



# Cambridge (CIE) IGCSE Biology



Your notes

## Human Diet & Digestion

### Contents

- \* Diet & Deficiencies
- \* Digestive System
- \* Physical Digestion
- \* Teeth & Digestion
- \* The Stomach
- \* Emulsification of Fats & Oils
- \* Chemical Digestion
- \* Enzymes in Digestion
- \* Hydrochloric Acid
- \* Digestion of Starch
- \* Digestion of Protein
- \* Bile
- \* Absorption
- \* Adaptations of the Small Intestine



# Balanced Diet

- A balanced diet consists of all of the food groups in the correct proportions
- The necessary food groups are:
  - Carbohydrates
  - Proteins
  - Lipids
  - Vitamins
  - Minerals
  - Dietary Fibre
  - Water

**Food Groups Table**

| FOOD TYPE     | FUNCTION   | SOURCES                                      |
|---------------|--|--|
| CARBOHYDRATE  | SOURCE OF ENERGY   | BREAD, CEREALS, PASTA, RICE, POTATOES        |
| PROTEIN       | GROWTH AND REPAIR  | MEAT, FISH, EGGS, PULSES, NUTS               |
| LIPID         | INSULATION AND ENERGY STORAGE                                      | BUTTER, OIL, NUTS                            |
| DIETARY FIBRE | PROVIDES BULK (ROUGHAGE) FOR THE INTESTINE TO PUSH FOOD THROUGH IT | VEGETABLES, WHOLE GRAINS                     |
| VITAMINS      | NEEDED IN SMALL QUANTITIES TO MAINTAIN HEALTH                      | FRUITS AND VEGETABLES                        |
| MINERALS      | NEEDED IN SMALL QUANTITIES TO MAINTAIN HEALTH                      | FRUITS AND VEGETABLES, MEATS, DAIRY PRODUCTS |
| WATER         | NEEDED FOR CHEMICAL REACTIONS TO TAKE PLACE IN CELLS               | WATER, JUICE, MILK, FRUITS AND VEGETABLES    |

**Vitamin and Mineral Requirements Table**



Your notes

| VITAMIN / MINERAL | FUNCTION   | SOURCES   |
|-------------------|--|---|
| VITAMIN C         | FORMS AN ESSENTIAL PART OF COLLAGEN PROTEIN, WHICH MAKES UP SKIN, HAIR, GUMS AND BONES<br><br>DEFICIENCY CAUSES SCURVY           | CITRUS FRUIT, STRAWBERRIES, GREEN VEGETABLES  |
| VITAMIN D         | HELPS THE BODY TO ABSORB CALCIUM AND SO REQUIRED FOR STRONG BONES AND TEETH  | OILY FISH, EGGS, LIVER, DAIRY PRODUCTS, ALSO MADE NATURALLY BY THE BODY IN SUNLIGHT |
| CALCIUM           | NEEDED FOR STRONG TEETH AND BONES AND INVOLVED IN THE CLOTTING OF BLOOD<br><br>DEFICIENCY CAN LEAD TO OSTEOPOROSIS LATER IN LIFE | MILK, CHEESE, EGGS  |
| IRON              | NEEDED TO MAKE HAEMOGLOBIN, THE PIGMENT IN RED BLOOD CELLS THAT TRANSPORTS OXYGEN  | RED MEAT, LIVER, LEAFY GREEN VEGETABLES LIKE SPINACH                                |

**Varying Dietary Needs of Individuals Table**

| FACTOR          | DIETARY NEEDS   |
|-----------------|---|
| AGE             | THE AMOUNT OF ENERGY THAT YOUNG PEOPLE NEED INCREASES TOWARDS ADULTHOOD AS THIS ENERGY IS NEEDED FOR GROWTH<br>CHILDREN NEED A HIGHER PROPORTION OF PROTEIN IN THEIR DIET THAN ADULTS AS THIS IS REQUIRED FOR GROWTH<br>ENERGY NEEDS OF ADULTS DECREASE AS THEY AGE                             |
| ACTIVITY LEVELS | THE MORE ACTIVE, THE MORE ENERGY REQUIRED FOR MOVEMENT AS MUSCLES ARE CONTRACTING MORE AND RESPIRING FASTER   |
| PREGNANCY       | DURING PREGNANCY, ENERGY REQUIREMENTS INCREASE AS ENERGY IS NEEDED TO SUPPORT THE GROWTH OF THE DEVELOPING FOETUS, AS WELL AS THE LARGER MASS THAT THE MOTHER NEEDS TO CARRY AROUND<br>EXTRA CALCIUM AND IRON ARE ALSO NEEDED IN THE DIET TO HELP BUILD THE BONES, TEETH AND BLOOD OF THE FETUS |
| BREASTFEEDING   | ENERGY REQUIREMENTS INCREASE AND EXTRA CALCIUM STILL NEEDED TO MAKE HIGH QUALITY BREAST MILK  |

