LIFEPAC®

SCIENCE

STUDENT BOOK

10th Grade | Unit 8

Alpha Omega
PUBLICATIONS

SCIENCE 1008

Cell Division and Reproduction

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

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Cell Division and Reproduction

Growth and reproduction are two primary characteristics of living things. To have an adequate understanding of biology without considering these two characteristics of living organisms is not possible. (An organism is a single plant or animal.) In the opening chapters of Genesis, plants, animals, and man are commanded to be fruitful and multiply or to bring forth living creatures after their own kind. All living things grow, or increase in size and mass, and have the ability to reproduce new individuals of the same kind.

In this LIFEPAC® you will be studying cell division and two basic kinds of reproduction.

We are told in Genesis 3:19, "In the sweat of thy face shalt thou eat bread, till thou return unto the ground; for out of it wast thou taken; for dust thou art, and unto dust shalt thou return." All individual organisms, including man, grow, live, and finally die. The growth of individual, multicellular animals and plants occurs by means of cell division. The study of cell division is the key to understanding growth. Because animals and plants die, new individuals must be added to their populations if their numbers are to be maintained. Reproduction is thus necessary if populations and species are to survive.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Explain the purpose of mitosis and meiosis.
2. Compare the functions of mitosis and meiosis.
3. Describe the different phases of mitosis.
4. Identify some of the factors which are involved in controlling mitosis.
5. Define asexual reproduction.
6. Discuss the advantages of asexual reproduction.
7. List and explain some of the mechanisms used in animals and plants for asexual reproduction.
8. Name and describe some of the techniques used by man in the production of plants for his use.
9. Discuss some of the advantages of sexual reproduction.
10. Describe fertilization and the kinds of cells it involves.
11. Distinguish two basic kinds of life cycles in animals.
12. Relate cellular differentiation to the presence of genetically identical cells within an organism.
13. Compare complete and incomplete metamorphosis.
14. Name and describe the three basic kinds of life cycles found in algae.
15. Relate life cycles in vascular plants to the basic types found in the algae.
16. Compare some of the basic life cycles found in vascular plants.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. CELL DIVISION

Have you ever taken care of a young animal from the time it could first leave its mother until it was an adult? Have you ever planted a seed and watched it germinate and produce a seedling that grew into a mature plant? One of the more obvious changes that take place in the development of most plants and animals is an increase in size and weight. Increasing size and weight is dependent on the process of **mitosis**, a kind of cell division that produces two cells genetically the same as the original cell that gave rise to them. Individual multicellular organisms of all kinds (including you) grow and maintain their bodies by means of mitosis.

Section Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Explain the purpose of mitosis and meiosis.
2. Compare the functions of mitosis and meiosis.
3. Describe the different phases of mitosis.
4. Identify some of the factors which are involved in controlling mitosis.

Vocabulary

Study these words to enhance your learning success in this section.

anaphase
asexual reproduction
cell plate
centriole
centromere
chromatin
chromosome
cytokinesis
daughter cell
diploid
fertilization
furrowing
G_1 phase
G_2 phase
gamete
genetic recombination
haploid
homologous chromosome
hormone
interphase
meiosis
metaphase
mitosis
mitotic division
nuclear envelope
organism
parent cell
prophase
reduction division
S phase
spindle apparatus
telophase

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.*

MITOSIS

Mitosis is the most common kind of cell division. It occurs only in **organisms** whose cells contain **chromosomes**. A **mitotic division** of a cell is one in which a **parent cell** divides to produce two **daughter cells**. Each daughter cell is genetically identical to the parent cell. Complex movements of chromosomes occur during mitosis. The daughter cells each receive the same number of chromosomes that originally occurred in the parent cell. Each daughter cell has the same genetic information as the other and also the same genetic information as the parent cell. Those organisms that do not have chromosomes divide by a different process. The blue-green algae and the bacteria do not divide by means of mitosis.

Growth. Mitosis enables multicellular animals and plants to grow in size and to increase in weight. Both animals and plants increase their cell numbers as they grow and mature. Most plants continue to add cells and to increase in size throughout their entire lives. Unlike plants, many animals attain a definite shape and size at maturity. Even in animals new cells are continually produced although the organism may not increase in size and weight.

Cell replacement. Replacement cells are made using mitotic cell divisions. Older cells die and new ones are produced to take their place.

