Pharyngeal arches and pouches

L.Moss-Salentijn

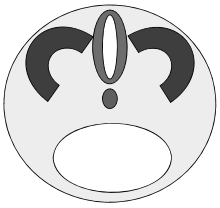
Pharyngeal arches: a definition

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 and their immediate precursors, 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

Basic body plan of all chordates (incl. vertebrates)



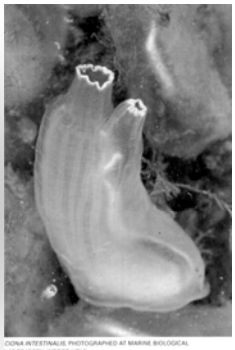
Dorsal hollow neural tube

Segmented lateral mesoderm

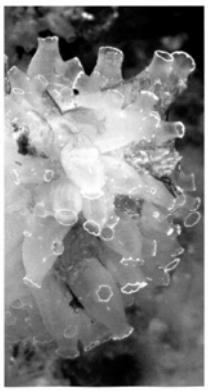
Central notochord

Ventral digestive tube

(Pharyngeal gill slits)

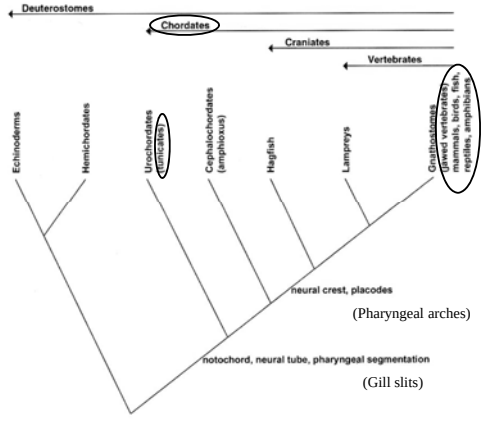


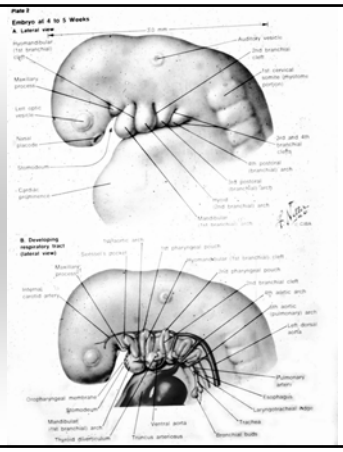
photograph by Purcell R,National Geographic November 2006



K. TELNES/IMAGE QUEST MARINE

Dell H (2006)





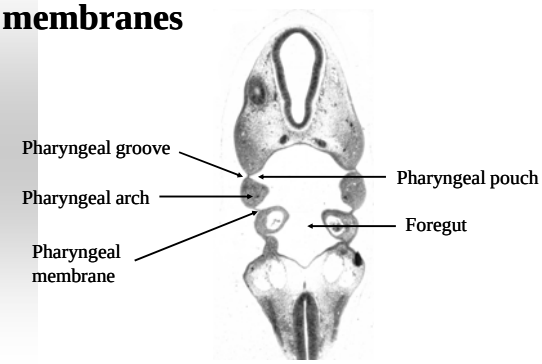
5 Pharyngeal arches

5 Aortic arches

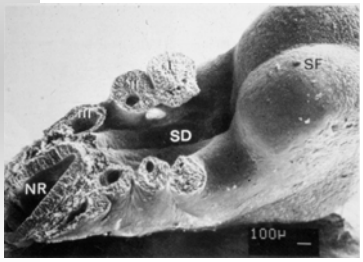
Arches numbered 1-6

Netter F, Ciba collection

Arches, grooves, pouches, and membranes



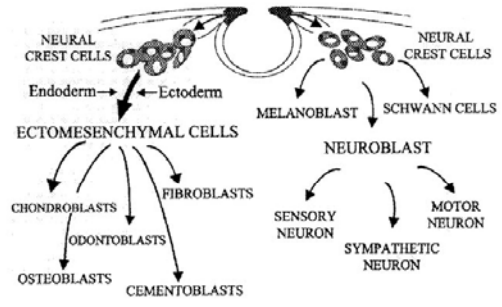
Pharyngeal cleft transient "gill-slit"



