

Human nutrition revision notes

Human nutrition is about how the body gets the materials and energy it needs from food. You will learn what a balanced diet contains, how the organs of the digestive system break food down physically and chemically, and how the small soluble products are absorbed into the blood.

For Cambridge IGCSE Biology 0610 (and 0970, which has the same content). **Supplement** is Extended content, only examined on Papers 2 and 4.

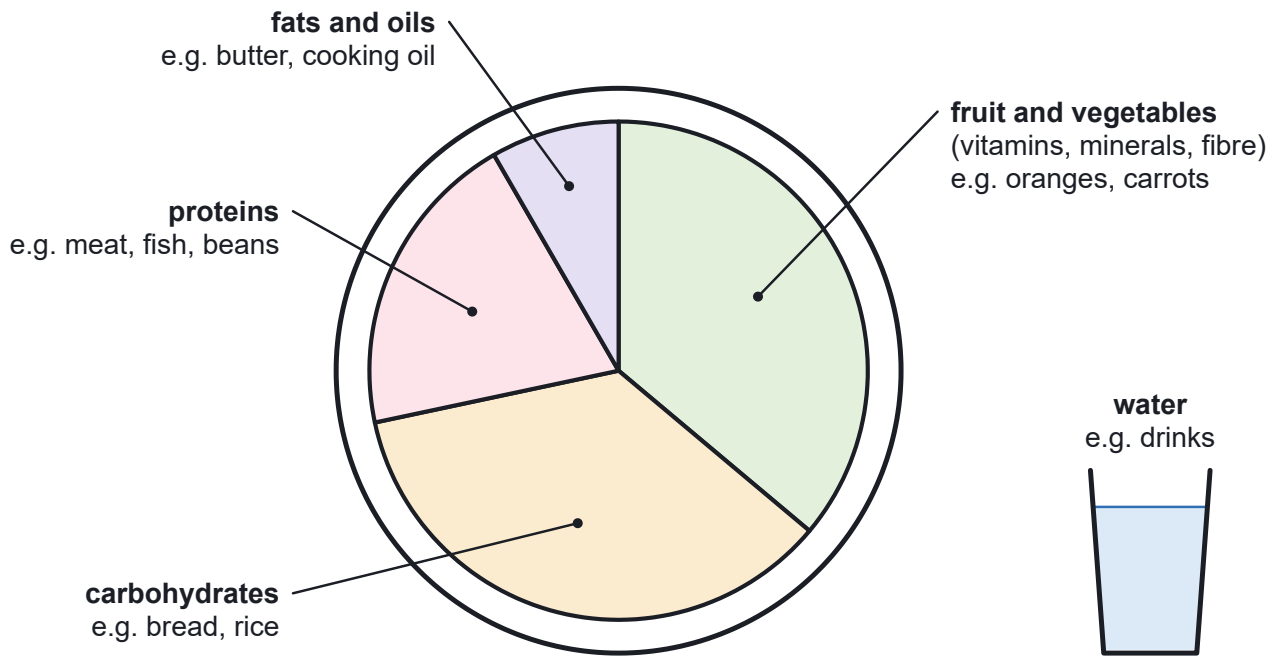
1 Diet Spec 7.1

A balanced diet and the main nutrients Spec 7.1.1, 7.1.2

A **balanced diet** contains all the nutrients the body needs, in the correct proportions, and gives the right amount of energy for the person. The amount of energy needed depends on age, sex and how active the person is.

You need to know the main source of each nutrient and why the body needs it. Vitamins are limited to C and D, and mineral ions are limited to calcium and iron.

Nutrients: sources and importance		
Nutrient	Main dietary sources	Importance in the body
Carbohydrates	Bread, rice, pasta, potatoes	Provide energy
Fats and oils	Butter, cooking oils, fatty meat, nuts	Provide energy, act as an energy store and give insulation (keeping the body warm)
Proteins	Meat, fish, eggs, beans	Growth and repair of tissues
Vitamin C	Citrus fruits, fresh fruit and vegetables	Needed for healthy skin and gums; prevents scurvy
Vitamin D	Oily fish, eggs, margarine (also made in the skin in sunlight)	Helps the body absorb calcium, so bones and teeth are hard; prevents rickets
Calcium	Milk, cheese, yoghurt	Making bones and teeth
Iron	Red meat, liver, green leafy vegetables	Making haemoglobin in red blood cells
Fibre (roughage)	Wholemeal bread, fruit, vegetables	Provides bulk for the muscles of the gut to push food along, which helps prevent constipation
Water	Drinks and most foods	Needed as a solvent and for the reactions in cells; forms the blood plasma, sweat and urine



A balanced diet contains all the nutrients in the **correct proportions**, plus fibre and water.

