

Pharyngeal arches and pouches

L.Moss-Salentijn

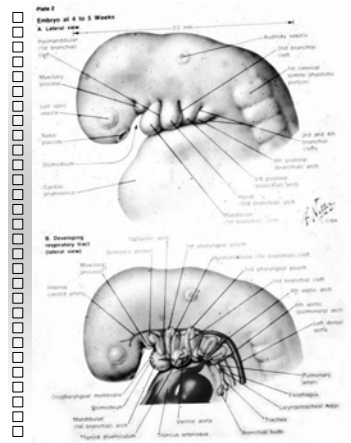
Pharyngeal arches: a definition

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

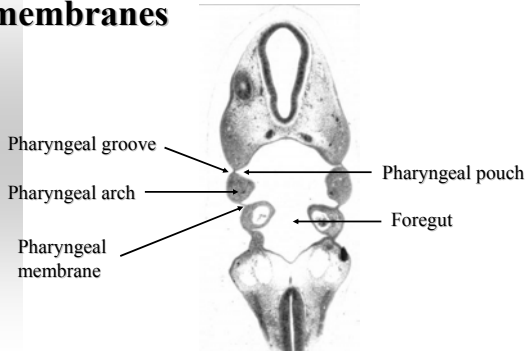
- a.k.a. visceral or branchial arches
- Develop (and disappear as distinctively visible structures) in a rostro-caudal sequence
- Require neural crest cells for their development
- Even after they are no longer visible externally, they have a lasting impact on the anatomy of the head and neck and of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



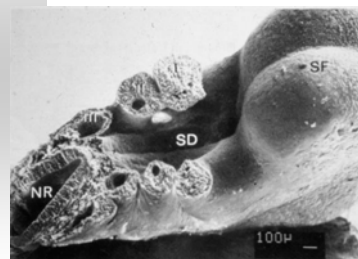
5 Pharyngeal arches
5 Aortic arches
Arches numbered 1-6

Netter F, Ciba collection

Arches, grooves, pouches, and membranes

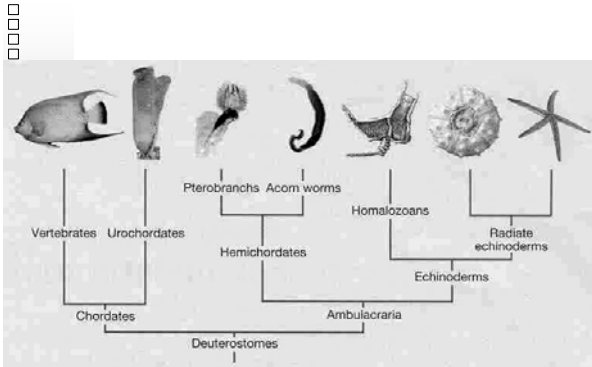


Pharyngeal cleft transient “gill-slit”

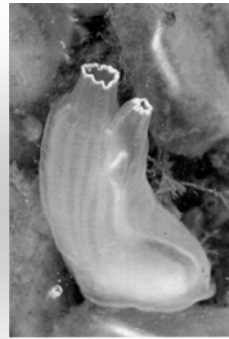


Mangold U et al (1981)





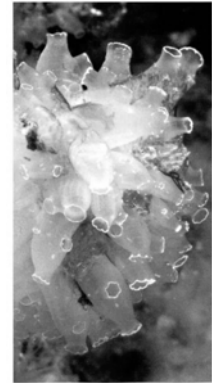
Smith AB (2004)



UROCHORDATE. PHOTOGRAPHS AT MARINE BIOLOGICAL LABORATORY, WOODS HOLE

SEA SQUIRT

photograph by Purcell R, National Geographic November 2006



K. TELNES/IMAGE QUEST MARINE Dell H (2006)

Basic body plan of all chordates (incl. vertebrates)

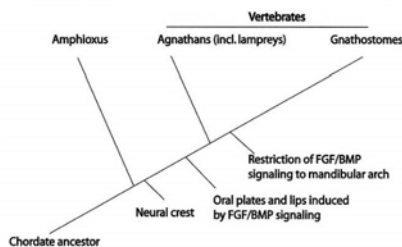
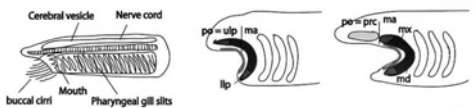


- Dorsal hollow neural tube
- Segmented lateral mesoderm
- Central notochord
- Ventral digestive tube
- (Pharyngeal gill slits)

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.

