

# ***DEVELOPMENT OF THE ORGANS OF THE HEAD AND NECK REGION***

***Face, palate, tongue  
Pharyngeal arches, grooves  
and pouches***

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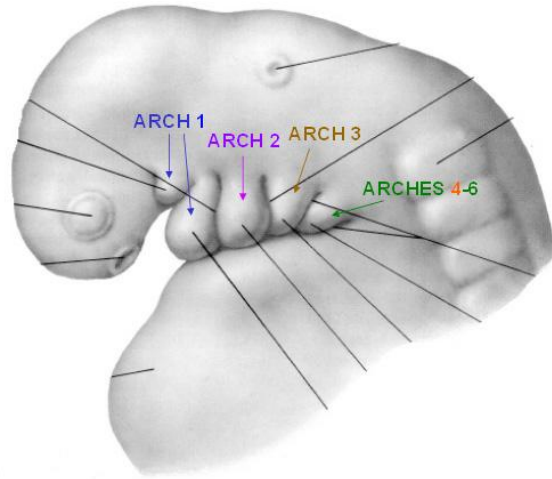
***Department of Anatomy, Histology and Embryology***

***Budapest***



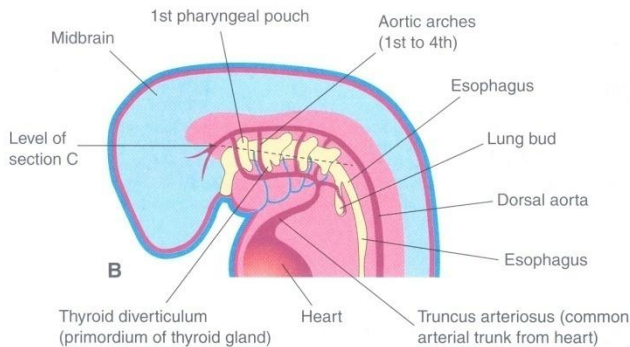
# GERMINAL LAYER DERIVATIVES

**ECTODERM** contributing to the formation of the face appears by the 4th week.



The *oropharyngeal membrane* (interface between **ECTODERM** and **ENDODERM**) is located in front of the later palatine tonsils. Ectodermal structures limiting the stomodeum participate in the formation of the face, as well as of the nasal and oral cavities.

**MESENCHYME** that fills the pharyngeal arches derives from the *neural crest*

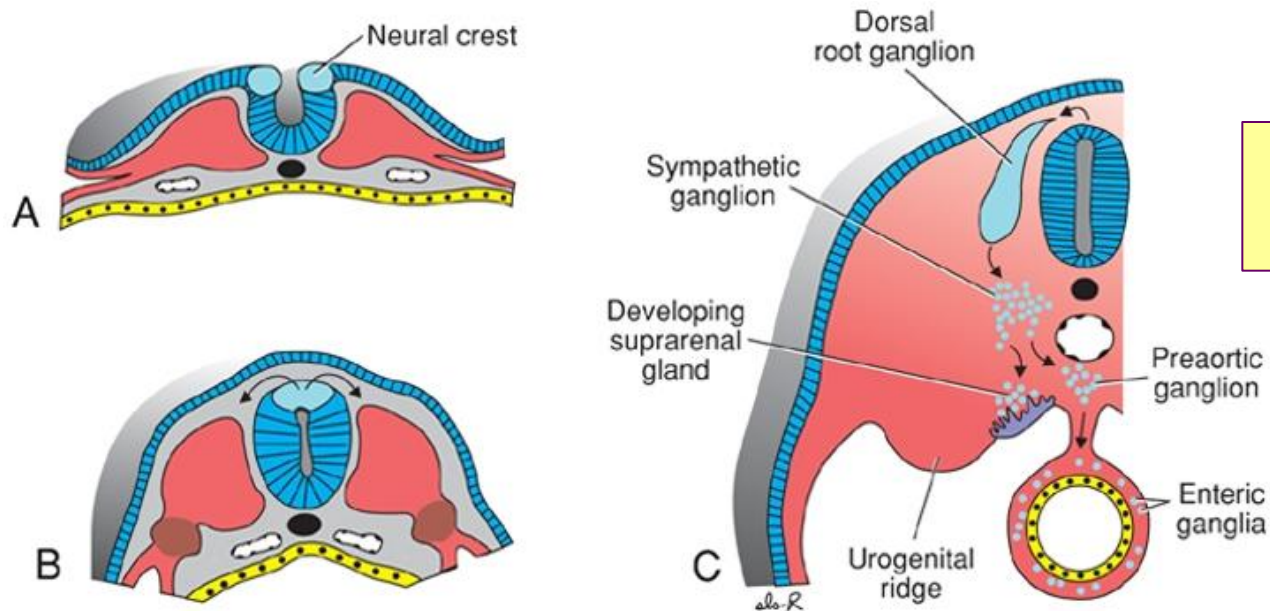


**ECTOMESENCHYME**

# NEURAL CREST

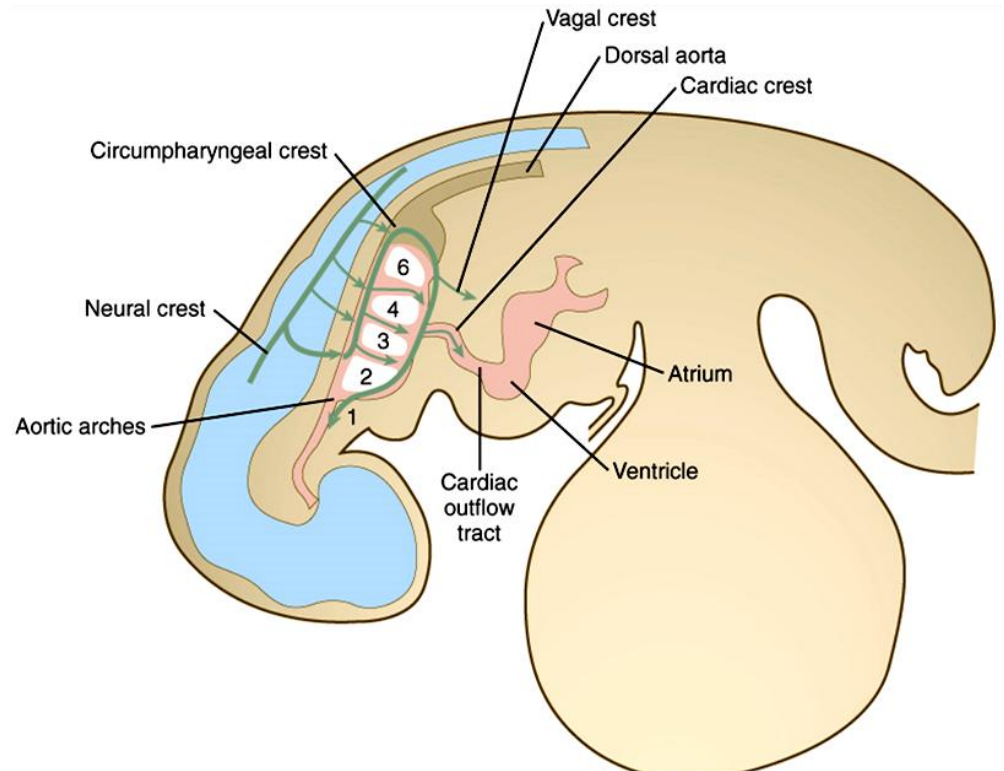
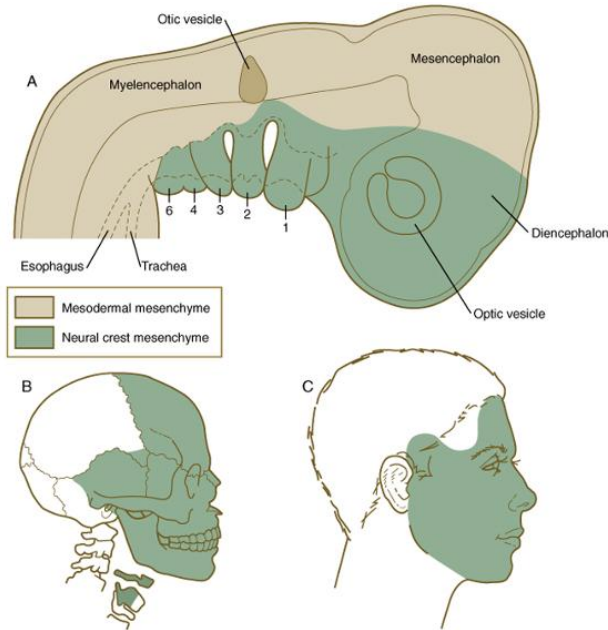
At the time of neurulation, cells at the lateralmost edge of the neural plate are exposed to a unique combination of factors from the adjacent skin, underlying mesoderm, and from the rest of the neural plate and are induced to form **neural crest**.

The neural crest cells downregulate cadherin expression and delaminate from the neuroepithelium, i.e., they **transform from epithelial cells into migratory mesenchymal cells** that contribute to forming MANY tissues in the body.



THE "4<sup>th</sup> GERM LAYER"

# NEURAL CREST



Carlson: Human Embryology and Developmental Biology, 4th Edition.  
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**PERIPHARYNGEAL  
(OR CIRCUMPHARYNGEAL)  
DIVISION**

- Arches 1 - 2 - 3 - 4 - 6
- Contribute to thyroid, parathyroid, and thymus
- **Cardiac crest** contributes to outflow tract cushions
- Malformations (e.g. DiGeorge syndrome, Hoxa-3 mutation) are represented **multiple** (*craniofacial (jaw), glandular & outflow tract*) **defects**

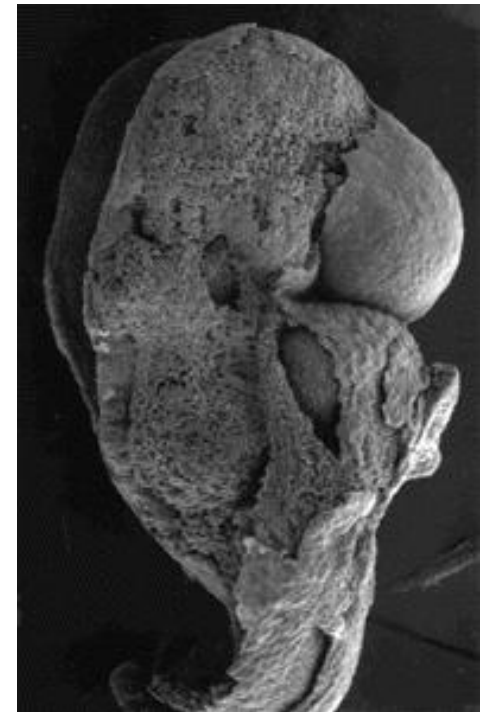
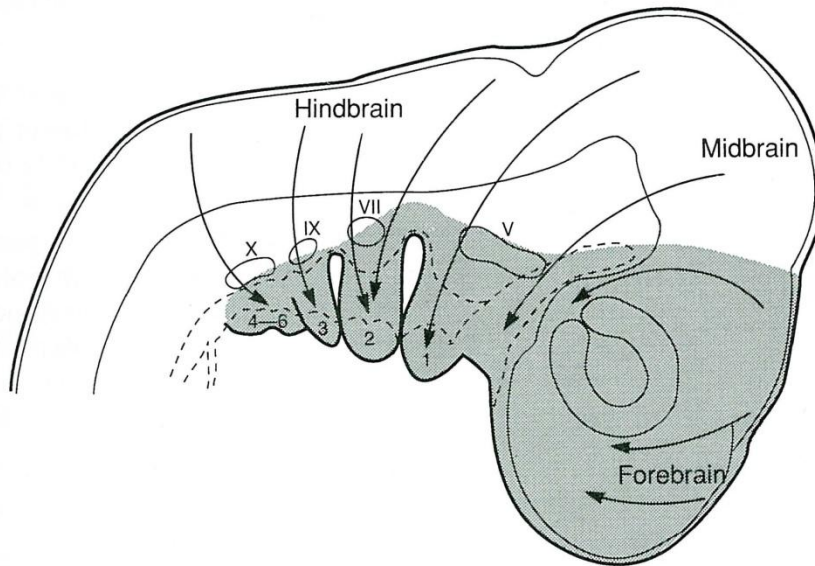
Adapted from Matt Velkey  
matt.velkey@duke.edu

# MESENCHYME IN THE HEAD&NECK REGION

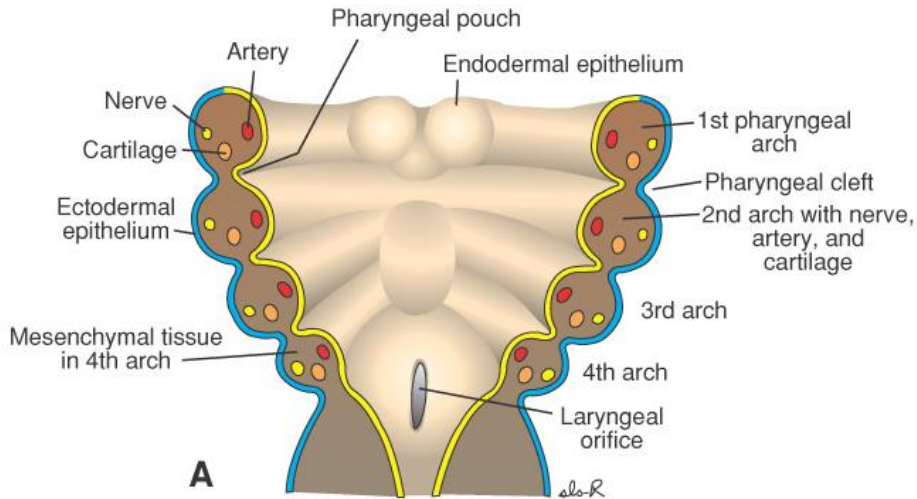
## Mesenchyme in general

- embryonic connective tissue
- loosely organized
- has the ability to migrate & differentiate into different cell types
- can develop from any germ layer

## Ectomesenchyme



# PRIMORDIAL TERMS



The **pharyngeal arches** form on either side of the foregut and correspond to the primitive vertebral gill bars or **branchial arches**.

A pharyngeal arch consists of

1. core of mesenchyme
2. external ectoderm
3. internal endoderm.

The arches are **separated**

- externally by a pharyngeal **cleft**
- internally by a pharyngeal **pouch**.