Common mistake: Do not say fibre 'gives energy' or is digested. Fibre is not digested by humans; it adds bulk to the food.

Exam tip: Give a specific use, not just 'for health'. Write 'iron for making haemoglobin' or 'calcium for strong bones and teeth'.

Vitamins, minerals, scurvy and rickets Spec 7.1.3

A **deficiency disease** is caused by not getting enough of a particular nutrient over a long period. Two you need to know are scurvy and rickets.

Scurvy and rickets		
Disease	Cause	Effect
Scurvy	Lack of vitamin C in the diet	Bleeding gums, slow healing of wounds and sore, damaged skin
Rickets	Lack of vitamin D (or calcium) in the diet	Bones do not harden properly, so they are soft and may bend, especially in children

Vitamin C is found in fresh fruit and vegetables, so a diet with none of these for a long time can lead to scurvy. Vitamin D helps the body absorb calcium from food. Without enough vitamin D, or without enough calcium, the bones and teeth cannot become hard.

- Scurvy: eat citrus fruits and fresh vegetables.
- Rickets: eat oily fish, eggs and dairy foods, and get some sunlight on the skin.

Common mistake: Do not swap the pairs. Scurvy goes with vitamin C and rickets goes with vitamin D (or calcium). Each is prevented only by eating more of the missing nutrient.

Quick check

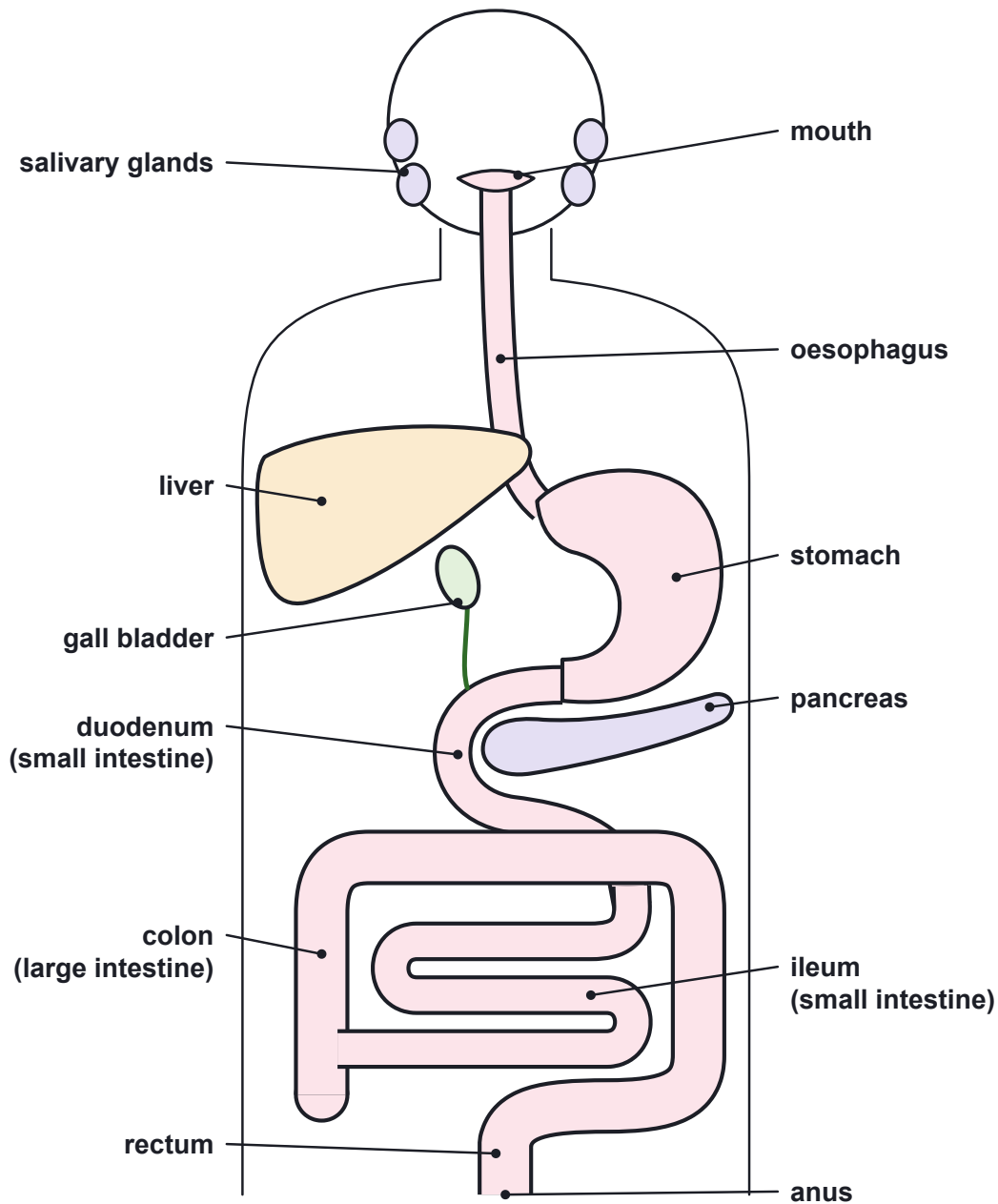
- 1 . What is a balanced diet?
- 2 . Which nutrient is needed for growth and repair?
- 3 . What causes scurvy?
- 4 . What causes rickets?
- 5 . Why does the body need iron?

