Maintaining A Balance

1.Most organisms are active in a limited temperature range

Random notes

- Homeostasis – constant internal balance
  - 37 degrees is good
  - 39 degrees is fever
  - 35 degrees is hypothermic
  - The body strives to achieve homeostasis for the sake of enzymes
- Homeostatic mechanisms attempt to keep the body at the right temp
  - Too hot – sweating, red (capillaries dilating), thirsty
  - Too cold – shivering (muscles move → generates heat)

- A control in an experiment is needed to prove that the experimental variable is the catalyst for the result that was produced

- **Isotonic:** The solutions being compared have equal concentration of solutes.
- **Hypertonic:** The solution with the higher concentration of solutes.
- **Hypotonic:** The solution with the lower concentration of solutes.

identify the role of enzymes in metabolism, describe their chemical composition and use a simple model to describe their specificity on substrates

Role = function
Describe = more detail required
Substrate = what the enzyme acts on

The role of enzymes in metabolism

Enzymes

- Enzymes are special large protein molecules that regulate an organism and the rate of its chemical activity/reactions
- Enzymes are biological catalysts i.e. they control the rate of a reaction (they slow down or speed up a reaction)
  - Not chemically changed by the reaction, but adjust their shape slightly
  - After the reaction, they release the product and return to its original form
  - Enzymes are specific which means they control only one reaction each

- The molecules on which they act are known as **substrates**
- Enzymes work by providing an **active site** where a reaction can take place.
  - Type and amount of enzymes depends on cell activity
  - Manufacture controlled by nucleus, made by ribosomes
  - Only needed in small quantities as they are just catalysts, not diminished in reaction
  - Inactive at low temps, denature at high temps

Metabolism

- All the chemical processes occurring within an organism are called metabolism

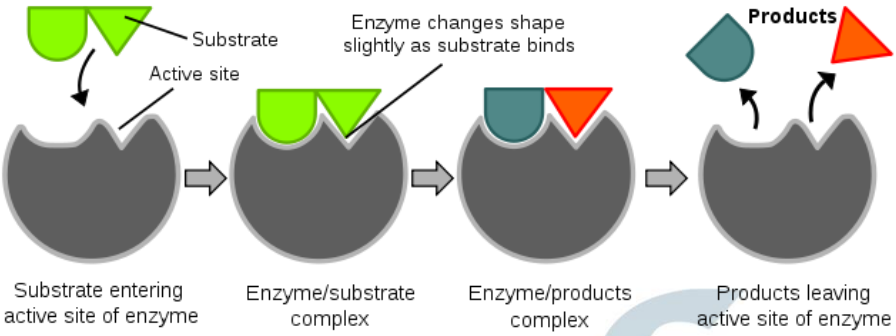
Describe their chemical composition

- Since enzymes are proteins, they are **comprised of chains of amino acids/polypeptides.**
- Chemically they contain CHON
  - CHON = Carbon, hydrogen, oxygen and nitrogen

A simple model to describe the specificity on substrates

- Scientists model processes to visually represent an idea, making an explanation easier

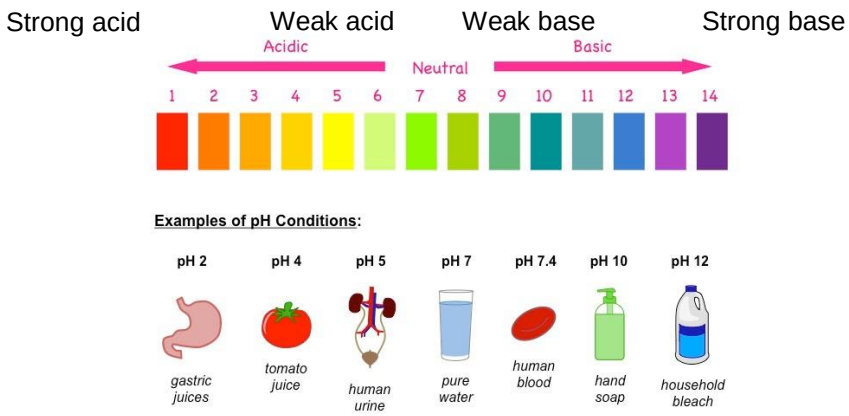
The lock and key model – implies that a specific enzyme fits a specific substrate



- The traditional model to explain enzyme activity is known as **the lock and key model**
  - Based on the idea that an enzyme fits a specific substrate and allows the reaction to take place
- Has been modified to the current model known as **induced fit model**
  - Implies that the presence of the substrate in ideal/optimum temp. and pH induces the enzyme to change shape slightly, allowing the reaction to take place
  - Came about as a result of experimental work that showed that optimal temp. is required for a reaction to take place

identify the pH as a way of describing the acidity of a substance

- pH is a measure of the acidity (and alkalinity, basic) of a solution.
- pH represents concentration of hydrogen ions in a substance



explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency

- All enzymes work best under certain conditions i.e. **optimum** conditions.
- **Homeostasis are those processes** that aim to maintain optimal environmental conditions for the enzymes to work
- Maintaining optimal conditions allows optimal metabolic efficiency
    - This requires the organism to coordinate internal and external signals and adjust the composition of the internal bodily fluids to remain within required limits
- EXAMPLE // ideal body temperature is 37 degrees, if the body temperature drops two degrees the body is said to be **hypothermic.** Increase of two degrees and the body is said to be **in fever**

describe homeostasis as the process by which organisms maintain a relatively stable internal environment

- **Homeostasis** is the process by which organisms maintain a relatively constant or stable internal environment for body cells.

explain that homeostasis consists of two stages:
– detecting changes from the stable state
– counteracting changes from the stable state

- Homeostasis consists of two stages
    1. Detecting changes from the **stable state**
    2. Counteracting changes to return to the stable state

- **Stimulus** is any information which provokes a response; special **receptors** detect stimuli
    - EXTERNAL STIMULI // light, sound, vibration, temperature, texture, odor
    - INTERNAL STIMULI // levels of CO_2, oxygen, water, waste, temperature

The stimulus response model example

1. Stimulus
    - EXAMPLE // increase CO_2 levels in blood
2. Receptor: organs or tissues that detect change
    - EXAMPLE // chemoreceptors in hypothalamus in brain
3. Control center (central nervous system)
    - EXAMPLE // brain
4. Effector: muscle or organs that counteract the stimulus
    - EXAMPLE // muscles in the chest increase breathing rate
5. Response: change in the stimulus
    - EXAMPLE // decreased CO_2 levels in blood

- Homeostatic organisms maintain a **feedback system** i.e. **the response alters the stimulus.**
    - Feedback can be negative i.e. where the stimulus is reduced
    - Or positive i.e. where the stimulus is increased

outline the role of the nervous system in detecting and responding to environmental changes

- The human nervous system is made of up of

    - the CNS i.e. the brain and spinal cord
    - the peripheral nervous system
        - a system of nerves connecting receptors and effectors, they pass messages to and from the CNS rapidly
- The nervous system acts as a communication channel between receptors and effectors.
    - They detect the stimulus, decide on the response required and bring about that response.
- PROCESS:
    - Receptor cells detect changes to the STABLE STATE.
    - These cells generate nerve impulses which travel along the sensory nerves to the CNS
    - The CNS determines the appropriate response
    - The CNS sends nerve impulses along the motor nerves to effect cells/muscles
- Therefore, the nervous system regulates and maintains the organism's internal environment by responding to changes in the external environment

identify the broad range of temperatures over which life is found compared with the narrow limits for individual species

- Temperatures on land vary much more than in water
- The poles can reach temperatures of -70 degrees, whilst the deserts can reach 50 degrees
- The temperature of the environment is known as the **ambient temperature**
- Organisms must be able to live within the temperature range of their local environment, as well as daily and seasonal changes
- Most species can tolerate a narrow temperature range
    - EXAMPLE // sugar cane needs a warm, frost free environment of 15+ degrees

- Ectotherms
    - Have limited control over their internal temperature
    - Their body temperature rises and falls with the ambient temperature
    - EXAMPLE // fish, all invertebrates, amphibians, reptiles

- Endotherms
    - Body metabolism generates heat
    - Internal temperature is independent of external temperature
    - To do this takes energy, so more food is required by endotherms

compare responses of named Australian ectothermic and endothermic organisms to changes in the ambient temperature and explain how these responses assist temperature regulation

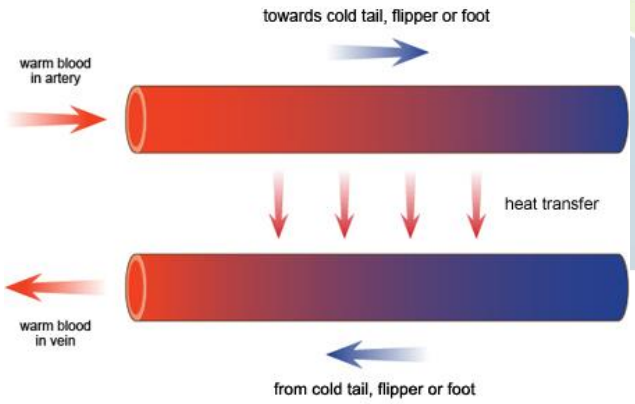
Behavioural adaptations

- Migration: animals move to avoid temperature extremes
    - EXAMPLE // birds spend spring and summer in south-eastern Australia and migrate to south-east Asia when the weather turns cold
- Hibernation: some animals remain in a sheltered spot, slowing their metabolism and dropping their temperature (endotherms) to survive long cold conditions
    - **Aestivation** is used for animals that hibernate in hot conditions
    - EXAMPLE // Bogong moth migrates to spend the summer months in caves in the Australian alps
- Shelter: animals may seek shelter by burrowing, sheltering in caves, crevices to escape high temperatures during the day and cold at night

    - EXAMPLE // central netted dragon climbs into trees to avoid hot conditions
- Controlling exposure: endotherms may huddle together to reduce heat loss
    - EXAMPLE // penguins huddle in crowds
- Nocturnal activity: when the daily temperature is hot, some organisms hunt at night
    - EXAMPLE // hopping mice dig burrows and are active and feed at night

Structural and physiological adaptations of endotherms

- Insulation: fur, feathers or subcutaneous fat act as an insulating layer that slows down heat exchange with the environment.
    - EXAMPLE // domestic cats grow a winter fur and lose it in the summer
- Metabolic activity: endotherms generate heat as a result of metabolic activity
    - EXAMPLE // shivering increases muscle activity and produces heat
- Control of blood flow: endotherms increase or decrease blood flow to the skin and its route
- Counter-current exchange: blood vessels leading to and from the extremities of the body (e.g. legs and tail) are placed together and chilled blood returning in the veins picks up heat from the arteries going to the extremities
    - EXAMPLE // seal fins
- Evaporation: endotherms control the rate of evaporation of water from their bodies
    - EXAMPLE // kangaroos lick their forearms in hot weather; their forearms have a good blood supply and when moisture evaporates from them it cools the forearms and thus the blood



identify some responses of plants to temperature change

Death and growth

- Plants respond to temperatures by…
    - Altering growth rate
        - Active plant growth occurs within 5-45 degrees in temperate regions
        - In tropical areas, growth ceases at 15 degrees
    - Dying but leaving dormant seeds with thick protective coats
    - Dying above ground
        - Results in roots, rhizomes, bulbs or tubers being left behind that sprout in favourable conditions

Developmental responses

- Temperature change can control developmental changes in a plant's life cycle, from germination to flowering to seed dispersal

- EXAMPLE // high Australian temperatures during flower formation produces poor wheat crop, because pollen formation in the anthers is very temperature-sensitive

Extremes

- **Vernalisation** is the process by which some plants only flower when exposed to cold
  - EXAMPLE // hyacinths, daffodils
- In some plants, seed dispersal is stimulated by extreme heat or fire
  - EXAMPLE // banksia trees bear fruit with hard woody cases, fire stimulates the fruits to open and seeds are released

Leaf adaptations

- Leaves may be…
  - EXAMPLE // frost-resistant, frost causes camellia leaves to turn transparent, and return to normal in warm temp.
  - EXAMPLE // reflective (silvery, waxy or shiny), which reduces the amount of heat absorbed and keeps the plant cool
  - EXAMPLE // arranged to reduce surface area exposed to sunlight, the Eucalyptus' leaves hang vertically
  - EXAMPLE // reduce transpiration in the hottest part of the day to conserve water

identify data sources, plan, choose equipment or resources and perform a first-hand investigation to test the effect of:
– increased temperature
– change in pH
– change in substrate
concentrations on the activity of named enzyme(s)

- Enzymes work optimally at a specific temperature, pH and substrate concentration
- Enzymes are specific to a reaction
- Rennin is an enzyme that causes milk to solidify; it naturally occurs in the stomach of newborn cows

Increased temperature

- SUBSTRATE: Milk
- ENZYME: Rennin, tablet or liquid form
- VARIABLE: temperature

- Aim: to observe the effects of an enzyme (rennin) on milk
- Materials: two test tubes, beaker (for water bath), hot plate, milk, enzyme sample
- Method:
  1. Drop 5 drops of enzyme into one test tube
  2. Pour 5ml of milk into each test tube (one w/o enzyme is your control)
  3. Place in water bath
  4. Heat water bath on hot plate to 40 degrees
  5. Repeat and heat to 70 degrees
  6. Repeat and cool to 10 degrees
  7. Record observations

- Results:

Temp (degrees)	Effect on milk (tube with enzyme)
10	No change, just cold
40	Solidified into chunky hard sludge

70	Smooth, shiny sludge, 'poached egg' consistency, denatured the enzyme (curdled, broke down)

- Conclusion: When the temperature is too low, the enzyme is not activated. When the temperature is too high, the milk denatures. When the temperature was at the optimal temperature of 40 degrees, the milk solidified due to the enzyme creating a site for the reaction to take place on.