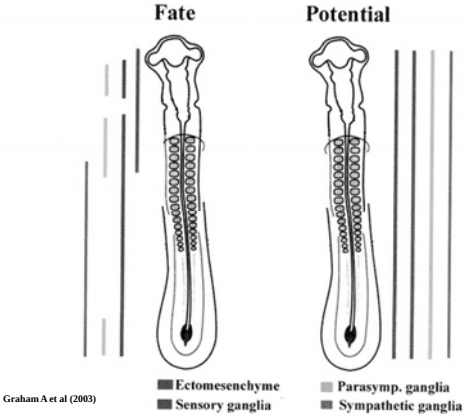
Mangold U et al (1981)

Mesenchyme in cephalic region is derived from:

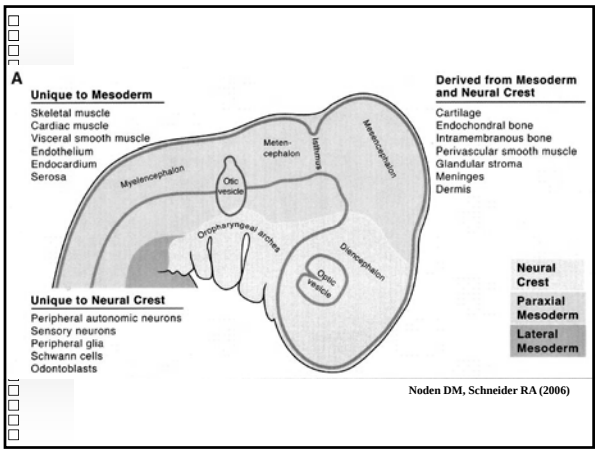
- Mesoderm
- Neural crest



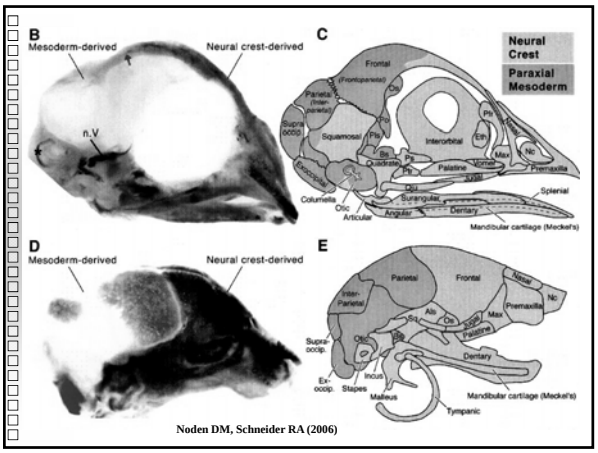
Chai Y, Ito Y, Han J (2003)



Graham A et al (2003)

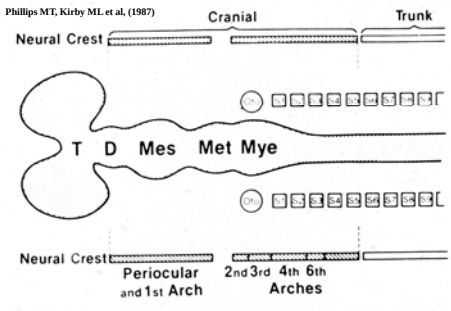


Noden DM, Schneider RA (2006)



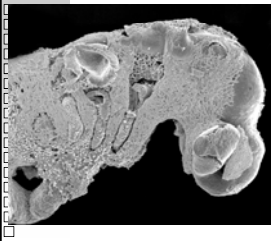
Noden DM, Schneider RA (2006)

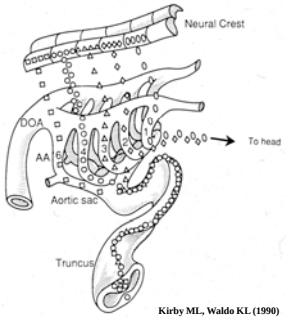
Extent of cephalic (cranial) neural crest