## Scurvy & Rickets

### Scurvy



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- Scurvy is the name for a severe **vitamin C deficiency**
  - It is caused by a lack of vitamin C in the diet for over 3 months
- Its symptoms include:
  - Anemia
  - Exhaustion
  - Spontaneous bleeding
  - Pain in the limbs
  - Swelling
  - Gum ulcerations
  - Tooth loss
- It is a condition that was commonly seen in sailors between the 15th to 18th centuries
  - Long sea voyages made it very hard to access a ready supply of fresh produce
- Scurvy can be treated with **oral or intravenous vitamin C supplements**

## Rickets

- Rickets is a condition in children characterised by **poor bone development**
- Symptoms include:
  - Bone pain
  - Lack of bone growth
  - Soft, weak bones (sometimes causing deformities)
- Rickets is caused by a severe **lack of vitamin D**
  - Vitamin D is required for the absorption of calcium into the body
    - Calcium is a key component of bones and teeth
- Vitamin D mostly comes from exposure to sunlight but it can also be found in some foods (fish, eggs and butter)
- The treatment for rickets is to increase consumption of **foods containing calcium and vitamin D**
  - Alternatively vitamin D **supplements** can be prescribed



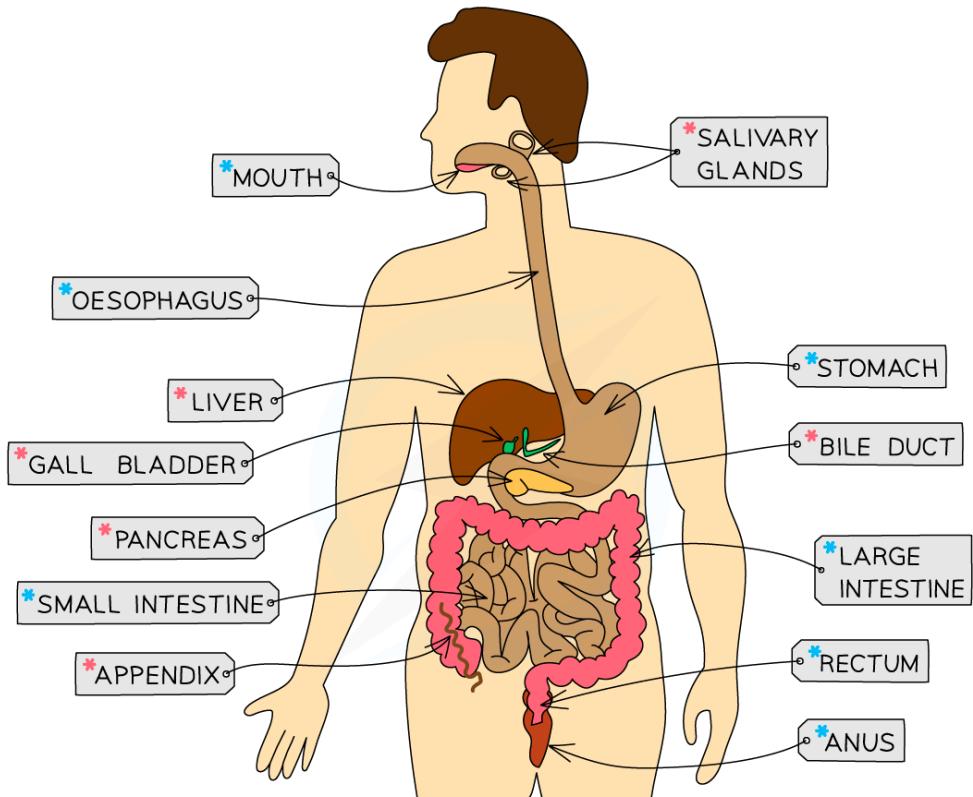
# Identifying organs of the digestive system

- The digestive system is an example of an [organ system](#)
- Some of the digestive system organs make up the **alimentary canal**; food passes directly through these organs as it moves through the body:
  - mouth
  - oesophagus
  - stomach
  - small intestine, including the duodenum and the ileum
  - large intestine, including the colon, rectum and anus
- Some of the organs of the digestive system do not form part of the route travelled by food, but are still involved with digestion; these are the **associated organs**, or accessory organs, and include the:
  - salivary glands
  - pancreas
  - liver
  - gall bladder

## Digestive system organs diagram



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\* = PART OF ALIMENTARY CANAL, THE PASSAGE ALONG WHICH FOOD PASSES THROUGH THE BODY

\* = ACCESSORY DIGESTIVE STRUCTURES

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**The organs of the human digestive system work together to digest food and absorb nutrients**

