

Unit 2: Cellular Chemistry, Structure, and Physiology

Module 5: Cellular Reproduction

NC Essential Standard:

- 1.2.2 Analyze how cells grow and reproduce in terms of interphase, mitosis, and cytokinesis
- 2.1.2 Analyze the survival and reproductive success of organisms in terms of [reproductive] adaptations
- 3.2.1 Explain the role of meiosis in sexual reproduction and genetic variation



Since we say family members are “blood” relatives, does that mean we share the same blood?

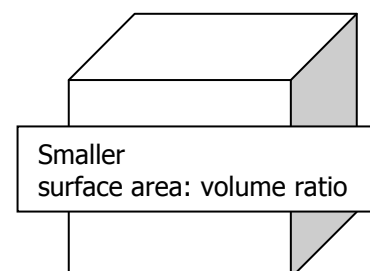
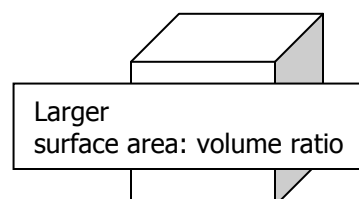
- You share no blood with anyone....not even your mother and father! Your family shares DNA.
- $\frac{1}{2}$ of your DNA came from your mother (egg) and $\frac{1}{2}$ from your father (sperm).
- The process that made this possible is **MEIOSIS** which makes the sperm and egg.
- A fertilized egg then grows into an organism by a different process of cell division called **MITOSIS**.

I. Why do cells divide?

A. Cells divide to maintain a workable _____

1. Volume is the amount of space _____ of a cell. This would include the cytoplasm and all of the organelles.
2. Surface area is the total amount of _____ which is exposed to the environment around the cell. This would include the outside of the cell membrane.
3. Volume increases faster than surface area. The surface area must be large enough for a sufficient amount of materials to enter the cell. The materials must enter quickly enough that all of the cell will get what it needs. Thus, a _____.

Examples:



EXPLAIN which of the cell sizes pictured is preferable.

B. Cells divide to make more cells



2 reasons that cells need to divide:

1.

2.

1. _____ of a multicellular organism requires the addition of cells. Larger organisms do not necessarily have bigger cells, but they will have more cells than smaller organisms.
2. _____ of damaged tissues by replacement of cells lost due to injury or cell death requires cell division. A healthy cell will divide to replace the lost cell(s).
3. Cell division occurs at _____ depending on the organism and the type of cell.
 - a. Plant root cells would divide _____ because this is an area of active growth.
 - b. Some _____ enter a phase of no division.
 - c. Some _____. For example, E. coli can divide every 20 minutes in ideal conditions.

Watch It!

II. How do cells divide?

A. Prokaryotic vs. Eukaryotic Division

1. The result of all cell division is the production of **daughter cells**. In order for the daughter cells to contain enough DNA, the _____ (DNA) of the parent cell must be _____.
2. Prokaryotic division differs from eukaryotic division because _____ or membrane-bound organelles.
3. Eukaryotic division requires the _____ and genetic material (DNA) as well as the allocation of the organelles into each daughter cell.

Reason that prokaryotic cell division is simpler than eukaryotic cell division...