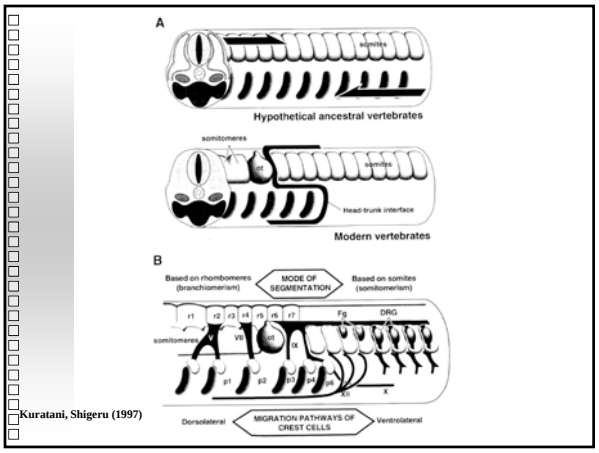
Phillips MT, Kirby ML et al, (1987)

Neural crest involvement in the development of the heart

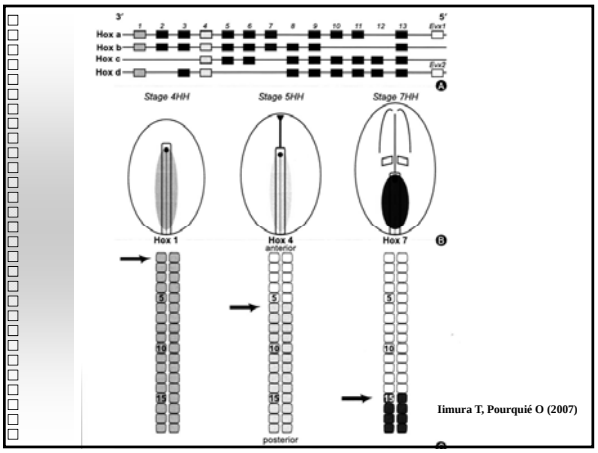

Kuratani S, Horigome N (2000)



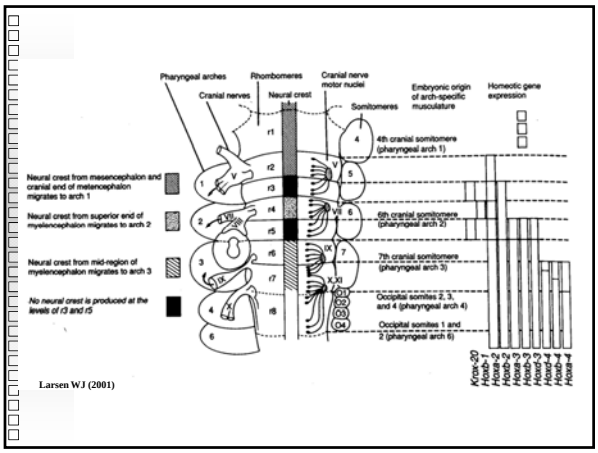
Kirby ML, Waldo KL (1990)



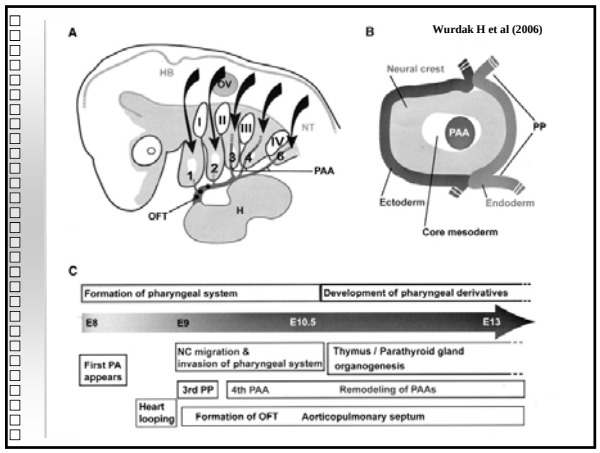
Kuratani, Shigeru (1997)

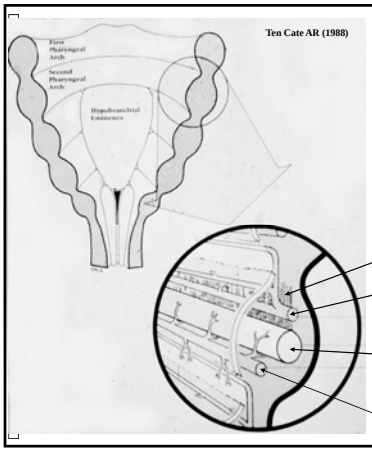


Iimura T, Pourquié O (2007)



Larsen WJ (2001)





