Topic 2 – Organisation

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2.1 Principles of organisation

Cells → tissues → organs → organ system → organism

Cells - basic structural & functional units of living organisms

Muscular	• Contracts to move things attached to it • In stomach, contracts to move food
Glandular	• Contains secretory cells • Produce & release substances (enzymes, hormones)
Epithelial	• Covers outside of body & internal organs

Tissues - a group of cells with similar structure & function working tgt

In stomach

Muscular	• Contract to churn food
Glandular	• Produce digestive juice to digest food with enzyme & HCl
Epithelial	• Covers outside & inside of stomach

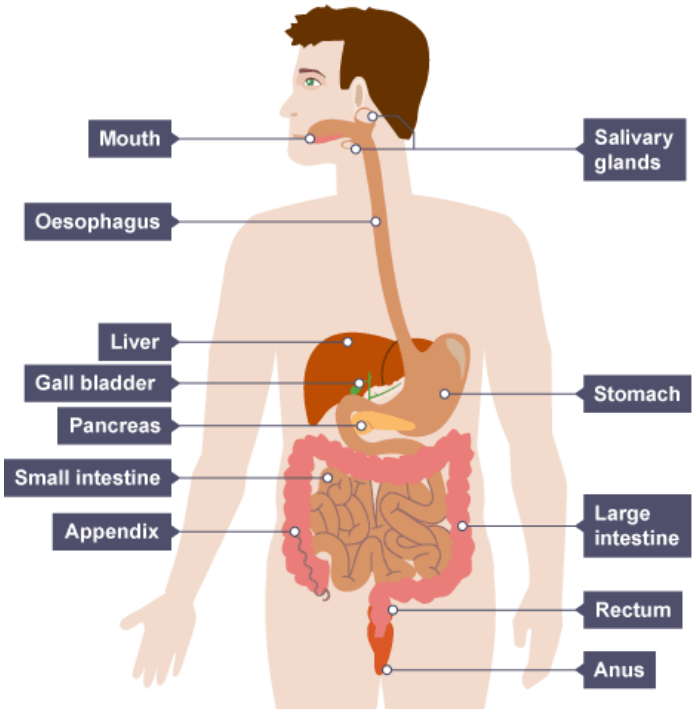
Organs - a group of different tissues working together to perform specific function

Organ system - a group of organs working together to perform specific functions

Organisms - a group of organ system working together

2.2 Animal tissues, organs and organ systems

2.2.1 The human digestive system



Balanced diet - right amount of nutrients & energy for needs

What is the function of digestive system?

- An organ system in which several organs work tgt to digest & absorb food

Mouth	**How can mouth break down starchy foods?** • Teeth break down food • Saliva contains amylase
Salivary gland	• Produce saliva containing amylase
Oesophagus	• Muscular tube which move food to stomach
Stomach	• Pummels food with muscular wall • Produce protease, pepsin & HCl • Gastric juice • Water to moisten food • HCl (pH2) to kill bacteria & help protease to work • Pepsin to break proteins into amino acid • Mucus to lubricate surface & protect from digestive enzyme & HCl
Bile (alkaline)	• Made in liver & store in gall bladder • Neutralise HCl from stomach to provide alkaline condition • Emulsifies fats to break large lipid droplets into small droplets to ↑SA to ↑rate of fat breakdown by lipase
Small intestine	• Digestion completed • Absorb digested food & nutrients to blood • Small molecules diffuse through villi walls into blood for respiration **Adaptation** • Small intestine is very long, which gives plenty of time to complete absorption • Villi are covered with microvilli, which increases SA to absorb quicker • Villi contain blood capillaries, which provide rich blood supply to maintain a steep concentration gradient to assist quick absorption • Villi have thin walls for short diffusion pathways into blood • Have lots of mitochondria to provide energy from respiration **Coeliac disease** • Damage villi ↓SA for absorption • ↓ amino acid & glucose absorb • ↓ amino acid available to build new tissues • ↓ glucose ↓energy transfer from respiration
Large intestine	• Absorb excess water from blood • Form faeces
Rectum	• Store faeces

