

Anatomy: **Head & Neck Embryology**



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Lecture Content Guide

- Red text on slides = know for exams.
- Anatomical structures labeled in red or red highlight = know for exams. Note: other structures may still be tested on anatomy exam (consult the lab checklist).
- \$ Clinical Correlates \$ = know for exams.
- Go over Learning Objectives in the CPG

BBC One



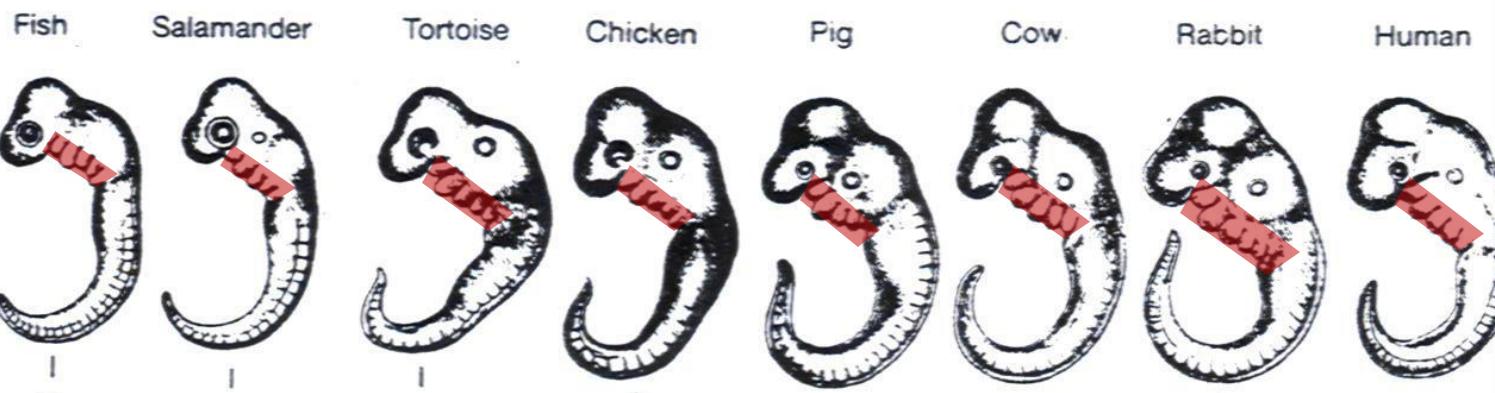
Lecture Outline

1. Head & Neck Segments
2. Unsegmented Structures
3. Ecto-, Endo-, Mesoderm, NCC contributions

Fish Salamander Tortoise Chicken Pig Cow Rabbit Human

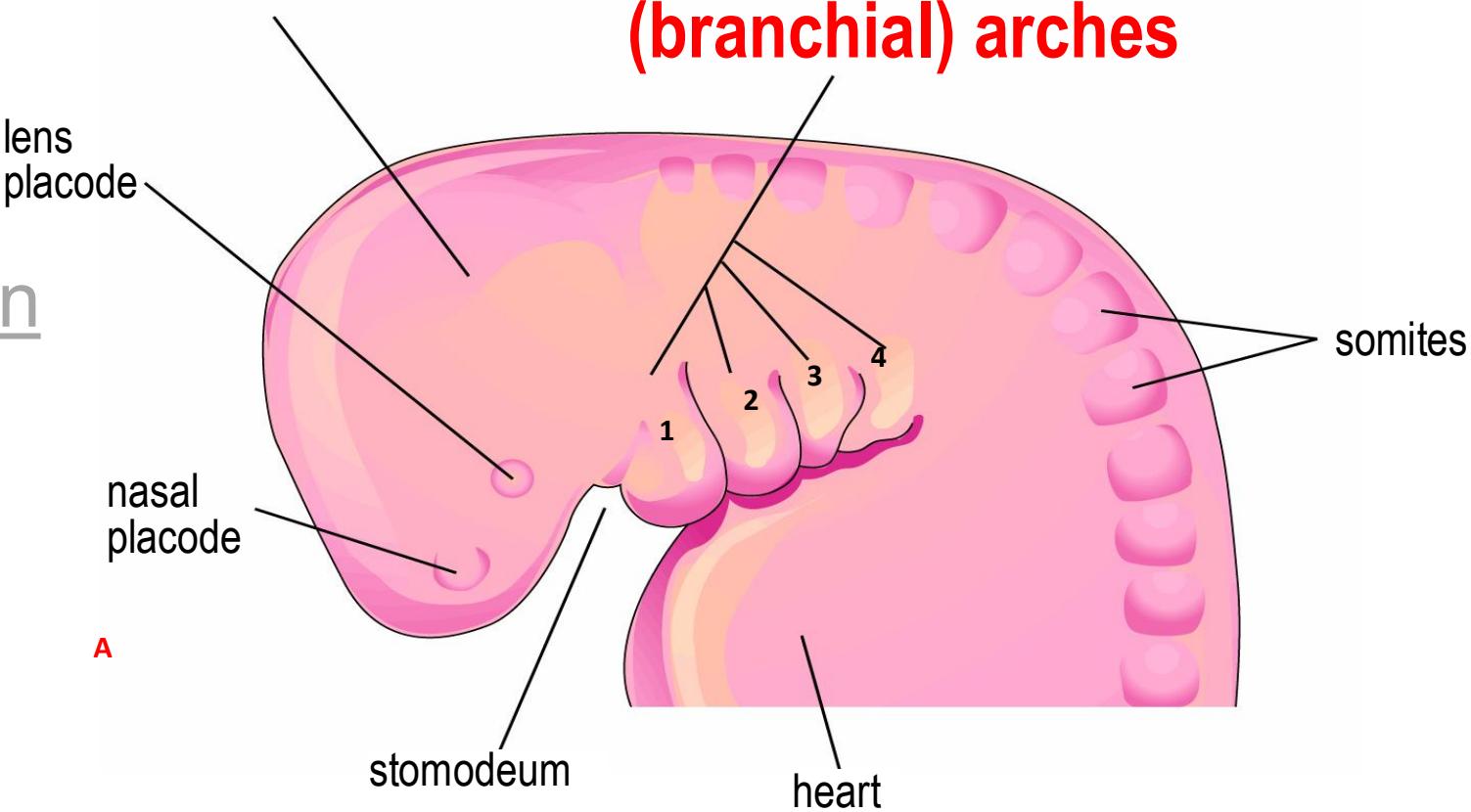


Romanes 1892 on Ernst Haeckel's notion of "Ontogeny recapitulates Phylogeny"



site of midbrain
pharyngeal (branchial) arches

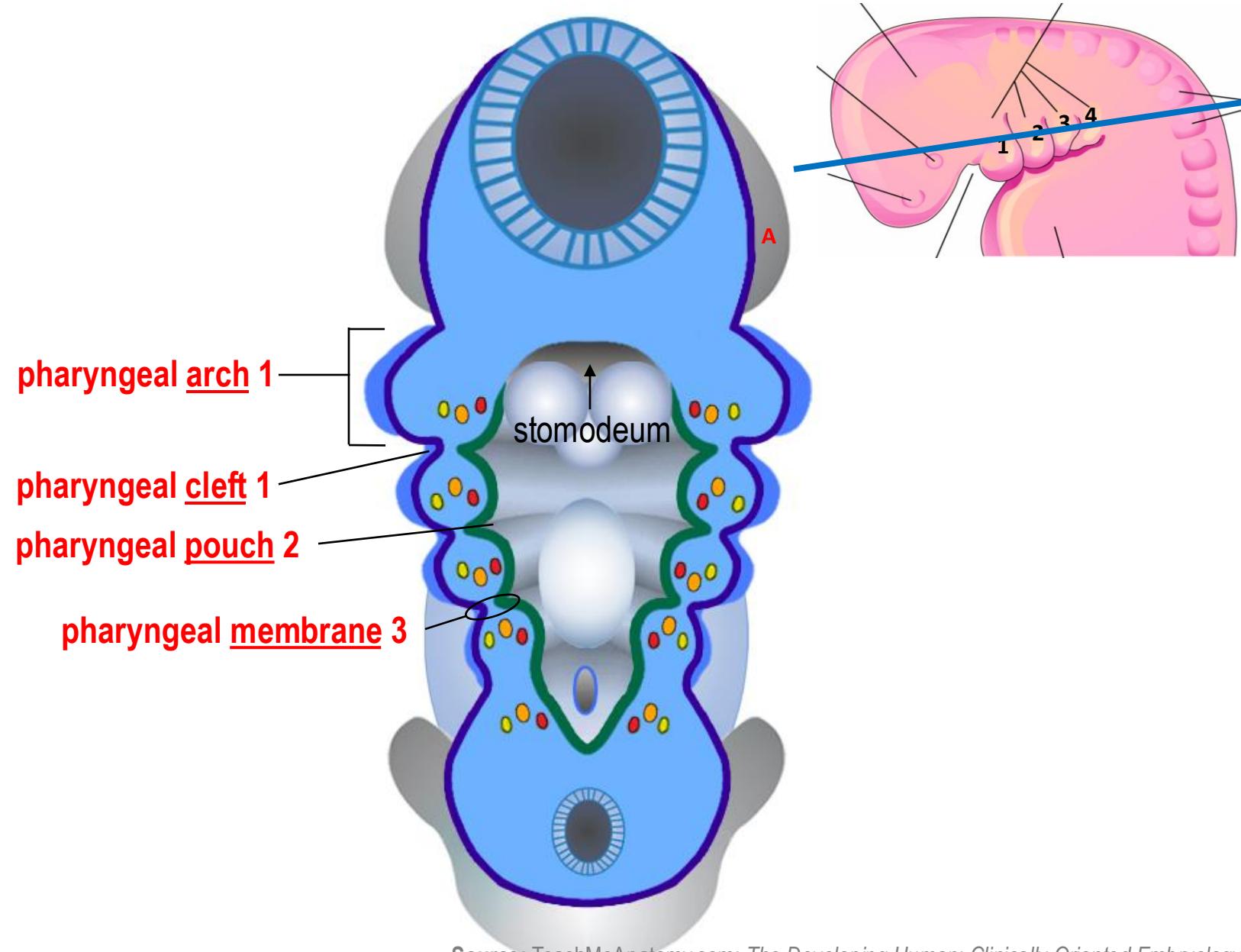
4–5 weeks
post-fertilization



Pharyngeal Apparatus

4 components

1. Pharyngeal arches
2. Pharyngeal clefts
3. Pharyngeal pouches
4. Pharyngeal membranes



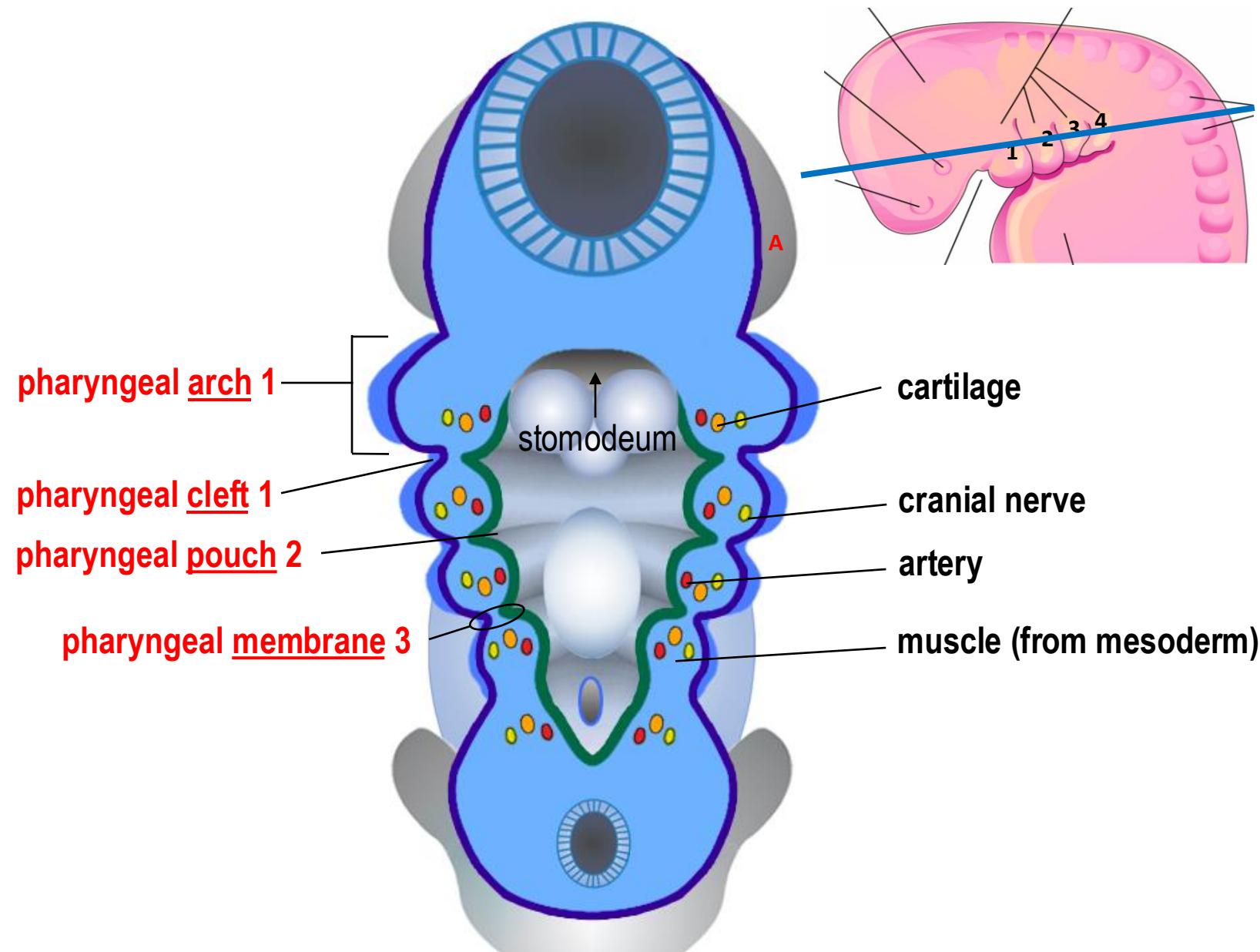
Pharyngeal Apparatus

4 components

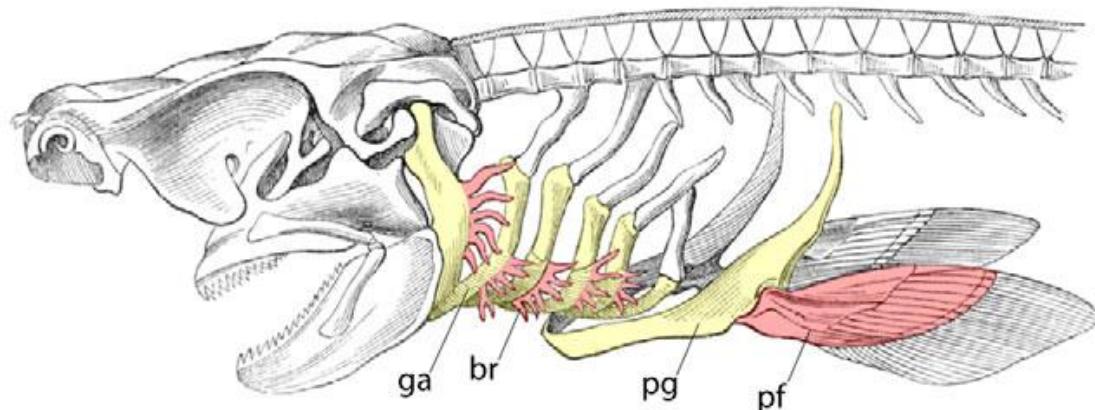
1. Pharyngeal arches
2. Pharyngeal clefts
3. Pharyngeal pouches
4. Pharyngeal membranes

Each pharyngeal arch has 4 derivative structures:

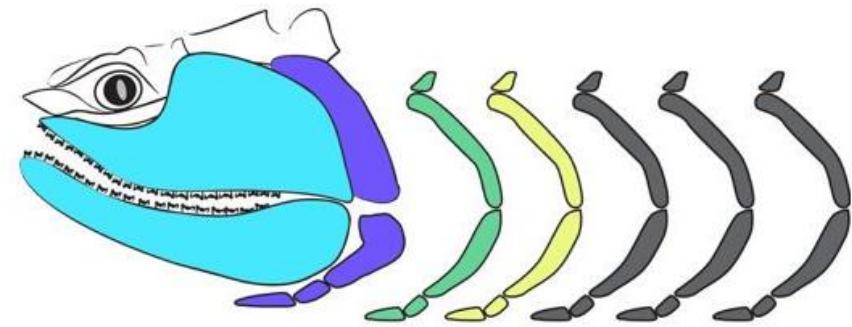
1. Bone & Cartilage
2. Artery
3. Nerve
4. Muscle (from mesoderm)



Pharyngeal Apparatus



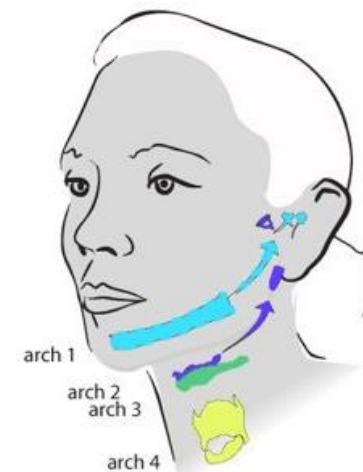
Shark Embryo



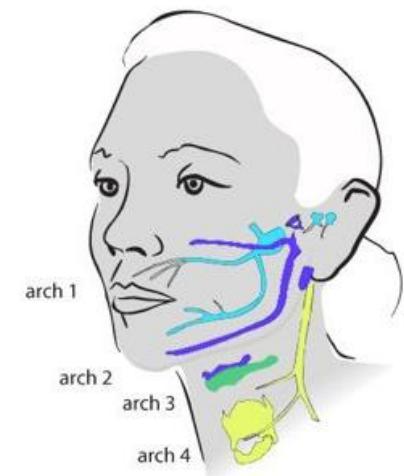
Adult shark



Human Embryo

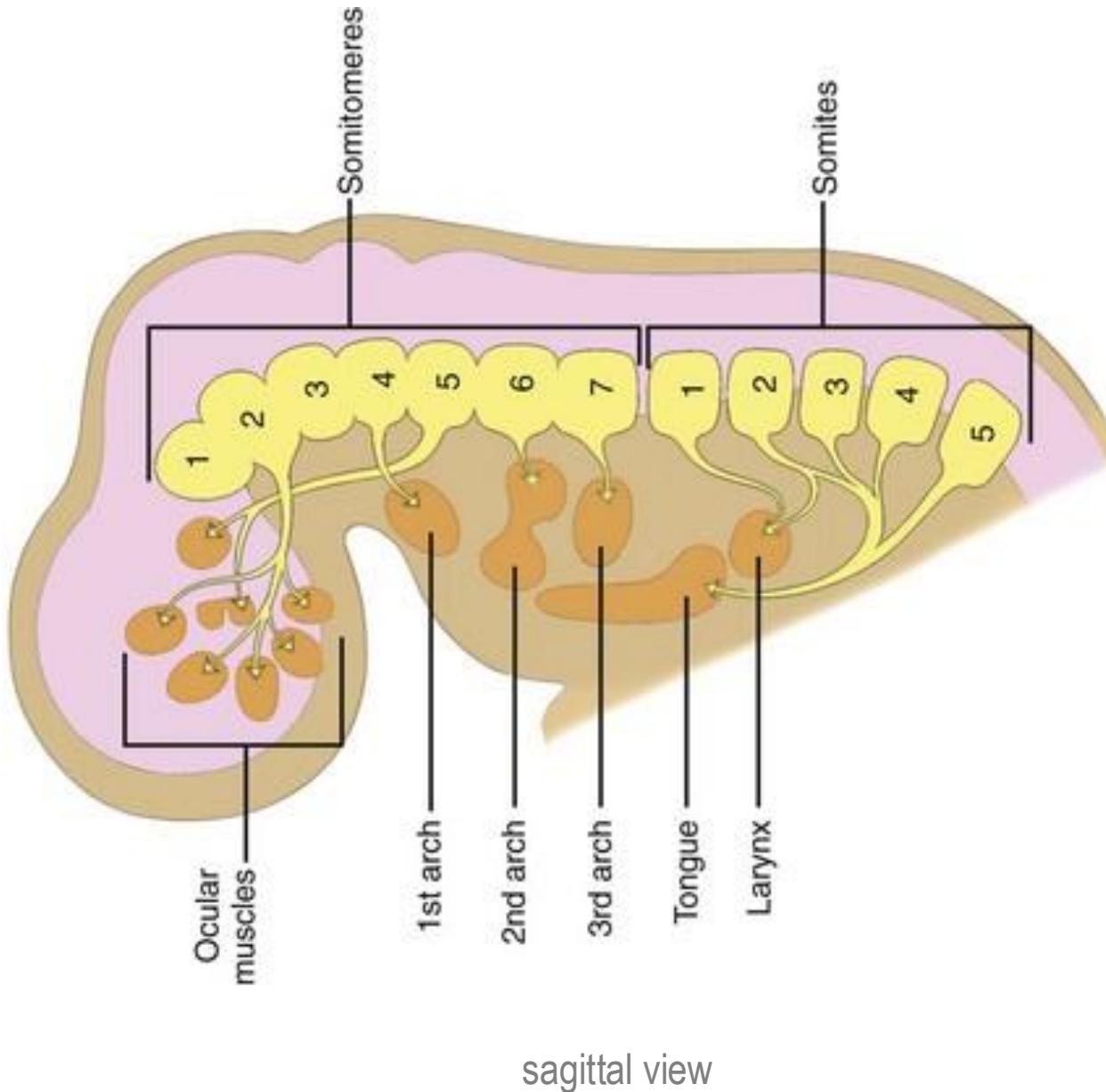


Bones in adult



Arteries in adult

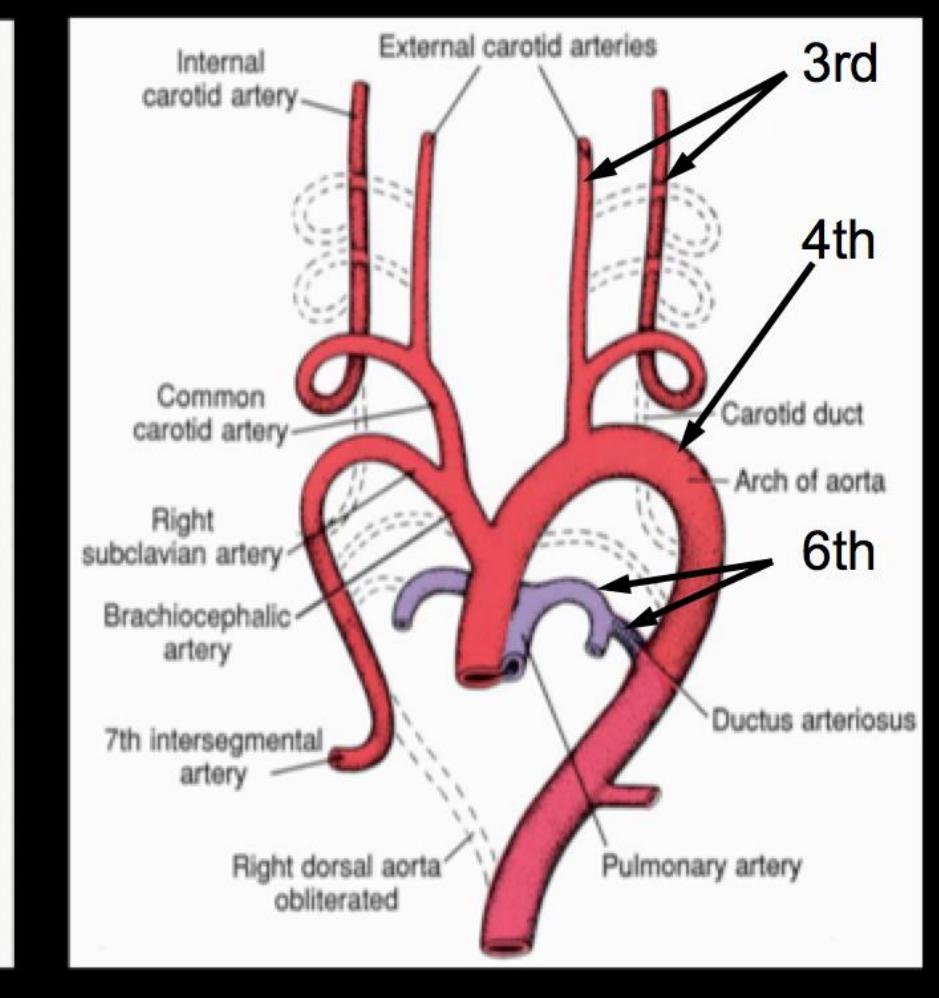
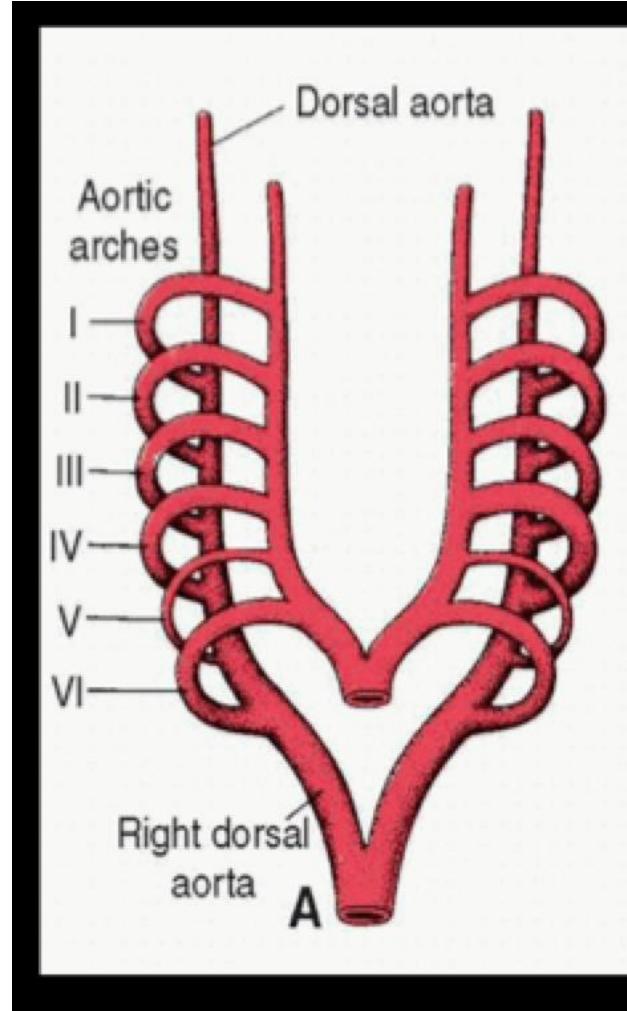
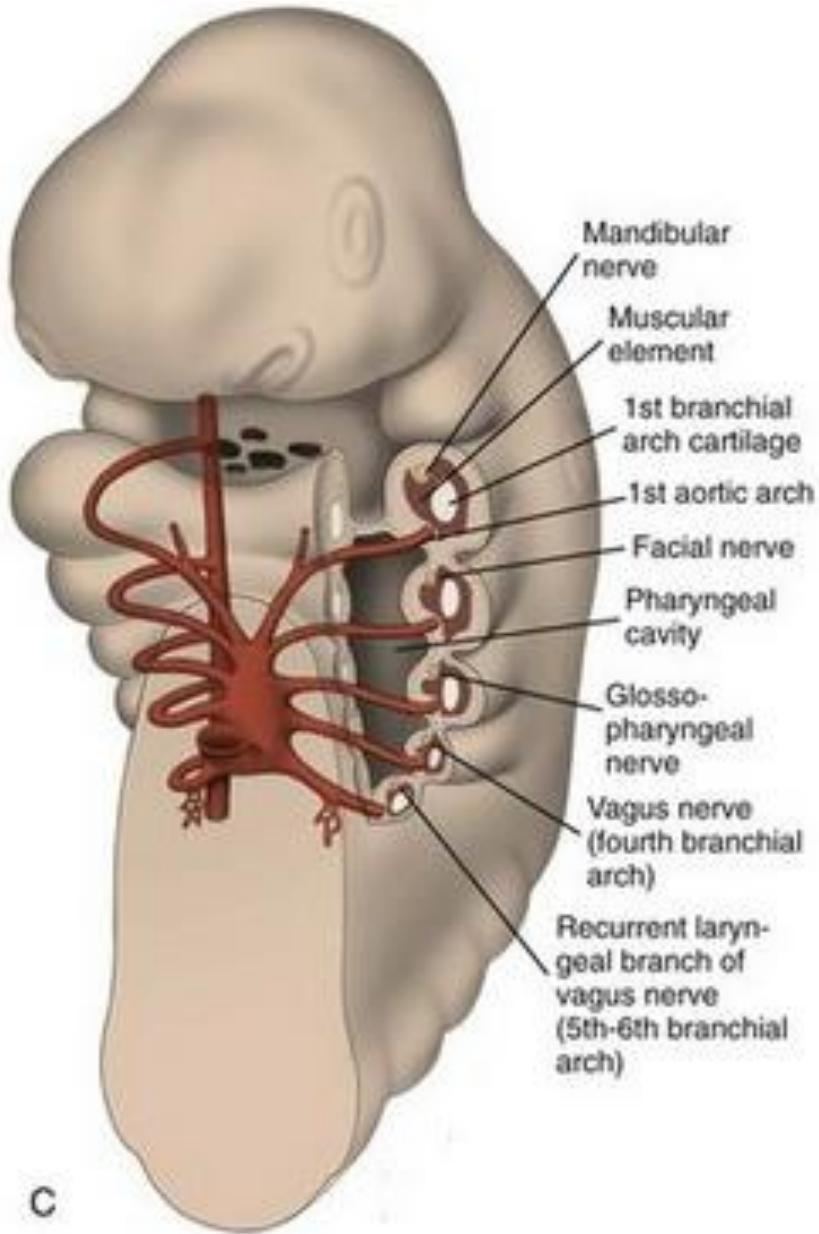
Pharyngeal Apparatus Derivatives: Muscles



Somitomeres

- Units of paraxial mesoderm in the head, but not distinct as in the body.
- Somitomeres are involved in formation of Arch 1, 2, 3 muscles.
- The tongue muscles originate from more caudal somites, hence their innervation from CN XII (hypoglossal n.).

