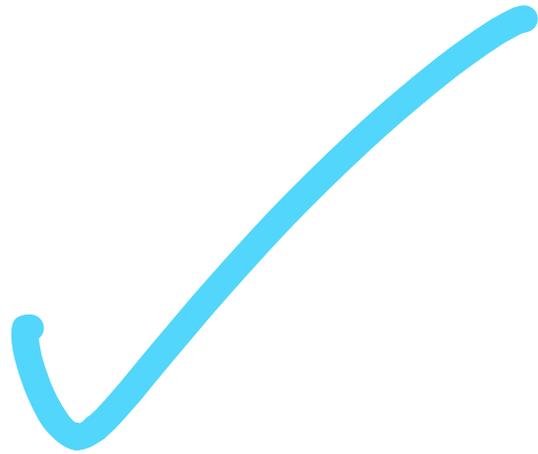




# Pharyngeal (Branchial) Apparatus

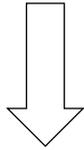


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Professor of Anatomy, Histology and Embryology

*Prepared and adapted for teaching by Prof. Dr. Heba Kalbouneh.  
Illustrations adapted from multiple educational resources for educational purposes.  
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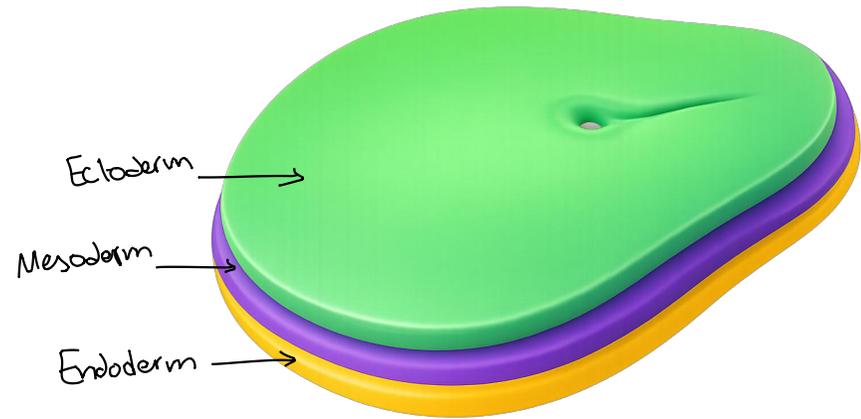
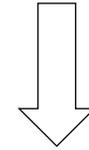


Bilaminar disc  
(2<sup>nd</sup> week)  
*of fetal life*

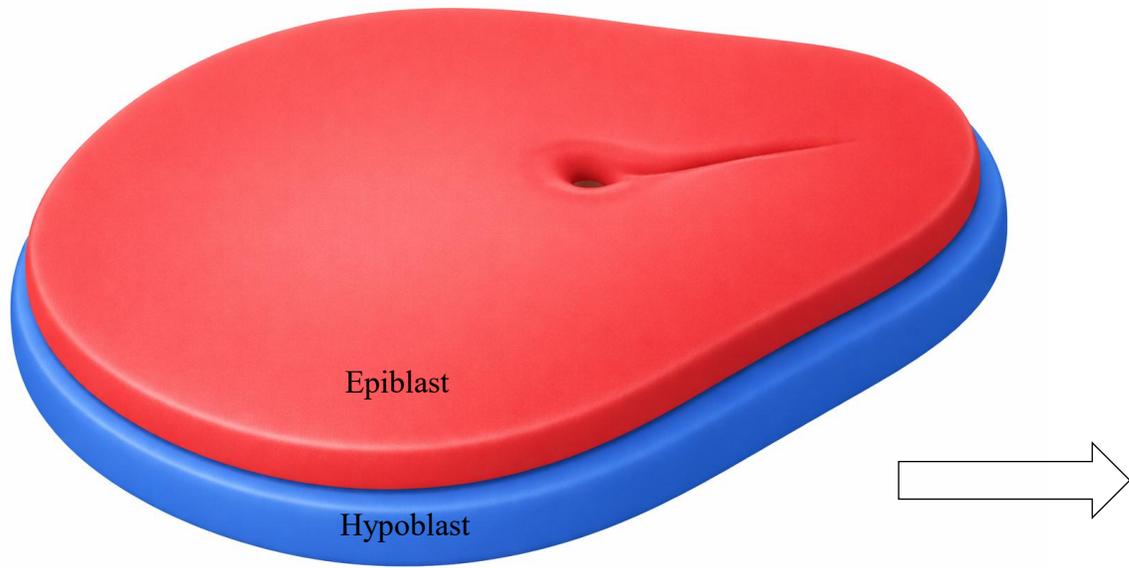


Trilaminar disc  
(3<sup>rd</sup> week)

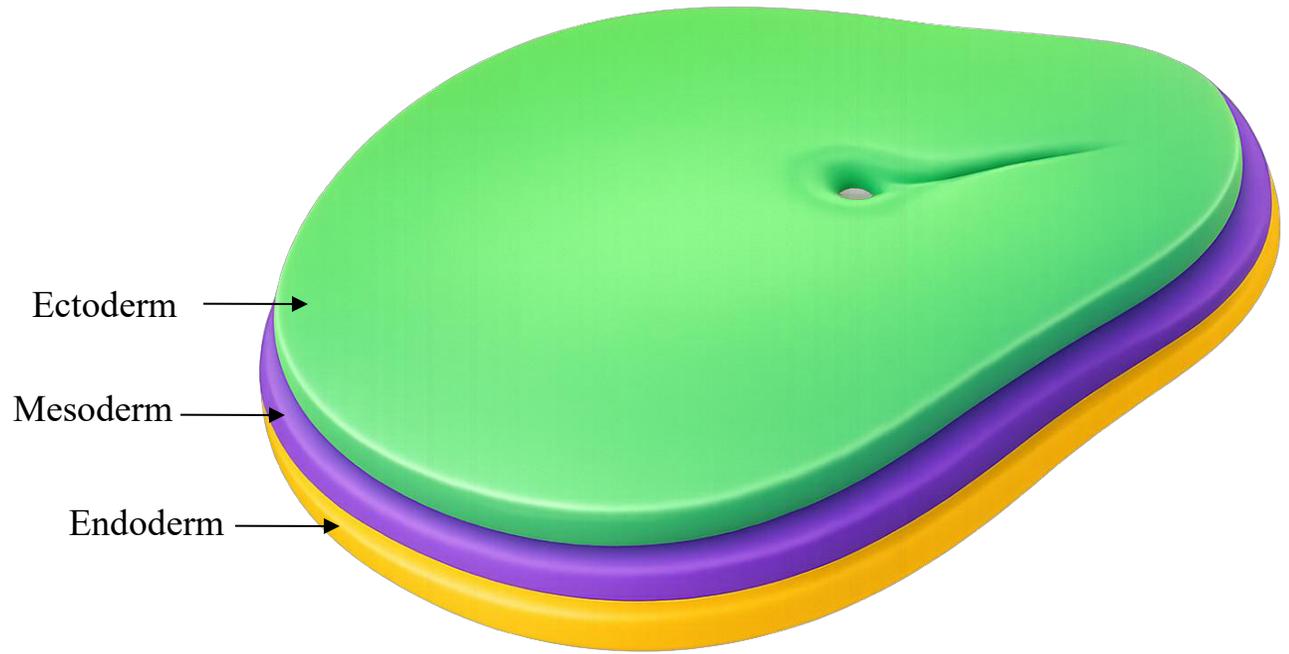
Ectoderm  
Mesoderm  
Endoderm



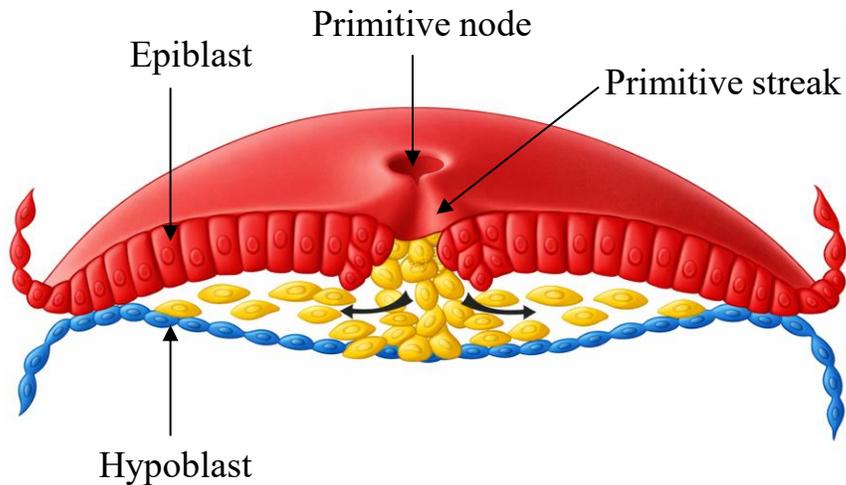
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**Bilaminar disc  
(2<sup>nd</sup> week)**



**Trilaminar disc  
(3<sup>rd</sup> week)**



↳ Cells from Epiblast migrate downward replacing hypoblast forming the Endoderm, & part of them cells form the mesoderm, & the rest (which remain at the top) form the ectoderm.

→ Endo, Meso & Ectoderm form from the Epiblast.  
 → the Hypoblast vanishes.

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\* the Ectoderm

- surface ectoderm → gives rise to skin epidermis
- Neural ectoderm (Neural plate)

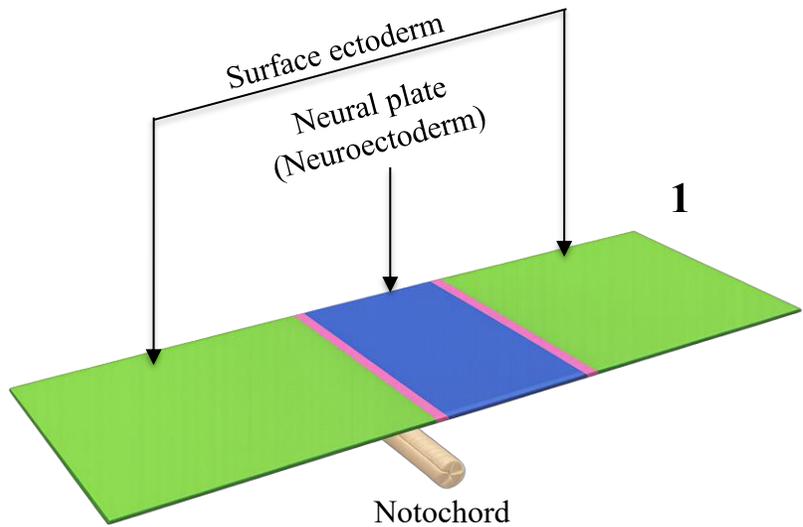
→ undergoes folding (by formation of Neural folds & Neural groove)  
to form → Neural tube → gives rise to our CNS

→ Neural crest cell → reside in the mesenchyme,  
migrate to different locations  
to give rise to many cell types, Ex:  
Melanocytes.

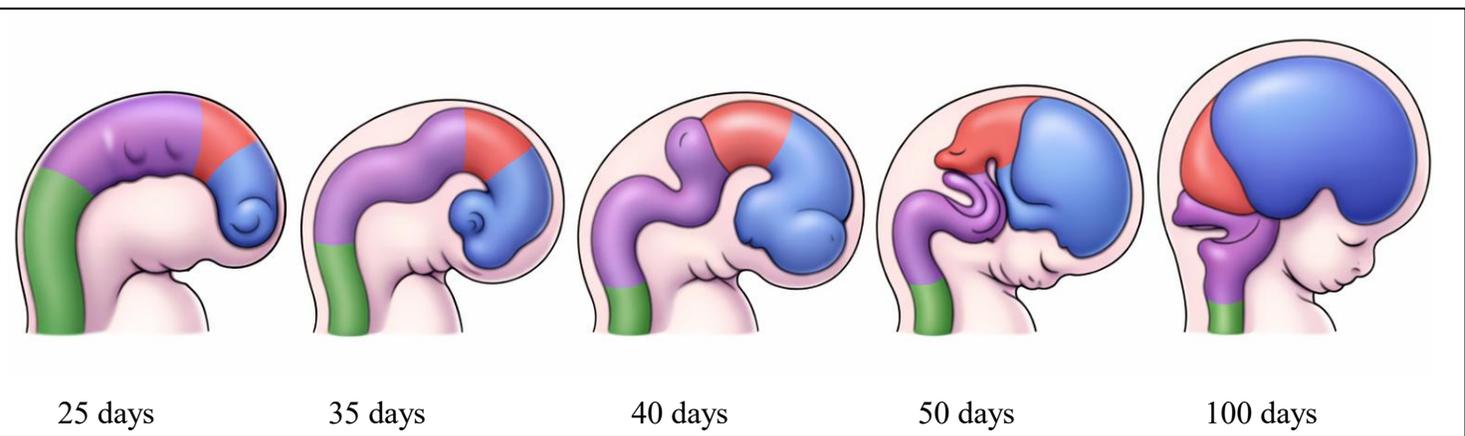
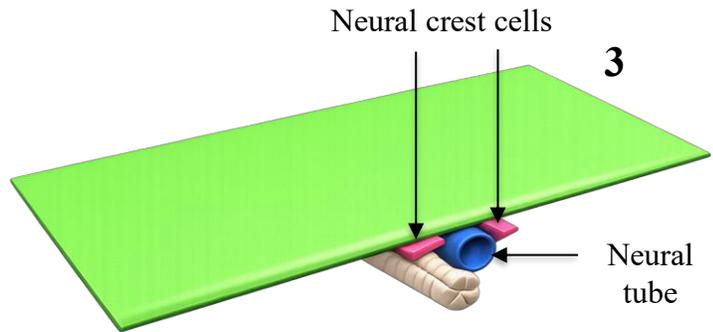
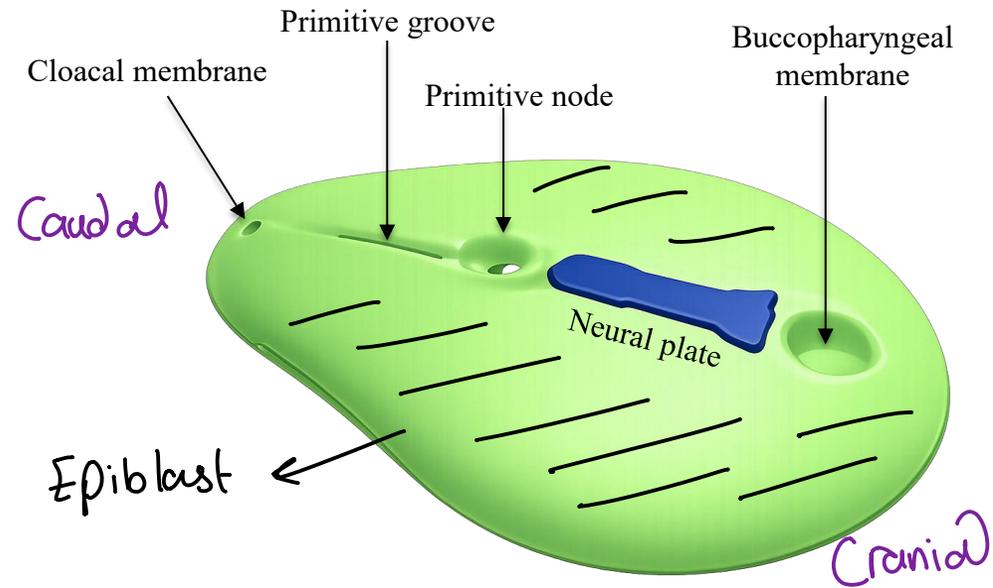
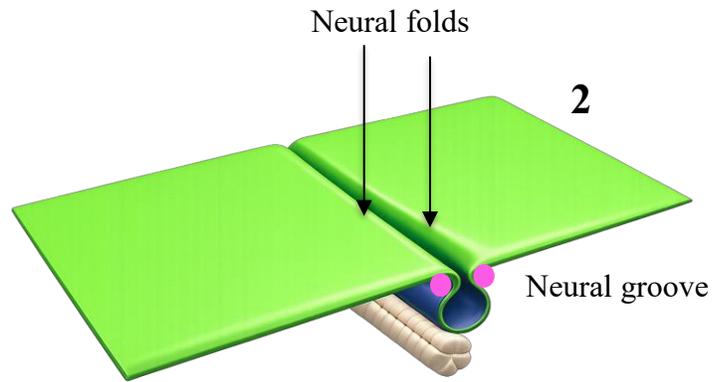
\* Neural tube → Cranial end → Brain

→ Dorsal end → spinal cord.

Cranial end → 3 vesicles (forebrain, Midbrain, Hindbrain) → undergo enlargement, esp. the most cranial one.



*gives the vertebral column.*



Buccopharyngeal membrane

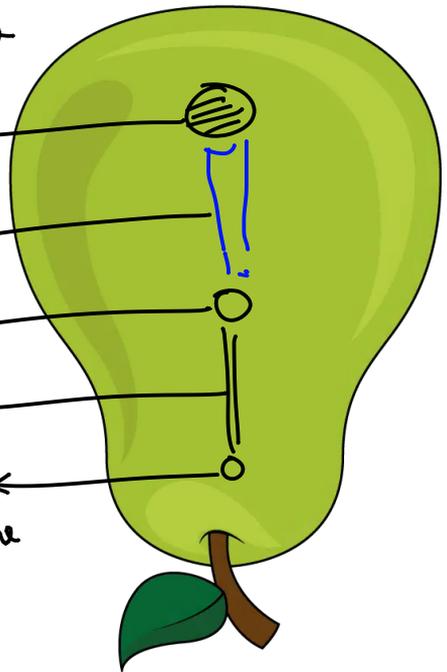
cranial

Neural plate

Primitive node

Primitive groove

Cloacal membrane

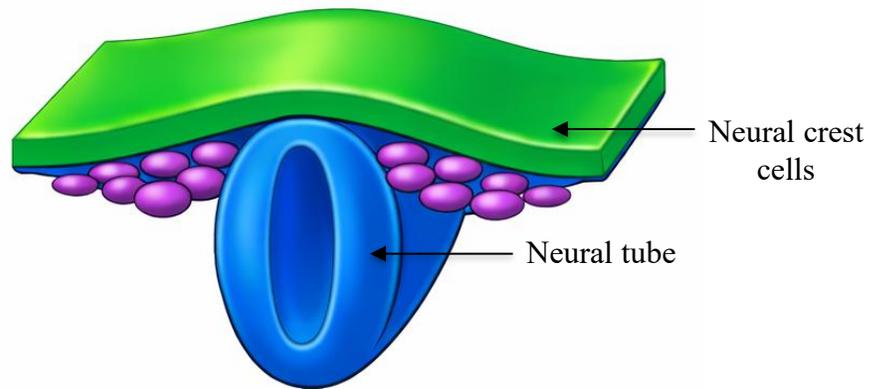
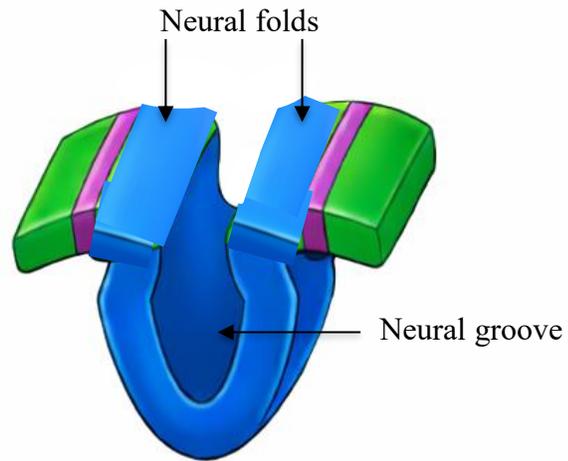
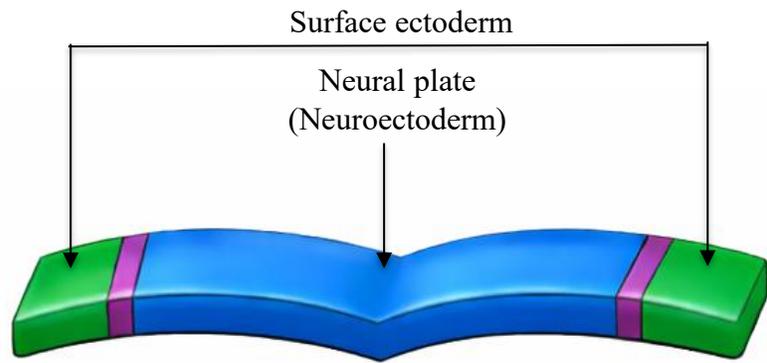


caudal

cranial



caudal

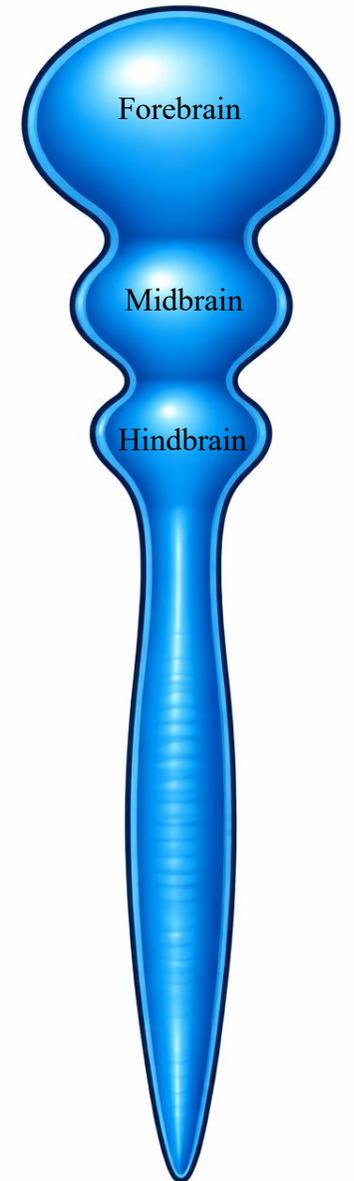


In early neural tube development, the brain forms three primary vesicles:

1. Forebrain
2. Midbrain
3. Hindbrain

Brain

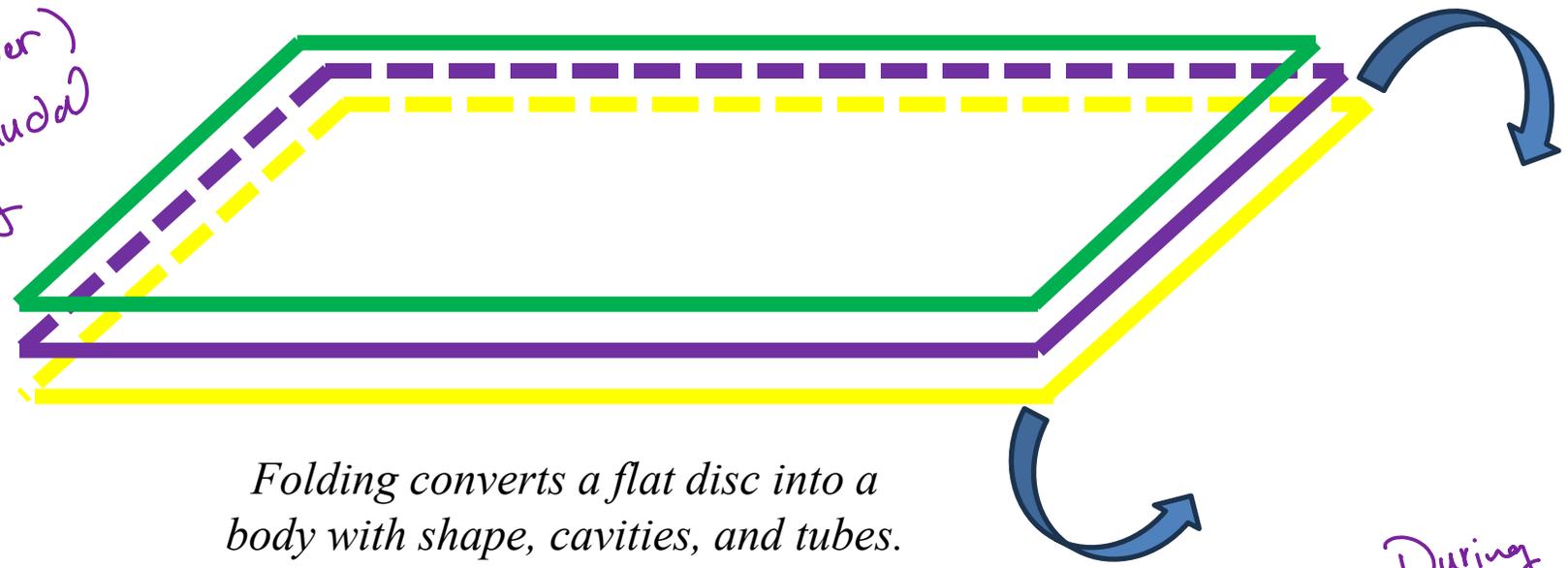
Spinal cord



# Embryonic Folding <sup>4th week</sup> → → → From trilaminar disc to human body form

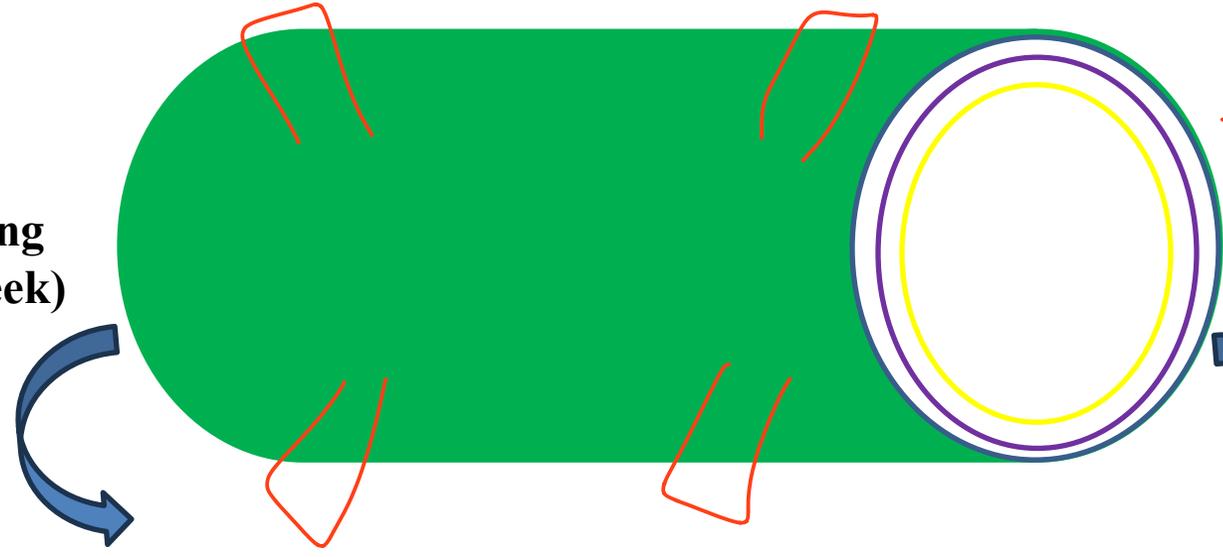
\* 2 Foldings  
 ① Side to side (disc → cylinder)  
 ② Cranio-caudal folding

Trilaminar disc (3<sup>rd</sup> week)



*Folding converts a flat disc into a body with shape, cavities, and tubes.*

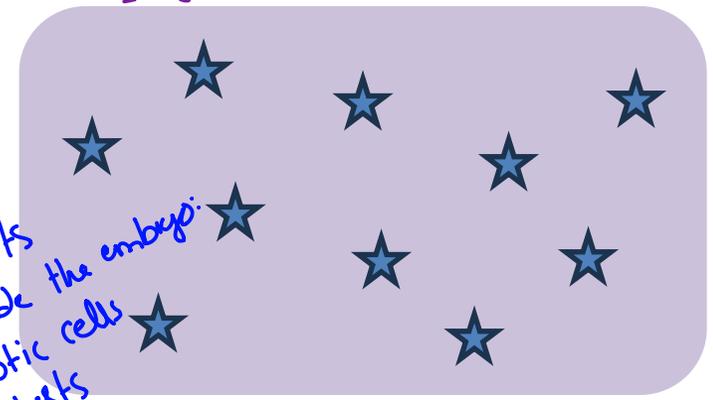
Folding (4<sup>th</sup> week)



\* 2 buds on each side (cranial & caudal) appear forming our limbs.

