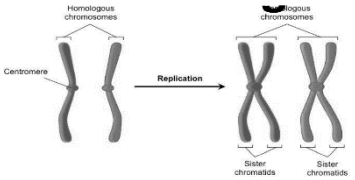
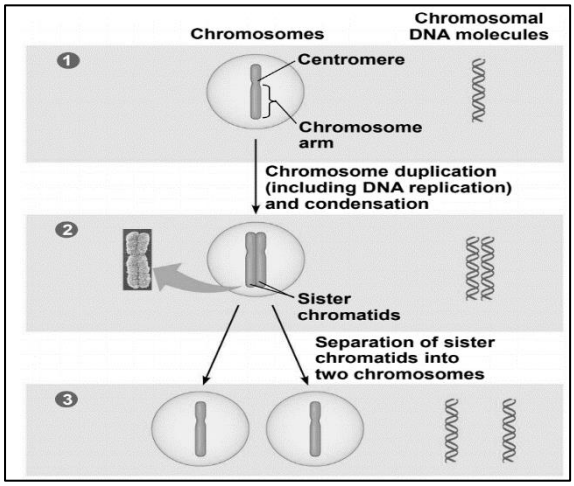
Chapter 12 summary BIO

The cell cycle

- The ability of organisms to produce more of their own kind best **distinguishes** living things from non-living matter
- The continuity of life is based on the reproduction of cells, or **cell division**
- In unicellular organisms, division of one cell reproduces the entire organism
- Multicellular organisms depend on cell division for:
  –Development from a fertilized cell –Growth –Repair
- Most cell division results in daughter cells with **identical genetic information,** DNA
- The exception is **meiosis**, a special type of division that can produce sperm and egg cells
- Meiosis:
  - Gametes are produced by a variation of cell division called meiosis
  - Meiosis yields nonidentical daughter cells that have only one set of chromosomes, half as many as the parent cell
- Eukaryotic chromosomes consist of chromatin, a complex of DNA and protein that condenses during cell division
- Every eukaryotic species has a characteristic number of chromosomes in each cell nucleus >> **Karyotype**
- Somatic cells (nonreproductive cells) have two sets of chromosomes
- Gamete (reproductive cells: sperm and egg) have half as many chromosomes as somatic cell
- In preparation for cell division, DNA is replicated and the chromosomes condense



- Each duplicated chromosome has two sister chromatids (joined copies of the original chromosome), which separate during cell division
- The **centromere** is the narrow waist of the duplicated chromosome, where the two chromatids are most closely attached
- During cell division, the two sister chromatids of each duplicated chromosome separate and move into two nuclei
- Once separate, the chromatids are called **chromosomes**



Eukaryotic cell division: consist

- Mitosis: the division of the genetic material in the nucleus
- Cytokinesis: the division of the cytoplasm
  - In 1882, developed **dyes** to observe chromosomes during mitosis and cytokinesis

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Phases of the Cell Cycle:

- Interphase (cell growth and copying of chromosomes in preparation for cell division):
  - Interphase (about 90% of the cell cycle) can be divided into subphases:
    – G_1 phase "first gap" – S phase "synthesis" – G_2 phase "second gap"
  - The cell grows during all three phases, but chromosomes are duplicated only during **S phase**
- Mitotic (M) phase (mitosis and cytokinesis)
  - **Mitosis:**

*divided into five phases:– prophase – Prometaphase – Metaphase – Anaphase – Telophase

*Cytokinesis overlaps the latter stages of mitosis

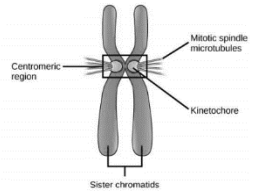
* The mitotic spindle: is a structure made of microtubules that controls chromosome movement during mitosis

*In animal cells, assembly of spindle microtubules begins in the centrosome, the microtubule organizing centre

* The centrosome replicates during interphase, forming two centrosomes that migrate to opposite ends of the cell during **prophase** and **prometaphase**

* An aster: a radial array of short microtubules extends from each centrosome

*The spindle includes the centrosomes, the spindle microtubules, and the asters



***Kinetochores:** are protein complexes associated with centromeres

*During prometaphase, some spindle microtubules attach to the kinetochores of chromosomes and begin to move the chromosomes

*At metaphase, the chromosomes are all lined up at the **metaphase plate**, an imaginary structure at the midway point between the two spindle poles

