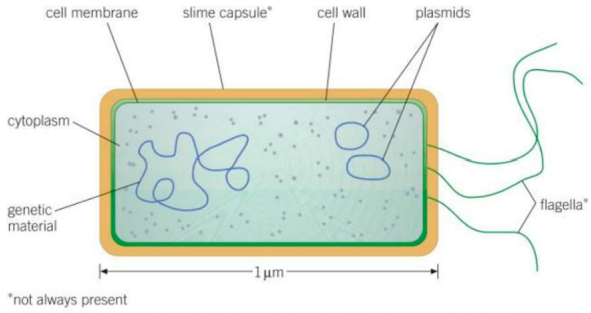
1.1 Cells

2022年12月1日 0:27

1.1.1a Difference between prokaryotes and eukaryotes

- Eukaryotic cells
  - 10 to 100 um
  - Have DNA enclosed in a nucleus
- Prokaryotes
  - About 1um
  - Single loop of DNA (not chromosome) in cytoplasm
  - Additional smaller, circular pieces of DNA called plasmids may also be present
  -

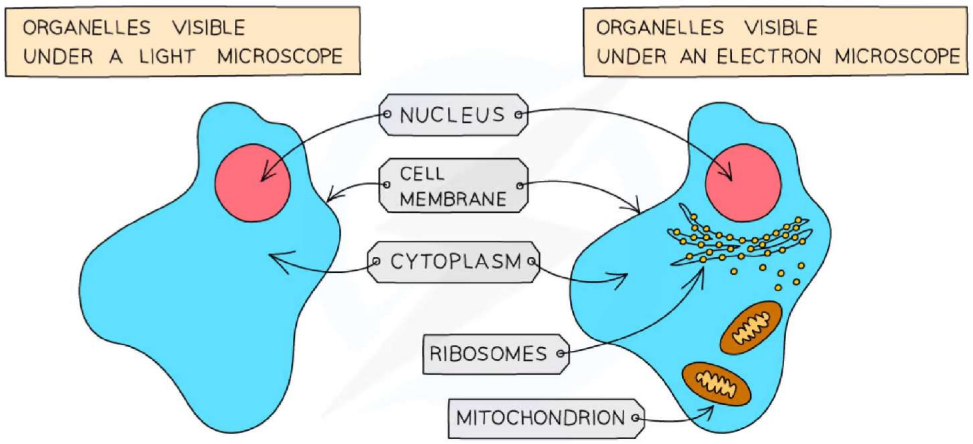


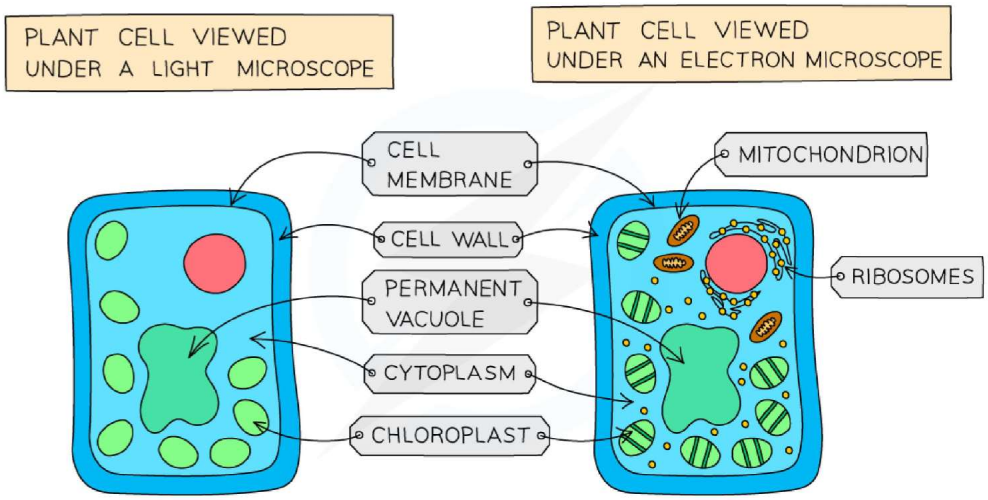
1.1.1b Structures

Structure	Animal	Plant	Prokaryotic cell
Ribosome	✓	✓	✓
Nucleus	✓	✓	
Mitochondria	✓	✓	
Cytoplasm	✓	✓	✓
Cell membrane	✓	✓	✓
Cell wall		✓	✓
Chloroplast		✓	
Permanent vacuole		✓	
Plasmid			✓

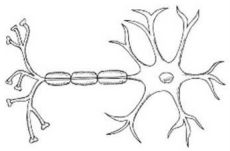
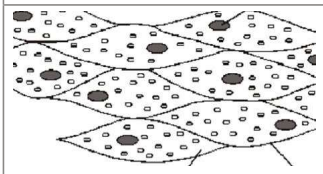
1.1.2 Animal and plant cells

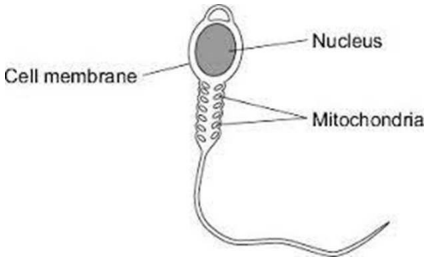
Nucleus	Contains genetic material that controls the cell
Ribosome	Site of protein synthesis (making proteins)
Cell membrane	Controls the movement of substances in and out of the cell. Described as selectively permeable.
Cytoplasm	Site where most chemical reactions occur controlled by enzymes
Mitochondria	Site where aerobic respiration (respiration with oxygen) occurs to release energy (ATP)
Chloroplast	Light energy is absorbed to make glucose during photosynthesis
Cell wall	Made from cellulose and provides support for plant and algal cells
Permanent vacuole	Filled with cell sap to keep cell turgid depending on the volume of water
Plasmid	Bacteria also have small, closed-circles of DNA

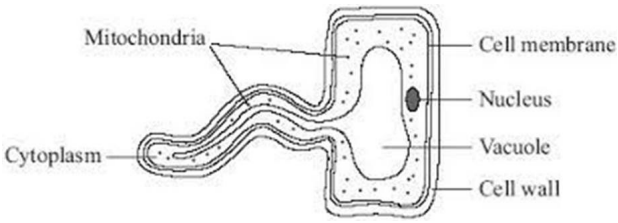
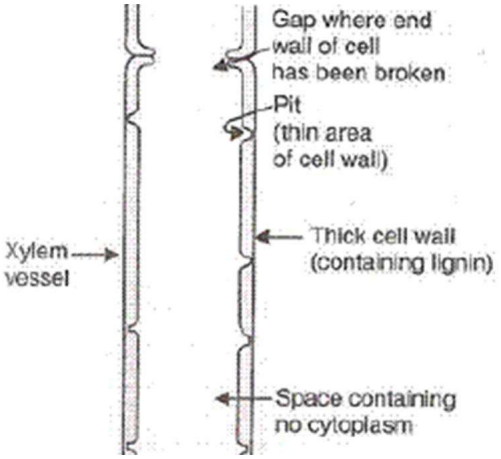


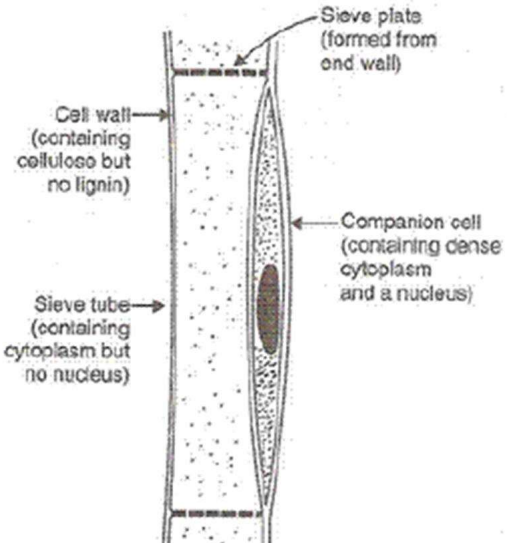


1.1.3 Cell specialisation

Animal cell	Function	Adaptation
 Nerve cell (neurone)	Transmits nerve impulse.	• Branched endings to connect with other cells. • Long to allow nerve impulses to travel to other parts of the body.
 Muscle cell	Contracts to allow movement	• Contains lots of mitochondria which provide the energy (ATP) for contraction.

 Sperm cell	Fertilise the egg cell	• Long tail and streamlined to swim to egg. • Many mitochondria to provide energy for movement. • Sperm head (acrosome) contains enzymes to digest cell membrane of egg cell. • Contains one unpaired set of chromosomes (half the amount of DNA).

