

Chapter 8

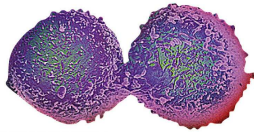
The Cellular Basis of Reproduction and Inheritance

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- You began life as a single cell, but there are now more cells in your body than stars in the Milky Way

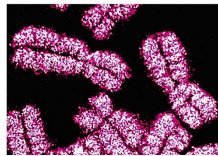


- Just in the past second, millions of your cells have divided in two

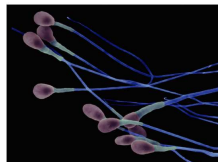


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- The dance of the chromosomes in a dividing cell is so precise that only one error occurs in 100,000 cell divisions



- Each sperm or egg produced in your reproductive organs carries one of over 8 million possible combinations of parental chromosomes



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BIOLOGY AND SOCIETY:

A \$50,000 EGG!

- A few years ago a sterile couple was willing to pay \$50,000 to a woman willing to donate her eggs

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Infertility

- Affects one in ten American couples

In vitro fertilization (IVF)

- A sperm and an egg are joined in a petri dish
- The embryo is implanted into the mother's uterus
- IVF is one of many reproductive technologies

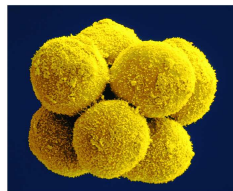


Figure 8.1

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WHAT CELL REPRODUCTION ACCOMPLISHES

Reproduction

- Is the birth of new organisms
- Occurs much more often at the cellular level.

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- Cell division plays a role in
 - The replacement of lost or damaged cells
 - Cell reproduction and growth

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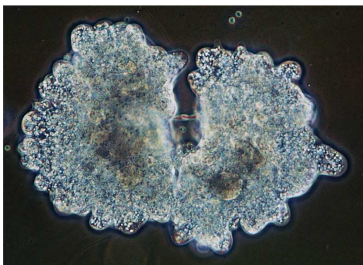
Passing On the Genes from Cell to Cell

- Before a parent cell divides, it duplicates its chromosomes
- The two resulting “daughter” cells are genetically identical.

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The Reproduction of Organisms

- In asexual reproduction, single-celled organisms reproduce by simple cell division



(a) Amoeba

Figure 8.2a

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- Some multicellular organisms can divide into pieces that then grow into new individuals



(b) Sea star

Figure 8.2b

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- Sexual reproduction is different
 - It requires fertilization of an egg by a sperm
 - Production of egg and sperm is called meiosis.

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THE CELL CYCLE AND MITOSIS

- A genome
 - Is the complete set of an organism's genes
 - Is located mainly on chromosomes in the cell's nucleus.

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Eukaryotic Chromosomes

- Chromosomes
 - Are made of chromatin, a combination of DNA and protein molecules
 - Are not visible in a cell until cell division.

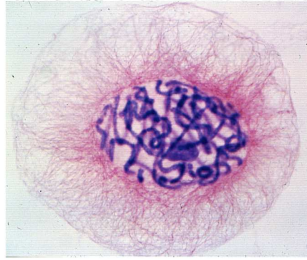


Figure 8.3

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- The DNA in a cell is packed into an elaborate, multilevel system of coiling and folding

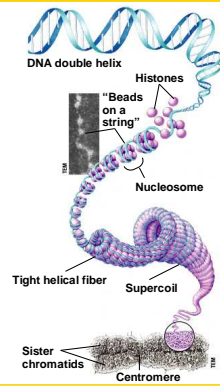


Figure 8.4

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- Before a cell divides, it duplicates all of its chromosomes, resulting in two copies called sister chromatids.

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- When the cell divides, the sister chromatids separate from each other.

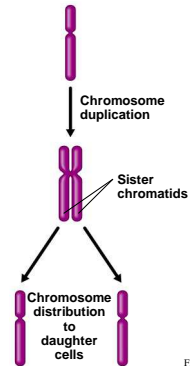


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The Cell Cycle

- Eukaryotic cells that divide undergo an orderly sequence of events called the cell cycle.

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- The cell cycle consists of two distinct phases

- Interphase
- Mitotic phase.