Every one of your cells, except those of the central nervous system, is replaced every few years. For example, the average life span of a human red blood cell is 127 days. New skin cells are continually made and older cells shed. Many of your cells have life spans which are only a few months in length. In one sense you are not the person you were, and you will be composed of different cells in a few years.

Cell repair. Mitosis is also useful to animals and plants in repairing damage from injury. Without mitotically produced cells, wounds would remain open exposing internal tissues to disease, more injury, and drying out.

Reproduction. Another major function of mitosis is that of reproduction. Most plants and many kinds of lower animals are capable of asexual reproduction. **Asexual reproduction** produces offspring that are genetically identical to the parent.

Mitosis is a process that is highly important to us because it permits us to grow and develop. Our lives are dependent on mitosis. The lives of a multitude of animals and plants are dependent on mitosis for their continued existence. God has clearly provided mitosis to enable living things to grow and develop, to maintain themselves, to repair potential damage from injury, and in many organisms to reproduce.

Complete the following statements.

1.1 Each daughter cell produced in mitosis has the same genetic composition as the _____ cell.

1.2 The number of daughter cells produced in mitosis is _____ .

1.3 Mitosis does not occur in cells which have no _____ .

1.4 Four major functions of mitosis are a. _____ , b. _____ , c. _____ , and d. _____ .

Answer the following questions.

1.5 How are the growth and development of a baby related to the process of mitosis? _____

_____

1.6 In a sentence or two describe what mitosis does. _____

_____

_____

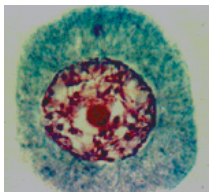
MEIOSIS

The most common kind of cell division in cells possessing chromosomes is mitosis, but there is another type of cell division. It is **meiosis**. Meiosis, a nuclear and cell division process, is highly limited in cell type and time of occurrence. In contrast to mitosis, meiosis is a **reduction division**. The daughter cells produced in a reduction division contain fewer chromosomes than the parent cell. Meiosis consists of two divisions that produce four daughter cells. Each daughter cell contains half of the chromosomes the parent cells possessed. This chromosome reduction is quite different from mitosis, which has only one cell division that produces two cells genetically identical to the parent cell. In contrast to mitosis, meiosis involves two successive divisions. The daughter cells have a genetic composition which is not identical to the parent cell. The genetic composition of the daughter cells in meiosis varies from the parent cell because the chromosome number of the daughter cells is less.

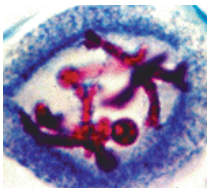
The process of meiosis is used in the production of **gametes**. A gamete is a cell, such as an egg or sperm, which functions in reproduction. Two gametes, each having half the chromosome number of the cells of the parents, come together to form one cell. This cell has the same number of chromosomes as each parent. The process in which two gametes fuse to make one cell is termed **fertilization**. Fertilization has often been defined as the union of egg and sperm.

Chromosome numbers. Chromosomes occur in matched pairs in cells of higher animals and the majority of the higher plants. Chromosomes also occur in matched pairs for a time after fertilization in many simpler animals and plants. A pair of matched chromosomes that are similar in size and shape and that carry information about the same characteristics in the cell or organism are said to be homologous chromosomes. A cell or organism having pairs of **homologous chromosomes** is said to be **diploid**. Nearly all higher animals and a majority of higher plants are diploids. Gametes and some simpler kinds of animals and plants are said to be **haploid**. A haploid has its chromosomes present in the nucleus of the cell as single units. Each chromosome occurs separately because no other chromosome similar in size and shape carries the same kind of genetic information.

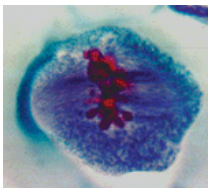
Gametes are normally haploid. When the nuclei of two gametes undergo fertilization each gamete contributes a "set" of chromosomes. A fertilized egg will contain one set from each gamete and therefore from each parent. All but one of the chromosomes from one set will have a matching equivalent in the other set. A fertilized egg will be diploid because each gamete contributes one-half of a homologous pair of chromosomes. Meiosis thus provides a mechanism by which the chromosome number may be kept the same from one generation to the next.