Pharyngeal Apparatus Derivatives: Arteries



Left & right aortic arches 1, 2, 5 mostly disappears.

Pharyngeal Apparatus Derivatives

Create a Table:

Arch Number	Bone & Cartilage	Muscles	Arteries	Cranial Nerve	Pouch, Cleft, Membrane Derivatives
1 ("mandibular")					
2 ("hyoid")					
3 ("carotid")					
4 ("systemic")					
6 ("pulmonary")					

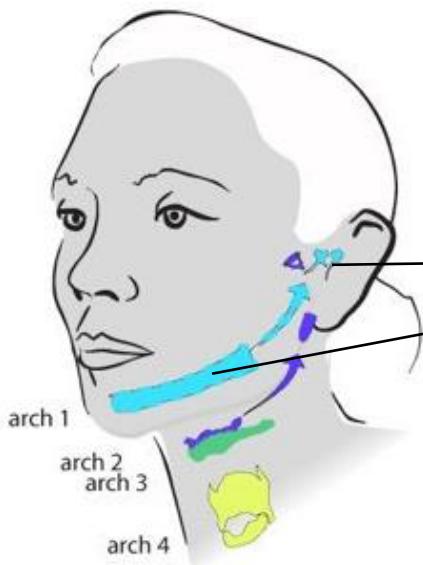
Pharyngeal Apparatus Derivatives

Create a Table:

Know this table for the exam.

Arch Number	Bone & Cartilage	Muscles	Arteries	Cranial Nerve	Pouch, Cleft, Membrane Derivatives
1 ("mandibular")			X		
2 ("hyoid")			X		
3 ("carotid")			X		
4 ("systemic")					
6 ("pulmonary")					

Pharyngeal Arch 1: “Mandibular”



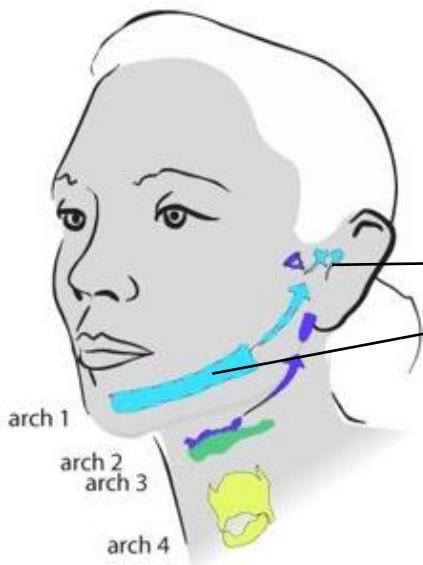
Bones in adult

Cartilage & Bone

- cartilaginous precursor of mandible
- malleus, incus



Pharyngeal Arch 1: “Mandibular”



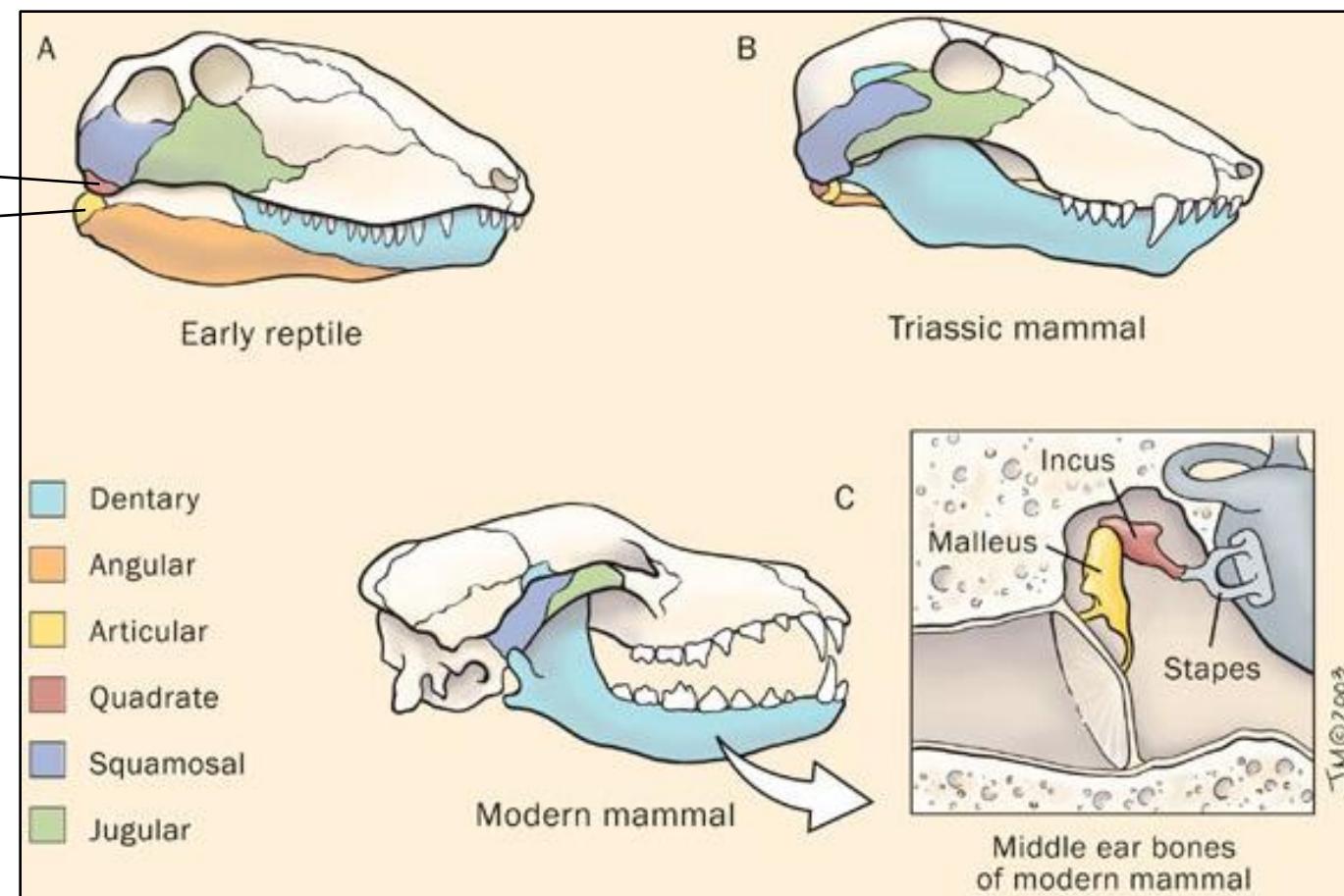
Cartilage & Bone

- cartilaginous precursor of mandible
- **malleus, incus**

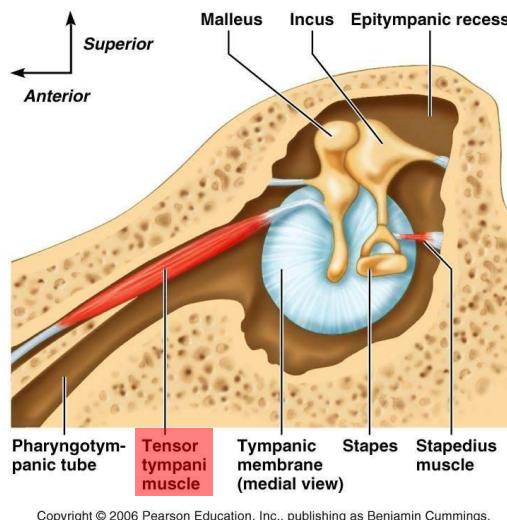
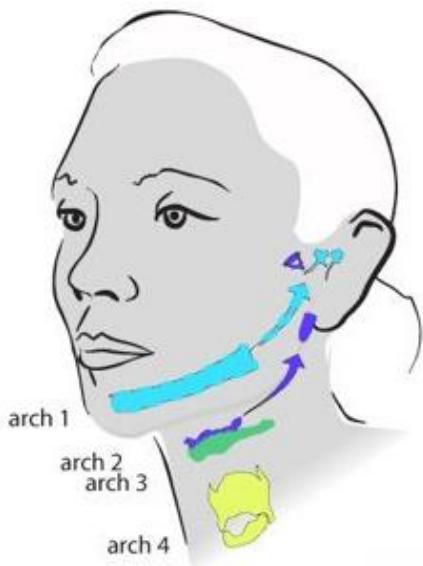
quadrat > malleus
articular > incus

Bones in adult

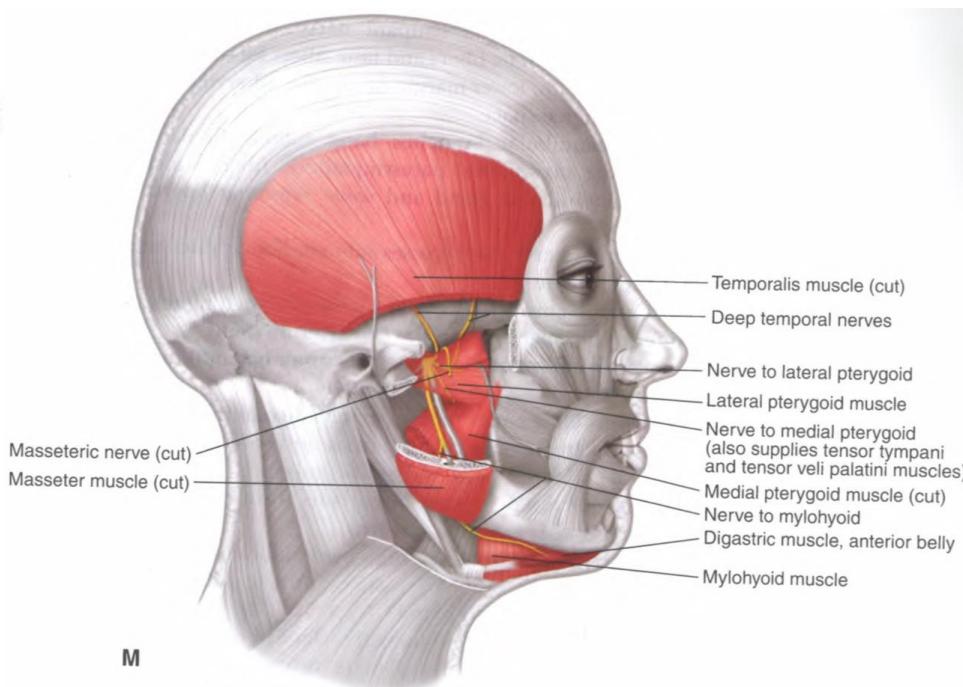
Evolution of the middle ear ossicles
malleus, incus evolved from jaw bones!



Pharyngeal Arch 1: “Mandibular”



Bones in adult



Cartilage & Bone

- cartilaginous precursor of mandible
- malleus, incus

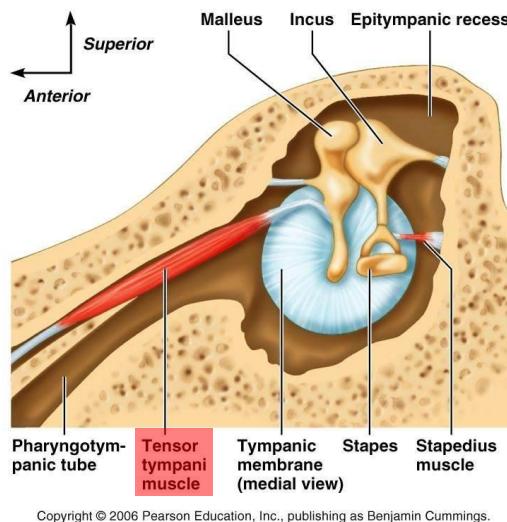
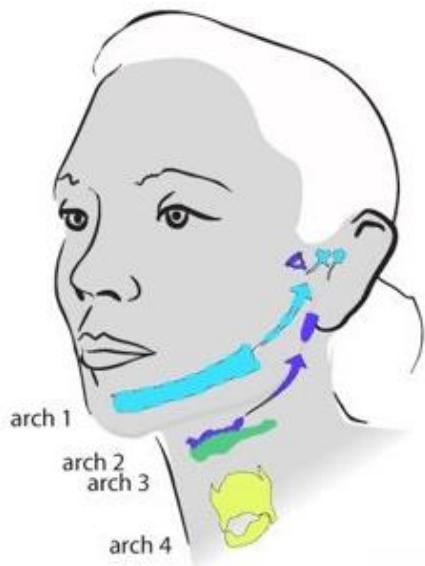
Arteries

- mostly disappears

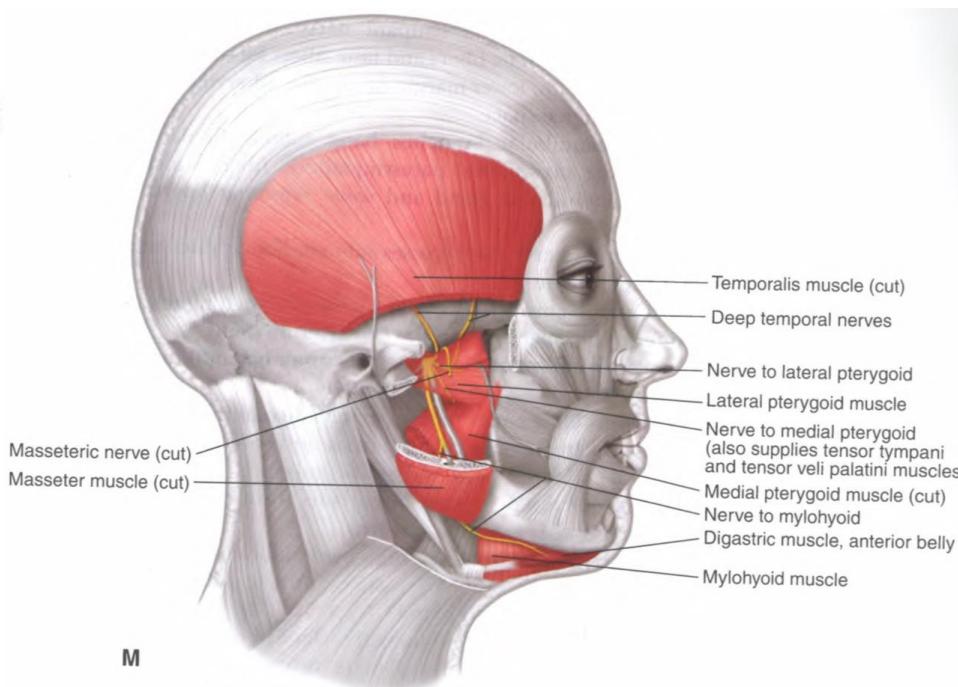
Muscles

- mm. of mastication: temporalis, masseter, pterygoids.
- tensor tympani, tensor veli palatini, anterior belly of digastric, mylohyoid

Pharyngeal Arch 1: “Mandibular”



Bones in adult



Cartilage & Bone

- cartilaginous precursor of mandible
- malleus, incus

Arteries

- mostly disappears

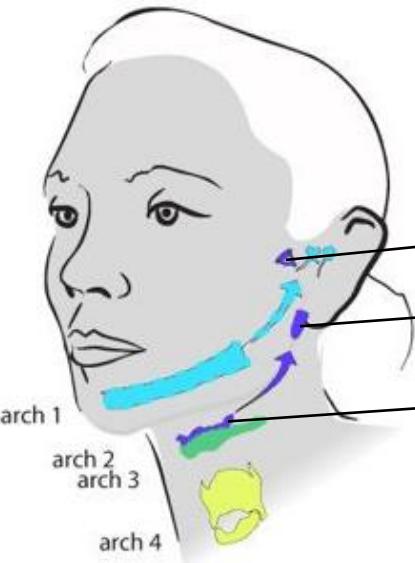
Muscles

- mm. of mastication: temporalis, masseter, pterygoids.
- tensor tympani, tensor veli palatini, anterior belly of digastric, mylohyoid

Cranial Nerve

- trigeminal (CN V)

Pharyngeal Arch 2: “Hyoid”



Cartilage & Bone

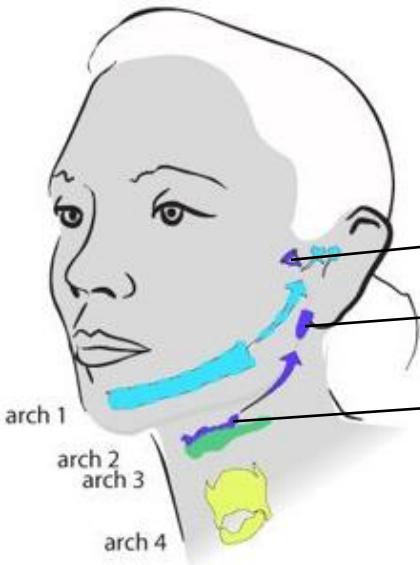
- stapes
- styloid process
- hyoid (lesser horn, upper body)

Arteries

- disappears

Bones in adult

Pharyngeal Arch 2: “Hyoid”



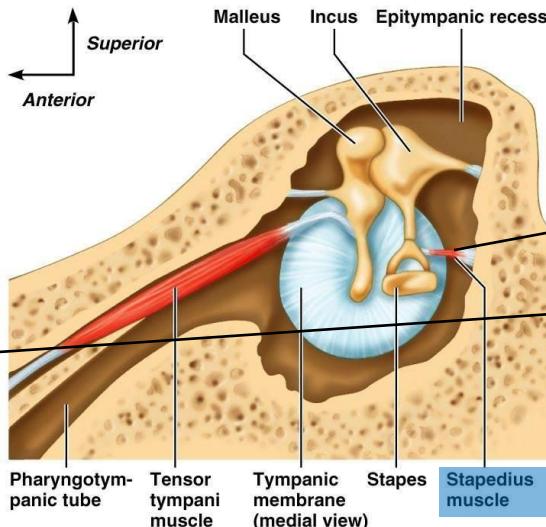
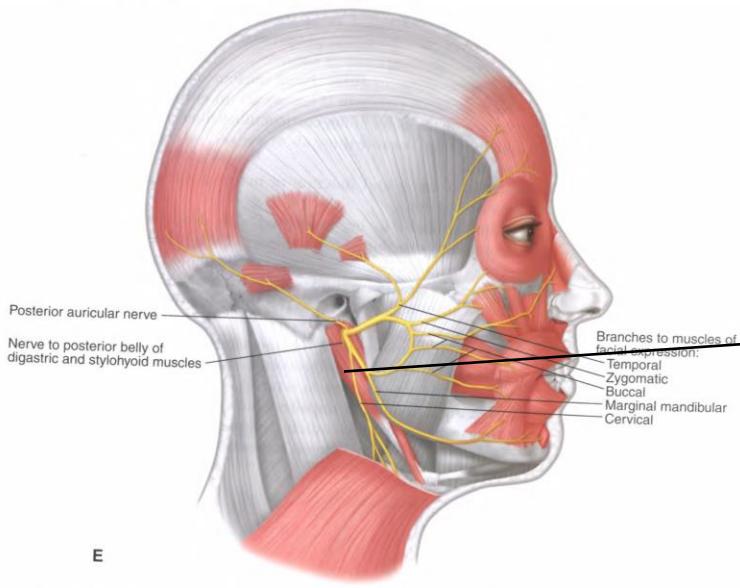
Cartilage & Bone

- stapes
- styloid process
- hyoid (lesser horn, upper body)

Arteries

- disappears

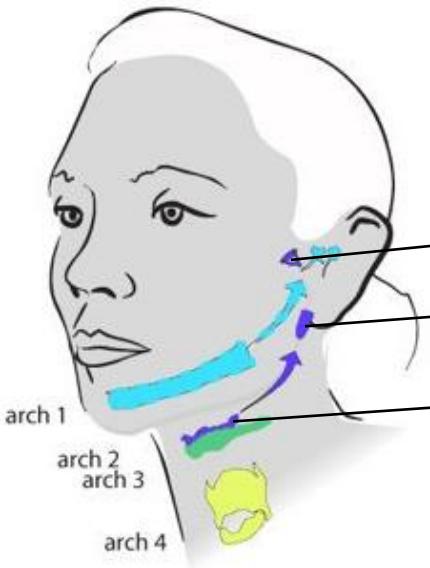
Bones in adult



Muscles

- muscles of facial expression
- stapedius
- posterior belly of digastric

Pharyngeal Arch 2: “Hyoid”



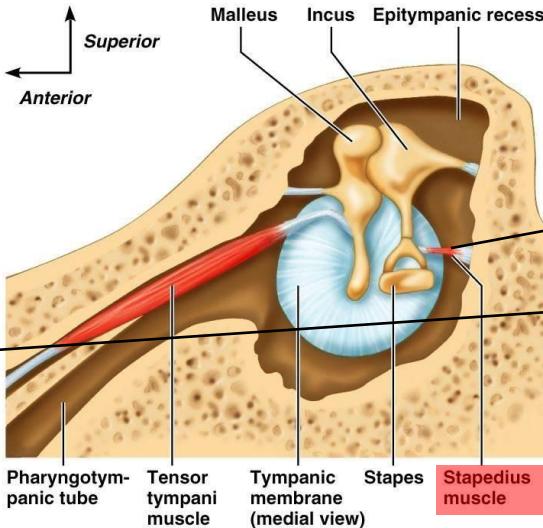
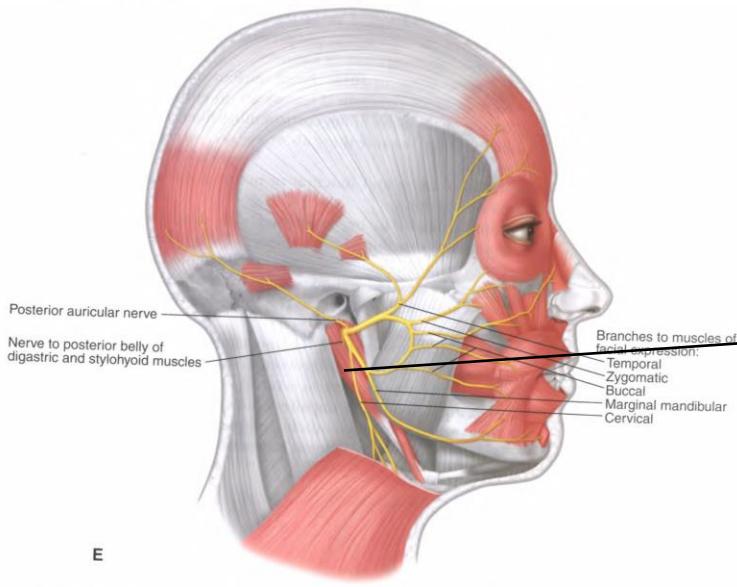
Cartilage & Bone

- stapes
- styloid process
- hyoid (lesser horn, upper body)

