Unit 2 – Digestion And Transport of Nutrients

Content :

Unit Summary :

A balanced diet with proper proportions of nutrients like water, carbohydrates, proteins, fats (lipids), vitamins, minerals, and fibre is essential for health. In animals that intake plant food, it is digested to small components and absorbed.

In humans, mechanical and chemical digestion takes place in the parts of the digestive system such as the mouth, stomach, and small intestine. Chemical digestion is aided by enzymes contained in digestive juices secreted by the salivary glands, stomach, pancreas and small intestine. Nutrients, water and vitamins obtained as a result of digestion are transported mainly through the **villi** in the small intestine to the lymph and blood and then to the extracellular fluid (tissue fluid). Nutrients from this fluid reach the cells and are assimilated (or it become part of the body).

Fatty acid and glycerol from the digestion of fat enter the lymph through the lacteal in the villi from the small intestine and gradually reach the blood in the venacava. Glucose and amino acids travel through blood capillaries in the villi to the liver via the portal vein and from there to the venacava through the hepatic vein. All these nutrients that reach the heart go to different parts of the body through the aorta and is known as the **systemic circulation**.

Oxygen-deficient blood reaches the lungs from the heart through the pulmonary artery and after receiving oxygen, it reaches the heart itself through the pulmonary vein. This is known as the **pulmonary circulation**. Blood circulation in humans is known as *double circulation* as the blood from one part passes through the heart twice through the systemic-pulmonary circulation.

Arteries are the vessels that carry blood from the heart to the lungs and other parts of the body. **Veins** are the vessels that carry blood back to the heart. **Capillaries** are minute vessels that connect the arteries and veins. **Tissue fluid** oozes from blood in the capillaries with nutrients and oxygen into the extra cellular space.

Our heart has a double-layered covering, called the pericardium. Heart is four chambered (the upper left atrium and right atrium and the lower left ventricle and right ventricle). The inferior and superior vena cava, which carry blood to the heart, carry blood to the right atrium. It passes through the *tricuspid valve* into the l right ventricle and then through the pulmonary artery to the lungs. Oxygenated blood from the lungs passes through the pulmonary vein into the left atrium and then through the bicuspid valve into the lower left ventricle.

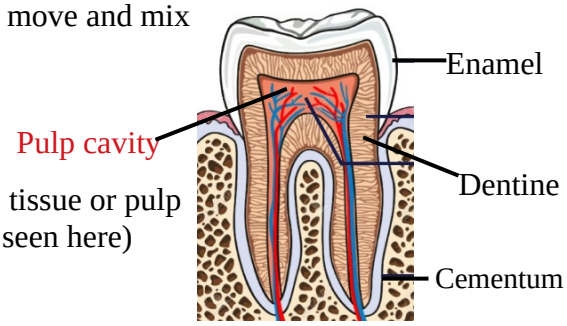
By the repeated contractions (systole) and relaxation (diastole) of the heart chambers (through the **cardiac cycle** or heartbeat) blood is pumped throughout the body. The SA node in the atrial wall that generates the electrical waves required for this is called the **pacemaker**.

Blood pressure is the pressure felt in the arteries due to the contractions and relaxation of the heart chambers. The normal range of BP is *120/80 mmHg* and above this is hypertension and below is hypotension. Unhealthy eating habits, lack of exercise, smoking, alcohol and stress are major risk factors for heart disease.

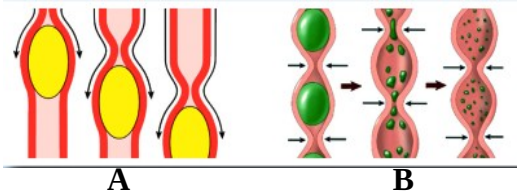
In plants, **xylem** vessels consisting of tracheids and vessels carry water and salts in the soil from the root to its different parts. The transport of water is enhanced by osmosis, root pressure, transpiration, cohesion and adhesion forces of water molecules etc. In plants, **phloem** vessels containing sieve tubes and companion cells transport food in the form of sucrose from the leaves to various parts. This process requires energy. The turgor pressure felt in the cells also facilitates the transport of sucrose.

