Edexcel IAL Biology A-level

2.1-2.5 - Gas Exchange and Membrane Transport

Flashcards

Why do large multicellular organisms require specialised exchange surfaces?

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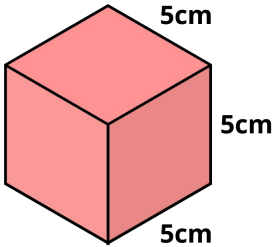
- Small SA:V ratio
- Diffusion insufficient to provide all cells with the required oxygen and nutrients, and to remove all waste products
- Exchange surfaces increase rate of diffusion and shorten diffusion distance

How is surface area to volume ratio calculated?

How is surface area to volume ratio calculated?

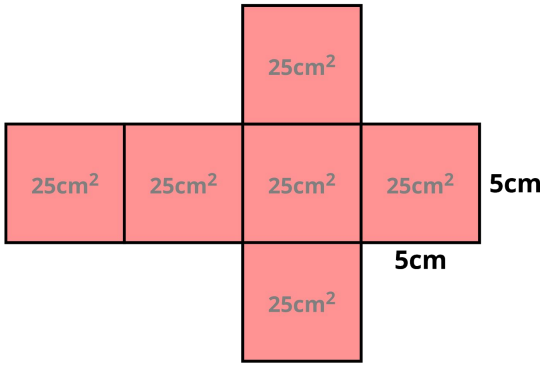
$$\text{Ratio} = \frac{\text{Surface area}}{\text{Volume}}$$

Volume



125cm^3
(5cm x 5cm x 5cm)

Surface area



150cm^2
(5x5) x 6

Give three properties of an efficient exchange surface

Give three properties of an efficient exchange surface

- Large surface area to volume ratio
- Small diffusion distance
- Large concentration difference

How does diffusion distance affect the rate of diffusion?

How does diffusion distance affect the rate of diffusion?

The greater the diffusion distance, the further the molecules must travel hence the slower the rate of diffusion

How does concentration gradient affect the rate of diffusion?

How does concentration gradient affect the rate of diffusion?

The steeper the concentration gradient, the faster the rate of diffusion

Areas with high concentrations have many more particles in a certain volume and so there is a much greater chance of each particle moving to the less concentrated area

How does surface area to volume ratio affect the rate of diffusion?

How does surface area to volume ratio affect the rate of diffusion?

The larger the surface area to volume ratio, the faster the rate of diffusion

As the size of the surface area increases, more molecules can diffuse across the surface and hence the diffusion rate increases. However, as the volume increases, there is a greater distance that molecules need to diffuse through, lowering the rate of diffusion. Thus having a large surface area and small volume (high SA:V), the rate of diffusion is greater

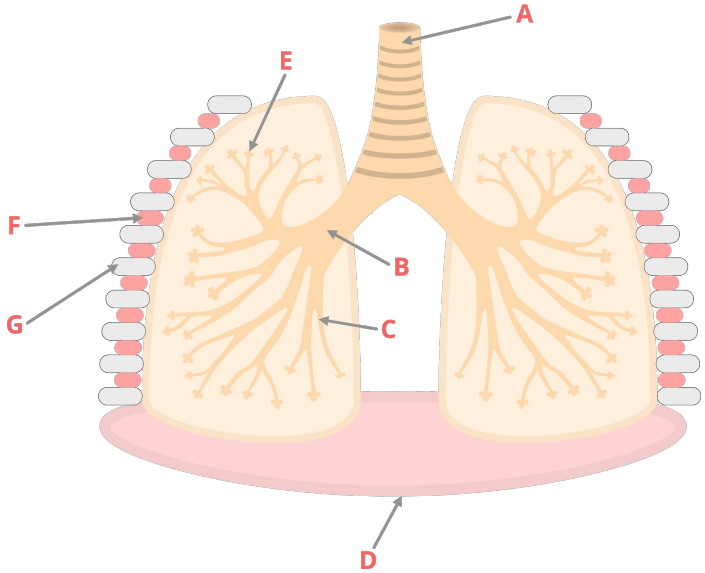
How can the rate of diffusion be calculated?

How can the rate of diffusion be calculated?

