PROPERTY OF:

BIOLOGY – UNIT 4 – CHAPTERS 10 & 11 NOTES

CHROMOSOMES

Human Chromosomes

- Humans have 46 chromosomes
- 23 pairs of "homologous" chromosomes
- (one of each type from your mom and one of each type from your dad)
  - 22 pairs of autosomes (regular chromosomes)
  - 1 pair of sex chromosomes (X and X = girl, X and Y = boy)
- each chromosome consists of 2 identical sister chromatids held together by a centromere

The Cell Cycle

- 4 stages of the cell cycle: G_1, S, G_2, and M
- $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$
  1. G_1 = Growth #1 (period of intense growth and cell activity)
  2. S = Synthesis (period of DNA replication)
  3. G_2 = Growth #2 (2^{nd} period of intense growth and cell activity)
  4. M = Mitosis (period of nuclear division and cell division)
- Cancer is a disease in which the cell cycle occurs too quickly and the cell divides uncontrollably.
- Nerve and brain cells typically do not go through the entire cell cycle. After G_1, they permanantly go to G_0, and do not go through the rest of the cell cycle. As a result, they do not divide and reproduce.

Mitosis

- GOAL: to produce an identical copy of a cell
  LOCATION: all cells (except sperm and egg cells)
- 6 stages of mitosis: I-P-M-A-T-C
  - I = interphase
  - P = prophase
  - M = metaphase
  - A = anaphase
  - T = telophase
  - C = cytokinesis

Stages of Mitosis

1. INTERPHASE =
   - The cell grows in size (gets bigger).
   - The cell does its normal functions.
   - The cell replicates (copies) its DNA by doing DNA replication.
   - This is the same as the G_1, S, and G_2 phases combined.
2. PROPHASE =
   - The chromatin turns into chromosomes.
   - The nuclear envelope dissolves (disappears).
   - The centrioles produce strings called spindle fibers.
3. METAPHASE =
   - Spindle fibers attach to the middle of each chromosome (called the centromere).
   - Chromosomes line up in the middle of the cell.
4. ANAPHASE =
   - Spindle fibers separate sister chromatids and pull them toward opposite ends of the cell.
   - The cell stretches and gets wider as the chromosomes are pulled.
5. TELOPHASE =
   - The chromosomes turn back into chromatin.
   - 2 nuclear envelopes form (1 on each side).
   - Spindle fibers are broken down by enzymes. (They are no longer needed.)
6. CYTOKINESIS IN ANIMALS =
   - The cell membrane is soft and flexible. It pinches inward at the middle of the cell.
   - 2 identical cells are formed, each with the same number of chromosomes.

   CYTOKINESIS IN PLANTS =
   - The cell wall is hard and rigid. It is unable to pinch inward at the middle of the cell.
   - Cellulose-containing vesicles (from the smooth ER and Golgi apparatus) line up at the center of the cell. They fuse together to form the cell wall. The vesicles themselves become the cell membrane on the inside of the cell wall, facing the cytoplasm.

Chromosomal Mutations

- A chromosomal mutation is any change in the structure of a chromosome.
  EX: Use the chromosome: AB~CDEF (the ~ represents the centromere)
  1. duplication mutation = part of a chromosome is duplicated (doubled)
     EX: AB~CDEF becomes ABB~CDEF (the B was duplicated)
  2. deletion mutation = part of a chromosome is deleted (erased)
     EX: AB~CDEF becomes A~CDEF (the B was deleted)
  3. inversion mutation = part of a chromosome is flipped
     EX: AB~CDEF becomes AE~DCBF (the BCDE sequence was flipped)
  4. translocation mutation = parts of 2 different chromosomes are exchanged
     EX: AB~CDEF and GHI~JKL becomes AB~CKL and DEF~GHIJ (DEFG and KL were switched)

Meiosis

- GOAL: to produce gamete cells that have half the number of chromosomes
  LOCATION: sperm and egg cells
- diploid = a cell with 2 copies of each chromosome [2n=46]
- haploid = a cell with only 1 copy of each chromosome [n=23]
- n = the number of different chromosomes
- All cells, with the exception of sperm and egg cells, are diploid.
- Sperm and egg cells are haploid. When they fuse together (at conception), they become a diploid cell (which will grow into a baby).
- Meiosis is divided into 2 phases: Meiosis 1 and Meiosis 2.
- GOAL of Meiosis 1: to separate the homologous chromosomes
- GOAL of Meiosis 2: to separate the sister chromatids
- Both phases of meiosis follow the 6 steps of mitosis (I-P-M-A-T-C)
- "Crossing Over" = an exchange or shuffling of genes on homologous chromosomes during prophase 1 or metaphase 1. This increases genetic diversity by making new combinations of genes.
- As a result of meiosis, males produce 4 haploid sperm cells.
  (The testes produce millions of sperm every single day.)
- As a result of meiosis, females produce 4 haploid egg cells.
  (Actually, 3 of them die and 1 larger one survives. One or two get released by the ovary every month as part of the menstrual cycle.)

Fertilization

- Fertilization is when the sperm and egg cell are united into 1 cell.
- During fertilization, the sperm and egg join together using a lock and key fit.
- 23 chromosomes in the sperm + 23 chromosomes in the egg = 46 chromosomes
- haploid sperm cell + haploid egg cell → diploid zygote
- zygote = the fertilized egg formed at conception (will grow into a baby)
- Chemical reactions that require a lock and key fit ensure that only sperm and egg from the same species can join together.

Chromosomal Abnormalities

- Nondisjunction =
  - the failure of chromosomes to separate during meiosis
  - creates sperm or egg cells with 22 or 24 chromosomes (both are disastrous)
- monosomy = having only 1 copy of a certain chromosome (instead of 2)
- trisomy = having 3 copies of a certain chromosome (instead of 2)
- Down Syndrome =
  - a disorder caused by "trisomy 21" (having an extra chromosome #21)
  - a mild form of mental retardation
- Turner Syndrome =
  - a disorder caused by monosomy X (XO = having 1 X chromsome, but no Y)
  - produces females who are sterile (can't have any babies)
- Klinefelter Syndrome =
  - a disorder caused by XXY sex chromosomes (a male with an extra X chromosome)
  - produces males who are sterile
- XYY Syndrome =
  - a disorder caused by XYY sex chromosomes (a male with an extra Y chromosome)
  - produces males who are basically normal, but may have extra aggression
- Babies that are born as XO and XXY prove 2 things…
  1. This proves that all people need an X chromosome to survive.
     (There is no such thing as a YO baby!)
  2. The Y chromosome determines the gender of the baby.
     Mothers can only give an X chromosome because they are XX.
     Fathers are XY, so they can give either an X or a Y.
     If he gives an X, the baby is a girl. If he gives a Y, the baby is a boy.

Testing for Chromosomal Abnormalities

- Amniocentesis =
  - the removal of fluid from the amniotic sac that surrounds the fetus during pregnancy
  - the fluid contains dead cells from the embryo that can be extracted to make a karyotype
- Karyotype =
  - a display or "map" of an organism's chromosomes
  - used to detect chromosomal abnormalities caused by nondisjunction