Arteries

- disappears

Bones in adult



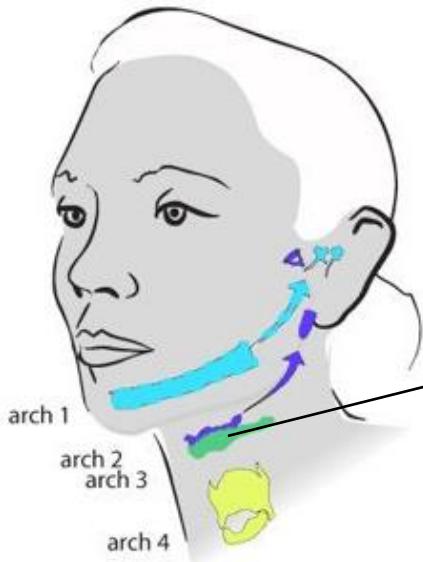
Muscles

- muscles of facial expression
- stapedius
- posterior belly of digastric

Nerve

- facial (CN VII)

Pharyngeal Arch 3: “Carotid”

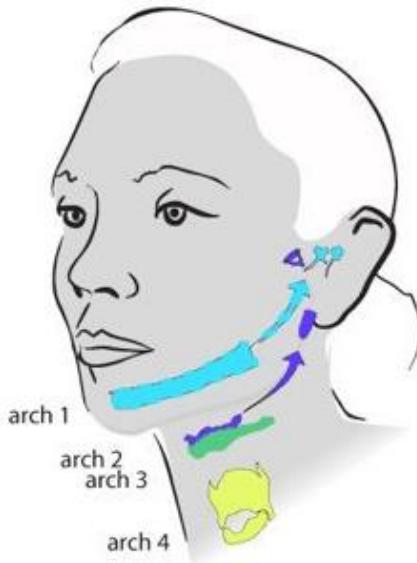


Cartilage & Bone

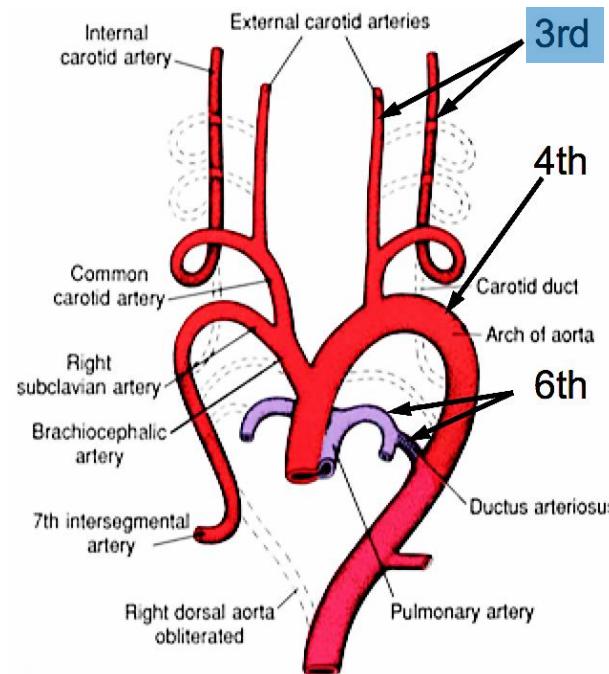
- hyoid (greater horn, lower body)

Bones in adult

Pharyngeal Arch 3: “Carotid”



Bones in adult



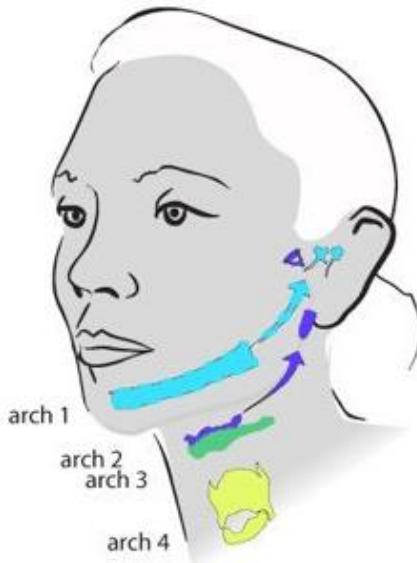
Cartilage & Bone

- hyoid (greater horn, lower body)

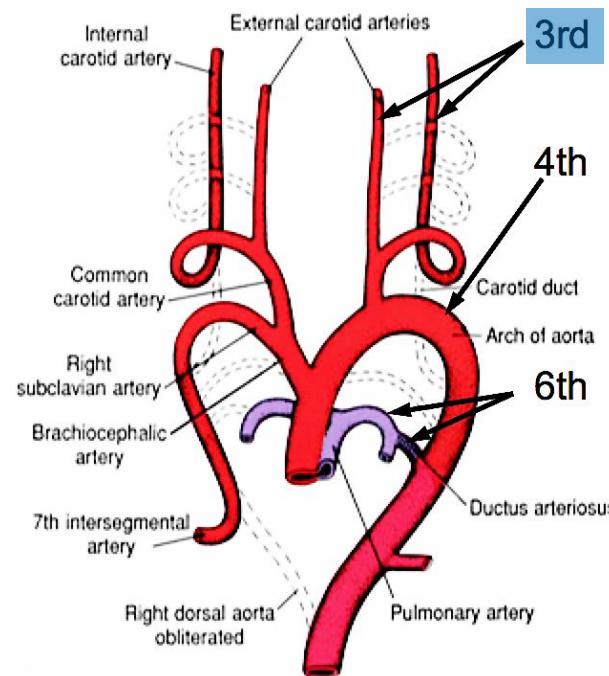
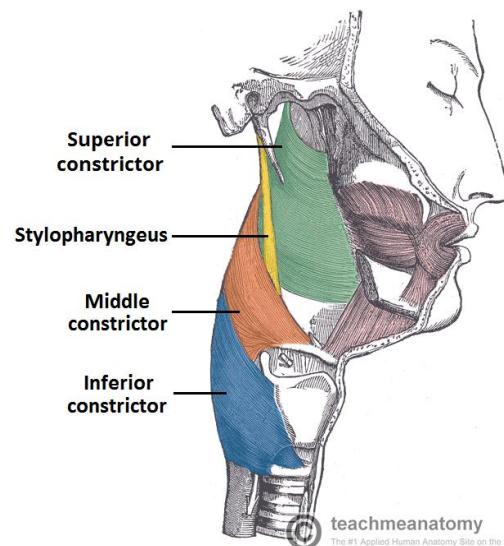
Arteries

- internal & external carotid aa.

Pharyngeal Arch 3: “Carotid”



Bones in adult



Cartilage & Bone

- hyoid (greater horn, lower body)

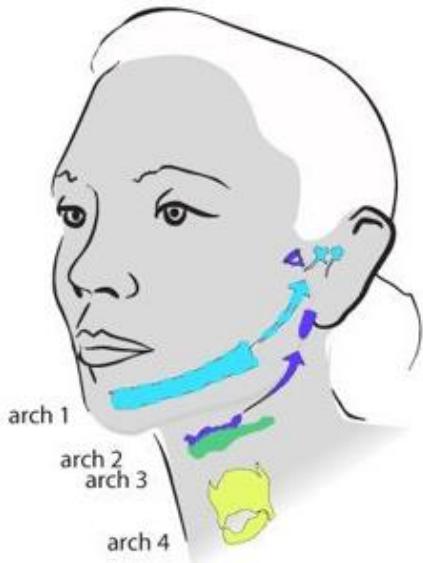
Arteries

- internal & external carotid aa.

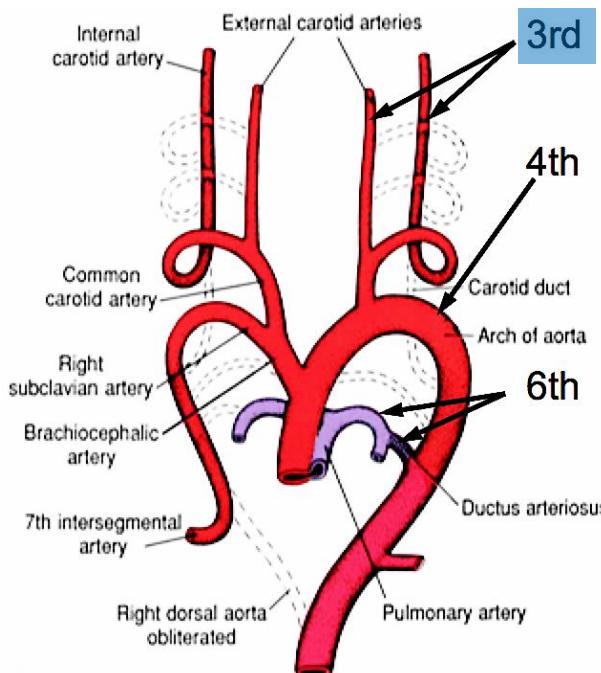
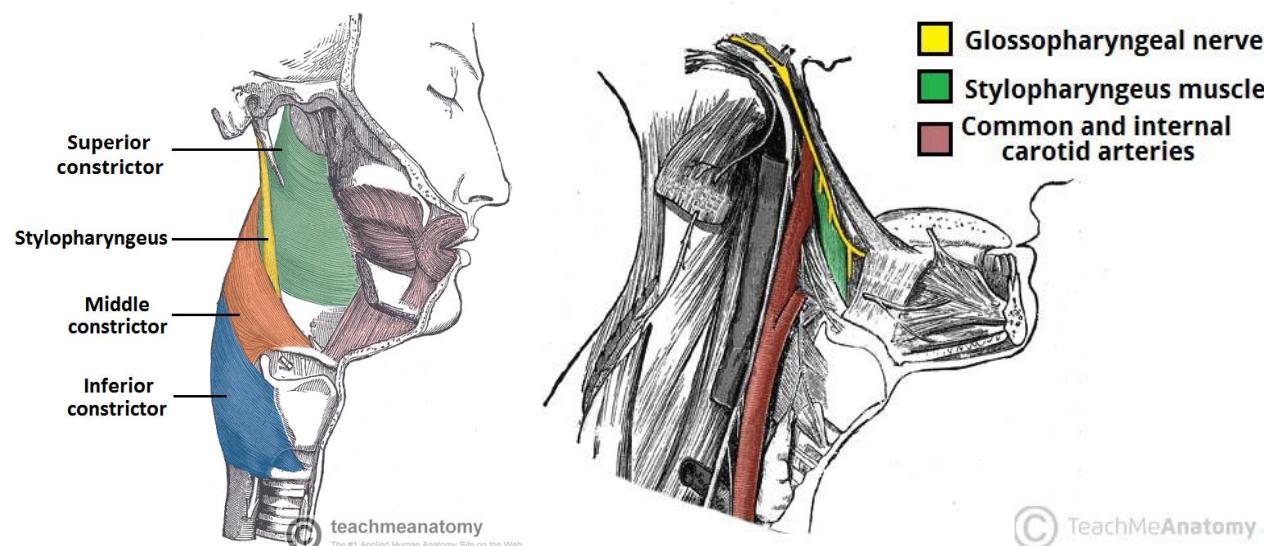
Muscles

- stylopharyngeus

Pharyngeal Arch 3: “Carotid”



Bones in adult



Cartilage & Bone

- hyoid (greater horn, lower body)

Arteries

- internal & external carotid aa.

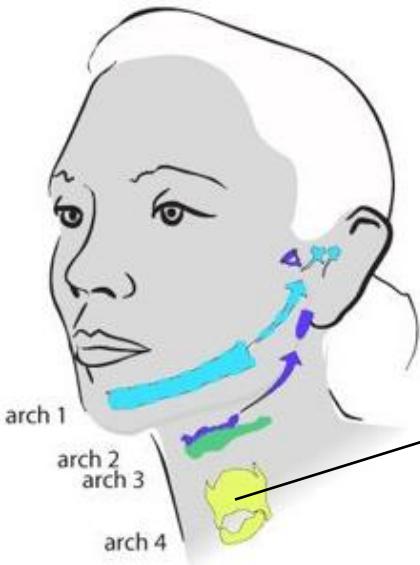
Muscles

- stylopharyngeus

Nerve

- glossopharyngeal (CN IX)

Pharyngeal Arch 4: “Systemic”

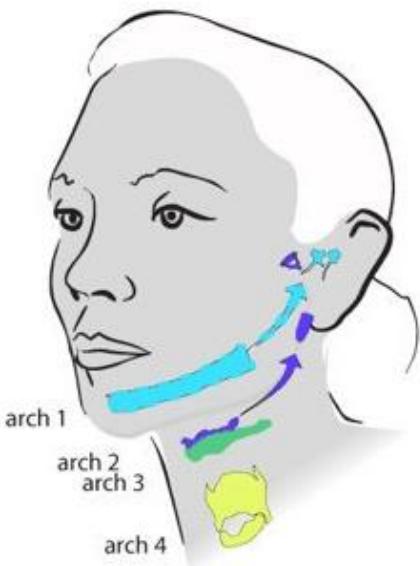


Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA6)

Bones in adult

Pharyngeal Arch 4: “Systemic”



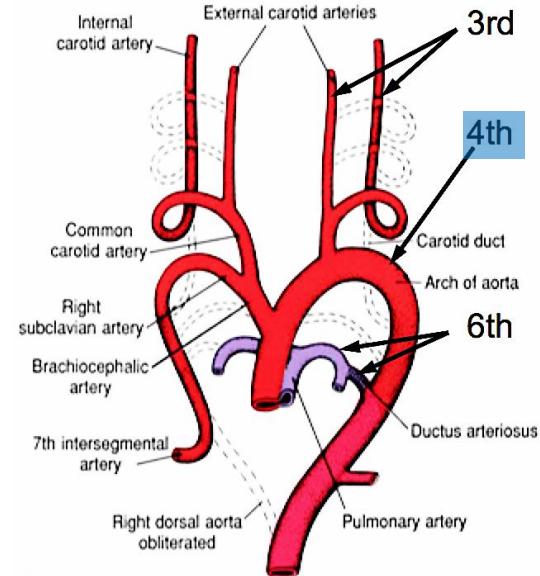
Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA6)

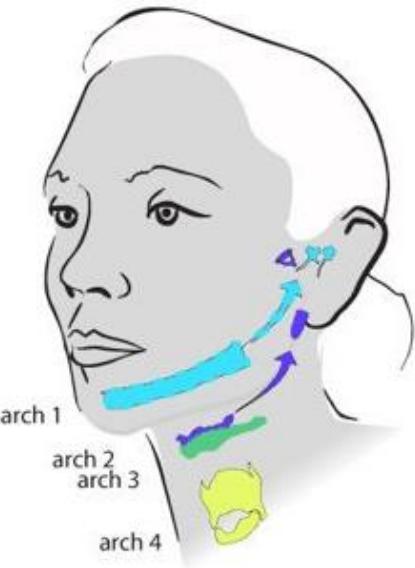
Arteries

- parts of aorta; right subclavian

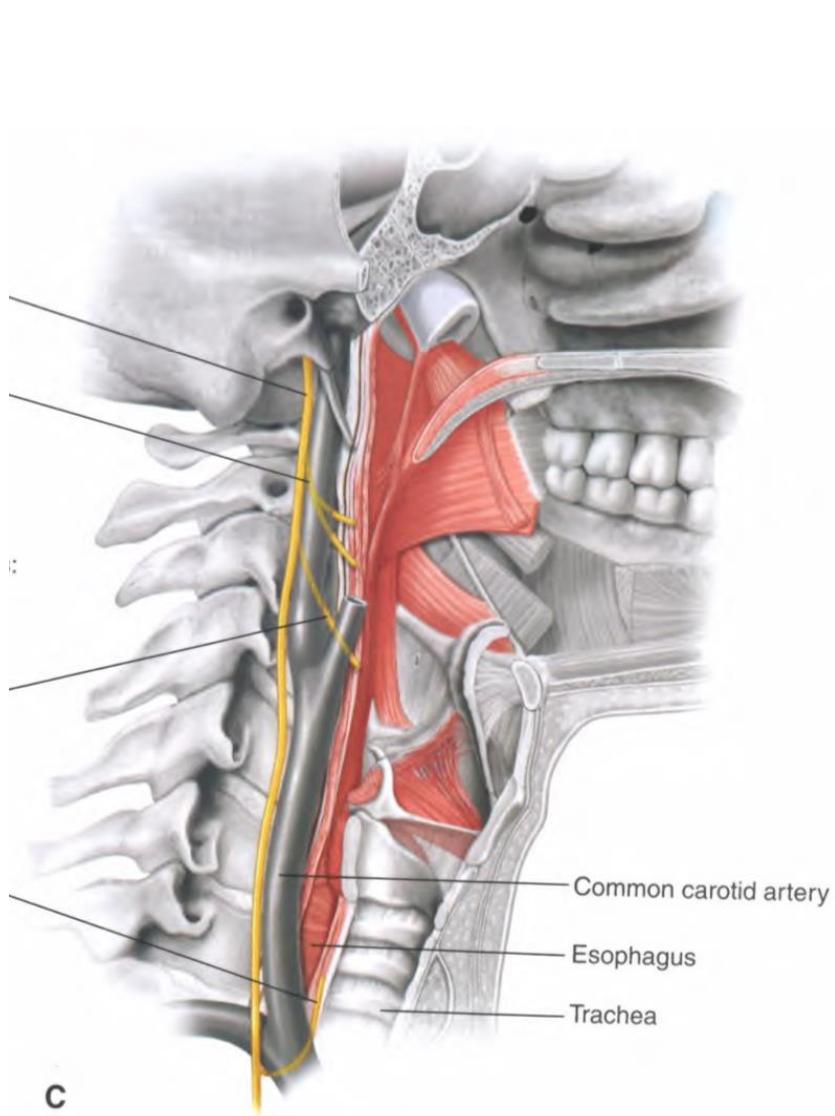
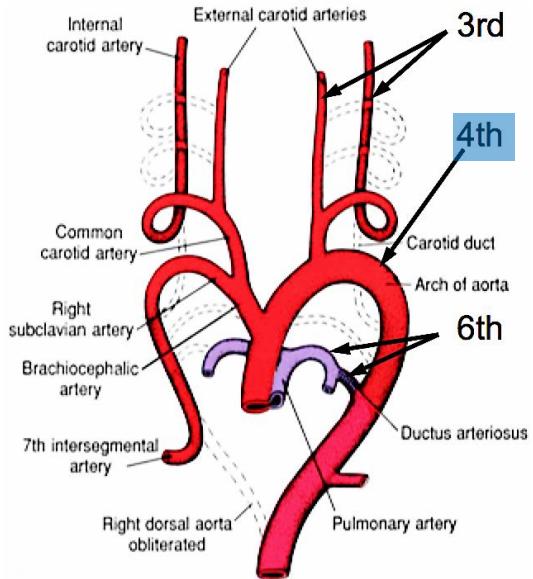
Bones in adult



Pharyngeal Arch 4: “Systemic”



Bones in adult



Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA6)

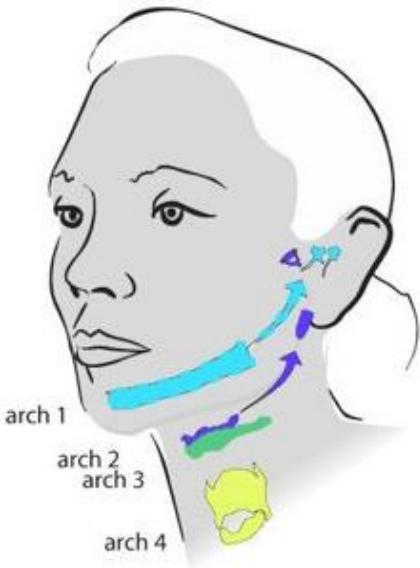
Arteries

- parts of aorta; right subclavian

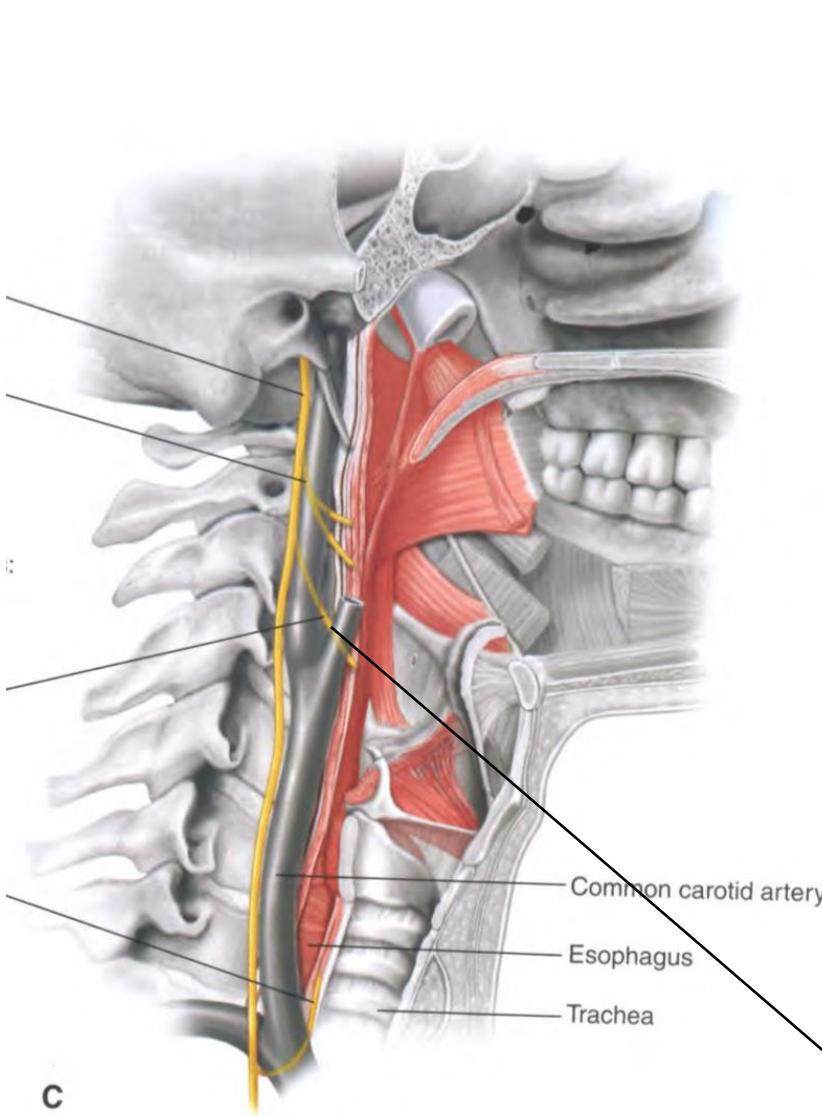
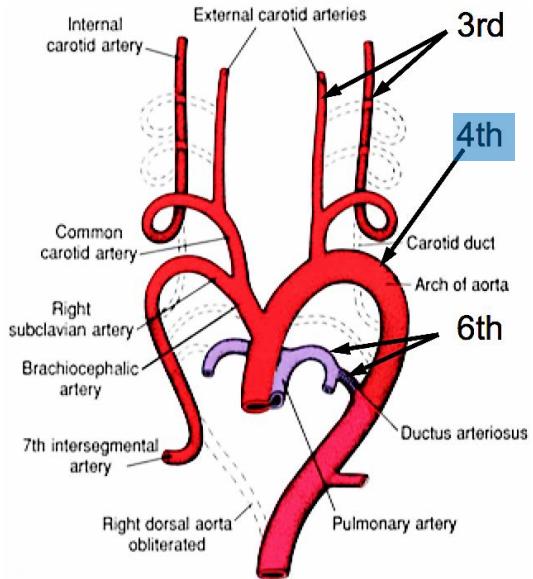
Muscles

- cricothyroid, levator veli palatini, constrictors of pharynx, striated mm. of esophagus

Pharyngeal Arch 4: “Systemic”



Bones in adult



Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA6)

Arteries

- parts of aorta; right subclavian

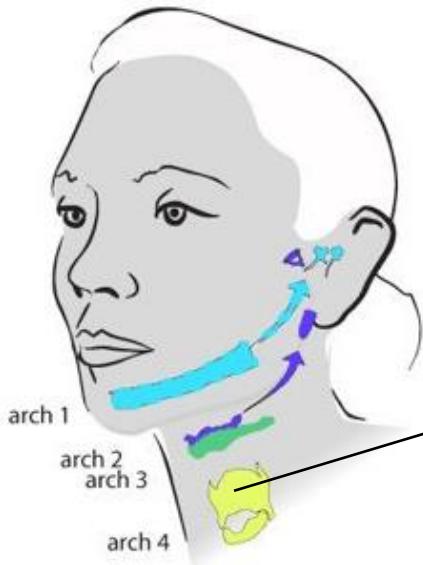
Muscles

- cricothyroid, levator veli palatini, constrictors of pharynx, striated mm. of esophagus

Nerve

- vagus (CN X): superior laryngeal n.

Pharyngeal Arch 6: “Pulmonary”

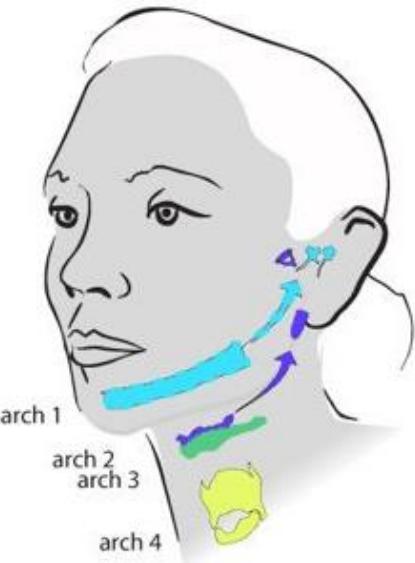


Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA4)

Bones in adult

Pharyngeal Arch 6: “Pulmonary”



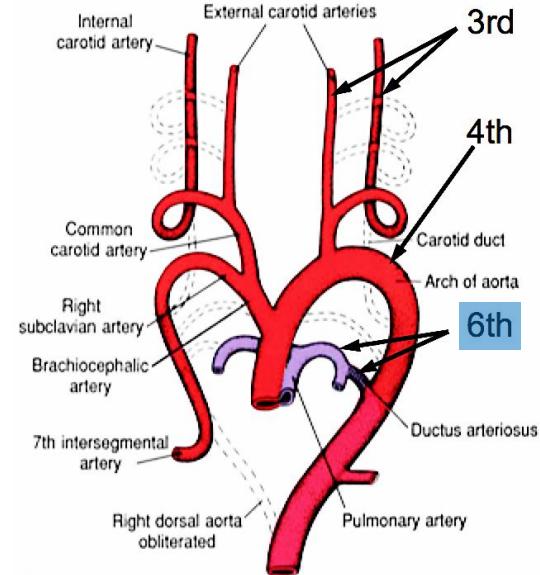
Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA4)

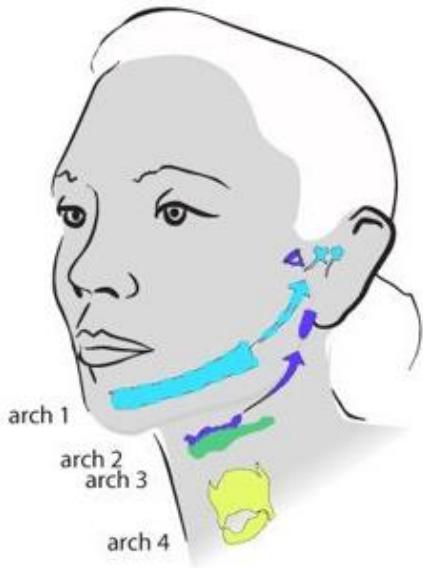
Arteries

- part of pulmonary aa.

