Pharyngeal (Branchial) Apparatus

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بسم الله الرحمن الرحيم
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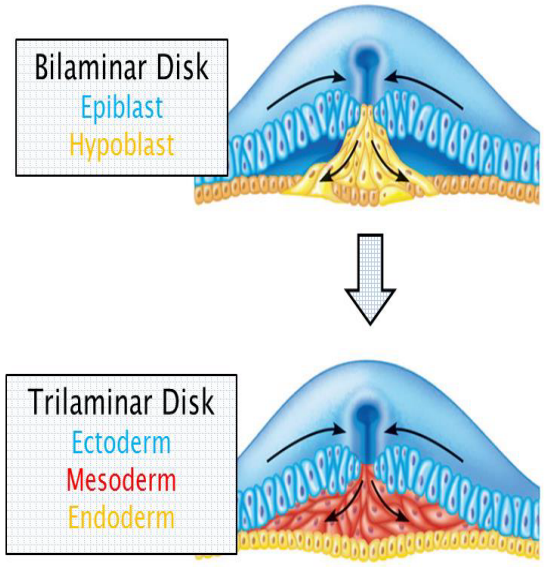
Two layers of cells forming embryonic disc

Bilaminar disc
(2nd week)

Ectoderm
Mesoderm
Endoderm

Trilaminar disc
(3rd week)



Fates of Epiblast Cells

1. *Migrate* to space between epiblast and hypoblast: form *Mesoderm*.
2. *Replace* hypoblast layer: form *Endoderm*.
3. *Stay put* : form *Ectoderm*.

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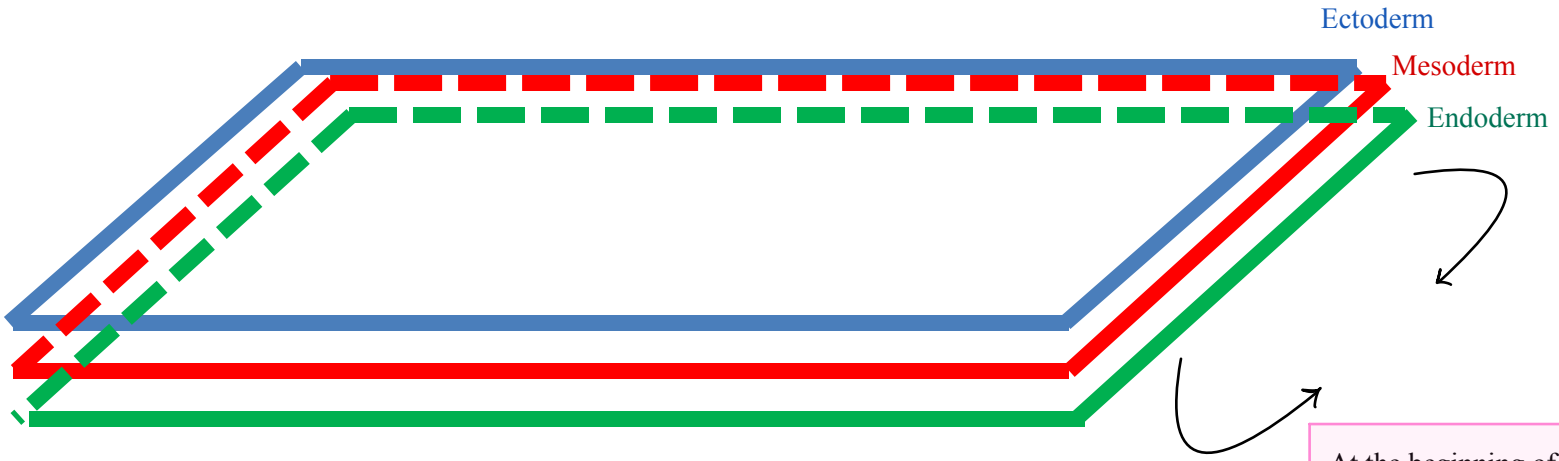
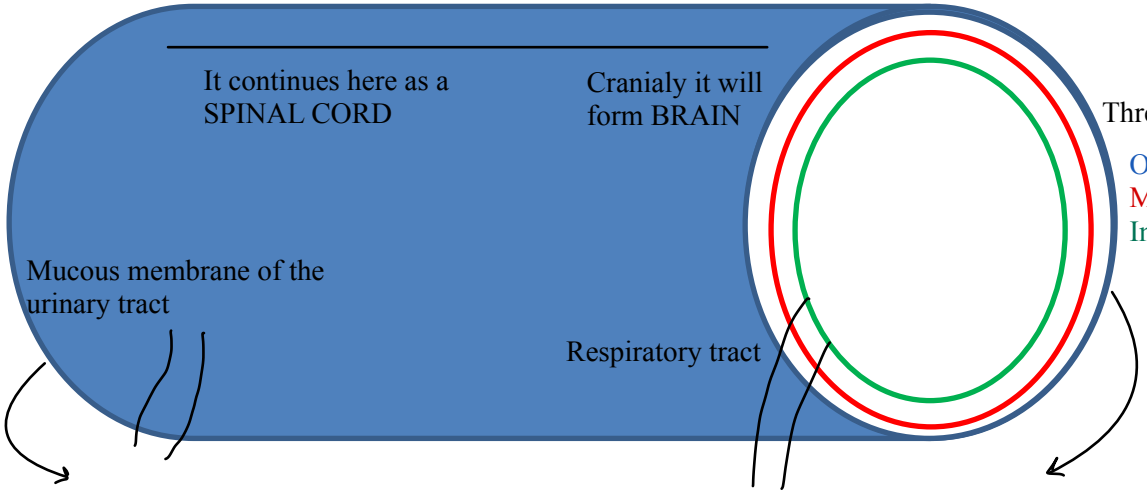


At the beginning of the fourth week, the embryonic disc undergoes folding from side to side, forming a tube. This transformation changes the embryo from a flat disc into a cylindrical shape.



Three cylinders inside each other.

Outer → Ectoderm
Middle → Mesoderm
Inner → Endoderm

After folding, we call the mesoderm "mesenchyme" and it is the tissue that forms the filling material between the outer ectoderm and the inner endoderm.

We also have craniocaudal folding at the head and tail regions.

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• The location of the mesenchyme in the embryo determines whether it will differentiate into a particular type of tissue.

• The ectoderm forms the neural groove, which will be converted into a neural tube. This neural tube will then be covered by surface ectoderm and will later develop into the central nervous system.

• Since it's the outermost layer, it will form the outermost layer of our body which is the EPIDERMIS of the skin.

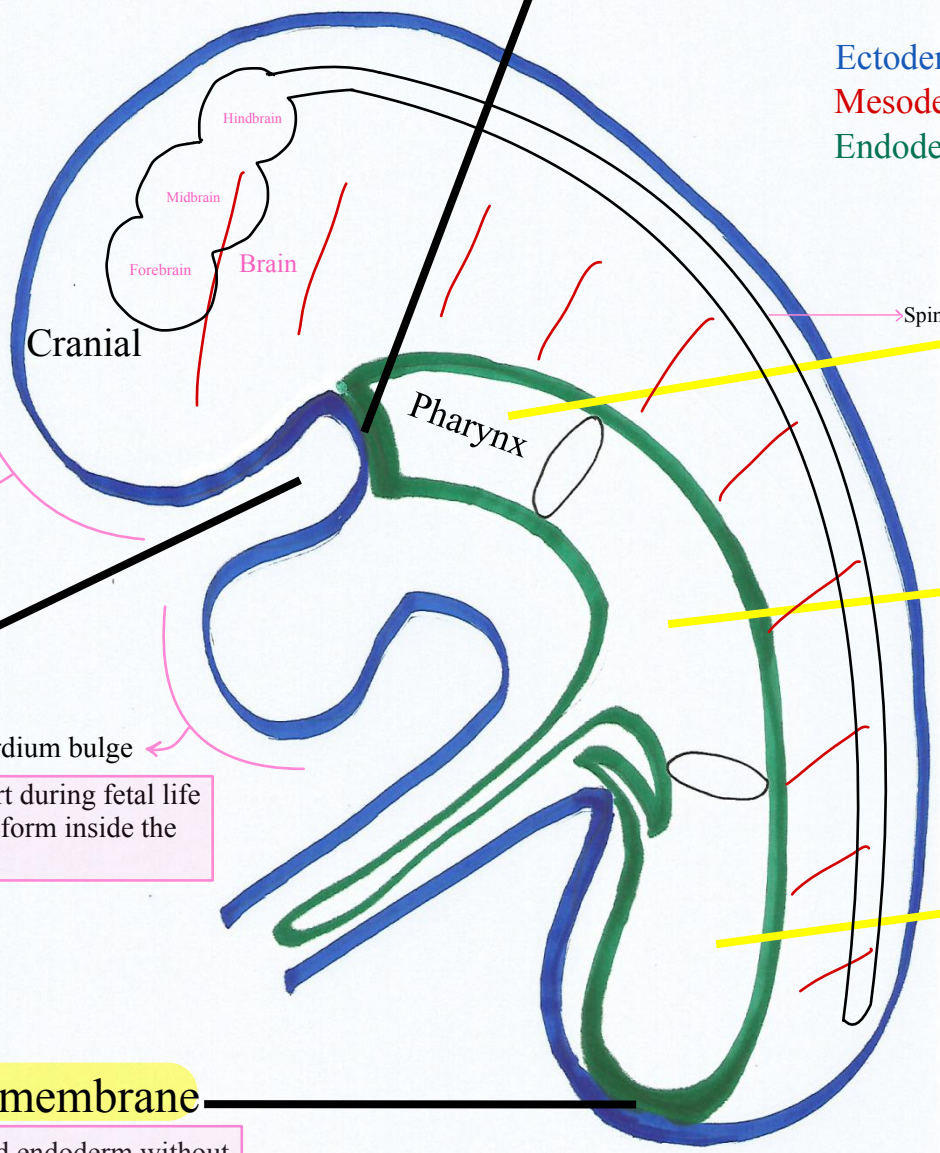
The endoderm will form:

• The mucous membranes of our digestive system and glands associated with our gut, such as the liver and pancreas.

• The mucous membranes of our respiratory tract.

• Part of the mucous membranes of our urinary tract.

Saggital Section through an embryo



Buccopharyngeal membrane

Ectoderm and endoderm without a filling mesenchyme.

Ectoderm
Mesoderm
Endoderm

The area of the featured head is enlarged because of the growth of the brain

Foregut

The most cranial part of it is the PHARYNX, which will form the lower part of the face and the neck.

Midgut

Hindgut

Stomodeum

The future nasal and oral cavities were initially open to each other and not yet separated.

The heart during fetal life starts to form inside the neck.

These two membranes have to rupture to have a communication with external environment.

Cloacal membrane

Ectoderm and endoderm without a filling mesenchyme.

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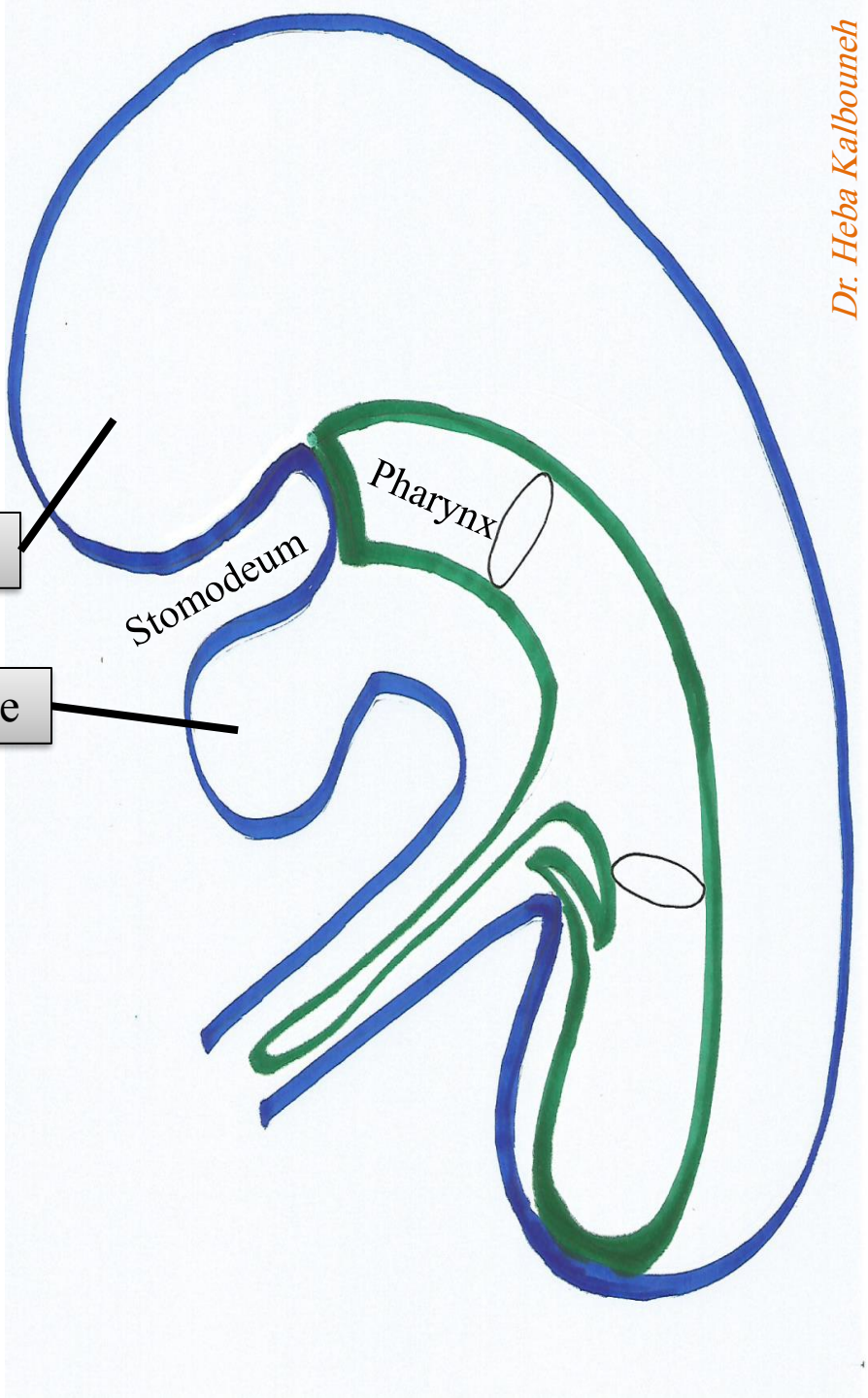
Note that the ectoderm and endoderm are in direct contact with each other (no mesoderm in between) in only two places:
The buccopharyngeal membrane: cranially
The cloacal membrane: caudally

The buccopharyngeal membrane lies between stomodeum and the pharynx

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

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

By the fourth week, the buccopharyngeal membrane breaks down so that the stomodeum communicates with the foregut



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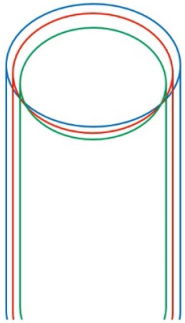
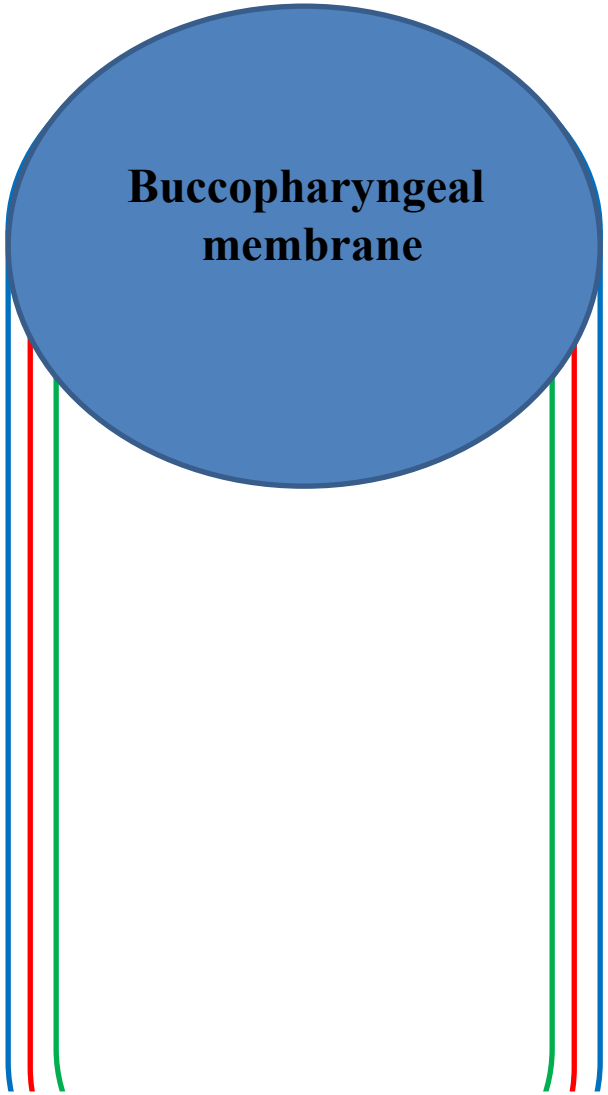


Coronal section through the pharynx



During the folding in the fourth week, the mesenchyme will thicken and proliferate, and the thickening will not occur uniformly, but along six lines at the site of the embryonic pharynx.

