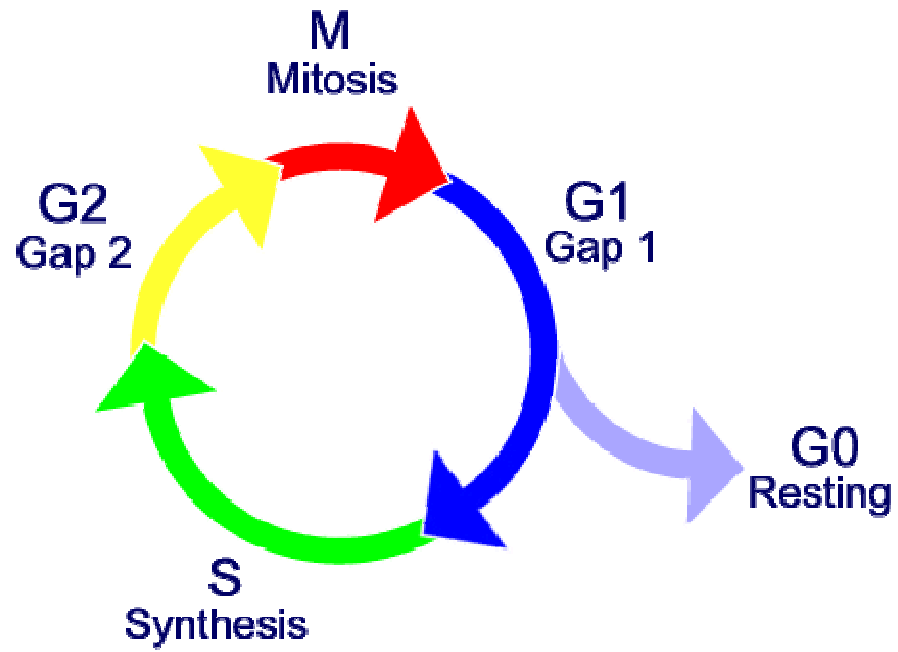
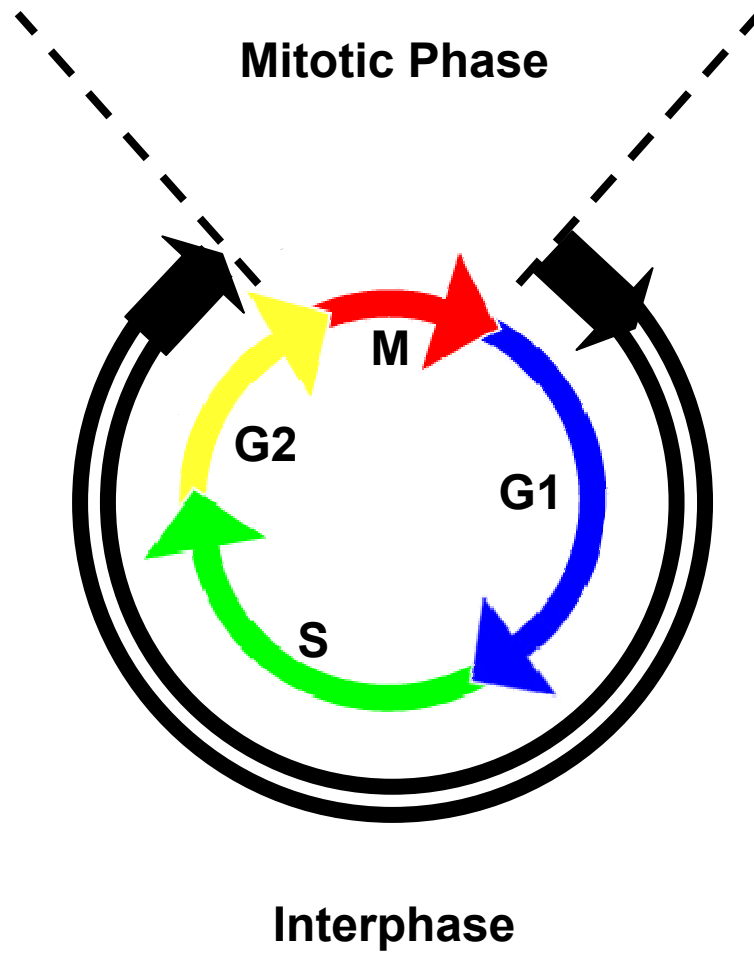
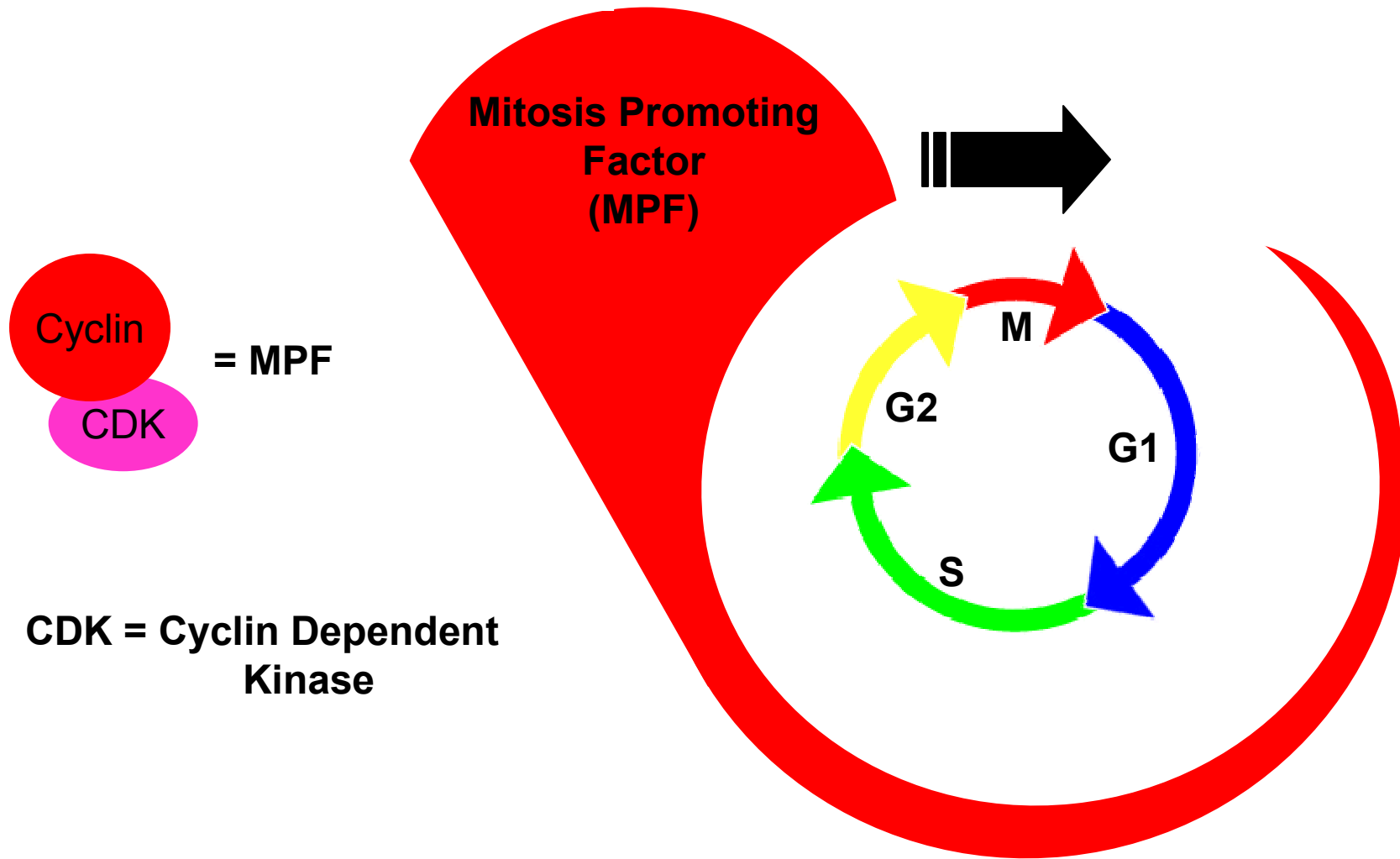


