A Cell structure
Microscopy

Light microscopes and electron microscopes

Cells are the basic units from which living organisms are made. Most cells are very small, and their structures can only be seen by using a microscope.

- Cell structure
- Microscopy

**Magnification and resolution**

Magnification can be defined as:

\[
\text{magnification} = \frac{\text{size of image}}{\text{actual size of object}}
\]

This can be rearranged to:

\[
\text{actual size of object} = \frac{\text{size of image}}{\text{magnification}}
\]

As cells are very small, we have to use units much smaller than millimetres to measure them. These units are micrometres, µm, and nanometres, nm.

- 1 mm = 1 x 10^3 mm
- 1 µm = 1 x 10^-6 mm
- 1 nm = 1 x 10^-9 mm

To change mm into µm, multiply by 1000.

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**Measuring cells using a graticule**

An eyepiece graticule is a little scale bar that you can place in the eyepiece of your light microscope. When you look down the microscope, you can see the graticule as well as the specimen.

The graticule is marked off in graticule units, so you can use the graticule to measure the specimen you are viewing in these graticule units. Just turn the eyepiece so that the graticule scale lies over the object you want to measure. It will look like this:

![Graticule Image]

We can say that the width of one cell is 2.3 graticule units.
You can see that the 60 mark on the stage micrometer is lined up with the 1.0 mark on the eyepiece graticule. Work along towards the right until you see another two lines that are exactly lined up. There is a good alignment of 68 on the stage micrometer and 90 on the eyepiece graticule. So you can say that:

- 80 small eyepiece graticule markings = 18 stage micrometer markings
  - 18 x 0.01 mm = 0.18 mm
  - 180μm

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**Prokaryotic cells**

- Cell wall made of peptidoglycan
- Membranes surface membrane
- Cyttoplasm
- Circular DNA
- Plasmid

Structure of a prokaryotic cell
**Cell structure and function**

- **Cell wall**
- **Plasmic surface membrane**
- **Chloroplast**
- **Plasmid**

**A typical plant cell, ×1500**

**Organelles**

- **Suspended in the cytoplasm are organelles, specialized structures that carry out particular functions.**
- **The nucleus contains the cell's genetic material.**
- **Chloroplasts are concerned with photosynthesis and contain chlorophyll.**
- **Lysosomes are membrane-bound vacuoles containing digestive enzymes.**
- **Ribosomes are involved in protein synthesis and are sometimes attached to the endoplasmic reticulum (ER) to produce rough ER.**
- **Many plant cells also contain large vacuoles that store water.**
- **The endoplasmic reticulum is a network of unit membranes running throughout the cell.**
- **The Golgi body is an area of the ER particularly concerned with secretory functions.**
- **Mitochondria carry on respiration and are surrounded by a plasma membrane, as are chloroplasts.**

**Cell structure and function**

- **Rough endoplasmic reticulum (RER)**
- **Nucleus**
- **Nucleolus**
- **Plasmic surface membrane**
- **Smooth endoplasmic reticulum (SER)**

**A typical animal cell, ×2000**
Plasma membrane

- All cells are surrounded by a plasma (cell) membrane, which separates and protects the cell and controls movement in and out of it. The plasma membrane is composed of unit membrane, a two-layered structure with proteins on the outer surfaces and hydrophobic (water insoluble) fat molecules on the inside.

Cytoplasm

- Inside the plasma membrane, cytoplasm takes up most of the cell volume. It maintains the shape and consistency of the cell and stores chemical substances needed for life. The cytoplasm is also the site of vital metabolic reactions such as protein synthesis.

