A. THE CELL CYCLE

- Has **two** general phases:
  - **interphase** (the **longest**, **non-dividing** phase that **prepares** the cell for division)
  - **mitosis** (**cell division** that produces **more genetically identical** cells)

MITOSIS

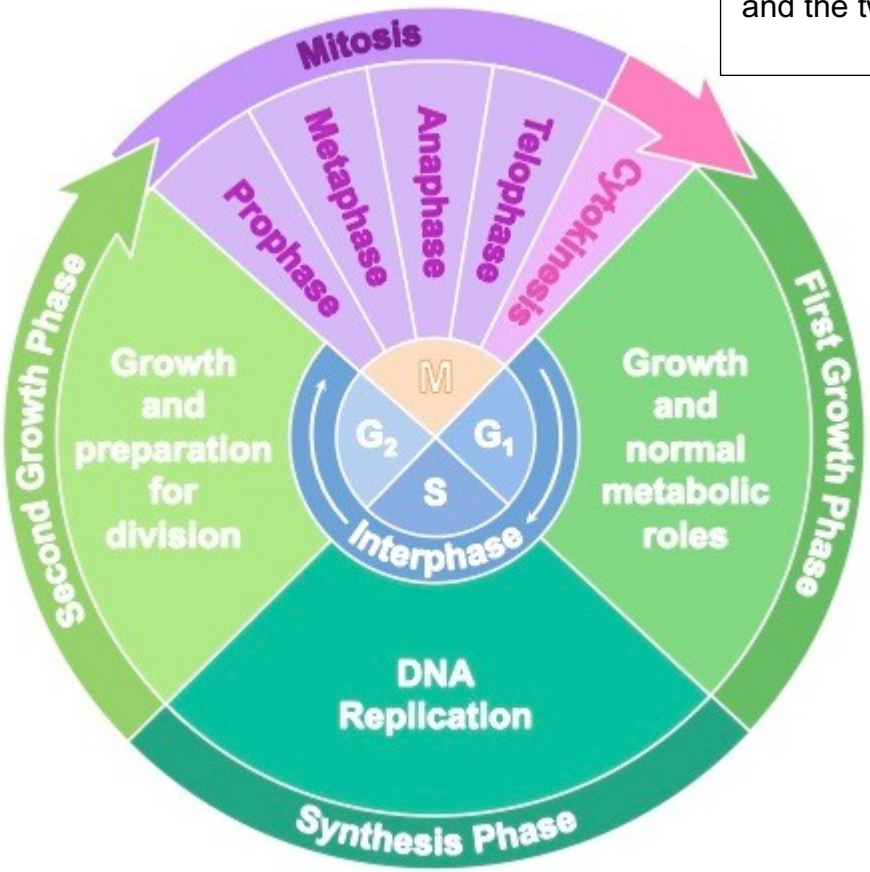
Cell division happens

Four stages: **PMAT**

CYTOKINESIS

Happens **after mitosis**

Cell **cytoplasm divides** and the two **cells pinch apart**



G2 PHASE

Cell **increases in size**

Organelles are **replicated**

Centrioles are replicated

Prepares cell for **division**

G1 PHASE

Cell **increases in size**

Proteins made

Prepares cell for **DNA replication**

