

# Salivary glands

## intro to teeth

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# Salivary glands - *glandulae salivariae*

Exocrine glands with watery, mucous or mixed secretions

## Salivary glands classification

- According to the **type of secretory compartments** and the nature of the secretion:
  - serous** - acini
  - mucinous** - tubules
  - mixed** - acini, tubules + tubules with Gianuzzi lunules (tubuloacinary units)
- According to size:
  - large** – gl. parotis, gl. submandibularis a gl. sublingualis
  - small** – in tela submucosa, the number of 800 – 1000

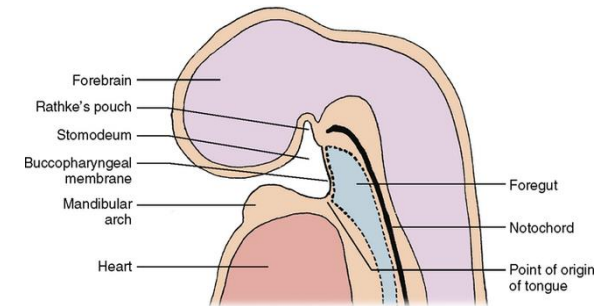
Origin in activated proliferation of oral epithelium (of ecto or endodermal origin) into the ectomesenchyme (similar to teeth!)

# Development of the salivary glands

Salivary glands are epithelial derivatives of various sites of the oral cavity:

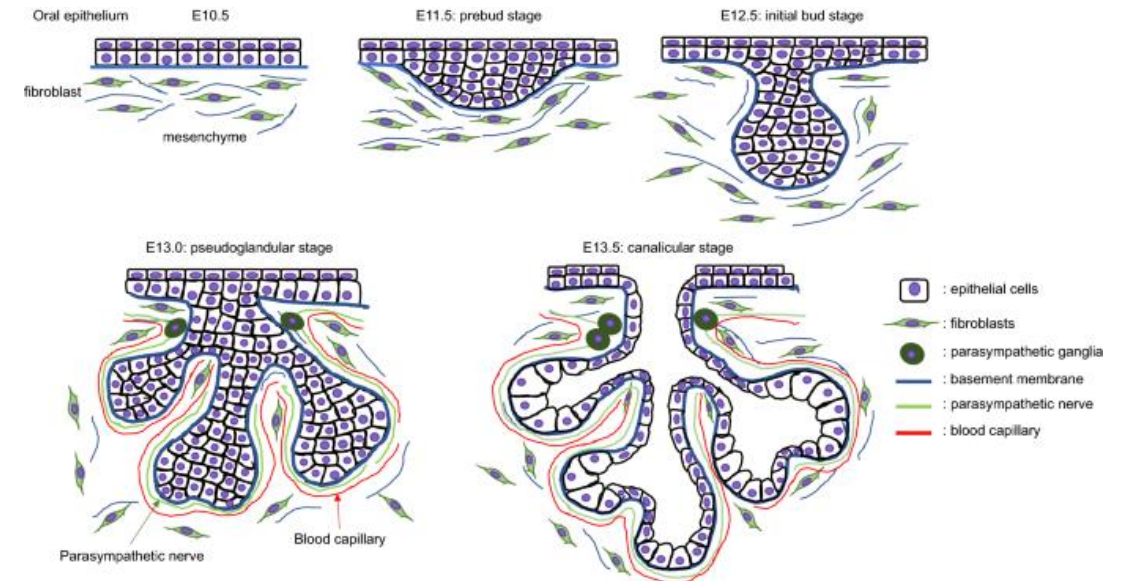
**Ectoderm:** small salivary glands of the lips and cheeks, palate, *gl. apicis linguae* and *gl. parotis*

**Entoderm:** Weber's and Ebner's glands of the tongue, *gl. submandibularis* and *gl. sublingualis*



The development proceeds in a similar way:

- In the epithelium (ectoderm or entoderm) at the site of the future gland(s), epithelial cells begin to proliferate against the ectomesenchymal substrate - **formation of buds**
- **Ectomesenchyme is essential** for the development of salivary glands.
- The epithelial cells in the bud proliferate and the organ branches.
- The foundation for the gland's **ductal system** is formed, and the **terminal secretory branches**



# Development of the salivary glands

Clusters of secretory cells subsequently form at the ends of the terminal branches (6th-7th generation)

Secretory compartments start secretion during the **5th month** of development, followed by gradual drainage - formation of the lumen of the established duct system: during the **6th month** of development

During this period, **the parenchyma begins to divide into lobules**, and thin septa (septa) form in the glandular parenchyma from the superficial mesenchyme

Lobulisation continues until birth, when the glands become fully functional and begin to secrete saliva

The beginnings of salivary gland development (embryonic weeks):

- |  |  |
|--|--|
| <b><i>Gl. parotis:</i></b>                       | <b>4th - 6th week</b> , at the upper edge of both corners of the mouth after narrowing of the rima oris, the ductus parotideus enters the vestibule on the buccal side |
| <b><i>Gl. submandibularis:</i></b>               | <b>6th week</b>  |
| <b><i>Gl. sublingualis</i> and small glands:</b> | <b>8th – 12th week</b> (from the epithelium of the floor of the mouth)   |

# General structure of large salivary glands

- Ligament → capsula fibrosa
- Ligament → septa (*+ vessels, nerves, interlobular and larger ducts*)
- Parenchyma → lobes

## Glandular compartments

(*serous acini, mucinous tubules, serous lunules*)

## Ducts

(*intercalated, striated, interlobular, main*)



# Structural components of the salivary glands

## Ligament

gl. parotis and gl. submandibularis ligament forms **capsule**

gl. sublingualis and gl. lingualis anterior capsule incomplete **septae**

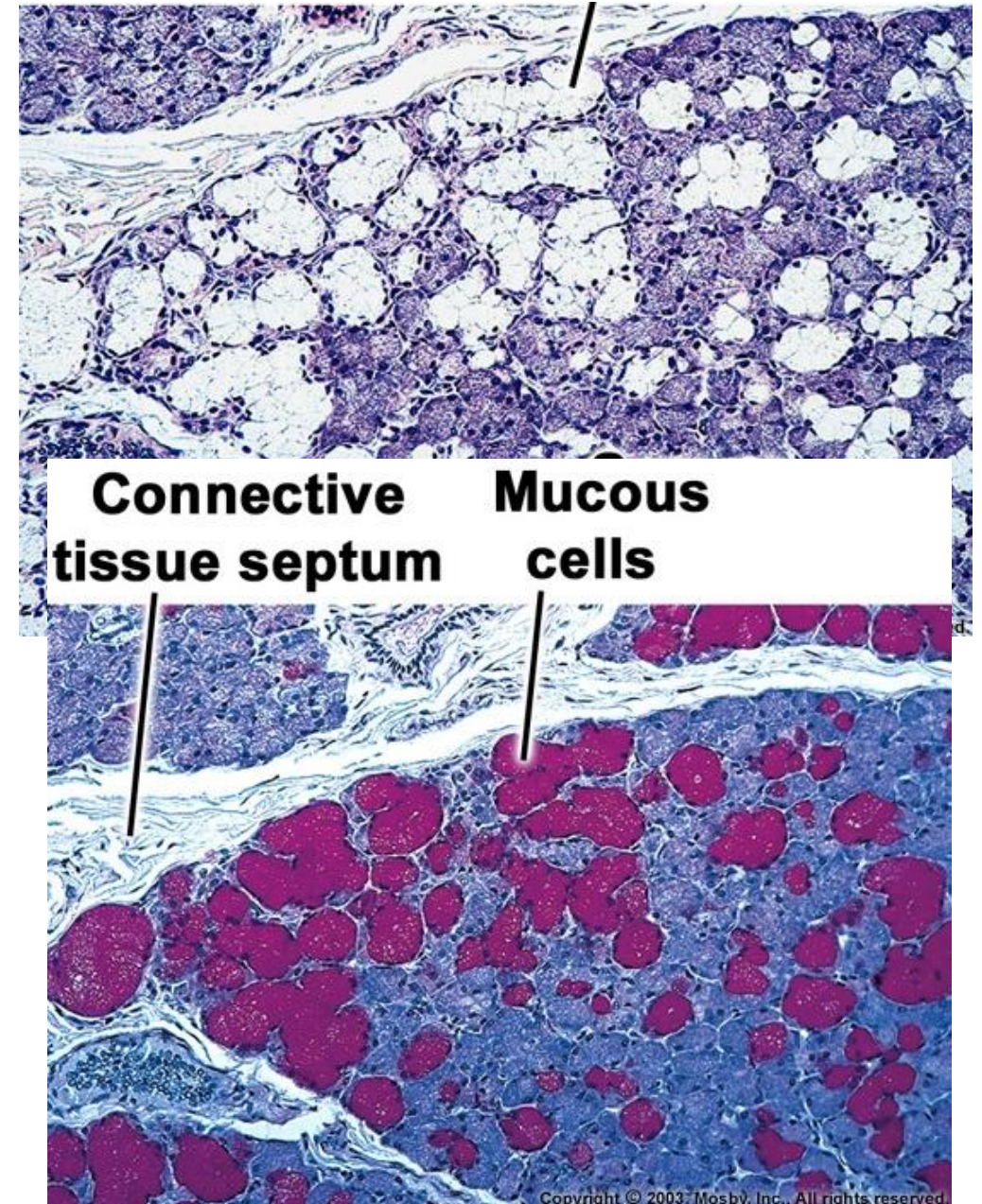
## Glandular tissue (parenchyma)

The lobules contain:

**secretory compartments:** serous acins, mucinous tubules or tubules with Gianuzzi lunules +

**2 parts of the duct system - intercalated and striated ducts**

(interlobular and main - in septal ligament)

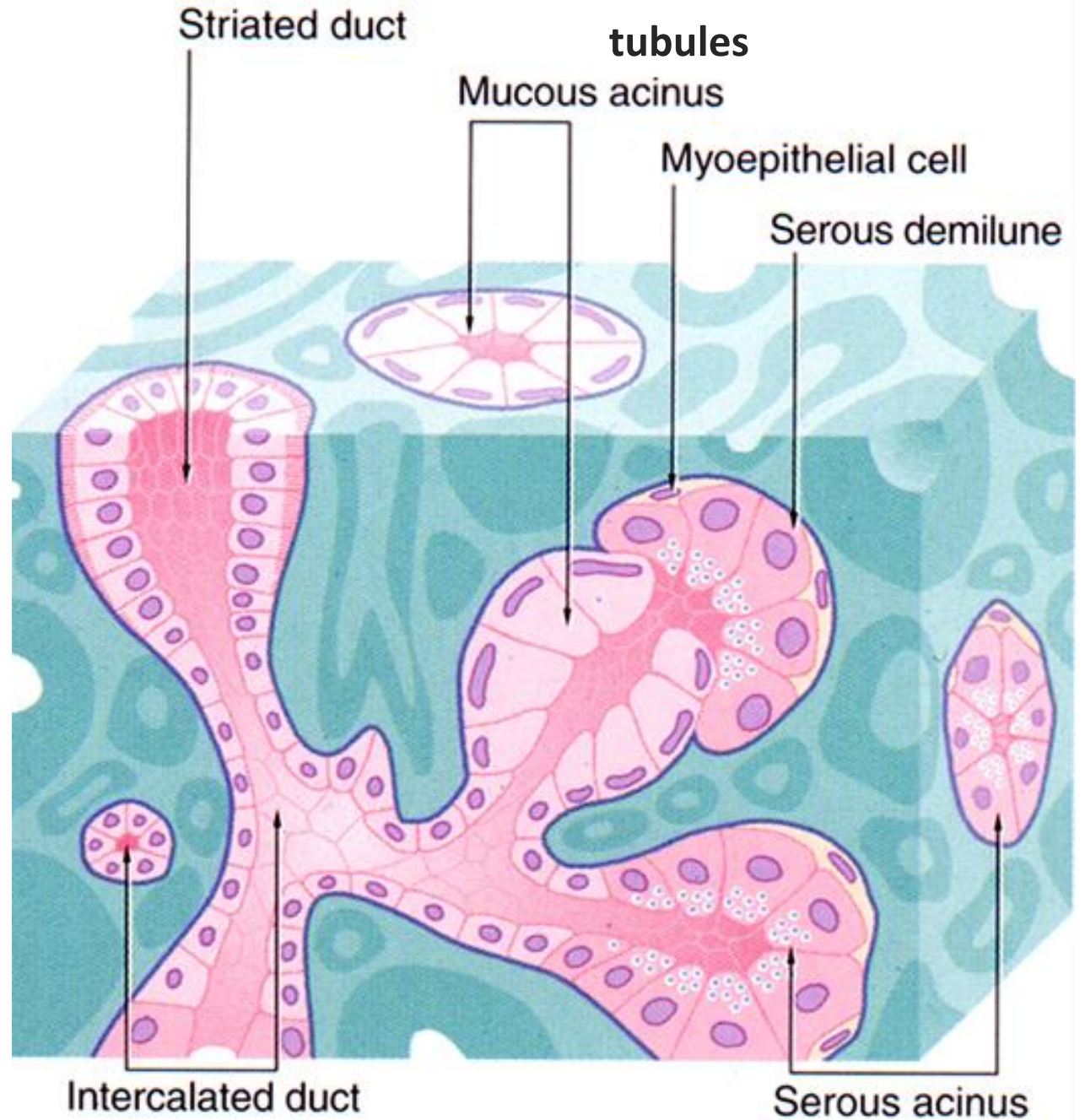


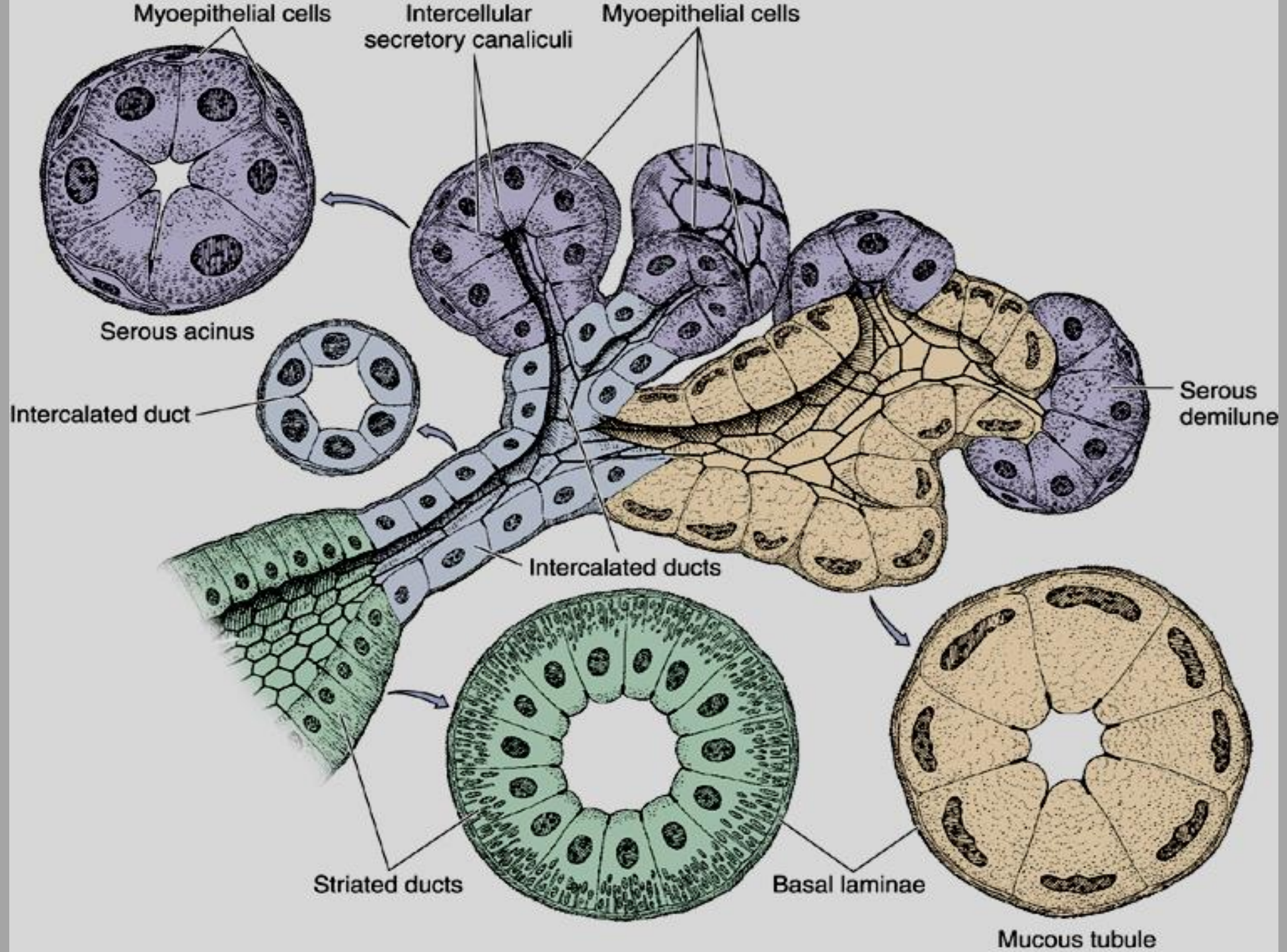
## Wall of secretory compartments:

- basement membrane
- myoepithelial cells
- glandular cells

## Wall of intercalated and striated ducts

- basement membrane
- myoepithelial cells (intercalated ducts only)
- Epithelial cells

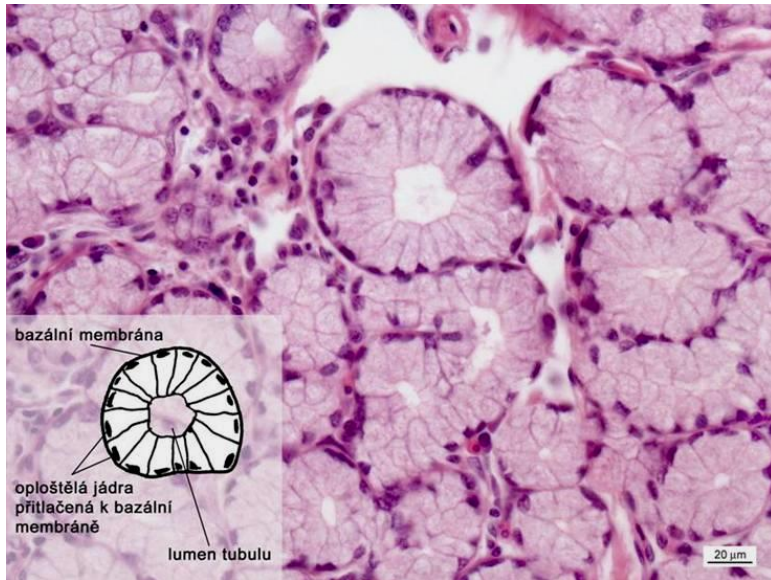




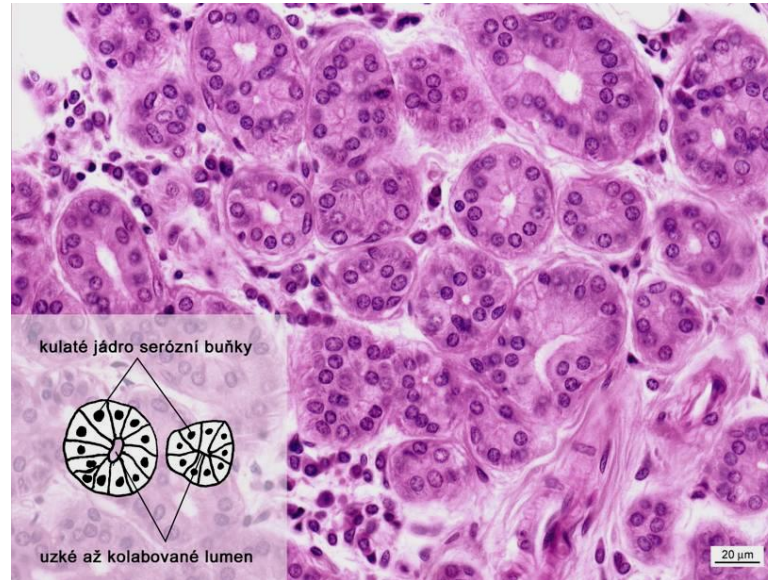


# Secretory compartments

## Mucinous tubules



## Serous acini

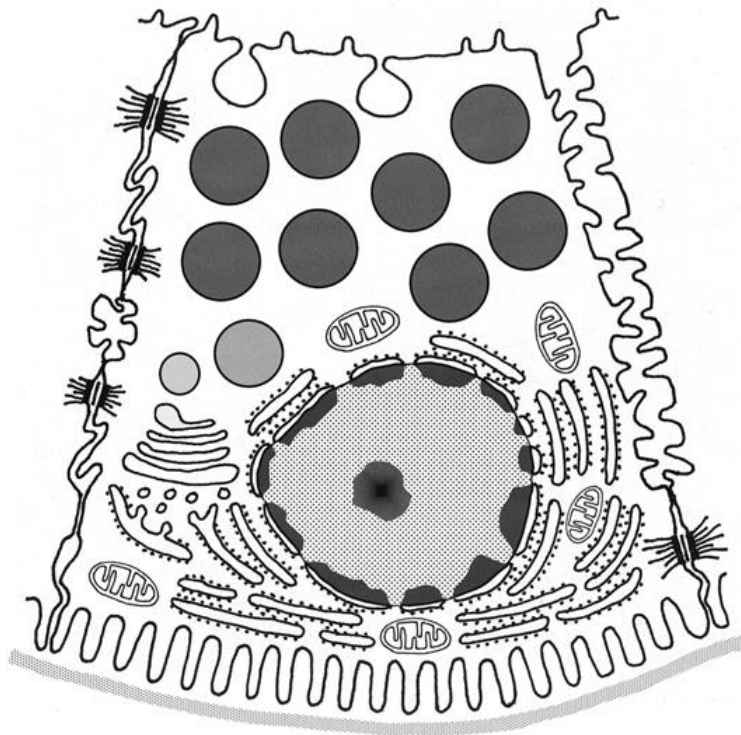
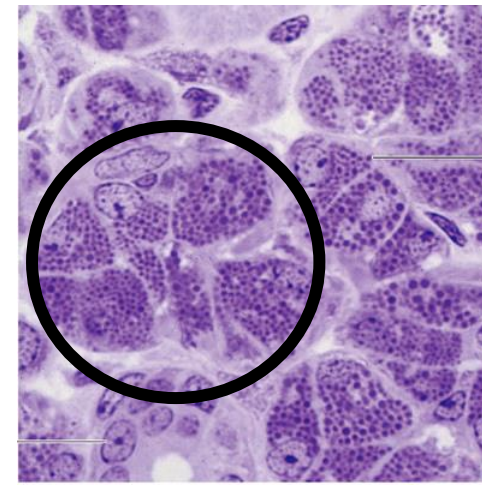