# PHARYNGEAL ARCHES IN FACE DEVELOPMENT

## WEEK 6

The face is formed by 5 processes

*Frontonasal prominence (1)*

*Maxillary prominence (2)*

*Mandibular prominence (2)*

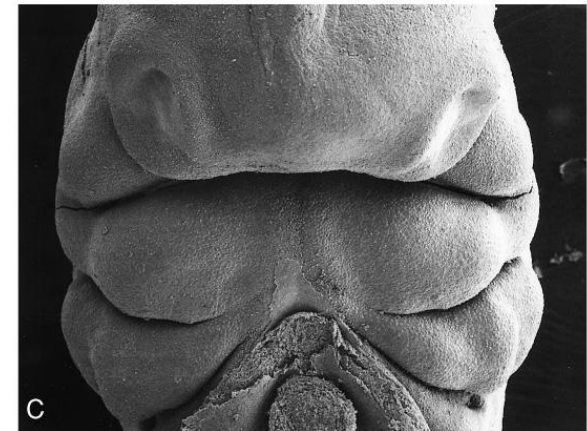
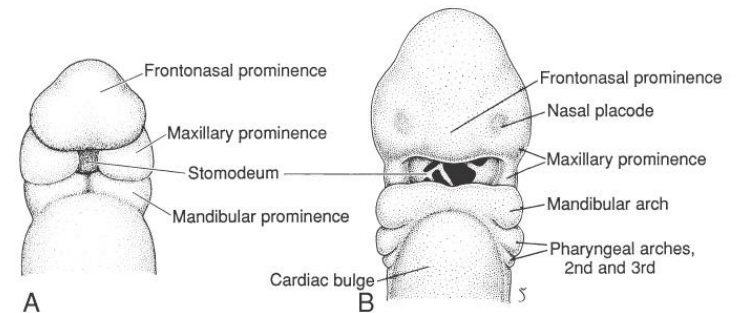
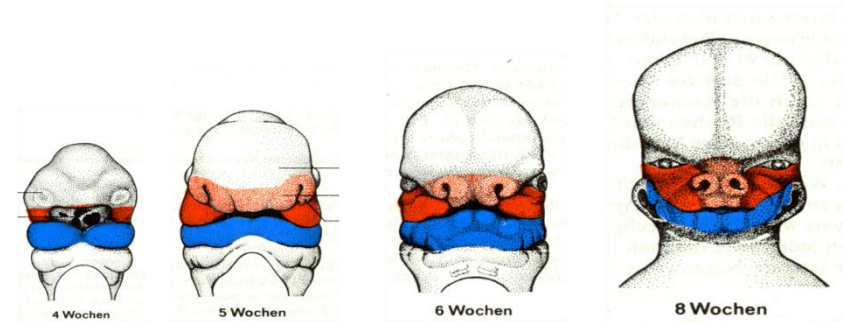
} 1st arch

*nasal (olfactory) pits* form surrounded by the medial and lateral nasal processes

*nasolacrimal groove* separates the lateral nasal process from the maxillary process

maxillary processes fuse with the medial nasal processes

lateral nasal processes fuse with the maxillary processes, thus obliterating the nasolacrimal groove.

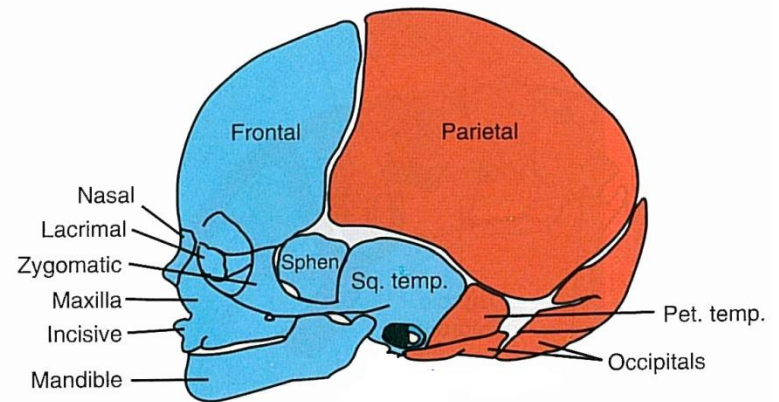
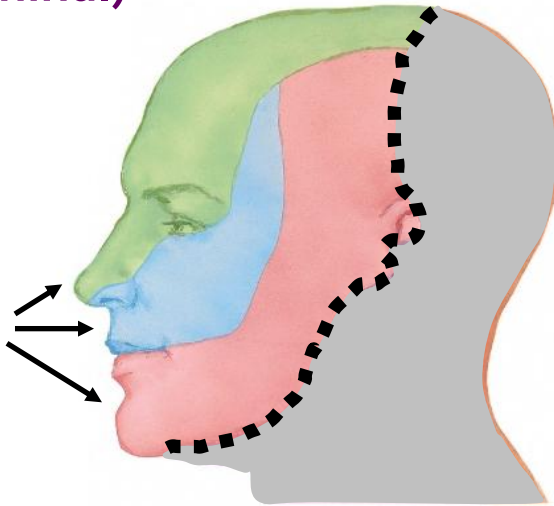


# ECTOMESENCHYME

## DEVELOPMENT OF THE CRANIUM

Blue = derived  
from neural crest  
cells

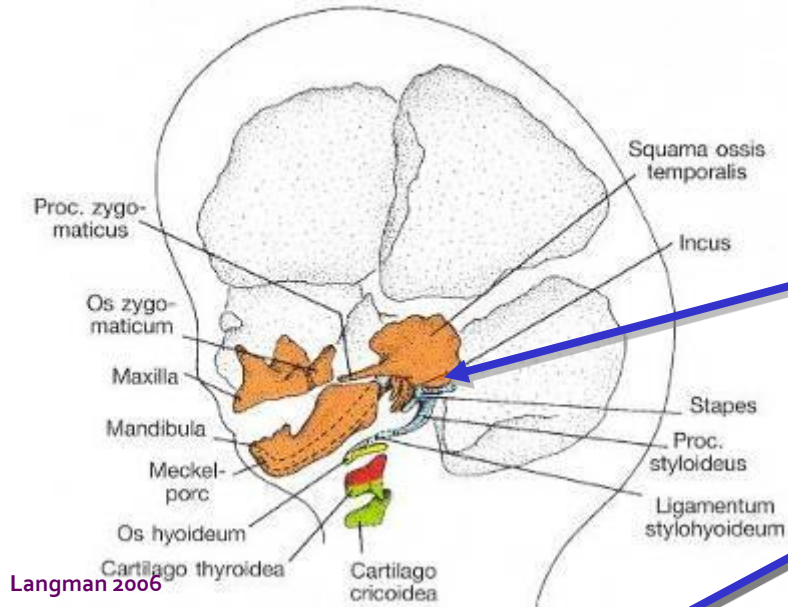
CN V  
(trigeminal)



Red = derived from  
paraxial mesoderm



# CARTILAGENOUS VISCEROCRANIUM BONES OF THE FACIAL SKELETON



Langman 2006

**1st pharyngeal arch**  
(Circumoral)  
mandibular prominence

**Meckel's cartilage**  
dorsal end  
rudiments of incus, malleus

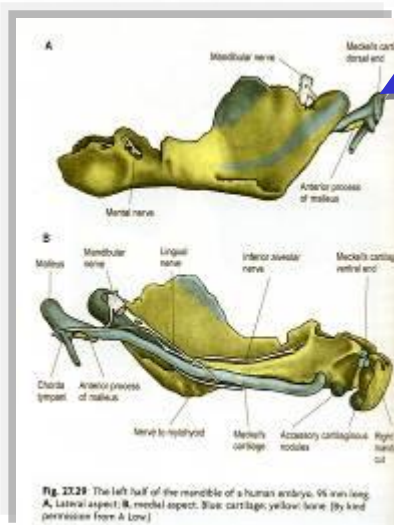
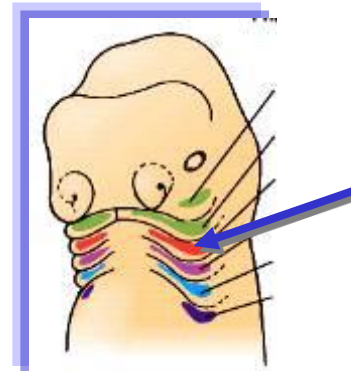
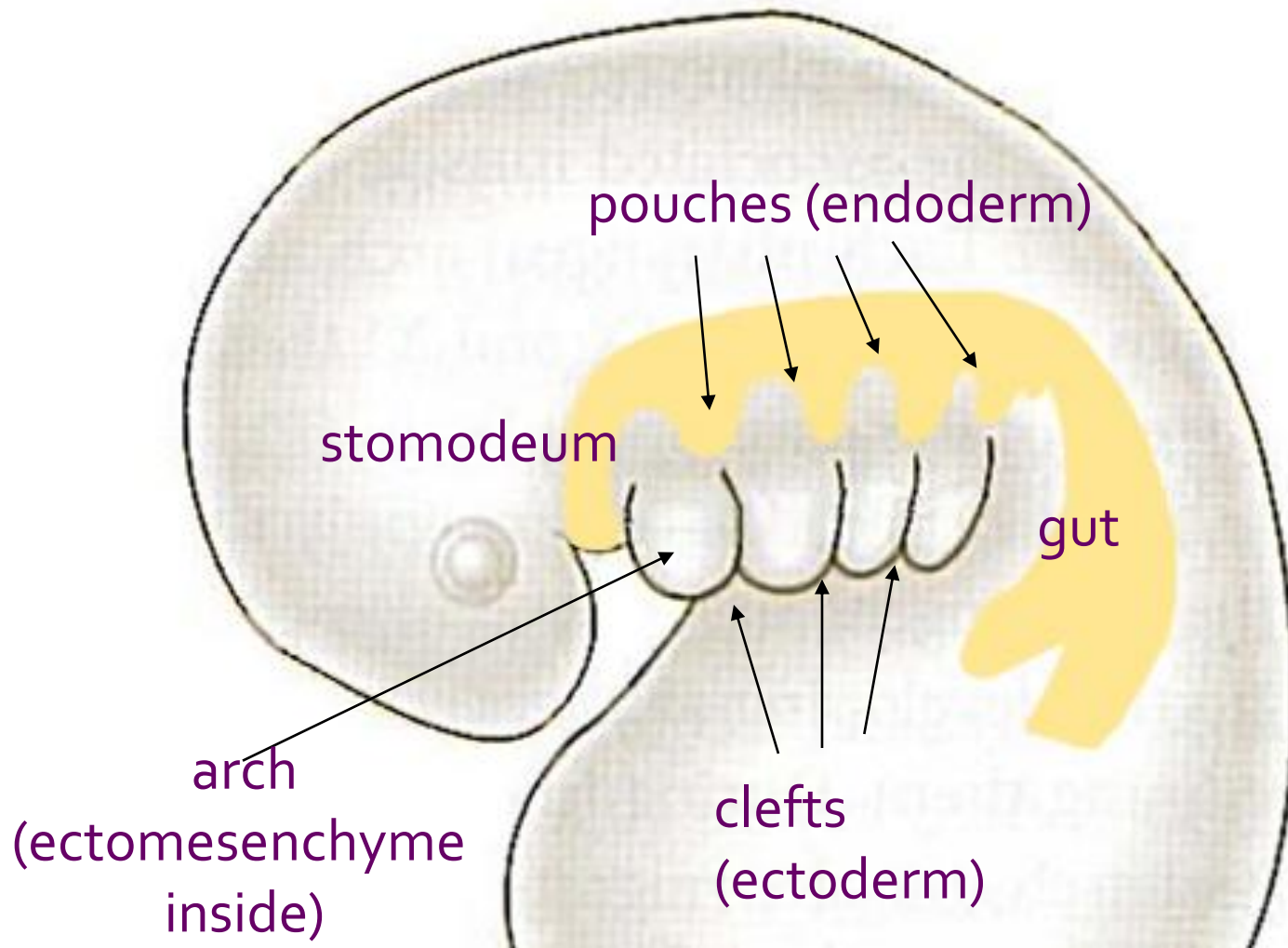


Fig. 22.29 The left half of the mandible of a human embryo. Os (in blue). A, lateral aspect; B, medial aspect. Blue: cartilage; yellow: bone (by kind pervasion from A to B).

