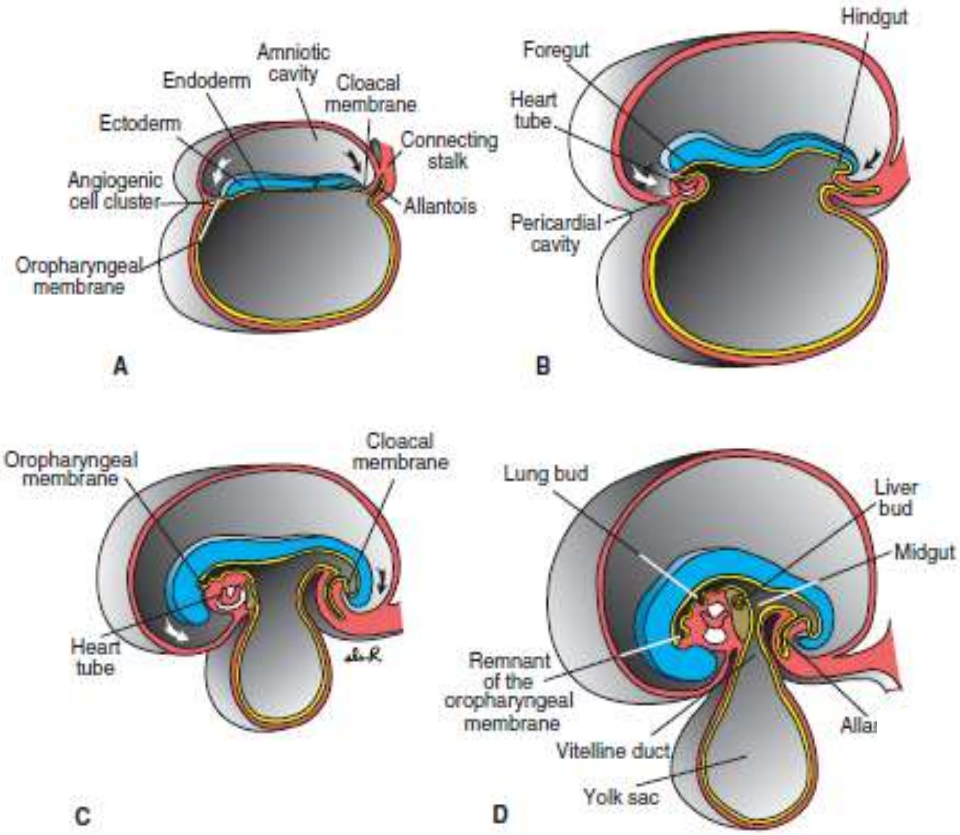
DEVELOPMENT OF THE HEAD. PHARYNGEAL ARCHES. STRUCTURE OF THE ORAL CAVITY

Department of Histology, Cytology, and Embryology

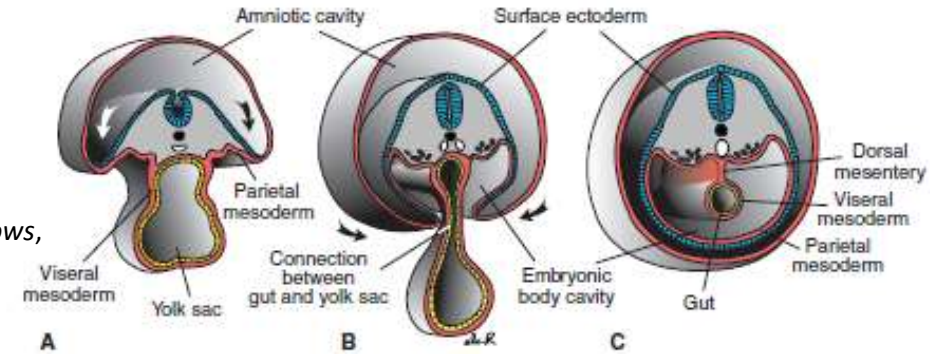
DEVELOPMENT OF THE HEAD. PHARYNGEAL ARCHES.



Sagittal midline sections of embryos at various stages of development to demonstrate cephalocaudal folding and its effect on position of the endoderm-lined cavity. **A.** 17 days. **B.** 22 days. **C.** 24 days. **D.** 28 days. *Arrows*, head and tail folds

As a result of cephalocaudal and lateral folding of the embryo, a portion of the endoderm-lined yolk sac cavity is incorporated into the embryo to form the **primitive gut**.

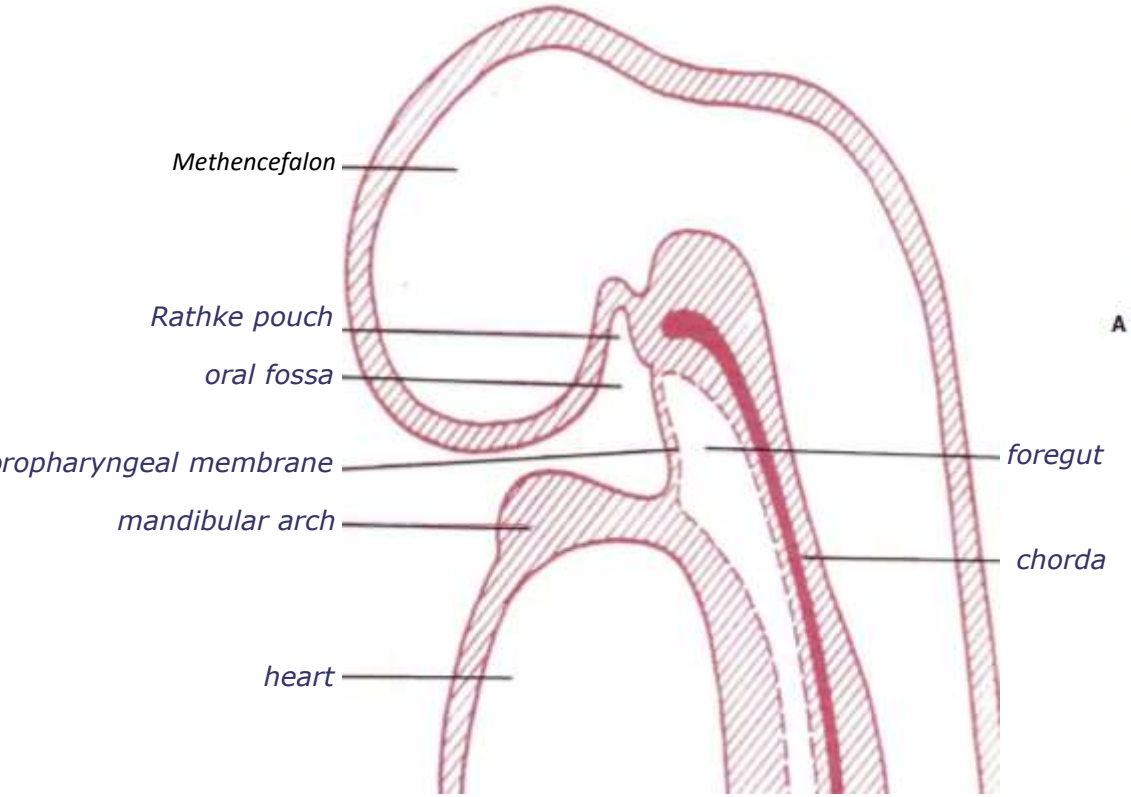
In the cephalic and caudal parts of the embryo, the primitive gut forms a blind-ending tube, the **foregut** and **hindgut**, respectively. The middle part, the **midgut**, remains temporally connected to the yolk sac by means of the **vitelline duct**, or **yolk stalk** .

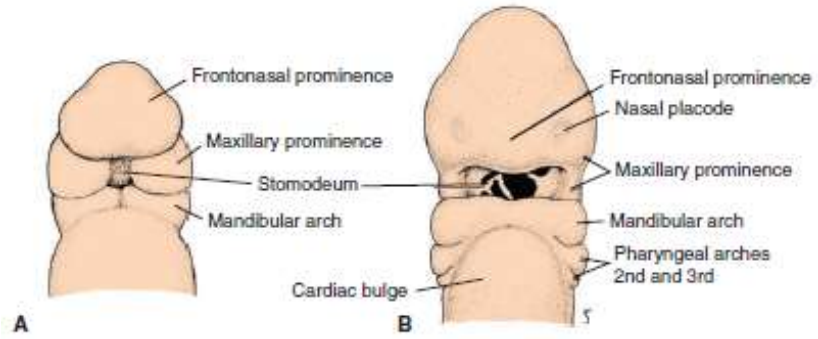


Cross sections through embryos at various stages of development to show the effect of lateral folding on the endoderm-lined cavity. **A.** Folding is initiated. **B.** Transverse section through the midgut to show the connection between the gut and yolk sac. **C.** Section just below the midgut to show the closed ventral abdominal wall and gut suspended from the dorsal abdominal wall by its mesentery. *Arrows*, lateral folds.

DEVELOPMENT OF THE HEAD. PHARYNGEAL ARCHES.

At its cephalic end, the foregut is temporarily bounded by an ectodermal–endodermal membrane called the **oropharyngeal membrane**. This membrane separates the **stomadeum**, the primitive oral cavity derived from ectoderm, from the pharynx, a part of the foregut derived from endoderm. In the fourth week, the oropharngeal membrane ruptures, establishing an open connection between the oral cavity and the primitive gut





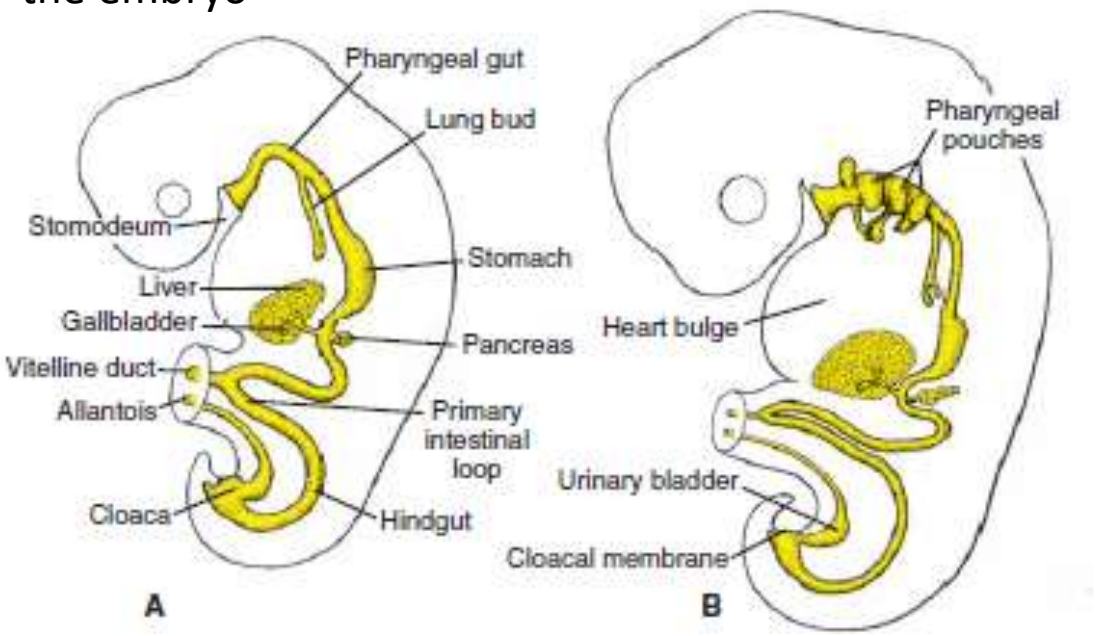
The **pharyngeal gut**, or **pharynx**, extends from the *oropharyngeal membrane* to the *respiratory diverticulum* and is part of the foregut; this section is particularly important for development of the head.

The human embryo is 3 mm long. Median section through the head.
The oral fossa is separated from the cavity of the foregut by the oropharyngeal membrane

DEVELOPMENT OF THE HEAD. PHARYNGEAL ARCHES.

Mesenchyme for formation of the head region is derived from **paraxial** and **lateral plate mesoderm, neural crest**, and thickened regions of ectoderm known as **ectodermal placodes**.