- \* According to its location inside the embryo:
- Hematopoietic cells
- Chondroblasts
- Adipoblasts
- Fibroblasts
- Myoblasts

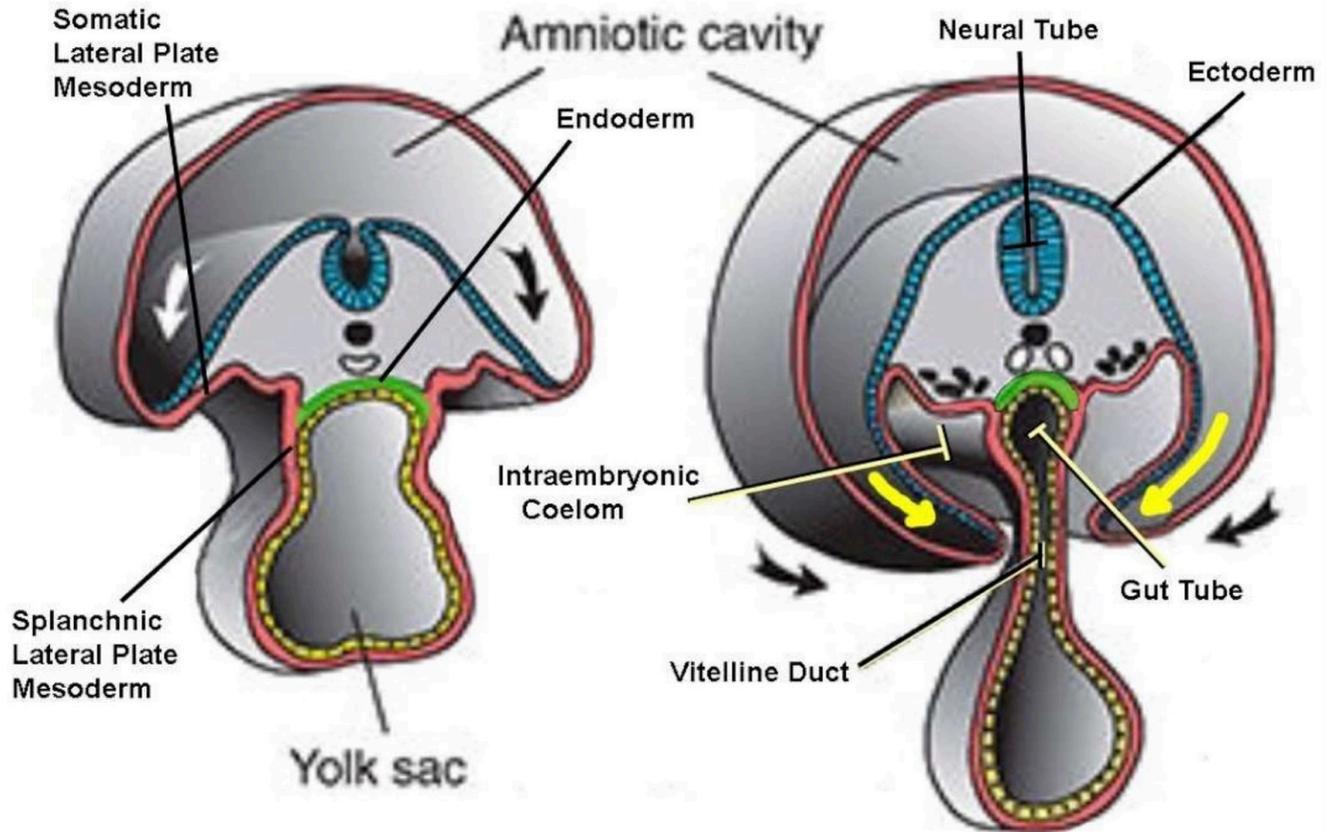
During folding, Mesoderm is converted into:



**Mesenchyme**

(Embryonic CT)  
 Stem cells suspended in ECM rich in ground subs.

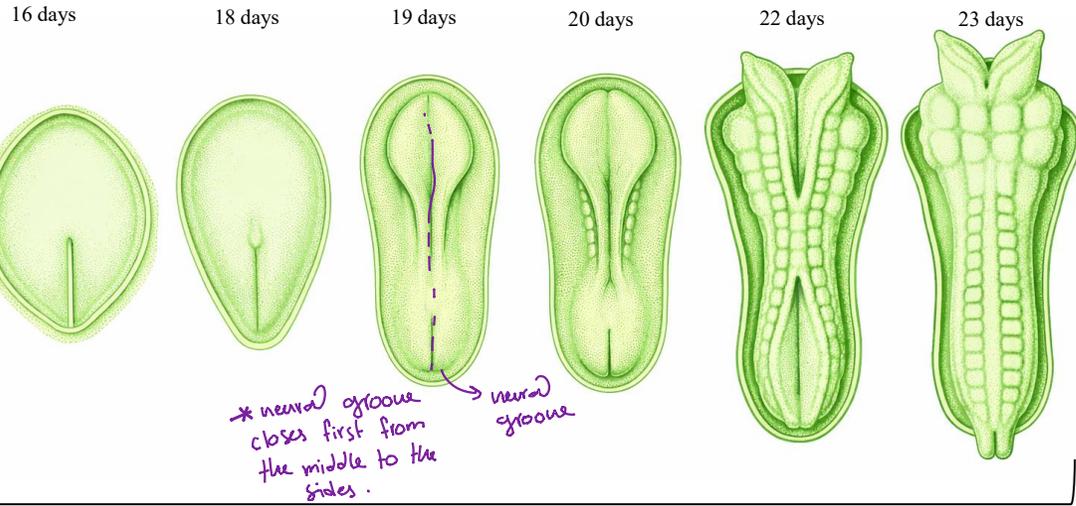
# Embryonic folding



Endoderm → Mucosa (Mucosa membranes)

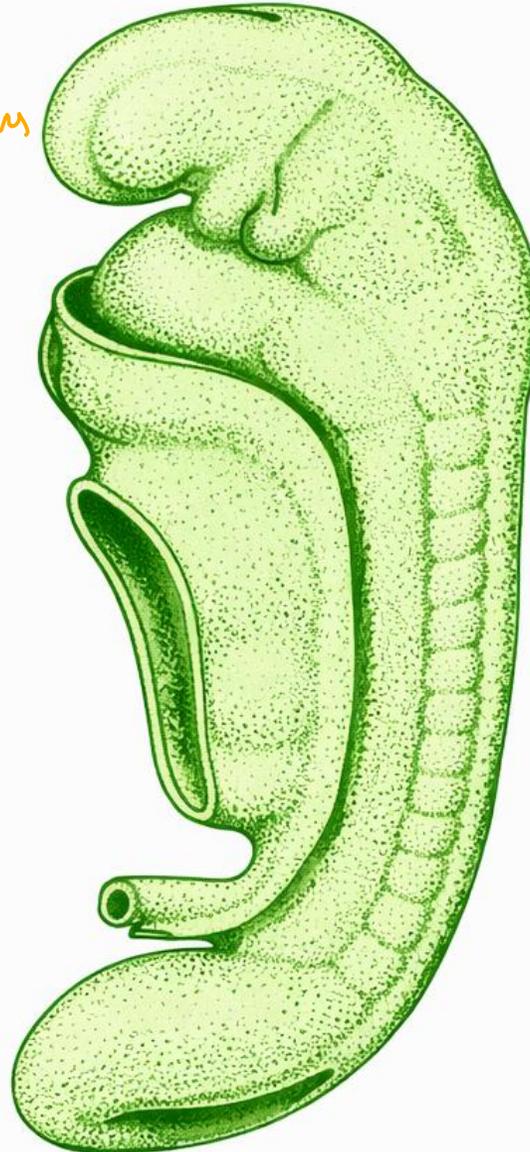
epidermal lining of the cavities that have connections to the outside environment.

∴ Endoderm forms the Gut & its components.

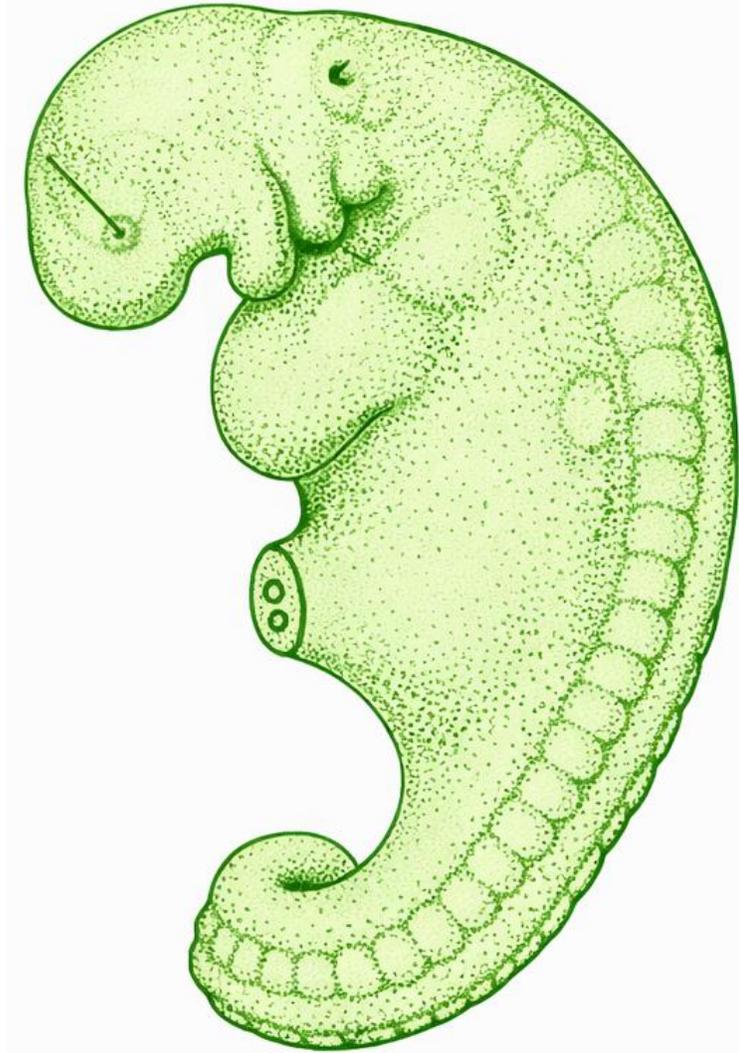


Dorsal view

25 days

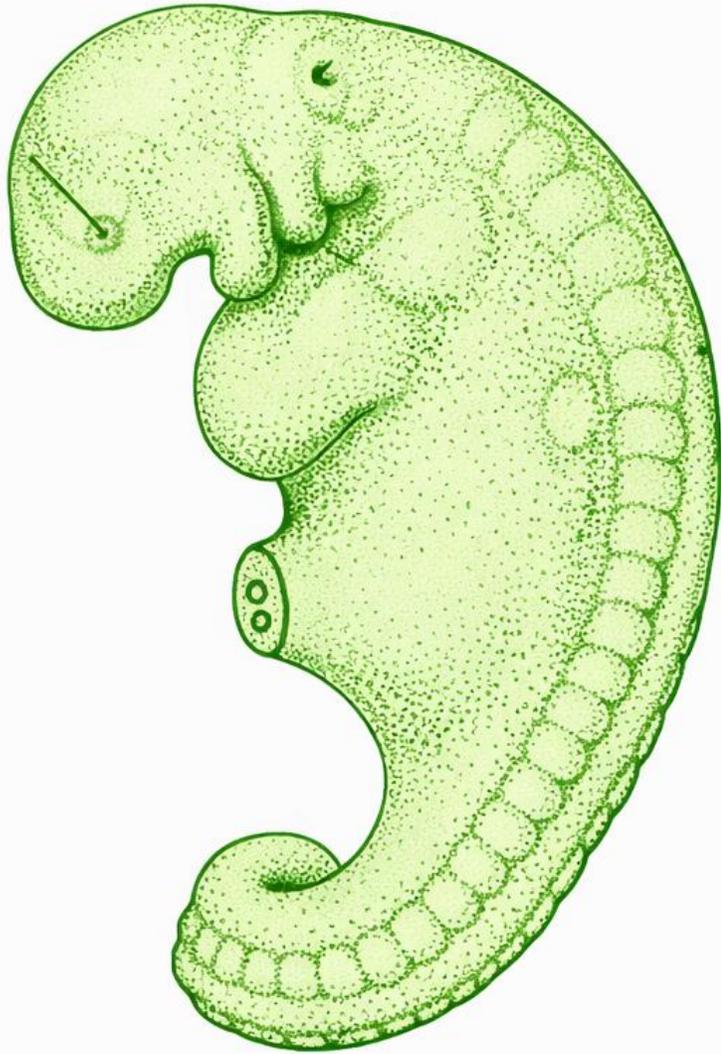


28 days



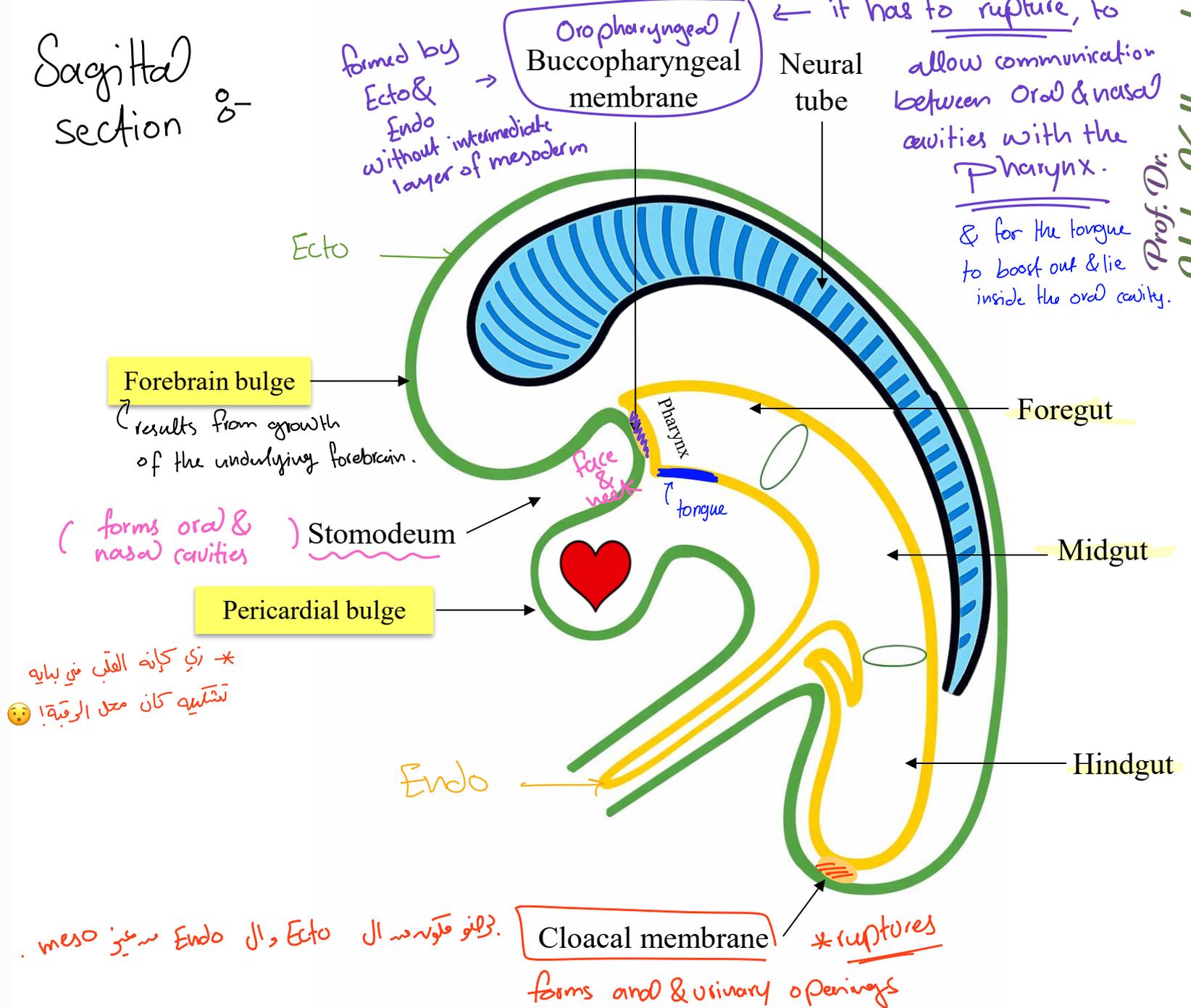
Lateral view

28 days



Lateral view

Sagittal section



\* زي كانه القلب مني بيايه تشابه كان مثل الرقبة!

قولنو علونو ال Ecto وال Endo من غير meso.

Note that the ectoderm and endoderm are in direct contact with each other (no mesoderm in between) in only two places:  
**The buccopharyngeal membrane:** cranially  
**The cloacal membrane:** caudally.

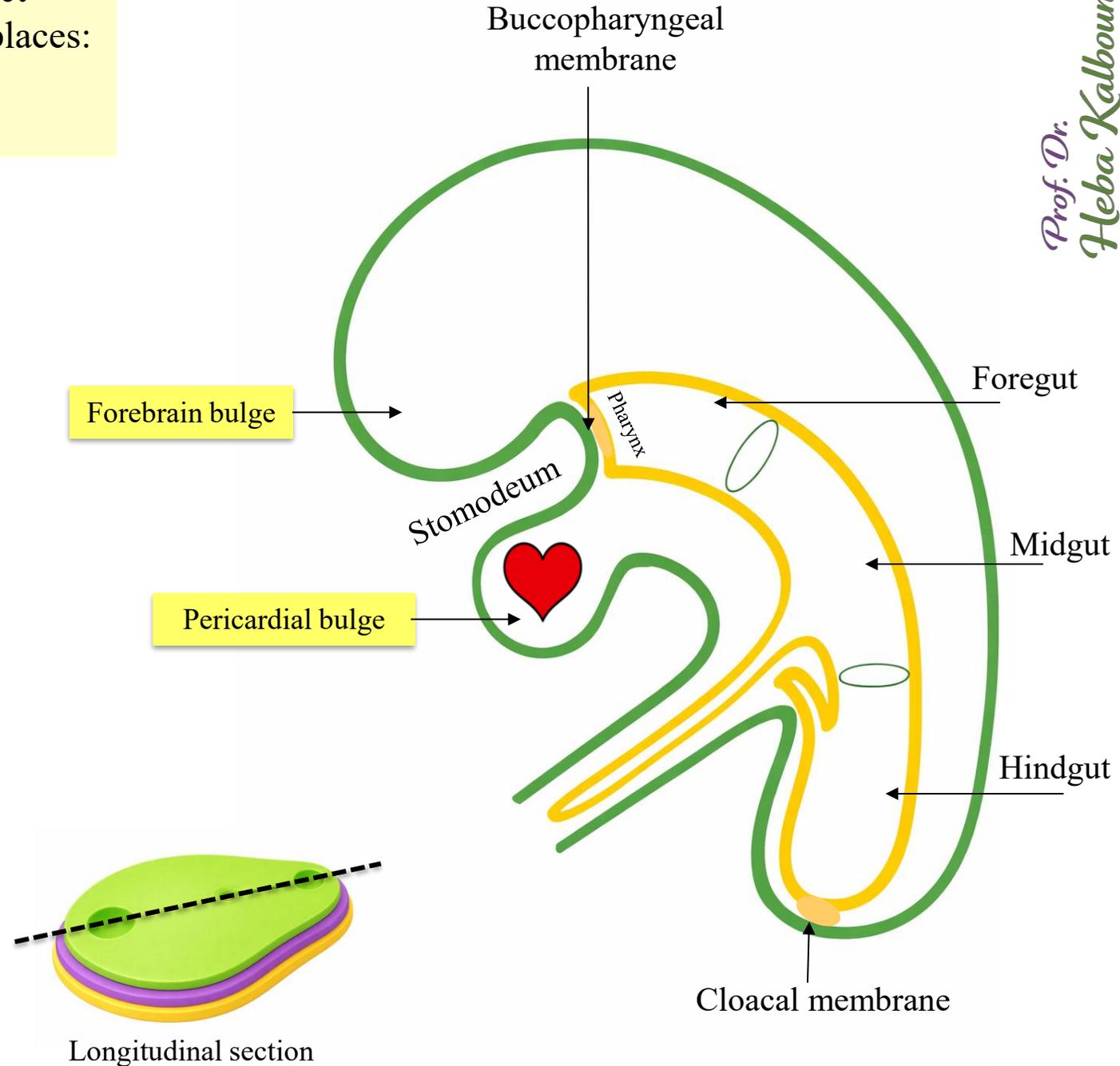
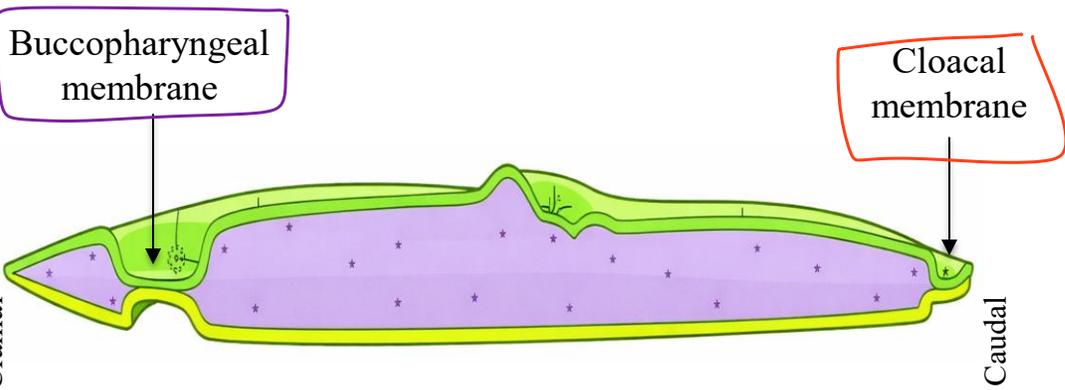
The buccopharyngeal membrane lies between stomodeum and the primitive pharynx.

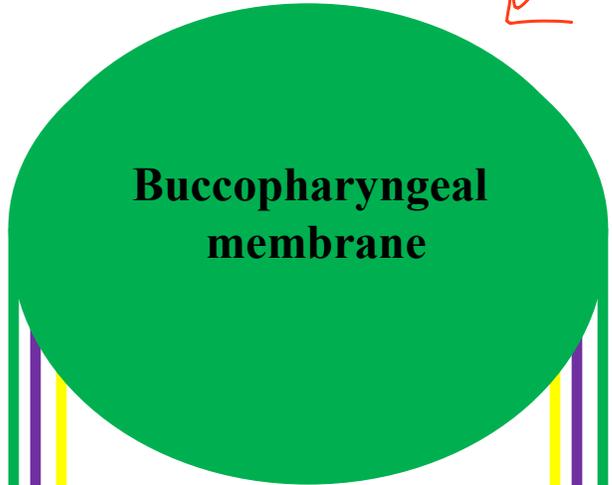
The **stomodeum** is a depression between the forebrain bulge and the pericardium bulge.

Stomodeum will form the **nasal and oral cavities**.

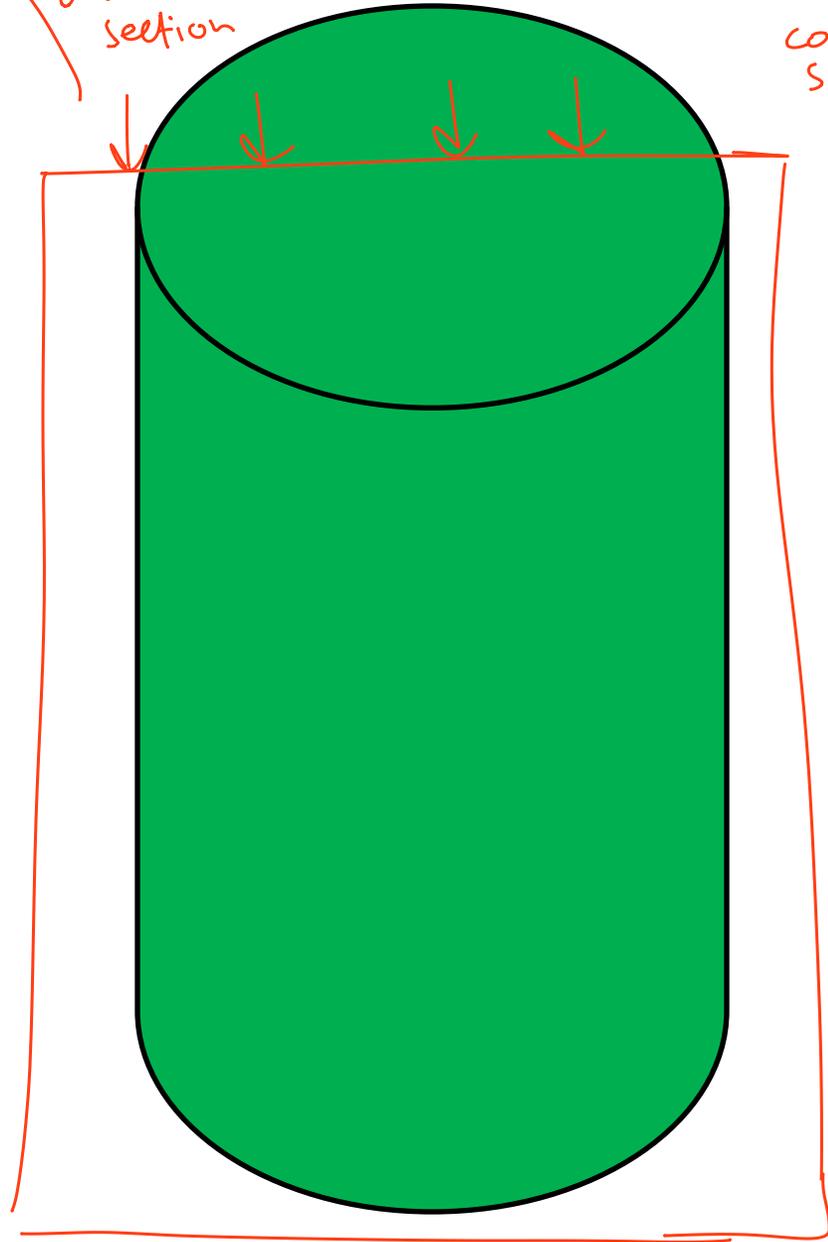
Later, the buccopharyngeal membrane breaks down so that the stomodeum communicates with the foregut.

