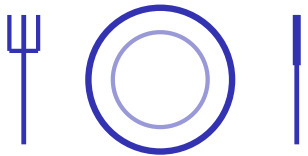
Human Nutrition

IGCSE Biology ▪ Topic 7

IGCSE Biology



What we will cover

1. A balanced diet
2. The digestive system
3. Teeth & physical digestion
4. Enzymes & chemical digestion
5. Stomach acid & bile
6. Absorption & villi

teeth and physical digestion

1

Diet

A balanced diet

- too little vitamin C → **scurvy** 坏血病 (bleeding gums, slow healing).
- too little vitamin D → **rickets** 佝偻病 (soft, bent bones), because the body cannot take in enough calcium.

Seven parts of a balanced diet

Carbohydrates	**Carbohydrates** 碳水化合物 for energy – the everyday fuel.
Fats and proteins	Fats are the energy *store* and insulate; **proteins** 蛋白质 are for growth and repair.
Vitamins	Small amounts, specific jobs: vitamin C for connective tissue, vitamin D for calcium uptake.
Mineral ions	**Mineral ions** 矿物质离子: calcium for bones and teeth, and **iron** 铁 – from red meat and leafy greens – to make **haemoglobin** 血红蛋白, the red pigment that carries oxygen.
Fibre and water	Fibre gives the gut muscles something to push against; water is the solvent everything else travels in.

"Balanced" means all seven, in the right proportions for that person's age, sex and activity – not simply enough food.

Vitamins and deficiency

vitamin C

fruit & veg; shortage → **scurvy** 坏血病

vitamin D

helps absorb calcium; shortage → **rickets** 佝偻病

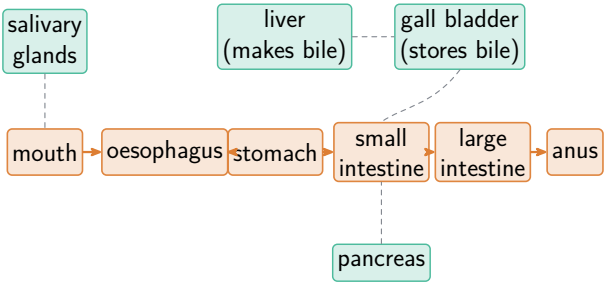
The two deficiency diseases the syllabus names

scurvy 坏血病	too little vitamin C: bleeding gums, and cuts that heal slowly
the source	fresh fruit and vegetables
rickets 佝偻病	too little vitamin D (or calcium): soft, weakened bones that bend under the body's weight
the source	dairy, oily fish, and sunlight on the skin
fats 脂肪 and oils	butter, oil, nuts – an energy store, and they help keep you warm
fibre 纤维	not digested; it gives the gut muscles something to push against, preventing constipation

Both diseases are named in the syllabus with their vitamin *and* their symptoms. A question giving symptoms wants the vitamin, and one giving the vitamin wants the symptoms.

2 Digestion

The digestive system



Food travels the **alimentary canal** 消化道: mouth → **oesophagus** 食道 → **stomach** 胃 → **small intestine** 小肠 → **large intestine** 大肠. The **liver** 肝脏, **pancreas** 胰腺 & glands add juices.

The route, end to end

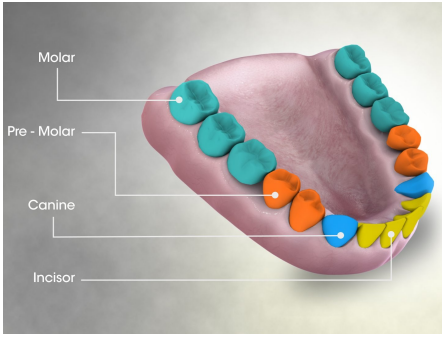
Mouth to stomach	Mouth → **oesophagus** 食道 → **stomach** 胃, which makes hydrochloric acid as part of the **gastric juice** 胃液.
Small intestine	The **duodenum** 十二指肠, then the **ileum** 回肠: where most digestion finishes and **nutrients** 营养物 are absorbed.
Large intestine	The **colon** 结肠 takes back water; the **rectum** 直肠 stores the waste and the **anus** 肛门 releases it.
At the wall	**Maltase** 麦芽糖酶 sits on the membranes of the **epithelium** 上皮 lining the small intestine and breaks maltose into **glucose** 葡萄糖 right where it is absorbed.