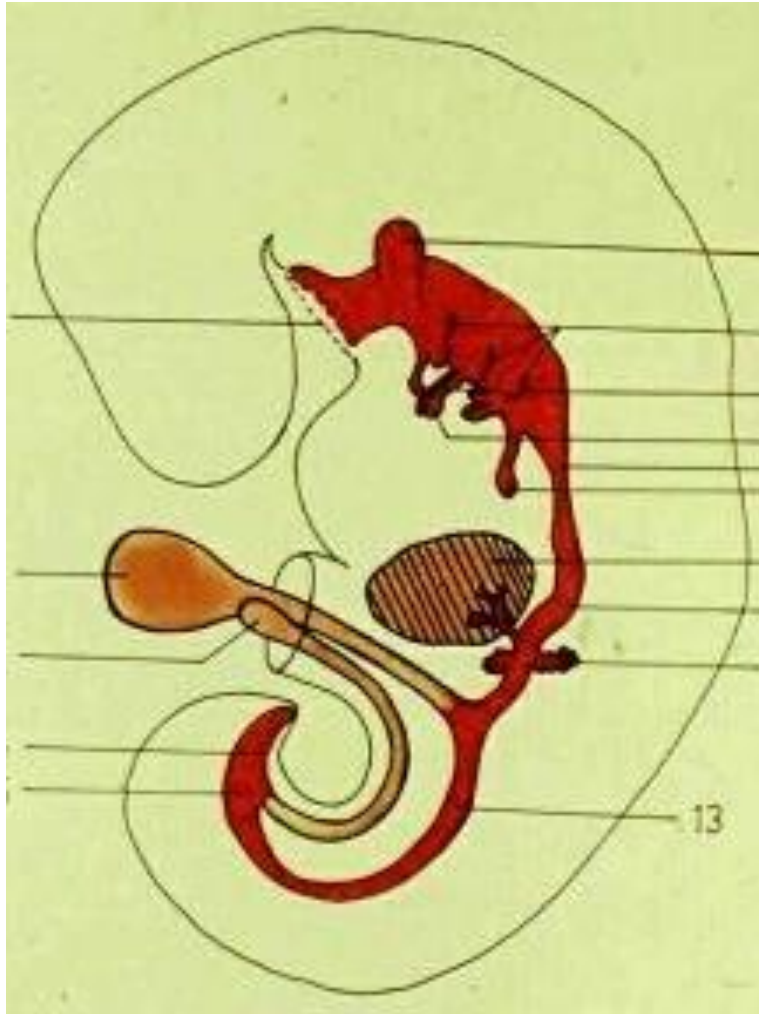


**2nd pharyngeal arch**  
Reichert's cartilage  
stapes,  
temporal  
styloid process

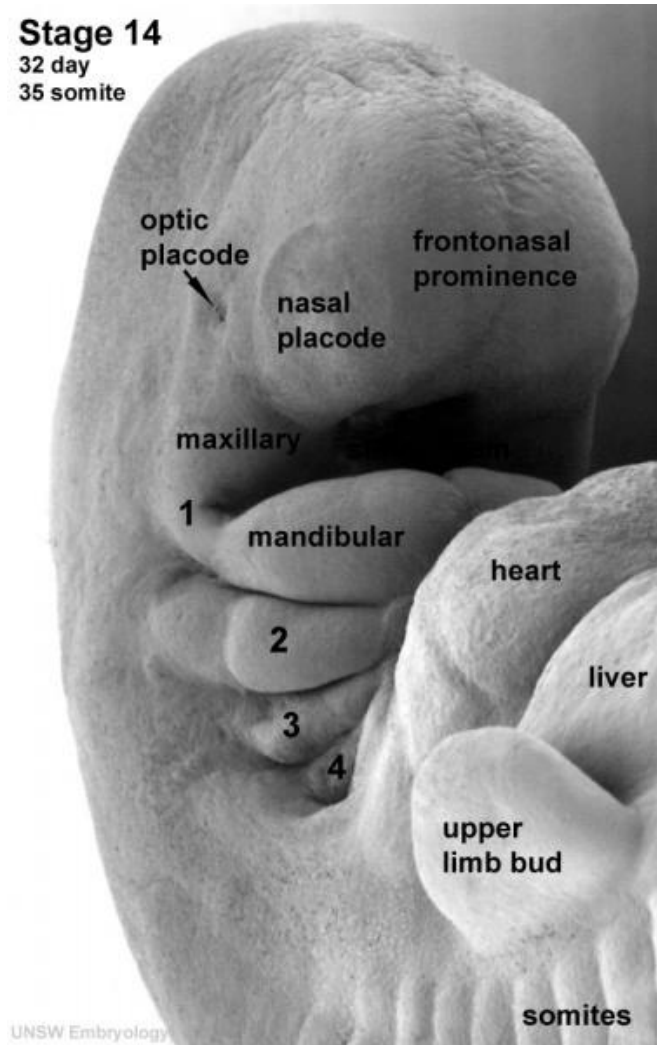
# PHARYNGEAL (BRANCHIAL) APPARATUS



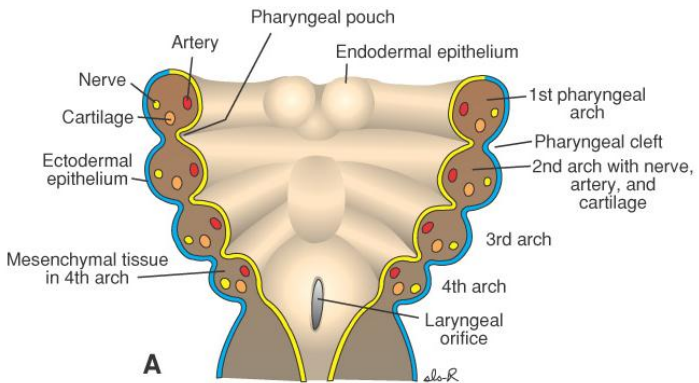
# PHARYNGEAL (BRANCHIAL) APPARATUS



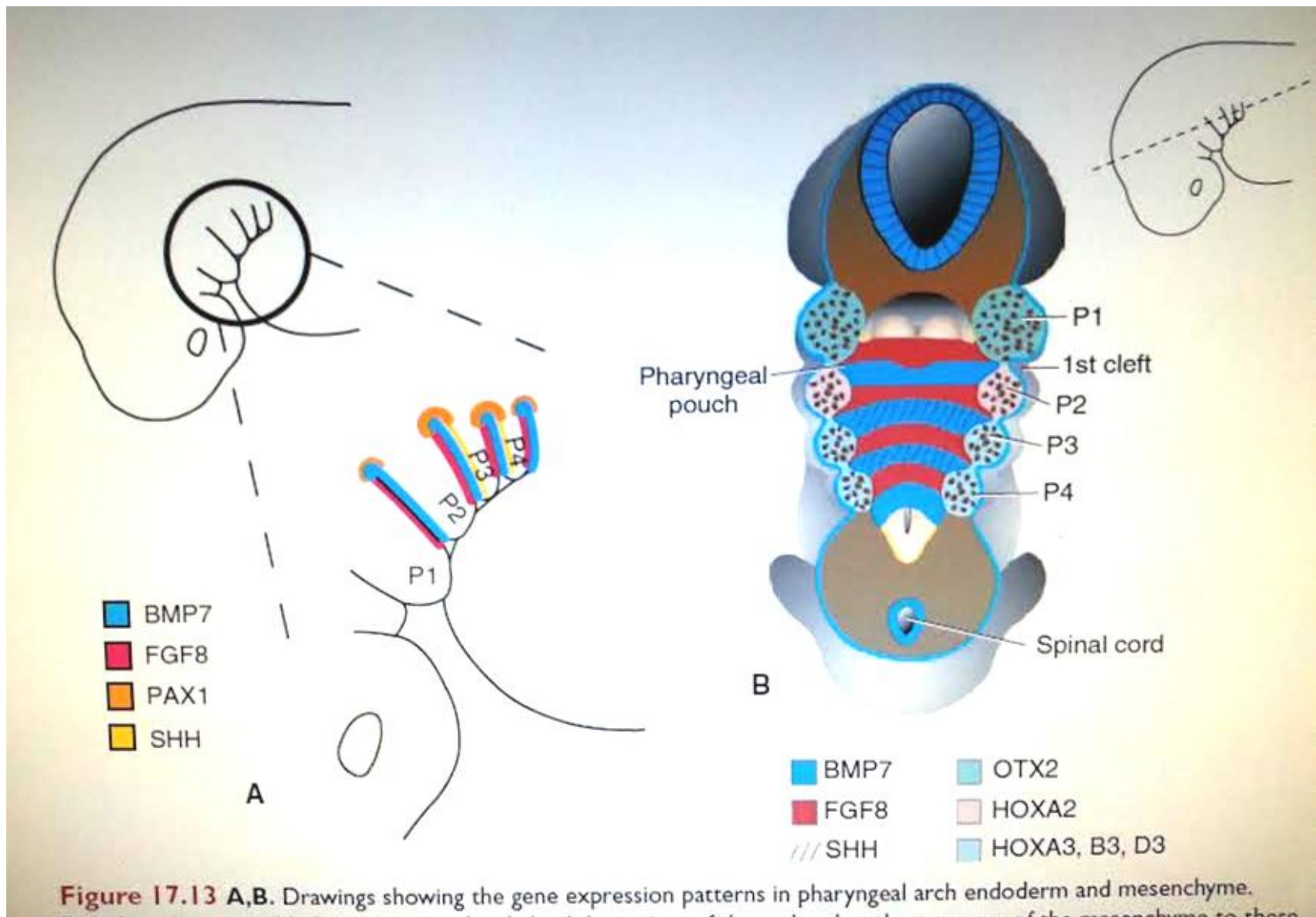
**Stage 14**  
32 day  
35 somite



# PHARYNGEAL (BRANCHIAL) APPARATUS

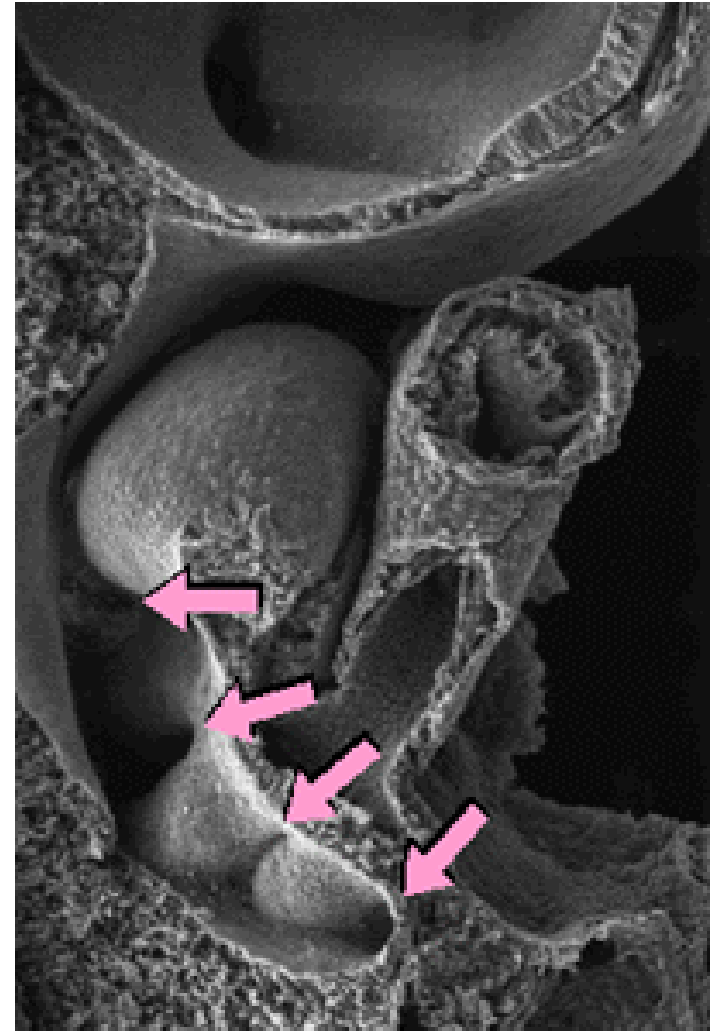
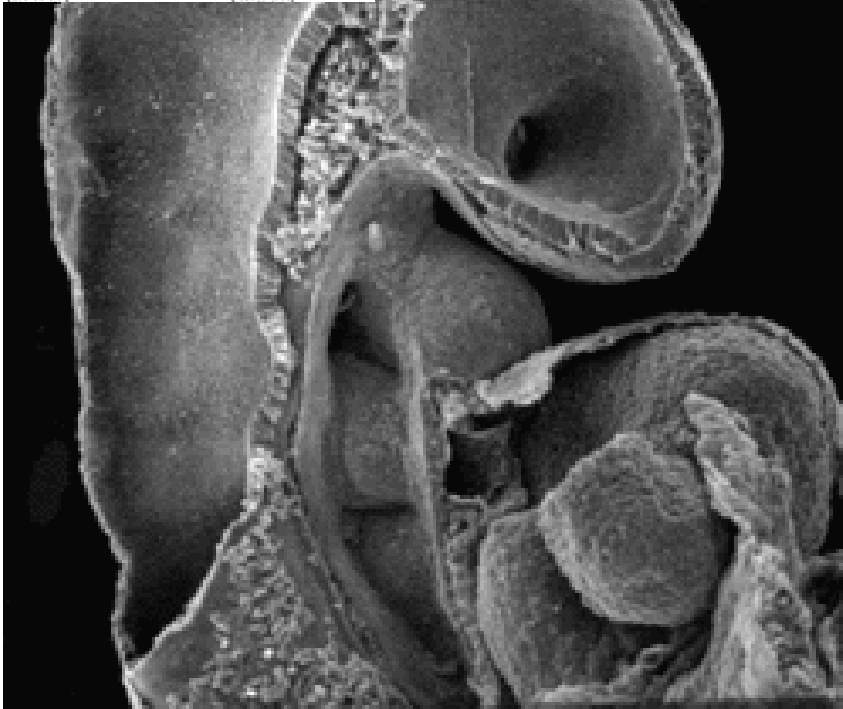
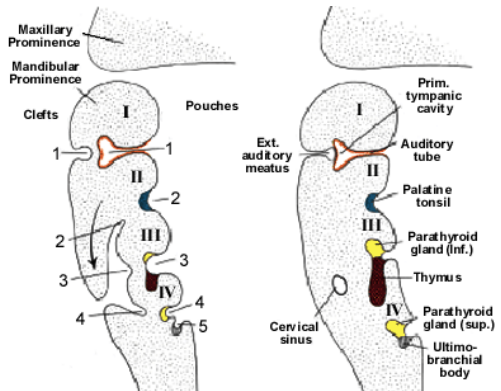