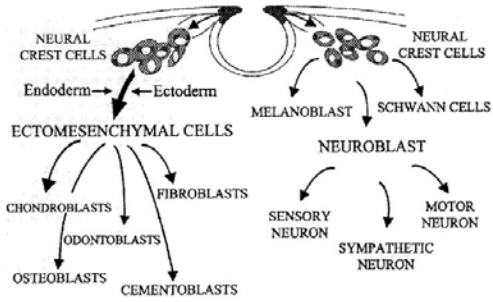
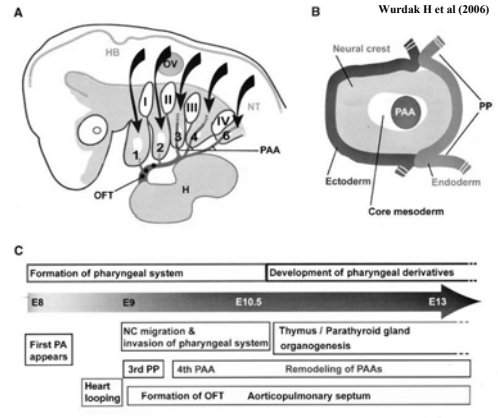
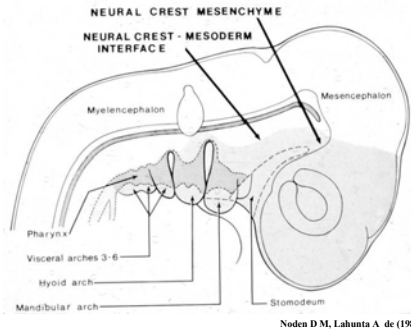


Chai Y, Maxson RE (2006)

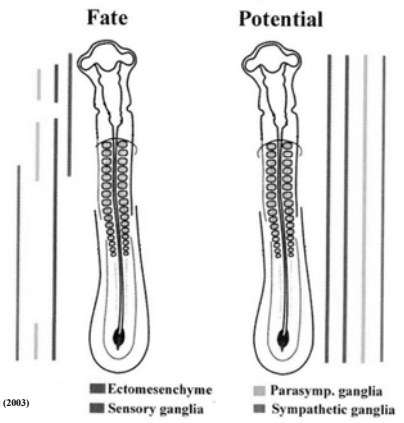
Mesenchyme in cephalic region is derived from:

- Mesoderm
- Neural crest

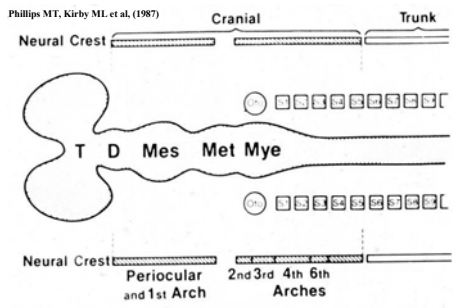
Neural crest and mesoderm in H&N area



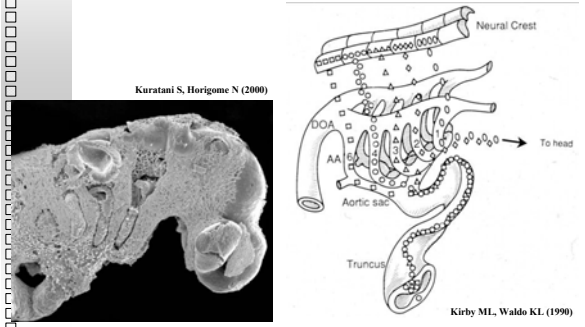
Chai Y, Ito Y, Han J (2003)

