

## 05 Animal Nutrition

### #49 Diet



The food an animal eat everyday is called **diet**. Most animals need 7 types of nutrients in their diet: **carbohydrates, proteins, fats** + **water, fibre, vitamins, minerals**.

The amount of **energy** needed is provided mainly by our carbohydrate and fat intake. Your dietary requirements depend on your **age, sex** and **activity**.

- Age: The energy demand increases until we stop growing. While children are growing they need more protein per kilogram of body weight than adults do.
- Sex: Generally, males use up more energy than females.
- Pregnant women need extra nutrients for the development of the fetus.

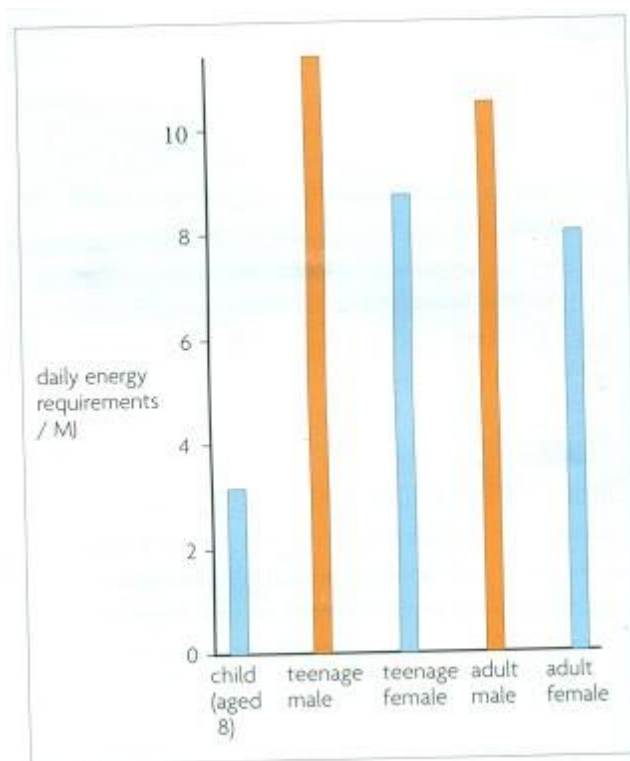


Figure 7.1 Daily energy requirements.

**A. A balanced diet** is a diet that contains all the **main nutrients** in the correct **amounts** and **proportions** to maintain good health.

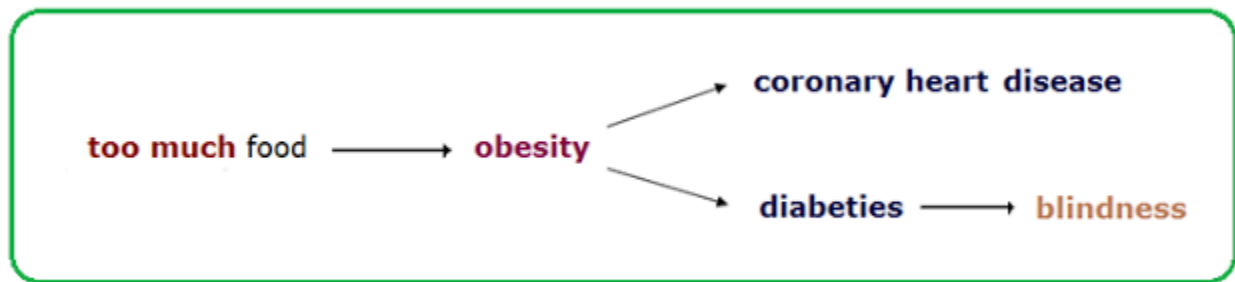


**B. Malnutrition** is the result of not eating a balanced diet. There may be:

- wrong **amount** of food: too little or too much
- incorrect **proportion** of main nutrients
- **lacking** in one or more key nutrients

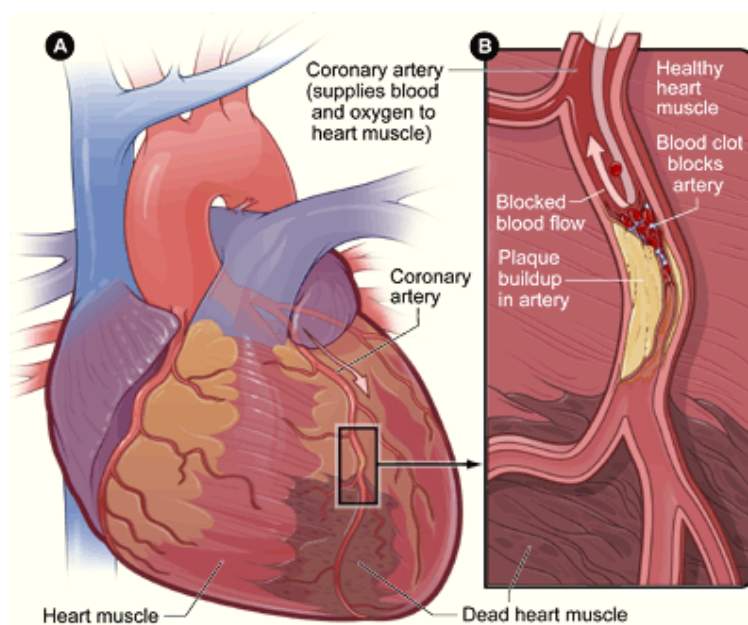
## Effects of malnutrition

### 1. Obesity - **Too much** food (carbohydrate, fat or protein)



### 2. Coronary heart disease

- **Too much** saturated/animal fat in the diet results in high cholesterol levels.
- Cholesterol can stick to the walls of arteries, gradually blocking them.
- If coronary arteries become blocked, the results can be angina and coronary heart disease.



### 3. Starvation

- **Too little** food can result in starvation.
- Extreme slimming diets, such as those that avoid carbohydrate foods, can result in the disease anorexia nervosa.



Starvation

### 4. Childhood protein-energy malnutrition (Kwashiakor)

Wrong proportion of nutrients e.g. too much carbohydrates (starchy foods) and a lack of protein can lead to Kwashiakor in young children.



Kwashiakor characterized by edema, anorexia, ulcerating dermatoses.

**5. Vitamin, mineral and fiber deficiency diseases** - Lacking key nutrients.

**Vitamin, minerals, fibre and water**

<b>Nutrient</b>	<b>Function</b>	<b>Deficiency</b>	<b>Food sources</b>
Vitamin C	Maintain healthy <b>skin</b> and <b>gums</b>	<b>Scurvy</b> - bleeding under skin, bleeding gums	Citrus fruits, cabbage, blackcurrants, guava, mango, tomato
Vitamin D	-Maintain hard bones -Help to absorb <b>calcium</b> from small intestine	<b>Rickets</b> - soft bones that become deformed (e.g. bow legs)	-Milk, butter, cheese, egg yolk, fish-liver oil. -Made by <b>skin</b> when exposed to sunlight
Calcium	-Formation of healthy <b>bones</b> and teeth - Normal <b>blood clotting</b>	-Rickets, brittle bones and teeth -Slow blood clotting	Milk, cheese, fish
Iron	-Formation of <b>haemoglobin</b> in red blood cells	<b>Anaemia</b> ( not enough red blood cells → not enough O <sub>2</sub> delivered to tissues): constant tiredness, lack of energy	Red meat, liver, kidney, eggs, vegetables (spinach, cabbage...) , chocolate
Fibre	<b>Cellulose</b> adds bulk (mass) to undigested food passing through the intestines, maintaining <b>peristalsis</b> (constriction and relaxation)	- <b>Constipation</b> -Long-term deficiency leads to <b>bowel cancer</b>	Vegetables, fruit, whole meal bread
Water	-Formation of <b>blood, cytoplasm</b> -Solvent for transport of nutrients and removal of wastes ( <b>urine</b> ) - <b>Enzymes</b> only work in solution	<b>Dehydration</b>	Drinks, fruit, vegetables



## #50 Use of modern technology for increasing food production



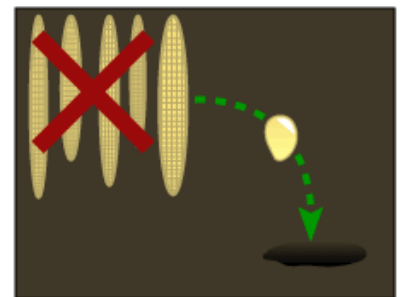
Modern technology such as chemical fertilisers, pesticides, herbicides, modern agricultural machinery, artificial selection... have been used to increase food production.

- Development and use of **chemical fertilisers** on farm land à boosts levels of nutrients in the soil, increasing crop yields.
- Development and use of **pesticides** such as insecticides and fungicides à kill pests that feed on or damage crops à increase crop yields.
- Development and use of **herbicides** à kill weeds that compete with crops for nutrients, light, water and space à increase crop yields.
- Use of **modern machinery**, such as tractors and combine harvesters à enables land and crops to be managed more efficiently.

