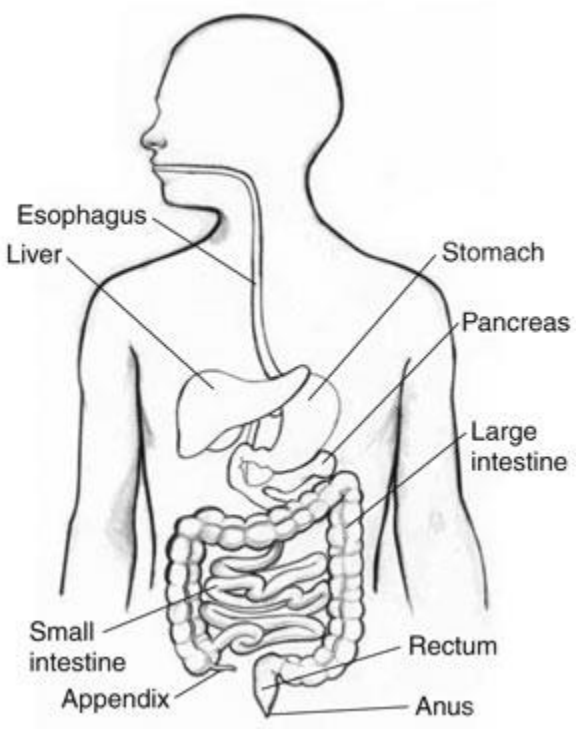
DIGESTION IN MAN

Digestion is the breakdown of complex food substance into simpler food substance which can be absorbed into the blood stream for body use.

Digestion is separated into four steps:

1. Ingestion: placing food into the mouth (entry of food in the digestive system),
2. Digestion. Mechanical and chemical breakdown, mastication and the mixing of food resulting into bolus which is also mixed with water, acids, bile and enzymes in the stomach and intestine to break down complex molecules into simple structures,
3. Absorption: of nutrients from the digestive system to the circulatory and lymphatic capillaries through osmosis, active transport, and diffusion.
4. Egestion : Removal of undigested materials from the digestive tract through defecation.

Compartments of digestive system



Mouth

The process of digestion begins in the mouth. Within the mouth lie the teeth, tongue and jaws. Through a chewing motion, the food is mechanically broken down between the teeth by action of chewing (mastication) and mixed with saliva, which aids in chemical digestion.

Stimulation of saliva is a reflex stimulated by sight, taste, smell and thought of food, saliva is produced in the salivary glands and brought into the mouth. It contains salivary amylase, an enzyme that breaks **starch** into **maltose**, a great deal of water and mucus for lubrication of food and aiding easy swallowing.

Once the digestion in the mouth is completed, the first phase of swallowing is initiated. This stage is voluntary and is characterized by contraction of the muscles of the floor of the mouth and that propel the food bolus into the pharynx.

Pharynx (act of swallowing)

The role of the pharynx is to facilitate the passage of the food bolus into the esophagus. The pharynx is designed to direct the food bolus in this direction. It is here where the second phase of swallowing takes place. After the moistened food bolus is moved to the back of the mouth by the tongue, an involuntary swallowing reflex is triggered which prevents food from entering the respiratory tract. The tongue closes off the mouth, the soft palate blocks the nose, and the larynx rises such that the epiglottis closes off the trachea. Food then moves from the pharynx into the esophagus.

Esophagus

Once in the esophagus, the muscles of peristalsis begin propelling the food bolus through the esophagus into the stomach by process of peristalsis.

Digestion in stomach

In the stomach there is only digestion of proteins. This is so because the conditions in the stomach are favorable for protein digestion. Once in the stomach the food is acted upon by gastric juice secreted by gastric glands situated in the thick stomach wall.

Gastric juice contains two enzymes and an acid,

1) Pepsin 2) Rennin 3) HCL

Pepsin breaks down proteins into short polypeptides.

Pepsin is secreted in an inactive form **pepsinogen**. This is activated by hydrochloric acid. This is a safe guard because if it was stored in an active form it would destroy the stomach wall which is also a protein. Once secreted the active form of the enzyme is prevented from attacking the tissues by the mucus lining the stomach wall. In its absence the hydrochloric acid attacks and destroys the gastric walls resulting in **gastric ulcers**.

