MP2

Notebook

NAME_____

SCI#_____

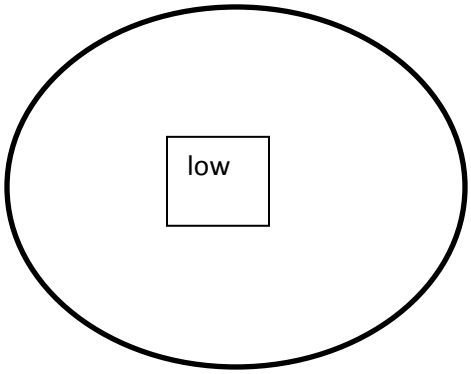
HOLT USERNAME / PASSWORD_____

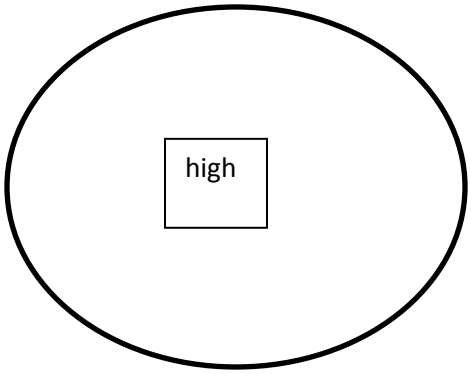
LAB PARTNER_____

201

Microscope number_____

FOV





NAMES AND SCI#S:_____

TITLE: This should include the title of the lab and the chapter. Ex. Ch 3 Biomolecules of Food Lab.
20 points (includes name, science number, proper format)

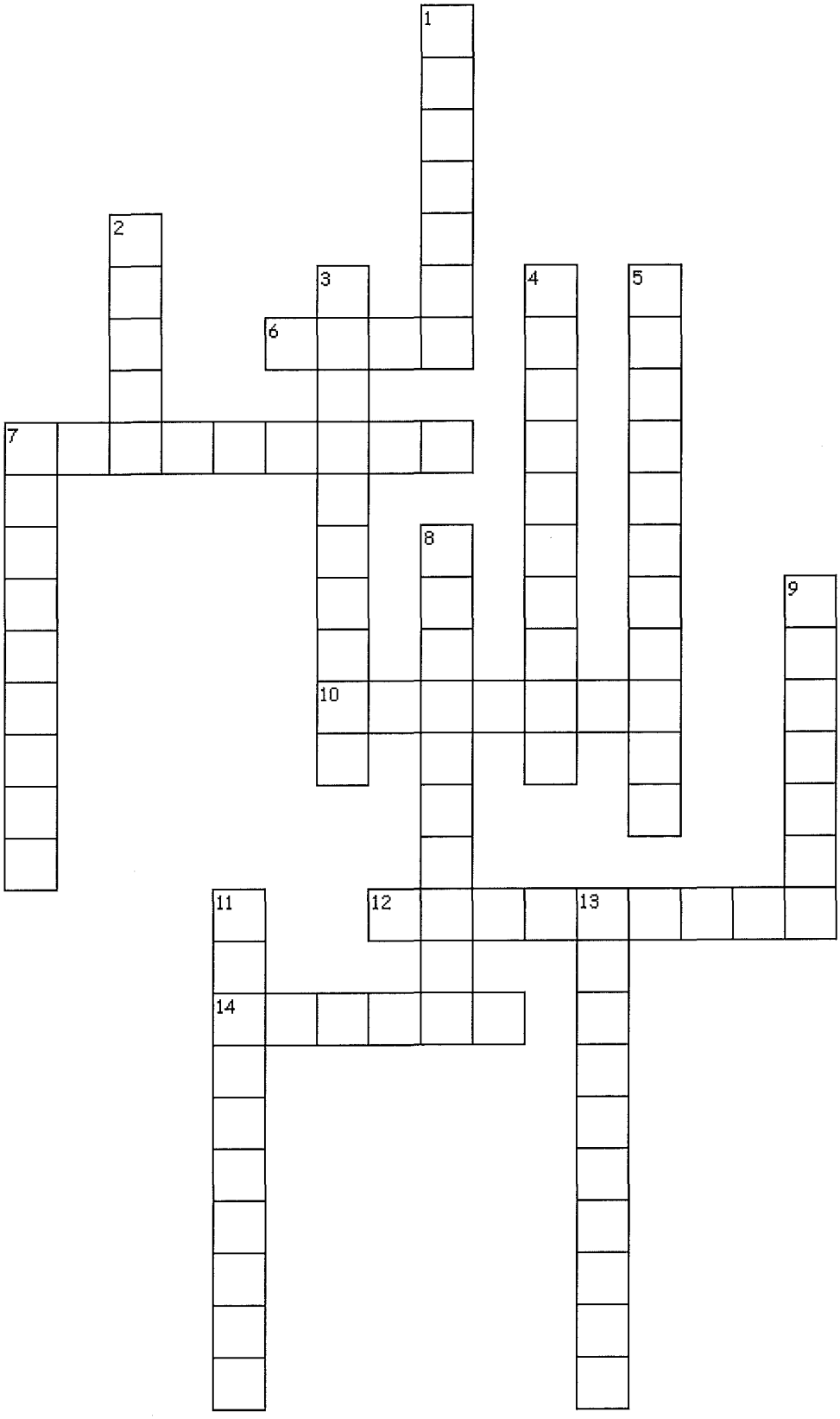
PURPOSE: State what the purpose of this lab is and a hypothesis when applicable. Ex. In this lab, we will be examining the amount and proportions of carbohydrates, fats and protein in a typical fast food meal.
10 points

BACKGROUND: List the relevant information regarding the lab. This should be AT LEAST one paragraph Ex. The four biomolecules are carbohydrates, lipids, proteins and nucleic acids. We will be measuring……
20 points

DATA: This is where microscope drawings, data tables, graphs and photos are included. EVERYTHING must be labeled and titled. For microscope drawings and pics, the magnification as well as the object must be given. All tables and graphs MUST have a title , key and the axes must be properly labeled. If this information is not included, the data will be given a zero.
30 points

CONCLUSION: you must relate the materials gathered/viewed/observed/collected in lab to the background information as well as any relevant information from class or previous labs. This is also a summary of what the lab showed or was able to exhibit. This will be AT LEAST a paragraph.
20 points

Ch 10 Crossword/ Vocab Flash Cards- complete the crossword and make a flashcard for each term with the word on one side and the definition on the back



Across

6. a unit of heredity that consists of a segment of nucleic acid that codes for a functional unit of RNA or protein
7. the substance of which eukaryotic chromosomes are composed
10. in eukaryotic cells, a process of cell division that forms two new nuclei, each of which has the same number of chromosomes
12. the life cycle of a cell
14. a group of diseases characterized by uncontrolled growth and spread of abnormal cells

Down

1. a network of microtubules that forms during mitosis and moves chromatids to the poles
2. a growth that arises from normal tissue but that grows abnormally in rate and structure and lacks a function
3. an organelle that contains the centrioles and is the center of dynamic activity in mitosis
4. the period of the cell cycle during which activities such as cell growth and protein synthesis occur without visible signs of cell division
5. the division of the cytoplasm of a cell
7. one of the two strands of a chromosome that become visible during meiosis or mitosis
8. the region of the chromosome that holds the two sister chromatids together during mitosis
9. a type of protein molecule found in the chromosomes of eukaryotic cells but not prokaryotic cells
11. a eukaryotic structural unit of chromatin that consists of DNA wound around a core of histone proteins
13. in a eukaryotic cell, one of the structures in the nucleus that are made up of DNA and protein; in a prokaryotic cell, the main ring of DNA

CHAPTER 10 VOCAB MAKE FLASHCARDS FOR ALL TERMS

Gene
Chromosome
Chromatin
Histone
Nucleosome
Chromatid
Centromere
cell cycle
interphase
mitosis
cytokinesis
spindle
centrosome
cancer
tumor

Chapter 10 Cell Growth and Division

I. **REPRODUCTION**- Because _____ cells are more difficult to maintain, cells divide when they grow to a certain size. The size of an organism does not increase by increasing cell size but by increasing the _____.

A. New cells are needed to help tissues and organs _____. New cells also replace _____ cells. As old cells die and new cells take their place.

B. A cell's ability to exchange substances is limited by its _____. As a cell gets larger, substances must travel farther to reach where they are needed.

C. The work of cells is done by _____. As a cell gets larger, more _____ are required to maintain its function.

D. If the cell gets too large, _____ instructions cannot be copied quickly enough to make the proteins that the cell needs to support itself.

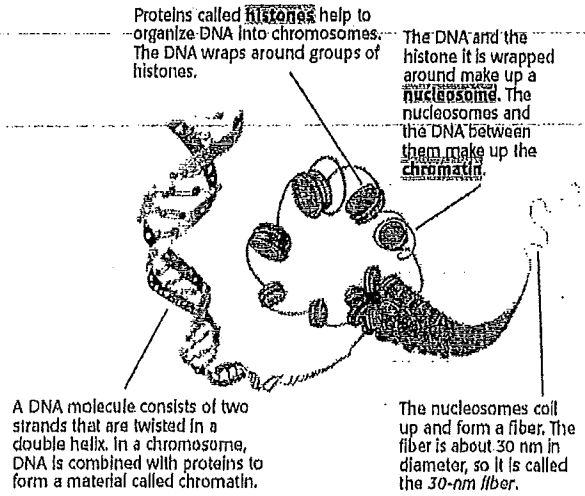
II. **CHROMOSOMES**-chromosomes are the _____ DNA of the cell. The way DNA is stored and read differs between eukaryotes and prokaryotes.

A. PROKARYOTES- Prokaryotic chromosomes also have genes which code for proteins and RNA for the prokaryotic cell functions.

1. A prokaryotic cell has a single _____ molecule of DNA. This loop of DNA contains thousands of genes.

2. A prokaryotic chromosome is condensed through repeated _____ or _____, like a rubber band twisted many times.

B. EUKARYOTES- Eukaryotic DNA is packaged into highly condensed _____ structures to fit in the nucleus with the help of many proteins.



1. The large molecule of DNA is organized into hereditary units called _____. A _____ is a segment of DNA that codes for the RNA and proteins of a particular trait (ex hair color).

2. The DNA and proteins make up a substance called _____.

3. The first level of packaging is done by a class of proteins called _____. A group of eight histones come together to form a disc-shaped histone core.

4. The long DNA molecule is wound around a series of histone cores in a regular manner and is called a _____.

5. The string of _____ lines up in a spiral to form a cord that is 30 nm in diameter.

6. During most of a cell's life, its chromosomes exist as _____.

7. As the cell prepares to divide, the chromosomes condense even further ensuring that the extremely long DNA molecules do not get tangled up during cell division.

8. The nucleosome cord forms loops then coil into the final, most highly condensed form of the chromosome.

9. Each of the two thick strands of a fully condensed, duplicated chromosome is called a _____.

10. Each chromatid is made of a single, long molecule of DNA.

11. Identical pairs, called _____ chromatids, are held together at a region called the _____.

12. During cell division, the sister chromatids are separated at the centromere, and one ends up in each _____ cell.

13. Each new cell has the same genetic information as the parent cell.

III. **PREPARING FOR CELL DIVISION**- The process of cell division involves more than cutting a cell into two pieces. Each new cell must have all of the equipment needed to stay alive. Each new cell will function in the same way as the cells that they replace.

A. Prokaryotes-prokaryotic cell division is more simple than eukaryotic division

1. In prokaryotic cells, the circular DNA molecule is attached to the inner cell membrane.

2. The cytoplasm is divided when a new cell membrane forms between the <u>two</u> DNA copies. Meanwhile the cell continues to grow until it nearly doubles in size.

3. The cell is constricted in the middle, like a long balloon being squeezed near the center.

4. Eventually the dividing prokaryote is pinched into two independent daughter cells, each of which has its own circular DNA molecule.

B. Eukaryotes

1. Eukaryotic cells have many organelles. In order to form two living cells, each daughter cell must contain enough of each organelle to carry out its functions.

2. The DNA within the nucleus must also be copied, sorted, and separated.

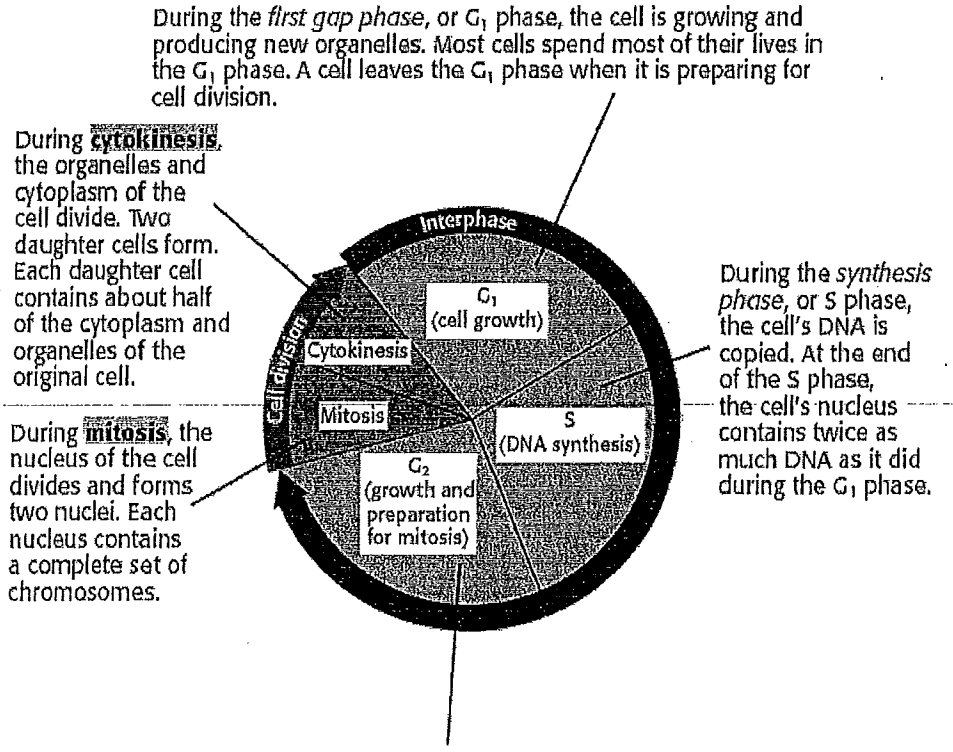
IV. **EUKARYOTIC CELL CYCLE**-The life of a eukaryotic cell cycles through phases of growth, DNA replication, preparation for cell division, and division of the nucleus and cytoplasm. The _____ is a repeating sequence of cellular growth and division during the life of a cell. The cell cycle is made up of five phases. The first three phases together are known as interphase. The remaining two phases make up cell division.

A. _____-During interphase, the cell is not dividing. It is growing and preparing to divide. Different types of cells spend different amounts of time in interphase. Cells that divide often, such as skin cells, spend less time in interphase. Cells that divide seldom, such as nerve cells, spend most of their time in interphase. There are 3 parts of interphase.

1. G1- During the _____ (G1), a cell grows rapidly as it builds more organelles. For most organisms, this phase occupies the major portion of the cell's life.

2. S-During the _____ (S), a cell's DNA is copied. At the end of the S phase, the cell's nucleus has twice as much DNA as it did in the G1 phase.

3. G2-During the _____ (G2), the cell continues to grow and prepares to divide. Hollow protein fibers called microtubules are organized in the cytoplasm during G2.



B. **STAGES OF MITOSIS-** Mitosis is a continuous process that can be observed in four stages: prophase, metaphase, anaphase, and telophase.

1. **Stage 1: Prophase**

a) Within the nucleus, chromosomes begin to condense

b) The nuclear membrane breaks down. Outside the nucleus, a special structure called the spindle forms. The spindle is made up of several spindle fibers.

c) Cells have an organelle called the _____, which helps assemble the spindle.

d) In animal cells, the centrosome includes a pair of _____.

e) Before mitosis, the cell's centrosome is duplicated. During prophase, the centrosomes move to opposite poles of the cell.

2. **Stage 2: Metaphase**

a) During metaphase, the chromosomes are packaged into their most condensed form.

b) The nuclear membrane is fully dissolved, and the condensed chromosomes move to the center of the cell and line up along the cell's equator.

c) Spindle fibers form a link between the poles and the centromere of each chromosome.

3. **Stage 3: Anaphase**

a) Once all of the chromosomes are lined up, the spindle fibers shorten. The spindle fibers shorten by breaking down the microtubules bit by bit.

b) _____ chromatids move toward opposite poles as the spindle fibers that are attached continue to shorten. Each pole now has a full set of chromosomes.

4. **Stage 4: Telophase**

a) A _____ forms around the chromosomes at each pole of the cell.

b) Chromosomes, now at opposite poles, uncoil and change back to their original _____ form.

c) The spindle dissolves and the spindle fibers break down and disappear.

d) Mitosis is complete.

C. **CYTOKINESIS-**During cytokinesis, the cell membrane grows into the center of the cell and divides it into two daughter cells of equal size. Each daughter cell has about half of the parent's cytoplasm and organelles. As mitosis ends, _____ begins. The end result of mitosis and cytokinesis is two genetically identical cells in place of the original cell.

1. Separating the Cytoplasm

a) In animal cells and other cells that lack cell walls, the cell is pinched in half by a belt of protein threads.

b) In plant cells and other cells that have rigid cell walls, the cytoplasm is divided by a cell plate.

V. **CONTROLS**-Cell growth and division depend on protein signals and other environmental signals. Cell division is highly controlled. Signals from surrounding cells or even from other organs can also regulate cell growth and division. Environmental conditions, such as availability of nutrients, the amount of light and temperature, also affect the cell cycle.

VI. **CHECKPOINTS**-Feedback signals at key checkpoints in the cell cycle can _____ or _____ the next phase of the cell cycle. During the cell cycle, a cell undergoes an inspection process to ensure that the cell is ready for the next phase in the cell cycle.There are three main checkpoints in the cell cycle—G1checkpoint, G2 checkpoint, mitosis checkpoint.

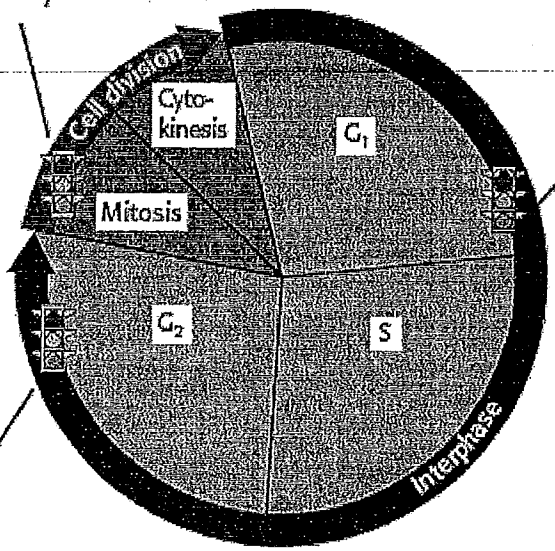
A. _____ Before the cell copies its DNA, the cell checks its surroundings. If conditions are favorable and the cell is healthy and large enough, the cell enters the synthesis phase. If conditions are not favorable, the cell goes into a resting period. Certain cells, such as some nerve and muscle cells, remain in this resting period forever

B. _____- Before mitosis begins, the cell checks for any mistakes in the copied DNA. _____ correct any mistakes. This checkpoint ensures that the DNA of the daughter cells will be identical to the DNA of the original cell. If the cell passes the G2 checkpoint, then the cell may begin to divide. Once past this checkpoint, proteins help to trigger mitosis.

C. _____- During the metaphase stage of mitosis, chromosomes line up at the equator. At this point, the cell checks that the _____ are properly attached to the spindle fibers. Without this checkpoint, the sister chromatids may not separate properly giving one daughter cell too many genes and one not enough

The *metaphase checkpoint* ensures that genetic material is evenly split between the daughter cells. At this point, the cell checks to make sure that the chromosomes are properly attached to the spindle fibers.

The G_1 *checkpoint* determines whether a cell's DNA is replicated. Before a cell copies its DNA, it checks its surroundings. If conditions are right and the cell is healthy and large enough to divide, the S phase begins.



The G_2 *checkpoint* determines whether mitosis can begin. Before mitosis begins, the copied DNA is checked for errors. Enzymes correct any mistakes. In addition, proteins double-check that the cell is large enough to divide.

VII. **CANCER**-cancer is _____ cell growth and division that can result in masses of cells that invade and destroy healthy tissues. Cancer cell reproduction continues without the normal feedbacks. The defective cell divides and produces more defective cells. Eventually, these cells form a mass called a _____.

A. Development

1. A _____ tumor does not spread to other parts of the body and can often be removed by surgery.

2. A _____ tumor invades and destroys nearby healthy tissues and organs.

3. _____ tumors, or cancers, can break loose from their tissue of origin and grow throughout the body. This process is called _____. Once a cancer has metastasized, it becomes difficult to treat.

B. Treatment

1. Some cancers can be treated by using drugs that kill the fast-growing cancer cells.

2. Because drugs are chemicals, this method of treatment is called _____, or "chemo" for short.

3. Some cancers can be treated by surgery to remove of the affected organ.

4. In _____ therapy, high-energy rays are focused on an area in order to destroy cancerous cells.

C. Usually, when cancer has metastasized, _____ (the likelihood of survival) is poor.

D. Prevention

1. The best way to prevent cancer is to avoid things that can cause cancer (_____)

2. Ultraviolet radiation in sunlight can damage genes that control the cell cycle (skin cancer)

3. Chemicals in cigarette smoke also affect how cell growth and division is regulated.

4. Large amounts of alcohol consumption have been linked to liver cancers

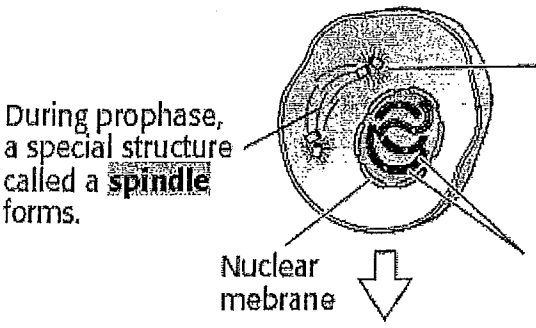
5. Teenage exposure cell phones has been linked to brain cancer (NOT A JOKE)

Type of tumor	Description
Benign	• does not spread to other parts of the body • most can be removed through surgery
Malignant	• invades nearby healthy tissue • pieces of tumor may break off and travel to other parts of the body (metastasis) • can be more difficult to treat than benign tumors

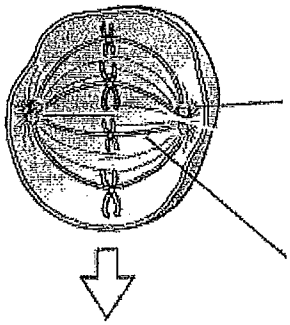
THE STAGES OF MITOSIS

There are four main stages of mitosis, as shown in the figure below.

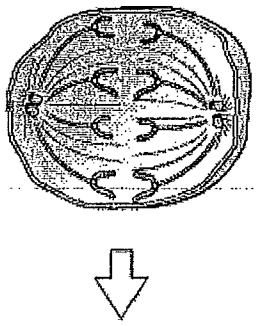
The first stage of mitosis is *prophase*. During this stage, the chromosomes begin to condense. The nuclear membrane breaks down.



The second stage of mitosis is *metaphase*. During this stage, the chromosomes line up along the equator of the cell.



The third stage of mitosis is *anaphase*. During this stage, the spindle fibers shorten. The chromatids are pulled to opposite sides of the cell.



The final stage of mitosis is *telophase*. During this stage, a new nuclear envelope forms at each pole. The spindle fibers break down and disappear.

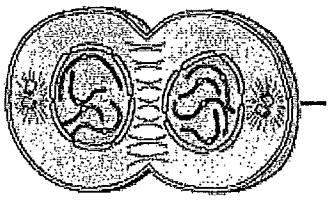


FIGURE 1

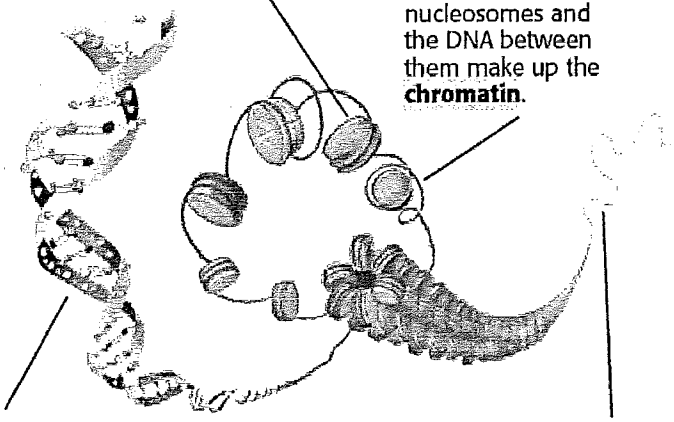


FIGURE 2

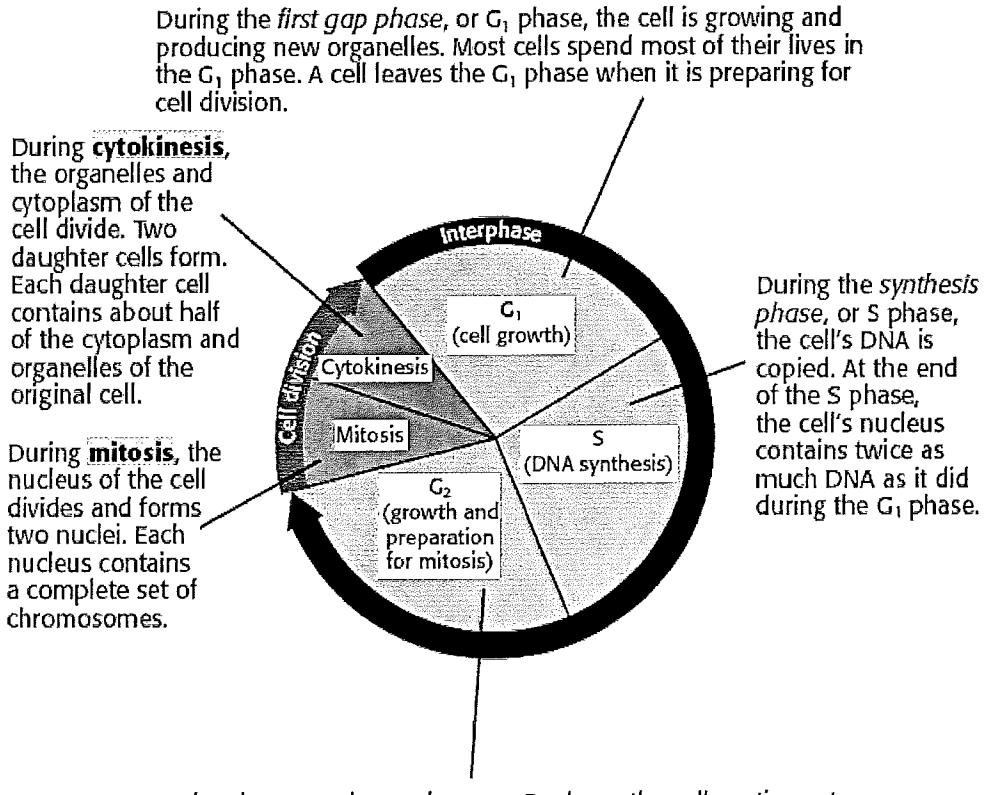
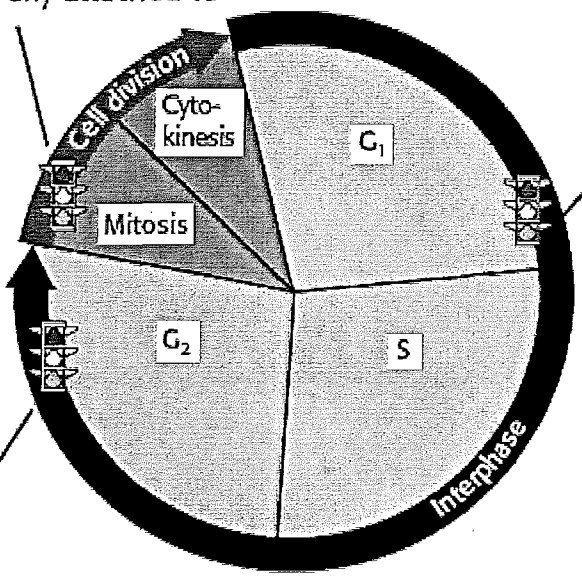


FIGURE 4

The *metaphase checkpoint* ensures that genetic material is evenly split between the daughter cells. At this point, the cell checks to make sure that the chromosomes are properly attached to the spindle fibers.

The G_2 *checkpoint* determines whether mitosis can begin. Before mitosis begins, the copied DNA is checked for errors. Enzymes correct any mistakes. In addition, proteins double-check that the cell is large enough to divide.



The G_1 *checkpoint* determines whether a cell's DNA is replicated. Before a cell copies its DNA, it checks its surroundings. If conditions are right and the cell is healthy and large enough to divide, the S phase begins.

FIGURE 5

Type of tumor	**Description**
Benign	• does not spread to other parts of the body • most can be removed through surgery
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CHAPTER 10

HOMEWORK CHAPTER 10 DIRECTED READING

You can not use a homework pass for this homework

THE CELL CYCLE

The **cell cycle**, or **cell-division cycle**, is the series of events that take place in a **eukaryotic cell** between its formation and the moment it replicates itself. These events can be divided in **two** main parts: **interphase** (*in between divisions* phase grouping **G_1 phase, S phase, G_2 phase**), during which the cell is forming and carries on with its normal metabolic functions; the **mitotic phase** (M mitosis), during which the cell is replicating itself. Thus, cell-division cycle is an essential process by which a single-cell fertilized egg develops into a mature organism and the process by which hair, skin, blood cells, and some internal organs are formed.

1. What is meant by the cell cycle or cell division cycle?

2. In what type of cells --- prokaryotes or eukaryotes --- does the cell cycle occur?

3. Name the 2 main PHASES of the cell cycle.

4. _____ is in between the times when a cell is dividing.

5. What is occurring in a cell during interphase?

6. What is occurring during the mitosis phase?

7. A fertilized cell develops into a _____ organism during the cell cycle.

8. Name three things that form during the cycle.

INTERPHASE

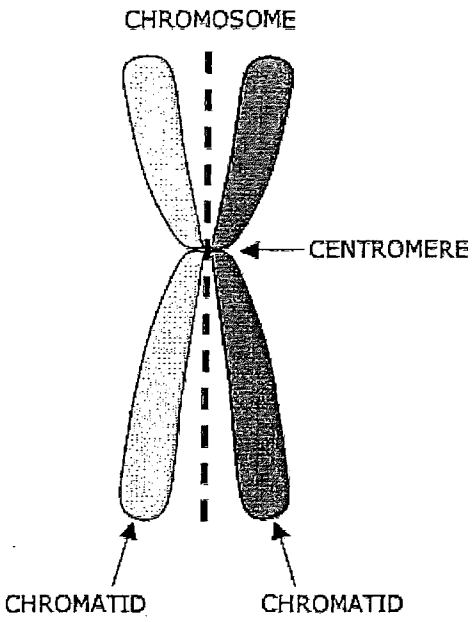
Interphase is a phase of the cell cycle, defined only by the absence of cell division. During interphase, the cell **obtains nutrients**, and **duplicates (copies) its chromatids** (genetic material). The genetic material or chromatids are located in **the nucleus** of the cell and are made of the **molecule DNA**.

9. What process NEVER occurs in interphase?

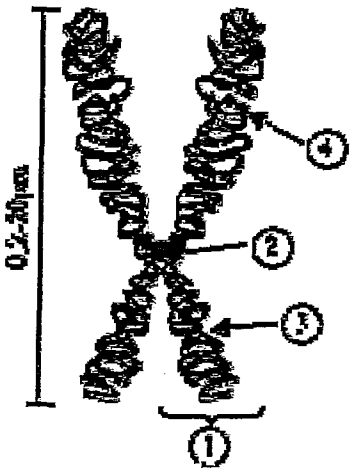
10. Cells obtain _____ and duplicate or copy their _____ or genetic material during interphase.
11. Where are chromatids found in a cell?

12. Chromatids are made of a molecule called _____.

Chromatids are connected by the **centromere** and have a **LONG AND SHORT ARM.**



Label the parts of the chromosome including the long and short arms.



1. _____
2. _____
3. _____
4. _____

Most eukaryotic cells spend most of their time in interphase. For example, human skin cells, which divide about once a day, spend roughly 22 hours in interphase.

About 90 percent of cells are in interphase. Some cells, such as nerve cells, can stay in interphase for decades. There are 3 parts of interphase: **G_1** (growth 1 in which the cell creates organelles and begins metabolism), **S phase** (DNA synthesis in which the chromosomes of the cell are copied) and **G_2** (growth 2 in which the cell grows in preparation for cell division). ***Find the cell cycle drawing*** on this worksheet and ***draw an additional line in red*** around those parts of the cell cycle diagram that are included in interphase.

13. In what PHASE do most cells spend the majority of their lifetime?

14. How often do human skin cells divide each day?

15. How many hours per day is a human skin cell in interphase?

16. What type of cell may spend decades in interphase instead of dividing?
17. Name the 3 stages in interphase.

18. What does G_1 stand for and what occurs in this stage?
19. What does S stand for and what occurs in this stage?

20. What does G_2 stand for and what occurs in this stage?

Sometimes the cells exit the cell cycle (usually from G_1 phase) and enter the **G_0 phase.** In the G_0 phase, **cells are alive and metabolically active**, but do not divide. In this phase cells do not copy their DNA and do not prepare for cell division. Many cells in the human body, including those in **heart muscle**, eyes, and brain are in the G_0 phase. **If these cells are damaged they cannot be replaced. Again find the cell cycle drawing** on this worksheet and ***draw an arrow in black*** on the cell cycle showing where a cell would enter the **G_0** phase.

21. From stage of the cell cycle do cells sometimes EXIT?

22. What happens to cells that enter the G_0 stage?

23. Name 3 types of cells that enter the G_0 phase when they are mature?

24. What happens if these cells are damaged during your lifetime?

The **G_1 phase** is a period in the cell cycle during interphase, after **cytokinesis** (process whereby a single cell is divided into two identical daughter cells whenever the **cytoplasm** is divided) and before the S phase. For many cells, this phase is the major period of **cell growth** during its lifespan. During this stage **new organelles are being synthesized (made)**, so the cell requires both structural proteins and enzymes, resulting in great amount of protein synthesis. ***Color the G_1*** phase **green** on the cell cycle drawing.

25. What stage occurs after cytokinesis?

26. What part of the cell is divided during cytokinesis?

27. What are the new cells called and how do they compare with each other?

28. What is major thing happening to a cell during G_1?

29. What cell structures are made in G_1?

30. Since proteins and _____ are being made during G1, there is a great amount of protein _____ occurring.

The **S phase**, short for **synthesis phase**, is a period in the cell cycle during interphase, **between G1 phase and the G2 phase**. Following G1, the cell enters the S stage, when **DNA synthesis or replication** occurs. At the beginning of the S stage, each chromosome is composed of one coiled **DNA double helix** molecule, which is called a chromatid. At the end of this stage, each chromosome has two identical DNA double helix molecules, and therefore is composed of **two sister chromatids**. During S phase, the centrosome is also duplicated. ***Color the S*** phase orange.

31. What does the S phase stand for?

32. What happens during the S phase?

33. Each chromosome originally is made of how many DNA molecules and how does this molecule appear in the chromosome?

34. At the end of S phase each chromosome has how many coiled DNA molecules?

35. What structure holds the duplicated chromosomes together and is also copied during the S phase?

G_2 phase is the third, final, and usually the **shortest subphase** during interphase within the cell cycle in which the **cell undergoes a period of rapid growth to prepare for mitosis**. It follows successful completion of DNA synthesis and chromosomal replication during the S phase, and occurs during a period of often four to five hours. Although chromosomes have been replicated they cannot yet be distinguished individually because they are still in the form of loosely packed **chromatin fibers**. The G_2 phase continues growth of the cell and prepares the cell for mitosis (M phase) by producing all of the enzymes that the cell will need in order to divide. ***Color the*** **G_2** phase light blue.

After the G_2 phase of interphase, the **cell is ready to start dividing**. The **nucleus and nuclear material** (chromosomes made of DNA) divide first during stage known as **MITOSIS**. Mitosis is also called **KARYOKINESIS** (*karyon* means nucleus) because only the nucleus is dividing. ***Color the Mitosis*** stage purple.

36. What is the final and shortest phase of interphase?

37. About how long would a typical cell be in the G_2 phase?

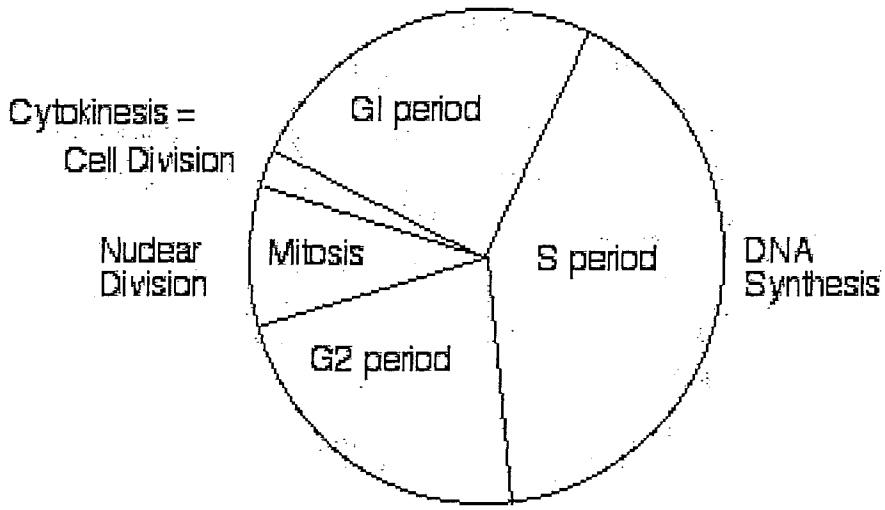
38. How is the cell prepared for mitosis during the G_2 phase?

39. What follows the G2 phase?

40. What part of the cell is actually dividing in mitosis?

41. What is another name for mitosis?

The Cell Cycle



MITOSIS (KARYOKINESIS) – NUCLEAR DIVISION

Mitosis is the process in which a **eukaryotic cell** (cell containing a nucleus) separates its already **duplicated chromosomes** (copied during the S phase) into **two sets** of chromosomes so there will be **two identical nuclei**. It is generally followed by **cytokinesis** which divides the cytoplasm and cell membrane. ***Color the Cytokinesis stage*** yellow. This results in **two identical cells** (both have an identical set of chromosomes) with an equal distribution of organelles and other cellular components. The **mitotic (M) phase** and **cytokinesis** (C phase) together are called **cell division**, the division of the **parent cell** (original) into **two daughter cells** (new cells), each with the same **genetic information (chromosomes) as the parent cell**. Mitosis **does NOT occur in prokaryotic cells** that do **NOT** have a nucleus. In multicellular organisms, the **somatic cells** (body cells) undergo mitosis, while **germ cells** — cells destined to become sperm in males or ova (eggs) in females — divide by a related process called **meiosis**. **Prokaryotic cells** (bacteria), which lack a nucleus, divide by a process called **binary fission**.

42. When are chromosomes duplicated --- before or during mitosis?
43. What process follows mitosis?
44. The nucleus is divided during _____, while cytoplasm of the cell is divided during _____.
45. How do the two new cells compare with each other?
46. The two new cells are called _____ cells.
47. Does mitosis occur in prokaryotes? Explain why or why not.

48. What process is used by bacteria to divide and reproduce?

49. Body cells are called _____ cells, while reproductive cells are known as _____ cells.

The process of **mitosis (division of the nucleus)** is divided into **four** stages **(Prophase, Metaphase, Anaphase, and Telophase).** Immediately following nuclear division (mitosis), the **cell membrane** must also divide **(cytokinesis).** Animal cells divide the cytoplasm by constricting the cell membrane in the middle to form a **cleavage furrow**. Plant cells form a **cell plate** in the center to divide the cytoplasm. At Interphase, there is only one cell, but after cytokinesis there are two identical cells.

50. Name the 4 mitotic stages.

51.

52. How does cytokinesis occur in an animal cell?

53. How does cytokinesis occur in a plant cell?

During interphase, the genetic material is called **chromatin** and can NOT be clearly seen because it isn't tightly coiled. When **prophase begins**, the DNA molecules are progressively shortened and condensed by coiling, to form visible **chromosomes**. **Enzymes** during prophase break down the **nuclear membrane and nucleolus** so they are no longer visible. Spindle fibers also form in prophase which will attach to the chromosomes. At **metaphase,** the spindle fibers attach themselves to the **centromeres** of the chromosomes and align the chromosomes at the **equator** (middle of the cell). **Anaphase** is the next stage. The spindle fibers shorten and the centromere splits separating the two sister chromatids. During **telophase,** the chromosomes pairs (chromatids are pulled to opposite poles of the cell. The **nuclear envelope and nucleolus reform** before the **chromosomes uncoil**. The **spindle fibers disintegrate.**

54. Genetic material is called _____ during interphase and **IS / IS NOT** clearly visible.
55. What makes the chromosomes become visible during prophase?

56. What is used to help break down the nuclear membrane?

57. Besides the nucleus, what else is broken down during prophase?

58. What forms during prophase to LATER attach and move chromosomes?
59. Doubled chromosomes are held together by the _____.
60. Where do chromosomes line up during metaphase?

61. During what stage are sister chromatids separated and moved to opposite ends of the cell?
62. Name 4 things that happen during telophase.
    a.

    b.

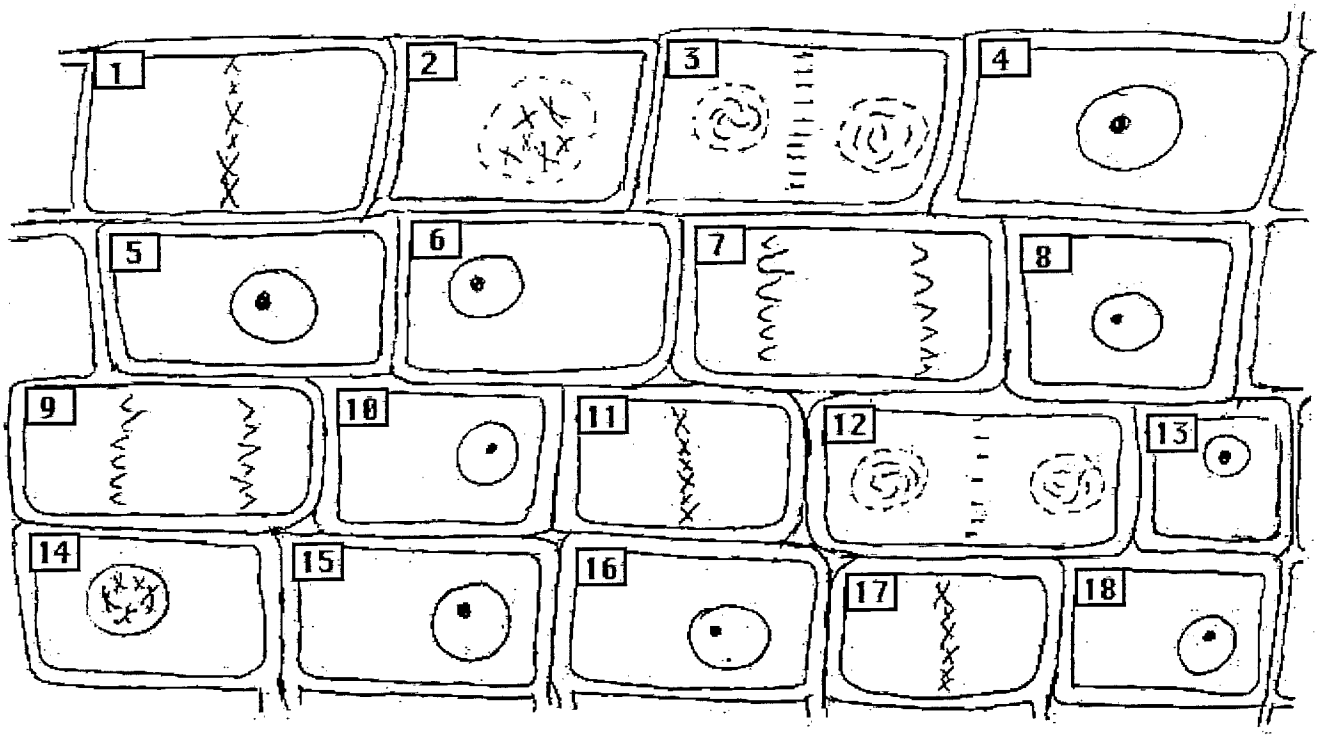
    c.

    d.

