2.1 – CELL THEORY

A2.2.1	Cells as the basic structural unit of all living organisms
A2.2.2	Microscopy skills
A2.2.3	Developments in microscopy
A2.2.4	Structures common to cells in all living organisms
A2.2.7	Processes of life in unicellular organisms
A2.2.9	Atypical cell structure in eukaryotes

FUNCTIONS OF LIFE

Outline the functions of life

- M _____
- R _____
- S _____
- H _____
- E _____
- N _____
- G _____

CELL THEORY

State the cell theory

1. _____
2. _____
3. _____

Explain why viruses are not considered to be alive according to the cell theory

_____

_____

_____

CELLS

Identify the four components present in all cells and describe their purpose

1. _____

2. _____

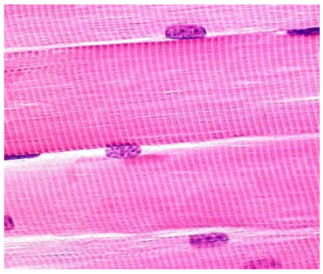
3. _____

4. _____

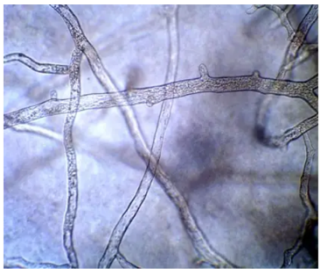
Outline examples of atypical cells based on the number of nuclei

No nuclei: _____

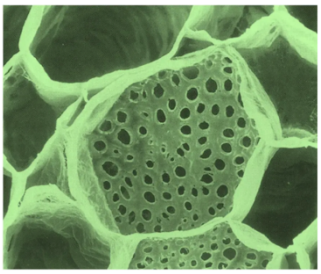
Multinucleated: _____



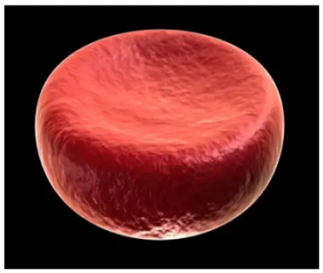
Skeletal Muscle



Aseptate Hyphae



Sieve Tube Element



Red Blood Cell

MICROSCOPY

Distinguish between light and electron microscopes (tick the box)

ADVANTAGE	LIGHT	ELECTRON
Has a higher resolution and magnification		
View things in natural colours		

Outline one example of an advancement that has occurred to improve each type of microscopy

Light Microscope: _____

_____

Electron Microscope: _____

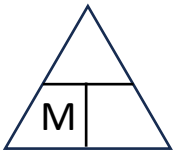
_____

MAGNIFICATION

Complete the following table

Power	10^0	10^{-2}	10^{-3}	10^{-6}	10^{-9}
Prefix	metre				
Symbol	m				

Identify the equation that is used for calculating the linear magnification of an image



_____

Calculate the actual size of the dust mite (in cm)

Actual Size:

_____

Number from the largest (1) to smallest (6)

Cell membrane (diameter)	
E. coli (bacterium)	
Mesophyll cell (plant tissue)	
Influenza A (virus)	
Glucose molecule	
Vesicle (organelle)	

State how the dust mite was viewed:

_____

Contrast resolution and magnification and identify how they can be improved using a light microscope

Term	Definition	Method for Improvement
Resolution		
Magnification		

2.2 – TYPES OF CELLS

A2.2.5	Prokaryote cell structure
A2.2.6	Eukaryote cell structure
A2.2.8	Differences in eukaryotic cell structure between animals, fungi and plants
A2.2.10	Cell types and cell structures viewed in light and electron micrographs
A2.2.11	Drawing and annotation based on electron micrographs
B2.2.1	Organelles as discrete subunits of cells that are adapted to perform specific functions
B2.2.2	Advantage of the separation of the nucleus and cytoplasm into separate compartments
B2.2.3	Advantages of compartmentalisation in the cytoplasm of cells

