

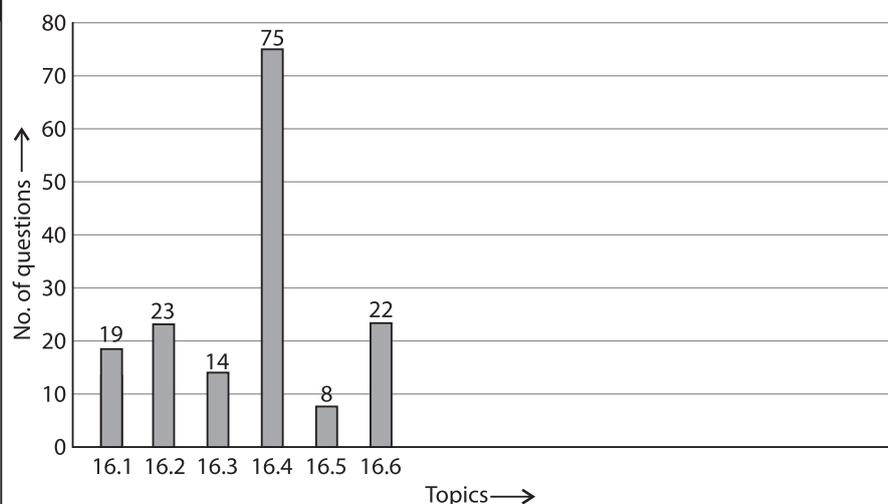
16

Digestion and Absorption

TOPICS

- 16.1 Nutrients
- 16.2 Alimentary Canal
- 16.3 Digestive Glands
- 16.4 Digestion of Food
- 16.5 Absorption of Digested Products
- 16.6 Disorders of Digestive System

Topicwise analysis of last 10 years (2016-2007) questions



Note : This graph shows that maximum number of questions appeared from topic 'Digestion of Food'.

HUMAN DIGESTIVE SYSTEM

- Digestive system comprises **alimentary canal** and **accessory digestive glands** which play an important role in digestion. **Alimentary canal** is a long coiled tube (8-10 m) having muscular wall and glandular epithelium extending from mouth to anus.
- Mouth is a transverse slit bounded by two soft, movable lips (upper and lower). It consists of two parts, vestibule and oral or buccal cavity.
- **Buccal cavity** is the space bounded dorsally by palate, ventrally by throat (with tongue) and laterally by alveolar processes of jaws having teeth.
- **Tongue** is a thick muscular protrusible structure, attached to the floor of buccal cavity by means of soft ligamentous fold called **frenulum**. Tongue helps in ingestion, chewing and swallowing of food.
- Teeth are hard structures meant for tearing, cutting, crushing and holding food. Human teeth are **thecodont** (teeth embedded in the

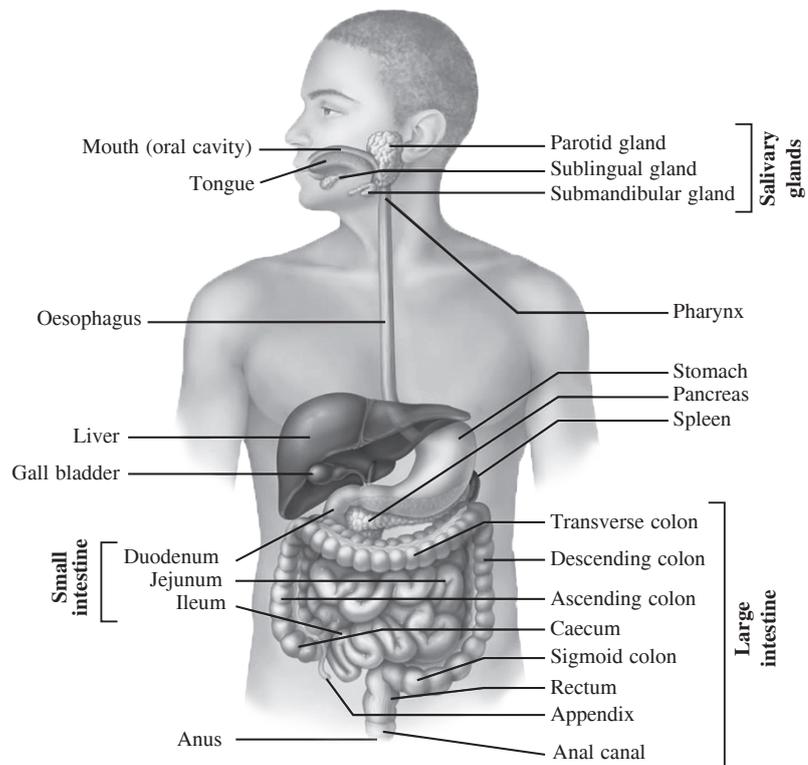


Fig.: Human digestive system

sockets of jaw bones), **heterodont** (presence of different types of teeth), **diphyodont** (appearance of two sets of teeth in the life span).

- **Milk, deciduous or temporary teeth** begin to erupt at the age of **6 - 11 months**. They are completed by the age of two years. There are **20 milk teeth**.
- **Permanent teeth** begin to erupt between the age of **6 - 12 years**. Milk teeth are lost. Last molars come out late after 18 years of age. They are called **wisdom teeth**. Teeth of man are of four types—**incisors (8), canines (4), premolars (8) and molars (12)**.
- **Dental formula** is the number of teeth in one half of upper jaw divided by teeth of one half of the lower jaw.

Dental formula for permanent teeth is

$$i \frac{2}{2} c \frac{1}{1} pm \frac{2}{2} m \frac{3}{3} \text{ or } \frac{2+1+2+3}{2+1+2+3} \times \frac{2}{2} = \frac{16}{16} \text{ or } 32.$$

Dental formula of milk teeth is

$$i \frac{2}{2} c \frac{1}{1} pm \frac{0}{0} m \frac{2}{2} \text{ or } \frac{2+1+0+2}{2+1+0+2} \times \frac{2}{2} = \frac{10}{10} \text{ or } 20.$$

- **Pharynx** is a common passage for food and air. It is divisible into **nasopharynx** (lying behind nasal cavities), **oropharynx** (serving as a common passage for food and air), **laryngopharynx** (leading into larynx).

Lymphatic tissue of the pharynx and oral cavity are arranged in a ring-like manner called **Waldeyer's ring** consisting of pharyngeal, lingual, tubal and palatine tonsils.

- **Oesophagus** is a long, narrow, muscular tubular structure which connects pharynx with stomach. The oesophagus serves to convey the food by **peristalsis** (a series of waves of contraction that passes from one end to other and is meant for pushing the food) from the pharynx to the stomach.
- **Stomach** is wide and distensible J-shaped part of alimentary canal, placed obliquely behind the diaphragm. It is differentiated into four parts: **cardiac, fundic, body and pyloric**.
- **Intestine** is divided into large and small intestine.
- **Small intestine** is the **longest part of alimentary canal**. It is divided into three parts- proximal **duodenum** (shortest and wider part), middle **jejunum** (thicker and vascular) and distal **ileum** (thinner than jejunum and less vascular).
- Along the entire length of the small intestine, small nodules of lymphatic tissue can be seen. These nodules get clustered together in groups at some places, particularly along the ileum and are called **Peyer's patches**. These nodules produce lymphocytes.
- Small finger-like projections of the mucosa called **villi** are present along the entire length of the small intestine (except Peyer's patches). These villi increase the absorptive surface area of the small intestine. The villi mucosa of the small intestine is thrown into a series of permanent circular folds called **Valves of Kerkring or plicae circulares**. They further increase the surface area for absorption.
- **Large intestine** consists of three parts: **caecum, colon and rectum**. **Caecum** in human is a pouch like small junction between ileum and colon. **Colon** is the largest part which has four segments: **ascending, transverse, descending and sigmoid**.
- The wall of the colon is made up of several pouches (**haustra**) that are held by three thick bands of muscle (**taeniae coli**).
- **Rectum** is the last part of the alimentary canal which terminates in the **anal canal**. Opening of anal canal is called **anus** which has sphincters to control the passage of faeces.
- The **alimentary canal** consists of four basic layers. From the outer surface inward to the lumen (cavity) these layers are: **visceral peritoneum (serosa), muscularis externa, submucosa and mucosa (= mucous membrane)**.
- The **human digestive glands** include salivary glands, gastric glands, liver, pancreas and intestinal glands. Salivary glands are of three types—**parotid, submaxillary and sublingual**.
- **Parotid** or **Stenson's duct** opens in vestibuli just outside the second upper molar. **Submaxillary** or **Wharton's duct** opens near

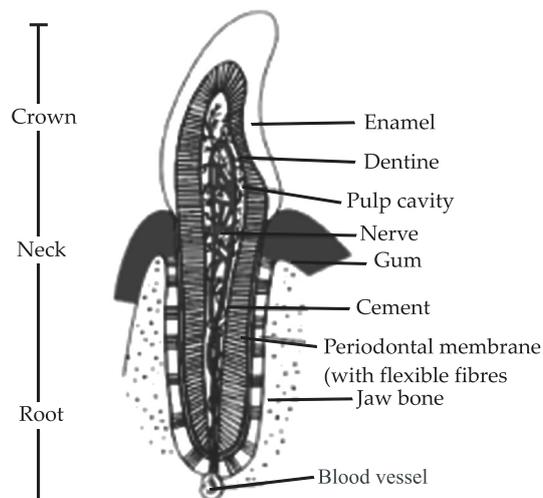


Fig.: V.S. tooth (incisor)

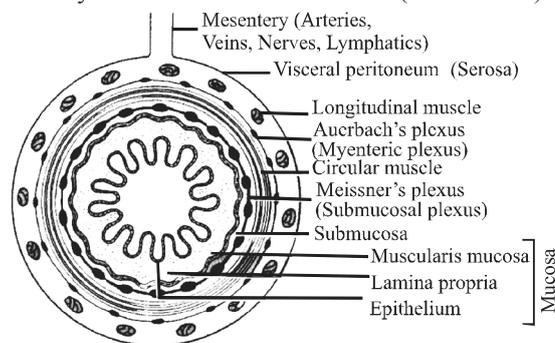


Fig.: General structure of the wall of mammalian gut

the lower central incisors. **Sublingual** or **Rivianian ducts** open under the tongue.

- Gastric glands are numerous simple, branched or unbranched tubular glands which are formed by infolding of the epithelium. Following types of cells are present in the epithelium of gastric glands.
- **Chief** or **peptic cells** (secrete inactive enzymes pepsinogen and prorennin), **oxyntic cells** (secrete HCl and castle intrinsic factor), **goblet cells** (secrete mucus), and **enteroendocrine cells** (secrete gastrin hormone). Secretion of gastric glands is called **gastric juice**.
- Daily secretion of gastric juices is 2-3 Lt. Secretion of gastric juice is under **nervous as well as hormonal control**.
- **Liver** is the **largest** and two lobed gland of about 1.5 kg weight and nearly 1/40 of total body weight. Liver is differentiated into small left lobe and large right lobe separated by **falciform ligament**. **Glisson's capsule**, characteristic feature of mammalian liver, is a thin layer of dense connective tissue which surrounds the liver lobule.
- **Kupffer's cells** of liver sinusoids **act as phagocytes** which eat up the dead cells and bacteria. Liver produces an anticoagulant heteropolysaccharide called **heparin** which prevents blood clotting inside the blood vessel. Liver produces two proteins - **prothrombin** and **fibrinogen** which help in clot formation.
- **Gall bladder** is a pear shaped yellow green sac like structure which lies on the inferior surface of the right lobe. Gall bladder **stores bile**, which is secreted by liver cells and collected by bile capillaries. Bile produced by liver makes the **media alkaline (pH 7.8 - 8.6)**.
- Bile contains 92% water; 6% bile salts; 0.3% bile **pigments** [bilirubin (yellow); biliverdin (green)] 0.3% to 1.2% fatty acids; 0.3-0.9% cholesterol and 0.3% lecithin. Lecithin compound decreases surface tension and helps in fat emulsification.
- **Bile salts** contain NaCl, sodium bicarbonate (both inorganic) and sodium glycocholate and sodium taurocholate (both organic). Bile capillaries unite to form **hepatic duct**. Bile duct also known as **choledocus duct**, is formed by joining of **cystic duct** (arising from gall bladder) and **common hepatic duct** from different liver lobes. In man, **bile duct** first opens into **Ampulla of Vater** which is guarded by **sphincter of Oddi**.

