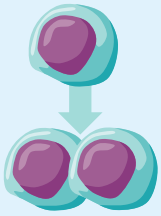
D2.1

Cell Cycle & Cyclins (HL)

MITOSIS – Production of two genetically identical cells

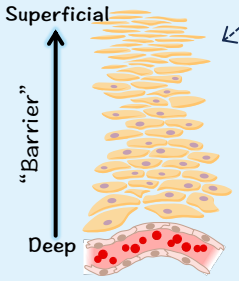
What – Refers to the splitting of the nucleus. It is divided into four steps: **prophase, metaphase, anaphase and telophase.** Mitosis is readily followed by **cytokenesis** which is the splitting of the cytoplasm (see D2.1 SL).

Result – 2 identical cells

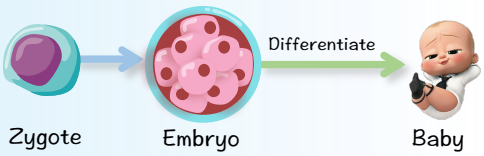


Where – Eukaryotes (somatic cells)

Purpose - Repair & Growth



When superficial layers of skin (dead cells) get damaged by abrasions (scratch), the deep layers of skin (stem cells) that can divide and then replace the dead superficial cells. This is repair.



As cells divide, an organism will increase in size.

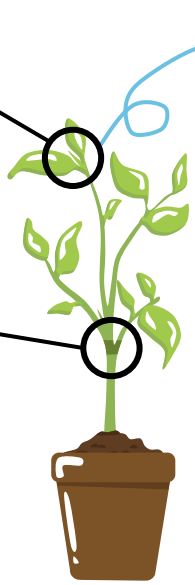
MITOSIS IN PLANTS

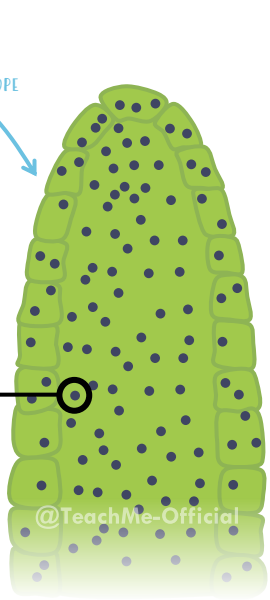
Meristems – Areas of special tissues found in plants. Meristematic cells are UNDIFFERENTIATED (stem cells) and rapidly divide.

They only differentiate later. Specific purpose like STRUCTURAL support or TRANSPORT of liquids as vascular tissue.

Apical meristem
(At root tips AND tips of branches)
Causes plants to LENGTHEN

Lateral meristem
(At lateral side of stems AND roots)
Causes plants to grow in WIDTH

