The Cell Cycle and Mitosis

**THE CELL CYCLE**

The cell cycle, or cell-division cycle, is the series of events that take place in a eukaryotic cell between its formation and the moment it replicates itself. These events can be divided into two main parts: interphase (in between divisions phase grouping G1 phase, S phase, G2 phase), during which the cell is forming and carries on with its normal metabolic functions; the mitotic phase (M mitosis), during which the cell is replicating itself. Thus, the cell cycle is an essential process by which a single fertilized egg develops into an embryo and eventually (accompanied by cell specialization) into a mature organism. It is also the process by which hair, skin, blood cells, and some internal organs replenish themselves.

1. Name the 2 main PHASES of the cell cycle. ___________________________

2. __________________________ is in between the times when a cell is dividing.

3. What is occurring in a cell during interphase?

4. What is occurring during the mitosis phase?

5. Give two reasons why the cell cycle is important.

**Colour this diagram according to the instructions in the text that follows.**

The Cell Cycle

![Diagram of cell cycle phases](image)
Interphase is a phase of the cell cycle, defined only by the absence of cell division. During interphase, the cell obtains nutrients, and duplicates (copies) its chromatids (genetic material). The genetic material or chromatids are located in the nucleus of the cell and are made of the molecule DNA.

6. What process NEVER occurs in interphase? ________________

7. Cells obtain ________________ and duplicate or copy their ________________ or genetic material during interphase.

8. Where are chromatids found in a cell? ________________

9. Chromatids are made of a molecule called ________________.

10. A chromosome consists of two sister ________________, which are connected by the ________________.

Most eukaryotic cells spend most of their time in interphase. For example, human skin cells, which divide about once a day, spend roughly 22 hours in interphase. About 90 percent of cells are in interphase. Some cells, such as nerve cells, can stay in interphase for decades. There are 3 parts of interphase: \( G_1 \) (growth 1, in which the cell creates organelles and begins metabolism), \( S \) phase (DNA synthesis in which the chromosomes of the cell are copied) and \( G_2 \) (growth 2, in which the cell grows in preparation for cell division). Find the cell cycle drawing on this worksheet and draw an additional line in red around those parts of the cell cycle diagram that are included in interphase.

11. In what PHASE do most cells spend the majority of their lifetime?

12. How often do human skin cells divide each day?

13. How many hours per day is a human skin cell in interphase?

14. What type of cell may spend decades in interphase instead of dividing?

15. Name the 3 stages in interphase.

16. What does \( G_1 \) stand for and what occurs in this stage?

17. What does \( S \) stand for and what occurs in this stage?
18. What does $G_2$ stand for and what occurs in this stage?

The $G_2$ phase is a period in the cell cycle during interphase, after cytokinesis (the process whereby a single cell is divided into two identical daughter cells whenever the cytoplasm is divided) and before the S phase. For many cells, this phase is the major period of cell growth during its lifespan. During this stage new organelles are being synthesized, so the cell requires both structural proteins and enzymes, resulting in a great amount of protein synthesis. Color the $G_1$ phase green on the cell cycle drawing.

19. What stage occurs after cytokinesis? ________________

20. What part of the cell is divided during cytokinesis? ________________

21. What are the new cells called and how do they compare with each other? ________________

22. What is happening in a cell during $G_1$? ________________

23. What cell structures are made in $G_1$? ________________

24. Since proteins and ____________ are being made during $G_1$, there is a great amount of protein ____________ occurring.

The S phase, short for synthesis phase, is a period in the cell cycle during interphase, between $G_1$ phase and the $G_2$ phase. Following $G_1$, the cell enters the S stage, when DNA synthesis or replication occurs. At the beginning of the S stage, each chromosome is composed of one coiled DNA double helix molecule, which is called a chromatid. At the end of this stage, each chromosome has two identical DNA double helix molecules, and therefore is composed of two sister chromatids. During S phase, the centrosome is also duplicated. Color the S phase orange.

25. What does the S in "S phase" stand for? ________________

26. What happens during the S phase? ________________

27. Each chromosome originally is made of how many DNA molecules and how does this molecule appear in the chromosome? ________________

28. At the end of S phase each chromosome has how many coiled DNA molecules? ________________

29. What structure holds the duplicated chromosomes together and is also copied during the S phase? ________________

$G_2$ phase is the third, final, and usually the shortest subphase during interphase within the cell cycle in which the cell undergoes a period of rapid growth to prepare for mitosis. It follows successful completion of DNA synthesis and chromosomal replication during the S phase, and occurs during a period of often four to five hours. Although chromosomes have been replicated they cannot yet be distinguished
individually because they are still in the form of loosely packed chromatin fibers. The G₂ phase continues growth of the cell and prepares the cell for mitosis (M phase) by producing all of the enzymes that the cell will need in order to divide. Color the G₂ phase light blue.

