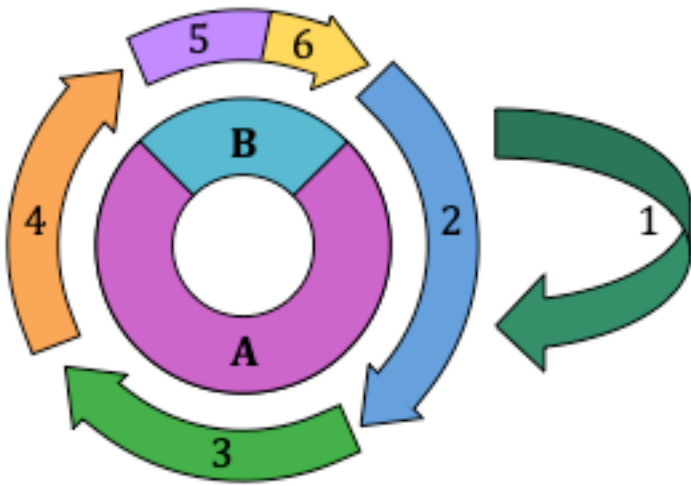


## 1.6 Cell Division

### Cell Cycle

Identify the various stages of the cell cycle



- A. Interphase
- B. M phase
- 1. G0 phase (quiescent / resting)
- 2. G1 phase (growth / preparation)
- 3. S phase (DNA replication)
- 4. G2 (growth / proof-reading)
- 5. Mitosis (nuclear division)
- 6. Cytokinesis (cytoplasmic division)

List the different events that occur during interphase

- D DNA replication (S phase)
- O Organelle duplication
- C Cell growth
- T Transcription / translation
- O Obtain nutrients
- R Respiration (cellular)



Differentiate between the three gap phases

G1: Cell grows and prepares for DNA replication (S phase)

G2: Cell finishes growing and prepares for cell division (M phase)

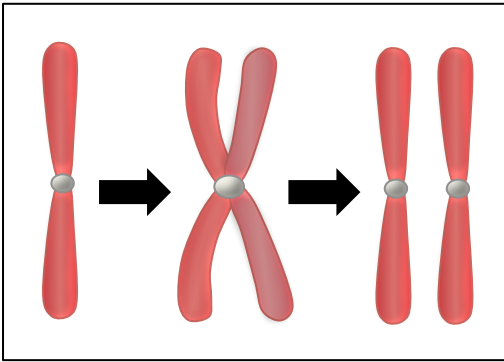
G0: A non-dividing, resting phase for fully differentiated cells (e.g. neurons)

Define mitosis

The division of a nucleus to produce two genetically identical daughter nuclei (diploid → diploid)

Mitosis occurs in human body cells and results in cloned copies

Outline, with a diagram, the changes in DNA organisation during interphase and mitosis



- ..... DNA is usually loosely packed within the nucleus as chromatin
- ..... During mitosis, the DNA supercoils and chromatin condenses
- ..... to form visible chromosomes
- ..... Because DNA is replicated in the S phase, each chromosome
- ..... is made of identical sister chromatids

Describe the stages of mitosis

Stage	Diagram	Description
Prophase	<p>The diagram shows a cell in the prophase stage of mitosis. Inside the cell, several chromosomes are visible, appearing as condensed, X-shaped structures in blue and purple. Two centrosomes, represented by purple spheres, are positioned at opposite poles of the cell. Spindle fibers, shown as thin white lines, are beginning to form and radiate from the centrosomes.</p>	<ul style="list-style-type: none"> <li>• Chromosomes condense (DNA supercoils)</li> <li>• Nuclear membrane dissolves</li> <li>• Paired centrosomes move to opposite poles of the cell and start producing spindle fibres</li> </ul>
Metaphase	<p>The diagram shows a cell in the metaphase stage. The chromosomes are now fully condensed and are aligned vertically along the equatorial plane (metaphase plate) in the center of the cell. Spindle fibers, shown as dashed blue lines, extend from two centrosomes at opposite poles to the centromeres of the chromosomes.</p>	<ul style="list-style-type: none"> <li>• Spindle fibres connect to centromeres of chromosomes</li> <li>• Contraction of spindle fibres cause chromosomes to align along the middle of the cell (equatorial plane)</li> </ul>
Anaphase	<p>The diagram shows a cell in the anaphase stage. The sister chromatids have separated and are being pulled toward opposite poles of the cell by the spindle fibers. The chromatids now appear as single, V-shaped structures. The spindle fibers are shown as dashed blue lines connecting the centromeres to the poles.</p>	<ul style="list-style-type: none"> <li>• Spindle fibres continue to contract and this results in the separation of the identical sister chromatids</li> <li>• Each chromatid is now referred to as a chromosome</li> <li>• The identical chromosomes move to opposite poles</li> </ul>
Telophase	<p>The diagram shows a cell in the telophase stage. Two new nuclei are forming, each with its own nuclear membrane. The chromosomes are beginning to decondense and are now surrounded by a network of spindle fibers. A cleavage furrow is visible at the bottom of the cell, indicating the start of cytokinesis.</p>	<ul style="list-style-type: none"> <li>• Chromosomes decondense</li> <li>• Nuclear membranes reform around the two separate sets of identical chromosomes</li> <li>• Cytokinesis occurs concurrently to split the cell in two</li> </ul>

Compare the process of cytokinesis in animal cells and plant cells

Animals: Microtubule filaments form a ring around the cell centre which then contracts (cleavage furrow)

Separation is centripetal because it starts at the outside and then moves in

Plants: Vesicles form in a row at the centre of the cell (equatorial plane) which fuse to form an end plate

