



# Cambridge (CIE) IGCSE Biology



Your notes

## Human Diet & Digestion

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## 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 <b>COLLAGEN</b> PROTEIN, WHICH <b>MAKES UP SKIN, HAIR, GUMS AND BONES</b> DEFICIENCY CAUSES <b>SCURVY</b>	CITRUS FRUIT, STRAWBERRIES, GREEN VEGETABLES
VITAMIN D	HELPS THE BODY TO ABSORB CALCIUM AND SO REQUIRED FOR <b>STRONG BONES AND TEETH</b>	OILY FISH, EGGS, LIVER, DAIRY PRODUCTS, ALSO MADE NATURALLY BY THE BODY IN SUNLIGHT
CALCIUM	NEEDED FOR <b>STRONG TEETH AND BONES</b> AND INVOLVED IN THE CLOTTING OF BLOOD DEFICIENCY CAN LEAD TO OSTEOPOROSIS LATER IN LIFE	MILK, CHEESE, EGGS
IRON	NEEDED TO MAKE <b>HAEMOGLOBIN</b> , 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 <b>INCREASES TOWARDS ADULTHOOD AS THIS ENERGY IS NEEDED FOR GROWTH</b> CHILDREN NEED A HIGHER PROPORTION OF PROTEIN IN THEIR DIET THAN ADULTS AS THIS IS REQUIRED FOR <b>GROWTH</b> ENERGY NEEDS OF ADULTS <b>DECREASE</b> AS THEY AGE
ACTIVITY LEVELS	THE MORE ACTIVE, THE MORE ENERGY REQUIRED FOR MOVEMENT AS <b>MUSCLES ARE CONTRACTING MORE AND RESPIRING FASTER</b>
PREGNANCY	DURING PREGNANCY, ENERGY REQUIREMENTS INCREASE AS <b>ENERGY IS NEEDED TO SUPPORT THE GROWTH OF THE DEVELOPING FOETUS</b> , AS WELL AS THE LARGER MASS THAT THE MOTHER NEEDS TO CARRY AROUND EXTRA <b>CALCIUM</b> AND <b>IRON</b> ARE ALSO NEEDED IN THE DIET TO HELP BUILD THE BONES, TEETH AND BLOOD OF THE FETUS
BREASTFEEDING	<b>ENERGY</b> REQUIREMENTS <b>INCREASE</b> AND EXTRA <b>CALCIUM</b> 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



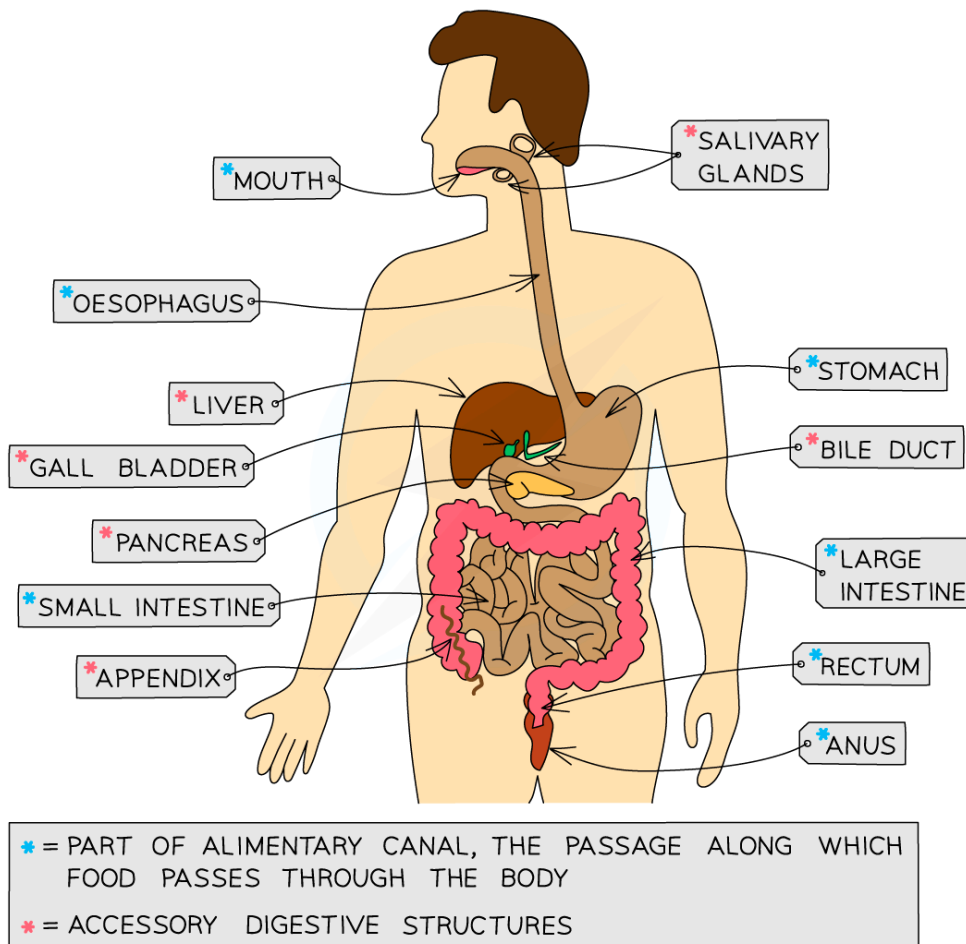
# Identifying organs of the digestive system