Food chemistry

Carbohydrates

Use	• Provide energy for metabolic reactions in cells in cellular respiration
Digestion	• Starch → amylase → maltose + simple sugars

Made in	• Salivary glands, pancreas & small intestine
Digestion sites	• Mouth & small intestine

Proteins

Use	• Build new tissues & cells • Basis of cell enzymes
Digestion	• protein → proteases → amino acids
Made in	• Stomach, pancreas & small intestine
Digestion sites	• Stomach & small intestine

Lipids

Use	• To provide energy & insulation • Forms part of cell membrane
Digestion	• Lipids → lipases → fatty acids + glycerol
Made in	• Pancreas & small intestine
Digestion sites	• Small intestine

Biochemical test

Starch	**Iodine solution** (orange)	+ve black/blue -ve orange
Glucose	**Benedict's solution** (blue) Boil 2 mins	+ve orange -ve blue
Protein	**Biuret's solution** (blue) Shake	+ve purple -ve blue
Lipids	**Ethanol** Shake	+ve cloudy -ve clear

Enzyme

What are enzymes?

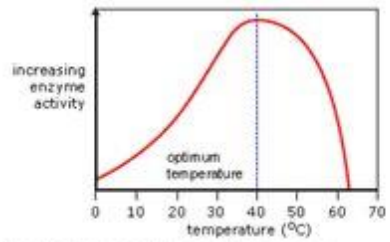
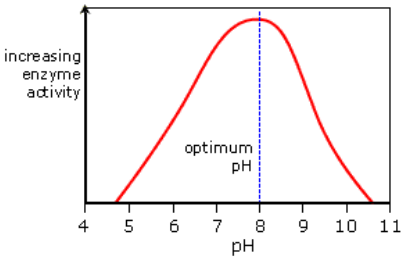
- Biological catalysts with a specific active site that increases rate of reaction

How do enzymes work?

'Lock & key theory'

- Enzyme acts as lock, substrate acts as key
- Shape of substrate collides with active site of enzyme, which has a complementary shape to substrate
- If substrate fits into active site, they binds together, reaction happens quickly & substrate splits into products to be released
- After reaction, products leave active site & enzyme is ready to used again

Factors that affect the rate of reaction

Temperature  Graph of enzyme activity against temperature	• ↑temp ↑ rate coz ↑KE, cells move faster, ↑ chance of collide active site of enzyme • Optimum temp (37°C) - where enzyme work fastest • High temp • Causes protein chains to unravel changing the shape of active site of enzyme • Active site no longer fit substrate's shape • Denatured
pH  	• Too low / high interferes with bonds holding enzyme together • Change shape of enzyme's active site • Active site no longer fit substrate's shape • Denatured • Optimum pH (pH8) • Different part produce different pH • Pepsin in stomach - pH2 • Pancreatic amylase in duodenum - pH8

Calculation

Rate of reaction = $\frac{\text{amount of produced formed or reactant used}}{time}$

2.2.2 The heart and blood vessels

Blood vessels

Arteries

Function	• Transport oxygenated blood under high pressure from heart to organs of body
Adaptation	• Thick walls - withstand high pressure • Thick layers of elastic tissue - stretch & return to original shape • Thick layer of muscle - maintain force on blood flow

Veins

Function	• Transport deoxygenated blood under high pressure from organs of body to heart • Low pressure coz long way & more friction reduces speed
Adaptation	• Thin walls coz low pressure • Large lumen help blood flow despite low pressure • Have valves that close to prevent backflow of blood

Capillaries

Function	• Transport blood to cells

	• Form huge network of tiny vessels linking arties & veins
Adaptation	• Thin permeable walls (1 cell thick) for short diffusion pathway • Substances eg O2 to diffuse easily out of blood into cell • Waste eg CO2 produced by cells diffuse easily into blood • Narrow so blood cells pass through them one by one so more O2 released to tissues & taken up from lungs, more time available, shorter distance for exchange, more SA exposed

Calculation

$$\text{Rate of Blood Flow} = \frac{\text{Volume of Blood}}{\text{Number of Minutes}}$$

2.2.3 Blood

Blood - a tissue consisting of plasma, in which the red blood cells, white blood cells & platelets are suspended

