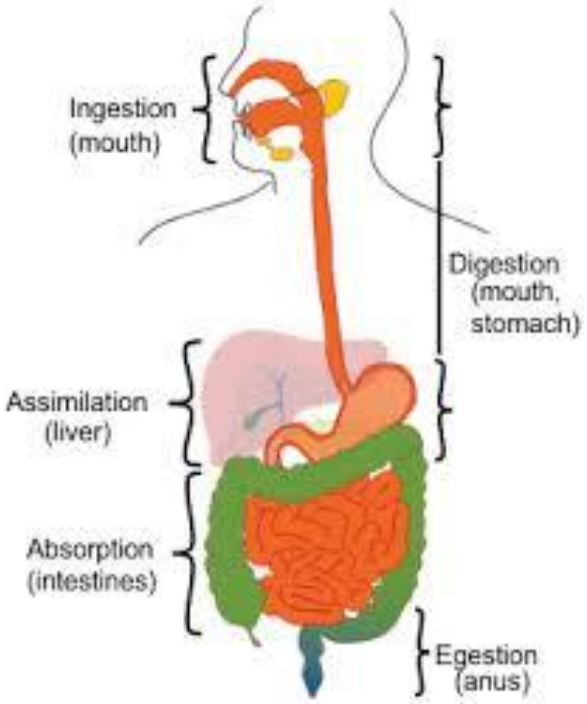
LO: Describe the functions of main regions of the alimentary canal and the associated organs: mouth, salivary glands, oesophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum, anus, in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate



- **Ingestion**: food taken into the body
- **Digestion**: large, insoluble molecules are broken down to small, soluble molecules for absorption into body cells
    - Physical process which involves mechanical break up of food into smaller pieces through chewing
    - Chemical process which involves the breaking of bonds in molecules which involves enzymes
- **Absorption:** Products of digestion such as glucose and amino acids will be taken into the bloodstream through the wall of ileum of the small intestine by processes active transport and diffusion
- **Assimilation**: Uptake of absorbed food substances into cells and tissues to be converted into new protoplasm or used to release energy (liver)
- **Egestion**: removal of undigested material

Mouth (Ingestion, digestion)

- Chewing action of teeth breaks up food into small particles to increase surface area to volume ratio (Physical digestion)
- Tongue mixes food with saliva
- Salivary glands secrete saliva to soften the food

- Saliva contains salivary amylase to digest starch to maltose. (Chemical digestion)
- Optimal pH of salivary amylase is pH 7.

Oesophagus (some digestion in the bolus)

- Long narrow muscular tube, made up of longitudinal and circular muscles
- Circular muscles constricts the lumen while the longitudinal muscles shortens the oesophagus
- Both sets of muscles work antagonistically (contract and relax alternately) to produce slow wave-like contractions that push the food down the oesophagus and the process is known as peristalsis.
- Starch digestion by salivary amylase in the bolus of food continues here and no enzymes are secreted here.

Stomach (Digestion)

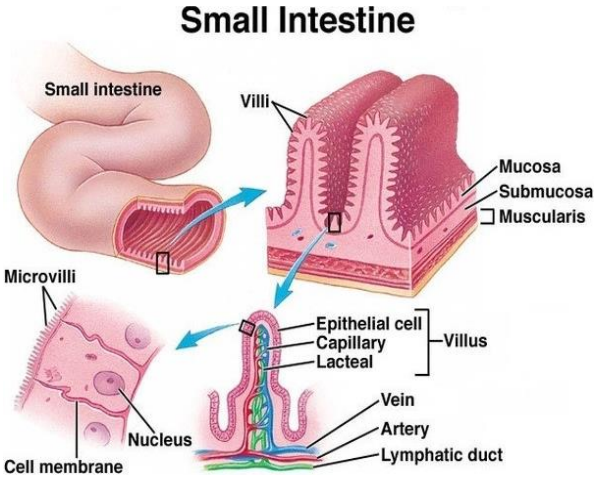
- Thick, muscular bag
- Peristalsis in the stomach churns, breaks up and mixes the food well with gastric juice
- Stomach wall secretes gastric juice (Dilute hydrochloric acid, pepsinogen, prorennin)
- Pepsin digest proteins into polypeptides
- Optimum pH of pepsin is pH 2
- Hydrochloric acid
    - Denatures salivary amylase
    - Activates pepsinogen into pepsin, prorennin into rennin (to curdle milk for digestion)
    - Provide acidic medium for optimal action of gastric enzymes
    - Kills harmful microorganisms such as bacteria
- Storage of food, where the partly digested food particles becomes liquefied chyme.