2 The digestive system Spec 7.2, 7.3

Organs of the digestive system Spec 7.2.1, 7.2.2

The **alimentary canal** is the long tube that food passes through from mouth to anus. The **associated organs** are not part of the tube, but they make and store the juices that digest food.

- Alimentary canal: mouth, oesophagus, stomach, small intestine (duodenum and ileum) and large intestine (colon, rectum and anus).
- Associated organs: salivary glands, pancreas, liver and gall bladder.



The **alimentary canal** (pink) runs from mouth to anus; the **associated organs** (salivary glands, liver, gall bladder, pancreas) are shown in other colours.

Five processes of nutrition

Ingestion	The taking of substances, e.g. food and drink, into the body.
Digestion	The breakdown of food.
Absorption	The movement of nutrients from the intestines into the blood.
Assimilation	Uptake and use of nutrients by cells.
Egestion	The removal of undigested food from the body as faeces.

Functions of the organs		
Organ	Function	Process
Mouth	Food and drink are taken in; teeth break food up; food mixes with saliva	Ingestion; digestion
Salivary glands	Make saliva containing amylase, which starts chemical digestion of starch	Digestion
Oesophagus	Carries food from the mouth to the stomach	(moves food along)
Stomach	Churns food; makes gastric juice containing protease and hydrochloric acid	Digestion
Liver	Makes bile; absorbed nutrients are carried to the liver in the blood, and some are used there, e.g. amino acids to make proteins	Digestion; assimilation
Gall bladder	Stores bile and releases it into the duodenum	Digestion
Pancreas	Makes enzymes (amylase, protease, lipase) and releases them into the duodenum	Digestion
Small intestine: duodenum	Receives bile and pancreatic juice; digestion of food continues	Digestion
Small intestine: ileum	Digestion is completed; nutrients and most of the water are absorbed into the blood	Digestion; absorption
Large intestine: colon	Absorbs some water from the undigested food	Absorption
Rectum	Stores faeces	(before egestion)
Anus	Faeces leave the body	Egestion

Assimilation happens after absorption. The blood carries the absorbed nutrients to the body's cells, which take them up and use them, for example glucose for respiration and amino acids to make proteins.