TYPES OF CELLS

Distinguish between prokaryotic and eukaryotic cells

Characteristic		Prokaryote	Eukaryote
DNA	Structure		
	Packaging		
Compartments			
Protein Synthesis			
Reproduction			
Average Size			

Prokaryotic cells are organised into two domains – identify three differences between these domains

1. _____

2. _____

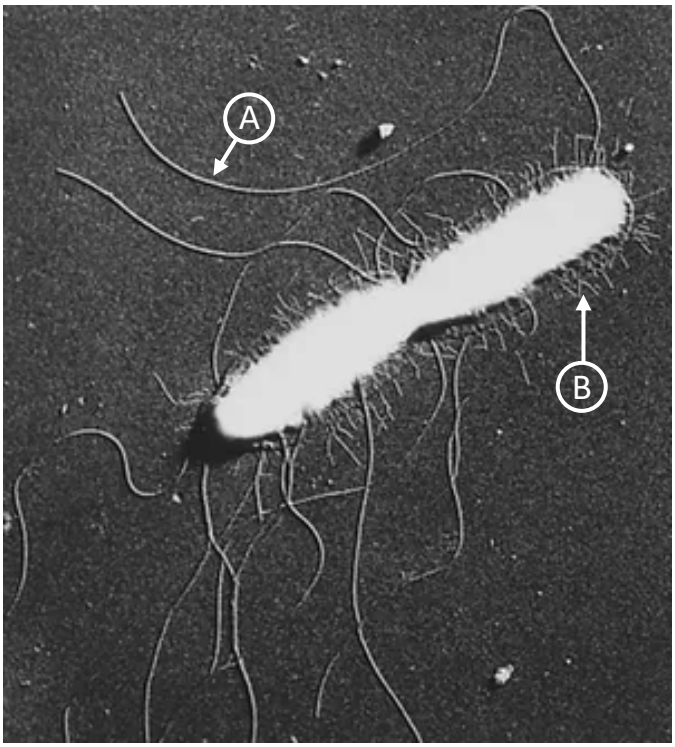
3. _____

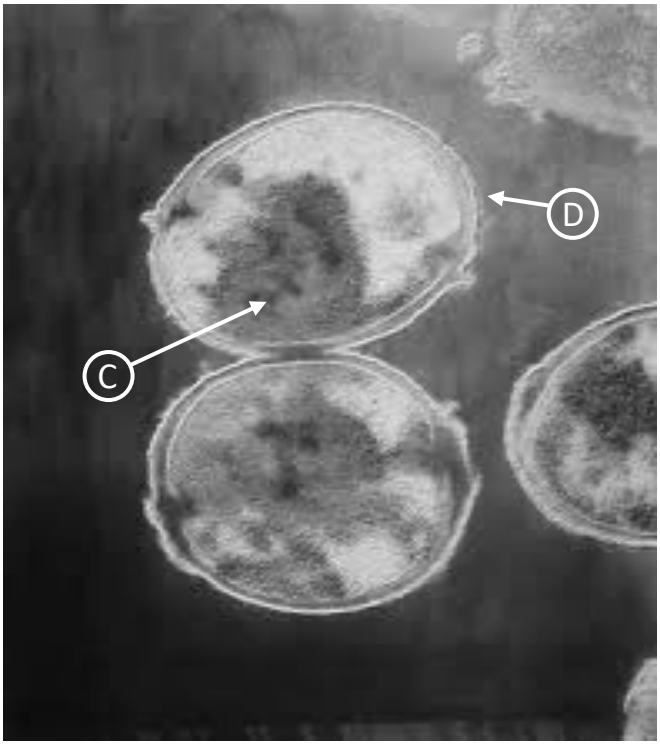
PROKARYOTIC CELLS

Draw a labelled diagram of the ultrastructure of a prokaryotic cell

Include: *pili, flagellum, cell wall, ribosomes, plasmid, nucleoid / genophore, cytosol, plasma membrane*

