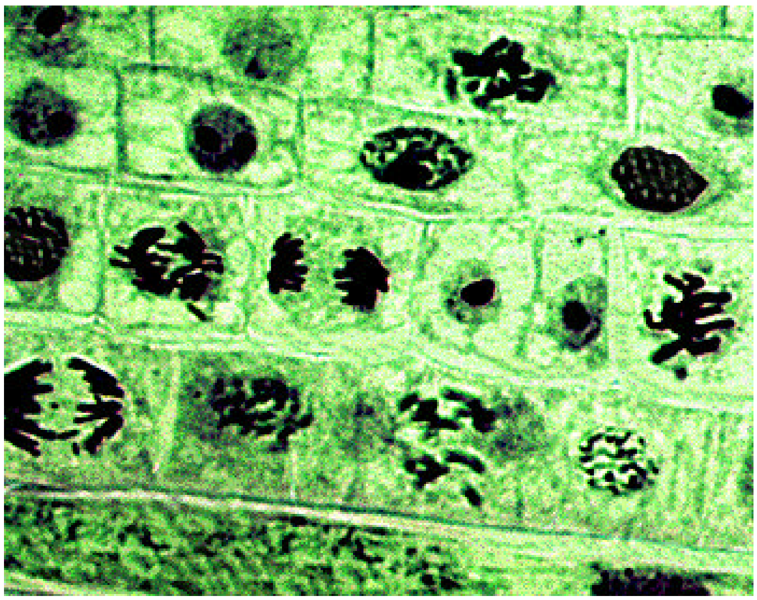
Interactive Biology™ Multimedia Courseware

Mitosis



Mitosis

TEACHING OBJECTIVES

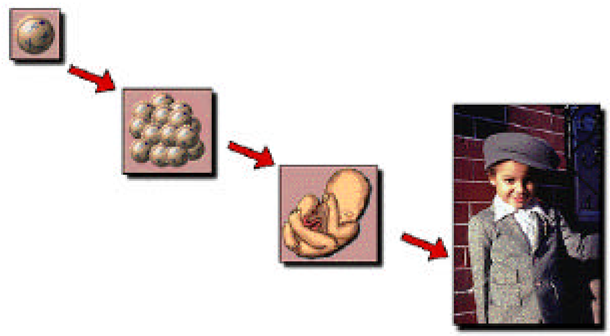
The following subject areas are illustrated throughout the Interactive Biology Multimedia Courseware program, *Mitosis*. Ideally, these areas would be augmented with additional course work outside of this program.

- **An introduction to the basic differences between prokaryotic and eukaryotic cells, and the concept that cells arise from other living cells.**
- **An overview of chromosomes, their location within cells, and the basics of prokaryotic cell division.**
- **Introduction to cell division in eukaryotic cells including the cell cycle, interphase, and duplication of DNA.**
- **Explanation of the stages of mitosis (prophase, metaphase, anaphase and telophase).**
- **An examination of cytokinesis in both plant and animal cells, and a look at differential rates of cell division.**

Study Guide #1

PROKARYOTIC AND EUKARYOTIC CELLS

Where do new cells come from? Perhaps you have heard before that cells must come from other living cells. This is true, but how do cells give rise to other new cells? The way cells reproduce (that is, the way they make copies of themselves) is through a process known as mitosis.



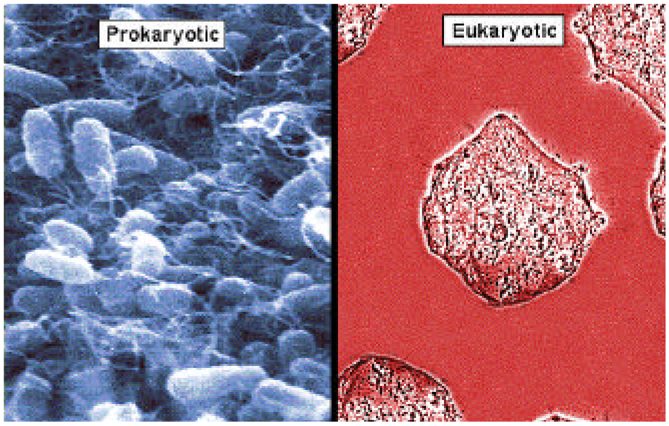
You began as a single cell that formed when your father's sperm fertilized your mother's egg. From this single cell, you have grown and developed into the complex organism you are today. Think about that for a moment. From a single cell, you have developed into organism containing over a trillion individual cells. That's a lot of growth.

After multi-cellular organisms (such as humans and oak trees) reach their full size, their cells continue to divide. Even now, your cells are continuously dividing to replace other cells that have become worn or damaged. These new cells remain a part of the larger organism. When a single-celled organism (such as a bacterium or amoeba) divides, the result is the formation of another, independent organism.

Before we examine the mechanism by which cells divide, we need to a closer look at the two classifications of cells. Cells are classified as being either eukaryotic or prokaryotic.

Prokaryotic organisms (also known as prokaryotes) lack a membrane-bound nucleus. All prokaryotes are bacteria and are composed of a single cell.

Eukaryotic organisms (also known as eukaryotes) posses a membrane-bound nucleus.