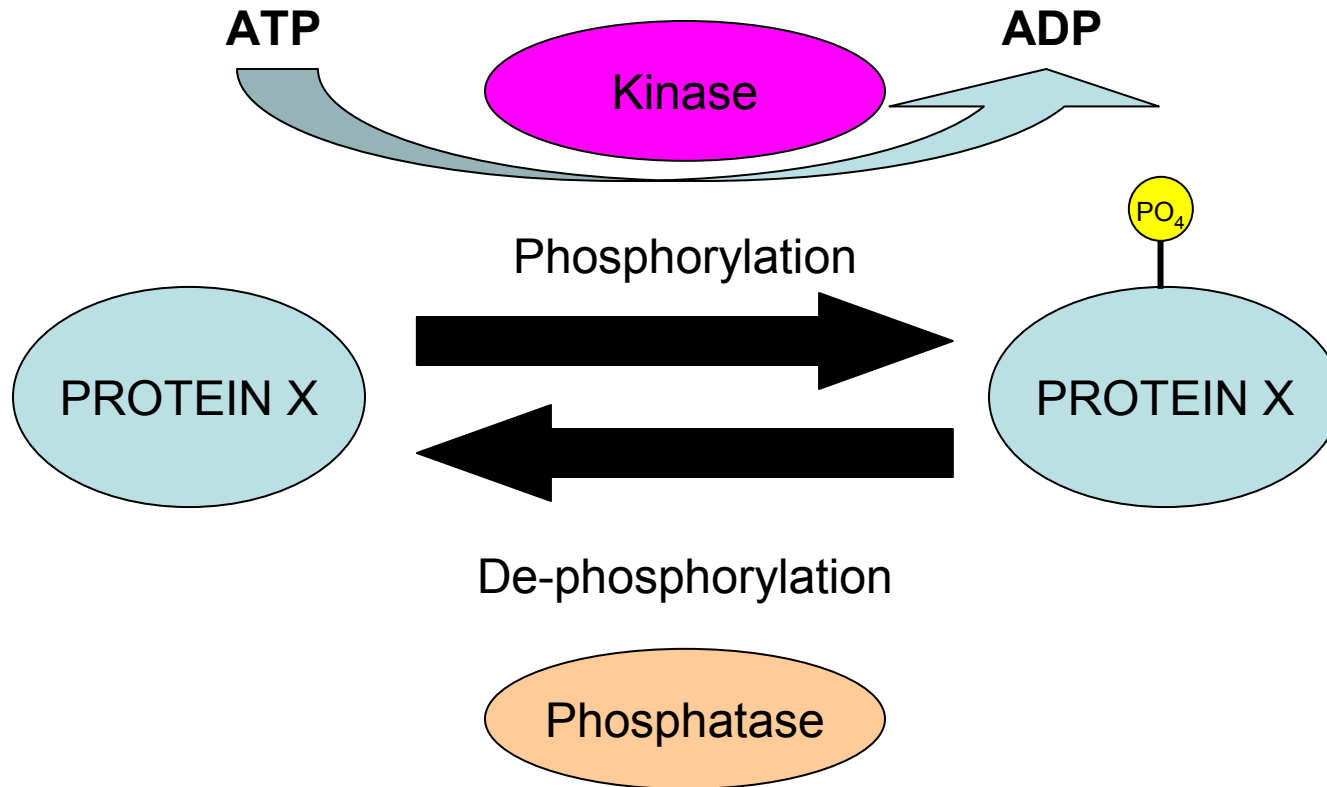
CELL CYCLE

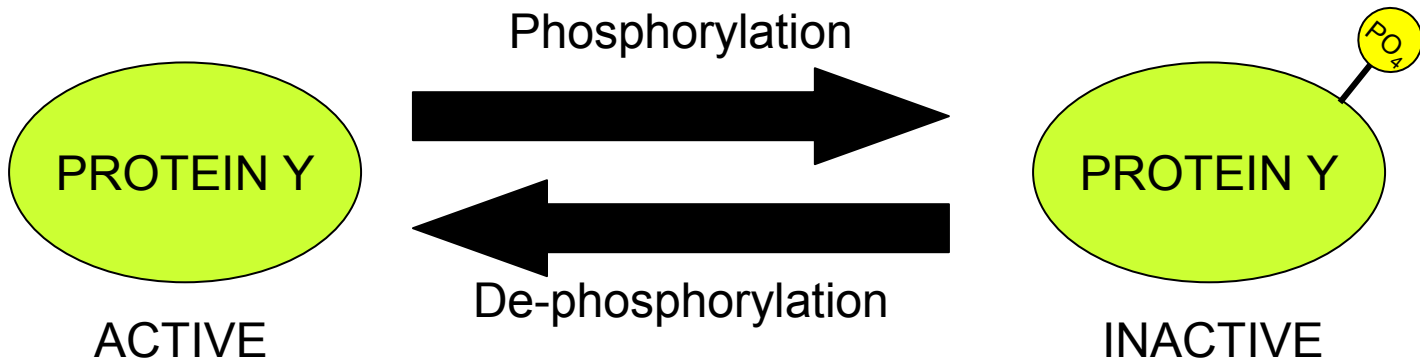
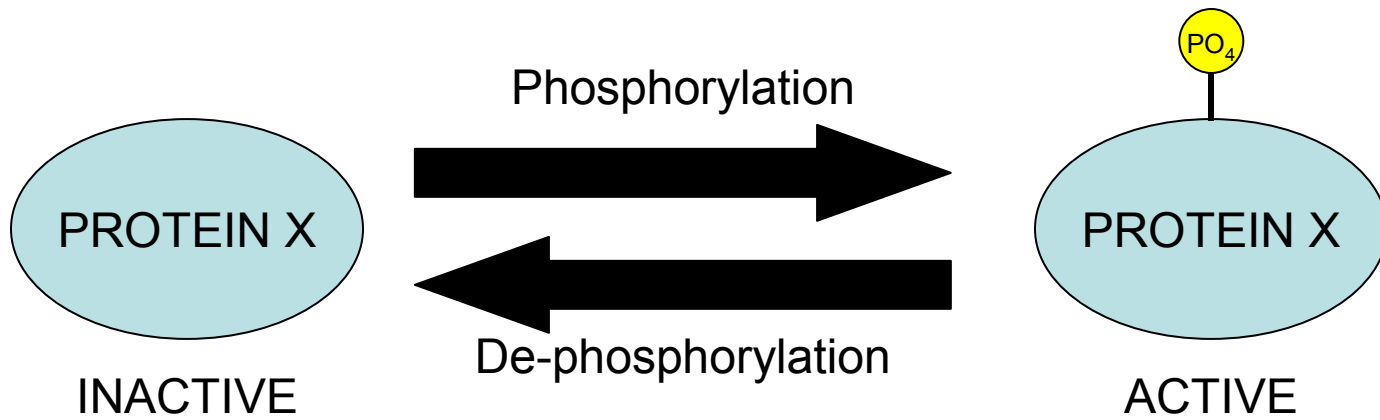