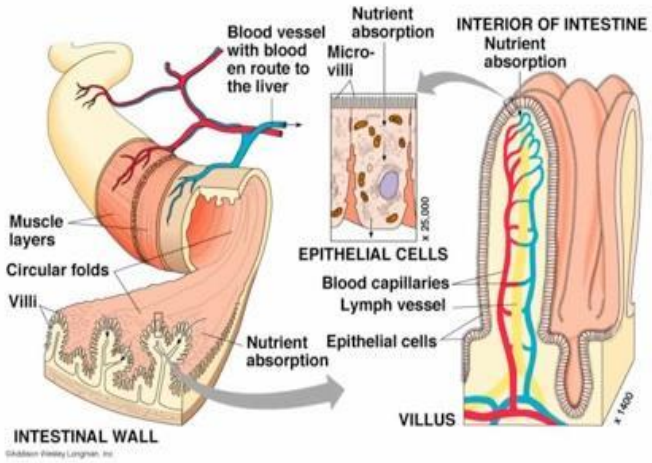
Duodenum (first part of small intestine) (Digestion)

- Peristalsis to churn, break up and mix the food well with digestive juices
- Receives bile (produced by liver, stored in gall bladder) via bile duct
    - Bile has no enzymes, so it cannot digest food.
    - Bile salt speeds up fat digestion by lipase by emulsification of fats into small fat globules, which increase surface area for lipase to act on.
- Secretes intestinal juice (**S**ucrase, **M**altase, **L**actase, **E**nterokinase, **E**repsin, **L**ipase)
- Receives pancreatic juice (amylase, lipase, trypsinogen) from pancreas via pancreatic duct.
- Complete digestion of carbohydrates, proteins and fats takes place

Ileum (last part of small intestine) (Absorption)

- Mainly for absorption
- Walls have numerous folds to provide a larger surface area for faster absorption of digested food substances.
- Villi walls are one-cell thick epithelial cells to decrease distance to allow for faster absorption of digested food substances.
- Epithelial cells have microvilli to increase surface area to volume ratio for faster absorption of digested food substances.
- Each villus is richly supplied with blood capillaries and lymphatic capillaries/lacteals to carry away quickly the absorbed food substances to maintain a steep concentration gradient.
    - Lacteals absorb and transport fats.
    - Blood capillaries absorb and transport glucose and amino acids away from the small intestine.
- Small intestine is long to provide sufficient time for more absorption of digested food substances.





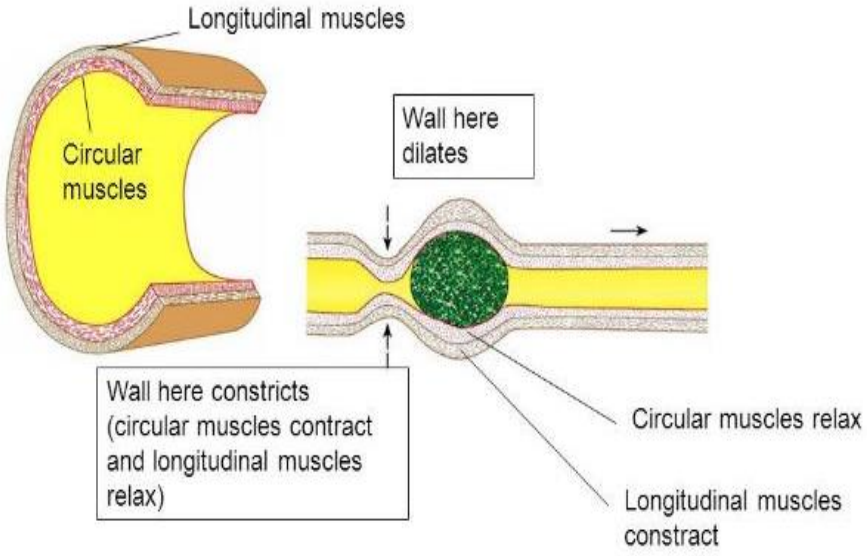
Colon (Large intestine)