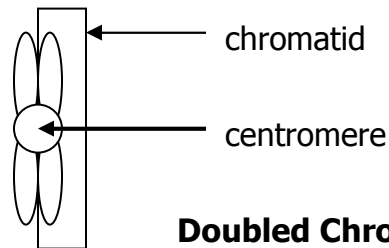
B. Eukaryotic Cell Cycle and Mitosis

Differentiate between..
Chromatin –

Chromatid –

Chromosome –

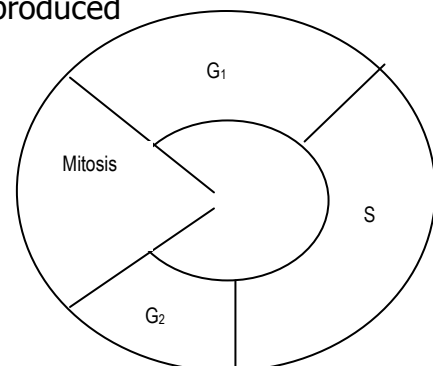
1. **Interphase** is the “normal” part of the cell cycle. The cells spend _____ (life of the cell) in interphase. There are three stages in interphase
- a. **G₁** – Cell _____ and synthesizes new proteins and organelles.
 - b. **S** – _____.
 - i. During most of interphase DNA exists in a “relaxed”, _____ form called **chromatin**. After being copied, there are two complete copies of the DNA in the cell. These copies are attached to each other.
 - ii. Each copy of DNA is called a **chromatid**. The two _____ in a region called the **centromere**. At this point in interphase, the chromatids are coiled / condensed. The entire structure is called a **doubled chromosome**.



Doubled Chromosome

Summary of the cell cycle
1. Interphase
 i.
 ii.
 iii.
2. Mitosis
 i.
 ii.
 iii.
 iv.
3.

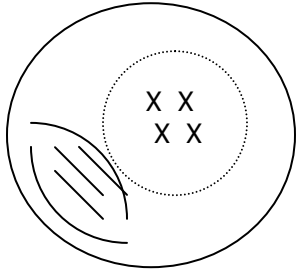
- c. **G₂** – _____ and molecules required for cell division are produced



On the diagram of the cell cycle, HIGHLIGHT the stages that are part of Interphase.

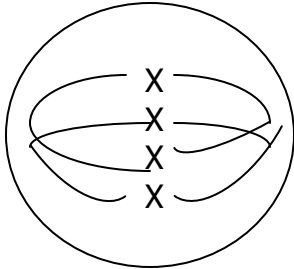
2. Stages of **Mitosis** (_____)

a. Prophase



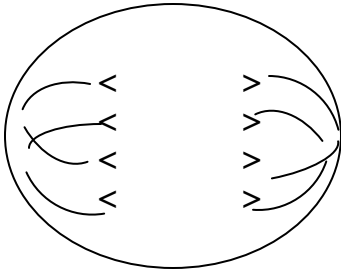
- Coiled _____ become visible
- Nuclear membrane is _____
- _____ (protein fibers that will attach to chromosomes and aid in chromosome movement) start to form

b. Metaphase



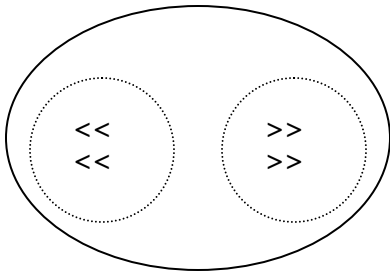
- Spindle fibers attach to the _____ regions
- Chromosomes are moved to the _____ of the cell

c. Anaphase



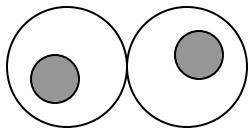
- Spindle fibers _____
- Doubled chromosomes are _____ into chromatids
- Chromatids begin to _____/ends of the cell

d. Telophase

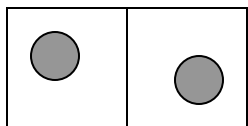


- Spindle fibers are broken down
- _____ around the clusters of chromatids at each pole of the cell

3. **Cytokinesis** is the _____ (including all organelles) into two identical daughter cells.



- a. Animal cells constrict in the middle to _____ forming two different cells.



- b. Plant cells also produce a **cell plate** dividing the two cells. This cell plate will become the _____.

C. Mitosis and Cancer

Cancer is caused by uncontrolled _____, which may occur because of

- 1.
- 2.
- 3.

1. Typically, cell division is _____ in the cell, contact with other cells, and available nutrients in the environment.
2. Cancer is a class of diseases characterized by _____ and the ability of these cells to invade other tissues.
3. Cancer occurs when the genes that control cell division _____. This may occur because of an inherited genetic defect, a spontaneous genetic mutation, or a mutation caused by environmental factors.

Check Yourself!

