OCR AS Level Biology Unit 1

What is the purpose of a microscope? to observe cells and micro-organisms

What are the different types of microscopes available?

- Light
- Electron (Transmission and Scanning)

How to judge the properties of a microscope? by its Magnification & Resolution

What is magnification?

- how much larger an image size is compared to its actual size
- calculate magnification by Image Size *divided by* Actual Size
- Electron Microscopes have higher magnification than Light Microscopes
- Transmission Electron Microscopes have higher magnification than Scanning Electron Microscope
- TEM = x 500,000. SEM = x 100 000. LM = x 1500.

How to convert milimetres into micrometres? 1mm = 1000 μm

What is resolution?

- the minimum distance at which two very close objects can be distinguished
- (represents the idea of detail)
- Electron Microscopes have higher resolution than Light Microscopes
- Transmission Electron Microscopes have higher resolution than Scanning Electron Microscope
- TEM = 0.2nm. SEM = 20nm. LM = 200nm.
- (if 2 objects are closer than 200nm, a LM would see them as one and not distinguish)

Why do electron microscopes have higher resolution than light microscopes?

- Electron microscopes use electrons which have a short wavelength
- Light microscopes use light which has a large wavelength

How do light microscopes work?

- involves passing light through the specimen/slide
- the light waves are then spread out by the aid of lenses, this leads to magnification
- the magnified image can then be observed
- the specimen needs to be stained to make the colourless contents (of cell/microorganism) visible

How do transmission electron microscopes work?

- involves passing electrons through specimen/slide
- magnets are used to spread out the electrons (magnification process)

- the electrons will hit a photographic film producing a image
- colour/stain can be added to the image after

Advantage and Disadvantage of TEM?

- Advantage = highest magnification and highest resolution
- Disadvantage = works in a vacuum so can only observe dead specimens, specimen needs to be thin, black and white image, 2D image, artefacts

How do scanning electron microscopes work?

- involves bouncing electrons off the surface of the specimen
- produces a 3D image

Advantage and Disadvantage of SEM?

- Advantage = produces 3D image
- Disadvantage = works in a vacuum so can only observe dead specimens, black and white image, artefacts

What is an organism? a living thing that performs a number of life processes

What kingdoms are organisms divided into?

- Animal, Plant, Bacteria, Fungi, Protoctista
- animal & plant are multicellular organism (made of millions of cells)
- bacteria, fungi, protoctista (& virus) are micro-organisms
- animal, plant, fungi, protoctista are eukaryotic – implies that their cells have a nucleus and membrane-bound organelles
- bacteria is prokaryotic – implies that their cells have no nucleus and no membrane-bound organelles

What is an Animal Cell made of?

- Organelles (nucleus, endoplasmic reticulum, golgi body, lysosomes, mitochondria, ribosomes, centrioles) – all have membrane except the ribosomes & centrioles
- Cytoplasm (site of chemical reaction)
- Cell Membrane (holds cell contents together, controls what enters/leaves cell, cell signalling)

Structure of Nucleus?

- contains DNA (made of genes, genes code for making proteins)
- DNA wrapped around histones to form Chromatin
- nucleus has a double membrane, called Nuclear Envelope, which contains pores
- at centre of nucleus is Nucleolus – produces mRNA (copy of a gene)
- rest of nucleus made of Nucleoplasm (contains the DNA/chromatin)

Endoplasmic Reticulum?

- 2 types = Rough and Smooth
- Rough Endoplasmic Reticulum has ribosomes on it, makes proteins
- Smooth Endoplasmic Reticulum has no ribosomes on it, makes lipids/carbohydrates

Golgi body?

- modifies and packages proteins
- packages them into vesicles for transport
- digestive enzymes are placed into lysosomes (vesicles with membranes around them)

Mitochondria?

- site of respiration, releases energy, produces ATP (energy carrier molecule)
- has a double membrane, inner membrane folded into Cristae (increases surface area for enzymes of respiration)
- middle portion called Matrix

Ribosomes?

- attached to RER
- site of protein synthesis

Centrioles?

- form spindle fibres in mitosis/cell division

What is a Plant Cell made of?

- Organelles (nucleus, endoplasmic reticulum, golgi body, lysosomes, mitochondria, *chloroplast*, ribosomes) – all have membrane except the ribosomes
- *Vacuole* (contains water & solutes to keep plant cell turgid)
- Cytoplasm (site of chemical reaction)
- Cell Membrane (holds cell contents together, controls what enters/leaves cell, cell signalling)
- *Cell Wall* (made of cellulose, freely permeable, prevents cell from bursting and keeps it rigid)

Chloroplast?

- site of photosynthesis
- has a double membrane
- contains discs called Thylakoids, these contain chlorophyll
- a stack of thylakoids = Granum
- the thylakoids are surrounded by a fluid called Stroma

Role of Cytoskeleton in Animal/Plant cells? maintains cell's shape by providing an internal framework (scaffold)

Role of Microtubules in Animal/Plant cells?