*Longitudinal section :-*

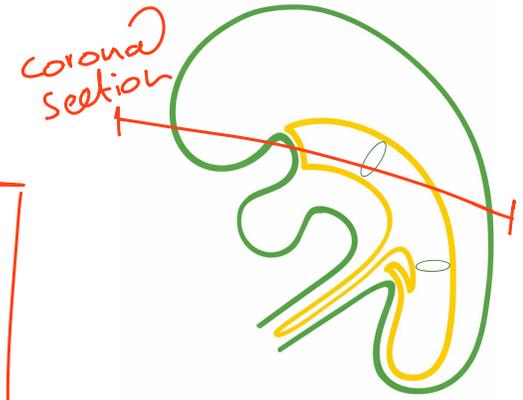




**Buccopharyngeal membrane**

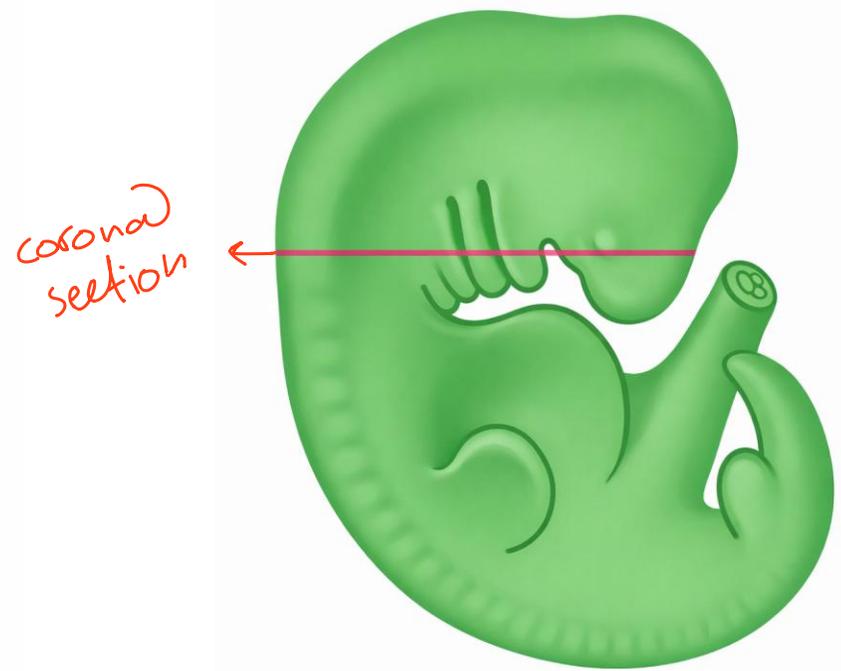
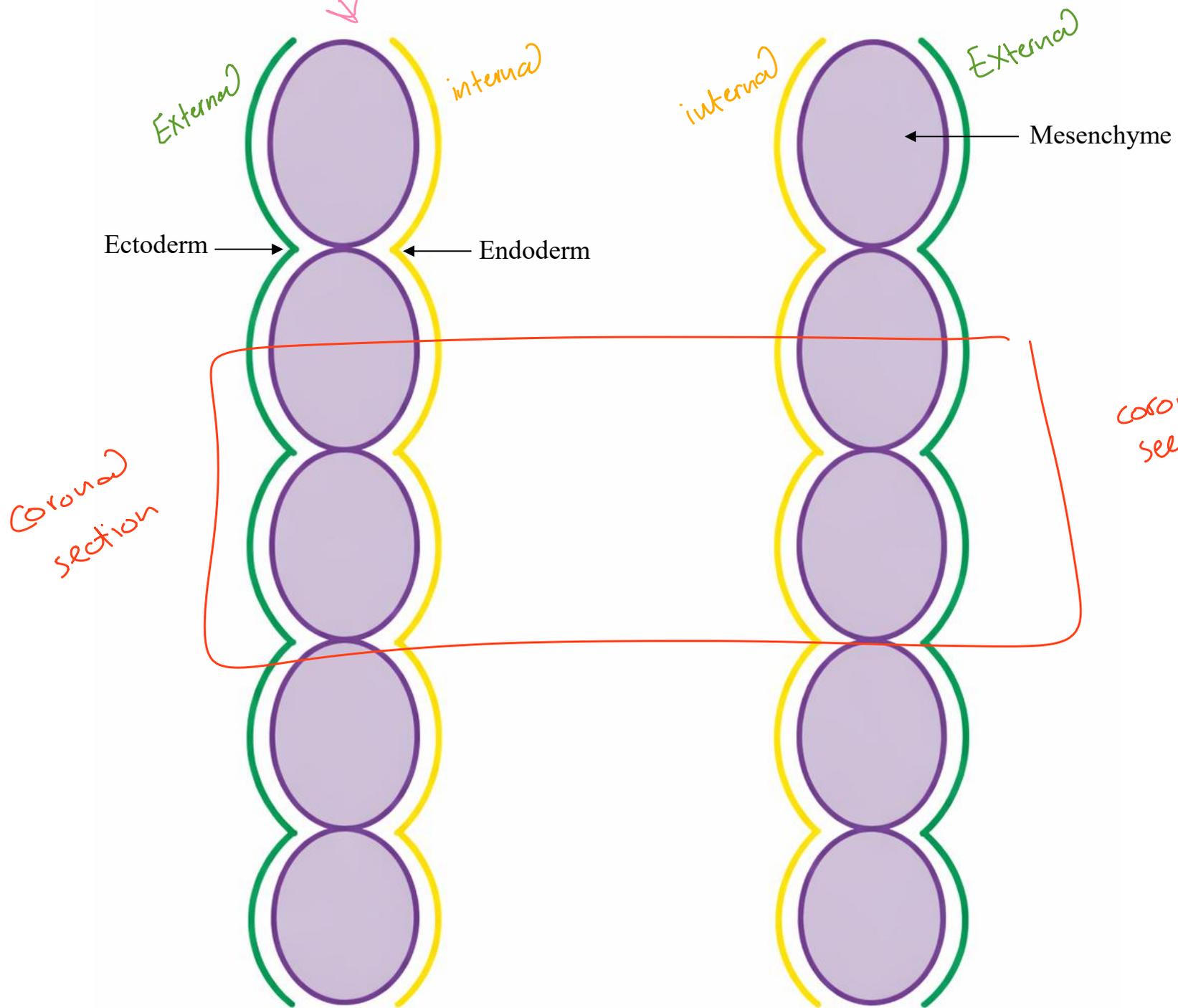


take a coronal section

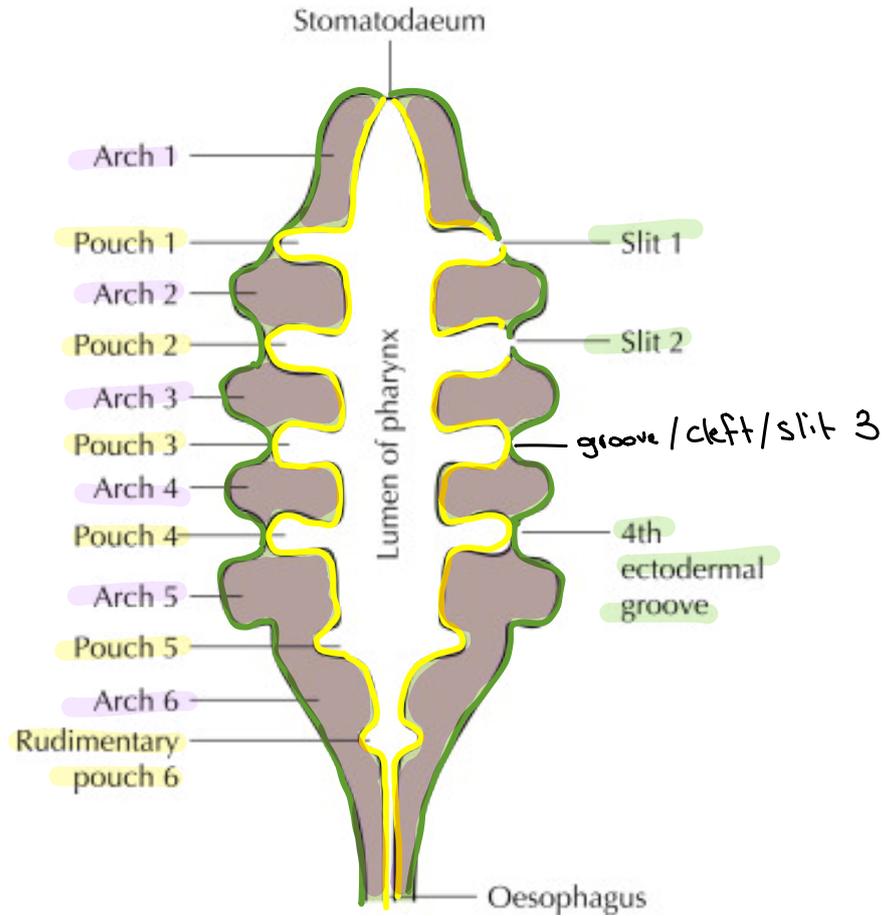


coronal section

\* During folding, the mesoderm on the 2 sides of the pharynx grows (thickens) along 6 lines, forming Pharyngeal arches (cylindrical shaped structures running from dorsal → ventral) they will then form the neck.



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Note :- Arch 5 can be absent -

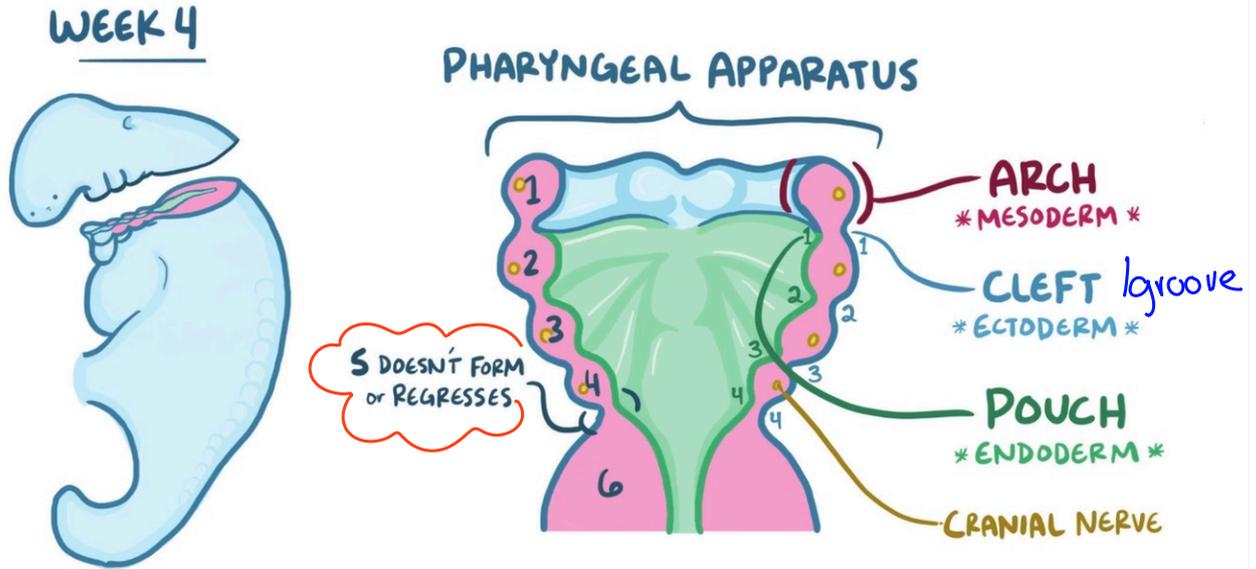


Figure 30.1 Locations of the pharyngeal arches, clefts, and pouches.

# Pharyngeal (Branchial) Arches

- The pharyngeal arches are six paired swellings that develop in the wall of the primitive pharynx.
- Each arch consists of a core of mesenchyme covered externally by ectoderm and internally by endoderm.
- They appear during the 4th and 5th weeks of development.
- The arches are separated externally by four pharyngeal clefts (grooves) → ectoderm.
- On the internal aspect, the arches are separated by pharyngeal pouches → endoderm.

↓  
five

Why pharyngeal arches?

In human embryo, the arches form on the sides of the pharynx

Why branchial arches?

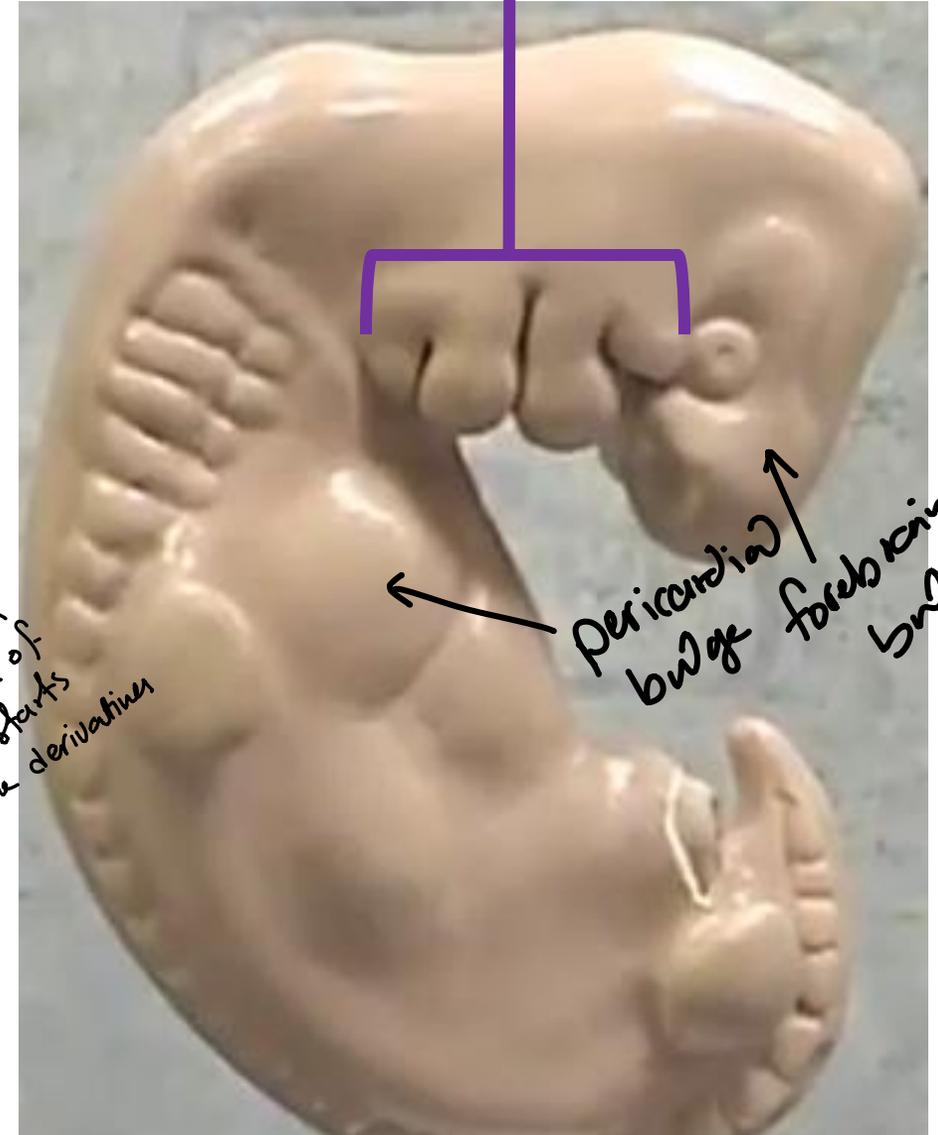
Pharyngeal arches resemble the gills of the fish in shape

**Gills=branchia**



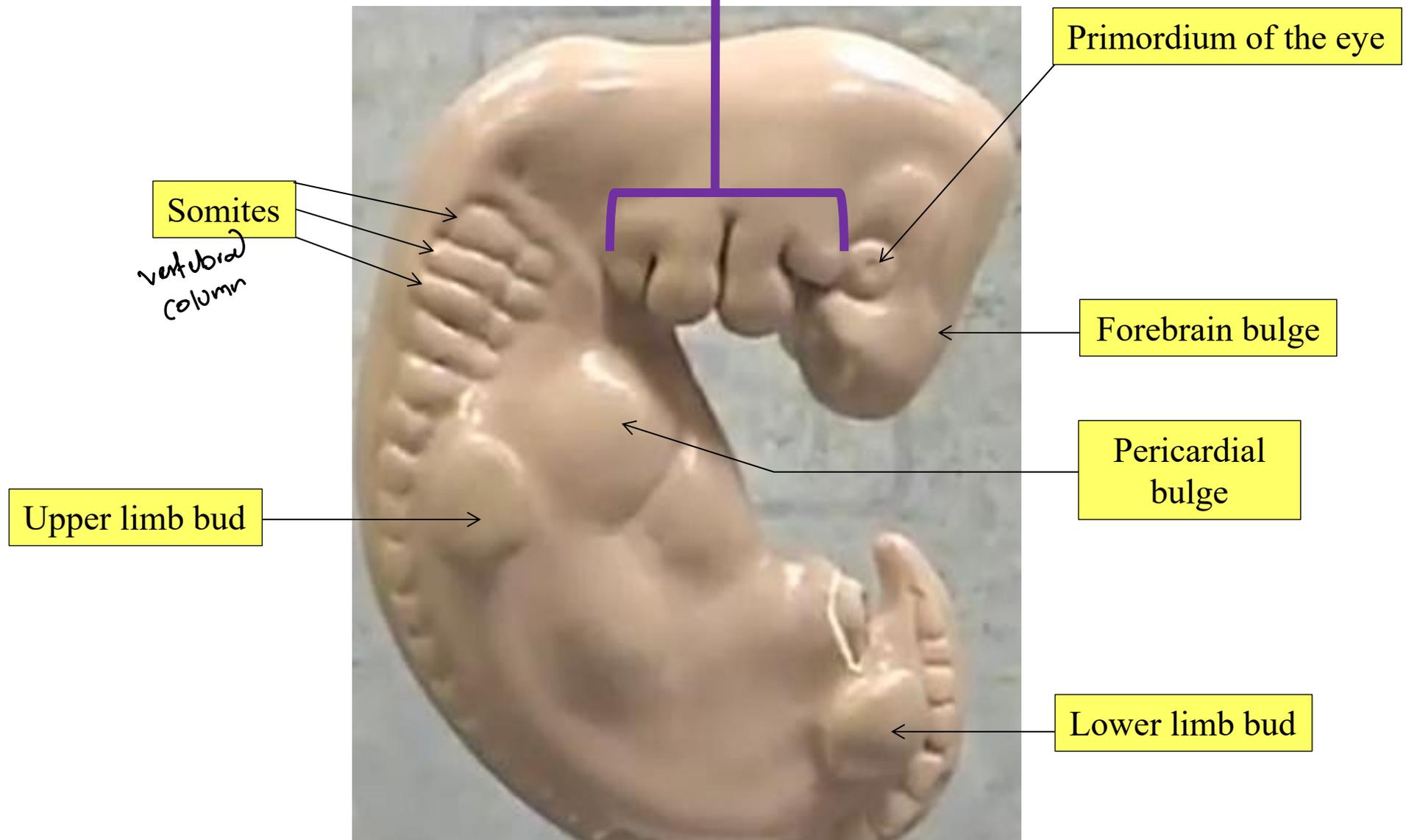
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## Pharyngeal arches



→ they can't be seen together at the same time, because they arise gradually & each one of them starts to give derivatives

# Pharyngeal arches



Somites  
*vertebral column*

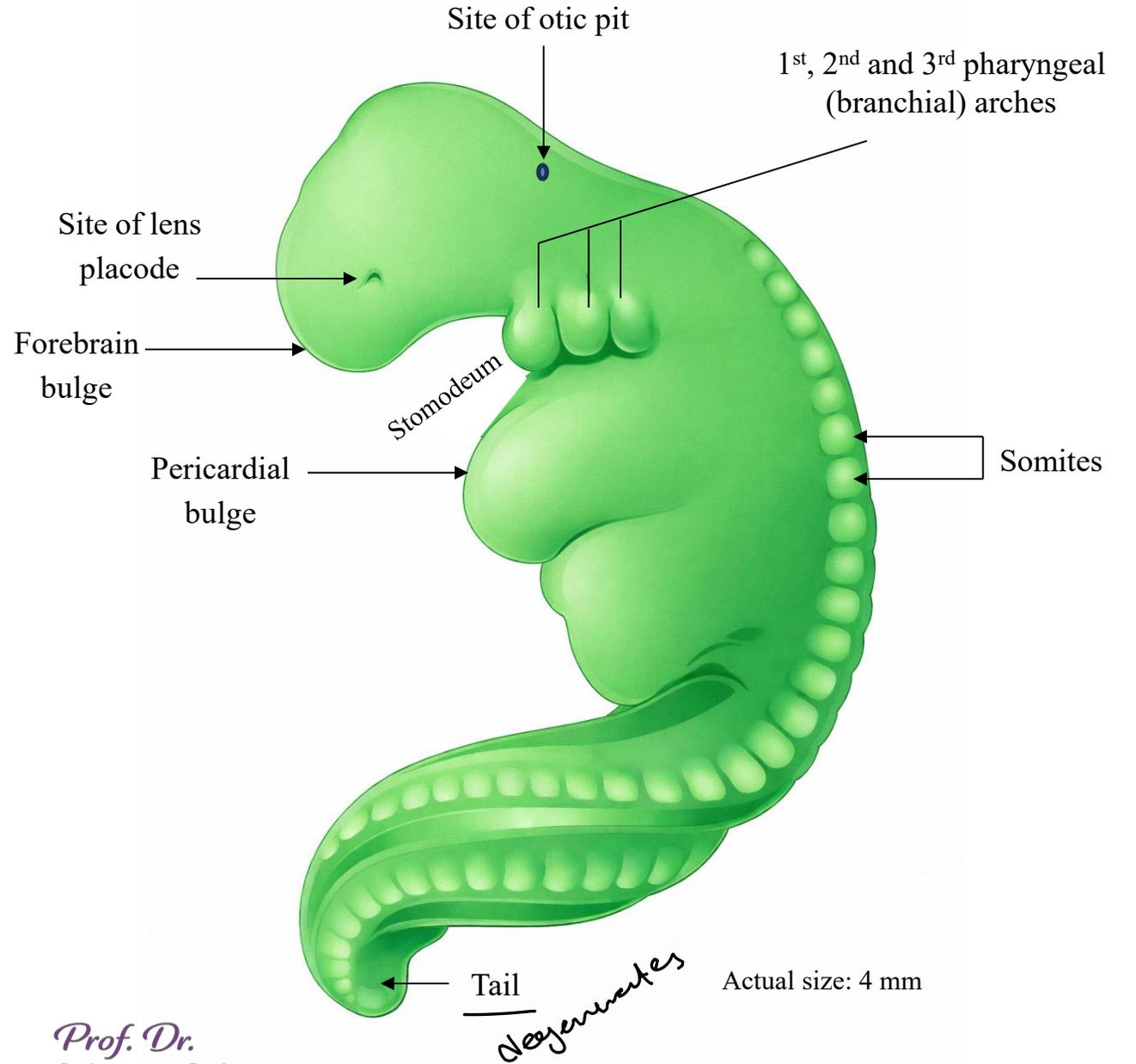
Primordium of the eye

Forebrain bulge

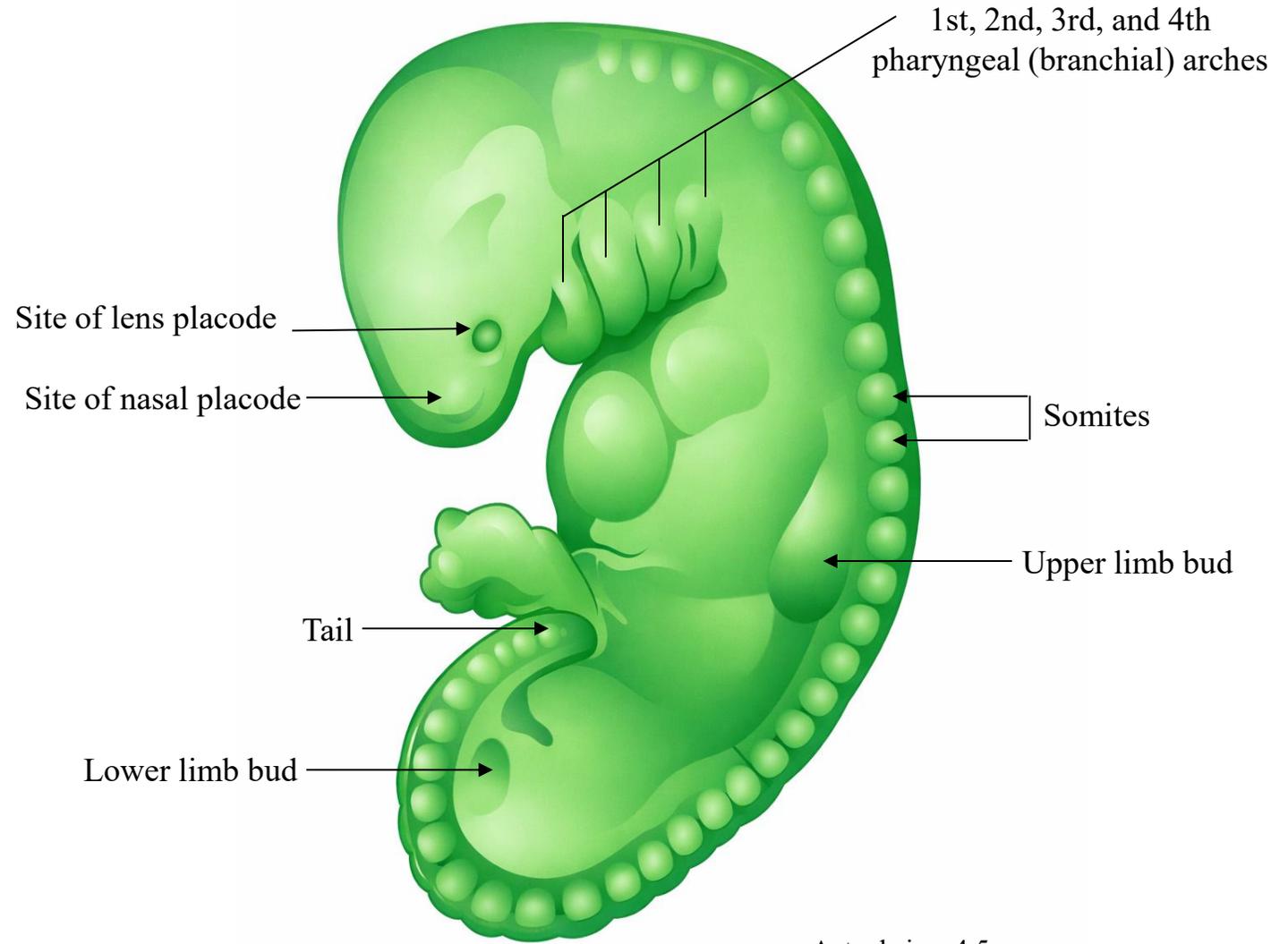
Pericardial bulge

Upper limb bud

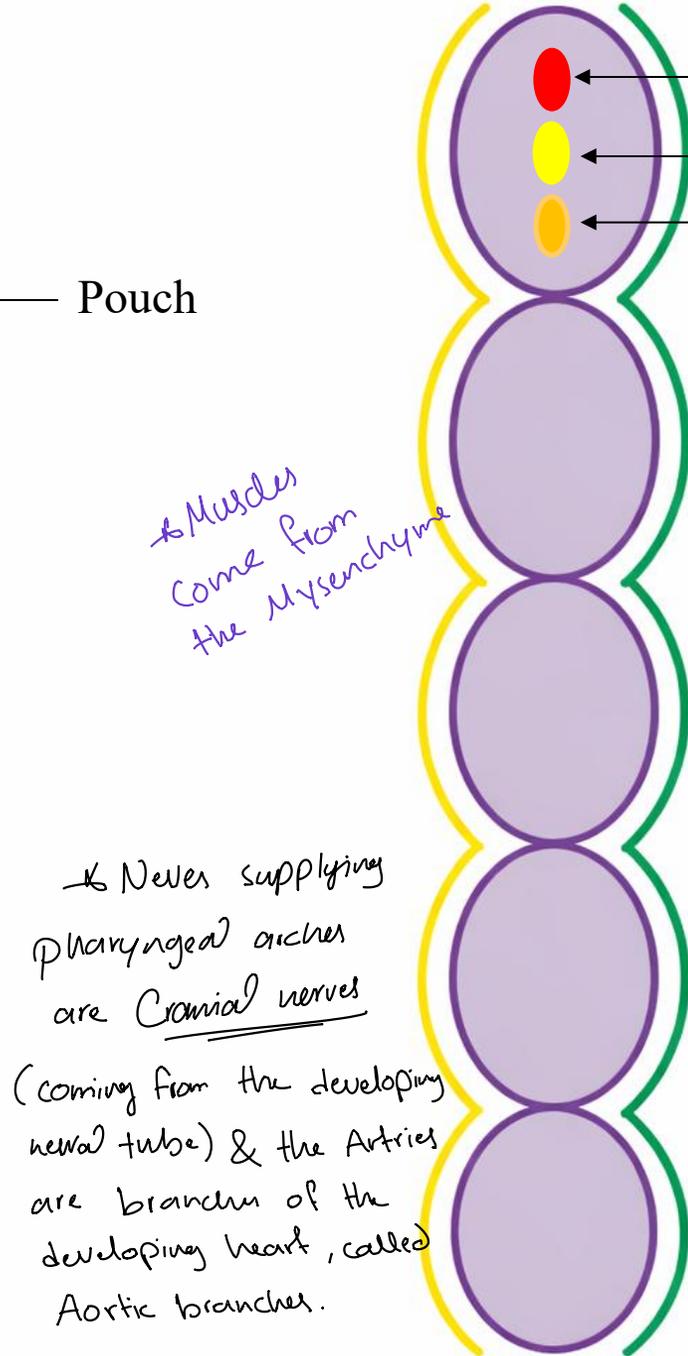
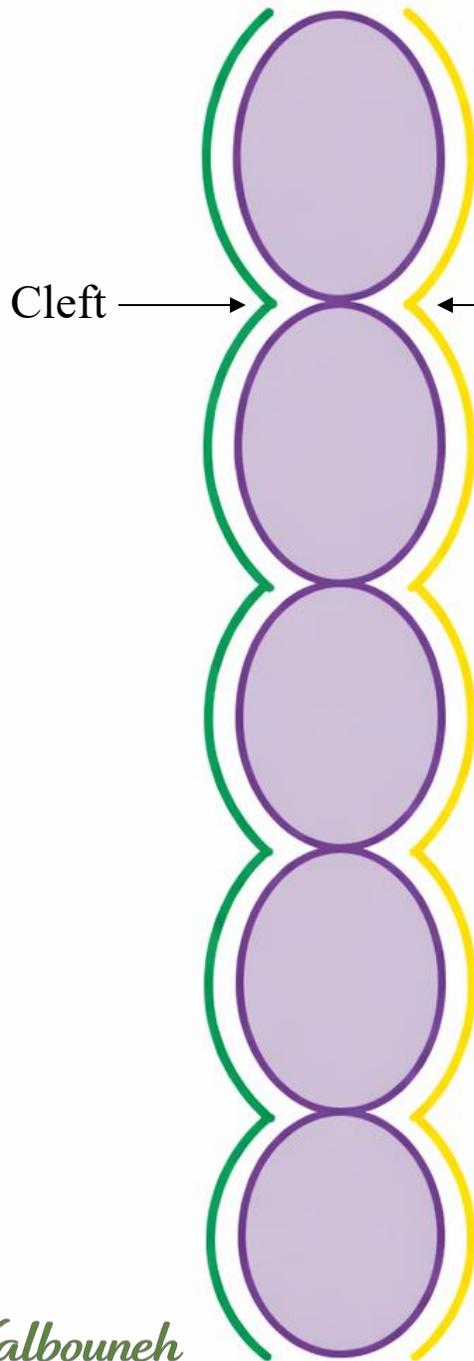
Lower limb bud



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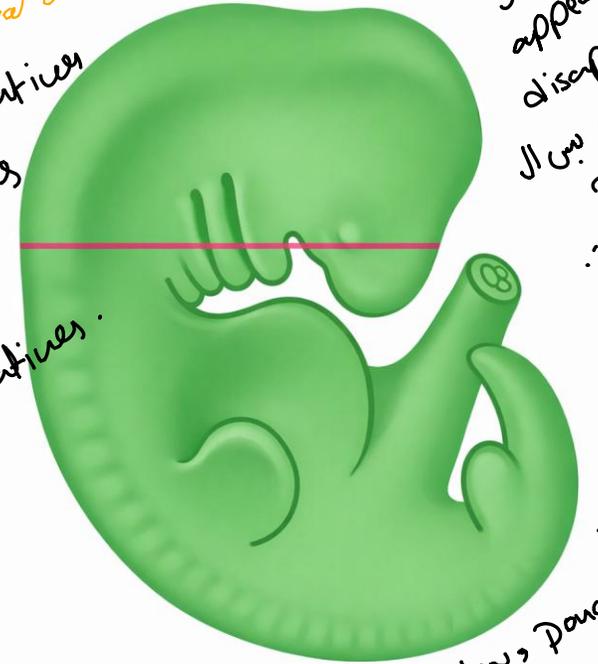
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Although six arches form, the 5th arch is rudimentary or absent in humans, so only five pharyngeal pouches are recognized.