Name each numbered stage in the plant cell cycle diagram: (interphase, prophase, metaphase, anaphase, or telophase)

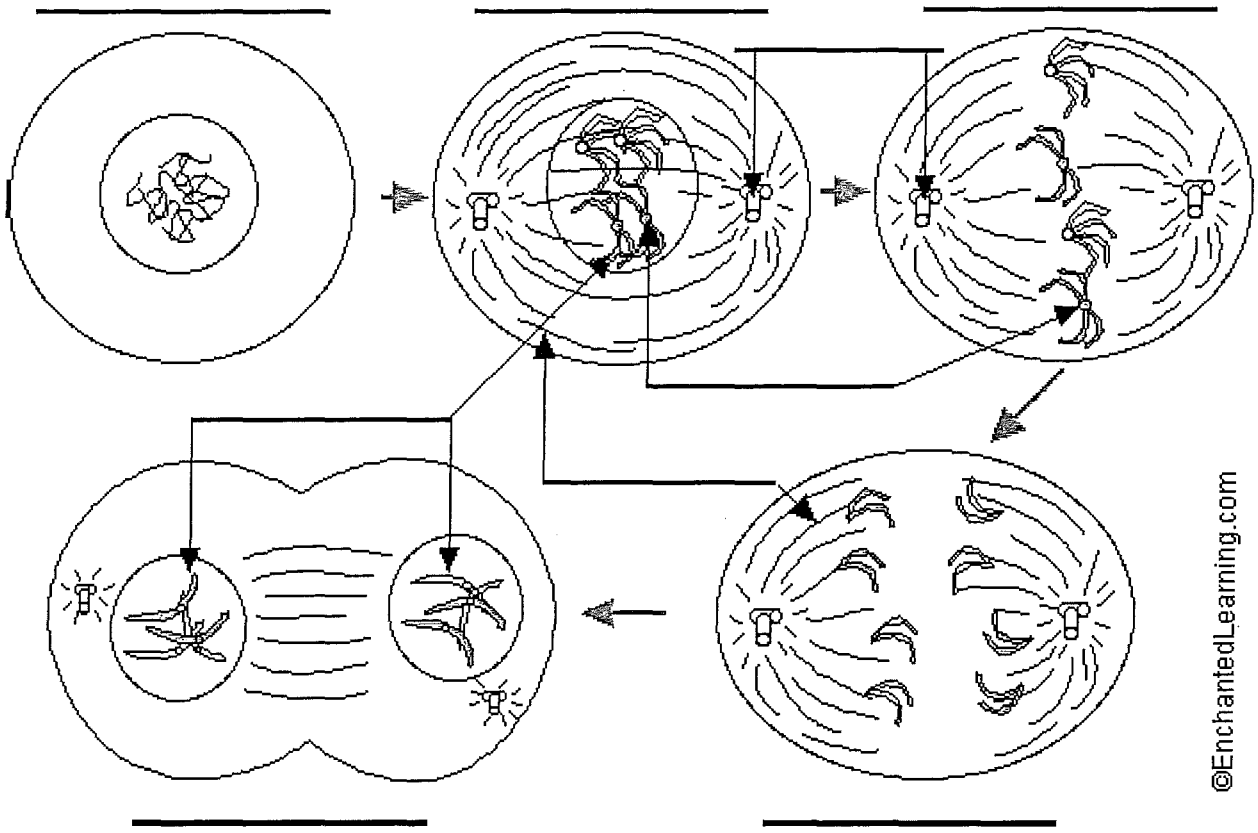
1. 7. 13.
2. 8. 14.
3. 9. 15.
4. 10. 16.
5. 11. 17.
6. 12. 18.

Plant Cells in Mitosis



Label the stages of the cell cycle & mitosis. ***LABEL and COLOR the stages in the plant cell and animal cell. The stages should be colored as follows ---*** interphase-pink, prophase-light green, metaphase-red, anaphase-light blue, and telophase-yellow. Also label the CENTRIOLES, SPINDLE FIBERS, CENTROMERE, and CHROMOSOMES.

Mitosis of an Animal Cell



Label the stages of the cell cycle & mitosis. ***LABEL and COLOR the stages in the plant cell and animal cell. The stages should be colored as follows ---*** interphase-pink, prophase-light green, metaphase-red, anaphase-light blue, and telophase-yellow. Also label the CENTRIOLES, SPINDLE FIBERS, CENTROMERE, and CHROMOSOMES.

CHAPTER 10 SEC 1 DUE DATE .

1. How is a cell's size related to its need for nutrients? How does this relationship make larger cells harder to maintain?

2. Fill in the blanks below using the terms *chromatin*, *nucleosomes*, *histones*, and *DNA*.

chromosomes			

3. Name two things that happen when a cell prepares to divide.

BELLRINGER

ANSWER:

CHAPTER 10 SEC 2 DUE DATE .

1. What happens during the G_1 phase of the cell cycle?

2. What two processes make up cell division?

3. What role do spindles play in mitosis?

4. Fill in the blank spaces in the table below.

Stage	Description
	sister chromatids move to opposite sides of the cell
	chromosomes condense; nuclear membrane breaks down
	new nuclear envelopes form around each set of chromosomes; chromosomes uncoil
	chromosomes line up along the equator of the cell

5. How is cytokinesis in plant cells different from cytokinesis in animal cells?

BellRinger:Day M T W Th F Date_____ Question_____

Answer_____

CHAPTER 10 SEC 3 DUE DATE .

1. How is cancer related to the cell cycle?

2. Where can signals that regulate the cell cycle come from? Name three sources.

3. Explain what happens at each of the three checkpoints in the eukaryotic cell cycle.

4. How do feedback signals affect the cell cycle?

5. Give two differences between benign tumors and malignant tumors.

6. Give two examples of things that can make cancer more likely.

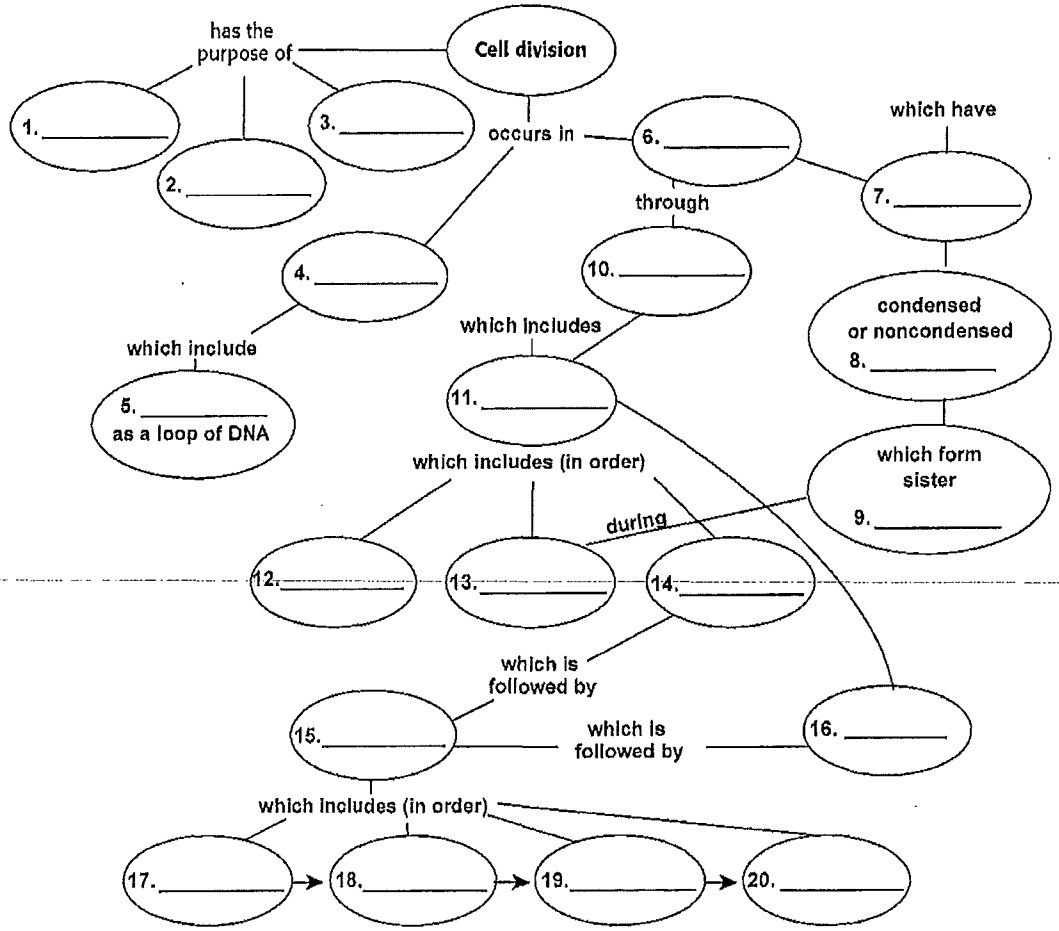
Bellringer:Day M T W Th F Date_____Question_____

Answer_____

Concept Mapping Ch 10

Using the terms and phrases provided below, complete the concept map showing the principles of cell division.

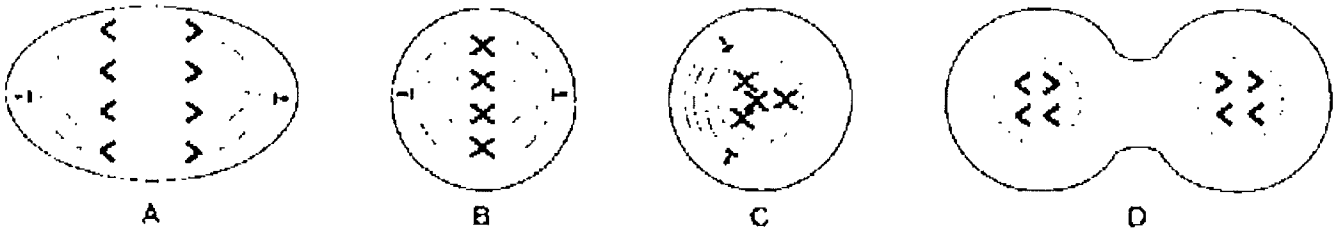
anaphase	G_1 phase	prokaryotes
the cell cycle	G_2 phase	prophase
chromatids	growth	replacement
a chromosome	interphase	S phase
chromosomes	metaphase	telophase
cytokinesis	mitosis	wound repair
eukaryotes	nucleosomes	



CHAPTER 10 TEST REVIEW

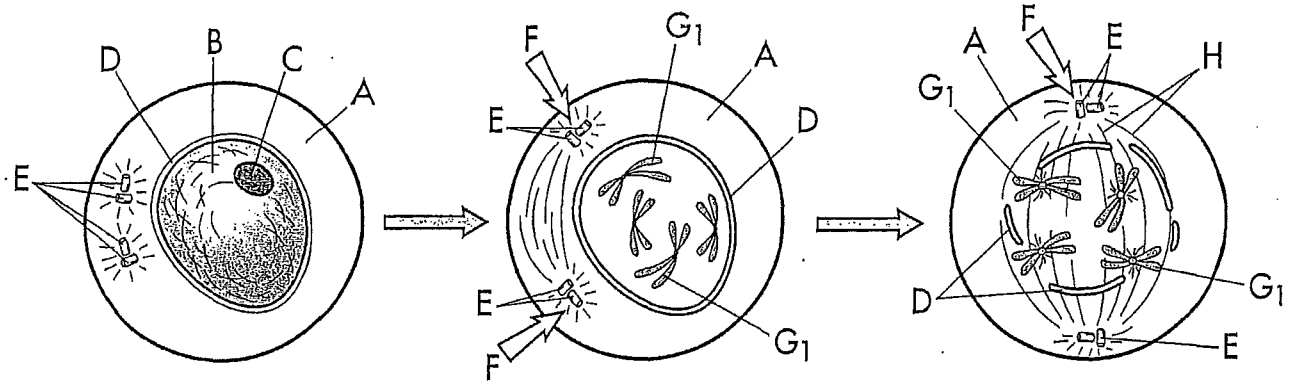
1) Why do cells divide?
2) What does the chromosome of a bacterium look like?
3) What is the region of a chromosome where two sister chromatids are held together called?
4) what are chromatids?
5) What occurs as the chromosome condenses?
6) In order to fit within the cell, how does DNA compact itself? Make sure to mention histones
7) How do prokaryotes (bacteria) go through cell division? What occurs? Is a cell wall formed?
8) Each cell occupies most of its time in what mitotic stage?
9) What occurs after cytokinesis is completed?
10) What is the correct sequence of the cell cycle?
11) When cells are not dividing, what phase do they remain in?
12) What occurs during the synthesis (S) phase?
13) what are the first three phases of the cell cycle collectively known as?
14) What does mitosis actually accomplish?
15) The phase of mitosis that is characterized by the arrangement of all chromosomes along the equator of the cell is called

16) These are not ordered. Name the phase they are in and place them in the correct chronomlogical order.

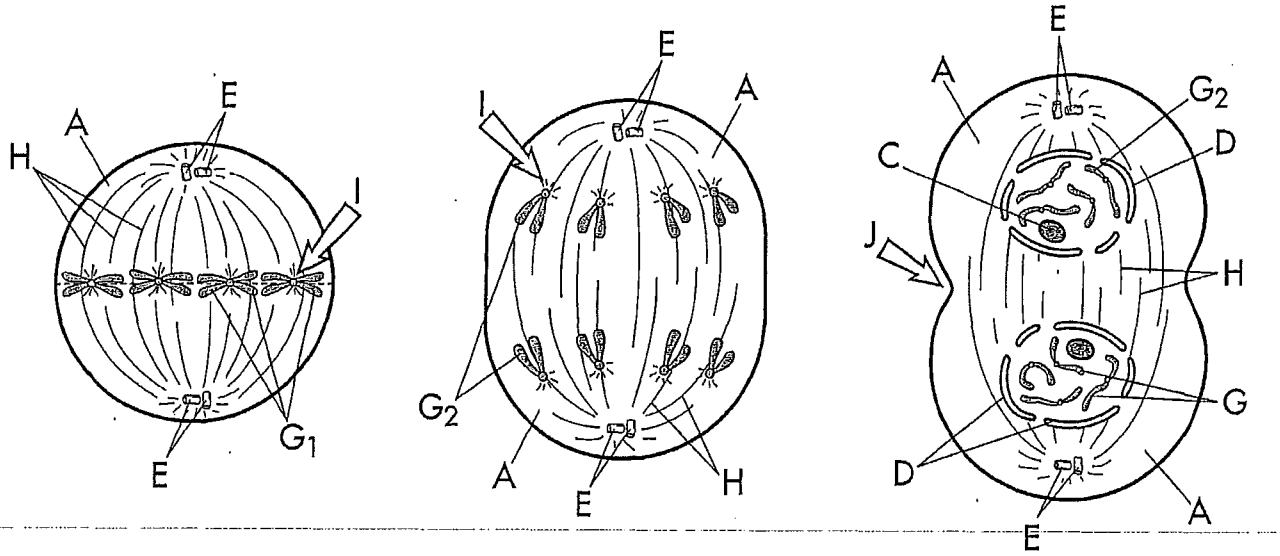


17) What stages are each of the drawing is and what order should they be in? At what point in the above diagram do centrosomes centerate.
18) how is genetic information divided in the two new cells?
19) What is different between the cytokinesis of plant and animal cells

Mitosis



Interphase ⟶ Prophase (Early) ⟶ Prophase (Late)

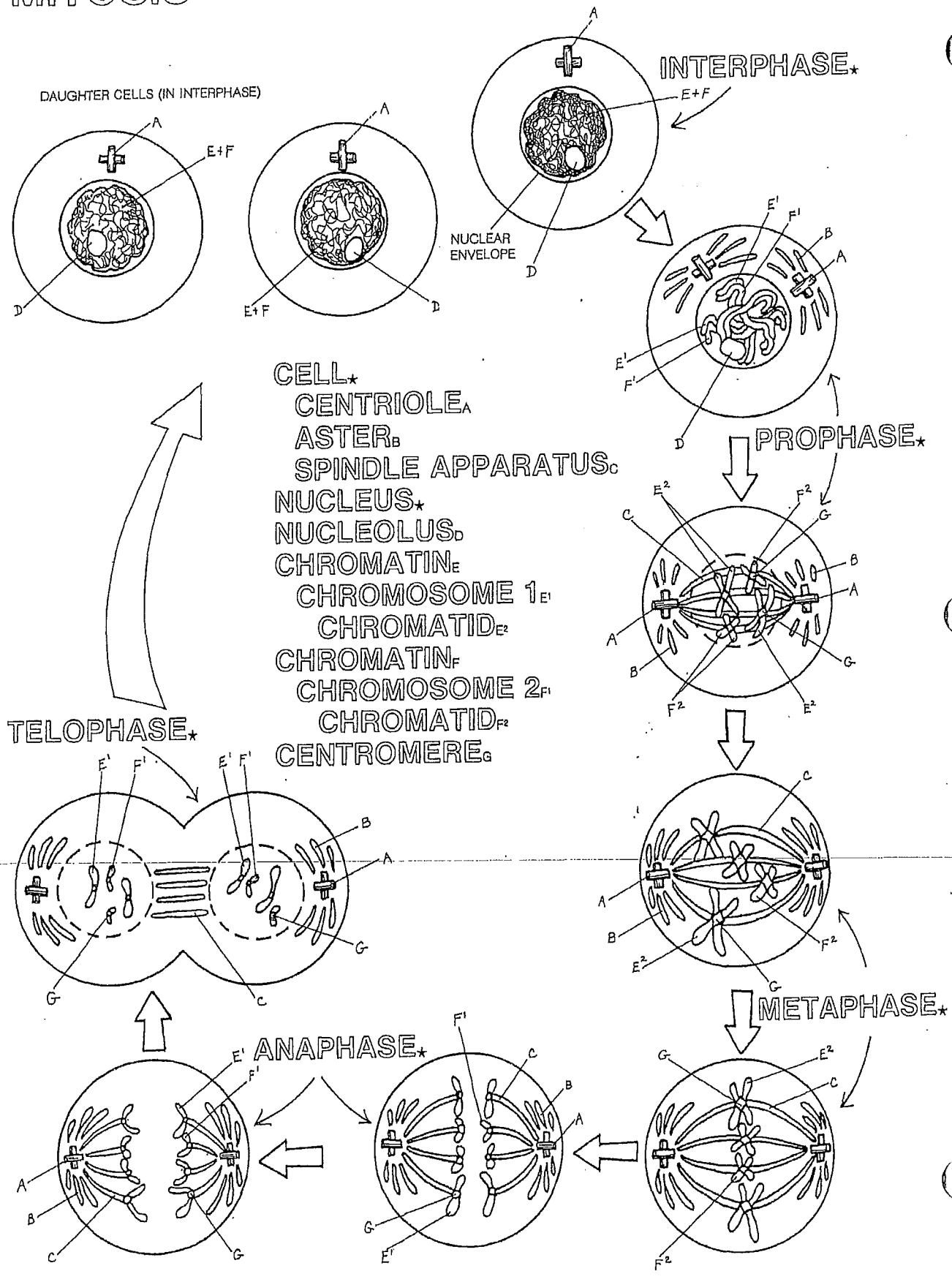


Metaphase ⟶ Anaphase ⟶ Telophase

Mitosis

○ Cytoplasm.....A	○ Centrioles .....E	○ Spindle Fibers .....H
○ Nucleus (Chromatin).....B	○ Asters .....F	○ Kinetochore.....I
○ Nucleolus.....C	○ Chromatids .....G_1	○ Cleavage Furrow.....J
○ Nuclear Membrane .....D	○ Chromosomes.....G_2	

MITOSIS


DAUGHTER CELLS (IN INTERPHASE)
INTERPHASE★
NUCLEAR ENVELOPE
PROPHASE★
METAPHASE★
ANAPHASE★
TELOPHASE★
CELL★
CENTRIOLE A
ASTER B
SPINDLE APPARATUS C
NUCLEUS★
NUCLEOLUS D
CHROMATIN E
CHROMOSOME 1 E'
CHROMATID E²
CHROMATIN F
CHROMOSOME 2 F'
CHROMATID F²
CENTROMERE G

Mitosis

17

A single fertilized human egg cell will divide to form two cells. These two cells will each divide into two cells. In time, millions of cells are produced. The division of nuclear material in which each new nucleus obtains the same number of chromosomes and the same nuclear code as the original nucleus is called mitosis. Mitosis occurs in four phases. There is an interphase between each mitosis.

In this investigation, you will

(a) locate cells in prepared onion root slides that are in the process of dividing by mitosis.
(b) identify cells in interphase and in each of the four stages of mitosis in the onion root tips by comparing them with diagrams.
(c) study the changes which occur in a cell as it undergoes mitosis.

Materials

microscope
prepared slides of onion root tip *(Allium)*, longitudinal section

Procedure

• Locate with a microscope the region of rapidly dividing cells on the prepared slide of onion root tip as shown in Figure 1. After locating the cells under low power, switch to high power.

• Locate cells that appear to be in the various stages of mitosis. Use Figure 2 as a guide.

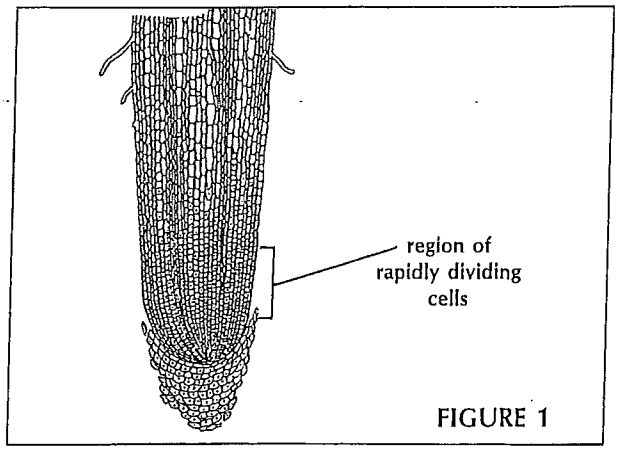


FIGURE 1

• Identify and label the following stages by using the brief description provided. Write the correct stage name on the lines provided in Figure 2.

(a) *Interphase*—cell contains easily seen nucleus and nucleolus—chromosomes appear as fine dots within nucleus

(b) *Prophase*—cell nucleus enlarged—nucleolus no longer visible—chromosomes appear as short strands within nucleus

(c) *Metaphase*—chromosomes long and thin strands—chromosomes lined up along cell center and look like "spider on a mirror"

(d) *Anaphase*—two sets of separate chromosomes can be seen—look as if they are being pulled apart from one another

(e) *Telophase*—chromosomes appear at opposite ends of cell—middle of cell has line across center that divides it almost into two new cells

(f) *Daughter cells*—appear as cells in interphase but smaller and side by side—actually start of new interphase

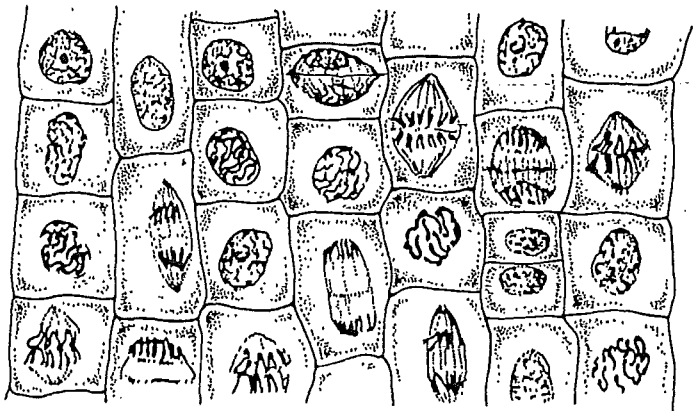
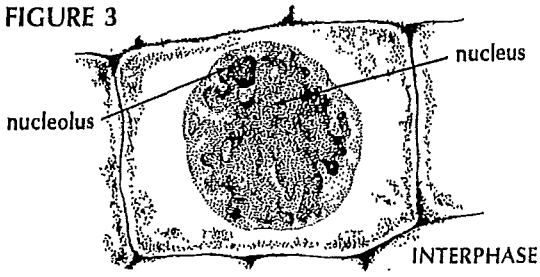


FIGURE 2

• Answer the following questions about each of the phases of mitosis.

FIGURE 3



Interphase

• Locate cells resembling Figure 3. Answer questions 1-3 while observing these cells.

1. Describe the contents of a nucleus during interphase. _____

2. Are a nucleolus and nuclear membrane present in the cell? _____

3. Are distinct rod-shaped structures called chromosomes easily observed in the nucleus at this time? _____

• Use your text for reference while answering questions 4-6.

4. Are chromosomes present in cells during interphase? _____

5. What term is used to describe nuclear contents during interphase? _____

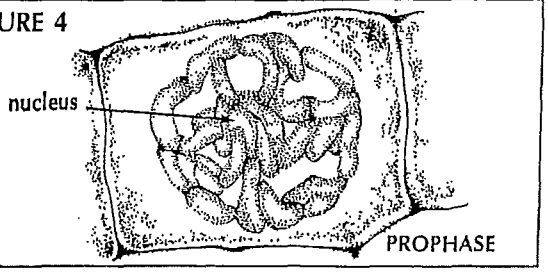
6. (a) What important event occurs to chromosomes during interphase? _____

_____

(b) What other important events occur during interphase? _____

_____

FIGURE 4



Prophase

• Locate cells resembling Figure 4. Answer questions 7 and 8 while observing these cells.

7. Are chromosomes now visible during prophase? _____

8. Describe the changes that have occurred to the nucleolus and nuclear membrane from interphase to prophase. _____

_____

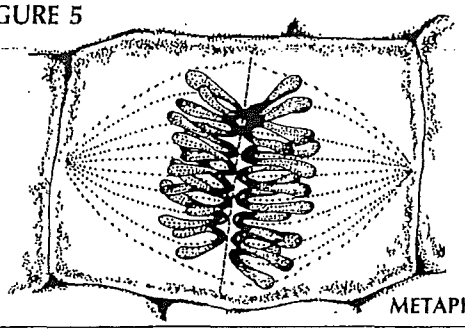
• Use your text for reference while answering question 9.

9. Explain why chromosomes can now be observed but were not observable during interphase. _____

_____

Name _____ Date _____

FIGURE 5



METAPHASE

Metaphase

• Locate cells resembling Figure 5. Answer questions 10 and 11 while observing these cells.

10. Describe where the chromosomes are now located in relation to the cell. _____

_____

11. Can evidence of chromosome duplication (replication) now be observed? _____

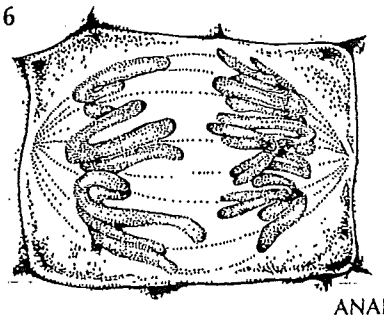
• Use your text for reference while answering questions 12 and 13.

12. What are the fibers called that become visible during this phase? _____

13. What term is used to describe the structure at which each fiber attaches to a chromosome?

_____

FIGURE 6



ANAPHASE

Anaphase

• Locate cells resembling Figure 6. Answer questions 14 and 15 while observing these cells.

14. In metaphase, chromosome pairs were lined up along the cell's center. Describe what is occurring to each chromosome pair during anaphase. _____

15. Toward what area of the cell are the chromosomes being directed? _____

• Use your text for reference while answering question 16.

16. What structure is responsible for the movement of chromosomes during this phase?

_____

Telophase

• Locate cells resembling Figure 7. Answer question 17 while observing these cells.

17. What cell parts begin to reappear during this phase? (See question 8.) _____

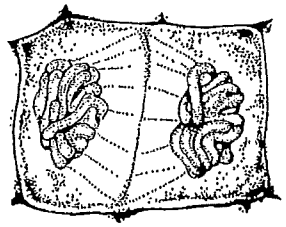
_____

18. Describe the location of the chromosomes now compared to where they were during metaphase. _____

_____

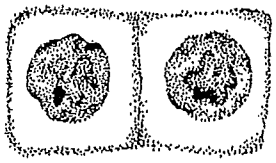
_____

FIGURE 7



TELOPHASE

FIGURE 8



DAUGHTER CELLS

Daughter Cells

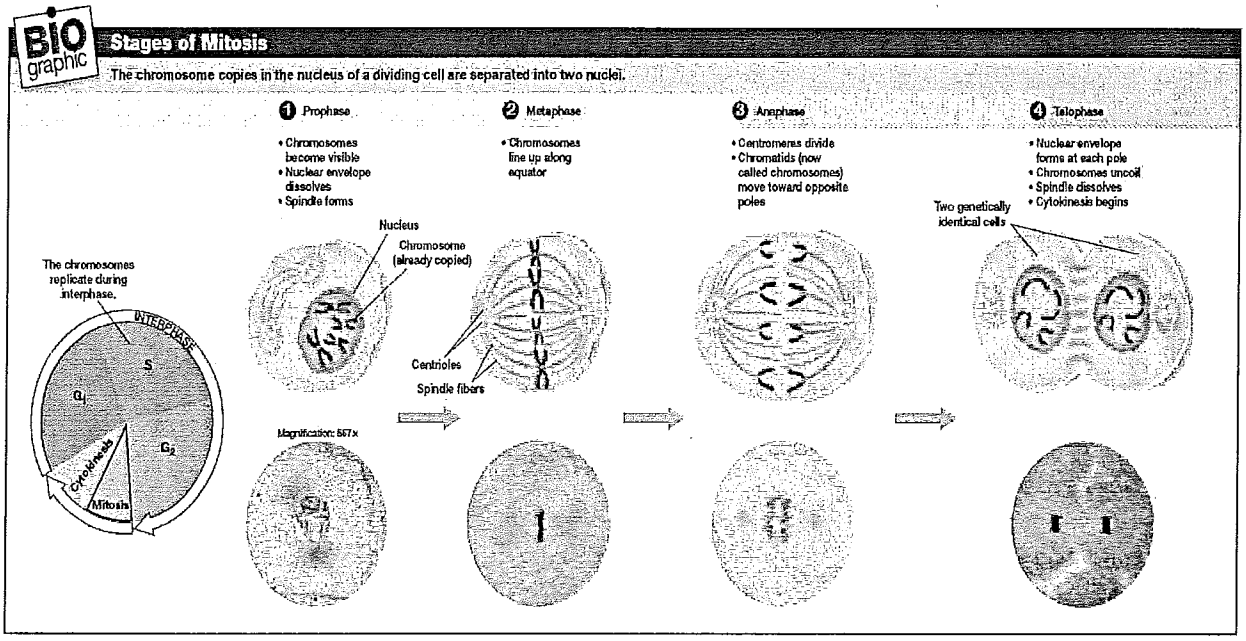
• Locate cells resembling Figure 8. Answer questions 19 and 20 while observing these cells.

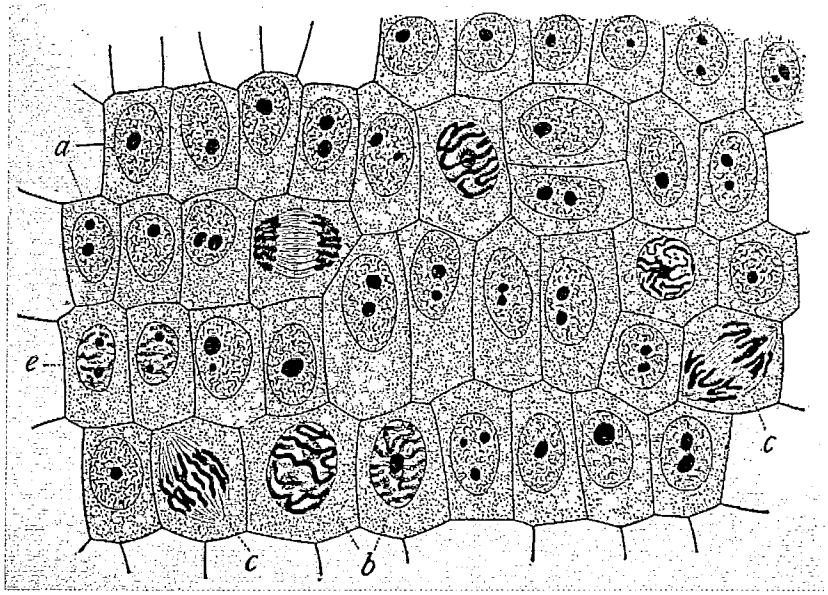
19. How many cells have now formed from an original cell? _____

20. Explain how the number of chromosomes found in each daughter cell compares to the number found in the original cell before mitosis. (HINT: Read introduction.) _____

_____

5. Cancerous tissue is composed of cells undergoing uncontrolled, rapid cell division. How could you develop a procedure to identify cancerous tissue by counting the number of cells undergoing mitosis?





Analysis

1. The term "mitosis" comes from the Greek word meaning "thread." Explain why this word may be helpful in describing this process of nuclear division. _____

_____

2. Explain how the process of mitosis helps an organism to grow in size. _____

_____

3. Complete Figure 9 to show the structures visible during each stage of mitosis. Draw in and/or label the structures listed below on the appropriate diagram. Be sure to label each animal cell with the correct mitosis stage name.
   (a) *Interphase:* draw and label *nuclear membrane, nucleolus, chromatin, centriole.*
   (b) *Prophase:* label *disappearing nuclear membrane, disappearing nucleolus, original chromosomes* (shaded), *chromosome copies* (unshaded).
   (c) *Metaphase:* draw in the two chromosome pairs as they would appear during metaphase. Label *chromosomes, spindle fibers.*
   (d) *Anaphase:* draw in the two chromosome pairs as they separate in anaphase. Label *centromeres.*
   (e) *Telophase:* label *reforming nuclear membrane, reforming nucleolus, pinching in of cell membrane.*
   (f) *Interphase:* draw in and label *nucleus, nucleolus, nuclear membrane,* and *chromatin* in each cell.

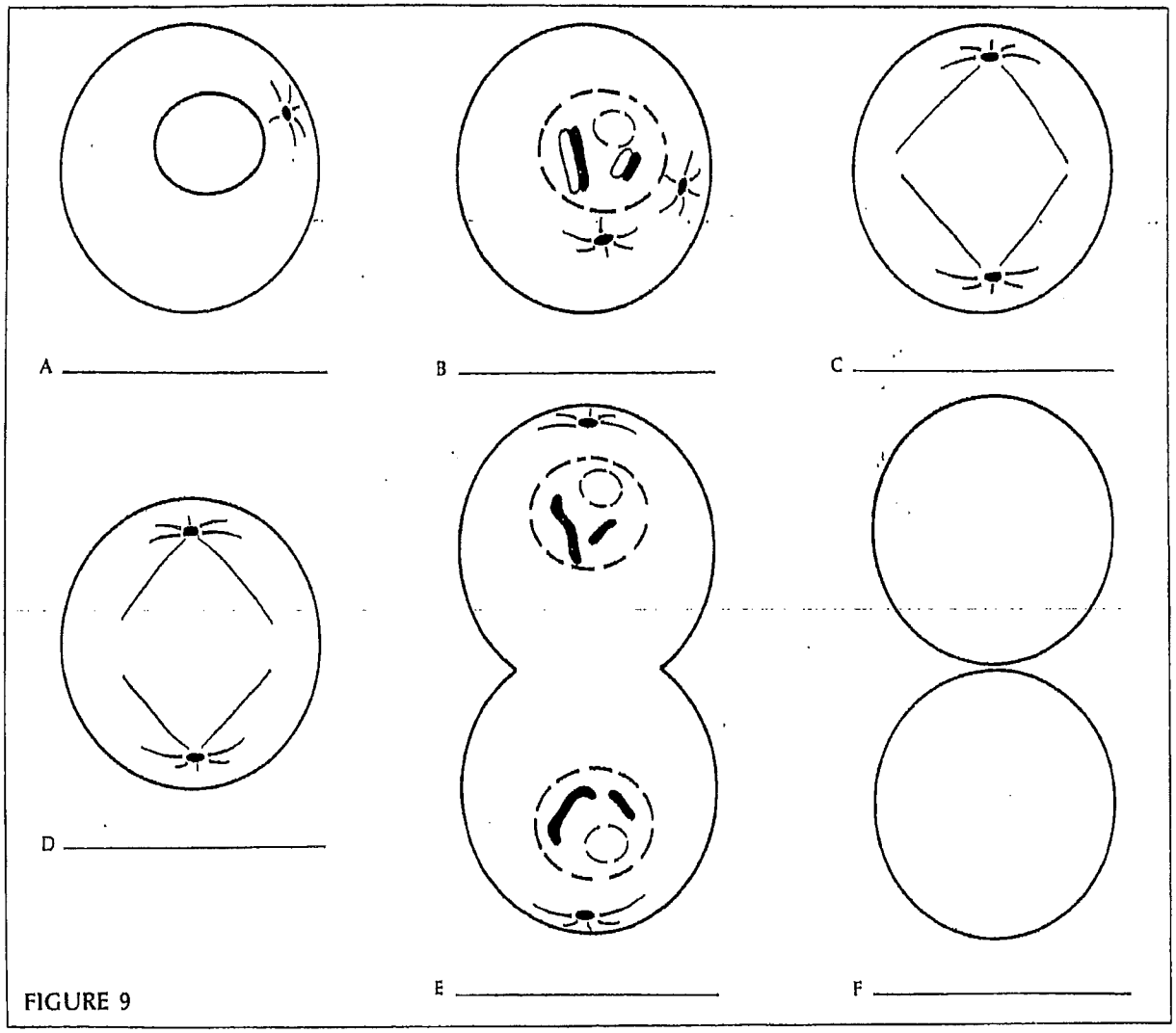


FIGURE 9

Mitosis in Plant Cells

OBJECTIVES

- **Examine** the dividing root-tip cells of an onion.
- **Identify** the phase of mitosis that each cell in an onion root tip is undergoing.
- **Determine** the relative length of time each phase of mitosis takes in onion root-tip cells.

MATERIALS

- compound light microscope
- prepared microscope slide of a longitudinal section of *Allium* (onion) root tip

Procedure

IDENTIFY THE PHASES OF MITOSIS

1. **CAUTION: Follow safety rules**
2. **CAUTION: Handle glass slides and cover slips with care.** Look at the meristem area of the slide on low power. Focus the microscope as needed.
3. Examine the meristem carefully. Choose a sample of about 50 cells. Look for a group of cells that appear to have been actively dividing at the time that the slide was made. The cells will appear to be in rows, so it should be easy to keep track of them. The dark-staining bodies are the chromosomes.
4. For each of the cells in your sample, identify the stage of mitosis. Use the data table on the next page to show how long each phase of mitosis lasts. Record your observations in the data table.

Relative Duration of Each Phase of Mitosis

Phase of mitosis	Tally marks	Count	Percentage of all cells	Time (min)
Prophase				
Metaphase				
Anaphase				
Telophase				

CALCULATE THE RELATIVE LENGTH OF EACH PHASE

5. When you have classified each cell in your sample, count the tally marks for each phase and fill in the "Count" column.

   Which phase of mitosis had the most cells? _____

   Which phase of mitosis had the least cells? _____

6. Find the percentage of all cells that were found in each phase. (Hint: see the formula below.) Divide the number of cells in a phase by the total number of cells in your sample. Then multiply by 100. Enter these figures in the "Percentage" column.

$$\text{Percentage} = \frac{\text{number of cells in phase}}{\text{total number of cells in sample}} \times 100\%$$

7. The percentage of the total cells in each phase (the numbers you just calculated) can be used to estimate how long each phase lasts. For example, imagine 25% of the cells are in prophase. If that is the case, then prophase takes 25% of the total time of mitosis. Mitosis in onion cells takes about 80 min. Using this information and the percentages you have just determined, calculate the time for each phase. Record it in your data table.

$$\text{Duration of phase (in minutes)} = \frac{\text{percentage}}{100} \times 80 \text{ min}$$

8. Use the table on the following page to record the data for the whole class. Collect and add the counts for each phase of mitosis for the entire class. Fill in the percentage and time information by using the data.

Class Data

Phase of mitosis	Count	Percentage of all cells	Duration (min)
Prophase			
Metaphase			
Anaphase			
Telophase			

Analyze and Conclude

1. **Identifying Structures** What color are the chromosomes stained?

_____

2. **Recognizing Relationships** How can you tell the difference between early and late anaphase?

_____

_____

3. **Scientific Methods Making Systematic Observations** According to your data table, which phase takes the least amount of time? _____

Which phase of mitosis lasts the longest? _____

Why might this phase require more time than other phases of mitosis?

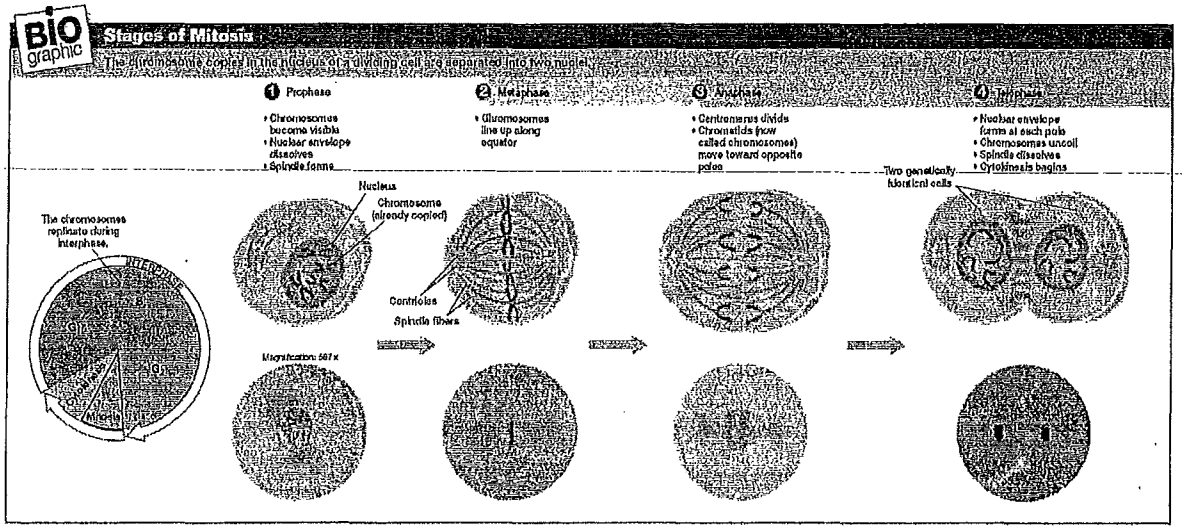
_____

_____

_____

4. **Critiquing Procedures** Do you remember how you calculated the time in each phase? You assumed that the percentage of time in any phase is equal to the percentage of the number of cells in that phase. Why might this not be true for very small samples of cells?

5. Cancerous tissue is composed of cells undergoing uncontrolled, rapid cell division. How could you develop a procedure to identify cancerous tissue by counting the number of cells undergoing mitosis?



