B. A program in Physical Education (Semester 2)
College: Raniganj Girls College (K.N.U)
Department: Physical Education

Digestive System

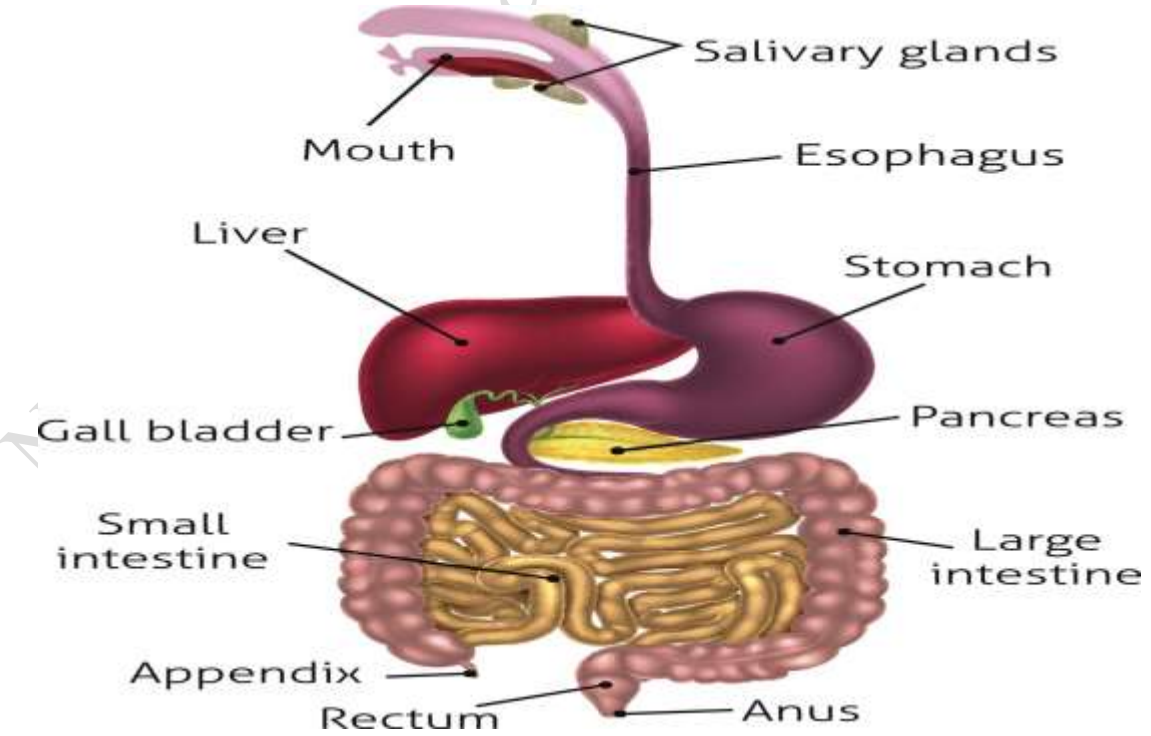
Introduction: - Human Digestive system includes Gastrointestinal Tract and other accessory parts like the liver, intestines, glands, mouth, stomach, gallbladder. There are 6 main functions of the Human Digestive System Process: **Ingestion, Motility, Secretion, Digestion, Absorption, Excretion.** The food that you eat gives you not only the required energy and nutrients to the body but also is used for cell growth and repair.

Digestive system: The system of organs responsible for getting food into and out of the body and for making use of food to keep the body healthy. The digestive system includes the salivary glands, mouth, esophagus, stomach, liver, gallbladder, pancreas, small intestine, colon, and rectum.

In Human digestive system, there are many parts that work together. The food that you eat has bio macromolecules, which are nothing but the carbohydrates (such as sugars), proteins, lipids (such as fats), and nucleic acids. These have to be converted to their simpler forms so that your body can absorb it. These bio macromolecules are the building blocks that you require to maintain your body, which is also made of these large biological molecules, along with water!

This process of converting complex food substances (molecules) into simpler forms to facilitate absorption is called Digestion. In humans, this system consists of many parts and organs, including the **alimentary canal, digestive glands**, and a few accessory organs such as **the teeth, salivary glands, tongue, pancreas, liver, gallbladder** etc.