Label the following structures in the electron micrographs





A: _____ C: _____

B: _____ D: _____

Classify the two types of bacterial cells according to their shapes

_____

EUKARYOTIC CELLS

Draw a labelled diagram of the ultrastructure of an animal and plant cell

Include: *nucleus, mitochondria, endoplasmic reticulum, golgi complex, ribosomes, cytosol, cell membrane*

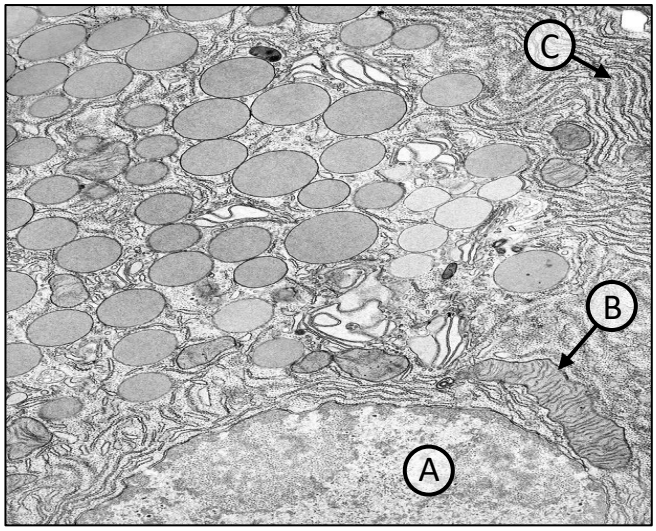
Pancreatic Gland Cell

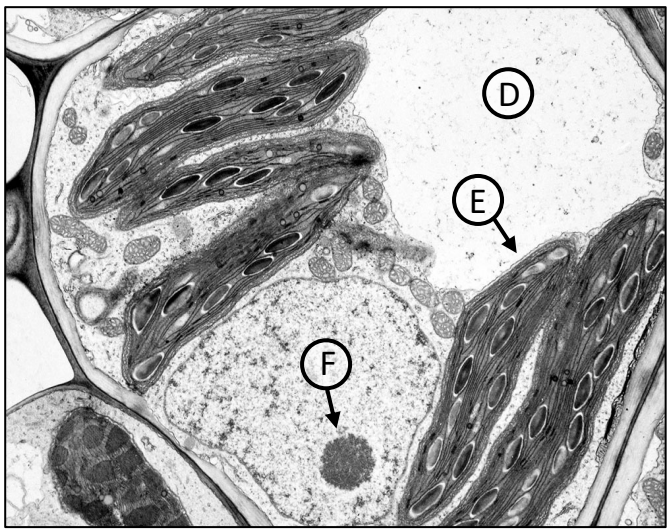
Animal: *lysosome, secretory vesicles*

Palisade Mesophyll Cell

Plant: *chloroplast, cell wall, vacuole*

Label the following structures in the electron micrographs





A: _____ D: _____

B: _____ E: _____

C: _____ F: _____

List three cellular structures that are not considered to be organelles

_____

ORGANELLES

State an advantage of dividing the nucleus and cytoplasm into separate compartments

_____

_____

State an advantage of having the cytoplasm compartmentalised

_____

_____

State the function of the following organelles

Ribosome: _____

Mitochondria: _____

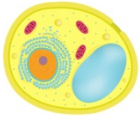
Golgi complex: _____

Endoplasmic Reticulum: _____

Chloroplast: _____

Plasma Membrane: _____

Distinguish between animal, plant and fungal cells

	Cell wall	**Vacuoles**	**Plastids**	**Centrioles, cilia, flagella**
 Animal				
 Plant				
 Fungi				