Mitosis Flip-Book

Purpose: For students to create a visual aid to help them understand the process of mitosis

Materials: 10-20 sheets of paper(cut into quarters and stapled, or a small pad at least 40 pages long or.a post it pad (no dark or bright colors). It can not be larger than 4 x 6 inches!!!

markers, coloured pencils, etc

stapler or tape to bind the book

mitosis stages from notes or text

Preparation: Cut each sheet of paper into quarters or eighths. The paper must all be the same size and SECURELY bound. Make a small booklet or use a prepared booklet or post it pack

Method:

1. You can make your books as detailed as you want, as long as you realize you'll be drawing a lot of very similar pictures.
2. To make a good flip-book, each successive picture should vary a tiny bit from the preceding picture. When you flip the book, the animation should be fairly smooth. There should be at least **40** pages in total.
3. Imagine mitosis as a smooth process. Mitosis doesn't happen in 4 or 5 static frames, the way it's depicted in textbooks. Emphasize the movement of chromosomes.
4. Use the textbook diagrams to help draw the cell in mitosis. Remember the movement of the chromosomes, the nuclear membrane changes and the condensing and uncondensing of the chromatin/chromatids/ chromosomes
5. Make sure each phase is labeled on one hand side for the entire portion of that stage
6. Use the checklist so that you include all parts

The following organelles and structures are required for the project		
DNA- 2 copies of chromosome 1. you must label at least one chromatid for at least 5 pages	purple	
centromere red		
nuclear membrane	green	
spindle fibers	yellow	
centrosome blue		
microtubules for cytokinesis	orange	
cell membrane	black	

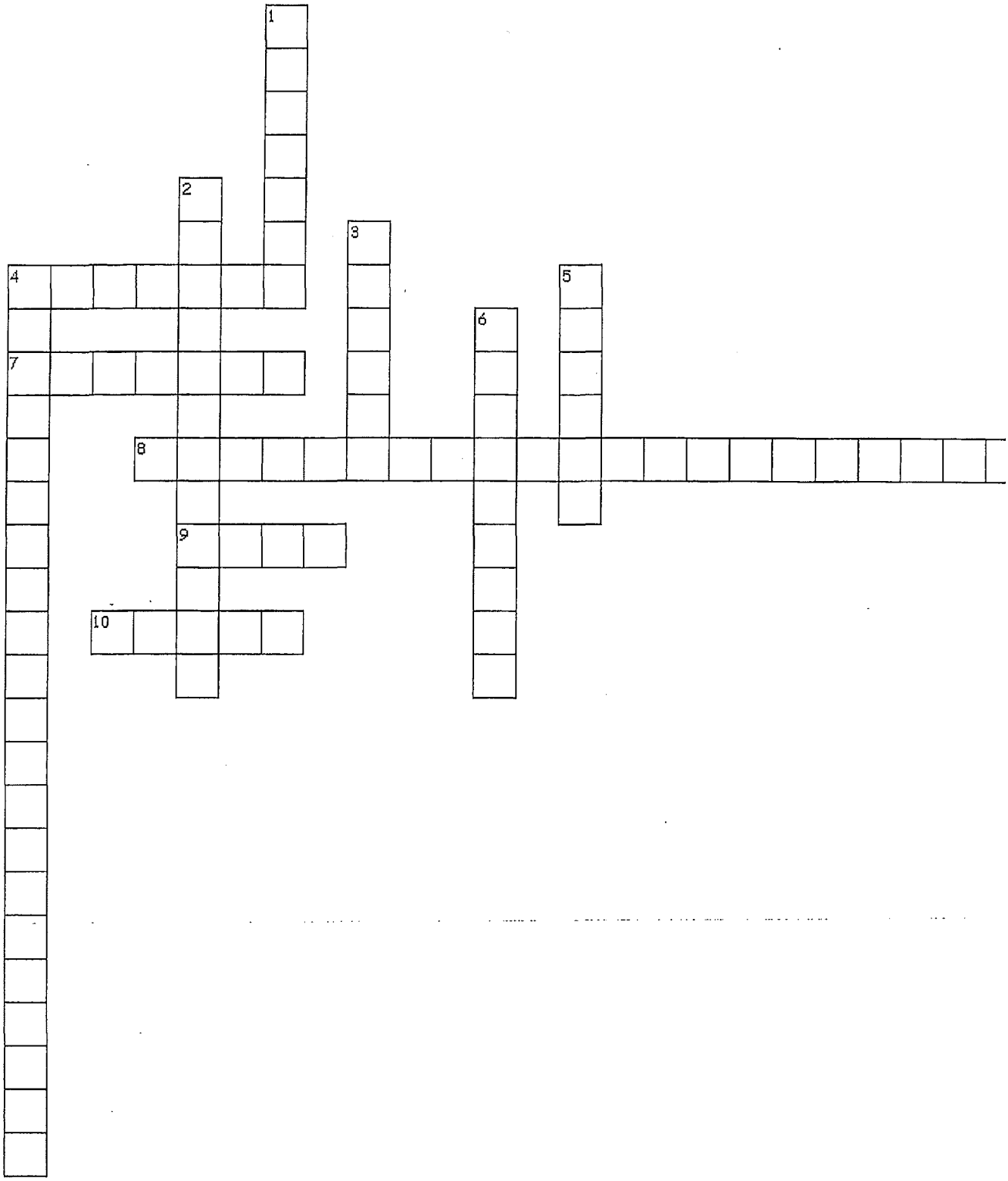
Assessment:

STAPLE STAPLE STAPLE

STAPLE STAPLE STAPLE

GRADING	yes=5 points	no= zero points
all stages of mitosis present including cytokinesis		
each stage of mitosis (including cytokinesis)is labelled on the edge through the whole stage. Every page will have a phase of mitosis written on it		
science number only is on the back of the book- no names		
proper colors for each structure are used as stated above		
animation is not jumpy and movement of chromosomes is spread out over enough pages to be smooth		
all parts that are required to be present are correctly depicted in booklet		
book is neatly presented, securely bound and easy to flip		
this rubric is included with the project and book is placed within folded sheet		

Ch 11 Crossword/ Vocab



Across

4. describes a cell, nucleus, or organism that has only one set of unpaired chromosomes
7. a process in cell division during which the number of chromosomes decreases to half the original number by two divisions of the nucleus, which results in the production of sex cells
8. the random distribution of the pairs of genes on different chromosomes to the gametes
9. a mature egg cell
10. the male gamete (sex cell)

Down

1. a cell that contains two haploid sets of chromosomes
2. the exchange of genetic material between homologous chromosomes during meiosis
3. a haploid reproductive cell that unites with another haploid reproductive cell to form a zygote
4. chromosomes that have the same sequence of genes, that have the same structure, and that pair during meiosis
5. the cell that results from the union of gametes
6. all of the events in the growth and development of an organism until the organism reaches sexual maturity

CHAPTER 11 VOCAB

Gamete
Zygote
Diploid
Haploid
homologous chromosomes
meiosis
crossing over
independent assortment
cell cycle
sperm
ovum
Gamete

Chapter 11 Meiosis and Sexual Reproduction

I. **ASEXUAL REPRODUCTION-** In asexual reproduction, a single parent passes a complete copy of its genetic information to each of its offspring. An individual formed by asexual reproduction is genetically _____ to its parent.

A. Prokaryotes reproduce asexually by a kind of cell division called _____.

B. Many unicellular eukaryotes also reproduce asexually.

1. Some multicellular eukaryotes, such as starfish, go through _____. _____ is reproduction in which the body breaks into several pieces. Some or all of these fragments regrow missing parts and develop into complete adults.

2. Other animals, such as the hydra, go through _____. In _____, new individuals split off from existing ones.

3. Some plants, such as potatoes, can form whole new plants from parts of stems. Other plants can reproduce from roots or leaves. (_____)

4. Some crustaceans, such as water fleas, reproduce by _____. _____ is a process in which a female makes a viable egg that grows into an adult without being fertilized by a male.

Type of asexual reproduction	Description	Example of an organism that can reproduce this way
Binary fission	An organism splits in half.	prokaryotes, such as bacteria
Fragmentation	An organism breaks into several pieces, each of which may grow into a complete organism.	starfish
Parthenogenesis	An unfertilized female sex cell grows into an adult.	water flea
Budding	An individual splits off from an existing organism.	potato

II.**SEXUAL REPRODUCTION**-In sexual reproduction, two parents give genetic material to produce offspring that are genetically different from their parents.

A. Most eukaryotic organisms reproduce _____.

B. Each parent produces a reproductive cell, called a _____. A gamete from one parent fuses with a gamete from the other. The resulting cell, called a _____, has a combination of genetic material from both parents. This is called fertilization. . Not all cells of eukaryotes can sexually reproduce.

III. GERM CELLS AND SOMATIC CELLS

A. The cells of a multicellular organism are often specialized for certain functions.

B. Cells that are specialized for sexual reproduction are called _____. Only germ cells can produce _____

C. Other body cells are called _____ cells. Somatic cells do not undergo _____ reproduction.

IV. ADVANTAGES OF SEXUAL REPRODUCTION

A. Asexual reproduction is the simplest, most _____ method of reproduction.

B. Asexual reproduction allows organisms to produce many offspring in a short period of time without using energy to make gametes or to find a mate.

C. There is very little genetic variation.

D. Sexual reproduction, in contrast, produces genetically _____ individuals.

V. **CHROMOSOME NUMBER-** Each chromosome has thousands of genes that play an important role in determining how an organism develops and functions. Each species has a characteristic number of chromosomes. (humans=_____) If an organism has too many or too few chromosomes, the organism may not develop and function properly.

VI. HAPLOID AND DIPLOID CELLS

A. The symbol _____ is used to represent the number of chromosomes in one set.

B. A cell, such as a somatic cell, that has two sets of chromosomes is _____. (2n)

C. A cell is _____ if it has one set of chromosomes.(n)

D. Gametes (sperm and eggs) are _____ cells.(n)

E. Human gametes have 23 chromosomes, so n = 23. The diploid number in somatic cells is written as 2n. Human somatic cells have 46 chromosomes (2n = 46).

VII. **HOMOLOGOUS CHROMOSOMES-** Homologous chromosomes are chromosomes that are similar in size, in shape, and in kinds of genes. Each diploid cell has pairs of chromosomes made up of two homologous chromosomes. Each chromosome in a homologous pair comes from one of the two parents. Homologous chromosomes can carry different forms of genes.

VIII. AUTOSOMES AND SEX CHROMOSOMES

A. _____ are chromosomes with genes that do not determine the sex of an individual.

B. Sex chromosomes have genes that determine the sex of an individual.

1. In humans and many other organisms, the two sex chromosomes are referred to as the X and Y chromosomes.

2. The genes that cause a zygote to develop into a _____ are located on the Y chromosome.

3. Human males have one X chromosome and one Y chromosome (XY), and human _____ have two X chromosomes (XX).

IX. **STAGES OF MEIOSIS-**During meiosis, a diploid cell goes through two divisions to form _____ haploid cells. _____ cells undergo meiosis to produce gametes (sex cells=egg or sperm) In meiosis I, homologous chromosomes are separated. In meiosis II, the sister chromatids of each homologue are separated.

A. MEIOSIS I- Meiosis begins with a diploid cell that has copied its chromosomes.

1. During prophase I, the chromosomes condense, and the nuclear envelope breaks down. Homologous chromosomes pair. Chromatids exchange genetic material in a process called crossing-over.

2. In metaphase I, the spindle moves the pairs of homologous chromosomes to the equator of the cell. The homologous chromosomes remain together.

3. In anaphase I, the homologous chromosomes separate. The spindle fibers pull the chromosomes of each pair to opposite poles of the cell. But the chromatids do not separate at their centromeres. Each chromosome is still made of two chromatids. The genetic material, however, has recombined.

4. During telophase I, the cytoplasm divides (cytokinesis), and two new cells are formed. Both cells have one chromosome from each pair of homologous chromosomes.

B. Meiosis II

1. Meiosis II begins with the two cells formed at the end of telophase I of meiosis I.

2. The chromosomes are not copied between meiosis I and meiosis II.

3. In prophase II, new spindles form.

4. During metaphase II, the chromosomes line up along the equators and are attached at their centromeres to spindle fibers.

5. In anaphase II, the centromeres divide. The chromatids, which are now called chromosomes, move to opposite poles of the cell.

6. During telophase II, a nuclear envelope forms around each set of chromosomes. The spindle breaks down, and the cell goes through cytokinesis.

7. The result of meiosis is four haploid cells.

X. COMPARING MITOSIS AND MEIOSIS- _____ makes new cells that are used during growth, development, repair, and asexual reproduction. _____ makes cells that enable an organism to reproduce sexually and happens only in reproductive structures.

A. _____ produces two genetically identical diploid cells.

B. _____ produces four genetically different haploid cells. The haploid cells produced by meiosis contain half the genetic information of the parent cell.

C. If you compare meiosis and mitosis, they may appear similar but they are very different.

1. In prophase I of meiosis, every chromosome pairs with its homologue. A pair of homologous chromosomes is called a _____.

2. As the tetrads form, different homologues exchange parts of their chromatids in the process of crossing-over. The pairing of homologous chromosomes and the crossing-over do not happen in _____.

Process	Description	Function
Mitosis	produces two genetically identical diploid cells	makes new cells for growth, development, repair, and asexual reproduction
Meiosis	produces four genetically different haploid cells	makes sex cells (gametes) for sexual reproduction

XI. GENETIC VARIATION-Genetic variation is advantageous for a population. Genetic variation can help a population survive a major environmental change. Genetic variation is made possible by _____ reproduction. Three key contributions to genetic variation are crossing-over, independent assortment, and random fertilization

A. CROSSING-OVER

1. During prophase I, homologous chromosomes line up next to each other.

2. Each homologous chromosome is made of two sister _____ attached at the centromere.

3. Crossing-over happens when one arm of a chromatid crosses over the arm of the other chromatid. – The chromosomes break at the point of the crossover, and each chromatid re-forms its full length with the piece from the other chromosome.

4. Thus, the sister chromatids of a homologous chromosome no longer have identical genetic information.

B. INDEPENDENT ASSORTMENT

1. During metaphase I, homologous pairs of chromosomes line up at the equator of the cell.

2. The two pairs of chromosomes can line up in either of two equally probable ways.

3. This random distribution of homologous chromosomes during _____ is called independent assortment.

C. RANDOM FERTILIZATION

1. Fertilization is a random process that adds genetic variation.

2. The zygote that forms is made by the random joining of two gametes.

3. Because _____ of an egg by a sperm is random, the number of possible outcomes is squared.

XII. **DIPLOID LIFE CYCLE**-In diploid life cycles, meiosis in germ cells of a multicellular diploid organism results in the formation of haploid gametes.

A. Most animals have a diploid life cycle. Most of the life cycle is spent in the _____ state. Somatic cells=2n

B. All of the cells except the gametes are _____.

C. A diploid germ cell in a reproductive organ goes through meiosis and forms gametes.The gametes, the sperm and the egg, join during fertilization. The result is a diploid _____.This single diploid cell goes through mitosis and eventually gives rise to all of the cells of the adult, which are also diploid.

D. MEIOSIS AND GAMETE FORMATION

1. Male animals produce gametes called sperm. A diploid germ cell goes through meiosis I. Two cells are formed, each of which goes through meiosis II.

2. The result is four haploid cells.

3. The four cells change in form and develop a tail to form four sperm.

4. Female animals produce gametes called eggs, or ova (singular, ovum). A diploid germ cell begins to divide by meiosis. Meiosis I results in the formation of two haploid cells that have unequal amounts of cytoplasm.

5. One of the cells has nearly all of the cytoplasm. The other cell, called a polar body, is very small and has a small amount of cytoplasm.

6. The polar body may divide again, but its offspring cells will not survive.

7. The larger cell goes through meiosis II, and the division of the cell's cytoplasm is again unequal.

8. The larger cell develops into an ovum. The smaller cell, the second polar body, dies. – Because of its larger share of cytoplasm, the mature ovum has a rich storehouse of nutrients.

XIII. **HAPLOID LIFE CYCLE-** In haploid life cycles, meiosis in a diploid zygote results in the formation of the first cell of a multicellular haploid individual.

A. The _____ life cycle happens in most fungi and some protists.

B. The _____, the only diploid structure, goes through meiosis immediately after it is formed and makes new haploid cells.

C. The haploid cells divide by mitosis and give rise to multicellular haploid individuals.

XIV. **ALTERNATION OF GENERATIONS-** Plants and most multicellular protists have a life cycle that alternates between a haploid phase and a diploid phase called alternation of generations.

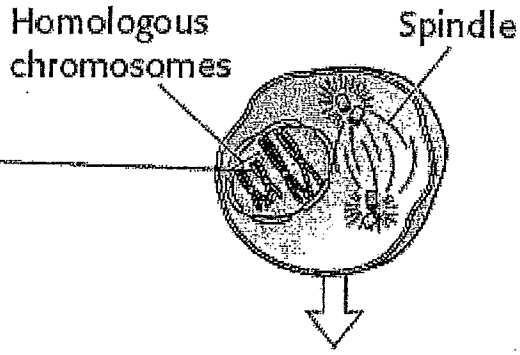
A. In plants, the multicellular diploid phase in the life cycle is called a _____. Spore-forming cells in the sporophyte undergo meiosis and produce spores.

B. A spore forms a multicellular _____

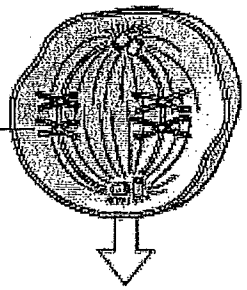
C. The gametophyte is the haploid phase that produces gametes by _____. The gametes fuse and give rise to the diploid phase.

Meiosis I

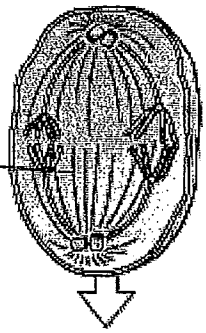
Meiosis I begins with a cell that has copied its chromosomes. The first stage of meiosis I is prophase I. During prophase I, the chromosomes condense. Homologous chromosomes pair up. The membrane around the nucleus breaks down.



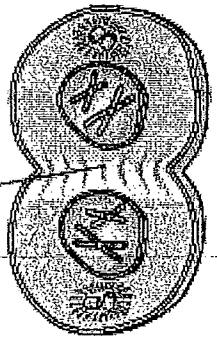
The second stage of meiosis I is metaphase I. During metaphase I, the pairs of homologous chromosomes move to the equator of the cell.



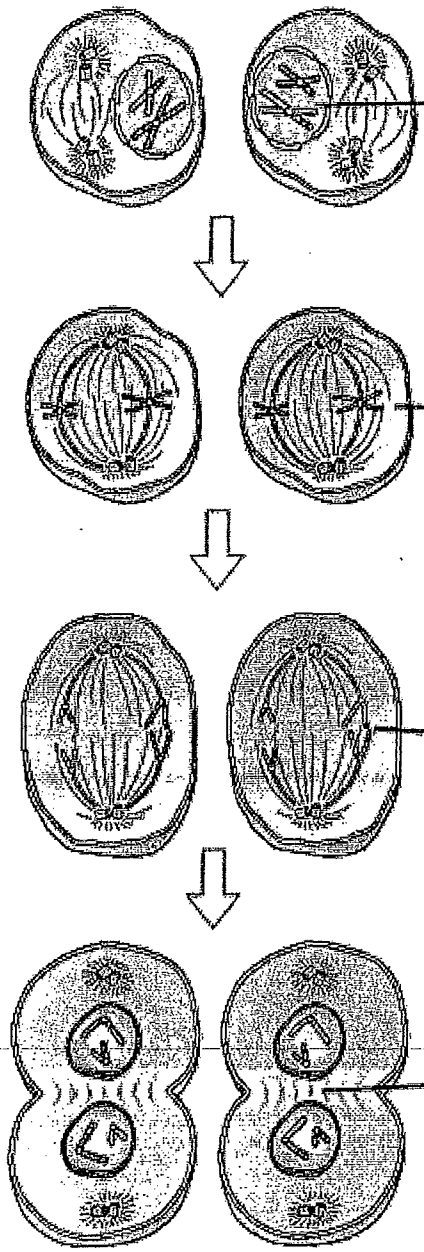
The third stage of meiosis I is anaphase I. During anaphase I, the homologous chromosomes separate. The spindle fibers pull one chromosome from each pair to each pole of the cell.



The fourth stage of meiosis I is telophase I. During telophase I, the cytoplasm divides (cytokinesis). Two new cells form. Each cell contains one chromosome from each pair of homologous chromosomes.



Meiosis II

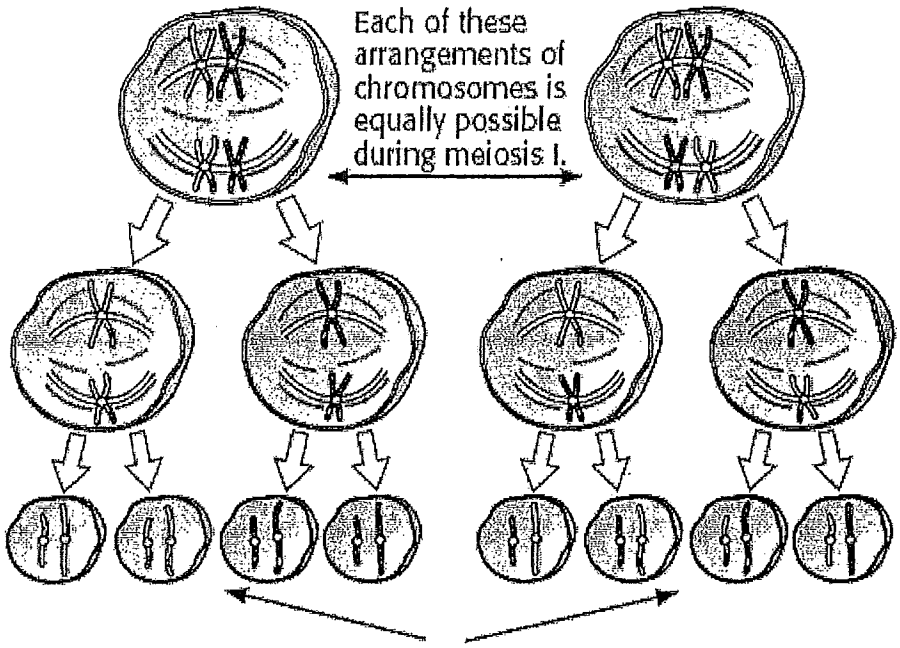


Meiosis II begins with the two cells formed at the end of meiosis I. The chromosomes are not copied at the end of meiosis I. The first stage of meiosis II is prophase II. During prophase II, a new spindle forms.

The second stage of meiosis II is metaphase II. During metaphase II, the chromosomes move to the equators of the cells.

The third stage of meiosis II is anaphase II. During anaphase II, the centromeres divide and the chromatids in each chromosome separate. The spindle fibers pull one chromatid from each pair to the pole of each cell.

The fourth stage of meiosis II is telophase II. During telophase II, the cytoplasm in each cell divides (cytokinesis). Four new haploid cells form. Each cell contains one chromatid from each pair of homologous chromosomes.



The alleles that each gamete contains depend on how the chromosomes were arranged at the beginning of meiosis. Different arrangements of chromosomes produce gametes with different alleles.

ONLY HALF THE STORY!

Body cells are produced by mitosis. But sperm and egg cells do not form this way. Reproductive cells are formed by meiosis. Each gamete has only half the usual number of chromosomes. But when the sperm and egg join, the zygote has the full number of chromosomes.

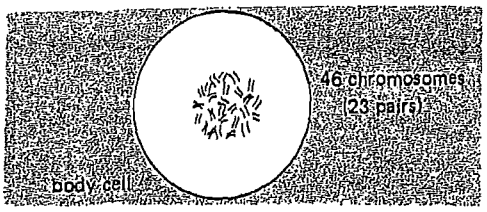


Figure B

A human body cell has 46 chromosomes. The chromosomes are paired. So there are 23 pairs.

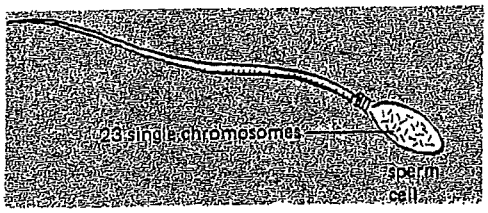


Figure C

Each human sperm cell has 23 single chromosomes.

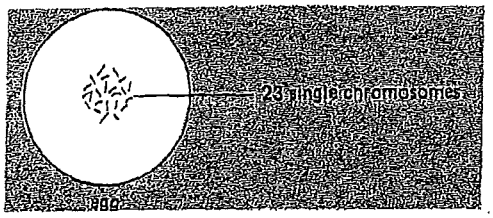


Figure D

Each human egg cell has 23 single chromosomes.

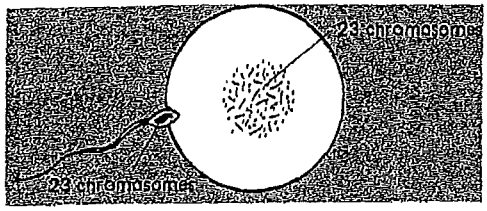


Figure E

Fertilization links the gamete chromosomes.

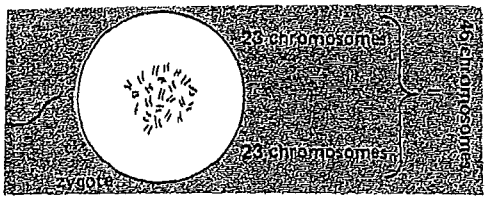


Figure F

The zygote, then has a total of 46 chromosomes. 23 are from the mother, 23 are from the father.

The zygote starts to divide after fertilization. It divides by mitosis. It divides over and over again as it develops.

MEIOSIS

1. Original cell with two pair of chromosomes.

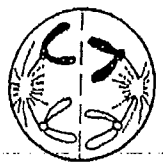
2. Each pair of chromosomes doubles.

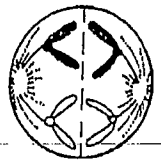
3. Spindle fibers form in the cell. The pairs of chromosomes attach to the spindle fibers.

4. The chromosomes separate.

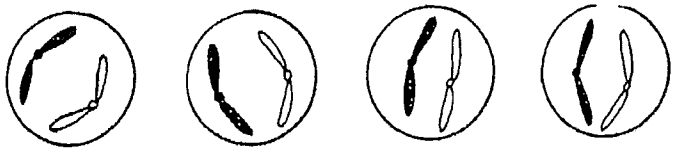
5. The cell splits in two, with each cell containing one double chromosome from each pair.

6. Spindle fibers form in each new cell. Double chromosomes attach to the spindle fibers.





7. The double chromosomes split. One chromosome goes to each side of the cell. Then, each cell splits.

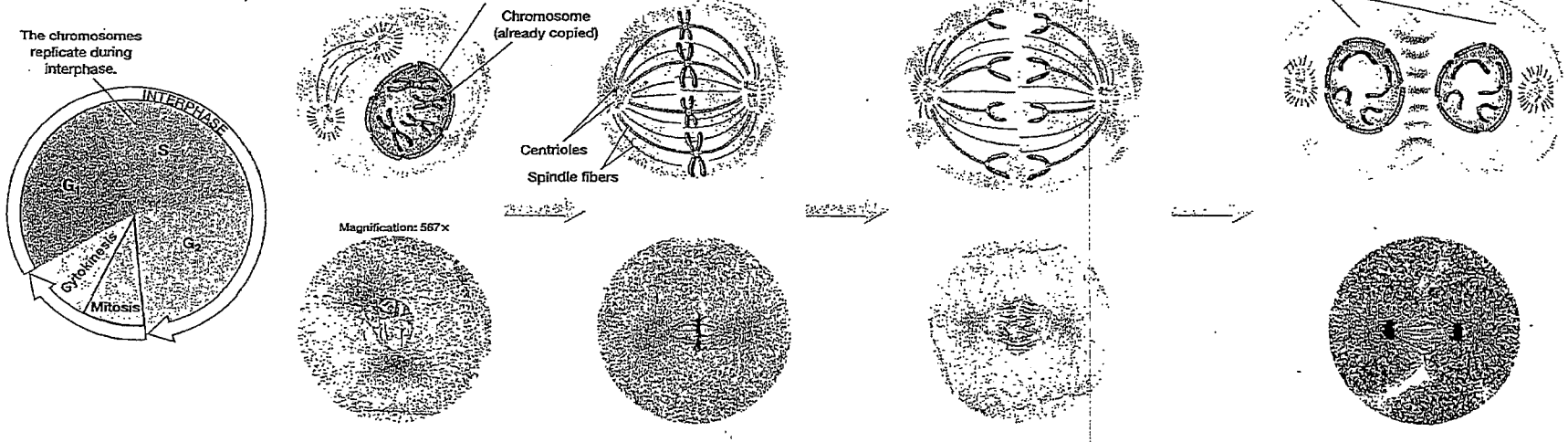


8. Four cells are produced. Each cell has one chromosome from each pair.

Figure A

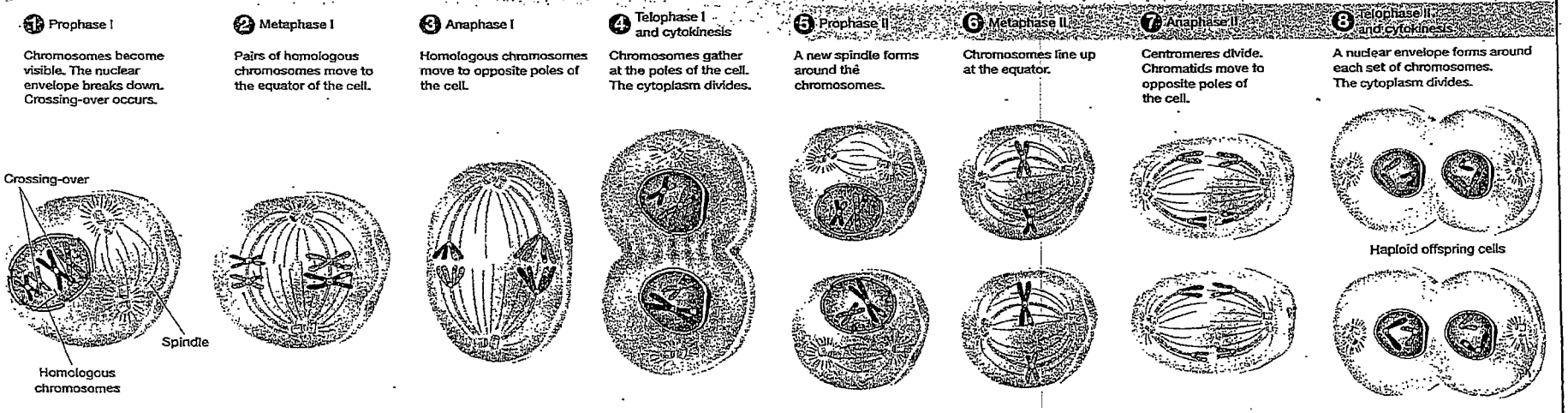
BIO graphic — Stages of Mitosis

The chromosome copies in the nucleus of a dividing cell are separated into two nuclei.



BIO graphic — Stages of Meiosis

Four cells are produced, each with half as much genetic material as the original cell.



CHAPTER 11 SEC 1 DUE DATE .

1. How are gametes and zygotes related?

2. What is one thing that all types of asexual reproduction have in common?

3. What would happen if the gametes of sexually reproducing organisms were diploid instead of haploid? Explain your answer.

4. How many chromosomes does a gamete of a dog have? Explain your answer.

5. Give two differences between sexual reproduction and asexual reproduction.

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

CHAPTER 11 SEC 2 DUE DATE

1. Describe the difference between what happens during anaphase I and what happens during anaphase II.

2. Fill in the blank spaces in the table below.

Stage of meiosis	Description
	Chromosomes condense, homologous chromosomes pair up, and crossing-over occurs.
	Cytokinesis occurs, and two new cells form.
	Pairs of sister chromatids move to the equators of the two cells.
	Cytokinesis occurs, and four new cells form.

3. Give two differences between meiosis and mitosis.

4. What are three processes that contribute to genetic variation during sexual reproduction?

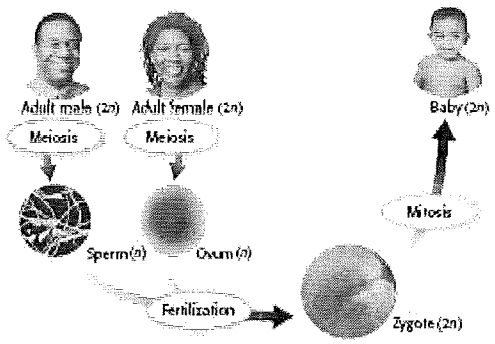
5. Why is sexual reproduction helpful to a species?

Bellringer:Day M T W Th F Date Question

Answer

CHAPTER 11 SEC 3 DUE DATE .

1. Label the haploid and diploid cells in the figure below.



2. What type of life cycle does the figure above show? Explain your answer.

_____

_____

3. A particular plant's diploid number of chromosomes is 50. Describe the number of chromosomes in one of the plant's cells during its sporophyte phase and during its gametophyte phase. (use the phrase alternation of generations)

_____

_____

_____

4. By what process do the spores of a plant form? By what process do the gametes form?

_____

_____

_____

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

_____

_____

_____

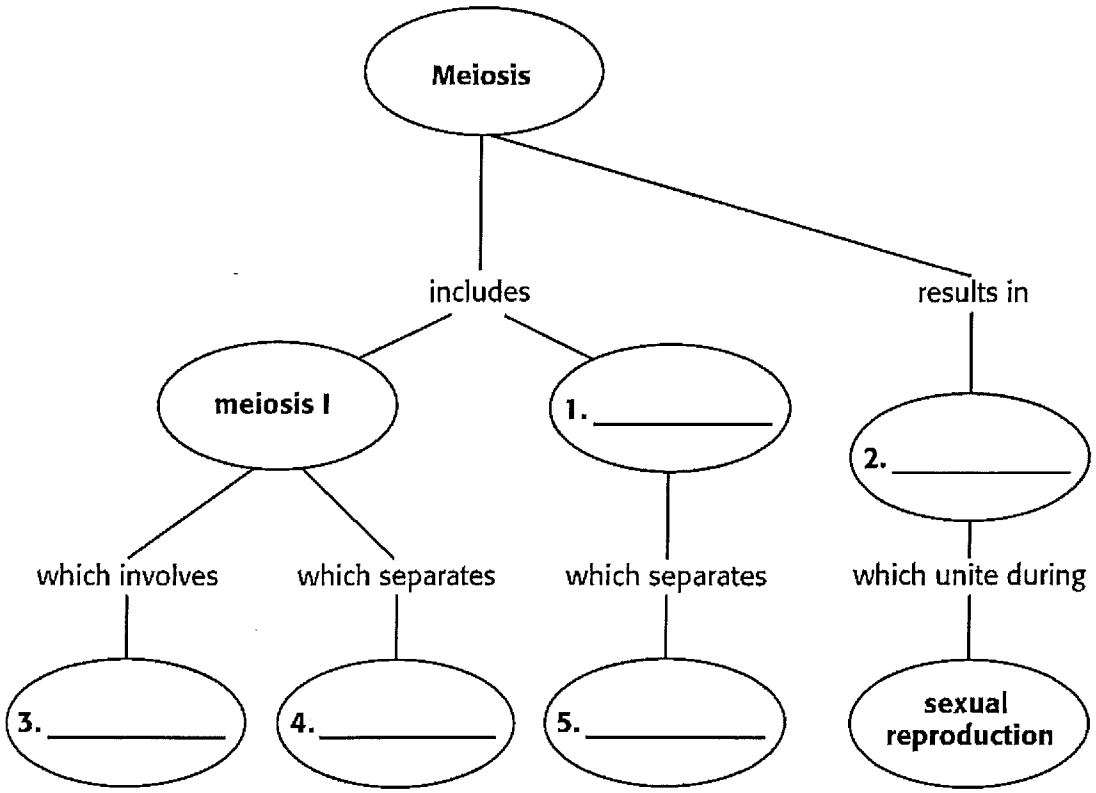
Name _____ Class _____ Date _____

Ch 11

Concept Mapping

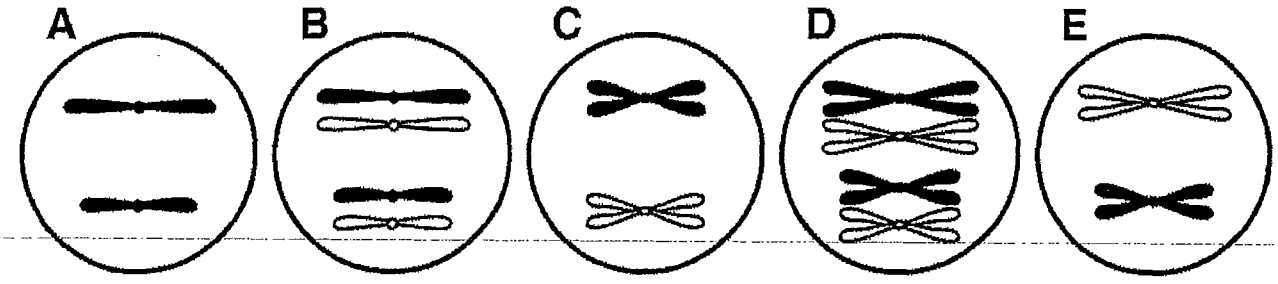
Using the terms and phrases provided below, complete the concept map showing the process of meiosis.

chromatids
crossing-over
haploid sperm and ovum
homologous chromosomes
meiosis II



CH 11 REVIEW

1. What is the most simple method of reproduction?
2. What is binary fission?
3. What is asexual and sexual reproduction? What is the difference?
4. What is budding? Fragmentation? Binary Fission?
5. What zygote sex chromosome combination do females develop from?
6. Homologous chromosomes are pairs of chromosomes containing genes that code for _____
7. What # of autosomes and sex chromosomes do humans have?
8. In humans, the male determines the sex of the child because males have _____
9. What is haploid and diploid? Where do you find these in humans?
10. Finish the simily-diploid : somatic cell :: haploid :
11. Separation of homologues occurs during _____
12. Crosssing over only takes place in _____
13. Label these stages and put them in order:



14. What is the difference between anaphase I of mitosis and anaphase I of meiosis?
15. why does crossing over occur?
16. When does crossing over occur?
17. What provides for NEW genetic combinations?
18. What is an ovum?
19. What is alternation of generations? What is the haploid life cycle? What is a diploid life cycle?

Chromosome Combinations

When a sperm and egg fuse, two sets of chromosomes are combined. In this lab, you will model this cross between two sets of chromosomes.

Procedure

1. Write "F1F2 × M1M2" on a sheet of paper. F1 and F2 represent the father's chromosomes. M1 and M2 represent the mother's chromosomes.
2. Determine all of the possible chromosome combinations in the zygote that forms from the fusion of the gametes with the chromosomes that you wrote in step 1.

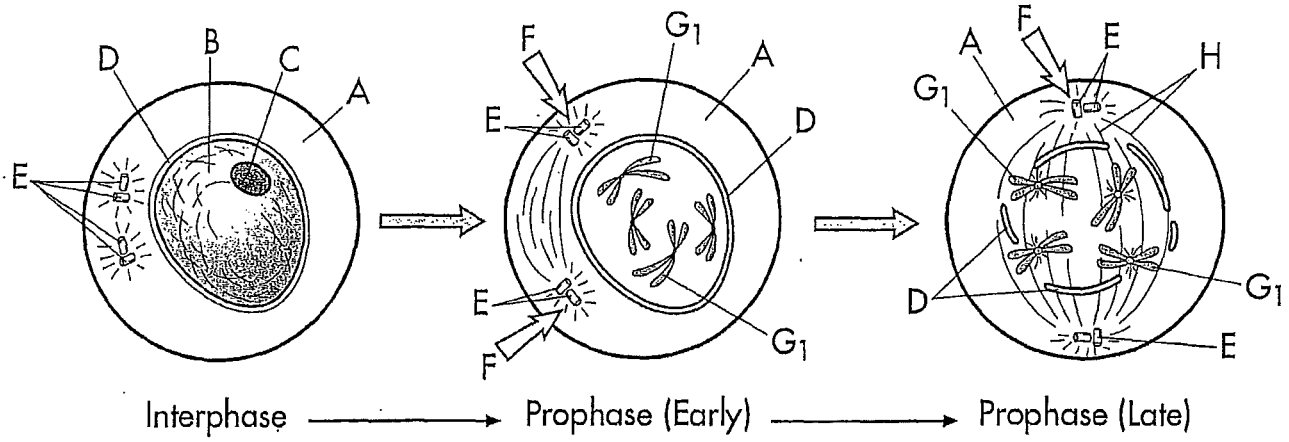
Analysis

1. **Calculate** the number of chromosome combinations that are possible in the zygote.

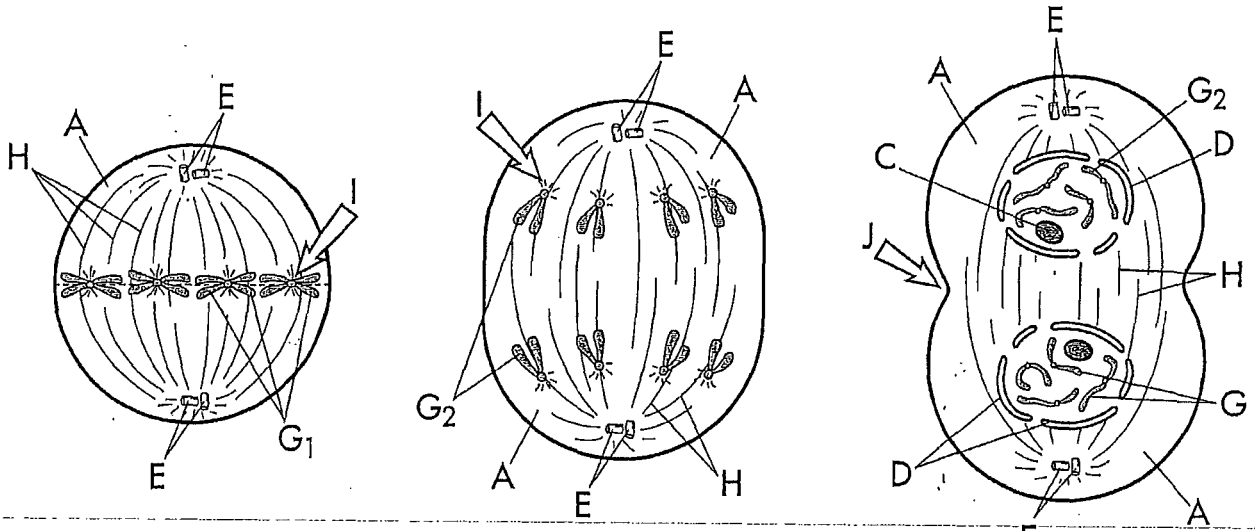
2. List all of the possible chromosome combinations.

3. Why can the offspring of 2 parents have a phenotype (appearance) significantly different from either parent? Ex- why can two parents with black hair have a blond child?

Mitosis



Interphase ⟶ Prophase (Early) ⟶ Prophase (Late)



Metaphase ⟶ Anaphase ⟶ Telophase

Mitosis

○ Cytoplasm.....A	○ Centrioles .....E	○ Spindle Fibers .....H
○ Nucleus (Chromatin).....B	○ Asters .....F	○ Kinetochore.....I
○ Nucleolus.....C	○ Chromatids .....G_1	○ Cleavage Furrow.....J
○ Nuclear Membrane .....D	○ Chromosomes.....G_2	

Meiosis Model

OBJECTIVES

- **Model** the stages of meiosis.
- **Describe** the events that occur in each stage of the process of meiosis.
- **Compare** your meiosis model to meiosis stages in a set of prepared slides of lily anther microsporocytes.

MATERIALS

- pop beads(40)
- marker
-
- plates (8) labeled with each stage
- centrosome (plastic)
- scissors

Procedure

BUILD A MODEL

1. Work in a team of two (not 4). Review the stages of meiosis I and meiosis II. Study what happens in each stage. Pay particular attention to the way the chromosomes look and act.
2. Work with your partner to design a model of a cell nucleus. Use the plate as the cell. Omit other structures
3. Label each of the eight plates with one stage of meiosis, like "Prophase II."
4. Using your model plan that you designed in step 2, you or your partner will make a set of models for the four stages of meiosis I. The other team member will make a set of models for the four stages of meiosis II. (each person must make 4)
5. Finish making your set of models. Then, position the plates in two horizontal rows. The top row is for the stages of meiosis I. The bottom row is for the stages of meiosis II. What are the differences between the corresponding stages.

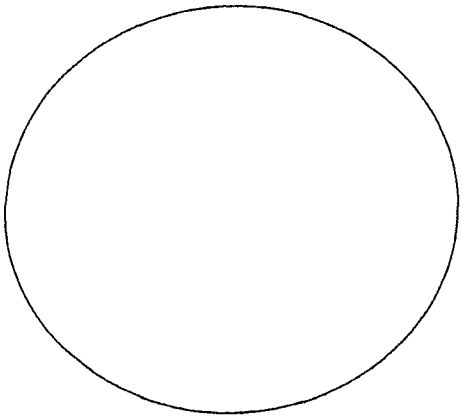
Questions

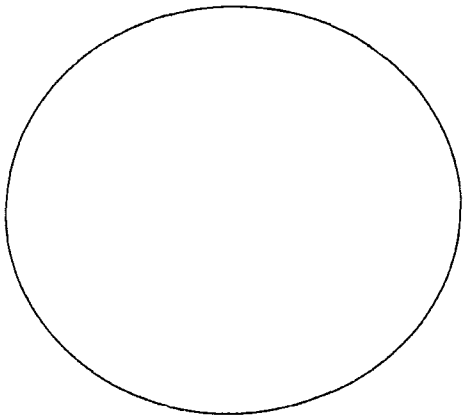
1. Identify and label each stage of meiosis as a haploid stage or a diploid stage.

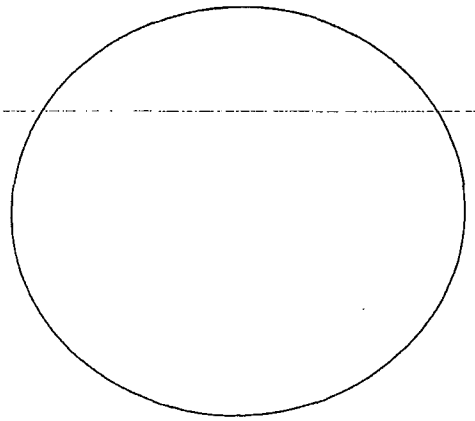
Prophase I	Metaphase I	Anaphase I	Telephase I

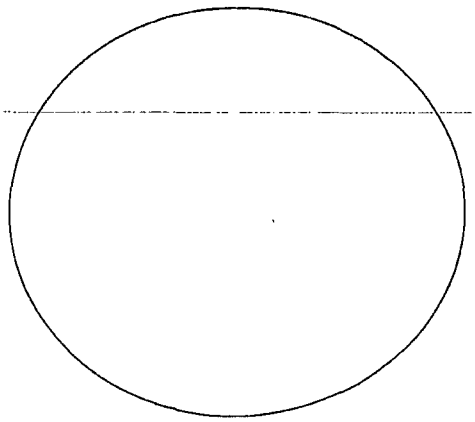
Prophase 2	Metaphase 2	Anaphase 2	Telephase 2

2. Draw AND LABEL each stage of meiosis below.







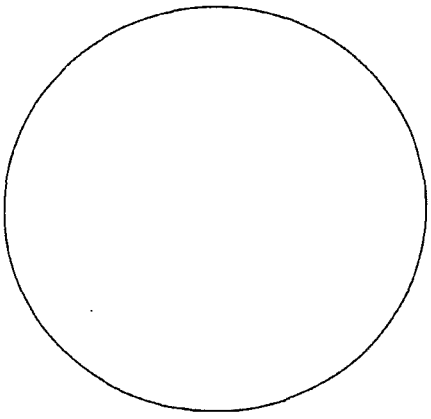


Whitefish Cells

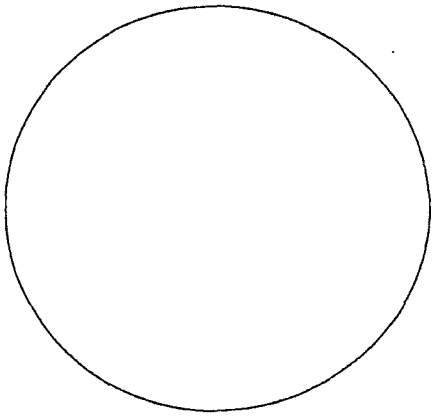
As an embryo develops, its cells divide rapidly. Few of these cells remain in a resting state, so when observing them, you will see groups of these cells in various stages of division.