- move organelles around the cell
- move vesicles/lysosomes around the cell
- act as spindle fibres in mitosis/cell division
- form cilia in lungs (sideways movement pushes mucus out of the lungs)
- form undulipodia in sperm cells (acts as a tail to move cell by sideways movement)

Process of Protein Synthesis in Animal/Plant cells?

- copy of gene made in Nucleus, copy is called mRNA
- mRNA leaves nucleus via nuclear pore
- mRNA attaches to ribosomes on RER
- RER uses the code on the mRNA to make the protein
- protein is transported to Golgi Body
- Golgi Body modifies and packages the protein
- protein packaged into vesicles (or lysosomes)
- vesicles/lysosomes move around the cell on microtubules

Structure of Bacteria?

- No nucleus – loose DNA in the form of a single loop and plasmid
- No membrane bound organelles: smaller ribosomes, mesosomes – infolding of cell membrane for respiration
- Cytoplasm
- Cell Membrane & Cell Wall (made of peptidoglycan)
- some have a Capsule (reduce water loss, protect from phagocytosis) and Flagella (movement)

Where are Membranes found?

- around organelles (membrane bound organelles) in eukaryotic cells = to hold organelles contents together, control what enter/leaves organelles
- around cells (cell surface membranes) in all cells = to hold cell contents together, control what enters/leaves cell, cell signalling

Basic structure of a membrane?

- made of a phospholipid bilayer (a double layer of phospholipids)
- hydrophilic heads of phospholipids face water/fluid
- hydrophobic tails of phospholipids face towards each other, protected from water/fluid

Additional structures in membranes? Proteins, Carbohydrates, Cholesterol

Role of proteins in the membrane?

- Extrinsic and Intrinsic
- extrinsic = found in one layer
- intrinsic = found in both layers – forms transport proteins (carrier and channel)

Role of carbohydrates in the membrane? form Glycoprotein and Glycolipid (if carbohydrate attaches to protein or lipid) – acts as receptors to hormones in cell signalling [cell signalling = how different cells communicate with each other]

Role of cholesterol in the membrane? sits between the phospholipids in the bilayer, provides membrane stability

Why are membranes defined as having a Fluid-Mosaic Model?

- fluid = describes the phospholipids in the bilayer – flexible
- mosaic = describes the appearance of the proteins

Effect of high temperature of membranes?

- high temperature = more kinetic energy
- phospholipids will vibrate more
- phospholipid bilayer/membranes become more leaky
- leads to loss of cell contents

How do substances move across membranes?

- diffusion
- osmosis
- active transport
- bulk transport

Define Diffusion? net movement of molecules from an area of high concentration to an area of low concentration until equilibrium is reached (down the concentration gradient)

Simple vs Facilitated Diffusion?

- Simple = molecules move directly through the phospholipid bilyaer
- Facilitated = molecules pass through transport proteins (large use carrier, charged use channel)

Factors that affect rate of diffusion?

- surface area (increase = increase rate of diffusion)
- concentration gradient (increase = increase rate of diffusion)
- thickness (decrease = decrease diffusion distance = increase rate of diffusion)
- temperature (increase = increase kinetic energy = molecules move faster = increase rate of diffusion)

- size of molecules (smaller molecules = increase rate of diffusion)

What is Ficks Law? (Surface Area x Concentration Gradient)/Thickness

Define Osmosis? movement of water molecules from an area of high water potential to an area of low water potential through a partially permeable membrane

Which liquid has the highest water potential?

- distilled/pure water
- has a value of 0kPa
- lower water potential by adding solutes (makes water potential negative)
- water moves from less negative water potential (e.g. -35 kPa) to more negative water potential (e.g. -75 kPa)

Surround animal cell with pure water? swells and burst (water enters by osmosis)

Surround plant cell with pure water?

- swells but does not burst
- cell wall prevents it from bursting
- made of cellulose – strong material
- the cell is <u>Turgid</u>

Surround animal cell with concentrated sugar/salt solution? shrinks (water leaves by osmosis)

Surround plant cell with concentrated sugar/salt solution?

- water leaves by osmosis
- cell wall prevents cell from shrinking, keeps it rigid
- the protoplast (cell membrane plus contents) shrink
- the cell is <u>Plasmolysed</u>

Define Active Transport? movement of molecules from an area of low concentration to an area of high concentration using ATP and carrier proteins (against concentration gradient)

Benefits of active transport?

- allows transport of molecules against concentration gradient
- carry molecules at a faster rate than diffusion
- allows accumulation of molecules on one side of membrane

Define Bulk Transport? movement of large amounts of molecules across a membrane (into cell = endocytosis, out cell = excocytosis) – requires ATP

Process of endocytosis?