Eukaryotes can be either multicellular (such as cats and roses) or unicellular (such as an amoeba).

Surrounding the nucleus is a membrane known as the nuclear envelope, and within the nucleus is a structure known as the nucleolus. The area inside a cell that lies outside of the nucleus is known as the cytoplasm. While prokaryotic cells do not have a nucleus (and therefore no nuclear membrane or nucleolus) they do have cytoplasm.

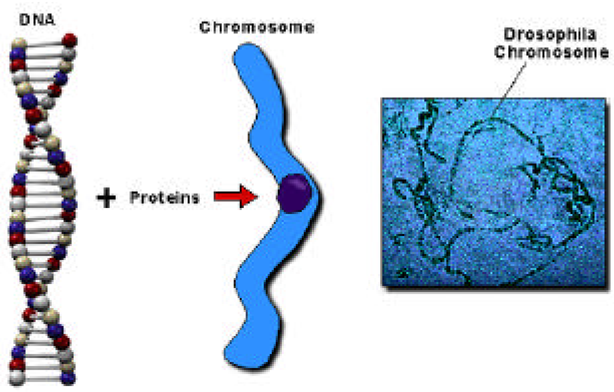
Study Guide #2

CHROMOSOME LOCATION AND COMPOSITION

A prokaryote, you will recall, has no nucleus. Therefore, the genetic material (DNA) of a prokaryote is found suspended in the cytoplasm of that cell.

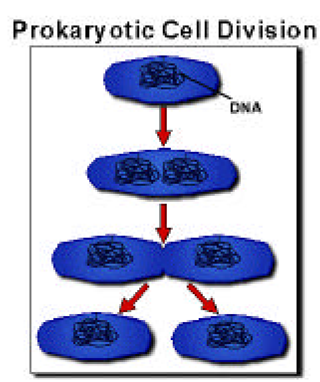
In eukaryotic organisms, genetic material is found inside of the nucleus. Therefore, the nucleus is a specialized organelle designed to house DNA (keeping it separate from the cytoplasm). Let's take a closer look at DNA in eukaryotes.

DNA (whether coming from a prokaryote or a eukaryote) is a macromolecule composed



of deoxyribonucleic acid. In eukaryotes, DNA comes in very long strands. It is compacted into linear structures known as chromosomes. Compacting DNA into chromosomes is an efficient way for cells to store their genetic material. Chromosomes often come in pairs, in which case they make up a chromosome set.

DNA is very important to the cell. Within DNA are long stretches of information known genes. Genes carry all the information a cell needs to live and reproduce.



DNA in prokaryotes is also compacted. However, whereas compaction in eukaryotes results in a long, linear strand, compaction in prokaryotes results in the formation of a circular chromosome.

Cell division (reproduction) in prokaryotes is less complicated than in eukaryotes. When the time comes for prokaryotic cell division to take place, the circular chromosome duplicates itself. The two chromosomes move apart and the cell then pinches in half to form two independent cells. In each identical cell is one circular chromosome.

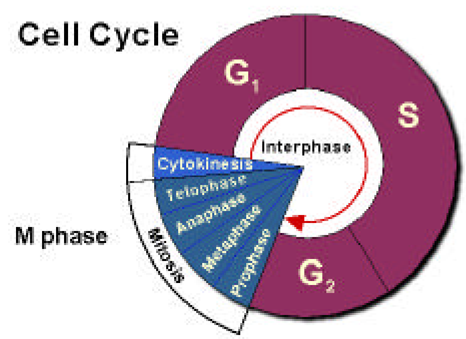
In the next study guide, we'll take a look at eukaryotic cell division.

Study Guide #3

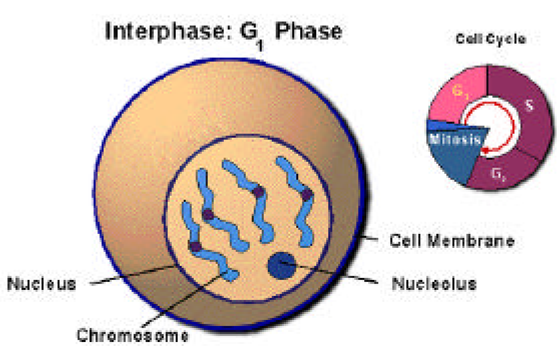
INTRODUCTION TO EUKARYOTIC CELL DIVISION AND INTERPHASE

As stated earlier, eukaryotic cell division is more complicated than prokaryotic cell division. Prokaryotes have only a single chromosome to copy when undergoing cellular division.

Eukaryotes, on the other hand, can have many pairs of linear chromosomes housed in the nucleus. For a eukaryotic cell to successfully divide, its entire complement of chromosomes as well as its nucleus must be duplicated. Only if this duplication process is carried out precisely will both the parent cell and the new cell receive a nucleus and chromosome set.