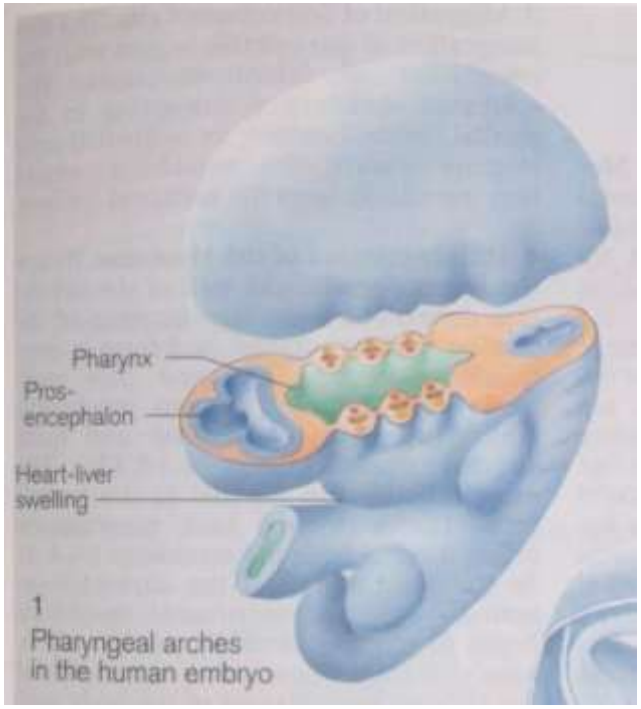
The most distinctive feature in development of the head and neck is the presence of **pharyngeal arches** (the old term for these structures is **branchial arches** because they somewhat resemble the gills [branchia] of a fish). These arches appear in the fourth and fifth weeks of development and contribute to the characteristic external appearance of the embryo

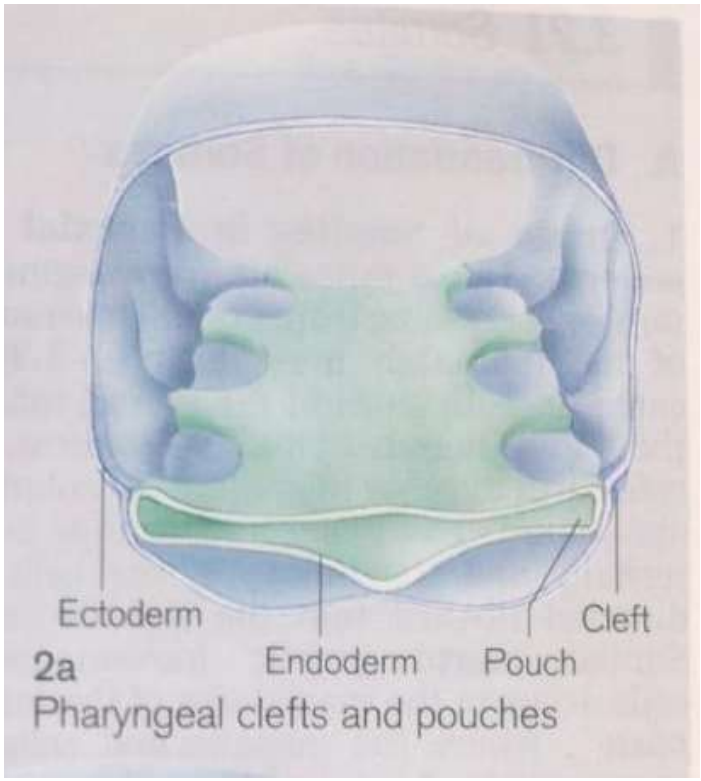


Sagittal sections through embryos showing derivatives of the endodermal germ layer. **A.** Pharyngeal pouches, epithelial lining of the lung buds and trachea, liver, gallbladder, and pancreas. **B.** The urinary bladder is derived from the cloaca and, at this stage of development, is in open connection with the allantois.

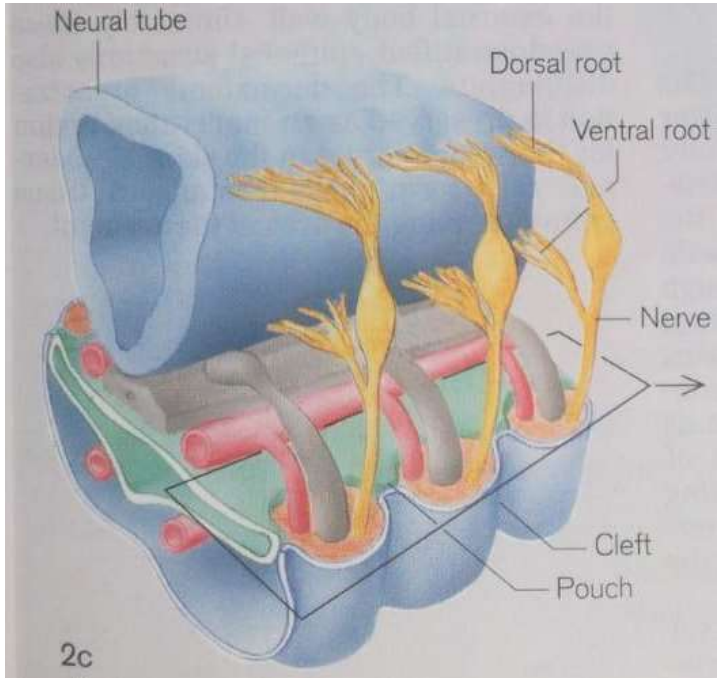
DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

Initially, **pharyngeal arches** consist of bars of mesenchymal tissue separated by deep clefts known as **pharyngeal clefts**. Simultaneously, with development of the arches and clefts, a number of outpocketings, the **pharyngeal pouches**, appear along the lateral walls of the pharynx, the most cranial part of the foregut. The pouches penetrate the surrounding mesenchyme, but do not establish an open communication with the external clefts. Hence, although development of pharyngeal arches, clefts, and pouches resembles formation of gills in fishes and amphibians, in the human embryo, real gills are never formed. Therefore, the term **pharyngeal** (arches, clefts, and pouches) has been adopted for the human embryo.

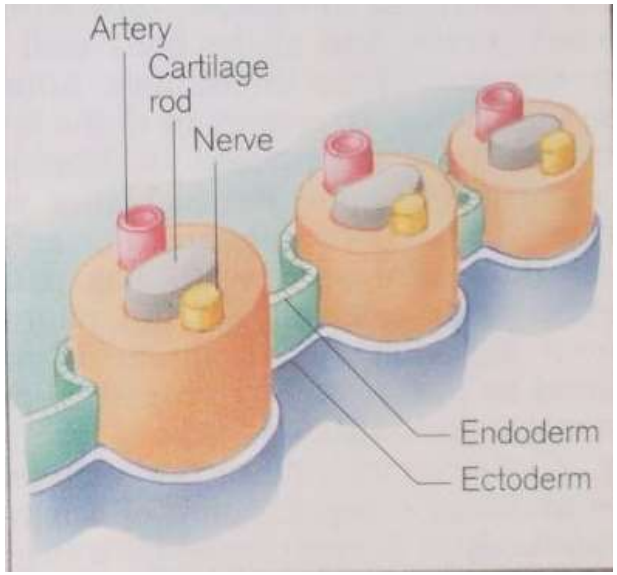


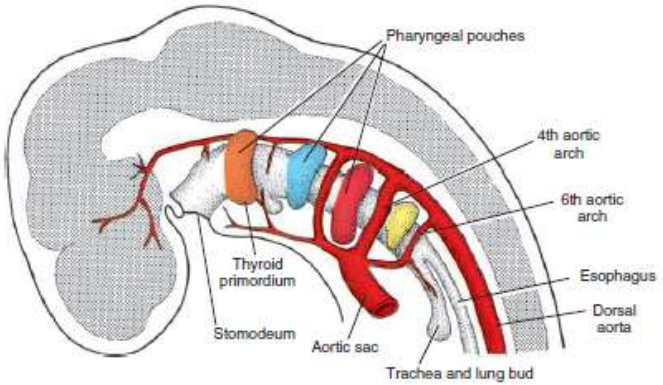


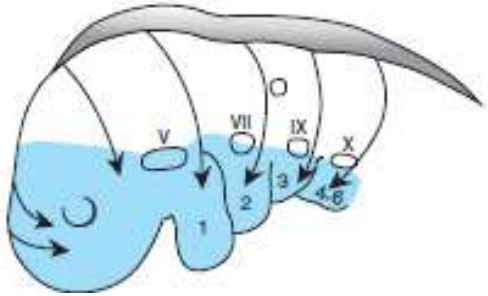
DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.



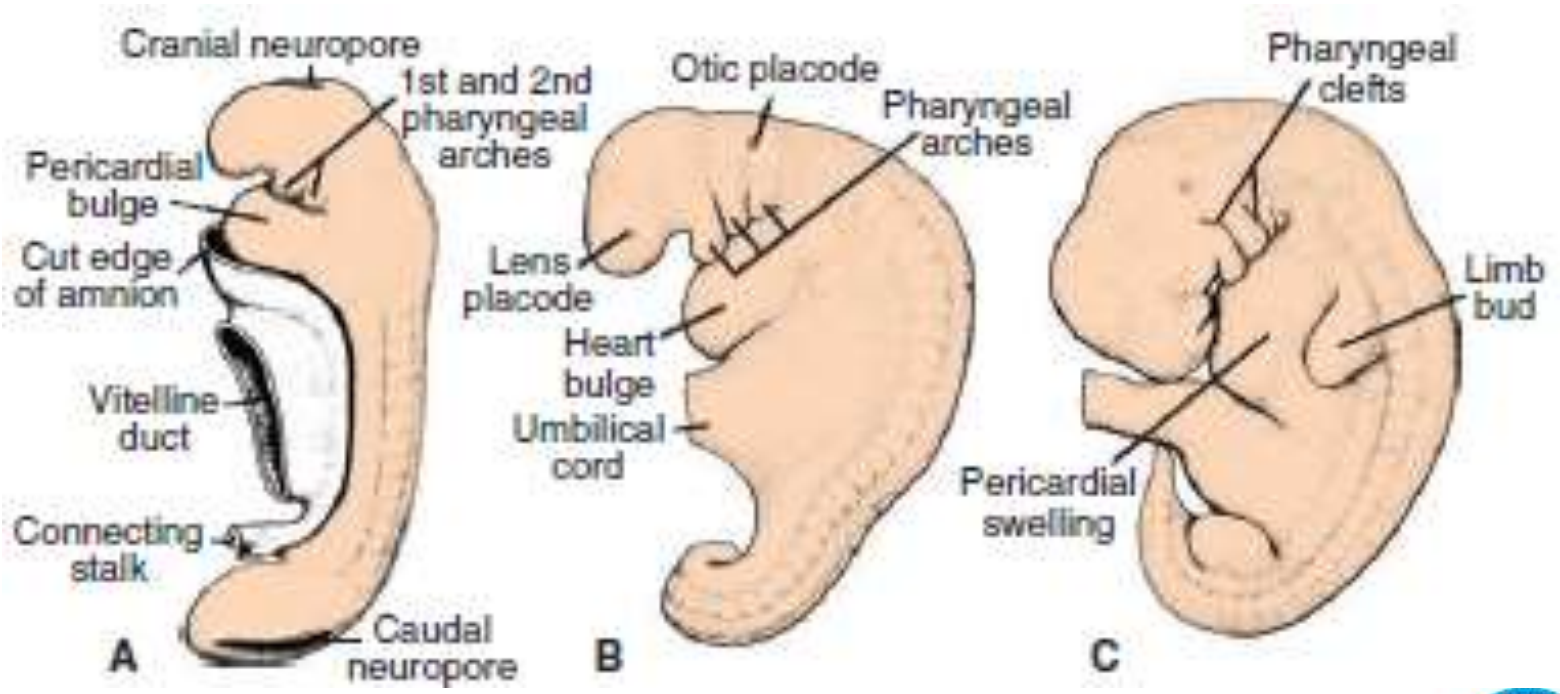
Each **pharyngeal arch** consists of a core of mesenchymal tissue covered on the outside by surface ectoderm and on the inside by epithelium of endodermal origin. In addition to mesenchyme derived from paraxial and lateral plate mesoderm, the core of each arch receives substantial numbers of **neural crest cells**, which migrate into the arches to contribute to **skeletal components** of the face. The original mesoderm of the arches gives rise to the musculature of the face and neck. Thus, each pharyngeal arch is characterized by its own **muscular components**. The muscular components of each arch have their own **cranial nerve**, and wherever the muscle cells migrate, they carry their **nerve component** with them . In addition, each arch has its own **arterial component** .



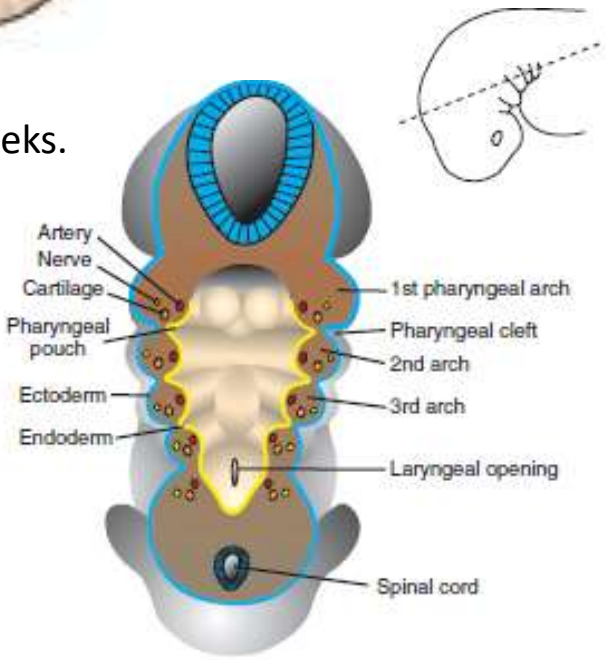




DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.