Segmental components of arches

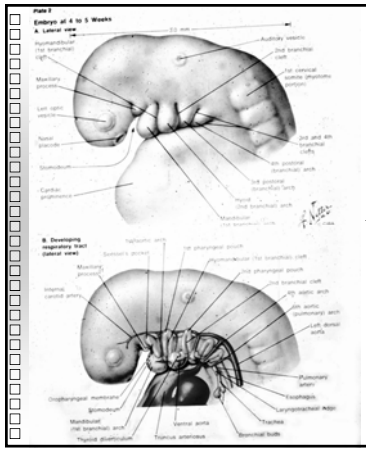
Connective tissues - nc

Muscle – mesoderm

Branchiomeric nerve – nc,ectoderm,neurectoderm

Skeletal bar- nc - (cartilage) last to form

Artery – mesoderm- first to appear

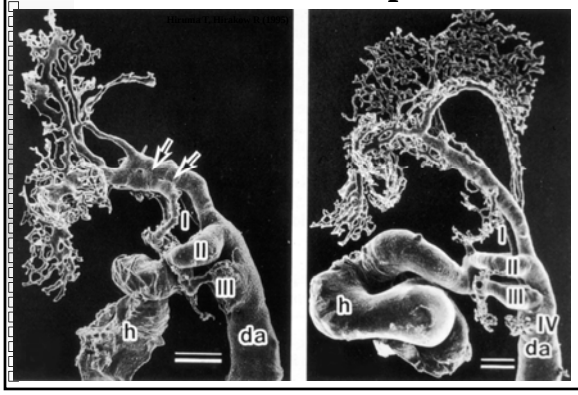


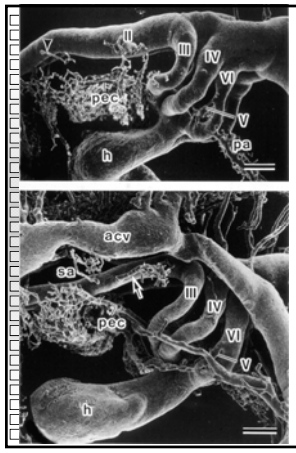
5 Aortic arches

Arches numbered 1-6

Netter F, Ciba collection

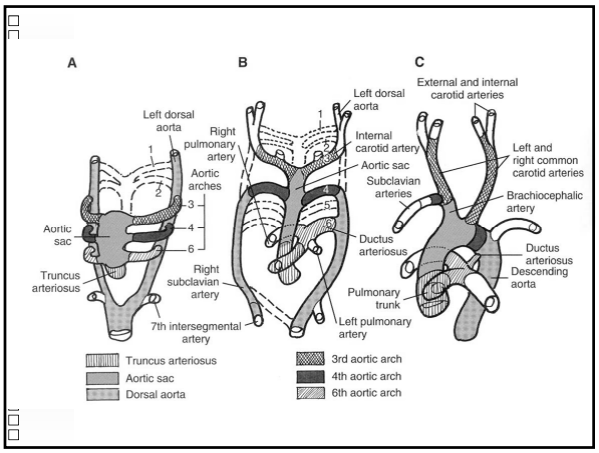
Aortic arch development

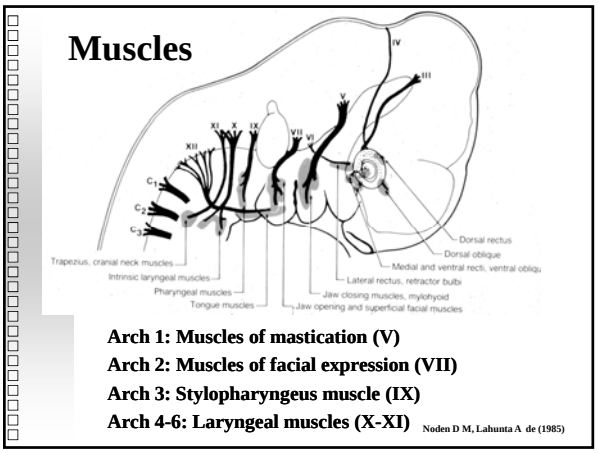


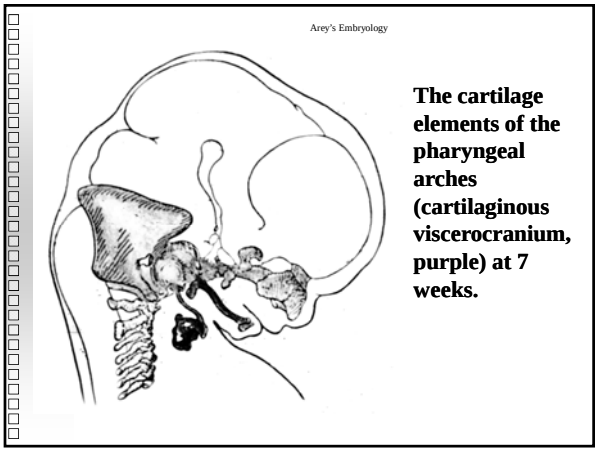


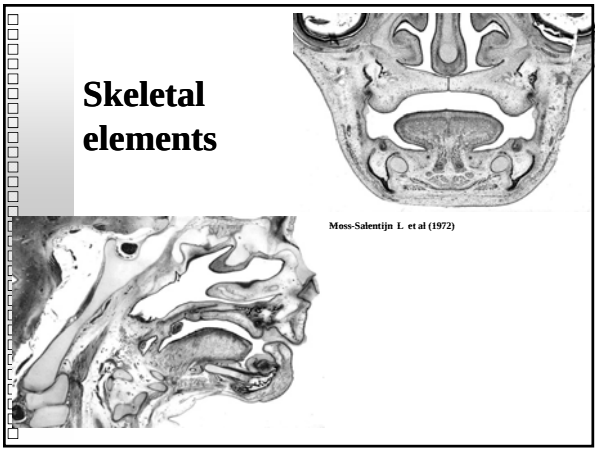
Aortic arch development cont'd

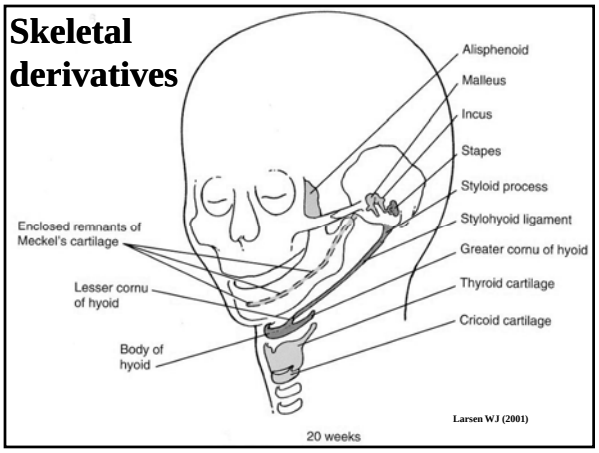
Hiruma T, Hirakow R (1995)

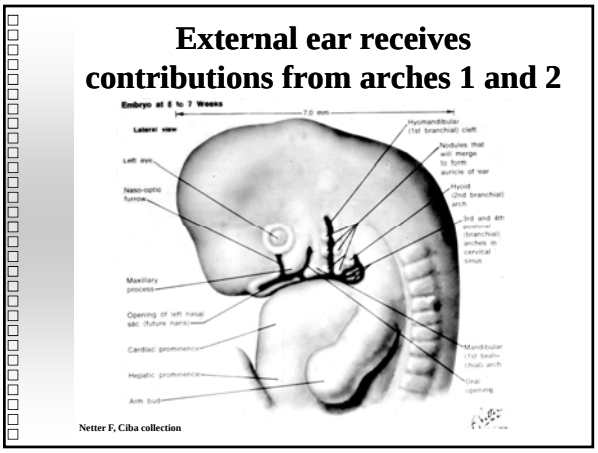

A
B
C
Left dorsal aorta
Right pulmonary artery
Aortic arches
Aortic sac
Truncus arteriosus
Right subclavian artery
7th intersegmental artery
Internal carotid artery
Aortic sac
Subclavian arteries
Ductus arteriosus
Pulmonary trunk
Left pulmonary artery
External and internal carotid arteries
Left and right common carotid arteries
Brachiocephalic artery
Ductus arteriosus
Descending aorta
Truncus arteriosus
Aortic sac
Dorsal aorta
3rd aortic arch
4th aortic arch
6th aortic arch


Muscles
Trapezius, cranial neck muscles
Intrinsic laryngeal muscles
Pharyngeal muscles
Tongue muscles
Dorsal rectus
Dorsal oblique
Medial and ventral recti, ventral oblique
Lateral rectus, retractor bulbi
Jaw closing muscles, mylohyoid
Jaw opening and superficial facial 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, Lahunta A de (1985)

