HISTOLOGY

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- the study of the microscopic structure of biological material and the ways in which individual components are structurally and functionally related

or

- the study of tissues, including their role in the body, their anatomy, their interaction with body systems and the ways they are affected by disease.

Histology can be considered as the study of anatomy and physiology at the microscopic level.

Why is the Study of Histology Important

or

Usefulness of Histology

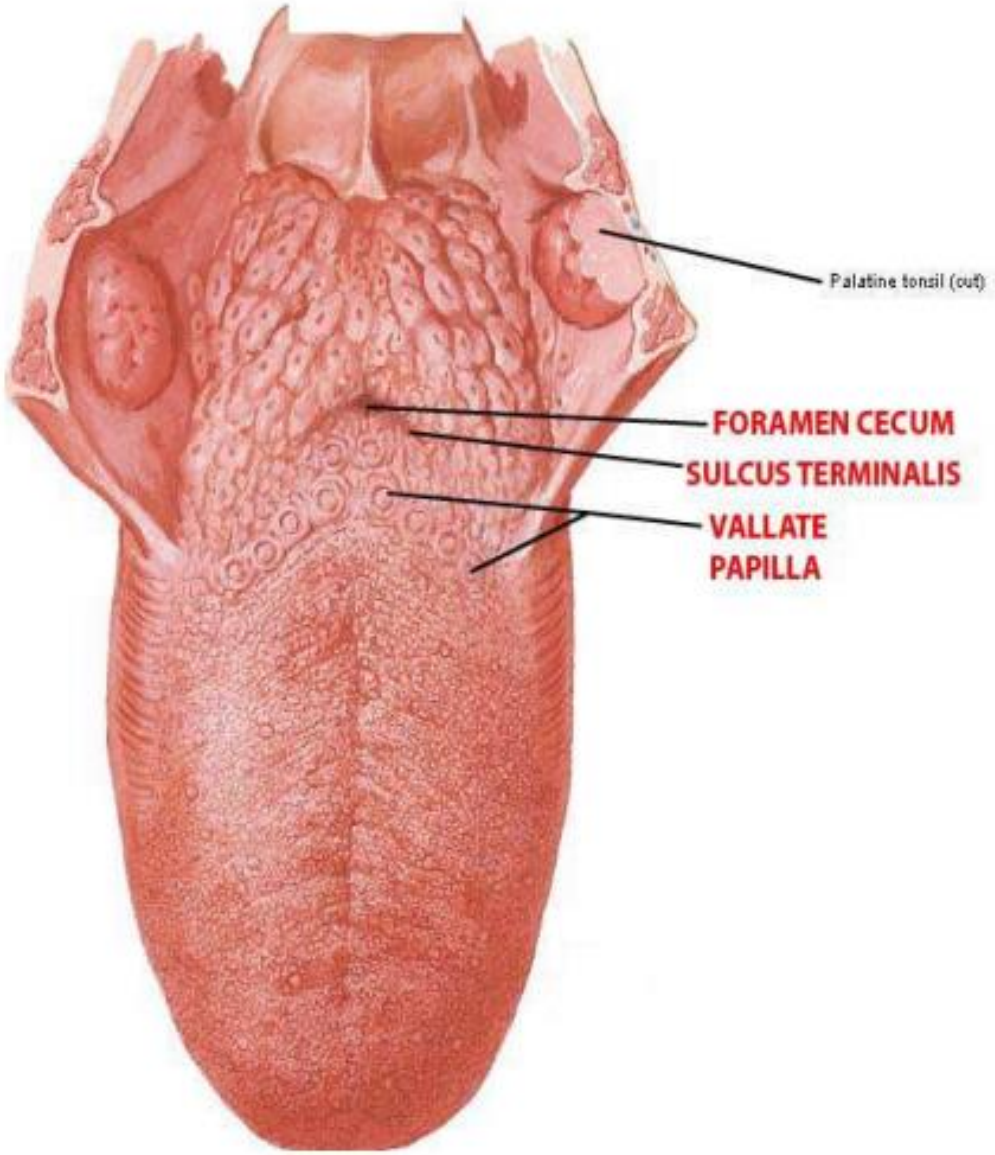
- **Tissues as Building Blocks**
- **Understanding Development and Evolution**
- **Role in Disease**
- **Preparation for Laboratory Work**
- **Purpose of Anatomy and Physiology**
- **Structure Reveals Function**
- **Pathophysiology and Pathology**
- **Inflammation**

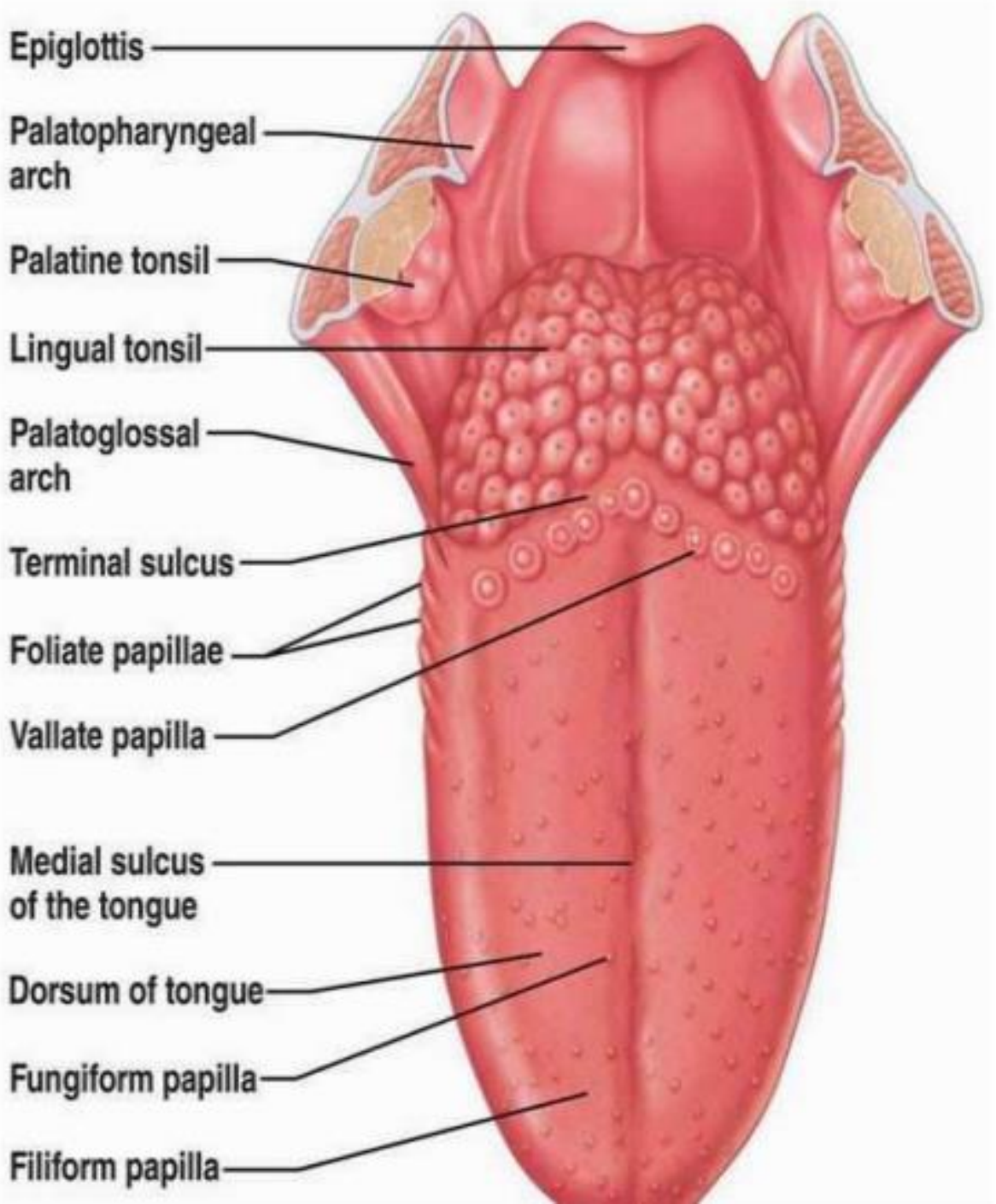
Histology of the Tongue

The subdivisions of the tongue are based on embryologic origins:

- Anterior two-thirds (body)
- posterior one-third (root)

❖ They are separated by the ***sulcus terminalis.***




Epiglottis
Palatopharyngeal arch
Palatine tonsil
Lingual tonsil
Palatoglossal arch
Terminal sulcus
Foliate papillae
Vallate papilla
Medial sulcus of the tongue
Dorsum of tongue
Fungiform papilla
Filiform papilla

Mucosa

- ***stratified squamous*** epithelium on both surfaces.
- The dorsal surface forms ***papillae***

Submucosa

- Has ***minor salivary*** glands that secrete both mucous and serous secretions.

Muscles

- Core of **skeletal *striated*** muscles running in all directions

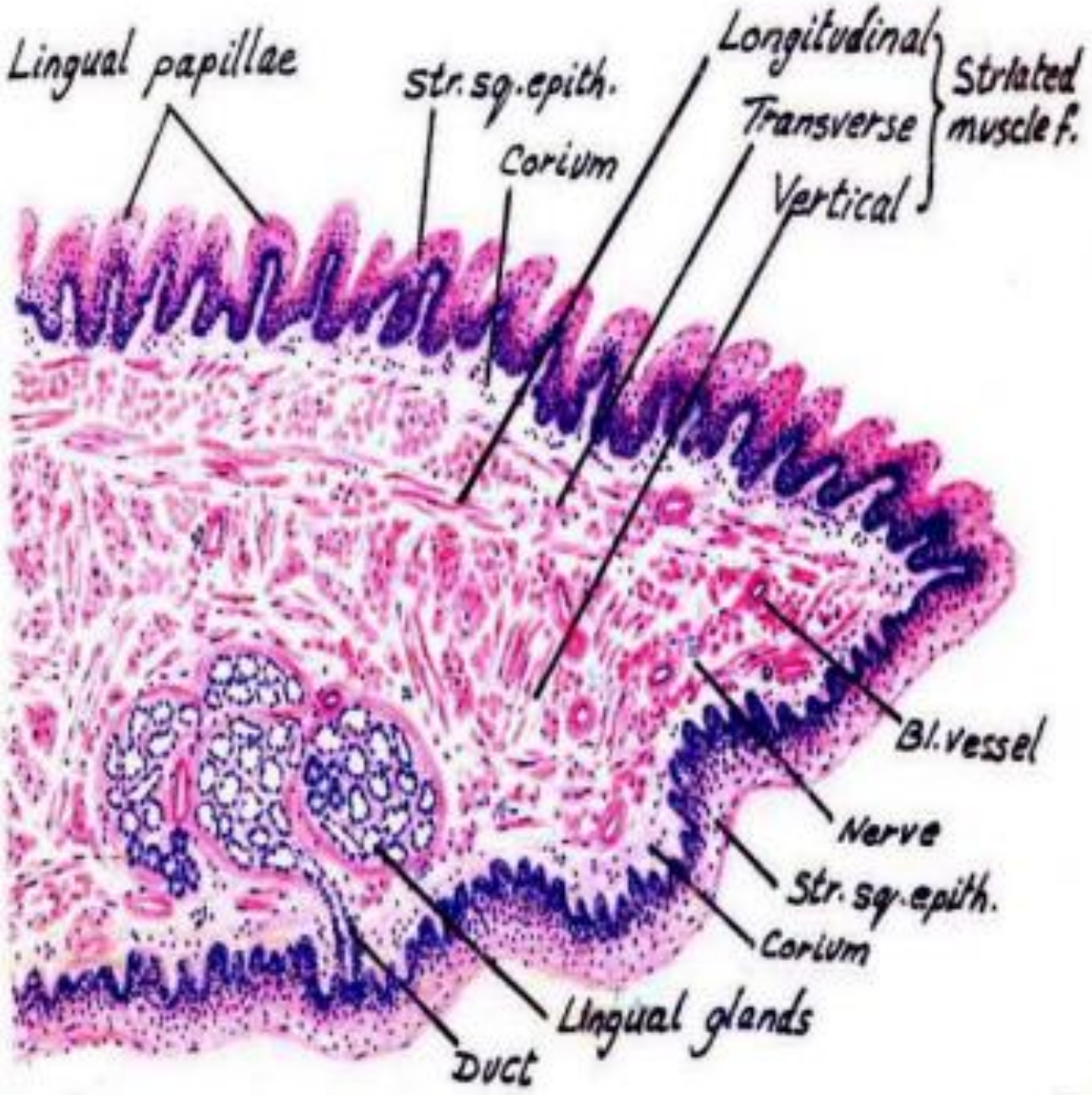
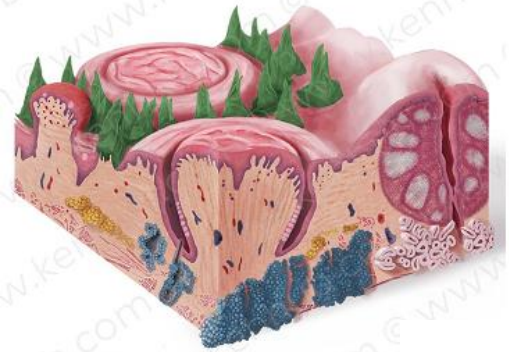
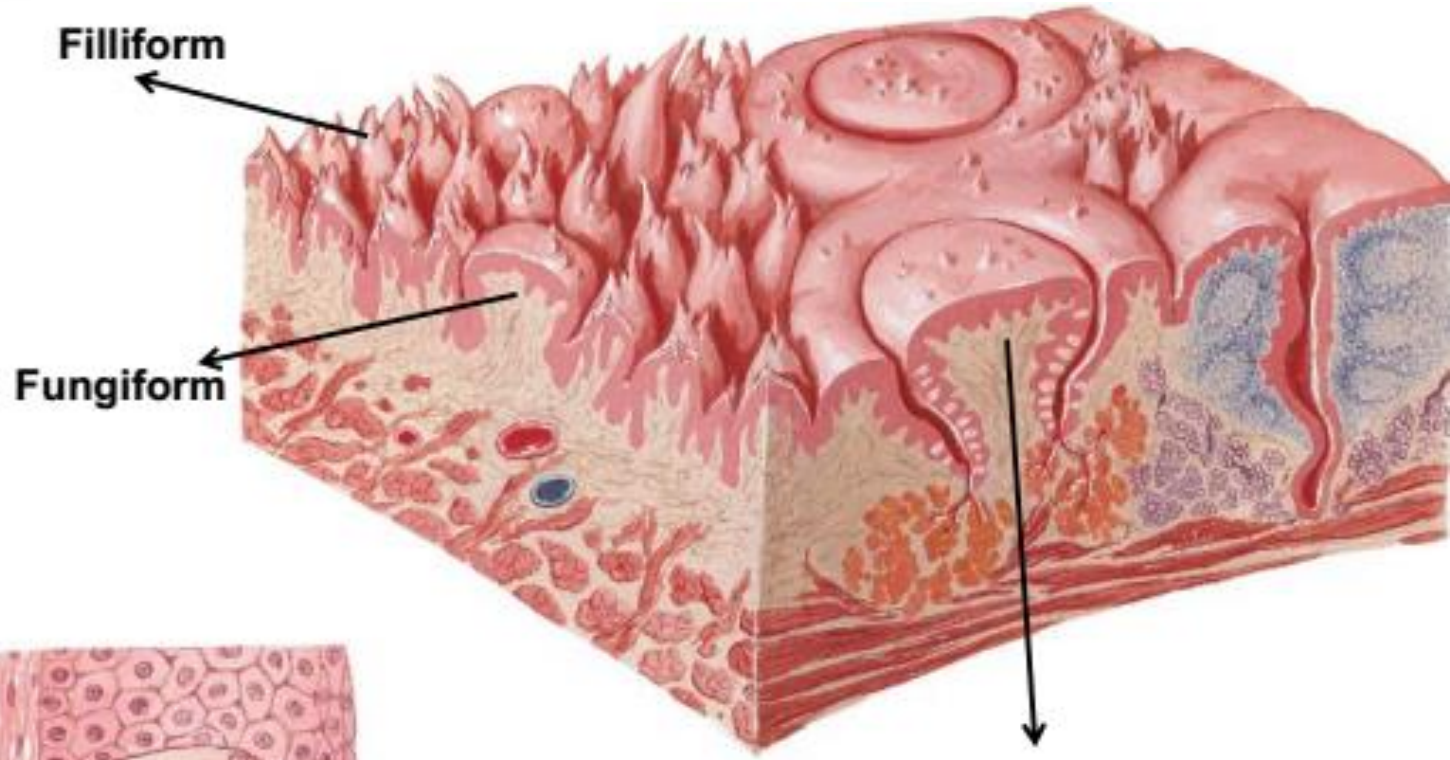
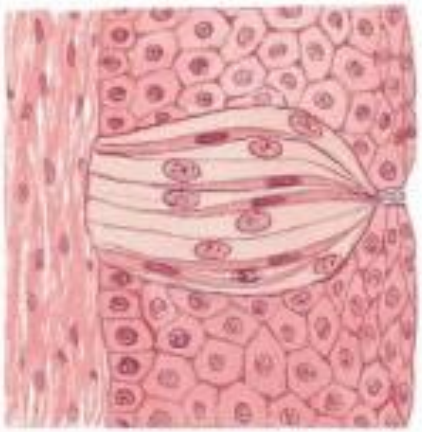


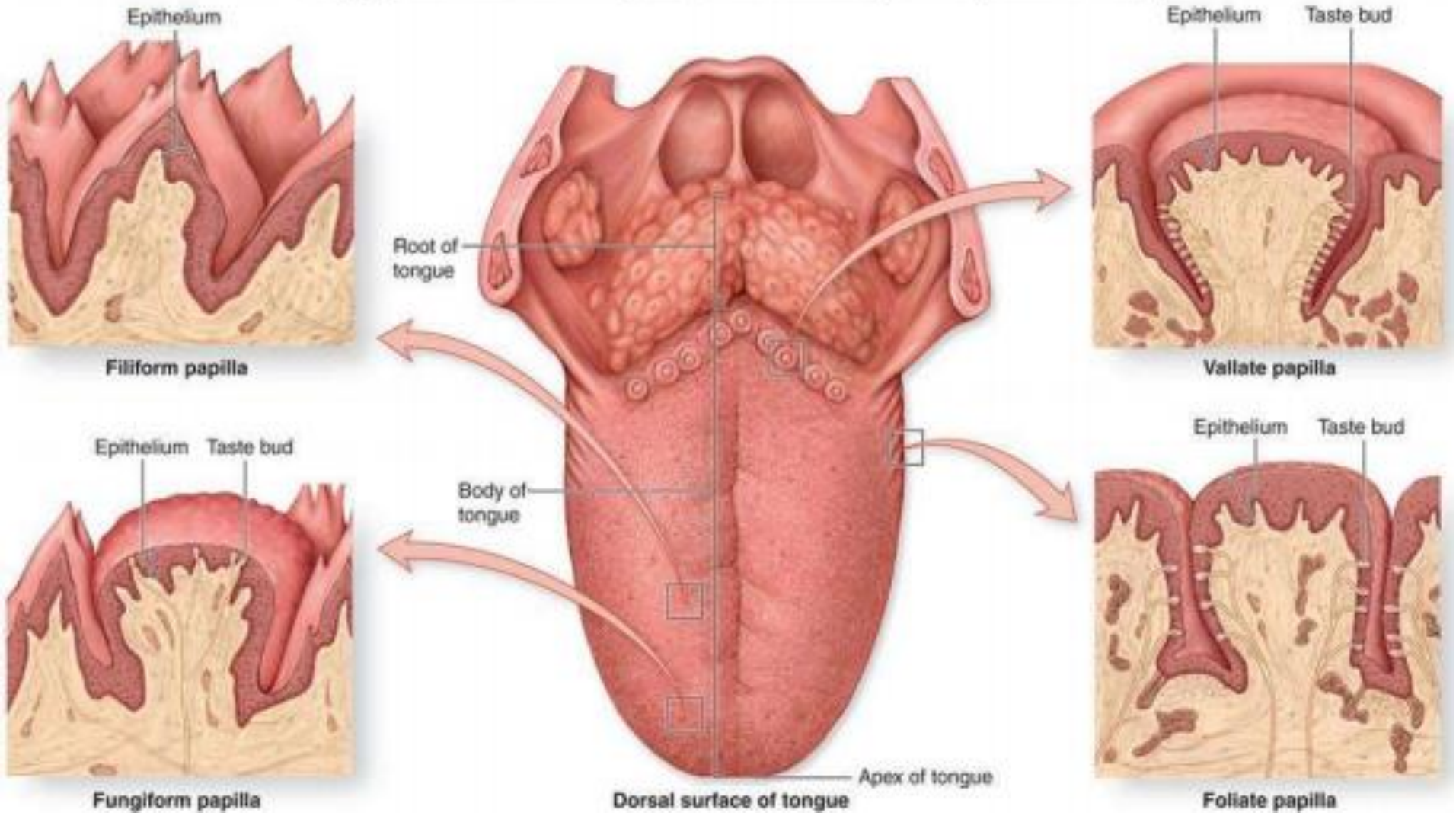
Fig. 3 Histology of the Tongue: Pearson Education 2013