S PHASE

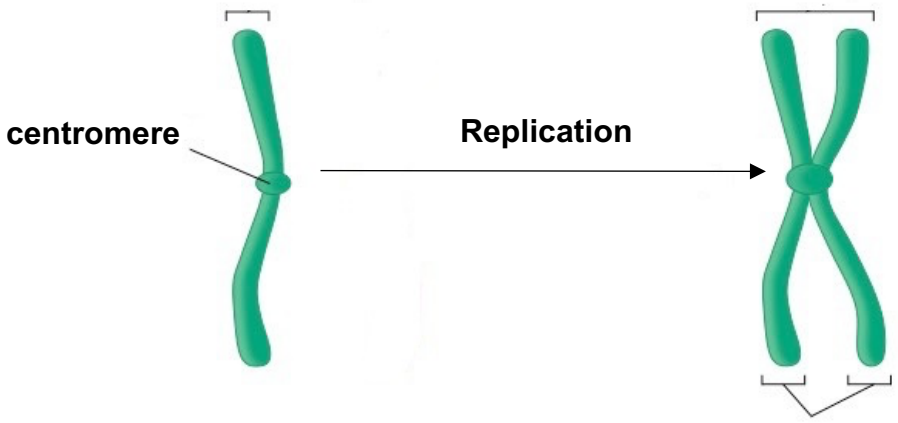
DNA replication occurs

Lots of ATP is made

Chromosomes and chromatids

Single chromosome **before** DNA replication

Chromosome now made up of the **original** chromosome and a **new copy** held together by the **centromere**

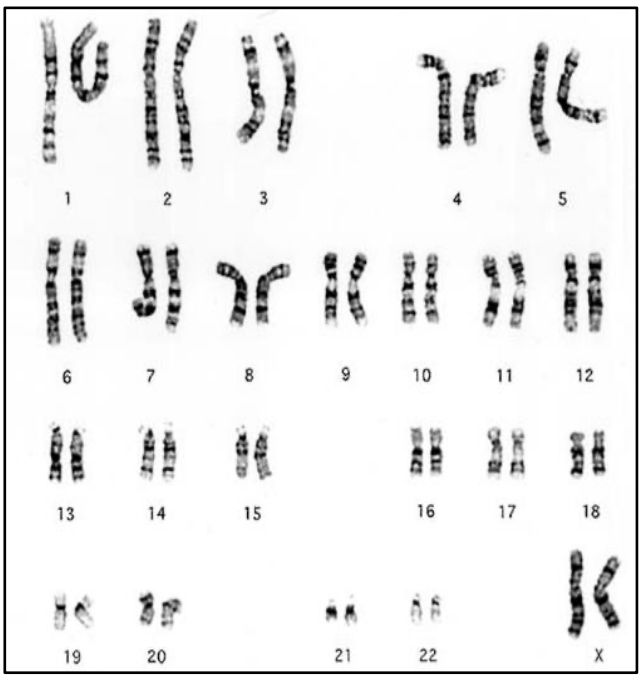


Consists of **two identical sister chromatids**

One original and one new

Diploid cells and haploid cells

DIPLOID CELLS (2n)

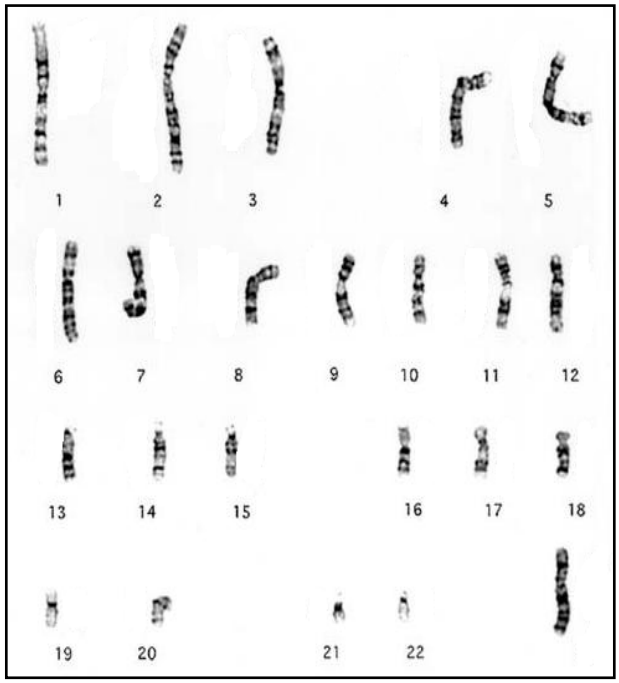


Paired chromosomes

2 copies of **each** chromosome (**one** from **mum**; **one** from **dad**)

e.g. liver cells, eye cells, brain cells

HAPLOID CELLS (n)