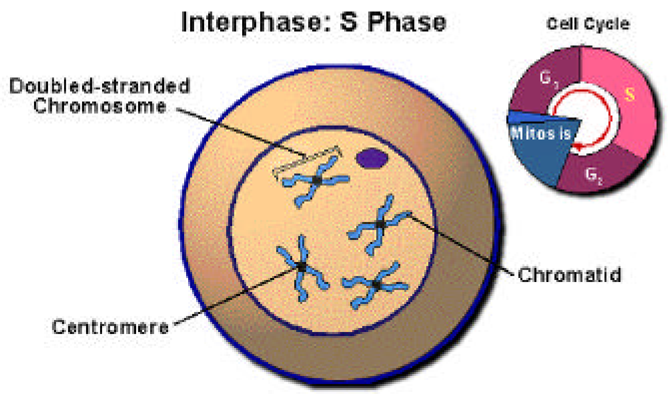


Eukaryotic cells have a distinctive cell cycle of growth and division. During this cycle, the G1 phase, S phase, and G2 phase make up what is called interphase. A eukaryotic cell spends about 90% of its time in interphase. Here is what happens at each of the 3 phases of interphase.



G1 phase: This stage in the cell cycle of a eukaryotic cell is one of general growth. During the G1 phase, each chromosome in the chromosome set consists of one uncondensed strand DNA.

S phase: During the S phase, each chromosome is copied. This results in two identical chromosomes that remain attached to each other by a centromere. (To visualize this, think of the letter X. Each side of this letter represents one chromosome, and where the

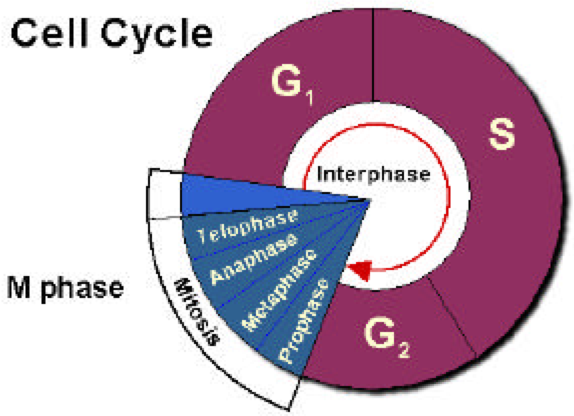


two sides come together is the centromere) Each chromosome now consists of two identical strands of DNA known as chromatids. (Each side of the letter X is a chromatid)

G2 phase: In the last phase of interphase, the cell readies itself for mitosis.

MITOSIS

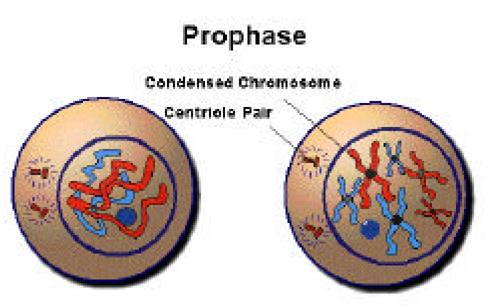
At the end of mitosis, two cells with equal number of chromosomes are formed. Here is a look at how this process works.



There are four stages in mitosis. These stages are prophase, metaphase, anaphase, and telophase. Let's look at these in order.

Prophase

When cells enter prophase, their chromosomes have been copied. However, these chromosomes are uncondensed. That is, they are long, stretched out, and difficult to see. In the first part of prophase, the chromosomes condense, becoming visible in the process. Condensed chromosomes make division easier for the cell. (Just like moving a very long thread is easier if the thread is wound onto a spool) During prophase in animal cells, rod-shaped structures known as centrioles appear and move to opposite sides of the cell.

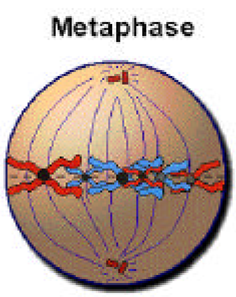


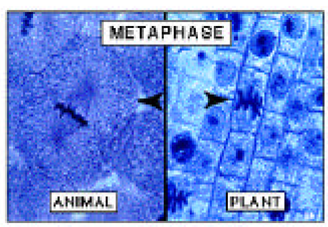
At the beginning of prophase, the cell's nucleus and nucleolus are readily visible. During prophase, the nucleus and nucleolus gradually fade until, at the end of prophase, both of these structures are no longer visible.

After the centrioles have moved to opposite sides, they extend fiber-like structures called microtubules. These microtubules form a spindle between the two centrioles. While plant cells do not have centrioles, they do form spindles.

Some of the microtubules that form the spindle attach to the doubled chromosomes. During prophase, all chromosomes become attached to microtubules. As prophase continues, the microtubules begin to pull the chromosomes towards the center of the cell, known as the equator. At the end of prophase, all chromosomes are attached to microtubules and positioned at the equator. The cell now enters the next phase; metaphase.

Metaphase





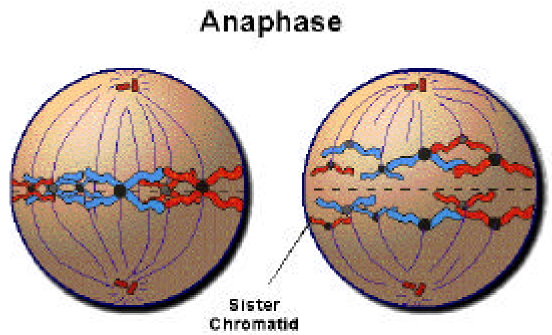
At the beginning of metaphase, all chromosomes are lined up along the equator. They are attached to microtubules in a very specific way.

