the neck. Often they will communicate via a jugular venous **arch**. The anterior jugular veins descend down the midline of the neck, emptying into the subclavian vein.



Internal Jugular Vein

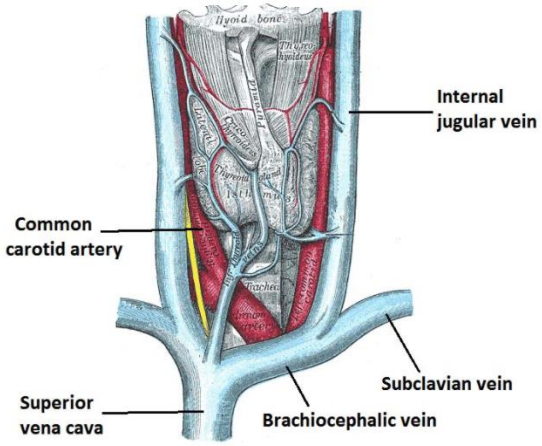
The **internal jugular vein** (IJV) begins in the cranial cavity as a continuation of the sigmoid sinus. It exits the skull via the jugular foramen.



In the neck, the internal jugular vein descends within the **carotid sheath**, deep to the sternocleidomastoid muscle and lateral to the common carotid artery. At the base of the neck, posteriorly to the sternal end of the clavicle, the IJV combines with the **subclavian vein** to form the brachiocephalic vein. During its descent down the neck, the internal jugular vein receives blood from the **facial**, **lingual**, **occipital**, **superior** and **middle** thyroid veins.

Dural Venous Sinuses

The dural venous sinuses are spaces between the **periosteal** and **meningeal** layers of dura mater, which are lined by **endothelial** cells. They collect venous blood from the veins that drain the brain and bony skull, and ultimately drain into the internal jugular vein.



Lymphatic Drainage of the Head and Neck

The lymphatic system functions to drain tissue fluid, plasma proteins and other cellular debris back into the blood stream, and is also involved in immune defence. Once this collection of substances enters the lymphatic vessels, it is known as **lymph.** Lymph is subsequently filtered by lymph nodes and directed into the venous system.

Lymphatic Vessels

The lymphatic vessels of the head and neck can be divided into two major groups; superficial vessels and deep vessels.

Superficial Vessels

The superficial vessels drain lymph from the scalp, face and neck into the superficial ring of lymph nodes at the junction of the neck and head.

Deep Vessels

The deep lymphatic vessels of the head and neck arise from the deep cervical lymph nodes. They converge to form the left and right jugular lymphatic trunks:

- Left jugular lymphatic trunk – combines with the thoracic duct at the root of the neck. This empties into the venous system via the left subclavian vein.
- Right jugular lymphatic trunk – forms the right lymphatic duct at the root of the neck. This empties into the venous system via the right subclavian vein.

Lymph Nodes

The lymph nodes of the head and neck can be divided into two groups; a superficial ring of lymph nodes, and a vertical group of deep lymph nodes.

