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What Happens To the Food Those We Eat

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We all know that food is the primary requirement of all living system. It is the key source of energy and also involved in growth and repair of tissue. The food that we ate are cannot directly utilized by our body, thus it will undergo some mechanical and chemical process to convert the complex material into simpler and absorbable one. Hence the body can utilize it for energy purpose. The process of conversion of food into energy molecule is known as **digestion** and is carried out by the **digestive system**.

The human digestive system is well developed and complicated, which starts from the mouth to the anus. Like ours, the cells of digestive system cannot works independently, they are associated with some glands and the microbes and exist as a society. The associated glands include liver, pancreas, and salivary gland. Microbes which are present in the gut are bacteria, viruses, fungi, and protozoa and the follow a symbiotic relationships. These are collectively called as **gut microbiome**. In which bacteria have most dominating role.

The gut microbiome is important but probably not essential-to digestion (1). The major role of gut microbiome includes; digestion of food which are not done by our body, production of some vitamins and amino acids, provide immunity, and it produce some complex substances like hormones which are essential for our growth (2). For example the breast milk is essential for growth and development of infants. It contains different growth factors, immunological substances and several microorganisms. The digestive system in our body is not capable to digest certain components like fructooligosaccharides present in the milk thus absorption will not take place. This can be achieved by the help of microbes present in it. The microbes will convert such complex compounds into SCFA which has different functions in our body such as homeostasis of energy (3, 4). However, the oxidation of long chain fatty acids requires the presence of oxygen which is scarce in the intestine. Thus the bacteria cannot involved in the digestion of lipids (5).

Infants have a microbial system which is similar to the vaginal microflora of mother (In case of caesarian it is similar to the skin). The major group of bacteria present in infants includes *Lactobacillus, Bifidobacteria, Staphylococcus, Propionibacteria,* and *Corneybacteria* (4). This will get altered when increasing age. From the age of 2.5 the microbial flora will develop as such as be the adult. The composition of microbes also influenced by certain factors such as genetic, diet, state of health, geographic location and length of gut (3).

Some microbes may possess some adverse effect on host cell. For example, obesity known as a metabolic syndrome. This may arise due to the over consumption of energy dense food and this will make some alterations in the microbial community and thereby create problems with glucose homeostasis and leads to the development of obese phenotypic organism. These changes may course diseases like obesity, and diabetes (5).