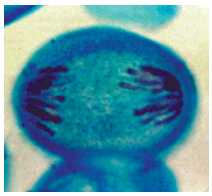
Interphase



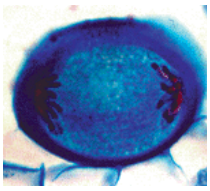
Prophase I
Diploid cell replication of DNA



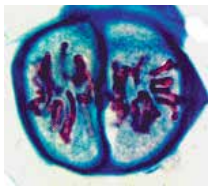
Metaphase I
Tetrad formation homologous chromosomes line up at equator



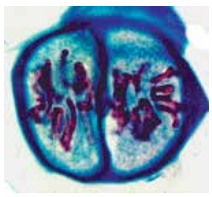
Anaphase I
Homologous chromosomes segregate



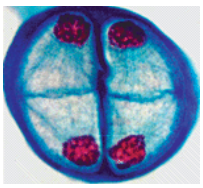
Telophase I
Cytoplasmic division



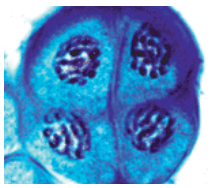
Metaphase II
Paired chromatids line up at equator



Anaphase II
Chromatids separate at centromere, moving to opposite poles



Telophase II
Cytoplasmic division



Interphase
Haploid gametes

Figure 1 | Stages of Meiosis

Genetic recombination. Meiosis has another major function in addition to maintaining chromosome number from one generation to the next. Meiosis is the cause of **genetic recombination**. Genetic recombination means that each new individual plant or animal produced using gametes has a different genetic composition than either parent. Each individual obtains its genetic information from both parents, but the combination of traits the new individual has is different from that of either parent.

Recall that there are two divisions in meiosis. The chromosomes of a cell are all duplicated before the first visible indications of the beginning of meiosis. During the first division the homologous chromosomes with already duplicated genetic material come together so that they are side by side. At that time genetic material is therefore present for four chromosomes. Homologous chromosomes then separate into two daughter nuclei, or cells, at the end of the first division of meiosis.

The separation of duplicated homologous chromosomes in the first division of meiosis provides a mechanism for producing *genetic variation* in the resulting cells or nuclei. Each half of a pair of homologous chromosomes may carry somewhat different information than the other homologous chromosome of the pair. However, the information carried by both homologous chromosomes of a pair will be concerned with the same characteristics. For example, one member of a homologous pair of chromosomes may have information that codes for brown eye color. The other homologous chromosome may carry information that codes for blue eyes. The information carried by each chromosome of the pair is different, but it controls the same characteristic, eye color. Because each chromosome of a homologous pair may have different information, which half of a homologous chromosome pair is finally present in a particular egg or sperm cell does make a difference.

Duplicated homologous chromosomes are separated during the second division of meiosis. No genetic recombination occurs in the second division, though a reduction of the chromosome does occur.

Genetic variations. The way in which one pair of a homologous pair of duplicated chromosomes separate during the first division has no effect on the way other pairs of duplicated chromosomes may separate. The individual homologous chromosomes may separate and go to the daughter cells in any combination. A cell with multiple pairs of chromosomes may produce large numbers of potential genetic combinations. The number of possible genetic combinations of chromosomes produced in the first division of meiosis is 223 in human beings.

Genetic variation in gametes will in turn produce genetic variation in animals and plants, which result from fertilization. The number of possible variations in the individuals resulting from fertilization is the number of variations or combinations in one gamete times the number possible in the other. Thus, in human beings the total number of possible genetic combinations in an individual baby produced by two parents is $2^{23} \cdot 2^{23}$—a number so large that it cannot be comprehended by the human mind.

There is one more source of variation in meiosis. During the first division of meiosis the duplicated homologous chromosomes come together and adhere to one another along their lengths. At one particular time in the first division, some of the chromosomes can exchange parts. This exchange increases the genetic variation produced in meiosis. This process is called crossing over.

Meiosis and mitosis. Meiosis is different from mitosis in several respects:

1. Mitosis produces two daughter cells. Meiosis produces four.
2. Mitosis produces daughter cells that are genetically identical to the parent cell. Meiosis produces daughter cells that vary from the parent cell in their genetic composition.
3. Daughter cells produced in mitosis have the same chromosome number as the parent cell. Daughter cells produced in meiosis have half the chromosome number of the parent cell.
4. Mitosis provides no genetic variation in individual produced through asexual reproduction. Meiosis is used to produce individuals that do vary from one another; therefore, meiosis is a means by which variation can occur in populations of animals and plants.