- 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



Your notes



*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



Your notes

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 The enzyme <b>amylase</b> in saliva begins to digest starch into maltose Saliva lubricates the food for easy swallowing
Oesophagus	This tube connects the mouth to the stomach 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 <b>Protease</b> enzymes begin protein digestion <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 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, 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 The acidic stomach contents are neutralised by bile and become slightly alkaline 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: 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: rectum	Faeces are stored here prior to egestion
Large intestine: anus	Faeces leave the body via the anus; this is <b>egestion</b>



Your notes



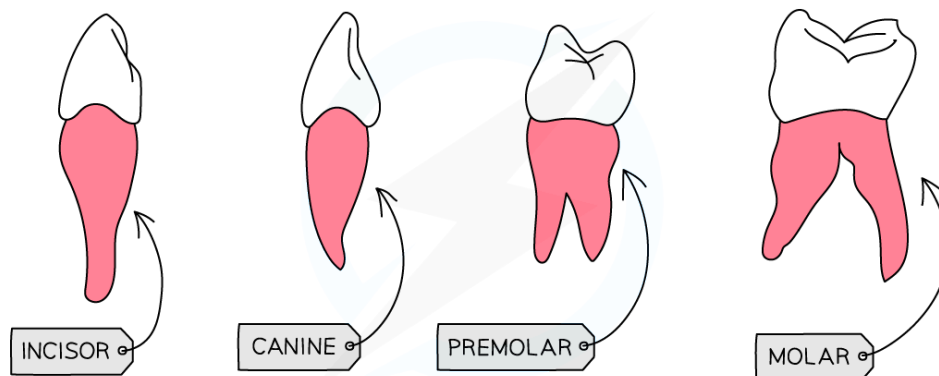
# Physical Digestion

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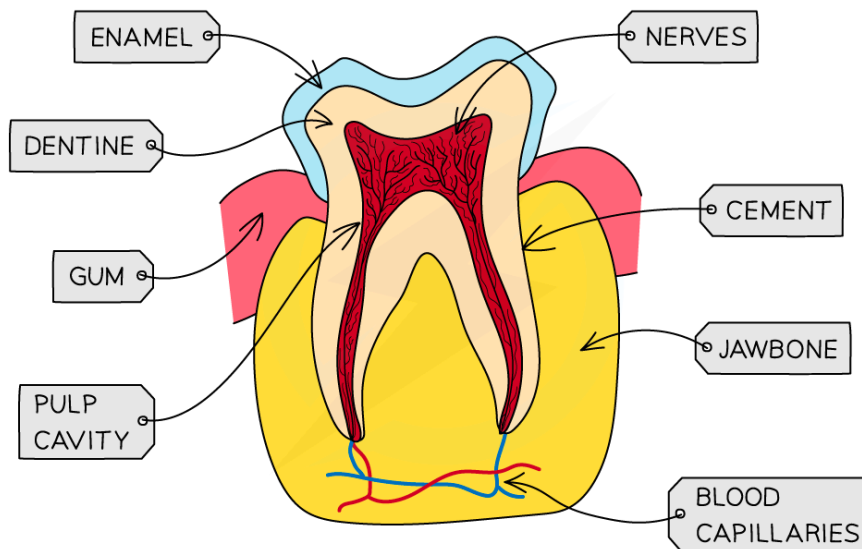
*Teeth are shaped to carry out different roles in mechanical digestion of food*

