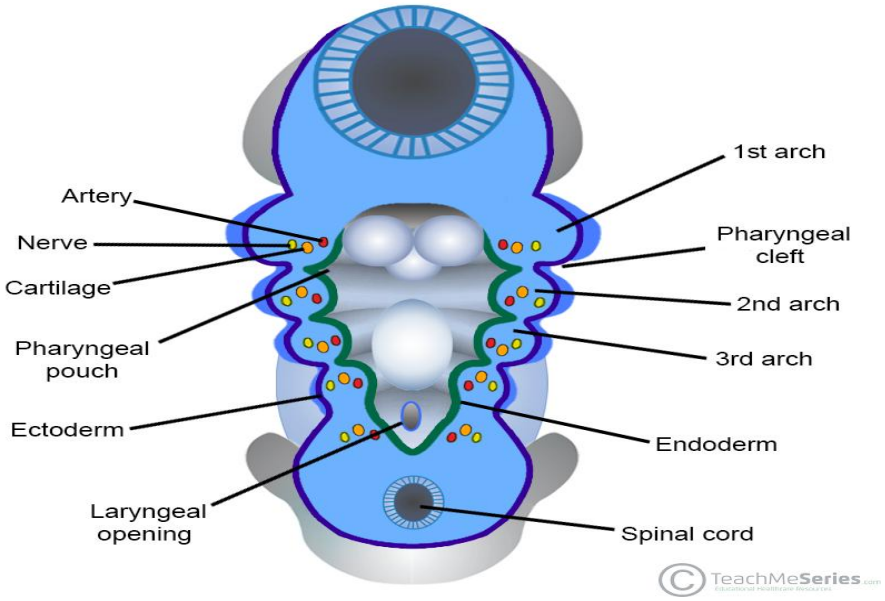
Embryology5 **Dr.Ban**

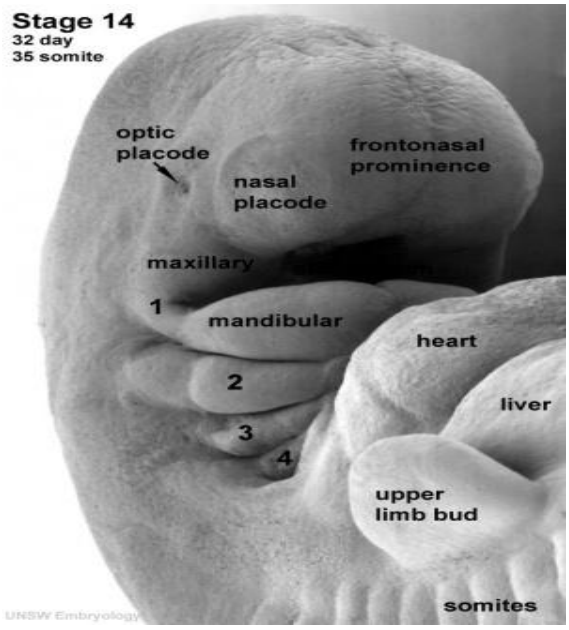
Pharyngeal arches

The development of the head and neck begins in the 4th and 5th week. Growth of mesenchymal tissue (connective tissue) in the cranial region of the embryo results in the formation of arches, separated by clefts. These are the pharyngeal arches and pharyngeal clefts**.**A number of out-pocketings appear on the lateral wall of the pharynx – the pharyngeal pouches. The pouches separate the arches on the internal (endodermal) surface whilst the clefts separate the arches on the external (ectodermal) surface.



The pharyngeal arches, development involves a number of embryonic cell types: ectoderm, endoderm, neural crest and mesoderm, begin to develop in the fourth week as neural crest cells migrate into the future head and neck regions.

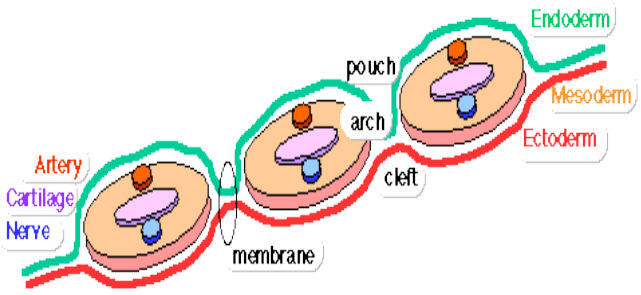
The pharyngeal arches are a series of externally visible anterior tissue bands lying under the early brain that give rise to the structures of the head and neck. Each arch though initially formed from similar components will differentiate to form different head and neck structures.