THE DIGESTIVE SYSTEM AND ASSOSCIATED MICROBES

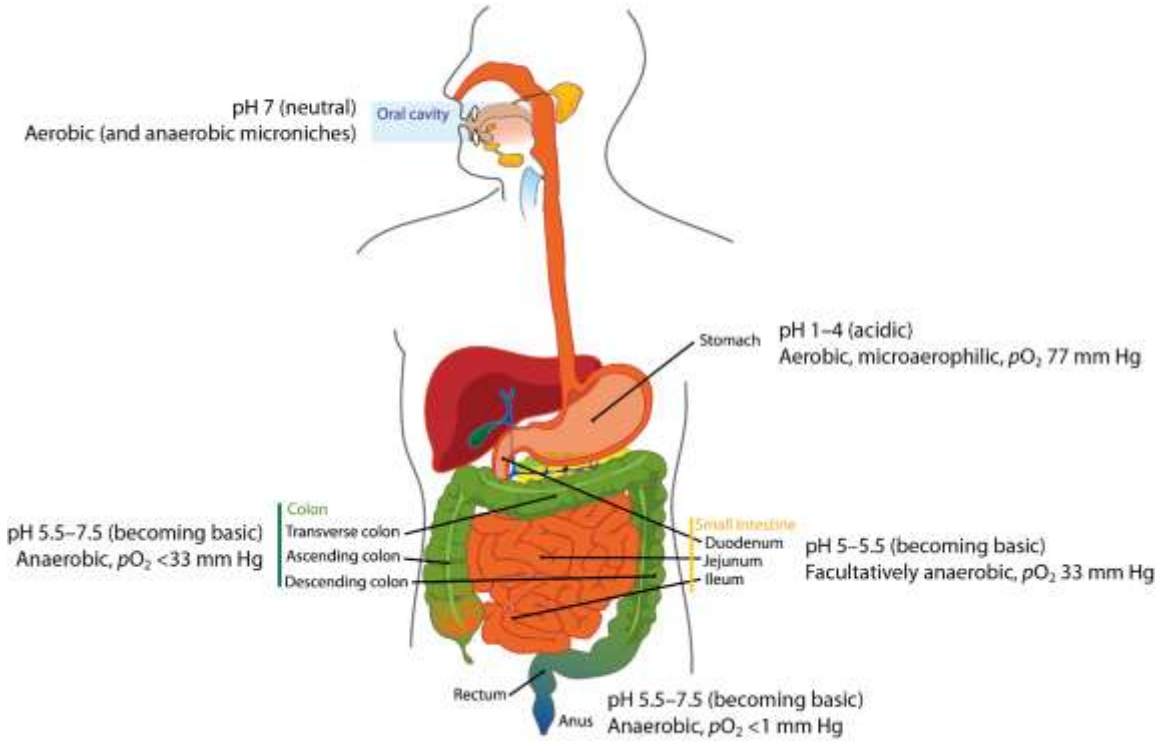

Fig 1: The oxygen content and P^H of human digestive system and associated microorganisms

Mouth; The digestive system starts from mouth. It is carryout mastication (chewing) and swallowing. This is done with the help of teeth and tongue. The salivary gland will also produce some secretion for lubricating and this will helps to adhere into bolus. It has a neutral P^H and have high oxygen concentration. Thus most of the microorganisms are aerobic in nature. The most common type of microbe colonized in oral cavity or buccal cavity are Fermicutes, Bacteriodetes, Proteobacteria, Actinobacteria, and Fusobacteria (6).

Esophagus; It is a tube like structure which conduct food from pharynx to stomach through peristalsis. It will take about 5-8 seconds. Some aerobic microbes are present in it but it do not possess any major functions.

Stomach; It has around 4L capacity and store food for 4-5 hours. Many secretions are involved in this to digest the food. It will have P^H of 1-4 due to the presence of gastric hydrochloric acid. Thus it will not support the growth of microorganisms. However it contains some aerobic and acidophilic groups (fig 1).

Small intestine; Major digestion reactions are carried out in the small intestine. It is separated into three parts- Duodenum, Jejunum, and Ileum. The secreted product of associated glands such as liver and pancreas will reaches to it. It has a basic P^H (5-5.5). The oxygen concentration will scares thus bacteria present in it are facultative anaerobes (fig 1) which include *Protenobacteria, Actinobacteria, Streptococcaceae, Fermicutes,* and *Bacteriodetes* (6, 7).

Large intestine; This involved in the absorption of materials such as water and minerals. And it also acts on salvaged undigested and unabsorbed materials. The P^H range is about 5.5-7 and it contains the largest amount of microbiome. Due to the absence of oxygen the bacteria present in it are anaerobic (*Bacteriodetes* is the major group) (2, 7, 8).

Rectum and Anus; The undigested, unabsorbed waste substances called faeces enters into the caecum of the large intestine through ileo-caecal valve, which prevents the back flow of the faecal matter. It is temporarily stored in the rectum till defaecation through anus. The rectum also contain some anaerobic bacteria and P^H is 5-7.5 (fig 1).

DIGESTION OF FOOD

Digestion of the food materials involves both mechanical and chemical reactions. In which first step is the mastication or chewing. This will help to reduce the particle size and thereby improves the surface area for digestion. The mucos secretions will help to lubricate it. The saliva (secreted by salivary gland) contains

salivary amylase enzyme which will act on starch at a P^H of 6.8 and convert into maltose. 30% hydrolysis of starch occurs in the buccal cavity. The saliva also contains some lysozyme which has antimicrobial activity and ions of sodium, potassium, chlorine, and hydrocarbons. This will facilitate the reaction. The microorganisms will secrete some enzymes for the hydrolysis of starch (9, 10). Then it will adhere to form bolus and move to the stomach through the esophagus (10).