# GENE EXPRESSION PATTERN

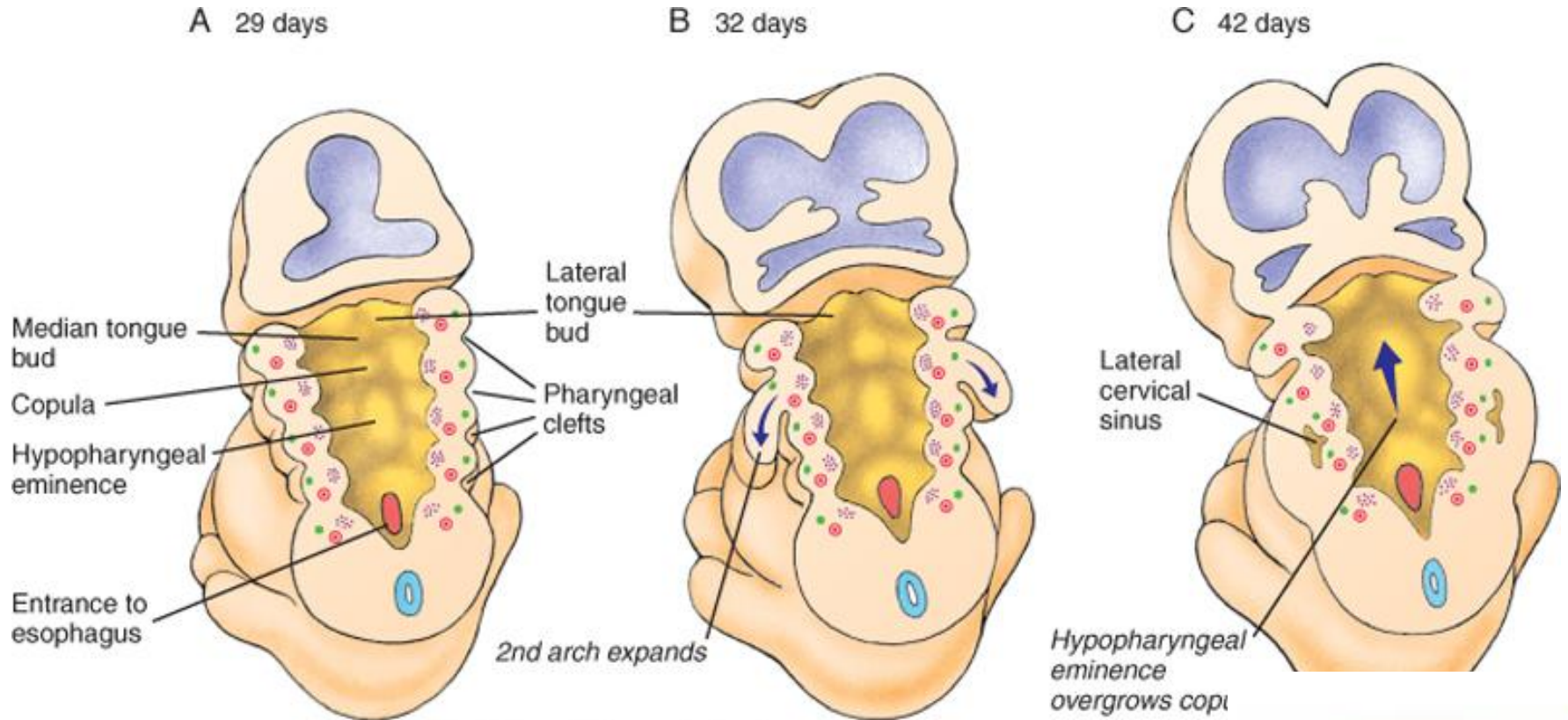


**Figure 17.13 A,B.** Drawings showing the gene expression patterns in pharyngeal arch endoderm and mesenchyme.

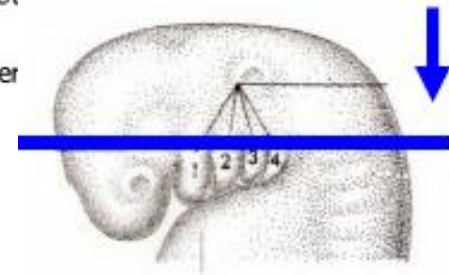
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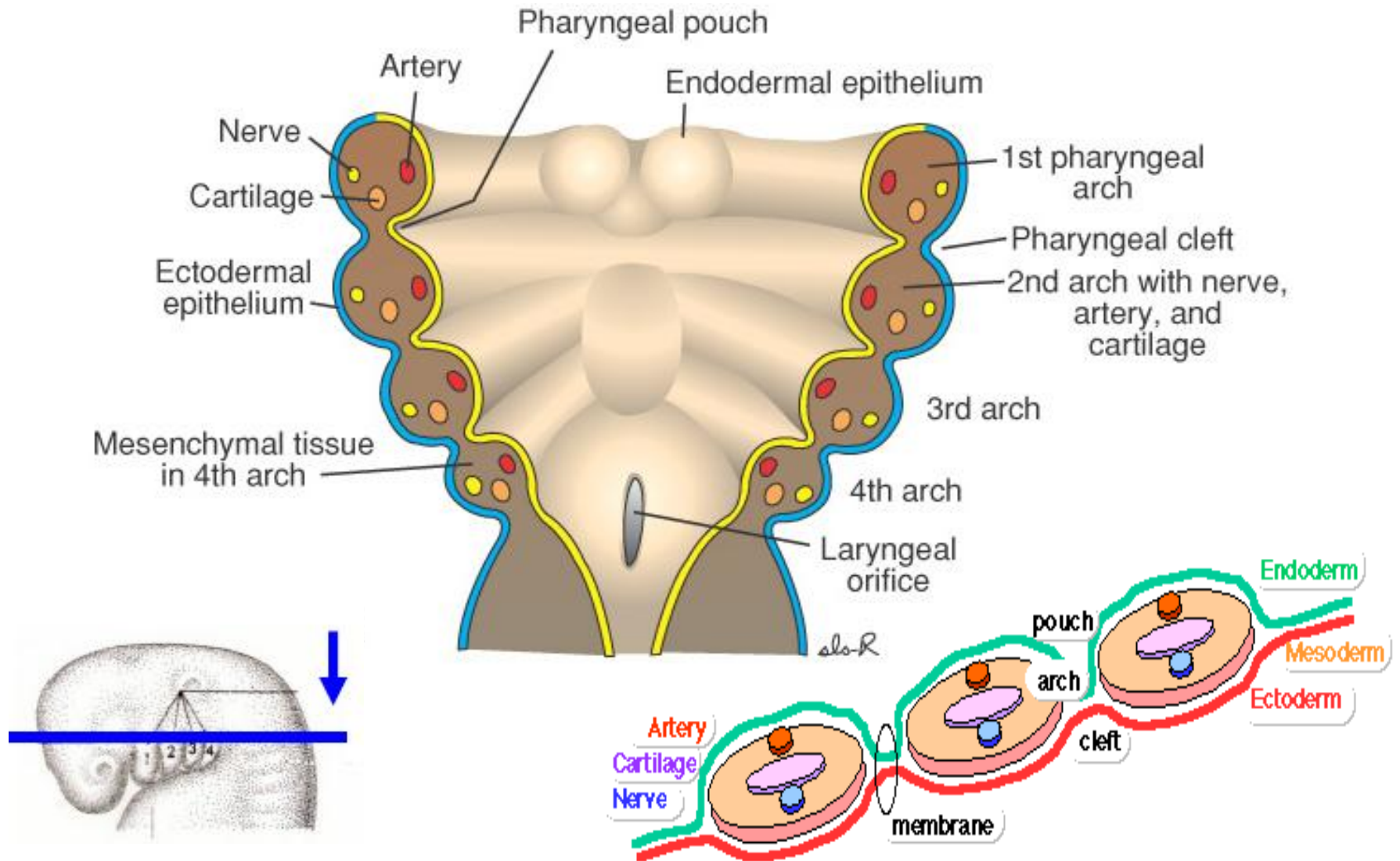
# PHARYNGEAL (BRANCHIAL) APPARATUS



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.  
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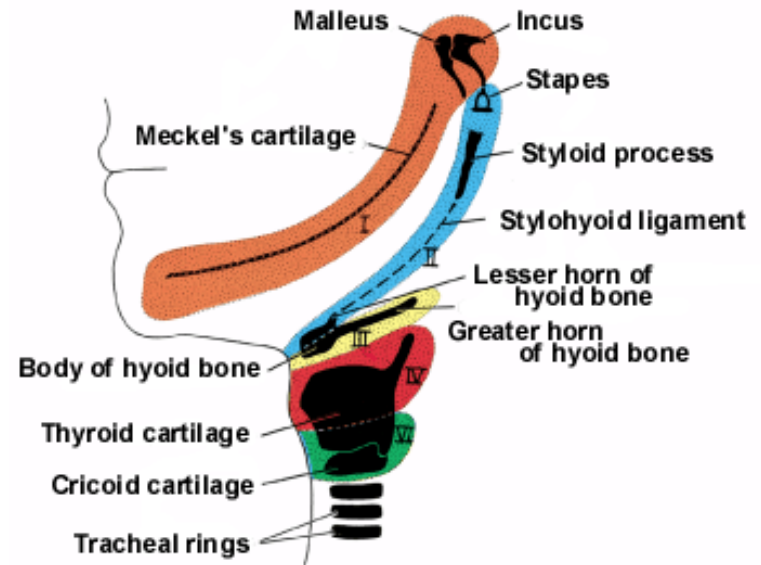
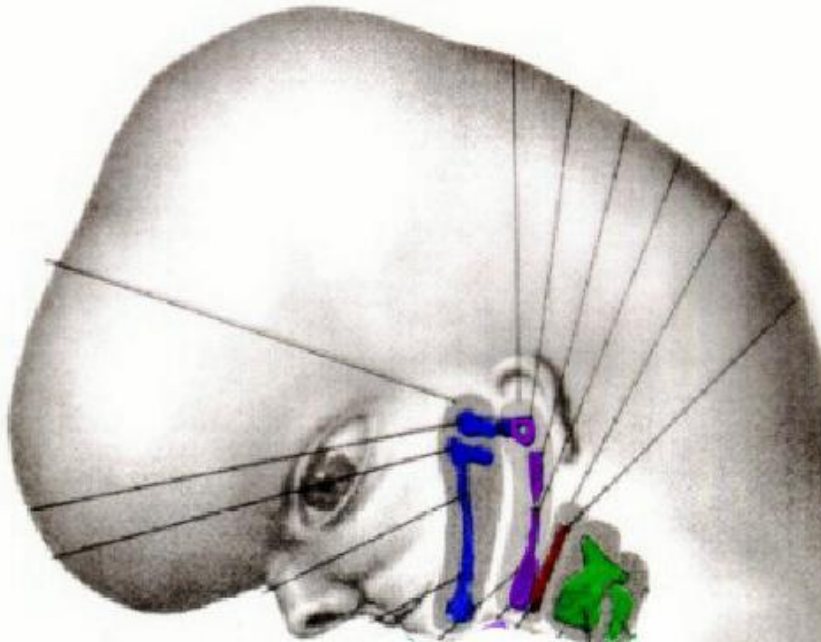


# PHARYNGEAL (BRANCHIAL) APPARATUS





# PHARYNGEAL ARCH CARTILAGES



## I First (Mandibular)

### Arch -

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

## II Second (Hyoid) Arch

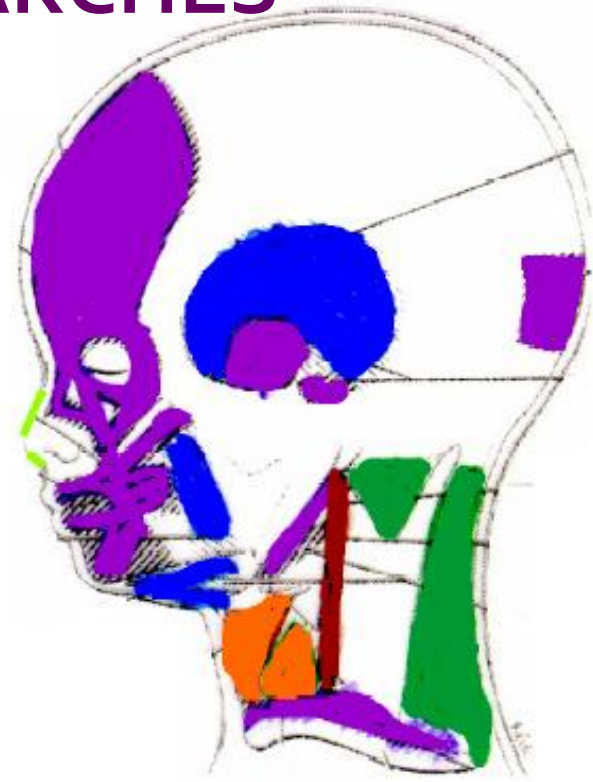
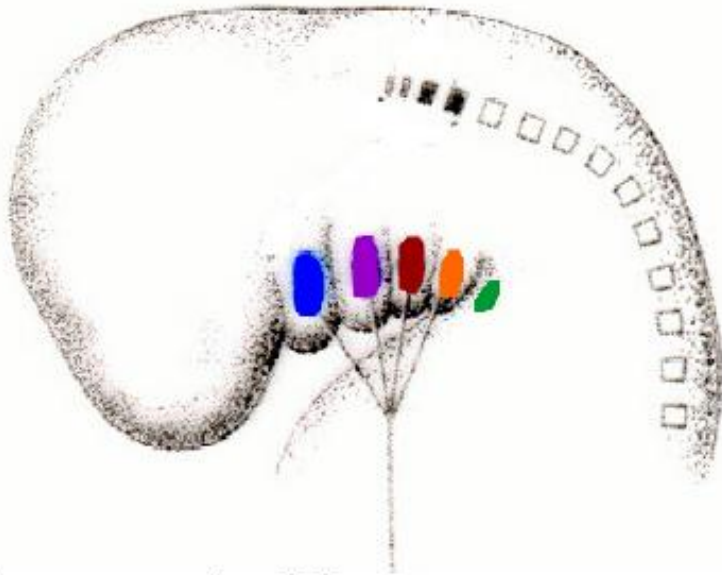
1. Stapes
2. Styloid Process
3. Stylohyoid Ligament
4. Lesser horn, Upper  $\frac{1}{2}$  body Hyoid