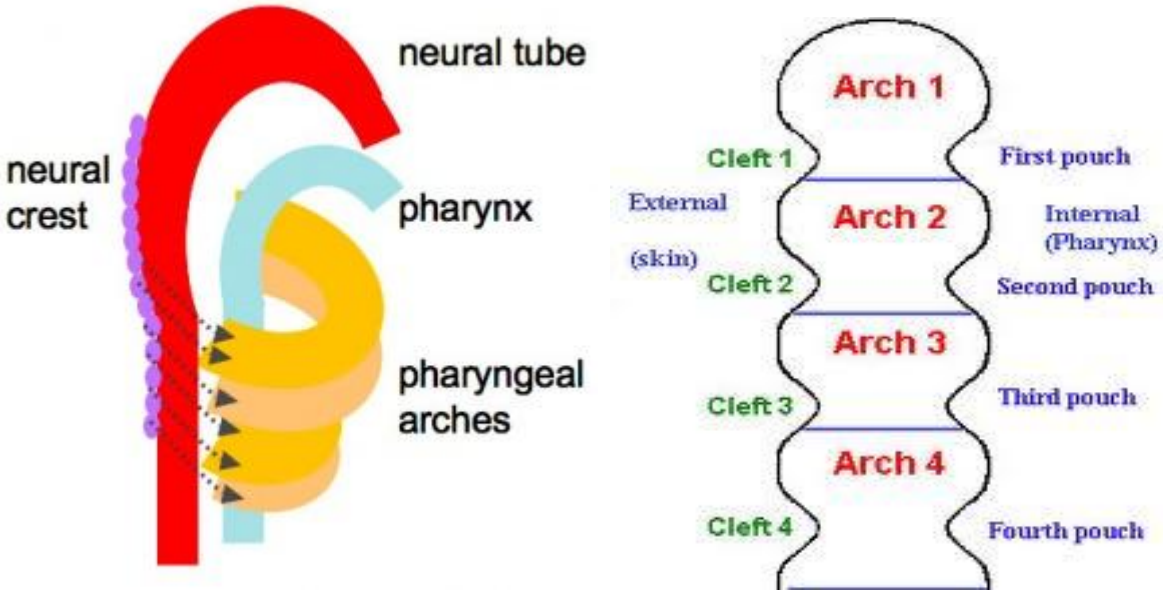
Pharyngeal arches are paired structures associated with the pharynx that contribute greatly to the formation of the face, jaw, ear, and neck

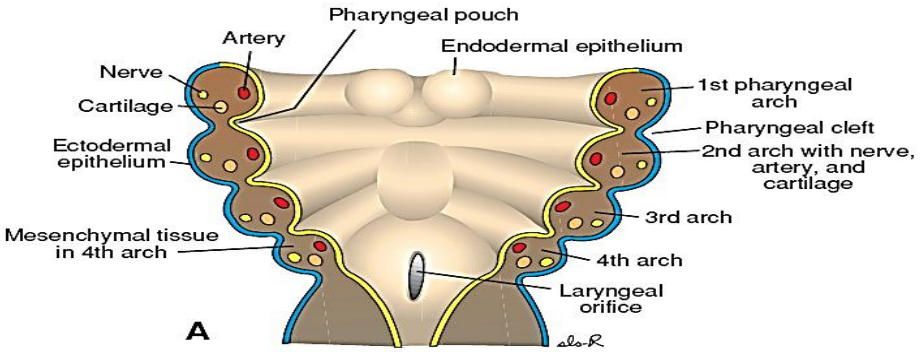
During vertebrate development, pharyngeal arch pairs project forward from the back of the embryo toward the front of the face and neck they grow and join in the ventral midline. Each arch develops its own artery, nerve , muscle and skeletal tissue. In humans, five arches form (1, 2, 3, 4 and 6) but only four are externally visible on the embryo. The grooves and pouches are numbered the same as the preceding arch.

The entire pharyngeal apparatus consists of paired pharyngeal arches, pharyngeal pouches, pharyngeal clefts (or grooves), and pharyngeal membranes , The approximation of the ectoderm of the pharyngeal cleft with the endoderm of the pharyngeal pouch forms the pharyngeal membrane.