Procedure

1. Place a slide of whitefish cells on the stage of a microscope. Examine the cells under low power. Do all of the cells look alike? If not, how do they differ? Draw several representative cells.
2. Carefully switch to high power. Slowly scan the slide, and look for obvious differences between cells. Pay particular attention to the appearance of the nuclei.
3. Make a sketch of each distinct pattern of cells that you see.



Object_____Mag_____



Object_____Mag____

Analysis

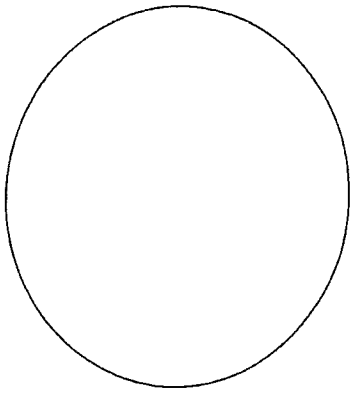
1. **Describe** any differences you observed in the nuclei of these cells.

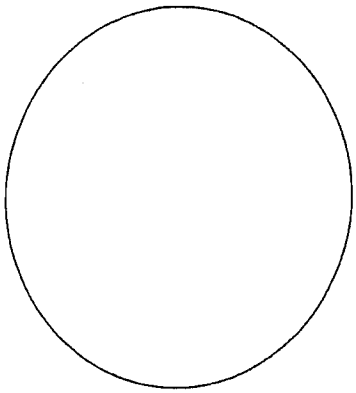
2. **Determine** whether all the cells you observed had a distinct nucleus. Explain.

NAME_____

OBJECT_____ OBJECT_____

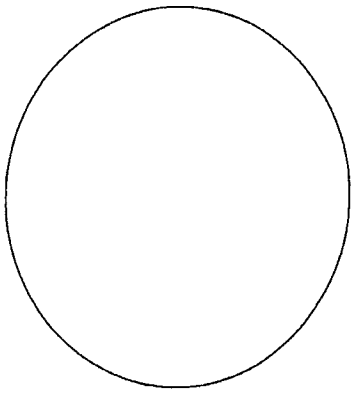
TOTAL MAGNIFICATION_____ TOTAL MAGNIFICATION_____

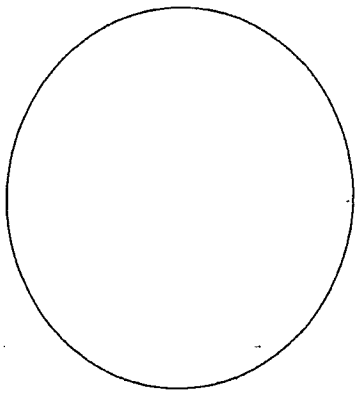




OBJECT_____ OBJECT_____

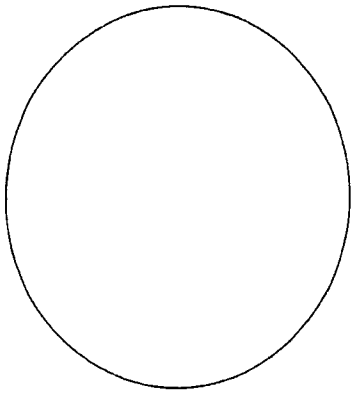
TOTAL MAGNIFICATION_____ TOTAL MAGNIFICATION_____

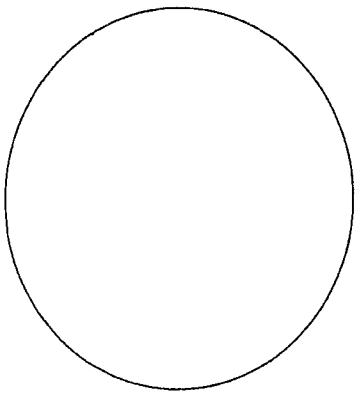




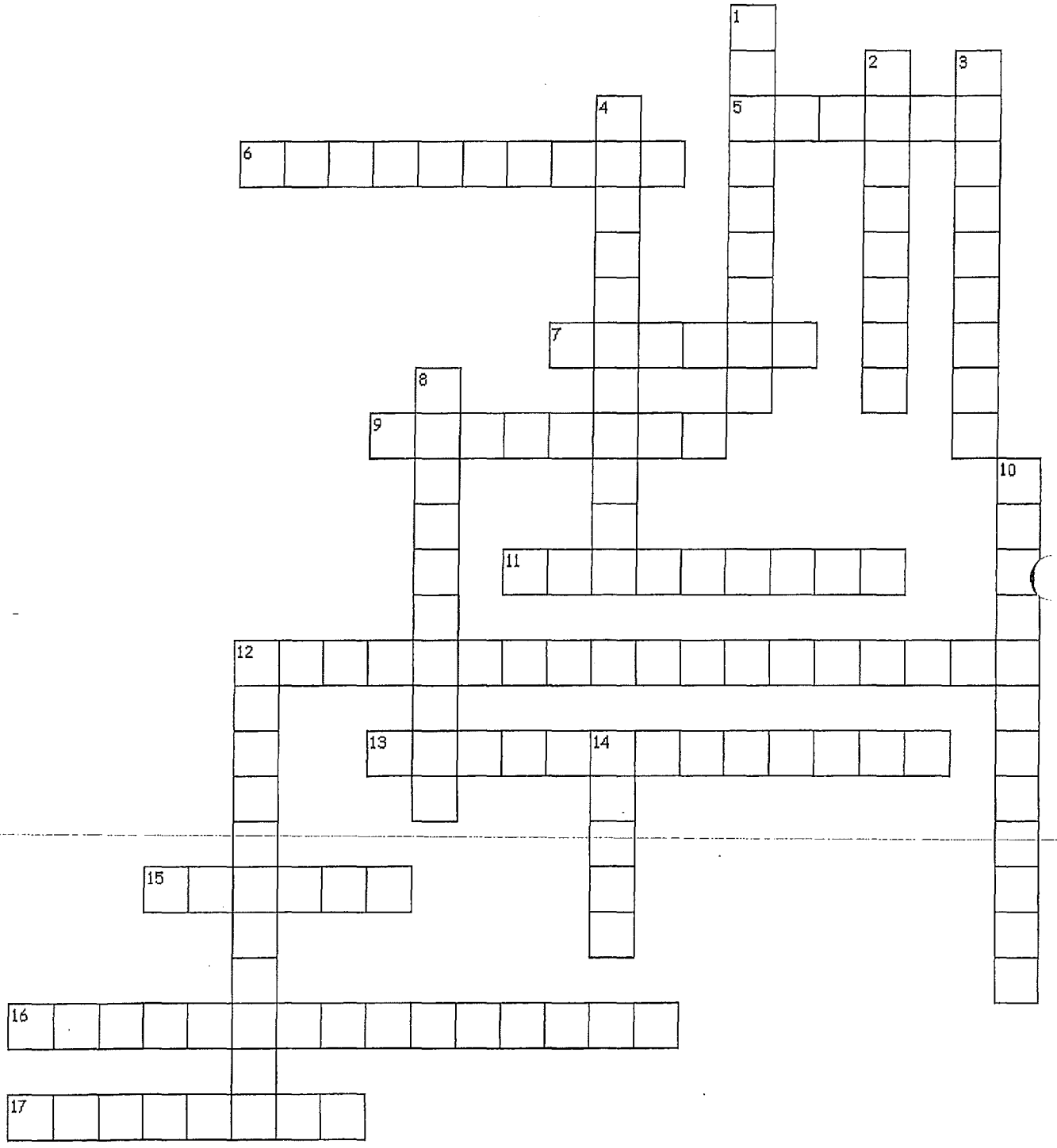
OBJECT_____ OBJECT_____

TOTAL MAGNIFICATION_____ TOTAL MAGNIFICATION_____





Ch 12 Crossword/ Vocab



Across

5. one of two or more alternative forms of a gene, each leading to a unique trait
6. the entire group of offspring produced by a given group of parents
7. in genetics, describes two or more genes that tend to be inherited together
9. describes an allele that is fully expressed whenever the allele is present in an individual
11. the detectable trait or traits that result from the genotype of an individual
12. a character that is influenced by more than one gene
13. a graphic used to predict the results of a genetic cross
15. the offspring of a cross between parents that have contrasting traits
16. an inherited disease or disorder that is caused by a mutation in a gene or by a chromosomal defect
17. a specific combination of alleles in an individual

Down

1. a recognizable inherited feature or characteristic of an organism
2. a diagram that shows the occurrence of a genetic trait in several generations of a family
3. describes an allele that is expressed only when there is no dominant allele present in an individual
4. a condition in which both alleles for a gene are fully expressed
8. describes an individual that carries two identical alleles of a gene
10. describes an individual that carries two different alleles of a gene
12. the likelihood that a specific event will occur
14. a genetically determined characteristic

CHAPTER 12 VOCAB

Character
Trait
Hybrid
Generation
Allele
Dominant
Recessive
Genotype
Phenotype
Homozygous
Heterozygous
Punnett square
Probability
Pedigree
genetic disorder
polygenic character
codominance

Chapter 12 Mendel and Heredity

I. **MENDEL'S BREEDING EXPERIMENTS-** Modern genetics is based on Mendel's explanations for the patterns of heredity in garden pea plants.

A. A monk named Gregor Mendel did breeding experiments in the 1800s with the garden pea plant.

B. The science of heredity and the mechanism by which traits are passed from parents to offspring is called genetics.

C. Most of Mendel's experiments involved crossing different types of pea plants. In this case, the word cross means "to mate or breed two individuals."

II. **MENDEL'S FIRST EXPERIMENTS** - Mendel's first experiments used monohybrid crosses and were carried out in three steps.

A. A _____ cross is a cross that is done to study one pair of contrasting traits..

B. Each step in Mendel's experiments involved a new generation of plants. A _____ is a group of offspring from a given group of parents.

C. Plants that self-pollinate for several generations produce offspring of the same type. Such a plant is said to be _____ for a given trait.

D. The first group of parents that are crossed in a breeding experiment are called the _____, or P generation. The offspring of the P generation is called the first _____ generation, or F1 generation.

E. Mendel allowed the F1 generation to self-pollinate and produce new plants. He called this offspring the _____ generation, or F2 generation.

III. **RATIOS IN MENDEL'S RESULTS-** For each of the seven characters that Mendel studied, he found a similar 3-to-1 ratio of contrasting traits in the F2 generation.

IV. **EXPLAINING MENDEL'S RESULTS-** Mendelian theory explains simple patterns of inheritance..

A. Different traits result from different versions of genes. Each version of a gene is called an _____.

B. Each allele can lead to a unique _____.

C. An allele that is fully expressed whenever it is present is called _____.

D. An allele that is not expressed when a dominant allele is present is called _____.

E. A recessive allele is expressed only when there is no _____ allele present.

V. **RANDOM SEGREGATION OF ALLELES-** In modern terms, the law of segregation holds that when an organism produces gametes, each pair of alleles is separated and each gamete has an equal chance of receiving either one of the alleles. Chance decides which alleles will be passed on.

VI. **GENOTYPE DETERMINES PHENOTYPE-** The combination of genes an individual has (_____) determines what an organism looks like (_____)

A. A _____ allele is shown as a capital letter. This letter usually corresponds to the first letter of the word for the trait.

B. A _____ allele is shown as a lowercase letter.

C. The set of specific combinations of alleles that an individual has for a character is called the _____.

D. The detectable trait that results from the genotype's set of alleles is called the _____.

E. If an individual has two identical alleles of a certain gene, the individual is _____ for the related character.

F. If an individual has two different alleles of a certain gene, the individual is _____ for the related character.

VII. **MENDEL'S SECOND EXPERIMENTS-** Mendel went from his monohybrid crosses (purple or white flower color) to _____ crosses where he examined how 2 traits are passed together. A _____ cross involves two characters, such as seed color and seed shape.

A. Mendel used dihybrid crosses in his second experiments and found that the inheritance of one character did not affect the inheritance of another character.

B. Genes are said to be _____ when they are close together on chromosomes. Scientists now know that many genes are linked to each other as parts of chromosomes.

C. Genes that are located close together on the same chromosome will NOT separate _____.

D. The only genes that follow Mendel's law of independent assortment are those that are far apart.

VIII. **USING PUNNETT SQUARES**-A Punnett square shows all of the genotypes that could result from a given cross.

A. A Punnett square is a model that predicts the likely outcomes of a genetic cross.

B. The combination of letters in each box represents one possible _____ in the offspring.

C. In a monohybrid homozygous cross, all of the offspring will be _____ (Yy) and will express the dominant trait.

D. In a monohybrid heterozygous cross the genotypic ratio will be 1 YY : 2 Yy : 1 yy. The _____ ratio will be 3 : 1.

IX. **USING PROBABILITY-** A Punnett square is a visual way to determine probability. Probability is the likelihood that a specific event will occur. Probability can be expressed in words, as a decimal, as a percentage, or as a fraction.

X. **USING A PEDIGREE-** A pedigree is a diagram that shows how a trait is inherited over several generations of a family. Pedigrees can be used to help a family understand a genetic disorder.

XI. **MANY GENES, MANY ALLELES-** The Mendelian inheritance pattern is rare in nature; other patterns include polygenic inheritance, incomplete dominance, multiple alleles, and codominance.

A. A character that is influenced or affected by more than one gene is called a _____ character. Eye color, height, and skin color are examples of polygenic characters. Most characters are polygenic.

B. Genes that have three or more possible alleles are said to have _____. Multiple alleles control the ABO blood groups (blood types) in humans.

C. _____ is a condition in which both alleles for the same gene are fully expressed. The genetics of human blood groups(above) is an example of codominance with multiple alleles

XII. **GENES AFFECTED BY THE ENVIRONMENT-** Phenotype (how it looks) can be affected by conditions in the environment, such as nutrients and temperature.

A. In humans, many characters that are partly determined by heredity, such as height, are also affected by the environment.

B. Many aspects of human personality and behavior are strongly affected by the environment, but genes also play an important role (nature vs. nurture)

XIII. **GENES LINKED WITHIN CHROMOSOMES-** During meiosis, genes that are close together on the same chromosome are less likely to be separated than genes that are far apart.

A. Many traits do not follow Mendel's laws because he studied the simplest kinds of heredity where characters are determined by _____ genes.

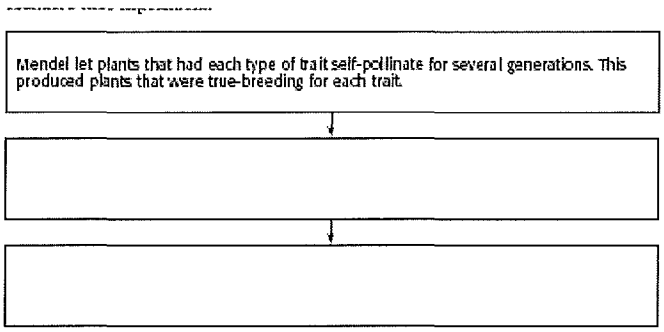
B. Genes that are close together, as well as the traits they determine, are said to be _____. Linked genes tend to be inherited together.

CHAPTER 12 VOCAB

CHAPTER 12 SEC1 DUE DATE .

1. What was Mendel's main contribution to hereditary science?

2. Complete the process chart below to describe the major steps of Mendel's first experiment.



3. Identify three reasons Mendel chose to use garden peas in his experiments.

4. What was the typical ratio of traits in the F2 generation in Mendel's first experiments?

:

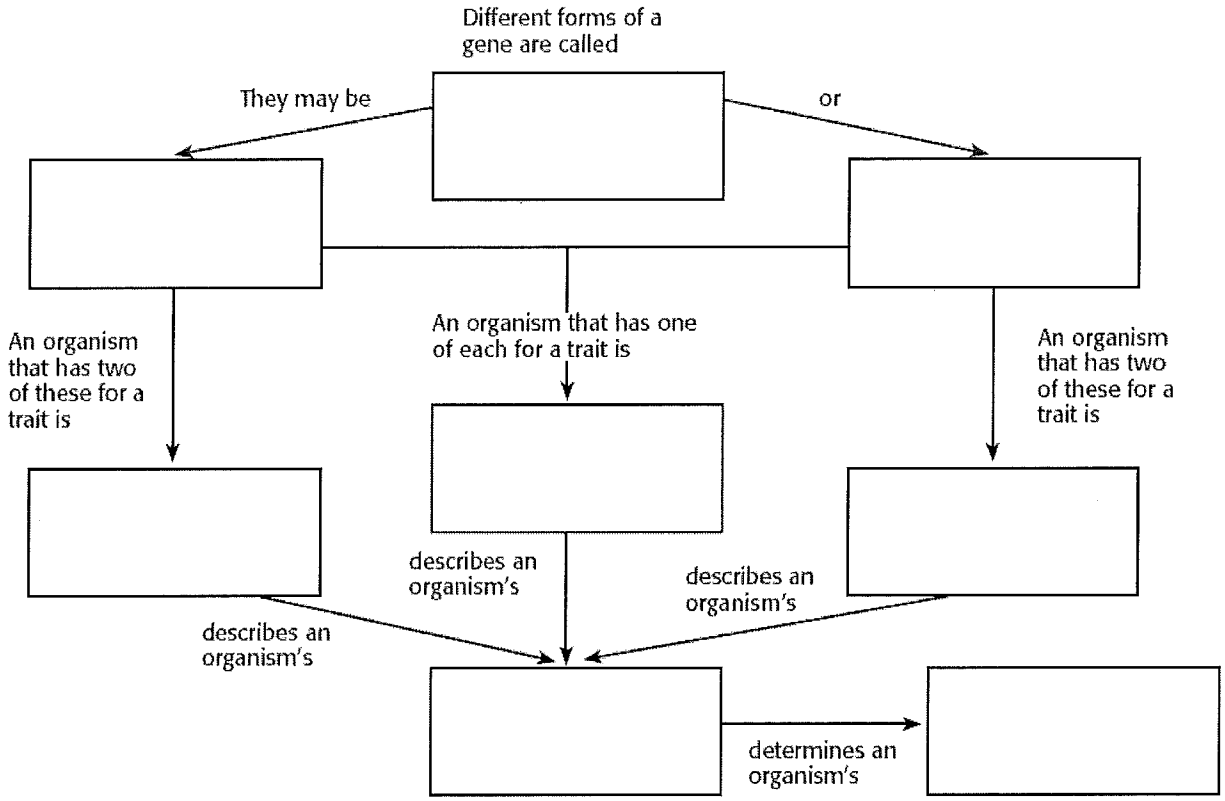
5. Mendel examined thousands of pea plants in his experiments. Why do you think he used so many?

Bellringer:Day M T W Th F Date Question

Answer

CHAPTER 12 SEC2 DUE DATE .

1. Complete the following concept map.



2. Is it possible for two individuals to have the same phenotype and different genotypes? Explain your answer.

3. According to the law of independent assortment, what gametes can an individual with the genotype *AaBb* produce?

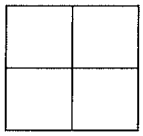
Bellringer:Day M T W Th F Date_____ Question_____

Answer_____

CHAPTER 12 SEC3 DUE DATE .

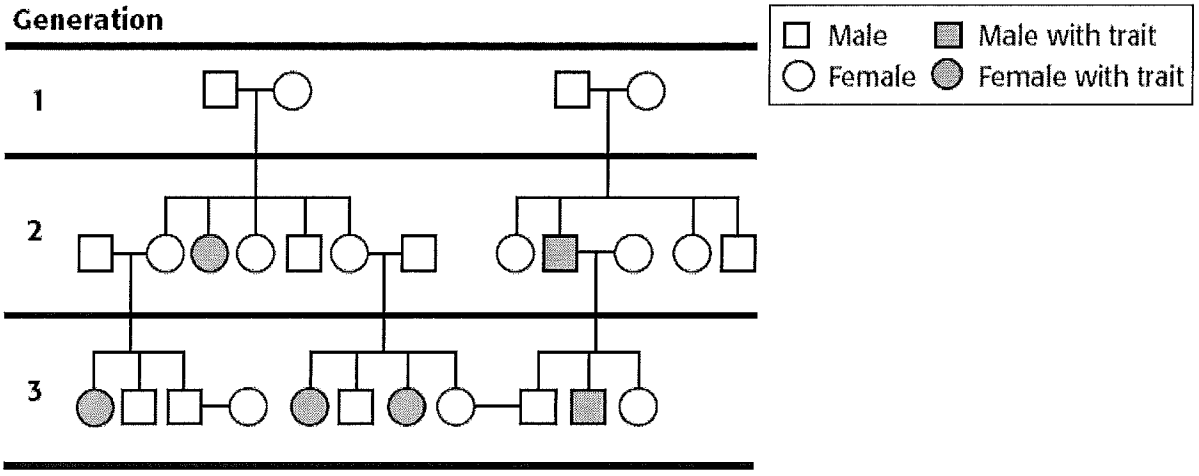
1. What are two ways a Punnett square can be used in genetics?

2. What is the probability that a cross between two heterozygous individuals will produce homozygous offspring? _____



3. When you analyze a pedigree, how can you determine whether an individual is a carrier for the trait?

Use the pedigree to answer the questions that follow. The pedigree shows the presence of albinism in a family. The gene for albinism is found on an autosome.



4. Is the allele for albinism recessive or dominant? How can you tell?

5. On the pedigree above, circle all the individuals who are definitely carriers for albinism.

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

_____

_____

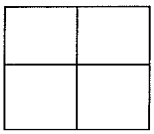
_____

CHAPTER 12 SEC4 DUE DATE .

1. What are three exceptions to the Mendelian pattern of one character controlled by two alleles?

2. How does codominance differ from incomplete dominance?

3. What are the possible genotypes and phenotypes for blood type of an individual whose father is *IAIB* and whose mother is *ii*? Use a Punnett square to show these possibilities.



4. In humans, height may be affected by both heredity and the environment. If an individual has tall parents, what kind of environmental, or outside, factors may cause the individual to be short?

5. If two genes are known to be linked, what would you expect to happen to these genes during meiosis?

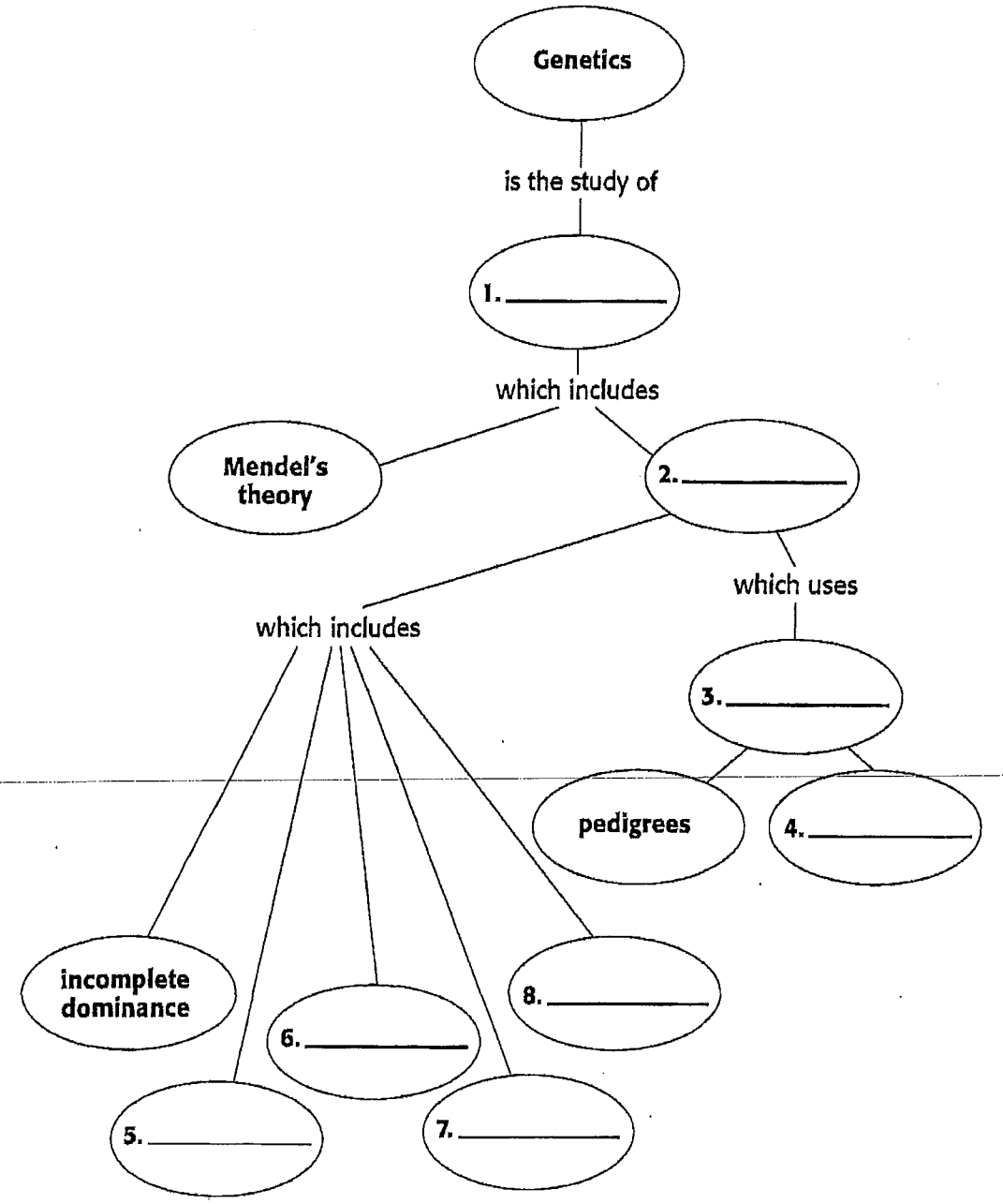
Bellringer:Day M T W Th F Date_____Question_____

Answer_____

Concept Mapping

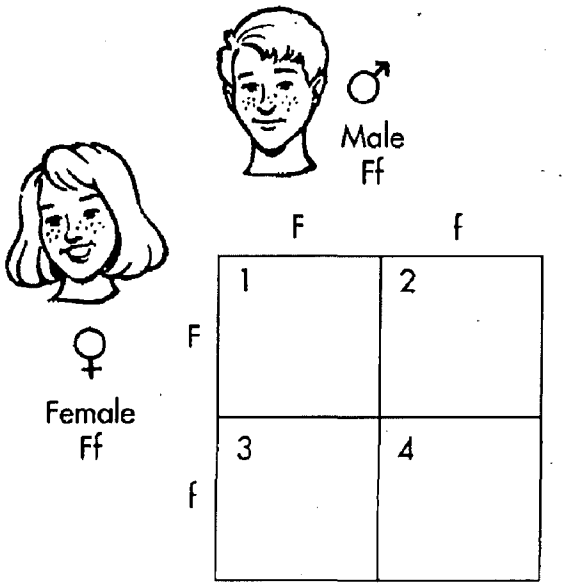
Using the terms and phrases provided below, complete the concept map showing the principles of genetics.

codominance	modern genetics	probabilities
heredity	multiple alleles	Punnett squares
linked genes	polygenic characters	



CHAPTER 12 REVIEW

1. What is the phenotype? Genotype?
2. What is the phenotype? Genotype? Whats the difference? Is genotype always expressed?
3. If an individual possesses two recessive alleles for the same trait, the individual is said to be _____
4. If an individual possesses two recessive alleles for the same trait, the individual is said to be_____. What will be the phenotype?
5. When an individual heterozygous for a trait is crossed with an individual homozygous recessive for the trait, the offspring produced will
6. When an individual heterozygous for a trait is crossed with an individual homozygous recessive for the trait, the offspring produced will have what genotype? Phenotype?
7. Tallness (T) is dominant to shortness (t) in pea plants. Which of the following represents a genotype of a pea plant that is heterozygous for tallness?
8. What is the law of independent assortment?
9. In humans, having freckles (F) is dominant to not having freckles (f). The inheritance of these traits can be studied using a Punnett square similar to the one shown below.



10. In rabbits, black fur (B) is dominant to brown fur (b). ANswer the questions for a cross between 2 heterozygous rabbits for fur color.

11. The unknown genotype of an individual with a dominant phenotype can be determined using a_____?

12. What is the probability that the offspring of a homozygous dominant individual and a homozygous recessive individual will exhibit the dominant phenotype? (in decimal- remember that a decimal can be changed into %)

13. Probability is calculated by dividing the number of one kind of possible outcome by the_____?

14. If a characteristic is sex-linked, the gene for it is found on

15. Since the allele for colorblindness is located on the X chromosome, colorblindness

16. A diagram in which several generations of a family and the occurrence of certain genetic characteristics are shown is called a

17. In humans, eye color and height are controlled by

18. name a human trasit that is controlled by multiple alleles

19. What would be the blood type of a person who inherited an A allele from one parent and an O allele from the other?

20. How can the environment influence expression of a gene? How can you tell if it is being influenced?

21. Genes that are close together on a single chromosome are considered to be

22. The passing of traits from parents to offspring is called

23. The scientific study of heredity is called

24. who is the father of genetics?

25. Step 1 of Mendel's garden pea experiment, allowing each variety of garden pea to self-pollinate for several generations, produced the

26. Define the generations- P, F1, F2

27. An allele that is always expressed whenever it is present is called

28. Whast is the law of segregation? What does it say?

Name _____ Date _____ Class _____

WORKSHEET 40 MATH IN SCIENCE: LIFE SCIENCE

MATH SKILLS USED
Multiplication
Decimals
Percentages

Punnett Square Popcorn

Use the Punnett Square to learn about dominance and codominance in inherited traits.

You are a cofounder of Flav-R-Gro, Inc., a company that specializes in creating genetically engineered foods. You and your partner, Maisie Mantequilla, have recently been concentrating on developing new types of corn. Together, you have developed a type of corn that, fresh from the stalk, tastes like it has been roasted with just the perfect amount of butter and salt! Your new creation, which you and Maisie call WonderCorn, is bringing you the admiration of your peers and the loyalty of customers. Hungry corn consumers are eager to try your tasty creation because they can eat it without worrying about the health risks caused by adding butter and salt to food. You and Maisie succeeded through determination, hard work, and an understanding of *codominance*.

Background

In some cases of genetic inheritance, two dominant traits are expressed together instead of one trait being dominant and one trait being recessive. This phenomenon is known as **codominance.** When codominance occurs, both traits are evident in the phenotype. For example, a cross between a homozygous red horse and a homozygous white horse results in offspring with a roan coat, which consists of both red hairs and white hairs. Human blood types are also determined by codominant traits.

You and Maisie suspected that the taste trait in corn was codominant. To find out, you crossed two other types of corn that you created: a homozygous salty corn (*SS*) and a homozygous buttery corn (*BB*). The offspring were all WonderCorn. See the Punnett square below for this cross.

	B	*B*
S	*SB*	*SB*
S	*SB*	*SB*

Solve the Punnet Problems!

1. What is the genotype of WonderCorn?

_____

2. What percentage of the offspring have this genotype?

_____

Name _____ Date _____ Class _____

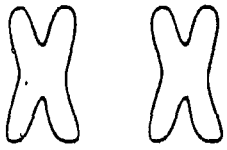
Use with Section 27:1.

CHROMOSOME NUMBERS

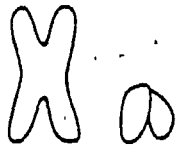
Several different numbers are important in understanding chromosomes in human genetics. Fill in the blanks in the sentences that follow with the correct numbers.

1. Each human sperm or egg has _____ chromosome(s).
2. Each human body cell has _____ chromosome(s).
3. There are _____ pairs of chromosome(s) in a human body cell.
4. Each body cell of a human female has _____ X chromosome(s).
5. The body cells of a human male have _____ X and _____ Y chromosome(s).
6. Females produce _____ kind(s) of egg.
7. Males make _____ kind(s) of sperm.

Look at the diagrams of the human sex chromosomes below. Use the diagram to help you answer the questions that follow.



Sex chromosomes of a female



Sex chromosomes of a male

1. Does the sex chromosome of the mother or of the father determine the sex of a child? Explain.

_____

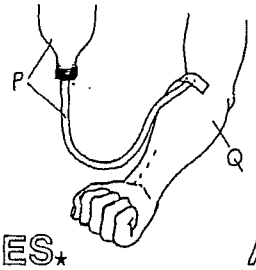
_____

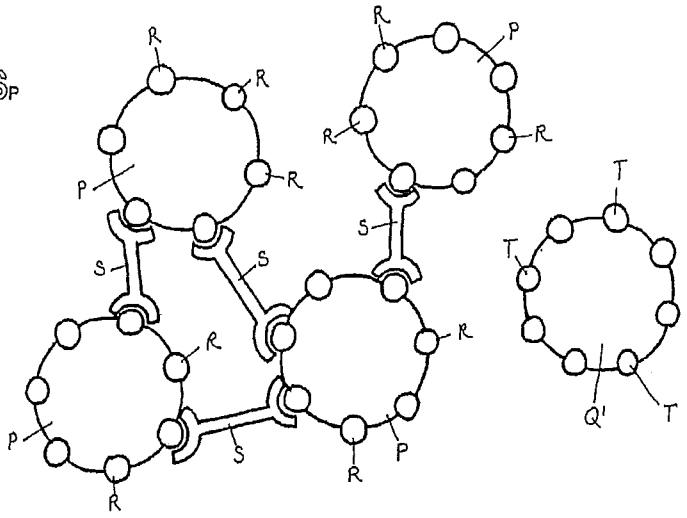
_____

2. X chromosomes are found in _____.
3. Y chromosomes are found in _____.
4. Design a Punnett square to show that the chance of having a male or female child is 1:1, or 50:50.

CODOMINANCE AND BLOOD TYPES.

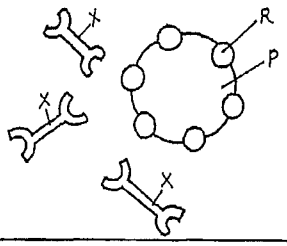
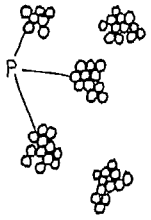
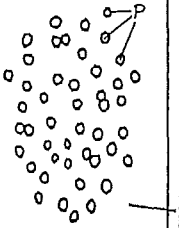
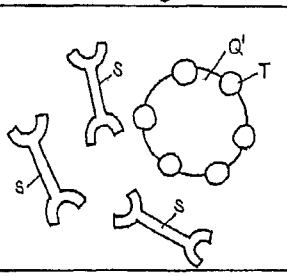
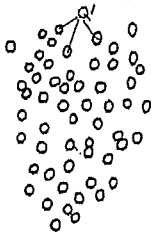
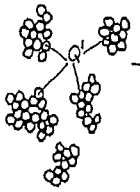
AGGLUTINATION★
TYPE A RED BLOOD CELLS$_P$
TYPE$_{P'}$
TYPE B PATIENT$_Q$/CELL$_{Q'}$
TYPE$_{Q^2}$
ANTIGEN A$_R$
ANTI-A ANTIBODIES$_S$
ANTIGEN B$_T$





BLOOD TYPES★
TYPE A GENE$_U$
TYPE O GENE$_V$
TYPE B GENE$_W$

ANTI-B ANTIBODIES$_X$
TYPE AB RED BLOOD CELL$_Y$/ TYPE$_{Y'}$
TYPE O RED BLOOD CELL$_Z$/ TYPE$_{Z'}$

GENOTYPE	BLOOD	PHENOTYPE (BLOOD "TYPE")	IN ANTI-A SERUM	IN ANTI-B SERUM
I_AI_A (U)		A$^{P'}$		
I_AI_O (U)				
I_BI_B (W)		B$^{Q^2}$		
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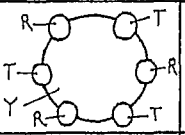
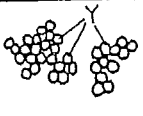
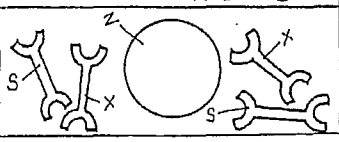
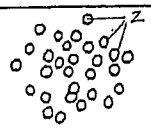
I_AI_B (U, W)		AB$^{Y'}$		
I_OI_O (V)		O$^{Z'}$		

NONAGGLUTINATED RED BLOOD CELLS

AGGLUTINATED RED BLOOD CELLS

Name _____ Class _____ Date _____

Quick Lab

Testcross

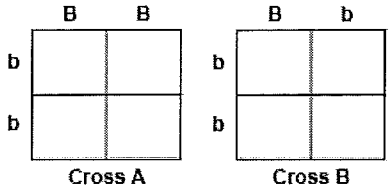
When genotypes are known, Punnett squares can be used to predict phenotypes. But can genotypes be determined if only phenotypes are known?

Suppose a breeder has a rabbit that has a dominant phenotype, such as black fur (as opposed to recessive brown fur). How could the breeder know whether the rabbit is homozygous (*BB*) or heterozygous (*Bb*) for fur color? The breeder could perform a testcross.

A *testcross* is used to test an individual whose phenotype for a characteristic is dominant but whose genotype is not known. This individual is crossed with an individual whose genotype is known to be homozygous recessive. In our example, the breeder would cross the black rabbit (*BB* or *Bb*) with a brown rabbit (*bb*).

Procedure

On a separate sheet of paper, copy the two Punnett squares shown here. Write the appropriate letters in the boxes of each square.



Analysis

1. **Label** what each pair of letters represents in each of the Punnett squares.

_____

_____

_____

2. **Identify** which figure represents a testcross involving a heterozygous parent.

_____

_____

_____

Name _____ Class _____ Date _____

Testcross *continued*

3. **Identify** which figure shows a cross in which all offspring will have black fur.

4. **Critical Thinking Applying Models** If half of the offspring in a testcross have brown fur, what is the genotype of the parent that has black fur?

Name _____ Date _____ Per. _____

Punnett Squares Practice

Monohybrid Crosses

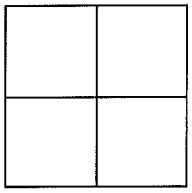
DIRECTIONS: All these genetic problems deal with pea plants and their traits. Use the following key for all problems. Put the gametes for the 1st parent of each cross along the top, and the gametes for the 2nd parent along the left side.

T = Tall **G = Green Pod** **Y = Yellow Seed** **S = Smooth Seed** **P = Purple Flower**

***t* = Short** **g = Yellow Pod** ***y* = Green Seed** ***s* = Wrinkled Seed** ***p* = White Flower**

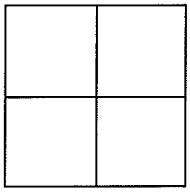
---

1. PP x P*p*



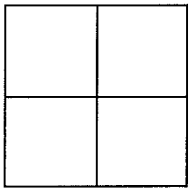
PP P*p* *pp*

2. TT x T*t*



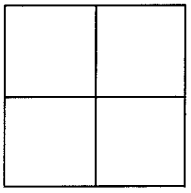
TT T*t* *tt*

3. S*s* x S*s*



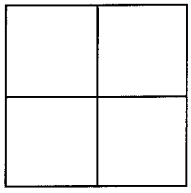
SS S*s* *ss*

4. *yy* x *yy*



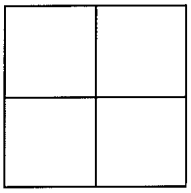
YY Y*y* *yy*

5. Gg x Gg



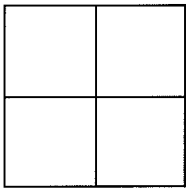
GG Gg

6. hybrid tall x short T*t* x *tt*



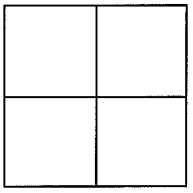
TT T*t* *tt*

7. purebrid tall x short TT x *tt*



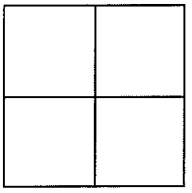
TT T*t* *tt*

8. heterozygous yellow seed x green seed



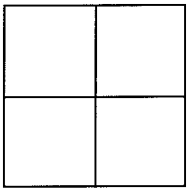
YY Y*y* *yy*

9. hybrid green pod x hybrid green pod



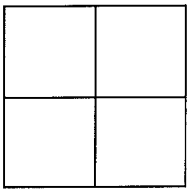
GG Gg gg

10. hybrid tall x purebred tall



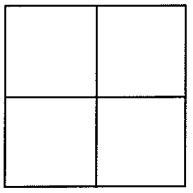
TT T*t* *tt*

11. purebred purple flowers x white flowers



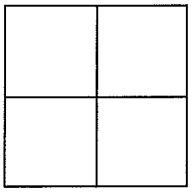
PP P*p* *pp*

12. hybrid purple flowers x white flowers



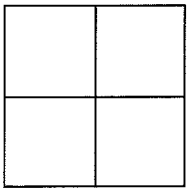
PP P*p* *pp*

13. heterozygous purple flowers x white flowers



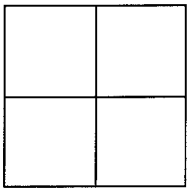
PP P*p* *pp*

14. hybrid smooth seeds x hybrid smooth seeds



SS S*s* *ss*

15. short plant x short plant



TT T*t* *tt*

phenotype ratios:

Purple White

Punnett Squares Practice Practice

Dihybrid Crosses

DIRECTIONS: All these genetic problems deal with pea plants and their traits. Use the following key for all problems. Put the gametes for the 1st parent of each cross along the top, and the gametes for the 2nd parent along the left side. Then, write the phenotypic ratio.

T = Tall **G = Green Pod** **Y = Yellow Seed** **S = Smooth Seed** **P = Purple Flower**

t = Short **g = Yellow Pod** **y = Green Seed** **s = Wrinkled Seed** **p = White Flower**

---

1. TTGG x ttgg

phenotype ratio

tall plant green pod _____

tall plant yellow pod _____

short plant green pod _____

short plant yellow pod _____

2. TtGg x TtGg

phenotype ratio

tall plant green pod _____

tall plant yellow pod _____

short plant green pod _____

short plant yellow pod _____

3. GgYy x ggYy

phenotype ratio

green pod yellow seed _____

green pod green seed _____

yellow pod green seed _____

yellow pod yellow seed _____

4. Ssgg x ssGg

phenotype ratio

smooth seed green pod _____

smooth seed yellow pod _____

wrinkled seed green pod _____

wrinkled seed yellow pod _____

5. PpGg x PpGg

phenotype ratio

_____

_____

_____

_____

_____

_____

_____

_____

6. ppGG x PPgg

phenotype ratio

_____

_____

_____

_____

_____

_____

_____

_____

7. TtSs x TtSs

phenotype ratio

_____

_____

_____

_____

_____

_____

_____

_____

8. ttss x TtSs

phenotype ratio

_____

_____

_____

_____

_____

_____

_____

_____

BACKGROUND: A long time ago, in a galaxy far, far away, a great race of beings lived on a planet called TECH. The inhabitants were known as Techonians. They are made up of 10 basic genes (unit) that code for their appearance. Each one of these genes is made up 2 alleles (traits). With this in mind, there are 1,024 different possible combinations for their appearance. This is called their **phenotype** or their physical appearance. If we look at their genes, there are 59,049 different combinations of the alleles! This is called the **genotype** or genetic makeup. Remember that we use letters for the alleles that control the genes and one letter or allele is inherited from each parent. You will be using Techs, who use the same genetic principles as a pea plant, to see how genes are passed on and inherited. You will be using Punnett Squares to do this.

Here are some things to help you. You must understand these concepts and terms! I will use traits from the table on the next page as examples.

Phenotype: The physical appearance or what the gene makes an organism look like. Examples would be two eyes, yellow hair, and green lips from a Tech.
1. Dominant: The trait that is shown the most. Example: Green hair is dominant over yellow hair.
2. Recessive: The trait that is hidden. In this example: yellow hair.

Genotype: The genetic makeup of an organism. We use letters for the genotype. Remember that you need to look at the genotype to see what the phenotype will be.

Example: There is a Gene or unit for hair color in a Tech. The alleles or traits (individual genes) for hair color would be yellow and green. There are 2 alleles for each gene and we use letters for each allele. The capital letters are the dominant alleles and the lower case letters are the recessive alleles.

Gene	Allele
Hair color	1. Green color = G
	2. Yellow color = g

1. **Heterozygous:** The term used for different alleles. There is always one dominant and one recessive allele. Example: Gg. There is only one possibility for this!
2. **Homozygous:** The term used for having the same alleles. This will be either 2 dominant alleles or 2 recessive alleles. Example: GG or gg. There are 2 possibilities for this!

Please refer back to this to help you as you work through this assignment. You will use the table on the next page to complete the problems that follow. Everything you need is in the table! The following are the traits of a Tech, which we will use to study genetics. You will be studying one family. Be sure to read each problem carefully, because in each case the information is built upon the previous problem.

