Pharyngeal (Branchial) Apparatus

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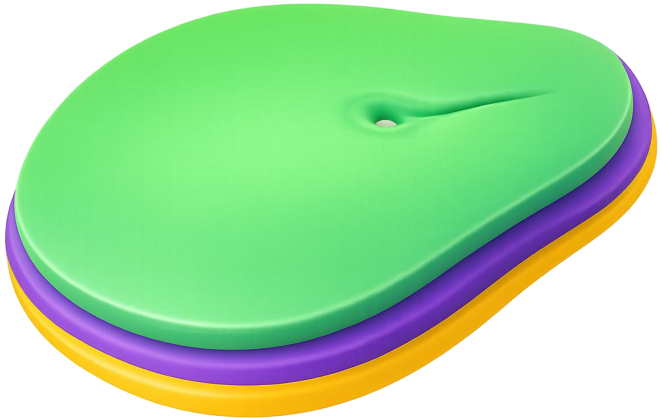
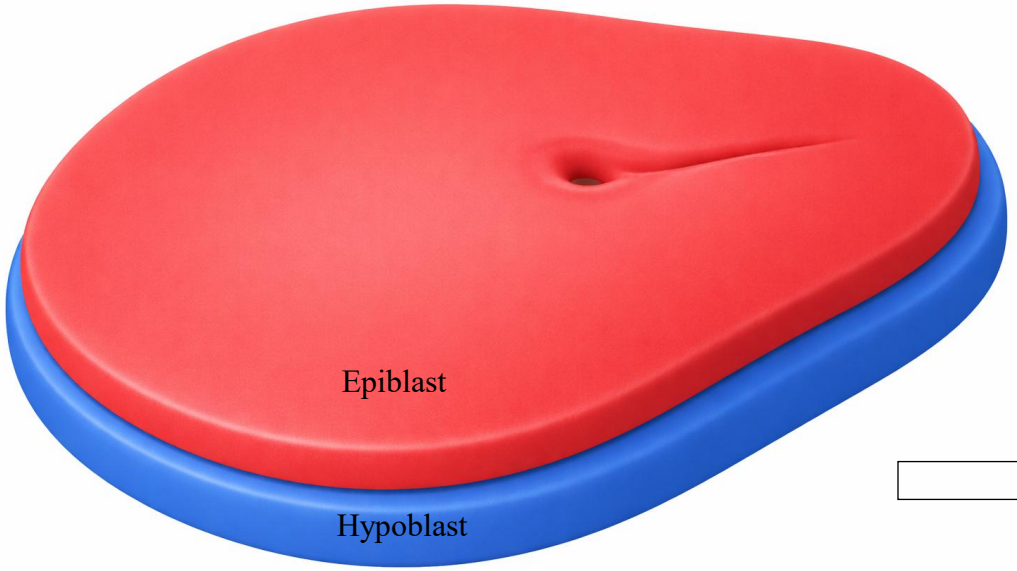
Bilaminar disc
(2nd week)

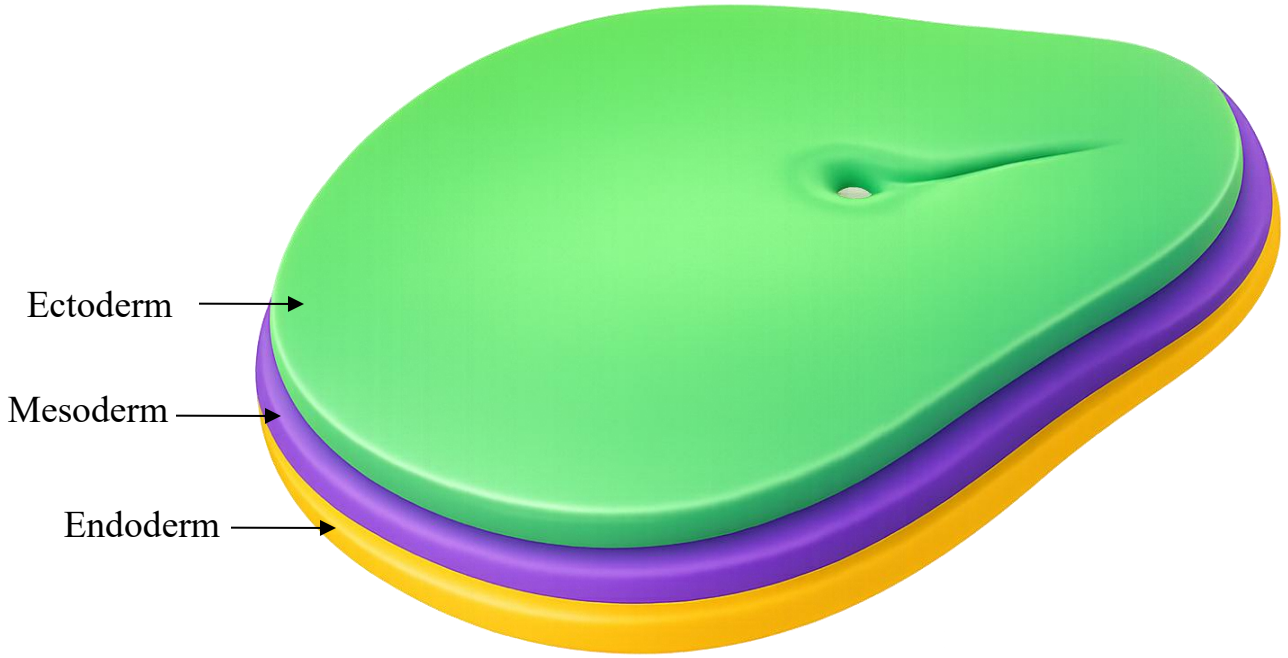
Ectoderm
Mesoderm
Endoderm

Trilaminar disc
(3rd week)

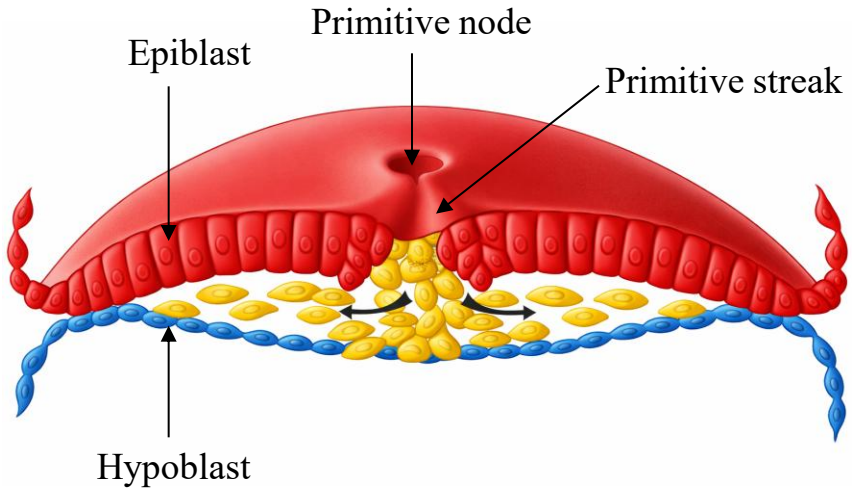


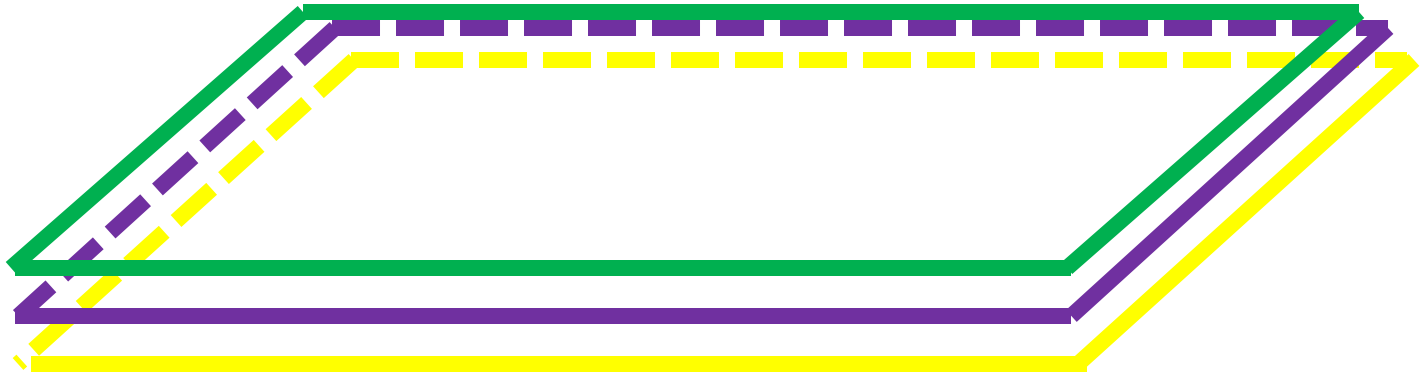


Bilaminar disc
(2nd week)



Trilaminar disc
(3rd week)





Trilaminar disc
(3rd week)

Folding
(4th week)

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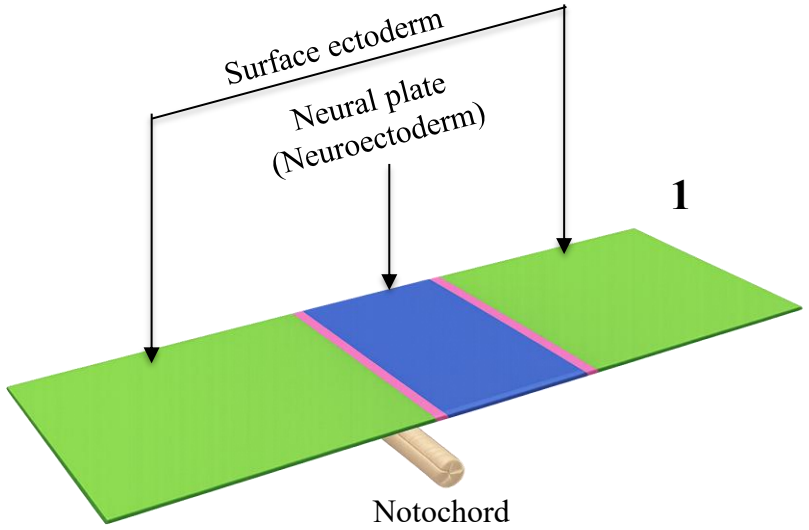
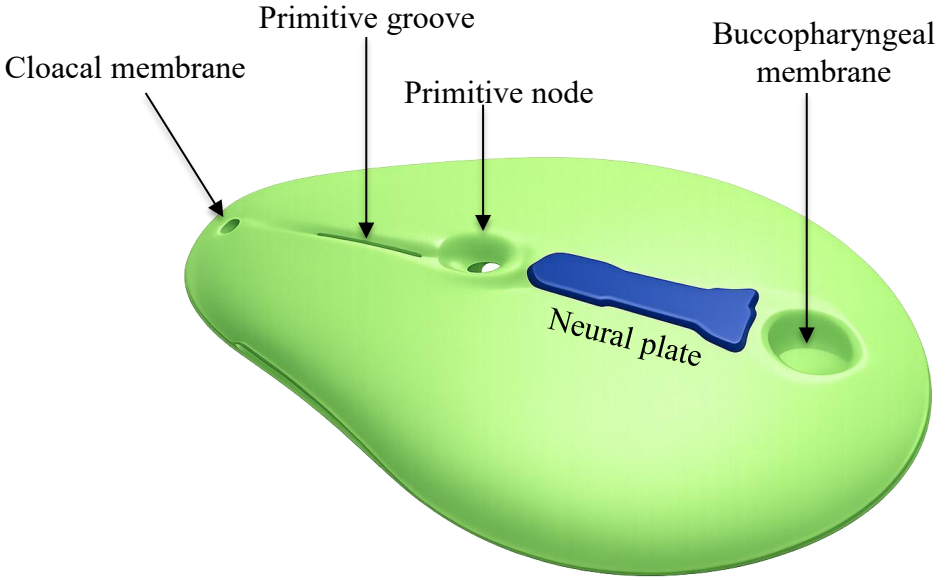
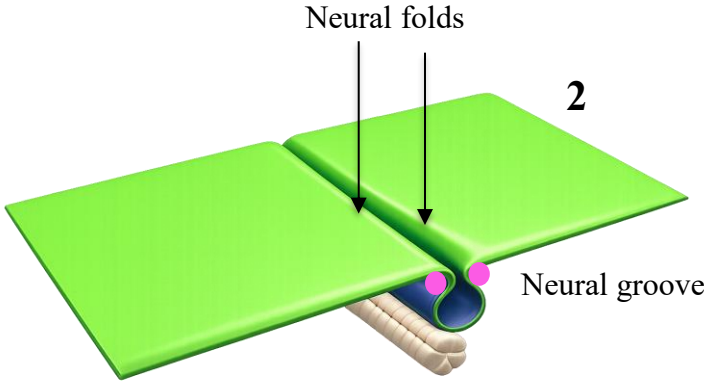
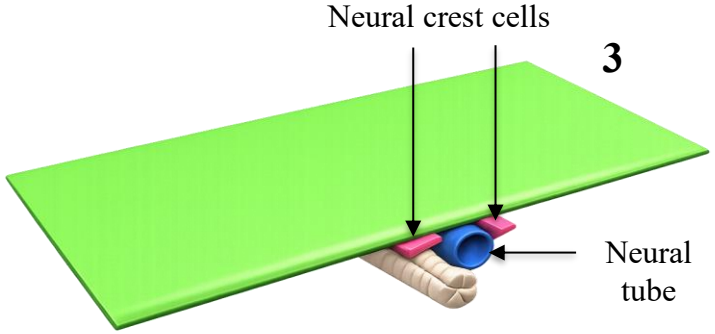
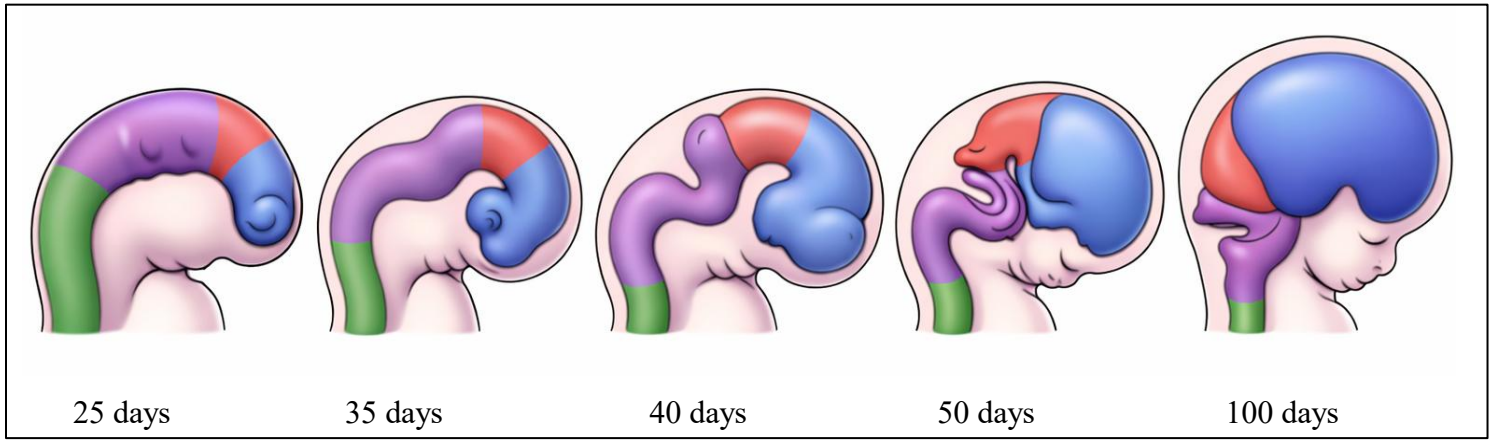
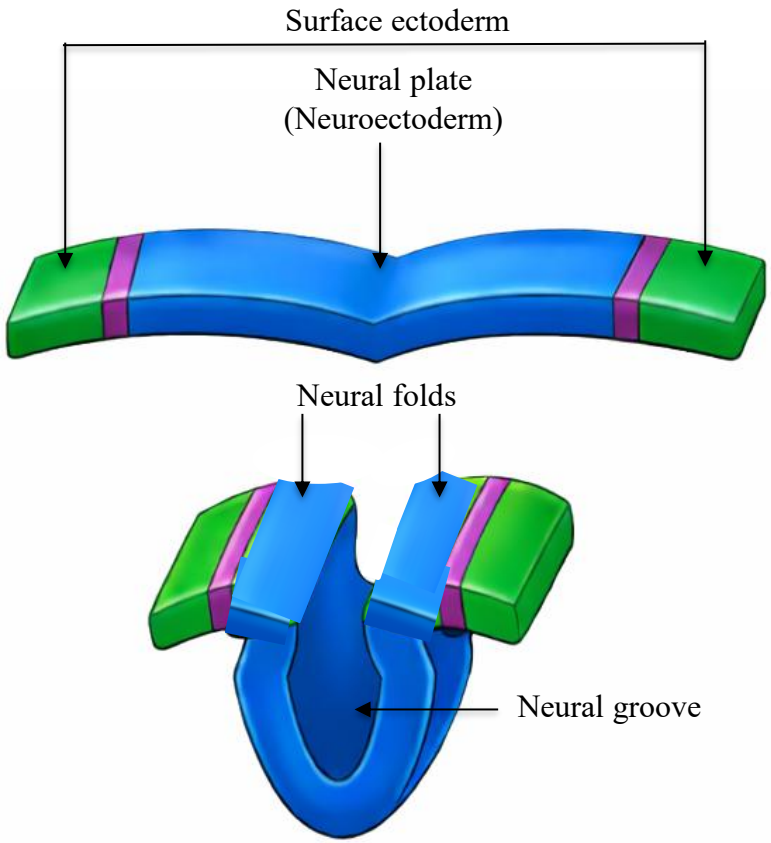


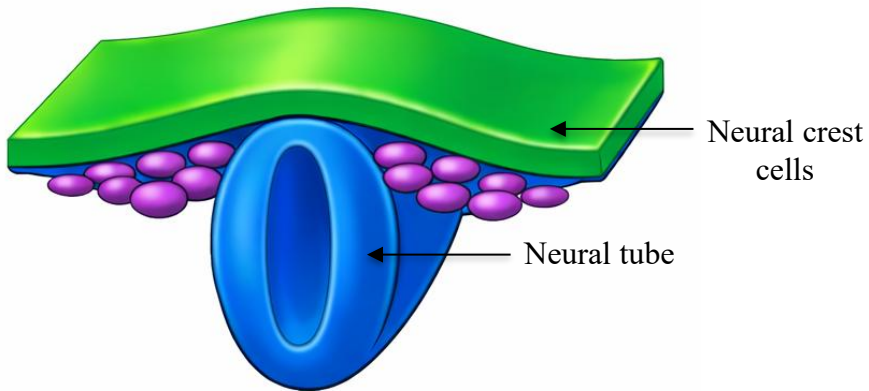






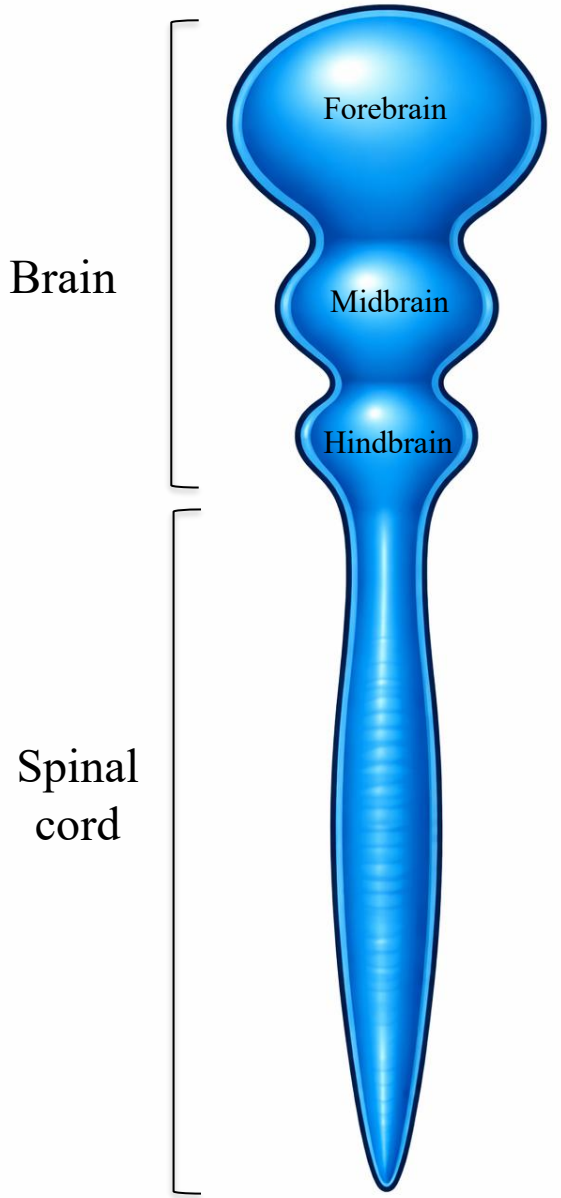


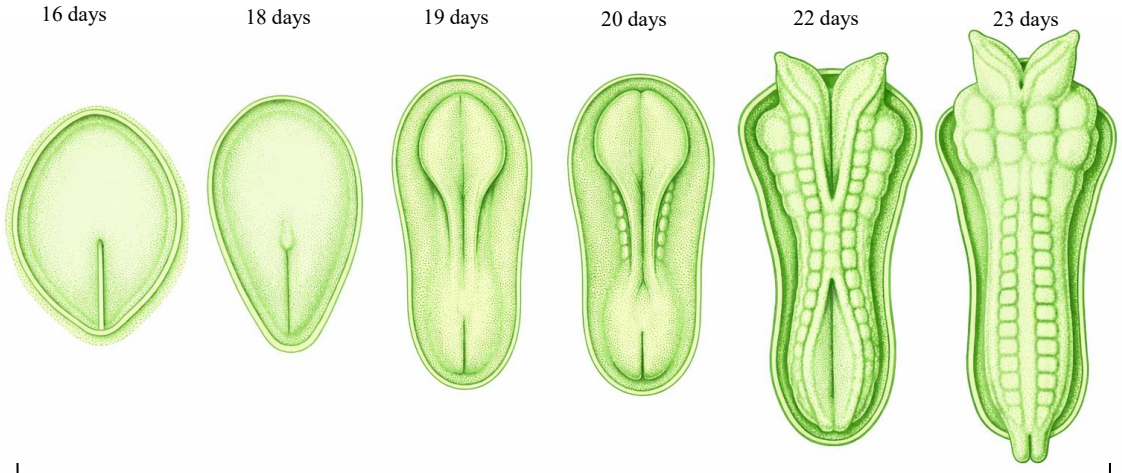




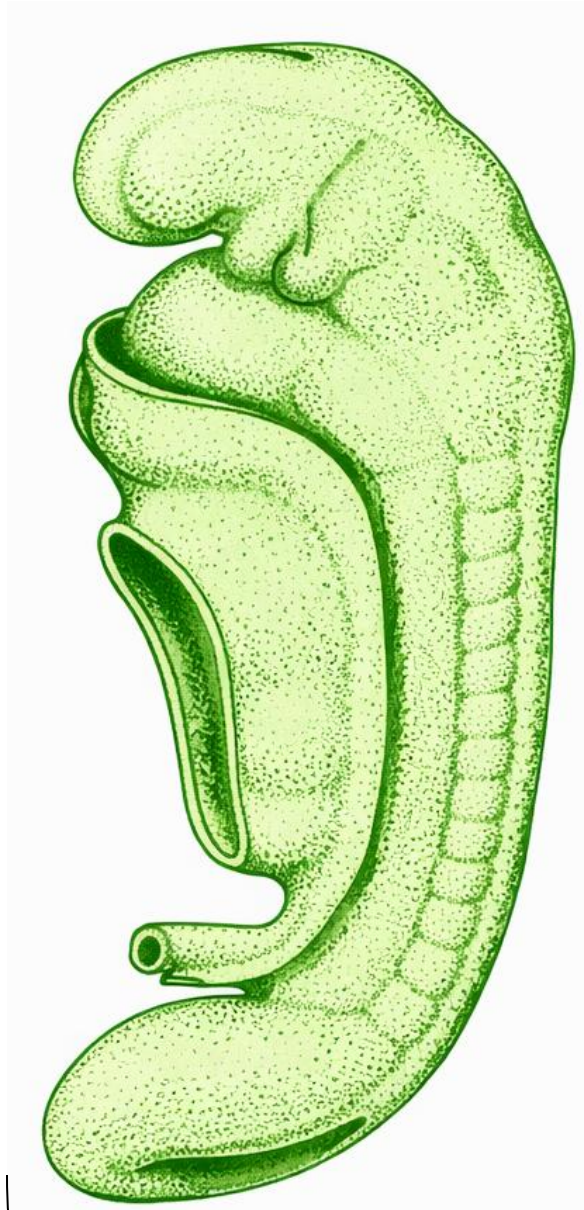
In early neural tube development, the brain forms three primary vesicles:

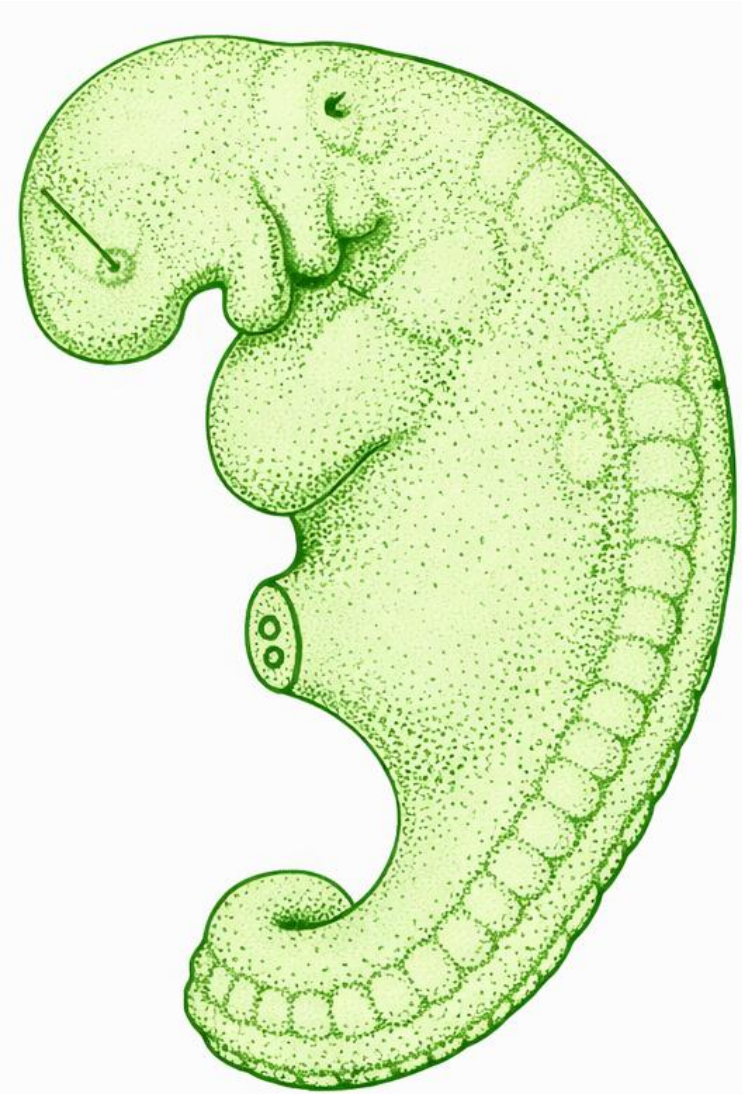
1. Forebrain
2. Midbrain
3. Hindbrain





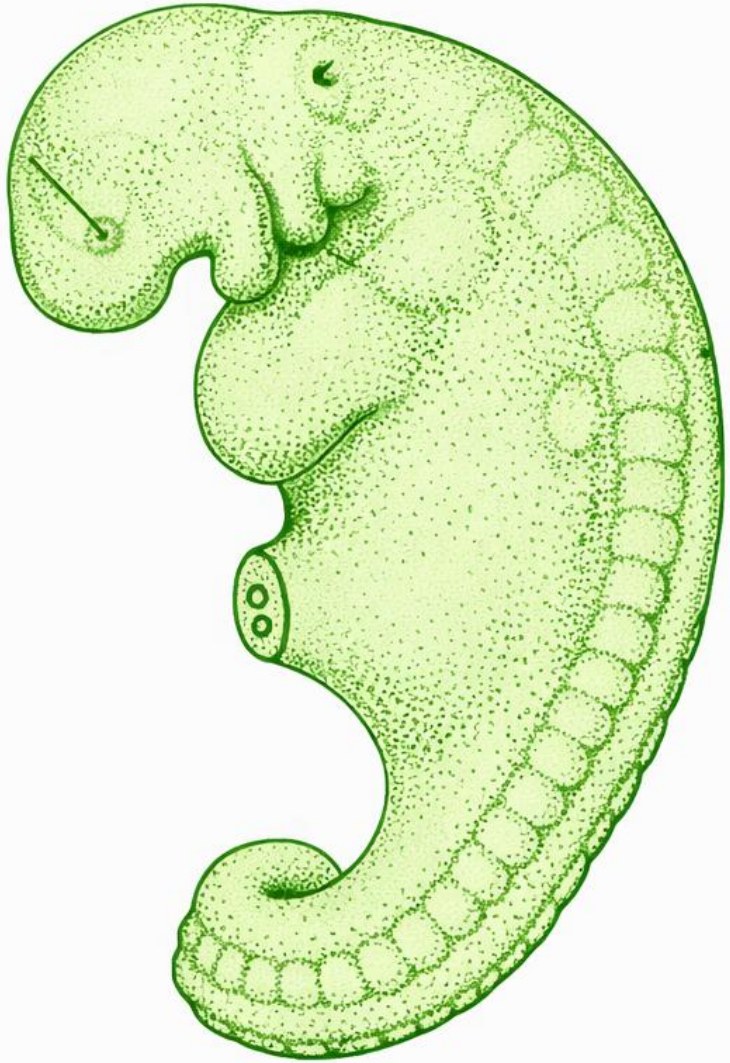
Dorsal view



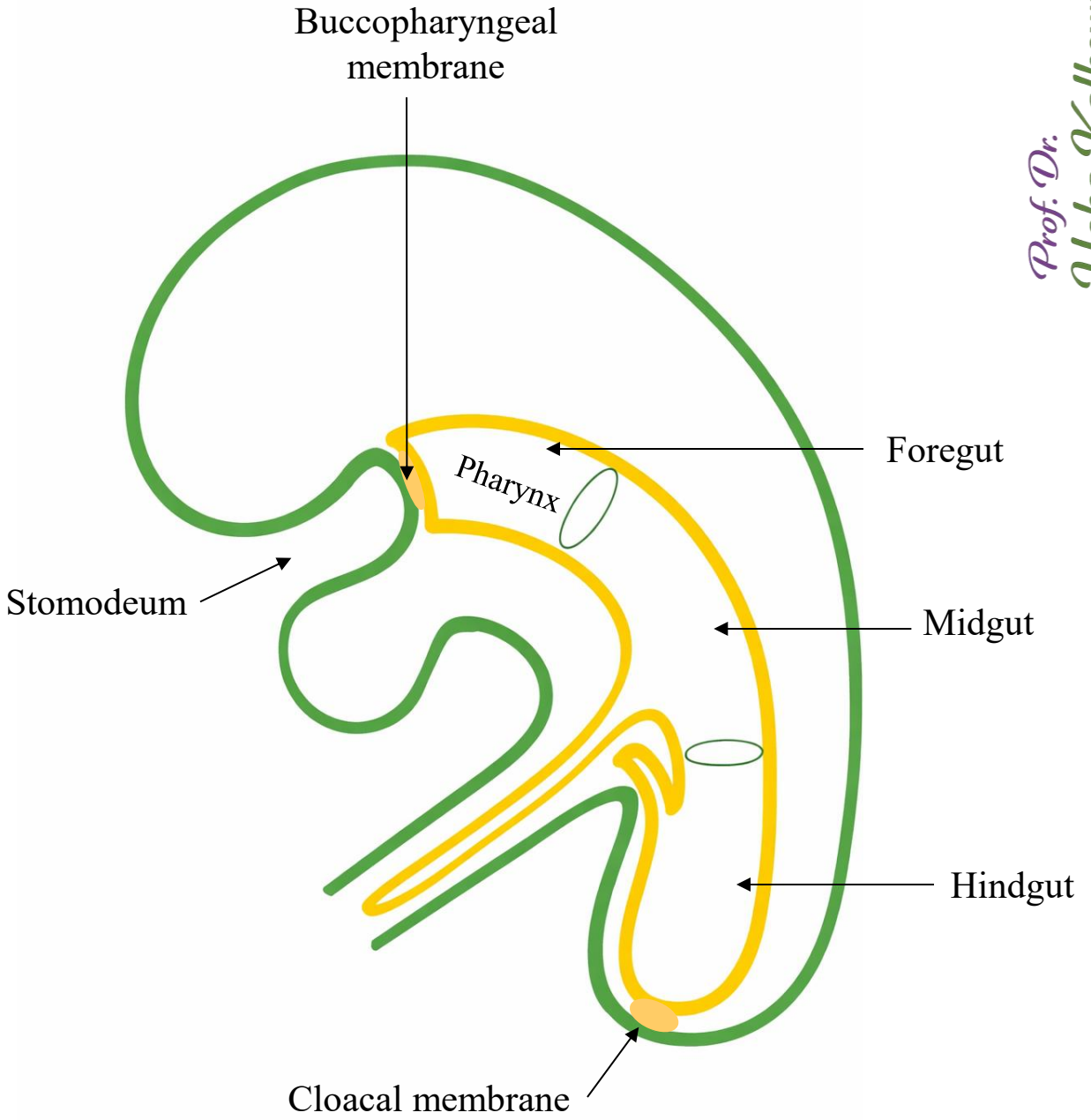


Lateral view

28 days



Lateral view



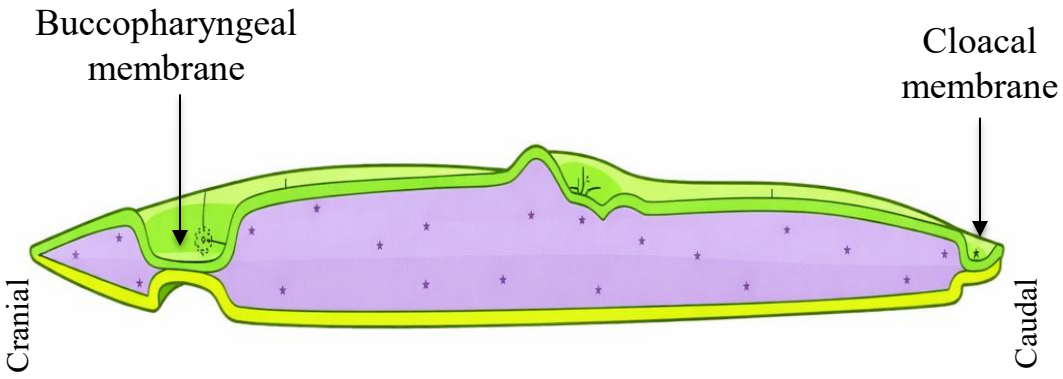
Note that the ectoderm and endoderm are in direct contact with each other (no mesoderm in between) in only two places:
The buccopharyngeal membrane: cranially
The cloacal membrane: caudally.

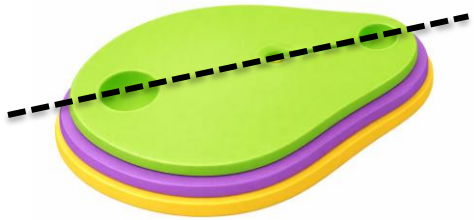
The buccopharyngeal membrane lies between stomodeum and the primitive pharynx.

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

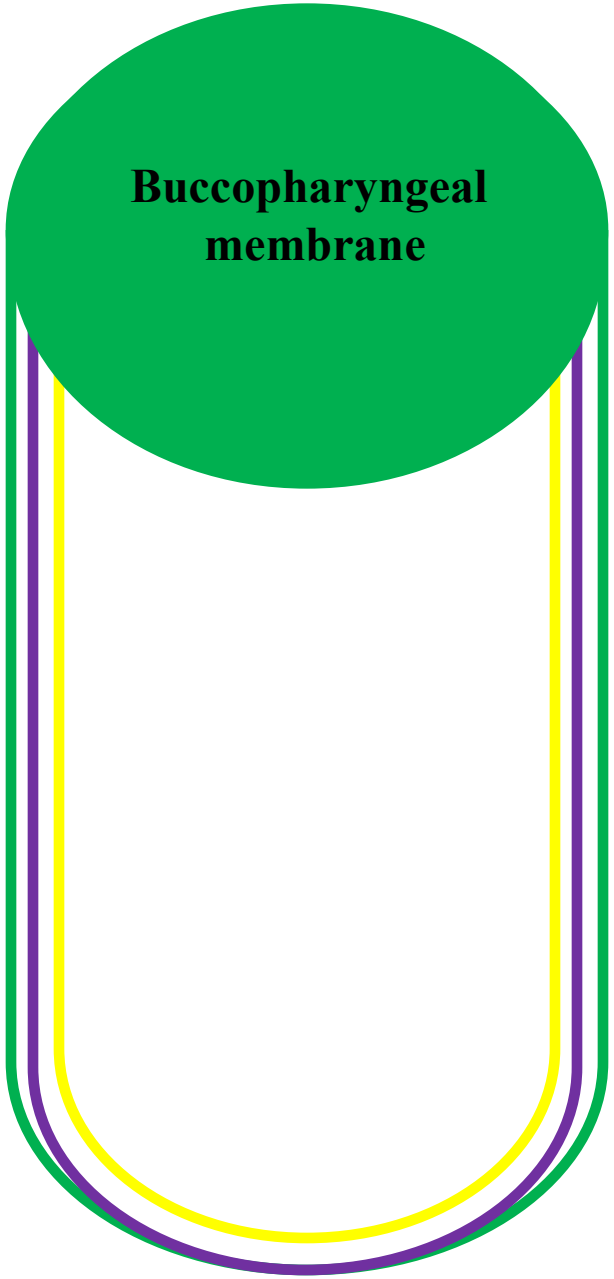
Stomodeum will form the **nasal and oral cavities.**

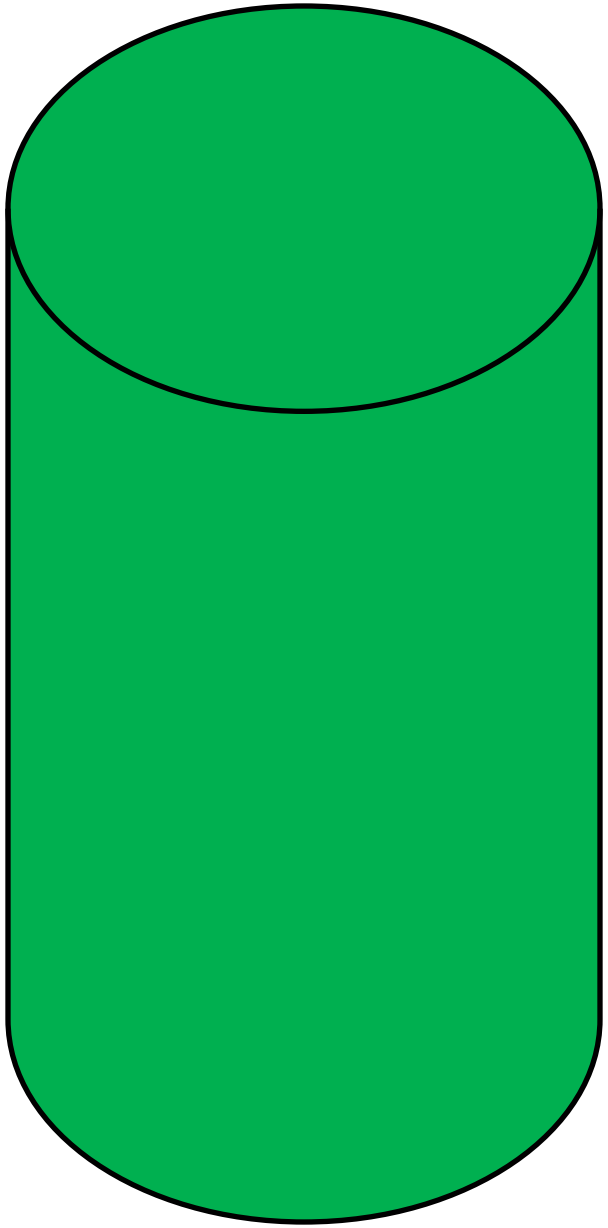
Later, the buccopharyngeal membrane breaks down so that the stomodeum communicates with the foregut.

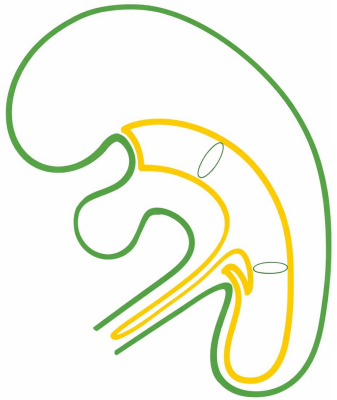




Longitudinal section







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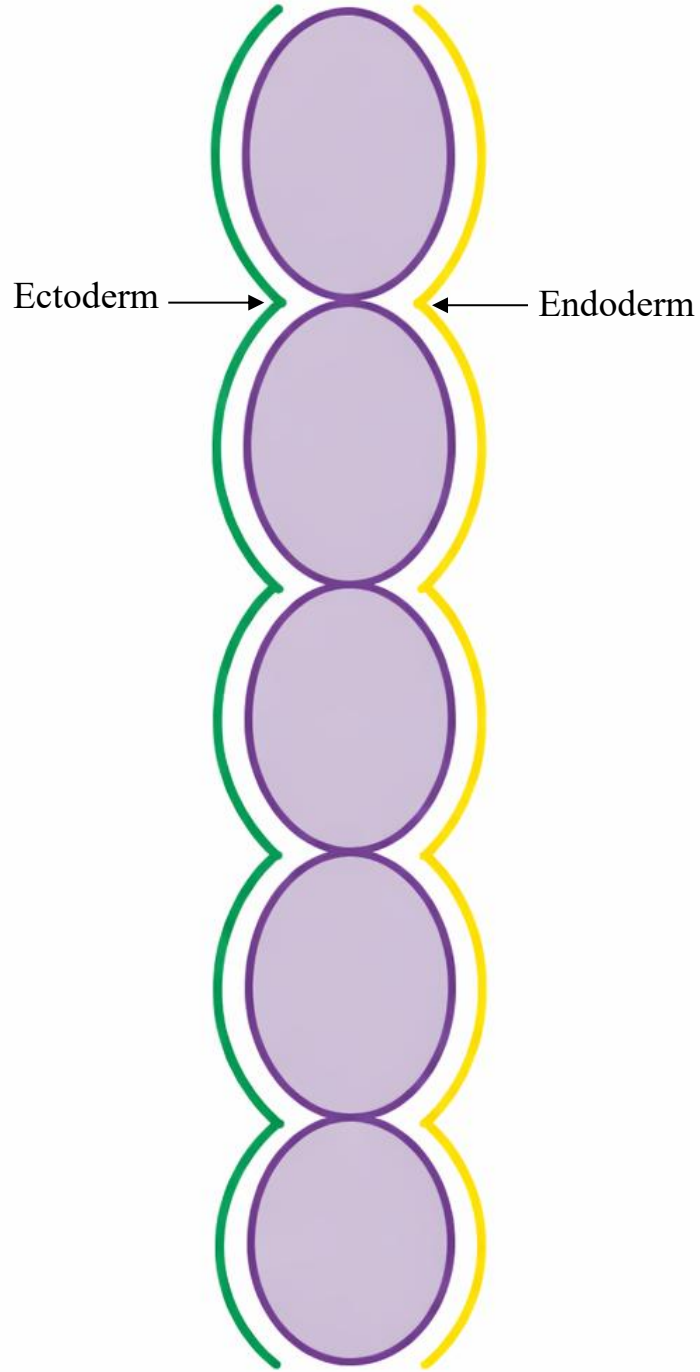