Complete the following sentences.

1.7 I am _____ (haploid or diploid).

1.8 Mitosis as a process consists of a. _____ division(s) and meiosis consists of b. _____ division(s).

1.9 A meiotic division produces _____ daughter cells.

1.10 Mitosis produces _____ daughter cells.

1.11 Mitosis produces daughter cells that have a chromosome number that is _____ that of the parent cell.

1.12 Meiosis produces daughter cells that have a chromosome number that is _____ that of the parent cell.

Complete the following activities.

1.13 Compare mitosis to meiosis.

a. Which occurs more frequently, mitosis or meiosis? _____

b. Why?_____

_____

1.14 State the main functions of meiosis._____

_____

1.15 Explain reduction division by completing these statements:

a. Meiosis is called a reduction division because _____

_____

b. The purpose of a reduction division is _____

_____

1.16 Explain genetic variability by completing these statements:

a. Meiosis is related to genetic variability in this way: _____

_____

b. This part of meiosis is involved in genetic variability: _____

_____

_____

STAGES OF MITOSIS

Cell division is a complex, continual process in that various events follow one another in time. Psalm 139 tells us that we are "fearfully and wonderfully" made. The events of mitosis provide us with graphic evidence that this statement is true.

Interphase. The process of mitosis begins before any part of the process is visible under a light microscope. The period in the life of a cell between cell divisions or mitotic divisions is known as **interphase**. In interphase no evident activity is associated with cell division, and the genetic material in the cell nucleus occurs in a thin, thread-like form known as **chromatin** (kroa' mah tin). During interphase all of the genetic material is duplicated, producing exactly twice the material as before. The time period in which this duplication occurs is termed the **S phase**. After duplication of the genetic material, an additional period of interphase follows in which no cell division takes place. It is called the **G_2 phase**.

Prophase. The beginning of active cell division is a time when there are many events taking place. This first part of mitosis is called **prophase**. One of the first visible signs of mitosis is a shortening and thickening of the chromatin. As the chromatin shortens and thickens it forms distinct chromosomes. Each chromosome pair contains two strands of genetic material attached by a **centromere**. As the chromosomes become shorter and thicker they move into the middle of the cell (see Figure 2). The **nuclear envelope** (the