After the G₂ phase of interphase, the cell is ready to start dividing. The nucleus and nuclear material (chromosomes made of DNA) divide during the stage known as MITOSIS. Color the Mitosis stage purple.

30. What is the final and shortest phase of interphase? ________________
31. About how long would a typical cell be in the G₂ phase? ________________
32. How is the cell prepared for mitosis during the G₂ phase?

33. What follows the G2 phase? ___________________________
34. What part of the cell is actually dividing in mitosis? _______________

**MITOSIS (NUCLEAR DIVISION)**

Mitosis is the process in which a eukaryotic cell (cell containing a nucleus) separates its already duplicated chromosomes (copied during the S phase) into two sets of chromosomes so there will be two identical nuclei. It is generally followed by cytokinesis which divides the cytoplasm and cell membrane. Color the Cytokinesis stage yellow. This results in two identical cells (both have an identical set of chromosomes) with an equal distribution of organelles and other cellular components. The mitotic (M) phase and cytokinesis (C phase) together are called cell division, the division of the parent cell (original) into two daughter cells (new cells), each with the same genetic information (chromosomes) as the parent cell. Mitosis does NOT occur in prokaryotic cells that do NOT have a nucleus. In multicellular organisms, the somatic cells (body cells) undergo mitosis, while germ cells — cells destined to become sperm in males or ova (eggs) in females — divide by a related process called meiosis. Prokaryotic cells (bacteria), which lack a nucleus, divide by a process called binary fission.

35. When are chromosomes duplicated? ________________________________
36. What process follows mitosis? ________________________________

37. The nucleus is divided during ________________, while cytoplasm of the cell is divided during ________________.
38. How do the two new cells compare with each other?

39. The two new cells are called ________________ cells.

40. Does mitosis occur in prokaryotes? Explain why or why not.

41. What process is used by bacteria to divide and reproduce? ________________________________

42. Body cells are called ________________ cells, while reproductive cells are known as ________________ cells.
The process of mitosis (division of the nucleus) is divided into four stages (Prophase, Metaphase, Anaphase, and Telophase). Immediately following nuclear division (mitosis), the cell membrane must also divide (cytokinesis). Animal cells divide the cytoplasm by constricting the cell membrane in the middle to form a cleavage furrow. Plant cells form a cell plate in the center to divide the cytoplasm. At Interphase, there is only one cell, but after cytokinesis there are two identical cells.

43. Name the 4 mitotic stages. ____________________________________________________

44. How does cytokinesis occur in an animal cell?

45. How does cytokinesis occur in a plant cell?

During interphase, the genetic material is called chromatin and can NOT be clearly seen because it isn’t tightly coiled. When prophase begins, the DNA molecules are progressively shortened and condensed by coiling, to form visible chromosomes. Enzymes during prophase break down the nuclear membrane and nucleolus so they are no longer visible. Spindle fibers also form in prophase which will attach to the chromosomes. At metaphase, the spindle fibers attach themselves to the centromeres of the chromosomes and align the chromosomes at the equator (middle of the cell). Anaphase is the next stage. The spindle fibers shorten and the centromere splits separating the two sister chromatids. During telophase, the chromosomes pairs (chromatids are pulled to opposite poles of the cell. The nuclear envelope and nucleolus reform before the chromosomes uncoil. The spindle fibers disintegrate.

46. Genetic material is called ______________ during interphase and IS / IS NOT clearly visible.

47. What makes the chromosomes become visible during prophase? ______________________

48. What is used to help break down the nuclear membrane? ____________________________

49. Besides the nucleus, what else is broken down during prophase? ____________________

50. What forms during prophase to LATER attach and move chromosomes? _______________
51. Doubled chromosomes are held together by the ____________________________.
52. Where do chromosomes line up during metaphase? ________________________________
53. During what stage are sister chromatids separated and moved to opposite ends of the cell? _________________________________________________________________

54. Name 4 things that happen during telophase.
   a. _________________________________________________________________
   b. _________________________________________________________________
   c. _________________________________________________________________
   d. _________________________________________________________________
Classify each cell in the plant tissue below according to one of the following stages of mitosis:

- **Interphase**: ______________________
- **Prophase**: ______________________
- **Metaphase**: ______________________
- **Anaphase**: ______________________
- **Telophase**: ______________________

Plant Cells in Mitosis
For each of the labeled cells, name the stage of the cell cycle observed and give a reason for your decision:

<table>
<thead>
<tr>
<th>PHASE</th>
<th>REASON</th>
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Label the stages of the cell cycle & mitosis

Mitosis of an Animal Cell