Plant cell	**Function**	**Adaptation**
 Root hair cell	Absorbs waterand mineral ionsions from the soil.	• Long shape = large surface area for the absorption of water • Shape allows growth between soil particles
 Xylem cell	Transport of water from the roots to leaves (transpiration). Provides support.	• Cells form hollow tubes through which water moves. • Lignin in the cell wall make the cell walls waterproof.

 Phloem cell	Transports sugar produced by photosynthesis (translocation).	• Small holes in the end plates allow sugars to move to different parts of the plant.

1.1.4 Cell differentiation

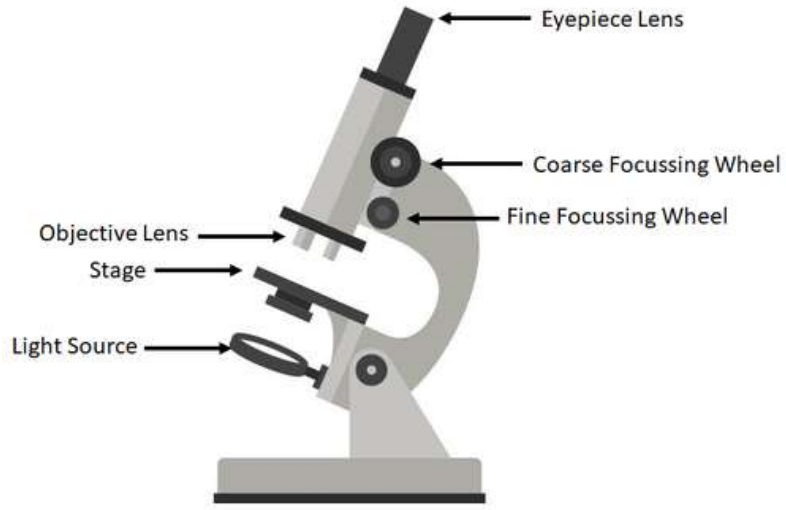
- Process of differentiation
  - Switching off genes
  - As a cell differentiates it acquires different sub-cellular to enable it to carry out a certain function
  - It has become a specialised cell
- Most types of animal cells differentiate at very early stage
- Many types of plant cells retain the ability to differentiate throughout life
- In mature animals cell division is mainly restricted to repair and replacement

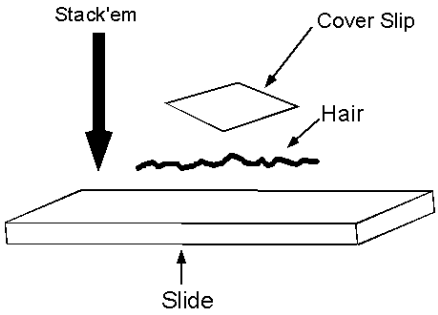
1.1.5 Microscopy

- Magnification
  - How much bigger the image of the sample is compared to its actual size
  - $magnification = \frac{size\ of\ image}{size\ of\ real\ object}$
- Resolution
  - The ability to distinguish between two points, so a higher resolution gives a sharper image.
- Electronic microscope
  - Much higher magnification and resolution than a light microscope
  - This means that it can be used to study cells in much finer detail
  - This has enabled biologists to see and understand many more sub-cellular structures
- Comparison

	Light microscope	Electron microscope
Magnification	Low magnification (x 1500)	High magnification (x 500000)
Resolution	Low resolution (250nm)	High resolution (0.25nm)
What can be seen		More details can be seen about sub-cellular structures e.g. mitochondrion and ribosomes

- Parts of the microscope

- 

- 

1.1.6 Culturing microorganisms

- Bacteria division
  - Binary fission (no nucleus so not mitosis)
  - As often as once every 20 minutes
    - If they have enough nutrients and a suitable temperature
- Culturing medium
  - Nutrient broth solution
  - Agar gel (form colonies on a petri dish)
- Aseptic techniques
  - Petri dishes and culture media must be sterilised (quickly heat with flame) before use
    - Kill unwanted bacteria
  - Inoculating loops used to transfer microorganisms to the media must be sterilised by passing them through a flame
    - Kill any microorganism existing on the loop
    - Avoid contamination
  - The lid of the Petri dish should be secured with adhesive tape but not sealed
    - Prevent bacteria escaping or other bacteria entering
    - Prevent growth of anaerobic bacteria by allowing air in
  - Stored upside down
    - Water vapour from respiration condense and fall
    - Avoid water on agar gel plate
  - In school laboratories, cultures should generally be incubated at 25°C
    - Reduce growth of pathogenic bacteria
  - Only lift the lid a little / at an angle only when opening the lid
    - Not expose to air

1.2 Cell division

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1.2.1 Chromosomes

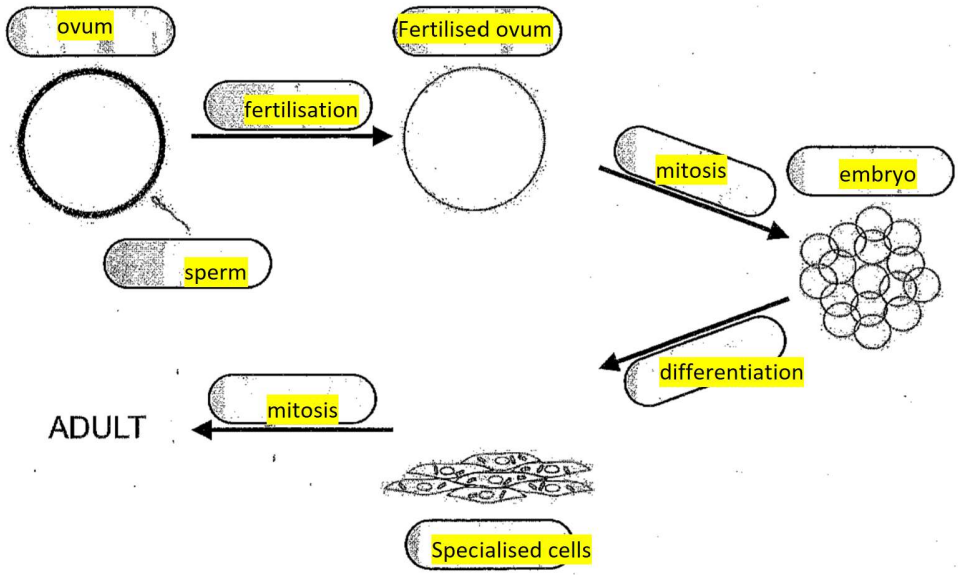
- Made of DNA molecules
- Found in pairs in the nucleus of body cells
  - 23 pairs in human body
- Each chromosome carries a large number of genes which determine our features

1.2.2 Cell cycle

- The cell cycle
  - Growth and replication of DNA - Stage 1
    - Increase the number of sub-cellular structures
    - The DNA replicates to form two copies of each chromosome
      - The chromosome and the copy remain attached as a x-shape
  - Mitosis - Stage 2
    - One set of chromosome is pulled to each end of the cell
      - Cell fibre from either side of the cell (poles) is attached to the respective half of each chromosome
      - Pulled to the opposite sides - poles
    - Two new nuclei formed
  - Cell division - Stage 3
    - Cytoplasm and cell membrane divides to form two identical cells
- Mitosis definition
  - Cell division to produce two genetically identical cells
- Functions of mitosis
  - Growth and development of multicellular organisms
  - Repair
  - Asexual reproduction

1.2.3 Stem cells

- Stages of the formation on an adult human



- Stem cell definition
  - Undifferentiated cells that can produce more stem cells and differentiate into specialised cells.
- Uses
  - Repair damaged organs / cells
  - Treat conditions like diabetes, leukemia and paralysis
- Therapeutic cloningn embryo is produced with the same genes as the patient

        - Their stem cells can be used to replace the faulty cells
        - Won't be rejected
            - Contain the same genes as the patient
- Problems
    - May transfer viruses
    - Ethical or religious objections
- Bone marrow stem cells
    - Differentiate into blood cells (platelets, red blood cells, white blood cells only)
- Meristems
    - Stem cells from meristems in plants can differentiate into any type of plant cell throughout the life cycle of the plant
    - They are found in the growing tips of shoots and roots
    - Produces clones of plants quickly and economically
        - Crop plants with special features such as disease resistance can be cloned to produce large number of identical plants for farmers
        - Rare species can be cloned to prevent them from extinction

1.3 Diffusion

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Keywords

- **Diffusion**: the **spreading out** of the particles resulting in a **net movement**(overall movement) from an area of **higher** concentration to an area of **lower** concentration.
- **Osmosis**: The diffusion of water from an area of higher water concentration to an area of lower water concentration through a partially permeable membrane.
- **Active transport**: The net movement of particles from an area of lower concentration to an area of higher concentration using energy.

