# OCR (B) Biology A-level

## 2.1.1 - Cells and microscopy

Flashcards

# Describe how light microscopes work.

# Describe how light microscopes work.

1. Lenses focus rays of light and magnify the image.
2. Different structures absorb different amounts and wavelengths of light.
3. Reflected light is transmitted to the observer via the objective lens and eyepiece lens.

# Describe how a Transmission Electron Microscope (TEM) works.

# Describe how a Transmission Electron Microscope (TEM) works.

1. High energy **beam of electrons** passed through a thin slice of specimen.
2. More dense structures absorb more electrons so appear darker.
3. Image focussed onto a fluorescent screen or photographic plate using magnetic lenses.

# Describe how a Scanning Electron Microscope (SEM) works.

# Describe how a scanning electron microscope (SEM) works.

1. Beam of electrons focussed onto the surface of a specimen using electromagnetic lenses.
2. Reflected electrons hit a collecting device and are amplified to produce an image on a photographic plate.

# Describe how a laser scanning confocal microscope works.

# Describe how a laser scanning confocal microscope works.

1. Laser beam focussed onto a small area on the surface of a sample using objective lenses.
2. Fluorophores in the sample emit photons.
3. Photomultiplier tube amplifies the signal onto a detector. An image is produced pixel by pixel in the correct order.

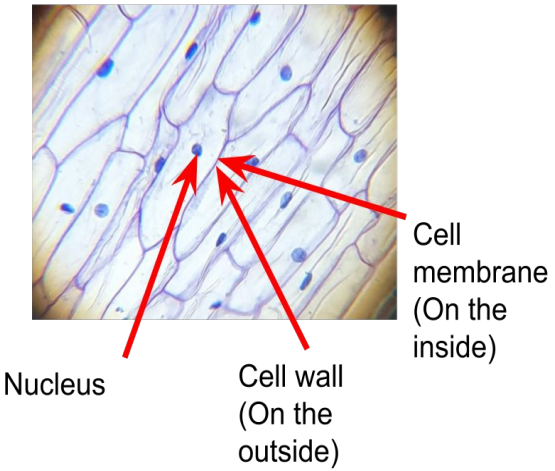
# How should the field of view in microscopy be recorded?

# How should the field of view in microscopy be recorded?

Draw a diagram with a sharp pencil. Do not use sketchy lines or shading.

Include a scale bar.

Annotate visible structures.



# Why do samples need to be stained for observation using light microscopes?

# Why do samples need to be stained for observation using light microscopes?

Coloured dye binds to structures, facilitating the absorption of wavelengths of light to produce an image.

Differential staining: contrast between heavily & lightly stained areas distinguishes different structures.

# Outline how to prepare a sample of blood to be observed under a microscope.

# Outline how to prepare a sample of blood to be observed under a microscope.

1. Smear a drop of blood onto a slide using a spreader held at a 45° angle.
2. Add Leishman's stain which stains the nuclei of leucocytes blue/purple.
3. Add a buffer and rinse.

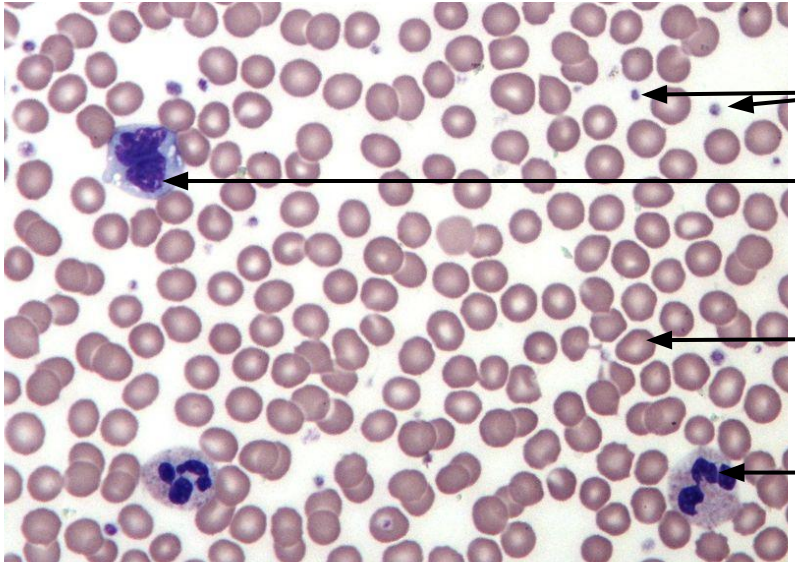
# Describe the specialised cell types in blood.

