UNIT 8: DIGESTION AND ABSORPTION

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1.0 Introduction

Units 3 to 7 discussed the various nutrients in the food. Most of these nutrients especially carbohydrates, proteins and fats are complex organic substances that cannot be utilized in the forms they are found in the foods. There is a need to break them down into simpler forms in which the body can absorb and utilize them. This process of breaking them down and absorbing them in for utilization in the cells of the body forms the subject matter of this unit — digestion and absorption.

2.0 Objectives

At the end of this unit, you should be able to:

- Identify the features of the gastrointestinal tract
- Discuss digestion of food in the mouth, stomach and small intestine
- Know the enzymes that are involved in the digestion processes
- Discuss the absorption of amino acids, simple sugars, fatty acids and glycerol.

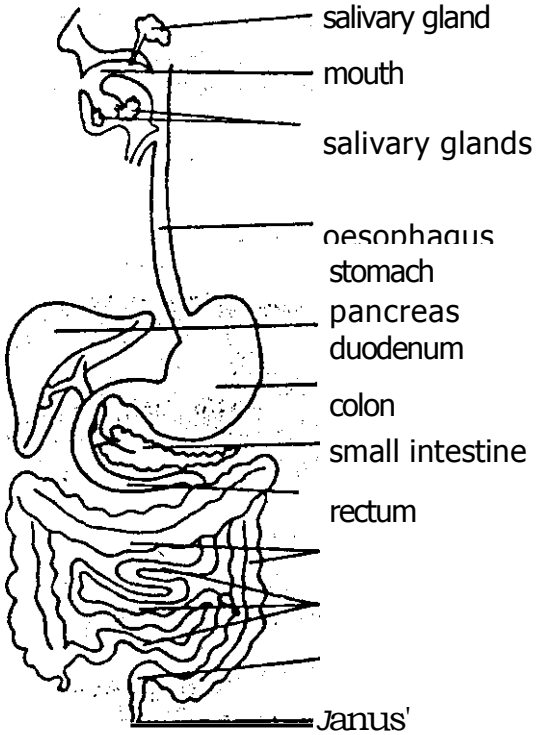
30 Main Content

3.1 The Gastro Intestinal Tract

The gastro-intestinal tract is a tube from the mouth, throat, to the stomach, small intestine and large intestine until it gets to the anus. The different parts of the tract varrin shape, length and internal diameter.

The gastro-intestinal tract is involved in the digestion of the complex food substances of carbohydrate, proteins and fats and oils. It is also involved in the absorption of the products of the digestion of these complex food substances.

Figure 8.1 Diagram of the Gastro-intestinal Tract and those Organs and Glands Concerned with Digestion



Source: Lake B. and Waterworth M, (1980) Foods and Nutrition 13th edition, Mills and Boon Ltd., Brooks Mews,London, Pg. 157

3.2 Digestion

This is the breaking down of complex molecules of carbohydrates, proteins and fat and oil by enzymes into smaller particles that can be absorbed or utilized by the body.

Enzymes are protein in nature and they act as catalysts. They cause chemical changes and remain chemically unchanged after the reaction. The enzymes may have minerals and vitamins ilc; co-enzymes before they can become active.

The digestive enzymes exist in inactive state and factors such as sight, smell of food, hormonal or chemical influence stimulate their secretion.

3.2.1 Digestion In the Mouth

Mastication or chewing of food breaks the large food molecules into small particles thereby creating greater surface area for the action of digestive enzymes. These small particles are then moistened by saliva secreted by the salivary glands.

In the saliva, there is a glycolitic enzyme called ptyalin which converts properly cooked starched into dextrin and maltose. The PH of the mouth varies from 6.4 to 7.3 whereas ptyalin is active between PH of 4 and 9. The food remains in the mouth for a short time to allow proper mastication or chewing of the food before the peristaltic movement of oesophagus allows the movement of the moistened food particles through the cardiac sphincter at the entrance of the stomach.

3.2.2 Digestion in the Stomach

Stomach serves more as a reserver than a digestive organ of food. The period of time the food stays in the stomach varies with the type of the nutrients in the food. Food consisting mainly of carbohydrate stays for a relatively shorter time period than food containing protein and fat. Food containing fat and oil stays longer in the stomach than food containing any other nutrients. This is why diet containing fat and oil has greater satiety value than food containing other nutrients.

The action of ptyalin that starts from the mouth continue in the stomach until the conditions of the stomach becomes highly acidic or basic. In the stomach, gastrin stimulates the secretion of gastric juice at the pyloric region of the stomach (the nearest part to the small intestine).

The gastric juice contains hydrochloric acid, mucin, water and two enzymes. The hydrochloric acid provides the favourable PH for the action of pepsin in the stomach. The PH of the stomach ranges from 1.5 to 4. There is the mechanical mixing of the gastric juice with the food by means of muscular contraction.

