Nutrition in Man

Definitions:

Starvation: when the cells do not receive enough energy and begin to die

Other nutrients:

Calcium: bones degenerate without them

Why does food need to be broken down?

Because it needs to be small enough to pass through the partially permeable membrane of the small intestine and enter the bloodstream.

Large Intestine:

Role of Large Intestine: To absorb water, mineral salts and electrolytes from indigestible food matter.

Shades of stool: brown (healthy) green (green food colouring, or food is not digested enough), yellow (excess fat or malabsorption disorder like celiac disease), black (internal bleeding or vitamins), white (bile duct obstruction) Blood-stained/red (cancer).

Stool can be a reflection of the digestive system's health.

Anus:

It carries out egestion, which is defined as the removal of undigested matter from the body.

Colon:

a. located in the large intestine
b. absorbs remaining water and dissolved mineral salts to e absorbed at the large intestine

Small intestine:

Chyme = partially digested food

Duodenum (the start, mostly digestion) and Ileum (near the end, mostly absorption)

Enzymes present:

1. pancreatic amylase
    a. digests starch into maltose
    b. It is found in pancreatic juice. The other kind of amylase is salivary amylase (the usual)
2. maltase
    a. digests maltose into glucose

3. lipase
    a. digests fats into fatty acids and glycerol
4. protease
    a. digests protein into polypeptides
    b. digests polypeptides to amino acids
    c. More than 1 protease are present in the small intestine
    d. Found in pancreatic juice

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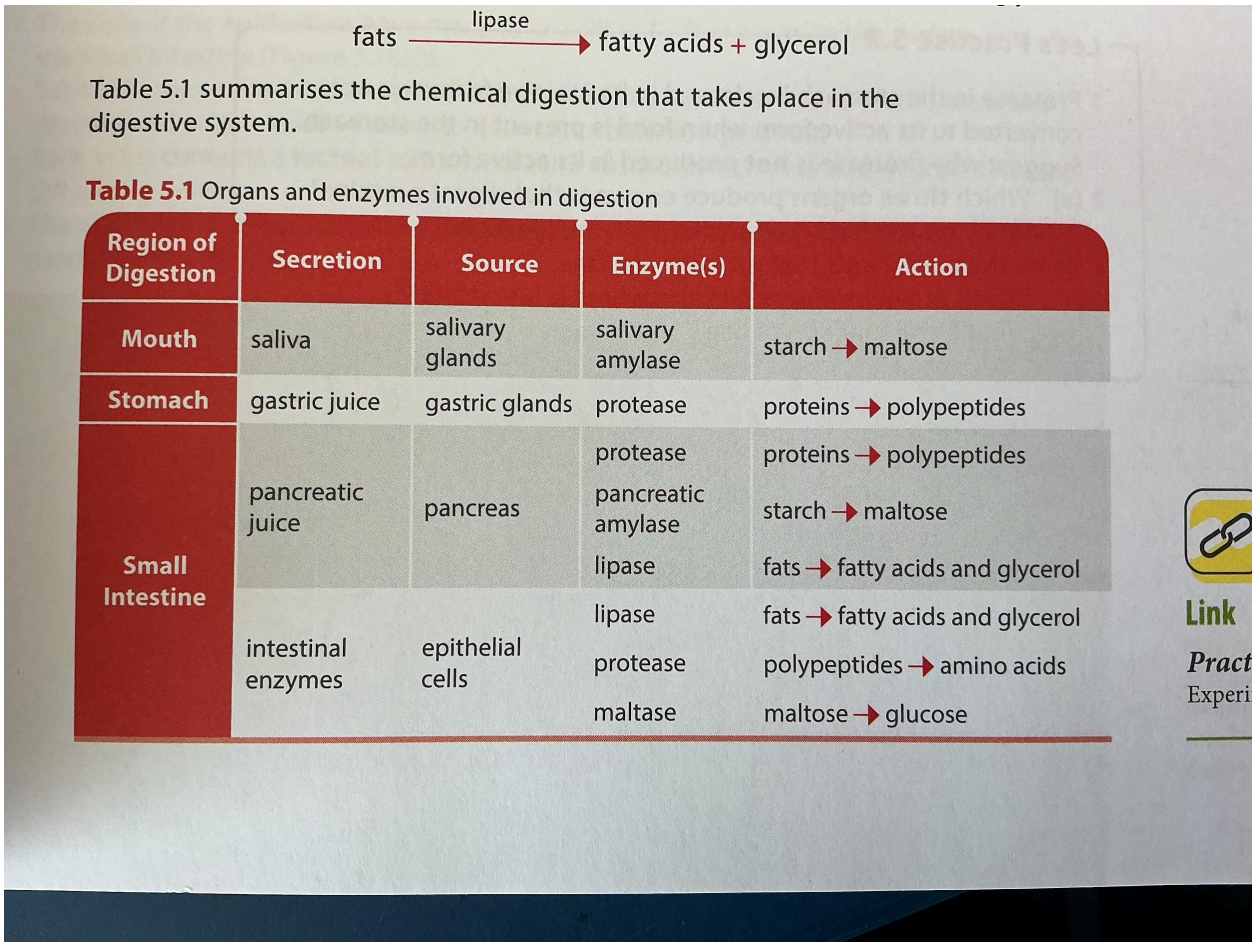

