Characteristics of Living Organisms

- **Nutrition:** Taking in food for growth and releasing energy.
- **Respiration:** Burning glucose to release energy.
- **Excretion:** Removing waste material like urea formed during chemical reactions.
- **Sensitivity:** Responding to changes in the environment.
- **Movement:** Transport inside cells and moving the body.
- **Homeostasis:** Control their internal conditions.
- **Reproduction:** Increasing the number of organisms.
- **Growth:** Increasing the number of cells.

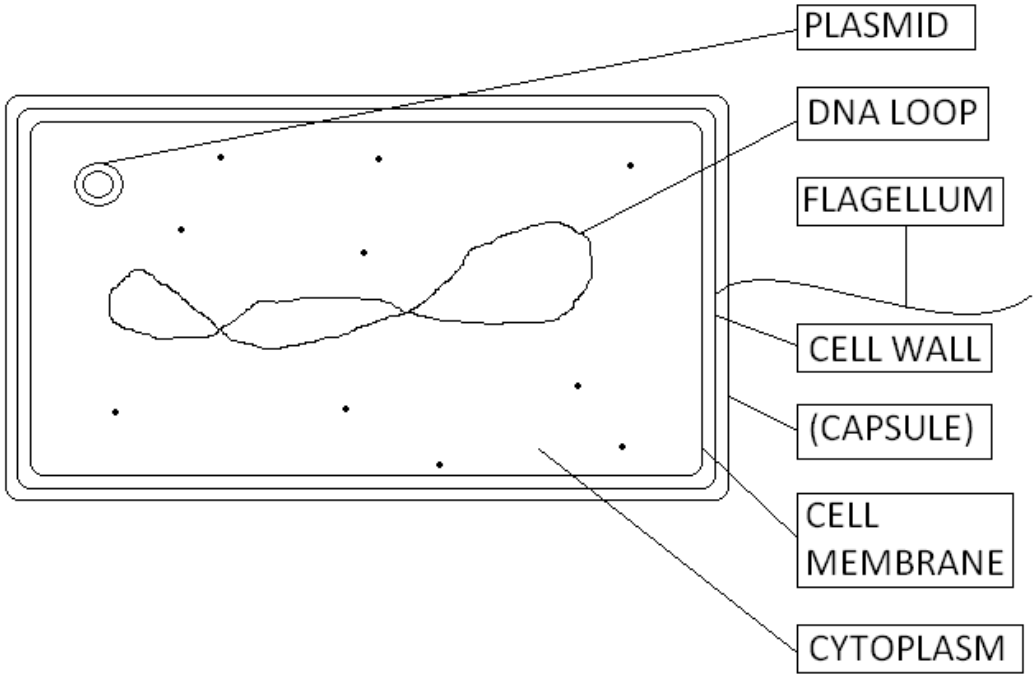
Variety of Living Organisms

- Plants:
  - Multicellular organisms
  - Contain chloroplasts and are able to carry out photosynthesis
  - Have cellulose walls outside the cell walls to provide support to the cell
  - Store carbohydrates as starch and sucrose
  - Have large permanent vacuoles filled with cell sap that contains water and dissolved substances
  - Vary greatly in size and shape
    - Example of flowering plant: Rose
    - Examples of cereals: Maize
    - Examples of non-flowering plant: Conifers
- Animals:
  - Multicellular organisms
  - Do not contain chloroplasts and cannot carry out photosynthesis
  - Do not have cell walls
  - Have small temporary vacuoles
  - Usually have a nervous system and can move from one place to another
  - Often store carbohydrates as glycogen
    - Example of a vertebrate is human
    - Example of invertebrate is earthworm
- Fungi:
  - Cannot carry out photosynthesis
  - Some are multicellular:
    - Consist of mycelium made from thread-like structures called hyphae, which contain many nuclei
    - Reproduce by spores
      - Example: Mucor
  - Some are single celled:

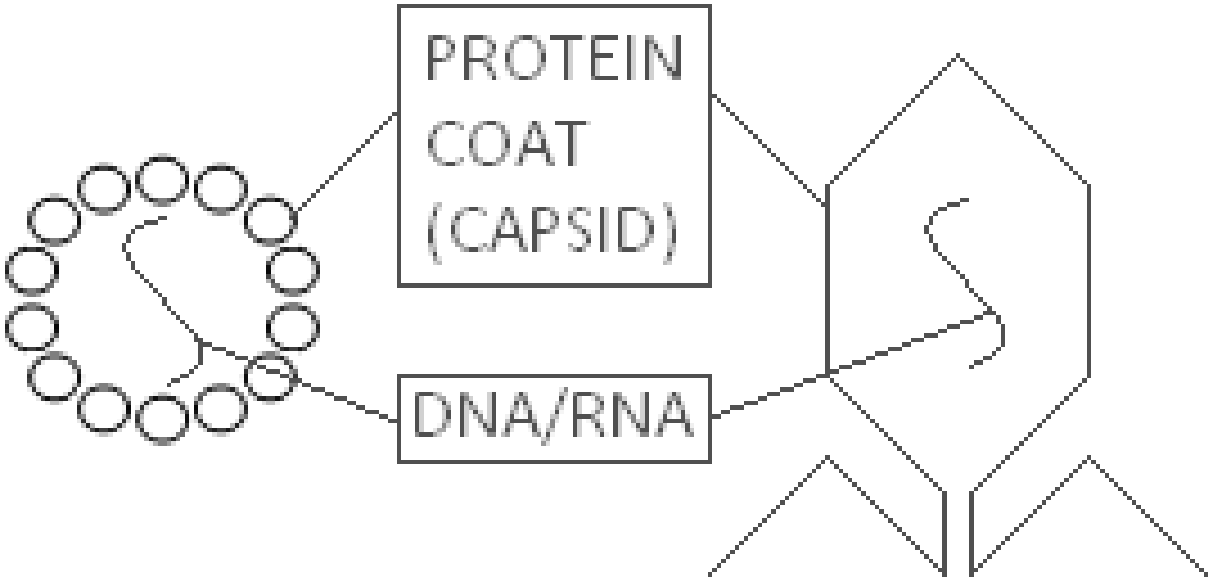
        - Have cell walls made of chitin
        - Reproduce by budding
            - Example: Yeast
    - Feed by extracellular secretion of digestive enzymes onto the food material and absorption of the organic products. Also known as saprotrophic nutrition.
    - Store carbohydrates as glycogen.
- Bacteria:
    - Microscopic single-celled organisms.
    - Lacks a nucleus but contains a circular chromosome of DNA
    - They have cell walls, cell membrane, cytoplasm and plasmids
    - Some can produce their own food during photosynthesis as they have chlorophyll
    - Some feed off other living or dead organisms and are known as decomposers
    - Many can move around using one or more flagella and have a protective layer around the cell wall called a capsule
        - Example:
            - Lactobacillus bulgaricus, a rod shaped bacterium is used in the production of yoghurt from milk
            - Pneumococcus, a spherical bacterium causes pneumonia
- Proctista:
    - Microscopic single celled organisms
    - They have a true nucleus and other organelles
    - Some are animal like while others resemble plant or fungus cell structure
    - All have a simple cell structure
        - Example:
            - Amoeba have features like animal cell and they live in pond water
            - Chlorella have chloroplasts and are more like plants
            - Plasmodium is a pathogen that causes malaria
- Virus:
    - Small particles – smaller than bacteria
    - Are parasite as they can only reproduce inside living cells
    - Infect every type of living organism
    - Have a wide variety of shapes and sizes
    - Have no cell structure but have a protein coat called capsid and a core that contains one type of nucleic acid , either DNA or RNA
        - Example:
            - Tobacco mosaic virus that causes the discolouring of the leaves of tobacco plants by preventing the formation of chloroplasts
            - Influenza virus that causes flu in humans. Influenza spreads by droplet infection
            - HIV that cause AIDS. AIDS spreads by exchange of body fluids
            - H1N1 virus that causes swine flu. Swine flu spreads by droplet infection

Pathogen: Any organism or agent, capable of causing disease or infection. This may be in the form of virus, bacteria, proctista or fungi.

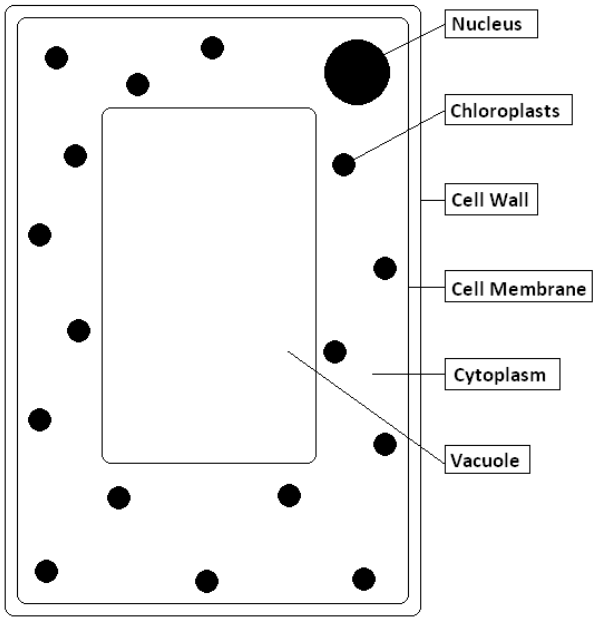
BACTERIA CELL



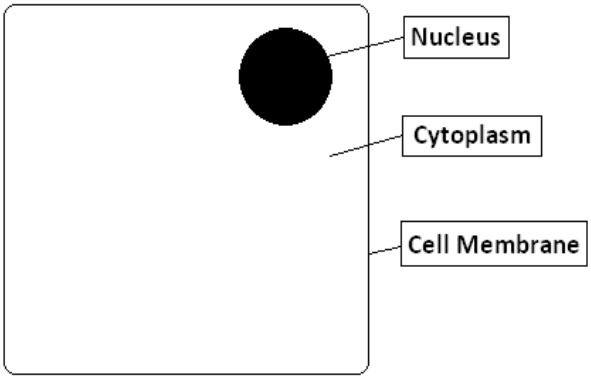
VIRUS CELL



PLANT CELL

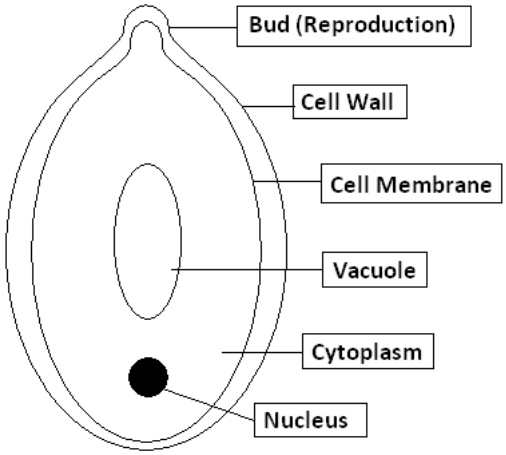


ANIMAL CELL

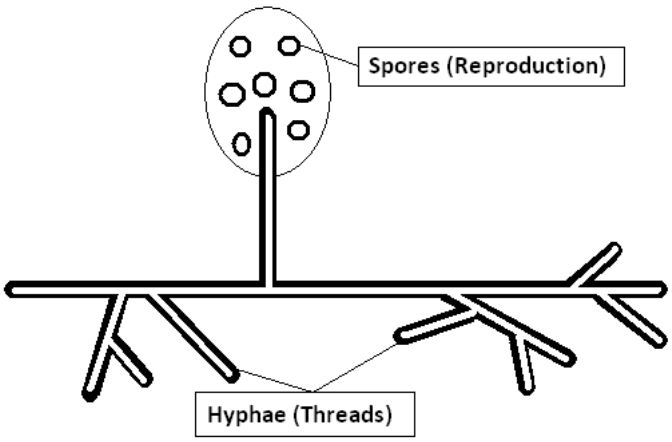


FUNGI CELL

Unicellular



Multicellular



Cell Structure and Organization

PLANTS	ANIMALS
Cell Membrane	
Cytoplasm	
Nucleus	
Cell wall made up of cellulose	**No cell wall**
Chloroplasts contains chlorophyll	**No chloroplasts**
Large permanent vacuoles containing cell sap	**Small temporary vacuoles**
Store carbohydrates in the form of starch	**Store carbohydrates in the form of glycogen**

Cell wall: Protects supports and gives a fixed shape to plant cells; totally permeable.