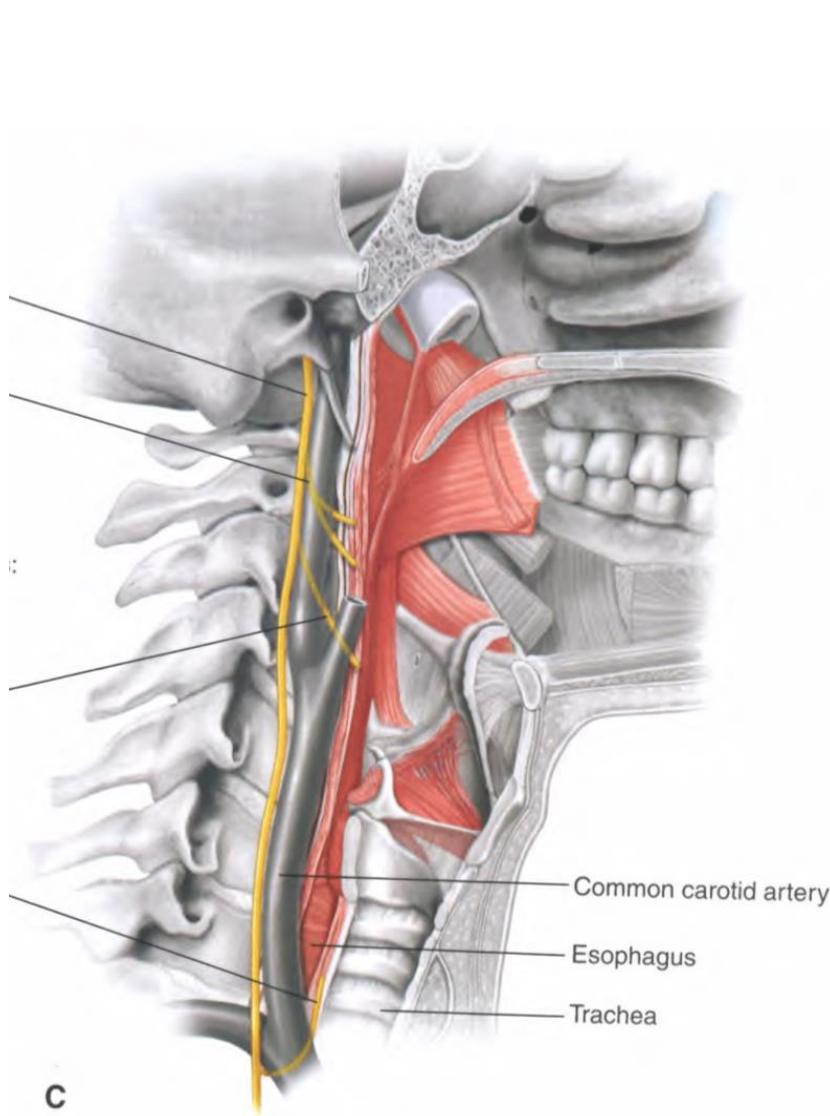
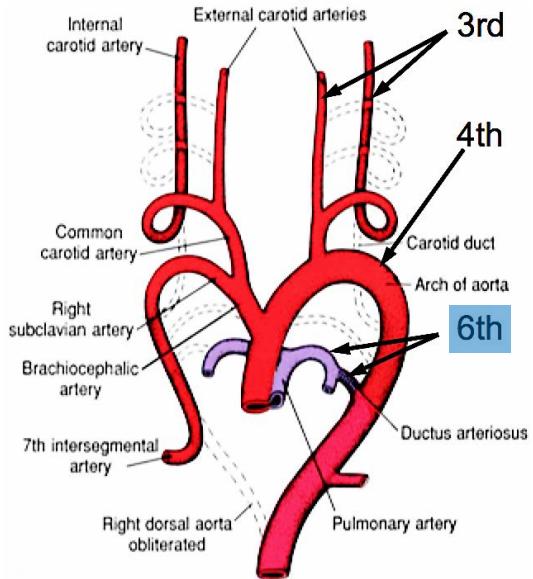
Bones in adult



Pharyngeal Arch 6: “Pulmonary”



Bones in adult



Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA4)

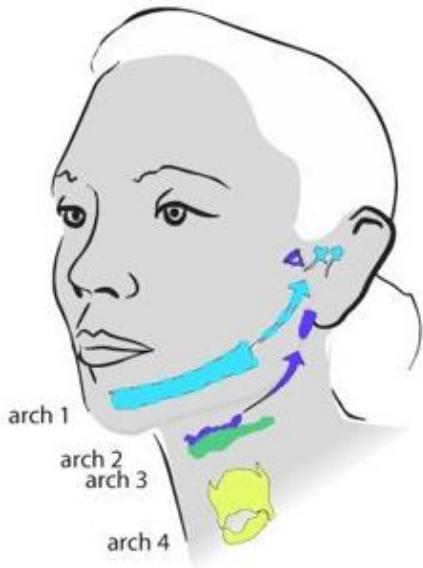
Arteries

- part of pulmonary aa.

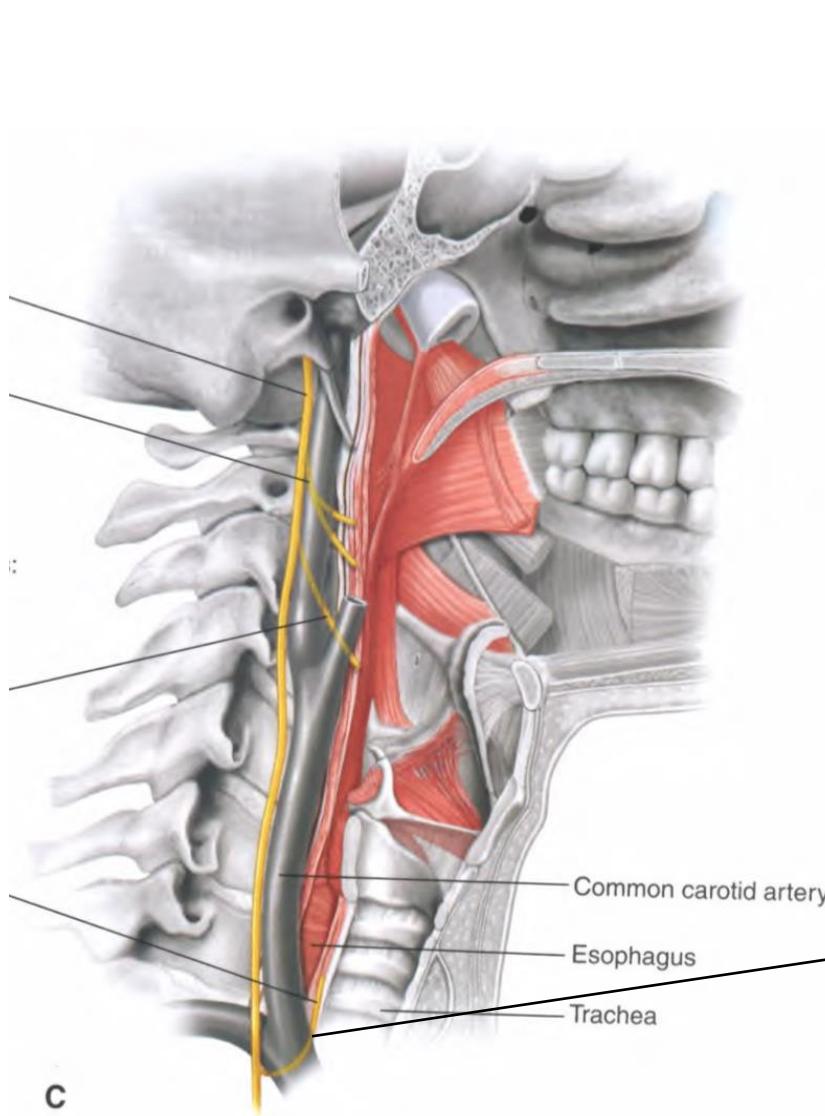
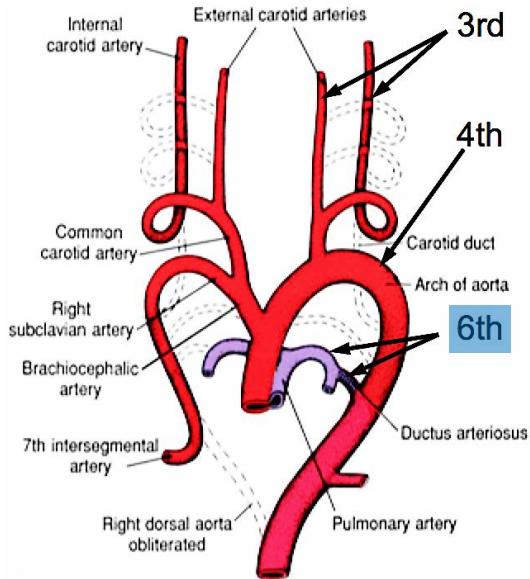
Muscles

- intrinsic laryngeal muscles except cricothyroid

Pharyngeal Arch 6: “Pulmonary”



Bones in adult



Cartilage & Bone

- laryngeal cartilages except for epiglottis (together with PA4)

Arteries

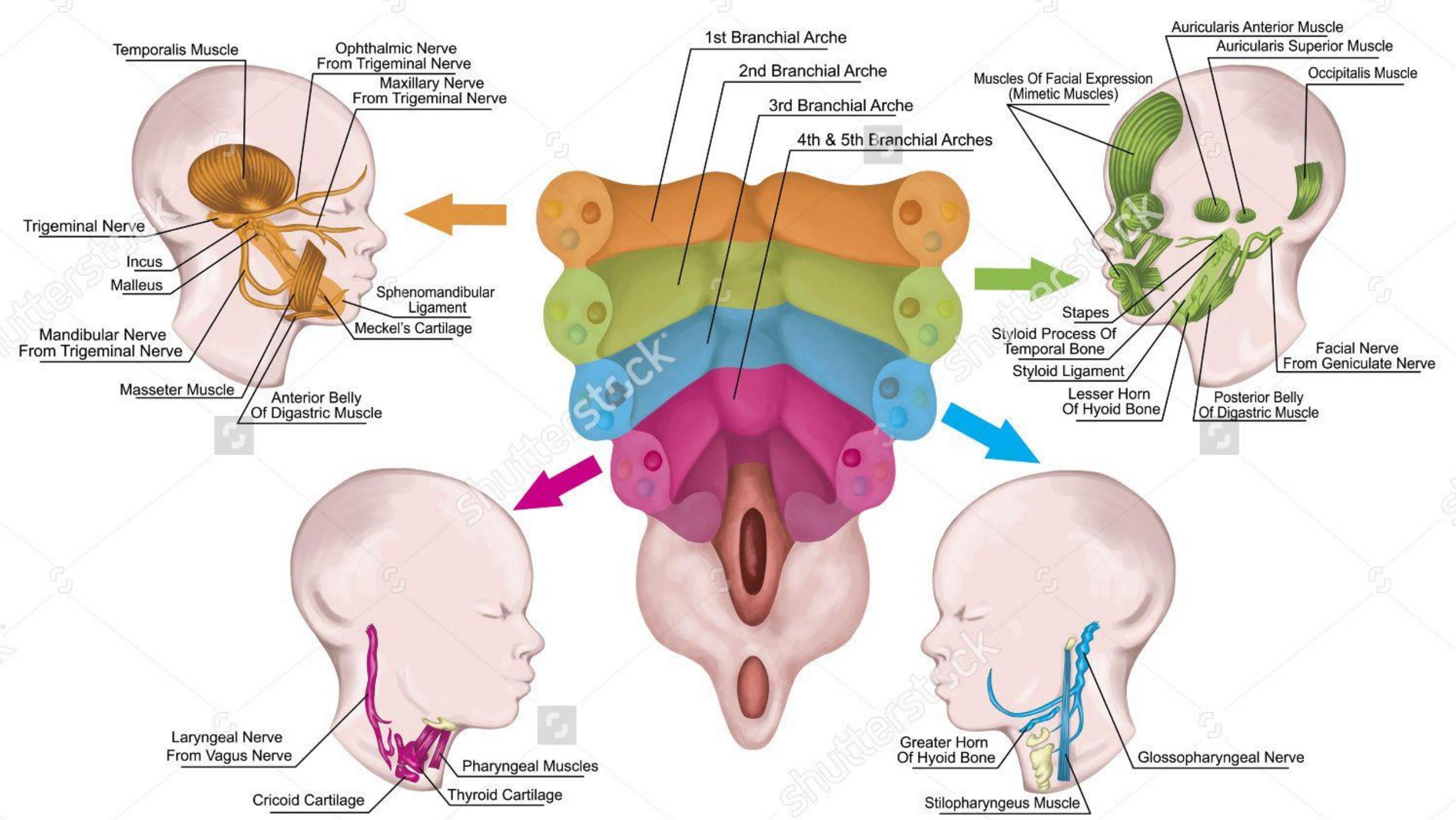
- part of pulmonary aa.

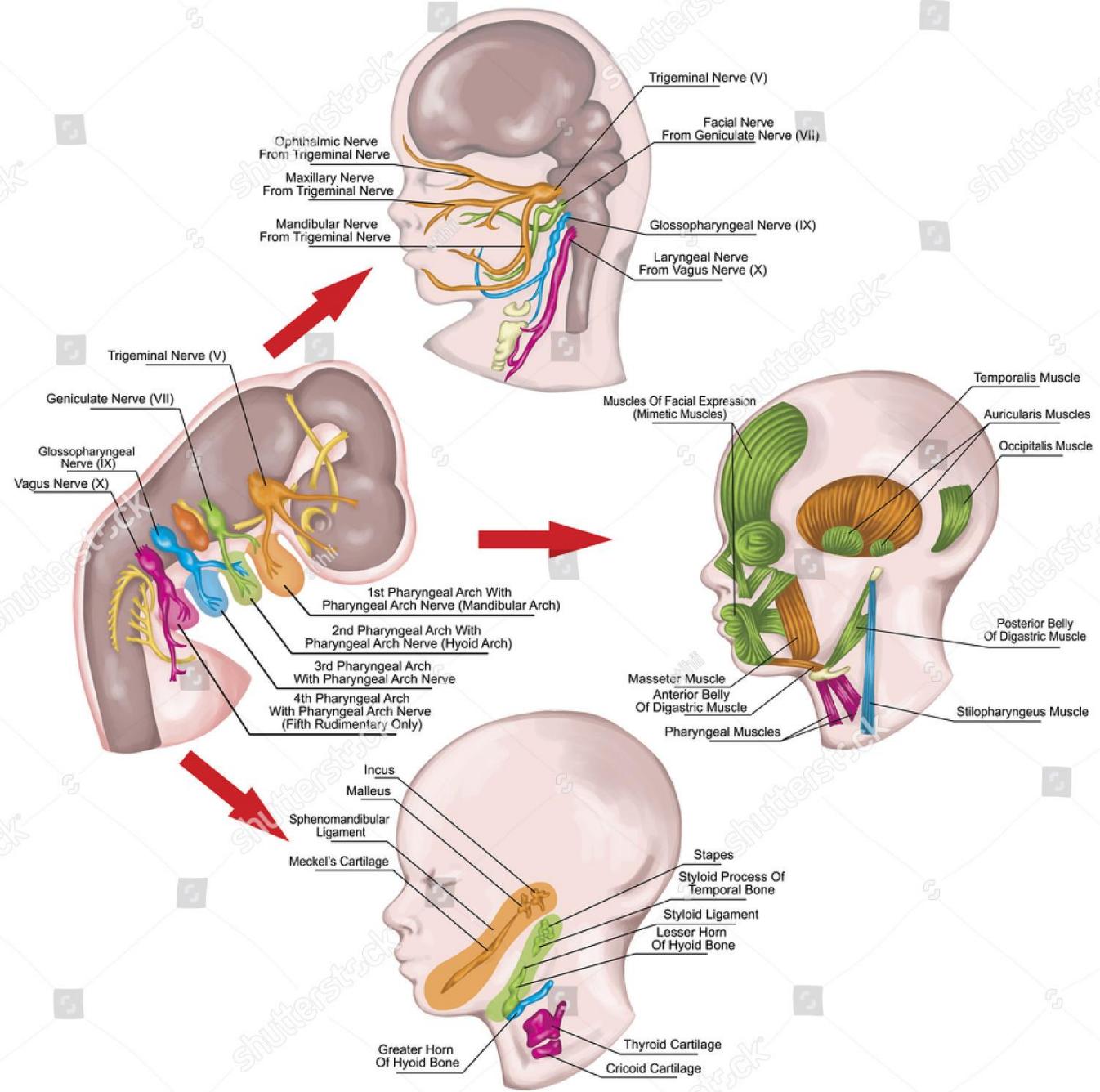
Muscles

- intrinsic laryngeal muscles except cricothyroid

Nerve

- vagus (CN X): recurrent laryngeal n.





Nerves

Arch 1: trigeminal (CN V)

Arch 2: facial (CN VII)

Arch 3: glossopharyngeal (CN IX)

Arch 4 & 6: vagus (CN X)

Muscles

Arch 1: mm. of mastication, etc.

Arch 2: mm. of facial expression, etc.

Arch 3: stylopharyngeus m.

Arch 4 & 6: mm. of larynx, esophagus

Cartilage & Bone

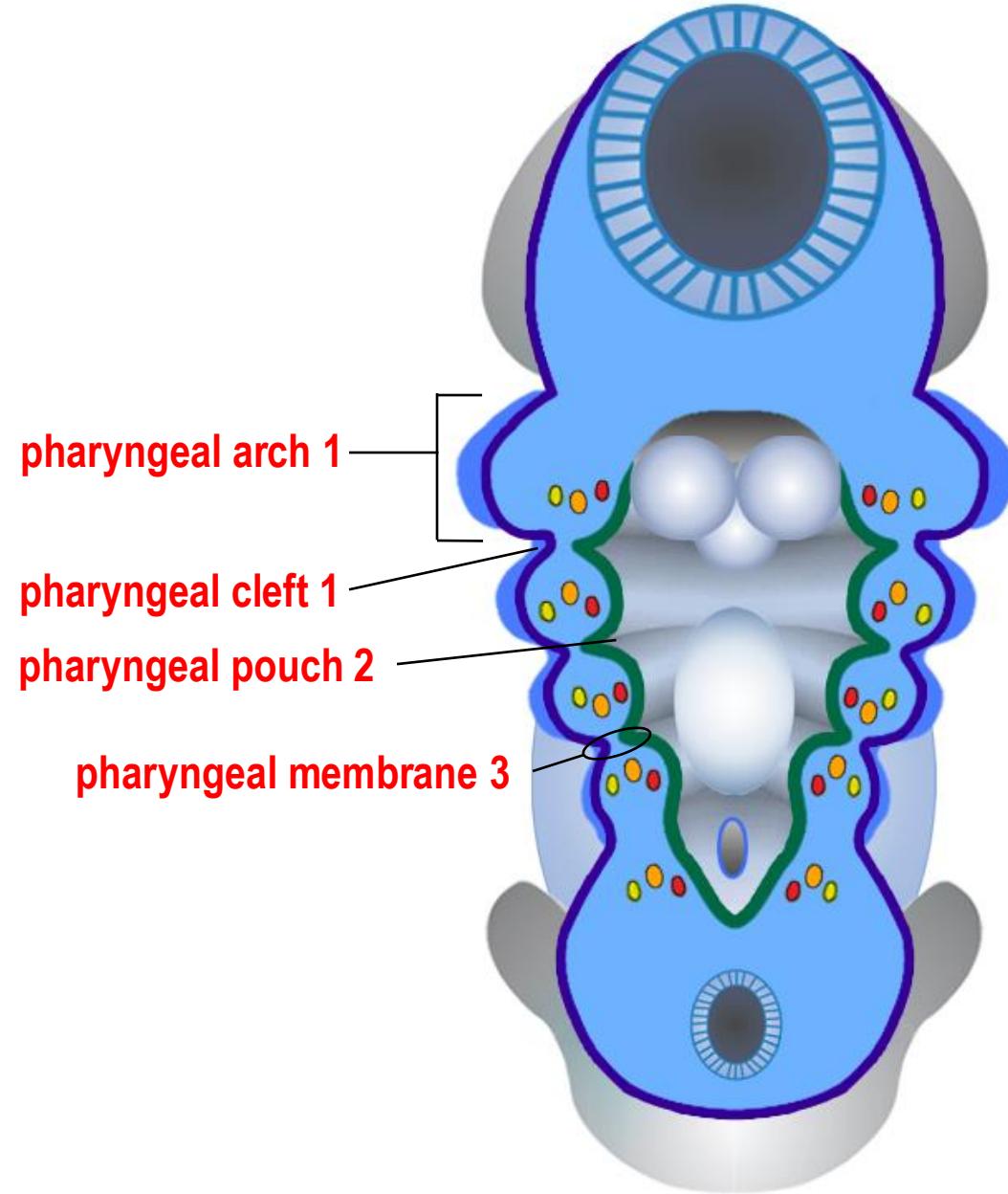
Arch 1: mandible, malleus, incus

Arch 2: hyoid (upper), stapes, styloid pr.

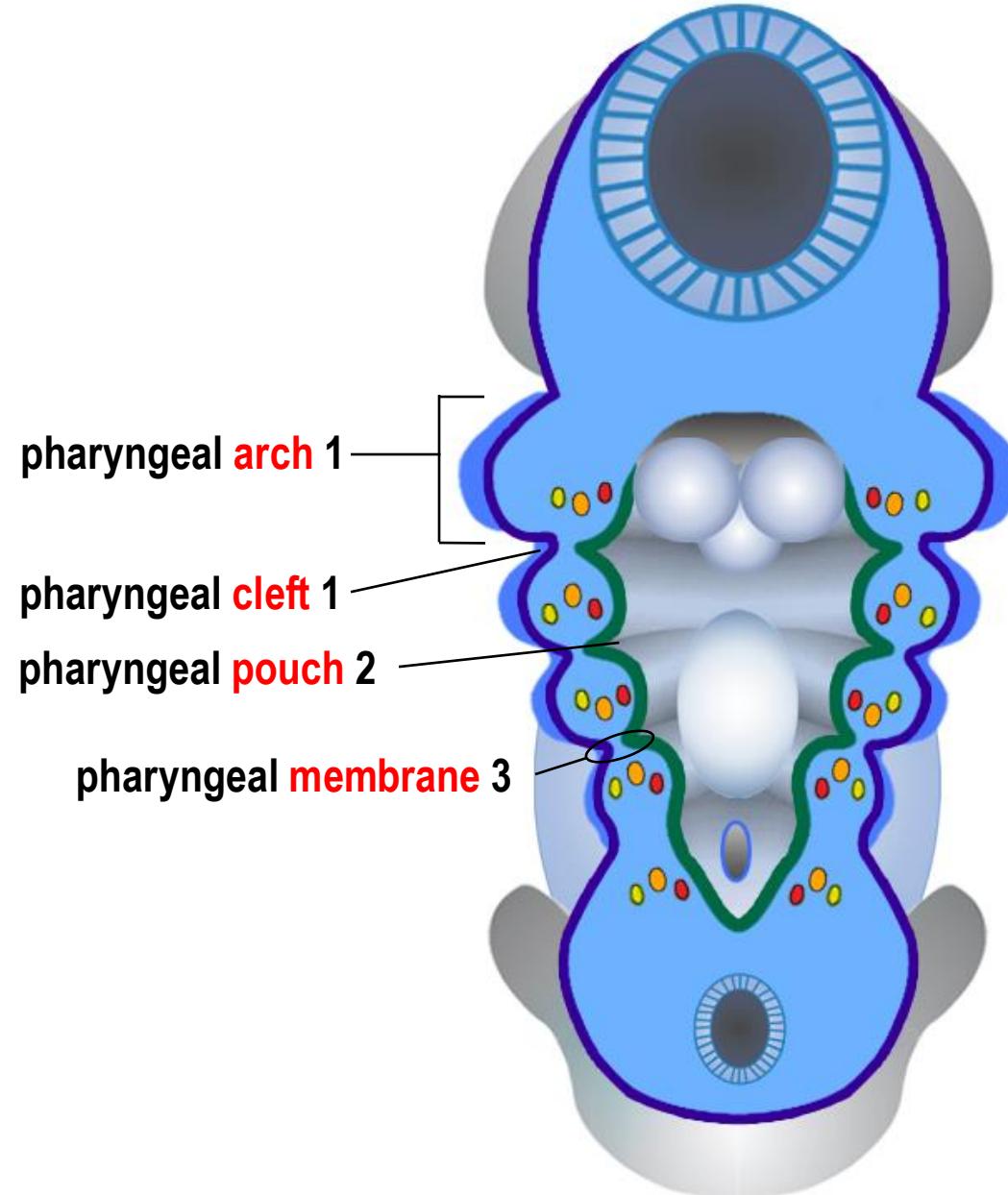
Arch 3: hyoid (lower)

