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**Week 6: Genetics**

**Part 1: The Cell Cycle, Mitosis and Meiosis:**

**1A: McGraw Hill Connect’s virtual labs “Human Genetics: Chromosomal Inheritance During Meiosis”**

**1B: Textbook Chapter 19: Patterns of Chromosome Inheritance and Questions**

**1C McGraw Hill Connect lab “ Genetic Inheritance”**

**Part 2: Lab 16 Patterns of Genetic Inheritance pdf (a separate attachment and a separate assignment on Blackboard)—please note that this worksheet is due in 2 weeks after we have fully covered the topic in lecture. This section relates to Chapter 21 Genetic Inheritance in your textbook.**

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**1A**. **McGraw Hill Connect labs Cell Division: mitosis”, “Cell Division: Meiosis” , “Human Genetics—Chromosomal Inheritance”**

1. Use this space to take notes on any vocabulary or concepts related to “ chromosomal inheritance during mitosis.”

* Homologous Chromosomes: A pair of matching autosomes with similar genes
* Sister chromatids: Replicated chromosomes composed of two identical attached copies
* Autosomes: 22 pairs of chromosomes in humans that are identical for both sexes
* Diploid: State of a cell with two copies of homologous chromosomes. Humans have 23 pairs of chromosomes
* Haploid: State of a cell with one copy of each chromosome. Human gametes have one copy of 23 chromosomes
* Interkinesis: Brief pause between meiosis I and meiosis II in which no DNA replication occurs
* Nondisjunction during meiosis I: Failure of homologous chromosomes to separate during anaphase I
* Nondisjunction during meiosis II: Failure of sister chromatids to separate during anaphase II
* Meiosis is the type of cell division required for gametogenesis.
* Gametogenesis in males is called spermatogenesis and produces sperm.
* Gametogenesis in females is called oogenesis and produces ova.
* In humans, meiosis produces cells called gametes that contain half the amount of genetic material as the parent cell. In the process of meiosis, several mechanisms shuffle the genetic material, thereby increasing genetic diversity.

2. Use this space to take notes on any vocabulary or concepts related to”cell division: meiosis”

* Meiosis: A cell division process in certain eukaryotic cells that partitions the genetic material into four genetically-different daughter nuclei, each with half the number of chromosomes as the parent cell
* Mitosis: A cell division process in eukaryotes that divides the genetic material into two identical daughter nuclei
* Centromere: Constriction where sister chromatids of a duplicated chromosome are held together
* Cytokinesis: Division of the cytoplasm into daughter cells
* Germ-line cells: Specialized cells that undergo meiosis to give rise to gametes
* Gametes: Haploid cells produced by meiosis that unite during fertilization as part of sexual reproduction; gametes contain half the number of chromosomes as body cells and are often called eggs and sperm
* Zygote: Diploid cell formed by the union of two gametes during fertilization
* Ovary: Paired gonad organ in females containing germ-line cells that give rise by meiosis to eggs
* Oocyte: Cell in an ovary that will undergo meiosis to form an ovum
* Follicle: An oocyte and its surrounding tissue sac
* Testis: Paired gonad organ in males containing germ-line cells that give rise by meiosis to sperm
* Spermatocyte: Cell in a testis that will undergo meiosis to form a sperm cell
* However, some cells in multicellular eukaryotes, often called germ-line cells, undergo meiosis, a specialized process of cell division that produces four genetically-different daughter nuclei with half the number of chromosomes as the parent cell.
* After the chromosomes are divided, the cytoplasm is partitioned to form daughter cells in a process called cytokinesis.
* Meiosis includes two divisions of the genetic material: meiosis I and meiosis II. The genetic material is replicated only once, before meiosis I, but chromosome segregation and cytokinesis occur twice.
* The result is that one nucleus divides to produce four daughter nuclei with half the number of chromosomes.
* Two processes occur during meiosis that generate genetic variability: crossing over, in which homologous chromosomes exchange genetic material; and independent assortment, in which chromosome pairs randomly align along the metaphase plate and assort independently into daughter nuclei.
* Meiosis I can be divided into four phases:
  + Prophase I: spindle fibers form, homologous chromosomes pair up, crossing over occurs in which homologous chromosomes may exchange segments, nuclear envelope breaks down
  + Metaphase I: homologous chromosome pairs align along equator of cell; the alignment of homologs toward each pole of the cell is random
  + Anaphase I: homologous chromosomes separate and move to opposite poles of the cell
  + Telophase I: nuclear envelopes form around two daughter nuclei, spindle disappears
* Meiosis II can be divided into four phases:
  + Prophase II: spindle fibers form, nuclear envelopes break down
  + Metaphase II: chromosomes align singly along equator of cell
  + Anaphase II: sister chromatids separate and move to opposite poles of the cell
  + Telophase II: nuclear envelopes form around four daughter nuclei, spindle disappears

3. Use this space to take notes on any vocabulary or concepts related to “human genetics—chromosomal inheritance.” (Will be doing notes on the Mitosis lab as there is already a section for chromosomal inheritance)