Nevertheless, the starting point where digestion actually starts in the mouth! From the mouth, it passes through the alimentary canal, which is also called the **gastrointestinal tract**. This tract consists of the **pharynx, esophagus, stomach, small intestine, large intestine, and anus.** The mouth can be considered as the **anterior opening of the alimentary canal**, while **the anus is the posterior opening.**



Digestive System Parts:

The **gastrointestinal tract** (GIT) consists of a hollow muscular tube starting from the oral cavity, where food enters the **mouth, continuing through the pharynx, esophagus, stomach and intestines to the rectum and anus,** where food is expelled.

The gastrointestinal tract is a muscular tube lined by a special layer of cells, called epithelium. The contents of the tube are considered external to the body and are in continuity with the outside world at the mouth and the anus. Although each section of the tract has specialized functions, the entire tract has a similar basic structure with regional variations.

The wall is divided into four layers as follows:

1) Mucosa: - The innermost layer of the digestive tract has specialized epithelial cells supported by an underlying connective tissue layer called the **lamina propria.**

2) Submucosa: - Its outer margin there is a specialized nerve plexus called the submucosal plexus or Meissner plexus. This supplies the mucosa and submucosa.

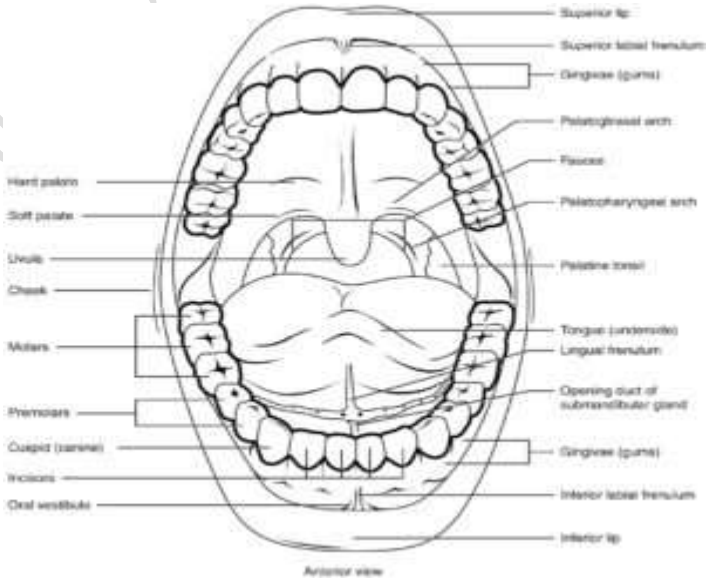
3) Muscularis externa: - This smooth muscle layer has inner circular and outer longitudinal layers of muscle fibres separated by the myenteric plexus or Auerbach plexus.

4) Serosa/mesentery: - The outer layer of the GIT is formed by fat and another layer of epithelial cells called mesothelium.

Individual components of the gastrointestinal system

Mouth

The anterior opening of the alimentary canal is the mouth. It leads to a buccal cavity or oral cavity, where teeth, tongue and salivary glands are present. Here, ingestion, mastication, and swallowing of food occur. In humans, there are a total of 32 permanent teeth. There are four different types of teeth, namely, incisors, canines, premolars, and molars. These help in the chewing of food.



Salivary Glands

They are exocrine glands that produce saliva in the oral cavity. They secrete an enzyme called **Amylase & Tyalin** which helps in the breakdown of starch into maltose. There are three types of salivary glands, namely:

- **Parotid gland: -** The parotid glands are large, irregular shaped glands located under the skin on the side of the face. They secrete 25% of saliva. They are situated below the zygomatic arch (cheekbone) and cover part of the mandible (lower jaw bone).
- **Submandibular gland: -** The submandibular glands secrete 70% of the saliva in the mouth. They are found in the floor of the mouth, in a groove along the inner surface of the mandible.
- **Sublingual gland: -** The sublinguals are the smallest salivary glands, covered by a thin layer of tissue at the floor of the mouth. They produce approximately 5% of the saliva and their secretions are very sticky due to the large concentration of mucin.