Remember that each chromosome is doubled. That is, each chromosome has been copied and now consists of a pair of chromatids connected by a centromere. Attached to each centromere are two microtubules; one from each centriole.

As metaphase progresses, each doubled chromosome splits at the centromere, forming and unattached pair of matching chromatids. At this point, the cell moves into the third phase of mitosis; anaphase.

Anaphase

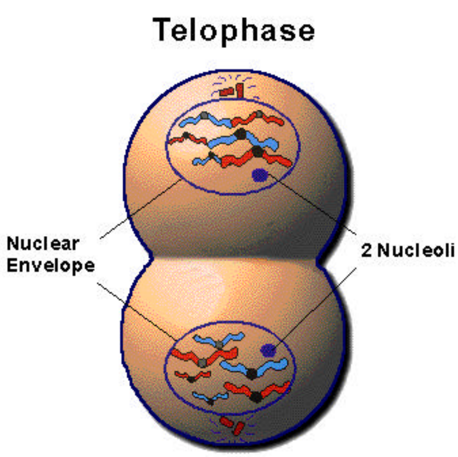
Anaphase opens with the splitting of the centromeres at the end of metaphase. In a highly organized manner, the cell then equally divides the pairs of chromatids. One chromatid from each pair is pulled towards one of the centrioles, and the second chromatid is pulled towards the other centriole.



At the end of anaphase, each side of the cell has received one complete set of chromosomes. At this point, the cell is ready to enter the final phase of mitosis; telophase.

Telophase

As the cell enters telophase, it has two complete sets of chromosomes (each positioned at opposite sides of the cell). During telophase, a nuclear envelope forms around each of the two sets of chromosomes. As this nucleus forms, a nucleolus begins to appear and the spindles begin to disappear. Finally, as mitosis comes to a close, the chromosomes begin to uncoil, stretching out and once again becoming indistinguishable.

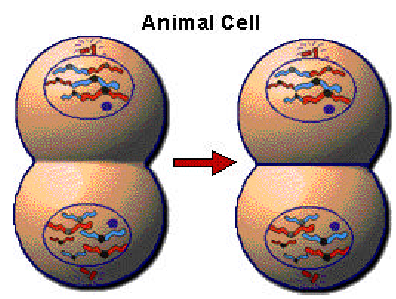


Now that the cell has two nuclei, each with a complete set of chromosomes, the cell is ready to divide into two cells. This final phase of the cell cycle is known as cytokinesis.

CYTOKINESIS AND RATES OF CELLULAR DIVISION

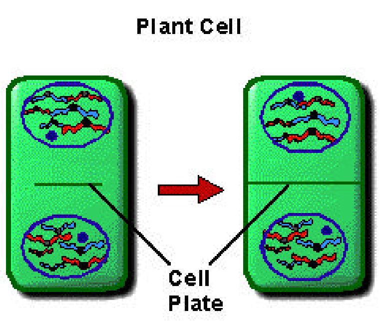
The process of mitosis resulted in the formation of a cell containing double the amount of chromosomes it would have normally. This cell must now divide in half, forming two cells containing the correct amount of chromosomes. This physical division of one cell into two cells is known as cytokinesis.

In cytokinesis, the cytoplasm divides into two equal portions, each containing a nucleus. The process of cytokinesis, unlike mitosis, differs markedly between plant and animals cells.



In animal cells, the membrane surrounding the entire cell pinches in at the middle, dividing the cell evenly into two new cells.

In plants however, a cell plate forms in the middle of the cell. This divides the cytoplasm in half. From the cell plate, two new cell walls are formed, one for each of the new plant cells.



The rates at which different cell types divide can vary widely. For example, red blood cells are continuously being produced in your bone marrow at the rate of about 2.5 million new cells per minute! On the other hand, nerve cells never undergo mitosis. Nerve cells are unable to divide at all. This explains why nerve damage is permanent and why you can recover from a loss of blood in a fairly short time.

There is also an all too common condition in which mitosis and cell division occur at accelerated rates that can lead to the death of an organism. We know this condition as cancer. Cancer is uncontrollable cell division and can occur in people of all ages and arise in nearly any cell in the human body.

Mitosis

QUIZ PAC

The following quizzes are meant to test student understanding of specific topic areas covered in the Interactive Biology Multimedia Courseware program, *Mitosis*. Many, but not all, of these questions have been addressed directly in the study guides designed to strengthen student understanding of these topics.

QUIZ #1 CELLS
QUIZ #2 CHROMOSOME LOCATION & COMPOSITION
QUIZ #3 EUKARYOTIC CELL DIVISION
QUIZ #4 MITOSIS
QUIZ #5 CELLULAR DIVISION

Quiz #1

CELLS

1. All cells come from other living cells.

A. True
B. False

2. The process of mitosis allows cells to reproduce.

A. True
B. False

3. When a single-celled organism divides by mitosis, the result is _______.

A. the organism becomes multicellular
B. immediate death of the cell
C. the formation of a new single-celled organism
D. None of the above (these organisms do not undergo mitosis).

