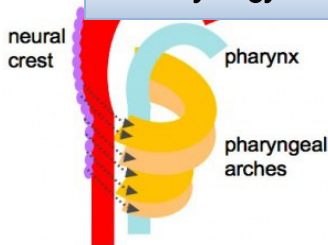


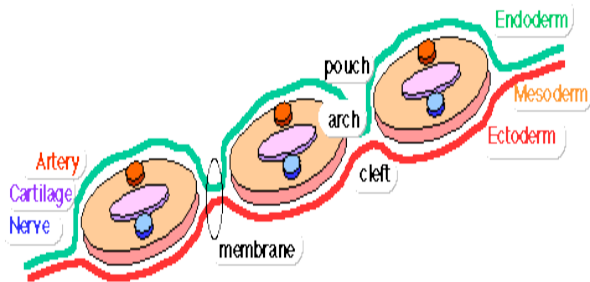
Embryology of the head and neck



the 1st 8th weeks constitute the period of **greatest** embryonic development of the head & neck

Pharyngeal/Branchial apparatus:

1. Pharyngeal **arch** (#6)
- 2.



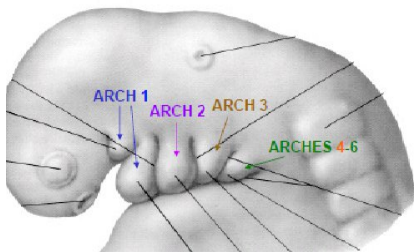
Pharyngeal **cleft** (#6)

3. Pharyngeal **pouch** (#6)
4. Pharyngeal **membrane**

Pharyngeal apparatus consists of all 3 trilaminar embryo layers:

1. Cleft (externally): Ectoderm
2. Arch: Mesoderm & neural crest
3. Pouch (internally): endoderm

1- The pharyngeal / branchial arch:



Series of **externally** visible tissue bands lying under the early brain over the **ventrolateral** surface of the head and neck region

Starts to form in the 4th week

In humans, 6 arches form:

The 5th arch do not form or degenerates rapidly (1,2,3,4 and 6)

The 4th and 6th arch fuses

So only four are **externally** visible on the embryo.

Each arch has own Cartilage, Nerve, muscle, artery (= **aortic arch artery**)

The nerves are located anterior to the arteries except in the 5th or it is called the 6th cartilage

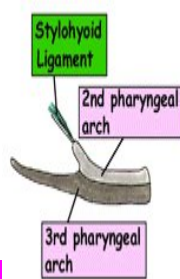
Each nerve innervates structures derived from its associated arch

1. Arch 1 (Mandibular Arch) has 2 prominences:

[post-trematic nerve: mandibular V3, pre-trematic nerve: Corda tympani VII]

Maxillary process: forms maxilla, zygomatic process, squamous part temporal bone and secondary palate

mandibular process: forms lower jaw and anterior 2/3 of the tongue; contains Meckel's cartilage



Meckel's cartilage:

upper part: the malleus (head & neck), incus (body & short process)

middle part: anterior malleolar ligament and sphenomandibular ligament

lower part: mandible

1. Arch 2 (Hyoid Arch)

[post-trematic nerve: Facial VII, pre-trematic nerve: Jacobson's nerve (of glossopharyngeal IX)]

Lesser horn + upper part of the hyoid bone

Reichert's cartilage (manubrium of malleus, long process & lenticular process incus, **stapes except the vestibular face of the footplate** (it is derived from the otic capsule, hence otosclerosis a disease of otic capsule will affect primarily the footplate))

The **second (hyoid) arch** enlarges and grows so that by the 6th week it will overlap the 3rd, 4th and 6th arches and covers them.

o It fuses with the neck skin (C2) burying the ectoderm of the 3rd, 4th & 6th arch

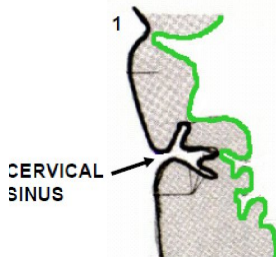
o The space between the 2nd arch and the other 3 arches is called the cervical sinus of his.

o The cervical sinus is lined by ectoderm.

o There is not normally communication with the pharyngeal lumen

It can at a later time, enlarge and form cysts that are called **cervical cysts**

1.