Using Fick's law:

$$\text{rate of diffusion} \propto \frac{\text{surface area} \times \text{concentration gradient}}{\text{thickness of membrane}}$$

Name the labelled parts of the mammalian respiratory system



Name the labelled parts of the mammalian respiratory system

A - Trachea

B - Bronchus

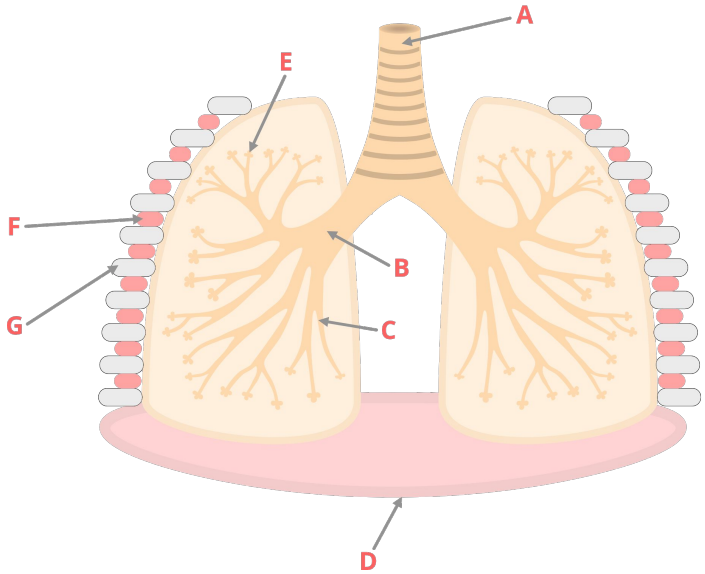
C - Bronchiole

D - Diaphragm

E - Alveolus

F - Ribs

G - Intercostal muscles



Describe the trachea and its function in the mammalian gaseous exchange system

Describe the trachea and its function in the mammalian gaseous exchange system

- Wide tube supported by C-shaped cartilage to keep the air passage open during pressure changes
- Lined by ciliated epithelium cells which move mucus, produced by goblet cells, towards the throat to be swallowed, preventing lung infections.
- Carries air to the bronchi

Describe the bronchi and their function in the mammalian gaseous exchange system

Describe the bronchi and their function in the mammalian gaseous exchange system

- Like the trachea they are supported by rings of cartilage and are lined by ciliated epithelium cells and goblet cells
- However, they are narrower and there are two of them, one for each lung
- They allow the passage of air into the bronchioles

Describe the bronchioles and their function in the mammalian gaseous exchange system

Describe the bronchioles and their function in the mammalian gaseous exchange system

- Narrower than the bronchi
- They do not need to be kept open by cartilage, therefore mostly have only smooth muscle and elastic fibres so that they can contract and relax easily during ventilation
- They allow the passage of air into the alveoli

Describe the alveoli and their function in the mammalian gaseous exchange system

Describe the alveoli and their function in the mammalian gaseous exchange system.

- Mini air sacs, lined with epithelium cells
- Site of gas exchange
- Walls only one cell thick, covered with a network of capillaries, 300 million in each lung. Both characteristics facilitate gas diffusion

Explain the process of inspiration and the changes that occur throughout the thorax

Explain the process of inspiration and the changes that occur throughout the thorax

- External intercostal muscles contract while internal relax, pulling the ribs up and out
- Diaphragm contracts and flattens
- Volume of the thorax increases
- Air pressure outside the lungs is therefore higher than the air pressure inside, so air moves in to rebalance

Explain the process of expiration and the changes that occur throughout the thorax

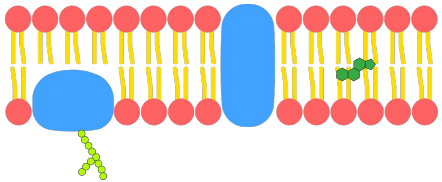
Explain the process of expiration and the changes that occur throughout the thorax

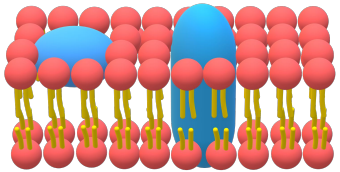
- External intercostal muscles relax (while internal contract), bringing the ribs down and in
- Diaphragm relaxes and and returns to its dome-like shape
- Volume of the thorax decreases
- Air pressure inside the lungs is therefore higher than the air pressure outside, so air moves out to rebalance