- No digestion takes place
- Absorbs water, vitamins and dissolved mineral salts from the undigested food and the remaining undigested matter is known as faeces.

Rectum

- Rectum stores faeces temporarily
- Rectum muscles would contract to expel faeces through the anus - process is known as egestion.

LO: Describe peristalsis in terms of rhythmic wave-like contractions of the muscles to mix and propel the contents of the alimentary canal

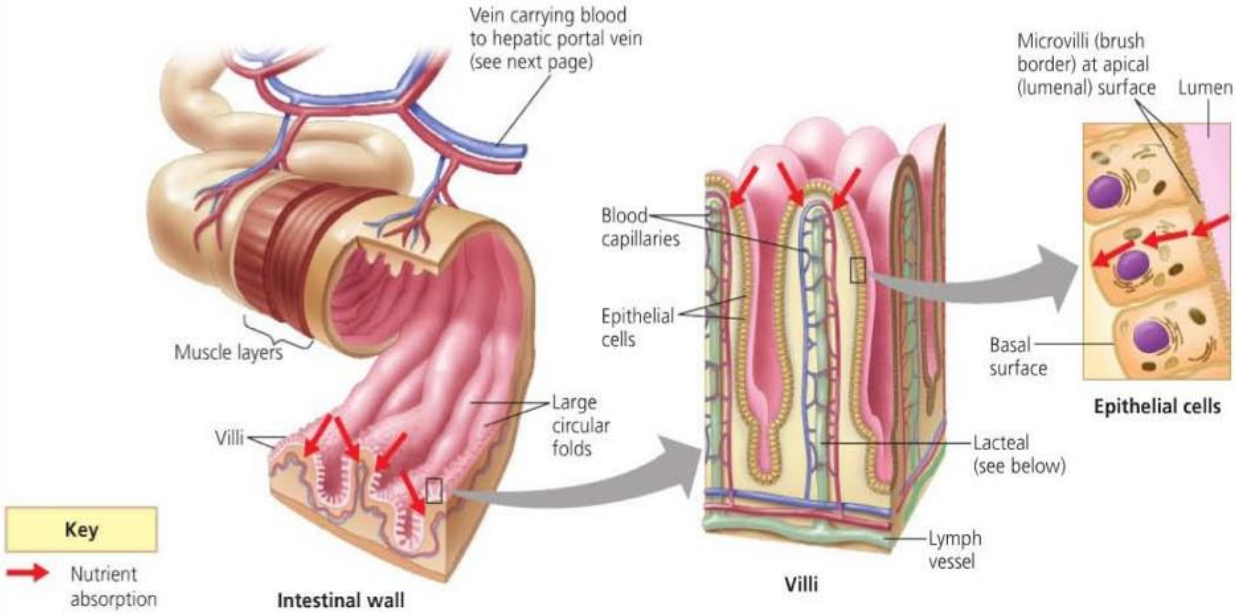


- **Peristalsis** is the rhythmic wave-like contractions of muscles.
- Circular and longitudinal muscles work antagonistically (one contracts and the other relaxes)
- Eg; Circular muscles contract, longitudinal muscles relax, wall of oesophagus constricts, becomes narrower and longer and push the food forward.