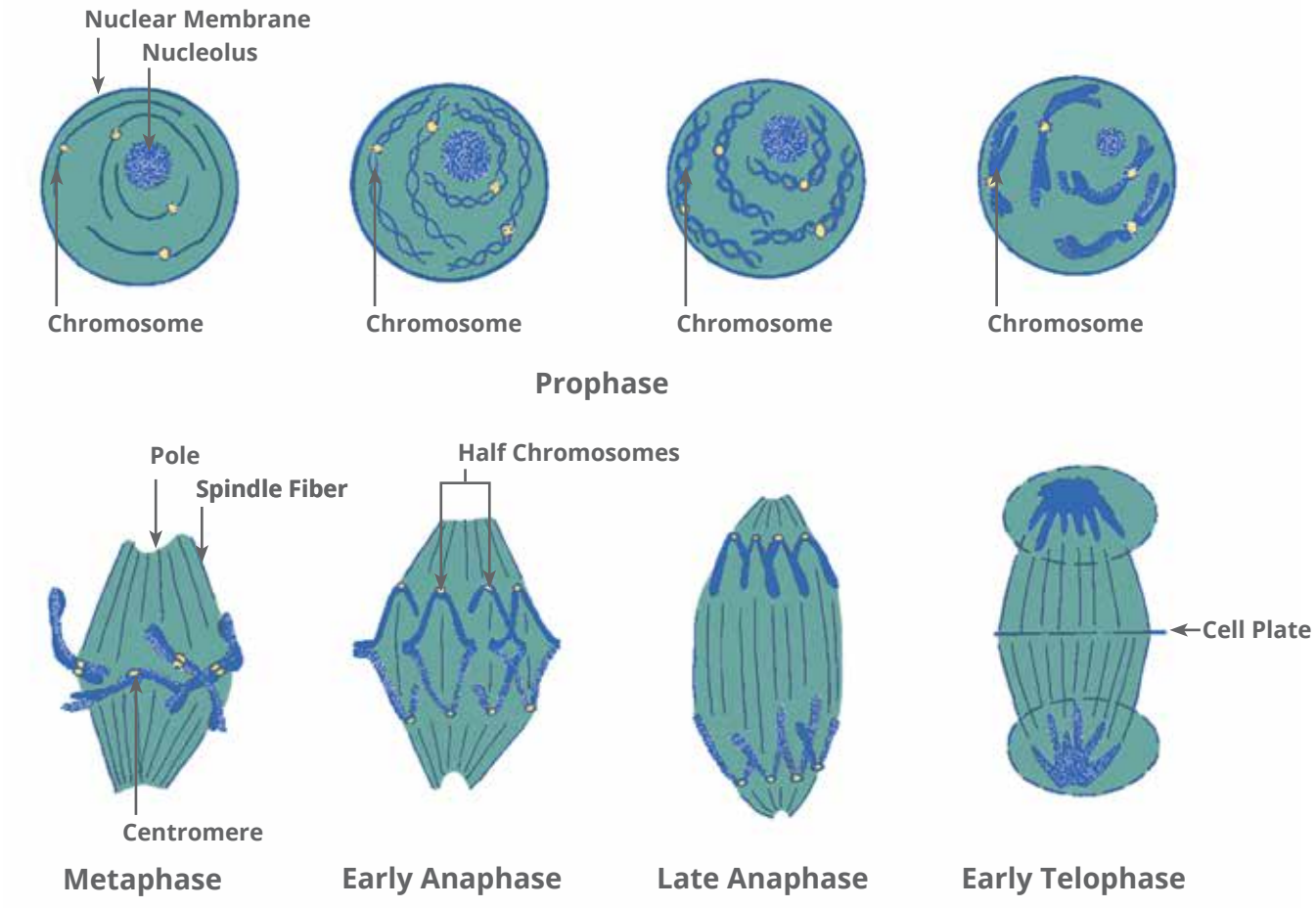


Figure 2 | Stages of Mitosis

membrane that surrounds the nucleus) disintegrates. During prophase a structure of fibrous material, the **spindle apparatus**, forms in the cell. This spindle extends from one end of the cell to the other. At each end the spindle apparatus of animals and of some lower plants centers on a cell part called the **centriole** (or pole). The cells of higher plants do not have centrioles.

Metaphase. The next period of mitosis is termed **metaphase**. In this phase the chromosomes line up across the middle of the cell. The chromosomes are attached to the spindle apparatus during metaphase.

Anaphase. The two strands of genetic material found in each chromosome during prophase and metaphase are separated from one another during **anaphase**. Each of the strands forms a new chromosome. The daughter chromosomes formed by the division, or splitting, of the parent chromosomes are moved to opposite poles of the cell. They are pulled along the fibers of the spindle apparatus. The mechanism of movement is not understood, and many theories exist to explain it. The marvel of mitosis and anaphase is that each of the parent chromosomes divides into two daughter chromosomes that are sent to opposite ends of the cell. Each end of the cell receives the same genetic material and information as the other. This production of two daughter cells that are identical to the parent cell is the object of mitosis.

Telophase. The final portion of mitosis is known as **telophase**. In telophase the newly formed chromosomes have reached opposite ends of the cell. The chromosomes begin to lengthen, become thinner, and more difficult to see with a light microscope. A new nuclear envelope is formed around each group of chromosomes at opposite ends of the cell.

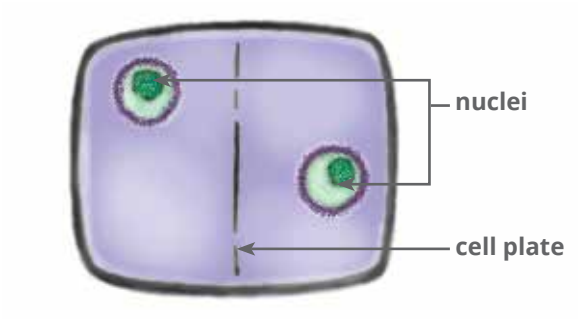


Figure 3 | Formation of a Cell Plate

The spindle apparatus begins to disintegrate. The events of telophase are in some ways the reverse of those in prophase.