Cell Membrane: Controls the substances that enter and exit the cell; selectively permeable.

Cytoplasm: Jelly like fluid containing cell organelles; living material in which chemical reactions take place.

Nucleus: Controls all activities in the cell since it contains the genetic information.

Chloroplast: Contains chlorophyll that absorbs light for photosynthesis.

Vacuole: Stores cell sap - solution of water, dissolved sugars, mineral ions and other solutes.

Organelles → Cells → Tissues → Organs → Organ Systems → Organisms

- Organelles group together to form cells.
  - For example, cell membrane, nucleus and cytoplasm forms a cell.
- Cells are grouped together to form tissues.
  - For example, red blood cells and white blood cells form blood tissue.
- Tissues are grouped together to form organs.
  - For example, blood tissue, nerve tissue and muscle tissue forms the stomach.

- Organs work together to for organ systems.
    - For example, stomach, intestine, liver and pancreas work together to form the digestive system.
- Several organ systems make an organism.
    - The digestive system, nervous system, circulatory system, respiratory system, excretory system and reproductive system form an organism.

Biological Molecules

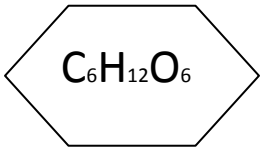
- Carbohydrates:
    - Carbon, Hydrogen and Oxygen
- Lipids:
    - Carbon, Hydrogen and Oxygen
        - Same as carbohydrates, however, it has a higher proportion of hydrogen and a lower proportion of oxygen
- Proteins:
    - Carbon, Hydrogen, Oxygen and Nitrogen

CARBOHYDRATES

- Monosaccharides: Simple sugars like glucose.
- Disaccharides: Double sugars formed from two monosaccharides – like maltose.
- Polysaccharides: Large molecules formed from many monosaccharides – starch and glycogen.

Glucose:

- Is a monosaccharide
- Is the major energy source for most cells
- It is highly soluble and is the main form in which carbohydrates are transported around the body of animals
- Is a hexose sugar meaning it is hexagonal in structure



Polysaccharides:

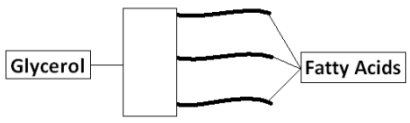
- An example is starch as it is made up of many molecules of glucose and is the major carbohydrate storage molecule in plants.
- Are mainly used as an energy store and structural components in cells.
- Main ones include starch and cellulose in plants, and glycogen in animals.

PROTEINS

- Groups of large and complex molecules made up of long chains of amino acids.
    - Amino acids are the building blocks of proteins.
- Are the main components of body tissues, such as muscle, skin, ligaments and hair.
    - All enzymes are proteins, catalyzing many biochemical reactions.
    - Many hormones are proteins

LIPIDS

- Are made up of fatty acids and glycerol.
    - Important lipids include waxes, steroids and cholesterol.
- Provides more than twice the amount of energy as carbohydrates.
- Needed for heat insulation:
    - In mammals, fat deposits underneath the skin to help reduce heat loss.
- Needed for protection:
    - Fatty tissue around delicate organs such as kidneys acts as a cushion against impacts.



TEST FOR STARCH

PROCEDURE

- Take a small piece of a food sample and place it on a white tile.
- Add 2-3 drops of Iodine solution.

OBSERVATION

- If sample turns blue-black in colour, starch is present.
- If sample remains brown in colour, starch is absent.

TEST FOR GLUCOSE

PROCEDURE

- Take a small piece of a food sample and put it in a test tube.
- Add some water and shake to dissolve the glucose (if any).
- Add some Benedict's solution.
- Heat the test tube in a hot water bath.

OBSERVATION

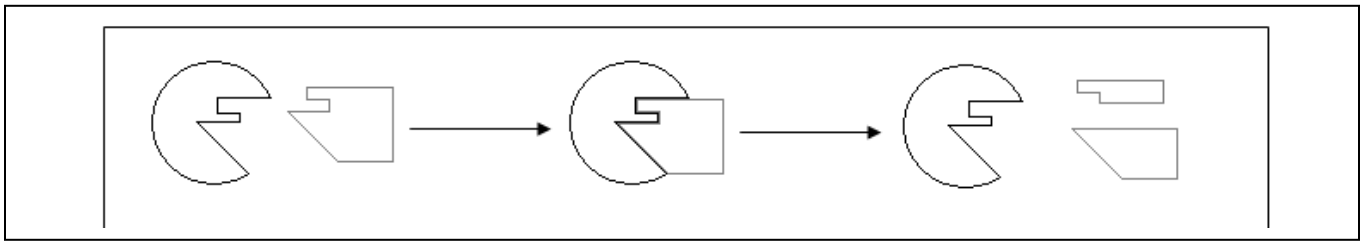
- If sample changes from blue to green to yellow to brick red, glucose is present.
- If sample remains blue in colour, glucose is absent.
- If sample turn into a greenish colour, there is a low concentration of glucose.

- Remember to wear safety goggles during the experiment and to us a holder to hold then test tube in such a way that the mouth of the test tube faces away from you as the solution squirts while boiling.

ENZYMES

- Are biological catalysts:
    - Catalysts are substances that increase the rate of chemical reactions without being used up.
    - Without catalysts, most of the reactions that happen in cells would be far too slow to allow life to go on.
- Are proteins that are folded into complex shapes that allow smaller molecules to fit into them.
- The place where a substrate molecule fits is the active site.
- Are needed to lower the energy required for the reactions and speed them up to produce the end product quickly.
- Are produced by cells:
    - Cells contain hundreds of different enzymes, each catalyzing a different reaction.
- Enzymes are inactivated by poisons as the poison fits into the active site blocking it temporarily or permanently.

LOCK AND KEY HYPOTHESIS



FACTORS AFFECTING ENZYMES:

- Temperature
- pH
- Concentration of substrate
- Concentration of enzyme

- The optimum:
  - The optimum temperature is the temperature at which the activity of an enzyme is greatest.
  - The optimum pH value is the pH value at which the activity of an enzyme is greatest.
- However, different enzymes have different optimums.
- The enzyme is denatured when:
  - The shape of an enzyme changes, as its active site may no longer work.
    - This usually happens at high temperatures or at extremes of pH.

TEMPERATURE

- At high temperature, there is lots of kinetic energy increasing the number of collisions which means that substrates combine with the active site quickly increasing the rate of reaction.
- Very high temperatures denature enzymes.
- When the enzymes are denatured, the rate of reaction decreases.
- At low temperatures, there is little kinetic energy and hence fewer collisions which means that substrates combine with the active site slowly reducing the rate of reaction.

pH

- Changes in pH alter an enzymes shape.
- Different enzymes work best at different pH values.
- The optimum pH for an enzyme depends on where it normally works.
  - For example, intestinal enzymes have an optimum pH of about 7.5
  - However, enzymes in the stomach have an optimum pH of about 2

Enzymes are specific which mean that they only work on one type of substrate.

ENZYME	SUBSTRATE	END PRODUCTS
PROTEASE	Proteins	Smaller Polypeptides
PROTEASE	Smaller Polypeptides	Amino Acids
LIPASE	Fats	Fatty Acids and Glycerol
AMYLASE	Starch	Maltose
MALTASE	Maltose	Glucose
AMYLASE	Sucrose	Glucose and Fructose

Experiment to illustrate how enzyme activity is affected by changes in temperature:

PROCEDURE

1. Using a spotting tile, place 10 spots of iodine solution in the depressions.
2. In a test tube, add 50ml of starch solution.
3. In another test tube, add 50ml of amylase solution.
4. Stand both test tubes in a hot water bath of 30°C.
5. Pour the amylase solution into the starch solution and leave in the hot water bath maintain the same temperature.
6. Immediately take a sample using a dropper and pour into the first depression in the spotting tray.
7. Record the colour change.
    a. If colour changes to blue-black, mark as negative.
    b. If colour stays brown, mark as positive.
8. Do this every three minutes for thirty minutes.
9. Repeat the experiment at different temperatures.

OBSERVATION

- At low temperatures, it took very long before the colour changed to brown as the rate of reaction is slow.
- At temperatures between 30°C and 40°C, the colour changed to brown very quickly as it was the optimum.
- At higher temperatures, the rate of reaction slowed down or did not take place at all as the enzymes denatured.

Activation Energy:	The energy needed to start a chemical reaction.
Active Site:	The part of the enzyme into which the reactant molecule fits.
Catalyst:	A substance that changes the rate of a reaction without being used up.
Denatured:	The state of an enzyme when it has been irreversibly damaged and has changed shape.
Enzyme:	A biological catalyst.
Fermentation:	The conversion of sugar to ethanol and carbon dioxide by enzymes in yeast.
Inhibitor:	A molecule that decreases the rate of enzyme-catalyzed reactions.
Lock and Key:	A model of how enzymes work and the importance of their shape.
Optimum:	The temperature and the pH that an enzyme catalyzed reaction proceeds at its fastest rate.
Reactant:	the molecule that binds and reacts with the enzyme.

Movement of Substances In and Out of Cells

Diffusion

- Net movement of particles from a region of higher concentration to a region of lower concentration until they are evenly spread out.
    - Gradient means difference in concentration.
- Particles move down the concentration gradient from a higher to a lower concentration.
- Particles move randomly by their own kinetic energy.
- The bigger the difference in concentration, the faster the rate of diffusion.

Examples of diffusion in living organisms:

- Oxygen diffuses from lungs to the blood to the respiring cells which contain a lower oxygen concentration.
- Carbon dioxide diffuses out of the respiring cells to the blood to the lungs which is then exhaled.

Osmosis

- Is the diffusion of water molecules from a dilute to a more concentrated solution across a partially permeable membrane.
    - The cell membrane is a partially permeable membrane.
        - It allows water molecules to pass through but not all solute molecules.

Osmosis in Plant Cells:

- The amount of water that enters a plant cell is limited by the cell wall, so they do not bust.
- A cell full of water is called a turgid cell.
    - Turgidity helps in the support of a plant.
    - During this period, the vacuole shrinks as the water diffuses out of the cell.
- If water leaves the cell by osmosis, the cell becomes soft and flaccid.
- In cases of severe loss of water, the cytoplasm may become pulled away from the cell wall. The cell is said to be plasmolysed.
- If a lot of cells become plasmolysed, the plant will wilt.

Osmosis in Animal Cells:

- Animal cells do not have a cell wall.
    - This means that the cell may burst if there is too much water in the cell.
- Also, animal cells do not have permanent vacuoles.
    - This means that the cell may burst as a contractile vacuole is needed to force water out of the cell.
        - This is called cytolysis in Red Blood Cells.
            - That is why kidneys excrete excess water.

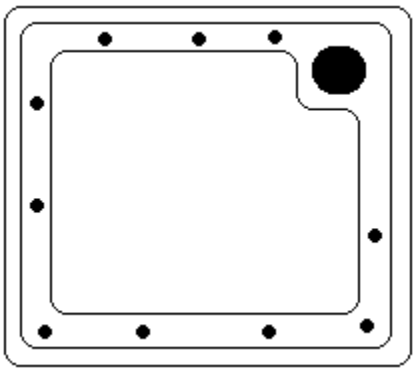
<u>Active Transport</u>

- This is the movement of a substance against the concentration gradient.
- Requires energy from respiration.