Change in pH

- SUBSTRATE: hydrogen peroxide
- ENZYME: catalase within potato
- VARIABLE: pH – acid, base and water
- $2H_2O_2 \xrightarrow{\text{catalase}} O_2 + 2H_2O$ (this is a balanced equation)
- the substrate (hydrogen peroxide) is changed by the enzyme
- Catalase is found in most living things including potato
- Bubbles and froth is produced as the hydrogen peroxide is broken down into oxygen and water

- Aim: to determine the effect of pH on milk
- Variables:
  - Potato slices should be same size
  - Volume of H_2O_2 should be same
- Method:
  1. Place pH indicator into test tubes with acid (hydrochloric acid), base (sodium hydroxide) and distilled water, and observe it turn appropriate colour
     - red for acid
     - purple for base
     - green for water
  2. Place slice of potato in test tubes
  3. Pour 5ml of hydrogen peroxide into each. Observe reactions

Results:

- Acid – nothing, little bit of fizz and bubble, in other groups webby bubbles
- Base – little bit of fizz
- Distilled water – effervescent, turned orange and then pale green, fizzing excessively, foamy white bubbles

OR

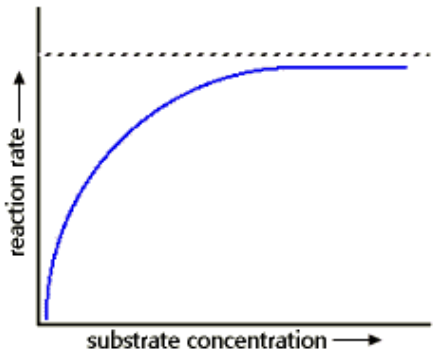
1. In three test tubes, pour equal amounts of milk
2. Add an acid, a base and distilled water to one each
3. Test substances with indicators
4. Drop 5 drops of rennin enzyme into each test tube

Change in substrate

- SUBSTRATE: milk
- ENZYME: rennin
- VARIABLE: substrate

- The **substrate** is the component that the experiment is working on, in this case it is the milk
- Varying the **concentration** of the substrate

- Variables
  - Place all test tubes in water bath to achieve equal temperature (ideally, 37 degrees)
- Method:
  1. In first test tube, pour 100% milk
  2. In second test tube, pour 75% milk diluted with water
  3. Third, 50% and fourth 25%, fifth 0% (control)
  4. Drop 5 drops of rennin into each test tube



  - The line plateaus despite increased substrate concentration due to all active sites being occupied

Results?
  - I would assume after about 50% concentration the rate of reaction would begin to plateau, froth heights being highest at about 50%

Change in surface area
Method:
1. Pour distilled water 5ml into 3 test tubes
2. Cut three pieces of potato into same length width size etc.
3. Cut piece in half, one piece in quarters and one piece in sixths
4. Place pieces in each test tube
5. Add hydrogen peroxide to each tube
6. Observe reactions

Results:
- Sixth – heaps of bubbles, loads of white foamy stuff
- Quarters – lots of bubbles
- Halves – not many bubbles

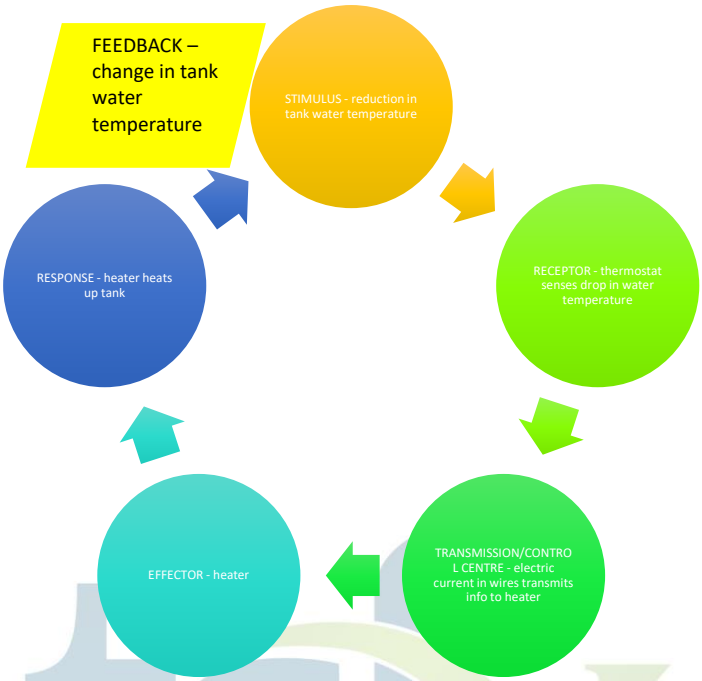
Conclusion: the more surface area the substrate has to work on, the more active sites there are available

gather, process and analyse information from secondary sources and use available evidence to develop a model of a feedback mechanism

- Organisms receive information from various parts of their bodies and environment in the form of **stimuli**
- Stimuli is detected by receptors and results in a **response** from an organ or collection of organs
  - Stimulus doesn't affect the organ directly but rather responses occur as a result of transmission through the nervous or endocrine systems
    - EXAMPLE // during exercise, increased respiration in the muscle cells increases CO_2 in the blood. This is detected by a center in the brain which sends more frequent nerve impulses to the muscles in your chest and diaphragm so they contract more and breathing increases. CO_2 levels fall

towards normal. When you stop exercising, the muscles stop creating excess CO_2, the brain stops sending impulses and breathing slows down

Stimulus response model – using the example of hot water in a household likened to homeostasis



FEEDBACK MECHANISM: Blood temperature – its regulation by the body

[DOCUMENT OF DIAGRAM IN BIOLOGY FOLDER[

analyse information from secondary sources to describe adaptations and responses that have occurred in Australian organisms to assist temperature regulation

Changes in the ambient temperature	Responses of Ectothermic organism – Eastern blue tongue lizard	Responses of Endothermic organism – the fairy penguin
Increased temperature	▪ Moves into the shade of trees and bushes ▪ Burrows ▪ Reduces cellular activity to reduce little heat internally produced ▪ Come out at night	▪ Feathers lay flat against skin, trapping less air ▪ Move into cold waters ▪ Overlapping penguin feathers are shed in water and on land
Decreased temperature	▪ Brumation – hibernation of cold-blood animals, slow metabolism, conserve energy and heat, hides in a hibernaculum for months on end and	▪ Feathers help to some degree – lifted away from skin, erect, trapping air ▪ Layer of subcutaneous fat insulates against cold and prevents heat

	rarely moves, become extremely lethargic ▪ Flattens self out in sunlight to increase surface area and heat taken in	loss, traps a layer of air close to the skin ▪ Dig deep burrows in coastal sand dunes ▪ Huddle together in crowds to decrease surface area each penguin is exposed to ▪ Muscle which control feet and flippers are located within the body, whilst feet and flippers are controlled by tendons, therefor when feet or flippers get cold they are still operational via the muscles ▪ Heat exchange blood flow, warm blood entering feet flows past cold blood, warming it up

2. Plants and animals transport dissolved nutrients and gases in a fluid medium

identify the form(s) in which each of the following is carried in mammalian blood:
– carbon dioxide
– oxygen
– water
– salts
– lipids
– nitrogenous waste
– other products of digestion

Substance	From	To	Form	Carried by	How does it change
Oxygen	Lungs	Body cells	Oxyhaemoglobin	Red blood cells	Refer to 2.4
Carbon dioxide	Body cells	Lungs	Hydrogen carbonate ions	Red blood cells and plasma	
Waste nitrogenous material	Liver and body cells	Kidneys	Mostly as urea	Plasma	
Water	Digestive system and body cells	Body cells	Water molecules	Plasma	
Salts	Digestive system and body cells	Body cells	Ions	Plasma	

Lipids	Digestive system	All cells	Glycerol and fatty acids	Proteins in plasma/molecules called chylomicrons	
Other products of digestion	Digestive system and liver	Body cells	As separate molecules e.g. glucose and amino acids	Plasma	

explain the adaptive advantage of haemoglobin

- **Hemoglobin** is the protein molecule in red blood cells that carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues back to the lungs.
- Mammalian cells need a continual supply of oxygen for respiration
- Oxygen diffuses across capillary membranes
- In the lungs, oxygen is added to the blood supply and transported to tissues where the oxygen is unloaded from the blood into the cells
- Oxygen is not very soluble in water and the plasma alone can only carry 0.2 mL of oxygen per 100mLs of blood
- Majority of oxygen is carried attached to haemoglobin found in RBC
    - Each haemoglobin molecule can carry 4 oxygen molecules
        - Haemoglobin is iron-based, taken in by the diet
        - Haemoglobin + oxygen → Oxyhaemoglobin
            - $Hb + 4O_2 \rightarrow Hb(O_2)_4$
- The presence of haemoglobin in the blood increases oxygen-carrying capacity by 100 times to about 20mL (0.2 x 100 = 20mL) per 100mL of blood
- Haemoglobin is therefor an adaptive advantage of mammals

compare the structure of arteries, capillaries and veins in relation to their function

STRUCTURE VS. FUNCTION TYPE QUESTION

- Blood is transported within a closed transport system
    - It is made up of three types of vessels
        1. Arteries: carry blood away from the heart
        2. Capillaries: site of the exchange of materials between blood and tissue
        3. Veins: take blood back into the heart

Arteries

- Blood pumped out of the heart is at a very high pressure, so the arterial structure must adapt to this
    - They have thick walls made of elastic fibers and smooth muscles
    - Narrow but flexible lumen
    - Expand with the contraction of the heart
    - Elastic allows walls to stretch so as not to rupture

Blood flow goin this way

- When the diameter of the walls is increased, the pressure reduces a little and vice versa
- The lowering of the pressure of blood when it is high and the raising of it when it is low smooths out the flow of blood

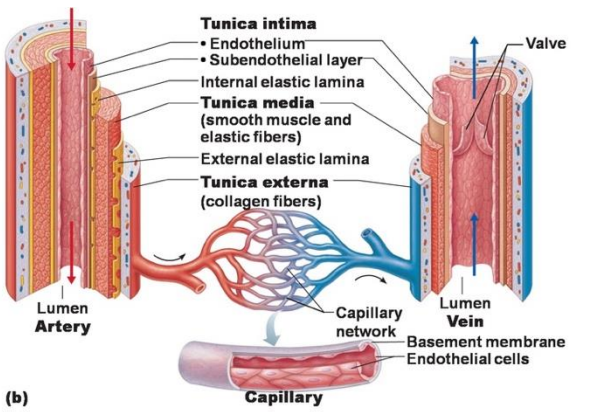
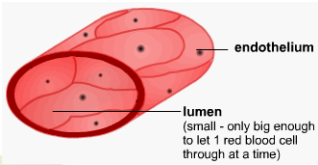


Figure 18.1b

- A large artery will split into smaller arterioles that then branch further into many capillaries
- Arterioles have walls with a similar structure to arteries but have a greater proportion of smooth muscle and elastic (they don't have to withstand high pressure)

Capillaries

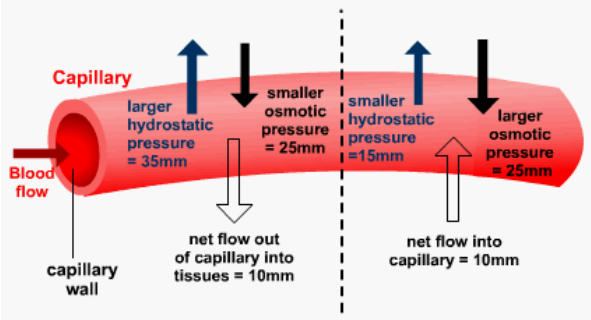
- The capillaries are where **exchange** between fluid and the blood can **only** occur
- 1 cell thick (6-8 um)
- To work efficiently capillaries, need to
  - be small enough to be close with small groups of cells
  - have thin walls to allow substances to move in and out of the blood



- To enable this there are tiny gaps between the cells making up the wall of a capillary
- Pressure changes across the capillary bed; this change is extrapolated upon below vv

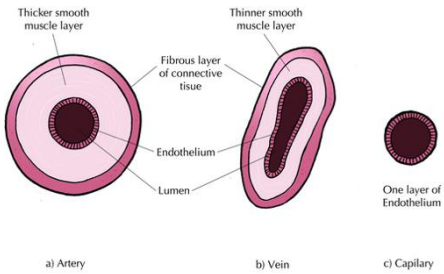
Tissue fluid – think of the following as a cyclic process; this is how exchange of nutrients and oxygen between the blood and body occurs

- Tissue fluid is made up of plasma and dissolved substances
- NOTE: A solute is the substance dissolved (outside blood); a solvent is the substance doing the dissolving (blood)
- At the arteriole end of a capillary; where the arteriole and start of capillaries meet
  1. the hydrostatic pressure of the blood is high
  2. The hydrostatic pressure is more influential than the solute potential of the outside (pressure to prevent inward flow of material) at the arteriole end and therefor fluid/water leaves the capillary and carries with it into the cells glucose and oxygen



- At the venule end of the capillary; at the end of the capillaries where they meet the vein
  1. The hydrostatic pressure of the blood is low and the solute potential is higher (because fluid/water has been lost)
  2. This will then cause fluid to be drawn back into the blood
  3. At this stage, the fluid being drawn back is now filled with waste/carbon dioxide/urea
- About 90% of the fluid which leaks out of the capillaries seeps back in; the remaining 10% becomes lymph