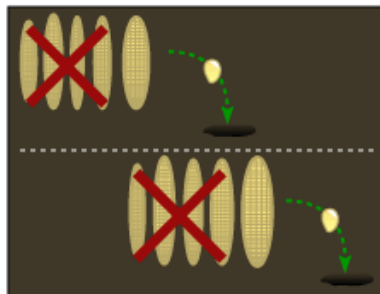
- **Artificial selection** to produce varieties of plants that are suited to particular climates and soil types, and breeds of animal for specific purpose such as optimum meat, milk, and wool production.



1. Natural variation occurs in the wild population.



2. Seeds for the next generation are chosen only from individuals with the most desirable traits.



3. Repeat this process for several generations.



4. Over time, the quality of the crop increases.

- Use of **medicines** such as antibiotics, hormones and artificial insemination techniques in intensive animal rearing.
- Use of **plant hormones** in plant growing and fruit production.
- Use of **genetic engineering** and cloning techniques to produce organisms to produce hormones, etc.



- Development of systems to **water plants** in **greenhouses** automatically and to grow plants in nutrient solutions (a process called hydroponics).
- Use of **satellites** to monitor crop development, observe crop diseases and assess the need for additional fertiliser.
- Development of **intensive farming** and automated feeding mechanisms.

## #51 Problems of world food supplies and the causes of famine



There is **not** always **enough food** available in a country to feed the people living there. A severe food shortage can lead to **famine**.

It has been calculated that more than enough food is produced on Earth to provide every single person with more than enough for their needs. Yet many people do not get enough food. Each year, many people die because they have an inadequate diet.

The fundamental problem is that **food is distributed unequally** on our planet: while some parts of the world produce more than enough food for the people that live there, in other part of the world not enough food is produced.

- Although large amounts of food are transported from one area to another, this is still not sufficient to supply enough food to everybody.
- If food prices rise too high, many people may not be able to afford to buy it.



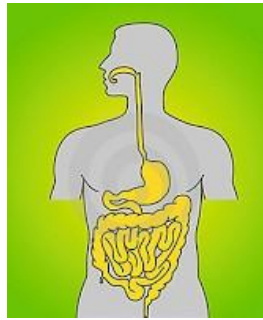
**Famine** can occur for many different reasons:

- Climate change and natural disaster such as **drought** and **flooding** that prevent crops from growing.
- Increasing **population**: population may grow so large that the land on which they live can no longer provide enough food for them.
- Unequal **distribution** of food.





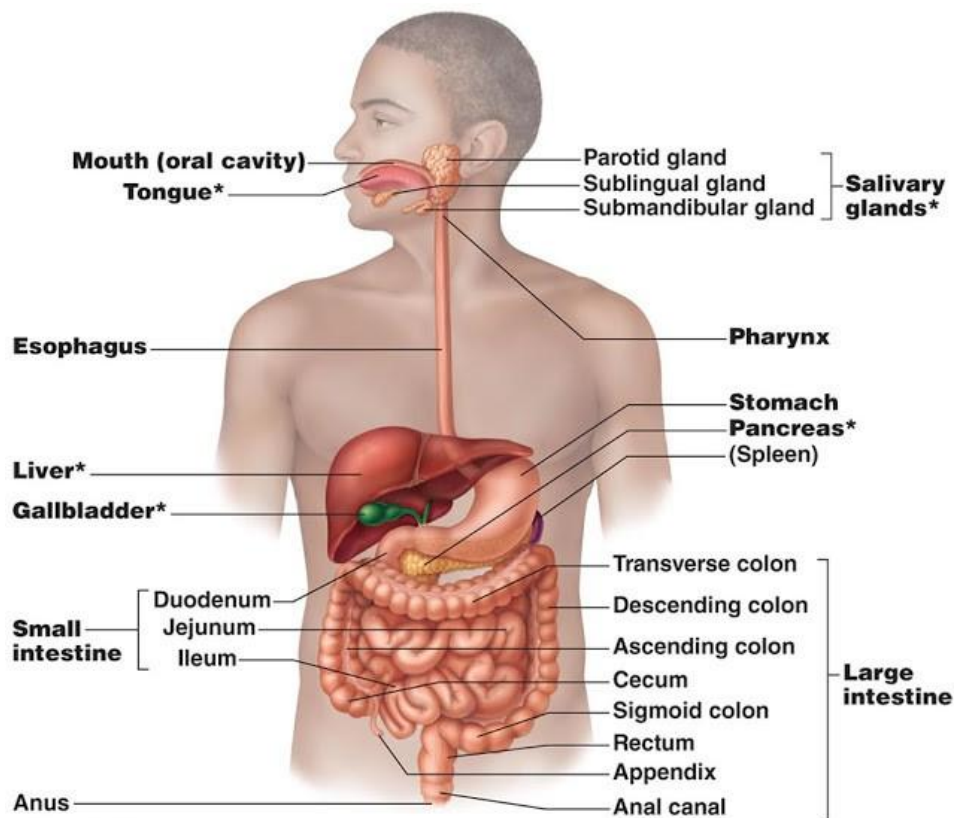
## #52 Human alimentary canal



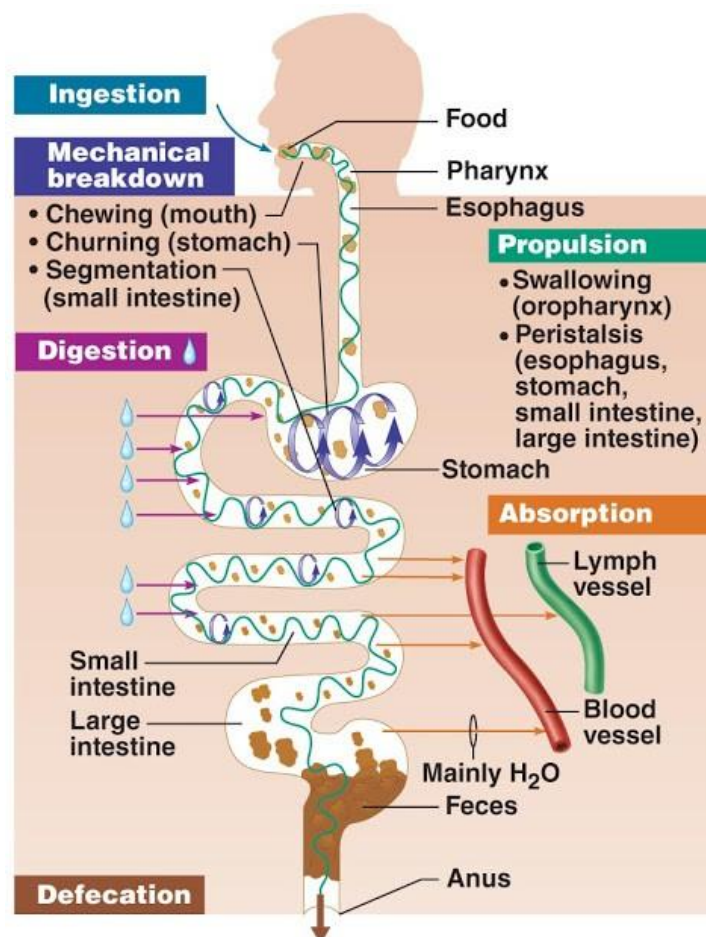
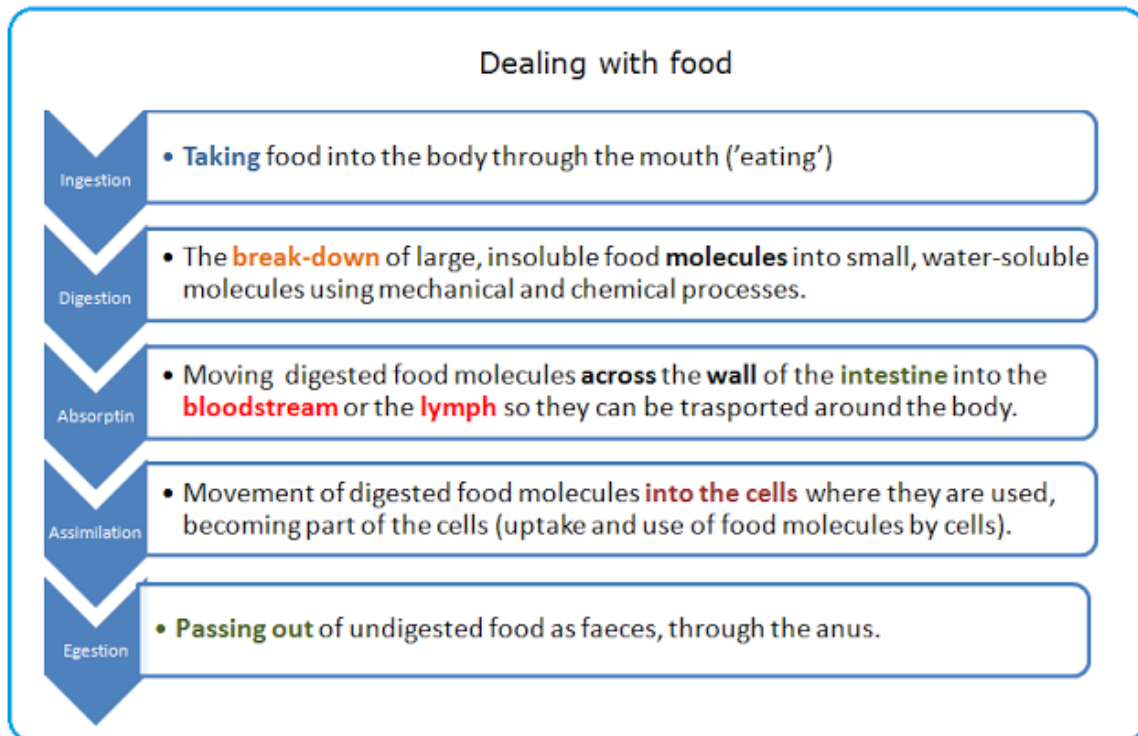
The **alimentary canal** is a long tube which starts at the mouth, runs through the stomach and intestines and finishes at the anus. It is part of the digestive system. The **digestive system** also includes the **accessory organs** (teeth, tongue, gallbladder, salivary glands, liver, the pancreas).