1. Why is a large surface area: volume ratio preferable?
2. Name three reasons cells must divide.
3. Why is eukaryotic cell division more complex than prokaryotic cell division?
4. What are the two basic stages of the cell cycle?
5. How is the genetic material "prepared" for cell division during interphase?
6. How many daughter cells are produced as a result of mitosis, and how do these cells compare to the parent cell?
7. How are mitosis and cancer connected?



III. Why does reproduction require two types of cell division?

A. Asexual reproduction and cell division

1. **Asexual reproduction** is reproduction involving only _____ (i.e. one parent). This means that offspring will be genetically _____ to the parent, or **clones**.

2. There are several types of asexual reproduction:

- a. **Binary fission** occurs when a unicellular organism (such as bacteria or an amoeba) _____ for the purpose of reproduction.
- b. **Budding** occurs when simple organisms (such as yeast or hydra) _____ than those of the parent organism.
- c. **Sporulation** occurs when an organism (such as mushrooms) produce spores – _____ – for the purpose of reproduction.
- d. **Vegetative propagation** occurs when a _____ in order to produce another plant.
- e. **Regeneration** occurs when a _____ (such as an earthworm) _____ to produce a new organism.

3. Advantages and Disadvantages of Asexual Reproduction:

- a. Advantages of asexual reproduction include _____ of reproduction and producing multiple copies of successful genetic combinations.
- b. Disadvantages of asexual reproduction include increased risk of a single factor affecting an entire population due to _____.

Simple pictures of asexual reproduction:
Binary fission
Budding
Sporulation
Vegetative Propagation
Regeneration

4. _____ is usually the mechanism that allows asexual reproduction to occur. For example, when an earthworm is cut in half, cells must use mitosis to divide in order to produce cells which will reconstruct the missing portion.

B. Sexual reproduction and cell division



1. **Sexual reproduction** is reproduction involving _____ (i.e. two parents). This means that offspring will be genetic combinations of the two parents.
- a. **Gametes** are _____, such as sperm and egg. The purpose of a gamete is to fuse with another gamete to combine genetic material (_____).
- b. A **zygote** is the cell which is produced by fertilization. The _____.

2. Advantages and Disadvantages of Sexual Reproduction:

- a. The main advantage of sexual reproduction is _____. With many genetic possibilities, the likelihood of a successful combination of traits for a particular environment is high.
- b. The disadvantages of sexual reproduction include the _____ for fertilization (which requires more time) and the risks of unfavorable genetic combinations.

Summary:		
	Advantage	Disadvantage
Asexual		
Sexual		

3. Although sexual reproduction begins differently than asexual reproduction (with two parents as opposed to one parent), sexual reproduction _____.
- a. **Meiosis** is a type of cell division which produces gametes. Meiosis is a unique type of cell division because it _____, allowing for fertilization.

In sexual reproduction...

Job of meiosis –

Job of mitosis -

Example: Human body cells contain 46 chromosomes.

In order for a zygote (fertilized egg) to contain 46 chromosomes, the sperm and egg must each contain only 23 chromosomes.

- b. Mitosis is the process which allows the zygote to begin dividing to produce a _____. The cells also must differentiate (become different types of cells to carry out different functions).

Check Yourself!

1. How many sources of genetic material are involved in asexual reproduction?

In sexual reproduction?

2. Name five types of asexual reproduction.

3. Why is mitosis necessary for asexual reproduction?

4. Name one advantage and one disadvantage of asexual reproduction.

5. What are gametes? How is a zygote produced from gametes?

6. Name one advantage and one disadvantage of sexual reproduction.

7. How are both mitosis and meiosis necessary for sexual reproduction?



IV. How does meiosis produce gametes?

A. Recall that a gamete is very different from a **somatic** (body) cell.

1. A somatic cell is **diploid**, which means it contains _____
_____. These chromosome pairs are called **homologous chromosomes**. For example, a human has 23 types of chromosomes. A human somatic cell has 46 total chromosomes, consisting of 23 homologous pairs.
2. A gamete is **haploid**, which means it contains only _____
_____ (one from each homologous pair). For example, a human egg cell (ovum) contains 23 total chromosomes.

