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# Chapter 12

## The Cell Cycle

PowerPoint® Lecture Presentations for

**Biology**

*Eighth Edition*

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### Overview: The Key Roles of Cell Division

- The ability of organisms to reproduce best distinguishes living things from nonliving matter
- In unicellular organisms, division of one cell reproduces the entire organism
- Most cell division results in daughter cells with identical genetic information, DNA
- A special type of division produces nonidentical daughter cells (gametes, or sperm and egg cells)
- Prokaryotes (bacteria and archaea) reproduce by a type of cell division called **binary fission**



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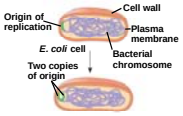
Fig. 12-11-1




In binary fission, the chromosome replicates (beginning at the **origin of replication**), and the two daughter chromosomes actively move apart

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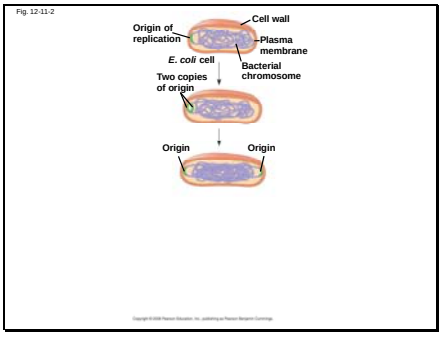


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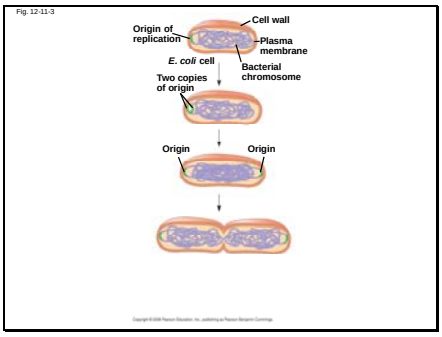


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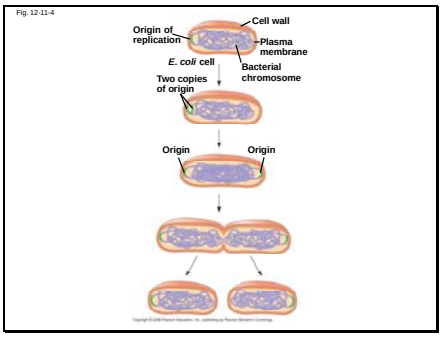

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## The Evolution of Mitosis

- 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



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Fig. 12-12

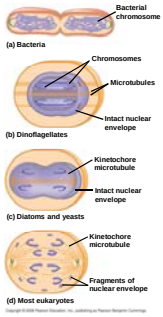


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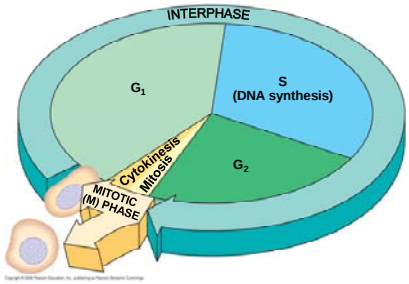
Fig. 12-5



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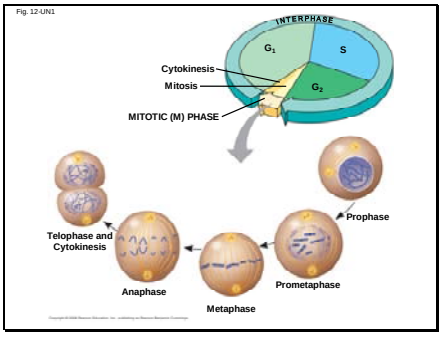


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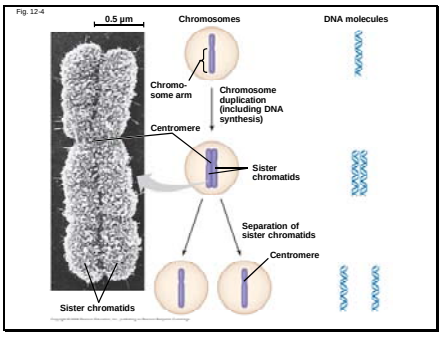