4. There are ________ basic classifications of cell types.

A. two (prokaryotic and eukaryotic)
B. three (plant, animal, fungus)
C. five (prokaryotic, eukaryotic, plant, animal, fungus)

5. ________ organisms posses a membrane-bound nucleus.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

6. ________ organisms lack a membrane-bound nucleus.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

7. ________ organisms possess cytoplasm.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

8. Surrounding the nucleus is a membrane known as ________.

A. the plasma membrane
B. the nucleolus
C. the cell wall
D. the nuclear envelope

9. Found within the nucleus is a structure known as ________.

A. the plasma membrane
B. the nucleolus
C. the cell wall
D. the nuclear envelope

10. Prokaryotes are ________.

A. unicellular (composed of a single cell)
B. multicellular (composed of more than one cell)
C. Either A or B.
D. None of the above.

11. Eukaryotes are ________.

A. unicellular (composed of a single cell)
B. multicellular (composes of more than one cell)
C. Either A or B.
D. None of the above.

Quiz #2

CHROMOSOME LOCATION AND COMPOSITION

1. A nucleus is a specialized organelle designed to house DNA.

A. True
B. False

2. A pair of matching chromosomes makes up a chromosome set.

A. True
B. False

3. The DNA in a prokaryote is found ________.

A. inside of the nucleus
B. suspended in the cytoplasm
C. Both A and B.
D. Neither A nor B (these simple organisms have no DNA).

4. The DNA in a eukaryote is found ________.

A. inside of the nucleus
B. suspended in the cytoplasm
C. Both A and B.
D. Neither A nor B (these simple organisms have no DNA).

5. DNA is composed of ________.

A. denatured nitrogenous amino acids
B. molecules of dinucleotide - A
C. deoxyribonucleic acid
D. variable compounds depending upon the organism

6. In eukaryotes, DNA ________.

A. comes in very long strands
B. is compacted into linear chromosomes
C. is often absent
D. All of the above
E. A and B only

7. In prokaryotes, DNA ________.

A. is compacted
B. forms a linear chromosome
C. forms a circular chromosome
D. Both A and B.
E. Both A and C.

8. Found within DNA are long sequences known as ________ that carry information needed by the cell to live and reproduce.

A. chromosomes
B. chromatids
C. genes
D. information sequences

9. Reproduction in prokaryotes is ________.

A. a rare event
B. less complicated than in eukaryotes
C. more complicated than in eukaryotes
D. results in immediate death of the cell

10. In prokaryotic reproduction ________.

A. the chromosome duplicates
B. the cell pinches in half
C. each cell winds up with a complete chromosome
D. All of the above.

Quiz #3

EUKARYOTIC CELL DIVISION

1. Eukaryotic cell division is less complicated than prokaryotic cell division.

A. True
B. False

2. For a eukaryotic cell to successfully divide, all of its chromosomes must be carefully copied.

A. True
B. False

3. Eukaryotic cells have distinctive cell cycles of growth and division. Most of this cycle is spent in ________.

A. interphase
B. prophase
C. metaphase
D. anaphase
E. telophase

4. In the G1 phase of interphase, the cell is in a period of ________.

A. rapid division
B. cellular death
C. general growth

5. During the G1 phase, each chromosome exists as ________.

A. one uncondensed strand of DNA
B. a pair of chromatids
C. one strand of very condensed DNA
D. a pair of very condensed chromatids

6. During the S phase, ________.

A. each chromosome is broken in half, forming a pair of identical chromosomes
B. each chromosome is copied, resulting in two identical chromosomes (two identical strands of DNA)
C. each chromosome is copied, but the copying process is not exact and results in a pair of unmatched chromosomes

7. The two chromosomes resulting from the process in question #6 are ________.

A. attached to each other by a centromere
B. attached to each other by a centriole
C. quickly split in half

8. At the end of the S phase then, each chromosome ________.

A. has been in broken in half, forming two chromosomes held together with a centromere
B. has been copied, forming two identical chromosomes held together with a centriole
C. has been inexactly copied, forming two non-identical chromosomes held together with a centromere
D. has been copied, forming two identical chromosomes held together with a centromere

9. At this point, each chromosome consists of ________.

A. two identical chromatids
B. two different chromatids
C. two half-length chromosomes

10. In G2, the last phase of interphase, ________.

A. the cell divides
B. the cell readies itself for division
C. the parental cell dies
D. each chromosome forms a circle

Quiz #4

MITOSIS

1. The four stages of mitosis include prophase, metaphase, anaphase and telophase.

A. True
B. False

2. In the first part of prophase, ________.

A. the chromosomes uncoil, becoming faint
B. the chromosomes are copied for the last time
C. the chromosomes condense, becoming visible
D. the cell pinches in half

3. Also in prophase, rod-shaped structures known as _________ appear and move to opposite sides of the cell.

A. centromeres
B. mitochondria
C. genes
D. centrioles

4. As prophase progresses, the nucleus and nucleolus ________.

A. gradually fade from view
B. gradually become visible
C. are both copied
D. move to different sides of the cell

5. Fiber-like structures known as ________ form a ________ which spans from one side of the cell to the other.

A. macromolecules, chromosome
B. spindles, microtubule
C. fibrinogen, bridge
D. microtubules, spindle

6. As prophase continues, all chromosomes become attached to ________ which ________.

A. each other, forms an easily moved mass of chromosomes
B. microtubules, pull the chromosomes to different sides of the cell
C. fibrinogen, pulls the chromosomes to the center of the cell
D. microtubules, pull the chromosomes to the center of the cell

