CHAPTER 9 BIOLOGY – *The Cellular Basis of Inheritance*

- All cells come from other cells.
- Why do cells divide?
    - To repair tissues (replace lost or damaged cells)
    - To grow (1 celled zygote eventually becomes adult after MANY cellular divisions!)
    - To reproduce (make an entirely new organism)
        - **Asexual reproduction =** when an organism reproduces itself by using simple cell division only.
            - A single cell duplicates its genetic material and splits into two new, genetically identical cells.
            - The offspring inherit all their genetic material from **ONE parent; the offspring are IDENTICAL** to the parent.
        - **Sexual reproduction = when two organisms combine** their genetic material to produce offspring that **differ** from either parent.
            - Involves the union of sex cells (sperm + egg)

- Gene = a piece of DNA that codes for a certain trait (hair color, for example)
- Almost all genes in a eukaryotic cell are found in the nucleus.
- **Chromatin** = the form DNA takes when NO cellular division is occurring; chromatin is basically a disorganized clump of DNA.
- **Chromosome =** the organized form of DNA; chromatin organizes itself into distinct packets (chromosomes) immediately before cell division (to ensure that each offspring cell gets the same genetic information).
- **Chromosome number differs with species.**
    - **Humans have 46 total chromosomes in their SOMATIC (regular body) cells.** (Somatic cells make up most of the body. Examples include muscle cells, skin cells, etc. The other type of cell is the sex cell, also known as the sperm or the egg.)
    - **Chromatid =** another word for chromosome:
        - Before cell division, each chromosome makes a copy of itself. After that copying takes place, each chromosome then contains two chromatids ("sister chromatids") joined at a point of attachment called the **centromere**.
        - It is the chromatids that separate during mitosis and meiosis.
        - **A chromatid is an exact copy of the original chromosome.**
        - *A common mistake amongst students is that they think that chromatids always exist; chromatids ONLY exist when a chromosome replicates itself prior to cell division.*

- **THE CELL CYCLE:**
    - **Interphase**
        - Up to 90% of a cell's cycle is spent in interphase.
        - During interphase, a cell carries out its normal functions.

        - 3 parts to interphase:
            - G1: Organelles grow
            - S: DNA synthesis; duplication of the DNA in the chromosomes in preparation for division
            - G2: cell prepares to divide
    - **Mitotic phase = stage where cell divides**
        - **Part 1 of mitosis:** nucleus and duplicated chromosomes divide and two "daughter nuclei" are now found in the original cell.
        - **Part 2 of mitosis is called cytokinesis:** the cytoplasm is now divided in two, forming two distinct cells, each with one of the "daughter nuclei".

- **More on mitosis:**
    - **Mitosis:** division of the cell nucleus in which chromosomes in the parent cells divide **and form two identical cells**.
    - *Chromosome number is not changed during mitosis. A human cell with 46 chromosomes that undergoes mitosis will produce 2 cells that EACH have 46 chromosomes.*
    - Mitosis produces **diploid cells;** a diploid cell is one that contains all the chromosomes it is supposed to have. (versus a **haploid** cell, which contains half the number of chromosomes found in a diploid cell)
    - Four main steps of mitosis:
        - **Prophase =** the nuclear envelope disappears.
        - **Metaphase =** sister chromatids line up across the Middle of the cell
        - **Anaphase** = sister chromatids separate
        - **Telophase (and cytokinesis) =** nuclear membranes reappear around each group of sister chromatids; cytoplasm divides into two, forming two daughter cells, each with its own nucleus.

- **What is meiosis?**

    - **Meiosis:** division of cell nucleus that reduces the number of chromosomes in the new nuclei by half.
        - Meiosis produces **haploid** egg and sperm cells.
        - (A **diploid** cell is one that contains all chromosomes.)

- **What are homologous chromosomes?**
    - As cells prepare to divide (whether it's mitosis or meiosis), DNA organizes itself into chromosomes. In the nucleus of a diploid cell, chromosomes exist in pairs. **The two members of a pair are called homologous chromosomes.**

    - The members of most homologous pairs of chromosomes look alike. They are the same length and they carry genes for the same inherited characteristics, lined up on the chromosome in the same order on each