## Organs of the digestive system: function

- The function of the digestive system is to **digest food** and **absorb nutrients**
- The digestive system carries out its function in several stages:
  - ingestion:** food and drink are taken into the body through the mouth
  - mechanical digestion:** food is broken down into smaller pieces without chemical change to the food molecules
  - chemical digestion:** large, insoluble molecules are broken down into small, soluble molecules
  - absorption:** small food molecules and ions move through the wall of the intestine into the blood
  - egestion:** food that has not been digested or absorbed passes out of the body as faeces

- Once nutrients have been absorbed into the blood by the digestive system they can be **assimilated** into the body; this occurs when they are taken up by the cells of the body

## Digestive system functions table



| Structure                 | Function   |
|---------------------------|--|
| Mouth                     | Food is <b>ingested</b> here and the teeth break it down into smaller pieces during <b>mechanical digestion</b>  |
| Salivary glands           | Saliva is secreted into the mouth<br>The enzyme <b>amylase</b> in saliva begins to digest starch into maltose<br>Saliva lubricates the food for easy swallowing  |
| Oesophagus                | This tube connects the mouth to the stomach<br>Contractions of the walls of the oesophagus force the food downwards; this is peristalsis   |
| Stomach                   | Churning of the muscular stomach walls continues the process of mechanical digestion<br><b>Protease</b> enzymes begin protein digestion<br><b>Hydrochloric acid</b> provides a suitable pH for the enzymes and also destroys any pathogens in food |
| Liver                     | <b>Bile</b> is produced here<br>Bile aids the digestion of fats, as well as neutralising stomach acid as it exits the stomach  |
| Gall bladder              | Bile is stored here before being released into the duodenum via the bile duct  |
| Pancreas                  | <b>Amylase</b> , <b>protease</b> and <b>lipase</b> enzymes are produced here before being released into the duodenum   |
| Small intestine: duodenum | Food enters the small intestine from the stomach here<br>The acidic stomach contents are neutralised by bile and become slightly alkaline<br>Enzymes complete <b>chemical digestion</b> here   |
| Small intestine: ileum    | Food and water are <b>absorbed</b> into the blood via villi in the lining of the ileum   |

|                            |  |
|----------------------------|--|
| Large intestine:<br>colon  | Remaining water is absorbed from food into the blood, and the solid waste left behind in the colon forms <b>faeces</b> |
| Large intestine:<br>rectum | Faeces are stored here prior to egestion   |
| Large intestine: anus      | Faeces leave the body via the anus; this is <b>egestion</b>  |



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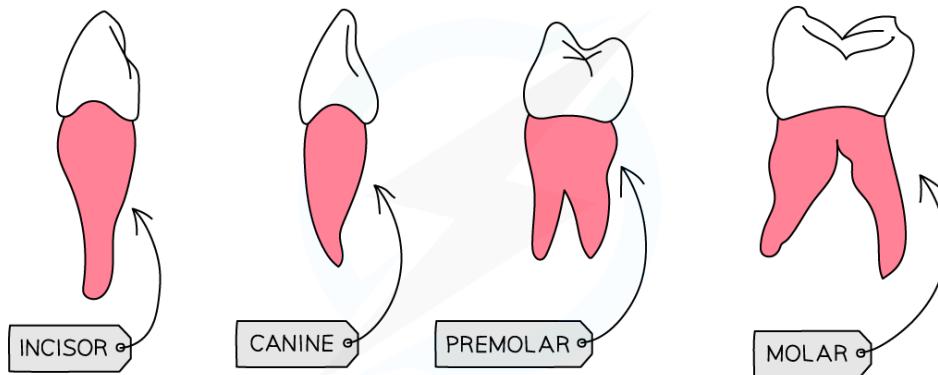
# Physical Digestion

- Physical digestion (sometimes referred to as mechanical digestion) is the breakdown of food into smaller pieces **without chemical change** to the food molecules
- The processes that take place during physical digestion help to **increase the surface area** of food for the action of **enzymes** during chemical digestion
- It is mainly carried out by the **chewing** action of the **teeth**, the **churning** action of the **stomach** and the **emulsification of fats** by **bile** in the duodenum



# Types of human teeth

- Mechanical digestion is the **breakdown of food into smaller pieces** without chemical change to the food molecules
- It is carried out by the:
  - **chewing** action of **teeth**
  - **churning** action of the **stomach**
  - **emulsification of fats** by **bile** in the duodenum
- Teeth are located in the bone of the jaws
- They are used for chewing **to increase the surface area of the food**
  - This increases the food's exposure to **saliva** and **digestive enzymes** so that it can be **broken down** more quickly
- Different teeth have different shapes, enabling them to perform slightly different functions:
  - **Incisors** are chisel-shaped for biting and cutting
  - **Canines** are pointed for tearing, holding and biting
  - **Premolars and molars** are large, flat surfaces with ridges for chewing and grinding up food