Arch 3:

[post-trematic nerve: glossopharyngeal IX]

Greater horn + lower part of the hyoid bone

1. Arch 4: Forms the thyroid cartilage + **cuneiform** cartilage

2. Arch 6: Forms the rest of the larynx cartilages

Note:

All Ossicles + the **inner** ear **except** the endolymphatic sac are adult size at birth

The **inner** ear develops from **ectoderm** & reach adult size at **4th** fetal month

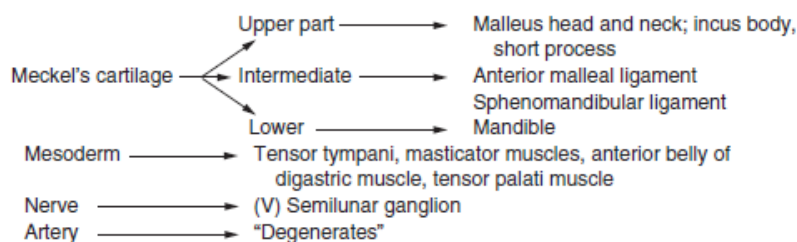
The endolymphatic sac is the 1st to appear & last one to stop growing

XII is **caudal** to **all** pharyngeal arches

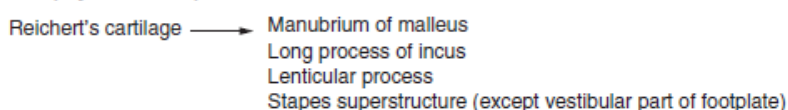
SCM is derived from the cervical somites (posterior & inferior to the pharyngeal arch)

ARCHES

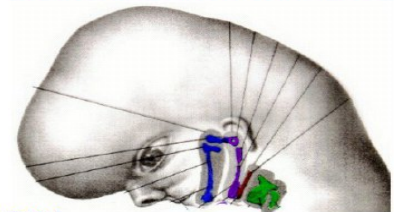
First Arch (Mandibular Arch), Meckel's Cartilage



Second Arch (Hyoid Arch)



BRANCHIAL ARCH CARTILAGES



I First (Mandibular) Arch -

1. Malleus
2. Incus
3. Ant. Ligament Of malleus
4. Sphenomandibular ligament

II Second (Hyoid) Arch

1. Stapes
2. Styloid Process
3. Stylohyoid Ligament
4. Lesser horn, Upper 1/2 body Hyoid

III Third Arch -

- Lower 1/2 Body, Greater Horn Of hyoid

IV Fourth (Sixth) Arch -

- Cartilages Of larynx

BRANCHIAL ARCH NERVES

Muscles of Arches are innervated by Cranial Nerves

- 1) First Arch - Trigeminal (V)
- 2) Second Arch - Facial

Fourth Arch

Cartilage bar	→	Thyroid cartilage, cuneiform cartilage
Mesoderm	→	Inferior pharyngeus constrictor muscle, cricothyroid muscle, cricopharyngeus muscle
Nerve	→	Superior laryngeal nerve (jugular and nodose ganglion)
Artery: Left	→	Aorta
Right	→	Proximal subclavian (the rest derived from seventh segmental artery)

Fifth Arch

Cartilage bar	→	Cricoid, arytenoid, corniculate
Mesoderm	→	Intrinsic muscles of larynx (except cricothyroid); trachea
Artery: Left	→	Pulmonary → Ductus arteriosus
Right	→	Pulmonary
Nerve	→	Recurrent laryngeal nerve

Note:

the 1st arch is innervated by 2nd (maxillary) & 3rd divisions (Mandibular) of the trigeminal nerve; gives anterior belly M.

the 2nd arch gives rise to platysma, Stapedius, facial muscles, auricular muscles (anterior, posterior and superior), stylohyoid, posterior belly of digastric M.

6th is innervated by the **recurrent** laryngeal nerve of the vagus nerve (motor fibers from **cranial accessory** nerve)

Pharyngeal arch ectoderm derivatives:

The ectoderm of the 1st arch:

the epithelium lining the buccal cavity, salivary glands, enamel of the teeth, Epithelium of the **body** of the tongue

The **external** surface ectoderm of the 1st arch gives rise to the epithelium over:

the maxilla, mandible, to some epithelium of the auricle

The ectoderm of the 2nd arch forms:

Epithelium of part of the auricle, Epithelium of external auditory canal, some of the epithelium behind the ear

The ectoderm of the 3rd and 4th arches:

mostly covered by the 2nd arch ectoderm.