Main regions of the alimentary canal and associated organs are:

- Mouth, salivary glands
- Oesophagus
- Stomach
- Pancreas, liver, gall bladder
- Small intestine (duodenum + ileum)
- Large intestine (colon + rectum)
- Anus.



Food is broken down with the help of digestive juices, which contain special chemicals called enzymes.



## Functions of the regions of the digestive system:

Organ	Function
Mouth	<b>Digestion</b> starts here! The teeth cut and grind the food, which is mixed with <b>saliva</b> . This contains <b>amylase</b> to break <b>starch</b> down into maltose (sugar).
Oesophagus	Boluses (balls) of food pass through by <b>peristalsis</b> , from mouth to stomach.
Stomach	Muscular walls squeeze on food to make it semi-liquid. Gastric juice contains: <ul style="list-style-type: none"><li>• <b>Pepsin</b> (a <b>protease</b>) to break big proteins down into small protein (polypeptides)</li><li>• Hydrochloric acid (<b>HCl</b>) to maintain an optimum pH (1-2,5). The acid also kills bacteria.</li></ul>
Gall bladder	Stores <b>bile</b> used to help in the digestion of <b>fats</b> .
Pancreas	Secretes <b>pancreatic juice</b> into the duodenum, also makes the hormones <b>insulin</b> and <b>glucagon</b> .
Liver	Makes <b>bile</b> , which is stored on the gall bladder. Bile contains <b>salts</b> that emulsify <b>fats</b> , forming droplets with a large surface area to make digestion by lipase more efficient. Digested foods are <b>assimilated</b> here. For example, glucose is stored as glycogen, surplus amino acids are deaminated.
Small intestine	<b>Duodenum + Ileum</b>
Duodenum	The first part of the small intestine. It receives pancreatic juice containing <b>protease</b> , <b>lipase</b> and <b>amylase</b> . Proteins, fats, starches and complex sugars are broken down into small soluble molecules. The juice also contains sodium hydrogen carbonate, which neutralises acid from the stomach, producing a <b>pH of 7-8</b> .
Ileum	The second part of the small intestine. Enzymes in the epithelial lining break down <b>lactose</b> and <b>peptides</b> . Its surface area is increased by the presence of villi which allow the efficient <b>absorption</b> of fully digested food molecules into the bloodstream.
Large intestine	<b>Colon + Rectum</b> Only undigested food reaches here. Water absorbed.
Rectum	This stores <b>faeces</b> until it is egested.
Anus	This has muscles to control when faeces is <b>egested</b> from the body.

## Common misconceptions

The liver does not make digestive enzymes- bile is not an enzyme. It breaks fat down into smaller droplets, but does not change them chemically.

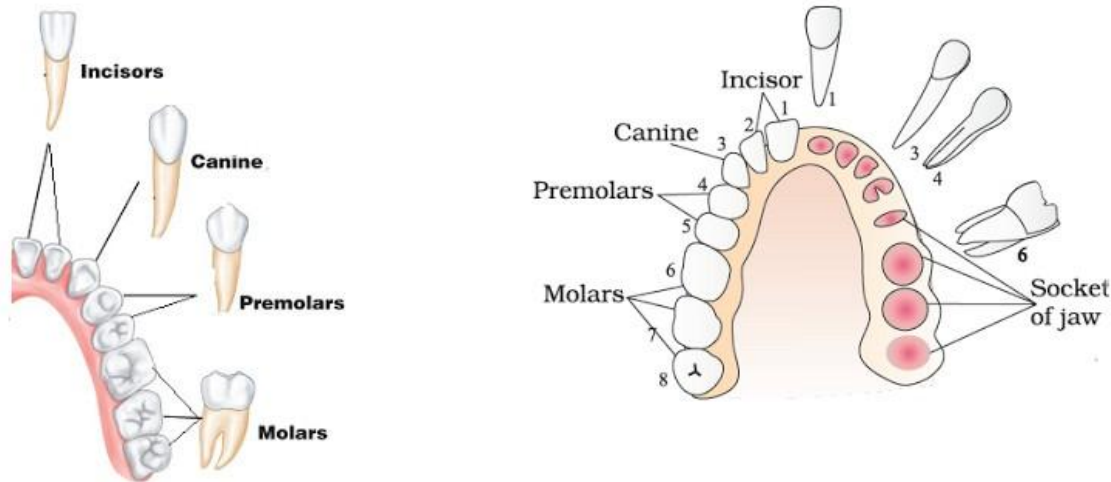
The fat molecules stay the same size, it is just the droplet size that changes from large to small due to the action of bile.

Additional resource: [classes.midlandstech.com](https://classes.midlandstech.com)





## #53 Human teeth and dental decay

There are four types of teeth in human (incisors, canines, premolars and molars), each specialised for different functions.

### Position of teeth in the mouth

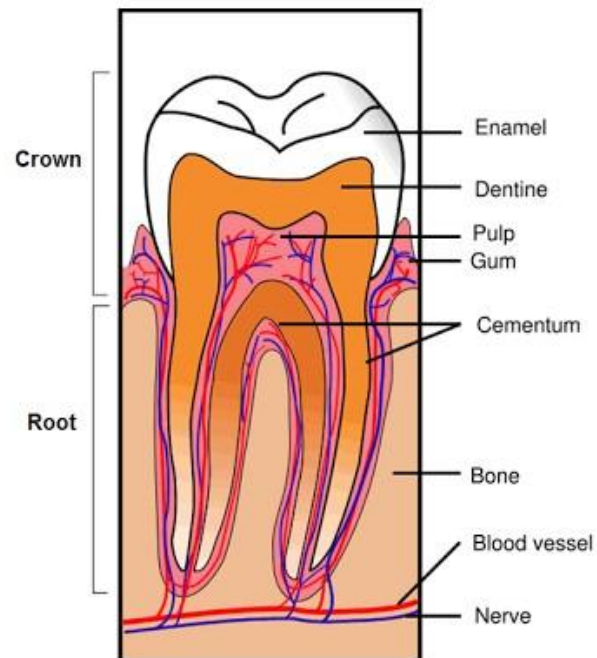


### Types of human teeth

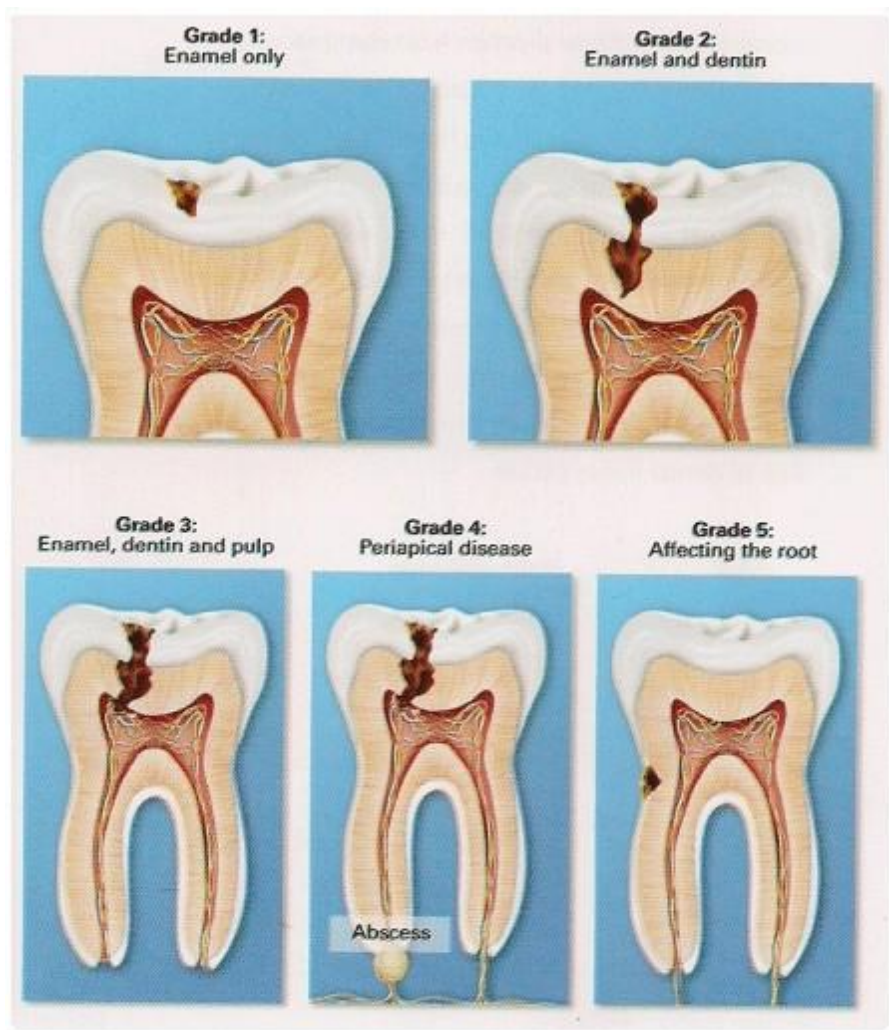
	Incisor	Canine	Premolar	Molar
				
Position in mouth	Front	Either side of incisors	Behind canine	Back
Description	Chisel-shaped (sharp edge)	Slightly more pointed than incisors	2 points (cusps), 1 or 2 roots	4 or 5 cusps 2 or 3 roots
Function	Biting of pieces of food	Similar function to incisors	Tearing and grinding food	Chewing and grinding food



