

Pharyngeal arches and pouches

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Pharyngeal arches: a definition

A **segmental series** of five paired swellings that surround the foregut between days 20 to 35 of embryonic development. These segments, which are unique to vertebrates, are “wedged” between the developing forebrain and heart.



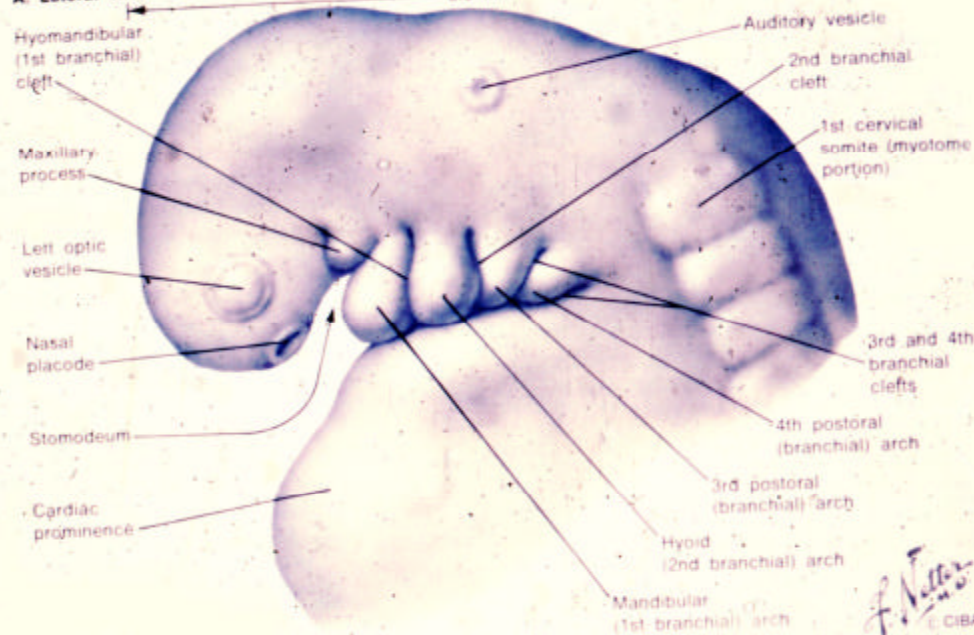
Pharyngeal arches

- a.k.a. visceral or branchial arches
- Develop (and disappear as distinctively visible structures) in a rostro-caudal sequence
- Require neural crest cells for their development
- Even after they are no longer visible externally, they have a lasting impact on the anatomy of the head and neck and of the great vessels

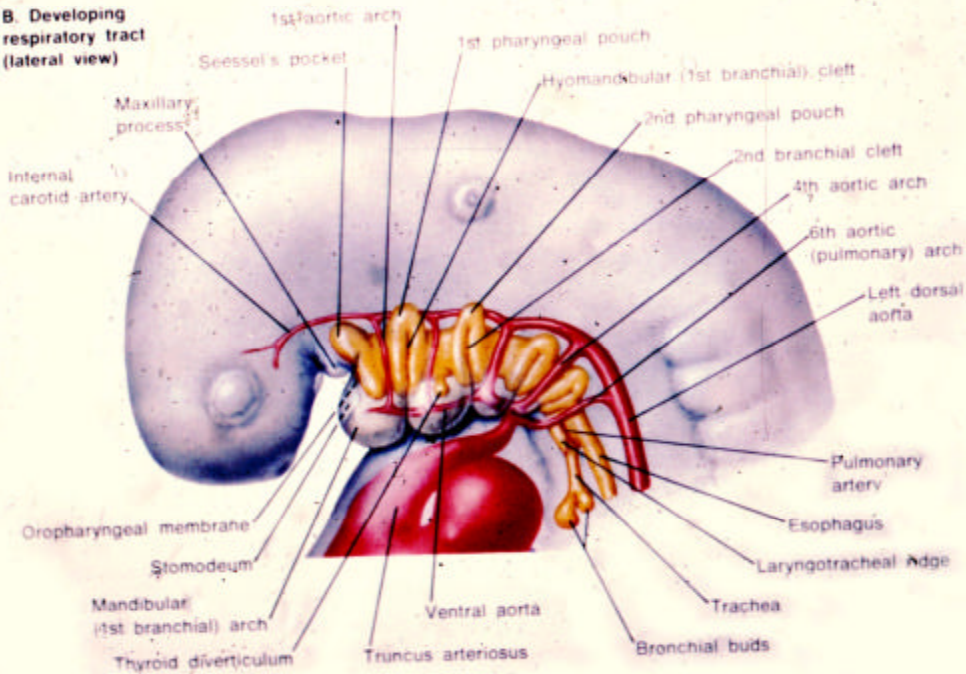
Plate 2

Embryo at 4 to 5 Weeks

A. Lateral view



B. Developing respiratory tract (lateral view)



5 Pharyngeal arches

5 Aortic arches

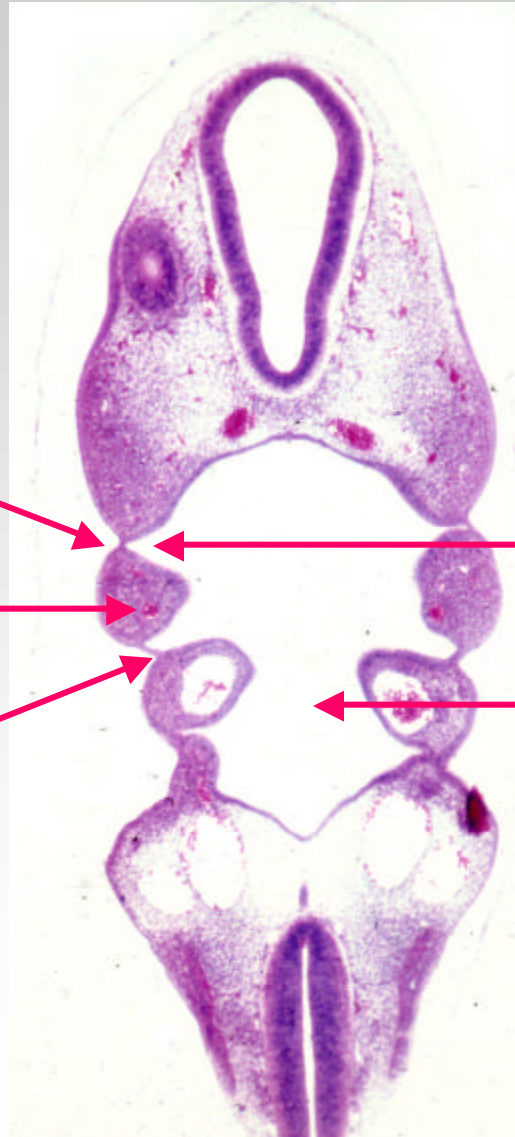
Arches numbered 1-6

Arches, grooves, pouches, and membranes

Pharyngeal groove

Pharyngeal arch

Pharyngeal membrane



Pharyngeal pouch

Foregut

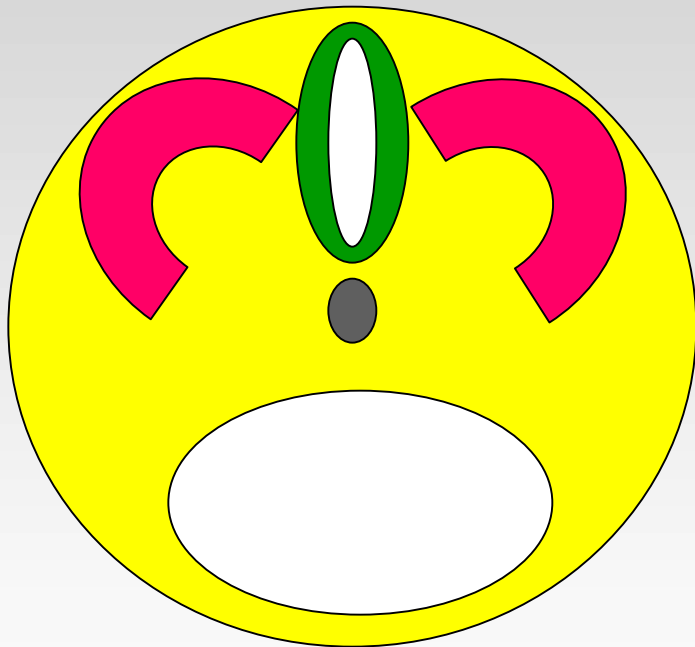
Pharyngeal arches are unique to vertebrates (subphylum of chordates)



Sedentary

Passive, filter-feeding

Basic body plan of all chordates (incl. vertebrates)



Dorsal hollow neural tube

Segmented lateral mesoderm

Central notochord

Ventral digestive tube

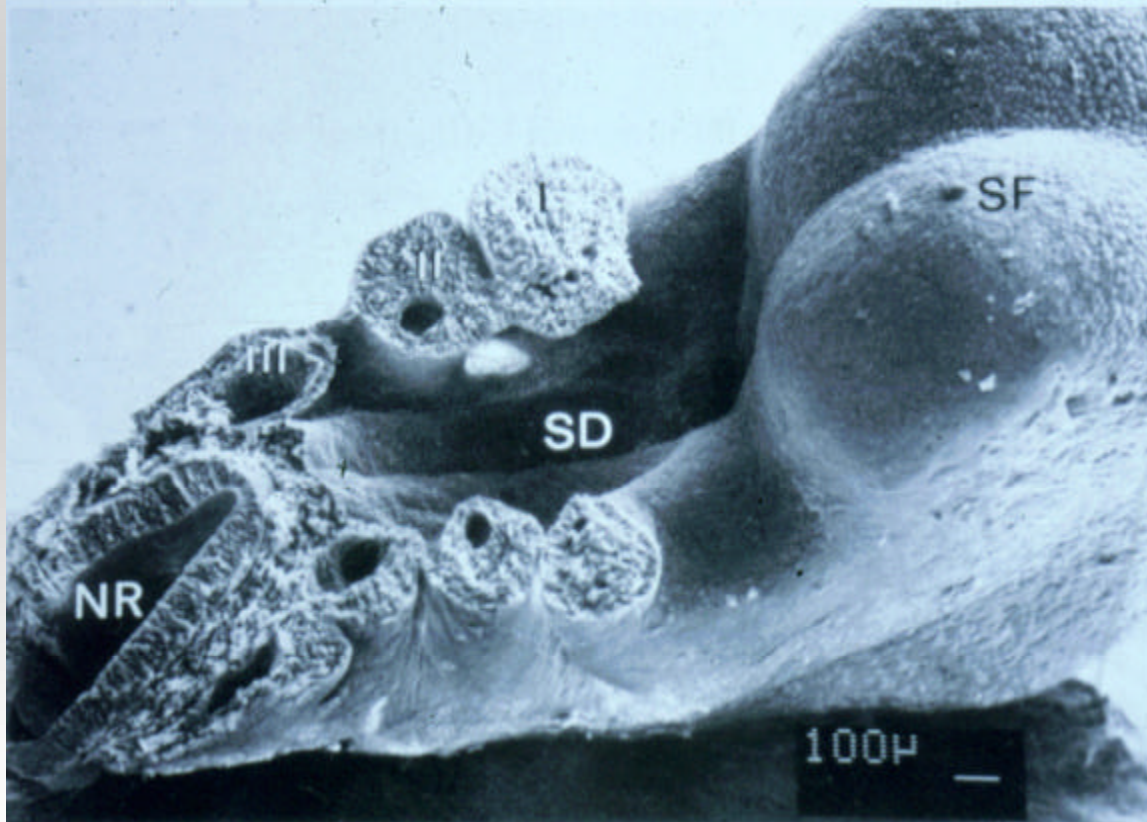
(Pharyngeal gill slits)

Evolution of vertebrates involved:

- Development of organs of special sense in head region to detect prey
- Development of a large neural circuitry (the brain) to integrate input and responses
- Development of an effective feeding apparatus (jaws: pharyngeal arch derivatives)
- Development of an improved respiratory apparatus (gills: pharyngeal arch derivatives).

This required the recruitment of an existing group of cells: neural crest cells, for a new role.

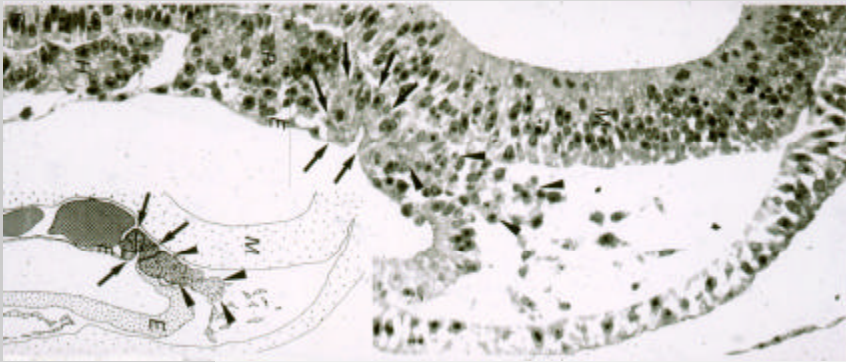
Pharyngeal cleft transient “gill-slit”



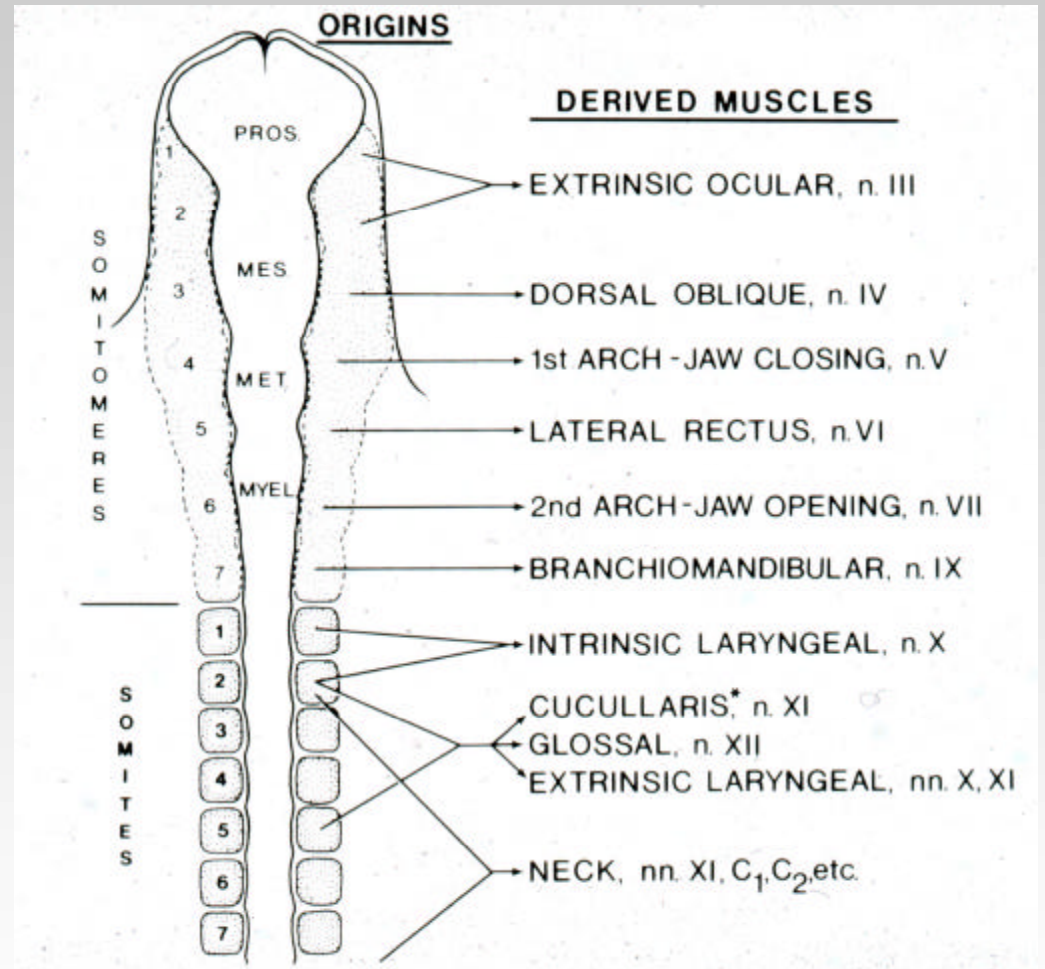
Mesenchyme in cephalic region derived from:

- **Mesoderm**
- **Neural crest**

Cephalic mesoderm

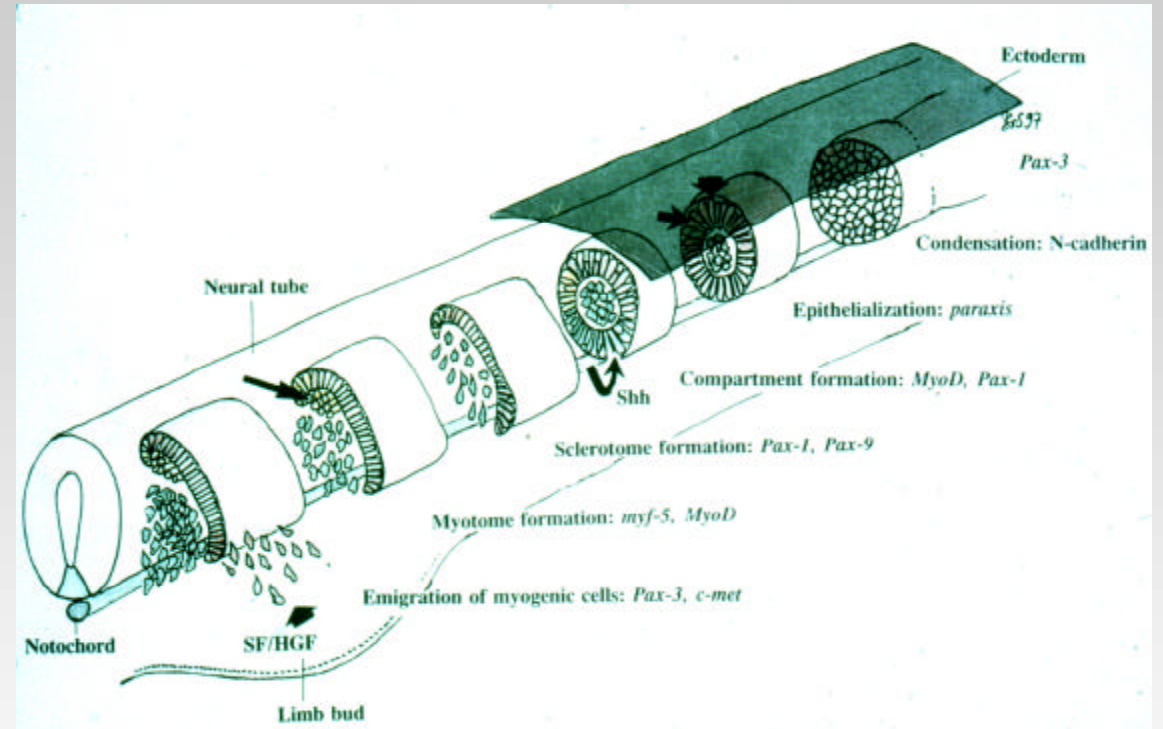
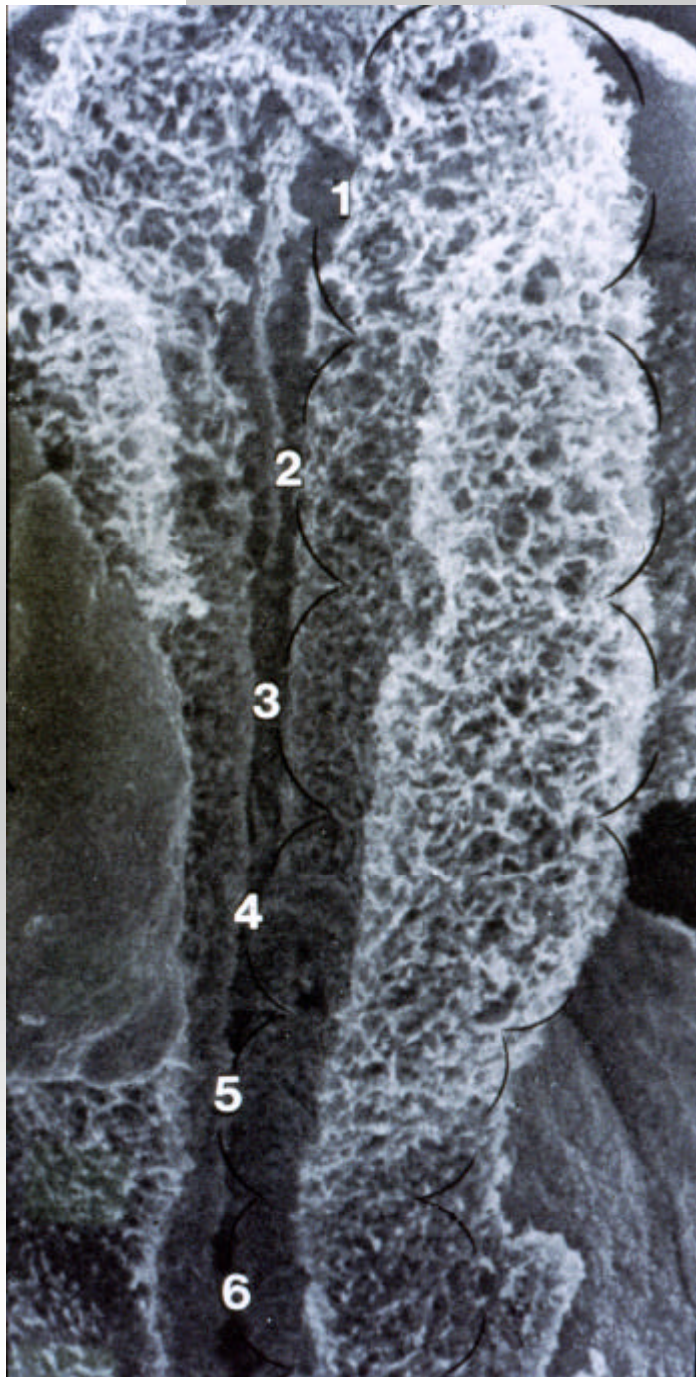


Prechordal plate origin ?



Somitomeres, not somites

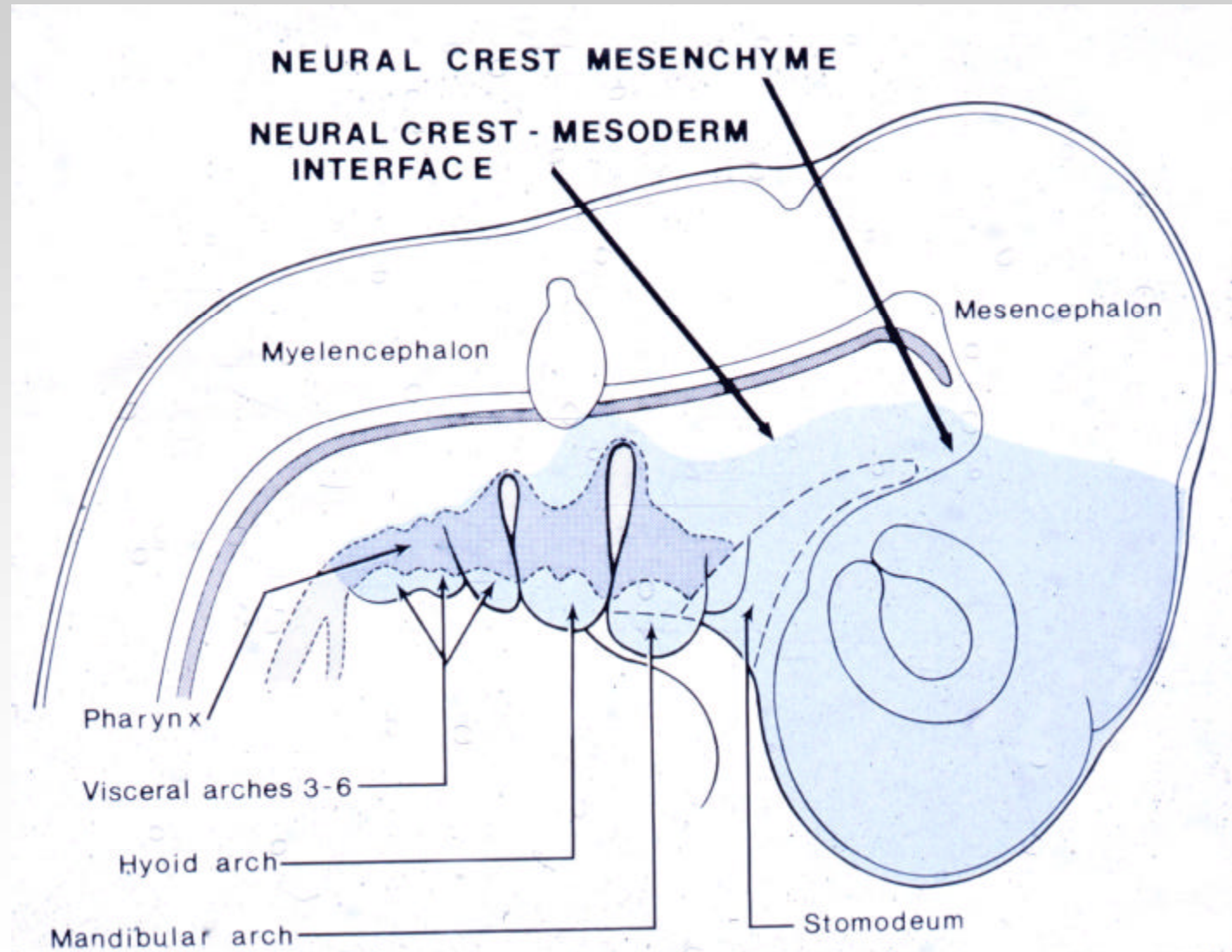
Somitomes



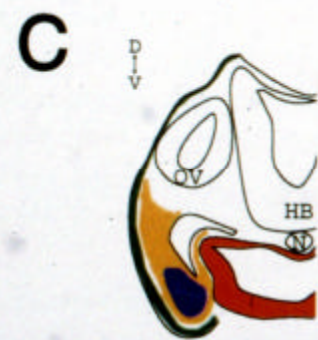
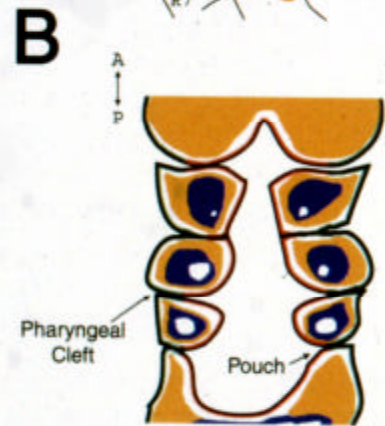
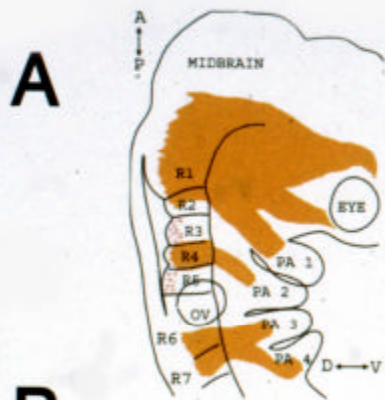
Somitogenesis

Cephalic somitomes

Neural crest and mesoderm in H&N area

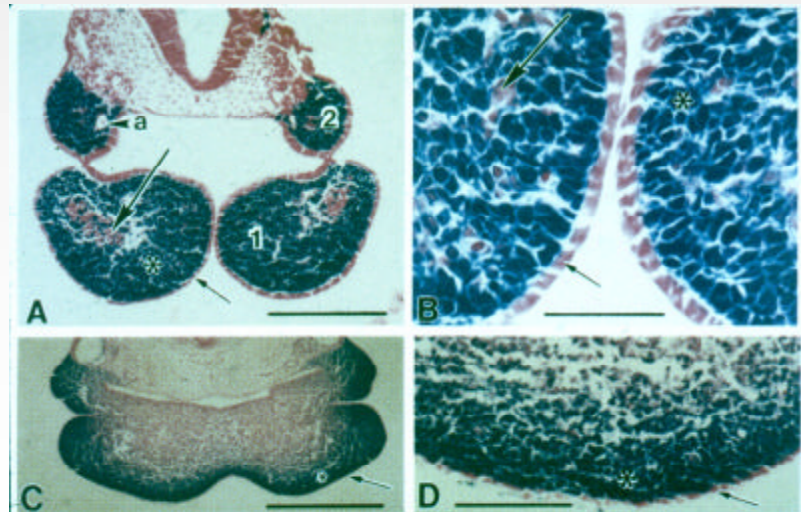
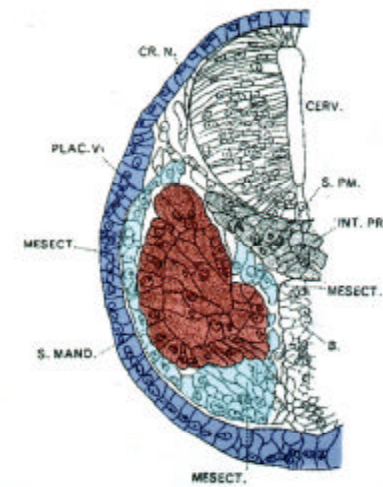
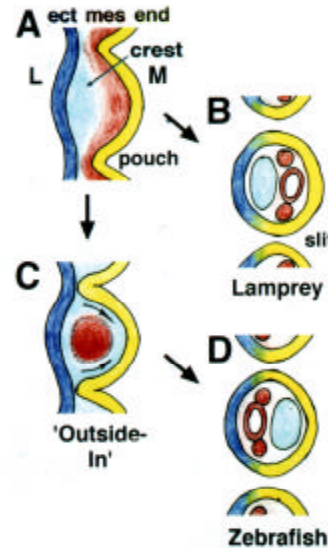