- cell surface membrane surrounds the molecules
- molecules are engulfed by the cell
- forms a vesicle around the molecules
- vesicle moves on microtubules to transport molecules around the cell

Process of exocytosis?

- golgi body packages molecules into vesicles
- vesicles transported on microtubules towards cell surface membrane
- vesicle binds to cell surface membrane, releasing molecules out of cell

Phagocytosis vs Pinocytosis? phagocytosis = moving solid material,
pinocytosis = moving liquid material

What is the Cell Cycle?

- one parent cell divides into 2 genetically identical daughter cells
- occurs in Animals & Plants
- for growth & repair of tissues
- involves Interphase + Mitosis + Cytokinesis
- Interphase = DNA replication & Organelle synthesis
- Mitosis = produce 2 genetically identical nuclei
- Cytokinesis = separates cell into 2

What occurs in interphase?

- 3 steps, GI/S/G2
- G1= protein synthesis
- S = DNA replication (humans = 46 chromatin to 92, 2 copies of each)
- G2 = organelle synthesis

What occurs in mitosis?

- 4 steps, prophase/metaphase/anaphase/telophase
- Prophase =
- nucleus breaksdown
- dna coils to form chromosomes (2 copies of each coil to form 2 sister chromatids, these are joined by a centromere to form a chromosome – humans have 46)
- spindle fibres form
- Metaphase =
- chromosomes line up in middle of cell
- chromosomes attach to spindle fibre via centromere
- Anaphase =
- spindle fibres pull
- centromere splits

- sister chromatids seperate & move to opposite poles
- Telophase =
- nucleus reforms, chromatids uncoil
- Result of Mitosis = 2 genetically identical nuclei (each carries same set of DNA)

What occurs in cytokinesis?

- cell splits into 2
- each cell receives one nuclei and equal portion of organelles
- Result = 2 genetically identical cells (each has same Nuclei/DNA)

Cell Cycle in Animals & Plants?

- Animals = occurs in all cells, Plants = only occur in meristem cells
- Animals = use centrioles to make spindle fibre, Plants = have no centrioles
- Animals = cytokinesis involves cell nipping inwards, Plants = cytokinesis involves forming a cell plate in the middle of the cell and then forming the cell membrane/cell wall from that

What are the 2 types of Reproduction?

- Sexual & Asexual
- Sexual =
- involves 2 parents (offspring has mix of characteristics from both parents)
- occurs in all Animals and some Plants
- Asexual =
- involves 1 parent (offspring has identical characteristic to parent)
- occurs in all Micro-organisms and some Plants

Process of Sexual Reproduction in Animals & Plants?

- each parent will produce a gamete
- gamete produced by Meiosis (produces 4 genetically different cells that are haploid – have half the DNA/chromosomes)
- male and female gametes fuse to form a Zygote (has half DNA/chromosome from each parent = full set of DNA/chromosomes = diploid)
- zygote is a stem cell
- stem cell = undifferentiated/unspecialised cell, can form any type of cell
- zygote copied by mitosis to make many stem cells
- each stem cell will differentiate to make a specialised cell (e.g. in animals: red blood cells, white blood cells, muscle cells & in plants: palisade cells, guard cells, root hair cells)
- each specialised cell will then be copied by mitosis to make many copies
- each set of specialised cells will group together to form a Tissue (e.g. group of muscle cells = muscle tissue)
- different tissues will group together to form an Organ (e.g. heart = muscle tissue, nervous tissue, connective tissue)
- different organs will group together to form Organ Systems (e.g. circulatory system,

digestive system, nervous system)
- all this is surrounded by a body
- = Animal or Plant

How do stem cells differentiate to become specialised cells?

- the stem cell may change in Shape or Number of Organelles or New Substances
- e.g. Red Blood Cells (erythrocytes) = biconcave shape, lose all organelles, produce haemoglobin
- e.g. White Blood Cells (neutrophils) = produce more lysosomes (contain digestive enzymes)

Example of tissues in animals?

- tissues = a group of similar specialised cells working together for a particular function
- 4 types in Animals
- Connective = holds cells & tissues together
- Epithelial = found on linings in the body
- Muscle = 3 forms – skeletal (moves body), smooth (in tubes), cardiac (in heart)
- Nervous = response to stimuli

Why are animals unable to asexually reproduce?

- adult animals do not have stem cells
- (bone marrow stem cells only form blood and bone cells)
- only stem cell in animals is zygote

Why can plants asexually reproduce?

- have stem cells in the form Meristem Cells
- can use these stem cells to produce clones
- process called Vegetative Propagation

How do Micro-organisms asexually reproduce?

- Bacteria by a process called Binary Fission
- Virus & Protoctista by Cloning
- Fungi by Budding

Describe the process of budding in fungi/yeast?

