Dude, mitosis starts in five minutes...
I can't believe you're not condensed yet.

CELL GROWTH, CELL REPRODUCTION AND MITOSIS
Goals

My goal for this packet is……..
_____________________________________________
_____________________________________________
_____________________________________________
_____________________________________________
My goal for 3rd Qtr is………
_____________________________________________
_____________________________________________
_____________________________________________
I know I have accomplished this goal when....
_____________________________________________
_____________________________________________
**Cell Growth and Division Vocabulary**

**Anaphase** - Twin copies of the chromosomes get separated and move to the opposite sides of the cell.

**Cell Division** - The method of one cell dividing into two cells. Mitosis, Meosis

**Cell plate** - The site of growth of a new cell wall between the two new daughter cells in the mitosis of plant cells.

**Centromere** - Site of attachment for sister chromosomes. Spindle fibers attach here.

**Chromatids** - A chromatid is one of the two identical copies of DNA making up a duplicated chromosome, which are joined at their centromeres, for the process of cell division.

**Chromatin** - Threadlike coils of chromosomes.

**Chromosome** - Rod-shaped cell structure that directs the activities of the cell and passes on the traits to new cells.

**Condensing** - The shortening of the thread-like chromatin into the visible chromosomes.

**Cytokinesis** - The division of the cytoplasm in the cell.

**Daughter cells** - The two new cells formed by cell division.

**Furrow** - The site of pinching of the cell membrane during cytokinesis.


**Metaphase** - Chromosomes move to the middle of the cell. Chromosomes attach to the spindle fibers at the centromere.

**Mitosis** - The process of duplication and division of the nucleus of a cell and the formation of two new daughter cells.

**Phase** - Cell division is broken down into different parts called cells.

**Prophase** - Mitosis begins. Nuclear membrane disappears, chromatin shortens to become Chromosomes, centrioles move to opposite ends of the cell, spindle fibers form.
**Sister chromosome** - The duplicated chromosome that separates from the original during **Cell division**

**Spindle** - Thread-like fibers attached to the chromosome pair that help separate the chromosomes during cell division.

**Telophase** - Chromosomes begin to uncoil to form chromatin, nuclear membrane reforms, nucleolus reappears, mitosis is complete.

**Additional notes:**

_______________________________________________________________________

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_______________________________________________________________________
5.1 Guided Reading
DNA, RNA, and Protein Synthesis
As you carefully read through the text, answer the following questions as completely as possible!

Introduction
1. What is DNA? What is its function?

What is DNA?
2. DNA is an abbreviation for ____________________________ ____________.

3. What does the “deoxyribo” part of the name refer to?

4. DNA is made of a long chain of ____________________________

5. List the three components of a nucleotide.

6. What is the only difference between each nucleotide?

7. List the four possible bases along with their abbreviation.

8. If there are only four letters in the “alphabet” of DNA, how can it encode all of the different genes in your cells?

9. Who discovered the structure of DNA? Whose data helped these gentlemen make their discovery?
10. Describe the structure of DNA.

**Base-Pairing**

11. Who discovered that DNA bases pair in a certain way?

12. Chargaff’s data showed that in DNA, the percentage of adenine (A) always equaled the percentage of ______________, and the percentage of guanine (G) always equaled the percentage of ______________.


14. What is meant by “complementary bases?”

**DNA Replication**

15. Explain when DNA replication occurs.

16. Summarize the three steps of DNA replication.

**Protein Synthesis**

17. The DNA sequence contains the instructions to make units called ______________ ______________, which are assembled in a specific order to make ______________.

18. What are genes? Explain.
Cells Can Turn Genes On or Off

19. There are about ________________ genes in every human cell.

20. Does every human cell have the same genes? Does every human cell use the same genes to make the same proteins? Explain.