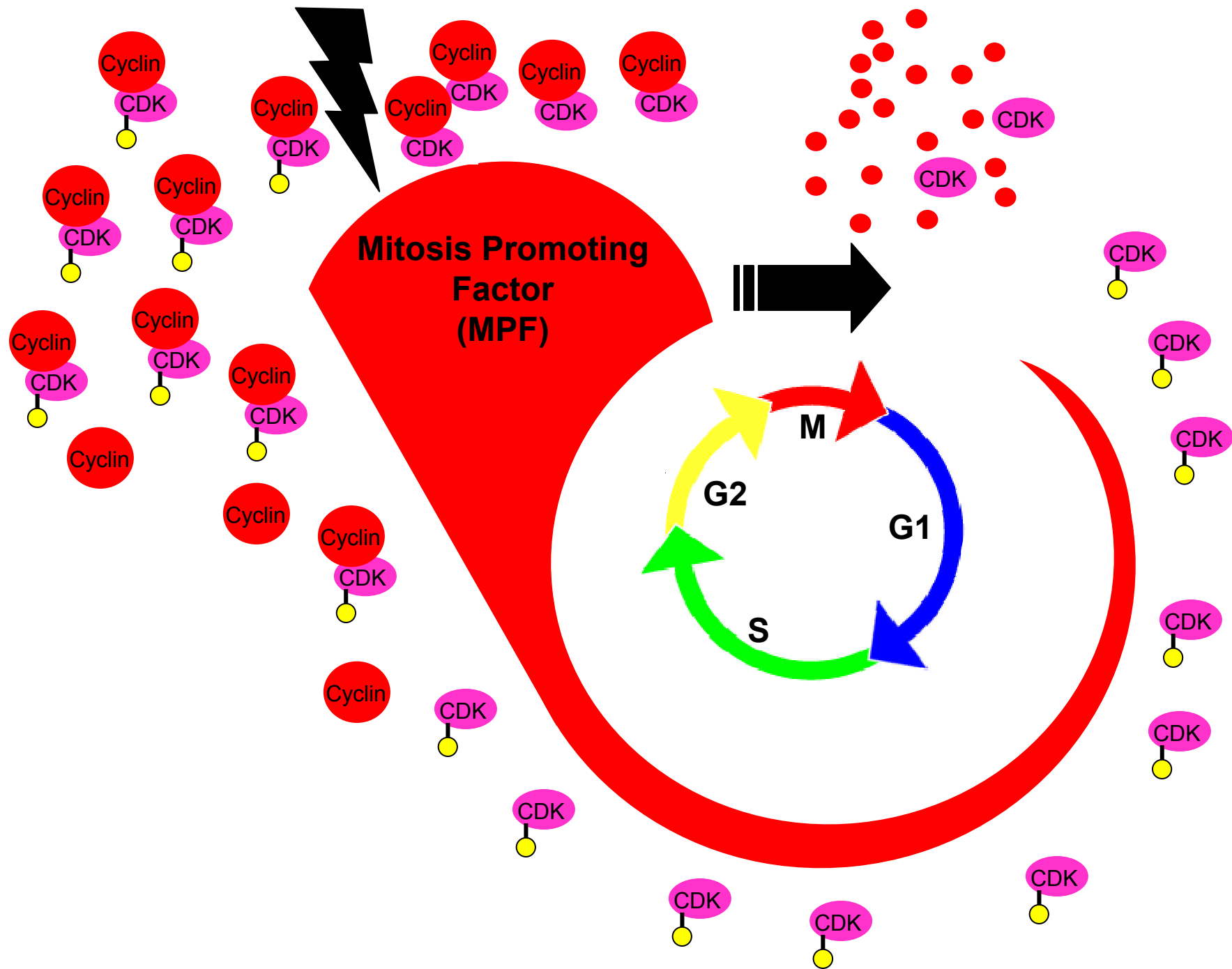


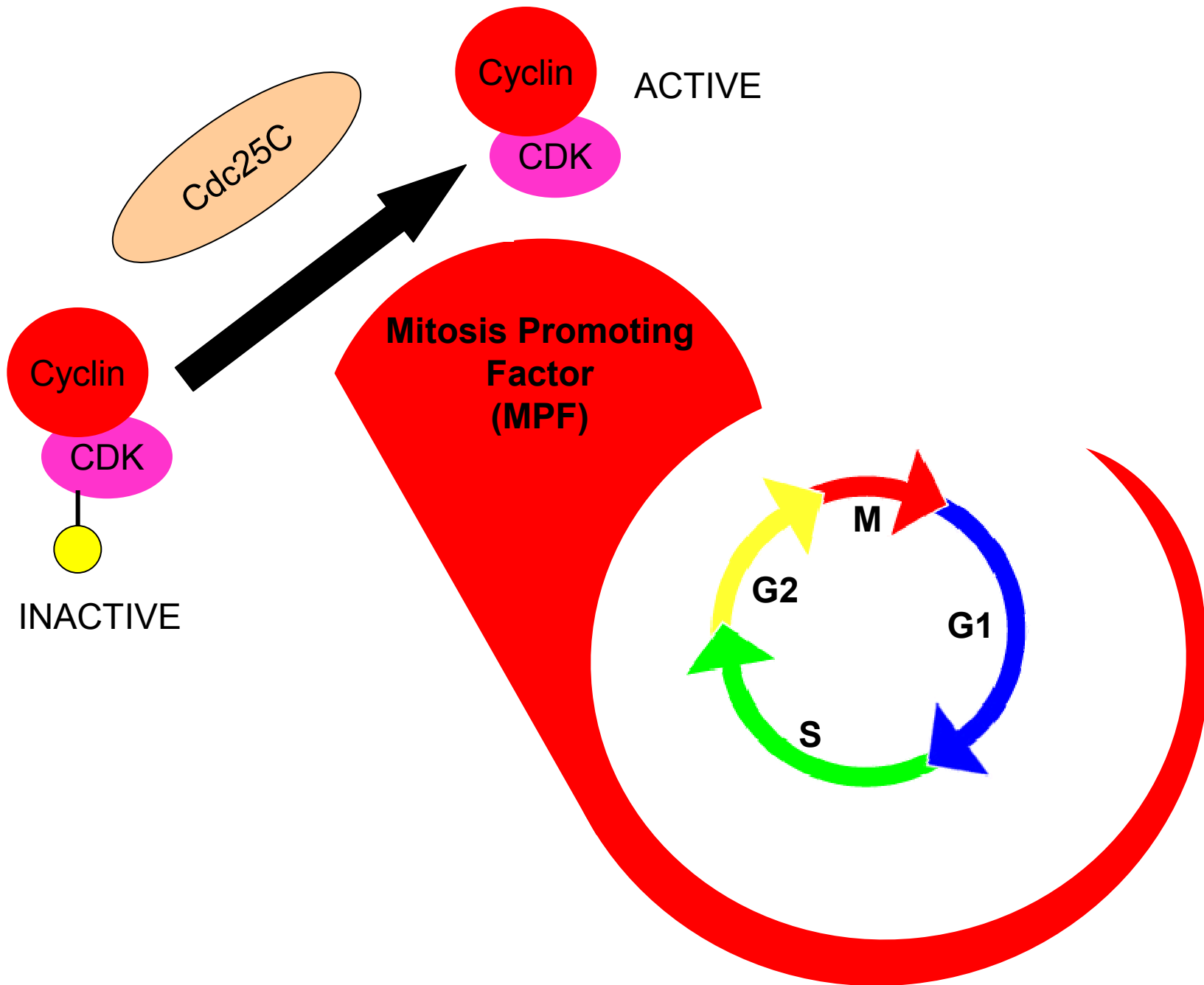


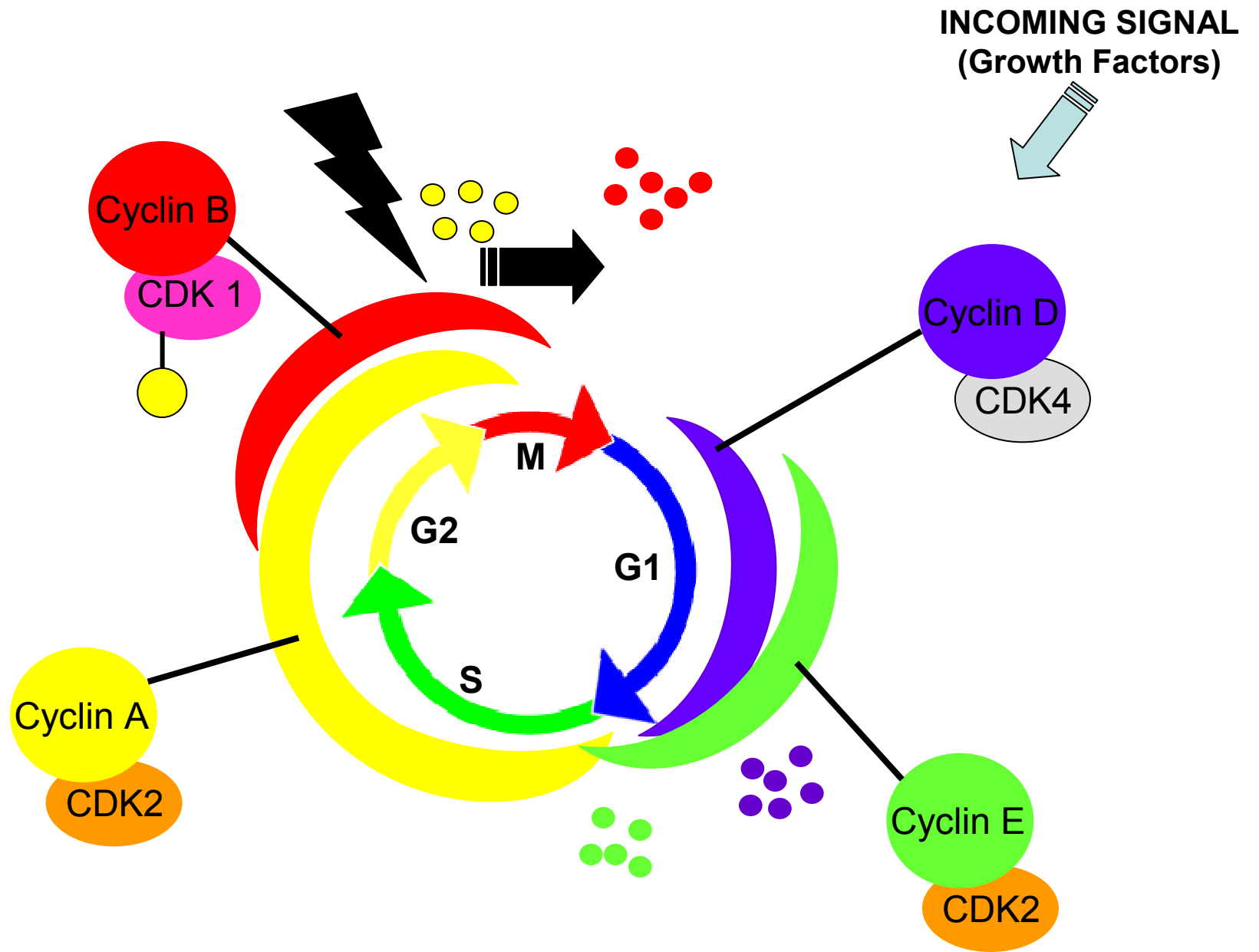
KINASES AND PHOSPHATASES





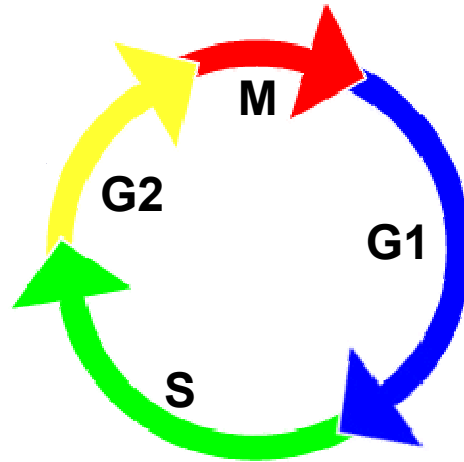




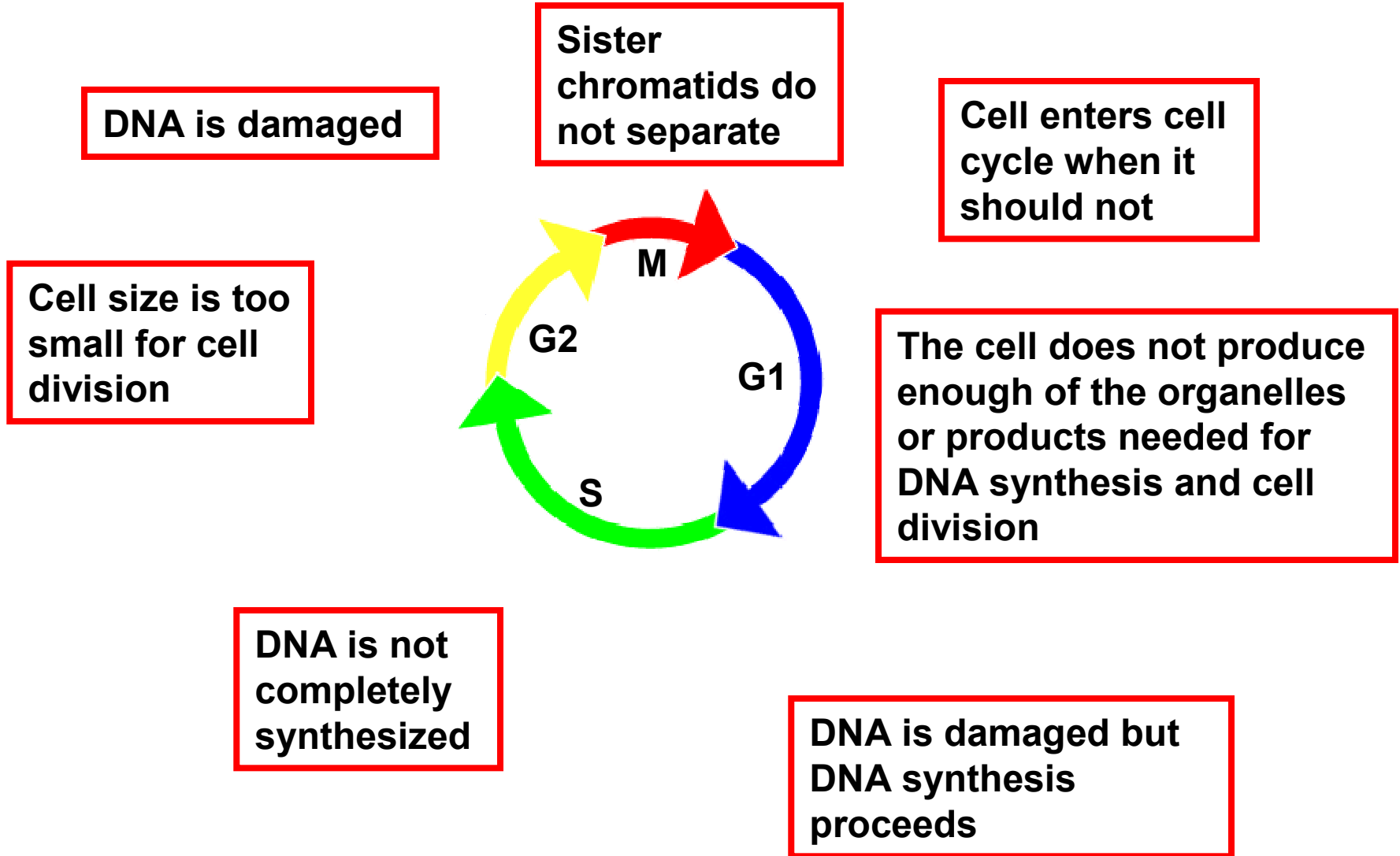


Why are there so many Cyclins and Kinases needed for cell division?

REGULATION!



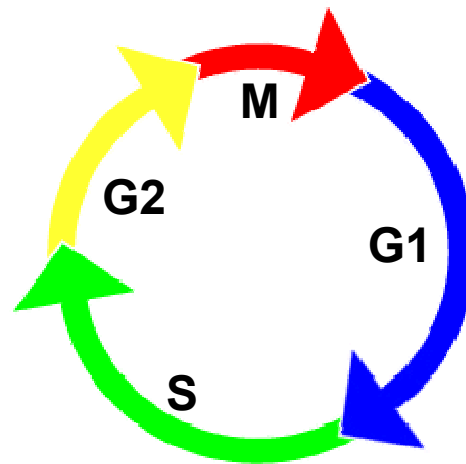
What can go wrong?



CELL CYCLE CHECKPOINTS

Critical points in the cell cycle that are tightly regulated.

Checkpoint failures lead to unregulated cell division or cancer.