*either remains as cartilage or undergoes endochondral ossification*

- the Arch itself has derivatives
- the Pouch has derivatives
- the Cleft has derivatives.

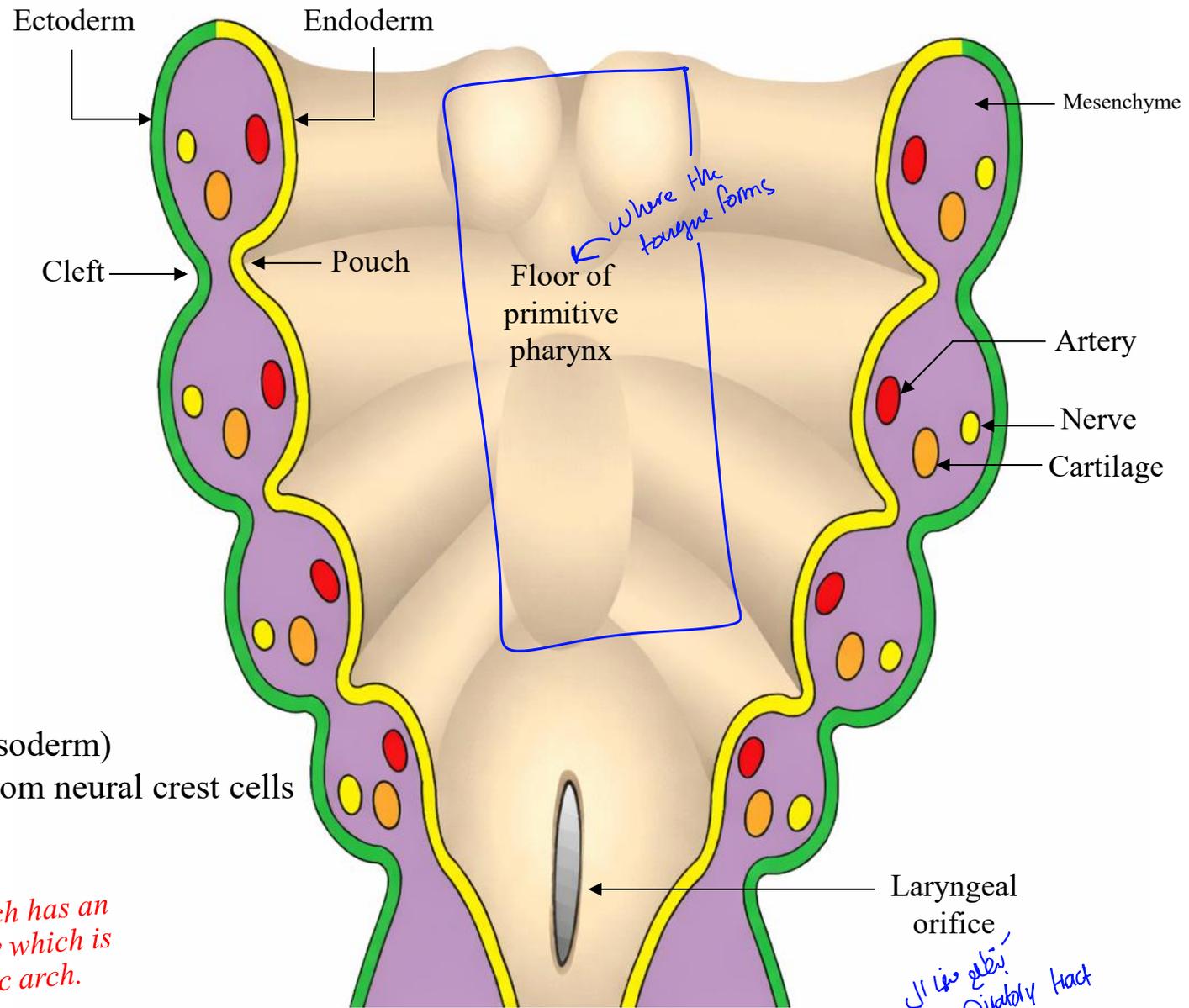
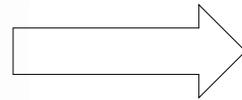
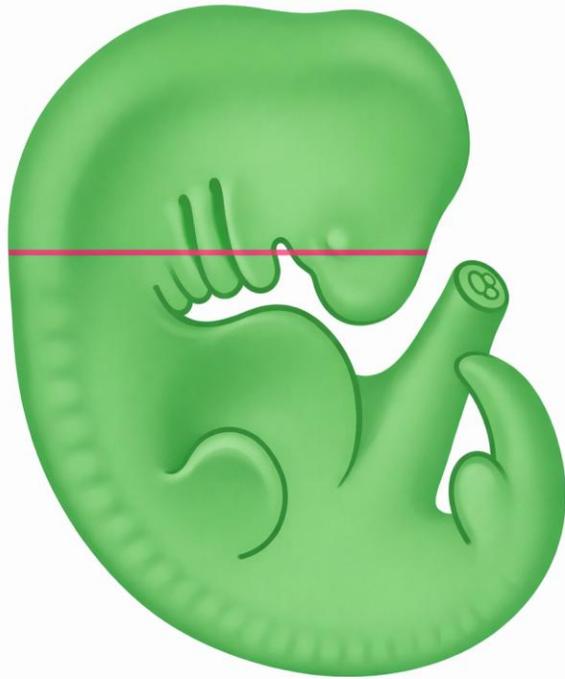


*5th arch appears then disappears, ∴ 5 Pouches, 4 Clefts*  
*5th arch appears then disappears, ∴ 5 Pouches, 4 Clefts*  
*∴ 5 Pouches, 4 Clefts*  
*∴ 5 Pouches, 4 Clefts*  
*∴ 5 Pouches, 4 Clefts*

*Muscles come from the mesenchyme*

*Nerves supplying pharyngeal arches are Cranial nerves (coming from the developing neural tube) & the Arteries are branches of the developing heart, called Aortic branches.*

**Pharyngeal apparatus (arches, clefts and pouches)**



*Note: Each arch has an arterial supply which is called aortic arch.*

*البنية التنفسية respiratory tract*

**Coronal section of neck showing structure of pharyngeal arches**

Each pharyngeal arch contains:

- Mesenchymal core (derived from neural crest cells and mesoderm)
- Cartilaginous rod (skeletal component) – mainly derived from neural crest cells
- Muscle component – derived from mesoderm
- Aortic arch artery
- Cranial nerve supplying the arch
- External ectoderm covering
- Internal endoderm lining

# Nerve supply of pharyngeal arches

*of the trigeminal nerve (V)*

**Mandibular & Maxillary nerves** supplies derivatives of **1<sup>st</sup> arch**

**Facial nerve** supplies derivatives of **2<sup>nd</sup> arch**

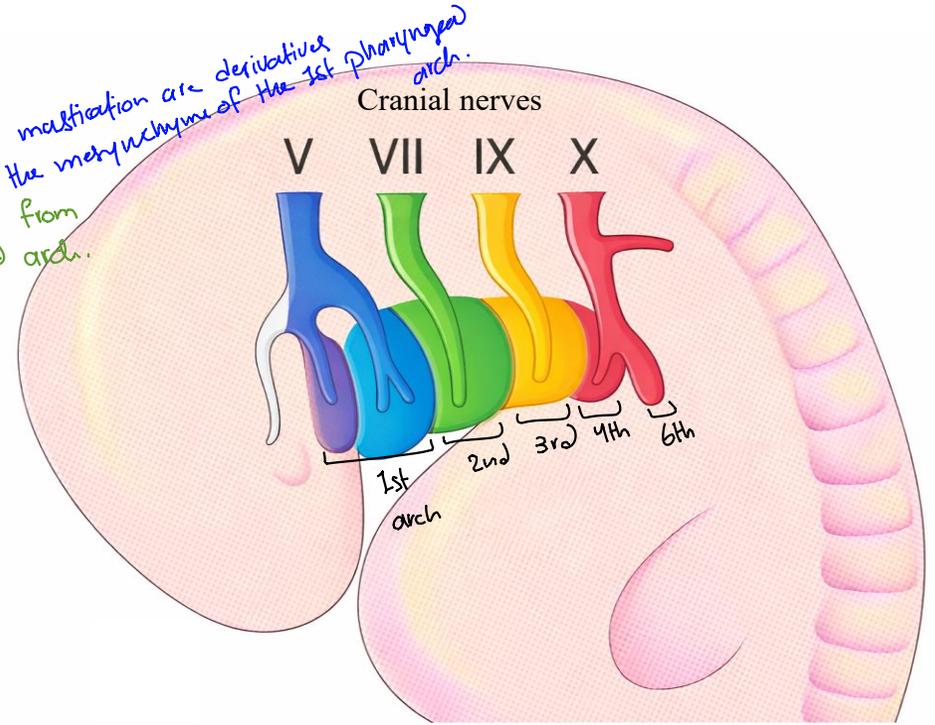
**Glossopharyngeal nerve** supplies derivatives of **3<sup>rd</sup> arch**

**Superior laryngeal nerve (vagus nerve)** supplies derivatives of **4<sup>th</sup> arch**

**Recurrent laryngeal nerve (vagus nerve)** supplies derivatives of **6<sup>th</sup> arch**

*muscles of mastication are derivatives of the mesenchyme of the 1<sup>st</sup> pharyngeal arch.*

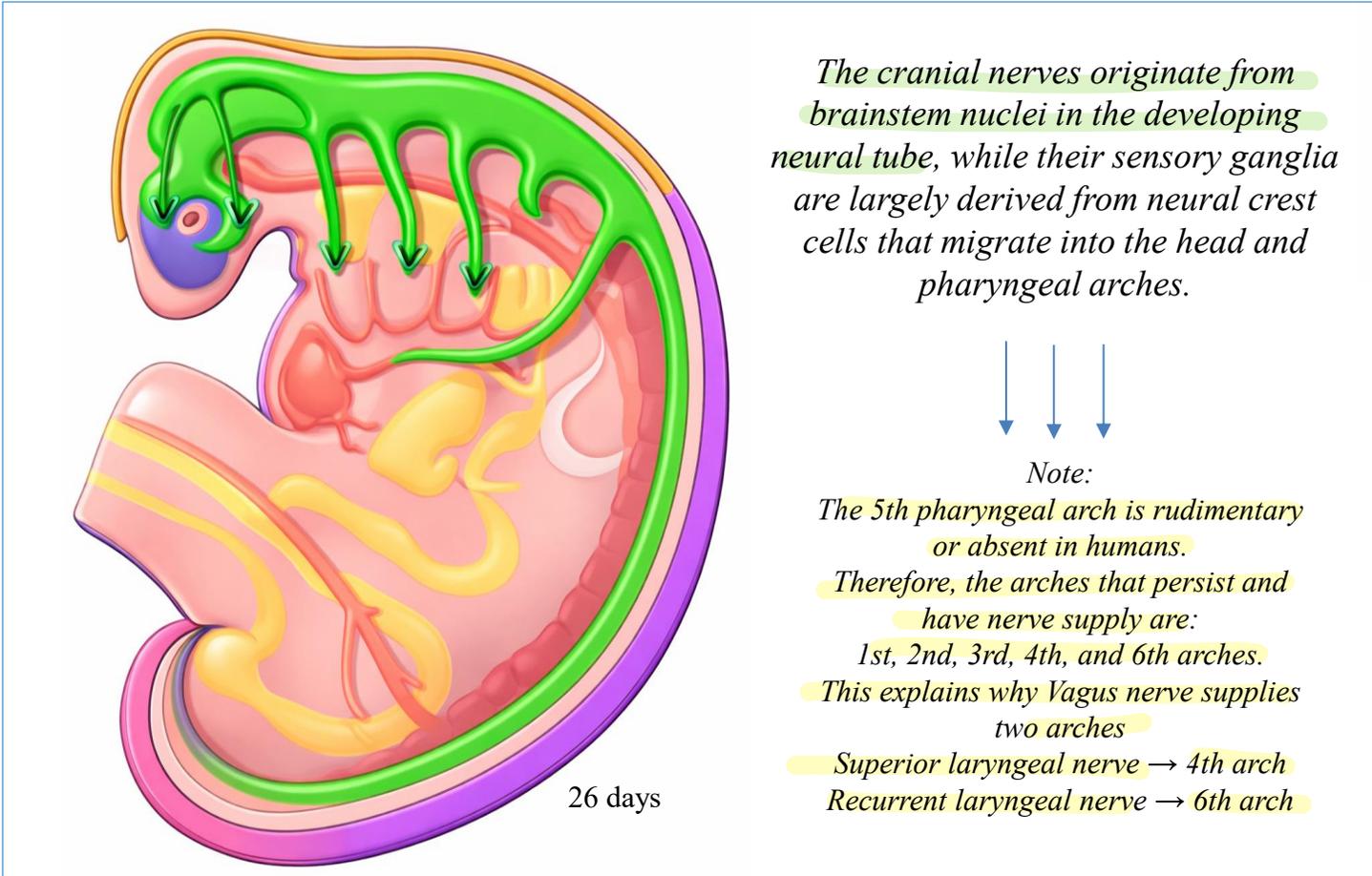
*muscles of facial expression are derived from mesenchyme of 2<sup>nd</sup> arch.*



*Each nerve supplies the mucosa and muscles derived from the arch*

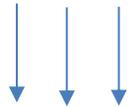
*Each arch has its own cranial nerve and wherever the muscle cells migrate, they carry their nerve component with them*  
*Example: Muscles of facial expression migrate over the face and innervated by CN VII.*

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26 days

*The cranial nerves originate from brainstem nuclei in the developing neural tube, while their sensory ganglia are largely derived from neural crest cells that migrate into the head and pharyngeal arches.*



**Note:**

*The 5<sup>th</sup> pharyngeal arch is rudimentary or absent in humans.*

*Therefore, the arches that persist and have nerve supply are:*

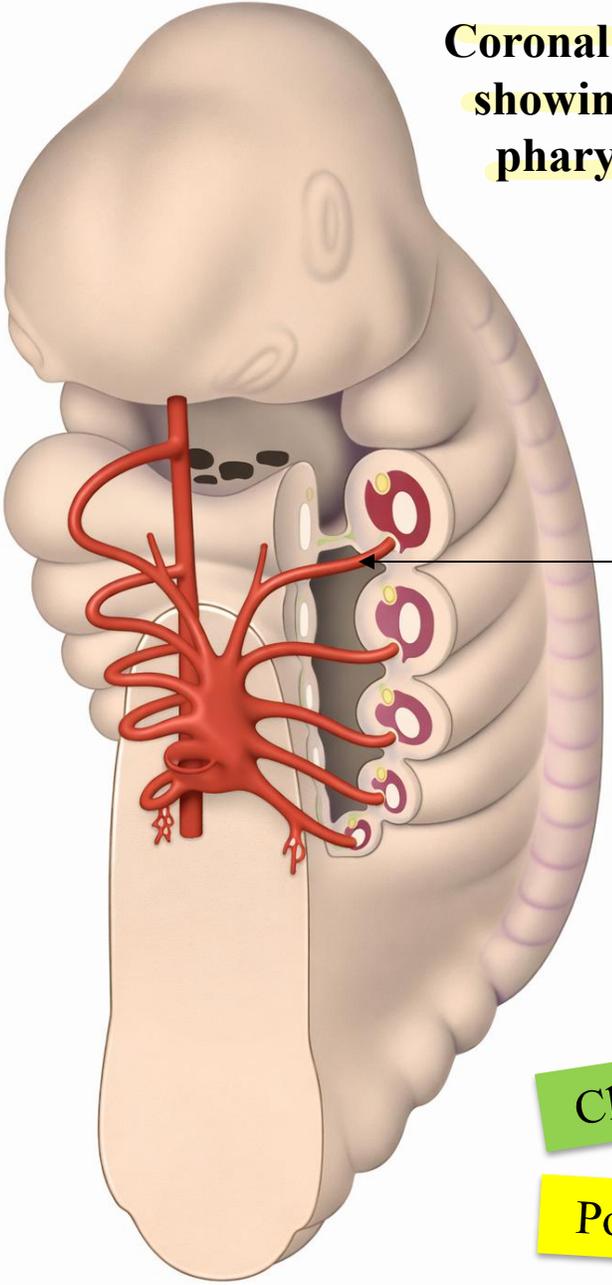
*1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 6<sup>th</sup> arches.*

*This explains why Vagus nerve supplies two arches*

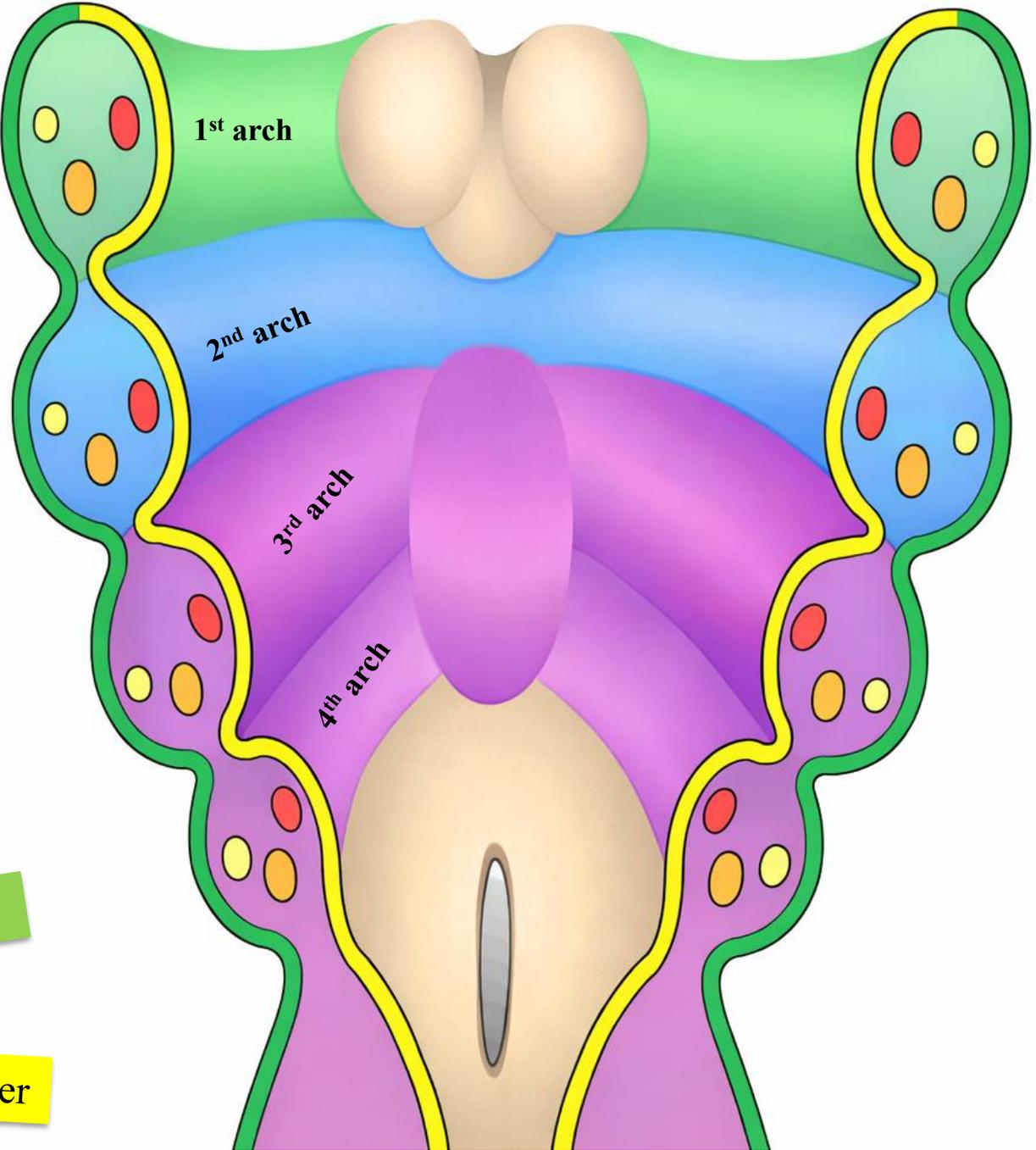
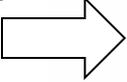
*Superior laryngeal nerve → 4<sup>th</sup> arch*

*Recurrent laryngeal nerve → 6<sup>th</sup> arch*

**Coronal section of neck  
showing structure of  
pharyngeal arches**



1<sup>st</sup> aortic arch



Clefts are **four** in number

Pouches are **five** in number

The **first arch** lies in a very special location : It actually lies in the **face**. Now, we've mentioned that the face and neck will form in the area between the two bulges, the forebrain bulge and the pericardial bulge, which is a depression called the stomodium. Now, the face does not have to be depressed, so the first pharyngeal arch will form two processes ( maxillary and Mandibular ) which will close the face laterally ( from the sides) . This means that the first pharyngeal arch will give derivatives which are face components. What are the Mandibular and Maxillary processes? each of the pharyngeal arches has a dorsal end and a ventral end. The ventral end grows ventrally and the dorsal end grows dorsally, **EXCEPT for the first pharyngeal arch**, as both ends will grow ventrally to form the lower portion of the face ( maxilla and the mandible ) , meaning that the dorsal end will kind of turn forward and continue growing ventrally , forming the maxillary process , in order to close the face from the sides .( with the other process , Mandibular, which is the original ventral end growing ventrally ). And the two Mandibular processes of the two first arches on both sides will eventually merge to form the synthesis menti, as the mandible is a single bone, not a paired bone.

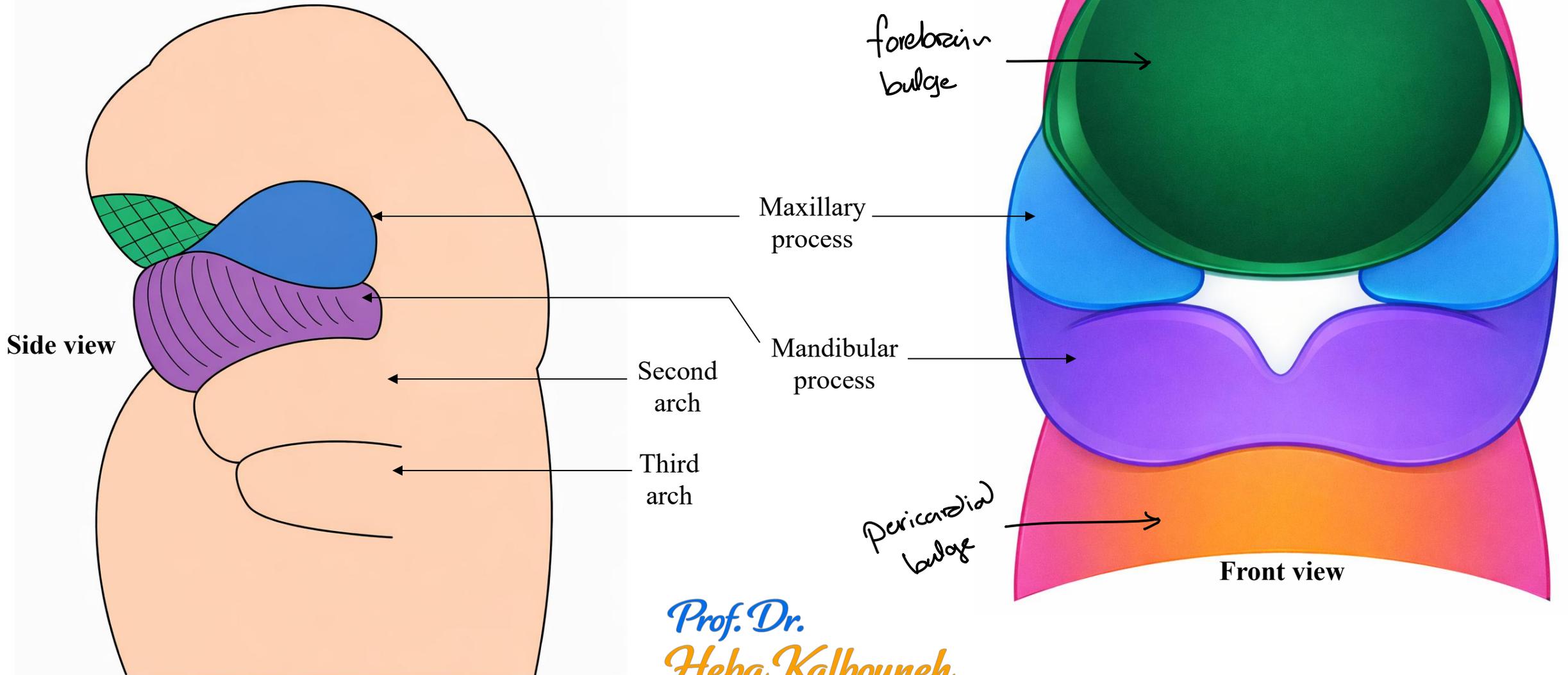
+the forebrain bulge grows downward to form the frontonasal process

∴ the face will be formed by ⑤ processes.  
2 Maxillary, 2 Mandibular, Frontonasal

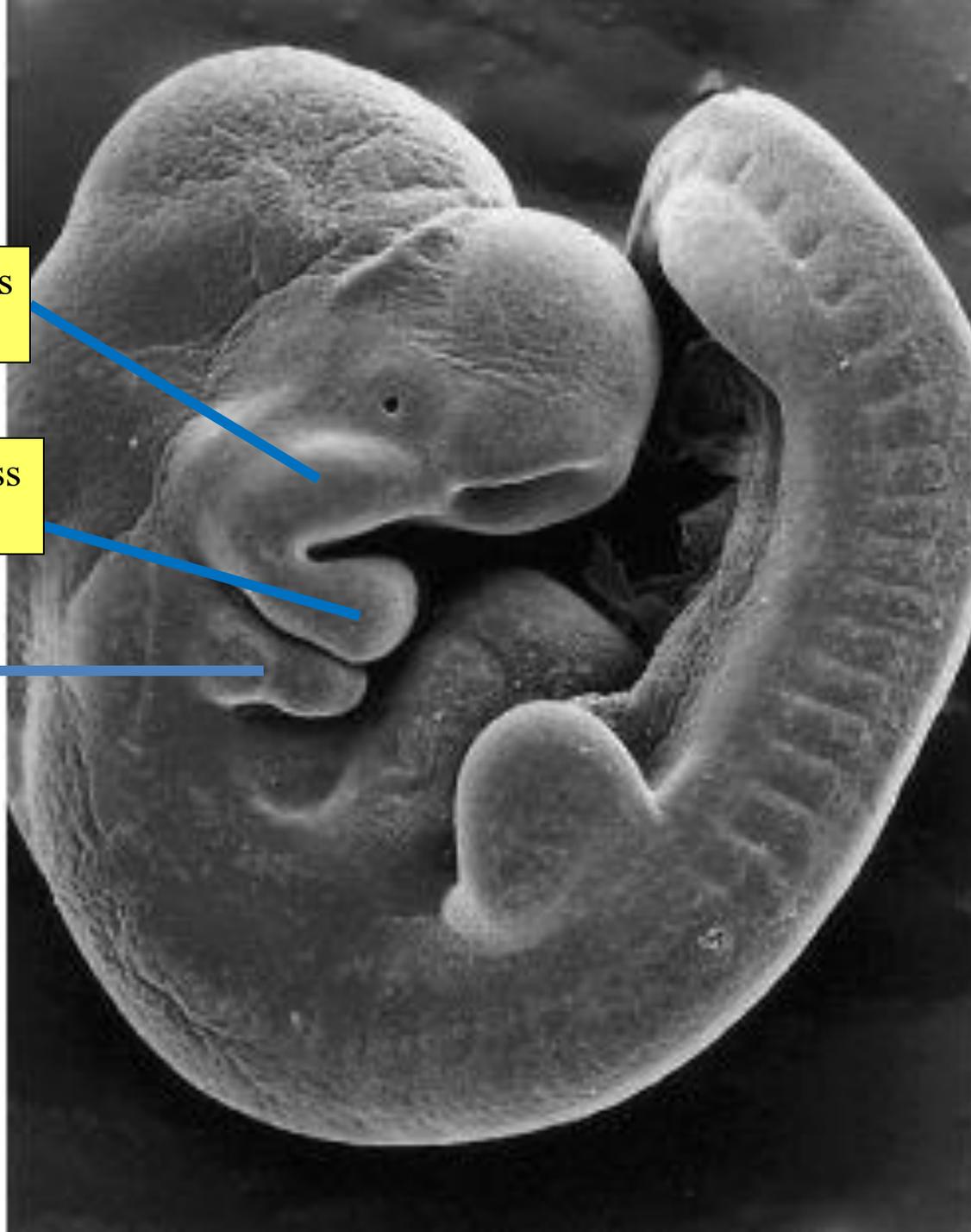
**First arch** has 2 processes:

- 1- Maxillary process
- 2- Mandibular process

*Both processes grow forward*



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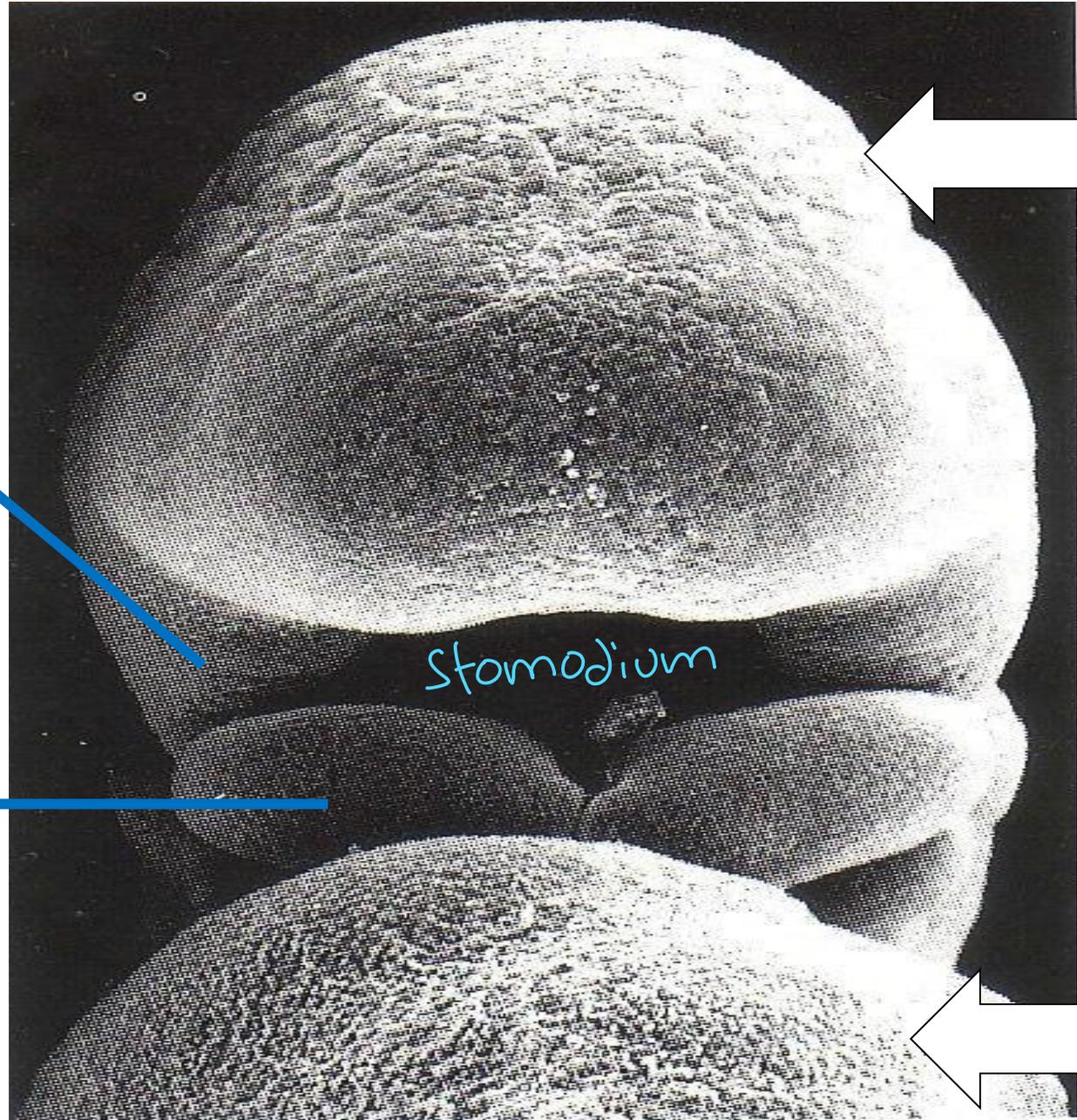


Maxillary process  
of first arch

Mandibular process  
of first arch

Second arch

- ✓ Maxillary process is a forward growth of dorsal end of 1<sup>st</sup> pharyngeal arch.
- ✓ Mandibular process is a forward growth of ventral end of 1<sup>st</sup> pharyngeal arch



Forebrain bulge

Maxillary process  
of first arch

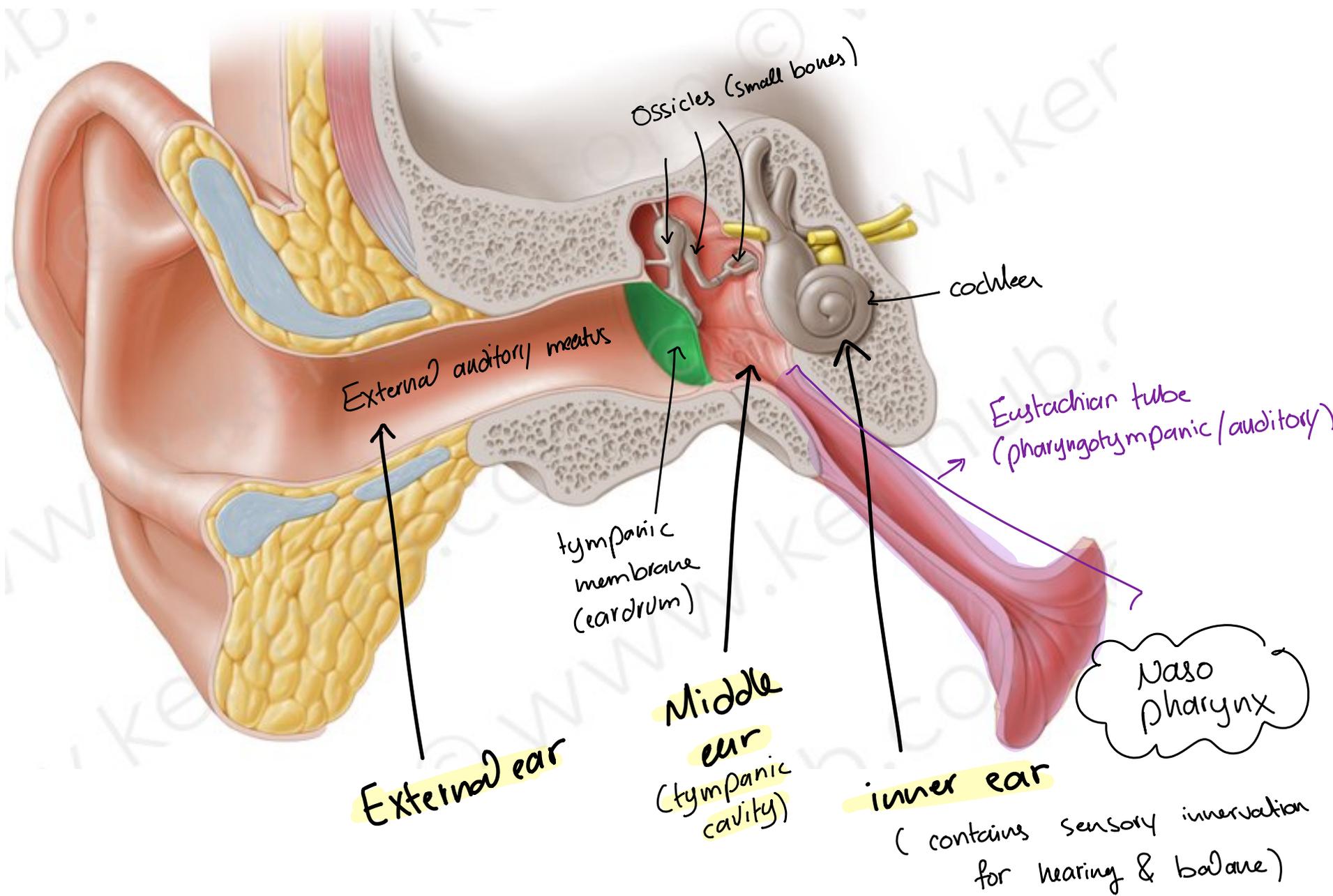
Stomodium

Mandibular process  
of first arch

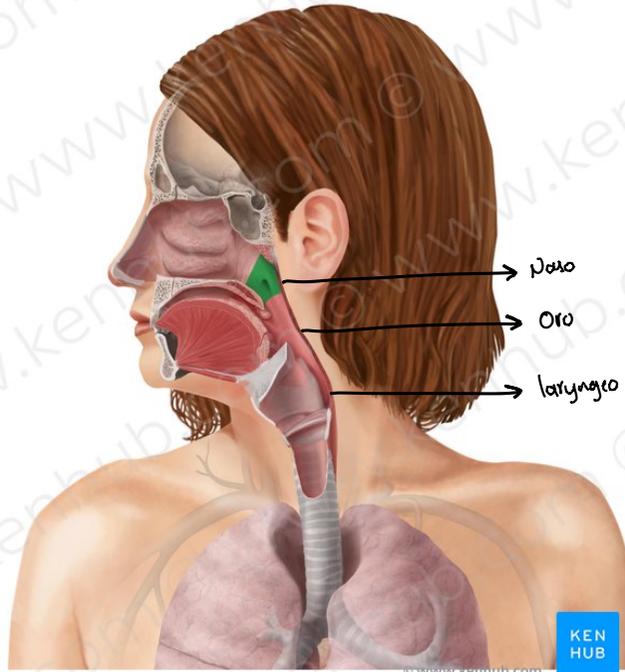
Pericardial bulge

Fourth Week

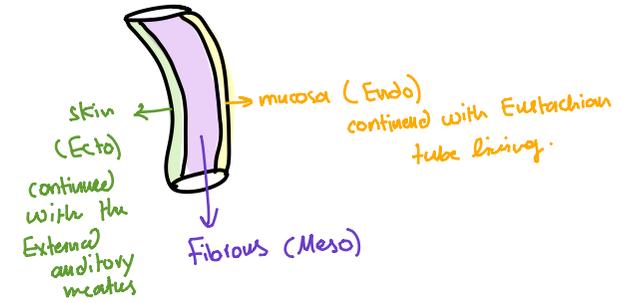
# Overview of the Anatomy of the Ear



→ Naso pharynx (green) :-



→ The tympanic membrane is lined by skin (ectoderm) from the outer side, & mucosa from the inner side, in between: Fibrous tissue.



→ Middle ear is filled with? Air  
 ∴ When you breath, you fill Middle ear with air.

→ Middle ear Ossicles :-



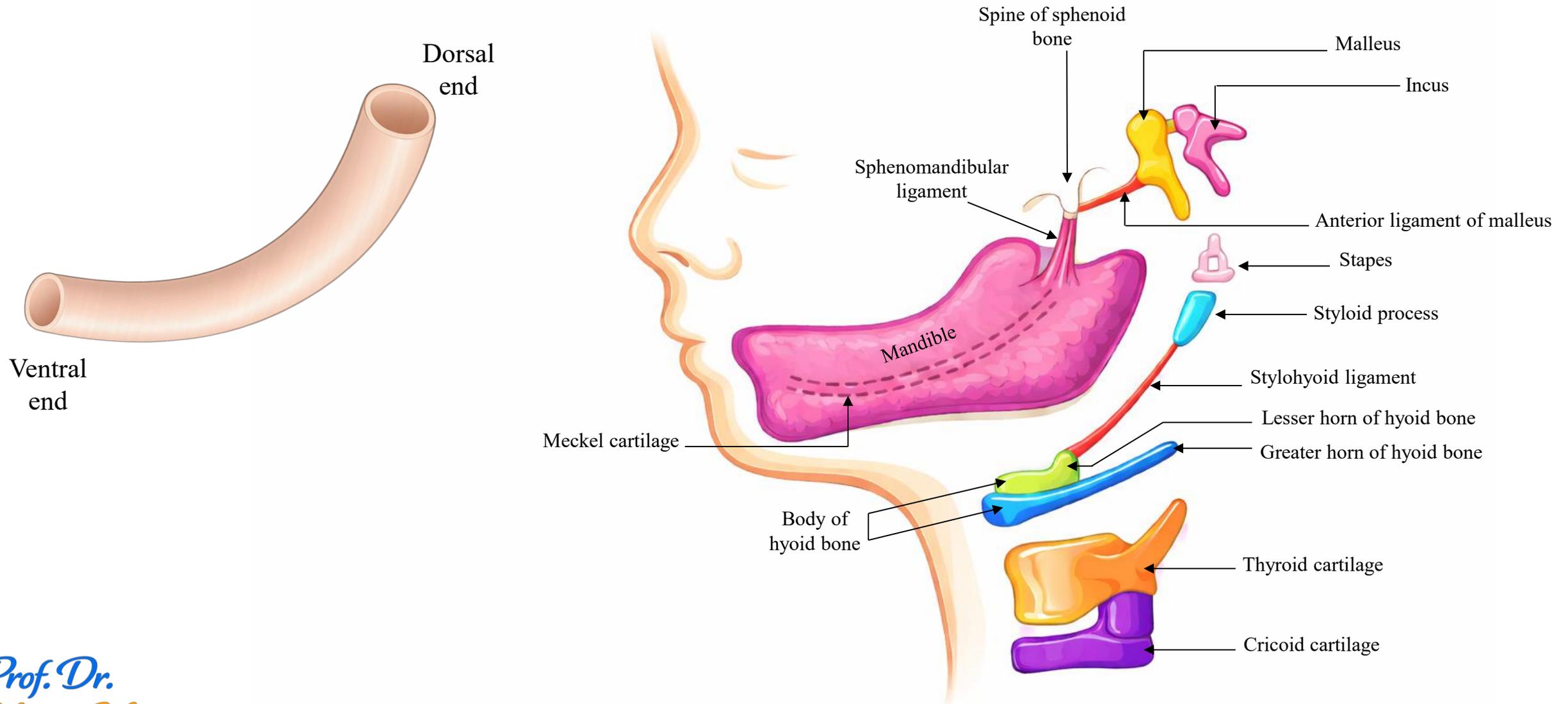
Malleus

Incus

Stapes

← لما الان تسر (زي لما تسزل عالفور)،  
 بتكون الكلبة فانتحوا (لعندال middle ear) (pushed inward)  
 لانه اشتمل هينط اخوا اللي برا عنه اللي هوا (المخال middle ear)  
 فلما بعني تملح هوا عشان تعقها، اهو  
 بيوصل ال middle ear عن طريق Eustachian → بتزيد الفنتا جوا  
 ف بيغتن العيلة لعلها الاهلي نبتس رانك فنت .

# Derivatives of pharyngeal arches



# Derivatives of first pharyngeal arch

## Maxillary process forms:

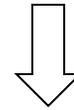
1. Lower part of temporal bone
2. Zygomatic bone
3. Maxilla

## Mandibular process forms

Meckel's cartilage

### Meckel's cartilage by endochondral ossification:

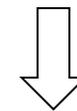
Ventral part



Ramus of mandible

الجزء الراجع من الفك  
يتم تشكيله مباشرة من  
الغضروف من الأجزاء  
التي تتكون من الغضروف  
(التصلب الغضروفي)

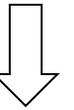
Middle part



- 1- Anterior ligament of malleus
- 2- Sphenomandibular ligament

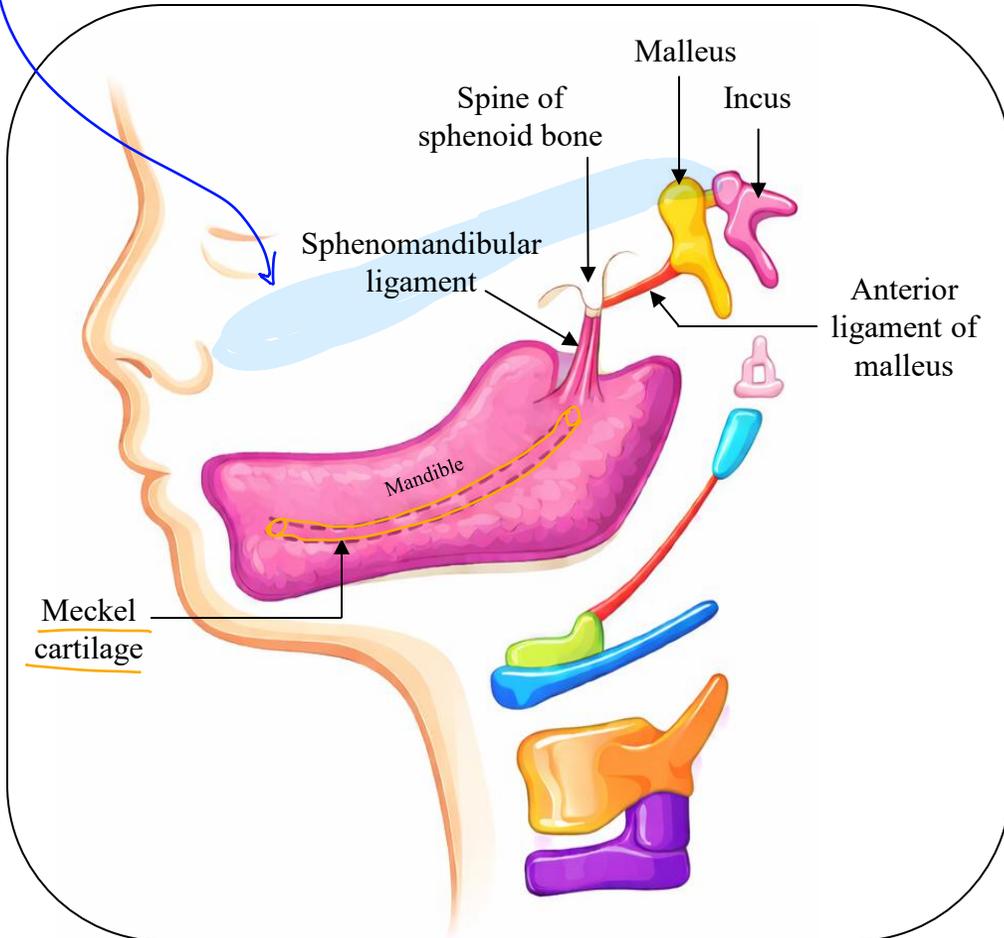
\* it disappears,  
but its perichondrium  
persists as  
2 ligaments

Dorsal part



- 1- Malleus
- 2- Incus

N.B The rest of the mandible is formed by intramembranous ossification



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## Muscles of first pharyngeal arch:

Are the muscles supplied by the **mandibular nerve**:

1. Muscles of mastication
2. Tensor tympani
3. Anterior belly of digastric
4. Mylohyoid
5. Tensor veli palatini

*The nerve supply to the muscles of the first arch is provided by the mandibular branch of the trigeminal nerve.*

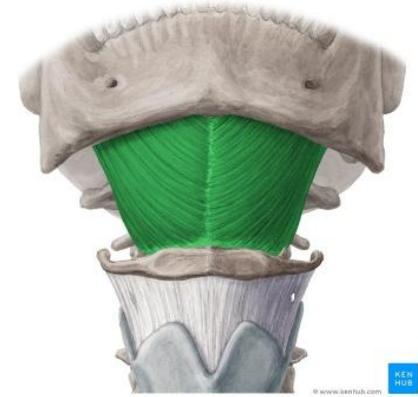
*Since mesenchyme from the first arch also contributes to the dermis of the face, sensory supply to the skin of the face is provided by ophthalmic, maxillary, and mandibular branches of the trigeminal nerve.*

*↳ Digastric muscle has double nerve supply (for the 2 bellies) ∴ Double origin*

Masseter & Temporalis

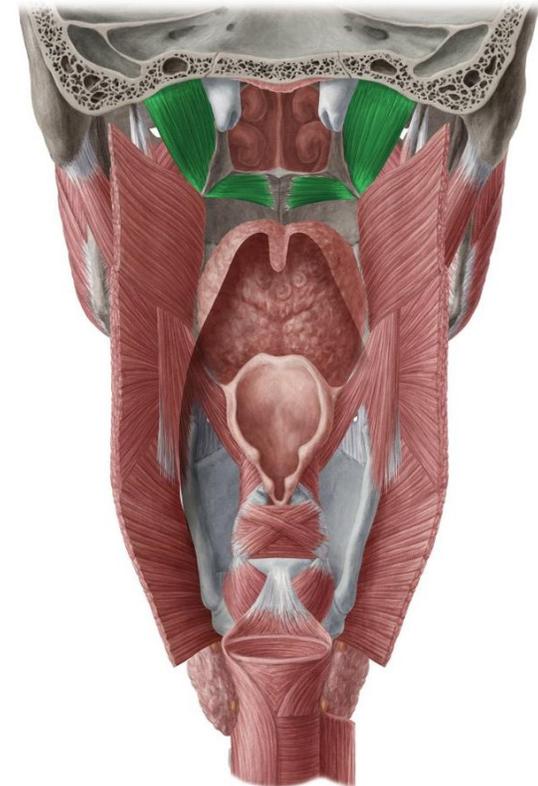


Mylohyoid

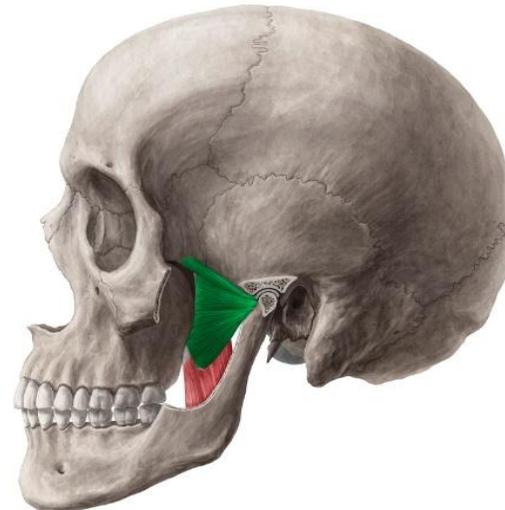


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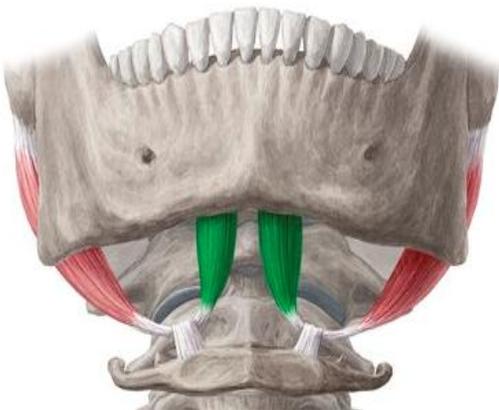
Tensor veli palatini



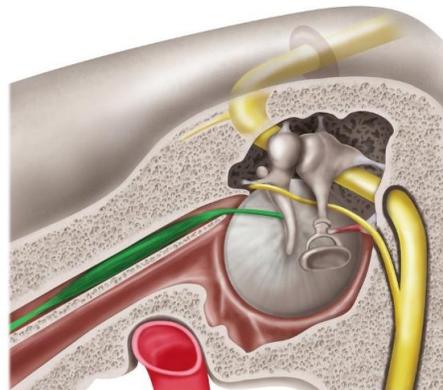
Medial & Lateral pterygoids



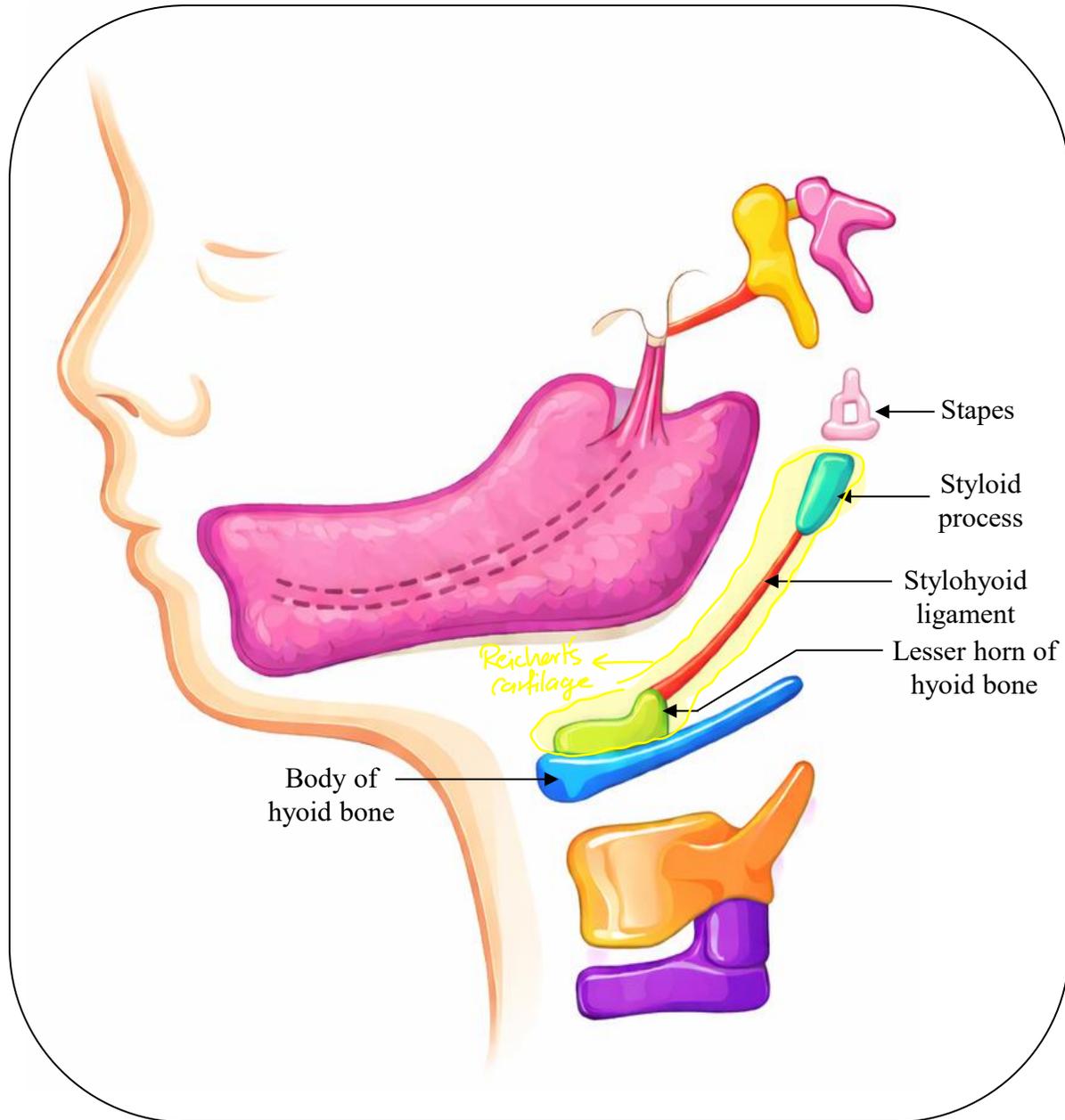
Anterior belly of digastric



Tensor tympani

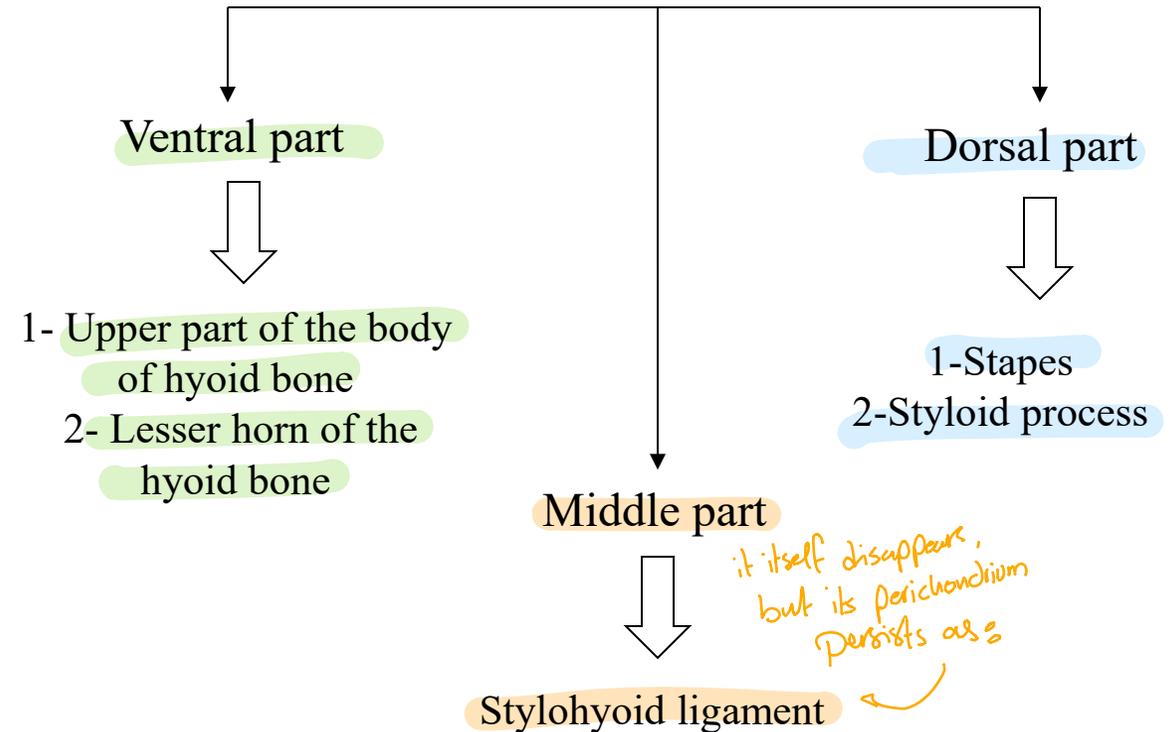


# Derivatives of second pharyngeal arch



The cartilage of the second or hyoid arch  
(Reichert's cartilage)

