Lecture 2 ESS_3rd semester

MICROSCOPIC STRUCTURE OF LIVER, GALLBLADDER, GALL DUCTS, AND PANCREAS

OVERVIEW OF DEVELOPMENT OF THE ALIMENTARY CANAL

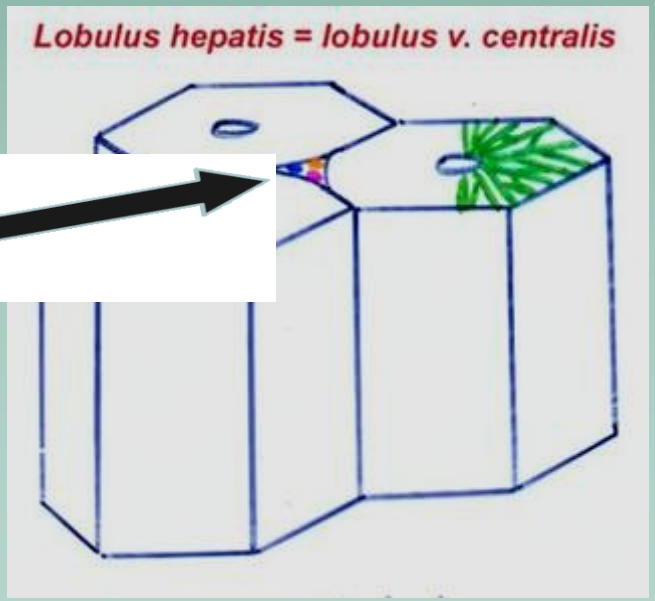
MICROSCOPIC STRUCTURE OF LIVER

- is the largest gland of the body
- is of endodermal origin
- it consists of the **connective tissue, parenchyma, and blood vessels**

connective tissue – 2 sites:

- **fibroconnective capsule (capsule of Glisson) –** on the surface of liver

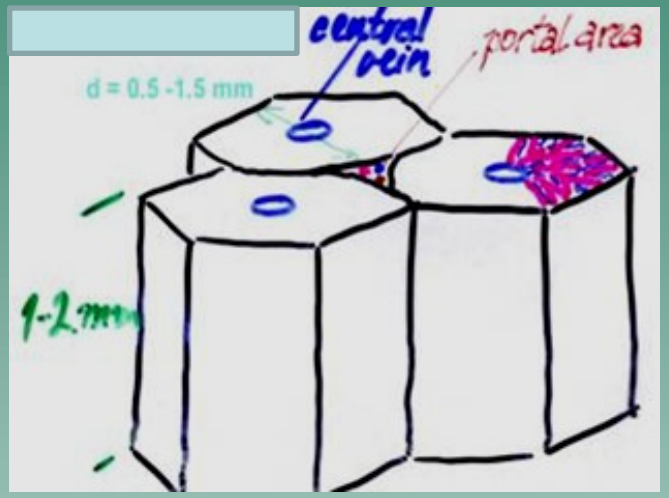
- **interstitial connective tissue within parechyma** - is poor in amount
  distinct is in **portal areas (portal canals)** – sites where usually meet 3 hepatic lobules (structural units of the parenchyma)
  portal areas have **triangular shape** (triangles of Glisson)
  portal area contains **triad of Glisson**:
  - interlobular vein (from v. portae)
  - interlobular artery (from hepatic artery)
  - bile duct

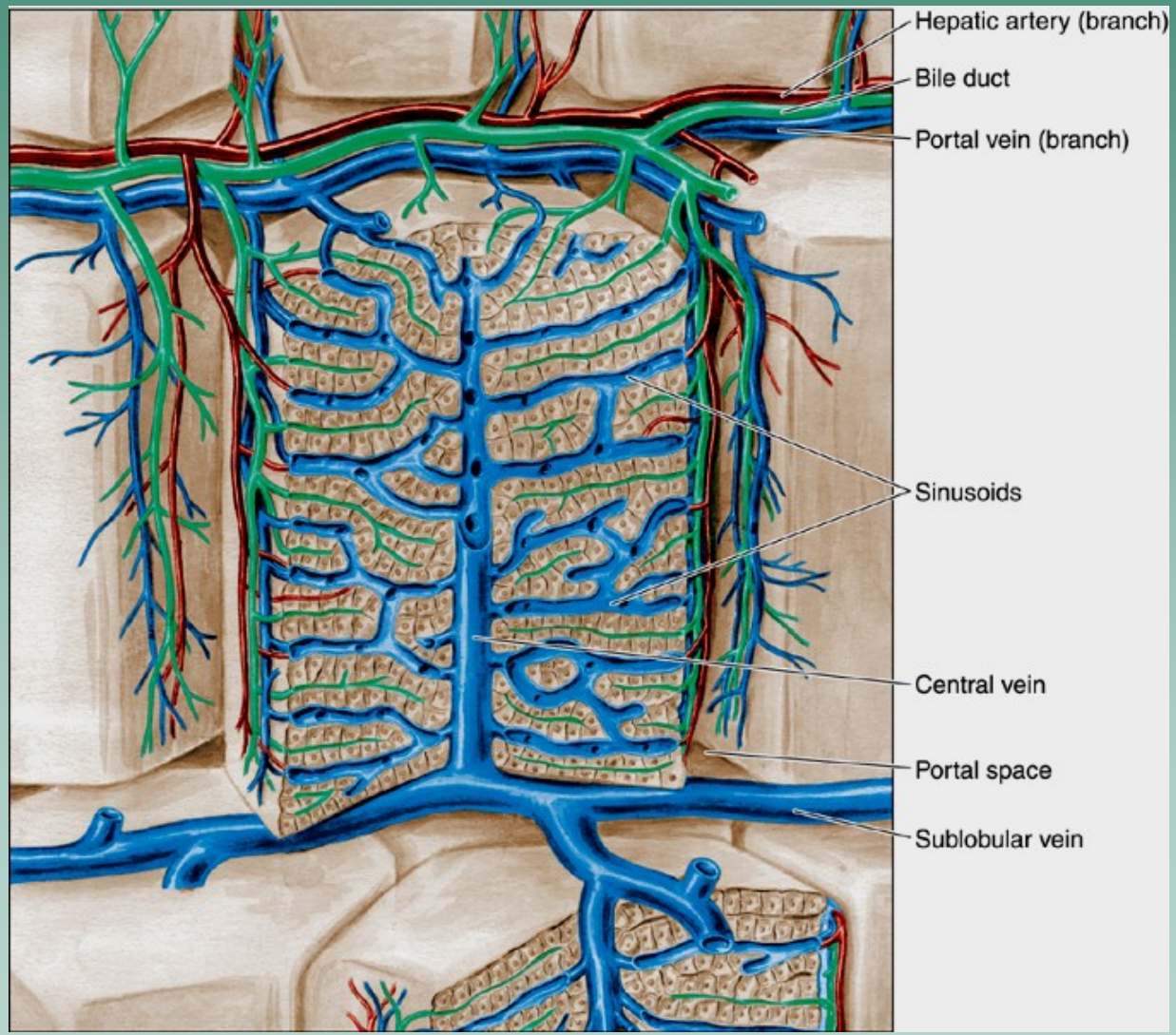


Parenchyma

hepatic lobules (lobules of a central vein) and **intrahepatic bile ducts**

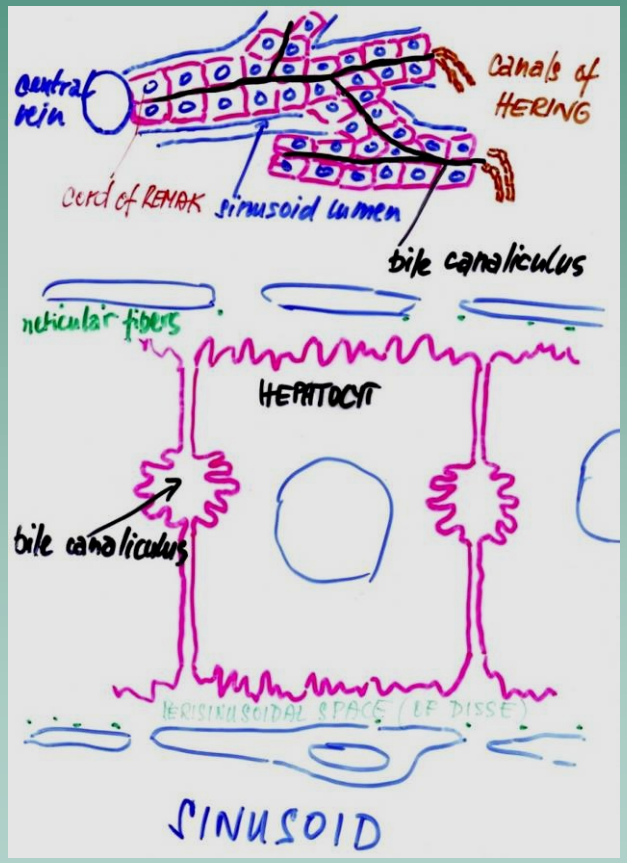
lobules are **polyhedral prisms** of 1 to 2 mm high nad wide
in cross sections lobules usually show **hexagonal profile** with a central vein in their centres

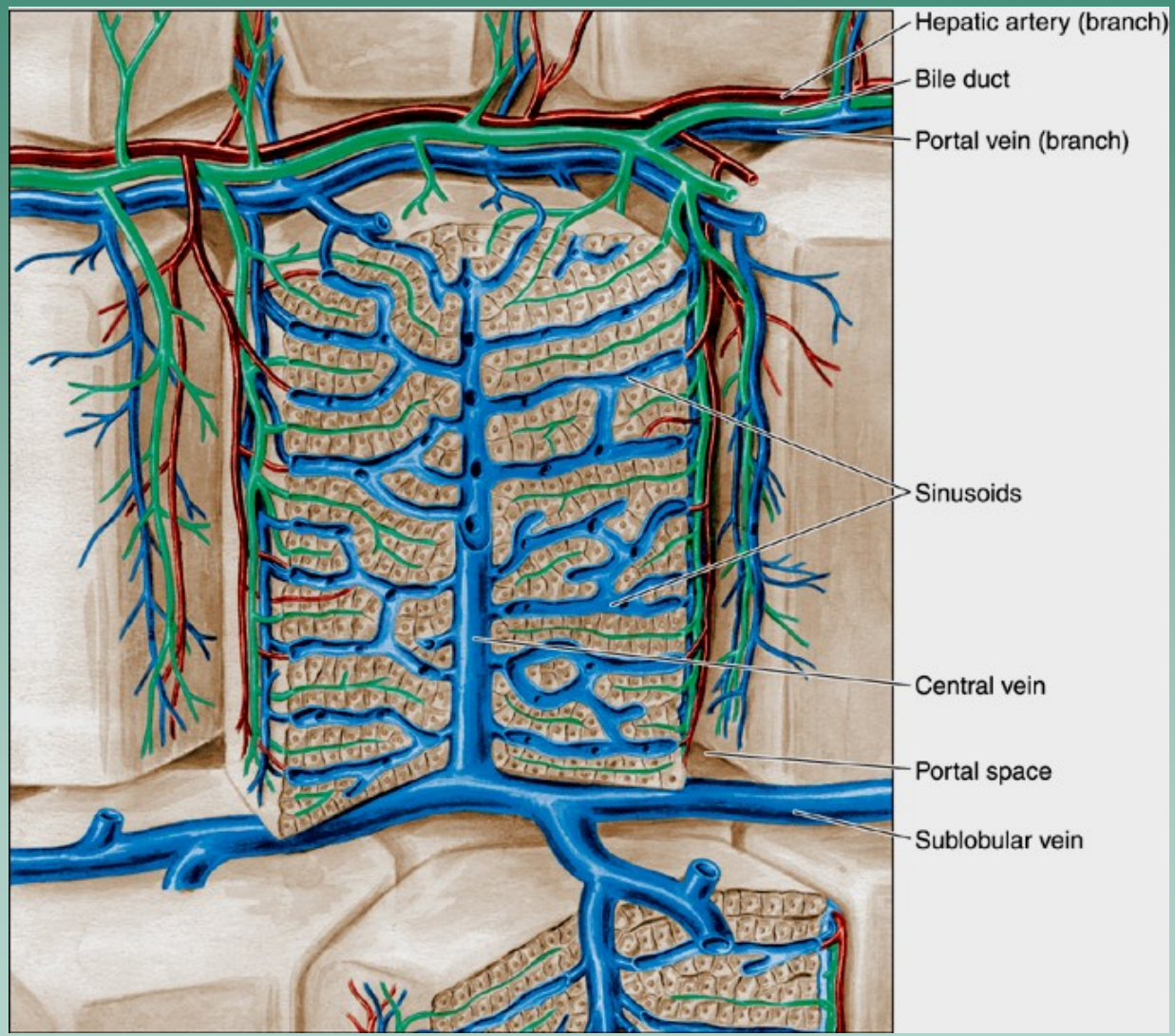




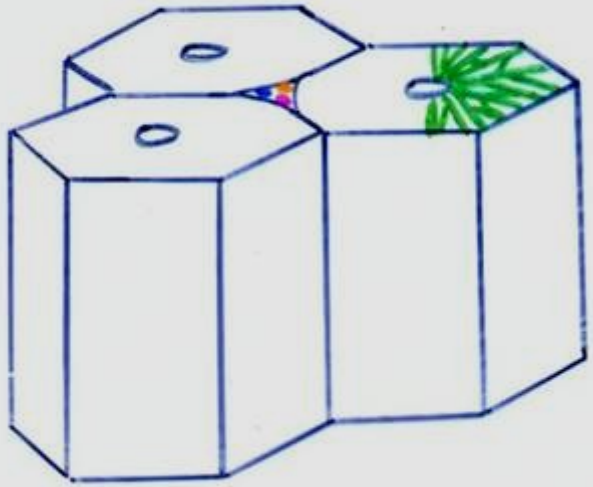
hepatic lobule consists of **hepatic cell plates** (**cords of Remak**) alternating with **sinusoids**

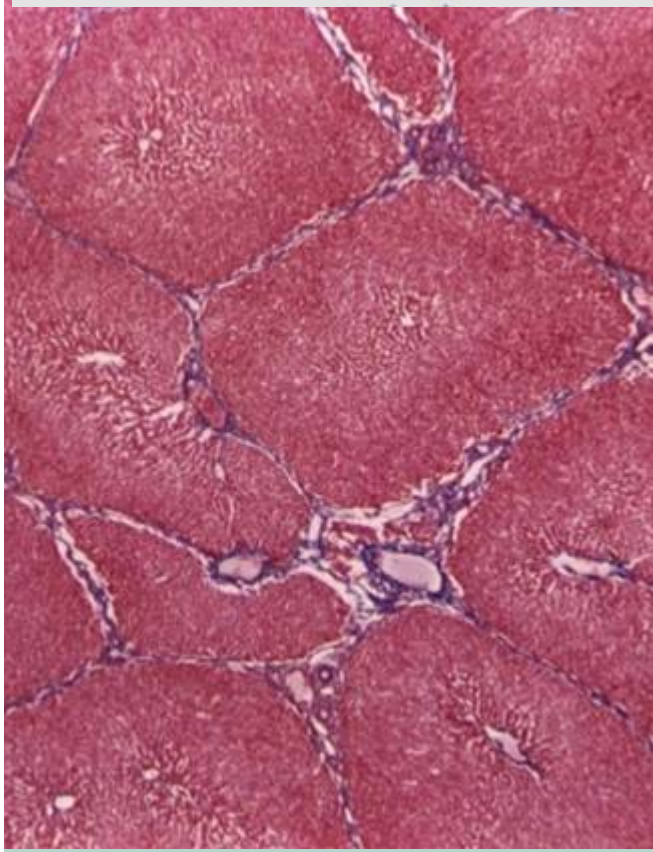
hepatic cell plates are made up of 1 or 2 rows of hepatocytes among them run bile canaliculi