## III Third Arch -

- Lower  $\frac{1}{2}$   
Body, Greater  
Horn Of hyoid

- ## IV Fourth (Sixth) Arch - Cartilages Of larynx

# MUSCLE DERIVATIVES OF THE PHARYNGEAL ARCHES



Innervated by

**First -  
Trigeminal  
V**

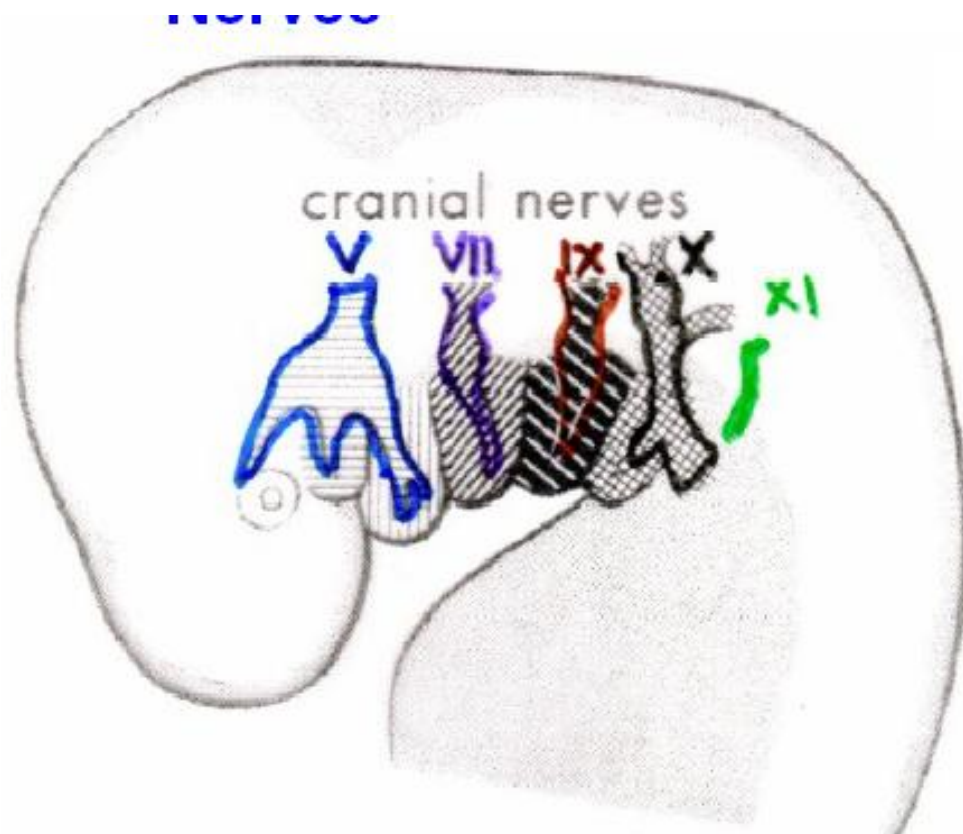
**Second -  
Facial  
VII**

**Third  
Glosso-  
pharyngeal  
IX**

**Fourth  
Vagus  
X**

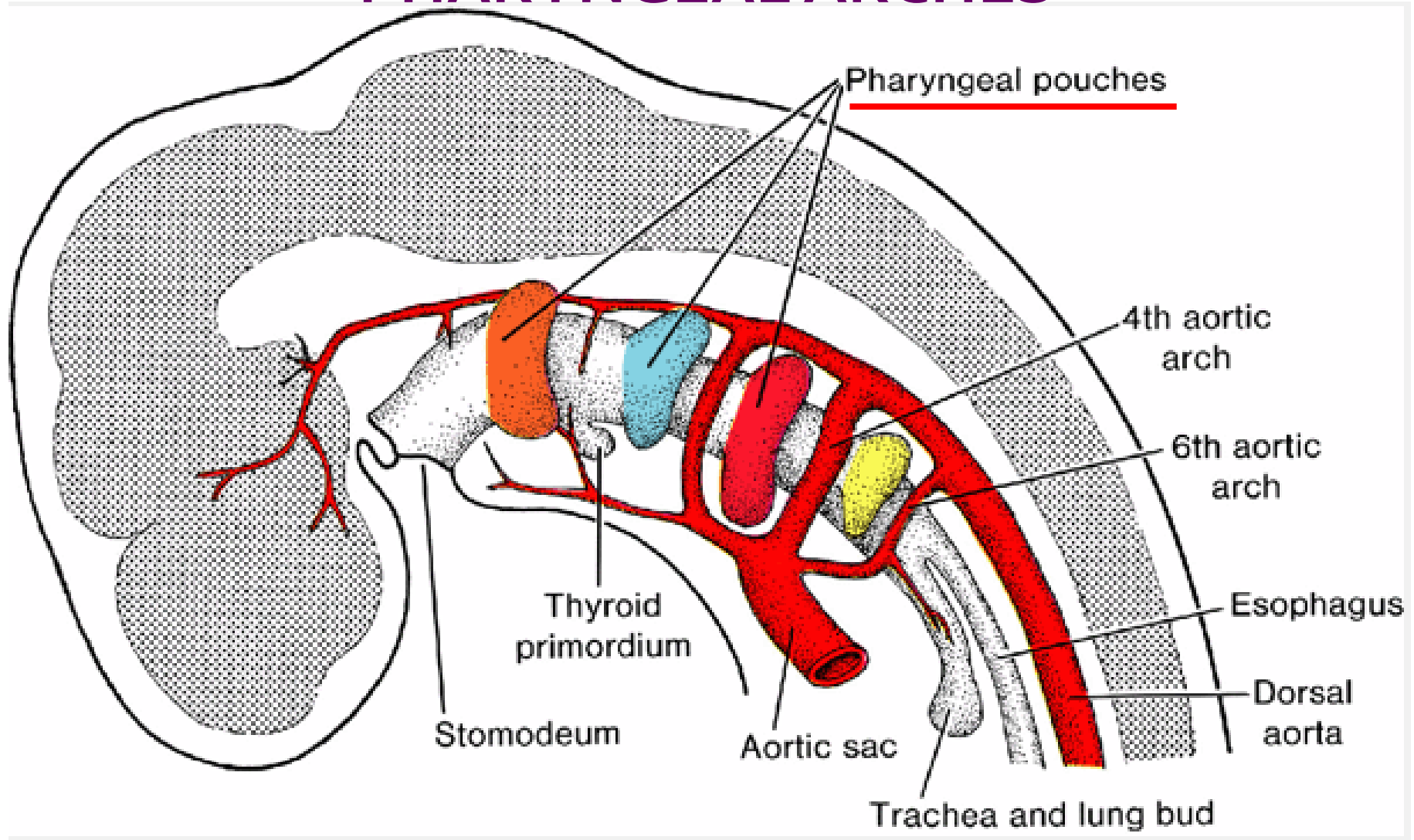
**Sixth  
Accessory  
XI**

# CRANIAL NERVE BRANCHES IN THE PHARYNGEAL ARCHES

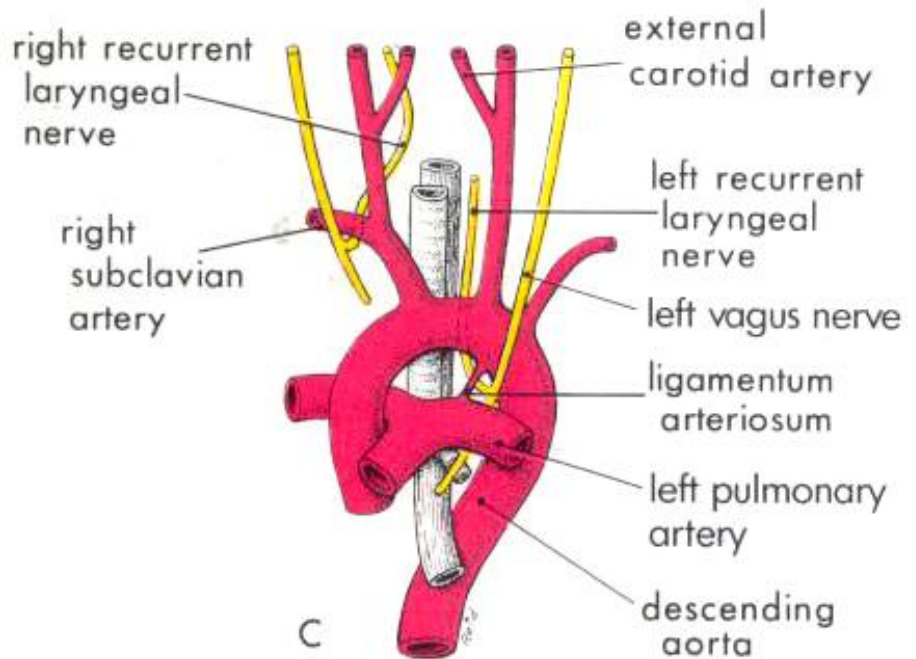
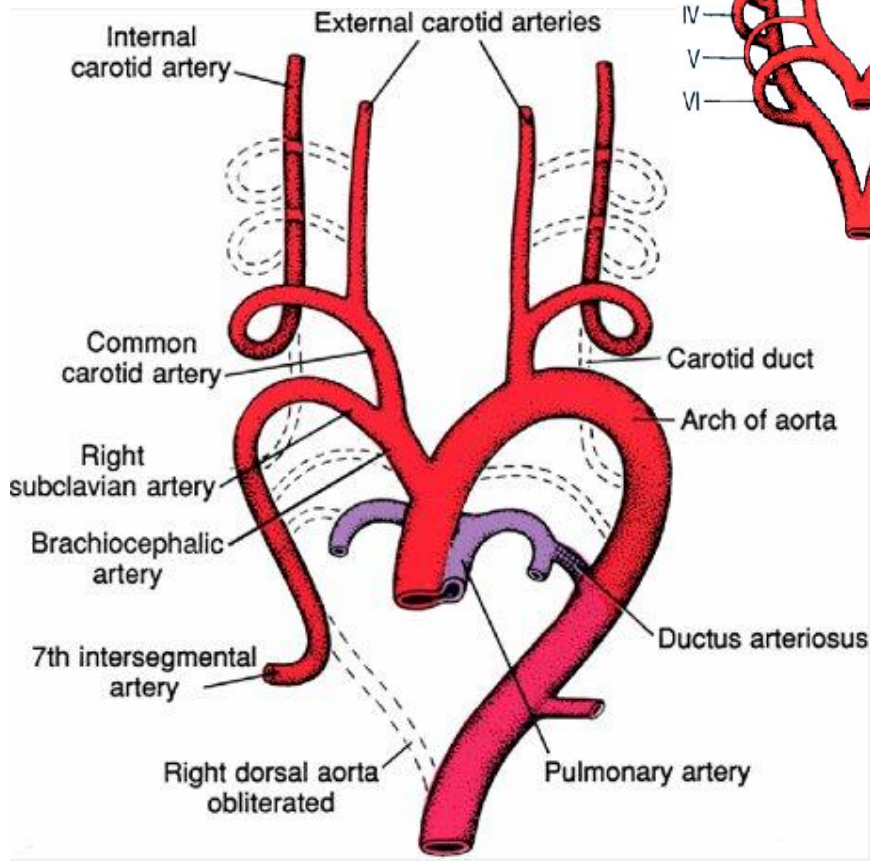
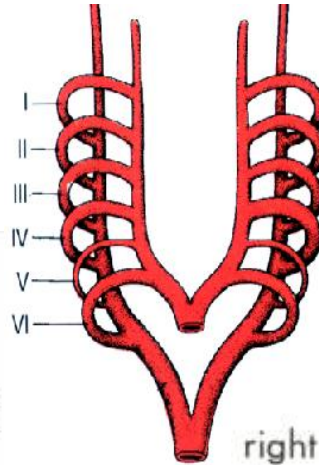


- 1) First Arch – Trigeminal (V)
- 2) Second Arch – Facial (VII)
- 3) Third Arch – Glossopharyngeal (IX)
- 4) Fourth Arch – Vagus (X)
- 5) Caudal Sixth – Accessory (XI)

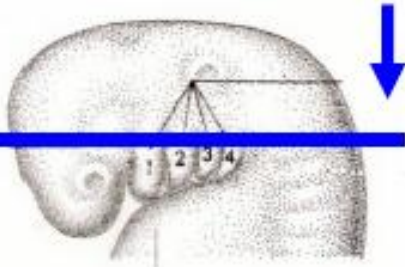
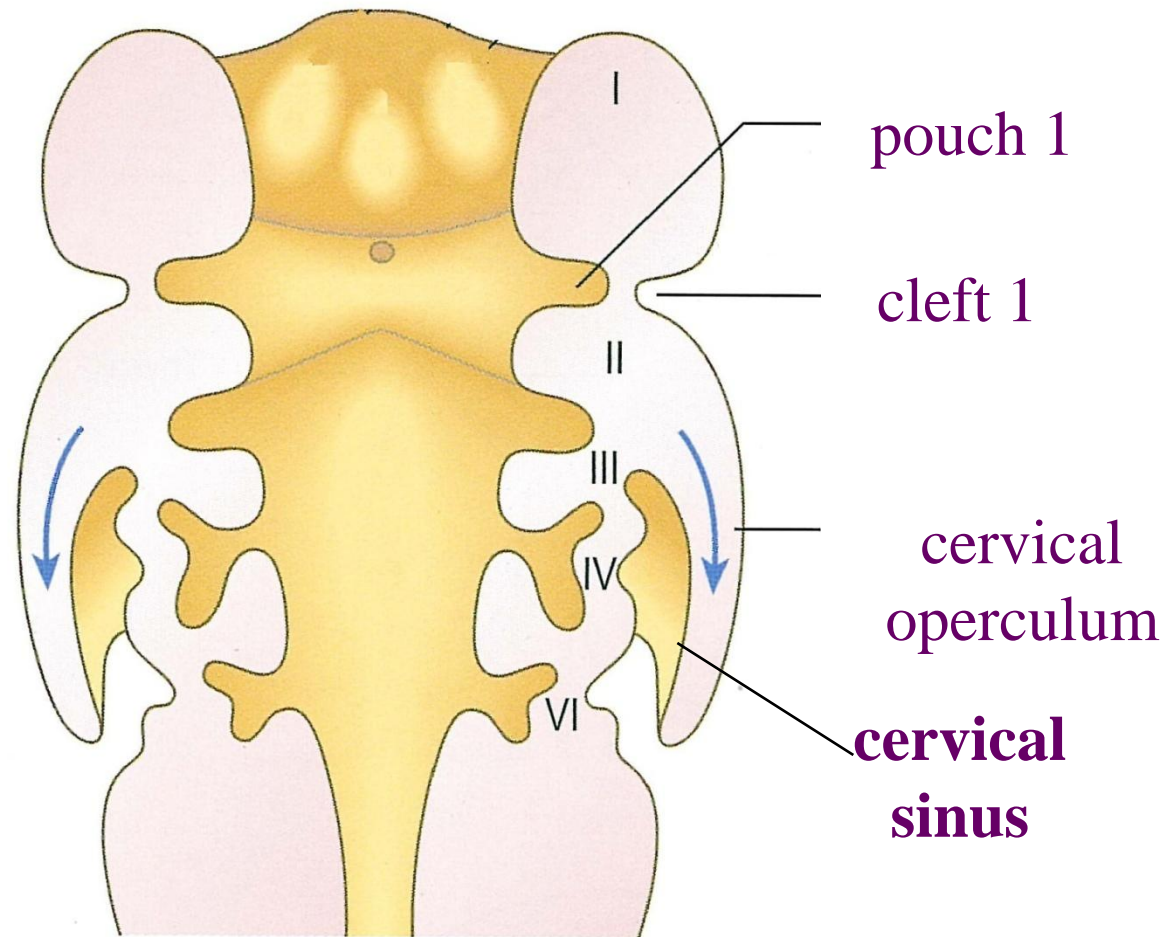
# INTERSEGMENTAL ARTERIES IN THE PHARYNGEAL ARCHES



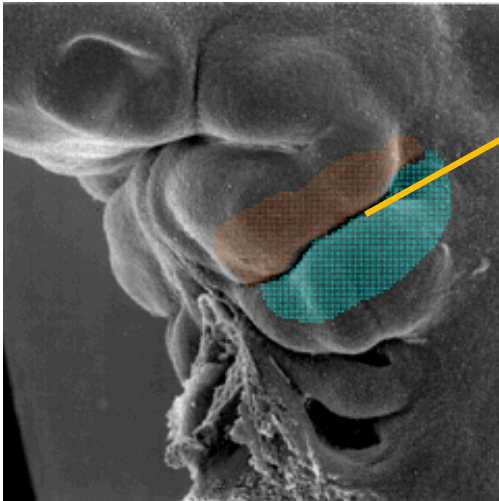
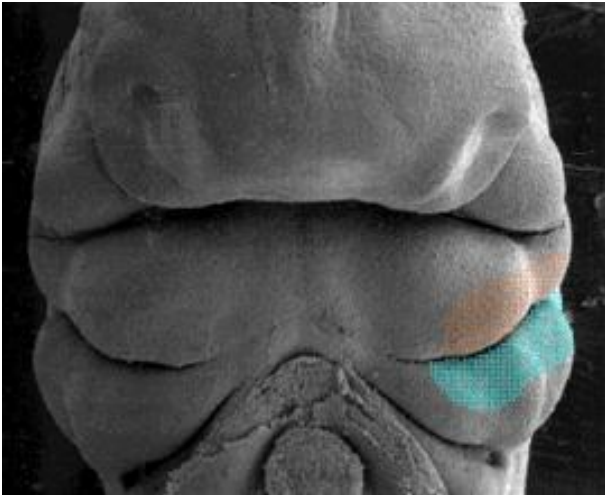
# DERIVATIVES OF THE INTERSEGMENTAL ARTERIES



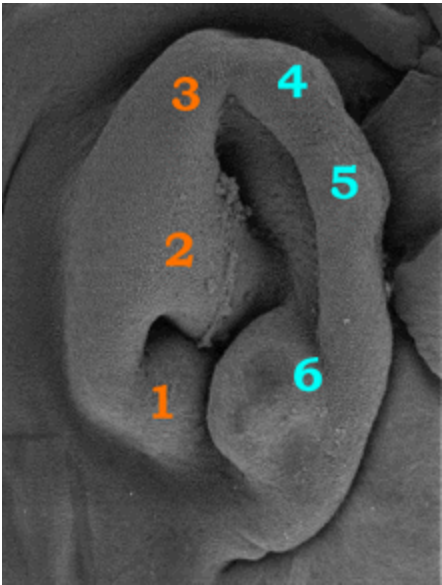
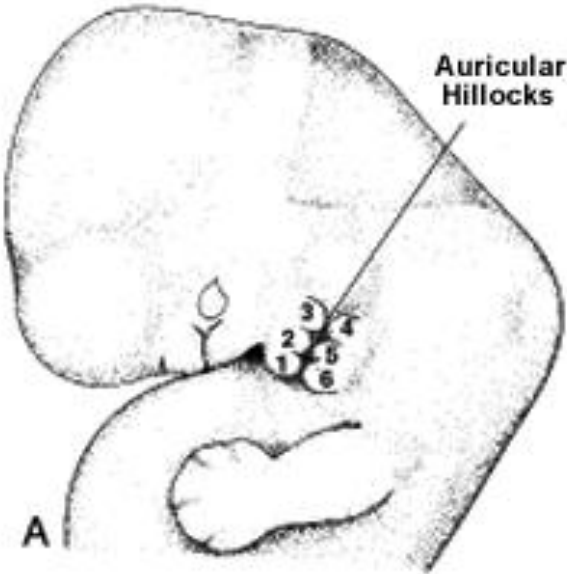
# DERIVATIVES OF THE PHARYNGEAL ARCHES AND CLEFTS (ECTODERM)