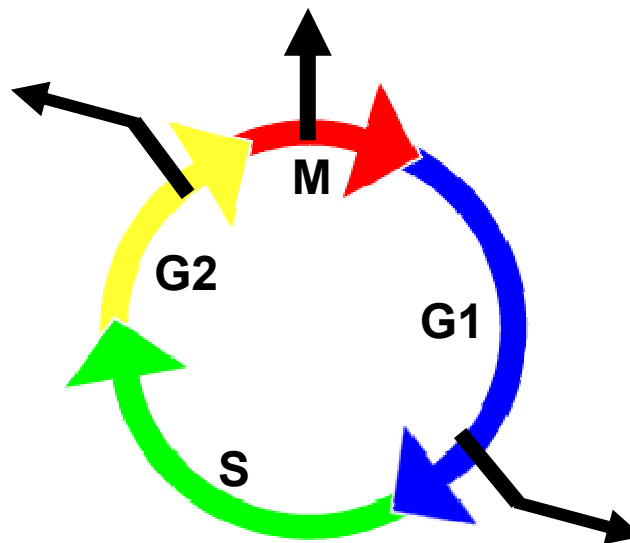


Metaphase Checkpoint

chromosome attachment
to mitotic spindles

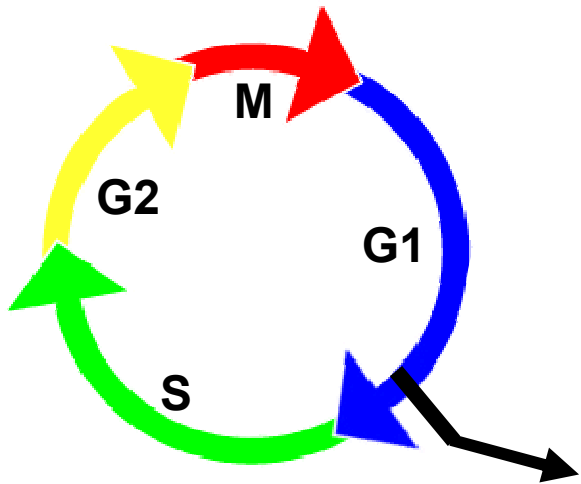
G2 Checkpoint

cell size
chromosome replication
DNA damage

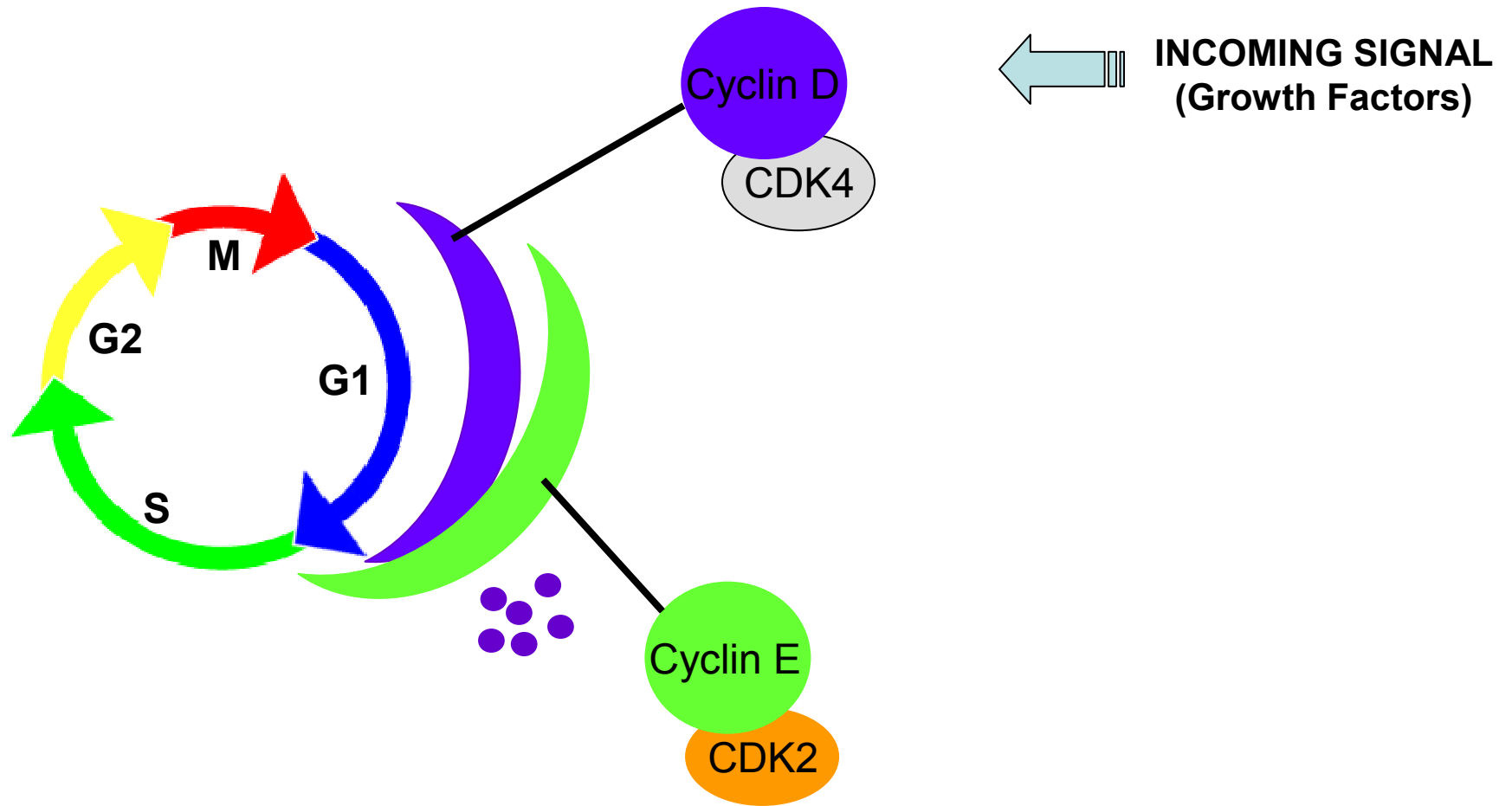