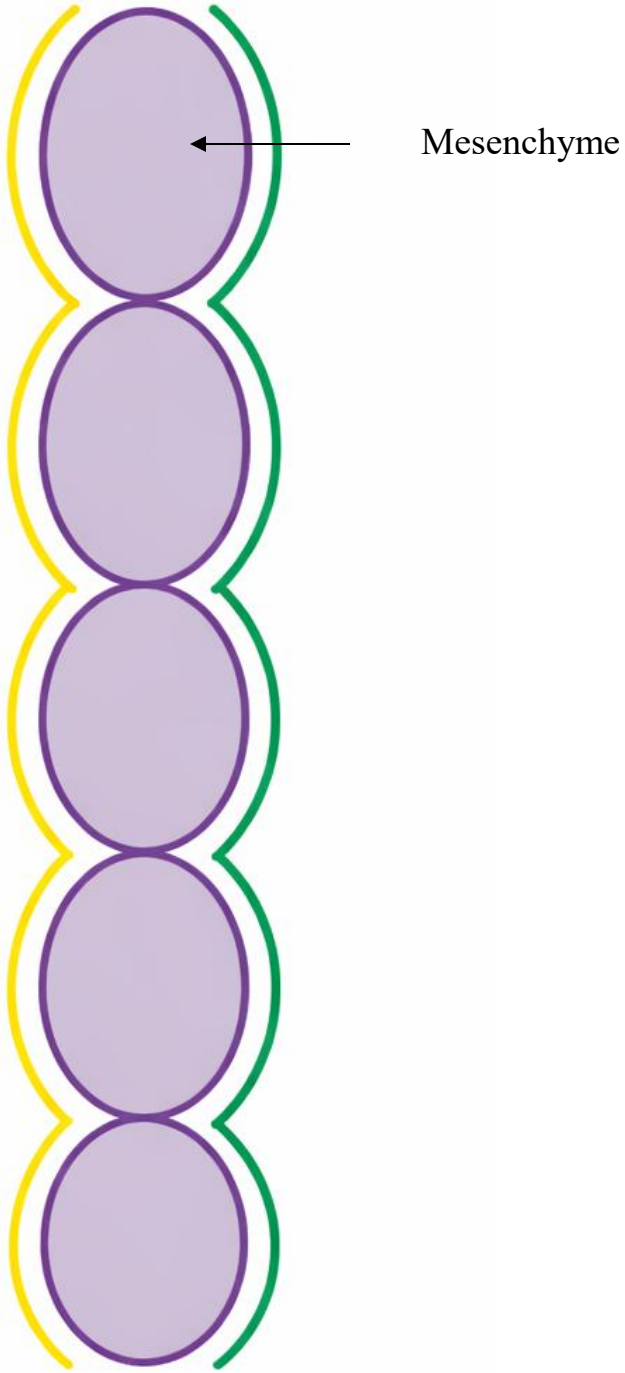

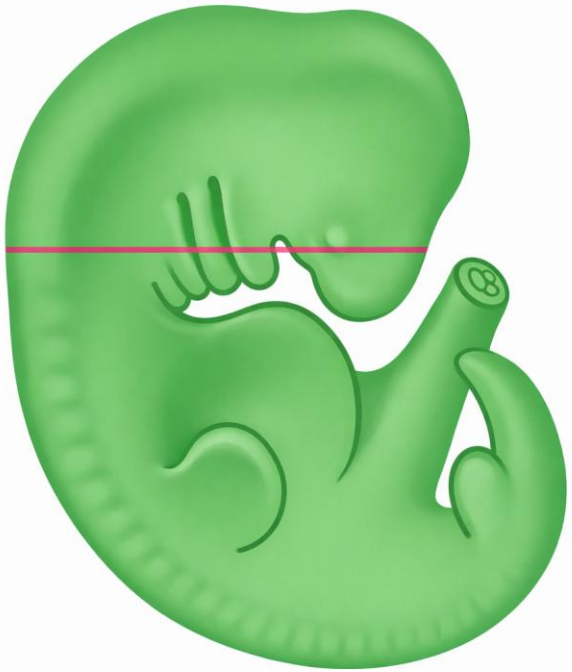

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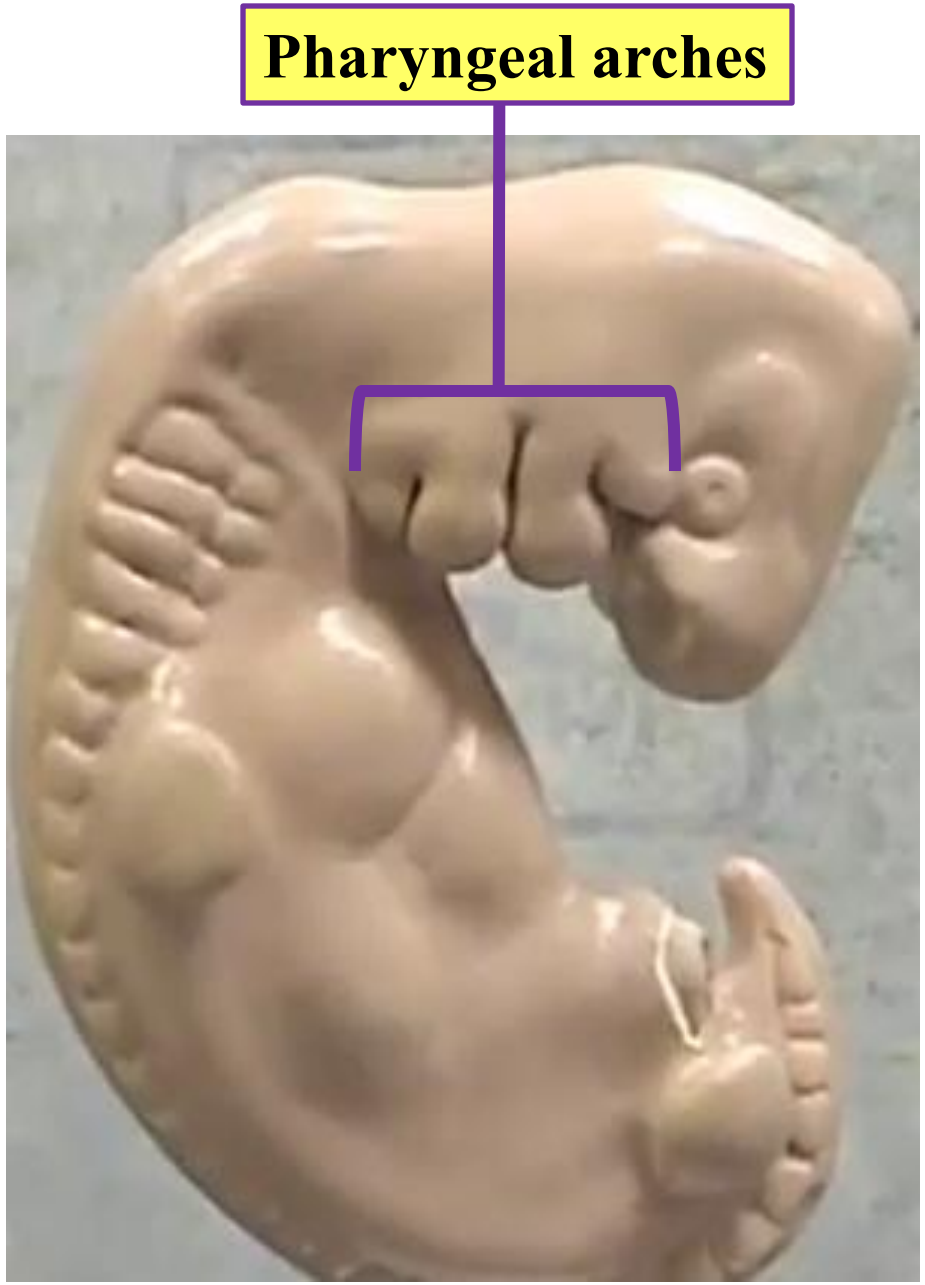
Pharyngeal (Branchial) Arches

- 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.



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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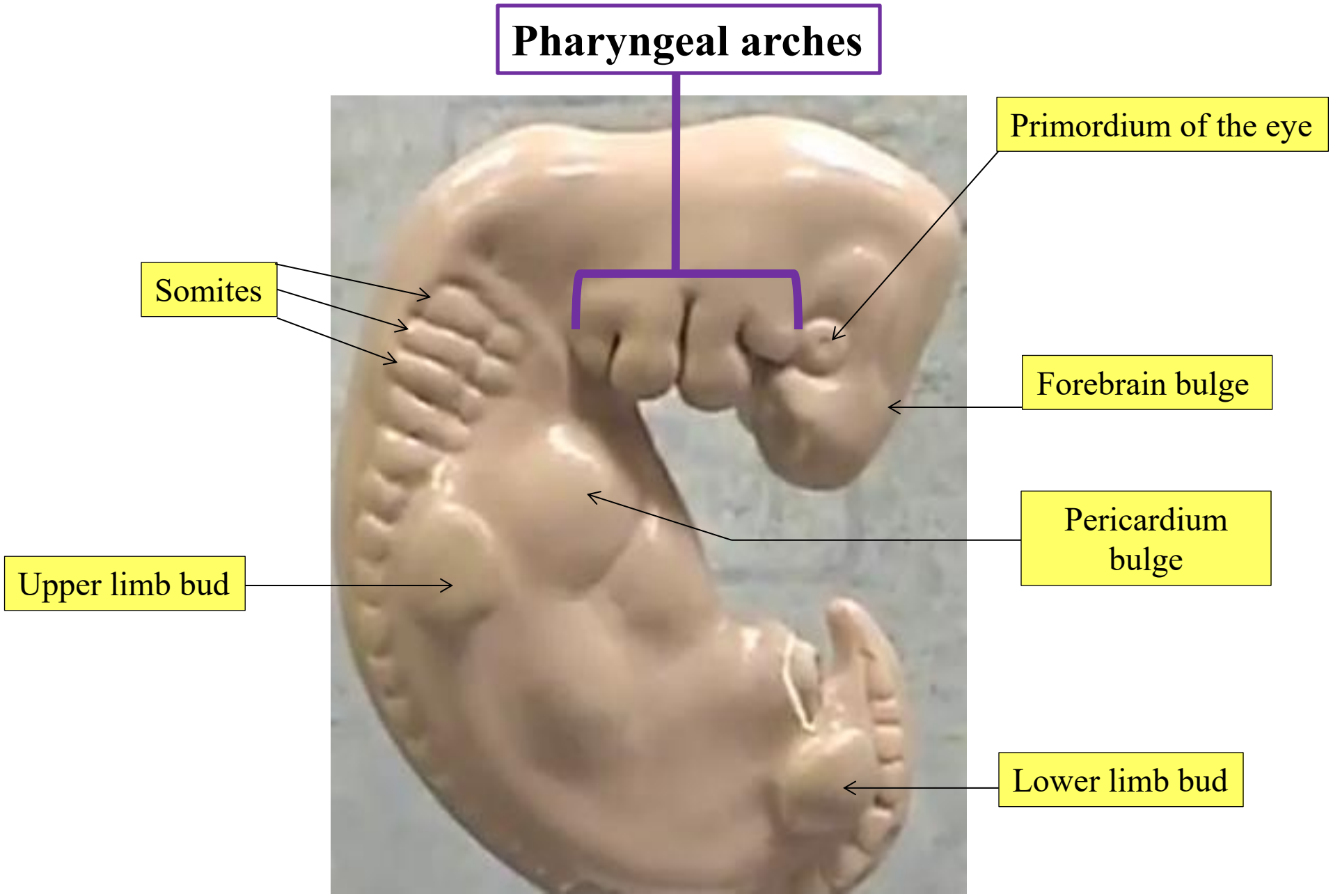
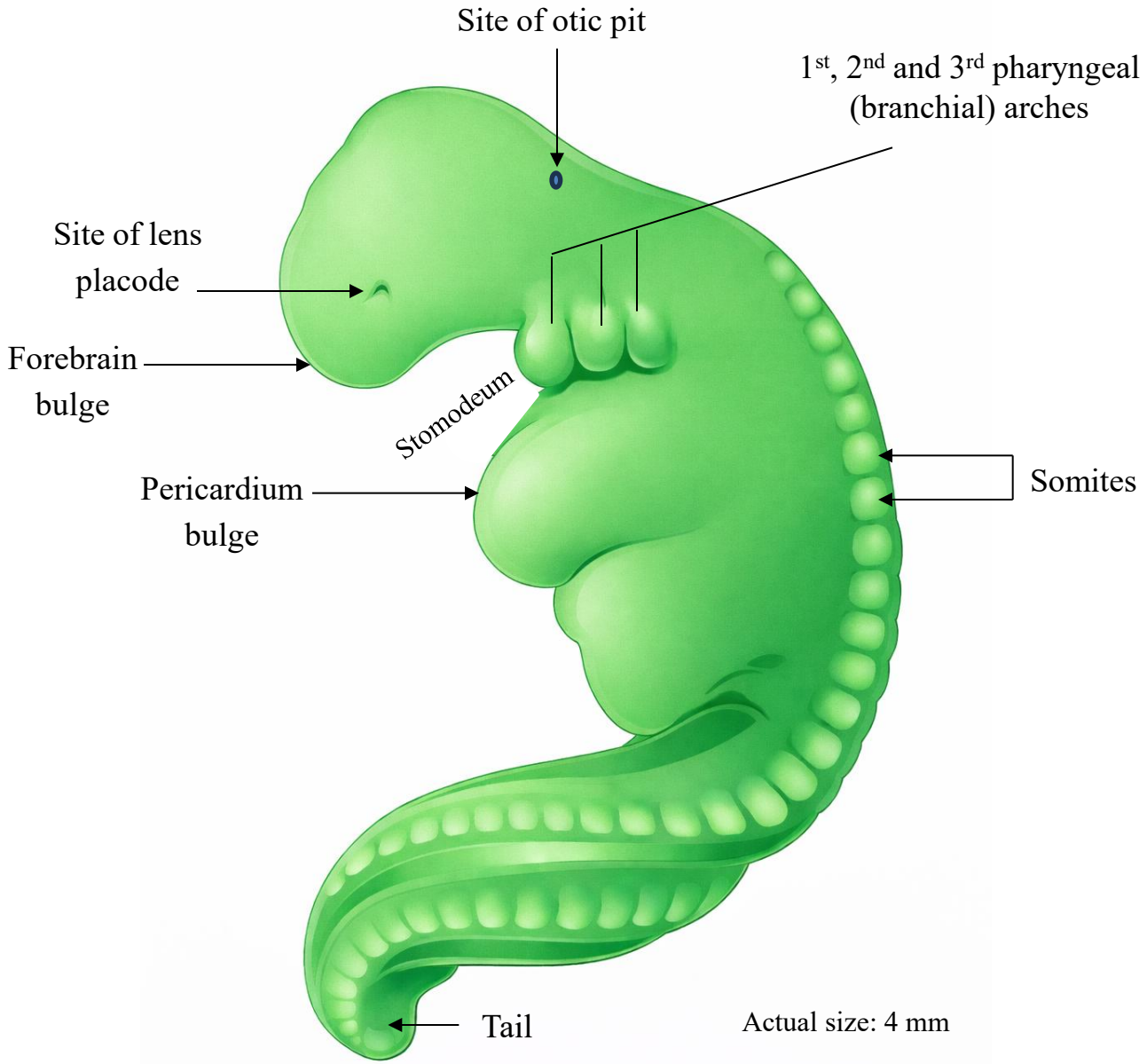

Pharyngeal arches
Primordium of the eye
Somites
Forebrain bulge
Pericardium bulge
Upper limb bud
Lower limb bud



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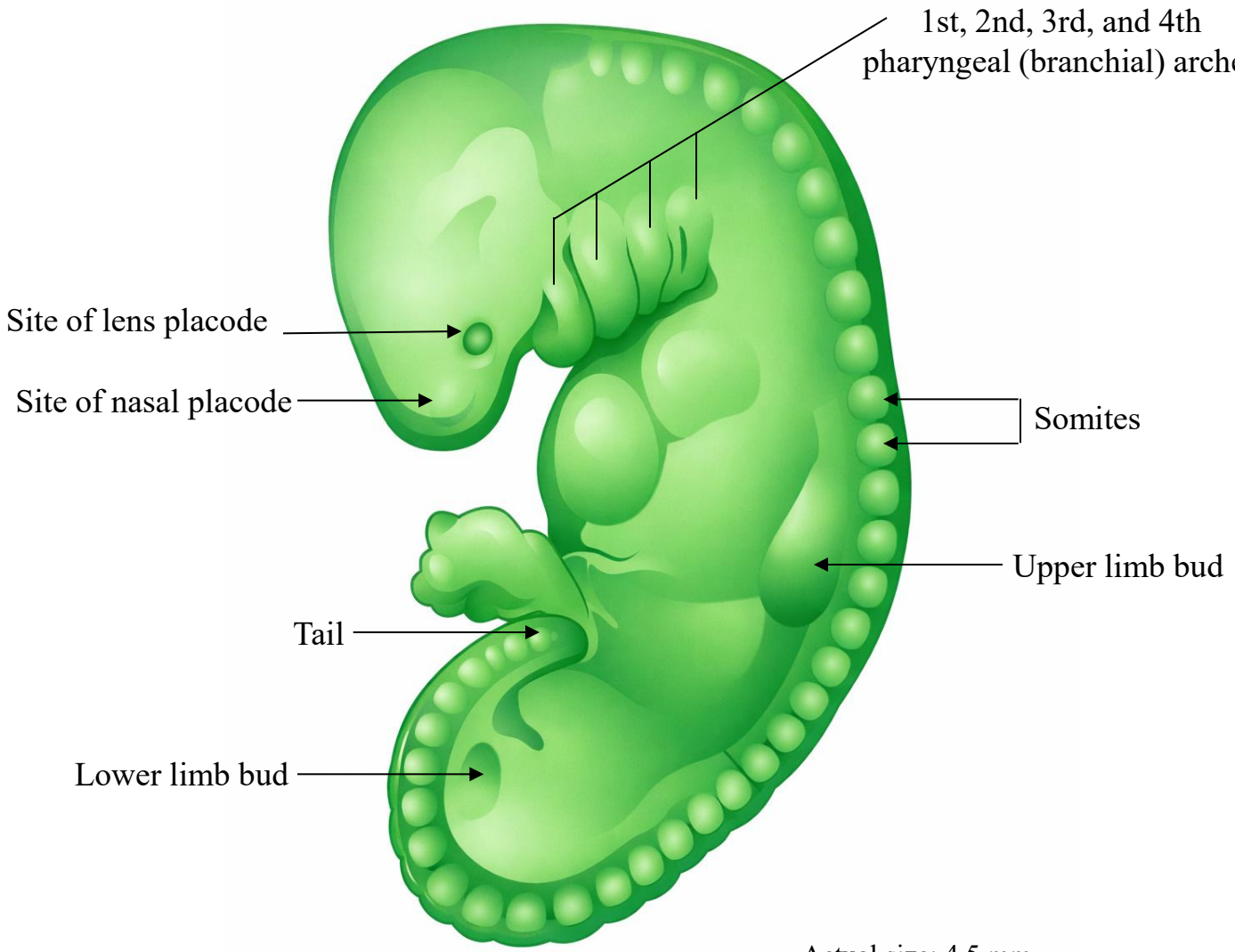

Actual size: 4.5 mm

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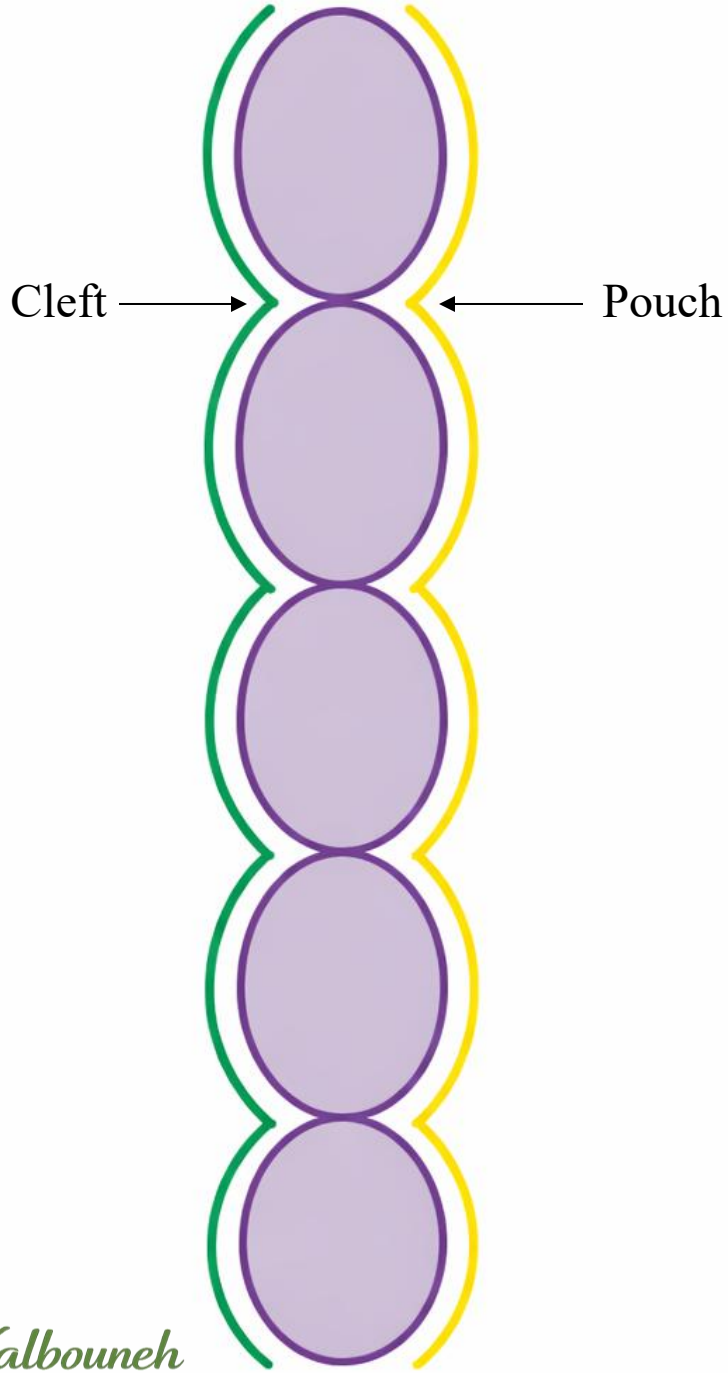
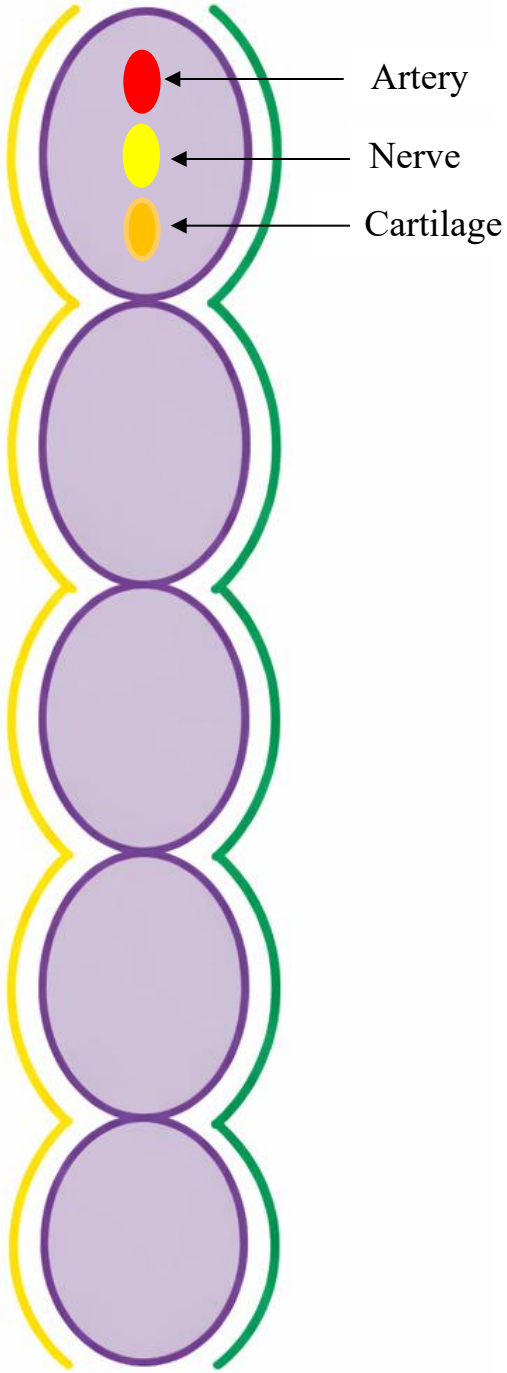
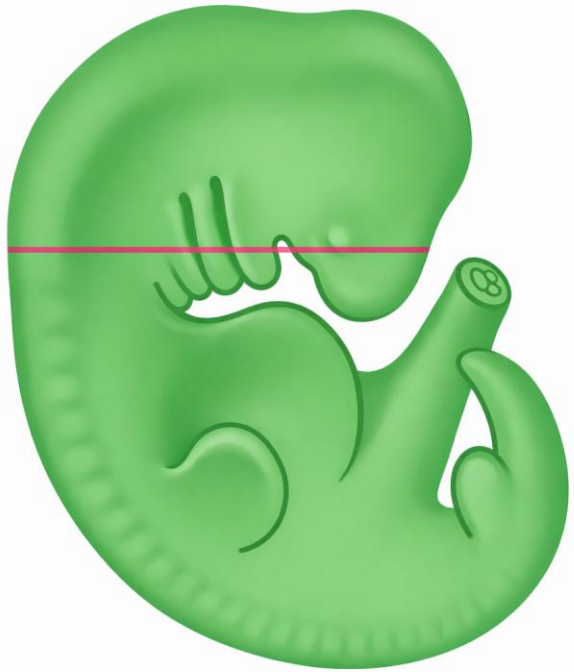




Although six arches form, the 5th arch is rudimentary or absent in humans, so only five pharyngeal pouches are recognized.