# DEVELOPMENT OF THE EXTERNAL EAR



First pharyngeal cleft



# TREACHER COLLINS SYNDROME

- *Autosomal dominant hereditary disease leading to problems with the structure of the face. It is caused by a defective protein called **treacle***
- *The treacle gene is found on chromosome 5*
- *TCOFL gene mutations are the main cause for this syndrome*
- *No genetic tests are available (similar ratios for boys&girls, approx 1.50000)*

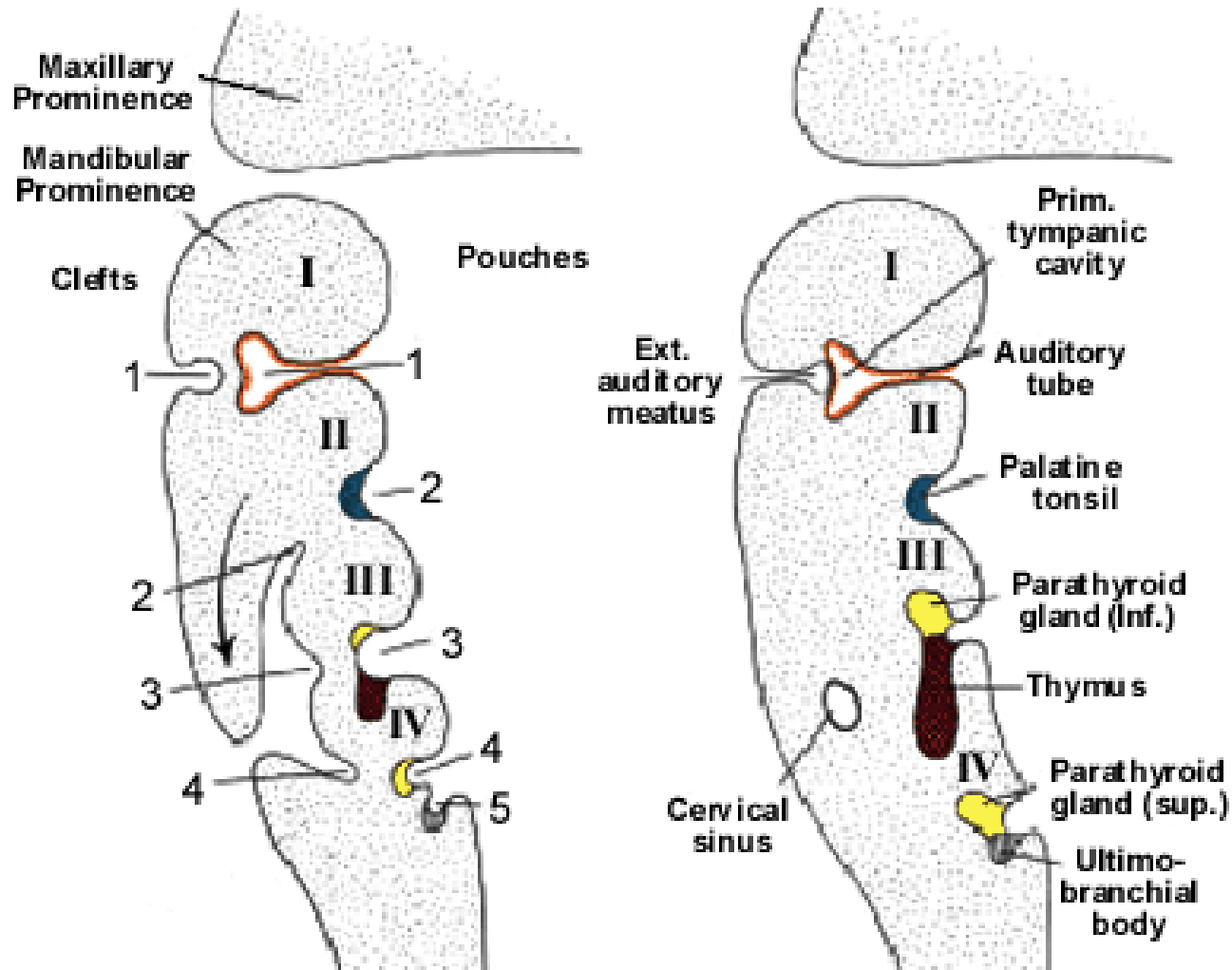


- *Outer part of the ear abnormal or completely missing*
- *Hearing loss*
- *Small jaw (Micrognathia)*
- *Very large mouth*
- *Defect in the lower lid (Coloboma)*
- *Scalp hair that reaches to the cheeks*
- *Cleft Palate*

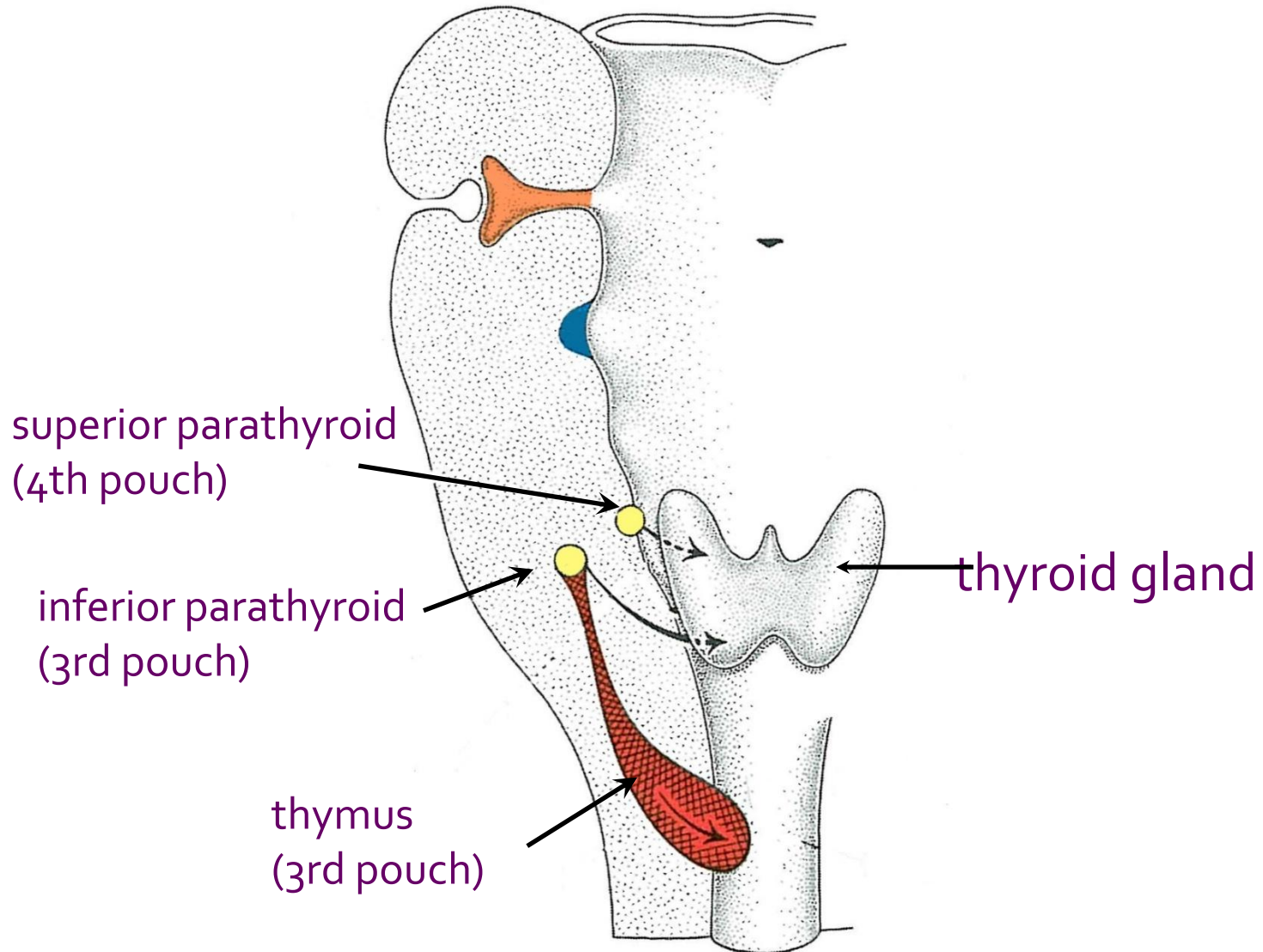
*Complex therapy  
Plastic surgery to fix the facial abnormalities  
Hearing loss is treated  
Corrective surgery of the underdeveloped jaw  
Speech therapy for eating and speech*



# DERIVATIVES OF THE PHARYNGEAL ARCHES AND POUCHES (ENDODERM)



# DERIVATIVES OF THE PHARYNGEAL ARCHES AND POUCHES (ENDODERM)



# SUMMARY TABLE OF THE ENDODERMAL DERIVATIVES

Pharyngeal Pouch	Adult Derivative
1 <sup>st</sup> pouch	middle ear cavity mastoid antrum auditory tube
2 <sup>nd</sup> pouch	tonsillar fossa palatine tonsils
3 <sup>rd</sup> pouch	thymus inferior parathyroid glands
4 <sup>th</sup> pouch	superior parathyroid glands

# SUMMARY TABLE OF THE DERIVATIVES

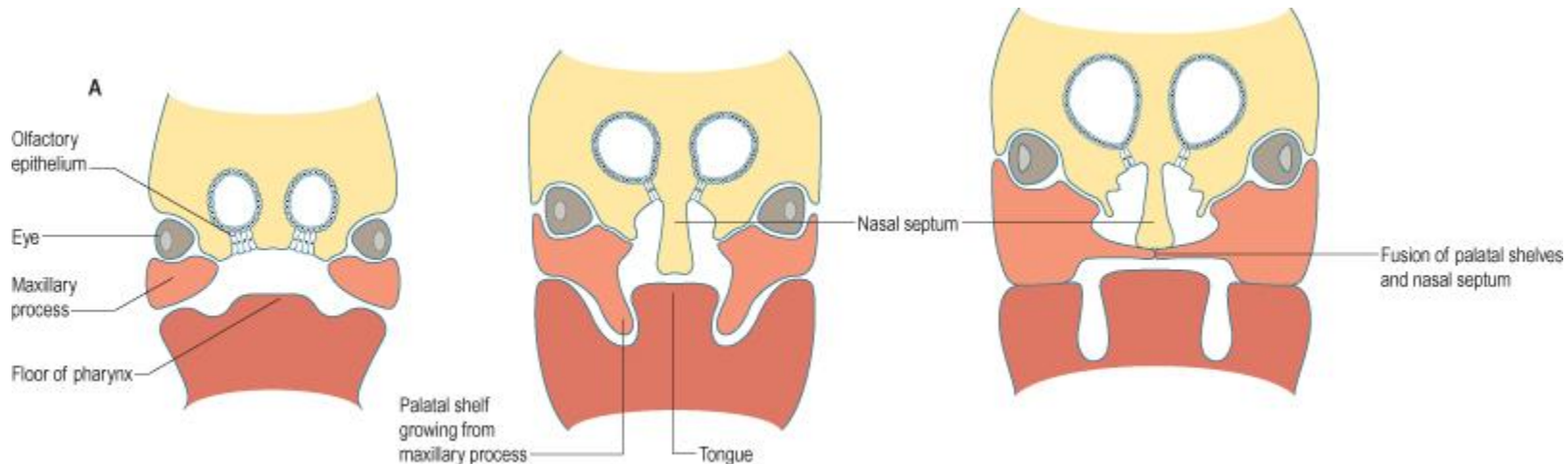
## Branchial Apparatus

Made by: dr. Károly Altdorfer and dr. János Hanics - Semmelweis University Medical School - Department of Anatomy, Histology and Embryology, Budapest, 2009.

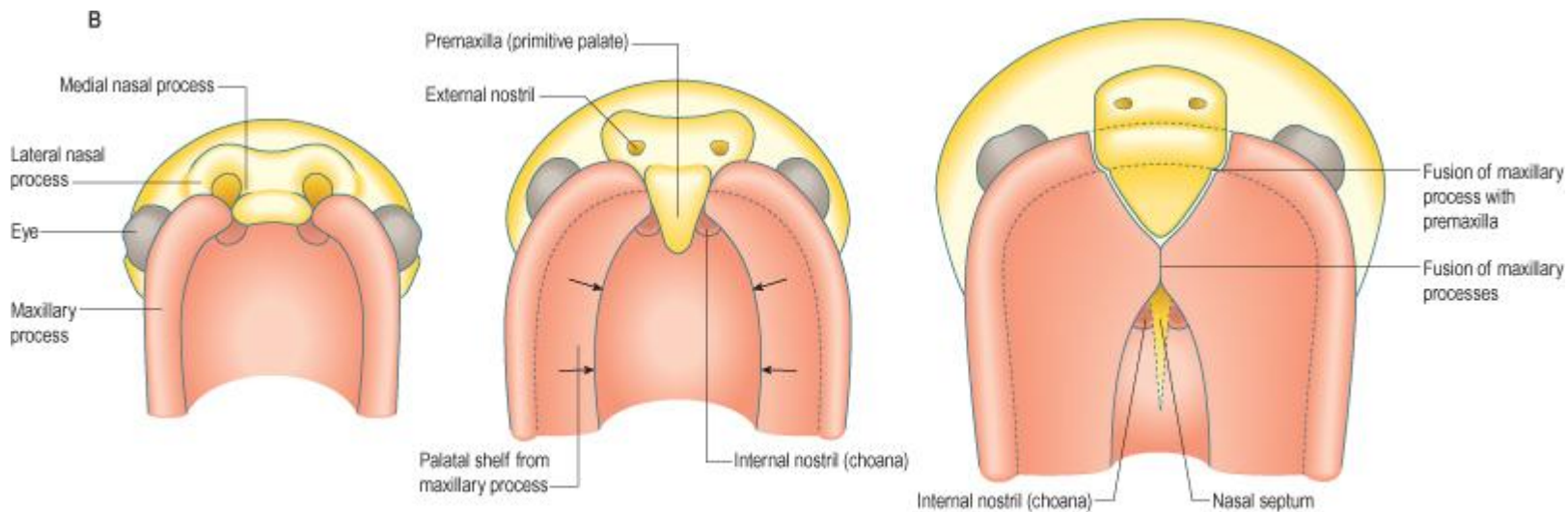
	Mesenchyme					Ectoderm		Endoderm
	Artery	Cartilage <sup>1</sup>	Bone <sup>1</sup>	Ligament <sup>1</sup>	Muscle <sup>2</sup>	Nerve		
Pharyngeal arch							Clefts	Pouches
I. (mandibular)	(Maxillary artery)	Meckel's (as model for mandible)	Mandible (intramembranous ossification); Malleus; Incus; (*)	Sphenomandibular lig.; Ant. lig. of malleus	Mm. of mastication; Tensor tympani; Tensor veli palatini; Mylohyoid; Digastric ant. belly;	Mandibular nerve (V/3.)		
							C1: External ac. meatus; ext. epithelium of tympanic membrane	P1: Auditory tube; Tympanic cavity; Int. epithelium of tympanic membrane
II. (hyoid)	(Stapedial artery; Hyoid artery)	Reichert's	Stapes; Styloid process; Hyoid (lesser horn and upper part of body)	Stylohyoid lig.	Muscles of facial expression; Stylohyoid; Digastric post. belly; Stapedius; Platysma (from Opercular proc.)	Facial nerve (VII.)		
							C2: (Cervical sinus)	P2: Epithelium of tonsillar fossa
III.	Internal carotid (prox. part)		Hyoid (greater horn and lower part of body)		Pharynx (upper part); Stylopharyngeus	Glossopharyngeal nerve (IX.)		
							C3: (Cervical sinus; Cervical vesicula)	P3: (Thymus) Inferior parathyroid glands
IV.	Left: Arch of aorta; Right: Right subclavian artery (prox. part)	Thyroid cartilage			Pharynx (lower part); Larynx: cricothyroid	Vagus nerve (X.) (Superior laryngeal nerve)		
							C4: (Cervical sinus)	P4: Thymus; Superior parathyroid glands
V. (**)		Thyroid cartilage			Pharynx and larynx muscles (n. XI.: arytenoid)	Vagus nerve (X.) + Accessory nerve (XI.)		
								P5: Ultimobranchial body, C-cells in thyroid gland
VI.	Right: Right pulmonary artery; Left: Left pulmonary artery and ductus art. Botalli	Cricoid cartilage (?)			Larynx muscles ('Intrinsic')	Vagus nerve (X.) (Recurrent laryngeal nerve)		