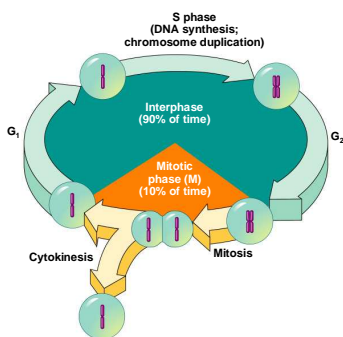


Figure 8.6

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Mitosis and Cytokinesis

- Mitosis

- Is the division of the chromosomes
- Is preceded by interphase.

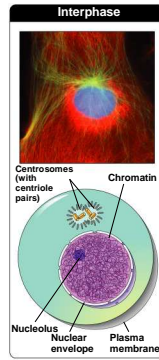


Figure 8.7.1

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- Mitosis consists of four distinct phases

- Prophase
- Metaphase.

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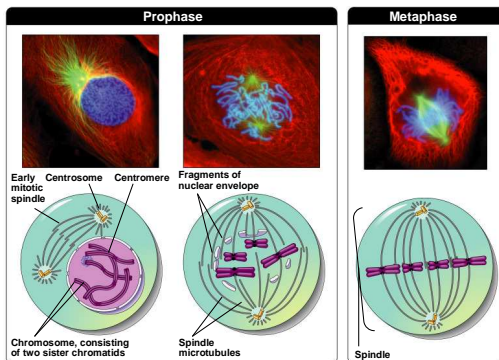


Figure 8.7.2

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- Anaphase
- Telophase

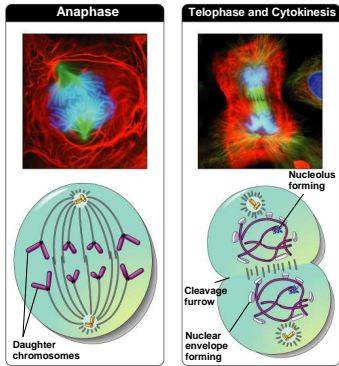


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- Cytokinesis
 - Typically occurs during telophase
 - Is the division of the cytoplasm.

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- Cytokinesis is different in plant and animal cells.

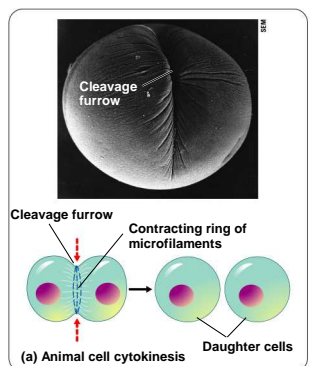
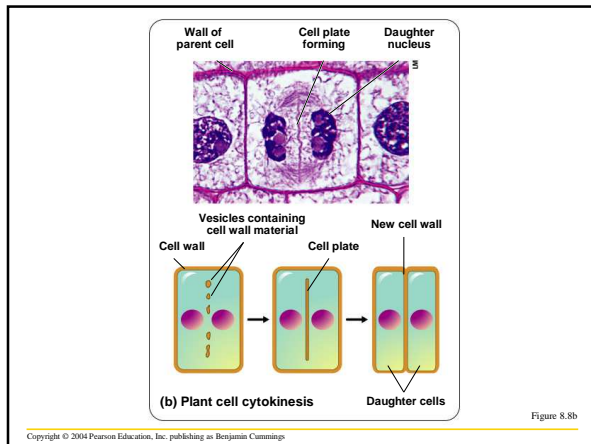


Figure 8.8a

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Cancer Cells: Growing Out of Control

- Normal plant and animal cells have a cell cycle control system
- When the cell cycle control system malfunctions
 - Cells may reproduce at the wrong time or place
 - A benign tumor may form.

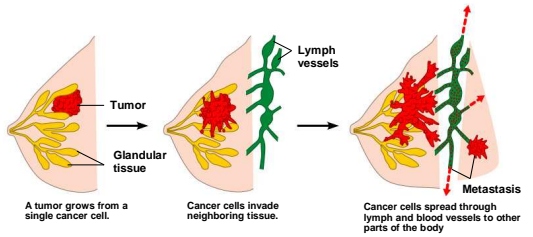
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What Is Cancer?