What remains can be found around the external ear (innervated by cranial nerve 9), and the external auditory meatus, external tympanic membrane and back of the ear (innervated by cranial nerve 10).

Pharyngeal arch artery

There are 2 dorsal & 2 ventral aortas in **early** embryonic life, The 2 **ventral** aorta fuse **completely**, The 2 **dorsal** aorta fuse **caudally**, The **Fate** of the pharyngeal arch artery:

1st **aortic arch**: Contributions are thought to persist as **maxillary artery**

2nd **aortic arches**: The 2nd arch artery has an upper branch which becomes the **Stapedius** artery the later on degenerates during late fetal period but can persist

3rd **aortic arch**: Stem of the **internal** carotid artery (and part of the common carotid artery).

4th **aortic**: On the **right**: the **proximal** subclavian artery; On the **left**: portion of the **arch** of the aorta.

6th **aortic arch**:

On the **right**: pulmonary arteries

On the **lt**: pulmonary arteries & **ductus arteriosus** in neonate/ligamentum arteriosum in adult

Note: if the Rt 4th artery degenerates the Rt subclavian will arise from the dorsal aorta

Persistent **ligamentum arteriosus** is an abnormality of the 4th arch

Sinus derived from	2 nd brachial arch	3 rd arch	Rt 4 th Arch	Lt 4 th Arch
Relation to the glossopharyngeal N/ superior laryngeal N	Superficial to it	Deep to it	Inferior to superior laryngeal nerve	Inferior to superior laryngeal nerve
Relation to	Superficial to it	Superficial to it	Lateral to it	Lateral to it

hypoglossal N				
Internal carotid artery/Subclavian/aortic arch	Superficial to it	Deep to it	Deep to subclavian artery	Medial to ligamentum arteriosum & aortic arch
Peirce	The middle constrictor deep to stylohyoid ligament	Thyrohyoid membrane above the internal branch of superior laryngeal nerve entry		
Opens into	Tonsillar fossa	Upper part of Pyriform fossa	Lower part of pyriform fossa	Lower part of the pyriform fossa

1- Pharyngeal cleft:

ectodermal cleft between adjacent arches

the ectoderm of the 1st branchial groove forms the lining of the external auditory meatus and the external surface of the TM

the mesenchyme of 1st and 2nd arches which are located on either side of this pharyngeal groove will also give rise to the auricle

Collaural fistula:

- o 1st brachial cleft defect
- o Passes between the external auditory canal & the skin of the neck (between the neck of the mandible & SCM)

1- Pharyngeal pouch:

out-pocketing from rostral foregut between adjacent arches internally separates each arch, has: ventral & dorsal wings; Derivatives:

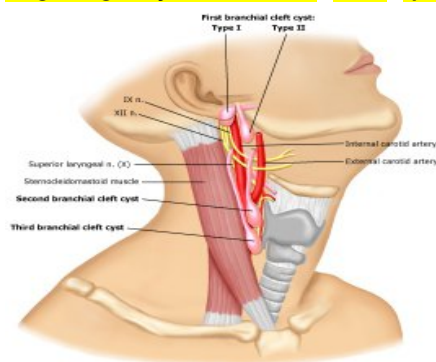
Pouch	Dorsal	Ventral
Pouch 1	Tubotympanic recess (Eustachian tube + tympanic cavity)	Obliterated
Pouch 2	Dorsal pharyngeal wall + nasopharynx + adenoid + Contributes to the middle ear cavity	Supratonsillar fossa + Tonsils
Pouch 3	Inferior parathyroid gland	Thymus
Pouch 4	Superior parathyroid gland	C-cells (Calcitonin)

The ET develops from the 1st brachial pouch between the 2nd pharyngeal arch & pharynx

The 2nd pouch derivatives are innervated by glossopharyngeal nerve

The mastoid air cells develops as expansion of the tympanic cavity

Digeorge syndrome: 3rd + 4th pouch fail to differentiate into thyroid & parathyroid gland



As these out pocketing pouches develop into glandular elements, their connection with the pharyngeal lumen (referred to as pharyngobranchial duct) become obliterated

