BIOLOGY REVISION NOTES

FOR AQA GCSE (9-1)
SIMPLE, CLEAR & MEMORABLE

PAPER 1

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USING THIS BOOK

This is **Higher Tier** only material – this means you will only need to revise this if you are sitting the higher tier Biology paper.

This is **Biology (separate science)** only material – this means you will only need to revise this if you are sitting the triple award separate science Biology paper (**8462**).

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THIS IS A SPECIFICATION CHAPTER

1.1 THIS IS A SPECIFICATION TOPIC

1.1.1 This is a specification subtopic

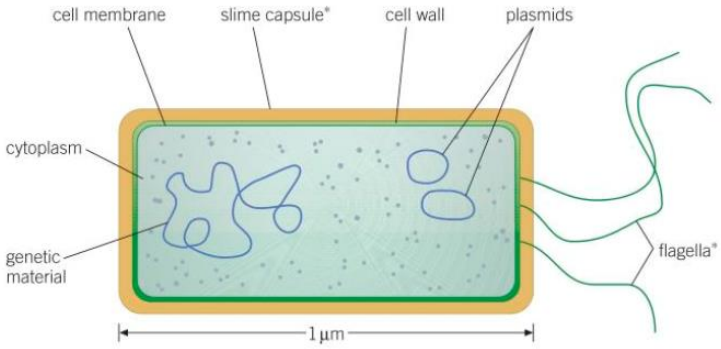
1 CELL BIOLOGY

1.1 CELL STRUCTURE

1.1.1 Eukaryotes and prokaryotes

- Eukaryotes:
  - animal/plant cells
  - cell membrane
  - cytoplasm
  - genetic material in nucleus
  - 10µm - 100µm

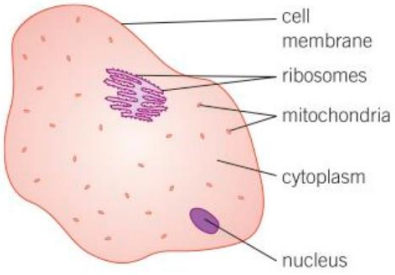
- Prokaryotes:
  - bacterial cells
  - cytoplasm
  - cell membrane
  - cell wall
  - DNA loop found free in the cytoplasm
  - plasmids code for specific features
  - flagella
  - slime capsule
  - 0.2µm - 2µm

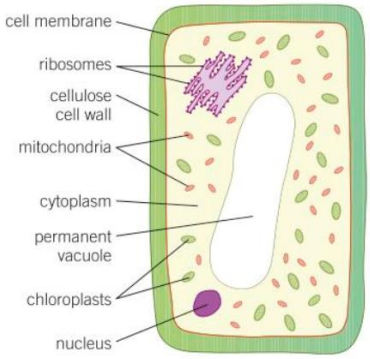


- 1mm = 1000µm
- 1µm = 1000nm

1.1.2 Animal and plant cells

- Animal cells have:
  - nucleus
  - cytoplasm
  - cell membrane
  - mitochondria
  - ribosomes





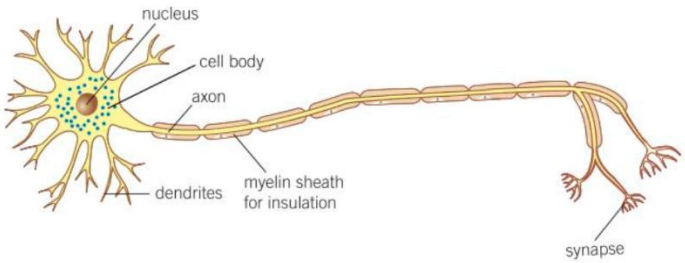
- Plant cells also have:
  - cell wall (made of cellulose)
  - chloroplasts (containing chlorophyll)
  - permanent vacuole (containing cell sap)

- Functions of subcellular structures:
  - **nucleus**:
    - controls cell activities
    - contains genetic material
    - carries instructions to make new cells
  - **cytoplasm**: liquid gel in which chemical reactions occur
  - **cell membrane:** controls what goes in and out of the cell
  - **mitochondria:** site of respiration
  - **ribosomes:** site of protein synthesis

1.1.3 Cell specialisation

Animal cells

- Nerve cell
  - lots of dendrites for connections
  - axon connects nerve impulse from one point to another
  - synapses are adapted to pass impulses using special transmitter chemicals



- Muscle cell
  - special proteins that slide over each other to make fibres contract
  - lots of mitochondria for respiration
  - stores glycogen used in mitochondria
- Sperm cell
  - long tail whips from side to side to swim
  - middle section full of mitochondria
  - acrosome stores digestive enzymes
  - large nucleus for genetic material

Plant cells

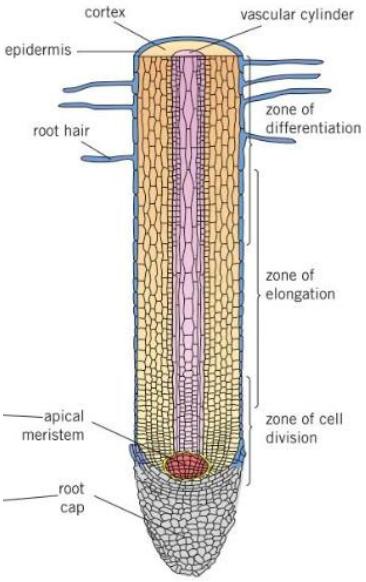
- Root hair cell
  - large surface area for water to move in
  - large permanent vacuole to speed up osmosis
  - mitochondria for active transport
- Photosynthetic cell
  - chloroplasts contain chlorophyll to trap light
  - continuous layers to absorb more light
  - large vacuole to speed up osmosis and turgor pressure
- Xylem cell
  - lignin builds up in spirals and dies to form hollow tubes for water and mineral ions
  - strong lignin means strong stem to withstand water pressure
- Phloem cell
  - cell walls break to form sieve plates to allow dissolved food flow
  - companion cells transfer energy from mitochondria

1.1.4 Cell differentiation

- Cells differentiate into different types of cells.

- Animals
- Stem cells differentiate by switching on/off the genes they do/do not need.
- Once a stem cell has differentiated it cannot redifferentiate, and can only split to make the same type of cell.
- Adult stem cells replace dead or damaged cells, but have limited differentiation.

- Plants
- Undifferentiated cells are formed at the meristems (active regions of stems and roots).
- Cells grow/elongate before they differentiate.
- Cells differentiate at their final position in the plant.
- Cells can redifferentiate.

