Biology 5.2
Genetics Ploidy, multicellularity, and Meiosis

”Behold, what manner of love the Father hath bestowed upon us, that we should be called the sons of God: therefore the world knoweth us not, because it knew him not.”

Diploid and multicellular genetics

1. All organisms are controlled by a set of genes located on one or more chromosomes.
2. Every species has a defined number of chromosomes.
3. One set of chromosomes is called a genome.
4. The number of genomes is referred to as a ploidy.
5. Haploid is one set of chromosomes and is designated as (1n).
6. Diploid is two sets of chromosomes and is designated as (2n).
7. Organisms with more than two sets of chromosomes are polyploid.
    a. Triploid is three sets of chromosomes and is designated as (3n).
    b. Tetraploid is four sets of chromosomes and is designated as (4n).
8. Humans are diploid with two sets of chromosomes for a total of 46.
9. Most eucaryotic cells are diploid.
10. Plants are commonly polyploidy.

Karyotyping

1. The identification and ordering of chromosomes by shape and size.
2. Cell samples are stained with Giemsa dye to microscopically identify cells with condensed chromosomes in the mitosis phase after prophase.
3. The Giemsa dye stains show dark bands on the chromosomes in regions of the chromosomes that are rich in the base pairs Adenine (A) and Thymine (T).
4. The unique banding patterns (number and size of G-bands) help to identify chromosomes.
5. In addition, the banding patterns are used to determine the length of the chromosomes and the placement of centromeres.
6. Identification of chromosomes helps to identify abnormalities.
7. Chromosomes are numbered and arranged by homologous pairs.
8. Homologous pairs are two similar chromosomes in a diploid or polyploid organism.
9. Humans have 44 autosomes and 2 sex chromosomes.

Mitosis (asexual reproduction)

1. Chromosomes are duplicated and results in two cells.
2. Asexual reproduction does not usually occur in diploid or polyploid cells.
    a. The development of an unfertilized egg is called parthenogenesis.
    b. Parthenogenesis occurs in plants, some invertebrates, and a few vertebrates.
3. Occurs in one step cycle.
4. Produces two cells that identical to the original cell.
5. Each resulting cell has a copy of the parental chromosome(s).

Ploidy cycle

1. Diploid organisms produce haploid cells.

2. The formation of haploid cells is called reductional division or meiosis.
3. Haploid cells fuse to produce diploid cells.
4. The fusing of two haploid cells is called fertilization.
5. Most diploid organisms have male and female gender versions for their species.
6. Reductional division of diploid cells is necessary to maintain the species' chromosome number.
7. Fertilization without reductional division results in an exponential increase in chromosome number. 2 > 4 > 8 > 16 > 32 > 64 > 128 > 256, etc.
8. Reductional division occurs in germ cells.
9. Reductional division in one diploid germ cell produces four haploid gamete cells (sperm or eggs).
10. Somatic cells (body) do not produce gamete cells.

Meiosis (sexual reproduction)

1. Chromosomes are duplicated, then the germ cell divides twice and results in four cells.
2. Requires two steps (first step separates the homologues, second step separate the sister chromatids)
3. Each resulting cell has half the number of somatic cells.
4. The four resulting haploid gamete cells are different from parent cells and each other.

Phase 1. Separating homologues

1. Interphase: duplicate the chromosomes
2. Prophase: homologues condense
3. Metaphase: homologues line up
4. Anaphase: homologues separate
5. Telophase: cell divides into two

Phase 2. Separating chromatids. Like mitosis.

1. Interphase: no duplication
2. Prophase: chromosomes condense
3. Metaphase: chromatids line up
4. Anaphase: chromatids separate
5. Telophase: cell divides into two

Heterogametes

1. male gametes: sperm (spermatogenesis).
    a. meiosis produces four sperm/cell at a time.
2. female gametes: ova (egg) (oogenesis)
    a. meiosis produces four gametes.
    b. Three ova, called polar bodies atrophy.
    c. One ovum remains as a viable egg.

Conception

1. The union of male and female gametes results in the formation of a zygote (fertilized egg).

2. The beginning of a new, diploid life, conception.
3. Organelles and cytoplasm of zygote comes from egg.

Stage	**Mitosis**	**Meiosis**	**Meiosis**
	Separating sister chromatids	Phase 1. Separating homologues Diploid 2n ➡ Haploid 1n	Phase 2. Separating sister chromatids
Interphase	Replication of DNA, Sister chromatids attached at centromere	Replication of DNA, Sister chromatids attached at centromere	Not necessary
Prophase	Chromosomes condense, nuclear membrane dissolves, centrioles divide and migrate, spindle fibers form	Chromosomes condense, nuclear membrane dissolves, centrioles divide and migrate, spindle fibers form	Spindle fibers form perpendicular to Prophase 1
Metaphase	Sister chromatids line up at equatorial plate	Homologues line up at equatorial plate	Sister chromatids line up at equatorial plate
Anaphase	Sister chromatids separate and now called daughter chromosomes	Homologues separate	Sister chromatids separate and now called daughter chromosomes
Telophase	Cytokinesis, chromosomes uncoil, nuclear envelope forms	Cytokinesis	Cytokinesis, chromosomes uncoil, nuclear envelope forms