Neural crest in pharyngeal arches

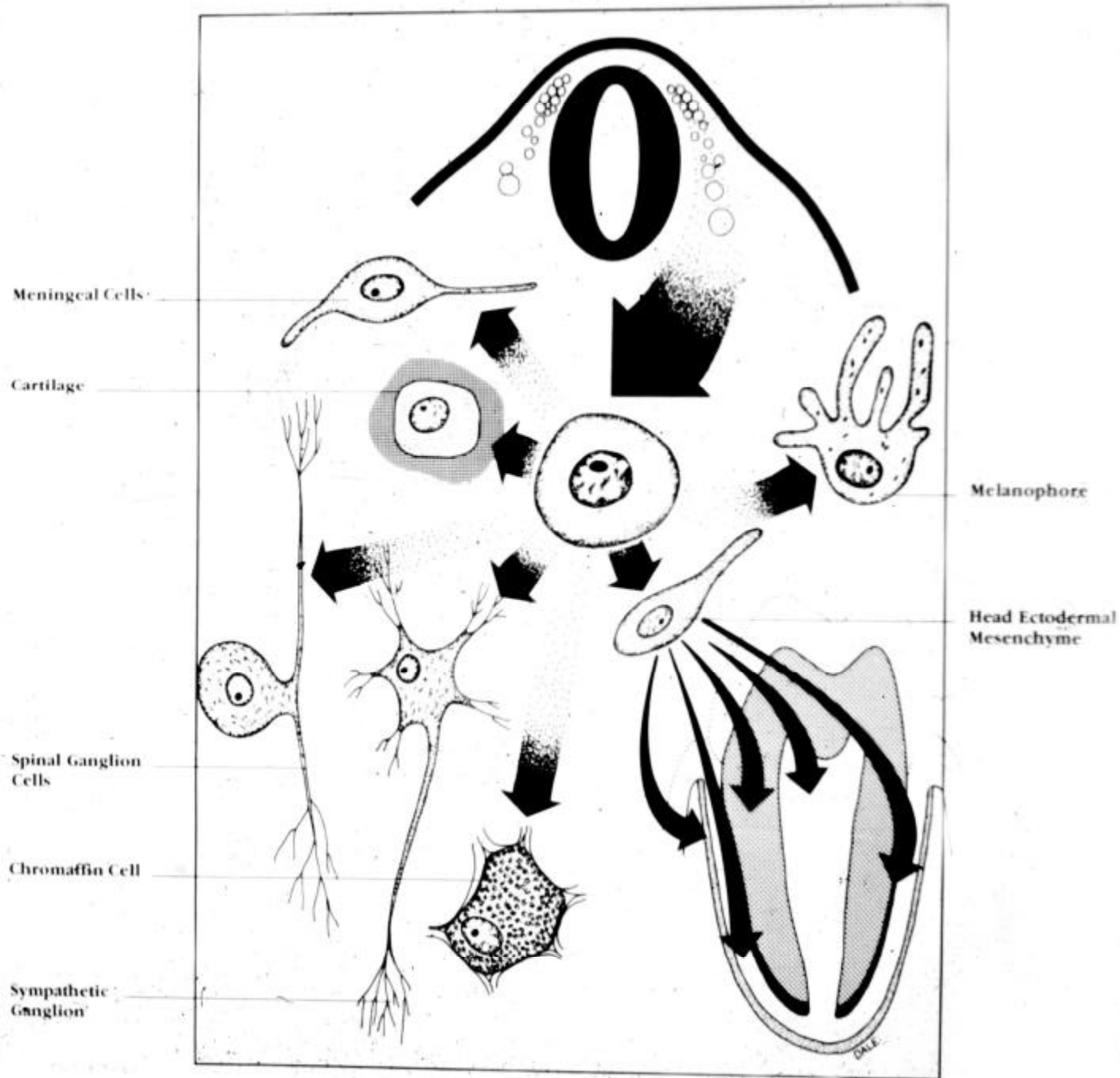


Neural Crest
 Mesoderm

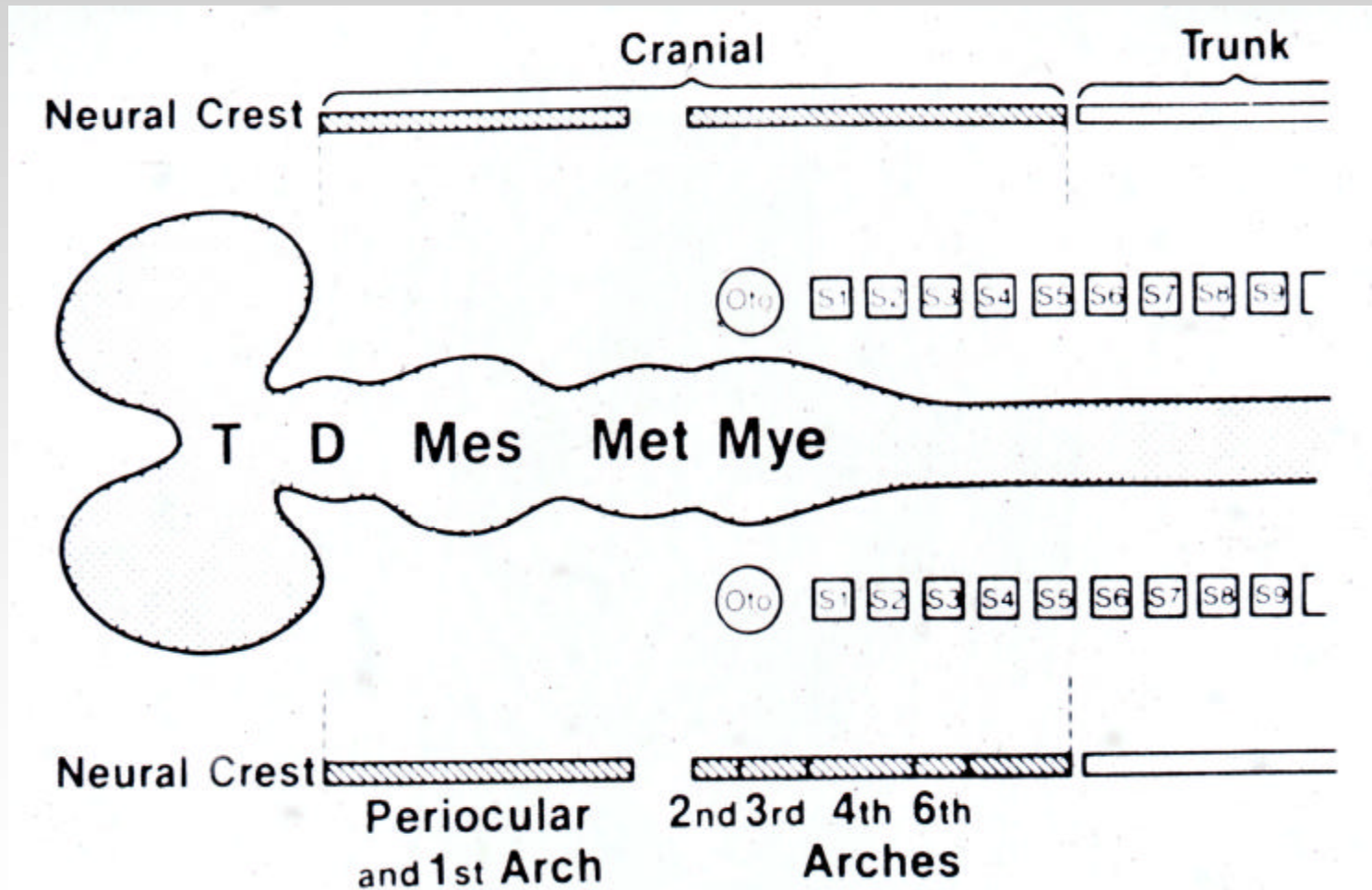
 Ectoderm
 Endoderm



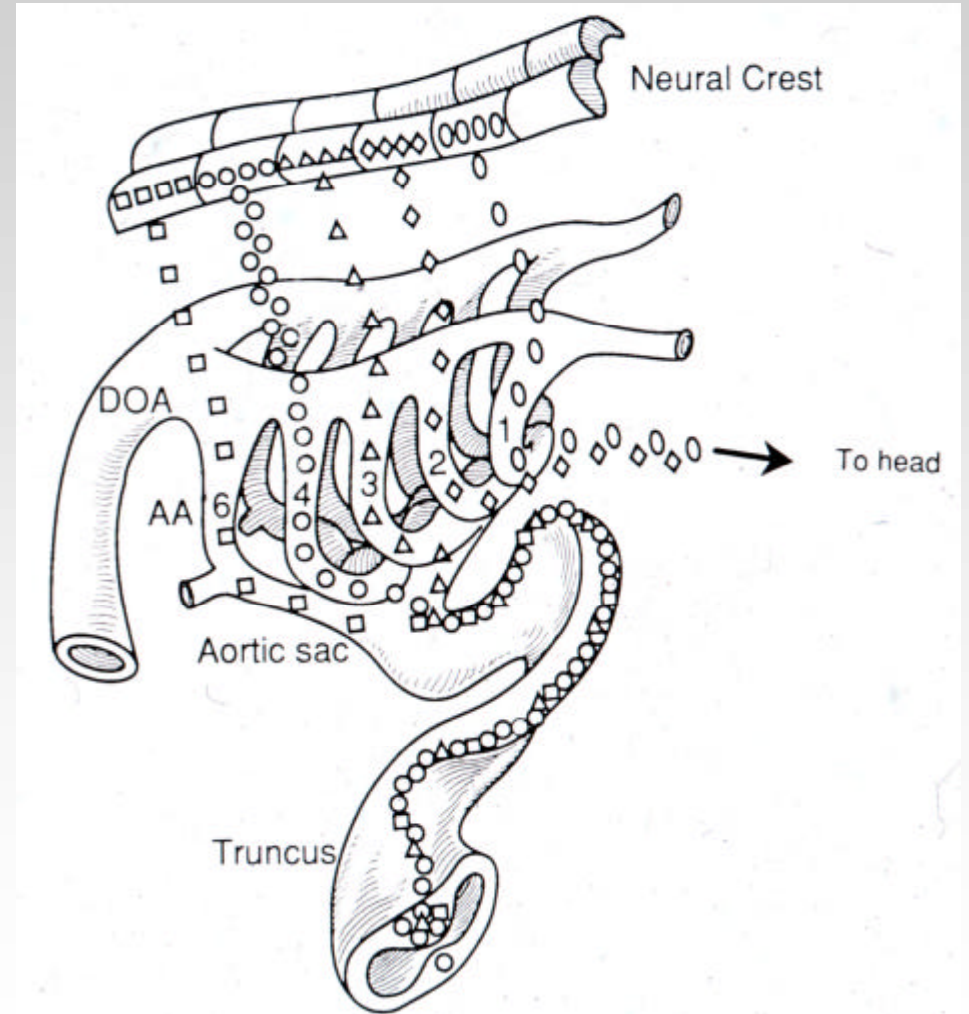
NC derivatives



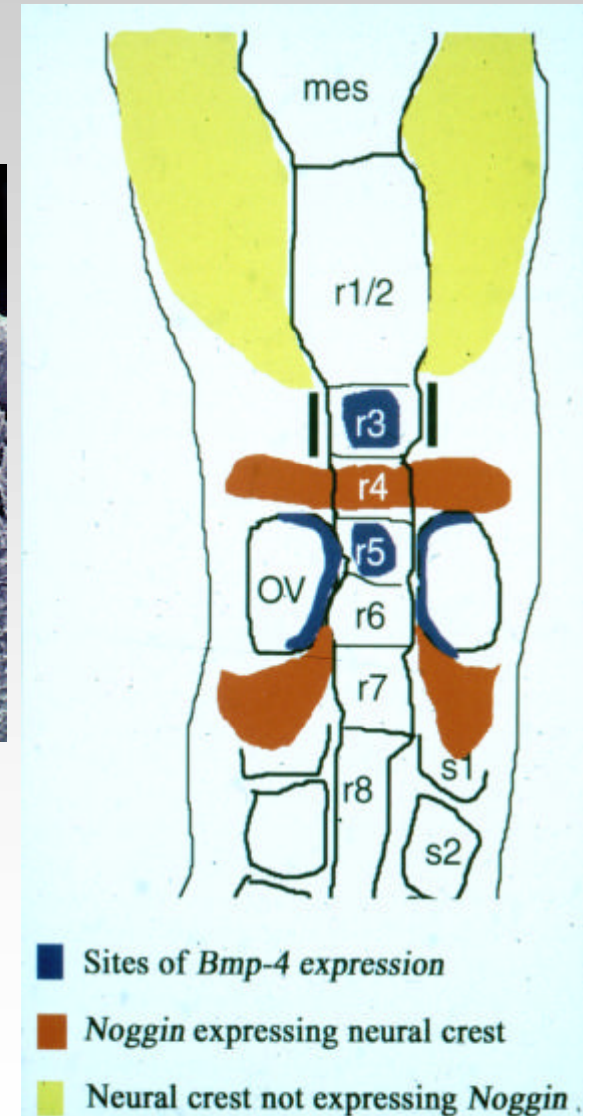
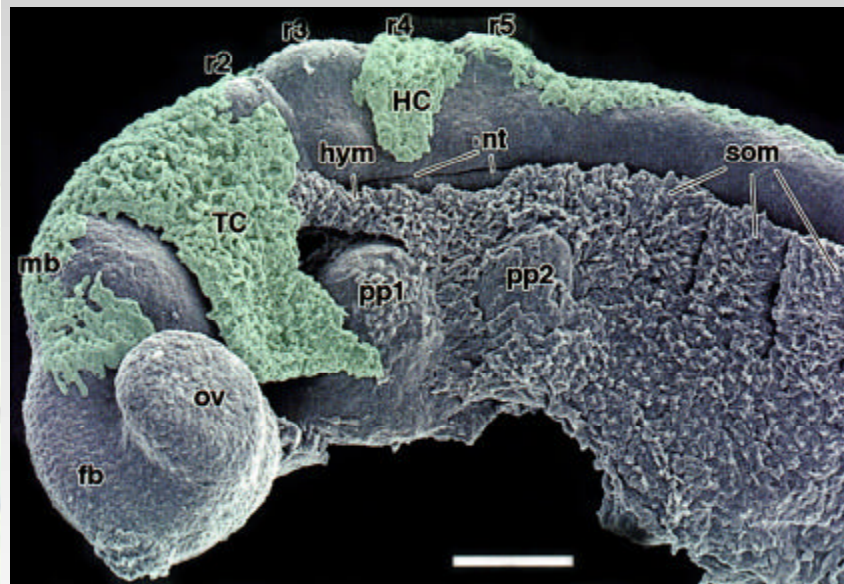
Extent of cephalic (cranial) neural crest