# Describe the specialised cell types in blood.

- Red blood cells (**erythrocytes**): Biconcave, no nucleus, lots of haemoglobin. Carry oxygen.
- **Platelets**: Cell fragments. Involved in blood clotting.
- **Neutrophils**: Lobed nucleus. Engulf foreign material.
- **Lymphocytes**: Little cytoplasm, nucleus stains deep blue. Release antibodies, engulf pathogens.
- **Monocytes**: Largest leucocyte, agranular cytoplasm. Respond to inflammation.

# How are cells in a blood smear identified?

# How are cells in a blood smear identified?



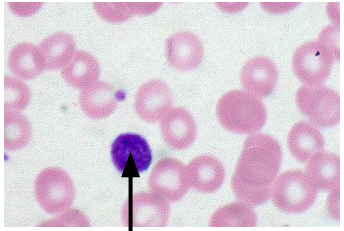
platelets

monocyte

erythrocytes

neutrophil

Image source: Scooter Project, CC BY-SA 3.0



lymphocyte

Image source: Ed Uthman, CC BY 3.0

Describe the general structure of an animal cell. Which features can be distinguished using a light microscope?

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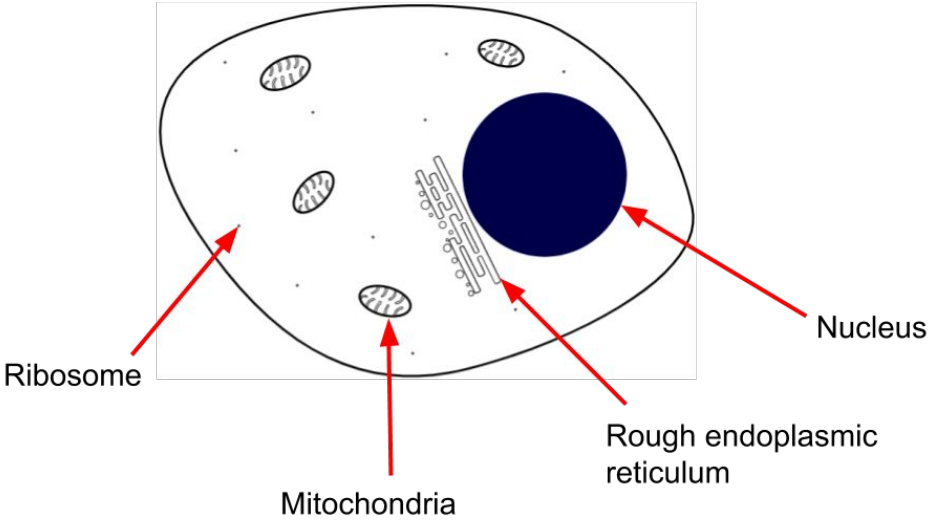


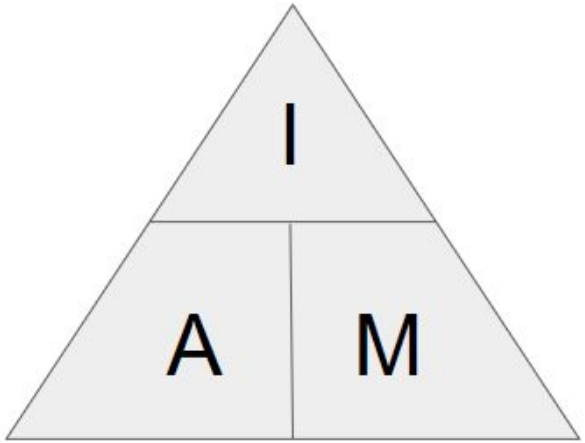

Light microscope can be used to view:

- cell membrane
- cytoplasm
- nucleus
- mitochondria

State an equation to calculate the actual linear dimension of a structure from microscopy.

