Chapter 10 Cell Growth and Division

Key Concepts

What problems does growth cause for cells?

How do organisms grow?
- produce more cells
- cells of an adult are no larger than that of the offspring, adults just have more cells

Limits to Cell Growth

Two reasons cell divide

1. Larger cells create more demands of DNA
   - DNA controls cells functions
   - DNA is in the nucleus
   - Cells will not make extra copies of DNA when large
   - If cell becomes too large, then the DNA is asked to increase its support to the cell and it will not be able to do that.
   - Example - gas station

2. Larger cells have problems with moving enough nutrients and wastes through cell membrane
   - Food, oxygen, water, and waste materials travel through the membrane. How fast this can occur depends on the surface area of the cell which is the total area of the cell membrane.
   - How much oxygen and wastes that are produced depends on the volume of the cell.
   - This relationship between volume and surface area is why cells must divide.

Ratio of Surface Area to Volume

Surface Area = L x W x # of sides
Volume = L x W x H

Ratio of Surface Area to Volume = \[
\frac{\text{Surface Area}}{\text{Volume}}
\]

Volumes increases faster than Surface Area

If a cell gets too large, it makes it more difficult for the cell to bring in enough nutrients and oxygen. Also, to get the waste products out.

Before the cell gets too large, it divides forming two daughters - process called Cell Division.

Double Check your understanding!

Two Reasons cells divide
1. too large causes more demands on the DNA
2. too large, cell has trouble moving nutrients and wastes

As a cell increases in size, which increases more rapidly, its surface area or volume?

- volume

Calculate the surface area, volume and ratio of surface area to volume of an imaginary cubic cell measuring 4 cm on each side.
Key Concepts

What are the main events of the cell cycle?

What are the four phases of mitosis?

Video - Cell Division

Chromosomes
Each cell must copy the genetic information before cell division can take place. Daughter cells will receive one copy of information. Two copies of information per cell.

Chromosomes carry the genetic information that is passed to the daughter cells.

DNA and proteins make up chromosomes.

Every organism have a specific number of chromosomes.

- Humans = 46 (23 pairs)
- Fruit Flys = 8
- Carrots = 18
- Turkey = 80

Chromosomes are usually not visible in most cells.

Chromosomes are spread out throughout the nucleus.

To start cell division, chromosomes coil up or condense into compact visible structures. Look similar to an X.

- chromosomes made of DNA and proteins
- chromatid: coiled up information
- sister chromatids: matching identical pairs of chromosomes
- centromere: usually near middle where chromosomes are attached

The Cell Cycle
A series of steps that cells go through as they grow and divide.

Cell Cycle is divided into various phases:

- Interphase, Mitosis, Cytokinesis

Each of these parts are divided into other parts.

Interphase
- cell spends most of it's time in interphase
- G<sub>0</sub> phase: resting period (book does not mention this)
- G<sub>1</sub> phase: cell growth, synthesize new proteins and organelles
- S phase: chromosomes are replicated, DNA molecules created, proteins associated with chromosomes synthesized
- once a cell gets to the S phase it usually completes the cell cycle
- G<sub>2</sub> phase: production of organelles needed for cell division, production of enzymes that check DNA for mistakes - repair if needed - completes growth

Mitosis
- also called - M phase includes cytokinesis
- broken down into 4 phases

- Prophase: longest stage - spend 50­60% of mitosis in this stage - chromosomes become visible, nuclear envelope disappears, centrioles separate and move to poles to an area called the centrosome and organize the spindles - separates the chromosomes
- spindle fibers form between centrioles, chromosomes attach to spindle fibers

- Metaphase: chromosomes line up across the center of the cell, still attached to spindle fiber by the centromere - kinetochore

- Anaphase: centromeres split, spindles start to pull chromosome to pole, chromosomes will move until they are at the poles

- Telophase: chromosomes begin to disperse - uncoil, nuclear envelope re-forms and surrounds each group of chromosomes, spindle fibers break apart, nucleolus forms

Cytokinesis
- mitosis produces two nuclei
- division of the cytoplasm
- animal cells - cytoplasm is drawn in inward and pinched into two equal parts
- plant cells - cell plate forms between nuclei, then a cell wall forms in the cell plate

Check your understanding!

Name the main events of the cell cycle.

- cell grows, replicates its DNA, prepares to divide, and divides into two daughter cells

How do Prokaryotic cells divide?
- binary fission

What are chromosomes made of?
- DNA and proteins

List all phases of the cell cycle.
- Interphase - G<sub>1</sub> phase, S phase, G<sub>2</sub> phase
- Mitosis - Prophase, Metaphase, Anaphase, Telophase
- Cytokinesis

Make sure you know what happens in each phase.

What function does the spindle serve during mitosis?
- Helps separate the chromosomes.

Does cytokinesis start when telophase ends?
- No, it actually begins during telophase.
Section 10-3  Regulating the Cell Cycle

Key Concepts
How is the cell cycle regulated?
How are cancer cells different from other cells?

Controls on Cell Division
Cells will grow until a signal is given.
You cut yourself, your body begins the healing process by dividing rapidly by the edge of the injury. The process is completed when cells touch each other and the process of cell division is slowed down.

Cell Cycle Regulators
Tim Hunt and Mark Kirschner discovered that cells in mitosis contained a protein that when put into a nondividing cell, the cell would start to divide.

The protein that caused the cell to divide = cyclin.

Internal Regulators
proteins that respond to events that happen in the cell will not let mitosis start until chromosomes are copied

External Regulators
proteins that respond to events outside the cell direct cells to speed up or slow down the cell cycle

Uncontrolled Cell Growth
Cancer
cells lose ability to control growth
form masses called tumors