Pharyngeal arch consists of all 3 trilaminar embryo layers :ectoderm- outside, mesoderm- core of mesenchyme ,endoderm- inside.





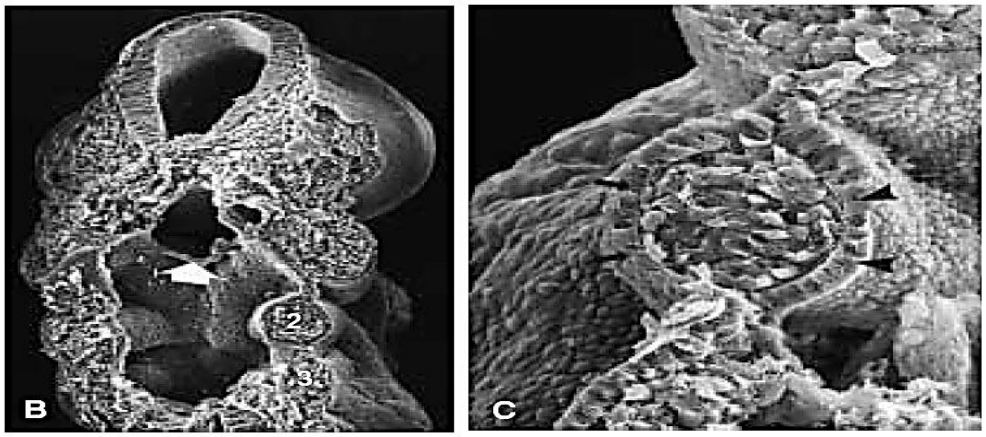


Figure 15.6 A. Pharyngeal arches. Each arch contains a cartilaginous component, a cranial nerve, an artery, and a muscular component. **B.** Scanning electron micrograph of the pharyngeal region of a mouse embryo, showing the pharyngeal arches, pouches, and clefts. The first three arches (I, II, and III) are visible. A remnant of the buccopharyngeal membrane (*arrow*) is present at the entrance to the oral cavity. **C.** Higher magnification of the pharyngeal arches of a mouse embryo. Pharyngeal arches consist of a core of mesoderm lined by endoderm internally (*arrowheads*) and ectoderm externally (*arrows*). Pouches and clefts occur between the arches, where endoderm and ectoderm appose each other.

Pharyngeal archs:

1-The first pharyngeal arch(mandibular arch)

Skeletal elements

- Malleus & Incus of the middle ear
- maxilla & mandible

Muscles

- Muscles of mastication (chewing)
- Mylohyoid muscle
- Digastric muscle, anterior belly
- Tensor palati muscle
- Tensor tympani muscle

Nerve

Trigeminal nerve

Artery

Maxillary artery

2-The second pharyngeal arch

The second pharyngeal arch or hyoid arch (or second branchial arch) assists in forming the side and front of the neck.

Skeletal elements

- Stapes
- Temporal styloid process,
- Stylohyoid ligament
- Lesser horn of the hyoid bone.

Muscles

- Muscles of face
- Occipitofrontalis muscle
- Platysma
- Stylohyoid muscle
- Posterior belly of Digastric
- Stapedius muscle
- Auricular muscles

Nerve supply

Facial nerve

Artery

Second aortic arch,

3-The third pharyngeal arch

Skeletal elements

- Hyoid (greater horn),and lower part of body),

Muscles

Stylohpharyngeus

Nerve
Glossopharyngeal nerve(IX)
Artery
Common carotid ,internal carotid artery.

4-The fourth pharyngeal arch aortic arch
Skeletal elements
Thyroid cartilage , parathyroid,Epiglottic cartilage.
Muscles
- Cricothyroid muscle
- All intrinsic muscles of the soft palate including levator veli palatini

Nerve
- Vagus nerve
- Superior laryngeal nerve.

Artery
- Right 4th aortic arch: subclavian artery
- Left 4th aortic arch :aortic arch.

5-The sixth pharyngeal arch
Skeletal elements
- Cricoid cartilage
- Arytenoid cartilage
- Corniculate cartilage

Muscles
- All intrinsic muscles of larynx except the cricothyroid muscle

Nerve
- Vagus nerve
- Recurrent laryngeal nerve.

Artery
- Right 6th aortic arch :pulmonory artery
- Left6th aortic arch: pulmonary artery,ductus arteriousus.