Key words

- chlorophyll
- lysosome
- chloroplast
- mitochondrion
- cytoplasm
- organelle
- endoplasmic
- reticulum
- membrane
- Golgi body
- ribosome

Membrane structure

- Membrane structure
- Hydrophobic regions of proteins
- Hydrophilic regions of proteins
- Hydrophilic channels
- Lipid bilayer external layer

The plasma membrane, also known as the cell surface membrane, controls what enters and leaves the cell. Its structure and functions are described in detail on pages 46-61. There are also many membranes within the cell, which help to make different compartments in which different chemical reactions can take place without interfering with one another.
**Protein-lipid mix**

- All membranes in the cell are made of the same basic structure. This is called the unit membrane and consists of two main chemicals: proteins (glycoproteins, etc.) and lipids (glycolipids, etc.).
- Lipids are organic molecules that are insoluble in water.
- The main lipid components of plasma membranes are phospholipids—molecules composed of glycerol, phosphate, and fatty acid residues—and heads with different chemical properties (see bottom diagram). The tails are hydrophobic (water insoluble) fatty acid residues that face the center of the membrane. The heads, which are hydrophilic (water soluble), form the surface.

**Membrane structure**

- Phospholipids form wide, thin bilayers. In between these phospholipids are membrane proteins floating like isobars in a sea of lipid.
- Some proteins reach completely across the lipid molecules. Others protrude above the lipid layer on one side but only get halfway through the fat layer in the middle of the membrane.
- Many of the protein molecules are not fixed—they can drift around in the lipid sea. This fluidity is essential for the proper function of proteins in the membranes.

**Double membranes**

- A unit membrane consists of one lipid layer with protein found on each side. However, the membranes in cells are made of two unit membranes laid on top of each other.

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**Plasma membrane: endocytosis**

**Phagocytosis**

- Large particle taken up by phagocytosis.

**Lysosome**

- Vesicle with waste products moves toward cell membrane.

**Exocytosis of waste products**

Destruction occurs in vacuole and products are absorbed.

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**Plasma membrane: exocytosis**

**Pinosomes**

- Particle is engulfed in vacuole.

**Endosome**

- Vesicle breaks down, releasing parts into cytoplasm.
Lysosomes

Mitochondrion: structure

Inti

**FUNGSI INTI ATAU NUKLEUS SEBAGAI PUSAT PENGATUR GENETIK SEL**

"BLUE PRINT" HEREDITAS SEL YANG MENGGATUR: AKTIVITAS SEL

DNA DIKAT PROTEIN MEMBENTUK BENANG PANJANG YANG DISEBUT KROMATIN

SELAMA MAJA REPRODUKSI SEL, KROMATIN BERGELING KE DALAM STRUKTUR YANG DISEBUT KROMOSOM
Rough endoplasmic reticulum: structure

Functions of membrane systems and organelles

Ribosomes are small structures made of RNA and protein. They are found free in the cytoplasm, and also attached to rough endoplasmic reticulum (RER). The RER is an extensive network of membranes in the cytoplasm. The membranes enclose small spaces called cisternae. Proteins are made on the ribosomes, by linking together amino acids.

Smooth endoplasmic reticulum (SER) is usually less extensive than RER. It does not have ribosomes attached to it, and the cisternae are usually more flattened than those of the RER. It is involved in the synthesis of steroid hormones and the breakdown of toxins.

Mitochondrion: structure

Mitochondria have an envelope (two membranes) surrounding them. The inner one is folded to form cristae. This is where aerobic respiration takes place, producing ATP. The first stage of this process, called the Krebs cycle, takes place in the matrix.
Mitokondria

- Mitokondria adalah organel yang penting dalam sel karena berfungsi sebagai pabrik energi bagi sel.
- Dalam sel, mitokondria berfungsi untuk mengubah bahan bakar menjadi energi dalam bentuk ATP.

Sel prokariot

- Sel prokariot memiliki ukuran yang lebih kecil (0.5-1 μm).
- Sel prokariot tidak memiliki membran nukleus (inti) seperti sel eukariot.
- DNA sel prokariot biasanya terletak dalam plasmid, bukan dalam memori nukleusa.