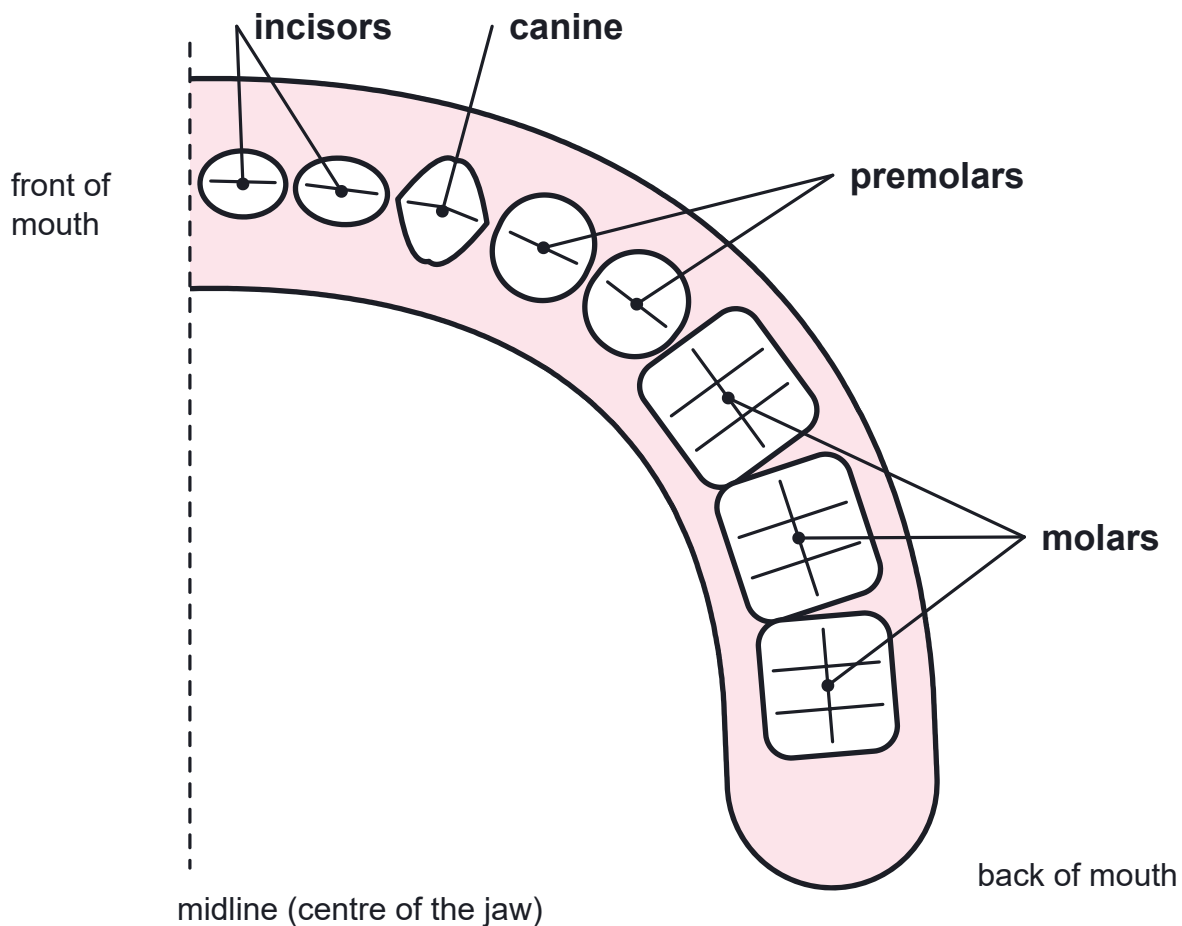
Common mistake: Egestion is the removal of undigested food as faeces. It is not excretion, and it is not the same as absorption.

Physical digestion and teeth Spec 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5

Physical digestion is the breakdown of food into smaller pieces without chemical change to the food molecules. It increases the **surface area** of the food, so enzymes in chemical digestion can act on more of it at once.

Types of human teeth

Human teeth and their functions		
Type	Shape	Function in physical digestion
Incisors	Flat, chisel-shaped edge	Biting and cutting food
Canines	Pointed	Tearing and gripping food
Premolars	Broad with a ridged surface	Crushing and grinding food
Molars	Large and broad with a ridged surface	Crushing and grinding food