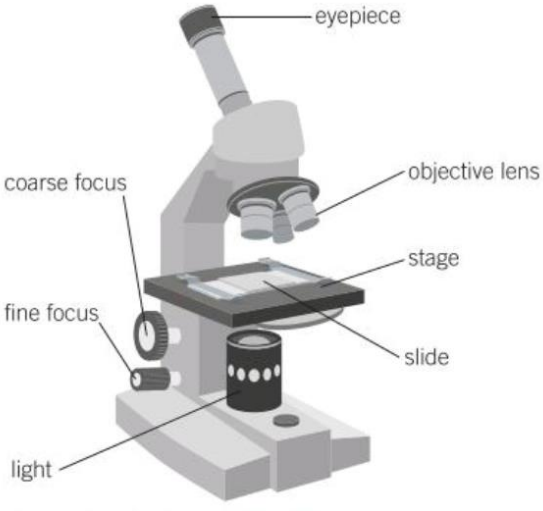


- Cloning is the production of identical offspring by asexual reproduction.
- Plant cells can become undifferentiated and produce more cells by mitosis.
- These will differentiate in a new plant which is identical to the parent.

1.1.5 Microscopy

- Light microscope
- Up to x2 000 magnification
- Uses a beam of light

- Electron microscope
- Up to x 2 000 000 magnification
- Uses a beam of electrons
- Transmission Electron Microscopes:
  - 2D image
  - high resolution
- Scanning Electron Microscopes:
  - 3D image
  - low resolution
- Enabled biologists to see more sub-cellular structures.



$$\textbf{magnification} = \frac{\textbf{size of image}}{\textbf{size of real object}}$$

- Resolution is the distance between two distinguishable points on a photomicrograph.

1.1.6 Culturing microorganisms

- Bacteria multiply by binary fission (cell division) as often as once every 20 minutes subject to having:
  - enough nutrients
  - a suitable temperature

- Bacteria can be grown in nutrient broth solution or as colonies on an agar gel plate.

- Uncontaminated cultures of microorganisms are required for investigating the action of disinfectants and antibiotics.

- To prepare an uncontaminated culture:
  - Petri dishes and culture media must be sterilised before use *(so that they will not contaminate the culture)*
  - inoculating loops used to transfer microorganisms to the media must be sterilised by passing them through a flame *(so that they will not contaminate the culture)*
  - lid of Petri dish should be secured with adhesive tape (not sealed so as to allow exchange of oxygen to prevent anaerobic growth)
  - Petri dish should be stored upside down *(so condensation does not fall on agar surface and contaminate the culture)*
  - in school laboratories, cultures should generally be incubated at 25˚C *(to prevent rapid uncontrolled growth and/or anaerobic growth at higher temperatures)*

- The cross-sectional area of colonies or clear areas is calculated using πr^2.

no. of bacteria after n divisions = no. of initial bacteria $\times$ 2^n

E.g. 3 bacterial cells with a mean division rate of 20 minutes
Calculate the number of bacteria after 4 hours, in standard form to 3 significant figures:
4 hrs ÷ 20 mins = 12 divisions
3 x 2^{12} = 12 888 bacteria
$\approx$ 12 900 bacteria (3 s.f.)
$= 1.29 \times 10^4$ bacteria

1.2 CELL DIVISION

1.2.1 Chromosomes

- The nucleus of a cell contains chromosomes made of DNA molecules.
- Each chromosome carries a large number of genes.
- Chromosomes are usually found in pairs in body cells.

1.2.2 Mitosis and the cell cycle

- Cell cycle
- Stage 1 – **Interphase**:
    - cell grows larger
    - cell carries out normal cell activities
    - cell increases subcellular structures
    - DNA is replicated
- Stage 2 – **Mitosis**:
    - nuclear membrane breaks down
    - sister chromatids line up in the centre of the cell
    - spindle fibres attach to the centromere
    - spindle fibres snap back pulling each of the sister chromatids to either end of the cell
    - a new nuclear membrane forms around each set of chromosomes
- Stage 3 – **Telophase**:
    - cytoplasm and cell membrane split

1.2.3 Stem cells

- A stem cell is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.

- Embryonic stem cells can be cloned and made to differentiate into different types of cells.
- Adult stem cells from the bone marrow have limited differentiation, and are used to repair and replace damaged cells.
- Meristematic cells have unlimited differentiation throughout the life of a plant.

- Embryonic stem cells can be used to:
    - grow nerve cells in a paralysed spinal cord
    - replace failing cells in the blind
    - treat diabetes

- Meristematic cells in plants can be used to:
    - cloning a mature plant quickly and economically
    - cloning rare species to prevent extinction
    - cloning disease-resistant plants

- Therapeutic cloning:
  - the DNA of an embryo can be replaced with the patient's DNA
  - the embryo produces stem cells with the same genes as the patient
  - these stem cells are not rejected by the patient's immune system.

- Problems with embryonic stem cells:
  - a potential human being
  - embryo cannot give permission; human rights
  - religious beliefs against interference with human reproduction
  - therapies are slow, difficult, expensive and hard to control
  - may cause cancer during treatment

- Advantages of adult stem cell therapy:
  - well-tried technique
  - adult can consent
  - quick recovery
  - doesn't kill donor

- Disadvantages of adult stem cells:
  - immune responses (needs immunosuppressant drugs)
  - hazardous operation (infections)
  - painful procedure
  - fewer diseases can be treated

1.3 TRANSPORT IN CELLS

1.3.1 Diffusion

- Diffusion is the movement of particles from an area of high concentration to an area of low concentration.

- Effect of concentration gradient:
  - steeper gradient
  - faster the diffusion

- Effect of temperature:
  - higher temperature
  - more kinetic energy
  - particles move faster
  - particles collide more often and harder
  - diffusion occurs faster

- Effect of surface area:
  - larger surface area
  - more membrane exposed to particles
  - faster diffusion

- Diffusion in animals:
    - oxygen and carbon dioxide between alveoli and capillaries
    - urea into the blood plasma in the kidney
    - nutrients from the small intestine to the bloodstream

- Unicellular organisms have a large surface area to volume ratio (SA:V) allowing sufficient transport of molecules in and out of the cell.

- Smaller SA:V ratios:
    - gases and food molecules cannot reach all cells by simple diffusion
    - metabolic waste is not removed fast enough without cell poisoning

- An effective exchange surface has:
    - a large surface area
    - a short diffusion pathway
    - an efficient blood supply (animals)
    - ventilation (animals)

- Large surface area: alveoli, villi, root hair cells, stomata
- Short diffusion pathway: thin leaves
- Ventilation: spongy mesophyll, fish gills

1.3.2 Osmosis

- Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.

- Isotonic – same concentration
- Hypertonic – higher concentration
- Hypotonic – lower concentration

- <u>Osmosis in animal cells:</u>
- **Crenation:** water moves out because solution is hypertonic to cell
- **Lysis:** water moves in (cell bursts) because solution is hypotonic to cell

- <u>Osmosis in plant cells</u>
- **Turgor pressure:** water moves in and vacuole swells to keep cell turgid
- **Plasmolysis:** water is lost and cell shrivels up
- Surrounding fluid needs to be hypotonic for water to move in

1.3.3 Active transport

- Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient using energy from respiration.