fats $\xrightarrow{\text{lipase}}$ fatty acids + glycerol

Table 5.1 summarises the chemical digestion that takes place in the digestive system.

Table 5.1 Organs and enzymes involved in digestion

Region of Digestion	Secretion	Source	Enzyme(s)	Action
Mouth	saliva	salivary glands	salivary amylase	starch → maltose
Stomach	gastric juice	gastric glands	protease	proteins → polypeptides
Small Intestine	pancreatic juice	pancreas	protease	proteins → polypeptides
			pancreatic amylase	starch → maltose
			lipase	fats → fatty acids and glycerol
	intestinal enzymes	epithelial cells	lipase	fats → fatty acids and glycerol
			protease	polypeptides → amino acids
			maltase	maltose → glucose

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All food should be fully digested by this point and absorbed.

Ileum

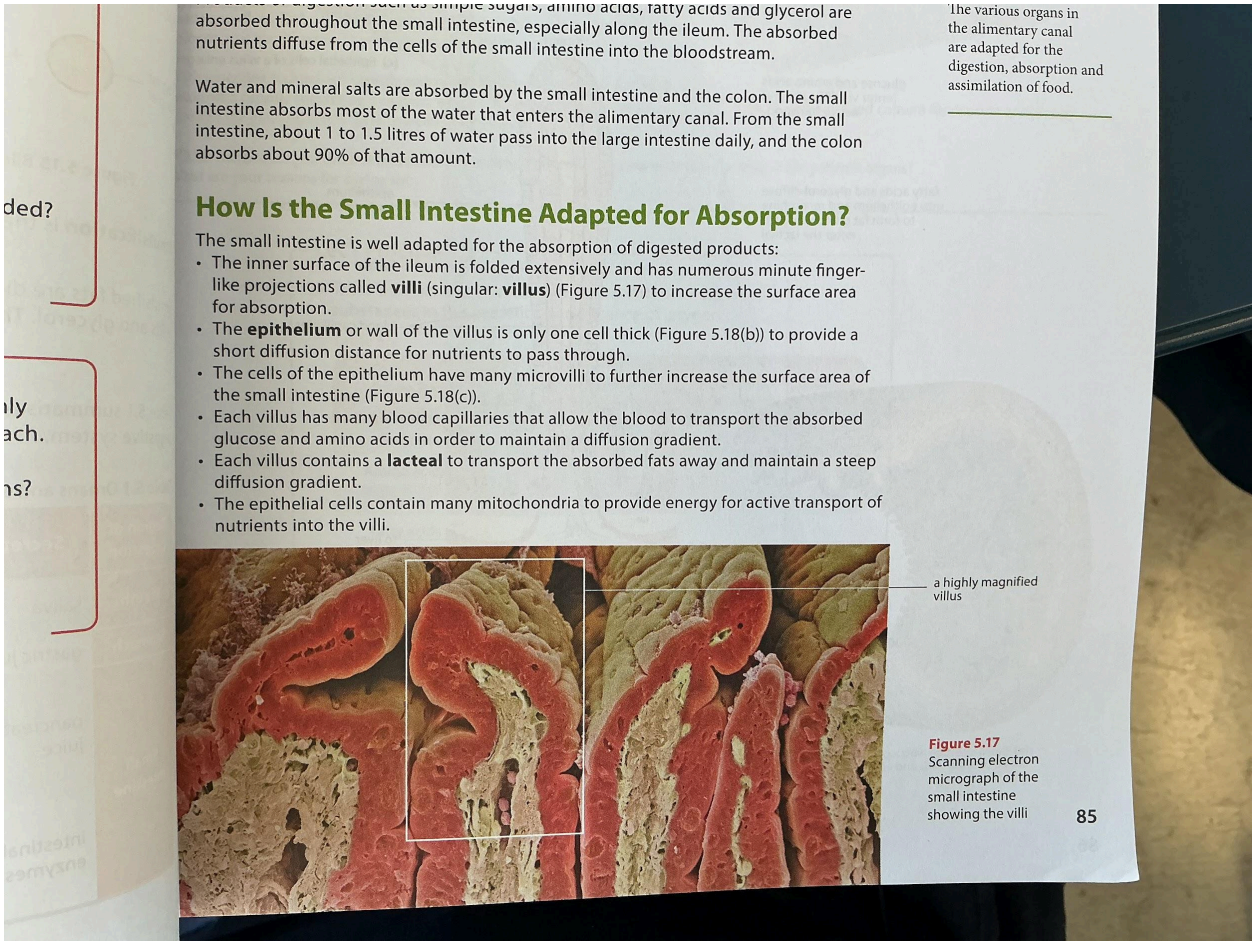
i. Less digestion takes place and more absorption takes place
ii. The inner wall of the small intestine is highly-folded