Allele	Trait	Dominant/Recessive	Genotype	Phenotype	Heterozygous	Homozygous
T	Tall	Dominant	TT,Tt	Tall	Tt	TT
t	Short	Recessive	tt	Short		tt
G	Green hair	Dominant GG,	Gg	Green Hair	Gg GG	
g	Yellow hair	Recessive gg		Yellow Hair	gg	
E	One Eye	Dominant	EE,Ee	One Eye	Ee	EE
e	Three Eyes	Recessive ee		Three Eyes	ee	
F	One Fang	Dominant FF,	Ff	One Fang	Ff	FF
f	Two Fangs	Recessive ff		Two Fangs	ff	
H	Two Horns	Dominant HH,	Hh	Two Horns	Hh HH	
h	One Horn	Recessive hh		One Horn		hh
L	Purple Lips	Dominant LL,	Ll	Purple Lips	Ll LL	
l	Green Lips	Recessive ll		Green Lips	ll	
W	Two Wings	Dominant WW,	W w	Two Wings	Ww W	W
w	No Wings	Recessive ww		No Wings		ww
N	One Leg	Dominant	NN,Nn	One Leg	Nn	NN
n	Two Legs	Recessive nn		Two Legs		nn
R	Green Skin	Dominant RR,	Rr	Green Skin	Rr RR	
r	Yellow Skin	Recessive rr		Yellow Skin	rr	
B	Thick Eyebrow	Dominant BB,	Bb	Thick Eyebrow	Bb BB	
b	Thin Eyebrow	Recessive bb		Thin Eyebrow	bb	

SINGLE CROSS PROBLEMS

1. Cross a heterozygous green skinned Tech with a yellow skinned Tech.

A. What do the possible offspring look Like?

2. Cross a homozygous two horned Tech with a heterozygous two horned Tech.

A. What are the genotypes of the possible offspring?

3. Cross a heterozygous green haired Tech with a heterozygous green haired Tech.

A. What are the genotypes and phenotypes of the possible offspring?

4. Cross a green lipped Tech with a heterozygous purple lipped Tech.

A. What are the number of phenotypes and genotypes of the offspring? Hint: Count what is in the boxes!

5. Tork, who is homozygous for tall meets Vorkina, who is short.

A. What are the phenotypes and genotypes if they were to have offspring?

6. Tork and Vorkina have two children. One is a boy named Torky and the other is a girl named Vorki. Many years later, Torky meets and marries a girl named Morkalina who is short.
A. What are the possibilities for the height of their offspring?
Hint: Look at 5A for information on Torky.

7. Vorki the daughter meets a Tech named Spork, who is heterozygous for tall.

A. How many will be tall? How many will be short? How many will be TT? How many will be Tt? How many will be tt?

8. Torky has green hair and Morkalina has yellow hair. They have four children and all of them have green hair. **What phenotype and genotype must Torky be?**

9. Spork and Vorki both have three eyes.
A. What would their offspring look like?

10. Using problems 5-9, give the phenotypes and genotypes of Tork, Vorkina, Torky, Morkalina, Spork and Vorki based ONLY on the traits given in the problems.

How Well Does a Punnet Square Predict the Actual Ratios?

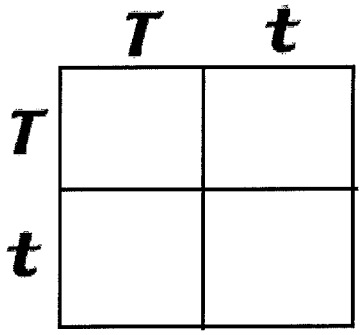
In this lab you will make predictions using Punnet Squares, you will then use pennies (or chips) to simulate the crosses. Then compare the Actual Ratios with the Predicted Ratios.

The trait you are looking at is the gene that codes for a short second toe in humans. **T** represents the dominant allele (short second toe), **t** is the recessive allele, long second toe. The following genotypes are possible. Fill in the phenotypes for them

Genotype	Phenotype
T T	_____
T t	_____
t t	_____

Part I

Use a Punnet Square to predict the ratio of offspring in a cross where the parents are both Tt(The Square is set up for you below)



What proportion of the offspring (out of 4) will be:

Short Toe_____

Long Toe _____

***These are your predicted ratios.**

Now you will determine the actual ratios by using pennies (chips) to represent the crosses. You have two pennies. One one side of the penny is the letter T, on the other side is the letter t. **This penny represents a parent that has the genotype T t.** A second penny represents the other parent. One partner is going to play the role of female, the other will play the role of male. When the coin is flipped, you are determining what sperm or what egg is being donated to the match.

Practice flips. Flip the two pennies. The results show you what your offspring will be.

Did you get a TT, a Tt or a tt _____ what is the Phenotype of your offspring (tall or short?) _____

Procedure: To determine Actual Ratios, you will flip your coins 100 times, recording in the table below how often each combination came up. (Use tally marks to record your data then summarize as a number)

Gene Combination (Genotype)	**Tally**	**Total**
TT		
Tt		
tt		

Phenotypes	**Total**
Short toe (add TT + Tt)	
Long Toe (tt)	

Since you flipped one hundred times, your totals above represent a Percentage. Your proportions from the Punnet Square in your prediction can also represent a Percentage.

1/4 = 25 % 2/4 = 50% 3/4= 75% 4/4 = 100%

Now compare your **predicted ratios** to your **actual Ratios** in the chart below.

	Predicted (from the Square your did)	**Actual (from the flips)**
TT		
Tt		
tt		
Short Toe		
Long Toe		

Would you consider the predicted values to be the same, close to the same, or not at all the same?_____

Part II

You will repeat the procedure for parents that are Tt and t t

1. First make your predictions by setting up a Punnet square for the parents. (This one is not set up for you)

How many are predicted to be:

Short Toe _____

Long Toe _____

**Replace one of your pennies (chips) with a t t penny

Perform the flips with your new set of parents (100). Record your data in the table below

	Tally	**Total**
Tt		
tt		

What percentage of your offspring are Tt _____ What percentage are short toes _____

What percentage of your offspring are tt _____ What percentage are long toes _____

Compare the **Predicted Ratios** of the cross to the **Actual Ratios**.

	Predicted (from Square)	**Actual (from flips)**
Short Toe		
Long Toe		

Analysis

1. Why are the Predicted Ratios rarely the same as the Actual Ratios?

_____

_____

2. Why are Punnet squares useful for determining the probabilities of phenotypes in the offspring?

_____

_____

3. Use a Punnet Square to predict the phenotypic ratios in this cross: T T x T t

Short toe _____ Long toe _____

4. If you used the coin toss method to determine the actual ratios, would it come out the same? Why?

_____

_____

5. What do the pennies or chips represent in the simulation?

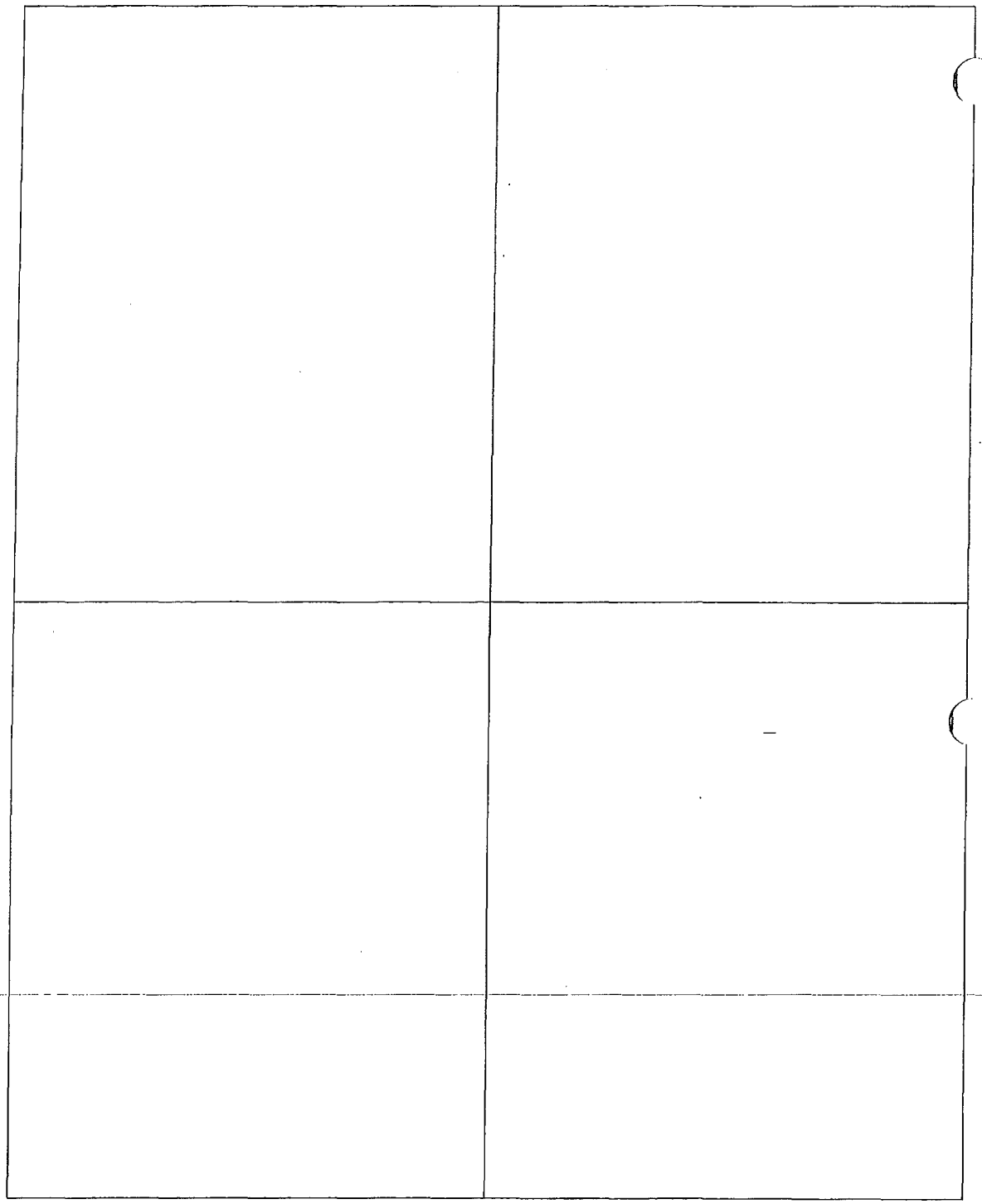
_____

6. When you toss the coin to see which side lands up, you are actually simulating what part of the process of sexual reproduction?

_____

7. When you put the two coins that are flipped together, you are simulating what part of the process of sexual reproduction?

_____



What Blood Types Can Be Mixed?

Sometimes patients may lose a lot of blood. In these cases, blood from another person can be given to the patient. Giving someone else's blood to a person is called a transfusion.

Only certain blood types can be mixed when a transfusion is done. There are four main blood types—A, B, AB, and O. Each of these blood types only can be mixed safely with certain other ones. Let's find out which blood types can be mixed safely.

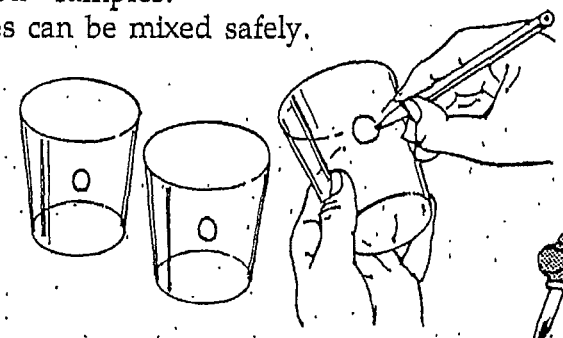
GOALS

In this exercise, you will:

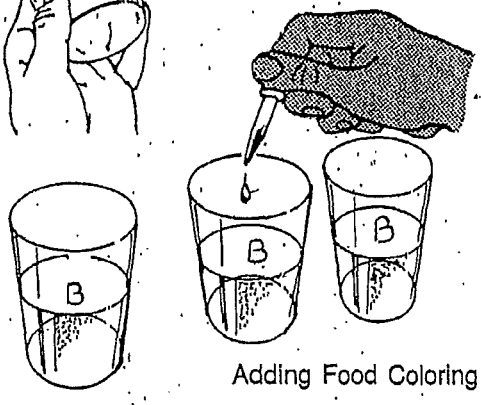
a. set up colored water "blood" samples.
b. find out which blood types can be mixed safely.

MATERIALS

clear plastic cups—12
wax pencil
red food coloring
blue food coloring
stirring rod



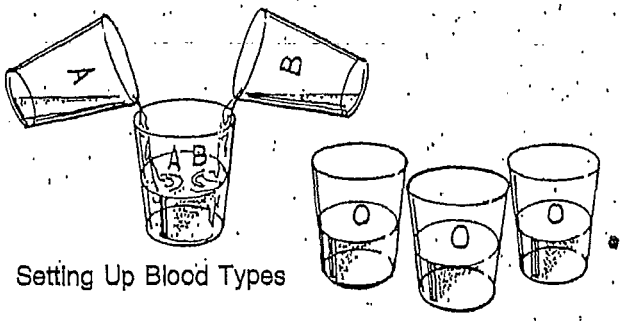
Labeling Cups



Adding Food Coloring

PROCEDURE

1. Label three cups with the letter *A*. Label three cups *B*, three cups *AB*, and three cups *O*.
2. Fill the *A* cups three-fourths full of water. Add 4 drops of red food coloring to each cup. Stir.
3. Repeat Step 2 using blue food coloring in the *B* cups.
4. Pour one-fourth of the liquid from each *A* cup into one of the *AB* cups.
5. Pour one-fourth of the liquid from each *B* cup into one of the *AB* cups.
6. Fill the *O* cups half full of water. Do not add food coloring. Now your blood types are set up and ready for "transfusions."



Setting Up Blood Types

7. Pour about-one-fourth of the liquid from one cup of each blood type into one cup of each of the other blood types. This pouring represents a transfusion. If the liquid changes color, the transfusion is not safe. If real blood of those types were mixed, the transfusion would not be safe because clumping would occur.

8. Record color changes with a "yes" or "no" in the color change table. Part of the table has been done for you. Note that there is no color change when blood of the same type is mixed. It is safe to mix blood of the same type.
9. Complete the table showing which blood types can be donated to which kind of patient. Use the information you got from mixing the colored water samples.

"Blood" type	Color change when mixed with "blood" type			
	A	B	AB	O
A	no			
B		no		
AB			no	
O				no

Blood type	Can donate blood to type(s)	Can receive blood from type(s)
A		
B		
AB		
O		

QUESTIONS

1. What blood types can be given safely to persons with all other blood types? _____

_____

2. What blood types can be given safely to persons with AB blood? _____

_____

3. What blood type(s) can be given safely to persons with B type blood? _____

4. What blood type(s) can be given safely to persons with O type blood? _____

APPLICATIONS

1. A person with type O blood is often called a "universal donor." From this exercise, explain why. _____

_____

2. A person with type AB blood is called a "universal receiver." Explain why.

_____

VOCABULARY

Complete the following sentences using the correct word.

1. Receiving another person's blood is called a(n) _____.
2. There are four main blood types which are _____, _____, _____, and _____.
3. If real blood samples were mixed that should not be, blood _____ results.

Blood typing game

http://nobelprize.org/educational_games/medicine/landsteiner/landsteiner.html

flash card game

http://www.quia.com/jfc/66181.html

hereditary diseases

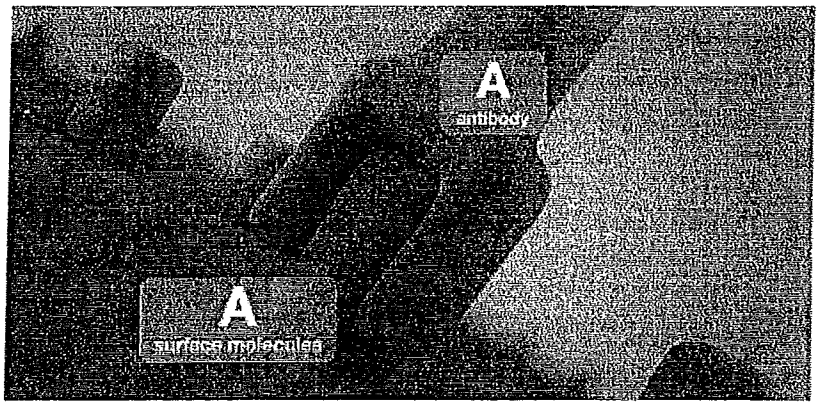
http://www.yourgenesyourhealth.org/

practice quiz

http://anthro.palomar.edu/mendel/quizzes/mendqui2.htm

pet chicken punnett square

http://www2.edc.org/weblabs/Punnett/punnettsquares.html



blood type	red blood cell surface molecules	plasma antibodies
type A	A only	B only
type B	B only	A only
type AB	A & B	neither
type O	neither	both

Simulating Blood Typing

Pre-Lab Discussion

Human blood may be classified according to the presence or absence of certain *antigens*, or factors, that are attached to the surface of the red blood cells, or erythrocytes. Two of the antigens used in blood typing are known as A and B. A person whose red blood cells have only antigen A has type A blood, whereas a person whose red blood cells have only antigen B has type B blood. People who have both A and B antigens on their red blood cells have type AB blood. Those whose blood cells have neither A nor B antigens have type O blood.

The plasma of each blood group contains a certain type or combination of *antibodies*. Antibodies are substances that attack antigens. Blood type A plasma contains anti-B antibodies, whereas blood type B plasma has anti-A antibodies. Anti-A antibodies attack red blood cells that have A antigens; anti-B antibodies attack those that have B antigens. The attacking antibodies bind to the red blood cells, causing them to *agglutinate*, or clump together. Type AB plasma has both A and B antigens and has neither type of antibody. Type O blood has neither A nor B antigens and contains both anti-A and anti-B antibodies. In transfusions, the blood types of the donor and recipient must be carefully matched because transfusion of the wrong type of blood can be fatal to the recipient.

In this investigation, you will simulate human blood typing.

Problem

How is a person's blood type determined?

Materials *(per group)*

Glass slide with two depressions
Simulated anti-A serum
Simulated anti-B serum
Simulated blood—types A, B, AB, O

Safety

Put on a laboratory apron if one is available. Put on safety goggles. Handle all glassware carefully. Always use special caution when working with laboratory chemicals, as they may irritate the skin or cause staining of the skin or clothing. Never touch or taste any chemical unless instructed to do so. Note all safety alert symbols next to the steps in the Procedure and review the meanings of each symbol by referring to the symbol guide on page 10.

Procedure

1. Put on safety goggles. Place 2 drops of the solution in the dropper bottle labeled Bottle 1 in each of the two depressions in the glass slide. To the left depression, add 2 drops of the solution in the bottle labeled anti-A serum. To the right depression, add 2 drops of the solution in the bottle labeled anti-B serum. **CAUTION:** *Use caution when working with laboratory chemicals. If a laboratory chemical comes into contact with your skin, wash the area with water immediately.*
2. Examine the substances in the two depressions for signs of clumping. If clumping occurs only on the left side of the depression slide, this simulates the presence of type A blood. If clumping occurs only on the right side of the depression slide, this simulates the presence of type B blood. If clumping occurs on both sides of the depression slide, this simulates the presence of type AB blood. If no clumping occurs on either side of the depression slide, this simulates the presence of type O blood. See Figure 1. Record your observations in the appropriate places in the Data Table.

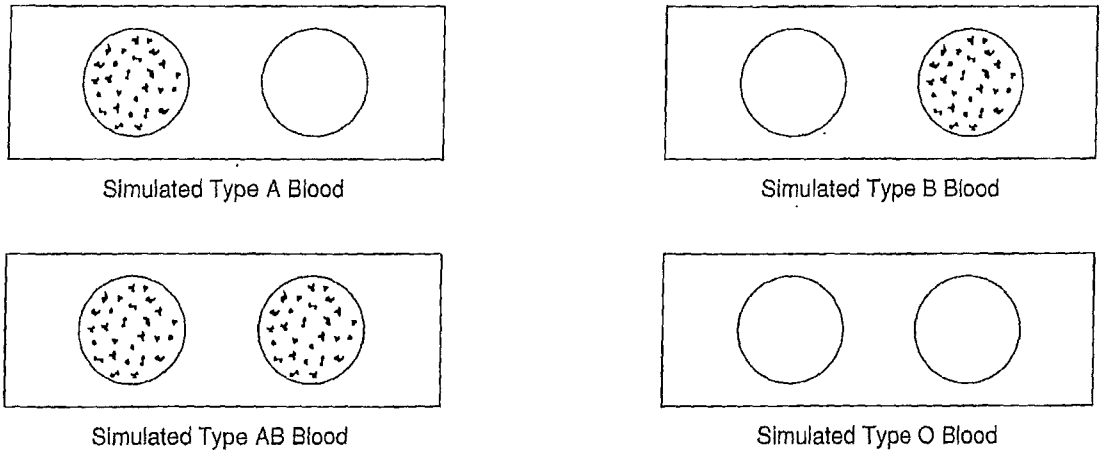


Figure 1

3. Based on your results, determine the type of simulated blood that is contained in Bottle 1. Record this information in the appropriate place in the Data Table.
4. Carefully wash and dry the glass slide thoroughly.
5. Repeat steps 1 through 4 using the solutions in Bottles 2, 3, and 4.

Observations

Data Table

Bottle	Clumping in the Left Side of the Depression Slide?	Clumping in the Right Side of the Depression Slide?	Simulated Blood Type
1			
2			
3			
4			

Name _____ Class _____ Date _____

Analysis and Conclusions

1. **a.** Which simulated blood type(s) showed clumping when simulated anti-A serum was added?

   _____

   b. Which simulated blood type(s) showed clumping when simulated anti-B serum was added?

   _____

2. **a.** If clumping occurs when both anti-A serum and anti-B serum are added, what is the blood type? _____

   b. If clumping does not occur when either anti-A serum or anti-B serum is added, what is the blood type? _____

3. Which blood type(s) must people have in order to safely receive a transfusion of type A blood? _____

4. Which blood type(s) must people have in order to safely receive a transfusion of type B blood?

   _____

5. Which blood type(s) must people have in order to safely receive a transfusion of type AB blood? _____

6. How is this simulation similar to actual human blood typing? _____

   _____

   _____

   _____

   _____

   _____

Critical Thinking and Application

1. Why is it advisable for you to know your own blood type? _____

   _____

   _____

2. How could you tell whether two blood samples are compatible for a transfusion if no typing serum were available? _____

_____

_____

3. Why is a person with type AB blood sometimes called a "universal recipient"?

_____

_____

_____

4. Why is a person with type O blood sometimes called a "universal donor"?

_____

_____

_____

5. Why is a person with type O blood unable to receive blood from any type other than O?

_____

_____

_____

Going Further

1. Successful organ transplant surgery depends on advances made in the area of tissue typing and compatibility. Using reference materials, write a report comparing blood typing with the relatively new science of tissue typing.
2. Use reference materials to research the topic of Rh factors. How were they discovered? How is a person's blood tested for Rh factor? Why is this knowledge important?

Interpreting Information in a Pedigree

Organizing information is often the key to solving a problem. Tracing the hereditary characteristics over many generations can be confusing unless the information is well organized. In this lab, you will learn how to organize hereditary information, making it much easier to analyze.

OBJECTIVES

- **Analyze** a pedigree.
- **Construct** a pedigree.

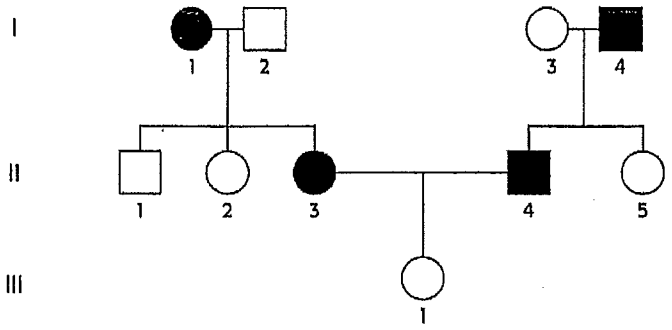
MATERIALS

- paper
- pencil

Procedure

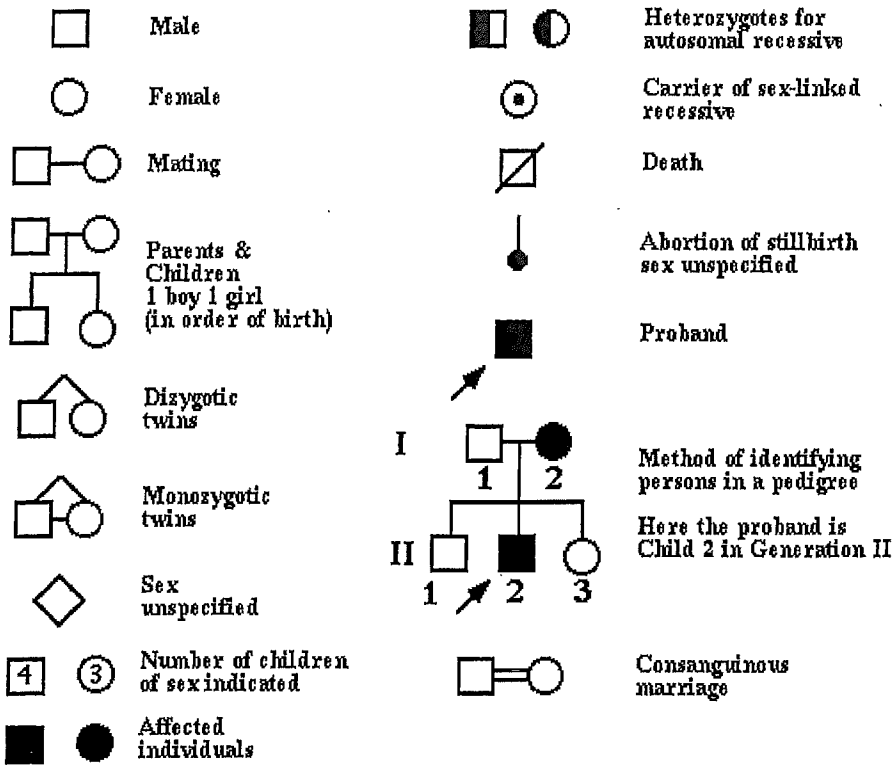
1. Examine Pedigree I, which traces the dimples trait through three generations of a family. Blackened symbols represent people with dimples. Circles represent females, and squares represent males.

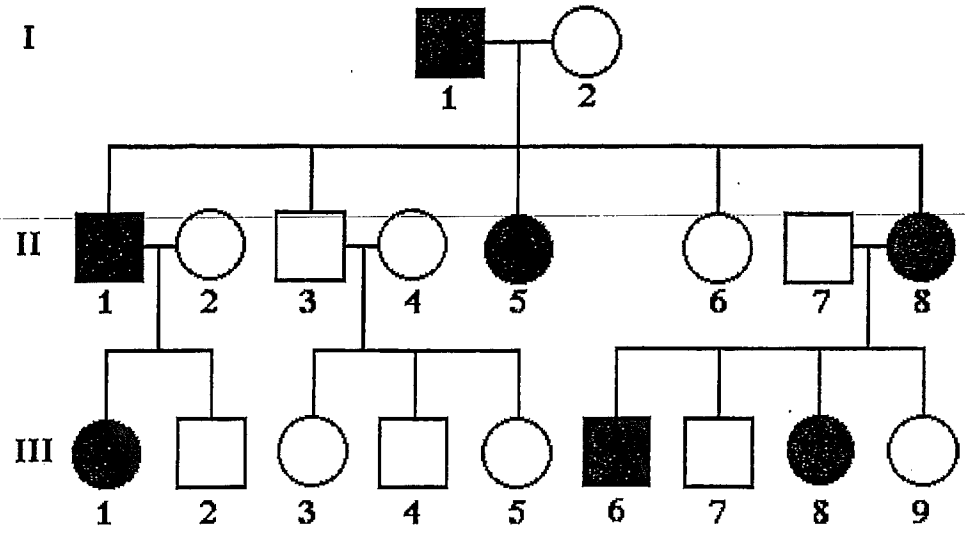
FIGURE 1



Pedigree I

2. Read the following passage, which describes the family shown in Pedigree I. Write the name of each person below the correct symbol in Pedigree I.
   Although Jane and Joe Smith have dimples, their daughter, Clarissa, does not. Joe's father has dimples, but his mother and his sister, Grace, do not. Jane's father, Mr. Renaldo, her brother, Jorge, and her sister, Emily, do not have dimples, but her mother does.
3. Look at Pedigree I again.

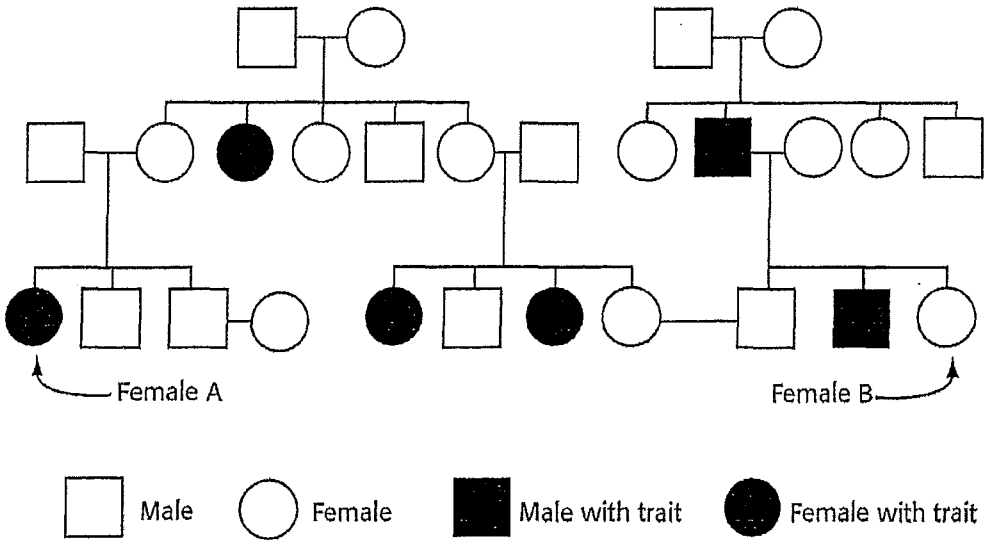




Pedigree 1. An idealized pedigree of a family with hypercholesterolemia, an autosomal dominant disease where the heterozygote has a reduced number of functional low density lipoprotein receptors.

Pedigree Analysis

You will practice interpreting a pedigree. The pedigree to the right shows the presence or absence of the albinism trait in several generations of a family.



Analysis

1. **Determine** whether the albinism trait is dominant or recessive. Explain your reasoning.

2. **Determine** if Female A could be heterozygous for albinism. Do the same for Female B.

3. **Critical Thinking** **Applying Information** Suppose that Female B is homozygous and produces children with Male C. If Male C is heterozygous, what is the probability that the children will have the albinism trait?

FAKE MISFITOYZ FAMILY 2013

Kaelin has brown eyes, no dimples, a widows peak, her second toe is shorter than her first toe, she can taste PTC, and she is color blind. Her younger brother, Kyle, has blue eyes, dimples, a widow's peak, can taste PTC, has a longer second toe, and is also colorblind. The youngest brother, Nick, has brown eyes, no dimples, a shorter second toe, no widows peak, can taste PTC and is NOT colorblind..

The siblings parents are Josh and Jocelyn. Jocelyn has blue eyes, dimples, a widows peak, a longer second toe, can taste PTC and can see color. Her husband, Josh, has brown eyes, dimples, a widows peak, a shorter second toe, can taste PTC and is colorblind.

Josh has an older brother, Stephen, who has blue eyes, no dimples, no widows peak, a longer second toe, can not taste PTC paper, and is not color blind. Stephen has a younger sister who is older than Josh, whose name is Meghan. Meghan has blue eyes, dimples, a widows peak, a shorter second toe, can taste PTC paper and can see color.

Her parents are Barry and Taylor. Barry has brown eyes, dimples, a widows peak, a shorter second toe, can not taste PTC paper and can see colors. Barry's wife, Taylor, has brown eyes, dimples, no widows peak, a longer second toe, can taste PTC paper and can see color.

Jocelyn, Josh's wife, has a younger sister, Daphne. Daphne has brown eyes, a widows peak, dimples, a shorter second toe, can not taste PTC paper and is color blind. Jocelyn and Daphne's parents are Justin and Katrina. Justin has brown eyes, dimples, no widows peak, a longer second toe, can taste PTC paper and is color blind. Katrina, Justin's wife, has blue eyes, dimples, a widows peak, a shorter second toe, can taste PTC paper and can see colors.

**** there are between 10 and 15 alleles that you will not be able****
to determine. You must leave these blank or you will lose substantial
**********credit**********

PEDIGREE PROJECT

You will complete a pedigree of your family. Each family member will have their own box with the traits you tested. You will try to determine the genotype based on phenotype and the offspring produced. You may only be able to determine one allele with certainty in the case of individuals with the dominant phenotype. Any individual with the recessive phenotype you will know the complete genotype.

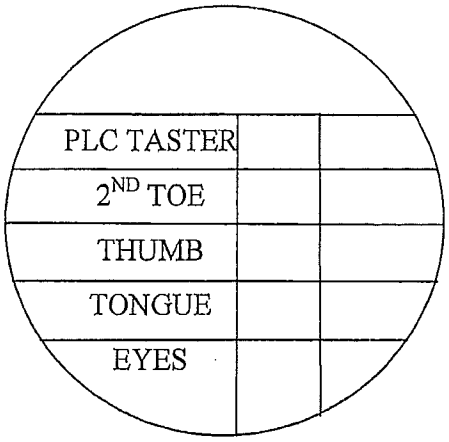
Instructions:

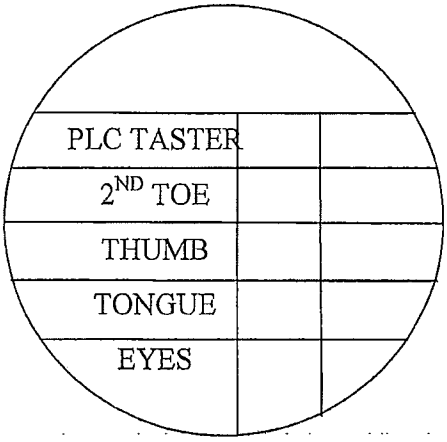
- Each male will have a square chart, females will have round.
- Each chart will have the person's name. you will follow the rules you have learned for creating pedigrees. All lines must be created using a ruler, all circles must be made with a stencil or compass. You can hand write the names and alleles, or you may print out the keys (on J drive)
- If the person has the dominant phenotype, color the boxes for the alleles in the color you choose for that trait. It must be included in the key and stay the same for the entire pedigree.
- You may use photos for extra credit. If you choose to use photos, you will need a poster sized paper.
- You will be graded on neatness and completeness. Please consult your notes (ch 12) for correct symbols used in a pedigree.

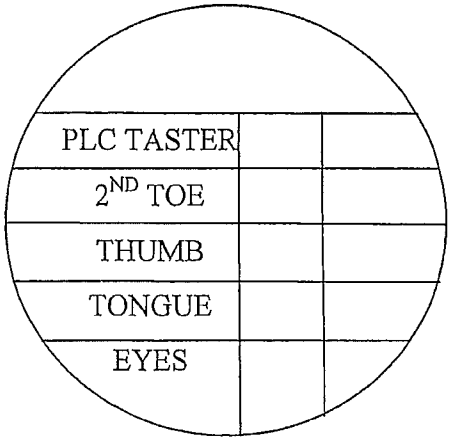
	Dominant		Recessive
T	Tongue rolling	t	No tongue roll
M	Second toe shorter	m	second toe longer
E	Brown eyes	e	blue, green, hazel eyes
P	PTC tasters	p	No taste
H	Straight thumb	h	Hitch hikers thumb
W	Widows peak	w	Straight hairline
C	Cleft chin	c	No cleft in chin
D	Dimples	d	No dimples
L	Free earlobes	l	Attached earlobes

***If you can not do the project and have spoken to me, you may use the Fred and Ethel family to make a pedigree. Use the chart above for all traits. The same grading will be used, but ALL the people on the fictitious family will have a COMPLETE genotypes!!! (That means you will know both alleles for everyone)

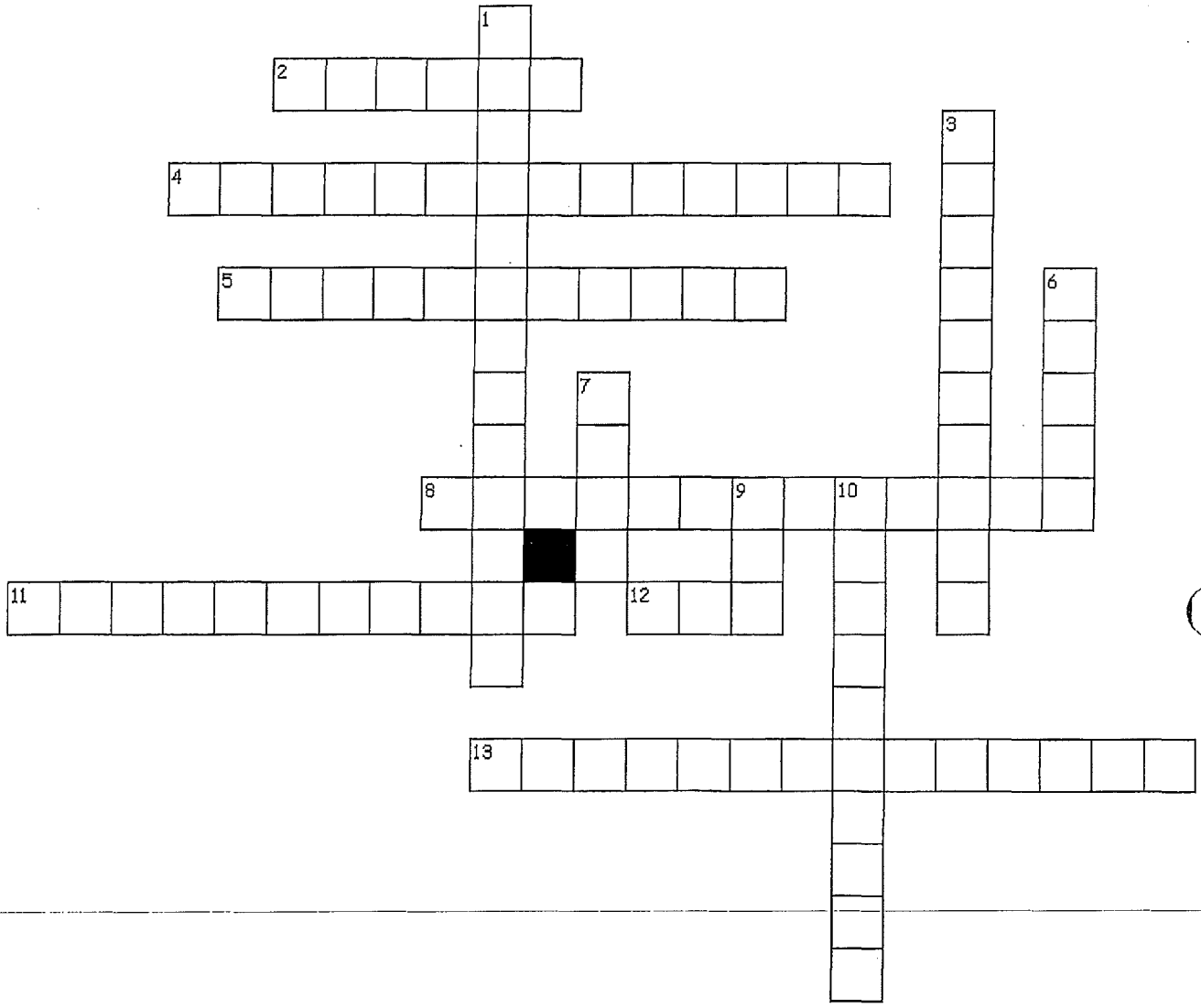
PLC TASTER		
2ND TOE		
THUMB		
TONGUE		
EYES		







Ch 13 Crossword/ Vocab



Across

2. a nitrogenous base that has a double-ring structure; adenine or guanine
4. the manifestation of the genetic material of an organism in the form of specific traits
5. the portion of protein synthesis that takes place at ribosomes and that uses the codons in mRNA molecules to specify the sequence of amino acids in polypeptide chains
8. the process of forming a nucleic acid by using another molecule as a template
11. an enzyme that unwinds the DNA double helix during DNA replication
12. deoxyribonucleic acid, the material that contains the information that determines inherited characteristics
13. the process of making a copy of DNA

Down

1. an enzyme that catalyzes the formation of the DNA molecule
3. in a nucleic acid chain, a subunit that consists of a sugar, a phosphate, and a nitrogenous base
6. in DNA and mRNA, a three-nucleotide sequence that encodes an amino acid or signifies a start signal or a stop signal
7. a segment of DNA that is located in a chromosome and that codes for a specific hereditary unit
9. ribonucleic acid, a natural polymer that is present in all living cells and that plays a role in protein synthesis
10. a nitrogenous base that has a single-ring structure; in DNA, either thymine or cytosine

gene a segment of DNA that is located in a chromosome and that codes for a specific hereditary unit

DNA deoxyribonucleic acid, the material that contains the information that determines inherited characteristics

CHAPTER 13 VOCAB

Gene
DNA
nucleotide
purine
pyrimidine
DNA replication
DNA helicase
DNA polymerase
RNA
Gene expression
Transcription
Translation
Codon
Purine
Pyrimidines
RNA polymerase
mRNA
tRNA
rRNA
anticodon

CHAPTER 13 VOCAB

Chapter 13 DNA, RNA, and Proteins

I. **DNA: THE GENETIC MATERIAL-** DNA is the _____ for all inherited traits. The instructions for each trait are called a gene and are a series of bases that are like a written language.

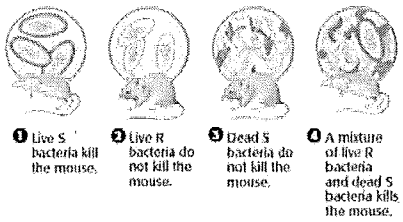
II. **SEARCHING FOR THE GENETIC MATERIAL-** The discovery and understanding of DNA was built on several people's research.

A. In 1928, Frederick Griffith worked with two related strains of bacteria.

1. Griffith discovered that when harmless live bacteria were mixed with heat-killed disease-causing bacteria and then injected into mice, the mice died.

2. These results led Griffith to discover transformation. Transformation is a change in genotype that is caused when cells take up foreign genetic material.

3. Griffith's experiments led to the conclusion that genetic material could be transferred between cells.



B. In the 1940s, Oswald Avery wanted to determine whether the transforming agent in Griffith's experiments was protein, RNA, or DNA.

1. Avery used enzymes to destroy each of these molecules in heat-killed bacteria.

2. Avery's experiments led to the conclusion that DNA is responsible for transformation in bacteria. Alfred Hershey and Martha Chase studied bacteriophages. Bacteriophages are viruses that infect bacterial cells and cause the cells to produce viruses.

3. By using radioactive isotopes, Hershey and Chase showed that DNA, not protein, is the genetic material in viruses.

C. James Watson and Francis Crick used information from experiments by Erwin Chargaff, Maurice Wilkins, and Rosalind Franklin to determine the three-dimensional structure of DNA.

1. Chargaff showed that the amount of adenine always equaled the amount of thymine, and the amount of guanine always equaled the amount of cytosine.

2. Franklin and Wilkins developed X-ray diffraction images of strands of DNA that suggested the DNA molecule resembled a tightly coiled helix.

3. Watson and Crick used both Chargaff's data and the X-ray diffraction studies to create a complete three-dimensional model of DNA.

4. Their model showed a "spiral staircase" in which two strands of nucleotides twisted around a central axis.

III. **THE SHAPE OF DNA-** A DNA molecule is shaped like a spiral staircase and is composed of two parallel strands of linked subunits.

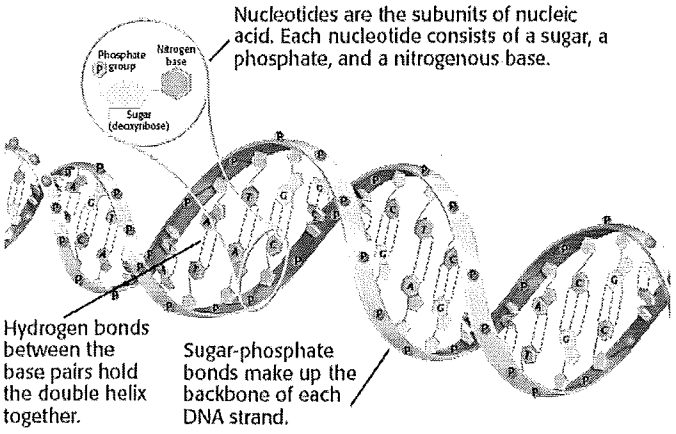
A. The spiral shape of DNA is known as a _____.

B. Each strand of DNA is made up of linked subunits called _____.

C. A nucleotide is made up of three parts: a _____ group, a five-carbon _____ molecule, and a nitrogen-containing _____.

D. The _____ groups and the sugar molecules of nucleotides link together to form a "backbone" for the DNA strand.

E. The five-carbon sugar in DNA is called _____, from which DNA gets its full name, deoxyribonucleic acid.



IV. **THE INFORMATION IN DNA-**The information in DNA is contained in the order of the bases, while the base-pairing structure allows the information to be copied. In DNA, each nucleotide has the same sugar molecule and phosphate group, but each nucleotide can have one of four nitrogenous bases.