Examples:

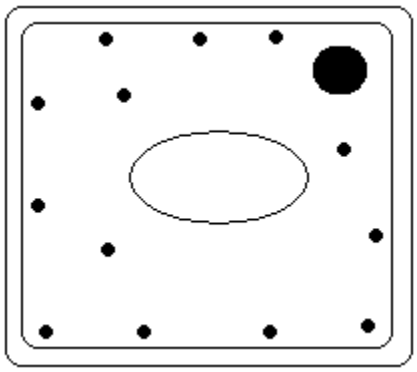
- Plant roots absorb ions from very dilute soil solutions.
- Sugar is absorbed from low concentrations in the small intestine into the blood.

OSMOSIS IN PLANT CELLS



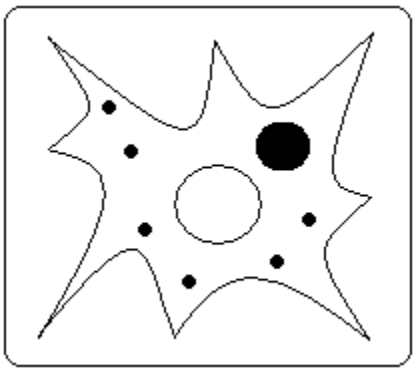
TURGID CELL

- Cell does not burst.
- Turgid pressure stops water from entering.



FLACCID CELL

- Vacuole shrinks as water diffuses out.
- Cell becomes soft.



PLASMOLYSED CELL

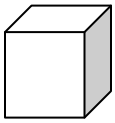
- Severe loss of water causes cell membrane to pull away from cell wall.
- Living volume decreases.
- *SURVIVAL MECHANISM*

FACTORS AFFECTING MOVEMENT OF SUBSTANCES IN AND OUT OF CELLS

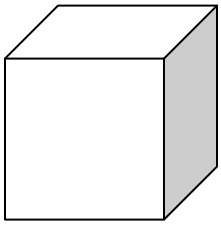
SURFACE AREA to VOLUME ratio:

- Small cells have a large surface area compared to their volume.
    - This means that substances can be moved more quickly in and out of cells.
        - E.g. small animals lose and gain heat very quickly.
- Large cells have a small surface area compared to their volume.
    - This means that substances may not move as quick, in and out of cells to meet the demand of the volume.
    - Hence, if the volume is large, then the demand may be more than the surface area can supply.
        - E.g. large animals do not lose or gain heat very quickly.

Formula:



Surface Area:	(2 x 2) x 6 = 24
Volume:	2 x 2 x 2 = 8
Ratio:	24/8 = 3



Surface Area:	(5 x 5) x 6 = 150
Volume:	5 x 5 x 5 = 125
Ratio:	150/125 = 1.2

- This simply proves that when cells increase in size, the volume increases more rapidly than the surface area.

TEMPERATURE:

- All particles move by their own kinetic energy.
- Higher temperatures increase kinetic energy.
- Therefore, the higher the temperature, the more the kinetic energy which means particles move faster and shall diffuse faster across a membrane.

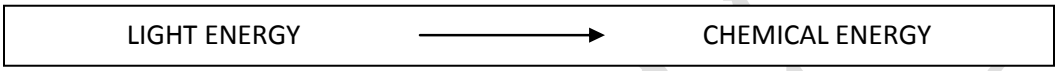
CONCENTRATION GRADIENT:

- In the case of a high concentration gradient, the particles will collide more often on the concentrated side and will diffuse faster across the membrane.
    - Example of high concentration gradient:
        - 90% sugar solution : 5% sugar solution.
- In the case of a low concentration gradient, net movement of particles in one direction is less and diffusion slows down.
    - Example of low concentration gradient:
        - 45% sugar solution : 50% sugar solution.

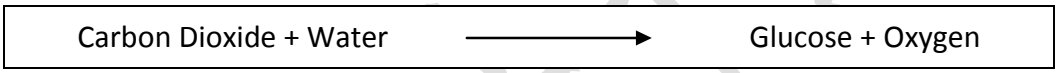
Nutrition

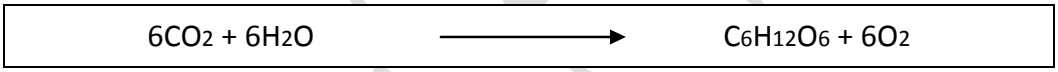
Photosynthesis: Is the process of making organic good (glucose) from inorganic raw materials (carbon dioxide and water) using chlorophyll molecules to trap light energy from the sun. Oxygen is the given off as a waster product.

- This is very important because all food chains start from plants that get their energy from the sun.
- Therefore, by converting light energy into chemical energy, the plant is storing energy in organic compounds which becomes available to all living organisms.



Equation for Photosynthesis





Limiting Factors

Light Intensity:

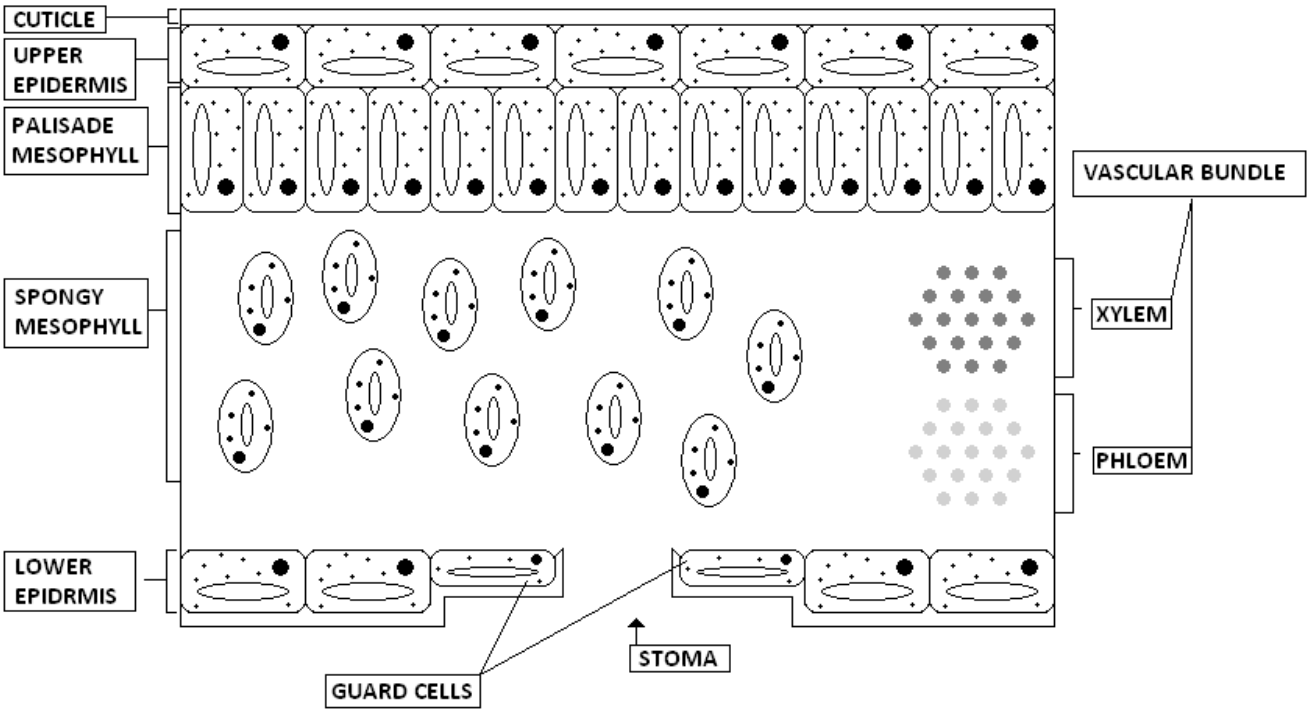
When more light is available, the rate of photosynthesis increases until other factors like carbon dioxide concentration or temperature limits the rate.

Carbon Dioxide Concentration:

When more carbon dioxide is available, the rate of photosynthesis increases until other factors like light intensity or temperature limits the rate.

Temperature:

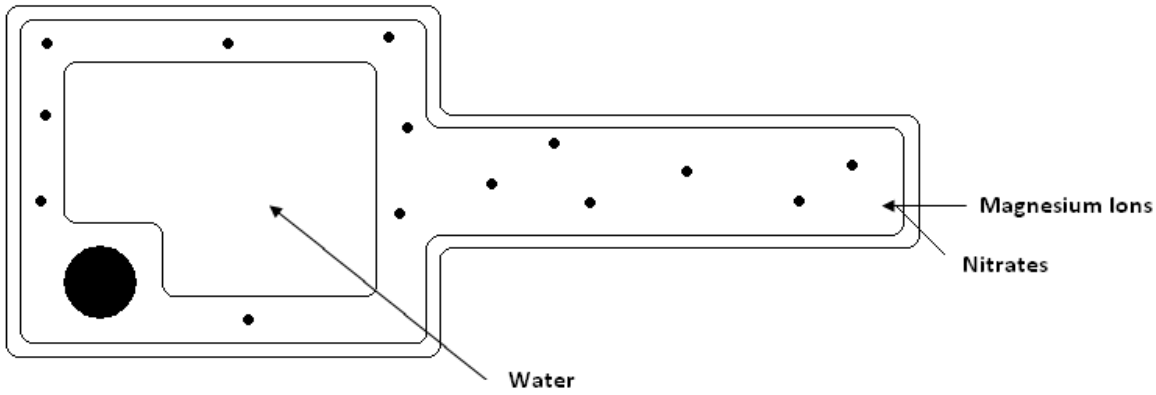
Rate of photosynthesis will rise eventually with an increase in temperature but only up to a point. Beyond this point, enzymes denature; rate of photosynthesis will decrease and eventually stop.



Adaptations of the Leaf

- FLAT
    - Large surface area for light absorption.
- WAXY CUTICLE
    - Prevents loss of water by transpiration.
- TRANSPARENT EPIDERMIS
    - Allows light to penetrate the leaf.
- STOMATA AND AIR SPACES
    - For gas exchange; oxygen and carbon dioxide.
        - Consists of guard cells
            - Guard cells become flaccid and the stoma closes when water leaves the cell.
            - Guard cells become turgid and the stoma opens when water enters the cell.
- PALISADE CELLS
    - Many chloroplasts in slender tightly packed cells increase light absorption.
- SPONGY CELLS HAVE THIN WALLS, LARGE VACUOLES AND AIR SPACES
    - For gas exchange.
    - To store food.
- VASCULAR BUNDLE
    - XYLEM
        - Transports water up from roots to leaves.
    - PHLOEM
        - Transports food molecules to all plant cells.

Root Hair Cell



What Happens To Glucose?

- It is used by the plant to give energy to cells for growth and repair of tissues.
- It can be stored as starch (linking thousand of glucose together.
- To make cellulose cell walls made up of many layers of glucose chains.
- To make other organic compounds like lipids and proteins. But for this glucose must be combined with mineral ions from the soil.
    - Mineral ions like magnesium and nitrates are actively taken up by the root hair cells from soil water.
        - Magnesium ions are needed to make chlorophyll.
        - Nitrates are needed to make amino acids and more complex proteins.

THE DIET

Carbohydrates

- Monosaccharides or Disaccharides
    - Sweets, fruit and table sugar:
        - Provides energy,
- Polysaccharides
    - Potatoes, bread, pasta and cereal:
        - Provide a concentrated source of glucose.
- Cellulose
    - Unrefined plant food such as celery, dried fruit, skin of fruit and vegetables:
        - Provides fibre which helps food to move along in the gut thus preventing constipation and possible colon cancer.

Protein

- Sources:
    - Animal sources:
        - Milk, egg white, meat, poultry and fish.
    - Plant sources:
        - Soy, beans, nuts, lentils and pulses.
- Functions:
    - Building body structures of living things (skin, muscle and hair).
    - Growth and repair of cells and tissues.
    - Provide energy when carbohydrates are depleted.