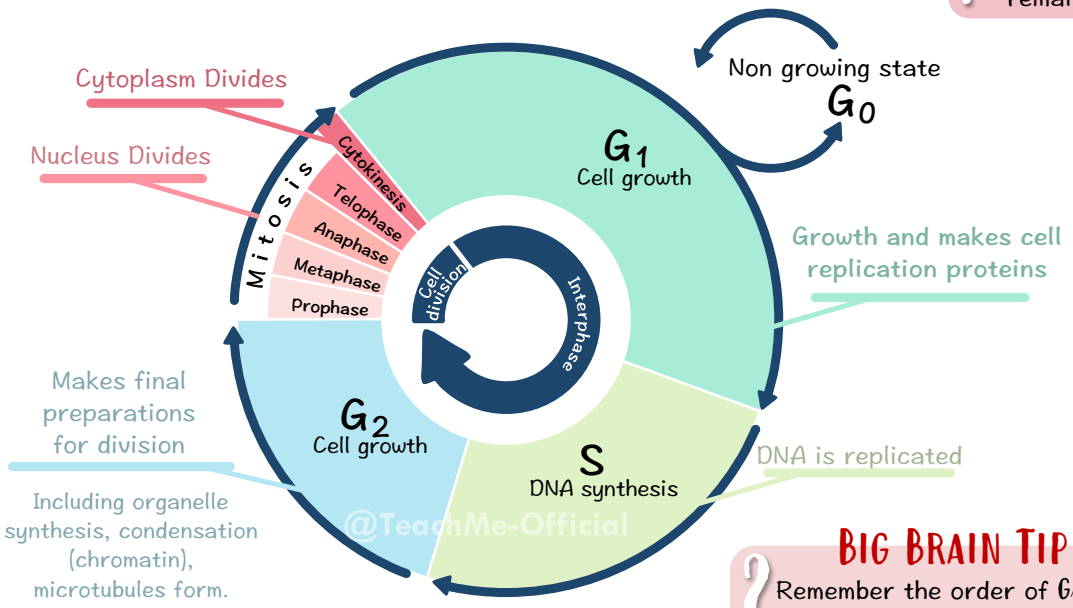




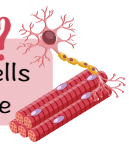
The dark spots represent condensed chromosomes inside cells which are rapidly undergoing mitosis.

THE CELL CYCLE

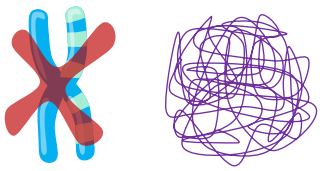
This is a series of stages a cell goes through throughout its life cycle up till the point where it divides (or not).



DID YOU KNOW?
Nerve and muscle cells remain in G0 phase



(G1, S, G2)
During INTERPHASE (longest phase) the cell prepares for division by growing and replicating its DNA and organelles.



DNA is not condensed during this phase.

BIG BRAIN TIP!
Remember the order of G1, S, G2 as: Getting Super Giant

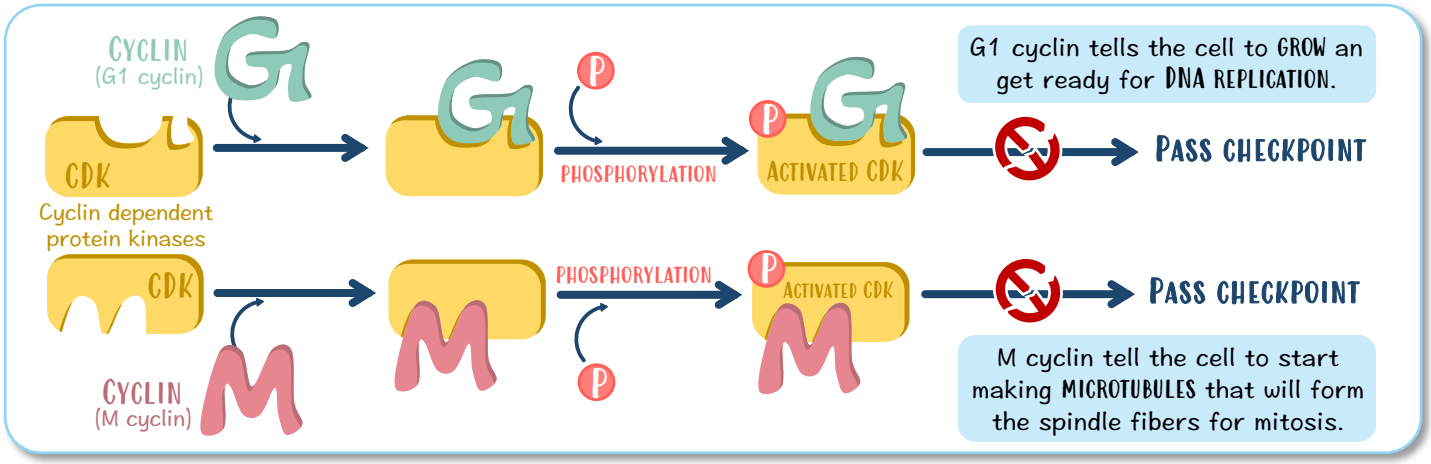
Cell Cycle & Cyclins (HL)

Controlling the Cell Cycle

To ensure the cell cycle runs smoothly, various **checkpoints** ( ) are found throughout the cell cycle. In order for a cell to move on to the next stage, it must pass said checkpoints, but only if it meets certain requirements.