Questions & Answers :

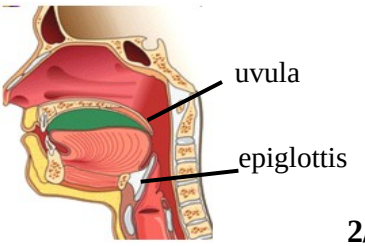
1. Nutrients required for the body ?
   Carbohydrates, Proteins, Fats (lipids), Vitamins, Minerals and Water.
2. What is meant by **balanced diet**?
   Food that provides all the nutrients required by the body in the right proportions.
3. The concept of food-plate is helpful for healthy living. What is a food-plate?
   A food plate consists of half a plate of fruits and vegetables, a quarter of grains, a quarter of protein-rich foods, and a glass of milk or milk products.
4. Why eating junk food on a regular basis is not good?
   Junk food is high in calories and low in nutritional value. This can lead to nutritional deficiencies and certain health problems.
5. It is not advisable to skip breakfast, why ?
   Skipping breakfast can lead to problems like fatigue, sleepiness, inattention and memory loss.
6. The process of breaking down complex nutrients into simpler ones for absorption ?
   Digestion.
7. The difference in digestive process in unicellular amoeba and multicellular hydra?
   Intracellular digestion takes place in amoeba. Both the intracellular digestion and extracellular digestion is seen in hydra.
8. Amoeba : Pseudopodia for receiving food, Hydra : ---------- ?
   Tentacles.
9. What is the difference between mechanical and chemical digestion in human extracellular digestion?
   Mechanical digestion includes the break down of food into small particles by teeth and muscles.
   Chemical digestion includes the break down of food by the enzymes presented in digestive juices.
10. Where does mechanical digestion and chemical digestion occur in humans?
    Mouth, Stomach and Small intestine.
    - The teeth in the mouth help in biting and chewing the food with the help of the tongue.
    - The peristalsis of the stomach wall causes the food to become a paste form.
    - Peristalsis and segmentation in the small intestine help food move and mix with digestive juices.
11. Structure of a tooth:
    - **Enamel** (white, hardest dead outer part)
    - **Dentine** (living tissue which forms the tooth)
    - **Pulp cavity** (the innermost cavity where the soft connective tissue or pulp seen. Blood vessels, nerve fibres and *odontoblast cells* also seen here)



12. The 3 outer region of a tooth?
    Crown, Neck and Root.
13. Calcium containing connective tissue that holds the tooth in the socket of the gum?
    Cementum.
14. The ---- present in the posterior part of the stomach retain food for a specific period.
    Circular muscles.
15. Processes denoted by **A** and **B** in the illustration ?



    A – Peristalsis.
    B – Segmentation.
16. What things should be taken care of for dental health care?
    Wash your mouth and brush your teeth after eating. Reduce sugar and acidic food. Avoid smoking. Visit the dentist at least twice a year to inspect and clean.
17. How does the uvula and epiglottis help in swallowing food?
    The uvula closes the nasal cavity that opens to the oesophagus, so food does not go there. Epiglottis act as a lid over the trachea.