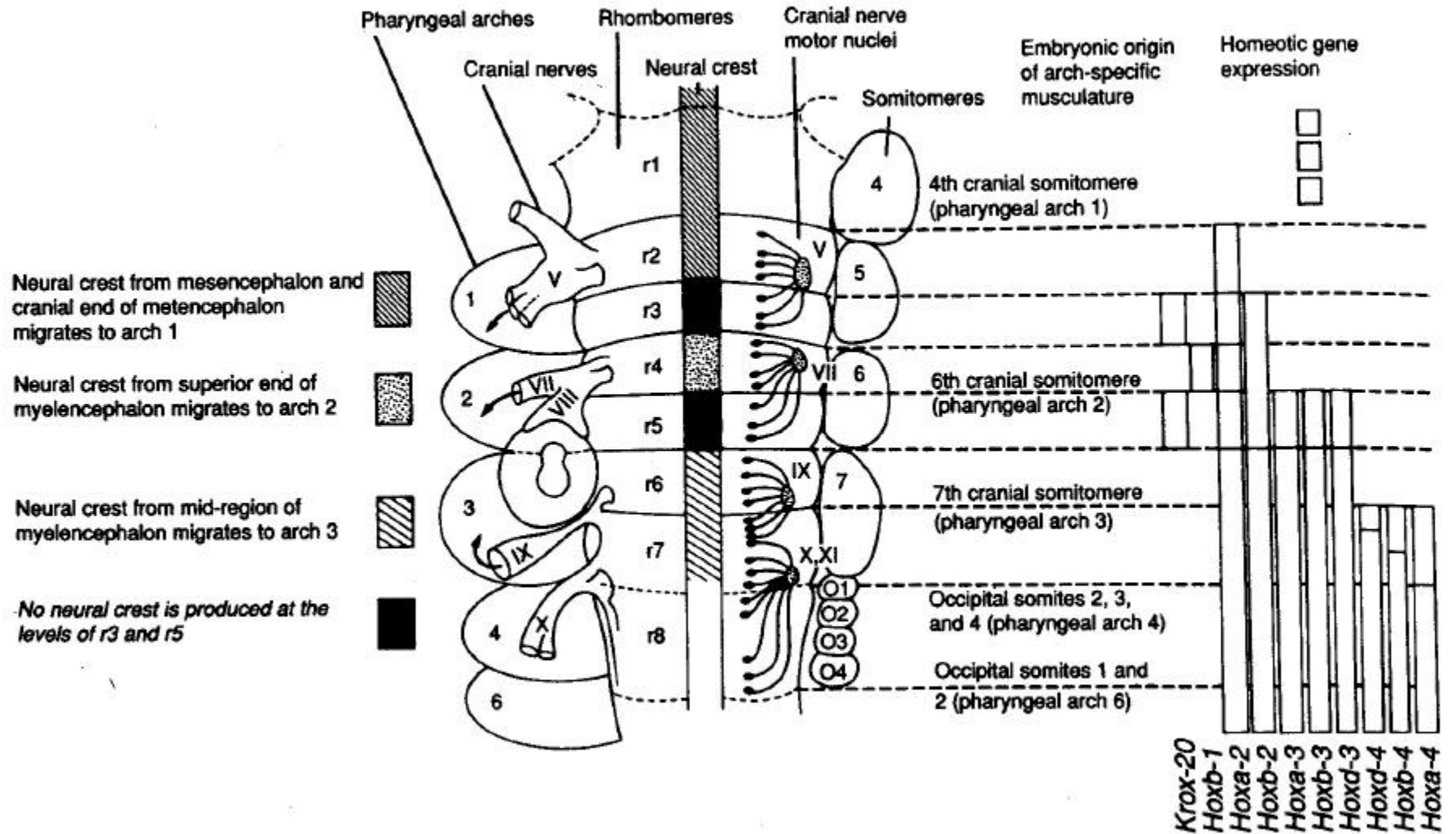


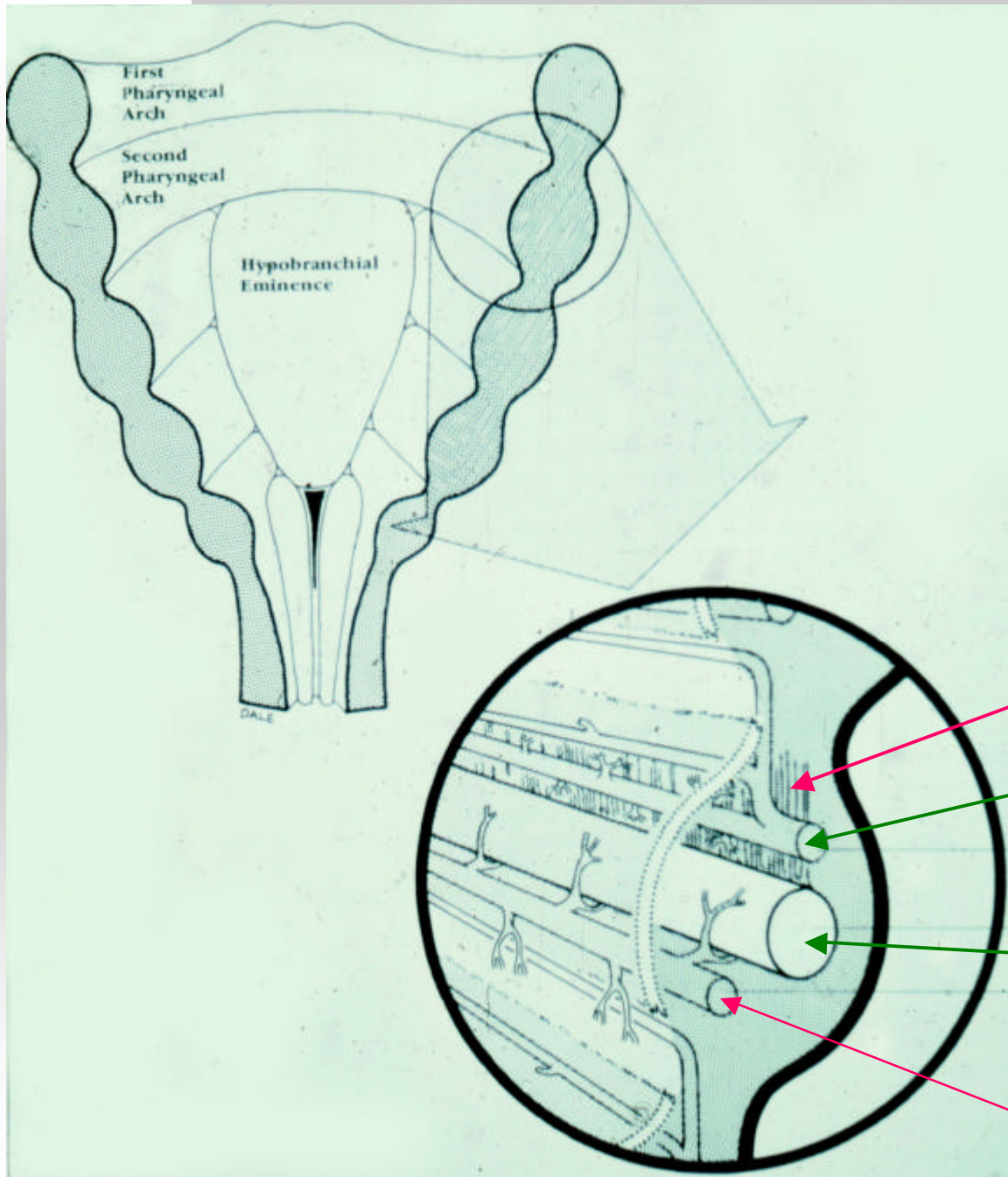
Neural crest involvement in the development of the heart



Arch segmentation and rhombomeres







Segmental components of arches

Connective tissues - nc

Muscle – mesoderm

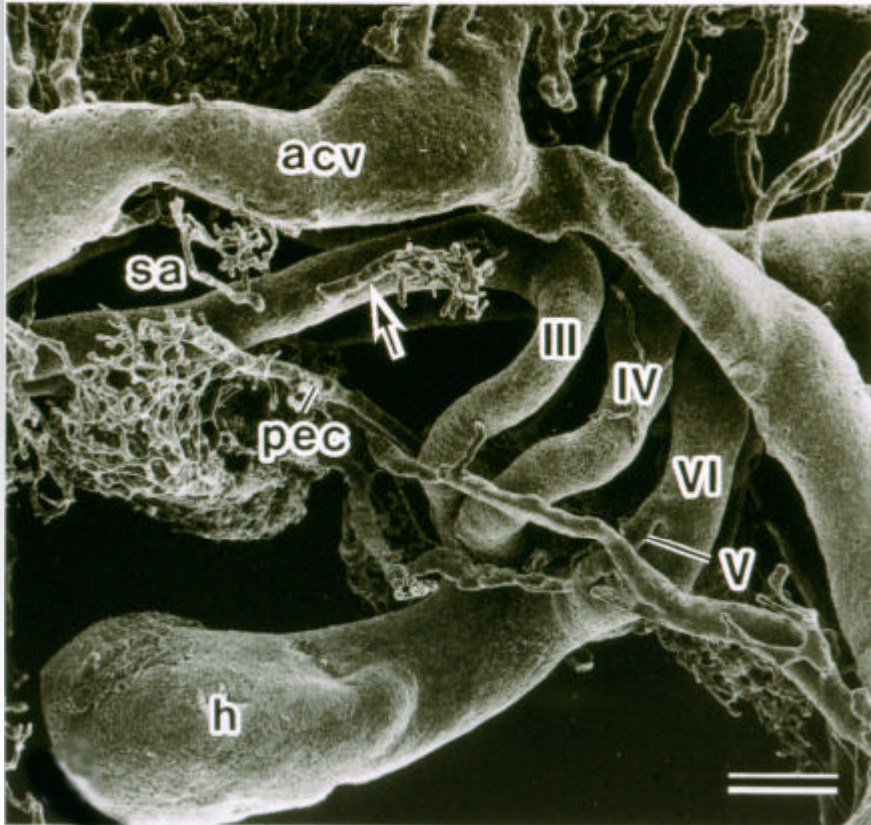
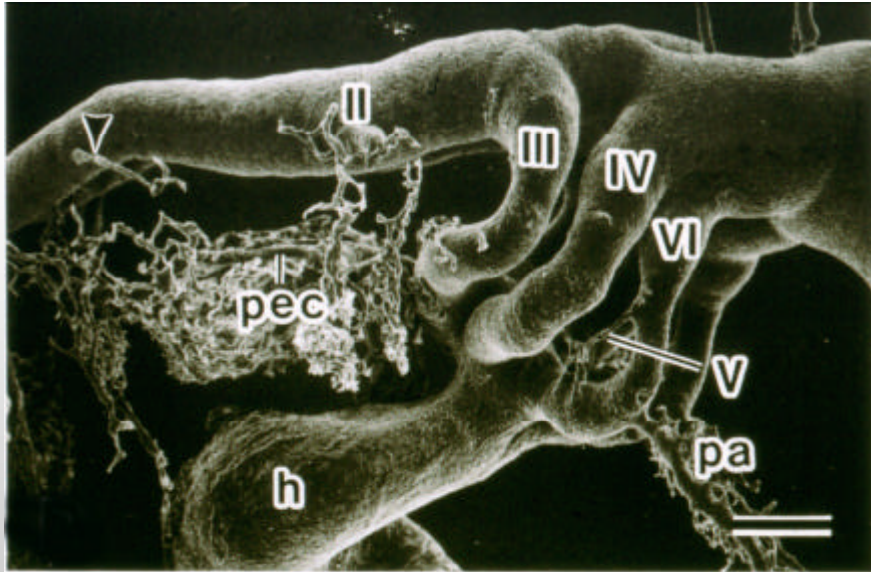
Branchiomeric nerve –
nc,ectoderm,neurectoderm