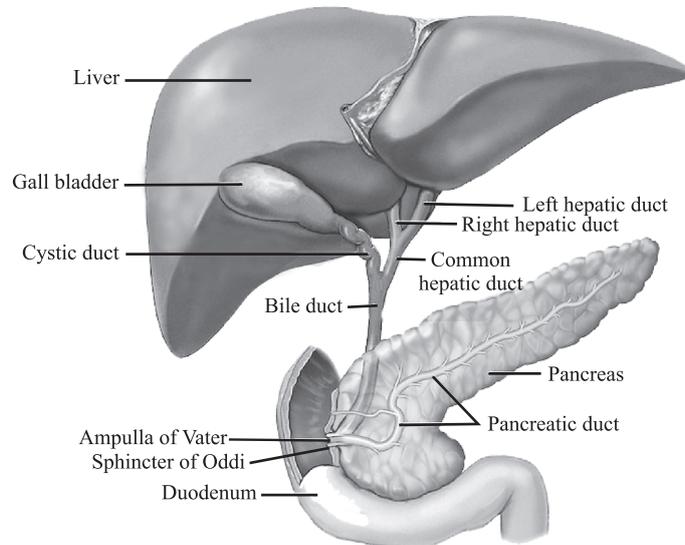
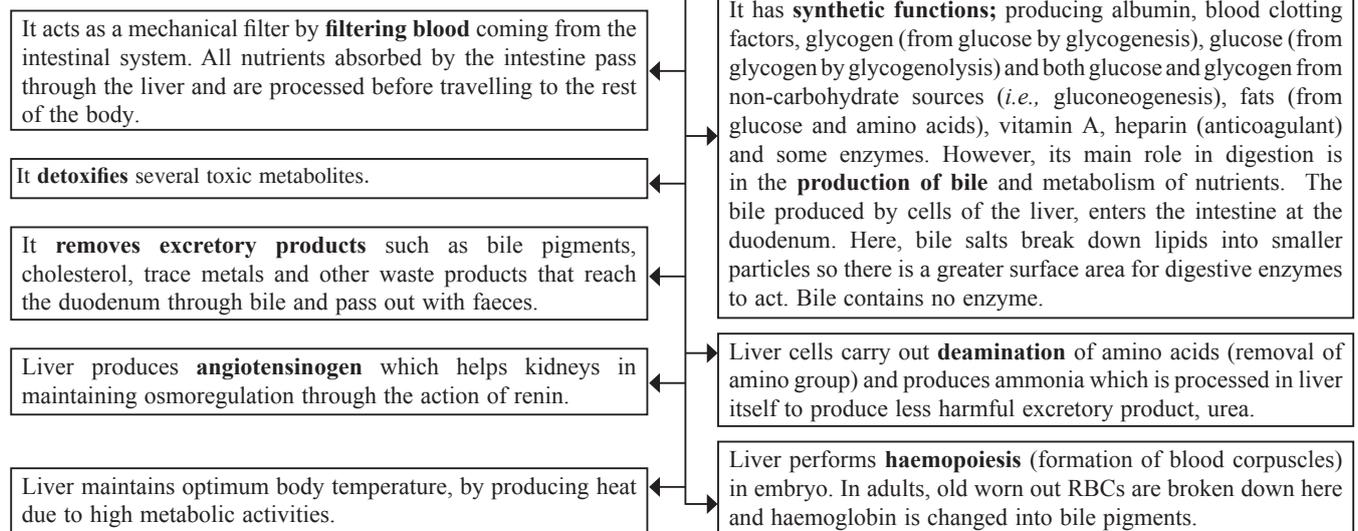


Fig.: Liver and associated structures

Functions of liver



- **Pancreas** is a lobular pinkish-grey organ situated in the limbs of the U shaped duodenum.
- Pancreas contain two different kinds of glandular tissue– an **exocrine part** (secretes **pancreatic juice**) and an **endocrine part** (secretes hormones-**insulin** and **glucagon**). Pancreatic juice is colourless watery fluid, slightly alkaline (pH 7.5–8)

due to presence of **sodium bicarbonate**. Pancreatic juice is complete digestive juice as it possesses amylolytic, lipolytic and proteolytic enzymes.

- **Intestinal glands**, formed by surface epithelium of small intestine, occur as **Crypts of Lieberkuhn** and **Brunner's gland**.
- Crypts of lieberkuhn occur throughout small intestine between the villi. They have 2 types of cells: **Argentaffin cells** (produce secretion) and **paneth cells** (secrete lysozyme).
- **Brunner's glands** mostly occur in duodenum and open into crypts of Lieberkuhn. The secretion of both glands are collectively called **intestinal juice** or **succus entericus**. Intestinal juice is **slightly alkaline** (pH 7.5) and contains mucus, inorganic salts, and many enzymes like enterokinase, intestinal lipase, maltase, sucrase, nucleopeptidase, isomaltase etc.
- Amino acids, fatty acids, mineral, vitamins and glucose are carried by hepatic portal vein. Some nutrients such as fructose and mannose are absorbed from intestine by facilitated diffusion. Water is absorbed by osmosis from the intestinal lumen to intestinal cells. The absorbed substances finally reach the tissues which utilise them for their activities. This process is called **assimilation**.

	Foodstuff	Enzyme(s)	Site of action	Path of absorption
Carbohydrate digestion	Starch and other polysaccharides ↓ Oligosaccharides and disaccharides ↓ Lactose, Maltose, Sucrose ↓ Galactose, Glucose, Fructose	Salivary amylase	Mouth	<ul style="list-style-type: none"> • Glucose and galactose are absorbed <i>via</i> co-transport with sodium ions. • Fructose passes <i>via</i> facilitated diffusion. • All monosaccharides leave the epithelial cells <i>via</i> facilitated diffusion, enter the capillary blood in the villi, and are transported to the liver <i>via</i> the hepatic portal vein.
		Pancreatic amylase	Small intestine	
Protein digestion	Proteins ↓ Large polypeptides ↓ Small polypeptides, small peptides ↓ Amino acids (some dipeptides and tripeptides)	Pepsin (stomach glands) in presence of HCl	Stomach	<ul style="list-style-type: none"> • Amino acids are absorbed <i>via</i> co-transport with sodium ions. • Some dipeptides and tripeptides are absorbed <i>via</i> co-transport with H⁺ and hydrolysed to amino acids within the cells. • Amino acids leave the epithelial cells by facilitated diffusion, enter the capillary blood in the villi, and are transported to the liver <i>via</i> the hepatic portal vein.
		Pancreatic enzymes (trypsin, chymotrypsin, carboxypeptidase)	Small intestine	
		Aminopeptidase and dipeptidase	Small intestine	
Fat digestion	Unemulsified triglycerides ↓ Monoglycerides (or diglycerides with gastric lipase) and fatty acids	Gastric lipase	Stomach	<ul style="list-style-type: none"> • Fatty acids and monoglycerides enter the intestinal cells <i>via</i> diffusion. • Fatty acids and monoglycerides are recombined to form triglycerides and then combined with other lipids and proteins within the cells. The resulting chylomicrons are extruded by exocytosis. • The chylomicrons enter the lacteals of the villi and are transported to the systemic circulation <i>via</i> the lymph in the thoracic duct. • Some short-chain fatty acids are absorbed, move into the capillary blood in the villi by diffusion, and are transported to the liver <i>via</i> the hepatic portal vein.
		Emulsification by the detergent action of bile salts	Small intestine	
		Pancreatic lipases	Small intestine	
Nucleic acid digestion	Nucleic acids ↓ Pentose sugars, N-containing bases, phosphate ions	Pancreatic ribonuclease and deoxyribonuclease	Small intestine	<ul style="list-style-type: none"> • Units enter intestinal cells by active transport <i>via</i> membrane carriers. • Units are absorbed into capillary blood in the villi and transported to the liver <i>via</i> the hepatic portal vein.
		Nucleotidases, nucleosidases, and phosphatases	Small intestine	

Fig.: Summary of digestion and absorption

- With the accumulation of faecal matter, colon develops a strong peristaltic movement, which produces the urge for defaecation. Defaecation or egestion is the elimination of undigested food through the anus.

DISORDERS OF DIGESTIVE SYSTEM

- **Diarrhoea** is watery stool, or increased frequency, or both, when compared to a normal amount. Diarrhoea may be acute (short-term), which is usually related to bacterial or viral infections, or chronic (long-term), which is usually related to a functional disorder or intestinal disease. Symptoms of diarrhoea may include: cramping abdominal pain, bloating, nausea, urgent need to use the restroom, fever, bloody stools etc.
 - **Hepatitis** is the inflammation of the liver, resulting in liver cell damage and destruction.
 - **Lactose intolerance** is a condition caused by a lack of an enzyme called lactase, which, in turn, causes the body to be unable to digest lactose, a sugar found in milk products. Symptoms of lactose intolerance are nausea, cramps, bloating, gas, diarrhoea.
 - **Alactasia** is inherited condition causing the lack of the enzyme needed to digest milk sugar.
 - **Constipation** is a condition in which the stool becomes hard and dry.
 - **Heartburn** is a painful, burning feeling in the chest caused by stomach acid flowing back into the oesophagus.
 - **Peptic ulcer** is sore in the lining of the oesophagus, stomach or duodenum; usually caused by the bacterium *Helicobacter pylori*. An ulcer in the stomach is a gastric ulcer; an ulcer in the duodenum is a duodenal ulcer.
 - **Appendicitis** is a condition in which the appendix becomes inflamed. If the appendix perforates (bursts), it releases infection into the abdomen, leading to peritonitis.
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POWER EXERCISE

16.1: Nutrients

2015

1. Which one of the following vitamins is not fat soluble?
(a) A (b) B
(c) D (d) E (AMU)

2014

2. Which one of the following vitamins is anti-haemorrhagic?
(a) Vitamin B₁₂ (b) Vitamin B₅
(c) Vitamin C (d) Vitamin K (AIIMS)

2013

3. A healthy person eats the following diet-5 gm raw sugar, 4 gm albumin, 10 gm pure buffalo ghee adulterated with 2 gm vegetable ghee (hydrogenated vegetable oil) and 5 gm lignin. How many calories he is likely to get?
(a) 126 (b) 164
(c) 112 (d) 144 (NEET Karnataka)

4. Which of the following elements is a constituent of biotin?
(a) Magnesium (b) Calcium
(c) Phosphorus (d) Sulphur (NEET Karnataka)

2012

5. In a normal adult, ascending order of concentration of following molecules is
(a) K > Na > Fe > Cu (b) Na > K > Cu > Fe
(c) Fe > Na > K > Cu (d) Na > Fe > K > Cu. (AIIMS)

6. Cyanocobalamin is required for the maturation of
(a) RBC (b) platelets
(c) WBC (d) lymph. (AFMC)

7. Which of the following acid is also a vitamin?
(a) Ascorbic acid (b) Formic acid
(c) Malic acid (d) Palmitic acid (AFMC)

8. Which one of the following vitamins is manufactured in human liver?
(a) Vitamin A (b) Vitamin D
(c) Vitamin C (d) Vitamin K (BHU)

2011

9. The purplish red pigment rhodopsin contained in the rods type of photoreceptor cells of the human eye, is a derivative of

- (a) vitamin B₁ (b) vitamin C
(c) vitamin D (d) vitamin A. (AIPMT Prelims)