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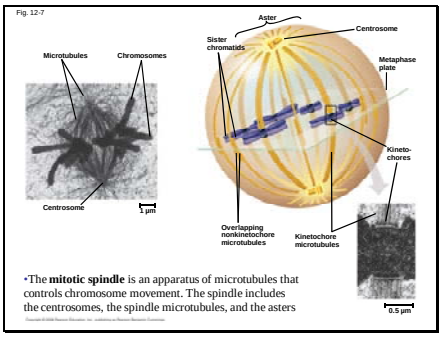

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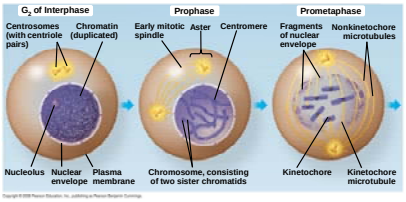
Fig. 12-6b




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

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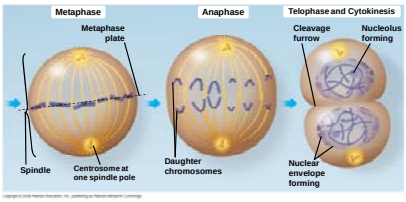
Fig. 12-6d

At metaphase, the chromosomes are all lined up at the **metaphase plate**, the midway point between the spindle's two poles




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

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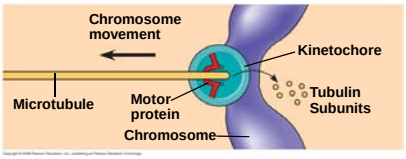
Fig. 12-8b




•The microtubules shorten by depolymerizing at their kinetochore ends

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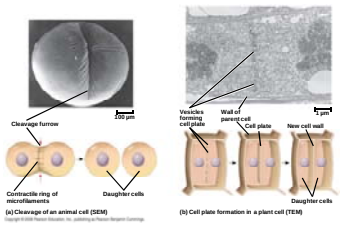
Fig. 12-9

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




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

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## Concept 12.3: The eukaryotic cell cycle is regulated by a molecular control system

- The frequency of cell division varies with the type of cell
- These cell cycle differences result from regulation at the molecular level
- 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



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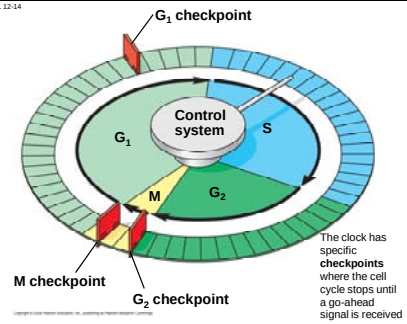
Fig. 12-14




The clock has specific **checkpoints** where the cell cycle stops until a go-ahead signal is received

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- For many cells, the $G_1$ checkpoint seems to be the most important one
- If a cell receives a go-ahead signal at the $G_1$ checkpoint, it will usually complete the S, $G_2$, and M phases and divide
- 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**



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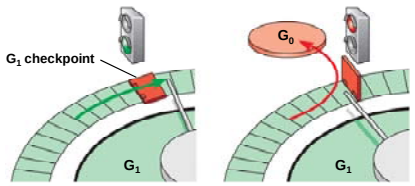
Fig. 12-15




(a) Cell receives a go-ahead signal

(b) Cell does not receive a go-ahead signal

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## *The Cell Cycle Clock: Cyclins and Cyclin-Dependent Kinases*

- Two types of regulatory proteins are involved in cell cycle control: **cyclins** and **cyclin-dependent kinases (Cdks)**
- The activity of cyclins and Cdks fluctuates during the cell cycle
- **MPF** (maturation-promoting factor) is a cyclin-Cdk complex that triggers a cell's passage past the $G_2$ checkpoint into the M phase

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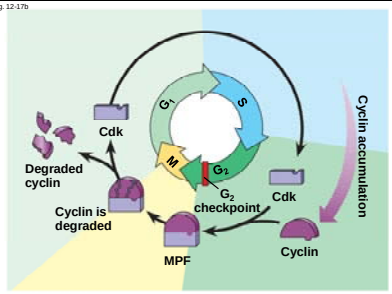


(b) Molecular mechanisms that help regulate the cell cycle

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### *Stop and Go Signs: Internal and External Signals at the Checkpoints*

- 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
- For example, platelet-derived growth factor (PDGF) stimulates the division of human fibroblast cells in culture



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- Another 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