1 Nutrition

All organisms need energy to perform various processes of their lives. Nutrition provides nutrients to the body so that it can obtain energy to carry out the activities required to stay alive. Nutrition is the process of nourishing or being nourished, especially the process by which a living organisms assimilates food and uses it for growth and replacement of tissues. The food taken by the organism is complex, but nutrients are much simpler molecules. The digestive system of an organism breaks down complex food into simpler molecules, so that the cells can take them in and use them for survival, growth and reproduction. Nutrition promotes growth of the body, which involves the formation of new protoplasm. It also helps synthesise a variety of substances like, proteins, carbohydrates, and lipids etc. which in turn perform a variety of functions.

NUTRIENTS: Chemical substance present in our food which provide energy and materials needed by the body to live and grow.						
Carbohydrates	Fats	Proteins	Minerals	Vitamin	Water	Fibre

Food					
Energy foods		Body building foods		Regulating foods	
Carbohydrates	Fats	Proteins	Minerals	Vitamin	Minerals

Note

Nutrition is the science that interprets the interaction of nutrients and other substances in food (e.g. phytonutrients, anthocyanins, tannins, etc.) in relation to maintenance, growth, reproduction, health and disease of an organism. It includes food intake, absorption, assimilation, biosynthesis, catabolism and excretion.

The diet of an organism is what it eats, which is largely determined by the availability, processing and deliciousness of foods. A healthy diet includes preparation of food and storage methods that preserve nutrients from oxidation, heat or leaching, and that reduce risk of food-borne illnesses.

Nutrition is defined as a process by which living beings obtain food, change food into simple absorbable forms and use it to make substances needed by the body.

Table 1.1 Nutrition/Mode of Nutrition

Autotrophic: can prepare their own food *"The term 'autotroph' is derived from two Greek words: autos (self) and trophe (nutrition)."*		**Heterotrophic:** food obtain from plants or from animals or both *"The word 'heterotroph' is derived from two Greek words: heteros (other) and trophe (nutrition)."*				
Photo-autotrophic nutrition (Solar energy is used and takes place in green plants)	**Chemo-autotrophic nutrition** (Chemical energy is used and takes place in sulphur bacteria)	**Parasitic Nutrition** (obtaining food synthesis by other	**Saprophytic Nutrition** (obtain nutrients from dead and decaying organic matter for example; fungi and bacteria)	**Holozoic Nutrition** (feed exclusively on the solid organic food material)		
				Herbivores: Plant eaters	**Carnivores:** meat eaters	**Omnivores:** eat both plants & animals

Photosynthesis

(photo = light; synthesis = to combine): the process in which plats synthesise food using water, carbon dioxide in the presence of sunlight and chlorophyll. The significance of photosynthesis is formation of food, oxygen and fuel.

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

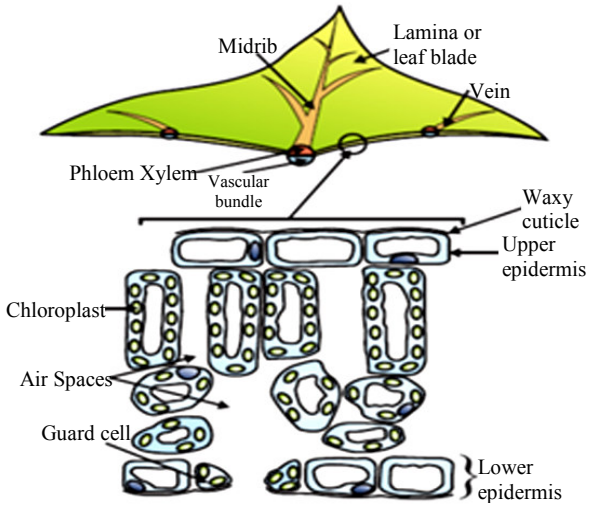


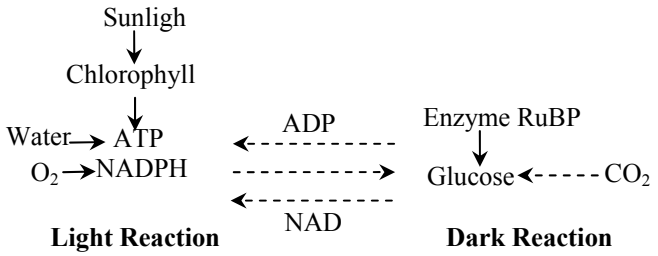
Figure 1.1 Cross-section of Leaf

Mechanism of Photosynthesis

There are two main stages in the entire process of photosynthesis. The first stage is dependent on light (Light reactions) hence also called **photochemical reaction**. The other stage does not require light (dark reactions) and purely **chemical reactions.**