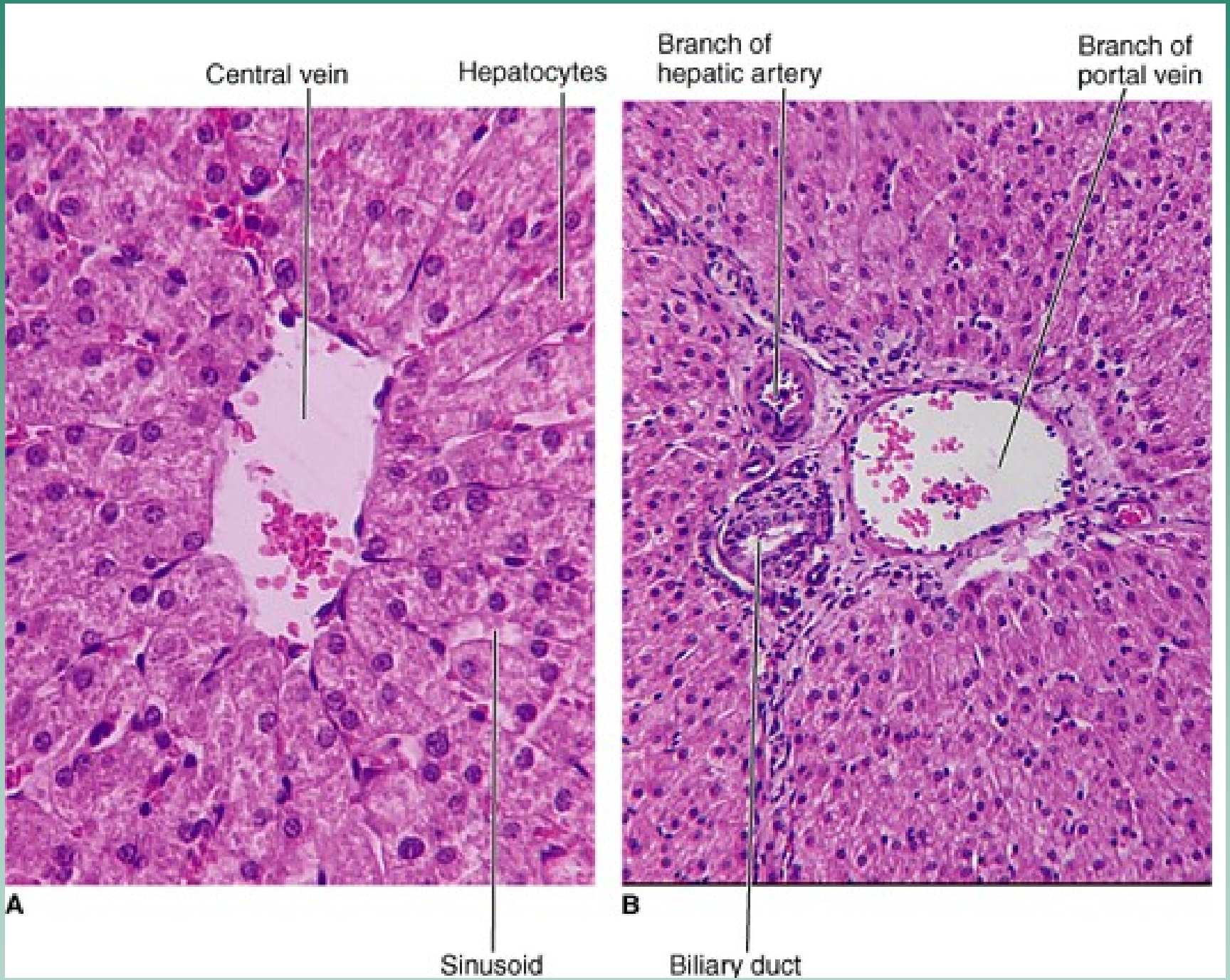


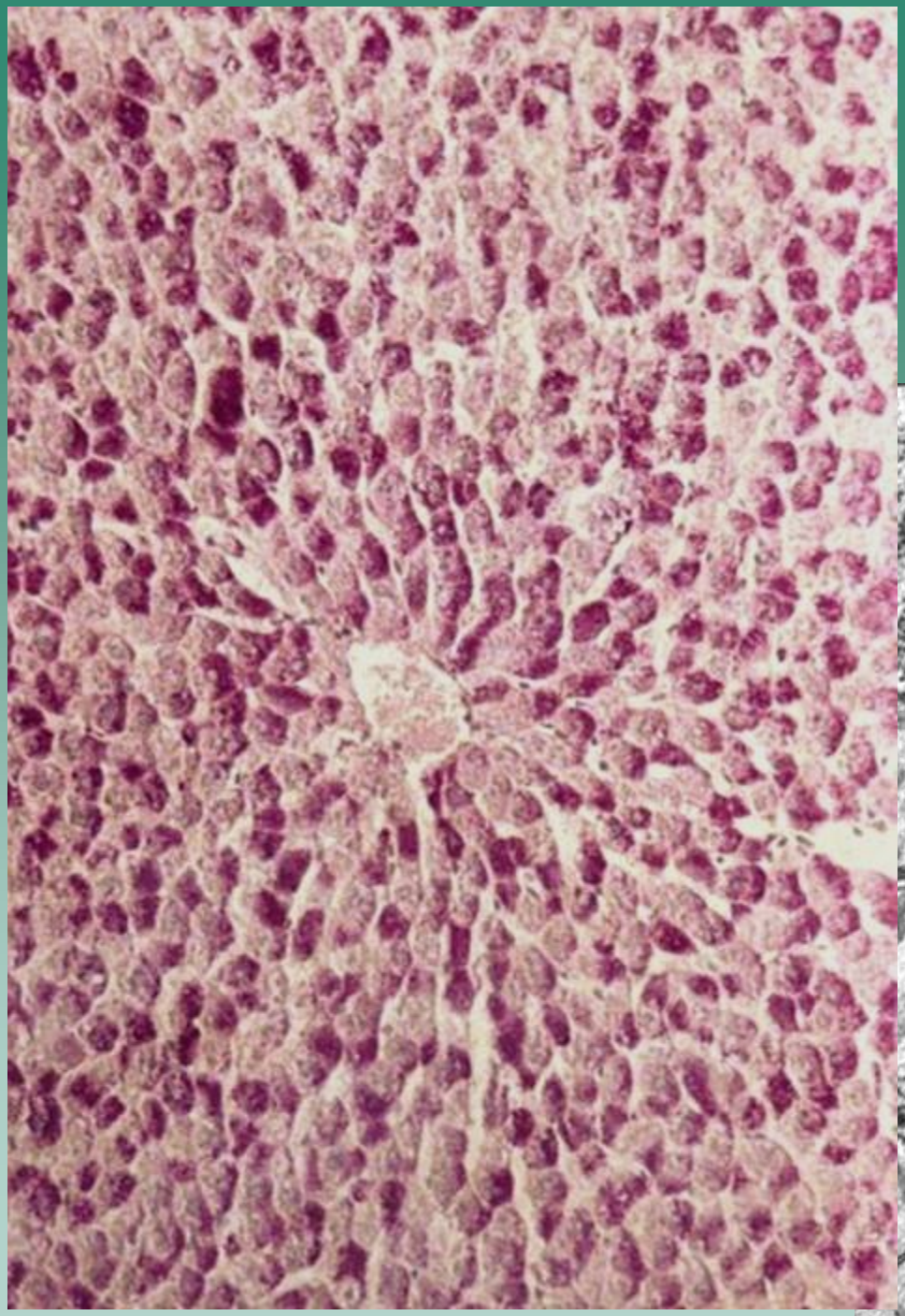


Lobulus hepatis = lobulus v. centralis

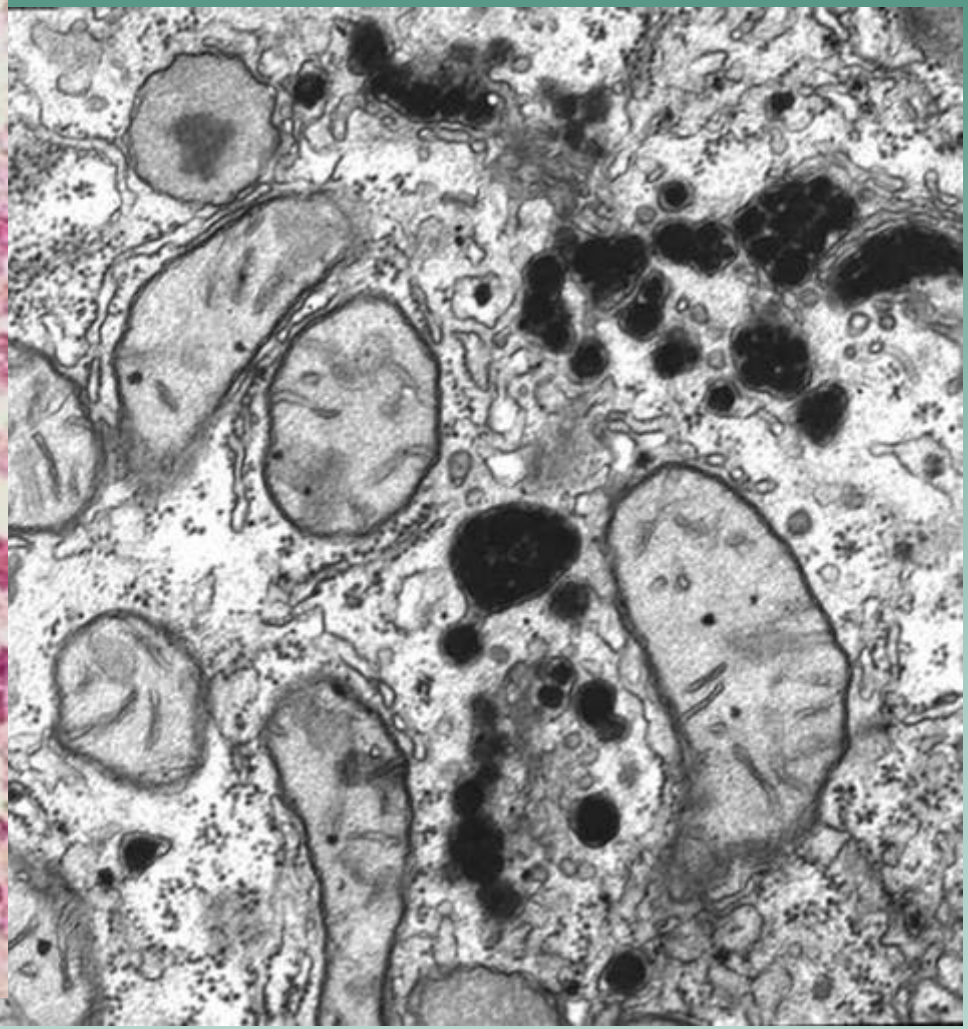





Central vein
Hepatocytes
Sinusoid
A
Branch of hepatic artery
Branch of portal vein
Biliary duct
B



hepatocytes
are mostly **polygonal** and often **binucleate cells**
the cytoplasm is eosinophilic and slightly granular. The plasma membranes of two adjacent hepatocytes are smooth except the surfaces limited the bile canaliculi and perisinusoidal spaces.

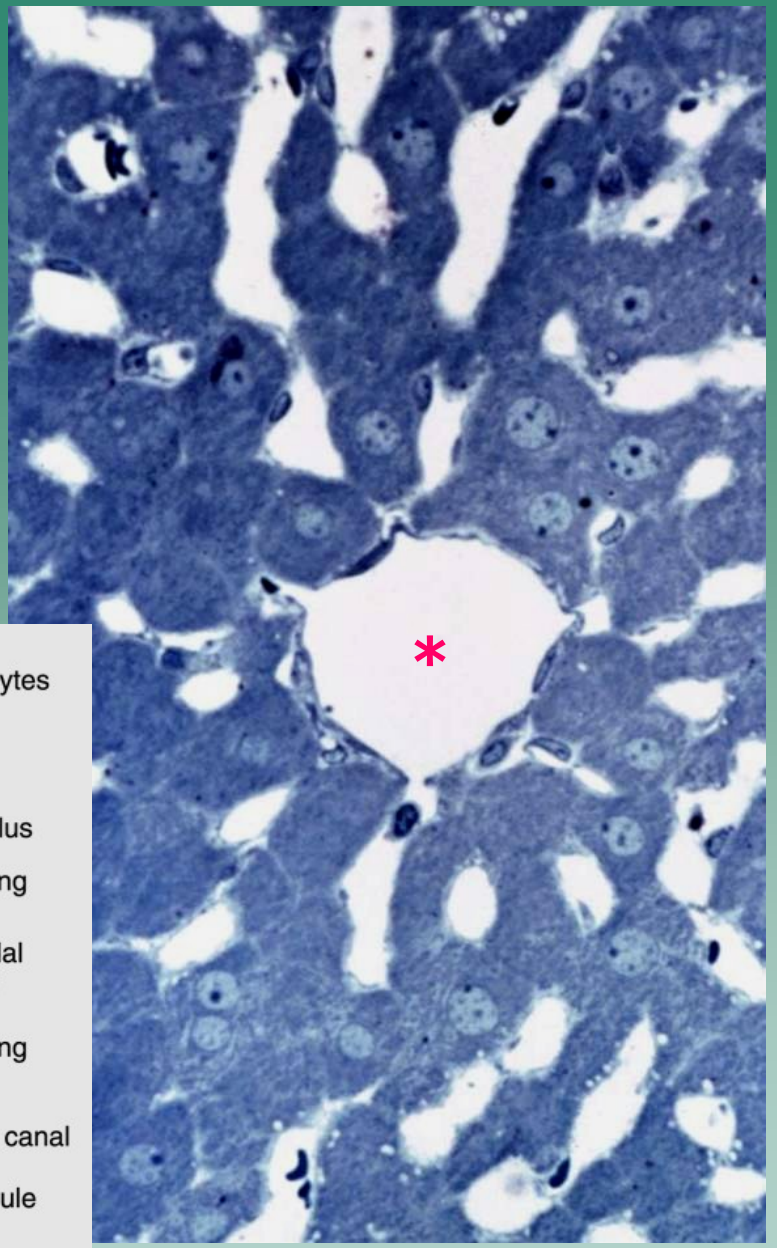


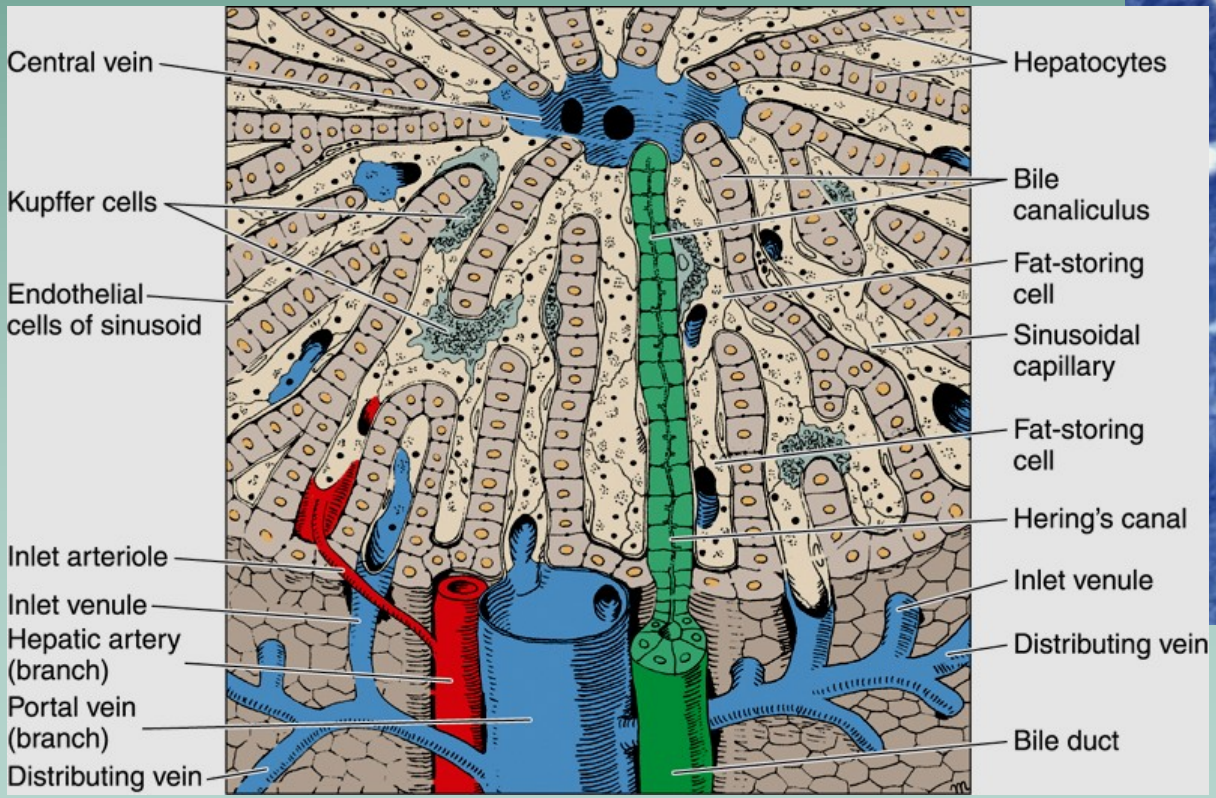
hepatic sinusoids = thin vascular channels

d. cca 20 μm, length of 500 μm or more, branched

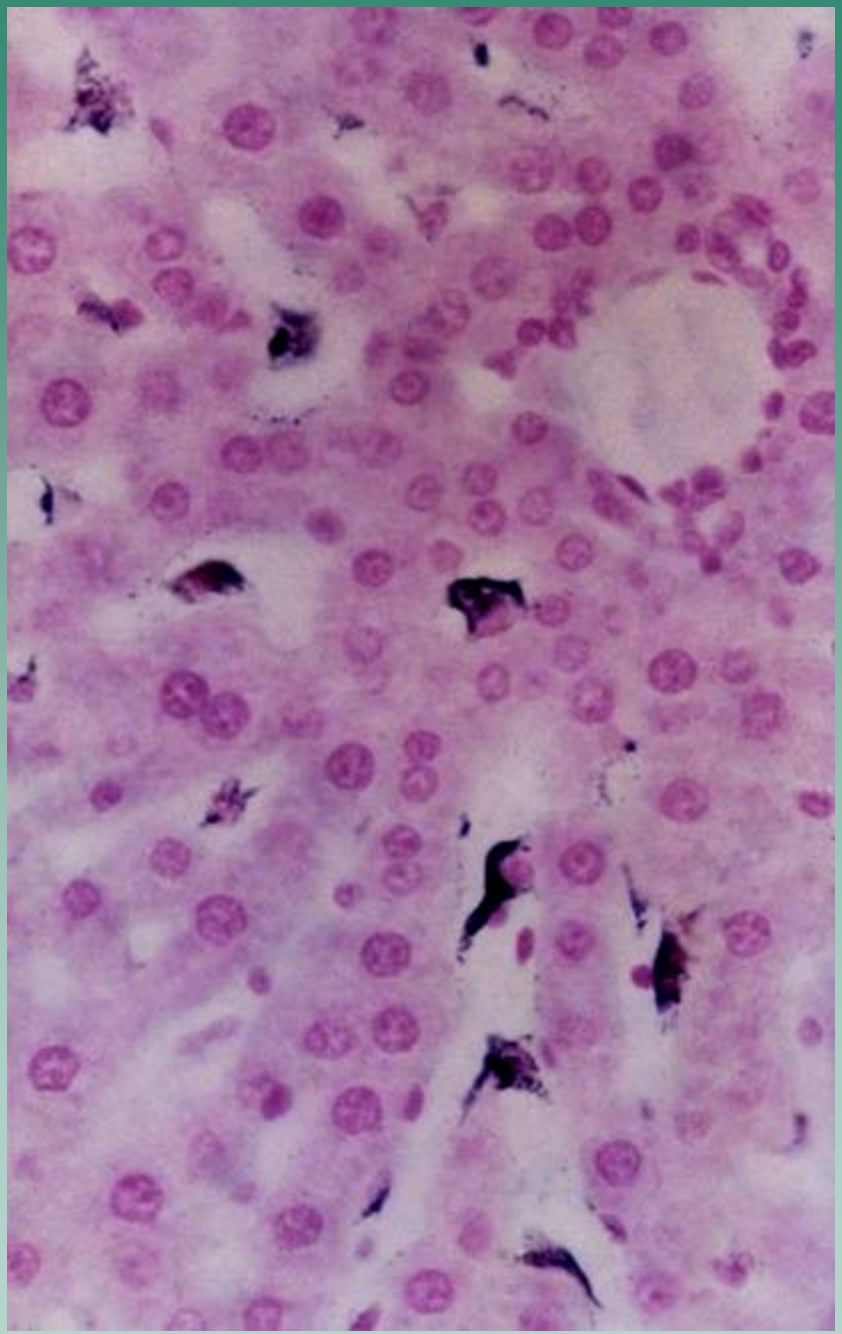
empty into a central vein

lined with **endothelium** + phagocytic **Kupffer cells**





Kupffer cells

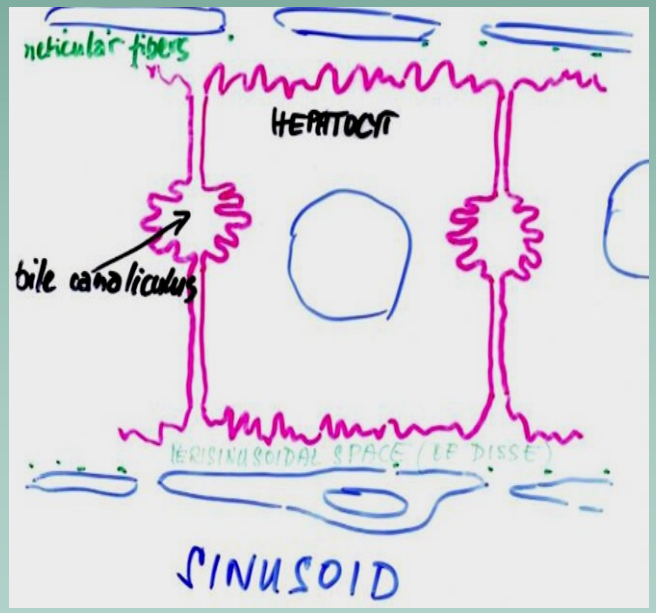


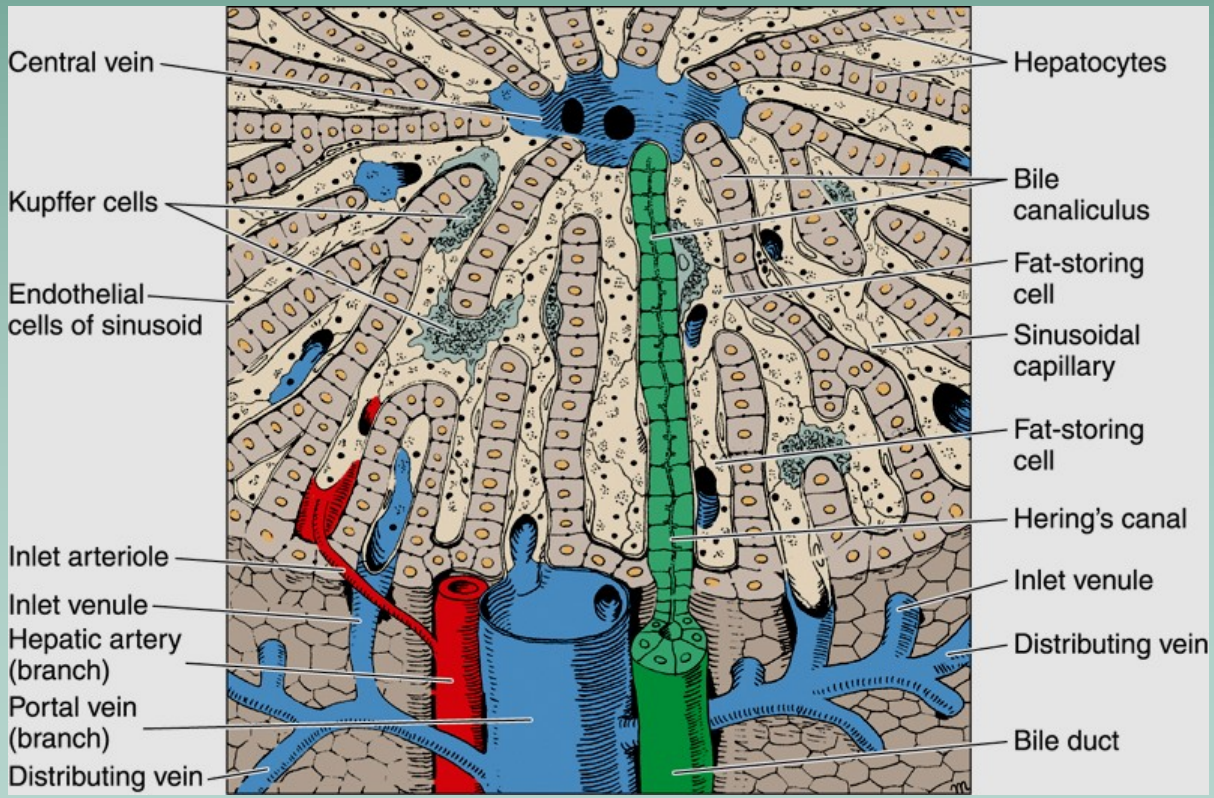
bile canaliculi
diameter cca 1-2 μm

surrounded with plasmalemmas of adjacent hepatocytes

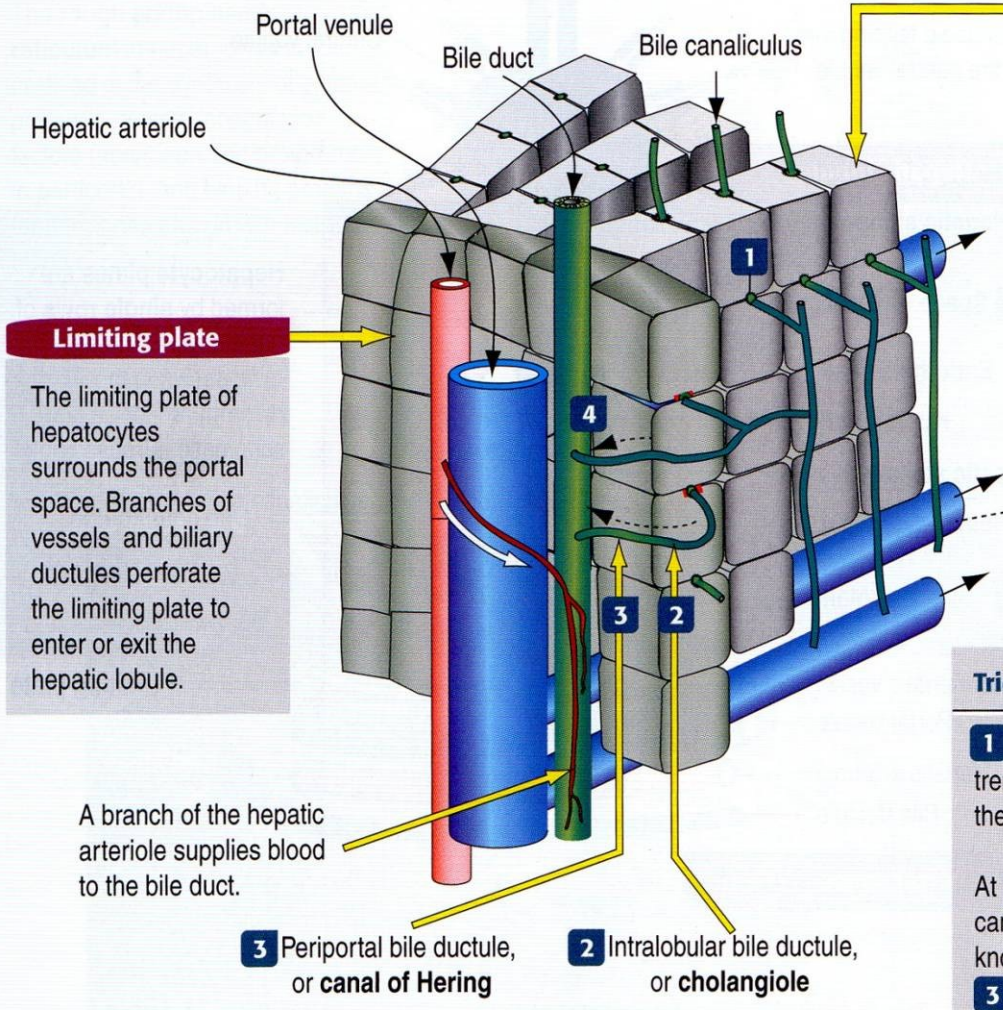
begin blindly near the central vein and run to the periphery of the lobule open into the canals of Hering

Intrahepatic bile ducts: **canals of Herring**
interlobular bile ducts





The portal space and the bile ducts



Hepatic plate

Hepatocytes are arranged in plates, one cell thick. Hepatic plates branch or anastomose, leaving a space containing venous sinusoids. In histologic sections, rows of hepatocytes, representing sections of plates, converge at the central vein.

Limiting plate

The limiting plate of hepatocytes surrounds the portal space. Branches of vessels and biliary ductules perforate the limiting plate to enter or exit the hepatic lobule.

Hepatic **venous sinusoid** (fenestrated) extending toward the central vein of the hepatic lobule

Tridimensional topography of hepatocytes

1 At least two faces of a hepatocyte contain a trench forming a **bile canaliculus**. The sides of the trench are sealed by a tight junction.

At the periphery of the hepatic lobule, bile canaliculi empty into thin intralobular ductules, known as 2 **cholangioles**, and then into a 3 **terminal ductule**, or **canal of Hering**, lined by cuboidal/squamous epithelial cells. The terminal ductules leave the lobule through the limiting plate and enter the 4 **bile duct** in the portal space.

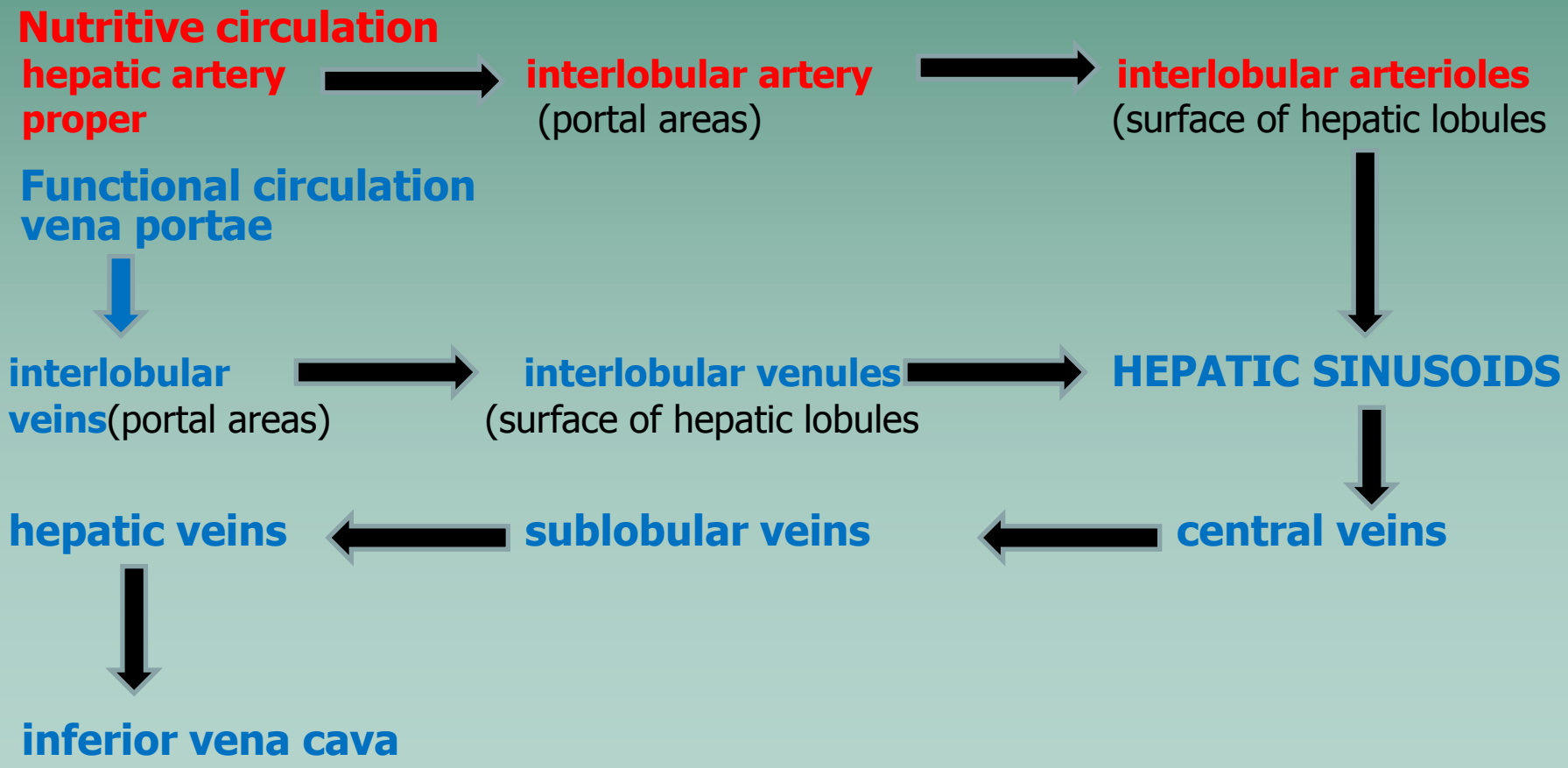
Kierszenbaum 2002

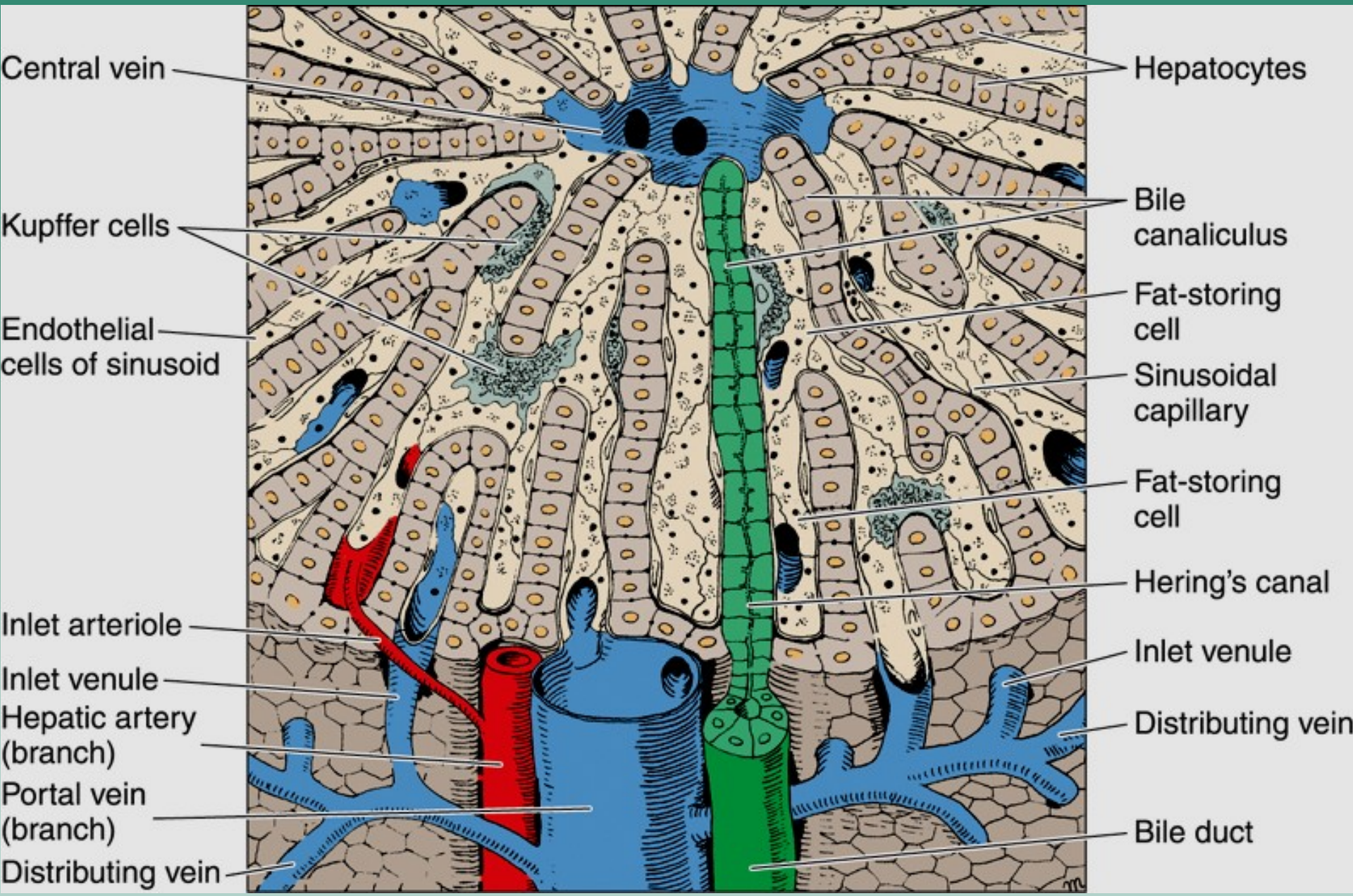
Blood circulation of the liver

2 circulations - nutritive one (hepatic artery) - oxygenated bood
- functional one (portal vein) - venous blood rich in absorbed products