Three Types of RNA

21. DNA contains the instructions to make ________________, but it does __________ make the proteins itself.

22. DNA is located in the ____________________, while proteins are made on the ____________________ in the cytoplasm.

23. DNA needs a messenger to bring its instructions to a ribosome located ________________ the nucleus.

24. DNA sends out a message, in the form of ___________, describing how to make the protein.

25. Describe the three types of RNA involved in protein synthesis.

26. All three RNAs are nucleic acids. The RNA nucleotide is different from DNA. Describe these three differences.

Transcription

27. Messenger RNA (mRNA) is created by using DNA as a _____________________.


29. Describe the processes of transcription.
Translation

30. What is translation?

31. During translation three bases, called ______________, are read in the ribosomes.

32. The ribosomes are the organelle responsible for making ____________ ___________, which are linked together to make _________________.

33. Summarize the five steps involved in translation.

Mutations

34. A permanent change in the sequence of DNA is known as a ____________________.

35. A mutation can cause the protein to be made incorrectly, which can affect how well the protein ________________, or whether it works at all.

36. What are the three types of mutations?

37. What is a major mutation?

38. What is a minor mutation?

39. What is a neutral mutation?

40. Mutations can happen spontaneously or they can be caused by ________________ in the environment.

41. List several types of mutagens.
5.2 Guided Reading

Mitosis

As you carefully read through the text, answer the following questions as completely as possible!

Introduction
1. Your DNA is organized into ___________________________; however, they are only tightly wound and visible when the cell is ready to ________________________.

Why Cells Divide
2. According to cell theory, all cells must come from _______________________ cells.

3. Explain how a new life goes from one cell to many.

4. What is the difference between an embryo and a zygote? Explain.

5. List and explain why cell division is necessary for life.

The Cell Cycle
6. What is the “cell cycle?”
7. List and explain the two main components of the cell cycle.
8. List and describe the three important changes that occur during interphase.
9. During mitosis, the ____________________ divides.
10. During mitosis, the parent cell (the dividing cell), forms two genetically identical ___________________________ cells.

11. What does “genetically identical” mean?


Mitosis and Chromosomes
13. The genetic information of the cell (DNA) is stored in the cell’s __________________________.
14. During __________________________, two nuclei must form so that one nucleus can be found in each daughter cell.
15. To begin mitosis, the DNA in the nucleus wraps around ________________________ to form ___________________________.

16. In human cells, the DNA is divided into _______ pairs of chromosomes.
17. After DNA is replicated at the end of interphase, each chromosome has two identical molecules of DNA, called ______________________________.

The Four Phases of Mitosis
18. During mitosis, the two sister chromatids must be ______________ apart and through this process each daughter cell receives one copy of each ____________________________.
19. List and describe the four phases of mitosis.
20. At the end of mitosis each new daughter cell must contain the exact same number and type of __________________________ as the parent cell.

Applying Concepts
21. Interphase is considered the “resting” stage of the cell cycle. Why is this technically incorrect?

22. What are some of the reasons that cells divide?

23. What would happen if the cells in your liver stopped going through the process of mitosis?

5.3 Guided Reading
Reproduction and Meiosis
As you carefully read through the text, answer the following questions as completely as possible!

Introduction
1. Do animals always have two parents? Explain.

What is Reproduction?
2. What is reproduction?

3. What are the two methods of reproduction?

Asexual Reproduction
4. What does it mean to reproduce asexually?

5. What are the advantages of asexual reproduction?

6. What are the disadvantages of asexual reproduction?
7. List several types of organisms who can reproduce asexually.

**Sexual Reproduction**

8. During sexual reproduction, ____________ parents are involved, with the male producing ____________ and the female producing ________________.

9. When a sperm and egg meet, a ________________, the first cell of a new organism is formed.

10. The zygote will divide and grow into the ________________.

11. The sperm and egg, the two sex cells, are known as ____________________.

**Meiosis and Gametes**


13. As gametes are produced through meiosis, the number of chromosomes must be reproduced by half? Why? Explain.

14. In humans, our cells have 23 pairs of chromosomes, or 46 total. How many chromosomes did you get from your mother? How many from your father?

15. Describe the three steps of meiosis.

16. What are alleles?

17. Since the separation of chromosomes into gametes is random, it results in different combinations of __________________________ (and alleles), in each ________________.

18. With 23 pairs of chromosomes, there is a possibility of ____________________ different combinations of chromosomes in a gamete!
Haploid vs. Diploid

19. A cell with two sets of chromosomes is ________________, referred to as _________, where \( n \) is the number of sets of chromosomes.