- Mineral and nitrate ions are absorbed into plant root hairs from very dilute solutions by active transport – they are needed for healthy growth.

- Sugar molecules are absorbed from lower concentrations in the gut to the concentrated blood – they are needed for cell respiration.

2 ORGANISATION

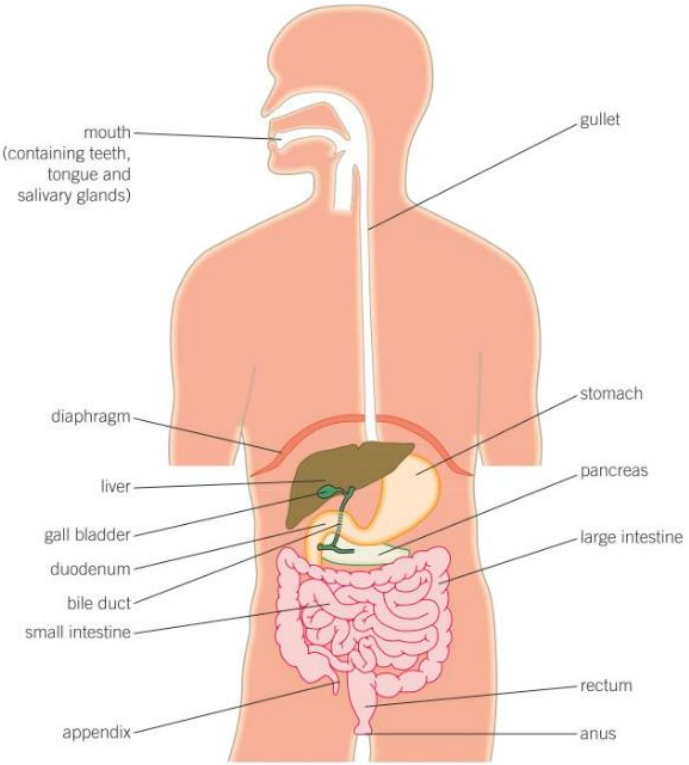
2.1 PRINCIPLES OF ORGANISATION

- Cells are the basic building blocks of all living organisms.
- A tissue is a group of cells with a similar structure and function.
- An organ is a group of tissues performing a specific function.
- An organ system is a group of organs working together.
- An organism is a collection of organ systems working together.

2.2 ANIMAL TISSUES, ORGANS AND ORGAN SYSTEMS

2.2.1 The human digestive system

- The digestive system is an example of an organ system in which several organs work together to digest and absorb food:
  - **mouth:** mechanically breaks down food into smaller pieces
  - **salivary gland:** produces saliva containing amylase
  - **gullet/oesophagus:** transports food from mouth to stomach
  - **liver:** produces bile which neutralises acidic substances from the stomach and emulsifies fat
  - **gall bladder:** stores bile produced in the liver
  - **pancreas:** produces digestive juices containing enzymes
  - **stomach:** churns food with digestive juices
  - **small intestine:** breaks down large insoluble molecules into smaller soluble molecules absorbed into the bloodstream
  - **large intestine:** absorbs water from undigested food

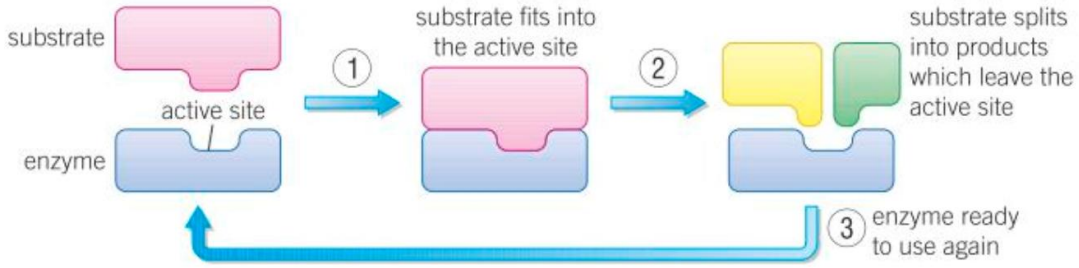


- Adaptations of the small intestine:
  - covered in villi; large surface area for fast diffusion
  - short diffusion pathway
  - rich blood supply to carry absorbed molecules
  - muscular walls squeeze undigested food towards the large intestine

- Carbohydrases break down carbohydrates to simple sugars.
- Amylase is a carbohydrase which breaks down starch.
- Proteases break down proteins to amino acids.
- Lipases break down lipids (fats) to glycerol and fatty acids.

- **Test for starch:** brown iodine solution turns blue-black
- **Test for protein:** blue biuret solution turns lilac
- **Test for glucose:** blue Benedict's solution turns orange
- **Test for lipids:** ethanol added to food solution produces cloudy white layer

- Enzymes catalyse specific reactions in living organisms due to the shape of their active site.
- Substrates bind into the active site of the enzyme.
- A substrate can be broken up into two smaller molecules and two smaller molecules can also be joined together by an enzyme.



- Metabolic reactions:
  - building large molecules from smaller ones, e.g. starch, glycogen or cellulose from glucose.
  - changing one molecule into another, e.g. converting glucose into fructose.
  - breaking down large molecules into smaller ones, e.g. breaking down excess amino acids to form urea.

- Enzymes work best at their optimum temperature and pH.