*Ukuran relatif hecii (Ø 0,5-1 μm)*
*Tidak memiliki membran nukleus (inti)*
*DNA yang bentuk dengan sitoplasma secara tidak langsung* (eukariot)
*Sitoplasma mengandung ribosa*
*Sel dibungkus oleh plasma membran, dinding luar sel yang kompleks pili, hadang-hadang berlagel*

**Comparison of prokaryotic, animal and plant cells**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Prokaryotic cells</th>
<th>Eukaryotic cells</th>
<th>Animal cells</th>
<th>Plant cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma/cell surface membrane</td>
<td>Always present</td>
<td>Always present</td>
<td>Always present</td>
<td>Always present</td>
</tr>
<tr>
<td>Cell wall</td>
<td>Always present; made up of peptidoglycan</td>
<td>Never present</td>
<td>Always present</td>
<td>made up of cellulose</td>
</tr>
<tr>
<td>Nucleus and nuclear envelope</td>
<td>Never present</td>
<td>Always present</td>
<td>Always present</td>
<td>Always present</td>
</tr>
<tr>
<td>Chromosomes</td>
<td>Contain so-called &quot;bacterial chromosomes&quot; — a circular molecule of DNA not associated with histones; bacteria may also contain smaller circles of DNA called plasmids</td>
<td>Contain several chromosomes, each made up of a linear DNA molecule associated with histones</td>
<td>Contain several chromosomes, each made up of a linear DNA molecule associated with histones</td>
<td></td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Never present</td>
<td>Usually present</td>
<td>Usually present</td>
<td>Usually present</td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>Never present, though some do contain chlorophyll or other photosynthetic pigments</td>
<td>Never present</td>
<td>Sometimes present</td>
<td></td>
</tr>
<tr>
<td>Rough and smooth endoplasmic reticulum and Golgi apparatus</td>
<td>Never present</td>
<td>Usually present</td>
<td>Usually present</td>
<td></td>
</tr>
<tr>
<td>Ribosomes</td>
<td>Present, about 18 nm diameter</td>
<td>Present, about 23 nm diameter</td>
<td>Present, about 23 nm diameter</td>
<td></td>
</tr>
<tr>
<td>Centrosomes</td>
<td>Never present</td>
<td>Usually present</td>
<td>Never present</td>
<td></td>
</tr>
</tbody>
</table>
HIV

HIV viruses budding from an infected human T lymphocyte. The cell is at bottom (pink). Four viruses are seen in different stages of budding: at center left the virus acquires its coat from the cell membrane (red); at right the virus buds from the cell; at center right budding is almost complete; at left the new virus is free-floating. Once free, the HIV virus with central RNA (green) reinfects other T cells. T cells form part of the body’s immune response and are weakened by the HIV virus. Magnification: 86,000×. (NIBSC/Photo Researchers, Inc.)

HIV/AIDS CASES AROUND THE WORLD

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>2001</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>20.3 million</td>
<td>22.5 million</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>180,000</td>
<td>460,000</td>
</tr>
<tr>
<td>South and Southeast Asia</td>
<td>3.8 million</td>
<td>4.1 million</td>
</tr>
<tr>
<td>East Asia</td>
<td>350,000</td>
<td>779,000</td>
</tr>
<tr>
<td>Oceania</td>
<td>25,000</td>
<td>57,000</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.1 million</td>
<td>1.4 million</td>
</tr>
<tr>
<td>Caribbean</td>
<td>240,000</td>
<td>246,000</td>
</tr>
<tr>
<td>Eastern Europe and Central Asia</td>
<td>760,000</td>
<td>1.4 million</td>
</tr>
<tr>
<td>Western and Central Europe</td>
<td>630,000</td>
<td>826,000</td>
</tr>
<tr>
<td>North America</td>
<td>1.2 million</td>
<td>1.5 million</td>
</tr>
</tbody>
</table>

Note: Table values are for adults and children living with HIV. Data is from the 2010 United Nations Report on AIDS.
Question 1

(a) The diagram shows a small part of a cell, as seen using an electron microscope.

(i) Name the parts labelled A to D. (2 marks)

(ii) Describe how part B is involved in the formation of extracellular enzymes. (3 marks)

(iii) Give two reasons, other than the presence of part B, why the cell in the diagram cannot be a prokaryotic cell. (2 marks)

Total: 7 marks