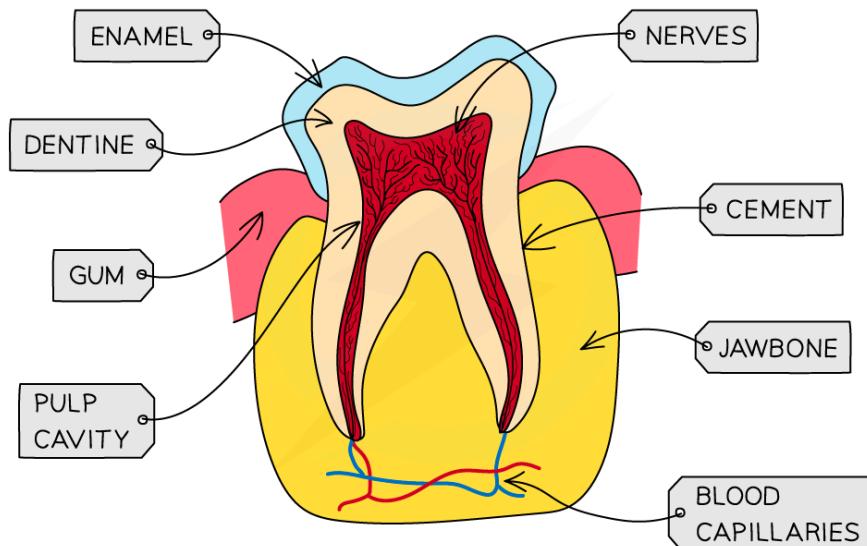
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Teeth are shaped to carry out different roles in mechanical digestion of food

# Structure of a tooth

- Teeth are embedded in the gums and within the bone of the jaw
- The structure of human teeth includes:
  - **enamel**: the hard, outer layer that protects the teeth
  - **dentine**: the layer beneath the enamel that protects the nerves
  - **pulp**: the soft, internal tissue of the tooth that contains **nerves** and **blood vessels**
  - **cement**: a hard layer around the root of a tooth that helps to anchor it within the jaw



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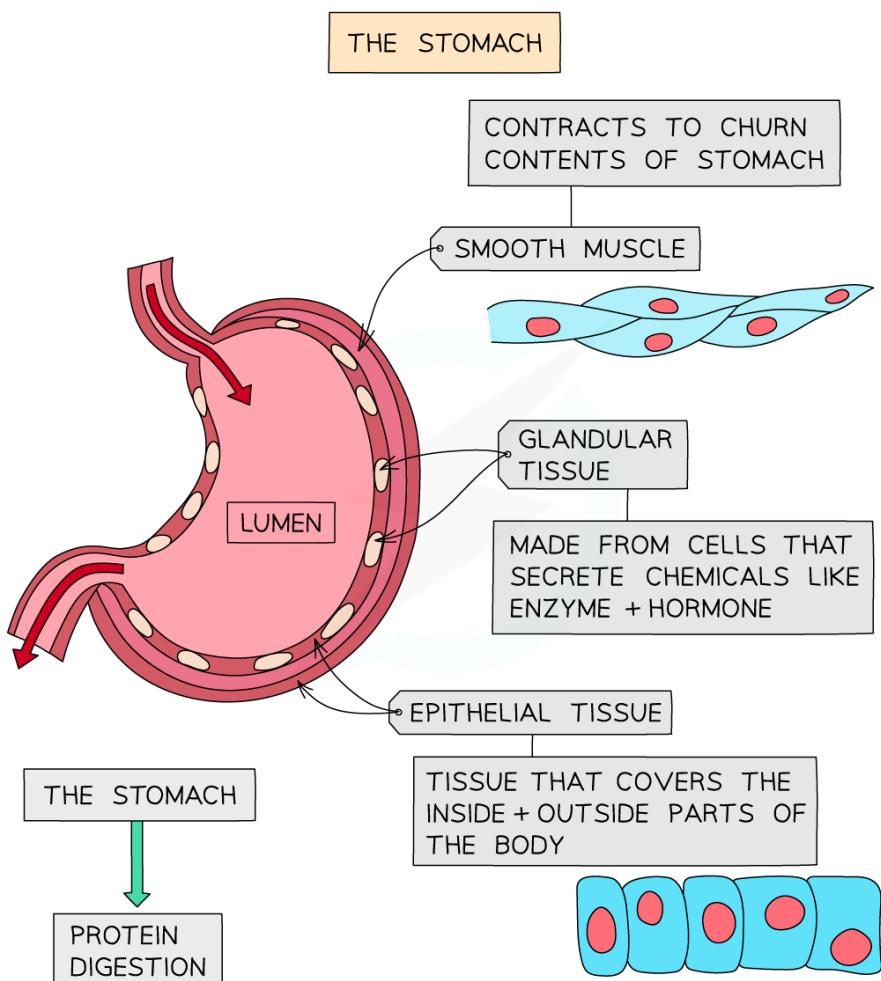