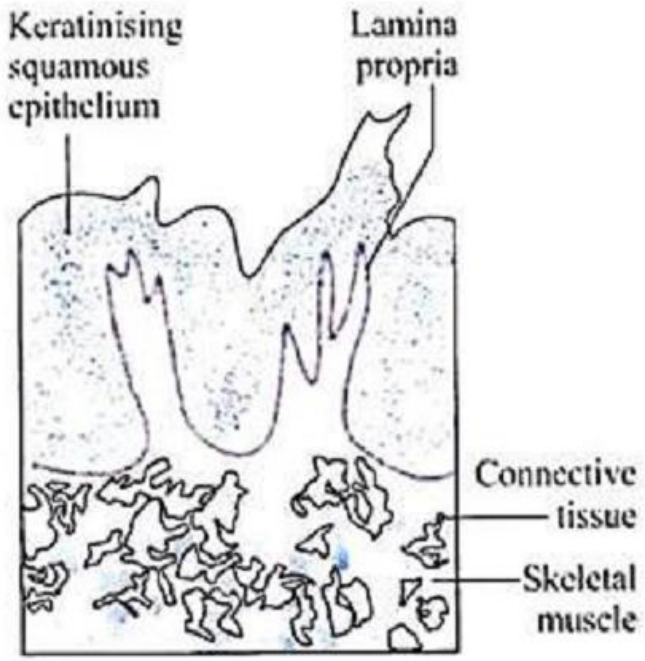



Filliform
Fungiform
Circumvallate

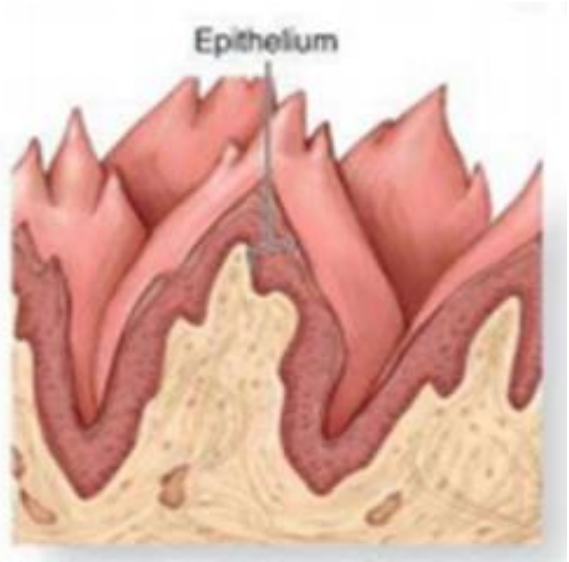


Lingual Papillae

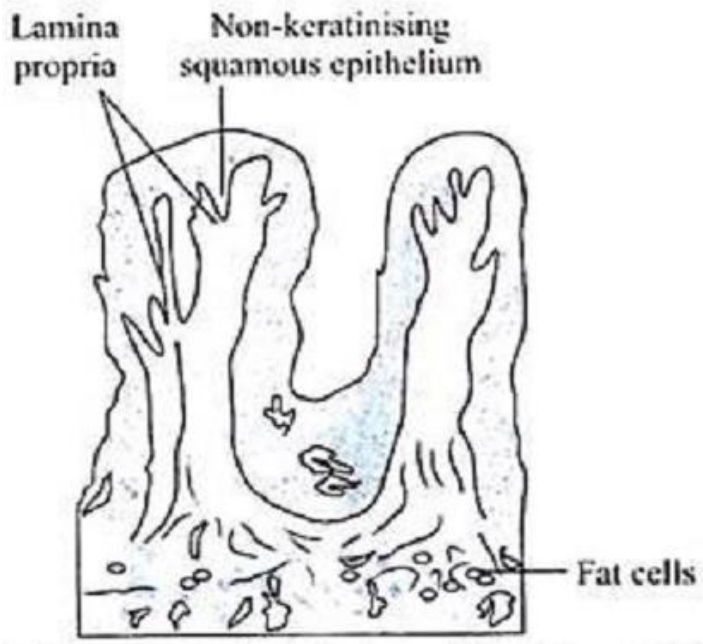


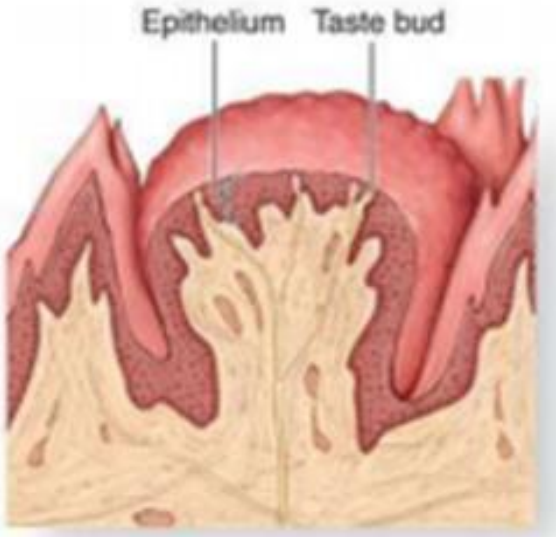


FILIFORM PAPILLAE



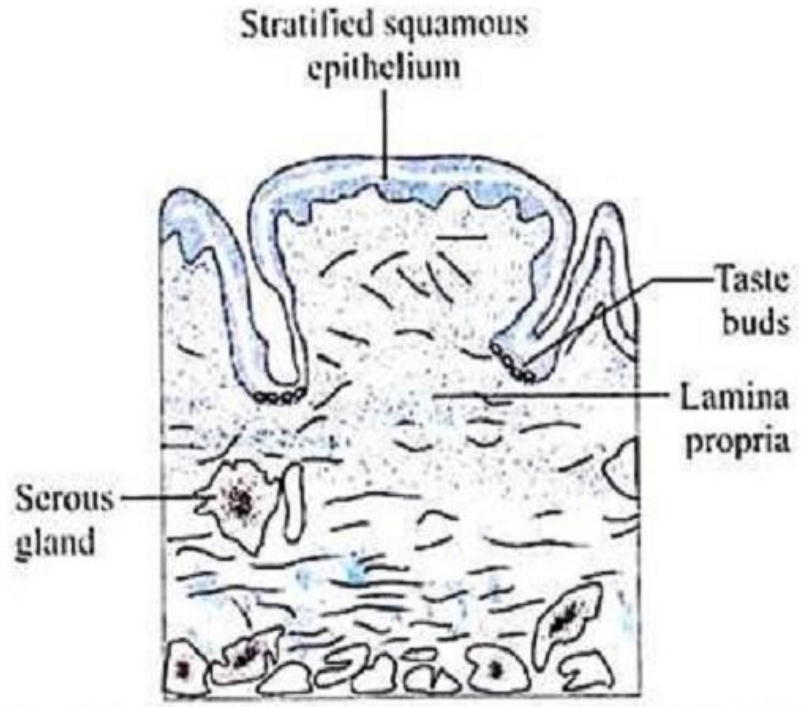
- Most numerous type.
- Entire **dorsal surface** of tongue.
- **Lined** – stratified squamous keratinized epithelium
- No taste buds
- Increase the friction between tongue & food

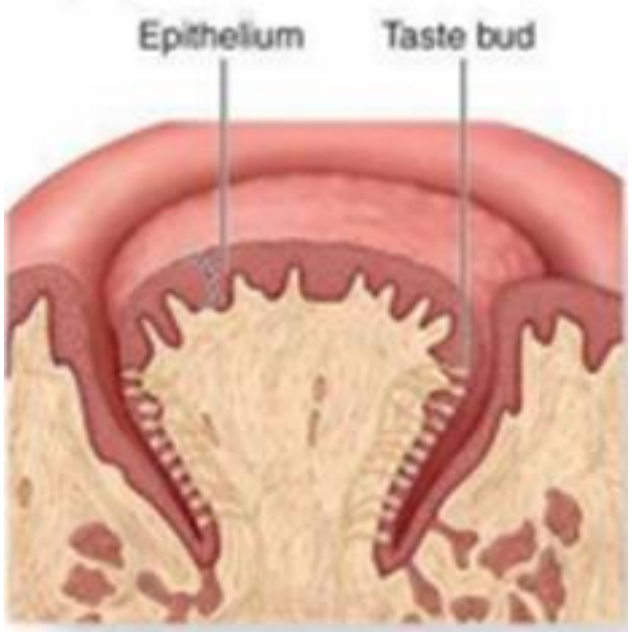




FUNGIFORM PAPILLAE

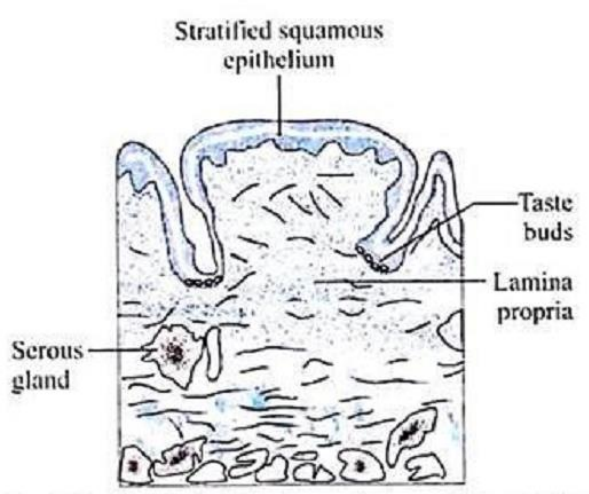
- **Rounded reddish elevations** – high vascular connective tissue core
- **Looks like fungi** – narrow base & broad top
- Scattered all over **anterior 2/3rd of tongue** most numerous in the **tip of tongue**
- Contains **taste buds** on surface.



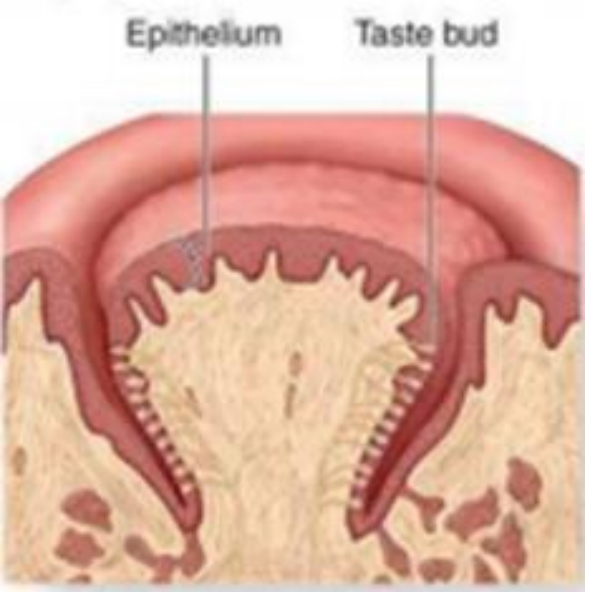


CIRCUMVALLET PAPILLAE

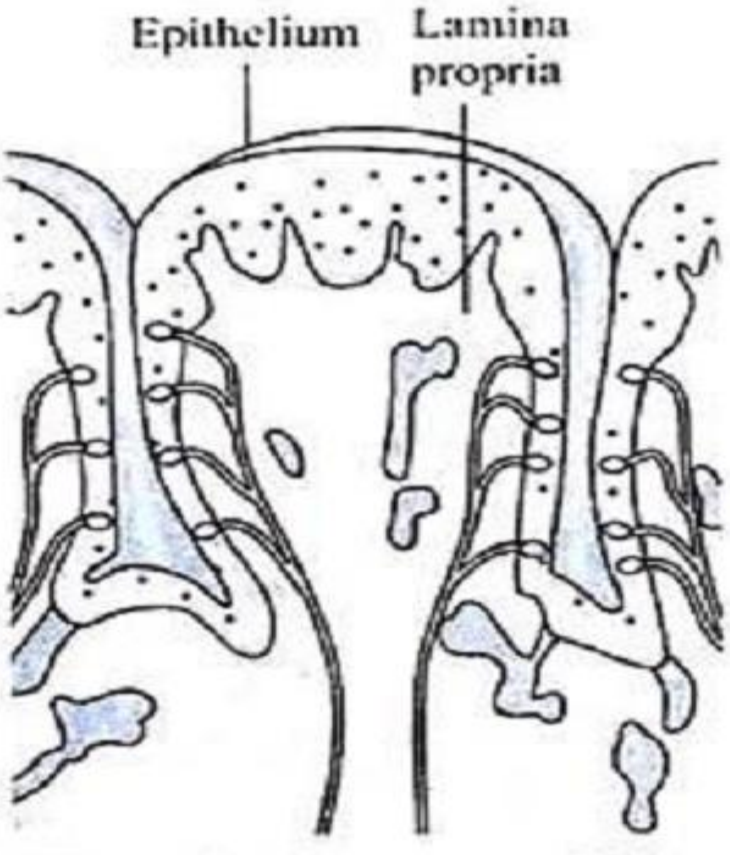
- **Circumvallate papillae** are the largest and least common type 8 to 12 in number.
- **Arranged in a single row** – infront & parallel to sulcus terminalis
- Each papillae is surrounded by a circular sulcus/ groove (trench) called vellum which separates rest of the part

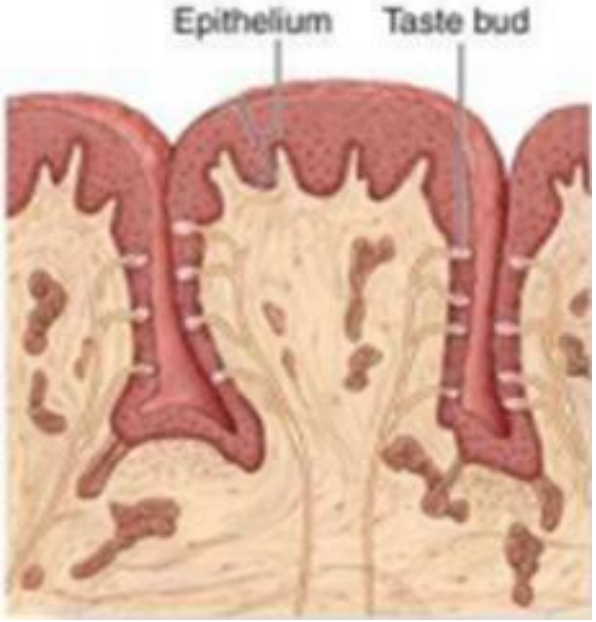


- These papillae has broad circular top and narrow base.
- Lined by stratified squamous non-keratinized epithelium
- Base of each papillae contains circular and longitudinal muscle fibers



- It also presents numerous of serous glands seen near the base and groove of papillae called serous glands of **von ebner**
- Serous secretions helps in appreciating taste of food by dissolving food particles in it
- Epithelium lining the walls of the sulcus shows numerous of taste buds

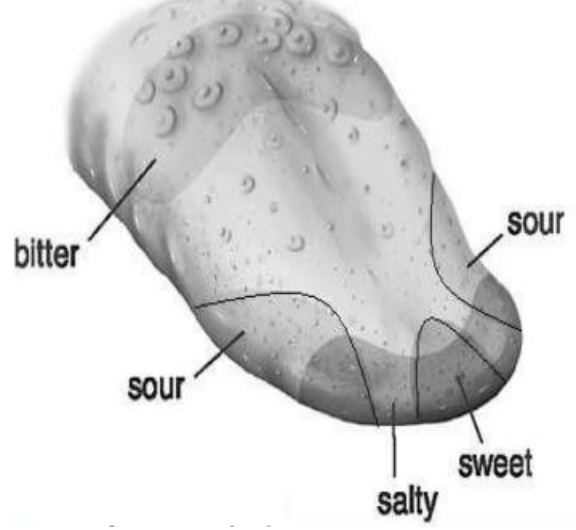




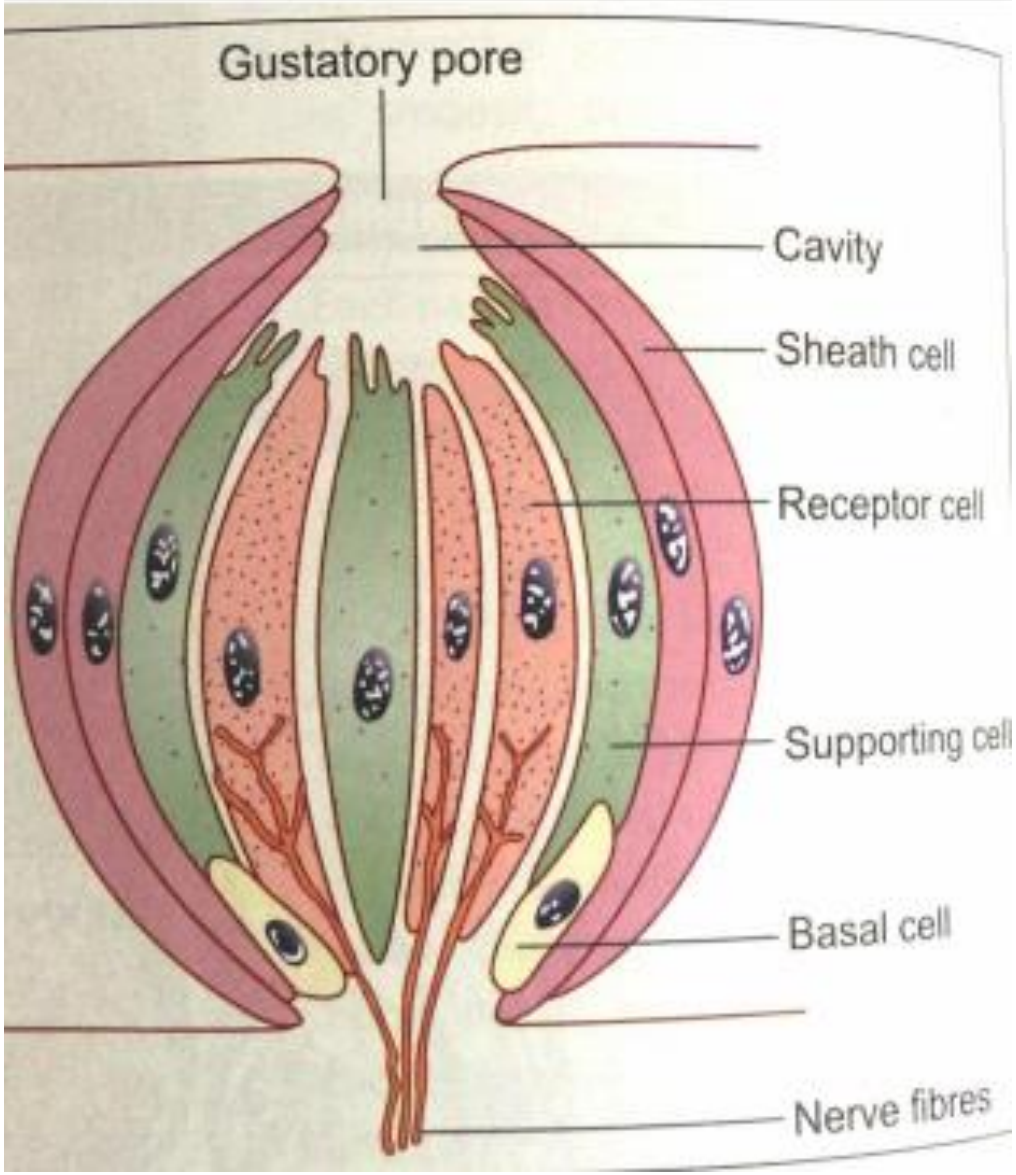
Foliate papillae

- **Shape** – leaf like
- Rudimentary in humans
- It is functional in lower animals such has cows and buffaloes.

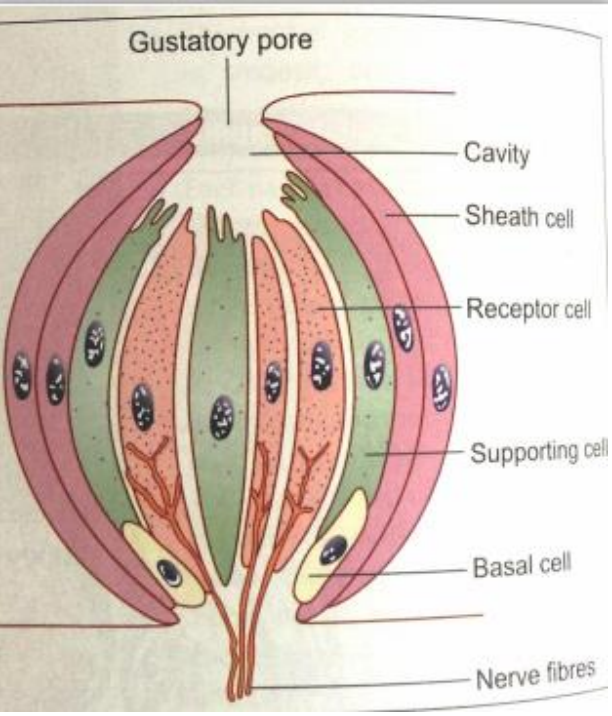
Taste bud



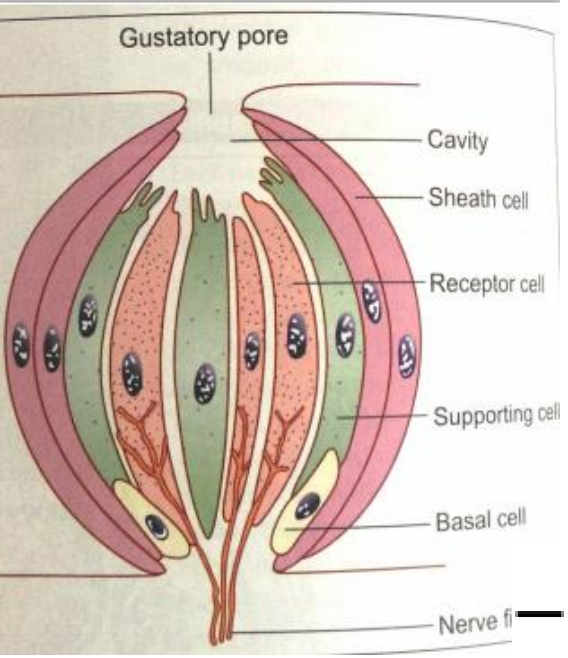
- It is a center for appreciation of taste
- Located in papillae of tongue
- In circumvallate it is located in groove
- In fungiform on surface or on its lateral part
- Filiform taste buds are absent
- Shape of taste bud is barrel.



- Made up modified epithelial cells
- Each bud has cavity which opens on the surface through gustatory pore.
- There are 5 types of cells

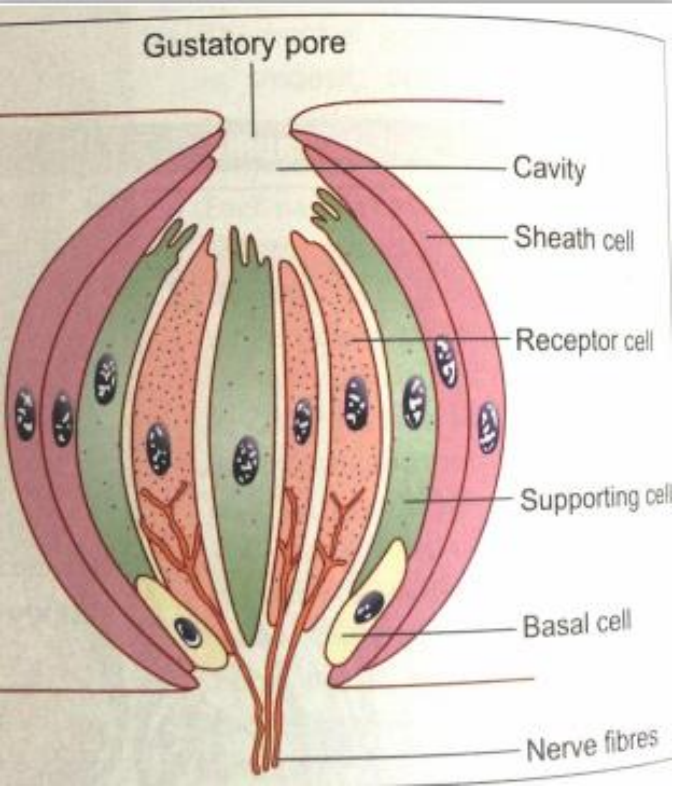


- There are **5 types** of cells
  - **Type I**
    - Supportive cells
    - Long elongated epithelial cells
    - Darkly stained
    - Upper pole bears fine microvilli
    - Lower pole is close to basal cells



Type II & III

- Gustatory cells or receptor cells
- It is the bipolar neuroepithelial cells
- Lightly stained
- Upper pole bears microvilli
- Lower pole is associated to sensory nerve fibers



– **Type IV**

- Basal cells or stem cells
- These pyramidal cells
- It is present close to the basement membrane of the epithelium

– **Type V**

- These cells forms the sheath or boundary

Muscles:

- voluntary and consist of cross-striated muscular fibres.

Glands: small and scattered.

They are of three types:

1. Mucous glands.
2. Serous glands.
3. Lymph nodes (glands) - very prominent at the posterior part **lingual tonsil**

Nerve Supply:

The sensation of taste is carried by

- chorda tympanic branch of the facial nerve (**anterior two-thirds of tongue**)
- glossopharyngeal nerve (**posterior one-third**)

The general sensations of touch, pain, temperature, pressure...etc.,

- trigeminal nerve

The muscles

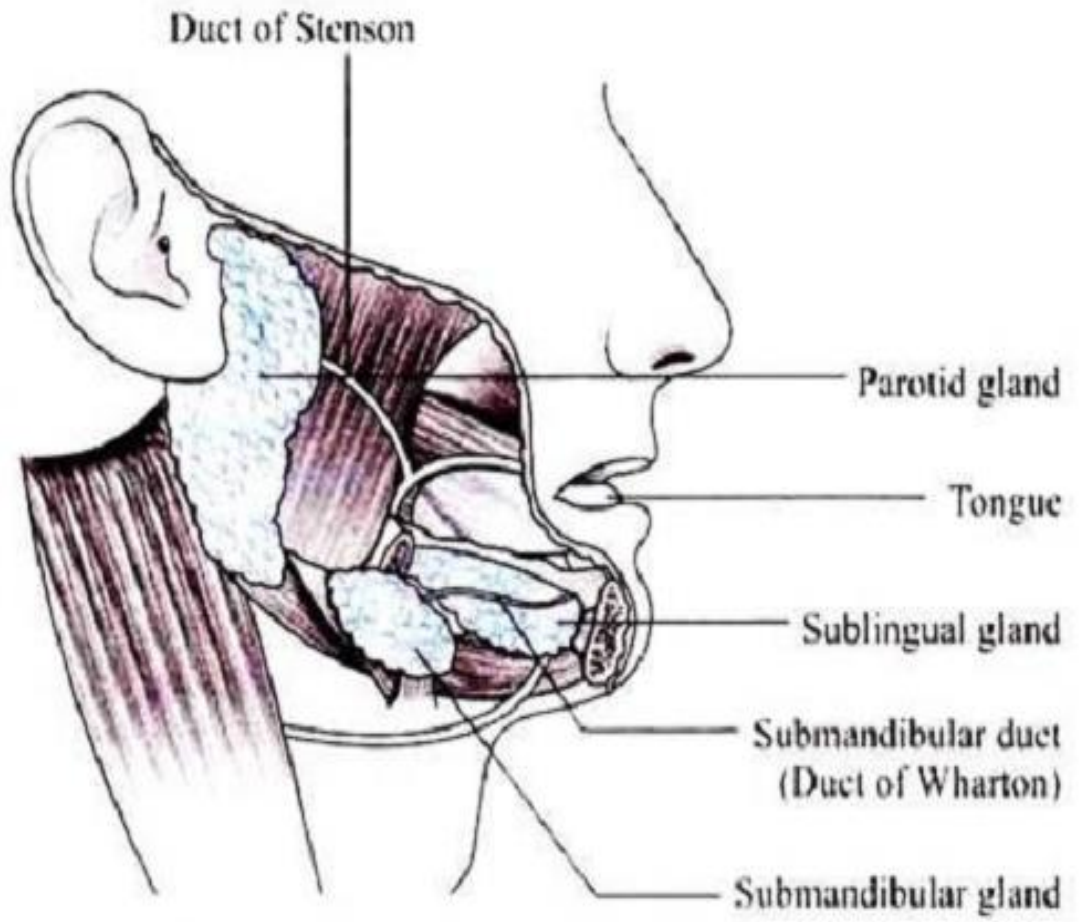
- hypoglossal nerve.

