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

- 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

Human Life Cycle

Maternal vs Paternal Chromosomes

2n = 6

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

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 same size, same genetic loci, same location of centromere.

Pair of homologous duplicated chromosomes

5 μm

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
Pair of homologous chromosomes in diploid parent cell
Duplicated pair of homologous chromosomes
Sister chromatids
Diploid cell with duplicated chromosomes
Homologous chromosomes separate
Sister chromatids separate
Haploid cells with unduplicated chromosomes

From 2n to 1n

Meiosis I

Prophase I
- Centrosome (with centriole pair)
- Sister chromatids
- Homologous chromosomes
- Duplicated homologous chromosomes (red and blue) pair and exchange segments; 2n = 6 in this example.

Metaphase I
- Chiasmata
- Spindle
- Microtubule attached to kinetochore
- Homologous chromosomes separate
- Chromosomes line up by homologous pairs.

Anaphase I
- Sister chromatids remain attached
- Each pair of homologous chromosomes separates.
- Two haploid cells form; each chromosome still consists of two sister chromatids.

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

Meiosis II

Prophase II
- Sister chromatids separate
- Haploid daughter cells forming

Metaphase II
- Sister chromatids separate
- Haploid daughter cells forming

Anaphase II
- Sister chromatids separate
- Haploid daughter cells forming

Telophase II and Cytokinesis
- Sister chromatids separate
- Haploid daughter cells forming

During another round of cell division, the sister chromatids finally separate; four haploid daughter cells result, containing unduplicated chromosomes.
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 = 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
   
   $n = 2$
   $2^n = 4$
   Metaphase II

Possibility 2

Combination 1
Combination 2
Combination 3
Combination 4

Daughter cells
Crossing Over

- homologous duplicated chromosomes pair up (synapsis) to form a tetrad
- nonsister chromatids cross over forming chiasma, exchange ends of chromatids

Key Terms for Chapter 13

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

Relevant Chapter Questions 1-9