Blood contains…

Red blood cell

Function	• Transport oxygen from lungs to all cells in body
Adaptation	• Biconcave discs - increase SA to vol ratio for diffusion • No nucleus - more space for haemoglobin & O2 • Contain red pigment - haemoglobin • In lungs, combines with O2 to form oxyhaemoglobin • In body tissues, oxyhaemoglobin splits up into haemoglobin & O2 to release O2 to cell • Small & flexible to fit through narrow blood vessals

White blood cell

Function	(See immune system) • Defend body from infection by phagocytosis, produce antibodies & antitoxins
Adaptation	• Have a nucleus to encode instructions for WBC to do their job

Platelets

- Small fragments of cells produce by giant cells in bone marrow, don't have nucleus

Function	• Help blood to clot at wound by holding cells together to stop bleeding & microorganisms getting in
How?	• Produce protein fibre o capture RBC & platelets to form clot, which plugs wound

Plasma - yellow liquid

Function	• Transport blood cells & different substances around body • RBC, WBC & platelets • Nutrients eg glucose & amino acid • CO2 from organs to lungs • Urea from liver to kidney • Hormones • Antibodies & antitoxins produced by WBC

Uses of donated blood in medicine

- Replace blood lost from injury
- Given platelets to help clotting

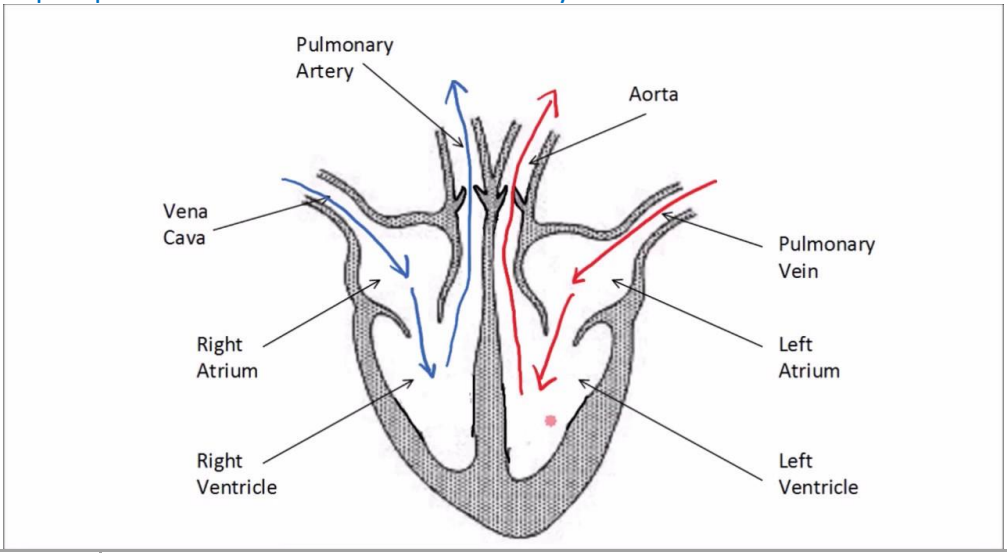
Risk

- If different blood type, immune system reject blood & patient could die
- Diseases can be transmitted through blood

2.2.4 Coronary heart disease: a non-communicable disease

Heart

- An organ that pumps blood around the body in a double circulatory system
- **Right ventricle** pumps blood to lungs where gas exchange takes place
- **Left ventricle** pumps blood around the rest of the body



Aorta	• Transport oxygenated blood under high pressure away from left ventricle of heart
Vena cava	• Return deoxygenated blood from the body to right atrium of heart
Pulmonary artery	• Transport deoxygenated blood from the heart to the lungs
Pulmonary vein	• Transport oxygenated blood from the lungs to the heart
Valves	• Close to prevent backflow of blood
Deoxygenated blood (right)	• Organs → vein → vena cava → right atrium → right ventricle → pulmonary artery → lungs
Oxygenated blood (left)	• Lungs → pulmonary vein → left atrium → left ventricle → aorta → artery → organs
Coronary arteries	• Branch off aorta, surround heart • Carry blood to heart • Supply O2 & nutrients for heart to function • If narrow/blocked - coronary heart disease

Why is muscle wall thicker on left ventricle?

