Cell Cycle

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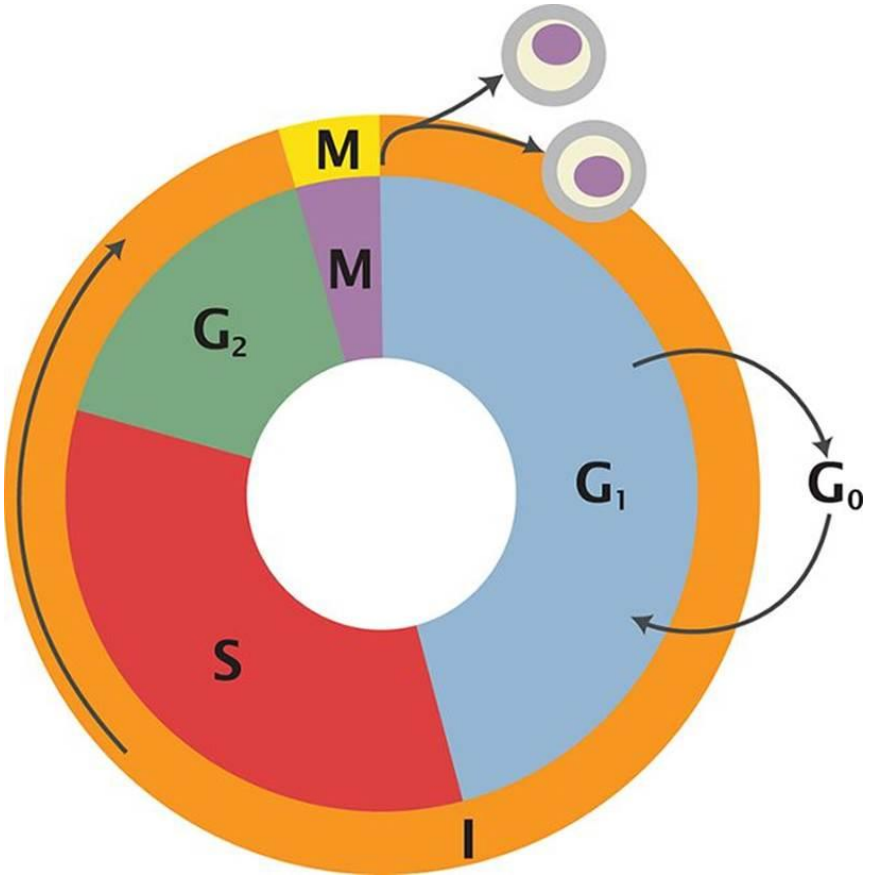
By the end of this lesson you will be able to:

Explain the stages of the cell cycle and how the cell cycle is regulated.



THE EUKARYOTIC CELL CYCLE

- Cells reproduce by duplicating their contents and then splitting into two daughter cells.
- Nuclear and cytoplasmic division (M phase)
- Between each M phase is an interphase.
- During interphase there are made preparations for cell division, in a carefully ordered and controlled sequence, with checkpoints.