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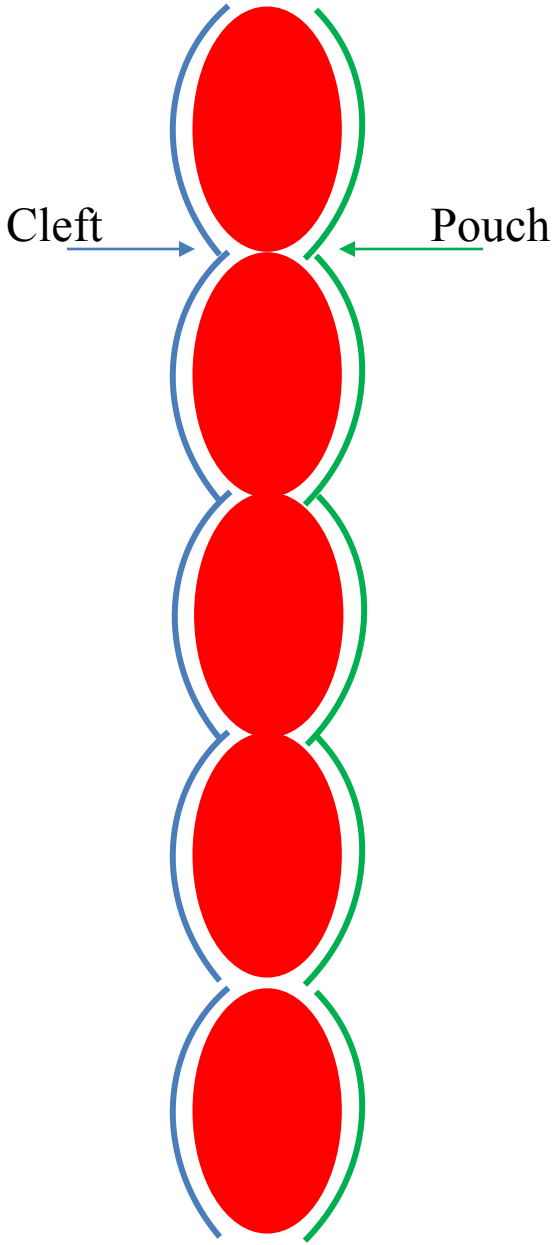

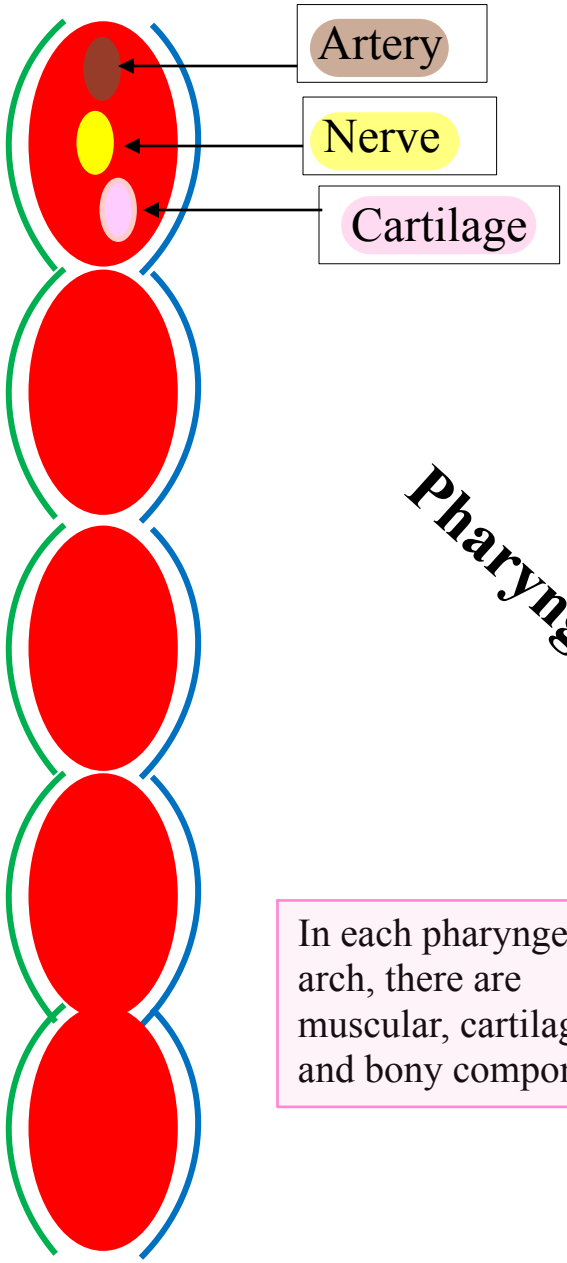

Pharyngeal apparatus

In each pharyngeal arch, there are muscular, cartilaginous, and bony components.

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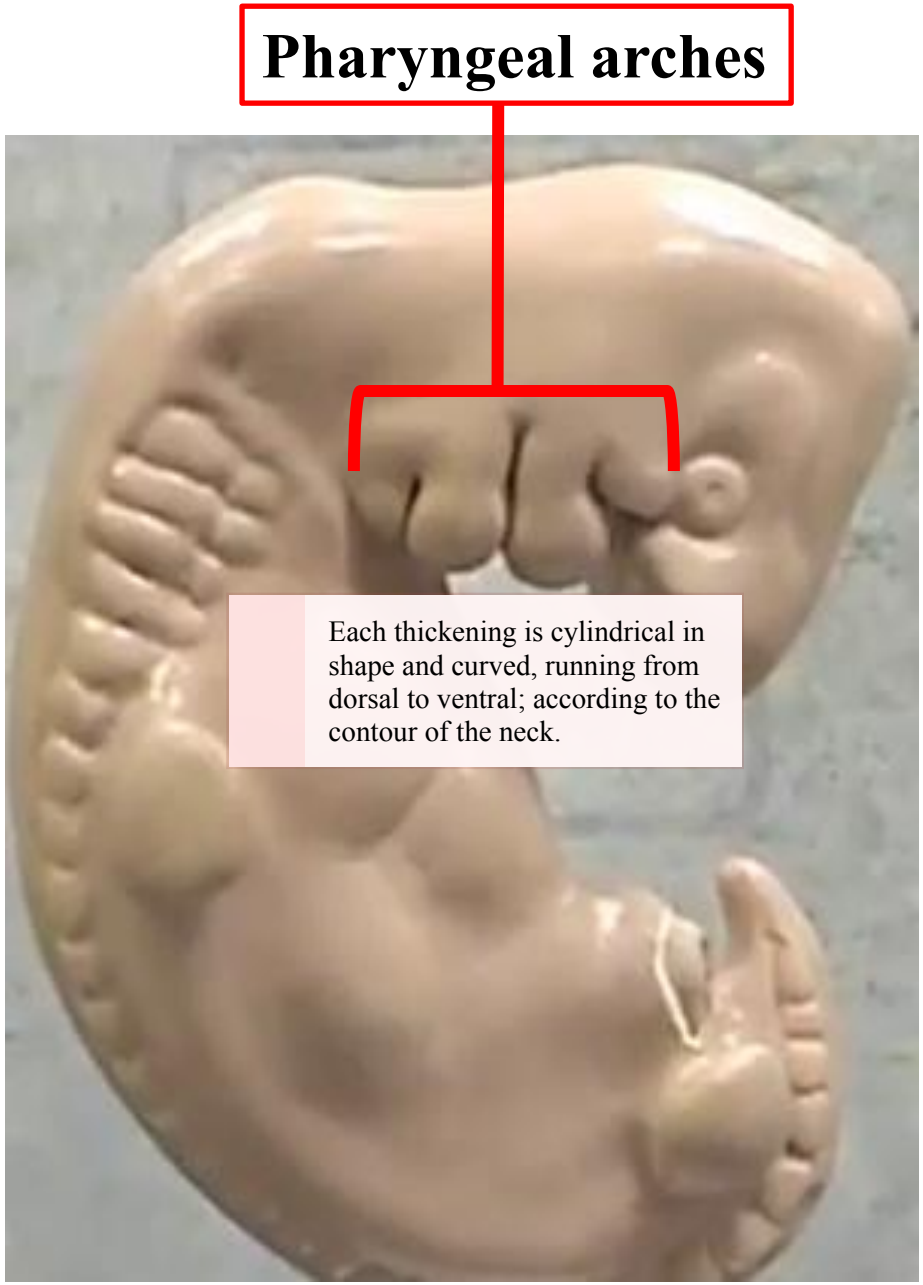
Pharyngeal (Branchial) Arches

- ✓ They are 6 mesodermal thickenings on both sides of pharynx
- ✓ They appear in the 4th and 5th weeks
- ✓ Arches are covered with ectoderm (externally) and lined with endoderm (internally)
- ✓ Arches are separated from each other by 4 clefts on outer surface which is covered with ectoderm
- ✓ Arches are separated from each other by 5 pouches on inner aspect (cavity of pharynx) which are lined with endoderm



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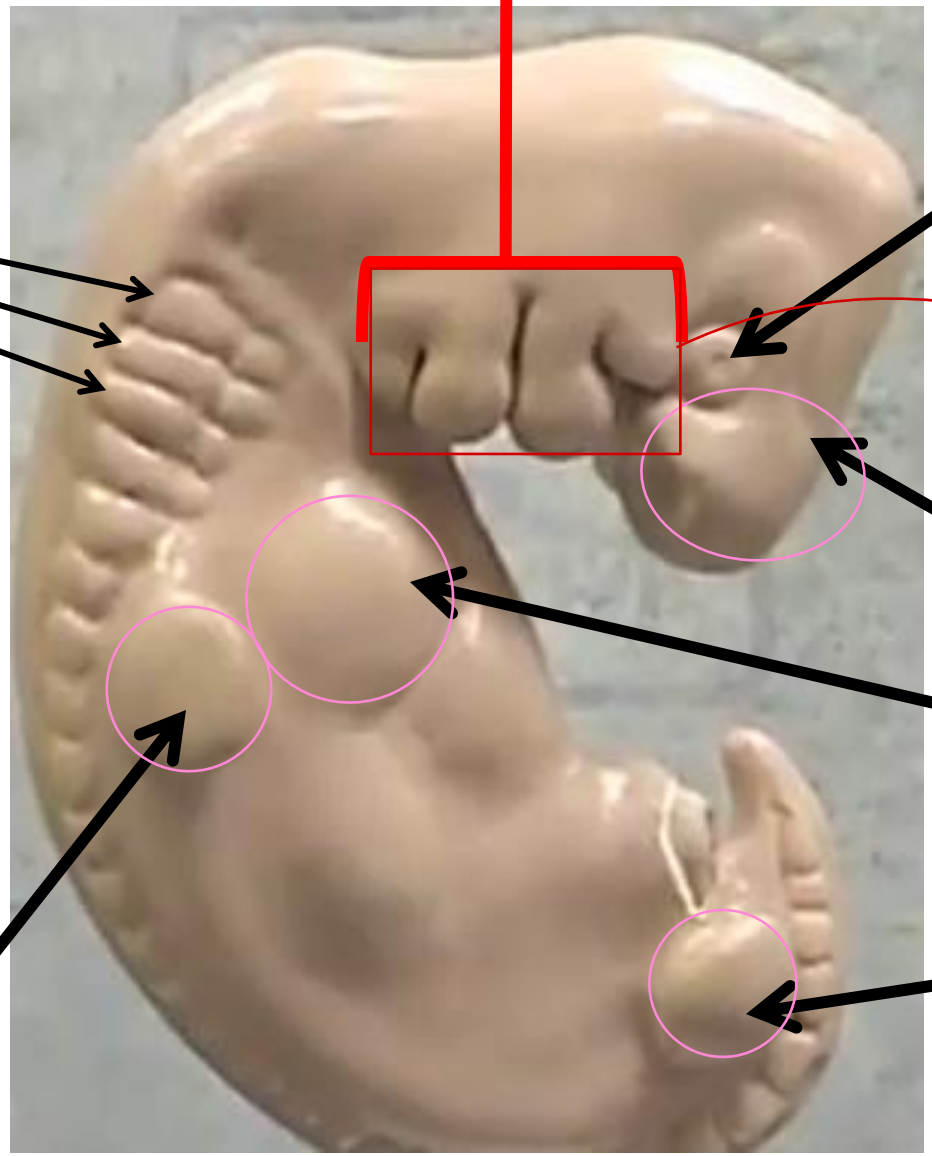
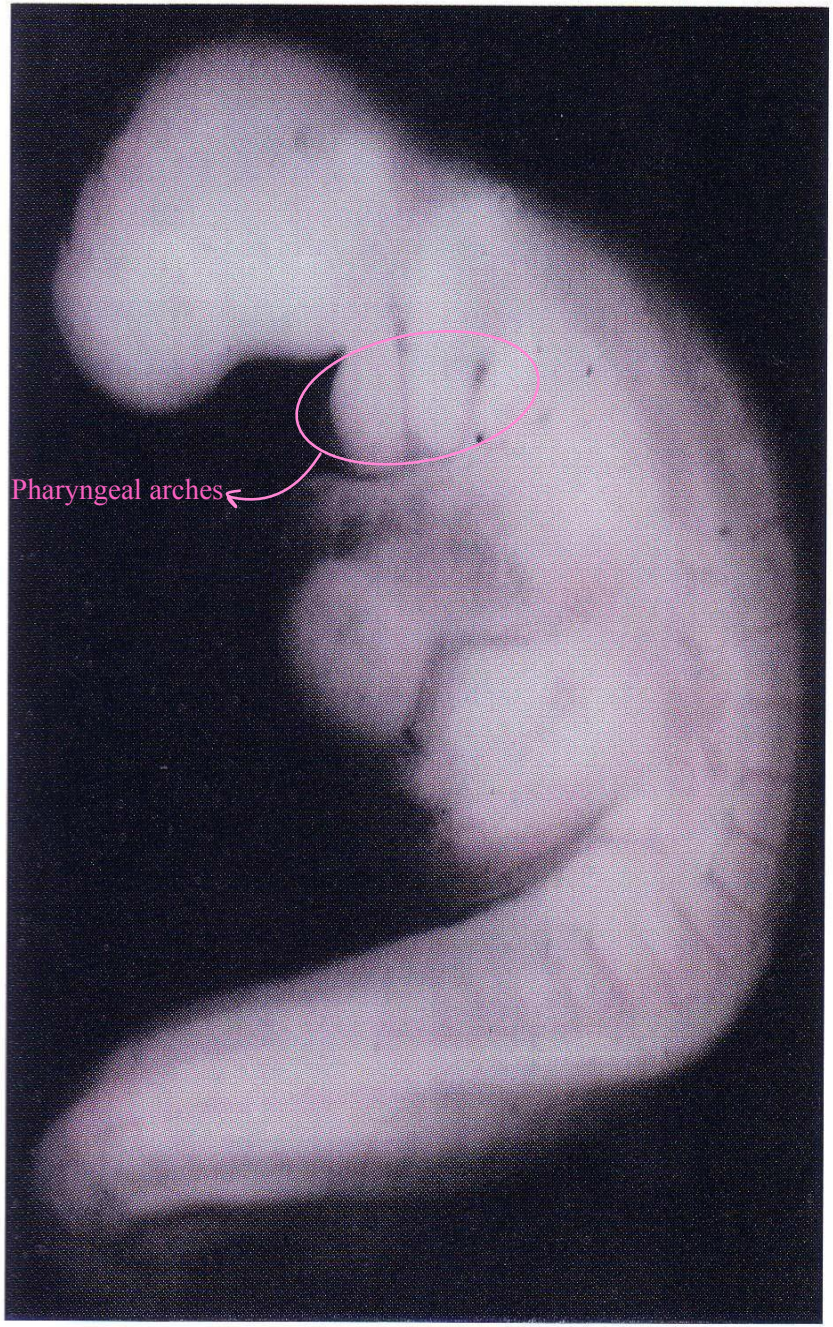
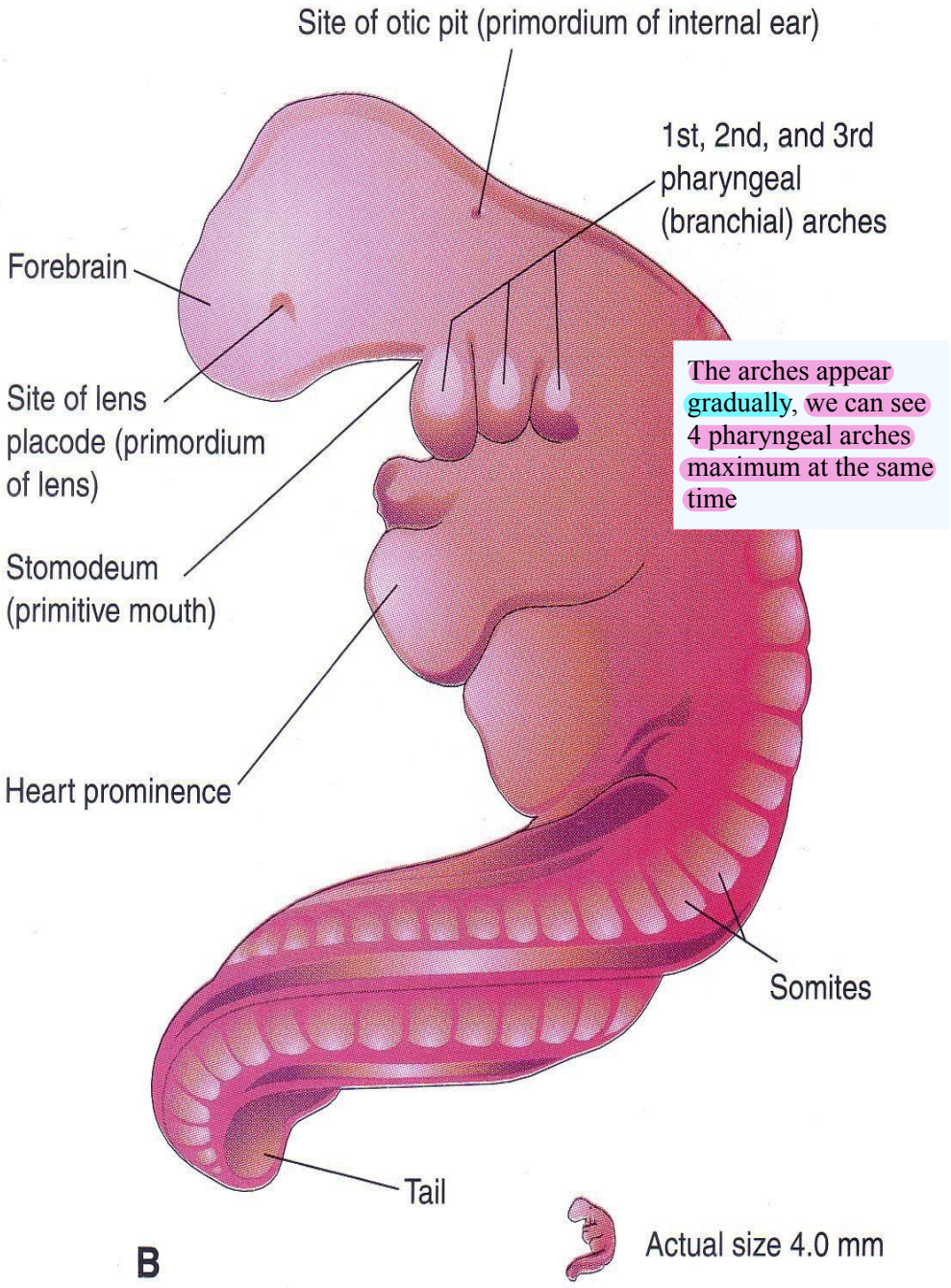
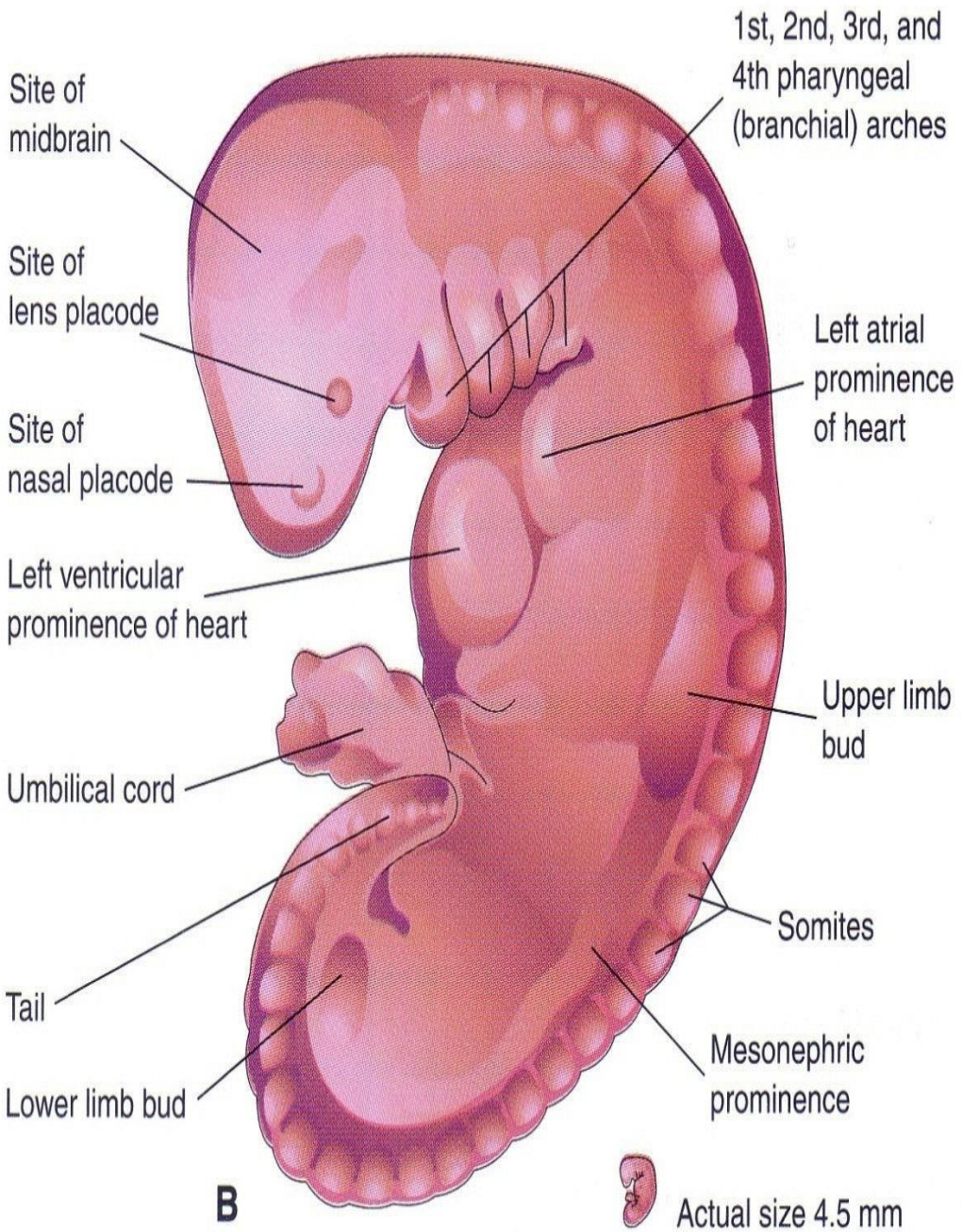

