LECTURE 1: Mitosis and Meiosis
Reading: Ch. 4, p. 83-95; Table 4.2
Book Problems: Ch. 4, # 4-1 – 4-4, 4-7 – 4-10, 4-16

In this lecture we review **mitosis**, the process by which the chromosomes of somatic cells are apportioned equally to two daughter cells during division. Mitosis ensures that all of our cells inherit the same genetic information. We will compare mitosis with **meiosis**, which is the process by which the gametes are made. Whereas mitosis produces daughter cells identical to the parental cell, meiosis generates haploid gametes containing various combinations of parental chromosomes. Meiosis contributes to genetic diversity.

THE CELL CYCLE:
Many cells in our body continually grow and divide, and the repeating process of growth followed by division, is called the cell cycle. The cell cycle consists of two major parts: a short division and a longer interphase.

Interphase is subdivided into three phases: G1, S, and G2.
G1 (gap 1): the period after the birth of a new cell until onset of chromosome replication
S (synthesis): the period when the cell duplicates its genetic material (synthesizes DNA)
G2 (gap 2): the period between chromosome duplication and the beginning of mitosis
Regulatory checkpoints occur during G1 and G2 to help regulate the cell cycle.

Terms:
chromatin: a tangled mass of DNA and protein. Chromosomes begin to condense and become visible at the beginning of mitosis.
chromosome: linear double-stranded DNA helix that contains a linear array of genes.
homologous chromosomes or **homologs**: chromosomes that match in size, shape, and gene arrangement [although the **alleles** (or forms) of each gene may be different]. One of the pair of homologs is derived from the mother (**maternal**) and one from the father (**paternal**).
autosomes vs. **sex chromosomes:** autosomes are not involved in sex-determination; sex chromosomes are (humans have 46 total chromosomes, 22 pairs of autosomes and two sex chromosomes, an X and a Y.
sister chromatids: After replication, each chromosome has replicated into two identical sister chromatids connected at the **centromere**.

MITOSIS:
Know the phases of mitosis – Prophase, Metaphase, Anaphase, and Telophase
--The equal distribution of a complete set of chromosomes (one from each parent) ensures that daughter cells are genetically equivalent.
--Mitosis is genetically conservative; there is no mixing of genetic information.
--**Cytokinesis** is the division of the cytoplasm, the process by which the parent cell separates into two genetically identical daughters. It begins during late anaphase and is completed by the end of telophase.

MEIOSIS:

Meiosis is the basis of sexual reproduction. Meiosis generates cells called **gametes** with half the number of chromosomes of a **diploid** (2n) cell. This is accomplished by one round of chromosome replication followed by two rounds of nuclear division. Fusion of two **haploid** (1n) gametes during fertilization restores the diploid complement of chromosomes.

Meiosis consists of two successive nuclear divisions: Meiosis I and Meiosis II.
---During Meiosis I, homologous chromosomes pair, exchange portions of their chromosomes (recombine), and then segregate from each other. Meiosis I consists of a long, complex Prophase I. This is the time when **crossing over** occurs, as each chromosome pair (a **tetrad** or **bivalent** of four chromatids) align and associate closely with each other (the process of **synapsis**). We will talk about crossing over (**recombination**) in more detail in future lectures. Prophase I is followed by Metaphase I, which is when the tetrads line up along the metaphase plate. During Anaphase I, homologous chromosomes are pulled to opposite poles, thus a maternal chromosome of each pair randomly goes to one pole and the homologous paternal chromosome to the other. (The possible number of chromosomal combinations is 2 to the n, where n is the number of chromosome pairs.)
---During Meiosis II, the sister chromatids now separate to form haploid gametes. There is no replication before Meiosis II. The chromosomes recondense during Prophase II, and they align at the metaphase plate during Metaphase II. During Anaphase II, the sister chromatids separate and move to opposite poles. In Telophase II, the nuclear membrane reforms and cytokinesis occurs.

<u>Comparing Mitosis and Meiosis:</u>
--Mitosis occurs in somatic cells; meiosis occurs in germ cells.
--Mitosis has one round of division; meiosis has two rounds.
--Homologous chromosomes do not pair during mitosis, but do synapse in meiosis.
--Genetic exchange between homologous chromosomes occurs in meiosis but only rarely in mitosis.
--Sister chromatids separate during Anaphase of Mitosis; homologous chromosomes separate in Anaphase of Meiosis I and sister chromatids separate during Anaphase II of Meiosis.
--Mitosis produces two daughter cells, both of which are identical to each other and the parental cell. Meiosis produces four haploid cells, none of which are identical to the original cell. The mixing of genetic information during meiosis occurs through independent assortment of homologous chromosomes and by crossover events that occur during Meiosis I.

Results of Meiosis (in terms of gene segregation):
--Meiosis generates haploid cells with half the number of chromosomes of the diploid cell.
--In Metaphase I, the maternal and paternal chromosomes have an equal chance of aligning on either side of the metaphase plate. The more chromosomes an organism has, the more different combinations of maternal and paternal chromosomes are possible in the meiotic products.
--Crossing over generates even more variation!