Table 1.2

Characters	Light Reactions (Presence of light)	Dark Reactions (not require light)
Pigments	Required	Not required
Site of action	Grana lamellae of chloroplast	Stroma of chloroplast
Products	ATP, $NADPH_2$ and O_2	Carbohydrates
Oxygen	Released as by-product of photosynthesis	Not released
Enzymes	Not required	Required (*Rubisco*)



Nutrition in Lower Organisms

Amoeba is **holozoic** and **omnivorous.** It feeds upon microscopic organisms like bacteria, Paramecia, diatoms, algae and dead organic matter. The process of obtaining food is termed as **phagocytosis.**

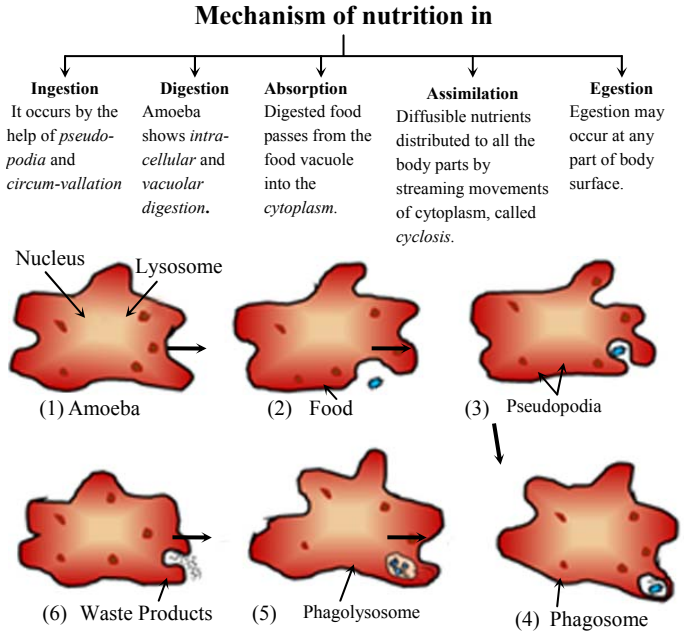


Figure 1.2 Stages of phagocytosis in Amoeba

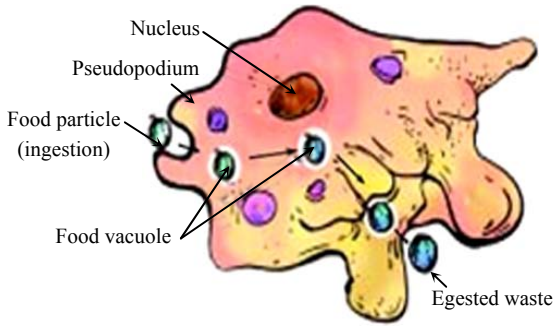


Figure 1.3 Egestion

Digestion

Although nutrients are contained in the food ingested by animals, many of those nutrients are not in a form that can be used directly by cells in the body. The process of digestion breaks large macromolecules into smaller organic molecules that are more easily absorbed by the digestive tract and then transferred to body fluids.

The digestive tract is the main component of the human digestive system. It consists of a passageway that begins at the mouths and ends at the other opening, the anus. Associated with the digestive system are glands and organs that secrete digestive juices.

- Digestive system of man includes the alimentary canal and the digestive glands.
- Alimentary canal includes the mouth, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus.
- Digestive glands include salivary glands, liver, pancreas, gastric glands and intestinal glands.
- The digestive system is responsible for the processing and uptake of nutrition. Every cell in an organism needs energy and an array of nutrients to remain alive.
- Humans ingest a variety of foods; these can be classified by their nutrition content as carbohydrates (sugars), lipids (fats), and proteins.

