

Mitosis

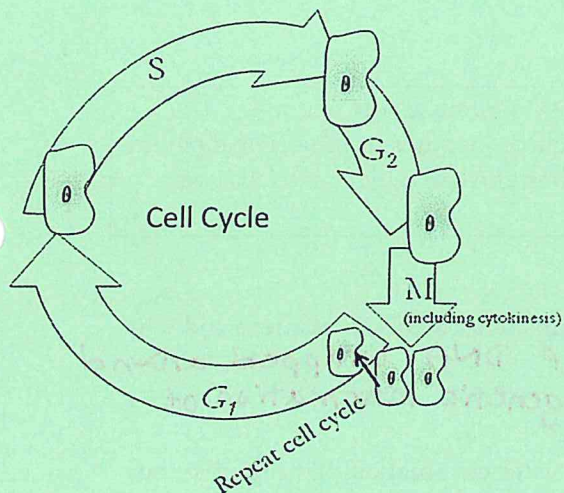
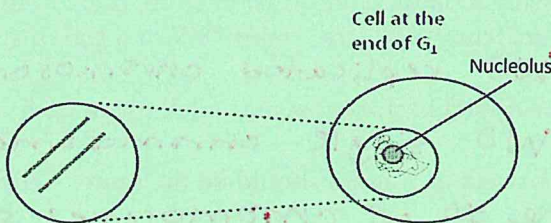
How do living things grow and repair themselves?

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 living thing to survive.

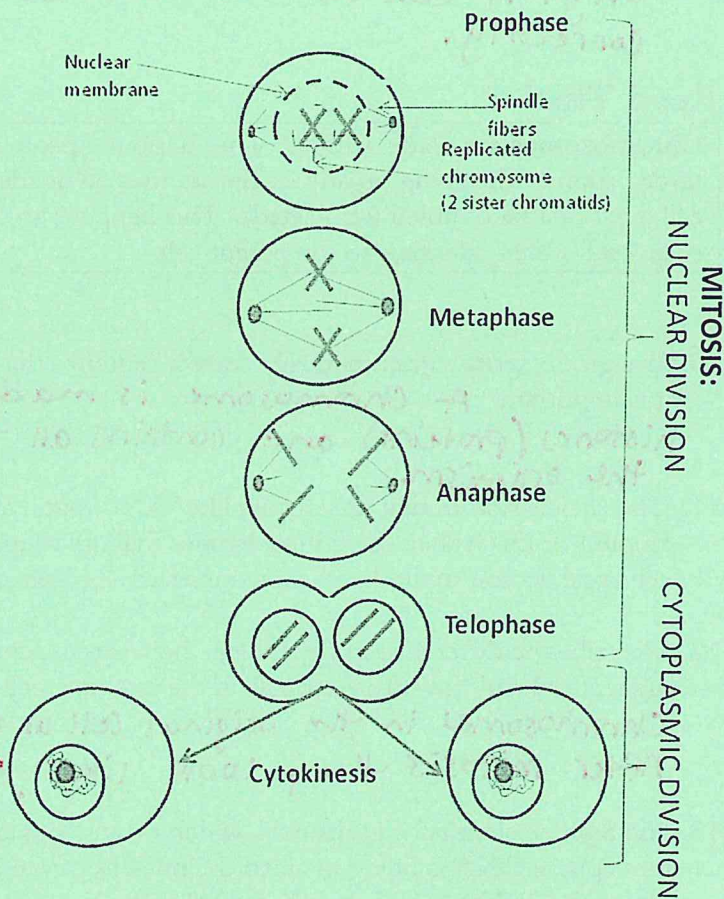
Model 1

If the chromatin were condensed two chromosomes would be visible



G₁ + S + G₂ = Interphase

M = nuclear & cytoplasmic division



1. List the phases in the mitosis process by looking at Model 1. There are four phases.

Prophase, metaphase, anaphase, telophase

2. Where is mitosis in the cell cycle? Before G₂ and after G₁

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

G₁, S, G₂

4. a) How many cells are present at the end of G₂? 1

b) How many cells are present at the end of M? 2

5. What shape do the replicated chromosomes look like in prophase of the original cell?

They look like X

6. How many chromatids are in each replicated chromosome?

2 chromatids per replicated chromosome

7. How many replicated chromosomes are there in the original cell during prophase? (Hint: When counting chromosomes, count "1" for a pair of sister chromatids)

TWO replicated chromosomes

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

TWO single chromosomes

9. Your answers to 7 and 8 should be the same. Why is this important?

The # of chromosomes should be the same in the original cell as the two daughter cells if it is copied correctly.