Pharyngeal clefts

- Pharyngeal cleft1

Develops into the external auditory meatus(the corresponding 1st pharyngeal pouch develops into the auditory or eustacian tube, and the intervening membrane develops into the typanic membrane).

Defects in the development of pharyngeal cleft1 can result in preauricular cysts and/or fistulas(in front of the pinna of the ear).

- Pharyngeal cleft 2,3 and 4 are overgrown by expansion of the 2nd pharyngeal arch and usually obliterated.

Pharyngeal pouches

- First pouch

The endoderm lines the future auditory tube (Pharyngotympanic Eustachian tube), middle ear, mastoid antrum, and inner layer of the tympanic membrane.

- Second pouch

Contributes to the middle ear, palatine tonsils, supplied by the facial nerve.

- Third pouch

Third pouch possesses dorsal and ventral wings. Derivatives of the dorsal wings include the inferior parathyroid glands, while the ventral wings fuse to form the cytoreticular cells of the thymus. The main nerve supply to the derivatives of this pouch is cranial nerve IX, glossopharyngeal nerve.

- Fourth pouch:Derivatives include:

• Superior parathyroid glands and ultimobranchial body which forms the parafollicular C-Cells of the thyroid gland.

• Musculature and cartilage of larynx (along with the sixth pharyngeal pouch).

- Fifth pouch

Rudimentary structure, becomes part of the fourth pouch contributing to thyroid C-cells.

- Sixth pouch

Along with the fourth pouch, the contributes to the formation of the musculature and cartilage of the larynx.

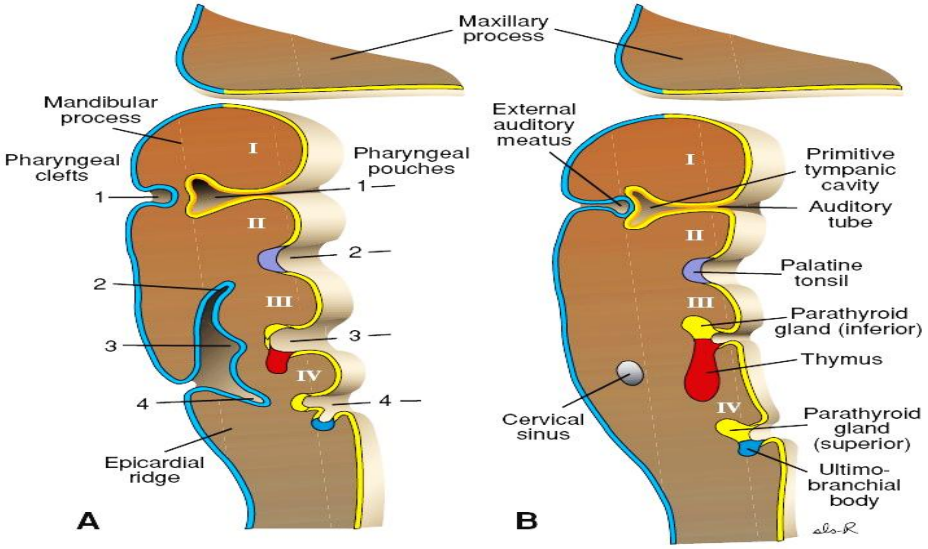


Figure 15.10 A. Development of the pharyngeal clefts and pouches. The second arch grows over the third and fourth arches, burying the second, third, and fourth pharyngeal clefts. **B.** Remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus, which is normally obliterated. Note the structures formed by the various pharyngeal pouches.