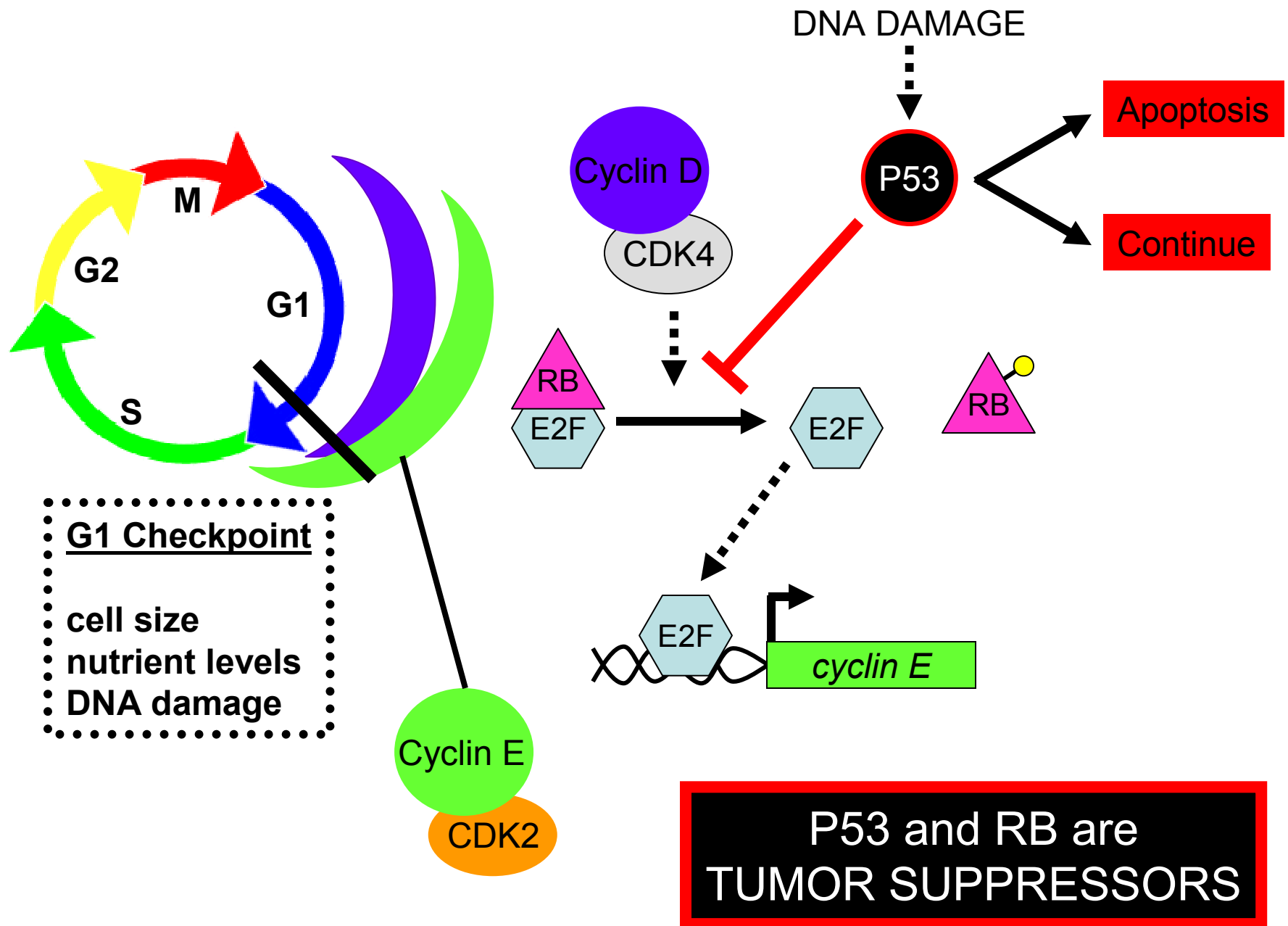
G1 Checkpoint

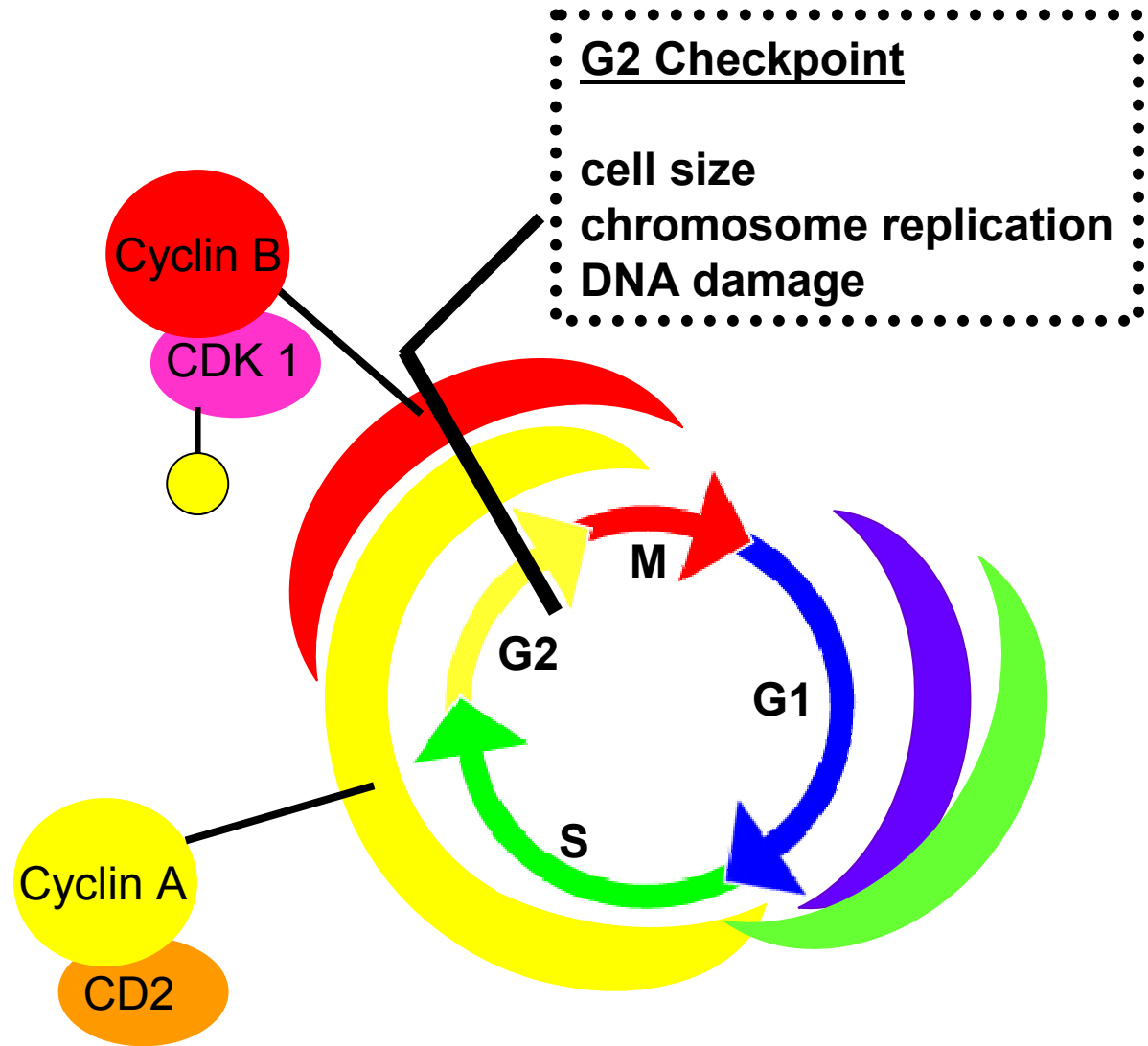
cell size
nutrient levels
DNA damage

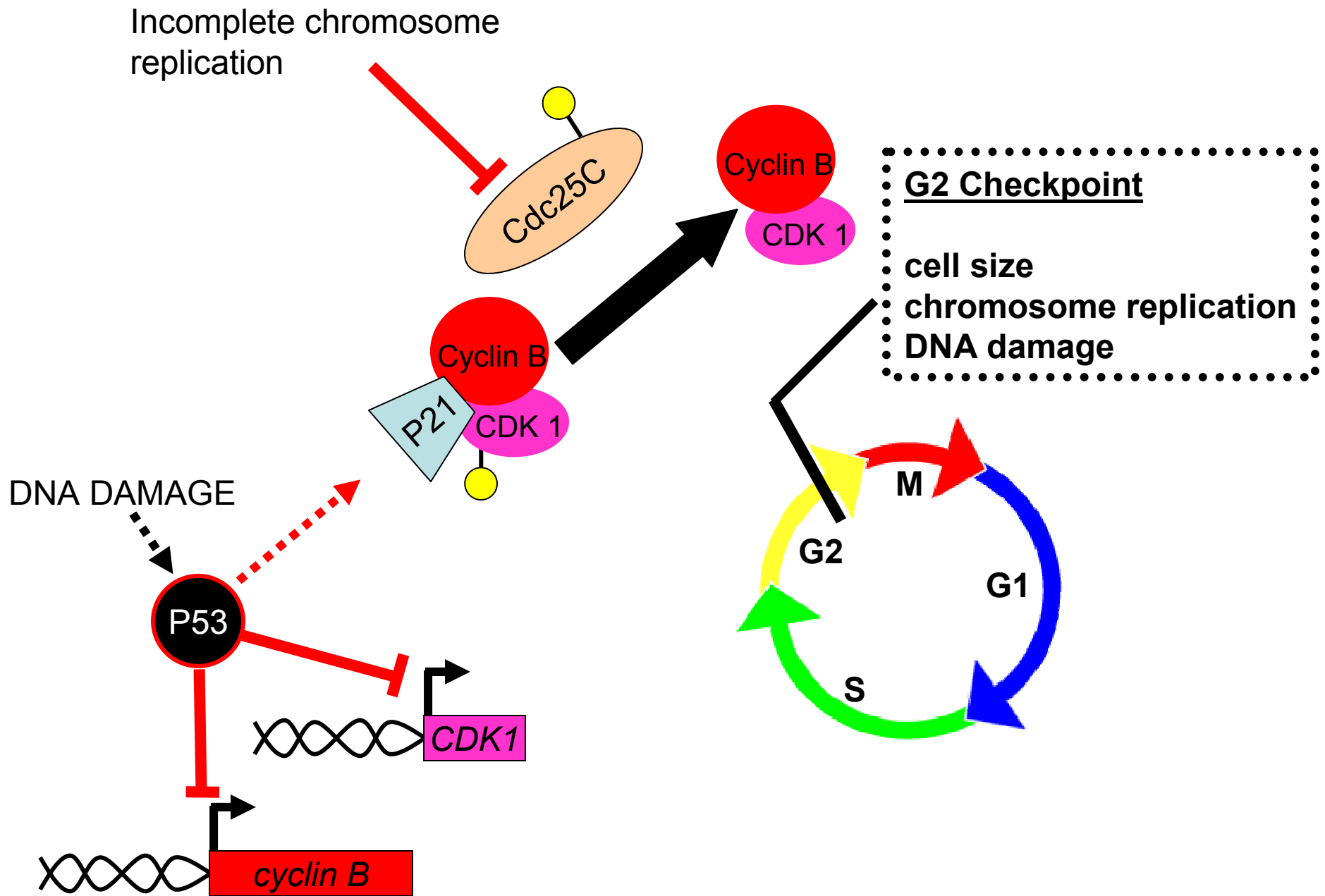


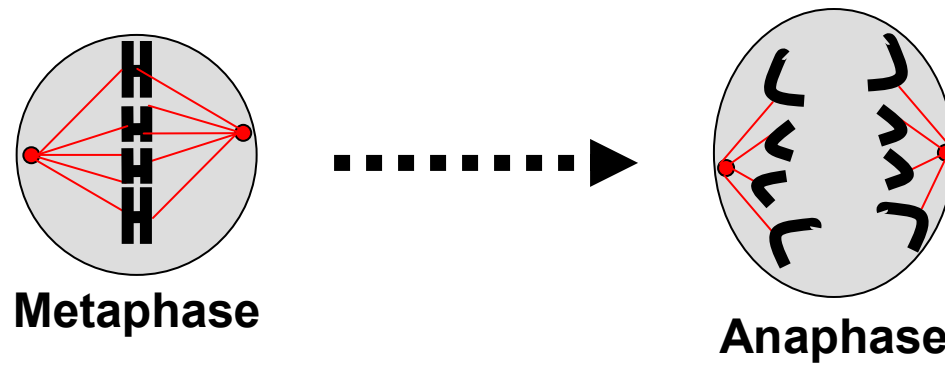
G1 Checkpoint
cell size
nutrient levels
DNA damage