10. Sulphur is not a constituent of
(a) cysteine (b) methionine
(c) ferredoxin (d) pyridoxine. (AMU)

11. A balanced diet does not include
(a) carbohydrates and fats
(b) nucleic acids and enzymes
(c) proteins and vitamins
(d) minerals and salts. (Karnataka CET)

2010

12. Vitamin B₆ is also called
(a) thiamine (b) pantothenic acid
(c) pyridoxine (d) retinol. (AIIMS)

13. Vitamin-D is produced in human body in
(a) muscles (b) nerves
(c) skin (d) bone-marrow. (WB JEE)

2009

14. In human percent of body weight of carbohydrates, lipids and proteins respectively is
(a) 1, 15, 17 (b) 15, 17, 7
(c) 7, 17, 15 (d) 17, 15, 7. (AMU)

15. The number of essential amino acids in adult human is
(a) nine (b) eight
(c) four (d) seven. (OJEE)

16. Which of the following is used for long term energy storage by animals?
(a) Amino acids (b) Glucose
(c) Fat (d) Glycogen (OJEE)

2008

17. Anti-haemorrhagic vitamin is
(a) vitamin C (b) vitamin B
(c) vitamin A (d) vitamin K. (BHU)

2007

18. Vitamin B₁₂ consists of which type of mineral?
(a) Co (b) Ni
(c) Fe (d) None of these (BHU)

19. Which of the following is true for vitamin C?
(a) Also called as ascorbic acid
(b) Also called as fumaric acid
(c) Obtained from citrus fruits
(d) Both (a) and (c) (UP CPMT)

16.2: Alimentary Canal

2016

20. Which of the following guards the opening of hepatopancreatic duct into the duodenum?
 (a) Pyloric sphincter (b) Sphincter of Oddi
 (c) Semilunar valve (d) Ileocaecal valve
(NEET Phase-I)
21. In the stomach, gastric acid is secreted by the
 (a) peptic cells (b) acidic cells
 (c) gastrin secreting cells (d) parietal cells.
(NEET Phase-I)
22. The main function of the lacteals in the villi of human small intestine is to absorb
 (a) fat globules (b) water and mineral salts
 (c) amino acids (d) glucose and amino acids
 (e) glucose and water. *(Kerala PMT)*

2015

23. The primary dentition in human differs from permanent dentition in not having one of the following type of teeth.
 (a) Molars (b) Incisors
 (c) Canines (d) Premolars *(AIPMT)*
24. Vermiform appendix arises from
 (a) caecum (b) colon
 (c) rectum (d) ileum. *(AMU)*
25. Brunner's glands are found in
 (a) duodenum (b) jejunum
 (c) stomach (d) both (a) and (b).
(JIPMER)
26. Choose the correct statement among the following.
 (a) The intestinal mucosal epithelium has oxyntic cells.
 (b) Ptyalin converts proteins into proteoses and peptones.
 (c) Crypts of Lieberkuhn is seen between the bases of villi in the intestine.
 (d) Sphincter of Oddi is present at the junction of oesophagus and cardiac stomach.
 (e) Goblet cells secrete hydrochloric acid in stomach.
(Kerala PMT)
27. The epithelium found in the inner linings of stomach and intestine is
 (a) columnar (b) squamous
 (c) stratified (d) pseudo-stratified.
(WB JEE)

2014

28. The middle part of the small intestine is
 (a) duodenum (b) jejunum
 (c) ileum (d) pyloric region.
(J & K CET)

2013

29. Ileocaecal valve is present in between
 (a) colon and large intestine
 (b) colon and small intestine
 (c) stomach and small intestine
 (d) cardiac stomach and fundus. *(Karnataka CET)*

2012

30. Argentaffin cells in human beings are found in
 (a) small intestine (b) stomach
 (c) large intestine (d) liver. *(AMU)*
31. In human beings, the three pair of salivary glands and numerous buccal glands produce about
 (a) 1.0 dm³ of saliva per day
 (b) 1.5 dm³ of saliva per day
 (c) 2.0 dm³ of saliva per day
 (d) 2.5 dm³ of saliva per day. *(AMU)*
32. In the gastrointestinal tract the Meissner's plexus and the Auerbach's plexus occur respectively in the
 (a) lamina propria and muscularis mucosa
 (b) submucosa and muscularis externa
 (c) submucosa and mucosa
 (d) mucosa and muscularis externa. *(AMU)*
33. The layer lining the lumen of the human alimentary canal is
 (a) serosa (b) sub-mucosa
 (c) muscularis (d) pleura
 (e) mucosa. *(Kerala PMT)*

2011

34. Which one of the following correctly represents the normal adult human dental formula?
 (a) $\frac{3}{3}, \frac{1}{1}, \frac{3}{2}, \frac{1}{1}$ (b) $\frac{2}{2}, \frac{1}{1}, \frac{3}{2}, \frac{3}{3}$
 (c) $\frac{2}{2}, \frac{1}{1}, \frac{2}{2}, \frac{3}{3}$ (d) $\frac{3}{3}, \frac{1}{1}, \frac{3}{3}, \frac{3}{3}$
(AIPMT Mains)
35. The mucosal layer in the stomach form irregular folds known as
 (a) villi (b) lumen
 (c) rugae (d) crypts of Lieberkuhn
 (e) lacteals. *(Kerala PMT)*
36. Column I contains names of the sphincter muscles of the alimentary canal and Column II contains their locations. Match them properly and choose the correct answer.
- | Column I | Column II |
|------------------------------|---|
| A. Sphincter of ani internus | 1. Opening of hepatopancreatic duct into duodenum |
| B. Cardiac sphincter | 2. Between duodenum and posterior stomach |
| C. Sphincter of Oddi | 3. Guarding the terminal part of alimentary canal |

- D. Ileocaecal sphincter
E. Pyloric sphincter
4. Between oesophagus and anterior stomach
5. Between small intestine and bowel

- (a) A - 3, B - 2, C - 4, D - 1, E - 5
(b) A - 2, B - 5, C - 1, D - 4, E - 3
(c) A - 3, B - 4, C - 1, D - 5, E - 2
(d) A - 4, B - 3, C - 1, D - 2, E - 5. (Karnataka CET)

37. Exclusive holozoic nutrition is seen in
(a) spider (b) man
(c) housefly (d) earthworm. (OJEE)

2010

38. Human dental formula is
(a) $\frac{2123}{2123}$ (b) $\frac{2123}{1223}$
(c) $\frac{1223}{2123}$ (d) $\frac{1223}{1223}$
(e) $\frac{2213}{2213}$. (Kerala PMT)

39. The type of teeth present in humans is
(a) monophodont and homodont
(b) diphyodont and heterodont
(c) diphyodont and homodont
(d) monophodont and thecodont. (OJEE)

40. The distal part of the stomach that opens into duodenum is called
(a) fundus (b) pylorus
(c) omentum (d) jejunum. (OJEE)

2008

41. The uniform protoplasmic extensions on the intestinal epithelium is known as
(a) brush border (b) striated border
(c) cilia (d) villi. (AMU)
42. Part of the stomach which opens into the duodenum is
(a) cardiac (b) pyloric
(c) fundus (d) body. (BHU)

16.3: Digestive Glands

2015

43. Identify the correctly matched structure and its secretion.
(a) Brunner's gland - Salivary amylase
(b) Intestinal mucosa - Insulin
(c) Gall bladder - Bile
(d) Salivary gland - Lysozyme
(e) Goblet cells - HCl (Kerala PMT)
44. The hormone that stimulates the release of pancreatic juice is
(a) secretin (b) glucagon
(c) inhibin (d) insulin. (WB JEE)

45. Zymogenic cells of gastric gland secrete
(a) pepsinogen (b) trypsin
(c) pepsin (d) chymotrypsin. (WB JEE)

2014

46. Which of the following organs does not produce any digestive enzymes?
(a) Salivary gland (b) Pancreas
(c) Liver (d) Stomach (WB JEE)

2012

47. Brunner's glands are found in
(a) mucosa of duodenum
(b) mucosa of ileum
(c) submucosa of duodenum
(d) submucosa of ileum. (BHU)
48. In man, Glisson's capsule is associated with the
(a) digestive system (b) excretory system
(c) nervous system (d) reproductive system
(e) endocrine system. (Kerala PMT)
49. Brunner's gland is present in
(a) duodenum (b) jejunum
(c) ileum (d) rectum. (WB JEE)

2010

50. Brunner's gland is present in
(a) liver (b) duodenum
(c) oesophagus (d) stomach. (AFMC)
51. This is the common passage for bile and pancreatic juices
(a) ampulla of Vater (b) ductus Choledochus
(c) duct of Wirsung (d) duct of Santorini. (AMU)
52. Glisson's capsule is the characteristic feature of
(a) mammals (b) birds
(c) reptiles (d) arthropods. (BHU)
53. The sphincter of Oddi found in man, guards the
(a) pancreatic duct (b) hepatopancreatic duct
(c) bile duct (d) cystic duct
(e) duodenum. (Kerala PMT)

2008

54. In humans, sphincter of Oddi is associated with the opening of
(a) hepatopancreatic ampulla
(b) pyloric stomach
(c) oesophagus
(d) common hepatic duct. (J & K CET)
55. Which of the following is the largest gland in an adult man?
(a) Thyroid (b) Pancreas
(c) Thymus (d) Liver (UP CPMT)

2007

56. Glisson's capsules are present in
 (a) liver (b) lung
 (c) kidney (d) stomach. (BHU)

16.4: Digestion of Food

2016

57. Which hormones do stimulate the production of pancreatic juice and bicarbonate?
 (a) Angiotensin and epinephrine
 (b) Gastrin and insulin
 (c) Cholecystokinin and secretin
 (d) Insulin and glucagon (NEET Phase-II)
58. Digestion of proteins is incomplete in the absence of enterokinase, because
 (a) trypsinogen is not converted into trypsin
 (b) pepsinogen is not converted into pepsin
 (c) prorennin is not converted into rennin
 (d) chymotrypsinogen is not converted into chymotrypsin. (Karnataka CET)
59. Read the following reactions and choose the correct option.
 1. Pepsinogen $\xrightarrow{\text{HCl}}$ Pepsin
 2. Proteins $\xrightarrow{\text{Pepsinogen}}$ Proteoses + peptones
 3. Trypsinogen $\xrightarrow{\text{HCl}}$ Trypsin
 4. Chymotrypsinogen $\xrightarrow{\text{Enterokinase}}$ Chymotrypsin
 5. Peptones $\xrightarrow{\text{Trypsin}}$ Dipeptides
 (a) 1 alone is correct.
 (b) 1 and 5 alone are correct.
 (c) 3 and 5 alone are correct.
 (d) 2, 4 and 5 alone are correct.
 (e) 2 alone is correct. (Kerala PMT)

2015

60. The optimum pH for pepsin is
 (a) 11 (b) 5-6
 (c) 1.6-2.4 (d) 4-7. (AMU)
61. Enzymes not present in pancreatic juice is
 (a) amylase (b) chymotrypsinogen
 (c) lipase (d) enterokinase. (AMU)
62. The enzyme that is not present in succus entericus is
 (a) nucleosidase (b) lipase
 (c) maltase (d) nuclease. (AIPMT)
63. Emulsification of fat occurs by
 (a) bile salts (b) bile pigments
 (c) pancreatic juice (d) succus entericus. (J & K CET)
64. The secretions of the brush border cells of the intestinal mucosa along with the secretion of goblet cells constitute the
 (a) succus entericus (b) chyme

- (c) gastric juice (d) chylomicrons
 (e) bolus. (Kerala PMT)

65. Emulsification of fat takes place through
 (a) bile pigments (b) liver enzymes
 (c) bile salts (d) intestinal enzymes. (UP CPMT)

66. In liver, _____ is converted into _____.
 (a) urea, ammonia (b) ammonia, urea
 (c) nitrate, ammonia (d) ammonia, nitrate (UP CPMT)

67. The usual cause(s) of peptic ulceration is/are
 (a) lower rate of secretion of gastric juice
 (b) higher rate of secretion of gastric and duodenal juices
 (c) improper neutralisation of gastric juice by duodenal juices
 (d) imbalance between the rate of secretion of gastric juice and the degree of protection offered by gastro-duodenal mucosa. (WB JEE)

2014

68. The initial step in the digestion of milk in humans is carried out by
 (a) lipase (b) trypsin
 (c) rennin (d) pepsin. (AIPMT)
69. Which of these is secreted by duodenum?
 (a) Somatostatin (b) Secretin
 (c) Gastrin (d) GIP (JIPMER)
70. Enteropeptidase present in 'succus entericus' converts _____.
 (a) alkaline medium to acidic medium
 (b) trypsinogen to trypsin
 (c) proteins to polypeptides
 (d) tyrosinase to tyrosine (JIPMER)
71. Match the column I with column II and column III. Choose the correct option.