In the stomach the parietal cells will secrete gastric acids (P^H 1-4) which will prevent the entry of microbes through food and it will activate the inactive proteolytic enzymes (proenzymes) present in the gastric juice. Mucus and bicarbonate are also present in the gastric juice will protect the epithelial cells and also involved in the lubrication of food materials. The food particle along with gastric juice is known as Chyme (10). The microbial community is very low in the stomach. However, they play a key role in digestion of carbohydrate.

The chyme will then enter into duodenum (small intestine). It is the portion where the major part of digestion is carried out. The intestinal juice contains enzymes such as disaccharidases, dipeptidases, lipases, and nucleosidases. The secretion from the liver and pancreas is reached here. The live will secrete bile it contains bile pigments (bilirubin and biliverdin), bile salts, cholesterol and phospholipids. This helps in the emulsification of fat and activate lipase enzyme. The pancreatic juice contains a mixture of inactive enzymes such as trypsinogen, chymotrypsinogen, procarboxypeptidases, amylases, lipases, nucleases. The inactive trypsin will get activated by the enterokinase enzyme which is secreted by the intestinal mucosa and form active trypsin. This will activate the other enzymes.

The digestion of different components are as follows,

- Proteins and peptones are converted in to dipeptides by the proteolytic enzymes and it will then to form amino acids by the enzyme dipeptidases.
- The polysaccharides are converted to form disaccharides by the enzyme called amylases and then into monosaccharides such as glucose and fructose by the enzyme disaccharidase.
- The nucleases will act on nucleic acid and form nucleosides and then into sugars and bases.
- Lipases will act on fat molecules and convert into fatty acids and glycerol.

About 150 microbial species are there which encode 60,000 varieties of carbohydrate degrading enzymes including 9000 type of glycoside hydrolase and 2000 type of polysaccharide lyase (11). These microbes possess a great role in digestion of compound which cannot done by human cells. The bacterial disaccharidase act on salvaged unabsorbed sugars such as lactose and alcohol and this will convert into short chain fatty acid (SCFA). The SCFA plays a great role in regulation of blood glucose level, energy harvesting and weight management. The bacteria such as *Bifidobacteria* involved in the carbohydrate metabolism whereas *Bacteriodetes* harvest and metabolise polysaccharide such as starch, glycogen, and cellulose. The microbes will act on (11)

- Starch from wheat, oats, rye, barley and rice.
- Polysaccharides and glycans from fruits, vegetables, potatoes, and legumes.
- Fibers of whole grain bread and brown rice.
- Fructooigosaccahrides of banana, onion, chicory root, garlic, asparagus and leeks
- Oxalate of spinach, dates, grapes, orange, avocado, carrots, celery and nuts.

Then it passed into jejunum and ileum- the other parts of small intestine. These are the principal organ for absorption of nutrients. Some finger-like projections are present in the intestinal wall called microvilli. This will improves the area of absorption. The end products of digestion such as glucose, fructose, fatty acids, glycerol and amino acids are absorbed through the mucosa into the blood stream and lymph. This will distribute throughout the body and then enters to the biochemical reactions such as glycolysis and glyconeogenesis for the release of energy and storage. The utilization of absorbed materials by the cell known as assimilation. Some microbes will facilitate the absorption and further processes.

After absorption the remaining materials will undergo into large intestine (colon). Here the absorption of water molecules and minerals will occur. The undigested and unabsorbed particles are treated and reabsorbed through diffusion. This plays an important role in the regulation of water and ion content in our body (10).

When it comes to the microbial part, large intestine having the largest microbial community. These are involved in the digestion of some compounds which are not done by the human gut. For example the fructooligosaccharides which is present in the fruits and vegetables. There is no enzyme to digest these compound in the human cell. This is done by the microorganism. These compounds will undergo degradation and form short chain fatty acids (SCFA). And digested product will transported to the liver and converted to storage fat. SCFA also involved in the regulation of homeostasis of energy. There is another compound known as oxalate. These are present in some green leafy vegetables. This will bind with calcium ions and may accumulate in kidney leads to the formation of kidney stone. Hence the digestion of these compound is very essential. It is done by the bacteria such as *Oxalobacter, Eubacteria,* and *Enterococcus* (11). The synthesis of essential vitamins (vitamin B complex and vitamin K) and amino acids (phenyl alanine, tyrosine, and tryptophan) is another important function of microbes. This will also occurs in the colon.