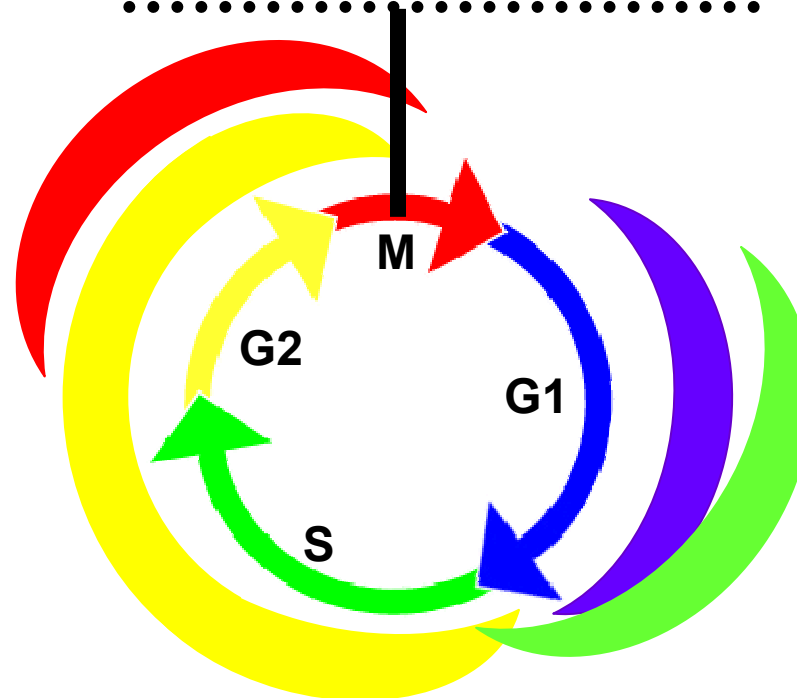


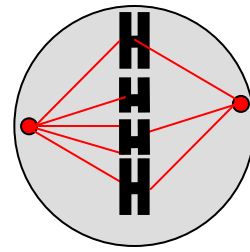




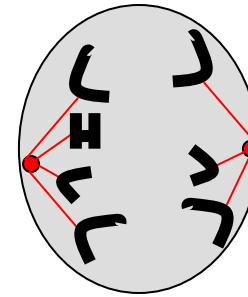


Metaphase Checkpoint
chromosome attachment
to mitotic spindles

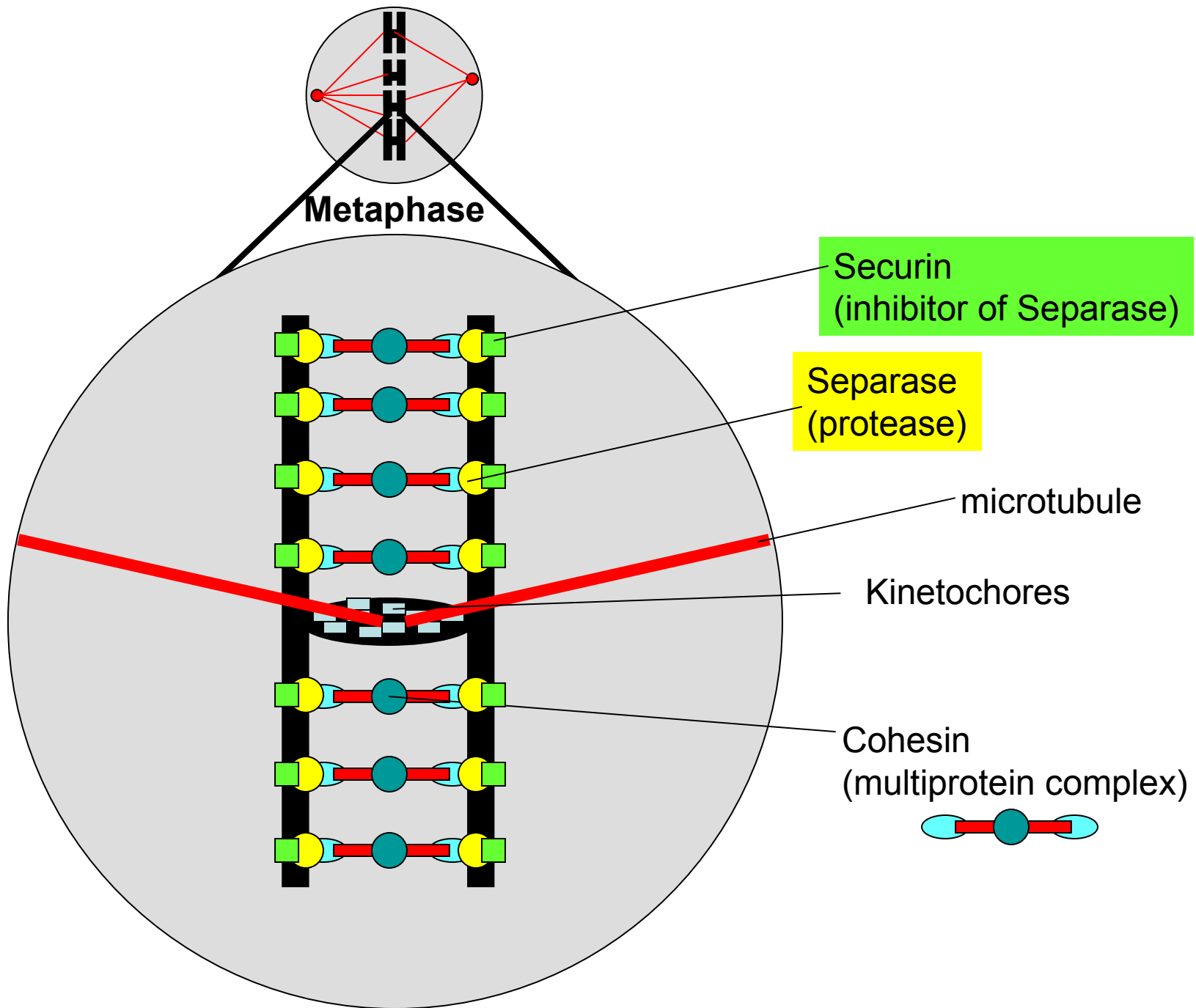


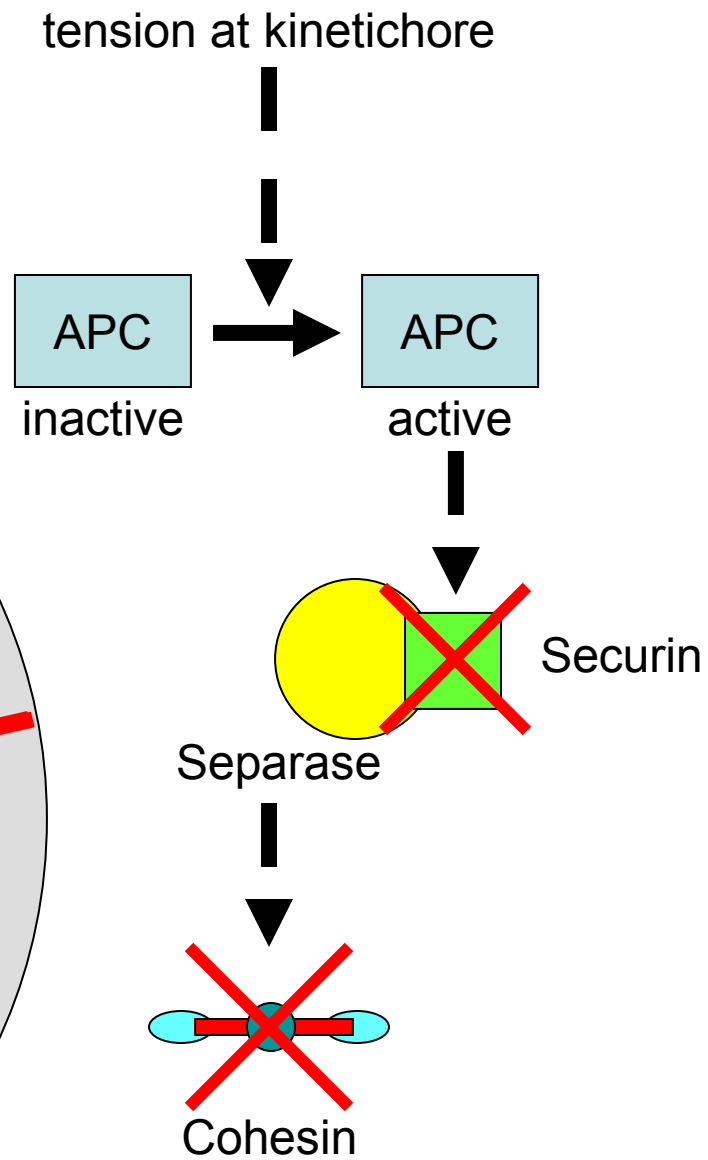
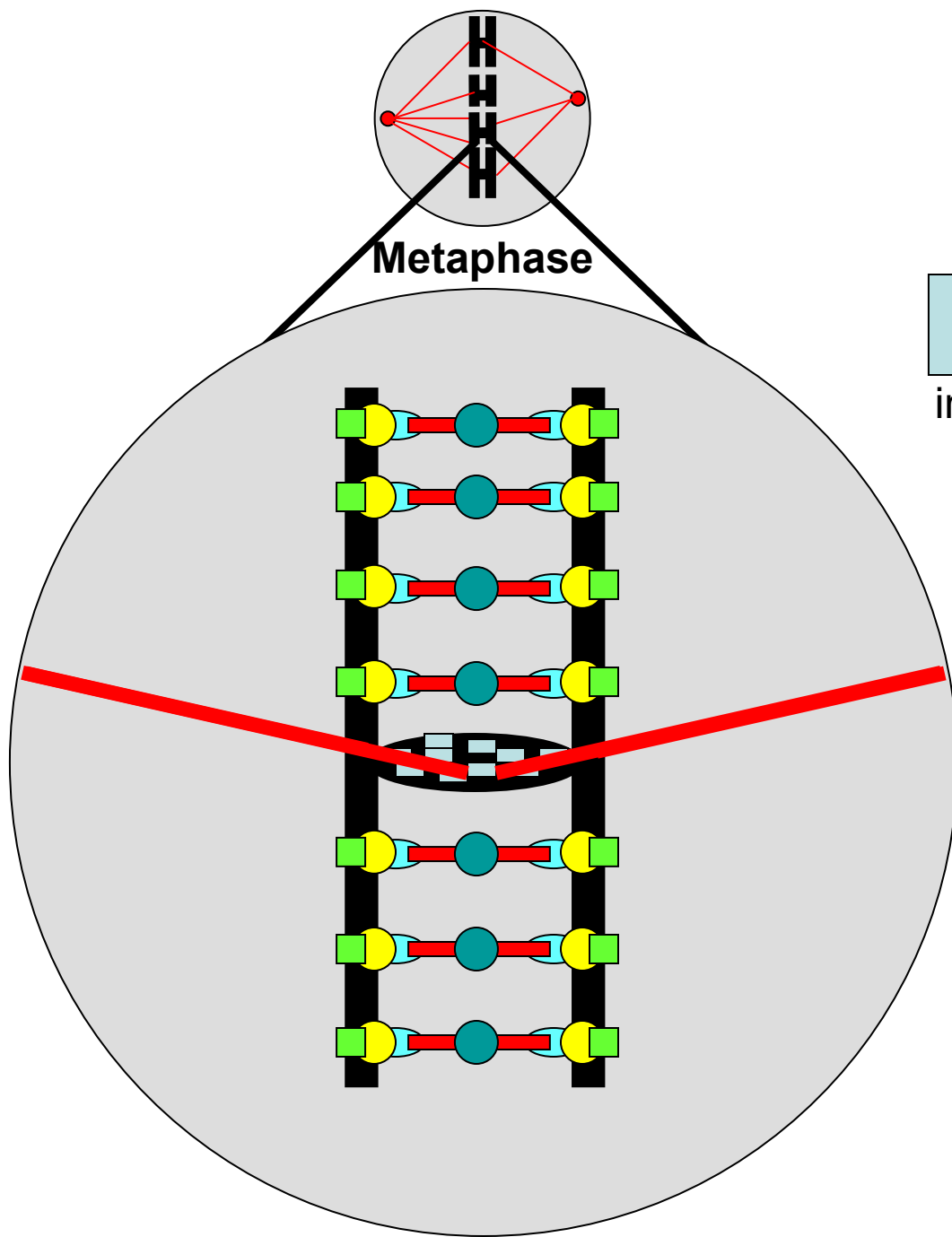