7. At the beginning of metaphase, all chromosomes are _________.

A. at different locations in the cell
B. still in the nucleus
C. aligned at the equator
D. at one of two poles in the cell

8. At the beginning of metaphase, each chromosome is attached to ________.

A. one microtubule
B. two microtubules (one leading to each centriole)
C. one fibrinogen fiber
D. two fibrinogen fibers (one leading to each centriole)

9. At the end of metaphase, ________.

A. the spindles disappear
B. each centromere splits in half
C. each chromosome becomes a pair of chromatids unattached to one another
D. All of the above.
E. B and C only.

10. As anaphase begins, each matching chromatid is ________.

A. pulled towards a different centriole
B. pulled towards the same centriole
C. pulled towards a different centromere
D. pulled towards the same centromere

11. At the end of anaphase, ________.

A. one side of the cell has received all of the chromatids
B. the matching chromatids become attached at their centromeres once more
C. a second equator is formed
D. each side of the cell has received a complete set of chromosomes

12. During telophase, a nuclear envelope ________.

A. forms around one of the two sets of chromosomes
B. forms around each set of chromosomes
C. forms in the center of the cell
D. forms near each set of chromosomes

13. As telophase continues, ________.

A. the spindles disappear
B. the chromosomes uncoil
C. a nucleolus becomes visible in each nucleus
D. All of the above.
E. A and C only.

Quiz #5

CELLULAR DIVISION

1. The physical division of one cell into two cells is known as cytokinesis.

A. True
B. False

2. Mitosis and cytokinesis result in the formation of two cells, each with the proper amount of nuclear material.

A. True
B. False

3. During cytokinesis in animal cells, ________, thus dividing the cell evenly into two new cells.

A. the cell membrane pinches together at the middle
B. a cell plate forms in the middle of the cell
C. two new cell walls are formed from the cell plate
D. All of the above.
E. B and C only.

4. During cytokinesis in plant cells, _________, thus dividing the cell evenly into two new cells.

A. the cell membrane pinches together at the middle
B. a cell plate forms in the middle of the cell
C. two new cell walls are formed from the cell plate
D. All of the above.
E. B and C only.

5. Red blood cells ________ whereas nerve cells ________.

A. are unable to be formed by mitosis, are constantly being produced in your body by mitosis
B. are constantly being produced in your body by mitosis, are unable to be formed by mitosis

6. Cancer ________.

A. is uncontrolled cell division
B. can occur in people of all ages
C. can arise in nearly any cell in the human body
D. All of the above.

Mitosis

COMPREHENSIVE EXAM

The following exam is based upon the *Interactive Biology Multimedia Courseware* program , *Mitosis*. Most, but not all, of these questions have been addressed directly in the study guides. All of the questions on this exam, however, are based on information put forth in the program.

Please determine if the following statements are true or false.

1. All cells come from other living cells.

A. True
B. False

2. The process of mitosis allows animal cells, but not plant cells, to divide.

A. True
B. False

3. A nucleus is a specialized organelle designed to house DNA.

A. True
B. False

4. A pair of matching chromosomes makes up a chromosome set.

A. True
B. False

5. Eukaryotic cell division is less complicated than prokaryotic cell division.

A. True
B. False

6. For a eukaryotic cell to successfully divide, all of its chromosomes must be carefully copied.

A. True
B. False

7. The order of stages in mitosis is prophase, anaphase, metaphase, and telophase.

A. True
B. False

8. Mitosis and cytokinesis result in the formation of two cells, each with the proper amount of nuclear material.

A. True
B. False

In the following portion of the exam, please choose the letter beside the word, words, or phrase that best completes each sentence.

9. When a single-celled organism divides by mitosis, the result is ________.

A. the organism becomes multicellular
B. immediate death of the cell
C. the formation of a new single-celled organism
D. None of the above (these organisms do not undergo mitosis).

10. There are ________ basic classifications of cell types.

A. two (prokaryotic and eukaryotic)
B. three (plant, animal, fungus)
C. five (prokaryotic, eukaryotic, plant, animal, fungus)

11. ________ organisms posses a membrane-bound nucleus.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

12. ________ organisms lack a membrane-bound nucleus.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

13. ________ organisms posses cytoplasm.

A. All
B. Very few
C. Prokaryotic
D. Eukaryotic

14. Found within the nucleus is a structure known as ________.

A. the plasma membrane
B. the nucleolus
C. the cell wall
D. the nuclear envelope

15. Prokaryotes are ________.

A. unicellular (composed of a single cell)
B. multicellular (composed of more than one cell)
C. Either A or B.
D. None of the above.

16. Eukaryotes are ________.

A. unicellular (composed of a single cell)
B. multicellular (composed of more than one cell)
C. Either A or B.
D. None of the above.