- 1 parent yeast produces 2 genetically identical daughter yeast
- nuclei replicated in parent yeast by Mitosis
- side of parent yeast swells up
- one nuclei plus some organelles enter swelling
- swelling becomes larger then pinches off
- result = 2 genetically identical yeast (have same nucleus/DNA/chromosomes)

Why do all organisms respire?

- respiration releases energy (energy needed for growth, repair, movement)
- glucose and oxygen are the nutrients required for respiration
- carbon dioxide is the waste product of respiration

How do Micro-organsisms (bacteria, fungi, protoctista, virus) obtain nutrients & remove waste?

- by diffusion through their surface
- nutrients in, waste out

Why can micro-organisms exchange nutrients/waste by diffusion through their surface?

- (are single celled or a few cells only, therefore:)
- have a Large Surface Area to Volume Ratio
- have a Short Diffusion Distance
- have a Low Demand
- their Surface is Permeable

Why cant Animals & Plants exchange nutrients/waste by diffusion through their surface?

- (are multicellular organisms, therefore:)
- have a Small Surface Area to Volume Ratio
- have a Large Diffusion Distance
- have a High Demand
- their Surface is Impermeable

How do Animals & Plants obtain nutrients and remove waste?

- have specialised Exchange & Transport System
- Exchange System = increases rate of exchange, increases rate of diffusion
- Transport System = delivers nutrients to all cells and remove waste
- Exchange in Animals = Lungs for Oxygen & Intestines for Glucose
- Exchange in Plants = Leaves for Gases & Roots for Water
- Transport in Animals = Circulatory System
- Transport in Plants = Xylem and Phloem

Function of Lungs? site of gas exchange (oxygen into blood – used in cells for respiration, carbon dioxide out of the blood – toxic waste product of respiration)

What is Lungs made up of? Trachea, Bronchi, Bronchioles, Alveoli (+ capillaries)

Function of trachea, bronchi, bronchioles? transport of air and filter air, (bronchioles also controls amount of air reaching alveoli)

Structure of trachea/bronchi?

- wall made of c-shaped cartilage
- cartilage is strong so trachea/bronchi do not collapse
- cartilage is c-shaped to give flexibility
- wall also contains loose tissue (elastic tissue, smooth muscle, blood vessels, connective tissue)
- lining made of goblet cells and ciliated epithelial cells
- goblet cells make mucus, which traps pathogens/particles
- ciliated epithelial cells have cilia, which pushes mucus up and out of lungs

Structure of bronchioles?

- wall made of smooth muscle
- smooth muscle contracts, lumen narrows, bronchiole constricts
- (occurs when surrounded by noxious gases – reduces amount reaching alveoli)
- when noxious gases clear – smooth muscle relaxes, elastic tissue recoils, lumen widens, bronchioles dilate
- lining made of goblet cells and ciliated epithelial cells

Adaptation of alveoli?

- millions of tiny alveoli that are folded (large surface area)
- thin wall/one cell thick/squamous epithelial cells (short diffusion distance)
- elastic tissue in wall (stretches when breathing in to increase surface area, recoils when breathing out to push the air out)
- ventilation maintains concentration gradient (high oxygen, low carbon dioxide)

Adaptation of capillaries?

- millions of tiny capillaries (large surface area)
- thin wall/one cell thick/squamous epithelial cells (short diffusion distance)
- narrow lumen (increases diffusion time, decreases diffusion distance)
- circulation maintains concentration gradient (low oxygen, high carbon dioxide)

How O_2 moves from the alveoli to the capillaries? by simple diffusion passing thru the alveolar epithelium and capillary epithelium

How CO_2 moves from capillaries to the alveoli? by simple diffusion passing thru the capillary epithelium and alveoli epithelium

Describe the process of Breathing/Ventilation?

- Breathing In/Inhalation = external intercostal muscles contract (rib cage moves up and out) & diaphragm contracts (flattens), therefore increase in volume in chest and decrease in pressure, so air moves in
- Breathing Out/Exhalation = external intercostal muscle relax (rib cage moves down and in) & diaphragm relaxes (back to dome shape), therefore decrease in volume in chest

and increase in pressure, so air pushed out (aided by elastic recoil in the alveoli)

Function of a Spirometer?

- measures a person's breathing pattern and the volume breathed in/out
- person places lips around the mouth piece
- (ensure mouth piece is sterilised and person is wearing a nose clip – so any air breathed in/out is from spirometer and not the surrounding air)
- when person breathes in, volume in spirometer chamber decreases
- when person breathes out, volume in spirometer chamber increases
- this change in chamber volume can be plotted on graph paper to show pattern & volume
- soda lime is used to remove CO_2 breathed out (if not removed, will become toxic to person to breathe)
- therefore, over time, the overall volume in the chamber will decrease
- the amount of CO_2 breathed out = amount of O_2 taken into blood
- therefore, decrease in overall volume of chamber = amount of O_2 taken into blood

Name for different processes of Breathing?

