PowerLecture:
Chapter 9
How Cells Reproduce
Section 9.0: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.0: Henrietta's Dance
- Section 9.0: Fluorescence Digital Image Gallery—Cell Culture Lines
- Section 9.0: By a Thousand Cuts. (cellular "immortality") Lori Oliwenstein. *Discover*, Feb. 1993.
- Section 9.0: The Tissue Culture Follies. (caring for cultured cells). Susan Jenkins. *The Scientist*, Oct. 14, 2002.

How Would You Vote?

The following is the question for this chapter. See national results below.

Do you think that the family of Henrietta Lacks should be compensated for the use of her cells?

Impacts, Issues: Henrietta's Immortal Cells

- Cancer cells isolated from Henrietta Lacks established a self-perpetuating lineage of cancer cells
- The cell lineage, name HeLa cells, is used in research laboratories across the world
- Henrietta Lacks' contribution is used to research cancer, viral growth, protein synthesis, effects of radiation, and more

Section 9.1: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.1: About Cell Division
- Section 9.1: Cell Division Tutorials

- Section 9.1: Disseminating the Genome: Joining, Resolving, and Separating Sister Chromatids during Mitosis and Meiosis. Kim Nasmyth. *Annual Review of Genetics,* Annual 2001.

Understanding Cell Division

- What instructions are necessary for inheritance?
- How are those instructions duplicated for distribution into daughter cells?
- By what mechanisms are instructions parceled out to daughter cells?

Reproduction

- Parents produce a new generation of cells or multicelled individuals like themselves
- Parents must provide daughter cells with hereditary instructions, encoded in DNA, and enough metabolic machinery to start up their own operation

Division Mechanisms

Eukaryotic organisms

- Mitosis
- Meiosis

Prokaryotic organisms

- Prokaryotic fission

Roles of Mitosis

- Multicelled organisms
  - Growth
  - Cell replacement
- Some protistans, fungi, plants, animals
  - Asexual reproduction

Chromosome

- A DNA molecule & attached proteins
- Duplicated in preparation for mitosis

Chromosome Number

- Sum total of chromosomes in a cell
- Somatic cells
  - Chromosome number is diploid ($2n$)
  - Two of each type of chromosome
- Gametes
  - Chromosome number is haploid (n)
  - One of each chromosome type

Human Chromosome Number

- Diploid chromosome number (n) = 46

- Two sets of 23 chromosomes each
  - One set from father
  - One set from mother

- Mitosis produces cells with 46 chromosomes--two of each type

Organization of Chromosomes

Section 9.2: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.2: The Cell Cycle and Mitosis Tutorial

- Section 9.2: Interactive Mitosis Tutorial

- Section 9.2: Mitosis Review

- Section 9.2: Cell Cycle Advances: Several Fields of Biological Research Have Converged on One Unifying Model of Cell Cycle Regulation. Carolyn Strange. *BioScience,* Apr. 1992.

- Section 9.2: Researchers Build Diagram of Cell Cycle Clock. *Gene Therapy Weekly,* Oct. 18, 2001.

The Cell Cycle

Interphase

- Usually longest part of the cycle
- Cell increases in mass
- Number of cytoplasmic components doubles
- DNA is duplicated

Mitosis

- Period of nuclear division
- Usually followed by cytoplasmic division
- Four stages:

Prophase

Metaphase

Anaphase

Telophase

Control of the Cycle

- Once S begins, the cycle automatically runs through G2 and mitosis
- The cycle has a built-in molecular brake in G1
- Cancer involves a loss of control over the cycle, malfunction of the “brakes”

Stopping the Cycle

- Some cells normally stop in interphase

- Neurons in human brain
- Arrested cells do not divide

- Adverse conditions can stop cycle
  - Nutrient-deprived amoebas get stuck in interphase

The Spindle Apparatus

- Consists of two distinct sets of microtubules
  - Each set extends from one of the cell poles
  - Two sets overlap at spindle equator
- Moves chromosomes during mitosis

Spindle Apparatus

Maintaining Chromosome Number

Maintaining Chromosome Number

Section 9.3: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.3: Mitosis Gallery & Animation

- Section 9.3: Mitosis World—Movies

- Section 9.3: Onion Root-Tip Simulation

- Section 9.3: Mitosis through the Microscope: Advances in Seeing inside Live Dividing Cells. Conly Rieder et al. *Science,* Apr. 4, 2003.

- Section 9.3: Mitotic Mischief: Can Cells Divide without Chromosomes? John Travis. *Science News,* Aug. 31, 1996.

Stages of Mitosis

Prophase

Metaphase

Anaphase

Telophase

Early Prophase -

Mitosis Begins

Duplicated chromosomes begin to condense

Late Prophase

- New microtubules are assembled
- One centriole pair is moved toward opposite pole of spindle
- Nuclear envelope starts to break up

Transition to Metaphase

Metaphase

- All chromosomes are lined up at the spindle equator
- Chromosomes are maximally condensed

Anaphase

- Sister chromatids of each chromosome are pulled apart
- Once separated, each chromatid is a chromosome

Telophase

- Chromosomes decondense
- Two nuclear membranes form, one around each set of unduplicated chromosomes

Results of Mitosis

- Two daughter nuclei
- Each with same chromosome number as parent cell
- Chromosomes in unduplicated form

Section 9.4: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.4: The Cytokinetic Mafia

- Section 9.4: Cytokinesis in Animal Cells (book review). Edward Bonder. *BioScience,* Mar. 1998.

Cytoplasmic Division

- Usually occurs between late anaphase and end of telophase
- Two mechanisms
  - Cell plate formation (plants)
  - Cleavage (animals)

Animal Cell Division

Animal Cell Division

- A ring of microfilaments in the same plane as the spindle equator contracts, dividing the animal cell

Cell Plate Formation

Cell Division

- Individual cells of a human embryo divide, developing from a paddlelike structure into a hand

Section 9.5: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 9.5: CancerQuest
- Section 9.5: Oncolink
- Section 9.5: *On Topic*—Cancer Updates & News
- Section 9.5: A Tale of Taxol
- Section 9.5: The Cell Cycle and Mitosis: In this article, Jeremy Hyams explains how mitosis occurs and how it is controlled in cells that grow and divide normally. Understanding these processes offers hope for better treatment of cancer—where normal regulation is lost. Jeremy Hyams. *Biological Sciences Review,* Apr. 2002.

Mitotic Control

- Kinases
- Growth factors
- Checkpoint genes

Tumors

- Sometimes a checkpoint gene mutates and control over cell division is lost.
- Cells uncontrollable division forms an abnormal mass called a tumor.
- Neoplasms

HeLa Cells

- Line of human cancer cells that can be grown in culture
- Descendents of tumor cells from a woman named Henrietta Lacks
- Lacks died at 31, but her cells continue to live and divide in labs around the world