2.3 – SPECIALISATION

B2.3.1	Production of unspecialised cells following fertilisation and their development into specialised cells by differentiation
B2.3.2	Properties of stem cells
B2.3.3	Location and function of stem cell niches in adult humans
B2.3.4	Differences between totipotent, pluripotent and multipotent stem cells
B2.3.5	Cell size as an aspect of specialisation
B2.3.6	Surface area-to-volume ratios and constraints on cell size

STEM CELLS

Identify the two fundamental properties of stem cells

1. _____

2. _____

Differentiate between the potency of stem cell types in humans

Potency	Type	Description	Example
Totipotent	Embryonic		
Pluripotent	Embryonic		
Multipotent	Adult		
Unipotent	Adult		

State the location and function of two stem cell niches in humans

1. _____

2. _____

State the location and function of stem cells in plants

_____

_____

DIFFERENTIATION

Outline how specialised tissues develop in multicellular organisms

_____

_____

_____

Describe the impact of gradients on gene expression within an early-stage embryo

_____

_____

Define emergent properties and provide a specific example

_____

_____

Explain how the surface area : volume ratio functions to limit cell size

_____

_____

_____

_____

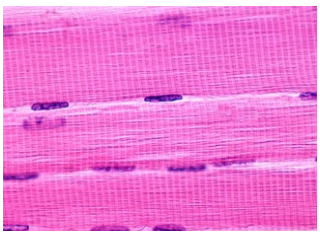
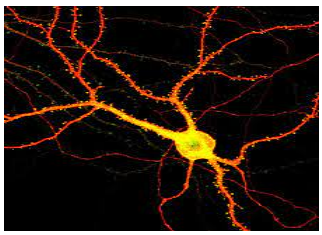
Identify how various sizes of different cells relate to their functional role within an organism

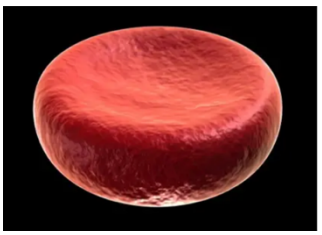
Muscle Fibre: _____

Neuron: _____

Ovum: _____

Red Blood Cell: _____

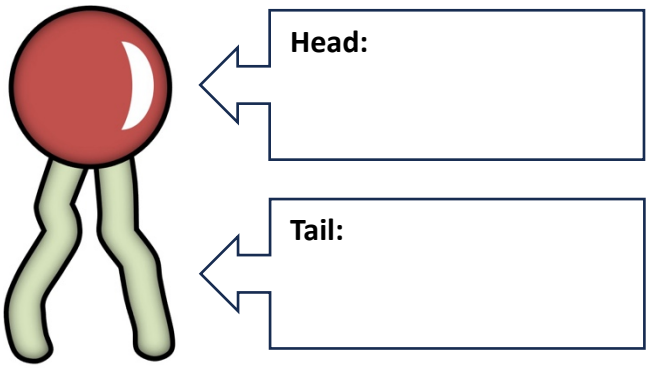


2.4 – MEMBRANE STRUCTURE

B2.1.1	Lipid bilayers as the basis of cell membranes
B2.1.2	Lipid bilayers as barriers
B2.1.4	Integral and peripheral proteins in membranes
B2.1.9	Structure and function of glycoproteins and glycolipids
B2.1.10	Fluid mosaic model of membrane structure
B2.1.12	Formation of phospholipid bilayers as a consequence of hydrophobic and hydrophilic regions

PHOSPHOLIPID BILAYER

Label the structure of a phospholipid



Charge: _____

Solubility: _____

Charge: _____

Solubility: _____

Note: The head and tail regions are connected by a central glycerol component (not shown in diagram)

Define amphipathic

_____

Explain how the amphipathic nature of phospholipids allows a bilayer to form spontaneously

_____

_____

_____

_____

_____

Outline the two key properties of a cell membrane

Semi-permeable: _____

Selectivity: _____

MEMBRANE PROTEINS

Distinguish between integral and peripheral proteins (structural properties and location)