1: derivatives of neural crest (ecto-mesenchyme); 2: derivatives of paraxial mesoderm or somite (mesoderm); (\*) partially forms the maxilla (from the maxillary process of the first pharyngeal arch); (\*\*) Some authors don't give derivatives for fifth pharyngeal arch but mention them at the sixth pharyngeal arch.

# DEVELOPMENT OF THE ORAL CAVITY WITH RELEVANCE TO THE TONGUE

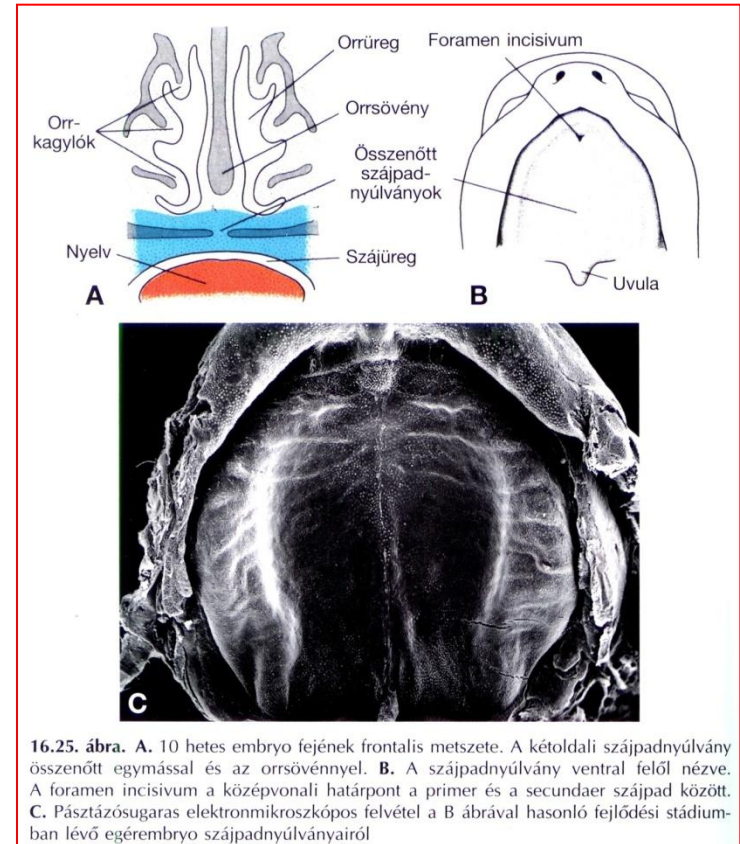
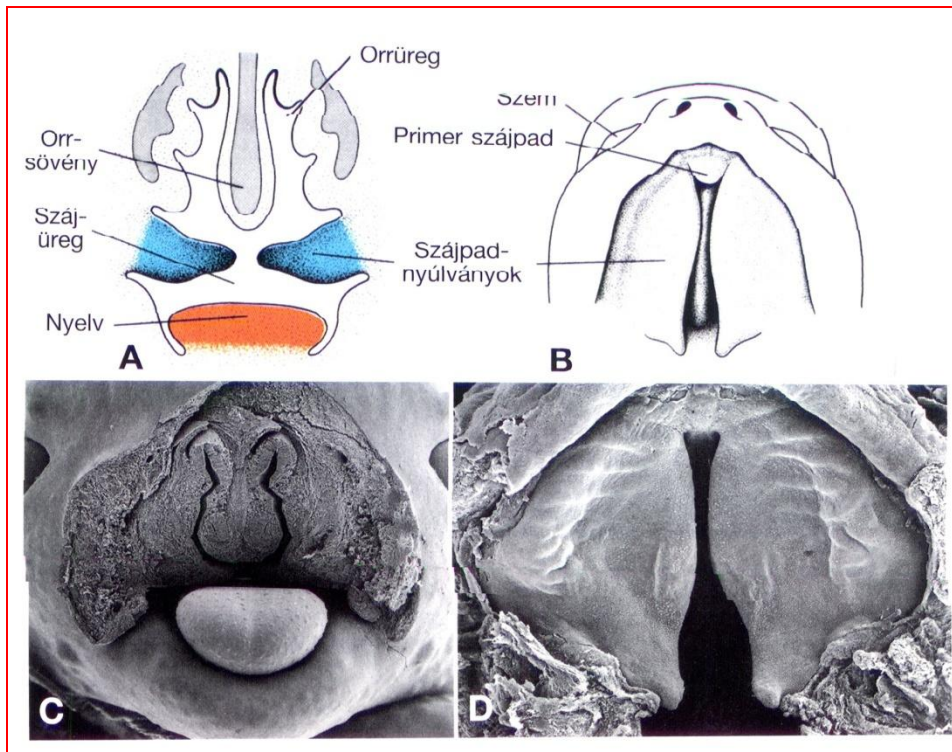


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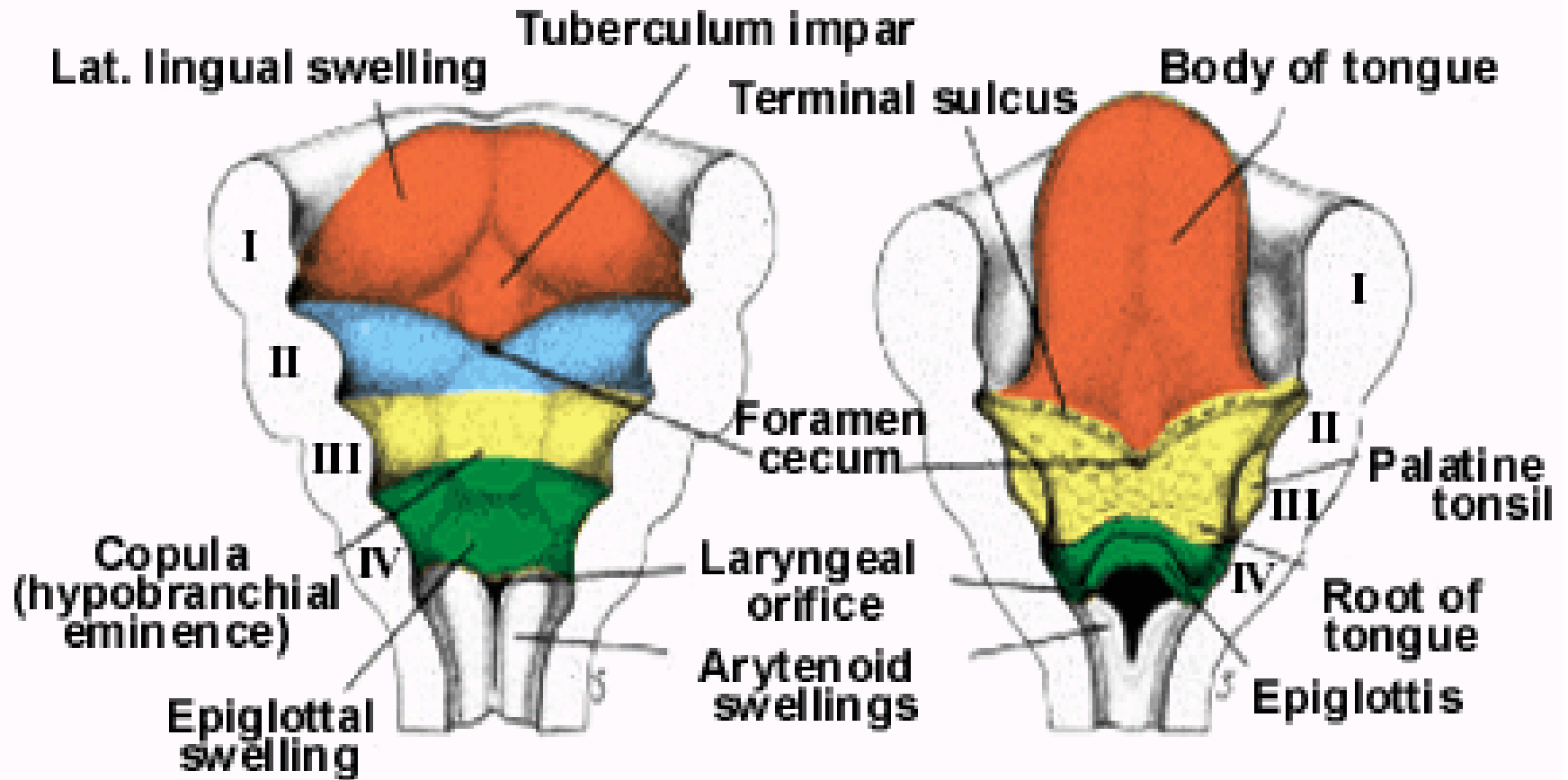


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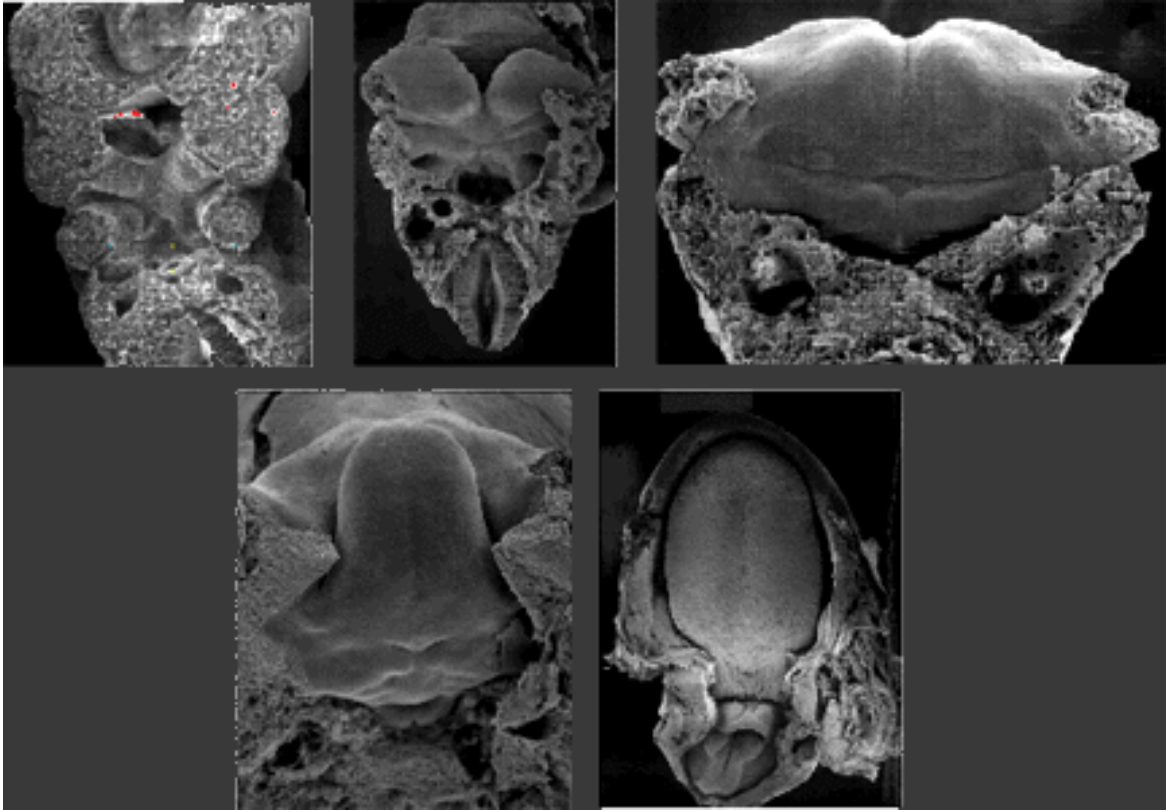
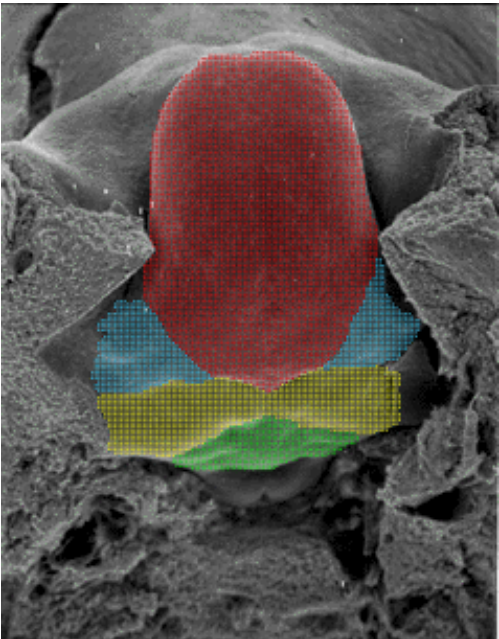
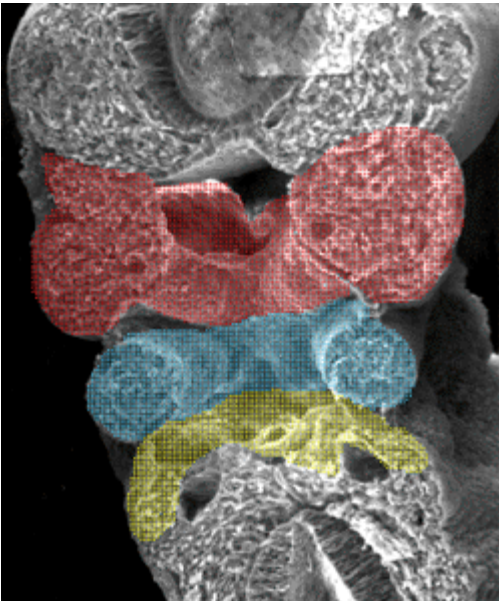
# DEVELOPMENT OF THE TONGUE