Then the waste materials (faeces) are stored in the rectum. The faeces are composed of 75 percent water and 25 percent solid matter. About 30 percent of the solid matter consists of dead bacteria; about 30 percent consists of indigestible food matter such as cellulose; 10 to 20 percent is cholesterol and other fats; 10 to 20 percent is inorganic substances such as calcium phosphate and iron phosphate; and 2 to 3 percent is protein. The bilirubin and end product of hemoglobin (red blood cells) degradation will impart the colour to the faeces. The odour of feces is caused by the chemicals such as hydrogen sulfide which are the byproduct of action of anaerobic bacteria present in the rectum (12). The gut microbiome will live attached to the mucosal lining of the GI tract. When the mucosa lining shed from the cells the mibrobes are also eliminated and thereby the microbial equilibrium in our body is regulated (13). Thus the stool can be used as a sample for the collection of microbes. At the end the faeces are secreted through the anus.

Reference

[1]. Zhang YJ, Li S, Gan RY, Zhou T, Xu DP, Li HB. Impacts of gut bacteria on human health and diseases. International journal of molecular sciences. 2015;16(4):7493-519.

[2]. Vyas U, Ranganathan N. Probiotics, prebiotics, and synbiotics: gut and beyond. Gastroenterology research and practice. 2012;2012:872716.

[3]. Rodriguez JM, Murphy K, Stanton C, Ross RP, Kober OI, Juge N, et al. The composition of the gut microbiota throughout life, with an emphasis on early life. Microbial ecology in health and disease. 2015;26:26050.

[4]. Walker WA, Iyengar RS. Breast milk, microbiota, and intestinal immune homeostasis. Pediatric research. 2015;77(1-2):220-8.

[5]. Woting A, Blaut M. The Intestinal Microbiota in Metabolic Disease. Nutrients. 2016;8(4):202.

[6]. Diaz PI, Chalmers NI, Rickard AH, Kong C, Milburn CL, Palmer RJ, Jr., et al. Molecular characterization of subject-specific oral microflora during initial colonization of enamel. Applied and environmental microbiology. 2006;72(4):2837-48.

[7]. Espey MG. Role of oxygen gradients in shaping redox relationships between the human intestine and its microbiota. Free radical biology & medicine. 2013;55:130-40.

[8]. Koropatkin NM, Cameron EA, Martens EC. How glycan metabolism shapes the human gut microbiota. Nature reviews Microbiology. 2012;10(5):323-35.

[9]. Hoebler C, Lecannu G, Belleville C, Devaux MF, Popineau Y, Barry JL. Development of an in vitro system simulating bucco-gastric digestion to assess the physical and chemical changes of food. International journal of food sciences and nutrition. 2002;53(5):389-402.

[10]. Kong F, Singh RP. Disintegration of solid foods in human stomach. Journal of food science. 2008;73(5):R67-80.

[11]. De Vadder F, Kovatcheva-Datchary P, Goncalves D, Vinera J, Zitoun C, Duchampt A, et al. Microbiota-generated metabolites promote metabolic benefits via gut-brain neural circuits. Cell. 2014;156(1-2):84-96.

[12]. Rose C, Parker A, Jefferson B, Cartmell E. The Characterization of Feces and Urine: A Review of the Literature to Inform Advanced Treatment Technology. Critical reviews in environmental science and technology. 2015;45(17):1827-79.

[13]. Stephen AM, Cummings JH. The microbial contribution to human faecal mass. Journal of medical microbiology. 1980;13(1):45-56.

XXXXX, et. al. What Happens To the Food Those We Eat." *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 16(02), (2022): pp 31-34.