

PowerLecture:
Chapter 10
Meiosis and Sexual Reproduction
Section 10.0: Weblinks and InfoTrac

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

- Section 10.0: Examples of Asexual Reproduction
- Section 10.0: Why Sex?
- Section 10.0: NOVA—The Advantage of Sex
- Section 10.0: Jacques Loeb—Parthenogenesis in the 19th Century
- Section 10.0: Life Without Sex: So, How Many Millions of Years Has It Been? Susan Milius. *Science News*, June 2003.
- Section 10.0: Stuff & Nonsex! (cartoon). Larry Gonick. *Discover*, Dec. 1995.
- Section 10.0: Checkmating Parasites. *The Economist (US)*, Nov. 30, 1996.
- Section 10.0: The Problem of the Evolution of Sex. Rosemary Redfield. *The Biological Bulletin*, June 1999.
- Section 10.0: The Benefits of Virgin Birth. Sarah Richardson. *Discover*, Mar. 1996.

How Would You Vote?

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

- Would you support a ban on creating parthenogenic, or “fatherless,” embryos?

Impacts, Issues: Why Sex

- Asexual reproduction is easier and faster
- Sexual reproduction can be an alternative adaption in changing environments

Impacts, Issues: Why Sex

- Sexual reproduction has advantages when other organisms change
- Red Queen hypothesis – evolutionary treadmill

Section 10.1

Sexual Reproduction

- Chromosomes are duplicated in germ cells
Germ cells undergo meiosis and cytoplasmic division
- Cellular descendents of germ cells become gametes

- Gametes meet at fertilization

Asexual Reproduction

- Single parent produces offspring
- All offspring are genetically identical to one another and to parent

Sexual Reproduction

- Involves
 - Meiosis
 - Gamete production
 - Fertilization
- Produces genetic variation among offspring

Section 10.2: Weblinks and InfoTrac

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

- Section 10.0: Biology Project Meiosis Tutorial
- Section 10.0: What's Meiosis?:
- Section 10.0: Mechanism of Meiosis: Cell division by meiosis is vital in the life cycle of sexually reproducing plants and animals. It halves the normal number of chromosomes, and creates new versions of chromosomes by recombining parental genes. What mechanisms underlie these processes and what happens if something goes wrong? Lynn Burnet. *Biological Sciences Review*, April 2003.
- Section 10.0: The Mad Ways of Meiosis. Greenfield Sluder et al. *Science*, July 14, 2000.

Homologous Chromosomes Carry Different Alleles

- Cell has two of each chromosome
- One chromosome in each pair from mother, other from father
- Paternal and maternal chromosomes carry different alleles

Sexual Reproduction

Shuffles Alleles

- Through sexual reproduction, offspring inherit new combinations of alleles, which leads to variations in traits
 - This variation in traits is the basis for evolutionary change
- #### Gamete Formation
- Gametes are sex cells (sperm, eggs)

- Arise from germ cells

Chromosome Number

- Sum total of chromosomes in a cell
- Germ cells are diploid ($2n$)
- Gametes are haploid (n)
- Meiosis halves chromosome number

Human Karyotype

Meiosis: Two Divisions

- Two consecutive nuclear divisions
 - Meiosis I
 - Meiosis II
- DNA is not duplicated between divisions
- Four haploid nuclei form

Meiosis I

Meiosis II

- The two sister chromatids of each duplicated chromosome are separated from each other

Section 10.3: Weblinks and InfoTrac

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

- Section 10.3: [VRML Meiotic Division of the Cell](#)
- Section 10.3: [Chromosome Choreography: The Meiotic Ballet. Scott Page et al. *Science*, Aug. 8, 2003.](#)

Meiosis I - Stages

Prophase I

- Each duplicated chromosome pairs with homologue
- Homologues swap segments
- Each chromosome becomes attached to spindle

Metaphase I

- Chromosomes are pushed and pulled into the middle of cell
- The spindle is fully formed

Anaphase I

- Homologous chromosomes segregate
- The sister chromatids remain attached

Telophase I

- The chromosomes arrive at opposite poles

- Usually followed by cytoplasmic division

Prophase II

- Microtubules attach to the kinetochores of the duplicated chromosomes

Metaphase II

- Duplicated chromosomes line up at the spindle equator, midway between the poles

Anaphase II

- Sister chromatids separate to become independent chromosomes

Telophase II

- The chromosomes arrive at opposite ends of the cell
- A nuclear envelope forms around each set of chromosomes
- Four haploid cells

Section 10.4: Weblinks and InfoTrac

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

- Section 10.4: Biology Hypertextbook—Meiosis and Genetic Recombination
 - Section 10.4: Assortment of Chromosomes in Meiosis
 - Section 10.4: Meiotic Recombination Hotspots. Michael Lichten et al. *Annual Review of Genetics*, Annual 1995.
 - Section 10.4: Unraveling the Mysteries of Meiosis. *Business Wire*, Aug. 6, 1998.
- Crossing Over

Effect of Crossing Over

- After crossing over, each chromosome contains both maternal and paternal segments
- Creates new allele combinations in offspring

Random Alignment

- During transition between prophase I and metaphase I, microtubules from spindle poles attach to kinetochores of chromosomes
 - Initial contacts between microtubules and chromosomes are random
- #### Random Alignment
- Either the maternal or paternal member of a homologous pair can end up at either pole

- The chromosomes in a gamete are a mix of chromosomes from the two parents
Possible Chromosome Combinations

As a result of random alignment, the number of possible combinations of chromosomes
in a gamete is:

$$2^n$$

(n is number of chromosome types)

Section 10.5: Weblinks and InfoTrac

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

- Section 10.5: Cell and Developmental Biology Online—Gametogenesis
- Section 10.5: Topics on Gametogenesis
- Section 10.5: Sex Matters in Meiosis (quality control in males vs. females). Patricia Hunt et al. *Science*, June 21, 2002.
- Section 10.5: The Tao of Stem Cells in the Germline (the cells that make gametes). Haifan Lin. *Annual Review of Genetics*, Annual 1997.

Oogenesis

Spermatogenesis

Fertilization

- Male and female gametes unite and nuclei fuse
- Fusion of two haploid nuclei produces diploid nucleus in the zygote
- Which two gametes unite is random
 - Adds to variation among offspring
- Crossing over during prophase I
- Random alignment of chromosomes at metaphase I
- Random combination of gametes at fertilization

Factors Contributing to Variation among Offspring

Section 10.6: Weblinks and InfoTrac

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

- Section 10.6: PBS—How Cells Divide: Mitosis vs. Meiosis
Mitosis & Meiosis Compared
Mitosis

- Functions
 - Asexual reproduction
 - Growth, repair
- Occurs in somatic cells
- Produces clones

Meiosis

- Function
 - Sexual reproduction

- Occurs in germ cells

- Produces variable offspring

Prophase vs. Prophase I

- Prophase (Mitosis)
 - Homologous pairs do not interact with each other
- Prophase I (Meiosis)
 - Homologous pairs become zippered together and crossing over occurs

Anaphase, Anaphase I, and Anaphase II

- Anaphase I (Meiosis)
 - Homologous chromosomes separate from each other
- Anaphase/Anaphase II (Mitosis/Meiosis)
 - Sister chromatids of a chromosome separate from each other

Results of Mitosis and Meiosis

- Mitosis
 - Two diploid cells produced
 - Each identical to parent
- Meiosis
 - Four haploid cells produced
 - Differ from parent and one another

An Ancestral Connection

- Was sexual reproduction a giant evolutionary step from asexual reproduction?
- *Giardia intestinalis*
- *Chlamydomonas*