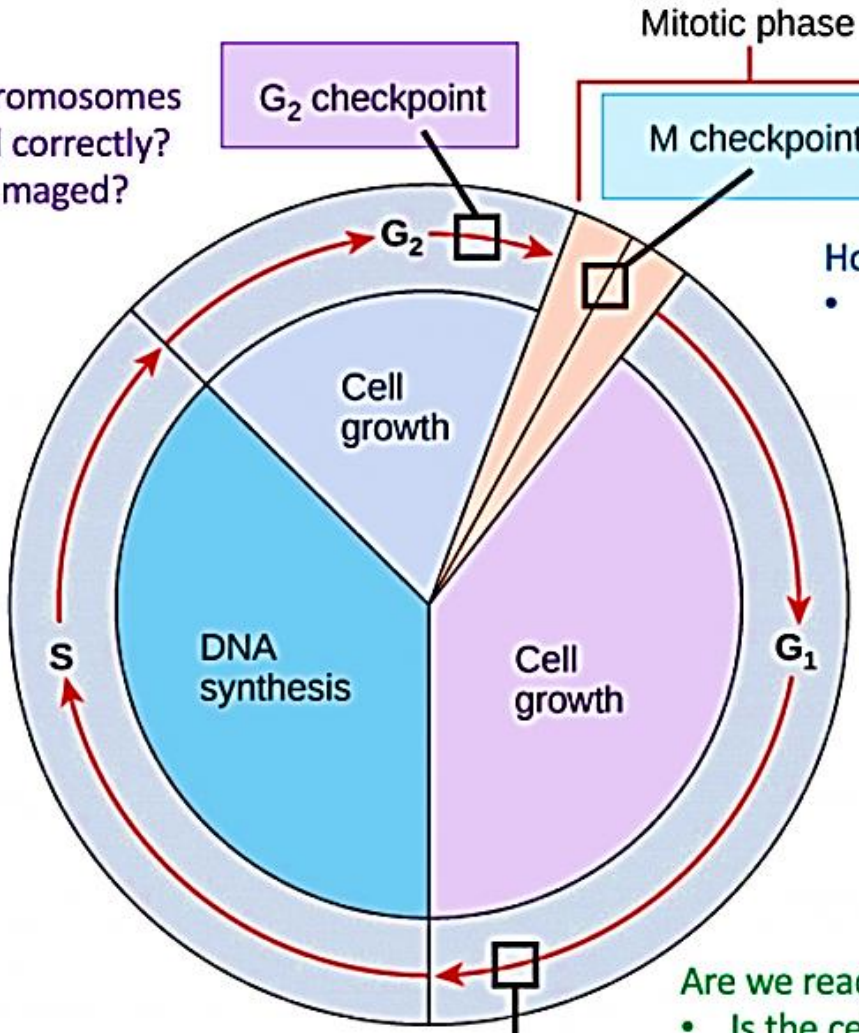
CHECKPOINTS

- Checkpoints are mechanisms that control the process of cell division so it can happen in a proper way.
- **The purpose of the checkpoints is:**
- to prevent uncontrolled division that would lead to tumors (cancer)
- to detect and repair damage to DNA (for example, damage caused by UV light)
- The major checkpoints in the cell cycle are :