LO: Describe the functions of enzymes (e.g. amylase, maltase, protease, lipase) in digestion, listing the substrates and end-products

Organ	Substrate	Enzyme	Products
mouth	starch	salivary amylase	maltose
stomach	proteins	pepsin	polypeptides
* cow's stomach	soluble caseinogen	rennin	insoluble casein (milk protein)
duodenum	starch	pancreatic amylase (from pancreatic juice)	maltose
	fats	pancreatic lipase (from pancreatic juice)	fatty acids + glycerol
	proteins	trypsin (from pancreatic juice)	polypeptides
	Trypsinogen (inactive)	enterokinase (from intestinal juice)	trypsin (active)
	polypeptides	erepsin (peptidase) (from intestinal juice)	amino acids
	fats	intestinal lipase (from intestinal juice)	fatty acids +glycerol
	lactose	lactase (from intestinal juice)	galactose + glucose
	maltose	maltase (from intestinal juice)	glucose + glucose
	sucrose	sucrose (from intestinal juice)	fructose + glucose

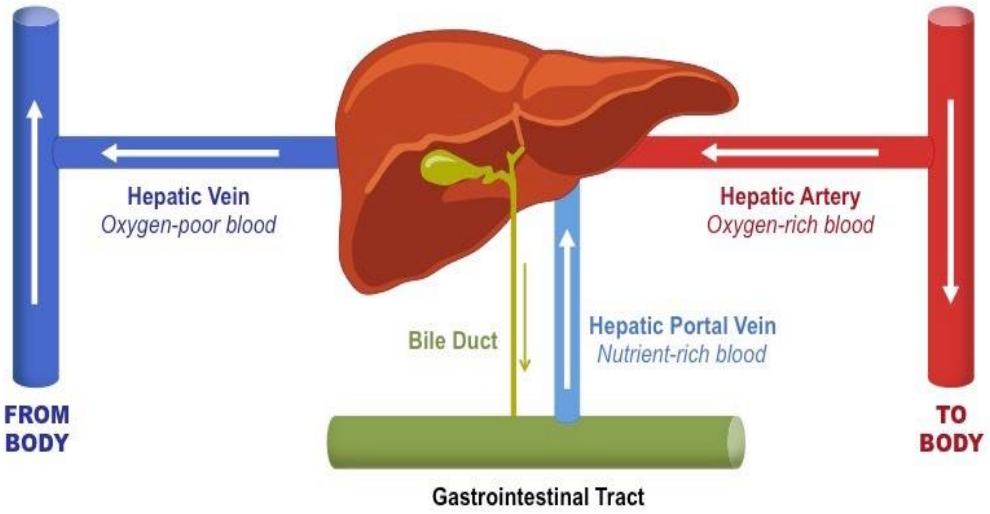
LO: Describe the structure of a villus and its role, including the role of capillaries and lacteals in absorption



- Each villus has <u>numerous microvilli</u> to <u>increase surface area to volume ratio</u> for <u>faster absorption of digested food</u>.
- <u>Villus wall is one-cell thick epithelium/ epithelial cells</u> to <u>decrease distance</u> for <u>faster absorption of digested</u> food <u>into the blood capillaries and lacteals by diffusion and active transport</u>.
- Each villus is surrounded by <u>large network of blood capillaries/ continuous blood flow</u> so that digested food substances can be transported away <u>faster</u> to <u>maintain a steep diffusion gradient.</u>
- Blood capillaries <u>absorb and transport glucose and amino acids</u> from small intestine to liver.
- <u>Lacteal/ lymphatic capillary</u> <u>absorbs</u> and <u>transports fats.</u>