A. The four bases are adenine (A), guanine (G), thymine (T), and cytosine (C).

B. Bases A and G have a double-ring structure and are classified as _____

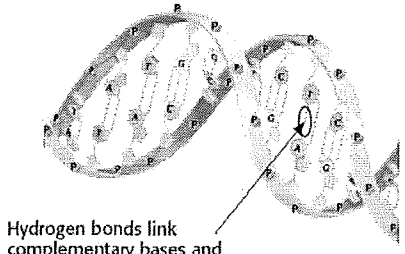
C. Bases T and C have a single-ring structure and are classified as

_____

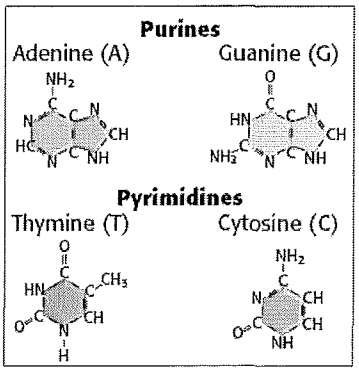
D. A purine on one strand of a DNA molecule is always paired with a pyrimidine on the other strand. Specifically, adenine always pairs with thymine, and guanine always pairs with cytosine.

E. The _____ bonds between bases keep the two strands of DNA together.

F. Because of base-pairing rules, if the sequence of bases is known for one strand of DNA, then the sequence of bases for the complementary strand can be quickly identified.

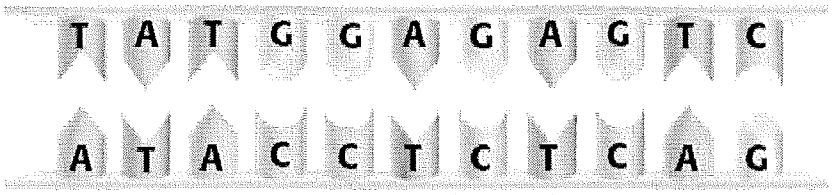


Hydrogen bonds link complementary bases and hold the two strands of DNA together.



Purines contain two rings of carbon and nitrogen atoms. Adenine (represented by the letter A) and guanine (G) are purines.

Pyrimidines contain one ring of carbon and nitrogen atoms. Thymine (T) and cytosine (C) are pyrimidines.



This diagram shows how complementary base pairs join together. Note that adenine (A) always pairs with thymine (T), and cytosine (C) always pairs with guanine (G). In other words, the bases are *complementary*.

V. **DNA REPLICATION-** In DNA replication, the DNA molecule unwinds, and the two sides split. Then, new bases are added to each side until two identical sequences result.

A. Because DNA is made of two strands of complementary base pairs, if the strands are separated, each strand can serve as a pattern to make a new complementary strand.

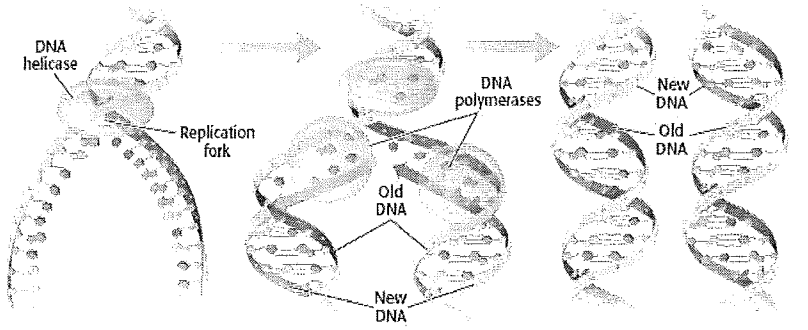
B. The process of making a copy of DNA is called _____.

C. As the double helix unwinds, the two complementary strands of DNA separate from each other and form Y shapes. These Y-shaped areas are called _____.

D. At the replication fork, new nucleotides are added to each side and new base pairs are formed according to the base-pairing rules.

E. Each double-stranded DNA helix is made of one new strand of DNA and one original strand of DNA.

DNA Replication



❶ DNA helicases separate the two original strands of the DNA molecule.

❷ DNA polymerases add complementary nucleotides to each strand.

❸ The two DNA molecules that form are identical to the original DNA molecule.

VI. **REPLICATION PROTEINS-** During the replication of DNA, many proteins form a machinelike complex of moving parts.

A. Proteins called DNA _____ unwind the DNA double helix during DNA replication. These proteins wedge themselves between the two strands of the double helix and break the hydrogen bonds between the base pairs.

B. Proteins called _____ drive the formation of the DNA molecule by moving along each strand and adding nucleotides that pair with each base.

1. DNA polymerases also have a "_____" function.

2. During DNA replication, errors sometime occur and the wrong nucleotide is added to the new strand.

3. If a mismatch occurs, the DNA polymerase can backtrack, remove the incorrect nucleotide, and replace it with the correct one.

VII. EUKARYOTES AND PROKARYOTES REPLICATE DIFFERENTLY

A. Prokaryotic cells usually have a single chromosome, which is a closed _____ attached to the inner cell membrane.

1. Replication in prokaryotes begins at one place along the loop. This site is called the _____ of replication.

2. Two replication forks begin at the origin of replication in prokaryotes.

3. Replication occurs in opposite directions until the forks meet on the opposite side of the loop.

B. Eukaryotic cells often have several chromosomes, which are linear and contain both DNA and protein.

1. Replication starts at many sites along the chromosome. This process allows eukaryotic cells to replicate their DNA faster than prokaryotes.

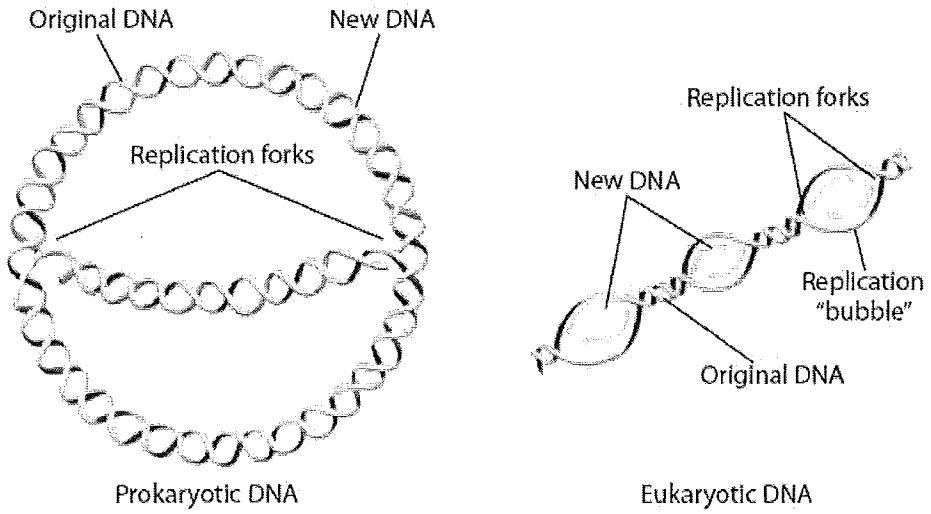
2. Two distinct replication forks form at each start site, and replication occurs in opposite directions.

3. This process forms replication "bubbles" along the DNA molecule.

4. Replication bubbles continue to get larger as more of the DNA is copied.

5. The smallest eukaryotic chromosomes are often 10 times the size of a prokaryotic chromosome. Eukaryotic chromosomes are so long that it would take 33 days to replicate a typical human chromosome if there were only one origin of replication.

6. Because eukaryotic cells have multiple replication forks working at the same time, an entire human chromosome can be replicated in about 8 hours.



In prokaryotic cells, each circular chromosome has two replication forks. In eukaryotic cells, each linear chromosome may have many replication forks.

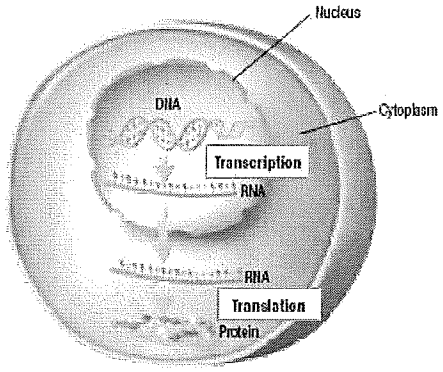
VIII. **GENE EXPRESSION**- Gene expression produces proteins by transcription and translation. This process takes place in two stages, both of which involve RNA.

A. DNA provides the original information from which proteins are made in a cell, but DNA does not directly make proteins because DNA does not leave the nucleus

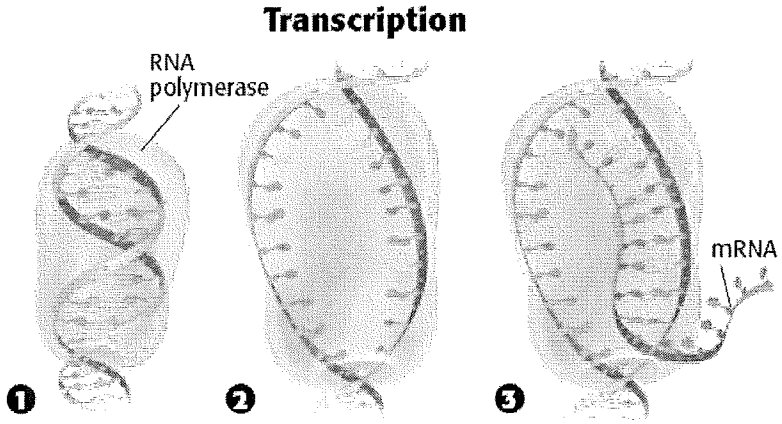
B. Ribonucleic acid, or _____, is a second type of nucleic acid, which takes the information from DNA and makes proteins.

C. The first stage of gene expression is called _____. Transcription is the process of making RNA from the information in DNA. Transcription is similar to copying (transcribing) notes from the board (DNA) to a notebook (RNA).

D. The second stage of gene expression is called _____. Translation uses the information in RNA to make a specific protein. Translation is similar to translating a sentence in one language (RNA, the nucleic acid "language") to another language (protein, the amino acid "language").



Gene expression consists of two main steps: transcription and translation. In eukaryotic cells, like the one shown here, transcription occurs in the nucleus, and translation occurs in the cytoplasm.



1. RNA polymerase binds to a specific part of the gene called the promoter region.
2. The two DNA strands unwind and separate.
3. The RNA polymerase moves along the DNA strand. It adds complementary mRNA nucleotides to a growing mRNA strand as it moves. At the end of transcription, the RNA polymerase has produced an mRNA strand that is complementary to the DNA in the gene.

IX. **RNA: A MAJOR PLAYER-** In cells, three types of RNA complement DNA and translate the genetic code into proteins. RNA differs from DNA in three ways.

A. First, RNA usually is composed of _____ strand of nucleotides rather than two strands. –

B. Second, RNA nucleotides contain the five-carbon sugar _____ rather than the sugar deoxyribose.

C. Third, RNA nucleotides have a nitrogenous base called _____ (U) instead of the base thymine (T).Uracil (U) is complementary to adenine (A) whenever RNA pairs with another nucleic acid.

X. **TYPES OF RNA-** The three main types of RNA that play a role in gene expression are messenger RNA, transfer RNA, and ribosomal RNA.

A. _____ RNA (mRNA) is produced when DNA is transcribed into RNA.The mRNA carries instructions for making a protein from a gene and delivers the instructions to the site of translation.

B. At the site of translation_____ RNA (tRNA) "reads" the instructions carried by the mRNA, and then translates the mRNA sequence into protein subunits called amino acids.

C. _____ RNA (rRNA) is an RNA molecule that is part of the structure of ribosomes. Ribosomes are the cellular structure where protein production occurs.

Type of RNA	Description
Messenger RNA (mRNA)	produced during transcription; is complementary to a DNA strand
Transfer RNA (tRNA)	used during translation; attaches to an amino acid; contains a sequence of bases that are complementary to part of an mRNA strand
Ribosomal RNA (rRNA)	found in ribosomes; helps to bind amino acids together during translation

XI. **TRANSCRIPTION: READING THE GENE**-During transcription, the information in a specific region of DNA (a gene) is transcribed, or copied, into mRNA.

A. _____ is carried out by a protein called RNA _____.

B. Transcription begins when RNA polymerase binds to the specific DNA sequence in the gene that is called the promoter.

1. RNA polymerase then unwinds and separates the two strands of the double helix to expose the DNA bases on each strand.

2. RNA polymerase moves along the bases on the DNA strand and adds complementary RNA bases as it "reads" the DNA of the gene.

3. As RNA polymerase moves down the DNA strand, a single strand of mRNA grows.

4. Behind the moving RNA polymerase, the two strands of DNA close up and re-form the double helix.

C. _____. In transcription, a new molecule of RNA is made from the DNA. In DNA replication, a new molecule of DNA is made from the DNA.

XII. **THE GENETIC CODE: CODONS=THREE-LETTER "WORDS"-** The genetic code is based on _____, each of which represents a specific amino acid. A three-nucleotide sequence is called a codon. Each codon corresponds to 1 of _____ amino acids. Codons also act as a start or stop signal for translation. There are 64 mRNA codons. Each codon specifies only one amino acid, but several amino acids have more than one codon.

Find the first base of the mRNA codon in this column.

Follow that row to the column that matches the second base of the codon.

Move up or down in that box until you match the third base of the codon with this column.

Codons in mRNA

First base	Second base U	Second base C	Second base A	Second base G	Third base
U	UUU Phenylalanine UUC Phenylalanine UUA Leucine UUG Leucine	UCU Serine UCC Serine UCA Serine UCG Serine	UAU Tyrosine UAC Tyrosine UAA Stop UAG Stop	UGU Cysteine UGC Cysteine UGA–Stop UGG–Tryptophan	U C A G
C	CUU Leucine CUC Leucine CUA Leucine CUG Leucine	CCU Proline CCC Proline CCA Proline CCG Proline	CAU Histidine CAC Histidine CAA Glutamine CAG Glutamine	CGU Arginine CGC Arginine CGA Arginine CGG Arginine	U C A G
A	AUU Isoleucine AUC Isoleucine AUA Isoleucine AUG–Start/Methionine	ACU Threonine ACC Threonine ACA Threonine ACG Threonine	AAU Asparagine AAC Asparagine AAA Lysine AAG Lysine	AGU Serine AGC Serine AGA Arginine AGG Arginine	U C A G
G	GUU Valine GUC Valine GUA Valine GUG Valine	GCU Alanine GCC Alanine GCA Alanine GCG Alanine	GAU Aspartic acid GAC Aspartic acid GAA Glutamic acid GAG Glutamic acid	GGU Glycine GGC Glycine GGA Glycine GGG Glycine	U C A G

XIII. **TRANSLATION: RNA TO PROTEINS-** _____ occurs in a sequence of steps, involves three kinds of RNA, and results in a complete polypeptide (protein).

A. Translation takes place in the _____, where tRNA, rRNA, and mRNA interact to assemble proteins.

B. A specific amino acid is added to one end of each tRNA. The other end of the tRNA has an _____. An anticodon is a three-nucleotide sequence on tRNA that is complementary to an mRNA codon.

C. The mRNA joins with a ribosome and tRNA.

D. A tRNA molecule that has the correct anticodon and amino acid binds to the second codon on the mRNA.

E. A peptide bond forms between the two amino acids, and the first tRNA is released from the ribosome.

F. The ribosome then moves one codon down the mRNA.

G. The amino acid chain continues to grow as each new amino acid binds to the chain and the previous tRNA is released.

H. This process is repeated until one of three stop codons is reached. A _____ codon does not have an anticodon, so protein production stops.

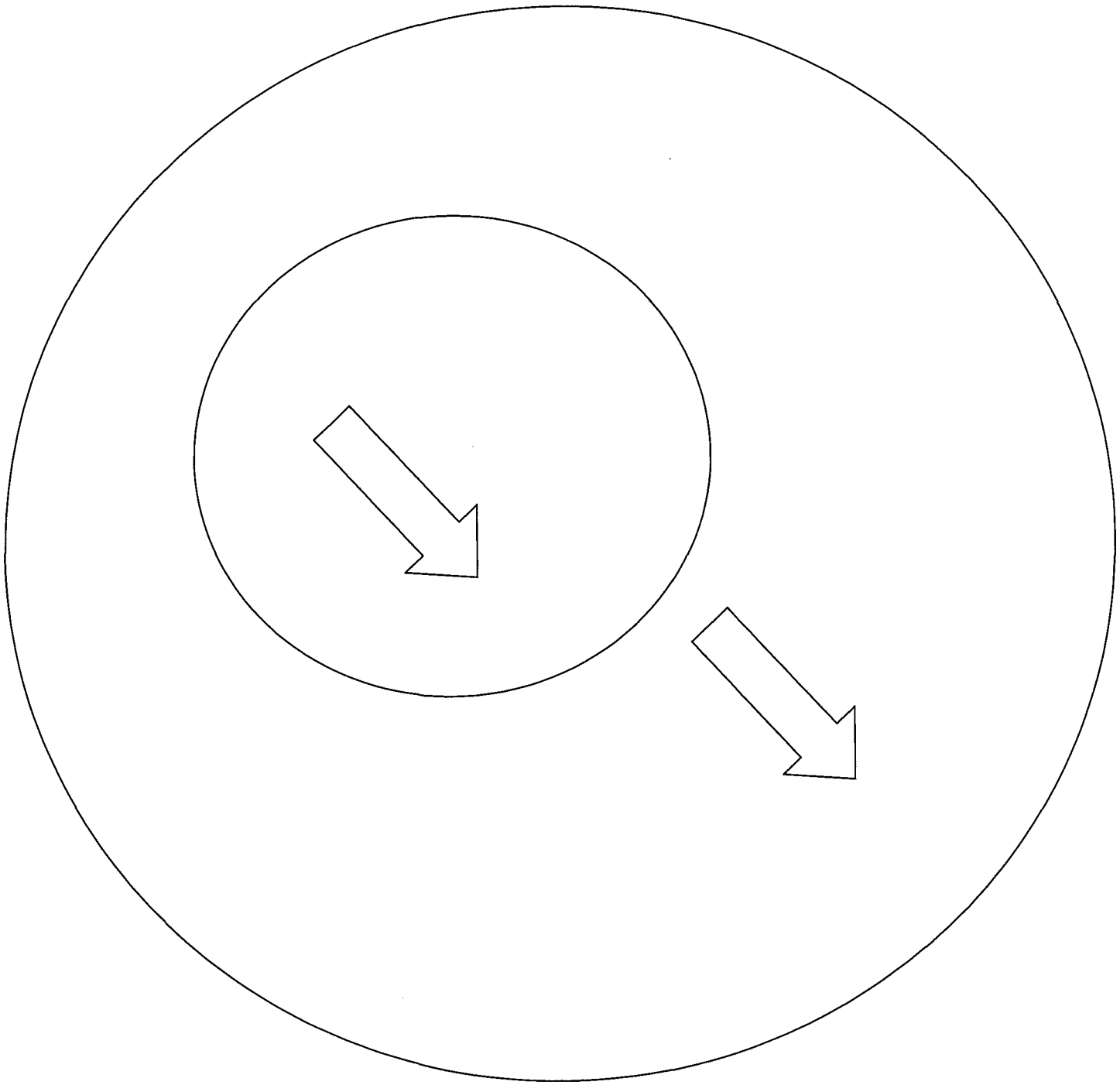
I. Many copies of the same protein can be made rapidly from a single mRNA molecule because several ribosomes can translate the same mRNA at the same time.

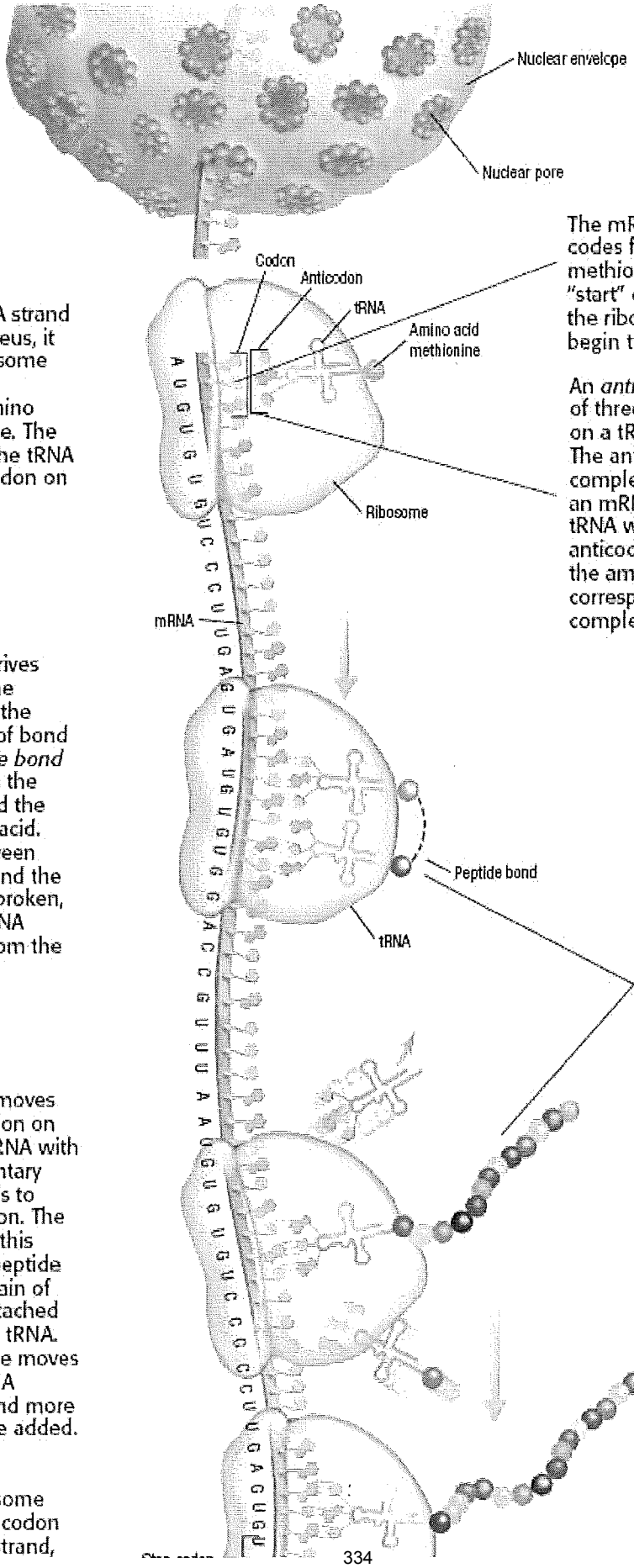
XIV. **COMPLEXITIES OF GENE EXPRESSION**- The relationship between genes and their effects is complex.

A. Some genes are expressed only at certain times or under specific conditions.

B. Variations and mistakes can occur at each of the steps in replication and expression.

C. The final outcome of gene expression is affected by the _____ of the cells, the presence of other cells, and the timing of gene expression.





❶ After the mRNA strand leaves the nucleus, it binds to a ribosome and to a tRNA carrying the amino acid methionine. The anticodon on the tRNA binds to the codon on the mRNA.

The mRNA codon AUG codes for the amino acid methionine. It is also the "start" codon, which tells the ribosome where to begin translation.

An *anticodon* is a group of three nucleotides on a tRNA molecule. The anticodon is complementary to an mRNA codon. A tRNA with a particular anticodon carries only the amino acid that corresponds to the complementary codon.

❷ A new tRNA arrives and binds to the next codon on the mRNA. A type of bond called a *peptide bond* forms between the methionine and the second amino acid. The bond between the first tRNA and the methionine is broken, and the first tRNA moves away from the ribosome.

❸ The ribosome moves to the next codon on the mRNA. A tRNA with the complementary anticodon binds to the mRNA codon. The amino acid on this tRNA forms a peptide bond to the chain of amino acids attached to the previous tRNA. As the ribosome moves down the mRNA strand, more and more amino acids are added.

❹ When the ribosome reaches a stop codon on the mRNA strand,

As one ribosome moves further down the mRNA strand, another ribosome can begin to translate the mRNA again. In this way, many molecules of the same protein can be produced from a single strand of mRNA.

CHAPTER 13 EXTRA NOTES

CHAPTER 13 SEC 1 DUE DATE

1. Describe the results of three experiments that helped to show that DNA is the genetic material.

2. What is the shape of a DNA molecule?

3. Give the sequence of bases that is complementary to the sequence AATGCCGTATAG.

4. How does the complementary pairing of bases allow both strands of a DNA molecule to contain the same information?

5. Explain how the results of Chargaff's experiment may have helped Watson and Crick determine the structure of DNA.

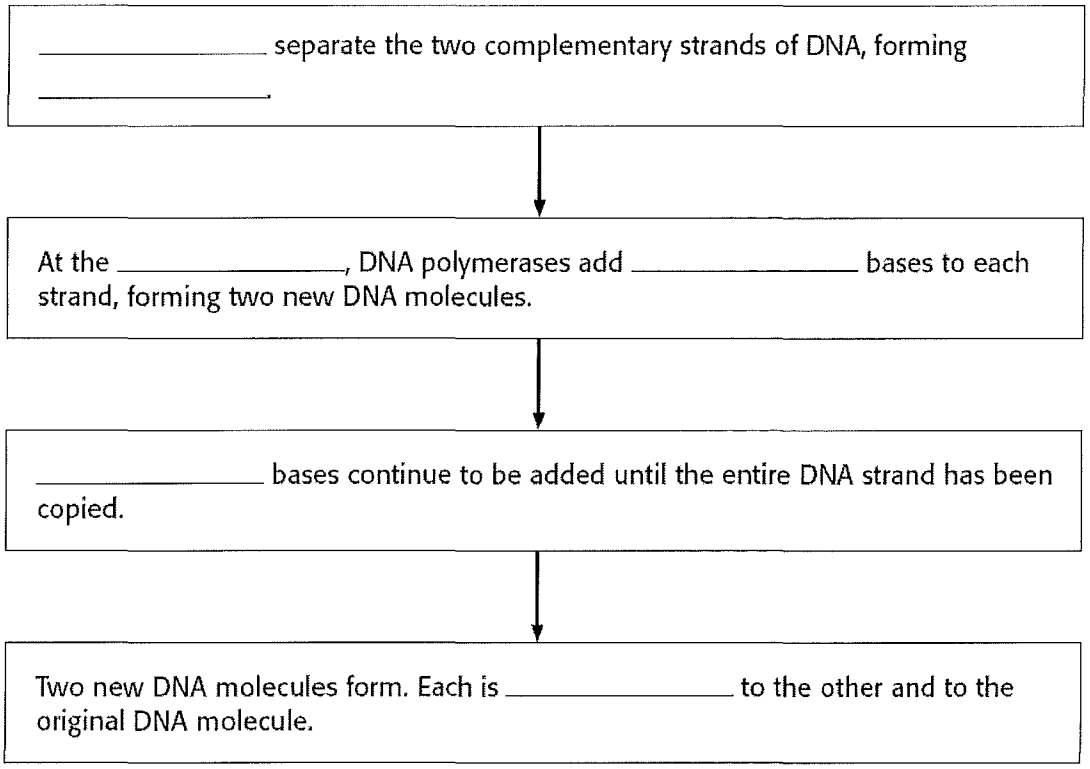
Bellringer:Day M T W Th F Date Question

Answer

CHAPTER 13 SEC2 DUE DATE .

1. Give two functions of DNA polymerase in DNA replication.

2. Fill in the blanks in the flowchart below to show how DNA replication occurs.



3. Give one difference and one similarity between DNA replication in eukaryotic cells and DNA replication in prokaryotic cells.

Bellringer:Day M T W Th F Date_____Question_____

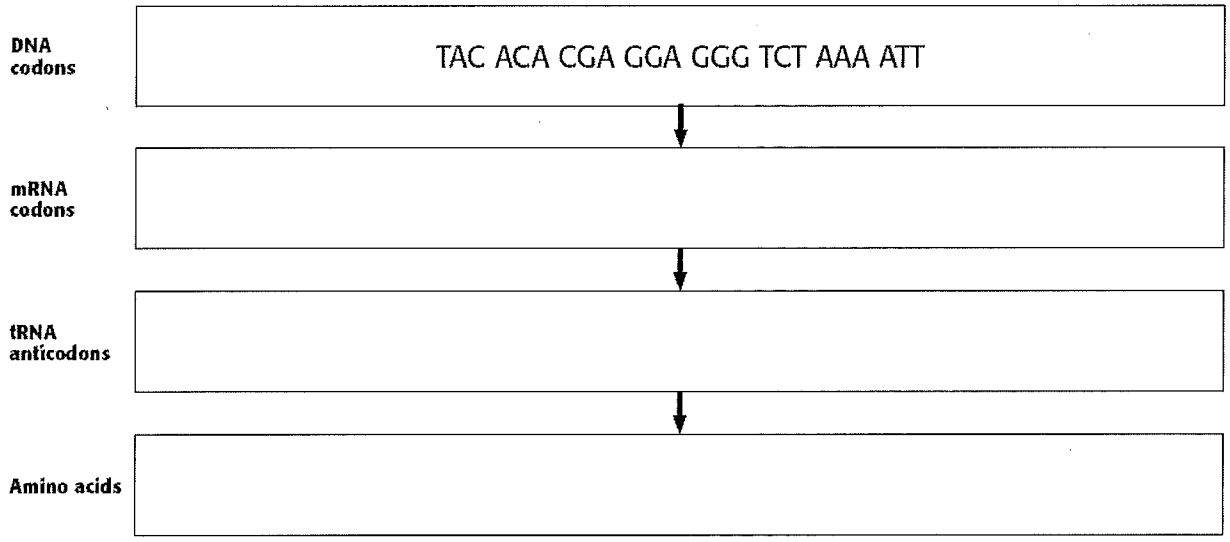
Answer_____

CHAPTER 13 SEC3 DUE DATE .

1. Write a definition of gene expression in your own words.

2. What role does tRNA play in gene expression?

3. Fill in the chart below to show how a DNA base sequence is converted into a sequence of amino acids.



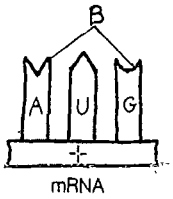
4. What are two things that can affect the result of gene expression?

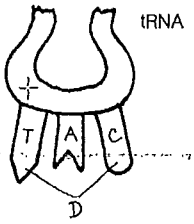
Bellringer:Day M T W Th F Date Question

Answer

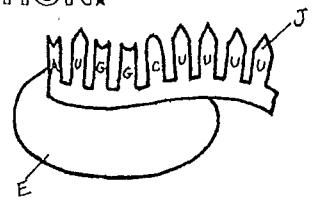
PROTEIN SYNTHESIS: TRANSLATION.

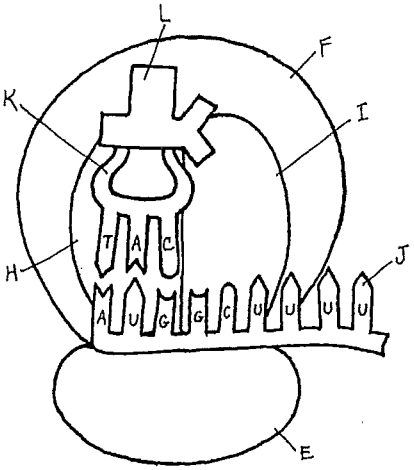
CODON$_B$
ANTICODON$_D$
RIBOSOME$_\star$
SMALL SUBUNIT$_E$
LARGE SUBUNIT$_F$
P SITE$_H$
A SITE$_I$



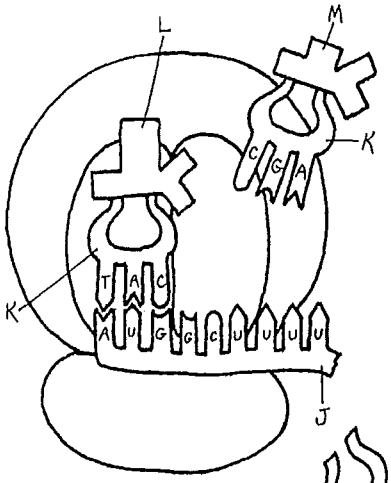


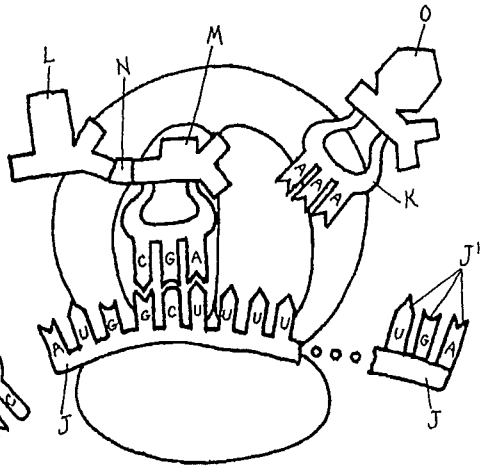
PHASES OF TRANSLATION$_\star$
INITIATION$_\star$
mRNA$_J$
tRNA$_K$
METHIONINE$_L$



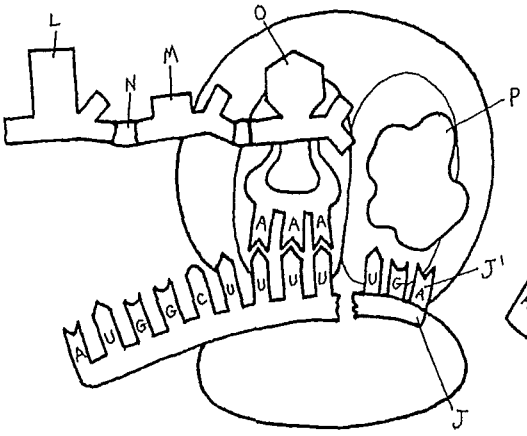


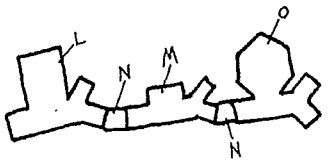
ELONGATION$_\star$
ALANINE$_M$
PEPTIDE BOND$_N$
PHENYLALANINE$_O$
STOP CODON$_{J'}$

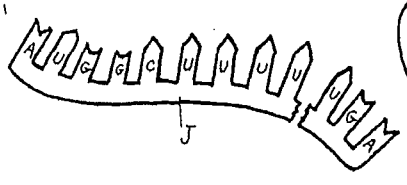


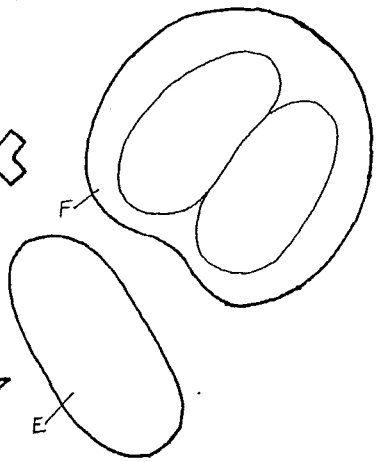


TERMINATION$_\star$
RELEASE FACTOR$_P$





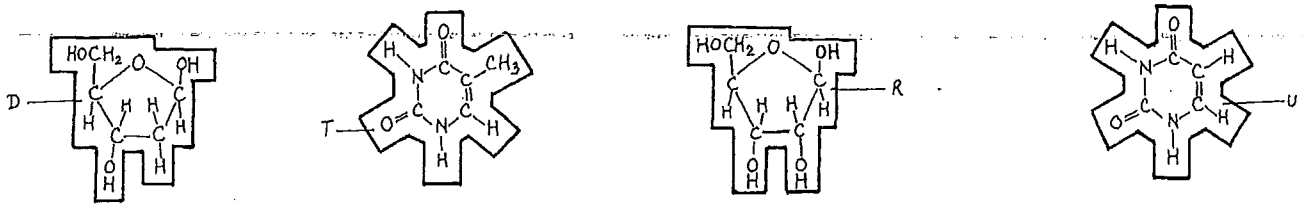




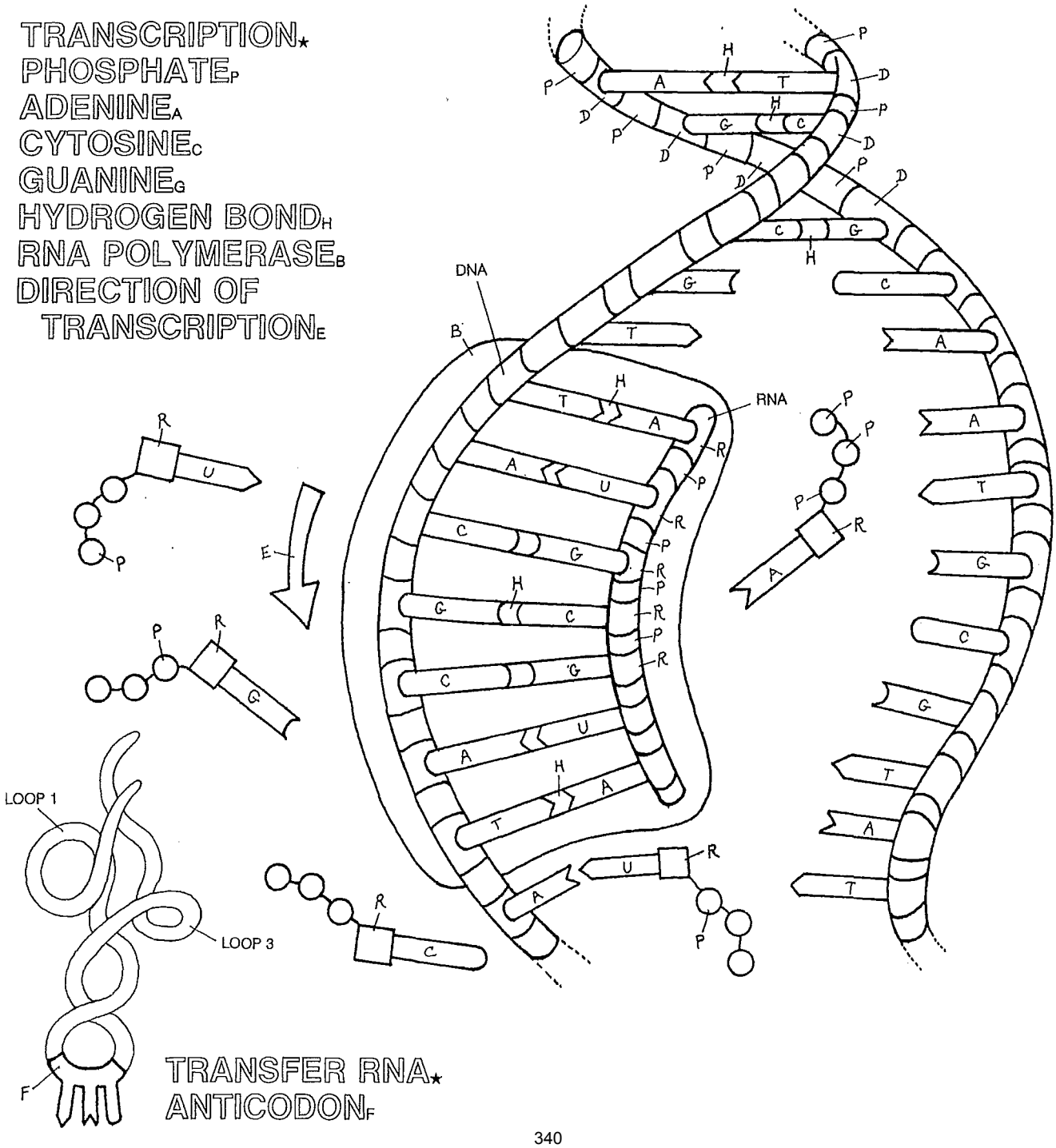
DNA TRANSCRIPTION.

DNA★
DEOXYRIBOSE$_D$
THYMINE$_T$

RNA★
RIBOSE$_R$
URACIL$_U$



TRANSCRIPTION★
PHOSPHATE$_P$
ADENINE$_A$
CYTOSINE$_C$
GUANINE$_G$
HYDROGEN BOND$_H$
RNA POLYMERASE$_B$
DIRECTION OF TRANSCRIPTION$_E$



TRANSFER RNA★
ANTICODON$_F$

Chapter 13 Review

1. what did Griffith's experiments show?
2. What is DNA made of?
3. what does a nucleotide consist of?
4. The part of the molecule for which DNA is named is the
5. What is a purine? Which DNA bases are purines? What is a pyrimidine? What bases are pyrimidines?
6. The amount of guanine in an organism always equals the amount of
7. Who discovered the structure of DNA?
8. During DNA replication, a complementary strand of DNA is made from each original DNA strand. Thus, if a portion of the original strand is CCTAGCT, then the new strand will be
9. What enzymes attach nucleotides to complementary strands of DNA?
10. The enzymes responsible for adding nucleotides to the exposed DNA bases during replication
11. What are the enzymes responsible for adding nucleotides to the exposed DNA bases during replication
12. The enzymes that unwind DNA during replication are called
13. What is the difference between replication forks in prokaryotes and eukaryotes?
14. What is transcription?
15. What is the difference between RNA and DNA
16. what is found in DNA that is not in RNA (bases)
17. In RNA molecules, adenine is complementary to
18. What are the types of RNA and what fo they do?
19. What is the product of transcription?
20. How does transcription begin?
21. Each nucleotide triplet in mRNA that specifies a particular amino acid is called a(n)

	U	C	A	G	
U	Phe	Ser	Tyr	Cys	**U**
	Phe	Ser	Tyr	Cys	**C**
	Leu	Ser	stop	stop	**A**
	Leu	Ser	stop	Trp	**G**
C	Leu	Pro	His	Arg	**U**
	Leu	Pro	His	Arg	**C**
	Leu	Pro	Gln	Arg	**A**
	Leu	Pro	Gln	Arg	**G**
A	Ile	Thr	Asn	Ser	**U**
	Ile	Thr	Asn	Ser	**C**
	Ile	Thr	Lys	Arg	**A**
	Met	Thr	Lys	Arg	**G**
G	Val	Ala	Asp	Gly	**U**
	Val	Ala	Asp	Gly	**C**
	Val	Ala	Glu	Gly	**A**
	Val	Ala	Glu	Gly	**G**

22. Refer to the illustration above. What is the portion of the protein molecule coded for by a piece of mRNA with the sequence CUCAAGUGCUUC?

23. Refer to the illustration above. Which of the following would represent the strand of DNA from which the mRNA strand CUCAAGUGCUUC was made?

mRNA codons	**amino acid**
UAU, UAC	tyrosine
CCU, CCC, CCA, CCG	Proline
GAU, GAC	aspartic acid
AUU, AUC, AUA	Isoleucine
UGU, UGC	Cysteine

24. Refer to the illustration above. Suppose that you are given a protein containing the following sequence of amino acids: tyrosine, proline, aspartic acid, isoleucine, and cysteine. Use the portion of the genetic code given to determine which of the following contains a DNA sequence that codes for this amino acid sequence.