- Tidal Volume = amount of air breathed in/out at rest
- Inspiratory Reserve Volume = how much more air can be inhaled over and above tidal volume when taking in deepest breath possible
- Expiratory Reserve Volume = how much more air can exhaled over and above tidal volume when breathing out fully
- Vital Capacity = largest volume of air that can be moved into and out of the lungs in one breath (inspiratory reserve volume + expiratory reserve volume + tidal volume)
- Residual Volume = volume of air that remains in the lungs after biggest possible exhalation (after ERV)

What is the name for the transport system in humans/mammals/animals?

- Circulatory System

What is the Circulatory System like in humans/mammals?

- Double =
- heart pumps twice, blood goes round the heart twice
- R pumps to lungs, L pumps to body
- ensure too high a pressure of blood does not go through lungs
- ensures that high enough pressure is applied to blood going to body
- Closed =
- blood carried in blood vessels (arteries/veins/capillaries)
- ensure blood pressure can be maintained
- ensures that blood can be redirected with need (e.g. when cold, less to skin)

What is the circulatory system made of?

- heart, blood vessel, blood
- heart = pumps blood
- blood vessel = carries blood
- blood = carries nutrients & waste

Description of circulatory system?

- heart to artery to arteriole (small arteries) to capillaries (site of exchange) to venules (small veins) to vein back to heart
- Right to Lungs
- Left to Body

Heart?

- job is to pump blood around the body (delivers nutrients to cells and remove waste)
- made of 4 muscular chambers (2 atria, 2 ventricles)
- atria pumps blood to ventricles, ventricles pump blood out of heart (R to lungs, L to body)
- ventricles thicker then atria (has to pump blood further)
- left ventricle has a thicker muscular wall then right ventricle, therefore has stronger contractions, so can generate higher pressure and pump the blood further around the body

Blood vessels of the heart?

- artery takes blood away from the heart, vein returns blood to the heart
- Vena Cava supplies R atrium (with deoxygenated blood from body)
- Pulmonary Vein supplies L atrium (with oxygenated blood from lungs)
- R ventricle supplies Pulmonary Artery (deoxygenated blood to lungs)
- L ventricle supplies Aorta (oxygenated blood to body)

Job of valves in heart?

- Ensure one way flow of blood, no backflow
- (blood flows from atria to ventricles to arteries)
- 2 sets of valves: Atrio-ventricular Valve & Semi-lunar Valve
- AV valve = between atria and ventricles
- SL valve = between ventricles and arteries

When are AV valves open or closed? Open = pressure in atria greater then pressure in ventricles, Closed = pressure in ventricles greater then pressure in atria

When are SL valves open or closed? Open = pressure in ventricles greater then pressure in arteries, Closed = pressure in arteries greater then pressure in ventricles

Describe the processes of the cardiac cycle?

- Filling Stage = atria relaxed, ventricles relaxed, AV valve open, SL valve closed
- Atria Contracts = the SAN located in the R atrium initiates the heart beat and sends the impulse across both atria making them contract, this pushes all the remaining blood into the ventricles so it becomes full
- Ventricles Contract = the AVN picks up the impulse, delays it (*stops the atria and ventricles contracting at the same time, so the atria empties and the ventricles fill*), sends the impulse down the septum in the Purkyne Fibres, then at the apex the impulse goes up both walls of the ventricles, *so the ventricles contract from the base upwards, pushing the blood up thru the arteries*, when the ventricles start to contract the AV valve closes then the SL valve opens and blood leaves the heart
- Ventricles Relax = the SL valve closes then the AV valve opens and filling starts again

What causes the Heart Sounds?

- when the valves close
- 1st = AV closes
- 2nd = SL closes

What does an ECG show?

- ECG = ElectroCardioGram
- shows the electrical activity of the heart
- 4 parts =
- Flat Line, filling stage
- P, atria contracts
- QRS, ventricles contract
- T, ventricles relax

Abnormalities in ECG?

- Heart Attack/Myocardial Infarction = Elevation of ST segment
- Atrial Fibrillation = Small unclear P waves
- Ventricular Hypertrophy = Deep S waves

Description of circulatory system?

- heart to artery to arteriole (small arteries) to capillaries (site of exchange) to venules (small veins) to vein back to heart
- artery/arteriole = takes blood away from heart
- capillaries = site of exchange
- veins/venules = takes blood back to heart

Structure and Function of arteries?

- takes blood away from the heart
- blood is under high pressure, therefore needs to withstand pressure & maintain pressure
- narrow lumen = maintains pressure
- lining made of squamous epithelial cells = smooth lining (reduces friction)
- thick wall = withstand pressure
- elastic tissue in wall = ventricle contract – elastic tissue stretches to withstand pressure, ventricle relax – elastic tissue recoils to maintain pressure and smooth out blood flow
- smooth muscle in wall = smooth muscle contracts – lumen narrows and arteriole constricts, smooth muscle relaxes – lumen widens and arteriole dilates [for redirection of blood flow]
- collagen in wall = prevents artery from tearing

Structure of veins?