## Structure of a tooth



Your notes

- 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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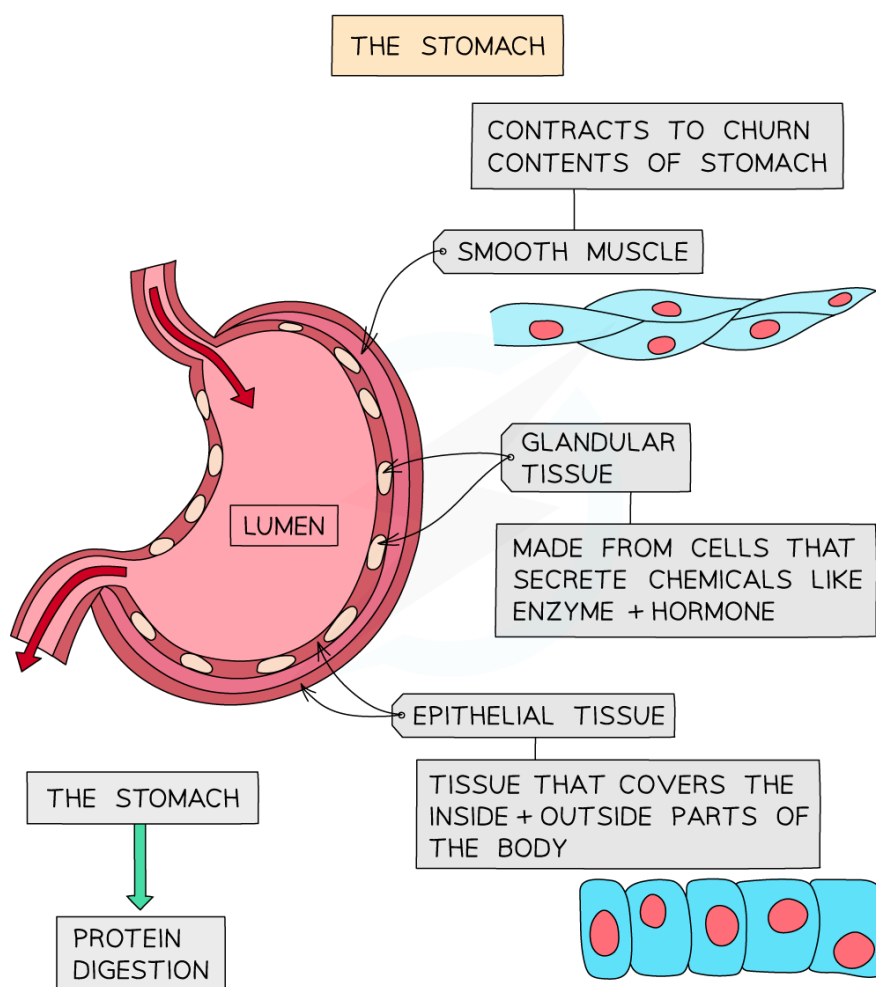