State an equation to calculate the actual linear dimension of a structure from microscopy.

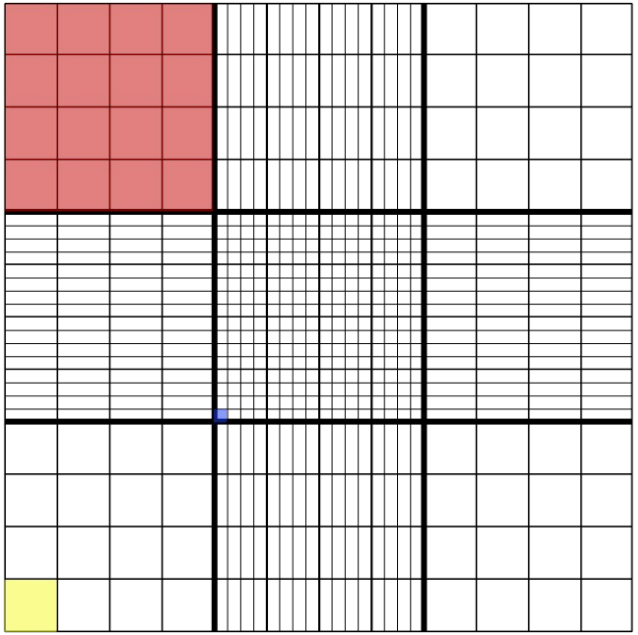
$$\text{actual size} = \frac{\text{image size}}{\text{magnification}}$$



# What is a haemocytometer?

# What is a haemocytometer?

Glass microscope slide with a grid divided into 9 squares, each 1mm$^2$. Central area for counting contains 25 large squares, each divided into 16 smaller squares.

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# Outline how to count the number of erythrocytes in a blood sample.

# Outline how to count the number of erythrocytes in a blood sample.

Use 10× magnification to focus on a haemocytometer. Dilute the sample so cells do not overlap and are evenly distributed.

To avoid counting cells twice, count only cells within squares and those that touch 2 chosen edges of the large square (e.g. right edge of one square forms the left edge of adjacent square).

# How can cell concentration be determined from a haemocytometer?

# How can cell concentration be determined from a haemocytometer?

average cell count × $10^4$ × dilution factor

# What is flow cytometry?

# What is flow cytometry?

Analysis technique used to determine cell phenotype and health e.g. to examine blood.

A suspension of cells with fluorescently tagged proteins is streamed past lasers. Light is emitted and scattered into distinct wavelengths that can be detected by photodiodes or photomultiplier tubes.

# Describe the structure of the cell surface membrane.

# Describe the structure of the cell surface membrane.

‘**Fluid mosaic**’ **phospholipid bilayer** with **extrinsic** and **intrinsic proteins** embedded.

# Describe the functions of the cell surface membrane.

# Describe the functions of the cell surface membrane.

- Isolates cytoplasm from extracellular environment
- Selectively permeable to regulate transport of substances
- Involved in cell signalling/cell recognition

# Explain the role of cholesterol, glycoproteins and glycolipids in the cell surface membrane.

# Explain the role of cholesterol, glycoproteins and glycolipids in the cell surface membrane.

**cholesterol**: steroid molecule, connects phospholipids and reduces fluidity

**glycoproteins**: cell signalling, cell recognition (antigens) and binding cells together

**glycolipids**: cell signalling & cell recognition

# Describe the structure of the nucleus.

# Describe the structure of the nucleus.

- Surrounded by **nuclear envelope** which is semi-permeable and double membraned
- **Nuclear pores** allow substances to enter/exit
- Dense **nucleolus** (made of RNA and proteins) assembles ribosomes

# Describe the function of the nucleus.

# Describe the function of the nucleus.

- Contains DNA coiled around chromatin into chromosomes
- Controls cellular processes: gene expression determines specialisation, the site of mRNA transcription, mitosis and semiconservative replication

# Describe the structure and function of a mitochondrion.

# Describe the structure and function of a mitochondrion.

- Surrounded by a double membrane
- Folded inner membrane forms **cristae**: site of electron transport chain
- Fluid **matrix**: contains mitochondrial DNA, respiratory enzymes, lipids and proteins
- Site of aerobic respiration to produce ATP

# Describe the structure of the Golgi apparatus.

# Describe the structure of the Golgi apparatus.

- Planar **stack of membrane-bound, flattened sacs**.
- **Cis face** aligns with RER.
- Molecules are processed in **cisternae**.
- Vesicles bud off **trans face** via exocytosis.