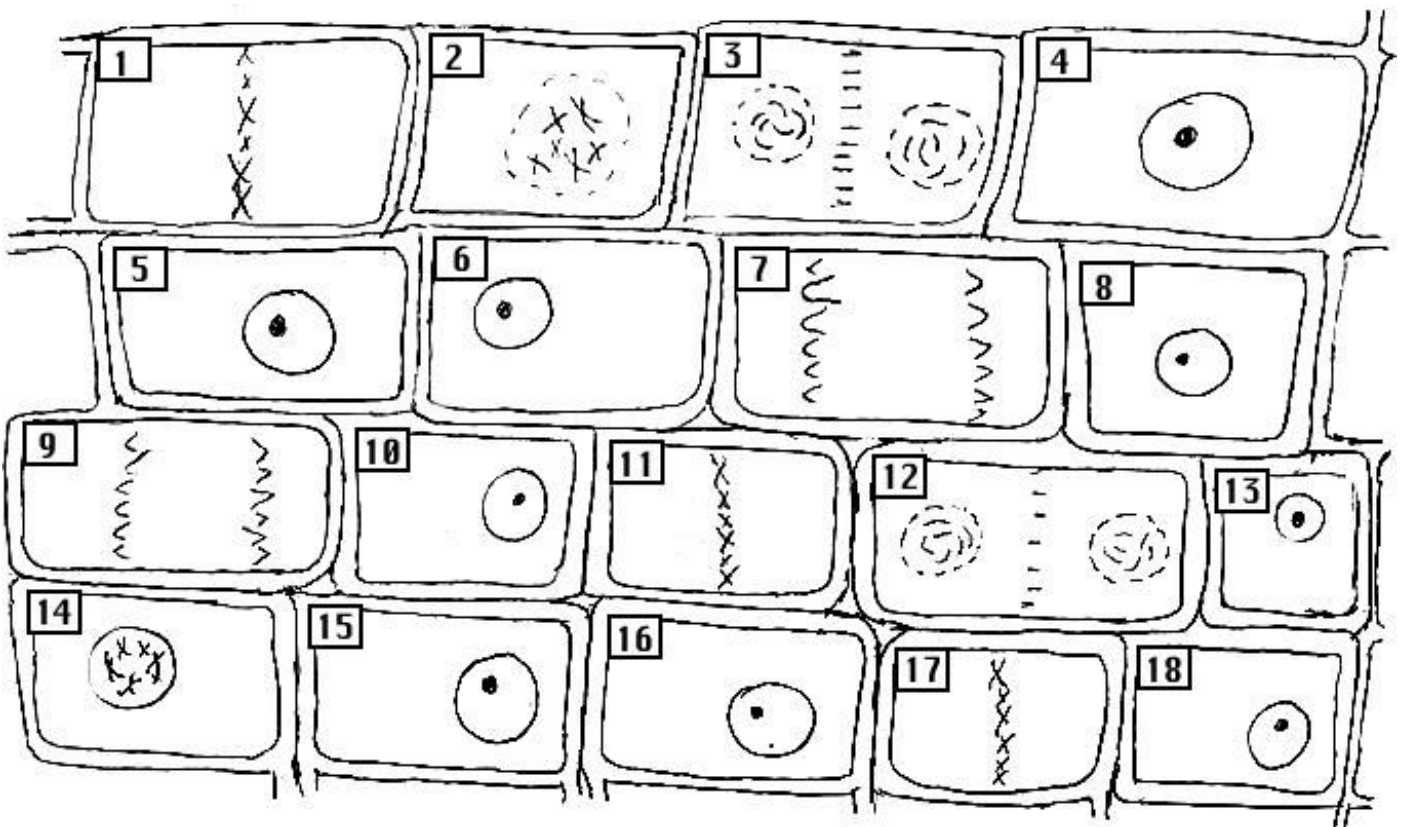
Separation is centrifugal because it starts in the centre and then moves out

List four processes that involve mitosis

- T Tissue repair
- O Organismal growth
- A Asexual reproduction (e.g. vegetative propagation)
- D Development of an embryo



Identify the stages of mitosis and calculate the mitotic index



Interphase: 4, 5, 6, 8, 10, 13, 15, 16, 18

Anaphase: 7, 9

Prophase: 2, 14

Telophase: 3, 12

Metaphase: 1, 11, 17

Mitotic Index:  $9 \div 18 = 0.5$

## Cell Cycle Regulation

*Outline the role of cyclins in the control of the cell cycle*

Cyclins are a family of regulatory proteins that control progression of the cell cycle

Cyclins bind cyclin dependent kinases (CDKs) and form an activated complex

This complex phosphorylates proteins involved in specific cell cycle events

After the event has occurred, the cyclin is degraded and CDK rendered inactive

*Compare apoptosis and necrosis as mechanisms of cell death*

Apoptosis	Necrosis
Programmed cell death (i.e. cell 'suicide')	Uncontrolled cell death (i.e. cell 'homicide')
Involves cellular signals and mitochondrial proteins	Premature death of cell due to injury or trauma
Membrane bulges (blebs) and contents are then repackaged for recycling by other cells	Membrane destabilises, leading to cell lysis
	Released cell contents trigger inflammation

*Define cancer*

Cancer is uncontrolled cell proliferation

*Distinguish between primary and secondary tumours*

Tumours are the growths caused by cancer and may be benign (stays local) or malignant (spreads)

A benign tumour that remains in its original location is called a primary tumour

A tumour that has spread (metastasised) is called a secondary tumour

*Outline the role of mutagens and oncogenes in the development of cancer*

A mutagen is an agent that causes a change in the genetic material of an organism

• E.g. Chemicals in cigarettes may cause cancer (carcinogens)

An oncogene is a gene that has the potential to cause cancer

• Proto-oncogenes code for proteins that promote cell growth and proliferation

• Tumor suppressor genes code for proteins that repress cell cycle progression