## Tubules with lunules



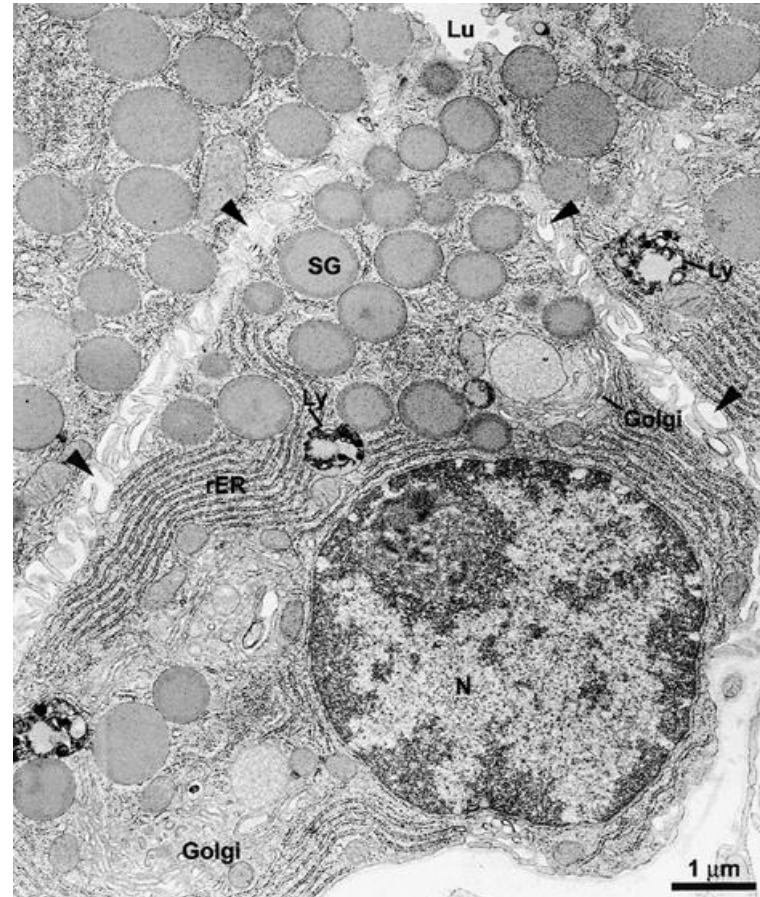
# Serous acini

spherical to ovoid sacs (60 - 150  $\mu\text{m}$ ) with a narrow lumen  
wall: serous cells, myoepithelial cells, basement membrane



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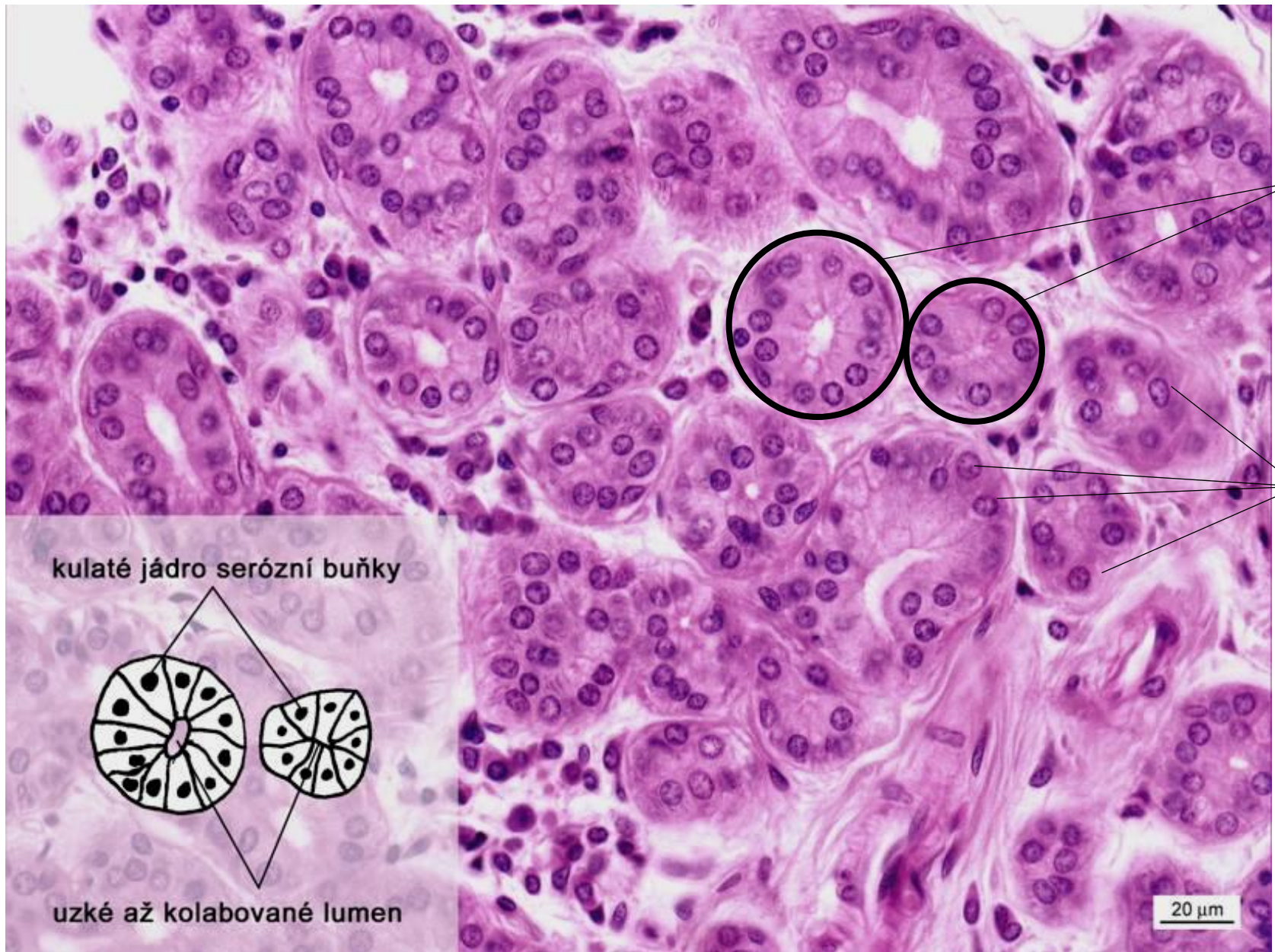
Serózní buňky



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## Cells

- pyramidal shape and spherical nucleus at the base
- below the nucleus is a basophilic cytoplasm (rER, mitochondria and ribosomes)
- supranuclear - eosinophilic secretory grains / zymogenic = proenzyme  
(zymogen = inactive enzyme precursor)



Serous acini

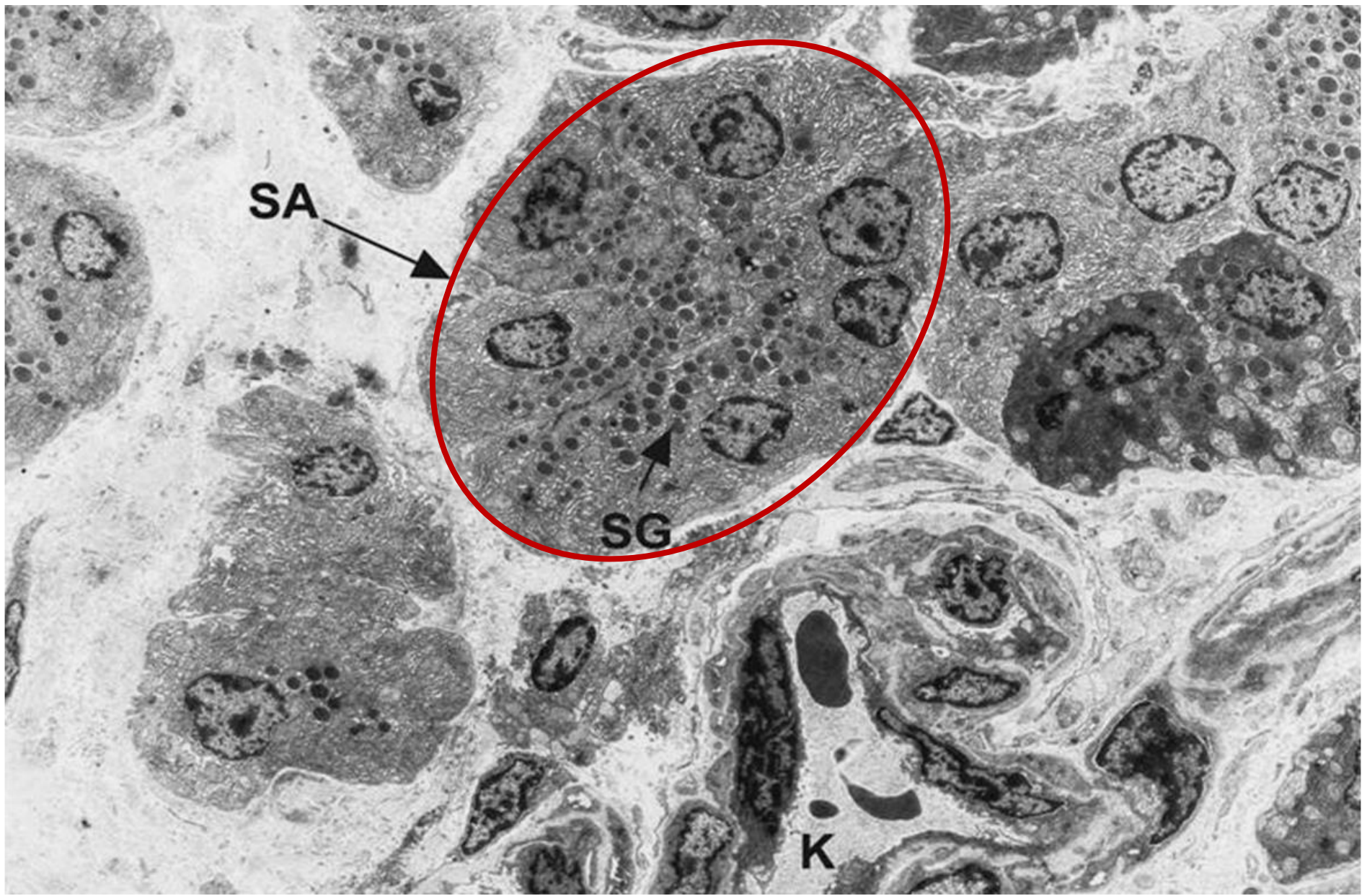
Serous cells

kulaté jádro serózní buňky

uzké až kolabované lumen

20 μm

Watery secretion, rich in proteins and enzymes



**Rat salivary gland parenchyma:** SA – serous acinus, SG – secretory granule, K – capillary. TEM, primary magnification 1,500x

# Mucinous tubules

Usually larger diameter than serous acins (about 200  $\mu\text{m}$ ), distinct lumen

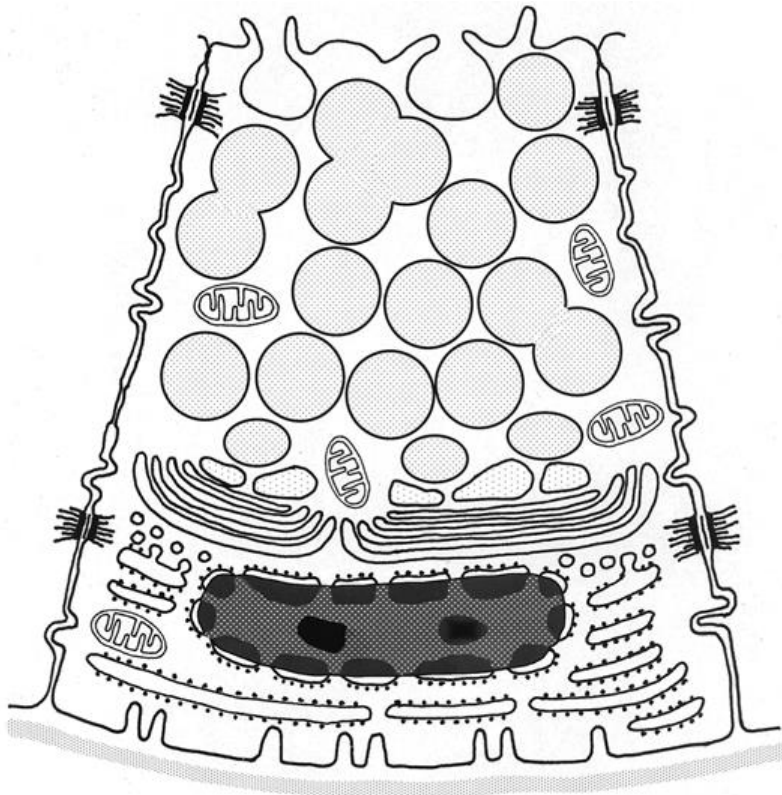
On sections: transversely or longitudinally sectioned

Wall: cylindrical mucinous cells, myoepithelial cells and basement membrane

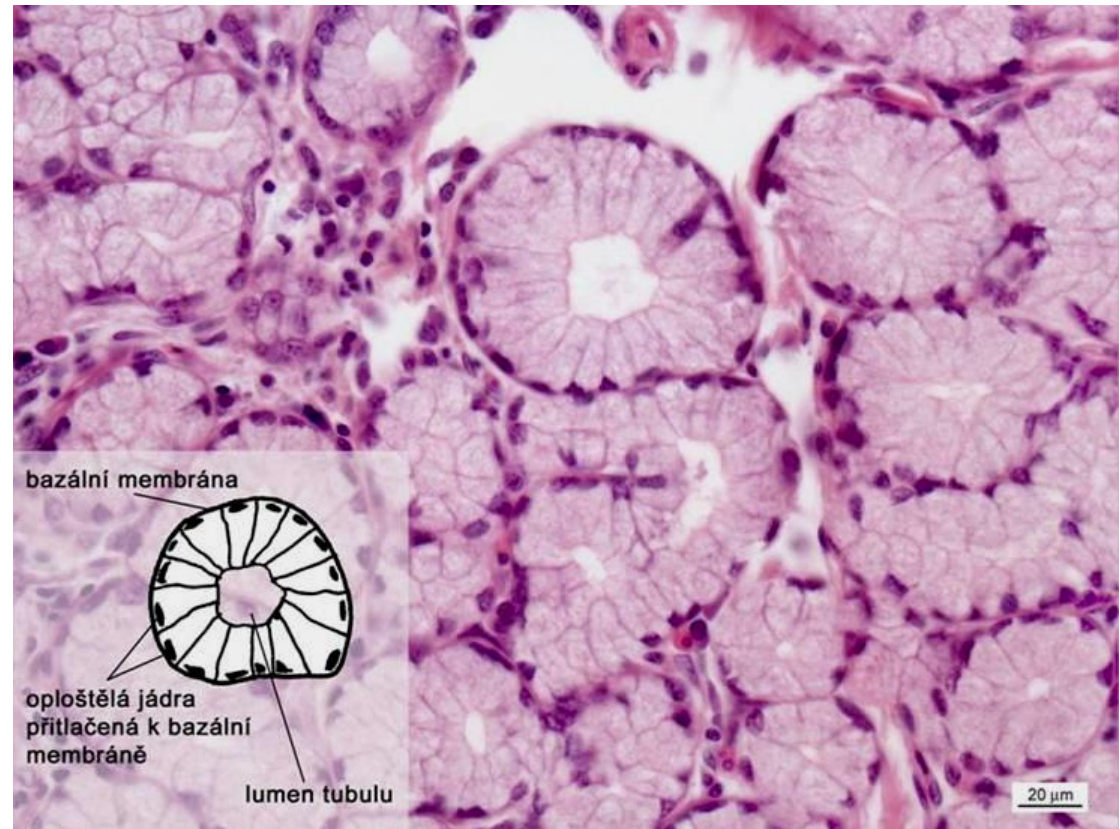
Flattened nuclei

**Apexes - numerous grains of mucinogen**

**Viscous mucus secretion**



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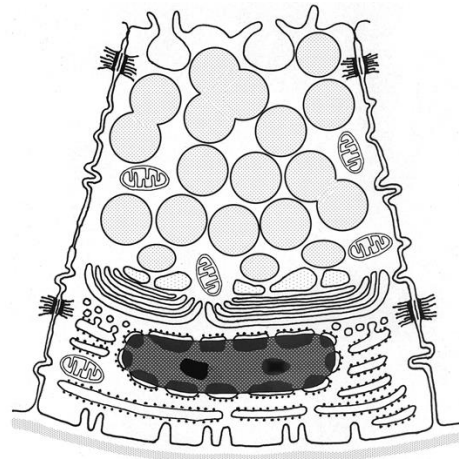
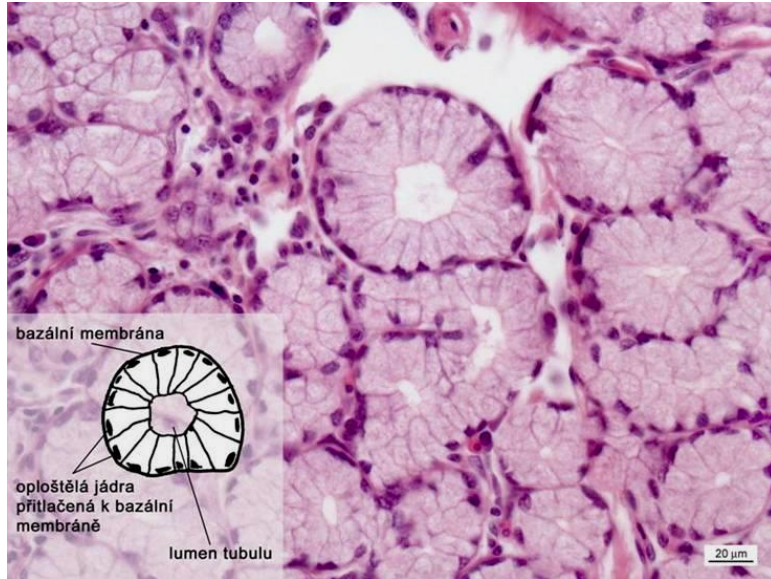
## Tubules with lunules (Gianuzzi) - tubuloacinary units

Lunule (demilune) = aggregation of serous cells at one or both ends of a mucinous tube, similar to a demilunes