# Describe the function of the Golgi apparatus.

# Describe the function of the Golgi apparatus.

- Modifies and packages proteins for export
- Synthesises glycoproteins

# Describe the structure of a lysosome.

# Describe the structure of a lysosome.

- **Sac** surrounded by single membrane
- Embedded **$H^+$ pump** maintains acidic conditions
- Contains digestive **hydrolase enzymes**
- **Glycoprotein coat** protects cell interior

# Describe the function of a lysosome.

# Describe the function of a lysosome.

- Role in phagocytosis
- Digest unwanted materials in the cytoplasm

# Describe the structure of vesicles.

# Describe the structure of vesicles.

- Temporary membrane-bound sacs containing water and chemicals (e.g. neurotransmitters)
- Numerous and much smaller than in plants

# Describe the function of vesicles.

# Describe the function of vesicles.

- Involved in exocytosis, endocytosis and the transport of materials in the cytoplasm
- Storage of enzymes

# Describe the structure of centrioles.

# Describe the structure of centrioles.

- Spherical group of 9 microtubules arranged in triples
- Located in centrosomes

# Describe the function of centrioles.

# Describe the function of centrioles.

- Migrate to opposite poles of the cell during prophase
- Involved in the organisation of spindle fibres

# Describe the structure of ribosomes.

# Describe the structure of ribosomes.

- Made from **rRNA** and **proteins**
- Found free in the cytoplasm or associated with the RER

# Describe the function of ribosomes.

# Describe the function of ribosomes.

Site of protein synthesis (translation)

- **Large subunit** joins amino acids
- **Small subunit** reads RNA

# Describe the structure of the endoplasmic reticulum (ER).

# Describe the structure of the endoplasmic reticulum (ER).

**Cisternae**: network of tubules and flattened sacs extends from cell membrane through cytoplasm and connects to nuclear envelope.

Two types: **rough ER** and **smooth ER**.

# Describe the function of the smooth endoplasmic reticulum (SER).

Describe the function of the smooth endoplasmic reticulum (SER).

Lipid synthesis

# Describe the function of the rough endoplasmic reticulum (RER).

Describe the function of the rough endoplasmic reticulum (RER).

Many ribosomes attached for protein synthesis & transport.

# Describe the structure of a chloroplast.

# Describe the structure of a chloroplast.

- Vesicular plastid with double membrane
- **Thylakoids:** flattened discs stacked to form grana
- **Grana:** contain photosystems with chlorophyll
- **Intergranal lamellae:** tubes attach thylakoids in adjacent grana
- **Stroma:** fluid-filled matrix

# What is the function of a chloroplast?

# What is the function of a chloroplast?

Site of photosynthesis

# Describe the structure of the plant cell wall.

# Describe the structure of the plant cell wall.

- Made of cellulose **microfibrils**
- **Plasmodesmata** allow molecules to pass between cells
- **Middle lamella** acts as boundary between adjacent cell walls

# Describe the function of the plant cell wall.

# Describe the function of the plant cell wall.

- Mechanical strength and support
- Physical barrier against pathogens
- Part of **apoplast pathway** for easy diffusion of water

# Describe the structure of the cell vacuole in plants.

# Describe the structure of the cell vacuole in plants.

- Surrounded by a single membrane: **tonoplast**
- Contains **cell sap**: mineral ions, water, enzymes, soluble pigments

# Describe the function of the cell vacuole in plants.

# Describe the function of the cell vacuole in plants.

- Controls turgor pressure
- Absorbs and hydrolyses potentially harmful substances in the cytoplasm

# Describe the structure and function of flagella and pili in prokaryotes.

# Describe the structure and function of flagella and pili in prokaryotes.

**Flagella**: Hollow helical tubes made of the protein flagellin, rotate to propel organism.

**Pili**: Hairlike microfibers made of the protein pilin, found on the surface of some Gram negative bacteria, enable attachment to surfaces e.g. other cells.