Rennin coagulates the soluble milk protein Caseinogen to insoluble curd casein which is then acted upon by pepsin and broken down to polypeptides.

Hydrochloric acid has the following functions;

i. Activates the inactive form of pepsinogen to pepsin
ii. It provides an acidic medium for the action of pepsin.
iii. It kills bacteria and so stops the food from going bad.
iv. It stops the actions of ptyalin by making the medium more acidic their by ensuring only protein digestion in the stomach.

Digestion of starch therefore does not occur in the stomach because.

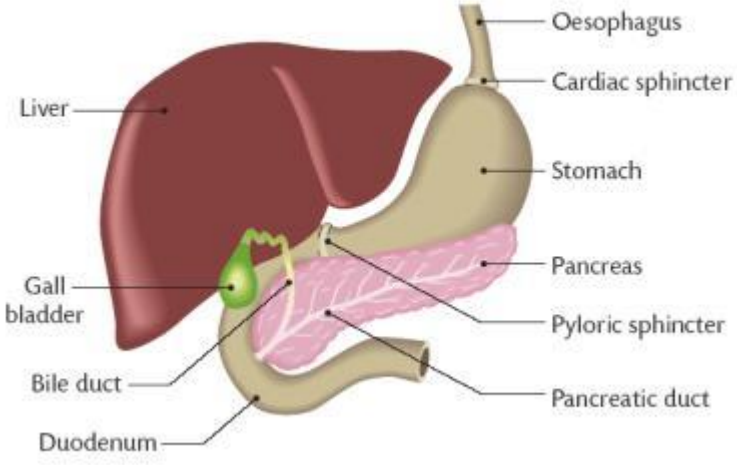
i. The enzyme (salivary amylase) necessary is not present.
ii. The low PH (acidic) stops the action of salivary amylase.

The secretion of gastric juice is a reflex stimulated by,

i. Site of food
ii. Smell of food
iii. Taste of food
iv. Thought of food

While the enzymes are working, rhythmical contractions of the stomach pound the food into a semi fluid state called **CHYME**. The chyme is released in small quantities by the pyloric sphincter, a ring of muscles.

DIGESTION IN THE DUODENUM



Duodenum is the first part of the small intestine and is the main seat of digestion in the gut

The agents of digestion come from three sources namely.

1) The liver

2) The pancreas

3) Wall of the small intestine (duodenum and ileum).The liver produces bile which is stored in the gall bladder. It then flows down through the bile duct into the duodenum.

Bile is a green liquid, and a mixture of substances not all of which are involved in the digestion. The digestion components are inorganic components of sodium.

These salts emulsify lipids by lowering their surface tension causing them to break up into numerous droplets their by increasing their surface area for enzyme action.

The secretion of bile is controlled by a hormone ***CHOLECYSTOKININ*****,** while its production in the liver is controlled by the hormone **Secretin.**

Bile is also rich in sodium bicarbonate, which neutralizes the acid from the stomach. The PH of the small intestines is therefore alkaline, which favors the action of the various enzymes.

The hormone **secretin** also stimulates the pancreas to release pancreatic juice rich in hydrogen carbonate ions into the duodenum via the pancreatic duct.

Pancreatic juice contains three enzymes.

i. Trypsin
ii. Lipase
iii. Amylase.

Trypsin is secreted in an inactive form **trypsinogen**. This is converted into trypsin by the action of the enzyme **enterokinase** Secreted from the wall of duodenum.

- Trypsin breaks down proteins and peptides to amino acids
- Pancreatic lipase breaks down lipids into fatty acids and glycerol.
- Pancreatic amylase breaks down starch that was not digested in the mouth into maltose

DIGSTION IN THE ILEUM.

Food moves from the duodenum to the ileum and along it by peristalsis. Presence of food in the ileum stimulates the secretion of the intestinal juice also called succus entericus. The collective function of these enzymes is to complete the digestion of the various compounds. At the end of their activity, the food is a milky fluid called **Chyle** ready for absorption.

The table showing the action of some intestinal enzymes

ENZYME	FOOD ACTED ON	PRODUCTS
Sucrase	sucrose	Glucose and fructose
Maltase	Maltose	Glucose
Peptidase	peptides	Amino acids
Lipase	Lipids	Fatty acids and glycerol
lactase	lactose	Glucose + galactose

NB

The wall of the ileum also secretes an enzyme enterokinase which activates trypsinogen.