Salivary Glands

The parotid gland opens by **Stensen** duct.

The sub-maxillary gland opens by **Wharton's** duct.

The sublingual gland opens by **Rivinus** ducts.



- Salivary glands are compound tubulo-alveolar glands (racemose)

- Secretory elements (end pieces/portio terminalis)

↓ may be

rounded (acini)

pear shaped (alveoli)

tubular

mixture (tubulo-acinar or tubulo-alveolar)

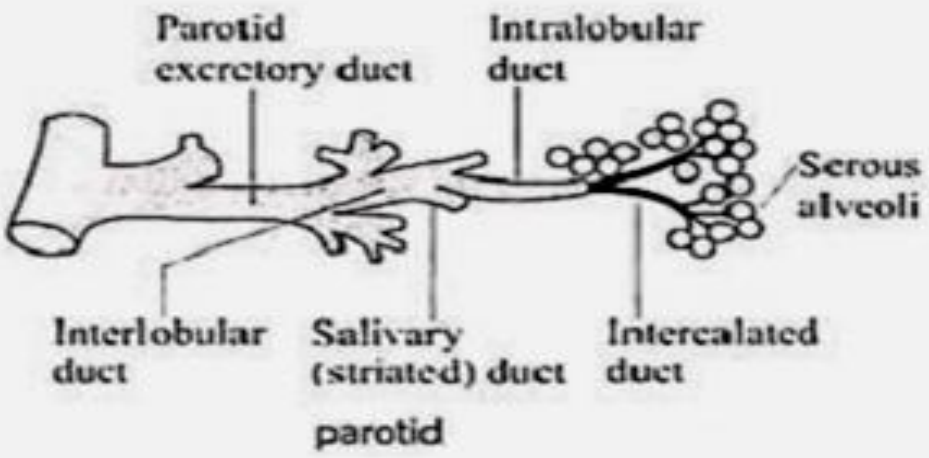
secretory element

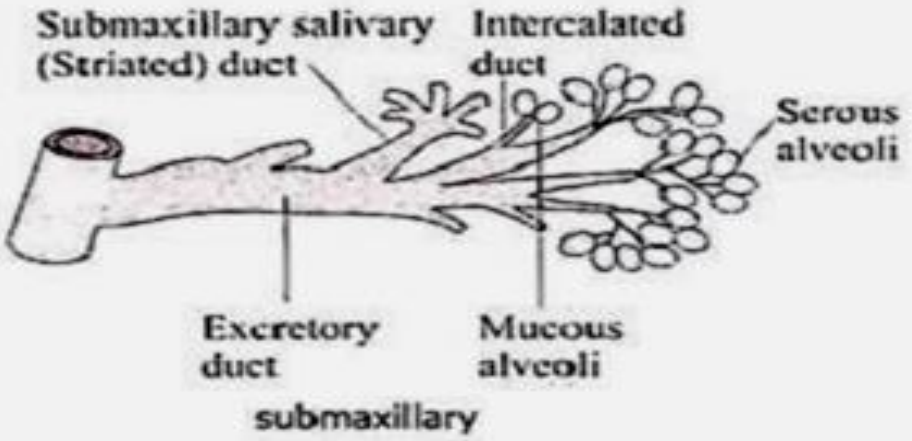
↓ lead into

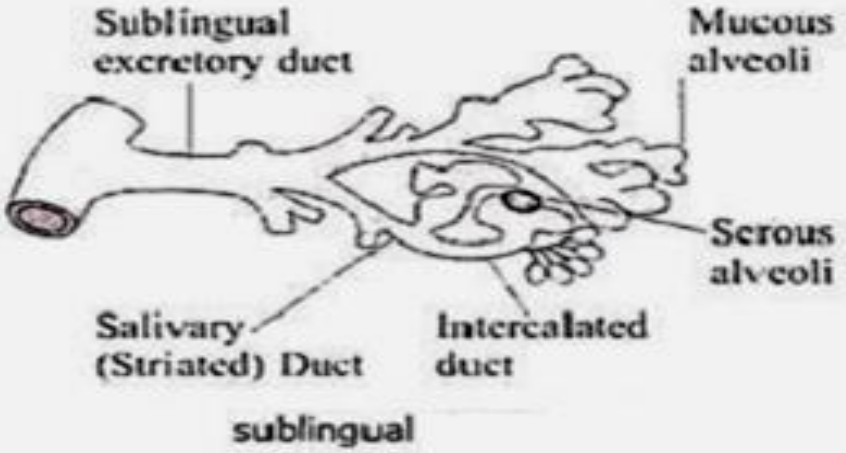
Series of ducts

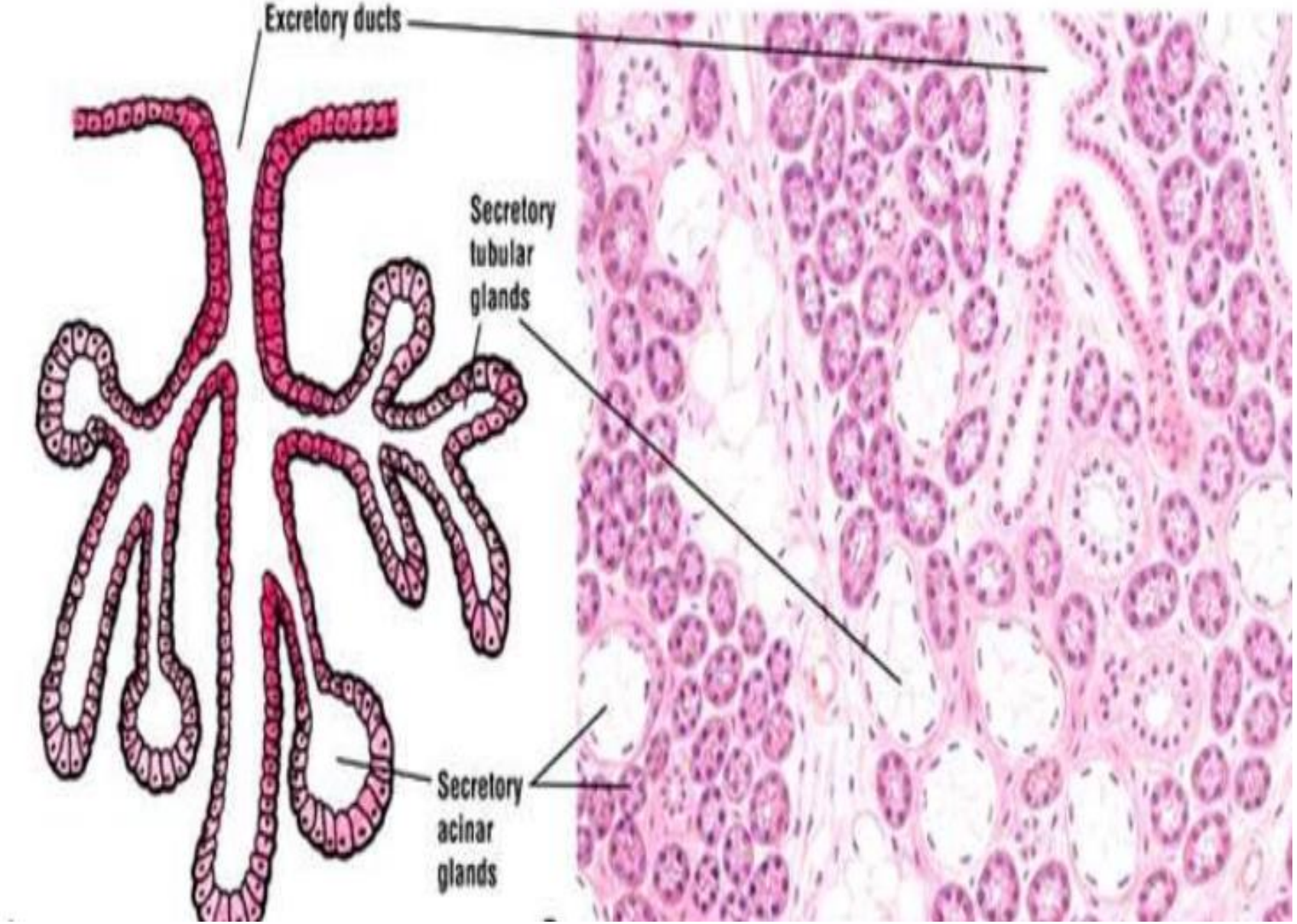
↓ through

Secretions are poured into the oral cavity







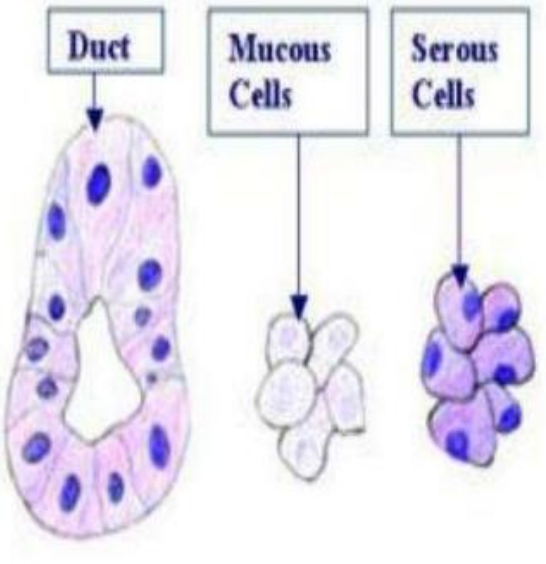

Excretory ducts
Secretory tubular glands
Secretory acinar glands

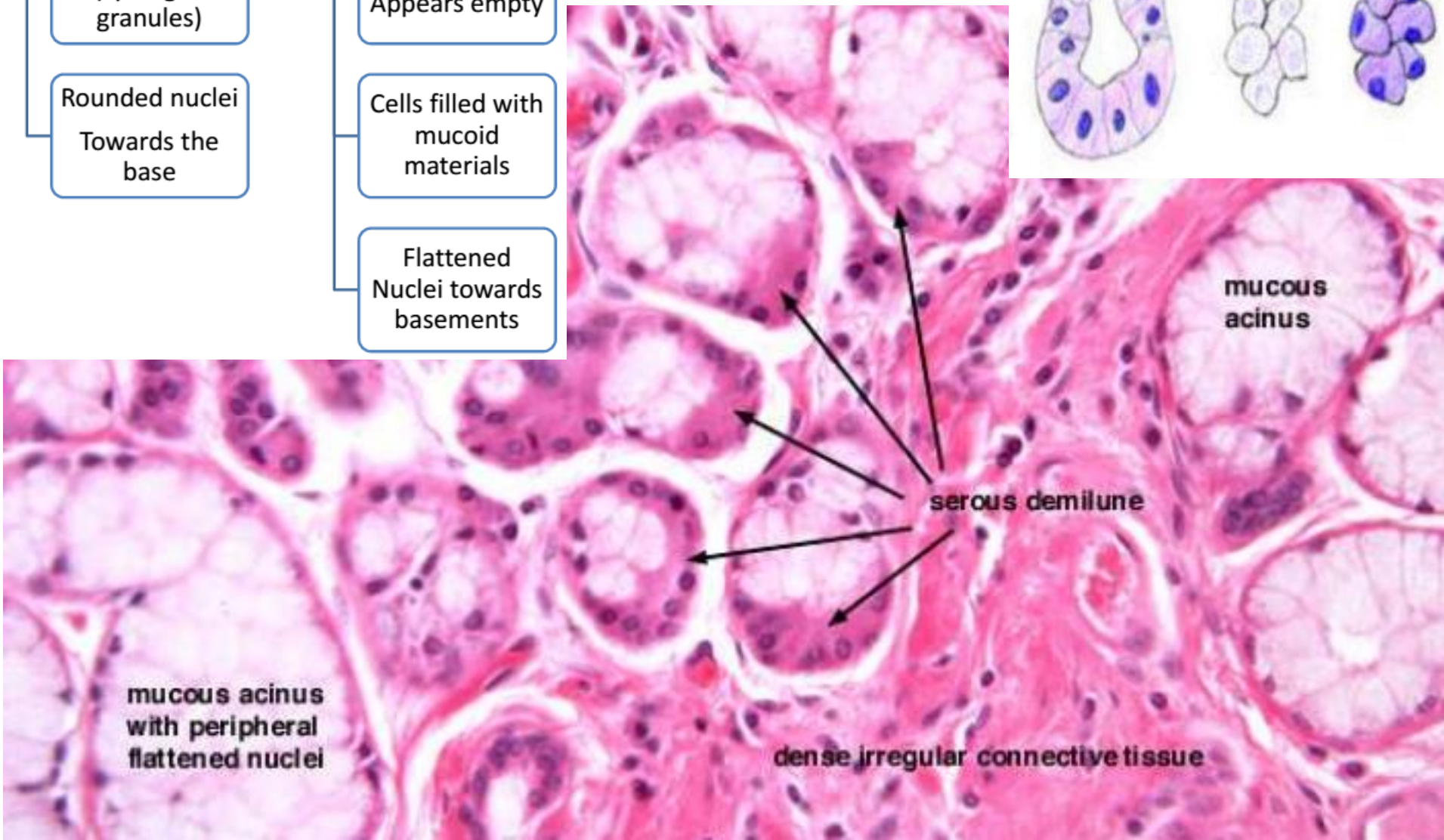
Serous

- Stain darkly (zymogen granules)
- Rounded nuclei Towards the base

Mucous

- Stains lightly Appears empty
- Cells filled with mucoid materials
- Flattened Nuclei towards basements





Alveolus

- Made up of serous or mucous cells
- Some cases,

  mucous alveoli are covered by groups of serous cells

  ↓ arranged in the form of

  Crescents or demilunes

  crescents of Giannuzzi

Alveolus in,

parotid gland – entirely serous

occ, mucous

submandibular gland – mixed

Sublingual gland – mucous

Secretions produced in alveoli

↓ pass along

A system of ducts

(different parts of these have differing structure)

↓ smallest ducts

Intercalated ducts

↓ lined by

Cuboidal / flattened cells

↓ open into

Straited ducts

↓ Lined by

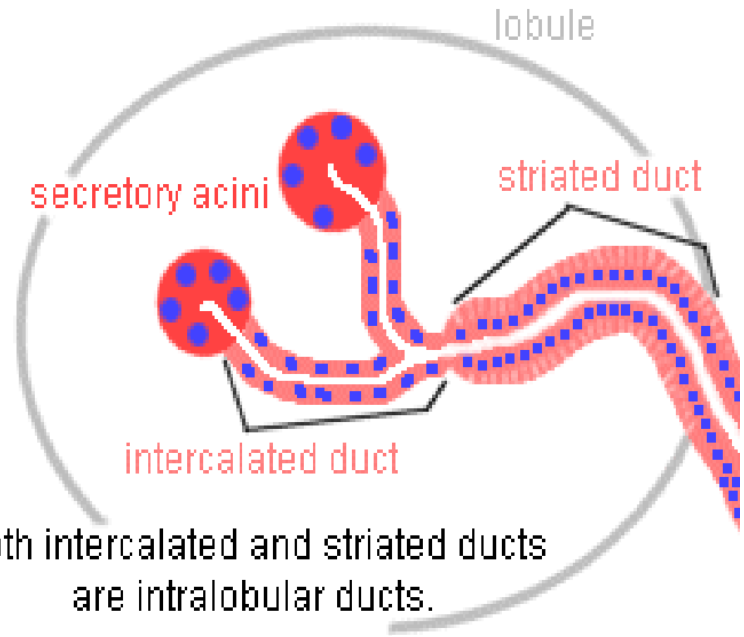
Columnar cells

↓ Open into

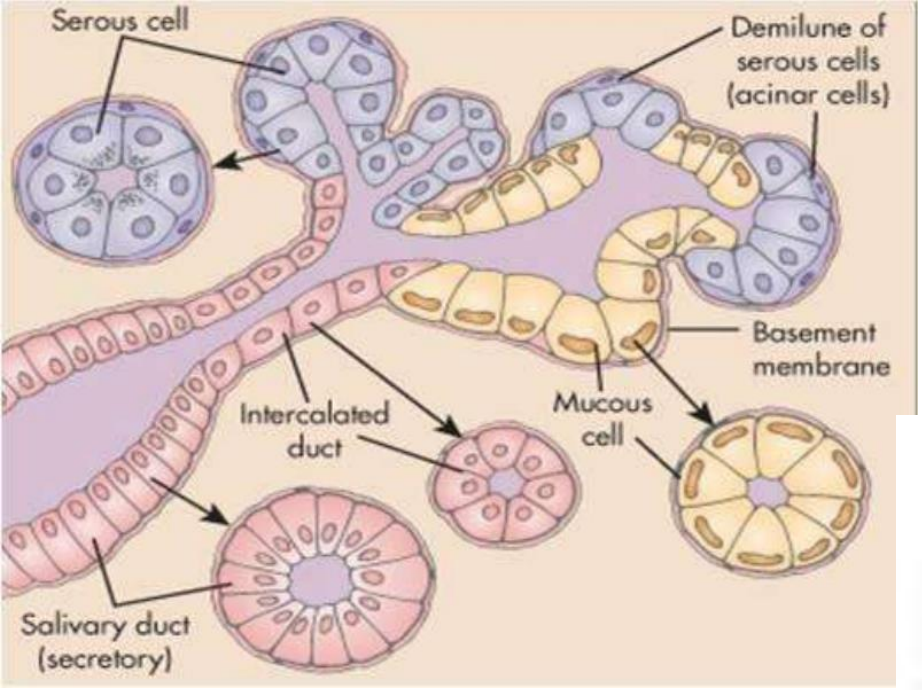
Excretory ducts

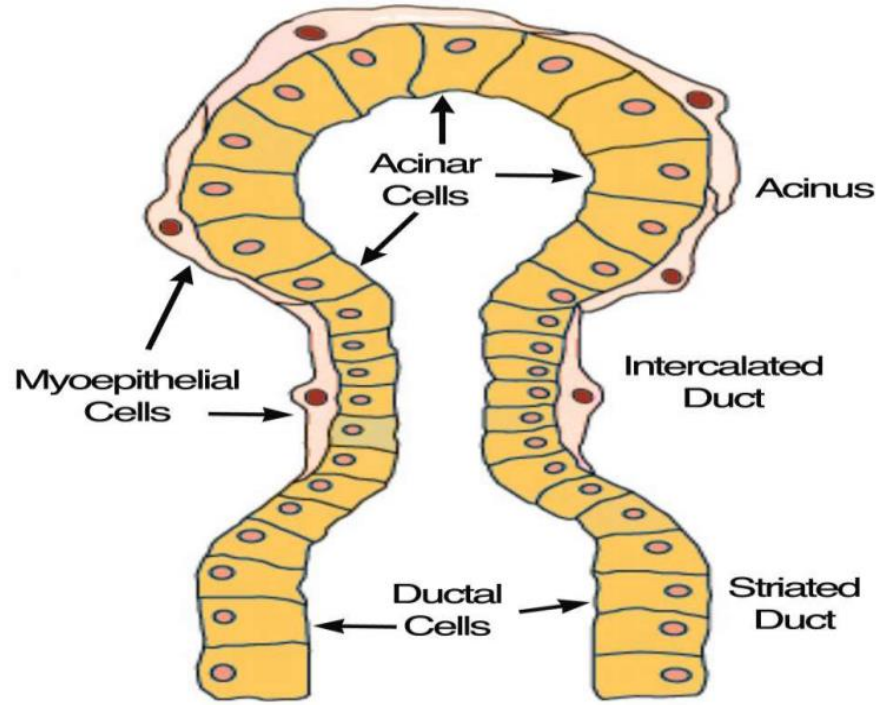
↓ Lined by

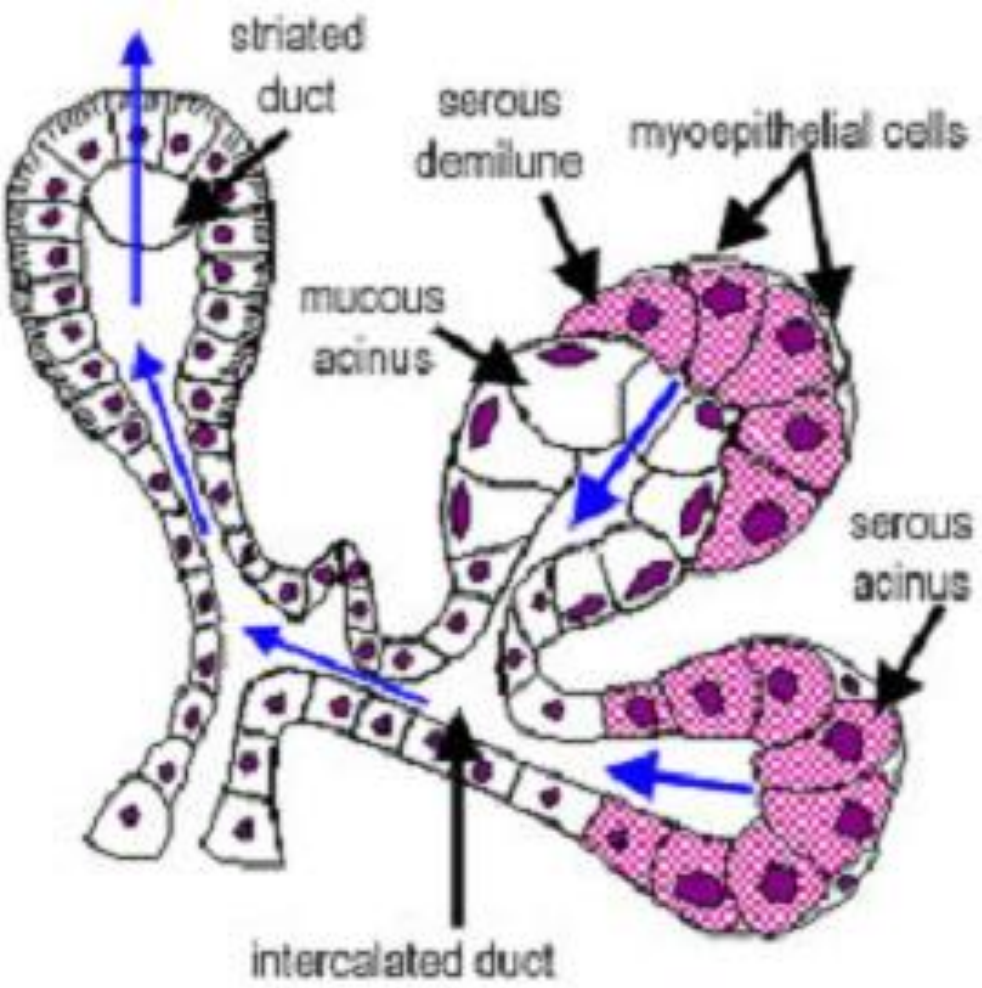
Simple columnar epithelium

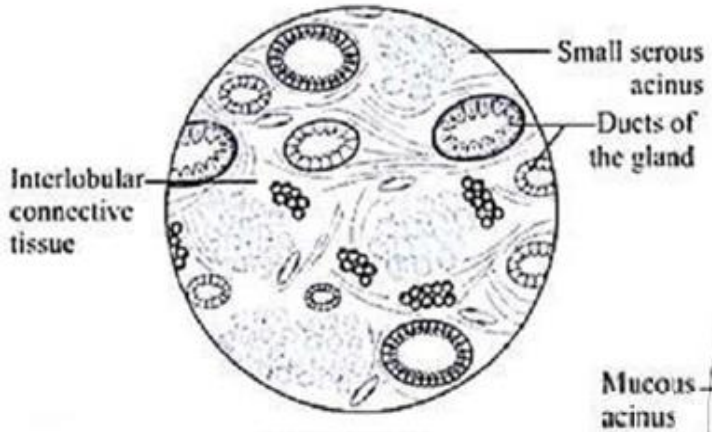


Both intercalated and striated ducts are intralobular ducts.