Integral: _____

_____

_____

Peripheral: _____

_____

_____

GLYCOSYLATION

Describe the structure and function of glycoproteins and glycolipids

Structure: _____

Function: _____

Example: _____

FLUID MOSAIC MODEL

Draw a labelled diagram of the fluid mosaic model

Include: *phospholipid (components labelled), integral / peripheral protein, glycolipid / glycoprotein*

2.5 – MEMBRANE TRANSPORT

B1.1.13 Ability of non-polar steroids to pass through the phospholipid bilayer

B2.1.3 Simple diffusion across membranes

B2.1.5 Movement of water molecules across membranes by osmosis and the role of aquaporins

B2.1.6 Channel proteins for facilitated diffusion

B2.1.7 Pump proteins for active transport

B2.1.8 Selectivity in membrane permeability

D2.3.2 Water movement from less concentrated to more concentrated solutions

D2.3.3 Water movement by osmosis into or out of cells

D2.3.4 Changes due to water movement in plant tissue bathed in hypotonic and hypertonic solutions

D2.3.5 Effects of water movement on cells with a cell wall

D2.3.6 Effects of water movement on cells that lack a cell wall

D2.3.7 Medical applications of isotonic solutions

CELL MEMBRANES

Identify the movement of different molecules across the plasma membrane of a cell

Include: *water, glucose, starch, ions, oxygen, carbon dioxide, steroids, amino acids, ethanol, polypeptides*

Movement	**Molecules**
Freely permeable	
Selective transport	

Note: Cell membranes typically restrict the movement of materials that are either **large** or **charged**

TYPES OF TRANSPORT

Differentiate between passive and active transport (including specific examples for each)

Passive Transport:

_____

_____

Active Transport:

_____

_____

SIMPLE DIFFUSION

Define simple diffusion

_____

_____

FACILITATED DIFFUSION

Define facilitated diffusion

_____

_____

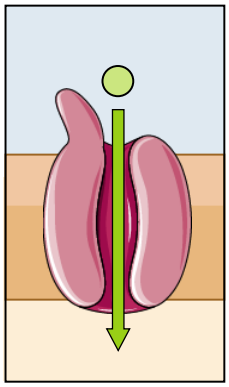
Describe how the structure of ion channels relates to their function (e.g. Na^+ channel)

_____

_____

_____

_____



ACTIVE TRANSPORT

Distinguish between direct (primary) active transport and indirect (secondary) active transport

_____

_____

_____

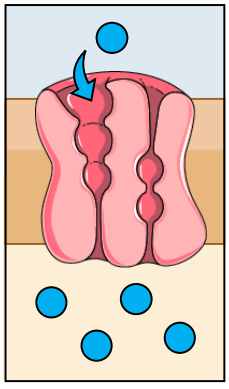
Describe how a protein pump functions to translocates molecules across membranes

