

Digestive functions

- Living body consist of organic and inorganic molecules.
- Inorganic molecules are water, phosphates, hydrogen ions etc.
- Water makes about 60% of our cells. It is present inside the cell as well as in the interstitial fluid which is the water surrounding the cells Having all the material dissolved in it.
- Organic molecules contain carbon bonded to hydrogen as well to other atoms, such as oxygen, sulphur and nitrogen.
- Large organic molecules form the macro molecules in our body which is the raw material of our cell and our body obtains energy from these macromolecules called nutrients.
- The energy obtained from these macro molecules regulate cell activities ,carry on tissue repair and perform all the functions required for the survival of life.

Macromolecules

- All the macro molecules are digested or broken down by our digestive system to be used by the body.
- **Carbohydrates:**
- Carbohydrates are the macro molecules that always contain carbon, hydrogen and oxygen atoms in the same proportion of CH_2O (one carbon, two hydrogens and one oxygen). They provide short term or long term energy storage for organisms. There are of two main types of sugars:
- Simple sugars and polysaccharides:
- Simple sugars: (mono-saccharide): These sugars contain 3-7 carbon atoms. For example glucose (found in blood) fructose (found in fruits)
- Disaccharides (di) : Di-saccharides are sugars made up of two simple sugars combined together. For example: sucrose (table sugar) maltose (found in grains) lactose(found in milk products).
- Polysaccharides: many simple sugars linked together are called poly-saccharides. Example: starch and cellulose (found in plants), glycogen(found in animal tissues). All these perform the same function of storing energy for the future use.

- **Lipids :**
- Lipid is formed by combination of **one glycerol and three fatty acids.**
- They stores 2.25 times more energy than other biological molecules, some of them behave as energy storing molecules. Other lipids such as phospholipids forms an important part of cell membrane , they are insoluble in water. Example : butter, oils etc.
- **Proteins:**
- proteins are the macromolecules formed by their smaller subunits called **amino acids** joined together by **peptide bonds** forming chains .**These chains are called polypeptides.**
- Almost everything in our body is made up of proteins, including antibodies muscles cell membrane, digestive enzymes.

Breaking down macromolecules

- Before the body can use carbohydrates , proteins and fats they need to be chemically broken down into smaller molecule so that they can be absorbed easily by the lining of the small intestine.
- The process that is used to break the bonds between macromolecules is Hydrolysis, where a water molecules is added that breaks the chemical bonds that are holding together smaller molecules. This breakdown also involves a special protein molecule called enzyme..
- Enzymes act as catalyze and speed up the rate of reaction without being used up in the reaction. There are three main types of digestive enzyme involved in digestive process.
- Refer to table 10.2 on page 404.
- **Vital role played by mineral and vitamins.**
- Refer to the table 10.3 on page 405

Role of water:

- Water helps to dissolve nutrients in the cells that line the small intestine.
 - Flushes toxins out.
 - Provide lubrication.
 - Forms essential body fluids like blood and mucus.
 - Regulate body temperature.
 - Helps eliminate waste.
 - Helps maintain homeostatic.
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- On average a healthy individual produces 1.5 litres of urine per day apart from losing water through breath, perspiration and bowel movement. Therefore this water needs to be replenished as we go.

How animal obtain food :

Filter feeding,

- This is the type of feeding in which food particles or small organisms are randomly strained from water.
- Filter feeding is found primarily among the small- to medium-sized invertebrates (tube worms) but also occurs in a few large vertebrates (*e.g.*, flamingos, baleen whales).
- Aquatic animal strain suspended material out of the water. Hair like filaments called cilia produce a water current over the gills in fishes (for example), and other cilia (found in other animals)filter out the trapped food particles. Many bristle-worms, such as the fan worm have ciliated tentacles near the mouth, which entrap passing food particles.

Substrate feeding:

- Animals such as earthworms or termites eat the soil or wood through which they burrow.
- Substrate feeding is the material upon or within which a plant or animal live or grows (*e.g.* Rocky or sandy substrate).
- Like earthworms, they eat their ways through the soil ingesting soil particles containing partially decayed organic material as they go.

Fluid feeders:

- Animals such as aphids and mosquitoes pierce the body of a host plant or animal and obtain food from ingesting its fluids. They have mouth parts that are adapted to pierce or rip skin or leaf tissues. They suck or lick the nutrient rich fluids from plants or animal.