The pepsin in the gastric juice, a proteolytic enzyme breaks down protein into proteoses and peptones and from these compounds to polypeptides. Renin that is abundant in babies converts caseins to paracesein. Mucin in the gastric juice protects the wall in the stomach from self digestion in the sense that mucin adheres to the lining of the stomach thereby keeping pepsin away from stomach walls. This action prevents perforation of the tissues of the stomach.

3.2.3 Digestion in the Small Intestine

The highly acidic chyme (liquidified mass of food) from the stomach passes through the pyloric sphincter into the small intestine. As a result of the interaction of hormonal, chemical and the mechanical factors in the intestine, pancreatic juice, bites and intestinal juice are secreted. Pancreatic juice as given by Lake and Waterworth (1980) consists of :

a. Water and inorganic ions Na^{-1-}
   K^{t}, Ca^{2I}, Cl^{-}, $HCO3^{-}$, $HPO4^{-2}$
b. Enzymes, precursor — trypsinogen, chemotrypsinogen and procarboxy-peptilase.

Trypsin from trypsinogen breaks down protein into proteoses to peptones, to polypeptides. Chemotrypsin which is activated by trypsin breaks specific linkages in the polypeptide bond to amino acids. Carboxyl-polypeptilase spilts off amino acids from peptide end having free carboxyl group.

Lipase breaks emulsified fat to fatty acid and glycerol and amylase breaks starch to soluble starch to dextrin to maltose.

Bile salt from bile causes emulsification of fat and aids the absorption of fatty acids and fat soluble vitamins. In view of this, bile salts play an important role in the digestion of fat.

The intestinal juice contains seven enzymes in addition to secretin, an activator of trypsin of the pancreatic juice. The PH of the intestinal tract at this level is about 8.3. the seven enzymes consist of two proteolytic enzymes, an amylopolypeptilase and dipeptilase; lipolytic enzymes, lipase and four glycolitic enzymes amylase, sucrase, lactase and maltase.

Amylopolypeptilase, specifically splits off peptide next to a terminal amino acid with a free amino group. Dispeptilase breaks down polypeptide into amino acids.

Lipase breaks down emulsified fat to fatty acids and glycerol.

Amylase breaks sown starches to dextrin and from dextrin to maltose. Maltase breaks down maltose to two molecules of glucose. Sucrase breaks down sucrose to glucose and fruclose and lactase breaks down lactose to glucose and galatose.

From our discussion so far we have seen that the digestion of food results into the production of amino acids, glucose fructose, galatose, fatty acids and glycerol.

The digestibility of the food is also important for us to consider. Approximately 95c/cof food stuffs are digested and absorbed. While sugars are quickly absorbed, fat remains in the digestive tract for many hours. Animal foods have greater digestibility than the corresponding plant foods.

Table 8.1:Average Percentage of Digestibility of Food by Man When Consumed in Mixed Diet.

Foods	Protein	Fat	Carbohydrate
Animal Foods	97	95	98
Cereals and Breads	85	90	98
Dried Legumes	78	90	97
Vegetables	83	90	95
Fruits	85	90	90
Total Food of Average Diet	92	95	98

Source: Fleck H. (1976) Introduction To Nutrition Third Edition, Macmillan Pub. Co., Inc., New York

Generally, digestibility is greater in fat than protein and in carbohydrate than fat. That is, it is highest in carbohydrates.

3.2.4 Large Intestine

There is no digestion in the large intestine; except that water is absorbed from the waste products in the large intestine to concentrate the feaces. Even the absorption of nutrients does not also take place in the large intestine. The faecal materials contain the unabsorbed food residues containing indigestible

fibres mainly cellulose from fruits and vegetables. It should be noted that these fibres are important roughages for the gastro intestinal health.

Student Assessment Exercise 8.1

Discuss digestion of starch or carbohydrate in the mouth, stomach and small intestine.

3.3 Absorption

Most of the absorption of the products of digestion of carbohydrate, protein and fat and oil takes place in the small intestine by active transport and diffusion.

This occurs particularly in the duodenum and the upper part of jejunum. The absorption takes place in the lining of the small intestine which contains the villi. These villi are fingerlike projections. The epithelial cells of the villi have a brush boarder which increases the absorptive surface of the villi.

The mitochondria that is near the brush boarder area of the villi supply the energy for the transportation of the fructose, galactose, monoglcerides and amino acids are all capillaries of the villi and then into the porter vein.

The absorption of the short chain fatty acids takes place from the endoplasmic membrane and the long chain fatty acids are absorbed into the lymphatics. Many of the cations and anions are absorbed through the small intestinal mucosa. While vitamin A is required for calcium absorption, the presence of vitamin C and E enhance the absorption of iron.

