

CELL CYCLE & CELLULAR REPRODUCTION

9.1 THE CELL CYCLE

Interphase

- **G₁** stage: growth, organelles increase in number, & material accumulates for DNA replication.
- **S** stage: growth & DNA replication; each chromosome is composed of 2 *sister chromatids*.
- **G₂** stage: growth; protein synthesis (e.g. proteins in microtubules).

M (Mitotic) Stage

- Cell division stage; mitosis (nuclear division) & cytokinesis (cytoplasmic division).

Cell Cycle Checkpoints

- **Growth factors** are external signals received at the plasma membrane.
- 3 checkpoints where cell cycle either stops or continues onward, depending on internal signals (proteins) it receives.
- **Cyclin** is an internal signal that increases or decreases during the cell cycle.
 - ✓ Cyclin must be present for cell to move from G₁ to S stage & from G₂ to M.
- **G₁ checkpoint**: primary checkpoint. DNA damage stops the cycle at G₁ checkpoint by protein **p53**; if DNA is not repaired, p53 triggers **apoptosis**.
- **RB** protein (**retinoblastoma**): interprets growth & nutrient availability signals.
 - ✓ Cancer of the retina occurs when RB gene undergoes a mutation.
- Cell cycle stops at **G₂ stage** if DNA has not finished replicating; stopping cell cycle at this stage allows time for repair of possible damaged DNA.
- Cycle stops if chromosomes are not properly attached to the **mitotic spindle**.

Apoptosis

- Programmed cell death:
 - ✓ nucleus fragments
 - ✓ PM blisters
 - ✓ macrophages (WBCs) &/or neighboring cells engulf cell fragments
 - Caused by enzymes (**caspases**) normally held by inhibitors; released by internal or external signals.
 - Apoptosis & cell division are balancing processes that maintain normal level of **somatic (body) cells**. Death by apoptosis prevents a *tumor* from developing.
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9.2 MITOSIS AND CYTOKINESIS

Eukaryotic Chromosomes

- Associated with **histone** proteins which organize chromosomes.
- When a cell is not undergoing division, DNA in nucleus is a tangled mass of threads called **chromatin**.
- At cell division, chromatin becomes highly coiled & condensed; visible as individual chromosomes.
- **Diploid (2n) number**: 2 sets of chromosomes of each type; found in all non-sex cells.
- **Haploid (n) number**: 1 of each kind of chromosome; only sperm & egg cells.

Preparations for Mitosis

- Somatic cells undergo mitosis for development, growth & repair.
 - **Sister chromatids**: 2 strands of genetically identical chromosomes; attached at a centromere.
 - **Centrosome** (main MTOC) divides before mitosis begins.
 - ✓ Organizes short rays (asters) around centrioles.
 - ✓ *Polar* spindle fibers & *kinetochore* spindle fibers.
 - **Mitotic spindle** contains many fibers, each composed of a bundle of microtubules.
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- In flowering plants, **meristematic tissue** retains the ability to divide – continued growth, both in height and laterally, of a plant.

Stem Cells

- Retain the ability to divide.
- Red bone marrow stem cells repeatedly divide to produce various types of blood cells.
- **Therapeutic cloning** to produce human tissues begins with adult/ embryonic stem cells.
- Embryonic stem cells used for **reproductive cloning** – production of a new individual.

9.4 PROKARYOTIC CELL DIVISION

Eukaryotic Chromosomes

- Unicellular organisms reproduce asexually by **binary fission**.
- **DNA replication** before cell division; both chromosomes are attached to a special site inside PM.
- **Cell elongation** separates the 2 chromosomes.
- Cell **enlarges** to twice its original length; new cell wall & plasma membrane form, dividing cell into 2 genetically identical daughter cells.

Comparing Prokaryotes and Eukaryotes

- Both binary fission & mitosis produce 2 genetically identical daughter cells.

Prokaryotes	Eukaryotes
binary fission	mitosis & cytokinesis
Single chromosome (DNA & proteins)	each species has characteristic n° (DNA & histone proteins)
no spindle apparatus	spindle apparatus involved
cytokinesis by cell elongation, new membrane & cell wall form b/w daughter cells	cytokinesis by furrowing (animal) or cell plate formation (plant)