**Teeth are embedded in the gums and within the bone of the jaw**



# The Stomach

- The stomach is one of a number of organs that make up the digestive system
- The role of the digestive system is to break down large insoluble molecules into smaller, soluble food molecules to provide the body with nutrients
- The stomach lining contains **muscles** which contract to **physically squeeze** and mix the food with the strong digestive juices that are present
  - Also known as "stomach **churning**"
- Food is digested within the stomach for several hours



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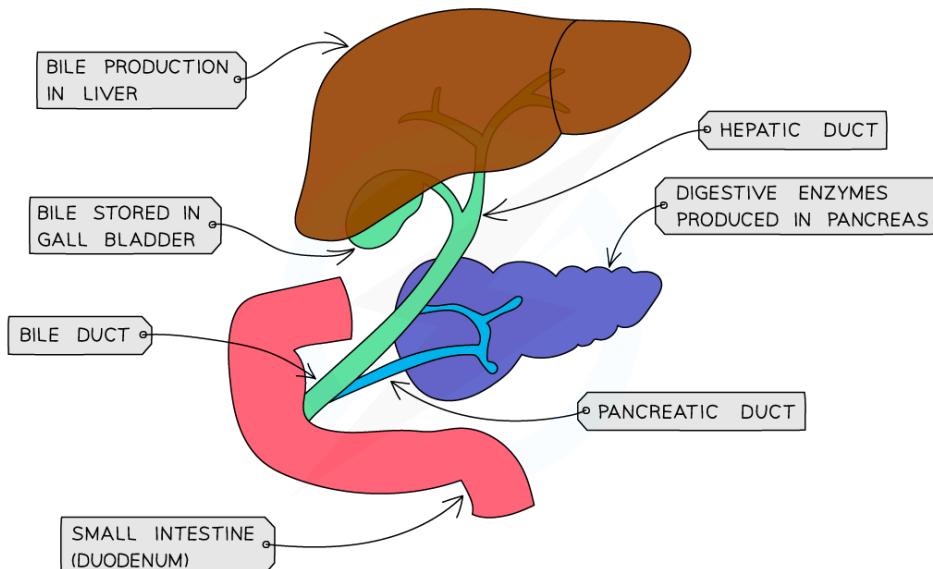
Three types of tissue found in the stomach are muscular, epithelial and glandular. These tissues work together to allow the stomach to carry out its role.



# Emulsification of Fats & Oils: Extended

## Extended Tier Only

- Cells in the liver produce bile which is then stored in the **gallbladder**



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### Bile production and secretion

Bile has two main roles:

- It is **alkaline** to **neutralise the hydrochloric acid** which comes from the stomach
- The enzymes in the small intestine have a higher (more alkaline) optimum pH than those in the stomach
- It **breaks down large drops of fat into smaller ones**. This is known as **emulsification**. The larger surface area allows lipase to chemically break down the lipid into glycerol and fatty acids faster



### Examiner Tips and Tricks

Emulsification is the equivalent of tearing a large piece of paper into smaller pieces of paper. This is an example of **mechanical digestion**, not chemical digestion – breaking something into smaller pieces does not break bonds or change the chemical

structure of the molecules which make it up, which is the definition of chemical digestion.

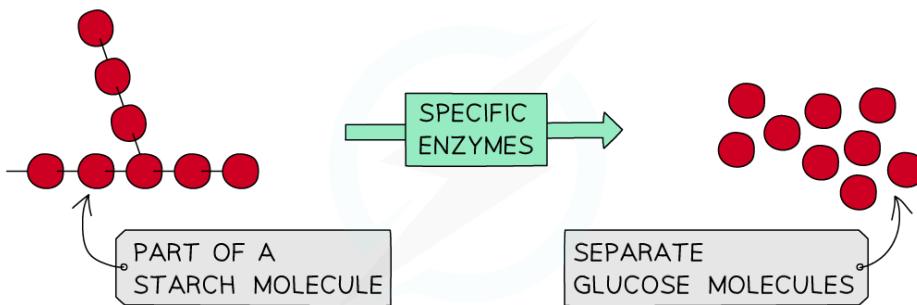


Your notes



# Chemical Digestion

- Chemical digestion is the **breakdown of large insoluble molecules** into **small soluble molecules**
  - E.g., starch is broken down into simple sugars using the enzyme amylase
- Chemical digestion is required because large insoluble molecules are **unable to be absorbed** through the wall of the small intestines
- Small soluble molecules produced from chemical digestion, are **easily absorbed** into the surrounding capillaries
- Enzymes** are required for chemical digestion to take place



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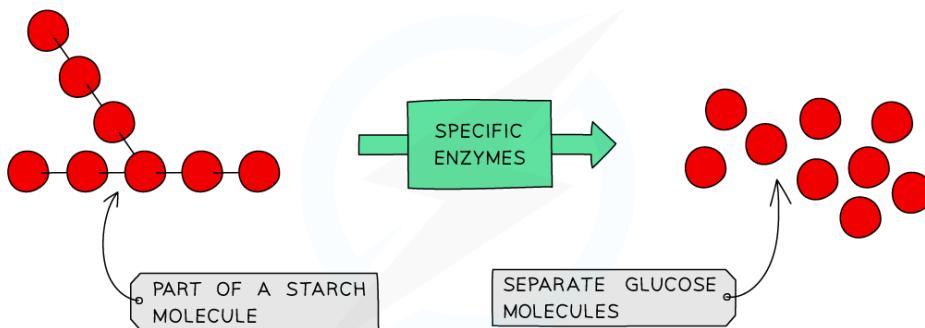
**Chemical digestion involves the breakdown of large insoluble molecules into small soluble molecules for absorption**



# Enzymes in Digestion

## Amylases

- Amylases are produced in the **mouth** and the **pancreas** (secreted into the **duodenum**)
- Amylases digest **starch** into smaller sugars



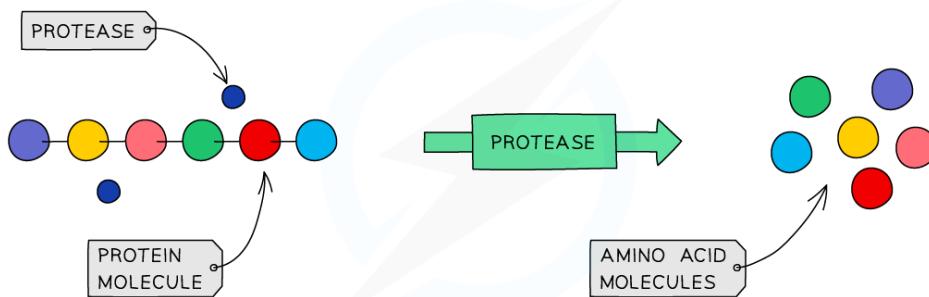
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### *The digestion of starch*

## Proteases

- Proteases are a group of **enzymes that break down proteins** into **amino acids** in the stomach and small intestine (with the enzymes in the small intestine having been produced in the pancreas)



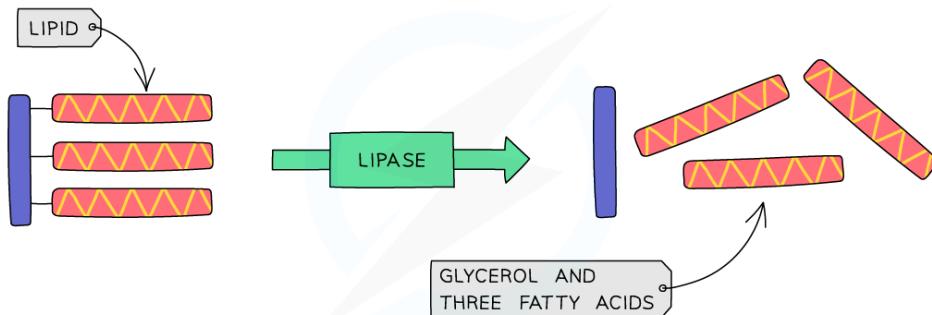
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### *The digestion of proteins*

## Lipases

- **Lipase** enzymes are produced in the **pancreas** and secreted into the **duodenum**
- They digest **lipids** into **fatty acids** and **glycerol**



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### *The digestion of lipids*



# Hydrochloric Acid

- The stomach produces several fluids which together are known as **gastric juice**
- One of the fluids produced is **hydrochloric acid**
- This kills **bacteria** in food and gives an **acid pH for enzymes** to work in the stomach

## How is a low pH helpful in the stomach?

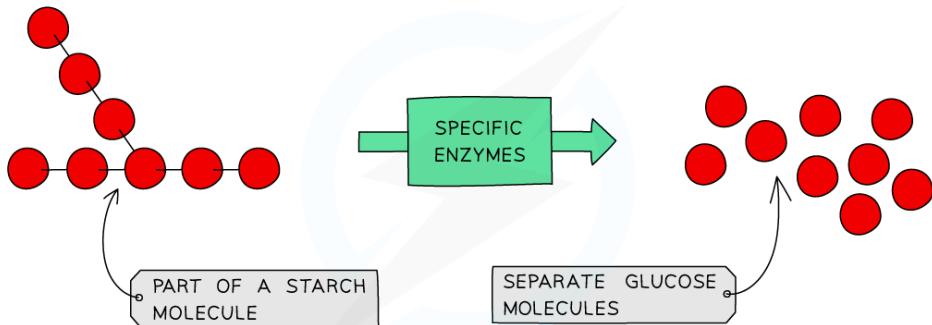
- The low pH kills bacteria in food that we have ingested as it **denatures the enzymes in their cells**, meaning they cannot carry out any cell reactions to maintain life
- **Pepsin**, produced in the stomach, is an example of an enzyme which has a very low optimum pH - around **pH 2**
- The hydrochloric acid produced in the stomach ensures that conditions in the **stomach remain within the optimum range** for pepsin to work at its fastest rate