_____

_____

_____

_____



OSMOSIS

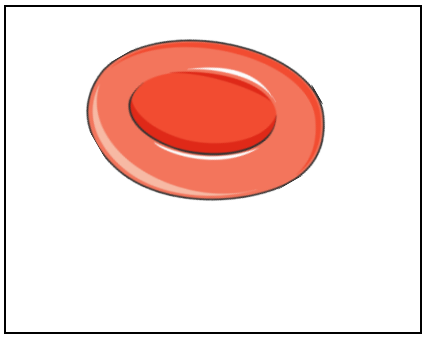
Define osmosis

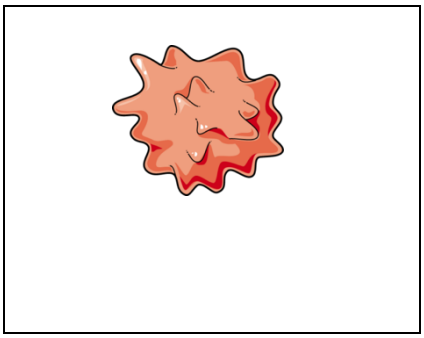
_____

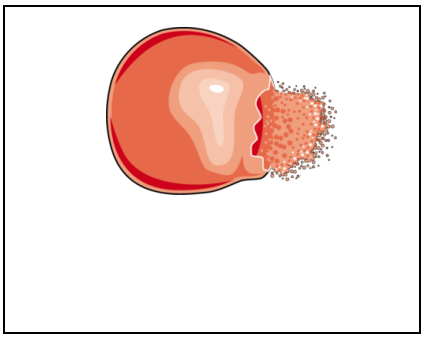
_____

_____

Deduce the solute concentration of each of the solutions below based on the shape of the red blood cell







Suggest, with a reason, how the effects would differ if a plant cell was placed in each solution instead

_____

_____

_____

_____

Describe the organelle used by freshwater unicellular organisms to remove excess water

_____

_____

Identify the membrane protein found in multicellular organisms that is used to support osmoregulation

_____

_____

State two medical applications of isotonic solutions

1. _____

2. _____

2.6 – ORIGIN OF CELLS (AHL)

A2.1.1	Conditions on early Earth and the pre-biotic formation of carbon compounds
A2.1.2	Cells as the smallest unit of self-sustaining life
A2.1.3	Challenge of explaining the spontaneous origin of cells
A2.1.4	Evidence for the origin of carbon compounds
A2.1.5	Spontaneous formation of vesicles by coalescence of fatty acids into spherical bilayers
A2.1.6	RNA as the presumed first genetic material
A2.1.7	Evidence for a last universal common ancestor
A2.1.8	Approaches used to estimate dates of the first cells and the last universal common ancestor
A2.1.9	Evidence for the evolution of the last universal common ancestor in the vicinity of hydrothermal vents
A2.2.12	Origin of eukaryotic cells by endosymbiosis
A2.2.13	Cell differentiation as the process for developing specialised tissues in multicellular organisms
A2.2.14	Evidence of multicellularity
A1.1.7	Extraplanetary origin of water on Earth and reasons for its retention
A1.1.8	Relationship between the search for extraterrestrial life and the presence of water

SPONTANEOUS GENERATION

List the proposed stages involved in the spontaneous generation of cells

1. _____

2. _____

3. _____

4. _____

Outline reasons for the lack of evidence to support the theory of the spontaneous origins of cells

_____

_____

PRE-BIOTIC CONDITIONS

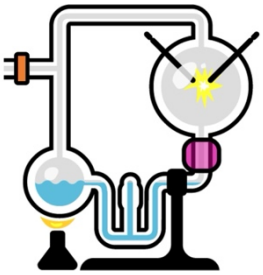
Describe the pre-biotic conditions that may have led to the formation of carbon compounds

_____

_____

MILLER-UREY EXPERIMENT

Outline how the Miller-Urey experiment demonstrated the non-living synthesis of carbon compounds



1. Early oceans form water vapour under high temperature conditions
2. Water vapour mixes with gases in a reducing atmosphere (no oxygen)
3. Electrical discharges (lightning strikes) function as an energy source
4. Trace amounts of organic compounds are then discovered over time

GENETIC MATERIAL

List the properties of RNA that suggest it was the first genetic material

Outline the reasons RNA functionality became superceded by DNA and proteins in modern cells

PROTOCELL FORMATION

Describe how spherical bilayers can form from the coalescence of micelles

Outline the relevance of membrane formation to the functions of life

ORIGINS OF WATER

Describe the conditions required for the retention of water in the atmosphere

_____

_____

Identify a source for the extraplanetary origin of water on Earth

_____

Define the "Goldilocks zone" in relation to the search for extraterrestrial life

_____

_____

_____

LAST UNIVERSAL COMMON ANCESTOR

Identify two pieces of evidence for the existence of a last universal common ancestor (LUCA)

1. _____

2. _____

Describe different approaches used to date the first living cells and the last universal common ancestor