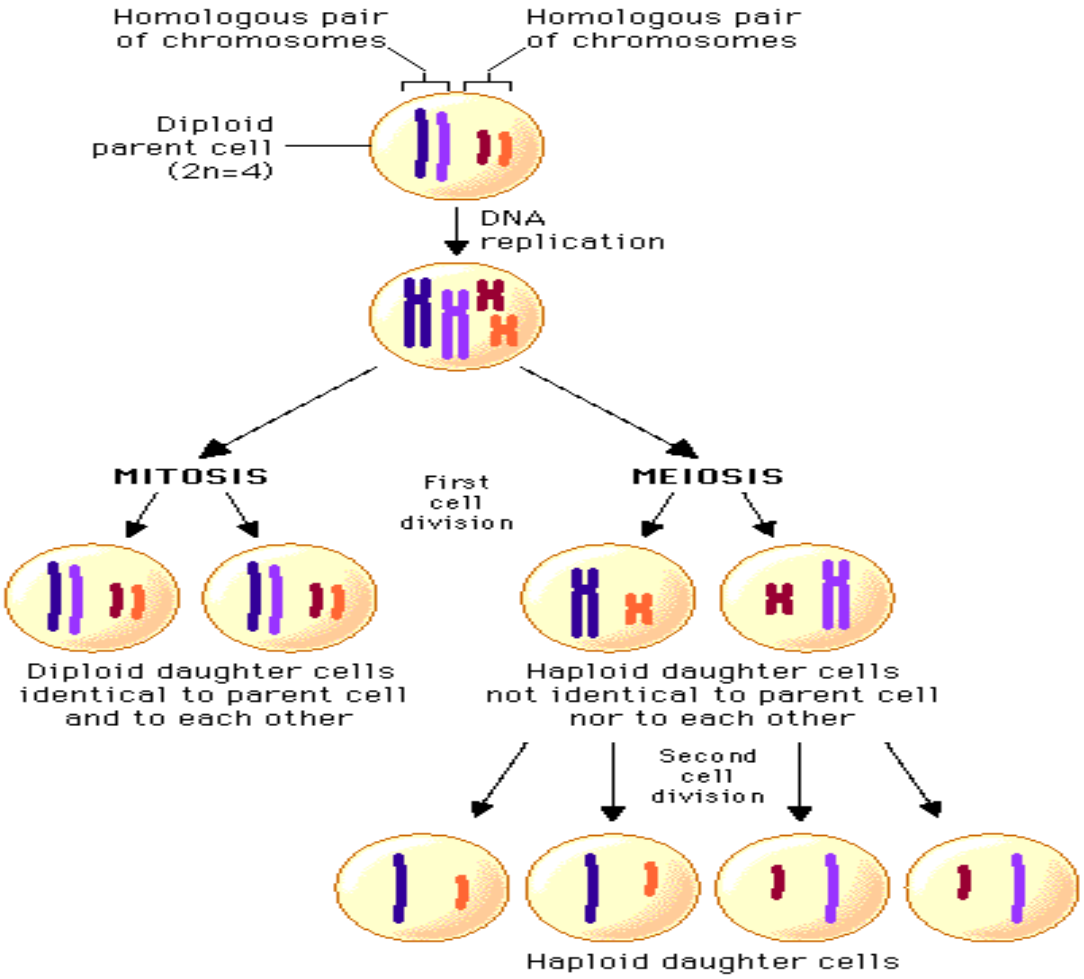
pair. ***However, the corresponding genes on the two homologous chromosomes are not necessarily identical.***

- For instance, one member of a chromosome pair may contain a gene for the protein that makes a person have brown eyes, while the other member of that pair may have a gene coding for a different version of this protein (blue eyes). Different versions of the same gene are referred to as alleles. You'll learn more about this later!

- Humans have 23 homologous pairs of chromosomes in their regular (somatic) cells, making the TOTAL diploid number of chromosomes 46.

  - How are men's and women's 23 pairs different?
  - We inherit one member of each chromosome pair from each parent. So the 46 chromosomes in our somatic cells are actually two sets of 23 chromosomes—a maternal set (from our mother) and a paternal set (from our father.)
  - Our sex cells are haploid, containing only 23 TOTAL chromosomes (only contain one member of a pair of homologous chromosomes.)

- **Back to meiosis:**
  - **In meiosis, cellular division occurs twice**:
    - In the first division, the homologous pairs separate.
    - In the second division, chromatids separate.
    - At the end of the two divisions, FOUR HAPLOID CELLS ARE PRODUCED. *(see diagram below for comparison of mitosis and meiosis – see also p. 200, fig. 9-20 for another diagram)*
    - **The four haploid cells produced in meiosis are different from their parent cell**:
      - For starters, the four offspring cells are haploid, while the parent cell was diploid.
      - Next, the genetic content of the offspring cells is not the same as the parent cell: **crossing over occurs during the first meiotic division and allows for genetic variation.**


Homologous pair of chromosomes
Homologous pair of chromosomes
Diploid parent cell (2n=4)
DNA replication
MITOSIS
First cell division
MEIOSIS
Diploid daughter cells identical to parent cell and to each other
Haploid daughter cells not identical to parent cell nor to each other
Second cell division
Haploid daughter cells