- What is cancer?
 - Cancer is caused by a breakdown in control of the cell cycle.

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- Cancer cells divide excessively
- Cancer cells spread from a malignant tumor
- Metastasis is the spread of cancer.



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Figure 8.9

Cancer Treatment

- Cancer treatment
 - Radiation therapy disrupts cell division
 - Chemotherapy involves drugs that disrupt cell division.

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- Cancer cells are often grown in culture for study.



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Figure 8.10

Cancer Prevention and Survival

- Cancer prevention includes changes in lifestyle
 - Not smoking
 - Avoiding exposure to the sun
 - Eating a high-fiber, low-fat diet
 - Visiting the doctor regularly
 - Performing regular self-examinations.

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MEIOSIS, THE BASIS OF SEXUAL REPRODUCTION

- Sexual reproduction depends on
 - Meiosis
 - Fertilization.



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Homologous Chromosomes

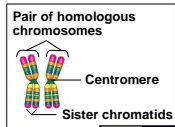
- Different organisms of the same species have the same number and types of chromosomes.

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- A somatic cell
 - Is a typical body cell
 - Has 46 chromosomes in a human.

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- A karyotype is an orderly arrangement of chromosomes



- Homologous chromosomes are matching pairs of chromosomes.

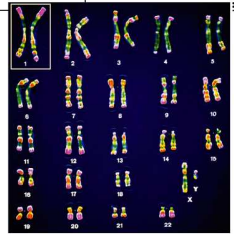


Figure 8.12

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- Humans have
 - Two different sex chromosomes, X and Y
 - 22 pairs of matching chromosomes, called autosomes.

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Gametes and the Life Cycle of a Sexual Organism

- The life cycle of a multicellular organism is the sequence of stages leading from the adults of one generation to the adults of the next.

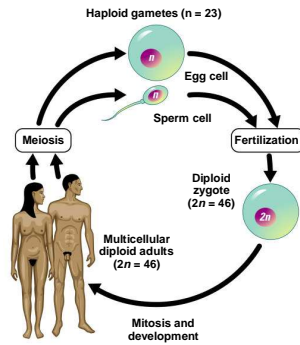


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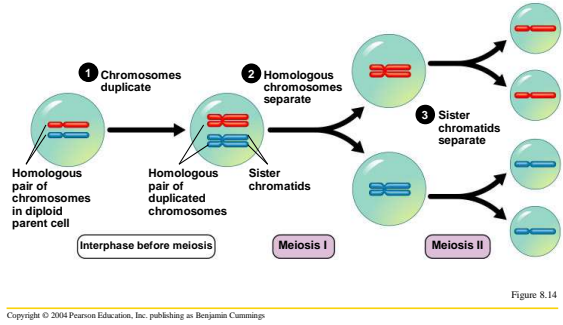
- Humans are diploid organisms
 - Their cells contain two sets of chromosomes
 - Their gametes are haploid, having only one set of chromosomes.

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- Fertilization
 - Is the fusion of sperm and egg
 - Creates a zygote, or fertilized egg.

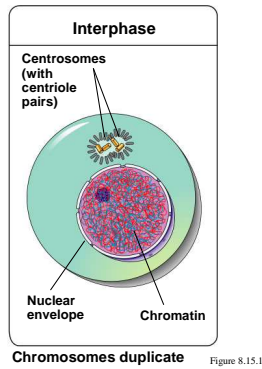
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- Sexual life cycles involve an alternation of diploid and haploid stages.