Development of the pharyngeal arches. **A**. 25 days. **B.** 28 days. **C.** 5 weeks.

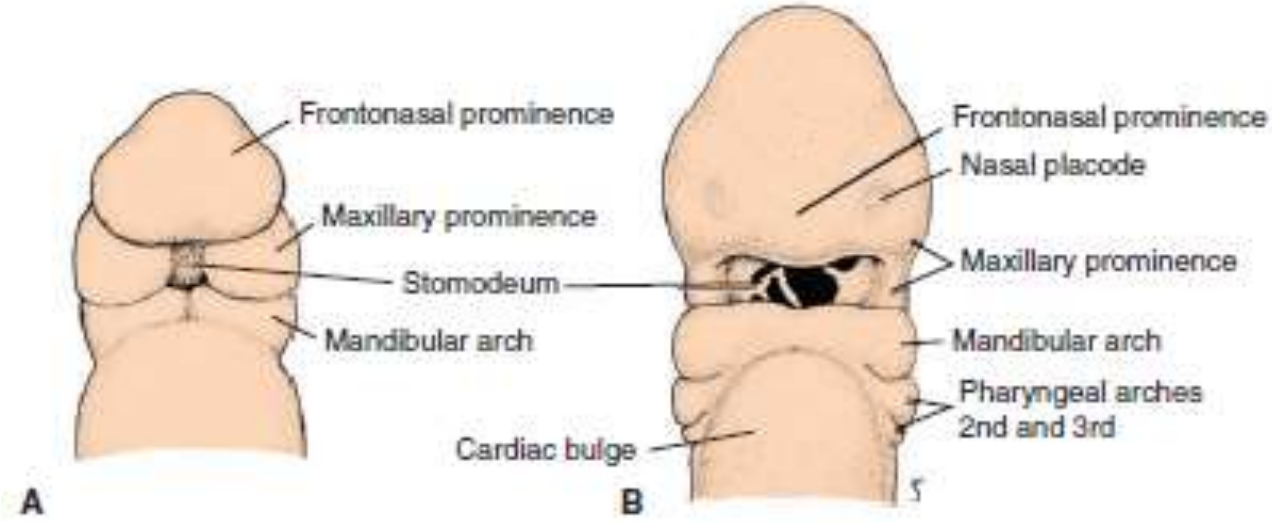


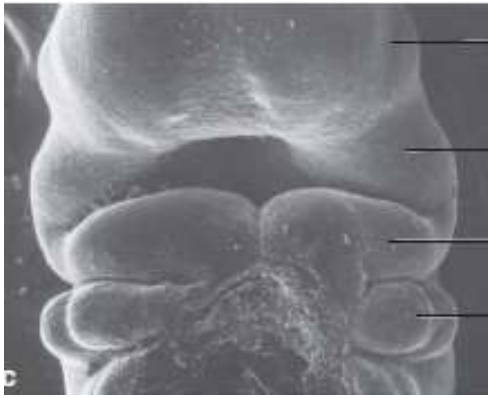
Human embryo has

- four pairs **pharyngeal arches (**1,2,3,4-6**)**
- four pairs of **pharyngeal pouches**,
- four pairs of **pharyngeal clefts (**2-4 are reduced**)**

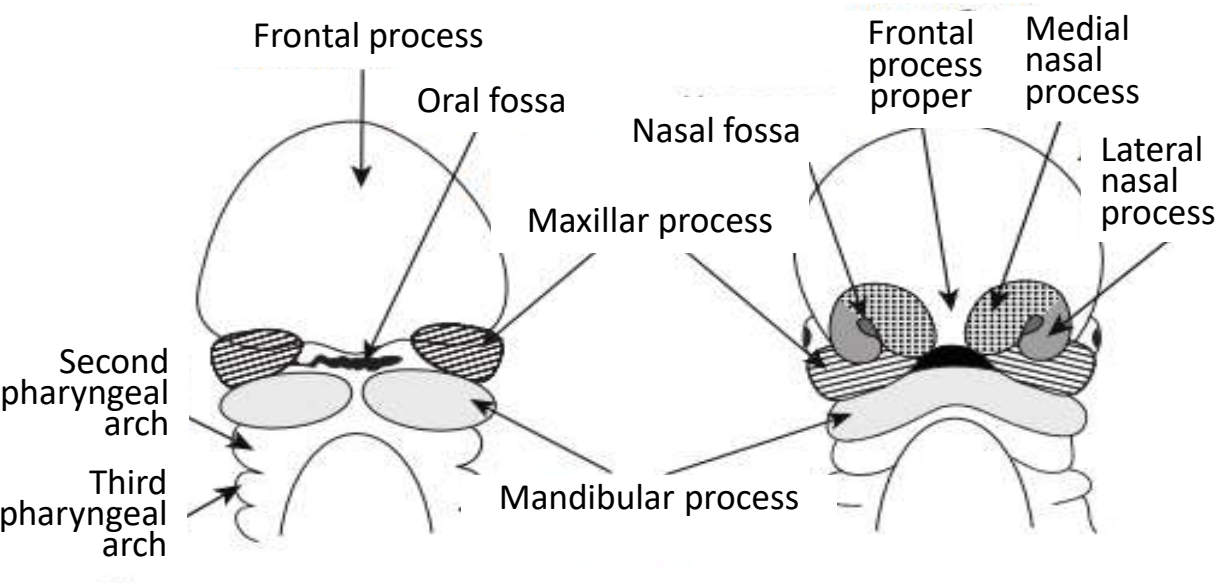
DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

Pharyngeal arches not only contribute to formation of the neck, but also play an important role in formation of the face. At the end of the *fourth week*, the center of the face is formed by the stomodeum, surrounded by the first pair of pharyngeal arches . When the embryo is 42 days old, five mesenchymal prominences can be recognized: the **mandibular prominences** (first pharyngeal arch), caudal to the stomodeum; the **maxillary prominences** (dorsal portion of the first pharyngeal arch), lateral to the stomodeum; and the **frontonasal prominence**, a slightly rounded elevation cranial to the stomodeum. Development of the face is later complemented by formation of the **nasal prominences**. In all cases, differentiation of structures derived from arches, pouches, clefts, and prominences is dependent on epithelial–mesenchymal interactions.

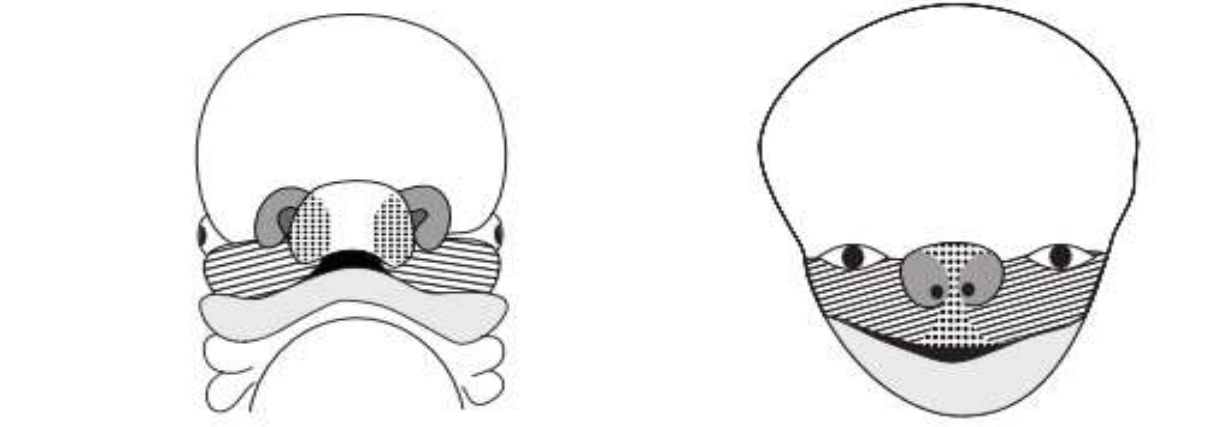




DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.



4th week of development **5th week of development**



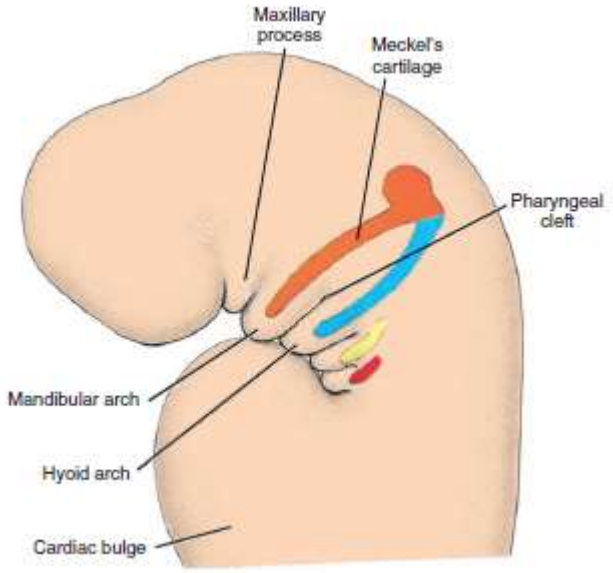
6x week of development **10th week of development**

First Pharyngeal Arch consists of a dorsal portion, the **maxillary process**, which extends forward beneath the region of the eye, and a ventral portion, the **mandibular process.**

Mesenchyme of the maxillary process gives rise to the **premaxilla, maxilla, zygomatic bone**, and part of the **temporal bone.**

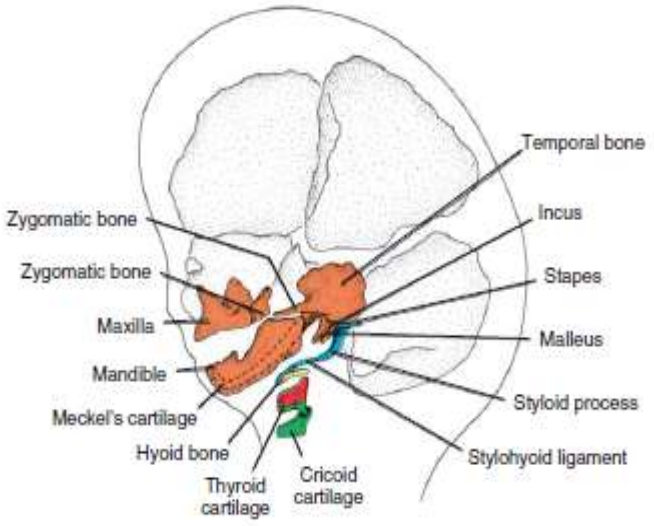
Mesenchyme of the mandibular process gives rise to the **mandible, incus** and **malleus**

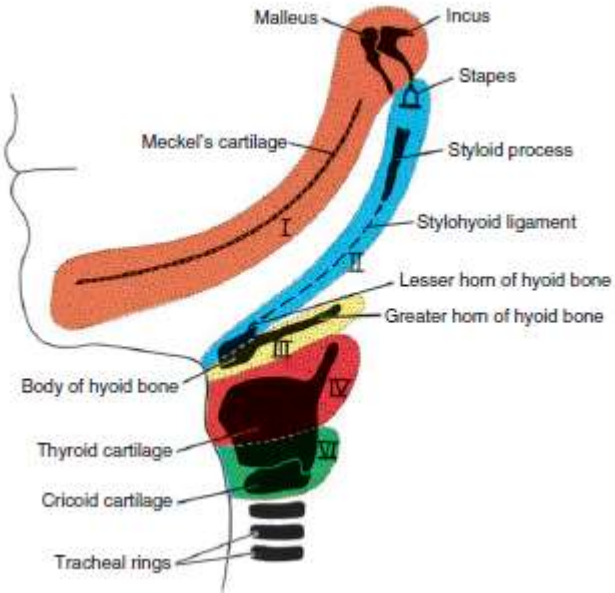
DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.



