

Mitosis

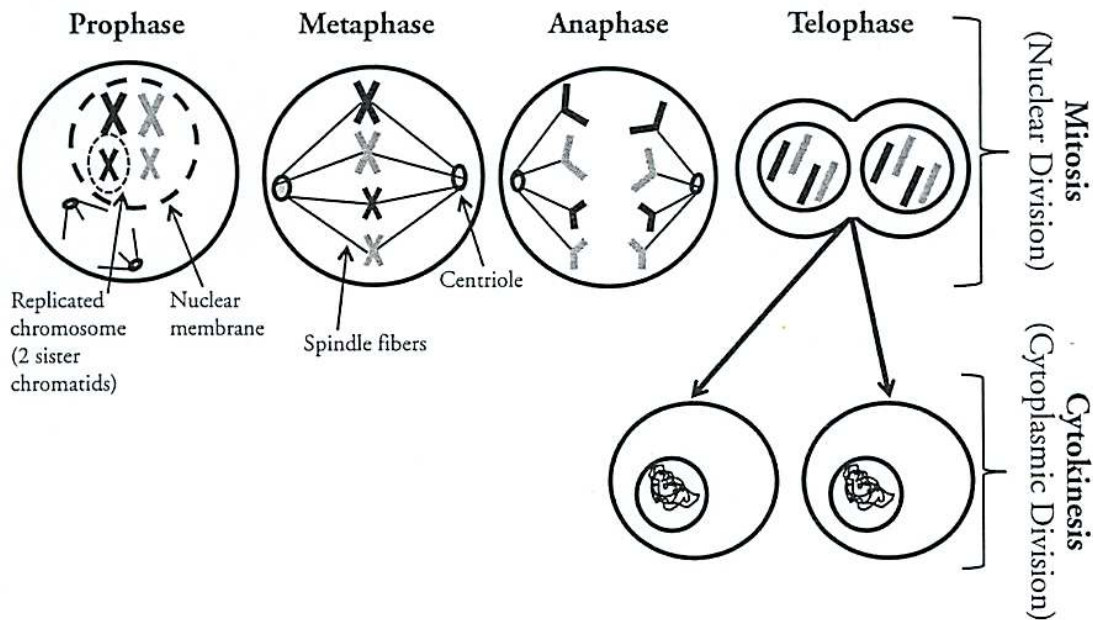
ANSWERS

How do living things grow and repair themselves?

Why?

Living things must grow and develop. At times they suffer injuries or damage, or cells simply wear out. New cells must be formed for the organism to survive. What process must occur to make a new, properly-functioning cell?

Model 1 – Mitosis as Part of the Cell Cycle



1. Refer to Model 1. List the four phases in the mitosis process.

Prophase, metaphase, anaphase, and telophase.

2. Where is mitosis in the cell cycle? Before G_1 , cytokinesis and after G_2 .

3. What three phases of the cell cycle are considered **interphase**?

G_1 , Synthesis, and G_2 .

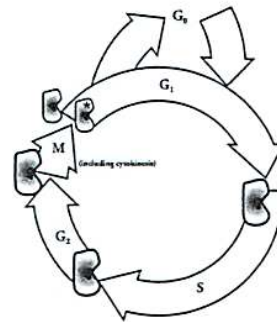
4. Refer to the cell cycle shown.

- a. How many cells are present at the beginning of mitosis?

One.

- b. How many cells are present at the end of mitosis?

Two.



5. Refer to the chromosomes in the cells in Model 1.

a. Draw a single chromosome as it appears in Model 1.



b. Draw a replicated chromosome as it appears in Model 1.



c. How many chromatids are in each replicated chromosome?

Two chromatids per replicated chromosome.

6. How many replicated chromosomes are in the original cell shown in Model 1 during prophase?

Hint: When counting chromosomes, count "1" for a pair of sister chromatids.

Four replicated chromosomes are in the original cell.

7. How many single chromosomes are in each of the new cells in telophase?

Four single chromosomes are in each of the new cells.

8. As a group, write a grammatically correct sentence that explains what a chromosome is and why it is important.

A chromosome is made of DNA wrapped around proteins and contains all the genetic information for the organism.

9. Refer to the cells in telophase in Model 1.

a. Use a complete sentence to describe what the new cells in telophase might contain if replication of chromosomes did not occur before cytokinesis.

The new cells might contain only half the original number of chromosomes, or one cell might contain more chromosomes than the other if replication did not occur before cytokinesis.

b. If the situation in part a occurred, would the new cells be viable? Explain.

The cells would not be viable because they would not have a complete set of DNA, which would affect cell processes necessary for survival.



10. The S phase stands for synthesis, which means to make or build something more complex out of simpler parts. Scientists know that during the S phase DNA is being made in the nucleus of the cell. Why do you think the cell needs to make more DNA at this time in the cell cycle?

