

## **ANSWERS**

### **2.10 Oral Cavity and Digestive System**

394. a + b + c + d – e –  
Salivary glands, the lining of the palate and the anterior part of the tongue all originate from embryonic ectoderm.
395. a + b – c + d + e +  
The soft palate possesses stratified squamous epithelium, striated muscle, mucous glands and adipose tissue.
396. a + b – c + d + e –
397. a + b + c + d + e –  
Cornfield (keratinized) epithelium lines the hard palate, gingival and dorsal surface of the tongue. Non-keratinized epithelium lines the inside of the lips, cheeks, floor of the mouth and lower surface of the tongue.
398. a + b + c + d + e +  
Saliva, whose functions include, wetting and lubricating the oral cavity and food, contains water, electrolytes, mucin, proteins and a number of enzymes including amylase (ptyalin), which begins the hydrolysis of carbohydrates.
399. a + b + c + d – e +  
The largest of the salivary glands are the parotid glands, which are branched acinar exocrine glands, whose secretory units are composed entirely of serous cells. These cells possess zymogen granules similar to those found in acinar cells of the exocrine pancreas and which have high amylase content.
400. a + b + c – d + e +  
The submandibular (sub maxillary) glands are branched tubulacinar exocrine glands, which have both serous and mucous secretory cells. The serous cells are often found in the form of demilunes. Secretion from the glands is caused by the contraction of myoepithelial cells that surround the secretory units.
401. a + b + c + d – e +  
Striated ducts are so called because of basal accumulations of aligned mitochondria and associated invaginations of the basal plasmalemma of the cells. After using stains such as iron hematoxylin, which shows up the mitochondrial accumulations, the basal 'striation' is well seen. Basal striations are found in duct of all the salivary glands and in proximal tubules of nephrons. Basal striations are typical of ion-transporting epithelium. Striated ducts are not found in the exocrine pancreas.

402. a + b – c + d – e –  
Amylase is a hydrolytic enzyme involved in the digestion of carbohydrates such as starch. It is found in the zymogen granules of parotid gland cells and in zymogen granules of serous cells of the other salivary glands as well as in acinar cells of the exocrine pancreas. The zymogen cells of the stomach produce in particular the enzyme pepsinogen.
403. a + b + c + d + e +  
The tongue is covered with stratified squamous epithelium. The body of the tongue is composed of striated muscle bundles orientated in several directions. The tongue is very sensitive possessing abundant nerve endings. It is also well vascularized. Small intrinsic salivary glands of both mucous and serous varieties and lymphatic nodules are commonly found in the tongue.
404. a + b + c + d + e +
405. a + b + c + d – e +  
Taste buds are sensory receptors situated in stratified epithelium of the tongue and also may be found in the palate. In normal histological preparations the taste buds stain lightly, but following impregnation techniques are seen to be in contact with non-myelinated nerve fibers. Each taste bud responds to a specific taste only (sweet, sour, salty, bitter). The cells of taste buds are epithelial spindle-shaped cells that are continuously being replaced. By electron microscopy these cells are seen to be rich in ribosomes and rough endoplasmic reticulum. Their apical edge is coated with long microvilli, which may pass through the taste pore.
406. a + b + c + d – e +  
Hydroxyapatite is present in tooth enamel, dentine and cementum. It is also present in alveolar bone.
407. a + b + c – d – e +  
Enamel is the hardest organic substance known. Enamel is not preserved in decalcified sections of teeth, but is preserved in ground sections.
408. a + b + c + d + e +  
Dentine is composed mainly of hydroxyapatite crystals. It is harder than bone owing to a higher content of calcium salts. Dentine has both hlycosaminoglycans and collagen fiber. In sections of decalcified teeth, the dentin is visible because the organic content remains.
409. a – b + c + d + e +  
The pulp of adult teeth has a loose type of connective tissue containing thin collagen fibers and reticular fibers. The pulp is well-vascularized and richly innervated.