- Allow left ventricle to develop pressure needed to force blood through arterial system all over body

Double Circulation

- Blood enters heart twice for one circuit around the body
- Efficient, pressure stay high so blood flows quickly

How is natural resting heart rate controlled?

- By a group of cells located in the right atrium that act as a pacemaker

Artificial pacemaker

- Electrical devices used to correct irregularities in the heart rate by sending electrical signals to heart

Cardiovascular diseases

Why do ppl have coronary heart disease eg cardiovascular diseases? (4)

- Layers of fatty material build up inside coronary arteries
- Narrow arteries
- Reduce blood flow
- Reduce O_2 supply for heart muscles

What symptoms do coronary heart disease have? (3)

- Pain, heart attack, fatal

What are the risk factors of cardiovascular diseases?

- Poor diet, smoking, lack of exercise

What are the treatments for coronary heart disease? (6)

Stents

- Keep coronary arteries open
- Increase blood flow
- More O2 supply for heart muscles

How?

- Metal mesh with balloon inside
- Balloon inflated to open stent & blood vessel
- Balloon deflated & removed but stent remains in place

Advantages	Disadvantages
• Effective in lower risk of heart attack • Quick recovery time from surgery	• Risk of heart attack or infection during operation • Risk of blood clots form near stent

Statins

- Reduce blood cholesterol levels
- Slows down rate of fatty material deposit
- Reduce risk of develop heart attack

Advantages	Disadvantages
• Reduce risk of heart attack • Increase levels of HDL cholesterol	• Produce side effects eg liver problems • Need to take statins continuously

Faulty heart valves

Why do ppl have faulty heart valves? (3)

- Faulty heart valves prevent valve from opening fully

- Heart valves develop a leak
- Become breathless

What are the treatments for faulty heart valves? (6)

Biological valve

- Valves taken from animals

Advantages	Disadvantages
• No medication • Low risk of blood clot	• Last for 10-20years • Expensive

Mechanical valve

- Made of titanium/polymers

Advantages	Disadvantages
• Last a lifetime • Cheap	• Increase risk of blood clots • Take anticlotting drugs everyday for the rest of their life

Heart failure

Why do ppl have heart failure? (1)

- Heart can't pump enough blood around body

What are the treatments for heart failure? (6)

Heart transplant

Advantages	Disadvantages
• Only solution • Better life quality after transplant	• Hazards of operation • Shortage of donors

Artificial heart

- Keep patients alive while waiting for heart transplant
- Allow heart to rest as aid to recovery

Advantages	Disadvantages
• Won't reject by immune system • Readily available	• Increase risk of blood clots • Increase risk of infection while operation

2.2.5 Health issues

Define health (1)

- State of physical & mental well-being

Define communicable disease (1)

- Caused by pathogens that can be passed from one person to another

Define non-communicable diseases (1)

- Cannot spread from one person to another

What causes ill health? (5)

- Communicable & non-communicable diseases
- Diet, stress & life situation eg accessibility to medical attention

Different types of diseases may interact

- **Defects in immune system** - more likely to suffer from infectious diseases
- **Viruses living in cells** - trigger for cancers
- **Immune reaction initially caused by pathogen** - trigger allergies eg skin rashes & asthma
- **Severe physical ill health** - metal illness eg depression

2.2.6 The effect of lifestyle on some non-communicable diseases

What are the effects of smoking? (4)

- **Cardiovascular diseases** - damage arteries lining, raise blood pressure, increase cholesterol
- **Emphysema (lung diseases)** - damage bronchioles & alveoli - shortness of breath
- **Lung cancer** - carcinogen causes mutation & uncontrolled growth of cells, damage cell lining in lungs
- Chemicals in smoke damage cilia - cause mucus production to increase - cause shortness of breath & increases risk of infection
- **Reduce O_2 supply for unborn babies** - cause health issues/death

Explain how a foetus may be affected if a mother smokes during pregnancy

The cigarette smoke will contain carbon monoxide which occupies the mothers red blood cells and so reduces the amount of oxygen that the mothers blood contains. This means that the foetus receives less oxygen which reduces the rate of respiration in the foetus which causes the birth mass of the baby to be less.

