Cells

The smallest units of life

- Nothing smaller or simpler than a cell is considered alive
- All living things are made of one or more cells

Structures that all cells (eukaryotic and prokaryotic cells) contain:

- Cell membrane
- Cytoplasm
- Chromosome(s)
- Ribosomes

There are two basic cell types: Prokaryotic cells and Eukaryotic cells

- Prokaryotic cells = Cells with no membrane around the DNA (no nucleus)

  √ Prokaryotic cells have only non-membranous organelles (no membranous organelles and are smaller than eukaryotic cells

  √ Bacteria and archaea domain species are prokaryotic cells

- Eukaryotic cells = Cells with a membrane around the DNA (a nucleus)

  √ Eukaryotic cells have membranous and non-membranous organelles organelles and are larger than prokaryotic cells

  √ Eukarya domain species have eukaryotic cells

Figs 1.8, 1.15, 6.6, 6.9

Organelles

Structures inside the cell

- Organelles carry out functions that keep the cell alive and operating

- Organelles can be membranous (made of a membrane (phospholipid bilayer)) or non-membranous (made of other molecules)

Fig 6.9

Plasma membrane (cell membrane)

The phospholipid bilayer (and its associated proteins) that surround a cell.

- Its function is to act as a barrier and as a selective gateway (controlling the entry and exit of materials)

  √ The hydrophobic phospholipids are barriers to most solutes

  √ Channel proteins bring solutes through the membrane in a controlled manner

  √ Receptors detect molecules outside the cell

Figs 7.3 and 7.15

Cell wall

A ridged structure outside the plasma membrane used for structural support of the cell.

- Made of cellulose in plant cells
- Animal cells do not have cell walls

Fig 6.9

Cytoplasm/cytosol

The liquid that fills the cell

- Mostly water with many dissolved solute molecules
- Organelles float in it

Fig 6.9

DNA

The genetic molecule of the cell.

- Chromosome = A long double-stranded piece of DNA, wrapped around histone proteins

  √ Centromere = central region of the chromosome

- Eukaryotes have several chromosomes, which are linear and located in the nucleus

- Prokaryotes have a single circular chromosome located in the cytoplasm (prokaryotes have no nucleus)

Figs 6.6, 6.9, and 19.2

Ribosome

A protein-RNA organelle that constructs proteins by linking together amino acids

Fig 17.3

DNA function

DNA contains the genetic information needed to operate the cell because it contains the instructions for making all the cell's proteins.

Figs 17.3 and 17.4

Gene

A section of a DNA molecule that encodes one protein

- Genes encode the amino acid sequence of each protein using codons

Fig 17.4

Codon

Three consecutive nucleotides

- Each codon represents one of the amino acids
- The genetic code = All 64 codons and the amino acid each one represents
  - √ Three of the codons represent stop (end-of-gene) signals

Fig 17.5

Steps from gene to protein:

1) Transcription of the gene into an mRNA (a temporary disposable RNA copy of the gene)

2) Translation of the mRNA into the protein

Fig 17.3

Transcription

Making an RNA copy of one strand of a gene

- The enzyme RNA Polymerase transcribes one DNA strand

  √ The enzyme uses complementary base pairing with one DNA strand to generate an RNA copy of the other DNA strand

- messenger RNA (mRNA) = The single-stranded RNA copy of one DNA strand

- In eukaryotes, the mRNA moves from the nucleus to the cytoplasm after transcription

Figs 17.3 and 17.7

Translation

When a ribosome constructs a protein from amino acids using an mRNA as the instructions

Figs 17.3 and 17.13

Transfer RNA (tRNA)

RNA molecules that bring amino acids to the ribosome

• Each tRNA has an anticodon for the amino acid it is carrying

√ Anticodon = Three nucleotides complementary to an amino acid's codon

√ The anticodon binds to the mRNA's codon by complementary base pairing

√ This process matches each of the mRNA's codons to the correct amino acid, thus correctly assembling the protein

Figs 17.13 and 17.14

Nucleus

A double membrane (**two** phospholpid bilayers) organelle that contains the chromosomes

- Nuclear pores = Holes in the membrane to allow materials in and out of the nucleus

Fig 6.10

Endoplasmic reticulum (ER)

A series of membranous compartments that is an extension of the nucleus' outer membrane

- The rough ER (closest to the nucleus) is where the ribsomes make new proteins

  √ The new proteins go inside the ER and travel to the smooth ER

- The smooth ER (farther from the nucleus) is where new lipids are made and where harmful substances are detoxified

- The newly made proteins and lipids leave the ER in vesicles that bud off from the smooth ER

Figs 6.9 and 6.12

Vesicles

Small membranous spheres that transport materials inside the cell

Figs 6.12 and 6.13

Golgi apparatus

A stack of membranous sacs that is the cell's protein and lipid sorting and distribution center

- The Golgi receives new proteins and lipids in vesicles from the smooth ER
- They are modified and sorted as they move through the Golgi
- They are distributed to other organelles in new vesicles that bud off from the Golgi

Fig 6.13

Exocytosis

The expelling of substances from the cell by fusion of a vesicle with the plasma membrane

Figs 6.16 and 7.10

Endocytosis

The formation of a vesicle by the budding inward of the plasma membrane

√ Example: Food vesicles bring macromolecules into the cell

Fig 7.20

Lysosome

A membranous organelle used for the digestion of materials.

• Lysosomes bud directly from the Golgi

√ They have an acidic internal environment and contain digestive enzymes

√ Example: Lysosomes fuse with food vesicles to digest the vesicle's contents

Fig 6.14

Vacuoles

Membranous spheres used for storage and other purposes.

- Central vacuole = A large vacuole found in plant cells that usually takes up most of the cell

Figs 6.9 and 6.15

The endomembrane system

The membranous organelles that share materials with each other (by sending or receiving vesicles)

Organelles of the endomembrane system are:

- The nucleus
- The endoplasmic reticulum
- The Golgi apparatus
- The cell membrane
- Lysosomes
- Vacuoles

The following three membranous organelles are **not** part of the endomembrane system (They do **not** share materials. They do **not** send or receive vesicles)

- Peroxysomes
- Mitochondria
- Chloroplasts

Figs 6.9 and 6.16

Peroxysome

A membranous organelle that digests fatty acids using O_2

Fig 6.19

Mitochondria

A double membrane organelle where ATP is made from the energy in glucose

Fig 6.17

Chloroplasts

A triple membrane organelle where photosynthesis (making glucose using sunlight energy) occurs

- Only present in the cells of plants (and some protistans)

Fig 6.18

Non-membranous organelles

Organelles not made of membranes
- The cytoskeleton
- Centrioles
- Ribosomes

Cytoskeleton

A system of protein fibers that form a network throughout the entire cytoplasm

- Holds organelles in place
- Controls the shape of the cell
  - √ Example: Cilia and flagella
- Forms "railroad tracks" for moving vesicles
- Microtubules and actin filaments are examples of cytoskeletal fibers

Figs 6.20, 6.21, and 6.24, Table 6.1

Cilia and flagella

Whip-like protrusions used for movement

- Flagella = one long whip
- Cilia = many tiny whips
- Formed from microtubules inside cell

Fig 6.21

Centriole (basal body)

A short cylinder made of microtubules

- Centrioles anchor and organize microtubules

√ Example: Microtubules in cilia and flagella are anchored to a basal body

Figs 6.20, 6.22, and 6.24