If the obliteration fails to occur a brachial cyst/sinus is formed

the brachial sinuses & fistula present at birth

branchial cysts:

- o present in early adult hood (20-30 yr)
- o brachial cyst are rarely associated with internal opening
- o lined with squamous epithelium & have lymphoid tissue lining their walls

Pharyngeal pouch anomalies:

- o complete branchial fistulas: fistula opens to both the external surface and the pharynx (above the tonsil) connecting these structures
- o incomplete branchial fistulas: open externally on the anterolateral surface of the neck or internally to the pharynx by way of a ruptured pharyngeal membrane

note the course of the cyst is deep to its own structures

the most common internal fistula is the 2nd

Cutaneous opening is always anterior to the SCM

Tracts are always subplatysma

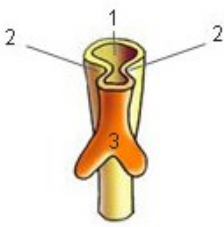
Deep to the external carotid artery

- 1- Pharyngeal membrane: contact area of the ectoderm (of the pharyngeal cleft) & endoderm (of pharyngeal pouch)
only 1st pair persist as tympanic membrane

STRUCTURES DERIVED FROM BRANCHIAL ARCHES AND POUCHES

ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES	POUCH
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Sphenomandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric	1) Auditory tube 2) Tympanic cavity
Second (VII)	1) Stapes 2) Styloid process 3) Hyoid bone - lesser horn, upper half of body	Stylohyoid ligament	1) Muscles of Facial Expression 2) Stapedius 3) Stylohyoid 4) Post. belly of Digastric	Lining (crypts) of palatine tonsils
Third (IX)	Hyoid bone - greater horn, lower half of body	-----	Stylopharyngeus	1) Inferior parathyroid gland 2) Thymus
Fourth (X)	Cartilages of Larynx	-----	1) All muscles of Larynx 2) All muscles of Pharynx (except Stylopharyngeus) 3) All muscles of Soft Palate (except Tensor palati)	1) Superior parathyroid gland 2) C-cells of Thyroid
Sixth (XI)	-----	-----	1) Sternocleidomastoid 2) Trapezius	-----

Note: First Branchial Groove (Cleft) becomes External Auditory Meatus
First Branchial Membrane becomes Tympanic Membrane



Larynx embryology

The entire respiratory system is an outgrowth of the primitive pharynx

So Any congenital malformation of the pharynx and oesophagus is always associated with certain degree of malformation of larynx and trachea

The most common TEF is atresia of the esophagus with distal anastomosis of the esophagus with the trachea

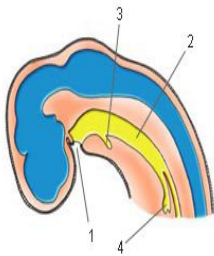
The **lower** respiratory system (larynx, trachea, bronchus) begins its development:

during the **4th** week as **respiratory** diverticulum **caudal** to the **hypobranchial** eminence

respiratory diverticulum: **evagination** (outgrowth) of the **ventral** wall of the **foregut** (pharynx)

The diverticulum elongates in the **caudal** direction and soon becomes separated from the foregut by the **esophagotracheal septum**

The **cranial** end of the tube forms the larynx and trachea and the caudal end the bronchi and lungs



The **endodermal** lining of the respiratory diverticulum gives rise to the **epithelial** lining of the larynx, trachea, bronchi and alveoli

Mesoderm of the pharyngeal arch **4 + 6th** give rise the **cartilaginous** and **muscular** components of the trachea and lungs:

4th branchial arch give rise to :

Supraglottic therefore, related to the development of the oral cavity and oropharynx

cartilage: thyroid cartilage + **cuneiform** cartilage

nerve: **superior** laryngeal branch of vagus nerve

muscles: cricothyroid m

6th branchial arch:

Glottis and subglottis

Cartilage: The rest of the laryngeal cartilage

Nerve: **recurrent** laryngeal nerve of the vagus nerve

Muscles: rest of intrinsic muscles

During the **6th** week the laryngeal lumen becomes **obliterated** by the mesenchyme

During the **10th** week **recanalization** occurs

Details of larynx cartilage development:

Arytenoid swellings: appear on **both** sides of the **tracheobronchial** diverticulum and, as they enlarge, the epithelial walls of the groove adhere to each other, and the aperture of the larynx is **occluded** until the **third** month

aryepiglottic folds: The arytenoid swellings grow upwards and deepen to produce the aryepiglottic folds.

