Meiosis Notes AP Biology Mrs. Laux

I. Meiosis
-4 daughter cells per 1 parent cell
-each has one-half the number of the chromosomes
-one from every homologous pair
    -same length, centromere position
    -genes that encode for the same trait are located at the same place on each chromosome
    -2 genes together determine the appearance of a certain trait
    -locus (loci)→specific location of a gene along the length of a chromosome
    A. Somatic cells (body cells)-mitosis
        1. diploid number of chromosomes
            -in humans-46
            -22 pairs of autosomes-all of the chromosomes that encode for an organism
    B. Sex cells
        1. haploid (monoploid) number of chromosomes
            -in humans-23
            -one pair
        2. X and Y-determine sex of the individual
            -not the same size/shape-exception to homologues rule)
    C. occurs in the gonads (sex organs)
        -gametes are produced
        -humans→sperm and egg
        -each daughter cell has half the number of chromosomes-one homologue
        -only cells of the body not produced by mitosis
    D. Fertilization (Syngamy)
        -haploid gametes fuse together to produce (restored) diploid zygote
        -get genetic variation in individuals-very important

II. Process of Meiosis I (reduction division)-Stages

A. Prophase I

-lasts longer and is more complex than in mitosis

-nucleolus disappears

-chromatin condenses→chromosomes

-once chromosomes are condensed, the homologous ones come together through process of synapsis to form tetrads (4 chromatids) or bivalents

-just an association, not bonded as in attraction of centromeres

-during the association of the tetrad, parts of non-sister chromatids cross each other and exchange genetic material

-sometimes sister chromatids exchange material too, but more rare

-the actual crossed X-shaped portion of the chromatids is called chiasma (chiasmata, pl.)

-chiasmata are the sites that are involved in the crossing over of genes

-during chiasmata, crossing over occurs

-a tetrad that contains chiasmata and crossing over is called a synaptonemal complex

-once again, microtubules connect to the kinetochores of the chromatids

-but here, the kinetochore microtubules attach to each pair of homologous chromosomes and not to 2 chromatids of the chromosome

-nonkinetochore microtubules still span across the cell overlapping in the center

-neither synapsis nor chiasmata occur during mitosis

B. Metaphase I

-homologous pairs of chromosomes line up along the metaphase plate

-kinetochore microtubules are attached to only one sister chromatid of each homologue

-nonkinetochore microtubules are once again spread across the cell in an overlapping fashion

C. Anaphase I

-kinetochore microtubules begin to shorten pulling apart the tetrads

-one chromosome from each homologous pair is taken to each pole

-sister chromatids are not separated

-in each daughter cell, now as a result of the first meiotic division, there will be only one chromosome from each homologous pair

-that chromosome consists of 2 sister chromatids

-has been reduced to n number of chromosomes

D. Telophase I

-chromosomes have reached poles

-a temporary “nuclear membrane” develops

-in some species, cytokinesis occurs in cells; in others, it is delayed until after Meiosis II (2^{nd} division)

-in some cases, a short interphase may begin at this point

-no further replication of chromosomes

-Meiosis II begins in both daughter nuclei

II. Process of Meiosis II (basically the same as mitosis-except no replication prior)

A. Prophase II

-nuclear envelope disappears

-spindle develops

-no chiasmata and no crossing over

-chromosomes progress towards metaphase plate

B. Metaphase II

-chromosomes align along metaphase plate-singly, not doubly

-kinetochore microtubules, at this time, are attached to the kinetochore of each sister chromatid in each chromosome

C. Anaphase II

-sister chromatids are pulled apart by shortening of kinetochore microtubules

-chromatids, now chromosomes, migrate to each pole

-still n number of chromosomes

D. Telophase II

-nuclear envelope reappears and cytokinesis occurs

-each daughter cell only has ½ number of chromosomes

III. Results of Meiosis

2n→n   diploid → haploid

→n

→n

→n

-each daughter cell (4) has only one chromosome from each homologue pair (n)

-2 divisions, but only one replication of chromosomes

IV. Sexual Life Cycles

-cells of many multicellular organisms alternate between mitosis and meiosis

-meiosis→ reproduction→ production of gametes→ fertilization→zygote→another individual→mitosis→growth, development from zygote, and repair and replacement

Ex: Humans

-all somatic cells→46 chromosomes

-gametes→ 23 chromosomes

Put diagram of humans below:

Some plant cells/some algae/fungi
-meiosis produces spores
-haploid
-spores do not undergo fertilization
-instead, they undergo mitosis (growth) and become a multicellular haploid structure, a gametophyte.
-spore structure in moss, mold, and ferns (little balls)
-gametes are produced in the gametophyte-produce egg and sperm

-Gametes fuse→diploid cell
-grows to produce a sporophyte
-specialized cells undergo meiosis to produce haploid spores
-repeat the life cycle

Put diagram of plants, algae, fungi below:

V. Genetic Variation
-result of meiosis (important)
-allows for variation within a species, which in turn, allows for evolution of the species
-occurs via genetic recombination in cell
-rearrangement of genetic information that is passed down from parents→daughter cells

1. caused by independent assortment of chromosomes

-during Anaphase I, tetrads separate and homologues travel to opposite poles

-which chromosome travels to which pole depends on the orientation of tetrad at the metaphase plate

-which chromosome is on which side

-this is random

Put drawing below

-just with independent assortment, the number of combinations possible when meiosis packages chromosomes into gametes is 2^n , n=haploid number

-therefore, if n=2, number of possible combinations is 4. If n=3, then 8.

-for humans, n=23, then 8 million

-8 million possible assortments of chromosomes available for each gamete

2. Crossing Over

-occurs during formation of chiasmata

-crossed portion of non-sister chromatids (sometimes sister)

-during crossing over, homologous portions of 2 non-sister chromatids trade places

-therefore, homologue in daughter cell no longer entirely represents the DNA of parent

-in humans, average of 2 crossover events occur per chromosome pair

3. Random joining (fusion) of gametes

-fertilization is random

-which sperm fertilizes which egg, and therefore, which genetic information will be combined

-if egg is one of 8 million possible chromosome combinations and sperm is 8 million, then (8 million)(8million)=64 trillion diploid combinations

Three mechanisms shuffle around genes carried by individuals of the population

-genetic variation and mutations in genetic information are important in natural selection