## Structure of tooth



## Causes of dental decay





- Bacteria are present on the surface of our teeth. Food deposits and bacteria form a layer called plaque. Bacteria on the plaque feed on sugars, producing acid. This acid dissolves enamel, forming a hole.
- Dentine underneath the enamel is softer – it dissolves more rapidly.
- If the hole reaches the pulp cavity, bacterial infection can get to the nerve. This results in toothache and possibly, an abscess (an infection in the jaw).

### **Common misconceptions:**

Do not say that sugar causes decay. It only causes problems because of the activity of bacteria feeding on it and producing acids.

### **Try this**

The outer layer of the crown of a tooth is resistant to attack by bacteria

1. Name this outer layer. (1 mark)
2. State the mineral and the vitamin needed in the diet for the healthy development of this layer. (2 mark)
3. Explain how bacteria can gain entry through this layer into the tooth and cause dental decay. (3 mark)

### **Answers**

1. Enamel
2. Mineral: calcium; vitamin: D
3. Three points from:
  - bacteria feed on sugar from food left on the teeth
  - bacteria produce acid
  - acid attacks or dissolves the enamel
  - dentine is softer, so it breaks down more quickly
  - this results in a hole in the enamel, exposing the pulp cavity.

## #54 Adding fluoride to public water supplies



Fluoride helps prevent **destruction** of the tooth surface caused by **acids** produced by bacteria. It forms a **reservoir** on the teeth from which fluoride is released during attack. It reduces the **loss of minerals** from the tooth and promotes **repair** of early tooth decay.

Growing children can absorb fluoride in their diet (from toothpaste or fluoridated water). It becomes part of the enamel of their developing teeth, and the enamel; is then more resistant to tooth decay.

### Arguments for and against the addition of fluoride to public water supplies



#### For:

- Tooth decay in the local population of children decreases.
- There is no need to buy fluoridated toothpaste.

#### Against:

- It is form of mass medication – people have no choice about whether or not they want the treatment.
- Fluoride is a benefit only to growing children – adults do not benefit.
- If people take proper care of their teeth, fluoridation is unnecessary.
- Fluoride may have side effects, such as an increase in risk of bone cancer (but this is unlikely).

## Proper care of teeth

- Avoid sugary food, especially between meals, so bacteria cannot make acid and clean teeth regularly to remove plaque.
- Use dental floss or a toothpick to remove pieces of food and plaque trapped between them.

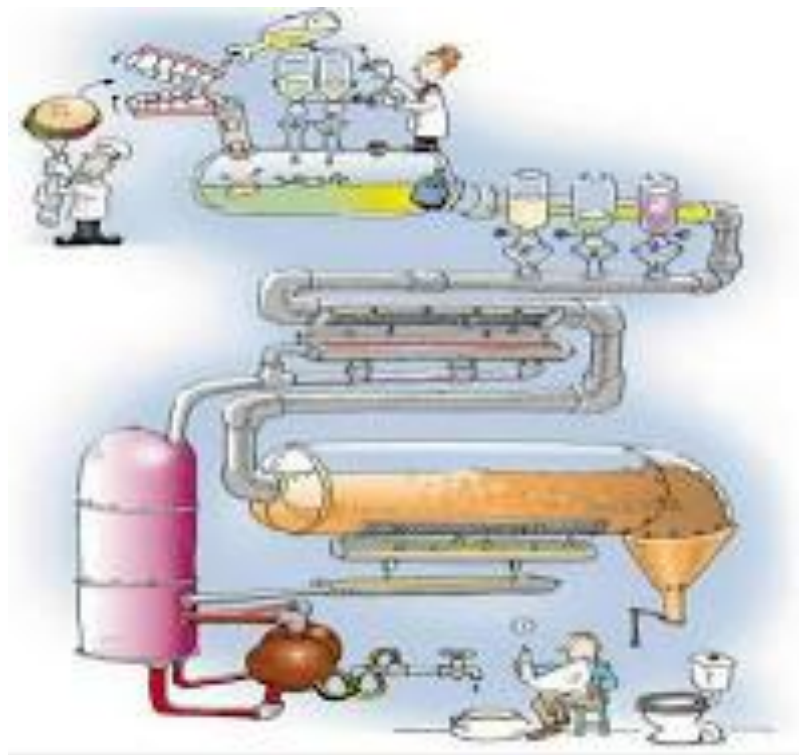


- Use fluoride toothpaste (or drink fluoridated water) – fluoride hardens tooth enamel.
- Visit a dentist regularly to make sure and tooth decay is reacted early and any stubborn plaque (called calculus) is removed.

## Common misconceptions

There is a big difference between **fluoride** and **fluorine**. Fluorine is a very toxic gas, while fluoride is a mineral that helps to strengthen teeth. Make sure do not use the term fluorine in an exam answer about teeth.

## #55 Mechanical and chemical digestion



Food that we ingest is mainly made up of **large, insoluble molecules** that can not be absorbed through the gut wall. It needs to be changed into **small, soluble** molecules.

**1. Mechanical digestion** is the physical process of preparing the food for chemical digestion.

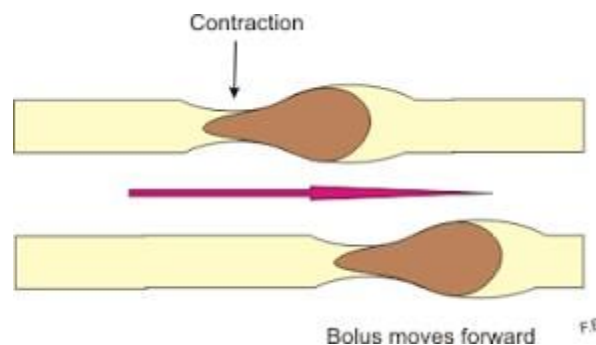
- It involves **chewing** (in the mouth), **mixing, churning** (in the stomach and intestine) and **segmentation** (in the intestine).
- Large pieces of food are breaking down into smaller pieces → increases the surface **area** of the food.
- **Bile** physically digests **fats** by emulsifying them – turning them into small droplets with a large surface area.

### Chewing

**Mechanical** digestion, performed by the teeth → pieces of food are mixed with saliva and become smaller → easier to swallow and have a larger surface area.

## Peristalsis

- The walls of the alimentary canal have an **inner, circular muscle** fibre coat and an **outer, longitudinal muscle** fibre coat.
- As the ball of food (bolus) formed in the mouth enters the pharynx, a reflex action is initiated.
- This produces slow, wave-like contractions in the walls of the esophagus and later along the whole length of the tract (**peristalsis**).
- Peristaltic waves involve the **contraction** of the **circular muscle** fibres **behind** the bolus (A) and their **relaxation in front** of the bolus.
- Longitudinal muscles provide the **wave-like action**. The two functions together push the ball down the tract (B).



**Misconceptions:** Chewing food does not involve breaking down large molecules into small molecules; it only breaks down large pieces into smaller pieces, giving a larger surface area for enzymes to work on.

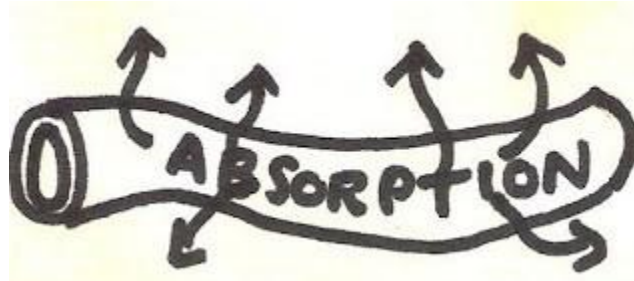
## Video Peristalsis

### 2. Chemical digestion

- Involves breaking down large, insoluble molecules into small, soluble ones.
- Enzymes speed up the process. They work efficiently at body temperature ( $37^{\circ}\text{C}$ ) and at suitable pH.
- The main places where chemical digestion happens are the mouth, stomach and small intestine.