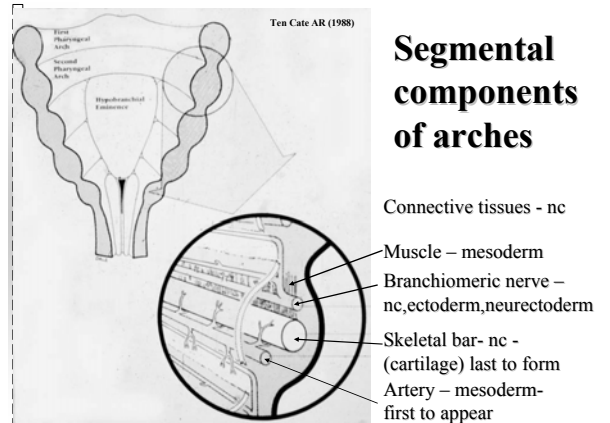
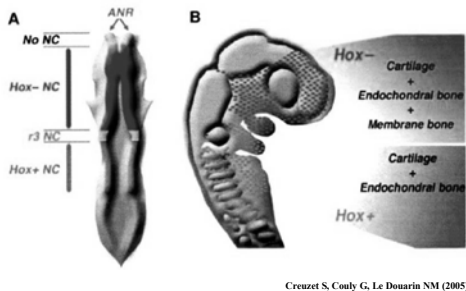
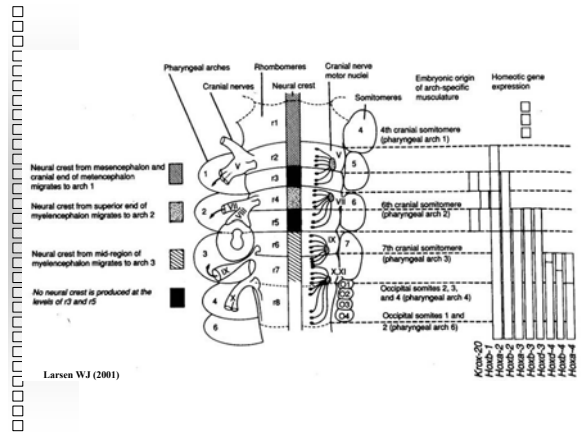
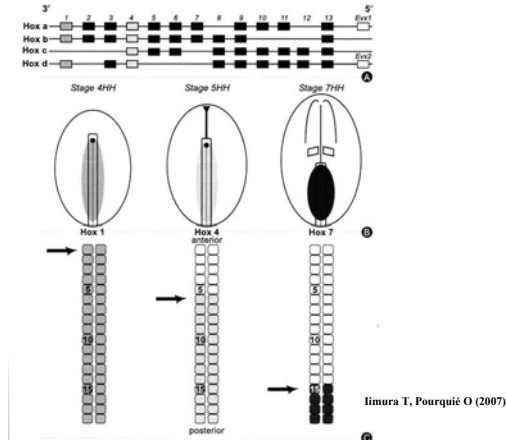


Extent of cephalic (cranial) neural crest

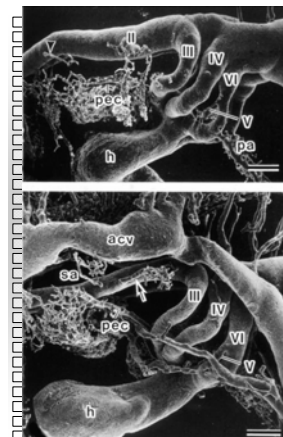
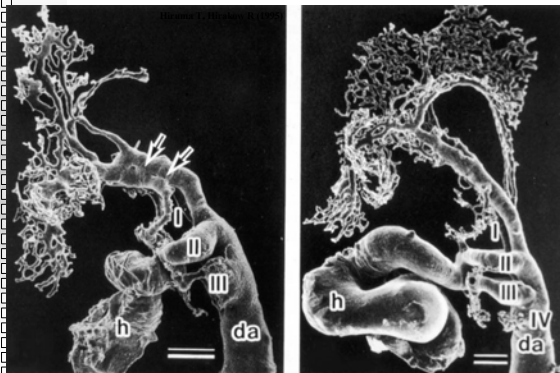