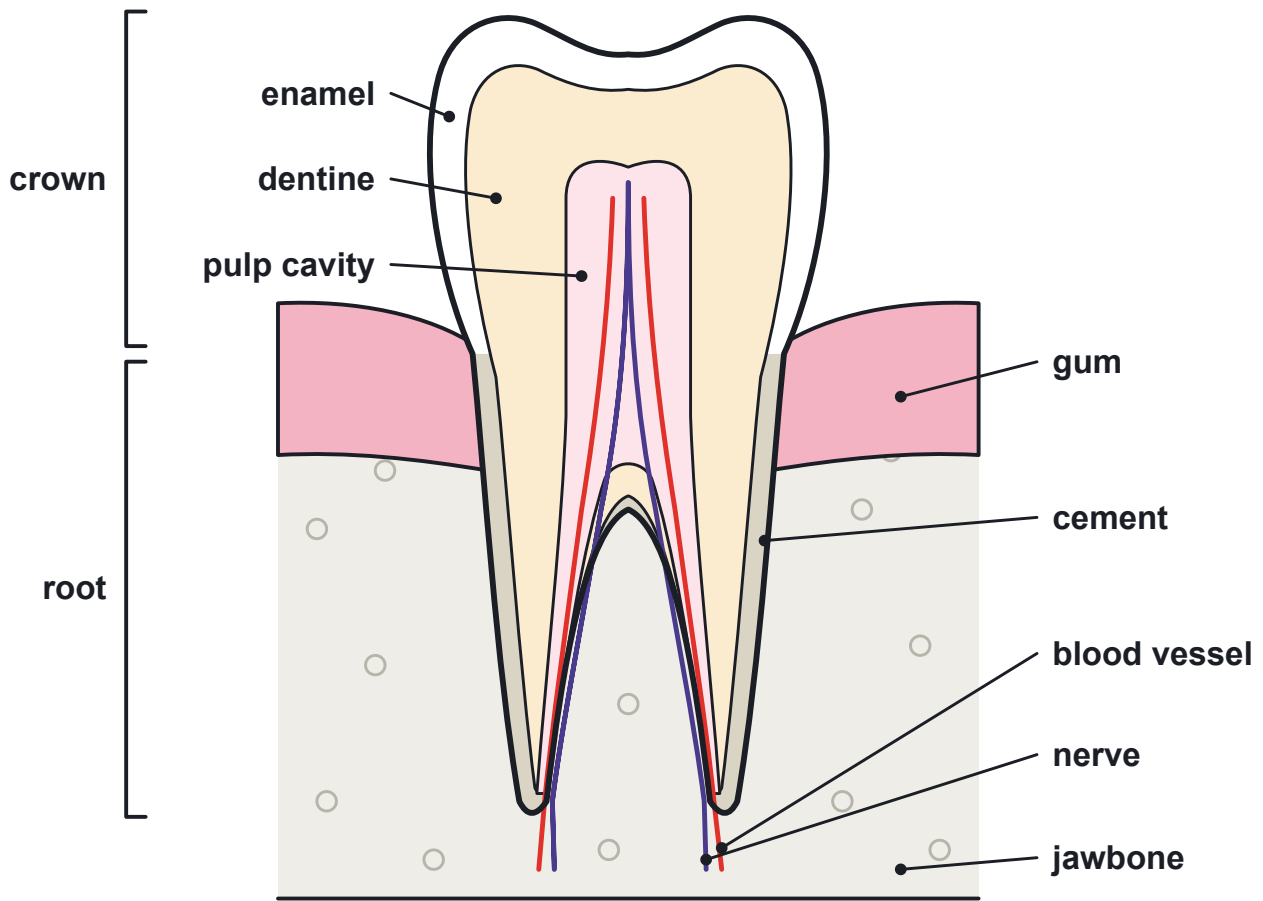


Half of the lower jaw: **incisors** cut, **canines** tear, **premolars** and **molars** crush and grind.

Structure of a tooth

Parts of a tooth	
Part	Description and function
Enamel	The hard outer covering of the crown; protects the tooth
Dentine	Hard, bone-like material under the enamel
Pulp	The soft centre of the tooth, containing nerves and blood vessels
Nerves and blood vessels	Nerves sense pain, temperature and pressure; blood vessels supply the living cells of the tooth
Cement	Covers the root and fixes the tooth in the jawbone

Teeth are **embedded in bone** (the jawbone) and in the **gums**, which hold them firmly in place.



Section through a molar: the root is fixed in the **jawbone** by **cement** and held by the **gum**.

Exam tip: Match each tooth to its job: incisors cut, canines tear, premolars and molars crush and grind. Use those exact verbs.

The stomach, acid and bile Spec 7.3.6, 7.3.7, 7.4.5, 7.4.8

The stomach

The wall of the stomach is muscular. It contracts and relaxes to **churn** the food. This is physical digestion: it breaks the food into smaller pieces and mixes it with **gastric juice**, which contains protease and hydrochloric acid.

Hydrochloric acid in gastric juice has two functions:

- It kills harmful microorganisms in food.
- It provides an acidic pH, which is the optimum pH for the protease enzyme in the stomach to work.

Bile

Bile is made in the liver, stored in the gall bladder and released into the duodenum.

Supplement

- Bile **emulsifies** fats and oils. It breaks large drops into many tiny droplets, which increases the surface area for lipase to act on (physical digestion, so there is no chemical change).
- Bile is **alkaline**. It neutralises the acidic mixture of food and gastric juice that enters the duodenum from the stomach. This provides a suitable pH for the enzymes in the small intestine to work.

Supplement

Common mistake: Bile is not an enzyme and does not chemically digest fat. It emulsifies fat so that lipase can work faster.

Quick check

1. Name the process: the removal of undigested food as faeces.
2. Which type of tooth is used for tearing food?
3. What part of a tooth contains nerves and blood vessels?
4. Give two functions of hydrochloric acid in the stomach.
5. **Supplement** How does bile help the digestion of fats?

