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GRADE 10 / SCIENCE

Chapter 5

Life Processes



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Nutrition in plants

A green plant builds sugars from carbon dioxide and water. Light supplies energy, while chlorophyll absorbs it.



Leaf · gas exchange | Chloroplast · organelle | Granum · stack of thylakoids

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ • net reaction in light

Covered leaf band
No light → iodine stays yellow-brown

Exposed green area
Light → starch → blue-black with iodine

Into the leaf

Carbon dioxide enters through stomata. Guard cells regulate these pores. Water reaches the leaf through xylem.

Inside a chloroplast

One flattened membrane sac is a thylakoid. A stack is a granum. Several stacks are grana. Chlorophyll is in thylakoid membranes.

Making carbohydrate

Light-dependent reactions supply energy used to fix carbon dioxide in the stroma. The oxygen released in photosynthesis comes from water.

Testing for starch

Start with a destarched plant. Cover part of a leaf, expose it to light, then test the decolourised leaf with iodine.

WORKED EXAMPLE

What should the shaded band look like after the iodine test?

It stays yellow-brown. The illuminated green tissue turns blue-black where starch formed.

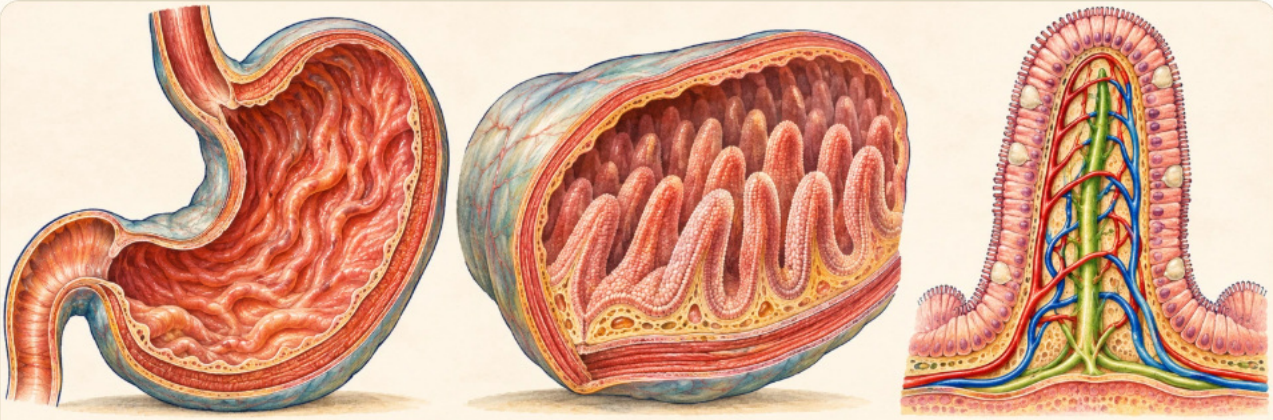
SELF-CHECK

Stomata close on a hot day. What limits sugar production?

Less carbon dioxide enters. Water loss falls, but carbon fixation may slow.

From bite to absorption

A bite of food takes two journeys. Digestion breaks it into absorbable units. Absorption moves digested nutrients across the intestinal lining.



Stomach · protein digestion

Small intestine · villi

Villus · capillaries and lacteal

Follow the absorbed nutrient

Glucose or amino acids
Villus capillaries → blood to liver

Most long-chain dietary fat
Lacteal → lymph → bloodstream

Mouth
Chewing breaks up food. Salivary amylase begins starch digestion.

Stomach
Hydrochloric acid provides acidic conditions for pepsin, which begins protein digestion.

Small intestine
Bile disperses fat into small droplets. Lipase digests fats. Other enzymes finish digestion of carbohydrates and proteins.

Two exit routes
Glucose and amino acids enter blood capillaries. Products of long-chain fat digestion enter intestinal cells. Repackaged fat travels in particles called chylomicrons through lacteals and lymph to the blood.

WORKED EXAMPLE

Why do villi improve absorption?