Skeletal bar- nc -
(cartilage) last to form

Artery – mesoderm-
first to appear

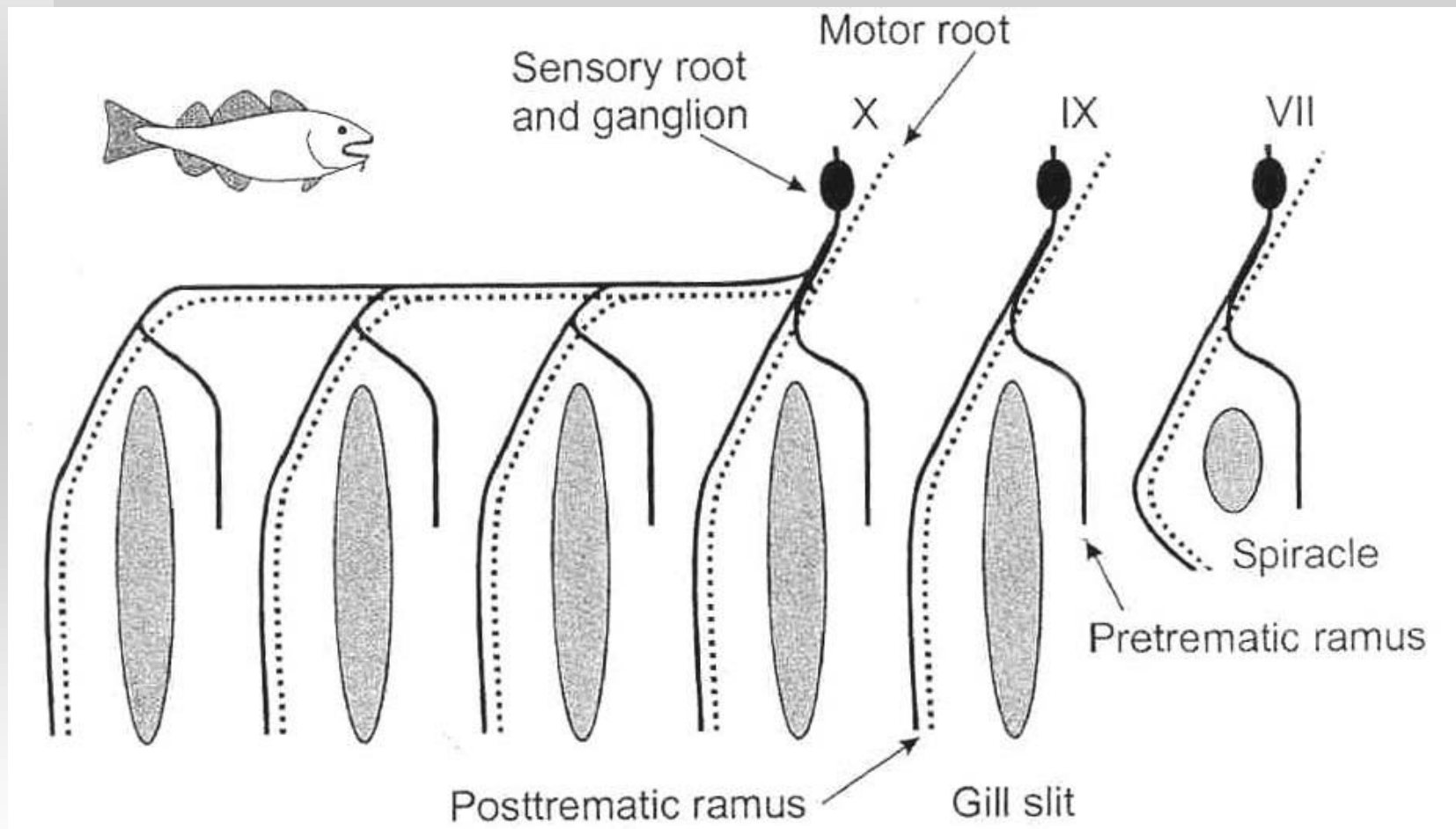
Aortic arch development





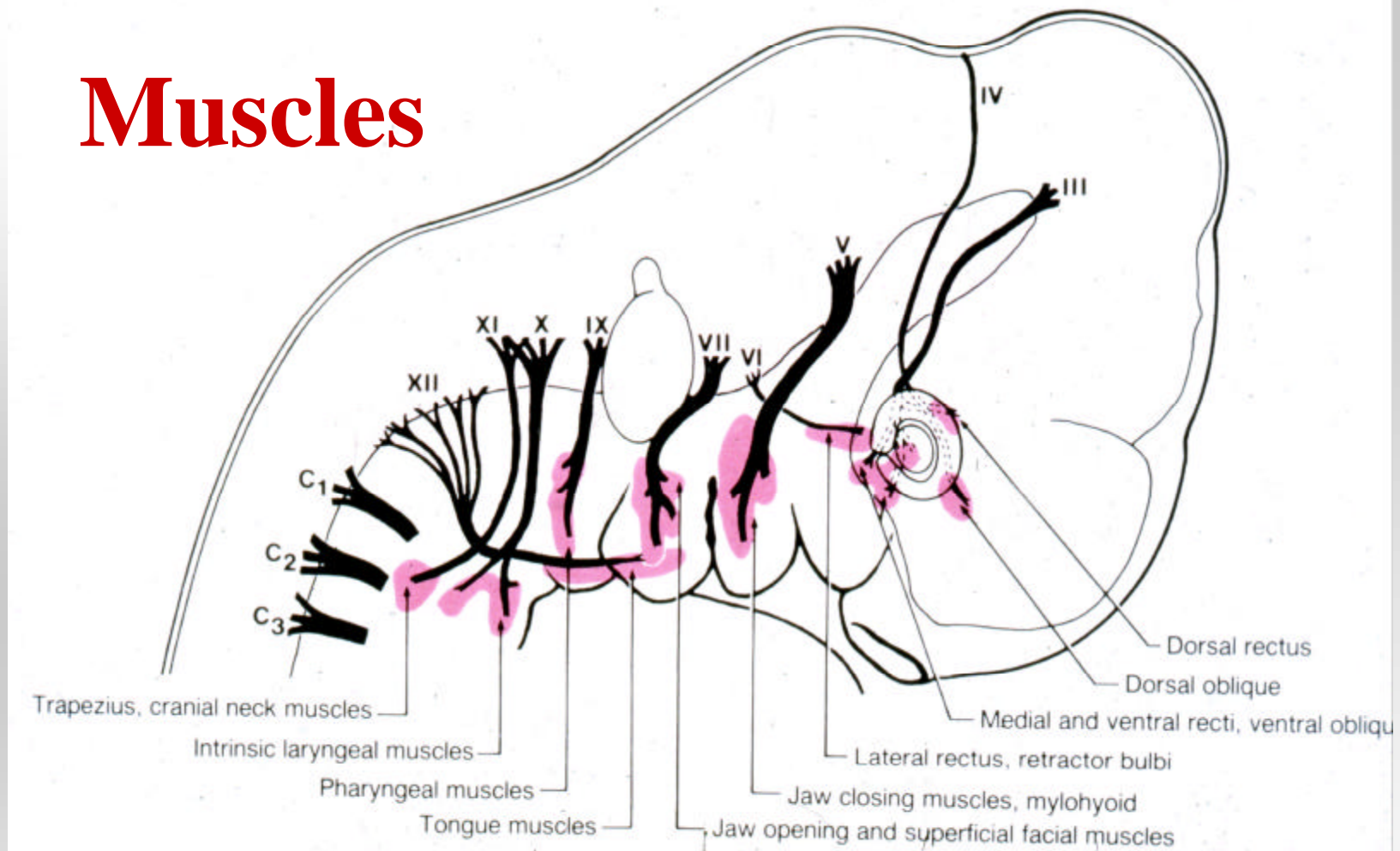
Aortic arch development cont'd

Branchiomeric nerves : pre- and posttrematic rami



Dual afferent innervation in each arch

Muscles



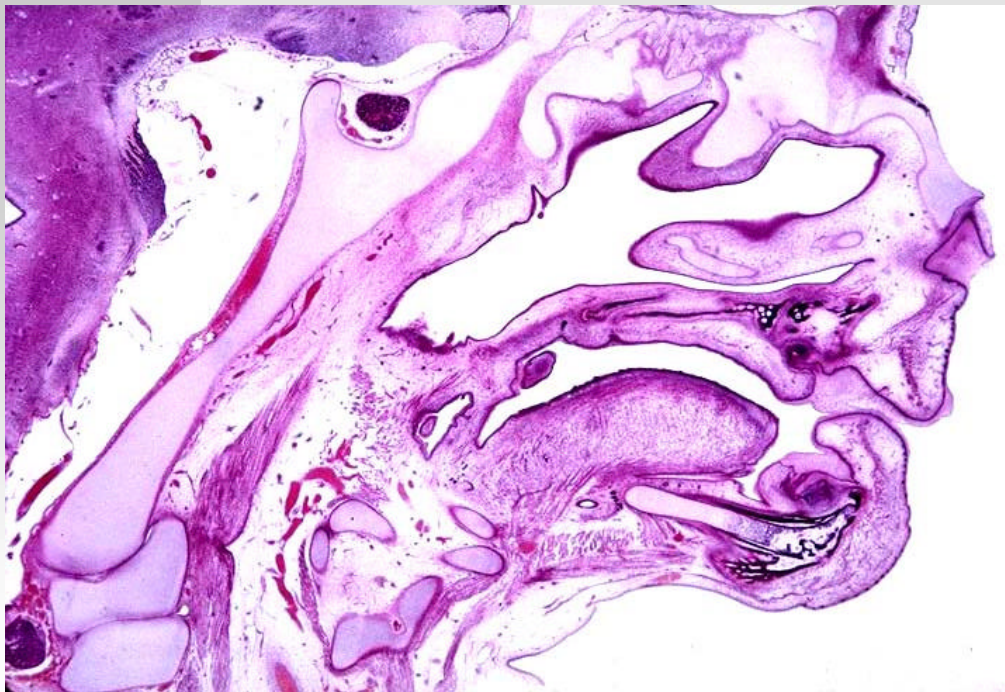
Arch 1: Muscles of mastication (V)

Arch 2: Muscles of facial expression (VII)

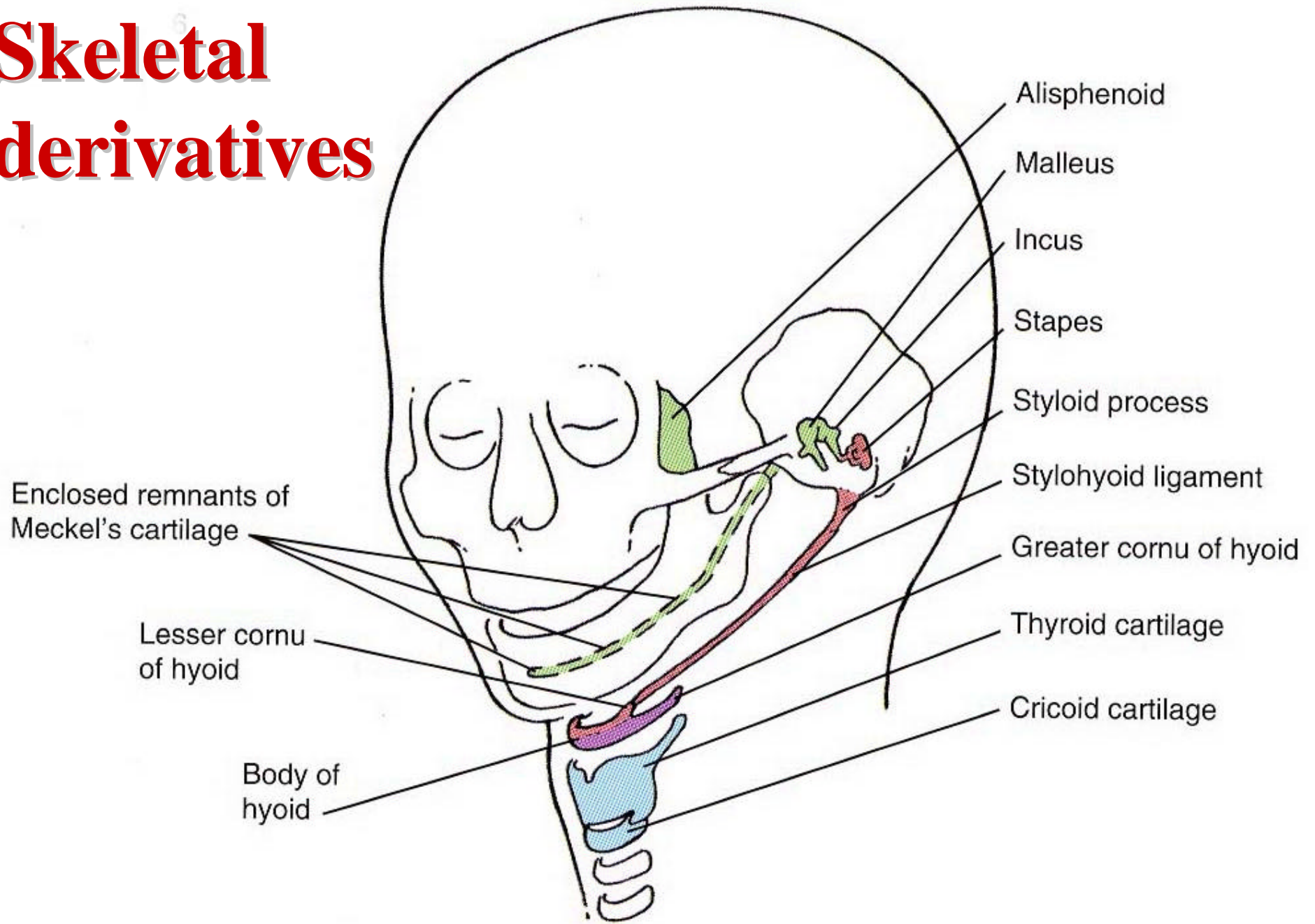
Arch 3: Stylopharyngeus muscle (IX)

Arch 4-6: Laryngeal muscles (X-XI)