The actual separation of the old cell into two new ones begins in telophase. Separation occurs in two different ways in different kinds of organisms. In higher plants a layer of material called the **cell plate** is formed across the middle of the old cell (see Figure 3.) The cell plate gradually thickens to form a new cell wall. The cell membrane grows across the cell plate to complete the separation of cells.

In animals and in some lower plants there is a process in which the middle of the cell gradually constricts, or tightens, until the two cells are separated from one another. This phenomenon is termed **furrowing**. The actual separation of the two ends of the old cell, each with its new nucleus, is called **cytokinesis** (sie toe ki nee' sis).

After telophase and cytokinesis, the two new daughter cells enter into interphase. The daughter cells then grow in size and carry out their usual functions within the animal or plant. In daughter cells, which will themselves undergo mitosis, the first part of interphase is termed the **G_1 phase**. This period of interphase is before the S phase, in which the genetic material is again duplicated.

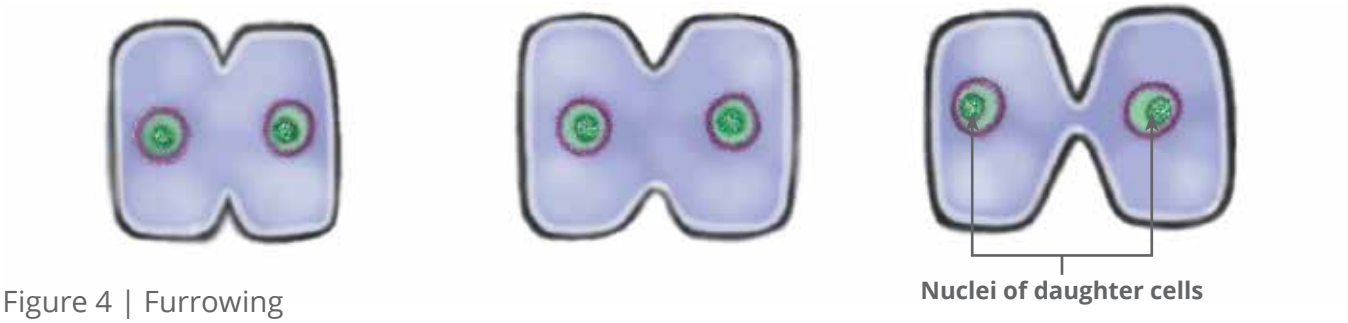


Figure 4 | Furrowing

Examine mitosis.

View 1008 Flytrap Adventure and Microscope: Chromosomes, from the 10th Grade SCIENCE EXPERIMENTS Video

These supplies are needed:

- microscope
- prepared slide of onion (Allium) root, stained to show chromosomes
- prepared slide of whitefish blastula, stained to show chromosomes

Follow these directions and complete the activities. Put a check in the box when each step is completed.

☐ 1. Place the slide of onion root on the stage of the microscope.

☐ 2. Focus the microscope on the slide using the lower power objective lens (as studied in Science LIFEPAC 1003). Bring the cells of the root into focus. Ask your teacher or helper to assist if you have trouble.

☐ 3. Move the slide until the section of onion root just above the root tip is in view, and search the area until cells in different phases of mitosis are in view. They will resemble the cells diagramed in Figure 2. (Telophase is often the most difficult to find.)

☐ 4. Using a high power objective, focus the microscope and search for cells in mitosis.

1.17 In the cell outlines that are shown, draw each of the major phases of mitosis. Below each write a brief description of what your drawing shows. (Since no visible changes occur during interphase it is not included.)

a.

prophase

_____

b.

metaphase

_____

Mitosis Experiment

(Continued on next page)

c.

telophase

d.

anaphase

5. Change the objective lens back to lower power.

6. Place a slide of whitefish blastula on the microscope stage and focus the microscope on the blastula.

7. Change to the high power objective and focus the microscope. Look for cells in the different phases of mitosis. Note the difference in the ends of the spindle apparatus compared to those in the onion root.

1.18 Draw each of the phases of mitosis of the whitefish blastula cells in the space provided.

a.

prophase

b.

metaphase

c.

anaphase

d.

telophase

Mitosis Experiment

Answer the following question.

1.19 How does mitosis differ between the onion root and the whitefish blastula?_____

Arrange the following terms in correct order.