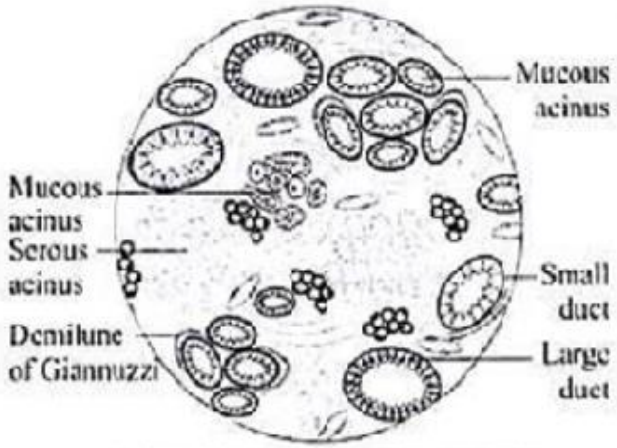

Serous cell
Demilune of serous cells (acinar cells)
Basement membrane
Intercalated duct
Mucous cell
Salivary duct (secretory)


Acinar Cells
Acinus
Myoepithelial Cells
Intercalated Duct
Ductal Cells
Striated Duct

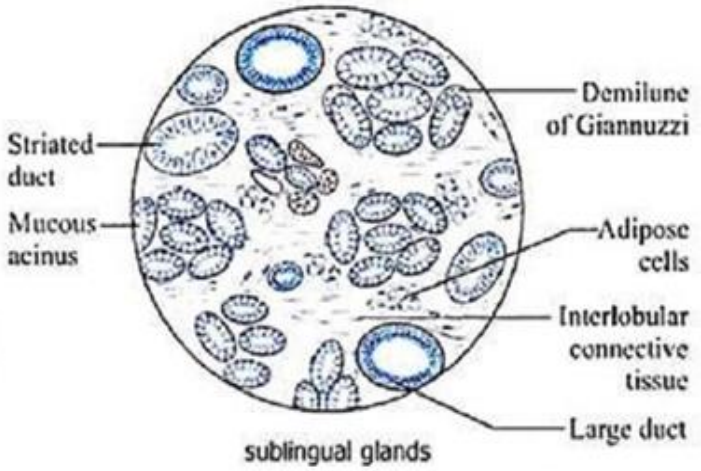

striated duct
serous demilune
myoepithelial cells
mucous acinus
serous acinus
intercalated duct



parotid glands

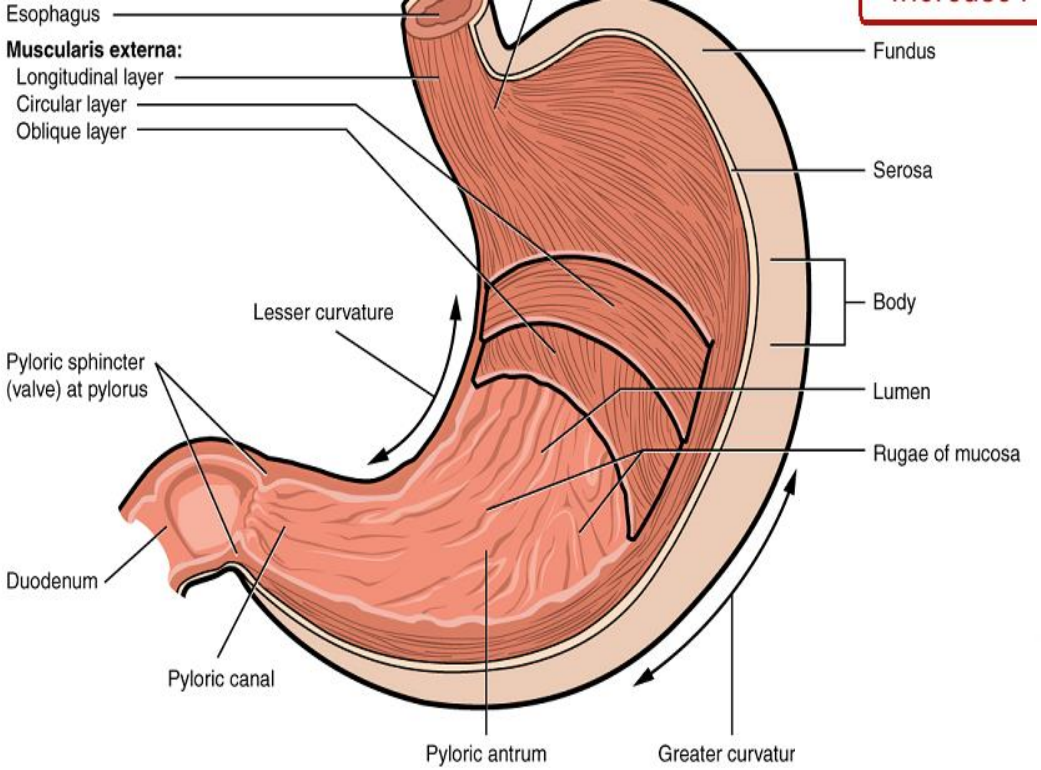


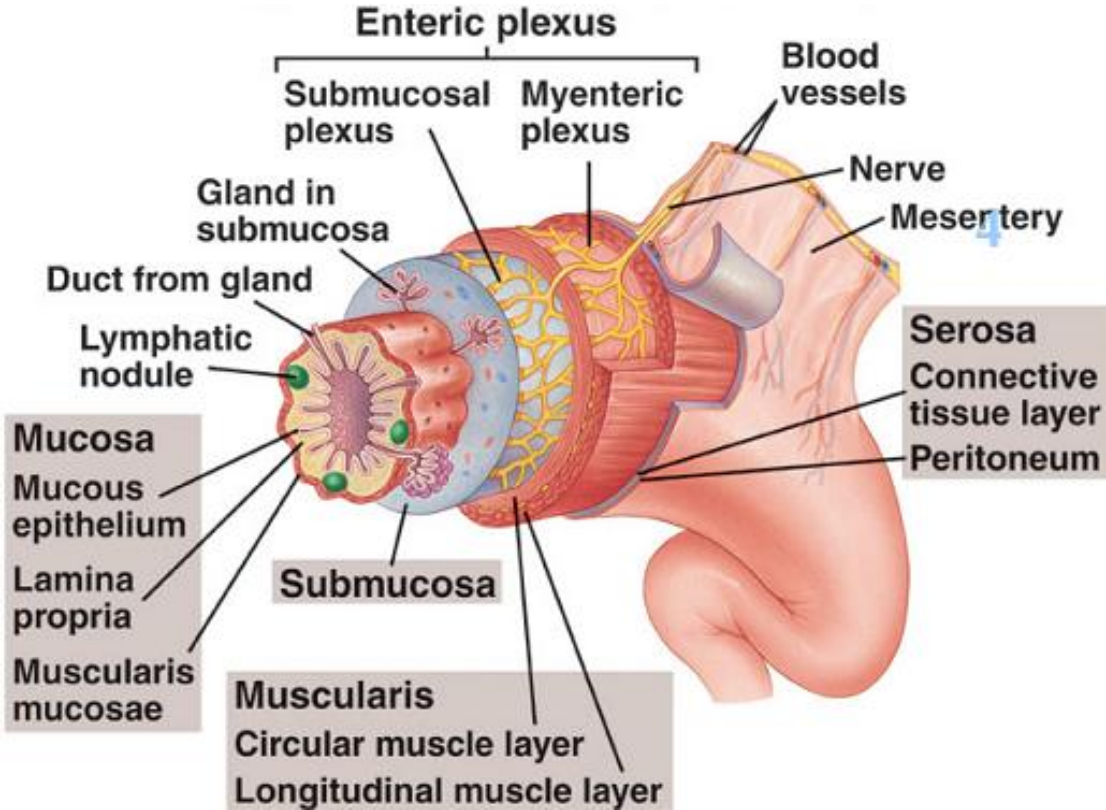
submaxillary (submandibular glands).

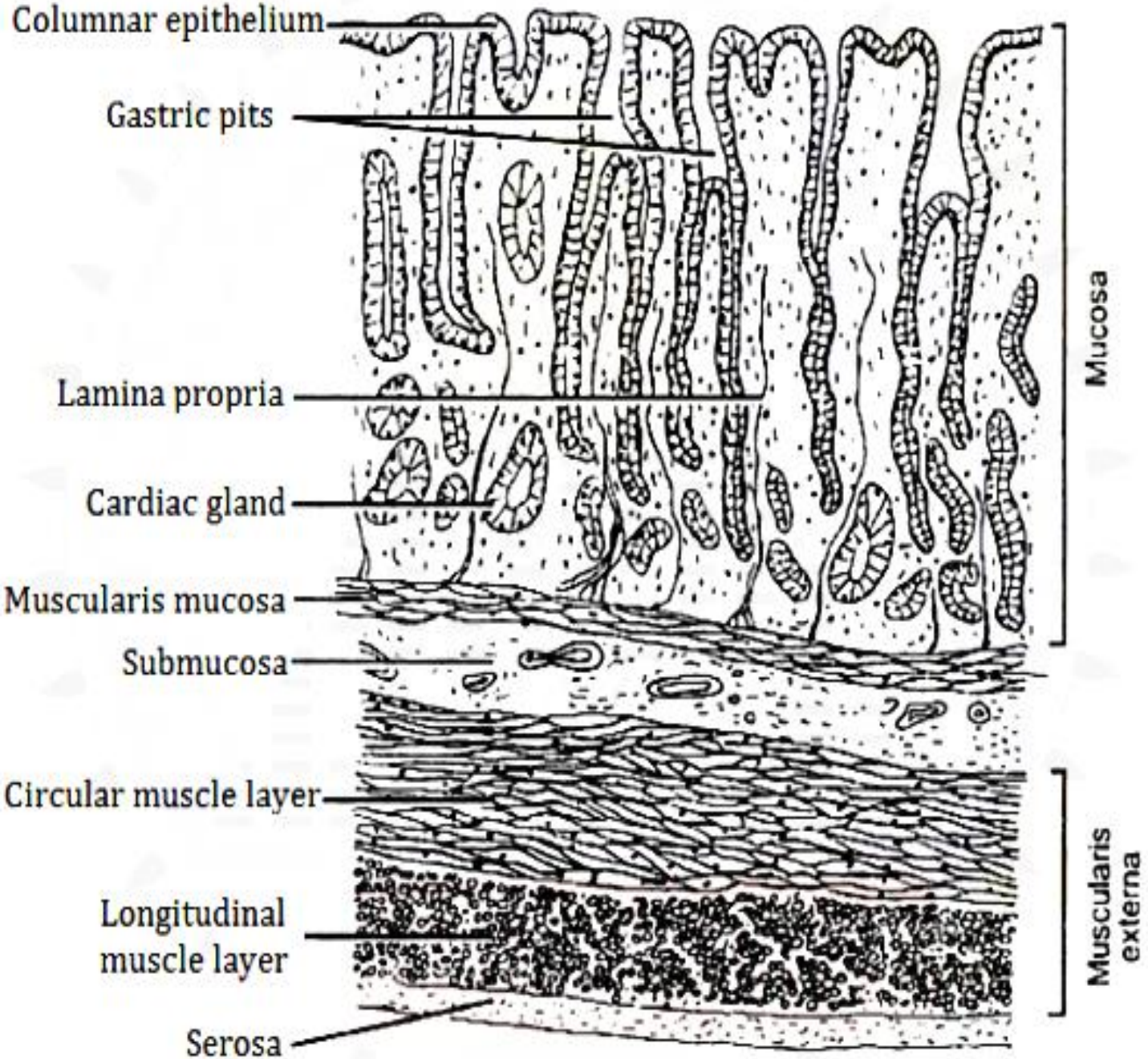


sublingual glands

STOMACH


Esophagus
Muscularis externa:
Longitudinal layer
Circular layer
Oblique layer
Fundus
Serosa
Body
Lesser curvature
Pyloric sphincter (valve) at pylorus
Lumen
Rugae of mucosa
Duodenum
Pyloric canal
Pyloric antrum
Greater curvatur


Enteric plexus
Submucosal plexus
Myenteric plexus
Blood vessels
Nerve
Mesentery
Gland in submucosa
Duct from gland
Lymphatic nodule
Serosa
Connective tissue layer
Peritoneum
Mucosa
Mucous epithelium
Lamina propria
Muscularis mucosae
Submucosa
Muscularis
Circular muscle layer
Longitudinal muscle layer



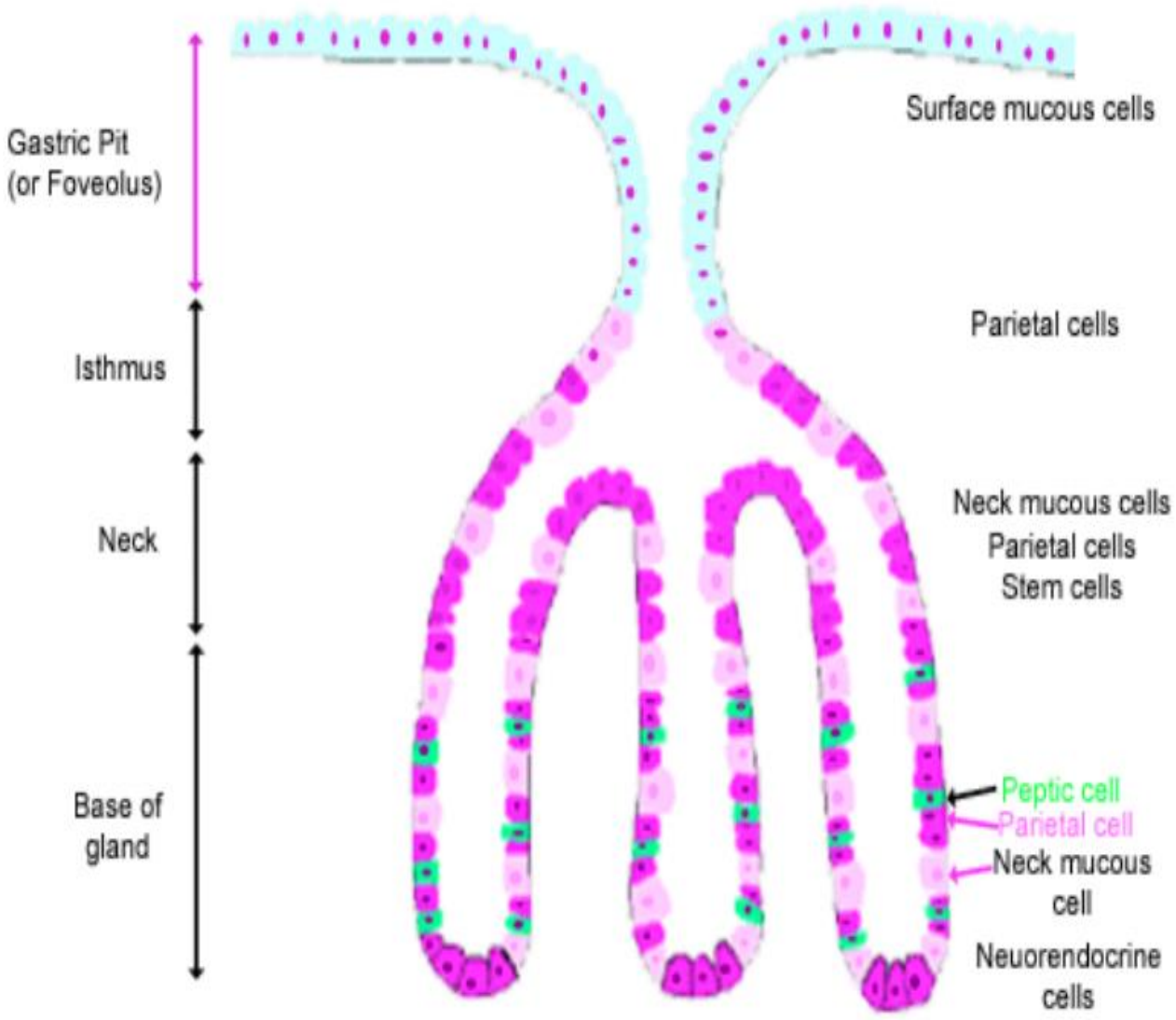
T.S. OF STOMACH

Gastric Glands of the stomach

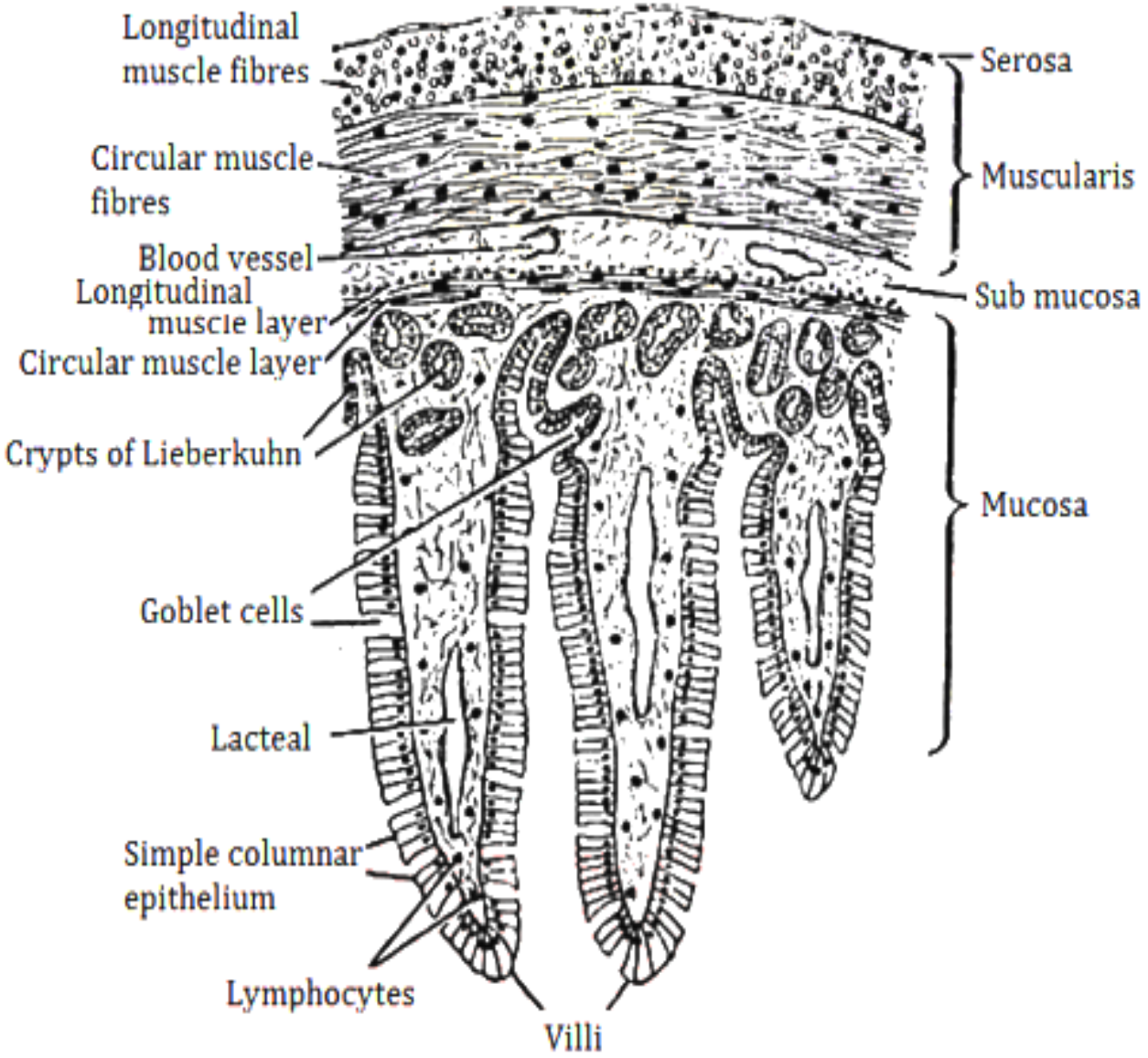
Stem cells- The isthmus and neck
Parietal cells – HCL and intrinsic factor- absorption of vitamin B_{12} -ileum

Chief/Peptic/zymogenic cells - basophilic granular cytoplasm, lots of rER for production of pepsinogen.

Endocrine cells
- gastrin-producing cells (G cells)
- somatostatin producing cells (D cells).



Small Intestine



T.S. OF SMALL INTESTINE

- Plicae circulares
- intestinal villi (about 1mm long) - a simple columnar epithelium (**absorptive cell** or **enterocyte)**

  -microvilli (1 µm long and about 0.1 µm wide).

- mucus-secreting **goblet cells**

- **endocrine cells** secreting Gastrin, Somatostatin, cholecystokinin and secretin.

crypts of Lieberkühn- Between the intestinal villi

- simple tubular glands,

secretion of intestinal juice (about 2 liter/day)

enteropeptidase (or enterokinase)

- activates the pancreatic enzyme trypsin and amylase.