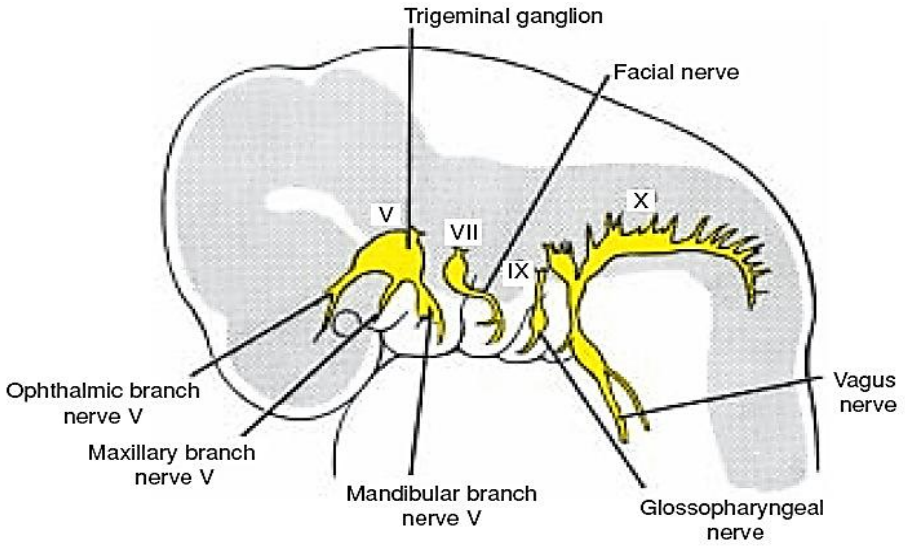


Figure 15.7 Each pharyngeal arch is supplied by its own cranial nerve. The trigeminal nerve supplying the first pharyngeal arch has three branches: the ophthalmic, maxillary, and mandibular. The nerve of the second arch is the facial nerve; that of the third, the glossopharyngeal nerve. The musculature of the fourth arch is supplied by the superior laryngeal branch of the vagus nerve, and that of the sixth arch, by the recurrent branch of the vagus nerve.

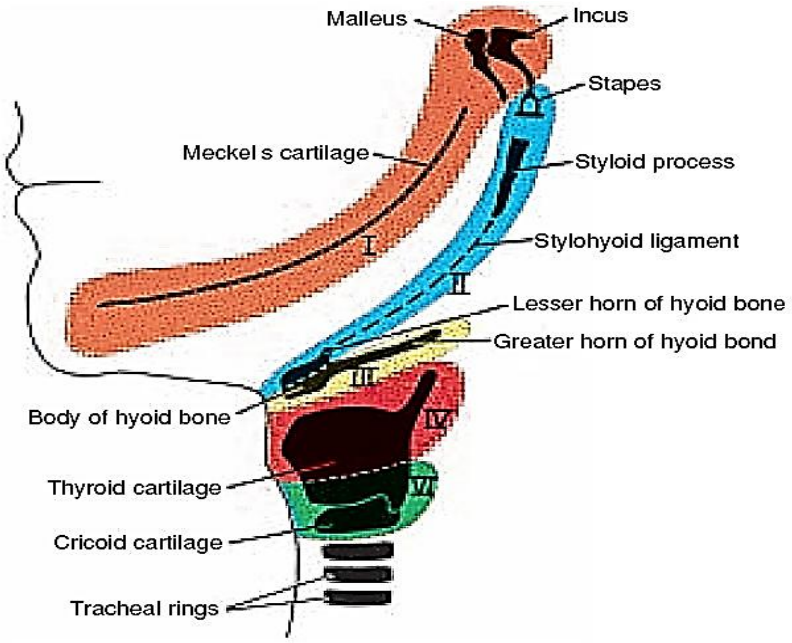


Figure 15.9 Definitive structures formed by the cartilaginous components of the various pharyngeal arches.