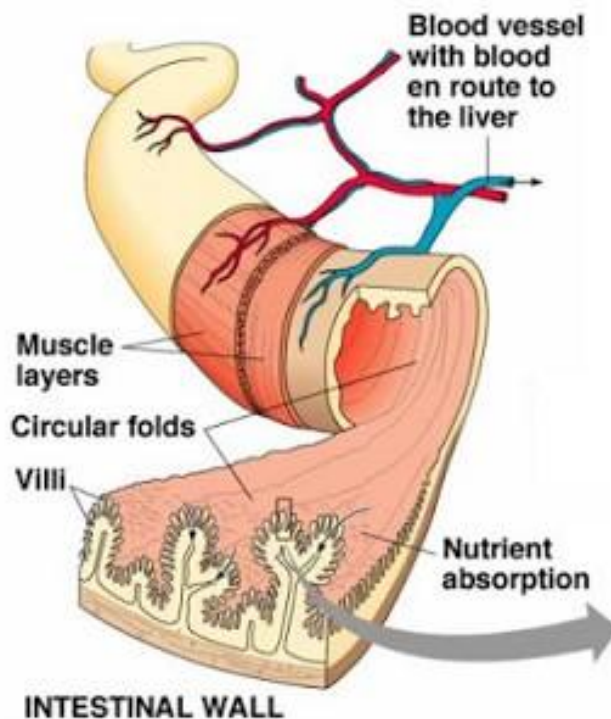


## # 56 Absorption – function of small intestine and significance of villi



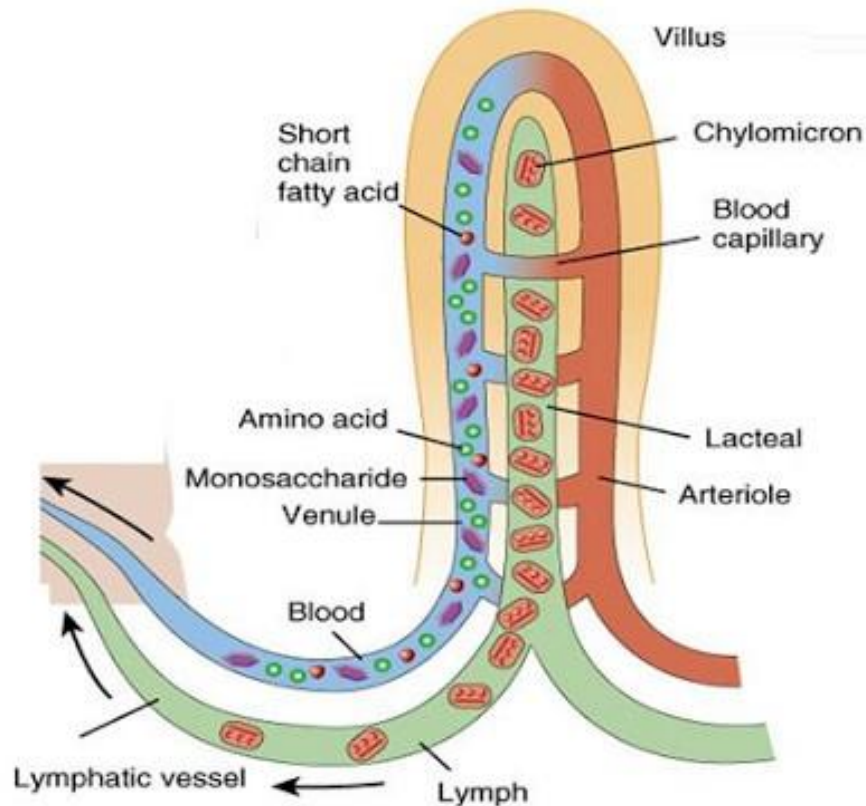
**Absorption** is the movement of digested food molecules **through the wall** of the intestine into the blood or lymph.

Digestion is completed in the small intestine. By now, most carbohydrates have been broken down to simple **sugar**, proteins to **amino acids**, and fats to **fatty acids** and **glycerol**. These molecules are small enough to **pass through** the wall of the **small intestine** and into the **blood**. This is called **absorption**. The small intestine is especially adapted to allow absorption to take place very efficiently.



It has a very rich blood supply. Digested food molecules are small enough to pass through the wall of the intestine into the bloodstream. **Water, mineral salts** and **vitamins** are also absorbed in the small intestine.

The small intestine absorbs 5-10 dm<sup>3</sup> of **water** each day. However, the colon absorbs much less water and salt than the small intestine, generally around 0,3–0,5 dm<sup>3</sup> per day.



*The adaptation of the small intestine for absorbing digested nutrients*

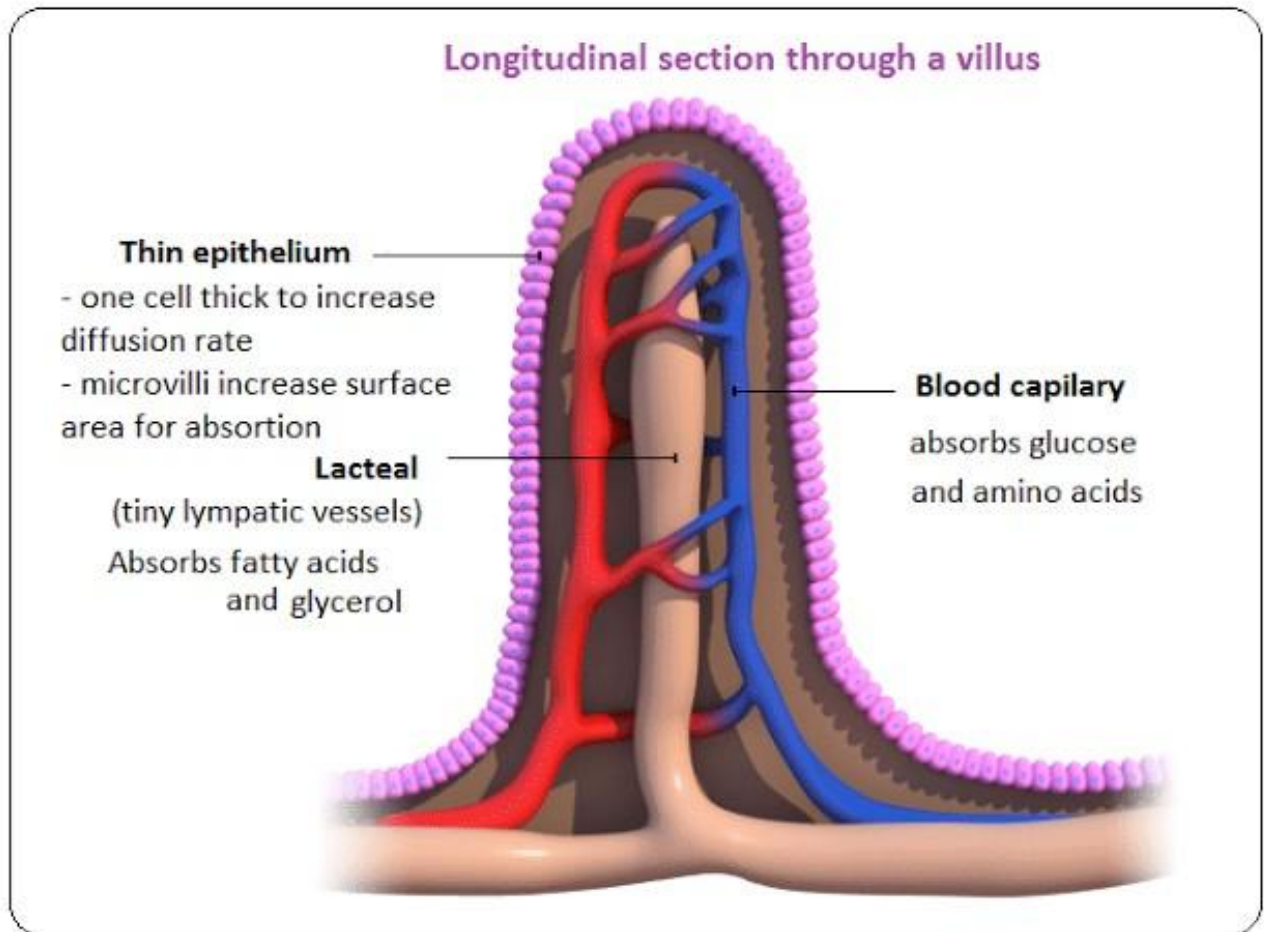
Features	How this helps absorption take place
It is very long, about 5 m in an adult human	This gives plenty of time for digestion to be completed, and for digested food to be absorbed as it slowly passes through.
It has villi, each villus is covered with cells which have even smaller projections on them, called microvilli.	This gives the inner surface of the small intestine a very large surface area. The larger the surface area, the faster nutrients can be absorbed.
Villi contain blood capillaries	Monosaccharides, amino acids, water, minerals and vitamins, and some fats, pass into the blood, to be taken to the liver and then round the body.
Villi contain lacteals, which are part of the lymphatic system.	Fats are absorbed into lacteals.
Villi have walls only one cell thick	The digested nutrients can easily cross the wall to reach the blood capillaries and lacteals.

## Significance of Villi

Villi are finger like projections that increase the surface area for absorption.

If a section of small intestine was turned inside out, its surface would be like a carpet. Inside each **villus** are:

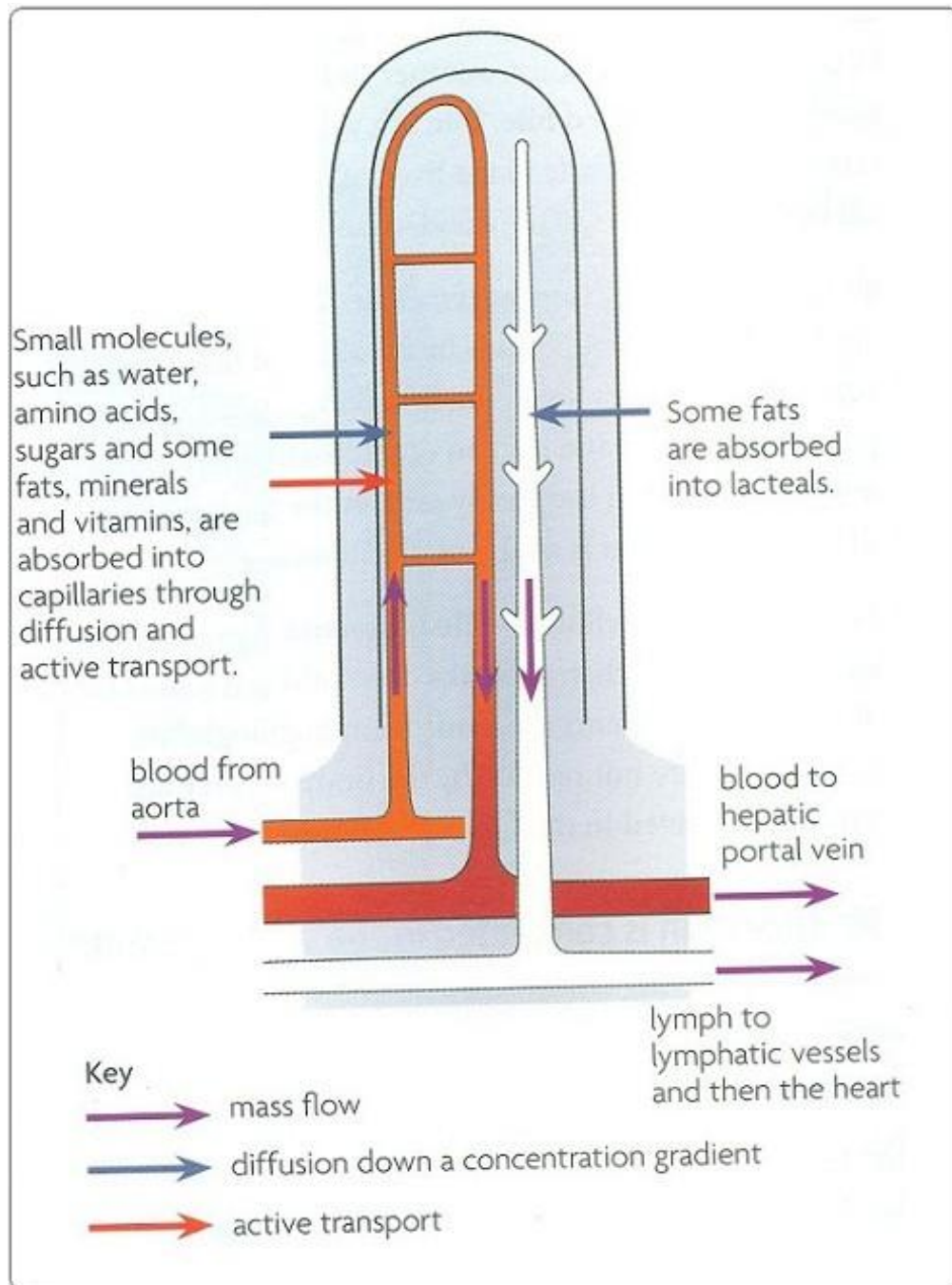
- Blood capillaries: absorb amino acids and glucose.
- Lacteals: absorb fatty acids and glycerol.



Food molecules are absorbed:

- mainly by **diffusion**.
- or by **active transport**.

Epithelial cells contain mitochondria to provide energy for absorption against the concentration gradient.

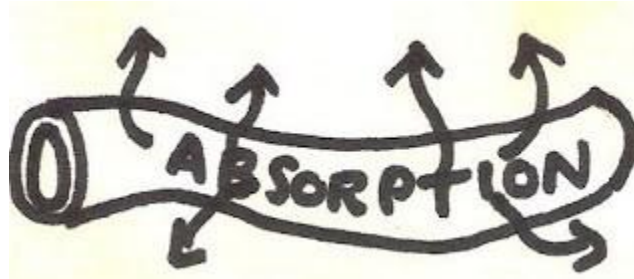


## Role of the hepatic portal vein

The hepatic portal vein transports absorbed food from the small intestine to the liver. After a meal, the blood in this vein contains very high concentrations of glucose and amino acids, as well as vitamins and minerals. The liver reduces levels back to normal.