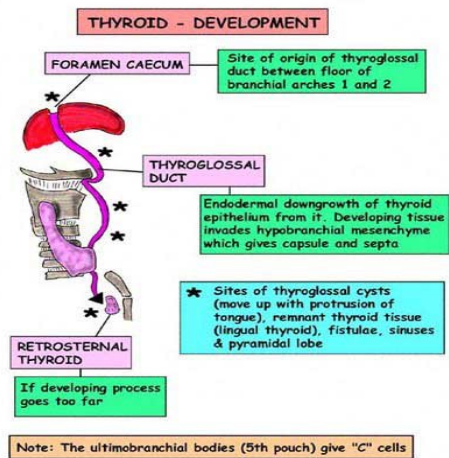
Epiglottis: The hypobranchial eminence (related to the 4th & 6th arch).

Thyroid cartilage: develops from the ventral ends of the cartilages of the 4th pharyngeal arch, appears as two lateral plates each with **two** chondrification centres.

cricoid cartilage and the cartilages of the trachea: develop from the **sixth** arch, during the sixth week

True & false V.C are formed between the 8th & 10th wk

Ventricle is formed at the 12th wk



Note: The ultimobranchial bodies (5th pouch) give "C" cells

Note:

Laryngeal movement can be detected by the 3rd month of gestation
in the late 2nd trimester occurs the following :

- o the epiglottis and soft palate overlaps for the 1st time
- o the larynx remains intranasal during fetal swallowing
- o pulmonary granular epithelium matures and produce surfactant
- o the skull base undergoes remodeling of its shape

Thyroid Gland Development:

diverticulum of endodermal origin can be identified between the first and second arches on the floor of the pharynx. situated between the tuberculum impar and the copula. (The tuberculum impar together with the lingual swellings becomes the anterior two-thirds of the tongue, and the copula is the precursor of the posterior one-third of the tongue.) The ventral diverticulum develops into the thyroid gland.

During development it descends caudally within the mesodermal tissues. At 4.5 weeks the connection between the thyroid diverticulum and the floor of the pharynx begins to disappear. By the 6th week it should be obliterated and atrophied, if persists a thyroglossal duct cyst is present. tract travels either superficial to, through, or just deep to hyoid and reaches the foramen cecum

7th week The thyroid reaches the final Adult position

Parafollicular C cells arising from neural crest of the 4th pharyngeal pouch as ultimobranchial bodies migrate & infiltrate the forming lateral thyroid lobes

Thyroid part	The origin
Medial part	Endoderm of 1 st +2 nd pharyngeal pouch
Lateral part	the 4 th pharyngeal pouch
Parafollicular C cell	Neural crest of the 4 th pharyngeal pouch

Congenital anomalies:

- 1- lingual thyroid: Result from complete arrest of the thyroid gland descend
- 2- pyramidal lobe:
 - o Occur if the inferiormost portion of the thyroglossal duct is maintained
 - o More prominent among children as it undergoes progressive degeneration with age
- 1- persistent thyroglossal duct: When the thyroglossus duct persist as epithelial tract from the foramen cecum to the laryngeal level
- 2- thyroglossal cyst:
 - Persistent of the thyroidglossal duct as series of midline blind pouch in close association with the hyoid bone
 - So surgery for thyroglossal cyst resection requires:
 - o resection of the midportion of the hyoid bone
 - o identification & resection of any cranially extending tract leading toward the base of the tongue
- 1- complete congenital absence of the thyroid gland: Is seldom noticed until few weeks after birth because the fetus is supplied with sufficient maternal thyroid hormone to permit normal development

Embryology of salivary glands: All salivary glands originates from the ectoderm of the 1st pouch

Summary of structure origin	
Structure	Origin
Epiglottis	Hypobranchial eminence
Thyroid cartilage	4 th arch
Cuneiform cartilage	
Cricothyroid muscle	
Rest of the larynx	6 th arch

Structure	Time of development
Epiglottis	3 rd wk
Thyroid & cricoid cartilage	5 th wk
Arytenoids(vocal process last 1 2 develop) & corniculate	12 th wk
Cuneiform	28 th wk