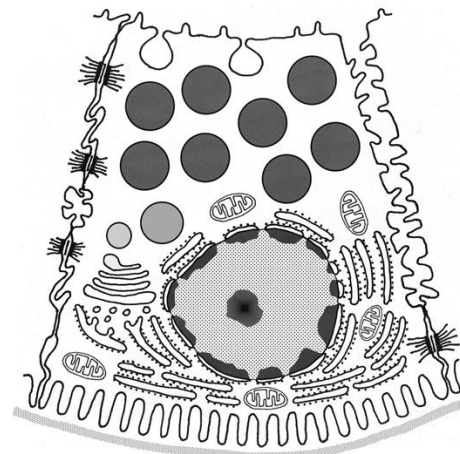
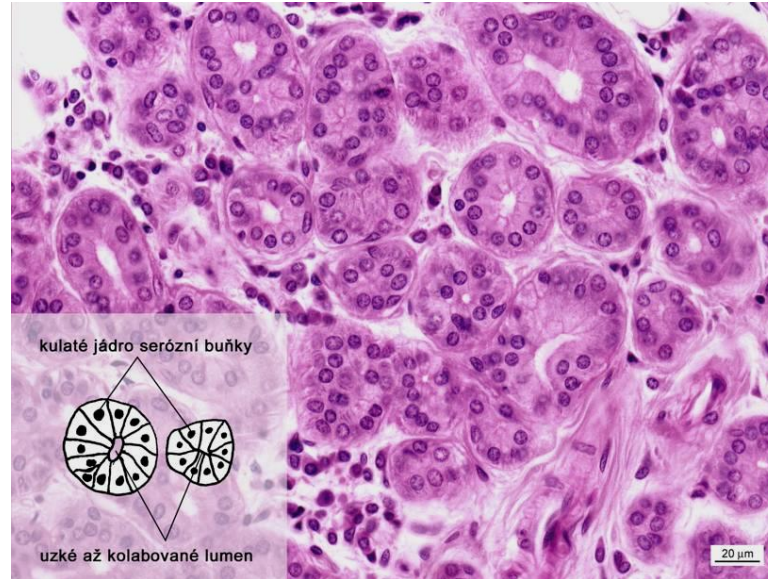
# Secretory compartments

## Mucinous tubules



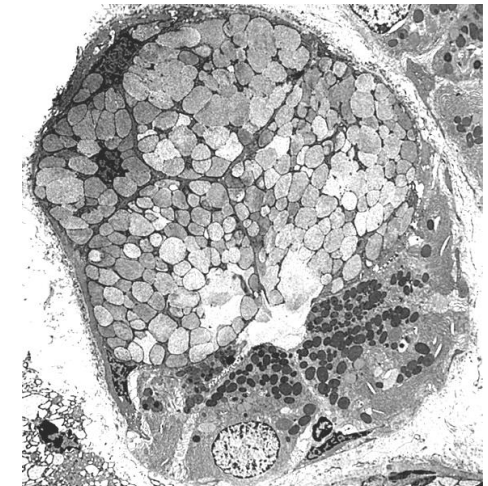
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## Serous acini



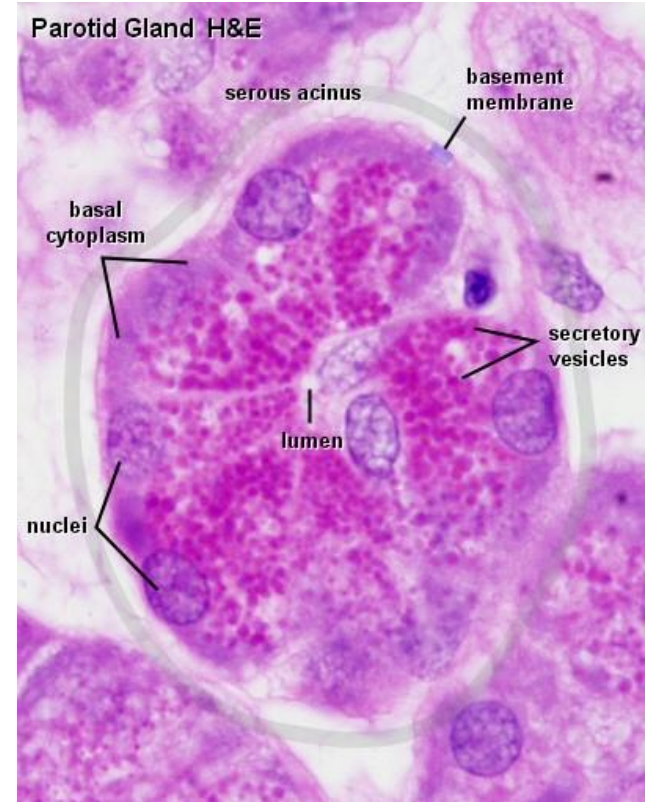
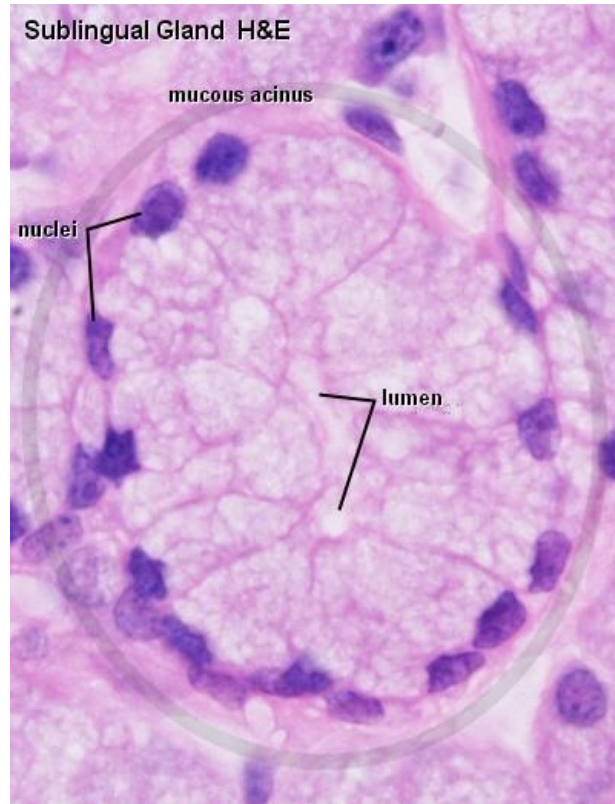
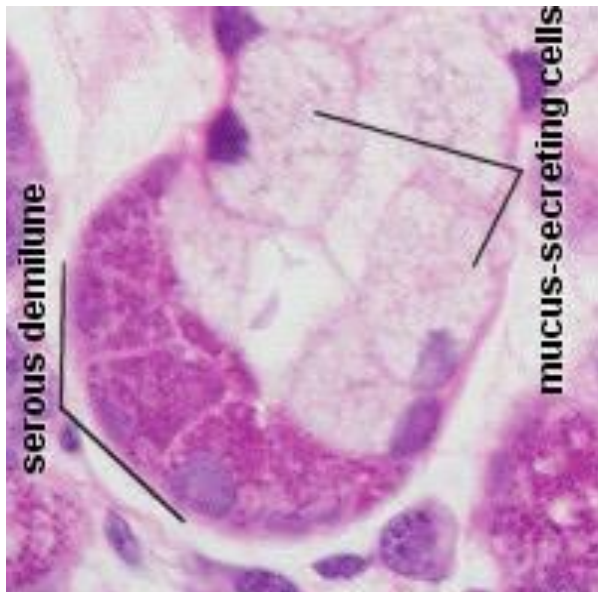
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## Tubules with lunules



# Secretory compartments

- Serous acini
- Mucinous tubules
- Lunules (demilunes)





# Myoepithelial cells

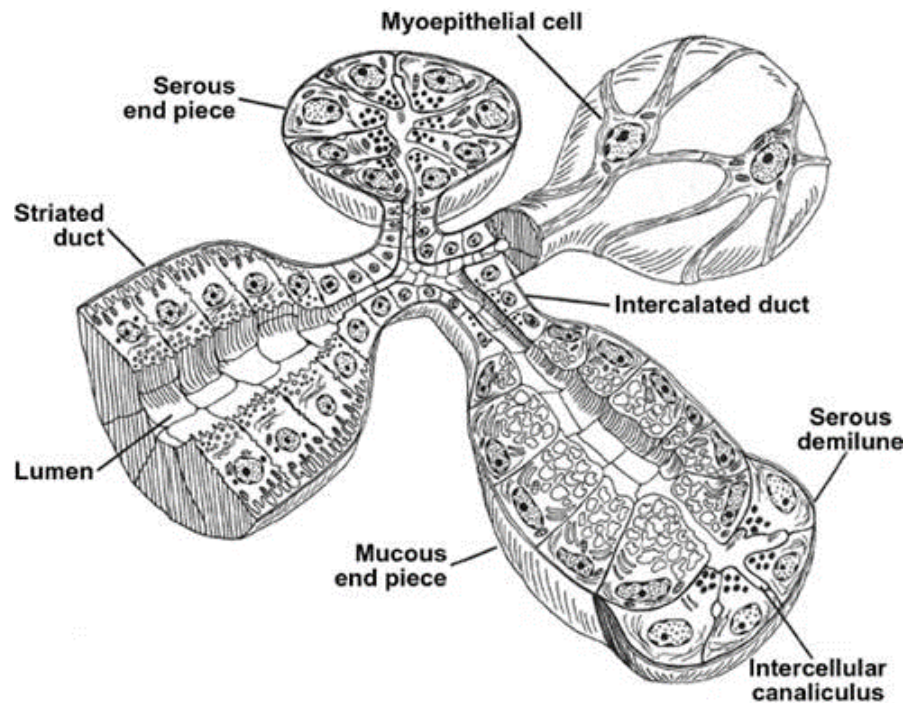
Capable **contractions**, **Vegetative** control

They **regulate secretion**, control nutrient supply and control electrolytes

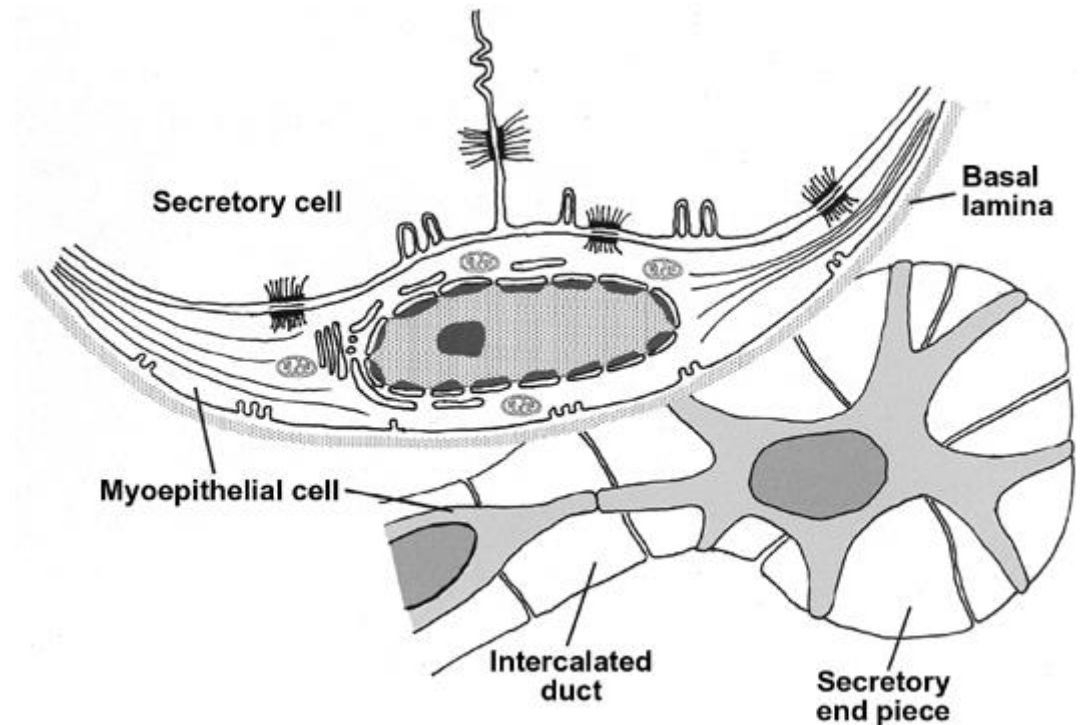
Inserted **between the bases of secretory cells** (acins and tubules) **and the basement membrane**, epithelial origin

**Flattened body**, several protrusions, between secretory and myoepithelial cells numerous desmosomes or hemidesmosomes

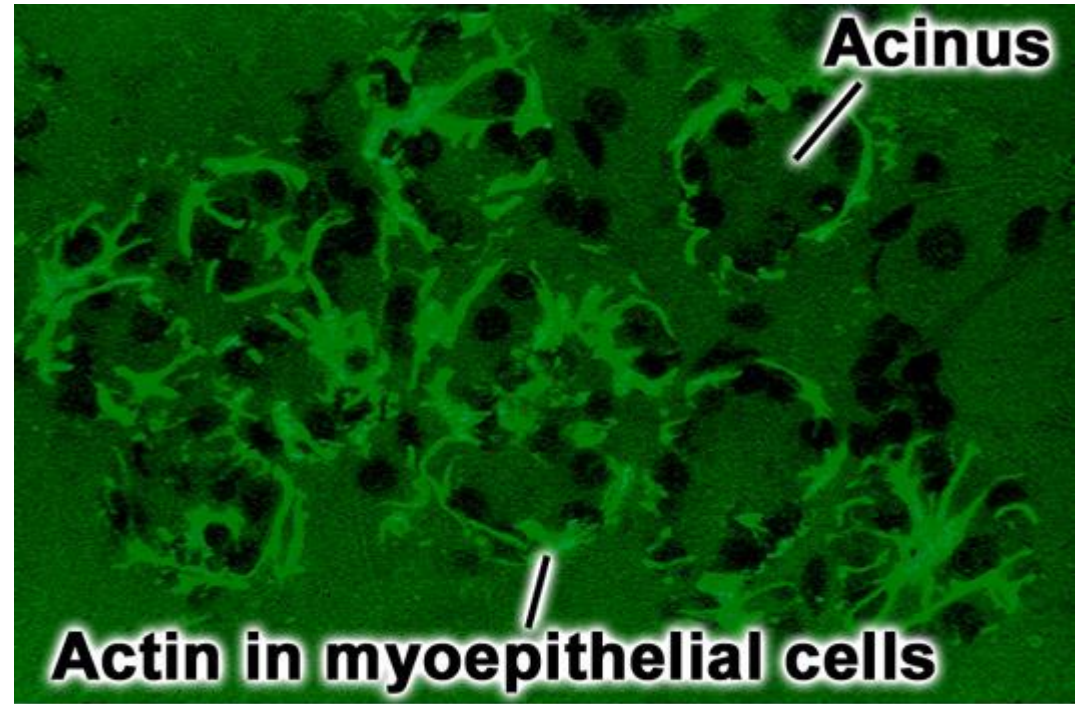
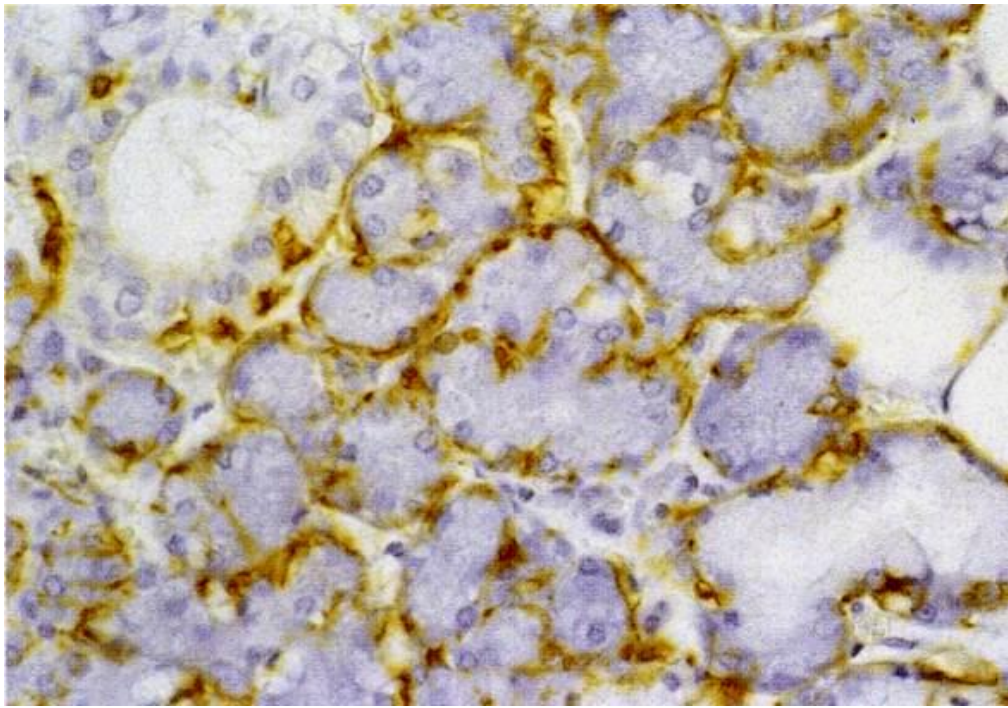
In the **cytoplasm actin microfilaments** (bundles) + cytokeratin filaments



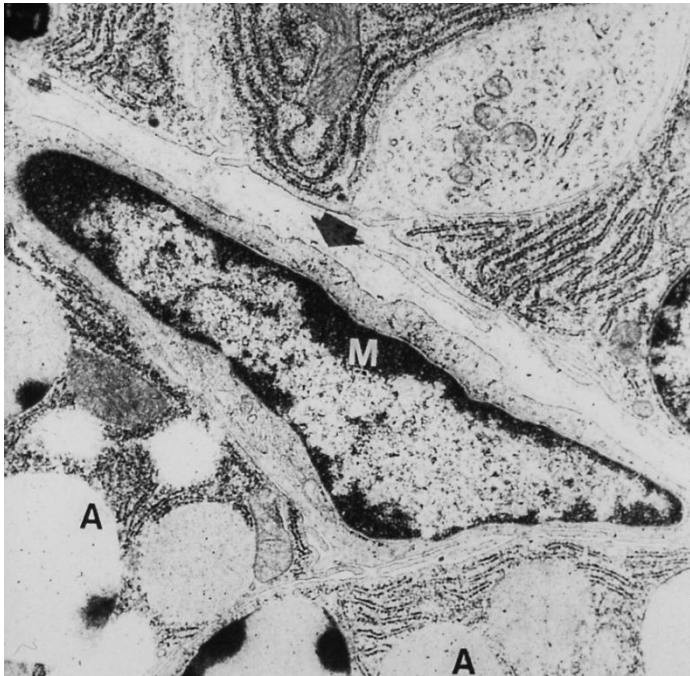
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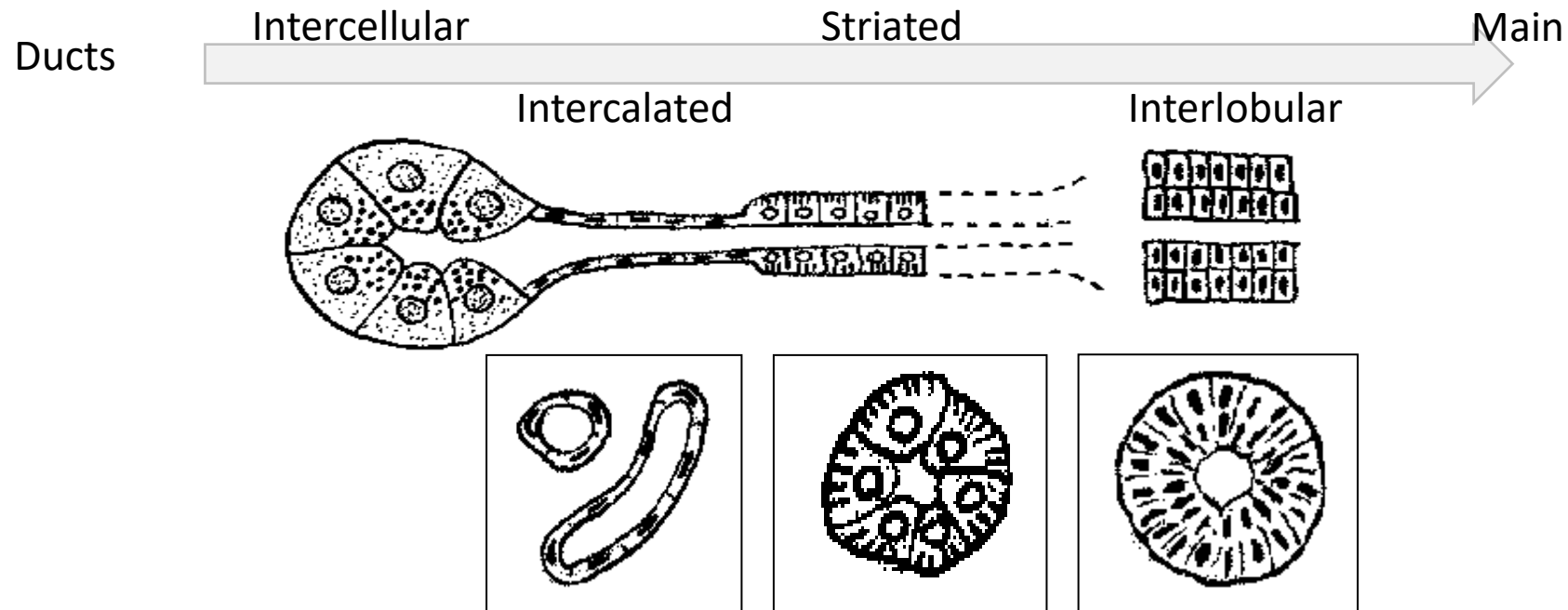


The cells help to release the secretion into the lumen of the secretory compartments and its further passaged through the inserted ducts (in the wall of which they are also present)

Active from the 25th week of development

# Salivary ducts types

- **Intercellular** (*they do not have their own wall, intercellular space*)
- **Intercalated** (*simple squamous ep., only serous and mixed glands*)
- **Striated** (*simple cuboidal/low columnar ep.; basal labyrinth → striation*)
- **Interlobular** (*simple – stratified columnar ep., in septs*)
- **Main** (*stratified columnar ep.*)