# How is genetic information stored in prokaryotes?

# How is genetic information stored in prokaryotes?

**Plasmids**: Small rings of DNA carry non-essential genes. They can be exchanged between bacterial cells via conjugation.

**Loop of DNA**: Circular DNA stored in the nucleoid region of the cell.

# Describe the structure and function of the mesosome.

# Describe the structure and function of the mesosome.

- Infolds of the cell membrane
- Increase the surface area of the cell, aiding cellular respiration

# Describe the structure and function of the cytoskeleton.

# Describe the structure and function of the cytoskeleton.

- Found in all cells but most significant in eukaryotes
- Network of microtubules and filaments that extend through the cytoplasm
- Provide mechanical strength, aid transport within cells and involved in cell movement.

Which organelles are found in both eukaryotic and prokaryotic cells.

Which organelles are found in both eukaryotic and prokaryotic cells?

- Cell membrane
- Cytoplasm with a form of cytoskeleton (although cytoskeleton of eukaryotes is more significant)
- Ribosomes

# Contrast eukaryotic and prokaryotic cells.

# Contrast eukaryotic and prokaryotic cells.

| Prokaryotic | Eukaryotic |
|---|---|
| small cells and always unicellular | larger cells and often multicellular |
| no membrane-bound organelles, no nucleus | always have organelles and nucleus |
| circular DNA not associated with proteins | linear chromosomes associated with histones |
| small ribosomes (70S) | larger ribosomes (80S) |
| binary fission - always asexual reproduction | mitosis & meiosis - sexual and/or asexual |
| cellulose cell wall (plants)/ chitin (fungi) | murein cell walls |
| capsule, sometimes plasmids | no capsule, no plasmids, always cytoskeleton |

# Compare and contrast eukaryotic plant and animal cells.

# Compare and contrast eukaryotic plant and animal cells.

| Plant cell | Animal cell |
|---|---|
| Cellulose cell wall | No cell wall |
| Large permanent vacuole | Small temporary vacuoles (vesicles) |
| Contain chloroplasts | No chloroplasts |
| No pseudopodia | May have pseudopodia |
| Otherwise, same organelles and 80S ribosomes | |

# Explain how to use an eyepiece graticule and stage micrometer to measure the size of a structure.

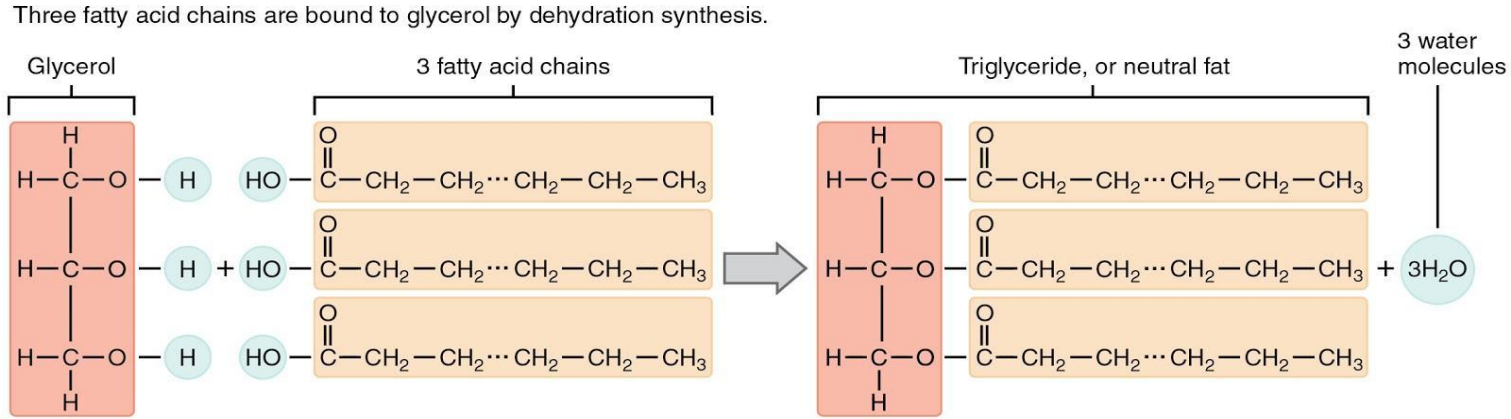
# Explain how to use an eyepiece graticule and stage micrometer to measure the size of a structure.