    - The lymphatic system allows tissue fluid to flow into its vessels via one way valves
    - These valves are large enough to allow proteins (too big for capillaries) into the lymph vessels
- If tissues fluid accumulates, bloating or oedema can occur
- Blood consists of cells bathed in liquid plasma
    - When this plasma leaks out of the capillaries it is called tissue fluid



Veins

- Capillaries join to form large venules which then form veins
- Thinner muscle and elastic fibres than artery
- The blood pressure at this stage in circulation is low and needs to be 'encouraged' to flow back to the heart
    - Therefore no need for elastic fibers or smooth muscles in walls
- To prevent blackflow (caused by gravity) veins have valves
- Veins pass through or close to muscles
    - The squeezing and contracting of the muscles pushes blood in the veins towards the heart

describe the main changes in the chemical composition of the blood as it moves around the body and identify tissues in which these changes occur

Oxygen

- Oxygen in the blood changes as it moves around the blood
- Oxygen (used in cellular respiration) when leaving the cells decreases in the blood
- Blood that leaves the lungs is high in oxygen and it decreases in the tissues (which has capillaries) where it is used for cellular respiration
- The desaturated oxygen ends up in the veins
- Blood that leaves the capillaries is low in oxygen i.e. veins generally have low oxygen levels

Carbon dioxide

- Blood that leaves the body cells will be high in carbon dioxide due to respiration
- The blood that enters the lungs is therefore high in carbon dioxide
- Gaseous exchange occurs and the carbon dioxide in the lungs decreases

Waste nitrogenous material (urea)

- When waste leaves the liver and body cells, waste material is high in the blood until it reaches the kidneys where it is filtered out
    - Blood in the kidneys is therefor low in waste after urination
- The capillaries become high in waste concentration during the transfer from liver to kidney

Water

- Water enters in a body cell through the digestive system
- Capillaries that leave the digestive system are high in water concentration
- Water is high in concentration in capillaries and therefor blood until the kidney filters out any excess water

Salts

- Salts enter the bloodstream through transfer with body cells and the digestive system

- They travel to body cells to be used
- However, excess is removed via kidneys

Other products of digestion (vitamins, minerals, proteins, glucose, amino acids)

- Enter blood in the digestive system
- Blood that leaves the digestive system and liver is high in products of digestion such as glucose
- Remains high until it enters the body cells where it is used for cellular respiration

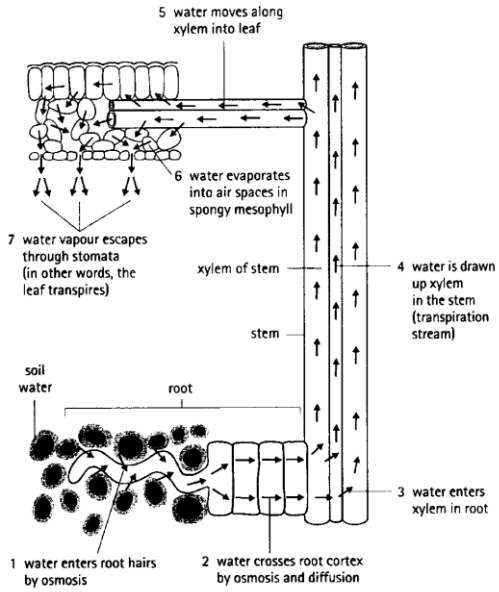
outline the need for oxygen in living cells and explain why removal of carbon dioxide from cells is essential

- Oxygen is necessary for cellular respiration (refer to 2.2 for detailed notes)
  - Glucose + oxygen → carbon dioxide + water + ATP
  - $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + ATP$
- Cells produce carbon dioxide as a result of respiration
- Carbon dioxide enters the bloodstream and is carried in one of three ways:
  1. About 70% of CO_2 combines with water to form hydrogen carbonate ions in the RBC
     (Carbonic acid → hydrogen ions + hydrogen carbonate ions)
     $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$
  2. 23% of CO_2 combines with haemoglobin to form carbaminohaemoglobin
  3. Around 7% is dissolved directly into the plasma
- Carbon dioxide levels change the pH of the blood
  - The pH of the blood is measured in the chemoreceptors in the hypothalamus
  - It should remain 7.35-7.45
- Low pH (a high acidity level) results in increased breathing rate
- pH in the blood and cells must be carefully maintained for optimal enzyme efficiency

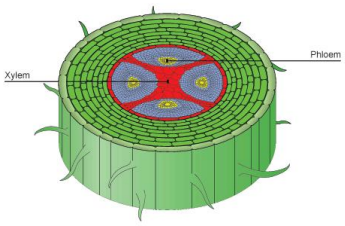
describe current theories about processes responsible for the movement of materials through plants in xylem and phloem tissue

Movement of Water in Xylem

- Several process are involved in the upward movement of water in plants
  - Capillarity: the rise of water in thin tubes by forces of adhesion and cohesion
    - Adhesion: forces of attraction between different particles of the plant and water
    - Cohesion: attraction between water particles
  - Root pressure: the upward movement of water caused by the pressure from water moving into the root through osmosis

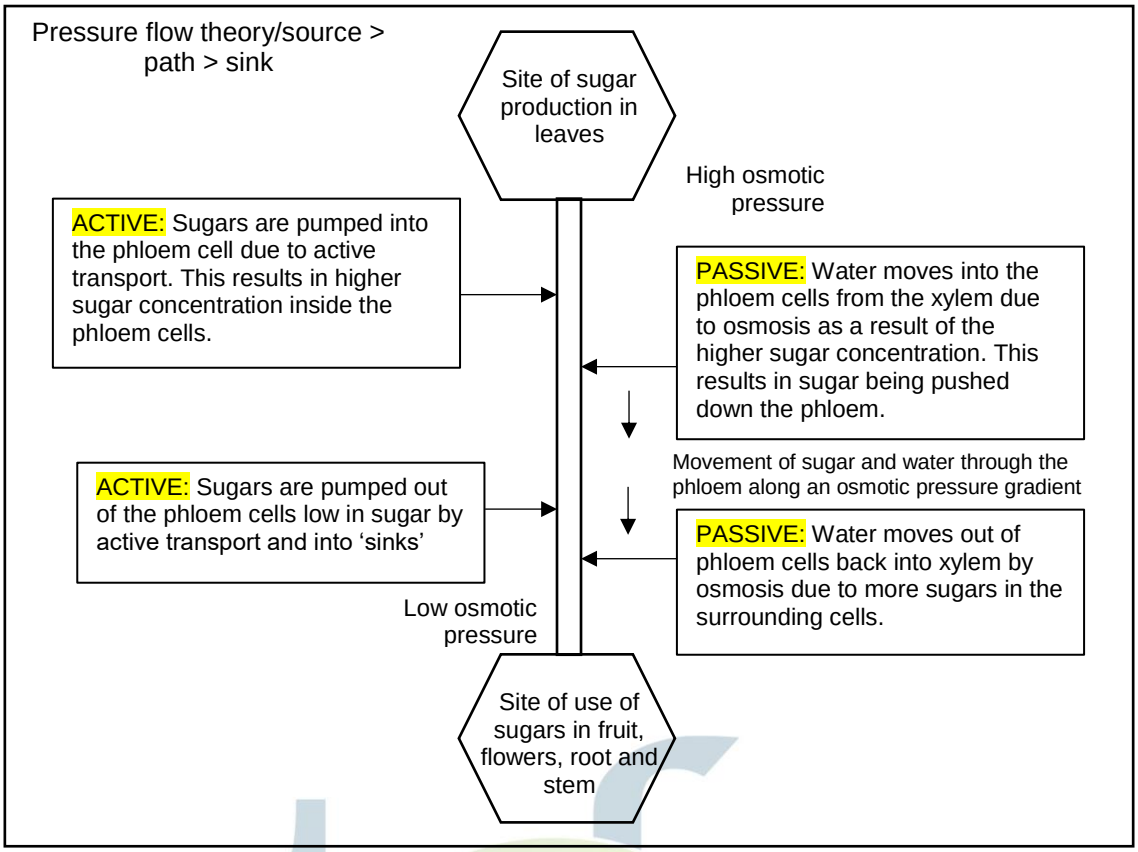


- Transpiration cohesion: the loss of water molecules from the leaves (transpiration) results in the upward movement of more water molecules (cohesion)
- Guttation: the loss of water in the form of a droplets from openings on the leaves

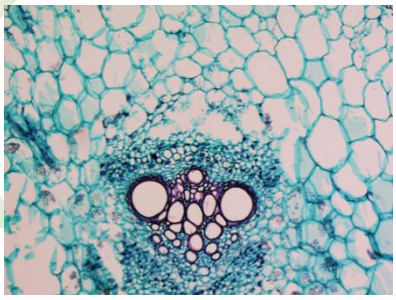


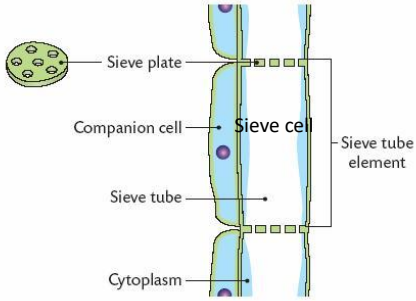
Movement of Sugars in Phloem

- Translocation: movement of products of photosynthesis in the phloem
- Biologists studied the ways that radioactively marked sugars move throughout plants. Observations included:
  - Their movement in the phloem is rapid; 1 metre per hour
  - The direction of movement can be reversed
  - Movement of materials can be in different directions in different parts of the same vascular bundle

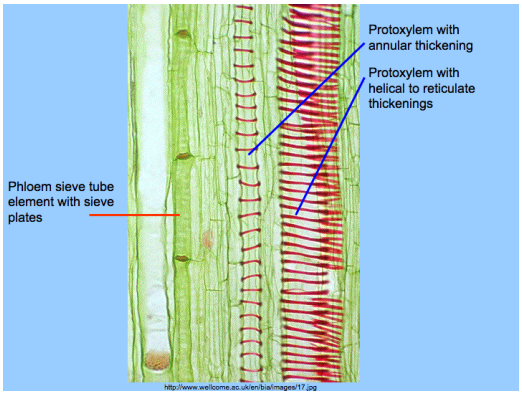


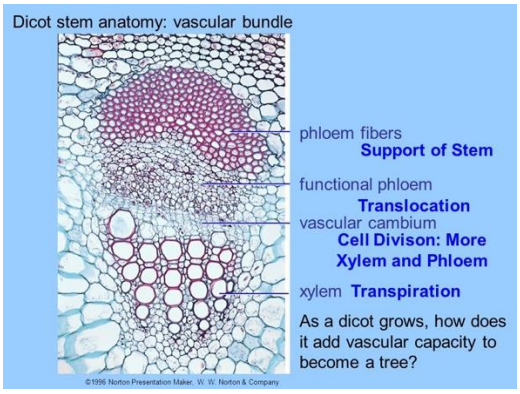
XYLEM	PHLOEM
Dead	Alive
Roots → shoots (one way)	Shoots → all other parts (any direction)
Transpiration	Translocation
Passive	Active and passive
Larger tubes	Smaller tube
Water and dissolved substances	Sugars and hormones
Moves in one direction	Can move up and down in both directions
Strengthened with lignin	Companion cell with a nucleus
Transport tissue	Transport tissues
No cytoplasm	Cytoplasm





- Sugars are pushed down the phloem tube via water moving into the cells by osmosis which is passive transport
- Sugars are unloaded into the cells that need it via active transport
- Water moves into roots by osmosis (high concentration of ions in roots)
- GET A DIAGRAM OF A LONGITUDINAL XYLEM CELL





Longitudinal versus transverse vascular bundle. Learn these!

perform a first-hand investigation to demonstrate the effect of dissolved carbon dioxide on the pH of water

Aim: to demonstrate the effect of dissolved carbon dioxide on the pH of water
Method:

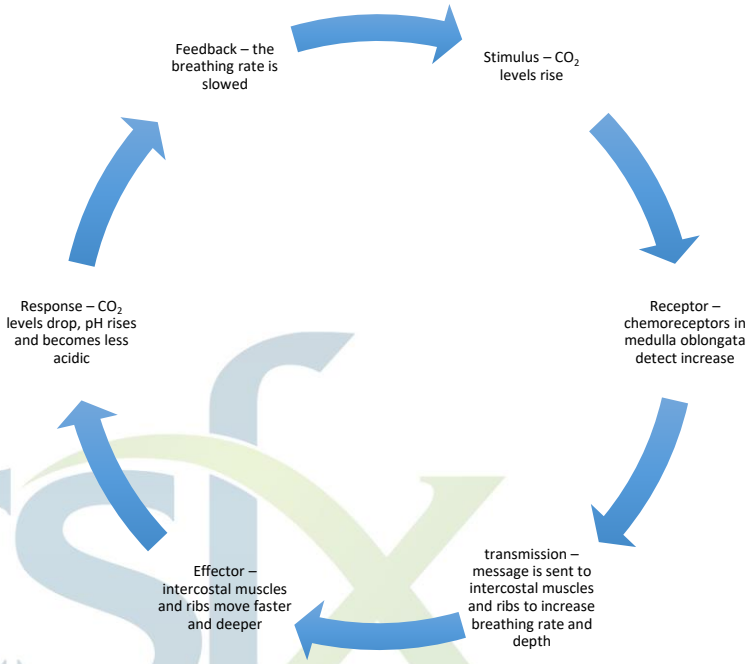
1. Place distilled water in conical flask
2. Add universal indicator to water and observe it turn green, a pH of 7
3. Exhale through straw into distilled water for two minutes
4. Add universal indictor to water again
    - It turned from a green 7 to a yellow 5.5-6.5