1.20 metaphase, telophase, prophase, interphase, anaphase

_____

1.21 G_2, S, mitosis, G_1

_____

Match the phase of mitosis with the event listed.

a. anaphase b. interphase c. telophase d. metaphase e. prophase

1.22 _____ the genetic material is duplicated

1.23 _____ daughter chromosomes move to opposite ends of the cell

1.24 _____ chromosomes become visible

1.25 _____ the cell plate forms

1.26 _____ the spindle apparatus forms

1.27 _____ the nuclear envelope is formed

1.28 _____ the chromosomes are attached to the spindle apparatus

Complete the following statements.

1.29 The process of actual separation of cells at the end of mitosis is termed _____ .

1.30 The period of time in which the genetic material is duplicated is called the _____ .

1.31 The daughter chromosomes are equally divided between the two ends of the dividing cell during _____ .

1.32 The process of actually dividing animal cells is called _____ .

Learn the following verse.

1.33 Write Psalm 139:14 in this space. _____

_____

_____

TEACHER CHECK _____ initials _____ date

THE CONTROL AND RATE OF MITOSIS

All animals and plants have controls that place limits on their rate of growth and on the rate of growth in their tissues and organs. This control means the process of mitosis is limited. The mechanism of control is poorly understood, and many questions remain concerning it. This control is an area of current research in biology.

One example of a loss of control over mitosis is found in cancer. In this condition a rapid rate of growth and cell division occurs. Mitosis is out of control. The normal formation of animal and plant organs is dependent on the control of mitosis.

Chemical influence. Certain kinds of chemical substances will either speed up or slow down the rate of mitosis. A whole group of chemicals will stimulate mitosis in plants. Some of these chemicals are normally present in the tissues of plants, especially in areas of growth. Animals also produce substances known to encourage the division of cells. Substances produced in one part of an animal or plant that have the effect of causing growth in another part of the same animal or plant are called **hormones**. The way these substances act is not completely known, but they are being studied.

The presence of other cells may exert control over mitosis in a cell or group of cells. In some kinds of tissues, mitosis occurs at the same time in a number of cells. Mitosis is thus coordinated between cells in some tissues. Mitosis may be more common during certain periods of the day or night in different animals and plants. It is also known that the presence of other cells often slows or stops the process of mitosis in a particular tissue.

Cell size. Another factor involved with the control of mitosis is the size of the cell itself. The nucleus of the cell remains about the same size however large the cell might grow to be. If the volume of the cell becomes very large compared to the nucleus, the large size of the cell will tend to encourage mitosis.

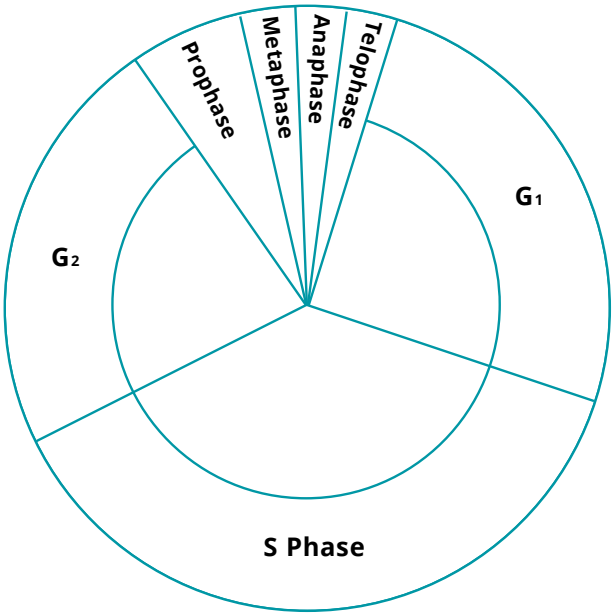


Figure 5 | The Cell Life Cycle

Cell size is also important in encouraging or slowing the rate of mitosis in another way. The volume of a cell and the surface area of the same cell do not increase at the same rate as cell size increases. The volume increases more rapidly than the surface area. The unequal increase is related to the shape of the cell. The volume of the cell tends to increase with the cube of the radius of the cell (r^3), and the surface area tends to increase with the square of the radius (r^2). After the cell increases beyond a certain size, it seems to stimulate mitosis. We do not know how.