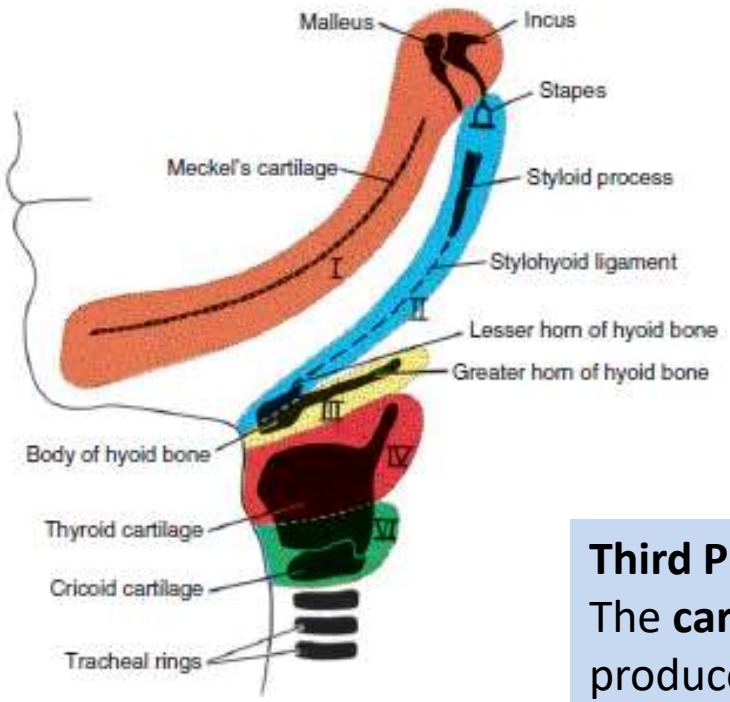
A. Lateral view of the head and neck region demonstrating the cartilages of the pharyngeal arches participating in formation of the bones of the face and neck.

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.





DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.



Second Pharyngeal Arch
The cartilage of the **second** or **hyoid arch (Reichert's cartilage)** gives rise to the **stapes, styloid process of the temporal bone, stylohyoid ligament**, and ventrally, the **lesser horn** and **upper part of the body of the hyoid bone.**

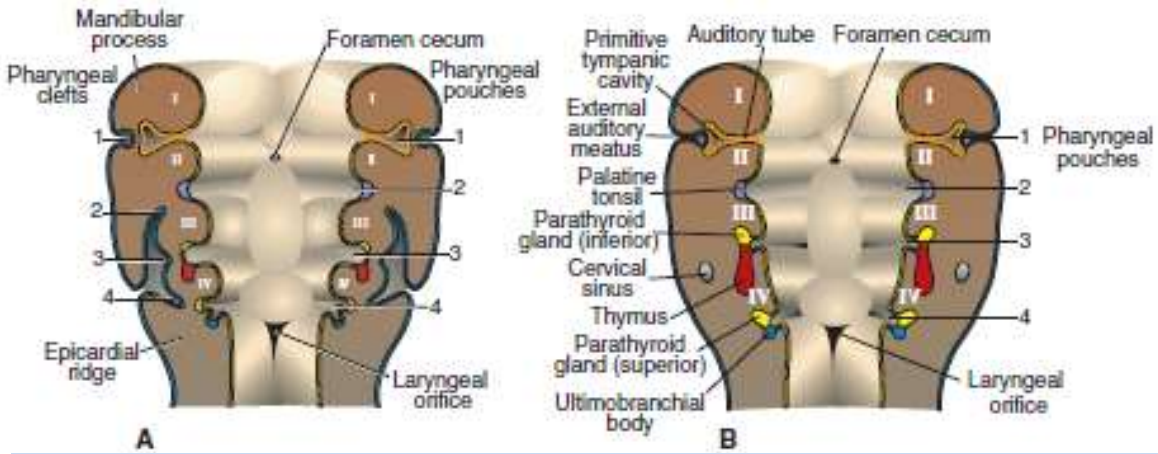
Third Pharyngeal Arch
The **cartilage** of the third pharyngeal arch produces the **lower part of the body** and **greater horn of the hyoid bone**

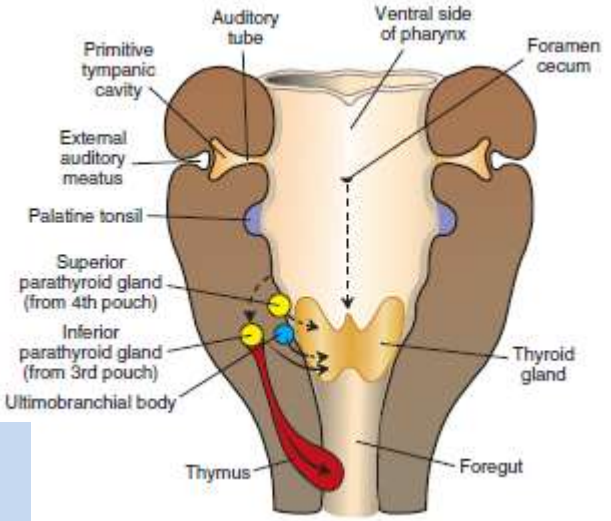
Fourth and Sixth Pharyngeal Arches
Cartilaginous components of the fourth and sixth pharyngeal arches fuse to form the **thyroid, cricoid, arytenoid, corniculate, and cuneiform cartilages** of the **larynx**

DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

PHARYNGEAL POUCHES

The human embryo has four pairs of pharyngeal pouches; the fifth is rudimentary





First Pharyngeal Pouch

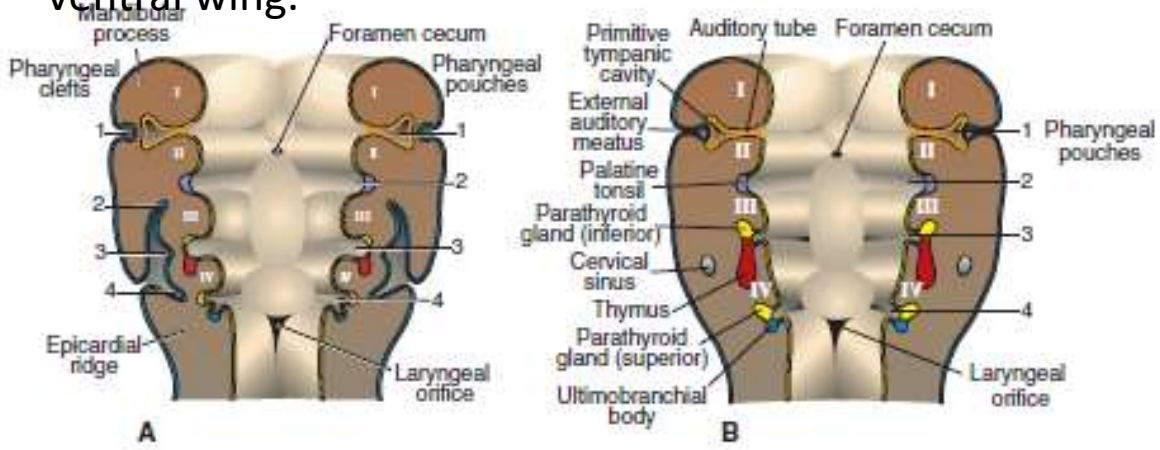
The first pharyngeal pouch forms a stalk-like diverticulum, the **tubotympanic recess**, which comes in contact with the epithelial lining of the first pharyngeal cleft, the future **external auditory meatus**. The distal portion of the diverticulum widens into a sac-like structure, the **primitive tympanic** or **middle ear cavity**, and the proximal part remains narrow, forming the **auditory (eustachian) tube.**

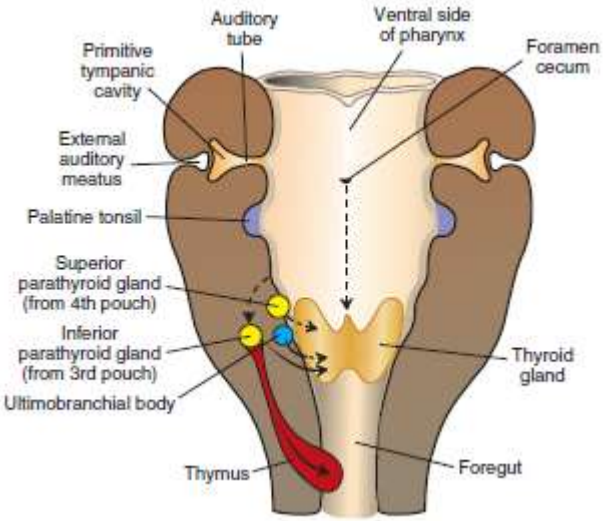
Second Pharyngeal Pouch

The epithelial lining of the second pharyngeal pouch proliferates and forms buds that penetrate into the surrounding mesenchyme and form the primordium of the **palatine tonsils**.

DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

The third and fourth pouches are characterized at their distal extremity by a dorsal and a ventral wing.





Third Pharyngeal Pouch

In the fifth week, epithelium of the dorsal region of the third pouch differentiates into the **inferior parathyroid gland**, while the ventral region forms the **thymus**. Both gland primordia lose their connection with the pharyngeal wall, and the thymus then migrates in a caudal and a medial direction, pulling the **inferior parathyroid** with it.

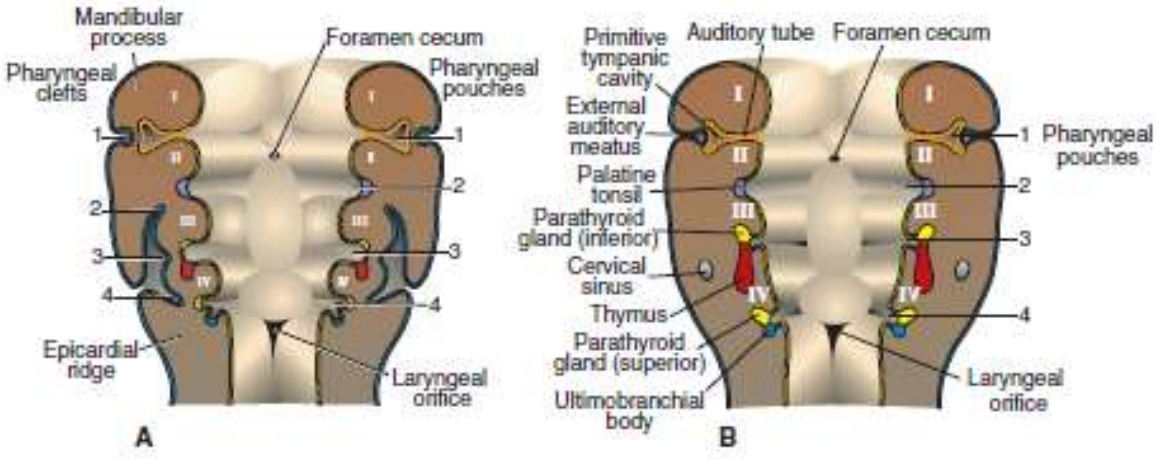
Fourth Pharyngeal Pouch

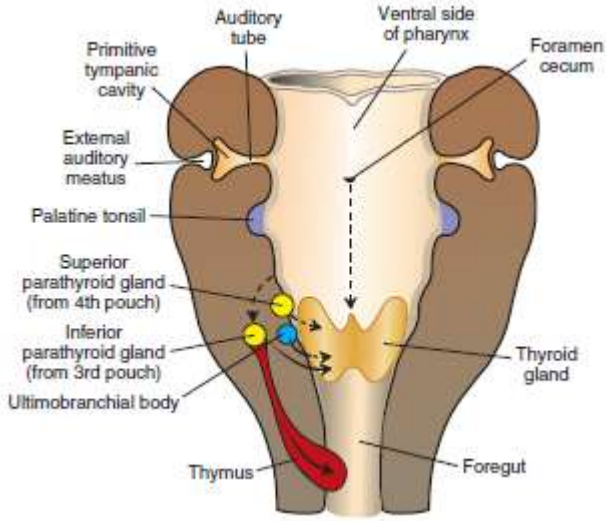
Epithelium of the dorsal region of the fourth pharyngeal pouch forms the **superior parathyroid gland**. When the parathyroid gland loses contact with the wall of the pharynx, it attaches itself to the dorsal surface of the caudally migrating thyroid as the **superior parathyroid gland**. The ventral region of the fourth pouch gives rise to the **ultimobranchial body**, which is later incorporated into the thyroid gland. Cells of the ultimobranchial body give rise to the **parafollicular**, or **C cells** of the thyroid gland.

DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

PHARYNGEAL CLEFTS

The 5-week embryo is characterized by the presence of four pharyngeal clefts, of which only one contributes to the definitive structure of the embryo. The dorsal part of the first cleft penetrates the underlying mesenchyme and gives rise to the **external auditory meatus**. The epithelial lining at the bottom of the meatus participates in formation of the **tympanic membrane** or **eardrum**.