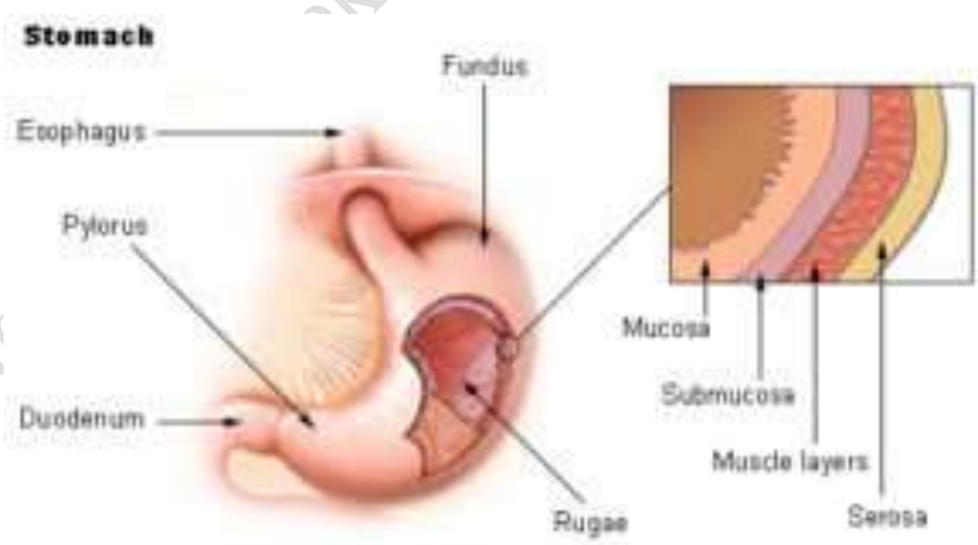
Oesophagus

The oesophagus is a muscular tube of approximately 25cm in length and 2cm in diameter. It extends from the pharynx to the stomach after passing through an opening in the diaphragm.

Stomach

The stomach is a J shaped expanded bag, located just left of the midline between the oesophagus and small intestine. It is divided into four main regions and has two borders called the greater and lesser curvatures. The stomach can hold up to 1.5 liters of material.

The stomach holds food and also is a mixer and grinder. It secretes strong acids and powerful enzymes that help in the process of breaking down of food. Food is generally in a liquid or pastes consistency when it leaves the stomach.



Small Intestine

The small intestine is composed of the **duodenum, jejunum, and ileum.** It averages approximately 6 m in length, extending from the pyloric sphincter of the stomach to the ileocecal valve separating the ileum from the caecum. The small intestine is compressed into numerous folds and occupies a large proportion of the abdominal cavity.

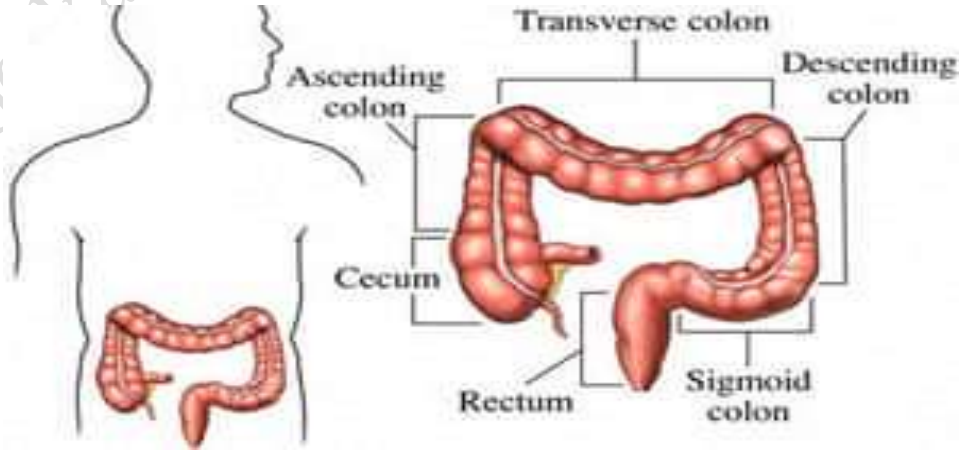
The **duodenum** is the proximal C-shaped section that curves around the head of the pancreas. The duodenum serves a mixing function as it combines digestive secretions from the pancreas and liver with the contents expelled from the stomach. The start of the **jejunum** is marked by a sharp bend, the duodenojejunal flexure. It is in the jejunum where the majority of digestion and absorption occurs. The final portion, the **ileum**, is the longest segment and empties into the caecum at the ileocecal junction.