Arch 4 & 6: laryngeal cartilages

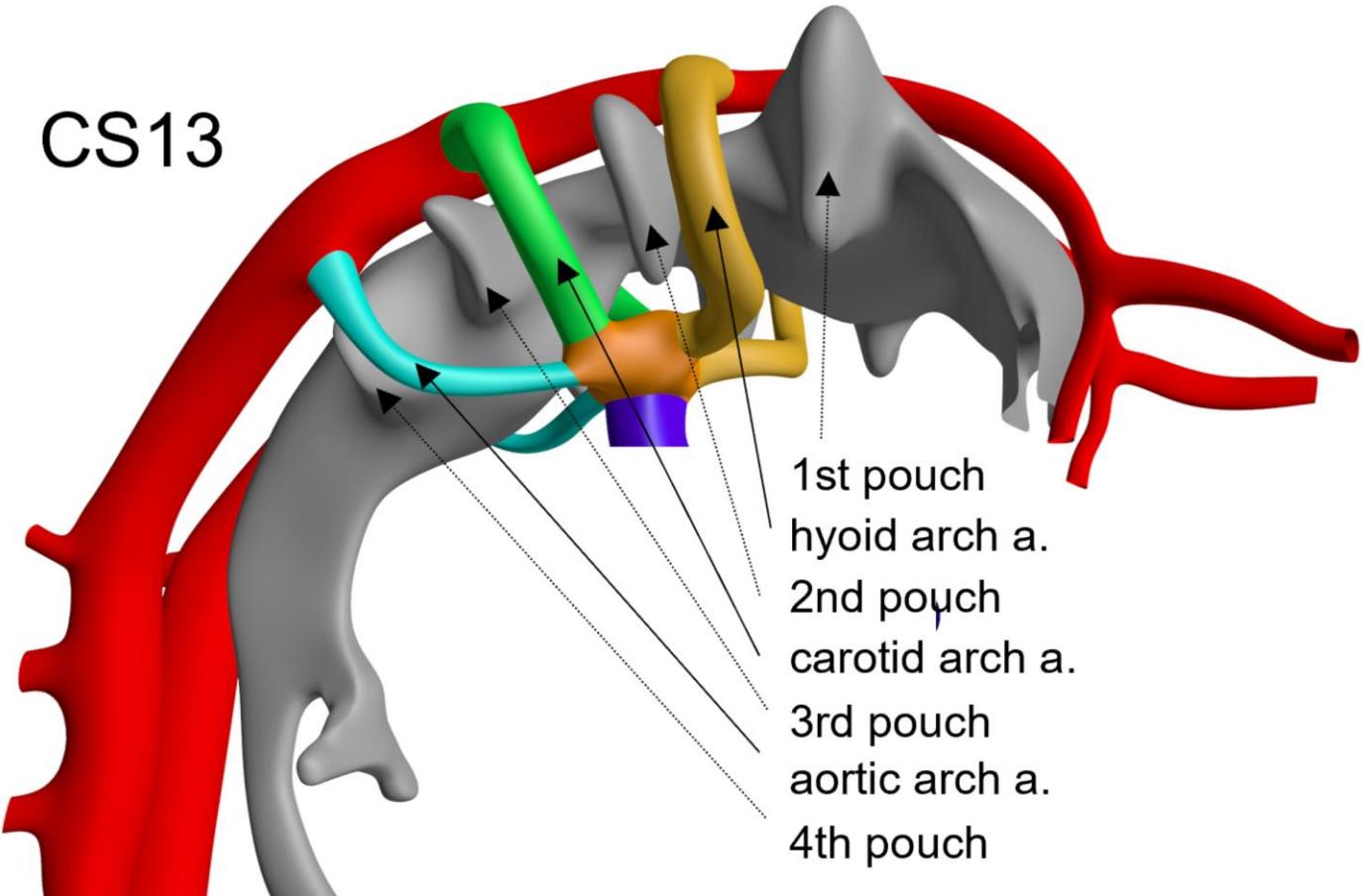
Pharyngeal Pouches, Clefts, Membranes



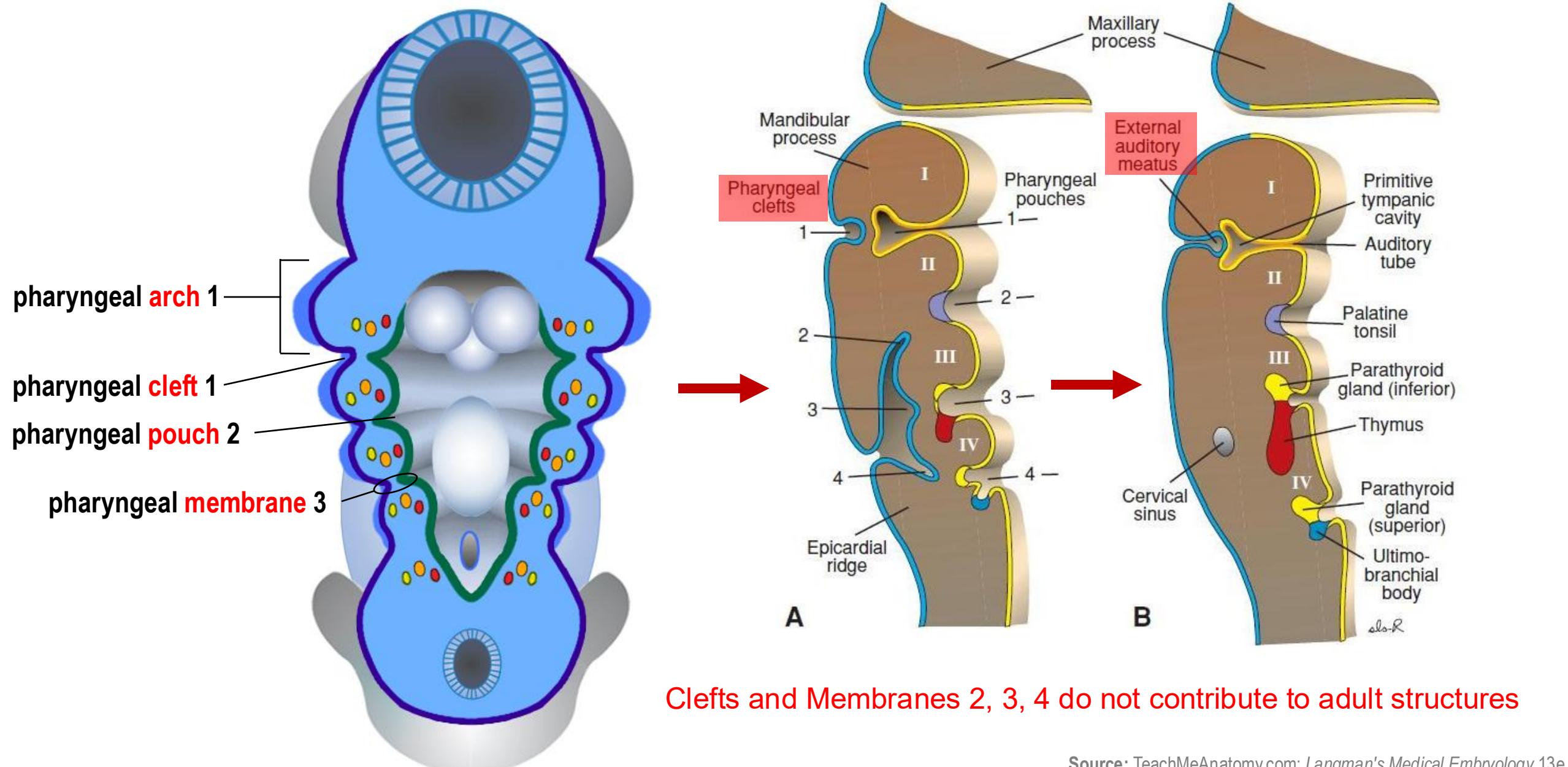
Pharyngeal Pouches, Clefts, Membranes



Lateral (side) view
(with pharyngeal arch & membrane removed)



Pharyngeal Pouches, Clefts, Membranes

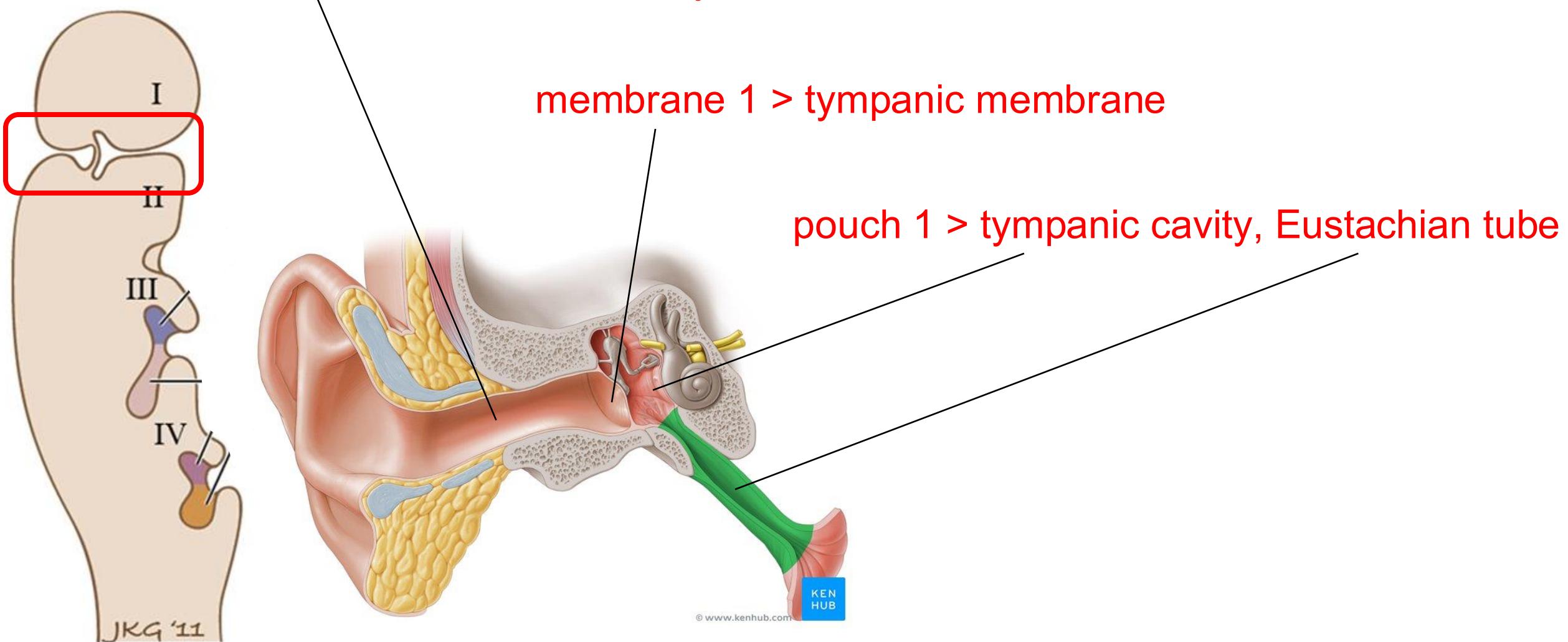


Pharyngeal Pouch, Cleft, Membrane 1

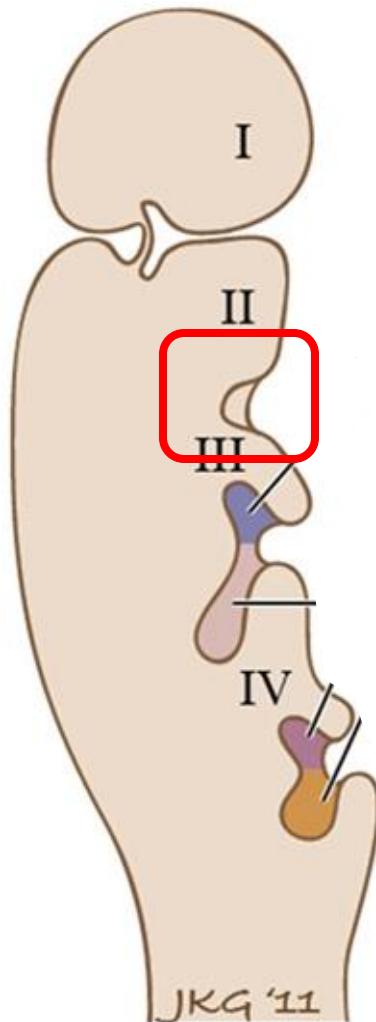
cleft 1 > external auditory meatus

membrane 1 > tympanic membrane

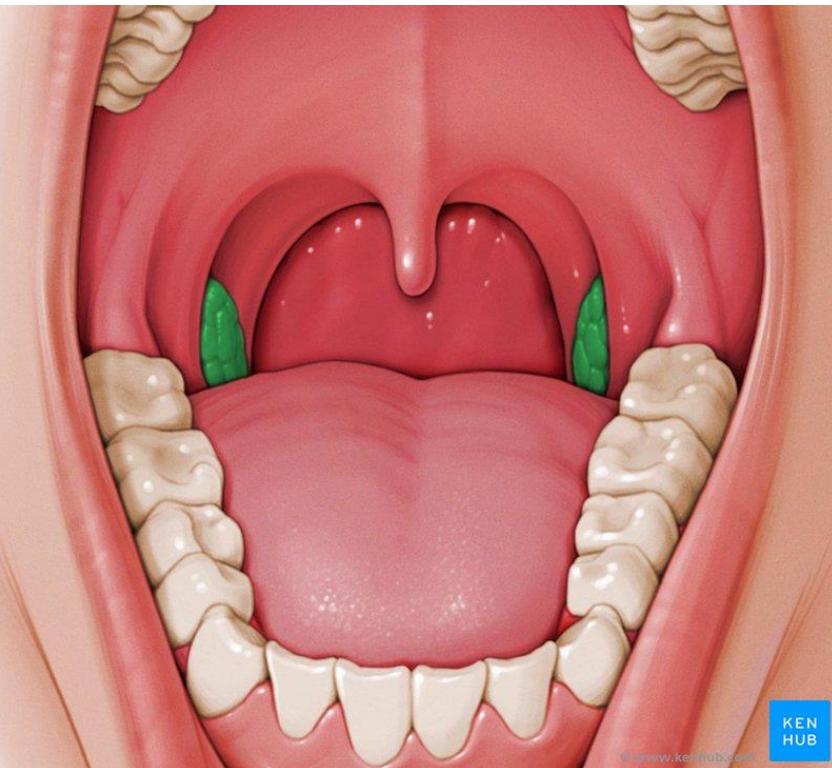
pouch 1 > tympanic cavity, Eustachian tube



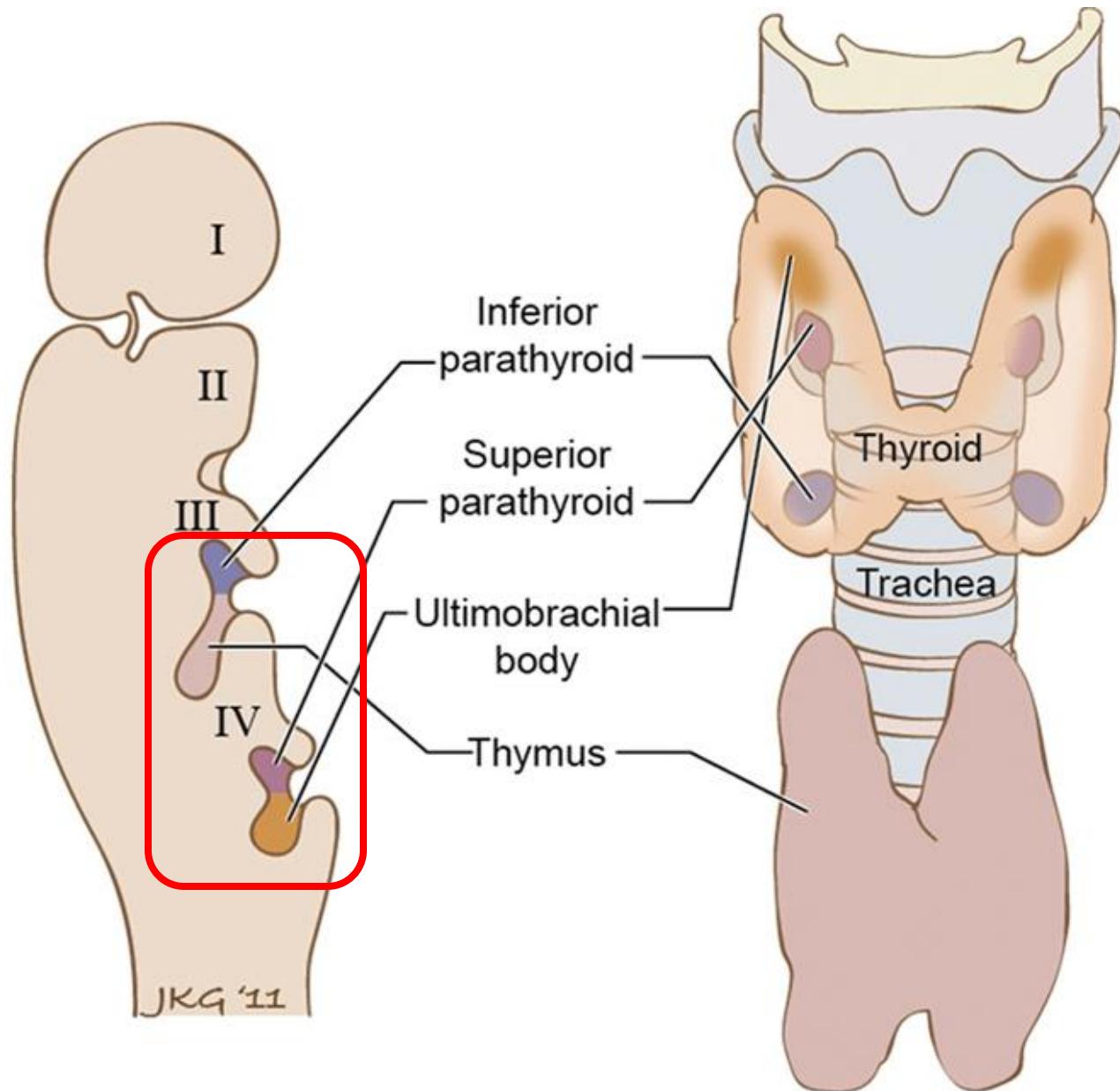
Pharyngeal Pouch 2



pouch 2 > palatine tonsils



Pharyngeal Pouches 3 & 4



Pouch 3

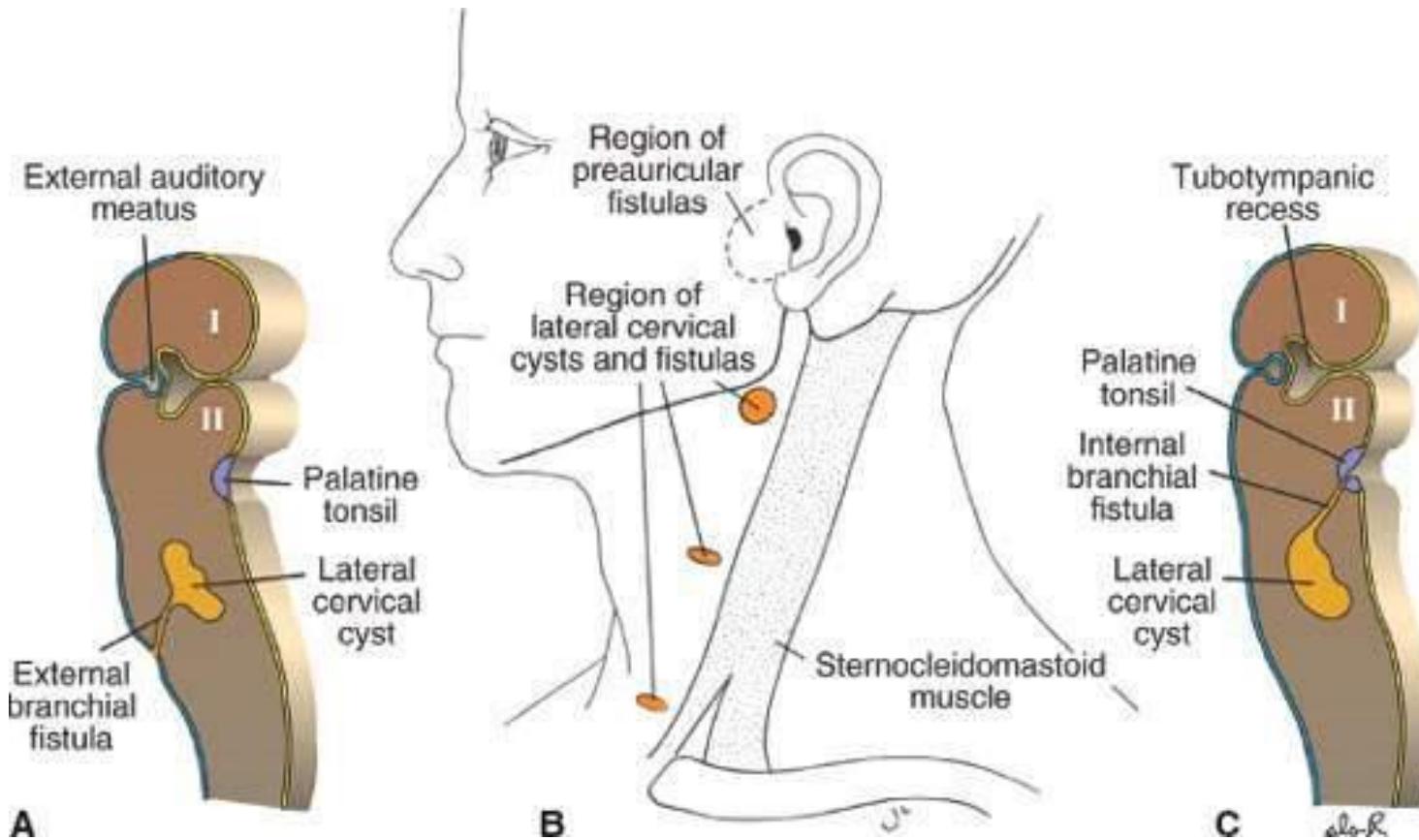
- thymus
- inferior parathyroid glands

Pouch 4

- superior parathyroid glands
- ultimobranchial body: gives rise to parafollicular/C-cells

Clinical Correlates Branchial Fistula & Cyst

- Caused by persistent cervical sinus derived from fusion of Pharyngeal Clefts 2–4.
- Typically, internal fistula opens at the palatine tonsil formed from Pouch 2 and external fistula opens on the skin of the neck anterior to the sternocleidomastoid m.

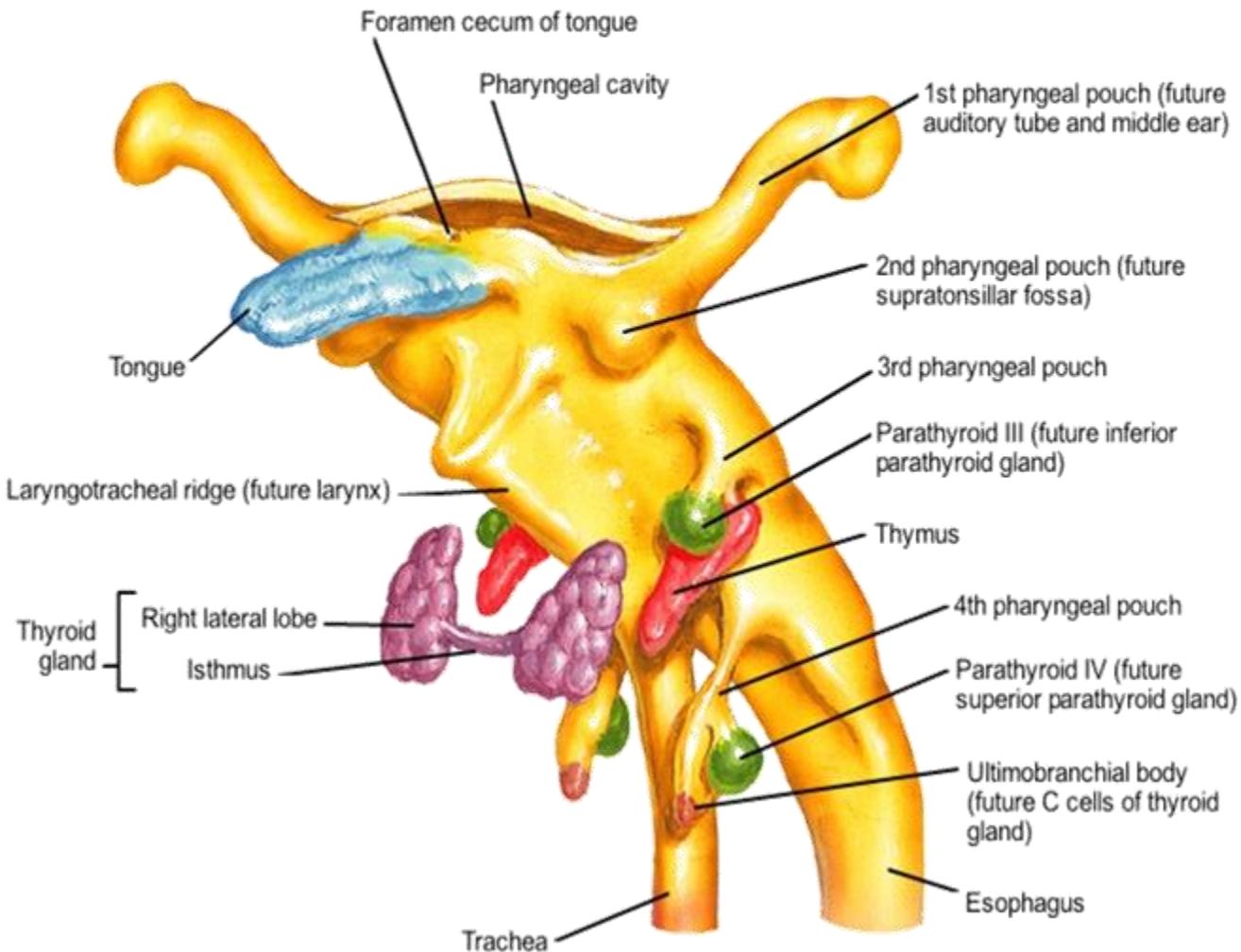


Pharyngeal Pouch, Cleft, Membranes

Fate of the Pharyngeal Pouches

Embryo at 4 to 5 Weeks

Pharynx (anterior view of left side)



Example Question

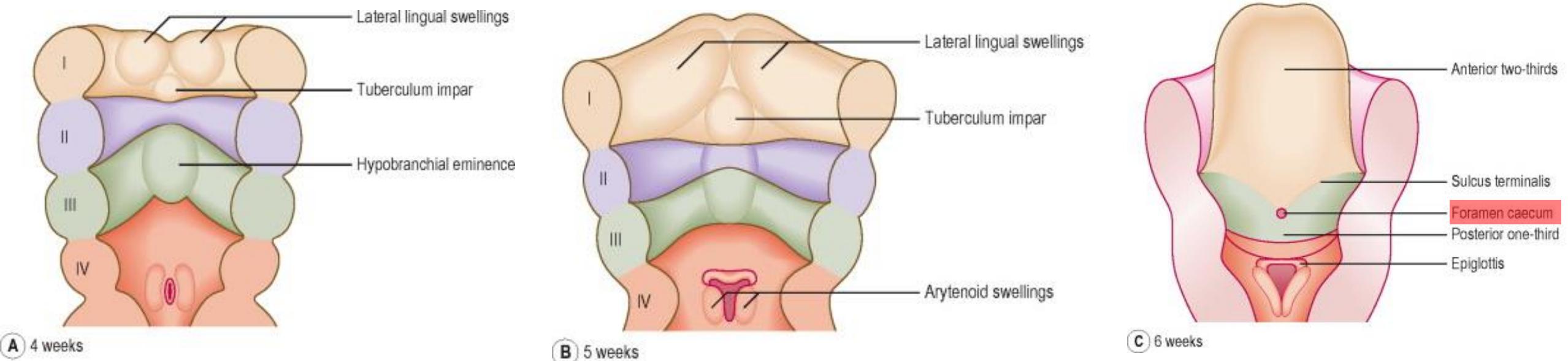
A toddler has a hearing defect. MRI scans show that the toddler has developmental defects in the auditory (Eustachian) tube and tympanic cavity. Which pharyngeal apparatus component mostly likely developed abnormally?

