

Organs Associated With the Digestive Tract:

The organs associated with the digestive tract include the salivary glands, the pancreas, the liver, and the gallbladder.

Pancreas:

1-The pancreas is a mixed exocrine-endocrine gland that produces both digestive enzymes and hormones . A thin capsule of connective tissue covers the pancreas and sends septa into it, separating the pancreatic lobules. The secretory acini are surrounded by a basal lamina that is supported by a delicate sheath of reticular fibers and a rich capillary network.

2-The exocrine portion of the pancreas is a compound acinar gland, similar in structure to the parotid gland. The two glands can be distinguished histologically by the absence of striated ducts and the presence of the islets in the pancreas.

3-Another characteristic detail is that in the pancreas the initial portions of intercalated ducts penetrate the lumens of the acini . Small pale-staining **centroacinar cells** constitute the intra acinar portion of the intercalated duct and are found only in pancreatic acini.

4-Each exocrine acinus of the pancreas is composed of several serous cells surrounding a very small lumen .

i)The acinar cells are highly polarized, with a spherical nucleus, and are typical protein-secreting cells .

ii)The number of zymogen granules present in each cell varies .

5-The digestive enzymes are produced by cells of the larger exocrine portion and the hormones are synthesized in clusters of endocrine epithelial cells known as **pancreatic islets** (islets of Langerhans).

Function of pancreatic islets:

The major hormone-producing **islet cells** are .

A-Alpha or **A cells** secrete primarily **glucagon** and are usually located near the periphery of islets.

B-Beta or **B cells** produce **insulin** , are located centrally in islets and are the most numerous cell type.

C-Delta or **D cells**, secreting **somatostatin**, are scattered and much less abundant.

D-A minor fourth cell type, more common in islets located within the head of the

pancreas, are **F** or **PP cells**, which secrete **pancreatic polypeptide**.

E- Enterochromaffin cells :Pancreatic islets also normally contain a few enterochromaffin cells, like those of the digestive tract, which secrete other polypeptide hormones having other effects within the digestive system and which are also scattered in the pancreatic acini and ducts.

Function of exocrine pancreas:

1- The exocrine pancreas secretes 1.5 to 2 L of fluid per day.

2- Pancreatic juice is rich in bicarbonate ions (HCO_3^-) and digestive enzymes, including several **proteases (trypsinogens, chymotrypsinogen, proelastases, protease E, kallikreinogen, procarboxipeptidases), alpha -amylase, lipases, and nucleases (DNAase and RNAase)**.

3- The proteases are stored as inactive zymogens in the secretory granules of acinar cells.

4-) After secretion trypsinogens are cleaved and activated by enterokinase only in the lumen of the small intestine, generating trypsins which activate the other proteases in a cascade.

5- This, along with production of protease inhibitors by the acinar cells, prevents the pancreas from digesting itself.

❖ Liver:

1- The liver is the body's biggest organ, With a large right lobe and smaller left lobe, it is the largest gland and is situated in the abdominal cavity beneath the diaphragm .

2- All the materials absorbed via the intestines reach the liver through the portal vein, except the complex lipids, which are transported mainly by lymph vessels.

3- The position of the liver in the circulatory system is optimal for gathering, transforming, and accumulating metabolites from blood and for neutralizing and eliminating toxic substances in blood.

4- The elimination occurs in the **bile**, an exocrine secretion of the liver that is important for lipid digestion in the gut. The liver also produces plasma proteins such as albumin, fibrinogen, and various carrier proteins.

Liver Stroma:

1- The liver is covered by a thin fibrous capsule of connective tissue that becomes thicker at the hilum, where the portal vein and the hepatic artery enter the organ

and where the right and left hepatic ducts and lymphatics exit.

2-These vessels and ducts are surrounded by connective tissue all the way to their termination (or origin) in the portal spaces between the liver lobules.

3-At this point,, a delicate reticular fiber network surrounds and supports the liver cells and the sinusoidal endothelial cells of the liver lobules .

Hepatic Lobules:

1-Liver cells or **hepatocytes** are epithelial cells grouped in interconnected plates. Hepatocytes are arranged into thousands of small, polyhedral **hepatic lobules** which are the classic structural and functional units of the liver .

2-Each lobule has three to six **portal areas** at its periphery and a venule called a **central vein** in its center .

3-The portal zones at the corners of the lobules consist of connective tissue in which are embedded a venule (a branch of the portal vein), an arteriole (a branch of the hepatic artery), and a duct of cuboidal epithelium (a branch of the bile duct system) – three structures called the **portal triad** .

4-Hepatocytes make up each of the interconnected plates like the bricks of a wall and the plates are arranged radially around the central vein. The spaces between these plates contain important microvascular components, the **liver sinusoids**.

Liver sinusoids:

1-These irregularly dilated sinusoids consist only of a discontinuous layer of fenestrated endothelial cells.