Neural crest involvement in the development of the heart





Aortic arch development

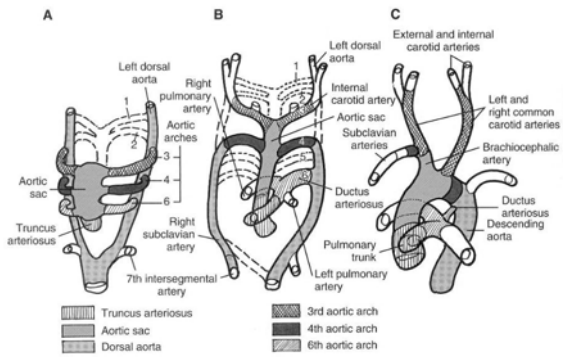


Aortic arch development cont'd

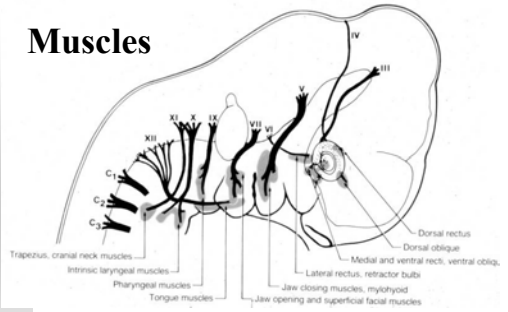
Hiruma T, Hirakow R (1995)

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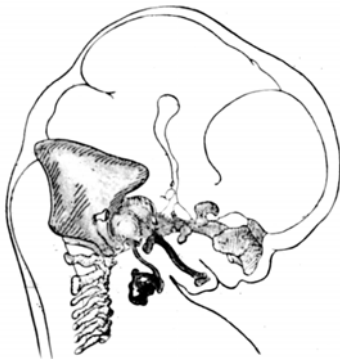
Muscles



- 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) Noden D.M., Labunta A. de (1985)

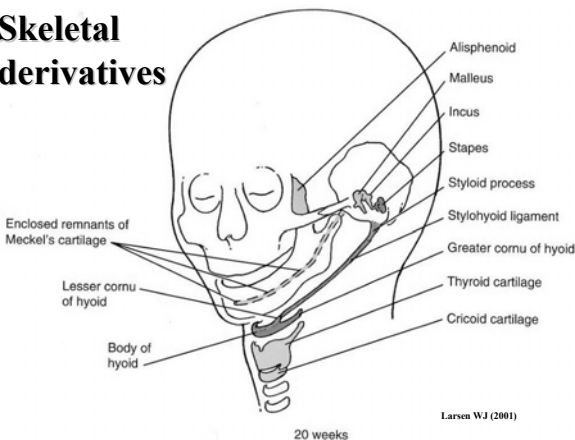
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Arey's Embryology



The cartilage elements of the pharyngeal arches (cartilaginous viscerocranium, purple) at 7 weeks.

Skeletal derivatives

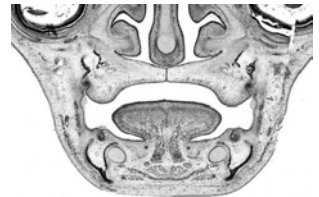


Larsen WJ (2001)