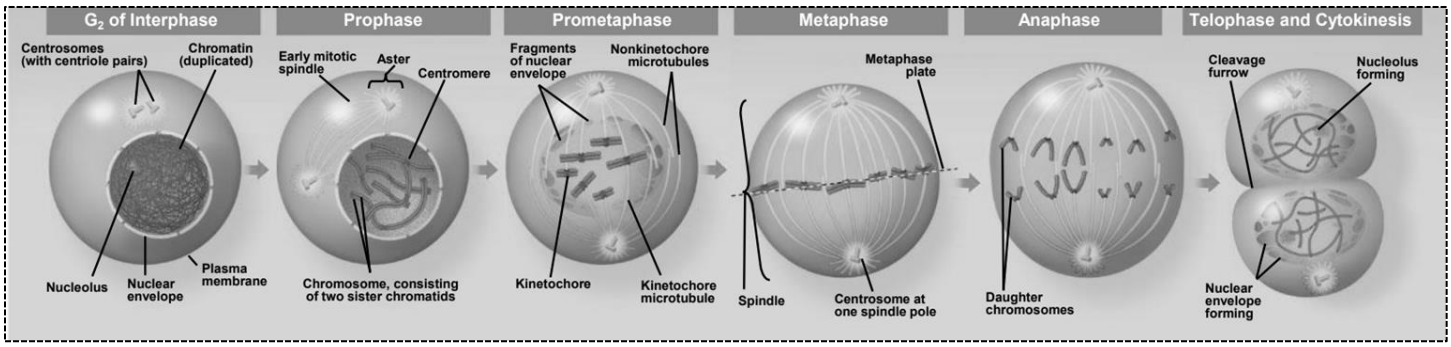
*In anaphase, sister chromatids separate and move along the kinetochore microtubules toward opposite ends of the cell

*Anaphase begins when the Cohesins holding together sister chromatids of each chromosome are **cleaved** by an enzyme called separase

* Non-kinetochore microtubules from opposite poles overlap and push against each other, elongating the cell

*In telophase, genetically identical daughter nuclei form at opposite ends of the cell

*Cytokinesis begins during anaphase or telophase and the spindle eventually disassembles



- **Cytokinesis:**

* In animal cells, cytokinesis occurs by a **cleavage** process, forming a cleavage furrow

*In plant cells, a **cell plate** forms during cytokinesis.

Binary Fission:

- Prokaryotes (bacteria and archaea) reproduce by a type of cell division called binary fission
- In binary fission:
  - the chromosome replicates (beginning at the origin of replication), and the two daughter chromosomes actively move apart
  - The plasma membrane pinches inward, dividing the cell into two

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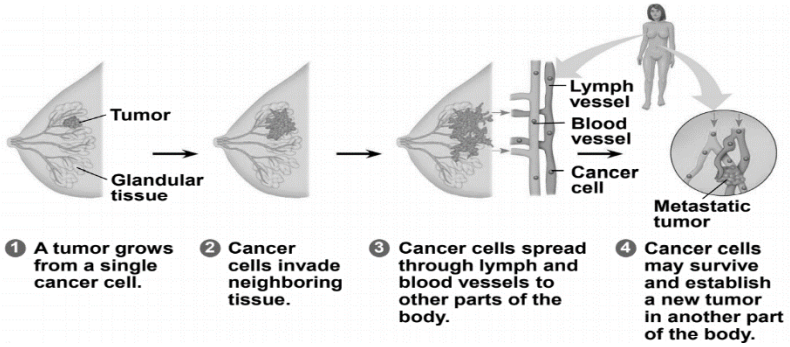
The Evolution of Mitosis:

- Since prokaryotes evolved before eukaryotes, mitosis probably evolved from binary fission
- Certain protists exhibit types of cell division that seem intermediate between binary fission and mitosis
- The frequency of cell division varies with the **cell type**
- These differences result from **regulation at the molecular level**
- Cancer cells manage to escape the usual controls on the cell cycle
- The Cell Cycle Control System:
  - The sequential events of the cell cycle are directed by a distinct cell cycle control system, which is similar to a clock
  - The cell cycle control system is regulated by both internal and external controls
  - The clock has specific **checkpoints** where the cell cycle stops until a go-ahead signal is received
  - For many cells, the **G_1 checkpoint** seems to be the most important
  - If the cell does not receive the go-ahead signal, it will **exit** the cycle, **switching** into a nondividing state called the **G_0 phase**
  - Two types of regulatory proteins are involved in cell cycle control: cyclins and cyclin-dependent kinases (Cdks)
  - Cdks activity fluctuates during the cell cycle because it is controlled by cyclins, so named because their concentrations vary with the cell cycle

- An example of an internal signal is that **kinetochores not attached to spindle microtubules** send a molecular signal that delays anaphase
- Some external signals are **growth factors**, proteins released by certain cells that stimulate other cells to divide
- A clear example of external signals is **density-dependent inhibition**, in which crowded cells stop dividing
- Most animal cells also exhibit **anchorage dependence**, in which they must be attached to a substratum in order to divide
- Cancer cells exhibit neither density-dependent inhibition nor anchorage dependence
- Cancer cells do not respond normally to the body's control mechanisms
- Cancer cells may not need growth factors to grow and divide:
  –They may make their own growth factor
  – They may convey a growth factor's signal without the presence of the growth factor
  –They may have an abnormal cell cycle control system
- A normal cell is converted to a cancerous cell by a process called **transformation**
- Cancer cells that are not eliminated by the immune system, form **tumours**, masses of abnormal cells within otherwise normal tissue
- If abnormal cells remain at the original site, the lump is called a **benign tumour**
- **Malignant tumours** invade surrounding tissues and can metastasize, exporting cancer cells to other parts of the body, where they may form additional tumours



- Recent advances in understanding the cell cycle and cell cycle signalling have led to advances in cancer treatment: