Unit 5: Mendelian Genetics
Content Outline: Meiosis (5.4)

I. Human Life Cycle is *Diploid Majority* (Please help students understand this very important difference and purposes.)
   A. **Somatic** ("soma" means "body") cells make up *most of our body*.
      1. These cells possess *46 chromosomes* inside them. (They are **2n – diploid**.)
      2. **Karyotypes** will display all 46. (A **karyotype** is basically pictures of the chromosomes.) ("kary" refers to "nucleus") (Good place to review very quickly prokaryote (before nucleus) and Eukaryote (true nucleus).
      3. **Homologous "same" Chromosomes** can be seen. (These are called **Autosomes**) 44 = 22 *pairs* exist in all human cells. If female, the two sex are the same too… two X chromosomes. (Remind students that 22 autosomes come from each parent.)
      4. **Heterologous "different" Chromosomes** *may* be seen in males. These may be the 2 sex chromosomes. In males, there is one X and one Y chromosome. (Please point out the difference using a karyotype.)
         a. Female (XX); Male (XY)
   B. **Germ** ("germ" means "beginning") cells (A.K.A. **gametes**)
      1. These are the *sex cells* (They are **n – haploid**.) (**egg**-come from females; **sperm**- comes from males)
      2. **Fertilization**, which is the *fusion* of egg and sperm together, *must* occur to be able to reproduce.
         a. This fusion between egg and sperm produces a single **diploid** cell called a **zygote**.
         b. The **zygote** goes on, through *repeated mitosis*, to produce the *new organism*.

II. **Meiosis** - means "The process of *Gamete Formation*"
   A. This process *occurs in the sex organs of the organism*. These organs are called **Gonads.**
   B. This process has 1 DNA replication followed by **2 cell DIVISIONS** therefore the result is 4 haploid cells.
      1. Remember that the S phase *doubles the amount* of DNA. In humans, when all 46 chromosomes are *replicated*, therefore the parent cell has 2x (96 chromosomes) the DNA of a non-dividing cell.
      2. **Meiosis I** (This division is the separation of chromosome *pairs***.**) This takes the cell *back* to diploid (a full set of chromosomes (e.g. 46 in humans).
      3. **Meiosis II** (This division is the separation of **sister chromatids.**) In humans, 46 → 23 chromosomes.
      4. A good visual is to start with 46 then draw a downward arrow under the 46 and label the arrow "S phase" under the arrow put 96. Then under the 96 draw two outward pointing arrows. Label them Mieosis I at each arrow end put 46. For each new 46, draw two outward pointing arrows. Label them Meiosis II. Put 23 at the end of the arrows. This allows students to visualize the numbers of chromosome in each phase.
   C. In this process, *Males produce **4** haploid sperm*; each having 23 chromosomes.
   D. In this process, *Females produce **1** haploid egg* with 23 chromosomes. The other three cells degrade. (Please remind students that if one of the cells from Meiosis I were to degrade; that would affect the "future" two cells it would have made.)
   E. Stages to the process of Meiosis
      1. These stages are *very similar* to the stages of Mitosis.
      2. *Three major differences*, from Mitosis, are present to increase variation. (Remember, Mitosis is normal cell division. It basically makes clones of the adult. *No variation* exists.)
         a. **Crossover** "genetic swapping" occurs in Prophase I. (*Creates variation*.)
         b. Chromosome *pairs* independently sort as they line up in Metaphase I (*Creates variation.) Good place to use the hand visual on Independent Assortment again.*
         c. **Sister Chromatids** separate in Anaphase II. (*Creates Variation*.)

III. **Crossover** "genetic swapping" between *homologous* chromosomes.
   A. This occurs to *create variation from the parent's genome*. (They are then called **Recombinant Chromosomes**.)
   B. **Synapsis** – Chromosomes are in a *state of being intertwined together*. ("syn" means "together"; "sis" means "process of")
   C. **Tetrad** - Four chromosomes twisted together ("tetra" means "four"… Like the game Tetris has four different shapes.)
   D. **Chiasmata** – Where the chromosomes *physically overlap* making an "x". ("Chi" is the Greek letter for "X".)

IV. *Major differences* between Mitosis and Meiosis: (Please make sure students understand these very important concepts.)
   A. The number of divisions (Mitosis has 1; Meiosis has 2)
   B. The final products of each process (Mitosis – "cloned" (identical) daughter cells; Meiosis – variable haploid gametes)
   C. Crossover, in Prophase I, creates variation (No crossover in Mitosis)
   D. Chromosome pairs vs. sister chromatids separating in the second division to REDUCE to haploid.

V. Evolution?

A. The genetic variation within individuals, produced during meiosis (both prophase – crossing over, and metaphase – segregation and independent assortment), along with random fertilization (the recombination of two haploid genomes) between individuals emerges as genotypic and phenotypic variety within a population. Natural selections seizes upon this variety, and drives the adaptation of a population over time. (Basically as organisms become more complex, like going from Prokaryotic to Eukaryotic, the process involved in them became more complex. Each type of reproduction is 1) Replication of the DNA in the S phase. 2) Replication of the cellular cytoplasmic components in the S and G2 phase. 3) Cytokinesis. When Eukaryotes evolved, a fourth step had to evolve to help solve the complexity of the DNA being encased in a nucleus… Mitosis which means "division of the nucleus". In this situation with Meiosis, we now discussing mainly diploid organisms which have two sets of chromosomes. To keep that level, evolution promoted the need to divide "cytokinesis" a second time to get the number to half. Each parents half will be different and so random fertilization creates even more diversity.)