Include: *biochemical evidence (stromatolites), phylogenetic comparisons, molecular clock technique*

_____

_____

_____

_____

_____

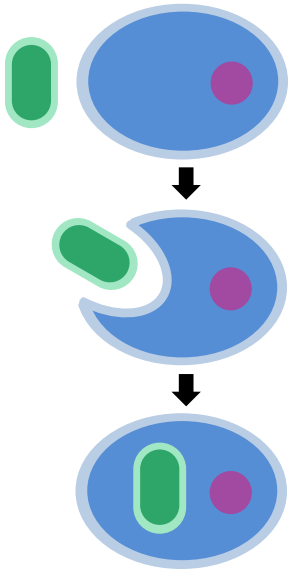
Suggest the location where LUCA likely existed and the evidence to support this hypothesis

_____

_____

ENDOSYMBIOSIS

Outline, with supporting evidence, how eukaryotic cells evolved via endosymbiosis

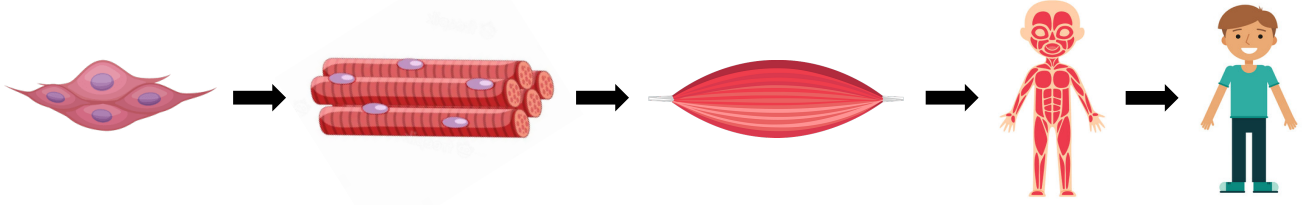


MULTICELLULARITY

Identify the advantages of organisms becoming multicellular

Distinguish between the genome and proteome of cells in a multicellular organism

Outline the organisation of cells in a multicellular organism

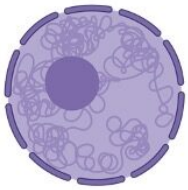
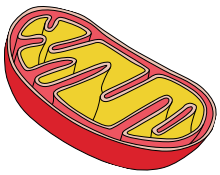
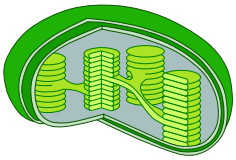
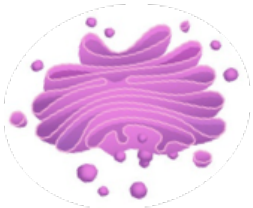


2.7 – CELL STRUCTURES (AHL)

B2.2.4	Adaptations of the mitochondrion for production of ATP by aerobic cell respiration
B2.2.5	Adaptations of the chloroplast for photosynthesis
B2.2.6	Functional benefits of the double membrane of the nucleus
B2.2.7	Structure and function of free ribosomes and of the rough endoplasmic reticulum
B2.2.8	Structure and function of the Golgi apparatus
B2.2.9	Structure and function of vesicles in cells
B2.3.7	Adaptations to increase surface area-to-volume ratios of cells
B2.3.8	Adaptations of type I and type II pneumocytes in alveoli
B2.3.9	Adaptations of cardiac muscle cells and striated muscle fibres
B2.3.10	Adaptations of sperm and egg cells

ORGANELLES

Describe how the structure of the following organelles relates to their function

ORGANELLE	STRUCTURE-FUNCTION RELATIONSHIP
 **NUCLEUS**	
 **MITOCHONDRIA**	
 **CHLOROPLAST**	
 **GOLGI COMPLEX**	

RIBOSOMES

Describe how the structure of a ribosome relates to its function

_____

_____

Describe the role of free ribosomes (cytosolic) and ribosomes bound to the endoplasmic reticulum (rER)