Substances that move in and out of cells

- Oxygen: in for aerobic respiration
- Carbon dioxide: out because it is toxic
- Urea (a waste product of metabolic reaction): out

Factors affecting rate of diffusion

- The concentration gradient
  - Higher probability to spread out when the gradient is high
- The temperature
  - Higher temperature will give the particles more kinetic energy, which allows the particles to move faster
- The surface area of the cell membrane separating the different regions
  - There is a larger area for entering and leaving the cells

Unicellular & multicellular organisms

- Unicellular organisms have large surface area to volume ratio, so enough gases and food can be diffused in
- Multicellular organisms have smaller surface area to volume ratio, so they need exchange surfaces

Effectiveness of exchange surfaces

- Large surface area: more space for entering and leaving
- Thin membrane allowing short diffusion distance
- Sufficient blood supply to maintain concentration gradient

Hypertonic & hypotonic solutions

- Hypertonic: a lower concentration of water than the concentration of water in the cell
  - Animal cell: shrink
  - Plant cell: cell membrane pulls away from cell wall, become flaccid / plasmolysed
- Hypotonic: a higher concentration of water than the concentration of water in the cell
  - Animal cell: lysis (burst)
  - Plant cell: cell membrane pushes against the cell wall, become turgid

Active Transport

- Necessary when diffusion cannot occur
- Require energy from respiration
- Examples: glucose into the bloodstream, mineral ions such as magnesium into root hair cells

Small intestine adaptations

- Villi provide a large surface area
- Walls of villi are one cell thick for short diffusion distance
- Small intestine is very long = increasing time for absorption
- Good / efficient blood supply to maintain concentration gradient
- Cells have many mitochondria for (aerobic) respiration to release energy for active transport of glucose

2.1 Tissues, organs and organ systems

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Tissues, organs and organ systems

- Cell: basic building blocks of living organisms
- Tissue: group of cells with a similar structure and function
- Organ: aggregations of tissues performing specific functions
- Organ system: organs are organised into organ systems which work together to form organisms.

2.2.1 The human digestive system

2022年10月17日 15:51

Keywords

- Catalyst
  - A substance that speed up reactions / increases the rate of a reaction
- Enzymes
  - Proteins that function as biological catalysts and speed up reaction

Food test

- Benedict's solutions:
  - Test for simple sugar (e.g. glucose)
  - Heat is required e.g. heat in hot water bath
  - Positive result: green – yellow – orange – brick red
  - Negative: remain blue
- Iodine:
  - Test for starch
  - Positive: blue black
  - Negative: brown
- Biuret reagent
  - Test for protein
  - Positive result: purple / lilac
  - Negative result: blue
- Emulsion test
  - Test for lipids
  - Steps (has to be in this order)
    1. Add oil
    2. Add ethanol to dissolve the lipids first and mix
    3. Add water and mix
  - If lipid present a white emulsion will form

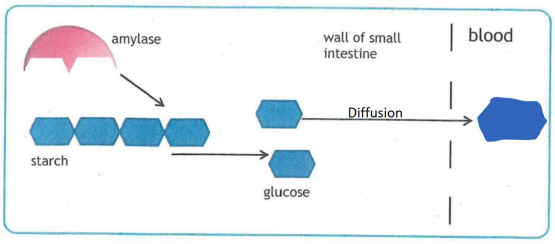
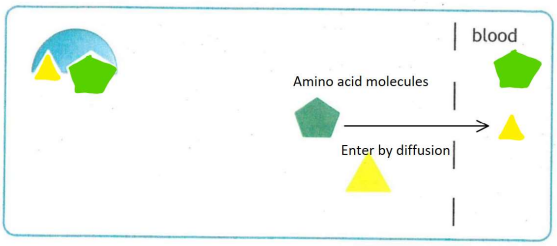
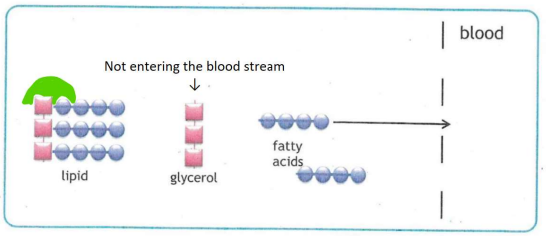
Enzymes

- Also called biological catalysts (speed up reactions)
- Why is enzymes used
  - Food molecules are too large to be absorbed directly, so they are digested and are broken down into smaller soluble molecules by enzymes so they can be absorbed
- Reaction process
  - Enzyme and molecules moving randomly until a successful collision
  - Substrate bind to the active site of the enzyme, forming an enzyme-substrate complex because shape of active site is complementary to the shape of the substrate
  - A chemical reaction occurs / bond between molecules broken so substrate is broken down into smaller molecules
  - Products are then released from the active site
- Active site
  - Complementary shape
  - Lock and key theory
    - Enzymes are specific because the substrate must be complementary to the active site
- Optimum pH / temperature
  - Highest rate of reaction
  - Temperature
    - Higher temperature - more kinetic energy - move faster - more successful collisions - more likely to bind - more reaction
    - Too high - denatured
    - Lower temperature - low kinetic energy, fewer collisions
  - pH

- Too high or too low - denatured

- Denatured
  - Caused by high temperature, too acidic / alkaline solutions
  - Active site shape changed so it cannot bind to substrates
  - Still able to react if the damage is small
  - Enzymes are not living so they cannot be killed
- Aerobic respiration
  - Enzymes reacting to release energy from glucose
  - Enzymes found in mitochondria

Enzymes in digestions

Enzyme	Food	Broken down into	Site of production
Amylase	Carbohydrates	Simple sugar (not glucose) 	Salivary gland & pancreas
Protease	Proteins	Amino acids 	Stomach & pancreas
Lipase	Lipids	3 fatty acids and 1 glycerol 	Pancreas

Digestion system

Organ	Physical changes	Chemical changes
Mouth	Food is torn into smaller pieces by the teeth Food is mixed with saliva	Amylase in saliva begins to break down carbohydrates
Stomach	Muscles churn food into a fluid (chyme) to increase surface area and rate of reaction	Protein digestion starts Hydrochloric acid: to break down proteins and kill microorganisms
Small intestine	Muscles in the small intestine help the fluid to mix with digestive juices Bile added: • Produced in the liver • Neutralize HCl acid • Emulsifies lipids to increase surface area • Enters before enzymes from pancreas enter - not denatured	Lipid digestion starts, carbohydrates, proteins continues
Large	Water is absorbed back into the body	Bacteria break down some undigested materials, help

intestine		produce certain vitamins

2.2.2 Heart and blood vessels

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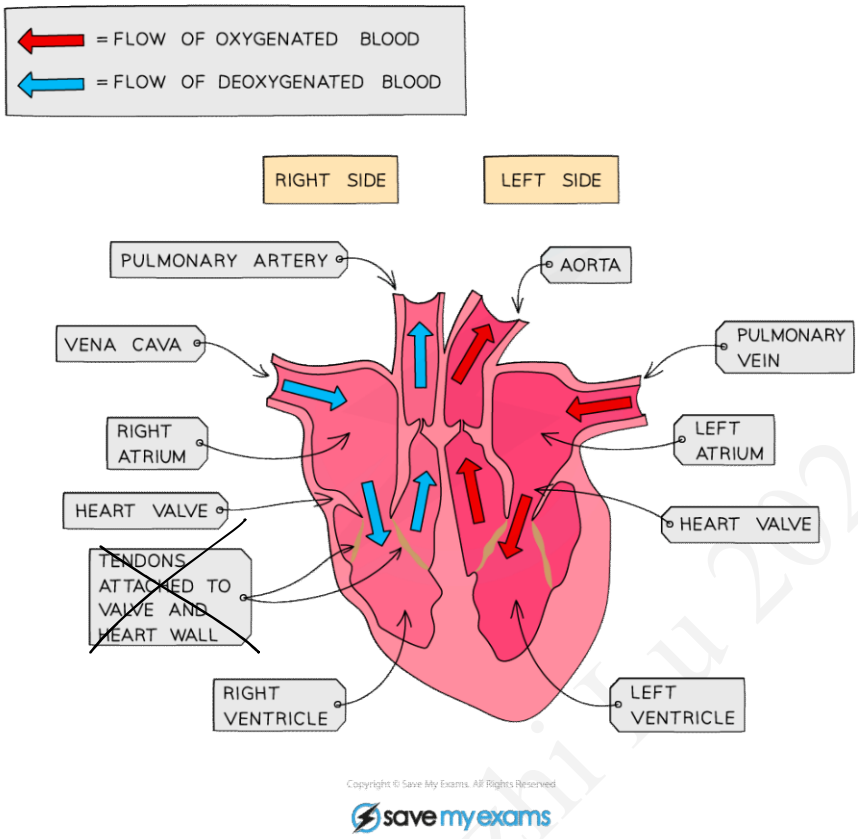
Heart structure