Superficial Lymph Nodes

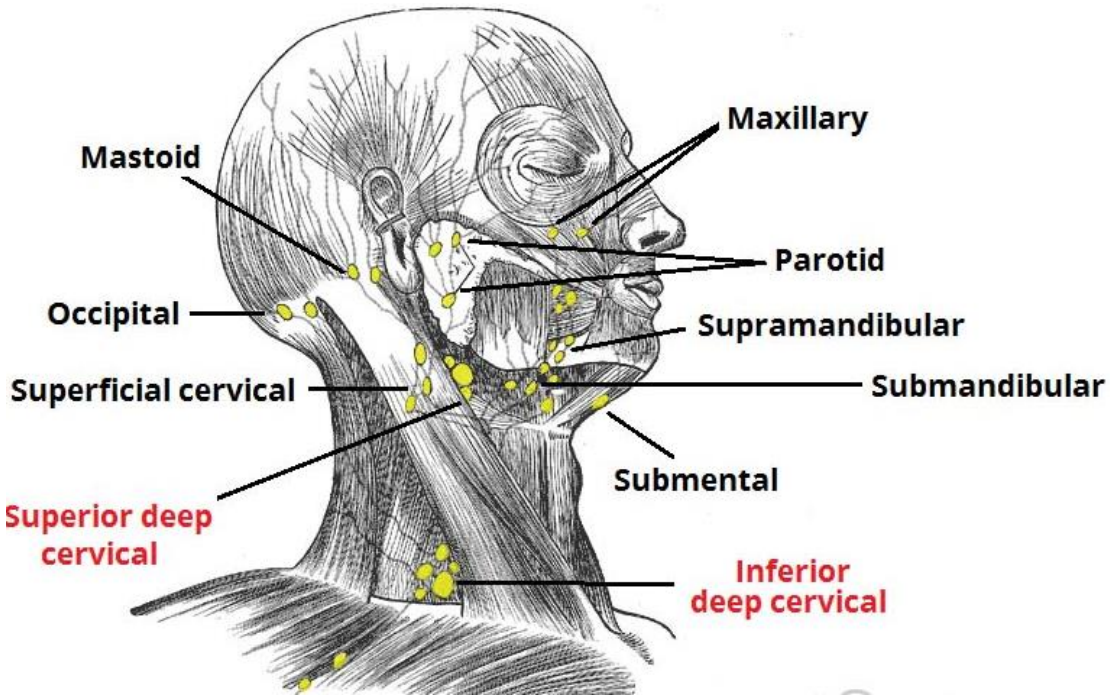
The superficial lymph nodes of the head and neck receive lymph from the scalp, face and neck. They are arranged in a ring shape; extending from underneath the chin, to the posterior aspect of the head. They ultimately drain into the deep lymph nodes.

- Occipital: There are usually between 1-3 occipital lymph nodes. Mastoid: There are usually 2 mastoid lymph nodes, which are also called the post-auricular lymph nodes.
- Pre-auricular: There are usually between 1-3 pre-auricular lymph nodes.
- Parotid: The parotid lymph nodes are a small group of nodes located superficially to the parotid gland.
- Submental: These lymph nodes are located superficially to the mylohoid muscle.
- Submandibular: There are usually between 3-6 submandibular nodes. They are located below the mandible.
- Facial: This group comprises the maxillary/infraorbital, buccinator and supramandibular lymph nodes.

- Superficial Cervical: The superficial cervical lymph nodes can be divided into the superficial anterior cervical nodes and the posterior lateral superficial cervical lymph nodes.

Deep Lymph Nodes

The deep (cervical) lymph nodes receive all of the lymph from the head and neck – either directly or indirectly via the superficial lymph nodes. They are organised into a vertical chain, located within close proximity to the **internal jugular vein** within the carotid sheath. The efferent vessels from the deep cervical lymph nodes converge to form the **jugular lymphatic trunks**.



(The superficial and deep lymph nodes of the head and neck)

Lymphatics of the Brain

It was thought that lymphatics were absent from the brain until in 2015, scientists located lymphatic vessels in the brains of mice and subsequently humans. Work is underway to determine and describe the lymphatic vessels involved.

Waldeyer's Ring

Waldeyer's tonsillar ring refers to the collection of lymphatic tissue surrounding the superior pharynx. This lymphatic tissue responds to pathogens that may be ingested or inhaled. The tonsils that make up the ring are as follows:

- Lingual tonsil – located on the posterior base of the tongue to form the antero-inferior part of the ring.
- Palatine tonsils – located on each side between the palatoglossal and palatopharyngeal arches. These are the common 'tonsils' that can be seen within the oral cavity. They form the lateral part of the ring.
- Tubal tonsils – these are located where each Eustachian tube opens into the nasopharynx and form the lateral part of the ring.
- Pharyngeal tonsil – also called the nasopharyngeal/adenoid tonsil, located in the roof of the nasopharynx, behind the uvulva and forms the postero-superior part of the ring