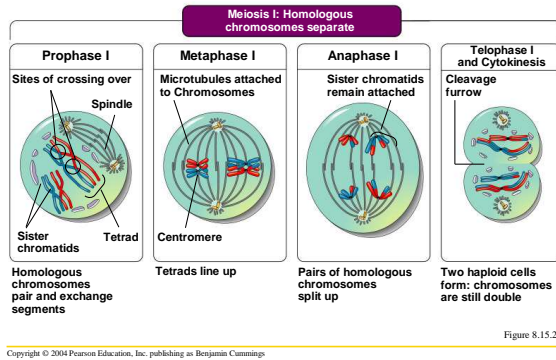


The Process of Meiosis

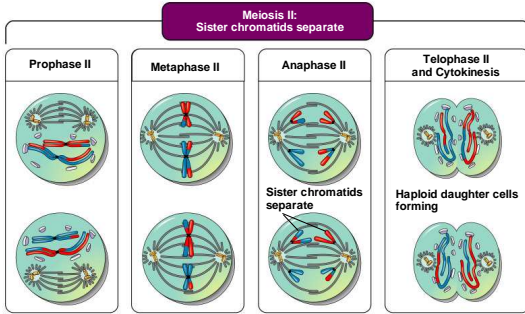
- In meiosis
 - Haploid gametes are produced in diploid organisms
 - Two consecutive divisions occur, meiosis I and meiosis II, preceded by interphase
 - Crossing over occurs.



Meiosis I



- Meiosis II



During another round of cell division, the sister chromatids finally separate; four haploid daughter cells result, containing single chromosomes

Figure 8.15.3

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Review: Comparing Mitosis and Meiosis

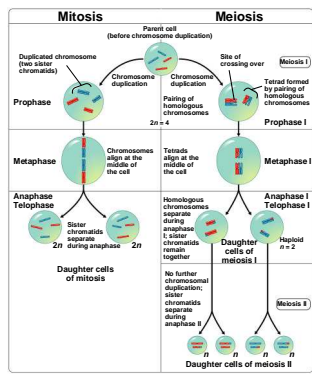


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The Origins of Genetic Variation

- Offspring of sexual reproduction are genetically different from their parents and from one another.

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Independent Assortment of Chromosomes

- In independent assortment every chromosome pair orients independently of the others during meiosis.

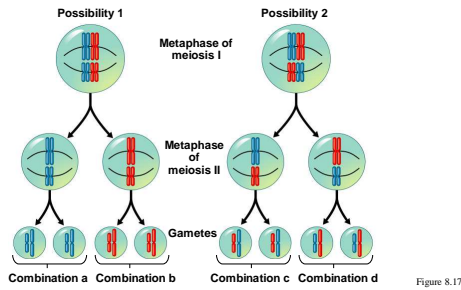


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Random Fertilization

- The human egg cell is fertilized randomly by one sperm, leading to genetic variety in the zygote.

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Crossing Over

- In crossing over
 - Homologous chromosomes exchange genetic information
 - Genetic recombination occurs.

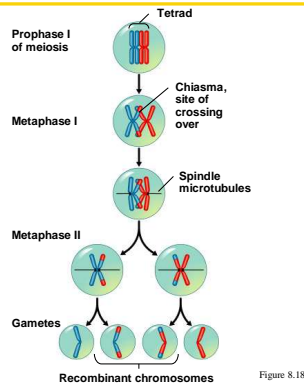


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When Meiosis Goes Awry.

- What happens when errors occur in meiosis?

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Down Syndrome: An Extra Chromosome 21

- Down Syndrome
 - Is a condition where an individual has an extra chromosome 21
 - Is also called trisomy 21.



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- The incidence of Down Syndrome increases with the age of the mother.