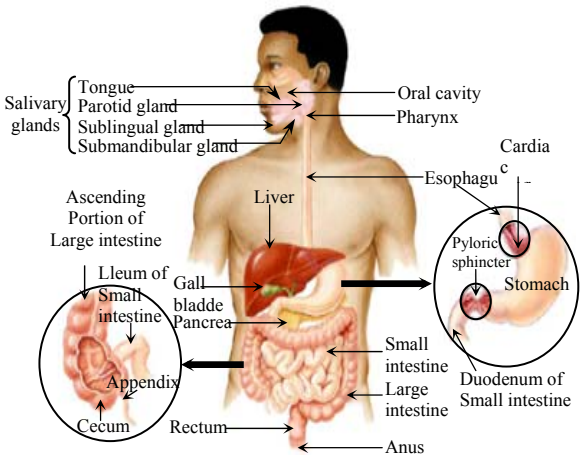


Figure 1.4 Digestive System in Human Beings

Table 1.3 Digestive System in Human Beings

Alimentary canal	Alimentary canal is in the form of a hollow tube of about 9 metres long with two openings, an anterior mouth and posterior anus.
Mouth: The first part of the digestive system is the mouth, the entry point of food.	**Teeth:** It consists: **root, neck** and **crown**. Types: **Incisors, Canine, Molar** and **Premolars**
	Tongue: Tongue is a thick muscular organ is composed of skeletal muscles covered with mucous membrane.
Salivary glands: Three pairs of large, multicellular salivary glands, these secrete **saliva** which contains a digestive enzyme called *ptyalin* and *salivary amylase.*	**Parotid glands**
	Sub-mandibular glands
	Sublingual glands
Pharynx: It is funneled shaped structure, where the food and air passages cross each other.	**Nasopharynx:** Superior to soft palate; communicates with nasal cavity and provides a passageway for air during breathing; provides connections for auditory tubes.
	Oropharynx: Posterior to mouth; is a passageway for food moving downward from the mouth and for air moving to and from the nasal cavity.
	Laryngopharynx: Below the oropharynx; extends from the epiglottis to the lower border of the cricoid cartilage of the larynx; is a passage way for food to the oesophagus.
Oesophagus: Straight, collapsible tube about 25 cm long and it provides a passageway for food from the pharynx to the stomach.	**Oesophageal hiatus**: Passes through penetrates the diaphragm through an opening called the oesophageal hiatus.
	Lower oesophageal sphincter: circular muscle fibers that help prevent the regurgitation of stomach contents back into the esophagus, serves as a valve between the oesophagus and the stomach.
Stomach: food is mixed with a liquid (gastric juice) and stomach initiates the digestion of proteins	**Cardiac:** Small area near the oesophageal opening.
	Fundic: Superior and balloons out; sometimes contains swallowed air.
	Body: Main part of the stomach.
	Pyloric: Funnel-shaped portion which becomes the pyloric canal, **pyloric sphincter** – serves as a valve between the stomach and the small intestine.
Small Intestine: The small intestine is responsible for the complete digestion of all macromolecules and the absorption of their component molecules (glucose, glycerol, fatty acids, amino acids and nucleotides).	**Duodenum** is c-shaped organ, enzymes are secreted into the duodenum form the pancreas and the gall bladder.
	Jejunum: Its role is absorption of nutrients.
	Ileum: It is responsible for pushing the waste materials into the large intestine.
Large Intestine: Large intestine has an approximate length of 1.5 metres (5 feet) and a diameter of 6.5 centimetres (2.5 inches).	Mechanical stimulation &and parasympathetic impulses control the rate of mucus secretion.
	Absorbs water and electrolytes and synthesise certain vitamins.
Accessory Organs: The accessory organs that support the digestive system but are not part of the digestive tract.	**Liver:** The liver performs a vast number of functions including production of bile from cholesterol, recycling of red blood cells, glycogen storage, storage of fat-soluble vitamins, deamination of amino acids, and detoxification of poisons.
	Gallbladder: Concentrates bile produced by the liver and stores this concentrate until it is needed for digestion.
	Pancreas: It exhibits both endocrine and exocrine functions.
Pancreatic Juice	It contains salts and enzymes for breaking down of carbohydrates, proteins and fats. It has **trypsin** for digestion of **protein, pancreatic amylase** for digestion of **starch** and **lipase** for digestion of **fats.**
Action of Intestinal Juice	**Enterokinase:** Activates *trypsinogen* of the pancreatic juice into *trypsin.*
	Aminopeptidease: Acts on terminal amino acids at the amino end of peptides and break them into *amino acids.*
	Sucrase: They convert *sucrose* (cane sugar) into *glucose* and *fructose.*
	Maltase: It converts *maltose* (Malt sugar) into *glucose*.
	Lactase: They act on *lactose* (milk sugar) to convert it into *glucose* and *galactose.*
Absorption	Absorption is the process by which the end products of digestion pass through the intestinal mucosa into the blood or lymph. It occurs through the *wall of ileum of small intestine.*
Assimilation	Utilisation of absorbed food by the body cells is called assimilation.
Defaecation or Egestion	The faecal material is stored in the rectum. The elimination of faeces from the rectum is called defaecation or egestion. It is a reflex action aided by the voluntary contractions of the diaphragm and abdominal muscles.