- returns blood to the heart – the blood is under low pressure
- wide lumen = ease of blood flow
- lining made of squamous epithelial cells = smooth lining
- thin wall = vein can be squashed by skeletal muscle pushing blood back to the heart
- valve in lumen = prevents backflow of blood

Adaptation of Capillaries?

- site of exchange, 3 locations = by Alveoli, by Intestines, by All Cells
- by Alveoli = for gas-exchange (O_2 in, CO_2 out)
- by Intestines = nutrients move into blood (including glucose)
- by All Cells = exchange of nutrients & waste
- many small capillaries = large surface area
- thin wall, one cell thick, squamous epithelial cells = short diffusion distance
- pores between cells = allows fluid to move in and out
- narrow lumen = increase diffusion time and decrease diffusion distance, plus allows build up of hydrostatic pressure

What is Blood made up of?

- Major Component = Plasma (fluid portion of blood)
- Cells (RBC, WBC, Platelets)
- Proteins
- Solutes (nutrients/waste)

How does exchange of nutrients/waste occur at the capillaries?

- at the arterial end of the capillary (start) there is a build up hydrostatic pressure
- this pushes fluid out of the capillary through the pores
- the fluid surrounds the cells, this is called tissue fluid
- the fluid carries the nutrients (glucose, oxygen) with it – these diffuse into the cells from the tissue fluid
- at the venous end of the capillary the tissue fluid moves back in by osmosis

- the capillary has low water potential due to the presence of proteins (too large to move out of capillaries)
- this brings in the waste (CO_2) from the cells
- any excess tissue fluid is picked up by the lymph system and deposited in the vena cava
- lymph system carries excess tissue fluid, lymphocytes (type of white blood cell) and fat/lipids

What are the pressure changes along the circulatory system?

- Artery,
- has the highest blood pressure (blood coming from the heart/ventricles)
- pressure fluctuates
- pressure goes up when ventricles contract
- pressure goes down when ventricles relax (elastic recoil helps to maintain the pressure)
- fall in pressure as we move further away from the heart – due to some friction
- Arteriole,
- large drop in pressure
- due to increase in total cross-sectional area
- ensures the high pressure does not damage capillaries
- Capillary,
- pressure in capillary is called hydrostatic pressure
- hydrostatic pressure falls along a capillary due to the loss of fluid
- Venule/Vein,
- blood under low pressure

How is Oxygen transported around the body?

- transported in the blood, carried by Red Blood Cells
- red blood cells contain haemoglobin
- the haemoglobin carries the oxygen

Structure of Haemoglobin?

- found in red blood cells
- carries oxygen
- made of 4 chains (2 alpha, 2 beta)
- each chain carries a Haem Group
- each haem group carries a Fe^{2+}
- a Fe^{2+} binds to oxygen to form oxyhaemoglobin
- therefore, a haemoglobin carries 4 oxygen molecules
- therefore, a RBC carries thousands of oxygen molecules

What is Affinity?

- haemoglobin's level of attraction to oxygen
- can be High = strong attraction
- can be Low = weak attraction

Affinity varies in the body?

- in the Lungs,
- affinity is High
- due to High partial pressure (concentration) of O_2 and Low pp of CO_2 [occurs by ventilation]
- therefore, oxygen becomes associated with haemoglobin, it is loaded onto the haemoglobin, the haemoglobin becomes full/saturated
- the haemoglobin will be carried in the RBC, in the blood, to the body cells
- in the Body Cells,
- affinity is Low
- due to Low pp O_2 and High pp CO_2 [occurs by respiration]
- therefore, oxygen becomes dissociated from haemoglobin, it is unloaded from haemoglobin, it is delivered to the body cells, the haemoglobin becomes unsaturated

What is the relationship between Oxygen pp & Affinity?

- positive correlation
- as O_2 pp increases, Affinity/Saturation of haemoglobin increases
- the correlation is not linear but produces an Oxygen Dissociation Curve
- importance: middle portion of curve has a steeper gradient then a normal linear curve
- benefit = small drops in O_2 pp causes large drops in affinity/saturation, so more O_2 will be unloaded

What is the relationship between Carbon Dioxide pp & Affinity?

- negative correlation
- as CO_2 pp increases, Affinity/Saturation of Haemoglobin decreases
- occurs in body cells due to respiration
- can be represented by the ODC being shifted to the Right Hand Side, represents lower affinity
- called Bohr Shift

How is Oxygen delivered at the body cells?

- respiration occurs in the body cells
- this produces Low pp of O_2 and High pp of CO_2
- both of these contribute to the haemoglobin's affinity being Lowered
- therefore, more Oxygen would be unloaded and delivered to the body cells

How is Carbon Dioxide carried in the blood?