Pharyngeal arches
Primordia of the eye
Somites
Between the forebrain and pericardium bulges
The mesenchyme at the sites of the neural tube separates into blocks called somites. These somites will later form the vertebral column.
Forebrain bulge
Pericardiam bulge
Upper limb bud
Lower limb bud





The arches appear gradually, we can see 4 pharyngeal arches maximum at the same time

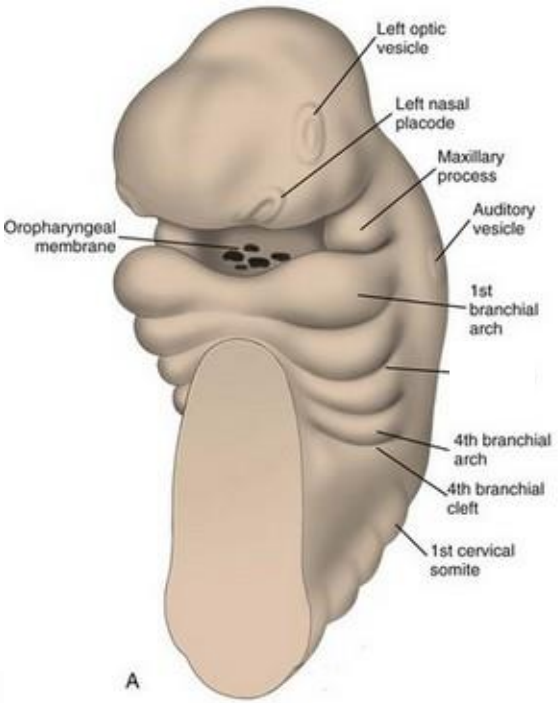
A


Site of midbrain
Site of lens placode
Site of nasal placode
Left ventricular prominence of heart
Umbilical cord
Tail
Lower limb bud
1st, 2nd, 3rd, and 4th pharyngeal (branchial) arches
Left atrial prominence of heart
Upper limb bud
Somites
Mesonephric prominence
Actual size 4.5 mm

B

Why pharyngeal arches?

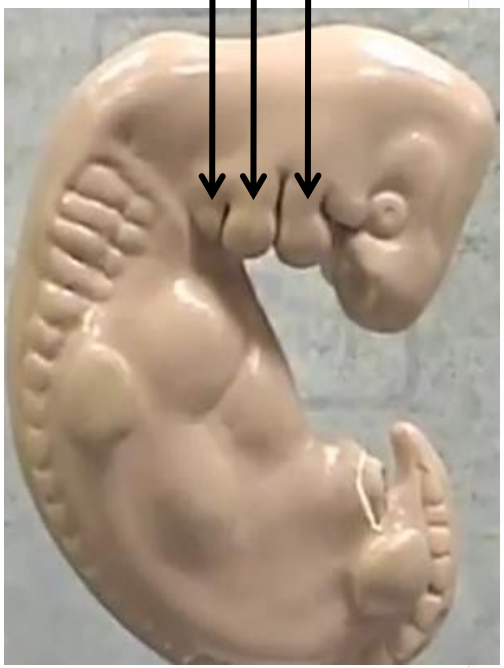
In human embryo, the arches form on the sides of the pharynx

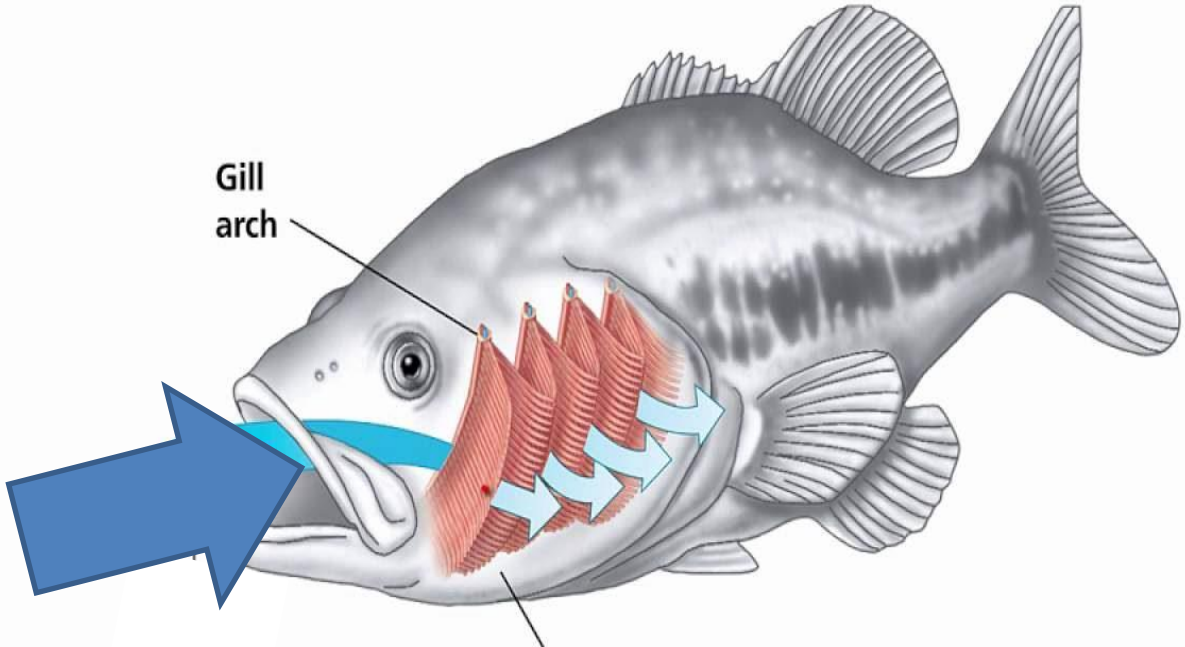


Why branchial arches?

Pharyngeal arches resemble the gills of the fish in shape

خياشيم Gills=branchia





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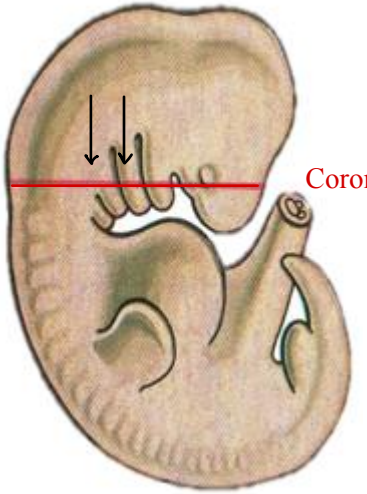

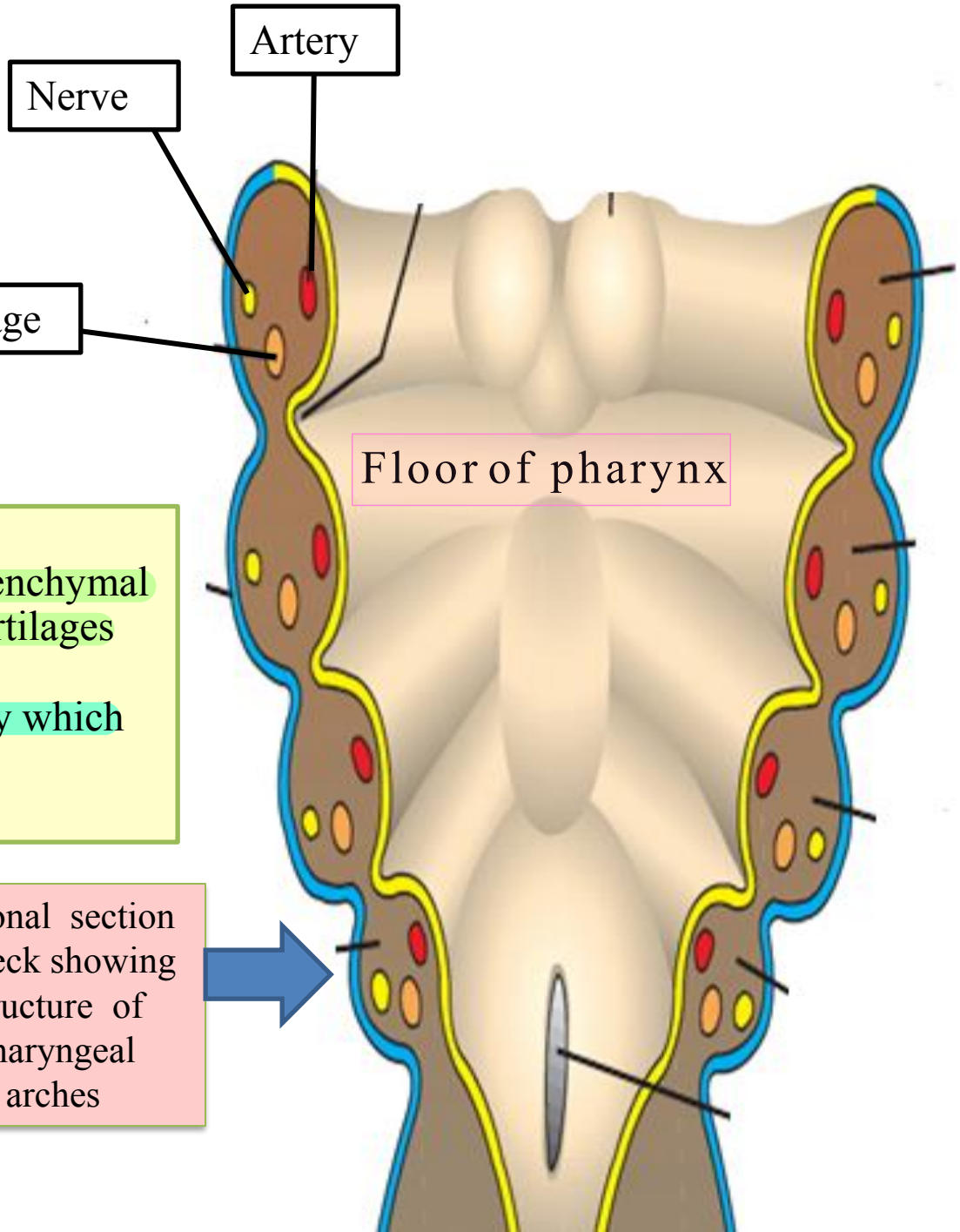

Structure of each arch

- Each arch is composed of mesenchymal cells that give rise to bones, cartilages and muscles.
- Each arch has an arterial supply which is called aortic arch.
- Each arch has a cranial nerve.

Coronal section of neck showing structure of pharyngeal arches

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Nerve supply of pharyngeal arches

Trigeminal

Mandibular & Maxillary nerves supplies derivatives of **1st arch**

Facial nerve supplies derivatives of **2nd arch**

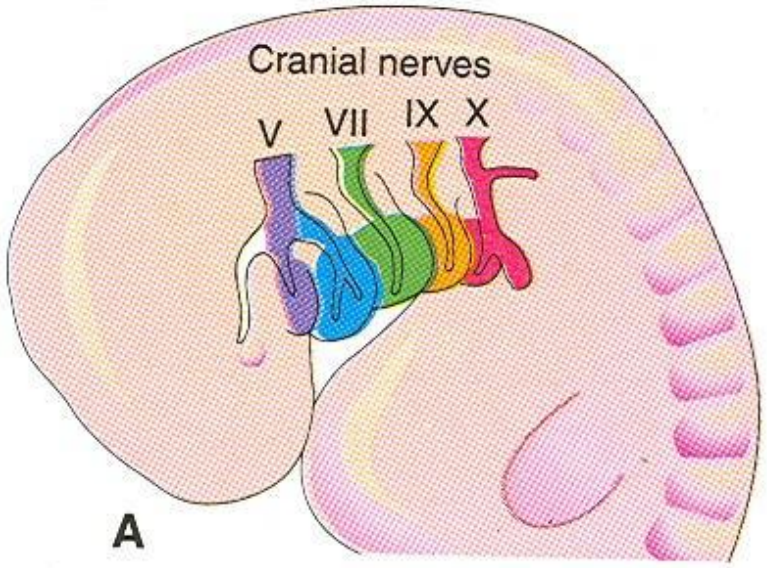
Glossopharyngeal nerve supplies derivatives of **3rd arch**

Superior laryngeal nerve (vagus nerve) supplies derivatives of **4th arch**

Recurrent laryngeal nerve (vagus nerve) supplies derivatives of **6th arch**

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



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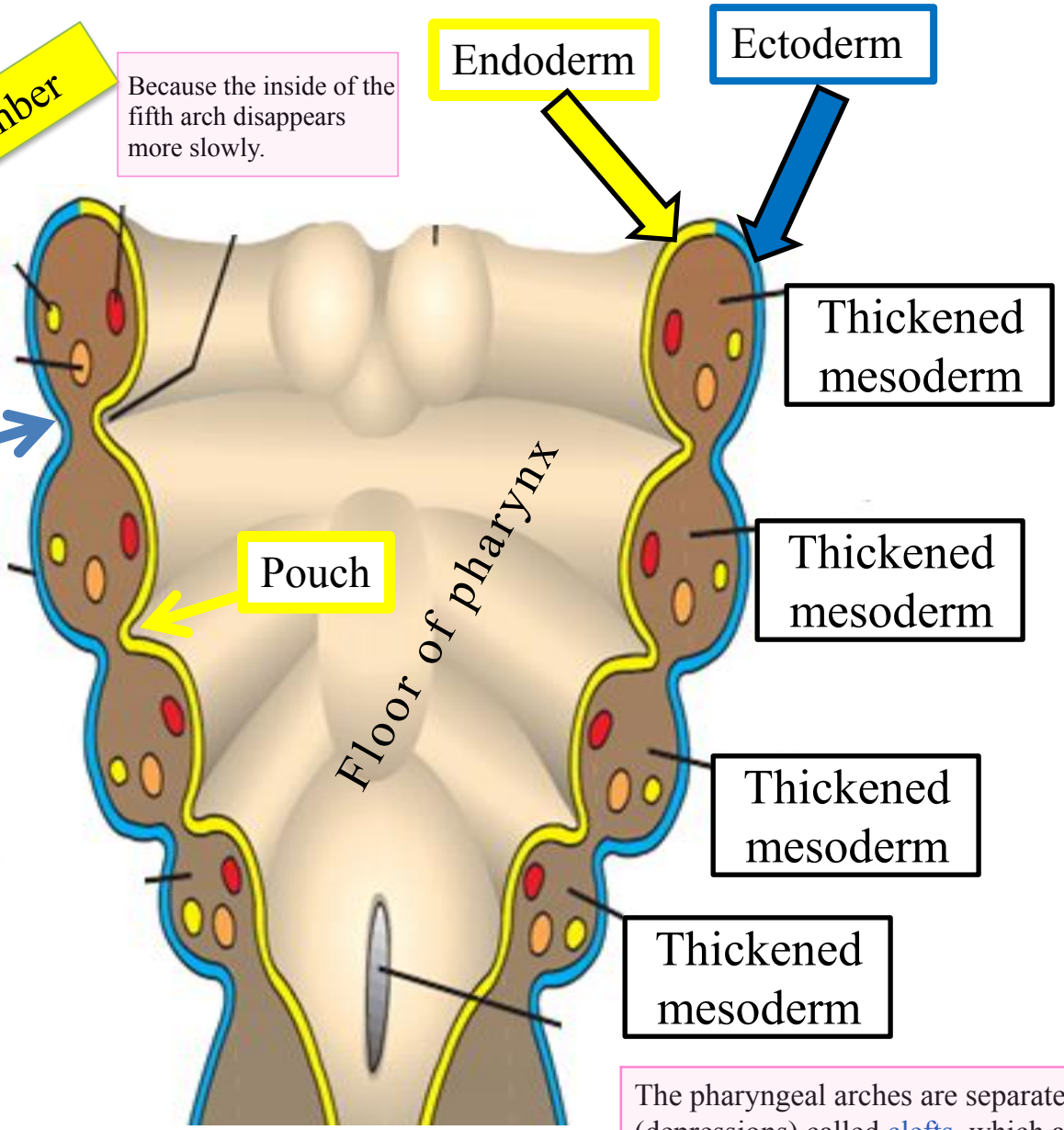
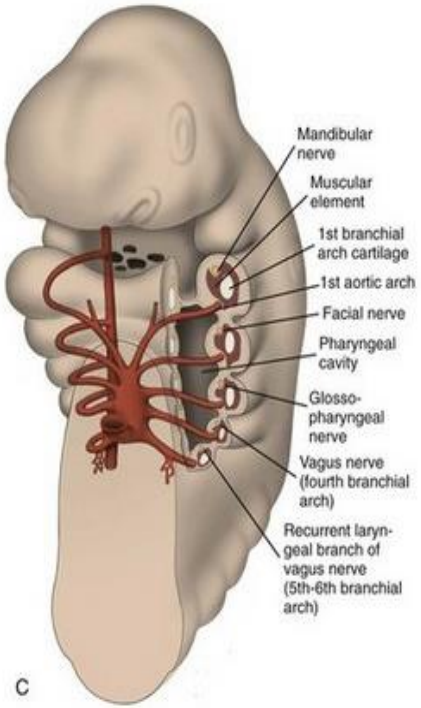
Clefts are **four** in number

Pouches are **five** in number

Because the inside of the fifth arch disappears more slowly.





The pharyngeal arches are separated by grooves (depressions) called clefts, which are covered by ectoderm on the outside, and pouches, which are lined by endoderm on the inside.