# DEVELOPMENT OF THE TONGUE



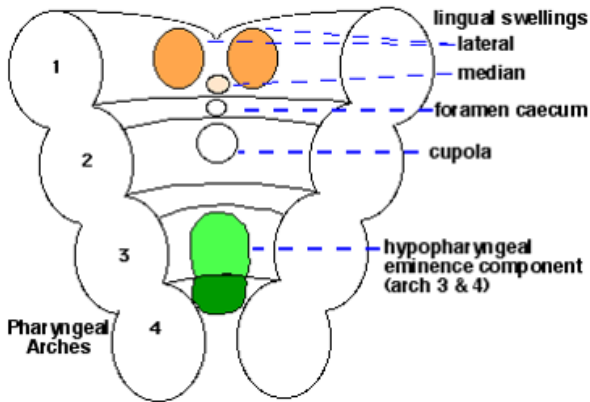
# DEVELOPMENT OF THE TONGUE



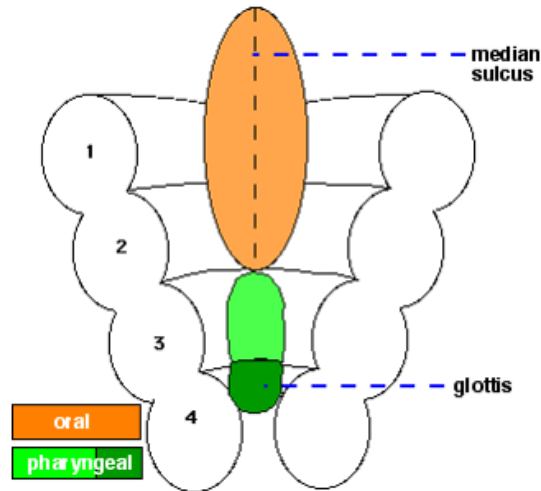


# DEVELOPMENT OF THE TONGUE

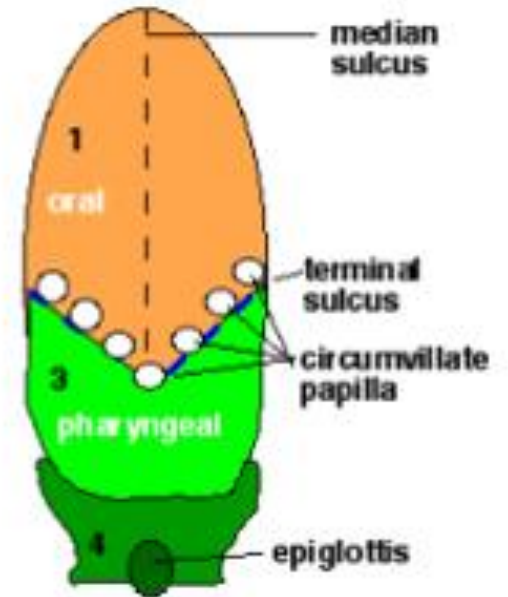
Development of the Tongue (part 1)



Development of the Tongue (part 2)



Development of the Tongue (part 3)



# SUMMARY TABLE OF THE LINGUAL DIVISIONS & NERVES

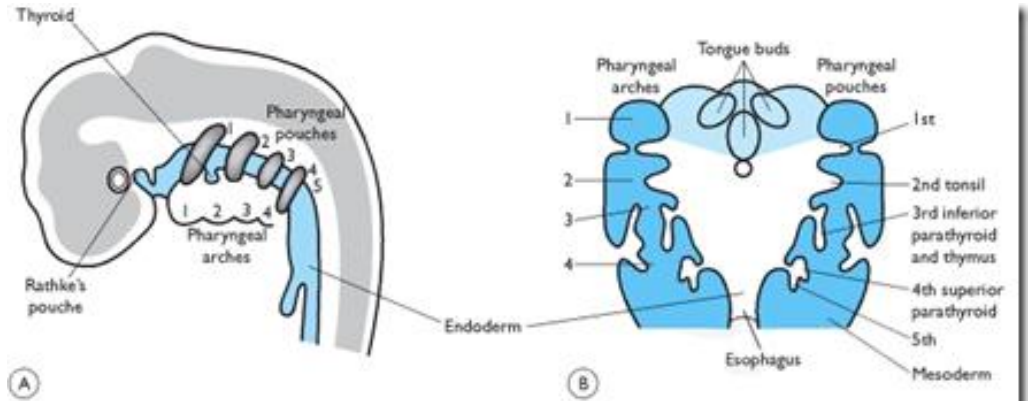
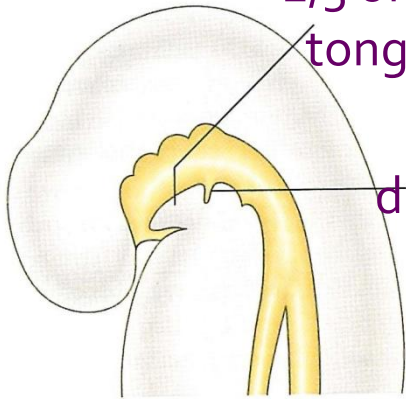
Tongue Primordia	Pharyngeal Arch	Cranial Nerve	Derivatives
Tuberculum impar & lateral lingual swellings	1 <sup>st</sup> arch	CN 5/3	<b>Connective tissue</b> of tongue <i>carrying CN 5/3 (lingual nerve, general sensation)</i> + <i>Mucosa of anterior 2/3 of tongue lies above this part (ECTODERM!)</i>
	2 <sup>nd</sup> arch	CN 7 (chorda tympani)	<b>Connective tissue</b> of tongue <i>carrying CN 7 (chorda tympani)</i> taste - anterior 2/3 of tongue
Copula and hypopharyngeal (hypobranchial) eminence	3 <sup>rd</sup> and 4 <sup>th</sup> arches	CN 9 and CN 10	<b>Connective tissue</b> of the tongue <i>General sensation and taste in the posterior 1/3 of tongue (CN9)</i> <i>General sensation and taste at the epiglottis (CN10)</i> + <i>Mucosa of posterior 1/3 of tongue lies above this part (ENDODERM!)</i>
Occipital somites		CN 12	all intrinsic tongue muscles; all extrinsic tongue muscles (except for palatoglossus)

# DEVELOPMENT OF THE THYROID GLAND

4<sup>th</sup> week

anterior  
2/3 of the  
tongue

thyroid  
diverticulum

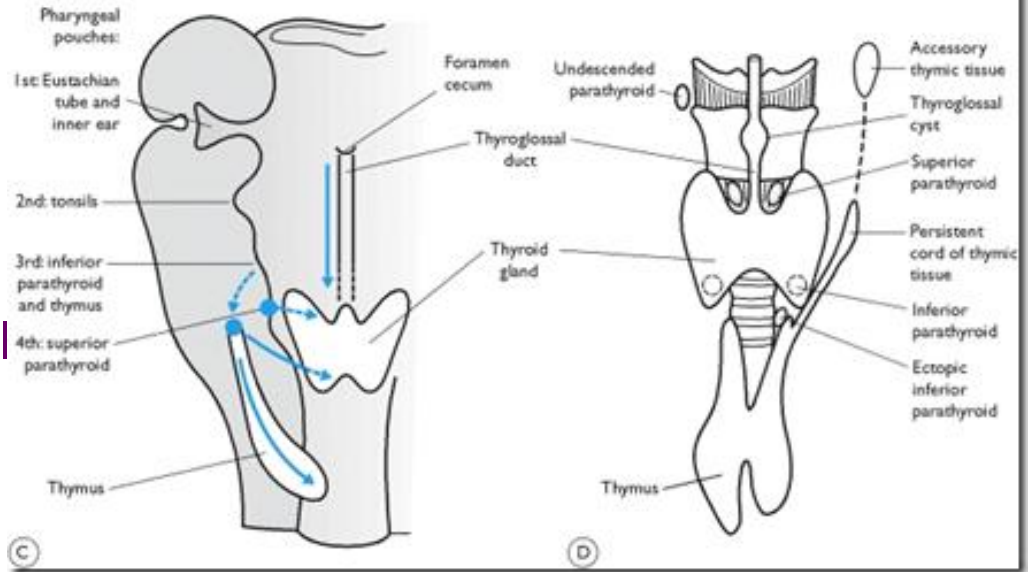
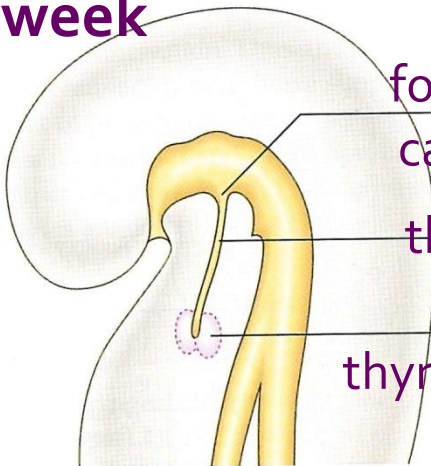


5<sup>th</sup> week

foramen  
caecum

thyroglossal  
duct

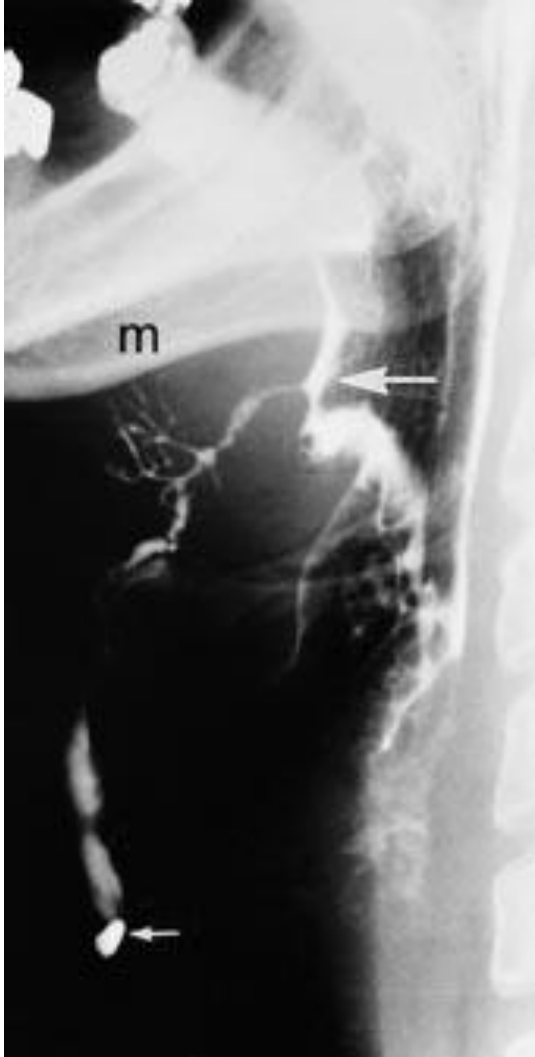
thyroid



# DEVELOPMENTAL MALFORMATIONS

*median cervical cyst*

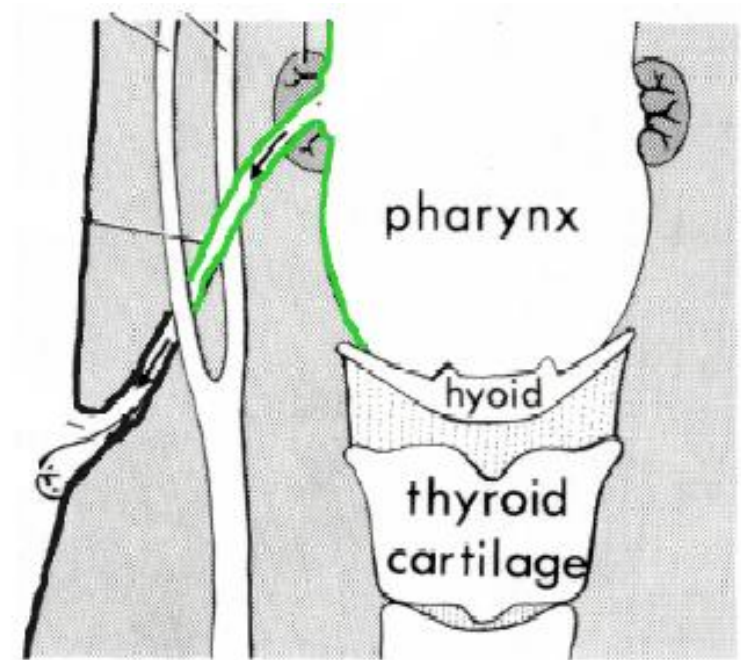
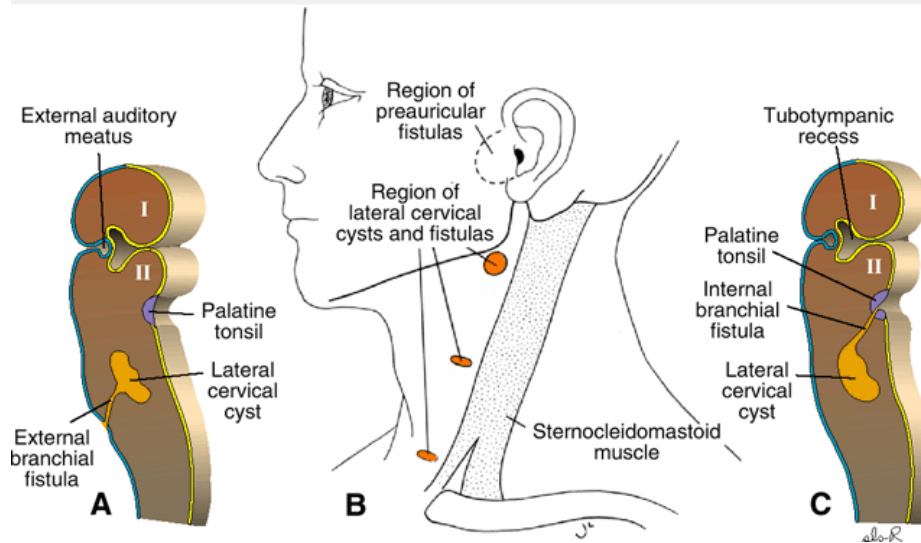
*persisting  
thyreoglossal duct*



# DEVELOPMENTAL MALFORMATIONS

*lateral cervical cyst*

*lateral cervical fistule*



**THANK YOU VERY MUCH**



**FOR YOUR ATTENTION!**