

DEVELOPMENT OF BRANCHIAL ARCHES

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I. **DEVELOPMENT OF BRANCHIAL ARCHES** - structures which develop in an embryo that are comparable to gills of fish; reflect fact that ontogeny (development of individual) resembles phylogeny (evolution of species); are important in understanding the final structure and innervation of head and neck.

A. Week 4 - Neural crest cells invade future head and neck region of embryo; cells form ridges on side of head and neck located lateral to rostral part of the foregut; will form branchial arch components. Terminology is confusing. (Note: Branchial Arch = Pharyngeal Arch, Branchial Arch Artery = Aortic Arch, Cleft = Groove)

B. Branchial apparatus - Composed of 4 elements (including branchial arches):

1. **Branchial arch** - components - arches are covered by ectoderm externally; lined internally by endoderm; core of arch formed by mesenchyme; mesenchyme will form muscles, arteries, connective tissue, cartilage and parts of skeleton; each arch has a specific nerve that innervates the muscles that develop from that arch; some arteries will form adult vessels (considered as Aortic Arches).

2. **Branchial groove** (Pharyngeal cleft) - ectodermal (external) cleft between adjacent arches

3. **Branchial pouch** - endodermal outpocketing of rostral part of foregut; pouches are located between adjacent branchial arches.

4. **Branchial membrane** - site of contact of ectoderm of branchial groove with endoderm of pharyngeal pouch.

D. Branchial apparatus of embryo is reshaped into new structures; structures can disappear or form vestigial remnants by the end of the embryonic period.

II. **FATE OF BRANCHIAL ARCHES** - contribute to formation of face, neck, mouth, larynx, and pharynx – see chart

A. Branchial Arch Cartilages – form skeletal elements (bones, cartilages and ligaments)

B. Branchial Arch Nerves are cranial nerves (**Branchiomotor, SVE component**) - **First** arch = **Trigeminal** (V), **Second** arch = **Facial N.** (VII); **Third** arch = **Glossopharyngeal N.** (IX); **Fourth** arch = **Vagus** (X); **Sixth** arch (caudal) = **Accessory N.** (XI)

Note: Fifth arch forms no adult structures in humans; Sixth arch is small; descriptions of Fourth and Sixth Arches vary among authors.

C. Branchial arch muscles – many (see chart); each muscle migrates but continues to be innervated by the cranial nerve to the arch from which the muscle is derived.

STRUCTURES DERIVED FROM BRANCHIAL ARCHES

ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Sphenomandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric
Second (VII)	1) Stapes 2) Styloid process 3) Hyoid bone - lesser horn, upper half of body	Stylohyoid ligament	1) Muscles of Facial Expression 2) Stapedius 3) Stylohyoid 4) Post. belly of Digastric
Third (IX)	Hyoid bone - greater horn, lower half of body	-----	Stylopharyngeus
Fourth (X)	Cartilages of Larynx	-----	1) All muscles of Larynx 2) All muscles of Pharynx (except Stylopharyngeus) 3) All muscles of Soft Palate (except Tensor palati)
Sixth (XI)	-----	-----	1) Sternocleidomastoid 2) Trapezius

Note: First Branchial Groove (Cleft) becomes External Auditory Meatus
First Branchial Membrane becomes Tympanic Membrane

PLANE OF SECTION

III. FATE OF BRANCHIAL POUCHES

A. **Pouch 1** - elongates into tubotympanic recess; forms **Auditory tube** and **Tympanic cavity (middle ear cavity)**.

B. **Pouch 2** - forms epithelial lining of **Crypts** (spaces) **of the Palatine tonsils**.

C. **Pouch 3** - Upper part forms **Inferior Parathyroid gland**; lower part forms **Thymus gland**

D. **Pouch 4** - forms **Superior Parathyroid gland** and **C cells of Thyroid gland** (produce hormone calcitonin).

NOTE: Superior parathyroid gland develops from Pouch 4 and Inferior parathyroid gland from Pouch 3; final position occurs because **elements from Pouch 3 migrate caudal to Pouch 4**.

IV. FATE OF BRANCHIAL GROOVES AND MEMBRANES, ANOMALIES

A. Four branchial grooves separate the branchial arches externally on each side; only one pair of branchial grooves forms a structure in the adult; the **First Branchial Groove** forms the **External Auditory meatus** (outer ear canal), the **First Branchial Membrane** forms the **Tympanic Membrane**.

B. The other **branchial grooves** develop to lie in a larger depression called the **Cervical Sinus**; this sinus is **normally obliterated** during development

Note: **Cervical sinus can persist as a Branchial sinus** (blind pouch off pharynx) or a **Branchial Cyst Fistula** (channel connecting pharynx to skin); when present are found **anterior to Sternocleidomastoid**.

Note: **Branchial fistula (channel)** - when present often extends from 2nd pharyngeal pouch and passes between Internal and External Carotid arteries and exits to skin Anterior to the sternocleidomastoid muscle; can become infected.

STRUCTURES DERIVED FROM BRANCHIAL POUCHES, CLEFT AND MEMBRANES

POUCH	FORMS	CLINICAL
First	1) Auditory tube 2) Tympanic cavity	First Branchial 'Cleft' cyst - tract linked to external auditory meatus
Second	Lining (crypts) of palatine tonsils	Second Branchial 'Cleft' cyst - tract linked to tonsillar fossa (palatine tonsils)
Third	1) Inferior parathyroid gland 2) Thymus	Third Branchial 'Cleft' cyst - tract at thyrohyoid membrane or piriform recess
Fourth	1) Superior parathyroid gland 2) C-cells of Thyroid	does not form
Sixth (XI)	-----	-----

Note: Cysts and fistuli - in lateral neck are **anterior to Sternocleidomastoid muscle**

Note: **Branchial Pouch structures are NOT innervated by the same nerves as the Branchial arches** (see lectures on Pharynx).

CLEFT	FORMS
First	External Auditory Meatus

MEMBRANE	FORMS
First	Tympanic membrane

V. DEVELOPMENT OF THYROID GLAND

A. Initial stage - a median endodermal thickening forms in floor of primitive pharynx at site of **junction of future anterior 2/3's and posterior 1/3 of tongue**.

B. Later - thickening elongates into floor of pharynx as the **Thyroid diverticulum**; opening of diverticulum on surface of developing tongue called the Foramen Cecum.

C. Developing Thyroid diverticulum descends in the neck anterior to the hyoid bone and larynx; as diverticulum (developing gland) elongates into neck, a Thyroglossal duct connects diverticulum with foramen cecum.

D. Developing thyroid gland reaches final site in neck (anterior to upper rings of trachea); thyroglossal duct disintegrates; foramen cecum remains as a vestigial pit on the

tongue.

E. Congenital malformations

1. **Persistent thyroglossal duct remnants** - part of duct can remain and form thyroglossal cysts anywhere from foramen cecum of tongue to thyroid gland in neck; cysts found in midline of neck and can be located anterior to hyoid bone or larynx.

Clinical note: **Lingual Thyroid** – Developing Thyroid Gland can fail to migrate and remain in tongue as Lingual Thyroid; can produce difficulty in swallowing (but should not be inadvertently removed).

2. **Pyramidal lobe** - present in 50 percent of people; represents persistent part of thyroglossal duct, which can contain some thyroid tissue; lobe can be attached to hyoid bone by fibrous strand; usually no associated clinical problems.