- 3 ways,
- 5% dissolved in blood plasma
- 10% binds to haemoglobin to form carbaminohaemoglobin
- 85% transported as Hydrogen Carbonate ions (HCO_3^-) in blood plasma

How is Carbon Dioxide carried as Hydrogen Carbonate ions (HCO_3^-) in blood plasma?

- At the body cells, CO_2 enters the Red Blood Cell
- the CO_2 reacts with Water to form Carbonic Acid (H_2CO_3)
- (this is catalysed by the enzyme carbonic anhydrase)
- the Carbonic Acid (H_2CO_3) splits into Hydrogen Carbonate ions (HCO_3^-) & H^+
- the HCO_3^- leaves the RBC and is transported in the blood plasma
- (Cl^- enters the RBC to balance out change in charges – called chloride shift)
- the H^+ binds to the haemoglobin to form haemoglobinic acid
- (the H^+ would cause the pH to decrease = acidic, therefore, the haemoglobin acts as a buffer – maintains constant pH)
- (by the H^+ binding to haemoglobin it replaces any O_2 that is bound, hence, it has Lowered the Affinity)
- At the lungs, the reverse occurs
- the HCO_3^- reenter the RBC and binds to H^+
- this forms Carbonic Acid which is converted into CO_2 & Water
- the CO_2 will diffuse into the alveoli for removal

What is the affinity of fetal haemoglobin like?

- the curve for fetal haemoglobin is shifted to the Left
- therefore, fetal haemoglobin has High Affinity
- therefore, it is able to take oxygen from mother's haemoglobin
- in the placenta is Low pp of O_2, therefore O_2 dissociates from the mother's haemoglobin and will associate with the fetal haemoglobin

What are the exchange system in Plants?

- Leaf (for gas-exchange, allow CO_2 in for photosynthesis)
- Roots (for water & minerals, water for cells to be turgid and photosynthesis)

What are the transport system in Plants?

- 2 vascular tissues: Xylem and Phloem
- Xylem transports water & minerals
- Phloem transports sugars
- Xylem transports in one direction (from roots to leaves)
- Phloem transports in both directions
- Xylem & Phloem found together in vascular bundle

Process of transport in the Xylem?

- water & minerals are absorbed at the roots and are transported up the stem to the leaves
- there are pits along the xylem that allows water to leave along the stem
- all plant cells need water to be turgid
- leaf cells need water to be turgid and for photosynthesis

How are water & minerals absorbed at the roots?

- water is absorbed by osmosis & mineral absorbed by active transport
- move from soil to root hair cell to cortex cells to endodermis cells into xylem
- root hair cell adapted for absorption (has large surface area, large vacuole to store water, many mitochondria to provide ATP for active transport)
- firstly,
- minerals are absorbed by active transport, from soil to xylem
- then,
- this lowers the water potential so water can follow by osmosis

How can water pass through the roots?

- 2 ways: Symplast & Apoplast
- Symplast = water moves directly through the cells, passing the cell membrane and in the cytoplasm
- Apoplast = water moves between the cells, in the cell wall
- *apoplast can continue until the endodermis cells are reached, the endodermis cells has a casparin strip (waterproof, impermeable barrier) around them, therefore, the water enters the endodermis cells by symplast, then the xylem*

Structure of the Xylem?

- long continuous hollow tube
- narrow lumen (supports capillary action – automatic movement of water up narrow tubes)
- wall contain gaps called pits (allows water to leave along the stem)
- wall contains lignin (waterproof, strong – so xylem does not collapse, adhesive – water particles stick to it)

How does water move up the xylem (in the stem)?

- Start, loss of water from the leaves (transpiration)
- therefore, water moves from the top of the xylem into the leaf by osmosis (called transpirational pull)
- this applies Tension ('pull') on the column of water in the xylem
- therefore, the column of water moves up the xylem as one, as the water particles stick together (called Cohesion)
- this process of movement is called the Cohesion-Tension Theory
- the process is supported by capillary action, adhesion, root pressure
- capillary action = water automatically moves up the narrow xylem
- adhesion = water particles stick to wall of the xylem, therefore, water particles move up along the wall
- root pressure = water absorbed at the roots enter the xylem, this applies a push on the column of water in the xylem, the push is called hydrostatic pressure

Why does the diameter of a tree decrease during the day?

- more light and higher temperature
- increase rate of transpiration
- increase transpirational pull
- water pulled up xylem by cohesion-tension
- because the water particles stick to the wall of the xylem (adhesion), the walls of the xylem are pulled inwards
- the lignin being strong prevents the xylem from completely collapsing

Structure of leaf?