Bulk feeders:

This is the type of feeding where animals eat large pieces of food or swallow their food whole. They use their tentacles, claws, jaws, teeth ,to tear off the pieces of meat or vegetable from other animals or plants. Ex “ Humans”.

Stages of food processing:

- After an individual eats food, it need to be broken down and go to individual cell of the animal in a usable form.
- The digestive system breaks down the food into usable form and transports it to circulatory system in the **alimentary canal**. Circulatory system transport this digested food to different parts of the body.
- **Alimentary canal** is a long tube (length depends on size of an animal) which starts at mouth and ends in anus.

- The four processes that are involved in digestion of the food are: Ingestion , Digestion, Absorption and Elimination.

Ingestion:

- taking in food.

Digestion:

- The process of digestion involves break down of food by mechanical and chemical process, so that the body can absorb nutrient easily.

Mechanical digestion:

- In complex animals when the food moves down the alimentary canal the food is physically broken down into smaller pieces by the muscular contraction called peristaltic movement. This process of physical breaks down of food into smaller pieces so called mechanical digestion.

Chemical digestion:

- As the food passes through the alimentary canal various fluids and enzymes are released from different organs which helps break the bond between macromolecules, this process is called chemical digestion.

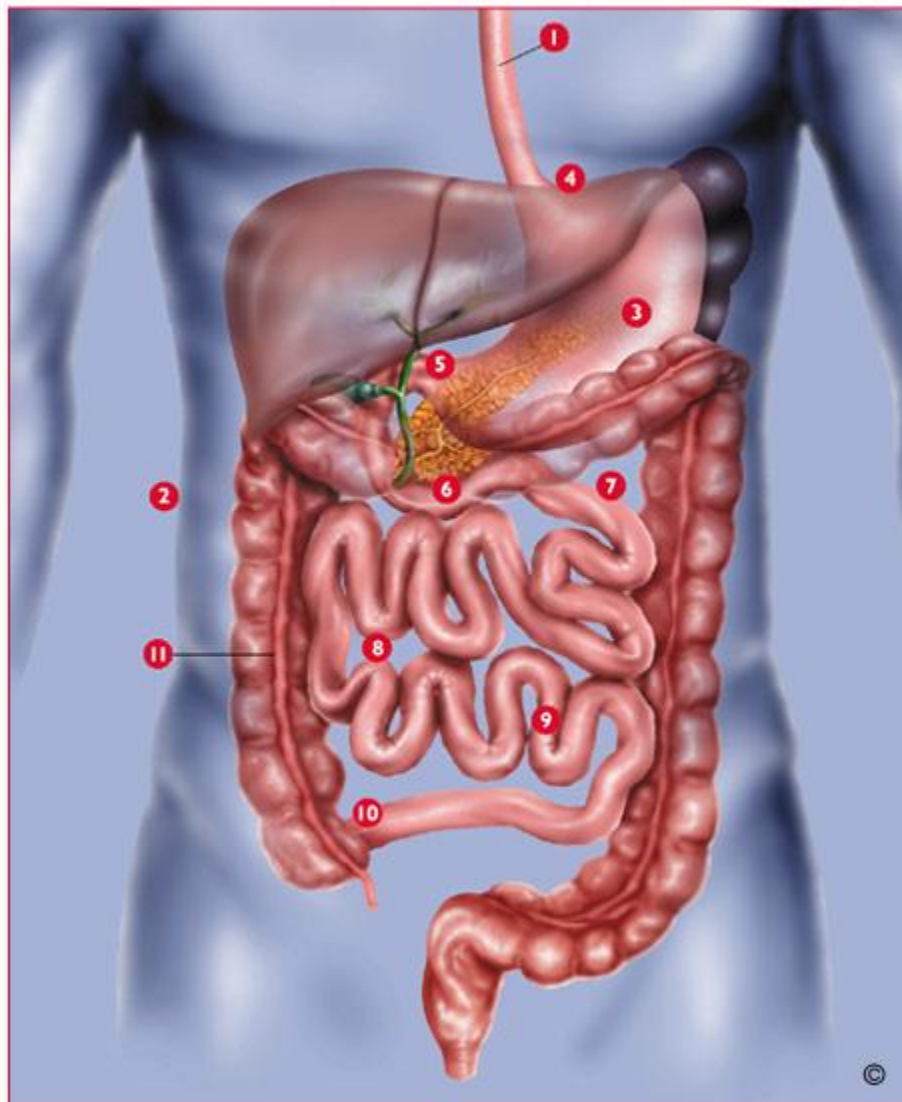
Absorption:

- The transport of the products of digestion from the digestive system into the circulatory system and distribution to all the body is called absorption.