Pharyngeal apparatus (arches, clefts and pouches)

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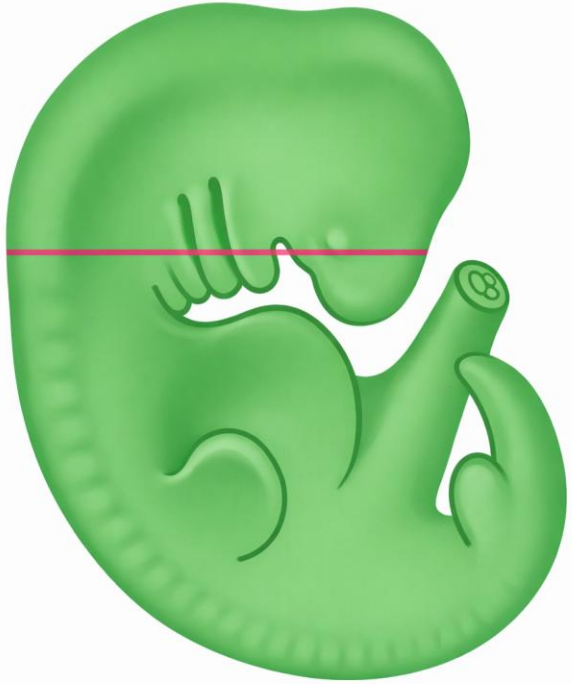
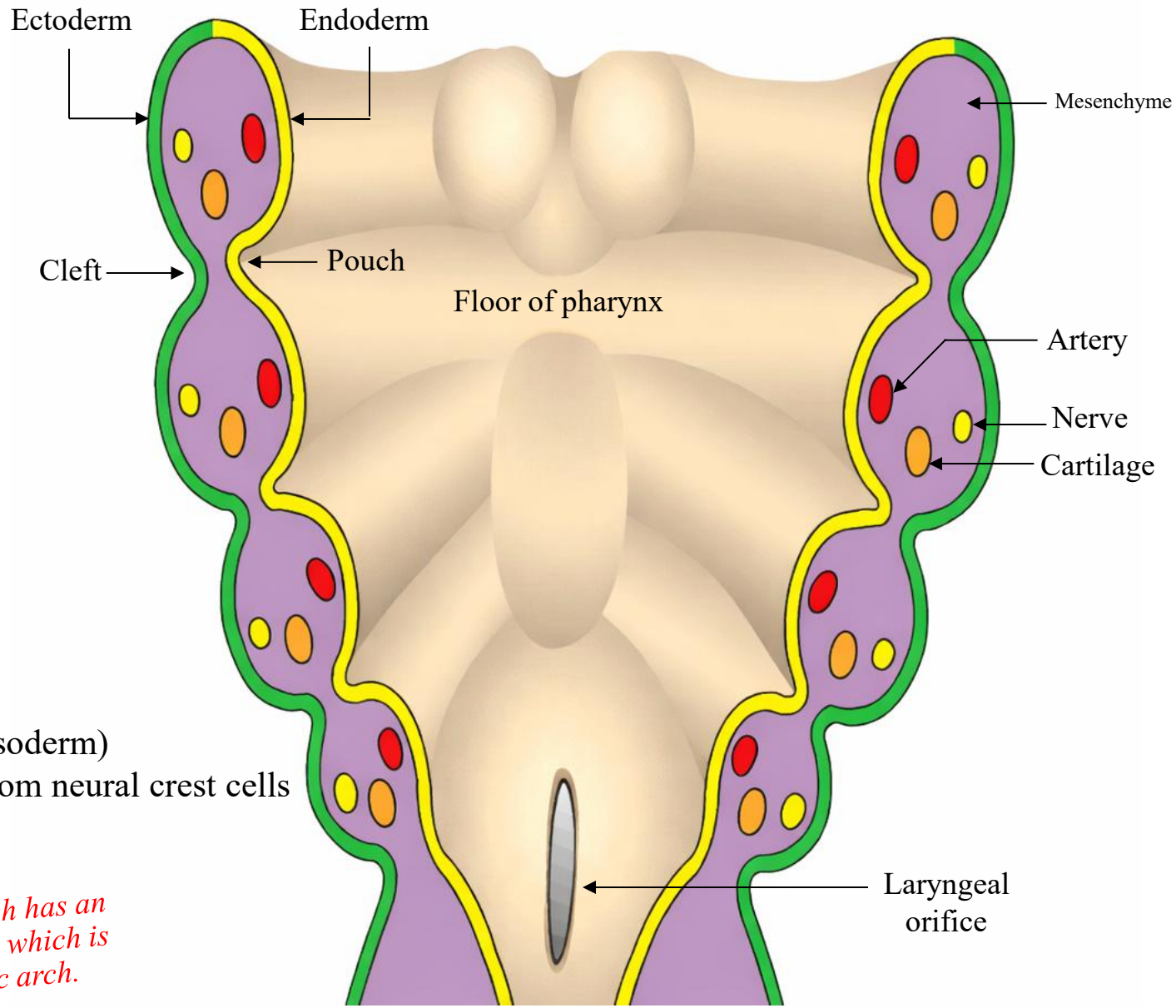




Each pharyngeal arch contains:

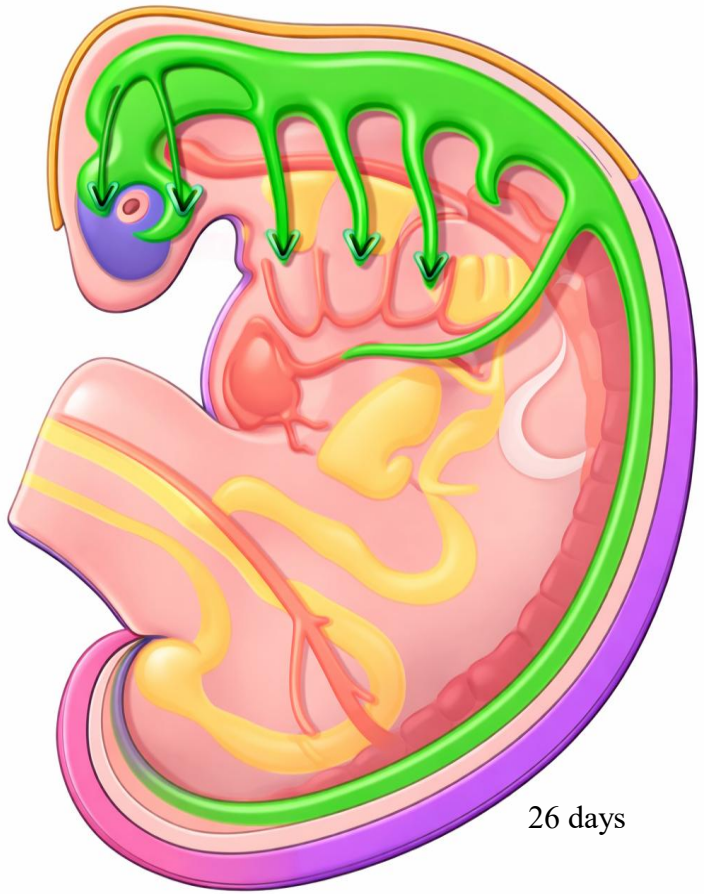
- Mesenchymal core (derived from neural crest cells and mesoderm)
- Cartilaginous rod (skeletal component) – mainly derived from neural crest cells
- Muscle component – derived from mesoderm
- Aortic arch artery
- Cranial nerve supplying the arch
- External ectoderm covering
- Internal endoderm lining

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

Coronal section of neck showing structure of pharyngeal arches

Nerve supply of pharyngeal arches

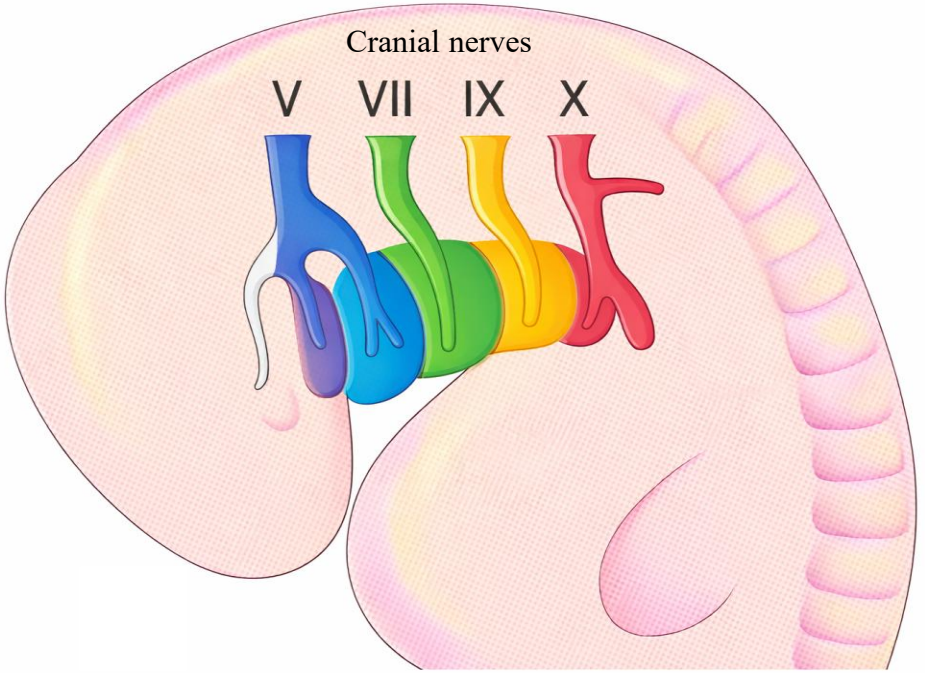
Mandibular & Maxillary nerves supplies derivatives of **1st arch**
Facial nerve supplies derivatives of **2nd arch**
Glossopharyngeal nerve supplies derivatives of **3rd arch**
Superior laryngeal nerve (vagus nerve) supplies derivatives of **4th arch**
Recurrent laryngeal nerve (vagus nerve) supplies derivatives of **6th arch**



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 5th pharyngeal arch is rudimentary or absent in humans.
Therefore, the arches that persist and have nerve supply are:
1st, 2nd, 3rd, 4th, and 6th arches.
This explains why Vagus nerve supplies two arches
Superior laryngeal nerve → 4th arch
Recurrent laryngeal nerve → 6th 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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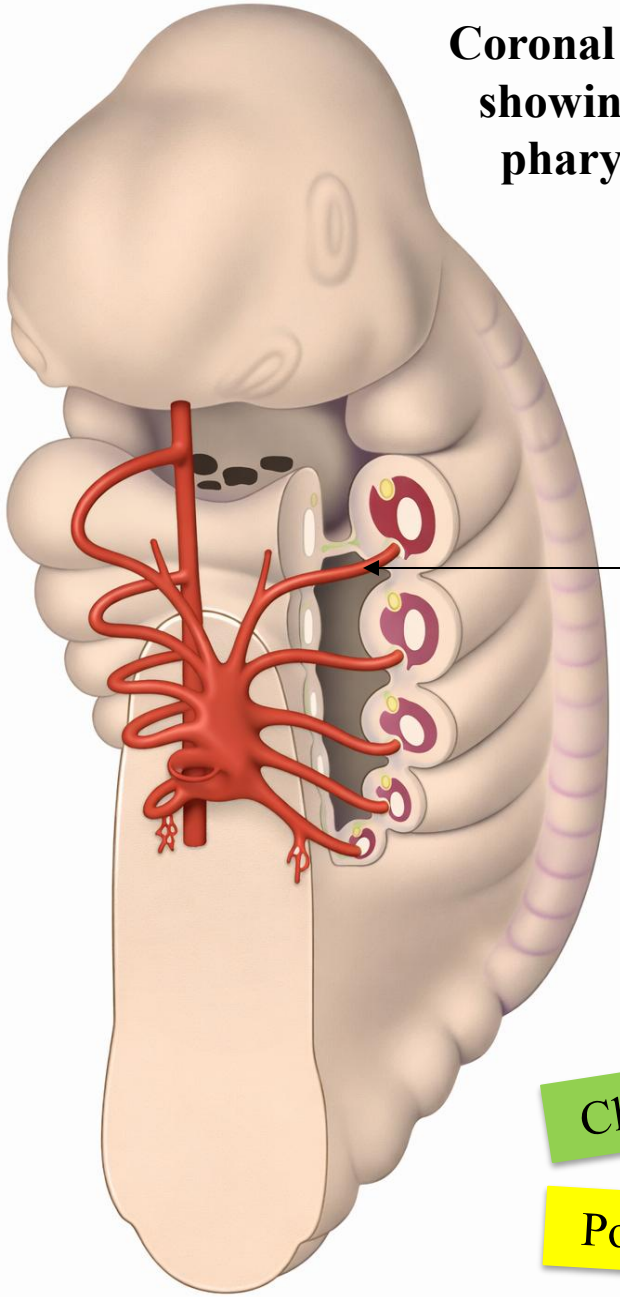
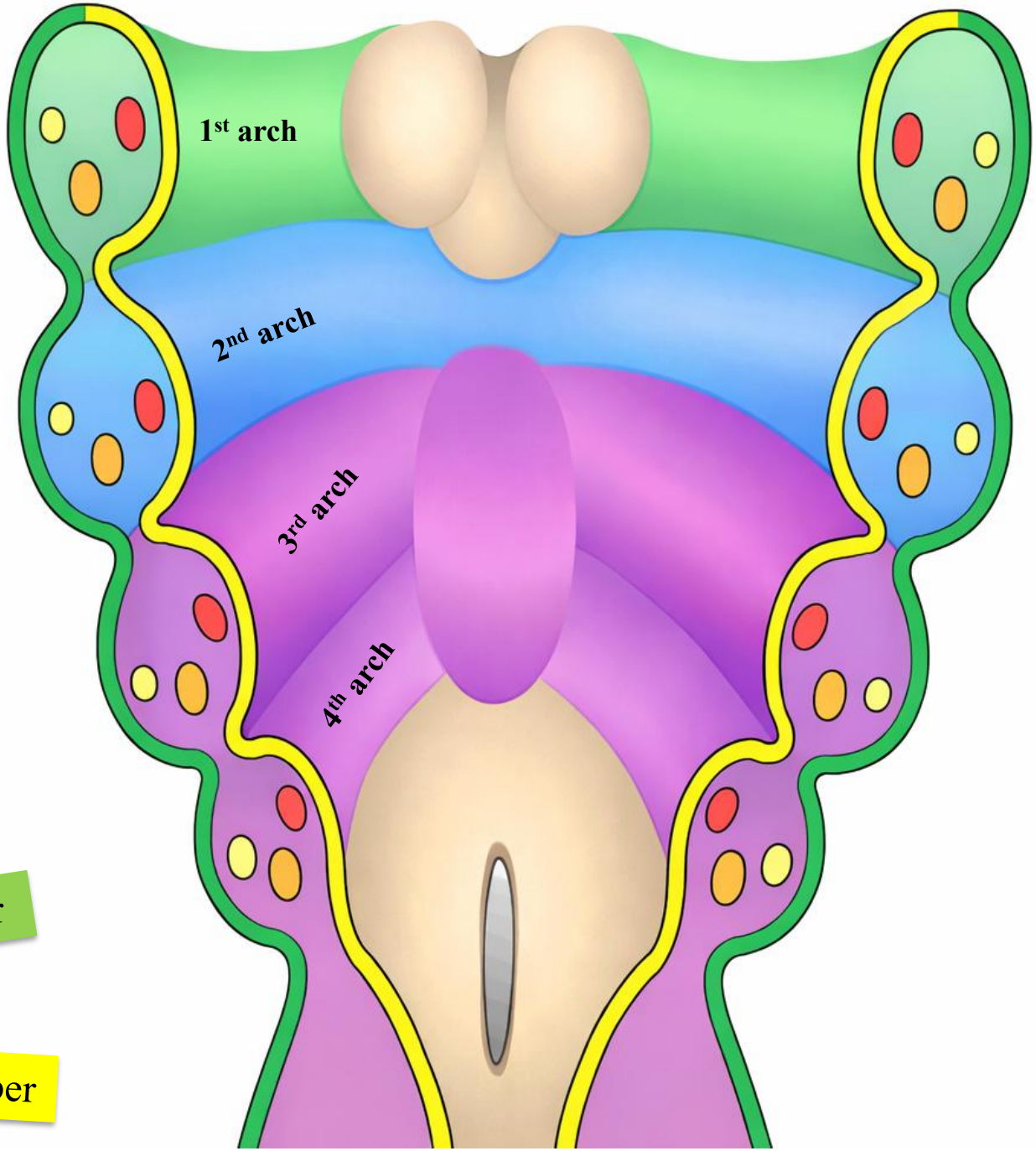
Coronal section of neck showing structure of pharyngeal arches





Clefts are **four** in number

Pouches are **five** in number

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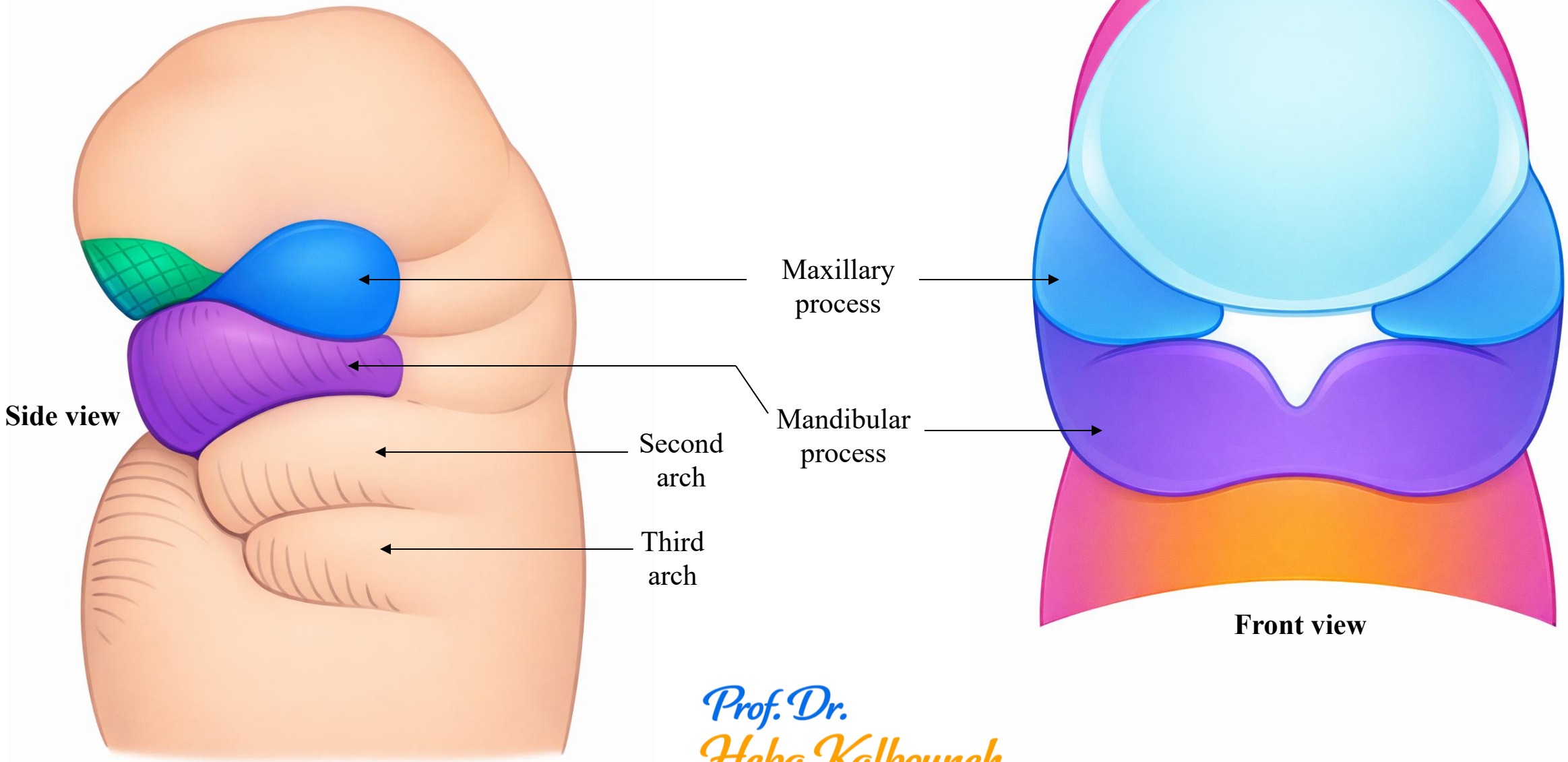
First arch has 2 processes:

1- Maxillary process
2- Mandibular process

Both processes grow forward



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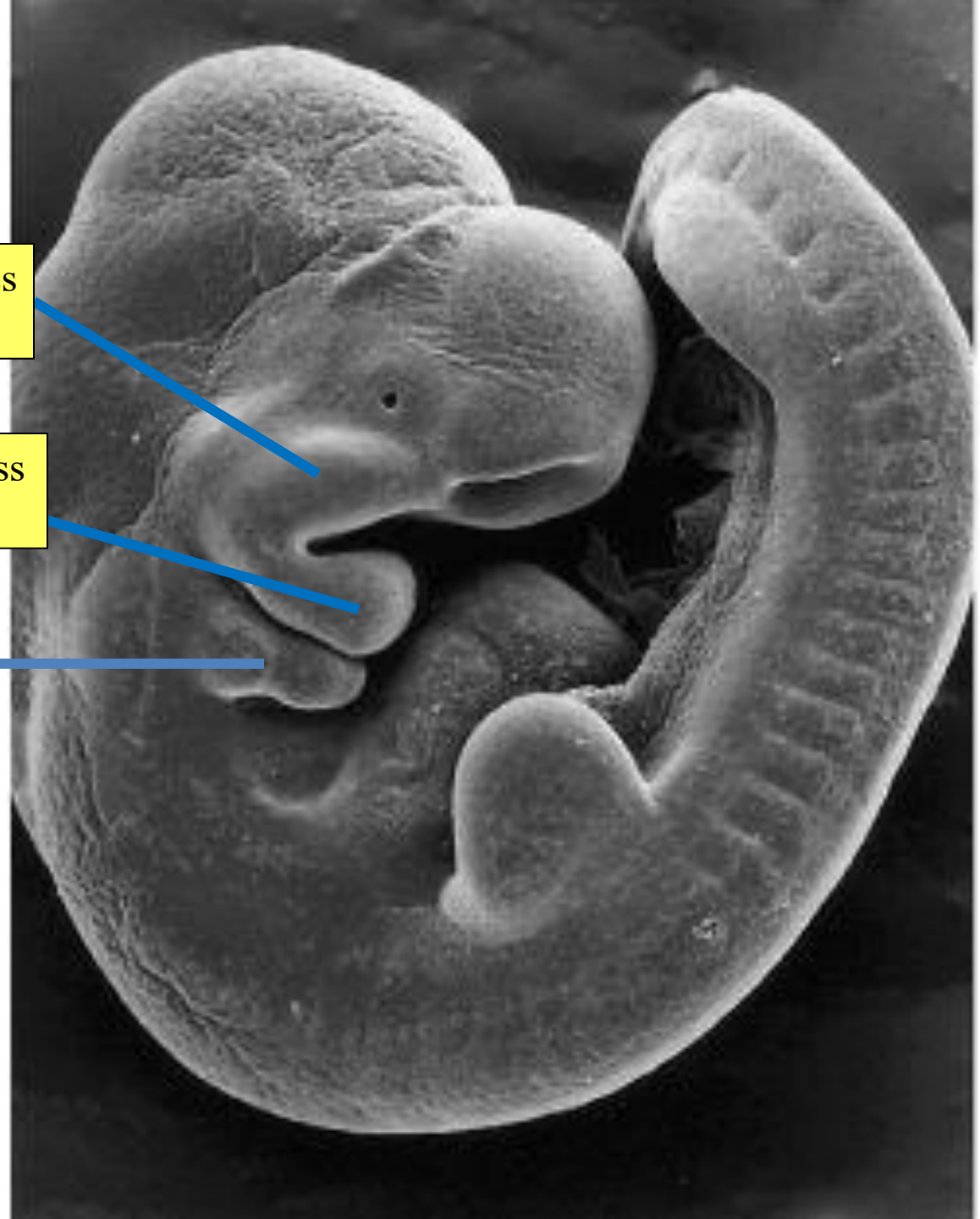

