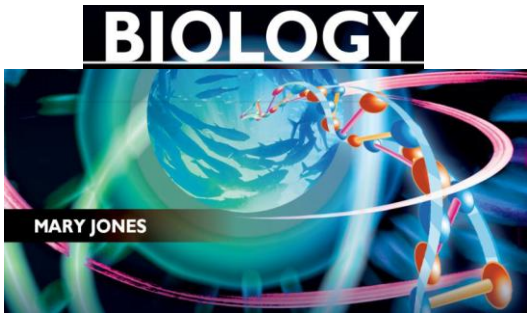


Nur Hidayat

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.

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**.

$1\ \text{mm} = 1 \times 10^{-3}\ \text{m}$
$1\ \mu\text{m} = 1 \times 10^{-6}\ \text{m}$
$1\ \text{nm} = 1 \times 10^{-9}\ \text{m}$

To change mm into µm, multiply by 1000.

Magnification calculations

You should be able to work out the real size of an object if you are told how much it has been magnified.

For example, this drawing of a mitochondrion has been magnified 100000 times.

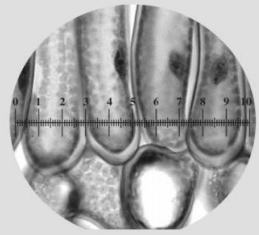
- Use your ruler to measure its length in mm. It is 50 mm long.
- As it is a very small object, convert this measurement to µm by multiplying by 1000.
  $50 \times 1000 = 50000\ \mu\text{m}$.
- Substitute into the equation:

$$\text{actual size of object} = \frac{\text{size of image}}{\text{magnification}}$$
$$= \frac{50000}{100000}$$
$$= 0.5\ \mu\text{m}$$

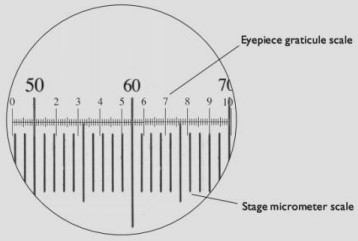
Measuring cells using a graticule

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:



We can say that the width of one cell is 23 graticule units.

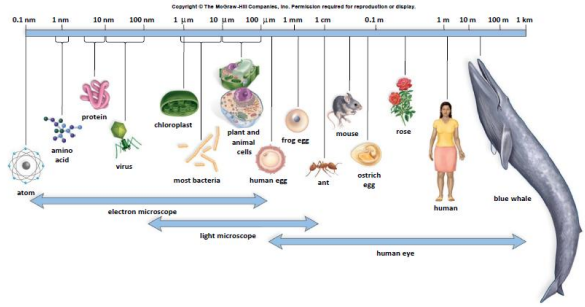


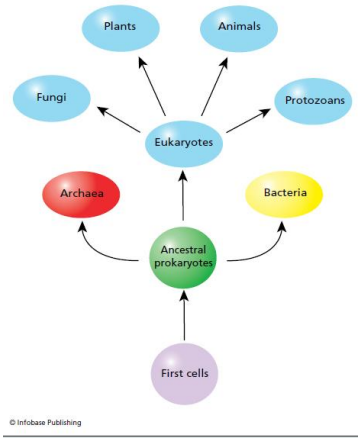
- You can see that the 50 mark on the stage micrometer is lined up with the 1.0 mark on the eyepiece graticule. Work along towards the right until you see another two lines that are exactly lined up. There is a good alignment of 68 on the stage micrometer and 9.0 on the eyepiece graticule. So you can say that:

80 small eyepiece graticule markings = 18 stage micrometer markings

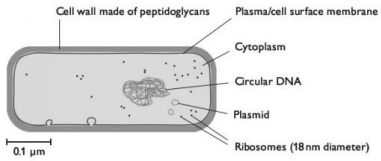
= 18 × 0.01 mm = 0.18 mm

= 180 µm

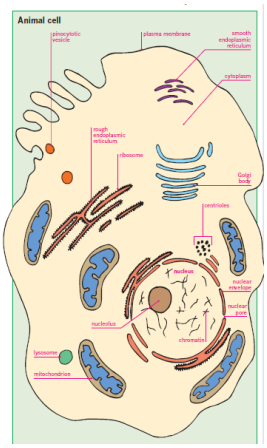


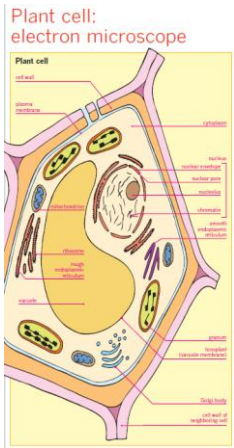


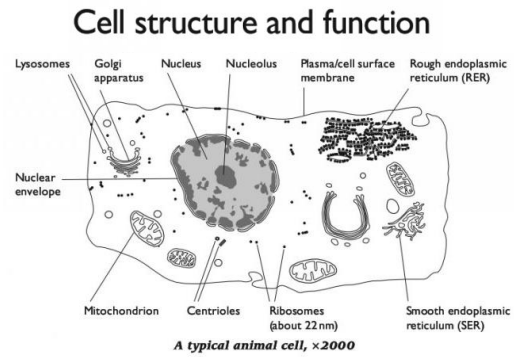
Prokaryotic cells

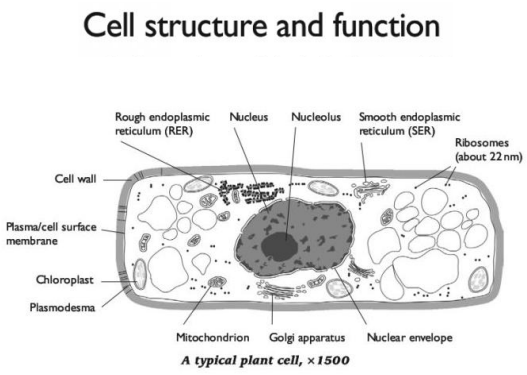


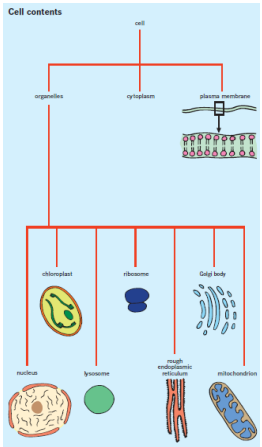
Structure of a prokaryotic cell











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 in groups to the *endoplasmic reticulum* (ER) to produce rough ER.
- Many plant cells also contain a large vacuole that stores waste.
- 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 out respiration and are surrounded by a plasma membrane, as are chloroplasts.

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.

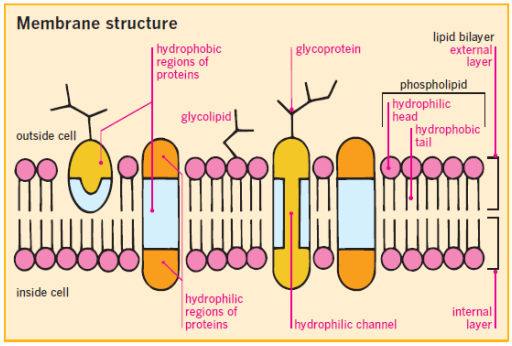
Cytoplasm

- 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.

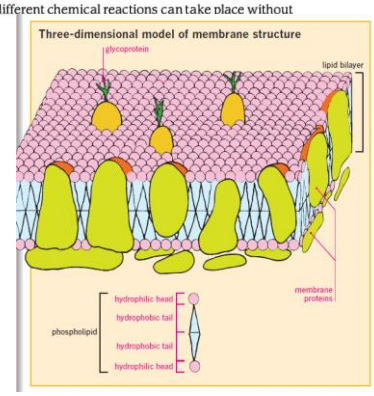
Key words

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

Plasma membrane: structure



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 45–51. 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.



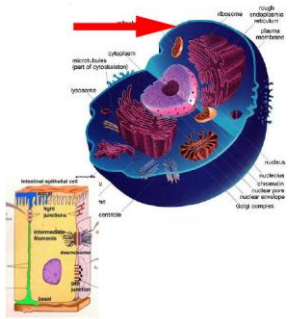
Membran Plasma

BAGIAN PERMUKAAN SEL

FUNGSI: PERLINDUNGAN, DUKUNGAN FISIK DAN KOMUNIKASI ATAU HUBUNGAN DENGAN SEL-SEL LAINNYA

PADA TANAMAN DINDING SEL YANG KAKU -> KERANGKA PENDUKUNG

KOORDINASI ANTAR SEL DILAKUKAN MELALUI STRUKTUR YANG MENGHUBUNGKAN SEL DISEBUT SEL JUNCTION



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.