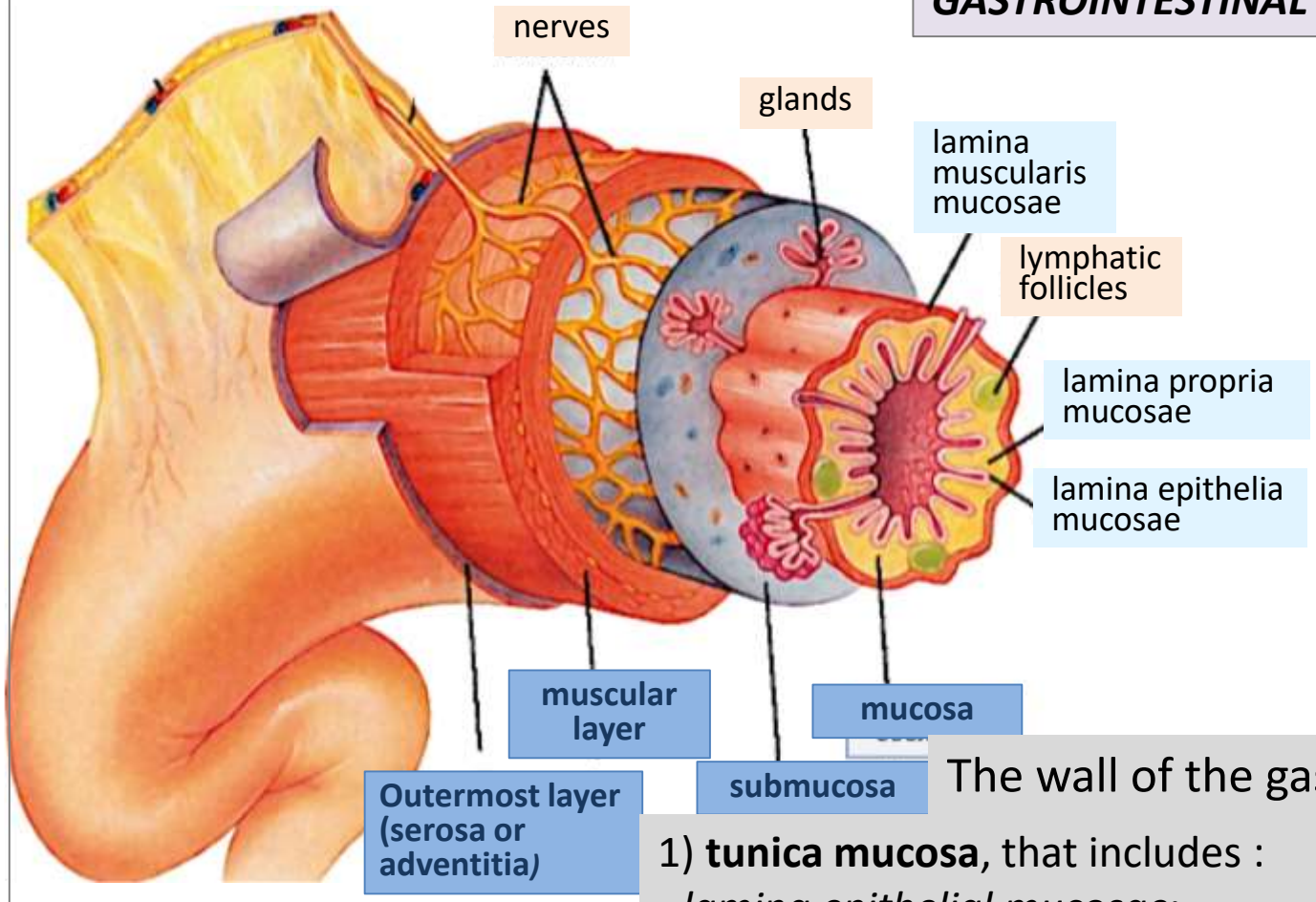


Active proliferation of mesenchymal tissue in the second arch causes it to overlap the third and fourth arches. Finally, it merges with the **epicardial ridge** in the lower part of the neck and the second, third, and fourth clefts lose contact with the outside (*B*). The clefts form a cavity lined with ectodermal epithelium, the **cervical sinus**, but with further development, this sinus disappears.

DEVELOPMENT and STRUCTURE OF THE PHARYNGEAL ARCHES.

Pharyngeal arch derivatives	Pharyngeal pouch derivatives	Pharyngeal cleft derivatives
I pair - mandible, maxilla, incus and malleus	I pair - middle ear cavity and eustachian tube	I pair - external auditory meatus, tympanic membrane
II pair (hyoid) –stapes, upper part of hyoid bone	II pair - palatine tonsils	III - IV pairs are reduced
III pair -the lower part of the hyoid bone	III pairs - inferior parathyroid glands and thymus	
IV- VI pairs – the thyroid, cricoid, arytenoid, corniculate, and cuneiform cartilages of the larynx	IV pairs - superior parathyroid gland, parafollicular cells of thyroid gland	

GASTROINTESTINAL TRACT STRUCTURE



The wall of the gastrointestinal tract:

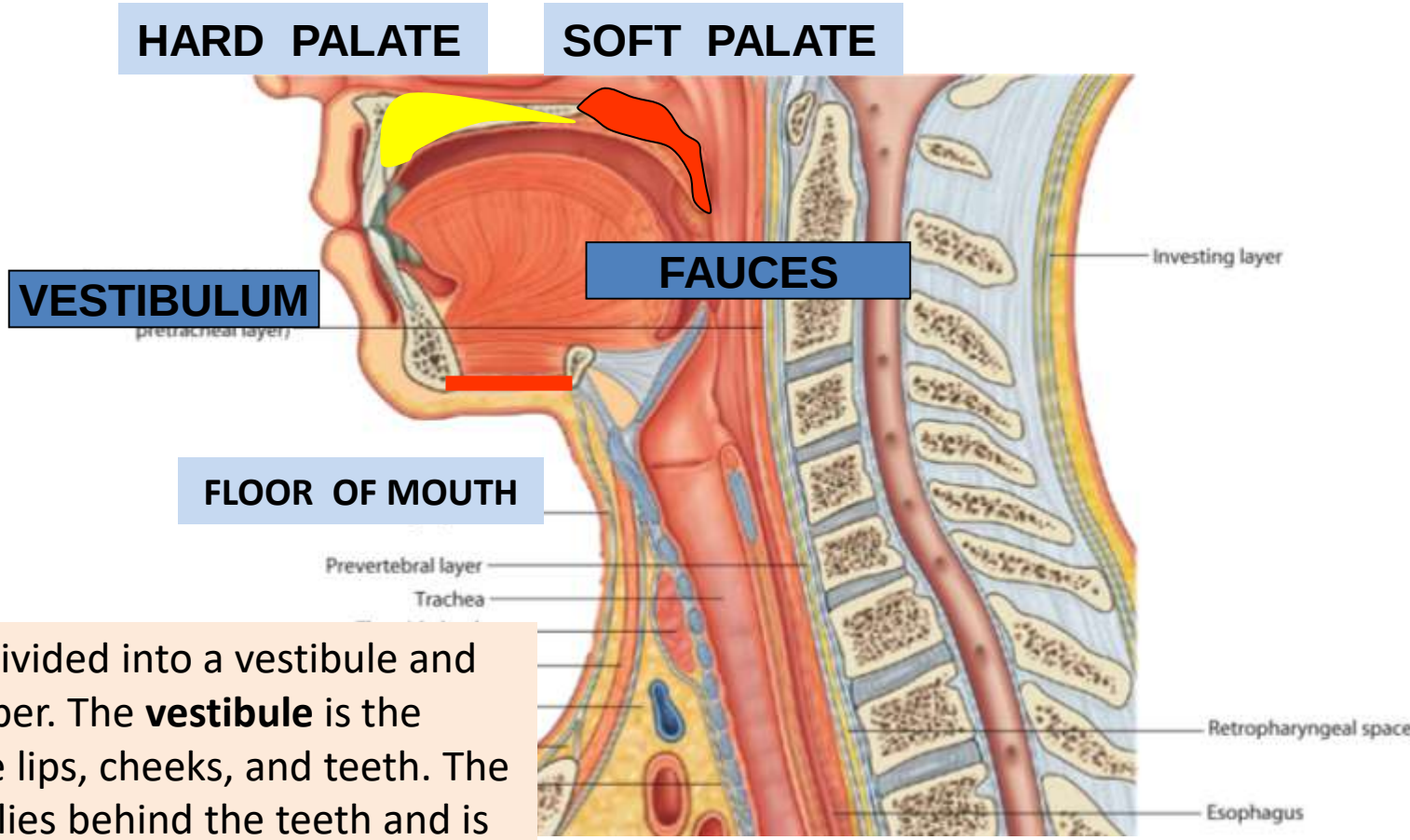
1) **tunica mucosa**, that includes :
- *lamina epithelial mucosae*;
- *lamina propria mucosae (*loose connective tissue);
- *lamina muscularis mucosae* (smooth muscle tissue);

2) **tunica submucosa** (loose connective tissue);

3) **muscular layer**;

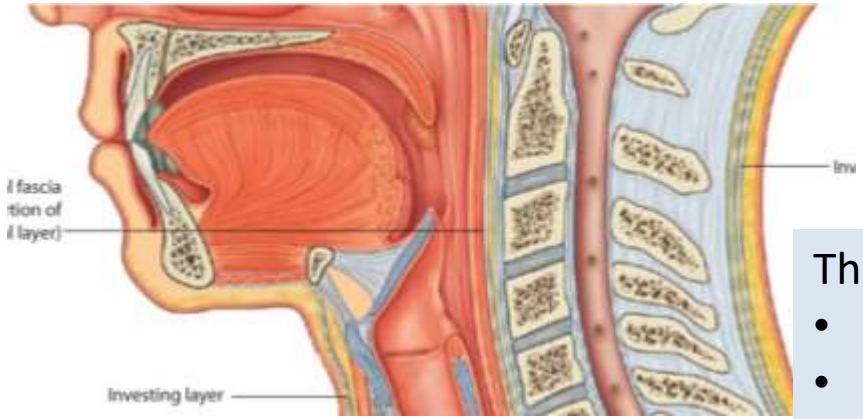
4) **tunica externa (serosa or adventitia) (**loose connective tissue with blood vessels and nerves).

ORAL CAVITY STRUCTURE



The **oral cavity** is divided into a vestibule and the oral cavity proper. The **vestibule** is the space between the lips, cheeks, and teeth. The **oral cavity proper** lies behind the teeth and is bounded by the hard and soft palates superiorly, the tongue and the floor of the mouth inferiorly, and the entrance to the oropharynx posteriorly.

ORAL CAVITY STRUCTURE



The oral cavity includes **lips, cheeks, gums, hard palate, and soft palate with uvula, tongue, teeth and their supporting structures (periodontium), major and minor salivary glands, and tonsils**.

There are only two layers in the oral cavity:

- **tunica mucosa**
- **tunica submucosa,** (except on the inferior surface of the tongue, gingiva, part of hard palate).

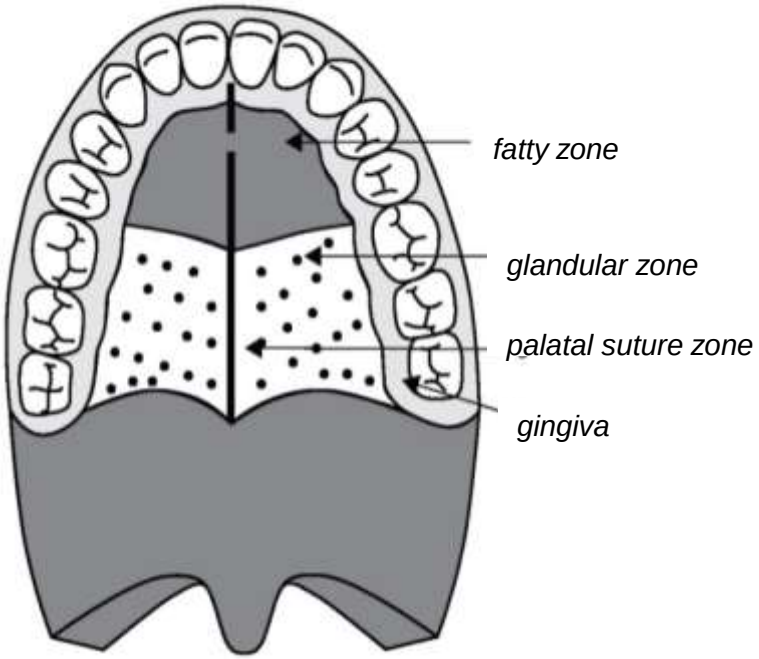
The oral mucosa consists of

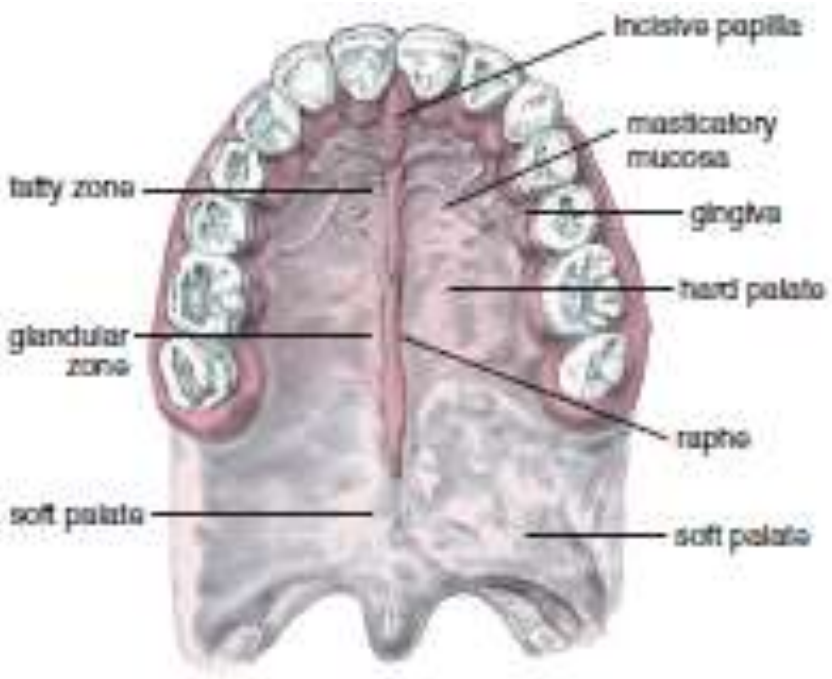
- **masticatory mucosa,**
- **lining mucosa,** and
- **specialized mucosa.**