- ✓ **Maxillary process** is a forward growth of **dorsal end of 1st pharyngeal arch.**
- ✓ **Mandibular process** is a forward growth of **ventral end of 1st pharyngeal arch**

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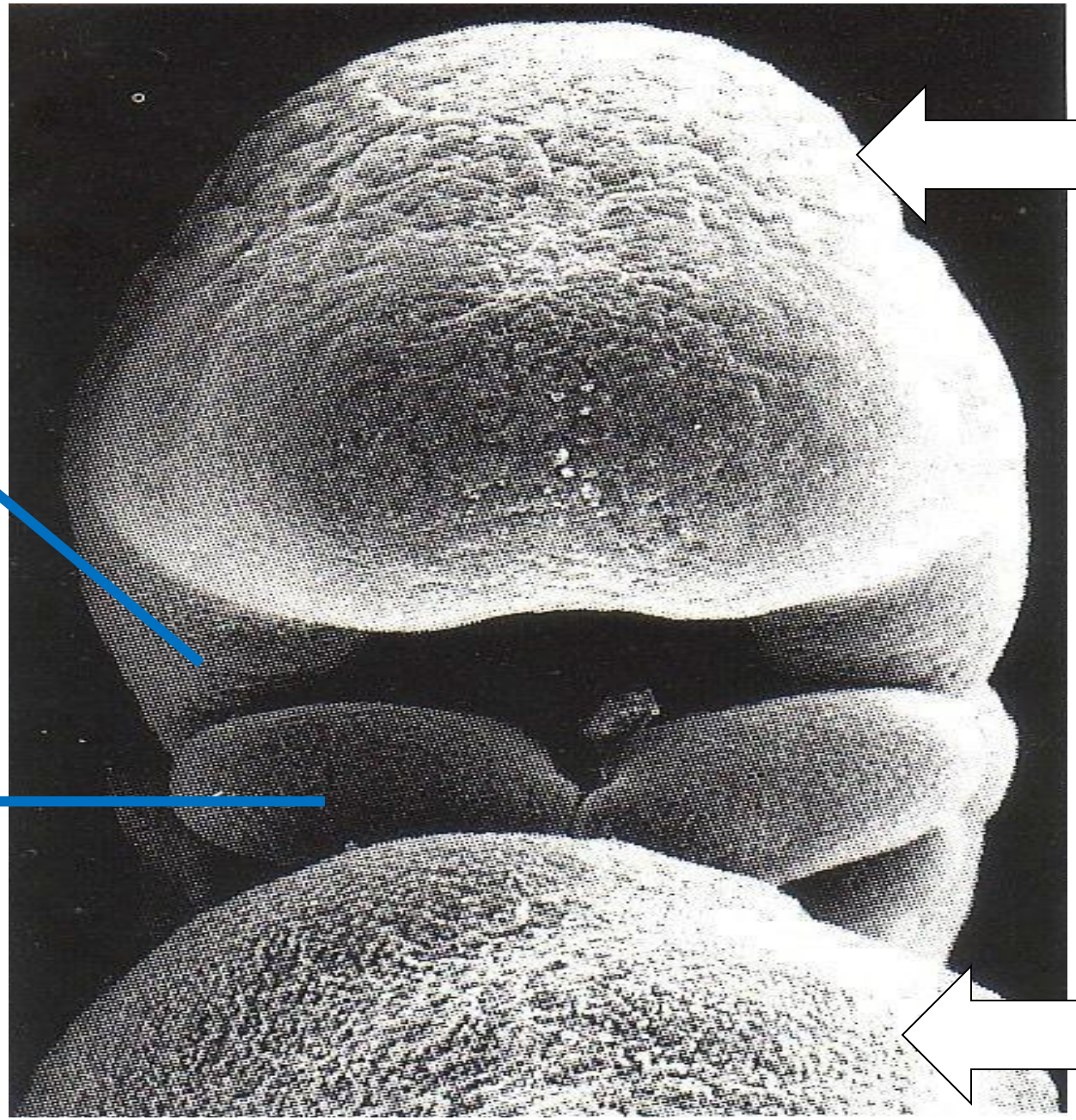
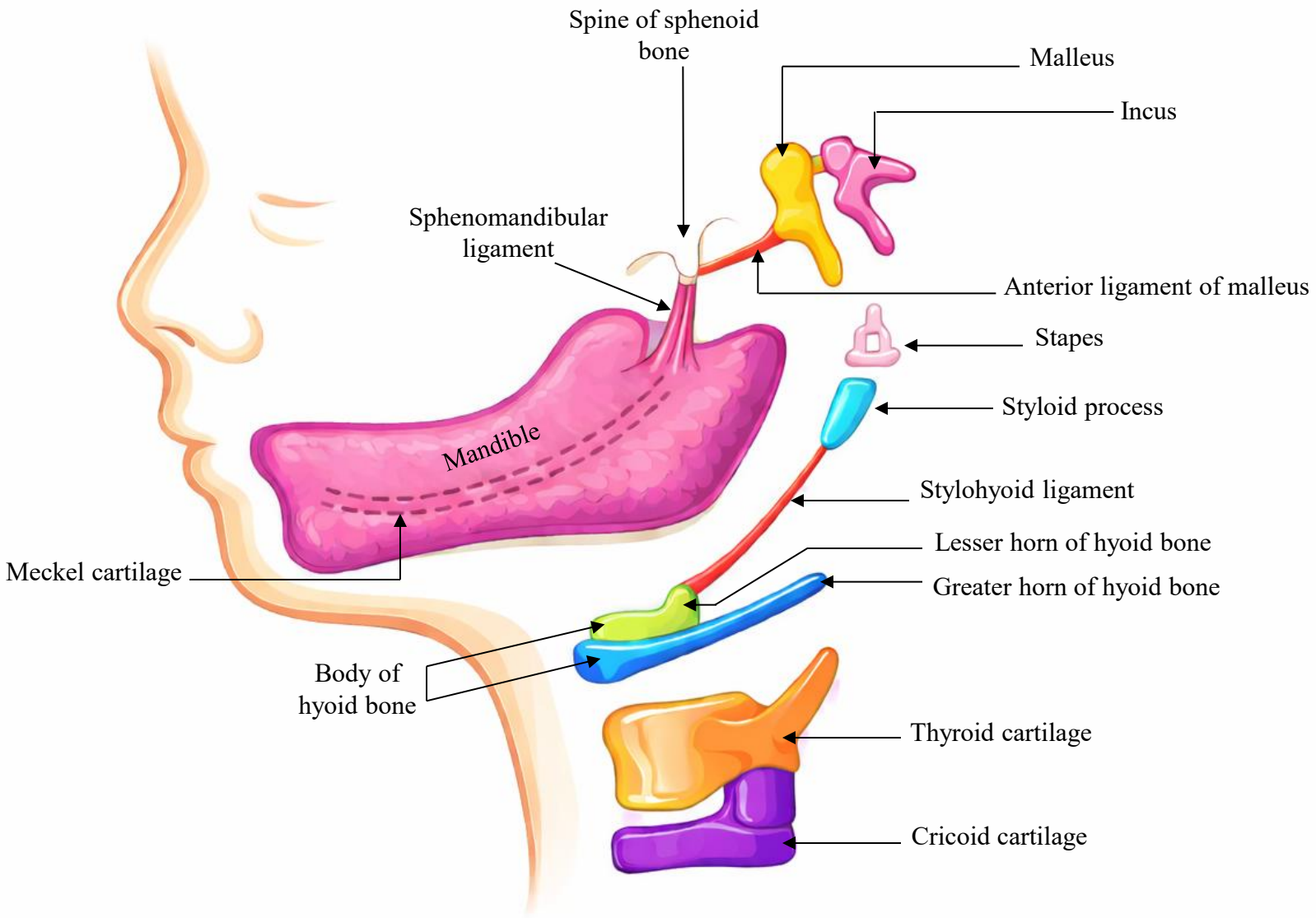


Fourth Week

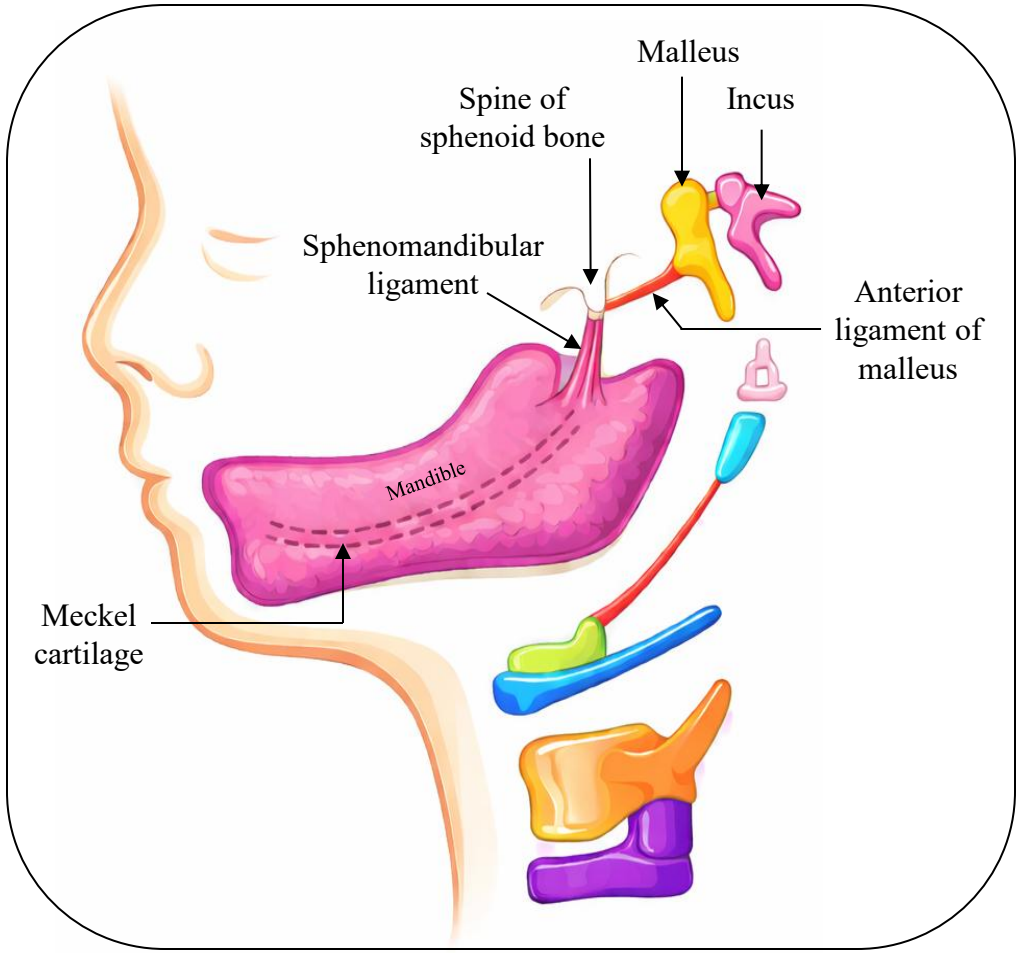
Derivatives of pharyngeal arches



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

- Ventral part → Ramus of mandible
- Middle part → 1- Anterior ligament of malleus; 2- Sphenomandibular ligament
- Dorsal part → 1- Malleus; 2- Incus

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

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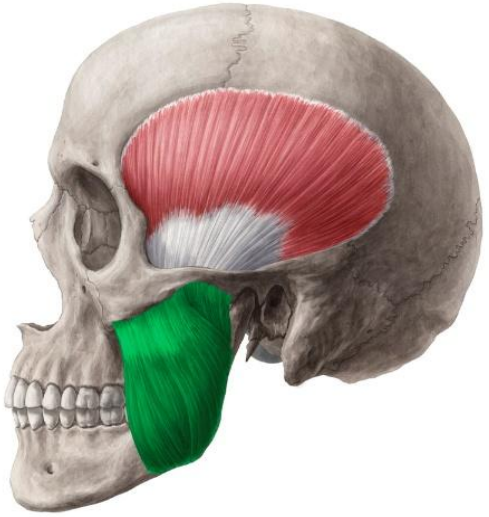
Muscles of first pharyngeal arch:
Are the muscles supplied by the **mandibular nerve**:

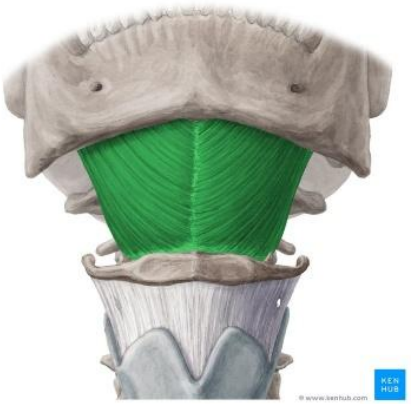
1. Muscles of mastication
2. Tensor tympani
3. Anterior belly of digastric
4. Mylohyoid
5. Tensor veli palatini

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.

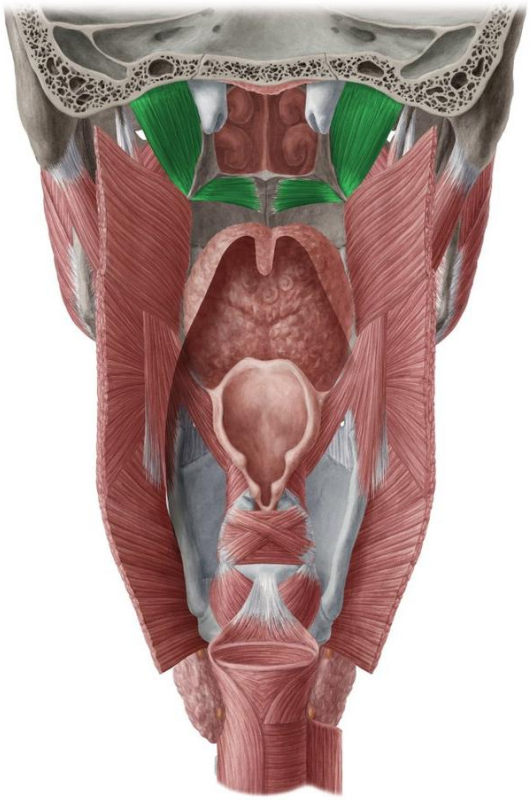
Masseter & Temporalis



Mylohyoid

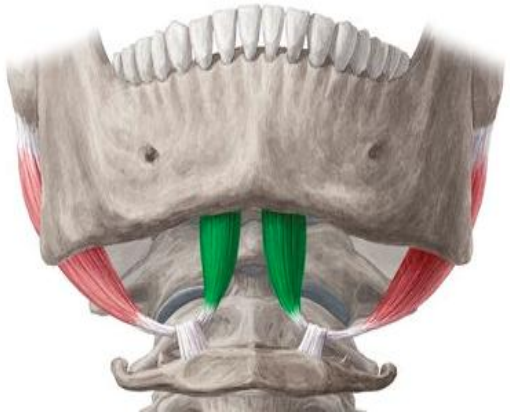


Tensor veli palatini

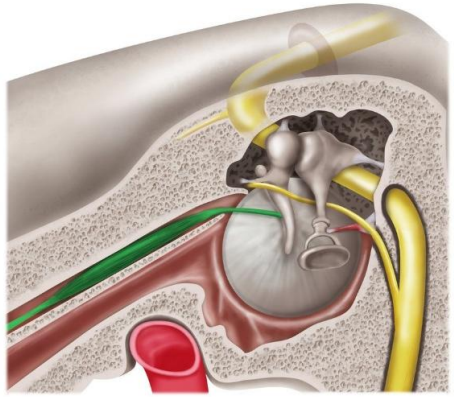


Medial & Lateral pterygoids

Anterior belly of digastric



Tensor tympani



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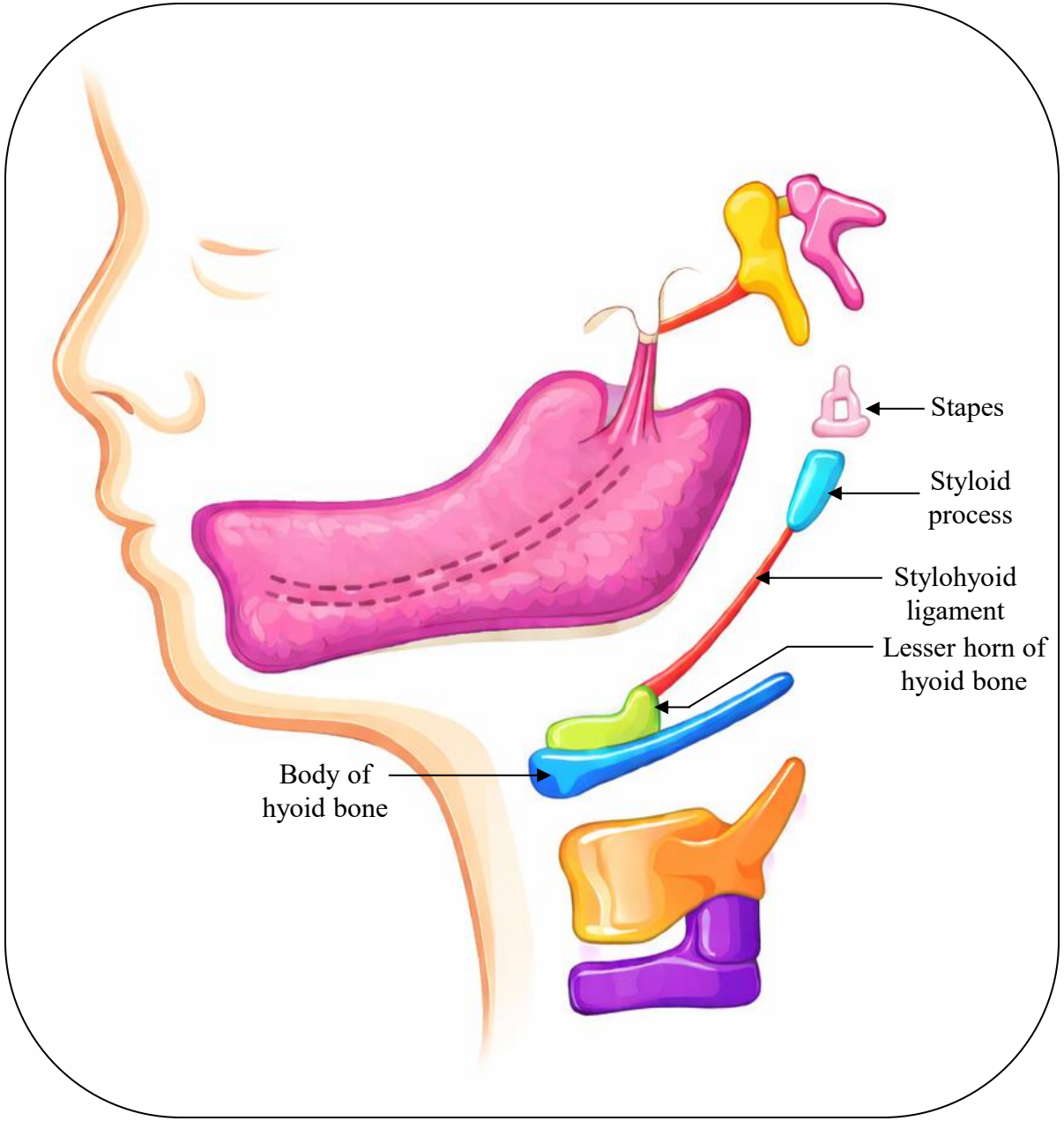
Derivatives of second pharyngeal arch



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

Reichert's cartilage

- Ventral part
  - 1- Upper part of the body of hyoid bone
  - 2- Lesser horn of the hyoid bone
- Middle part
  - Stylohyoid ligament
- Dorsal part
  - 1-Stapes
  - 2-Styloid process

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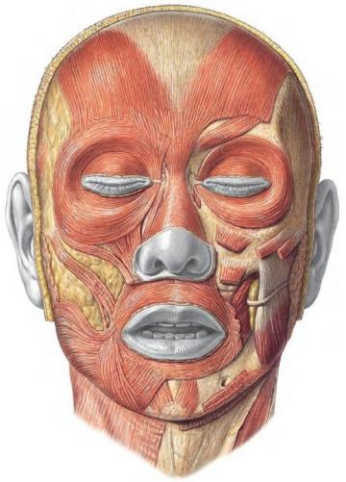
Muscles of second pharyngeal arch:

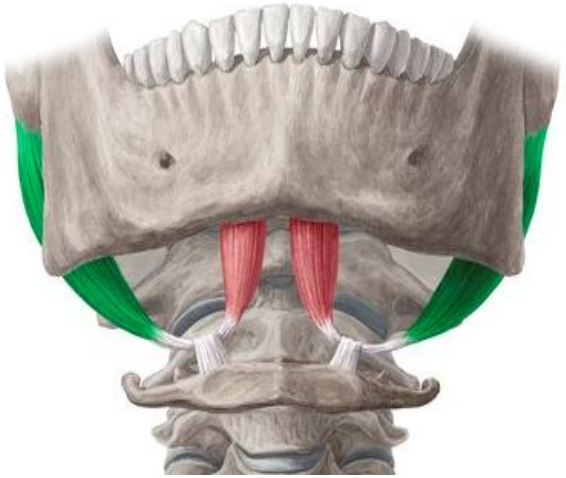
Are the muscles supplied by the **facial nerve**:

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

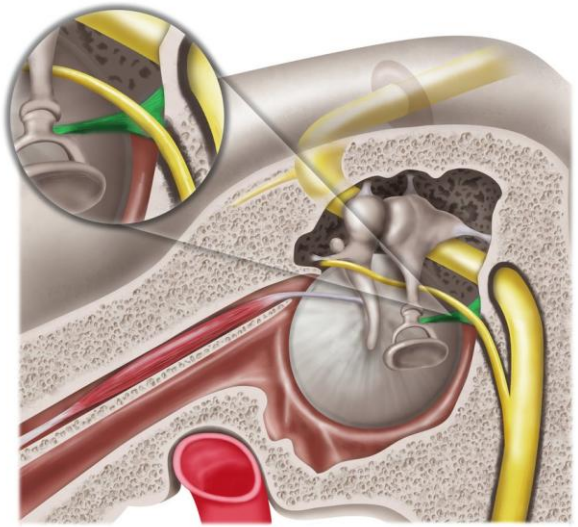
Muscle of facial expression



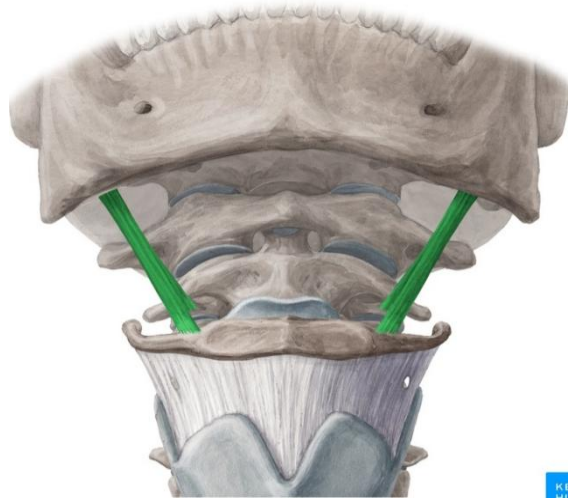
Posterior belly of the digastric



Stapedius



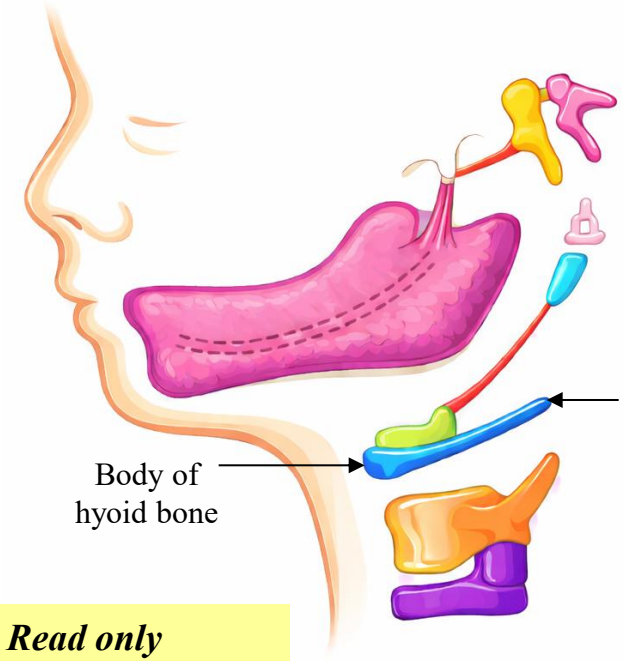
Stylohyoid

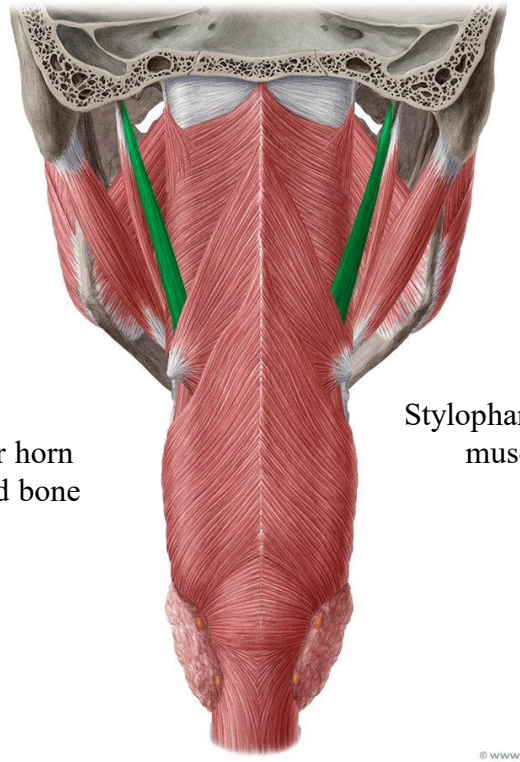


Derivatives of third pharyngeal arch

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





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(For Digestive System)

Derivatives of fourth pharyngeal arch

The cartilage of the fourth pharyngeal arch produces:
Laryngeal cartilages

Muscles of fourth pharyngeal arch:
Only one muscle (Cricothyroid muscle)
Supplied by **Superior laryngeal nerve (vagus)**

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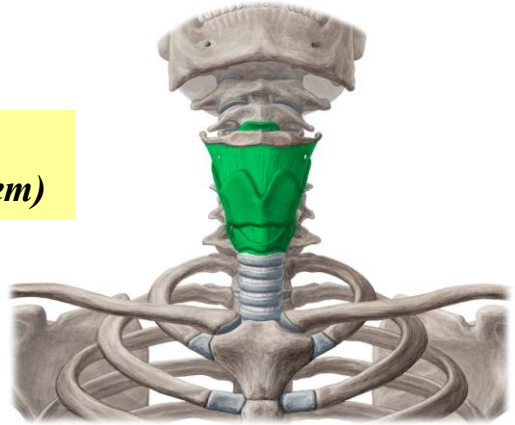
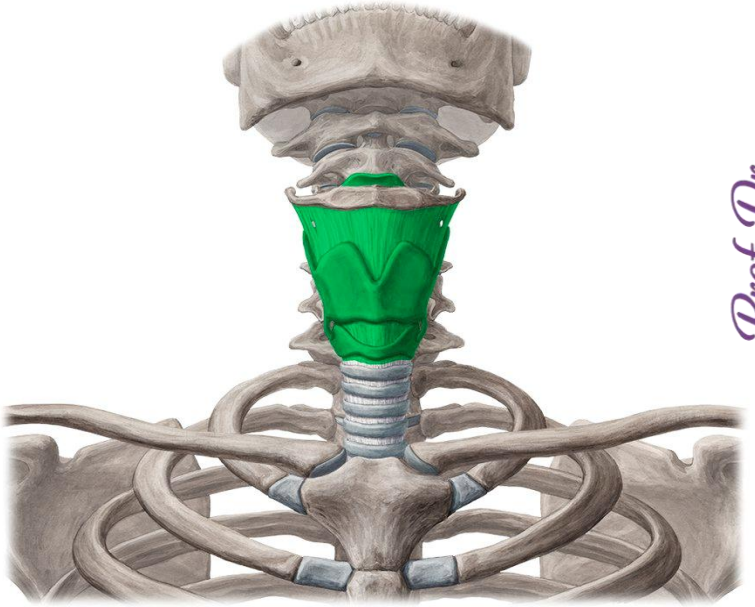
(For Respiratory System)



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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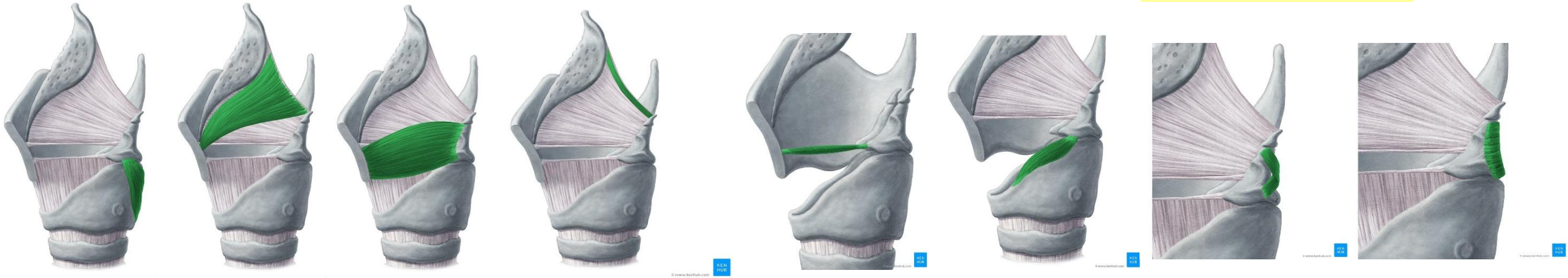
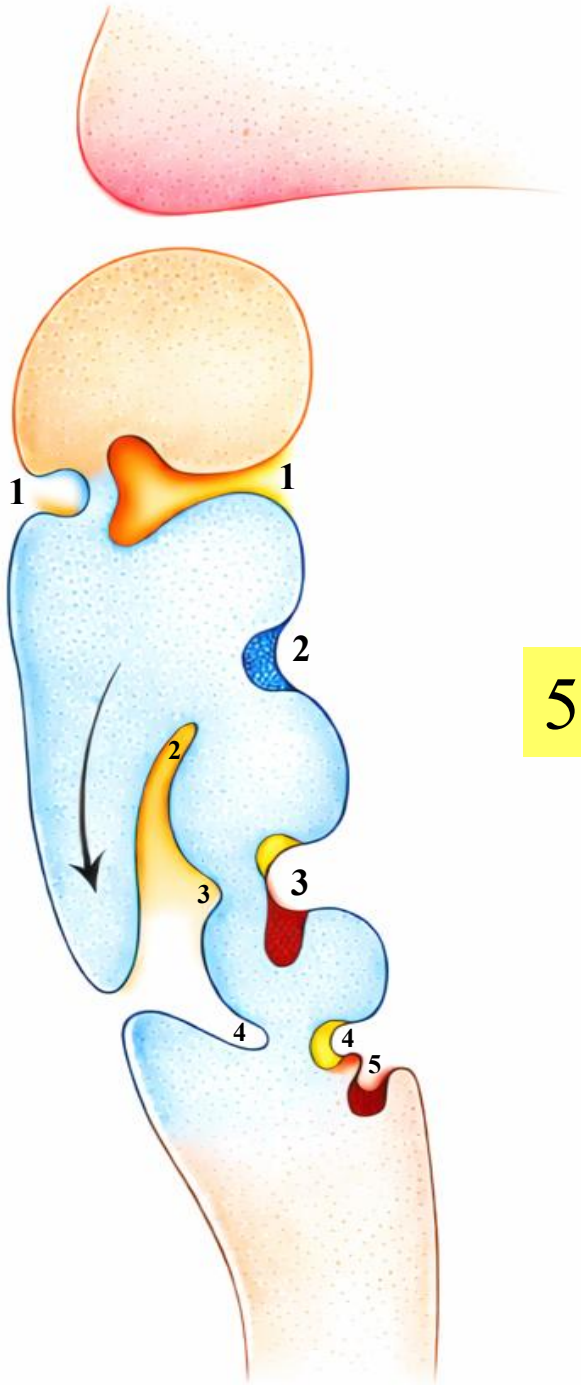


4 pharyngeal clefts



5 pharyngeal pouches

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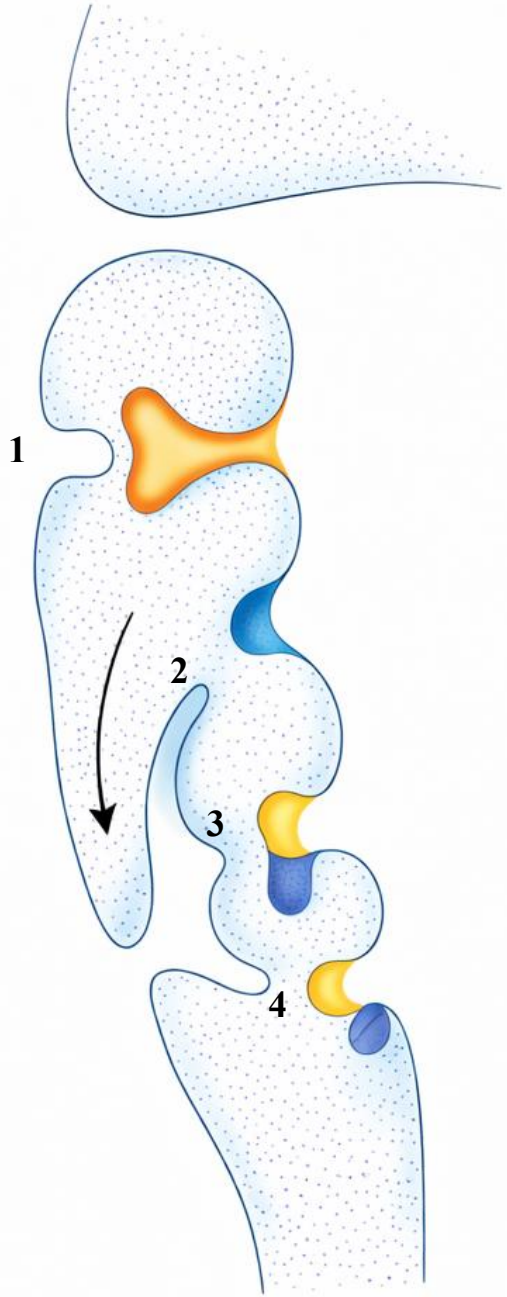

Fate of pharyngeal clefts

Clefts are **four** in number

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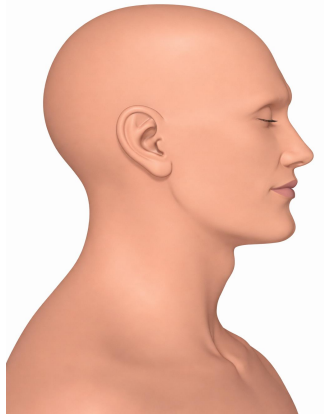
First pharyngeal cleft

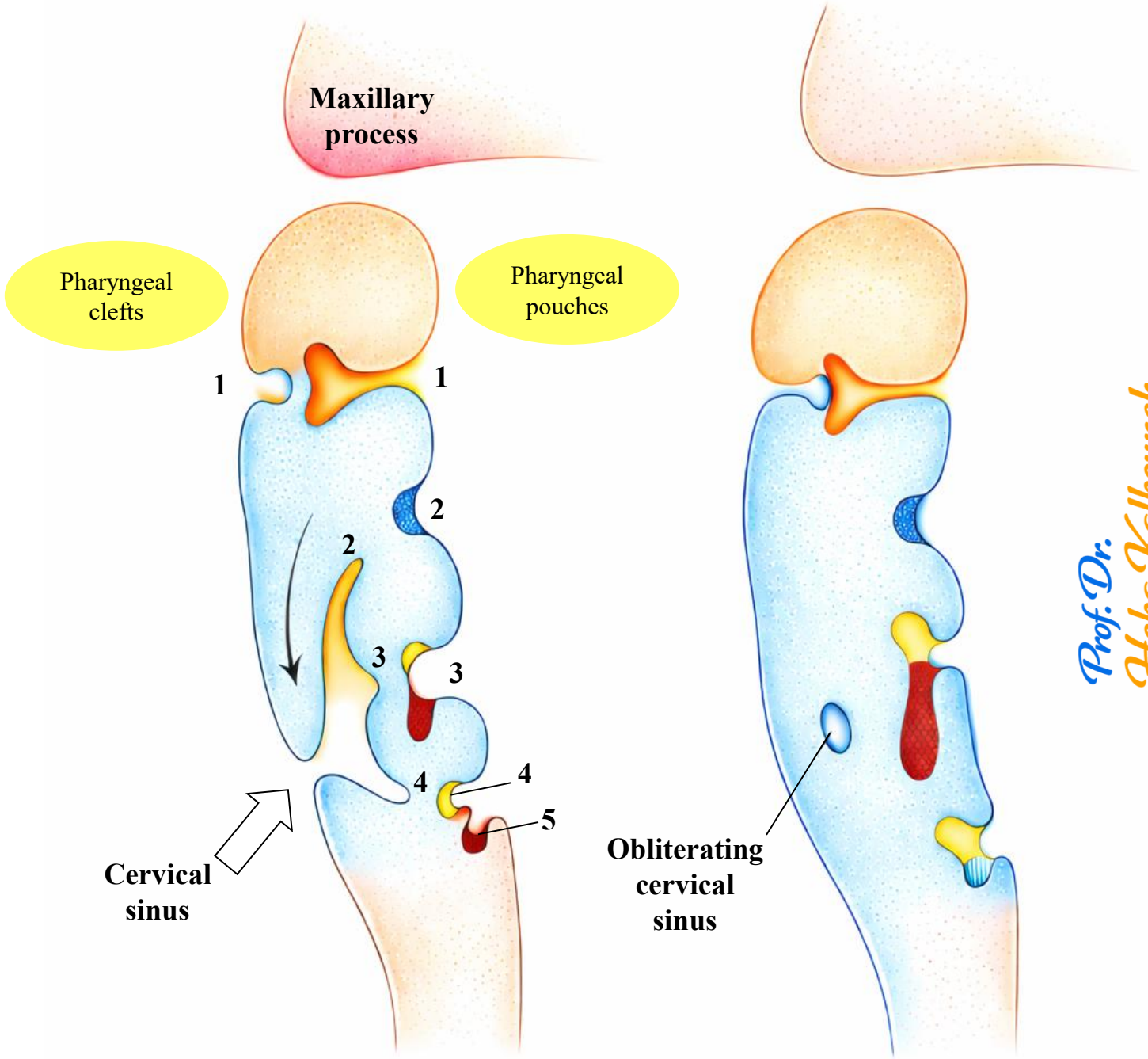
Forms:
1- External auditory meatus
2- Outer layer of tympanic membrane (skin)



2nd 3rd and 4th pharyngeal clefts

Note the downward growth of 2nd arch

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



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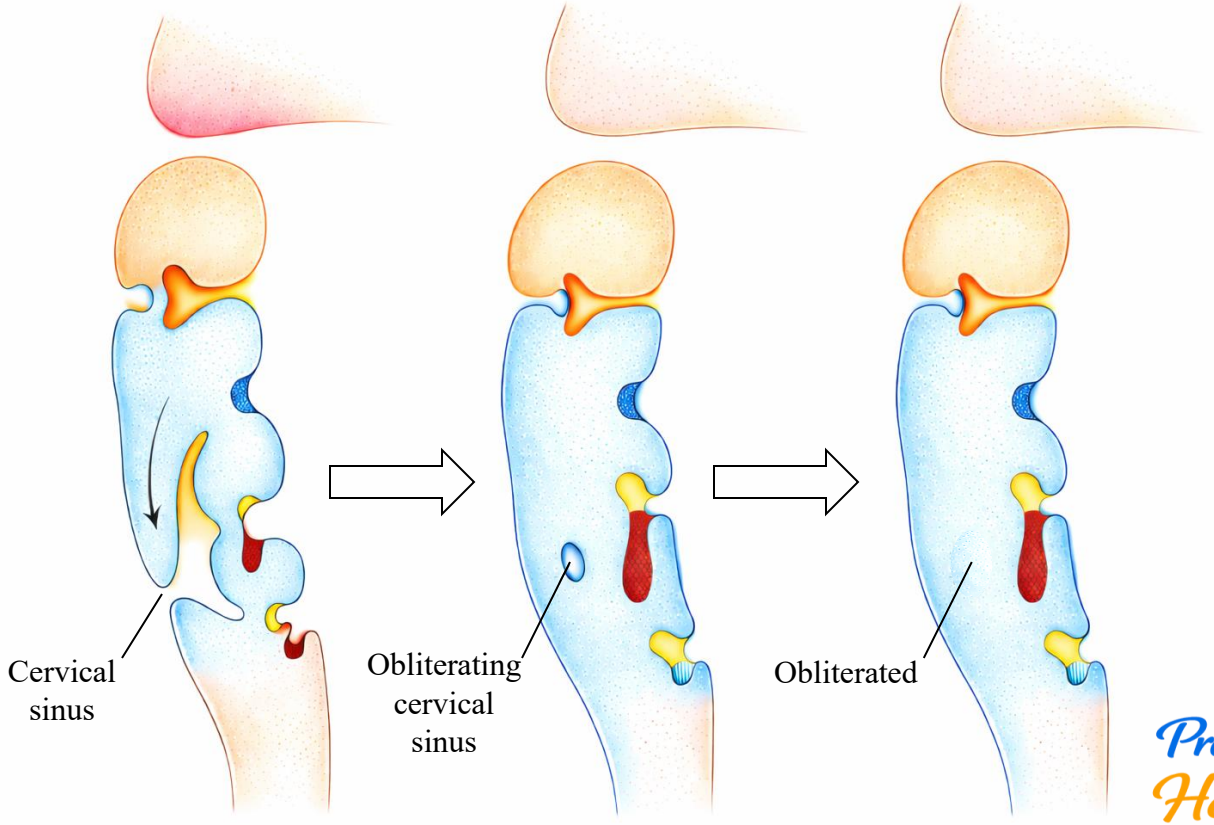
During early embryonic development, the lateral surface of the neck initially shows a segmented appearance due to the presence of the pharyngeal arches separated by pharyngeal clefts. As development progresses, the **second pharyngeal arch (hyoid arch)** grows caudally and posteriorly, extending over 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

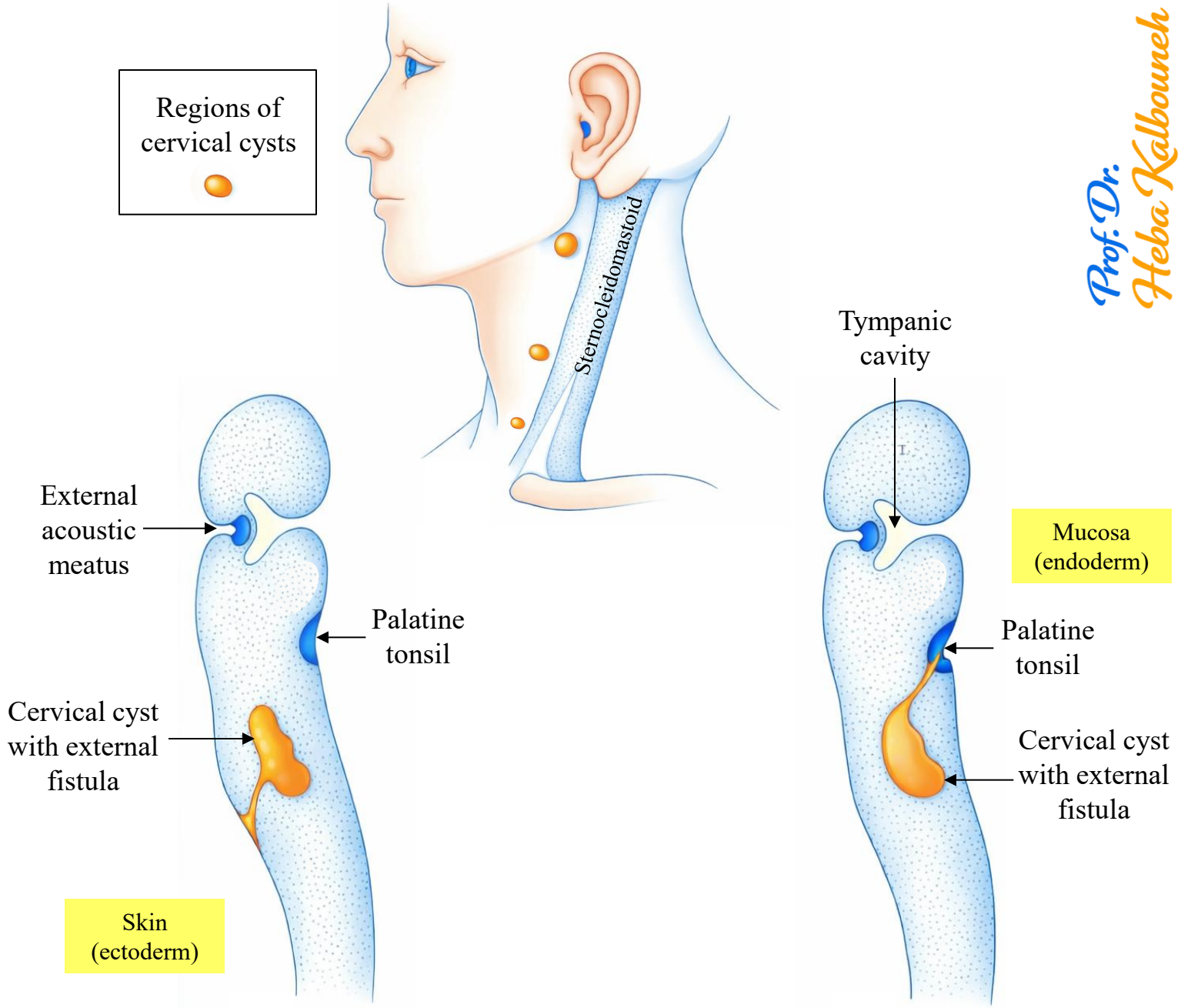
- Remnant of cervical sinus
- Can form a fluid filled cyst in the neck