- **Stem cell-** Undifferentiated cells close to the bottom of the crypts

- **Paneth cells** - at the bottom of the crypts

- release a number of antibacterial substances, (eg., Lysozyme)

- Brunner’s glands in the submucosa of duodenum – (not in the jejunum and ileum)

- Peyer’s patches -ileum –

  (not in the duodenum and jejunum)

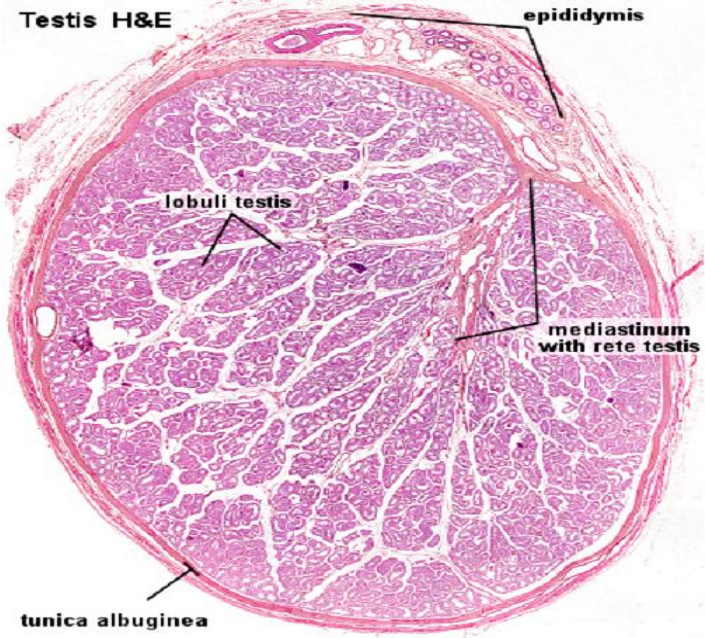
Histology of Testis

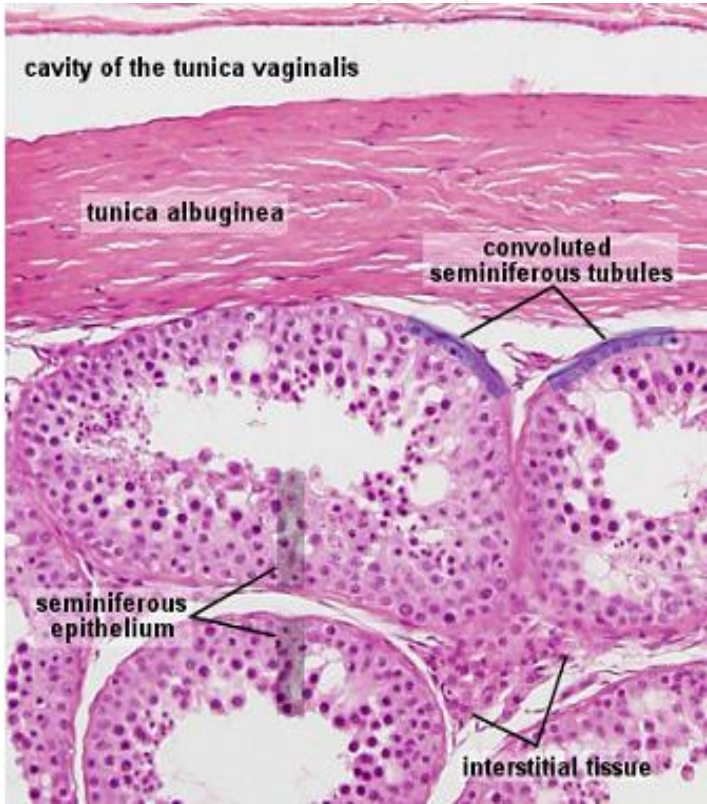
- male reproductive gonad.
- functions: hormone production and sperm.

• Capsule- **Tunica albuginea**
(smooth muscle)
• **Tunica vasculosa testis** - a layer of loose vascular connective tissue

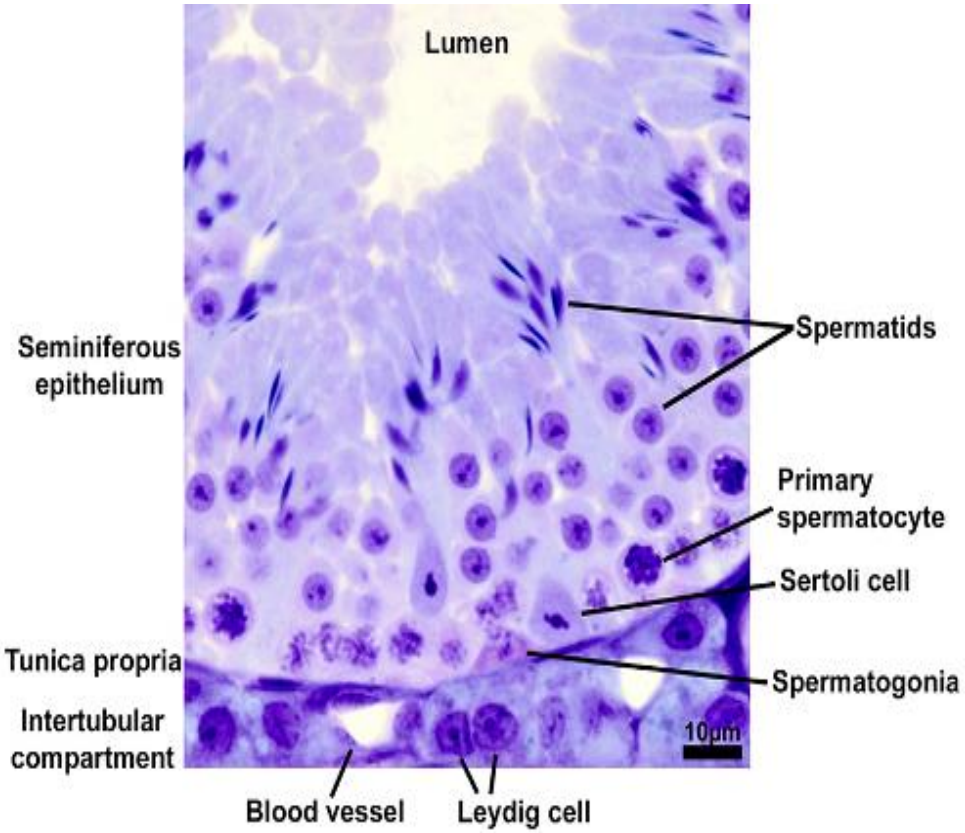
• **Testicular parenchyma**
- **tubular** (**seminiferous tubules**)
and
- **intertubular/ interstitium**

• seminiferous tubule - rete testis- tubulus rectus - mediastinum
Capsule regulating - blood flow, temperature, pressure, sperm movement.





seminiferous tubules
-tunica propria,
-seminiferous epithelium
-tubular lumen.



• tunica propria
- peritubular smooth muscle (**myoid cells)**
- containing collagen and laminin fibers

• seminiferous epithelium
-G**erminal cells/ Spermatogenic cells**
- somatic supporting **Sertoli cells**
-**No blood vessels, nerves or other cell types**

Intertubular compartment
- the steroidogenic **Leydig cells,**
- blood and lymphatic vessels, nerves
-mast cells, macrophage, dendritic cells,
- fibroblasts and connective tissue fibers

Spermatogenic cells

Spermatogonia (first cells of spermatogenesis)

-remain dormant until puberty.

-Two types of spermatogonia

- **Type A spermatogonia**

(a rounded nucleus + one or two nucleoli + fine chromatin grains).

stem cells - both type A and type B spermatogonia

- **Type B spermatogonia**

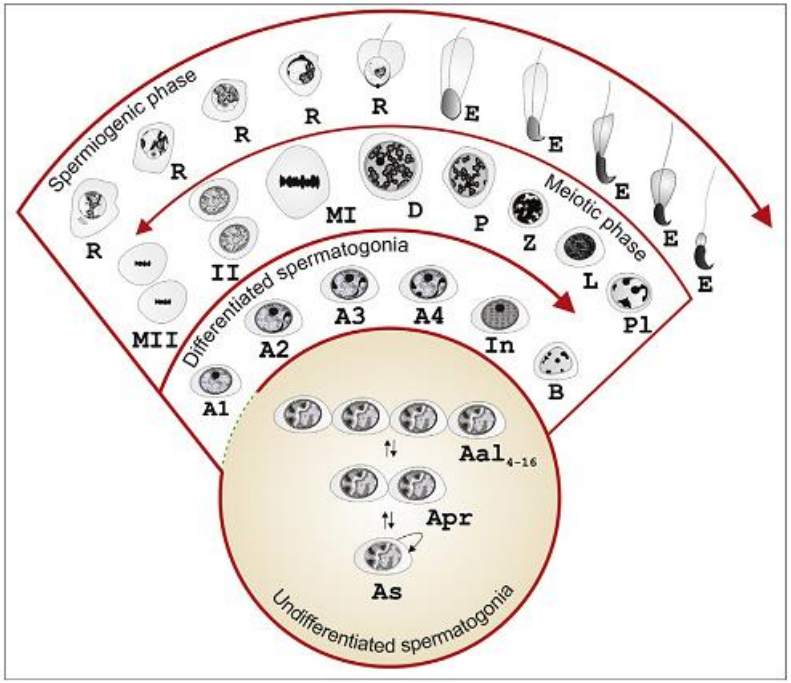
(rounded nuclei + one nucleolus + chromatin granules of variable size attach to the nuclear membrane).

type B spermatogonia.....final mitosis.....**Primary spermatocytes**.

•**Primary spermatocytes**
(larger than spermatogonia)

↓ enter and complete first meiotic division

•**Secondary spermatocytes**
(smaller than primary spermatocytes)
↓enter and complete the second meiotic division



• **Spermatids.**

-Initially small nucleus with very light color
-chromatin condenses during the maturation (Dark nucleus)

• **Spermatozoa -----spermiogenesis**
- long and actively motile
- divided into head, neck and tail

Sertoli cells (highly irregular).

- Nucleus – large, ovoid or angular and lightly stained - contains a large nucleolus
- Lateral processes - interconnected by tight junctions (blood-testis barrier).

- provide mechanical and nutritive support for the spermatogenic cells.
- two hormones - inhibin and activin

  -positive and negative feedback on FSH secretion from the pituitary.

Interstitial tissue

Leydig cells (endocrine component of the testis)

- occur in clusters, variable in size and richly supplied by capillaries.
- Nucleus - large, round and located eccentric in the cell.
- synthesise and secrete - testosterone.

Histology of Ovary

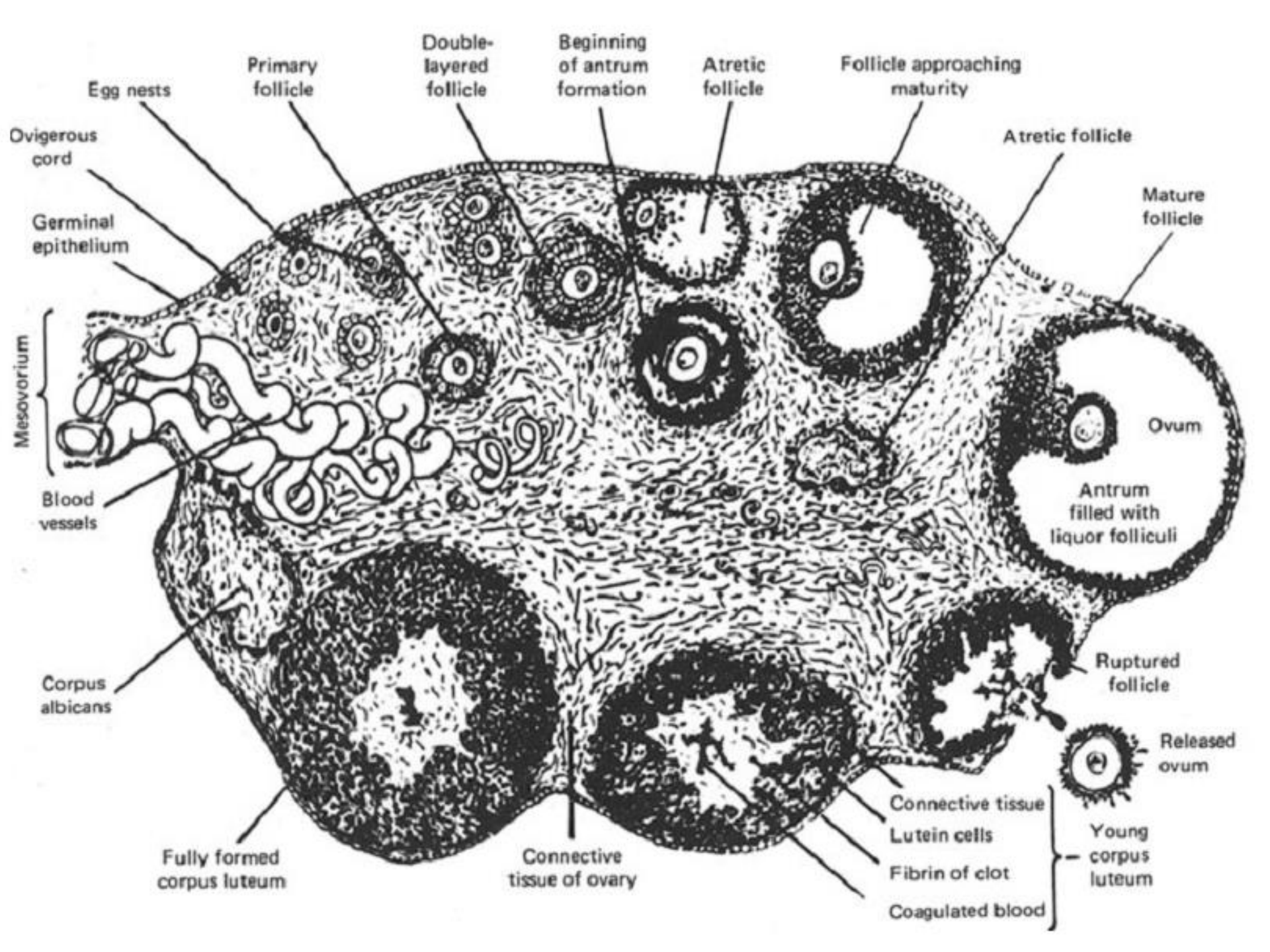
- ovaries are two nodular bodies located in a shallow depression called the ovarian fossa.

- The anterior margin - a fold of peritoneum (**mesovarium**) - **hilus** of the ovary.

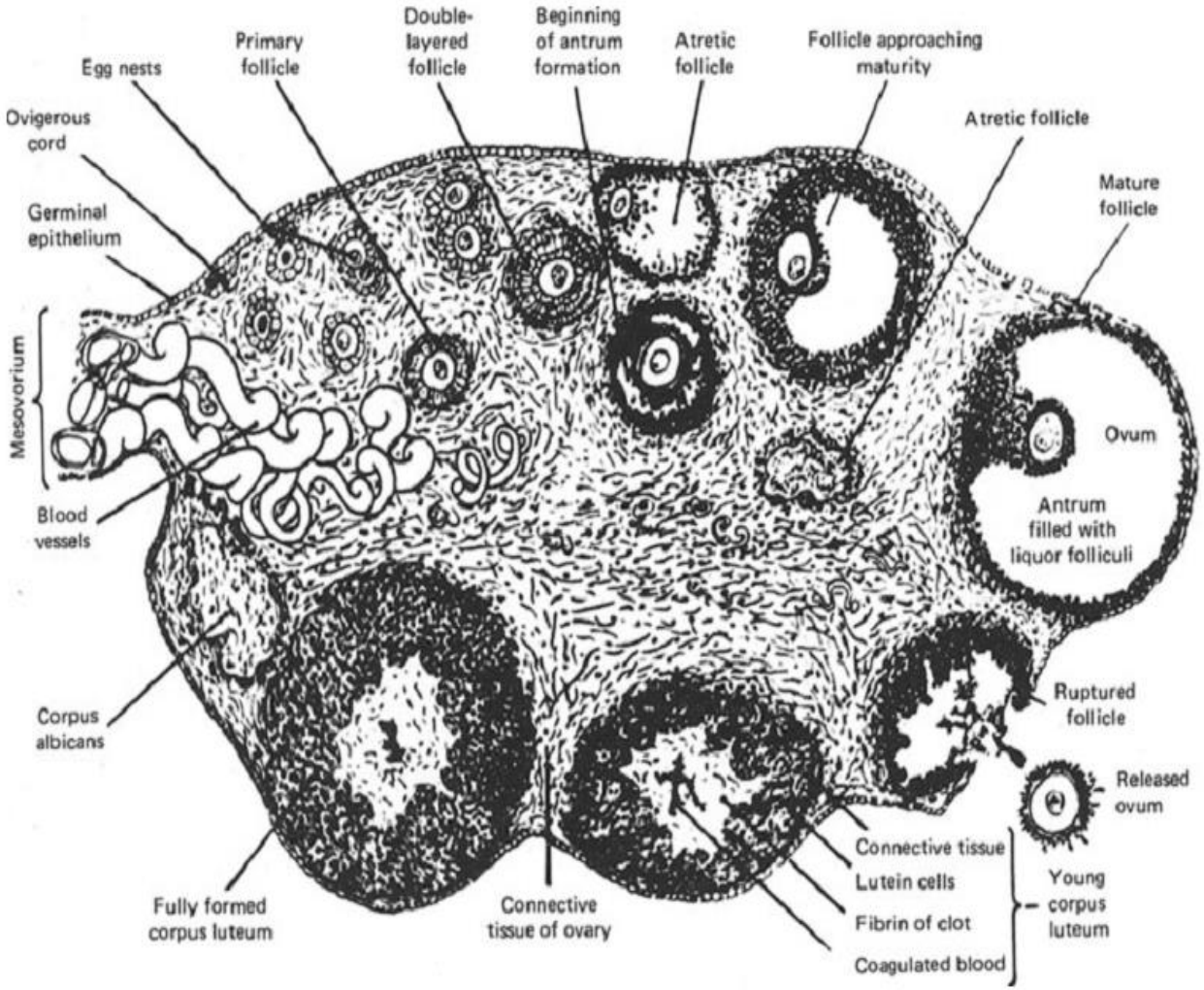
- The posterior - free margin- is rounded, convex and unattached.

- The ovaries have two functions –

•Production and ovulation of oocytes.
•Production and secretion of hormones.


Egg nests
Primary follicle
Double-layered follicle
Beginning of antrum formation
Atretic follicle
Follicle approaching maturity
Ovigerous cord
Atretic follicle
Germinal epithelium
Mature follicle
Mesovorium
Ovum
Antrum filled with liquor folliculi
Blood vessels
Corpus albicans
Ruptured follicle
Released ovum
Connective tissue
Lutein cells
Fibrin of clot
Coagulated blood
Young corpus luteum
Fully formed corpus luteum
Connective tissue of ovary

ovary surface cover - outer single layer of cuboidal epithelium **germinal epithelium** – continued with the **peritoneal mesothelium**. Fibrous connective tissue forms a thin capsule, the **tunica albuginea**



Ovary divided into-

an outer cortex and an inner medulla.

The **cortex -** cellular connective tissue **stroma** in which the **ovarian follicles** are embedded.

The **medulla -** loose connective tissue contains **blood vessels and nerves**.

Ovarian Follicles

one oocyte and surrounding follicular cells.

Follicular development - divided into stages

- **Primordial follicles**

One layer of **flattened follicular cells** surround the oocyte

- located in the cortex just beneath tunica albuginea
- nucleus eccentric contains a prominent nucleolus.

- **The primary follicle (**first morphological stage)

➢ **flattened** cell → **cuboidal** or columnar epithelium

➢ cytoplasm (granular) **-** called **granulose cells**.

↓continued proliferation

- a **stratified epithelium** surrounding the oocyte

➢ zona pellucida becomes visible

(between oocyte and granulosa cells)

➢ **Formation of the theca folliculi**

- Parenchymal cells of the ovary surrounding the growing follicle organised in concentric sheaths

Secondary follicle

- Development of **follicular antrum**
- oocyte – eccentric, in the **cumulus oophorus** surrounded by granulosa cells.
- The theca folliculi

  - differentiates into a **theca interna** and a **theca externa**.

- Vascularization of the **theca interna**

  - (spindle-shaped or polyhedral cells)

  - start to produce **oestrogens**
- The theca externa – unchanged (smooth muscle cells).
- oocyte (diameter of about 125 μm), follicle (diameter of about 10-15 mm).

The mature or tertiary or preovulatory or Graafian follicle

Graafian follicle increases further in size forms a small "bump" on the surface of the ovary, the stigma (or macula pellucida).

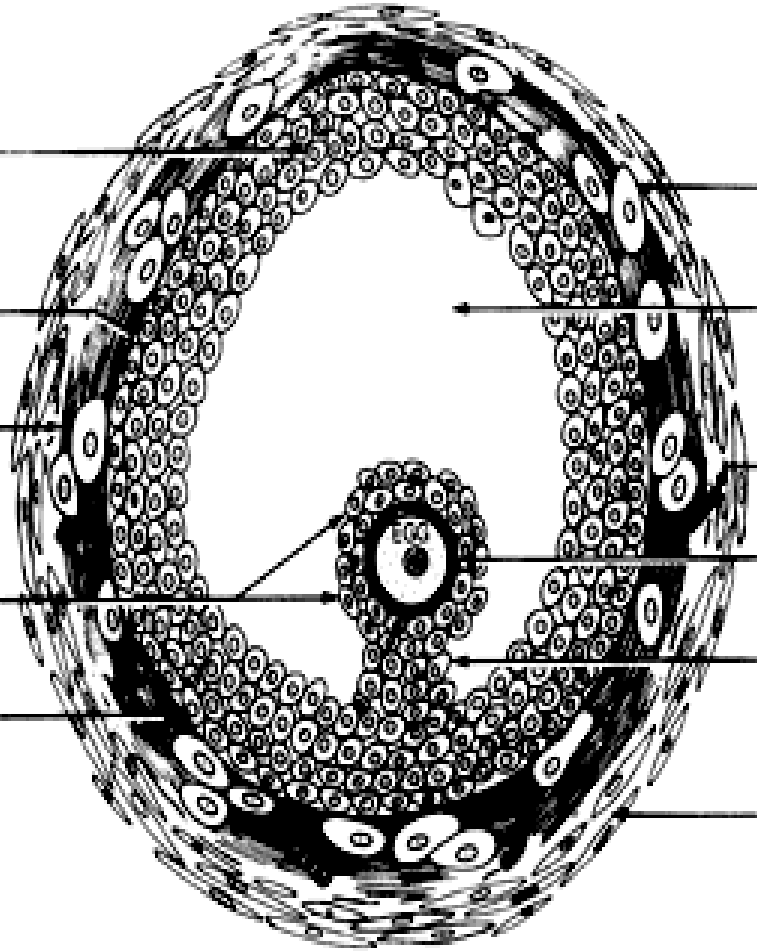
- The stigma is characterised by a **thinning of the capsule** and a progressive restriction of the blood flow to it.

Prior to ovulation the cumulus oophorus separates from the follicular wall.

The oocyte surrounded by granulosa cells - **corona radiata** - floating freely in the follicular antrum.

The follicle finally **ruptures at the stigma** and the oocyte is released from the ovary.

HISTOLOGIC ARCHITECTURE OF GRAAFIAN FOLLICLE



Atresia

-is degenerative process- oocytes (and follicles) perish without having been expelled by ovulation.

-is operating before puberty to remove follicles which begin to mature during this period.

The Corpus luteum

- formed by **granulosa** cells and **thecal** cells after ovulation
- The wall of the follicle collapses into a folded structure

Vascularization increases and a connective tissue network is formed.

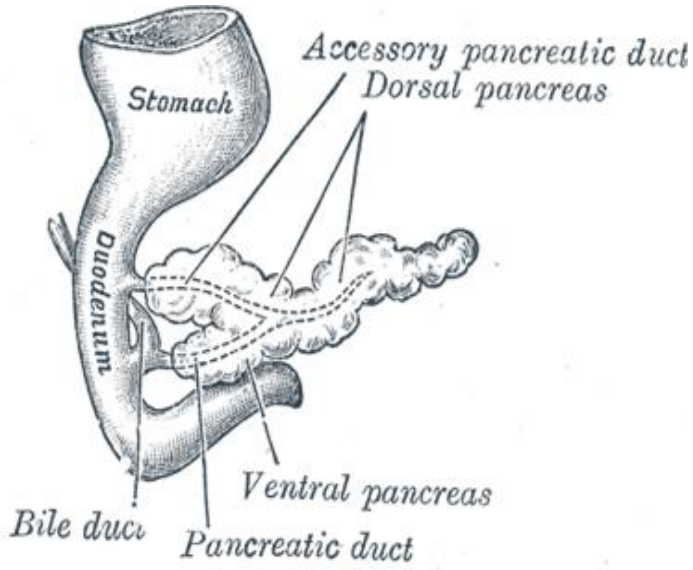
Theca interna cells and granulosa cells triple in size and start accumulating **lutein** within a few hours after ovulation. They are now called **granulosa lutein cells** and **theca lutein cells** and produce **progesterone** and **oestrogens**.