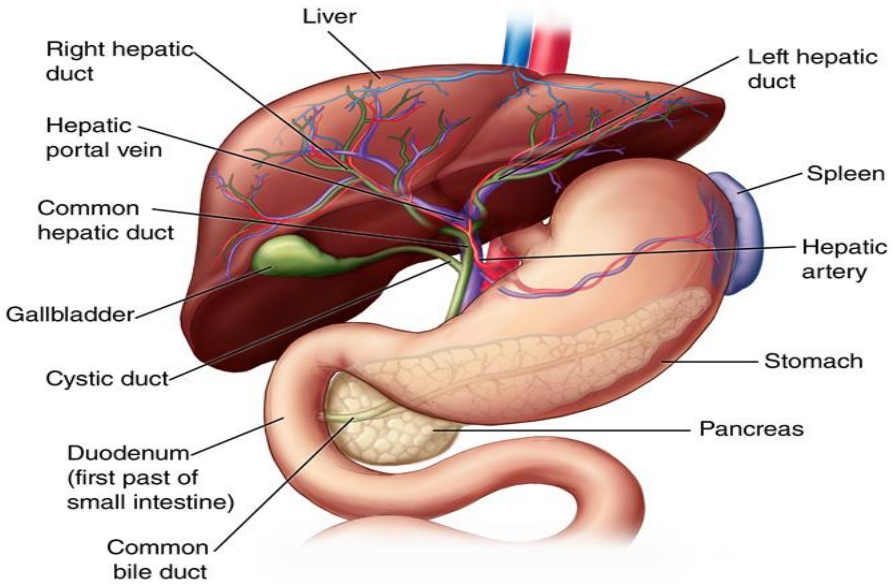
LO: State the function of the hepatic portal vein as the transport of blood rich in absorbed nutrients from the small intestine to the liver

Hepatic portal vein carries blood rich in absorbed nutrients (glucose and amino acids) from the small intestine to the liver.

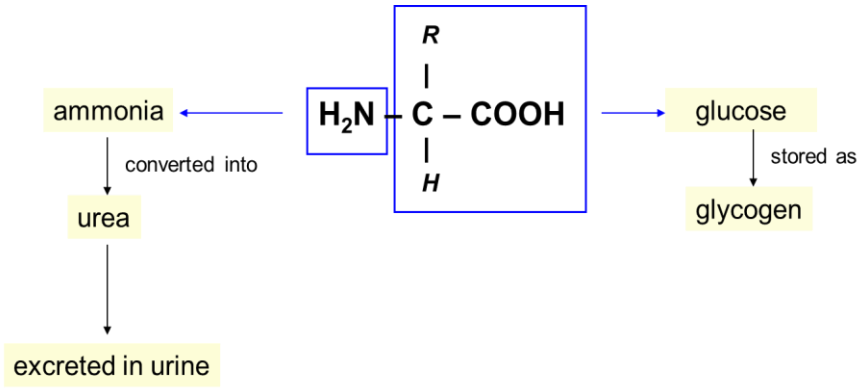


LO: State the role of the liver in

- ***carbohydrate metabolism***
- ***fat digestion***
- ***breakdown of red blood cells***
- ***metabolism of amino acids and the formation of urea***
- ***breakdown of alcohol***



- **Carbohydrate metabolism**
  - Regulation of blood glucose levels by converting excess glucose into glycogen for storage in the liver or muscles, with the aid of insulin.
  - Regulation of blood glucose levels by converting stored glycogen into glucose, with the aid of glucagon
- **Fat digestion**
  - Produces bile, which emulsify fats into smaller fat droplets, which increases surface area for faster digestion of fats by lipase into fatty acids and glycerol.
- **Breakdown of red blood cells** to form bile pigments from haemoglobin and iron released is stored.
- **Metabolism of amino acids & formation of urea**: Deamination of excess amino acids to form urea. Carbon residue is converted to glucose and excess glucose is converted to glycogen and stored in the liver. Synthesis of proteins (prothrombin, fibrinogen)



- **Breakdown of alcohol** by alcohol dehydrogenase into acetaldehyde (Excessive alcohol consumption will lead to liver cirrhosis)
- Detoxification by converting harmful substances to into harmless substances

LO: Describe the effects of excessive consumption of alcohol: reduced self-control, depressant, effect on reaction times, damage to liver and social implications

Short-term effects:
- Slows down brain functions, increases reaction time
- Reduced self-control
- Symptoms of drunkenness

Long-term effects:
- Causes liver cirrhosis
- Addiction
- Increases the risk of gastric ulcers