Column I (Substrate)	Column II (Enzyme)	Column III (Product)
1. Lactose	A. Lipase	I. Galactose
2. Monoglycerides	B. Trypsin	II. Maltose
3. Starch	C. Lactase	III. Fatty acid
4. Peptones	D. Amylase	IV. Dipeptides
(a) 1- A-I; 2-C-II; 3-B-III; 4-D-IV		
(b) 1-D-I; 2-A-II; 3-B-III; 4-C-IV		
(c) 1-C-I; 2-A-III; 3-D-II; 4-B-IV		
(d) 1-C-I; 2-A-II; 3-D-III; 4-B-IV		
(e) 1-B-I; 2-D-II; 3-C-III; 4-A-IV		

(Kerala PMT)

72. Choose the wrong statement among the following.
 (a) Trypsinogen is activated by enterokinase.
 (b) The optimum pH for salivary amylase activity is 8.9.
 (c) Rennin helps in the digestion of milk proteins.
 (d) Goblet cells secrete mucous.
 (e) Submucosal glands of the intestine are also known as Brunner's glands. (Kerala PMT)

73. Chylomicrons are
 (a) small fat globules coated with protein
 (b) protein molecules coated with fat
 (c) small granules found in gastric juice
 (d) neural signals that stimulate intestinal secretions
 (e) aerobic microbes. (Kerala PMT)
74. Absorption of vitamin B₁₂ in human requires "P" glycoprotein secreted from "Q". The correct choices of P and Q are
 (a) P = Extrinsic factor and Q = Stomach
 (b) P = Intrinsic factor and Q = Stomach
 (c) P = Intrinsic factor and Q = Small intestine
 (d) P = Exopolysaccharide and Q = Small intestine. (WB JEE)

2013

75. Which enzymes are likely to act on the baked potatoes eaten by a man, starting from the mouth as they move down the alimentary canal?
 (a) Pancreatic amylase → Salivary amylase → Lipases
 (b) Disaccharidase like maltase → Lipases → Nucleases
 (c) Salivary amylase → Pancreatic amylase → Disaccharidases
 (d) Salivary maltase → Carboxypeptidase → Trypsinogen (NEET Karnataka)
76. Which of the following gastric secretions is correctly matched with its source?
 (a) Pepsin – Chief cells
 (b) Chymotrypsin – Parietal cells
 (c) HCl – Goblet cells
 (d) Mucus – Oxyntic cells (AIIMS)
77. After surgical removal of an infected gall bladder, a person must be especially careful to restrict dietary intake of
 (a) starch (b) protein
 (c) sugar (d) fat. (AMU)
78. The contraction of gall bladder is due to
 (a) gastrin (b) enterogastrone
 (c) secretin (d) cholecystokinin. (JIPMER)
79. The semi-digested food that moves down the oesophagus is known as
 (a) bolus (b) chyme
 (c) rugae (d) protein. (Karnataka CET)

2012

80. The gastrointestinal hormone which stimulates insulin secretion is
 (a) gastrin (b) CCK
 (c) secretin (d) GIP. (AMU)
81. The parietal cells secrete
 (a) pepsinogen (b) mucus
 (c) lysozyme (d) intrinsic factor
 (e) parathormone. (Kerala PMT)

82. Choose the wrong statement.
 (a) Lipases and nucleases are not present in pancreatic juice.
 (b) Goblet cells secrete mucus.
 (c) Brunner's glands are sub-mucosal glands.
 (d) Carboxypeptidase catalyses conversion of proteins, peptones and proteoses to dipeptides.
 (e) Bile contains no enzymes. (Kerala PMT)
83. One of the following movements in our body is not completely involuntary. Identify it.
 (a) Deglutition
 (b) Peristalsis
 (c) Systole of the ventricles
 (d) Dilation of pupil of the eye (Karnataka CET)
84. If this enzyme were to be absent in our small intestine, digestion of proteins in our body would be severely affected.
 (a) Pancreatic amylase (b) Maltase
 (c) Lipase (d) Enterokinase (Karnataka CET)
85. Secretin and cholecystokinin are the hormones secreted in
 (a) pyloric stomach (b) duodenum
 (c) ileum (d) oesophagus. (Karnataka CET)
86. Which of the following is secreted by pancreas ?
 (a) Dipeptidases (b) Amylase
 (c) α-Dextrins (d) Pepsin (OJEE)
87. Main function of HCl present in gastric juice is
 (a) digestion of starch (b) emulsification of fat
 (c) conversion of pepsinogen to pepsin
 (d) detoxification of harmful constituents of food. (OJEE)
88. Glycogenesis refers to
 (a) conversion of glycogen to glucose
 (b) breakdown of glucose to form pyruvate
 (c) breakdown of pyruvate to form glucose
 (d) conversion of glucose to glycogen. (OJEE)
89. Peristalsis occurs in
 (a) liver (b) ureter
 (c) alimentary canal (d) blood vessels. (OJEE)
90. Cholecystokinin stimulates the secretion of
 (a) bile (b) gastric juice
 (c) pancreatic juice (d) succus entericus. (WB JEE)

2011

91. One of the constituents of the pancreatic juice which is poured into the duodenum in humans is
 (a) trypsinogen (b) chymotrypsin
 (c) trypsin (d) enterokinase. (AIPMT Mains)

92. The back flow of faecal matter in the large intestine is prevented by the presence of
 (a) epiglottis
 (b) sphincter of Oddi
 (c) ileo-caecal valve
 (d) gastro-oesophageal sphincter
 (e) pyloric sphincter. *(Kerala PMT)*
93. Oxyntic cell produces
 (a) pepsin (b) HCl
 (c) trypsin (d) renin. *(OJEE)*
94. The special feature of bile juice is that it
 (a) has no enzyme (b) has amylase
 (c) contains lipase (d) contains H₂O. *(OJEE)*
95. Ptyalin is the another name of
 (a) chymotrypsin (b) pepsin
 (c) salivary amylase (d) renin. *(OJEE)*
96. The gastrin is secreted from
 (a) intestine (b) stomach
 (c) pancreas (d) rectum. *(WB JEE)*
97. Which of the following is a gastro-intestinal hormone ?
 (a) Prolactin (b) Enterokinase
 (c) GH (d) FSH *(WB JEE)*
98. Ptyalin is inactivated by a component of gastric juice known as
 (a) pepsin (b) mucus
 (c) rennin (d) HCl. *(WB JEE)*
- 2010**
99. If for some reason the parietal cells of the gut epithelium become partially non-functional, what is likely to happen?
 (a) The pancreatic enzymes and specially the trypsin and lipase will not work efficiently.
 (b) The pH of stomach will fall abruptly.
 (c) Steapsin will be more effective.
 (d) Proteins will not be adequately hydrolysed by pepsin into proteoses and peptones. *(AIPMT Mains)*
100. If for some reason our goblet cells are non-functional, this will adversely affect
 (a) production of somatostatin
 (b) secretion of sebum from the sebaceous glands
 (c) maturation of sperms
 (d) smooth movement of food down the intestine. *(AIPMT Prelims)*
101. Which of the following is correct?
 (a) Paneth cells secrete pepsinogen.
 (b) Parietal cells secrete hydrochloric acid.
 (c) Argentaffin cells secrete mucus.
 (d) Chief cells secrete gastrin. *(AIIMS)*
102. This gastrointestinal hormone stimulates insulin secretion.
 (a) Gastrin (b) CCK
 (c) Secretin (d) GIP *(AMU)*
103. The process of conversion of excess glucose into glycogen is called
 (a) glycolysis (b) glycogenesis
 (c) gluconeogenesis (d) oogenesis. *(J & K CET)*
104. The wall of the stomach is protected against the action of HCl by
 (a) epidermal layer (b) mesodermal layer
 (c) mucous layer (d) muscular layer. *(J & K CET)*
105. The gastric juice contains
 (a) trypsin, pepsin, lipase
 (b) pepsin, lipase, rennin
 (c) pepsin, amylase, trypsin
 (d) trypsin, pepsin, rennin
 (e) pepsin, rennin, carboxypeptidase. *(Kerala PMT)*
106. Match column I with column II and choose the correct option.
- | Column I | Column II |
|------------------|------------------------|
| A. Goblet cells | 1. Antibacterial agent |
| B. Lysozyme | 2. Mucus |
| C. Saliva | 3. HCl |
| D. Oxyntic cells | 4. Sublingual gland |
- (a) A-3, B-1, C-4, D-2
 (b) A-1, B-3, C-4, D-2
 (c) A-2, B-3, C-1, D-4
 (d) A-4, B-1, C-2, D-3
 (e) A-2, B-1, C-4, D-3 *(Kerala PMT)*
107. The sugar present in milk is _____.
 (a) fructose (b) sucrose
 (c) glucose (d) lactose *(Karnataka CET)*
108. Succus entericus is secreted by _____.
 (a) Auerbach's plexus (b) Brunner's glands
 (c) Peyer's patches (d) Crypts of Lieberkuhn *(Karnataka CET)*
109. Bile salts in bile help in _____ of fats.
 (a) dehydration (b) deglutition
 (c) emulsification (d) peristalsis *(OJEE)*
110. Which of the following are proteolytic enzymes?
 (a) Ptyalin, trypsin, pepsin
 (b) Lipase, erepsin, trypsin
 (c) Erepsin, trypsin, pepsin
 (d) Pepsin, nuclease, nucleotidase *(OJEE)*
111. Which of the following statements is correct?
 (a) Argentaffin cells produce serotonin.
 (b) Villikin is secreted by large intestine.
 (c) In cheilosis, deficient nutrient is nicotinamide.
 (d) Bleeding diseases occur due to deficiency of vitamin E. *(UP CPMT)*
112. Name the hormone that stimulates the secretion of gastric juice
 (a) renin (b) enterokinase
 (c) enterogastrone (d) gastrin. *(WB JEE)*

113. Bile salts act as activator of which enzyme?
 (a) Pepsinogen (b) Trypsinogen
 (c) Lipase (d) Pancreatic amylase
 (WB JEE)
114. Which of the following cells produce HCl?
 (a) β -Cell (b) α -Cell
 (c) Oxyntic cell (d) Chief cell (WB JEE)

2009

115. Which one of the following pairs of food components in humans reaches the stomach totally undigested?
 (a) Starch and fat (b) Fat and cellulose
 (c) Starch and cellulose (d) Protein and starch
 (AIPMT)

116. The food that enters intestine from stomach is called
 (a) chyle (b) chyme
 (c) fundus (d) none of these.
 (AFMC)

117. Secretin
 (a) stimulates enzyme secretion by pancreas, inhibits acid secretion in stomach, stimulates gall bladder
 (b) stimulates bicarbonate secretion by pancreas, inhibits acid secretion in stomach, stimulates bicarbonate secretion by liver
 (c) stimulates acid secretion in stomach, potentiates action of CCK, inhibits intestinal movement
 (d) stimulates gall bladder, inhibits acid secretion in stomach, stimulates bicarbonate secretion by pancreas.
 (AMU)

118. In the absence of enterokinase, the digestion of _____ would be affected in our intestine.
 (a) albumin (b) starch
 (c) maltose (d) amino acid
 (Karnataka CET)