410. a + b + c - d + e +  
The cementum of adult teeth is similar in structure to woven bone. It covers the dentin of the root and helps bind the teeth into the sockets of the jaw. The cementocytes, which are somewhat similar to osteocytes. If the periodontal ligament is severely injured or destroyed, the cementum becomes necrotic.
411. a + b + c + d - e +  
The periodontal membrane or ligament is composed of dense connective tissue, mainly collagen. It helps anchor the tooth in its socket and acts as the periosteum of the alveolar bone, but unlike other periosteum lacks elastic fibers. The periodontal membrane is connected by thick special collagenous fibers to the cementum in such a way as to allow limited tooth movements during mastication. The collagen of the periodontal membrane has a very rapid protein turnover rate and in much way is similar to fetal collagen including its large content of soluble collagen.
412. a - b - c + d + e +
413. a + b + c - d + e +  
The esophagus is basically a fairly straight tube connecting the pharynx with the stomach. In man this is lined with a stratified squamous epithelium that is non-keratinized (through in many animals that eat rough material the esophagus is keratinized) the esophagus has some mucous glands (esophageal glands) scattered in the submucosa. There are also some glands (cardiac glands) in the lamina propria near the cardiac portion of the stomach, that morphologically are very similar to the glands of the cardia. The upper third of the esophagus has striated muscle in the muscularis externa. The lower part of the esophagus the muscularis externa is composed entirely of smooth muscle fibers. The adventitia, found along the length of the esophagus, consists of loose, fibroelastic, connective tissue binding the esophagus to adjacent structures.
414. a + b - c + d + e -  
The cardiac glands of the stomach are restricted to the initial portion of the stomach. They are lined with columnar, mucus-secreting cells and are similar in structure to the cardiac glands of the final portion of the esophagus.
415. a + b + c + d + e +  
The mucous neck cells of the stomach are continuous with the epithelium lining the stomach. They are found in the area of the 'neck' or 'isthmus' of the gastric glands. The mucous neck cells are columnar or flask-shaped and contain PAS-positive material. In this respect they are similar to the mucous cells of the cardiac and pyloric glands.
416. a - b - c + d + e +
417. a + b + c + d - e -

418.  $a + b - c + d - e -$

419.  $a + b + c + d - e +$

In the gastric gland of the stomach are found zymogen cells, parietal cells, mucous neck cells and argentaffin cells. The parietal cells have an intensely acidophilic cytoplasm and have nuclei which are fairly centrally placed. At the electron microscope level these cells are seen to possess large numbers of mitochondria and to have characteristic intracellular canaliculi. The parietal cells secrete hydrochloric acid and are the source of the vitamin B<sub>12</sub> intrinsic factor. The zymogen cells are basophilic and have well-developed, basal, rough, endoplasmic reticulum. The zymogens granules are mainly found in the apical part of the cells. The function of these zymogenic cells is to secrete digestive enzymes including pepsin.

420.  $a + b + c + d + e +$

The endocrine cells of the stomach are usually isolated or in very small groups. They can be identified in light microscope preparations after impregnation techniques with silver or chromium salts. At the electron microscope level these endocrine cells are seen to have a large number of small, membrane-bound, secretory granules. These endocrine cells secrete polypeptide hormones including gastrin.

421.  $a - b - c - d - e +$

422.  $a + b + c + d - e -$

The mucous membrane of the stomach has a rapid rate of turnover probably owing to the effects of the acidity of the stomach and its secretions. The epithelial lining is replaced every two to three days. In contrast the turnover of zymogen and parietal cells of the gastric gland is relatively slow and may take a year or longer.

423.  $a + b + c + d + e +$

If the pyloric region of the stomach is compared and contrasted with the fundic region or body of the stomach one finds that in the pylorus the gastric pits are longer, the gastric glands are smaller, the glandular tubules are wider and more branched. The main epithelial cell type of the pyloric mucosa is a mucous cell similar to the fundic mucous neck cells.

424.  $a - b + c + d - e -$

425.  $a + b + c - d - e +$

The duodenum is partly intraperitoneal and partly retroperitoneal. The retroperitoneal duodenum has an adventitial layer, whereas the intraperitoneal portion has a tunica serosa. Although isolated lymphatic nodules may be present, these are not found in large concentrations such as are present in the ileum. The

duodenum has the usual two layer of muscle (inner circular, outer, longitudinal) in the muscularis externa. The duodenum has glands in the submucosa (Brunner glands) and in the lamina propria. The Brunner glands are composed of an homogeneous epithelium with mucus-secreting cells whose main function is to neutralize the acidity of the food contents coming from the stomach.

426.  $a + b + c + d - e -$

Devices to increase the effective surface area for absorption in the small intestine include the plicae circulares (valves of Kerckring), villi and microvilli.

427.  $a - b + c + d + e +$

Device to protect the small intestine from the acidity of the juices produced in the stomach include alkaline and mucoid secretions. The small intestine is able to deal with microorganisms by means of fairly abundant lymphatic tissue in the lamina propria and by means of leukocytes, which can migrate through the epithelial lining.

