

# 3.3.3 Digestion and absorption

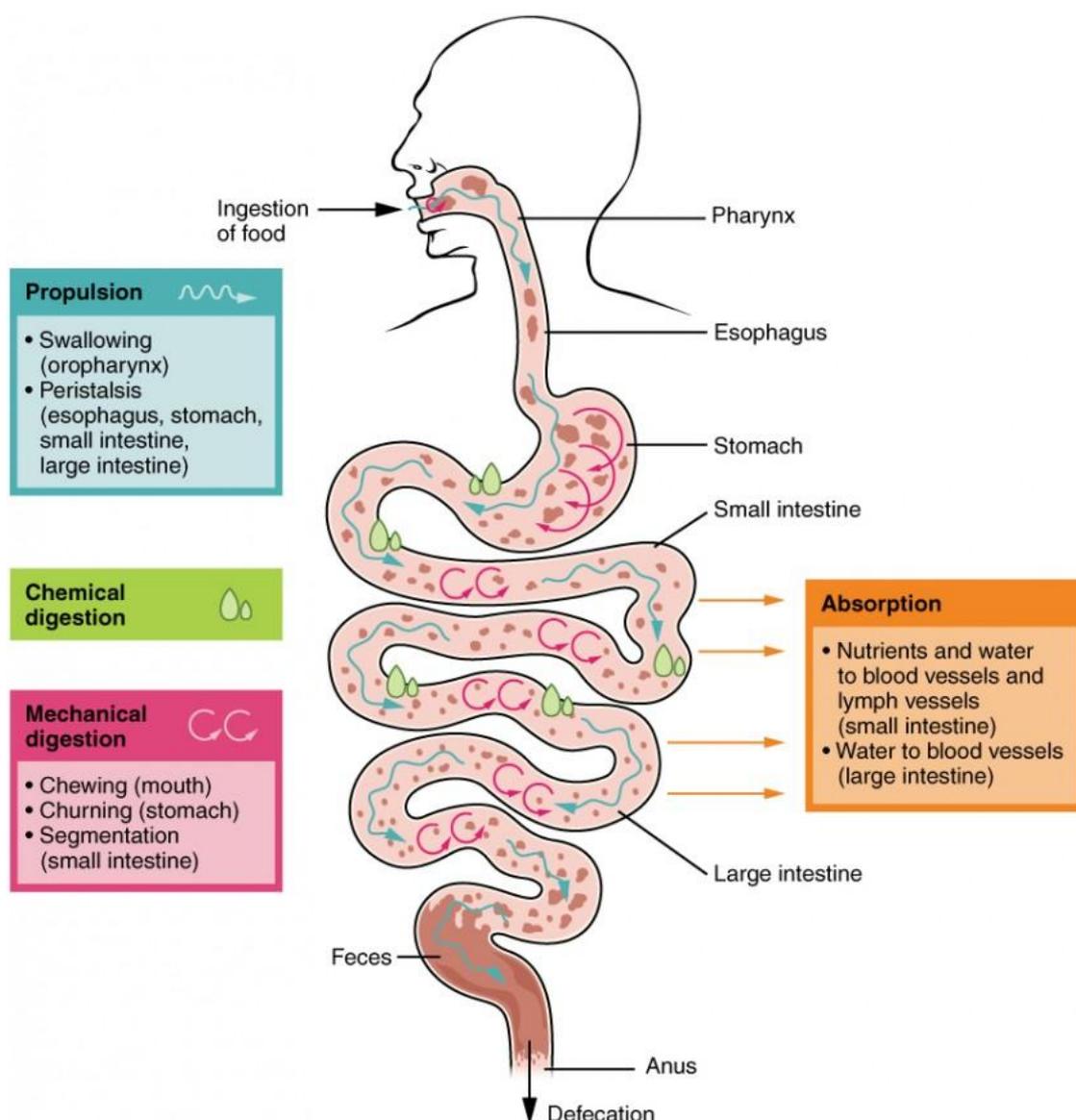
## SPECIFICATION

- ▶ During digestion, large biological molecules are hydrolysed to smaller molecules that can be absorbed across cell membranes.
- ▶ Digestion in mammals of:
  - ▷ carbohydrates by amylases and membrane-bound disaccharidases
  - ▷ lipids by lipase, including the action of bile salts
  - ▷ proteins by endopeptidases, exopeptidases and membrane-bound dipeptidases.
- ▶ Mechanisms for the absorption of the products of digestion by cells lining the ileum of mammals, to include:
  - ▷ co-transport mechanisms for the absorption of amino acids and of monosaccharides.
  - ▷ the role of micelles in the absorption of lipids.