<u>HOMEWORK QUESTIONS – MAY NOT BE PARTICULARLY RELEVANT</u>

1. The pH of the distilled water may have been above 7 (the usual pH for drinking water) due to the dishwashing liquid used on the conical flask in which the water was poured. Dishwashing liquid has a pH of 7-8 and may have raised the water's pH.
2. Universal indicator utilizes color as a symbol to help identify the pH, whilst the pH sensor can pin point the numerical pH of the substance. The pH sensor can also record change in pH over time, whilst the universal indicator records the pH at the moment in which it mixes with the substance.
3. To prove that exhaled air contains carbon dioxide, the limewater test can be done. This involves:
    a. Add 50 ml of lime water to two beakers
    b. Bubble room air through a pipette using a pipette pump for one minute into one beaker
    c. Bubble exhaled air through a pipette using your mouth for one minute into one beaker
    d. Observe the results. (room air shouldn't cause any change in the beaker, whilst exhaled air will cause the carbonic acid and limewater to combine and form a white precipitate formed by calcium carbonate).
1. Homeostasis is defined by the self regulating processes by which a biological organism maintains stability and adjusts to the features (temperature, pH, etc.) of its ambient surroundings. The respiratory system helps to maintain an organism's homeostatic state by inhaling oxygen and exhaling carbon dioxide, which if left to build up can poison the bloodstream.
2. Carotid bodies and aortic bodies are chemoreceptors found in the blood vessels in the neck that detect slight increase in acidity caused by CO_2 levels. Conditions that may cause increased CO_2 levels include:
        a. Hypoventilation, shallow or low breathing which lets carbon dioxide build up and less to be exhaled (this can be caused by sleep apnea or drug overdose)

b. Airway blockages can be caused by asthma or lung disease which also causes hypoventilation
c. Diminished gas exchange, CO_2 must be transferred to the lungs from the blood via air sacs, capillaries. Diseases such as pulmonary edema (fluid in the lungs) restrict exchanges; sometimes there is so much CO_2 in the blood it is difficult to transfer
d. Exposure to high levels of atmospheric carbon dioxide or bad ventilation

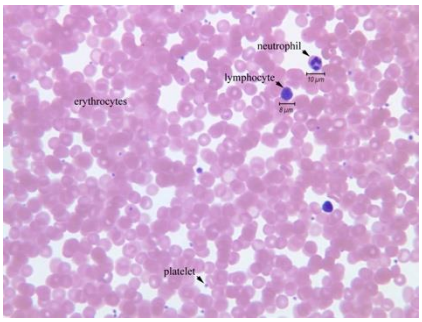
- The medulla oblongata is the control center for breathing
  - It has chemoreceptors which monitor CO_2 levels
  - When the chemoreceptors detect high CO_2 levels a message is sent to the intercostal muscles and ribs to increase breathing rate and depth



perform a first-hand investigation using the light microscope and prepared slides to gather information to estimate the size of red and white blood cells and draw scaled diagrams of each

1. Carry and set up the microscope. Ensure the light is switched on.
2. Place a minigrid on the stage of the microscope and focus the microscope on low power
3. Note what size each grid is in mm and count the number of boxes across the diameter
   - In our investigation, we found that at x40 (4 x 10) the FOV (field of view) was 4.1mm; at x100 (10 x 10, which is an increase of 2.5) the FOV was 1.5mm
   - When magnification increases, FOV decreases
4. Place blood slide on stage and count how many blood cells across there are at LP and then HP

5. FOV divided by NUMBER OF CELLS = how big those lil red babies are



analyse information from secondary sources to identify current technologies that allow measurement of oxygen saturation and carbon dioxide concentrations in blood and describe and explain the conditions under which these technologies are used

- Oxygen concentration is referred to as oxygen saturation
  - Oxygen saturation is the percentage of haemoglobin saturated in oxygen
- Oxygen saturation and carbon dioxide concentration in the blood are measured by current technology
- Blood gases are often expressed in terms of the pressure the gas exerts and have the units mmHg

Pulse Oximeter

- Non invasive, portable, simple and provide continuous data
- Measures blood flow and pulse
- Measures the amount of oxygen in the blood by sensing the change in color of circulating blood
  - Blood is bright red when there is plentiful oxygen which has attached to haemoglobin (Oxyhaemoglobin)
  - Blood is dark purple when there is less oxygen
- Looks like a clothes peg which fits on the finger
- Red infrared light is emitted from the top of the peg and the amount of light which passes through the skin is detected by an electronic sensor on the bottom of the peg
  - The value determined by a processor and is used to calculate the amount of oxygen in the arterial capillaries, which usually are 95-100% saturation
- Used for patients who
  - are undergoing surgery
  - have abnormal breathing or circulation
  - are in intensive care, emergency or wards
  - in recovery
  - have respiratory or cardiac issues
  - have sleep apnea
  - are athletes or mountain climbers in high altitudes
  - pilots flying unpressurized aircraft

Arterial Blood Gas Analysis

- Machine that measures both oxygen and CO_2
- A small sample of blood is taken from an artery, meaning it is an invasive technique
- The movement of oxygen through a membrane from the blood produces an electrical current

    - Converted by the machine to a digital reading of the partial pressure/amount of oxygen
- The diffusion of carbon dioxide through a membrane changes the pH of the solution inside the membrane
    - Carbon dioxide produces carbonic acid and the acid dissociates hydrogen ions in plasma
    - Used by the machine as a measure of CO_2 present
- Used when a patient is
    - In treatment
    - In surgery
    - Have abnormal breathing or circulation
    - Shivering (physiological)
    - Experiencing vasoconstriction
    - Labour wards
    - Intensive care wards – monitor the the success of ventilation procedures during which air is punched into the lungs

analyse information from secondary sources to identify the products extracted from donated blood and discuss the uses of these products

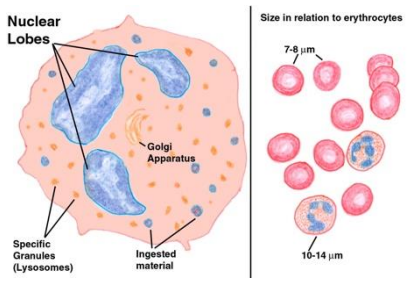
- A blood transfusion is the transfer of blood or any of its components to a recipient
- Blood transfusions are necessary in life threating situations, surgeries or treatment of sever burns etc.
- The standard blood donation is 450mL
- The blood is tested for the presence of antibodies, hepatitis and HIV. The type is then determined
- Donated blood may be given as whole blood or broken into components using a centrifuge. Components include
    - Plasma
    - White blood cells and platelets
    - Red blood cells
    - Antibodies
    - Clotting factors
    - Albumin

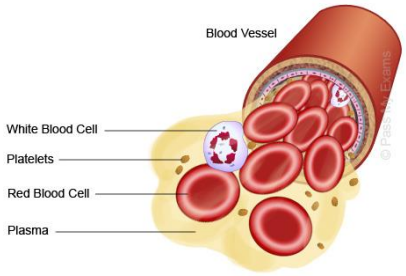
Components of Donated Blood	Description and Function	Type of Recipient
Whole blood	○ Blood which has been directly extracted from the body and none of its components have been extracted. ○ Whole blood supplies cells, tissues and organs with sugars, oxygen and hormones; it also helps to flush waste produced by cells out of the body	▪ Those with live infections, who cannot make their own blood ▪ Anemic peoples who have blood deficient in things such as iron or B-12 ▪ Surgery! ▪ Major accidents or trauma
Red blood cells 6-8 um in diameter	○ Erythrocytes, most common and are the primary way to deliver oxygen to tissues, then	▪ Surgeries such as those for cancer lead to red blood cell loss

	bring carbon dioxide back to the lungs. ○ Small, round and biconcave. ○ Membrane is comprised of lipids and proteins, ○ has no nucleus and ○ contains hemoglobin (gives blood red colour)	▪ Anemia, don't have enough red blood cells to carry oxygen to tissues ▪ Low levels of hemoglobin ▪ Oxygen deficient – cirrhosis, emphysema
White blood cells (e.g. granulocytes) Between 12-15 um in diameter	➢ Leukocytes ➢ belong to the immune system ➢ account for 1% of the blood ➢ made in the bone marrow ➢ fight antigens ➢ contain nucleus ➢ two important types are ➢ phagocytes (surround and engulf pathogens) ➢ lymphocytes (specialize into B and T cells) ○ between 400-12'000 per ml of blood	▪ Chemotherapy can damage bone marrow cells ▪ Rarely are WBC given, instead doctors prescribe colony-stimulating factors to help the body make its own ▪ Anybody with a compromised immune system ▪ Recovery, WBC are low and the body is fragile and susceptible to disease
Platelets 3um	○ Colorless cells which circle through the bloodstream ○ no nucleus ○ bind together when a blood vessel is damaged and bind to the site of the cut and cause the blood to clot, helping to stop bleeding	▪ Those with low platelet count (thrombocytopaenia) ▪ Chemotherapy ▪ Bone marrow transplantation ▪ Major surgery ▪ Liver disease ▪ Severe trauma
Antibodies	○ Proteins/immunoglobins that are produced by B cells when an antigen is present ○ bind to antigens detected within the body via an antigen-antibody complex and work to kill or deactivate the antigen	▪ Those who's body cannot produce its own antibodies, passive immunity ▪ Those who may be ill with a severe illness and need an instant boost in antibodies (snake bite, tetanus)
Clotting factors (Factor VIII)	○ Protein which is created by the F8 gene and assists in blood clotting	▪ Heomphilia A ▪ Von Willebrand syndrome

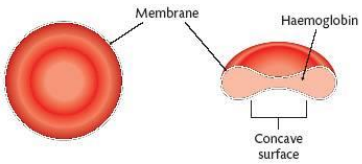
	○ circulates through the blood bound with the von Willebrand factor until an injury which damages tissue is detected ○ interacts with factor IX to catalyze a chain of reactions which helps blood clot	
Albumin	○ Globular proteins, water-soluble ○ found in blood plasma ○ main function is to regulate the osmotic pressure of blood ○ can bind with water, cations, fatty acids, hormones etc.	▪ Transfusion of albumins has reportedly no effect on the patient ▪ Shock ▪ Heart surgery ▪ Burns ▪ Hemodialysis ▪ Cirrhosis
Plasma	○ 90% water, straw colored, slightly salty, sticky solution. ○ makes up 55% of the blood ○ It contains ions and large plasma proteins. ○ It has a pH of around 7.4 ○ Solution by which all other components are carried	▪ Cancer ▪ Childbirth ▪ Haemophilia ▪ People with significant fluid loss (BURNS), risk of dehydration ▪ HIV

▪





analyse and present information from secondary sources to report on progress in the production of artificial blood and use available evidence to propose reasons why such research is needed



REASONS WHY SUCH RESEARCH IS NEEDED

- Artificial blood is a substance created to act as a substitute for the red blood cells
- Artificial blood is created for the soul purpose of transporting oxygen around the body

- Therefor it represents emergency and temporary treatment
- It cannot defend against pathogens or clot blood

- Artificial blood is needed because:
  - To deal with demands when blood supply is insufficient
    - 1 in 30 Australians donate blood while 1 in 3 will need blood at some point in life
  - Donated blood has a shelf life of 1 month. This is costly and time consuming
  - Donated blood must be typed and matched to specific blood groups
    - O can be donated to any blood type; A, B, and AB contain specific proteins that cause blood reactions if matched incorrectly
  - Donated blood must be screened for diseases
    - Individuals living in Britain in the 1980s can't donate due to mad cow disease concerns
- Ideal artificial blood has the following characteristics
  - Must be compatible with the body i.e. the blood can be received no matter the blood style
  - Has been processed to remove all diseases/viruses/etc.
  - Must be able to transport oxygen and collective carbon dioxide
  - Its must be shelf stable
    - Artificial blood can last 1 year

<u>TIMELINE – DEVELOPMENT OF PRODUCTION OF ARTIFICAL BLOOD: 'PROGRESS IN PRODUCTION'</u>

- 1616 – William Harvey described how blood circulated throughout the body
    - practitioners tried to substitute blood for beer, milk, urine, sheep blood and plant resin
- 1800s – other materials trialed included haemoglobin and animal plasma
- 1840 – Hunefeld found blood contained haemoglobin
- 1854 – patients were injected with milk as a substitute for blood to treat Asiatic cholera; physicians believed milk helped regeneration of white blood cells
- 1871 – trialed animal blood and plasma as a substitute; hampered by technological problems including haemoglobin separation
- 1883 – Ringer's solution was created; it was comprised of sodium, potassium and calcium salts
    - scientists found the heart could be kept beating by applying the solution
    - reduction in blood pressure caused by loss of blood could be remedied by Ringer's solution ← maintaining pressure and pump up volume
- Landsteiner discovered when blood from different subjects was mixed the blood did not always clot
    - He suspended RBC in a saline solution then mixed each individual's serum with a sample from every cell suspension; clotting separated
    - Landsteiner determined that human beings could be separated into blood groups according to the capacity of their RBC to clot in the presence of different serums
      - Blood transfusion was made much safer onwards
- World War II – human plasma was used to save soldiers from hemorrhagic shock
- 1966 – experiments with mice suggested a new type of blood substitute; perfluorochemicals (PFC)
    - This gave scientists the idea to use PFC as a blood thinner