20. A cell with one set of chromosomes, such as a gamete, is ________________, referred to as \( n \). Sex cells are haploid.

21. When a haploid sperm \((n)\) and a haploid egg \((n)\) combine, a ________________ zygote is formed \((2n)\).

22. When a diploid zygote is formed, half of the DNA comes from each ________________.
Many, many years ago (actually probably around 13 years ago) you were made of just one cell. Yes, you were just one tiny cell that people needed a microscope to see. Then one day that cell underwent mitosis, which means cell division. Everything inside that cell was copied (the nucleus, the mitochondria, the vacuoles, all the DNA, etc.) so that when the cell split, both the new cell and the old cell would have everything they needed to survive. These two cells then each underwent mitosis so that these two became four cells, and those four cells became eight, and then sixteen cells, and then thirty-two cells and so on. Eventually, there enough cells so that a beautiful bouncing baby was born (that's you). But it didn't stop there! You'd look pretty funny as a 7 pound 7th grader, so instead your cells continued going through mitosis making more and more cells. That's why you are bigger today than when you were born. You have more cells (but NOT bigger cells) than when you were a baby. Elephants have more cells than you do but the cells they have are about the same size as yours.

Louis Pasteur taught us that no living thing, not even cells or bacteria, can pop into being out of nowhere. Everything has to come from somewhere; every living thing has to have parents of some kind. All living things are made of cells and all cells come from other cells (kind of makes you wonder where the very first cell came from then doesn’t it?!?). So as you can see, mitosis is the basis of all life! Let’s find out how it works.

Mitosis is a process that can be broken down into 4 steps. These steps are called Prophase, Metaphase, Anaphase, and Telophase. A phase called interphase is not actually part of mitosis, but is the resting phase that the cell is in when it is not dividing.

**Interphase.** Most of the time, a cell is not actually dividing. Instead it spends most of its time just resting and performing cell activities like cellular respiration, osmosis, and for plant cells, photosynthesis. During interphase, DNA and other cell materials are copied. While in interphase, the DNA is shaped like uncoiled strands that look like spaghetti. When it is in this shape, it is called chromatin. When DNA is loosely packed like this it is much easier for the cell’s machinery to copy.

**Prophase.** This is the first step of mitosis. The nuclear membrane (membrane around the nucleus) breaks apart. Chromatin condenses into rod-like structures called chromosomes. Take a look at the other side of this paper and find something inside any of the cells that looks like a big fat X. This is a chromosome that has been copied. One half of the X is the original chromosome and the other half is the copy.

Another thing that happens during Prophase is that the centrioles move to opposite sides of the cell and spindle fibers form across the cell. We’ll find out what these do later...

**Metaphase.** During this stage of mitosis the chromosomes line up in the middle of the cell, right along the equator. Each chromosome attaches itself to a spindle fiber.

**Anaphase.** The centrioles act like fishermen and start to reel in their fish (the chromosomes) using the spindle fibers as line. During anaphase the twin copies of the chromosomes get separated and each copy moves to opposite sides of the cell.
**Telophase.** Now that the chromosomes are separated, two new cells are formed. The spindle fibers disappear; the chromosomes uncoil and become spaghetti-like chromatin again. The nuclear membrane reappears and finally the cytoplasm divides to form two new daughter cells which are identical to each other. In a plant cell, a cell wall forms between the two new cells.

**Questions:** Answer these questions by following the directions in each one and using the pictures on the coloring page. The questions do not necessarily go in order.

1. Outline the cell membrane of the cells in these colors:
   - Prophase cells—red
   - Metaphase cells—green
   - Anaphase cells—yellow
   - Telophase cells—orange
   - Interphase cells—purple

2. What is the name for the resting period between cell divisions? ______________. Color the word brown.

3. In interphase, the DNA is in the form of loose threads called ______________. Color the word and pictures blue.

4. Condensed DNA is called ______________. Color the word and these structures in metaphase cells green.

5. During metaphase the chromosomes line up along the middle of the cell called the ______________. Write the answer in the top left corner on the other side of this paper.