1. Place micrometer on stage to calibrate eyepiece graticule.
2. Line up scales on graticule and micrometer.
3. Count how many graticule divisions are in 100μm on the micrometer.
4. length of 1 eyepiece division = 100μm ÷ number of divisions
5. Use calibrated values to calculate actual length of structures.

# How do triglycerides form?

# How do triglycerides form?

**Condensation** reaction between **1** molecule of **glycerol** and **3 fatty acids**. Forms **ester bonds.**

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# Relate the structure of triglycerides to their functions.

# Relate the structure of triglycerides to their functions.

- High energy to mass ratio - **high calorific value** from oxidation (energy storage)
- Insoluble hydrocarbon chain - doesn't affect water potential of cells, used for **waterproofing**
- Slow conductor of heat - **thermal insulation** e.g. adipose tissue
- Less dense than water - **buoyancy** of aquatic animals

# Describe the structure and function of phospholipids.

# Describe the structure and function of phospholipids.

Amphipathic molecule: **glycerol** backbone attached to **2 hydrophobic fatty acid** tails and **1 hydrophilic polar phosphate** head.

- Forms phospholipid **bilayer** in water - component of membranes
- Tails can splay outwards - waterproofing

# Define simple diffusion.

# Define simple diffusion.

**Passive process** requiring no energy.

**Net movement** of **small, lipid-soluble** molecules directly through a bilayer from an area of high concentration to an area of lower concentration (i.e. **down a concentration gradient**).

# Define facilitated diffusion.

# Define facilitated diffusion.

**Passive process** requiring no energy.

Specific **channel** or **carrier proteins** with complementary binding sites transport **large and/or polar molecules/ions** (not soluble in hydrophobic phospholipid tail) **down their concentration gradient**.

# State 5 factors that affect the rate of diffusion.

# State 5 factors that affect the rate of diffusion.

- Temperature
- Diffusion distance
- Surface area
- Size of molecule
- Steepness of concentration gradient

# Explain how channel proteins work.

# Explain how channel proteins work.

- Hydrophilic channels bind to specific ions
- One side of the protein closes and the other opens

# Explain how carrier proteins work.

# Explain how carrier proteins work.

- Carrier protein binds to complementary molecule
- Conformational change releases molecule to the other side of the membrane
- Facilitated diffusion - passive process
- Active transport - requires energy from ATP hydrolysis

# Define active transport.

# Define active transport.

**Active process**: ATP hydrolysis releases a phosphate group. This binds to a carrier protein, causing it to change shape.

Specific carrier protein transports molecules/ ions from area of low concentration to area of higher concentration (i.e. **against** concentration gradient).

# Define exocytosis.

# Define exocytosis.

- **Active process**
- The mass movement of material out of the cell

# Define endocytosis.

# Define endocytosis.

- **Active process**
- The mass movement of material into the cell

# Describe the functions of membranes within cells.

# Describe the functions of membranes within cells.

- Provide internal transport system
- Selectively permeable to regulate the passage of molecules into/out of organelles or within organelles
- Provide reaction surface
- Isolate organelles from the cytoplasm for specific metabolic reactions

# How are the organelles involved in producing and secreting proteins interrelated?

# How are the organelles involved in producing and secreting proteins interrelated?

- Genetic code from the nucleus is transcribed into mRNA which attaches to ribosomes for protein synthesis.
- Ribosomes are attached to the RER. Golgi apparatus, which modifies proteins for secretion, aligns with the RER.
- Proteins associate with lipids to form vesicles for exocytosis. Motor proteins from the cytoskeleton move vesicles.