- 1968 – the idea was tested on rats; the animals blood was completely removed and replaced with a PFC emulsion. The animals lived for a few hours and recovered fully after their blood was replaced
- 1989 – Fluosol DA became the first FDA approved blood substitute
- 2001 – South Africa became the first country to approve Hemopure, a substance made from cow haemoglobin used as an alternative to blood transfusions
- 2005 – PolyHeme a haemoglobin substitute was used in Phase III trial for severely injured bleeding trauma patients
- 2005 – oxycte was approved for clinical trials on traumatic brain injuries in Switzerland
- 2008 – a study revealed the results of five different blood substitutions administered to 3'500 patients
    - Those with substitutes had a threefold increase in the risk of heart attacks compared to the control group given human blood
    - 2005 – approved in Mexico
- June 25 – The UK announced a trial of 20 people that will begin in 2017 looking at blood and transplant recipients

DESCRIPTIONS OF ARTIFICAL BLOOD

There are three types of artificial blood which are all still in the research stage:

1. Haemoglobin based oxygen carriers (HBCO)
2. Perfluorocarbons (PFC)
3. Growing red blood cells from stem cells

Haemoglobin-based Oxygen Carriers (HBOCs)

- Easily supplied, extracted from the red blood cells of cows
- There is no need for blood typing and cross matching
- Molecules are so small they clog up the kidneys, causing kidney damage. Thus they need to be treated in a process which clumps them together to make it a bigger protein
- HBOCs are currently the blood substitute that is closest to approval
- Brands include:
    - Hemopure
    - PolyHeme
    - Hemospan
- Limitations include
    - Costly
    - requires refrigeration (being a protein)
    - only works within the body for about a day

Perfluorocarbons (PFCs)

- Contain fluorine and carbon atoms
- Can carry 5 times more oxygen than haemoglobin (wow!)
- Insoluble in blood, thus they must be combined with lipids to form an emulsion
- Perfect size, not too small yet small enough to reach tissues and provide oxygen in situations where RBC fail to do so (e.g. stroke victims)
- Brands include:
    - Oxygen
    - Oxycyte
- Advantages over donated blood:
    - Long shelf life

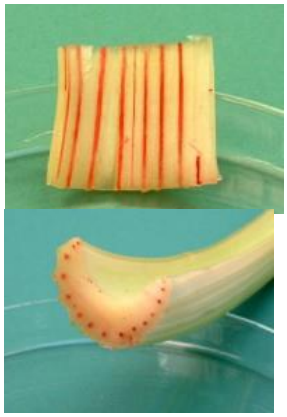
- Universal, regardless of blood type
- Sterile, zero chance of transmitting disease
- Potentially mass producible at little cost

- Limitations include
  - only works within body for 2 days

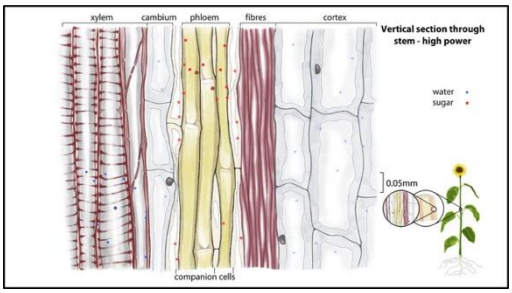
Growing RBC from stem cells

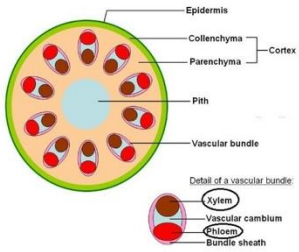
- RBC have been successfully grown from stem cells from bone marrow or umbilical cords
- Cells selected to produce O-negative blood (the universal donor)
- A new trial will begin in 2017 where 20 volunteers will receive RBC grown from stem cells
- Limitations include
  - Not feasible at present as very complicated procedures
  - Expensive
  - Time consuming

choose equipment or resources to perform a first-hand investigation to gather first-hand data to draw transverse and longitudinal sections of phloem and xylem tissue



- Materials:
  - A fresh stick of celery
  - A single sided razor
  - A glass or container with water
  - Eosin (water based red food dye)
- Method:
  1. Place an end of freshly cut celery with its leaves (to ensure transpiration can move the eosin up) still attached into a container containing a strong solution of eosin
  2. Leave it until the dye is observed in the leaves
  3. Take a piece of the celery stalk and use a hard-backed razor blade to cut across it; a transverse section
  4. Observe the section under microscope
  5. Cut off a piece of celery longitudinally about 2 cm long
  6. Observe the section under microscope





3. Plants and animals regulate the concentration of gases, water and waste products of metabolism in cells and in interstitial fluid

explain why the concentration of water in cells should be maintained within a narrow range for optimal function

- No life can exist without water
- Water plays a number of essential roles:

- Water is the universal solvent
  - inorganic and organic molecules (sugar) can dissolve in it
  - water is a polar molecule which separates ions into true substances
  - can form a hydration layer around proteins, forming a colloid
    - some important lubricants are colloids
  - metabolic reactions only take place in solutions where water is the solvent
  - water is a transport medium
- Water is an important reactant
  - the digestion of food is a hydrolysis reaction
  - respiration and photosynthesis need water
- Water has a favorable relationship with heat
  - It can absorb/release heat without changing temperature
  - Water has high heat of vaporization (liquid to gas), accelerates heat loss, when we perspire water evaporates from the skin
- Water has a cushioning effect
  - Solutions in body cells and tissues form a cushion around organs
    - The cerebrospinal fluid cushions the brain

- Therefore, water concentration must be held constant

explain why the removal of wastes is essential for continued metabolic activity

- When nutrients enter the blood and then the body cells, they are involved in numerous biological reactions of the metabolism
  - Majority of these reactions are catalyzed by enzymes
  - Interactions of these reactions ensures that the body can function efficiently
- Sometimes metabolic products are formed that are of no use e.g. wastes, or ingestion of useless compounds
  - EXAMPLE // caffeine, alcohol
  - Carbon dioxide as well
- These waste substances can
  - affect some enzymes
  - disrupt metabolism and homeostasis
  - damage cellular components
  - accumulate and take up space
    - EXAMPLE // excess hydrogen ions reduce pH (making it more acidic) and can in turn effect the activity of enzymes and the oxygen saturation of haemoglobin
    - EXAMPLE // brain is vulnerable to ammonia, urea, toxins and drugs. Hence, the blood capillaries in the brain are less permeable than other capillaries, known as the blood-brain barrier
- Because of the importance of eliminating waste, the body has the urinary system which specifically performs this function

identify the role of the kidney in the excretory system of fish and mammals

- The respiratory system consists of the lungs and bronchial tubes and the thoracic (chest) cavity
  - Ensures that oxygen can enter the blood and carbon dioxide leave
  - There are mechanisms to to maintain these gases
    - EXAMPLE // saturation of haemoglobin responds to oxygen saturation in surrounding tissues

        - The other substance exchanged between body and air in lungs is water vapour
        - The lungs are within the body core, which remains at a constant temperature, preventing excessive water loss
        - The respiratory system is a part of the excretory system
            - Other parts of the excretory system are the skin, urinary system and digestive system
- The skin…
    - Water loss is a mechanism for heat loss and is under the control of the autonomic nervous system
    - As well as water, ingested drugs, small amounts of salts, nitrogenous wastes such as urea, lactic acid and vitamin C may be present in perspiration (sweat)
    - Thus the skin is an excretory organ

- The urinary system…
    - Consists of the kidneys, ureters, bladder and urethra
    - The kidneys have two main functions
        - Excretion
            - The removal of wastes from the organism
        - Osmoregulation
            - The regulation of the concentration of water and salts in body cells and tissues so that homeostasis is maintained; partially under control of hormones

- Fiber (the undigested cellulose from plant foods), the breakdown of haemoglobin, water and other wastes are excreted via faeces via the large intestine

- Function of mammalian kidneys
    - Regulate water and salt levels via osmoregulation
    - Excrete ***some*** nitrogenous waste in the form of ***urea***
        - Urea is less toxic and can be stored in the bladder
        - The liver converts ammonia/nitrogenous waste to urea

- Function of fish kidneys
    - Regulate water and salt levels via osmoregulation
    - Excrete ***all*** nitrogenous waste in the form of ***ammonia***
        - Ammonia is highly toxic and therefor must be removed from the fish quickly
        - This is why most nitrogenous waste (ammonia) is excreted by fish via the gills

	Fresh water fish	*Salt water fish*	*Terrestrial animals*
Urine concentration	Very dilute	Very concentrated	Concentration varies
Explanation	Hypotonic (watery) environment results in **water moving into the fish by osmosis and salt moving out by diffusion.** Thus water needs to be removed and salt retained	Hypertonic environment results in **water moving out of fish by osmosis and salt moving in by diffusion.** Thus water needs to be retained and salts removed	Hormones (e.g. aldosterone) regulate the concentration of urine based on changes in the organism's activities and environment

explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms

- **Diffusion and osmosis** are forms of passive transport where substances are transferred without the cell expending energy
- **Osmosis** is a specialized form of diffusion that involves the movement of water across a semi-permeable membrane in an attempt to equal out concentrations
- In **active transport** specific carrier proteins bind to a substance to carry it across the membrane. This requires the use of energy.
- 3.6 as well: In the kidneys both passive and active transport occurs...
    - Passive transport/osmosis occurs during filtration, where the osmosis of water back into the blood and the movement of some ions
    - Active transport occurs in secretion of substances, the selective reabsorption of salts, and the movement of nutrients back into the blood
- Diffusion and osmosis are inadequate since these processes aim to balance concentrations of solutes such as nitrogenous wastes
    - This would mean that urea would be equal in the nephron tubules and in the blood
        - This will leave toxic products of urea within the blood
        - ALL UREA MUST BE REMOVED FROM THE BLOOD, therefore osmosis (which achieves equal concentration in the blood and nephron) is inadequate
    - They fail to make them equal
    - Therefor, in the kidneys we need ACTIVE TRANSPORT

distinguish between active and passive transport and relate these to processes occurring in the mammalian kidney

REFER TO NEXT DOT POINT

explain how the processes of filtration and reabsorption in the mammalian nephron regulate body fluid composition

- The kidneys are osmoregulatory (regulate the internal salt and water concentrations of the body) organs that excrete urea
- Deamination
    - Proteins are broken down in the cell metabolism to become amino acids
    - They are broken down in liver via deamination
    - Remove nitrogen from the amino acids to form urea
        - Urea is transported to, via the blood, the kidneys to be excreted in the urine

Kidneys

- Compact, bean shaped
- Produce yellow urine composed of nitrogenous waste
- Each kidney is made up of millions of small filtering units called nephrons
    - It is within nephrons where the urine is produced

Steps to the formation of urine

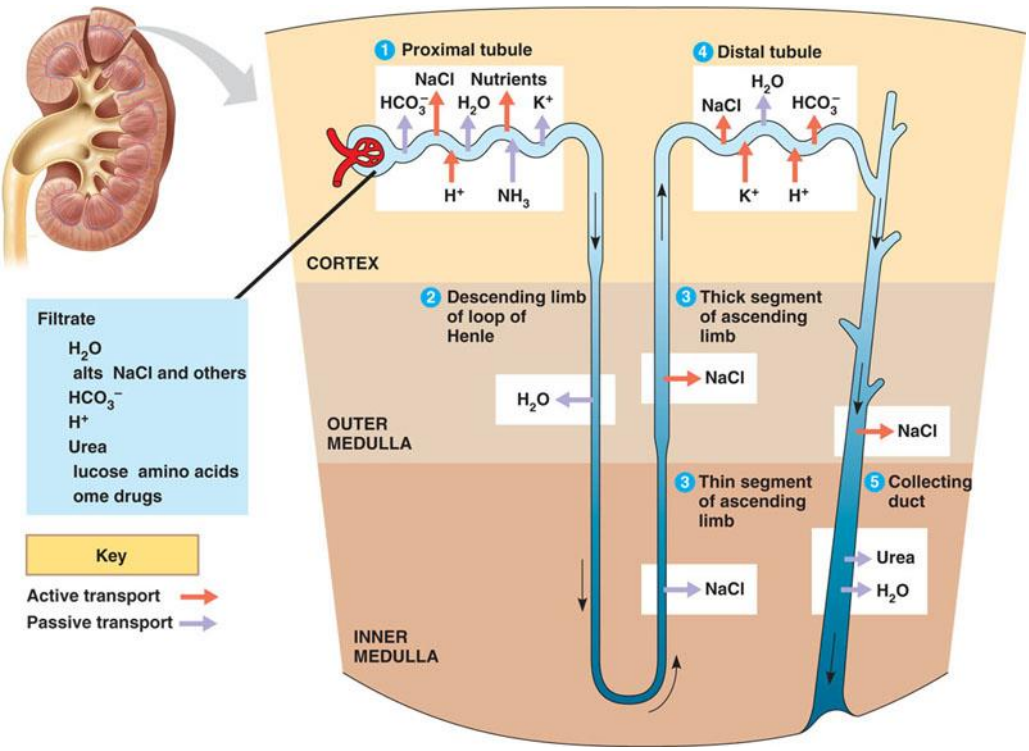
1. Filtration
    - Non-selective process
    - Blood is brought to the kidneys via the renal artery, which divides to form a network of capillaries called the glomerulus
    - The blood pressure is so high in the glomerulus that some of the liquid from the blood is forced through the walls of the blood vessels into the Bowman's capsule where the two meet
        - This liquid is called the glomerular filtrate