What are the effects of alcohol? (3)

- **Liver disease** - damage liver cells when liver break down alcohol
- **Affect brain function** - damage nerve cells
- **Damage unborn babies' cells** - affect development & cause health issues

Why are carcinogens, including ionising radiation, risk factors in cancer? (2)

- Damage cell's DNA
- Makes cell divide uncontrollably

2.2.7 Cancer

Define cancer (1)

- Changes in cells that lead to uncontrolled growth & division
- Form tumour

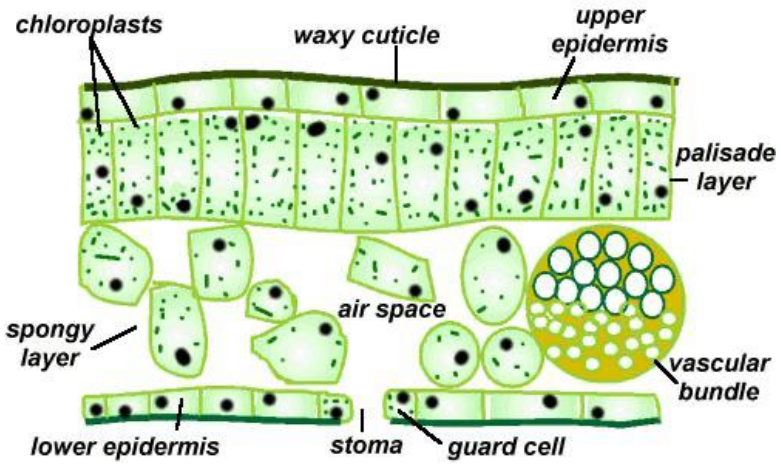
Types of tumours

Benign tumours	Malignant tumours
• Growths of abnormal cells	• Growths of abnormal cells

• Contained in one area, usually within membrane • Do not invade other parts of body, not cancerous	• Cells split up, invade neighbouring tissues & spread to other organs through blood • Form secondary tumours in other organs

2.3 Plant tissues, organs and systems

2.3.1 Plant tissues



Waxy cuticle	• Reduce water loss by evaporation • So it doesn't wilt
Upper epidermis	• Cover the leaf • **Root hair cell** • Adapt to absorb **water** by osmosis & **mineral ions** by active transport from soil efficiently
Palisade mesophyll	• **Chloroplast** - absorb light for photosynthesis • Close towards upper surface of leaf, packed with chloroplasts & are arranged closely together
Spongy mesophyll	• **Air space** - CO_2 in, O_2 out (gas exchange) • Cells packed loosely to allow gaps between cells • Cells are covered by a thin layer of water which gases dissolve in
Xylem	• Transport **water** & **mineral ions** from root to stems & leaves • Have strong lignin spirals which allow them to withstand water pressure to transport water in **transpiration stream** & support plant stem

<table>
<tr><td></td><td>• Cell die & form long hallow tube which is strengthened by lignin spirals allow water & mineral ions to move up easily</td></tr>
<tr><td>Phloem</td><td>• Transport dissolved sugar through translocation from leaves to rest of plant for immediate use or storage
• Cell walls between cells break down to form sieve plates - allow water carrying dissolved food move freely up & down tube to where it's needed
• Companion cells keep them alive & contain mitochondria to provide energy to move dissolved food up & down plant</td></tr>
<tr><td>Guard cells / Stomata</td><td>• Small pores on the underside of the leaf that control gas exchange & water loss by diffusion
<table>
<tr><td>High light intensity</td><td>High temp</td></tr>
<tr><td>• Guard cells swell & cause stomata to open
• CO2 diffuse into leaf for photosynthesis</td><td>• Close stomata to reduce water loss by transpiration</td></tr>
</table></td></tr>
<tr><td>Lower epidermis</td><td></td></tr>
<tr><td>Root</td><td>• Anchorage & absorption of water & mineral ions</td></tr>
</table>

Why more stomata on lower surface of leaf? (3)

- Cooler & more humid around lower surface
- Less water evapourate so won't wilt

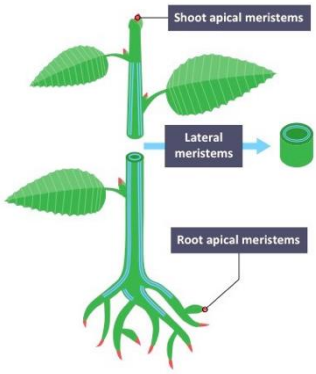
Meristem tissue

Define meristems in plants.