Table 1.4 Summary of Digestive Enzymes

Organs	Digestive juice	Digestive enzyme	Acts on	Product formed
Mouth	**Salivary juice**	Salivary amylase	Starch	Maltose
Stomach	**Gastric juice**	Pepsin	Proteins	Smaller chains of Amino acids
		Gastric lipase	Fats	Fatty acids and glycerol
Small intestine	**Pancreatic juice**	Trypsin	Protein	Smaller chains of Amino acids
		Pancreatic amylase	Starch	Maltose
		Pancreatic lipase	Fats	Fatty acids and Glycerol
		Intestinal lipase	Fats	Fatty acids and Glycerol
	Intestinal juice	Amino peptidases & Di-peptidase	Smaller chains of Amino acids	Free Amino acids
		Maltose	Maltose	Glucose

Definitions

- **Alimentary canal:** A long tube extending from the mouth to the anus that has regions specialised for ingestion, digestion, absorption, and egestion.
- **Autotrophic nutrition:** Nutrition characterised by the ability to use simple inorganic substances for the synthesis of more complex organic compounds, as in green plants and some bacteria
- **Autotrophs:** An organism capable of synthesising its own food from simple inorganic substances, using light or chemical energy.
- **Bile:** A digestive juice secreted by the liver, stored in the gallbladder and aids in the digestion of fats.
- **Chyme:** It is a thick liquid produced in the stomach and made of digested food combined with gastric juice.
- **Egestion:** The elimination of the waste and undigested matter from the digestive tract through the anus.
- **Emulsification of fat:** A process in which bile salts emulsifies fat globules, i.e. increases the surface area of the oil–water interface, which promotes the breakdown of fats by pancreatic lipase.
- **Enzymes:** The biological catalysts which speed up the rate of biochemical reactions in the body.
- **Gastric glands:** The glands present in the wall of the stomach that release HCl, pepsin and mucus.
- **Heterotrophic nutrition:** A type of nutrition in which energy is derived from the intake and digestion of organic substances, normally plant or animal tissues.
- **Heterotrophs:** An organism that cannot synthesise its own food and is dependent on complex organic substances for nutrition.
- **Intestinal juice:** The digestive fluid secreted by the glands lining the walls of the small intestine.
- **Lipase:** An enzyme that catalyse the breakdown of fats into fatty acids and glycerol.
- **Nutrition:** The process of obtaining and utilising the nutrients necessary to sustain life.
- **Pancreatic juice:** A clear alkaline secretion of the pancreas containing enzymes that aid in the digestion of proteins, carbohydrates, and fats.
- **Pepsin:** A digestive enzyme found in gastric juice that catalyzes the breakdown of proteins to peptides.
- **Peristalsis:** The process of wave-like contractions and relaxations of the alimentary tract that propels the food forward through the tract.
- **Photosynthesis:** The process by which plants and other organisms generate carbohydrates and oxygen from carbon dioxide and water using light energy, with the help of chlorophyll.
- **Stomata:** The minute pores present in the epidermis of a leaf or stem through which gaseous exchange and transpiration occur.
- **Trypsin:** A pancreatic enzyme that catalyses the breakdown of proteins into smaller units.
- **Villi:** The numerous projections arising from the inner lining of the small intestine, which increase the surface area for absorption.

