

Chapter 12- The Cell Cycle

(Key Concepts are Underlined)

The Key Roles of Cell Division

Cell Division functions in reproduction, growth, and repair
- involves the distribution of identical genetic material to two daughter cells

Cell Division distributes identical sets of chromosomes to daughter cells

Daughter Cells

Genome- total hereditary endowment of DNA (in a eukaryotic cell, its length is 300,000 times greater than its diameter of.... WOW!!!)

Chromosome

Somatic Cells

Gametes

Chromatin- loosely packed DNA-protein complex

Sister Chromatids- identical copies

Centromere

Mitosis- division of nucleus

Cytokinesis- division of cytoplasm

Meiosis- reduction division

The Mitotic Cell Cycle

The mitotic phase alternates with interphase in the cell cycle: *an overview*

Mitotic (M) Phase- includes mitosis and cytokinesis

Interphase- includes **G₁**, **S**, and **G₂ Phase**

The mitotic spindle distributes chromosomes to daughter cells: *a closer look*

Prophase- chromatin condenses into discrete chromosomes w/sister chromatids, nucleoli begins to disappear, mitotic spindle begins to form

Prometaphase- nuclear envelope fragments, spindle microtubules begin to interact with more condensed chromosomes via kinetochores

Metaphase- chromosomes on metaphase plate

Anaphase- sister chromatids migrate to poles, while nonkinetochore microtubules lengthen and elongate the cell

Telophase- cell elongation continues until two daughter cells are formed, nuclear envelopes reform, chromosomes become less tightly coiled, cytokinesis follows

Mitotic spindle- fibrous spindle of microtubules and associated proteins, which appear to emerge from the **centrosome**

- spindle microtubules attach to **kinetochores** (specific sections of chromosomal DNA at centromeres); each chromosome has two

Metaphase Plate- when chromosomes are positioned midway between the poles

- the poleward migration of chromosomes is due to the depolymerization of kinetochore microtubules

- nonkinetochore microtubules elongate the cell during anaphase

Cytokinesis divides the cytoplasm: *a closer look*

Cleavage Furrow- exterior groove near old metaphase plate caused by a contractile ring of cytoskeletal microfilaments (in animal cells)

Cell Plate- cell wall material coalesces at the middle of the cell, originating via vesicles from the Golgi

Mitosis in eukaryotes may have evolved from binary fission in bacteria

Binary Fission- prokaryote reproduction (division); copied chromosomes attach themselves to plasma membrane and separate as cell grows; cell membrane grows inward to form two daughter cells

Regulation of the Cell Cycle

A molecular control system drives the cell cycle

Cell-Cycle Control System- a cyclically operating set of molecules that trigger and coordinate key events in the cell cycle

Cell-Cycle Checkpoints- critical control points (major ones found in G₁, G₂, and M phases)

G₀ Phase- nondividing state

Cyclin- a cell-cycle regulatory protein with cyclically fluctuating concentration levels

Cdks- cyclin-dependent kinases (activated by **cyclin**)

MPF- **m**aturation **p**romoting **f**actor- promotes “M-phase” (*cyclin-Cdk complex*); triggers the passage of G₂ checkpoint via phosphorylating and stimulating other proteins associated with initiating mitosis; MPFs are hydrolyzed later in M-phase

Internal and external cues help regulate the cell cycle

- an anaphase-promoting complex (APC) triggers the M-phase checkpoint only when spindle microtubules are attached to ALL chromosome kinetochores during metaphase

Growth Factor- proteins that bind to plasma membrane receptors, stimulating cell division via a signal-transduction pathway

Density-Dependent Inhibition- cell stop dividing under crowded conditions (apparently, required growth factors and nutrients become deficient)

Anchorage Dependence- cells must be attached to a substratum in order to divide

Cancer cells have escaped from cell-cycle controls

-cancer cells do not respond normally to the body's control mechanisms (i.e. they do not exhibit density-dependent inhibition or anchorage dependence)

- cancer cells either make their own growth factors or ignore growth factors' signaling pathways

- the cell-cycle of cancer cells is irregular, in that they continue to divide when provided the necessary nutrients (said to be "immortal"), or stop dividing at random points in the cell cycle

Transformation- conversion of a normal cell to a cancer cell (normally destroyed by immune system)

Tumor- mass of abnormal cells; **benign tumors** remain at their original site, where a **malignant tumor** is invasive and impairs functions of one or more organs

Metastasis- spread of cancer beyond their original site; may be treated by high energy radiation or chemotherapy