18. The reason for saying "don't talk while eating" is?
If you talk while eating, the epiglottis will not close and the food will pass into the windpipe, causing difficulty in breathing

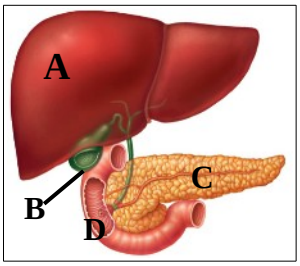
19. Chemical digestion and its changes in food occur in the mouth, stomach and small intestine:
* **Mouth** :- The enzyme salivary amylase secreted by the salivary glands initiates the digestion of starch.
* **Stomach** :- Pepsin, an enzyme in gastric juice produced by gastric glands, partially digests proteins and lipase, another enzyme, helps in the digestion of lipids.
* **Small intestine** :– Bile, secreted by the *liver*, breaks down fat/lipid into smaller particles.
Pancreatic juice of *pancreas* contains pancreatic amylase digests starch like carbohydrates partially, trypsin digests proteins partially and the lipase digest the lipids completely into fatty acid and glycerol.
Various enzymes called carbohydrases in the *intestinal juice* produced by the small intestine break down the carbohydrates into glucose, fructose or galactose. Another enzyme, proteases convert proteins into amino acids.

	Starch/Carbohydrate	Protein	Lipid
Mouth	Action of salivary amylase.	-	-
Stomach	-	Action of pepsin.	Action of lipase.
Small intestine	- Action of pancreatic amylase. - Converts into glucose, fructose or galactose by the action of carbohydrases.	- Action of trypsin. - Converts into amino acids by the action of protease.	- Breaks down into small particles by the action of bile. - Converts into fatty acids and glycerol by the action of lipase

20. The ------- of the oesophagus helps in bringing the food to the stomach.
Peristalsis.

21. The components in gastric juice ? Function of each ?
Hydrochloric acid, the enzyme *pepsin* and mucus.
- HCl destroys germs in the food, regulates its pH.
- Pepsin partially digests protein.
- Mucus protects the stomach wall from the actions of digestive juices.

22. The digestive juice of liver ? Its function ?
Bile. Though it has no enzyme, it breaks fats into smaller particles and regulate the pH of food.



23. Identify and name the **A**, **B**, **C**, **D** in the figure:
A – Liver (The largest gland, Produces bile)
B – Gall bladder (Bile is stored and mixed with the blood)
C – Pancreas (produces digestive juice containing various enzymes)
D – Duodenum (The part where bile and pancreatic juice mix in the small intestine)

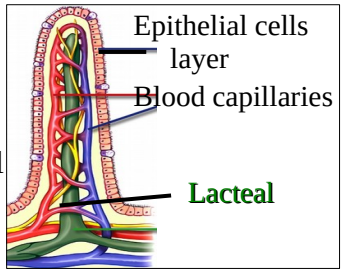
24. Absorption of water and salts left unabsorbed in the small intestine takes place in -------.
Large intestine.

25. Vitamins produced in the large intestine as a result of the action of certain bacteria?
Vitamin B complex, Vitamin K.

26. How suitable is the structure of the small intestine for nutrient absorption?
The small intestine, which is about six meters long and two and a half cm in diameter, is elongated and coiled. Numerous finger-like foldings **villi** are found throughout the inner wall of the small intestine. Because the primary surface of the villus is composed of a single layer of *epithelial cells*, the absorption is easy and facilitated.

27. Special parts in the inner lining of the small intestine for absorption of nutrients ?
Villi.

28. How suitable is the structure of villus for the absorption process?



The presence of numerous finger-like **villi** increases the area of absorption. More over the primary surface of each villus is composed of a single layer of *epithelial cells* that enhances easy absorption. Blood capillaries formed from the branch of artery join together and exit as a vein. Lacteal, which is the small branches of lymph vessel is also seen there.

Fatty acids and glycerol are absorbed by the lacteals into its lymph. Amino acids, glucose, fructose and galactose are absorbed by the blood capillaries into blood.

29. Components of blood ? Function of each?

- **Plasma** (55%) - Water, Proteins (Albumin, Globulin, Fibrinogen), and other components.
- **Blood cells** (45%) - Red Blood Cells, White Blood Cells and Platelets.