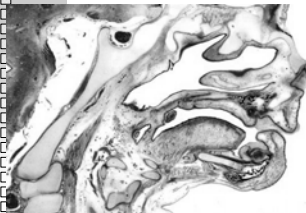
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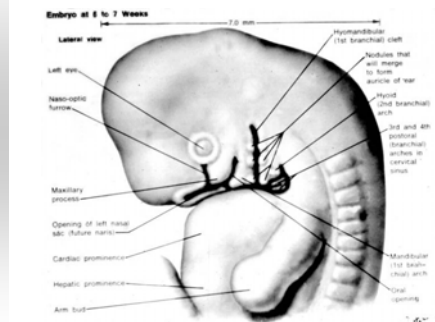
Skeletal elements



Moos-Salentin L. et al (1972)



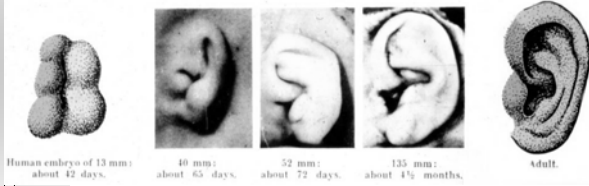
External ear receives contributions from arches 1 and 2



Netter F. Ciba collection

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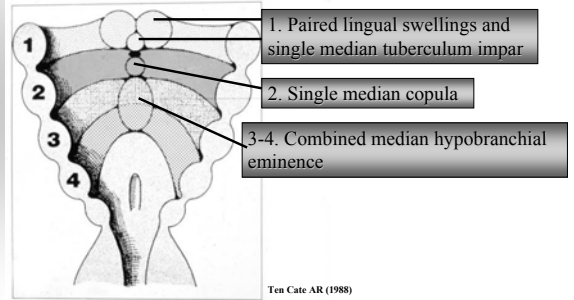
External ear development by merging of 6 auricular hillocks



Human embryo of 13 mm) about 12 days, 40 mm; about 65 days, 52 mm; about 72 days, 135 mm; about 4 1/2 months, Adult.

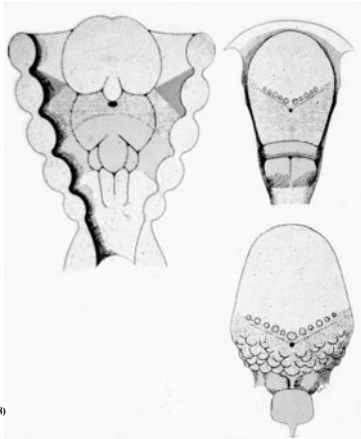
Tuchmann-Duplessis H et al, (1975)

Endodermal swellings on arches 1-4 contribute to the tongue



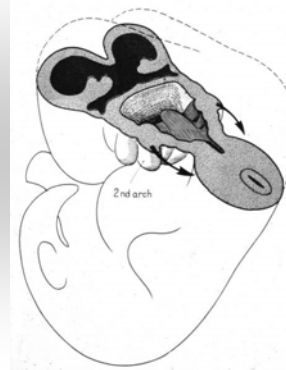
Ten Cate AR (1988)

Merging of lingual swellings



Ten Cate AR (1988)

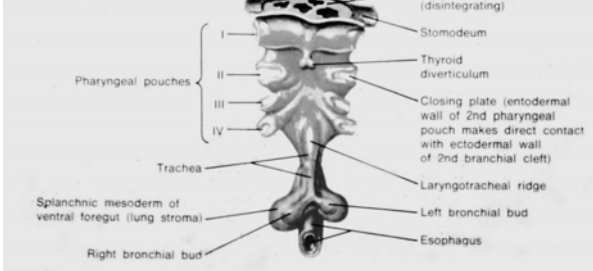
Fate of pharyngeal grooves 2-4



Covered by rapid outgrowth of 2nd arch "operculum."