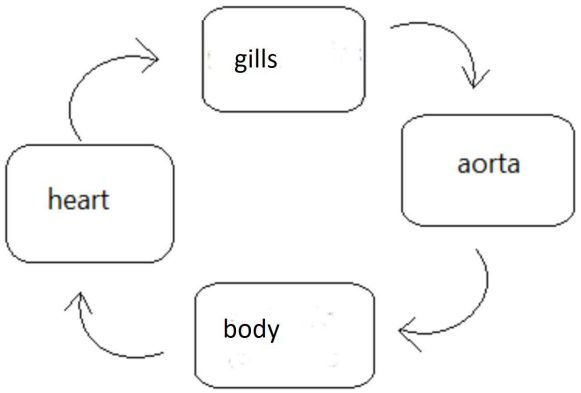


- Pacemaker
  - In the right atrium
  - Controls the resting heart muscle
  - They release an electrical impulse allows the muscle to contract
    - Create heart beats
  - Artificial pacemakers correct irregularities in heart rate
- Muscle walls
  - Thicker in left ventricle because they pump blood all way round to the body
  - Allows higher pressure - faster speed
  - Pressure too high in lungs - capillaries will burst
- Coronary arteries
  - Branch from the aorta
  - Pass through the heart muscle
  - Deliver oxygen to heart muscular tissue
  - Oxygen is used to carry out aerobic respiration to release energy for contraction
- Valves
  - Close when muscle contracts
  - Blood is forced out of the pulmonary artery
  - Prevent backflow of blood
    - Blood may flow back if valves relax

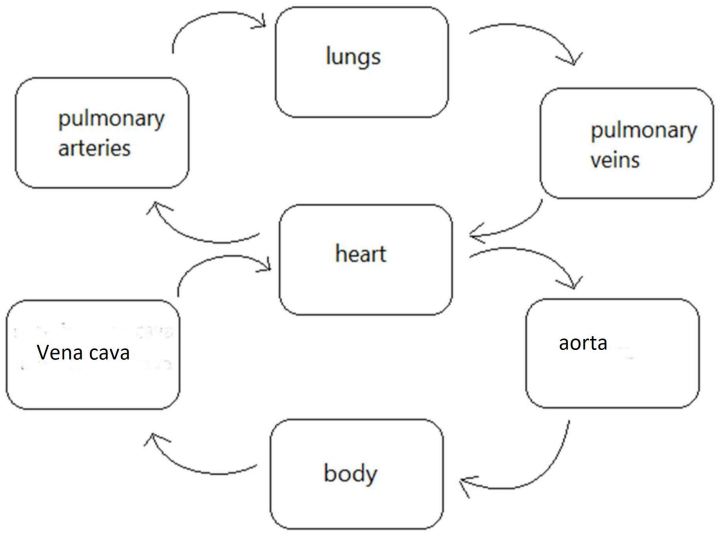
Types of circulation

- Single circulatory system
  - Blood passes through the heart once for one cycle through the body
  - e.g. fish
  - Blood loses pressure as it passes through the gills

- Blood travels at lower pressure from the gills to organs
- Blood delivering oxygen more slowly



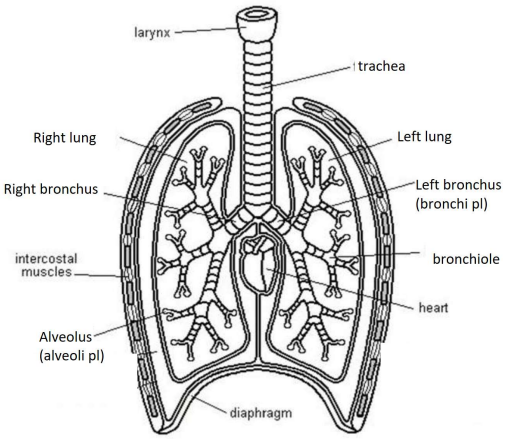
- Double circulatory system
  - Blood passes through the heart twice for one cycle through the body
  - e.g. human
  - Blood travels at higher pressure and delivers oxygen more rapidly



Blood vessels

- Artery
  - Carry blood away from the heart
  - Thick muscular layer wall and small lumen to withstand high pressure
  - Thicker elastic fibre than veins
    - Stretches when surge of the blood pulse through the arteries and recoil
    - Keeps the blood flowing smoothly
    - Creates pulses
- Veins
  - Carry blood to the heart
  - Thin muscle layer and large lumen: blood flowing slowly and at low pressure
  - Valves to stop the backflow of blood as it moves slowly
  - Valves close when blood starts to flow back
- Capillaries
  - Large network
    - Large surface area
    - Reduce the pressure
    - Slows the blood flow so more time for diffusion
      - Oxygen and glucose can diffuse in and carbon dioxide and urea can diffuse out
  - Thin wall
    - One cell thick
    - Short diffusion distance to increase rate of diffusion

Lungs



- Lungs
  - Organ for gas exchange
- Trachea
  - Carries air to bronchi
  - Contains rings of cartilage to hold it open
- Bronchi
  - Carries air from trachea to bronchioles
- Bronchioles
  - Carries air from bronchioles to the alveoli
- Alveoli
  - Site of gas exchange
  - Oxygen diffuses in and carbon dioxide diffuses out of the bloodstream
  - Adaptations
    - Folded shape to increase surface area
    - Good blood supply to maintain concentration gradient
    - One cell thick walls allowing for short diffusion distance

2.2.3 Blood components

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Blood components

- Plasma
  - The liquid part of the blood
  - Transport dissolved substances around the body
    - Glucose from the small intestine to body cells
    - Carbon dioxide to lungs to be breathed out
    - Urea from the liver to the kidney to be excreted in urine
- Red blood cell
  - Transport oxygen from the lungs to body cells for aerobic respiration
  - oxygen + haemoglobin $\xrightarrow{\text{lungs}}$ oxyhaemoglobin
  - oxyhaemoglobin $\xrightarrow{\text{organs}}$ oxygen + haemoglobin
  - Adaptations: no nucleus, biconcave shape
- White blood cell
  - Defend the body against harmful pathogens
  - Produce antibodies against microorganisms
  - Produce antitoxins against toxins made by microorganisms
  - Engulf and digest pathogens
- Platelets
  - Blood clotting
  - Small fragments of cells get trapped in protein fibres to produce a clot

2.2.4 Cardiovascular diseases

2022年11月30日 23:19

Diseases

- Coronary heart disease
  - A layer of fatty material builds up inside the coronary arteries
  - Causes the coronary arteries to narrow, reduce the flow of blood through the coronary arteries
  - Results in a lack of oxygen to the heart muscle, and a heart attack in extreme cases
- Faulty Valves
  - Valves not opening fully between atrium and ventricle so heart have to pump harder
  - Valves leaking
    - Oxygenated and deoxygenated blood mixing
    - Less oxygenated blood is pumped around the body, the patient feels weak and tired
- Faulty pacemaker
  - May result in a slow or fast heart rate
  - Slow heart rate - insufficient oxygen
  - Fast heart rate - can result in a heart attack

Treatments

Treatment	Description	Advantages	Disadvantages
Statins	• Drugs which reduce the level of cholesterol in the blood • Slows the rate at which fatty material builds up in these arteries	• Statins reduce cholesterol levels • Helps slow down the build-up of fatty layers in the arteries • Reducing the risk of a heart attack	• May produce unwanted side effects such as liver damage • Patients has to remember to take the statins regularly
Stent	• Used when there is an almost total blockage of the coronary artery • A tube which is inserted into the coronary artery to keep it open	• Major surgery not required • Lower risk of infection • Less complicated	• Fatty deposits can build up again • Scar tissue can grow inside the stent resulting in higher risk of clotting and stroke, so anti-clotting drugs are needed
(Mechanical) Heart valves	• Mechanical heart valves made of metal	• No rejection	• Major surgery - risk associated • Can damage RBCs, so anti-clotting drugs are needed
Biological heart valve	• Biological heart valves from animals e.g. pigs, cattle.	• RBCs not damaged • Blood not clotting around the valve	• Major surgery - risk associated • Valves can harden and need replacing • May be rejected so need immuno-suppressant medication
Human heart replacement	• Transplanted from a healthy donor when a heart is damaged and failing	• Better quality of life • Improved chance of longer life	• Major surgery • Anti-rejection drugs needed for life • A shortage of donors
Artificial hearts	• Used to keep patients alive when waiting for a heart transplant • Allow the heart to rest to assist recovery	• Allows patient to survive	• Blood clots
Artificial pacemaker	• Electrical device to treat irregular heart beat	• Major surgery not required, lower risk of complications and infections	• The immune system can reject the pacemaker and it will need replacing • The pacemaker may sometimes malfunction so regular check-ups required