119. Compare the statements A and B
Statement A : Blood sugar level falls rapidly after hepatectomy.
Statement B : The glycogen of the liver is the principal source of blood sugar.
 Select the correct description.
 (a) Statement A is wrong and B is correct.
 (b) Both the statements A and B are correct and B is not the reason for A.
 (c) Both the statements A and B are correct and B is the reason for A.
 (d) Statement A is correct and B is wrong.
 (Karnataka CET)

120. Digestion is brought about by
 (a) hormones (b) neurotransmitters
 (c) growth factors (d) enzymes. (OJEE)
121. Salivary amylase, a digestive enzyme begins digestion of
 (a) proteins (b) fats
 (c) carbohydrates (d) all of these. (OJEE)

122. Gastric enzymes are
 (a) pepsin (b) rennin
 (c) gastric lipase (d) all of these. (UP CPMT)

2008

123. Which one of the following is the correct matching of the site of action on the given substrate, the enzyme acting upon it and the end product?
 (a) Small intestine : proteins $\xrightarrow{\text{Pepsin}}$ amino acids
 (b) Stomach : fats $\xrightarrow{\text{Lipase}}$ micelles
 (c) Duodenum : triglycerides $\xrightarrow{\text{Trypsin}}$ monoglycerides
 (d) Small intestine : starch $\xrightarrow{\alpha\text{-Amylase}}$ disaccharide (maltose)
 (AIPMT)

124. What will happen if the secretion of parietal cells of gastric glands is blocked with an inhibitor?
 (a) In the absence of HCl secretion, inactive pepsinogen is not converted into the active enzyme pepsin.
 (b) Enterokinase will not be released from the duodenal mucosa and so trypsinogen is not converted to trypsin.
 (c) Gastric juice will be deficient in chymosin.
 (d) Gastric juice will be deficient in pepsinogen.
 (AIPMT)

125. Food that enters into intestine is known as
 (a) bolus (b) chyme
 (c) chyle (d) none of these.
 (AFMC)

126. pH of gastric juice is
 (a) 2 (b) 4
 (c) 6 (d) 8. (OJEE)

2007

127. A child took sugar cane and sucked its juice. Regarding this which of the following match is correct?

Substrate	Enzyme	Site of secretion of enzyme	Products formed
(a) Protein	pepsin	duodenum	polypeptides
(b) Starch	amylase	salivary glands	glucose
(c) Lipids	lipase	pancreas	fat globules
(d) Sucrose	invertase	duodenum	glucose + fructose

(AIIMS)

128. Succus entericus is secreted by
 (a) crypts of Lieberkuhn (b) Brunner's gland
 (c) both (a) and (b) (d) none of these.
 (Karnataka CET)
129. Carbohydrate digestion occurs first in which structure?
 (a) Mouth (b) Intestine
 (c) Stomach (d) None of these
 (OJEE)

Digestion and Absorption

130. Enzyme pepsin acts in
 (a) acidic medium in the pancreas
 (b) acidic medium in the stomach
 (c) intestine
 (d) mouth. (OJEE)
131. Digestion of protein is completed in
 (a) stomach (b) duodenum
 (c) ileum (d) duodenum and ileum. (UP CPMT)

16.5: Absorption of Digested Products

2014

132. Fructose is absorbed into the blood through mucosa cells of intestine by the process called
 (a) active transport
 (b) facilitated transport
 (c) simple diffusion
 (d) co-transport mechanism. (AIPMT)

2013

133. Select the correct match of the digested products in humans given in column I with their absorption site and mechanism in column II.

Column I	Column II
(a) Glycerol, fatty acids	Duodenum, move as chylomicrons
(b) Cholesterol, maltose	Large intestine, active absorption
(c) Glycine, glucose	Small intestine, active absorption
(d) Fructose, Na ⁺	Small intestine, passive absorption

(NEET)

2012

134. During absorption of carbohydrates in the blood the most rapidly transported monosaccharide is
 (a) glucose (b) galactose
 (c) fructose (d) sucrose. (BHU)

2010

135. Carrier ions like Na⁺ facilitate the absorption of substances like
 (a) amino acids and glucose
 (b) glucose and fatty acids
 (c) fatty acids and glycerol
 (d) fructose and some amino acids. (AIPMT Prelims)
136. The food materials in intestine are absorbed through
 (a) cilia (b) flagella
 (c) villi (d) vibrissae. (OJEE)

2009

137. Which one of the following statements is true regarding digestion and absorption of food in humans?
 (a) Fructose and amino acids are absorbed through intestinal mucosa with the help of carrier ions like Na⁺.
 (b) Chylomicrons are small lipoprotein particles that are transported from intestine into blood capillaries.
 (c) About 60% of starch is hydrolysed by salivary amylase in our mouth.
 (d) Oxyntic cells in our stomach secrete the proenzyme pepsinogen. (CBSE PMT)

138. Most digestion and absorption of food takes place in
 (a) stomach (b) small intestine
 (c) large intestine (d) caecum. (OJEE)

2008

139. Fats and lipids are absorbed in
 (a) lymph capillaries (b) blood capillaries
 (c) hepatic portal vein (d) none of these. (AFMC)

16.6: Disorders of Digestive System

2015

140. The deficiency of which of the following vitamins will cause xerophthalmia?
 (a) A (b) B
 (c) C (d) K (AMU)
141. A patient with bleeding gums is advised to take fresh fruits and vegetables in diet specially because he suffers from
 (a) scurvy (b) night blindness
 (c) beri-beri (d) anaemia. (COMEDK)

142. Match column I with column II.

Column I	Column II
P. Vitamin B ₁	(i) Accumulation of fat
Q. Gastric juice	(ii) Loss of fat
R. Starvation	(iii) Pepsin
S. Obesity	(iv) Beri-beri
(a) P-(iii), Q-(iv), R-(ii), S-(i)	
(b) P-(iii), Q-(iv), R-(i), S-(ii)	
(c) P-(iv), Q-(iii), R-(ii), S-(i)	
(d) P-(iv), Q-(ii), R-(iii), S-(i)	

(WB JEE)

2014

143. Which of the following pairs is not correctly matched?
 (a) Vitamin B₁₂ - Pernicious anaemia
 (b) Vitamin B₆ - Loss of appetite
 (c) Vitamin B₁ - Beri beri
 (d) Vitamin B₂ - Pellagra (JIPMER)

144. The disease that occurs in mature adult human being due to deficiency of calciferol is

- (a) keratomalacia (b) osteomalacia
(c) glossitis (d) pernicious anaemia.

(WB JEE)

2013

145. Which of the following is a protein deficiency disease?

- (a) Osteomalacia (b) Kwashiorkor
(c) Pellagra (d) Rickets (AMU)

146. A person is exclusively feeding on meat, egg and milk. He is likely to suffer from

- (a) scurvy (b) night blindness
(c) pellagra (d) dermatitis. (JIPMER)

2012

147. Anxiety and eating spicy food together in an otherwise normal human, may lead to

- (a) indigestion (b) jaundice
(c) diarrhoea (d) vomiting.

(AIPMT Prelims)

2011

148. Two friends are eating together on a dining table. One of them suddenly starts coughing while swallowing some food. This coughing would have been due to improper movement of

- (a) epiglottis (b) diaphragm
(c) neck (d) tongue.

(AIPMT Prelims)

149. Pellagra is caused due to deficiency of

- (a) niacin (b) pantothenic acid
(c) tocopherol (d) cyanocobalamine.

(J & K CET)

150. Osteomalacia is a deficiency disease of

- (a) infants due to protein energy malnutrition
(b) adults due to protein energy malnutrition
(c) adults due to vitamin D deficiency
(d) infants due to vitamin K deficiency. (WB JEE)

2010

151. Marasmus is caused by the deficiency of

- (a) protein (b) thiamin
(c) riboflavin (d) niacin. (J & K CET)

152. Deficiency of vitamin C causes

- (a) beri-beri (b) scurvy
(c) night-blindness (d) pellagra. (OJEE)

2009

153. When breast feeding is replaced by less nutritive food low in proteins and calories; the infants below the age of one year are likely to suffer from

- (a) rickets (b) kwashiorkor
(c) pellagra (d) marasmus.

(CBSE PMT)

154. A young infant may be feeding entirely on mother's milk which is white in colour but the stools which the infant passes out is quite yellowish. The yellow colour of stool is due to

- (a) bile pigments passed through bile juice
(b) undigested milk protein casein
(c) pancreatic juice poured into duodenum
(d) intestinal juice. (CBSE PMT)

155. Liver necrosis and muscular dystrophy are caused due to lack of this trace element.

- (a) Arsenic (b) Molybdenum
(c) Zinc (d) Selenium (AMU)

156. A protein deficiency disease is

- (a) kwashiorkor (b) marasmus
(c) pellagra (d) osteomalacia.

(UP CPMT)

2008

157. Nobel prize for medicine was given for confirming the role of *Helicobacter pylori* in causing

- (a) nephritis (b) rhinitis
(c) bronchitis (d) peptic ulcer.

(Karnataka CET)

2007

158. Which one of the following is a fat-soluble vitamin and its related deficiency disease?

- (a) Retinol - xerophthalmia
(b) Cobalamin - beri-beri
(c) Calciferol - pellagra
(d) Ascorbic acid - scurvy

(CBSE PMT)

159. Which match is true?

	Vitamin deficiency disease	Vitamin	Source
(a)	Severe bleeding	tocopherol	milk, egg
(b)	Anaemia	ascorbic acid	lemon, orange
(c)	Night blindness	retinol	carrot, milk
(d)	Sterility	calciferol	milk, butter

(AIIMS)

160. The deficiency of which vitamin causes keratomalacia?

- (a) Vitamin K (b) Vitamin D
(c) Vitamin A (d) Vitamin E

(J & K CET)

161. The condition in which the potassium level is increased, is known as

- (a) hypercholesterolemia
(b) hyperkalaemia
(c) osteomalacia
(d) hyperexcitability.

(J & K CET)

EXPLANATIONS

1. **(b)**: Vitamins are regarded as organic compounds required in the diet in small amounts to perform specific biological normal maintenance of optimum growth and health of the organisms. Vitamin A, D, E and K are fat soluble vitamins, while vitamin B-complex and C are water soluble.

2. **(d)**: Anti-haemorrhagic vitamins are those substances which promote haemostasis or stops bleeding. Vitamin K is one of them.

3. **(d)**: Physiological value is the energy produced by 1 gm of food on oxidation in the body. For carbohydrates, it is 4.0 kcal/g, for proteins, it is 4.0 kcal/g and it is 9.0 kcal/g for fats. Lignin is a fibre that is present in plant cells but is not digestible in humans and thus it does not produce energy. Hence,

5 g raw sugar will yield $5 \times 4.0 = 20.0$ kcal

4 g albumin will yield $4 \times 4.0 = 16.0$ kcal

(10 + 2) g of fat will yield $12 \times 9.0 = 108.0$ kcal

Total yield = 144 kcal.

4. **(d)**: Sulphur is present in two vitamins of B complex, thiamine and biotin. Biotin is important to hair. It is normally found in protein foods, such as eggs, lettuce, sprouts etc.

5. **(a)**

6. **(a)**: The production of normal erythrocytes (red blood corpuscles) number requires extremely small quantities (one-millionth of a gram per day) of a cobalt containing molecule, vitamin B₁₂ (also known as cyanocobalamine), because it potentiates the action of folic acid, required for rapid proliferation of erythrocyte precursors. Vitamin B₁₂ is found only in animal products. Deficiency of this vitamin leads to pernicious anaemia (deficiency of erythrocytes).

7. **(a)**: Ascorbic acid or vitamin C is a colourless, crystalline, water-soluble, heat labile vitamin with antioxidant properties, found especially in citrus fruits and green vegetables. It functions as a scavenger of free radicals within cells and in extracellular fluid and blood plasma. Most organisms synthesize it from glucose but humans and other primates obtain it from diet. The recommended daily intake is 30 mg for an adult. Deficiency of vitamin C leads to scurvy.