Multiple Choice Questions

1. Carbon dioxide is taken in from the atmosphere by the plants through
a. roots **b.** stems
c. leaves **d.** all of these

2. Which of the following is/are raw materials for photosynthesis?
a. Water
b. Water and carbon dioxide
c. Sunlight, water and carbon dioxide
d. Sunlight, chlorophyll, water and carbon dioxide

3. Stomatal opening is surrounded by
a. guard cells **b.** stomata
c. epidermal cells **d.** chloroplast

4. Which of the following is a saprophyte?
a. Amarbel **b.** Lichen
c. Mushroom **d.** None of these

5. Which of the following is a symbiotic plant?
a. Amarbel **b.** Lichen
c. Yeast **d.** Pitcher plant

6. The green coloured pigment in plants is
a. haemoglobin **b.** chlorophyll
c. chloroplast **d.** xanthophyll

7. During photosynthesis, food is synthesised in the form of
a. proteins **b.** fats
c. carbohydrates **d.** vitamins

8. The end products of photosynthesis are
a. carbohydrate and hydrogen
b. carbohydrate and oxygen
c. water and carbon dioxide
d. carbohydrate, water and oxygen.

9. Chlorophyll is present
a. chloroplast **b.** mitochondria
c. stroma **d.** ribosomes

10. The process in which water is split during photosynthesis is
a. hydrolysis **b.** plasmolysis
c. photolysis **d.** None of these

11 The energy is stored during photosynthesis is in the form of
a. ADP **b.** ATP
c. DNA **d.** Nucleotides

12. Which of the following are the features of photosynthesis?
a. production of carbohydrates
b. production of oxygen
c. conversion of light energy into chemical energy
d. All of the above

13. The assimilatory power in photosynthesis is
a. ATP **b.** NADPH
c. ATP and $NADPH_2$ **d.** ATP, NADPH and CO_2

14. ATP formation during photosynthesis is known as
a. phosphorylation
b. photophosphorylation
c. oxidative phosphorylation
d. substrate level phosphorylation

15. Dark reaction of photosynthesis occurs in the
a. space between the two membranes of the chloroplast
b. stroma of the chloroplast outside the lamellae
c. membranes of the stroma lamellae
d. thylakoid membrane of the grana

16. Dark reaction raced by
a. X-rays **b.** O^{18}
c. $^{14}CO_2$ **d.** P^{32}

17. The primary acceptor during CO_2 fixation in C_3 plants is
a. ribulose biphosphate **b.** glycolate
c. Phosphoenolpyruvate **d.** triose phosphate

18. First stable compound in C_3 cycle is
a. phosphoglyceric acid **b.** phosphoglyceraldehyde
c. fructose-1-6 diphosphate **d.** glucose-6- phosphate

19. Synthesis of an intermediate takes place in …… phase of photosynthesis.
a. Light phase **b.** Dark phase
c. Glycolysis **d.** All of these

20. Which would do maximum harm to a tree?
a. the loss of all of its leaves
b. the loss of half of its branches
c. the loss of its bark
d. the loss of half of its leaves

21. If the rate of translocation of food is slow then the rate of photosynthesis will
a. remains the same **b.** becomes double
c. decrease **d.** increase

22. Which pigment is present universally in all green plants?
a. chlorophyll a **b.** chlorophyll b
c. chlorophyll c **d.** chlorophyll d

23. The first step in photosynthesis is
a. joining of three carbon atoms to form of glucose
b. formation of ATP
c. ionisation of water
d. absorption of light energy