2.2.5-7 Non-communicable diseases

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2.2.5 Health issues

- Health
  - The state of physical and mental wellbeing
- Causes of ill
  - Disease
    - Both communicable and non-communicable
  - Diet
    - Not getting enough food or not enough of the right nutrients
      - e.g. starvation, anaemia, rickets
    - Eating too much food or the wrong type of food
      - e.g. obesity, some cancers, type 2 diabetes
  - Stress
    - Increasing stress increases the risk of developing a range of health problems
    - e.g. heart disease, certain cancers and mental health problems
  - Life situations
    - Part of the world living
    - Gender
    - Financial status
    - Ethnic group
    - Level of free healthcare provided at where you live
    - How many children you have
    - Local sewage and rubbish disposal
- How health problems interact
  - Defects in the immune system mean that an individual is more likely to suffer from infectious diseases
  - Viruses living in cells can trigger cancer
  - Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma
  - Severe physical ill health can lead to depression and other mental illness

2.2.6 The effect of lifestyle on some non-communicable diseases

- Risk factors for disease
  - Aspects of a person's lifestyle
    - e.g. smoking, lack of exercise, or overeating
  - Substances in the person's body or environment
    - e.g. ionising radiation, UV light from the sum, second hand tobacco smoke
- Causal mechanisms
  - The effects of diet, smoking and exercise on cardiovascular disease
  - Obesity as a risk factor for Type 2 diabetes
  - Alcohol damaging the liver and brain function
  - Smoking as a risk factor of lung disease and lung cancer
  - The effects of smoking and alcohol on unborn babies
  - Carcinogens, including ionising radiation, as risk factors in cancer

2.2.7 Cancer

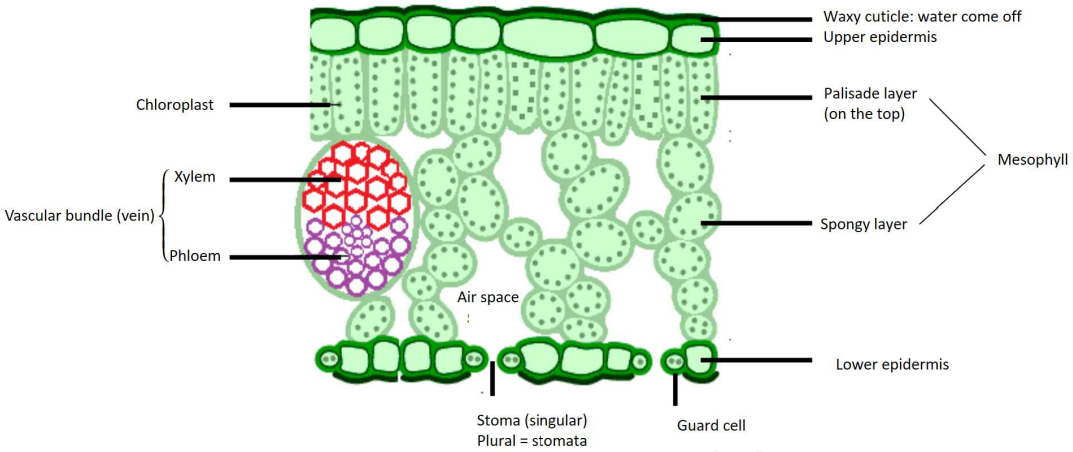
- Cause
  - Changes in cells that lead to uncontrolled growth and division
- Tumours
  - A mass of abnormally growing cells
- Benign tumour
  - Growths of abnormal cells which are contained in one area, usually within a membrane

    - Do not invade other body parts
- Malignant tumour
    - Known as cancer
    - They invade neighbouring tissues by spreading to different parts of the body via the blood stream, where they form secondary tumours
- Risk factors
    - Genetics
        - We inherit a higher risk of these cancers from our parents
        - Breast cancer
        - Cancer of the large intestine
        - Prostate cancer
    - Lifestyle
        - Smoking - lung cancer
        - UV light - skin cancer
        - Alcohol - mouth and throat cancer
    - Environment (carcinogen)
        - Radon
            - Releases ionising radiation
            - Damages the DNA of cells, causing the cells to undergo uncontrolled cell division and leading to cancer
            - High risk of lung cancer

2.3 Plant tissues, organs and systems

2023年2月27日 19:16

2.3.1 Plant tissues

- Leaf cross-section
- 

- Epidermal tissue
  - Covers the surface and protect them
  - Often secrete waxy substance to waterproof the surface of the leaf
  - Upper epidermis
    - Transparent to allow light to pass through the palisade layer
  - Lower epidermis
    - Has stomata and guard cells to control gas exchange and water loss
- Palisade mesophyll
  - Tall cells packed closely together
  - Contain a large number of chloroplasts to allow maximum absorption of light for photosynthesis
- Spongy mesophyll
  - Contains some chloroplast for photosynthesis
  - Large air spaces to allow carbon dioxide to diffuse into and oxygen to diffuse out of cells easier
- Xylem
  - Xylem tissue transports water and mineral ions from the roots to the stems and leaves (unidirectional)
  - Composed of hollow tubes strengthened by lignin
    - Keep water in + provide support
    - Adapted for the transport of water in the transpiration stream
  - Continuous tube - allow continuous flow of water
- Phloem
  - Phloem tissue is composed of tubes of elongated cells
  - Dissolved sugar can move from one phloem cell to the next through pores in the end walls
  - The movement of dissolved sugars is called translocation
  - Sugar is transported bidirectionally
- Meristem tissue
  - Located at the growing tips of shoots and roots
  - Made up of rapidly dividing plant cells that can grow and differentiate into all other cell types needed
- Stomata
  - Control gas exchange and water loss
  - Can be opened when the plant needs to allow air into the leaves
    - Carbon dioxide diffuse into the air spaces then the cells down the concentration gradient

        - Oxygen from photosynthesis is removed from the leave by diffusion into the surrounding air
        - Maintains concentration gradient for oxygen
    - Water is lost as water vapour when opened
        - Located at the lower epidermis so less water will be lost
    - Guard cells
        - Control the size of stomata and their opening and closing

2.3.2 Plant organ system

- Organ system
    - The root, stem and leaves of the plant form a plant organ system for transport of substances around the plant
- Transpiration
    - When water evaporates from a leaf and diffuses out through stomata
    - The transpiration stream brings water to the leaf through xylem
    - Water moves from the soil, into root hair cells, then into the stem and up to the leaves
    - Water vapour then evaporates from the surface of cells in the leaves and diffuses out through the stomata
- Translocation
    - The movement of dissolved sugars from the leaves to the rest of the plant through phloem tissue
    - e.g. growth areas of the stems and roots for making new plant cells, storage organs as energy store for winter
    - Phloem is a living tissue
- Importance of transportation
    - Transport food
        - Sugar is made in the leaves
        - All the cell need sugars for respiration and as materials for growth
    - Transport water and dissolved mineral ions
        - Mineral ions are needed for the production of proteins and other molecules within the cells
            - Magnesium ions for producing chlorophyll
        - The plant needs water for photosynthesis, cooling and to hold itself upright
- Factors affecting rate of transpiration
    - Temperature
        - Higher temperature gives more kinetic energy in water molecules so faster diffusion
        - Higher temperature increases the rate of photosynthesis so more stomata will be open for gas exchange to take place
        - Higher rate of transpiration
    - Humidity
        - High humidity decreases rate of transpiration because diffusion happens slower due to gentler concentration gradient of water
    - Amount of air movement
        - Windy conditions increase the rate of evaporation and maintain a steep concentration gradient from the inside of the leaf to the outside by removing water vapour as it diffuses out so there is faster diffusion
        - Higher rate of transpiration
    - Light intensity
        - Increases the rate of photosynthesis so more stomata open up to let in carbon dioxide
        - So there are more water lost by evaporation and diffusion increases so higher rate of transpiration
- Potometer
    - Show how the uptake of water by a plant changes in different conditions