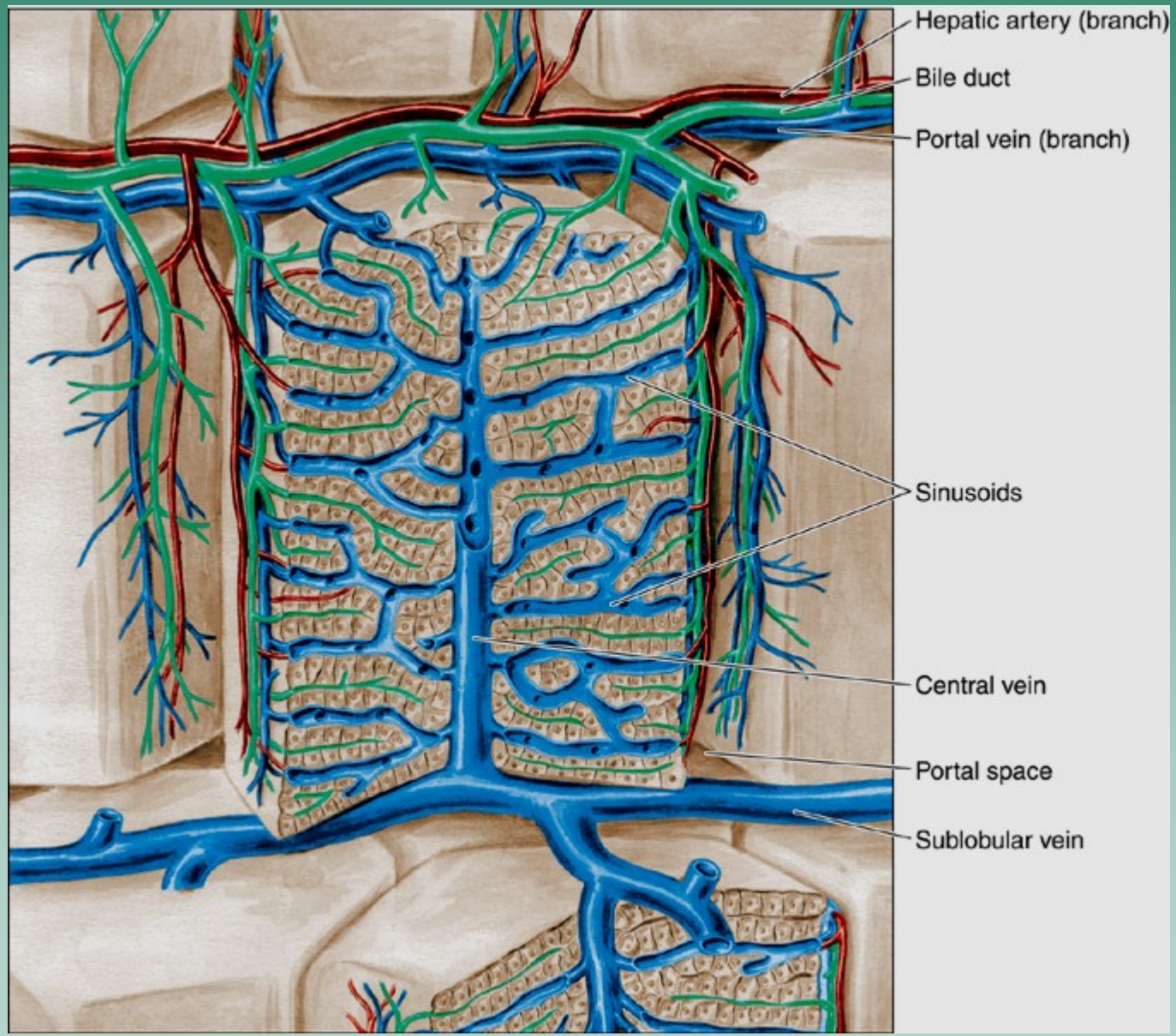
division of blood streams - 20 to 30 % of blood flows nutritive through circulation
- 80-70 % of blood flows through functional circul.

blood of both circulations meets at the level of hepatic sinusoids



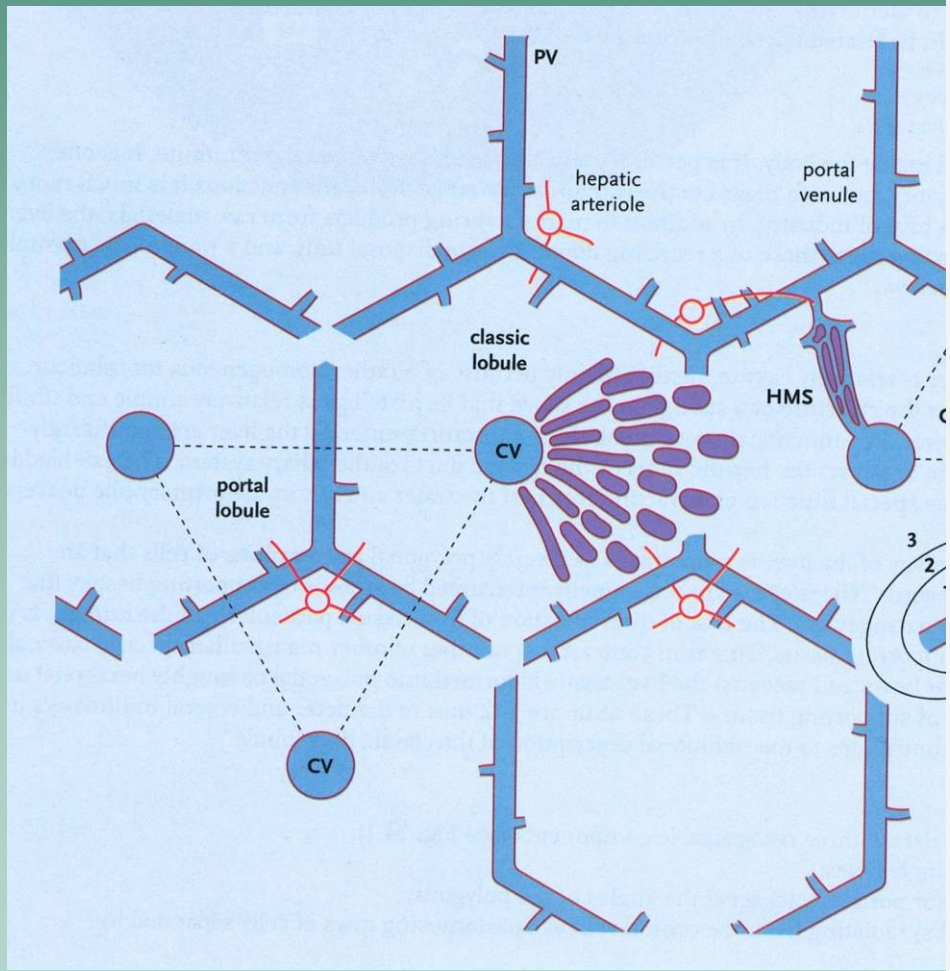

Central vein
Kupffer cells
Endothelial cells of sinusoid
Inlet arteriole
Inlet venule
Hepatic artery (branch)
Portal vein (branch)
Distributing vein
Hepatocytes
Bile canaliculus
Fat-storing cell
Sinusoidal capillary
Fat-storing cell
Hering's canal
Inlet venule
Distributing vein
Bile duct

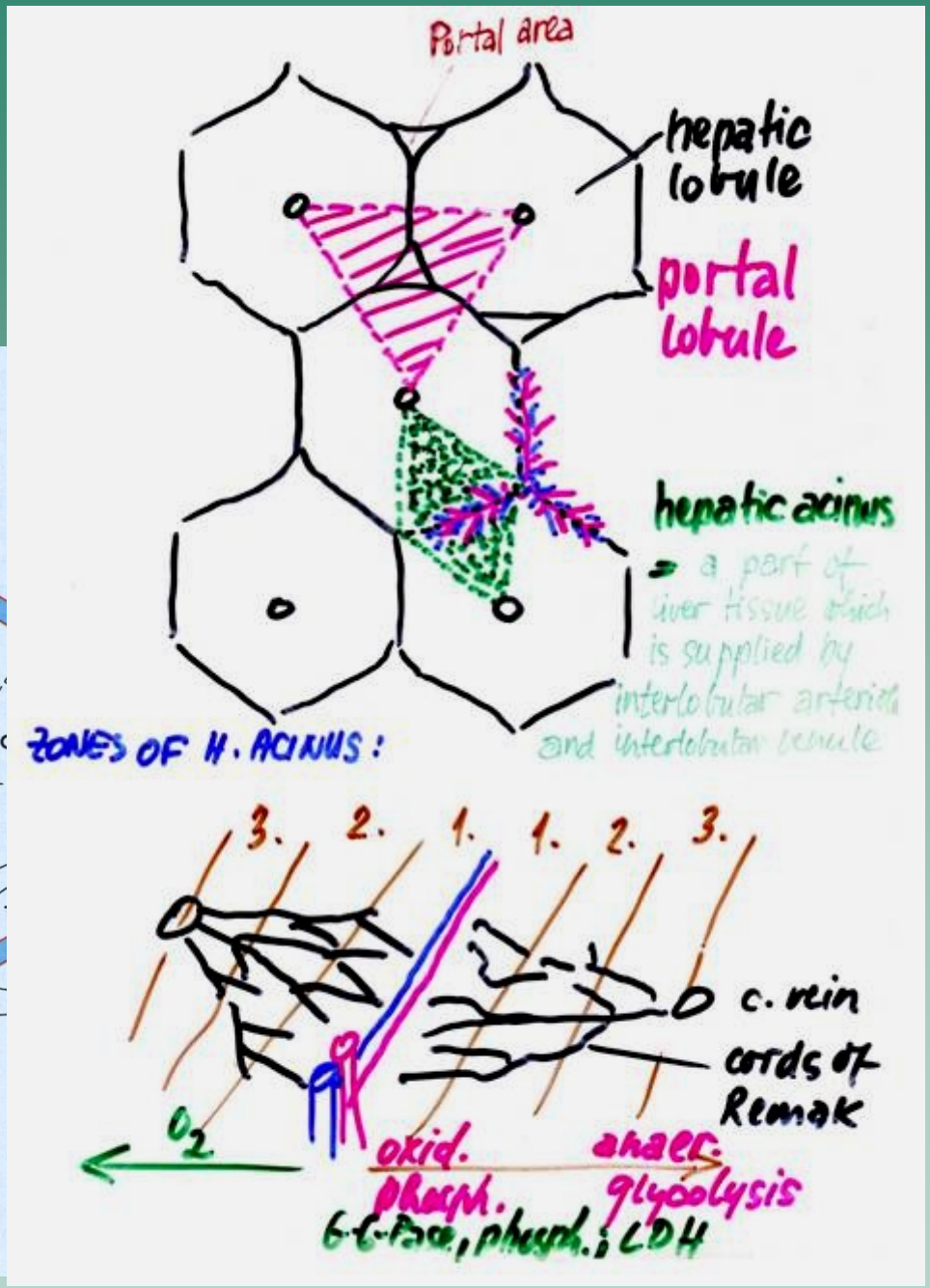
Hepatic lobus (lobule of a central vein)



Concept of a portal lobule

portal lobule - has triangular shape
its centre is formed by a portal area and tissue draining bile into bile duct of that portal area





Zones of hepatic acinus:

1. **zone of permanent activity**
2. **transient zone**
3. **quiescent zone**

Extrahepatic biliary passages

right + left hepatic duct
common hepatic duct
cystic duct

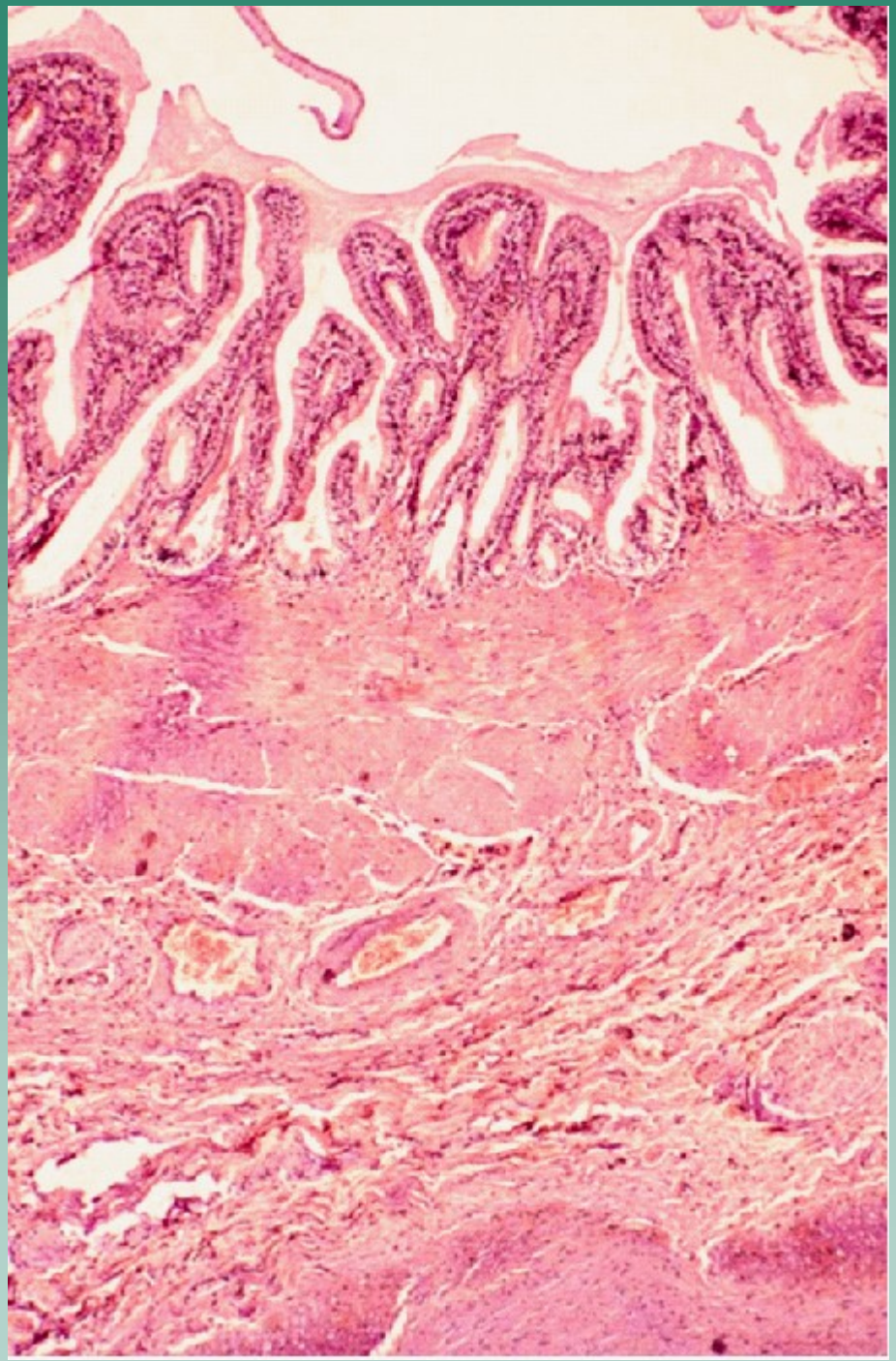
common bile duct (d. choledochus)

gallbladder - 3 layers

- mucosa
- muscular l.
- serous coat (partly also adventitia)

Wall:

1. **simple columnar epithelium**
2. **lamina basalis**
3. **dense collagen conn. tissue**



wall of the gallblader

MICROSCOPIC STRUCTURE OF PANCREAS

- gland of 120 -130 g

- it lies in the concavity of the duodenum (head, body and tail)

- pancreas consists of

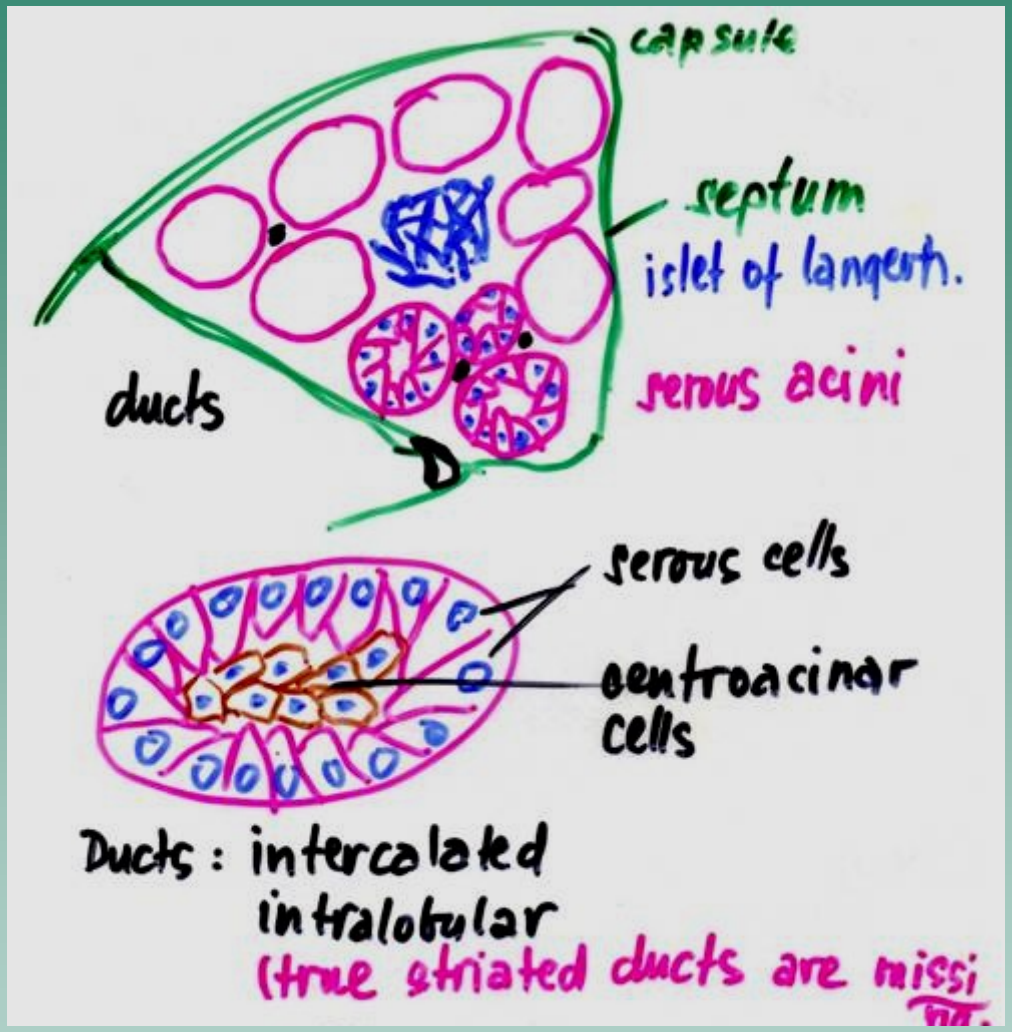
a) connective tissue - capsule + septae

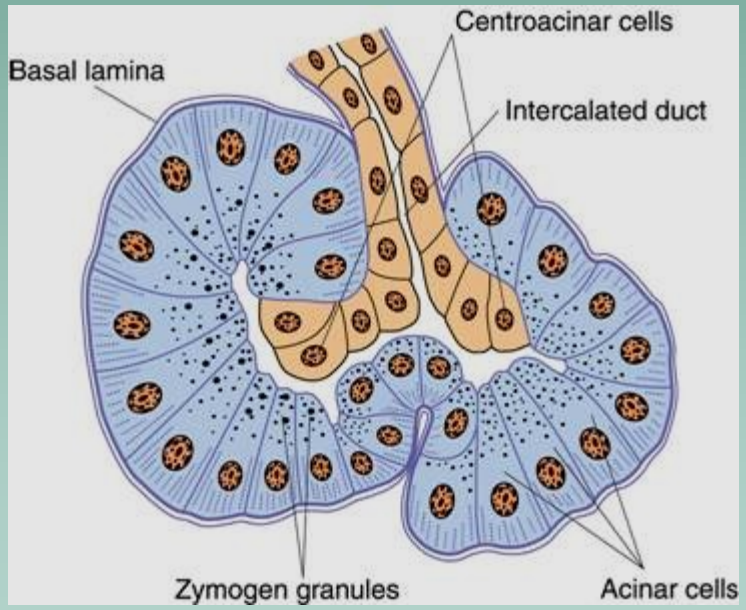
b) parenchyma – exocrine + endocrine glandular tissue