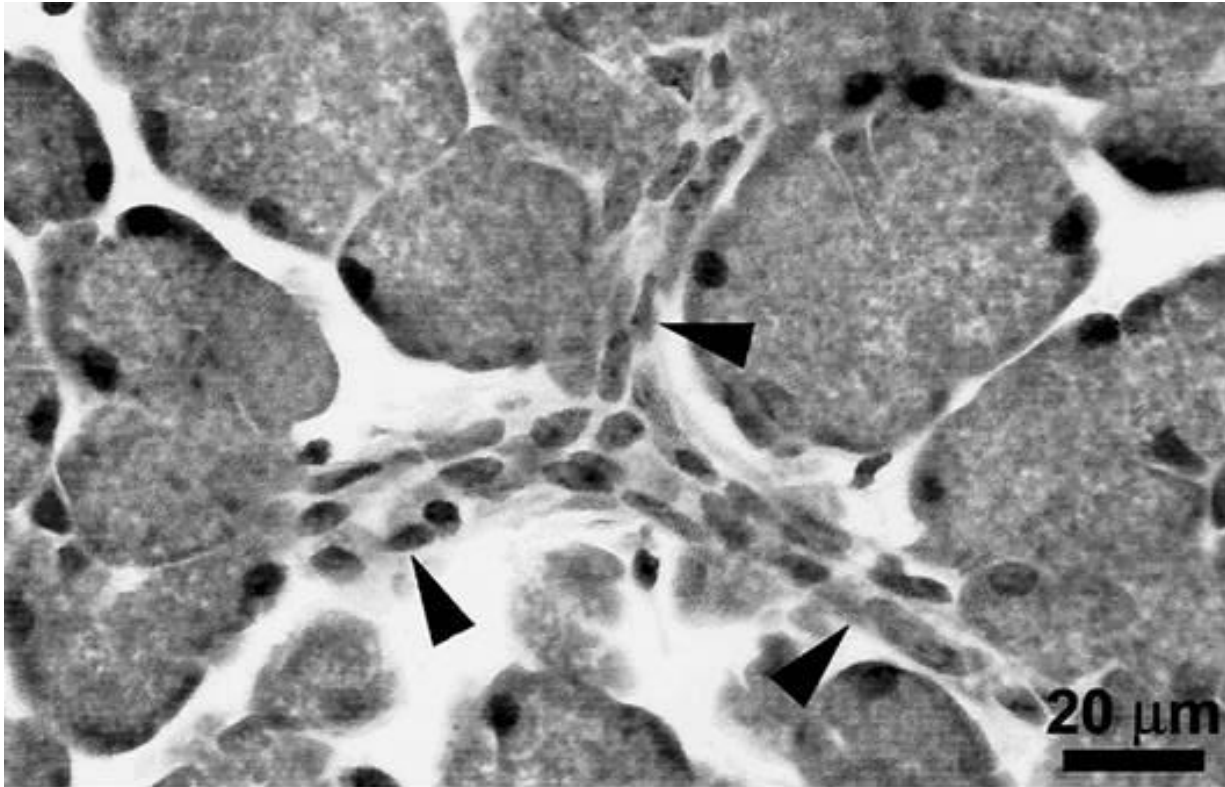
## Intercalated ducts

Narrow and thin-walled channel, collapsed on slides

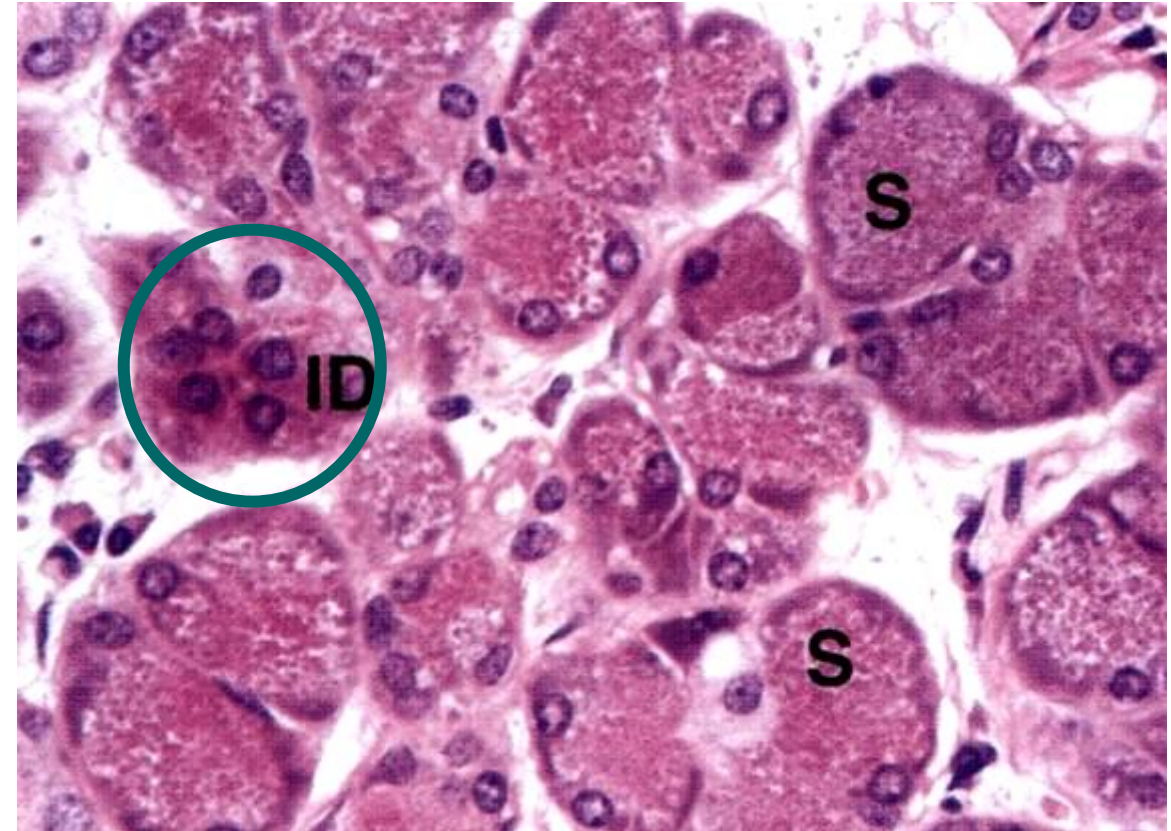
Wall: basal membrane, myoepithelial cells and simple squamous to low cubic ep.

Numerous in serous type of glands

**(cells of intercalated ducts secrete to saliva macromolecular substances: lysozym + lactoferin)**



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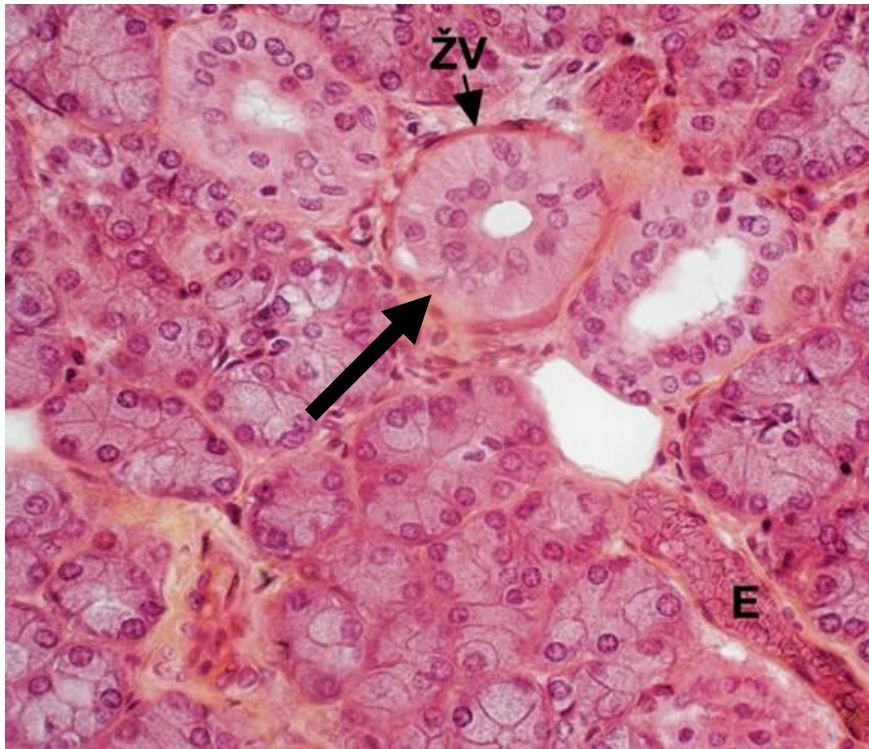
# Striated ducts

Wider than the intercalated ducts (easy to find), usually in the middle of lobe

**Wall:** Basal membrane and simple cuboidal/low columnar ep.

**Microvilli on apices and an bases characteristic striation (basolateral labyrinth)**

In the cytoplasm of cytokeratin filaments



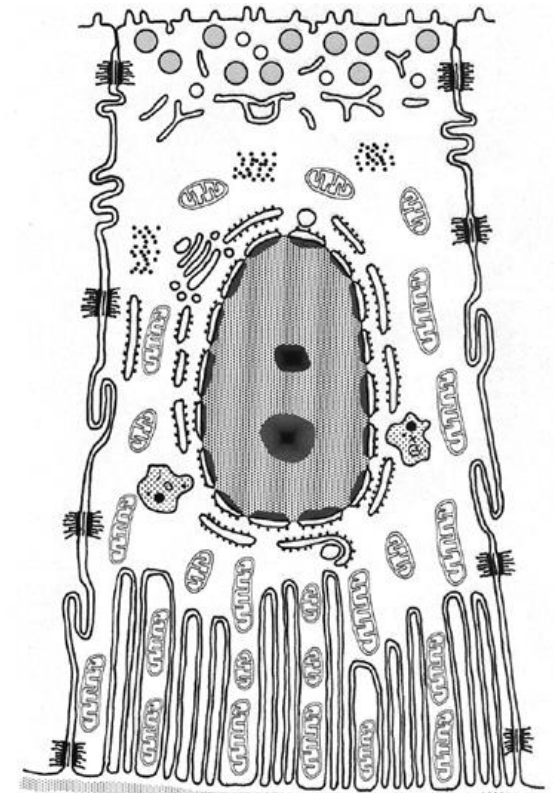
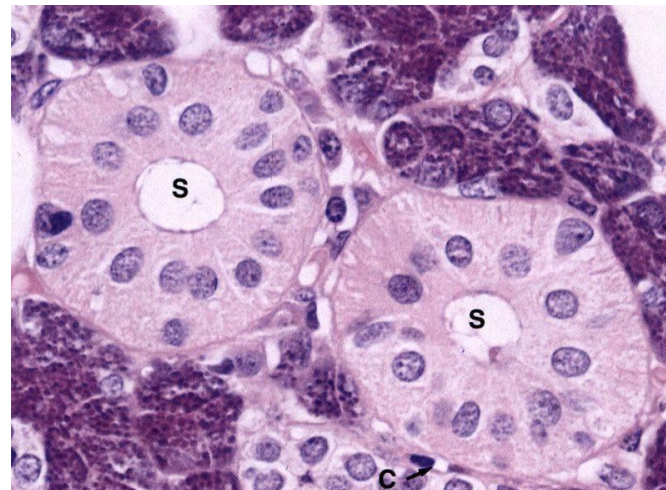
Glandula submandibularis

The cells of striated ducts regulate the content of water and electrolytes ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{HCO}_3^-$ ) in the secretion.

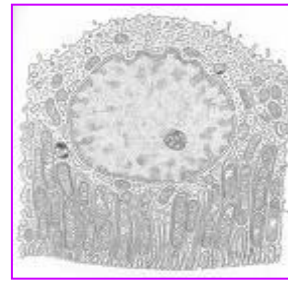
**Resorption of  $\text{Na}^+$ , and  $\text{Cl}^-$**

**Secretion of  $\text{K}^+$  and  $\text{HCO}_3^-$**

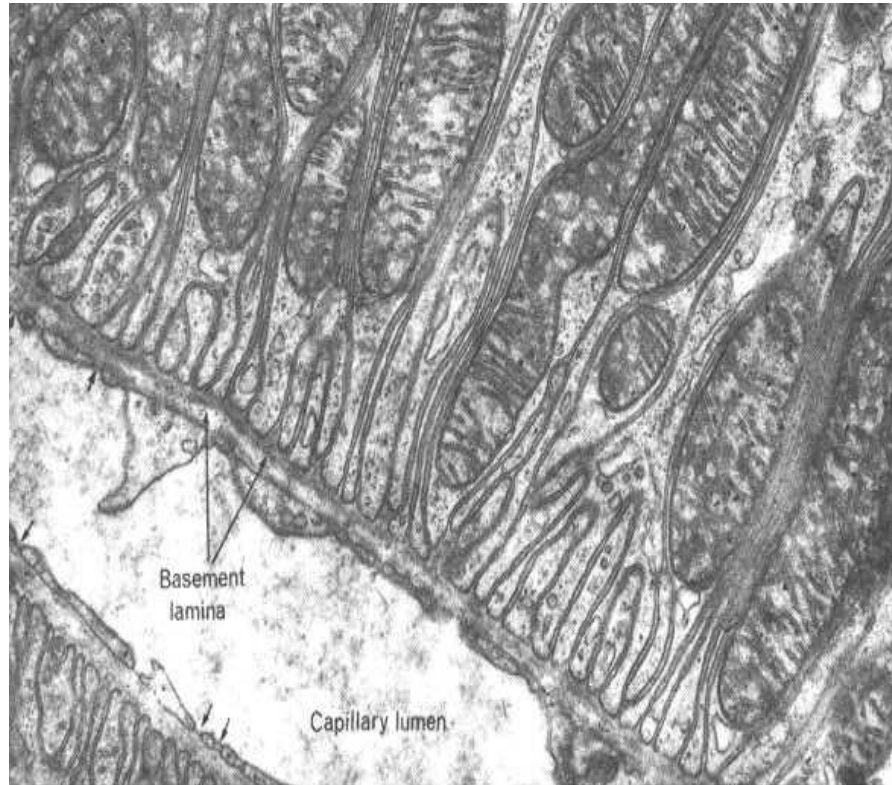
nerve control



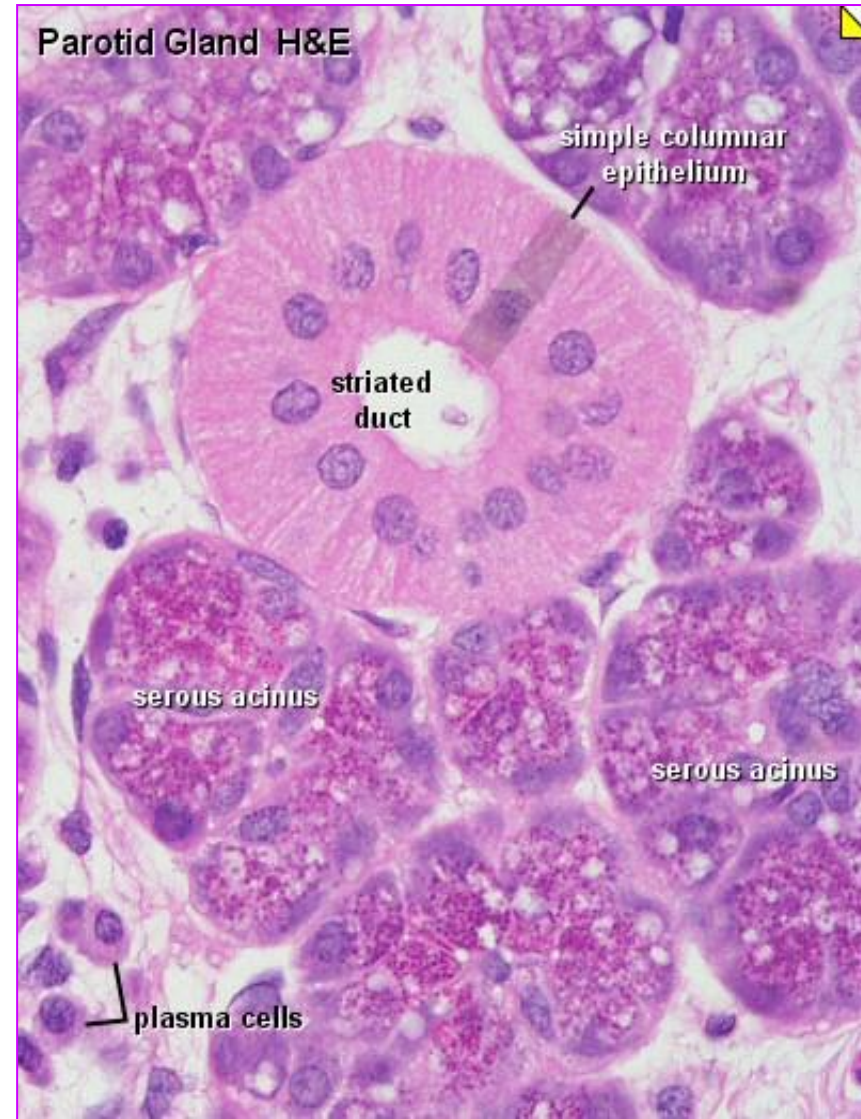
# Striated duct – basal labyrinth



*Epithelial cell*



**Base of epithelial cell:**  
Invagination of cytoplasmic membrane,  
numerous mitochondria



Parotid Gland H&E

simple columnar  
epithelium

striated  
duct

serous acinus

serous acinus

plasma cells

# Interlobular and main ducts

## Interlobular ducts

Located in fibrous septae between the lobes (columnar or stratified columnar epithelium)

They are formed by the **connection of several striated ducts**

Lined by a **high single-layer columnar** and in the terminal sections also a **stratified columnar** epithelium

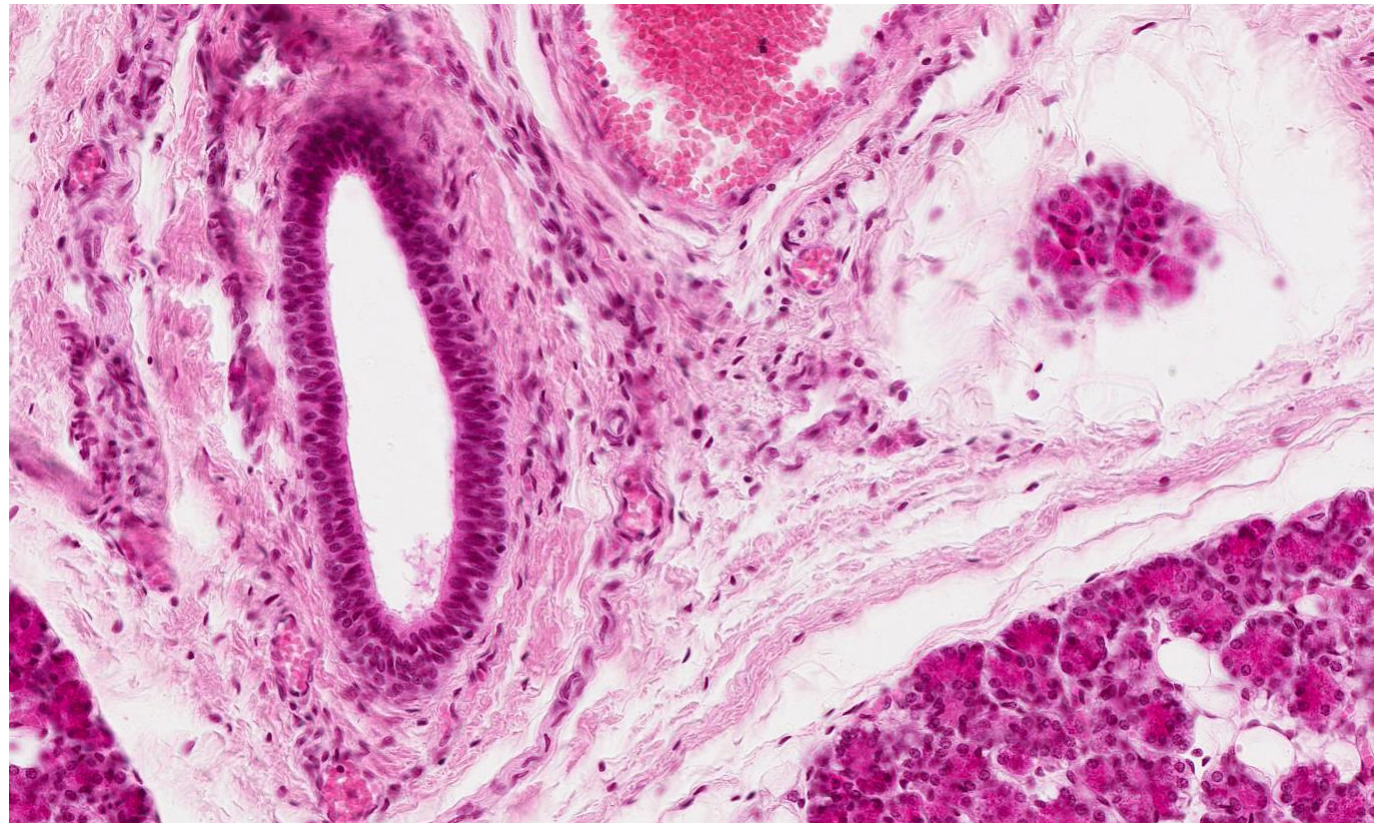
## Main ducts

Stratified columnar ep. with goblet cells

*Ductus parotideus*

*Ductus submandibularis*

*Ductus sublinguales (major et minores)*

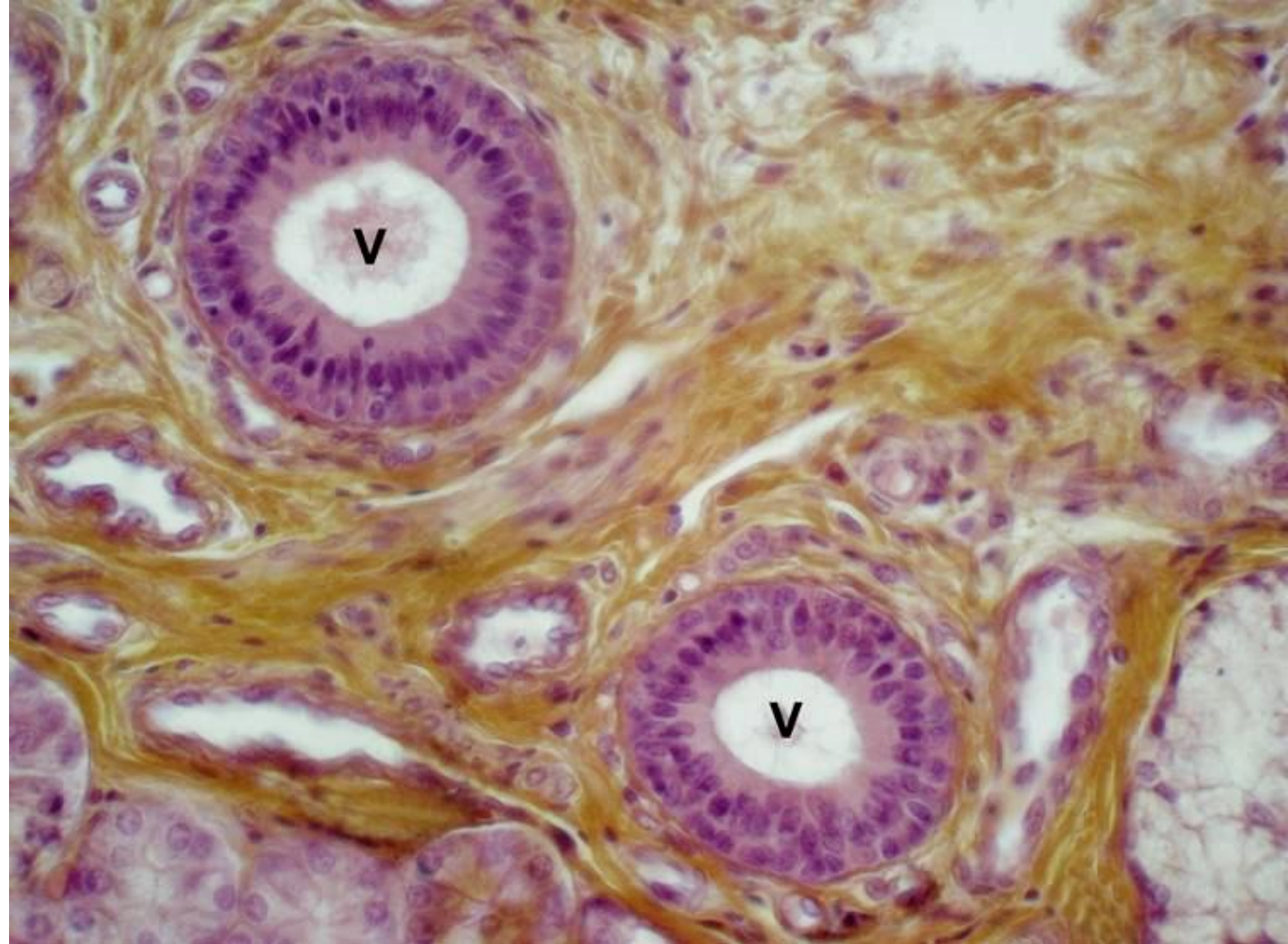


## Main ducts

**Stratified columnar ep.**

In epithelium **Goblet cells**

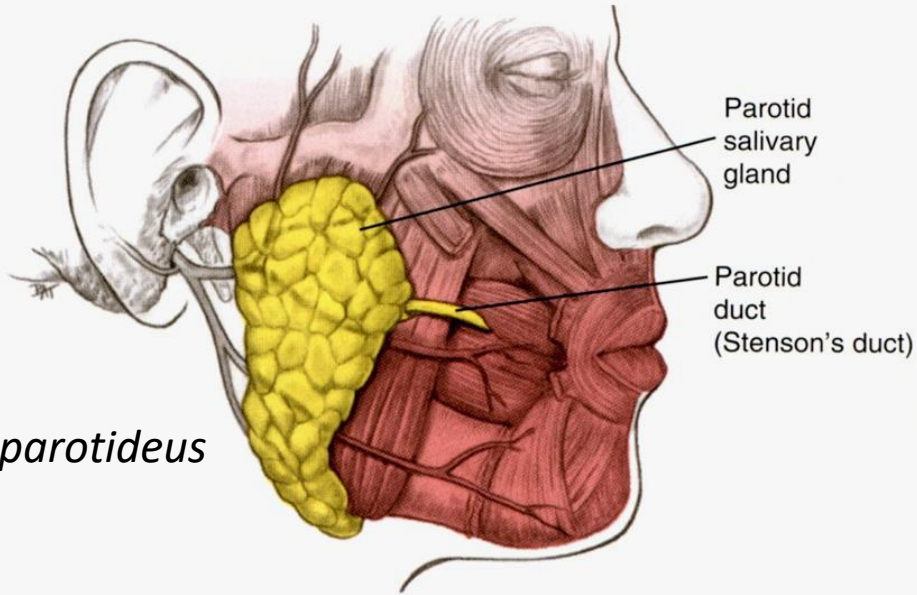
**Wall supported by the dense collagenous connective tissue and smooth muscle cells**



Ductus Rivini (V) – septum of *gl. sublingualis*.



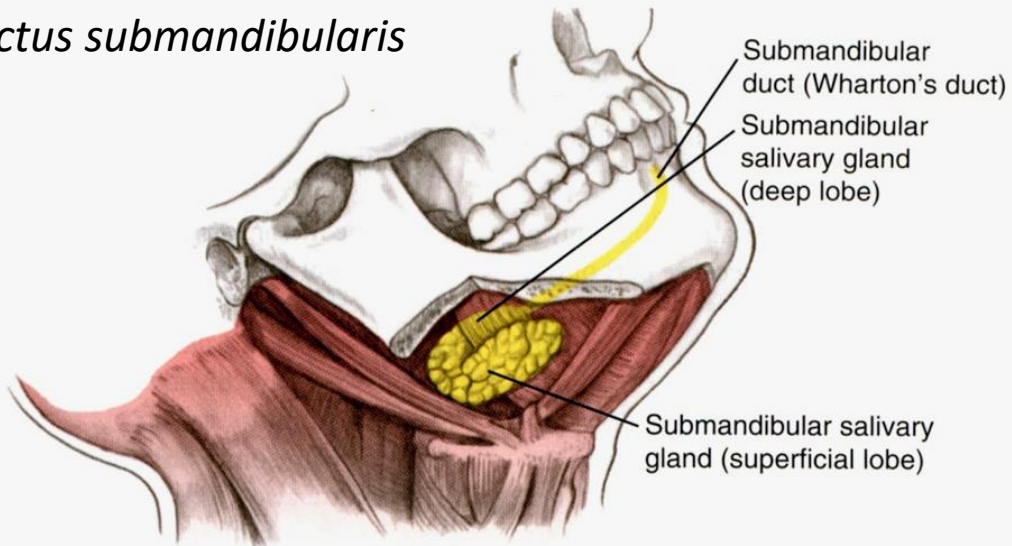
# Topography of large salivary glands



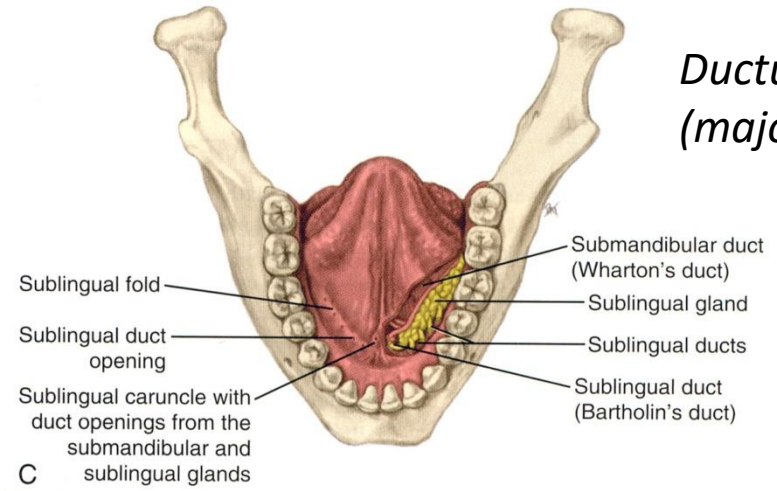
*Ductus parotideus*

A

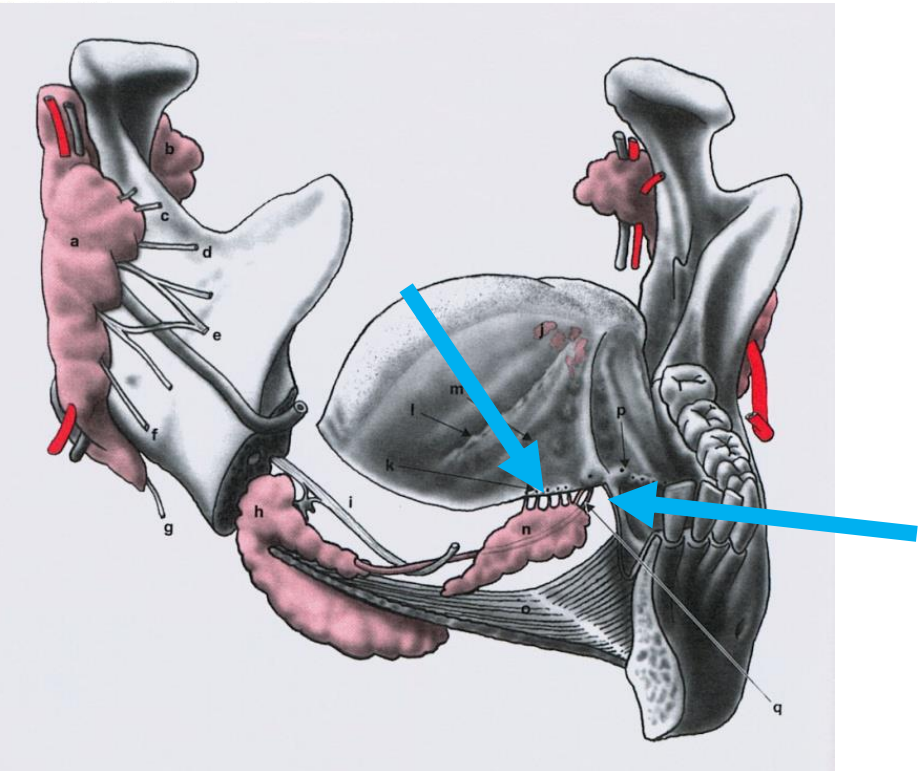
*Ductus submandibularis*



B

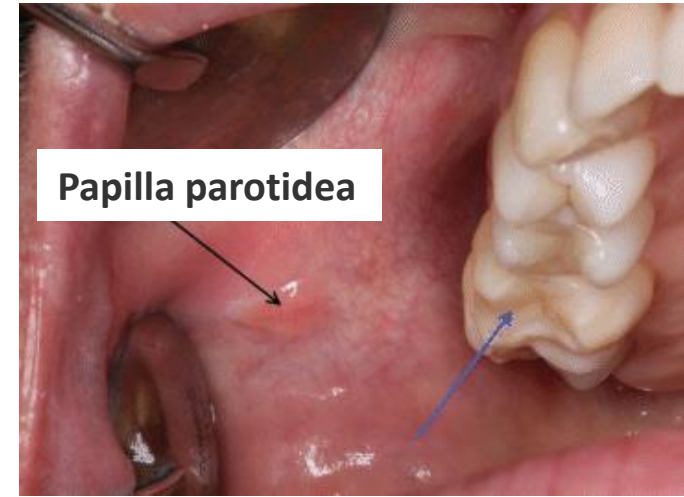
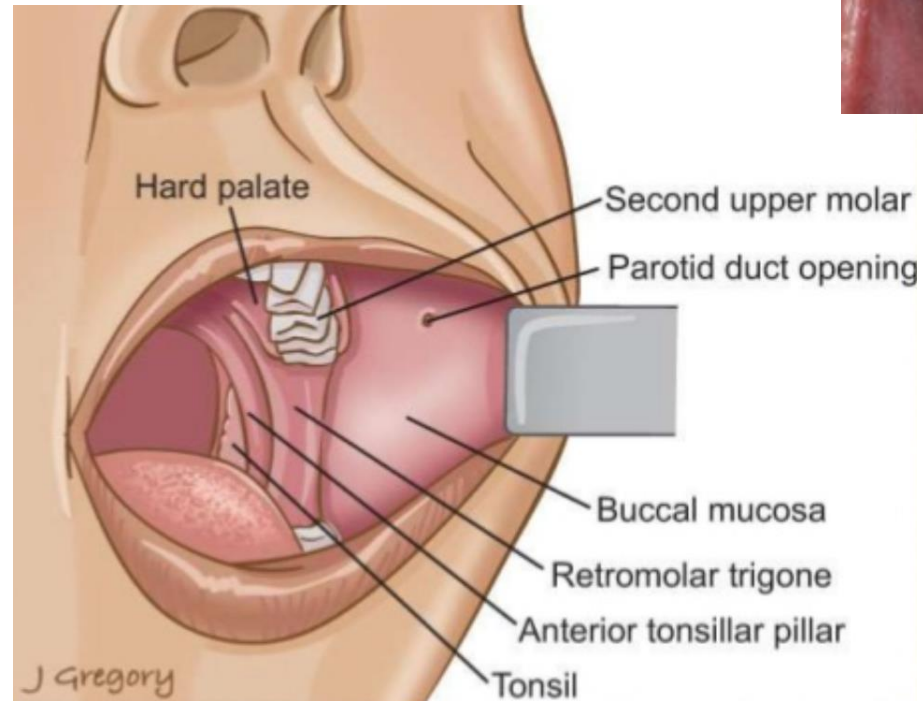
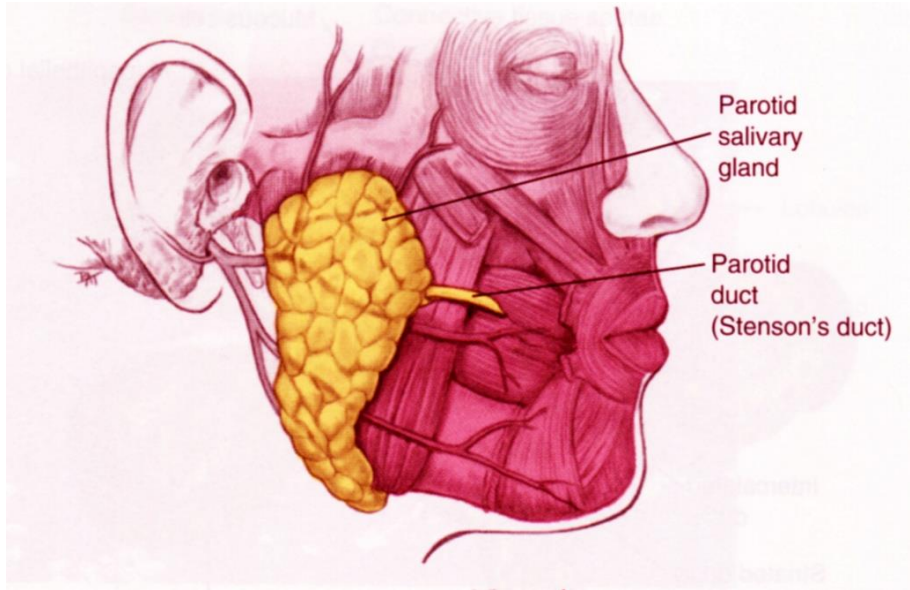


