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AUTHOR	Henderson, Paula
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ABSTRACT

Cytology is the subject that is dealt with in this autoinstructional program. The process to be understood by secondary school students who are taking biology is mitosis. The material is presented to be adequate for achievers at the middle level. Knowledge of the structure of the DNA molecule and of the parts of the cell are considered as prerequisites for this lesson. Three behavioral objectives are suggested. Equipment and materials needed are itemized. Approximately 15 minutes is needed. A vocabulary sheet, a student script and a suggested method of evaluation are included in this packet. (EB)

MITOSIS

Prepared By

Paula Henderson
Science Teacher
NEWARK SCHOOL DISTRICT

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A-T TEACHER'S GUIDE

Packet Number - AT 574.87 H

Subject - Cytology

Title - Mitosis

Grade - 10 middle level

Prerequisites - Knowledge of the structure of the DNA molecule and the parts of the cell

Behavioral Objectives -

1. To be able to list the five basic stages of mitosis and explain each briefly.

2. To be able to list similarities and differences of plant and animal mitosis.

3. To be able to point out the stages when given a slide of *Allium* root tip and *Ascaris*.

Equipment and Material -

* Cassette tape
* Poster with objectives
* Thirteen slides
** Slide viewer
** Tape recorder
* Evaluation papers with stages of mitosis
** Vocabulary sheet

Time - Approximately 15 minutes

Sample Evaluation - Self-evaluation in which the student puts cards with various stages of mitosis in order

Space Required - Carrel with electrical outlet

Bibliography/Biology - Smallwood and Green. Silver Burdett, 1968.

VOCABULARY FOR MITOSIS

MITOSIS	the process of cell duplication and division
INTERPHASE	the first stage of mitosis during which the DNA strands duplicate
PROPHASE	the second stage of mitosis during which the chromosomes become visible while the nucleolus and nuclear membrane break down
METAPHASE	the third stage of mitosis during which the chromosomes line up along the equatorial plane of the cell and the spindle fibers are formed
ANAPHASE	the fourth stage of mitosis during which the spindle fibers pull one chromatid from each pair to opposite ends of the cell
TELOPHASE	the fifth stage of mitosis during which the nuclei form at the two ends of the cell while the center divides the parent cell into two daughter cells
CHROMATID	one of the identical strands formed after the duplication of DNA
CENTROMERE	joins the two identical chromatids together
CANCER	a condition characterized by a rapid and improper mitotic division
SPINDLE FIBERS	protein fibers formed during mitosis which pull apart the chromatid pairs
CENTRIOLE	the structure in an animal cell to which the spindle fibers attach
ASTER	the star-shaped structure observed during mitosis which is formed by the centriole surrounded by spindle fibers

MITOSIS

Hi! By now you know that living things are made of cells. But where do they come from? You began as a single fertilized egg cell and are now a composite of billions of cells. How is it possible that your cells increased so greatly in number and that they all know what to do? You are constantly replacing skin cells with skin cells and liver cells with liver cells. Since you have probably not reached the end of your growth yet, you not only are replacing but also increasing the number of certain cells.

It is very important that when a new cell is formed that it has all the parts and information that the other cells of its type have. Our cells take care of this through a process called mitosis. Mitosis is the process of making a new cell identical to the cell it originated from. Answer this question - What substance found in the cell do you think is of utmost important in mitosis? Hopefully your answer was DNA. Remember from what you have already studied that DNA gives the instructions to the cell. It acts as the blueprints for any activity in the cell. It is important then that when parent cells produce a new cell that the new cell gets the identical DNA. In order to do this the DNA ladder must duplicate itself. You should remember that this is done by the ladder unzipping and each half picking up the matching parts available in the nuclear material, thus forming two identical new DNA strands.

In the average cell mitosis takes about one half hour but the length of time varies from cell to cell. Brain cells for example do not undergo mitosis. If therefore for some reason certain brain cells are destroyed, more cannot be made.

Mitosis is actually one continuous process from start to finish. For the purpose of convenience of learning, however, scientists have broken this process down into five steps. The first step is the longest and goes back to what I said earlier about the DNA. It is often referred to as interphase of the preparation stage. Listen carefully and try to understand fully what is occurring in each of the following stages. You will get a vocabulary sheet to take with you so concentrate on the basic process rather than the words.

LOOK AT SLIDE ONE

To look at this cell you would think that nothing related to mitosis was going on. In fact most scientists thought this and therefore originally called this the resting stage. Something very important is going on though. If this stage is not carried through correctly

the whole process fails. The only structure drawn is the nucleus since it is the part involved in mitosis. You should recall that the dark structure in the center is the nucleolus.

NOW LOOK AT SLIDE TWO.

This should look familiar to you. It represents the "unzipping" of the DNA ladder and the formation of two new identical DNA strands. This process occurs in interphase. Originally each cell has a set number of chromosomes. In our example we will be using a cell with four chromosomes. Each chromosome is equal to one complete DNA ladder, therefore, our cell will have four DNA ladders. At the end of interphase each DNA strand should have duplicated in the manner shown in this slide and there should therefore be eight DNA strands - twice the original number. This process is the longest stage of mitosis. When it is completed the second stage begins.