- Plant stem cells that can differentiate into specialised cells throughout the life of the plant
- Found at growing tips of shoots & roots

What can plant stem cells be used for?

- They can be used to make clones of plants quickly & economically



Apical Meristems
Causes **primary** growth *(i.e. lengthening of plant)*
Occurs at tips of shoots and roots
Produces new leaves and flowers

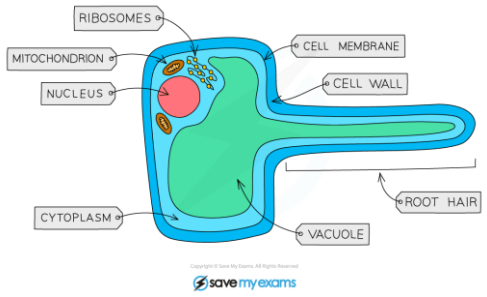
Lateral Meristems
Causes **secondary** growth *(i.e. widening of plant)*
Occurs at the cambium
Produces bark on trees

Describe and explain the functions of stem cells in meristem tissue in plants. (4)

- Differentiate into any type of plant cell, throughout life of plant
- Used to produce clones of plant quickly & economically
- Protect rare species from extinction
- To produce large no of identical plants for farmers eg disease resistance crops

2.3.2 Plant organ system

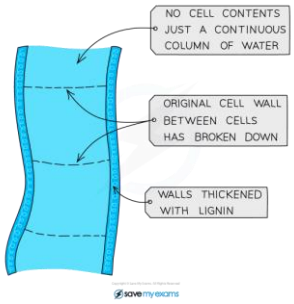
Root hair cells	**Function** • To absorb water by osmosis & mineral ions by active transport from soil efficiently



Adaptation

- Have **large SA** to absorb water & mineral ions
- Have **large permanent vacuole** to speed up movement of water by osmosis
- Contain **mitochondria** to provide energy to transport mineral ions into cell

Xylem cells



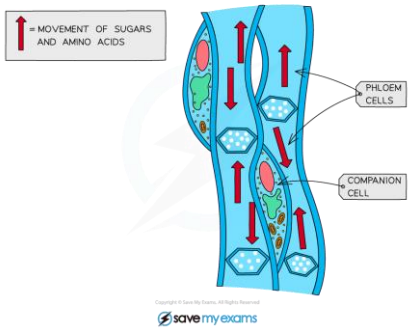
Function

- Transport water & mineral ions from root to stems & leaves

Adaptation

- Have **strong lignin spirals** which allow them to withstand water pressure to transport water in **transpiration stream** & support plant stem
- Cell die & form long **hallow tube** which is strengthened by lignin spirals allow water & mineral ions to move up easily
- Few cell structures & so they are dead for more space & supported by lignin

Phloem cells



Function

- Transport dissolved sugar through **translocation** from leaves to rest of plant for immediate use or storage

Adaptation

- Cell walls between cells break down to form **sieve plates** - allow water carrying dissolved food move freely up & down tube to where it's needed
- **Companion cells** keep them alive & contain mitochondria to provide energy to move dissolved food up & down plant

Transpiration

Define transpiration (2)

- Water loss from plant by evaporation
- The transport of water through the xylem from root to leaf, doesn't require energy

Define transpiration stream (2)

- Movement of water from roots to leaves through xylem

How do water move from roots to leaves? (2)

- By transpiration stream in xylem

Describe the process of transpiration (4)

1. Water evaporates from leaves through stomata, causing a pull

2. Water from soil moves up through roots → stem → leaves by osmosis as transpiration stream in xylem to replace water loss

What factors & explain how these factors affect the rate of transpiration (4)