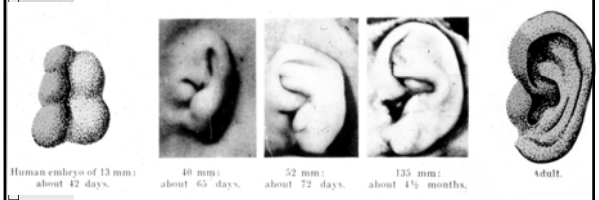

Arey's Embryology
The cartilage elements of the pharyngeal arches (cartilaginous viscerocranium, purple) at 7 weeks.


Skeletal elements
Moss-Salentijn L et al (1972)


Skeletal derivatives
Alisphenoid
Malleus
Incus
Stapes
Styloid process
Stylohyoid ligament
Greater cornu of hyoid
Thyroid cartilage
Cricoid cartilage
Enclosed remnants of Meckel's cartilage
Lesser cornu of hyoid
Body of hyoid
Larsen WJ (2001)
20 weeks

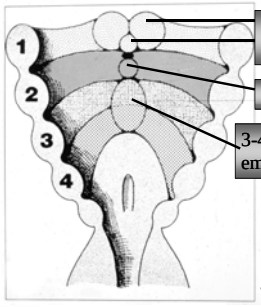

External ear receives contributions from arches 1 and 2
Embryo at 6 to 7 Weeks
Lateral view
Left eye
Naso-optic furrow
Maxillary process
Opening of left nasal sac (future nares)
Cardiac prominence
Hepatic prominence
Arm bud
Hyomandibular (1st branchial) cleft
Nodules that will merge to form auricle of ear
Hyoid (2nd branchial) arch
3rd and 4th (cervical) branchial arches in cervical sinus
Mandibular (1st branchial) arch
Oral opening
Netter F, Ciba collection

External ear development by merging of 6 auricular hillocks



Tuchmann-Duplessis H et al, (1975)

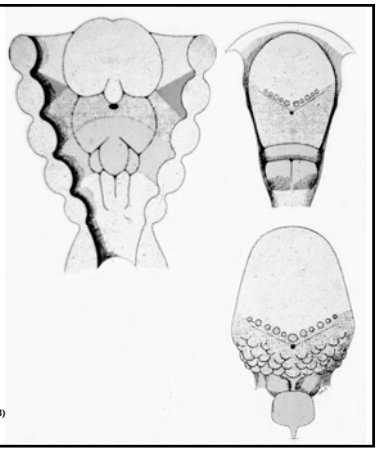
Endodermal swellings on arches 1-4 contribute to the tongue



1. Paired lingual swellings and single median tuberculum impar
2. Single median copula
3-4. Combined median hypobranchial eminence

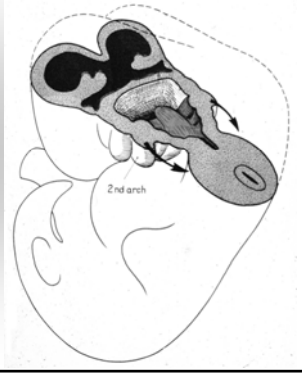
Ten Cate AR (1988)

Merging of lingual swellings



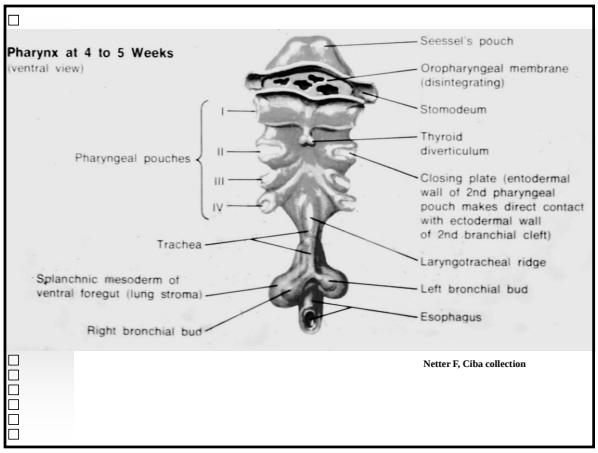
Ten Cate AR (1988)

Fate of pharyngeal grooves 2-4



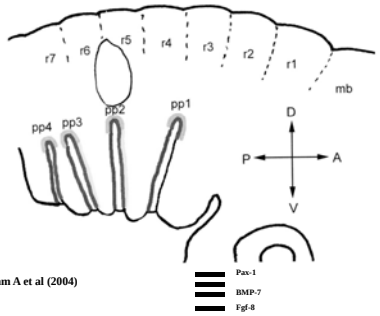
Covered by rapid outgrowth of 2nd arch "operculum."