Skeletal elements

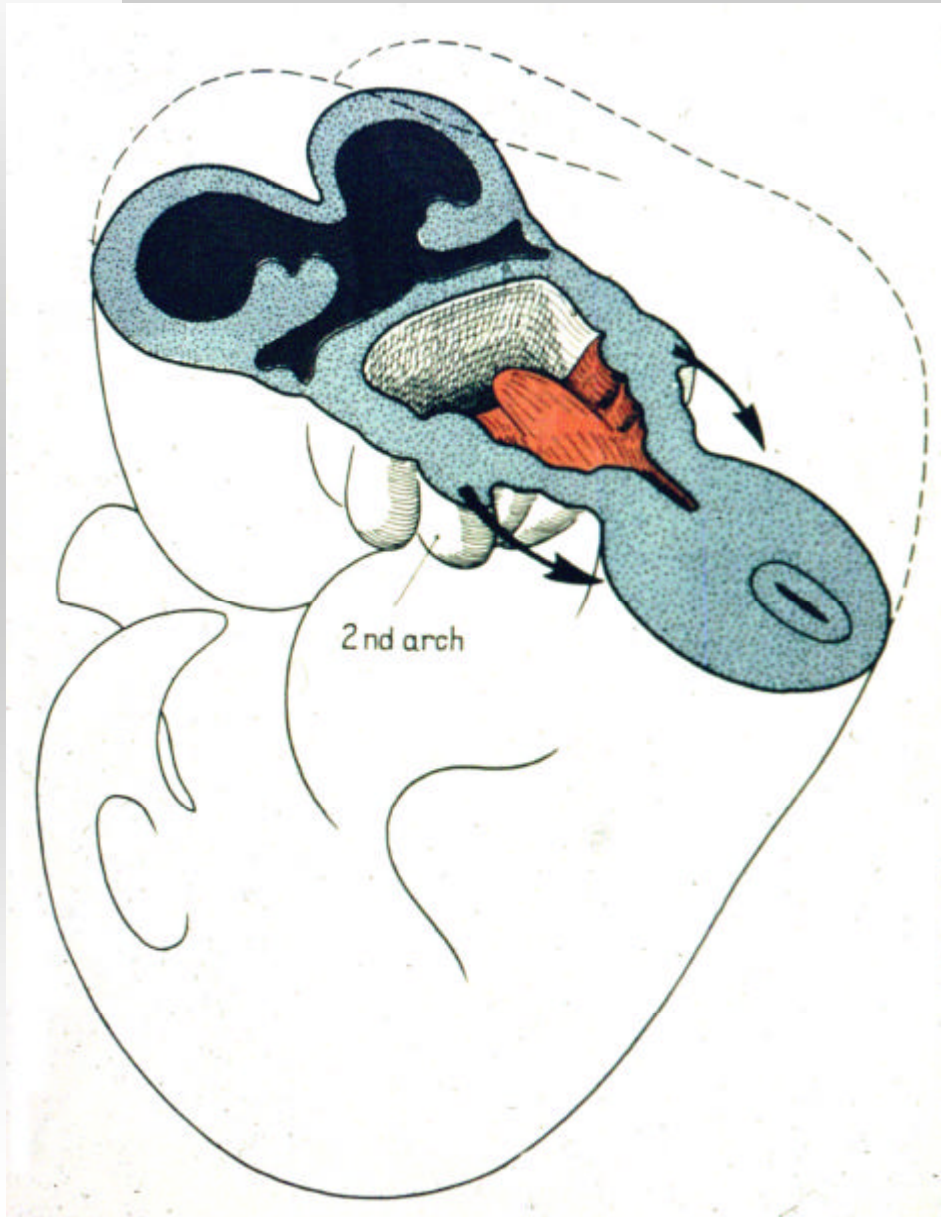


Skeletal derivatives



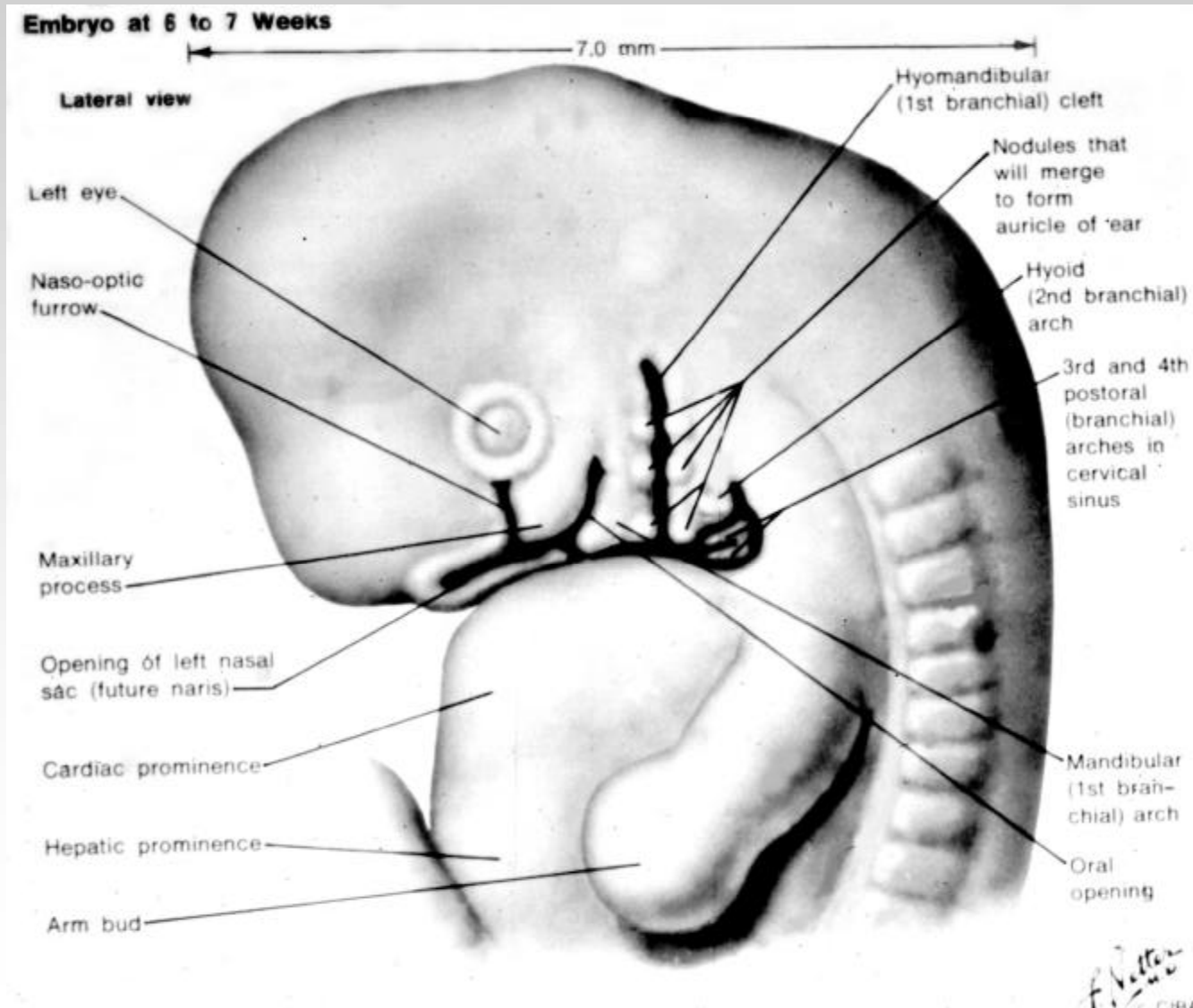
20 weeks

Fate of pharyngeal grooves 2-4



Covered by rapid outgrowth of 2nd arch “operculum.”

External ear receives contributions from arches 1 and 2



External ear development by merging of 6 auricular hillocks



Human embryo of 13 mm:
about 42 days.



40 mm:
about 65 days.



52 mm:
about 72 days.

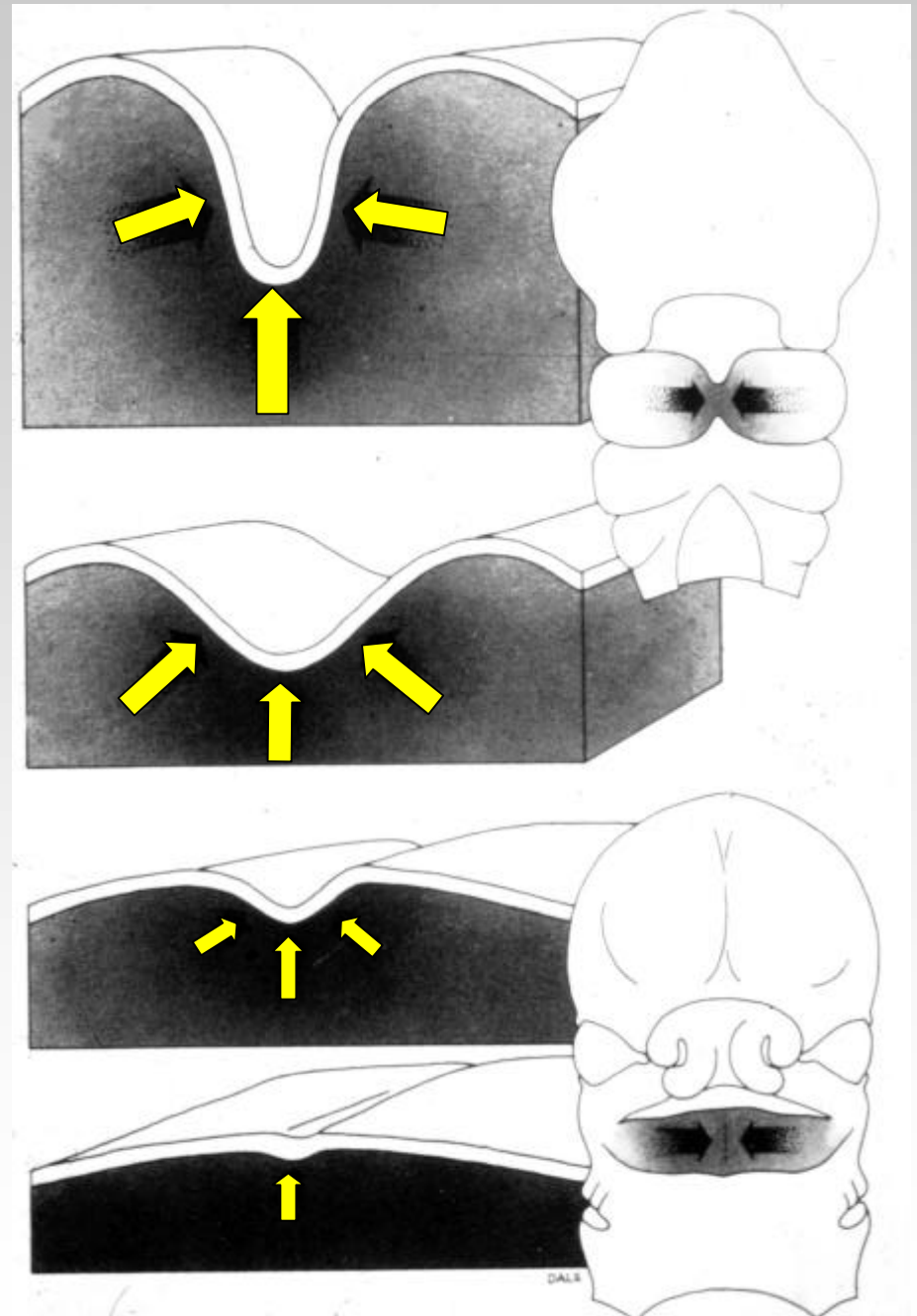


135 mm:
about 4½ months.

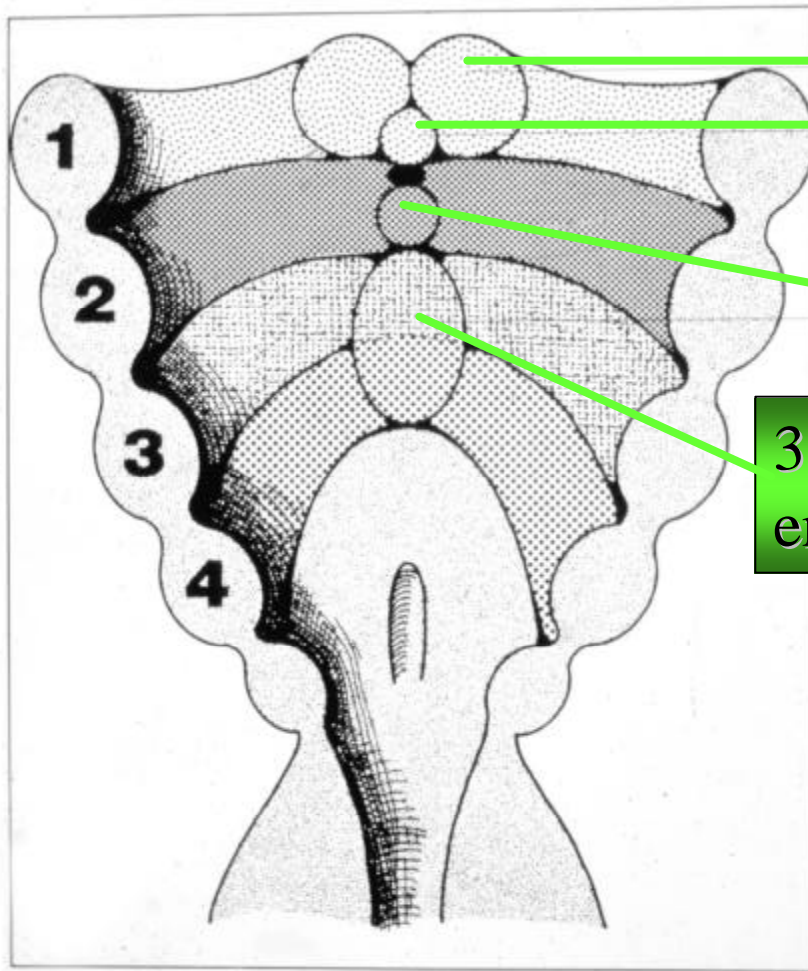


Adult.

External ear and tongue development require merging: the elimination of a groove between facial processes by differential growth



Endodermal swellings on arches 1-4 contribute to the tongue

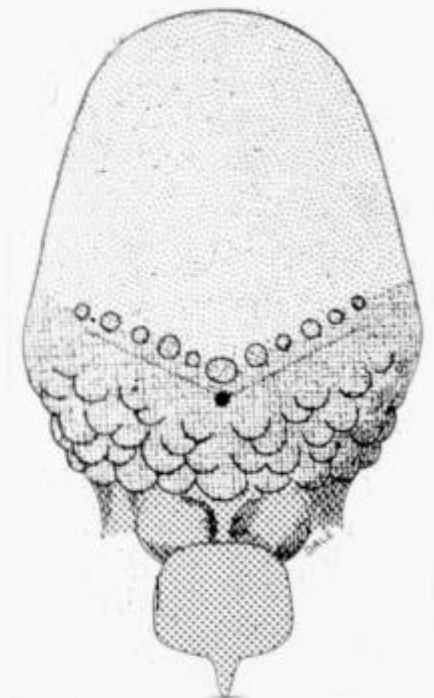
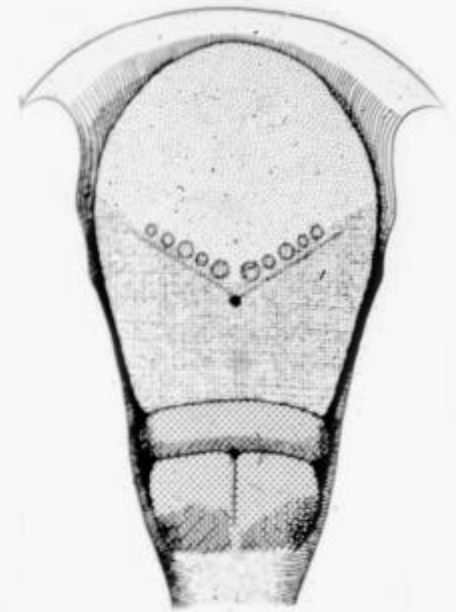
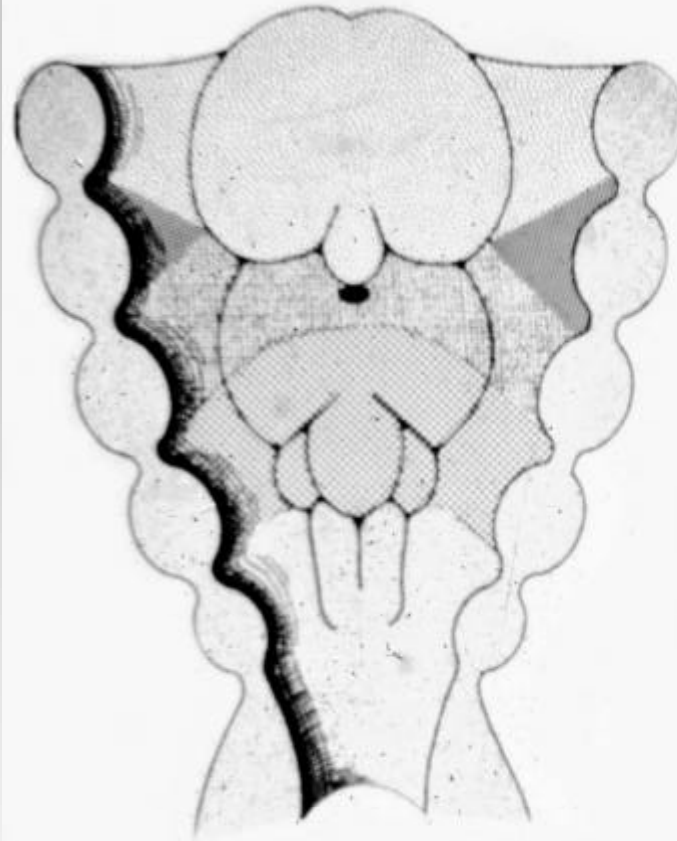