The **masticatory mucosa** is found on the gingiva (gums) and the hard palate. It has a **keratinized** and, in some areas, a **parakeratinized stratified squamous epithelium.**

The underlying **lamina propria** consists of a thick papillary layer of loose connective tissue that contains blood vessels and nerves. Deep to the **lamina propria** is a reticular layer of more-dense connective tissue. The depth and number of connective tissue papillae contribute to the relative immobility of the **masticatory mucosa**, thus protecting it from frictional and shearing stress. At the midline of the hard palate, in the **palatine raphe**, the mucosa adheres firmly to the underlying bone. The **reticular layer** of the lamina propria blends with the periosteum, and thus there is no submucosa. The same is true of the **gingiva.**

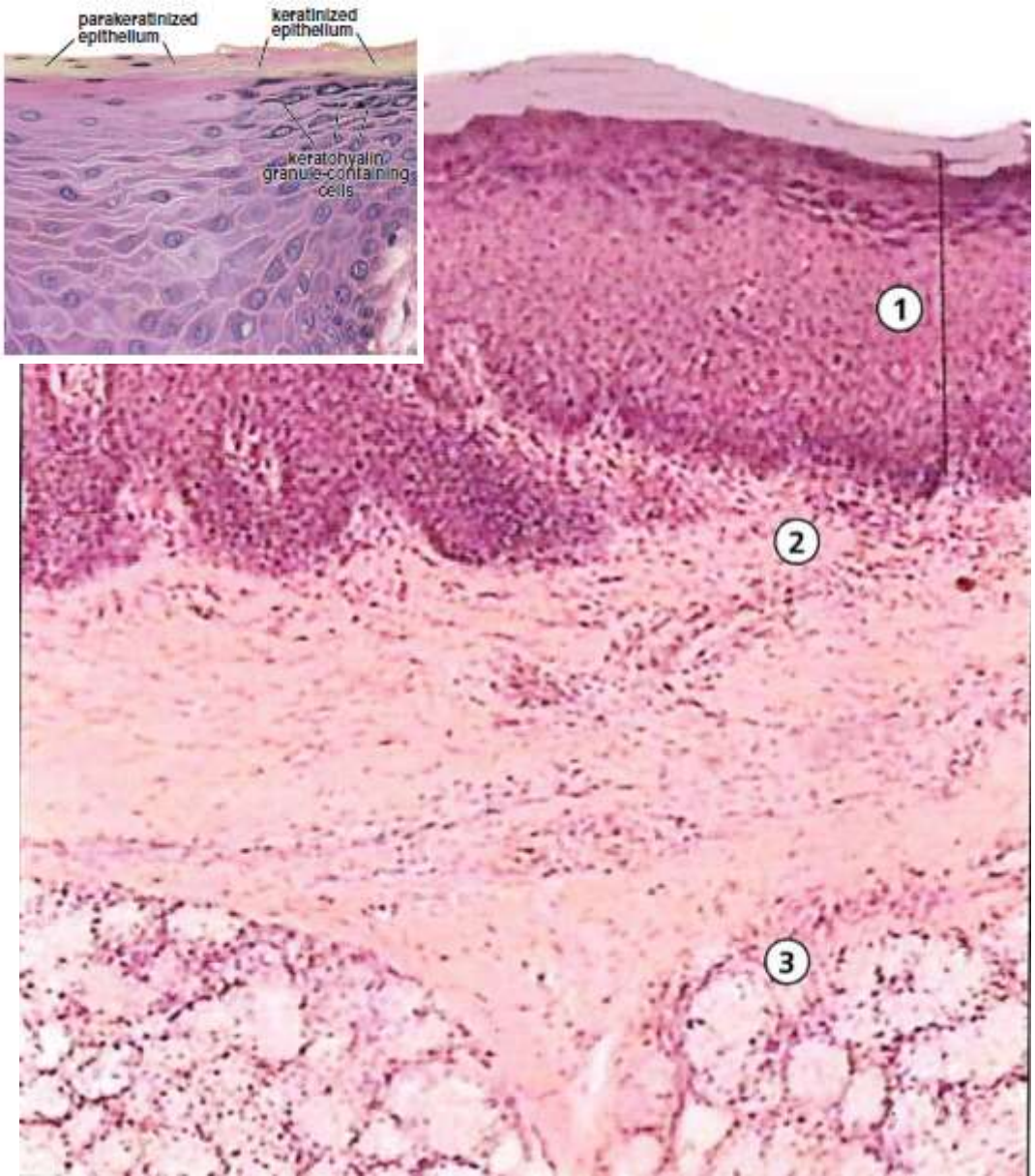
ZONES OF THE HARD PALATE





The hard palate, which contains bone, is bisected into right and left halves by a **raphe**. Anteriorly, in the **fatty zone**, the submucosa of the hard palate contains adipose tissue; posteriorly, in the **glandular zone,** there are mucous glands within the submucosa. Neither the **raphe** nor the **gingiva** contains a submucosa; instead, the mucosa is attached directly to the bone. The soft palate has muscle instead of bone, and its glands are continuous with those of the hard palate in the submucosa.

Hard palate. Glandular (posterior) zone. (Stained with hematoxylin and eosin).



Where there is a submucosa underlying the lamina propria on the hard palate, it contains adipose tissue anteriorly (**fatty zone**) and mucous glands posteriorly (**glandular zone**) that are continuous with those of the soft palate. In the submucosal regions, thick collagenous bands extend from the mucosa to the bone.

1-stratified keratinized epithelium

2-lamina propria of the mucosa

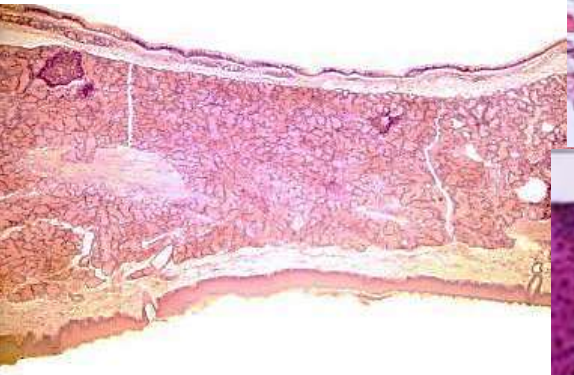
3-submucosa with mucous salivary palatine glands

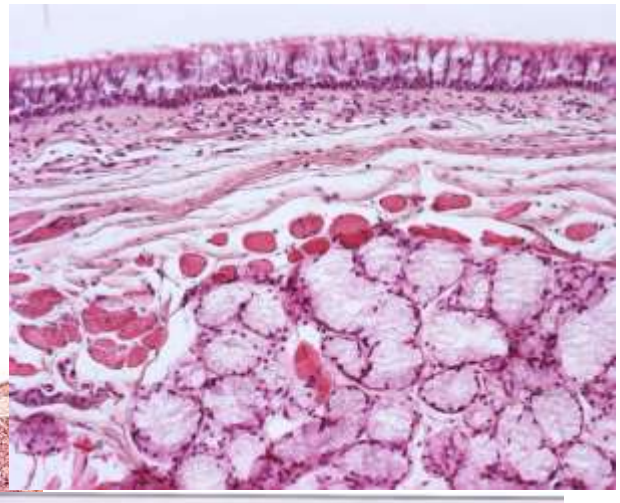
LINING MUCOSA

Lining mucosa is found on the **lips, cheeks, alveolar mucosal surface, floor of the mouth, inferior surfaces of the tongue, and soft palate.** At these sites it covers striated muscle (lips, cheeks, and tongue), bone (alveolar mucosa), and glands (soft palate, cheeks, inferior surface of the tongue).
The **lining mucosa** has fewer and shorter papillae so that it can adjust to the movement of its underlying muscles.
Generally, the epithelium of the **lining mucosa** is nonkeratinized, although in some places it may be parakeratinized.
The epithelium of the **vermilion border** of the lip (the reddish portion between the moist inner surface and the facial skin) is keratinized. The nonkeratinized lining epithelium is thicker than keratinized epithelium.

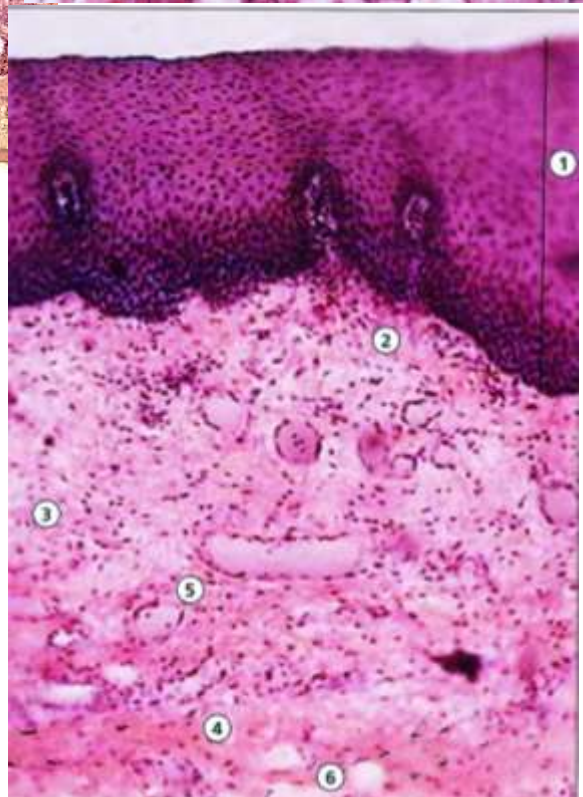
A distinct **submucosa** underlies the lining mucosa except on the inferior surface of the tongue. This layer contains large bands of collagen and elastic fibers that bind the mucosa to the underlying muscle; it also contains the many minor salivary glands of the lips, tongue, and cheeks. The submucosa contains the larger blood vessels, nerves, and lymphatic vessels that supply the subepithelial neurovascular networks in the lamina propria throughout the oral cavity.

Soft palate.
(Stained with hematoxylin and eosin).





Posterior (nasal) surface.



Anterior (oral) surface.