LOOK AT SLIDE THREE

The second stage of mitosis is called the prophase. Several things happen at this time. First of all the chromosomes begin to appear as long thin strands which gradually thicken and shorten. These don't come from nowhere but are the DNA ladders shortening and becoming visible as chromosomes. Notice that the four pairs are united. Each single strand is called a chromatid. When the DNA ladders duplicated the pairs remained together. Each chromatid (label A on the diagram) represents a DNA strand and is joined to its identical partner by a centromere (label B). As soon as these begin to appear the nucleolus (label C) and the nuclear membrane (label D) begin to break down and disappear.

NOW LOOK AT SLIDE FOUR

This is metaphase. During this stage the chromosomes line up in the center of the cell as shown in the picture. Protein spindle fibers are formed which attach onto the chromatide at one end and extend to the end of the cell. It is very important that this spindle fiber attachment and lining up process is done properly. A mistake at this stage is often seen among cancerous cells. Cancer is a disease in which mitosis fails to occur properly causing improperly formed cells to interfere with the normal activity of the cells in an area One of the reasons why the understanding of mitosis is so important is that by knowing how the process takes place, cancer researchers hope to be able to stop the process in only the cancerous cells, thereby stopping the spread of the disease.

LOOK AT SLIDE FIVE

After the chromosomes have lined up and the spindle fibers attached, the spindle fibers start to shorten and pull the chromatids toward the ends of the cell. If mitosis occurs properly the centromere binding the chromatid pairs should break under the strain allowing one of each pair to go to each end of the cell. This should leave the cell with one of each of the DNA strands at each end. As these reach the opposite ends of the cell they begin to cluster into a mass.

LOOK AT SLIDE SIX

The final stage is telophase. The events in this stage are the reverse of what we saw in prophase only now two cells are being formed. The chromosomes become less and less distinct as the DNA strands lengthen. The nuclear membrane and nucleolus are reformed. Finally, a cell plate forms in the center dividing the old parent cell into two new identical daughter cells. Notice that only the nuclear material is divided exactly. This is important so that each cell has the same DNA. When the cell plate forms, it divides the rest of the cellular material more 50/50. This does not have to be exact since the DNA can give instructions for the building of any other material that may be needed.

What you have just learned represents mitosis in plant cells. The process is the same in animals with only two small differences. Let's run quickly through the last few slides. This will give you a good opportunity to review what you have learned and see some pictures of mitosis actually taking place in some whitefish cells.

Interphase, the preparation phase occurs just as in the cells of plants. Remember that it is during this stage that the DNA duplicates so that the new cells will be identical. The next stage (See Slide Seven) shows the early prophase. In the center is the nucleus with purple lines which are the chromosomes becoming visible. Do you see two darker pink areas one above the nucleus and one just below and to the left? These are one of the differences between the plant and animal cells. They are called asters and are the structures to which the spindle fibers will attach in animal mitosis. They are called asters because the fibers radiating from them appear starlike. Actually there is a small structure within these asters called a centriole to which these fibers all connect. Notice you can still see most of the nuclear membrane in the slide.

LOOK AT SLIDE EIGHT

This shows late prophase. At this point the nuclear membrane is gone, the asters are big and appear to the left and right of the

chromosomes which now appear as the dark purple strands you see.

NOW LOOK AT SLIDE NINE

What is happening here? This is metaphase. The chromosomes have lined up in the center and the spindle fibers run from them to the asters which are the two large pink spots.

LOOK AT SLIDE TEN

In slide ten you see early anaphase. At this point the chromatids are being pulled toward the asters. Remember that it is important that at this point one of each pair goes to each and otherwise the cells will not be identical.

NOW LOOK AT SLIDE ELEVEN showing late anaphase. The same thing is happening but the chromosomes are farther apart now and are beginning to clump. The asters are now starting to fade as their job of pulling the chromosomes apart is almost finished.

NOW LOOK AT TWELVE TWELVE

In slide 12 the process is almost complete. The nuclei are forming and the asters are gone. Here you can see the second difference between plant and animal mitosis. Instead of a cell plate forming at this stage between the two cells, the side walls pinch in and separate the cells.

The process of mitosis is always occurring but it occurs at different rates in different cells. At any one time you can find all the stages occurring.

LOOK AT SLIDE THIRTEEN and see what I mean by this. Look carefully and see how many different phases you can identify. You should see at least one of each of the five I mentioned.

MUSIC

Now as a final test take the pictures from the envelope and place them in a line in front of you in the order in which they would occur. When you are done turn on the tape and check to make sure you are correct.

MUSIC

Check to see that the order you have is as follows. Blue with a dot in the corner, green with a dot, pink with a dot, orange with a dot, yellow with an X, purple with an X, green with an X, orange with an X, yellow with a dot, pink with an X, blue with an X, and purple with a dot.