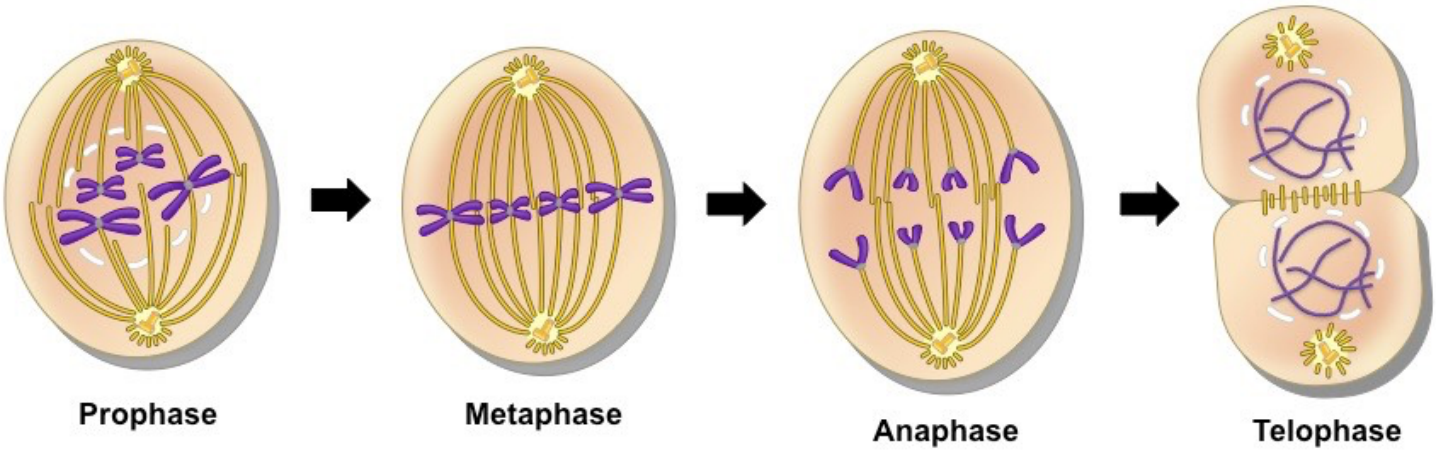
Unpaired chromosomes

1 copy of **each** chromosome (from **either mum or dad**)

e.g. sperm cells, egg cells

B. MITOSIS

- **Cell division** that produces **more genetically identical** cells.



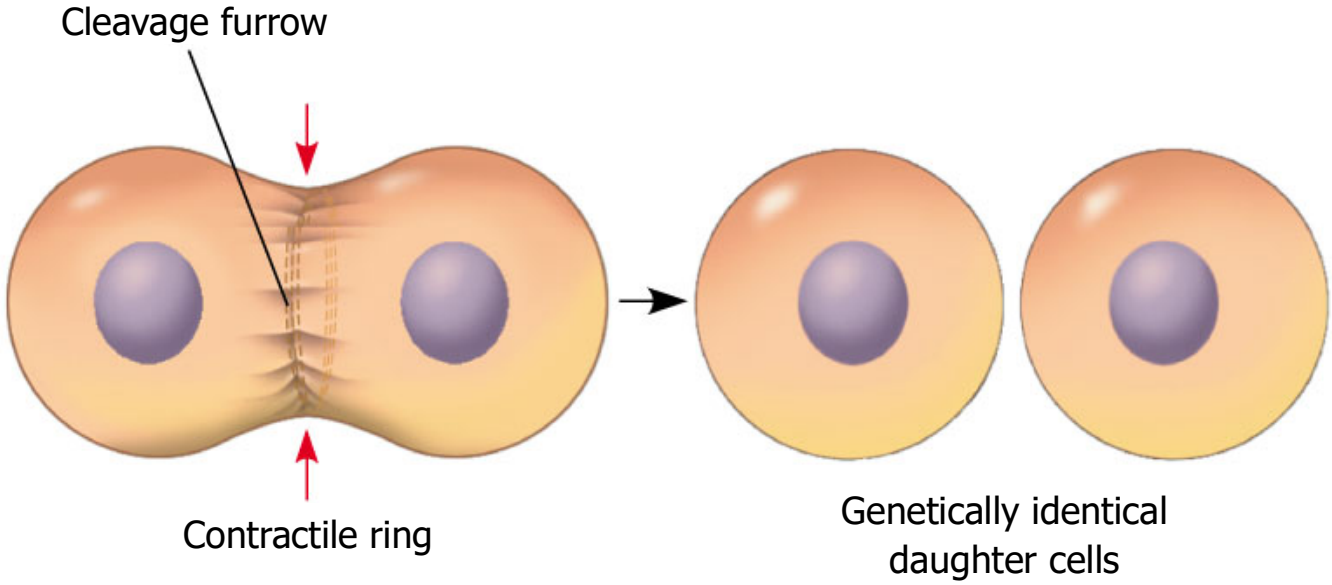
Prophase	Metaphase	Anaphase	Telophase
Nuclear membrane starts to **break down** **Chromosomes condense** (DNA supercoils) to become **shorter** and **fatter** They are now **visible** **Centrioles** move to the **opposite poles** of the cell and form microtubule **spindle fibres**	**Chromosomes** move to the **equator** of the cell **Each** chromosome **attaches** to **two spindle fibres** (one from each pole) by its **centromere**	**Centromeres break/ divide** **Genetically identical sister chromatids** are **pulled apart** by **spindle fibres**. Due to **contraction/shortening** of the **spindle fibres** They then **move** to **opposite poles** of the cell	**Chromosomes uncoil** and are **no longer visible** Nuclear membranes **reform**

- **In exams,** always refer to **sister chromatids** for **Anaphase**.

C. CYTOKINESIS

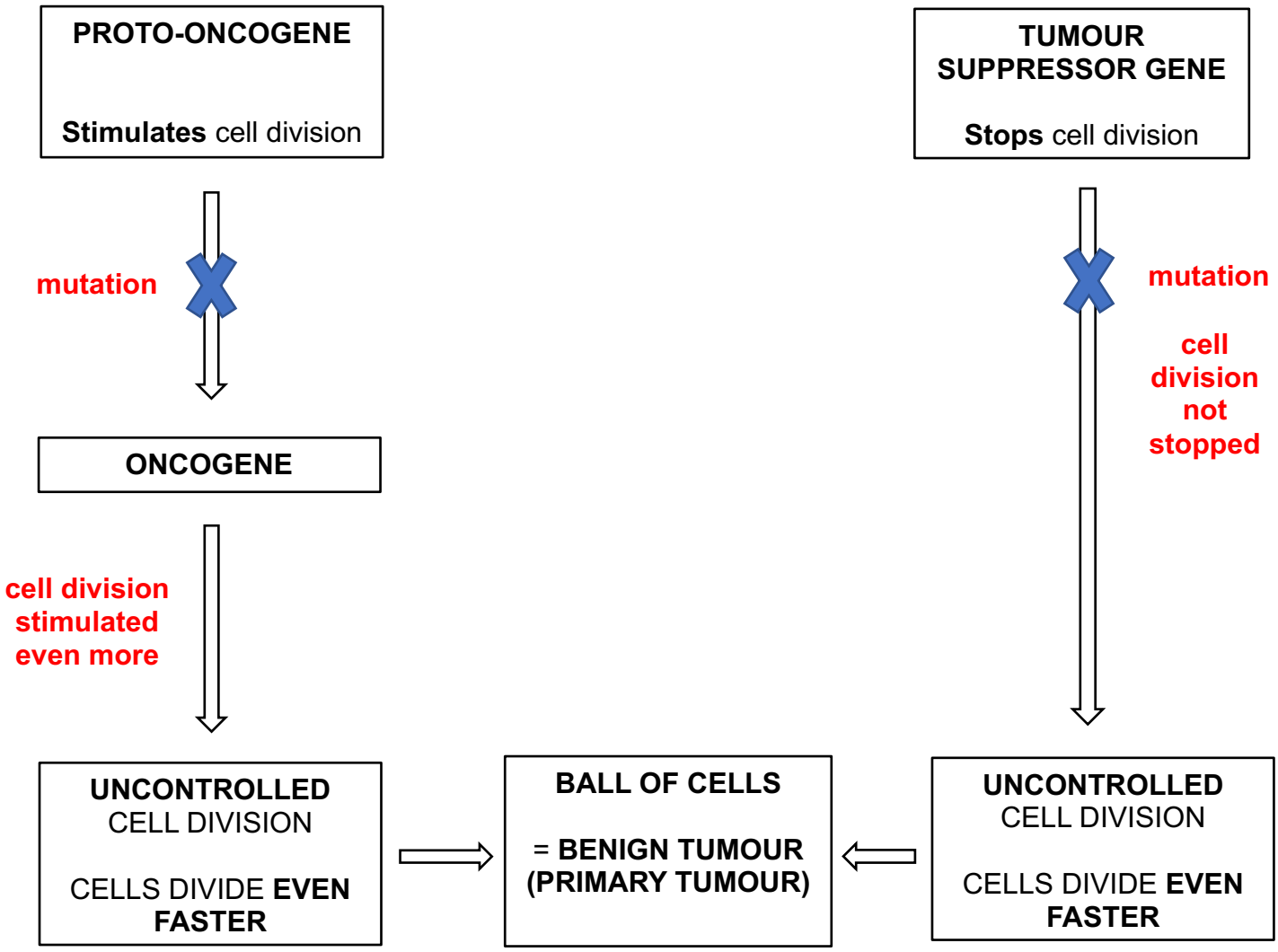
- Happens **after** telophase of mitosis.
- The **cytoplasm divides** and the **cells pinch apart**
- Is slightly **different** in **animal** and **plant cells**

Animal cells	Plant cells
Plasma membrane at **equator** is **pulled inward** until it meets at the centre This **pinches** the **two** cells **apart**	A **new cell wall** (‘**cell plate**’) forms at the **equator**, with **plasma membrane** on **both** sides This **pinches** the **two** cells **apart**



D. TUMOUR FORMATION (ONCOGENESIS)

- **Mutations** in **genes** that **control cell division** can lead to **cancer**.
- Anything that increases the chance of **mutation** also increases the chance of **cancer**.
- **Chemical mutagens** and **ionising radiation** can increase the chance of mutation and cancer. Examples include asbestos, tar, gamma rays, UV rays and X rays.



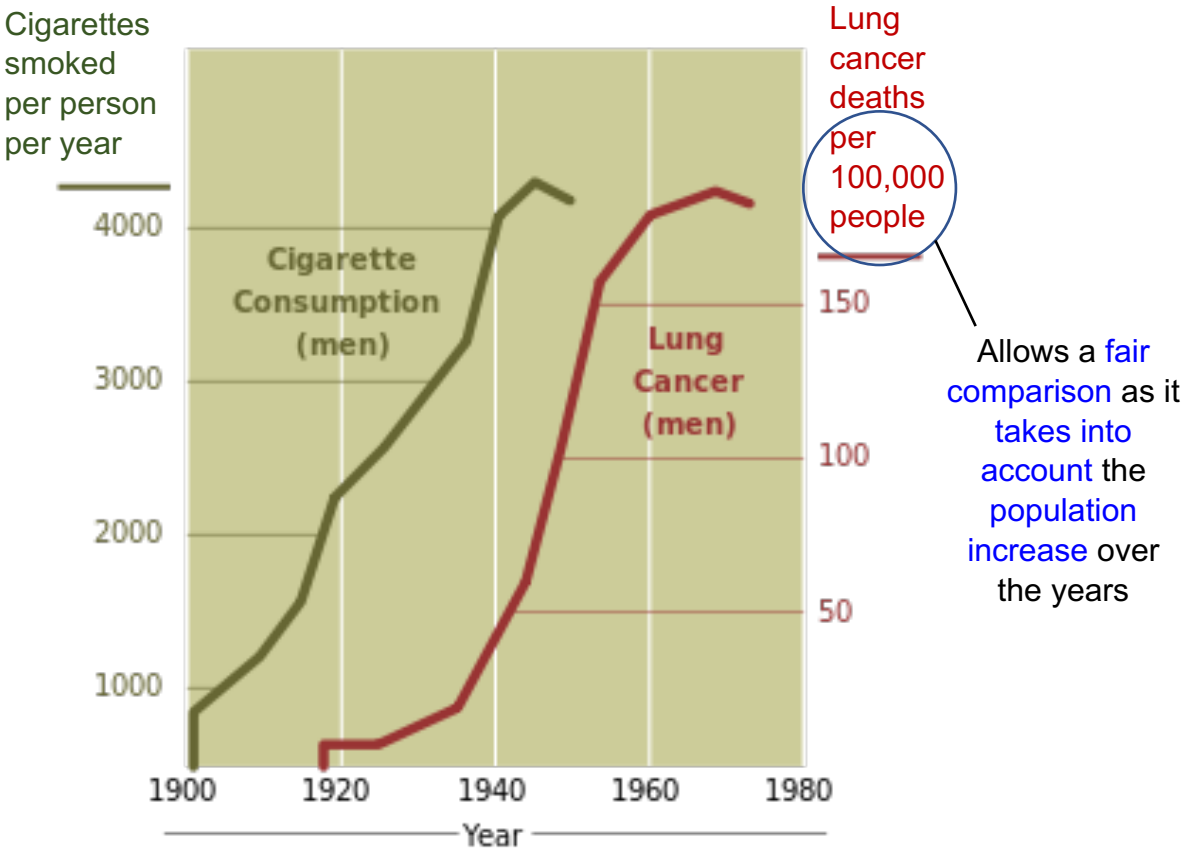
- If cells from the **benign tumour** (primary) **break off** and **enter** the **blood**, they can form **secondary** (malignant) **tumours** in **other parts** of the body. This is called **metastasis**.

Primary and secondary tumours

	Primary Tumour (Benign)	Secondary Tumour (Malignant)
Rapid growth	NO	YES
Invades other tissues	NO	YES
Has entered the blood and spread	NO	YES
Cancerous	NO	YES

E. SMOKING AND CANCER

20-year time lag between smoking and cancer



What we can conclude from the graph

- Generally, **cigarette consumption increased**.
- Generally, the **number of men who died from lung cancer increased**.
- As **cigarette consumption increased**, the **number of men who died from lung cancer increased**.
- There is a **positive correlation** between **cigarette consumption** and the **number of men who died from lung cancer**.

The graph **alone** does **not prove** that smoking cigarettes **causes** lung cancer.

Correlation does not mean causation as there may be **other factors** that were responsible for **causing** cancer that we do not know about.

