

## Unit 1: Cell Structure and Function

### Content Outline: The Cell Cycle (1.5) – Part 1

- I. Reproduction by cells
  - A. The main purpose is for *propagation (maintaining) of the lineage*.
  - B. This is a part of the **Cell cycle**. (A Cell Life History basically.)
    1. Cell Division, by a **parent cell**, results in 2 *genetically identical daughter cells (offspring cells)*.
      - a. The daughter cells are *genetically identical* to each other and the *previous* parent cell.
    2. *Maturation* occurs after division. (The cells are growing and being able to perform its adult functions.)
  - C. This is also necessary for normal growth (Such as in size of organs) and repair (of existing structures).
  - D. The process requires that DNA Reproduction take place.
    1. DNA could be thought of as the “Million Dollar Blue Prints” for making items required by cells.
    2. **Genome** – This is the *entire genetic material (DNA)* for an organism or cell.
      - a. The genomes “Blue Prints” *vary from species to species*.
      - b. In humans, the genome length is about 2 m or 7 ft. per cell.
      - c. DNA has two different *appearances (states)* within a cell and it depends on what is happening within the cell.
        - i. **Chromatin** – this is the *loose state* of DNA. It is like looking at a bowl of spaghetti noodles (without the sauce). The DNA “noodles” can be moved around to *find* the gene segment of interest for Protein Synthesis.
        - ii. **Chromosomes** – this is the *tightly coiled state* of DNA. It looks like a cork screw shaped pasta noodle. These are for *dividing equally* and easily. (Have you ever tried to divide a bowl of spaghetti noodles 100% equally?)
- II. **Somatic cells** – “soma” means body (These are your *normal body cells*.)
  - A. These are the cells that make up the majority of an organism.
  - B. Their chromosomal content is **2n or diploid**. (They get half “n” from the “mother”; half “n” from the “father”)
    1. Half (in terms of chromosomal content) is referred to as “**haploid or n**”
  - C. For humans this is 46 chromosomes = 2n .(n= 23 in the egg; n=23 in the sperm)
- III. **Histones**
  - A. These are the *proteins* that help DNA *coil up “condense”* to form the chromosomes needed for division.
- IV. **Sister Chromatids** (“Tid” means “portion”; Portion of the whole “duplicated” chromosome)
  - A. This term refers to half of a duplicated chromosome.
  - B. The two halves are held together at the **centromere** (means “center unit”), which is a *group of proteins*.
- V. **Mitosis** – This process refers to *ordinary cell division*. (Parent cell and daughter cells are exactly alike genetically.)
  - A. Involves only one division after replication occurs in the S phase.

## The Cell Cycle – Part 2

### I. The Cell Cycle Phases are:

#### A. Interphase

1. Cells spend 90% of their existence in this phase.
2. This phase consists of three parts:
  - a. **G1** (Primary or “first” growth)
    - i. This is *ordinary, everyday growth, activity, or repair* of the cell.
    - ii. First checkpoint (called “point of no return”) is the *barrier* to the rest of the cycle.
  - b. **S** (synthesis)
    - i. The *DNA replicates* or is *synthesized* during this phase.
    - ii. In humans, we go from 46 Chromosomes “2n” to 92 chromosomes “4n”.
  - c. **G2** (Secondary or “second” growth)
    - i. The cell and organelles mainly enlarge or replicate.
    - ii. Second checkpoint occurs after this “part”. (Do we have everything for two cells? If yes, then proceed to dividing; if no, then make what is missing.)