- Blood plasma, glucose, amino acids, water, hormones, urea, vitamins and minerals
- not blood, immunoglobins or proteins because they're too big
- contains some of the substances your body can reuse

➢ Passive transport

2. Reabsorption
   - At this stage, the blood is a custard consistency
   - Surrounding each nephron tubule is a large capillary network
   - As the filtrate travels through the tubule, reusable materials are reabsorbed
     - ➢ Useful products are ***actively*** reabsorbed back into the bloodstream; requires energy
       - Glucose, amino acids, salts, nutrients
     - ➢ Water moves ***passively*** back into the bloodstream
   - Occurs in the proximal and distal tubules, and the loop of Henle

3. Secretion
   - Osmo-regulatory
   - Regulation of the body fluid composition
   - This involves the body selecting specific salts and water levels required by the body



- Some important/key things to remember about the nephron
  - All products except blood and large proteins are pushed into the Bowman's capsule
  - Water and glucose are the very first things to be reabsorbed in the convoluted distal tubule
  - The top half of the nephron is within the cortex; the bottom half is within the medulla
  - Water is reabsorbed in the descending Loop of Henle; salt is reabsorbed in the ascending Loop of Henle
  - Potassium (K+) and hydrogen (H+) are added into the nephron tubules during secretion if necessary

outline the role of the hormones, aldosterone and ADH (anti-diuretic hormone) in the regulation of water and salt levels in blood

- The nephron acts as an osmo-regulatory unit controlling salt and water levels
  - Two hormones, anti-diuretic hormone (ADH) and aldosterone regulate salt and water levels

ADH – also called vasopressin

- Reabsorption of water is controlled by ADH
- The hypothalamus monitors concentration of the blood
  - ADH is made here
- The pituitary gland controls the release of ADH to which the kidneys react
  - ADH is stored and released here
- Increased levels of ADH increase the permeability of the distal tubules and collecting ducts and water moves by osmosis back into the blood
  - This occurs when there has been water loss from the body (sweating)
  - The blood, when passing through the brain, is detected by the hypothalamus to be 'dry'
- When blood levels return to normal, the level of ADH decreases and more water passes out with the urine

Aldosterone

- Produced by the adrenal glands (on top of the kidneys)
  - These glands consist of two parts
    - The cortex, which secretes steroid hormones
      - Aldosterone is one of these hormones
    - The medulla, which secretes adrenalin
- Its function is to increase the amount of salt reabsorbed from kidney tubules and as a result helps to regulate blood pressure
  - EXAMPLE // if sodium levels are low in the blood, aldosterone is increased and less salt is excreted by the kidneys, moving salt and water back into the blood and increasing pressure
  - The reabsorption of sodium ions (Na+) and potassium ions (K+) back into the blood takes place in the loop of Henle and distal tubules
  - Regulation of blood pressure is essential to efficient transport of materials around the body and in the functioning of many organs
- Increased aldosterone results in increase in salt concentrations within the blood and vice versa
- Changed secretion rates of aldosterone, in response to changes in the ionic composition of the body and/or in the blood pressure, act to maintain homeostatic control of blood pressure and ionic composition of bodily fluids
- Increased salt reuptake in the distal tubule also causes more water to be retained due to maintenance of osmotic balance

define enantiostasis as the maintenance of metabolic and physiological functions in response to variations in the environment and discuss its importance to estuarine organisms in maintaining appropriate salt concentrations

- **Enantiostasis** is the maintenance of metabolic and physiological functions in response to variation in the environment

- **Mangrove** is often used to describe both
    - An individual plant species
    - A type of swampy forest where trees grow

- Organisms which inhabit estuaries and can tolerate a wide fluctuation in water salinities are called **euryhaline**
    - EXAMPLE // crabs burrow into the sand where salt levels are more uniform to escape the fluctuating salinity of estuaries
    - There are two main ways euryhaline organisms are adapted to salt conditions:
        1. **Osmoconformers**; most marine invertebrates, allow the osmolarity of their interstitial fluid and blood to follow that of the environment
        2. **Osmoregulators**; most marine vertebrates, use active transport to maintain a constant osmolarity of blood and interstitial fluid regardless of change to environment

- The ground in estuaries is waterlogged, meaning that the roots of mangroves have difficulty obtaining oxygen for respiration and growth. There are some adaptations to remedy this:
    - Pneumatophores extend above the low water tide line and absorb oxygen from the air
    - Leaves excrete salt onto the upper surface
    - Salt is accumulated in older leaves, bark, roots and stem; these tissues are discarded and salt leaves the plant

More Examples of Adaptations

- MUSSELS // survive low tide via tightening their shells or passing air over moist gills to breathe
- SALMON // when moving to fresh water, the hormone cortisol is released which influences the direction of salt transport in the kidneys and across the gills MORE DETAIL

- An **estuary** is the fragile region where fresh water meets salt water
    - EXAMPLE // at a tidal mouth or coastal inlet
- Organisms that live in estuaries must adapt to fluctuating conditions
    - EXAMPLE // when the tide comes in, the water becomes salty, when the tide goes out the salt content declines
    - EXAMPLE // fluctuating exposure to air
- If care isn't taken, humans can negatively impact estuaries via urban development, cutting down mangroves, and harming sea grass beds which are breeding sites for prawn, and feeding grounds for fish and birds

describe adaptations of a range of terrestrial Australian plants that assist in minimising water loss

- Australia is a dry continent, so many plants show adaptations to minimize water loss
- Xerophytes are plants adapted to arid regions where water availability is low
    - EXAMPLE // cactus
    - Adaptations include:
        - Structure, size and shape of leaves
        - Extent of root system
        - Length of reproductive cycle
        - Presence of waxy cuticle
        - Water storage organs
        - Sunken stomates

Mechanism	Adaptation	Example
Limit water loss	waxy stomata	prickly pear
	few stomata	
	sunken stomata	pine
	stomata open at night	tea plant
	CAM photosynthesis	cactus
	large hairs on surface	Bromeliads
	curled leaves	esparto grass
Storage of water	succulent leaves	*Kalanchoe*
	succulent stems	*Euphorbia*
	fleshy tuber	*Raphionacme*
Water uptake	deep root system	*Acacia*, *Prosopis*
	below water table	*Nerium oleander*
	absorbing surface moisture from leaf hairs or trichomes	*Tillandsia*

- EXAMPLE // Spinifex grass
    - Found in inland Australia
    - Behavioural adaptation: only produce and release seeds after exceptional rainfall in order to ensure a moist germination environment
    - Structural adaptation: roots go into ground 3 metres, each root develops from the same nodes as the shoots and has its own water supply
    - Physiological: spiky leaves contain silica which makes them rigid and unbending in high wind
- EXAMPLE // Eucalyptus
    - Structural (?) adaptation: thick waxy cuticle on leaves which acts as a protective barrier and reflects sunlight therefor reducing evaporation
- EXAMPLE // Queensland bottle tree
    - Has the ability to store copious amounts of water in fibrous inner bark layers, can drop its leaves during arid conditions to store water in trunk and reduce water loss via leaves

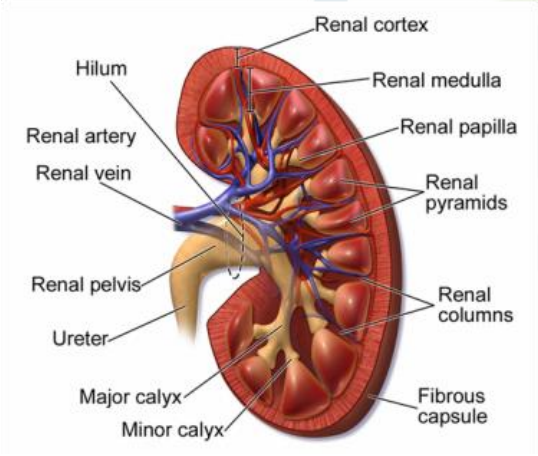
- Stomates
    - WHAT ARE THEY // microscopic porous openings in the epidermis of leaves and young stems, usually located on the underside of a leaf
    - THEIR FUNCTION // stomates are opened via pressure exerted from surrounding guard cells. Stomata mediate a plant's water loss (transpiration) and carbon dioxide diffuses from the surrounding atmosphere into the leaf
    - HOW THEY CONTROL WATER LOSS // stomata controls water loss via opening at night to lose little water and closing during the day to reduce evaporation. Change in internal pressure of guard cells affects the degree of stomatal opening (when turgor pressure increases and guard cells fill with potassium and water, the stomata will open. And vice versa)

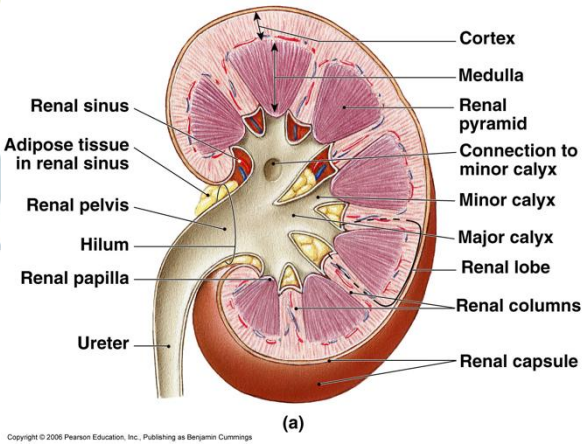
perform a first-hand investigation of the structure of a mammalian kidney by dissection, use of a model or visual resource and identify the regions involved in the excretion of waste products

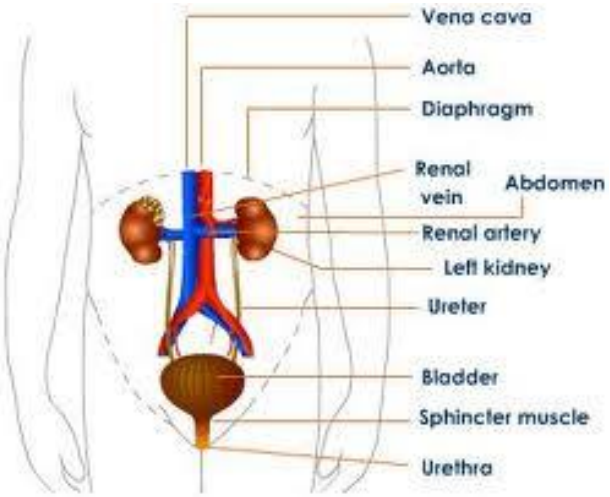
Kidney Dissection

- Aim: to dissect a mammalian kidney and identify the main structures, relating them to their function
- Materials and method:
  1. Observe protective outer layer of skin, called **capsule**
  2. Identify the three tubes which enter the kidney
     - The ureter, which is the large tube in the centre
     - The renal artery, which has a thick wall
     - The renal vein, which has a thinner wall
  3. To observe the internal structure of the kidney, cut through the kidney lengthwise, carefully cutting away from your fingers
  4. Now look inside. You will notice a funnel-shaped structure with a hole in the centre. This hole leads into the ureter. Taken an object like a knitting needle and push it gently through the opening. Discover where the ureter leaves the kidney.
  5. Find the following structure:
     - The brown outer layer, where waste substances are squeezed out through membranes of the glomeruli into the Bowman's capsules
     - An inner pink layer of medulla. Here, water and some salts are reabsorbed into the blood from the tubules of the nephrons
     - A hollow whitish region. This is the pelvis of the kidney where large collecting tubes empty urine into the funnel-shaped beginning of the ureter

Diagram of kidney (must include renal cortex, renal medulla, renal pelvis, ureter, and fibrous capsule)



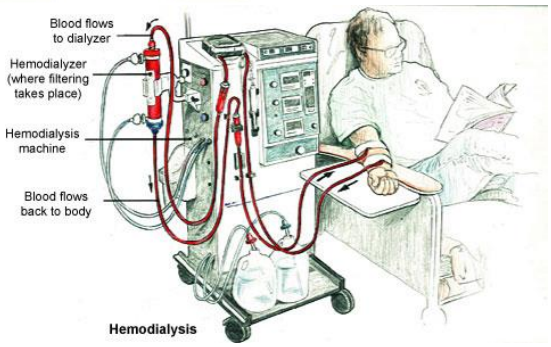




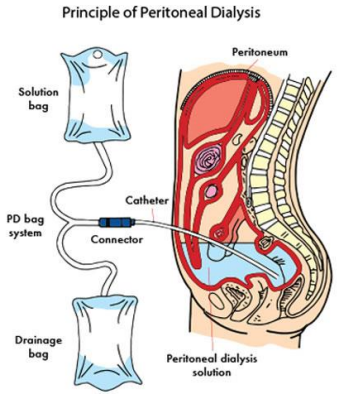
gather, process and analyse information from secondary sources to compare the process of renal dialysis with the function of the kidney
[DIAGRAM OF KIDNEY DIALYSIS PROCESS]

Renal dialysis

- When kidney failure occurs the patient must rely on some alternative way of removing wastes
    - Kidney failure can mean when blood acidity, urea, or potassium levels increase much above normal
- In kidney dialysis blood flows through a system of tubes composed of partially permeable membranes
- Dialysis fluid (dialysate) has a composition similar to blood except the concentration of wastes is low
    - It flows in the opposite direction to the blood on the outside of the dialysis tubes
        - Consequentially, waste products diffuse from the blood into the dialysis fluid
- There are two different ways to treat kidney failure:
    1. Hemodialysis
        - involves the use of a kidney dialysis machine where the blood is diverted into an external machine and filtered automatically and returned to the body
        - the blood is taken via tubing through a special filter which cleans the blood
        - the blood flows from your vascular access and is pumped through lines before and after the dialyzer on the dialysis machine before the blood is returned to the body
        - most people need 3 sessions a week, each 4 hours
        - the dialyzer is surrounded by a pouch of dialysate which the urea moves into
        - the dialysate has the same salt, glucose etc. levels so the patient doesn't lose their salt or glucose etc.