Elimination:

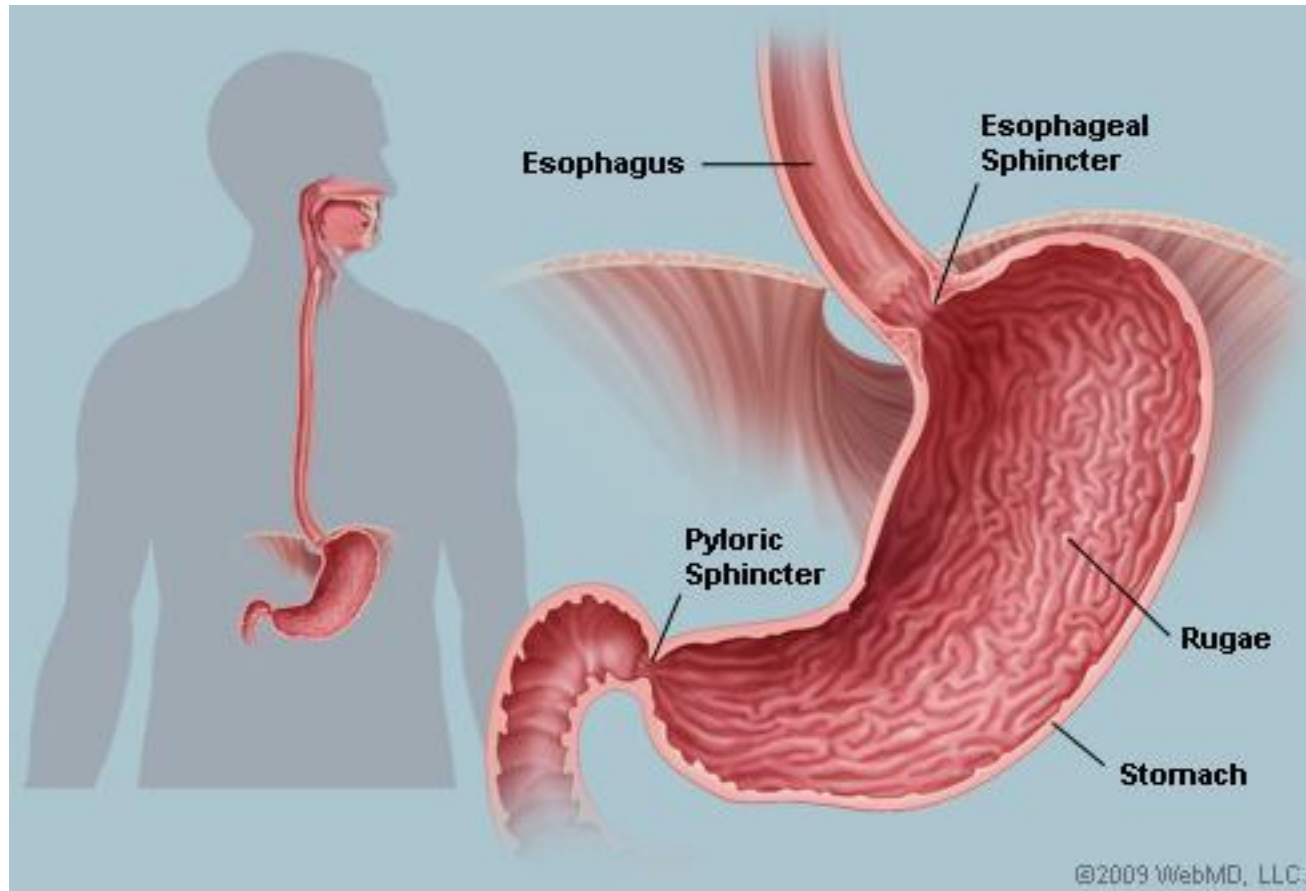
- The removal of waste products from the body is called elimination.