How does a cell pass these checkpoints?

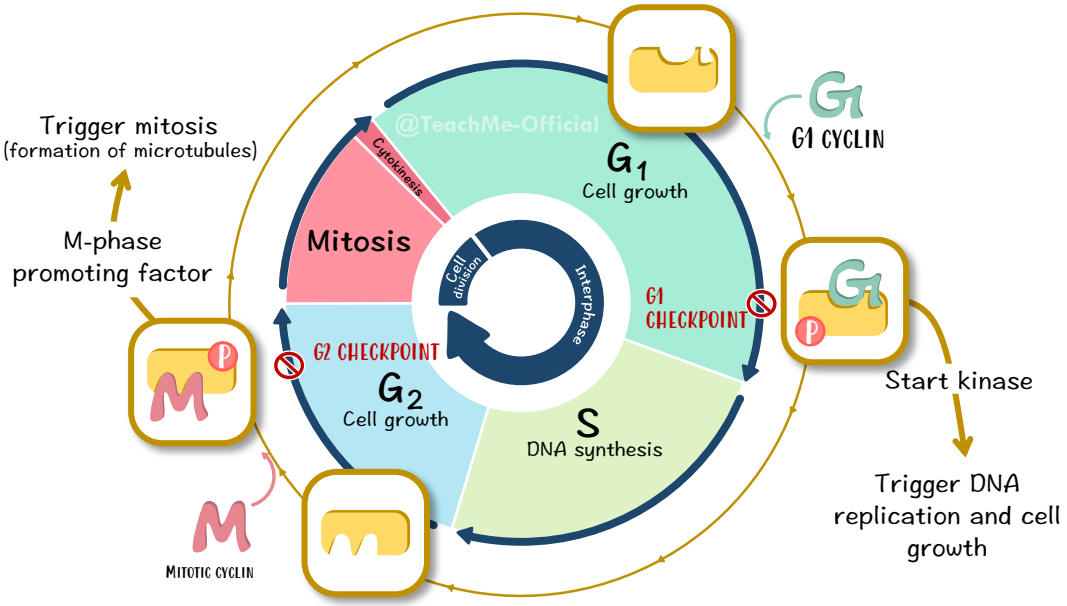
There are a group of proteins (different kinds) that control the cells progression through the cell cycle. They are called **cyclins**. For example, **cyclin G1** ( ) binds to a **cyclin dependent kinases** (CDKs). This complex (Cyclin & CDK) then gets **phosphorylated** (added a phosphate) forming an activated Cyclin-CDK complex. This activated complex triggers the cell to progress from the G1 phase to the S phase. These cyclins ensure the cell only progresses when conditions are right: if issues are detected, the cycle stops until the requirements are met.

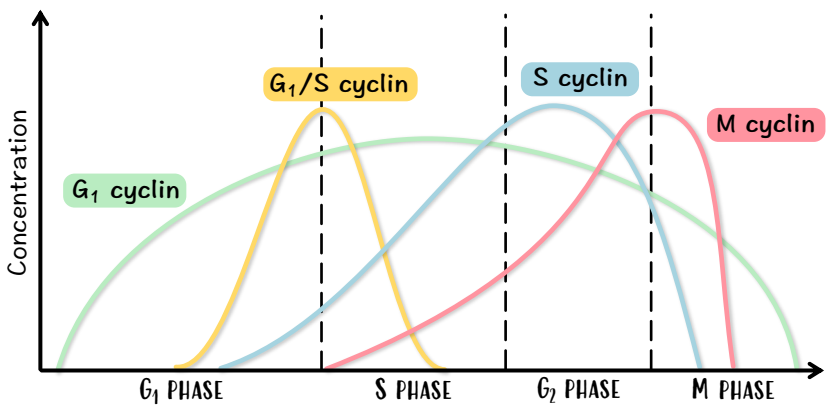


Two very important checkpoints are:

The G1 checkpoint
(between G1 and S phase)
Ensures the cell is ready to start DNA replication

The G2 checkpoint
Ensures the cell is ready to start the division of the nucleus (mitosis)





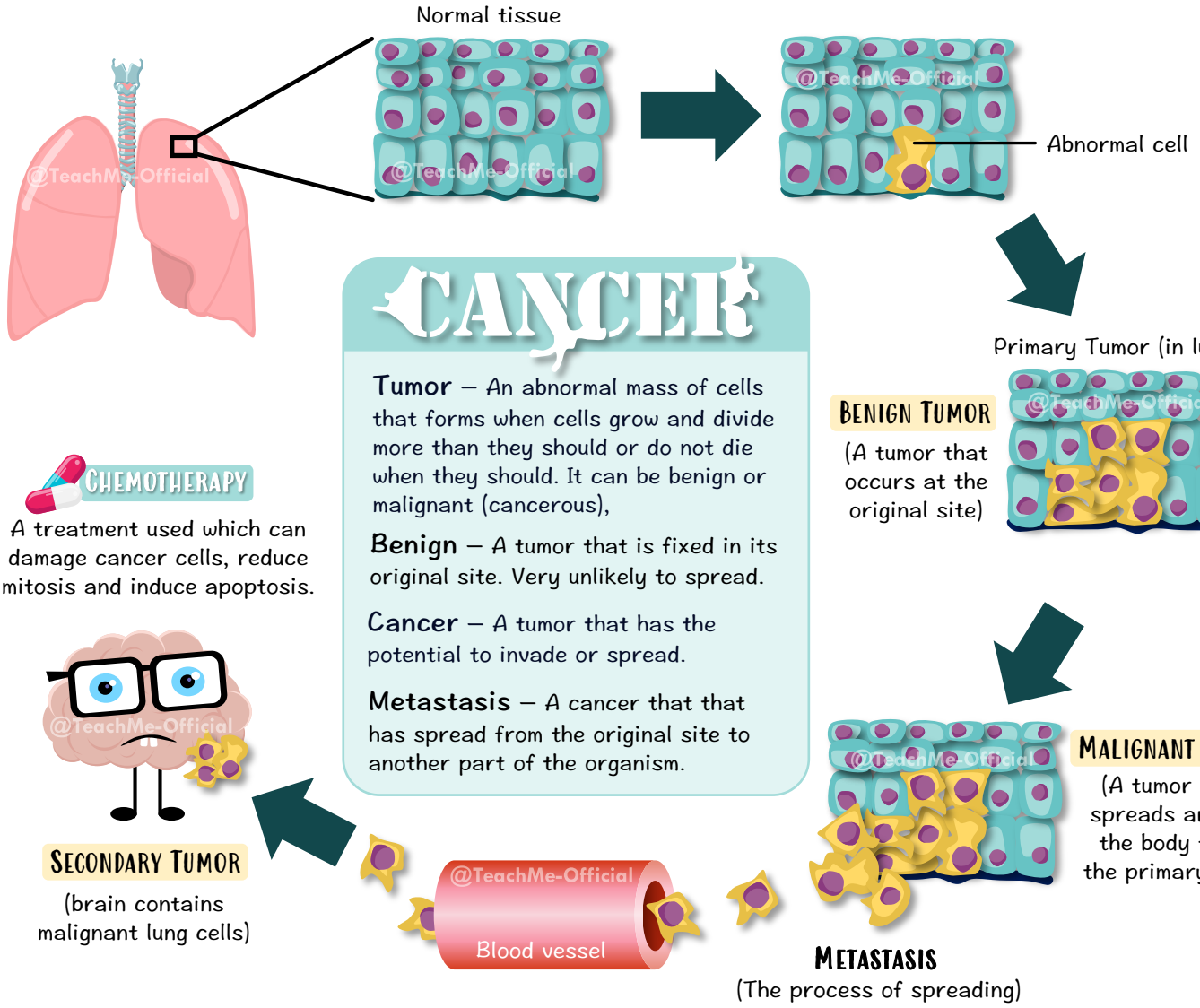
At a low concentration of a particular cyclin, very few bind to CDKs and a checkpoint cannot be reached.