3 Chemical digestion Spec 7.4

Chemical digestion and digestive enzymes Spec 7.4.1, 7.4.2, 7.4.3, 7.4.4

Chemical digestion is the breakdown of large insoluble molecules into small soluble molecules. It is carried out by enzymes. The small soluble molecules can be **absorbed** into the blood. Large insoluble molecules cannot pass through the wall of the gut.

Digestive enzymes				
Enzyme	Breaks down	Into	Secreted by (made in)	Acts in
Amylase	Starch	Simple reducing sugars	Salivary glands and pancreas	Mouth and small intestine
Protease	Protein	Amino acids	Stomach and pancreas	Stomach and small intestine
Lipase	Fats and oils	Fatty acids and glycerol	Pancreas	Small intestine

starch → simple reducing sugars (amylase)

protein → amino acids (proteases)

fats and oils → fatty acids + glycerol (lipase)

Enzymes made in the pancreas flow into the duodenum, so the pancreas is where they are **secreted** but the small intestine is where they **act**. Quote both places if a question asks where an enzyme is secreted and where it acts.

Exam tip: Learn each enzyme as a set of three: substrate, product, and where it is secreted and acts. Mark schemes ask for the product by name.

Digesting starch and protein in detail Spec 7.4.6, 7.4.7 Supplement

Starch

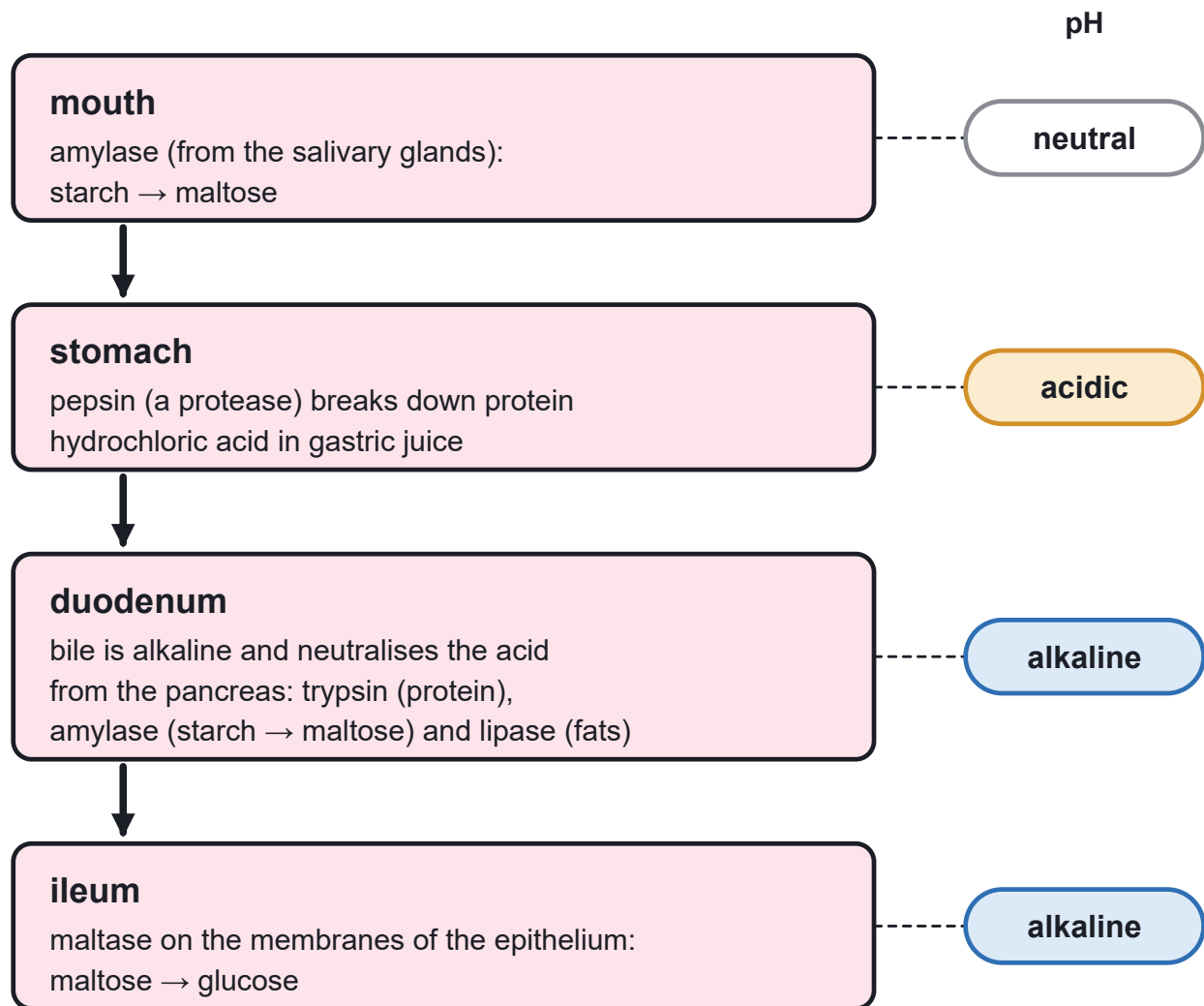
1. Amylase from the salivary glands and the pancreas breaks starch down to **maltose**.
2. Maltase breaks maltose down to **glucose**. Maltase is on the membranes of the epithelium lining the small intestine.
3. Glucose is small and soluble, so it can be absorbed into the blood.