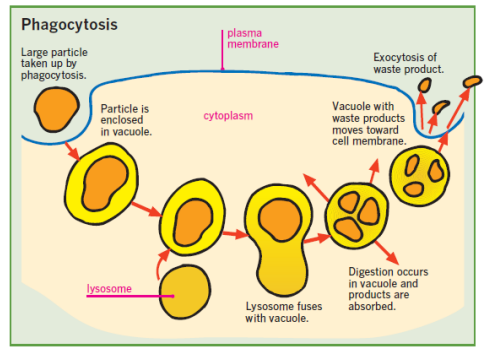
Membrane structure

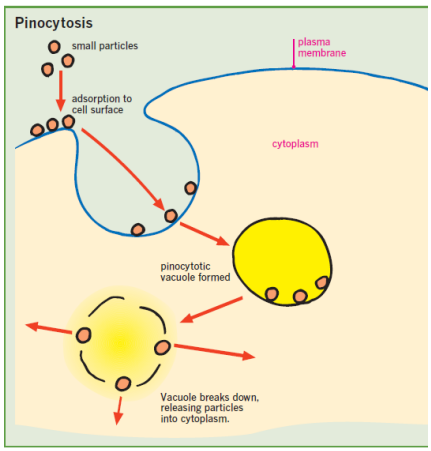
- Phospholipids form wide, thin bilayers. In between these phospholipids are membrane proteins floating like icebergs in a sea of lipid.
- Some proteins reach completely across the lipid molecules. Others protrude above the lipid layer on one side but only get halfway through the fat layer in the middle 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

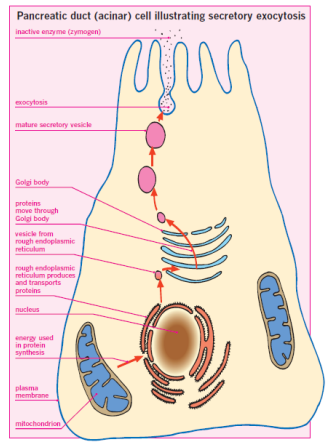
- A unit membrane consists of one lipid layer with protein found on each side. However, the membranes in cells are made of two unit membranes laid on top of each other.