Large Intestine

The large intestine is horse-shoe shaped and extends around the small intestine like a frame. It consists of the appendix, caecum, ascending, transverse, descending and sigmoid colon, and the rectum. It has a length of approximately 1.5m and a width of 7.5cm.

The caecum is the expanded pouch that receives material from the ileum and starts to compress food products into faecal material. Food then travels along the colon. The wall of the colon is made up of several pouches (haustra) that are held under tension by three thick bands of muscle (taenia coli).

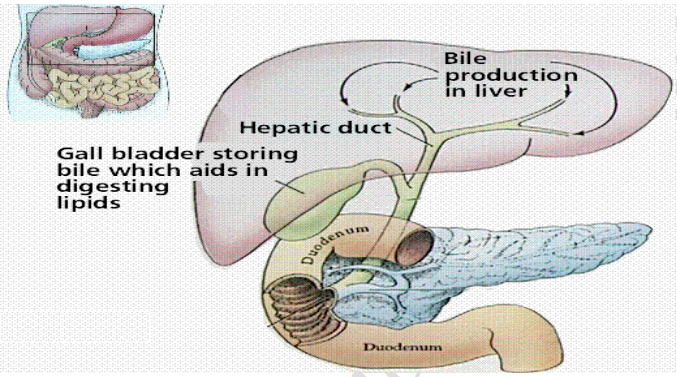
The rectum is the final 15cm of the large intestine. It expands to hold faecal matter before it passes through the anorectal canal to the anus. Thick bands of muscle, known as sphincters, control the passage of faeces.



These organs also play a significant role in the human digestive system. The pancreas secretes enzymes which help in the breakdown protein, fat, and carbohydrate. The liver secretes bile and cleanses and purifies the blood coming from the small intestine. The gallbladder stores the bile that the liver produces. It releases bile into the small intestine to aid in the digestion process.

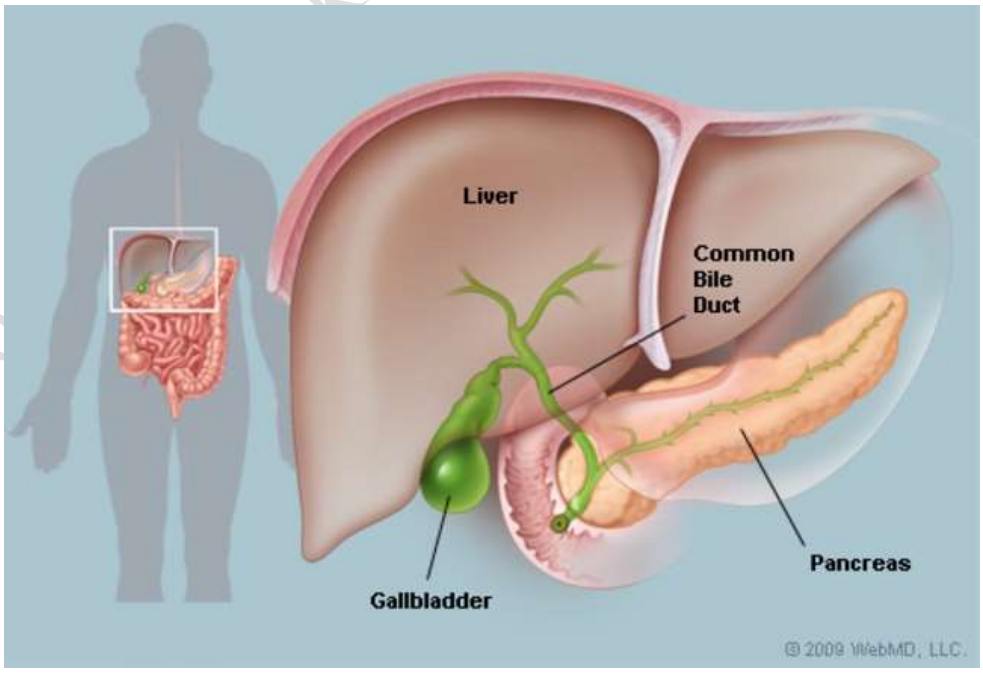
Liver

The liver is a large, reddish-brown organ situated in the right upper quadrant of the abdomen. It is surrounded by a strong capsule and divided into four lobes namely the right, left, caudate and quadrate lobes. The liver has several important functions. It acts as a mechanical filter by filtering blood that travels from the intestinal system. It detoxifies several metabolites including the breakdown of bilirubin and estrogen. In addition, the liver has synthetic functions, producing albumin and blood clotting factors.