iii. There are many tiny protrusions allied Villi (singular: villus) in the inner wall. ii and iii both increase surface area to volume ratio, which increases the efficiency of absorption

iv. Villi are structurally adapted via

1. Surrounded by a 1 cell thick wall called the epithelium, made up of epithelial cells. The epithelial cells have more protrusions on them called microvilli.
2. Adaptation of Epithelial Cells: contains many mitochondria to provide energy for active transport of the nutrients into the villi
3. fatty acids and glycerol are reformed as fats after passing through.
4. Inside the villi, amino acids and glucose enter the capillary. They get transported away almost immediately through the hepatic portal vein, and into the liver.
5. While the lacteal is used to transport the reformed fats into a separate system

This allows for a steep concentration gradient between the outside of the villi compared to the inside of the villi, allowing diffusion to take place alongside active transport.



absorbed throughout the small intestine, especially along the ileum. The absorbed nutrients diffuse from the cells of the small intestine into the bloodstream.

Water and mineral salts are absorbed by the small intestine and the colon. The small intestine absorbs most of the water that enters the alimentary canal. From the small intestine, about 1 to 1.5 litres of water pass into the large intestine daily, and the colon absorbs about 90% of that amount.

The various organs in the alimentary canal are adapted for the digestion, absorption and assimilation of food.

How Is the Small Intestine Adapted for Absorption?

The small intestine is well adapted for the absorption of digested products:

- The inner surface of the ileum is folded extensively and has numerous minute finger-like projections called **villi** (singular: **villus**) (Figure 5.17) to increase the surface area for absorption.
- The **epithelium** or wall of the villus is only one cell thick (Figure 5.18(b)) to provide a short diffusion distance for nutrients to pass through.
- The cells of the epithelium have many microvilli to further increase the surface area of the small intestine (Figure 5.18(c)).
- Each villus has many blood capillaries that allow the blood to transport the absorbed glucose and amino acids in order to maintain a diffusion gradient.
- Each villus contains a **lacteal** to transport the absorbed fats away and maintain a steep diffusion gradient.
- The epithelial cells contain many mitochondria to provide energy for active transport of nutrients into the villi.

a highly magnified villus

Figure 5.17 Scanning electron micrograph of the small intestine showing the villi

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Small intestine carries out most of the digestive processes in the body

Amino Acids and glucose are transported to the blood vessels, then through the hepatic portal vein to the liver.