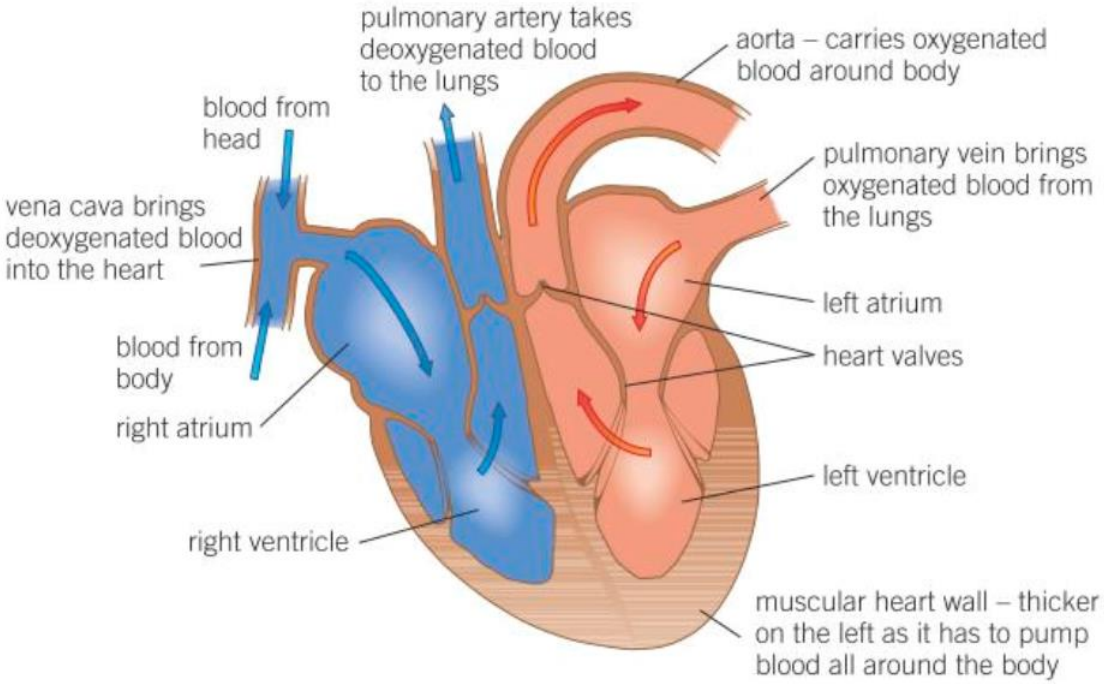
- When temperature increases:
  - substrate molecules have more kinetic energy
  - they move faster
  - collisions between the substrate and active site are more likely
  - rate of reaction increases
  - above the optimum temperature the enzyme denatures and rate of reaction decreases

- Changes in the pH can change the shape of the active site.

Enzyme	Produced in	pH	Works in	Breaks down
Amylase (Carbohydrase)	Salivary glands Pancreas Small intestine	Alkaline	Mouth Small intestine	Carbohydrates into glucose
Proteases	Stomach	Acidic	Stomach	Proteins into amino acids
	Pancreas Small intestine	Alkaline	Small intestine	
Lipase	Pancreas Small intestine	Alkaline	Small intestine	Lipids into fatty acids and glycerol

- Bile is made in the liver and stored in the gall bladder.
- It is alkaline to neutralise hydrochloric acid from the stomach.
- It emulsifies fats to form small droplets for an increased surface area.
- Alkaline conditions and a large surface area increase the rate of fat breakdown by lipase.

2.2.2 The heart and blood vessels

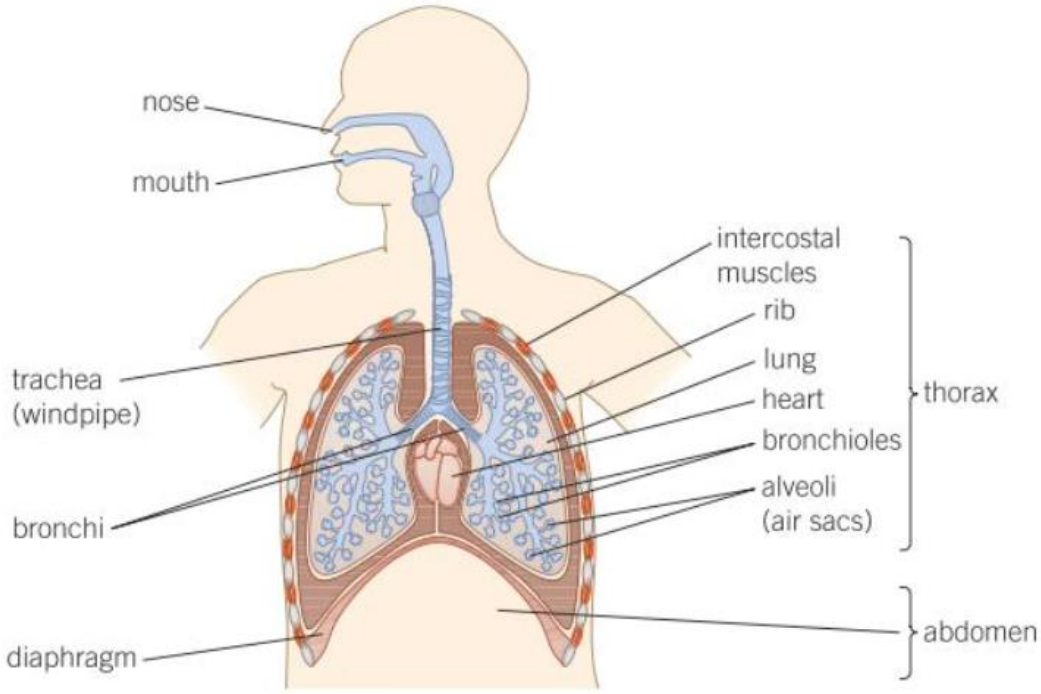


- Humans have a double circulatory system:
  - one transport system carries blood from the heart to the lungs for oxygenation
  - another transport system carries blood from the heart to the organs of the body and back again
  - this means oxygenated blood can be sent at high pressure to all organs efficiently
- Coronary arteries provide the muscular walls of the heart with oxygen.
- These walls contract to pump blood into the next chamber or vessel.

- Deoxygenated blood enters the right atrium through the vena cava.
- Blood is forced into the right ventricle and sent to the lungs for oxygenation through the pulmonary artery.
- Oxygenated blood enters the left atrium through the pulmonary vein.
- Blood is forced into the left ventricle and sent to the body to the body through the aorta.

Chapter 2 – Organisation

- Adaptations of the heart:
    - valves open and close to prevent backflow.
    - left ventricle has thick walls to withstand the high blood pressure
    - natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker
    - artificial pacemakers are electrical devices that correct irregularities in the heart rate



- Arteries:
    - carry blood away from the heart to the organs
    - blood is bright-red and oxygenated
    - thick walls containing muscle and elastic fibres
    - small lumen; high blood pressure
    - at every beat, blood is forced through them, stretching them

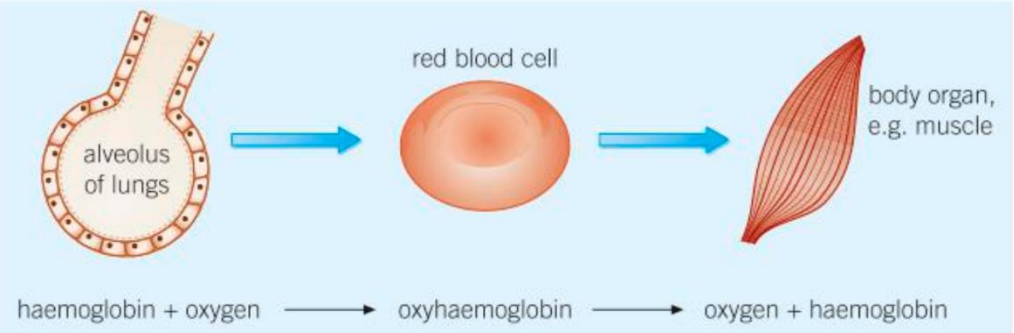
- Veins:
    - carry blood to the heart from the organs
    - blood is purple-red and deoxygenated
    - no pulse
    - thin walls
    - large lumen; low blood pressure
    - valves open/close to prevent backflow
    - blood is squeezed to the heart by skeletal muscles