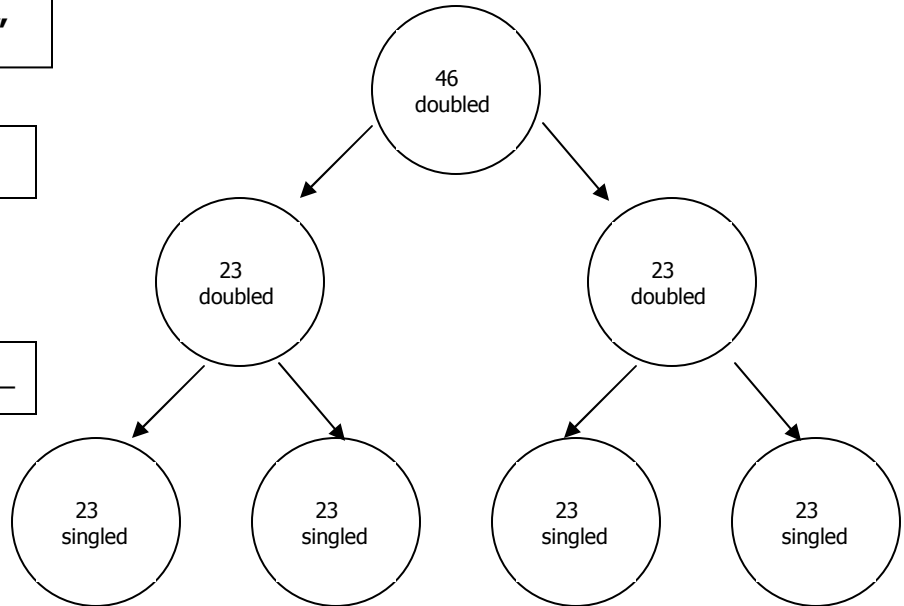
<p># of chromosomes in a human...</p> <p>DIPLOID cell _____</p> <p>HAPLOID cell _____</p>
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B. Eukaryotic Cell Cycle and Meiosis

1. At the end of interphase (the longest part of the cell cycle in which the cell completes normal life functions), the cell _____. This creates doubled chromosomes. The cell is now ready to divide.
2. Meiosis requires two cell divisions:
 - a. Meiosis I is called the **reduction division**. In this division, the _____
_____. The end result of Meiosis I is two daughter cells, each of which is haploid but contains doubled genetic material.
 - b. Meiosis II uses the same basic steps as mitosis. In this division, the doubled chromosomes are separated. The _____, each of which is haploid and contains no duplicated DNA.

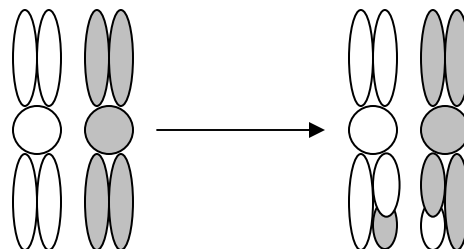
Label each of the cells in the diagram as "diploid" or "haploid"

c. Graphical representation of Meiosis:



5. Meiosis provides several sources of **genetic variation**:

- a. **Gene mutations** can occur during the _____ at the end of interphase before meiosis (or mitosis) begins.
- b. **Crossing over** occurs when the homologous pairs come together during Meiosis I. In crossing-over a part of one chromosome can _____ with the same part of the homologous chromosome. Then, when the homologous pairs are separated, each chromosome will be different than the original.



Summary of sources of genetic variation:

- 1.
- 2.
- 3.
- 4.
- 5.

- c. **Random assortment** of chromosomes into daughter cells during Meiosis I allows for a _____
_____ inherited from each parent.
- d. **Nondisjunction**, when homologous chromosomes do not properly separate, may occur during Meiosis I, creating a gamete with _____
_____.
- e. The **random fertilization** of any one egg by any one sperm allows for _____ in offspring.

Check Yourself!