*Teeth are embedded in the gums and within the bone of the jaw*



# 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



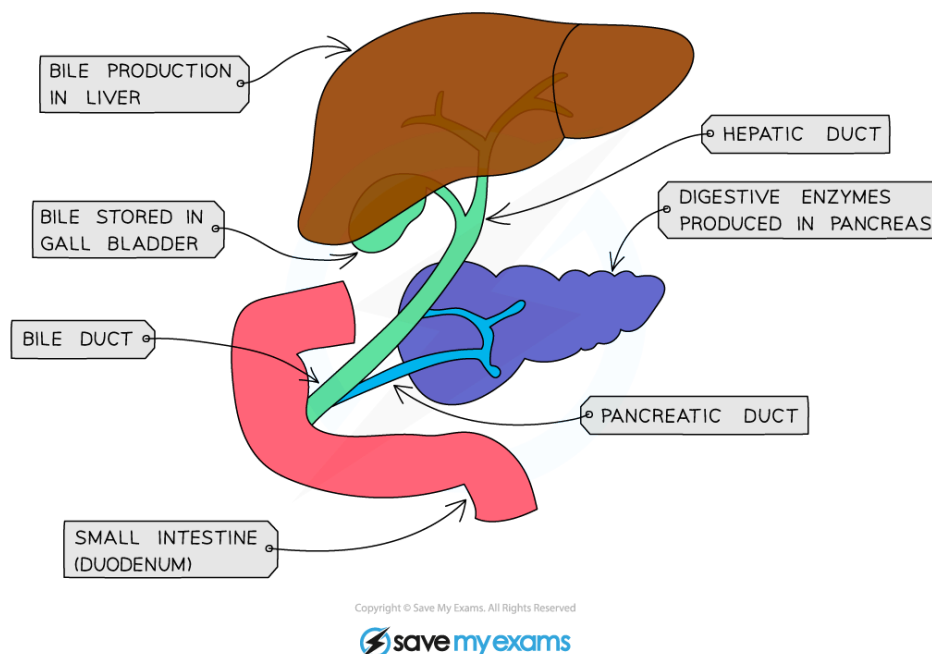
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Three types of tissue found in the stomach are muscular, epithelial and glandular. These tissues work together to allow the stomach to carry out its role.



# Emulsification of Fats & Oils: Extended Extended Tier Only

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



### *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.

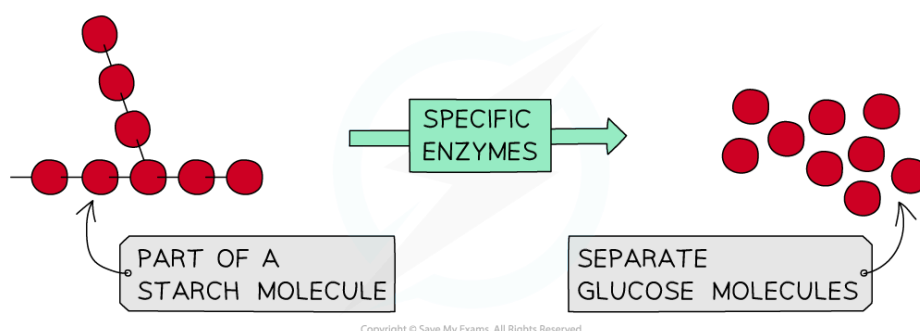


Your notes



# 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



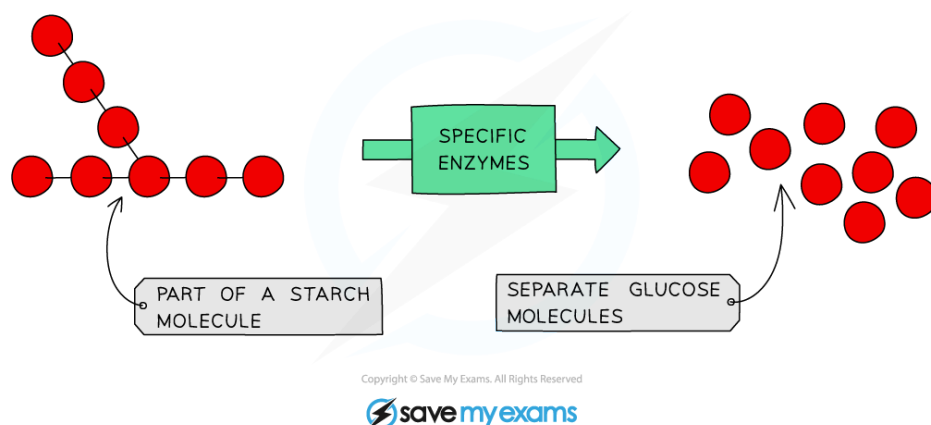
*Chemical digestion involves the breakdown of large insoluble molecules into small soluble molecules for absorption*