# Digestion of Starch: Extended

## Extended Tier Only

- Amylases are produced in the **mouth** and the **pancreas** (secreted into the **duodenum**)
- Amylases digest **starch** into **smaller sugars**



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### *The digestion of starch*

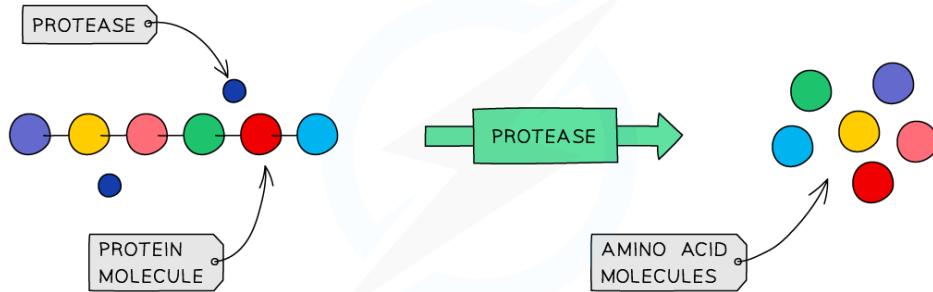
- **Amylase** is secreted into the alimentary canal in the **mouth** and the **duodenum** (from the pancreas) and digests **starch to maltose** (a disaccharide)
- **Maltose** is digested by the enzyme **maltase** into **glucose** on the membranes of the epithelium lining of the small intestine



# Digestion of Protein: Extended

## Extended Tier Only

- Proteases are a group of **enzymes that break down proteins into amino acids** in the stomach and small intestine (with the enzymes in the small intestine having been produced in the pancreas)



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### The digestion of proteins

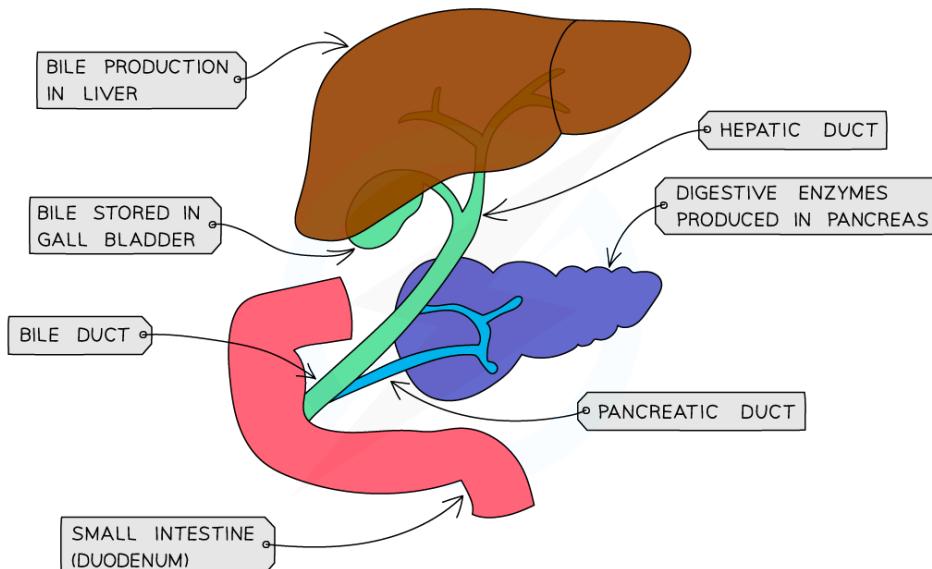
- Protein digestion takes place in the stomach and duodenum with two main enzymes produced:
  - **Pepsin** is produced in the **stomach** and **breaks down protein in acidic conditions**
  - **Trypsin** is produced in the **pancreas** and secreted into the **duodenum** where it breaks down protein in **alkaline conditions**



# Bile: Extended

## Extended Tier Only

- Cells in the liver produce bile which is then stored in the **gallbladder**



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### Bile production and secretion

**Bile has two main roles:**

- It is **alkaline** to **neutralise the hydrochloric acid** which comes from the stomach
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structure of the molecules which make it up, which is the definition of chemical digestion.





