

Chapter 11

Cellular Reproduction

I. The Role of Cellular Reproduction in the lives of individual cells and entire organisms.

- A. According to Cell Theory, all new cells must arise from other cells. This means that all cells must multiply.
- B. Prokaryotic cells divide by enlarging, replicating their chromosome and dividing in two (**binary fission**)
 1. Prokaryotic cells have to physically separate the chromosomes that they have, this is done through attaching them to separate **attachment points** on the inner surface of the plasma membrane.
 2. As the cell expands, it adds material to the plasma membrane and cell wall *between* the attachment points, leading to more physical separation in the cell.
 3. At the point where the cell is large enough to split, the plasma membrane and cell walls grow inward and close the cells away from each other.
- C. The Eukaryotic cell cycle consists of various stages.
 1. **Interphase** – the main life of the cell during which it grows and differentiates, subdivided into three (3) distinct phases.
 - a. **G₁** – The main phase of cell growth and differentiate (chromosome numbers: 46 total, 23 pairs in humans).
 - b. **S** – Synthesis of new DNA (chromosome numbers: 92 total, 46 pairs in humans)
 - c. **G₂** – Cell Growth in prep for division (chromosome numbers: 92 total, 46 pairs in humans)
 - d. Some cells will be pushed out of the replication cycle during G₁ phase of Interphase and enter into **G₀** which is a nondividing offshoot.
 2. After Interphase there are two (2) types of cellular reproduction
 - a. **Mitotic Cellular Reproduction** – asexual reproduction, used to create two (2) daughter cells that are identical to the original cell. All eukaryotic cells are capable of this.
 - b. **Meiotic Cellular Reproduction** – specialized division of sex cells, resulting in the formation of four (4) daughter cells with one-half the total genetic information required for an organism.

II. DNA Organization into Chromosomes

- A. Prokaryotic cells have chromosome structure in that they usually consist of a single circular chromosome.
- B. Eukaryotic cells have their genome divided among multiple linear chromosomes with associated structure.

1. The chromosome is structured as a linear string of DNA wrapped around a number of proteins (the most prevalent being **histones**) to compact the DNA
 2. When visualized the chromosomes have a visibly constricted area, typically near the center, referred to as a **centromere**.
 3. The ends of the chromosome are specialized structures referred to as **telomeres**.
- C. Sexual Eukaryotes are matched pairs, in humans there are 23 pairs of chromosomes, making a total of 46 chromosomes. Creatures with paired chromosomes are referred to as **diploid**
- D. During mitotic division the chromosomes replicate into 46 duplicate **chromatids** that are joined to their partners at the centromeres.
- E. An entire set of chromosomes can be stained and visualized as a **karyotype**, allowing for analysis of gross chromosomal defects.

III. Mitotic Cellular Reproduction

- A. **Mitotic Cellular Reproduction** is composed of two distinct parts
1. **Mitosis** – the duplication and separation of chromosomes
 2. **Cytokinesis** – the separation of cellular material.
- B. Mitosis has four classic phases.
1. **Prophase**
 - a. Early Prophase – occurs after G₂ phase of Interphase and is determined by the condensation of the chromosomes and microtubule formation between centriole pairs.
 - b. Late Prophase – identified by the breakdown of the nuclear envelope and the microtubules attaching to the centromeres of the duplicated chromatids.
 2. **Metaphase** – sister chromatids align on the equator of the cell between the centriole pairs.
 3. **Anaphase** – sister chromatids separate and migrate towards the opposite poles of the cell
 4. **Telophase** – the sets of chromosomes reach opposite poles and the nuclear envelope reforms, microtubules start to disappear.
- C. Cytokinesis – The division of the cellular components and the physical separation of the cells into daughter cells.

IV. Meiotic Cellular Reproduction and Sex

- A. Mutations are the ultimate source of all genetic variation.
- B. Mutations to a gene produce different forms of the gene, termed **alleles**.
- C. Sexual reproduction combines differing allele from parents in a single offspring.
- D. **Meiotic cellular reproduction** divides the mother cells into four haploid cells.
- E. Meiotic cellular reproduction is divided into two divisions

1. **Meiosis I** – produces two cells that contain paired chromatids but only one set of each of the homologous pairs.
 2. **Meiosis II** – produces four cells that each has a single chromosome from each of the paired chromosome, and only one of each homologous pair.
- F. During Meiosis I **genetic recombination** (the swapping of homologous regions) occurs between homologous pairs, allowing for variation in the genetic code.

V. How Sexual Reproduction leads to genetic variation.

- A. Since the chromosomes are randomly segregated between the haploid cells it produces random combinations of chromosomes in the sex cells.
- B. The crossover recombination of alleles produce further variation in sex cells.
- C. The fusion of unique sex cells form new variations.