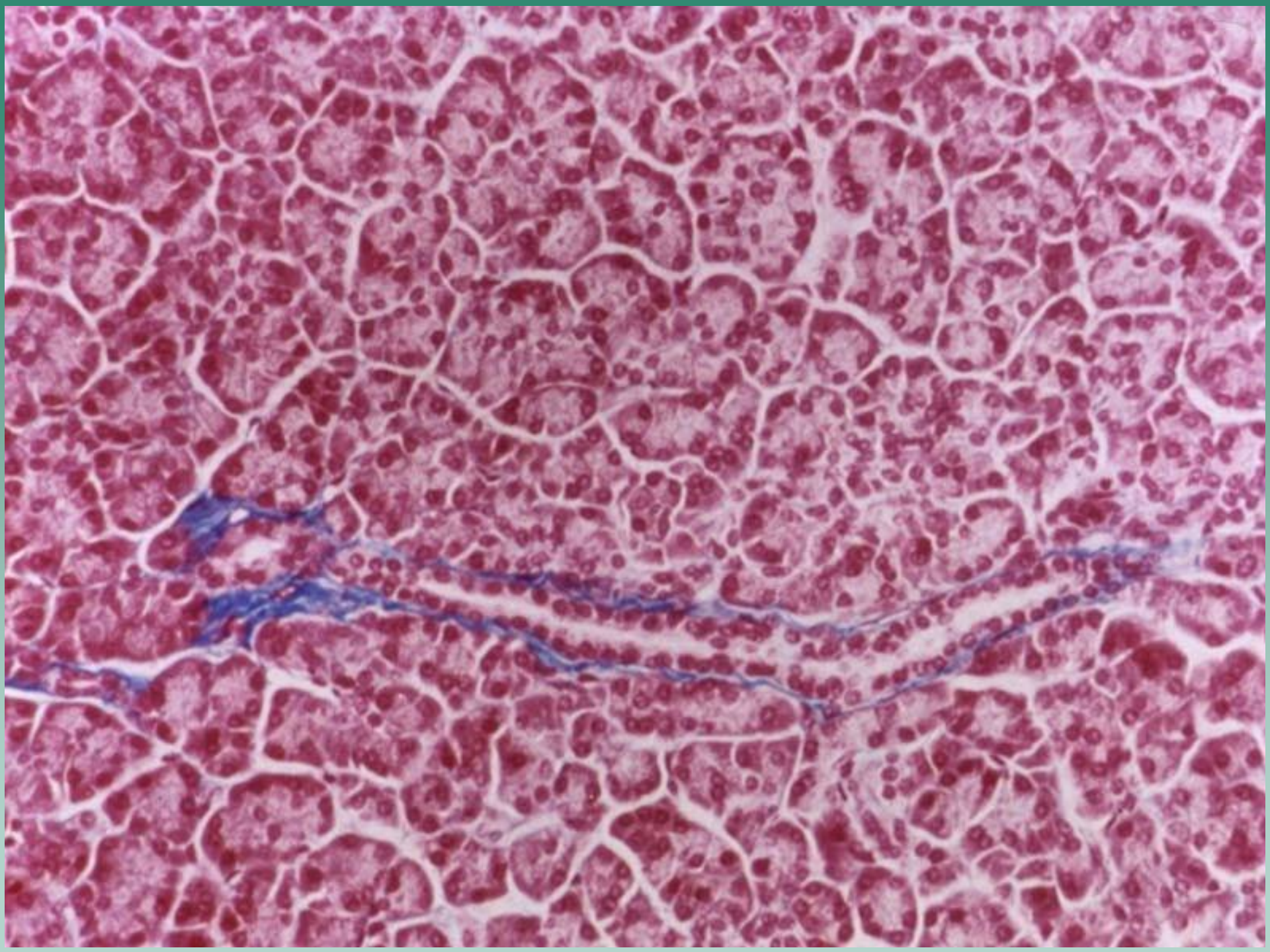
lobules - serous acini + ducts

- islets of endocrine cells (islets of Langerhans)

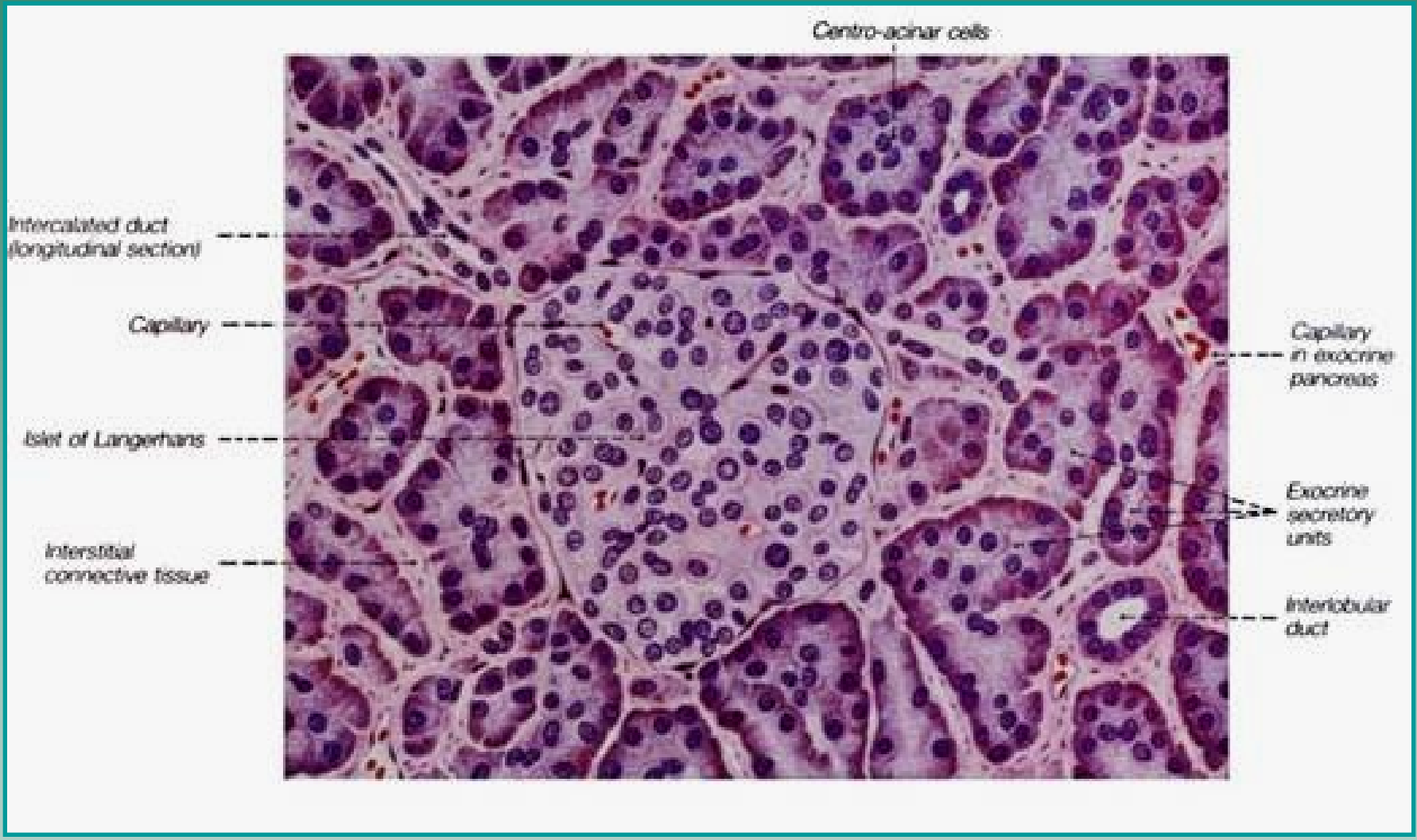
Exocrine pancreas : serous acini + ducts



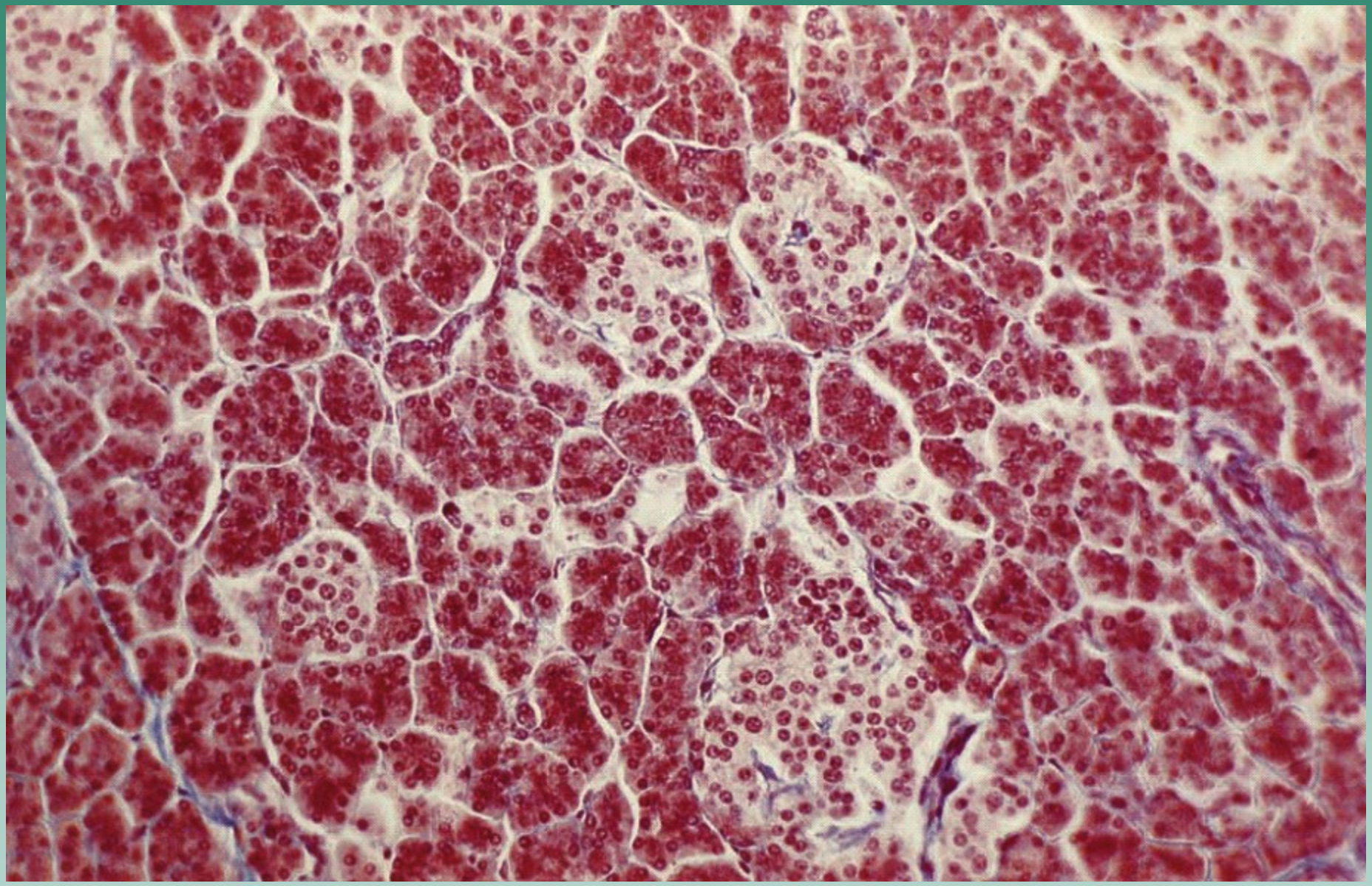




Endocrine pancreas: islets of Langerhans



A cells, B cells, D cells, PP cells - pancreatic polypeptide



ENDOCRINE CELLS OF THE DIGESTIVE TRACT - GEP SYSTEM

Endocrine cells - in the wall of the stomach, small and large intestines, bile ducts (hepatic, cystic or common bile) and islets of Langerhans; produce catechol amines or peptide hormones; cells form together diffuse (scattered) system unit - GEP system (Gastro-Entero-Pancreatic).

Visualization of endocrine cells: by impregnation techniques (term argentaffin or argyrophilic cells) or chromaffin reaction (term chromaffin cells). Recently, the classification of GEP cells is based on the electron microscopy and immunohistochemistry.

Type of cell	Chief distribution	Hormone and its influence
A	Islets of Langerhans	Glucagon (stimulation of the glycogen breakdown in the liver and adipose tissue)
B	Islets of Langerhans	Insulin (stimulation of the glucose transfer in cells, increase of the activity of enzymes of glycogenetic pathway, inhibition of the fat breakdown, activation of protein synthesis)
D	Islets of Langerhans+ mucosa of the stomach and intestine	Somatostatin (it influences other cells of GEP)
EC cells	Mucosa of the stomach and intestine	Serotonin + peptide hormones (stimulation of contraction of smooth muscle cells)
EC like	Epithelium of the gastric fundus	Histamine (stimulation of the HCl secretion)
G	Epithelium of the pylorus and duodenum	Gastrin (stimulation of the production of gastric juice and bile)
S	Epithelium of the duodenum	Secretin (inhibition of the gastric juice secretion, stimulation of sodium bicarbonate production in the pancreatic juice).