Source: [AQA Spec](#)

## Digestive process

The need for energy to operate the body is met by the food intake and the process of converting the large insoluble food particles into small molecules capable of producing the required energy, is called digestion. A typical process of digestion consists of two basic parts – one being the mechanical digestion where large chunks of food get broken down to smaller ones, while the second part is the chemical digestion which involves the action of enzymes to break those smaller particles up to the molecular level. Although the basic process of breaking down the food into energy is referred to as digestion, the complete process however includes ingestion (intake of food), propulsion, mechanical and chemical digestion, absorption and egestion.



The complete process of digestion and absorption

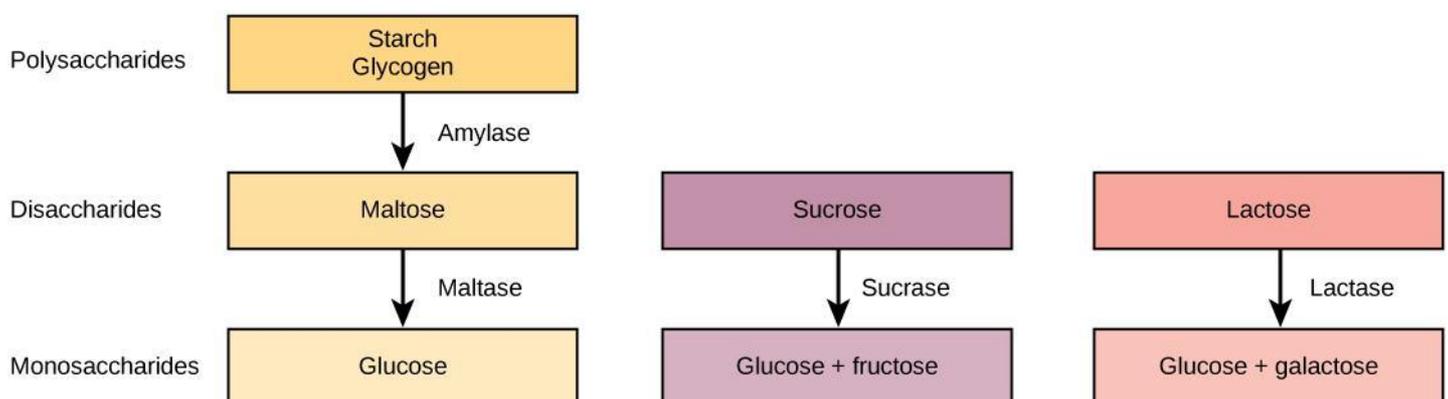
Image Source: OpenStax CNX

### Working of the digestive process – points to remember

1. Digestion is the process by which complex food materials are broken down into smaller water soluble molecules.
2. These water soluble substances can be absorbed by the cells
3. The food to be broken may include large molecules or **macromolecules** like carbohydrates, lipids, proteins and small molecules or **micromolecules** like minerals and vitamins and **water**
4. The macromolecules or large molecules are broken down or hydrolysed by the enzyme called **hydrolases**
5. Hydrolases are enzymes which help in splitting up of a molecule by adding water and the process is **hydrolysis**
6. Examples of Hydrolases: digestive enzymes like amylase, lipase, protease etc.