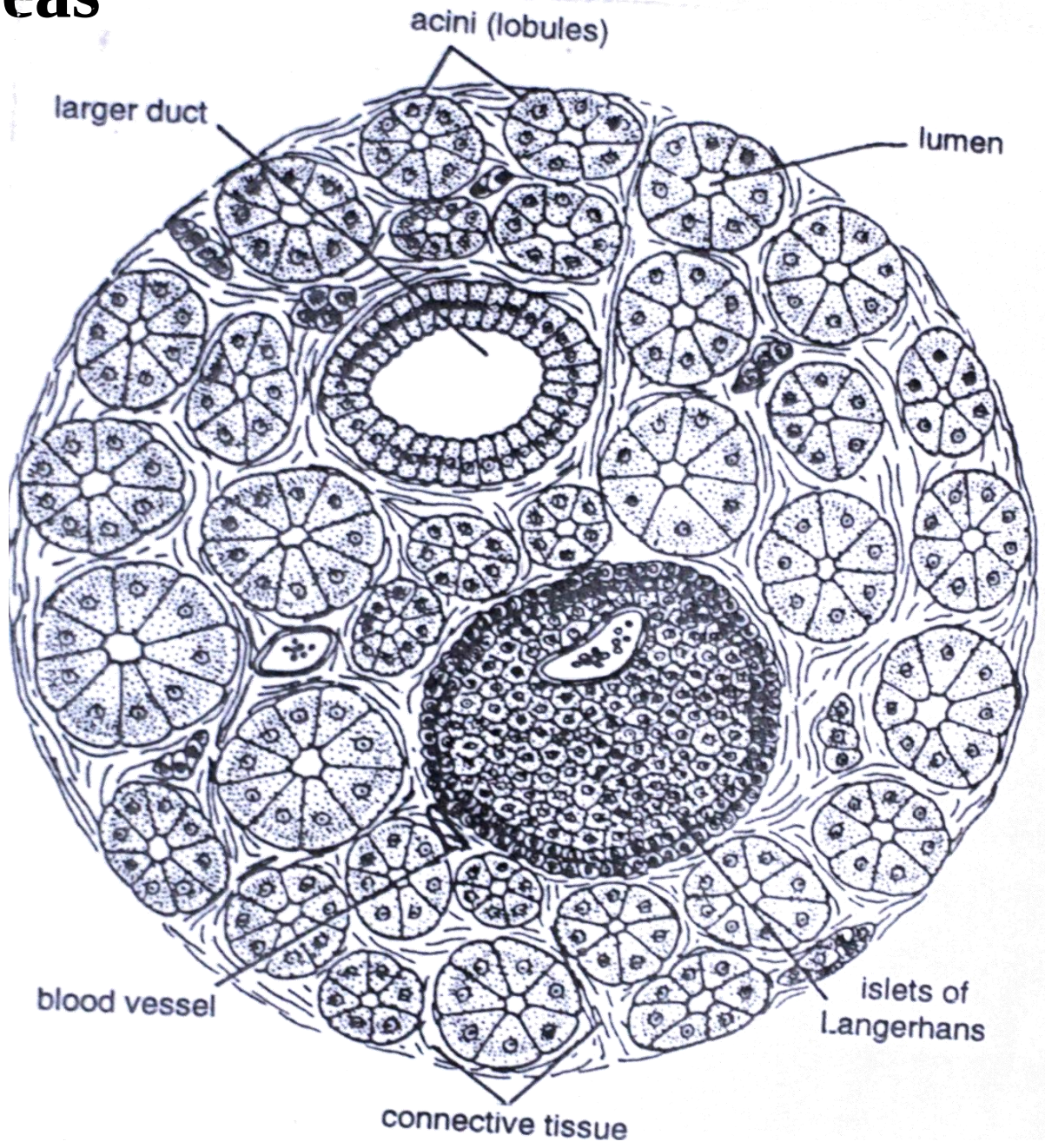
Hormone secretion in the corpus luteum ceases within 14 days after ovulation if the oocyte is not fertilised. In this case, the corpus luteum degenerates into a **corpus albicans -** whitish scar tissue within the ovaries.

Hormone secretion continues for 2-3 month after ovulation if fertilisation occurs.

Histology of Pancreas

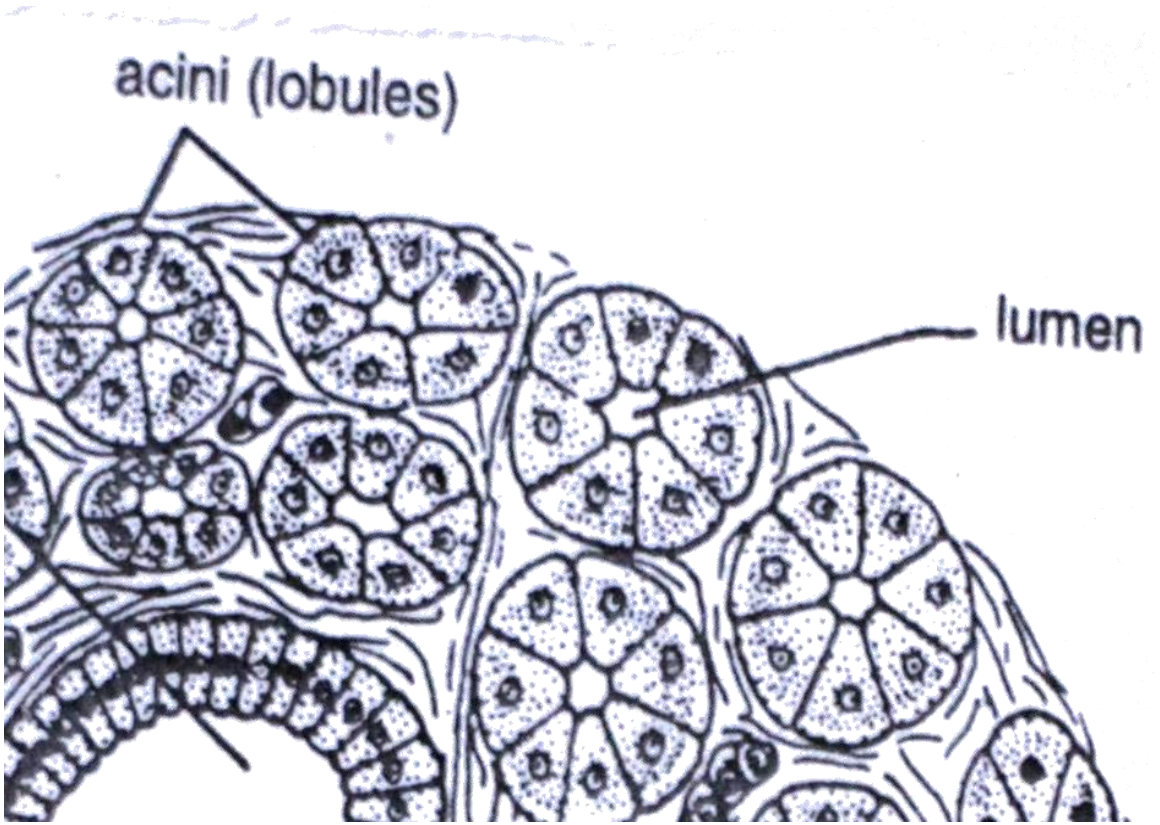
- second largest, elongated, pinkish digestive gland
- lies in the C-shaped curve of the duodenum





- mixed gland - exocrine part and endocrine part (heterocrine gland)

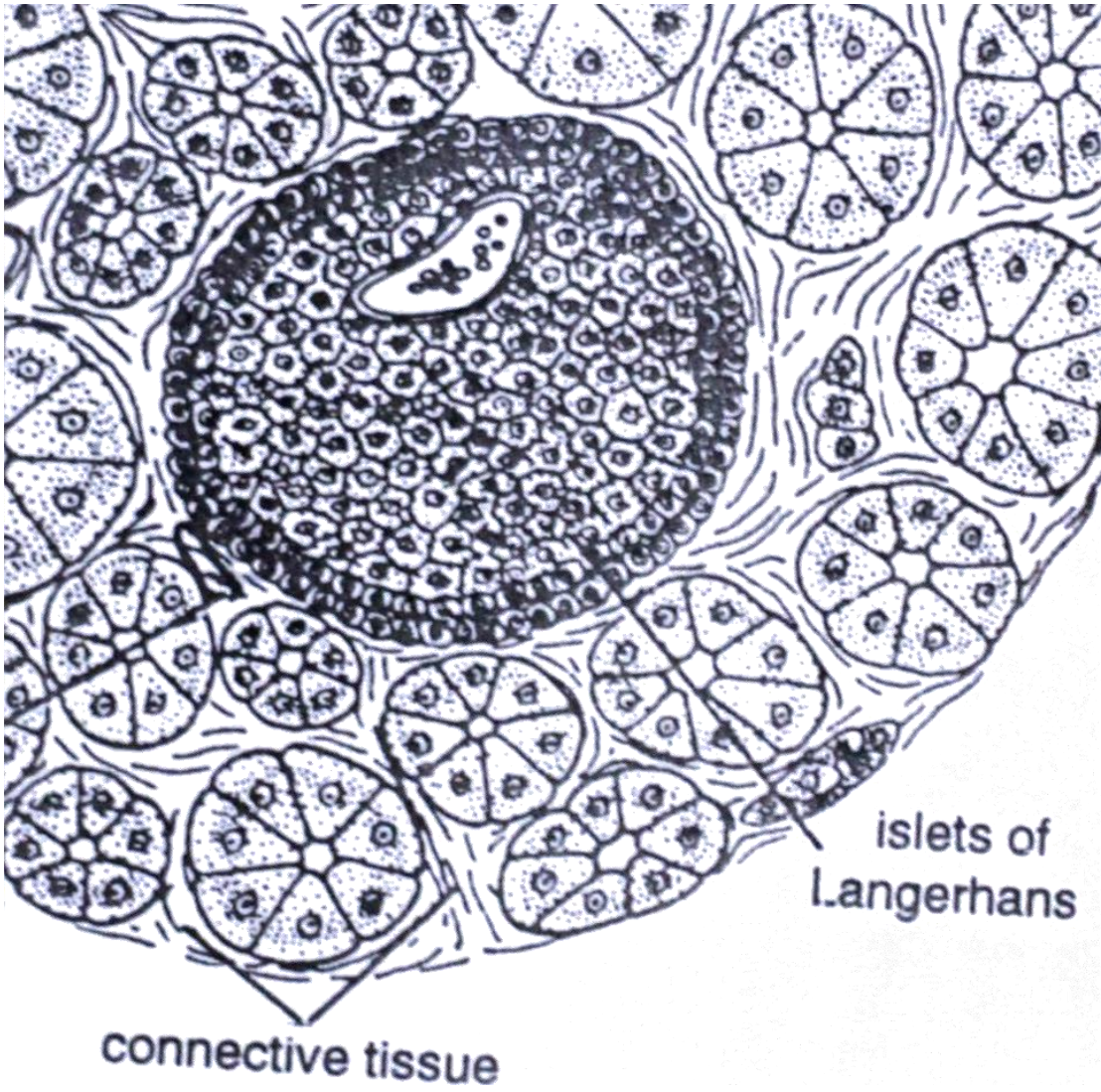
Exocrine part - exocrine cells arranged in **acini.**



- Each acinus
  - ➢ Lumen - narrow to wide
  - ➢ Walls - pancreatic cells, pyramidal in shape

Endocrine component

- **islet of Langerhans**
- scattered throughout
- small rounded or oval clusters of yellowish cells



human islets

- **Beta cells -** middle part

-secrete **insulin**

-role carbohydrate metabolism.

-deficiency **diabetes**

- **Alpha cells** – periphery

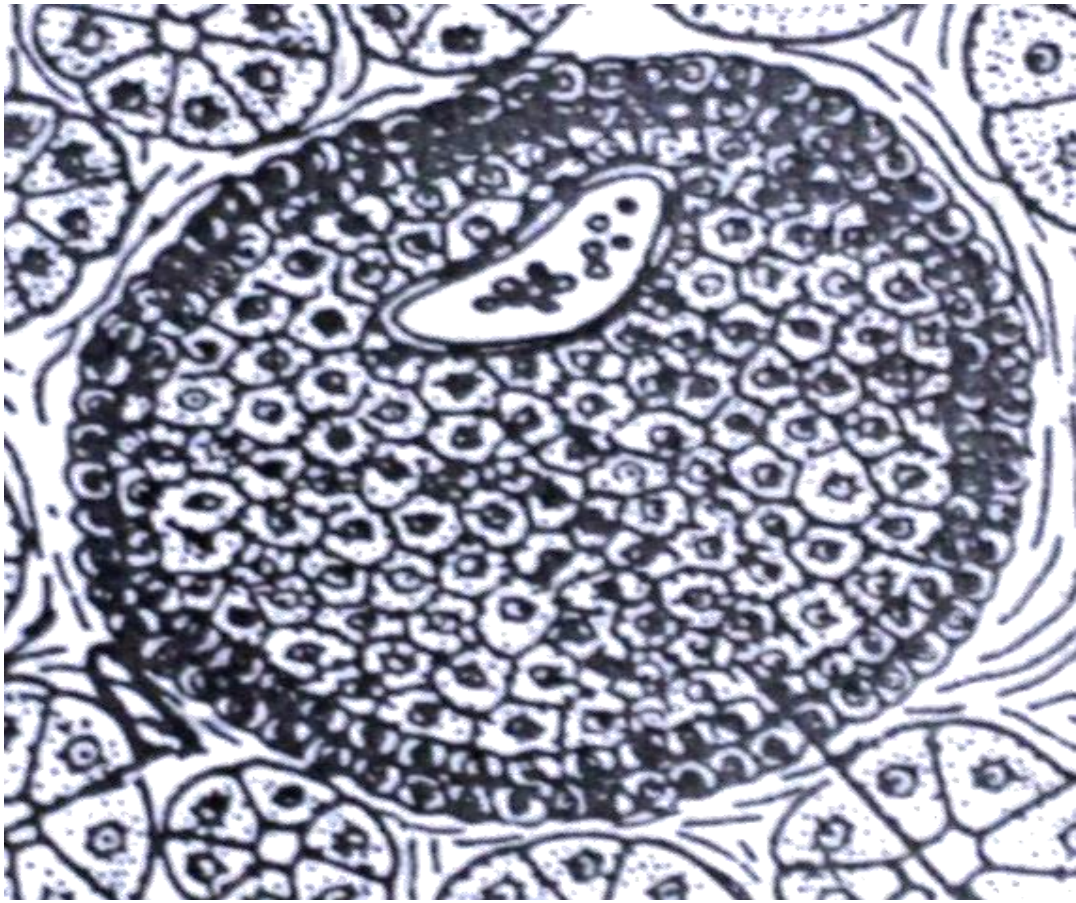
-secrete **glucagon** (15-20%)

-deficiency **hypoglycemia**

- **Delta cells** – periphery

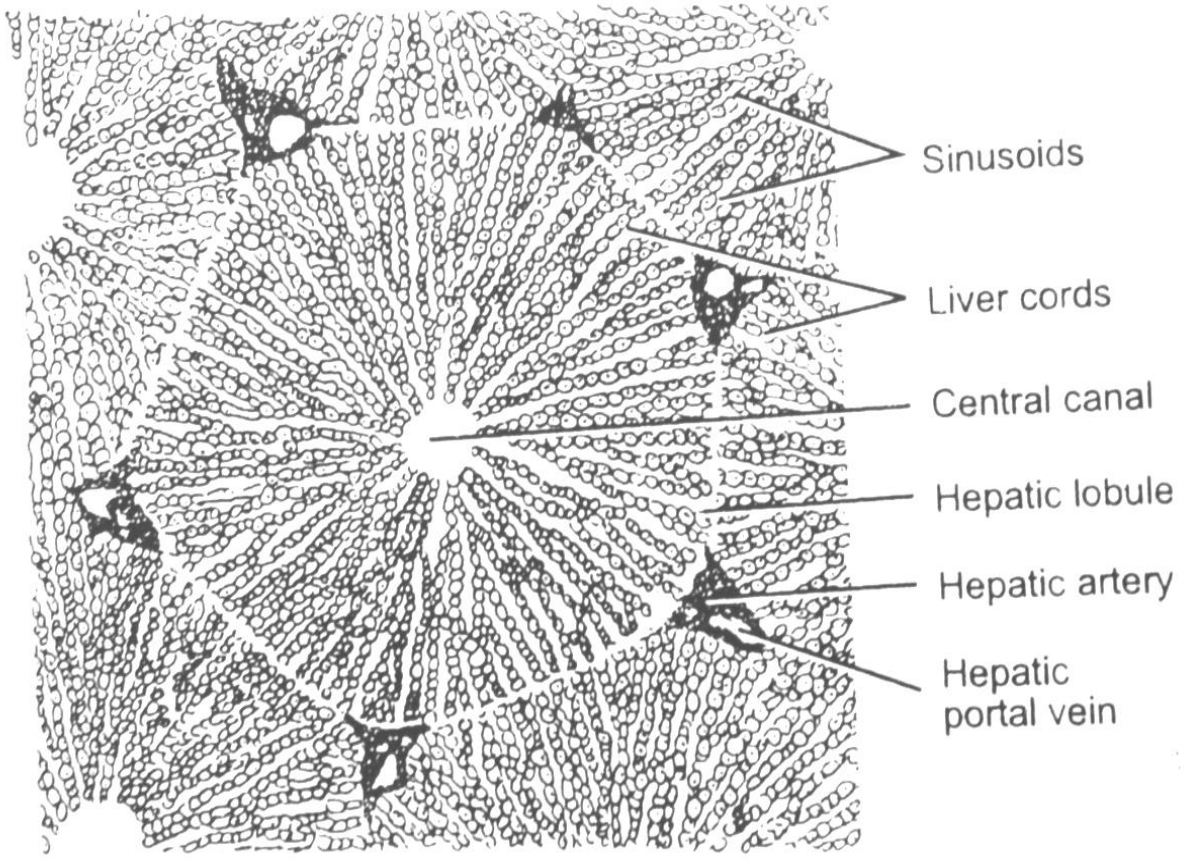
-secrete **somatostatin**

-inhibits both insulin and glucagon secretion



Histology of Liver

- largest visceral organ
- organ of homeostasis
- maintenance of the composition of blood
- liver is surrounded by **a capsule** of two layers
  - Outer -smooth, moist peritoneum
  - Inner - fibrous - Glisson's capsule.



T.S shows hepatic strands, bile ducts, blood vessels and central vein.

The liver consists

- large number of hexagonal functional units- lobules.
- hepatic cells or hepatocytes

- Irregular interconnecting sheets
- radiate outward from the central vein

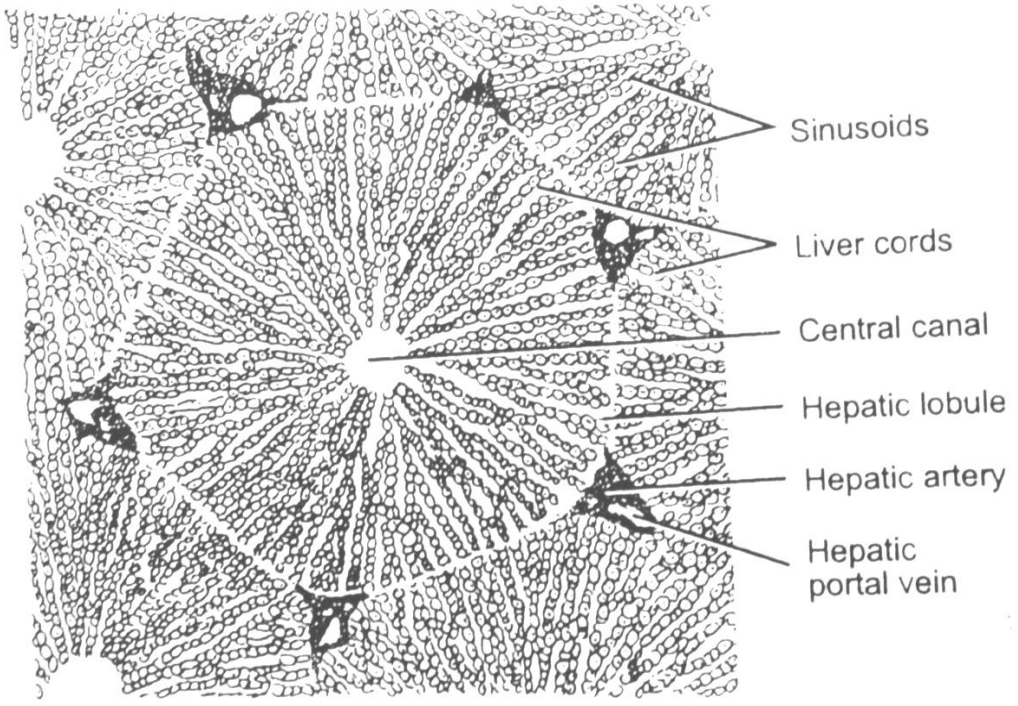
Hepatocytes:

-large sized polygonal cells

-have prominent nuclei, golgi apparatus, many mitochondria and lysosomes.

- rich in glycogen granules and fat droplets.

-They are tightly packed and where their surface is in contact with blood vessels there are microvilli used for the exchange of materials between the two.



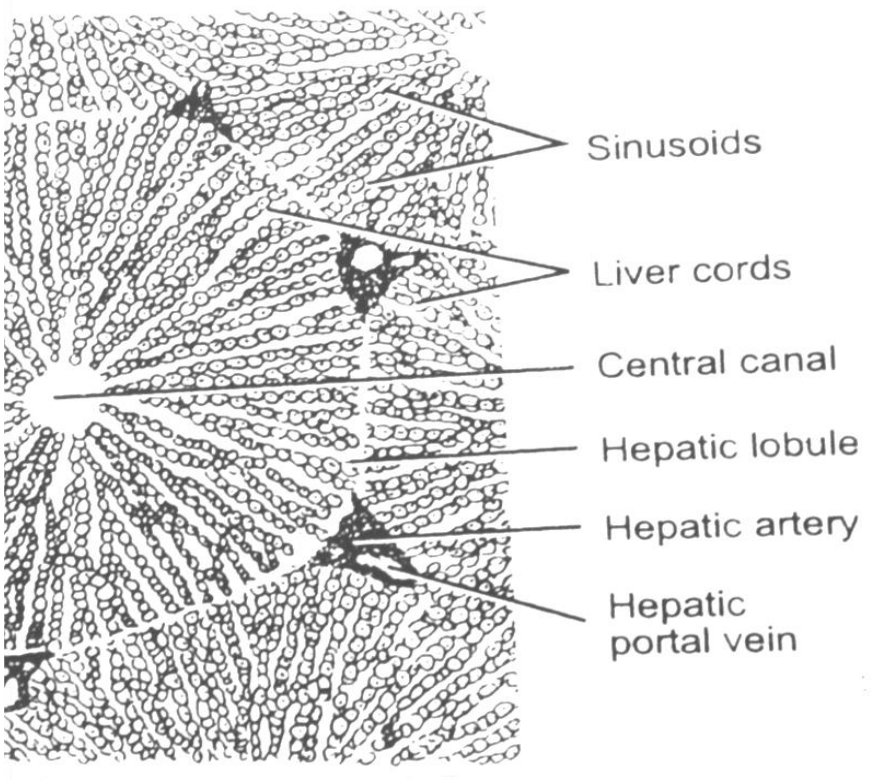
- Sinusoids
- angles of hexagons- **portal triads** (hepatic artery, portal vein and bile duct)

  -lymphatic vessel
- **Blood vessels** from the alimentary canal and the hepatic artery, carrying oxygenated blood, join together to form venules which carry blood to the hepatocytes.
- **kupffer cell -** lining of the sinusoids

  - highly **phagocytic,**

  ingest damaged RBC and

  other suspended particles.



Histology of Kidney

- Kidneys are paired, bean shaped organs locate on either side of the spinal column high on the posterior abdominal wall.

- Kidney is covered by a thin but rough renal capsule.

- Inside the renal capsule, the nephrons which are the structural and functional unit of kidney are seen.