Fats and Oils

- Sources:
    - Animal sources:
        - Butter, egg yolk, cheese and milk.
    - Plant sources:
        - Canola oil, olive oil, sunflower oil, seeds and nuts.
- Functions:
    - Insulation against heat loss.
    - Part of cell membranes.
    - Important store of energy; long term.

Water

- All foods and drinks contain some water.
- Functions:
    - Biological solvent.
    - Transport of substances in solution – blood and cytoplasm.

Vitamins

- Vitamin A
    - Sources:
        - Milk, butter, carrots, fish liver oil, liver.
    - Function:
        - Healthy skin.
        - Light sensitive cells in retina for dim light.
    - Deficiency disease:
        - Skin problems and sores.
        - Night blindness.
- Vitamin C
    - Sources:

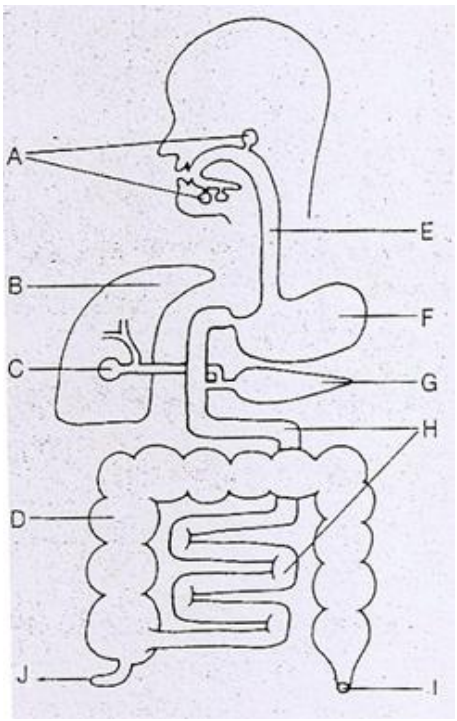
        - Citrus fruits (lemons and oranges), chillies and potatoes.
    - Functions:
        - Healthy skin and gums.
        - Healing of wounds.
    - Deficiency disease:
        - Scurvy: bleeding gums, nose and other tissues.

Minerals:

- Calcium:
    - Sources:
        - Dairy products (milk, yoghurt) and green leafy vegetables (spinach and broccoli).
    - Functions:
        - Strong bones and teeth.
        - Muscle contraction.
        - Blood clotting.
    - Deficiency disease:
        - Rickets: in children (soft bendy bones).
        - Osteoporosis: in adults (loss of bone density).
- Iron:
    - Source
        - Red meat, liver and spinach.
    - Functions:
        - Part of haemoglobin inside red blood cells.
    - Deficiency disease:
        - Anaemia: low red blood cell count leads to tiredness and lack of energy due to lack of oxygen.

Fibre:

- Source:
    - Unrefined plant food such as celery, dried fruit, skin of fruit and vegetables:
- Function:
    - Helps food to move along in the gut thus preventing constipation and possible colon cancer.



A:	Salivary Glands
B:	Liver
C:	Gall Bladder
D:	Large Intestine
E:	Oesophagus
F:	Stomach
G:	Pancreas
H:	Small Intestine
I:	Anus
J:	Appendix

Mouth

- pH = 8 ALKALINE
- Food is:
  - Chewed
  - Mixed in water and mucus in saliva
  - Salivary maltase starts the breakdown of starch to maltose.
  - Formed into a ball (Bolus)
  - Swallowed

Oesophagus

- Bolus transported by muscular contractions and relaxations called peristalsis, towards the stomach

Stomach

- pH = 2 ACID
- Food is:
  - Churned by contractions of stomach wall
  - Acidified by hydrochloric acid in gastric juice
  - Gastric protease breakdown complex protein into shorter polypeptide chains
  - Turned into semi-fluid chime

- Released into duodenum, bit-by-bit (controlled by the sphincter)

Small Intestine

- pH = 8 ALKALINE
- Semi-fluid chime from stomach made alkaline by bile salts secreted from gall bladder
- Bile emulsifies fat into fat droplets
- Pancreas secretes pancreatic juice containing lipase, amylase and protease enzymes to continue digestion
- Wall of the ileum secretes intestinal juice containing lipase, amylase and protease enzymes to continue digestion

Place in the Alimentary Canal	Gland	Juice	Enzymes	Substrates	Products
Mouth	Salivary	Saliva	Maltase	Starch	Maltose
Stomach	Glands in stomach lining	Gastric juice	Protease	Protein	Polypeptides
Duodenum (Small Intestine)	Liver	Bile	-	Fat	Fat droplets
	Pancreas	Pancreatic juice	Lipase	Fat droplets	Fatty acids and glycerol
			Amylase	Starch	Maltose
			Protease	Protein	Polypeptides
Ileum (Small Intestine)	Glands in the wall of the small intestine.	Intestinal juice	Lipase	Fat droplets	Fatty acids and glycerol
			Amylase	Maltose	Glucose
			Protease	Polypeptides	Amino acids

Digestion is complete!

Colon

- No digestion here
  - Only water is reabsorbed (osmosis)
- Indigestible matter (e.g. cellulose- fibre) is compacted into faeces and moved towards the rectum by peristalsis.

Caecum and Appendix

- No longer functional in humans – only in herbivores.
- Contains cellulose digesting bacteria that break down cellulose into glucose.

Rectum

- Faeces are stored here before being egested through the anus.

Ingestion: Food taken into the gut through the mouth.

Digestion: Food broken up into soluble molecules.

Absorption: Soluble products absorbed into the blood.

Assimilation: Soluble products are taken into the cells.

Egestion: Undigested food leaves the body through the anus.

Peristalsis: moving of food through the gut by muscle contractions and relaxations.

- This is because:

Bile:

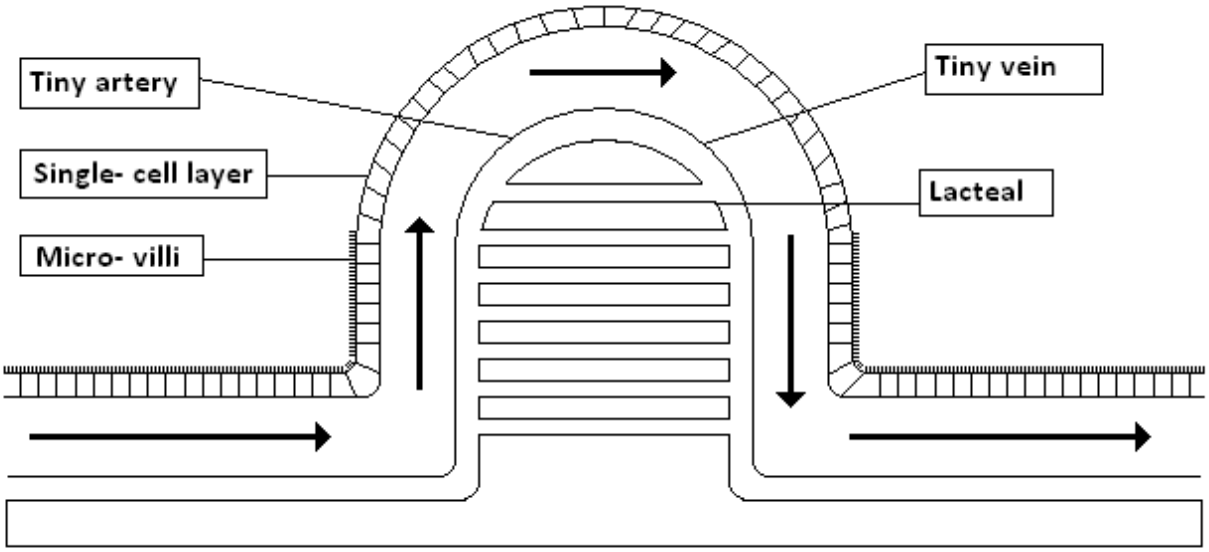
- Is produced by the liver.
- Is stored in the gall bladder.
- Neutralizes stomach acid.
- Make semi-fluid chime alkaline.
- Emulsifies lipids.

HCL functions:

- Gastric protease only works in acidic conditions.
- Kills germs
- Neutralizes alkaline bolus.
- Splits sucrose into glucose and fructose which is absorbed by stomach lining.

Absorption in the Small Intestine

- The organ of absorption is the villus.



Adaptations of the Villus

- Finger-like projection increases surface area for absorption.
- Has a single- cell layer to allow quick diffusion of food molecules.
- Tiny artery is close to the single- layer to take in molecules quickly.

Substances that pass into the lymph in the lacteal:

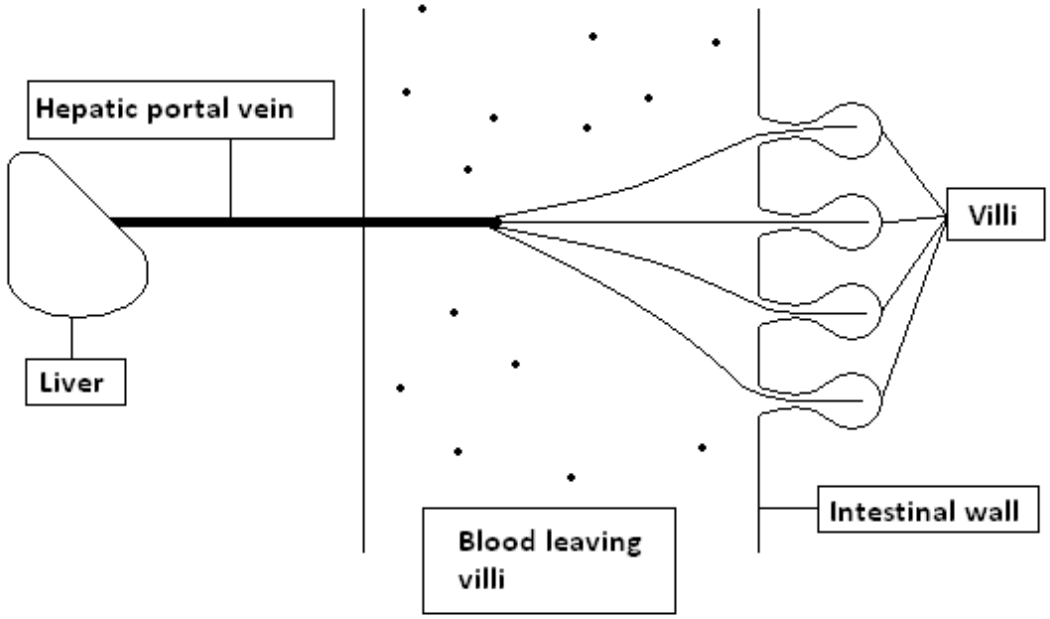
- Fatty acids
- Glycerol

Substances that pass into the blood capillaries:

- Glucose
- Amino acids
- Minerals
- Vitamins

Absorption in the Small Intestine:

- The capillaries join to form the hepatic portal vein.
    - The hepatic portal vein carries food molecules to the liver.



Excess:

- Excess vitamins and minerals will be removed from the blood and excreted in urine.
- Excess amino acids are deaminated (nitrogen base removed) excreted in urine as urea.
- Excess glucose are linked together by insulin (from the pancreas) to form glycogen and later stored as fat.

Respiration

Aerobic Respiration: is the complete breakdown of glucose in the presence of oxygen to release all of its stored energy.

Word Equation:

Glucose + Oxygen ⟶ Carbon Dioxide + Water + lots of Energy

Chemical Equation:

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + lots of Energy

Anaerobic Respiration: is the incomplete breakdown of glucose due to the absence of oxygen. Less energy is produced since glucose is not fully oxidized.

Alcoholic Fermentation

In plants and yeast.