6. During what stage do the chromosomes pull apart? ______________. Color the word yellow.

7. Another name for cell division is ______________. Color the word blue.

8. What structure reappears during telophase? ______________
   Outline this structure in the telophase cells with red.

9. During which stage does the DNA copy itself? ______________. Draw an orange star next to this word.

10.
Mitosis

2 NEW DAUGHTER CELLS ARE FORMED

INTERPHASE

PROPHASE

METAPHASE

ANAPHASE

TELOPHASE
Label the stages of mitosis in the below diagrams. COLOR the stages as follows --- interphase-pink, prophase-light green, metaphase-red, anaphase-light blue, and telophase-yellow. Also label the CENTRIOLES, SPINDLE FIBERS, CENTROMERE, and CHROMOSOMES. Color the centrioles purple, spindle fibers brown, centromeres dark blue and the chromosomes orange.

Mitosis of an Animal Cell
Cell Division Drawings

A
Label chromosomes.
Label whether or not DNA has been "copied".
Label two errors in the model (explain two inaccuracies in the model)
Under "A" write the name of this phase of cell division.
Also under "A" explain what happens to the DNA and what DNA is called when it is not seen.

B
Label chromosome pair, chromatid, centromere.
When labeling centromere also explain what it does.
Under "B" label the name of this phase of cell division.
Also under "B" explain what happens to chromosomes so we can "see" them.

C
With a pencil sketch in the spindle and centriole, color the spindle blue and centriole red
Label spindle, centriole, chromosome pair, chromatid
Under "C" label the name of this phase of cell division.
Also under "C" explain how the chromatids organize themselves.

D
With a pencil sketch in the spindle & centriole, color the spindle blue & centriole red
Label spindle.
Label sister chromatids separate.
Under "D" label the name of this phase of cell division.
Also under "D" explain what happens to the chromatids, and explain what they are called now.

E
Label chromosome (uncoiling), centromere
Under "E" label the name of this phase of cell division
Also under "E" explain what happens to the chromosomes at this time and explain what they become.

Questions: Answer on the back of the poster
1. What is happening in the cell from the 1st through the 5th stage.
2. Strands are genetic material. How does it appear in stage 1.
3. What happens to the genetic material in B and C?
4. How does E (both of them) compare to A? And how do they compare to each other.
**Observing Mitosis Lab**

**Label:**
- **Chromosome**
- Whether DNA has been copied
- Two errors in the model (explain two inaccuracies in the model)

**Label:**
- **Chromosome pair**
- Sister chromosomes
- Centromere
- Chromatid
- When labeling centromere also explain what it does.

**Label:**
- **Spindle**
- Centriole
- Sister chromosomes
- Chromosome pair
- Use a red marker to add spindle and blue marker to add centrioles

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**A**
**Name**
Explain what happens to the DNA and explain what DNA is called when it is not seen.

**B**
**Name**
Explain what happens to chromosomes so we “see” them.

**C**
**Name**
Explain how the chromatids organize themselves at this time.

**Label:**
- **Spindle**
- Centriole
- Sister chromosomes

**Label:**
- Chromosomes (uncoiling)
- Centromere

---

**D**
**Name**
Explain what happens to the chromatids, and explain what they are called now.

**E**
**Name**
Explain what happens to the chromosomes at this time and explain what they become.
**Problem:** How do the phases of mitosis appear under a microscope?

2. Place the slide on the stage of the microscope and find the stages of mitosis.

3. Compare the stages on the slide to the drawing of the stages in the textbook on pages 90 and 91.

4. Draw and label the stages of mitosis (include interphase).

**Procedure:**

1. Obtain a prepared slide that shows mitosis in cells (*Allium* root tip l.s.).

**Analysis and Conclusions:**

1. What occurs during cell division? ____________________________________________________________

2. How is mitosis different from cell division? ___________________________________________________

3. List the stages of mitosis in the proper order.
   
   1st _______ 2nd _______ 3rd _______ 4th _______ 5th _______

4. To which structures do the chromosomes become attached during prophase? ________________

5. Based on your plate drawing describe the entire process of mitosis? ____________________________

6. Why are the daughter cells produced by mitosis exactly like the parent cell? ____________________
7. If the chromosomes of a cell do not duplicate during mitosis, how many chromosomes does each daughter cell have?