The Human Digestive System



Mouth and salivary gland

- Digestive tract starts with mouth.
- Mouth contains salivary glands which secrete saliva in the mouth.
- There are three pairs of salivary glands.
- Saliva contains an enzyme called amylase.
- Amylase starts the break down of starches into simple sugars.
- Saliva dissolves water soluble food particles stimulate taste buds, lubricates the food to swallow it easier, mechanical digestion is done in the mouth.
- There are teeth and saliva present in the mouth and they both help bring about both mechanical and chemical digestion.



Esophagus

- The esophagus is a long muscular tube, which moves food from the mouth and transport it to the stomach by using muscular movement called peristalsis.
- The food in the mouth is incompletely digested and converted into a soft mass called **bolus** that tongue pushed to the back of the mouth into oesophagus.
- The opening of esophagus lies close to trachea which is a part of breathing system. To prevent food from entering into trachea instead of oesophagus, trachea is covered by a valve like structure epiglottis.

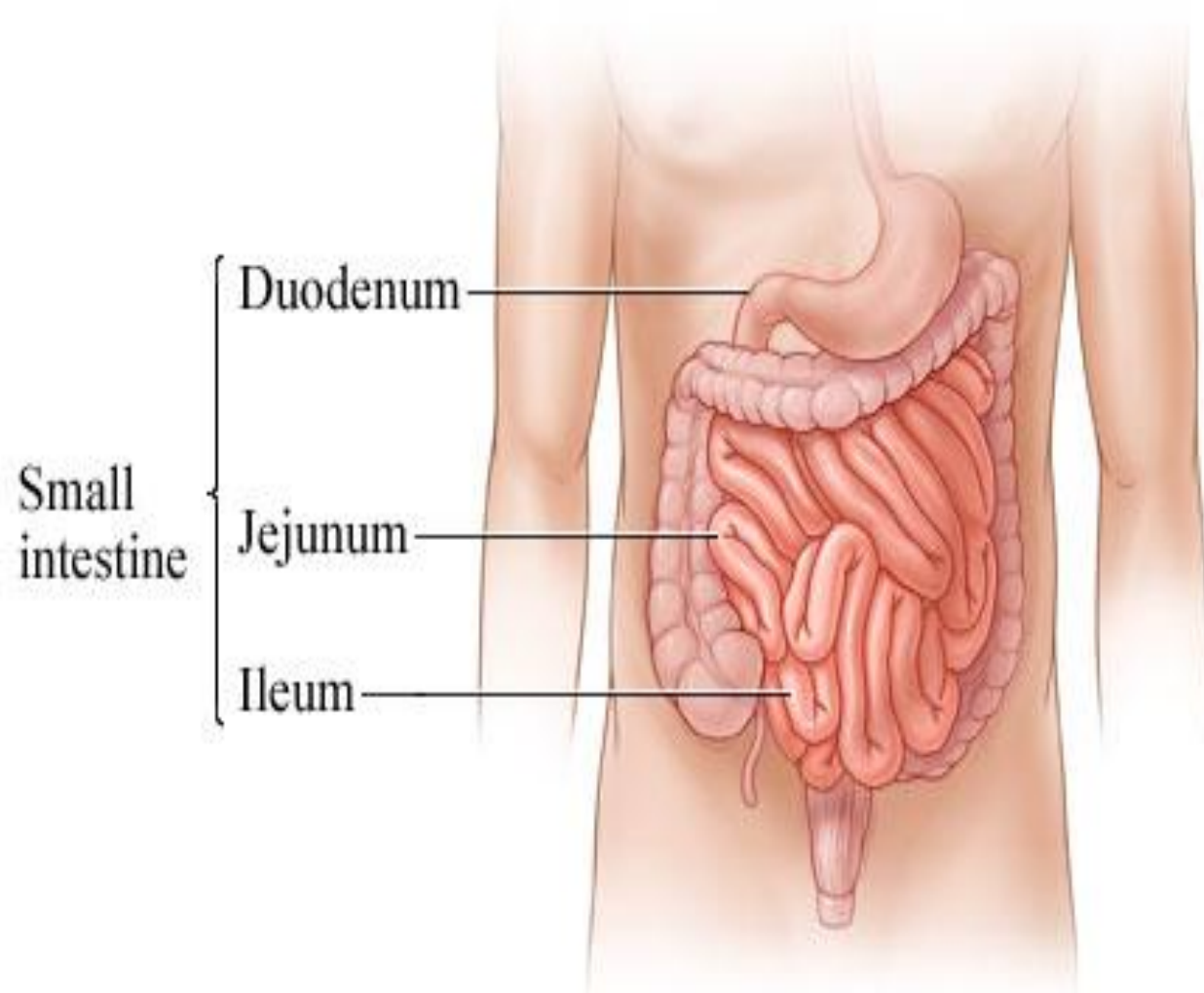
- Esophagus is lined by glands producing mucus which helps keep the passage soft for swallowing.
- The part of oesophagus that connects to stomach is controlled by a ring of muscles called **esophageal sphincter**. This sphincter is closed to keep the acidic contents of stomach to flow backward, however relaxes to let the bolus enter into the stomach.
- **Esophageal sphincter** s can be triggered to open, to back flow the food, from stomach during vomiting causing Acid reflex. Acid reflex is a process where if there is too much food and fluid in the stomach ,some of the fluid flow backward . This fluid also has acids that causes burning sensation.