3.4 Utilization

Let us discuss how the nutrients from the digestion of carbohydrates, proteins and fat and oil are utilized in the body.

Amino acids, glucose and fatty acids can all be used for the energy needs of the body and some of these products of digestion are also used for the synthesis of non-essential amino acids, enzymes and hormones. The amino acids absorbed are circulated in the blood for the use of cells for the synthesis of new tissues, for maintenance or repair of body protein and for manufacture of hormones and enzymes.

The liver in its role of controlling human plasma protein makes a lot of demand for amino acids. If after all these functions are still excess amino acids, the amino group containing the nitrogen is detached from the non-

nitrogenous fraction of the amino acids in a process known as "Deamination". The non-nitrogenous fraction, consisting of hydrogen, carbon and oxygen, produced may be used to serve as source of fuel after its conversion to glucose or may be stored as fat in the adipose tissue or may take part in the synthesis of non-essential amino acid. The amino group detached by the process of deamination from the amino acids may be used for the synthesis of non-essential amino acids in a process called "Transamination".

Glucose, galactose and fructose released. from digestion of starches are converted to glucose and later to glycogen when glucose content in the blood is in excess of the immediate needs. The glycogen is the temporary fuel reserve of the blood and this is depleted during exercises. If glucose is in excess of what can be stored as glycogen it will be converted to fat which is stored in the adipose tissue and the excess glucose can also be used for the synthesis of non-nitrogenous part of the non-essential amino acids.

Fatty acids and glycerol form fat digestion are metabolized in separate ways in the body. Glycerol is converted to glucose in the liver and then follows the same metabolism as that of the glucose. Fatty acids may be used by the cells form the circulating blood to form the structure of the cell. In the absence of this the metabolism of fatty acids which occur in the liver may cause its conversion into phospholipids in the presence of choline or methioline. Fatty acids in excess of all these functions are converted into adipose tissue.

Student Assessment Exercise 8.2

Discuss the utilization of the products of digestion of protein, carbohydrate and fat and oil after their absorption in the body.

4.0 Conclusion

In this unit we discuss the components of the gastrointestinal tract, the digestion, of carbohydrate, proteins and fat and oil form the mouth to the stomach and to the small intestine.

The unit also teaches the absorption and utilization of products of the digestion of the carbohydrate, protein and fat and oil in the body.

5.0 Summary

The unit shows the features of the gastro intestinal tract and explains digestion of carbohydrate, protein, fat and oil in the mouth, stomach and small intestine.

he unit shows the various enzymes that are involved in the digestion process. The digestion of starched commences from the mouth by the action of ptyalin in reducing the starches to dextrin and maltose. The digestion of protein and fats commences from the stomach.

The digestion process could be summarized as follows:

Site	Enzymes	Reaction
Mouth	Ptyalin (In saliva)	Starch —> Soluble Starch Dextrin —> Maltose
Stomach	Pepsin (In Gastric Juice) Rennin	Protein —> Proteoses Peptones —> Polypeptides Casein ntracesein
Small Intestine	Pancreatic Juice:	
	i. Trypsin	Proteoses —> Peptone —> Polypeptide
	Chymotrypsin	Catalyses break down of peptide —> amino acids.
	Carboxy — Polypeptilas	Splits off amino acid from peptide end having free carboxyl group
	iv. Lipase	Fat —> Fatty acids and glycerol
	v. Amylase	Starch —*Soluble Srarches—>Dextrin —Maltose
	Intestinal Juice	Polypeptides—> Amino Acids
	i. Peptilase	Starch — > Soluble Starched—*Maltose
	ii. Amylase	
	iii. Maltose	Maltose—*Glucose—> + Glucose
	iv. Sucrase	Sucrose —*Glucose + Fructose
	v. Lactase	Lactose —> Glucose + Galactose
		Fat —*Fatty Acids—> + Glycerol.

Absorption of the products of digestion takes place in the small intestine and there is the diffusion of the product in the blood stream while they are drawn by the various cells for the various functions of the nutrients for the digestion.

6.0 Tutor Marked Assignment

Discuss the digestion of protein sand fat in the body.

8.1 See the answers in Sections 3.2.1, 3.2.3 and 3.2.3
8.2 See the answers in sections 3.4 in this unit

7.0 References and Other Sources

Davidson S. eta! (1975) Human Nutrition and Dietetics. Sixth editionLongman Group Ltd.

Fleck H. (1976) Introduction To Nutrition.Third edition, Macmillan Pub. Co., Inc., New York

Gultrie H. A. (1979) Introductory Nutrition. Forth edition, The C.V. Mosby Company. St. Louis, London, Toronto.

Lake B and Inlaternurte M. (1980) Food and Nutrition 13th edition, Mills and Boon Ltd., London