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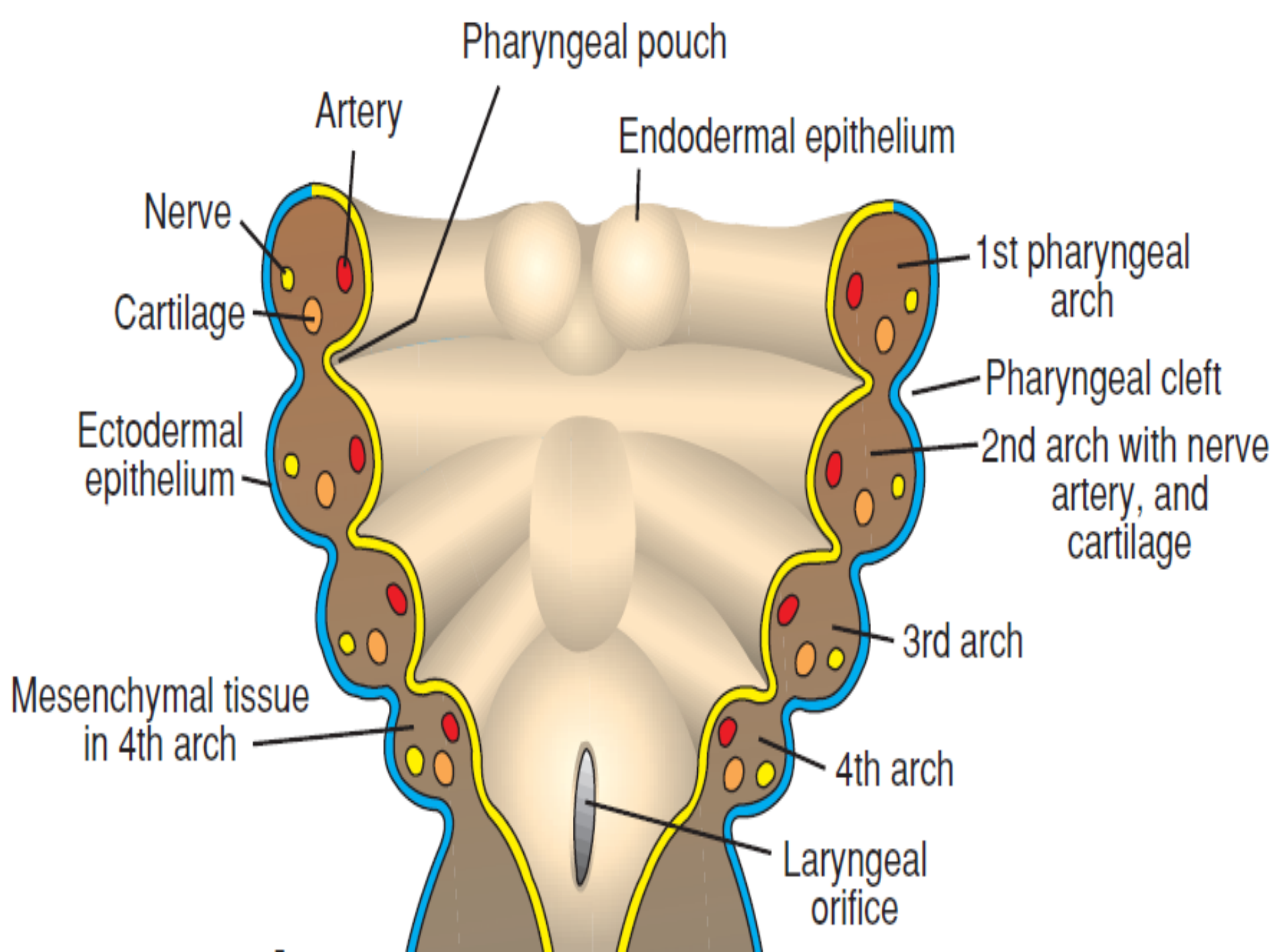

Pharyngeal pouch
Artery
Endodermal epithelium
Nerve
Cartilage
1st pharyngeal arch
Pharyngeal cleft
Ectodermal epithelium
2nd arch with nerve artery, and cartilage
3rd arch
Mesenchymal tissue in 4th arch
4th arch
Laryngeal orifice

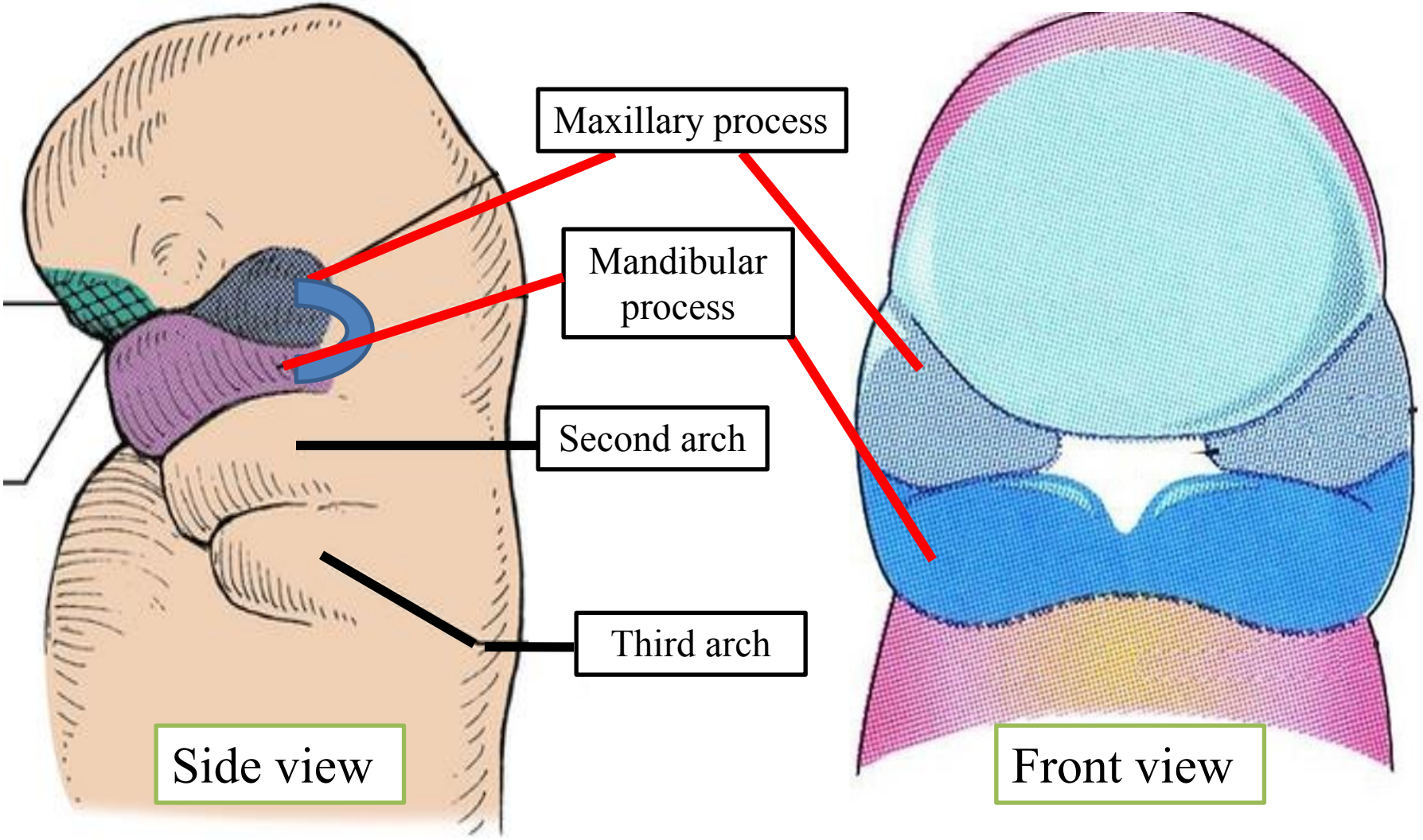
First arch has 2 processes:

1- Maxillary process

2- Mandibular process

Both processes grow forward

This will form the lower part of the head.



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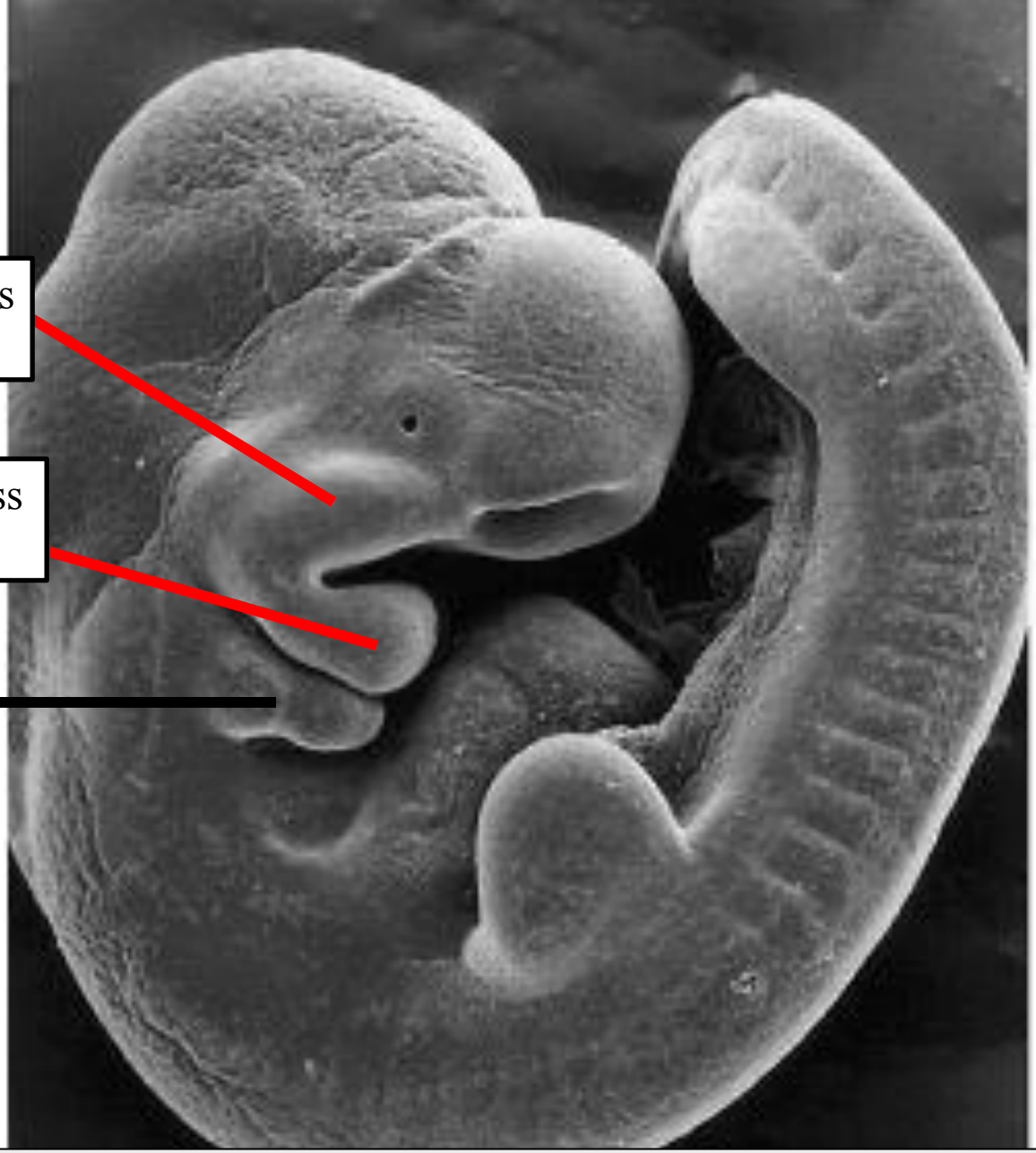
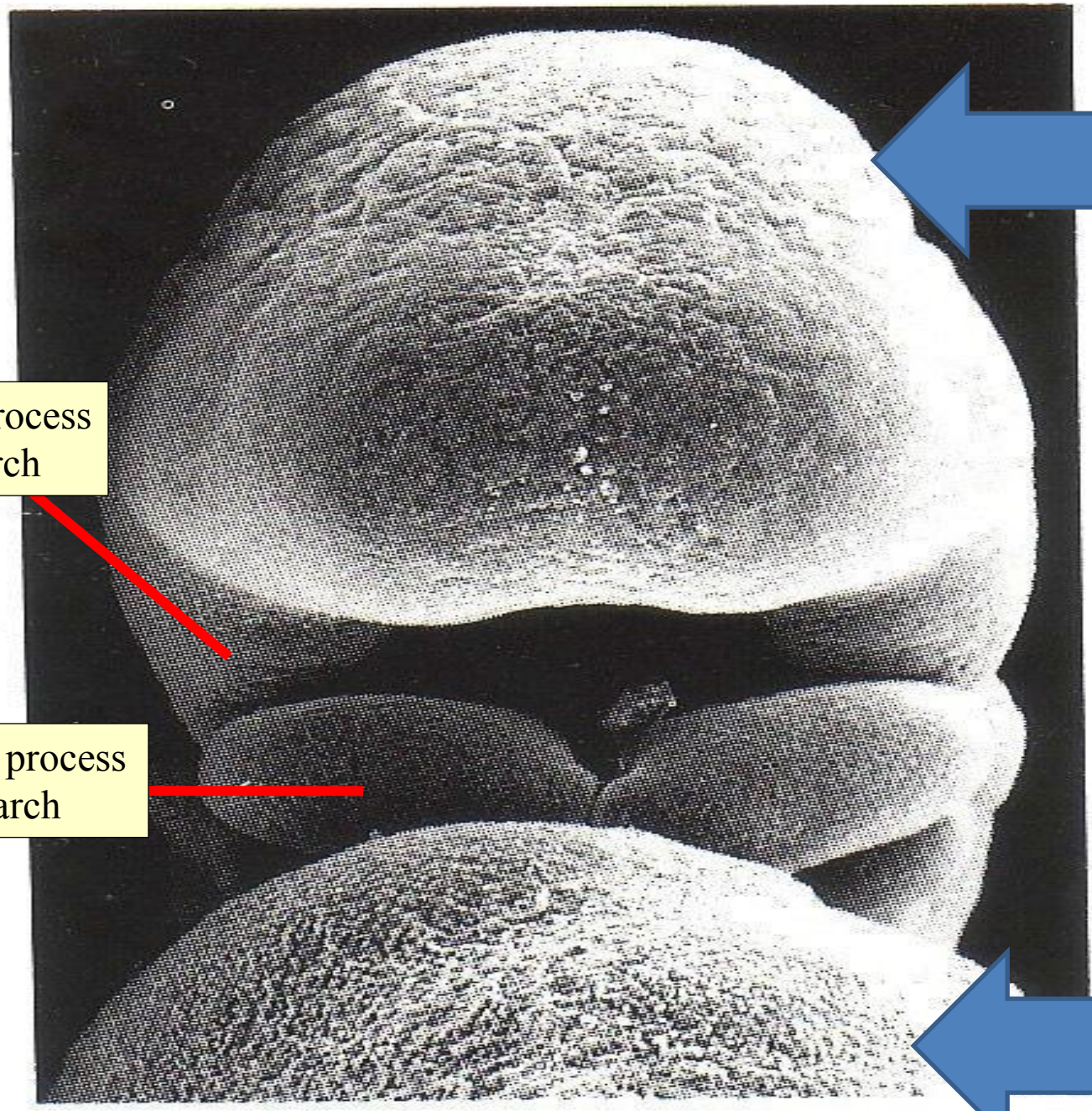


- ✓ **Maxillary process** is a forward growth of **dorsal end of 1st pharyngeal arch**
- ✓ **Mandibular process** is a forward growth of **ventral end of 1st pharyngeal arch**



After the formation of the neck, the heart will be displaced down inside the thorax.

Fourth Week

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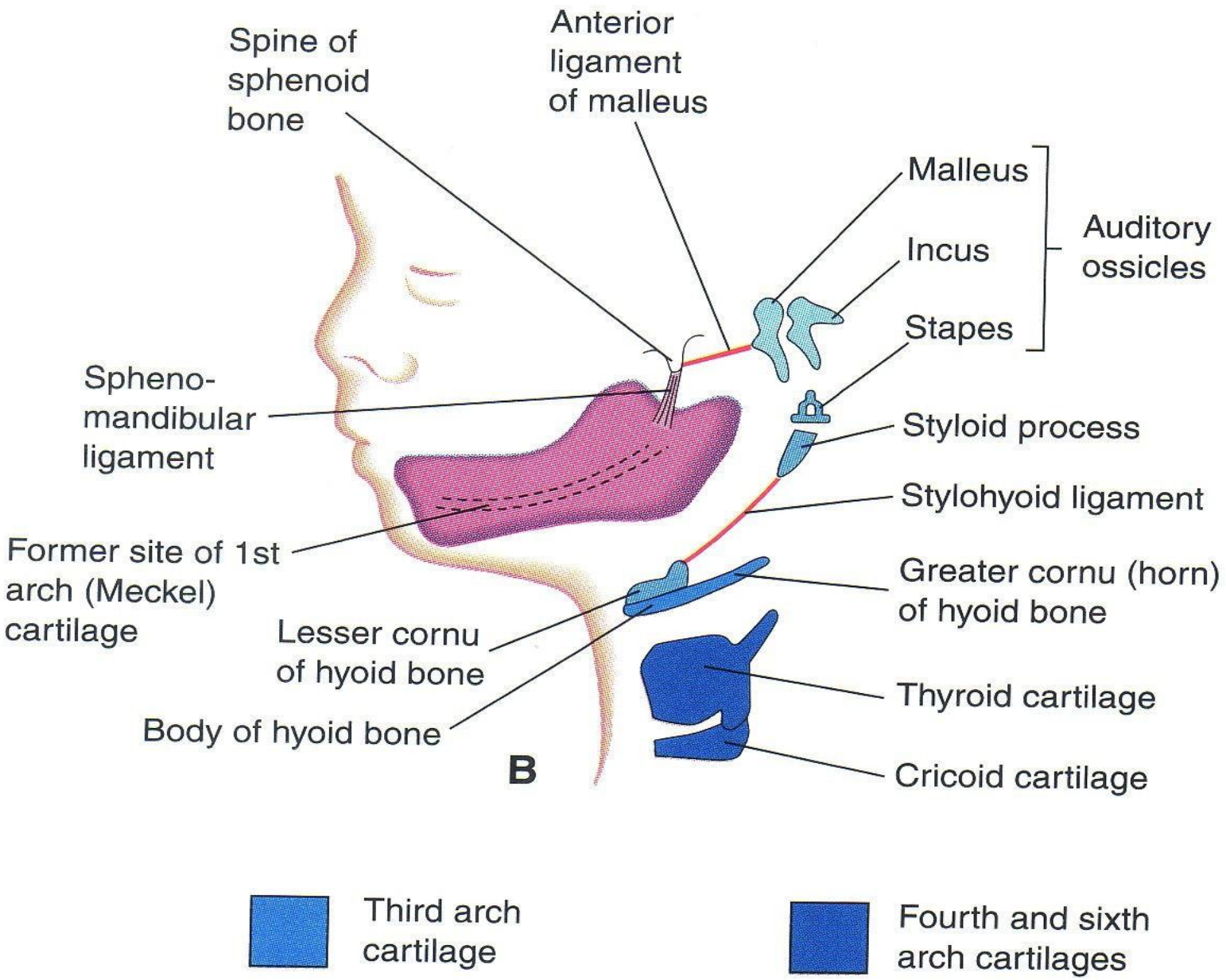
Derivatives of pharyngeal arches

Derivatives of pharyngeal arches



Derivatives of first pharyngeal arch

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Maxillary process forms:

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

Mandibular process forms Meckel's cartilage

Meckel's cartilage

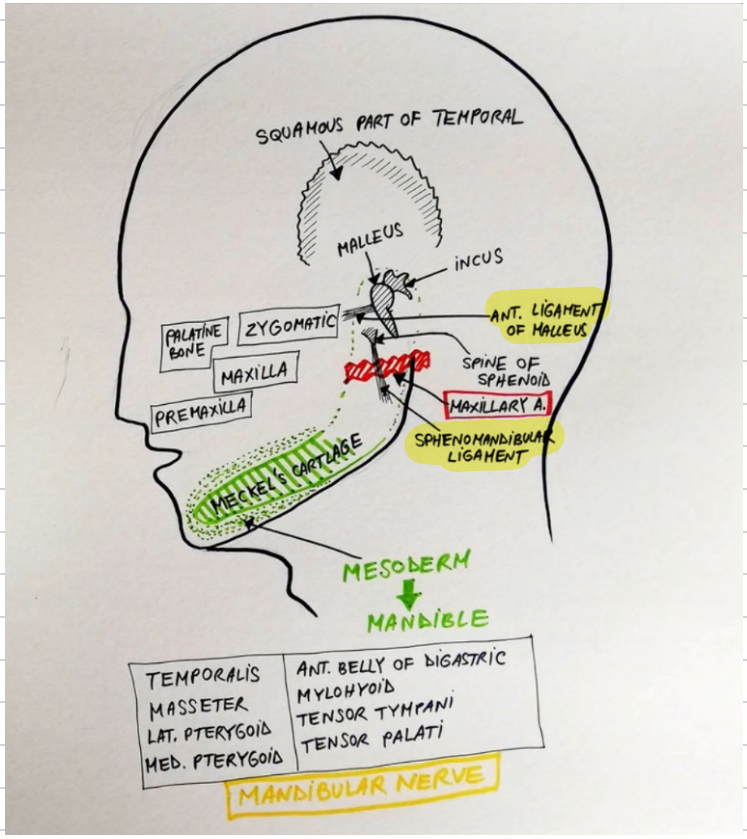
- Ventral part
  - Ramus of mandible
- Middle part
  - 1- Anterior ligament of malleus
  - 2- Sphenomandibular ligament
- Dorsal part
  - 1- Malleus
  - 2- Incus

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

From the mesenchyme of the first pharyngeal arch.