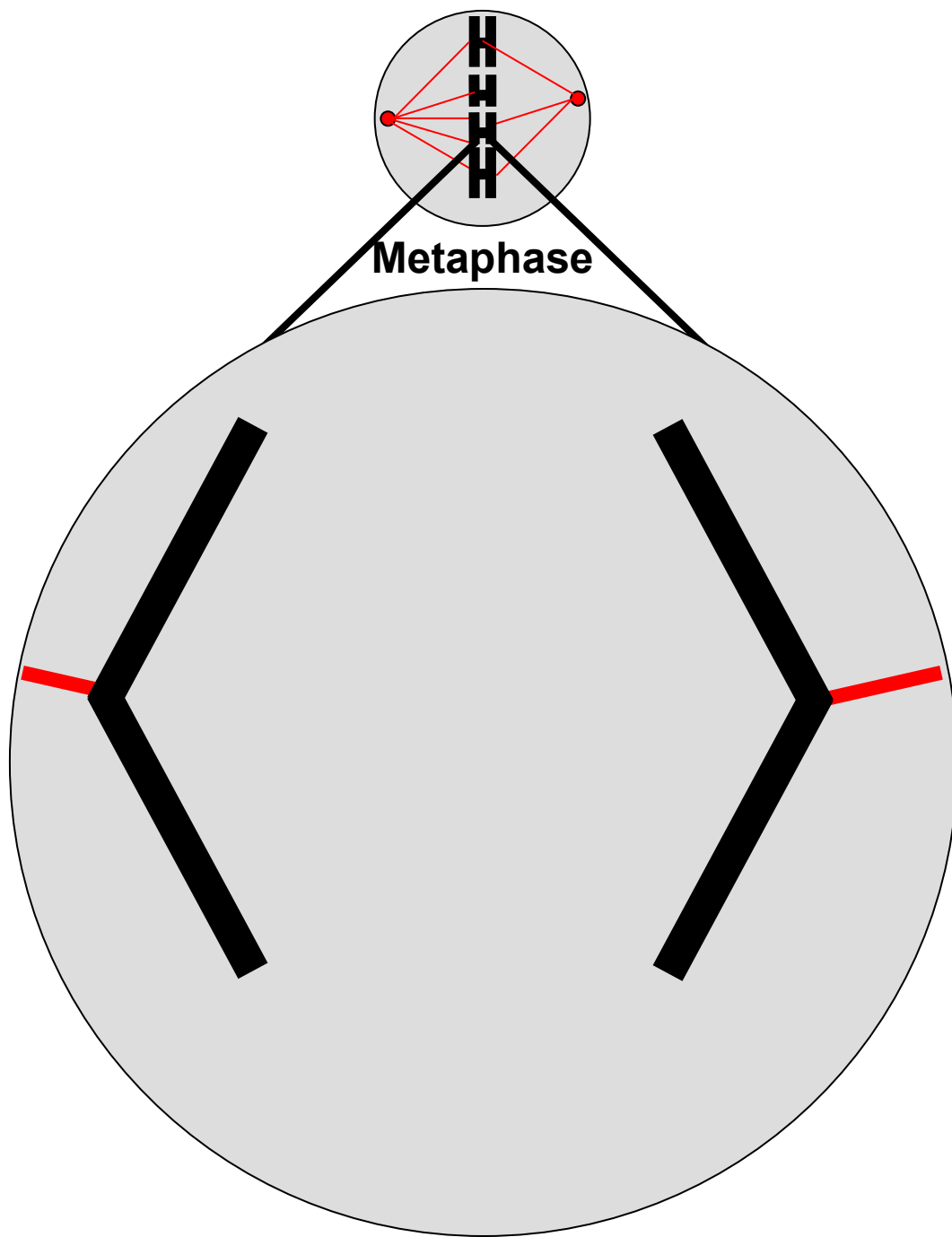
Metaphase



Anaphase







Metaphase Checkpoint

chromosome attachment
to mitotic spindles

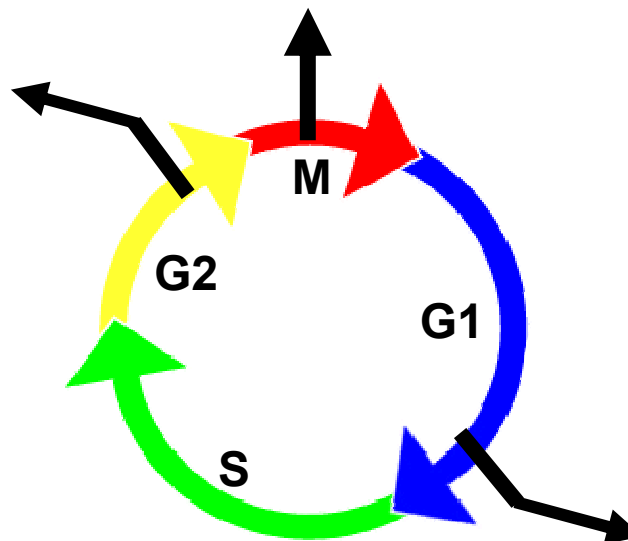
APC

G2 Checkpoint

cell size
chromosome replication
DNA damage

P53

Cdc25C



G1 Checkpoint

cell size
nutrient levels
DNA damage

RB

E2F

P53

The Nobel Prize in Physiology or Medicine 2001



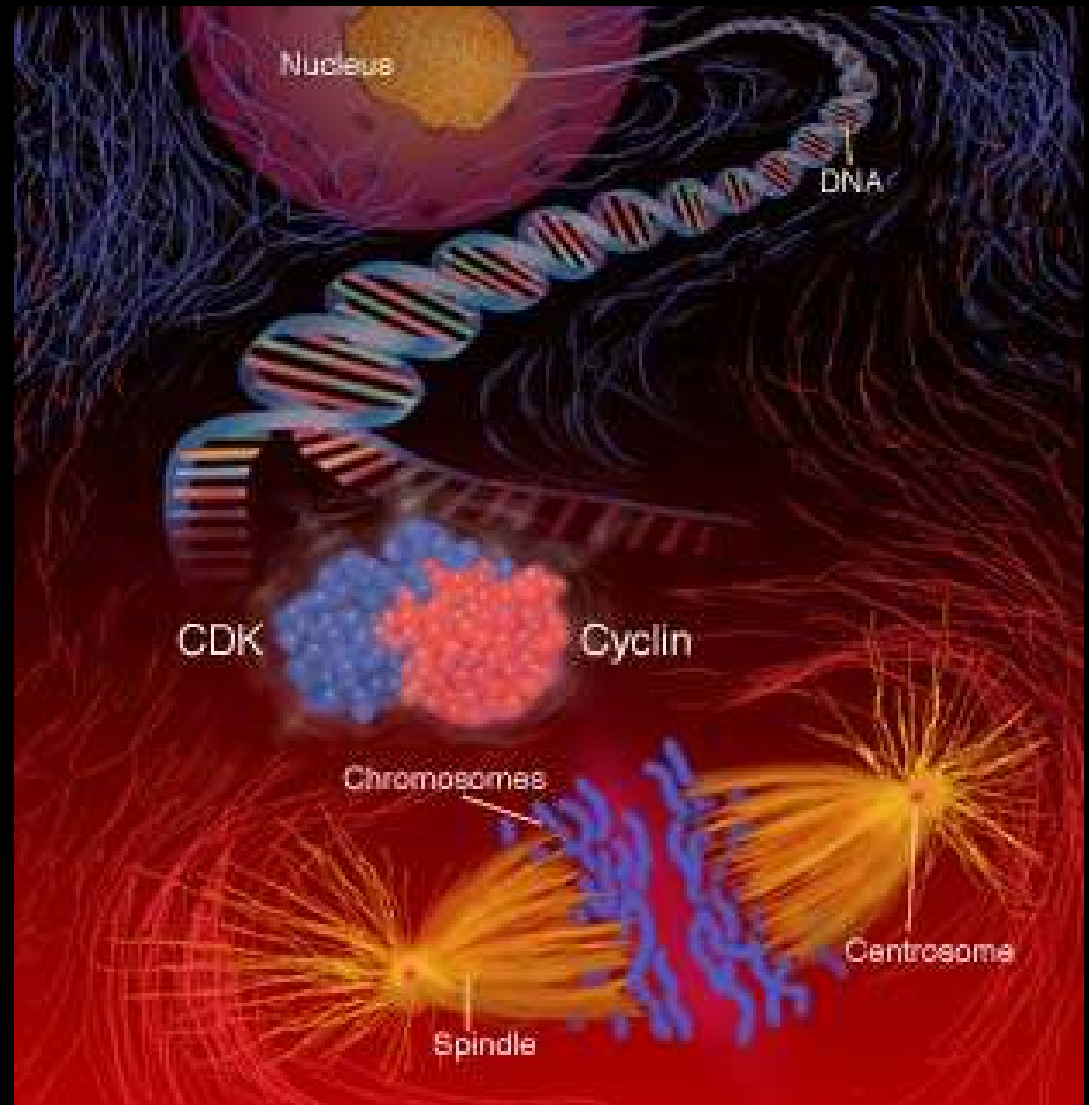
Leland Hartwell



Paul Nurse



Tim Hunt



SUMMARY

- **Activities that occur during different stages of the cell cycle**
 - G1: cell growth, preparation for DNA synthesis
 - S: DNA synthesis
 - G2: cell growth, preparation for cell division
 - M: Cell divides
- **Regulatory factors that control the cell cycle**
 - Cyclins, kinases, phosphatases, and tumor suppressors
- **Communication within cells** - Phosphorylation and de-phosphorylation
- **Cell cycle checkpoints** - G1, G2, and Metaphase checkpoints
- **Tumor suppressors** - P53, and RB
- **Cancer** – Occurs when checkpoints fail or an oncogene is expressed