### Digestion of carbohydrates

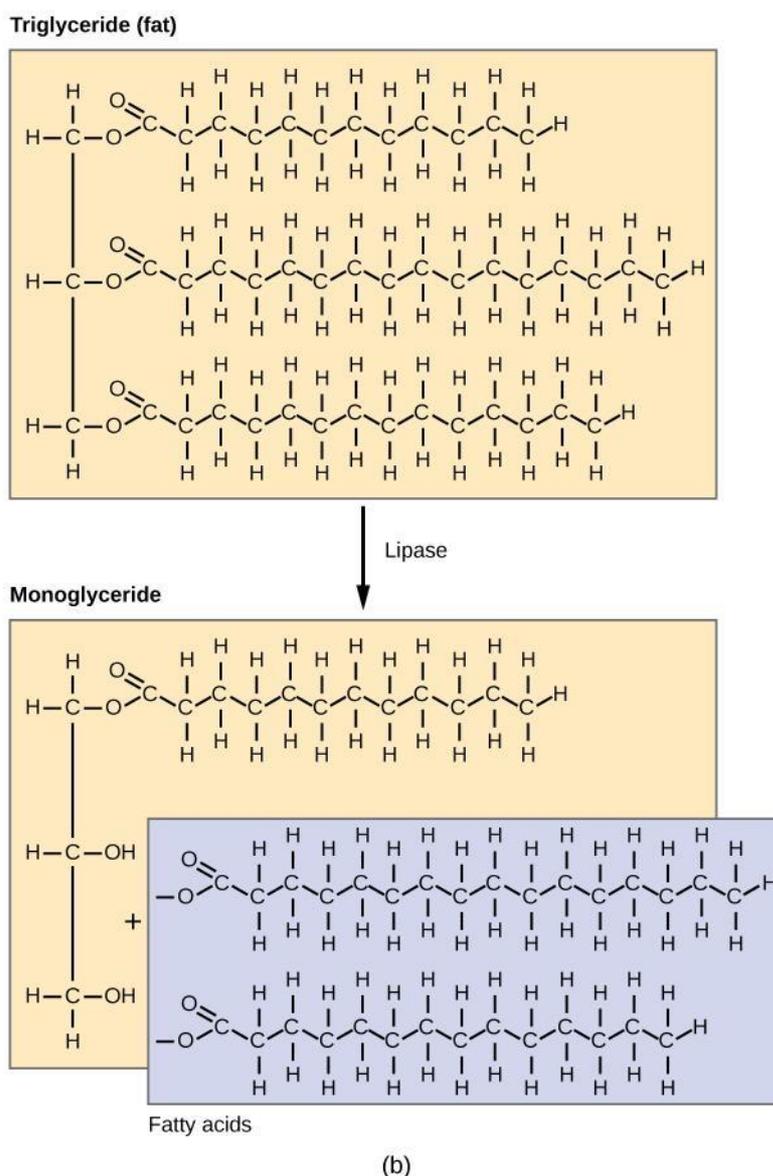
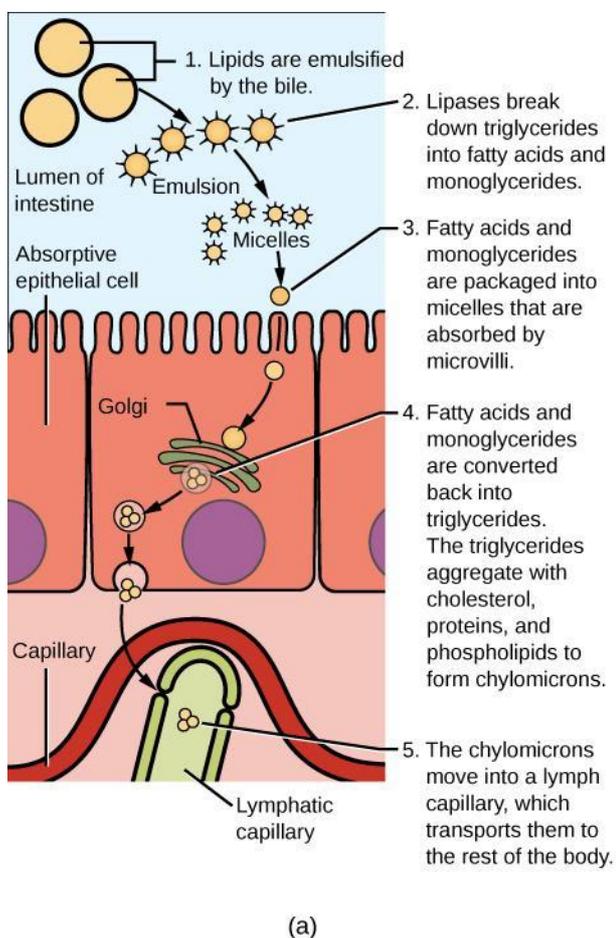
- Digestion of carbohydrates in mammals takes place in mouth as well as small intestine.
- Digestion of carbohydrates especially starch takes place in mouth under the action of ptyalin or salivary amylase. Salivary amylase functions at an alkaline pH of 7.5 to 8.
- Its action continues up to oesophagus but stops at stomach due to acidic pH. So, carbohydrate digestion resumes at small intestine again, where pH is again alkaline.
- Digestion of carbohydrates in jejunum and ileum of small intestine takes place with the help of pancreatic juice and intestinal juice.



Digestion of carbohydrates  
Image Source: OpenStax CNX

### Digestion of fats and lipids

- ▶ Digestion of fats and lipids takes place in duodenum of small intestine.
- ▶ Fats do not dissolve in water but lipases are present in aqueous medium.
- ▶ Fats are broken down into small droplets to increase the surface area.
- ▶ Lipases are present in pancreatic juice and intestinal juice. But apart from that bile also plays important role in digestion of fats and lipids.
- ▶ Bile juice also makes the medium alkaline which is essential for lipase activity. Bile juice also kills bacteria.
- ▶ Emulsification of fats: breaking down of fats into small droplets in presence of bile salts.