8. **(a)**: Liver synthesises vitamin A from β -carotene. The latter is an orange-yellow substance of carrot.

9. **(d)**: Vitamin A (retinol) is a fat-soluble vitamin that cannot be synthesised by mammals and other vertebrates and must be provided in the diet. It is a constituent of the visual pigment rhodopsin. Deficiency affects the eyes, causing night blindness.

10. **(d)**: Cysteine and methionine are the amino acids which contain sulphur. Ferredoxin is iron sulphur compound which transfer electron from special chlorophyll molecule called

as P₇₀₀ to plastoquinone in photosystem I. Vitamin B₆ or pyridoxine lacks sulphur.

11. **(b)**: A diet is said to be balanced when various nutritional materials *i.e.*, proteins, carbohydrates, fats, minerals, vitamins, roughage and water are present in sufficient amount and proper proportion. Various constituents of the balanced diet provide energy, growth, repair, replacement of cells, and physiological regulation.

12. **(c)**: Vitamin B₆, also called pyridoxine is widely distributed in cereal grains, yeast, liver, milk, etc. It is a constituent of a coenzyme (pyridoxal phosphate) involved in amino acid metabolism. Its deficiency causes retarded growth, dermatitis, convulsions, and other symptoms.

13. **(c)**: Vitamin D is a fat-soluble vitamin that enhances the absorption of calcium and phosphorus from the intestine and promotes their deposition in the bone. It occurs in two forms : ergocalciferol (vitamin D₂ or calciferol), which is manufactured by plants when the sterol ergosterol is exposed to ultraviolet light, and cholecalciferol (vitamin D₃), which is produced by the action of sunlight on 7-dehydrocholesterol, a sterol widely distributed in the skin.

14. **(a)** 15. **(a)** 16. **(c)**

17. **(d)**: Refer to answer 2.

18. **(a)**: Cobalamin or vitamin B₁₂ is cobalt containing B-complex vitamin which is synthesised only by some bacteria and moulds. Human beings obtain the vitamin from colon bacteria, milk, meat, liver, egg yolk and fish, etc.

19. **(d)**: Vitamin C is also known as ascorbic acid. It is obtained from citrus fruit, tomatoes, pepper and leafy green vegetables.

It plays a role in the hydroxylation of proline and lysine during collagen formation, maintains integrity of capillary walls, also maintains normal growth of bones and teeth, and takes part in cellular oxidation and reduction.

20. **(b)**: The sphincter of Oddi is a muscular valve that controls the flow of digestive juices (bile and pancreatic juice) through the hepatopancreatic duct into the duodenum.

21. **(d)**: Parietal cells are large cells present on the side walls of the gastric glands. They lie against the basement membrane. They secrete hydrochloric acid and Castle's intrinsic gastric factor that helps in the absorption of vitamin B₁₂ in the ileum.

22. **(a)**

23. **(d)**: Milk/primary teeth of man include 8 incisors, 4 canines and 8 molars (premolars are absent). Molars of milk teeth are shed off and premolars of permanent teeth take their place. The permanent teeth are 8 incisors, 4 canines, 8 premolars and 12 molars. Thus, 12 teeth (8 premolars and

4 molars) are monophyodont (teeth which grow only once in life). Dental formulae of milk teeth and permanent teeth of human are given below.

$$\frac{2120}{2120} \times 2 = 20$$

Milk teeth

$$\frac{2123}{2123} \times 2 = 32$$

Permanent teeth

24. (a) : The vermiform appendix is an outgrowth of the caecum. It is a slightly coiled blind tube, about 8 centimeters long. Its wall contains prominent lymphoid tissue. Appendix is thought to be vestigial.

25. (a) : Brunner's glands are found only in the duodenum and are located in the submucosa. They secrete a little enzyme and mucus. Mucus protects the duodenal wall from getting digested.

26. (c) : The mucosa of stomach has gastric glands. Gastric glands have parietal or oxyntic cells which secrete HCl and intrinsic factor (factor essential for absorption of vitamin B₁₂). Mucosa also forms crypts in between the bases of villi in the intestine (crypts of Lieberkuhn). Pepsin converts proteins into proteoses and peptones (peptides). The bile duct and the pancreatic duct open together into the duodenum as the common hepato-pancreatic duct which is guarded by a sphincter called the sphincter of Oddi.

27. (a) : Inner lining of stomach and intestine have simple columnar epithelial cells, which are elongated and are placed side by side like column. The epithelium contains mucus secreting cells, along with underlying supporting connective tissue.

28. (b) : Jejunum is the middle part of the small intestine, which has a diameter of about 4 cm and is about 2.5 metres long.

29. (b) : The junction of the ileum (small intestine) with the caecum is called ileocaecal junction and it is guarded by ileocaecal valve.

30. (b) : The wall of stomach contains innumerable, simple, tubular glands called gastric glands. They have five types of cells -

- (i) peptic (chief or zymogen cells),
- (ii) oxyntic (acid, parietal) cells,
- (iii) mucous cells,
- (iv) argentaffin cells and
- (v) endocrine cells.

Argentaffin cells are less common and are generally located at the base of the glands and secrete serotonin, a potent vasoconstrictor.

31. (b) : There is a much debate about the amount of saliva produced in a healthy person per day. It is estimated to range from 0.75 to 1.5 litres per day. A litre corresponds to 1 cubic decimeter or dm³. Hence, average saliva secretion in human is 0.75 to 1.5 dm³ per day.

32. (b)

33. (e) : The wall of alimentary canal consists of four basic layers. From the outer surface inwards to the lumen, the layers are as follows – visceral peritoneum (serosa), muscularis (muscular coat), submucosa and mucosa (mucous membrane). Mucosa is the innermost layer lining the lumen of the alimentary canal. It is so named because it secretes mucus to lubricate the inner lining of the gut. It is further composed of three layers — muscularis mucosa, lamina propria and epithelium.

34. (c) : An adult human has 32 permanent teeth which are of four different types (heterodont dentition) namely, incisors (I), canine (C), premolars (PM) and molars (M). Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by a dental formula which in human is $\frac{2123}{2123}$.

35. (c) : Inner surface of the stomach has numerous folds of mucous membrane. These are known as rugae. These folds, by unfolding, let the stomach expand to accommodate a large meal.

36. (c) 37. (b)

38. (a) : Refer to answer 34.

39. (b) : Majority of mammals including human being forms two sets of teeth during their life, a set of temporary milk or deciduous teeth replaced by a set of permanent or adult teeth. This type of dentition is called diphyodont. An adult human has 32 permanent teeth which are of four different types (heterodont dentition), namely, incisors (I), canines (C), premolars (PM) and molars (M).

40. (b) : Pylorus is the distal part of the stomach that opens into duodenum. This region is divided into the pyloric antrum and the pyloric canal. The latter opens into the duodenum.

41. (d) : Villi are finger like protoplasmic extensions of mucosal epithelium of small intestine. The villi increase absorptive surface area of small intestine.

42. (b) : Refer to answer 40.

43. (d) : The Brunner's glands are found only in the duodenum and are located in the submucosa. They secrete a little enzyme and mucus. The mucus protects the duodenal wall from getting digested. Intestinal mucosa has goblet cells which secrete mucus, which along with secretion of brush border cells of mucosa constitute intestinal juice. Insulin is secreted by endocrine portion of pancreas. Bile secreted by liver is stored in gall bladder. Lysozyme present in saliva acts as an antibacterial agent that prevents infections. Parietal cells of gastric glands of stomach secrete HCl.

44. (a) : Hormone secretin secreted by intestinal mucosa of duodenum and jejunum acts on the exocrine part of pancreas that secretes pancreatic juice. It stimulates secretion of water and bicarbonate ions.

45. (a): Zymogenic cells of gastric gland secrete proenzyme pepsinogen, which gets converted into active pepsin by action of HCl. It helps in protein digestion in the stomach.

46. (c): Liver is the largest gland of body. Hepatocytes of liver secrete non-enzymatic digestive juice called bile.

47. (c): The Brunner's glands are found only in the duodenum and are located in the submucosa. They secrete a little enzyme and mucus. The mucus protects the duodenal wall from getting digested. Digestion of most of nutrients takes place in the duodenum under the action of various enzymes. The Brunner's glands open into the crypts of Lieberkuhn.

48. (a): Glisson's capsule is a characteristic feature of mammalian liver. Liver is the largest gland of the body and plays an important role in the process of digestion. Internally, the structural and functional unit of liver are the hepatic lobules containing hepatic cells arranged in the form of cords. Each lobule is covered by a thin connective tissue sheath called Glisson's capsule.

49. (a): Refer to answer 47.

50. (b): Refer to answer 47.

51. (a): Ampulla of Vater is also called as hepatopancreatic ampulla. It is formed by joining of the bile duct and the main pancreatic duct.

52. (a): Refer to answer 48.

53. (b): The cystic duct arises from the gall bladder. The cystic duct and common hepatic duct join to form bile duct which passes downwards posteriorly to join the main pancreatic duct to form the hepatopancreatic ampulla (ampulla of Vater). The ampulla opens into the duodenum. The opening is guarded by the sphincter of Oddi.

54. (a): Refer to answer 53.

55. (d)

56. (a): Refer to answer 48.

57. (c): Cholecystokinin pancreozymin (CCK-PZ) is a hormone secreted from small intestine. It stimulates the gall bladder to release bile and pancreas to secrete and release digestive enzymes in the pancreatic juice. Hormone secretin is secreted from duodenum and releases bicarbonates in the pancreatic juice. It also increases secretion of bile and decreases gastric secretion and motility.

58. (a) 59. (b)

60. (c): Pepsin is a protease in stomach. It converts proteins into proteoses and peptones. HCl provides the acidic pH (1.8), optimal for pepsin.

61. (d): The exocrine part of pancreas secrete an alkaline pancreatic juice with pH 8.4. The pancreatic juice contains trypsinogen, chymotrypsinogen, amylase, lipase, etc. Enterokinase is present in intestinal juice.

62. (d): Succus entericus or intestinal juice (pH = 7.8) refers to the secretion of glands of small intestine. It contains many enzymes viz maltase, isomaltase, lipase, lactase, α -dextrinase, enterokinase, aminopeptidase, nucleotidase, nucleosidase, etc. for the digestion of carbohydrates, proteins, fats, nucleic acids etc. Enzyme nuclease is not a digestive enzyme. It is not present in any digestive juice.

63. (a): The first process during digestion of fat is emulsification of fat. It is carried out by bile salts which break down fat droplets into many small ones by reducing their surface tension. Bile salts help in the digestion and absorption of fats.

64. (a): The intestinal mucosal epithelium has goblet cells which secrete mucus. The secretions of the brush border cells of the mucosa alongwith the secretions of the goblet cells constitute the intestinal juice or succus entericus. This juice contains a variety of enzymes like disaccharidases (e.g., maltase), dipeptidases, lipases, nucleosidases, etc. The mucus along with the bicarbonates from the pancreas protects the intestinal mucosa from acid as well as provide an alkaline medium (pH 7.8) for enzymatic activities.

65. (c): Refer to answer 63.

66. (b): Ammonia is an extremely toxic compound and its accumulation in body can be fatal. Thus, it needs to be converted into a less toxic substance called urea, which is then excreted out of the body in the form of urine. The production of urea from ammonia through a cycle of biochemical reactions is called urea cycle, which primarily takes place in liver of mammals.

67. (c & d): Peptic ulcers develop when acid in digestive tract destroys inner surface of oesophagus, stomach or small intestine. If the amount of acid is increased or amount of mucus is decreased (mucous layer protects against acid), then it results in ulcers. Ulcer is a result of an imbalance between digestive fluids in stomach and duodenum. Emphasis of treatment is on neutralising and inhibiting secretion of stomach acid.

68. (c): Rennin is secreted by peptic cells present in epithelium of gastric glands. It is found in the gastric juice of human beings during infancy and in calf. In adults gastric juice is devoid of rennin. It converts milk protein casein into paracasein, leading to milk coagulation.