# Enzymes in Digestion

## Amylases

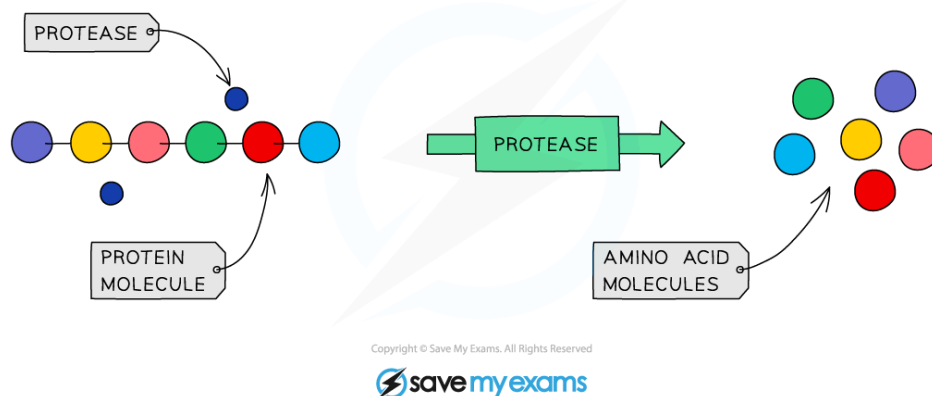
- **Amylases** are produced in the **mouth** and the **pancreas** (secreted into the **duodenum**)
- Amylases digest **starch into smaller sugars**



*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)



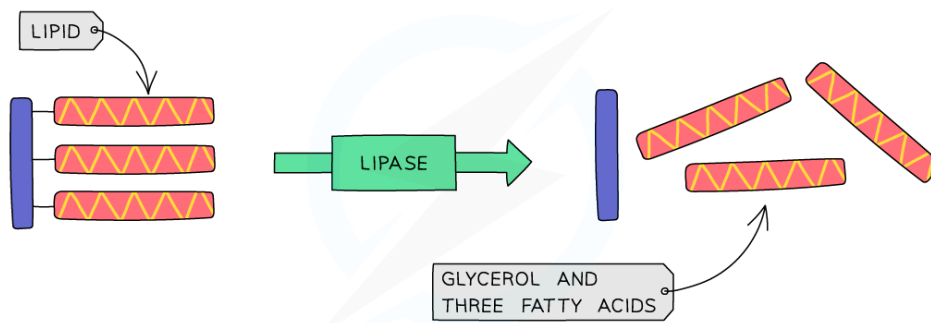
*The digestion of proteins*

## Lipases

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



Your notes



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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?

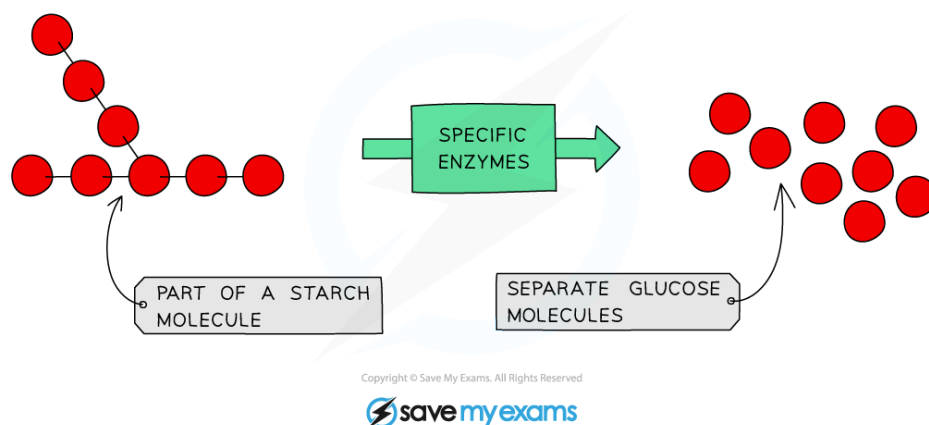
- The low pH kills bacteria in food that we have ingested as it **denatures the enzymes in their cells**, meaning they cannot carry out any cell reactions to maintain life
- **Pepsin**, produced in the stomach, is an example of an enzyme which has a very low optimum pH - around **pH 2**
- The hydrochloric 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**