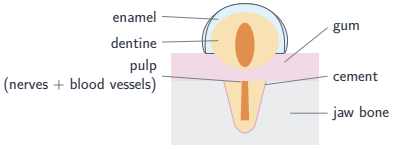
Amylase 淀粉酶 breaks starch into **reducing sugars** 还原糖; the last step happens at the wall, not in the cavity.

Five processes

Take in → break down → into blood → used by cells → waste out. Egestion (faeces) is not excretion.

Teeth and physical digestion





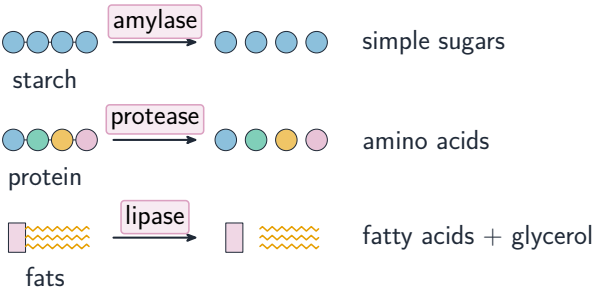
Incisors 门齿 cut, **canines** 犬齿 tear, **premolars** 前臼齿 & **molars** 臼齿 grind. A tooth: hard **enamel** 牙釉质 over **dentine** 牙本质, a soft **pulp** 牙髓. Chewing makes more surface for enzymes.

The four kinds of tooth, and what a tooth is made of

incisors	chisel-shaped, at the front – cutting and biting
canines	pointed – tearing
premolars and molars	broad with ridges, at the back – grinding and chewing
enamel 牙釉质	the hard white outer layer – the hardest material in the body
dentine 牙本质	a softer, bone-like layer beneath the enamel
pulp and cement 牙骨质	the pulp holds nerves and blood vessels; the cement fixes the root into the jaw

Chewing is physical digestion: it does not change any molecule, it only increases the surface area for the enzymes to act on.

Enzymes and chemical digestion



Enzymes break big **insoluble** 不溶性 molecules into small **soluble** 可溶性 ones:

- **amylase** 淀粉酶: starch → sugars
- **protease** 蛋白酶: protein → amino acids
- **lipase** 脂肪酶: fat → fatty acids + glycerol

Stomach acid and bile

stomach acid

hydrochloric acid 盐酸
kills microbes & sets a low pH for **pepsin** 胃蛋白酶

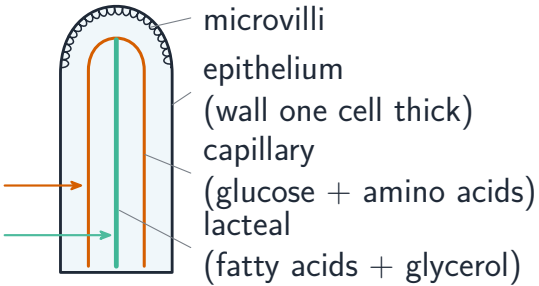
bile 胆汁

emulsifies 乳化 fat (more surface) & neutralises the acid

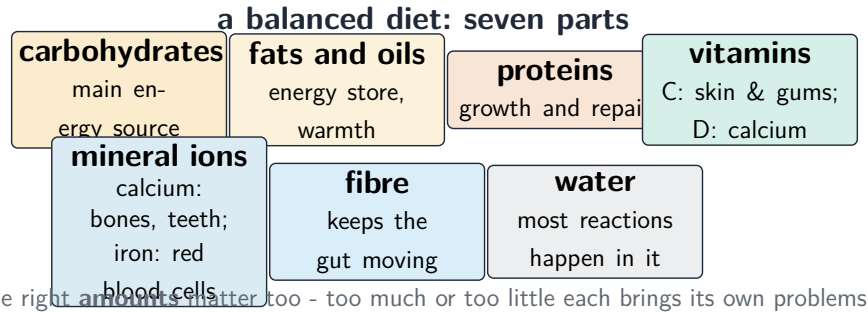
Absorption and villi

Millions of **villi** 绒毛 line the small intestine.