Tuchmann-Duplessis H, Haegel P (1975)



Netter F, Ciba collection

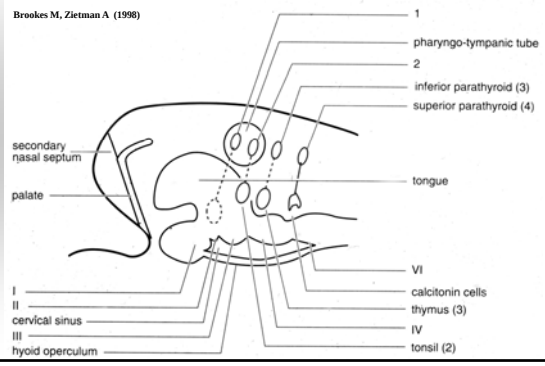
Endoderm plays key role in morphogenesis of pharyngeal region

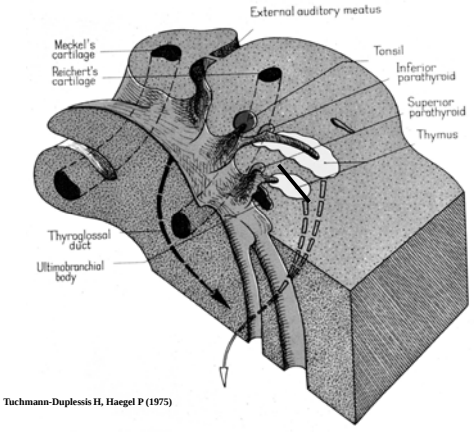


Graham A et al (2004)

Derivatives of dorsal and ventral parts of pharyngeal pouches

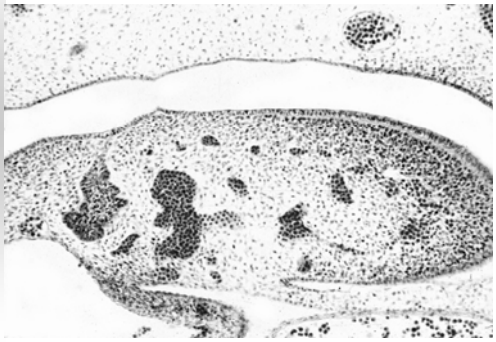
Brookes M, Zietman A (1998)

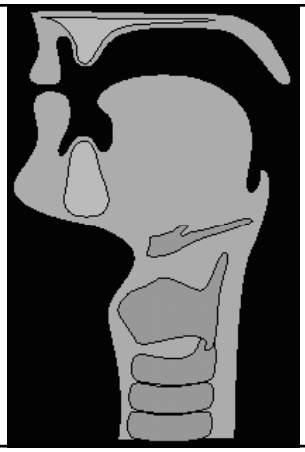




Tuchmann-Duplessis H, Haegel P (1975)

Thyroid gland development Thyroglossal duct





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

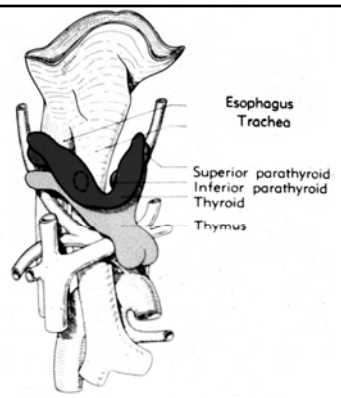
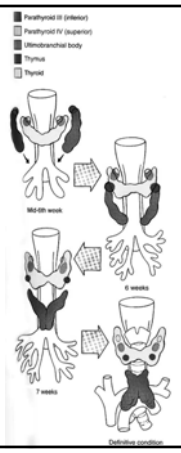


Diagram showing thyroid in place.

Superior and inferior parathyroid glands

Tuchmann-Duplessis H, Haegel P (1975)



Larsen WJ (2001)