## Reichert's cartilage

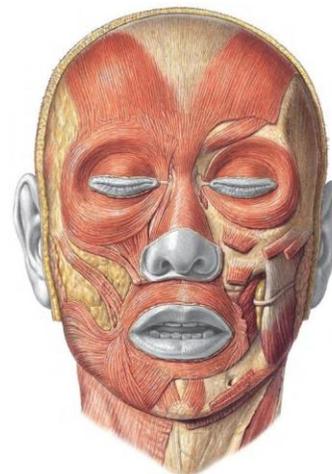


## Muscles of second pharyngeal arch:

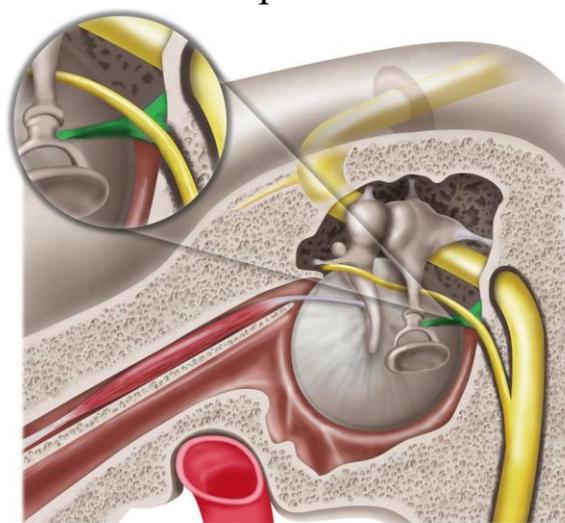
Are the muscles supplied by the facial nerve:

- 1-Muscle of facial expression
- 2- Stapedius
- 3- Stylohyoid
- 4-Posterior belly of the digastric

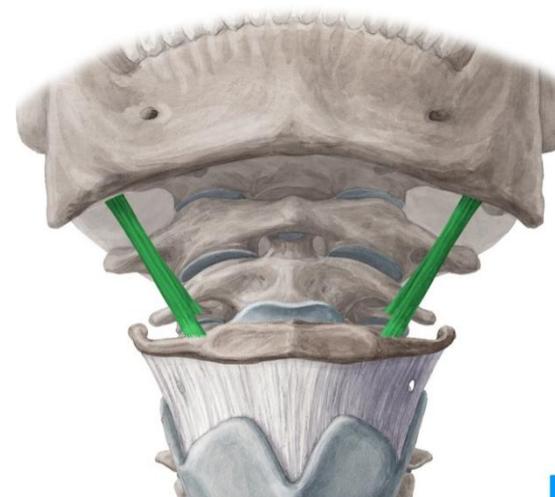
Muscle of facial expression



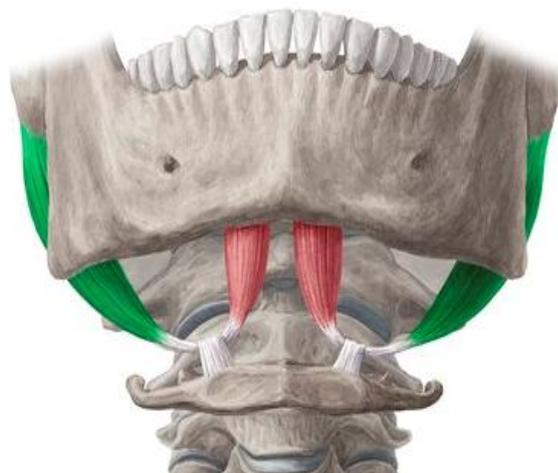
Stapedius



Stylohyoid



Posterior belly of the digastric



## Derivatives of third pharyngeal arch

The cartilage of the third pharyngeal arch produces:

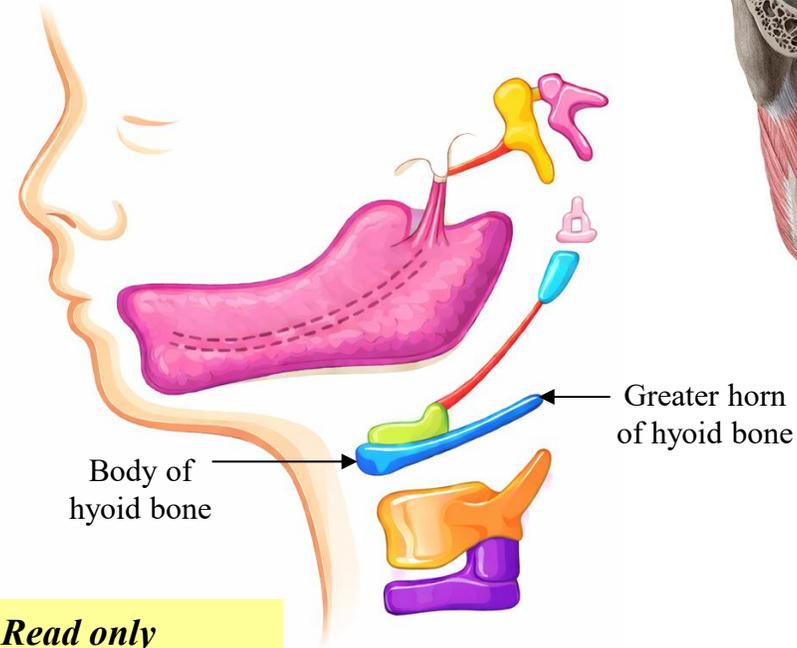
- 1- Lower part of the body of hyoid
- 2- Greater horn of hyoid bone

**Muscles of third pharyngeal arch:**

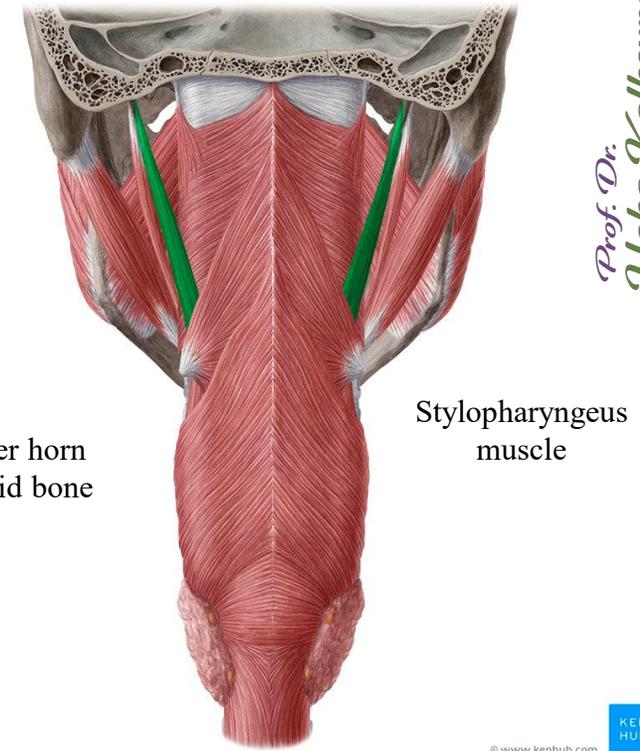
Only one muscle supplied by

**Glossopharyngeal nerve:**

Stylopharyngeus muscle



*Read only  
(For Digestive System)*



## Derivatives of fourth pharyngeal arch

The cartilage of the fourth pharyngeal arch produces:

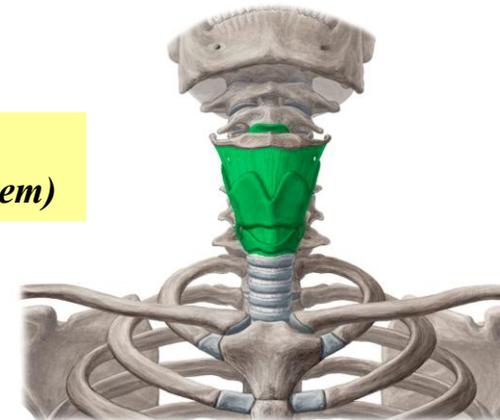
Laryngeal cartilages, ex: Thyroid cartilage

**Muscles of fourth pharyngeal arch:**

Only one muscle (Cricothyroid muscle)

Supplied by **Superior laryngeal nerve (vagus)**

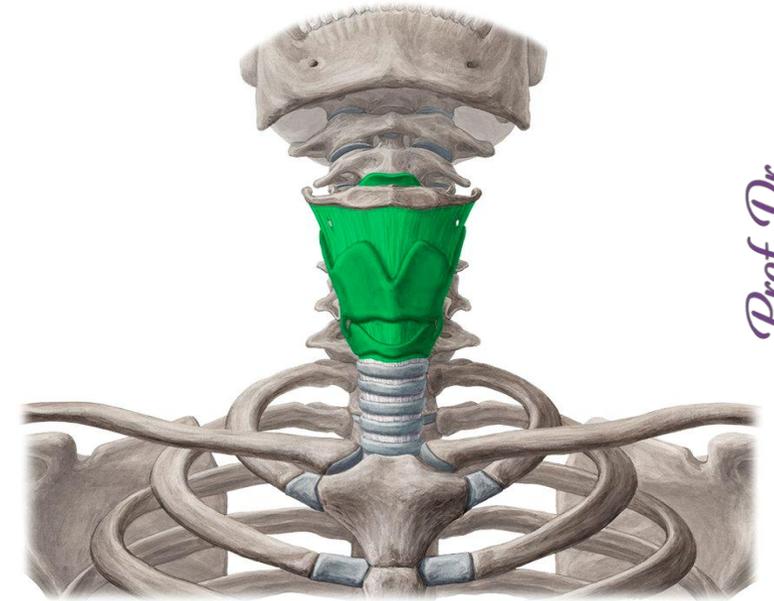
*Read only  
(For Respiratory System)*



## Derivatives of sixth pharyngeal arch

The cartilages of the sixth pharyngeal arch produce:  
Laryngeal cartilages

**Muscles of sixth pharyngeal arch:**  
All laryngeal muscles (except cricothyroid)  
Supplied by **Recurrent laryngeal nerve (vagus nerve)**



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*Read only  
(For Respiratory System)*

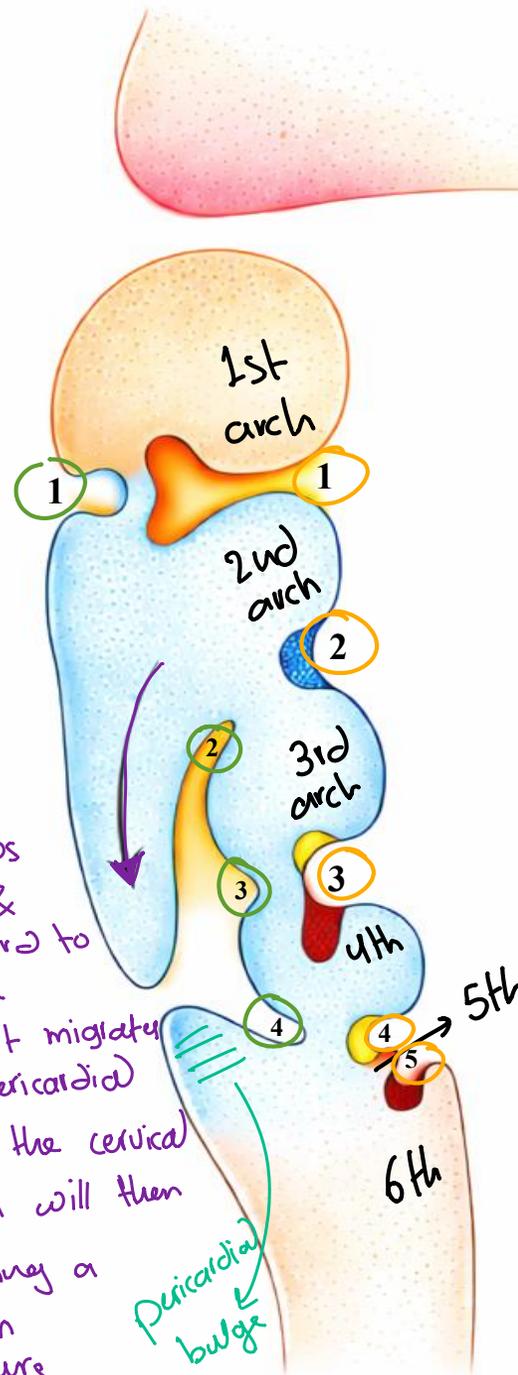


This is a coronal section, from one side

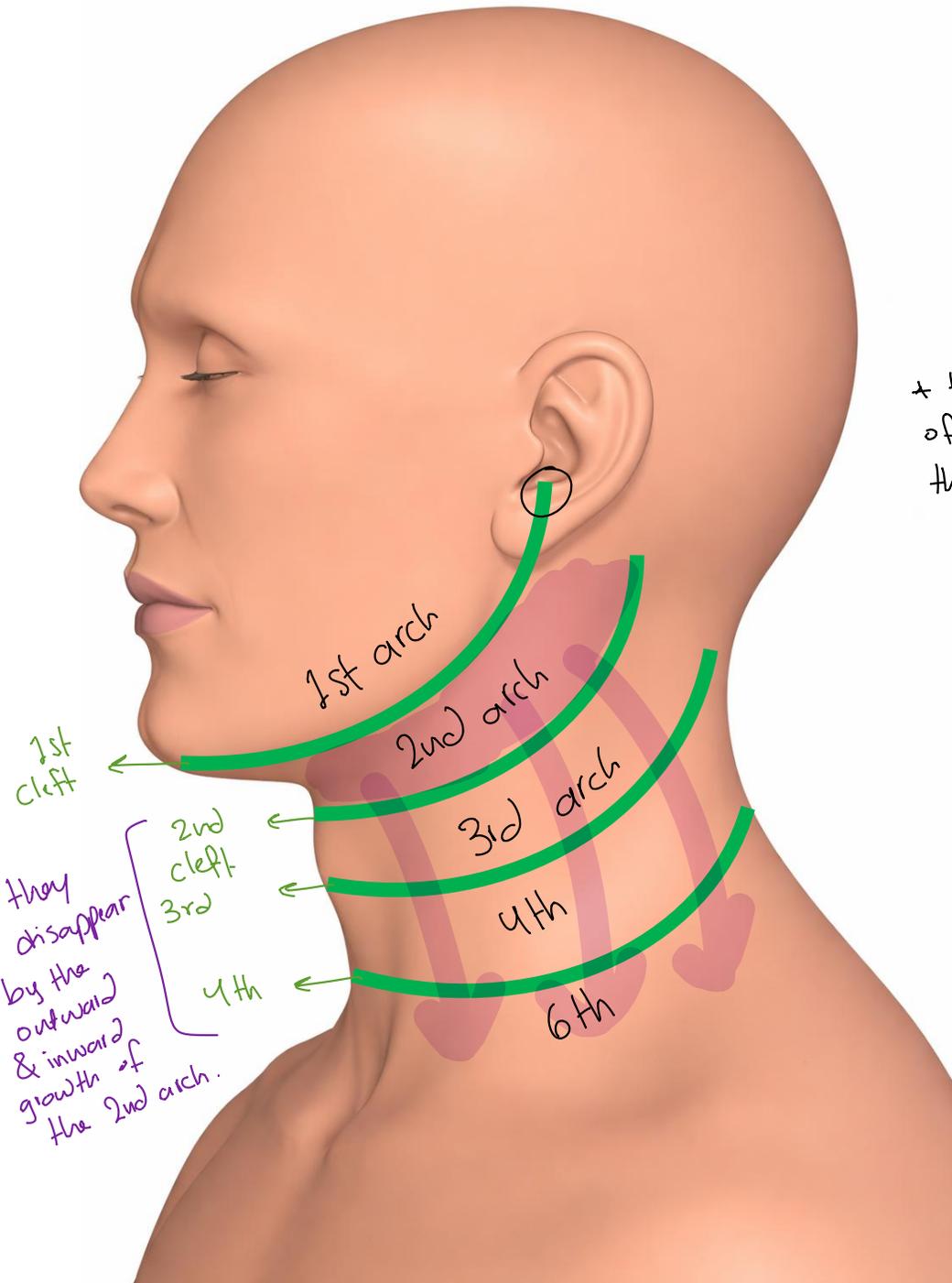
4 pharyngeal clefts

5 pharyngeal pouches

The 2nd arch grows outward & downward to cover the clefts, it migrates toward the pericardial bulge, forming the cervical sinus, which will then close forming a cyst, then complete closure







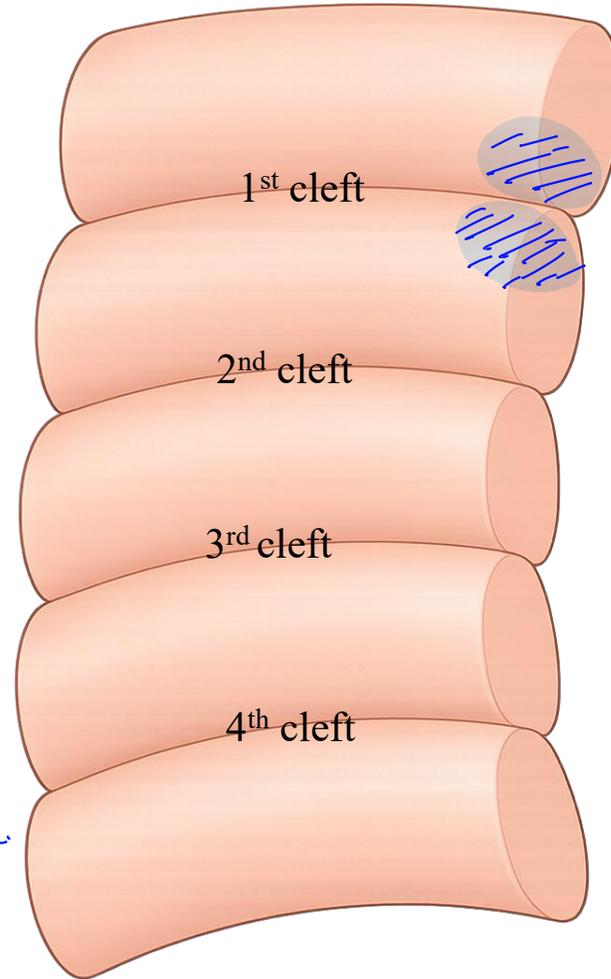
+ the Dorsal end of the 1st cleft forms the External Auditory meatus.

What about the Auricle?

The Auricle is formed from thickenings of the ectoderm above & below the dorsal end of the 1st cleft, as they form tubercles that will later form the Auricle in a very special & distinct shape.

Ventral ends

Dorsal ends



Auricle will form here

Ectodermal tubercles forming the auricle

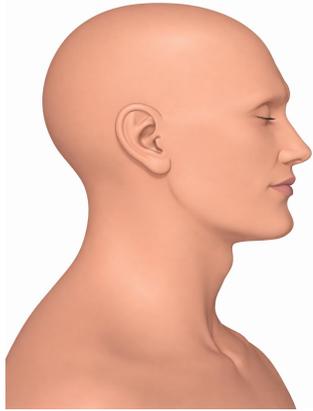


# First pharyngeal cleft

Forms: by its dorsal end :-

- 1- External auditory meatus
- 2- Outer layer of tympanic membrane (skin)

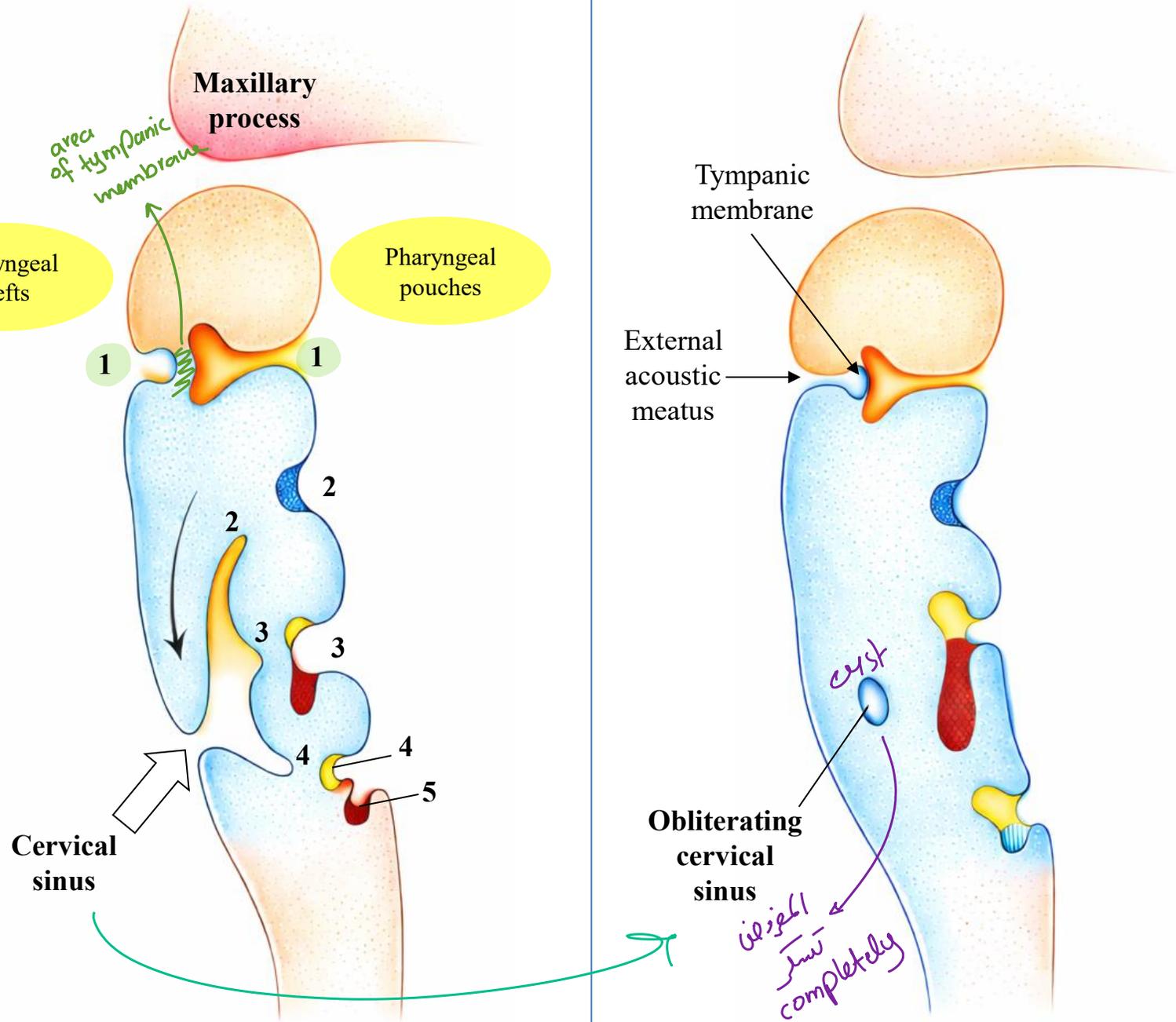
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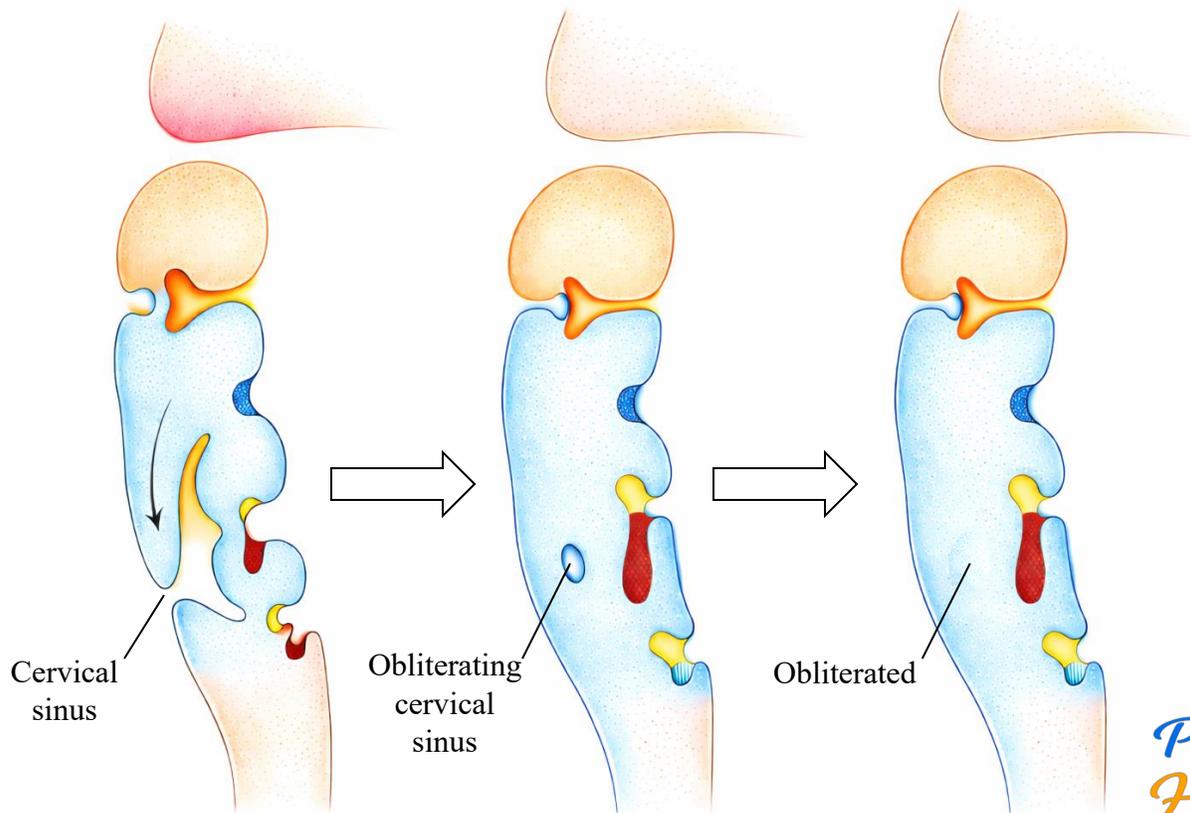
## 2<sup>nd</sup> 3<sup>rd</sup> and 4<sup>th</sup> pharyngeal clefts

