Some word roots useful for Lab exercise 2 and 3:

a- = not or without (asexual: type of reproduction not involving fertilization)

ana- = up, throughout, again (anaphase: the mitotic stage in which the chromatids of each chromosome have separated and the daughter chromosomes are moving to the poles of the cell)

-apsis = juncture (synapsis: the pairing of replicated homologous chromosomes during prophase I of meiosis)

auto- = self (autosome: the chromosomes that do not determine gender)

bi- = two (binary fission: a type of cell division in which a cell divides in half)

centro- = the center; -mere = a part (centromere: the narrow "waist" of a condensed chromosome)

chiasm- = marked crosswise (chiasma: the X-shaped microscopically visible region representing homologous chromosomes that have exchanged genetic material through crossing over during meiosis)

chroma- = colored (chromatin: DNA and the various associated proteins that forms eukaryotic chromosomes)

co- = together (codominance: phenotype in which both dominant alleles are expressed in the heterozygote)

cyclo- = a circle (cyclin: a regulatory protein whose concentration fluctuates cyclically)

cyto- = cell; -kinet = move (cytokinesis: division of the cytoplasm)

di- = two (diploid: cells that contain two homologous sets of chromosomes)

fertil- = fruitful (fertilization: process of fusion of a haploid sperm and a haploid egg cell)

gamet- = a wife or husband (gamete: a haploid egg or sperm cell)

gen- = produce (genome: a cell's endowment of DNA)

geno- = offspring (genotype: the genetic makeup of an organism)

haplo- = single (haploid: cells that contain only one chromosome of each homologous pair)

hetero- = different (heterozygous: having two different alleles for a trait)

homo- = alike (homozygous: having two identical alleles for a trait)

inter- = between (interphase: time when a cell metabolizes and performs its various functions)

karyo- = nucleus (karyotype: a display of the chromosomes of a cell)
**meio-** = less (*meiosis*: a variation of cell division which yields daughter cells with half as many chromosomes as the parent cell)

**meta-** = between (*metaphase*: the mitotic stage in which the chromosomes are aligned in the middle of the cell, at the metaphase plate)

**mito-** = a thread (*mitosis*: the division of the nucleus)

**mono-** = one (*monohybrid cross*: a breeding experiment that uses parental varieties differing in a single character)

**pheno-** = appear (*phenotype*: the physical and physiological traits of an organism)

**pro-** = before (*prophase*: the first mitotic stage in which the chromatin is condensing)

**re-** = again; **com-** = together; **bin-** = two at a time (*recombinant*: an offspring whose phenotype differs from that of the parents)

**soma-** = body (*somatic*: body cells with 46 chromosomes in humans)

**syn-** = together; **gam-** = marriage (*syngamy*: the process of cellular union during fertilization)

**telos-** = an end (*telophase*: the final stage of mitosis in which daughter nuclei are forming and cytokinesis has typically begun)

**tetra-** = four (*tetrad*: the four closely associated chromatids of a homologous pair of chromosomes)

**trans-** = across (*translocation*: attachment of a chromosomal fragment to a nonhomologous chromosome)
Some key concepts for Lab exercise 2 and 3:

**Alleles**: alternate versions of a gene; each gene may have 2 or more alternative forms (e.g. dominant and recessive).

**Antibody**: an antigen-binding immunoglobulin, produced by B cells, that functions as the effector in an immune response.

**Antigen**: a foreign macromolecule that does not belong to the host organism and that elicits an immune response.

**Autosomal**: allele is present on any chromosome except the sex chromosome (X and Y).

**Back cross or Test cross**: test cross is a simple method devised by Mendel to verify the genotype of the F1 hybrid. When the F1 hybrid is crossed with the homozygous recessive parent, it is called a test cross. Since, the F1 is crossed back with one of the parents, it is also called a back cross.

**Carrier**: in human genetics, an individual who is heterozygous at a given genetic locus, with one normal allele and one potentially harmful recessive allele. The heterozygote is phenotypically normal for the character determined by the gene but can pass on the harmful allele to offspring.

**Cell cycle**: an ordered sequence of events in the life of a eukaryotic cell, from its origin in the division of a parent cell until its own division into two; composed of the M, G1, S, and G2 phases.

**Centriole**: a structure in an animal cell composed of cylinders of microtubule triplets arranged in a 9+0 pattern. An animal cell usually has a pair of centrioles involved in cell division.

**Centromere**: the centralized region joining two sister chromatids.

**Centrosome**: material present in the cytoplasm of all eukaryotic cells, important during cell division; the microtubule organizing center.

**Chiasma**: (plural, chiasmata) the X-shaped, microscopically visible region representing homologous chromatids that have exchanged genetic material through crossing over during meiosis.

**Chromosome theory of inheritance**: a basic principle in biology stating that genes are located on chromosomes and that the behavior of chromosomes during meiosis accounts for inheritance patterns.

**Chromatids**: duplicated chromosomes attached to one another.

**Chromatin**: the complex of DNA and proteins that makes up a eukaryotic chromosome.

**Chromosome**: a threadlike, gene carrying structure found in the nucleus. Each chromosome consists of one, very long DNA molecule and associated proteins.
**Crossing over**: The reciprocal exchange of genetic material between nonsister chromatids during synapsis of meiosis I.

**Deletion**: (1) a deficiency in a chromosome resulting from the loss of a fragment through breakage. (2) a mutational loss of one or more nucleotide pairs from a gene.

**Dihybrid cross**: cross where both parents have two different traits.

**Diploid cell**: a cell containing two sets of chromosomes, one set inherited from each parent.

**DNA**: a double stranded, helical nucleic acid molecule capable of replicating and determining the inherited structure of cells proteins

**Dominant allele**: this allele is always expressed (homozygous or heterozygous) and masks the recessive allele.

**Down syndrome**: a human genetic disease resulting from having an extra chromosome 21, characterized by mental retardation and heart and respiratory defects.

**Duplication**: an aberration in chromosome structure resulting from an error in meiosis or mutagens; duplication of a portion of a chromosome resulting from fusion with a fragment from a homologous chromosome.

**Dyad**: one of the homologous chromosomes composed of two chromatids. The two dyads separate in Anaphase I of Meiosis.

**Epistasis**: A phenomenon in which one gene alters the expression of another gene that is independently inherited.

**F1**: Filial generation one, or first generation.

**Fertilization**: the union of haploid gametes to produce a diploid zygote.

**Gamete**: haploid cell such as an egg or sperm. Gametes unite during sexual reproduction to produce a diploid zygote.

**Gene**: a discrete unit of hereditary information consisting of a specific nucleotide sequence of DNA (or RNA in some viruses).

**Genetic map**: an ordered list of genetic loci (genes or other genetic markers) along a chromosome.

**Genotype**: genetic makeup of an organism.

**Haploid cell**: a cell containing only one set of chromosomes.

**Homologous chromosomes**: chromosome pairs of the same length, centromere position, and staining pattern that possess genes for the same characters at corresponding loci. One homologous chromosome is inherited from the organism’s father, the other from the mother.
**Incomplete dominance**: A type of inheritance in which F1 hybrids have an appearance that is intermediate between the phenotypes of the parental varieties.

**Inversion**: An aberration in chromosome structure resulting from an error in meiosis or from mutagens; specifically, reattachment of a chromosomal fragment to the chromosome from which the fragment originated, but in a reverse orientation.

**Karyotype**: a method of organizing the chromosomes of a cell in relation to number, size, and type.

**Linked genes**: genes that are located on the same chromosome.

**Locus**: a particular place along the length of a certain chromosome where a given gene is located.

**Meiosis I**: the first division of a two stage process of cell division in sexually reproducing organisms that results in cells with half the chromosome number of the original cell.

**Meiosis II**: the second division of a two stage process of cell division in sexually reproducing organisms that results in cells with half the chromosome number of the original cell.

**Meiosis**: a two stage type of cell division in sexually reproducing organisms that results in cells with half the chromosome number of the original cell.

**Metaphase plate**: an imaginary plane during metaphase in which the centromeres of all the duplicated chromosomes are located midway between the two poles.

**Mitosis**: a process of nuclear division in eukaryotic cells conventionally divided into five stages: Prophase, Prometaphase, Metaphase, Anaphase, Telophase. Mitosis conserves chromosomes numbers by equally allocating replicated chromosomes to each of the daughter nuclei.

**Monohybrid cross**: cross focusing on just one trait which means that a single pair of alternative alleles is being studied.

**Oogenesis**: the production of female sex cells (ova).

**Pedigree**: a family tree describing the occurrence of heritable characters in parents and offspring across as many generations as possible.

**Phenotype**: the visible expression of the genetic makeup of an organism.

**Pleiotropy**: The ability of a single gene to have multiple effects.

**Polygenic inheritance**: an additive effect of two or more gene loci on a single phenotypic character.

**Polyploidy**: a chromosomal alteration in which the organism possesses more than two complete chromosome sets.
**Punnett square**: a diagram used in the study of inheritance to show the results of random fertilization.

**Polytene chromosome**: chromosomes composed of some thousands identical copies of a DNA strand at their core.

**Recessive allele**: this allele is masked by the dominant allele and is only expresses when both homologous chromosomes possess this allele (homozygous).

**Reciprocal cross**: the opposite of the original cross in which the male possesses the traits that in the original cross female had and vice versa.

**Recombination**: the general term for the production of offspring with new combinations of traits inherited from the two parents.

**Sex-linked gene**: a gene located on a sex chromosome (X or Y).

**Spermatogenesis**: the production of male sex cells (sperm).

**Spindle fibers**: microtubules with attach to centromeres of the chromosomes and cause movement of the chromosomes.

**Somatic cell**: any cell in a multicellular organism except a sperm or egg cell.

**Tetrad**: a paired set of homologous chromosomes, each composed of two sister chromatids. Tetrads form during Prophase I of Meiosis.

**Translocation**: (1) an aberration in chromosome structure resulting from an error in meiosis or from mutagens; specifically, attachment of a chromosomal fragment to a nonhomologous chromosome. (2) During protein synthesis, the third stage in the elongation cycle when the RNA carrying the growing polypeptide moves from the A site to the P site on the ribosome.

**Trisomic**: a chromosomal condition in which a particular cell has an extra copy of one chromosome, instead of the normal two; the cell is said to be trisomic for that chromosome.

**True breeding**: both parents are homozygous for one or more traits.
<table>
<thead>
<tr>
<th></th>
<th>MITOSIS</th>
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<tbody>
<tr>
<td>Number of DNA replications</td>
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<td>Crossing over?</td>
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<tr>
<td>Number of daughter cells</td>
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<td>Chromosome count in parent cell</td>
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<td>2N (diploid)</td>
</tr>
<tr>
<td>Chromosome count in daughter</td>
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<td>N (haploid)</td>
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<td>Functions</td>
<td>Development, growth, tissue repair</td>
<td>Produces haploid gametes for sexual reproduction, conserves chromosome numbers, introduces genetic variability</td>
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</table>
Genetic variability: Independent assortment of chromosome during meiosis, crossing over during meiosis, and random fertilization.

**MENDEL’S LAWS**

**LAW OF SEGREGATION**

Mendel's first law, stating that allele pairs separate during gamete formation, and then randomly re-form as pairs during the fusion of gametes at fertilization.

**LAW OF INDEPENDENT ASSORTMENT**

Mendel's second law, stating that each allele pair segregates independently during gamete formation; applies when genes for two characteristics are located on different pairs of homologous chromosomes.