Aim: What is the cell cycle?

The ability of organisms to reproduce their kind is one characteristic that best distinguishes living things from nonliving matter.

What are the stages of the cell cycle?

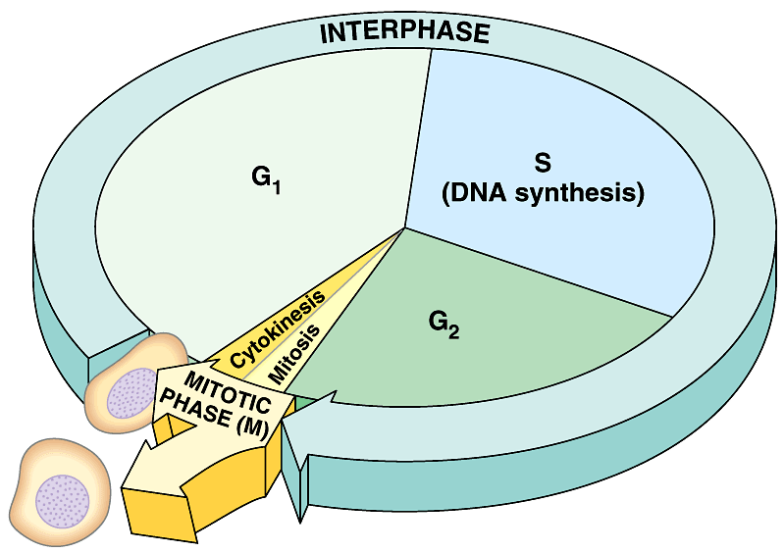
- Cell cycle – events that occur in the life of a cell.
- Life span of a cell varies:
  - A) bacteria – 20 minutes
  - B) most plant cells – 10 to 30 hours
  - C) most animal cells – 18 to 24 hours

What are the stages of the cell cycle? (2)

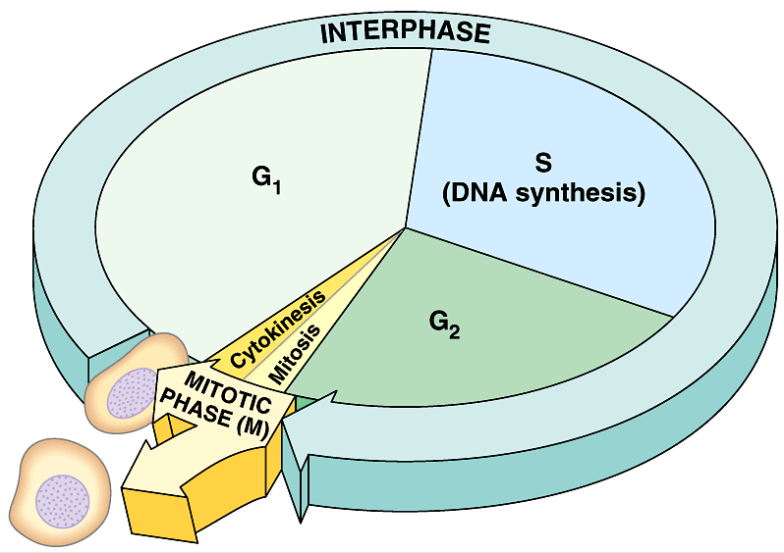
- Stages in the cell cycle:
- I: Interphase (no cell division)
  - 1) G_1 = cell ***grows*** in size as it performs most of the metabolic processes. 42%
  - 2) S = ***synthesis*** of DNA in preparation for cell division (mitosis) 37%
  - 3) G_2 = cell ends DNA synthesis and prepares for mitosis by producing various mitotic enzymes 17%
- II: mitosis – cell actually divides. (4%)

What are the stages of the cell cycle? (3)

- Each phase of the cycle may have different duration (time span) depending upon its chemical environment.
- Embryonic cells have no real G_1 stage
- Liver cells may never leave G_1 unless they are stimulated in an emergency.



What are the stages of the cell cycle? (4)

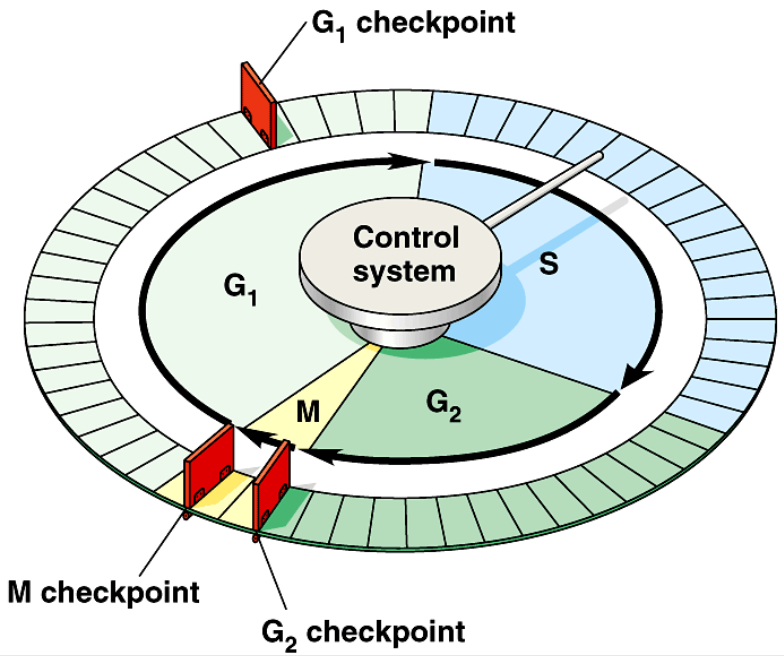


- Mature skeletal and nerve cells never leave G_1. These cells are called G_0 cells.
- Heart muscle cells stop at G_2. Chromosomes have doubled but do not go through mitosis. Reason evades biologists.

What controls the progress from one stage to another? (1)

- The cell cycle is controlled by a molecular signaling system that cyclically switches the cell's metabolism on and off.
- This signaling system has *checkpoints* in the G_1, G_2 and M stages of the cell cycle.
- The cell cycle doesn't advance beyond these checkpoints unless certain conditions are strictly met. (favorable environment, proper size, enough DNA)
- For most cells, the G_1 checkpoint, known as the *restriction checkpoint*, is the most important. If the cell gets beyond this checkpoint, it is likely that it will divide by mitosis.

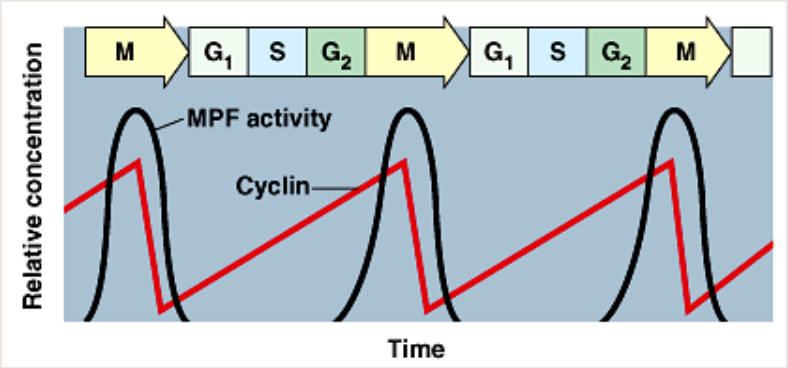
What controls the progress from one stage to another? (2)



- The ordered sequence of cell cycle events is synchronized by rhythmic changes in the activity of protein kinases.
- Kinases are enzymes that catalyze the transfer of a phosphate group from ATP to a target protein.
- Phosphorylation either activates or inactivates the target protein.

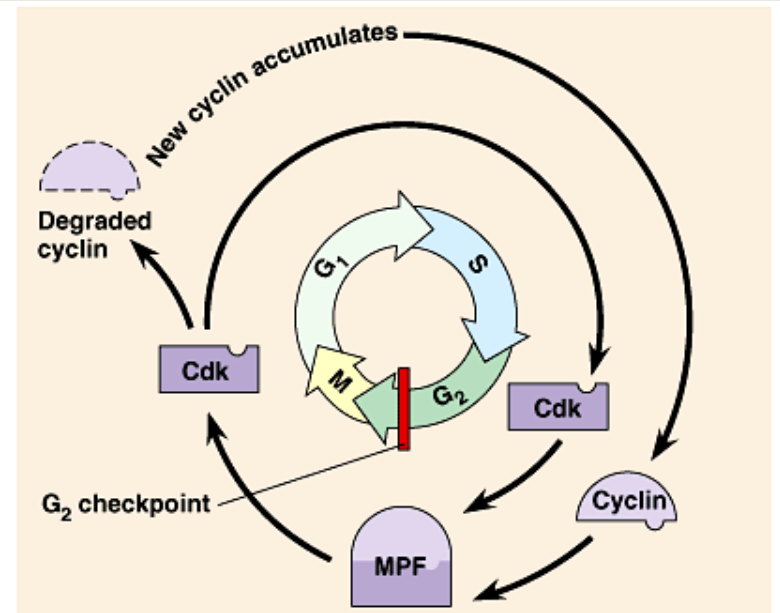
What controls the progress from one stage to another? (3)

- The levels of these kinases are present in constant amounts, but these kinases require a second protein, a **cyclin**, to become activated
  - Level of cyclin proteins fluctuate cyclically.
  - The complex of kinases and cyclin forms **cyclin-dependent kinases** (**Cdks**).



What controls the progress from one stage to another? (4)

- Cyclins are regulatory proteins. Their levels change *cyclically* during the cell cycle.
- Cyclin levels rise sharply throughout interphase, then fall abruptly during mitosis.



How cyclins work

- S-cyclin activity:

- 1) As G_1 begins, protein $kinase_1$ is inactive.
- 2) S-cyclin is produced and begins to bind to protein $kinase_1$, activating it. The complex is called cdk_s
- 3) When there is enough cdk_s in the cell, it overcomes the G_1 checkpoint and the cell enters S phase. Cdk_s phosphorylates a chemical messenger.
- 4) The chemical messenger is now activated and:
  - regulates DNA replication
  - destroys S-cyclin, ending all former G_1 activity

How cyclins work (2)

- M-cyclin

- 1) As S stage begins, inactive protein kinase$_2$ is in the cytoplasm.
- 2) M-cylin is synthesized and starts to bind to protein kinase$_2$, activating it. The complex is called cdk$_M$ (M-promoting factor)
- 3) When there is enough cdk$_M$ in the cell, it overcomes the S checkpoint and the cell begins mitosis.
- 4) Cdk$_M$ activates a different messenger which:
  - Triggers mitosis (chromosome condensing and nuclear envelope dispersion)
- Destroys M-cyclin, ending all S stage activity