Note the downward growth of 2<sup>nd</sup> arch

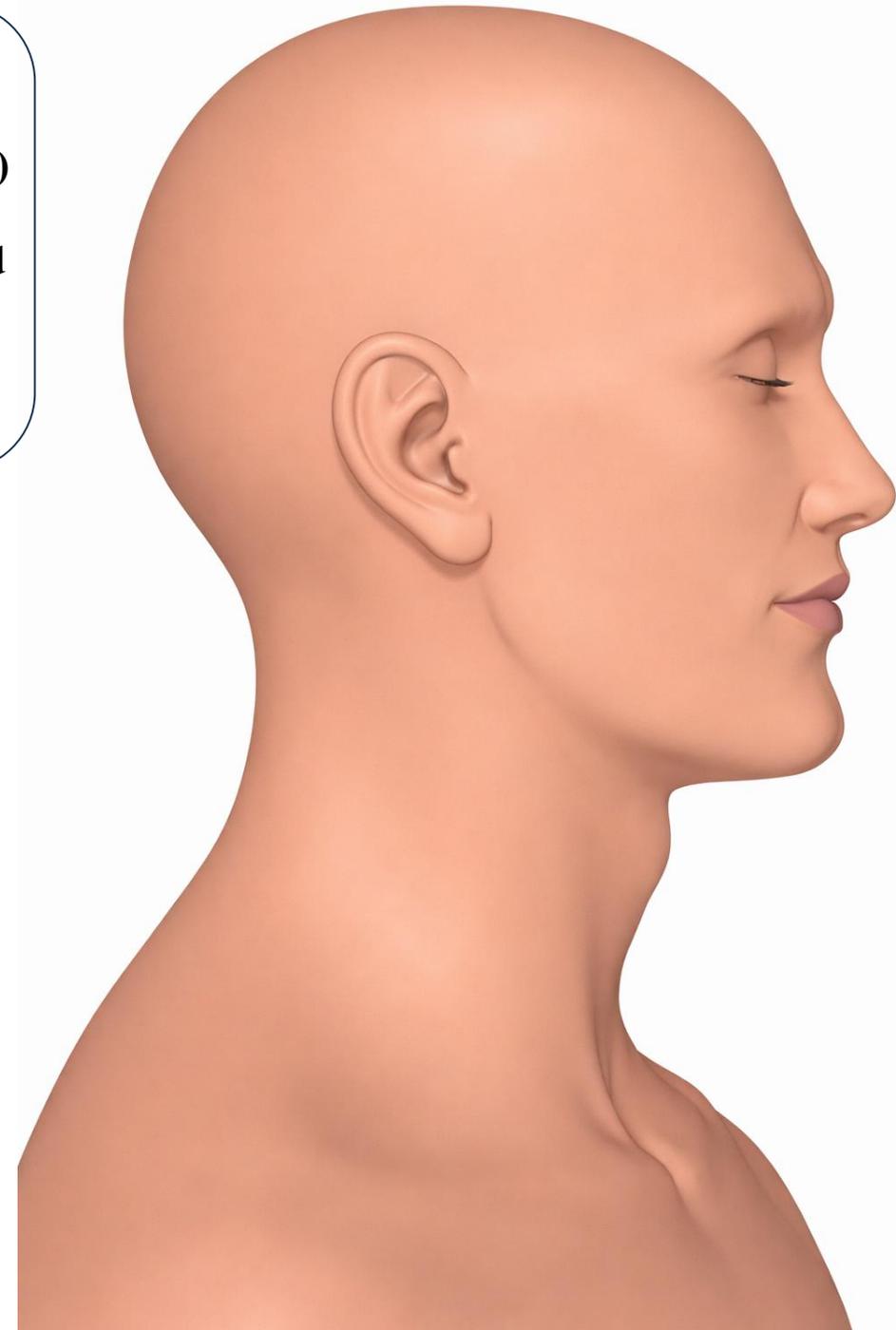
- Downward and backward growth of 2<sup>nd</sup> arch will cover the other clefts with a space in between called **cervical sinus**.
- Cervical sinus becomes smaller till it is completely obliterated

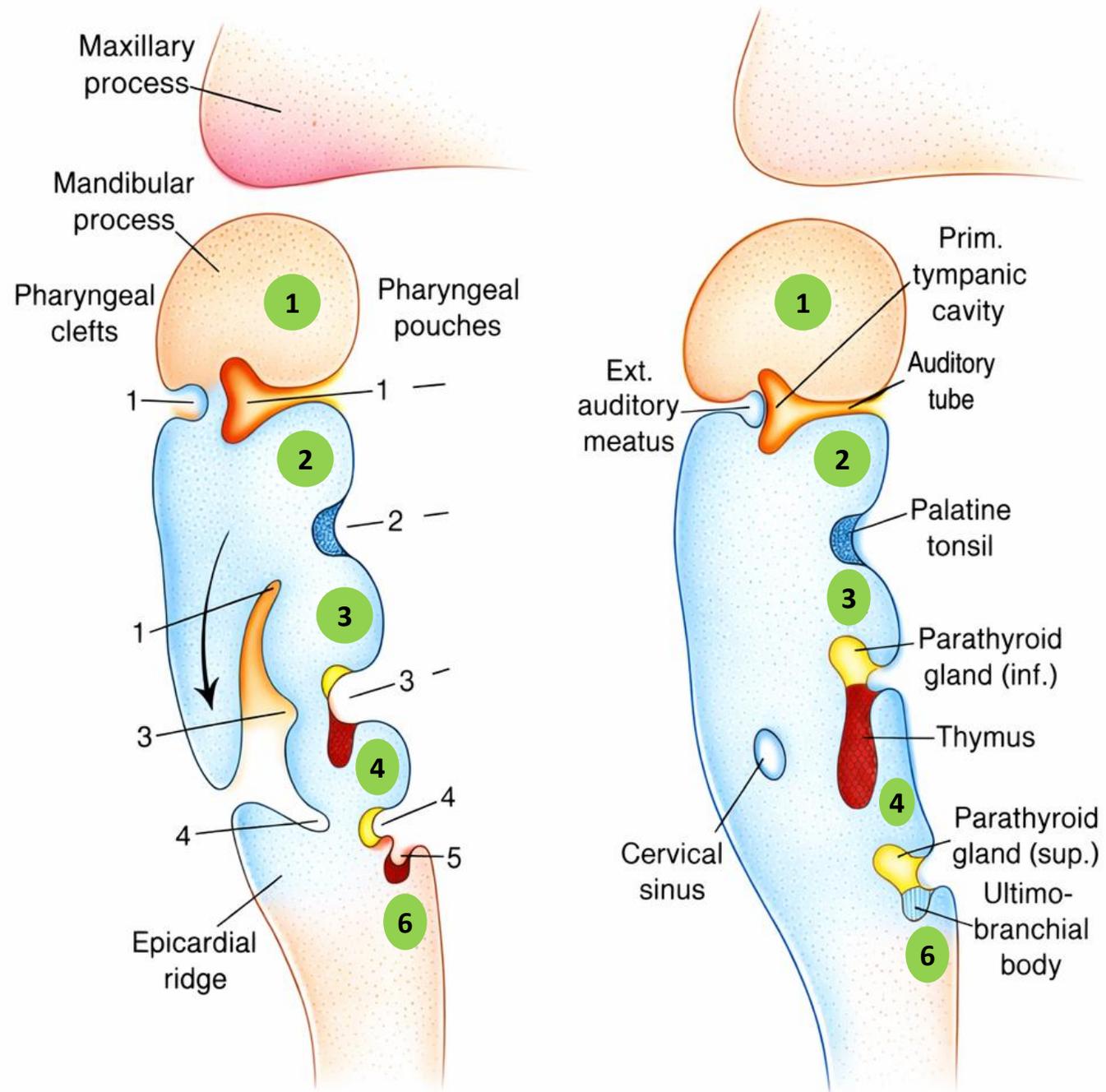


During early embryonic development, the lateral surface of the neck initially shows a segmented appearance due to the presence of the pharyngeal arches separated by pharyngeal clefts. As development progresses, the **second pharyngeal arch (hyoid arch)** grows caudally and posteriorly, extending over the third and fourth arches. This downward expansion covers the intervening clefts and forms a temporary ectoderm-lined cavity known as the **cervical sinus**, which later disappears as the tissues fuse and remodel. As a result, the initially segmented pharyngeal region becomes smooth, producing the **characteristic smooth contour of the neck** seen in normal anatomy.



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## Cervical (branchial) cyst

- Remnant of cervical sinus (didn't close completely)
- Can form a fluid filled cyst in the neck

## Cervical (branchial) fistula

Results from persistence of the cervical sinus, forming an epithelial-lined tract. If the tract opens to the skin of the neck, it is called an external fistula; if it opens into the pharynx, it is called an internal fistula.

*The cervical cyst is usually not visible at birth but becomes evident as it enlarges during childhood.*

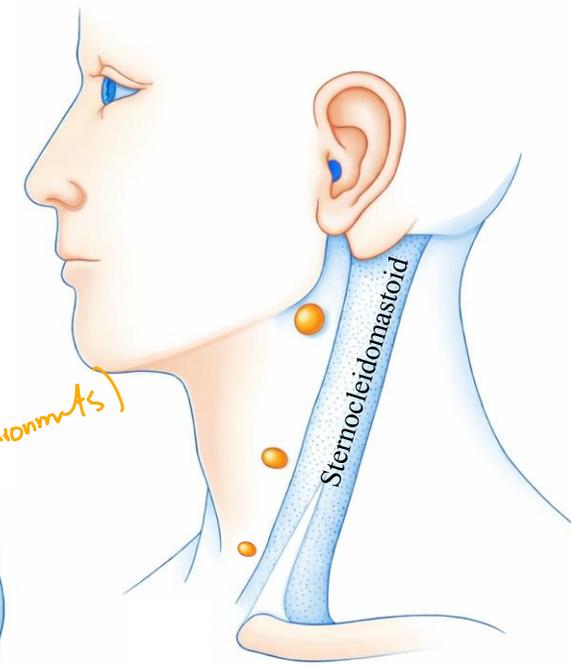
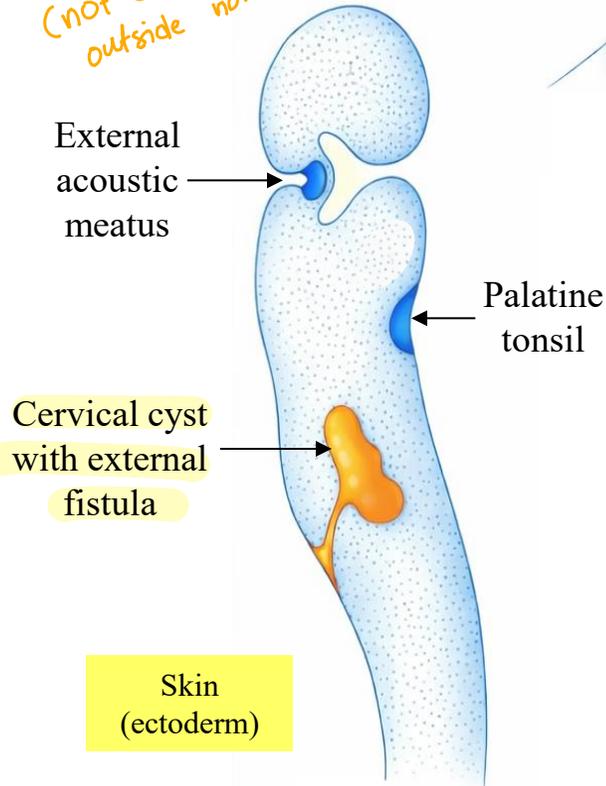
Presents as slowly enlarging lateral neck mass on the lateral side of the neck in front of the sternocleidomastoid



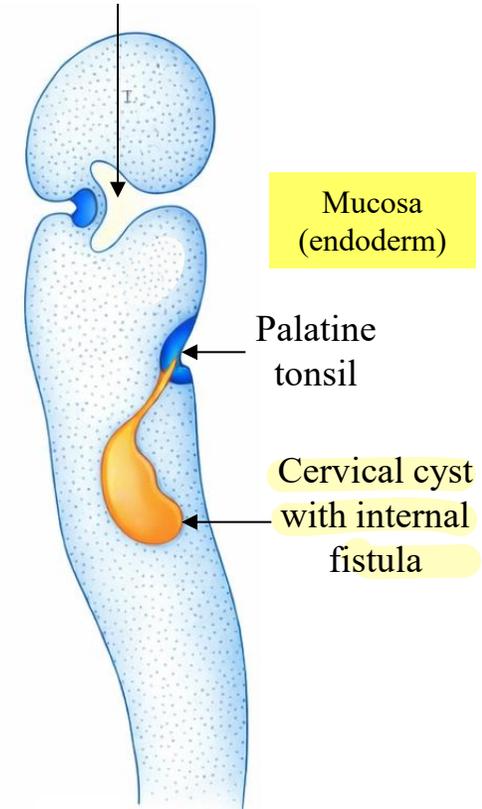
Regions of cervical cysts

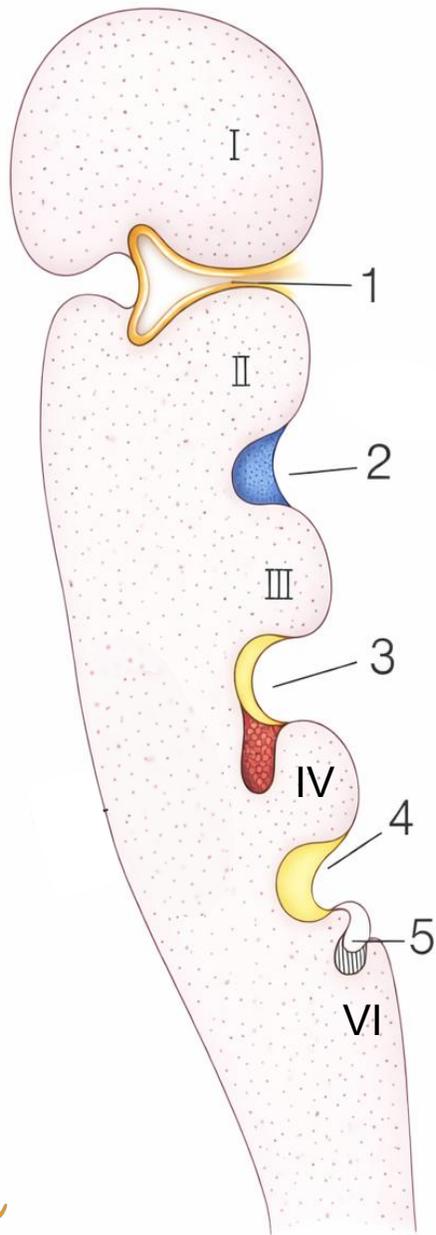
A small diagram showing a box with the text 'Regions of cervical cysts' and a small orange circle representing a cyst.

*it can be neither external nor internal (not communicating with outside nor inside environments)*



Tubo-tympanic recess





# Fate of pharyngeal pouches

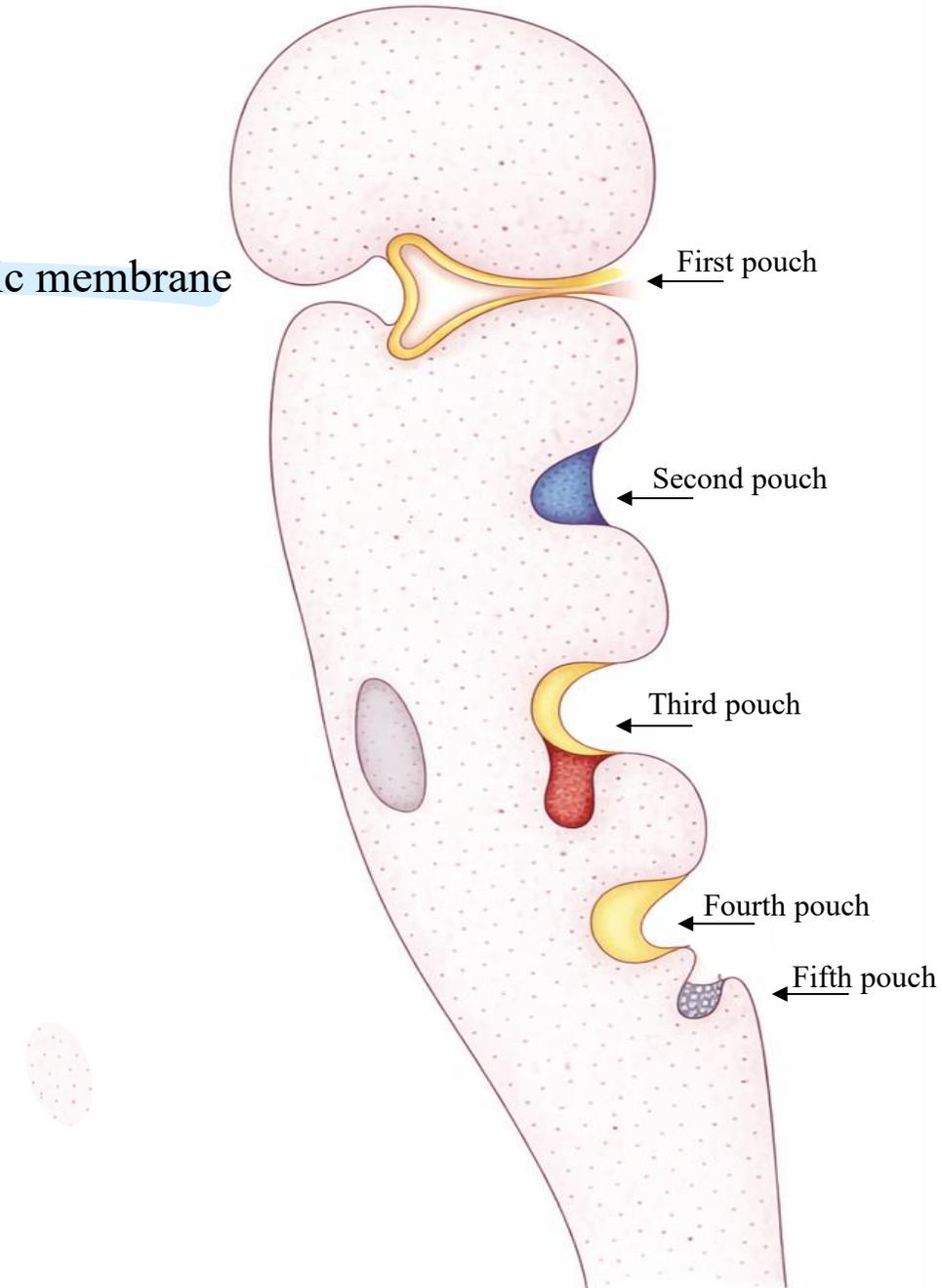
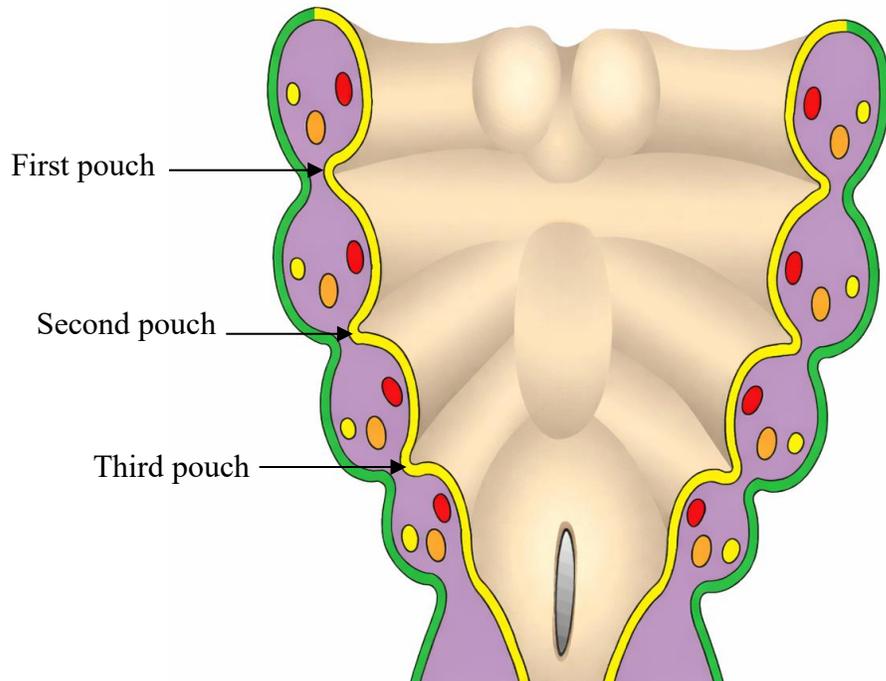
Pouches are **five** in number

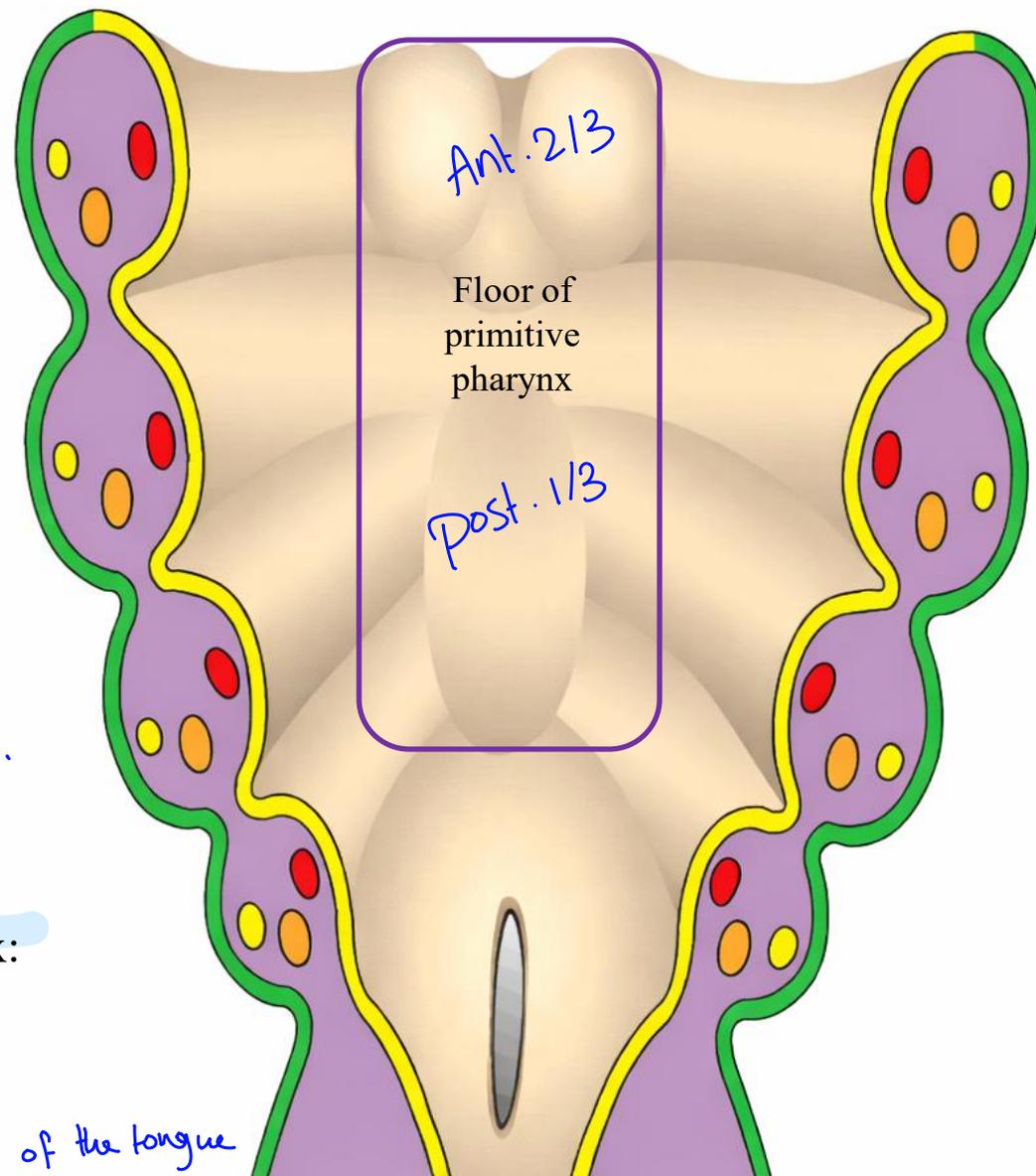
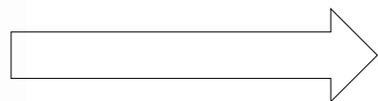
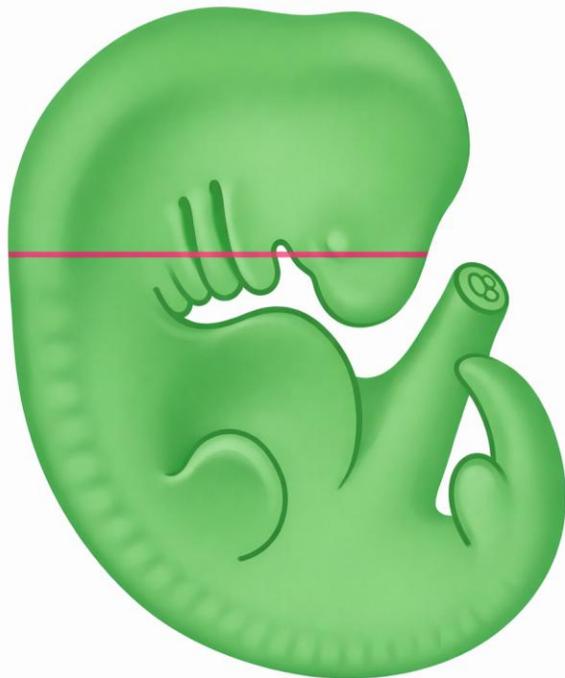
# Fate of pharyngeal pouches

Only first and second pouches are covered in MSS

Pouch	Derivatives
1	Middle ear cavity, <u>auditory tube</u> , inner layer of tympanic membrane
2	Palatine tonsil
3	Thymus, inferior parathyroid glands
4	Superior parathyroid glands
5	Ultimobranchial body → thyroid parafollicular cells

For Endocrine System





→ Glands are derivatives of Endoderm.

