

Gas exchange, membranes and transport

**State three properties of a gas exchange surface.**

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**State Fick's law of diffusion.**

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**Why do large organisms need specialised gas exchange surfaces?**

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**Name the path of air to the gas exchange surface in a mammal.**

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**How does ventilation help gas exchange?**

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**How is an alveolus adapted for rapid diffusion?**

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**Describe the arrangement of phospholipids in a membrane.**

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**What is the role of cholesterol in a membrane?**

Rate of diffusion  $\propto$  (surface area  $\times$  difference in concentration)  $\div$  thickness of the exchange surface.

Large surface area to volume ratio, thin (short diffusion distance), large difference in concentration (steep gradient).

Trachea, bronchi, bronchioles, alveoli.

They have a small surface area to volume ratio, so diffusion across the body surface is too slow to supply all cells.

Walls one cell thick; very many alveoli; capillary network around each; elastic fibres.

Brings in fresh air and removes carbon dioxide, so the concentration gradients are maintained.

Lies between phospholipid tails; regulates fluidity and stabilises the membrane.

A bilayer: hydrophilic heads face the water on both sides, hydrophobic tails face inwards.

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**What are glycoproteins and glycolipids used for in membranes?**

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**Why is the fluid mosaic model called a model?**

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**What did the cell fusion experiment (mouse and human cells) show?**

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**Why does beetroot pigment leak at high temperature?**

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**How is the colour of the liquid measured in core practical 3?**

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**How does ethanol affect membrane permeability?**

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**Define osmosis.**

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

It is an explanation built from, and revised in the light of, experimental data.

Cell recognition (antigens) and receptors for hormones and other signals.

Membrane proteins denature and the bilayer becomes more fluid, so permeability increases.

Fluorescently labelled surface proteins mixed over time, so proteins can move within the membrane: it is fluid.

It dissolves lipids and disrupts the phospholipid bilayer, so the membrane becomes more permeable.

With a colorimeter (blue-green filter), zeroed on distilled water, or by comparing with colour standards.

Zero kPa, the highest value. Solutions have negative water potentials.

The net movement of free water molecules through a partially permeable membrane, down a water potential gradient.

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**What happens to a plant cell in a solution of lower water potential?**

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**Percentage change in mass: formula?**

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**Define facilitated diffusion.**

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**Channel protein or carrier protein: which changes shape during transport?**

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**Define active transport.**

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**What happens to ATP in active transport?**

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**Difference between endocytosis and exocytosis?**

Proteins and enzymes

**Draw (describe) the general structure of an amino acid.**

$$\frac{(\text{final mass} - \text{initial mass})}{\text{initial mass}} \times 100.$$

Water leaves by osmosis; the cytoplasm shrinks away from the cell wall (plasmolysis).

Carrier protein. Channel proteins form a pore (often gated).

Passive movement of ions or polar molecules down a concentration gradient through channel or carrier proteins.

It is hydrolysed to ADP + P<sub>i</sub>, releasing energy to change the shape of the carrier protein.

Movement of molecules or ions across a membrane against a concentration gradient, using ATP and carrier proteins.

Central carbon bonded to an amino group (-NH<sub>2</sub>), a carboxyl group (-COOH), a hydrogen atom and an R group.

Endocytosis takes material into the cell in a vesicle from the membrane; exocytosis releases material by vesicle fusion with the membrane.

Proteins and enzymes

**How is a peptide bond formed?**

Proteins and enzymes

**What is the difference between a polypeptide and a protein?**

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**What does the biuret test detect, and what is a positive result?**

Proteins and enzymes

**What is the primary structure of a protein?**

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**Which bonds hold the secondary structure?**

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**Which bonds hold the tertiary structure?**

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**What is quaternary structure?**

Proteins and enzymes

**Describe the structure of haemoglobin.**

A polypeptide is a chain of amino acids; a protein is one or more polypeptides folded into a functional shape.

By a condensation reaction between the carboxyl group of one amino acid and the amino group of another; water is released.

The sequence of amino acids in the polypeptide chain, joined by peptide bonds.

Peptide bonds / protein. Purple (lilac) colour.

Hydrogen bonds, ionic bonds and disulfide bonds, plus hydrophobic interactions.

Hydrogen bonds between the backbone C=O and N-H groups (alpha helix, beta pleated sheet).

Globular, soluble; four polypeptide chains (two alpha, two beta), each with a haem group containing  $\text{Fe}^{2+}$  that binds  $\text{O}_2$ .

More than one polypeptide chain in a protein (for example the four chains of haemoglobin).

Proteins and enzymes

**Why does collagen have high tensile strength?**

Proteins and enzymes

**Compare globular and fibrous proteins.**

Proteins and enzymes

**What is an enzyme?**

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**Why are enzymes specific?**

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**Intracellular vs extracellular enzymes: examples?**

Proteins and enzymes

**Why does an enzyme denature above its optimum temperature?**

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**What limits the rate at high substrate concentration?**

Proteins and enzymes

**How do you find the initial rate from a graph?**

Globular: compact, soluble, metabolic role.  
Fibrous: long, insoluble, structural role.

Three polypeptides wound in a triple helix with hydrogen bonds, and covalent cross-links between molecules.

The active site has a three-dimensional shape complementary to only one substrate (or a few similar ones).

A globular protein that acts as a biological catalyst by lowering the activation energy of a reaction.

Hydrogen and ionic bonds break, the tertiary structure and active site change shape, so substrate no longer fits.

Intracellular: catalase, enzymes of respiration. Extracellular: amylase, trypsin (secreted to digest food).