Describe the structure and components of a typical cell membrane

Describe the structure and components of a typical cell membrane

A typical cell membrane contains a **phospholipid bilayer** which is studded with various **proteins**. They also typically contain **cholesterol** which sits in the hydrophobic portion of the membrane to regulate fluidity. Other molecules like **glycoproteins** and **glycolipids** may protrude from the membrane





State five functions of cell membranes

State five functions of cell membranes

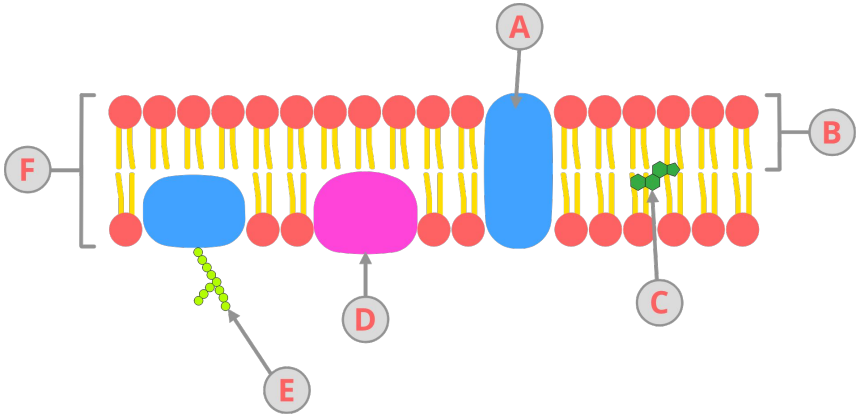
- They act as selectively permeable barriers
- They contain receptors used for communication
- They are the site of chemical reactions
- They allow for signal transduction
- They are used for the transport and uptake of substances

What is the fluid-mosaic model?

What is the fluid-mosaic model?

A model that describes membrane structure as a ‘sea’ of mobile phospholipids studded with various proteins

Label the following diagram of a typical membrane



Label the following diagram of a typical membrane

A - Integral membrane protein

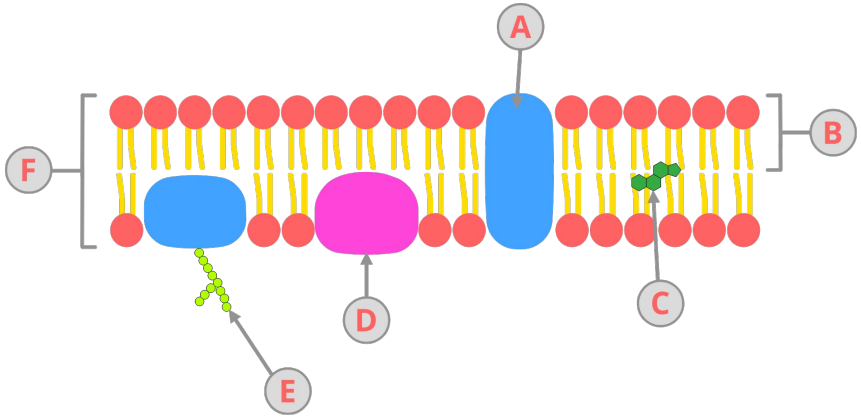
B - Phospholipid

C - Cholesterol

D - Peripheral membrane protein

E - Glycoprotein

F - Phospholipid bilayer



What are intrinsic proteins?

What are intrinsic proteins?

Proteins found within the phospholipid bilayer. Includes channel and carrier proteins

Outline the functions of intrinsic proteins

Outline the functions of intrinsic proteins

- Structural support
- Carry water-soluble molecules across the phospholipid bilayer
- Form ion channels to enable active transport

What are extrinsic proteins?

What are extrinsic proteins?

Proteins found at the edges of the phospholipid bilayer

Outline the functions of extrinsic proteins

Outline the functions of extrinsic proteins

- Receptors
- Act as antigens, enabling cell recognition
- Help cells adhere to each other

What is meant by the term compartmentalisation in biology?

What is meant by the term compartmentalisation in biology?

Compartmentalisation is the separation of areas within cells which allows for the localisation of enzymes and molecules so that separate areas can carry out specific functions

What is the glycocalyx?

What is the glycocalyx?