Fats are transported to the lacteal into a separate system.

Other organs that are involved in digestion but are not actively digesting:

2. pancreas
    a. Connected to the small intestine via the pancreatic duct, which releases the pancreatic juice that contains the mentioned amylase into the small intestine.
3. gall bladder
    a. connected to the small intestine by the bile duct which is also connected to the liver

b. Role: temporarily store bile produced by the liver. When it contracts, it releases the bile into the duodenum. It also helps in physical digestion.

c. Without it, you digest more slowly

d. Bile is a thick greenish yellow liquid that has a bitter taste to it. It is needed to digest and absorb fats and breaks down dietary fats into smaller droplets via emulsification. If the bile duct is blocked, the rate of digestion simply slows down. A person can survive without the gall bladder

e. Emulsification:

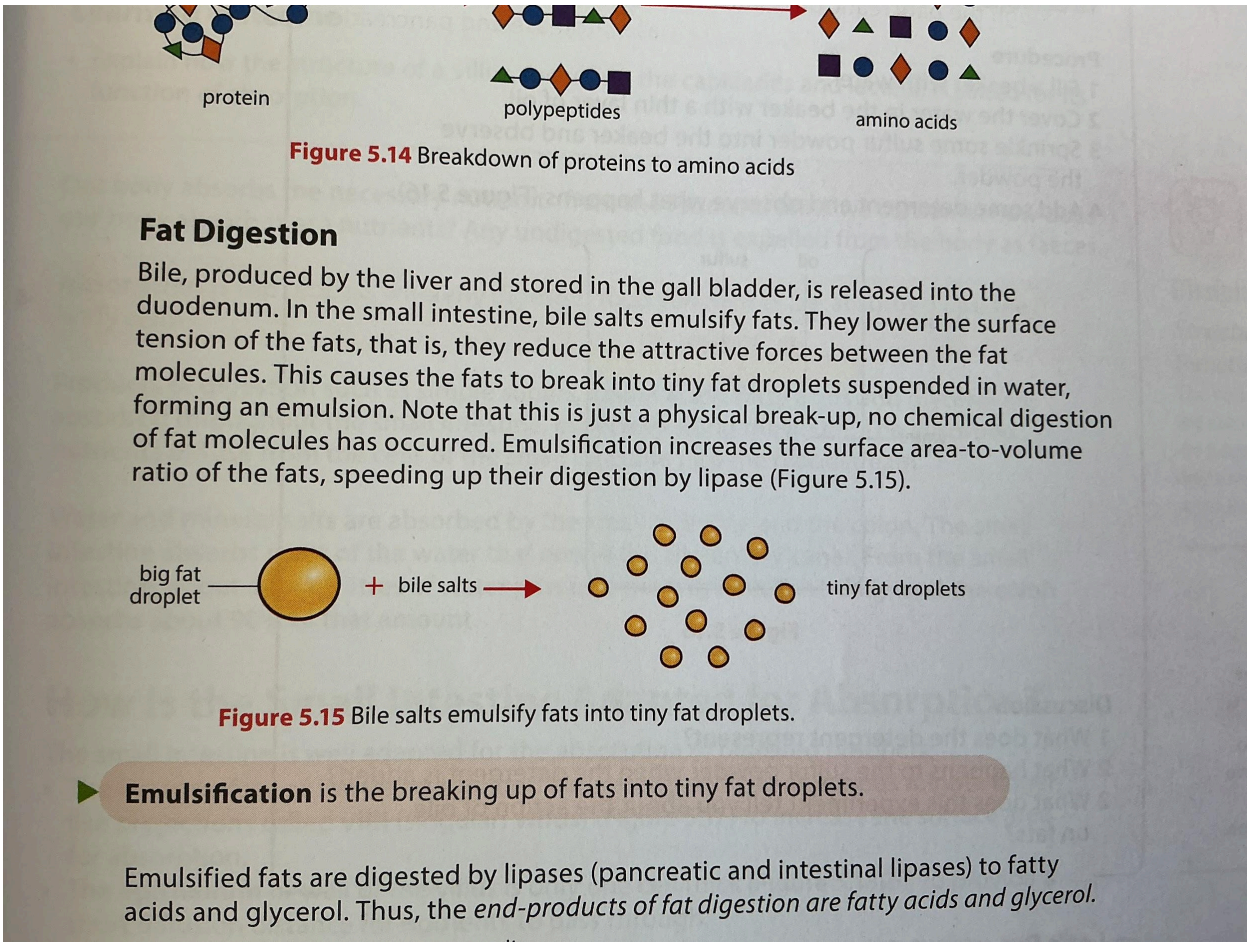

Figure 5.14 Breakdown of proteins to amino acids

Fat Digestion

Bile, produced by the liver and stored in the gall bladder, is released into the duodenum. In the small intestine, bile salts emulsify fats. They lower the surface tension of the fats, that is, they reduce the attractive forces between the fat molecules. This causes the fats to break into tiny fat droplets suspended in water, forming an emulsion. Note that this is just a physical break-up, no chemical digestion of fat molecules has occurred. Emulsification increases the surface area-to-volume ratio of the fats, speeding up their digestion by lipase (Figure 5.15).

Figure 5.15 Bile salts emulsify fats into tiny fat droplets.

Emulsification is the breaking up of fats into tiny fat droplets.

Emulsified fats are digested by lipases (pancreatic and intestinal lipases) to fatty acids and glycerol. Thus, the *end-products of fat digestion are fatty acids and glycerol.*

definition: it is a physical break up of any fat. Is also on the page.

This increases surface area to volume ratio, which increases the rate of digestion.

4. liver

Bolded text is a **MUST KNOW**

a. produces bile

i. bile is produced by liver but stored in gall bladder

ii. bile is secreted into duodenum of small intestine via the **bile duct**