Note:

Three major structures originate from the floor of the primitive pharynx:

1. Tongue
2. Thyroid gland
3. Respiratory tract

→ the thyroid gland forms at the junction between the Ant. 2/3 of the tongue & the post. 1/3. The descends downward to reside in its final position → J's in larynx

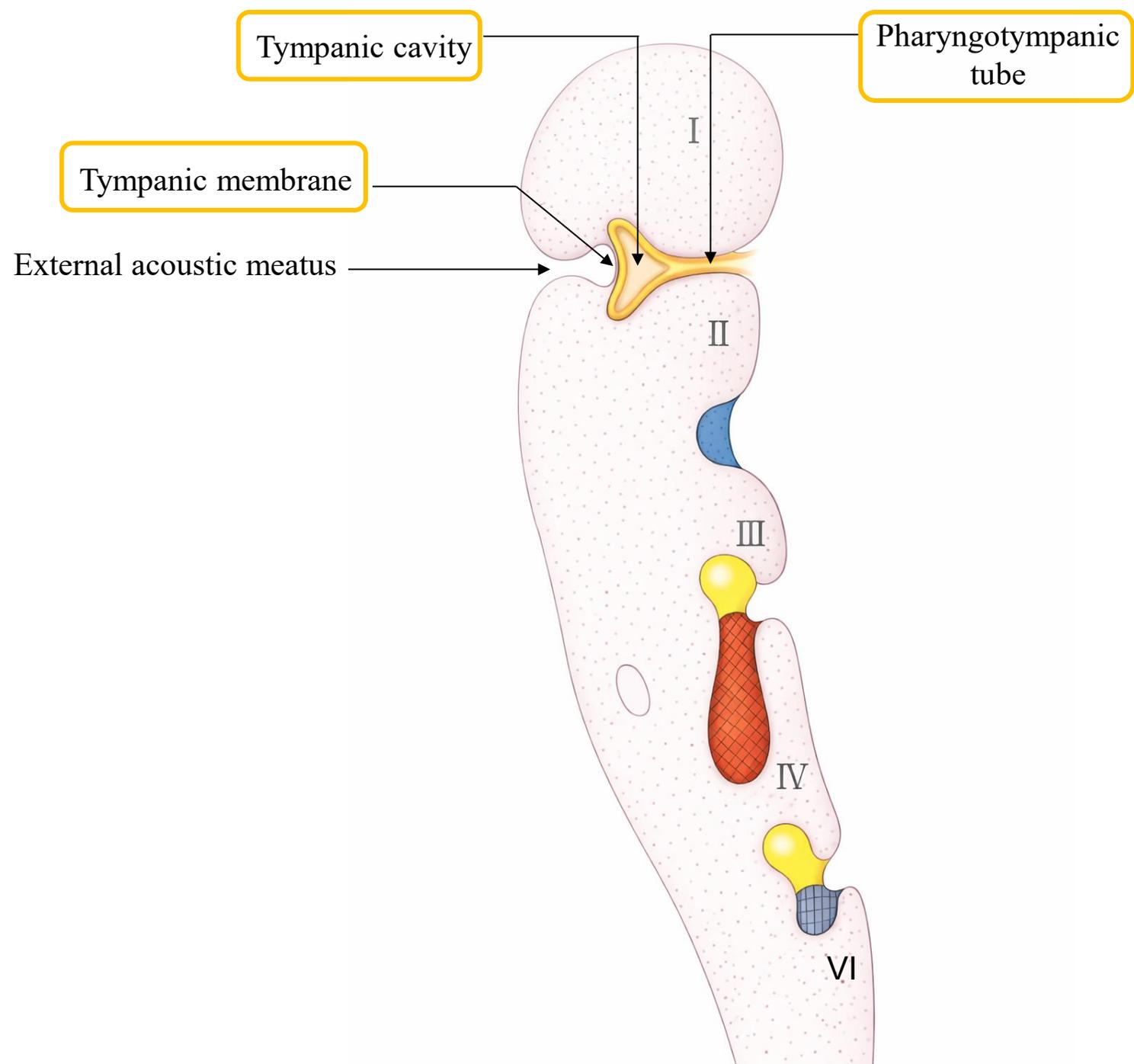
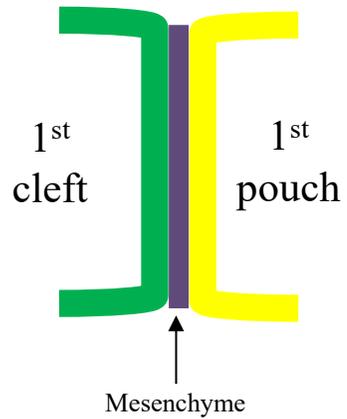
**Coronal section of neck showing structure of pharyngeal arches**

# First pharyngeal pouch

Forms:

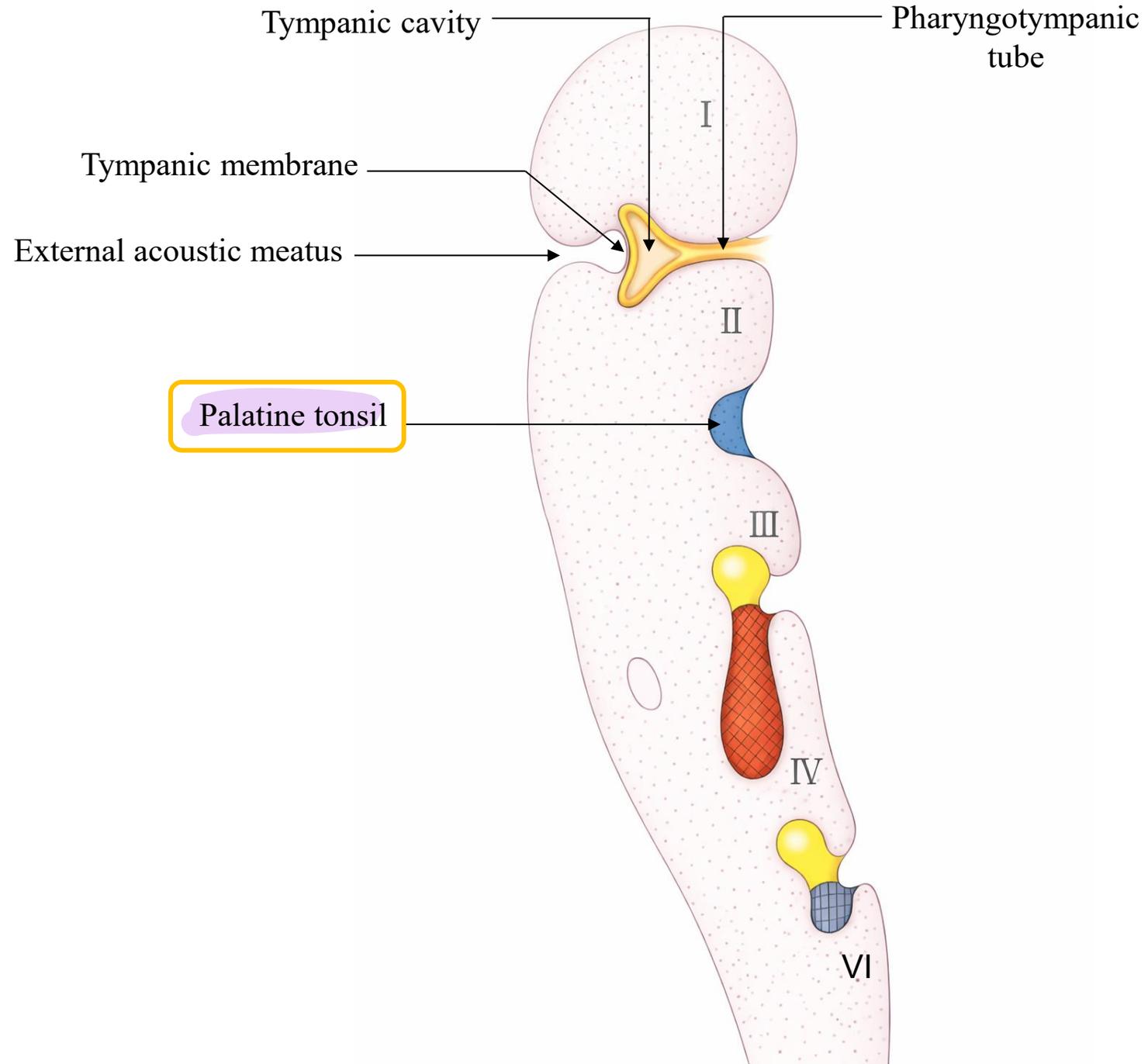
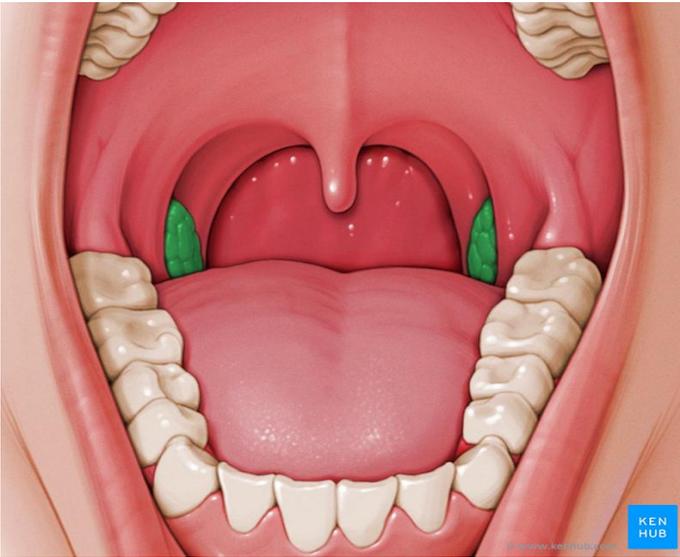
- 1- Inner layer of tympanic membrane (mucous membrane)
- 2- Middle ear (tympanic cavity)
- 3- Eustachian tube (pharyngotympanic tube)

Tympanic membrane



## Second pharyngeal pouch

Forms:  
Palatine tonsils



# Third pharyngeal pouch

Forms:

Thymus

Inferior thyroid gland

Note: The thymus migrates in a caudal and a medial direction, pulling the inferior parathyroid with it.

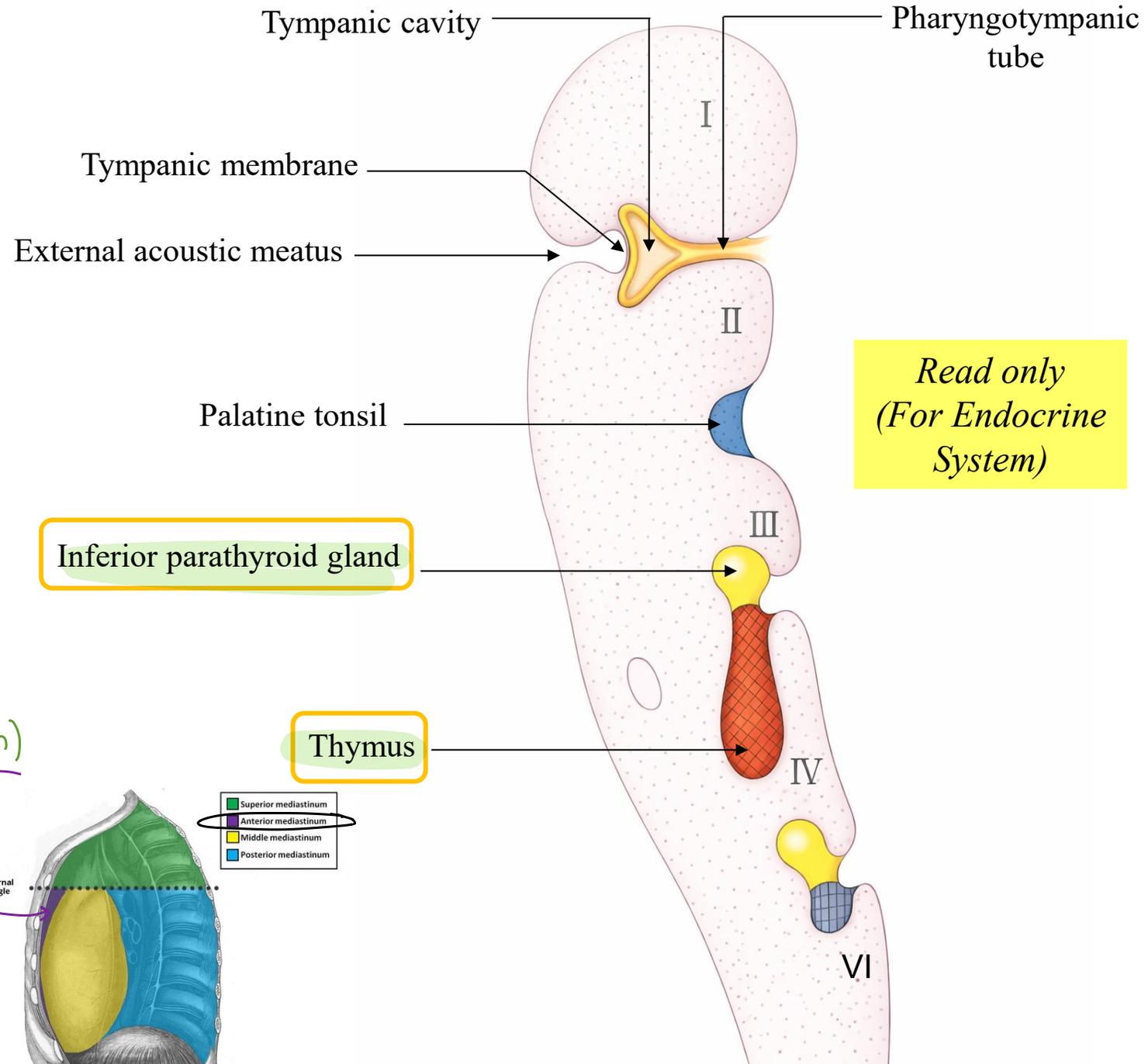
Note:

**Postnatal**

**Thymus:** lies in the thorax behind the sternum (in the Anterior mediastinum)

**Inferior thyroid glands:** lie on the posterior surface of thyroid gland

بدرجہ بنفشہ  
عشان کی دوسری تاقہ  
Position ال  
-انگھا.



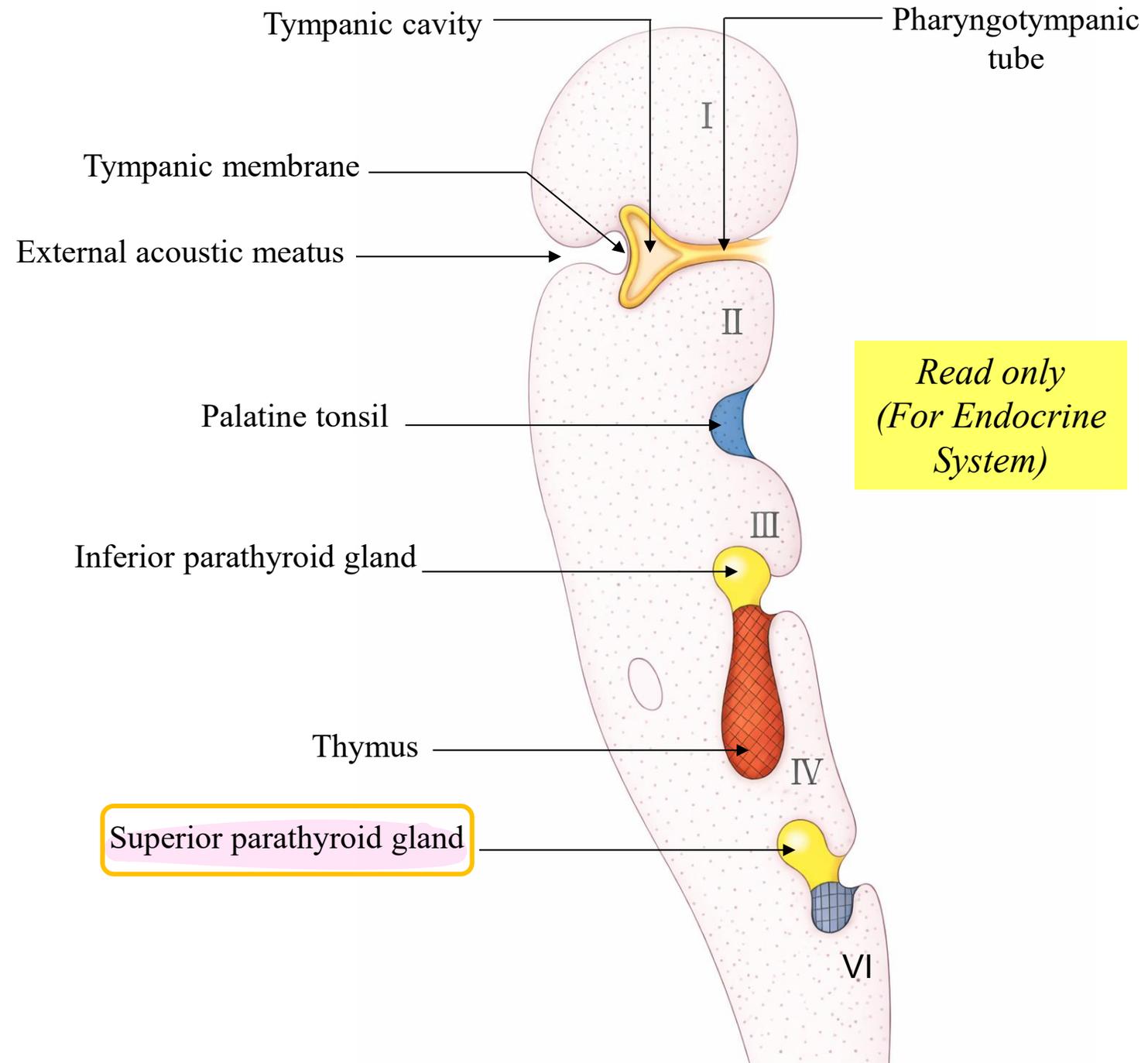
## Fourth pharyngeal pouch

Forms:

Superior thyroid gland

Note:

Superior thyroid glands: lie on the posterior surface of thyroid gland

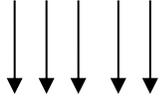


## Fifth pharyngeal pouch

Forms

### Ultimobranchial body:

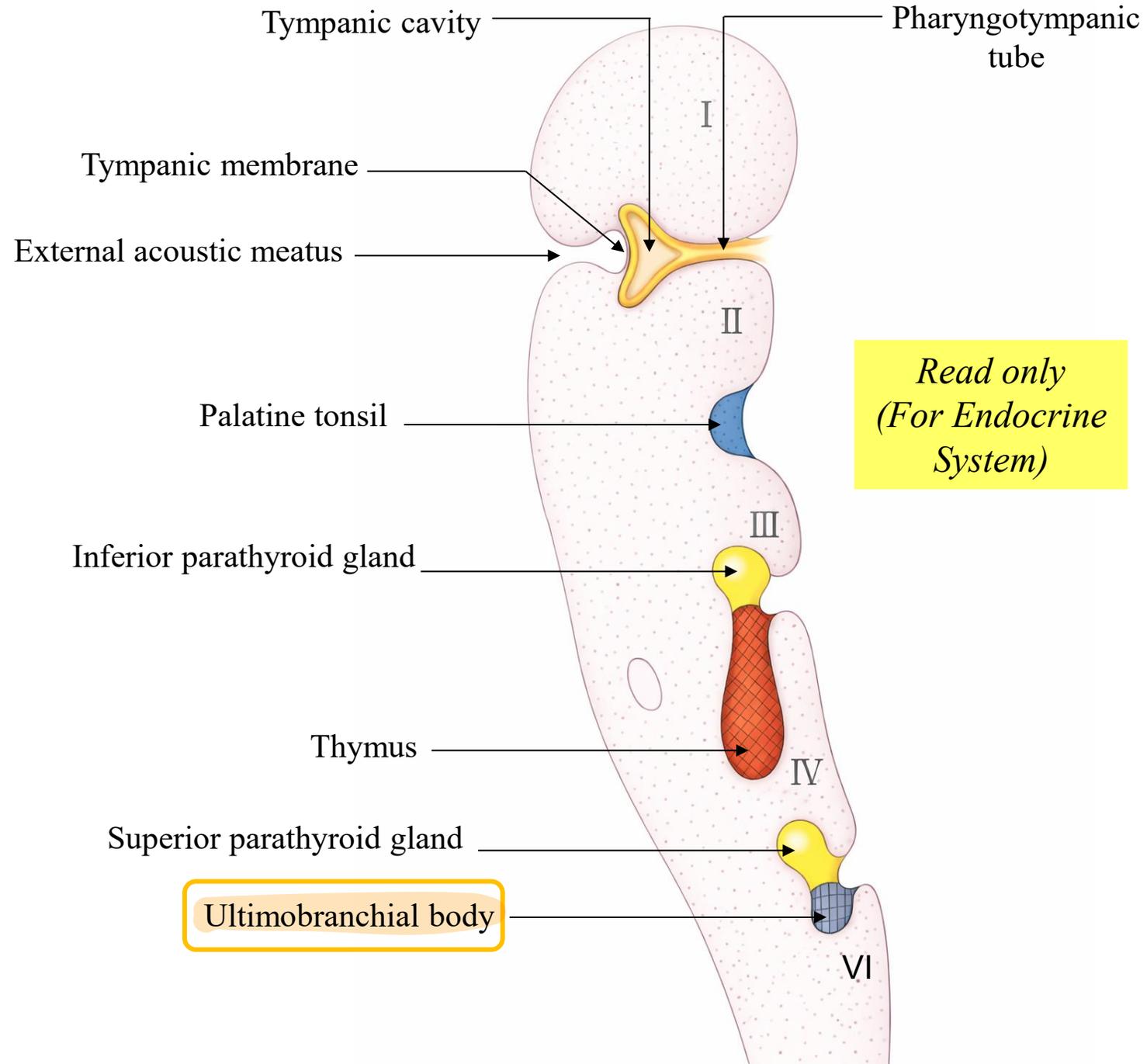
Is incorporated into the thyroid gland.

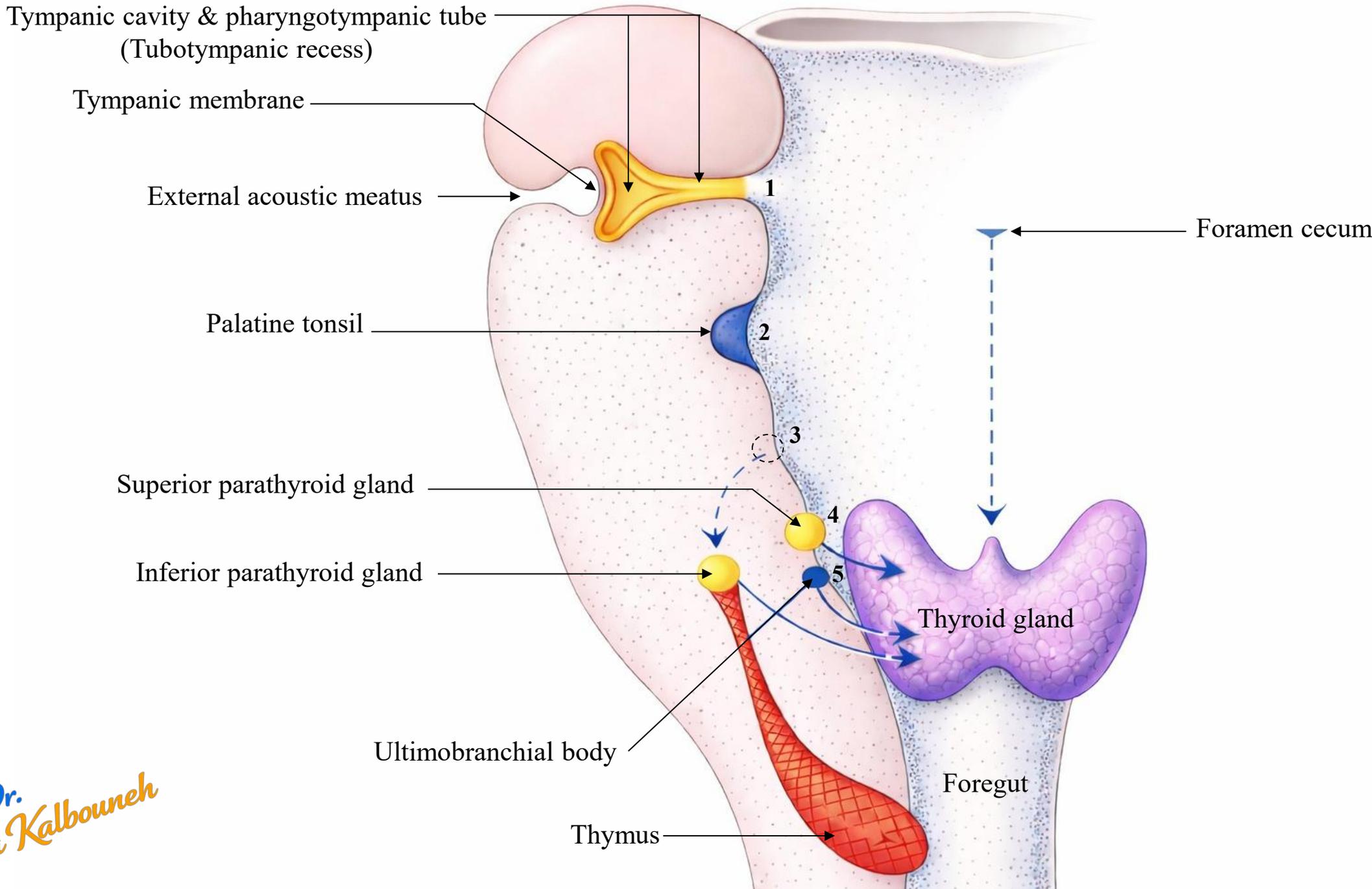


Cells of the ultimobranchial body give rise to the parafollicular of the thyroid gland

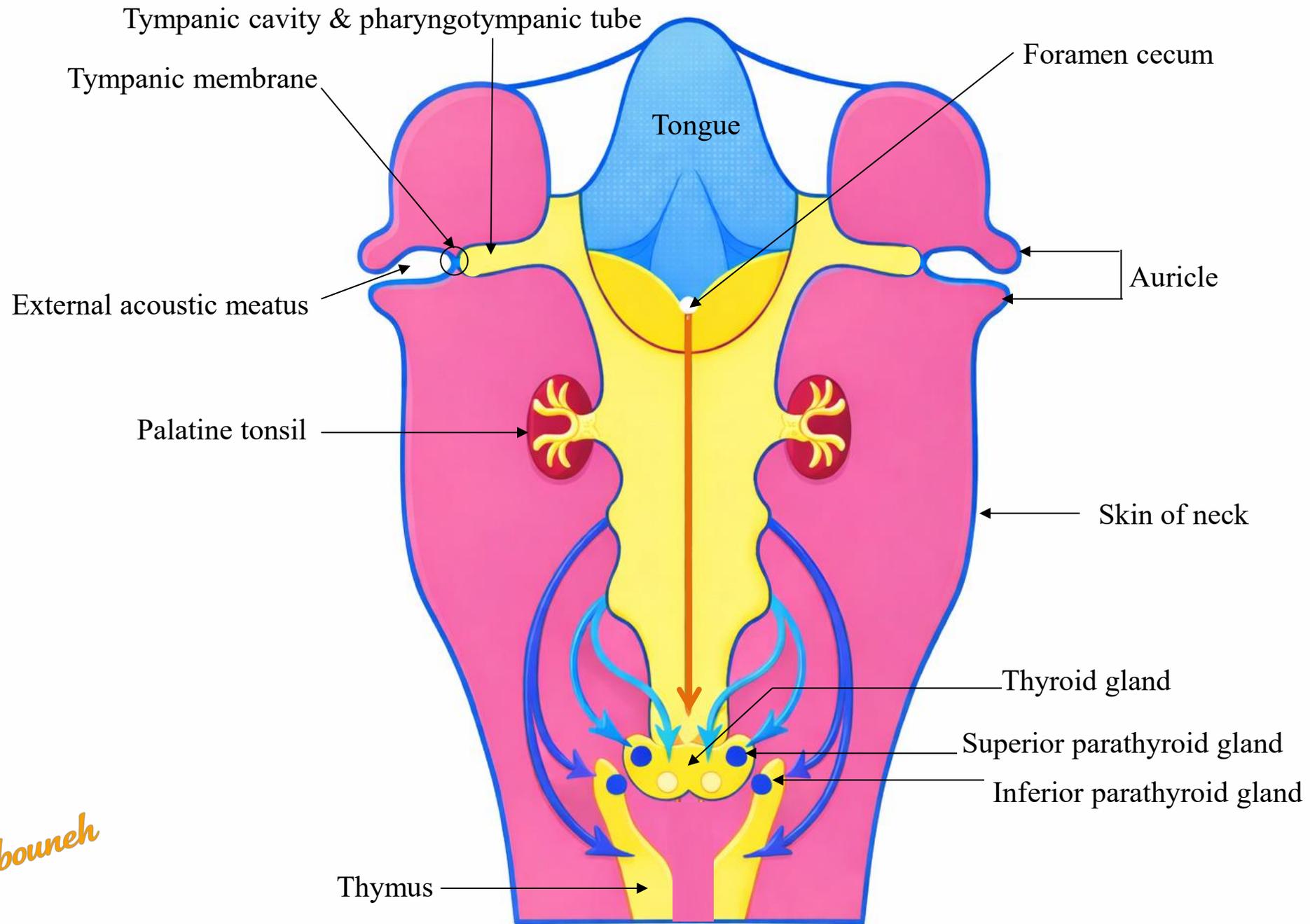
*Note:*

The thyroid tissue is made up of two types of cells: follicular cells and parafollicular cells.

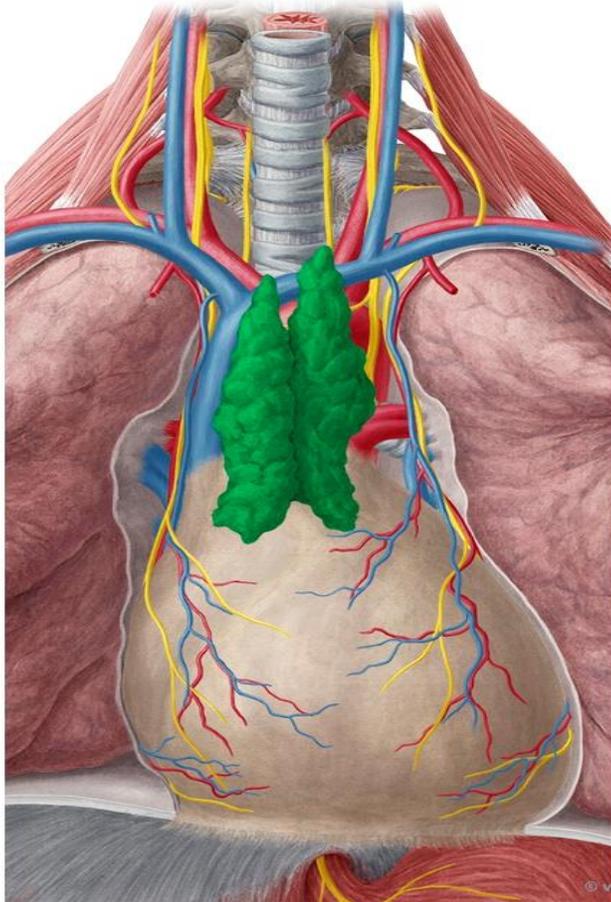




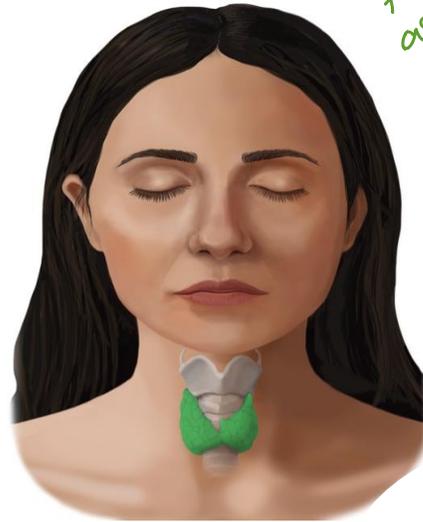
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## Thymus gland



## Thyroid gland



Ant.  
aspect of  
larynx

## Parathyroid glands



## Cervical branchial cyst



[Branchial Cysts - Dr Murali Mahadevan - ENT Surgeon](#)

A cervical branchial cyst is a congenital cyst in the lateral neck caused by persistence of the cervical sinus, which normally disappears during development when the second pharyngeal arch grows downward and covers the third and fourth arches.

It usually appears as a painless swelling along the anterior border of the sternocleidomastoid muscle.

Treatment: surgical removal of the cyst.

## Congenital Anomalies

Read only  
(For Endocrine System)

- 1- Ectopic thymus: in the neck
- 2- Ectopic parathyroid : especially the inferior parathyroid (in thorax)
- 3- Cervical branchial cyst