A glycoprotein and glycolipid coating surrounding the cell membrane of some cells

State three factors that affect the permeability of the plasma membrane

State three factors that affect the permeability of the plasma membrane

- The amount of unsaturated fatty acids
- The temperature
- The amount of cholesterol present

Describe how varying temperatures affect membrane permeability

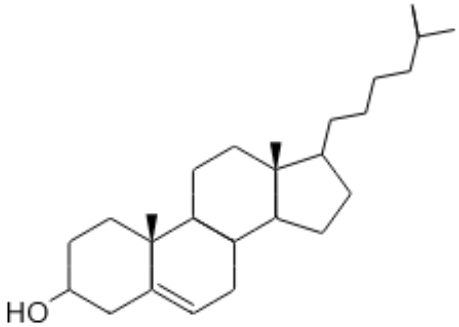
Describe how varying temperatures affect membrane permeability

- As temperature increases, the molecules have more kinetic energy and so move around more, creating gaps in the membrane
- As the temperature increases past a certain point, the proteins in the membrane become denatured, disrupting the membrane

Describe the structure of cholesterol (2)

Describe the structure of cholesterol (2)

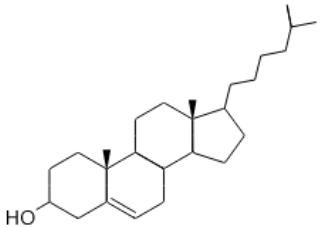
- 4 rings
- Mostly hydrophobic



Describe the function of cholesterol

Describe the function of cholesterol

Cholesterol regulates membrane fluidity. At high temperatures, it stabilises the membrane and at low temperatures, it keeps the phospholipids apart which allows the membrane to remain fluid



How does the amount of unsaturated fatty acids affect membrane permeability?

How does the amount of unsaturated fatty acids affect membrane permeability?

- Unsaturation causes a bend in the fatty acid tails
- This means they cannot pack as tightly together which allows more substances to pass through the membrane so the membrane is more permeable

How do organic solvents affect membrane fluidity?

How do organic solvents affect membrane fluidity?

Organic solvents can disrupt or even dissolve the membrane, making it more fluid

Define osmosis

Define osmosis

The **passive** diffusion of water molecules from a region of high water potential to a region of lower water potential (down a water potential gradient) through a **selectively permeable membrane**

What is water potential (Ψ)?

What is water potential (Ψ)?

A measure of the tendency of water molecules to move from one area to another

What unit is water potential measured in?

What unit is water potential measured in?

Kilopascals (KPa)

What is the water potential of **pure** water?

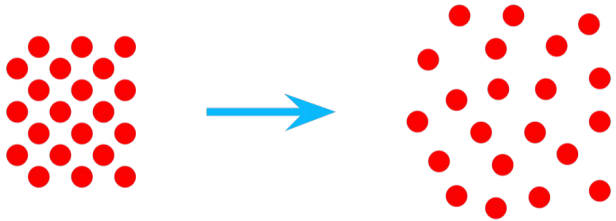
What is the water potential of **pure** water?

0 KPa

Define diffusion

Define diffusion

The random net movement of particles from a high concentration to a low concentration, down their concentration gradient without the use of energy



Define facilitated diffusion

Define facilitated diffusion

The net movement of substances from a high concentration to a lower concentration (down their concentration gradient) through **transport proteins** without the use of energy

Define active transport

Define active transport

The movement of substances from a low concentration to a higher concentration (**against** the concentration gradient) through **carrier proteins** with the use of energy in the form of **ATP**

What are the two mechanisms of bulk transport?

What are the two mechanisms of bulk transport?

Endocytosis

Exocytosis

Define endocytosis

Define endocytosis

The bulk uptake of substances into a cell by invagination of the membrane to form a vesicle. Uses energy in the form of ATP

State the two types of endocytosis

State the two types of endocytosis

Phagocytosis

Pinocytosis

What is pinocytosis?

What is pinocytosis?

The bulk uptake of **liquids** into the cell using energy in the form of ATP

What is phagocytosis?

What is phagocytosis?

The bulk uptake of **solids** into the cell using energy in the form of ATP

Define exocytosis

Define exocytosis

The bulk transport of substances out of a cell via a vesicle that fuses with the plasma membrane. Uses energy in the form of ATP

What are two differences between carrier proteins and channel proteins?

What are two difference between carrier proteins and channel proteins?

- Channel proteins provide a **hydrophilic** passage for molecules to **passively** diffuse through
- Carrier proteins can transport substances across a membrane through conformational changes which can be either **passive** or **active**