OVERVIEW OF DEVELOPMENT OF THE ALIMENTARY CANAL

Stomodeum

Oropharyngeal membrane

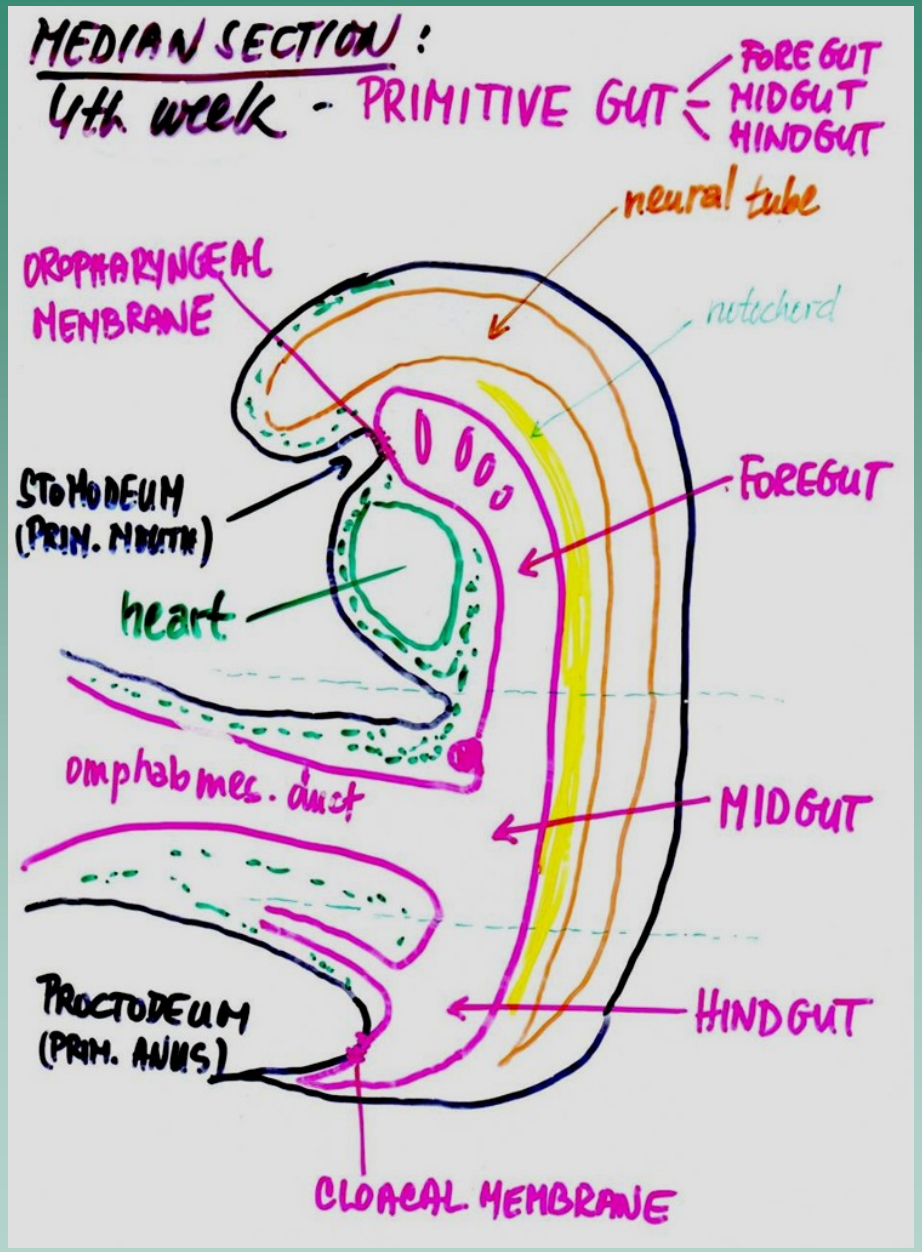
Primitive gut

- **foregut**
- **midgut**
- **hindgut**

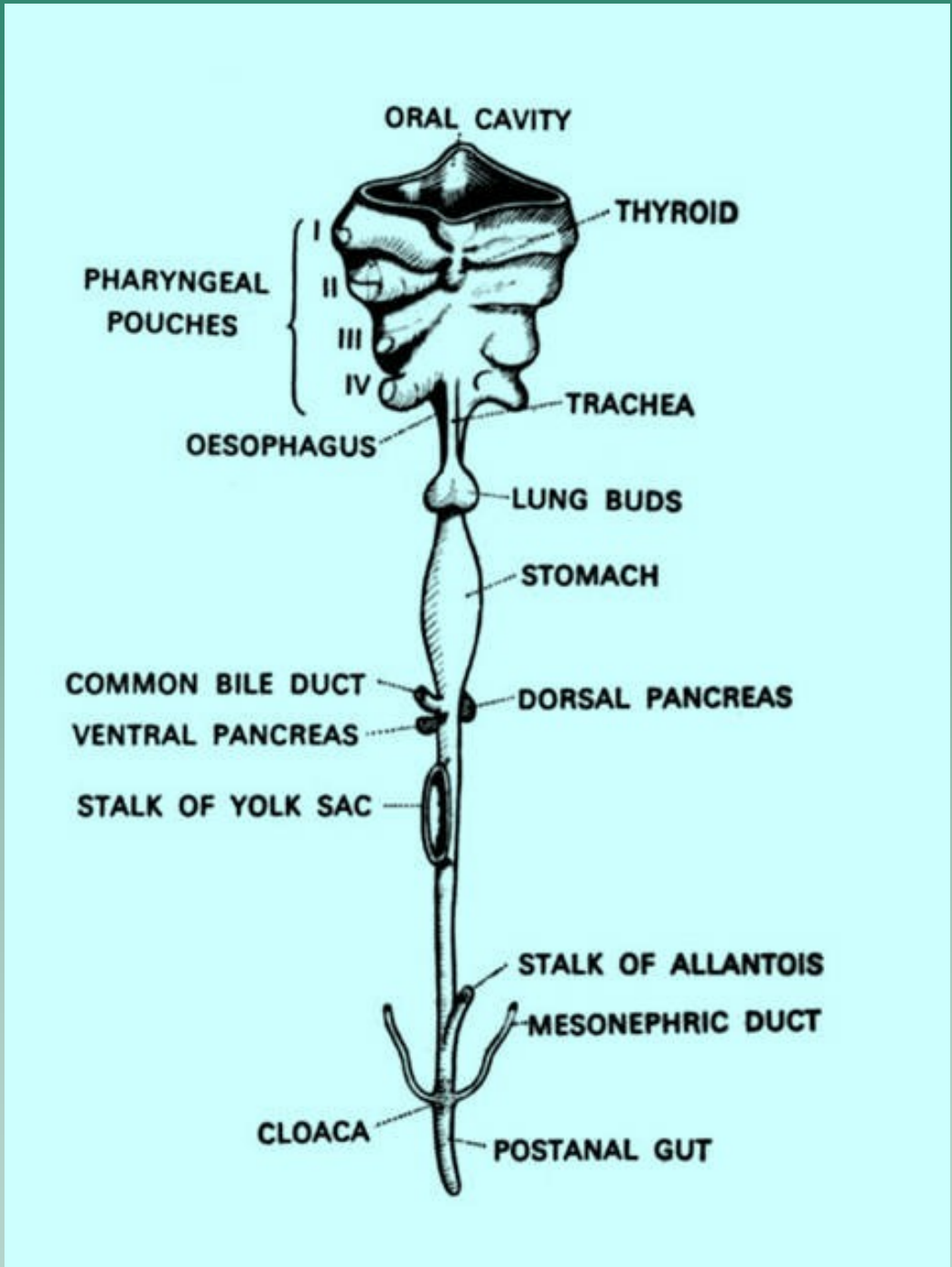
ventral mesenterium
dorsal mesenterium

Cloacal membrane

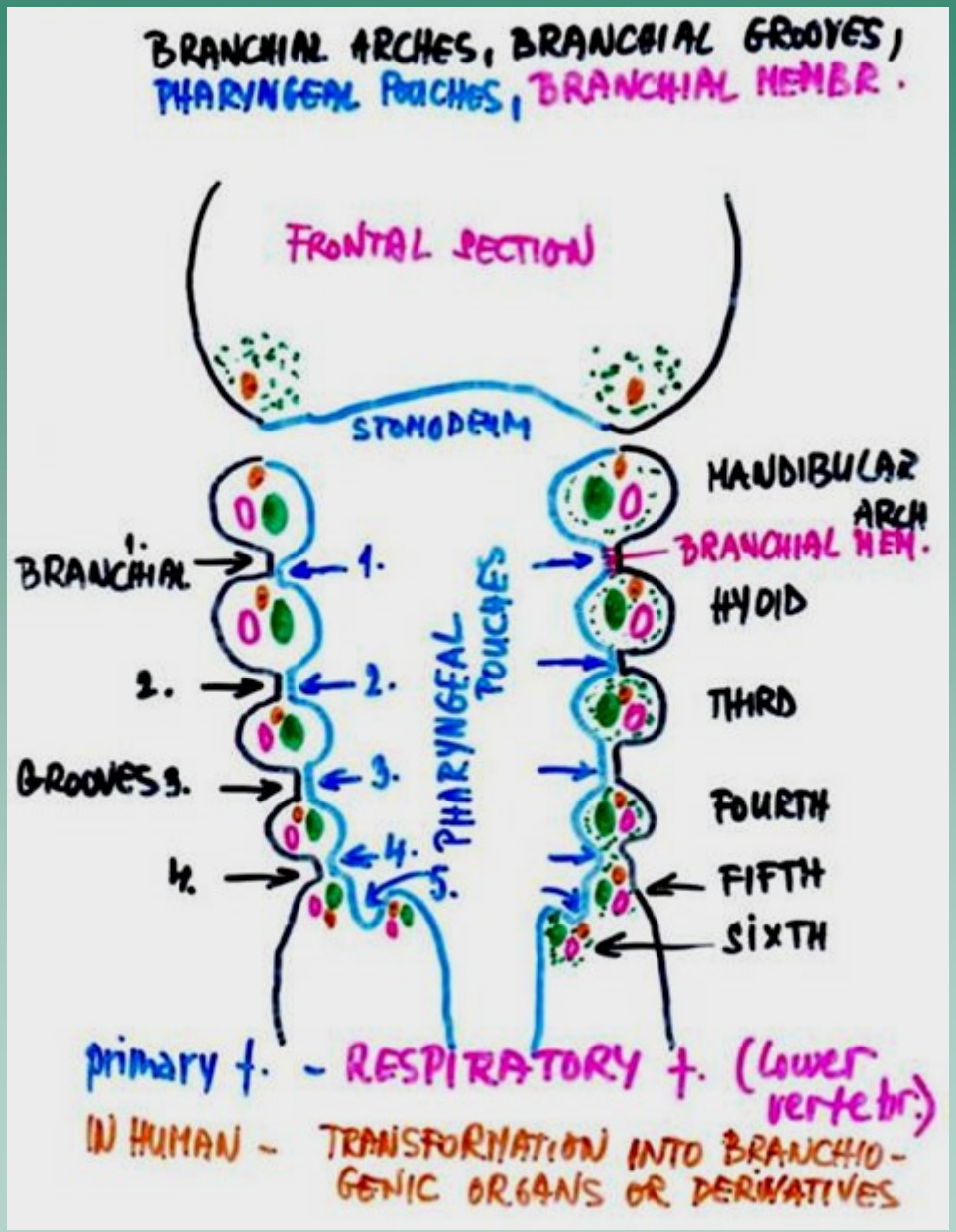
Proctodeum

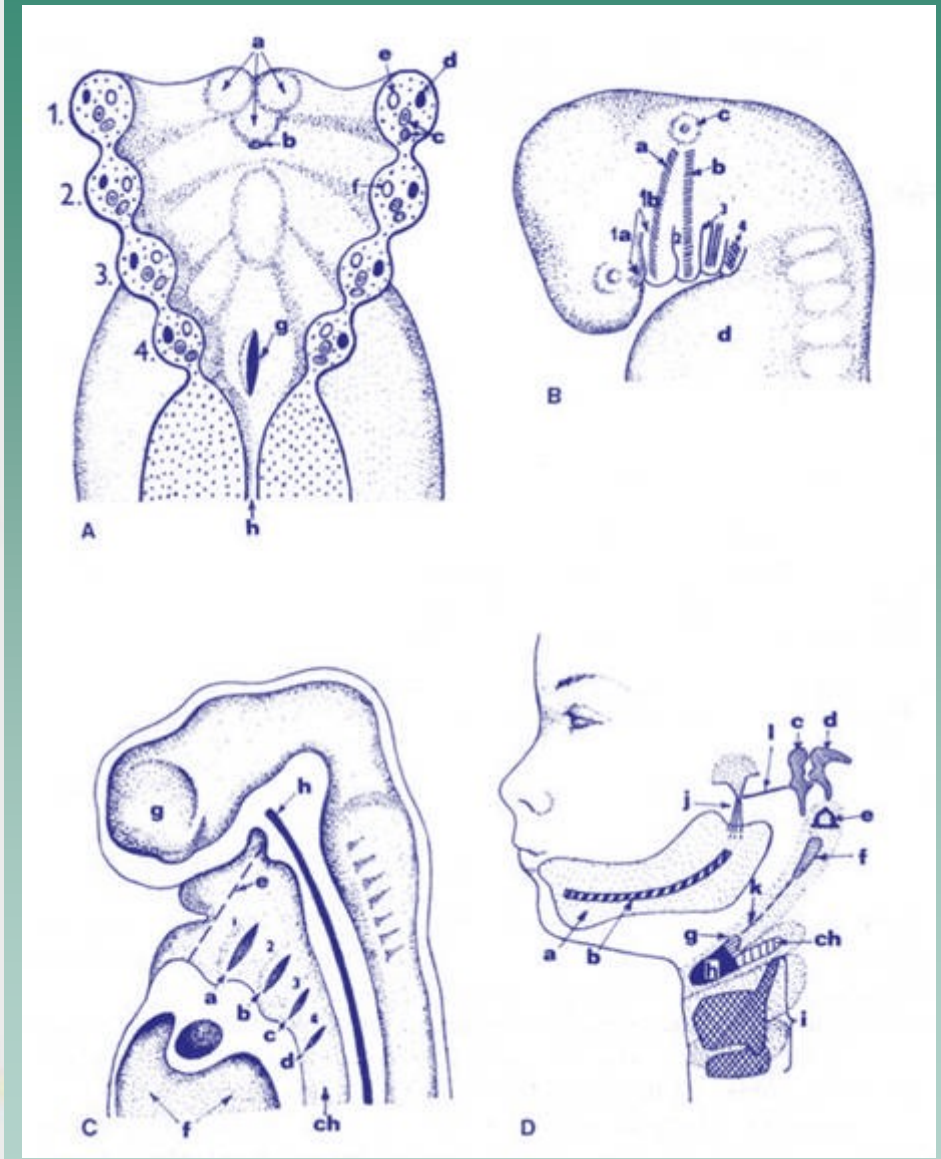


Frontal view of the alimentary canal (5th week)



Branchial apparatus of the embryo and its fate



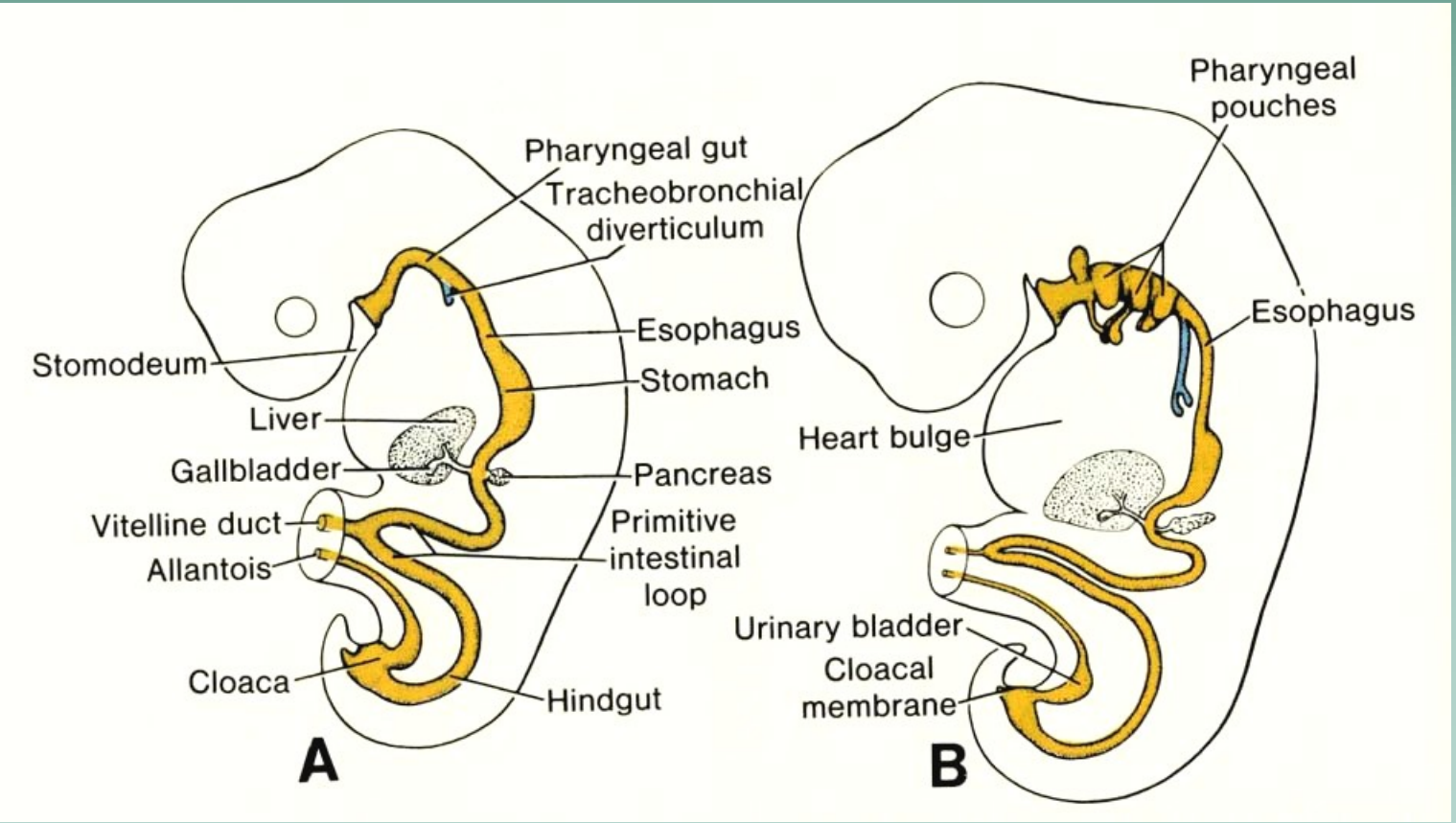


Development of pharynx, esophagus and stomach

Pharynx - constitutes after completion of the branchial apparatus development, when process of separation of branchiogenic organs was finished

Esophagus - ventrally proliferates respiratory diverticulum, initially very short, by 7 th week - final length

Stomach - appears as fusigorm dilatation of the caudal part of the foregut



Stomach

5th week - dorsal wall grows rapidly than vetral - **major and lesser curvatures**

6th week - undergoes rotation movement according to axis:

A/longitudinal

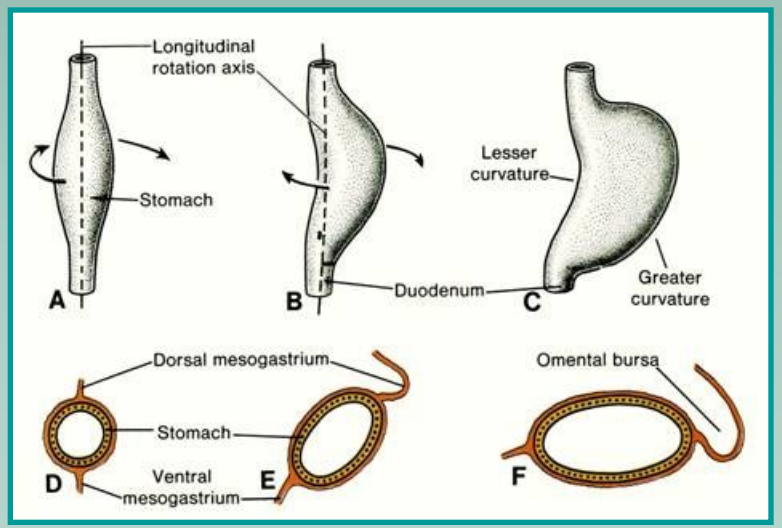
major c. to the left (right side becomes the dorsal side