starch → maltose (amylase); maltose → glucose (maltase)

Protein

Two proteases		
Protease	Where it works	Conditions
Pepsin	Stomach	Acidic, because of the hydrochloric acid in gastric juice
Trypsin	Small intestine	Alkaline, because of the bile mixed with the food

Each enzyme has an optimum pH. Pepsin works best in acid and trypsin works best in alkali. Both are proteases, so both break down protein.



Pepsin works in the **acidic** stomach; trypsin works in the **alkaline** small intestine, where bile has neutralised the acid.

Common mistake: Amylase does not make glucose directly. It makes maltose, and maltase then makes glucose. Link each enzyme to its own product.

Quick check

1. What is chemical digestion?
2. What does lipase break down fats and oils into?
3. Where is amylase secreted?
4. **Supplement** Which enzyme breaks maltose down to glucose, and where is it found?
5. **Supplement** Why does trypsin work in the small intestine but pepsin does not?

4 Absorption Spec 7.5

Absorption in the small intestine and colon Spec 7.5.1, 7.5.2

Absorption is the movement of nutrients from the intestines into the blood. The **small intestine** is the region where nutrients are absorbed, mostly in the ileum.

Water is also absorbed. **Most water** is absorbed from the small intestine, but some is also absorbed from the **colon**. What is left in the large intestine is the undigested food, which is stored in the rectum as faeces and removed by egestion.

Where absorption happens	
Region	What is absorbed
Small intestine	Nutrients (e.g. glucose, amino acids, fatty acids and glycerol, vitamins and mineral ions) and most of the water
Colon	Some water

Exam tip: If asked where water is absorbed, say 'mostly in the small intestine and some in the colon'. 'Colon only' loses the mark.