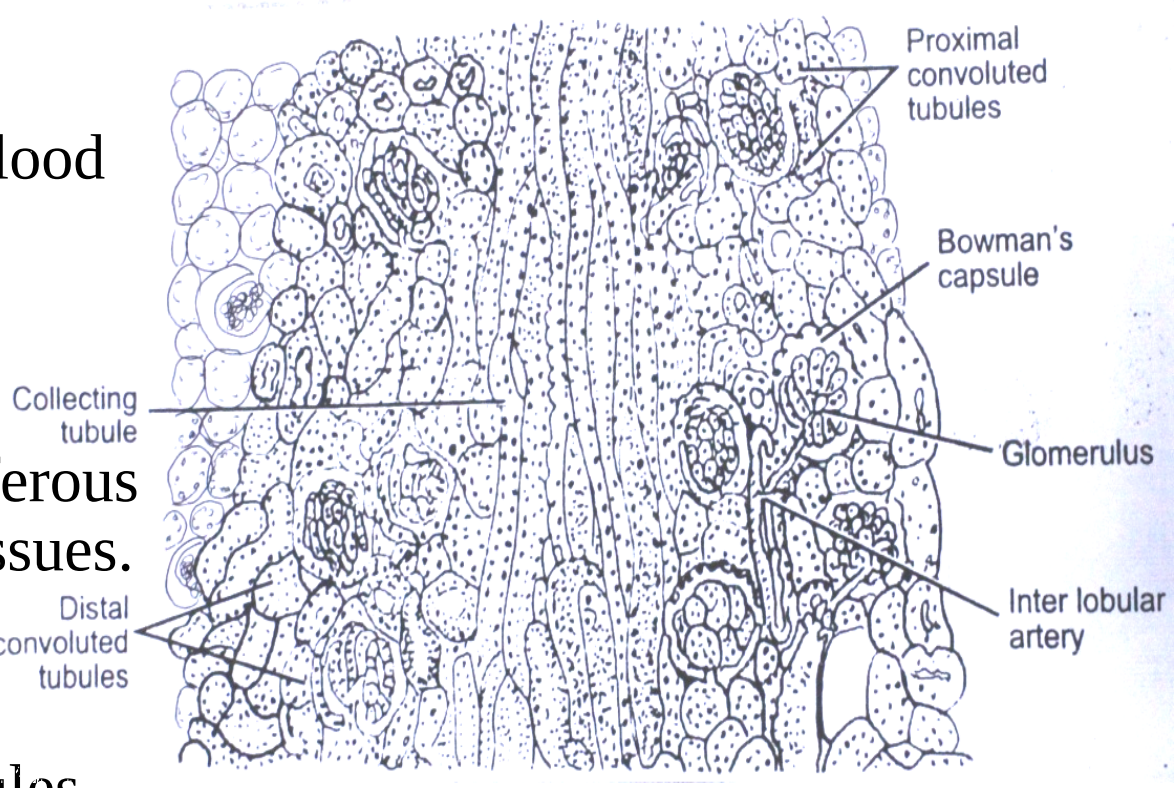
Histology of Kidney

- Section reveals two distinct portion- cortex and medulla
- Between these two zones - undefined boundary zone characterized by large blood vessels.

(a) Cortex:

(i) Tuft of blood vessel forming Renal corpuscles or Malpighian corpuscles encircling network of blood vessels-the glomerulus

(ii) excretory canals



(b) Medulla: includes uriniferous tubules and connective tissues.

The structural variation of epithelial cells of the tubules

flattened (at the capsule),

granulated cubical

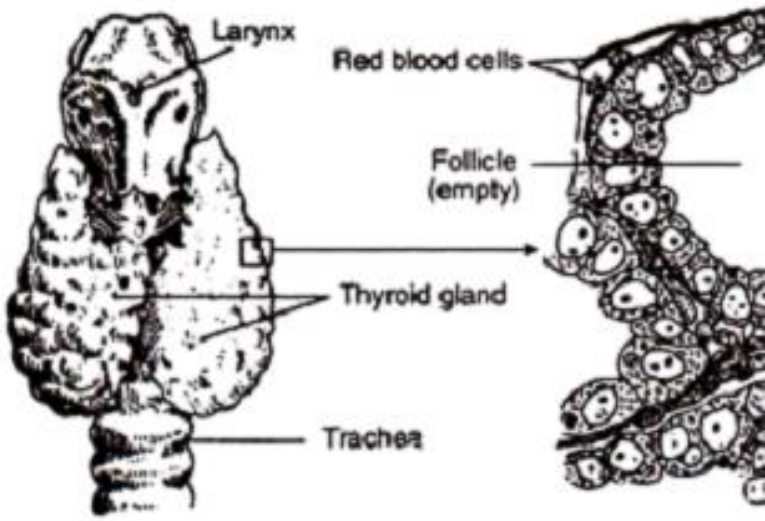
(convoluted tubule)

non-granulated cubical

(collecting tubule).

Histology of Thyroid

- a bilobed endocrine gland
- Located in the neck,
- It consists of **two lateral lobes** arranged on either side of the **thyroid cartilage**.
- lobes connected on ventral side by **isthmus**.
- The thyroid is enclosed by a thin collagenous capsule.
- The adult human thyroid gland weighs 15-20 g.



- Gland enclosed capsule-

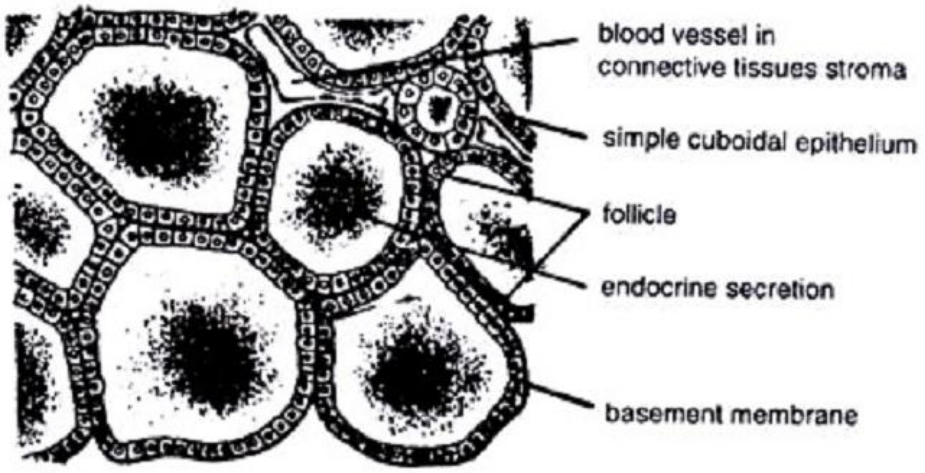
  two layered - outer and inner

- Septa of **fibro-elastic tissue** extend inwards from the inner capsule and divide the gland into lobules.

- The glandular tissue consists of groups of irregularly **spherical follicles**.

  - lined by **cuboid cells** with spherical nucleus

  - supported by **connective tissue** carrying blood vessels, lymphatic's and nerves.



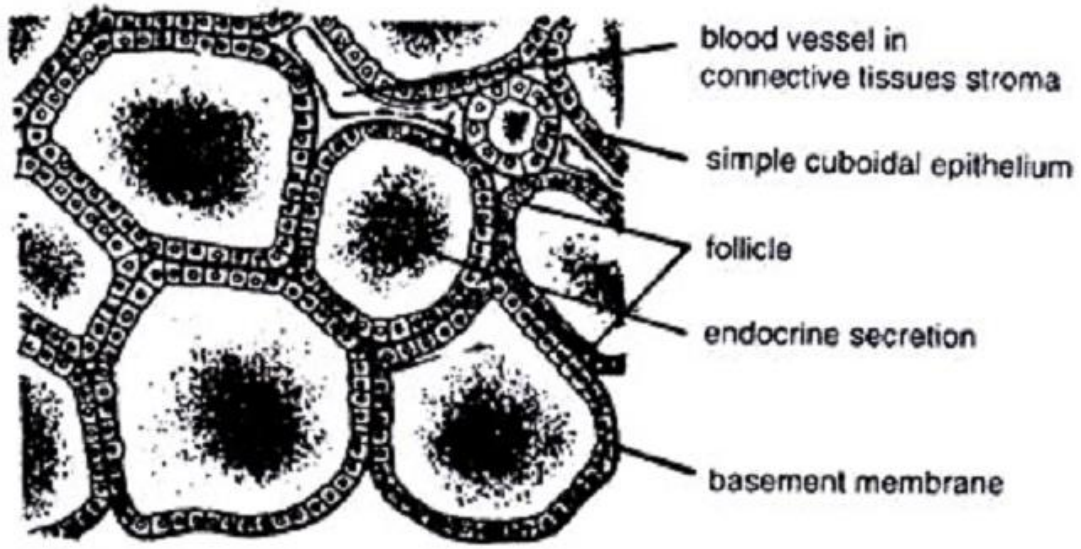
- The lumen of each follicle comprises 2 types of cells

➢ Principal, chief or follicular cells - secrete hormones

T4 (tetraiodothyronine)

T3 (tri-iodothyronine)

➢ Parafollicular cells or c-cells-secrete **calcitonin**.



- Cytoplasm contains granules and droplets

Histology of Adrenal Gland

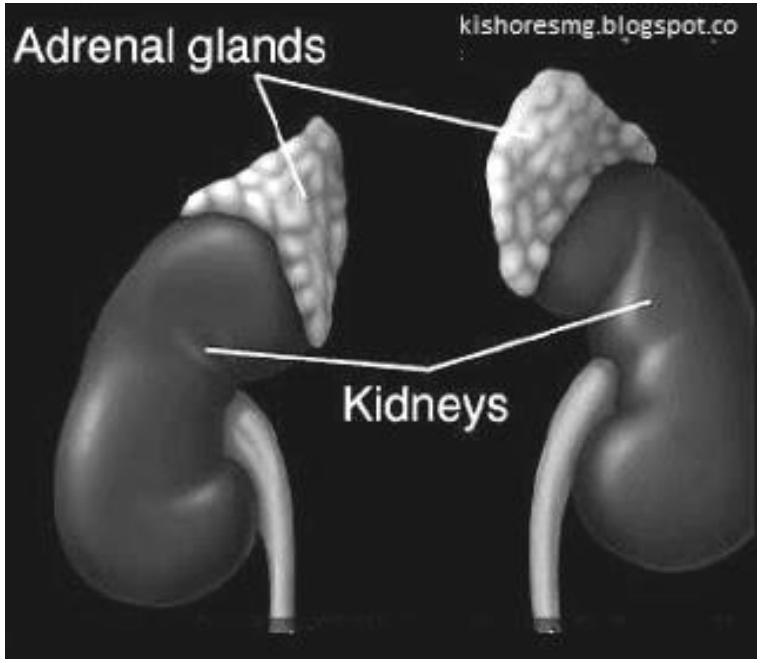
-small triangular in shape,

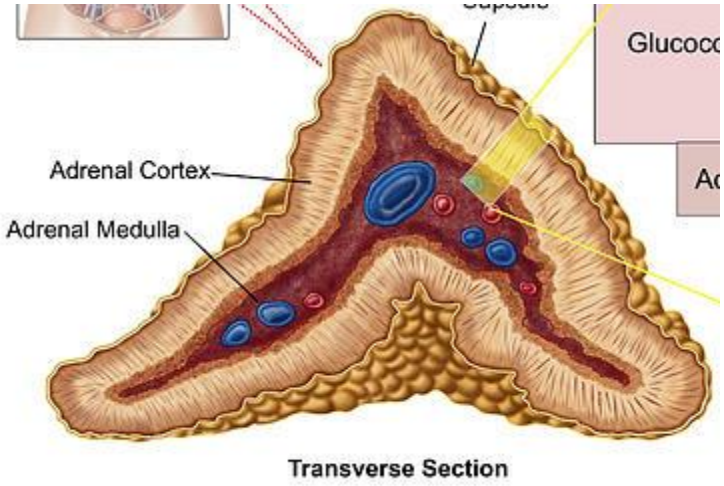
-anterior end of the kidney

- The entire gland is covered by fibrous capsule.
- it is composed of

- outer vertically striated, **yellow coloured cortex**

- inner soft highly vascular **dark brown medulla**.





CORTEX - steroid secreting portion.

-divided into 3 zones based on arrangement of cells

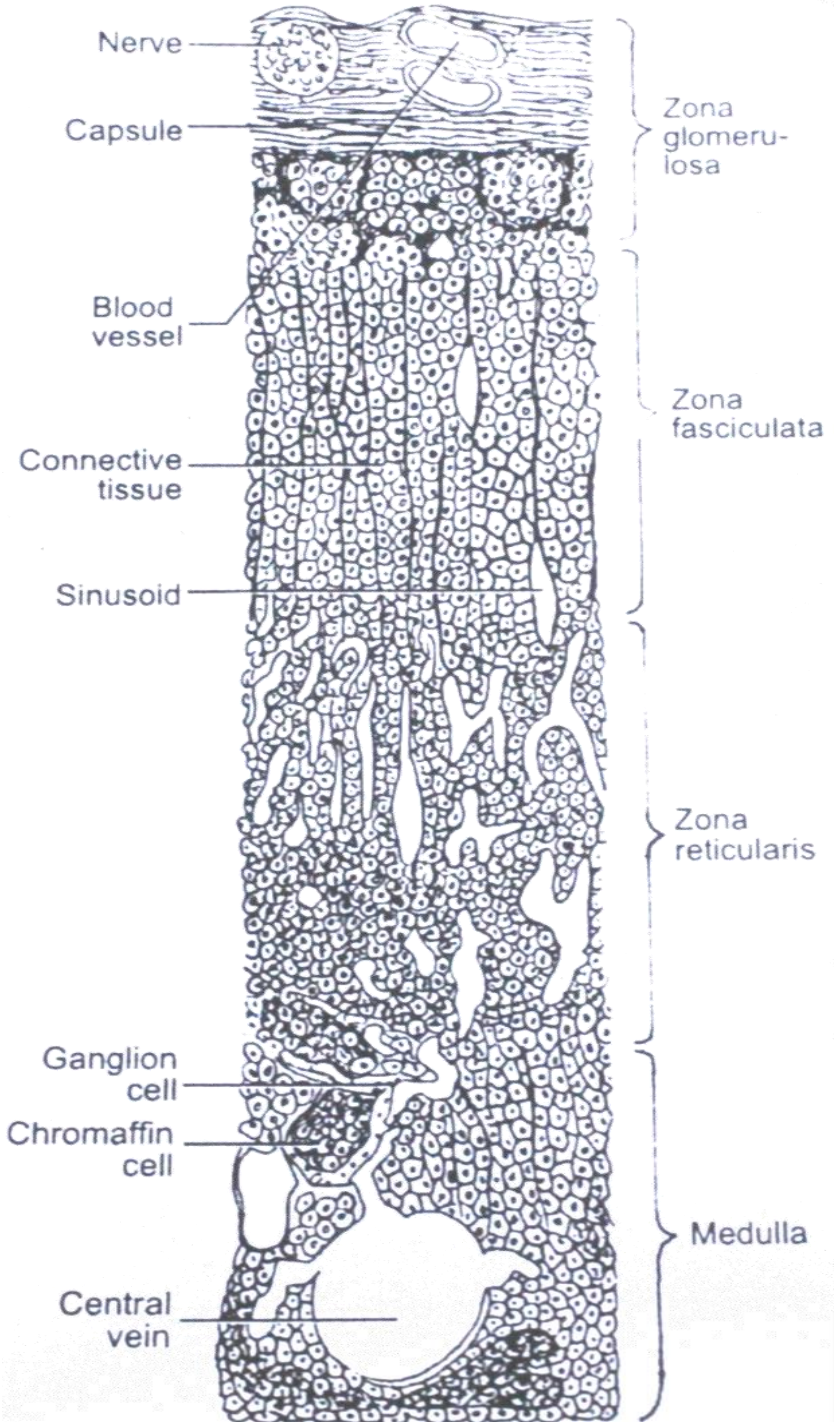
- **Zona glomerulosa**

-found below the capsule

-comprises columnar cells

-synthesize and secrete **mineralocorticoids**

- controls the mineral and water balance of the body
- fat and carbohydrate absorption



- **Zona fasciculata**

-cells are large and polyhedral

-arranged in long straight cords,

-one or two cells thick, that are separated by the sinusoidal capillaries

-secretes **glucocorticoids**

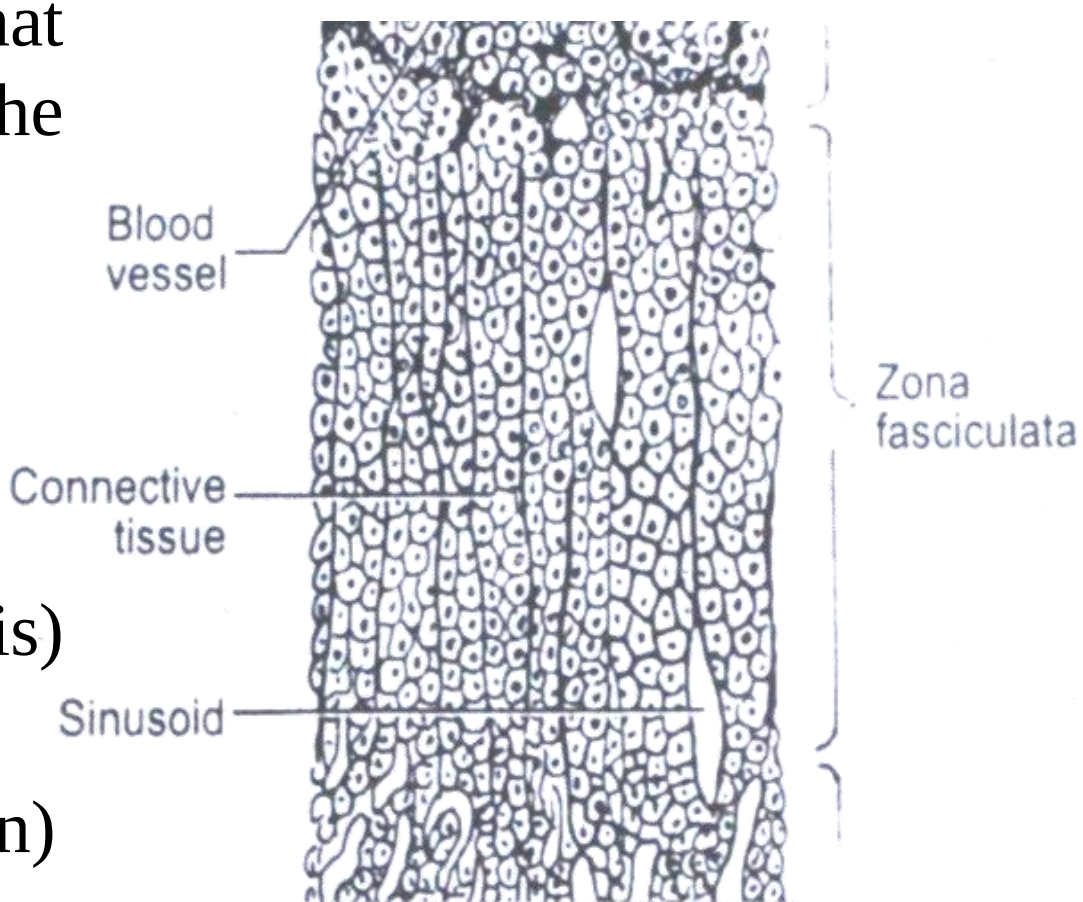
-regulating

gluconeogenesis

(glucose synthesis)

glycogenesis

(glycogen polymerization)



- **Zona reticularis**

-Cells are arranged in anastamosing cords, separated by fenestrated capillaries

-The cells have few lipid droplets.

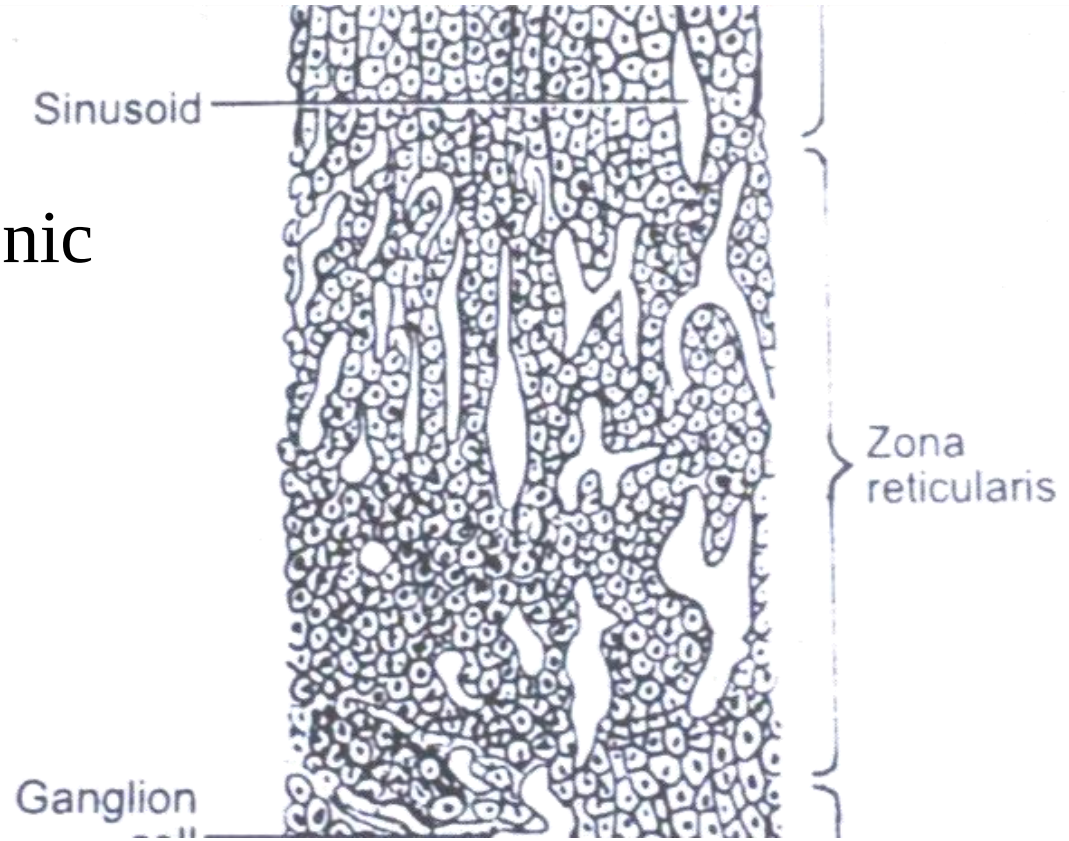
-cells secrete weak androgenic steroids

Dehydroepiandrosterone

(DHEA)

and

Glucocorticoids (Hydrocortisone)



- **MEDULLA** composed of

-**chromaffin cells** (they react with chromate salts)

-connective tissue,

-numerous sinusoidal blood capillaries

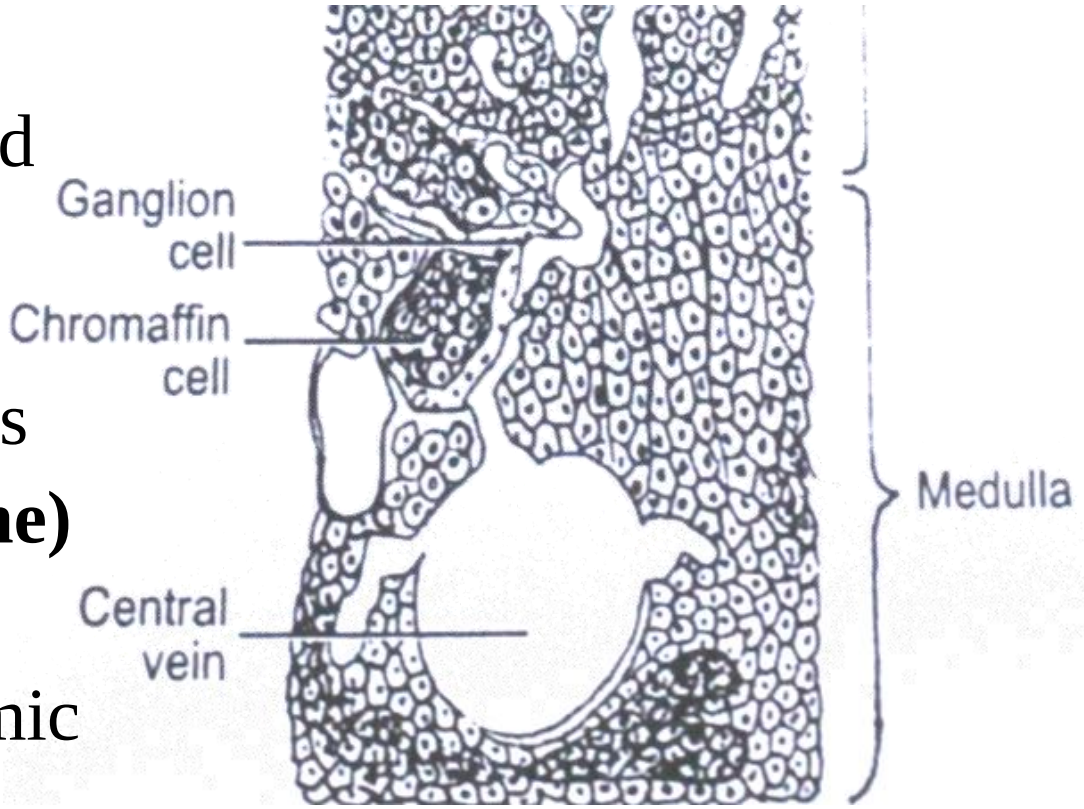
-nerves.