- Capillaries:
    - small lumen
    - walls are one cell thick
    - short diffusion pathway for oxygen and glucose
    - veins and arteries are linked by the capillary network

2.2.3 Blood

- Plasma transports:
  - waste carbon dioxide produced by cells
  - urea formed in the liver
  - nutrients from digestion

- Red blood cells:
  - are biconcave disks (large SA:V for diffusion)
  - contain haemoglobin that binds to oxygen
  - have no nucleus; more space for haemoglobin



- White blood cells:
  - have a nucleus
  - lymphocytes produce antibodies against microorganisms
  - phagocytes engulf and digest pathogens

- Platelets:
  - fragments of cells with no nucleus
  - they form blood clots by:
    - converting fibrinogen to fibrin in a reaction
    - this produces protein fibres that capture red blood cells
    - it forms a jelly-like clot
    - the clot dries to form a scab
    - this protects the new skin as it grows and prevents bacteria from entering the body

2.2.4 Coronary heart disease: a non-communicable disease

- Coronary heart disease is when the coronary arteries become narrow due to the build-up of fatty material in the linings of the artery walls.
- If blood flow through the coronary arteries is reduced, supply of oxygen to the heart muscles is reduced.

- Stents are used to keep an artery open:
    - a metal mesh is placed in a narrow artery
    - a balloon inflates to open the stent and the artery
    - the balloon is removed but the stent stays in place

- Statins are drugs that reduce blood cholesterol levels which slows down the rate of fatty material deposit.

- Leaky valves make the heart less efficient and the person breathless:
    - replacement by mechanical valves:
        - last a long time
        - patient must take medicine for the rest of their life to prevent blood clotting
    - replacement by biological valves from other mammals:
        - work extremely well
        - no medication
        - only last 12-15 years

- Failing heart:
    - heart transplants
    - artificial hearts:
        - a chance to live a normal life until a heart is available for transplant
        - diseased heart has time to recover
        - requires lots of machinery
        - risk of blood clot formation

2.2.5 Health issues

- Health is the state of physical and mental well-being.
- It is affected by:
    - diet (malnutrition, obesity, cancer, diabetes)
    - stress (high blood pressure, cancers, mental illnesses)
    - life situations (location, gender, ethnicity, finance, healthcare)

- Health issues can interact:
    - immunodeficiency can make infectious diseases more suffering
    - viruses living in cells can trigger cancers
    - immune reactions can trigger allergies
    - severe physical health can lead to mental illness

2.2.6 The effect of lifestyle on some non-communicable diseases

- A non-communicable disease is a non-infectious disease that cannot be passed from one organism to another.

- Risk factors:
  - genetic makeup (inherited)
  - lifestyle (e.g. smoking, alcohol, fitness, diet)
  - environmental factors (e.g. carcinogens such as ionising radiation)

- A causal mechanism is something that explains how one factor influences another.
- A correlation is an apparent link between two factors, but is not proof of causation.

- Impacts of non-communicable diseases:
  - emotional effect on individual and family
  - financial difficulties (cannot work; local community compensate)

- People who exercise more have:
  - more muscle tissue
  - faster metabolisms
  - lower blood cholesterol
  - lower risk of developing arthritis, diabetes, high blood pressure and cardiovascular disease

- Excess food is stored as fat and leads to obesity.
- Obesity is a risk factor for type 2 diabetes, high blood pressure, and cardiovascular disease.

- In type 2 diabetes:
  - pancreas does not produce enough insulin/cells do not respond to it
  - problems with circulation, kidney function and eyesight

- Smoking problems:
  - nicotine is addictive and increases heart rate
  - carbon monoxide takes space in the red blood cells
  - carbon monoxide intake means the foetus will not receive enough oxygen for growth (premature births, low birthweight, still births)
  - tar increases the risk of developing bronchitis
  - tar build-up can damage the alveoli, causing COPD
  - tar is a carcinogen and risks developing lung cancer
  - chemicals stop cilia from functioning, so pathogens can enter more freely and mucus causes coughing
  - chemicals damage the lining of the arteries
  - smoking increases the risk of cardiovascular disease

- Alcohol problems:
    - liver cirrhosis (destroys tissue)
    - liver cancer (alcohol is a carcinogen)
    - brain damage (loss of structures)
    - in pregnancy, foetal alcohol syndrome (FAS) is when the foetus cannot deal with the alcohol it receives
    - FAS can cause facial deformities, jaw problems, heart problems and learning difficulties

- Ionising radiation penetrates cells, damaging chromosomes and causes mutations.

- Examples of ionising radiation:
    - Ultraviolet (UV) light
    - X-rays
    - nuclear power station accidents
    - radioactive materials in the soil, water and air

2.2.7 Cancer

- A tumour is a mass of abnormally growing cells that forms when the cells do not respond to normal control mechanisms.

- A benign tumour:
    - is contained in one area, usually within a membrane
    - does not invade other parts of the body
    - however, size/pressure may damage a nearby organ