- The stomach is a muscular j shaped organ situated at the left side of the abdomen, normally holds just over 3 pints (about 1500 ml) of food from a single meal.
- The lining of the stomach has lot of gastric glands secreting gastric juices which stimulated by the presence of food.
- Gastric juice consists of **hydrochloric acid, salt, enzymes water and mucus**. Mucus lines the walls of the stomach protect it from the acid. Acids and other digestive juices are added to the ingested food to facilitate breakdown of complex proteins, fats and carbohydrates into small, more absorbable units.
- Pepsin brings about hydrolysis of proteins and forms polypeptide.

WHY PEPSIN DOES NOT DIGEST STOMACH CELLS

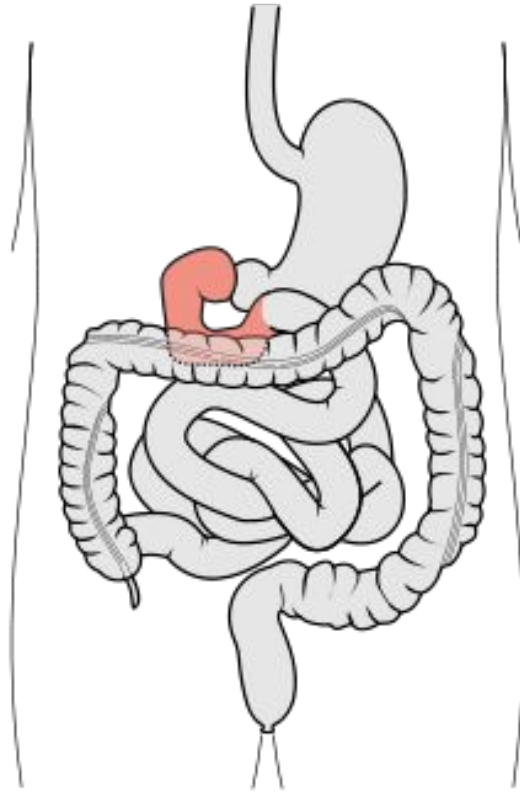
- Stomach does not digest proteins that makes up its own cells, BECAUSE it produces protein digesting enzyme in inactive form called pepsinogen.
- Pepsinogen becomes active ONLY when it combines with HCL, and act upon protein that is ingested.
- Gastric juices or enzymes are released only when needed. They are not stored.
- Mucus also helps protect the stomach

