Chapter 13:
Meiosis & Sexual Life Cycles

1. Sexual Reproduction
2. Meiosis
1. Sexual Reproduction

Chapter Reading – pp. 252-257
Asexual Reproduction

Many organisms can reproduce asexually:

• involves mitosis only

• produces genetic clones of the single parent organism

Easy to accomplish, no genetic variation
Sexual Life Cycles

Key
- Haploid \((n)\)
- Diploid \((2n)\)

- **Gametes**
- **MEIOSIS**
- **FERTILIZATION**
- **Mitosis**
- **Zygote**

(a) Animals
- Diploid multicellular organism
- MEIOSIS
- FERTILIZATION
- Zygote
- 2n
- Mitosis

(b) Plants and some algae
- Haploid multicellular organism (gametophyte)
- MEIOSIS
- FERTILIZATION
- Zygote
- 2n
- Mitosis
- Spores
- Gametes

(c) Most fungi and some protists
- Haploid unicellular or multicellular organism
- MEIOSIS
- FERTILIZATION
- Zygote
- 2n
- Mitosis

- **Involve a diploid stage, meiosis to produce a haploid stage, fusion of haploid cells restoring the diploid state**

- Harder to accomplish, lots of genetic variation
Key
- Haploid \((n)\)
- Diploid \((2n)\)

Haploid gametes \((n = 23)\)

Sperm \((n)\)

Egg \((n)\)

Diploid zygote \((2n = 46)\)

Mitosis and development

Multicellular diploid adults \((2n = 46)\)
Maternal vs Paternal Chromosomes

Key

- Maternal set of chromosomes ($n = 3$)
- Paternal set of chromosomes ($n = 3$)

$2n = 6$

Sister chromatids of one duplicated chromosome

Centromere

Two nonsister chromatids in a homologous pair

Pair of homologous chromosomes (one from each set)
Homologous Chromosomes

Homologous chromosomes have the same size, same genetic loci, and the same location of the centromere.

Pair of homologous duplicated chromosomes

Centromere

Sister chromatids

Metaphase chromosome
2. Meiosis

Chapter Reading – pp. 257-265
Meiosis Produces Haploid Gametes

Meiosis requires 2 rounds of cell division:

- **Meiosis I** - differs from mitosis in prophase, metaphase, anaphase
- **Meiosis II** - essentially the same as mitosis
From 2n to 1n
**Meiosis I**

**Prophase I**
- Centrosome (with centriole pair)
- Sister chromatids
- Chiasmata
- Spindle
- Fragments of nuclear envelope
- Homologous chromosomes

**Metaphase I**
- Centromere (with kinetochore)
- Metaphase plate
- Chromosomes line up by homologous pairs.

**Anaphase I**
- Sister chromatids remain attached
- Homologous chromosomes separate
- Each pair of homologous chromosomes separates.

**Telophase I and Cytokinesis**
- Cleavage furrow
- Two haploid cells form; each chromosome still consists of two sister chromatids.

**Duplicated homologous chromosomes (red and blue) pair and exchange segments; 2n = 6 in this example.**
During another round of cell division, the sister chromatids finally separate; four haploid daughter cells result, containing unduplicated chromosomes.
Mitosis vs Meiosis

**MITOSIS**

- **Prophase**
  - Duplicated chromosome
- **Metaphase**
- **Anaphase**
- **Telophase**

Daughter cells of mitosis

**MEIOSIS**

- **Prophase I**
  - Chromosome duplication
- **Metaphase I**
- **Anaphase I**
- **Telophase I**

Daughter cells of meiosis I

- **Prophase II**
  - Chromosome duplication
- **Metaphase II**
- **Anaphase II**
- **Telophase II**

Daughter cells of meiosis II

**Parent cell**

- **Chiasma**
  - Homologous chromosome pair

**Chromosome duplication**

- **Parent cell**
  - 2n = 6

**Daughter cells**

- **Haploid**
  - n = 3
Meiosis Yields Genetic Variation

1) Independent Assortment of Chromosomes
   • the assortment of chromosomes in one homologous pair is independent of the assortment of chromosomes in other homologous pairs
   • possible combinations of maternal & paternal chromosomes is $2^n$ ($n = \text{haploid chromosome number}$)
     
     e.g., in humans $2^n = 2^{23} = 8,388,608$

2) Crossing Over
   • produces “recombinant chromosomes” different from all parental chromosomes

2) Random Fertilization
Independent Assortment of Chromosomes

Possibility 1

Two equally probable arrangements of chromosomes at metaphase I

Possibility 2

n = 2

$2^n = 4$

Metaphase II

Daughter cells

Combination 1

Combination 2

Combination 3

Combination 4
Crossing Over

- **homologous** duplicated chromosomes pair up (synapsis) to form a tetrad

- **nonsister** chromatids cross over forming chiasma, exchange ends of chromatids

  - Nonsister chromatids can undergo exchange 0, 1 or >1 pieces
Key Terms for Chapter 13

- asexual vs sexual reproduction
- homologous chromosomes
- synapsis, tetrad, chiasma, crossing over
- independent assortment

Relevant Chapter Questions 1-9