The middle part of Meckel's cartilage gradually disappears, while its surrounding perichondrium persists and differentiates into ligaments. At its ends, however, the cartilage undergoes transformation into bone and periosteum.

Anteriorly, part of Meckel's cartilage contributes to the formation of the anterior ligament of the malleus, which extends from the malleus to the anterior wall of the middle ear. A portion of this ligament continues further forward, attaching to the spine of the sphenoid. Additionally, the sphenomandibular ligament develops from the perichondrium of Meckel's cartilage and extends from the spine of the sphenoid to the lingula on the inner aspect of the mandibular ramus.



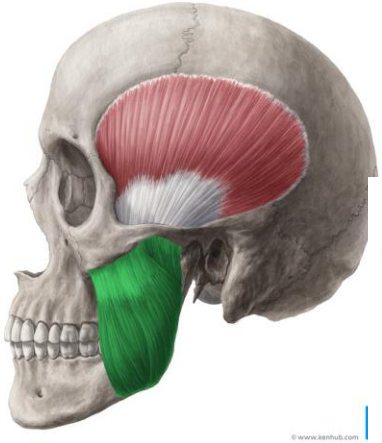
Muscles of first pharyngeal arch:

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

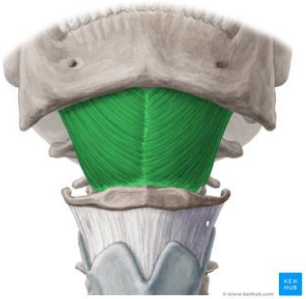
1. Muscles of mastication
2. Tensor tympani
3. Anterior belly of digastric
4. Mylohyoid
5. Tensor veli palatini

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.

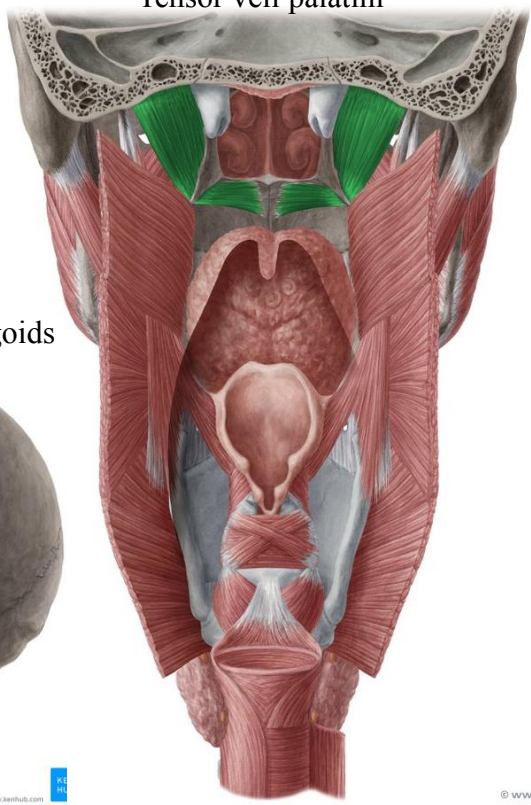
Masseter & Temporalis



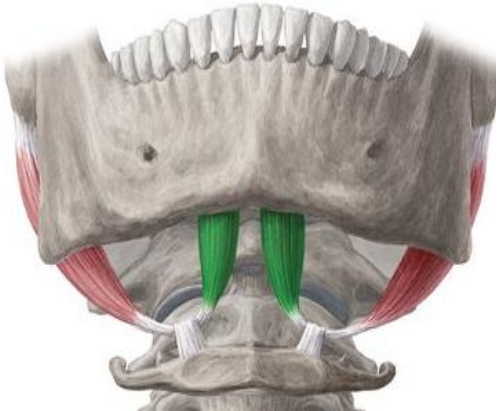
Mylohyoid



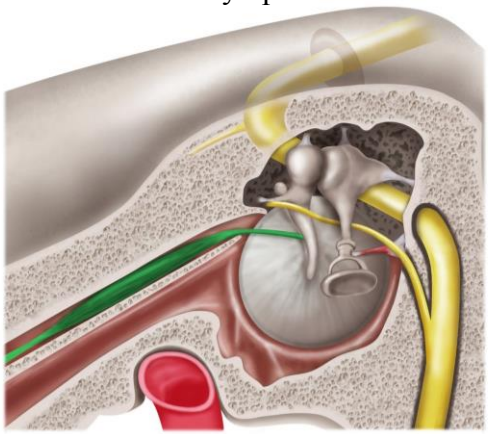
Tensor veli palatini



Anterior belly of digastric



Tensor tympani



Medial & Lateral pterygoids

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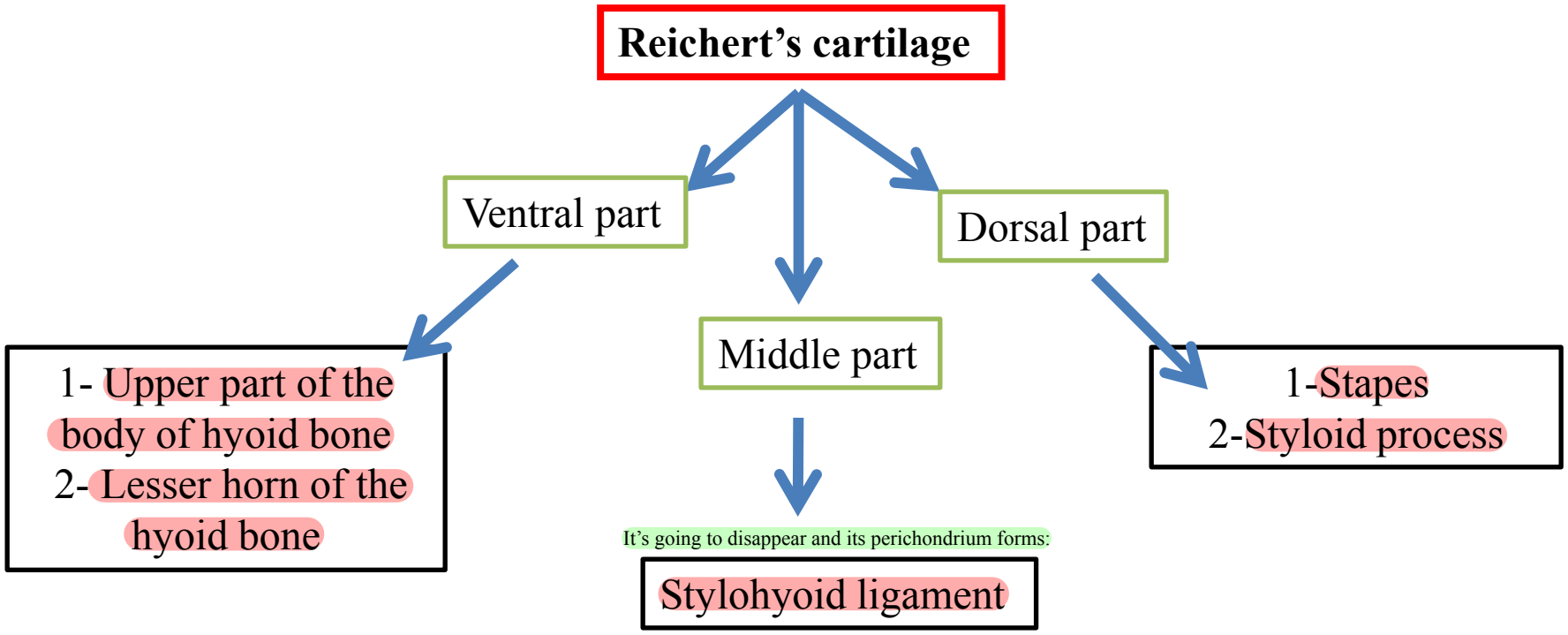
Derivatives of second pharyngeal arch

Below the first arch.

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



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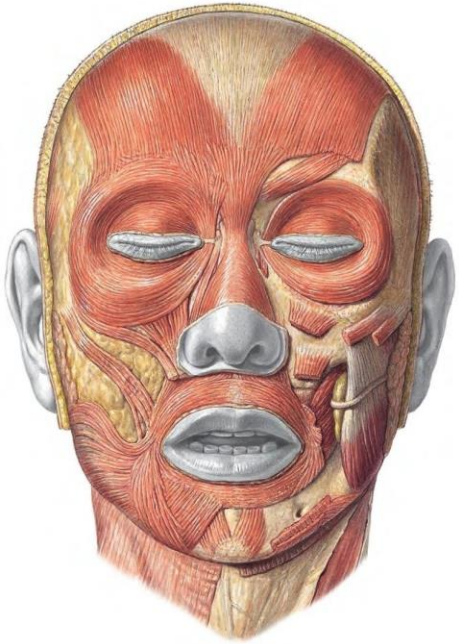
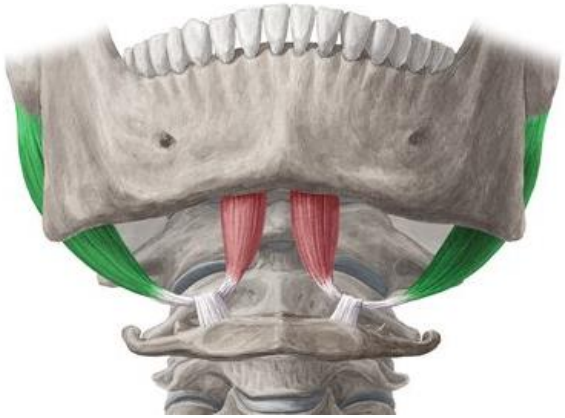
Muscles of second pharyngeal arch:
Are the muscles supplied by the **facial nerve** :

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

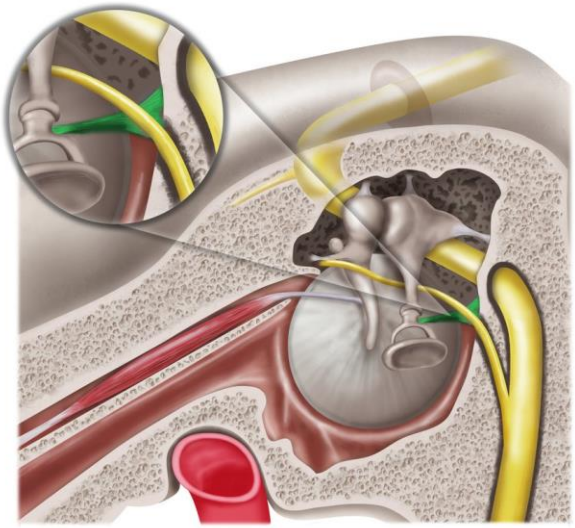
Muscle of facial expression



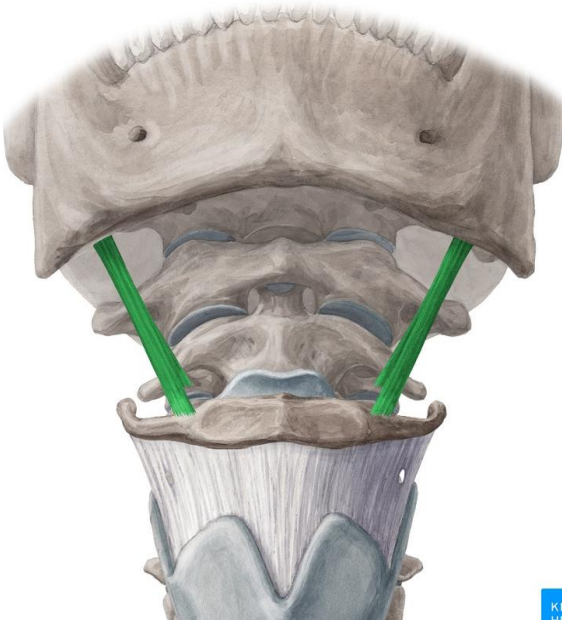
Posterior belly of the digastric



Stapedius



Stylohyoid



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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
Digestive system

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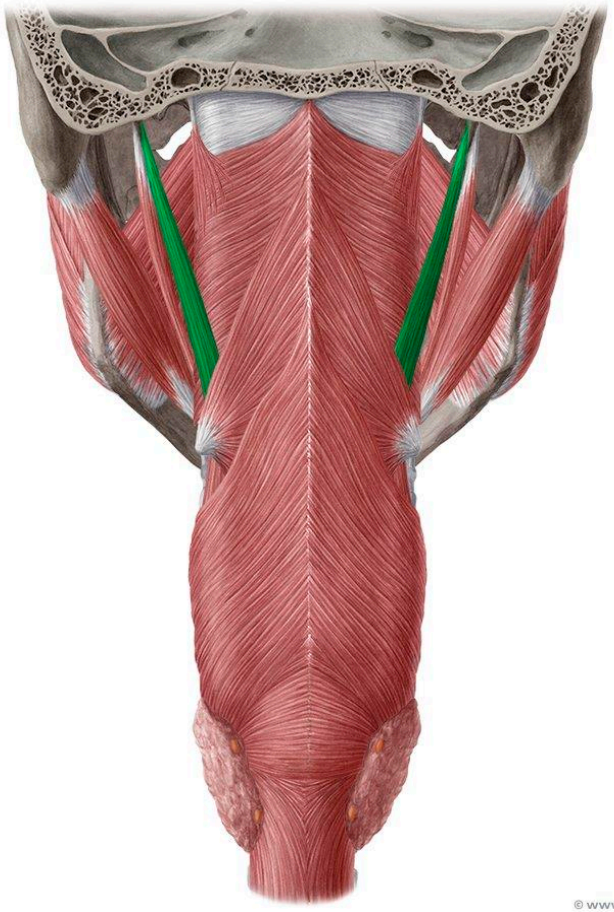

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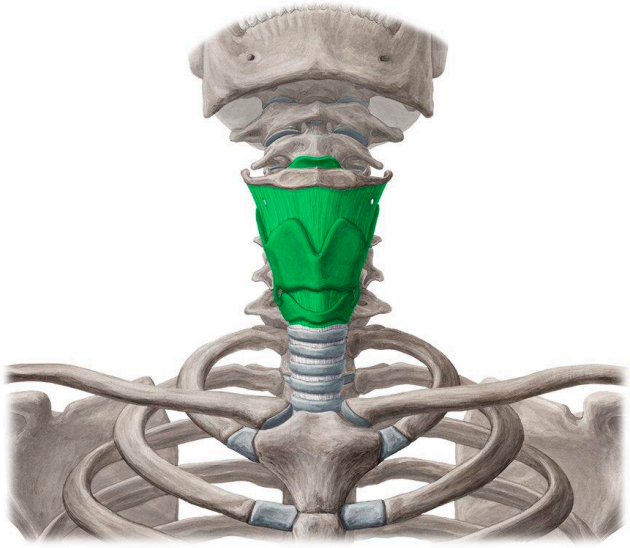
Derivatives of fourth pharyngeal arch

Read only
Respiratory system

The cartilage of the fourth pharyngeal arch produces:
Laryngeal cartilages

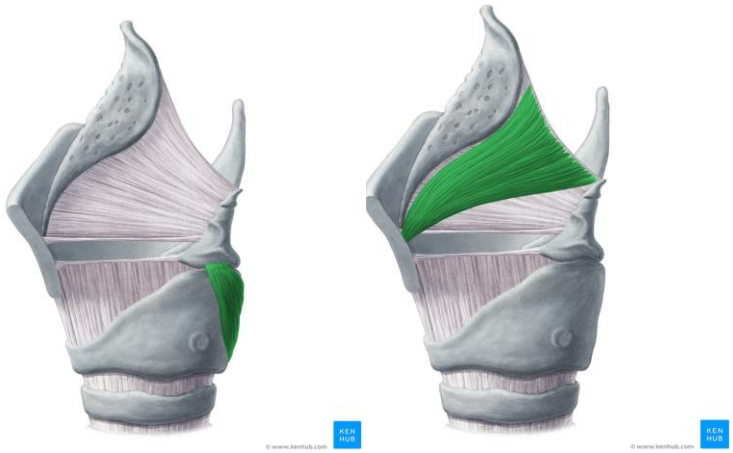
Muscles of fourth pharyngeal arch:
Only one muscle (Cricothyroid muscle)
Supplied by **Superior laryngeal nerve (vagus)**