428.  $a + b + c + d + e +$

The mucosa of the small intestine has villi lined with a simple columnar epithelium and specialized for the absorption of digested food particles. There are also a fair number of goblet cells and crypts (glands) of Lieberkühn.

429.  $a + b - c - d + e +$

Intestinal villi are found only in the small intestine. They are composed of epithelium and lamina propria. The muscularis mucosae and submucosa does not extend into the villi as is the case with plicae circulares. The villi function in the absorption of digested or degraded foodstuffs including fats. Emulsified fats are absorbed via the epithelial cells and pass into the small lymphatic capillaries or 'lacteals', so-called because of their milky appearance following a fatty meal.

430.  $a - b + c + d - e +$

The absorptive cells of the intestinal villi when viewed by transmission electron microscopy are seen to possess on their luminal surface a coating of microvilli, which have an associated glycocalyx. In the apical part of the cells is a terminal microvillus (microvillus) may be found in absorptive cells, especially after lipid-rich meals

431.  $a + b - c + d + e +$

The glycocalyx on the microvilli of absorptive cells create a microenvironment different from that in the rest of the gut lumen. The glycocalyx stains intensely PAS-positive owing to its glycol-protein composition and is now known to be the site of a calcium-binding protein. The presence of microvilli and the glycocalyx increase the effective surface area of the absorptive cells.

432.  $a - b + c + d - e -$

433.  $a + b + c + d - e -$   
 The lacteals of the villi of the small intestine are small lymphatic capillaries that absorb excess fluid from the surrounding connective tissue. Their main function, however, is connected with the absorption of lipids from the small intestine. Fats in the diet are digested by lipase activity from the pancreas and emulsified by the action of bile. The absorption of lipids occurs mainly in the carbohydrate digestions, which pass directly into the mesenteric veins and to the portal system of the liver, the lipids are absorbed in the lymphatic capillaries.
434.  $a + b + c - d + e +$   
 Paneth cells are found at the base of intestinal glands. They possess large zymogen granules, which are easily visible by light microscopy. Paneth cells secrete the enzyme, lysozyme, which is an antibacterial agent. Paneth cells have high concentrations of zinc, though the significance of this is not known. The significance of Paneth cells is still not really understood and there are many mammals which lack them completely.
435.  $a - b - c - d + e -$   
 Peyer's patches are concentrations of lymphatic nodules found in the ileum. Many researches believe that they may represent the human analogue of the Bursa of Fabricius of birds and have a role in the development of B lymphocytes.
436.  $a + b - c + d + e +$   
 The myenteric plexus of Auerbach is located between the circular and longitudinal muscle layers and constitutes part of the intrinsic nervous system of the intestine wall. The plexus is well seen in histological preparations after impregnation techniques using silver salts. The other main intrinsic nervous system of the Meissner. The neurons with the myenteric plexus include multipolar neurons with short dendrites and motor neurons, which innervate the muscularis externa. In addition 'intestine cells', believed to be microglia, are found.
437.  $a + b - c - d + e +$   
 The large intestine is characterized by its fairly smooth mucosal membrane, which lacks features to increase its surface area such as are found in the small intestine. There are no folds comparable to plicae circulares and no villi below the ileocecal valve. Glands of Lieberkühn are present and are longer than those of the small intestine. Many more goblet cells are found than are present in the small intestine.
438.  $a - b - c + d + e +$   
 Taenia coli are three thick bands of longitudinal muscle, visible to the naked eye, found in the large intestine. They should not be confused with the pork tapeworm (*Taenia solium*) or beef tapeworm (*Taenia saginata*) that may be found as parasites in the human gut.

439. a + b + c + d – e -

The vermiform appendix has a fairly similar histological structure to that of the large intestine, but has a relatively small and angular lumen often packed with cellular debris and masses of dead cells. The appendix is characterized by an abundance of lymphoid tissue. There are relatively few crypts of Lieberkühn and these are irregular. Unlike the large intestine the appendix does not have taeniae coli.

440. a + b + c + d + e +

The colon possesses haustra, taenia coli, semilunar folds and appendices epiploicae, which are fatty bodies visible to the naked eye. The colon is intraperitoneal and has a serosal layer.

441. a + b + c + d + e +

The colon has several functions including the re-absorption of water from the lumen, the production of feces and the production of mucus, which serves as a lubricant to minimize damage from the dried feces. Usually many nodules of lymphatic tissue are present in the colon and eosinophilic leukocytes are also common.