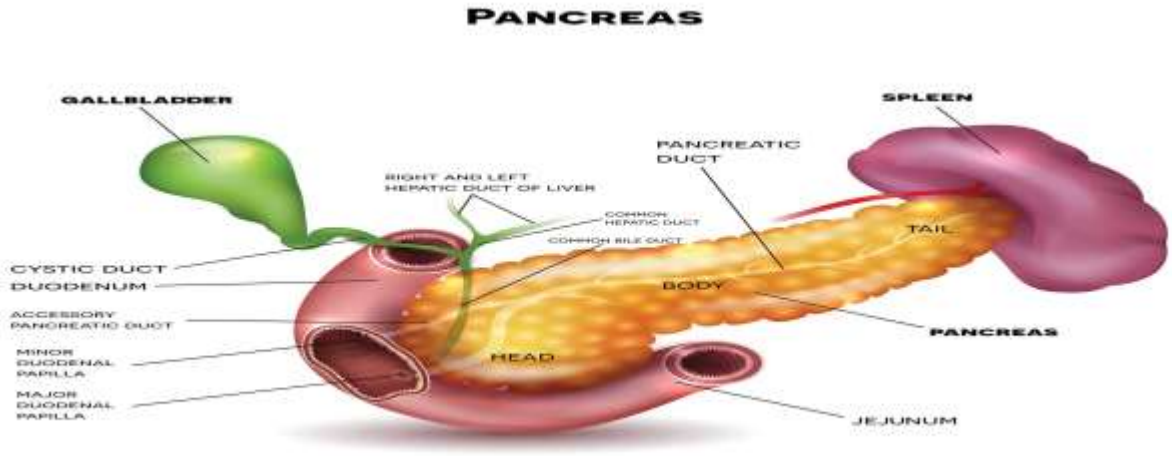
Gall bladder

The gallbladder is a hollow, pear shaped organ that sits in a depression on the posterior surface of the liver's right lobe. It consists of a fundus, body and neck. It empties via the cystic duct into the biliary duct system. The main functions of the gall bladder are storage and concentration of bile.



Pancreas

Finally, the pancreas is a lobular, pinkish-grey organ that lies behind the stomach. Its head communicates with the duodenum and its tail extends to the spleen. The organ is approximately 15 cm in length with a long, slender body connecting the head and tail segments. The pancreas has both exocrine and endocrine functions. Endocrine refers to production of hormones which occurs in the Islets of Langerhans. The Islets produce insulin, glucagon and other substances and these are the areas damaged in diabetes mellitus. The exocrine (secretory) portion makes up 80-85% of the pancreas and is the area relevant to the gastrointestinal tract.



Digestive System Process:

From the Mouth to the Large Intestine and Anus. The Human digestive system process can be divided into stages, namely:

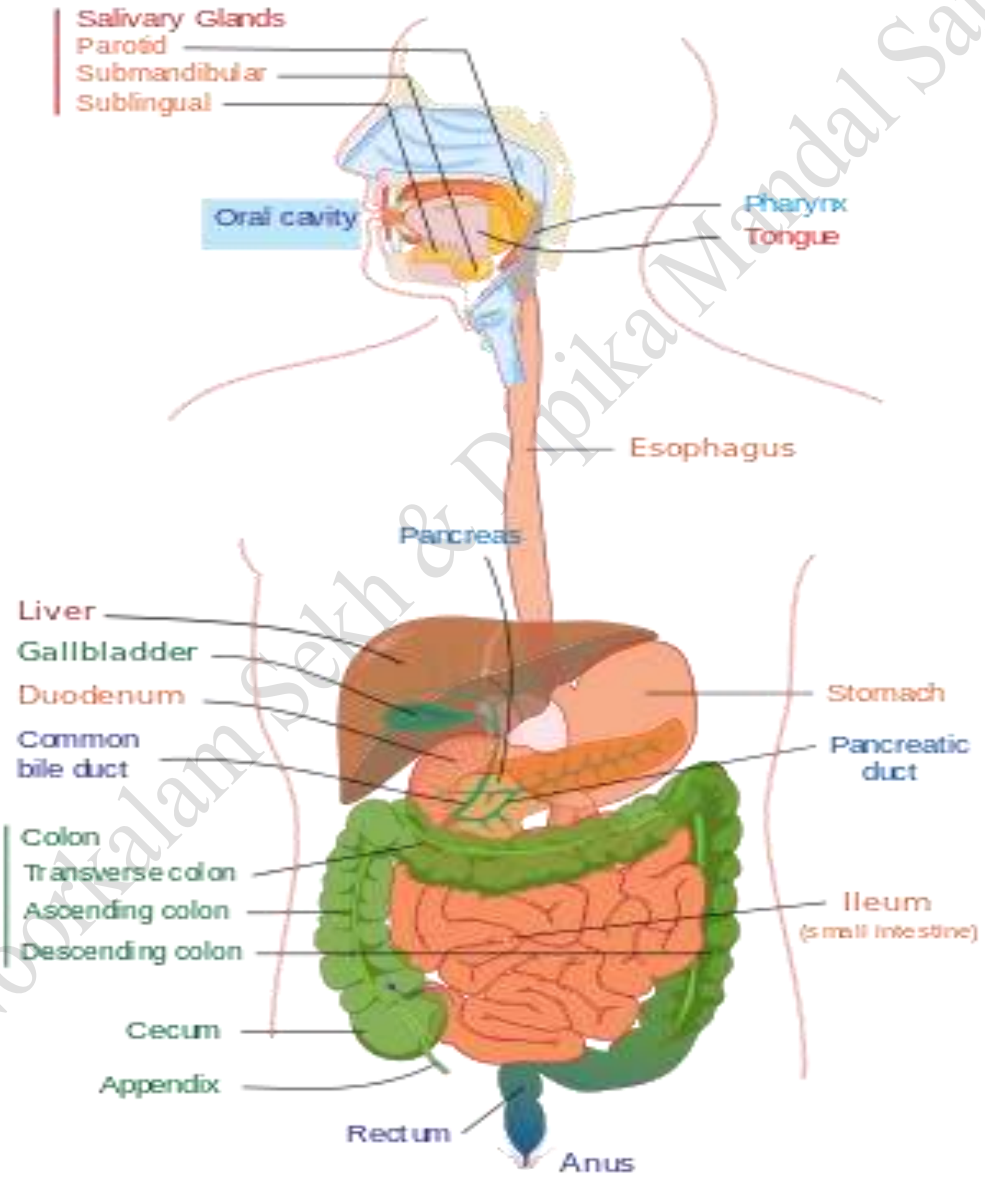
- **Ingestion**
- **Motility**
- **Secretion**
- **Digestion**
- **Absorption**
- **Excretion**

The whole process starts in the oral cavity, where the saliva from the salivary glands mixes with the food and starts to begin the breakdown of food. From the mouth, the food passes to the hollow tube-like organ the esophagus. From the esophagus, food then travels to the stomach, where it breaks down further with the help of the acids and powerful enzymes secreted by the stomach.

Why is digestion important?

It is an important process that breaks down the proteins, fats, carbohydrates, vitamins, minerals into simpler forms so that it can be absorbed easily into the body cells. During this process, proteins are converted into amino acids, carbohydrates are converted into simple sugars and fats are broken down into fatty acids and glycerol.

Many digestive enzymes and hormones act on food, at various stages during the process of digestion. The whole process occurs in a sequential manner.



Mechanism of Digestion

The digestion process can be divided into different stages, such as digestion in the:

- Oral cavity
- Stomach
- Small intestine
- Large intestine

Digestion includes a complex combination of mechanical and chemical processes. Some of the activities in the process include ingestion and propulsion of food, mechanical or physical digestion, chemical digestion, absorption, and defecation.