#### B. Mitosis - means “nucleus division” (First divide the DNA; then secondly the cytoplasm.)

1. This process has four parts:
  - a. **Prophase** (“pro” means “first”)
    - i. Nuclear envelope is *broken down and rearranged* to make the spindle apparatus.
    - ii. The *chromatin condenses* to form “X” shaped chromosomes. (**two** chromatids)
    - iii. *Centrioles move toward the poles.* (In animal cells only...plants use the cell wall.)
  - b. **Metaphase** (“meta” means “middle”)
    - i. The replicated chromosomes *line up on the metaphase plate* (Middle of cell).
    - ii. The *spindle apparatus attaches to the kinetochore* (a part of the centromere) and centrioles (the anchors).
    - iii. Third checkpoint occurs here. (Are all the chromosomes attached and lined up and ready to “divide/separate” or “segregate”?)
  - c. **Anaphase** (“ana” means “separate”)
    - i. Replicated chromosomes are *pulled apart* into sister chromatids and each chromatid moves toward opposite poles (ends) of the cell.
    - ii. The spindle apparatus is being broken down as the two sister chromatids are “walked” toward the poles by the *motor protein* using ATP.
  - d. **Telophase** (“telo” means “last”)
    - i. The nuclear envelope is *rebuilt* by using broken down spindle apparatus pieces.
    - ii. The chromatids begin to *decondense* back to their chromatin state.
    - iii. A **cleavage furrow (indent)** begins to form using *actin and myosin microfilaments*.

#### C. Cytokinesis (Cleavage means “split”) (This is the division of the cytoplasm.)

1. The *cytoplasm and cell organelles are separated* to produce two **daughter cells**.

#### D. G0 (Zero growth phase)

1. The cells are tired and take a brief *break and rest*.

### II. Spindle Apparatus

- A. These structures are formed from the broken down cytoskeleton and nuclear envelope. (*recycled*)
- B. The construction starts at the **centrosome** (where the centrioles are) and *works toward* the chromosomes.
- C. They attach to the replicated chromosomes.
- D. *Motor Protein* “walks” the sister chromatids toward the opposite poles (ends) *using ATP by phosphorylation*.
- E. Non-kinetochore spindles are used to “*push*” the poles *farther apart* to help produce the cleavage furrow.

### III. Cell Plate

- A. Remember plant cells do not have centrioles because they have cell walls to anchor to.
- B. The *new* cell wall “Plate” develops, using small segments of cellulose, instead of a cleavage furrow.

### IV. Binary Fission

- A. This is the process of Reproduction/Replication in prokaryotes (bacteria).
- B. DNA replication(S phase) starts at the “origin” and works around the entire single circular chromosome, this results in two identical chromosomes in the nucleoid region.
- C. This is followed by producing a cleavage furrow (cytokinesis) to produce 2 new cells that are referred to as clones. The cleavage furrow is produced using actin and myosin microfilaments.

- D. How is Binary Fission related to mitosis in terms of evolution? Binary Fission would have evolved into Mitosis as the DNA content increased dramatically and also the endosymbiant hypothesis occurred to produce “organelles”. The two major steps are the same: synthesis and division.

### Control of the Cell Cycle – Part 3

- I. *Regulation “control” of the Cell Cycle.*
  - A. Regulation is crucial for *normal* growth and development.
  - B. Regulation *varies for each different type of cell.*
  - C. The regulation is controlled by molecules called **Cyclins**. (They control the cell *cycle*.)
  - D. Three *checkpoints* exist: (Checkpoints are “stopping points to make sure everything is correct before going on to the next phase.)
    1. First – It is at the end of G1. (Called the Restriction point.) “point of no return”
    2. Second – It is at the End of G2. (Do we have 2 sets of DNA and 2 sets of organelles?)
    3. Third – It is at the End of Metaphase. (Are all the replicated chromosomes in the middle of the cell and are they ALL attached to the spindle fibers?)
- II. G0 (Resting State) Cell Division is a huge E consuming process, so rest is required for the cell.
- III. Cancer (*Abnormal* cell growth)
  - A. *No checkpoints exist* within cancerous cells, so there is no density-dependent inhibition.
  - B. Normal cells divide between 1 and 100X –It depends on the cell type.
  - C. Cancer starts with *transformation of the DNA (mutation)* in a cell.
  - D. **Tumor** – means “Abnormal growth”
  - E. Two main types of cancer are:
    1. **Benign** (It is *encapsulated* – like a tennis ball.) (This kind is *Non-invasive*.)
      - a. Usually not deadly – easy to *cure by removal* of the tumor.
    2. **Malignant** (means “the crab”) (It is *Invasive*. It grows between cells destroying the tissue.)
      - a. It *can* be deadly.
      - b. Normally *treated* with chemotherapy, radiation, or surgery.