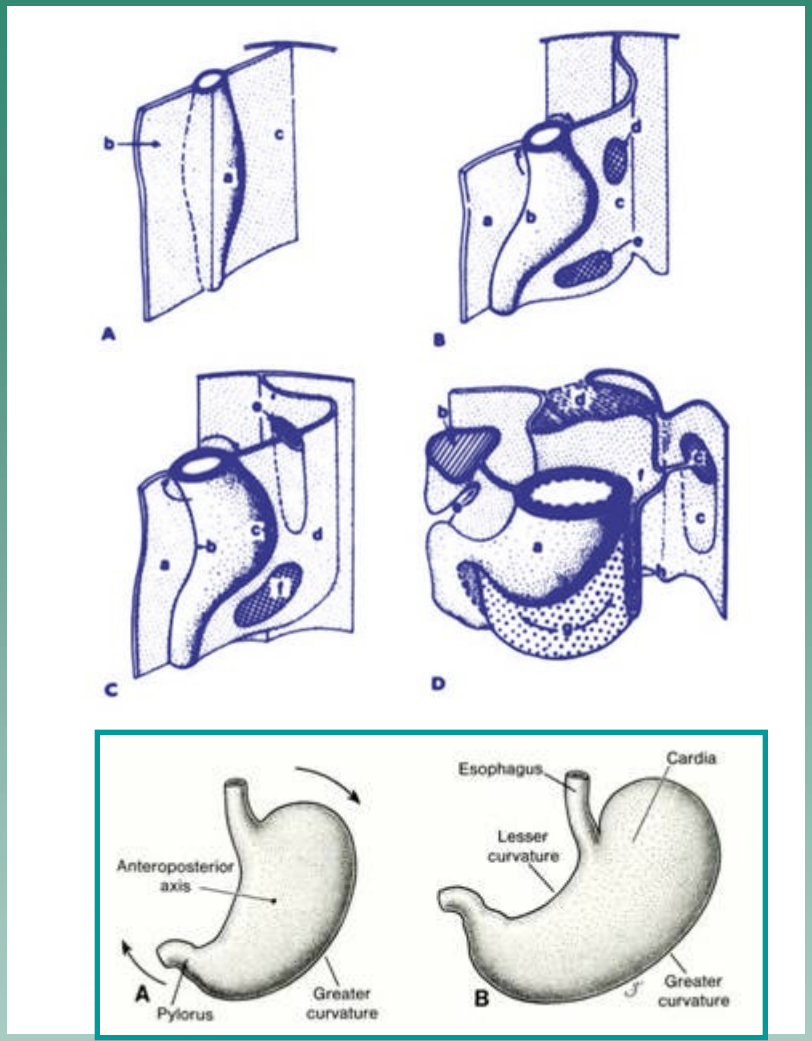
lesser c. to the right (lect side becomes the ventral side

B/ sagittal

cardiac part moves inferiorly

pyloris part moves rather superiorly





Development of the intestine

midgut + hindgut

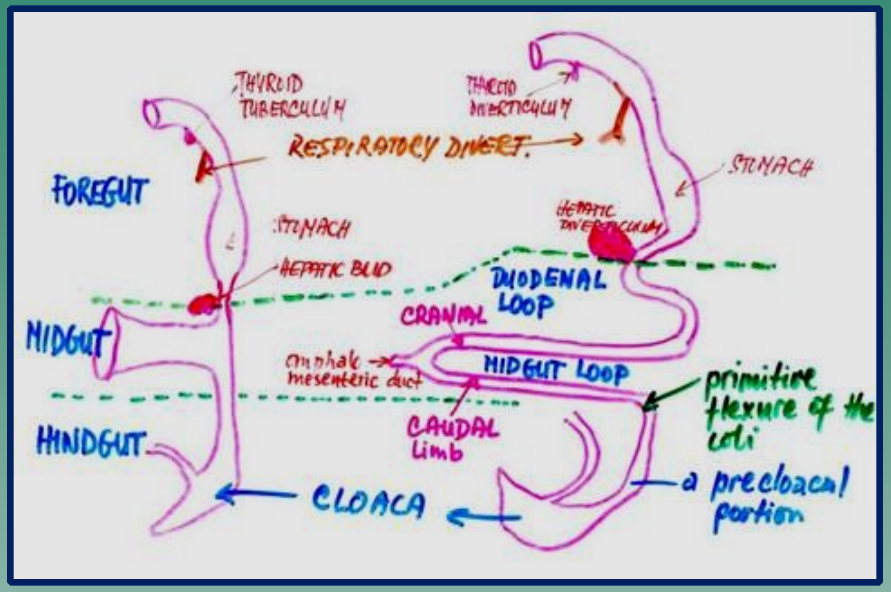
midgut elongates to form 2 loops:

- **duodenal loop** - C - shaped

- **midgut loop** - U - shaped
cranial limb (jejunoileal) caudal limb (ileocaecal)

by primitive flexure of the coli

hindgut - precloacal portion
- cloaca

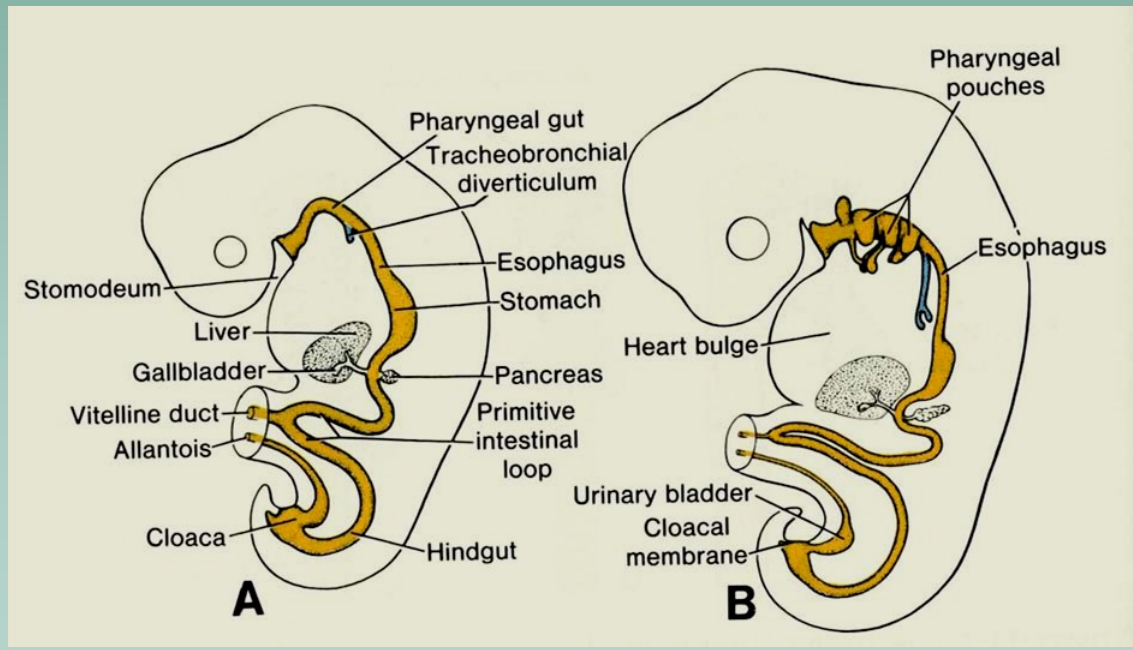


Duodenum

develops from duodenal loop, that rotates around the longitudinal axis to the right,

rotation is connected with dislocation of mesenteries

between the 5th and 6th w. comes to obliteration of the duodenal lumen, recanalization in the 8th w.



Development of the midgut loop

- midgut loop elongates and has not enough room in the abdomen
- 6th w. - loop projects into the extra-embryonic coelom of the umbilical cord (physiological umbilical herniation)
- cecal diverticulum occurs on the caudal limb
- counterclockwise rotation around the sagittal axis / superior meseuteric artery / within umbilical cord
  90°
- 10th w. - loop return rapidly to the abdomen / reduction of the midgut hernia / their rotation continues 180°
  90 + 180 = 270°
- loops of the cranial limb / jejunum + prox. ileum / - LEFT UPPER PART OF THE ABD. CAVITY
  caudal limb / distal ileum + ceecum with vermiform appendix, ascending c. + transverse colon / - RIGHT PART OF THE ABDOMINAL CAVITY

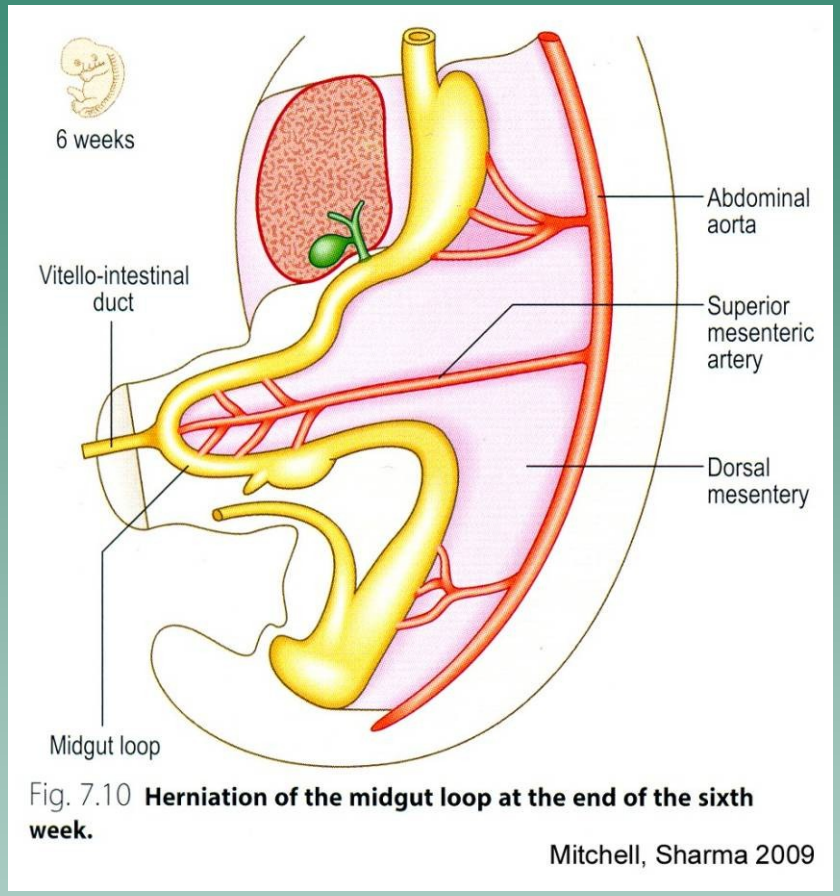
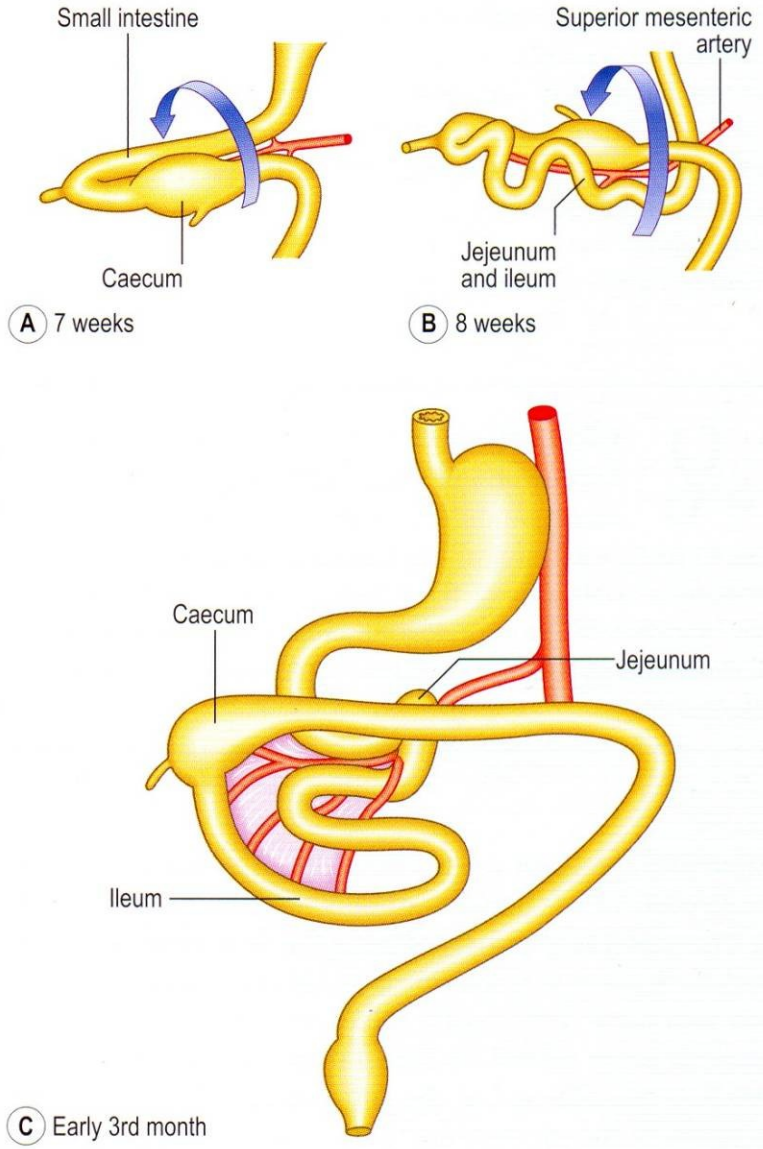


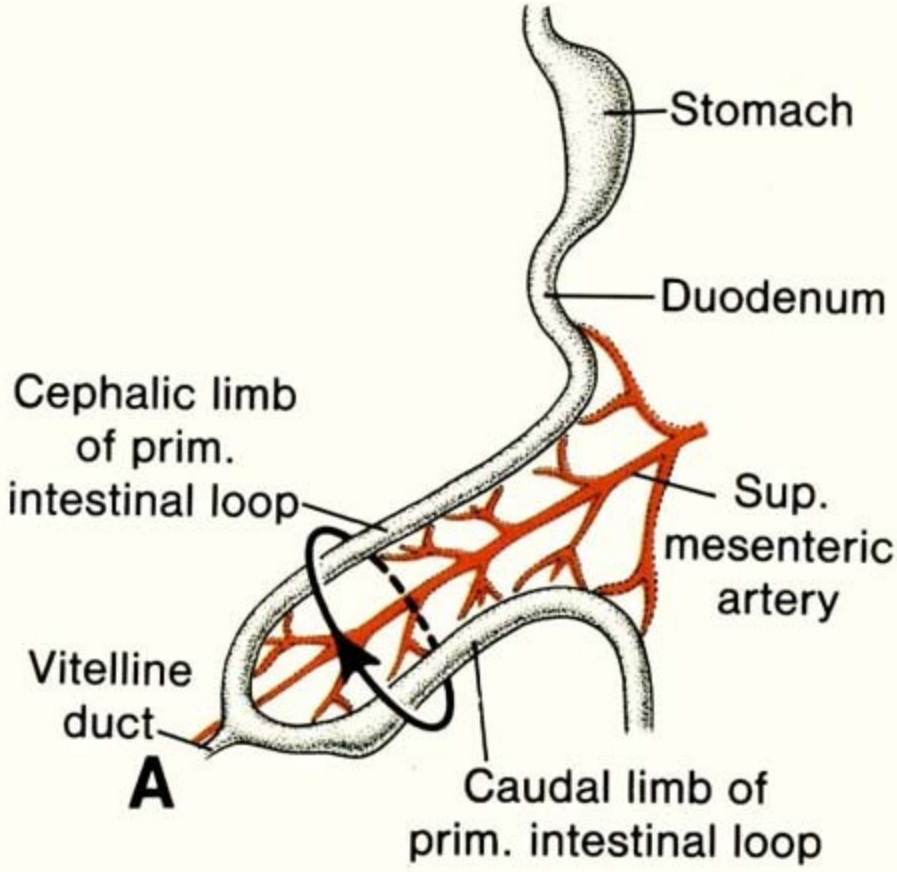
Fig. 7.10 **Herniation of the midgut loop at the end of the sixth week.**