1. Paired lingual swellings and single median tuberculum impar

2. Single median copula

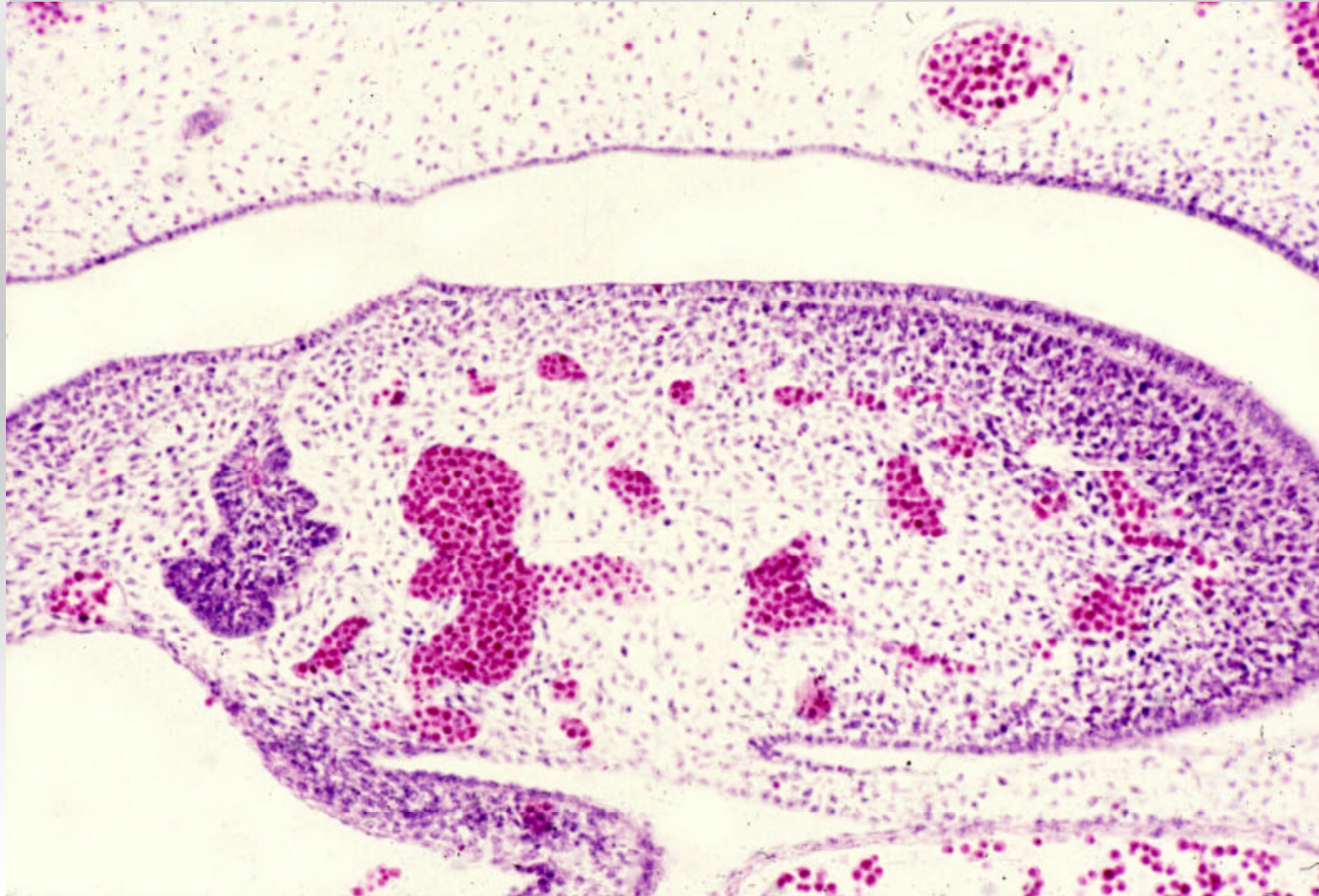
3-4. Combined median hypobranchial eminence