### *The digestion of starch*

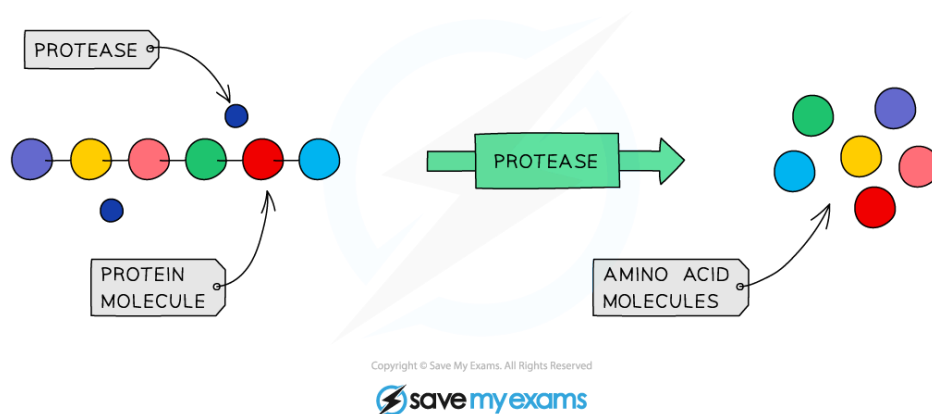
- **Amylase** is secreted into the alimentary canal in the **mouth** and the **duodenum** (from the pancreas) and digests **starch to maltose** (a disaccharide)
- **Maltose** is digested by the enzyme **maltase** into **glucose** on the membranes of the epithelium lining of the small intestine



# 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)



### *The digestion of proteins*

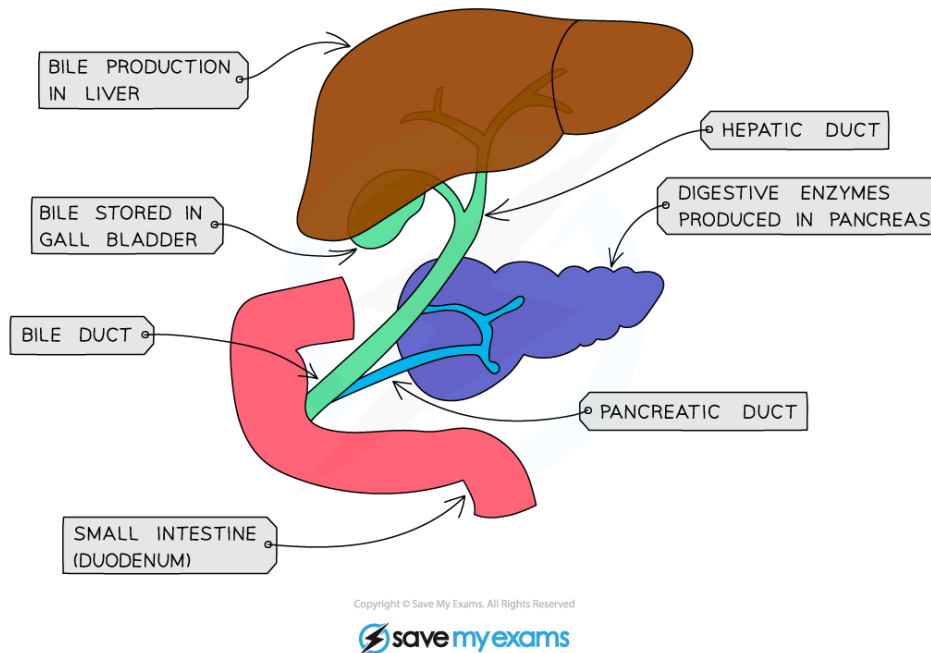
- Protein digestion takes place in the stomach and duodenum with two main enzymes produced:
  - Pepsin** is produced in the **stomach** and **breaks down protein in acidic conditions**
  - Trypsin** is produced in the **pancreas** and secreted into the **duodenum** where it breaks down protein in **alkaline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