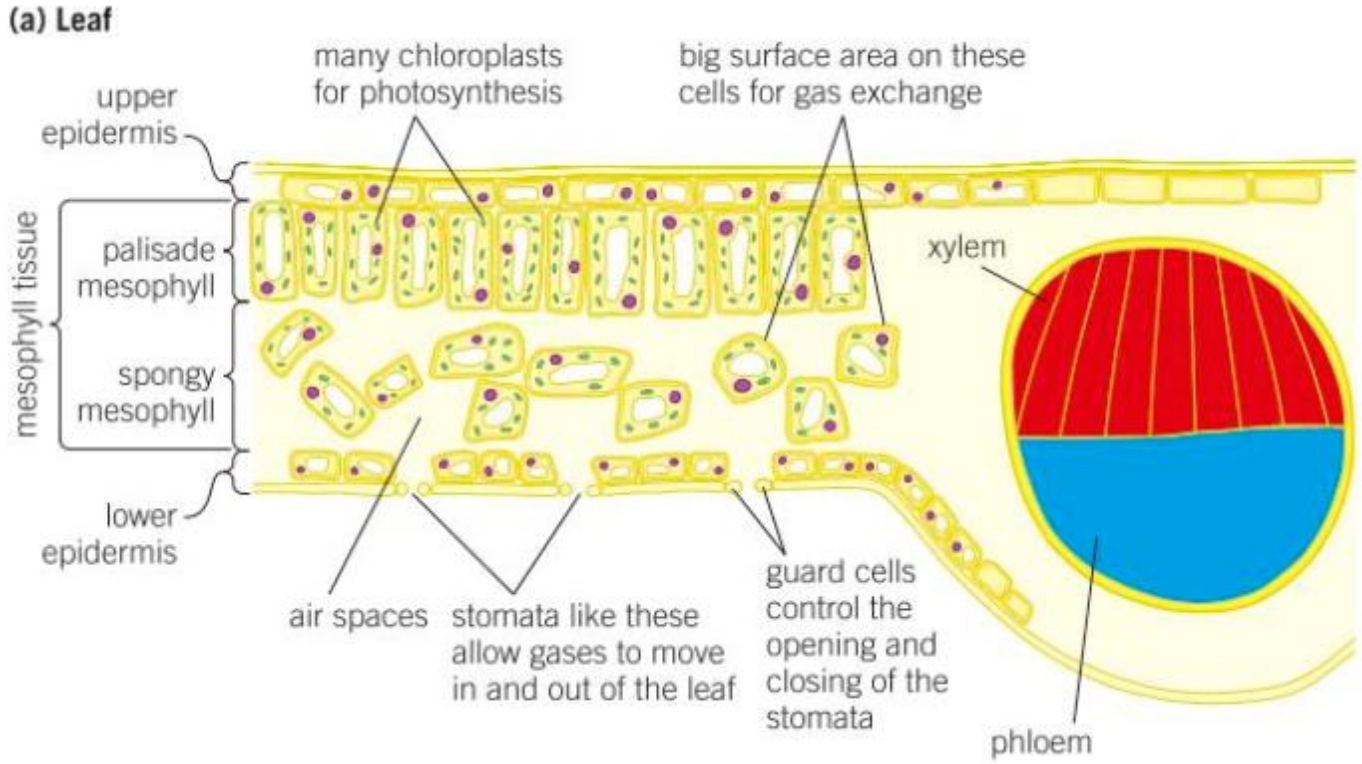
- A malignant tumour:
    - a cancer
    - invades neighbouring tissues
    - spreads around the body in the blood to form secondary tumours

- Causes of cancer:
    - genetic makeup
    - carcinogens
    - ionising radiation (UV light/X-rays)
    - viral infections

- Treatment of cancer:
    - **radiotherapy:** uses radiation to kill cancer (and some healthy) cells
    - **chemotherapy:** uses chemicals to make cells self-destruct

2.3 PLANT TISSUES, ORGANS AND SYSTEMS

2.3.1 Plant tissues



- Plant tissues include:
  - **wax cuticle:** prevents water loss
  - **epidermal tissue:** protects surface of the leaf
  - **palisade mesophyll:** site of photosynthesis
  - **spongy mesophyll:** large air spaces and a large surface area for diffusion
  - **xylem:** transports water and dissolved mineral ions from the roots to the leaves
  - **phloem:** carries dissolved food from leaves to the rest of the plant
  - **meristem tissue:** at the growing tips of the roots and shoots: site of rapid mitosis

- Xylem and phloem are a vascular bundle.

2.3.2 Plant organ system

- The plant organ system:
  - roots:
    - absorb water by osmosis
    - absorb mineral ions by active transport
  - stem:
    - supports leaves and flowers

    - phloem consists of tubes of live elongated cells
    - it transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage by translocation
    - cell sap can move from one phloem cell to the next through pores in the end walls

    - xylem consists of dead hollow tubes strengthened by lignin
    - xylem transports water and mineral ions from the roots to the stems and leaves in the transpiration stream
  - leaves:
    - carry out photosynthesis
    - stomata open and close to control water and gas exchange

- Importance of the transport system:
  - sugars are needed for cell growth and respiration
  - water is needed for photosynthesis and turgor pressure
  - mineral ions are needed for the production of proteins

- Factors affecting the rate of transpiration:
  - **temperature:** faster evaporation and diffusion
  - **light intensity:** more photosynthesis, so stomata open more regularly
  - **humidity:** slower evaporation if surrounding air is already moist
  - **air flow:** faster evaporation, steep concentration gradient

- If more water is lost than absorbed by the roots:
  - stomata close, which stops photosynthesis and risks overheating but stops further water loss
  - the whole plant may wilt

- On a potometer, the movement of the air bubble across the scale shows how much water has been absorbed by the plant through the xylem.

3 INFECTION AND RESPONSE

3.1 COMMUNCIABLE DISEASES

3.1.1 Communicable (infectious) diseases

- A communicable disease is a pathogenic disease that can be passed from one person to another.

- Pathogens are microorganisms that cause infectious disease.
- Bacteria, viruses, fungi and protists are pathogens.

- Bacteria:
  - unicellular organisms
  - rapidly divide
  - produce toxins that damage tissues and make us feel ill

- Viruses:
  - live and reproduce inside cells
  - cause cell damage
  - infect a single cell and use it to replicate their genetic material

- Pathogens are spread by:

	Air	Direct contact	Water
Animals	Infected people expel droplets of pathogens when sneezing/coughing which are inhaled by others.	Sexual contact, cuts/scratches etc. which give access to the blood.	Drinking contaminated water, eating raw/undercooked food.
Plants	Pathogens carried from plant to plant in the air.	Infected plant material can damage entire crop.	Splashes of water containing pathogens.
Examples	Influenza Tuberculosis Common cold	HIV/AIDS Chlamydia Syphilis	Salmonellosis Cholera Diarrhoeal diseases
Information	Mainly bacteria, viruses and fungi.	Animals can act as vectors by carrying pathogens between organisms.	Pathogens enter the body through the digestive system.

3.1.2 Viral diseases

- Measles:
  - **Symptoms:** fever, red rash
  - **Spread by:** droplet infection
  - **Details:** causes blindness and brain damage, can be fatal
  - **Treatment:** none (infected people are isolated)
  - **Prevention:** children are vaccinated at the age of 1

- HIV/AIDS (Human Immunodeficiency Virus):
  - **Symptoms:** flu-like illness
  - **Spread by:** bodily fluids (sexual contact, blood)
  - **Details:**
    - attacks immune cells
    - late stage HIV, i.e. AIDS, is when the immune system is so badly damaged it cannot fight infections or cancers
  - **Treatment:** antiretroviral drugs slow down the development of AIDS
  - **Prevention:**
    - barrier method contraception
    - not sharing needles
    - screening blood used for transfusions

- TMV (Tobacco Mosaic Virus):
  - **Symptoms:** distinctive mosaic pattern of discoloration on leaves
  - **Spread by:**
    - contact of diseased plant material with healthy plants
    - insects as vectors
  - **Details:** reduced area for photosynthesis reduces growth
  - **Treatment:** none (affected leaves removed and destroyed)
  - **Prevention:**
    - TMV-resistant strains of crop plants can be grown
    - good field hygiene and good pest control