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



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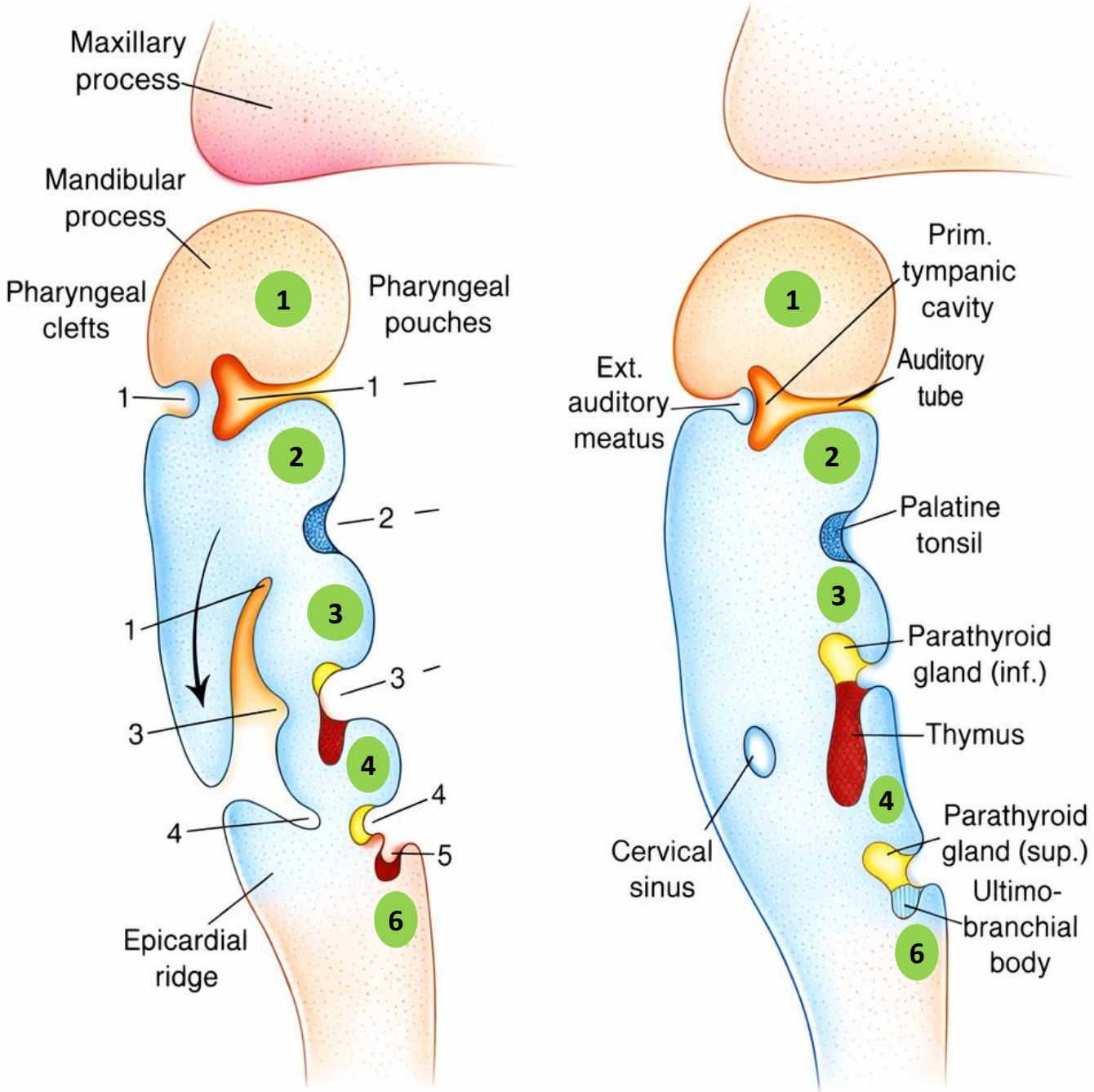
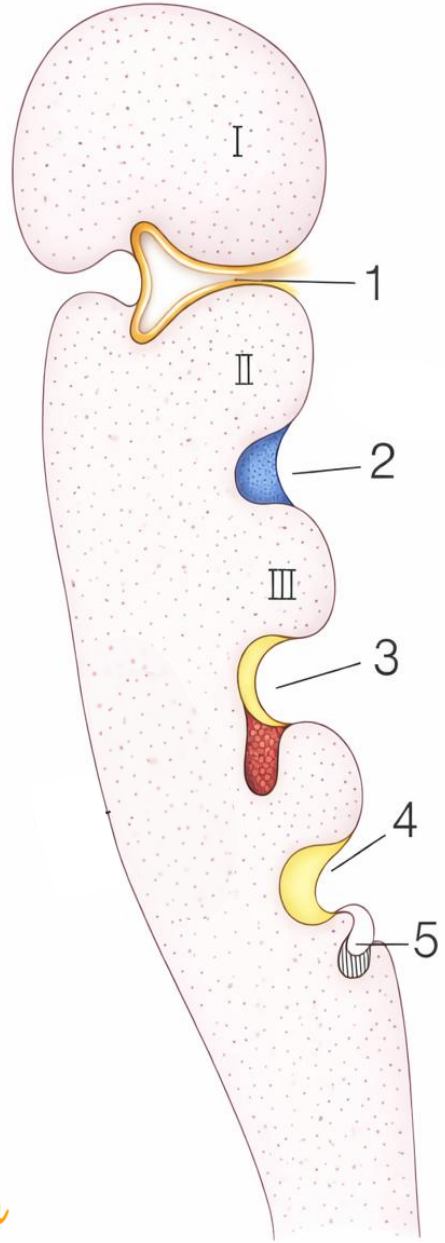
Ectodermal tubercles forming the auricle





Fate of pharyngeal pouches

Pouches are **five** in number

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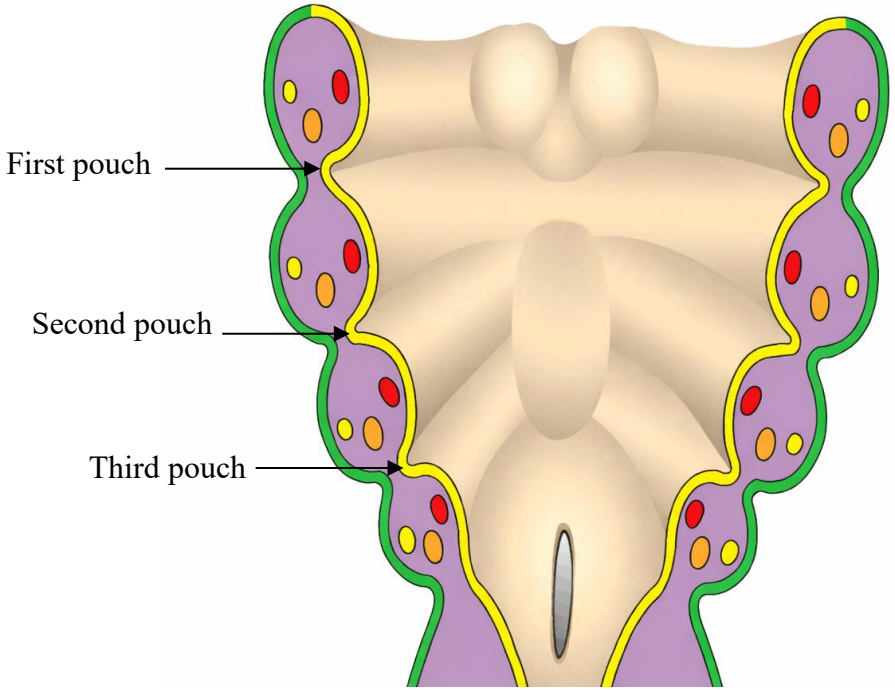
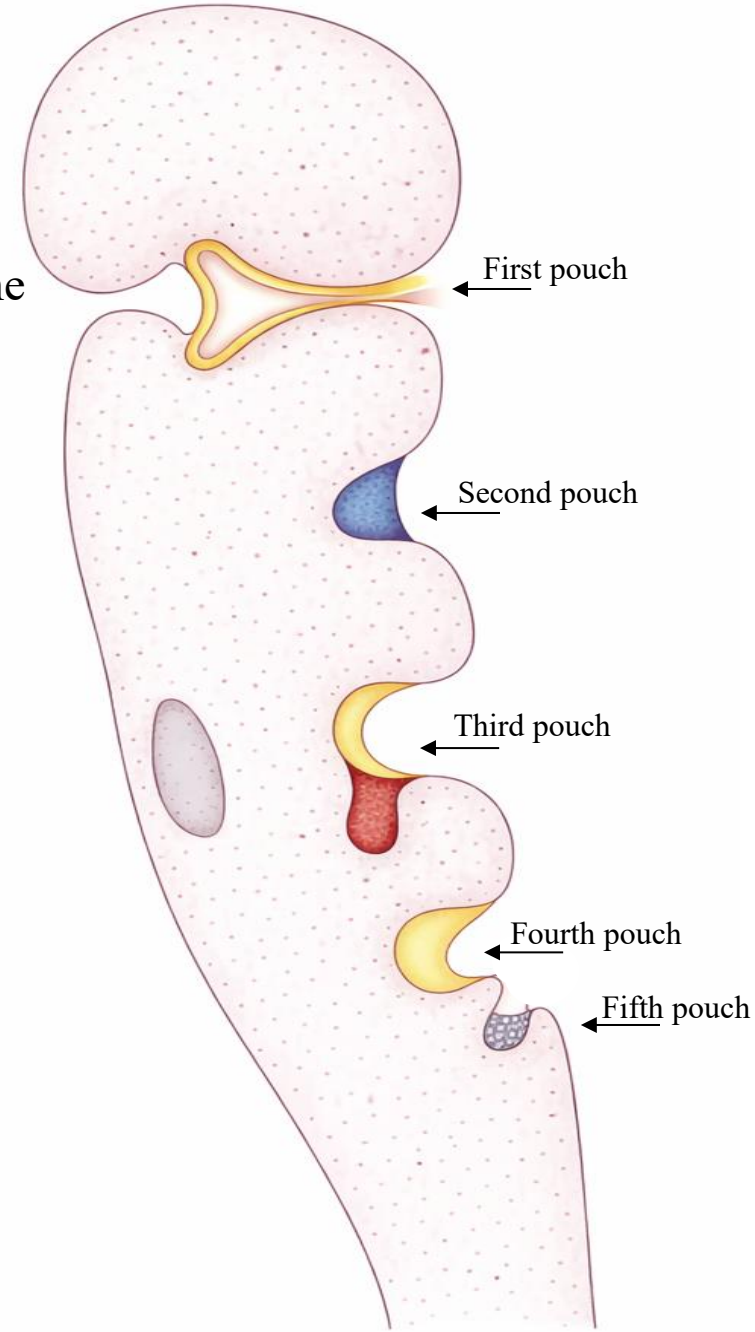
Fate of pharyngeal pouches

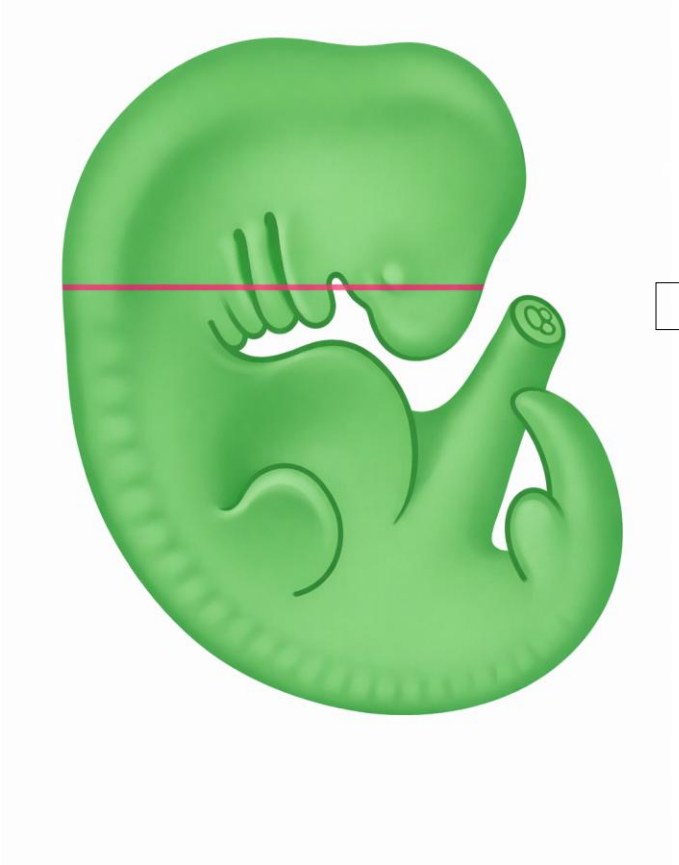
Only first and second pouches are covered in MSS

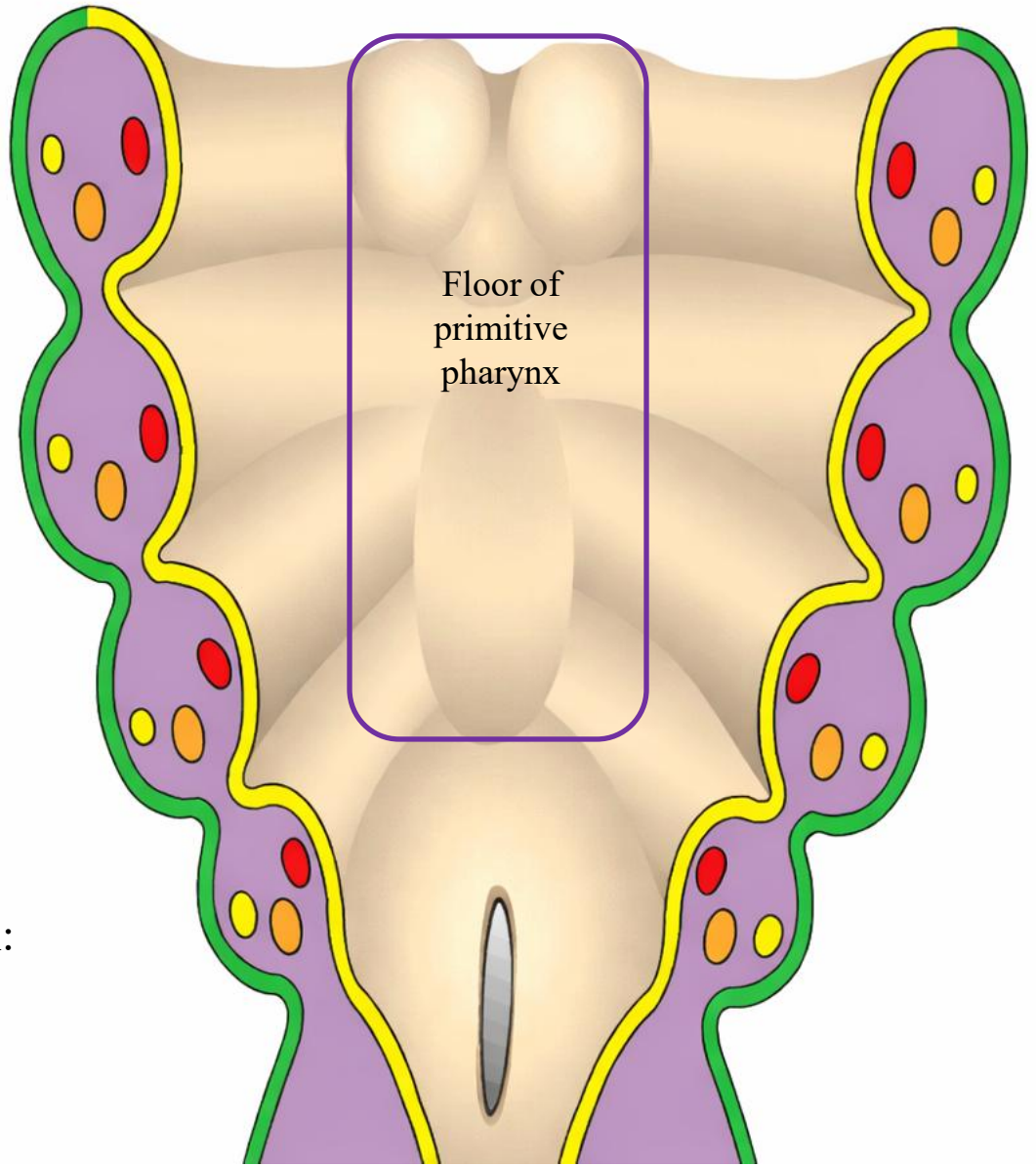
Pouch	Derivatives
1	Middle ear cavity, auditory tube, inner layer of tympanic membrane
2	Palatine tonsil
3	Thymus, inferior parathyroid glands
4	Superior parathyroid glands
5	Ultimobranchial body → thyroid parafollicular cells

For Endocrine System









Coronal section of neck showing structure of pharyngeal arches

Note:

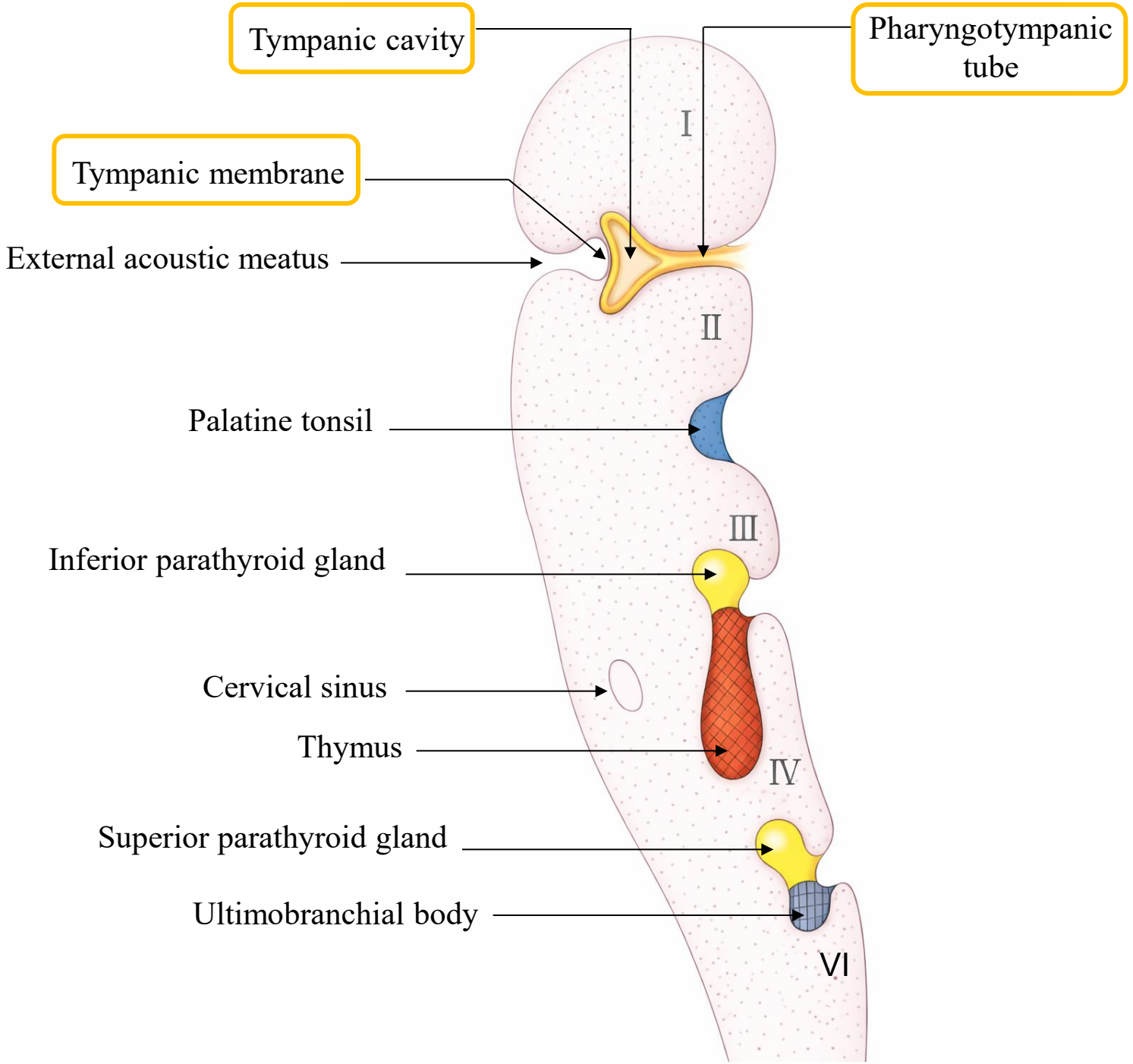
Three major structures originate from the floor of the primitive pharynx:

1. Tongue
2. Thyroid gland
3. Respiratory tract

Arise from endodermal proliferations in the floor of the primitive pharynx during the 4th week of development.