24. Where do the energy-capturing reactions of photosynthesis occur?
a. plasma membrane **b.** cytoplasm
c. storma **d.** thylakoids

25. Which enzyme is most abundantly found on earth?
a. rubisco **b.** nitrogenase
c. invertase **d.** catalase

26. Which gland is not associated with human alimentary canal?
a. salivary glands **b.** adrenal gland
c. liver **d.** pancreas

27. In human, bile juice is secreted by:
a. pancreas **b.** small intestine
c. oesophagus **d.** liver

28. An enzyme which can only act in acidic medium is:
a. trypsin **b.** pepsin
c. rennin **d.** amylase

29. Which is the first part of the small intestine in humans?
a. duodenum **b.** oesophagus
c. stomach **d.** mouth

30. Large intestine is mainly carries out:
a. absorption **b.** adsorption
c. assimilation **d.** acidification

31. Which of the following are chiefly digested in the stomach?
a. carbohydrates **b.** protein
c. lipids **d.** fats

32. Digestion is:
a. conversion of large food particles into small food particles
b. conversion of small food particles into large food particle
c. conversion of non-diffusible food particles into diffusible food
d. conversion of food into protoplasm

33. Digestion within a digestive tract is:
a. incomplete **b.** extracellular
c. the same as absorption **d.** an irreversible process

34. Muscular contractions of alimentary canal are:
a. circulation **b.** deglutition
c. peristalsis **d.** churning

35. Main function of prolonged chewing is to rupture:
a. membranes **b.** cell wall
c. connective **d.** muscle bundle

36. According to natural eating habits, a human is:
a. an herbivore **b.** a carnivore
c. an omnivore **d.** agranivore

37. Which of the following regions of the alimentary canal of man does not secrete a digestive enzyme?
a. stomach **b.** oesophagus
c. duodenum **d.** mouth

38. Which teeth are different in shape, size and function the these are called
a. acrodont **b.** pleurodont
c. homodont **d.** heterodont

39. Number of teeth, which are replaced in man
a. 20 **b.** 28
c. 32 **d.** 12

40. Bulk of the tooth in mammals is made up of
a. enamel **b.** dentine
c. pulp cavity **d.** root

41. The layer of cells that secretes enamel of tooth is
a. dentoblast **b.** osteoblast
c. ameloblasts **d.** odontoblast

42. The hardest part of tooth is the
a. dentine **b.** enamel
c. pulp **d.** dental tubules

43. Diastema is associated with
a. presence of certain teeth **b.** absence of certain teeth
c. absence of tongue **d.** presence of tongue

44. Incisor tooth is meant for
a. Biting and cutting **b.** Chewing
c. Munching and chewing **d.** Munching

45. A dental disease characterised by mottling of teeth is due to the presence of an ingredient in drinking water, namely
a. mercury **b.** fluorine
c. boron **d.** chlorine

46. A digestive enzyme, salivary amylase, in the saliva begin digestion of:
a. protein **b.** carbohydrates
c. nucleic acids **d.** fats

47. A lubricant, mucin in saliva is made up of:
a. poly unsaturated fats **b.** actin and myosin
c. glycoproteins **d.** phospholipids

48. A bolus is
a. the semisolid material resulting from partial digestion in the stomach
b. a mass of crushed food moistened with saliva
c. the milky emulsified fat absorbed from small intestine
d. indigestible materials that helps in movement and absorption

49. In the presence of lactase, lactose breaks down into molecules of
a. glucose and galactose **b.** glucose and fructose
c. galactose only **d.** glucose only

50. Saliva has the enzyme
a. pepsin **b.** trypsin
c. ptyalin **d.** rennin

51. Pepsin digests
a. proteins in duodenum
b. protein in stomach
c. carbohydrates in duodenum
d. fats in ileum

52. Which of the following enzyme acts efficiently at pH two?
a. pepsin **b.** trypsin
c. ptyalin **d.** All of these

53. Trypsin enzyme in mammals is formed from the
a. trypsinogen by the action of protein
b. trypsinogen by the action of enterokinase
c. trypsinogen by the action of fat
d. none of these