Word Equation:

Glucose ⟶ Alcohol + Carbon Dioxide + less Energy

Chemical Equation:

$C_6H_{12}O_6 \longrightarrow$ Alcohol + CO_2 + less Energy

- **Non-reversible reaction!**

- Remember: you can test for carbon dioxide with limewater. Carbon dioxide is present if limewater goes milky.

Lactic Acid Fermentation

In animal cells and bacteria.

Word Equation:

Glucose ⟶ Lactic Acid + less Energy

Chemical Equation:

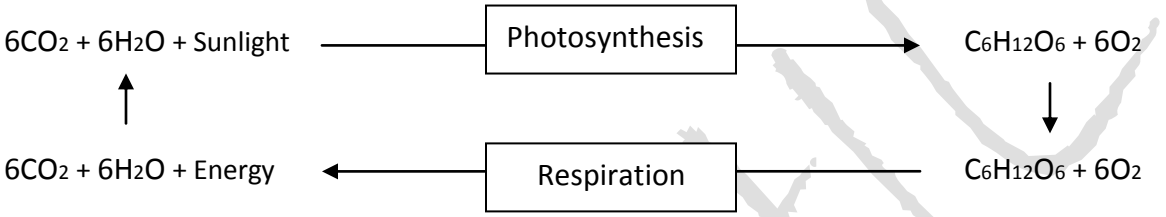
$C_6H_{12}O_6 \longrightarrow$ Lactic Acid + less Energy

- **Reversible reaction!**

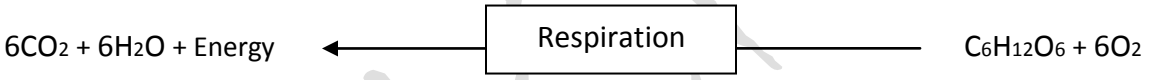
Gas Exchange

Cellular Respiration in Producers

DAY



NIGHT

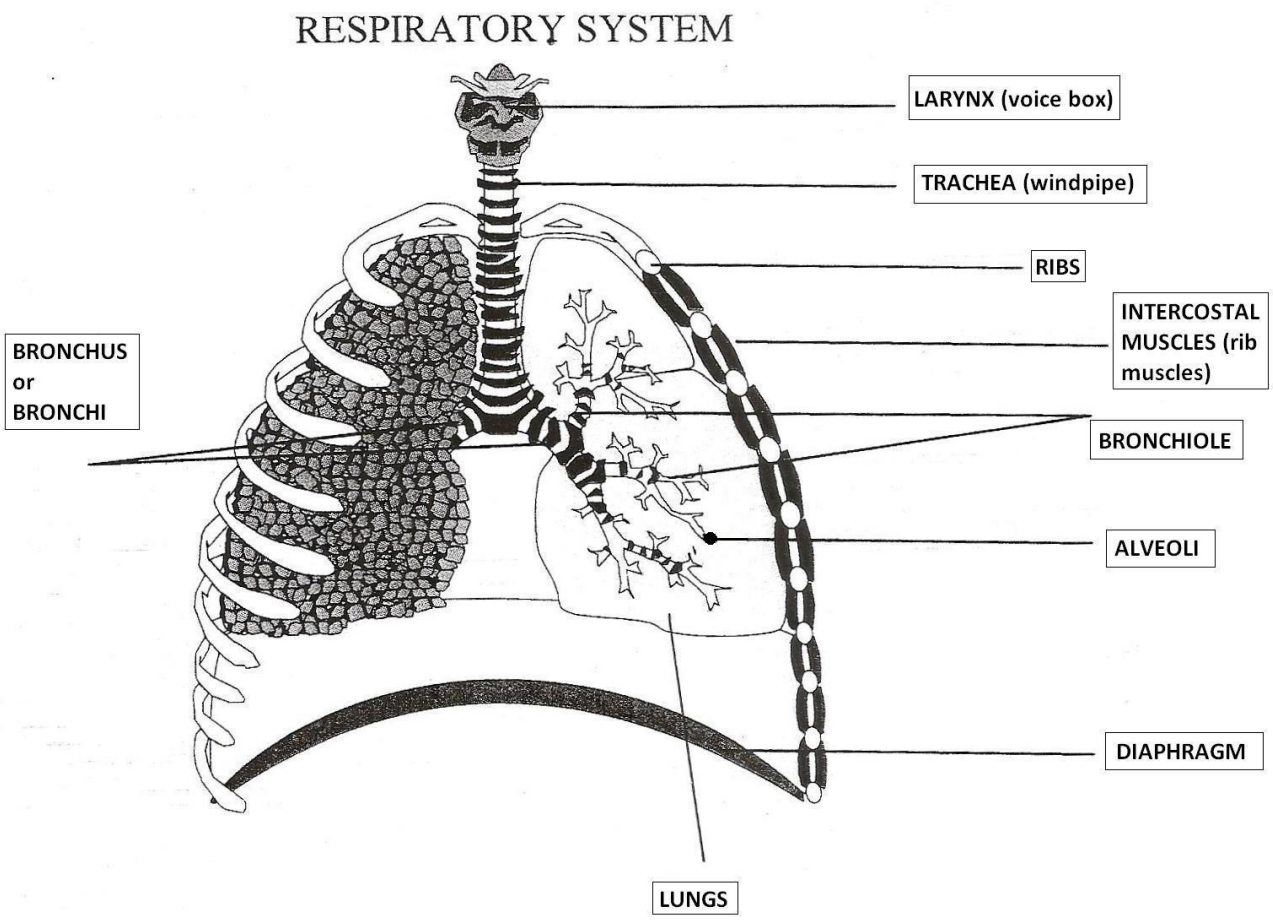


Cellular Respiration in Consumers

DAY & NIGHT

How the leaf is adapted for gas exchange:

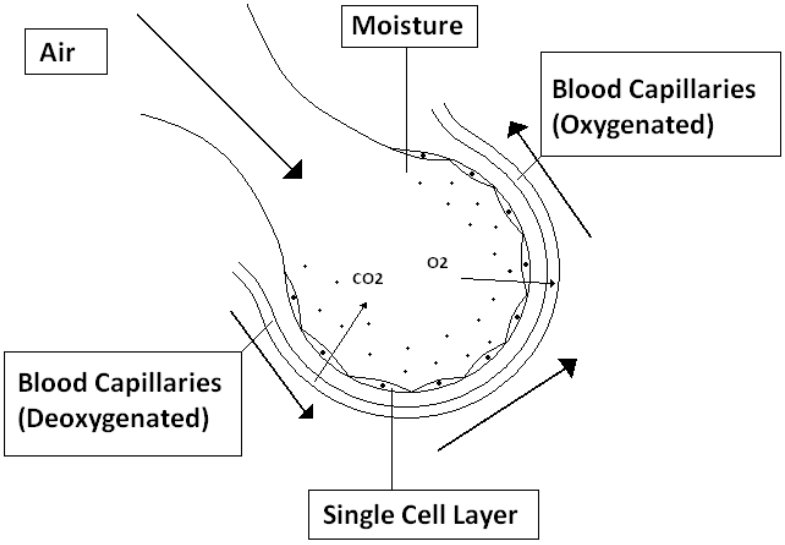
- The leaf has several stomas to allow maximum gas exchange.
    - The stoma is on the underside of a leaf and allows carbon dioxide and oxygen to diffuse in an out of the leaf.
- The leaf has air spaces between spongy cells to allow gas to diffuse quickly.



Gas Exchange in Animals

- Lungs:
  - Are located inside the thorax.
  - Are protected by the rib cage.
  - Have a double membrane surrounding each lung called the pleura.
    - Outer membrane is attached to thorax cavity.
    - Inner membrane is attached to lung tissue.
      - The fluid filled space between the two membranes which prevents friction is called the pleural cavity.
- Muscles:
  - Diaphragm:
    - Dome shaped muscle that separates the thorax from the abdomen.
  - Intercostal muscles:
    - Muscles located between ribs.
  - *Together these muscles function to change the volume of the thorax when breathing.*
- Air Passages:

- Nasal Cavity:
  - Structure:
    - Line with mucus membrane.
    - Lined with ciliated epithelium.
  - Function:
    - To warm, moisten and clean the air by trapping dust and germs in mucus which is swept away by cilia to be swallowed.
- Pharynx (throat):
  - Food and air passage.
  - Eustachian tubes from middle ear open into it.
- Larynx (voice box):
  - Vocal cords.
  - Consists of an epiglottis:
    - A small lid that closes the trachea when we swallow food.
- Trachea:
  - Structure:
    - Lined with ciliated epithelium.
    - Consists of C-shaped rings of cartilage.
  - Function:
    - C-shaped rings of cartilage ensure that the trachea is clean and always open.
- Bronchi:
  - Two branches of the trachea that split into each lung.
  - Structure:
    - Lined with ciliated epithelium.
    - Consists of C-shaped rings of cartilage.
  - Function:
    - C-shaped rings of cartilage ensures that the bronchi are clean and always open.
- Bronchioles:
  - Small narrow branches of bronchi.
  - Structure:
    - Lined with ciliated epithelium.
    - C-shaped rings of cartilage start to disappear.
  - Function:
    - Takes clean air to the alveoli.
- Alveoli:
  - Gently enlarges surface area for gas exchange.
  - Have millions of round shaped air sacks.
  - Each surrounded by capillary network for quick gas exchange.
  - Only one cell layer thick so that gases can diffuse quickly into the blood.
  - Moisture on the inside allows oxygen to dissolve quickly.



VENTILATION	
Inhalation	Exhalation
Diaphragm contracts and flattens	Diaphragm relaxes and becomes dome shaped
Intercostals contract	Intercostals relax
Ribcage moves up and outwards	Ribcage moves downwards
Volume inside thorax increases	Volume inside thorax decreases
Lung pressure drops	Lung pressure increases
Elastic lungs expand because lung pressure is lower than atmospheric pressure	Lung partially deflates since atmospheric pressure is lower
Air is drawn into the lungs	Air is forced out of the lungs

Effects of Smoking on Lungs

- Diseases:
    - Lung cancer
    - Bronchitis
    - Emphysema
- Secondary effects:
    - Coronary heart disease
    - Stomach and intestinal ulcers
    - Underweight babies from smoking pregnant woman
- Effects on air passages:
    - Reduced number of cilia
    - Mucus not swept away and builds up in airways causing smokers cough
    - Bacteria trapped in clogged mucus causing difficulty in breathing; Bronchitis
- Effects on alveoli:
    - Harmful chemicals in smoke cause alveoli to break down and fuse together
    - This forms large spaces with reduced surface area for gas exchange; Emphysema
        - This has no cure, only survival mechanism is by using an oxygen mask

Harmful Chemicals in Smoke

- Nicotine:
    - Odourless, colourless chemical which causes addiction
    - Is the cause for yellow teeth and finger stains
- Tar:
    - 17 toxic chemicals called carcinogens
        - Smoking does not cause cancer, but carcinogens increase the chances of getting cancer
            - Cancer is when cells start to divide uncontrollably to form a tumor
                - It can spread to other part of the body via the blood stream
    - Is the cause for black stains on teeth and lungs
- Carbon Monoxide:
    - Toxic gas: reduces oxygen in blood
    - Binds more readily to haemoglobin in red blood cells than oxygen to form carboxy haemoglobin
        - Much less oxygen is transported to body cells causing dizziness or cramps in arms and legs

Investigate the effect of exercise on breathing rate:

Method:

- Make sure you are completely relaxed by sitting quietly for five minutes
- Count the number of breaths you take in three minutes and divide the number by three to get an average
- Carry out some vigorous exercise, like running up and down a staircase for two minutes
- Immediately after exercise, record your breathing rate
- Continuously record your breaths per minute until your breathing rate returns to normal
- Plot your results on a graph, showing the breathing rates before, during and after exercise

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Transport

Unicellular organisms:	are only one cell big, so all the nutrients, water and oxygen needed can be obtained from their environment by the process of diffusion.
Multicellular organisms:	cannot rely on diffusion as it would take very long before the nutrient, water and oxygen is transported to all the cells, hence they need a transport system.