Read This!

Chromosomes are made of DNA wound around proteins. They contain all the genetic information of the living organism. Before the cell divides the chromosomes in the original parent cell must first be doubled (replicated). This happens so that when the cell divides into two new cells, both will be identical to the parent cell.

10. 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 histones (proteins) and contains all the genetic information of the organism.

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

12. Describe the difference in appearance between the chromosomes during prophase in the original cell and the chromosomes in the two new cells in telophase.

Chromosomes in the original cell are duplicated and look like X. After mitosis they look like I.

13. The S phase stands for synthesis, which means to make something. 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 that there is enough to make two new cells with the correct chromosome number.

14. At what stage of mitosis do the replicated chromosomes (sister chromatids) separate?

Anaphase

15. During what phase do you see the spindle fibers forming?
 (late) prophase
16. During what phase do you see that the spindle fibers have disappeared?
 telophase
17. Look at metaphase and anaphase. What do you think the function of the spindle fibers is during mitosis? To pull replicated chromosomes into each new cell

18. Describe happens to the nuclear membrane after prophase.
 The membrane disintegrates.

19. Why do you think it is necessary to disintegrate the nuclear membrane during mitosis?
 The chromosomes need to move across the cell so the nuclear membrane needs to be out of the way.
20. By the end of what phase of mitosis has the nuclear membrane reformed?
 The end of telophase
21. What structure reappears in the nucleus after cytokinesis?
 The nucleolus
22. What is actually dividing during cytokinesis?
 The cytoplasm (organelles & cytosol)

23. 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. If the cell divides before the nucleus the DNA would have no way to get into both cells. The nucleus must divide first in order to get the chromosomes in both cells.

24. During cytokinesis the chromosomes unwind and become a pile of very long, thin, threadlike DNA and the cell goes back to looking "normal" until mitosis begins. Brainstorm with your group ideas why the DNA must coil up into chromosome structures before it divides.
 The long thin DNA would be really difficult to separate (like spaghetti noodles or yarn) and is easier to separate when it's wound up tightly into chromosomes.

25. Make a table below where you list each of the phases of nuclear and cell division in the left hand column and a word description of what is happening during that phase in the right hand column.

Phase of Cellular Division	Word description of what is occurring in the cell during this phase.
P prophase	Replicated chromosomes become visible. Each replicated chromosome is made of two identical chromatids. Spindle fibers start to form and the nuclear membrane disintegrates.
M metaphase	Replicated chromosomes line up in the center of the cell. Spindle fibers are attached at the centromere of each chromosome.
A anaphase	Spindle fibers separate the replicated chromosomes (sister chromatid pairs) into single chromosomes and move them to opposite sides of the cell.
T telophase	The single chromosomes unwind into chromatin →

	and the nuclear membranes reform.
C cytokinesis	The original cell pinches in two and makes two 2 new cells.

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

The cell would have multiple nuclei (multinucleated)

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

In order for the skinned knee to heal, new cells must be formed. Plants also need new cells to grow. Forming new cells requires cellular division which, in eukaryotes, means dividing the nucleus which is mitosis.



28. 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?

Cells could end up with too few or too many chromosomes. This could lead to a harmful mutation or even the death of the cell.

Extension Questions

29. 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.

If the spindle fibers are not formed correctly, they will not function correctly. This could cause the chromosomes to be unevenly divided or other complications.

30. 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 simpler because there are no ^{multiple} chromosomes to separate. Only one loop of DNA needs to be copied then they move to both sides of the cell and cytokinesis occurs.