Extra evidence is needed to prove causation

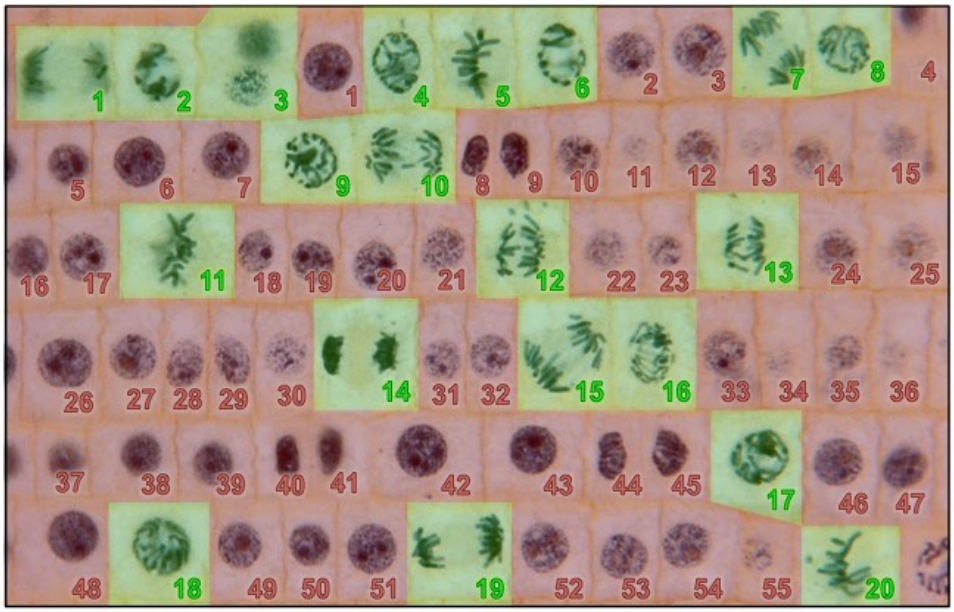
- **Cigarettes** contain **chemicals**, such as **tar,** that are known to **cause mutations**.
- **Human cells** are **more likely** to turn **cancerous** when **exposed** to **cigarette smoke**, compared with **control groups** of cells that have **not been exposed** to **cigarette smoke**.

F. MITOTIC INDEX

- Indicates the **ratio/percentage** of **cells** undergoing **mitosis (cell division)** in a **tissue**.

MITOTIC INDEX	=	Number of cells in **mitosis** (chromosomes are visible) **Total number** of cells

- **Tumours** will have a **higher mitotic index** that non-cancerous tissues because **more** cells will be **dividing** by **mitosis**.



Mitotic Index

$$\frac{\text{Cells in mitosis}}{\text{Total number of cells}}$$

Cells with visible chromosomes:

20

Cells without visible chromosomes:

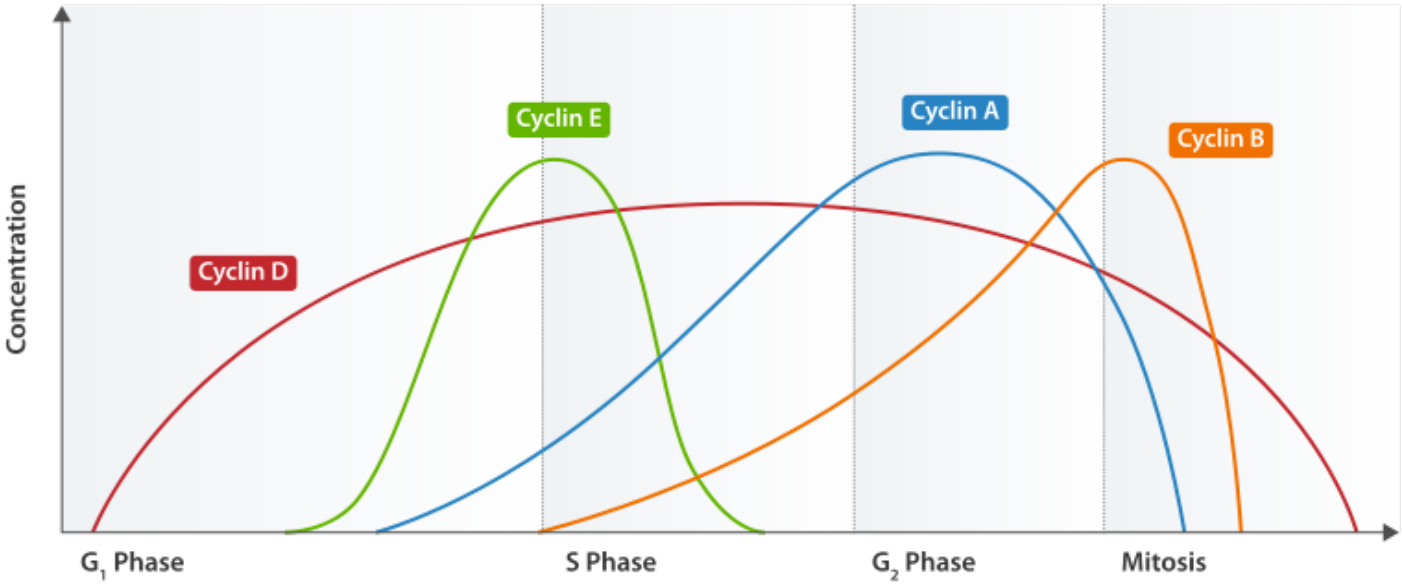
55

Mitotic Index:

20 ÷ (20 + 55) = 0.267

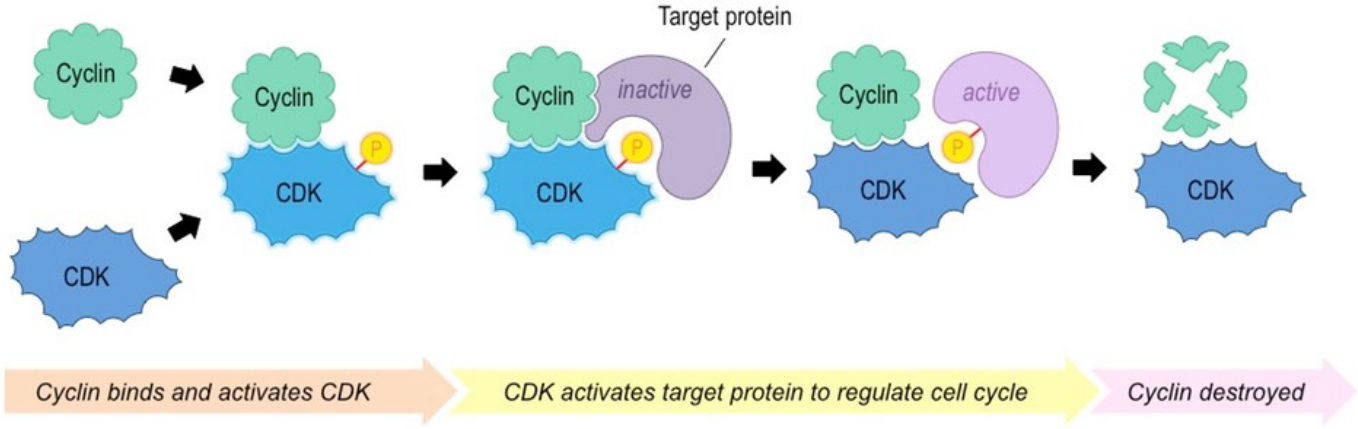
G. CYCLINS AND CONTROL OF THE CELL CYCLE

- The **cell cycle** is a **sequence** of stages: **G1, S, G2** and **mitosis.**
- **Controlled** by **cyclins.**



- **Four c**yclins (**A**, **B**, **C** & **D**) control the **timing** of the cycle.
- Each **cyclin** must reach a certain '**threshold**' concentration, for the **next phase** to **start**.
- Ensures that **cells only divide when new cells are needed** and **not at other times**.

How cyclins work



Cyclins **bind** to **enzymes** called **cyclin-dependent kinases** (**CDKs**)

This **activates** the **CDKs**

Active CDKs then **attach phosphate** (**P**) **groups** to **target proteins**

This **activates** the **target proteins**

Active target proteins carry out specific **roles** in **different phases** of the **cell cycle** e.g. DNA replication

Cyclins are then **destroyed**