Albumin	: Helps to control blood pressure.
Globulin	: Helps in disease resistance.
Fibrinogen	: Helps in blood clotting.
Red Blood Cells /RBC	: Transport of O_2, CO_2 .
White Blood Cells /WBC	: Helps in disease resistance.
Platelets	: Helps in blood clotting.

30. How is tissue fluid formed between cells?

Tissue fluid is formed from blood through the minute pores of the capillary wall, when blood flows.

31. How is lymph formed?

Lymph is formed when a few part of the tissue fluid enters the lymph capillaries (lacteals).

32. What is the importance of tissue fluid and lymph in substance transport?

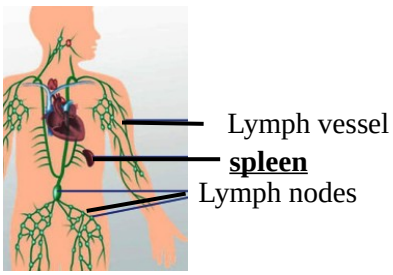
The exchange of substances between blood and cells takes place through tissue fluid. Simple components formed as a result of fat digestion and fat-soluble vitamins are transported through the lymph. Some of the white blood cells seen in the lymph helps to resist germs.

33. How is the quantity of tissue fluid maintained in the intercellular space?

A portion of the tissue fluid, which was formed from blood, returns to the blood through capillaries. A few portion of tissue fluid enters the lymph lacteals to form lymph.

34. Parts of the lymph system include?

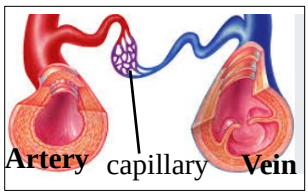
Lymph, lymph vessels, lymph nodes, spleen, bone marrow and thymus gland.



35. Does lymph contain all the components of blood?

No, Red blood cells, platelets and large protein molecules are not seen in the lymph. But plasma and some white blood cells are there.

38. Various kinds of blood vessels ?



Arteries – Vessels that carries blood from the heart. Thick and elastic walls. Blood flows with high pressure and high speed.

Veins - Vessels that carries blood to the heart. Thin wall. Valves are seen. Blood flows with low pressure and low speed.

Capillaries - Vessels that connect artery and vein. Wall having minute pores, is formed of a single layer of cells. Blood flows with low pressure and low speed.

39. How are nutrients absorbed from the small intestine?

Fatty acid and glycerol from the digestion of fat enter the lymph through the lacteal in the villi from the small intestine and gradually reach the blood in the venacava.

Glucose and amino acids travel through blood capillaries in the villi to the liver via the portal vein and from there to the venacava through the hepatic vein.

40. The portal vein between the liver and the small intestine is -------?

Hepatic portal vein. (Between the liver and the venacava is the hepatic vein).

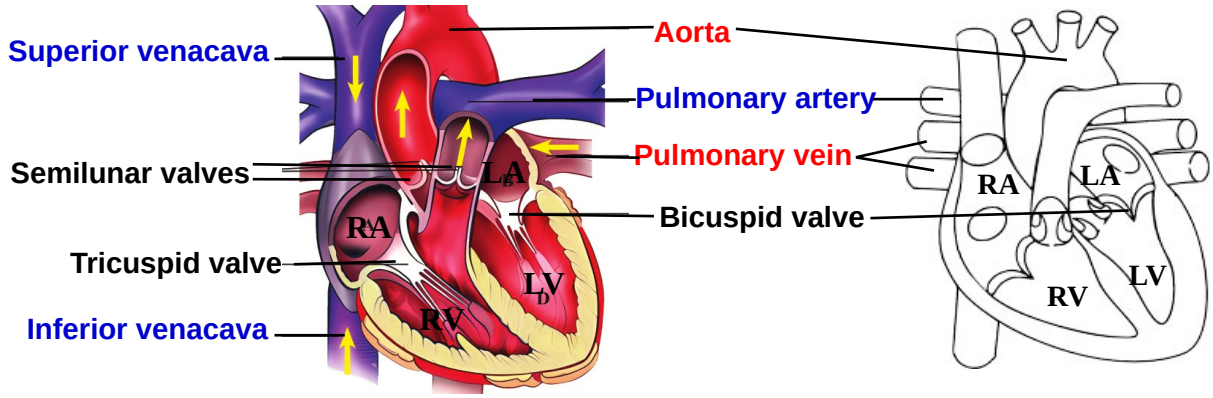
41. Why nutrients reach the liver before the heart?