# Bile: Extended

## Extended Tier Only

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



### *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
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Your notes



# 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**



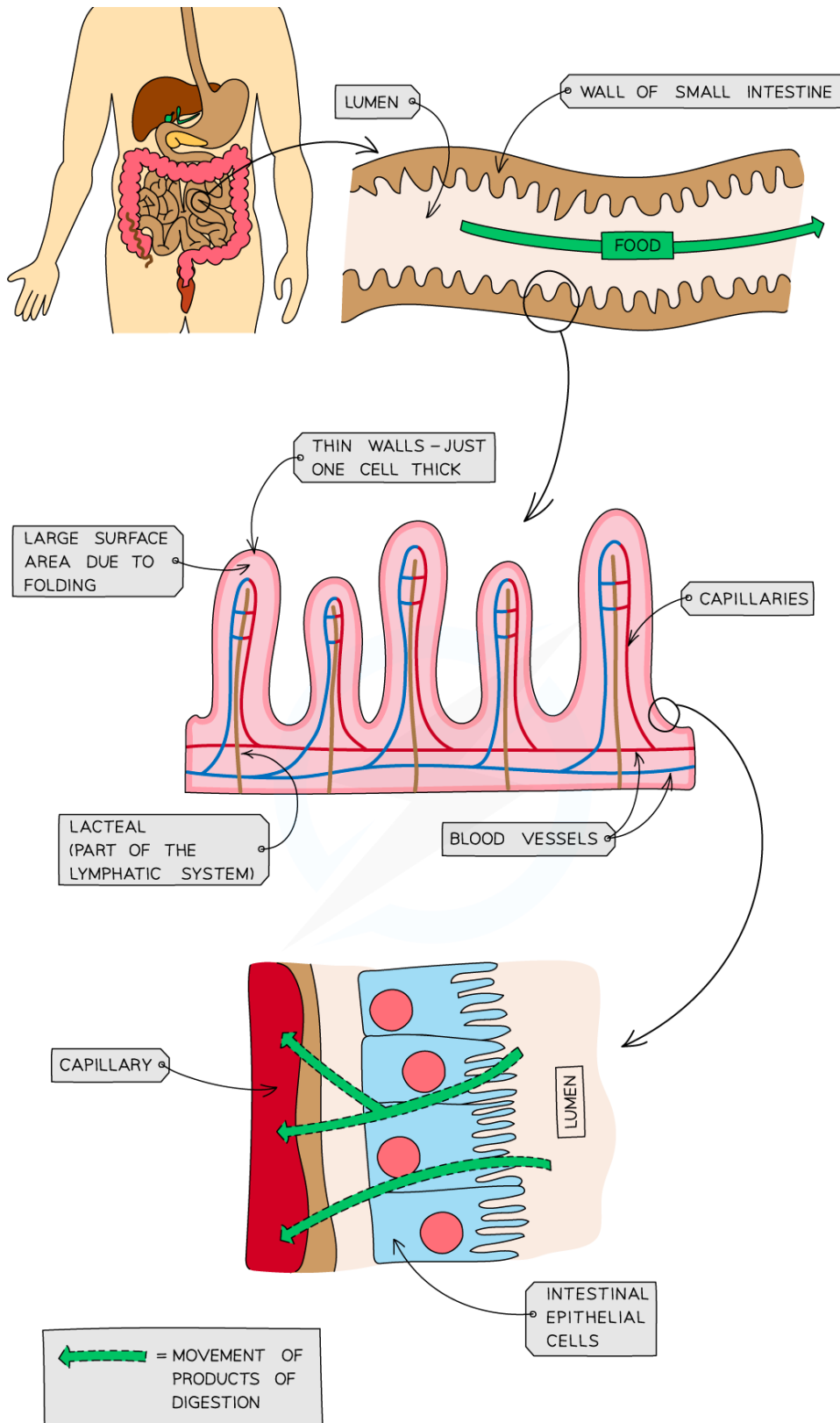
# Adaptations of the Small Intestine: Extended

## 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



Your notes



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### Adaptations of the small intestine



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- **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.