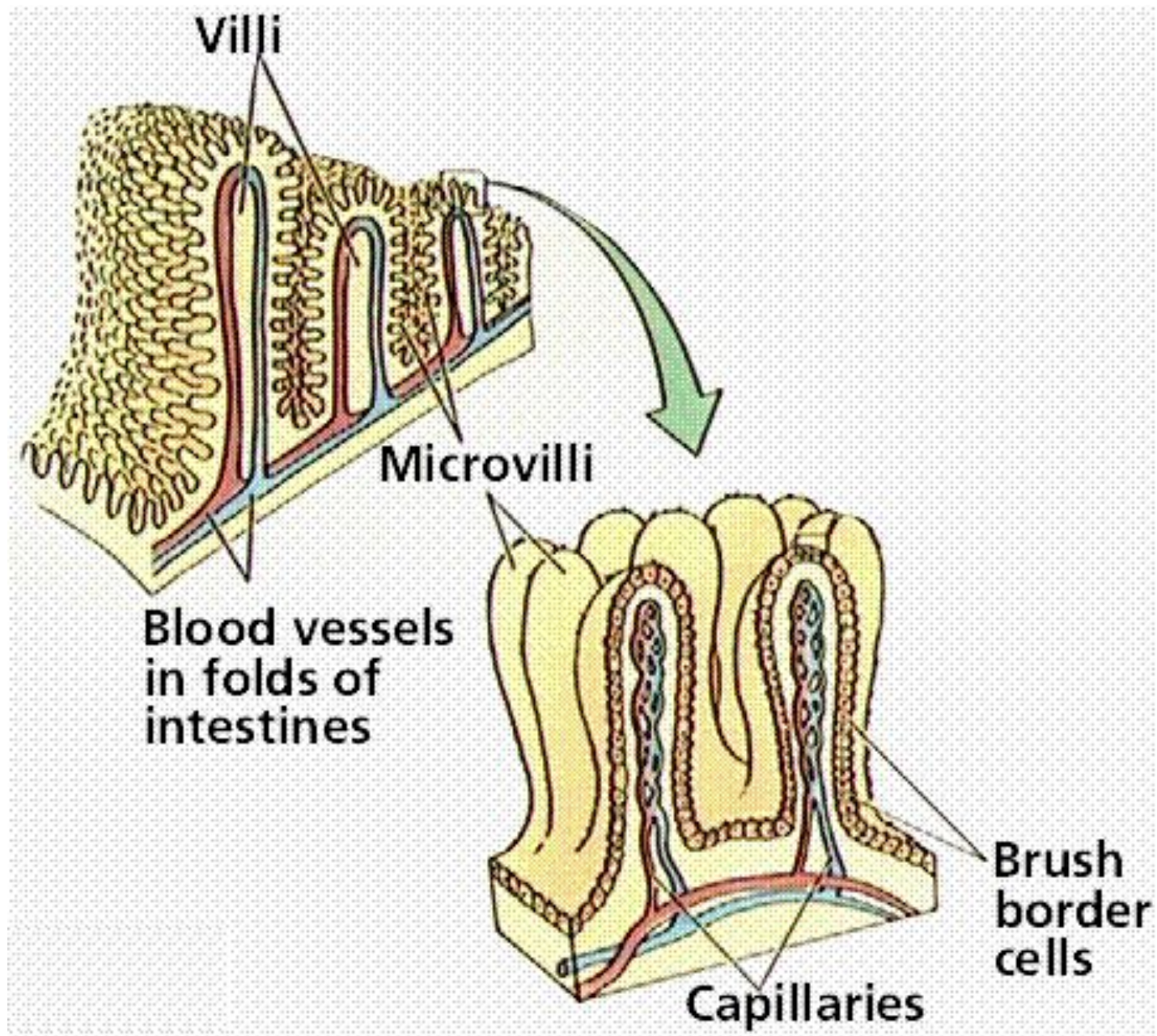
- The partially digested food in the stomach is called chyme. **Chyme** is **highly acidic with a PH of 1**. Chyme is temporarily stored in stomach, it is moved to small intestine once contents of the small intestines have been moved to large intestine.
- When stomach senses that small intestine is empty its pyloric sphincter open to let the chyme move into the first part of small intestine called “the duodenum”.
- The pylorus (pyloric sphincter) is a small round muscle located at the outlet of the stomach and the entrance to the duodenum (the first section of the small intestine).
- It closes the stomach outlet while food is being digested into smaller particles , more easily absorbed form. When food is properly digested, the pylorus opens and allows the contents of the stomach into the duodenum.