The rate of mitosis. The rate at which mitosis occurs is variable in different kinds of organisms. In a typical mammal cell the G_1 phase lasts about ten hours. The S phase requires about eight hours, and the G_2 phase about five hours. Mitosis itself, from prophase to telophase, seems to require about one hour.

Invertebrates often have faster rates of mitosis. The whole cycle of mitosis, including all of interphase, requires only seventy minutes in sea urchin embryos. Higher plants require from ten to thirty hours for the whole cycle, though the period of prophase to telophase usually requires more than one hour.

Rates of mitosis can be very high. About 2.5 million red blood cells are made and destroyed each second in an adult human being. Many plants can add cells to a stem or other plant organ at the rate of many millions per hour.

Answer these questions.

1.34 What factors are known to be involved in the control of mitosis? _____

_____

_____

_____

_____

1.35 Compare mitosis in plants and animals.

a. How common is mitosis in plants and animals? _____

_____

_____

b. Cite an example. _____

_____

1.36 Why do you think that a control system for mitosis is necessary for animals and plants?

_____

_____

_____

_____

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Match these items (each answer, 2 points).

1.01 _____ centriole

1.02 _____ hormone

1.03 _____ haploid

1.04 _____ homologous chromosomes

1.05 _____ reduction division

1.06 _____ spindle apparatus

1.07 _____ anaphase

1.08 _____ furrowing

1.09 _____ chromatin

1.010 _____ interphase

a. having chromosomes which occur singly, not in matched sets or pairs

b. a chemical substance produced in one part of an animal or plant which may cause growth in another part of that organism

c. forms the pole of the spindle apparatus

d. period when the cell is not engaged in division

e. method of cytokinesis in animals

f. thread-like substance in nucleus which carries genetic information

g. period of mitosis in which chromosomes move to opposite poles of the cell

h. a system of fibers which go from one end of the cell to the other

i. matched pairs of structures containing genetic information

j. produces daughter cells with fewer chromosomes than the parent cell

k. the point of attachment between two chromosomes

Write the letter for the correct answer on each line (each answer, 2 points).

1.011 Chromatin or chromosomes are duplicated during _____ .

a. G_2 phase b. S phase c. prophase d. G_1 phase

1.012 Which of the following cells would not divide using mitosis? _____

a. mammal cell b. flowering plant cell

c. fungal cell d. bacterial cell

1.013 The nuclear envelope disintegrates during _____ .

a. metaphase b. prophase c. anaphase d. telophase

1.014 In a typical mammal cell the period of time required for a complete cycle of interphase, mitosis, and a return to the beginning of interphase is _____ .

a. 5 hours b. 10 hours c. 16 hours d. 24 hours

1.015 Which of the following expressions is not a function of mitosis? _____

a. production of gametes
b. growth
c. replacement of cells
d. repair of damage from injury

1.016 The cell plate is formed during _____ .

a. metaphase b. prophase c. telophase d. anaphase

1.017 The number of daughter cells produced by meiosis is _____ .

a. one b. two c. three d. four

1.018 Which of the following would be produced by meiosis? _____

a. red blood cell
b. cells of the stem in plants
c. sperm cell
d. epithelial cell

1.019 Genetic recombination results from events during _____ .

a. first division of meiosis
b. mitosis
c. second division of meiosis
d. second division of mitosis

1.020 The chromosomes split into daughter chromosomes during _____ .

a. anaphase b. telophase c. prophase d. metaphase

Complete these statements (each answer, 3 points).

1.021 The kind of cell division associated with an increase in size and weight of an organism is _____ .

1.022 Gametes have _____ the chromosome number of the parent cell.

1.023 Chromosomes are attached to the spindle fibers during _____ (phase) of mitosis.

1.024 The time period required for mitosis to begin and then for the cell to begin the process again, would be about _____ in the cell of a higher or flowering plant.

1.025 The spindle apparatus disintegrates during the _____ (phase) of mitosis.

Answer these questions (each numbered item, 5 points).

1.026 How does mitosis in animal cells differ from mitosis in higher plant cells? _____

_____

_____

1.027 What are the two basic functions of meiosis?

a. _____

b. _____

1.028 What are four important functions of mitosis?

a. _____

b. _____

c. _____

d. _____

56/70 **SCORE** _____ **TEACHER** _____ _____
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