iii. biles's purpose is to emulsify fats

b. detoxifies alcohol

i. converts harmful substances to harmless substances such as alcohol and food preservatives by breaking down the harmful substance.

ii. E.g: Alcohol -> Acetaldehyde. The enzyme involved in catalysing this reaction is alcohol dehydrogenase.

c. deamination of excess amino acids

i. <u>Definition of deamination: the process by which amino groups are removed from amino acids and converted to urea.</u>

ii. NH_2 (amino group) —> CH —> COOH
(converted to urea). (converted to glucose,
. stored as glycogen)

d. Regulation of blood glucose concentration

i. Constant between 70 to 90 mg/100cm^3

1. After a meal, you would have higher blood glucose levels
2. Islets of Langerhans in pancreas secrete **<u>insulin</u>** (a protein based hormone) that regulates glucose.
3. The liver converts glucose into glycogen.
4. Blood glucose levels return to normal.

ii. Between meals/fasting

1. Blood glucose levels are lower than usual
2. Islets of Langerhans in pancreas secrete Glucagon.
3. The liver converts Glycogen to Glucose
4. Blood glucose levels return to normal

e. Manufacture of Plasma Proteins

i. Plasma is the fluid component of blood

ii. Amino Acids caused to synthesise proteins

f. Heat Production

i. Heat is produced due to numerous activities in the liver

ii. Distributed to body to maintain overall temperature

g. Storage of iron

i. When red blood cells die or are worn out, they are destroyed in the spleen.

ii. Haemoglobin from RBC is sent to the liver to be broken down into iron to create new RBCs.

Effects of alcohol:

Digestive:

- Liver failure as the liver is overloaded, and the cells are continuously broken down, creating an excess of scar tissue. This is called liver cirrhosis which may lead to internal bleeding of the liver.

Nervous system:

- Slows down brain functions. This slows reaction time and compromises self-control.

Social:

- Addiction

Peristalsis: (check textbook definition)

A series of wave-like, involuntary muscle contractions that move food and waster throughout the digestive system.

It doesn't only occur in the oesophagus btw, the stomach, small intestine and large intestine all have peristalsis too.