## Digestion of proteins

- ▶ Digestion of proteins takes place in stomach and duodenum of small intestine.
- ▶ When food enters into stomach it has alkaline pH which becomes acidic as it mixes with gastric juice (HCL, enzymes and mucus).
- ▶ HCl maintains acidic pH of 1-2, which is optimum for pepsin action.
- ▶ It kills bacteris and other germs too due to acidic nature.

## Digestion in stomach:

- ▶ Pepsinogen (Inactive) + HCl  $\rightarrow$  Pepsin (Active) + Inactive peptide
- ▶ Proteins + Pepsin  $\rightarrow$  Proteose + Peptones
- ▶ Milk Casein (Soluble form) + Pepsin  $\rightarrow$  Paracasein + Whey Protein
- ▶ Paracasein +  $\text{Ca}^{2+}$   $\rightarrow$  Calcium paracaseinate (curdling of milk)
- ▶ Calcium paracaseinate + Pepsin  $\rightarrow$  Proteose +Peptones
- ▶ Human adults lack one enzyme called rennin. It is present in small children and calf.
- ▶ Prorennin + HCl  $\rightarrow$  Rennin
- ▶ Milk Casein (Soluble form) + Rennin  $\rightarrow$  Paracasein (curdling of milk).

## Digestion in small intestine:

- ▶ Endopeptidases break the peptide bond in the middle of the peptide chain.
- ▶ Exopeptidases acts at the end of the peptide chain and helps in releasing the last amino acid.
- ▶ Pancreatic juice contains trypsinogen, chymotrypsinogen and carboxypeptidases.

## Action of Endopeptidases:

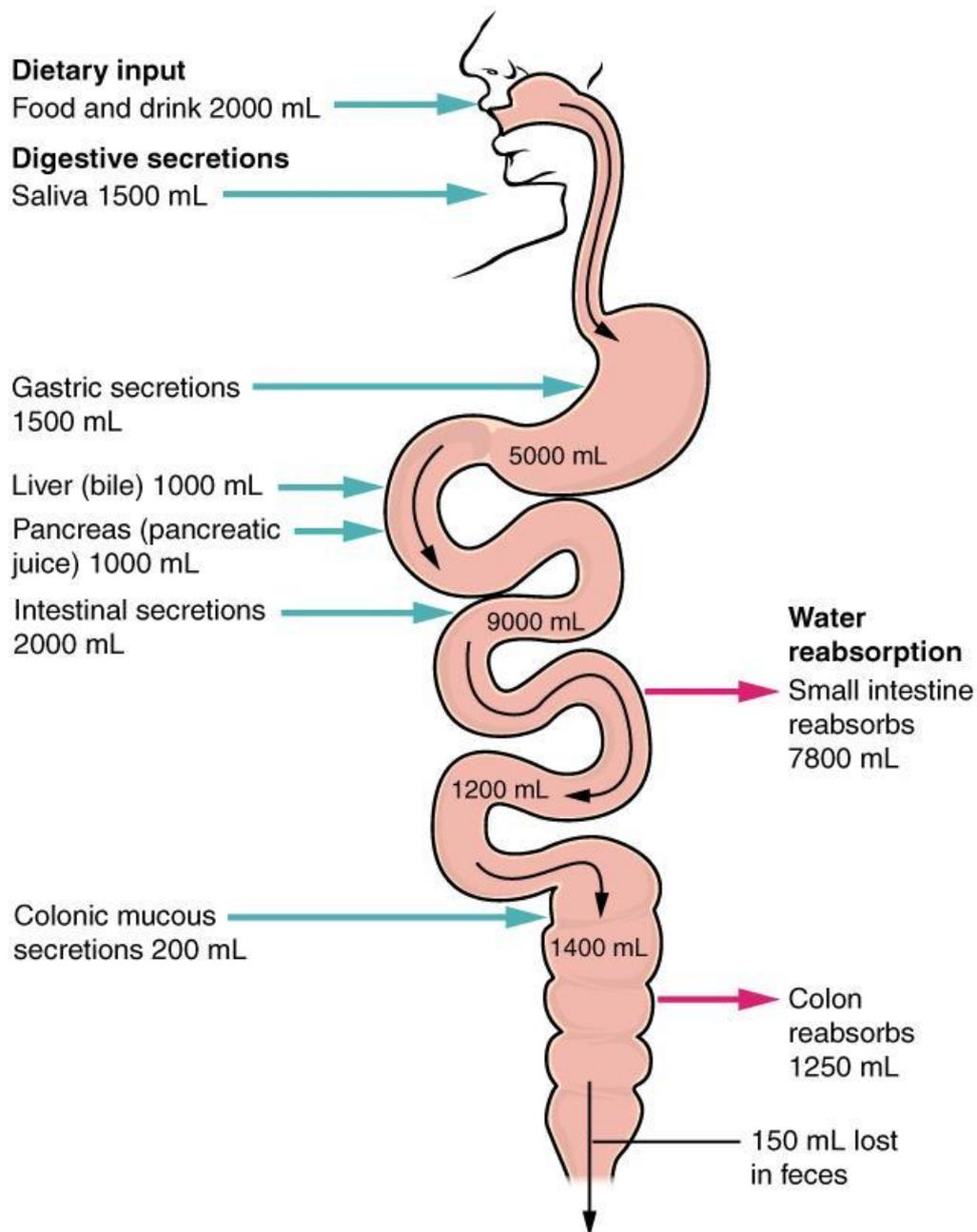
- ▶ Trypsinogen + Enteropeptidase  $\rightarrow$  Trypsin + inactive peptide
- ▶ Proteins + Trypsin  $\rightarrow$  Peptides
- ▶ Chymotrypsinogen (Inactive) + Trypsin Chymotrypsin(Active)
- ▶ Proteins + Chymotrypsin  $\rightarrow$  Peptides