2. Peritoneal dialysis



- Uses the peritoneum membrane, a thin membranous sheath lining in the abdominal cavity and organ cavity
- In this type of dialysis the blood is cleaned inside the body
- A catheter is placed into your abdomen
- The abdominal area/peritoneal cavity is slowly filled with dialysate/peritoneum
- Wastes diffuse from the body fluids and pass through the membrane that lines the peritoneum into the saline solution
- It is then drained out by another catheter
- This reduces the risk of blood clotting and infection
- There are two types of peritoneal dialysis
    1. Continuous ambulatory: a person uses gravity to introduce sterile dialysis to the abdomen and then disconnects and is free to move
    2. Automated: a person connects to the machine and the dialysis is performed overnight

Kidney function

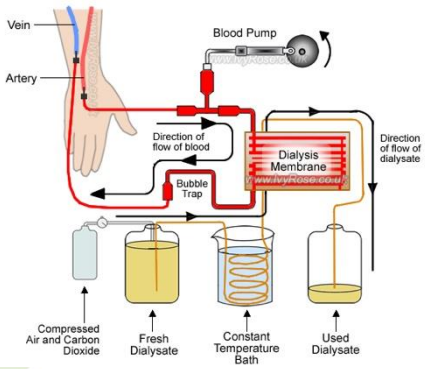
- Kidneys eliminate nitrogenous wastes from the body while controlling water balance.
- They play a major role in stabilizing the internal environment, (pH and temperature of blood)
- The kidneys filter the blood, remove wastes (salt, hormones, vitamins) and create a urine; this is known as the excretory system
- You would be unable to survive without your kidneys for longer than three days
- Structural features
    - The dent on one side of the kidney is known as the hilum
        - This is where the blood enters/leaves the kidney
            - The renal artery enters the kidney and branches into arterioles and then into capillaries
            - The capillaries clump together to form glomerulus'
            - Each glomerulus is surrounded by a double cup known as the Bowman's Capsule
    - A kidney is a flattened bean shape about 11 cm long, are located on each side of your spine and are protected by the ribcage
    - The outer layer is known as the cortex is gritty and extends into the medulla layer
        - The functional parts of the kidney and the nephrons are found in these regions
- The formulation of urine
    - begins with the filtration of the blood through the nephron at the bowman's capsule
    - the fluid moves along the nephron tubule and glucose and amino acids are reabsorbed by the blood
    - urea and salts continue through the tubule

	KIDNEY FUNCTION	RENAL DIALYSIS
SIMILARITIES	Removes wastes from blood	Removes wastes from blood
	Uses filtration in glomerulus	Uses filtration in dialysis machine

DIFFERENCES	Natural process	Artificial process
	Continuous removal of wastes	Waste removal only occurs while attached to dialysis machine
	Rapid process	Slow process
	Uses passive and active transport	Uses filtration only
	Glomerulus is the filter	Dialysis tubing is the filter
	Wastes and some metabolites are removed	Water and wastes removed and metabolites stay in the blood
	Internal process	External process
	Urination occurs	No urination

Filtration and reabsorption in a nephron

- Osmoregulation and excretion by nephrons in the kidneys are accomplished by the production and eliminated of Urine
- Urine is produced by:
  - **Filtration** of waste and useful substances from the blood at the glomerulus/Bowman's capsule
  - **Reabsorption** of useful substances into the blood and the tubules and loop of Henle



- **Filtration:** Substances move from the blood into the Bowman's capsule because of the high pressure of the blood through the glomerulus
  - Diffusion, because there is a lower concentration of substances in the blood and a higher concentration in the tubule
- **Reabsorption:** Substances move from the tubules back into the blood
  - Once the concentration has been balanced, energy must be used to move substances (glucose, amino acids) back into the blood
    - ➢ Energy use results in active transport, which allows the body (specifically the endocrine system) to monitor what is reabsorbed
      - EXAMPLE // all glucose is reabsorbed but only some salt

What gets filtered into the Bowman's and what gets made into urine?

Material	Bowman's capsule (filtrate)	Renal pelvis (urine)
Nitrogenous waste – urea	Y	Y
Glucose	Y	N
Amino acids	Y	N
Salt (ions)	Y	Variable amounts
Water	Y	Variable amounts
Large proteins	N	N
Blood cells	N	N

	Where in the nephron it occurs	What substances are involved	Why it's important

Filtration	The glomerulus	Water, solutes, plasma, nitrogenous waste, glucose, amino acids, salts	Filters the fluids looking for large particles which cannot be transferred into the renal cavitiy, detects substances which may still be useful → resourceful/recycling, bathes substances in fluids which cleanse them
Reabsorption	The proximal and distal convoluted tubules, and loop of henle	Water and solutes (glucose, amino acids), small proteins, peptides, phosphate, urea, potassium, sodium	Reabsorbs any substances which are found not to be useful to be carried to the renal cavity, picks up substances which have been cleaned
Secretion	In both the distal and proximal tubules, and the collecting duct	Potassium, hydrogen and aluminium ions, creatinine, urea, some drugs, hormones	Gets rid of unwanted substances, keeps the body's blood balance of substances (potassium, urea, acidic substances) in check

Active Transport	Passive Transport	Kidneys example
Uses energy	Doesn't require energy/ATP	Substances move into the Bowman's capsule because of the high pressure of the blood through the glomerulus. This is diffusion which doesn't require energy and is passive (filtration). However, when substances need to be moved back into the blood this requires energy which is active (reabsorption). Active transport allows the body to be selective in what it reabsorbs e.g. it reabsorbs all glucose but only some salt
Moves molecules against the concentration gradient (low to high)	Moves molecules with the concentration gradient (high to low)	
Allow body to maintain homeostasis by moving substances in and out of cells	Allow body to maintain homeostasis by moving substances in and out of cells	
Move material across a membrane	Move material across a membrane	

present information to outline the general use of hormone replacement therapy in people who cannot secrete aldosterone

- Hormone replacement therapy began in 1927
- Involves restoring the imbalance of hormones at levels that are normal for the body by administering hormones
- Can influence fluid retention, raise blood pressure and remove danger of heart failure
- Modern day HRT involves administering a genetically engineered hormone called fludrocortisone/fluorocortisol
    - Taken orally once a day

Adrenal insufficiency

- an endocrine or hormonal disorder that occurs when the adrenal glands do not produce enough of certain hormones
- Symptoms include
  - Chronic or long lasting fatigue
  - Muscle weakness
  - Loss of appetite
  - Weight loss
  - Abdominal pain
  - Hyperpigmentation or darkening of the skin

Addison's disease/primary adrenal insufficiency

- occurs when
  - the adrenal glands are damaged and cannot produce enough of the adrenal hormone cortisol or aldosterone
  - or the pituitary gland which controls the adrenal gland is damaged
- 110-144 of every 1 million people are affected in developing countries
- Incorrect sodium levels as a result of aldosterone insufficiency can cause problems such as cardiac failure

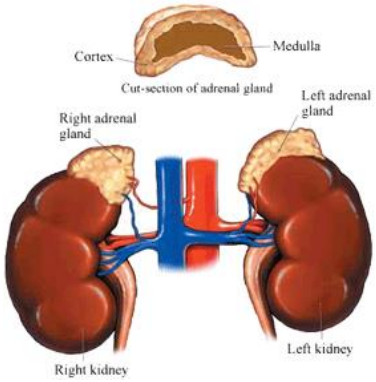
Secondary adrenal insufficiency

- occurs when the pituitary gland – a pea sized gland at the base of the brain – fails to produce enough adrenocorticotropic (ACTH)
  - ACTH – a hormone that stimulates the adrenal glands to produce cortisol
- eventually the adrenal glands can shrink due to lack of ACTH stimulation
- more common than Addison's disease

- Aldosterone
  - affects the body's ability to regulate blood pressure
  - sends signals to organs (the kidney, colon) that can increase the amount of sodium the body retrieves from the nephron back into the bloodstream or the amount of potassium released in the urine
  - causes the bloodstream to reabsorb water with the sodium to increase blood volume
  - indirectly helps maintain the blood's pH and electrolyte levels
- All of these actions are integral to increasing and lowering blood vessels

Treatment for Addison's disease

- Replacing and/or substituting the hormones that the adrenal glands aren't making
  - Cortisol is replaced orally with hydrocortisone tablets, taken twice a day
  - Aldosterone is replaced orally with doses of fludrocortisone acetate, taken once a day
    - Increasing aldosterone may also require the patient to increase their salt intake
- During an Addisonian crisis, low blood pressure and glucose, and high levels of potassium can be life threatening
  - Therapy involves intravenous injections of hydrocortisone, saline, and dextrose (sugar) and then doses of fludrocortisone acetate



analyse information from secondary sources to compare and explain the differences in urine concentration of terrestrial mammals, marine fish and freshwater fish

- Proteins and nucleic acids contain nitrogen in addition to water and carbon dioxide
  - This is ammonia, which is highly toxic
- Organisms either excrete waste in the form of ammonia, or convert it to a less toxic product such as urea and uric acid
  - Organisms that excrete ammonia are called ammonotelic organisms
  - Organisms that excrete urea are call ureotelic e.g. humans!

Terrestrial organisms

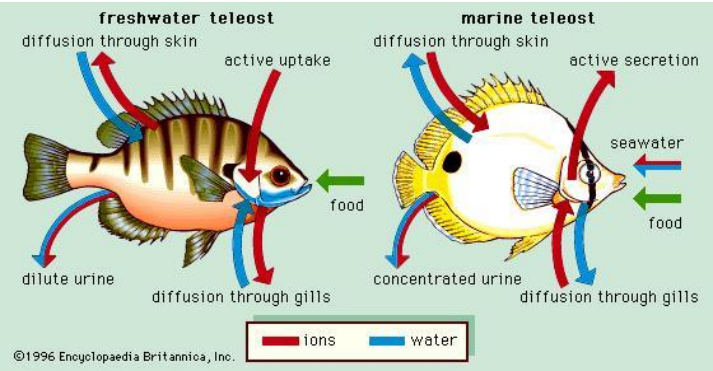
- Have an issue with excretion since they are not surrounded by a constant excretory medium
- Since the ammonia cannot be excreted quick enough, it must be detoxified
  - Most terrestrial animals convert ammonia into urea or uric acid
- Urea is synthesized in the liver and excreted in the kidneys
  - Soluble in water
  - There is a risk that excessive amounts of water will be excreted
    - To prevent this, the mammalian kidney can excrete urine that is more concentrated than bodily fluids, ensuring little water loss

- A third group of animals – terrestrial – conserve water by excreting uric acid as their principal nitrogenous waste product
  - They are called uricotelic
  - Not very soluble in water
  - EXAMPLE // birds, reptiles, insect
  - Forms a paste

Aquatic organisms

- In freshwater environments, cell fluids are more concentrated (more salt) than surrounding water
  - Therefore, in fresh water, cells tend to gain more water by osmosis than they lose
- In marine environments, cell fluid is less concentrated (less salt) than the surrounding water

- Therefor, in salt water, cells tend to lose more water by osmosis than they gain



- Excrete ammonia
  - Diffuses into the surrounding water in which it is highly soluble

Osmoregulation and excretion in fish

- Bony fish excrete mainly ammonia
  - Ammonia is solute and toxic, but fish avoid poisoning via access to water which dilutes the ammonia
- Fish urinate constantly
  - They excrete urea through the gills
- Absorb salt
- Fish excrete ammonia by diffusion from the blood across the gill membranes
  - Sharks and rays have a skeleton made of cartilage instead of bone; they excrete urea
  - Crocodiles, tadpoles and most aquatic invertebrates excrete ammonia
    - Tadpoles excrete ammonia, but when they become adult frogs, excrete urea

Salt water fish

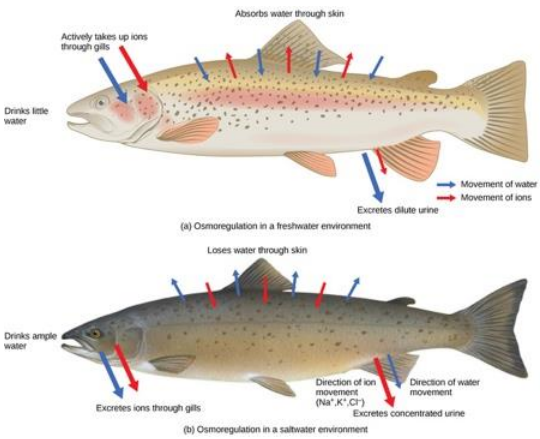
- Have a lower concentration of salts in their bodies than the surrounding water
- Constantly lose water to their surroundings via osmosis, particularly through gill membranes
- Bony fish drink water with their food intake to replace this water loss
- Fish have special cells in the gills that can excrete excess salt back into the water by active transport
- Excrete concentrated urine with low water content
- Bony fish

Freshwater fish

- Water is constantly taken up through the body cells from the surrounding water where salt concentration is lower than the fish's bodily fluids
- Absorb salt across the gills
- Fish have the added disadvantage of

Fish that move between salt and fresh water

- The native bass
  - Lives in freshwater coastal rivers of eastern Australia
  - Returns to estuaries in winter to breed
- Two native eel species
  - Migrate between fresh and marine environments
- Species such as the bass and eel are capable of changing their responses to fit their environments and osmotic changes