2- The endothelial cells are separated from the underlying hepatocytes by a thin, discontinuous basal lamina and a very narrow **perisinusoidal space** , into which project microvilli of the hepatocytes for exchanges between these cells and plasma.

3-Liver sinusoids are surrounded and supported by delicate sheathes of reticular fibers.

4- cells are associated with these sinusoids in addition to the endothelial cells:

A- Stellate macrophages (Kupffer cells) are found between sinusoidal endothelial cells and on the luminal surface within the sinusoids, mainly near the portal areas. Their main functions are to break down aged erythrocytes and free heme for re-use, remove bacteria or debris that may enter the portal blood from the gut, and act as antigen-presenting cells in adaptive immunity.

B- Stellate fat storing cells (Ito cells) In the perisinusoidal space (not the lumen) with small lipid droplets containing vitamin A. These cells,

which make up about 8% of the cells in a liver but are difficult to see in routine preparations, store much of the body's vitamin A, produce ECM components, and have a regulatory role in local immunity.

The Hepatocyte:

1-Hepatocytes are large polyhedral cells, with six or more surfaces, In H&E-stained sections their cytoplasm is usually eosinophilic because of the large number of mitochondria, . Hepatocytes have large spherical nuclei with nucleoli. The cells frequently have two or more nuclei .

2-The surface of each hepatocyte is in contact with the wall of a sinusoid, through the perisinusoidal space, and with the surfaces of other hepatocytes . Where two hepatocytes abut, they delimit a tubular space between them known as the **bile canaliculus**.

3-The cell membranes near these canaliculi are firmly joined by tight junctions. Gap junctions also occur between hepatocytes, allowing intercellular communication and coordination of the cells' activities.

Hepatic Lobule Structure & Function.

The different categories of hepatocyte functions—including secretion of protein factors into blood, the secretion of bile components, and the removal of oxygen and small compounds of all kinds from blood—has led to **three ways** to think of liver lobule structure.

1-The **classic hepatic lobule**, with blood flowing past hepatocytes from up to six portal triad areas to a central venule, emphasizes the endocrine function of the structure producing factors for uptake by plasma.

2-The **portal lobules** of hepatocytes is more useful when considering the exocrine function of these cells, ie, bile secretion. The portal area has the bile ductule at the center and bile, moving in the opposite direction as the blood, flows toward it from all the surrounding hepatocytes. The tissue draining bile into each portal area duct is roughly triangular in shape, with the central veins of three classic lobules at its angles.

3-The **liver acinus**, a third way of viewing liver cells, emphasizes the nature of the blood supply to the hepatocytes and the oxygen gradient from the hepatic artery branch to the central vein. The acinus contains the hepatocytes in an irregular oval or diamond-shaped area extending from two portal triads to the two closest central veins .

Biliary Tract.

- 1-The bile canaliculi form a complex anastomosing network progressing along the plates of the hepatic lobule and terminating in the region of the portal spaces . Near the peripheral portal areas, bile canaliculi empty into **bile ductules** composed of cuboidal epithelial cells called **cholangiocytes** .
- 2-After a short distance, these ductules cross the limiting hepatocytes of the lobule and end in the **bile ducts** in the portal spaces.
- 3-Bile ducts are lined by cuboidal or columnar epithelium and have a distinct connective tissue sheath. They gradually enlarge and fuse, forming right and left **hepatic ducts**, which subsequently leave the liver.

Gall bladder.

- 1-The bile produced by the hepatocytes flows through the **bile canaliculi, bile ductules, and bile ducts**. These structures gradually merge, forming a network that converges to form the **hepatic duct**.
- 2-The hepatic duct, after receiving the **cystic duct** from the gallbladder, continues to the duodenum as the **common bile duct**.
- 3-The hepatic, cystic, and common bile ducts are lined with a mucous membrane having a simple columnar epithelium of cholangiocytes.
- 4- The lamina propria and submucosa are relatively thin, with mucous glands in some areas of the cystic duct, and surrounded by a thin muscularis.
- 5-This muscle layer becomes thicker near the duodenum and finally, in the portion within the duodenal wall, forms a sphincter that regulates bile flow.

The main function of the gall bladder:

- 1-It is store bile, concentrate it by absorbing its water, and release it when necessary into the digestive tract.
- 2-This process depends on an active sodium-transporting mechanism in the gallbladder's epithelium, with water absorption from bile an osmotic consequence of the sodium pump.
- 3- Contraction of the smooth muscle of the gallbladder is induced by cholecystokinin (CCK) released from enteroendocrine cells of the small intestine. Release of CCK is, in turn, stimulated by the presence of dietary fats in the small intestine.
- 4-Removal of the gallbladder due to obstruction or chronic inflammation leads to direct flow of bile from liver to gut, with few major consequences on digestion.