- A. Pharyngeal Arch 1 (“Mandibular” arch)
- B. Pharyngeal Pouch 1
- C. Pharyngeal Cleft 1
- D. Pharyngeal Arch 2 (“Hyoid” arch)
- E. Pharyngeal Pouch 2

Lecture Topic

1. Head & Neck Segments
2. Unsegmented Structures
3. Ecto-, Endo-, Mesoderm, NCC contributions

Tongue Development

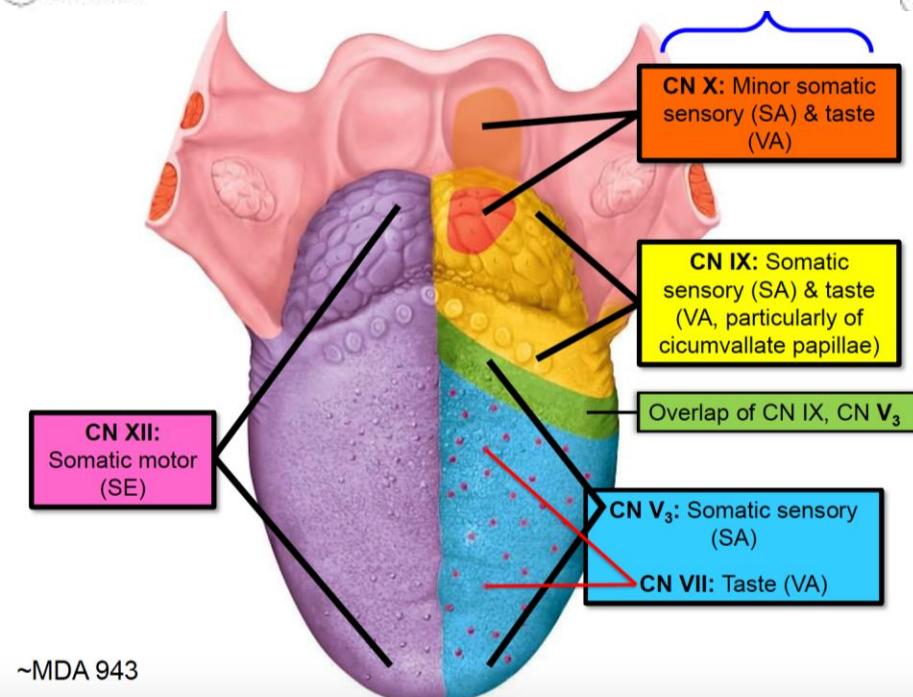
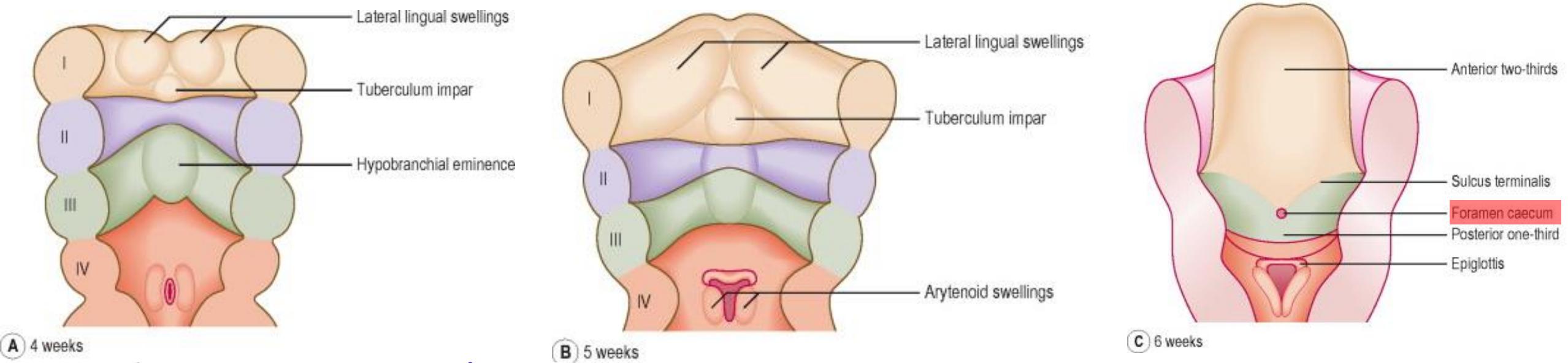


The sensory and mucosal aspects of the tongue is formed from swellings in Pharyngeal Arch 1–4.

- Arch 1 forms mucosa of anterior 2/3 of the tongue.
- Arch 2 is overgrown by arch 3 but provides taste innervation to anterior 2/3.
- Arch 3 and 4 form mucosa of posterior 1/3 of the tongue.

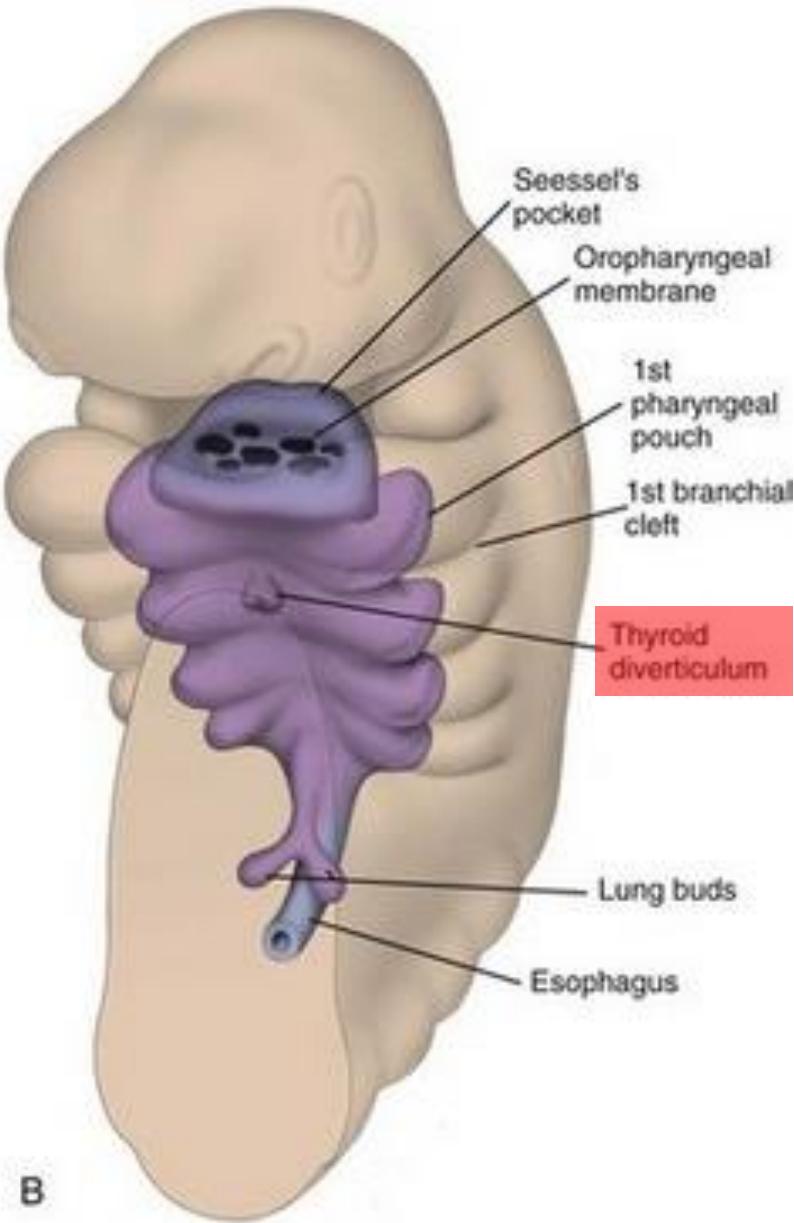
Tongue muscles form from occipital somites (hence CN XII motor innervation).

Tongue Development

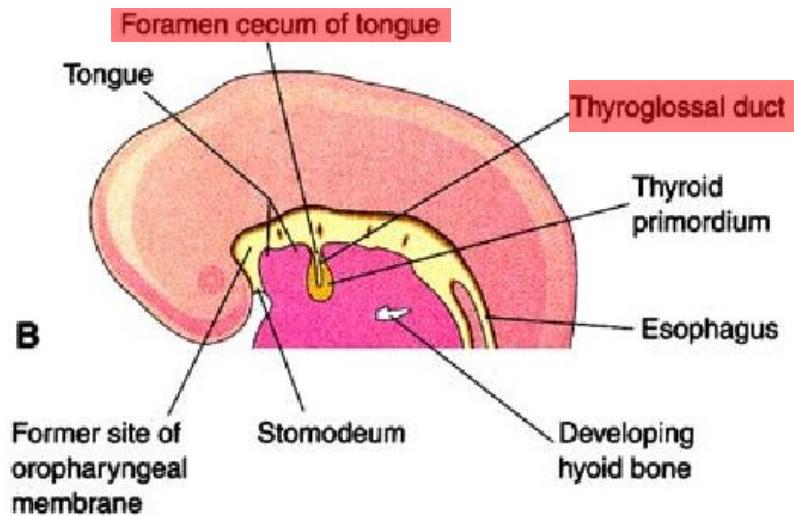
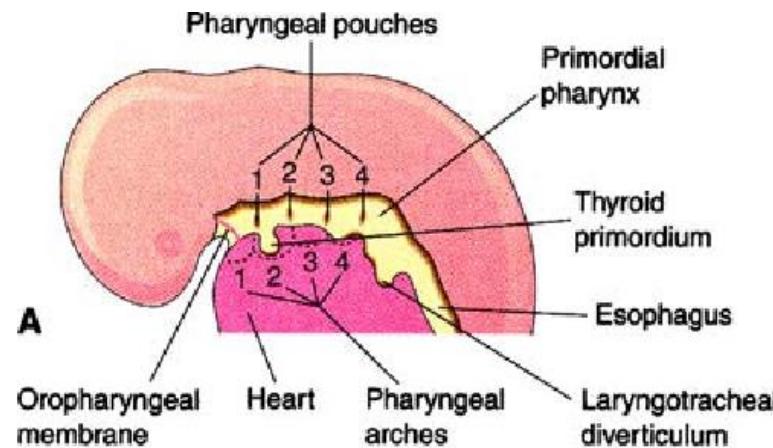
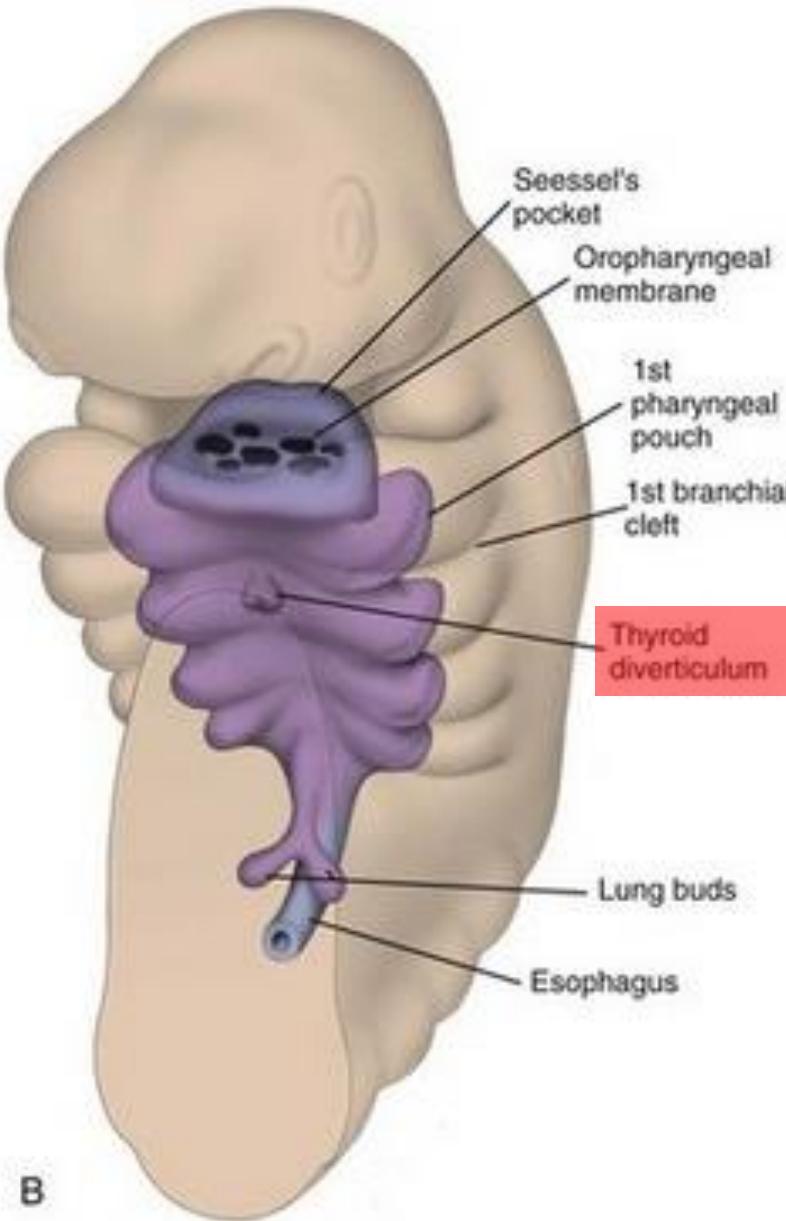


The complex origin of the tongue is why it is innervated by several cranial nerves.

Thyroid Development

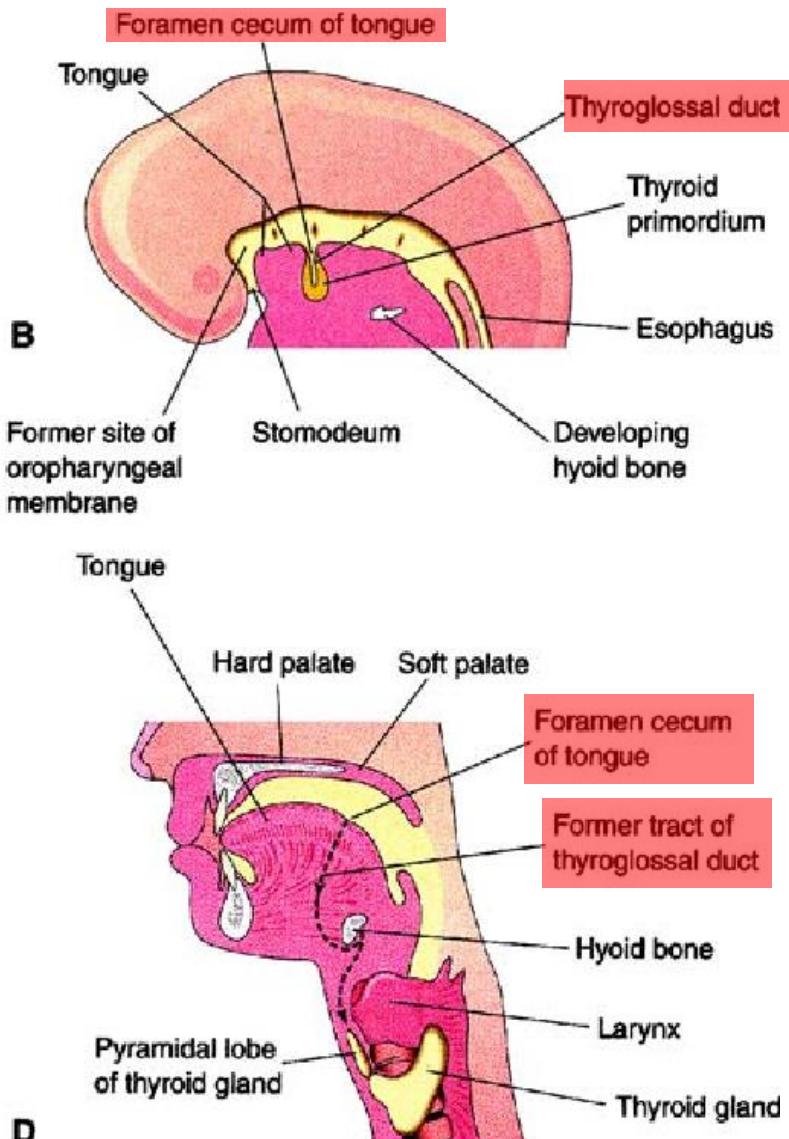
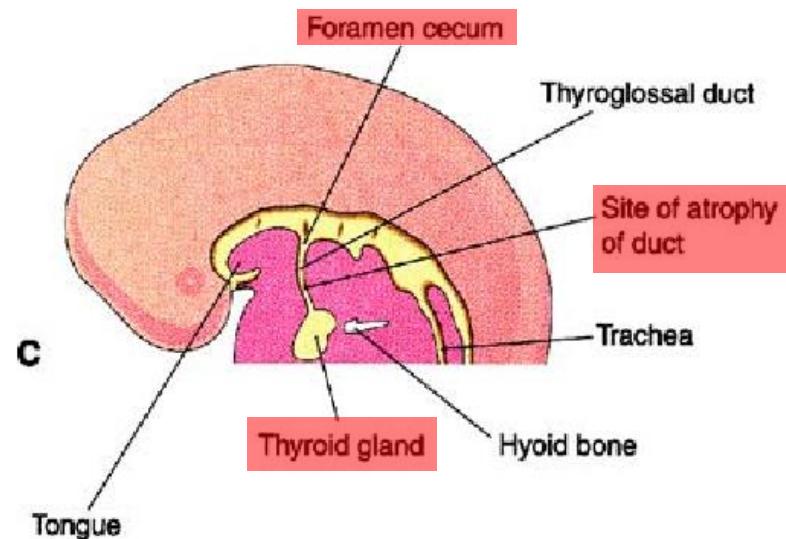
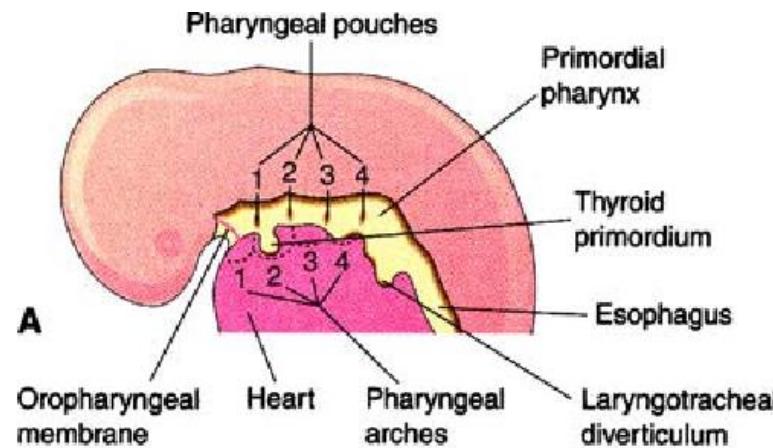
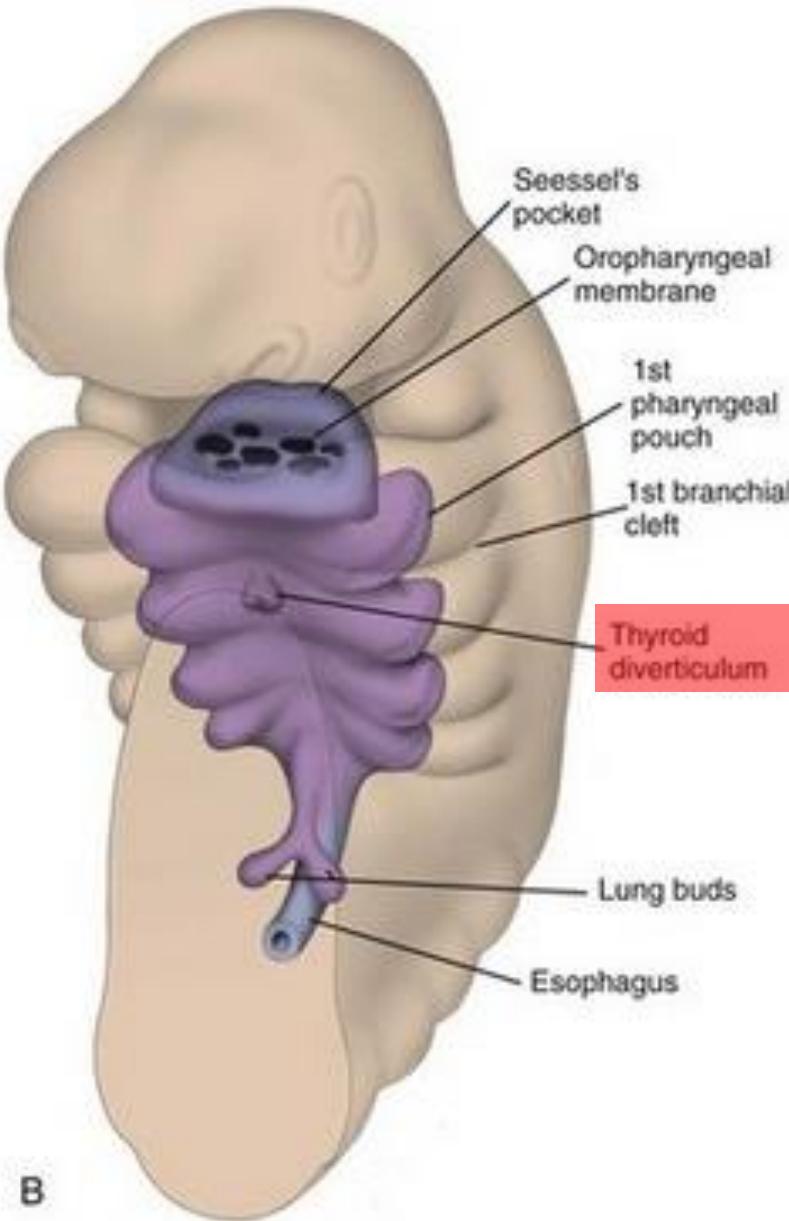


Thyroid Development



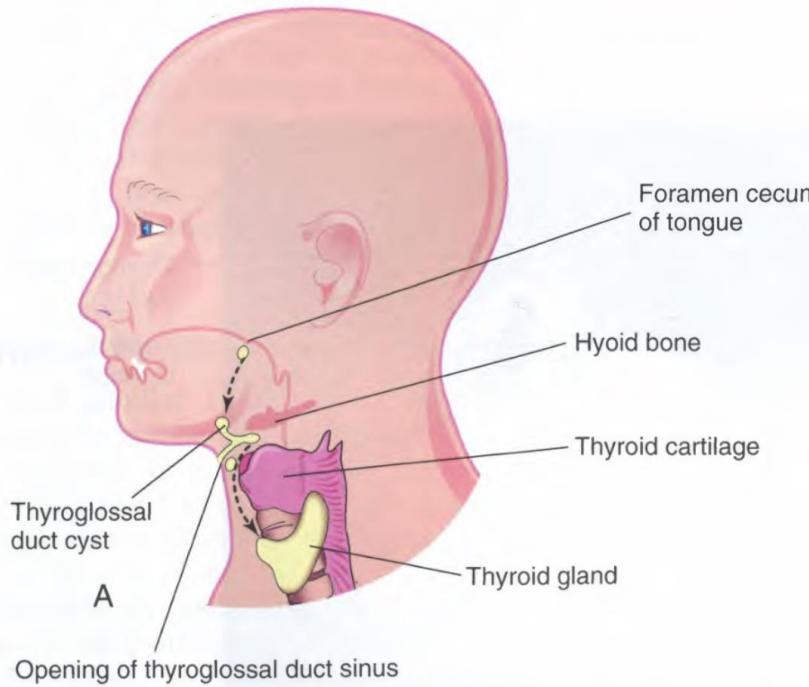
The thyroid primordium (diverticulum) descends, forming a **thyroglossal duct**.

Thyroid Development



\$ Clinical Correlate \$ Thyroglossal Duct Cyst, Sinus; Pyramidal Lobe

Thyroglossal Duct Sinus



Thyroglossal Duct Cyst

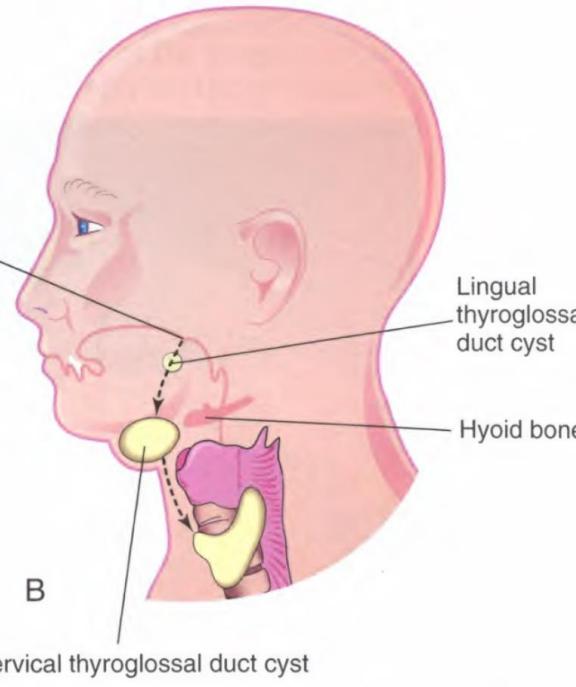


FIGURE 9-19 A, Sketch of the head and neck showing the possible locations of thyroglossal duct cysts. A thyroglossal duct sinus is also illustrated. The *broken line* indicates the course taken by the thyroglossal duct during descent of the developing thyroid gland from the foramen cecum to its final position in the anterior part of the neck. B, Similar sketch illustrating lingual and cervical thyroglossal duct cysts. Most thyroglossal duct cysts are located just inferior to the hyoid bone.

- Thyroglossal duct cyst forms in the midline (not lateral) of the neck from incomplete closure of the thyroglossal duct. Rupture of this cyst from infection, creates a sinus.
- Ectopic thyroid gland is the existence of gland tissue along the path of the thyroglossal duct (common).