Small Intestine

- The small intestine is about 15 to 20 feet long (4.5 to 6 meters) and is where the majority of the absorption of the nutrients from food takes place.
- The small intestine is made up of three sections: **The duodenum, The jejunum and The ileum.**
- The **duodenum** is U shaped the **first section** of the small intestine and is where the food is **mixed with bile** produced by the liver and with **other juices** from the **pancreas.** To increase the reaction area it is provided with lot of **villi and micro villi this is where much of the iron and calcium is absorbed.**





- The **jejunum** is the **middle** part of the small intestine extending from the duodenum to the ileum; It is 2.5 m long and contain more folds than duodenum. These parts **break remaking protein and carbohydrates.**
- The **last** segment of the intestine, the **ileum**, is about 3m long containing fewer and smaller villi. It's the place almost all **the nutritional absorption of fat-soluble vitamins A, D, E and K and other nutrients are absorbed.** Ileum is also responsible for pushing undigested food

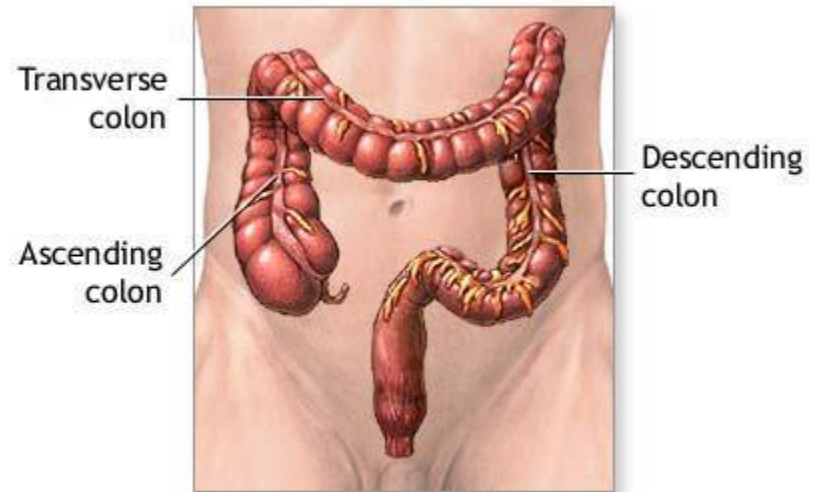
Absorption In small intestine.

- **Monosaccharide** : are absorbed into the blood stream through the lining of the small intestine, transported to liver—in liver its converted to glucose—glucose is carried from liver to all parts of the body through circulatory system and is used by every cell. Excess glucose can be converted to glycogen nod stored as glycogen
- **Proteins**: Amino acids are taken by blood stream from blood to liver directly. Here it may be converted to sugar or become urea. Other amino acids may help to form different enzymes at different location in the body.
- **Fats**: Glycerol and fatty acid gets reassembled to form triglycerides in the small intestine. The triglycerides gets coated by protein to become water soluble and then move to blood stream. The protein coat is removed in the blood and is broken down by lipase enzyme back or glycerol and fatty acid.

Large Intestine

- In the large intestines, excess fluids are absorbed and a firm stool is formed. The colon may absorb protein, when necessary.
- Large intestine contains lot of anaerobic bacteria. Some of these bacteria help produce important vitamins, folic acid, B12 and vitamin k
- Also gives brown coloration to feces by breaking down bilirubin. Bilirubin is the by-product of the break down of haemoglobin.