3.1 Infection

2023年1月23日 19:58

3.1.1a Communicable diseases

- Health
  - State of physical and mental wellbeing
- Communicable diseases
  - Diseases caused by pathogens
- Pathogens
  - Microorganisms that cause infectious diseases
  - e.g. bacteria, virus, fungi or protists
- Bacteria
  - Prokaryotic cells
  - Multiply rapidly by binary fission in the blood stream but do not have to enter the cell to multiply
  - Release toxins that damages tissues and make people feel ill
- Viruses
  - Not a living organism
  - Much smaller than bacteria
  - Can only reproduce in a host cell because they do not have organelles to reproduce on their own
    - Damages cells because they use molecules that the host cell needs
    - Leaves the cell and the host cell bursts and is destroyed

3.1.1b Mechanisms of spread of disease

- By air
  - Bacteria, viruses and fungal spores
  - In human
    - Patients expel tiny droplets full of pathogens from the breathing system when coughing, sneezing or talking
    - Other people breathe in droplets along with pathogens contained so they pick up the infection
    - e.g. influenza, tuberculosis and the common cold
- Direct contact
  - In plant
    - A piece of infected plant material can in a field can infect an entirely new crop via contacting
  - In human
    - Diseases including sexually transmitted infections are spread by direct contact of the skin
    - Pathogen such as HIV/AIDS enter the body through sexual contact, cuts, scratches, and shared needle punctures that give access to the blood
  - Animal can act as a vector for both plant and animal diseases by carrying a pathogen between infected and healthy individuals
- By water
  - In plant
    - Fungal spores carried in splashes of water often spread plant diseases
  - In human
    - Pathogen enters the body through the digestive system
      - Eating raw, undercooked, or contaminated food
      - Drinking water contaminated with sewage e.g. cholera

3.1.1c Mechanisms to prevent the spread of disease

- Simple hygiene

    - Hand washing / hand sanitization
    - Disinfectants to reduce the number of pathogens
    - Keep raw meat away from food that is eaten uncooked
    - Face masks
- Quarantine
    - The fewer healthy people in contact with the infected person the less likely the pathogen will be passed on
    - Can also work with smaller plants that can be moved and destroyed easily
- Destroying vectors
    - Destroying vectors can prevent the spread of disease
- Vaccination
    - Doctors introduce a small amount of harmless form of a specific pathogen into the body
    - The immune system will be prepared when in contact with a live pathogen so people will not get ill
    - Cannot protect plants because they doesn't have an immune system

3.1.2 Viral diseases

- Measles
    - Symptoms
        - Fever
        - Red skin rash
        - Can be fatal if complications arise
            - Virus damages breathing system and the brain
    - Transmission
        - Inhalation of droplets from coughs and sneezes
    - Prevention and treatment
        - Vaccination
        - Quarantine
- Human Immunodeficiency Virus
    - Symptoms
        - Initial flu-like symptoms that may last for two weeks
        - The virus destroys the immune system
            - Less WBC
            - Less antibodies and antitoxins
        - When the immune system is damaged and cannot combat infections AIDS occur
        - The individual becomes susceptible to TB and cancer which are fatal
    - Transmission
        - Sexual contact
        - Exchange of body fluids e.g. transfusion of contaminated blood and shared needles through drug users
    - Prevention and treatment
        - Anti-retroviral drugs
            - Prevent the virus replicating but does not cure the disease
            - Have to be taken for the rest of the life
        - Condoms
        - Screening blood products

3.1.3 Bacterial diseases

- Salmonella
    - Symptoms
        - Fever
        - Abdominal cramps
        - Vomiting
        - Diarrhoea
    - Transmission
        - Ingestion of infected food contaminated with bacteria

        - e.g. chicken
    - Prevention and treatment
        - Hygienic food preparation
        - Avoid eating undercooked chicken
        - Vaccinating chickens to prevent infection with Salmonella
        - Slaughter infected chicked
- Gonorrhoea
    - Symptoms
        - Thick yellow or green discharge from vagina or penis
        - Pain urinating
    - Transmission
        - Unprotected sexual contact
        - Exchange of body fluids e.g. transfusion of contaminated blood and shared needles through drug users
    - Prevention and treatment
        - Antibiotics
            - Resistant strains have developed making it more difficult to treat
        - Protected sex e.g. use of condoms
        - Limiting sexual partners
        - Getting tested for Gonorrhoea

3.1.5 Protist diseases

- Malaria
    - Symptoms
        - Anaemia
        - Recurrent fever
        - Can be fatal
    - Transmission
        - Mosquito = vector
        - Sting infected people → pass to healthy people
    - Prevention and treatment
        - Eliminating vector
            - Draining stagnant water
            - Spraying with Insecticides
        - Preventing biting
            - Sleeping under Insecticide treated nets which mosquitoes cannot get through
        - Anti-malarial drugs
            - Quinine
                - Works for all types of malaria
                - Stops the development of the malaria parasite in your blood
            - Chloroquine
                - Preferred treatment
                - Many plasmodium protists are resistant to it

3.1.6a Non-specific defence systems

- Skin
    - Acts as a physical barrier
    - Blood clotting to stop pathogens entering when there is a cut
    - Produces antimicrobial substances to kill pathogens
- Eyes
    - Tears containing antiseptic substances
- Nose
    - Hair and mucus trap particles containing pathogens
- Stomach
    - Produces HCl which kills pathogens
- Trachea and bronchi

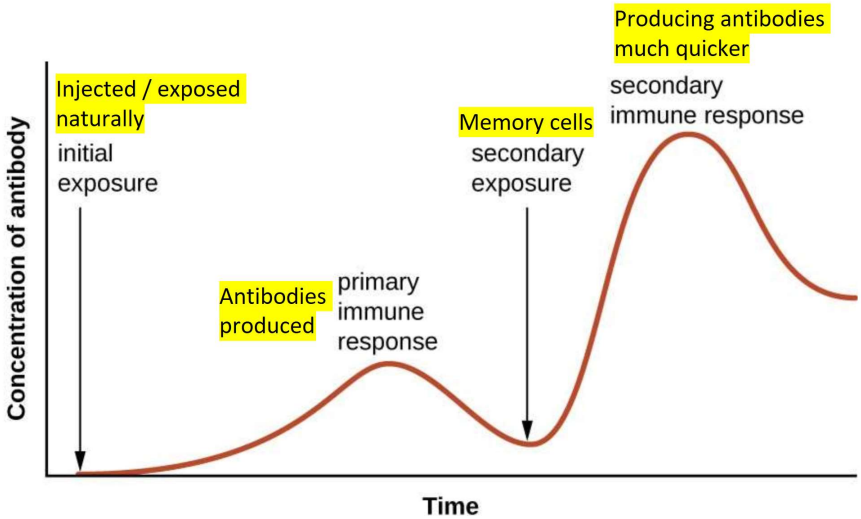
- Mucus trap pathogens
- Cilia beats to move the mucus to oesophagus and swallow it
- Pathogens killed in the stomach

3.1.6b Specific defence systems

- Phagocytosis
  - Phagocytes engulf pathogens during phagocytosis
  - Pathogen is killed and digested by enzymes
- Producing antibodies
  - Lymphocytes produce antibodies that destroy pathogens
  - Antibodies
    - Specific and complementary in shape to the antigens on the surface of the pathogen
    - Binds to specific antigens and destroy them
  - Antigen
    - Any molecule that causes a WBC to be activated
    - Every pathogen has antigens on its surface
  - Memory cells are formed
    - Form more antibodies at a faster rate when the same pathogen enters the body again
- Producing antitoxins
  - Lymphocytes produce antitoxins that neutralise toxins made by the pathogens

3.1.7 Vaccination

- Stages in the vaccination process
  - Small amounts of dead or inactive pathogen is injected into the body
  - WBCs are stimulated to produce antibodies against the dead or inactive pathogen
    - Divide by mitosis to produce many copies
    - A few memory cells are formed that remain in the body
  - If the same pathogen enters the body (even years later)
    - The memory white blood cells divide and produce the correct antibody quickly and in large amounts
    - This prevents infection
- Graph of antibody concentration after vaccination (initial exposure) and infection with the same pathogen (secondary exposure)



- Herd immunity
  - If a large proportion of the population is vaccinated more people are immune to the pathogen
  - More difficult to pass the pathogen to people who are not immunised

3.1.8 Antibiotics and painkillers

- Antibiotics
  - Kill bacteria inside the human body without harming body cells (no cell wall)
    - Kill by breaking down cell wall of bacterial cells
  - Cannot kill viral pathogens because they have no cell walls