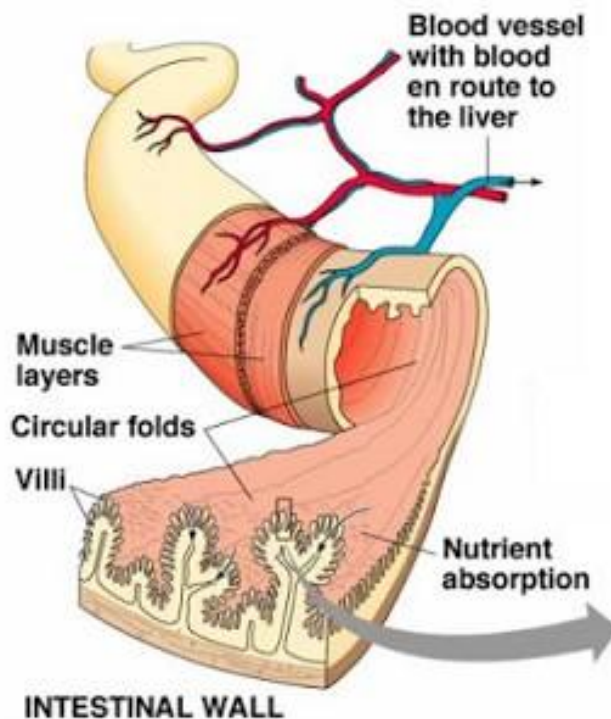


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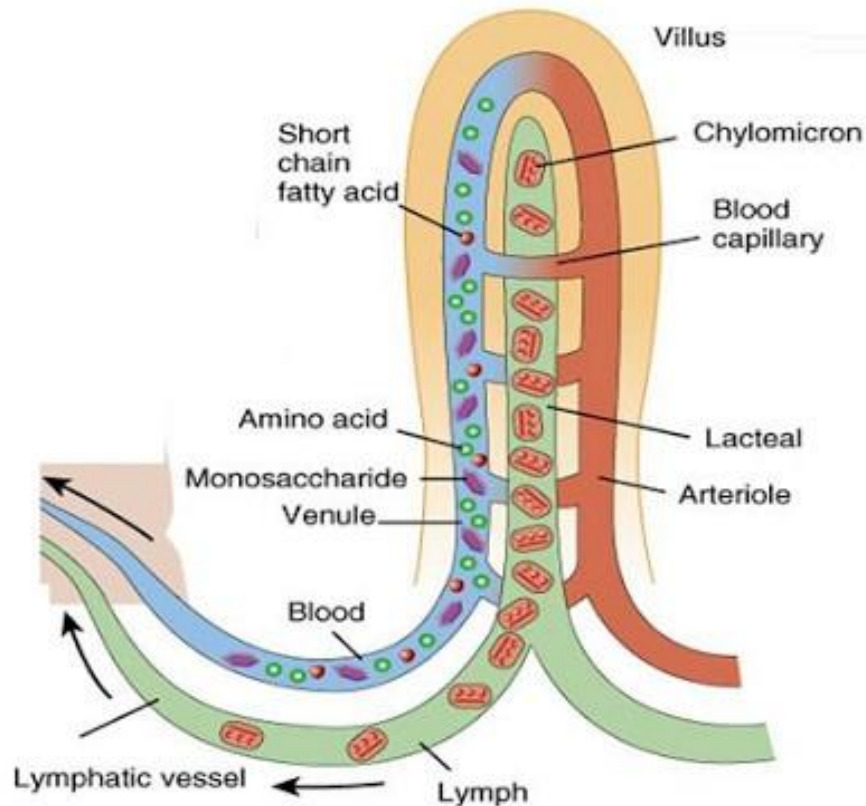
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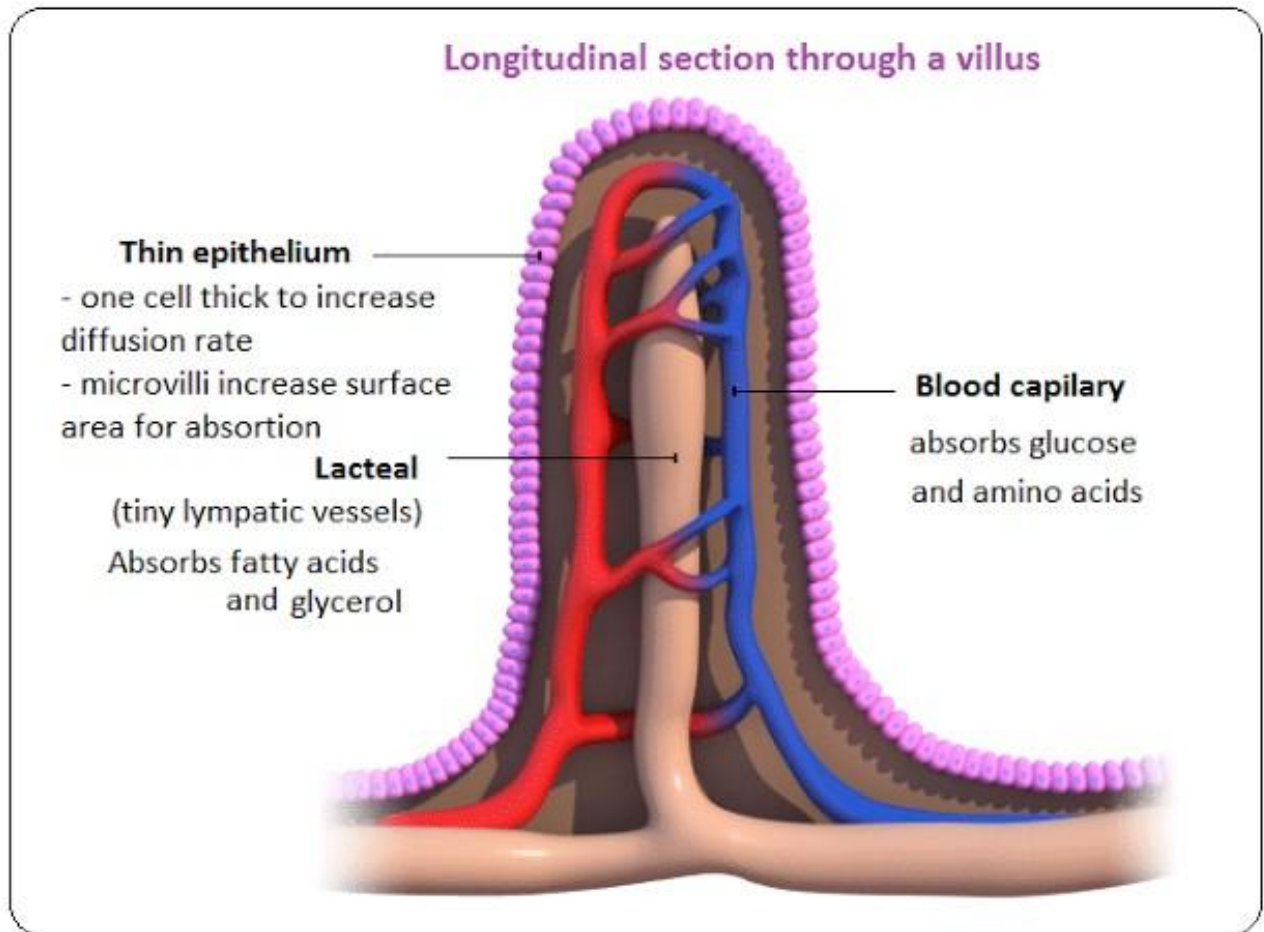
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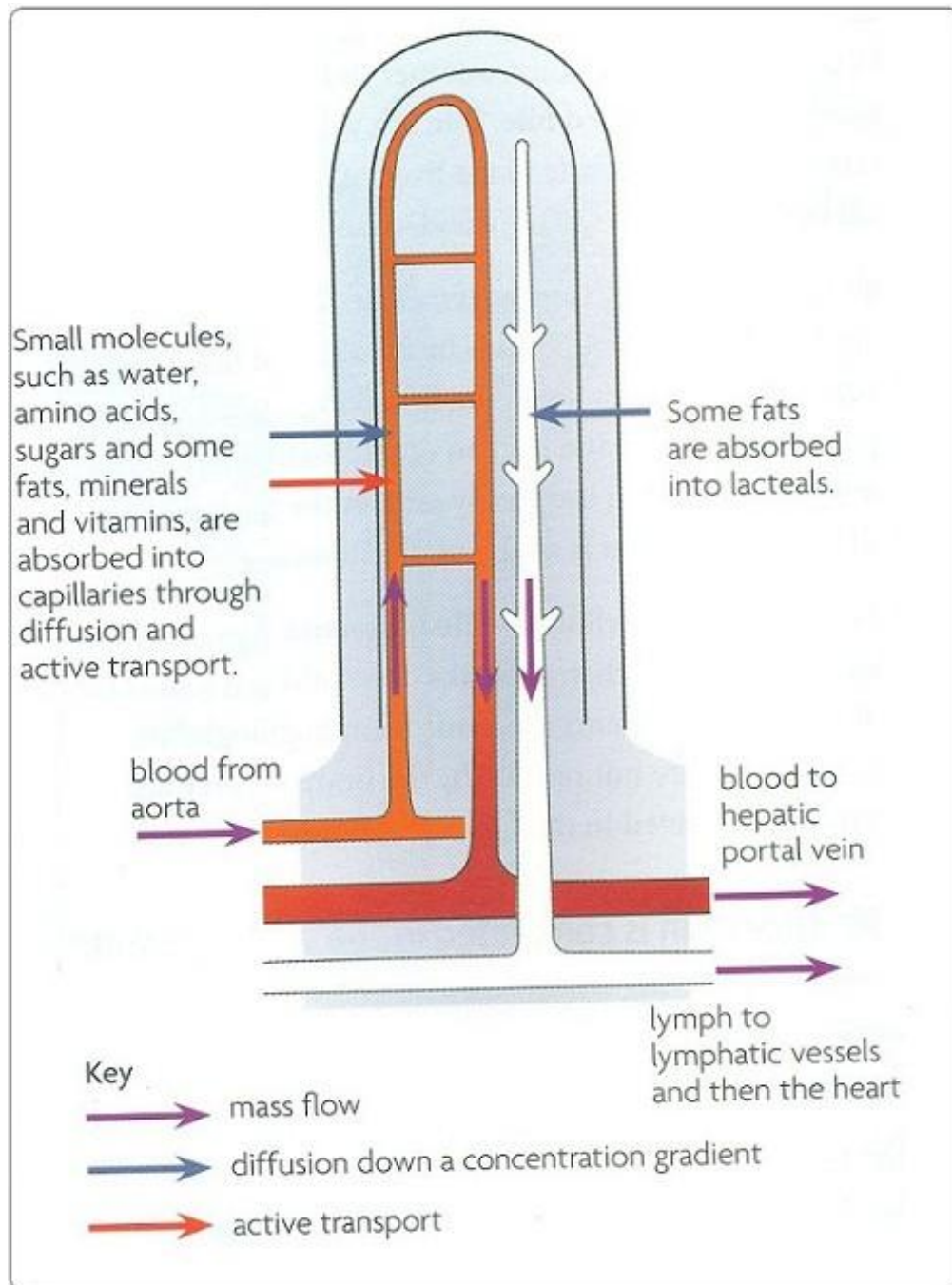
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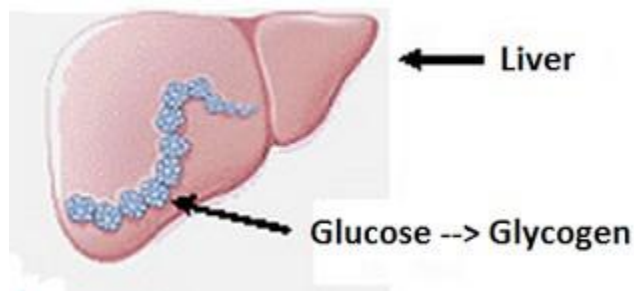
## #57 Assimilation and role of the liver



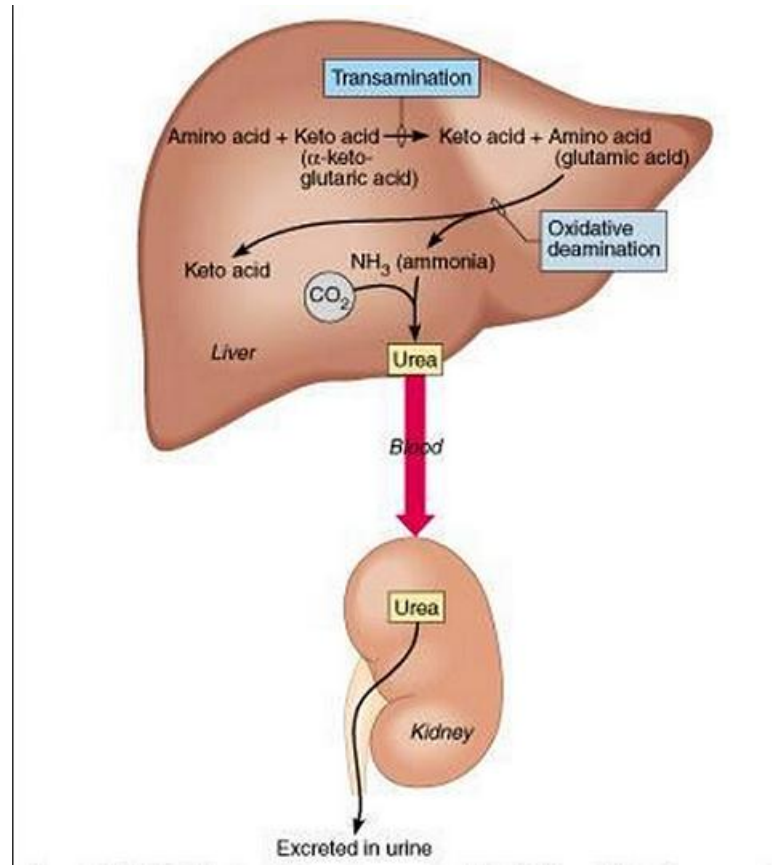
*Assimilation* is the movement of **digested food molecules** into **the cells** of the body where they are used, becoming part of the cells.