69. (b): Secretin is a hormone secreted by the S-cells mainly in the wall of duodenum and some in jejunum, under stimulus of acidic food coming from stomach. It causes the pancreas to secrete alkaline pancreatic juice and stimulates bile production in the liver.

70. (b): Succus entericus contains enterokinase also called enteropeptidase, aminopeptidases and dipeptidases. Enterokinase or entero-peptidase converts trypsinogen of pancreatic juice into trypsin.

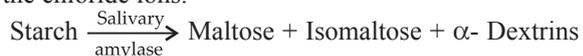
71. (c)

72. (b) : The salivary amylase is the starch digesting enzyme found in saliva and it functions at almost neutral pH, that is at pH of about 6.8.

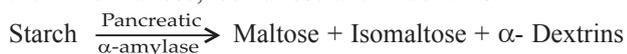
73. (a) : Chylomicrons are lipoprotein molecules which consist of small fat globules coated with protein. They are synthesised by intestinal epithelial cells and consist mainly of triglycerides. Dietary fat is transported in the circulatory system in the form of chylomicrons.

74. (b) : Oxyntic cells (Parietal cells) are large and are most numerous on the side walls of the gastric glands. They secrete hydrochloric acid and Castle's intrinsic factor which affect absorption of vitamin B₁₂ from food.

75. (c) : Baked potatoes consist of starch which is a polysaccharide. In oral cavity, the food is mixed with saliva. The saliva contains an enzyme called salivary amylase (also called ptyalin) which converts starch into maltose, isomaltose and small dextrans. Salivary amylase is activated in the saliva by the chloride ions.



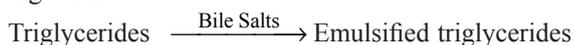
The pancreatic juice (present in small intestine) contains starch digesting enzyme, called pancreatic amylase which converts starch into maltose, isomaltose and α -dextrans.



Further, disaccharidases such as maltase (present in intestinal juice in small intestine) breakdown disaccharides such as maltose into monosaccharides or simpler sugars.

76. (a) : Parietal cells (or oxyntic cells) secrete hydrochloric acid (HCl) and Castle's intrinsic factor. Chief cells (or peptic cells) secrete gastric digestive enzymes as proenzymes - pepsinogen and prorennin. HCl helps in converting pepsinogen to pepsin. Goblet cells secrete mucus which helps to neutralize acid in stomach and protects stomach wall against HCl action.

77. (d) : Gall bladder is attached to the posterior surface of the liver on the right side by connective tissue. The main function of the gall bladder is to store and concentrate the bile secreted by the liver. Bile contains no enzyme, and, thus, has no chemical action on food. Its salts, namely, sodium glycocholate and sodium taurocholate, reduce the surface tension of large fat droplets and break them into many small ones. This increases lipase action on fats and enhances fat digestion.



After removal of gall bladder, bile could no longer be stored and hence fat metabolism would be affected. Therefore, fat intake should be restricted.

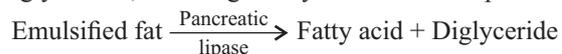
78. (d) : Cholecystokinin (CCK) is produced by the GI cell in the small intestine and acts on pancreas to stimulate the secretion and release of digestive enzymes in pancreatic juice. It also acts on the gall bladder to stimulate contraction and expulsion of bile which is produced in liver and stored in gall bladder.

79. (a) : Bolus is a mass of food mixed with saliva. It passes down through the oesophagus by peristalsis.

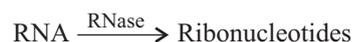
80. (d) : GIP is a most recently recognized hormone that is released by duodenum. This hormone was originally named gastric inhibitory peptide (GIP) for its presumed role as an enterogastrone. It was believed to inhibit gastric motility and secretion. It is established that GIP is now called glucose dependent insulinotropic.

81. (d) : Numerous microscopic, tubular glands are present in mucosa of stomach. Parietal cells are present in the epithelium of gastric glands and are most numerous on their side walls. They are also called oxyntic cells because they stain strongly with eosin. They secrete hydrochloric acid and castle intrinsic factor (essential for absorption of vitamin B₁₂). HCl maintains a strongly acidic pH of about 1.5 to 2.5 in the stomach. This kills bacteria as well as other harmful organisms that may be present along with food.

82. (a) : Lipase is present in the pancreatic juice and intestinal juice. Pancreatic lipase is the principal enzyme for the digestion of fat. The pancreatic lipase converts emulsified fats (triglycerides), first into diglycerides and then into monoglycerides, releasing a fatty acid at each step.

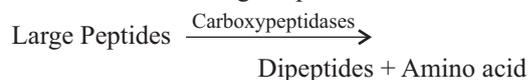
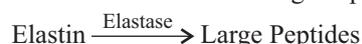
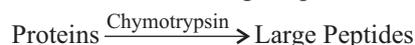
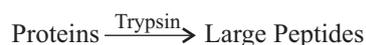


Pancreatic juice also contains two nucleases: deoxy-ribonuclease (DNase) and ribonuclease (RNase), which act as follows:



83. (a) : Swallowing or deglutition is the process by which food is transferred from the mouth to the oesophagus (gullet). Voluntary raising of the tongue forces food backwards towards the pharynx. This stimulates reflex actions in which the larynx is closed by the epiglottis and the nasal passages are closed by the soft palate, so that food does not enter the trachea (windpipe). Lastly, food moves down the oesophagus by peristalsis and gravity.

84. (d) : Enterokinase is an enzyme secreted by the glands of the small intestine that acts on trypsinogen to produce trypsin. This trypsin breaks chymotrypsinogen into chymotrypsin and procarboxypeptidase into carboxypeptidase. All these are concerned with protein digestion which is summarised below:



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85. (b) 86. (b) 87. (c) 88. (d)

89. (c) 90. (a)

91. (a) : Pancreatic juice contains proenzymes -trypsinogen, chymotrypsinogen and procarboxypeptidase. In the presence of enterokinase (a protease of intestinal juice), inactive trypsinogen is converted to active trypsin. Trypsin then activates chymotrypsinogen and procarboxypeptidase into chymotrypsin and carboxypeptidase respectively. This enables simultaneous action of all pancreatic proteases for a rapid digestion of proteins. The bile provides alkaline medium for various reactions.

92. (c)

93. (b) : Oxyntic cells (= Parietal cells) are large and are most numerous on the side walls of the gastric glands. They secrete hydrochloric acid and Castle intrinsic factor. Hydrochloric acid serves many functions like it kills harmful bacteria; it provides acidic medium in the stomach for gastric digestion; it changes pepsinogen into pepsin and prorennin into rennin; softens the food and make it readily available for enzyme action; it stops the action of salivary enzyme.

94. (a) : The bile is an alkaline viscous greenish yellow fluid. It contains bile salts, bile pigments, cholesterol and phospholipid. It does not have any enzymes.

95. (c) : The salivary glands secrete a viscous fluid called saliva. It contains water, salts, mucin and an enzyme salivary amylase or ptyalin. Amylase is a starch digesting enzyme, breaking starch into maltose and triose.

96. (b) : Gastrin is a hormone, produced by G cells in the mucosa of the stomach that controls the release of gastric juice. The secretion of gastrin is stimulated by the presence of food in the stomach. It is one of the hormones that integrates and controls digestive processes.

97. (b) : Enterokinase is a gastro-intestinal hormone that activates trypsinogen to trypsin.

98. (d) : Ptyalin is an enzyme that digests carbohydrates. It is present in mammalian saliva and is responsible for the initial stages of starch digestion. In the stomach, it gets inactivated due to action of HCl of the gastric juice.

99. (d) : Parietal or oxyntic cells secrete HCl (due to which pH of stomach is highly acidic) and intrinsic factor. Parietal glands also secrete pepsinogen to which hydrochloric acid acts to convert it into pepsin. Pepsin in return causes digestion of protein. If parietal cells become non-functional it will directly affect protein digestion.

100. (d) : The intestinal mucosal epithelium has goblet cells which secrete mucus. The mucus lubricates the food for an easy passage. Thus, if for some reason goblet cells become non-functional, it will adversely affect smooth movement of food down the intestine. It along with bicarbonates from the pancreas also protects the intestinal mucosa from acid as well as provide an alkaline medium for enzymatic activities.

101. (b)

102. (d) : Gastric inhibitory peptide (GIP) contains 43 amino acids and is produced by duodenal mucosa. The release of GIP is stimulated by the presence of glucose in the gut. The most important function of GIP is to stimulate the release of insulin from pancreas. This is evident from the fact that the plasma insulin level is elevated much before the increase in blood glucose. GIP also inhibits gastric HCl secretion, gastric motility and its emptying.

103. (b) : Glycogenesis is the conversion of glucose to glycogen, which is stimulated by insulin from the pancreas. Glycogenesis occurs in skeletal muscles and to a lesser extent in the liver. Glucose that is taken up by cells is phosphorylated to glucose 6-phosphate; this is converted successively to glucose 1-phosphate, uridine diphosphate glucose, and finally to glycogen.

104. (c) : The entire surface of the stomach mucosa between glands has a continuous layer of a special type of mucous cells called simply "surface mucous cells." They secrete large quantities of a very viscid mucus that coats the stomach mucosa with a gel layer of mucus providing a major shell of protection for the stomach wall as well as contributing to lubrication of food transport. Another characteristic of this mucus is that it is alkaline. Therefore, the normal underlying stomach wall is not directly exposed to the highly acidic, proteolytic stomach secretion. Even the slightest contact with food or any irritation of the mucosa directly stimulates the surface mucous cells to secrete additional quantities of this thick, alkaline, viscid mucus.

105. (b) : Gastric juice is an acidic mixture of inorganic salts, HCl, mucus, rennin, pepsin and gastric lipase are secreted by the gastric glands.

106. (e)

107. (d) : Lactose (milk sugar) is a sugar comprising one glucose molecule linked to a galactose molecule. Lactose is manufactured by the mammary gland and occurs only in milk.

108. (d) : Succus entericus or intestinal juice is secreted by intestinal glands. It contains enzymes such as maltase, sucrase, lactase, enterokinase etc. Intestinal glands are formed by surface epithelium of the small intestine. These are of two types crypts of Lieberkuhn and Brunner's glands. Succus entericus is majorly produced by the crypts of Lieberkuhn as these glands occur throughout the small intestine. They secrete digestive enzymes and mucus. Whereas, the Brunner's glands are found only in the duodenum. They secrete mucus and small amount of enzymes. Mucus helps in protecting the duodenal wall from getting digested.

109. (c) : Bile salts (sodium bicarbonate, sodium glycocholate and sodium taurocholate) of the bile break down fat droplets into many small ones by reducing the surface tension of fat droplets. This process is called emulsification. This increases lipase action on fat.

110. (c) : Proteolytic enzymes are the protein digesting enzymes. Erepsin is an enzyme that digests peptones into amino acids. It is grouped under exopeptidases. It is produced by the intestinal glands in the ileum and is found in the intestinal juices. It is also produced by the pancreas. Trypsin is present in the pancreatic juice and converts proteins into large peptides. Pepsin is present in the gastric juice and converts proteins into proteoses, peptones and large peptides.

111. (a) : Argentaffin cell, one of the round or partly flattened cell occurring in the lining tissue of the digestive tract and containing granules is thought to be secretory in function. These epithelial cells, though common throughout the digestive tract, are most concentrated in the small intestine and appendix. The cells are located randomly within the mucous membrane lining of the intestine and in tube-like depressions where the Lieberkühn glands are present. Their granules contain a chemical called serotonin, which stimulates smooth muscle contractions. Functionally, it is believed that serotonin diffuses out of the argentaffin cells into the walls of the digestive tract, where neurons leading to the muscles are stimulated to produce the wave like contractions of peristalsis. Peristaltic movements encourage the passage of food substances through the intestinal tract.