3.1.3 Bacterial diseases

- Salmonella food poisoning:
  - **Symptoms:** fever, abdominal cramps, vomiting, diarrhoea
  - **Spread by:** eating raw, undercooked or unhygienically prepared food
  - **Details:**
    - disrupt balance of natural gut bacteria
    - cause food poisoning
  - **Treatment:** none because it only lasts a few days
  - **Prevention:** poultry are vaccinated against Salmonella

- Gonorrhoea:
  - **Symptoms:**
    - thick yellow or green discharge from the vagina or penis
    - pain on urinating
  - **Spread by:** unprotected sexual contact (STD)
  - **Details:** causes pelvic pain, infertility, ectopic pregnancies
  - **Treatment:** penicillin (but antibiotic-resistant strains evolving)
  - **Prevention:** barrier method of contraception

3.1.4 Fungal diseases

- Rose black spot:
  - **Symptoms:**
    - purple/black spots on leaves
    - leaves turn yellow and drop early
    - plants do not flower well
  - **Spread by:** spores of fungus in water and wind
  - **Details:** reduced area for photosynthesis reduces growth
  - **Treatment:**
    - chemical fungicides
    - affected leaves removed and destroyed
  - **Prevention:** horticulturists have bred resistant roses

3.1.5 Protist diseases

- Malaria:
  - **Symptoms:** fever
  - **Spread by:** mosquitos as vectors
    - female mosquito needs two meals of human blood to lay egg
    - malarial protists are passed into the human bloodstream
    - protists damage red blood cells and the liver in circulation
  - **Details:** can weaken body to death
  - **Treatment:** none
  - **Prevention**:
    - insecticide-impregnated bed nets
    - preventing vector reproduction by killing larvae
    - antimalarial drugs which can fight parasites; given before traveller is bitten

3.1.6 Human defence systems

- If a pathogen enters the body, the immune system tries to destroy it.

- Skin:
  - covers tissues below, acts as a barrier
  - platelets form a clot at cuts which stops pathogens coming in
  - produces antimicrobial secretions to destroy pathogenic bacteria
  - covered with healthy microorganisms to stop pathogens

- Nose:
  - hairs and mucus in the nose trap pathogenic particles

- Trachea and Bronchi:
  - cilia trap airborne pathogens
  - cilia move the mucus up to the throat to be swallowed

- Stomach:
  - produces acid which destroys microorganisms

- Internal immune defences (white blood cell):
  - **phagocytosis:** pathogens are engulfed, digested and destroyed
  - **antibody production:** specific antibodies lock onto specific antigens
  - **antitoxin production:** counteract toxins produced by bacteria

3.1.7 Vaccination

- **Vaccination** is the introduction of a vaccine, dead or inactive pathogenic material to develop immunity to a disease in a healthy person.

- How a vaccine works:
  - a small amount of dead/inactive forms of a pathogen are introduced into the body
  - this stimulates the production of antibodies for that pathogen
  - memory cells 'remember' these pathogens and antibodies
  - on secondary infection, memory cells ensure white blood cells produce these antibodies rapidly
  - this provides protection against that disease

- Herd immunity is when a large proportion of the population is immune to a pathogen through vaccination and the spread of the pathogen is reduced.

3.1.8 Antibiotics and painkillers

- Antiseptics can be used to kill pathogens outside (on) the body.
- Disinfectants can be used to kill pathogens on external surfaces.
- Painkillers treat disease symptoms, not the pathogen itself.

- Antibiotics:
  - kill bacteria (not viruses) in the body
  - damage bacterial cells without harming other cells
  - pathogen-specific
  - have greatly reduced deaths from infectious diseases

- Antibiotics cannot kill viral pathogens as viruses replicate inside cells.
- It is difficult to develop drugs to kill viruses without damaging the body's tissues.
- Antibiotic-resistant strains of bacteria are developing.

3.1.9 Discovery and development of drugs

- A drug is a substance that alters chemical reactions in the body.

- Traditionally, drugs were extracted from plants and microorganisms:
  - the heart drug digitalis originates from foxgloves
  - the painkiller aspirin originates from willow
  - penicillin originates from the Penicillium mould

- Most new drugs are synthesised by research chemists in the pharmaceutical industry.
- However, the starting point may still be a chemical extracted from a plant.

- New drugs are extensively tested for efficacy, toxicity and dosage.

- Preclinical trials:
  - compounds tested using computer models
  - compounds tested on cells and tissues in test tubes
  - useful compounds tested on live animals to check unpredictable effects

- Clinical trials:
  - **Phase 1:** low dose tested on healthy humans to check safety
  - **Phase 2:** different doses tested on patients to check efficacy and find optimum dose
  - **Phase 3:** optimum dose tested on large number of patients
  - **Licensing:** data is studied by regulatory authorities and approved
  - **Phase 4:** drug is monitored for safety and further developed

- Double blind trials:
  - neither the patient or doctor knows what the medicine contains
  - some are given placebos (medicine not containing active drug being tested) where the reassurance of treatment makes them better

3.2 MONOCLONAL ANTIBODIES

3.2.1 Producing monoclonal antibodies

- Monoclonal antibodies are produced from a single clone of cells.
- The antibodies are specific to one binding site on one protein antigen and so are able to target a specific chemical or cell in the body.

- Production of monoclonal antibodies:
  - stimulate mouse lymphocytes to make a particular antibody
  - lymphocytes are combined with particular kind of tumour cell
  - hybridoma cell is formed
  - hybridoma cell can divide and produce the antibody
  - single hybridoma cells are cloned to produce many identical cells that all produce the same antibody
  - a large amount of the antibody is collected and purified

- Ethical issues of monoclonal antibodies:
  - use of animal by injecting with antigen
  - 2006 drug trial went wrong (organ failure)
  - mouse spleen cells shouldn't be used in humans

3.1.2 Uses of monoclonal antibodies

- Examples of uses of monoclonal antibodies:
  - **diagnosis:** in pregnancy tests monoclonal antibodies bind to HCG hormone (produced in early stages of pregnancy) to produce a colour change
  - **in laboratories:** to measure levels of hormones/chemicals in blood or to detect pathogens
  - **in research:** to locate or identify specific molecules in a cell/tissue by binding to them with monoclonal antibodies with a fluorescent dye
  - **treatment of disease:** for cancer the monoclonal antibody can be bound to a radioactive substance, toxic drug or a chemical that stops cell growth/division and it will deliver the substance to the cancer cells without harming other cells in the body

- Monoclonal antibodies create more side effects than expected, so they are not yet as widely used as everyone hoped when they were first developed.