For detoxification of food, storage of certain nutrients and synthesis of substances.

42. The double layered membrane of heart?
Pericardium.
The *pericardial fluid* seen in between these membrane protects the heart from external shock and helps to reduce friction.

43. The protective measures of our heart ?
Sternum, Ribs, Vertebral column, Pericardium.

44. Inside the heart:
Chambers 4 :- Upper Right and Left **Atrium**, Lower Right and Left **Ventricle**s.
Veins :– Pulmonary veins, Superior and inferior venacava.
Arteries :– Pulmonary artery, Aorta.
Valves :- Tricuspid (between right chambers), Bicuspid (between left chambers), Semilunar (at the beginning of pulmonary artery and aorta).



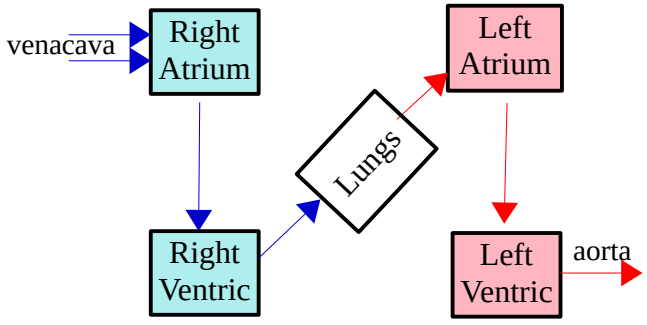
45. What is the function of valves in heart ?
Valves prevent the back flow of blood.

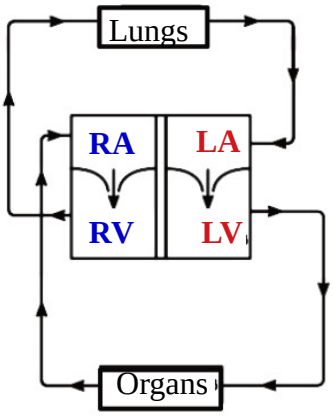
46. How does blood circulate throughout our body by our heart?
De oxygenated blood carried by the inferior and superior venacava reaches the right atrium of the heart and further into the lower right ventricle by the contraction of the atrium (*atrial systole*) through the tricuspid valve . It reaches the lungs through the pulmonary artery when the ventricles contract (ventricular systole).

Oxygenated blood from the lungs passes through the pulmonary vein into the left atrium and further into the lower left ventricle through the bicuspid valve by the *atrial systole*. It travels through the aorta to different parts of the body by the ventricular *systole*.

47. What is joint diastole ?
The contraction of both ventricles (ventricular systole) followed by the temporary relaxation of all four chambers of the heart is called joint diastole.
(During joint diastole, blood enters the left atrium through the venacava and also the right atrium through the pulmonary vein).

48. The reason why human blood circulation is called ***double circulation*** ?
There is a circulation between the heart and various parts of the body (systemic circulation) and a circulation between the heart and the lungs (pulmonary circulation)..
Blood circulation in humans is known as double circulation as blood from one part passes through the heart twice through the systemic-pulmonary circulation.





49. Why does blood enter the lungs? (Importance of pulmonary circulation?)
To take in CO_2 and deliver O_2 to the blood.

50. Which are the phases involved in a **cardiac cycle**? (Phases in a heart beat?)
Atrial systole - Ventricular systole – Joint diastole.
(0.8 second time is required for a cardiac cycle / a heart beat.)