Digestion in the Oral Cavity

When food is taken in through the mouth, chewing and mixing of the food occurs. There is also a chemical breakdown of carbohydrates, due to the action of saliva from the salivary glands. 30% of the starch is hydrolyzed by the action of amylase, which is a salivary enzyme. The other enzyme, lysozyme is an antibacterial agent that prevents infections.

Starch + Salivary amylase → Maltose

Mastication of food and swallowing of food are the important activities that take place here in the oral cavity. Food is broken down into smaller particles by the chewing action of teeth. As saliva is added, it mixes with the food particles, slowly moistening and lubricating the food. This small ball is called a bolus, which is then swallowed. The pharynx helps in the movement of the bolus into the oesophagus, from where it moves to the stomach through the peristaltic movements of the oesophagus.

Digestion in the Stomach

When food reaches the stomach, it stays for approximately 4 to 5 hours. There are various gastric glands in the mucosa lining of the stomach. The mucus neck cells secrete mucus. The Peptic Cells secrete the proenzyme pepsinogen. The Parietal or Oxyntic Cells secrete HCl (Hydrochloric acid) and intrinsic factor that is essential for vitamin B12 absorption.

Food in the stomach gets mixed thoroughly with the gastric juices through the churning movements of the stomach muscle. This mass of food that is semi-digested, acidic and pulpy is called the chyme. It is mostly the proteins that get digested in the stomach. The mucus and the bicarbonates of the gastric juice help in protecting the mucosal epithelium from the highly acidic HCl. Mucus also helps in lubricating the food.

The different chemical reactions that take place in the stomach are summarized as follows.

Gastric juices and enzymes:

- HCl provides the acidic pH.
- Pepsinogen(proenzyme) is converted into Pepsin by HCl
- Pepsin, in turn, converts protein into peptones & proteoses.

- Prorenin (proenzyme) is converted into Renin by HCl.
- Casein (milk protein) is converted into peptides by Renin.

After the action of the gastric juices and enzymes, food then enters the small intestine.

Digestion in the Small Intestine

In the small intestine, further digestion takes place. Due to the various movements of this organ, the chyme is further mixed and churned. There are many enzymes that are secreted into the small intestine from organs such as pancreas, liver; apart from the intestinal juices. All these react with the food particles and digest them into smaller particles that can be absorbed into the bloodstream.

The different chemical reactions that occur are summarized below:

Pancreatic juices:

- Amylase converts starch into Maltose.
- Enterokinase converts Trypsinogen into Trypsin
- Trypsin converts proteins into Dipeptides
- Trypsin converts Chymotrypsinogen into Chymotrypsin.
- Chymotrypsin converts peptones into Dipeptides.
- Trypsin converts Procarboxypeptidase into Carboxypeptidase.
- Carboxypeptidase converts proteoses into Dipeptides.
- Trypsin converts Proelastase into Elastase.
- Elastase converts elastin into Dipeptides.
- Pancreatic amylase converts polysaccharides (Starch) into Disaccharides.
- Nucleases in the pancreatic juice, act on nucleic acids and form nucleotides and nucleosides.

Intestinal juices:

- Maltase converts maltose into glucose.
- Sucrose converts sucrose into glucose & fructose.
- Lactase converts lactose into glucose & galactose.
- Aminopeptidases convert peptides into amino acids.
- Dipeptides convert dipeptides into amino acids

Bile -Bile converts fat globules into fat droplets through a process called emulsification. Fats are broken down into diglycerides and monoglycerides.