Once the cyclin's concentration increases, more bind to CDK's which allows the checkpoint to be passed.

Cell Cycle & Cyclins (HL)

Abnormalities of the Cell Cycle

When the cell cycle isn't properly controlled, it can lead to an uncontrolled replication of the cells. In such instances, it may lead to the formation of cancer. **Oncologists** are doctors who specialize in cancer prevention and treatment.



Cancer

Tumor – An abnormal mass of cells that forms when cells grow and divide more than they should or do not die when they should. It can be benign or malignant (cancerous),

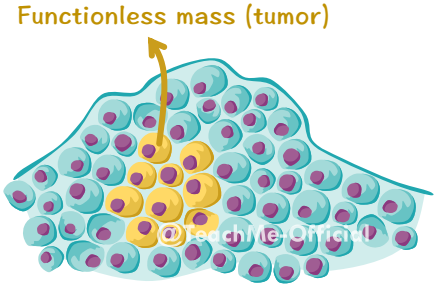
Benign – A tumor that is fixed in its original site. Very unlikely to spread.

Cancer – A tumor that has the potential to invade or spread.

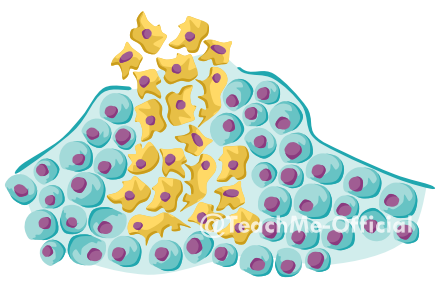
Metastasis – A cancer that that has spread from the original site to another part of the organism.

Benign vs. Malignant Tumors

Benign – if the tumor is not spreading and doesn't have characteristics of spreading.



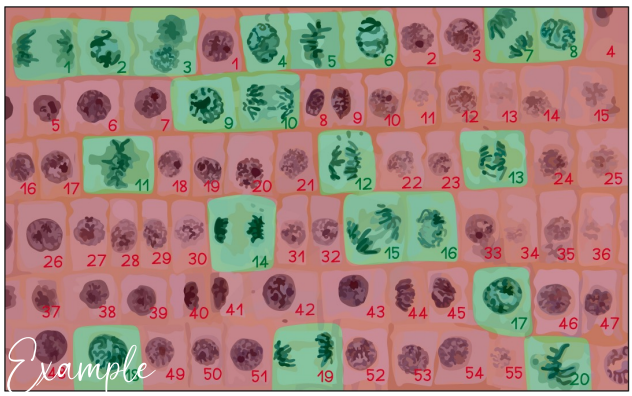
Malignant – tumors that spread around the body from the primary site.



Cell Cycle & Cyclins (HL)

Mitotic Index (MI)

Definition: The ratio between the number of a population's cells undergoing mitosis to its total number of cells.



When looking at cells under the microscope (after staining) you can identify the stage of mitosis the cells are in.

The mitotic index is important for predicting response of cancer cells to chemotherapy.