- huge surface area; wall one cell thick
- **capillaries** 毛细血管 take glucose & amino acids
- a **lacteal** 乳糜管 takes fats



A balanced diet, continued



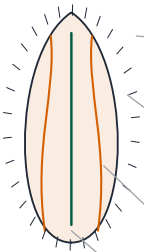
The seven parts of a balanced diet and the job each one does

The digestive enzymes, and what each does

amylase 淀粉酶	starch → maltose. Made in the salivary glands and pancreas
maltase 麦芽糖酶	maltose → glucose. On the wall of the **small intestine** 小肠 – so starch takes two steps
protease 蛋白酶	protein → amino acids. **Pepsin** 胃蛋白酶 in the stomach, **trypsin** 胰蛋白酶 from the pancreas – again two proteases
lipase 脂肪酶	fats → fatty acids and glycerol. Made in the pancreas
bile 胆汁	made in the liver, stored in the **gall bladder** 胆囊. Alkaline, so it **neutralises** 中和 the acidic food entering the **duodenum** 十二指肠, and it emulsifies fat

Bile is not an enzyme. It does two physical jobs – change the pH, and break fat into droplets so lipase has more surface to work on.

Villi (Supplement)



microvilli: even more surface area

thin wall (one cell thick): a short path to the blood

rich **blood supply**: carries absorbed food away fast

a **lacteal** absorbs fats

millions of villi give a **huge surface area**, so absorption is fast

A villus is adapted for fast absorption: microvilli, a thin wall, a rich blood supply and a lacteal

Exam tips

- A balanced diet has the right amount of each part. Learn one source and one use for each.
- Vitamin C scurvy; vitamin D rickets.
- The five processes in order: ingestion $\rightarrow$ digestion $\rightarrow$ absorption $\rightarrow$ assimilation $\rightarrow$ egestion. Egestion (faeces) is **not** excretion.

Exam tips (continued)

- Physical digestion makes pieces smaller (more surface area); chemical digestion uses enzymes to make molecules smaller and soluble.
- amylase $\rightarrow$ sugars, protease $\rightarrow$ amino acids, lipase $\rightarrow$ fatty acids + glycerol. Stomach acid kills microorganisms and sets a low pH.
- Villi and microvilli give a large surface area, and a thin wall gives a short distance – both make absorption faster.

3 Recap

Worked example – matching enzyme to food

A person's pancreas makes no lipase. Which food is affected, and what is seen?

- Lipase digests fats: fat → fatty acids + glycerol.
- No lipase ⇒ fat is not broken into small enough molecules to absorb.
- Undigested fat stays in the gut and passes out in the faeces.
- Starch and protein are unaffected – amylase and protease still work.

Three to know: amylase starch → maltose; protease protein → amino acids; lipase fat → fatty acids + glycerol.

Topic 7 – key takeaways

1 Diet

vitamin C → scurvy; vitamin D → rickets

2 Processes

ingest, digest, absorb, assimilate, egest

3 Enzymes

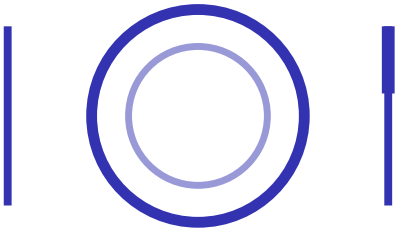
amylase, protease & lipase make it soluble

4 Villi

big surface, thin wall – fast absorption

Check yourself

1. Which deficiency causes scurvy?
2. Which process is NOT excretion: egestion or sweating?
3. What does lipase break fat into?
4. Why do villi have a thin wall?



Answers **1.** too little vitamin C **2.** egestion **3.** fatty acids & glycerol **4.** a short distance for fast absorption