*Ductus sublinguales (major et minores)*

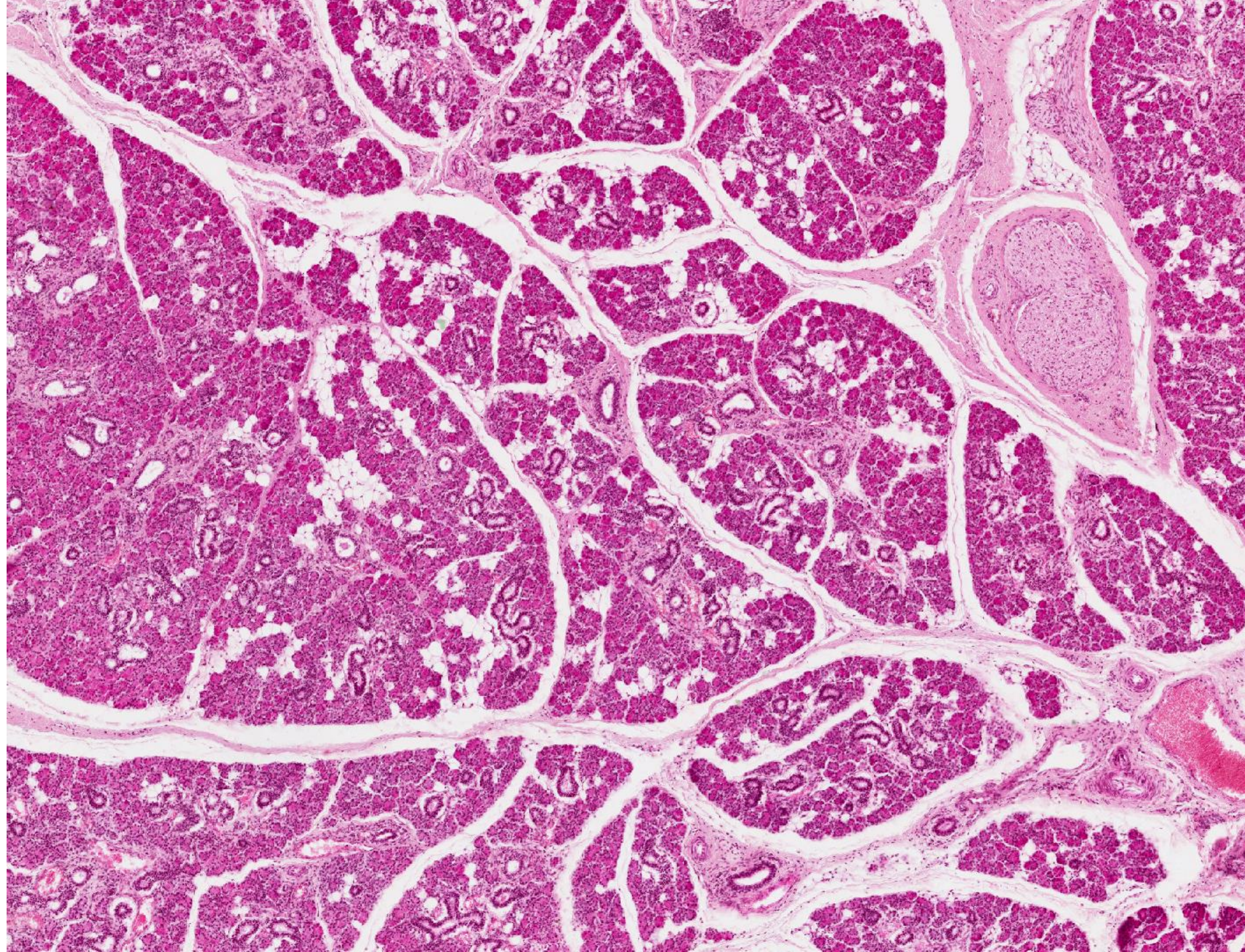


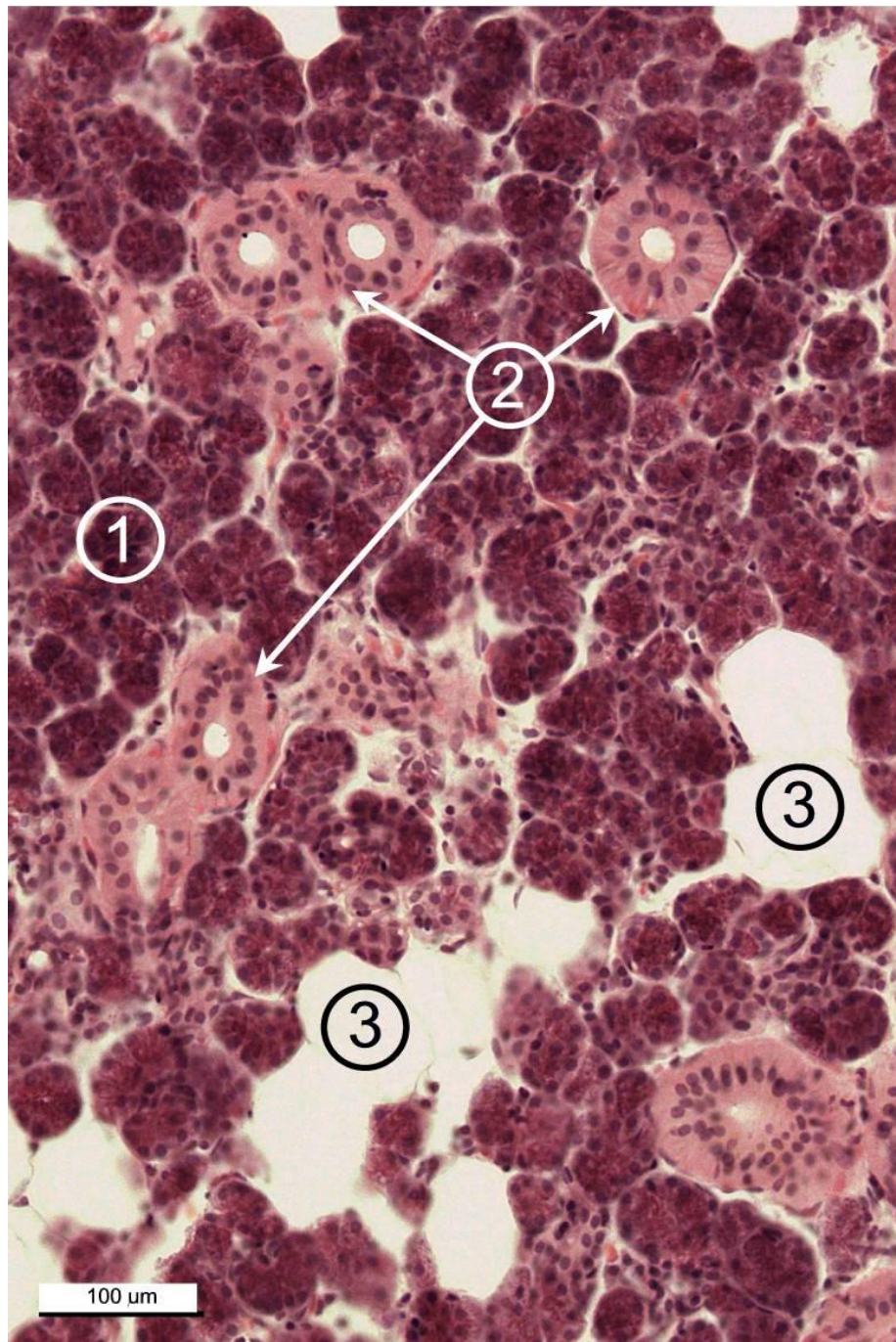
# Glandula parotis

- **SEROUS** gland
- 14 - 28 g
- capsule, septs and lobules
- Serous acini, ducts: **long** intercalated ducts, **numerous** of striated ducts
- **ductus parotideus (Stenoni)** - 2. upper molar (Steno/Stensen, Niels)
- adipocytes



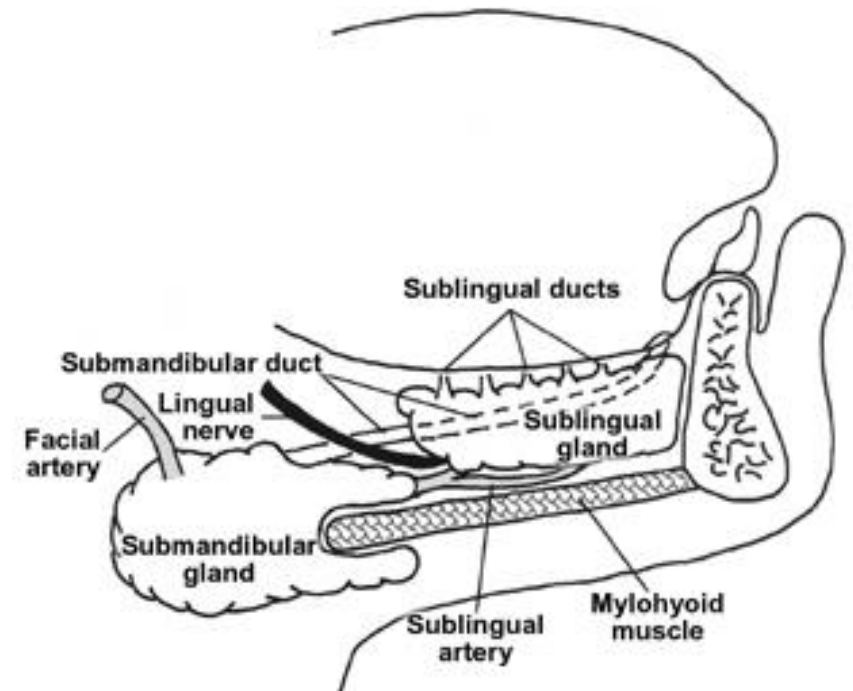
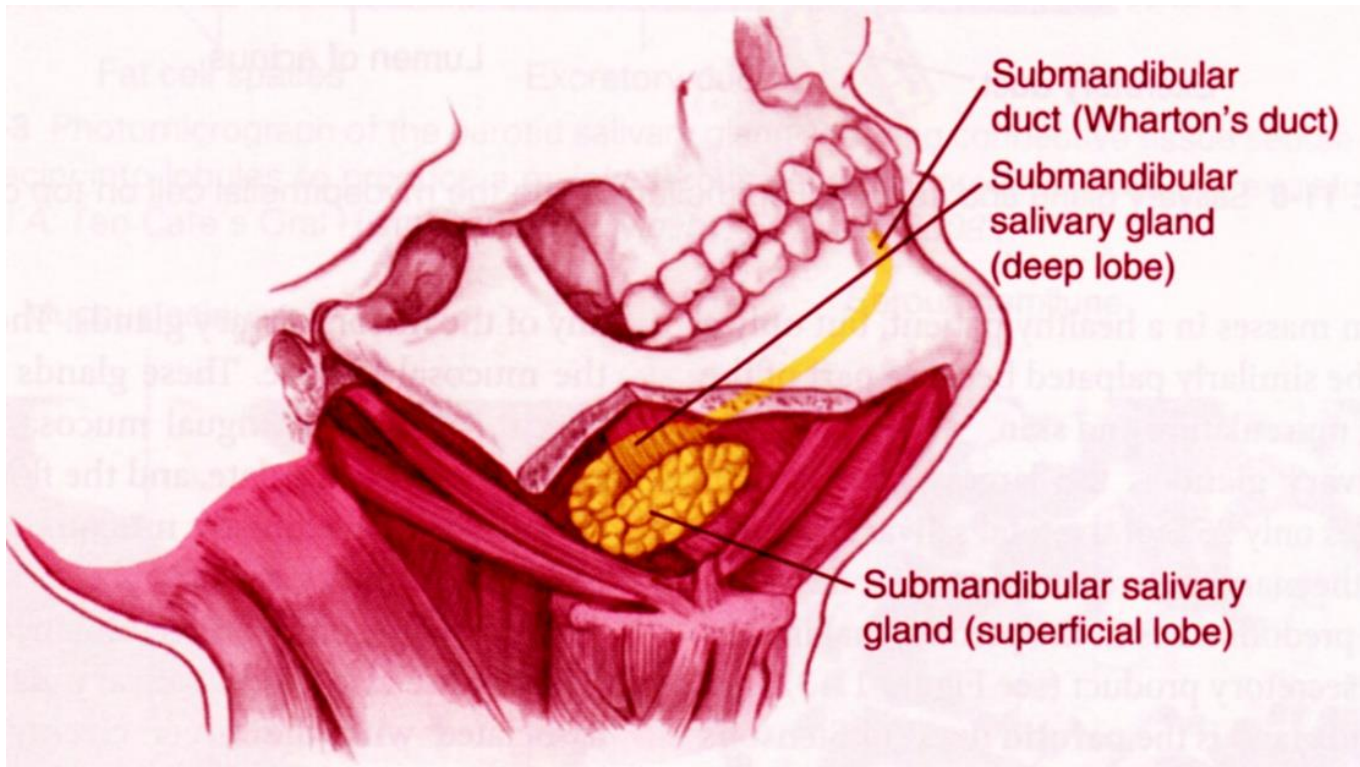
## Glandula parotis



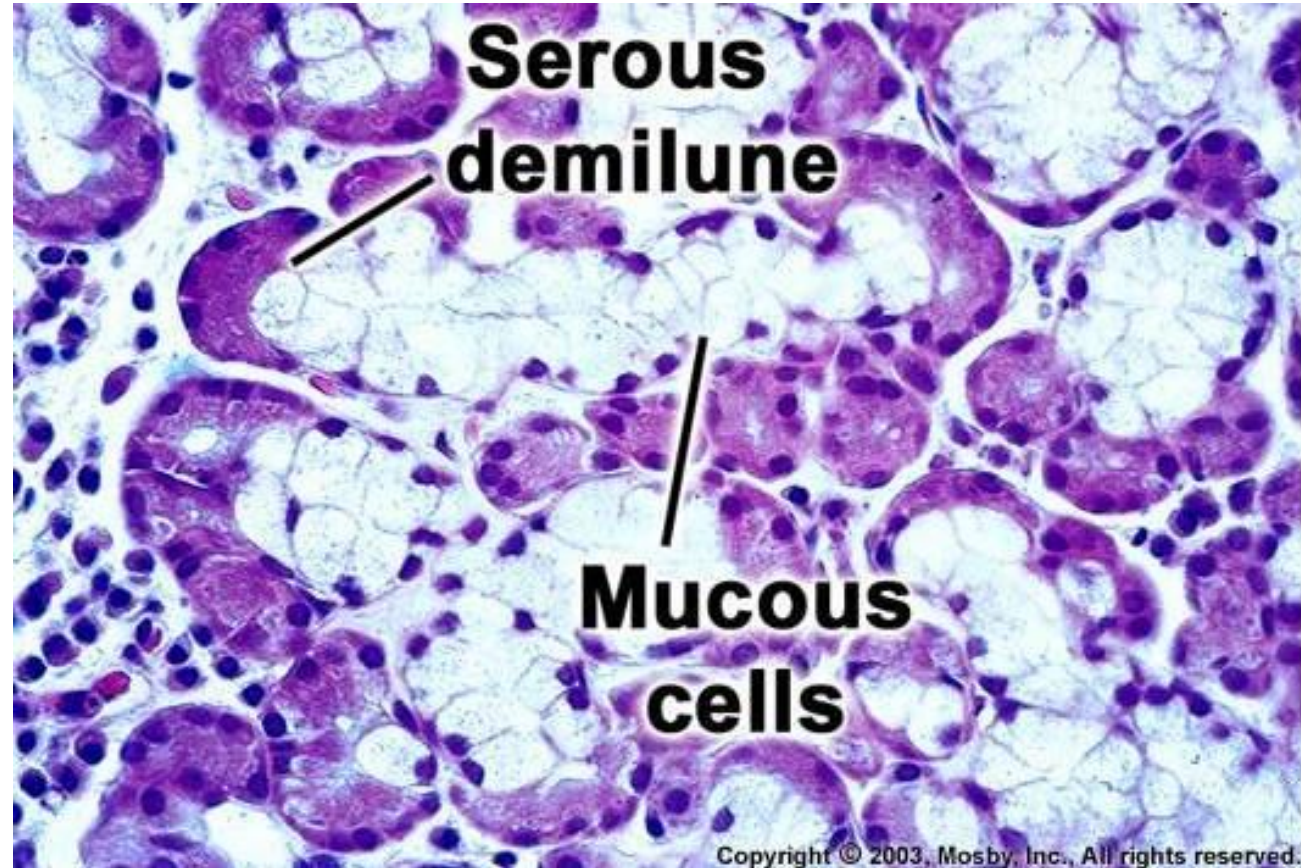
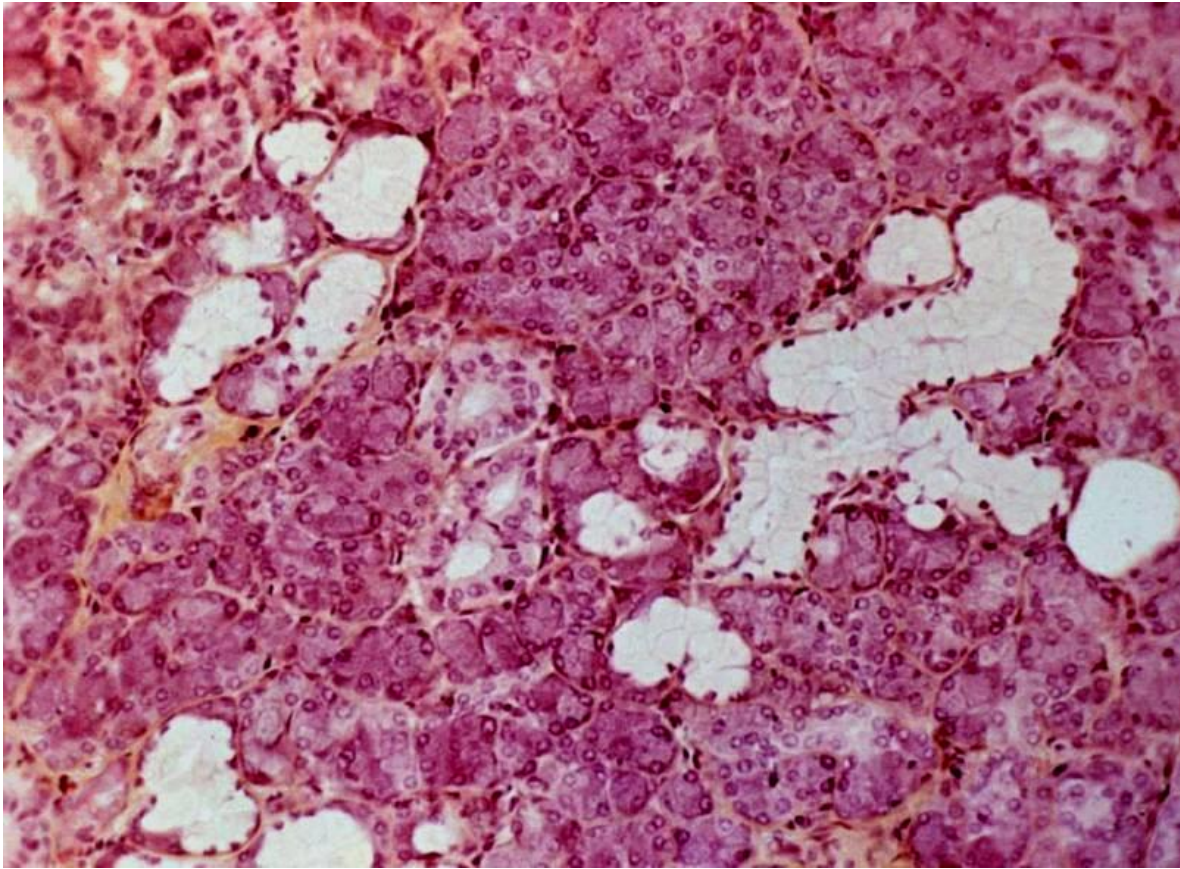


# Glandula submandibularis

- **MIXED** tuboalveolar gland, predominantly **SEROUS**
- 10-15 g
- serous acini - 80 %, rest are mucinous tubules with **Gianuzzi demilunes**
- intercalated and striated ducts
- **ductus submandibularis (Whartoni) - frenulum linguae**