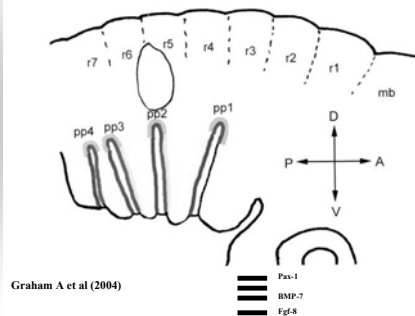
Tuchmann-Duplessis H, Haegel P (1975)

Pharynx at 4 to 5 Weeks (ventral view)



Netter F, Giba collection

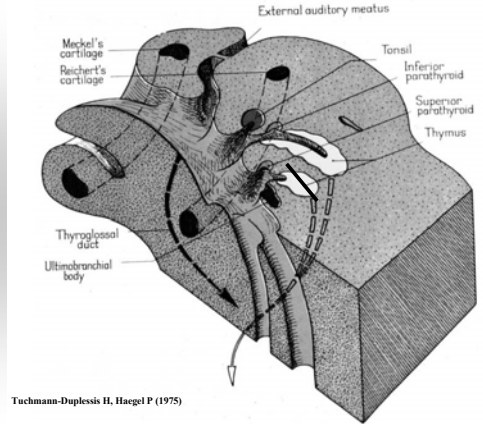
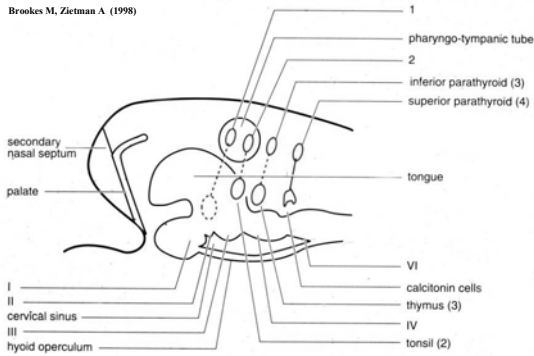
Endoderm plays key role in morphogenesis of pharyngeal region



Graham A et al (2004)

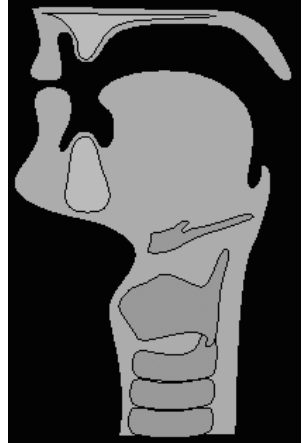
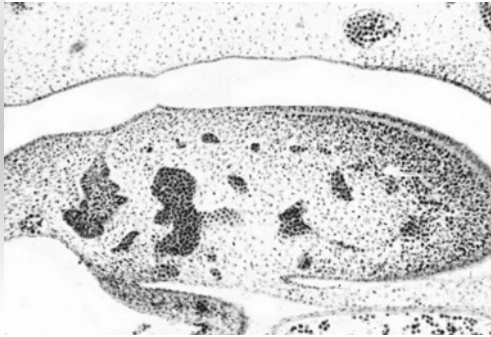
Derivatives of dorsal and ventral parts of pharyngeal pouches

Brookes M, Zietman A (1998)

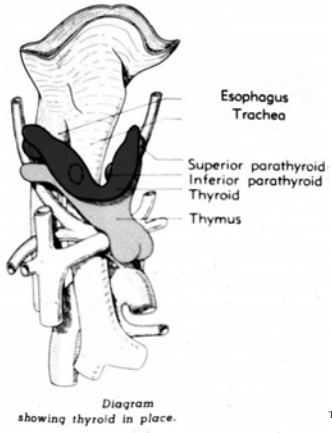


Tuchmann-Duplessis H, Haegel P (1975)

Thyroid gland development Thyroglossal duct



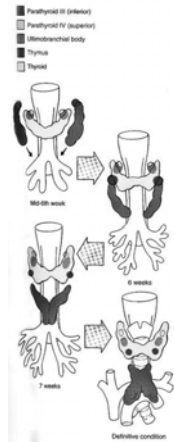
Watt, Marie A, and Sanders, Colin
University of Glasgow



Superior and inferior parathyroid glands

Diagram showing thyroid in place.

Tuchmann-Duplessis H, Haegel P (1975)



Larsen WJ (2001)