- The medullary hormones

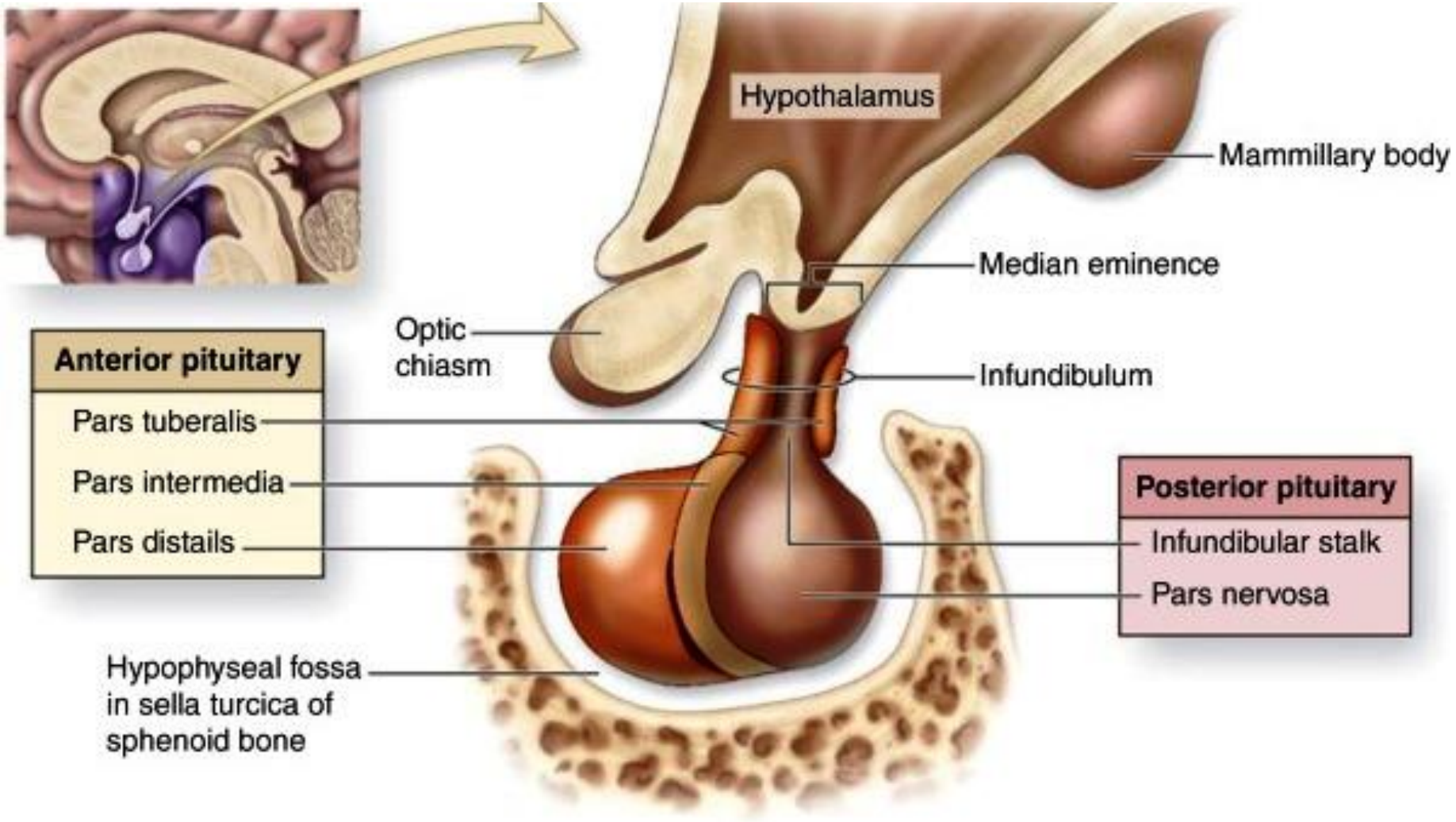
- Epinephrine (Adrenaline)

- Norepinephrine

Epinephrine is hypoglycemic hormone (emergency hormone) promotes glycogenolysis and increases blood pressure



Histology of Pituitary Gland



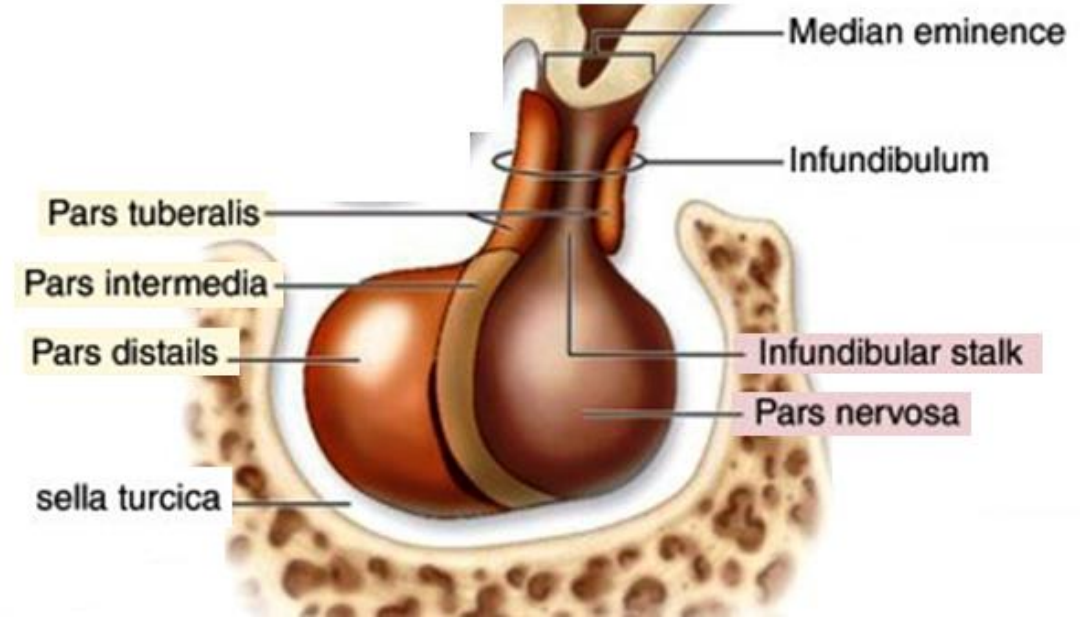
Adenohypophysis (anterior or glandular pituitary)

Neurohypophysis (posterior or neural pituitary)

Adenohypophysis

- glandular epithelial tissues.
- parts, viz.,

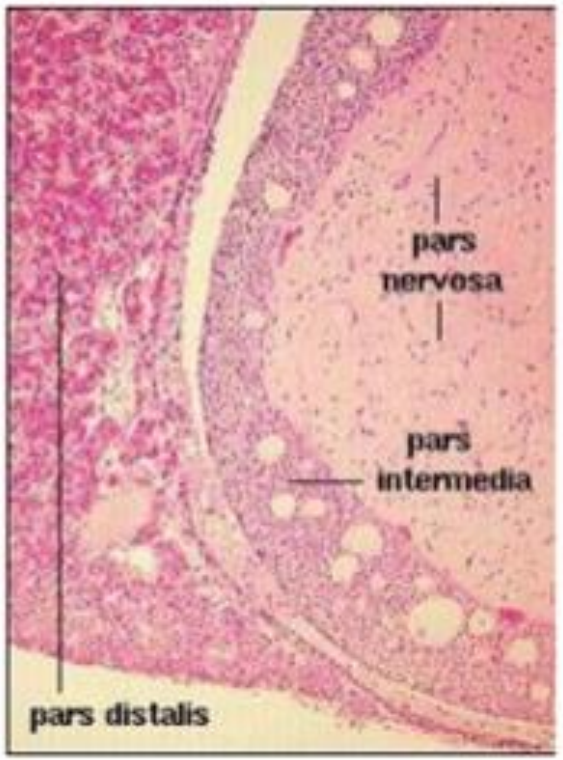
- Distal lobe/ Pars distalis
- Intermediate lobe/ Pars intermedia
- Tubular lobe/ Pars tuberalis



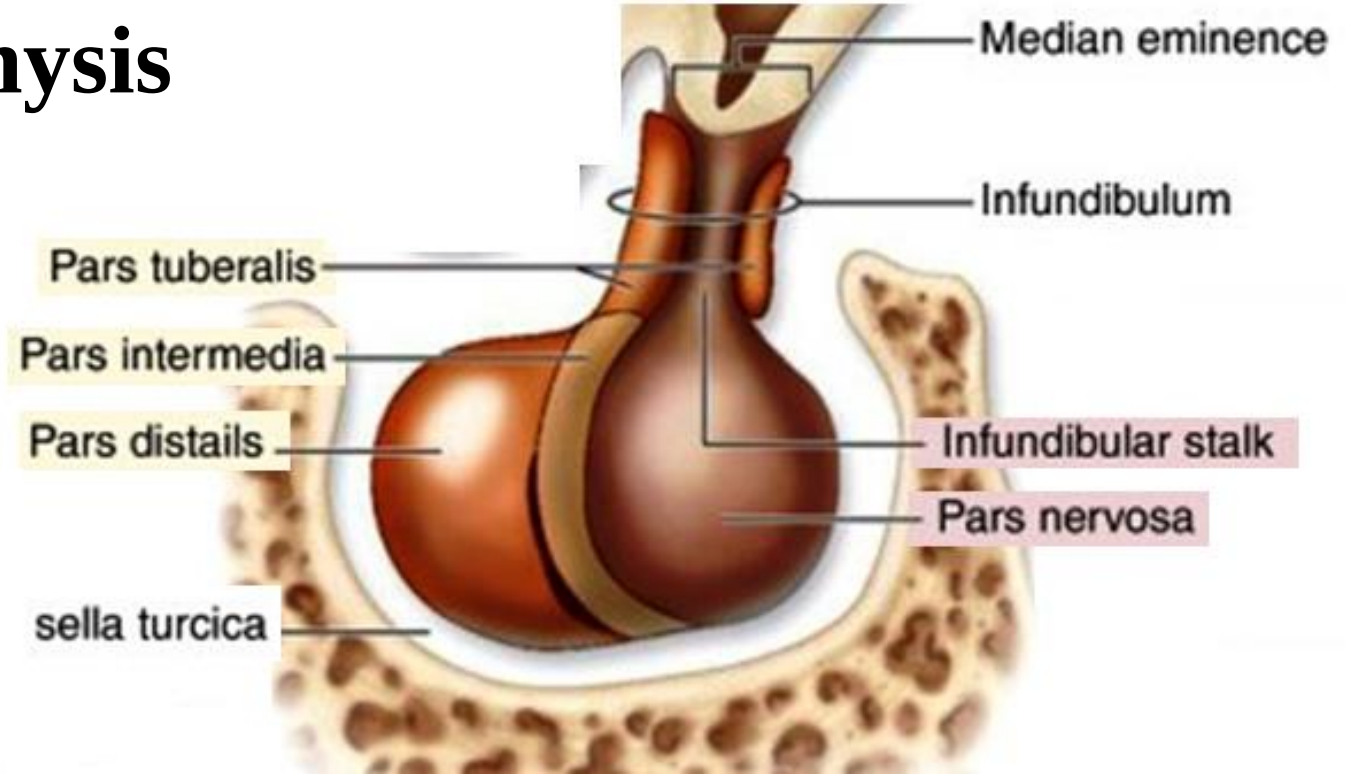
Neurohypophysis

- neural secretary cells.
- parts, viz.,

- Neural lobe/ Pars nervosa
- Pituitary stalk/ Infundibular stem
- Median eminance/ Infundibulum



Adenohypophysis



- **Pars distalis**

- is the largest part of pituitory (75%)
- supported by collagenous capsule
- two major types of cells
  chromophils

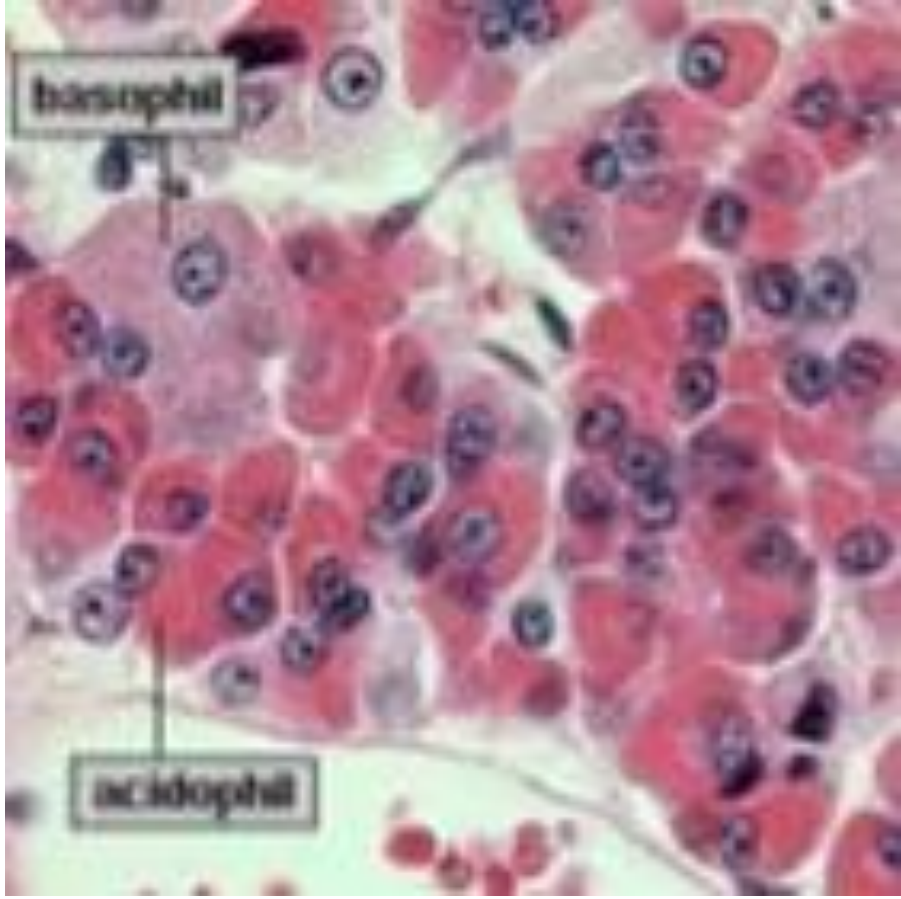
  chromophobes

Chromophils

- ovoid cells with granular cytoplasm and nuclei
- take up acid or basic stains
- two types

a. Acidophils (alpha cells)

- rounded or ovoid cells 10 to 20µ
- stains red or orange
- Acidophils are of two types

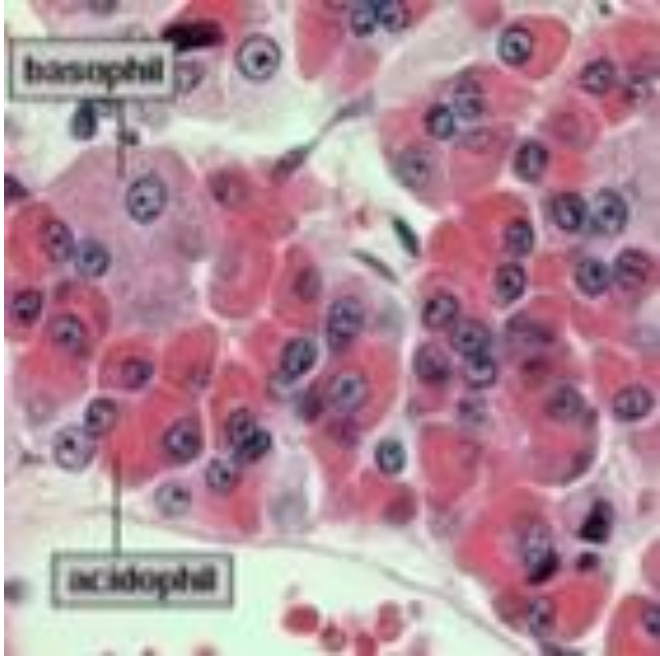


• Somatotrophs- secrete somatotropin - growth hormones.

• Mammotrophs (leutotrophs or prolactin cells)- secrete prolactin hormone.

b. Basophils (beta cells)

- irregular shaped
- stain with basic dyes
- Basophils are of two types



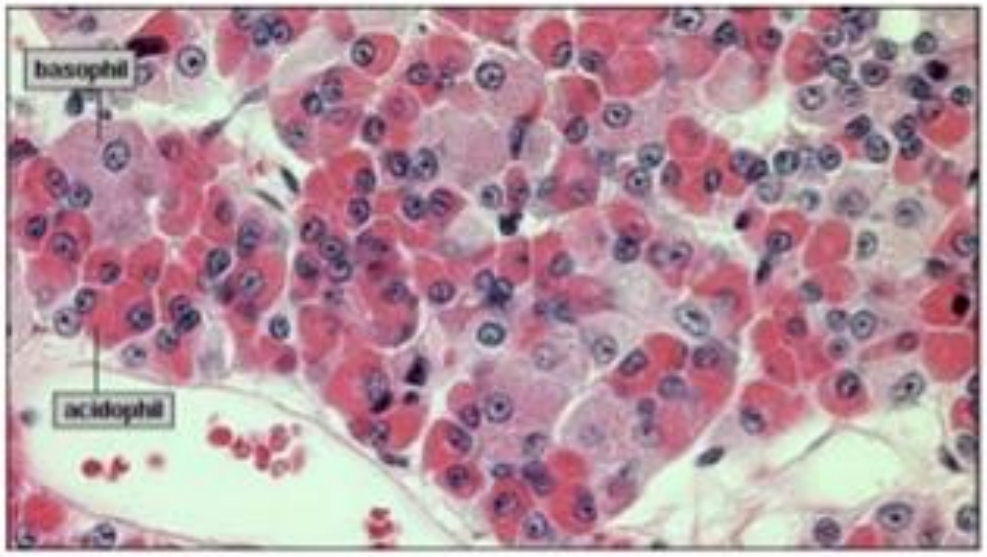
- **Thyrotrophs-** secrete thyrotrophic hormone

- **Gonadotrophs-** secrete gonadotrophic hormone
  i.e. FSH (Follicle stimulating hormone)
  LH (leutinizing Hormone)

Chromophobes

(chief cells)

- spherical, elongated and irregular cells
- appear in groups near center of cords
- light staining cytoplasm

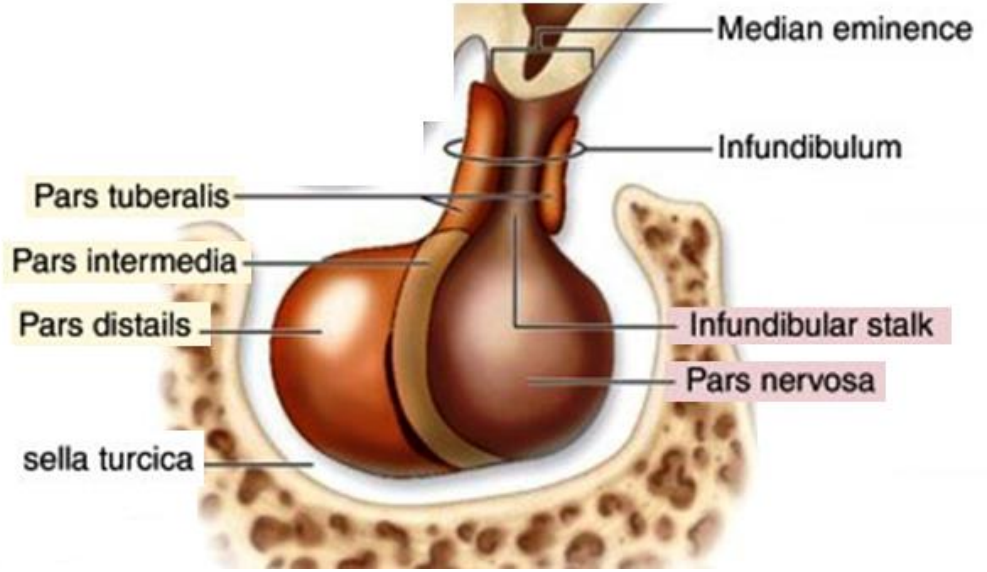


cells produce adrenocorticotropic hormone (ACTH) - Adrenal glands- **cortisol**

Pars Intermedia

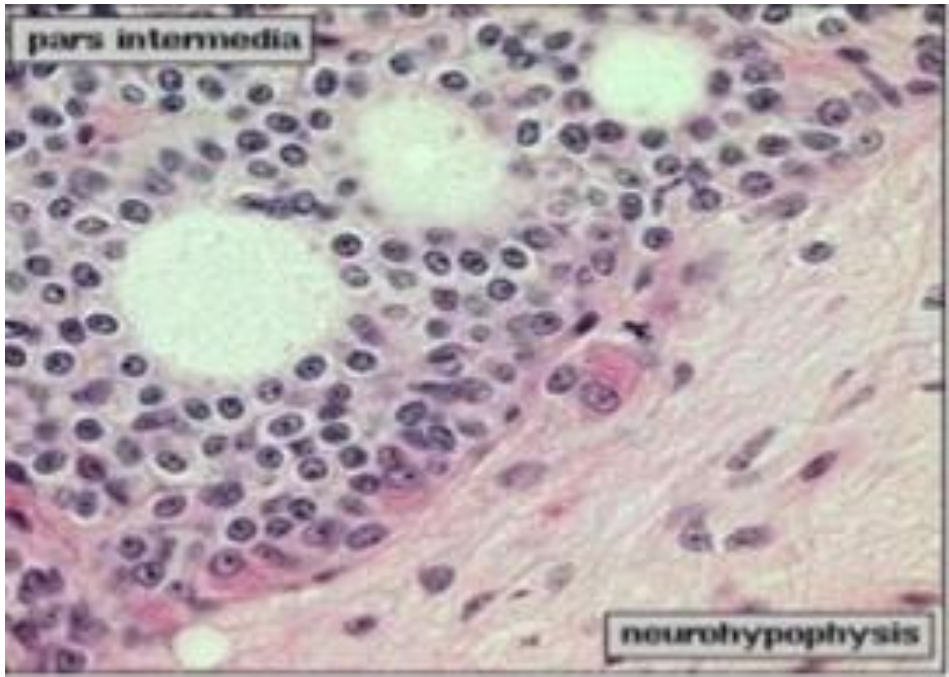
- polygonal cells
- Basophilic
- secrete melanonocyte stimulating hormone

  (fish and amphibians)
- In mammals ?



Pars tuberalis

- layer of cuboidal cells
- highly vascular
- produce any hormone?



Neurohypophysis

- Formed from the floor of the diencephalon
- stalk and
- posterior 1/3 of the pituitory gland - swollen end –

  pars nervosa or

  infundibular process

- cells of neural lobe – pituicytes

- Two hormones

  Oxytocin

  Anti-diuretic