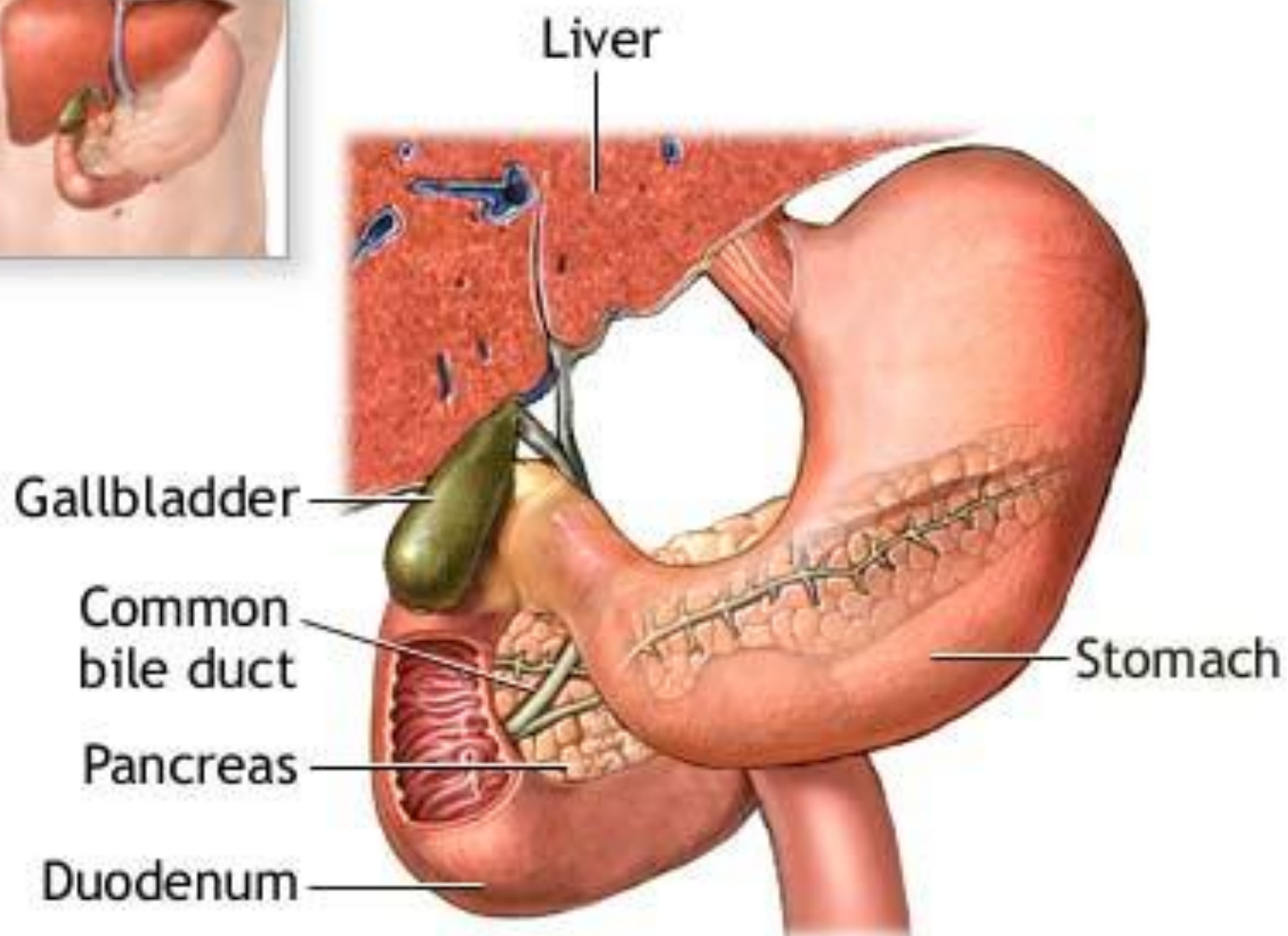
- 1.5 metres long, 5 cm in diameter
- absorbs water
- helpful bacteria produces vitamins K and B



Glands associated with digestive system.

Pancreas and gall Bladder

- These two glands are not part of the alimentary gland but they are connected to alimentary canal by ducts., because of this association they are called as accessory gland, which means that they help in the process of digestion by releasing their enzymes in the form of fluid.
- Pancreas secretes pancreatic juice, which help in final digestion of carbohydrates, protein and fats.
- Pancreatic juice cannot function in acidic condition therefore the atmosphere needs to be changed to basic before pancreatic juice starts working.
- The pancreatic fluid contains bicarbonate, which changes the PH of chyme (strongly acidic) to weakly basic (PH 8).



liver

- Liver is largest internal organ of the human body. Its weight is about 1.5 kg's.
- It releases bile, a greenish Yellow fluid that is made up of bile pigment and bile salts.
- Bile salts help in digestion process, not the bile pigment.
- Bile pigment is the waste product that is formed because of the destruction of old red blood cells, they are eliminated out with feces. (recall bilirubin in large intestine).
- Bile produced by the liver is sent to gall bladder, which stores bile between meals and helps to breakdown fats.
- Fat being insoluble in water remains as fat droplets dispersed all over in the chyme . Bile helps to break down these droplets into further smaller droplets , so that it can be easily acted upon by enzymes and gets easily absorbed by the intestinal cells.
- Smaller fat droplets provide more surface area to be exposed to digestive enzymes.

Chemical digestion and absorption

- The bile and pancreatic juice in the duodenum help break down carbohydrates, protein and fats into smaller molecules that can be absorbed into cells that line the small intestine.
- Carbohydrases digest carbohydrates
- Proteases digest proteins
- Lipases digest fats
- Nucleases digest nucleic acids.
- Refer to figure 10.12 on page: 416