_____________________________________________________________________________

8. Would the daughter cells in question seven be identical to the parent cell? Explain.

_____________________________________________________________________________

9. Why was onion root tip cells used for observing mitosis?

_____________________________________________________________________________

10. Name each numbered stage in the plant cell diagram below. Choices: Interphase, Prophase, Metaphase, Anaphase, or Telophase.
   1. _____________________  2. _____________________  3. _____________________
   4. _____________________  5. _____________________  6. _____________________
   7. _____________________  8. _____________________  9. _____________________
   10. _____________________ 11. _____________________ 12. _____________________
   13. _____________________ 14. _____________________ 15. _____________________
   16. _____________________ 17. _____________________ 18. _____________________

Plant Cells in Mitosis
Objective: Look at computer models of mitosis, describe the dividing cell and its components.

Navigating the site: After accessing the page, click on CELL BIOLOGY found on the left side navigation bar. From here, you will access the link: Mitosis. Animal cell mitosis animation demonstrates the stages of mitosis. Use the control buttons in the upper left to run the complete animation. Click on any stage (for example anaphase) and see a still frame.

Sketch Interphase
Label centrioles the nucleus in interphase.
In interphase cells are active. Explain.

_________________________________________________________
_________________________________________________________
_________________________________________________________

Sketch Prophase
In prophase what happens to the nucleus? _________________________
_________________________________________________________
_________________________________________________________

In prophase what happens to the DNA? ___________________________
_________________________________________________________

In prophase what happens to the spindle? _________________________
_________________________________________________________

Sketch Metaphase
In metaphase what happens to the chromosomes? ___________________
_________________________________________________________
What moves the chromosomes? _________________________________
_________________________________________________________

Sketch Anaphase
During anaphase what happens to the chromosomes? _________________
_______________________________________________________

Sketch Telophase
During telophase what happens to the chromosomes? _______________
_________________________________________________________
What happens to the spindle _________________________________
_________________________________________________________
What happens after telophase? ________________________________
_________________________________________________________
Mitosis Tutorial

Website:  http://biog-1101-1104.bio.cornell.edu/BioG101_104/tutorials/cell_division.html

Review the whitefish mitosis.

1. Which stage is this ________? What is happening in this stage? ________________________________

2. Which stage is this ________? What is happening in this stage? ________________________________

3. Which stage is this ________? What is happening in this stage? ________________________________

Review the Onion Root tip mitosis.

4. Which stage is this ________? What is happening in this stage? ________________________________

5. Which stage is this ________? What is happening in this stage? ________________________________

6. Which stage is this ________? What is happening in this stage? ________________________________

7. Which stage is this ________? What is happening in this stage? ________________________________

Take the quiz, do questions 1-6.

1. Stage of mitosis shown _____ Double-chromatid chromosomes present: ______

2. Stage of mitosis shown _____ Structure indicated: ______

3. Stage of mitosis shown _____ Draw an arrow to the place cytokinesis will occur:

4. Stage of mitosis shown _____ Structure indicated: ______

5. Stage of mitosis shown _____ Ploidy state of cell and condition of chromosomes:_______

6. Stage of mitosis shown _____ Draw an arrow to the place where the cell plate is located:
1. How many chromosomes are in this cell? ________

2. What is replicated? ________________ How many chromosomes are there now? ________

3. What are doubled chromosomes? ________________________________

4. What is the equator? ________________________________________

5. What happens to the doubled chromosomes? _______________________

6. What forms around each set? __________________________________

7. How do the chromosome sets compare? ____________________________

8. What is dividing now? _________________________________________
Online Onion Root Tips
Objective: Determining time spent in different phases of the cell cycle
Objective: Recognize the processes cells go through to reproduce

URL: www.biology.arizona.edu/CELL_BIO/activities/cell_cycle/assignment.html

In this activity, you will be presented with cells from the tip of an onion root. You will classify each cell based on what phase it is in. At the end you will count up the cells found in each phase and use those numbers to predict how much time a dividing cell spends in each phase. You can base your calculation on a total cell cycle of 24 hours.