# Absorbing Nutrients

- Absorption is the **movement of digested food molecules from the digestive system into the blood** (glucose and amino acids) and **lymph** (fatty acids and glycerol)
- Nutrients are absorbed in the **small intestine**
- **Assimilation** is the process where digested food molecules are taken up by cells and used for growth, repair, and energy production

# Absorbing Water

- **Water** is absorbed in both the **small intestine** and the **colon**, but **most absorption of water** (around 80%) happens in the **small intestine**



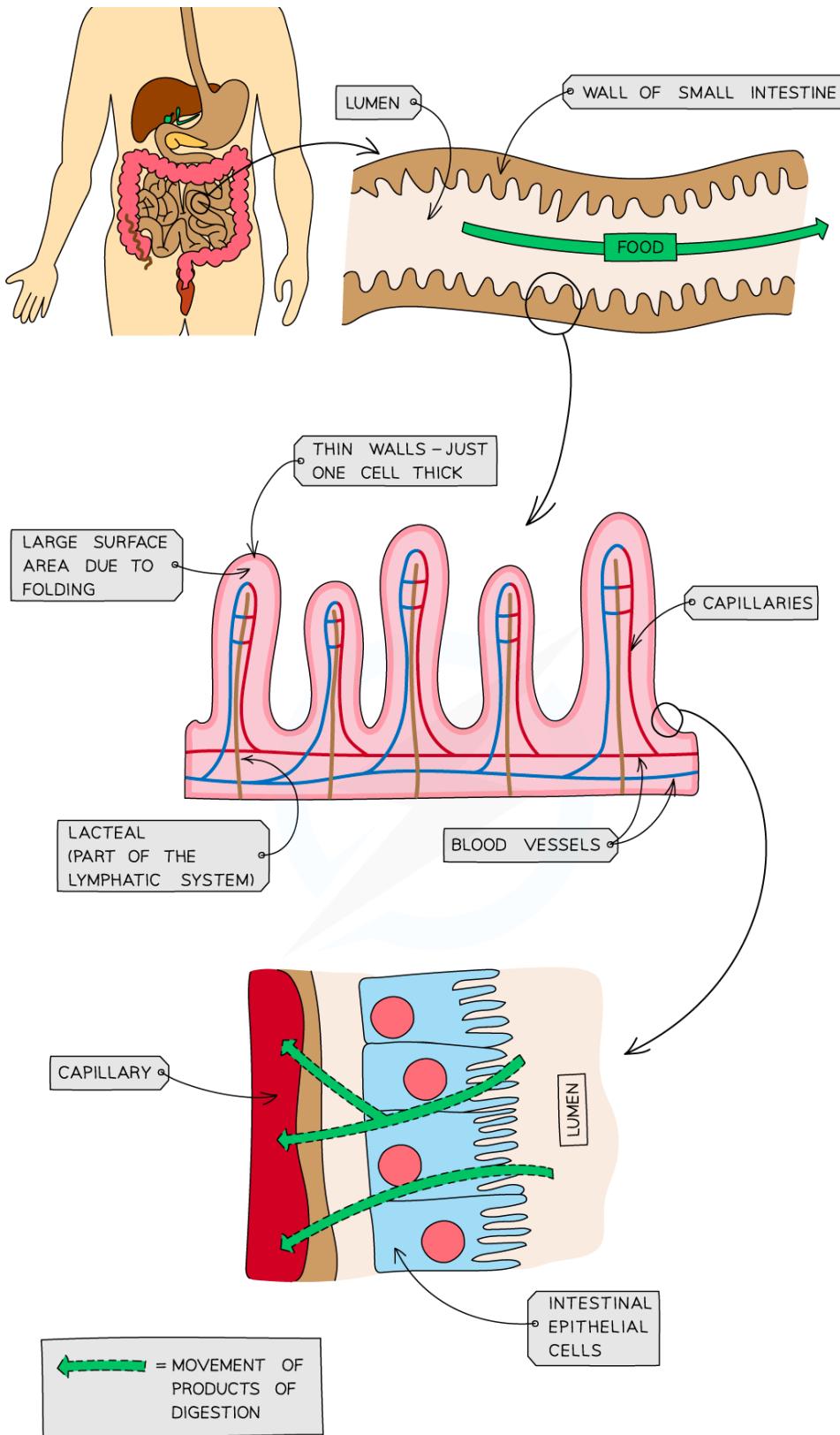
# Adaptations of the Small Intestine: Extended

## Extended Tier Only

- The ileum is adapted for absorption as it is **very long** and has a **highly folded surface with millions of villi** (tiny, finger like projections)
- These adaptations massively **increase the surface area** of the ileum, allowing absorption to take place faster and more efficiently



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### Adaptations of the small intestine

- **Microvilli** on the surface of the villus further increase surface area for faster absorption of nutrients
- Wall of the villus is **one cell thick** meaning that there is only a short distance for absorption to happen by diffusion and active transport
- Well supplied with a **network of blood capillaries** that transport glucose and amino acids away from the small intestine in the blood
- **Lacteal** runs through the centre of the villus to transport fatty acids and glycerol away from the small intestine in the lymph



### Examiner Tips and Tricks

The **way in which the structure of a villus is related to its function** comes up frequently in exam questions so it is worth ensuring you have learned these adaptations.