25. What is the function of rRNA

26. What is the function of tRNA

	T	C	A	G
T	TTT Phe (F) TTC Phe (F) TTA Leu (L) TTG Leu (L)	TCT Ser (S) TCC Ser (S) TCA Ser (S) TCG Ser (S)	TAT Tyr (Y) TAC TAA STOP TAG STOP	TGT Cys ® TGC TGA STOP TGG Trp (W)
C	CTT Leu (L) CTC Leu (L) CTA Leu (L) CTG Leu (L)	CCT Pro (P) CCC Pro (P) CCA Pro (P) CCG Pro (P)	CAT His (H) CAC His (H) CAA Gln (Q) CAG Gln (Q)	CGT Arg ® CGC Arg ® CGA Arg ® CGG Arg ®
A	ATT Ile (I) ATC Ile (I) ATA Ile (I) ATG Met (M) START	ACT Thr (T) ACC Thr (T) ACA Thr (T) ACG Thr (T)	AAT Asn (N) AAC Asn (N) AAA Lys (K) AAG Lys (K)	AGT Ser (S) AGC Ser (S) AGA Arg ® AGG Arg ®
G	GTT Val (V) GTC Val (V) GTA Val (V) GTG Val (V)	GCT Ala (A) GCC Ala (A) GCA Ala (A) GCG Ala (A)	GAT Asp (D) GAC Asp (D) GAA Glu (E) GAG Glu (E)	GGT Gly (G) GGC Gly (G) GGA Gly (G) GGG Gly (G)

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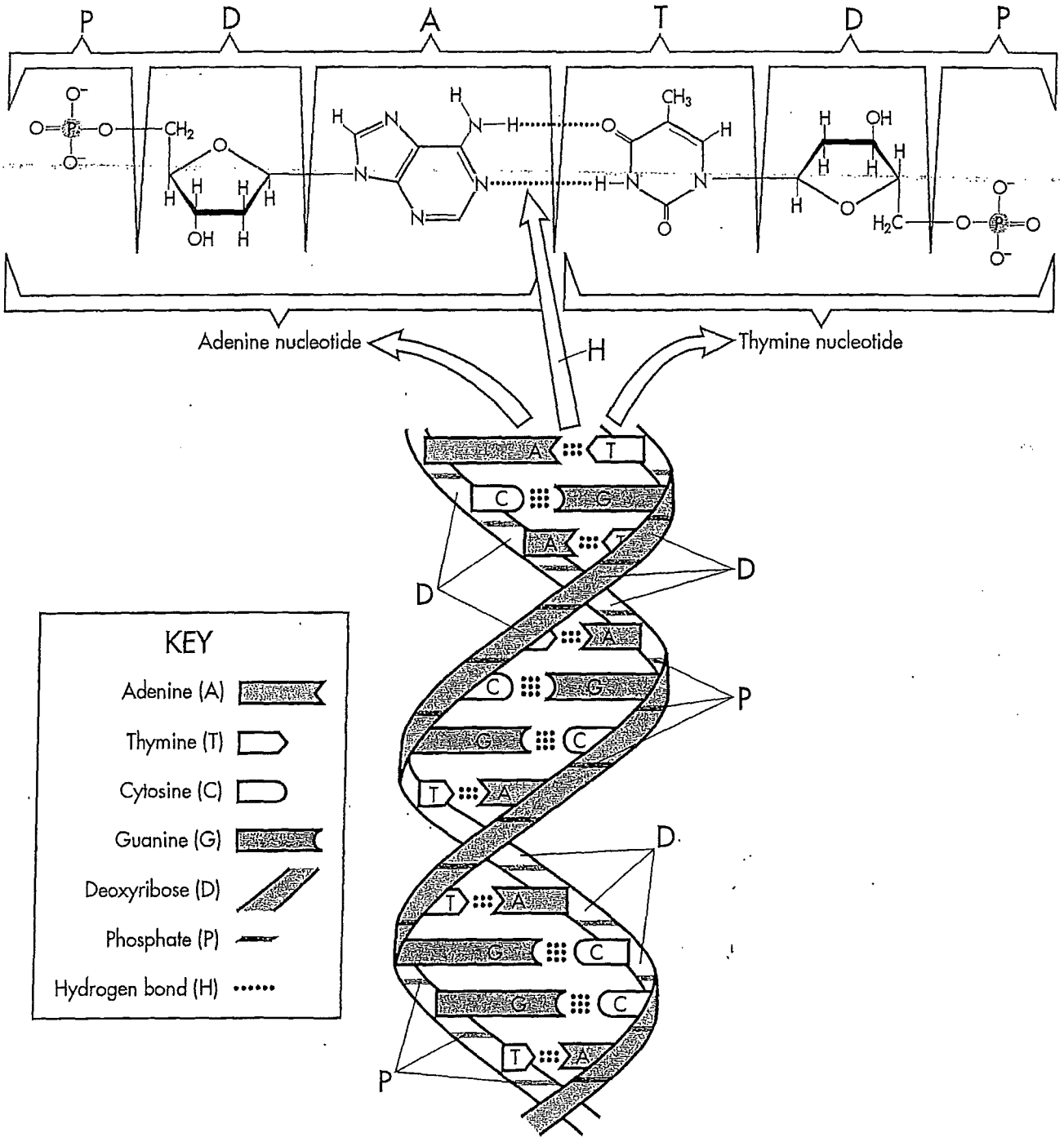
Structure of DNA



Structure of DNA

○ Phosphate Group.....P	○ Adenine.....A	○ Cytosine C
○ Deoxyribose.....D	○ Thymine.....T	○ Guanine.....G
	○ Hydrogen Bond.....H	

RETEACHING

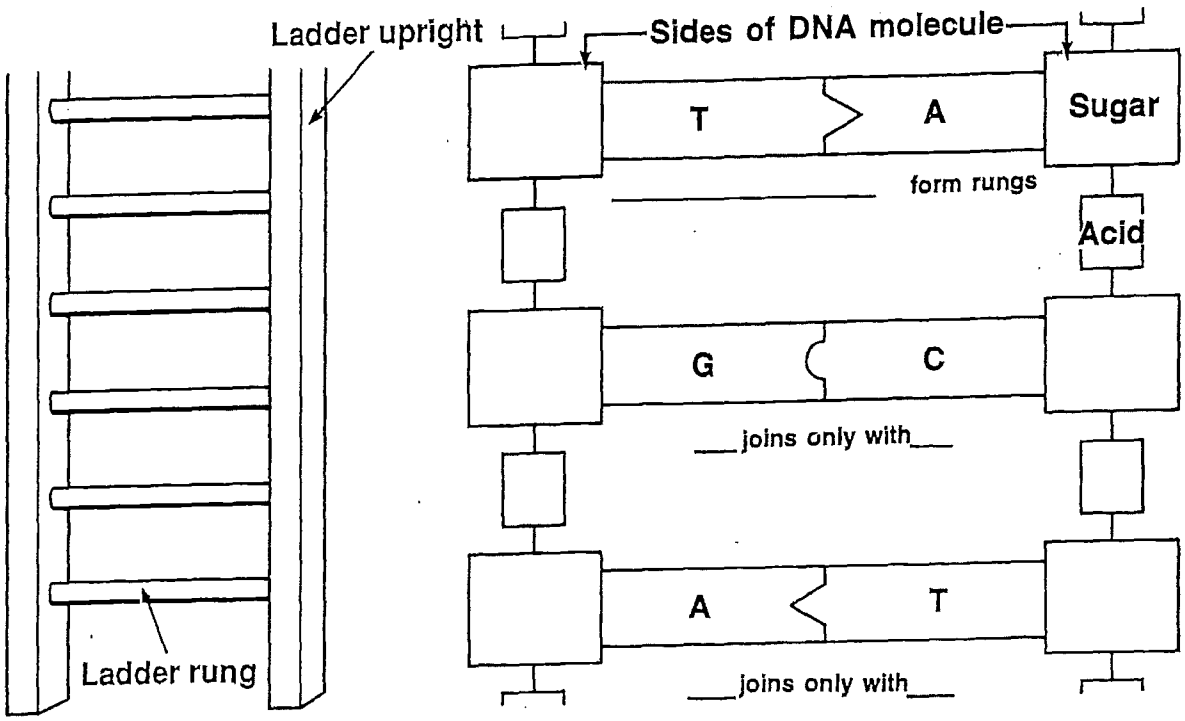
CHAPTER 28

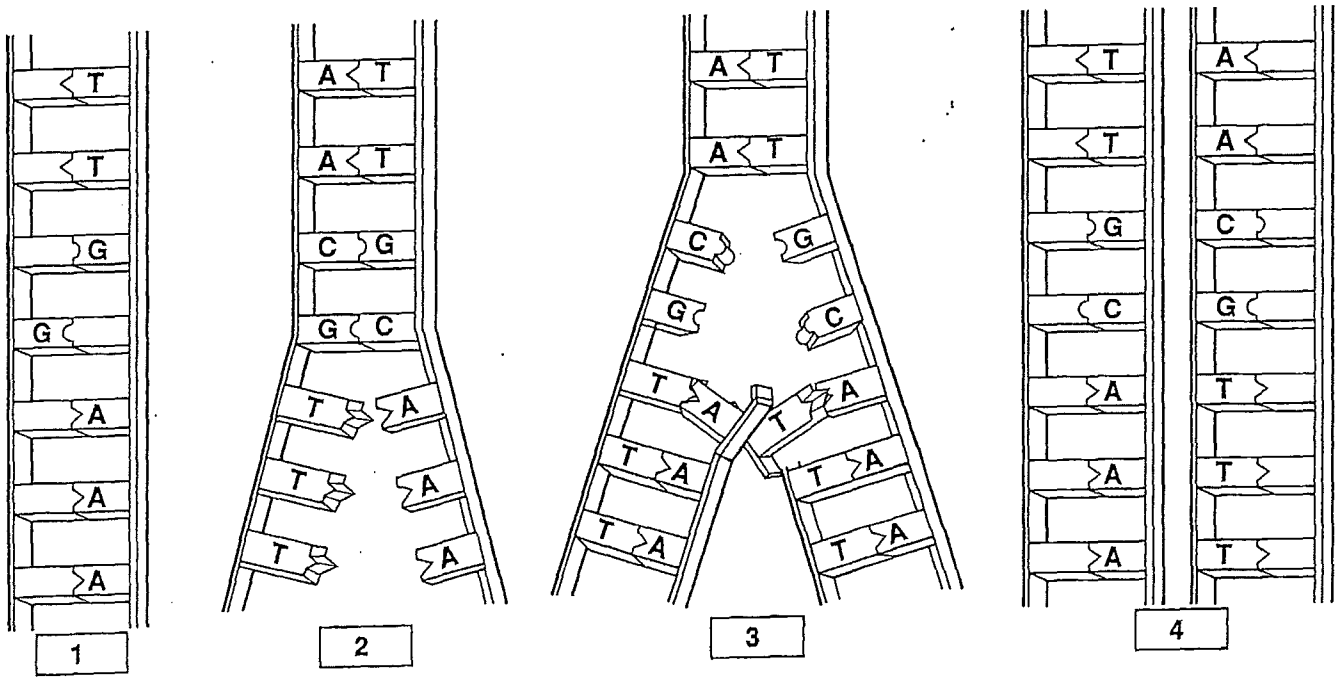
Name _____ Date _____ Class _____

Use with Section 28:1.

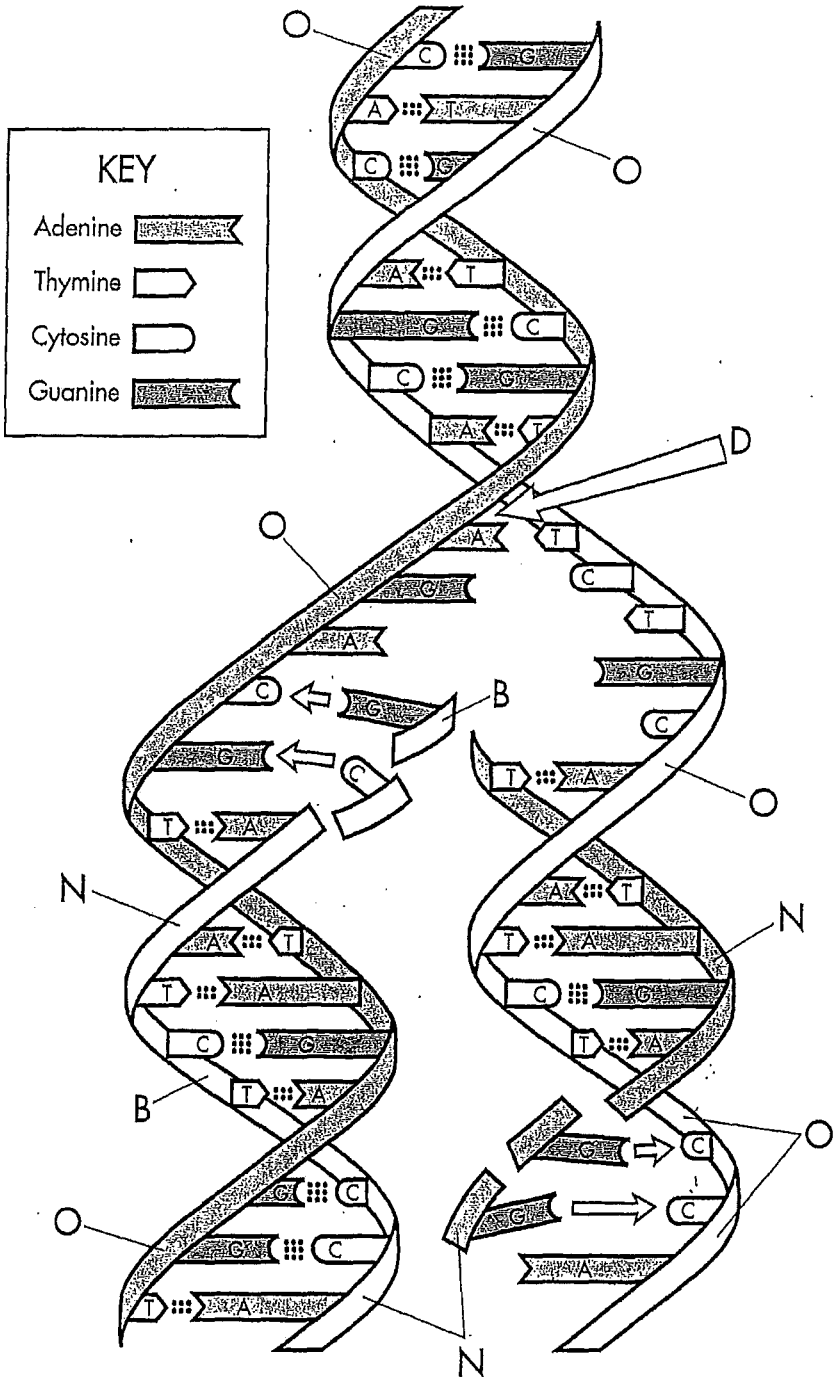
DNA STRUCTURE AND HOW DNA COPIES ITSELF

Complete the diagrams by filling in the correct terms and letters.





Replication of DNA



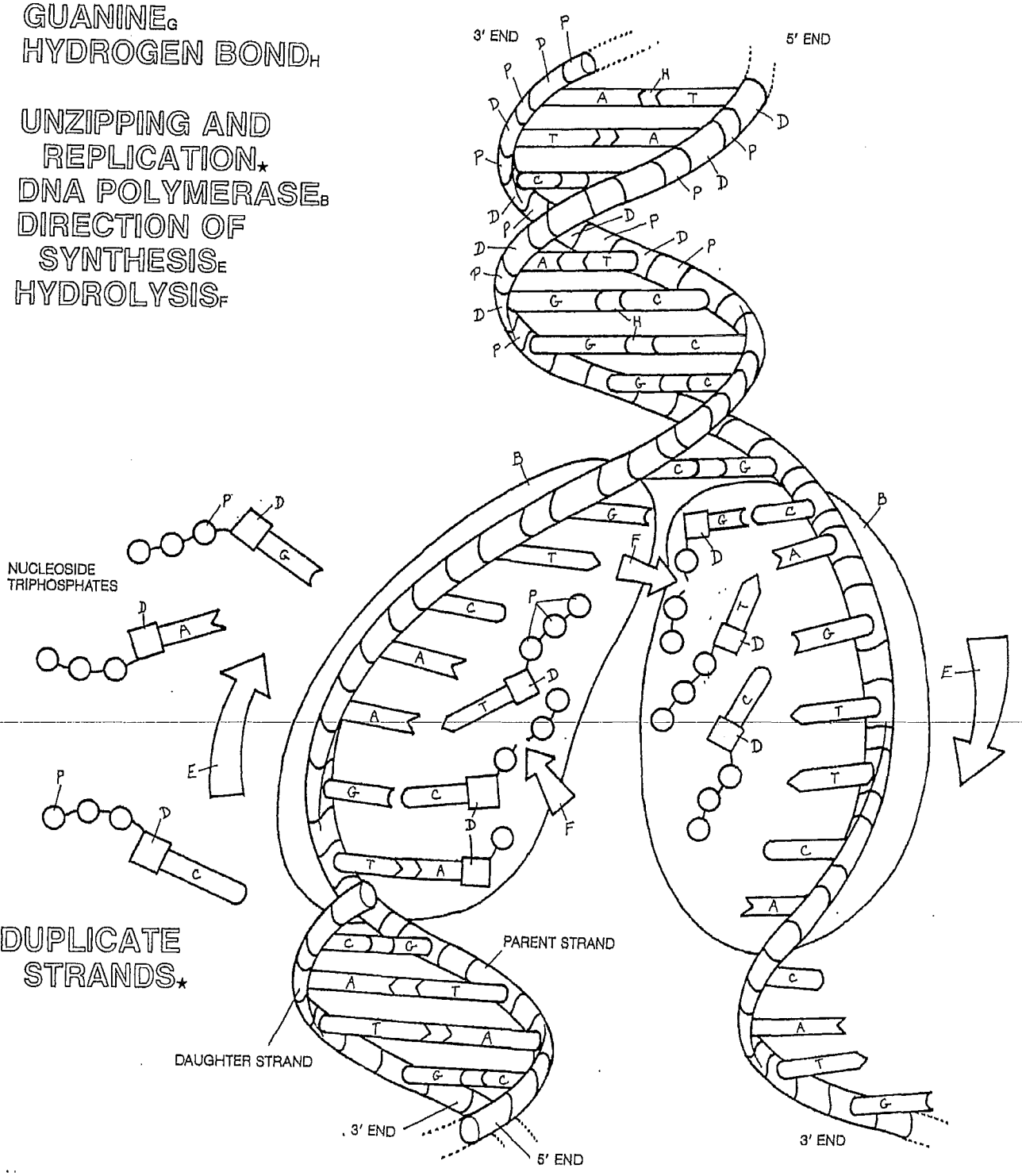
Replication of DNA

- Deoxyribose-Phosphate Backbone (Old) .....O
- Deoxyribose-Phosphate Backbone (New) .....N
- Adenine.....A
- Thymine.....T
- Cytosine C
- Guanine.....G
- Replication Fork .....D

DNA REPLICATION.

DEOXYRIBOSE$_D$
PHOSPHATE$_P$
ADENINE$_A$
THYMINE$_T$
CYTOSINE$_C$
GUANINE$_G$
HYDROGEN BOND$_H$

UNZIPPING AND REPLICATION$_\star$
DNA POLYMERASE$_B$
DIRECTION OF SYNTHESIS$_E$
HYDROLYSIS$_F$

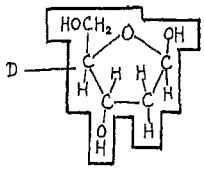


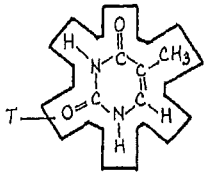
DUPLICATE STRANDS$_\star$

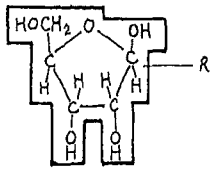
DNA TRANSCRIPTION.

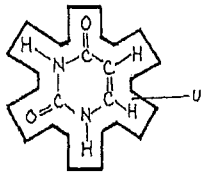
DNA★
DEOXYRIBOSE$_D$
THYMINE$_T$

RNA★
RIBOSE$_R$
URACIL$_U$

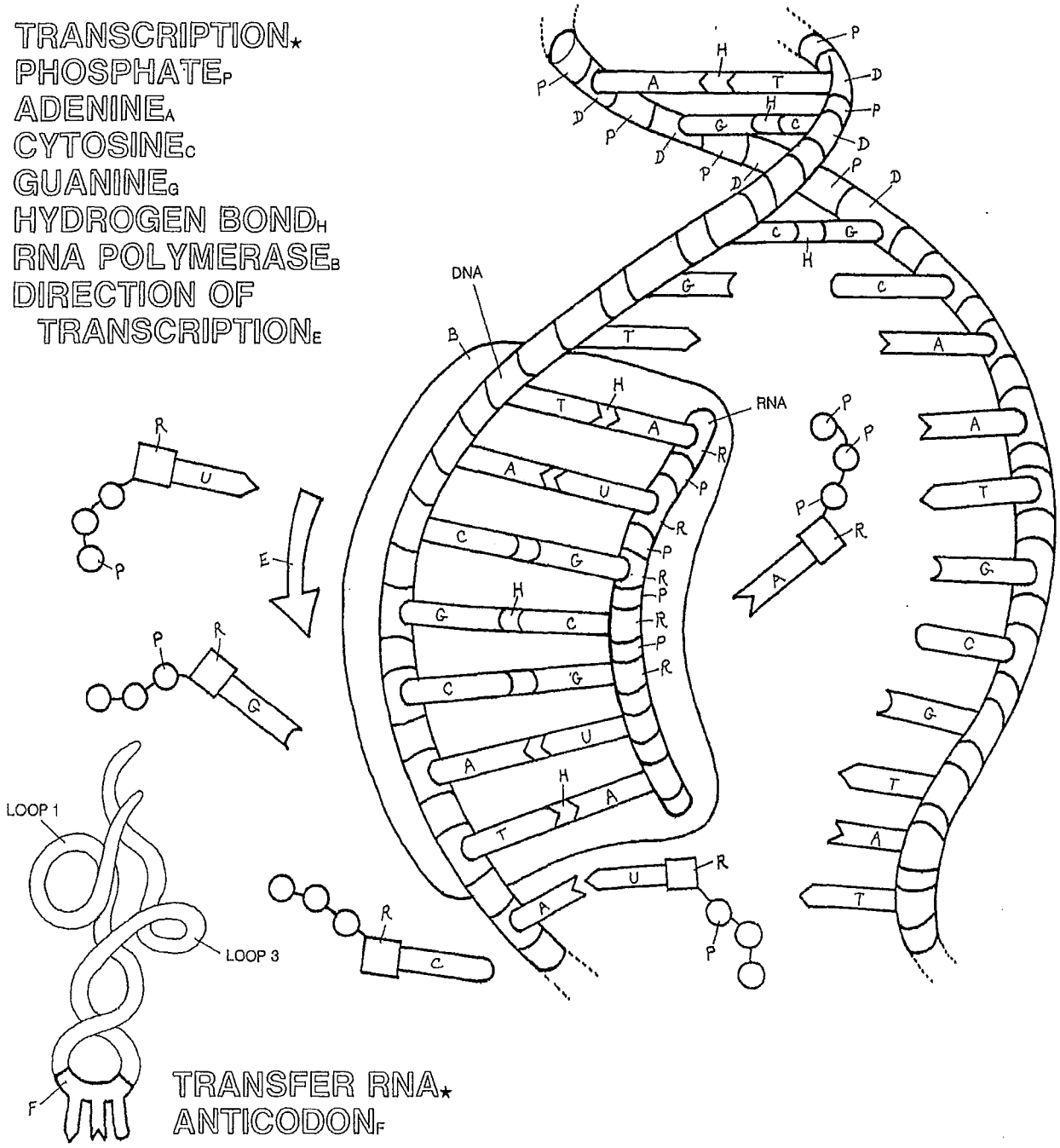








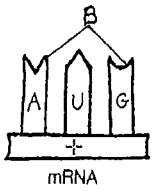
TRANSCRIPTION★
PHOSPHATE$_P$
ADENINE$_A$
CYTOSINE$_C$
GUANINE$_G$
HYDROGEN BOND$_H$
RNA POLYMERASE$_B$
DIRECTION OF TRANSCRIPTION$_E$

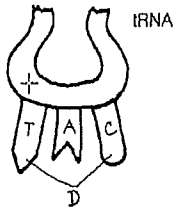


TRANSFER RNA★
ANTICODON$_F$

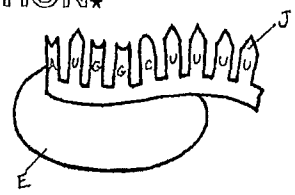
PROTEIN SYNTHESIS: TRANSLATION.

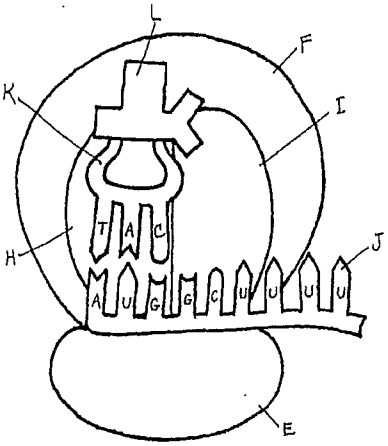
CODON$_B$
ANTICODON$_D$
RIBOSOME$_\star$
SMALL SUBUNIT$_E$
LARGE SUBUNIT$_F$
P SITE$_H$
A SITE$_I$



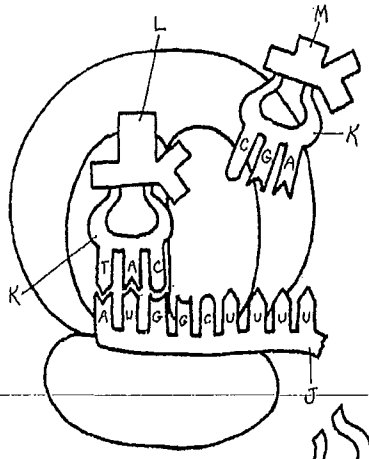


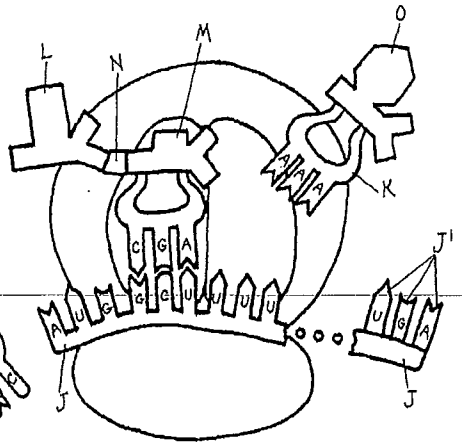
PHASES OF TRANSLATION$_\star$
INITIATION$_\star$
mRNA$_J$
tRNA$_K$
METHIONINE$_L$



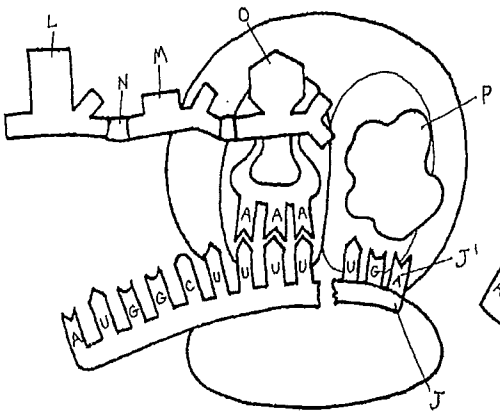


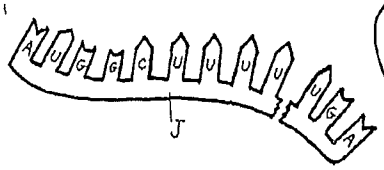
ELONGATION$_\star$
ALANINE$_M$
PEPTIDE BOND$_N$
PHENYLALANINE$_O$
STOP CODON$_{J'}$

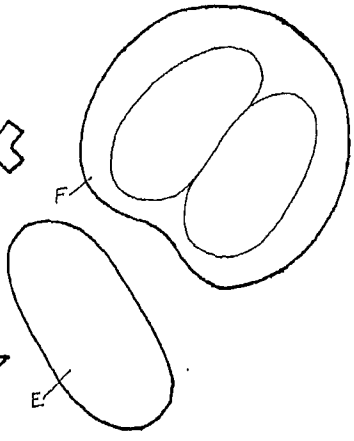




TERMINATION$_\star$
RELEASE FACTOR$_P$

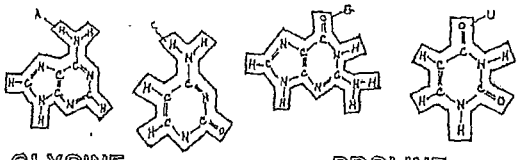






IE GENETIC CODE,

NA BASES★
ENINE$_A$
OSINE$_C$
ANINE$_G$
ACIL$_U$



INO ACIDS★
ANINE$_B$
INE$_D$
ARAGINE$_E$
ARTIC ACID$_F$
STEINE$_H$
JTAMINE$_I$
JTAMIC ACID$_J$

GLYCINE$_K$
HISTIDINE$_L$
ISOLEUCINE$_M$
LEUCINE$_N$
LYSINE$_O$
METHIONINE$_P$
PHENYLALANINE$_Q$

PROLINE$_R$
SERINE$_S$
THREONINE$_V$
TRYPTOPHAN$_W$
TYROSINE$_X$
VALINE$_Y$.

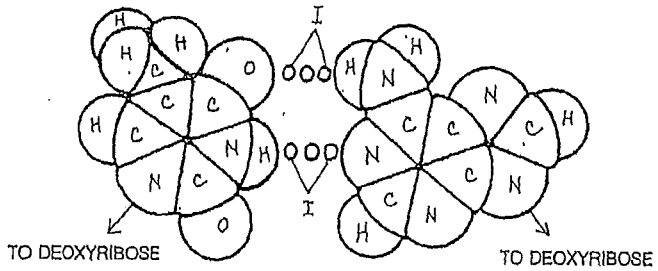
SECOND mRNA BASE★ STOP CODON$_Z$

FIRST mRNA BASE★	U	C	A	G	THIRD mRNA BASE★
U	UUU Q	UCU S	UAU X	UGU H	U
	UUC Q	UCC S	UAC X	UGC H	C
	UUA N	UCA S	UAA Z	UGA Z	A
	UUG N	UCG S	UAG Z	UGG W	G
C	CUU N	CCU R	CAU L	CGU D	U
	CUC N	CCC R	CAC L	CGC D	C
	CUA N	CCA R	CAA I	CGA D	A
	CUG N	CCG R	CAG I	CGG D	G
A	AUU M	ACU V	AAU E	AGU S	U
	AUC M	ACC V	AAC E	AGC S	C
	AUA M	ACA V	AAA O	AGA D	A
	AUG P	ACG V	AAG O	AGG D	G
G	GUU Y	GCU B	GAU F	GGU K	U
	GUC Y	GCC B	GAC F	GGC K	C
	GUA Y	GCA B	GAA J	GGA K	A
	GUG Y	GCG B	GAG J	GGG K	G

GINAL MESSAGE$_{AA}$
THE BIG DOG BIT TED AND RAN OFF

.ETION AND FRAME SHIFT$_{BB}$
THE BID OGB ITT EDA NDR ANO FF
↑
DELETION

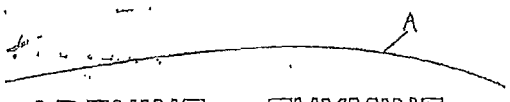
BASE PAIRS★
CARBON$_C$
NITROGEN$_N$
HYDROGEN$_H$
OXYGEN$_O$
HYDROGEN BONDS$_I$



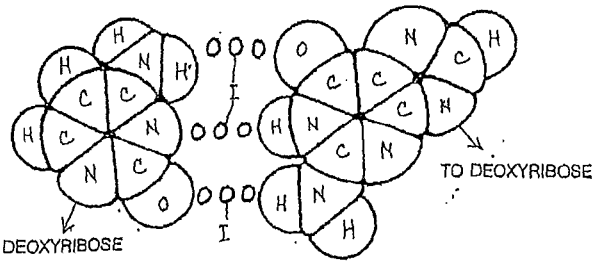
THYMINE★ ADENINE★

CHARGAFF'S RULE$_A$

DNA BASE PAIRING

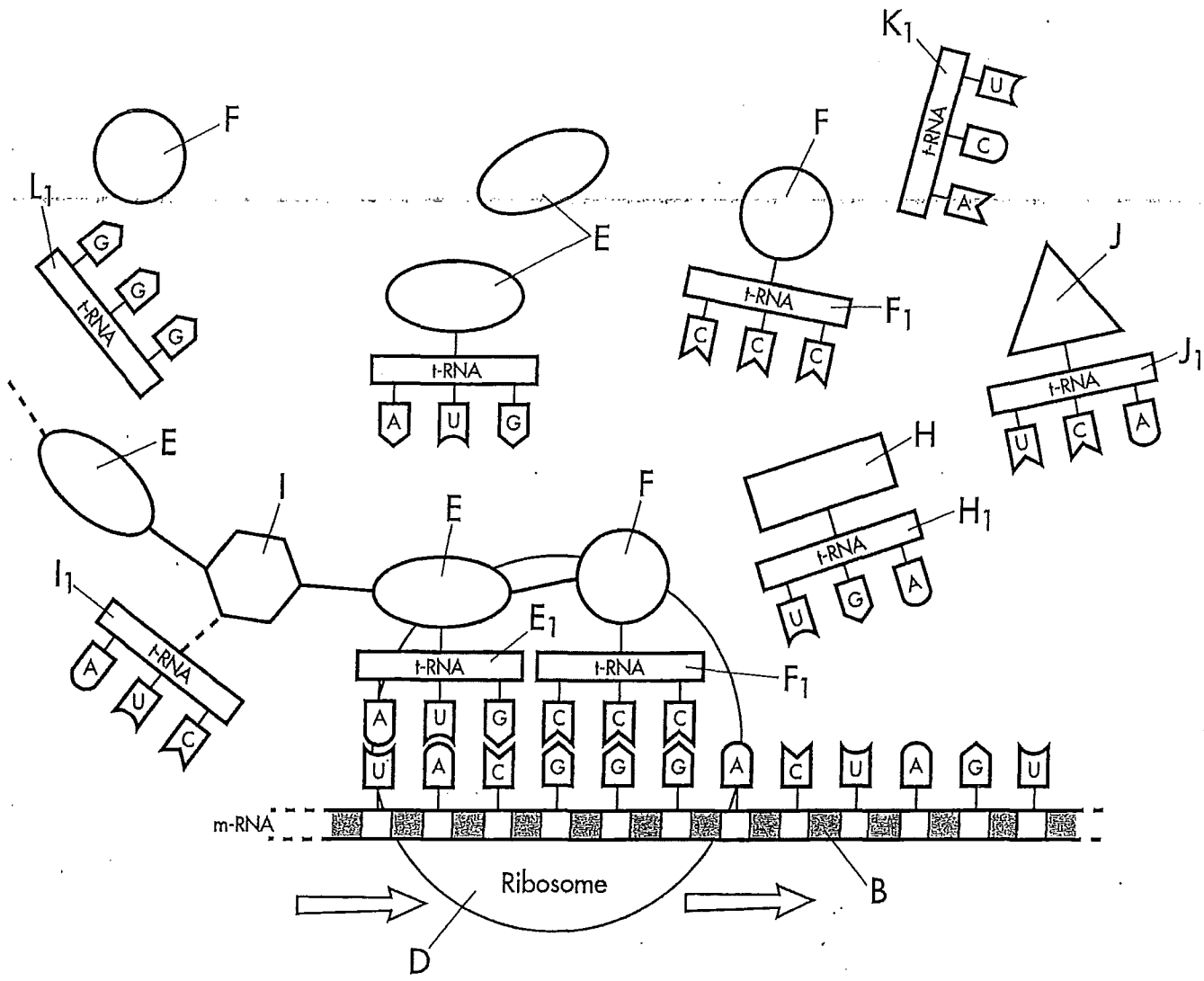


ADENINE = THYMINE
CYTOSINE = GUANINE



CYTOSINE

Protein Synthesis (Translation)



Protein Synthesis (Translation)

- ○ Ribose-Phosphate Backbone .....B
- ○ Adenine.....A
- ○ Cytosine C
- ○ Guanine.....G
- ○ Uracil .....U
- ○ Ribosomal Complex.....D
- ○ Alanine.....E
- ○ tRNA for Alanine.....E_1
- ○ Lysine .....F
- ○ tRNA for Lysine .....F_1
- ○ Tryptophan .....H
- ○ tRNA for Tryptophan ..H_1
- ○ Serine I
- ○ tRNA for Serine .....I_1
- ○ Valine .....J
- ○ tRNA for Valine .....J_1
- ○ tRNA for Tyrosine ....K_1
- ○ tRNA for Leucine.....L_1

DNA Extraction from Wheat Germ

OBJECTIVES

- **Extract** DNA from wheat germ.
- **Explain** the role of detergents, heat, and alcohol in the extraction of DNA.

MATERIALS

- test tube or beaker (50 mL)
- salt, table
- isopropyl alcohol, cold (15 mL)
- inoculating loop
- wheat germ, raw (1 g)
- water, hot tap (55(C, 20 mL)
- soap, liquid dishwashing (1 mL)
- glass rod, 8 cm long
- glass slide

Procedure

1. Put on safety goggles
2. **CAUTION: Glassware, such as a test tube, is fragile and can break.** Place 1 g of wheat germ into a clean test tube.
3. Add 20 mL hot (55(C) tap water and stir with glass rod for 2 to 3 min.
4. Next, add a pinch of table salt, and mix well.
5. Add a few drops (1 mL) of liquid dishwashing soap. Stir the mixture with the glass rod for 1 min until it is well mixed.
6. Slowly pour 15 mL cold isopropyl alcohol down the side of the tilted tube or beaker. The alcohol should form a top layer over the original solution. Note: Do not pour the alcohol too fast or directly into the wheat germ solution.
7. Tilt the tube upright, and watch the stringy, white material float up into the alcohol layer (this result should occur after 10 to 15 min). This material is the DNA from the wheat germ.
8. Carefully insert the inoculating loop into the white material in the alcohol layer. Gently twist the loop as you wind the DNA around the loop. Remove the loop from the tube, and tap the DNA onto a glass slide.
9. Clean up your lab materials according to your teacher's instruction. Wash your hands before you leave the lab.

Analyze and Conclude

1. **Describing Events** Describe what the DNA on the slide looks like.

_____

_____

2. **Interpreting Information** You can extract DNA from a cell using detergent, isopropyl alcohol, and _____.
3. Does your DNA sample relate more to the structure of prokaryotic or eukaryotic DNA? Support your answer with what you see.

_____

_____

_____

_____

NAME_____SCI#_____

DNA Models

Deoxyribonucleic acid, or *DNA,* carries the hereditary information. DNA and proteins make up the chromosomes of cells. Although the chemical composition of DNA was known in the 1920s, its structure was not determined until the 1950s. James D. Watson and Francis H. C. Crick worked out the structure of DNA in 1953, after long months of research. Watson, Crick and Maurice Wilkins shared the 1962 Nobel Prize for this important discovery. DNA is made up of molecules of the sugar *deoxyribose, phosphate groups,* and *nitrogen bases.* The basic unit of DNA, the *nucleotide, is* made up of one of each. A molecule of DNA may contain as many as 200,000 nucleotides. The nucleotides make up two chains that are linked and twisted around one another in the form of a *double helix.* **OBJECTIVES** In this activity you will:

1. Learn the basic units and structure of DNA.
2. Use paper models to understand how the units making up DNA fit together.
3. Use paper models to learn how DNA makes copies of itself.

MATERIALS

scissors 1/2-in transparent tape, or glue stick
thumbtacks or masking tape sheets of different
colored construction paper cardboard

PROCEDURES AND OBSERVATIONS Part I. Structure and Composition of DNA

a. Imagine that you can untwist the DNA ladder. Then study Figure 1, a diagram of the untwisted ladder. Note that the uprights of the ladder consists of alternating units-.phosphate groups and deoxyribose molecules. Now study Figure 2 to see the structures of deoxyribose and phosphate, and how they chemically bond together. Their symbols are also shown.

FIGURE 2

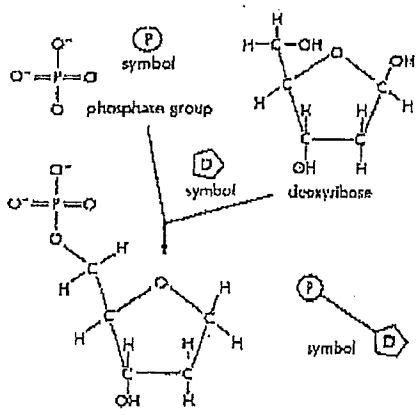
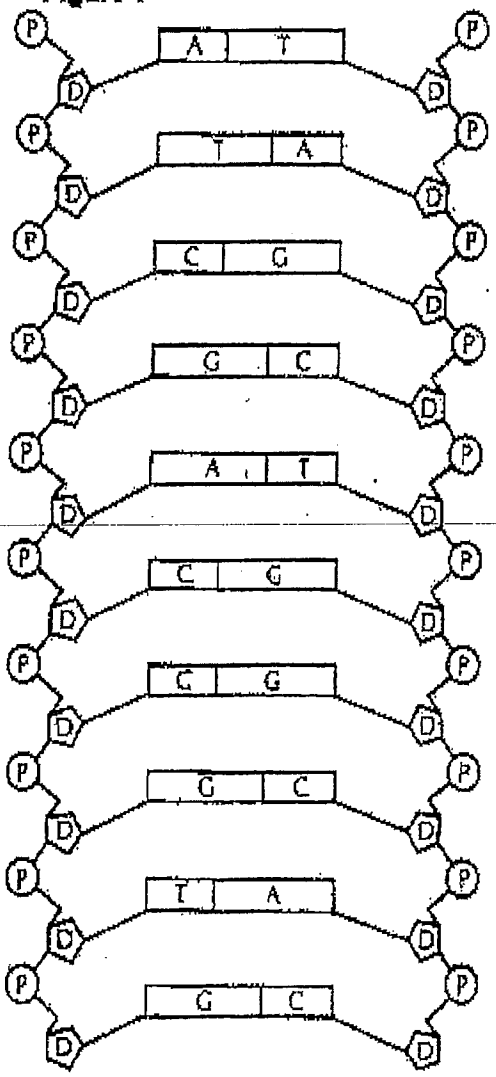


Figure 1



The rungs of the DNA ladder consist of pairs of nitrogen bases. There are two kinds of nitrogen bases: *purines* and *pyrimidines*. The purines have a two-ringed structure; they are *adenine* (A) and *guanine (G)*. The pyrimidines have a one-ring structure; they are *cytosine (C)* and *thymine* (T).

- Figure 3 shows the structures of the four nitrogen bases found in DNA. Note the symbols for the bases.
- A nucleotide consists of one nitrogen base, one phosphate group, and one deoxyribose molecule.
- Study Figure 4 to see how the phosphate group, deoxyribose molecule, and nitrogen base are related in a nucleotide. Each nitrogen base is attached to the deoxyribose- side of a phosphate-deoxyribose combination. Note that because there are four different nitrogen bases there are four kinds of nucleotides.

FIGURE 3

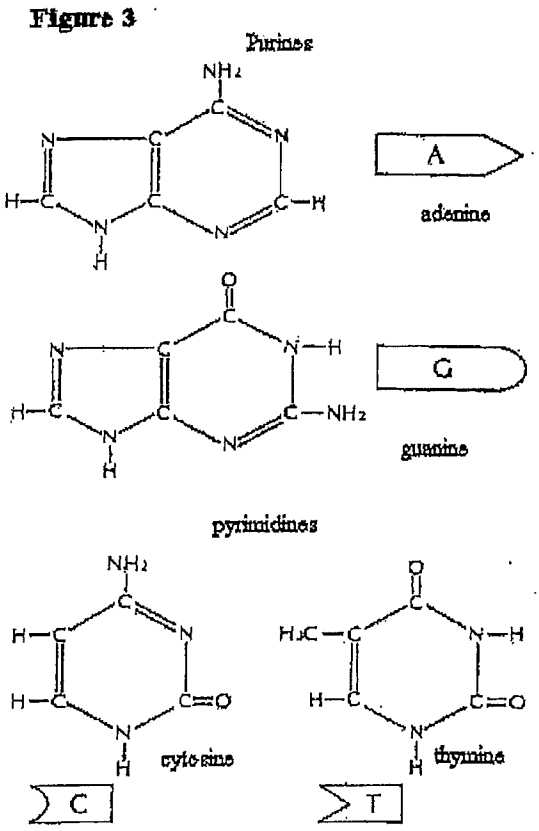
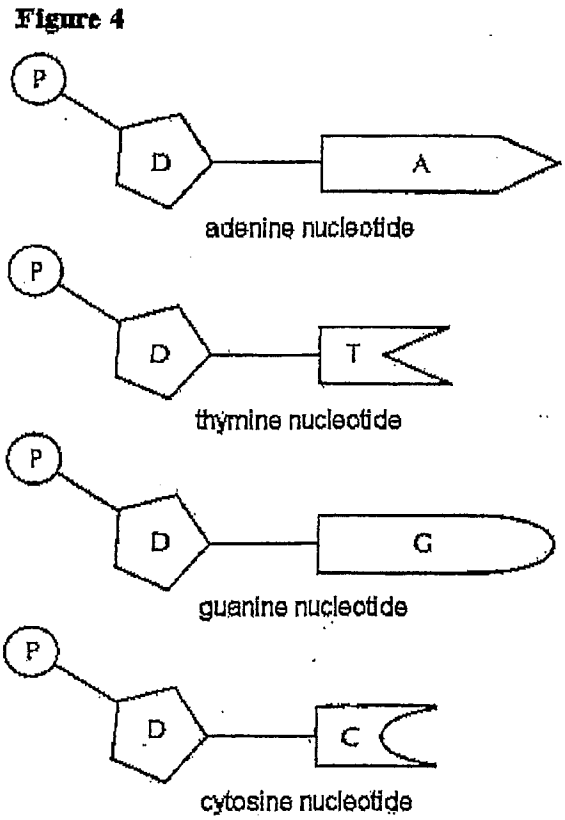


FIGURE 4



Part II. Making Models of DNA

1. Cut out the phosphate, deoxyribose, and nitrogen base symbols below. Paste them onto a piece of cardboard and cut them out.
2. Then rise the cardboard symbols to trace symbols on construction paper. Trace and cut out 20 each of the phosphate and deoxyribose symbols and 5 of each nitrogen base symbol. Use a different color paper for each symbol. Label each nitrogen base with its abbreviation.

3. Make a nucleotide model by laying a phosphate, a deoxyribose, and a nitrogen base symbol on the pattern in Figure 5. Fasten the symbols together with short pieces of transparent tape. Prepare 20 nucleotides. Be sure to attach the symbols at the correct angles to one another. Otherwise your DNA model will not fit together properly.
4. In DNA, a particular purine always bonds with a particular pyrimidine. Adenine bonds to thymine and guanine bonds to cytosine. The purines and pyrimidines are bonded together by hydrogen bonds.
5. Study Figure 6 to see how the nitrogen bases are bonded together in a DNA segment. Then construct a 10-rung model segment of DNA using the nucleotides you have assembled. Match up two nitrogen bases, either A-T or G-C, in each ladder rung. Use short pieces of tape for the bonds. The rungs of the ladder must be of equal length. The nucleotides of each strand can be in any sequence, as long as the two nitrogen bases paired together in the rung are correct. Attach the deoxyribose molecules and the phosphate groups of each strand with tape.
6. Label Figure 7 to show the nucleotide sequences of the DNA model that you constructed. Draw in the shapes of the nitrogen base symbols and label them A, T, G, or C.