17. The DNA in a prokaryote is found ________.

A. inside of the nucleus
B. suspended in the cytoplasm
C. Both A and B.
D. Neither A nor B (these simple organisms have no DNA).

18. The DNA in a eukaryote is found ________.

A. inside of the nucleus
B. suspended in the cytoplasm
C. Both A and B.
D. Neither A nor B (these simple organisms have no DNA).

19. In eukaryotes, DNA ________.

A. comes in very long strands
B. is compacted into linear chromosomes
C. is often absent
D. All of the above.
E. A and B only.

20. In prokaryotes, DNA ________.

A. is compacted
B. forms a linear chromosome
C. forms a circular chromosome
D. Both A and B.
E. Both A and C.

21. In prokaryotic reproduction ________.

A. the chromosome duplicates
B. the cell pinches in half
C. each cell winds up with a complete chromosome
D. All of the above.

22. Eukaryotic cells have distinctive cell cycles of growth and division. Most of this cycle is spent in ________.

A. interphase
B. prophase
C. metaphase
D. anaphase
E. telophase

23. In the G1 phase of interphase, the cell is in a period of ________.

A. rapid division
B. cellular death
C. cellular growth

24. During the G1 phase, each chromosome exists as ________.

A. one uncondensed strand of DNA
B. a pair of chromatids
C. one strand of very condensed DNA
D. a pair of very condensed chromatids

25. During the S phase, ________.

A. each chromosome is broken in half, forming a pair of identical chromosomes
B. each chromosome is copied, resulting in two identical chromosomes (two identical strands of DNA)
C. each chromosome is copied, but the copying process is not exact and results in a pair of unmatched chromosomes

26. The two chromosomes resulting from the process in question #25 are ________.

A. attached to each other by a centromere
B. attached to each other by a centriole
C. quickly split in half
D. quickly linked to other chromosomes

27. At the end of the S phase then, each chromosome ________.

A. has been broken in half, forming two chromosomes held together with a centromere
B. has been copied, forming two identical chromosomes held together with a centriole
C. has been inexactly copied, forming two non-identical chromosomes held together with a centromere
D. has been copied, forming two identical chromosomes held together with a centromere

28. At this point, each chromosome consists of ________.

A. two identical chromatids
B. two different chromatids
C. two half-length chromosomes

29. In G2, the last phase of interphase, ________.

A. the cell divides
B. the cell readies itself for division
C. the parental cell dies
D. each chromosome forms a circle

30. In the first part of prophase, ________.

A. the chromosomes uncoil, becoming faint
B. the chromosomes are copied for the last time
C. the chromosomes condense, becoming visible
D. the cell pinches in half

31. Also in prophase, rod-shaped structure known as __________ appear and move to opposite sides of the cell.

A. centromeres
B. mitochondria
C. genes
D. centrioles

32. As prophase progresses, the nucleus and nucleolus ________.

A. gradually fade from view
B. gradually become visible
C. are both copied
D. move to different sides of the cell

33. Fiber-like structures known as _______ form a ________ which spans from one side of the cell to the other.

A. macromolecules, chromosome
B. spindles, microtubule
C. fibrinogen, bridge
D. microtubules, spindle

34. As prophase continues, all chromosomes become attached to ________ which ________.

A. each other, forms an easily moved mass of chromosomes
B. microtubules, pull the chromosomes to different sides of the cell
C. fibrinogen, pulls the chromosomes to the center of the cell
D. microtubules, pull the chromosomes to the center of the cell

35. At the beginning of metaphase, all chromosomes are ________.

A. at different locations in the cell
B. still in the nucleus
C. aligned at the equator
D. at one of two poles in the cell

36. At the beginning of metaphase, each chromosome is attached to ________.

A. one microtubule
B. two microtubule (one leading to each centriole)
C. one fibrinogen fiber
D. two fibrinogen fibers (one leading to each centriole)

37. At the end of metaphase, _________.

A. the spindles disappear
B. each centromere splits in half
C. each chromosome becomes a pair of chromatids unattached to one another
D. All of the above.
E. B and C only.

38. As anaphase begins, each matching chromatid is ________.

A. pulled towards a different centriole
B. pulled towards the same centriole
C. pulled towards a different centromere
D. pulled towards the same centromere

39. At the end of anaphase, ________.

A. one side of the cell has received all of the chromatids
B. the matching chromatids become attached at their centromeres once more
C. a second equator is formed
D. each side of the cell has received a complete set of chromosomes

40. During telophase, a nucleus ________.

A. forms around one of the two sets of chromosomes
B. forms around each set of chromosomes
C. forms in the center of the cell
D. forms near each set of chromosomes

41. As telophase continues, __________.

A. the spindles disappear
B. the chromosomes uncoil
C. a nucleolus becomes visible in each nucleus
D. All of the above.
E. A and C only.

42. During cytokinesis in animal cells, ________, thus dividing the cell evenly into two new cells.

A. the cell membrane pinches together at the middle
B. a cell plate forms in the middle of the cell
C. two new cell walls are formed from the cell plate
D. All of the above
E. B and C only.

43. During cytokinesis in plant cells, ________, thus dividing the cell evenly into two new cells.

A. the cell membrane pinches together at the middle
B. a cell plate forms in the middle of the cell
C. two new cell walls are formed from the cell plate
D. All of the above.
E. B and C only.