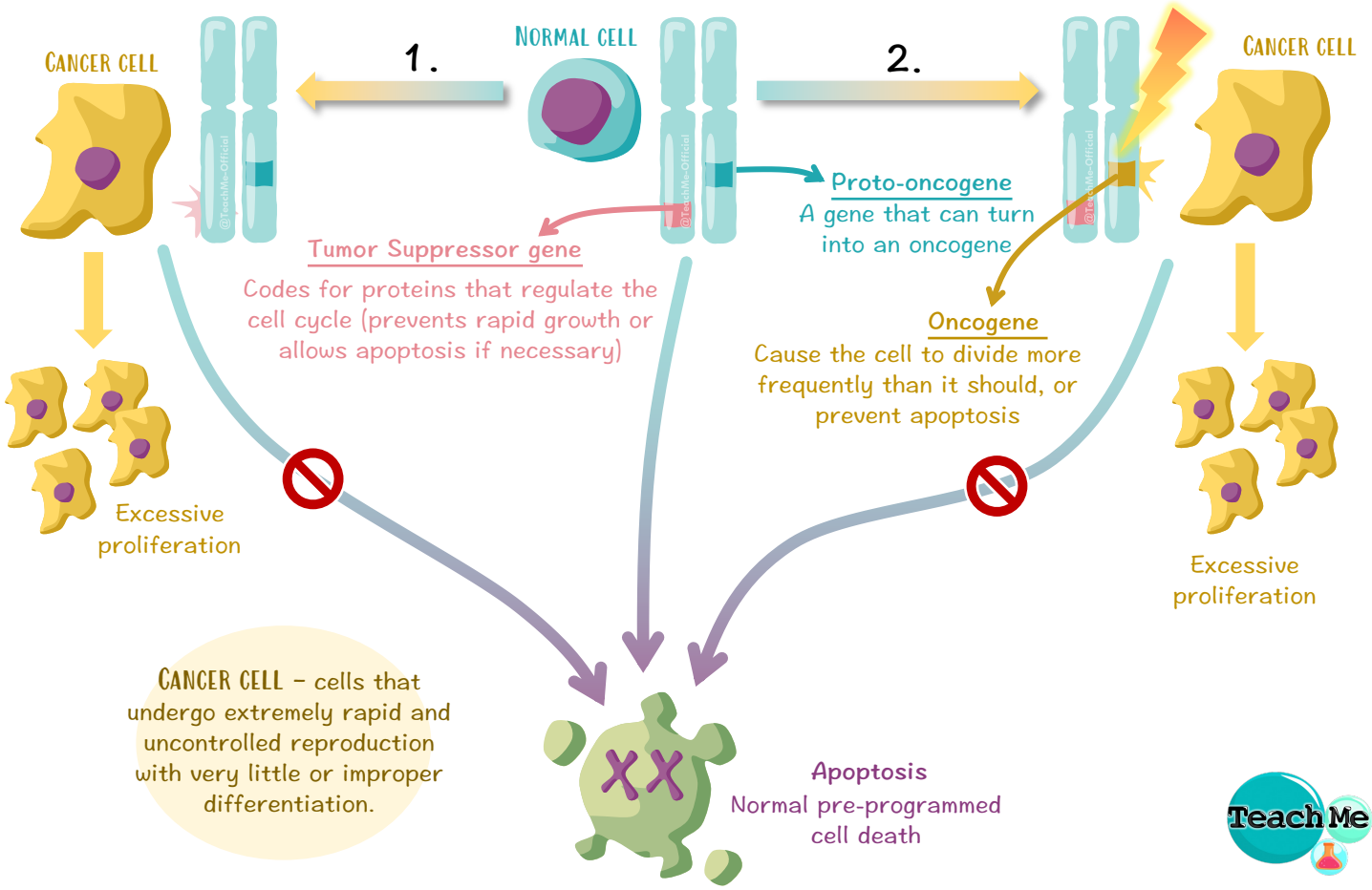
$$\text{MI} = \frac{\text{Cells undergoing mitosis}}{\text{Total number of cells}} \qquad \text{MI} = \frac{20}{75} = 26.7\%$$

High MI = more rapid proliferation of cells
Mitotic index of over 75% is considered very high

The Effect of Mutations

1. If a mutation occurs on a **TUMOR SUPPRESSOR GENE**, the lack of function of that gene may cause rapid uncontrolled growth or even prevent the defective cell from undergoing **apoptosis**. This results in a cancer cell.
2. If a mutation occurs on a **PROTO-ONCOGENE**, it would cause it to turn into an oncogene, leading to the cell dividing rapidly and uncontrollably, or prevent the cell from undergoing apoptosis. This results in a cancer cell.

Mutagen
An external factor which may trigger a mutation (e.g cigarette smoke, radiation)



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