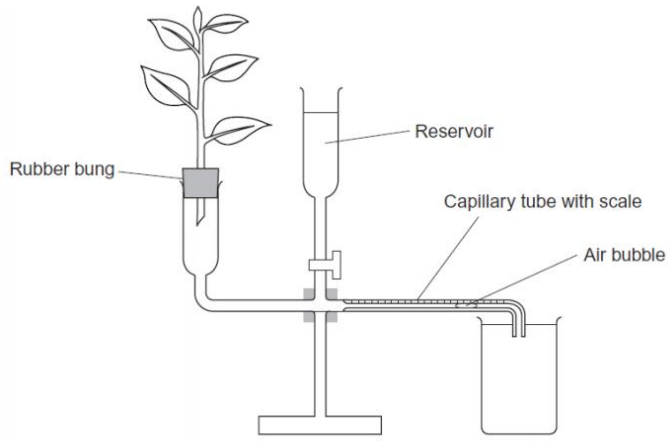
- ↑ temp & air movement, ↓ humidity - ↑ evaporation from cell surfaces
- ↑ light intensity - ↑ rate of photosynthesis
- ↑ rate

20. What happens to the rate of transpiration if temperature is increased and why?	20. It increases because there is increased evaporation from cell surfaces and the rate of diffusion of water molecules from the lead is increased.
21. What happens to rate of transpiration if humidity decreases and why?	21. It decreases. The increased humidity decreases the concentration gradient between water in the leaf and water in the air and so rate of diffusion of water from the leaf decreases.
22. What happens to the rate of transpiration if air movement increases and why?	22. It increases. The air flow removes water vapour from leaf surfaces and so more water diffuses from the leaf.
23. What happens to the rate of transpiration if light intensity increases and why?	23. It increases. The light intensity increases the rate of photosynthesis and so stomata open so there is increased diffusion of water out of the leaf.

Potometer

- Estimates transpiration rate by measuring water uptake
- Assume water uptake is directly related to water loss of leaves

Method



1. Cut a shoot underwater - to prevent air entering xylem
2. Fill potometer with water & make sure there's no air bubbles
3. Insert shoot to potometer using rubber tube under water
4. Remove potometer from water & seal joints with Vaseline
5. Dry leaves coz moisture on leaves will affect transpiration rate
6. Remove capillary tube from beaker of water to allow an air bubble introduced into capillary tube & place tube back into water
7. Allow plant to adapt to new environment for 5 mins
8. Record starting location of air bubble
9. Leave for set period of time eg 1 min
10. Record end location of air bubble
11. Calculate rate of transpiration = $\frac{\pi r^2 l}{time}$

r = radius of capillary tube

l = distance moved by air bubble

12. Measure rate for 3 times & calculate mean
13. Once air bubble near junction of reservoir, open tap to add water from reservoir to push air bubble to start of capillary tube
14. Repeat experiment with one different variable eg temp / species

- Further bubble travels in same time period, faster transpiration rate

Describe how student return air bubble to start of capillary tube? (1)

- Open tap to add water from reservoir

Give 2 precautions when setting up potometer to obtain reliable measurements of water uptake by plant shoot (2)

- Ensure airtight & watertight
- Cut shoot under water - prevent air entering xylem
- Cut shoot at a slant

Student assumed water uptake was equivalent to transpiration rate. Why this might not be a valid assumption? (2)

- Water used in photosynthesis
- Water used to provide support
- Apparatus not sealed

Why repeat experiment? (1)

- Improve reliability / identify anomalous result

5 (d) The students' results are shown in the table.

Number of leaves removed from the plant shoot	Mean rate of water uptake / cm^3 per minute
0	0.10
2	0.08
4	0.04
6	0.02
8	0.01

Explain the relationship between the number of leaves removed from the plant shoot and the mean rate of water uptake. (3)

↓ no. of leaves, ↓ SA, ↓ stomata, ↓ transpiration, ↓ cohesion

Translocation

- Transport of dissolved sugar from leaves to rest of plant through phloem both upwards & downwards for immediate use or storage, requires energy

Why is it important?

- Sugar made in leaves need to move to other part of plant for growth