1. How is the chromosome number of a gamete different from the chromosome number of a somatic cell?
2. What types of cells are diploid? Haploid?
3. What is the purpose of meiosis?
4. What is another name for Meiosis I?
5. How is the purpose of Meiosis I different from the purpose of Meiosis II?
6. Name five sources of variation meiosis provides.
7. Describe crossing-over.



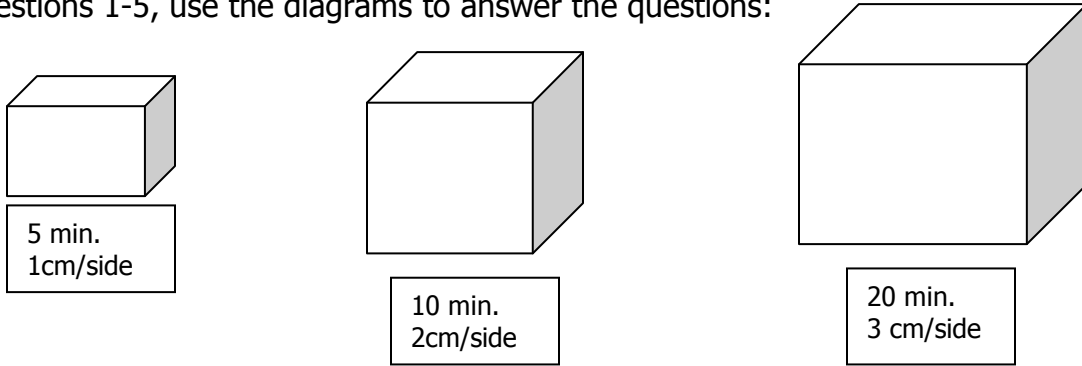
Comparing Mitosis and Meiosis

Put an "X" in a box to indicate if the statement applies to Mitosis or Meiosis. If the statement applies to both, put an "X" in both boxes.

Characteristic	Mitosis	Meiosis
A cell with 8 chromosomes would create two cells with 8 chromosomes each		
Two divisions		
Four daughter cells are produced		
Used for growth and asexual reproduction		
Used for sexual reproduction		
One division		
Two daughter cells are produced		
The chromosome number is maintained from parent to daughter cells		
Creates identical daughter cells		
No regulation of the process can lead to cancer		
Daughter cells are not identical to the parent cell		
Produces gametes		
Takes place in somatic cells		
Chromosomes move around in the cell during different phases		
DNA is duplicated before the process begins		
Type a unicellular organism would most likely use		

**Unit 2 / Module 5
Problem-Solving Set**

The diagrams below show a plant cell at different stages of cell growth. For questions 1-5, use the diagrams to answer the questions:



1. Surface area is calculated by the formula length x width x 6. Calculate the surface area for the cell at each time.

- a. 5 min. cm^2
- b. 10 min. cm^2
- c. 20 min. cm^2

2. Volume is calculated by the formula length x width x height. Calculate the volume of the cell at each time.

- a. 5 min. cm^3
- b. 10 min. cm^3
- c. 20 min. cm^3

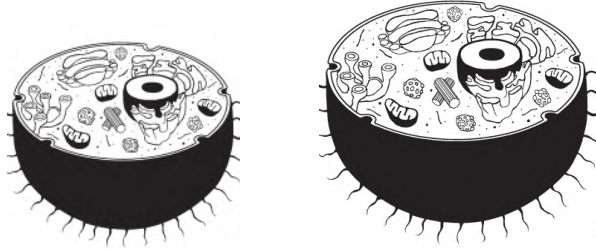
3. What is the surface area : volume ratio for the cell at each time?

- a. 5 min.
- b. 10 min.
- c. 20 min.