The cell must copy the chromosome material so there is enough to make two new cells with the correct chromosome number.

11. Refer to Model 1. The chromosomes that are shaped like "X" (made of two sister chromatids) have double the amount of DNA than the chromosomes that are shaped like "I." During what phase of the cell cycle do you think the chromosomes are replicated (copied)?

Synthesis.

12. Refer to Model 1.

- a. In which phase of mitosis do you see the spindle fibers forming?

The spindle fibers start to form in [late] prophase.

- b. At what phase of mitosis do the replicated chromosomes (sister chromatids) separate?

Anaphase.

- c. In which phase do you see that the spindle fibers have disappeared?

The spindle fibers disappear during [late] telophase.

- d. Look at metaphase and anaphase. Suggest the purpose of the spindle fibers during mitosis.

The spindle fibers separate the replicated chromosomes and move each single chromosome to opposite sides of the cell.

13. Refer to Model 1.

- a. Describe what happens to the nuclear membrane after prophase.

The nuclear membrane is disintegrating.

- b. Explain why it is necessary that the nuclear membrane disintegrates during mitosis.

The nuclear membrane must be temporarily removed so the chromosomes can be divided into the two cells.

- c. At what point during mitosis has the nuclear membrane reformed?

The nuclear membrane reforms during telophase.

14. What is actually dividing during cytokinesis?

The cytoplasm of the cell and its non-nuclear contents are dividing in cytokinesis.

15. Cellular division has two parts—mitosis is the division of the nucleus and cytokinesis is the division of the cell into two new cells. Explain why mitosis has to come before cytokinesis in the cell cycle.

The contents of the nucleus must be duplicated and the chromosomes must be correctly divided up before the actual cell can divide into two new cells.

16. During cytokinesis the chromosomes unwind and become a pile of very long, thin, thread-like DNA and the cell goes back to looking “normal” until mitosis begins again. Brainstorm with your group ideas why the DNA must coil up into chromosome structures before it divides.

Students should understand the concept that it would be very difficult to accurately divide long, thin threads of DNA rather than smaller, more compacted chromosomes.

17. Fill in the table below where each of the phases of nuclear and cell division is listed in the left hand column and write a description of what is happening during that phase in the right hand column.

Phase of Cellular Division	Description of what is occurring in the cell during this phase.
<i>Prophase</i>	<i>Replicated chromosomes become visible (coil up). Each replicated chromosome is made of two identical chromatids. The spindle fibers start to form and the nuclear membrane starts to disintegrate.</i>
<i>Metaphase</i>	<i>Replicated chromosomes line up in the center of the cell. Spindle fibers attach to the replicated chromosomes at their centers.</i>
<i>Anaphase</i>	<i>Spindle fibers separate the replicated chromosomes (sister chromatid pairs) into single chromosomes and move them to the opposite sides of the cell.</i>
<i>Telophase</i>	<i>The single chromosomes are now in two "piles" that will become two new nuclei. A new nuclear membrane begins to form around each of the piles of separated chromosomes.</i>
<i>Cytokinesis</i>	<i>The original cell pinches in two and makes two new cells.</i>

18. In some cells, mitosis occurs without cytokinesis. What would the resulting cell look like?

If mitosis occurred without cytokinesis, the cell would be multinucleated.

19. Explain the importance of mitosis of cells in a skinned knee and during the growth of a plant.

In order for a skinned knee to heal, new cells must be formed. In order for a plant to grow, new cells must form. The process of new cells forming includes mitosis, where the chromosomes must be carefully divided into the new cells so they are identical to the original cell.



20. With your group, consider the effect on a cell if the sister chromatids did not line up correctly during metaphase. For example, if some lined up side by side instead of single file along the middle, how might this affect the resulting cells?

If the division of chromosomes is not accurate, cells could end up with too few or too many chromosomes. This could lead to the death of the cell or a mutation.



Extension Questions

21. Colchicine is a poison that acts to inhibit the development of spindle fibers. Describe the effects on mitosis in a cell that has been treated with colchicine.

When a cell is treated with colchicine, the spindle fibers would not be formed correctly. So the chromosomes would not be able to be divided correctly or be moved to the appropriate positions in the dividing cell.

22. Binary fission is cell division in prokaryotic organisms (bacteria), which have no nucleus. In addition, prokaryotic cells typically have only one circular chromosome. Together with your group, predict how binary fission in prokaryotic cells might be different than mitosis in eukaryotic organisms.

Binary fission is less complex than mitosis in eukaryotic organisms because there is no nucleus or multiple chromosomes. In binary fission the single chromosome is copied and the cell pinches into two cells, each with a single chromosome. This is a simpler operation than mitosis, where multiple, replicated chromosomes must be split carefully and moved into two equal "piles" that will become the nuclei of two new cells after cytokinesis is complete.