### Role of liver in the metabolism of glucose and amino acids

- **Excess glucose** in the blood arriving at the liver is converted into **glycogen** (animal starch) for storage, or broken down through respiration, producing **energy** for other purposes.



- Amino acids cannot be stored in our body, so any that is **excess** has to be dealt with in the liver.
  - Some amino acids are **transaminated** to produce a different amino acid.
  - The rest are **deaminated** to produce **ammonia (NH<sub>3</sub>)** and a **keto acid**.
- + **NH<sub>3</sub>** is converted into **urea**, which is transported to the kidneys and excreted.
- + The **keto acid** is used primarily as energy for liver cells



So **Deamination** is the removing of **nitrogen-containing** part of amino acids to form **urea** and using of the remainder of amino acid to provide **energy** to the liver cells.

### Role of liver in the breaking down of alcohol and other toxins

- Breaking down any toxins absorbed from the alimentary canal, including drugs such as alcohol. Cells in the liver are able to convert many toxins to harmless substances that can be transported in the blood and excreted from the body.

### Role of fat as an energy storage substance

- **Fatty acids** and **glycerol** pass into the lymphatic system and then the bloodstream. Once in the blood nutrients are carried to all cells of the body. Some are oxidised to produce **energy** and others are used to repair the cell, build new cells.
- Fat is a good storage compound – it releases twice as much energy as carbohydrates when respired, and act as insulation in the skin. Some nerve cells form a **myelin sheath** from fat, to prevent electrical impulses from leaking out.

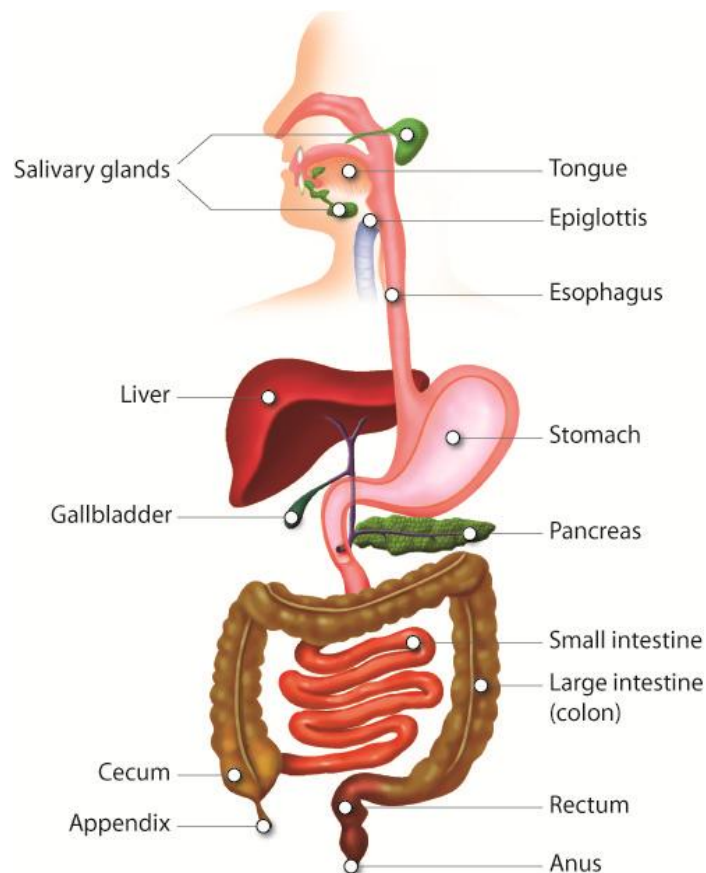


## #58 Summary of animal nutrition



A **balanced diet** contains suitable proportions of each group of nutrients – carbohydrates, fats, proteins, minerals, vitamins, water and fibre – and the correct amount of energy.

- Eating food containing more energy than you can use up causes weight increase, which can lead to obesity. Children who do not get enough food may suffer from energy protein malnutrition, in which they do not grow properly and have little energy.
- Digestion is the breakdown of large molecules of food into small ones, so that they can be absorbed through the wall of the alimentary canal.



- Mechanical digestion breaks down large pieces of food to small ones. It is done by the teeth, the muscles in the wall of the alimentary canal and bile salts. Chemical digestion breaks down large molecules to small ones. It is done by enzymes.
- Mammals have four types of teeth – incisors, canines, premolars and molars – each with their own functions.
- Digestion begins in the mouth, as teeth grind food into smaller pieces, and amylase digests starch to maltose.
- Protein digestion begins in the stomach, where pepsin digests proteins to polypeptides. Rennin is present in young mammals, and clots milk protein. Hydrochloric acid kills bacteria and provides a low pH for the action of pepsin.
- Pancreatic juice flows into the duodenum. It contains enzymes that digest starch, proteins and lipids, and also sodium hydrogencarbonate to partly neutralise the acidity of food coming from the stomach.

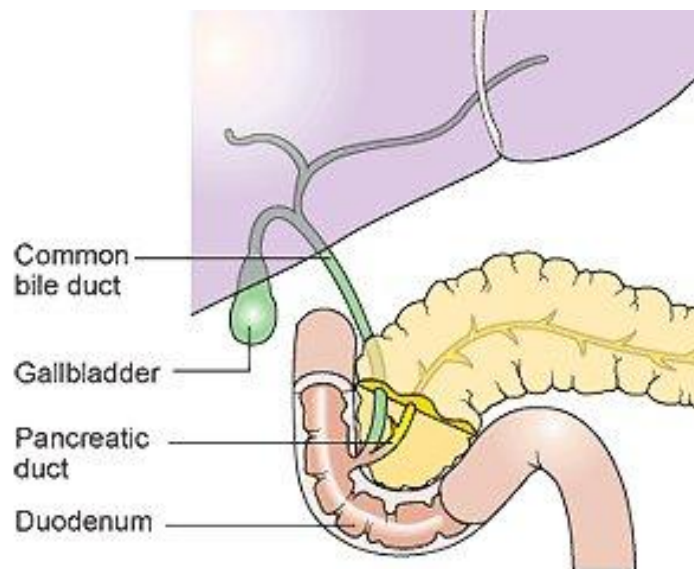
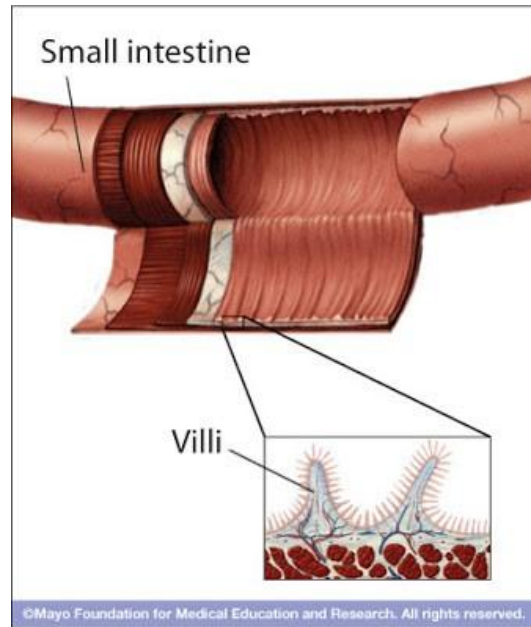


Diagram showing the bile ducts in the pancreas  
© CancerHelp UK

- Bile also flows into the duodenum. It contains bile salts, which emulsify fats, making it easier for lipase to digest them.
- The lining of the small intestine is covered with villi, giving it a very large surface area, which helps to speed up absorption. Cells on the surface of the villi make enzymes, which complete the digestion of food. The villi contain blood capillaries to absorb glucose, amino acids, water, vitamins and minerals, and lacteals to absorb fatty acids and glycerol.



- The absorbed nutrients are carried to the liver in the hepatic portal vein. Some are used in the liver, some are stored, and some are sent on in the blood to be delivered to cells all over the body.
- The colon absorbs more water from the food. In the rectum, the undigested food is formed into faeces, which are eventually egested through the anus.