44. Red blood cells ________ whereas nerve cells ________.

A. are unable to be formed by mitosis, are constantly being produced in your body by mitosis
B. are constantly being produced in your body by mitosis
C. are unable to be formed by mitosis

45. Cancer ________.

A. is uncontrolled cell division
B. can occur in people of all ages
C. can arise in nearly any cell in the human body
D. All of the above.

In the following portion of the exam, please fill in the word, words, or phrase that best completes each sentence.

46. The physical division of one cell into two cells is known as ______________________.

47. Surrounding the nucleus is a membrane known as the __________________________.

48. Chromosomes are composed of DNA, which stands for ________________________.

49. Found within DNA are long sequences known as ______________ that carry information needed by the cell to survive.

Mitosis

ANSWER GUIDE

QUIZ PAC

QUIZ #1	QUIZ #2	QUIZ #3	QUIZ #4	QUIZ #5
1. A	1. A	1. B	1. A	1. A
2. A	2. A	2. A	2. C	2. A
3. C	3. B	3. A	3. D	3. A
4. A	4. A	4. C	4. A	4. E
5. D	5. C	5. A	5. D	5. B
6. C	6. E	6. B	6. D	6. D
7. A	7. E	7. A	7. C	
8. D	8. C	8. D	8. B	
9. B	9. B	9. A	9. E	
10. A	10. D	10. B	10. A	
11. C		11. D		
		12. B		
		13. D		

COMPREHENSIVE EXAM

1. A	8. A	15. A	22. A	29. B	36. B	43. e
2. B	9. C	16. C	23. C	30. C	37. E	44. b
3. A	10. A	17. B	24. A	31. D	38. A	45. d
4. A	11. D	18. A	25. B	32. A	39. D	46. cytokinesis
5. B	12. C	19. E	26. A	33. D	40. B	47. nuclear envelope
6. A	13. A	20. E	27. D	34. D	41. D	48. deoxyribonucleic acid
7. B	14. B	21. D	28. A	35. C	42. A	49. genes

GLOSSARY

anaphase: the stage in mitosis in which individual chromosomes, after being separated from double chromosomes, move to opposite sides of the cell. Each cell side receives one complete set of chromosomes.

bacterium: a one-celled microorganism that contains no nucleus.

cell cycle: the sequence of growth and division that dividing cells go through. The cycle includes interphase, mitosis, and cytokinesis.

cell plate: a structure formed in cytokinesis that divides the cytoplasm of a plant cell in half. From the cell plate, two cell walls will form, one for each of the two plant cells.

centrioles: cylindrical structures in animal cells from which the spindle extends from in mitosis.

centromere: the structure that is the point of attachment for two chromatids in a double chromosome.

chromatid: a single chromosome that is part of a double chromosome.

chromosomes: structures composed of a very long strand of DNA that has been tightly compacted. Within this DNA lie the genes for the organism.

chromosome set: a group of chromosomes that exist together within the nucleus of a eukaryotic cell.

cytokinesis: stage following mitosis in which the cytoplasm of a cell divides into two equal portions, each with one nucleus.

cytoplasm: area within a cell between the nucleus and the outer cell membrane.

DNA (deoxyribonucleic acid): large molecules that carry the genetic information necessary for all cellular functions. DNA, when tightly compacted, forms chromosomes.

equator: midplane of the cell.

eukaryotic cell: a cell that has a true nucleus surrounded by a membrane (or nuclear envelope). This group includes all animal and plant cells , except blue-green algae.

genes: segments of DNA that carry information and give directions for everything the cell is and will be, and controls the cell's heredity.

interphase: period in the cell cycle when the cell grows, produces more cell structures, and doubles its chromosome set. Interphase includes the G1, S, and G2 stages in the cell cycle.

metaphase: the second stage in mitosis in which the doubled chromosomes line up along the cell's equator and are split into single chromosomes.

microtubules: fiber-like structures that extend from opposite sides of the cell in mitosis. These form the spindle that facilitates chromosome movement.

mitosis: the separation of doubled chromosomes and the division of the nucleus into two nuclei that is necessary for cell division to occur in eukaryotic cells. Mitosis includes prophase, metaphase, anaphase, and telophase.

nuclear envelope: a membrane that surrounds the nucleus in a eukaryotic cell.

nuclei: plural form of nucleus.

nucleolus: a dark structure seen within the nucleus.

nucleus: a membrane-bound structure, found in eukaryotic cells, that contains the genetic material for the cell.

prokaryotic cell: a cell that does not have a membrane-bound nucleus; for example, a bacterium.

Prophase: the first and longest stage of mitosis. In this stage, the chromosomes condense, the nucleus and nucleolus disappear, and the centrioles move to opposite sides of the cell. The spindle forms and attaches to the chromosomes during this stage.

Telophase: the last stage in mitosis in which a nuclear envelope forms around each set of chromosomes located at opposite sides of the cell. A nucleolus appears in each nucleus during this stage.

spindle: football-shaped structure formed from microtubules during prophase. The spindle extends from opposite sides of the cell and facilitates chromosome movement in mitosis.