Chapter 9 – How Cells Reproduce

Lecture Outline

Impacts, Issues: Henrietta's Immortal Cells

A. Researchers at Johns Hopkins cultured a line of immortal cells in 1951.
   1. They are referred to as HeLa cells after their source—a woman named Henrietta Lacks.
   2. Her cells continue to provide for research around the world.
B. Understanding cell division starts with three questions.
   1. What kind of information guides inheritance?
   2. How is the information copied in a parent cell before being distributed into daughter cells?
   3. What kinds of mechanisms actually parcel out the information to daughter cells?

I. Overview of Cell Division Mechanisms

A. Mitosis, Meiosis, and the Prokaryotes

1. Before cells are able to reproduce, there must be a division of the _____ and its DNA.

2. _____ and meiosis are eukaryotic nuclear division mechanisms that lead to the distribution of DNA to new nuclei in forthcoming daughter cells.

   a. Mitosis is used by _____ organisms for growth by repeated divisions of somatic cells.

   b. Meiosis occurs only in _____ cells that divide to form gametes.

3. _____ cells reproduce asexually by an entirely different mechanism called prokaryotic fission.

B. Key Points About Chromosome Structure

1. Each chromosome is a molecule of _____ complexed with proteins.

2. Prior to division, each threadlike chromosome is duplicated to form two sister

   _____ held together by a centromere.

3. Proteins called _____ tightly bind to DNA and cause spooling into structural units called nucleosomes, which prevent tangling.

4. The centromere is also the region called the _____ where the duplicated chromosome will attach to the microtubules of the spindle during nuclear division.

II. Introducing the Cell Cycle

A. The _____ is a recurring sequence of events that extends from the time of a cell's formation until each division is completed.

B. The Wonder of Interphase

1. The control of cell division resides in the _____ of interphase.

   a. During _____, cells assemble most of the carbohydrates, lipids, and proteins that are needed by the cell and for export.

   b. During the _____ phase the DNA and histones are copied.

   c. During _____ further protein synthesis drives the cell toward mitosis.

2. Most of a cell's existence (about _____%) is spent in interphase; mitosis occupies only a small portion.

   a. During interphase the cell's mass _____, the cytoplasmic components approximately double in number, and the DNA is doubled.

   b. Some cells are arrested in _____ and usually never divide again (example: brain cells).

C. Mitosis and the Chromosome Number

1. All somatic cells of a particular species have the same number of _____; for example, humans have 46.

   a. Chromosomes come in _____—one member from each parent.

   b. Chromosome pairs carry _____ for the same traits.

2. Chromosome number (n) tells how many of _____ type of chromosome is present in a cell; 2n is diploid.

3. Mitosis proceeds through _____ stages: prophase, metaphase, anaphase, and telophase.

4. Chromosomes are moved by a bipolar mitotic _____ composed of two sets of microtubules that extend from each pole of the cell and overlap at the equator.

III. A Closer Look at Mitosis

A. Mitosis begins with prophase.

1. Chromosomes become _____ as rodlike units, each consisting of two sister chromatids.

2. Microtubules move one pair of _____ to opposite poles of the cell.

3. The nuclear envelope begins to _____.

4. Microtubules of the spindle extend from the centrioles and attach to the centromeres (kinetochore area) of the duplicated chromosomes.

B. The transition to metaphase occurs as the chromosomes begin an orderly arrangement.

1. Sister _____ are each attached separately to microtubules from opposite poles.

2. When all the chromosomes are aligned at the cell's _____ halfway between the poles, the cell is said to be in metaphase.

C. During anaphase the chromosomes migrate to opposite poles.

1. The kinetochores of sister chromatids separate and move toward opposite poles.

a. Microtubules attached to the centromeres _____ and pull the chromosomes toward the poles.

b. Other microtubules at the spindle poles _____ past each other to push the two spindle poles apart.

2. Once separated, each chromatid is now an _____ chromosome.

D. _____ gets underway when the chromosomes reach the respective poles.

1. Each half of the cell now contains _____ clusters of chromosomes that are identical and equal in number.

2. The chromosomes _____ and return to the threadlike form typical of interphase.

3. The nuclear envelope _____ from the fusion of small vesicles; mitosis is complete.

IV. Cytoplasmic Division Mechanisms

A. How Do Animal Cells Divide?

1. Cytoplasmic division (cytokinesis) in animals is by means of a _____ furrow.

a. The flexible plasma membrane of animal cells can be _____ in the middle to separate the two daughter cells.

b. Parallel arrays of contractile microfilaments slide past one another at the cleavage furrow, pulling the plasma membrane inward.

2. Each daughter cell ends up with a _____, some cytoplasm (with organelles), and a plasma membrane.

B. How Do Plant Cells Divide?

1. Because of the rather rigid _____, the cytoplasm of plant cells cannot just be pinched in two.

2. Instead vesicles containing remnants of the microtubular spindle form a disk-like

   structure, called a _____, between the two new cells.

C. Appreciate the Process!
   1. Astonishingly precise mechanisms assure that cells will be produced in the right numbers at the right times and places.
   2. Failure to do this can result in genetic disorders and cancer.

V. When Control Is Lost

A. The Cell Cycle Revisited
   1. The cell cycle has built-in checkpoints where proteins can advance, delay, or block forward progress of the cycle.
   2. For example, kinases can signal the end of DNA replication; growth factors signal the start of mitosis.

B. Checkpoint Failure and Tumors
   1. When checkpoint mechanisms fail, a cell loses control over its replication cycle.
      a. In some cases, mitosis repeats over and over.
      b. In others, the cells do not die as they are supposed to.
   2. Proto-oncogenes code for proteins that stimulate mitosis.
      a. Neoplasms are abnormal masses of cells that have lost controls over their growth and cell division.
      b. Benign growths pose no threat to the body.

C. Characteristics of Cancer
   1. Cancers are abnormally growing and dividing cells of a malignant neoplasm.
   2. All cancer cells display four characteristics.
      a. They grow and divide abnormally.
      b. The cell membrane is leaky, and the cytoskeleton is disorganized.
      c. Cells have a weakened capacity for adhesion and may break away to move to other sites in the body (metastasis).
      d. Cancer cells have lethal effects.