<table>
<thead>
<tr>
<th></th>
<th>Interphase</th>
<th>Prophase</th>
<th>Metaphase</th>
<th>Anaphase</th>
<th>Telophase</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cells</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Percent of cells</td>
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</tbody>
</table>

Mitosis Video Clip: Website
http://highered.mcgrawhill.com/sites/0072437316/student_view0/chapter11/animations.html#

Click on mitosis – cytokinesis to watch the video

1. Mitosis is what type of division? ___________________________________________

2. What is formed by mitosis? ________________________________________________

3. What is formed during prophase
   a. ___________________________   b. ___________________________

4. What are kinetochores? ____________________________________________________

5. What do the chromosomes do during metaphase? ______________________________

6. What moves the chromosomes a part? _______________________________________

7. Where are the chromosomes during telophase? _______________________________

8. What happens to the nucleus during telophase? ______________________________

9. What happens after telophase? ____________________________________________
Cell Division
Discovery streaming video

1. How does all life start? ____________________________

2. How often can bacteria divide/reproduce? ____________________________
   How many bacteria can a single bacterium become in less than 12 hours? _______
   Why is this called asexual reproduction? ____________________________

3. For most kinds of life, reproduction requires two parents, a father and a mother. This
   type of reproduction is called ____________________________.
   Special cells for reproduction called _______ from each parent _______ together.
   In males, they are called a _______. In females they are called _______.
   A human egg is _____________ of times larger than a sperm, but it is still tiny -
   smaller than a _____ left by a finely-sharpened pencil.

4. When the sperm and egg combine, these two cells form a single cell called a ________.

5. After fertilization, the zygote divides to form _____ cells, but instead of _______
   like the cells of bacteria, they stay together.
   These two cells in turn also divide so that there are _____ cells. This happens over
   and over again.

6. After awhile, the cells begin to differentiate, or ____________________________.

7. After 4 weeks, different areas of cells begin to form ____________________________.

8. By the end of 7 weeks, the shape of a person begins to appear. A _____________
   become distinguishable, as well as buds that will become ____________________________.

9. By the fourth month, such features become more distinct and ____________________________.

10. After birth, cells continue to ____________________________.

11. Throughout childhood, cell division makes it possible for our ____________________________

12. But even when we reach our full size, cells continue to divide. For example, the body
   constantly makes ____________________________ to replace cells that wear out and die.

13. This continues into old age. In fact, it stops only when we ________________.

14. The master plan to tell which cell should divide and into what type of cell exists in
   structures, called ____________________________
15. Humans have _____ chromosomes.

16. When a ______&______ combine, their chromosomes also combine so that half the chromosomes in the fertilized egg come from the male parent and the other half from the ________.

17. Each chromosome contains many different _______. These are distinct parts of a chromosome that control how different traits are developed.

18. There are over ___________different genes on human chromosomes, each containing specific instructions, but only a very few of these ____________ in any single cell.

19. For example, genes for ________ are switched on when muscle cells are made.

20. When a cell divides, it makes a complete ___________. In this way every _______ gets a complete copy of all the genetic instructions in the original cell.

21. The process through which most cells divide is called ___________.

22. After the chromosomes have made copies of themselves, the chromosomes ______ ________

23. The membrane of the cell's nucleus begins to ___________

22. While the twin chromosomes are still attached to each other, they ____________

23. The twin chromosomes then ____________ and move to opposite ends of the cell, and the cell pinches, dividing in two.

24. A ____________ forms around each set of chromosomes. Each contains a complete set of chromosomes, and _____________.

25. There is, however, an important exception to how cells divide. This exception occurs when ______ ______ - sperm and eggs - are formed.

26. If human sperm and egg each (full set of 46 chromosomes) had a full set of chromosomes.

When the sperm entered the egg, the resulting cell would then contain ________.

The children would have ________ the # of chromosomes as their parents.

27. Sperm and egg cells have only ____ the normal number of chromosomes, because they are formed as a result of a different kind of cell division called ______________.

28. Meiosis starts with special cells that are located in a females ______ and the males _________

29. During meiosis cells then go through a __________ round of cell division and each of the four cells has ______ number of chromosomes.