## Action of Exopeptidases:

- ▶ Peptides + Carboxypeptidases  $\rightarrow$  smaller peptide chain + amino acid

## Mechanisms for the absorption of the products of digestion

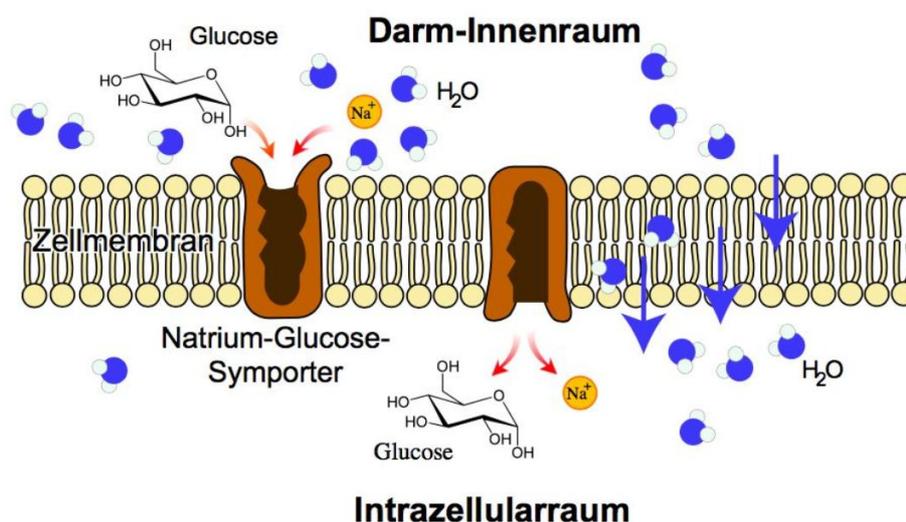
- ▶ Active transport.
- ▶ Passive diffusion.
- ▶ Facilitated diffusion.
- ▶ Co-transport (secondary active transport).
- ▶ Endocytosis.



Mechanism of absorption  
Image Source: OpenStax CNX

## Carbohydrate Absorption

- ▶ Absorption as monosaccharides.
- ▶ Transport of monosaccharides glucose and galactose is facilitated by symporters, which can transfer two substances in the same direction. An example of a symporter is the sodium-glucose symporter. This process is called Co-transport (secondary active transport). This is followed by facilitated diffusion
- ▶ Monosaccharide fructose is absorbed as well as transported through facilitated diffusion.



Co-transport of monosaccharides  
Image Source: OpenStax CNX

## Protein Absorption

- ▶ Active transport in small intestine mostly takes place at duodenum and jejunum absorbing about 98% of amino acids.
- ▶ Co-transport of di and tripeptides is also possible with  $H^+$  ions via the PepT1 transporter.

## Absorption of Fats And Lipids

- ▶ Fatty acids are absorbed by lacteals and not by blood capillaries.
- ▶ Fatty acids are not directly absorbed.
- ▶ They are first made into small spherical water soluble droplets called micells.
- ▶ This is done with the help of bile salts.
- ▶ Fatty acids, fat soluble vitamins and sterols are absorbed by intestinal cells from the micells.