- upper layer = upper epidermis – have a waxy cuticle to reduce water loss (transpiration)
- next layer = mesophyll cells (palisade cells) – adapted for photsynthesis [close to top of leaf & large size to receive more light, contains many chloroplast, has a large vacuole to push chloroplast to edge of cell closer to light]
- next layer = xylem/phloem & spongy mesophyll cells (loosely arranged leaving air spaces to allow ease of gas-exchange)
- lower layer = lower epidermis – contains guard cells which form openings called stomata when turgid (stomata = site of gas-exchange, allows CO_2 to enter for photosynthesis)

Process of transpiration?

- transpiration = loss of water vapour from the leaf (via stomata)
- process,
- spongy mesophyll cells have a moist lining
- temperature in leaf causes the moist lining to evaporate, forms water vapour
- water vapour build up in the air spaces
- if the water vapour concentration is high enough and the stomata is open, the water vapour will move out by diffusion = transpiration
- (water from spongy mesophyll cells will replace that lost from lining, water from top of xylem will replace that lost from the spongy mesophyll cells = transpirational pull)

Factors that increase rate of transpiration?

- light = more light, more stomata open, increase surface area for transpiration
- temperature = more temperature
- more evaporation (increase concentration of water vapour in air space)
- higher kinetic energy (water vapour moves faster)
- less water vapour in the surrounding air (higher concentration gradient)
- wind = more wind, removes water vapour, maintains concentration gradient
- humidity = less humidity, less water vapour in the surrounding air, higher concentration gradient

Measuring rate of transpiration?

- use a potometer
- measures rate of water uptake by a plant
- presume, rate of water uptake = rate of transpiration
- healthy leaf and shoot of plant is used
- shoot of plant is cut underwater and connected to potometer underwater (ensures that a continuous column is maintained and no air bubble enter plant – air bubble would block xylems)
- also ensure potometer is air tight and water tight
- as the experiment runs, transpiration will occur and the plant will pull up more water (transpirational pull/cohesion-tension), this will cause the marked air bubble to move along the tubing
- measure the distance the air bubble has moved in a certain time, then use πr^2 to calculate the volume that was taken up (equates to transpiration volume)
- therefore, Rate of Transpiration = volume *divided by* time
- the final rate will be an overestimate of transpiration because water may also be taken up to replace loss due to photosynthesis and turgidity

How are plants adapted to reduce water loss (transpiration)?

- have a waxy cuticle on upper epidermis (forms a waterproof impermeable barrier)
- stomata on lower epidermis (less affected by heat or wind)
- stomata closed at night (no photosynthesis, so no CO_2 required)
- deciduous plants lose leaves in the winter

What is a xerophyte? a plant adapted to reduce water loss (reduce transpiration)

Adaptations of Xerophyte?

- spiky, needle like leaves = reduced surface area
- thick waxy cuticle = waterproof, impermeable barrier
- densely packed spongy mesophyll = less air spaces, less water vapour build up
- sunken stomata/hairy leaves/rolled up leaves = traps moist layer of air, reduces concentration gradient

Structure of Phloem?

- made of sieve tube element cells & companion cells
- sieve tube element cells are attached end-to-end to form a long continuous tube = sieve tube
- (contains gaps between the cells, called sieve plate)
- alongside the sieve tube are companion cells
- companion cells are connected to the sieve tube by gaps called plasmodesmata
- companion cells also contain a lot of mitochondria (produces ATP for active transport)

What is Translocation?

- transport of assimilates (sugar/sucrose) in the phloem to all parts of the plant
- source = part of plant that releases sucrose into phloem
- sink = part of plant to removes sucrose from phloem

How is sucrose loaded into the phloem at the source?

- Hydrogen ion (H^+) are actively transported from the companion cells into the surrounding tissues
- the H^+ will then diffuse back into the companion cells
- as it does, it brings in Sucrose with it via a co-transporter protein
- sucrose builds up in the companion cell, then diffuses into the sieve tube via the plasmodesmata

How is sucrose transported along the phloem?

- when sucrose enters the sieve tube, it lowers the water potential
- therefore, water follows and enters the sieve tube by osmosis
- the water applies hydrostatic pressure and moves the sucrose by mass flow through the phloem (up or down the plant)

How is sucrose unloaded from the phloem at the sink?

- the sucrose will move out of the sieve tube/phloem into the surrounding tissue by diffusion
- this lowers the water potential of the surrounding tissue, so the water from the phloem follows by osmosis

Evidence for mechanism of translocation?

- <u>uses phloem</u>,
- radioactively labelled carbon on CO_2 used in photosynthesis will be found in the phloem (in the sucrose)
- ringing of a tree, removing the phloem, leads to a build up of sugar above the ring
- aphid feeding on plants will have their mouth-parts connected to the phloem
- <u>uses ATP</u>,
- companion cells have many mitochondria
- metabolic poisons that inhibit respiration will stop translocation
- rate of flow of sugars in phloem is very fast
- <u>uses H^+</u>,
- pH of companion cells higher than surrounding cells (loses H+, less acidic)

Evidence against mechanism for translocation?

- solutes in phloem move at different rates
- role of sieve plate unclear