1-stratified non-keratinized epithelium

2-lamina propria of the mucosa

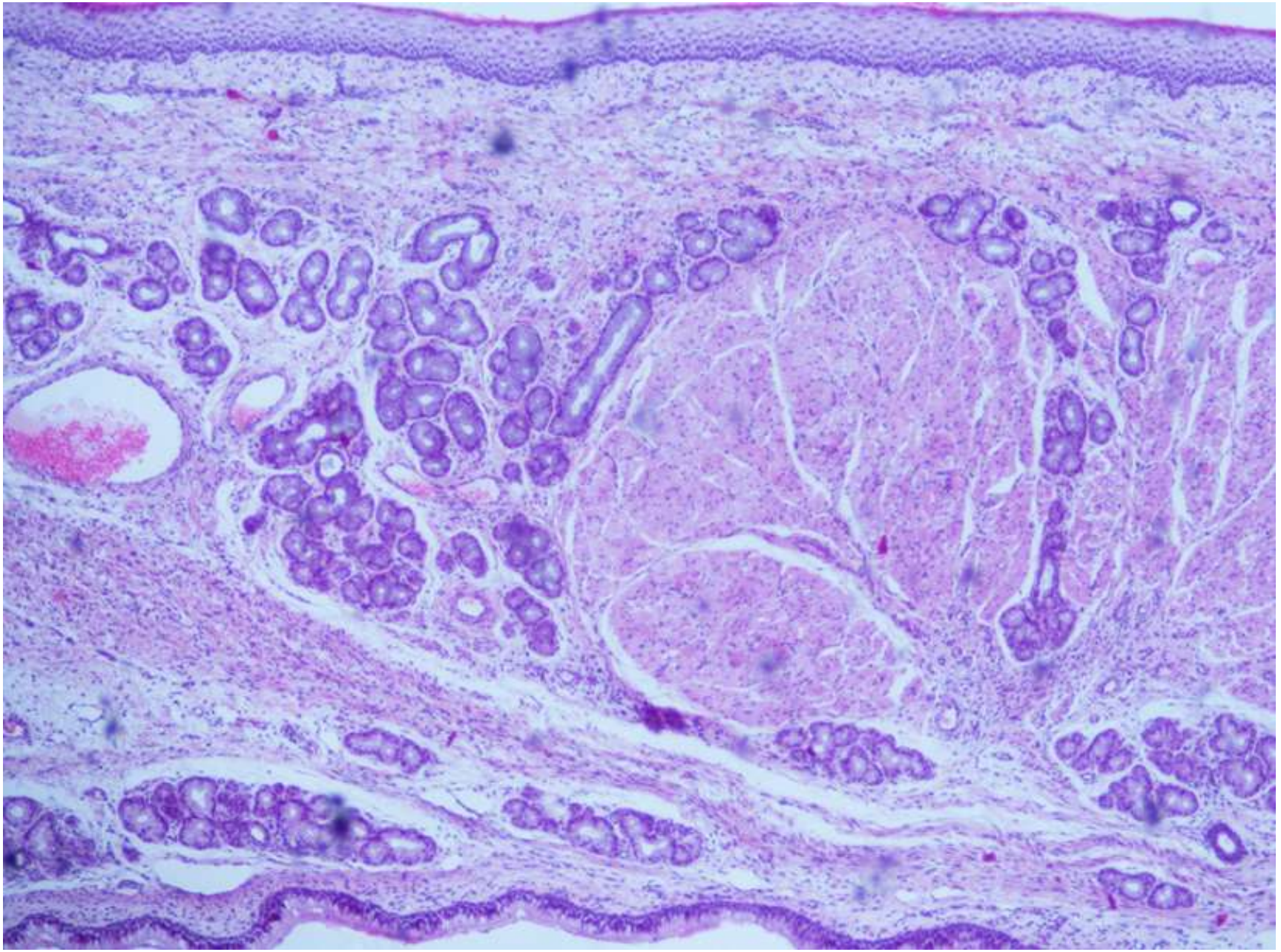
3-submucosa

4-striated muscle fibers

5-blood vessels

6- adipose cells

"The structure of the soft palate“ (Staining: hematoxylin-eosin)



LIP STRUCTURE

Three zones can be distinguished in the lip:

- **skin zone**
- **transitional zone** (vermilion border)
- **mucous zone**

1-skin zone with epidermis and dermis with hair follicles, sebaceous and sweat glands

2- transitional zone

3- mucous zone of the lip

4-striated muscle fibers of the labial muscles

5-lip mucosa

6-stratified non-keratinized mucosal epithelium

7-lamina propria of the mucosa

8-submucosa with labial glands

9-blood vessel

Lip. Skin part. (Stained with hematoxylin and eosin).

1-epidermis

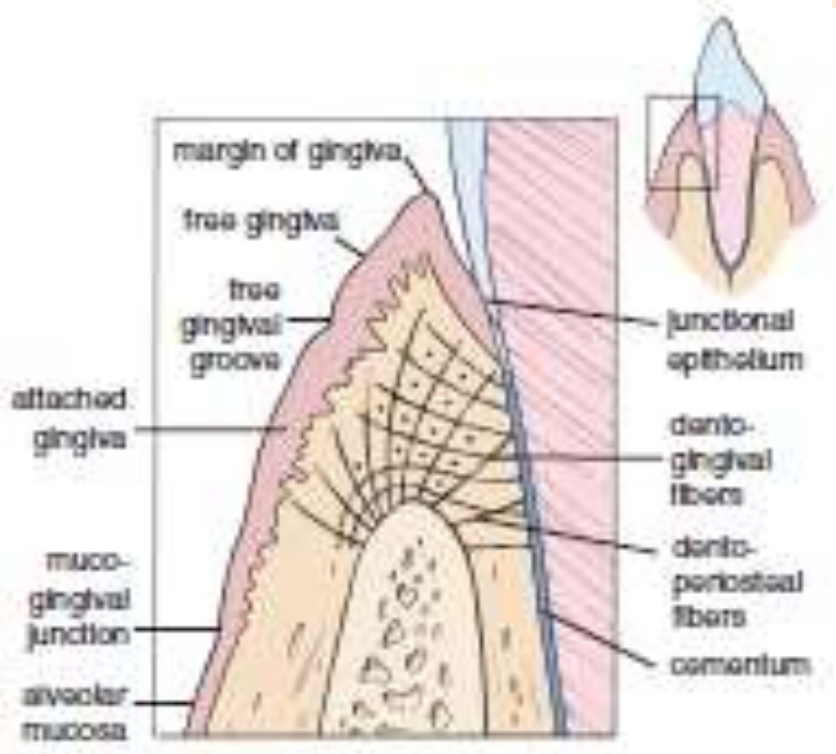
2-dermis

3-hair roots

4-sebaceous gland

5 sweat glands

GINGIVA



The **gingiva** is a specialized part of the oral mucosa located around the neck of the tooth. It is firmly attached to the teeth and to underlying alveolar bony tissue. The gingiva is composed of two parts:

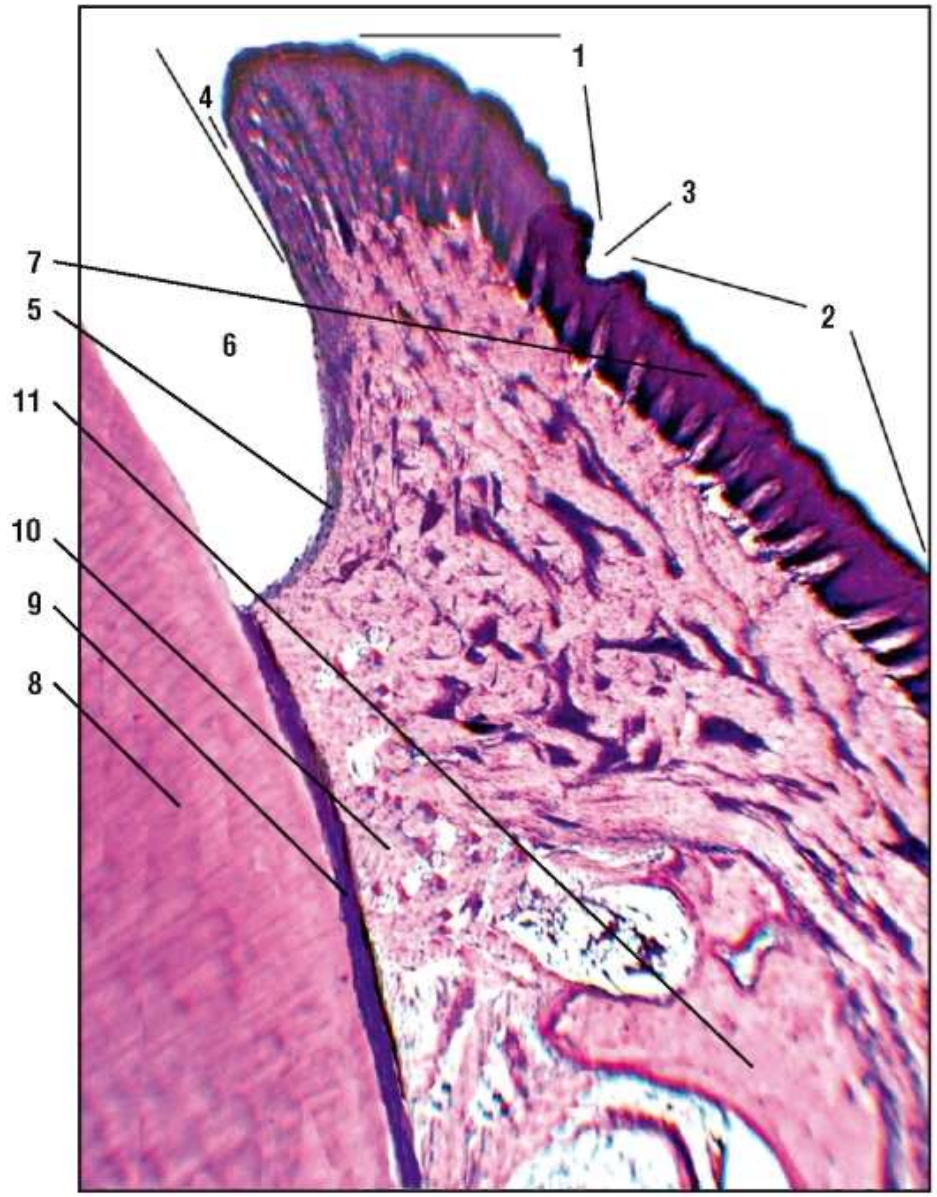
- **Gingival mucosa**, which is synonymous with the masticatory mucosa described above
- **Junctional epithelium**, or **attachment epithelium**, which adheres firmly to the tooth.

Above the attachment of the epithelium to the tooth, a shallow crevice called the **gingival sulcus** is lined with **crevicular epithelium** that is continuous with the attachment epithelium.

The term **periodontium** refers to all the tissues involved in the attachment of a tooth to the mandible and maxilla. These include the crevicular and junctional epithelium, the cementum, the periodontal ligament, and the alveolar bone.

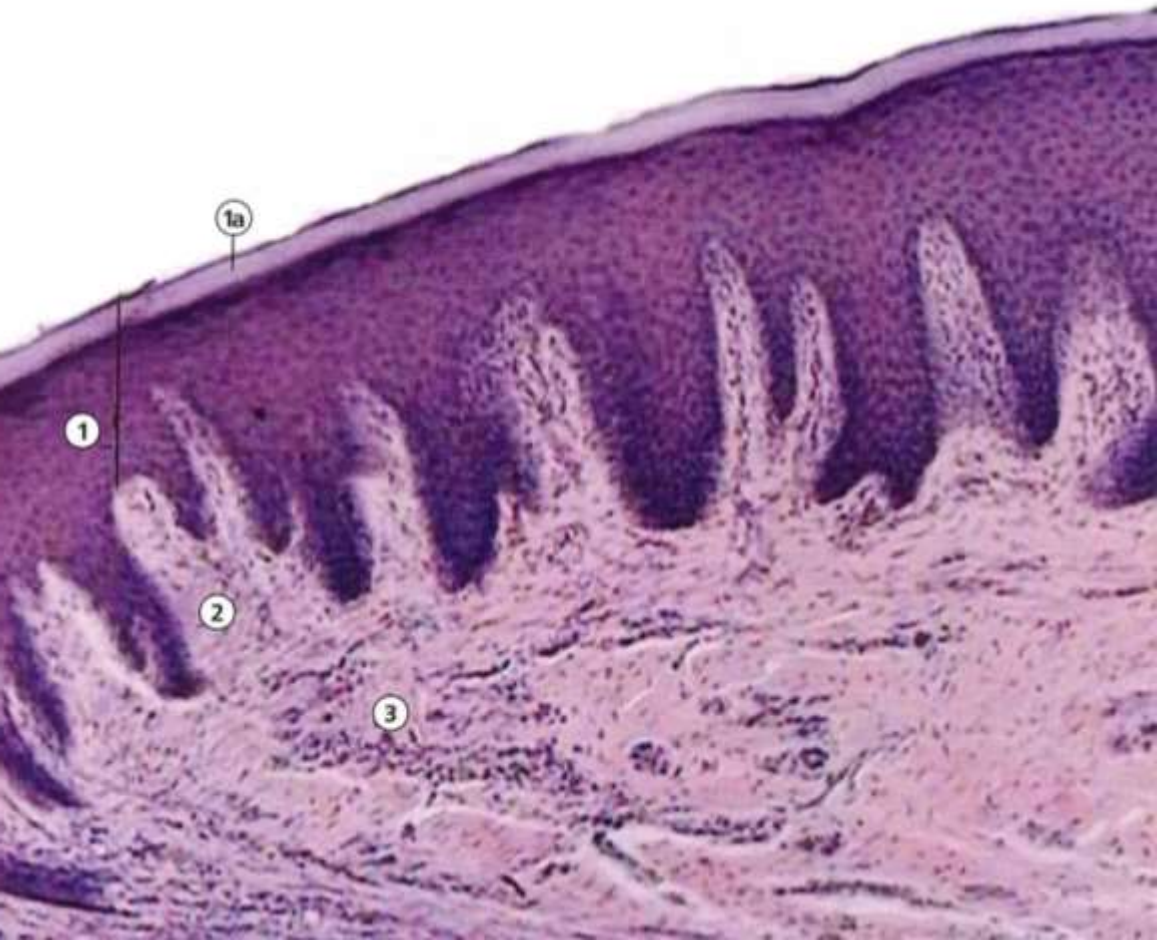
A basal lamina-like material is secreted by the junctional epithelium and adheres firmly to the tooth surface. The cells then attach to this material via hemidesmosomes. The basal lamina and the hemidesmosomes are together referred to as the **epithelial attachment**. **In young individuals, this attachment is to the enamel; in older individuals, where passive tooth eruption and gingival recession expose the roots, the attachment is to the cementum.**

Gingiva. Dental attachment.
(stained with hematoxylin and eosin, low magnification).