_____

_____

VESICLES

Describe the role of the following vesicles

Lysosome: _____

Sap Vacuole: _____

CELL TYPES

Describe, with examples, adaptations to increase the surface area : volume ratios of cells

_____

_____

Compare the structures of the following types of cells

Type I Pneumocyte	Type II Pneumocyte
Striated Muscle Fibre	**Cardiac Muscle Cell**
Sperm Cell	**Egg Cell**

2.8 – CELL MEMBRANES (AHL)

B2.1.11 Relationships between fatty acid composition of lipid bilayers and their fluidity

B2.1.12 Cholesterol and membrane fluidity in animal cells

B2.1.13 Membrane fluidity and the fusion and formation of vesicles

B2.1.14 Gated ion channels in neurons

B2.1.15 Sodium-potassium pumps as an example of exchange transporters

B2.1.16 Sodium-dependent glucose cotransporters as an example of indirect active transport

B2.1.17 Adhesion of cells to form tissues

FATTY ACID COMPOSITION

Identify the relationship between fatty acid composition of lipid bilayers and their fluidity

Fatty Acid	Structure	Shape	Melting Point	Fluidity
Saturated				
Unsaturated				

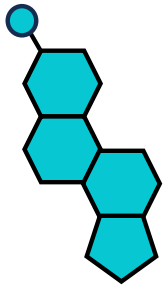
Provide an example of an environment that would promote each type of fatty acid composition

_____

_____

CHOLESTEROL

Describe the role of cholesterol as a bi-directional modulator of membrane fluidity



_____

_____

_____

Explain why cholesterol is found in the membranes of animal cells but is not in plant cell membranes

_____

_____

VESICULAR TRANSPORT

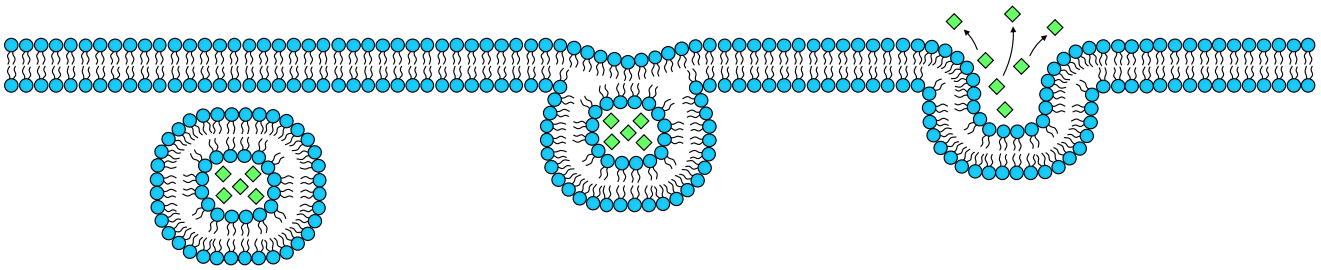
Outline the organelles involved in transporting materials via vesicles

_____

_____

_____

Describe how materials are transported by endocytosis or exocytosis



Exocytosis:

_____

_____

_____

Endocytosis:

_____

_____

_____

Distinguish between phagocytosis and pinocytosis

_____

_____

Describe the role of clathrin in the formation of vesicles

_____

_____

_____

_____

MEMBRANE PROTEINS

Describe, using examples, the role of the following membrane proteins in the movement of materials

Gated Ion Channels:

_____

_____

_____

Cotransporters:

_____

_____

_____

Exchange Transporters:

_____

_____

_____

CELL ADHESION MOLECULES

State the function of cell adhesion molecules (CAMs) in multicellular organisms

_____

_____

Identify two examples of cell-cell junctions in humans and where they would be found in the body

1. _____

2. _____

Describe how cancers can be impacted by the absence of CAMs on tumour cells

_____

_____

_____