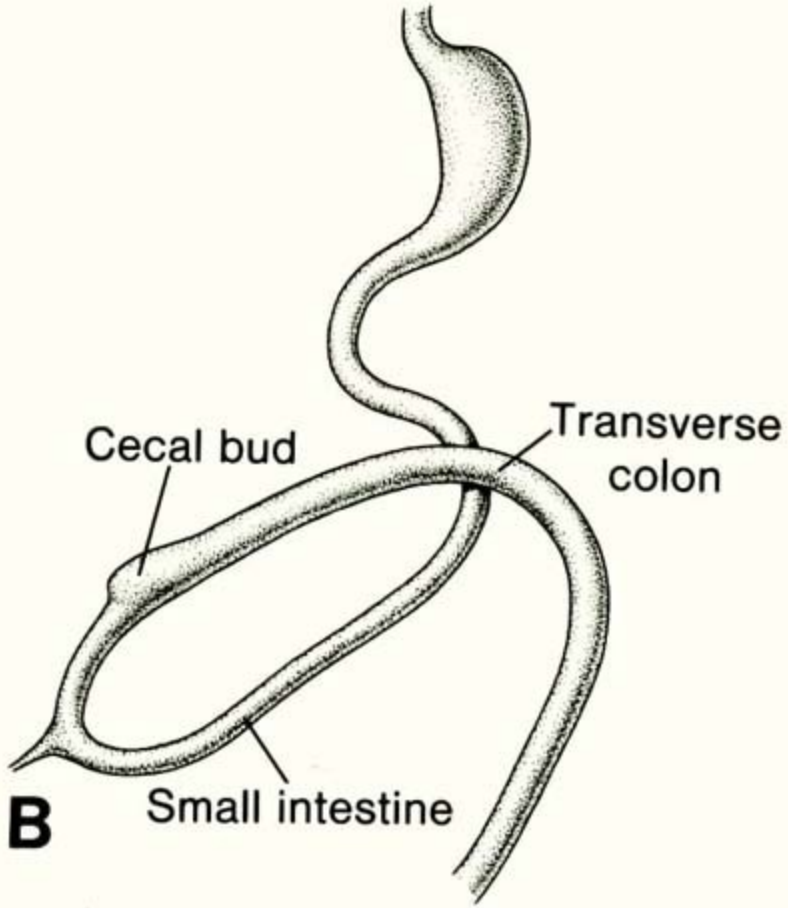
Mitchell, Sharma 2009



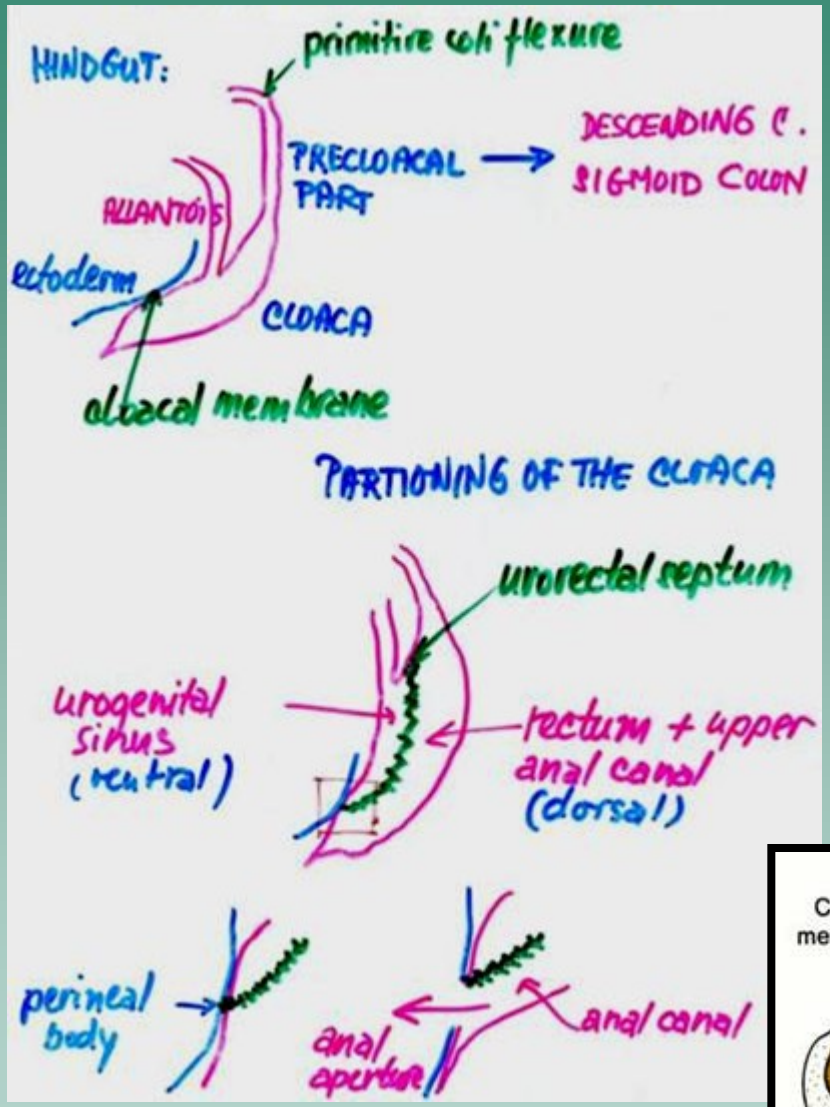
Mitchell, Sharma 2009

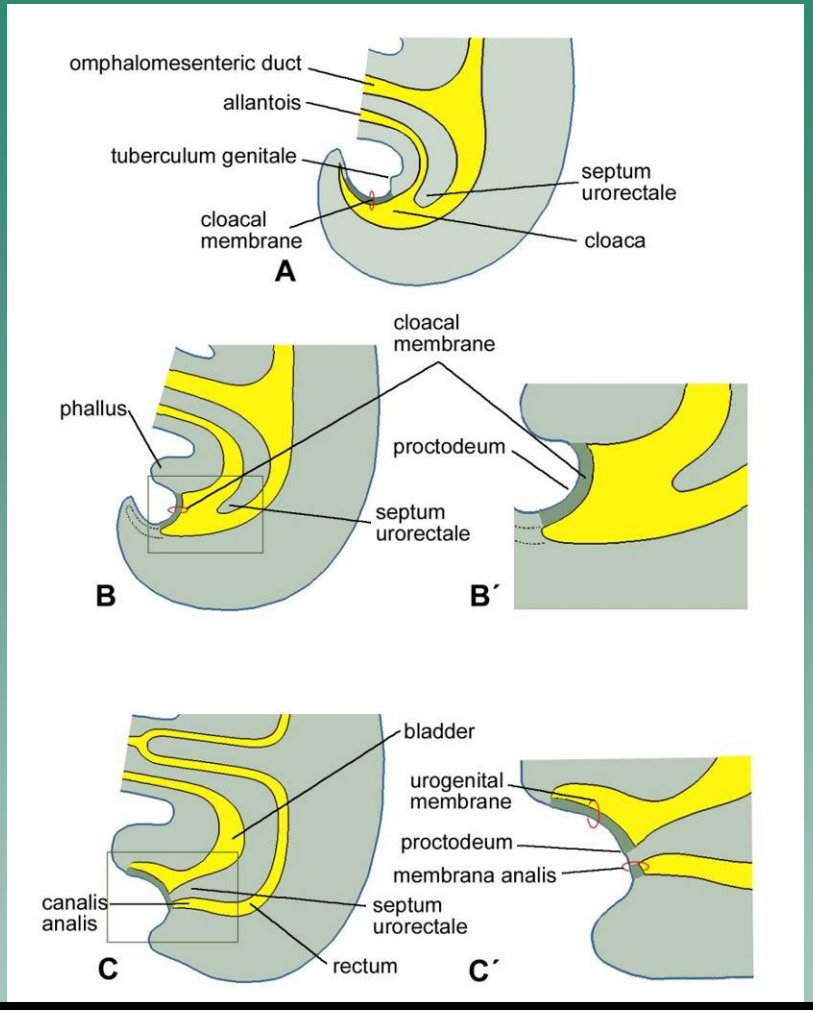
Fig. 7.11 **Rotation of the midgut loop.** (A) 7 weeks; (B) 8 weeks; (C) early third month; (D) late third month. A–C show the 180° anticlockwise rotation, and (D) the elongation of the midgut loop. The arrow indicates the descent of the caecum.

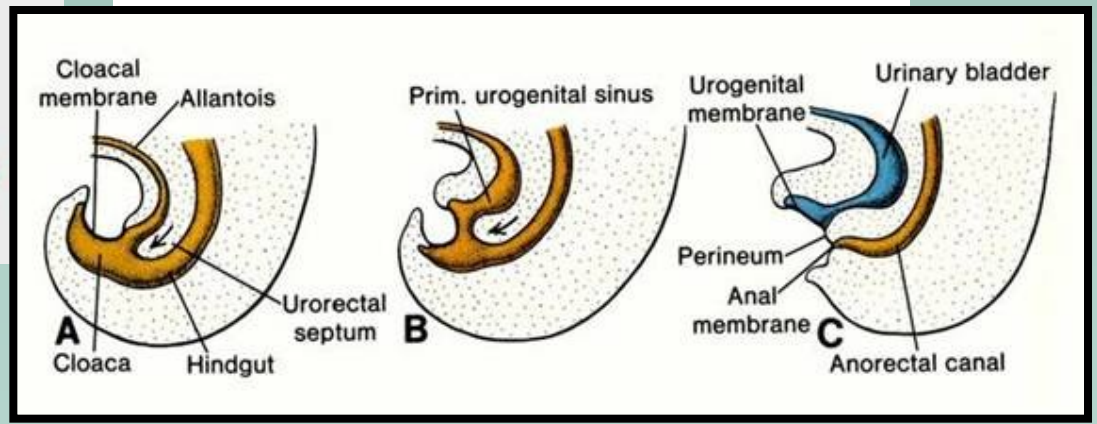

Stomach
Duodenum
Cephalic limb of prim. intestinal loop
Sup. mesenteric artery
Vitelline duct
A
Caudal limb of prim. intestinal loop


Cecal bud
Transverse colon
B
Small intestine

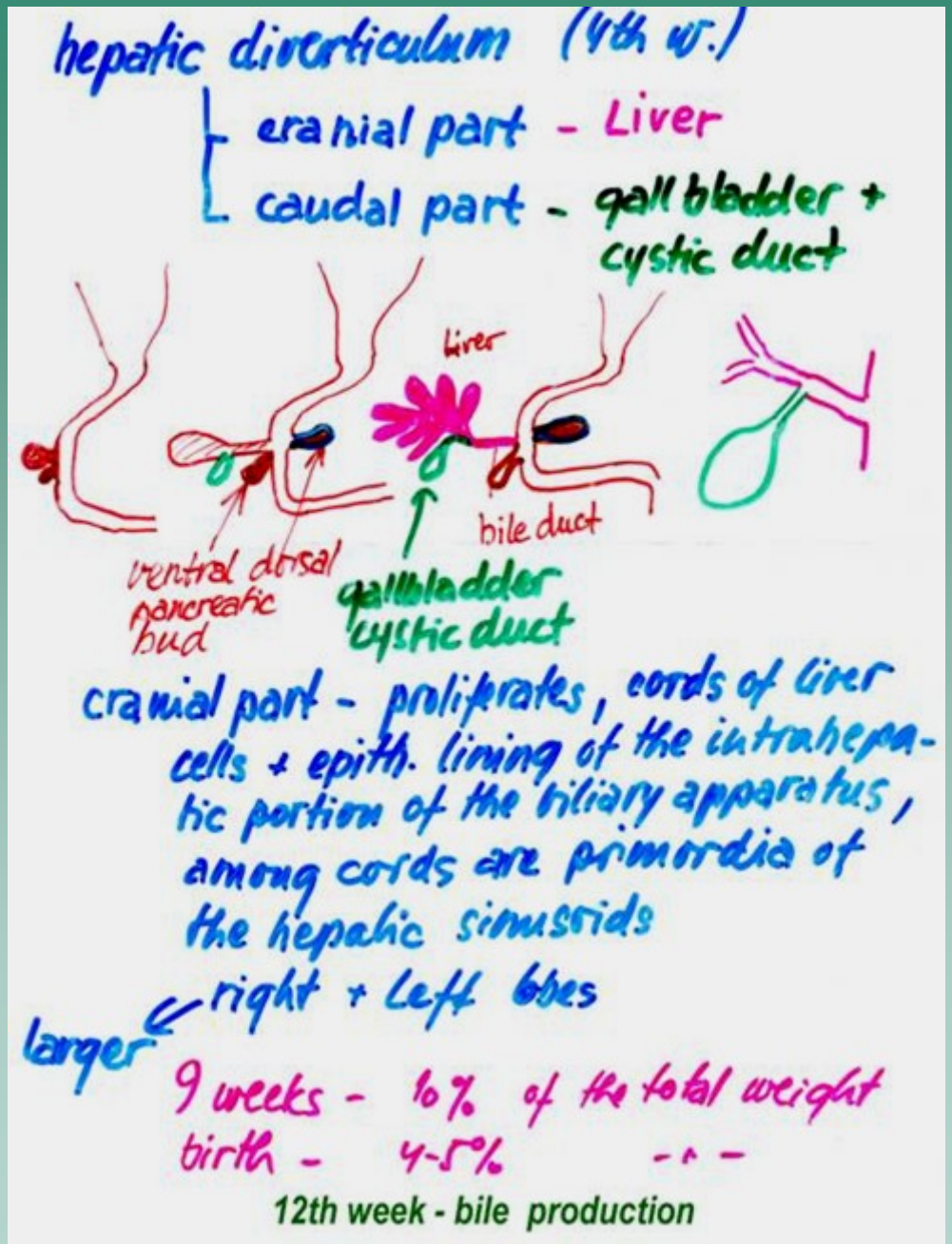
Development of the hindgut



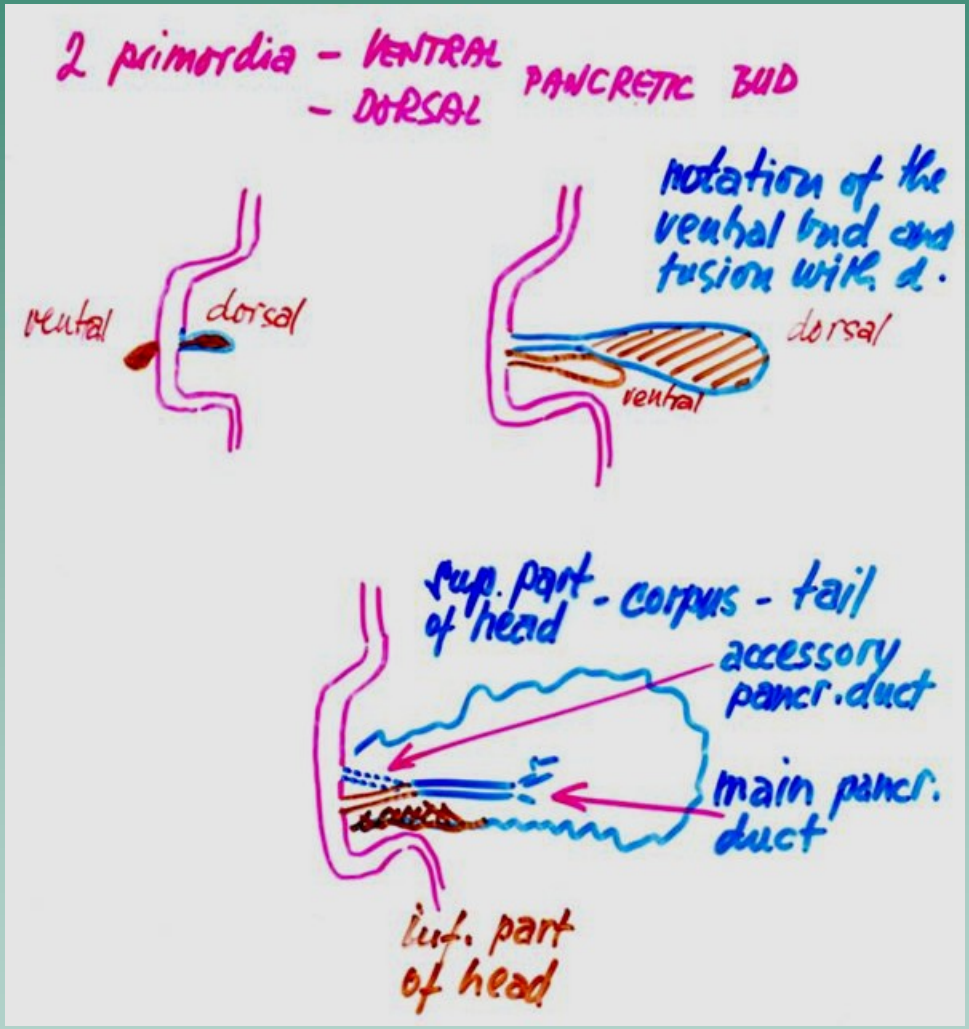




Development of the liver and biliary apparatus



Development of the pancreas



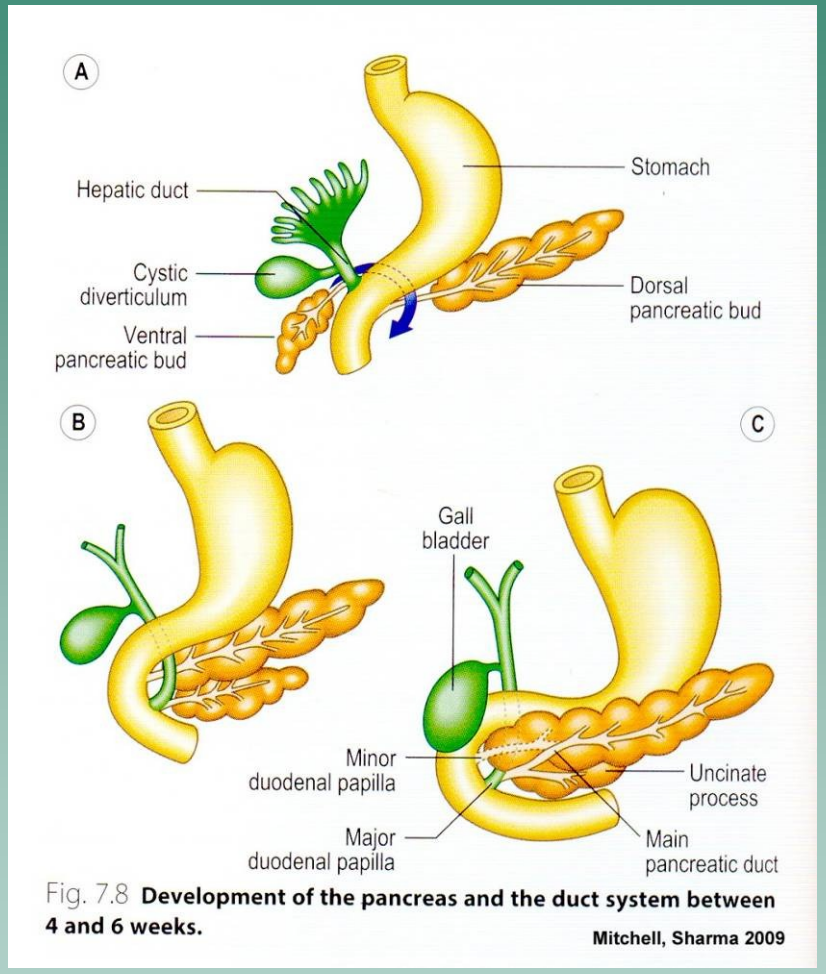


Fig. 7.8 **Development of the pancreas and the duct system between 4 and 6 weeks.**

Mitchell, Sharma 2009