Advantages	Disadvantages
- can target specific cells without harming others - used in pregnancy tests	- unwanted side effects - expensive to produce

3.3 PLANT DISEASE

3.3.1 Detection and identification of plant diseases

- Plant diseases can be detected by:
  - stunted growth
  - spots on leaves
  - areas of decay (rot)
  - growths
  - malformed stems or leaves
  - discolouration
  - presence of pests

- Identification can be made by:
  - reference to a gardening manual or website
  - taking infected plants to a lab to identify the pathogen
  - using testing kits containing monoclonal antibodies

- Plant diseases for this specification:
  - **tobacco mosaic virus (TMV):** stunted growth, mosaic pattern of discolouration, yellow spots, malformed leaves
  - **rose black spot:** purple/black spots on leaves, early falling, little flowering
  - **aphids:** insects which suck sap out of stems and transfer pathogens, causing wilting and malformed stems

- Ion deficiencies:
  - **nitrate deficiency:** stunted growth (needed for protein synthesis)
  - **magnesium deficiency:** chlorosis (needed to make chlorophyll)

3.3.1 Plant defence responses

- Physical defence responses: (to resist invasion of microorganisms):
  - cellulose cell walls
  - tough waxy cuticle
  - layers of dead cells around stems (bark on trees)

- Chemical plant defence responses:
  - antibacterial chemicals
  - poisons to deter herbivores

- Mechanical adaptations:
  - thorns and hairs to deter animals
  - leaves which droop/curl when touched
  - mimicry to trick animals

4 BIOENERGETICS

4.1 PHOTOSYNTHESIS

4.1.1 Photosynthetic reactions

- Photosynthesis is an endothermic reaction in which energy is transferred from the environment to the chloroplasts by light.

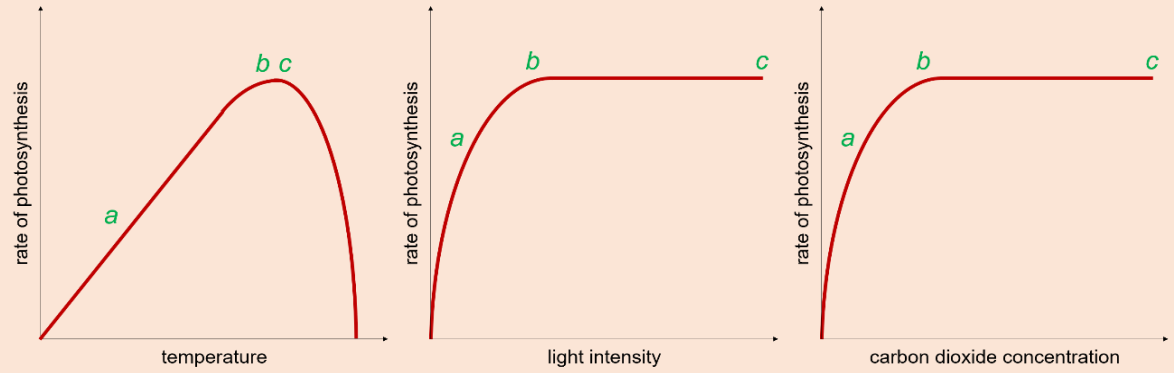
- carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{light}}$ glucose + oxygen

- $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$

4.1.2 Rate of photosynthesis

- Factors affecting the rate of photosynthesis:
  - temperature (enzymes denature above optimum temperature)
  - light intensity
  - carbon dioxide concentration
  - amount of chlorophyll

- A limiting factor is one that restricts the rate of a reaction:



- At *a*, the limiting factor is that on the x-axis.
- At *b* to *c*, the limiting factors are those other than that on the x-axis.

$$\textbf{light intensity} \propto \frac{\textbf{1}}{\textbf{distance}^2}$$

$$\textbf{light intensity} = \frac{\textbf{k}}{\textbf{distance}^2}$$ **where k is the constant of proportionality**

- Conditions in greenhouses are enhanced to gain the maximum rate of photosynthesis while still maintaining profit.
- Growers try to apply the highest light intensity and carbon dioxide concentration at the optimum temperature.

4.1.3 Uses of glucose from photosynthesis

- Glucose is used for immediate respiration or storage.

- Glucose can be converted into:
  - cellulose (cell walls)
  - starch (insoluble for storage)
  - lipids (storage)
  - amino acids (protein synthesis)
  - with nitrates, proteins

4.2 RESPIRATION

4.2.1 Aerobic and anaerobic respiration

- Cellular respiration is an exothermic, glucose energy-release reaction which continuously occurs in living cells.

- Respiration supplies the energy needed for these living processes:
  - chemical reactions to build larger molecules
  - movement
  - keeping warm

- Aerobic respiration is the release of energy in the presence of oxygen.

- **Aerobic respiration:**
- glucose + oxygen → carbon dioxide + water (+energy) **(exothermic)**
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (+energy)

- **Anaerobic respiration:**
- glucose → lactic acid (+energy) **(exothermic)**
- $C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ (+energy)

- Less energy is transferred in anaerobic respiration because the oxidation of glucose is incomplete.

- **Anaerobic respiration in yeast cells:**
- glucose → ethanol + carbon dioxide (+energy) **(exothermic)**
- $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ (+energy)
- This is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks.

4.2.2 Response to exercise

- During exercise:
  - energy (and oxygen) demand increases
  - heart rate increases
  - breathing rate increases
  - breath volume increases
  - this supplies muscles with more oxygenated blood

- When insufficient oxygen is supplied during exercise:
  - anaerobic respiration occurs
  - the incomplete oxidation of glucose causes a build-up of lactic acid
  - muscles become fatigued and stop contracting efficiently
  - an oxygen debt is created
  - when you rest you will puff and pant
  - oxygen is needed to complete the oxidation of lactic acid in the muscles

  - blood flowing through the muscles transports lactic acid to the liver
  - lactic acid is either converted into glucose or completely oxidised:

  - lactic acid → glucose **(endothermic)**
  - $2C_3H_6O_3 \rightarrow C_6H_{12}O_6$

  - lactic acid + oxygen → carbon dioxide + water **(endothermic)**
  - $2C_3H_6O_3 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ **(oxygen debt repayment)**

4.2.3 Metabolism

- Metabolism is the sum of all the reactions in a cell or body.
- Energy from respiration is used for the continual enzyme-controlled processes of metabolism that synthesise new molecules.

- Metabolism includes:

  <u>Synthesis</u>
  - synthesis of starch and glycogen (for storage) and cellulose (for cell walls and growth) from glucose
  - synthesis of lipid molecules from a molecule of glycerol and three molecules of fatty acids
  - synthesis of proteins from amino acids (formed from glucose and nitrate ions)
  - synthesis of glucose in photosynthesis

  <u>Breakdown</u>
  - breakdown of glucose in respiration
  - breakdown of excess proteins to form urea for excretion
  - breakdown of carbohydrates, proteins and lipids in digestion

BIOLOGY PAPER 1