112. (d) : Gastrin is a hormone, produced by G cells in the mucosa of the stomach and first part of the duodenum, that controls the release of gastric juice. The secretion of gastrin is stimulated by the presence of food in the stomach. It is one of the hormones that integrates and controls digestive processes.

113. (c) : Bile salts (sodium glycocholate and sodium taurocholate) are the alkaline salts of bile that is necessary for the emulsification of fats which is brought about by lipase. Lipase breakdown fats into glycerol and fatty acids during digestion. Thus, bile salts act as activator of enzyme lipase.

114. (c) : Oxyntic cell (parietal cell) present in the wall of the stomach produces hydrochloric acid, which forms part of gastric juice. The oxyntic cells also produces intrinsic factor, which is involved in the absorption of vitamin B₁₂ in the small intestine.

115. (b) : Saliva contains no lipase. The stomach also lacks any fat-emulsifying agents. Fat is largely digested in the small intestine. Cellulose is not digested in human beings.

116. (b) 117. (d) 118. (a) 119. (a)

120. (d) 121. (c) 122. (d)

123. (d) : In small intestine the food meets with two juices : pancreatic juice and intestinal juice. Pancreatic juice contains a carbohydrase, named pancreatic α -amylase. This enzyme hydrolyses more starch and glycogen to dextrin and the latter to double sugar, maltose and isomaltose and α dextrins.

Starch and glycogen $\xrightarrow{\text{Pancreatic amylase}}$ Maltose + Isomaltose + α dextrins

124. (a) : The parietal or acid or oxyntic cells of gastric glands secrete HCl (hydrochloric acid). In the presence of HCl, pepsinogen (proenzyme) which is an inactive precursor of pepsin enzyme, gets converted to an active form, *i.e.*, pepsin. The activated pepsin by autocatalysis activates more pepsinogen to pepsin. This pepsin enzyme is the principle protease or proteolytic enzyme of the stomach.

Pepsinogen $\xrightarrow{\text{HCl}}$ Pepsin
(Inactive form) (Active form)

So, in the absence of HCl secretion, inactive pepsinogen is not converted into the active enzyme pepsin.

125. (b) : In stomach, food is thoroughly mixed with gastric juice and becomes a semifluid mass called chyme. This chyme enters the intestine for further digestion.

126. (a)

127. (d) : Sucrose (cane sugar; beet sugar; saccharose) is a sugar comprising one molecule of glucose linked to a fructose molecule. It occurs widely in plants and is particularly abundant in sugar cane and sugar beet (15-20%), from which it is extracted and refined for table sugar. If heated to 200°C, sucrose becomes caramel. Sucrose is broken down into the monosaccharides glucose and fructose with the help of carbohydrate digesting enzyme, invertase, produced in the small intestine (duodenum).

128. (c) : Secretion of intestinal glands (which are crypts of Lieberkuhn and Brunner's gland) are called succus entericus or intestinal juice. Intestinal juice refers to the clear to pale yellow watery secretions from the glands lining the small intestine walls. Secretion is stimulated by the mechanical pressure of partly digested food in the intestine. Its function is to complete the process begun by pancreatic juice.

Intestinal juice contains hormones, digestive enzymes, mucus, substances to neutralize hydrochloric acid coming from the stomach.

129. (a) : The digestion of starch (carbohydrate) is initiated in mouth due to the action of starch digesting enzyme ptyalin or salivary amylase present in saliva secreted by salivary glands.

130. (b) : Gastric juice is a mixture of hydrochloric acid (HCl), pepsinogen, prorennin (in infants and not in adults), lipase and mucus. In the presence of HCl, pepsinogen gets converted to an active form, *i.e.*, pepsin. The activated pepsin by autocatalysis activates more pepsinogen to pepsin. This pepsin enzyme is the principle protease or proteolytic enzyme of the stomach which hydrolyses proteins into peptides in highly acidic medium of stomach.

131. (b) : The last digestive stage of the proteins in the intestinal lumen is achieved by the enterocytes that line the villi of the small intestine, mainly in the duodenum and jejunum. These cells have a brush border that consists of hundreds of microvilli projecting from the surface of each cell. In the membrane of each of these microvilli are multiple hydrolases that protrude

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through the membranes to the exterior, where they come in contact with the intestinal fluids. These hydrolases bring about final digestion of food products.

132. (b) : Fructose and mannose are absorbed through facilitated diffusion that is by the help of the carrier molecule. It is along the concentration gradient (higher concentration to low concentration).

133. (c) : Glycerol and fatty acids are absorbed in jejunum by diffusion into intestinal cells where they are converted into chylomicrons. Cholesterol is also absorbed by simple diffusion in small intestine. Maltose is broken into glucose and galactose which are absorbed by active transport into small intestine. Fructose is absorbed by facilitated diffusion. Amino acids are also absorbed in small intestine, some by active transport and some by facilitated diffusion.

134. (b) : All carbohydrates are absorbed as monosaccharides in stomach and jejunum. Glucose and galactose are absorbed by active pump of the cell membrane which helps in its active take up. Fructose is absorbed by facilitated transport. Glucose, galactose and fructose are absorbed into the blood capillaries. The most rapidly transported monosaccharide is galactose with glucose running a close second.

135. (a) : The absorption of glucose and amino acids is mediated by carrier ions like Na^+ . The concentration of Na^+ is higher in the intestinal lumen compared to mucosal cells. Na^+ , therefore moves into the cells along its concentration gradient and simultaneously glucose is transported into the intestinal cells. Thus, Na^+ diffuses into the cell and it drags glucose along with it. The intestinal Na^+ gradient is the immediate energy source. The mechanism for transport of amino acid is same as glucose.

Fructose absorption does not require energy and is independent of Na^+ transport.

136. (c) : Villi are microscopic outgrowths from the surface of some tissue and organs, which serve to increase the surface area of the organ. Numerous villi line the interior of the small intestine. Their shape may vary from finger-like (in the duodenum) to spade-like (in the ileum). Intestinal villi are specialized for the absorption of soluble food material. Each contains blood vessels and a lymph vessel.

137. (a) : Glucose and galactose are absorbed by active transport. Sodium pump of the cell membrane helps in their active take up. Fructose is absorbed by facilitated diffusion that involves a specific transmembrane carrier. Amino acids are absorbed by active transport coupled with active sodium transport. They also enter the blood stream.

138. (b)

139. (a) : Fats and lipids are insoluble in water, therefore, they cannot reach the blood stream directly. They are first incorporated into small, spherical, water soluble droplets called micelles with the help of the bile salts and phospholipids in the intestinal lumen. From the micelles

fatty acids, glycerides, sterols and fat soluble vitamins are absorbed into the intestinal cells by diffusion where they are resynthesised in the ER and are converted into very small fat molecules (droplets) called chylomicrons. The latter are released from the intestinal cells into the lymph present in the lymphatic capillaries, the lacteals.

140. (a) : Xerophthalmia is caused due to deficiency of vitamin A. It causes abnormal dryness of the eyeball which results from inadequate functioning of lacrimal gland, which produce tears.

141. (a) : Scurvy is a disease that results from the deficiency of vitamin C (ascorbic acid). Bleeding gums is one of the symptoms of this disease. The disease can be prevented and cured by a diet that includes fresh fruits and vegetables, especially citrus fruits (such as orange, lemon etc.).

142. (c)

143. (d) : Pellagra, characterised by dermatitis, diarrhoea, dementia and death (4Ds) is a deficient disorder of vitamin B_3 (nicotinic acid or niacin).

144. (b) : Calciferol (vitamin D) increases calcium absorption from the gastrointestinal tract and helps to control calcium deposition in the bones. Its deficiency causes rickets in children and osteomalacia in adults.

145. (b) : Kwashiorkor is a disease caused by protein malnutrition. It occurs due to deficiency of proteins in the diet of children, though the diet may contain adequate amounts of carbohydrates. It is the most common among children between 1 to 3 years of age.

The common symptoms of kwashiorkor are being underweight, stunted growth, poor brain development, loss of appetite, anaemia, protruding belly, slender legs, and bulging eyes. Oedema (fluid accumulation) in lower legs and face and change in skin and hair colour may also occur in kwashiorkor.

146. (a) : A person who is exclusively feeding on meat, egg and milk is likely to suffer from scurvy. It occurs due to deficiency of vitamin C or ascorbic acid as meat, egg and milk are very poor sources of vitamin C.

147. (a) : Indigestion is the condition in which the food is not properly digested leading to a feeling of fullness. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating and spicy food.

148. (a) : This coughing would have been due to improper movement of epiglottis. Epiglottis is present in the laryngopharynx, which is the lowest part of pharynx. Laryngopharynx possess two apertures - anterior slit-like glottis and posterior gullet. Glottis leads into trachea or wind pipe, which is closed by bilobed leaf-like cartilage, the epiglottis, during the swallowing of food-bolus. Hence, during eating one may suddenly coughs due to opening of epiglottis and movement of some food particles in the trachea.

149. (a) : Pellagra is a vitamin deficiency disease most commonly caused by a chronic lack of niacin (vitamin B₃) in the diet. Its symptoms are scaly dermatitis on exposed surfaces, diarrhoea and depression.

150. (c) : Osteomalacia occurs due to deficiency of vitamin D in adults. It results in softening of bones. The most common symptoms are bone pain, backache and muscle weakness.

151. (a) : Marasmus is a mixed deficiency of both protein and calories, resulting in severe wasting in infants. Body weight is below 60% of that expected for age, the infant looks 'old', has thin sparse hair, is pallid and pathetic, lacks skin fat, and has subnormal temperature. The condition may be due to malabsorption, wrong feeding, metabolic disorders, repeated vomiting, diarrhoea, severe disease of the heart, lungs, kidneys, or urinary tract, or chronic bacterial or parasitic disease.

152. (b) : Refer to answer 141.

153. (d) : Marasmus is common in infants under one year of age. It develops due to deficiency of proteins and calories. It can be cured by providing adequate proteins, fats and carbohydrates.

154. (a) : The yellow colour of stool is due to the presence of bile pigment (bilirubin-yellow). Bile pigments are excretory products. Bile is a bitter-tasting greenish-yellow alkaline fluid produced by the liver, stored in the gall bladder, and secreted into the duodenum of vertebrates. It assists the digestion and absorption of fats by the action of bile salts, which chemically reduce fatty substances and decrease the surface tension of fat droplets so that they are broken down and emulsified.

155. (d)

156. (a)

157. (d) : For their discovery of bacterium *Helicobacter pylori* and its role in gastritis and peptic ulcer diseases, the nobel prize in physiology and medicine – 2005 was given to Barry J. Marshall and J. Robin Warren of Australia.

158. (a) : Retinol (vitamin A) and calciferol are fat soluble vitamins but the pellagra is not the deficiency disease of calciferol. Vitamin A cannot be synthesized by mammals and other vertebrates and must be provided in the diet. Green plants contain precursors of the vitamin, notably carotenes, that are converted to vitamin A in the intestinal wall and liver. The aldehyde derivative of vitamin A, retinal, is a constituent of the visual pigment rhodopsin. Deficiency affects the eyes, causing night blindness, xerophthalmia (dryness and thickening of the cornea), and eventually total blindness. Pellagra is caused by the deficiency of vitamin B₃ or nicotinic acid or niacin.

159. (c) : Night blindness is the inability to see in dim light or at night. It is due to disorder of the cells in the retina that are responsible for vision in dim light and can result from dietary deficiency of vitamin A (retinol), which is found in milk, egg, papaya and green vegetables, etc.

160. (c) : Keratomalacia is a progressive nutritional disease of the eye due to vitamin A deficiency. The cornea softens and may become perforated. This condition is very serious and blindness is usually inevitable.

161. (b) : Hyperkalaemia is the presence of an abnormally high concentration of potassium in the blood, usually due to failure of the kidneys to excrete it. Hypercholesterolemia is the high concentration of cholesterol in the blood. Osteomalacia is softening of the bones caused by a deficiency of vitamin D, either from a poor diet or lack of sunshine or both.