1 - free gingiva;
2 - attached gingiva;
3 – free gingival groove;
4 – crevicular epithelium ;
5 – junctional epithelium (stratified non-keratinized);
6 - space occupied by enamel before decalcification;
7 - outer epithelium of the gums (stratified keratinized);
8 - dentin;
9 - cement;
10 - periodontum;
11 - top of the alveolar process

Human gingiva. (Stained with hematoxylin and eosin).



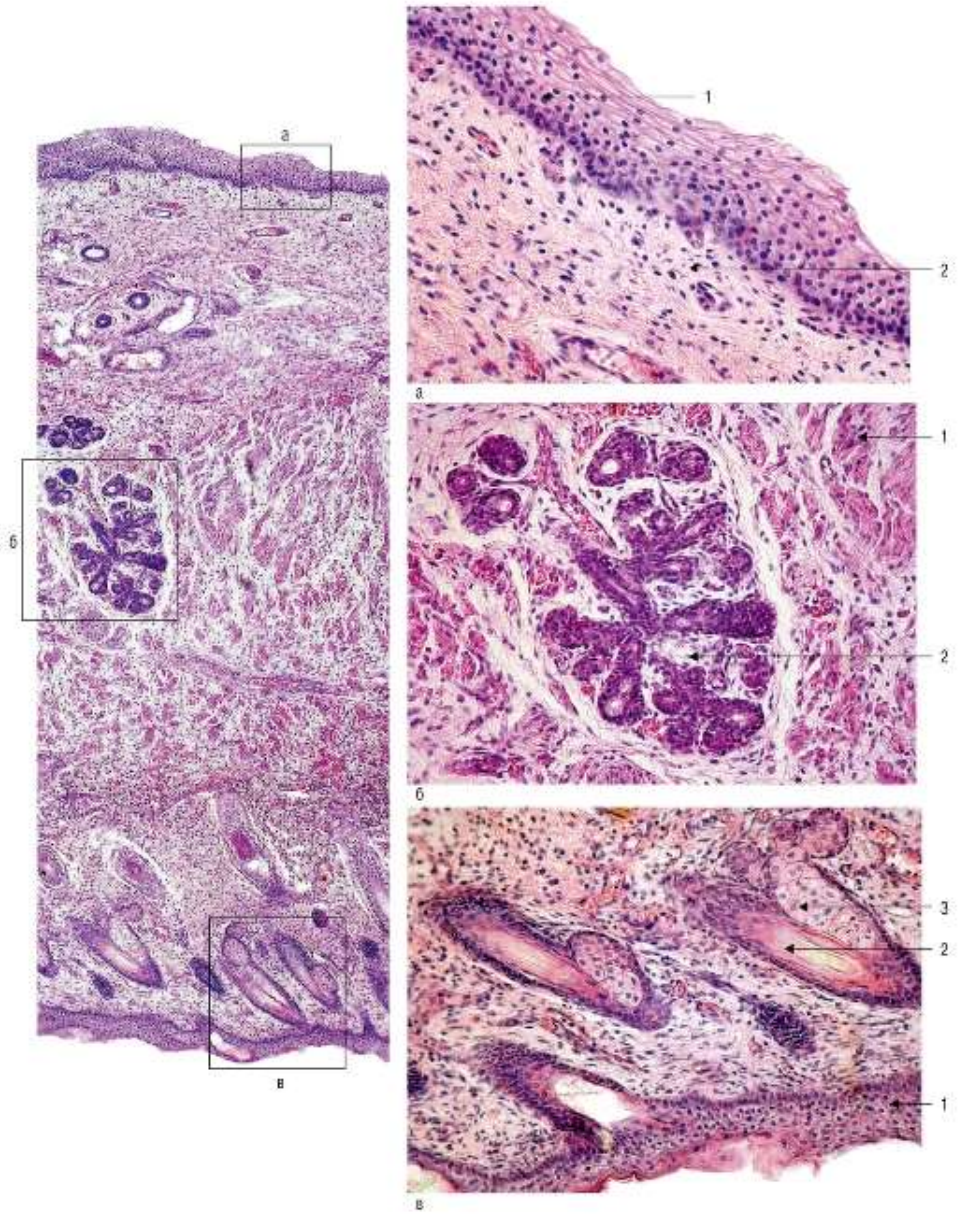
1-stratified keratinized epithelium

1a-stratum corneum

2-connective tissue papillae in the lamina propria of the gingival mucosa

3-reticular layer of the lamina propria of the gingival mucosa

The cheek of a human fetus. (Stained with hematoxylin and eosin).



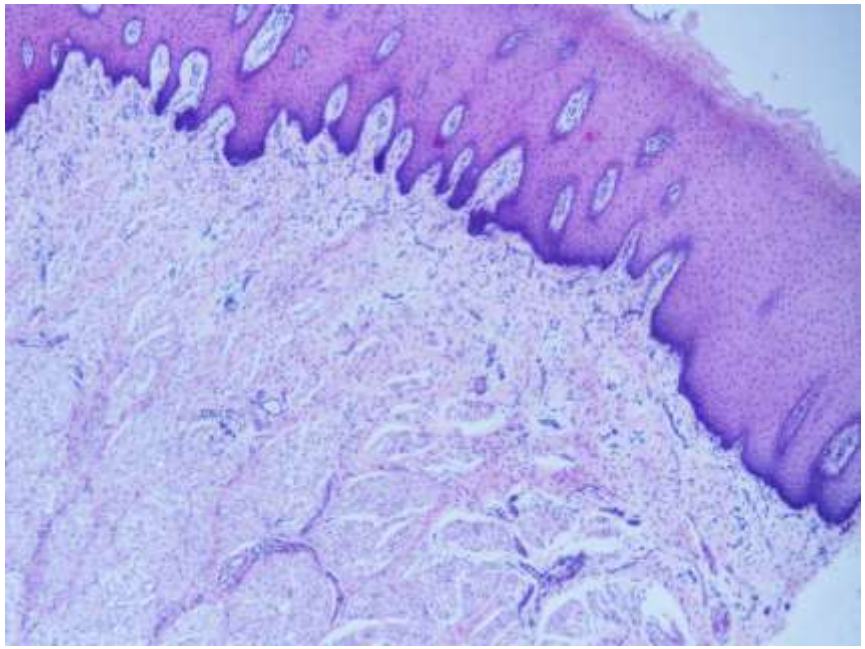
(a-c - at high magnification)

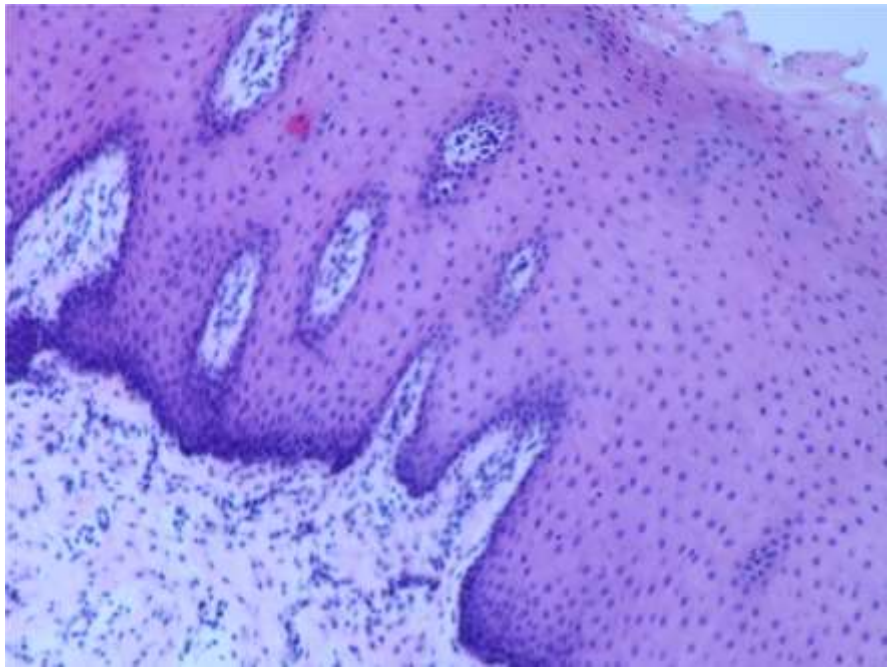
The mucous surface of the cheek (a):
1 - stratified non-keratinized epithelium;
2 – lamina propria of the mucosa

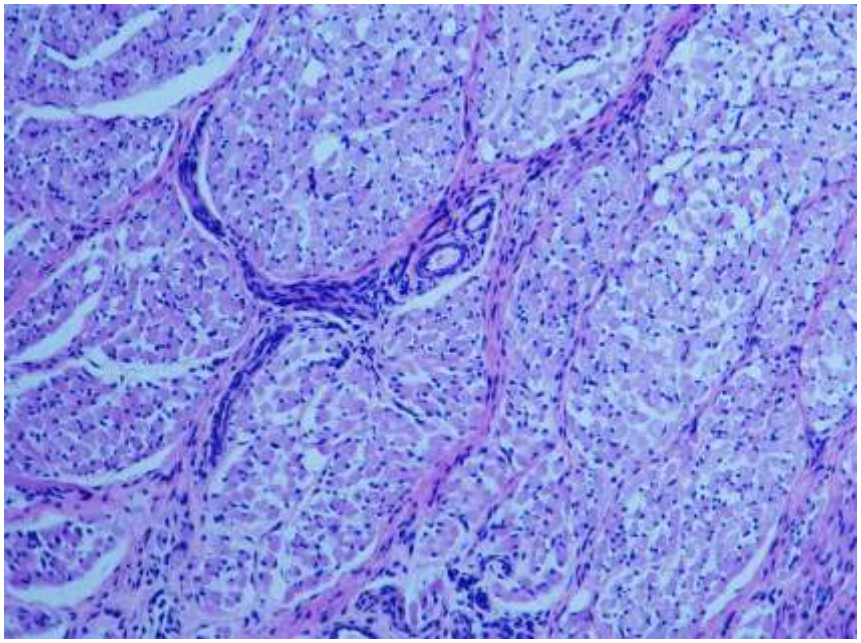
Maxillary zone (b):
1 - striated skeletal muscle fibers;
2 - buccal salivary gland

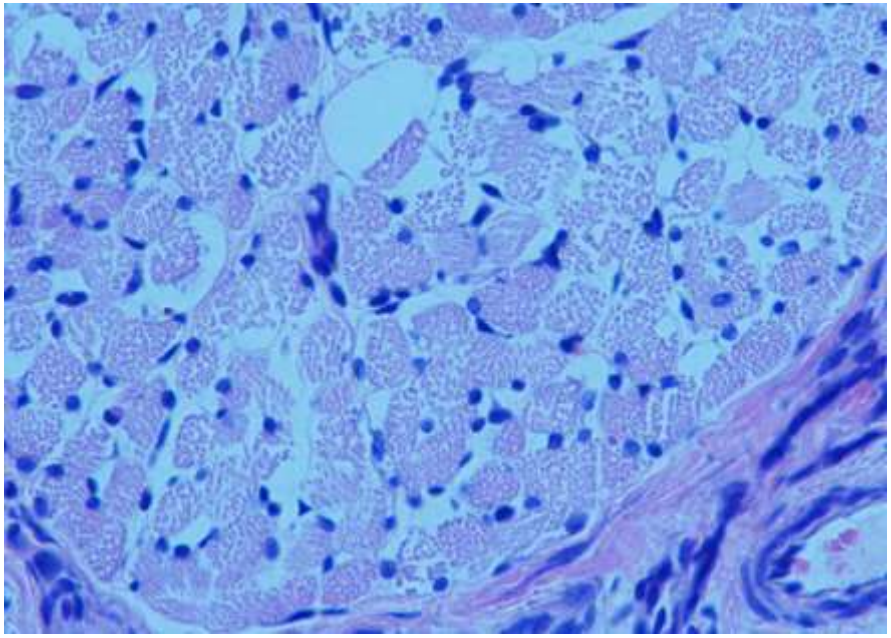
The skin surface of the cheek (c):
1 - stratified keratinized epithelium;
2 – hair follicle;
3 - sebaceous gland

The structure of the cheek" (Staining: hematoxylin-eosin*)*









SPECIALIZED MUCOSA

Specialized mucosa is associated with the sensation of taste and is restricted to the dorsal surface of the tongue. It contains papillae and **taste buds** responsible for generating the chemical sensation of taste.