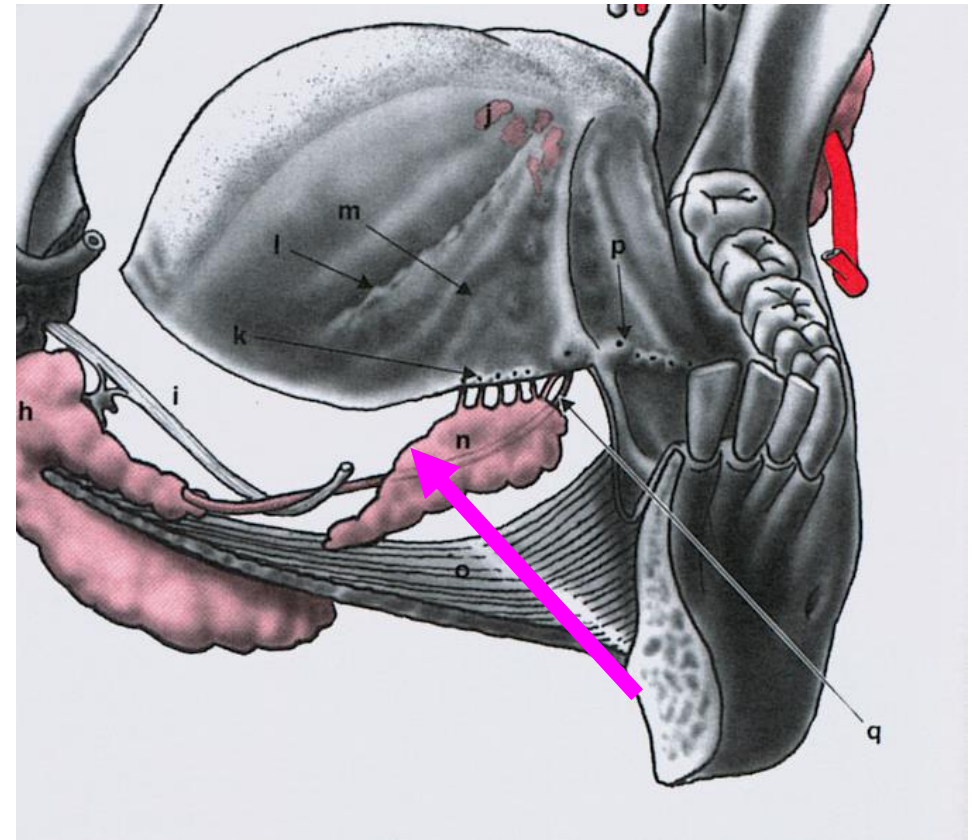


# Glandula submandibularis

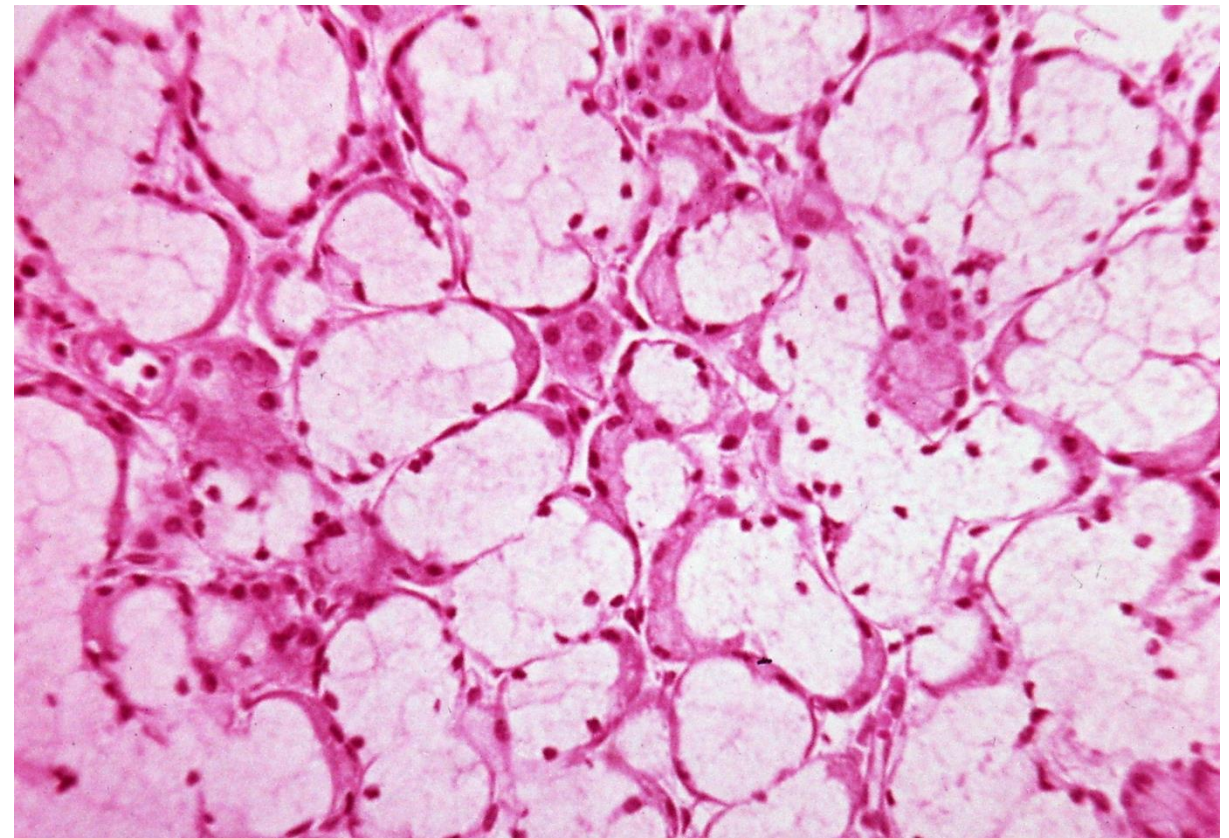
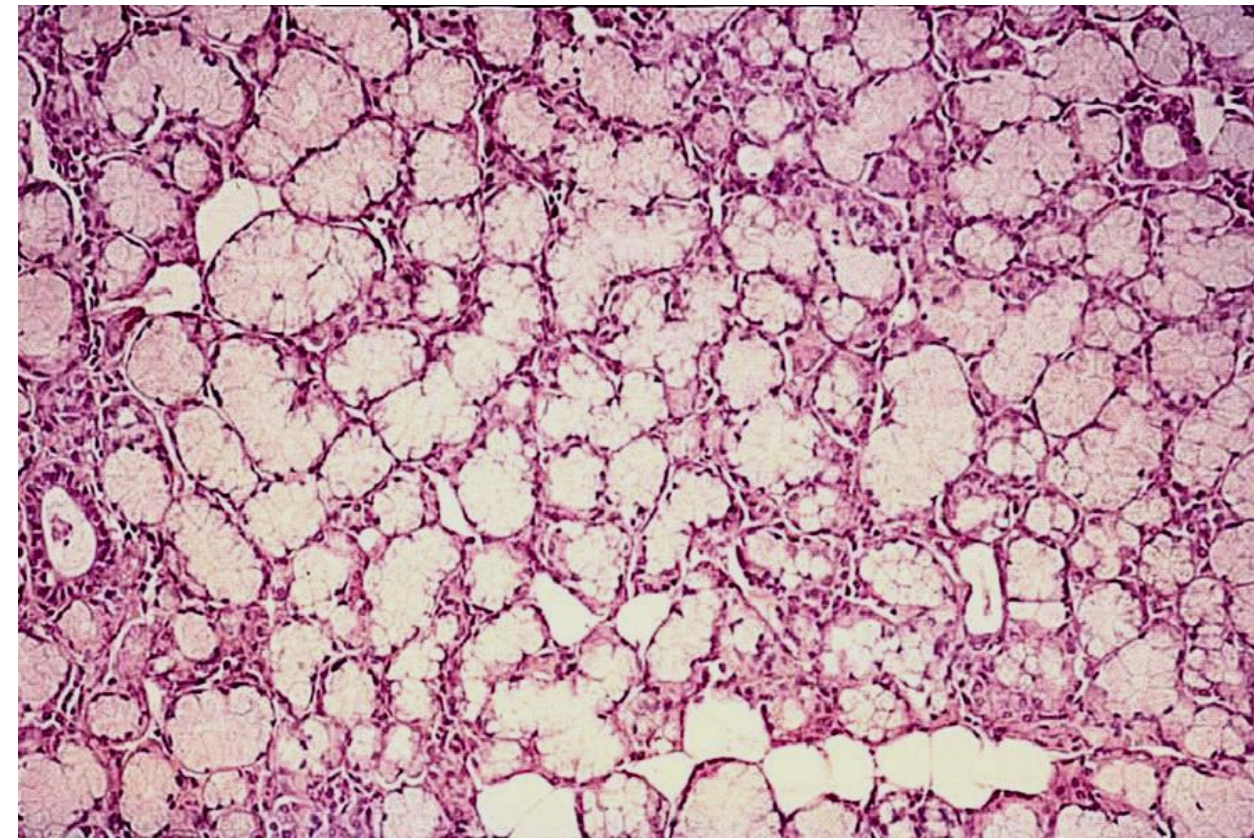


# Glandula sublingualis

- **MIXED** tuboalveolar gland, predominantly **MUCOUS**
- 2g
- located on the floor of the mouth on mylohyoid muscle near the midline
- Mucinous tubules, **serous acini are rare**, instead of them: **Gianuzzi demilunes**
- Intercalated ducts are missing, striated ducta are present, but are reduced in number and short
- **ductus sublingualis major** (Bartholini)
- **ductus sublinguales minores** (Rivini) along the crest of the plica sublingualis



# Glandula sublingualis





# Saliva (function)

- **Protective:** Forms a thin film on the surface of the mucosa and teeth - a salivary film  
Ensures moisture and self-cleaning of the oral mucosa  
Protects teeth from bacteria (removal of sugars - preventing the spread of acidogenic microorganisms)
- **Reparative:** Stimulates reparative processes in the oral cavity - growth, differentiation, healing participates in remineralization and maintains tooth integrity
- **Remineralization:** Involved in remineralization and maintaining tooth integrity (saliva is saturated with calcium and phosphate ions)
- **Buffering:** Balances pH (bicarbonates, phosphates, ions) - prevents demineralization
- **Antimicrobial:** Proteins with bacteriostatic effect - lysozyme, peroxidase, lactoferrin, immunoglobulin A (aggregation of specific bacteria)
- **Moisturizing:** Moisturizes dry food and makes them easier to swallow
- **Digestive:** Initiates digestion of polysaccharides (salivary amylase)
- **Taste perception:** Dissolving food, contact with chemoreceptors

saliva is a **sensitive indicator of oral health**  
(changes during periodontal disease, caries, candidiasis, etc.)

# Saliva

Product of all salivary glands of the oral cavity

**1.0-1.5 liters / day** (0.3-0.6 ml / min)

**Small glands 10 % / large glands 90 %** (gl. Parotis 25 %, gl. Submand. 60-65 %, gl. Sublingualis 10 %)

Clear or slightly opalescent viscous liquid, **slightly acidic pH: 6.8** (6.5 - 7.2)

It consists of a liquid and solid component:

**Liquid:** water (95 %)

ions - Na +, K +, Cl-, Ca<sup>2+</sup>, Mg<sup>2+</sup>, HCO<sub>3</sub><sup>-</sup>, etc.

proteins: amylase (ptyalin) and maltase, peroxidase, lysozyme, lactoferrin

glycoproteins - mucus (mucin)

immunoglobulins (Ig A, IgG and IgM)

small organic molecules (glucose, amino acids, urea, uric acid, etc.)

**Formed:** removed dead cells of the epithelium of the oral cavity,

salivary bodies (altered lymphocytes) and

non-pathogenic saprophytic bacteria

2 stages of saliva production: **primary saliva (isotonic)** – before passing through striated ducts and **definitive saliva (hypotonic)** - was modified by striated ducts

Location		Name	Type	Size
<b>Lips</b>		gll. labiales sup. et inf.	mixed, pred. mucinous	minor
<b>Cheeks</b>		gll. buccales	mixed, pred. mucinous	minor
		gll. molares (retromolares)	mixed, pred. mucinous	minor
		<b>GL. PAROTIS</b>	serous	<b>MAJOR</b>
<b>Palate</b>	hard	gll. palatinae (glandular zone)	mucinous	minor
	soft	gll. palatinae	mucinous	minor
<b>Tongue</b>	Apex	gl. apicis linguae (Blandini-Nuhni)	mixed, pred. mucinous	<b>minor/ major</b>
	Terminal sulcus	gll. Ebner's (gll. papillae vallatae)	serous	minor
	Base	gll. Weber's (gll. linguales post.)	mucinous	minor
<b>Floor of the mouth</b>		<b>GL. SUBMANDIBULARIS</b>	mixed, pred. serous	<b>MAJOR</b>
		<b>GL. SUBLINGUALIS</b>	mixed, pred. mucinous	<b>MAJOR</b>

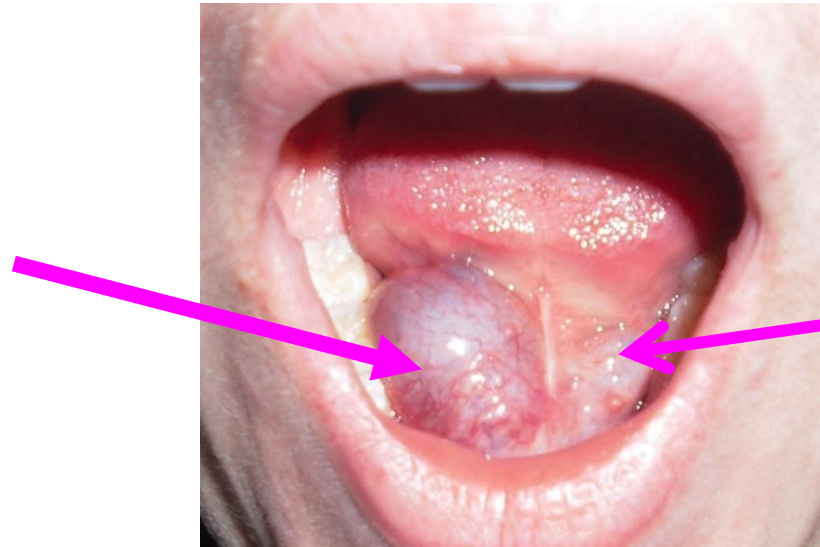
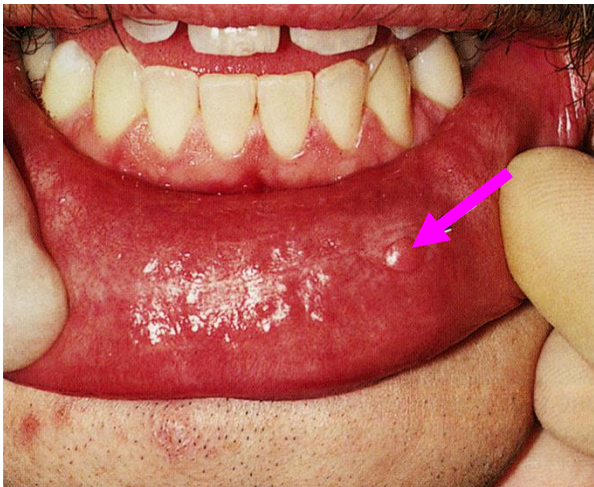
# Pathology (diseases) of the salivary glands

**Sialadenitis (sialoadenitis)** – inflammation of the salivary glands, of bacterial or viral origin

**Sialolithiasis** - saliva in the ducts becomes a viscous to such an extent that the concentrated secretion can secondary calcify - prevents drainage - impermeability of the outlets

Sialolithiasis in small salivary glands - dilatation of secretory compartments (mucocele), and enlargement of glands

In case of obstruction of the ductus submandibularis - large retention cyst located at the base of the oral cavity - **ranula**



# Control of salivary gland function

**Autonomic nervous system:** efferent fibers enter the glands from the parasympathetic and thoracic sympathetic fibers, forming dense network on the surface of the secretory compartments and ducts

Stimulation of **sympathetic** fibers **reduces** saliva production

Stimulation of **parasympathetic** fibers **increases** saliva production

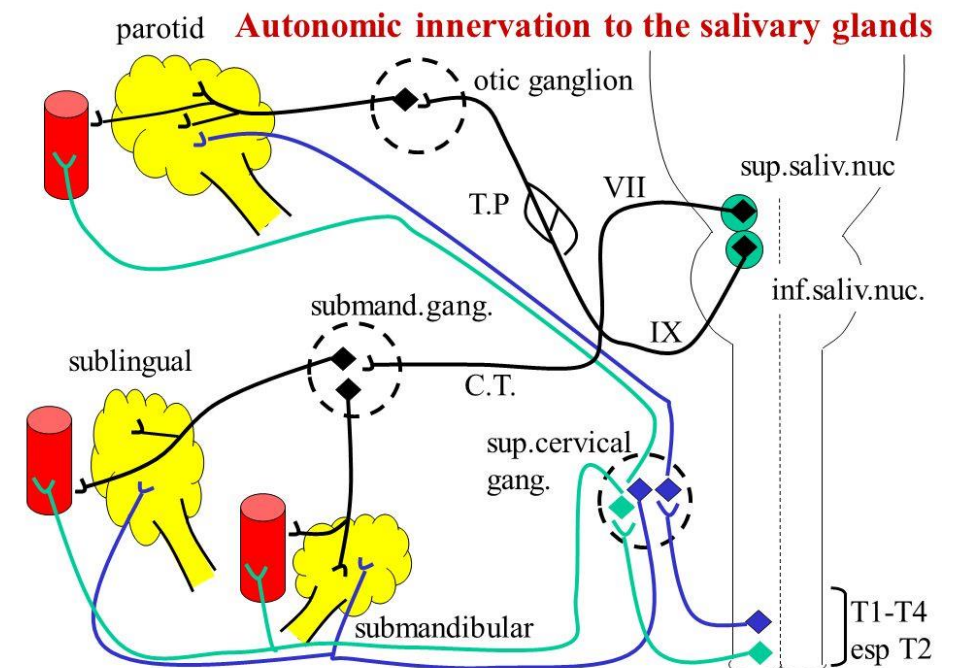
**small salivary glands secrete constantly**

the large salivary glands secrete only on stimulus (e.g. chemical, mechanical, etc.).

**Atrophy of the glandular parenchyma**

atrophy accompanies some systemic diseases, drug-induced, irradiation

Consequence: **hyposalivation - xerostomia ("dry mouth")**



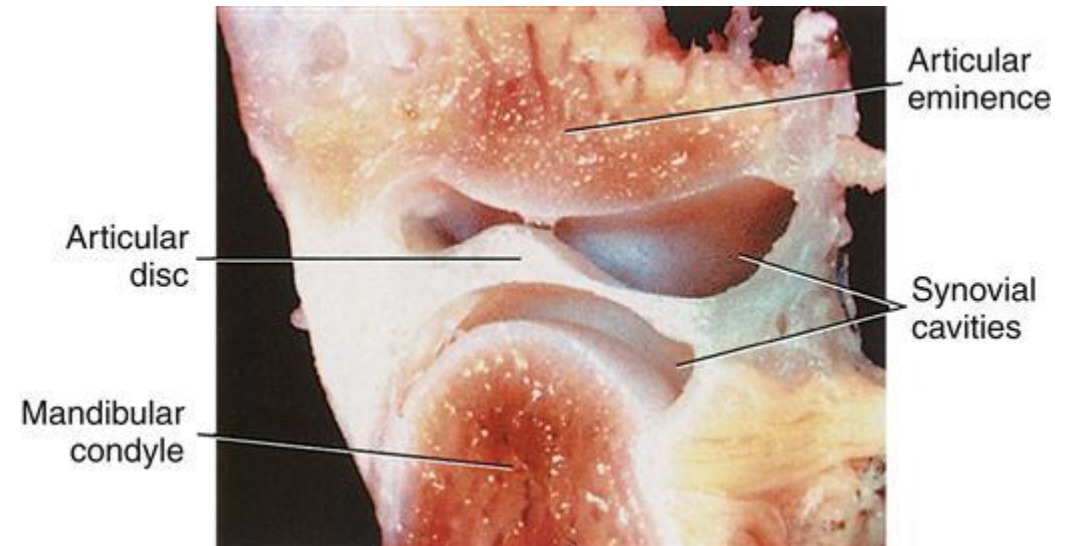
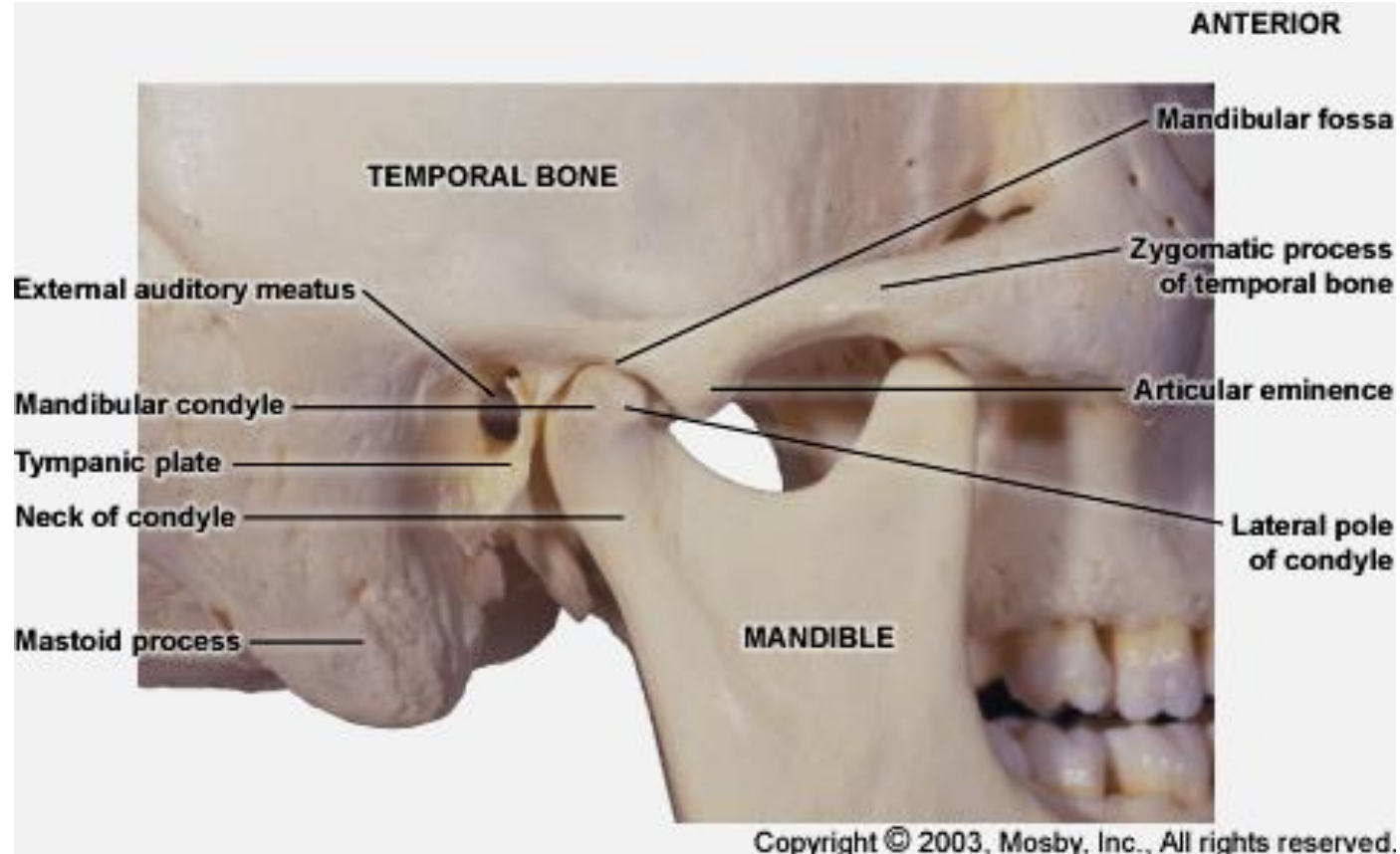
# Temporomandibular joint (*art. temporomandibularis*, TMJ)

The connection between the mandible and the fixed temporal bone of the cranial base