-

-
- NEPHRON DIAGRAM

use available evidence to explain the relationship between the conservation of water and the production and excretion of concentrated nitrogenous wastes in a range of Australian insects and terrestrial mammals

Terrestrial mammals

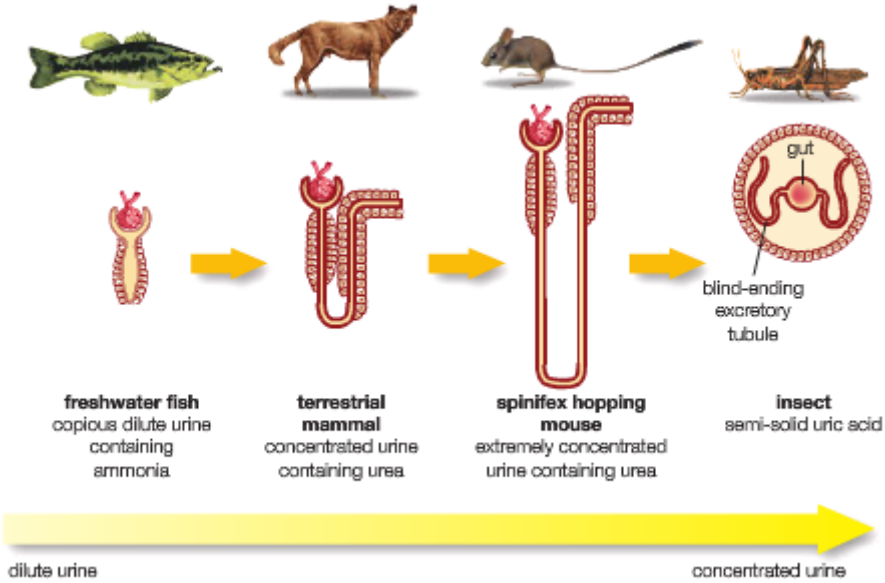
- Mammals excrete urea which does not require much energy for production, but uses up a lot of water
- Mammals living in arid conditions show many adaptations to assist them to conserve water

- In hot weather, humans urinate less to conserve water and contradict evaporation from the skin and lung surfaces, and vice versa
    - The urine becomes darker and concentrated
- Different animals produce/excrete different waste products
- The type of waste produced is dependent on the animal's environment; more specifically, the water availability in the environment

- Aquatic animals excrete ammonia (which is toxic) directly into the water
    - Ammonia
        - Very toxic
        - Requires no energy to be made
        - Must be eliminated immediately
        - Needs large amount of water to dilute it
        - EXAMPLE // freshwater fish and aquatic invertebrates
- Terrestrial animals convert ammonia to less toxic forms/products
    - Forms
        - Urea
            - Requires more energy than ammonia to be made
            - Can be stored for short time
            - Excreted in concentrated form
            - EXAMPLE // mammals, adult amphibians and some fish
        - Uric acid
            - Least toxic
            - Requires large amount of energy to be made
            - Can be stored for short time
            - Can be excreted in extremely concentrated form (semisolid white paste)
            - EXAMPLE // birds, insects, most invertebrates

    - Therefor the concentration of urine produced by terrestrial animals is dependent on their water availability
        - EXAMPLE // desert dwelling mammals produce a highly concentrated urine.

- EXAMPLE // earthworms can excrete dilute urine containing both ammonia and urea



MAMMAL CASE STUDY – Australian crest-tailed mulgara

- Small, native marsupial mammal
- Lives in sandy, hot and arid desert regions of central Australia
- Carnivorous
  - Prey includes insects, scorpions and spiders
- The mulgara accounts for evaporative loss of water vapor via the airways and water loss through structural, physiological and behavioral adaptions
  - STRUCTURAL AND PHYSIOLOGICAL // mulgaras minimize water loss by producing very concentrated urine (nearly 4000 mOsm/L) compared to humans (1200 mOsm/L).
    - Therefore, they excrete urea, losing far less water
    - This is achieved by the function of two structures in the nephrons of their kidneys
      1. Glomerular filtration is reduced
         - meaning that less fluid leaves the blood and enters the kidney tubules
      2. Tubular reabsorption is increased, meaning that more fluid is reabsorbed from the tubules in the loop of Henle

MAMMAL CASE STUDY #2 – Australian spinifex hopping mouse

- Placental mammal
- Lives in sandy deserts in Australia
- Can survive without drinking liquid water and can therefor endure drought through physiological adaptations such as
  - Its kidney tubules reabsorb almost all water from the kidney filtrate
    - It therefor produces highly concentrated and almost solid urine
      - Approx. 9370 mOsm/L
- Water sources for the hopping mouse are
  - Food
    - Mainly consume dry seeds
      - The amount of water in these seeds depends on the humidity of the air in which the seed is found. Humidity at night is greater, meaning

the seeds have the most water content at night, and thus the hopping mouse adopts the behavioral adaption of nocturnalism
- Store seeds in burrows which are insulated, deep and where mice huddle during day, creating high humidity, and thus seeds in burrows have a great water content

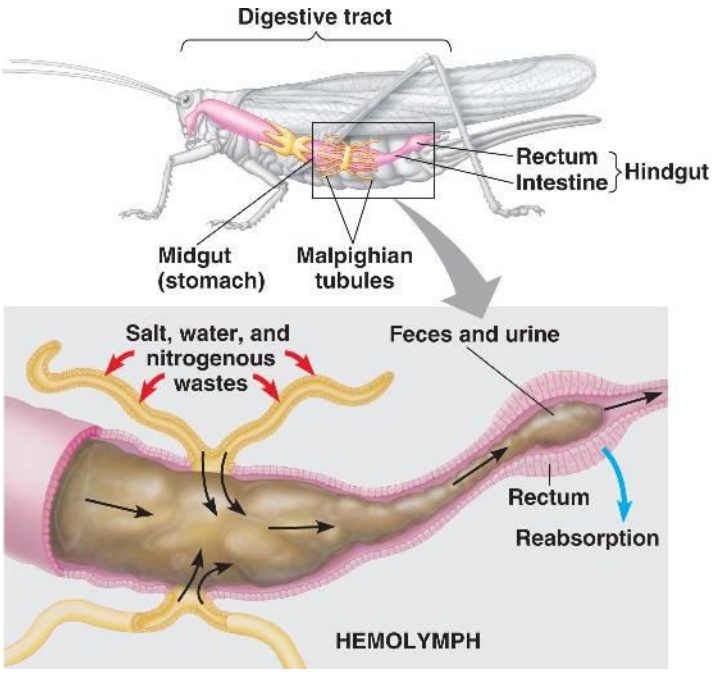
- Metabolic water
  - When carbs and fat are oxidized, the products are CO_2 and water
    - This water is used by the mouse
- Free standing water
  - Include dew and rainwater, though this type of water is very rare in arid conditions

- Water loss occurs via
  - The skin
  - Faeces
  - Exhaled air
  - Urine
  - Milk (females only)

Insects

- insects release nitrogenous waste as uric acid into the body fluid
- it is then absorbed by the Malpighian tubules and passes into the hind gut
  - the low pH in the tubules causes the uric acid to precipitate out as crystals
- in the rectum there is selective reabsorption of water and ions
- insects do not urinate!
  - Uric acid passes out with their food wastes in an almost dry form

- Insects are found in terrestrial environments such as grasslands and deserts where water is scarce
- Most insects obtain their water from plants
  - Eating leaves
    - EXAMPLE // grasshoppers
  - Sucking nectar
    - EXAMPLE // butterfly
  - Sucking sap
    - EXAMPLE // aphid
- Some insects can go without food or water for days
  - EXAMPLE // the Australian plague locus can survive on its stores of fat. Waste eliminated during this time is dry



INSECT CASE STUDY – Bogong moth

- All insects have an exoskeleton or cuticle which is impervious to water
  - One of the layers of which the cuticle is comprised of is called the epicuticle
    - Within the epicuticle there are three layers
      1. Inner lipoprotein layer
      2. Wax layer
         - Essential for water retention
         - Hydrophobic molecules face outwards and rejects water
      3. Cement layer
         - Produces the wax layer
- All insects produce uric acid in a dry paste

process and analyse information from secondary sources and use available evidence to discuss processes used by different plants for salt regulation in saline environments

- Plants living in saline environments must be able to tolerate high levels of salt.
- On land, vascular plants transpire when the stomatas are open.
- Water is drawn up from the roots to their leaves – if the water in the soil is salty, then salt is also drawn up
  - Salt accumulates in the leaves and show dead areas known as 'salt burn' and may die early
  - High concentration of salt in the soil water reduces the difference in concentration between the plant cells and soil water; less water enters the plant by osmosis and the stomata may close, or growth reduces
- **Halophytes** grow and thrive with high levels of salt

<u>Salt exclusion</u>

- Salt tolerant plants can stop salt entering tissues. Halophyte roots prevent 95% of salt in soil water from entering
  - EXAMPLE // the coastal mangrove Avicenna marina prevents 98% entering

Control of Salt Movements

- Salt levels in the xylem are kept low by salt remaining in the roots or entering old parts of the plant

Salt excretion

- Halophyte leaves secrete salt
- Salt glands move salt from leaf tissue to the surface of the leaf; it may be blown or washed away
- Some plants have salt bladders - the salt accumulates and bursts releasing the contents

Osmotic adjustment

- Halophytes have a higher concentration of dissolved substances
- They maintain this by producing and storing organic compounds such as glycerol
    - EXAMPLE // in aquatic algae and seagrasses glycerol helps maintain a balance in concentration with seawater in cells

Questions

Rice is very salt sensitive while barley is salt-tolerant

a) 124umol
b) 4umol
c) Salt concentration and distribution is higher in the leaves than in the stem
d) It could possibly be control of salt movement combined with with salt excretion; the majority of the salt is kept in the roots and some salt is distributed to the leaves, mostly to the biggest and oldest, to be washed away

e) Over time, leaves in wheat take up more and more salt, in this case the oldest leaf has a salt concentration of 4.2 umol
f) Wheat distributes its salt to its leaves, whilst barley keeps the majority of its salt in its roots
g) Mangroves control salt levels primarily through salt excreting glands on leaves and excluding salt from entering roots. Red mangroves can block 90-97% of salt from entering their roots. Salt excreting on the black mangrove results in salt crystal formation
h) Halophytes with salt excretion glands/bladders include
    - Mangroves (Acanthus, Aegiceras, Avicennia)
    - Atriplex (salt bush)
i) The Australian salt bush, known as the salt bush, concentrate sodium ions in the salt glands in the leaves. The salt is pumped from the glands into the bladder, which eventually expand and burst, releasing excess salt.
j) Plants which live in saline environments must adapt to regulate their salt levels in order to avoid either poisoned by high levels of salt, or concentrating salt too much in leaves which results in salt burns or early death of leaves. This in turn stunts growth and photosynthesis.

perform a first-hand investigation to gather information about structures in plants that assist in the conservation of water

- Plant adaptations to conserve water include:
    - Leaf surface area
    - Positioning of stomata
    - Shape of leaves
    - Depth and nature of roots
    - Arrangement of leaves
    - Thickness of cuticles

    - Number of stomata
    - Colour of leaf surface
- Stomata
    - control the movement of gases in and out of a leaf
    - make CO_2 available
    - control loss of water
    - occur in the lower epidermis usually
    - open in daylight and close in the dark
- Pores or stoma are surrounded by two guard cells, which change shape to control the size of the stomatal aperture
    - Guard cells contain chloroplasts but don't photosynthesize
- Plants that use CAM or C4 photosynthesis to reduce water loss in aridity have stomata which close during the day and open at night (absorb CO_2)
- Dicot
    - EXAMPLE // geraniums
- Monocot
    - EXAMPLE // spider plant

Prac

- Hypothesis: That stomata are found dominantly on the bottom of the leaves. The waterproofing (petroleum) will reduce water loss on those leaves protected on the lower epidermis.
- Aim: to investigate structural features of various leaves that assist in the conservation of water and make inferences about stomata distribution
    - Plants cannot simply close their stomata to reduce water loss because their chlorophyll-containing mesophyll needs CO_2 for photosynthesis
- Method:
    1. Place four leaves on newspaper
    2. Smear a thin layer of petroleum jelly on each leaf as follows
        - One should have jelly only on the lower epidermis
        - One should have jelly only on the upper epidermis
        - One should have no jelly on either sides
        - One should have jelly on both sides
    3. Hang leaves on a string attached to two retort stands with paperclips
    4. Wait approximately a week
    5. Observe the change in colour, texture etc. of each leaf
- Results (TABLE):

Leaf	Observations
Leaf with upper epidermis Vaselined	Mostly dry and discolouring, yellowing and pale due to unprotected bottom stomata
Leaf with lower epidermis Vaselined	Slightly dry but mostly green, flexible
Leaf with both epidermis Vaselined	Dried out the least, stomata on the top and bottom, same as a week before, flexible
Lead with neither epidermis Vaselined	Very dried and desiccated, since neither stomata venues were protected, inflexible

- Risk Assessment and Safety

Risk Assessment	Safety
Vaseline/petroleum in the eyes	Wear safety goggles
Scissors to cut string	Use safety scissors

Vaseline on the ground, slippery	Grip shoes, watch where you step, don't drop and if you do clean up immediately
Broken equipment	Leather shoes
Fingers becoming slippery	Wear gloves

- Discussion
  - Experiment makes inferences about the location of stomata on leaf surface
  - Stomata are found dominantly on lower epidermis to minimise water loss