54. Inactive enzyme precursors, such as pepsinogen for pepsin, are called
a. holoenzymes **b.** actinases
c. zymogens **d.** mucopolysaccharides

55. Pepsinogen secreted by
a. intestinal glands **b.** chief cells
c. gastric glands **d.** parietal cells

56. Gastric juice has a pH about
a. 1 **b.** 2
c. 16 **d.** 10

57. Gastric digestion takes place efficiently in
a. acidic medium **b.** alkaline medium
c. neutral medium **d.** highly alkaline medium

58. If stomach did not produce any hydrochloric acid HCl, which enzyme will not function
a. pepsin **b.** trypsin
c. ptyalin **d.** collagenase

59. Curdling of milk in the stomach is due to the action
a. pepsin **b.** rennin **c.** HCl **d.** trypsin

60. Where is bile produced?
a. in gall bladder **b.** in blood
c. in spleen **d.** in liver

61. Chief function of bile is:
a. to digest fats by enzymatic action
b. to eliminate waste product
c. to emulsify fat for digestion
d. to regulate process of digestion

62. Peyer's patches produce
a. lymphocytes **b.** enterokinase
c. mucos **d.** trypsin

63. Which of the following plays a key role in absorption and distribution of fats?
a. villi **b.** lacteals
c. secretin **d.** segmentation movements

64. Vermiform appendix is made up of
a. respiratory tissue **b.** excretory tissue
c. lymphatic tissue **d.** digestive tissue

65. Pancreas has
a. only endocrine cells
b. only one type of cell, the same functioning both in an exocrine and endocrine
c. only exocrine cells
d. two types of cells-exocrine and endocrine

66. Which of the following are produced from the pancreas?
a. three digestive enzymes and three hormones
b. three digestive enzymes and two hormones
c. three digestive enzymes and one hormones
d. two digestive enzymes and one hormones

67. The specific function of liver is:
a. excretion
b. digestion
c. histolysis
d. glycogenesis and glycogenolysis

68. Glisson's capsules are found in
a. heart of frog **b.** kidney of frog
c. cerebellum of rabbit **d.** liver of mammals

69. Largest gland in human body is:
a. Pancreas **b.** liver **c.** pituitary **d.** thyroid

70. Toxic substances in the diet are detoxicated in the human body by
a. kidney **b.** liver
c. lungs **d.** stomach

71. The digestive glands of mammalian digestive system are

a. salivary glands, liver, pancreas, gastric glands, intestinal glands

b. salivary glands, hepatopancreas, gastric gland, intestinal glands

c. salivary glands, mesenteric cells, gastric gland, intestinal glands

d. zymogen cells, liver, pancreas, gastric glands

72. Chyme is:

a. an undigested food **b.** partially digested food

c. absorbed food **d.** solid food

73. All enzymes are chemically

a. carbohydrates **b.** lipids

c. proteins **d.** lipoproteins

74. The enzyme renin is present only in

a. adults **b.** infants **c.** both **d.** None

75. Cystic duct originates from

a. liver **b.** spleen **c.** pancreas **d.** gall bladder

ANSWERS

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
c	d	a	c	b	b	c	d	a	c
11.	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**
c	d	c	b	b	c	a	b	a	a
21.	**22.**	**23.**	**24.**	**25.**	**26.**	**27.**	**28.**	**29.**	**30.**
c	a	d	d	a	b	d	b	b	a
31.	**32.**	**33.**	**34.**	**35.**	**36.**	**37.**	**38.**	**39.**	**40.**
b	c	b	c	b	c	b	d	c	b
41.	**42.**	**43.**	**44.**	**45.**	**46.**	**47.**	**48.**	**49.**	**50.**
d	b	b	a	b	b	c	b	a	c
51.	**52.**	**53.**	**54.**	**55.**	**56.**	**57.**	**58.**	**59.**	**60**
b	a	b	c	b	b	a	a	b	d
61.	**62.**	**63.**	**64.**	**65.**	**66.**	**67.**	**68.**	**69.**	**70.**
c	a	b	c	d	b	d	d	b	B
71.	**72.**	**73.**	**74.**	**75.**					
a	b	c	b	d					

□ □ □