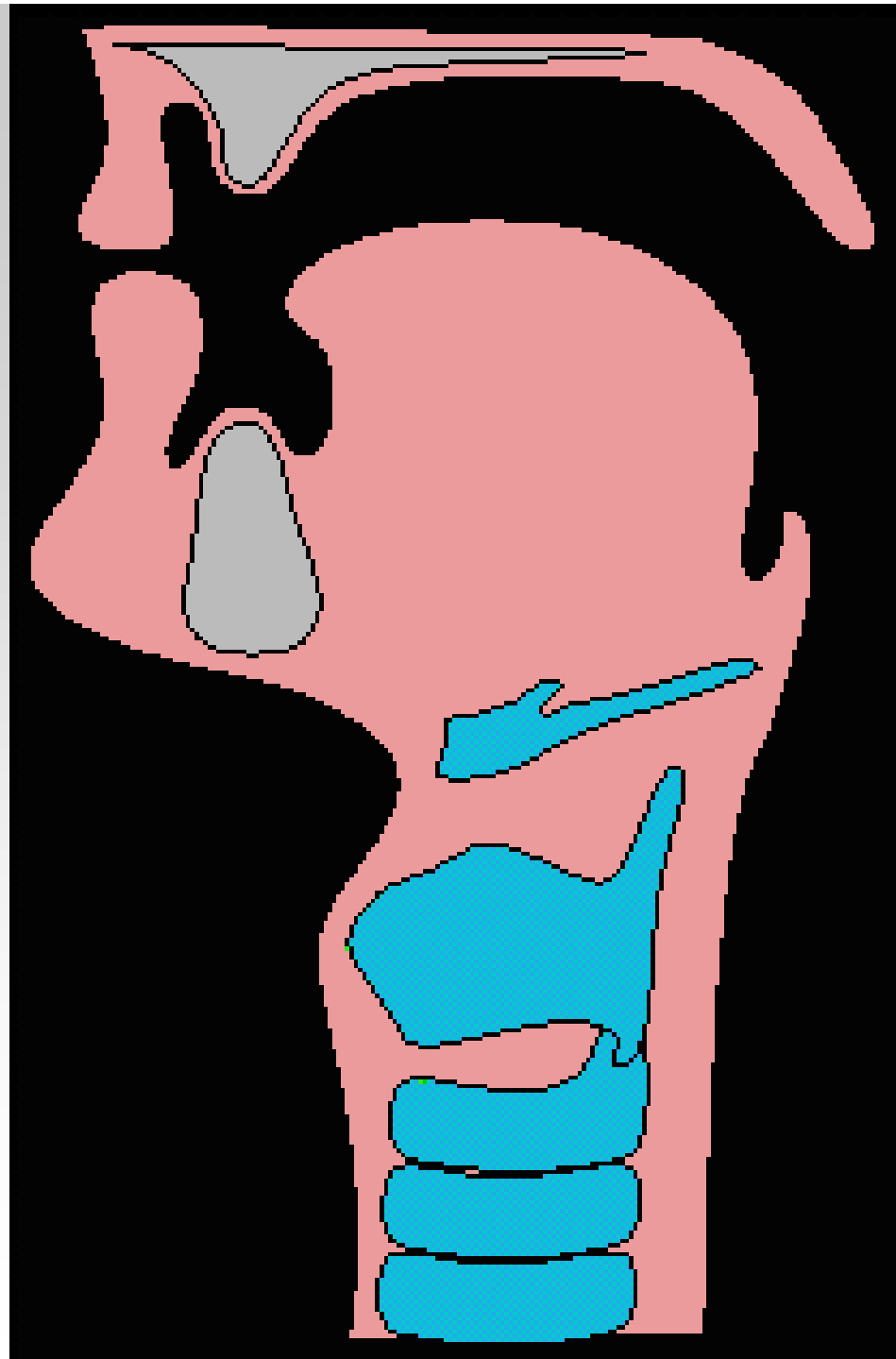
Merging of lingual swellings



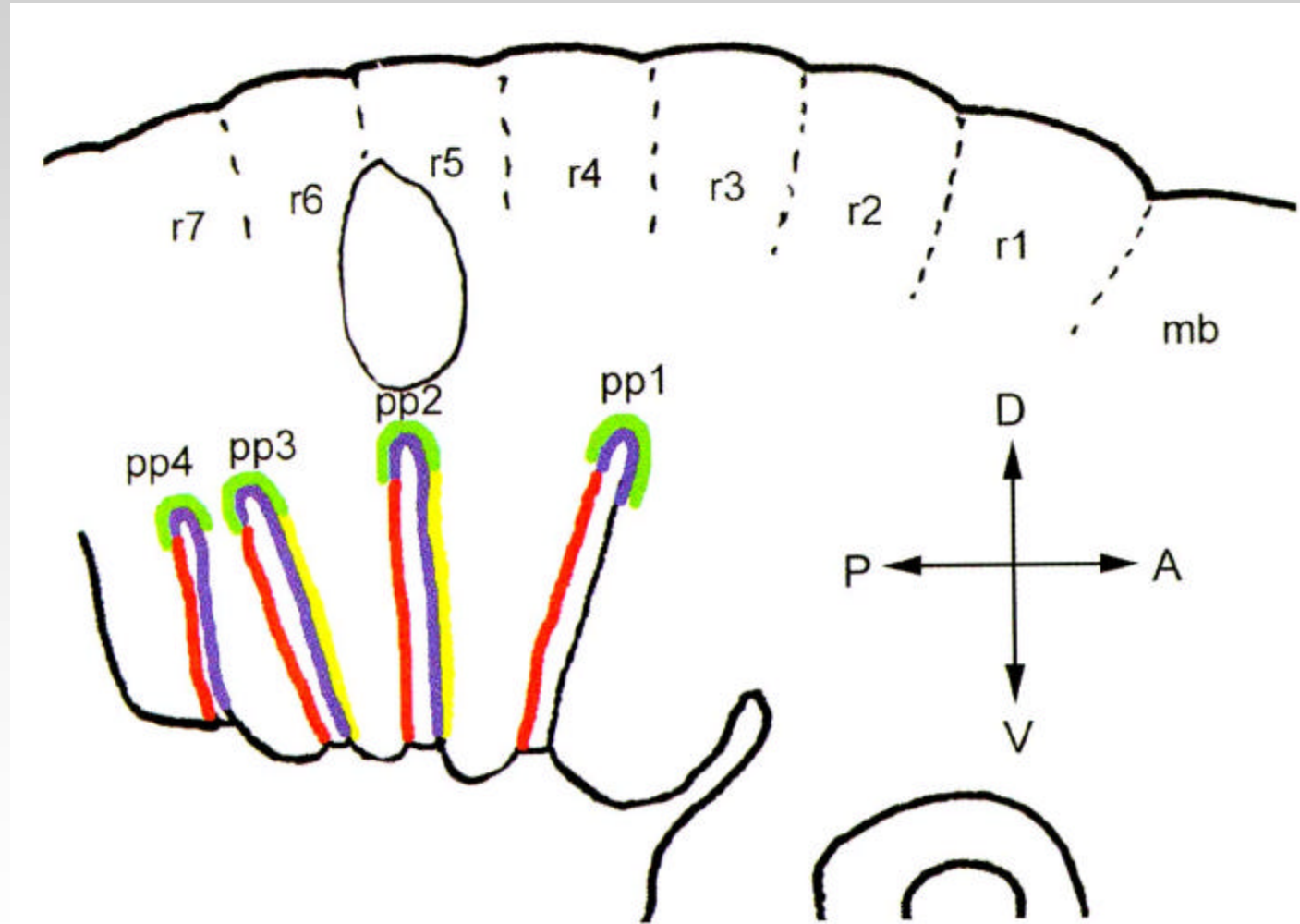
Thyroid gland development

Thyroglossal duct

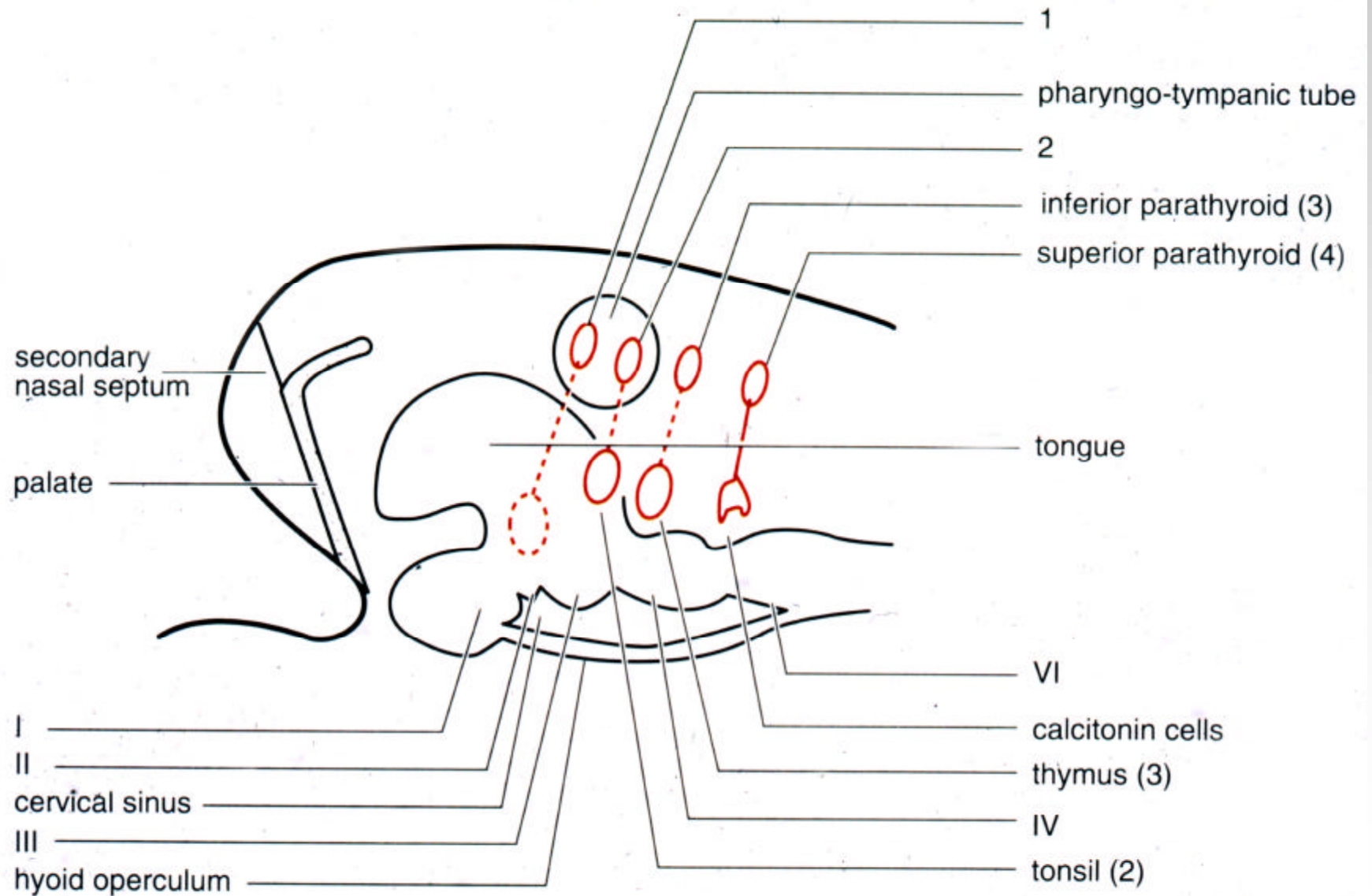




Endoderm plays key role in morphogenesis of pharyngeal region



Derivatives of dorsal and ventral parts of pharyngeal pouches

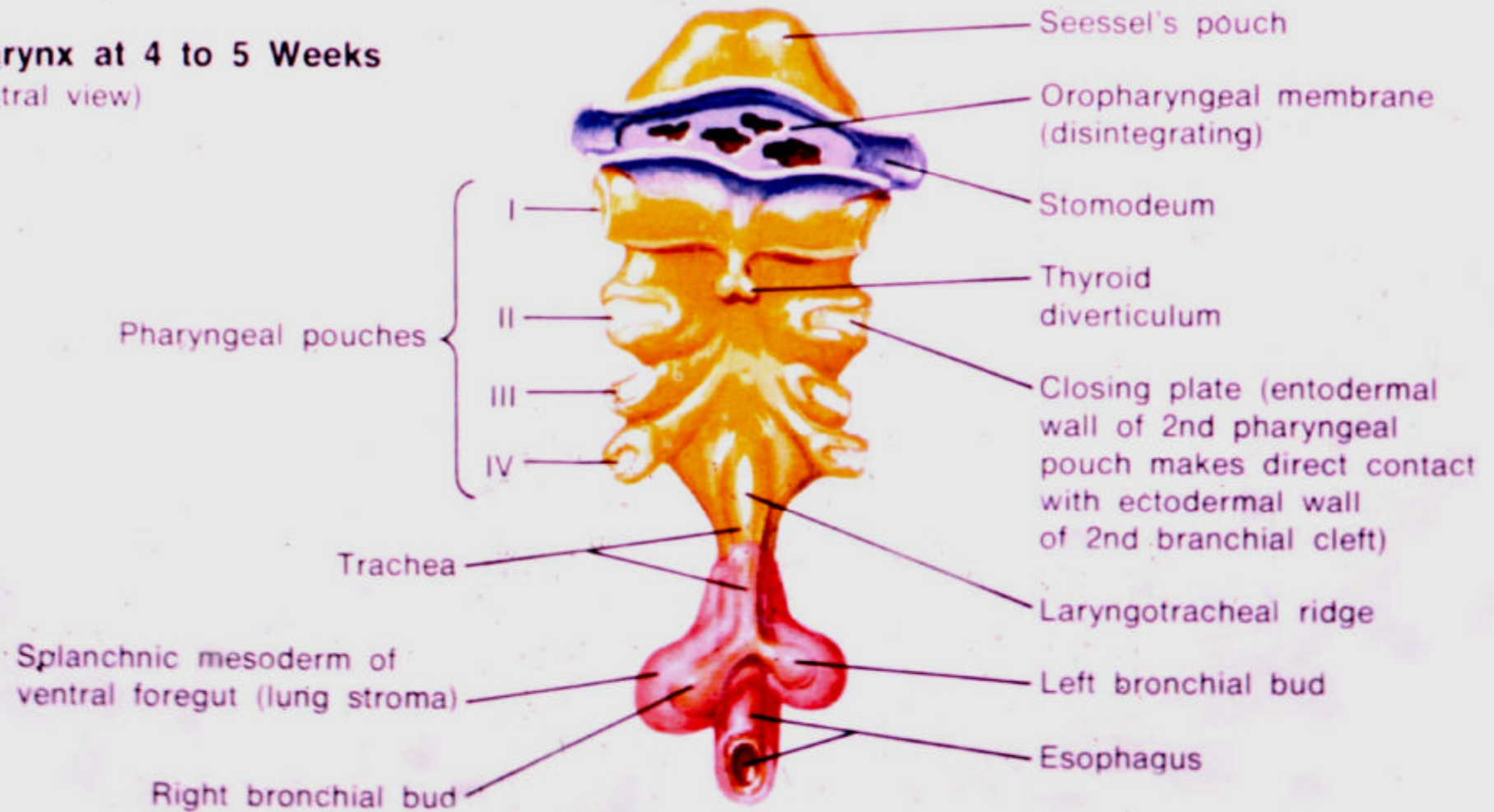


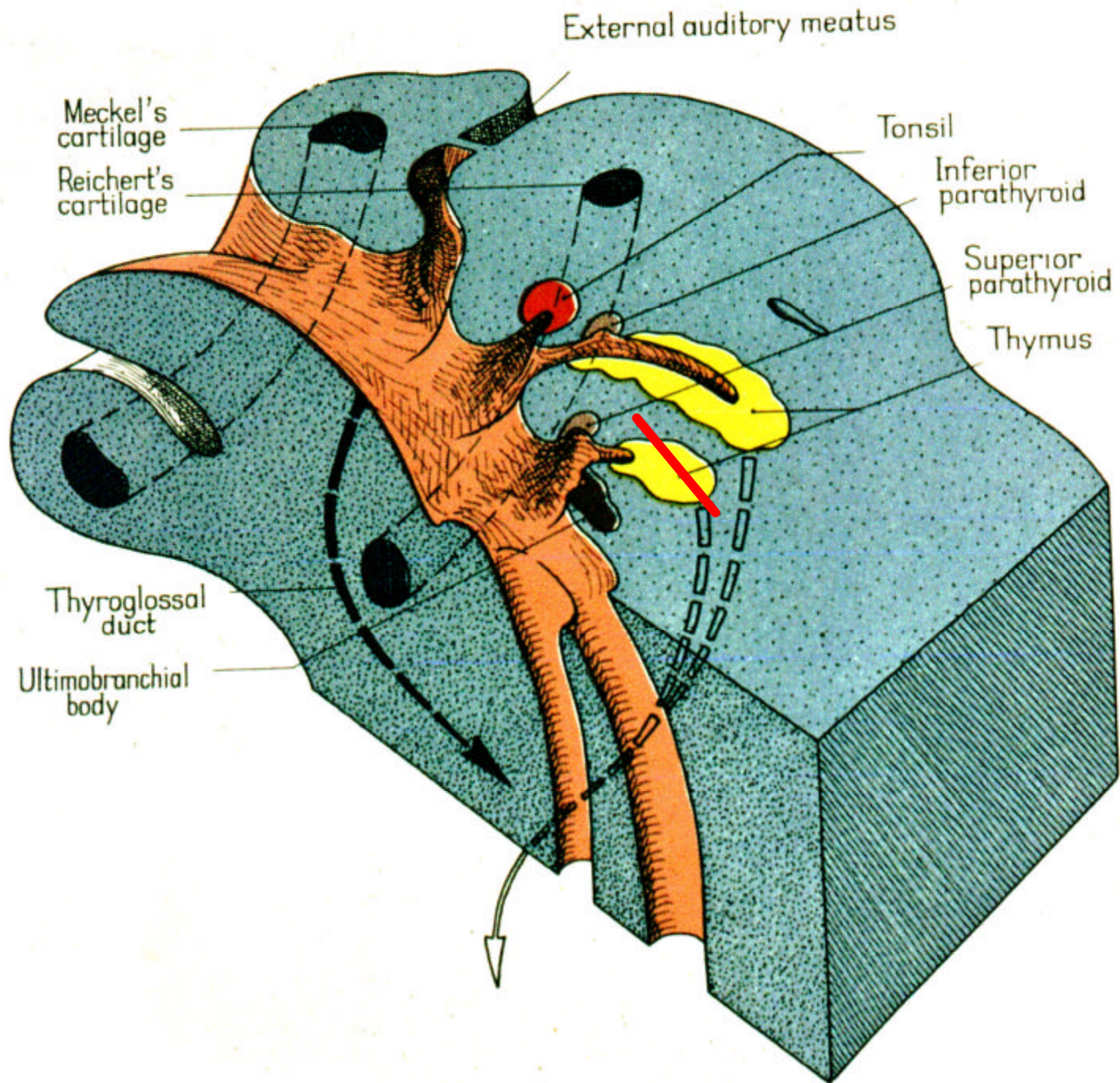
Fate of 1st pharyngeal groove and pouch



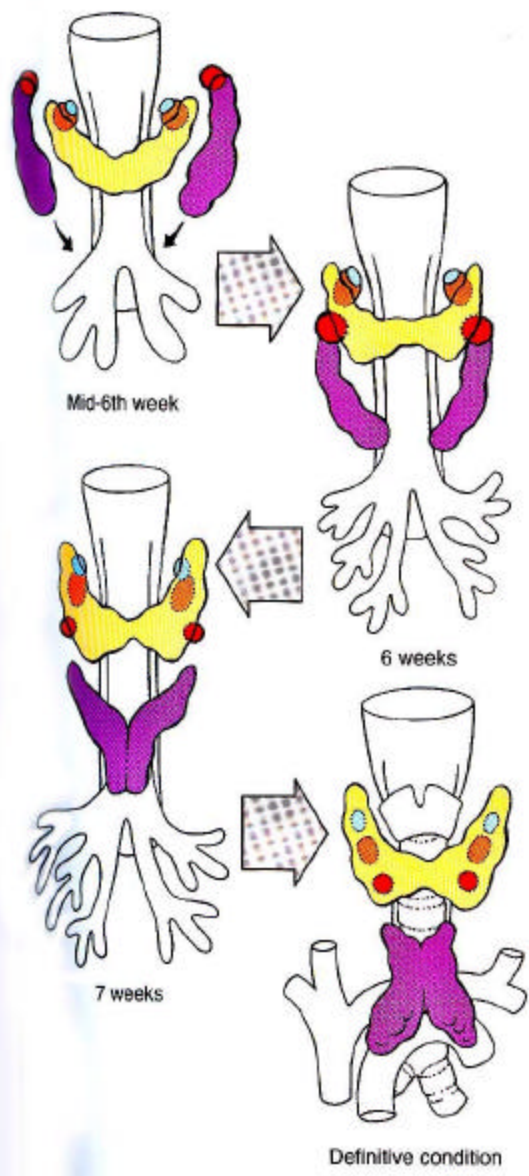
Pharynx at 4 to 5 Weeks

(ventral view)





- Parathyroid III (inferior)
- Parathyroid IV (superior)
- Ultimobranchial body
- Thymus
- Thyroid



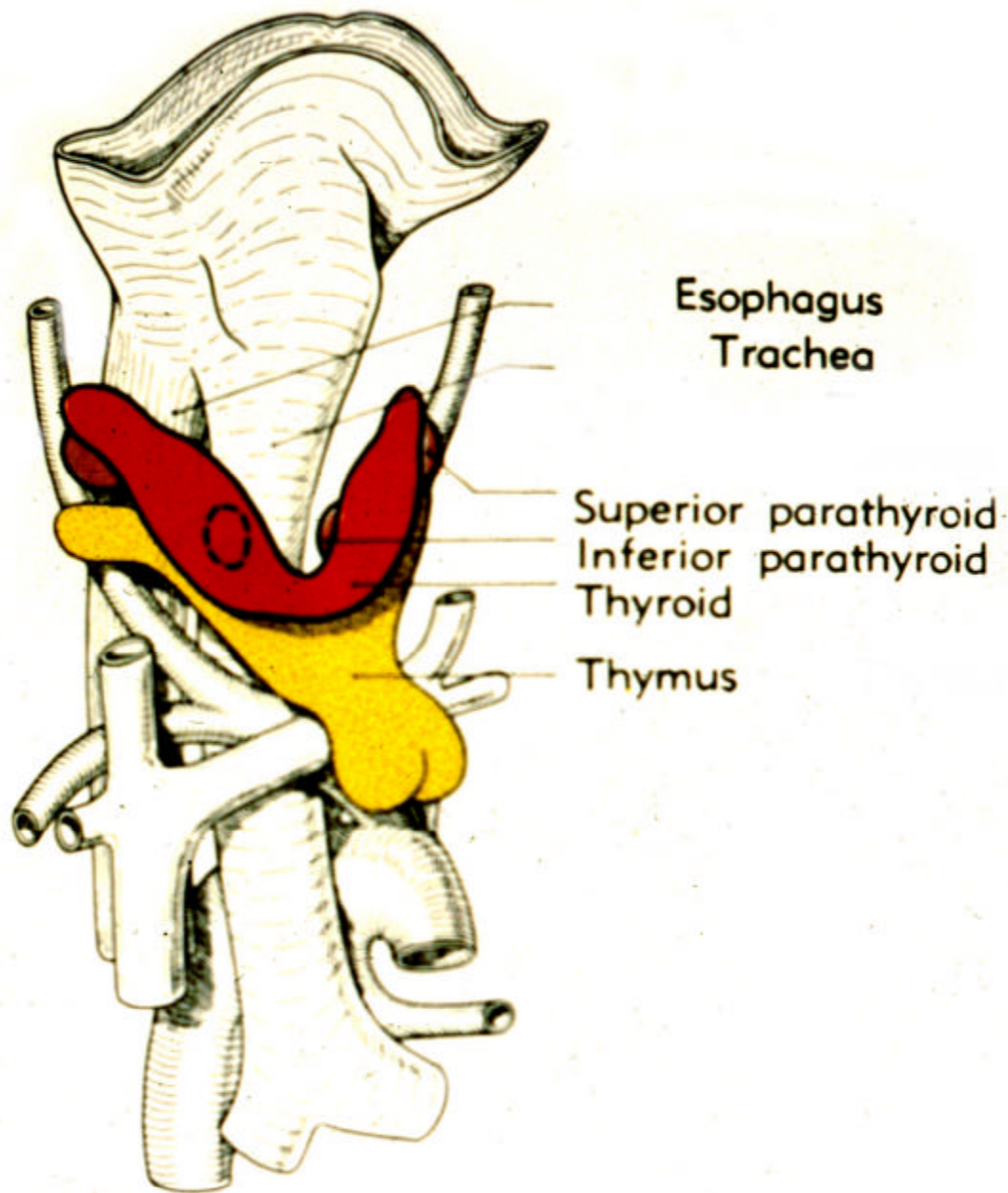


Diagram
showing thyroid in place.

Superior and inferior parathyroid glands