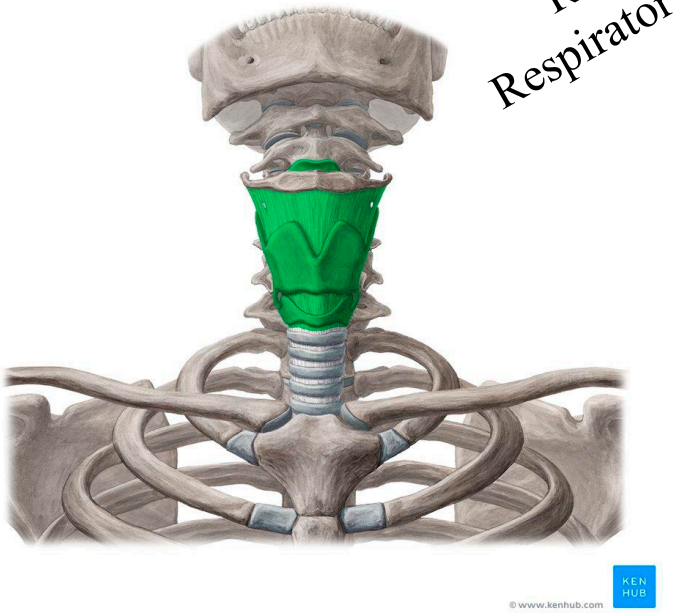
Derivatives of sixth pharyngeal arch

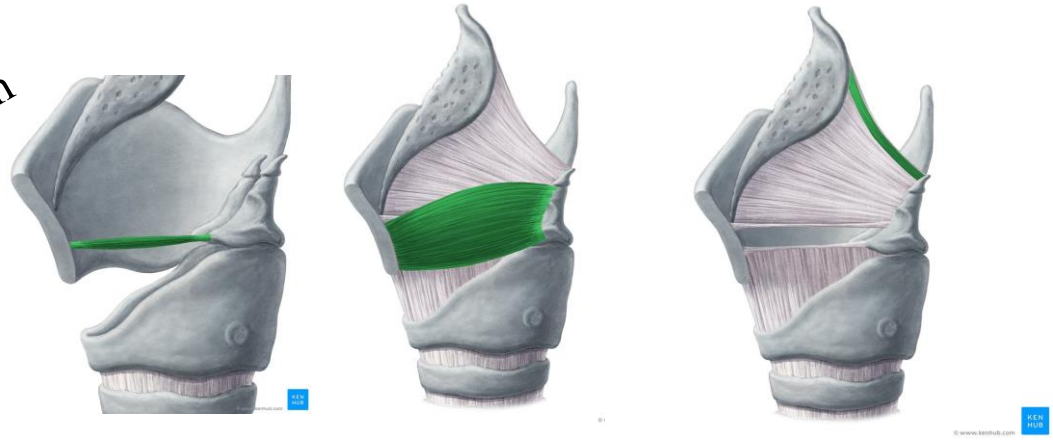
The cartilages of the sixth pharyngeal arch produce:
Laryngeal cartilages

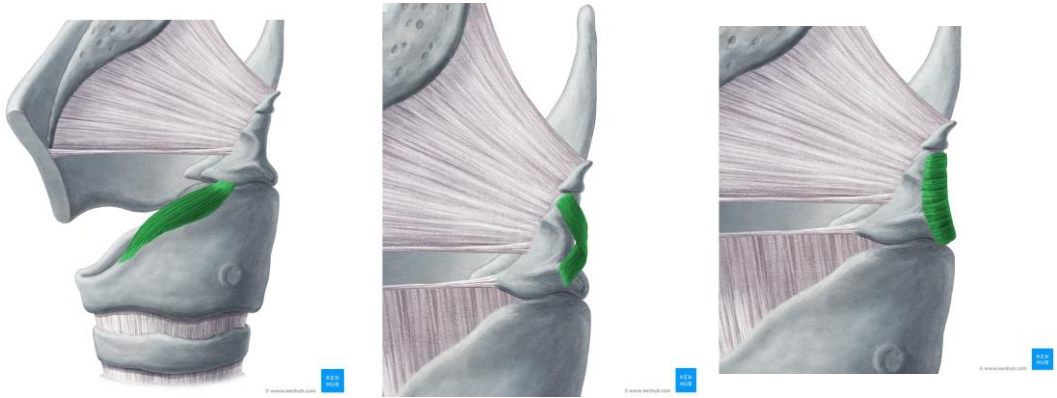
Muscles of sixth pharyngeal arch:
All laryngeal muscles (except cricothyroid)
Supplied by **Recurrent laryngeal nerve (vagus)**



Read only
Respiratory system







Fate of pharyngeal clefts

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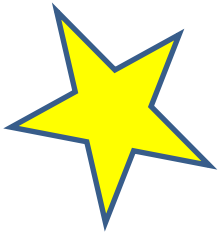

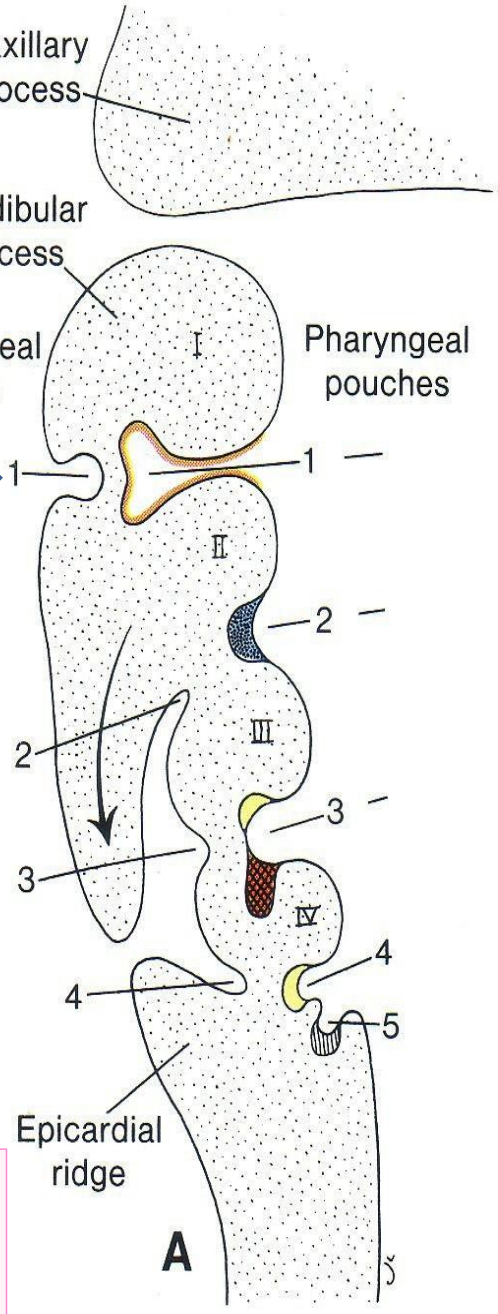

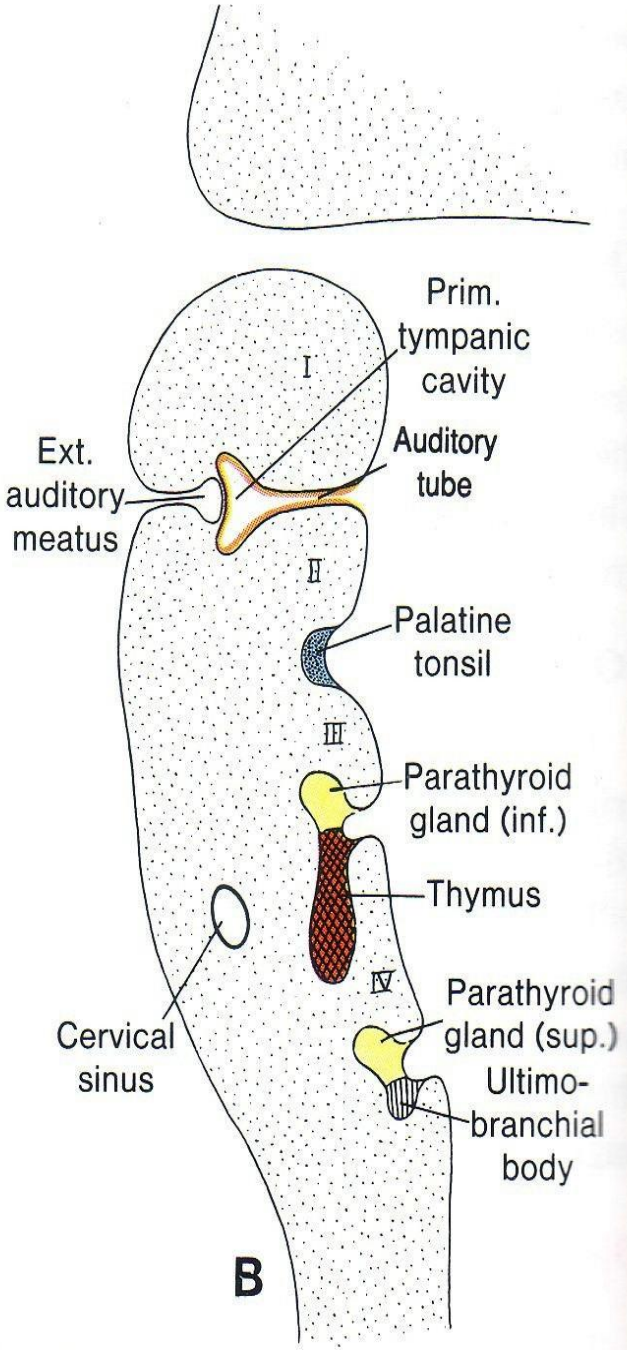

FIRST PHARYNGEAL CLEFT

Forms:

1- External auditory meatus

2- Outer layer of tympanic membrane (skin)

How is the auricle formed?
It develops from the formation of tubercles above and below the first pharyngeal cleft, in specific locations rather than randomly, to create the characteristic shape of the external auricle.

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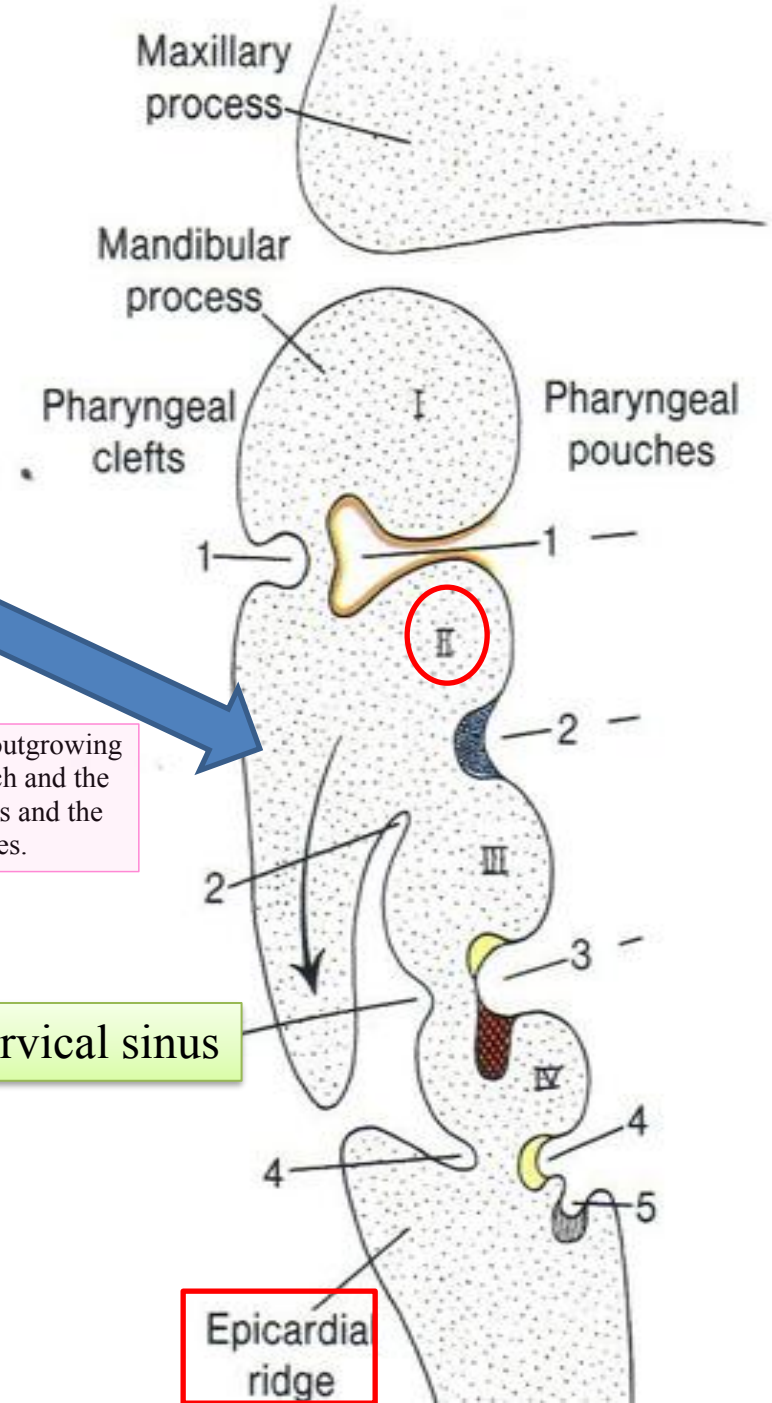
2nd 3rd and 4th PHARYNGEAL CLEFTS

Note the downward growth of 2nd arch

- Downward 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

A space between the outgrowing second pharyngeal arch and the 2nd, 3rd and 4th clefts and the other pharyngeal arches.



The second pharyngeal arch will proliferate laterally and downward to cover the second, third, and fourth pharyngeal clefts, contributing to the formation of the characteristic contour of the neck.

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Cervical (branchial) cyst
Remnant of cervical sinus
Can form a fluid filled cyst in the neck

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

Presents as a slowly enlarging lateral neck mass typically located in the lateral aspect of the neck, arising at any point along the anterior border of the **sternocleidomastoid muscle.** These cysts may intermittently swell, particularly in association with upper respiratory tract infections.

Fate of pharyngeal pouches

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Fate of pharyngeal pouches

Arch	Ventral part	Dorsal part
First pouch	Occupied by the developing tongue	Inner mucous layer of tympanic membrane, middle ear and Eustachian tube
Second pouch	Occupied by the developing tongue	Palatine tonsils
Third pouch	Thymus gland	Inferior parathyroid glands
Fourth pouch	Unknown	Superior parathyroid glands
Fifth pouch	Ultimo-branchial body which forms parafollicular cells in thyroid	

Endocrine system

Only first and second pouches are covered in MSS

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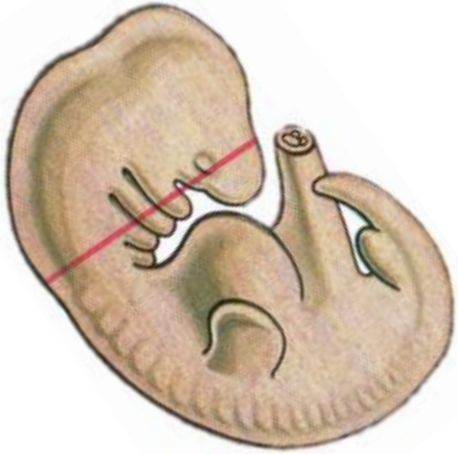

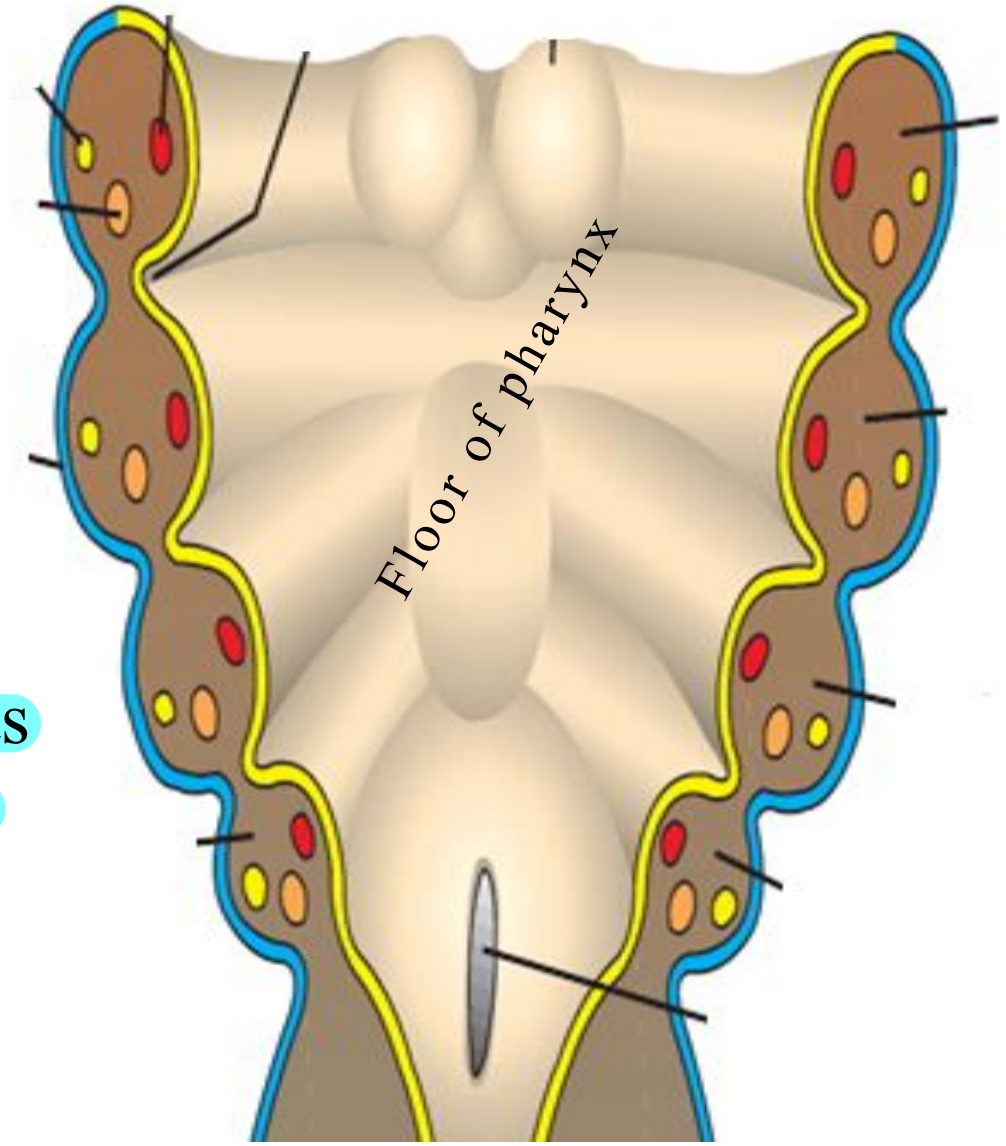

Note that the ventral parts of the pouches form the floor of the pharynx

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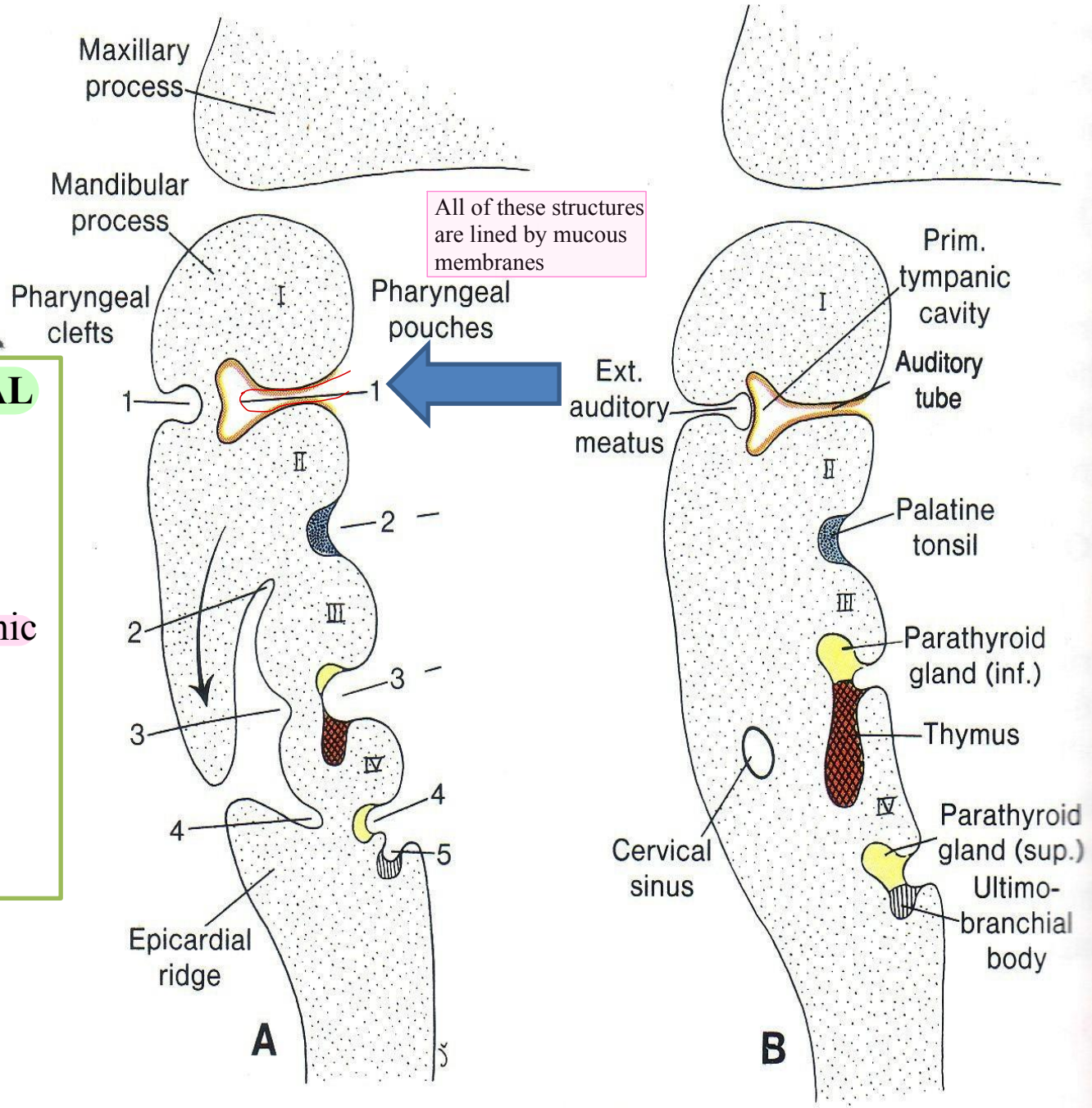
FIRST PHARYNGEAL POUCH
(Dorsal end)