    - Penicillin
        - The first antibiotic that is commonly used
- Antibiotic resistance
    - It is important to use specific antibiotics for specific bacteria
    - Overtime, certain antibiotics were overused and stopped working
    - The bacterial evolved to become resistant to the antibiotic and no longer killed by it (resistant strains)
        - Certain antibiotics were no longer effective against certain bacteria
- Painkillers
    - Treat the symptoms of a disease by relieving pain
    - Do not kill pathogens
- Drugs against viruses
    - Virus live and reproduce inside human cells
    - Difficult to develop drugs that kill viruses without damaging the body's tissue

3.1.9 Discovery and development of drugs

- Development
    - Traditionally drugs were extracted from plants and microorganisms
        - The heart drug digitalis originates from foxgloves
        - The painkiller aspirin originates from willow
        - Penicillin was discovered by Alexander Fleming from the Penicillin mould
    - Most new drugs are synthesised by chemists in the pharmaceutical industry
        - The starting point may still be a chemical extracted from a plant
- Drug trials
    - New medical drugs have to tested and trialled before being used to check if they are safe and effective
    - Their toxicity, efficacy and dosage are extensively tested
        - Toxicity: is the drug being toxic to humans
        - Effectiveness: is the medicine effective for the disease to be treated
        - Dosage: optimum dose
    - Preclinical testing
        - Done in a laboratory
        - Testing order
            - Cells → tissues → live animals
        - Mainly testing for toxicity
    - Clinical trials
        - Use healthy volunteers and patients first
            - Very low doses are given because we don't know if the drug is toxic to human or not
            - Less damage will be caused to human body if the drug is found toxic
        - If the drug is found safe further trials are carried out
            - It is tried on a small number of patients first to see if it is effective
            - Bigger trials are then carried out if the drug is safe and effective to find the optimum dose
        - Double blind
            - Some patients are given a placebo
                - Placebo: looks like the treatment but contains no drug
                - Allow comparison / provide control experiment
                    - To see if people recover from the disease if they think they are being treated but actually they are not
            - Neither the patient or the doctor knows who is receiving the drug or placebo
            - Prevent bias

3.2 Monoclonal antibodies

2023年1月23日 20:00

3.2.1 Producing monoclonal antibodies

- Mouse injected with antigens to produce antibodies
  - Injected more than once to get a high level of antibodies
- Each lymphocytes produces one type of antibody but do not divide
- Tumour cells divide but do not produce antibodies
- Lymphocyte fused with the tumour cell to form a hybridoma cell
  - Divide and produce antibodies
- Single hybridoma cells are cloned to produce many identical cells that all produce the same antibody
- A large amount of the antibody can be collected and purified
- Monoclonal antibodies are specific to one binding site on one antigen

3.2.2 Uses of monoclonal antibodies

- Diagnosis such as pregnancy test and LFD
- Measure the levels of hormones and chemicals in the blood
- Identify and locate specific molecules in a cell or tissue by binding fluorescently labelled monoclonal antibodies
- Treatment of diseases such as cancer
  - Using a monoclonal antibody with a radioactive substance, toxic drug or a chemical that kills or stops cells dividing
  - The substance is delivered to the cancer cells without harming other cells
- Pregnancy test
  - The urine is applied at the test strip
  - The urine travels to the reaction zone, and the HCG molecules bind to mobile monoclonal antibodies that are specific to it
  - Some antibodies remains free because there is a lot of mobile antibodies
  - The antibodies than move down the test strip to the result window
  - The immobilised antibodies in there are specific to HCG molecules and bind to them
  - The enzymes in the monoclonal antibodies then react with the blue dye in mobile antibodies, forming a blue line
  - The unbound antibodies then travel to the control window, where there are immobilised antibodies that are specific to the mobile antibodies and bind to them
  - The enzymes in the monoclonal antibodies than react with the blue dye attached to the mobile antibodies, forming a blue line
- Monoclonal antibodies create more side effects than expected
  - They are not yet as widely used as everyone hoped when they were first developed.

3.3 Plant disease

2023年2月28日 19:55

Plant communicable diseases

- Tobacco mosaic virus (TMV, viral)
  - Symptoms
    - Distinctive mosaic patterns of discoloration on leaves
  - Damage
    - Reduced photosynthesis results in reduced growth
- Rose black spot (fungal disease)
  - Symptoms
    - Purple or black spots develop on leaves
  - Damage
    - Reduced photosynthesis results in reduced growth
  - Treatment
    - Remove and destroy affected leaves
    - Treat with fungicides
- Aphid
  - Symptoms
    - Aphids on plant
  - Damage
    - Aphids are not pathogen but acts as a vector and transmits diseases between plants
    - Aphids extract nutrients such as sugars and amino acids slowing growth

Plant non-communicable diseases

- Ion deficiency diseases
- Nitrate deficiency
  - Symptoms
    - Stunted growth
  - Damage
    - Amino acid synthesis reduced
    - Protein synthesis slowed because amino acid needed for protein synthesis
    - Stunted growth - no enough material for growth
- Magnesium deficiency
  - Symptoms
    - Chlorosis (yellow colour of leaves) and reduced growth
  - Damage
    - Chlorophyll synthesis reduced (chlorosis) because magnesium ions required for chlorophyll
    - Leaves lose green colour (chlorosis)
    - Less light absorbed
    - Less photosynthesis
    - Less glucose produced
    - Slow growth

3.3.1 Detection and identification of plant diseases

- Symptoms
  - Stunted growth
  - Spots on leaves
  - Areas of decay (rot)
  - Growths
  - Malformed stems and leaves
  - Discoloration
  - Presence of pests

- Identification of plant diseases
    - Referencing to garden manuals and websites
    - Take the plant to a plant laboratory to identify the disease
    - Using testing kits that contain monoclonal antibodies

3.3.2 Plant defence responses

- Physical defence responses
    - Individual cells
        - Cellulose cell walls makes it difficult for pathogens to enter the plant cell
    - Leaves
        - Tough waxy cuticle protects the leaf from entry by pathogens
        - Many plant pathogens can be transmitted by water droplets falling onto leaves
    - Stem
        - Bark consists of a thick layer of dead cells
        - If pathogens infect the bark it is unlikely to enter the living tissue
        - Over time the bark falls off
- Chemical defence responses
    - Antibacterial chemicals to kill bacteria
    - Poisons to deter herbivores
        - Bitter chemical make it less likely that the plant will be eaten
- Mechanical adaptations
    - Hair and thorns deter animals from eating the plant
        - Hairs irritate and thorns are physically painful
    - Leaves which droop or curl when touched
        - Less likely to be seen and eaten
    - Mimicry to trick animals