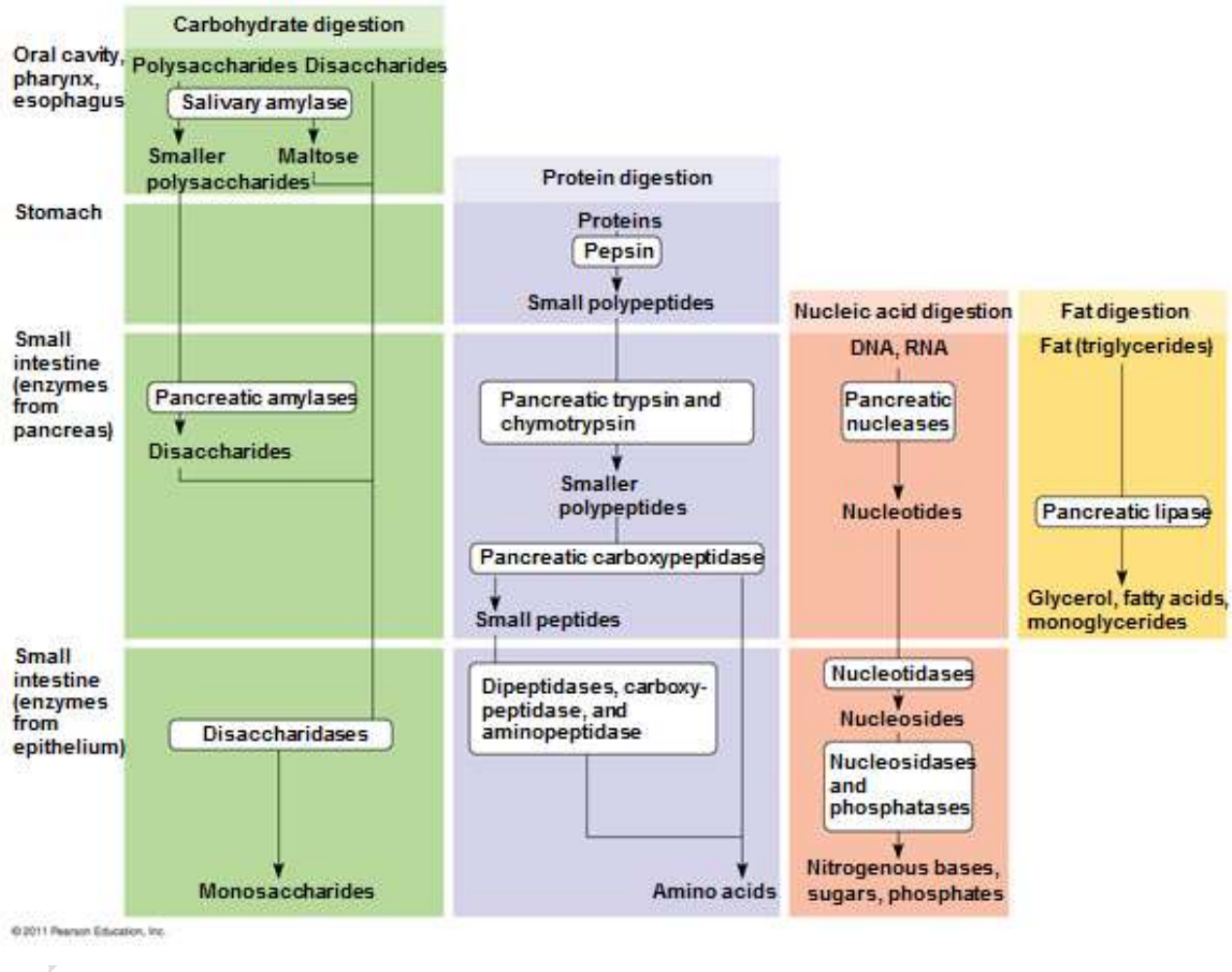
Pancreatic lipase – It converts triglycerides into fatty acids & glycerol.

The bio macromolecules are broken down in the duodenum region. All the simpler forms of the digested food are absorbed in the jejunum and ileum regions. Any leftover undigested, unabsorbed food particles are then passed on to the large intestine.

Digestion in the Large Intestine

In the large intestine, the digestion activity is significantly less. Here, bacterial action on the leftover food particles occurs. Minerals, water, and certain drugs are absorbed in the large intestine. The mucus secreted by the large intestine helps in holding the waste particles, apart from lubricating it.

Any undigested and unabsorbed waste particles called as the faecal matter, are then passed to the rectum, from where it is eliminated through the anus.



Control of the Digestive Processes

The digestive processes are controlled by the hormones and the nerves. There is a constant flurry of signals between the brain and the alimentary canal. Hormones control the digestion process by signaling the body at appropriate times to make the digestive juices. They also send signals to the brain to indicate being hungry or full. The nervous system, through the brain and spinal cord, controls the digestive processes.