1. G1/S checkpoint
2. G2/M checkpoint
3. M checkpoint

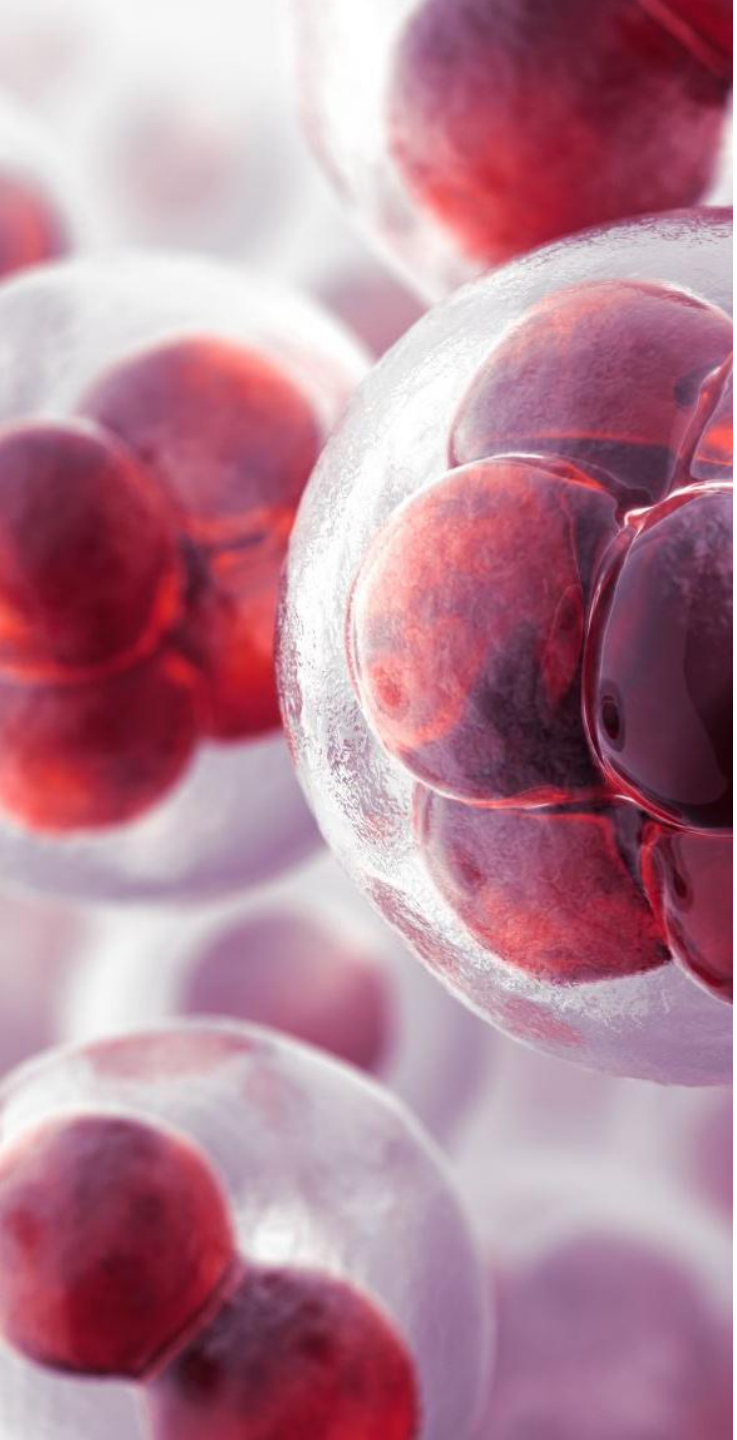
CHECKPOINTS

How's our DNA?
- Did all the chromosomes get replicated correctly?
- Is the DNA damaged?



How's our chromosomal alignment?
- Did all the chromosomes line up in the center of the cell, ready to be pulled apart?

Are we ready to divide?
- Is the cell big enough?
- Are there enough energy and other reserves?
- Is the DNA damaged?



CHECKPOINTS

- Progression through checkpoints is regulated by these cellular mechanisms:

1. Cyclins
2. Cyclin dependent Kynases (CDK)
3. Tumor suppressors (gene p53)

Phase of cell cycle and checkpoints	Events within the cell
M phase • A checkpoint chemical triggers condensation of chromatin. • Halfway through the cycle, the metaphase checkpoint ensures that the cell is ready to complete mitosis.	• Cell growth stops. • Nuclear division (mitosis) consisting of stages: prophase, metaphase, anaphase and telophase (see topic 2.6.2 for more on mitosis). • Cytokinesis (cytoplasmic division).
G_0 (gap 0) phase • A resting phase triggered during early G_1 at the restriction point (see below), by a checkpoint chemical. • Some cells, e.g. epithelial cells lining the gut, do not have this phase.	• In this phase, cells may undergo apoptosis (programmed cell death), differentiation or senescence. • Some types of cells (e.g. neurones) remain in this phase for a very long time or indefinitely.
G_1 (gap 1) phase – also called the growth phase • A G_1 checkpoint control mechanism ensures that the cell is ready to enter the S phase and begin DNA synthesis.	• Cells grow and increase in size. • Transcription of genes to make RNA occurs. • Organelles duplicate. • Biosynthesis, e.g. protein synthesis, including making the enzymes needed for DNA replication in the S phase. • The p53 (tumour suppressor) gene helps control this phase.
S (synthesis) phase of interphase • Because the chromosomes are unwound and the DNA is diffuse, every molecule of DNA is replicated. There is a specific sequence to the replication of genes: housekeeping genes – those which are active in all types of cells, are duplicated first. Genes that are normally inactive in specific types of cells are replicated last.	• Once the cell has entered this phase, it is committed to completing the cell cycle. • DNA replicates. • When all chromosomes have been duplicated, each one consists of a pair of identical sister **chromatids**. • This phase is rapid, and because the exposed DNA base pairs are more susceptible to mutagenic agents, this reduces the chances of spontaneous mutations happening.
G_2 (gap 2) phase of interphase • Special chemicals ensure that the cell is ready for mitosis by stimulating proteins that will be involved in making chromosomes condense and in formation of the spindle.	• Cells grow.

Interactive learning

https://www.youtube.com/watch?v=e6N9_RhD10Q

https://www.biointeractive.org/classroom-resources/eukaryotic-cell-cycle-and-cancer