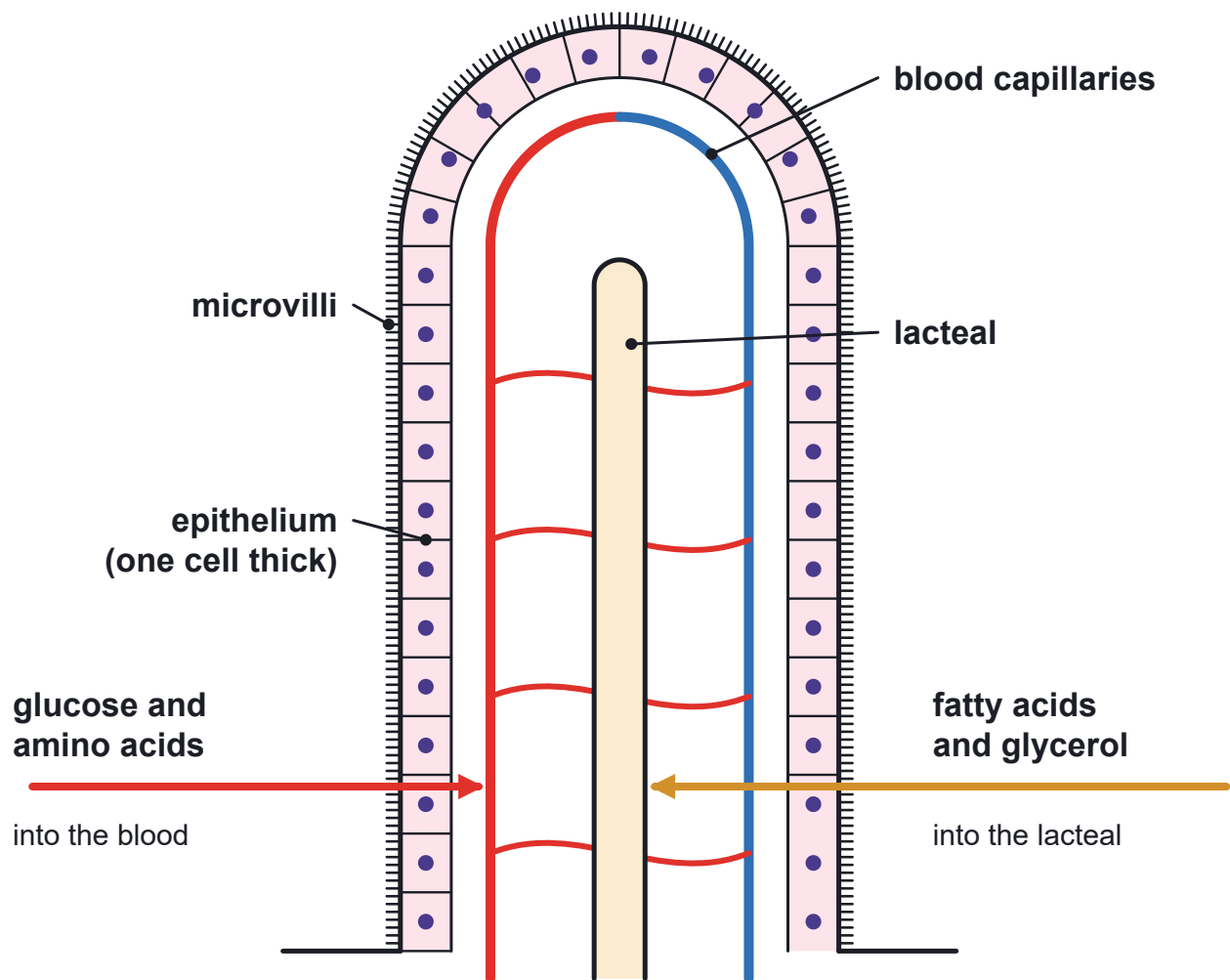
Villi and microvilli Spec 7.5.3, 7.5.4, 7.5.5 Supplement

The inside of the small intestine is covered in tiny finger-like projections called **villi** (singular: villus). The cells on the surface of each villus have even smaller projections called **microvilli**.

Villi and microvilli greatly increase the **internal surface area** of the small intestine. A larger surface area means more nutrients can be absorbed into the blood in a given time.

Structure of a villus

- The wall is a single layer of epithelial cells, so the distance for nutrients to travel is short.
- The epithelial cells have microvilli, which increase the surface area further.
- Inside the villus there is a network of **capillaries** and a **lacteal**.



A villus: **microvilli** and a thin epithelium give fast absorption; **glucose and amino acids** enter the capillaries, **fatty acids and glycerol** enter the lacteal.

Roles of capillaries and lacteals

Capillaries and lacteals	
Structure	Role
Capillaries	Absorb glucose and amino acids (and other nutrients) into the blood; the flowing blood carries them away, which keeps absorption going
Lacteal	A lymph vessel in the centre of the villus that absorbs fatty acids and glycerol and carries them away in the lymph

Exam tip: For a 'how is a villus adapted' question: large surface area (villi and microvilli), thin wall (one cell thick) and a good blood supply (capillaries). Always link the feature to absorption.

Quick check

1. Where are nutrients absorbed?
2. Where is most water absorbed?
3. **Supplement** What is the role of villi and microvilli?
4. **Supplement** What does the lacteal absorb?

Quick check answers

Diet

1. A diet containing all the nutrients in the correct proportions, giving the right amount of energy for the person.
2. Protein.
3. A lack of vitamin C.
4. A lack of vitamin D (or calcium).
5. To make haemoglobin in red blood cells.

The digestive system

1. Egestion.
2. Canine.
3. The pulp.
4. It kills harmful microorganisms in food and provides an acidic pH for optimum enzyme activity.
5. It emulsifies them, which increases the surface area for lipase.

Chemical digestion

1. The breakdown of large insoluble molecules into small soluble molecules.
2. Fatty acids and glycerol.
3. Salivary glands and pancreas.
4. Maltase, on the membranes of the epithelium lining the small intestine.
5. Trypsin works in alkaline conditions and pepsin works in acidic conditions; bile makes the small intestine alkaline.

Absorption

1. The small intestine.
2. The small intestine (some is absorbed in the colon).
3. They increase the internal surface area of the small intestine.
4. Fatty acids and glycerol.