Gradient of the tangent at time zero on a graph of product against time.

Enzyme concentration: all active sites are occupied (saturated).

Proteins and enzymes

**Why is the initial rate measured?**

DNA, the genetic code and gene expression

**What are the three parts of a mononucleotide?**

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**Which bond joins nucleotides in a polynucleotide?**

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**State the complementary base pairs in DNA.**

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**Two differences between DNA and RNA nucleotides?**

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**What does semi-conservative replication mean?**

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**What is the role of DNA polymerase?**

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**What do the template strands do in replication?**

A pentose sugar (deoxyribose or ribose), a phosphate group and a base.

The substrate concentration is highest and the product has not built up, so the comparison is fair.

A-T (two hydrogen bonds); C-G (three hydrogen bonds).

A phosphodiester bond, formed by condensation between a phosphate and a sugar.

Each new DNA molecule has one original strand and one new strand.

RNA has ribose (not deoxyribose) and uracil (not thymine).

Each acts as a template, so new nucleotides pair by complementary base pairing.

Joins free nucleotides complementary to the template strand, forming phosphodiester bonds.

DNA, the genetic code and gene expression

**Meselson and Stahl: result after one generation?**

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**Meselson and Stahl: result after two generations?**

DNA, the genetic code and gene expression

**Describe the genetic code.**

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**Define a gene.**

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**Why is the genetic code degenerate?**

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**What is transcription?**

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**What is the template (antisense) strand?**

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**Where does the mRNA go after transcription?**

Two bands: intermediate and light in equal amounts, which refuted the dispersive model.

One intermediate-density band (hybrid DNA), which refuted the conservative model.

A sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain.

Triplet code (three bases per amino acid), non-overlapping and degenerate.

Making mRNA from the template strand of a gene, by RNA polymerase, in the nucleus.

64 possible triplets but only 20 amino acids, so most amino acids have more than one codon.

Out of the nucleus through a nuclear pore to a ribosome in the cytoplasm.

The DNA strand copied by RNA polymerase; mRNA is complementary to it.

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**What is translation?**

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**What is the start codon and what does it code for?**

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**Role of tRNA?**

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**How does translation end?**

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**Name three types of gene mutation.**

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**Why does an insertion or deletion usually have a large effect?**

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**Why do many mutations have no observable effect?**

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**How can mutations lead to cancer?**

AUG; codes for methionine and starts translation.

Making a polypeptide at a ribosome using the codons of mRNA, with tRNA bringing amino acids.

At a stop codon (UAA, UAG, UGA): no tRNA matches, so the polypeptide is released.

Its anticodon pairs with an mRNA codon and it carries the matching amino acid to the ribosome.

It causes a frameshift: every codon after the change is altered.

Substitution, insertion, deletion (of bases).

Mutations in genes controlling cell division cause uncontrolled division, forming a tumour.

The code is degenerate, or the change is in non-coding DNA, or the protein's function is unchanged.

Inheritance, cystic fibrosis and genetic screening

**Define allele.**

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**Define genotype and phenotype.**

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**Define homozygote and heterozygote.**

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**Define codominance, with an example.**

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**What is the phenotype ratio from  $Aa \times Aa$ ?**

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**How does a pedigree show a recessive allele?**

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**How does a pedigree show a dominant allele?**

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**Why are X-linked recessive conditions more common in males?**

Genotype: the alleles an organism has.  
Phenotype: its observable characteristics.

One of the different forms of a gene.

Both alleles are expressed in the heterozygote, for example the  $I^A$  and  $I^B$  alleles giving blood group AB.

Homozygote: two identical alleles.  
Heterozygote: two different alleles.

Two unaffected parents have an affected child.

3 dominant : 1 recessive.

Males have only one X chromosome, so a single recessive allele is expressed.

Two affected parents have an unaffected child.

Inheritance, cystic fibrosis and genetic screening

**Can a colour-blind father pass colour blindness to his son?**

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**What protein is faulty in cystic fibrosis?**

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**How does the mutation cause thick mucus?**

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**Effect of cystic fibrosis on the digestive system?**

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**Effect of cystic fibrosis on the reproductive system?**

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**What is PGD?**

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**What is amniocentesis?**

Inheritance, cystic fibrosis and genetic screening

**What is chorionic villus sampling?**

The CFTR protein, a chloride ion channel in cell-surface membranes.

No: sons inherit his Y chromosome. His daughters inherit the allele and become carriers.

Pancreatic duct blocked; enzymes do not reach the small intestine; poor digestion and absorption.

Chloride and so water are not secreted out of cells by osmosis, so the mucus is thick and sticky.

Pre-implantation genetic diagnosis: cells taken from IVF embryos are tested, and only unaffected embryos are implanted.

Males: blocked or missing vas deferens, infertility. Females: thick cervical mucus reduces fertility.

Taking placental cells (chorionic villi) from about 11 weeks to test the fetus's DNA or chromosomes.

Taking amniotic fluid with fetal cells using a needle (about 15 weeks) to test the fetus's DNA or chromosomes.

Inheritance, cystic fibrosis and genetic screening

**Name a risk of prenatal tests.**

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**Give a social issue raised by genetic screening.**

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**Give a moral argument against embryo screening.**

Inheritance, cystic fibrosis and genetic screening

**Give a religious viewpoint on screening.**

Discrimination by insurers or employers,  
pressure on parents, or unequal access.

A small risk of miscarriage.

Some traditions hold life is sacred from  
conception, so termination or discarding  
embryos is wrong; others accept screening.

Embryos may have a right to life; selection  
could lead to designer babies.