* Spindle: A set of microtubule proteins that coordinate the movement and division of chromosomes during mitosis
* Cells must divide to grow, reproduce, or replace themselves. As part of cell division, the replicated genetic material is divided and equally partitioned into daughter cells.
* In eukaryotes, the genetic material consists of multiple chromosomes contained in the nucleus of the cell. Eukaryotic cell division thus consists of a sequence of steps to properly divide the multiple chromosomes into daughter cells.
* The division of a eukaryotic cell’s genetic material into two identical daughter nuclei is called mitosis.
* A cell stage called interphase precedes mitosis. During interphase, each chromosome replicates to become two identical sister chromatids attached at a region called the centromere. Cell growth and protein synthesis also occur during interphase in preparation for cell division.
* Mitosis can be divided into four phases:
* Prophase: chromosomes condense, spindle fibers form, nuclear envelope breaks down
* Metaphase: chromosomes align along equator of cell
* Anaphase: sister chromatids separate and move to opposite poles of the cell
* Telophase: nuclear envelopes re-form, chromosomes decondense
* After the chromosomes are divided, the cytoplasm is partitioned to form two daughter cells in a process called cytokinesis.
* The phases of mitosis
* In animals, plants, and other multicellular eukaryotes, most of the body cells divide using mitosis.
* In eukaryotes, mitosis functions to produce more cells for growth, to replace damaged cells, and to repair tissues. Mitosis also plays a role in producing identical daughter cells during asexual reproduction in some organisms.

4. From the module on human genetics, what is nondisjunction? What is its molecular cause(s)?

The failure of sister chromatids separating properly during cell division.

6. Do you have any questions about the concepts in these modules? Please use Google to help you find the answer.

**1B. Textbook Chapter 19: Patterns of Chromosome Inheritance**

i. The Cell Cycle

1. What events happen at each stage of the human cell cycle?

G1\_\_: Growth

S\_\_\_: Growth and DNA replication

G2\_\_: Growth and final preparations for division

M\_\_\_: Mitosis, which is prophase, metaphase, anaphase, telophase and cytokinesis.

2. What is the purpose of mitosis?

To make more diploid cells.

3. Given a single parent cell, how many cells will result from one cycle of mitosis?

2, a single cell can split into two cells.

4. What structure of mitosis is the cagelike structure that is responsible for chromosomal movement in cell division?

The spindle apparatus and motor proteins cause the movement of chromosomes.

5. What structure of mitosis is the constriction point by which sister chromatids of a chromosome are attached?

The centromeres.

6. What structure that is found in animal cells only, is made up of microtubule minis, and is found at the location of the spindle poles and is involved in organization of the spindle fibers?

The centrosome.

7. Using two different colored pens to indicate parental chromosomes, illustrate the phases of mitosis, simplifying so that only 2 sets of homologous chromosomes (1 big, 1 little, are represented); include descriptions of what is happening/label the images.:



Early Prophase Prophase Early Metaphase

(cell structures begin to break down) (centrioles begin to separate) (centrosomes line up)



Metaphase Anaphase Telophase

(chromosomes center on equator of cell) (centrosomes pull apart chromosomes) (two new daughter cells are created)

ii. Meiosis

8. In the body, where do we find haploid cells? \_\_\_Egg or sperm cells\_\_\_\_

Where do we find diploid cells? \_\_\_\_All other non-sex cells\_\_\_\_

9. Fill in what happens in meiosis I, using red for maternal chromosome and blue for paternal chromosomes. Write a brief description of the event near the drawings.





iii. Gametogenesis:

1. Where does gametogenesis occur in males?

In the male testes at puberty.

2. For one single primary spermatocyte, how many sperm are produced, and what process generates this?

4 sperms are produced by spermatogenesis.

3. What is the progression of maturing cells from the diploid primary spermatocyte to the haploid sperm?

Diploid spermatogonia -> gametes -> primary spermatocyte -> 2 haploid spermatocytes

4. Where does oogenesis happen in females?

In the ovaries.

5. For one single primary oocyte, how many egg are produced, and what process generates this?

1 egg is produced through meiosis.

6. What is the progression of maturing cells from the diploid primary oocyte to the haploid egg?

Primary oocyte -> secondary oocyte -> ovum

7. What are polar bodies and how are they produced?

A small haploid cell that is formed at the same time as an egg cell during oogenesis.

**1c. This section relates to the McGraw Hill Connect lab “Genetic Inheritance”. There is an accompanying worksheet with more practice examples that are tailored towards studying deeper in the areas that lecture and lab overlap.**

1. Use this space to take notes on things you learned on the module on genetic inheritance.

Alleles: Variations of genes inherited in pairs from two parents

* Dominant: A dominant allele exerts its phenotypic effect in a heterozygote and is written as a capital letter
* Recessive: A recessive allele only exerts its phenotype when not in the presences of the dominant allele and is written as a lowercase letter
* Phenotype: Phenotype is a characteristic of an organism that can be observed and measured
* Genotype: Genotype is the genetic makeup of an organism
* Homozygous: An organism with two identical alleles for a gene
* Heterozygous: An organism with two different alleles for a gene
* Genetic traits are inherited in specific, predictable patterns. Through observation of phenotype in offspring, you can determine the parental genotypes.
* Autosomal traits come from genes on one of the non-sex-linked chromosomes and follow dominant and recessive patterns of inheritance.
* X-linked traits are genes found on the sex chromosomes: the X and Y chromosome.
* Females have two X chromosomes.
* Males only have one X chromosome and a single Y chromosome.
* X-linked traits can be concealed as recessive in females but not in males because males have only one X chromosome.

2. Do you have any questions about the concepts in this lab??

**Please see the handout on “lab 16 Patterns of Genetic Inheritance.” Begin working on this worksheet. It will be due in 2 weeks (week 8). It is a separate assignment submission.**