Many finger-like villi increase the surface area of the intestinal lining. A thin lining and nearby blood and lymph vessels allow nutrients to move away.

SELF-CHECK

Does bile turn fat into fatty acids?

No. Bile emulsifies fat and increases the area available to lipase. Lipase performs the chemical digestion.

Respiration pathways

Glucose breakdown starts in the cytoplasm. Oxygen availability and the cell type influence what happens to pyruvate next.



Glucose in fruit | Yeast · ethanol and CO_2 | Working muscle · lactate

Cytoplasm · 1 glucose → 2 pyruvate + net 2 ATP

Aerobic breakdown	Yeast fermentation	Muscle fermentation
Mitochondria → CO_2 + water	Ethanol + CO_2	Lactate

With oxygen

In aerobic respiration, further breakdown in mitochondria ultimately yields CO_2 and water. The complete pathway produces much more ATP.

In yeast

During alcoholic fermentation, pyruvate is converted to ethanol and CO_2. This restores NAD^+, the electron carrier that glycolysis needs.

In working muscle

Pyruvate can be converted to lactate, restoring NAD^+ so glycolysis can continue.

ATP accounting

Glycolysis supplies the net 2 ATP per glucose. The subsequent conversion of pyruvate to lactate or ethanol adds no extra ATP.

WORKED EXAMPLE

During a sprint, muscle produces lactate. Which stage supplied the net ATP from this pathway?

Glycolysis supplied it when glucose became pyruvate. Lactate formation helps glycolysis continue.

SELF-CHECK

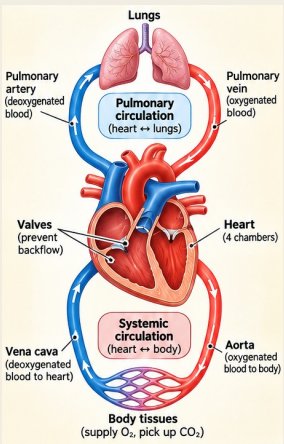
Why does fermenting yeast make dough rise?

Carbon dioxide produced during alcoholic fermentation forms bubbles in the dough.

Life Processes

Transport systems

In humans, blood passes through the heart twice in one full circuit. In plants, water and sugars travel in different tissues.



Follow one red blood cell

Body → right heart → lungs → left heart → body. Follow the blue route to the lungs and the red route back to the body. The colours indicate oxygen level.

Two blood circuits

Right ventricle → lungs → left atrium. Left ventricle → body tissues → right atrium. Blood flows through valves that help prevent backflow.

Xylem and phloem

Xylem carries water and mineral ions mainly upwards. In phloem, sugar moves from a source to a sink. Different sieve tubes can transport sugar in different directions.

WORKED EXAMPLE

Why does loss of water from a leaf help water move up the stem?

Evaporation contributes to tension in the continuous xylem water column. Cohesion transmits that pull down the column. The bulk flow does not require a pump at each point.

SELF-CHECK

Does each sugar molecule travel the length of a phloem tube under its own power?

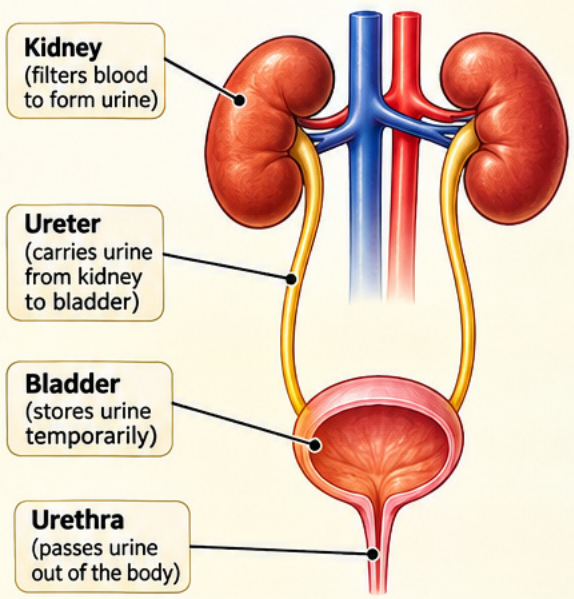
No. In plants with active loading, cells spend energy concentrating sugar at the source. Water enters by osmosis, and a pressure difference drives bulk flow.