Plasma membrane: endocytosis

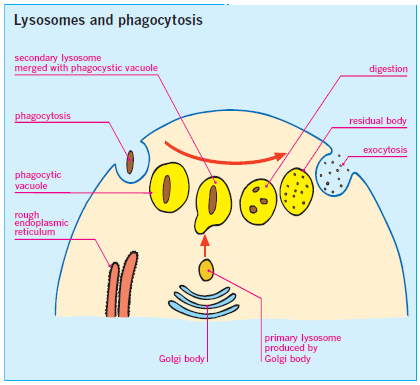




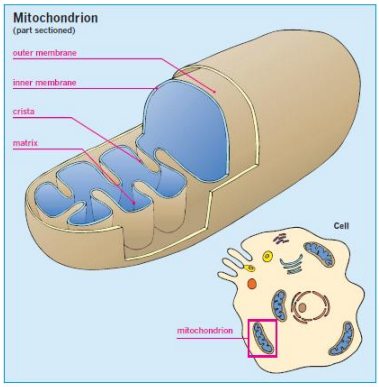
Plasma membrane: exocytosis

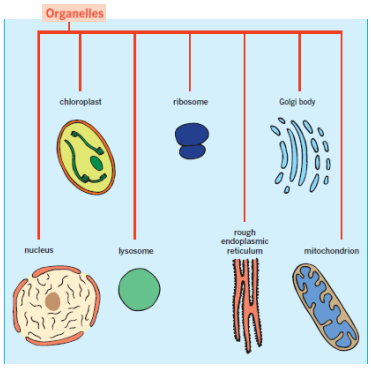


Lysosomes



Mitochondrion: structure





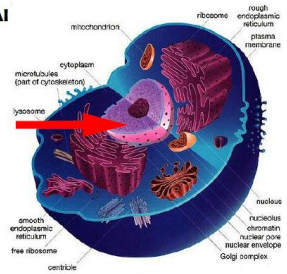
Inti

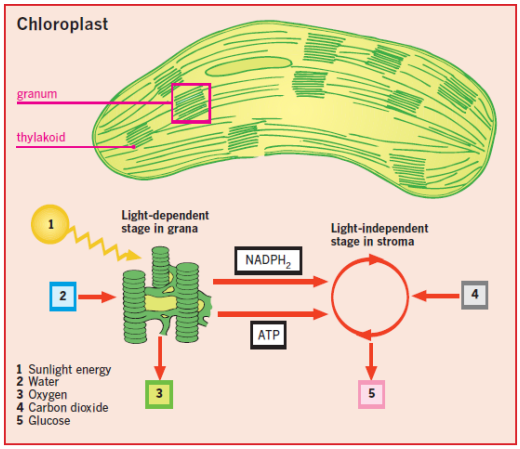
FUNGSI INTI ATAU NUKLEUS SEBAGAI PUSAT PENGATUR GENETIK SEL

"BLUE PRINT" HEREDITAS SEL YANG MENGATUR: AKTIVITAS SEL

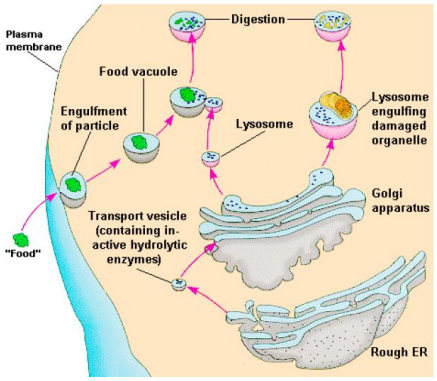
DNA DIIKAT PROTEIN MEMBENTUK BENANG PANJANG YANG DISEBUT KROMATIN

SELAMA MASA REPRODUKSI SEL, KROMATIN BERGELUNG KE DALAM STRUKTUR YANG DISEBUT KROMOSOM

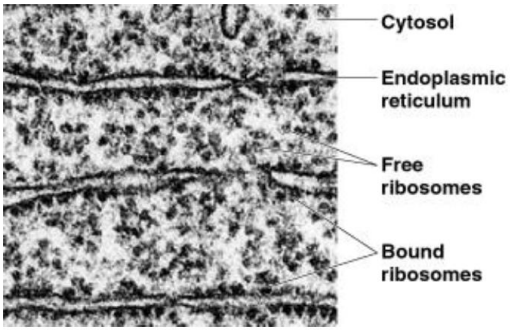




Lisosom

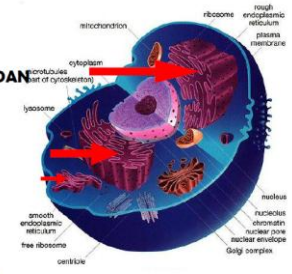


Ribosom



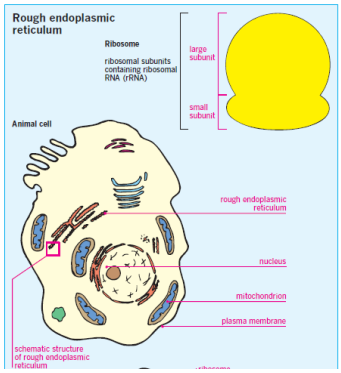
Endoplasmic Reticulum

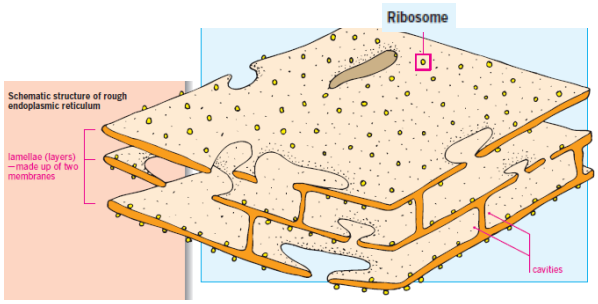
- **SMOOTH:** MEMBENTUK LEMAK DAN KARBOHIDRAT



- **ROUGH:** MENYIMPAN PROTEIN YANG DIPRODUKSI OLEH RIBOSOM YANG MENEMPEL DI ER

Rough endoplasmic reticulum: structure



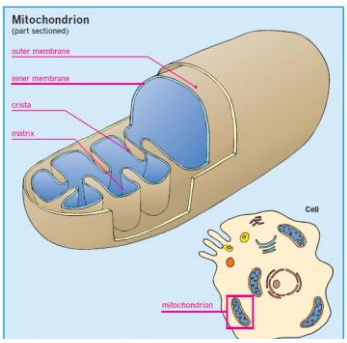


Functions of membrane systems and organelles

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.