Ectopic Thyroid Gland

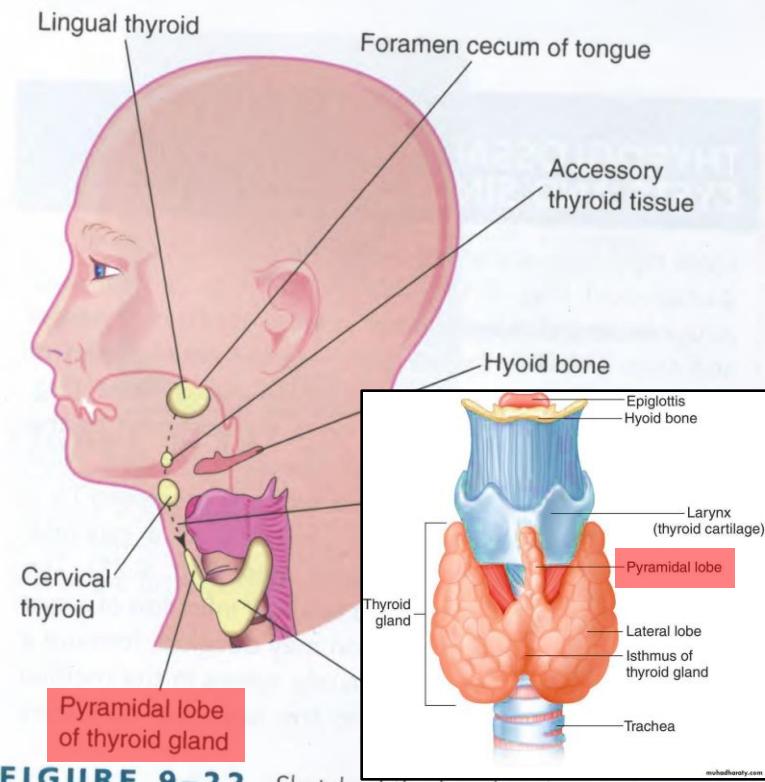
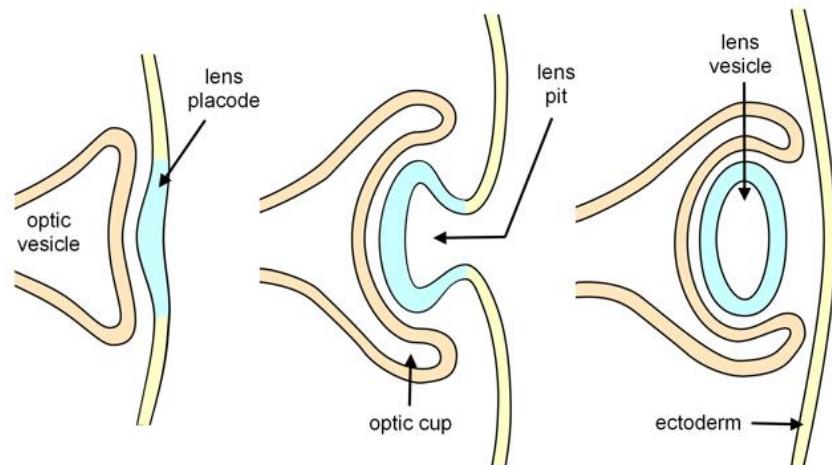
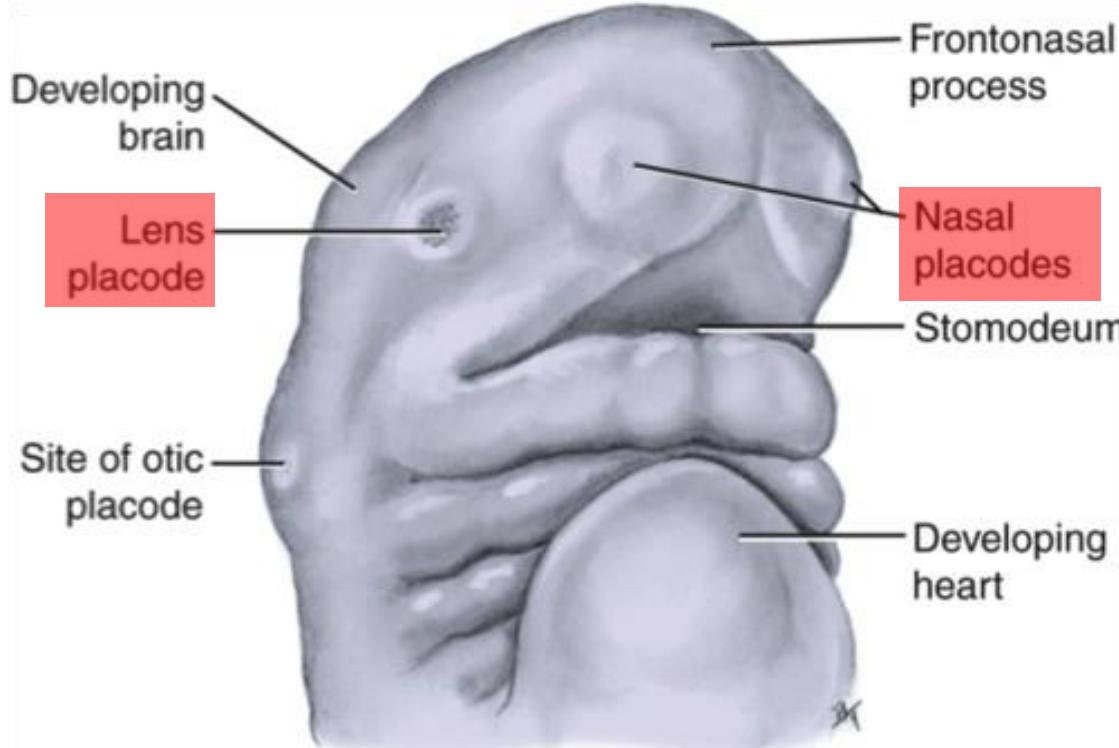


FIGURE 9-22 Sketch of the head and neck showing the usual sites of ectopic thyroid tissue. The *broken line* indicates the path followed by the thyroid gland during its descent and the former tract of the thyroglossal duct.

Placodes

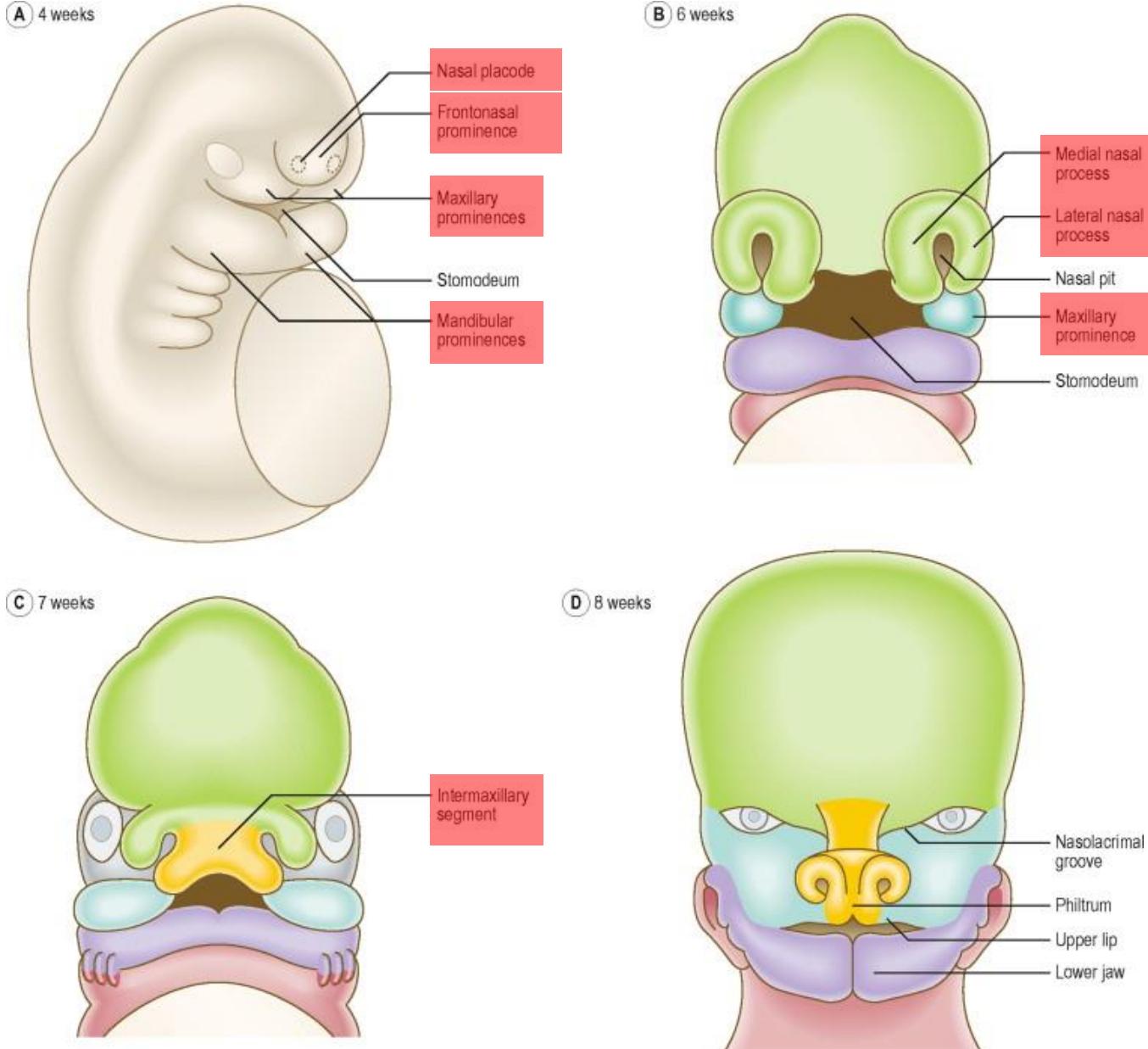


Placodes: ectodermal discs that form special sense organs of the head.

- nasal placode > mucosa of nasal cavity
- lens placode > lens of the eye
- otic placode > vestibule & cochlea of the ear
- neurogenic placodes > parts of CNs

- nasal placode associated with CN I
- lens placode associated with CN II
- otic placode associated with CN VIII

Development of the Face



Facial Primordia

- **Frontonasal prominence:** forms the forehead and dorsum/apex of nose.
 - Lateral nasal prominences: form sides of the nose.
 - Medial nasal prominences: form the intermaxillary segment that eventually gives rise to the nasal septum, middle part of upper lip, and philtrum (medial cleft).
- **Left & right maxillary prominences:** form upper cheek regions and upper lip.
- **Left & right mandibular prominences:** form lower jaw, lower lip, and lower cheek regions.

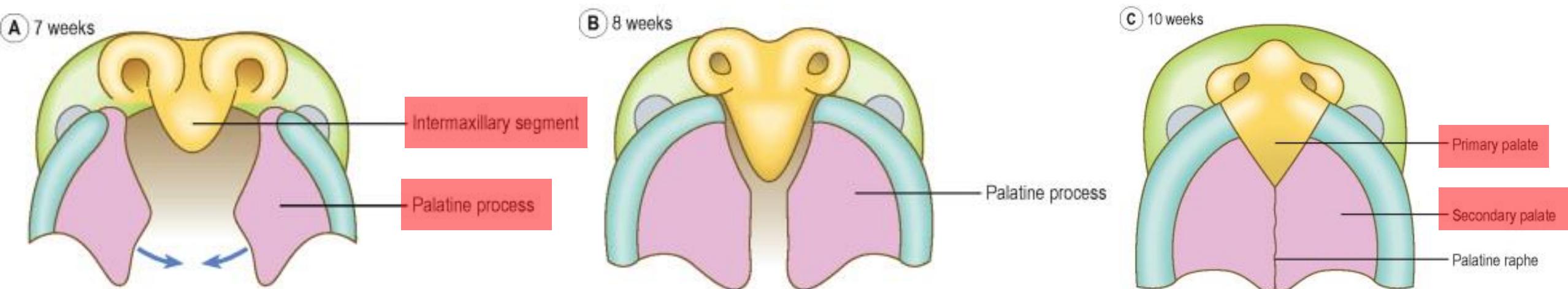
Development of the Face



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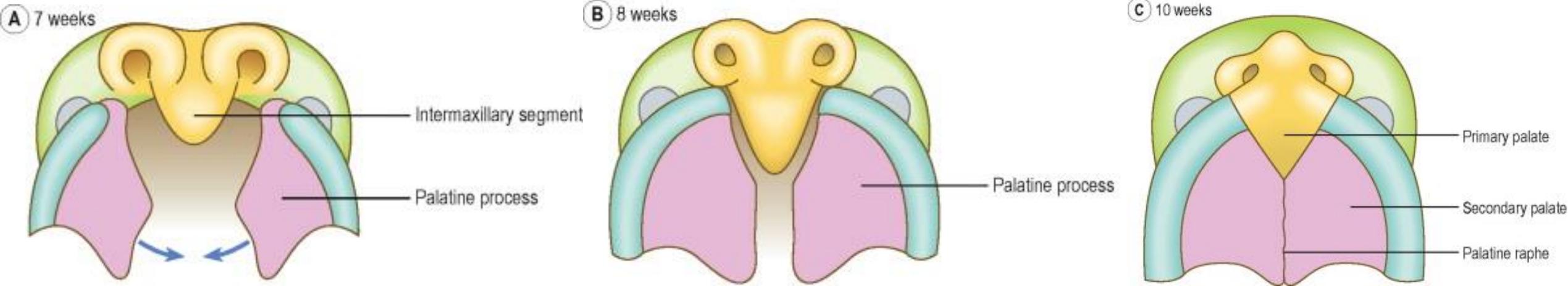
⌘ Clinical Correlate ⌘ Cleft Lip, Cleft Palate



The palate forms through two stages

- Primary palate: extension of the intermaxillary segment from the nasal prominences.
- Secondary palate: joining of the palatine process from the maxillary prominences.

Clinical Correlate Cleft Lip, Cleft Palate



Cleft Lip & Palate: caused by incomplete closure of the maxilla and/or palate. Occurs in 1 in ~1,000 births.

- Results in abnormal facial appearance, defective speech.
- Treatment involves surgery and any therapies (e.g., speech) to improve related conditions.

Skull Development

3 Embryonic Components:

chondrocranium: **endochondral** cranial base that later ossifies

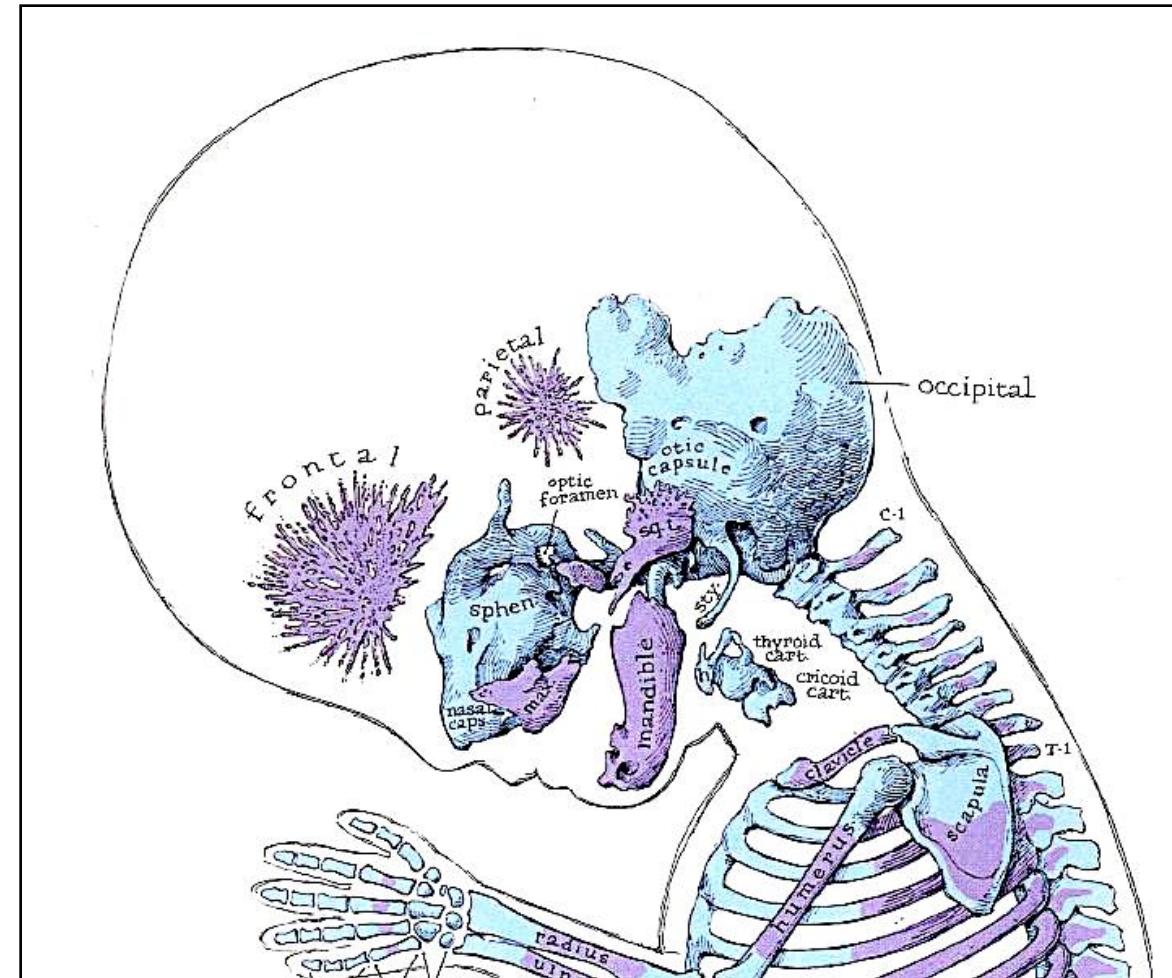
- occipital, sphenoid, ethmoid, temporal (petrous part)

desmocranum: **membranous** bone to the sides and tops of braincase; forms the calvaria

- frontal, occipital, parietal

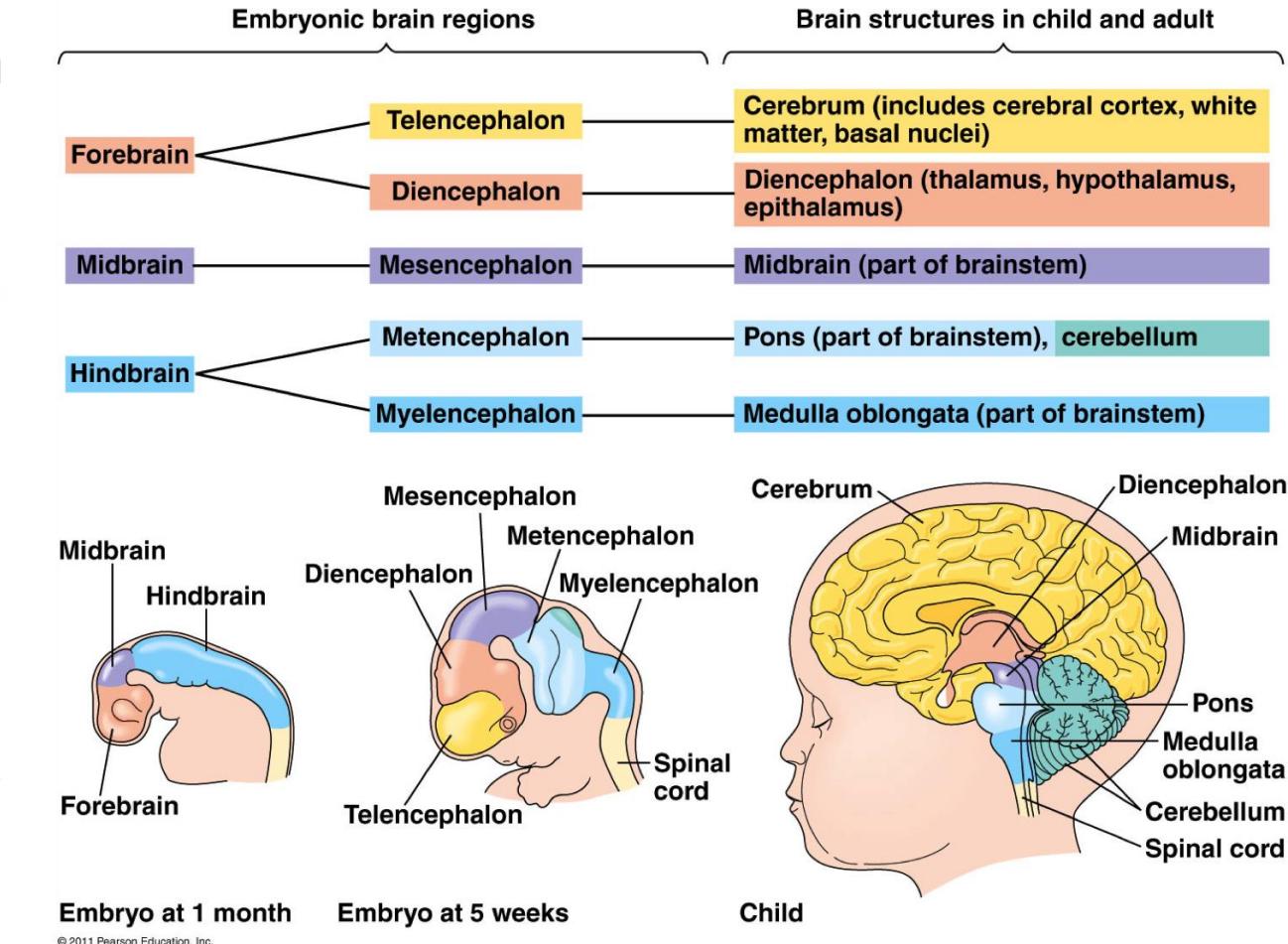
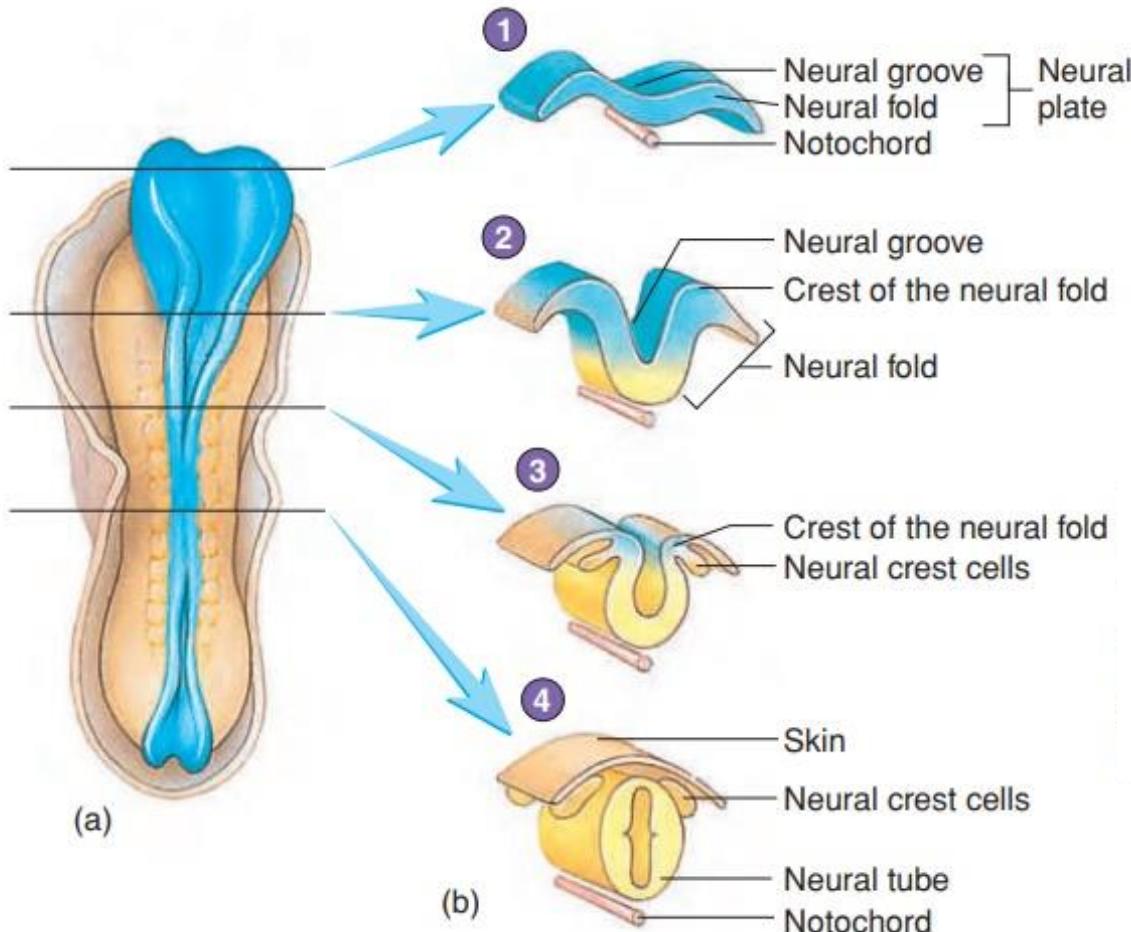
viscerocranum: derived from pharyngeal arches via **membranous** ossification.

- temporal (squamous part), maxilla, zygomatic, mandible

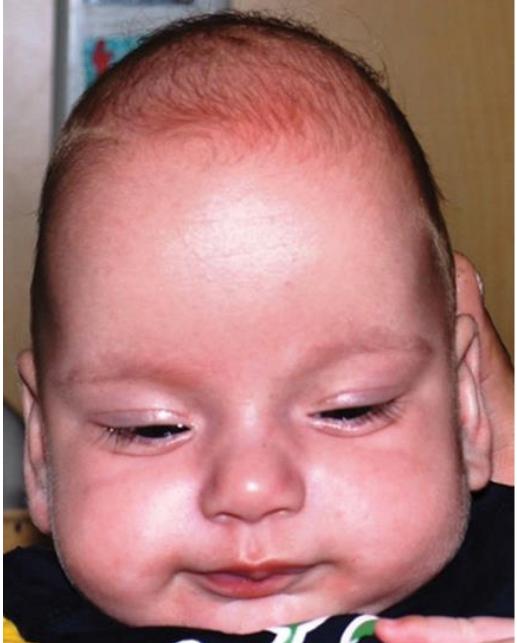


Brain Development

Note: Brain anatomy will be covered in detail in Neuroanatomy next semester.