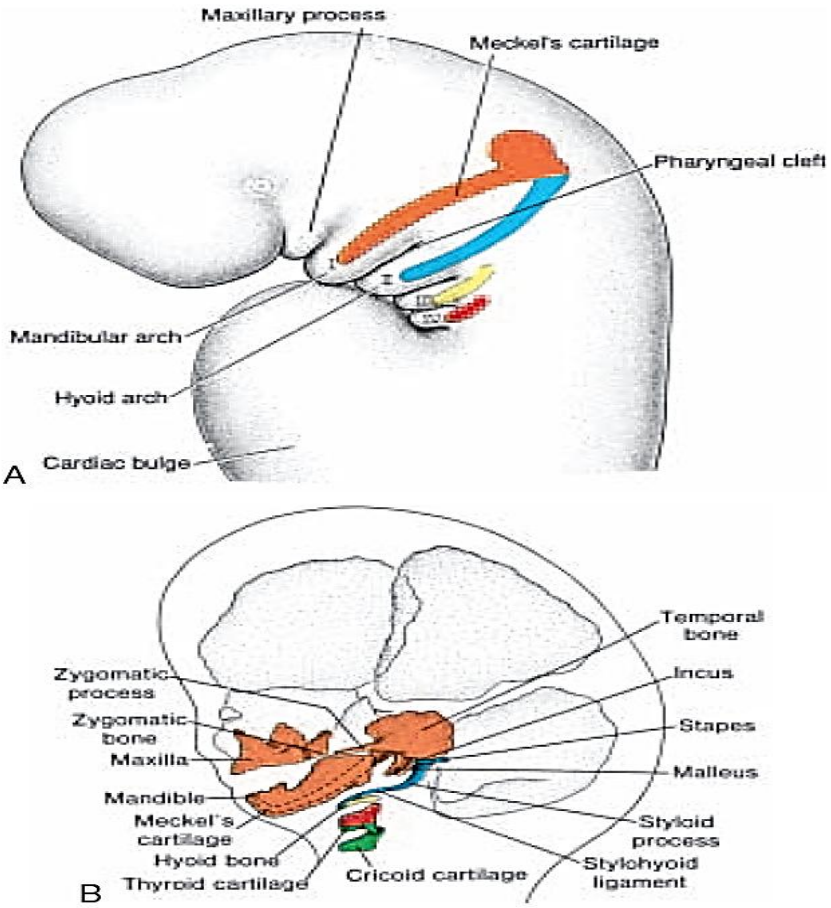


Figure 15.8 A. Lateral view of the head and neck region of a 4-week embryo demonstrating the cartilages of the pharyngeal arches participating in formation of the bones of the face and neck. **B.** Various components of the pharyngeal arches later in development. Some of the components ossify; others disappear or become ligamentous. The maxillary process and Meckel's cartilage are replaced by the maxilla and mandible, respectively, which develop by membranous ossification.

Fate of pharyngeal arches

- The pharyngeal arches contribute exclusively to the formation of the face, nasal cavities, mouth, larynx, pharynx and neck.
- During the fifth week, the second pharyngeal arch enlarges and overgrows the third and fourth arches, forming the ectodermal depression called cervical sinus.
- By the end of seventh week the second to fourth pharyngeal grooves and the cervical sinus have disappeared, giving the neck a smooth contour

Branchial cyst

Branchial cyst is a congenital epithelial cyst that arises on the lateral part of the neck usually due to failure from an incompletely closed branchial cleft, usually located between the 2nd and 3rd branchial arches.

Remnants of pharyngeal clefts 2-4 can appear in the form of cervical cysts or fistulas found along the anterior border of the sternocleidomastoid muscle.

Most branchial cleft fistulae are asymptomatic, but they may become infected.

Treatment:Conservative (i.e. no treatment), or surgical excision. With surgical excision, recurrence is common, usually due to incomplete excision. Often, the tracts of the cyst will pass near important structures, such as the internal jugular vein, carotid artery, or facial nerve, making complete excision impractical.

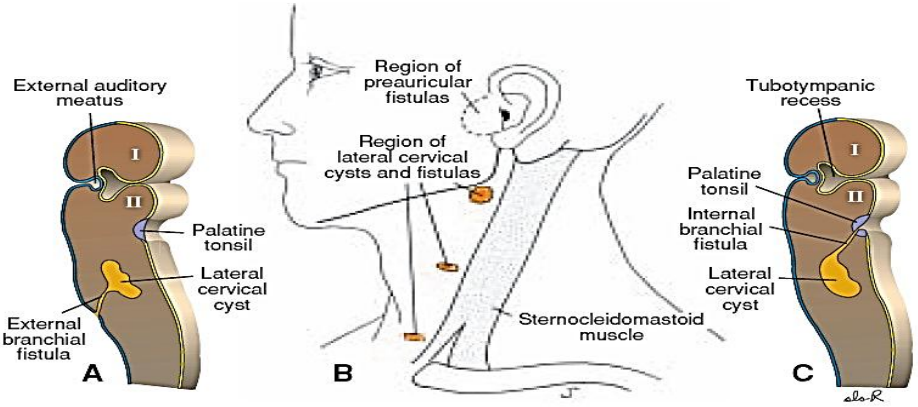


Figure 15.14 A. Lateral cervical cyst opening at the side of the neck by way of a fistula. **B.** Lateral cervical cysts and fistulas in front of the sternocleidomastoid muscle. Note also the region of preauricular fistulas. **C.** A lateral cervical cyst opening into the pharynx at the level of the palatine tonsil.

Figure 15.15 Patient with a lateral cervical cyst. These cysts are always on the lateral side of the neck in front of the sternocleidomastoid muscle. They commonly lie under the angle of the mandible and do not enlarge until later in life.