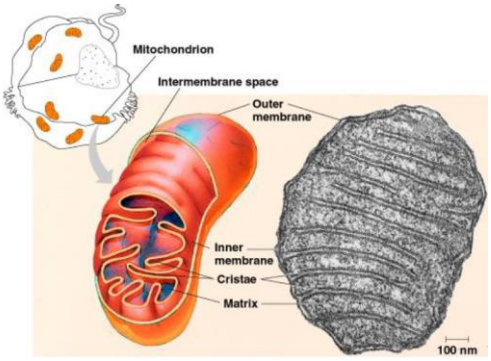
Smooth endoplasmic reticulum (**SER**) is usually less extensive than RER. It does not have ribosomes attached to it, and the cisternae are usually more flattened than those of the RER. It is involved in the synthesis of steroid hormones and the breakdown of toxins.

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



Sel prokariot

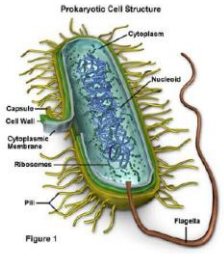
Ukuran relatif kecil (Ø 0,5-1 μm)

Tidak memiliki membran nukleus (inti)

DNAnya kontak dengan sitoplasmanya secara tidak langsung

Sitoplasmanya mengandung ribosom

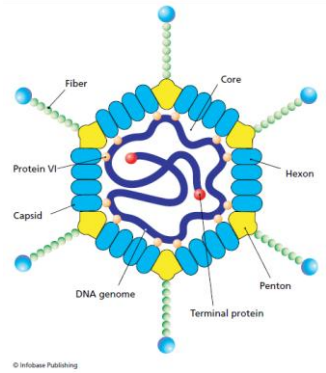
Sel dibungkus oleh plasma membran, dinding luar sel yang kompleks, pili, kadang-kadang berflagela



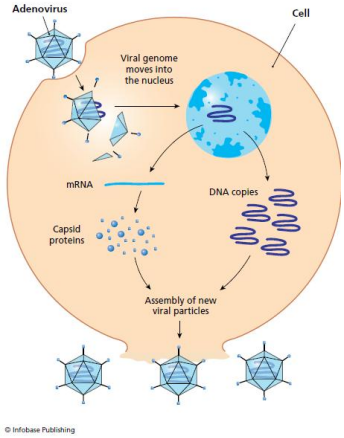
Comparison of prokaryotic, animal and plant cells

Feature	Prokaryotic cells	Eukaryotic cells	
		Animal cells	Plant cells
Plasma/cell surface membrane	Always present	Always present	Always present
Cell wall	Always present; made up of peptidoglycans	Never present	Always present; made up of cellulose
Nucleus and nuclear envelope	Never present	Always present	Always present
Chromosomes	Contain so-called 'bacterial chromosomes' — a circular molecule of DNA not associated with histones; bacteria may also contain smaller circles of DNA called plasmids	Contain several chromosomes, each made up of a linear DNA molecule associated with histones	Contain several chromosomes, each made up of a linear DNA molecule associated with histones
Mitochondria	Never present	Usually present	Usually present
Chloroplasts	Never present, though some do contain chlorophyll or other photosynthetic pigments	Never present	Sometimes present
Rough and smooth endoplasmic reticulum and Golgi apparatus	Never present	Usually present	Usually present
Ribosomes	Present, about 18 nm diameter	Present, about 22 nm diameter	Present, about 22 nm diameter
Centrioles	Never present	Usually present	Never present

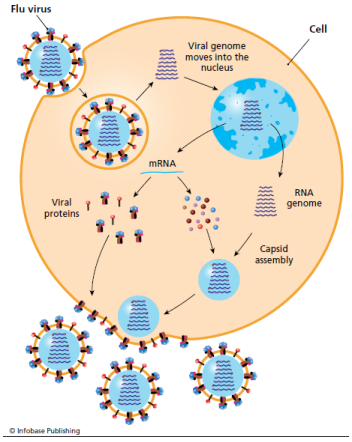
Virus



Siklus Virus



Siklus Virus Influenza



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.)*

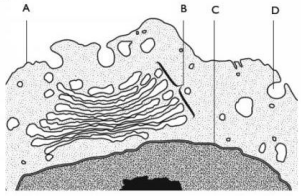
HIV/AIDS CASES AROUND THE WORLD

LOCATION	2001	2009
Sub-Saharan Africa	20.3 million	22.5 million
Middle East and North Africa	180,000	460,000
South and Southeast Asia	3.8 million	4.1 million
East Asia	350,000	770,000
Oceania	29,000	57,000
Latin America	1.1 million	1.4 million
Caribbean	240,000	240,000
Eastern Europe and Central Asia	760,000	1.4 million
Western and Central Europe	630,000	820,000
North America	1.2 million	1.5 million

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

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)

(b) 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