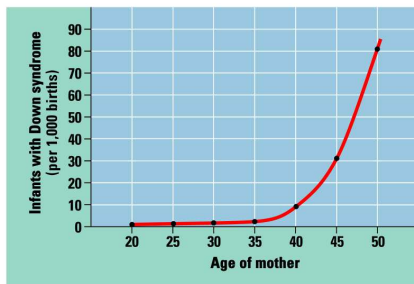


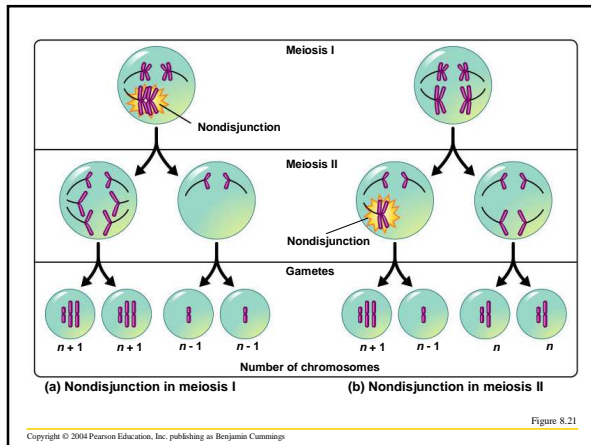
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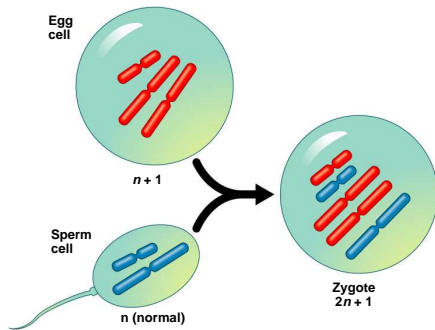
How Accidents During Meiosis Can Alter Chromosome Number

- In nondisjunction
 - The members of a chromosome pair fail to separate during anaphase
 - Gametes with an incorrect number of chromosomes are produced.

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The result of nondisjunction



Abnormal Numbers of Sex Chromosomes

- Nondisjunction
 - Also affects the sex chromosomes

Sex Chromosomes	Syndrome	Origins of Nondisjunction	Frequency in Population
XXY	Klinefelter syndrome (male)	Meiosis in egg or sperm formation	$\frac{1}{2,000}$
XYY	None (normal male)	Meiosis in sperm formation	$\frac{1}{2,000}$
XXX	Metafemale	Meiosis in egg or sperm formation	$\frac{1}{1,000}$
XO	Turner syndrome (female)	Meiosis in egg or sperm formation	$\frac{1}{5,000}$

Table 8.1

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- Two kinds of sex chromosome abnormalities

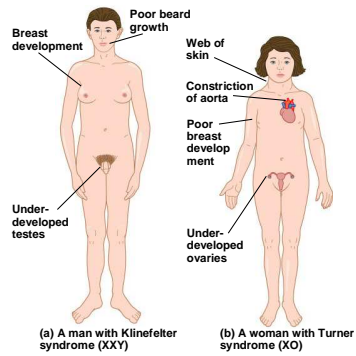


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NEW SPECIES FROM ERRORS IN CELL DIVISION

- Errors in meiosis may have been instrumental in the evolution of many species

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- Polyploids
 - Are new species
 - Have more than two sets of homologous chromosomes in each somatic cell.

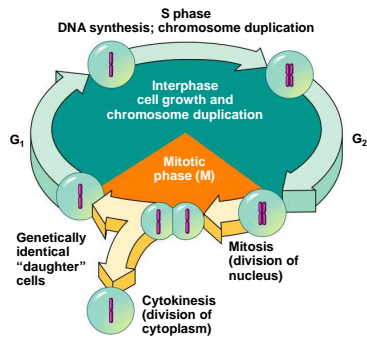


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SUMMARY OF KEY CONCEPTS

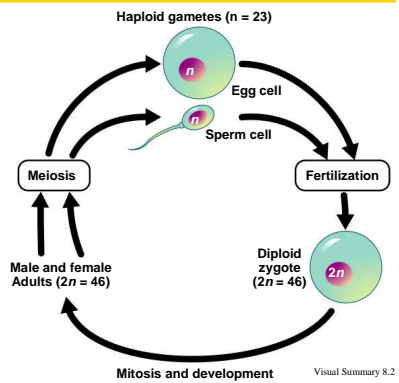
- The Cell Cycle.



Visual Summary 8.1

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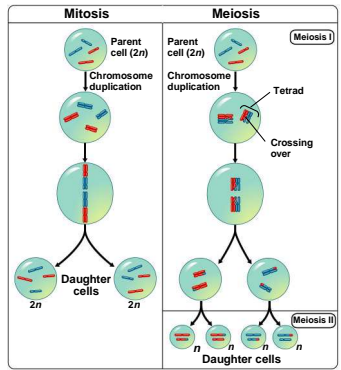
- Gametes and the Life Cycle of a Sexual Organism.



Visual Summary 8.2

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- Review: Comparing Mitosis and Meiosis.



Visual Summary 8.3

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