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Excretion and the nephron

Human excretory system

Removes nitrogenous wastes (mainly urea), excess water and salts, and maintains water–salt balance (homeostasis).



Urine vs Filtrate

Feature	Filtrate (glomerular filtrate)	Urine
Where?	In Bowman's capsule	In collecting duct and to bladder
Contents	Water, salts, glucose, amino acids, urea (no cells, no large proteins)	Water, excess salts and urea (no glucose or amino acids)
Volume (average day)	≈ 180 L day^{-1} (≈ 125 mL min^{-1})	≈ 1–2 L day^{-1} (≈ 1 mL min^{-1})

Plant waste strategies

Plants lack a special excretory organ. They remove or isolate wastes by:



Shedding
Wastes (e.g., excess salts) stored in leaves and shed with them.



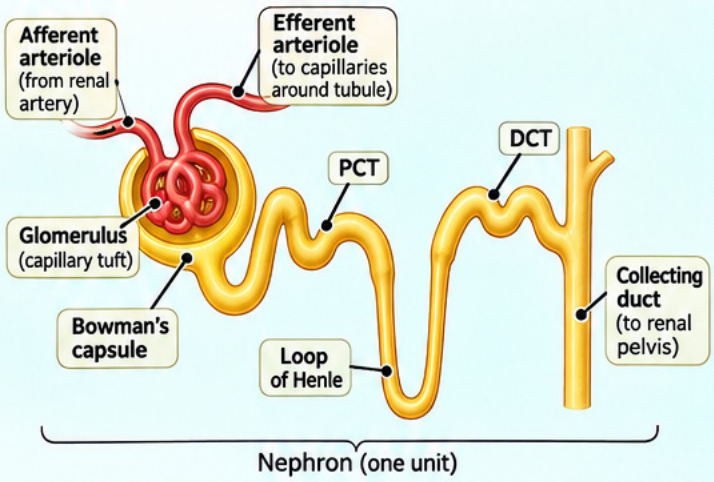
Secretion
Harmful wastes (e.g., resins, gums, latex) are secreted and removed.



Storage
Wastes (e.g., calcium oxalate) are stored in vacuoles, often as crystals.

The nephron: structure and working

Nephron is the functional unit of kidney (≈ 1–1.5 million per kidney) that forms urine in two main steps.



Glomerular filtration vs Selective reabsorption

Glomerular filtration (ultrafiltration)

- First step in glomerulus; high blood pressure filters water and small solutes (salts, glucose, amino acids, urea) into Bowman's capsule to form filtrate.

Selective reabsorption

- As filtrate flows through PCT, loop of Henle and DCT, useful substances (all glucose, amino acids, most water and needed salts) are reabsorbed into blood capillaries.
- Leaves urea, excess salts and water to form urine.

Worked example (reasoning)

Q. A person's kidneys filter 180 L of filtrate per day, and 1.5 L of urine is produced. Calculate the percentage of filtrate reabsorbed.

Solution:

Volume reabsorbed = 180 − 1.5 = 178.5 L

$$\text{Percentage reabsorbed} = \frac{178.5}{180} \times 100 = 99.2\%$$

Answer: About 99.2% of the filtrate is reabsorbed.

Self-check

Q. Why is glucose normally absent in urine, even though it is present in the filtrate?

Answer: It is selectively reabsorbed completely in the proximal convoluted tubule (PCT) and returns to the blood, so it is normally absent from urine.

ONE LAST CHALLENGE

Who blew bubbles in the bread?

A ball of dough rises on the counter. What made the gas pockets inside it?



THE REVEAL

Yeast did.

During fermentation, yeast breaks down sugars and releases carbon dioxide. The dough traps the gas and expands.

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