51. Rate of normal heart beat in man ? Ans: 72 per minute.

52. A graphical representation of the electrical waves felt in the walls of the heart when the heart beats shown as in the figure ?

Electrocardiogram (ECG). (for identifying the functional defects of heart)

53. What is **pacemaker** ?
The SA node in the wall of the right atrium is also called the pacemaker, which produces the electrical waves necessary for the contraction of the heart chambers.
(For those who are unable to do this, an artificial pacemaker is implanted)

54. Pulse? Blood pressure ?
A **pulse** is the pressure felt on the elastic arterial wall when the heart beats.. (0.8 seconds).
Blood pressure is the pressure in the arteries when the heart contracts (systole) and relaxes (diastole).

Normal blood pressure of a healthy person is **120/80 mmHg**.
(Systolic pressure =120, Diastolic pressure =80)

Sphygmo manometer

Digital BP Apparatus

55. The equipment used to measure blood pressure ?
Sphygmomanometer, Digital BP Apparatus etc.

56. Define hypertension and hypotension.
Blood presence rising above 120/80 mmHg level is called hypertension and lowering from this level is hypotension.
Mental stress, excessive consumption of salt, lack of exercise, smoking, alcohol consumption, certain disease and age can cause hypertension. Dehydration, heart failure and blood loss can cause hypotension.

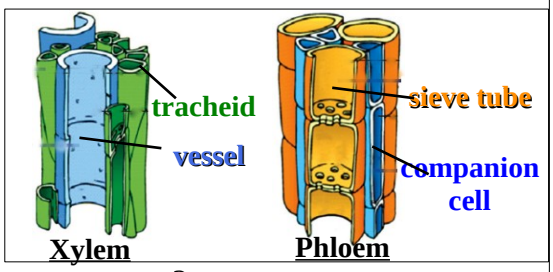
57. Things that damage heart health ?
Unhealthy food habits, lack of exercise, smoking, alcohol, excessive stress, over weight and obesity etc.

58. How does a high-fat diet, lack of exercise, etc. affect the body's health?
Atherosclerosis (ie, deposition of fat in the arterial wall) leads to Coronary thrombosis (clotting of blood in the coronary artery) and this in turn may causes heart attack.
Stroke is caused by the blockage or rupture of blood vessels in the brain.

59. World Heart Day ?
September 29.

60. Vascular tissues in plants?
Xylem – (transport water and salts from roots)
Phloem – (transport food from leaves)

61. Xylem : Tracheids and vessels, Phloem : ---------- ?
Sieve tubes and companion cells.



62. How far the structure of xylem and phloem are suitable for substance transport?
Long spindle shaped dead cells, ***tracheids***, forms the small veins. ***Vessels***, which are also formed of dead cells, look like long pipes as their cross walls have been disintegrated. Transport of water and salts through the xylem takes place by some process such as osmosis.
The ***sieve tubes*** in phloem are arranged one above the other and the cytoplasm of these living cells is interconnected through the pores of their cross walls. Along with these, the ***companion cells*** also helps to transport food in the form of sucrose.

63. Circumstances that facilitate water transport through the xylem without expending energy ?
Osmosis, and there by root pressure, cohesion and adhesion of water molecules and transpiration.

64. How does sucrose transport take place through the phloem?
Glucose in the leaf is converted into sucrose and transferred to the sieve tubes by utilizing energy.
The turgor pressure exerted by the cells due to the entry of water fro xylem, also enables the conduction of sucrose.

65. Reason for water droplets on the margins of the leaves of some plants in the early morning?
A process called guttation (excretion of water through hydathode pores).

Youtube Class links
Part 1 : https://youtu.be/oto3M76ZXQw?si=X0zLw9_gK_aWC0yF
Part 2 : https://youtu.be/FLH9elOJu7s?si=q_40QLWIfqtHL1C5