Transport through Vascular Tissue:

Vascular bundles or veins have two parts for transporting substances around the plant.

- Xylem
  - Takes water and mineral ions up from the roots to the leaves.
- Phloem
  - Takes the sucrose and amino acids made during photosynthesis up and down from the leaves to the other parts of the plant.

How the Xylem is Adapted for Transportation:

- Water and minerals travel in xylem vessels.
- Xylem vessels have thick cellulose cell walls, strengthened by lignin.
  - The inside of the cell is hollow.
  - Xylem vessels are dead cells.

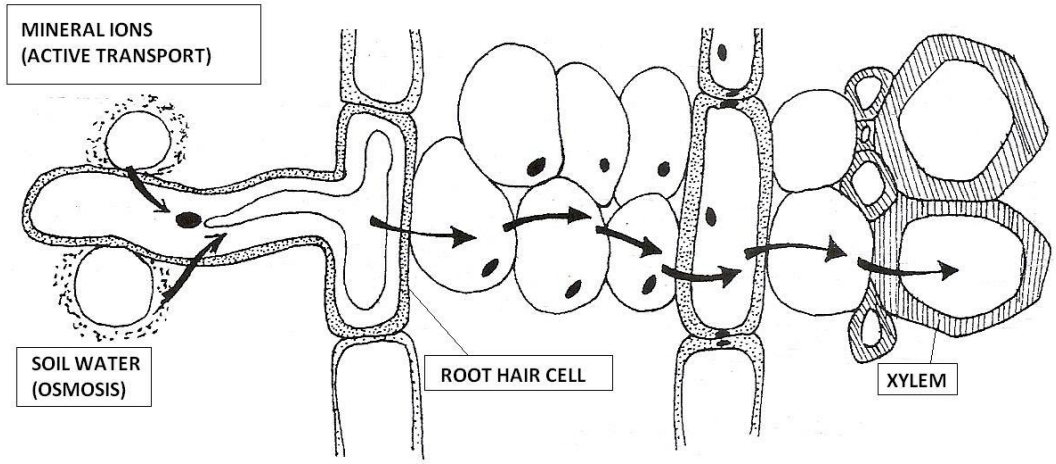
- Xylem vessels transport water and mineral from the roots to the shoot and leaves.
    - This transport only occurs in one direction.
- The thick walls of the xylem cells also help support plants.

Uptake of Water and Mineral Ions in Root Hair Cells:

- Soil water is less concentrated than cell sap in vacuoles in plant cells.
- Water diffuses from a more dilute to a more concentrated solution into root hair cells.

How Root Hairs are Adapted for Water Absorption:

- They have a long extension which greatly enlarges the surface area for water and mineral ions diffuse through.
- They store lots of mineral salts in the vacuole cell sap to allow water to diffuse by osmosis from a more dilute to a more concentrated solution.



TRANSPIRATION

- Is the loss of water in the form of water vapour, through the stomata.
- More than 95% of water absorbed by the roots of a plant is lost to the air.
- Water flows in a continuous column from the roots to the leaves known as the transpiration stream.

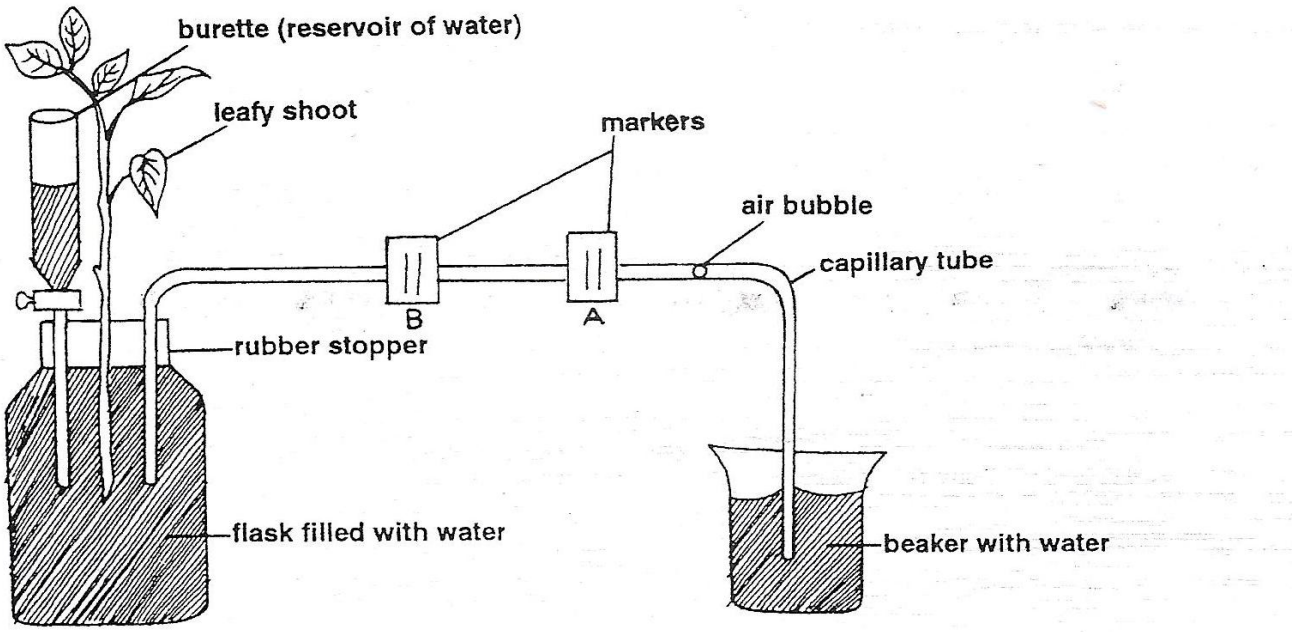
Benefits of continuous uptake of water:

- Gets the needed mineral ions.
- Prevents plant from wilting and provides support.
- Turgid cells open stomata:
    - Evaporation of water has cooling effect on plant which is helpful in hot weather.

Factors affecting the rate of transpiration

- Temperature
- Humidity
- Light
- Wind

These factors can be measured experimentally by using a potometer**.**



Take the following precautions:

- Cut the twig underwater to make sure that there are no air bubbles in the xylem.
    - Theses would block the flow of water.
- The stopper must fit very tightly so that the apparatus is airtight and no air can enter.
- Make sure that your markers, A and B, stay in the same places.
- Place the entire apparatus in a shady place for about 30 minutes to allow the plant to become adjusted to these conditions.
- Introduce a bubble of air into the tube by lifting the end of the tube out of the beaker, quickly pressing down on the stopper, and then putting the tube back into the water again.
- Use a stop-watch to measure the time the bubble takes to travel from marker A to marker B. Drive the bubble back again by opening the stopcock. Repeat the timing again and work out an average time. Open the stop stopcock again to drive the bubble back.
- Now place the potometer in various positions, taking a number of reading in each case:
    - In a windy place (using a fan)
    - In bright sunlight
    - In a warm place (using a heater)
    - In a humid place (by covering the apparatus with a damp bag)

Blood

- Is a tissue
- Has a liquid portion called the plasma (60%)
- Has a cellular portion of blood cells (40%)

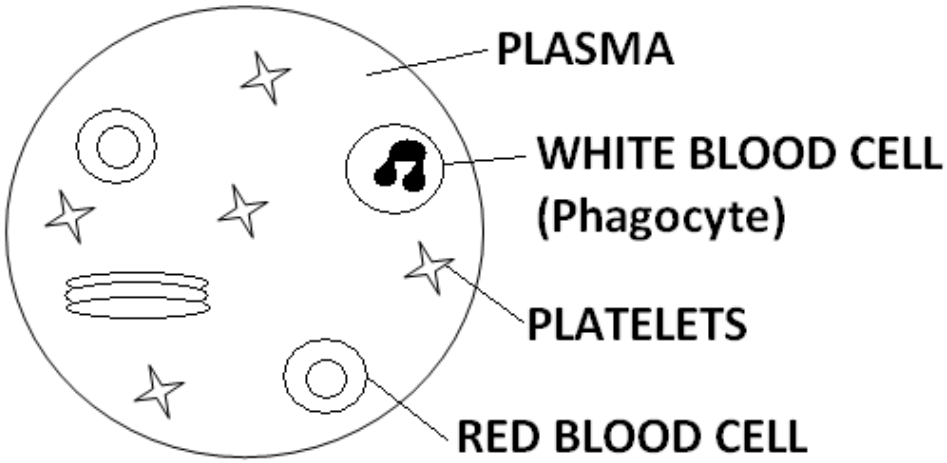
Blood Plasma

- Is a solution made up of 90% water and dissolved solutes:
    - Amino acids
    - Nutrients (minerals, vitamins, glucose)
    - Antibodies
    - Hormones
    - Wastes (urea, carbon dioxide)
    - Proteins
- Is yellow in colour

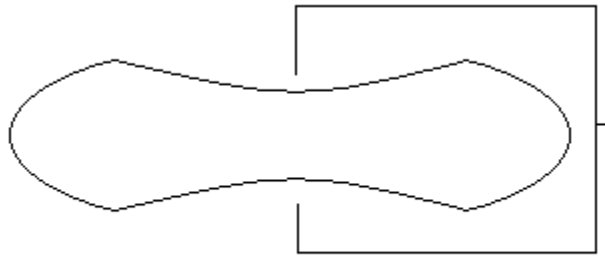
Cellular Portion

- Red Blood Cells
    - Flat discs – biconcave in shape (flexible)
    - They have no nucleus
    - They are filled with a protein called haemoglobin which binds to oxygen
    - Blood appears red due to the iron inside haemoglobin
        - Oxygen + Iron = Iron Oxide
    - Function:
        - Carrying oxygen to body cells and some carbon dioxide away from body cells.
    - Deficiency:
        - Anaemia
            - Due to lack of iron in the diet
                - Less red blood cells produced
                - Less oxygen to cells
- White Blood Cells
    - Larger than red blood cells
    - Have a nucleus but no haemoglobin
    - Fewer in number compared to red blood cells
        - 2 white blood cells : 100 red blood cells
    - Two types of white blood cells:
        - Phagocytes:
            - Have a lobed nucleus
            - Can change shape and migrate from blood vessels to tissue fluid
            - They destroy germs by engulfing and digesting them
                - They have digestive enzymes
            - A high concentration of them causes inflammation
            - Disease:
                - Leukaemia
                    - White blood cell mutation (over production)
                        - Leads to cancer
        - Lymphocytes:
            - Large round nucleus
            - Smaller than phagocytes
            - They destroy germs by producing antibodies
                - Antibodies bind to the membranes of foreign organisms like viruses and bacteria
                - They hold the germs together for a phagocyte to engulf them
                - Will remain in the blood stream ready to attack the next time these foreigners enter the body
                    - Also called immunity

- Platelets
    - In the bone marrow, large cells form cell fragments by pinching off bits of their cytoplasm
    - They are not whole cells but pieces of cells
    - Function:
        - Blood exposed to air causes platelets to shatter releasing their clotting agents which is fibrous:
            - Catching the blood cells in a fibrous network and forming a scab
    - Diseases:
        - Haemophilia:
            - Lack of blood clotting protein
            - Lack of Vitamin K
        - Thrombosis:
            - Blood clot in blood vessels
            - Cholesterol leads to thrombosis which causes a heart attack or stroke
        - Pulmonary Embolism
            - Clot in the lung artery

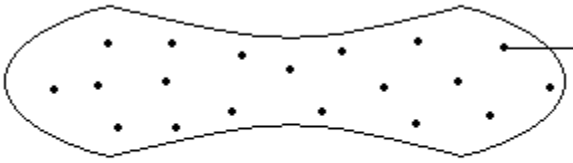


Adaptations of RBC



Biconcave

Increases Flexibility



Haemoglobin

Binds to Oxygen

No Nucleus

More Space for Haemoglobin

The Mammalian Heart

Structure:

- Located in chest cavity between lungs
- Size of a clenched fist
- Protected by ribcage
- Tip of the heart points to the left
- Made of cardiac muscle:
  - Involuntary (automatic)
  - Never stops working, never gets tired
  - Coronary artery gives oxygen to the cardiac muscle

Blood Pressure: **120 (systolic) ÷ 80 (diastolic)**

Why two circulations?