First pharyngeal pouch

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



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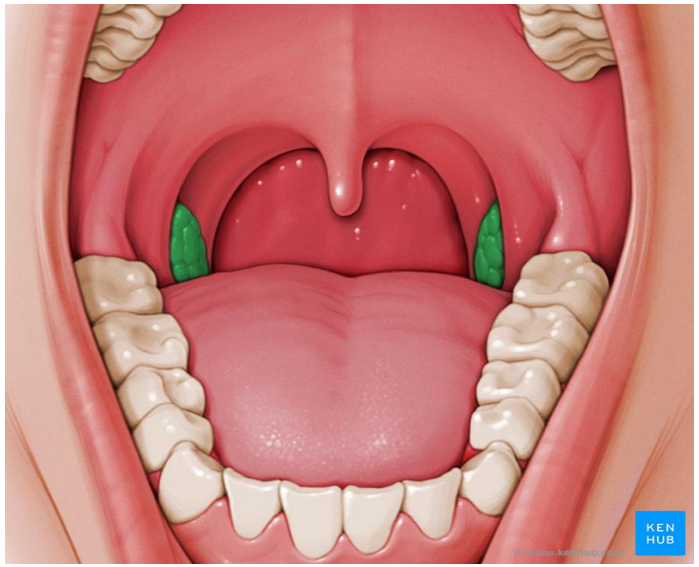
Second pharyngeal pouch

Forms:
Palatine tonsils



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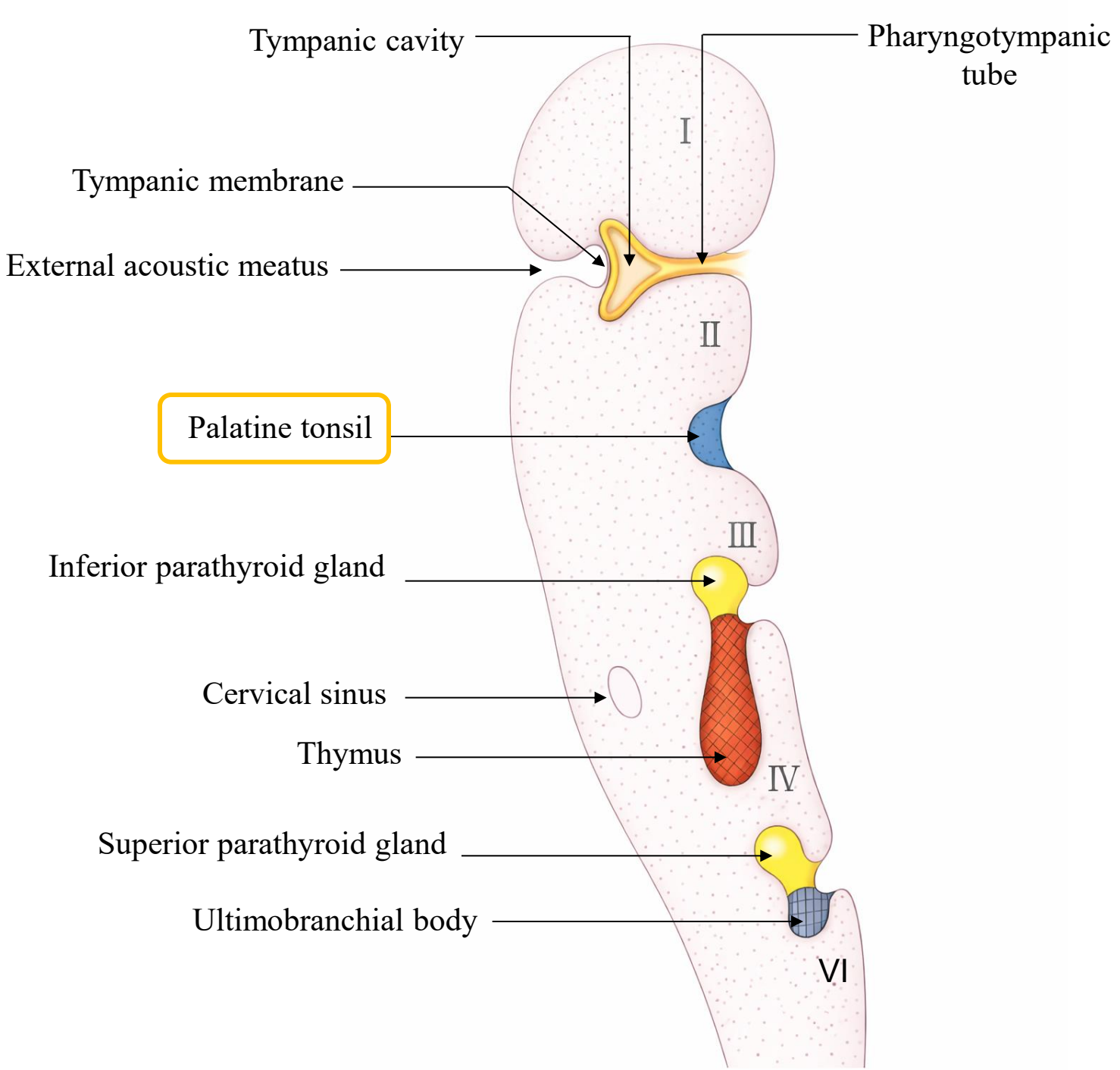
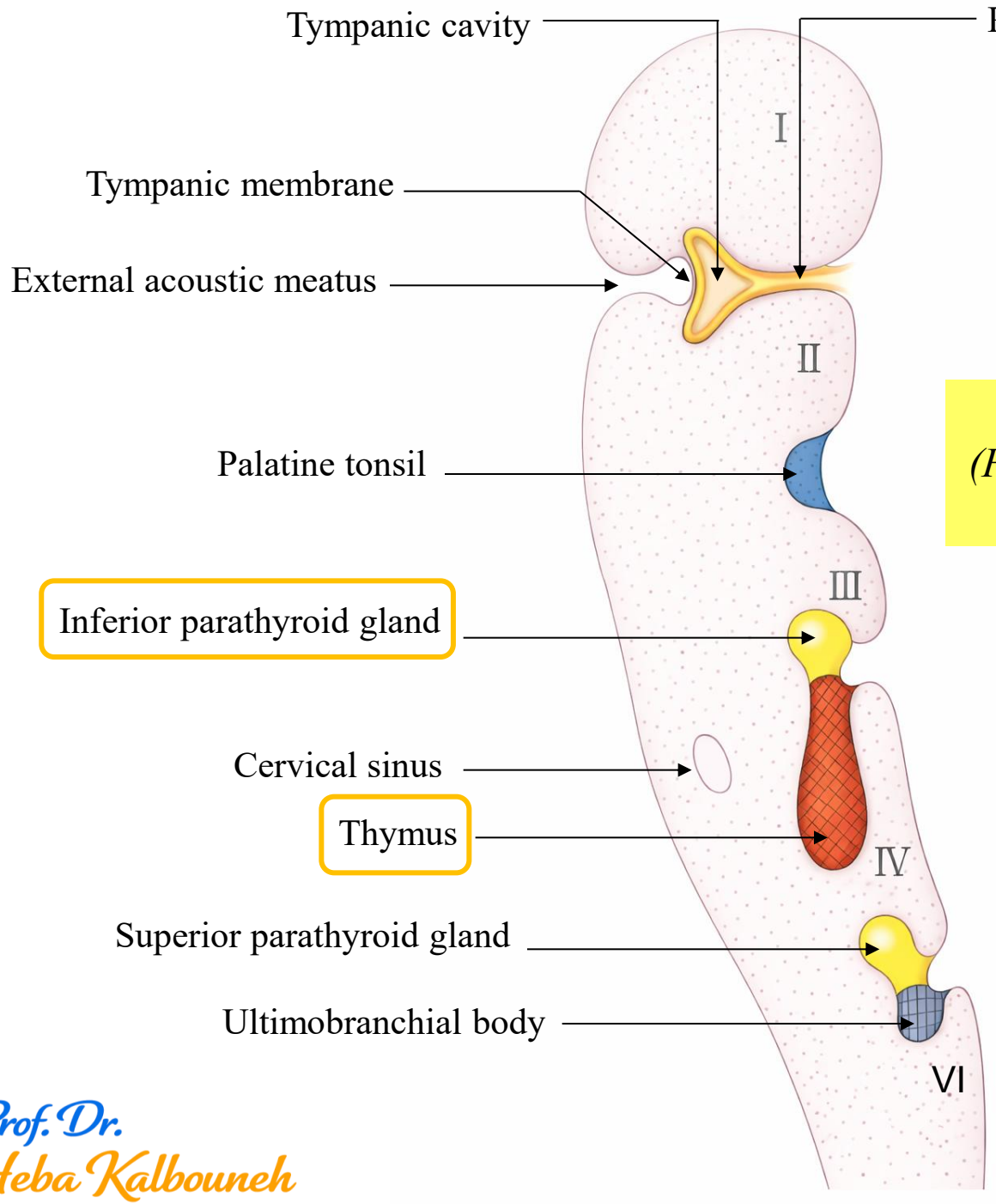


Third pharyngeal pouch

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



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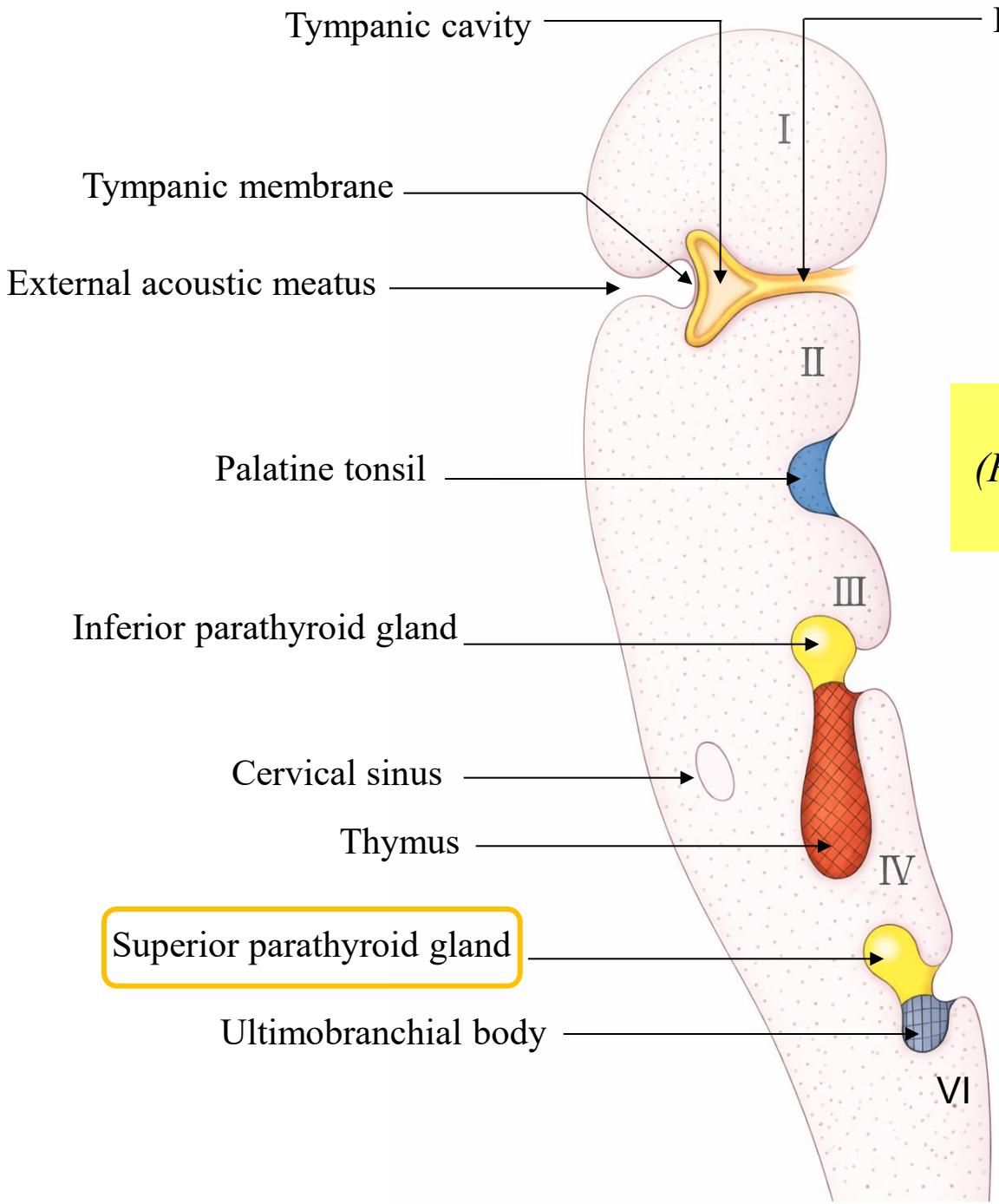
Fourth pharyngeal pouch

Forms:
Superior thyroid gland

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



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Fifth pharyngeal pouch

Forms

Ultimobranchial body:

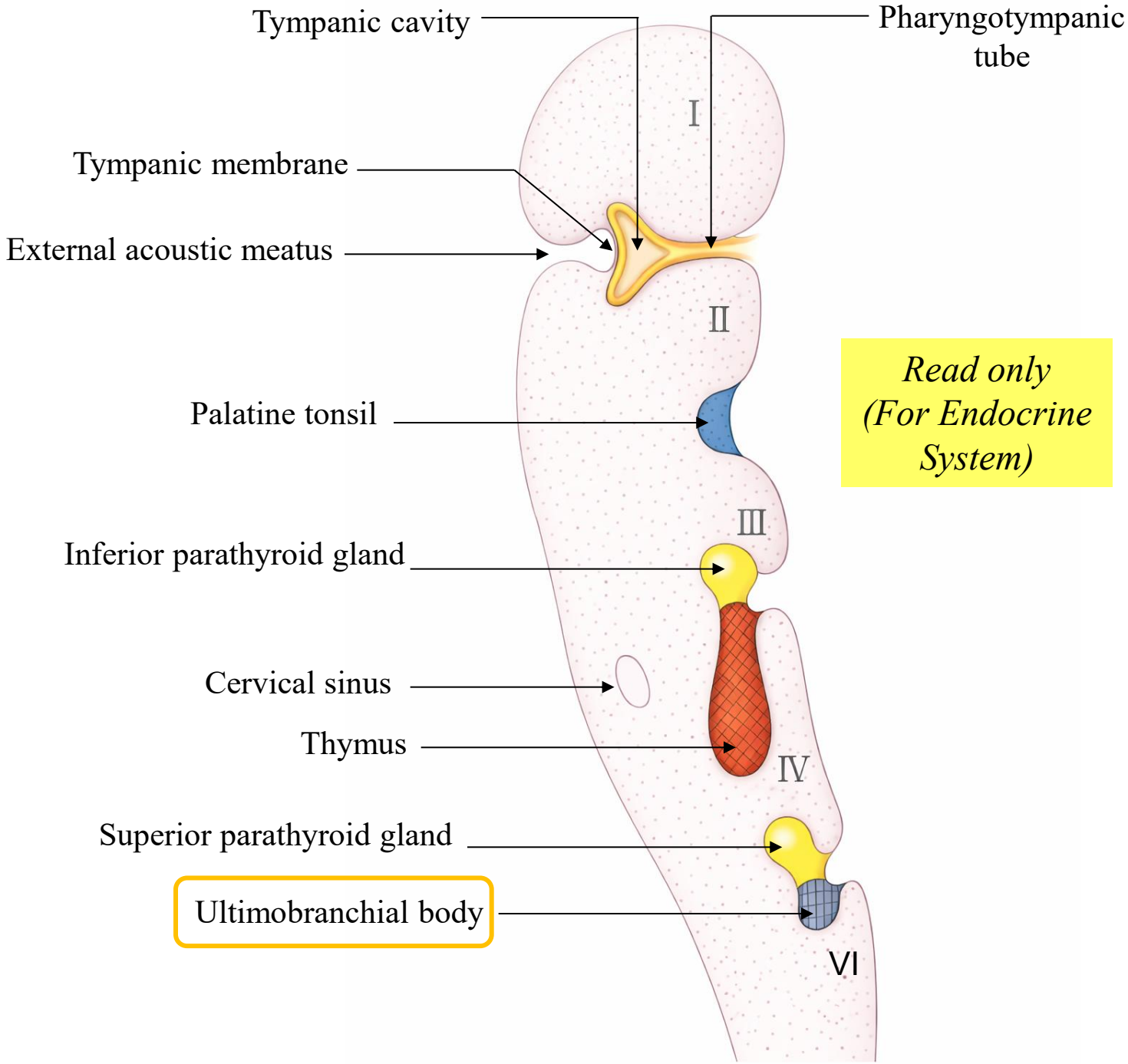
Is incorporated into the thyroid gland.

↓↓↓↓↓

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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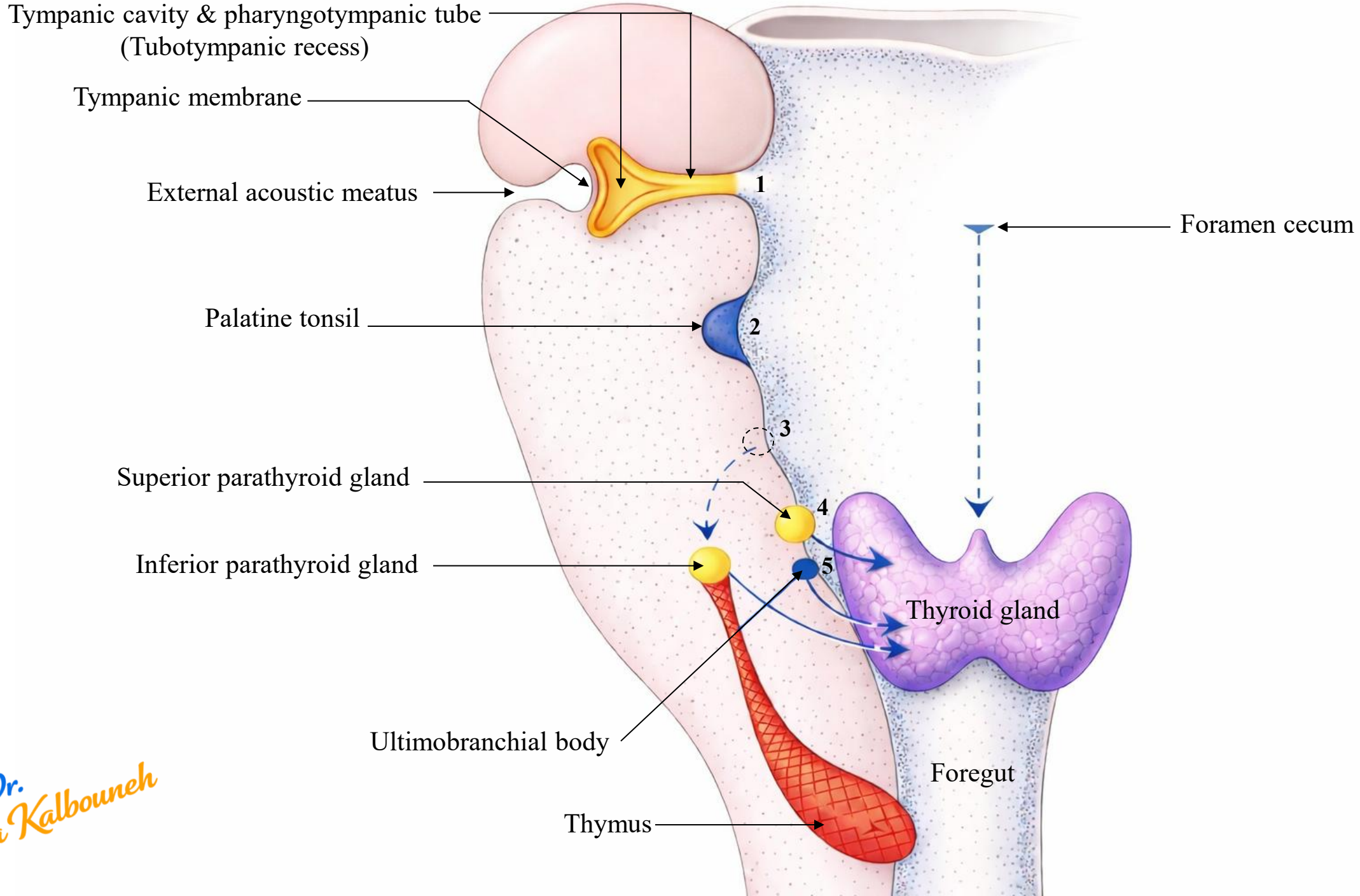

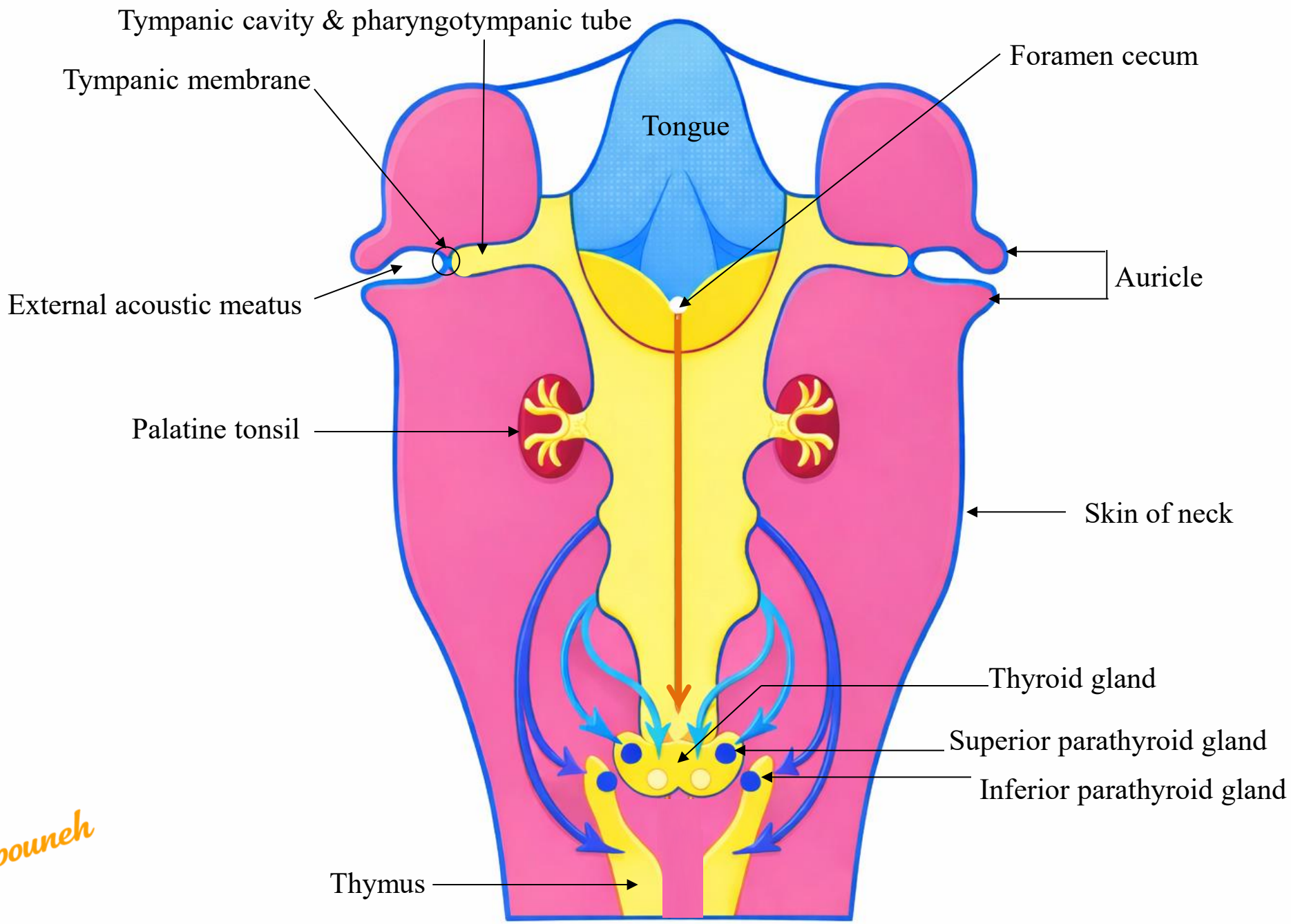

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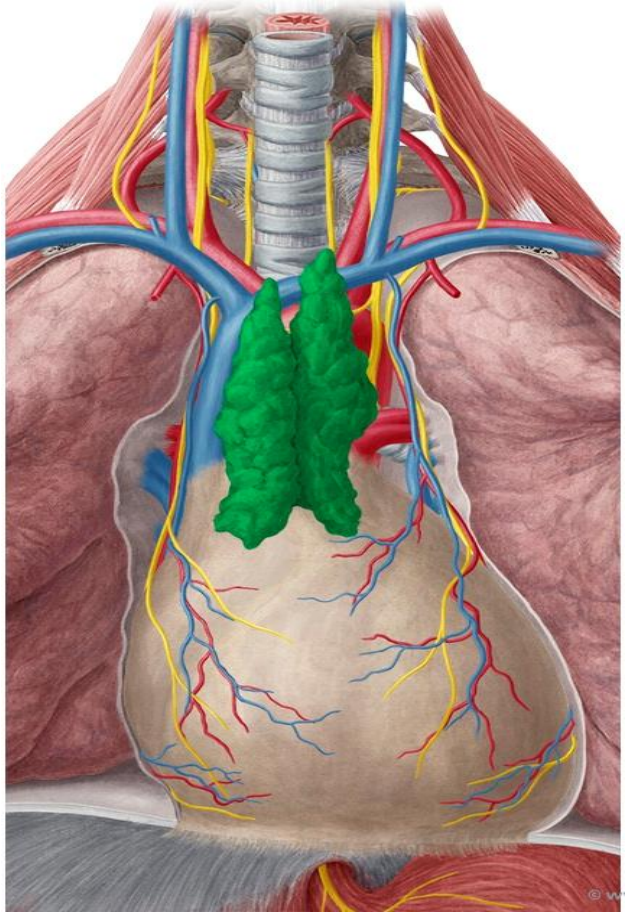
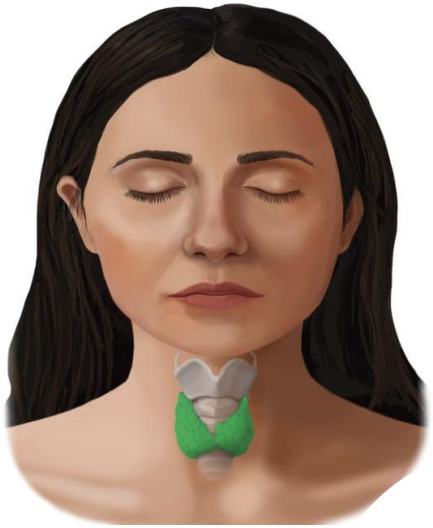
Thymus gland



Thyroid gland



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.

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Congenital Anomalies

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

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