\$ Clinical Correlate \$ Craniosynostosis, Microcephaly, Hydrocephalus

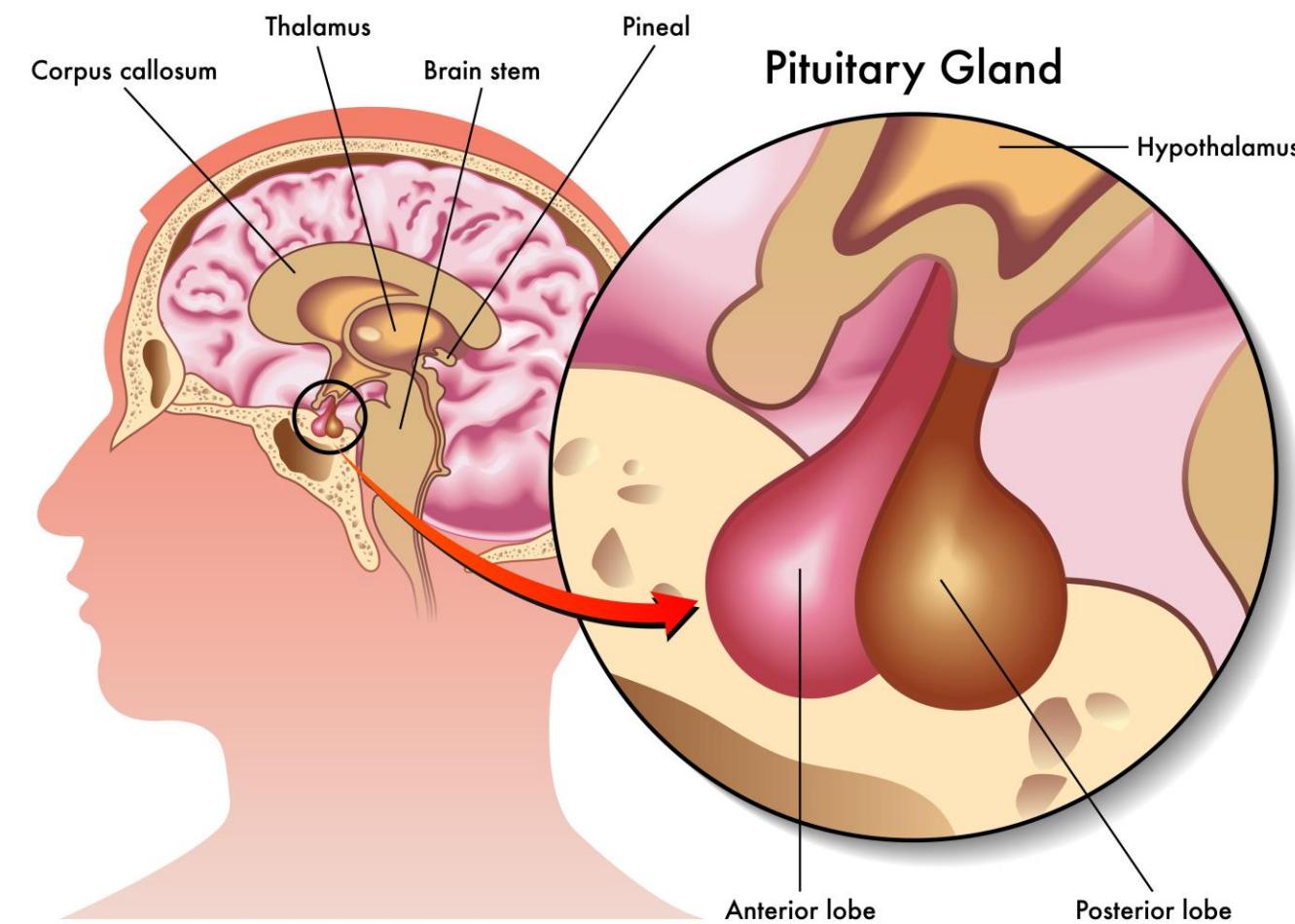


Craniosynostosis: deformity in the cranium due to premature closure of sutures/fontanelles. Type of defect depends on which suture closes prematurely.

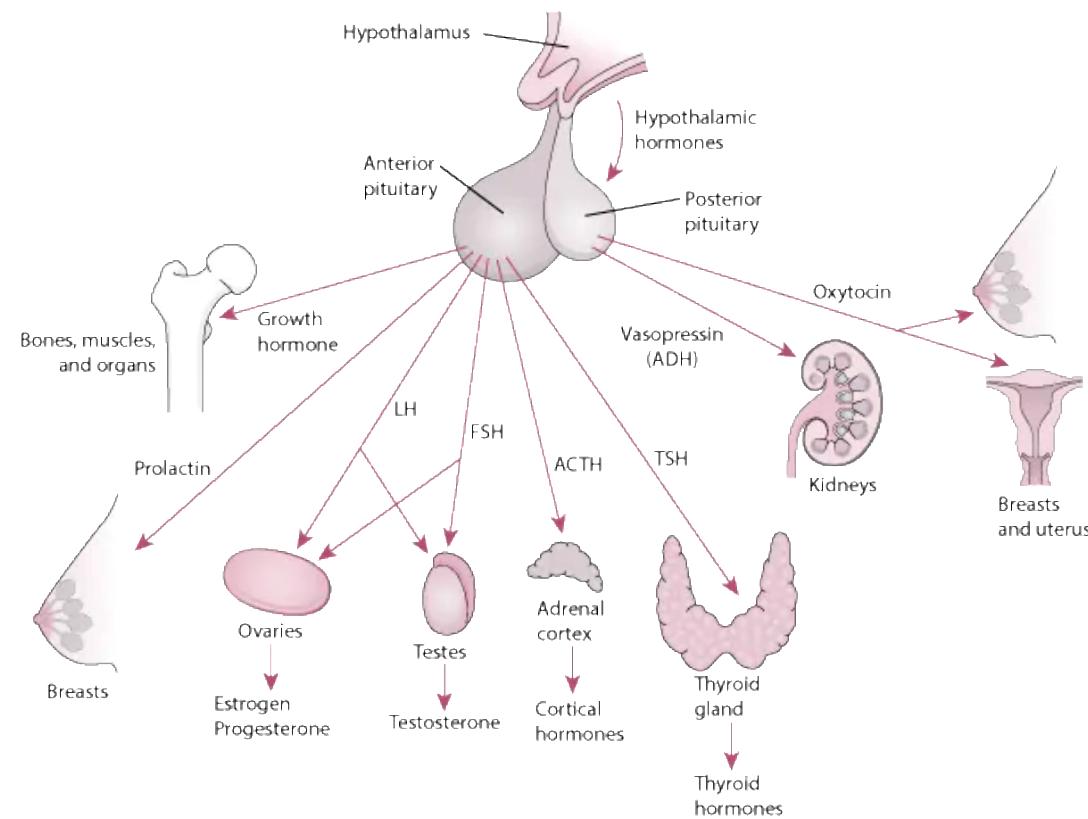
Microcephaly: caused by abnormal development of the brain, rather than premature closure of sutures. Often results in mental deficiency.

Hydrocephalus: caused by elevated pressure in ventricles due to CSF buildup (resulting in enlarged brain ventricles). Occurs 1 in ~1,000 births.

Pituitary

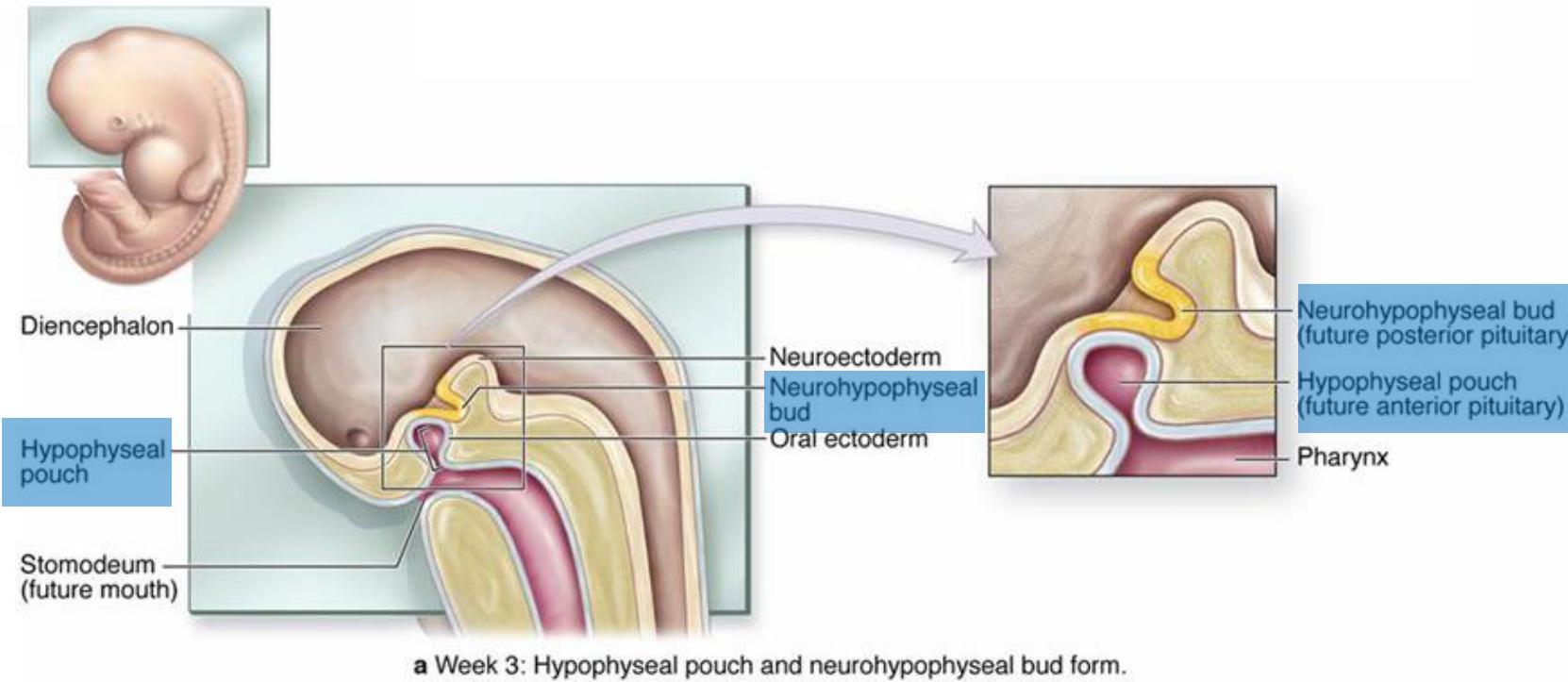


Pituitary Gland: pea-sized endocrine gland that receives signal from the brain via the hypothalamus and produces hormones for the entire body.



Pituitary

Anterior and posterior lobes have completely different origins!



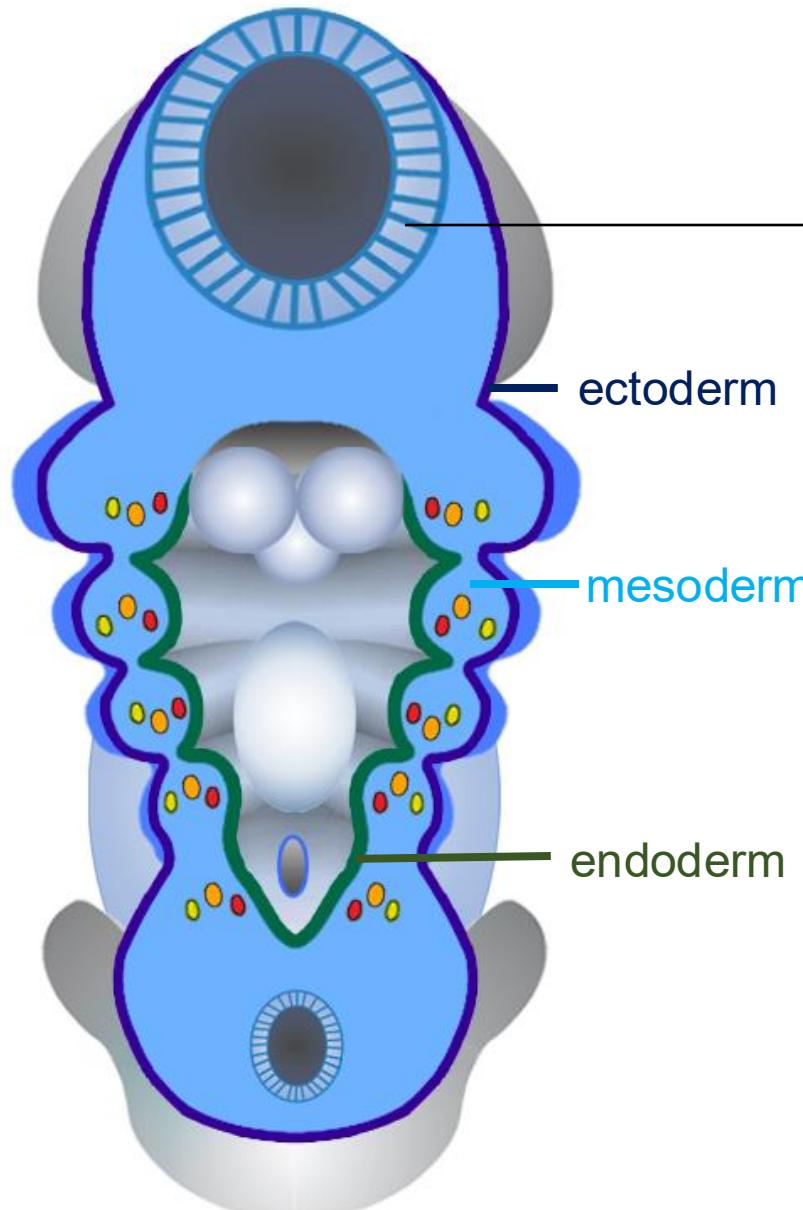
Anterior lobe: from upgrowth of ectodermal roof of the mouth (hypophyseal pouch).

Posterior lobe: from downgrowth of floor of embryonic brain (also ectodermal in origin) (neurohypophyseal bud).

Lecture Topic

1. Head & Neck Segments
2. Unsegmented Structures
3. Ecto-, Endo-, Mesoderm, NCC contributions

Germ Layer Contributions to the Head & Neck



Ectoderm

- **brain & cranial nerves:** from ectoderm-derived neural tube
- **placodes:** eye lens, vestibule, cochlea, nasal cavity
- parotid gland

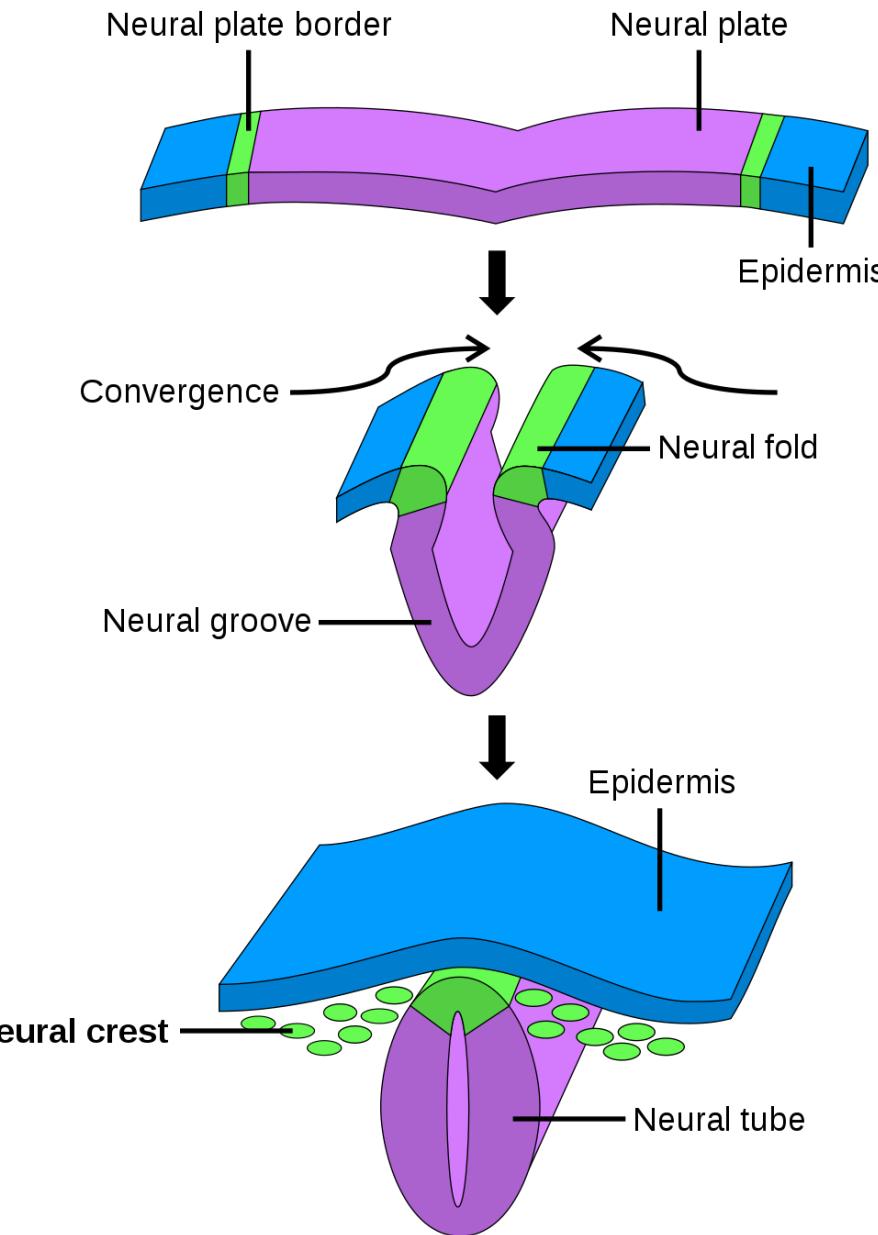
Mesoderm

- **pharyngeal structures** (bone/cartilage, arteries, muscles): in general from mesoderm but interacts with ectoderm-derived **neural crest cells** (next section).
- **skull**

Endoderm

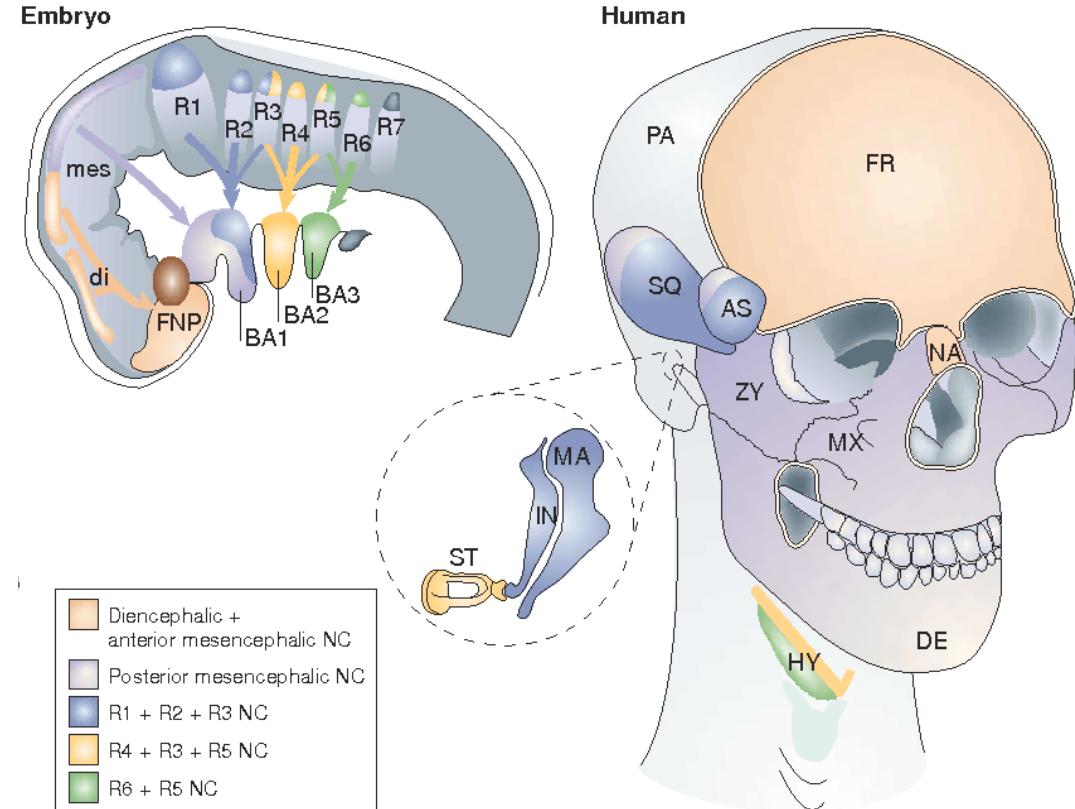
- **glands** (except for parotid gland) & **mucosae**

Neural Crest Cells



- Ectoderm-derived but forms secondary mesenchyme (mesectoderm) to form “mesoderm”-derived structures.
- Migrates all over the body to turn into cartilage and bone, teeth, skin, melanocytes, smooth muscles, glands, adipose tissue, neurons, glia, adrenal medulla, etc.
- Responsible for most of the connective and skeletal tissue of the head, nerves, and pigment cells

Neural Crest Derivatives in Head and Neck



Cartilage & Bone

facial bones (frontal, nasal, maxilla, zygomatic, mandible, etc.), some in the cranial base (parts of sphenoid bone), middle ear ossicles (malleus, incus, stapes), hyoid, laryngeal cartilage.

Nervous System

sensory ganglia of CN V, VII, IX, X (branchiomeric nerves) and peripheral nerves.

Muscles

(muscles are from primary mesenchyme, not NCC)

Other

- teeth: dentine (not enamel)
- dermis and hypodermis of face and neck
- choroid and sclera of eye
- melanocytes in the iris (and rest of the body).
- meninges
- connective tissues of lacrimal, salivary, thymus glands

Neural Crest Cells



Affenpinscher Brussels Griffon Cavalier King Charles Spaniel Chihuahua Chinese Crested



English Toy Spaniel Havanese Italian Greyhound Japanese Chin Maltese



Manchester Terrier Miniature Pinscher Papillon Pekingese Pomeranian



Pug Shih Tzu Silky Terrier Toy Fox Terrier Toy Poodle Yorkshire Terrier



Husky skull



Chihuahua skull

⌘ Clinical Correlate ⌘ Treacher Collins Syndrome

Genetic disorder that involves faulty migration of NCC in pharyngeal arches 1 and 2. Occurs in 1 in 50,000 births.

Symptoms include:

- Hearing loss
- Downturned eyes
- Hypoplasia (underdevelopment) of midface
- Micrognathia (small lower jaw)
- Cleft palate



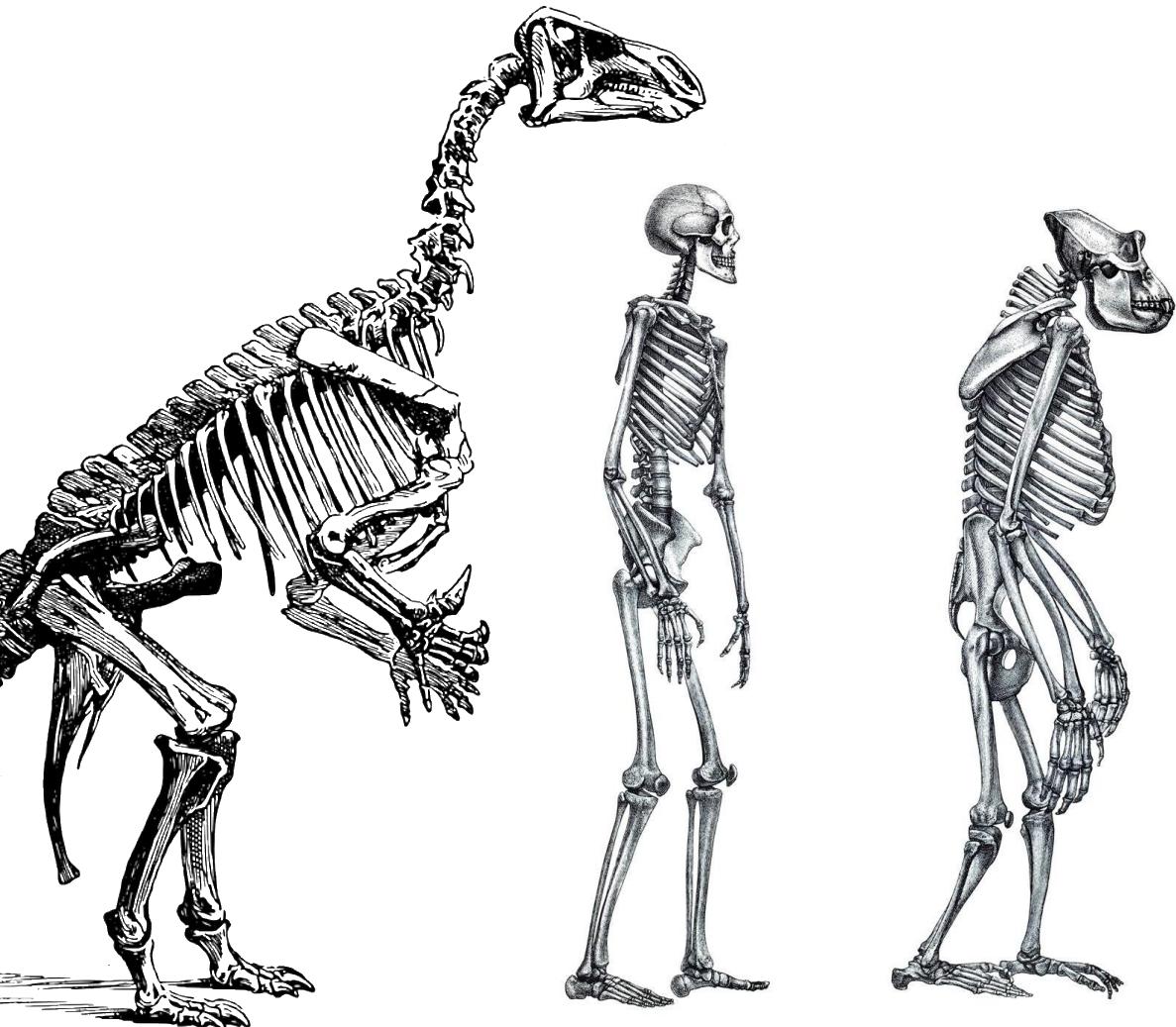
Example Question

A six-year-old girl exhibits a swelling in the anterior part of her neck, just inferior to the hyoid bone. Which of the following may explain the swelling?

- A. intact cervical sinus
- B. obliteration of the cervical sinus
- C. intact thyroglossal duct
- D. obliteration of thyroglossal duct
- E. incomplete closure of secondary palate

The Head (and neck that supports it) is a Special Region

Full of Unique Features



Doctor-Patient Interface



Source: Photo by A. Yahya; Huxley 1863; Dollo

“High-Yield” Topics

- Derivatives of pharyngeal arches, pouches, clefts, and membranes.
- Development of the face, skull, palate, tongue, thyroid gland, placodes, and pituitary gland.
- Germ layer and neural crest cell origins of head & neck structures.
- Clinical implications arising from abnormalities in head & neck development.

Lecture Feedback

Lecture Feedback:

Click [HERE](#)

Questions:

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