- Blood pressure must be sustained to reach all the cells in the body
    - Also needed to remove waste
    - To absorb nutrients

Heart Diseases

- Heart attack:
    - When an area of the heart muscle does not get enough oxygen
        - Blood clot in coronary arteries
        - Fatty deposits inside coronary arteries (cholesterol)
- Stroke:
    - Obstruction of a blood vessel in the brain (may leave a person paralysed)
        - Blood vessels bursting in the brain due to high blood pressure
        - Blood clot blocking a vessel in the brain
- Blood Pressure:
    - Must be reasonably high to move the blood all around the body
    - High enough for kidneys to filter blood, but not too high causing capillaries to burst

---

Superior Vena Cava:

- Large vein that bring de-oxygenated blood from the upper part of the body to the right atrium

Pulmonary Veins:

- Bring fresh oxygenated blood from each of the lungs to the left atrium

Pulmonary Semi Lunar Valve:

- Prevents blood from flowing back into the right ventricle after it has entered the pulmonary artery

Tricuspid Valve:

- Prevents blood from flowing back into the right atrium after it has entered the right ventricle

Inferior Vena Cava:

- Vein that brings de-oxygenated blood from the lower part of the body to the right atrium

Aorta:

- Brings oxygen-rich blood from the left ventricle to the body

Pulmonary Arteries:

- Bring oxygen-poor blood to the right or left lung

Aortic Semi Lunar Valve:

- Prevents blood from flowing back into the left ventricle after it has entered the aorta

Bicuspid Valve:

- Prevents blood from flowing back into the left atrium after it has entered the left ventricle

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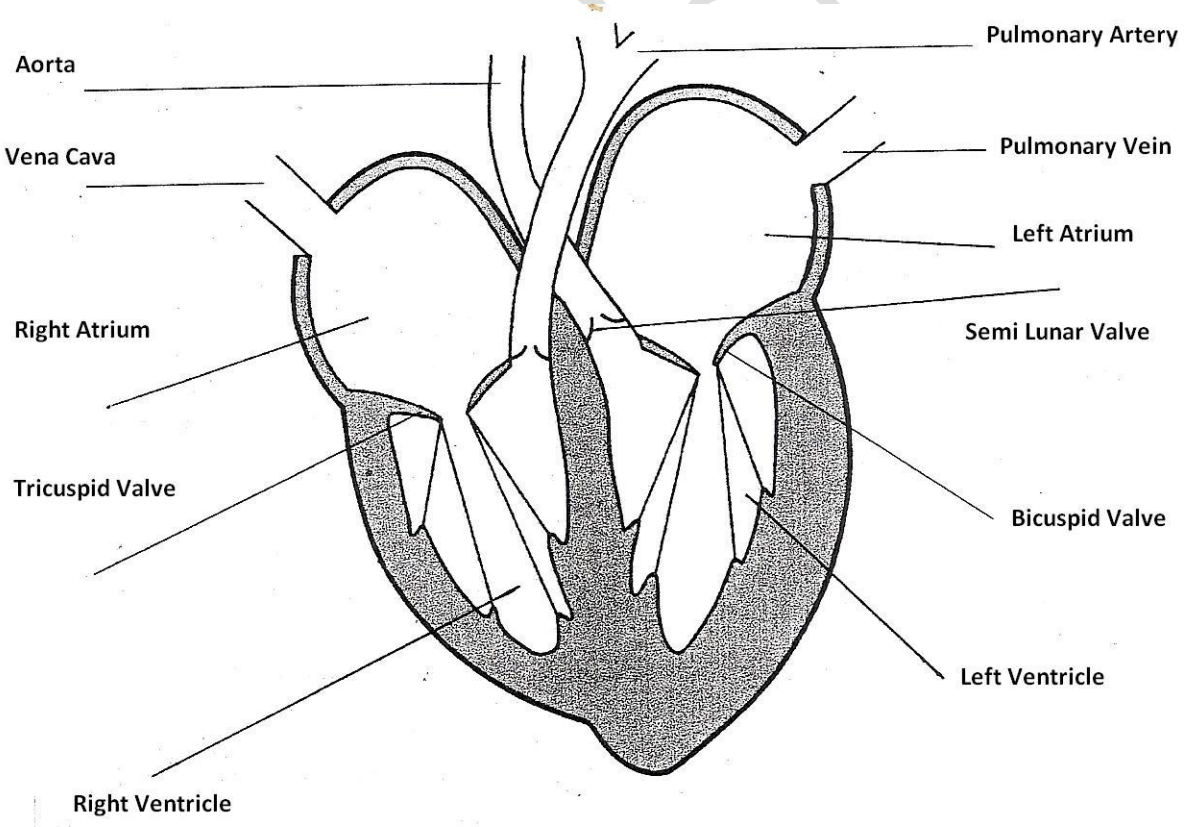

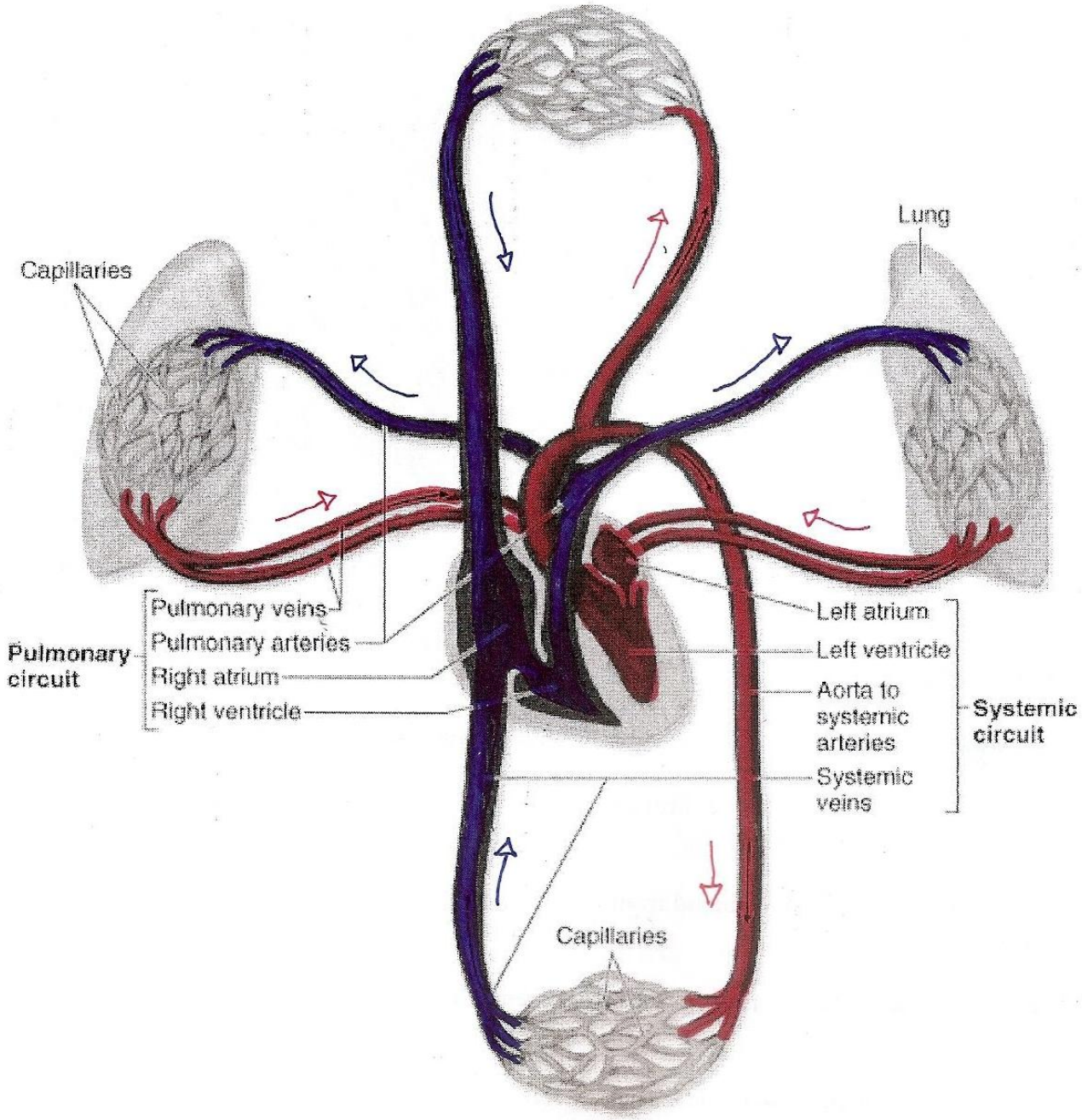

Pulmonary Circulation

- Pathway that carries blood between the heart and the lungs

Systemic Circulation

- Pathway that carries blood between the heart and the rest of the body

Heart's Natural Pacemaker

- Is located in the right atrium
- Sends electric impulses to the cardiac muscles of the atria to cause atrial contractions
- Impulses are then picked up by muscle fibres in the ventricles, causing contraction of ventricles
- Artificial pacemakers are required for patients who have irregular heartbeats

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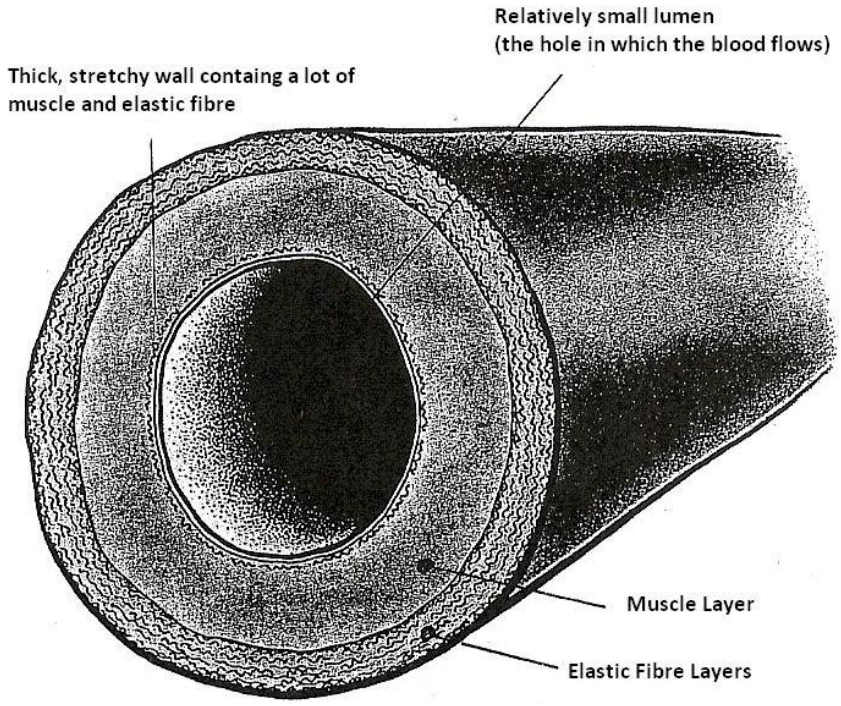
Arteries:

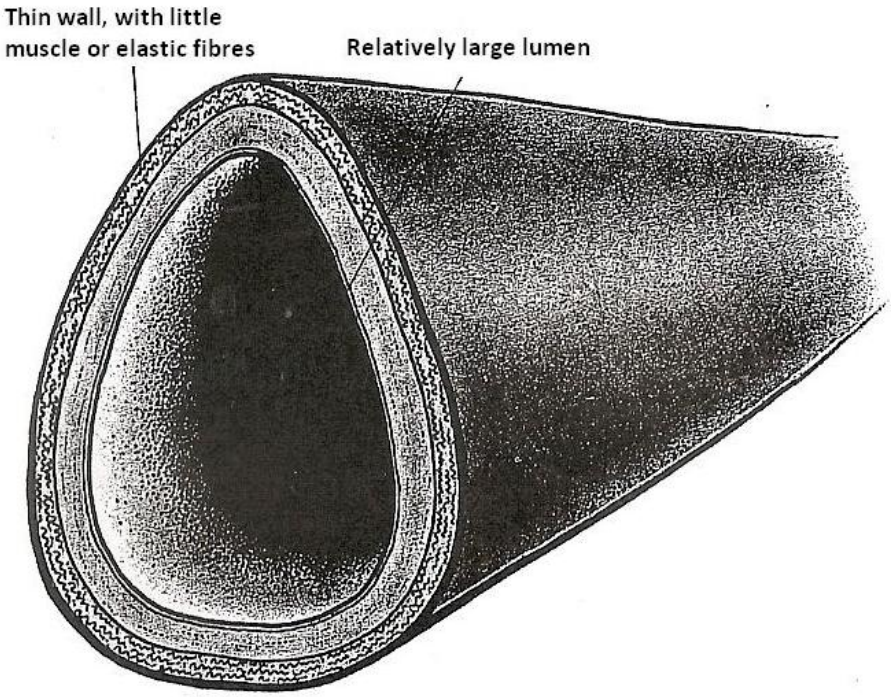
- Blood vessels that carry blood from the heart to other parts of the body
    - Hence the blood is at high pressure and is travelling fast
- Have strong walls to contain high pressure blood
- Are elastic
    - This allows them to expand a little as blood surges through
- Surges of blood push outwards on artery wall
- Between surges, artery wall recoils inwards
    - This keeps the blood flowing smoothly, as the elastic recoil of the wall fives the blood an extra push in between the pushes from the heart



Veins:

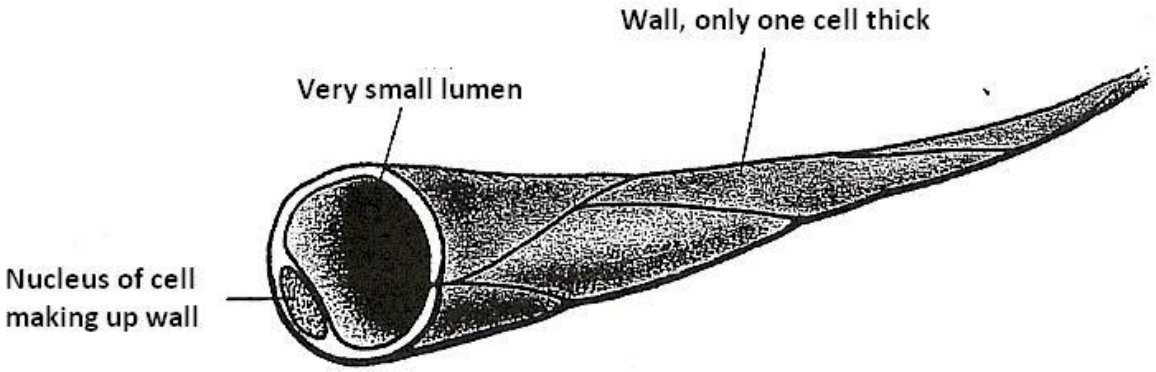
- Blood vessels that bring blood back to the heart from other parts of the body

    - Hence the blood is at low pressure and is travelling quite slowly
- Have thin walls as there is little pressure
- Are wide and have valves
    - This stops blood from flowing backwards, and makes sure that any movement is always towards the heart



Capillaries:

- Delivers oxygen, food and other substances to body tissues
- Collects waste materials from body tissues
- Have thin walls (one cell thick) to allow substances to pass through them
- Have small gaps in them to make it easier for substances to pass through



Ecology and the Environment

Population: a population is all of the members of the same species in a particular area.

- E.g. flamingos in Ras Al Khor

Community: a community is all of the populations of living organisms in one area.

- E.g. flamingos, zebras, wild beasts and grass around Lake Nakuru

Habitat: a habitat is a part of the environment that can provide food, shelter, and a breeding site for a living organism.

- E.g. a desert is a habitat for a camel

Ecosystems: an ecosystem is all of the loving organisms and non-living factors in a particular part of the environment.

- E.g. a desert ecosystem

Producers: green plant that can synthesize their own food by photosynthesis.

- E.g. grass

Primary Consumers: herbivores that feed on plan or plant material.

- E.g. rabbits

Secondary Consumers: carnivores that feed on herbivores.

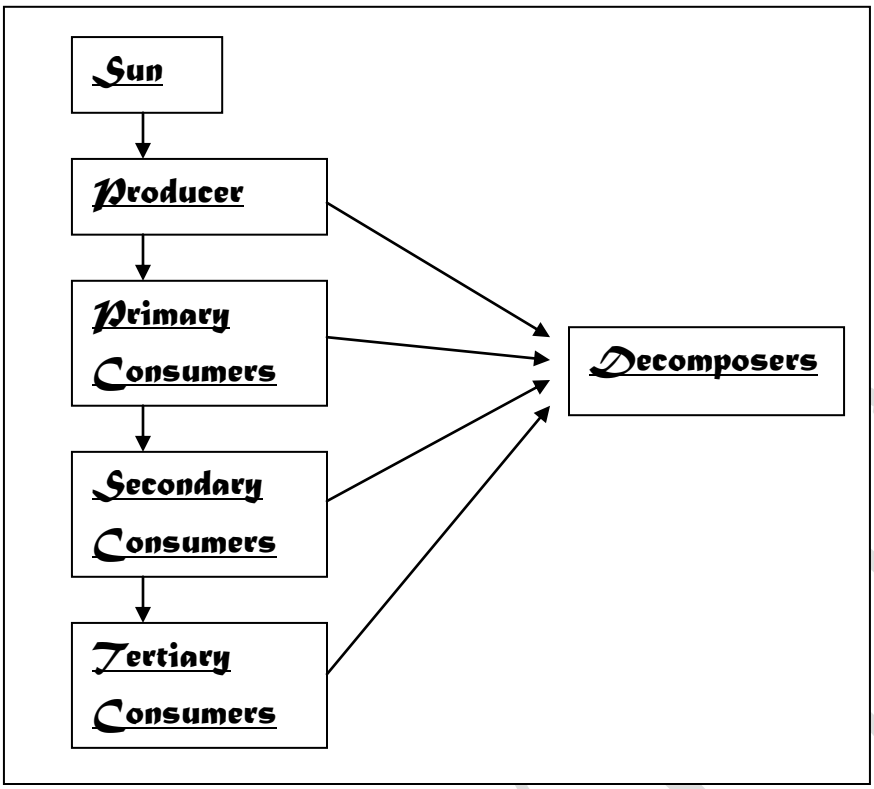
- E.g. snakes

Tertiary Consumers: carnivores that feed on other carnivores.

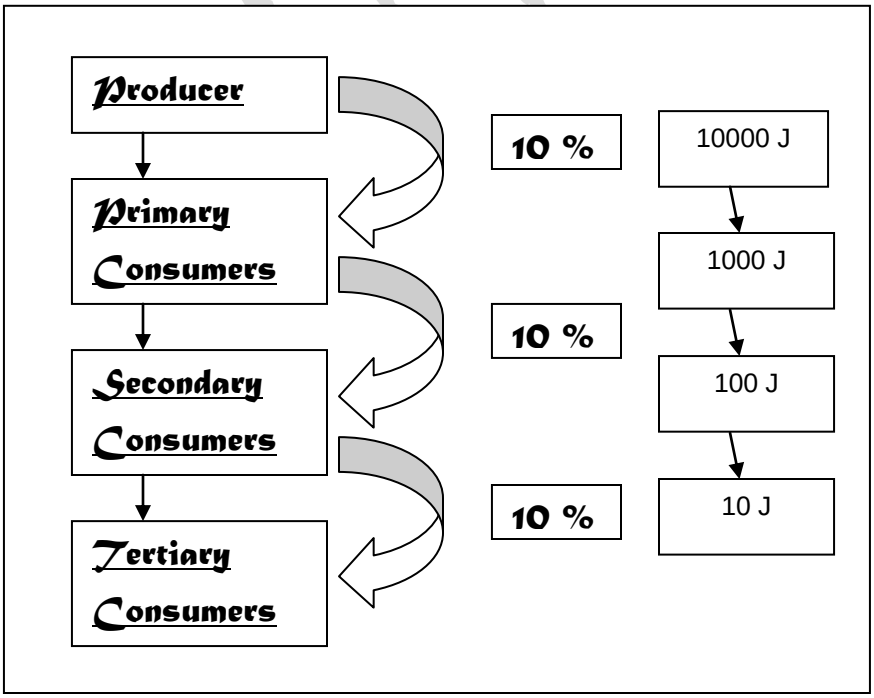
- E.g. crocodiles

Decomposers: fungi and bacteria that break down organic matter and help to recycle nutrients.

- E.g. lactobacillus



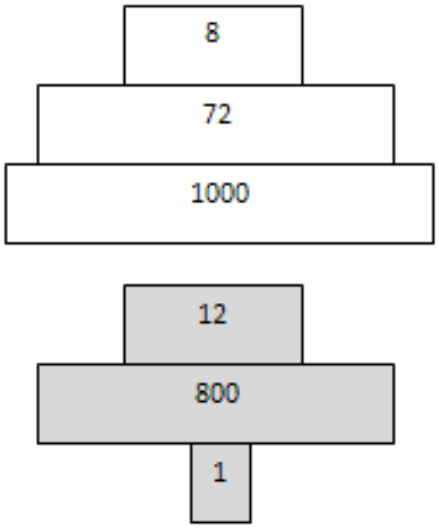
Food Chain: a linear feeding relationship of eating and being eaten is called a food chain.



Energy flow in a food chain!

Energy is lost by:

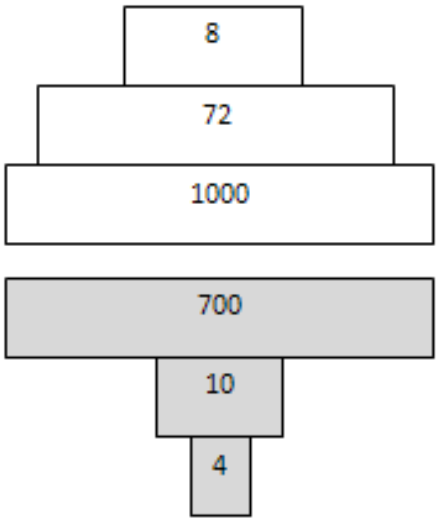
- Heat
- Movement
- Respiration
- Excretion of wastes
- Inedible parts
- Indigestible parts



Pyramid of Numbers

Grass	→	Zebra	→	Lion
1000		72		8

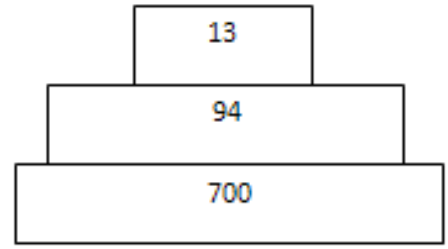
Tree	→	Insects	→	Birds
1		800		12



Pyramid of Biomass

Tree	→	Insects	→	Birds
1000kg		72kg		8kg

Algae	→	Fish	→	Shark
4 kJ		10 kJ		700 kJ



Pyramid of Energy

Algae	→	Fish	→	Shark
700 kJ		94 kJ		13 kJ

Quadrats:

- Are used to estimate the population size of an organism in two different areas
- Is used as a technique for sampling the distribution of organisms in their habitats

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