1. **Name three functions of cell division.**

   **Reproduction**
   
   For many single-celled microbes, cell division is their primary means of reproduction. Prokaryotic cell division is called binary fission. Multi-cellular eukaryotes create sex cells (eggs and sperm) through a unique kind of cell division called meiosis. Mitosis is used by all kinds of plants, animals, fungi, and multi-cellular protists to reproduce asexually: grafting, cuttings, vegetative propagation, budding, fragmentation, and parthenogenesis.

   **Growth and Development**
   
   Since cell size is limited by the dictates of diffusion, cells grow, not by an increase in cell size but by an increase in cell numbers. At conception, a human begins as a single cell (a zygote) about the size of a period at the end of a sentence and after thousands of cell divisions we become an interacting collection of 60 trillion cells.

   **Renewal and Repair**
   
   Your body is in a constant state of flux. Most of the cells that make up you now are different from the cells that you will be next year. Cells wear out. Some cells, like epithelia, are there to be sacrificed daily to protect us. A lot of body tissues and organs are replaced throughout your life. Your red blood cells are replaced every 120 days, much less for many white blood cells. Intestinal cells are replaced every few days. Every week you get new taste buds, a new stomach lining, and lose and gain 5% of your bone mass. A typical skin cell lasts about a month before it sloughs off. Your body is in a constant state or renewal. Imagine you own a jacket that not only keeps you warm and protected but can also repair any rips and tears that may befall it. Our bodies are like that. When we cut ourselves, platelets send a chemical message to our skin, blood vessels, and connective tissue to increase cell division to repair the wound.

2. **Describe the process of binary fission in prokaryotic cells.**

   Cell division in bacteria and archeans is called binary fission (mitochondria and chloroplasts do it too). Binary fission literally means “dividing in half”. A simpler process than mitosis, binary fission begins when the DNA of the bacterial chromosome begins to replicate at a specific place on the chromosome called the origin of replication, producing two origins. During replication, one origin moves to the opposite pole of the cell. The cell elongates as replication
continues. When replication is finished and the cell is about twice its original size, the plasma membrane grows inward and divides the cell into two. The new daughter cells are genetically identical to each other and to their parent cell.

3. **Compare and contrast chromatin and chromosome.**
Chromatin and chromosomes are both composed of DNA and histone proteins. Chromosomes are only visible in dividing cells and are simply supercoiled chromatin.
4. Define mitosis and cytokinesis.
Mitosis is the division of the nucleus. Cytokinesis is the division of the cytoplasm.

5. Describe the cell cycle.
The cell cycle comprises all the preparations before cell division plus mitosis and cytokinesis. Interphase is the preparation stage and makes up 90% of the cell cycle. Interphase is divided into three sub-phases: G₁, S, and G₂. The “S” phase is the period of time when DNA is replicated. G₁ stands for Gap 1: the period of time from the end of cytokinesis to the start of DNA replication. Organelles duplicate in G₁. Gap 2 (G₂) spans the time between DNA replication and the start of mitosis. G₂ includes all the final metabolic preparations for mitosis and cytokinesis.

6. Describe the division of cells in the G₀ phase.
Cells that have ceased dividing are said to be in the G₀ phase. Muscle cells and neurons are in the G₀ phase because once formed, they don’t divide again. Some cells in G₀ can reenter the cell cycle under certain conditions. For example, children under 12 can re-grow their spleens if they are damaged.
7. **Diagram the stages of mitosis. List the events of each stage.**

**Prophase** is the first stage of mitosis. The big events of prophase include the:
- fragmentation of the nuclear envelope
- appearance of the chromosomes
- disappearance of the nucleoli
- formation of the spindle fibers

During prophase, the spindle fibers attach to both sides of the centromere of each chromosome. The spindle fibers don’t attach directly to the centromere but connect to a piece of protein embedded on the surface of the centromere called a kinetochore. The spindle fibers pull and push the chromosomes toward the equator of the cell.
**Metaphase** follows prophase. Metaphase begins when the chromosomes arrive at the equator (a.k.a. the metaphase plate).

**Anaphase** follows metaphase. Anaphase starts with the shortening of the spindle fibers that split the centromeres and drag the chromatids to the opposite poles of the cell.
**Telophase** is the final stage of mitosis but not the end of cell division. Essentially the reverse of prophase, during telophase we see the disappearance of the chromosomes, the reappearance of the nucleoli, the reformation of the nuclear envelope, and the dismantling of the spindle fibers.

8. Describe and compare the process of cytokinesis in animal and plant cells.
   
   Cytokinesis often begins before mitosis ends. In animal cells, actin filaments just deep to the cell membrane at the equator, contract forming a groove, we call the cleavage furrow. The cleavage furrow continues to deepen until the cell pinches in two forming two daughter cells.

   Plant cells have a cell wall, preventing the formation of a cleavage furrow. Instead, a cell plate forms at the equator. The cell plate is built by the fusing of vesicles containing new cell wall material at the middle of the cell. These vesicles arise from each poles’ respective Golgi apparatus.
Figure 2  Onion root tip cells in interphase. Photographed from microscope slide 97-8093.

Figure 3  Onion root tip cell in prophase (center), From microscope slide 97-8093.

Figure 4  Onion root tip cell in metaphase (center). From microscope slide 97-8093.

Figure 5  Onion root tip cell in anaphase. From microscope slide 97-8093.

Figure 6  Onion root tip cell in late anaphase (center). From microscope slide 97-8093.

Figure 7  Onion root tip cell in telophase. From microscope slide 97-8093.

Figure 8  Onion root tip in telophase. The nuclear membranes are re-forming. From microscope slide 97-8093.

Figure 9  Onion root tip cell in telophase. The nuclei have reappeared. From microscope slide 97-8093.

Figure 10 Recently divided onion root tip cells. Cytokinesis is complete and the nuclei have reentered interphase. From microscope slide 97-8093.