Fossa mandibularis + **Tuberculum art.** of temporal bone

**Caput mandibulae** (condylus mandibulae)

**Discus articularis** – cartilage plate

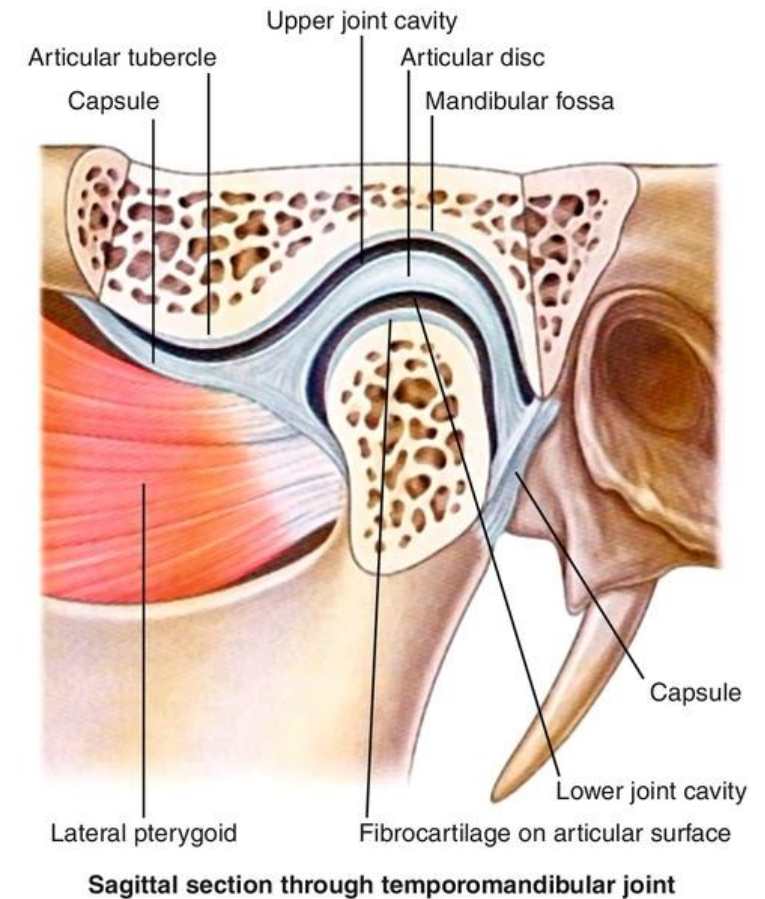
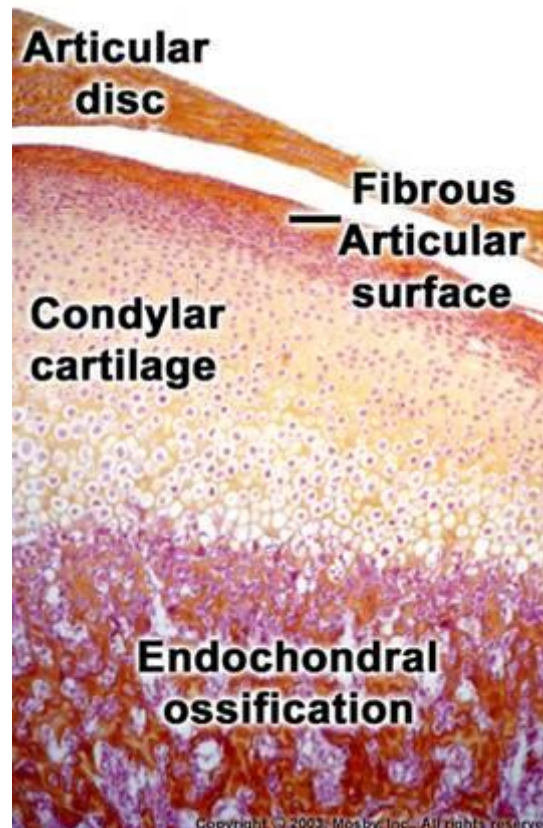
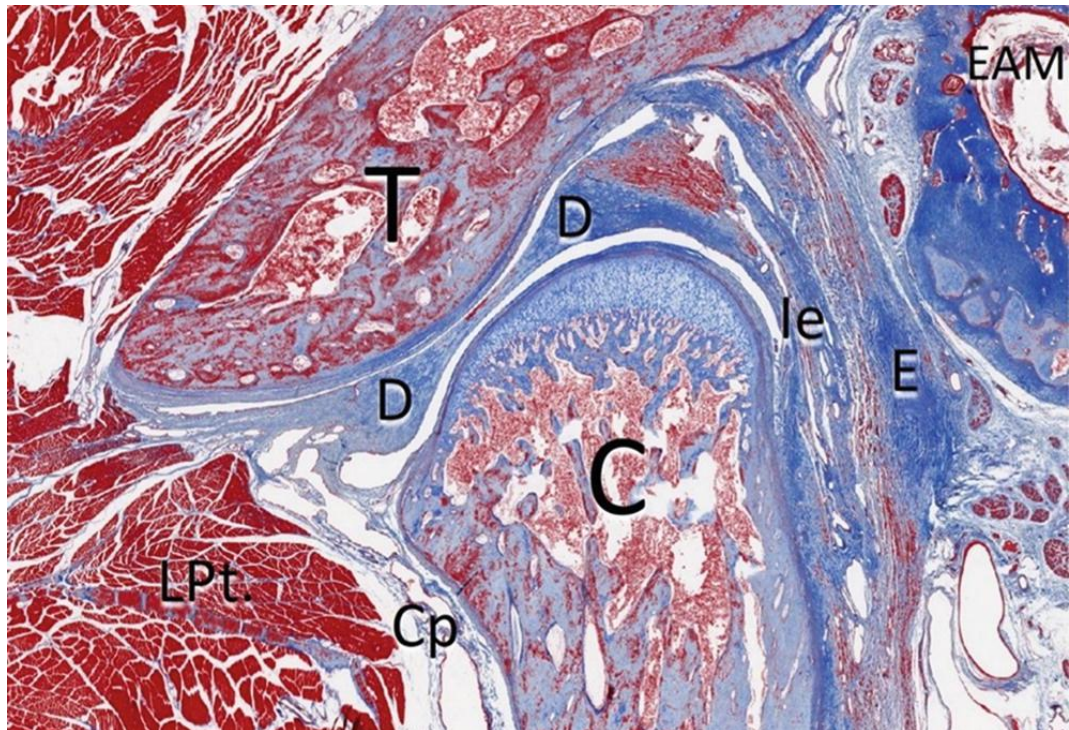


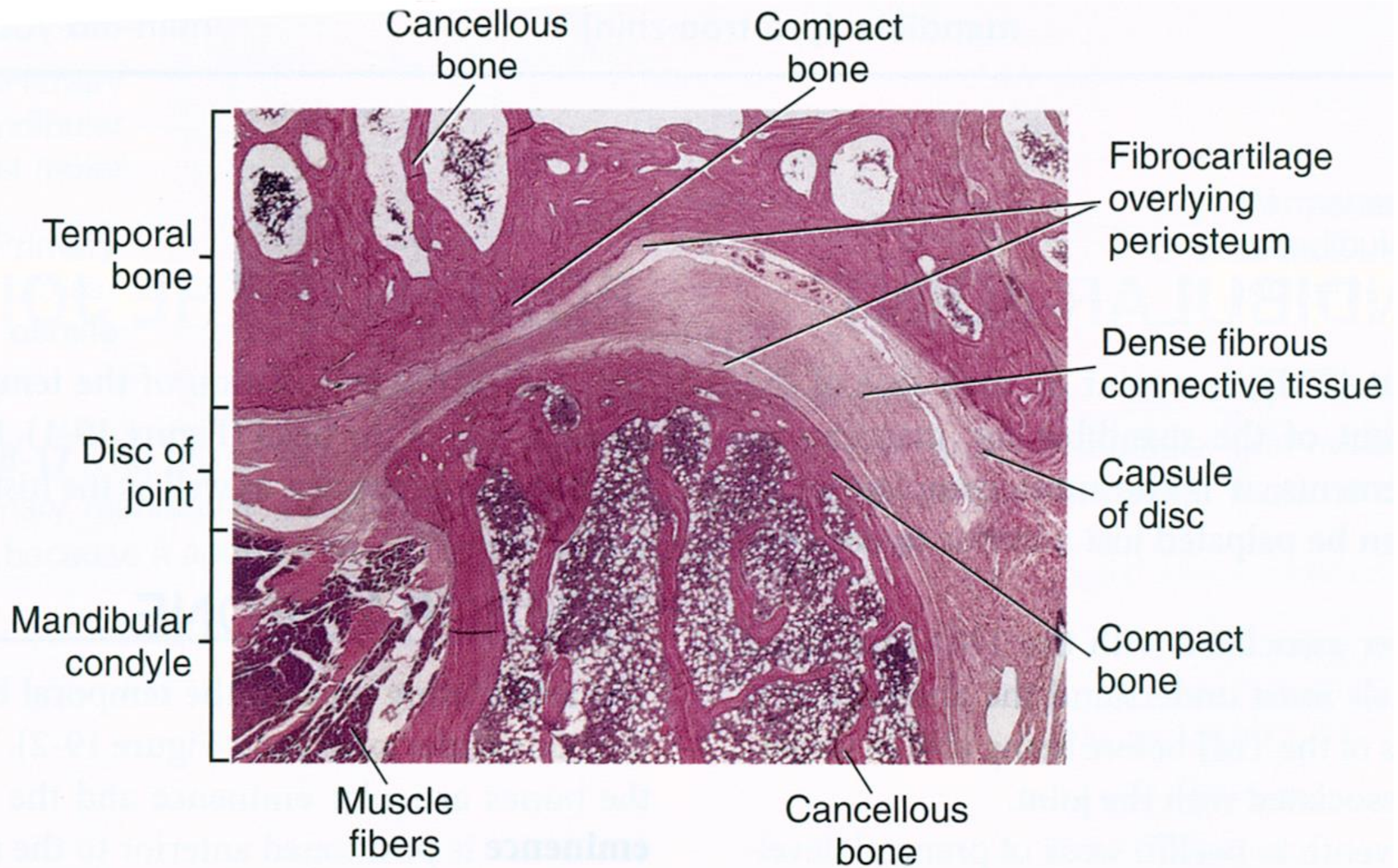
# Microscopic structure of TMJ

Caput mandibulae (condylus mandibulae) – elongated ellipsoidal shape, elongated axis oriented horizontally on the condyle surface - thin plate of compact

Inside is cancellous bone – trabeculae diverge from the center of the condyle radially to the surface

During childhood trabeculae can contain islands of hyaline cartilage







## Fossa mandibularis

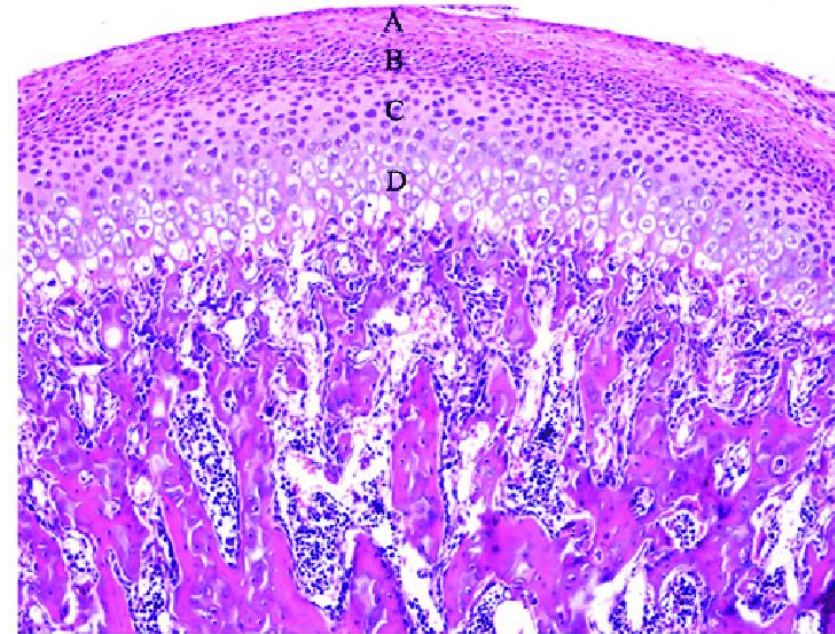
- Plate of compact bone
- The anterior border of mandibular fossa constitutes the **tuberculum articulare** - it has a similar structure to the caput mandibulae

## TMJ surfaces - fibrous cartilage

- It is reinforced on the back of the tuberculum articulare
- Cartilage better resists degeneration and has a good ability to regenerate

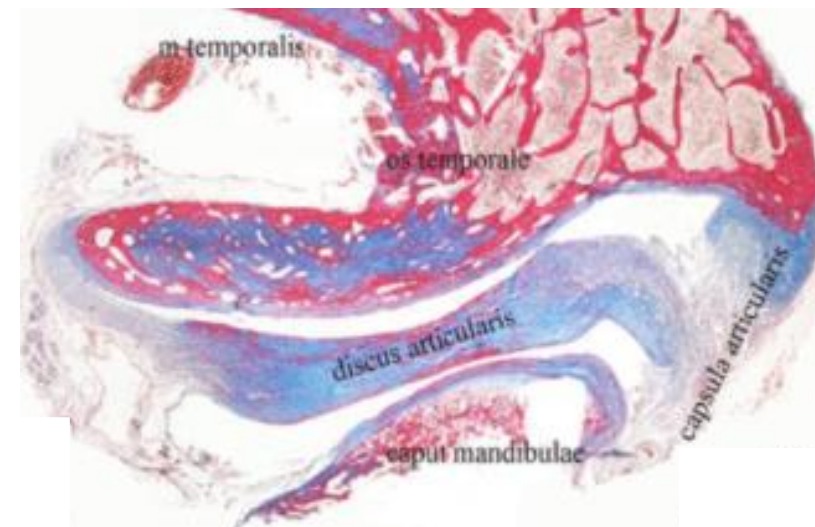
## Discus articularis

- Ligament plate 3 - 4 mm thick
- Its edges are fixed in a joint
- Thinner in the middle - intermediate zone (1 - 1.5 mm)
- **Dense collagen tissue of a irregular type**
- In adulthood, it may contain islets of hyaline cartilage
- Function: Stabilization and absorption of shocks and vibrations



## Mandibular condyle

- A: Articular layer
- B: Proliferative layer
- C: Chondrogenic layer
- D: Hypertrophic layer



# Discus articularis

Complex inner structure

**Dorsal section** is divided in 2 lamellae:

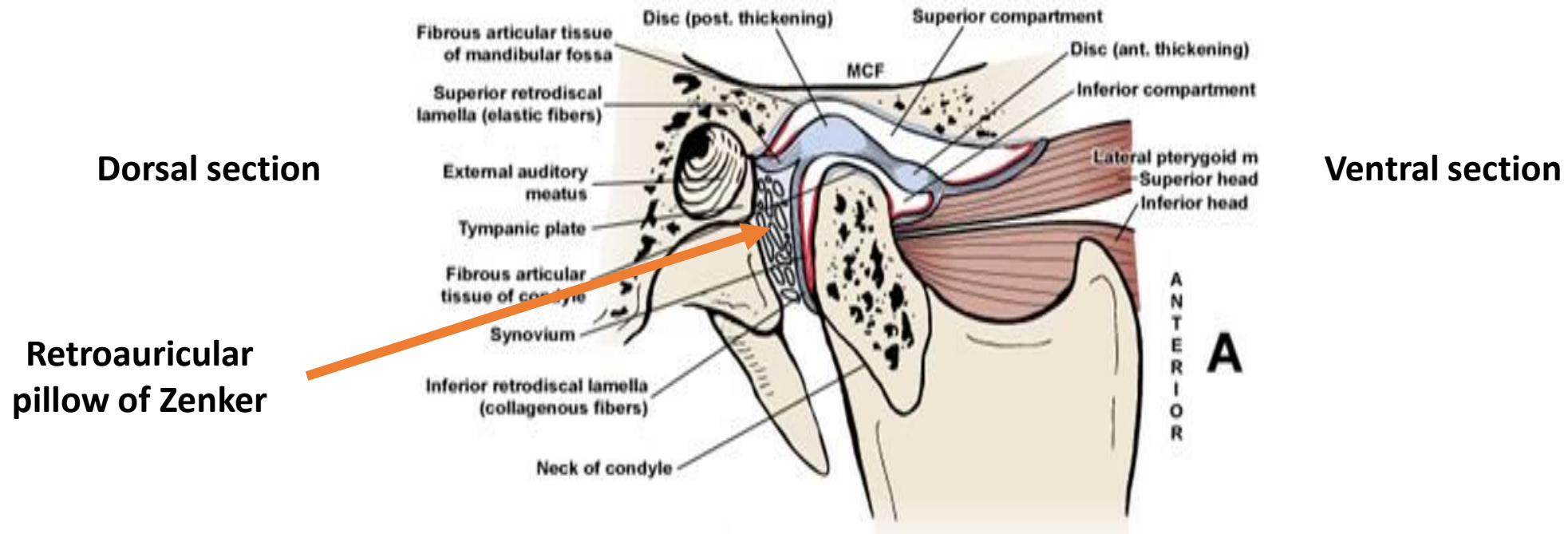
**Superior retrodiscal lamella** of elastic fibers, which are inserted to dorsal edge of the fossa

**Inferior retrodiscal lamella** inserts to the rear edge of condyle

Between lamellae the **retroauricular pillow of Zenker** is present - areolar connective tissue with rich venous plexus (it is continuous by pterygoid plexus - plexus pterygoideus)

**Ventral section** is thickened and ends in places of insertion of lateral pterygoid muscle

Thickened compartments act as stabilizing regions (wedges): stabilize condylus in the fossa



# Temporomandibular joint (art. temporomandibularis, TMJ)

**Joint capsule** - free, especially on the medial side externally supported by the lateral and medial ligaments

2 layers: stratum fibrosum and stratum synoviale

**Articular cavity** contains synovial fluid and is divided in two sections

upper - **discotemporal**

lower - **discomandibular**

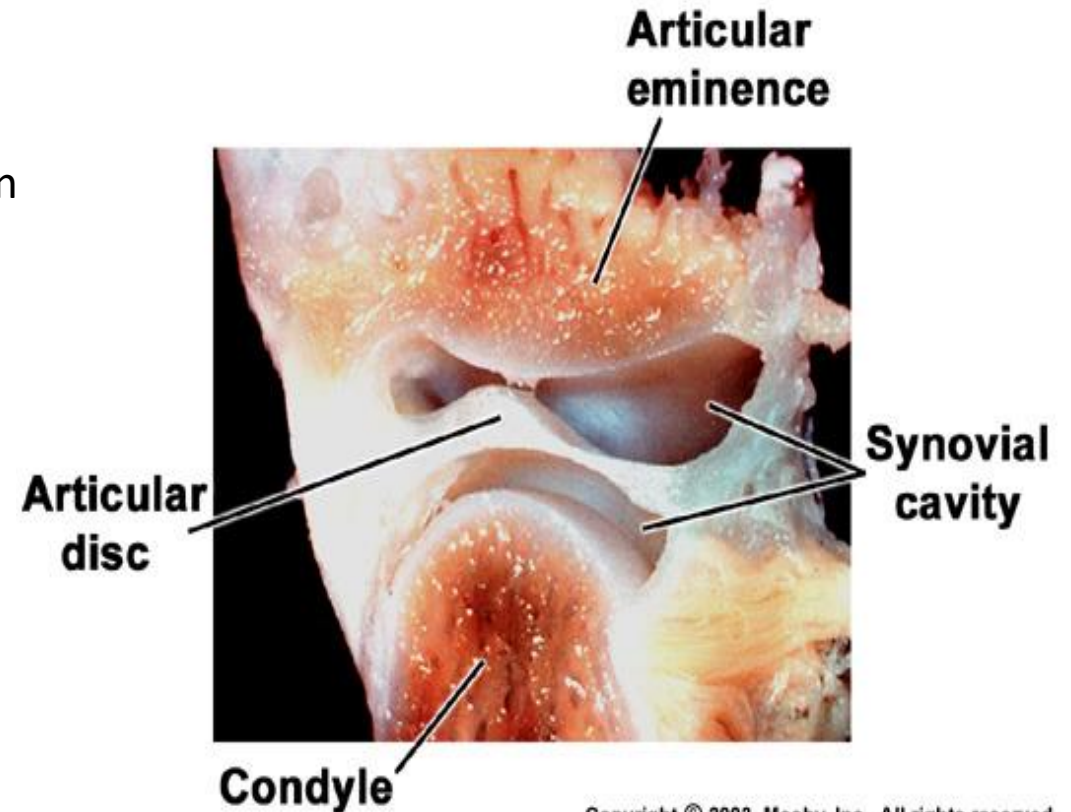
## Joint biomechanics:

TMJ (articular disc) movements:

[https://www.youtube.com/watch?v=mB468Jh9aAY&ab\\_channel=AlilaMedicalMedia](https://www.youtube.com/watch?v=mB468Jh9aAY&ab_channel=AlilaMedicalMedia)

MRI:

[https://www.youtube.com/watch?v=ZnNgMnSfAaws&ab\\_channel=SpringerVideos](https://www.youtube.com/watch?v=ZnNgMnSfAaws&ab_channel=SpringerVideos)



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# Age changes in TMJ

Final form takes between 20 - 25 years of age

**Adaptability of TMJ** – the ability to adapt to new functional requirements

Very good in cartilage

Poor in discus articularis

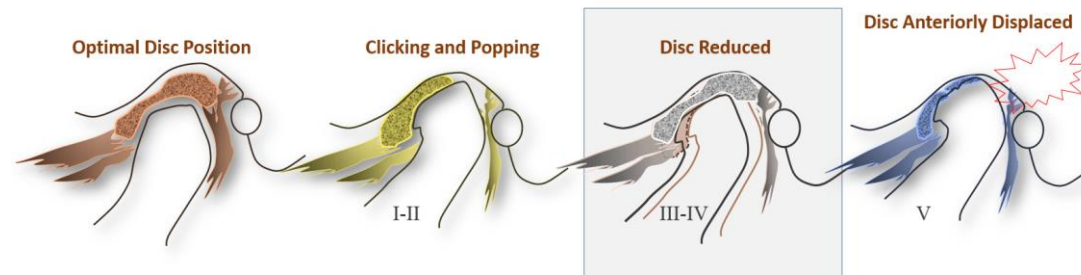
a) Degenerative changes in the discus articularis, rupture or disintegration

b) After the 5th decade perforation of the central disc part and connection of both sections of the articular cavity can occur

TMJ clicking:

[https://www.youtube.com/watch?v=Opgz2EUyI0w&ab\\_channel=WellingtonVillageOrthodonticsOttawa](https://www.youtube.com/watch?v=Opgz2EUyI0w&ab_channel=WellingtonVillageOrthodonticsOttawa)

Staging of Internal Derangement of TMJ



Condyles and positioning can change with age and time.