4. At which time is the surface area : volume ratio the largest?

5. At which time will diffusion of materials into the cell be least effective?

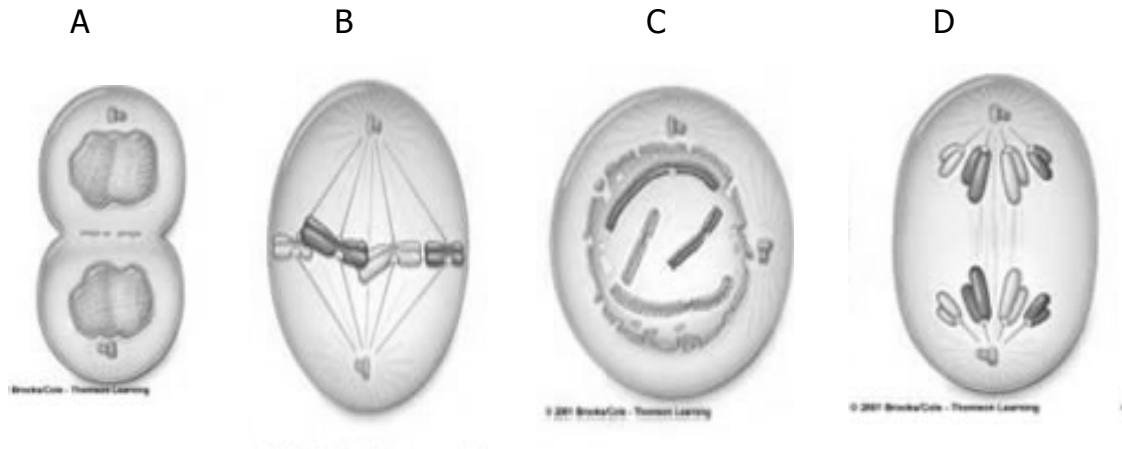
6. On the cell diagrams shown below, **OUTLINE** the area that represents the surface area in blue, **SHADE IN** the area that represents the volume in red.



LABEL each cell with the correct surface area : volume ratio using the choices below:

- a. 2:1
- b. 3:1

Use the diagrams of a cell undergoing mitosis to answer questions 7 – 10:

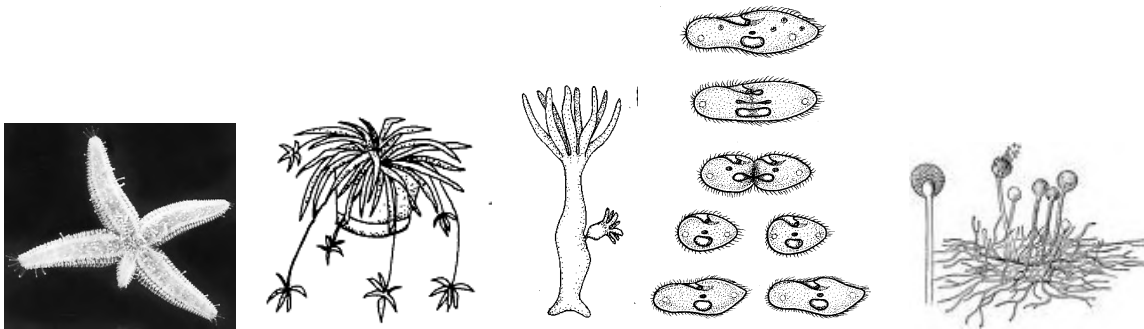


7. What is the correct order of the cells above? _____, _____, _____, _____
8. Describe the location of the chromosomes in diagram B. _____

9. How many daughter cells will be produced in this process? _____
10. If the original cell has 4 chromosomes, how many chromosomes will be in each daughter cell? _____

11. Describe how the growth of cancerous tumors is related to mitosis.

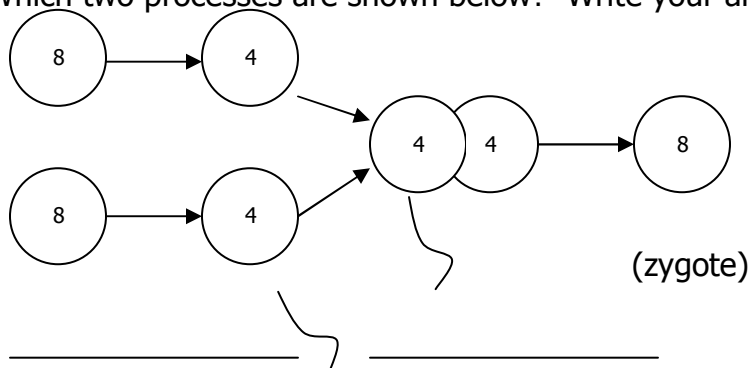
12. Identify the type of asexual reproduction being shown:



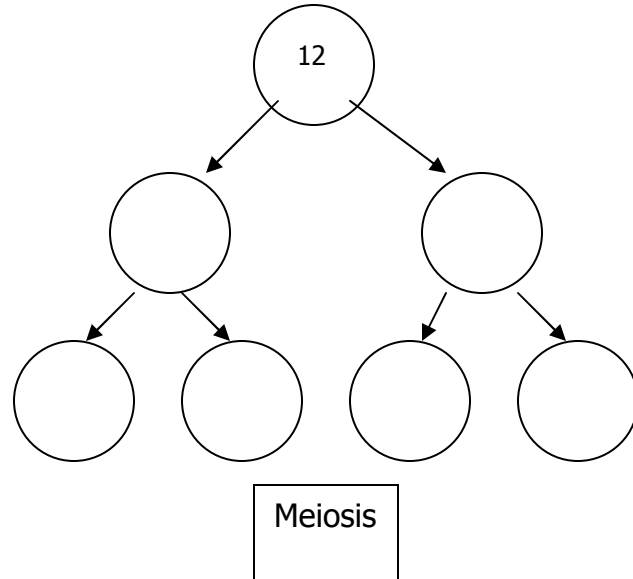
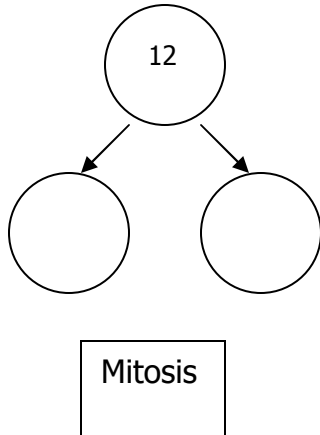
13. For the chart below, place an X in the column to indicate if the statement applies to sexual or asexual reproduction. If the statement applies to both, put an "X" in both boxes.

Characteristic	Sexual Reproduction	Asexual Reproduction
Produces genetically identical offspring.		
Mitosis is the mechanism which allows this to occur.		
Requires mating for fertilization of the egg.		
Two genetic sources are combined to produce offspring.		
Typically begins with meiotic division to produce gametes.		
The main advantage is genetic variation.		
Increases the size of the population.		

14. Which two processes are shown below? Write your answers on the lines.



Use the following diagrams for questions 15 – 18



15. Using the number of chromosomes in the parent cell, write the number of chromosomes that would be found in each cell.
16. Color all diploid cells red and all haploid cells blue.
17. If this **meiotic** division was occurring in a **males** body, what type of cells would the "daughter" cells be? _____
18. Which type of cell division shown above would be used to heal a wound?

For questions 19-23, identify the source of genetic variation being described. Each source (gene mutation, crossing over, random assortment of chromosomes, nondisjunction, and random fertilization) will be used just once.

Description	Source of genetic variation
19. A male fruit fly produced 500 sperm cells. The female fruit fly produced 100 egg cells. Only 50 of that males sperm cells were used to fertilize 50 of the females eggs.	
20. A daughter cell of meiosis was produced with one additional chromosome (one too many)	
21. Each sperm cell produced in the male cat's body has a combination of genes from his mother cat and his father cat	
22. The DNA was not duplicated exactly before meiosis.	
23. After Meiosis I, a chromosome is different than the original	

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<http://www.biology.iupui.edu/biocourses/N100/images/8mitosiscropped.jpg>

<http://tonkydesigns.com/blog/wp-content/gallery/2009-random/animal-cell-diagram-wall-sticker-silo2.jpg>