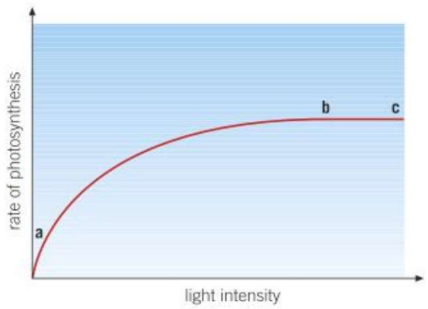
4.1 Photosynthesis

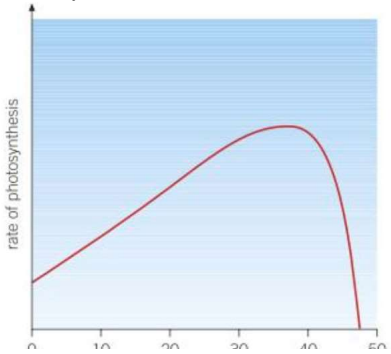
2023年3月19日 23:00

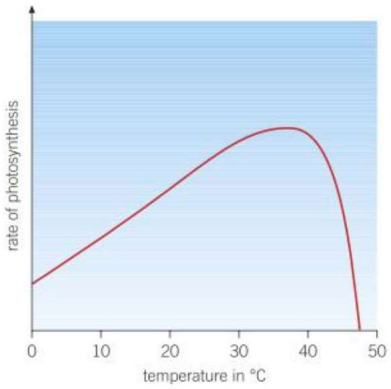
4.1.1 Photosynthetic reaction

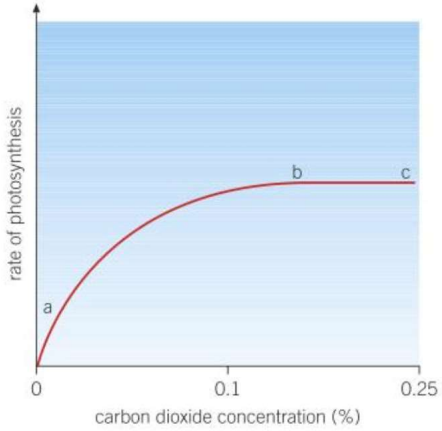
- Equation
  - carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen
- Process
  - CO_2 enters leaf from air via diffusion through the stomata or comes from adjacent leaf cells, also formed in respirations
  - Water absorbed from soil by root hair cells and carried to the leaf in the xylem
  - Energy is transferred from the environment to the chloroplast by light
  - Absorbed by chlorophyll in chloroplasts
  - Energy then transferred to convert carbon dioxide and water into glucose
  - Oxygen is produced as a by-product and released into the air
- Uses of oxygen
  - Used by the leaf cells for aerobic respiration
  - Released into the air via diffusion through the stomata
- Endothermic reaction
  - Heat is transferred from the environment to the chloroplasts
- Leaf adaptations
  - Broad leaves giving large surface area for light to fall on
  - Most leaves are thin so diffusion distances for gases are short
  - Chlorophyll in chloroplasts to absorb light
  - Xylem to bring water to the leaf cells
  - Phloem remove products of photosynthesis
  - Air spaces that allow carbon dioxide to get to the cells and oxygen to leave by diffusion
  - Guard cells that open and close the stomata to regulate gas exchange

4.1.2 Rate of photosynthesis

- Light intensity
  - The brighter the light the faster the photosynthesis
  - 

- Temperature
  - Photosynthesis is controlled by enzymes
  - As temperature rises the rate of photosynthesis increases as the reaction speeds up
  - If the temperature goes too high (around 40-50℃) the enzymes are denatured and the rate of photosynthesis fall
  - 

- 

- Carbon dioxide concentration
  - CO_2 is needed to make glucose
  - The atmosphere is only about 0.04% carbon dioxide so it often limits the rate of photosynthesis
  - Increasing the rate of carbon dioxide increases the rate of photosynthesis
  - 

- Chlorophyll levels in the leaf
  - Less photosynthesis will take place if the amount of chlorophyll is limited
  - Plants with white, chlorophyll-free areas grow less vigorously than plant with all green leaves
  - If a plant does not have enough minerals (especially magnesium) it cannot make chlorophyll
    - The rate of photosynthesis drops and the plant eventually die
- Limiting factor
  - Important in the economics of enhancing the conditions in greenhouses to gain the maximum rate of photosynthesis while still maintaining profit

4.1.3 Uses of glucose from photosynthesis

- Used by leaf cells for respiration
- Converted into insoluble starch for storage
  - Glucose is soluble so storing glucose can affect osmosis
  - It can affect water balance of the whole plant if stored in large amounts
  - Starch is insoluble so it won't affect water balance and can be stored in large amounts
  - Starch is the main energy store of plants
  - Used when light level is low or in winter
- Used to produce lipids for storage
  - Can be used as an energy store in cells or seeds
  - Sometimes used in cell walls to make them stronger
- Used to produce cellulose which strengthens cell walls
- Used to produce amino acids for protein synthesis
  - Combine glucose with nitrate ions and other mineral ions from the soil to form amino acids
  - These amino acids are then built up into proteins to be used in plant cells

4.2 Respiration

2023年3月21日 14:21

4.2.1 Aerobic and anaerobic respiration

- Respiration
  - Release energy from glucose molecules
  - An exothermic reaction (energy transferred to the surroundings)
  - Continuously occurring in living cells
  - Supplies all the energy needed for living processes
- Aerobic vs. anaerobic

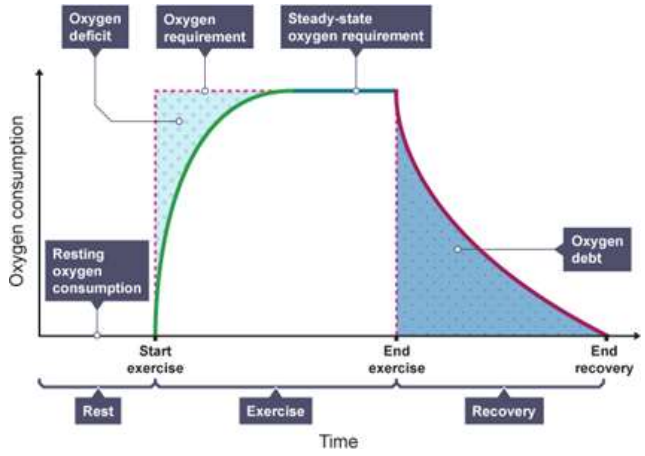
	Aerobic	**Anaerobic**
Need for oxygen	Yes	No
Products	Water + carbon dioxide	Plant / yeast: ethanol + carbon dioxide Muscles: lactic acid
Relative amount of energy transferred	A lot higher	Much lower (oxidation of glucose is incomplete)

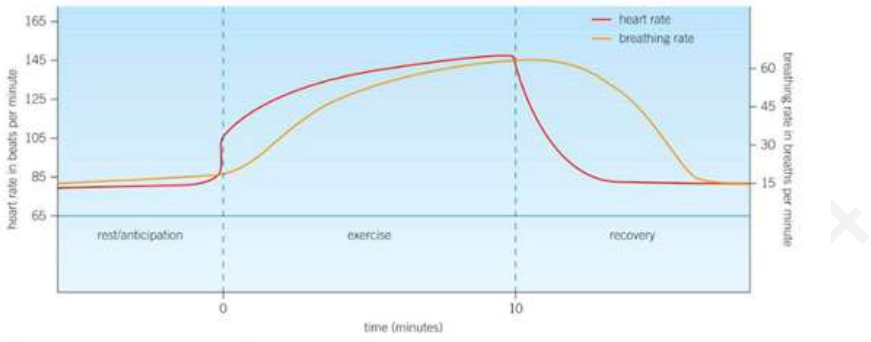
- Energy usage
  - Chemical reactions to build larger molecules
  - Movement
  - Keeping warm
- Fermentation
  - Anaerobic respiration in yeasts
  - Economic importance for manufacturing bread and alcoholic drinks

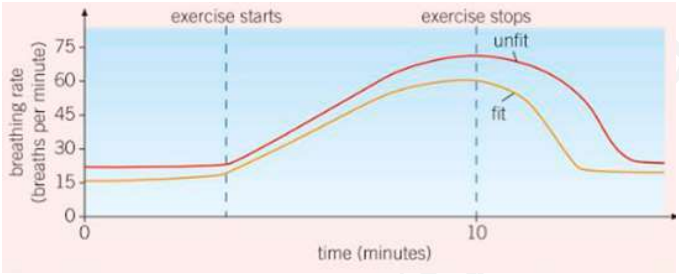
4.2.2 Response to exercise

- Body change
  - Requires a large amount of oxygen when exercising
  - The brain detects increased carbon dioxide levels
  - Responds by increasing the heart rate and the rate and volume of breathing
  - The increased blood flow to muscles
    - Delivers more oxygen and glucose from the breakdown of glycogen
      - More respiration so more energy released
        - Less anaerobic respiration so less lactic acid made
    - Takes away the carbon dioxide and lactic acid

- Anaerobic respiration
  - If insufficient oxygen is supplied anaerobic respiration takes place in muscles
  - The incomplete oxidation of glucose causes a build-up of lactic acid in muscle
  - The lactic acid prevents the muscle cells from contracting efficiently
  - This causes the muscle cells to become fatigued
- Blood flowing through muscles transports the lactic acid to the liver
  - It is converted back into glucose
  - This requires oxygen
  - Oxygen debt
    - The amount of extra oxygen the body still needs after exercise to react with the accumulated lactic acid and remove it from cells
    - Created by the build-up of lactic acid
    - The breathing rate and breathing volume is greater than normal after exercise
- Graph

- 

- 

- 

4.2.3 Metabolism

- Metabolism definition
  - The sum of all the reactions in a cell or the body
- Uses
  - The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules
- Reactions included

Breakdown	**Synthesis**
Proteins are digested into amino acids	In plants, glucose molecules are joined together to form starch
Glucose is used in respiration to release energy	Amino acids are formed from glucose and nitrate ions which are used to synthesise proteins
Starch is broken down into glucose	Glucose is converted into glycogen to be stored in animal cells as an energy source
Glycerol and fatty acids are produced from the breakdown of lipids	Plant cells make cellulose for their cell walls from simple sugars
In animals, excess proteins are converted into urea in the liver and excreted via the kidneys	The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids
Conversion of glucose to starch, glycogen and cellulose	

- Glycogen
    - Stored simple sugar in animals