442. a + b + c + d + e -

The liver is the largest internal organ in the body and serves as both an exocrine and endocrine gland. Both the exocrine and endocrine secretions arise from the same cells, the hepatocytes. The main exocrine is the bile. Endocrine secretions include vitamin D metabolites and somatomedin. The liver has relatively little connective tissue.

443. a – b + c + d – e

Blood in the liver lobules flows from the branches of the hepatic portal vein via the sinusoids to the central vein. Arterial blood, from branches of the hepatic artery in the portal areas, is released into the sinusoids where it mixes with the venous blood.

444. a – b – c + d - e +

The endothelial cells lining the sinusoids in the liver are fenestrated and also there are gaps between adjacent cells allowing the easy passage of fluid from the blood to the space of Disse. These endothelial cells lack a basal lamina.

445. a + b + c + d + e +

446. a + b – c + d + e +

Hepatocytes have an endodermal origin. They frequently possess two nuclei per cell. Typically hepatocytes have both abundant, rough endoplasmic reticulum (important for protein synthesis) and abundant, smooth endoplasmic reticulum (important in steroid metabolism). Hepatocytes can synthesize lipoproteins and often have large lipid droplets, which are especially conspicuous after alcohol

consumption. Peroxisomes (or micro bodies) are also commonly found in hepatocytes. The liver is an essential organ with many metabolic functions including detoxification.

447.  $a - b + c - d - e -$

448.  $a - b - c + d + e +$

Lipoproteins synthesized in the hepatocytes are secreted directly into the space of Disse, which is situated between the hepatocytes and the sinusoids. The space of Disse contains: microvilli that project from the free surface of hepatocytes, reticular fibers and fat-storing cells.

449.  $a - b + c + d + e +$

Bile is form in the liver and concentrated and stored in the gall bladder. The bile is discharged from the gall bladder into the duodenum after a fatty meal in response to the release of the polypeptide hormone, cholecystokinin, from scattered endocrine cells of the epithelium of the small intestine.

450.  $a - b - c + d + e +$

451.  $a - b - c - d + e +$

Bile canaliculi are formed from modifications of the lateral plasma membrane of adjacent hepatocytes. A small number of microvilli usually project into the lumen. The bile canaliculi are limited by tight junctions, which prevent leakage of bile into the blood system. The bile canaliculi are rich in ATP-ase activity. Cytochemical techniques for ATP-ase activity can be used on frozen sections of liver to reveal the extend of the bile canalicular system.

452.  $a - b + c + d + e -$

453.  $a - b + c + d + e +$

Kupffer cells are fixed macrophages that have a stellate form with long processes that can extend between the endothelial cells into the sinusoids. They are active phagocytes and have a filtering activity to remove particulate matter from the sinusoids. Although they are fixed macrophages, they lack any specialized system of attachment to the endothelial cells. Kupffer cell possess considerable peroxidase activity. One of the functions of Kupffer cells is connected with the active breakdown of aged erythrocytes. Today it is fairly widely accepted that the Kupffer cells originate, like other macrophaged, from monocytes and that they should be included in the Monocuclear Phagocyted System (MPS).

454.  $a + b + c - d + e +$

The extrahepatic bile ducts have a mucous membrane and are lined with cuboidal or columnar epithelium, which is situated like all epithelium on a basal lamina. The bile ducts have a muscular wall.



455. a + b - c - d + e +

456. a - b + c - d + e -

The epithelium lining the gall bladder is homogeneous. It is a simple columnar epithelium, the cells of which possess both apical and lateral microvilli. A layer of smooth muscle is found in the wall of the gall bladder. Only the free surface of the gall bladder not in contact with the visceral surface of the liver is covered by a typical serous membrane, the peritoneum.

457. a + b + c + d + e +

458. a - b + c + d - e +

459. a + b - c - d + e +

The cells of the exocrine pancreas secrete a number of enzymes including trypsinogen, amylase, carboxypeptidase, ribonuclease. The pancreatic exocrine cells have well developed, basally-situated, rough, endoplasmic reticulum, large Golgi bodies, usually near the cells are all serous and are rich in RNA, coinciding with their active protein synthesizing function.

460. a + b + c - d - e -

The acinar cells of the secretory units of the pancreas are all serous. The centroacinar cells are the initial cells of the intercalated ducts. Unlike salivary glands the exocrine pancreas lacks myoepithelial cells and striated ducts.

461. a - b - c - d + e +

The polypeptide hormones, secretin and pancreaticozymine, are formed in scattered endocrine cells of the small intestine epithelium and are believed to be involved in the control of pancreatic exocrine secretion.