The components of chyle are.

- ✓ Glucose
- ✓ Fructose
- ✓ Amino acids
- ✓ Fatty acids and glycerol.

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ABSORPTION

Absorption is the process by which soluble products of digestion diffuse through the cellular lining of the villi into the blood stream.

The villi are located in the ileum (small intestine) and thus absorption takes place in the small intestine. Some nutrients like minerals and vitamins also enter the villi by active transport.

The ileum shows various adaptions to suit the process of absorption which includes:

i) It is highly coiled/folded and consequently long thus providing a large surface area for digestion and absorption of food. (It is six (6) meters long).

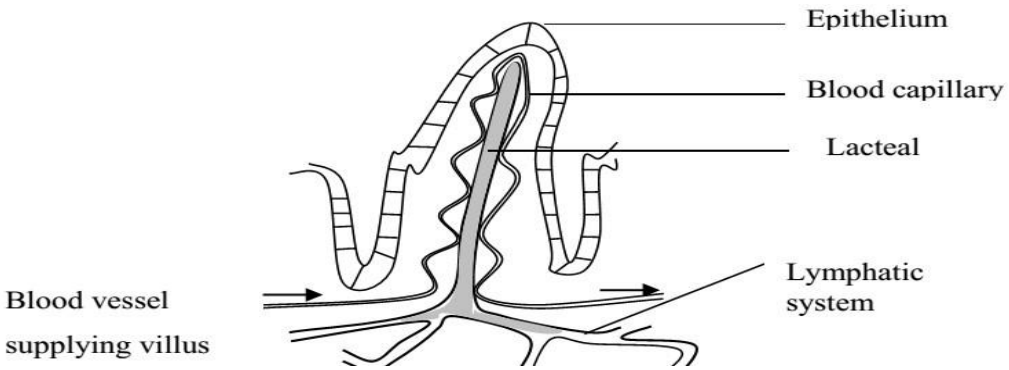
ii) Has a thin layer of cells to reduce the diffusion distance over which soluble food passes through.

iii) They are highly supplied with blood capillaries and lacteals which transport away absorbed food thus maintaining a diffusion gradient.

iv) Have finger-like projections called the villi which increase the surface area for absorption of soluble food.

v) The villi also have hair like extensions called the micro villi which ***further*** increase the surface area for absorption of soluble food products. The villi are the actual sites for absorption of soluble food products.

Diagram of Villus



Fatty acids and glycerol are absorbed into the lacteal of the villi. These lacteal later join up to form the lymphatic system carrying these food materials and distributing them to all parts of the body.

Glucose, Amino acids and Fructose pass into the blood capillaries of the villus which join up to form the **Hepatic portal vein which transport these nutrients to the liver.**

ASSIMILATION

This is the process by which absorbed food materials are built up into complex constituents of the organism. Assimilation is also the utilization of the products of digestion into the body's metabolism for life processes e.g. respiration, growth and repair and digestion.

Question:

Describe the fate of the absorbed food materials in the human body? Or

Describe what happens to the absorbed food materials in the human body after they are absorbed? **Solution:**

1) Carbohydrates: (Glucose)

Glucose is mainly broken down in the process of respiration to provide energy for the body's metabolic process. Excess glucose is stored as **Glycogen** (animal starch); however, the liver has the ability to re-covert back the glycogen to Glucose in periods of starvation.

2) Proteins

Amino acids are used in the synthesis of new proteins especially regulators like enzymes, and hormones.

Some Amino acids are used in body growth and repair and in absence of Glucose and Fats, Amino acids can instead be used in the process of respiration to produce energy.

Excess Amino acids are not stored in the liver, they are instead **deaminated** by the liver (removal of the Amino group) to form urea which is then passed on to the kidneys and excreted in urine.

Deamination is the removal of the amino group from Amino acids to form urea (which is a toxic waste product).

3) Lipids (Fatty acids & Glycerol)

Fatty acids and glycerol in the absence of Glucose can be oxidized to release energy. Fats produce much more energy compared to glucose considering the same amount by mass.

Fats are used for body insulation i.e. they prevent heat loss from the body which is an important temperature regulatory mechanism.

Lipids are used in the formation of structures like the cell membrane.

Excess fats and Glycerol are stored under the skin in the **adipose tissue.**