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



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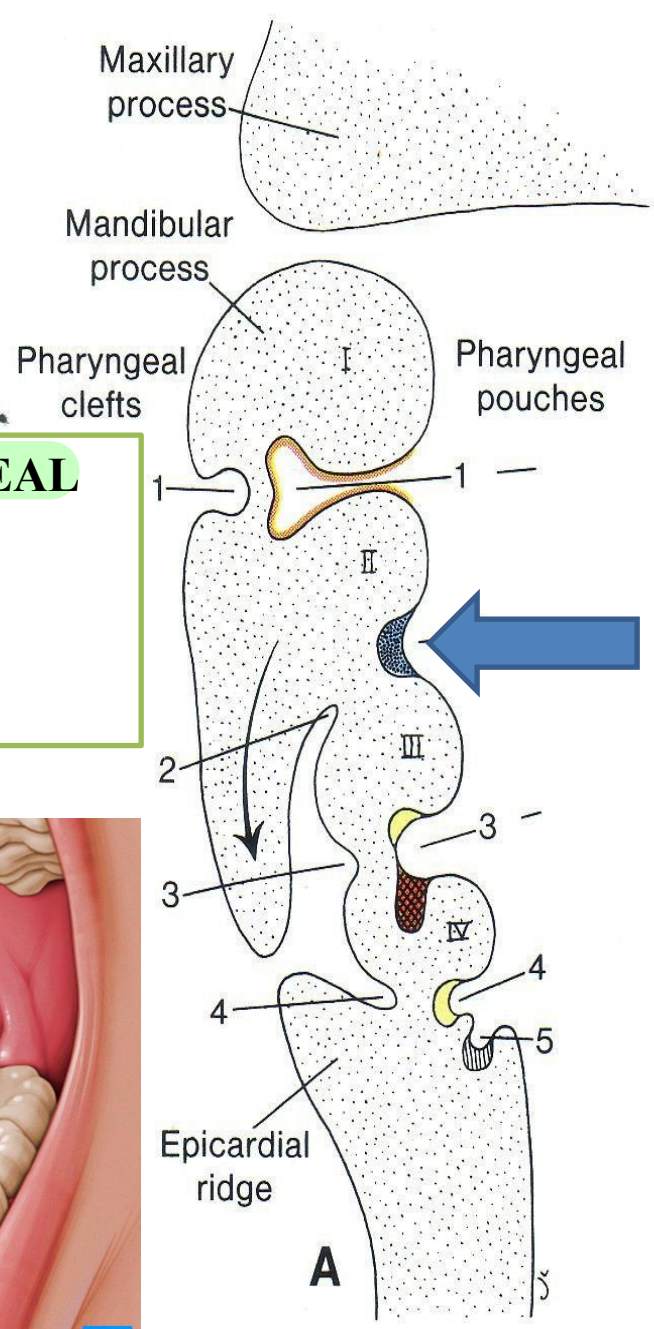
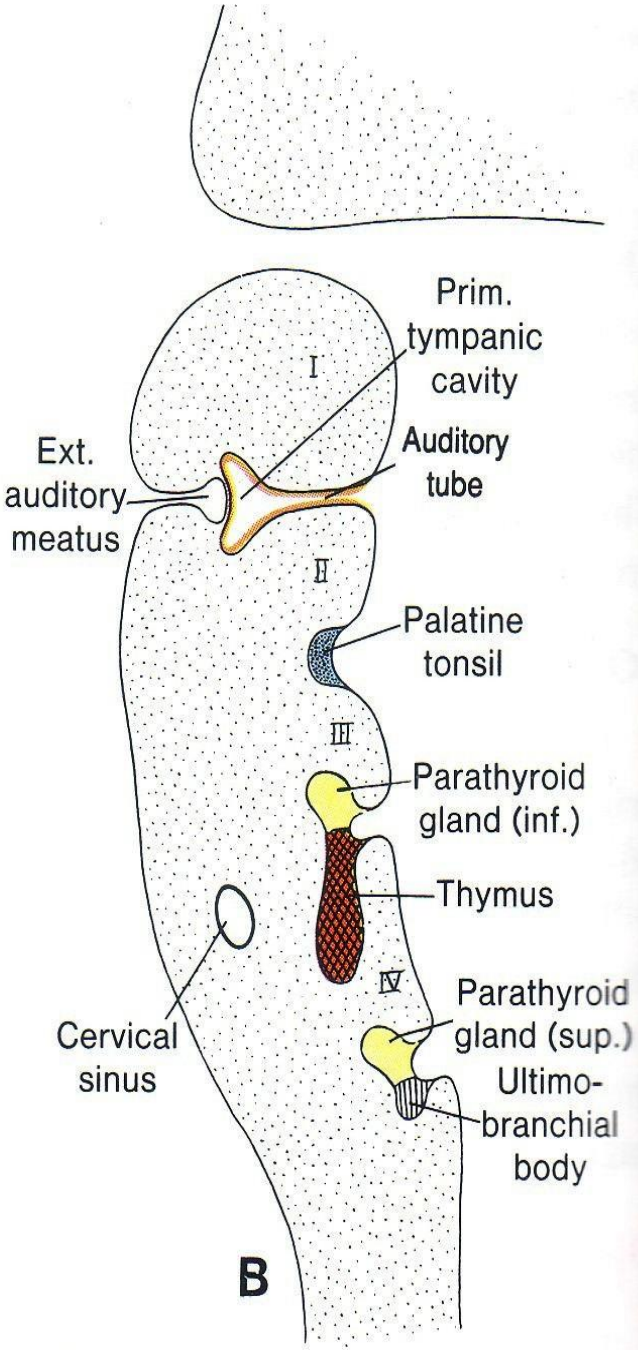
SECOND PHARYNGEAL POUCH
(Dorsal end)
Forms:
Palatine tonsils





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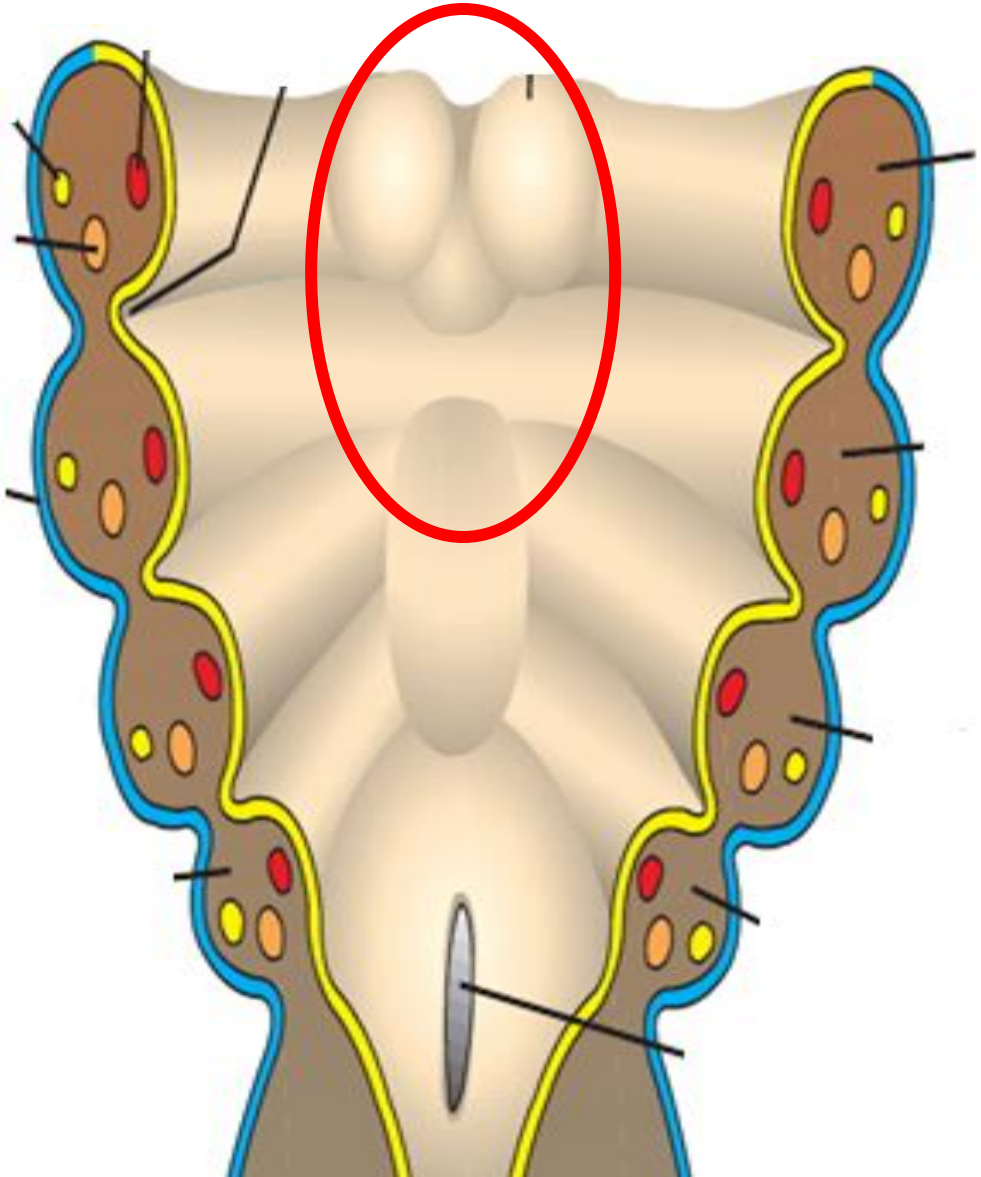
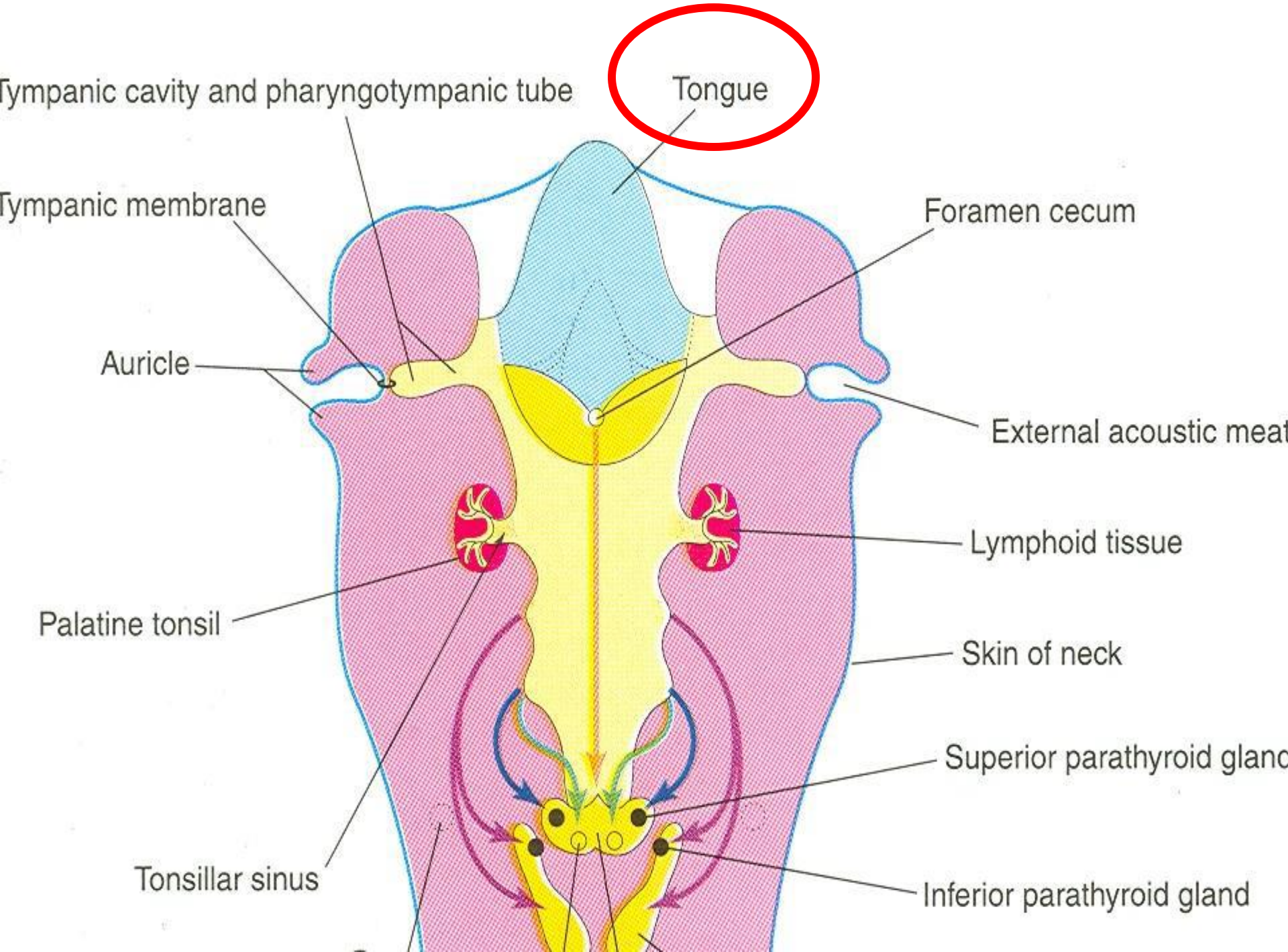
Note: the **ventral ends of the first and second pharyngeal pouches are occupied by the developing tongue** At the floor of the pharynx



Note: Pre-trematic nerve crosses from one arch to other, e.g. To supply the structures derived from the other arch chorda tympani n. (branch of facial n.) supplies anterior 2/3 of tongue (taste sensation).

Note: the mandibular nerve supplies anterior 2/3 of tongue (general sensations)

The post trematic nerve is the nerve of the arch itself.


Tympanic cavity and pharyngotympanic tube
Tongue
Tympanic membrane
Foramen cecum
Auricle
External acoustic meat
Lymphoid tissue
Palatine tonsil
Skin of neck
Superior parathyroid gland
Tonsillar sinus
Inferior parathyroid gland

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THIRD PHARYNGEAL POUCH

Ventral part:

Forms:

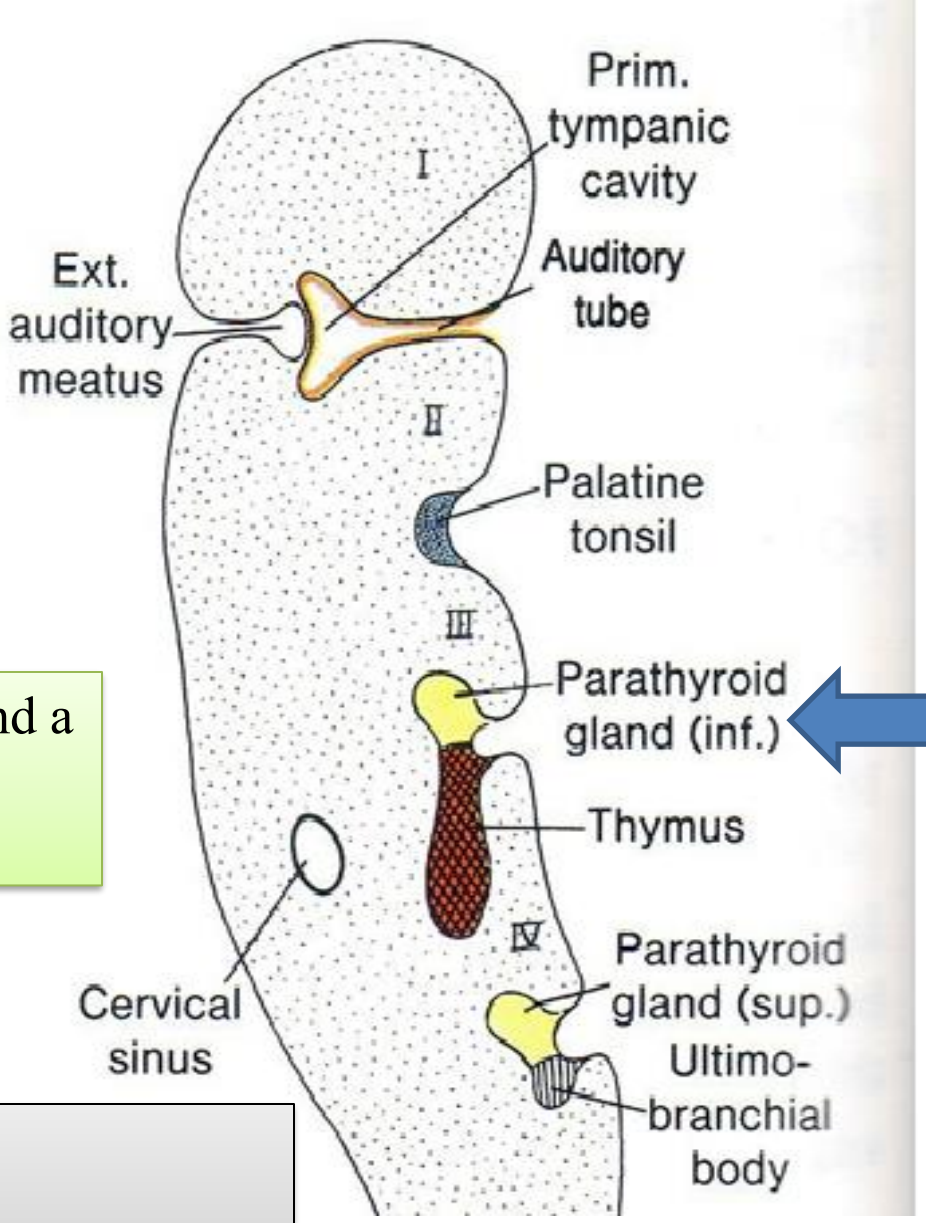
Thymus

Dorsal part

Forms:

Inferior parathyroid gland

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



Read only
Endocrine system

Note:

Postnatal →

Thymus: lies in the thorax behind the sternum

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

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Read only
Endocrine system

FOURTH PHARYNGEAL POUCH

Ventral part:

Unknown

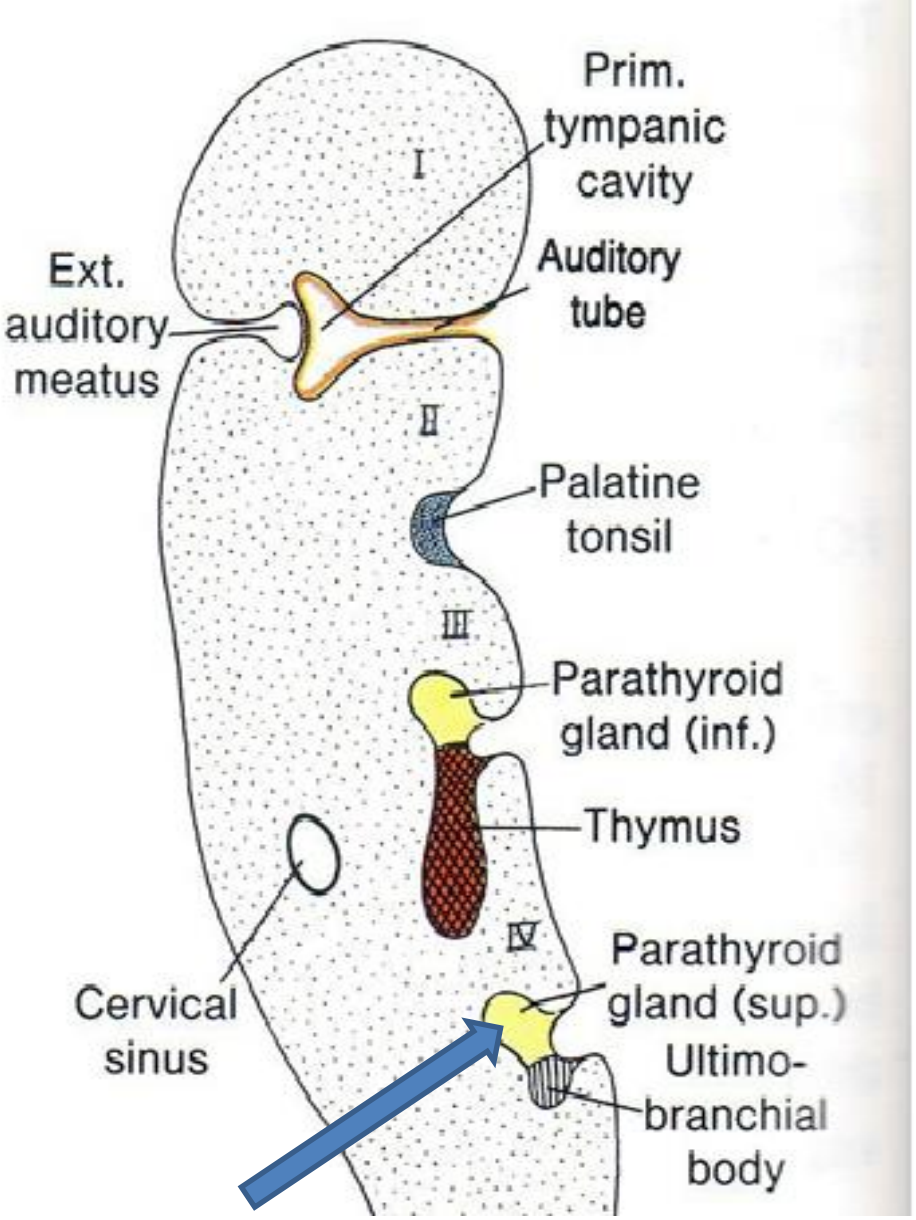
Dorsal part

Forms:

Superior parathyroid gland

Note:

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



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Endocrine system

FIFTH PHARYNGEAL POUCH

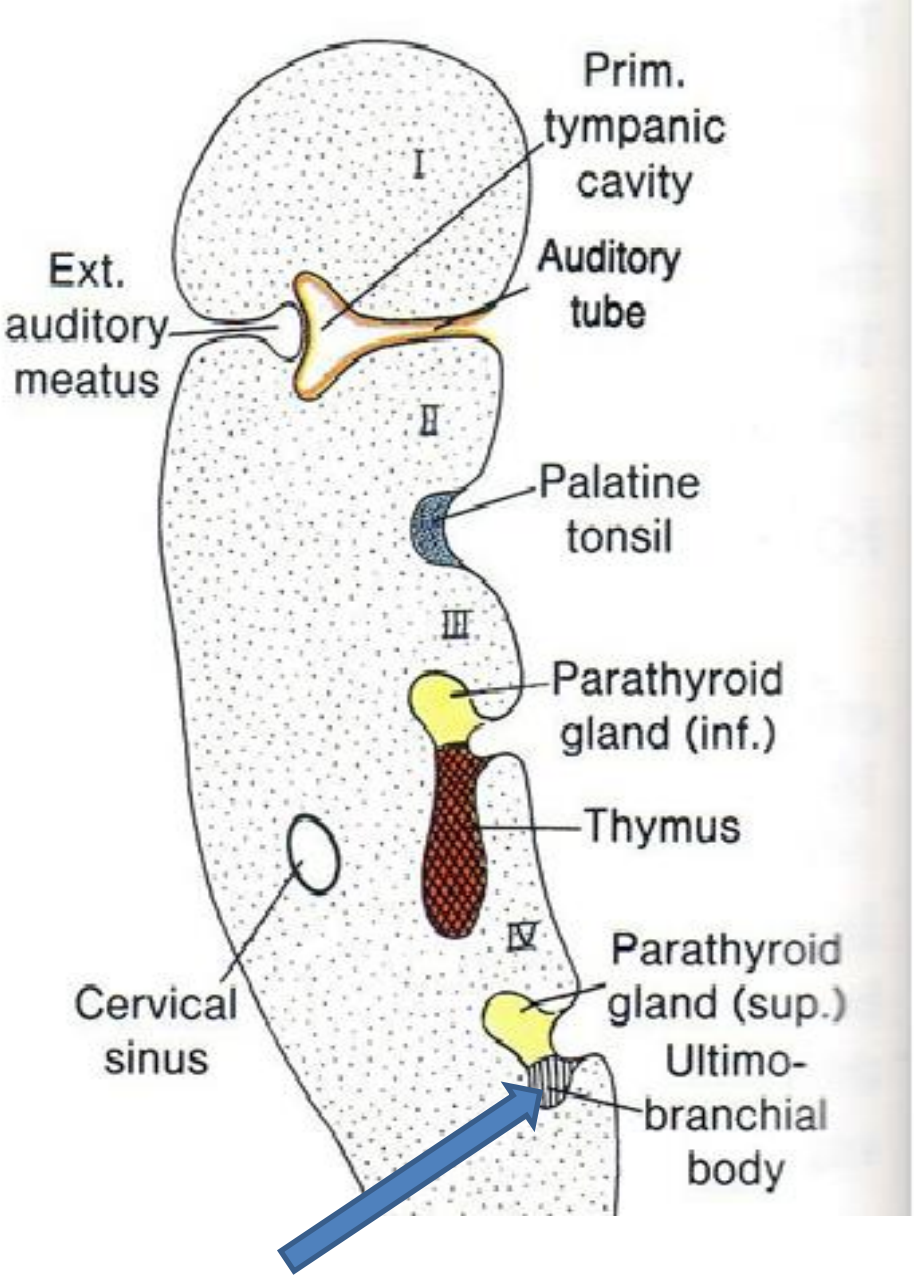
Forms

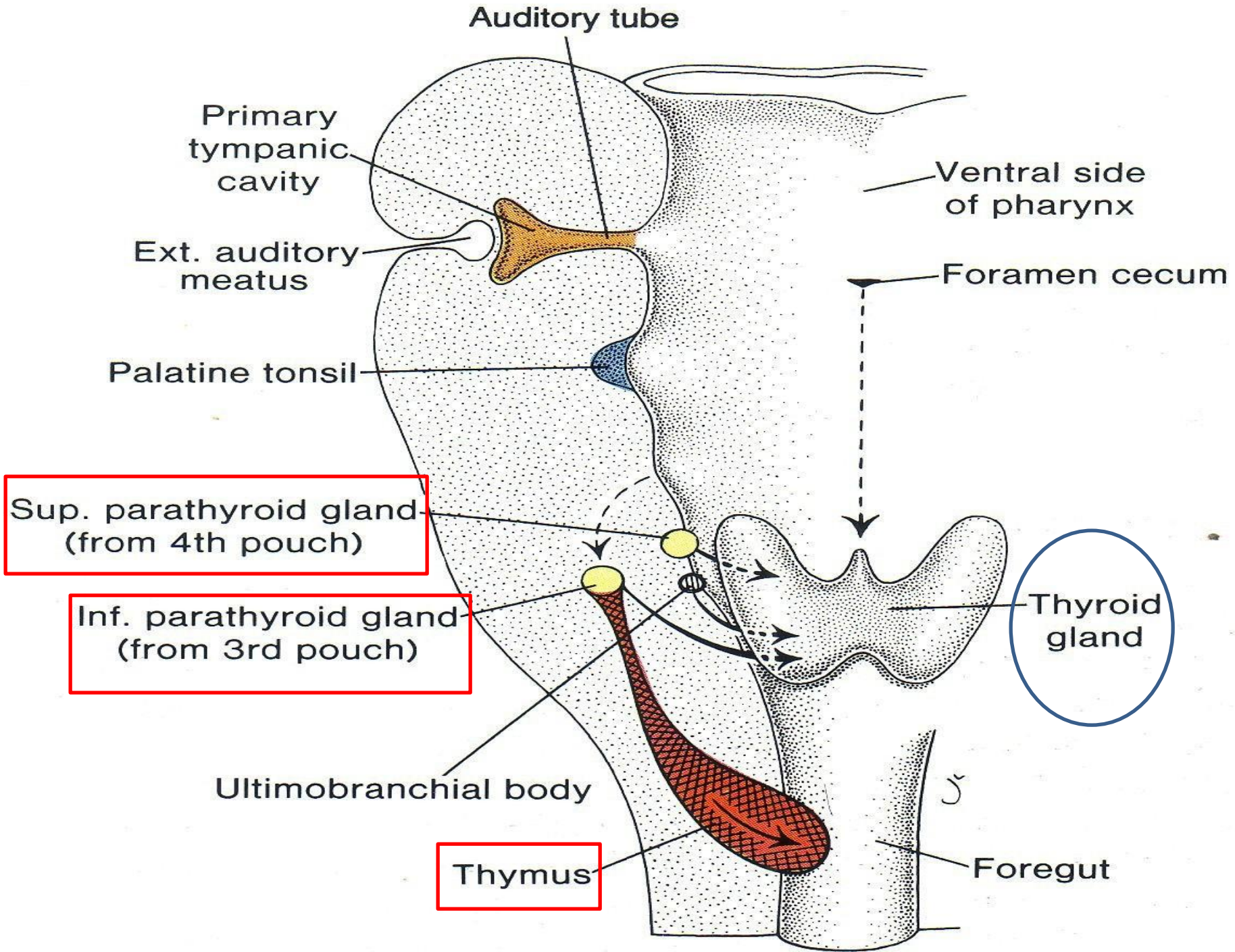
Ultimobranchial body:

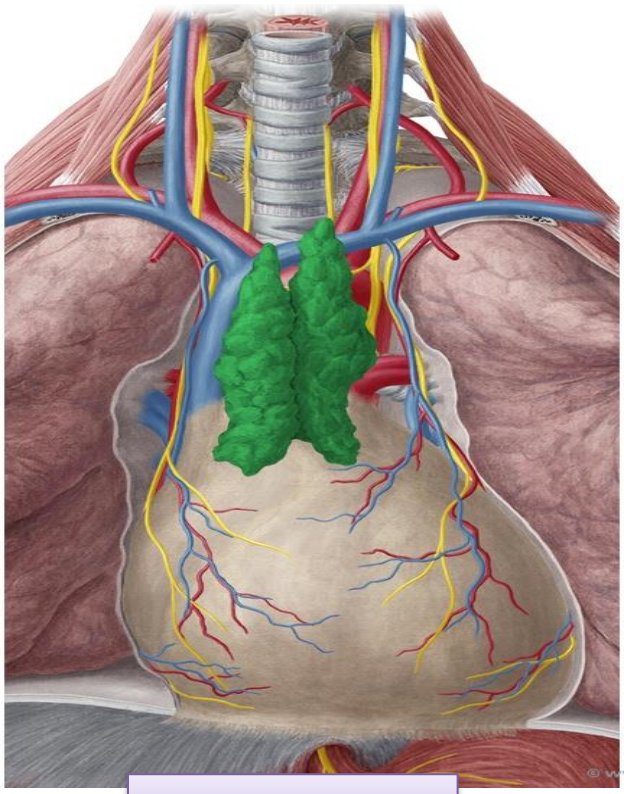
Is incorporated into the thyroid gland.

Cells of the ultimobranchial body give rise to the parafollicular, or C cells of the thyroid gland

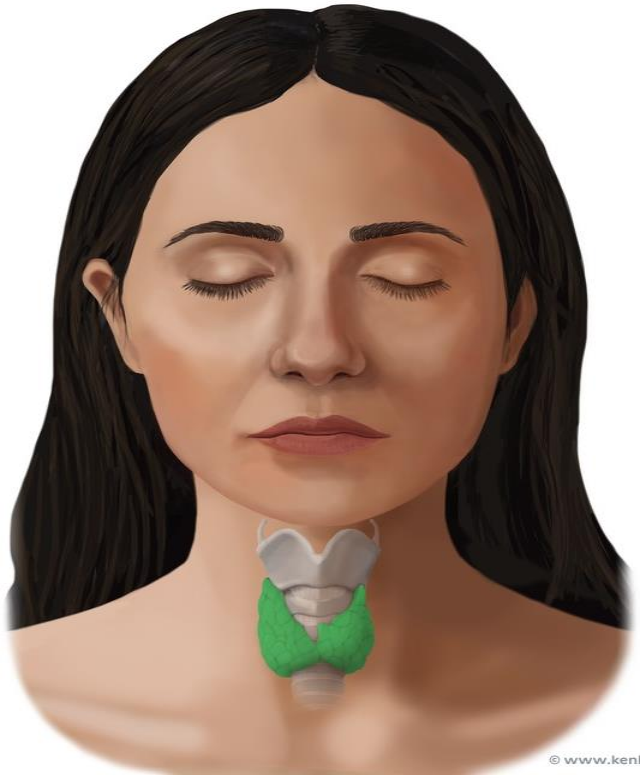
Note:
The thyroid tissue is made up of two types of cells: follicular cells and parafollicular cells.




Auditory tube
Primary tympanic cavity
Ventral side of pharynx
Ext. auditory meatus
Foramen cecum
Palatine tonsil
Sup. parathyroid gland (from 4th pouch)
Inf. parathyroid gland (from 3rd pouch)
Thyroid gland
Ultimobranchial body
Thymus
Foregut



Thymus gland



Thyroid gland

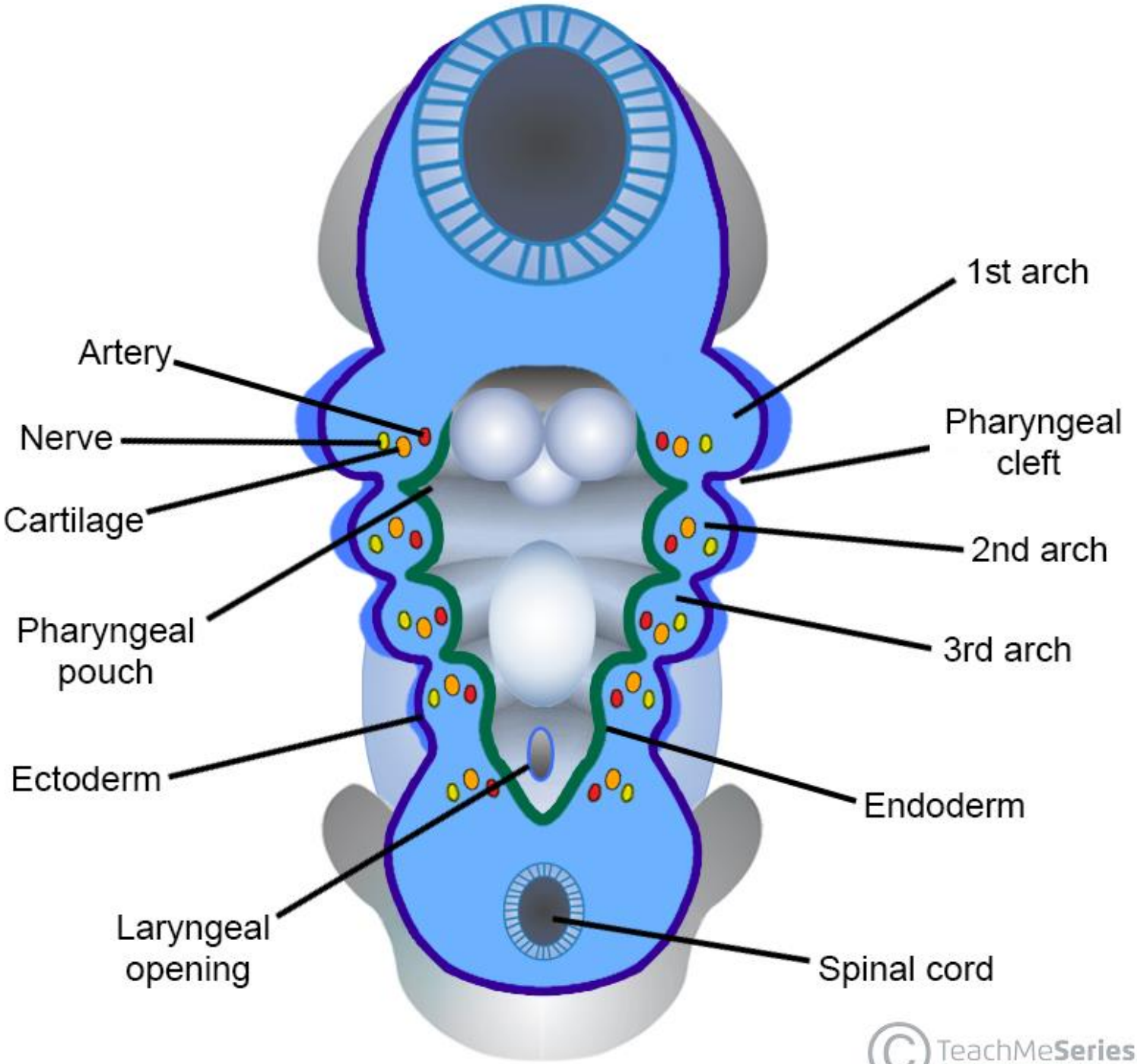
Read only
Endocrine system

Congenital Anomalies

1- Ectopic thymus: in the neck

2- Ectopic parathyroid : especially the inferior parathyroid (in thorax)

3- Cervical cyst



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