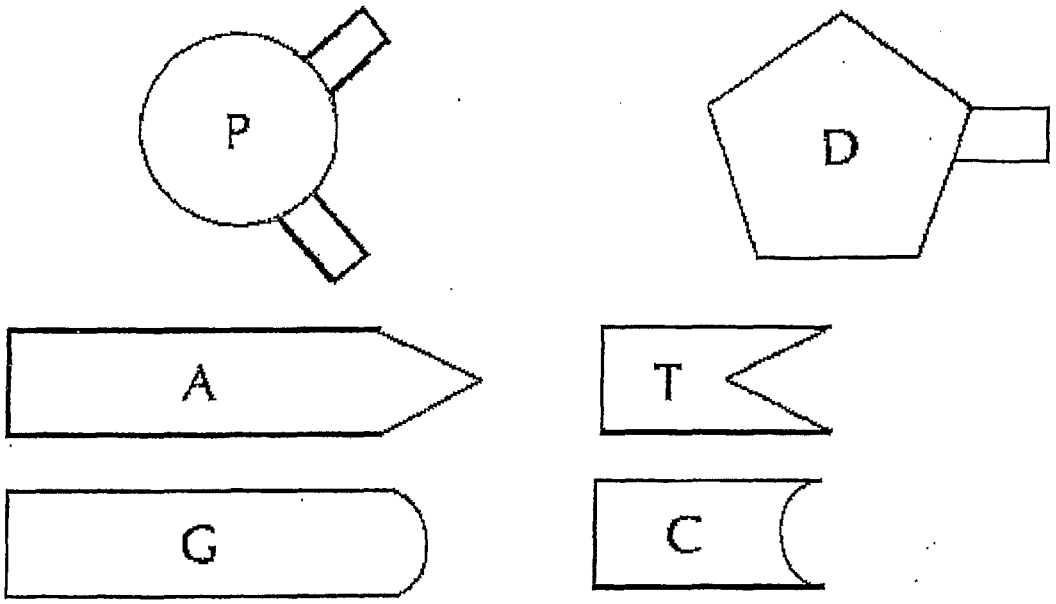
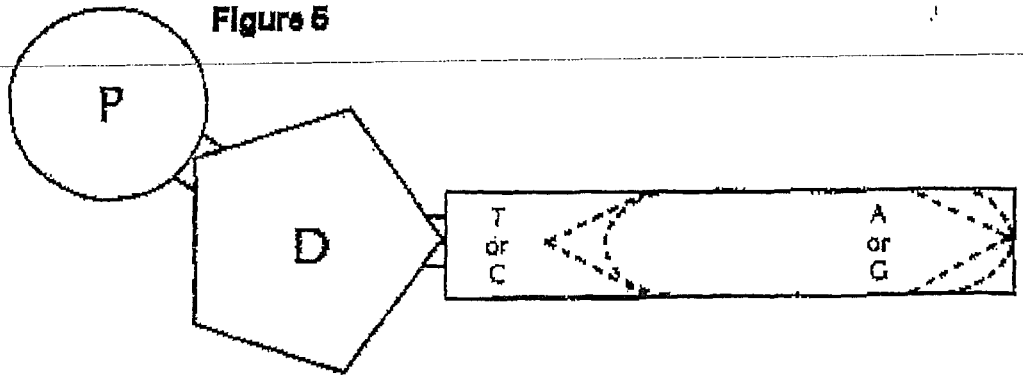
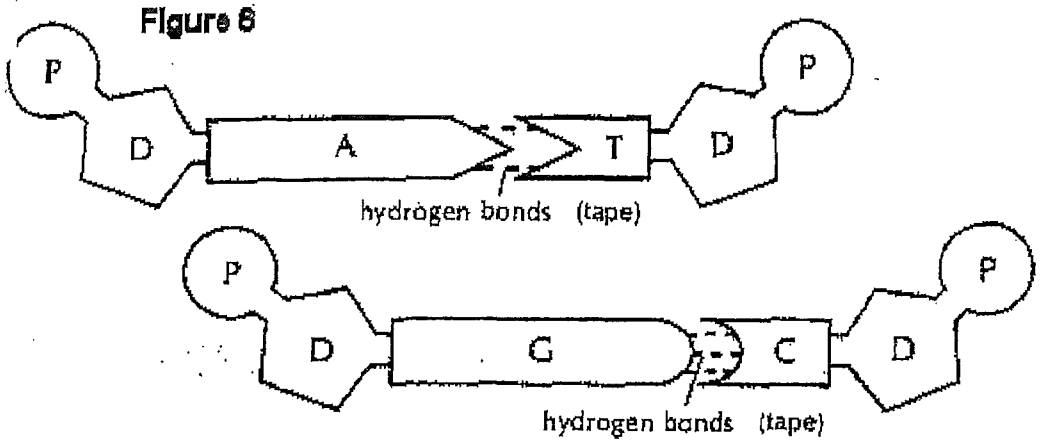


Figure 5



DO NOT CUT THESE ←

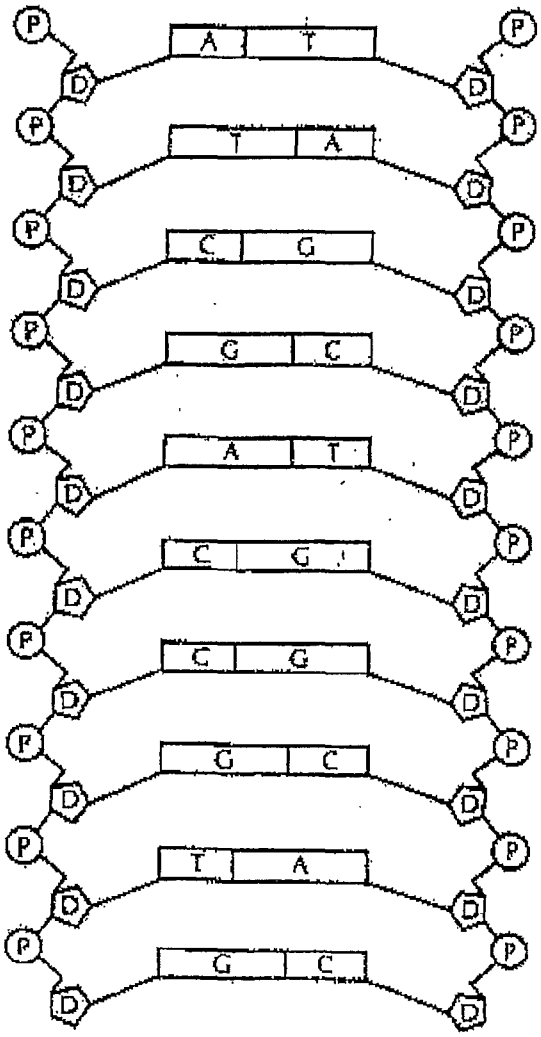
Figure 6



Part III. Learning About DNA Replication

DNA can replicate itself. In this way, the hereditary information encoded in its structure is passed on to new cells formed by mitosis. During replication, the DNA double helix untwists, and the bonds between the nitrogen bases of each rung break. Nucleotides are normal constituents of cells, and as the DNA double helix splits apart, free nucleotides link up to matching nucleotides of each DNA strand according to the rules of base pairing. The two new double-stranded chains then twist into two separate double helixes. In this way two identical DNA molecules are formed.

FIGURE 7



a. Lay your *DNA* model flat on the table. Starting at one end of the model, cut the pieces of tape that connect the nitrogen bases on five of the rungs. Be careful not to cut the symbols. The effect is something like unzipping a zipper. Lay the unzipped model aside.
b. Then prepare 20 more nucleotides as you did in Part II. Be sure to use the pattern to assemble the nucleotides at the proper angles.
c. Matching C with G and *A* with T, attach new nucleotides to both strands of your *DNA* model, using short pieces of tape.
d. Cut apart more rungs as you work along your model. Continue to add new

nucleotides to each strand until all the rungs have been cut and new nucleotides attached.

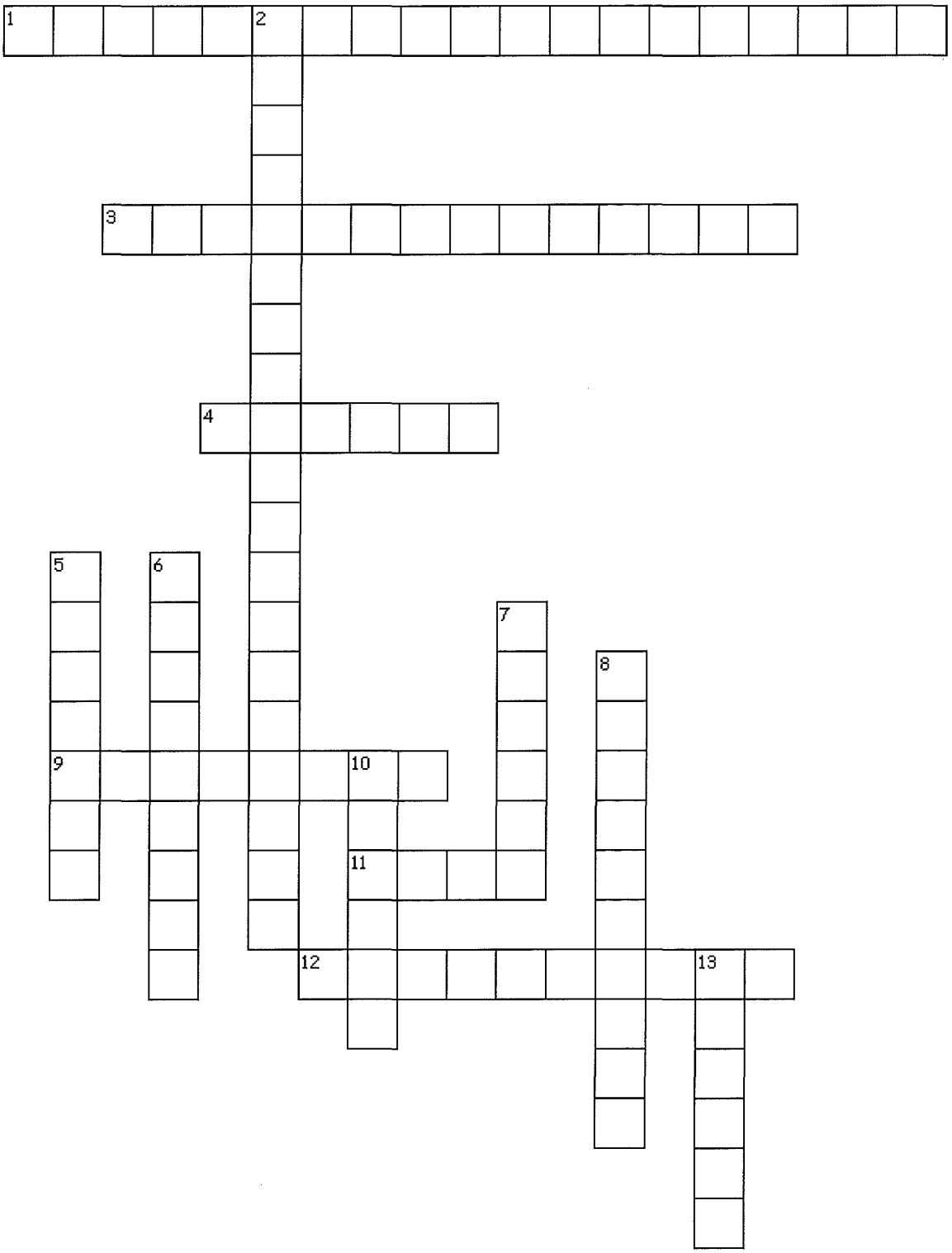
e. Compare the sequences of the two new segments of *DNA* that you constructed.
   1. Are the two segments alike?
   2. How do their sequences compare with the sequences shown in figure 7?

f. Toward the end of the class, carefully fasten one of your model segments of *DNA* to one of your' neighbor's model segments. Work together with the rest of your classmates, fastening segments together until one long, ladderlike segment has been formed. With the help of your teacher, attach one end of the segment to the upper left corner of the classroom bulletin board. Use thumbtacks or heavy masking tape to do it. Carefully twist the *DNA* model, starting near the attached end, as tightly as its structure permits. Twist it evenly along its entire length. Then fasten the end to the other side of the bulletin board, draping it as necessary to maintain its form.

CONCLUSIONS AND APPLICATIONS

1. What determines the sequence of the nitrogen bases in a new DNA strand?
2. Write out the sequence of the new DNA segment that would form next to the segment GGACTGTTA.
3. If an incorrect nucleotide is incorporated into a fanning strand of DNA, will this mistake lie transmitted to the next generation of DNA molecules that forms from this strand?
4. When a DNA molecule replicates, are the two newly formed strands identical to each other? Why or why not?

Ch 14 Crossword/ Vocab Flash Cards- complete the crossword and make a flashcard for each term with the word on one side and the definition on the back



Across

1. an enzyme that is needed to begin and/or continue genetic transcription
3. a failure of homologous chromosomes to separate during meiosis I or the failure of sister chromatids to separate during mitosis or meiosis II
4. the complete genetic material contained in an individual or species
9. a change in the structure or amount of the genetic material of an organism
11. one of several nonadjacent nucleotide sequences that are part of one gene and that are transcribed, joined together, and then translated
12. an abnormal condition of having more than two sets of chromosomes

Down

2. the process by which a cell becomes specialized for a specific structure or function during multicellular development
5. a genetic structure that can replicate independently of the main chromosome(s) of a cell
6. in multicellular organisms, a genetically controlled process that leads to the death of a cell; programmed cell death
7. a nucleotide sequence that is part of a gene and that is transcribed from DNA into mRNA but not translated into amino acids
8. a genetic sequence that is randomly moved, in a functional unit, to new places in a genome
10. a unit of adjacent genes that consists of functionally related structural genes and their associated regulatory genes
13. in proteins, a functional unit that has a distinctive pattern of structural folding

Mutation
Nondisjunction
Polyploidy
Operon
transcription factor
intron
exon
domain
genome
plasmid
transposon
cell differentiation
apoptosis

Chapter 14 Genes in Action

I. **MUTATION: THE BASIS OF GENETIC CHANGE-** a mutation is a change in the structure or amount of the genetic material of an organism. A genetic _____ is an individual whose DNA or chromosomes differ from some previous or normal state. Every unique allele of every gene began as a mutation of an existing gene.

II. CAUSES OF MUTATIONS

A. Mutations occur naturally as accidental changes to DNA or to chromosomes during the cell cycle.

B. Enzymes repair most DNA that is mismatched during replication, but rarely, some DNA is not repaired.

C. The rate of mutation can be increased by some environmental factors. Such factors, called _____, include many forms of radiation and some kinds of chemicals, including cigarette smoke.

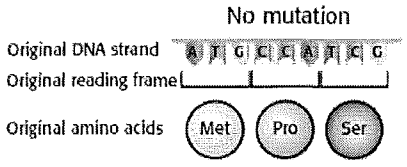
III. **KINDS OF MUTATIONS**-Different kinds of mutations are recognized as either 1. changes in DNA or 2. changes in the results of genes. In eukaryotic cells, the process of meiosis creates the chance of mutations at the chromosomal level.

A. MUTATIONS AS CHANGES IN DNA SEQUENCE

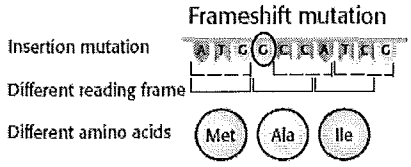
1. **POINT MUTATION** -A point mutation is a change of a single nucleotide in a sequence from one kind of base to another.

2. **INSERTION/DELETION**- errors in replication can cause the insertion or deletion of one or more nucleotides in a sequence.

EFFECTS OF INSERTIONS AND DELETIONS



Remember that the genetic code is "read" in "words" of three letters each (codons). Insertions or deletions can change the *reading frame* by changing the groupings of nucleotides that are read during translation.



This insertion mutation has caused a *frameshift mutation*. It has changed the reading frame of the DNA sequence. As a result, the DNA codes for a different set of amino acids.

B. RESULTS OF SEQUENCE MUTATIONS

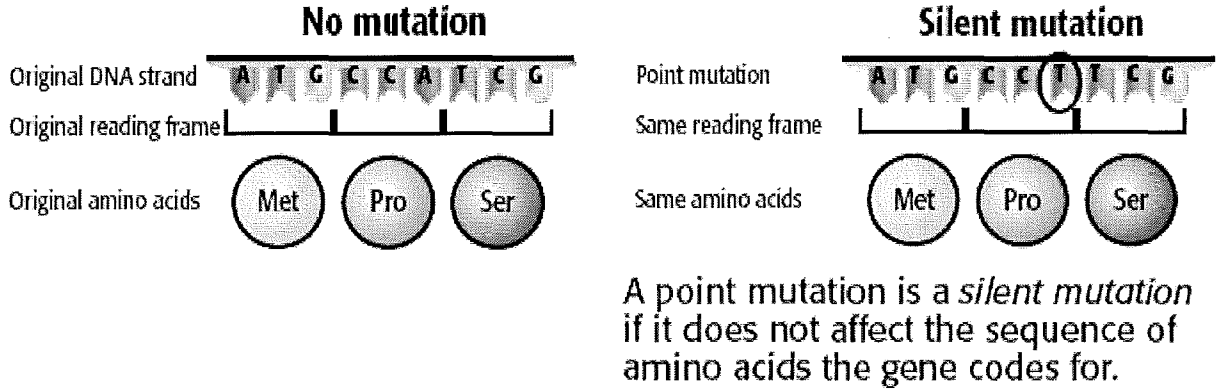
1. **SILENT**- A mutation is silent when it has no effect on a gene's function. Point mutations are often silent because the genetic code is redundant (each amino acid has multiple codons).

2. **MISSENSE**-A missense or replacement mutation results when a codon is changed such that the new codon codes for a different amino acid.

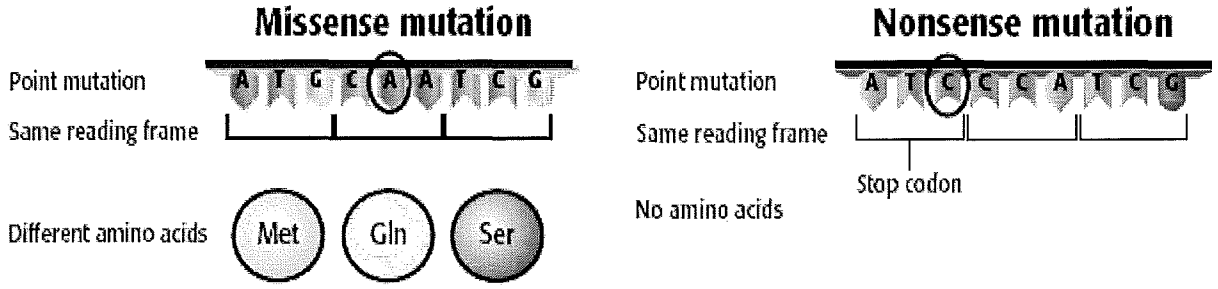
3. **NONSENSE**- A nonsense mutation results when a codon is changed to a "stop" signal. In this case, the resulting string of amino acids may be cut short, and the protein may fail to function.

4. **FRAMESHIFT**- The reading frame of a sequence depends on the starting point for reading. An insertion or deletion can shift the reading frame, or cause a frameshift. In frameshift mutations, the remaining sequence may be "read" as different codons. If an insertion or deletion is a multiple of 3, the reading frame will be preserved. However, the protein that results may have a few more or less amino acids in it.

EFFECTS OF POINT MUTATIONS



A point mutation is a *silent mutation* if it does not affect the sequence of amino acids the gene codes for.



A point mutation is a *missense mutation* if it changes one of the amino acids in the sequence.

A point mutation is a *nonsense mutation* if it changes a codon to a stop codon.

C. **CHROMOSOMAL MUTATIONS**- During meiosis, chromosomes pair up and undergo crossover. Usually, the result is an equal exchange of alleles between homologous chromosomes. Errors in the exchange can cause chromosomal mutations. The following are types of mutations at the CHROMOSOMAL (condensed DNA=x) level

1. **DELETION**- A deletion occurs when a piece of a chromosome is lost. At the end of meiosis, one of the cells will lack the genes from that missing piece. Such deletions are usually harmful.

2. **DUPLICATION**- duplication occurs when a piece remains attached to its homologous chromosome after meiosis. One chromosome will then carry both alleles for each of the genes in that piece.

3. **INVERSION**- An inversion occurs when a piece reattaches to its original chromosome, but in a reverse direction.

4. **TRANSLOCATION**- A translocation occurs when a chromosome piece ends up in a completely different, nonhomologous chromosome.

IV. **EFFECTS OF GENETIC CHANGE**- Mutations that occur in gametes will be passed on to offspring, but mutations in body cells(somatic) affect only the individual in which they occur and die with the organism

A. If a mutation occurs in a somatic cell, the change may be silent or it may change the function of the cell.

B. Only a mutation in a germ cell may be passed on to the next generation. However, any such mutation may be silent or have little effect. Only rarely do mutations cause dramatic changes in future generations.

C. Certain genes control the normal growth, division, and specialization of cells in bodies. Mutations in these genes can cause a normal somatic cell to "lose control" and begin growing and dividing abnormally. The group of cells that grows will become a tumor.

D. Although cancers result from somatic cell mutations, not all somatic cell mutations cause cancer.

E. Genetic Disorders

1. Harmful effects produced by inherited mutations (defective alleles) are called genetic disorders. A disorder results because a mutation has altered the normal function of a gene.

2. Many disorders are recessive—that is, the disorder develops only in a person who is homozygous (double recessive) for the mutated allele. Two heterozygous people may be healthy, yet have children who develop a genetic disorder. A person who is _____ for such an allele is said to be a carrier of the disorder.

Disorder	Dominant or recessive?	Effect of mutant allele	Physical symptoms
Sickle cell anemia	recessive	The protein that carries oxygen in the blood is defective.	poor blood circulation; organ damage
Tay-Sachs disease	recessive in most cases	An enzyme in nerve cells is defective.	nervous system damage; early death
Cystic fibrosis	recessive	An enzyme in cells that secrete proteins is defective.	mucus buildup in certain organs; shortened life span
Hemophilia A	recessive (sex-linked)	A protein that helps blood clot is defective.	lack of formation of blood clots; can cause severe bleeding from minor injuries
Huntington disease	dominant	A protein in brain cells is abnormal.	brain damage; shortened life span

V. **COMPLEXITIES OF GENE REGULATION-** gene expression (transcription and translation) can be regulated. Not all genes are expressed in every cell. Through gene regulation, a genetic sequence can be expressed in different ways—in different bodies or tissues, under different conditions, or at different times. One benefit of gene regulation is that cells can use energy and materials efficiently.

VI. **GENE REGULATION IN PROKARYOTES-** The major form of gene regulation in prokaryotes depends upon operons that respond to environmental factors.

A. An _____ is a gene regulation system in which adjacent DNA segments control the expression of another group of genes

B. Operons are common in _____ but uncommon in eukaryotes.

C. The lac Operon Example

1. An example of gene regulation is found in the bacterium Escherichia coli.

2. Usually, when you eat or drink a dairy product, the chemical lactose ("milk sugar") is digested by E. coli cells living in your gut. These cells can use the lactose for energy or for other needs. These tasks require three different enzymes, each of which is coded for by a different gene.

3. The system that involves the lac genes is called the lac operon.

4. This system includes the three genes plus a promoter site and an operator site.

5. When lactose is available, the system "turns on" and the three genes are transcribed. When lactose is absent, the system "turns off" and transcription is blocked.

VII. **GENE REGULATION IN EUKARYOTES-** Gene regulation in eukaryotes is more complex and variable than gene regulation in prokaryotes. _____ are

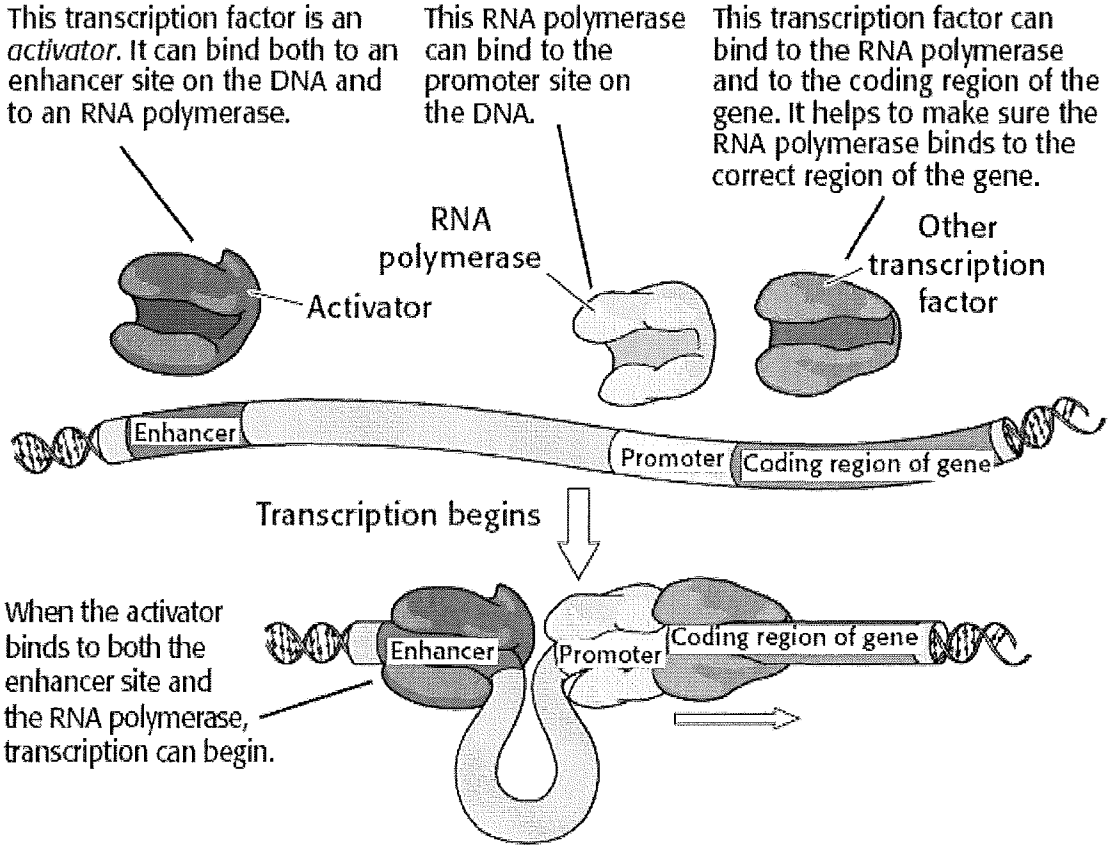
very rare in eukaryotic cells.Regulation can occur before transcription, after transcription, or after translation.

A. **CONTROLLING TRANSCRIPTION-** The genetic switch involves the first step of transcription, when RNA polymerase binds to the promoter region. The proteins involved in this kind of genetic switch are called transcription factors. Some transcription factors act as activators, and some act as repressors.

B. **PROCESSING RNA AFTER TRANSCRIPTION-** In eukaryotes, many genes contain noncoding sequences, or segments of code that will not be translated into amino acids. The noncoding segments are called _____, while those portions of the gene that do code for amino acids and will be translated are called exons. Exons and introns are handled in a process called RNA splicing. The introns are removed the exons that remain are spliced together. Finally, the spliced mRNA leaves the nucleus and is then translated.

C. **PROCESSING PROTEINS AFTER TRANSLATION**- After translation, a chain of amino acids is formed, but the protein may not go directly into action. The process of getting proteins to their correct destination is called protein sorting. Protein sorting occurs in many parts of the cell, such as the _____.

An Example of Gene Regulation in Eukaryotes



VIII. **GENOMES AND THE DIVERSITY OF LIFE**- genetic comparisons of many organisms reveal basic biological similarities and relationships. A _____ is all of the DNA that an organism or species has within its chromosomes. With few exceptions, the genetic code is the same in all organisms. The genetic code is often described as being _____.

A. Genome Size- Genome size can be measured as an amount of DNA or a number of genes.

1. Genomes in microbes range from 400,000 to millions of base pairs and include from 400 to 9,300 genes.

2. Eukaryote genomes range from 100 million to more than 3 billion base pairs with 6,000 to 100,000 genes.The human genome has about 30,000 genes. Some plants have more than 100,000 genes.

B. DNA Versus Genes- Not all DNA in a cell is part of a gene or even part of a chromosome.

1. However, most bacteria have extra pieces of DNA called plasmids. Plasmids are small, circular DNA segments that are replicated independently and can be transferred between cells.

2. Plasmids are an important source of genetic variation in bacteria.

3. Eukaryotes have a great deal of noncoding DNA. Introns are non-coding pieces of DNA. Also, long stretches of repeating sequences exist that are never transcribed.

4. Mitochondria and chloroplasts are organelles that have small genomes that are separate from nuclear DNA. Remember - chloroplasts perform photosynthesis and mitochondria are respiration centers (glucose to ATP)

IX. **ENDOSYMBIOTIC THEORY-** Chloroplast-like bacteria could have been engulfed, but not killed, by larger cells. The cells would live together in a close relationship called symbiosis. This idea is known as the endosymbiotic theory

X.

XI. **MOBILE GENETIC ELEMENTS**- Small bits of genetic material can be stored, moved, and changed by a variety of interactions. MGEs are units of DNA or RNA that are transposed, or moved from one place to another . MGEs cause genetic change by bringing together new combinations of genes. MGEs can transfer genetic material between individuals and even between species. (ex- swine flu)

A. Plasmids- Plasmids are just one kind of mobile genetic element (MGE). Plasmids carry antibiotic resistance between bacteria and are responsible for antibiotic resistant strains of MRSA

B. Transposons- Sets of genes that are transposed randomly are jumping genes, or transposons. When a transposon moves to a new place, it may inactivate a nearby gene, much like an operon does. Some bacteria have transposons that jump between plasmids and chromosomes.

C. Viruses– Viruses infect cells by using the cells' own replication processes to make new virus copies. Certain kinds of RNA viruses, called retroviruses, produce DNA that becomes part of the host cell's genome.

Type of MGE	Description
Plasmid	small, circular piece of DNA; can be transferred between bacterial cells
Transposon	set of genes that move randomly between chromosomes; also called "jumping genes"
Virus	small, nonliving particle consisting of DNA or RNA inside a protein coating

XII. **MULTICELLULAR DEVELOPMENT AND AGING**-Each cell within a developing body will express specific genes. Gene expression depends on the cell's age and location within the body.

A. CELL DIFFERENTIATION- In cell differentiation, each new cell is modified and specialized as the cells multiply to form a body. _____ genes are examples of genes that regulate differentiation. Mutations in homeotic genes can cause one body part, such as a leg, to develop in place of another body part. All homeotic genes code for proteins that regulate the expression of other genes. Many homeotic genes contain a similar sequence of 180 bases. This sequence, called a homeobox, determines where in the DNA the protein binds to regulate transcription

B. CELL GROWTH AND MAINTENANCE-two kinds of proteins regulate the cell cycle: CDK and cyclin. These proteins are present in all eukaryotes and drive the cell cycle forward. The CDK molecules function like an engine, and the cyclins function like gears. They control the speed of the cell cycle. Cancer results when control of cells has been lost because either the "engine" or the "gears" malfunction.

C. CELL DEATH AND AGING- Almost all body cells are "programmed" to age and die. This process of cellular "suicide" is known as _____. Apoptosis seems to occur in consistent steps, much like other cellular processes, such as mitosis. The effect of aging is seen on the ends of chromosomes (called _____). As cells divide repeatedly, the telomeres lose nucleotides and become shortened.

CHAPTER 14 SEC 1 DUE DATE .

1. How are nondisjunction and polyploidy related?

2. What is the origin of almost all genetic differences between organisms?

3. Explain the difference between point mutations, insertion mutations, and deletion mutations.

4. How is a missense mutation different from a nonsense mutation? How are they similar?

5. Skin cancer can occur if the DNA in skin cells is mutated by ultraviolet radiation in sunlight. Can the mutation that causes skin cancer be passed on to offspring? Explain your answer.

6. List Describe three types of chromosomal mutations.

Bellringer:Day M T W Th F Date Question

Answer

CHAPTER 14 SEC 2 DUE DATE .

1. What is the difference between an intron and an exon?

2. What controls most gene regulation in prokaryotes?

3. Give three differences between gene regulation in eukaryotes and gene regulation in prokaryotes.

4. Fill in the blank spaces in the table to describe ways that genes are regulated in eukaryotic cells.

When regulation occurs	Example and description
	transcription factors determine when a gene is transcribed
After transcription, but before translation	
After translation	

5. Give two ways that proteins are important to cells.

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

CHAPTER 14 SEC 3 DUE DATE .

1. What is the difference between a genome and a gene?

2. A scientist is studying three different species. The scientist concludes that species A is more closely related to species B than to species C. How might the scientist have come to this conclusion?

3. Give three examples of MGEs.

When regulation occurs	Example and description
	transcription factors determine when a gene is transcribed
After transcription, but before translation	
After translation	

4. What can happen to an organism if its hox genes are mutated?

5. Most cells undergo apoptosis if their DNA is damaged. How can this be beneficial to an organism?

6. Give two groups of proteins that help to regulate the cell cycle

Bellringer:Day M T W Th F Date_____Question_____

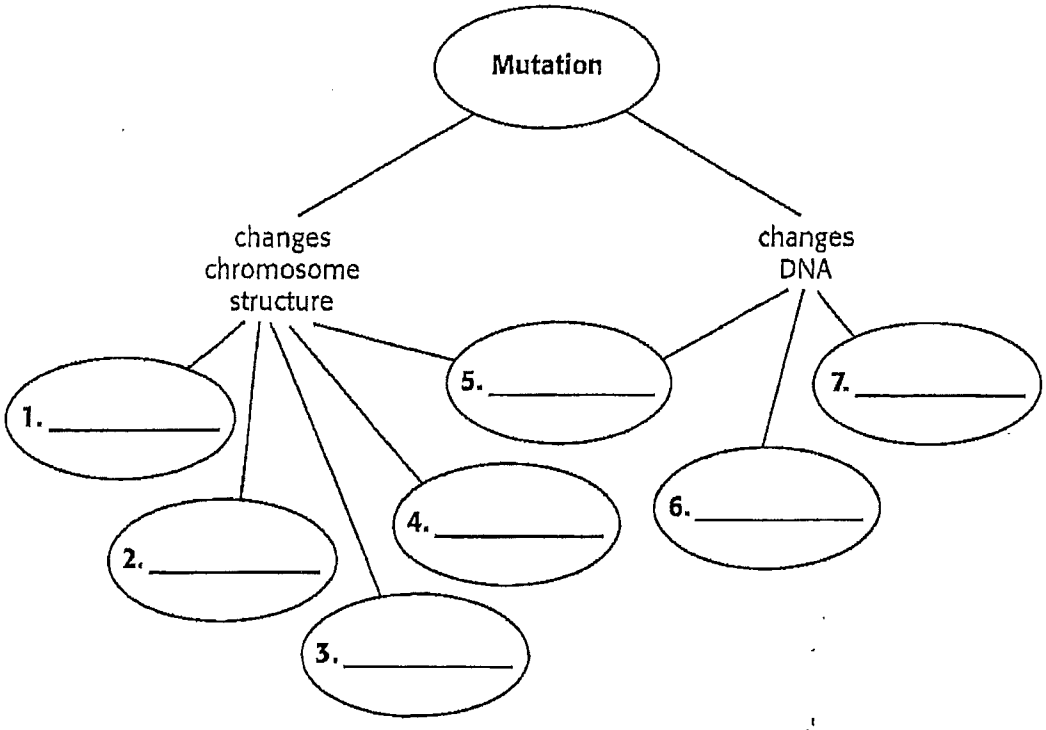
Answer_____

Ch 14

Concept Mapping

Using the terms provided below, complete the concept map showing the types of mutations.

deletion	insertion	translocation
duplication	inversion	
gene rearrangement	point	



Chapter 14 Review

1. A mutation caused by a piece of DNA breaking away from its chromosome and becoming attached to a nonhomologous chromosome is called
2. What is nondisjunction? What happens when this occurs?
3. What is trisomy?
4. How many chromosomes do people with Down's syndrome have?
5. Why do cells control gene expression?
6. Define a repressor protein
7. In bacteria, a group of genes that code for functionally related enzymes, their promoter site, and the operator that controls them all function together as a(n)
8. What is the function of an operon?
9. The presence of a repressor protein prevents the action of what enzyme?
10. What are transcription factors?
11. What is an intron? An exon?
12. How do different proteins get formed from a limited number of exons?
13. What is a plasmid? Where is it found?
14. Which cell organelle contains its own DNA?
15. What is a MGE?
16. What is a virus made out of?
17. What could result from a mutation in a homeotic gene?
18. Which disease is caused by a problem in the regulation of the cell cycle?

A Model of Introns and Exons

You can model introns and exons with masking tape.

Procedure

1. Place a 15 to 20 cm strip of masking tape on your desk. The tape represents a gene.
2. Use two colored pens to write letters on the tape, exactly as shown in the example here. Space the letters to take up the entire length of the tape. The segments in one color represent introns; those in the other color represent exons.
3. Lift the tape. Working from left to right, use scissors to cut apart each group of letters of the same color.
4. Stick the pieces of tape to your desk as you cut them. Make two strips of matching colors, and join the pieces in their original order.

Analysis

1. **Determine** from the resulting two strips which strip represents "introns" and which represents "exons."

2. **Critical Thinking** **Predicting Results** What might happen to the protein if an intron were not removed?

Make a Model of Mutations

You have learned about (and may have built models of) DNA replication and gene expression. Now, challenge yourself to build (or add to) a model that demonstrates each type of mutation described in this section.

Analysis

1. **List** each mutation type on 12 separate sheets of paper. Work with a partner.

2. **Demonstrate** each mutation type by using assorted materials (or models that you have built previously).

3. **Draw** the "before" and "after" state for each mutation.

4. Trade your drawings with another group. What is accurate and useful about their model? What could be improved? Write down your comments for the other group.

Karyotyping—Genetic Disorders

It's not possible to predict with certainty the health of a newborn baby. However, some tests can be done before birth to detect certain genetic disorders. For example, Down syndrome, a genetic disorder that occurs in people who have an extra copy of chromosome 21, can be detected before birth.

A fetal karyotype can be used to check a fetus for normal chromosome number and shape (or structure). A *fetal karyotype* is a diagram, usually a photograph, that shows the chromosomes from the fetus's cells arranged in order from largest to smallest chromosome. The chromosomes are then examined for irregularities. Cells from the fetus are needed to make a fetal karyotype. There are two main ways of obtaining fetal cells for this procedure.

In *amniocentesis*, cells are taken from a sample of fluid surrounding the fetus. *Chorionic villi sampling* is a procedure similar to amniocentesis in which a tiny piece of embryonic membrane is removed. The cells obtained from either of these procedures can then be used to make a karyotype.

Each chromosome in a karyotype has dark and light bands on it. These bands are made using dyes so that the chromosomes are easier to see and compare. Different dyes are used to produce different banding patterns. When analyzing chromosomes in a karyotype, the technician compares the chromosomes band by band. If the bands do not match up, the chromosomes might have a structural mutation. For example, in a *deletion* mutation, part of a chromosome has broken off and is no longer present. This means that a cell will lack the genes on the missing part. In a *duplication* mutation, a piece of a chromosome breaks off and attaches to its homologous chromosome. This means that the homologous chromosome will now carry two copies of some genes.

A typical karyotype has 400 bands. Some have 650 bands. The number of bands and the pattern they make depends on the dye used. Each band can contain several hundred genes. Different dyes and banding patterns are used to detect different genetic disorders.

In this lab, you will observe different photomicrographs of fetal chromosomes. You will use one of the photomicrographs to produce and analyze a fetal karyotype. You will also identify the genetic disorder, if any, caused by an abnormal number of chromosomes seen in your karyotype. Finally, you will pool your data with those of your classmates.

OBJECTIVES

- **Make** a human karyotype by arranging chromosomes in order by length, centromere position, and banding pattern.
- **Identify** a karyotype as normal or abnormal.
- **Identify** any genetic disorder that is present and describe the effect of the genetic disorder on the individual.

MATERIALS

- chromosome spread
- human karyotyping form
- metric ruler
- photomicrograph of chromosomes
- scissors
- transparent tape

Procedure

1. Obtain a photomicrograph and note the letter identifying which individual the cells were taken from.
2. Carefully cut apart the chromosomes on each photomicrograph. Be sure to leave a slight margin around each chromosome.
3. Arrange the chromosomes in homologous pairs. The members of each pair will be the same length and will have their centromeres located in the same area. Use the ruler to measure the length of the chromosome and the position of the centromere. The banding patterns of the chromosomes may also help you pair up the homologous chromosomes.

FIGURE 1 NORMAL HUMAN KARYOTYPE

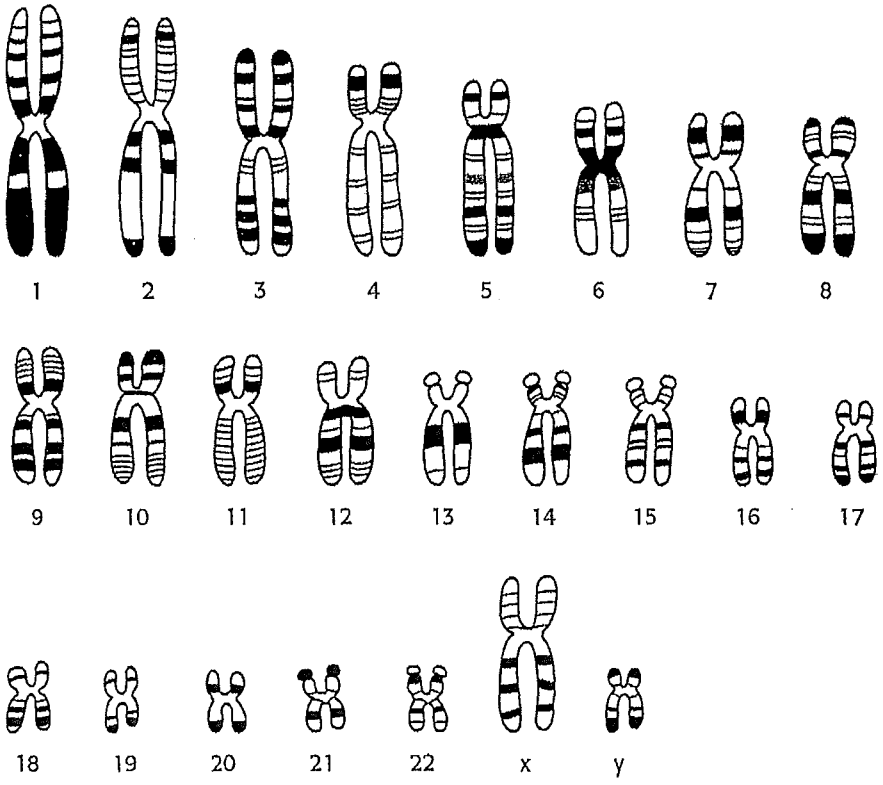


TABLE 1 GENETIC DISORDERS CAUSED BY AN ABNORMAL CHROMOSOME NUMBER

Name of abnormality	Chromosome affected	Description of abnormality
Down syndrome, or Trisomy 21	#21	47 chromosomes; mental retardation with specific characteristic features; may have heart defects and respiratory problems
Edwards' syndrome, or Trisomy 18	#18	47 chromosomes; severe mental retardation; very characteristic malformations of the skull, pelvis, and feet among others; die in early infancy
Patau syndrome, or Trisomy 13	#13	47 chromosomes; abnormal brain function that is very severe; many facial malformations; usually die in early infancy
Turner's syndrome	Single X in female (XO)	45 chromosomes; in females only; missing an X chromosome; do not develop secondary sex characteristics; are infertile
Klinefelter's syndrome	Extra X in male (XXY)	45 chromosomes; in males only; sterile, small testicles; otherwise normal appearance
XYY syndrome	Extra Y in male (XYY)	47 chromosomes; in males only; low mental ability; otherwise normal appearance
Triple X syndrome	Extra X in female (XXX)	47 chromosomes; sterility sometimes occurs; normal mental ability

4. Arrange the pairs according to their length. Begin with the largest chromosomes and move to the smallest.
5. Tape each pair of homologous chromosomes to a human karyotyping form. Place the centromeres on the lines provided. Place the longest chromosome at position 1, and the shortest at position 22. Place the two sex chromosomes at position 23.
6. The diagram you have made is a karyotype, as in **Figure 1**. Analyze your karyotype to determine the sex of the individual. Use the information in **Table 1** to guide your analysis.
7. Record your results in **Table 2**. Pool your data with that from the rest of the class.
8. Dispose of your materials according to the directions from your teacher.

TABLE 2 POOLED CLASS DATA

Letter identifier	Sex	Condition	Chromosome abnormality
A			
B			
C			
D			
E			
F			
G			
H			
I			

Analysis

1. **Analyzing Data** Is the baby represented by your karyotype male or female? How do you know?

2. **Analyzing Data** Will the baby have a genetic disorder? How do you know?

Name _____ Class _____ Date _____

3. **Identifying Relationships** Assume that two students started with the same photomicrograph. One student concluded that the individual had Down syndrome. The other student concluded that the individual had Edwards' syndrome. Explain how this could happen.

Conclusions

1. **Drawing Conclusions** How is sex determined in a person who has more than two sex chromosomes? Explain your answer.

2. **Drawing Conclusions** In this lab, you examined karyotypes for the presence of abnormal chromosome numbers in both autosomes and sex chromosomes. Which condition seems to have a greater influence on a person's health: trisomy of an autosome or trisomy of a sex chromosome?

3. **Making Predictions** Assume that an individual has a deletion mutation in one of their chromosomes. What would the karyotype look like in this situation?

Name _____ Class _____ Date _____

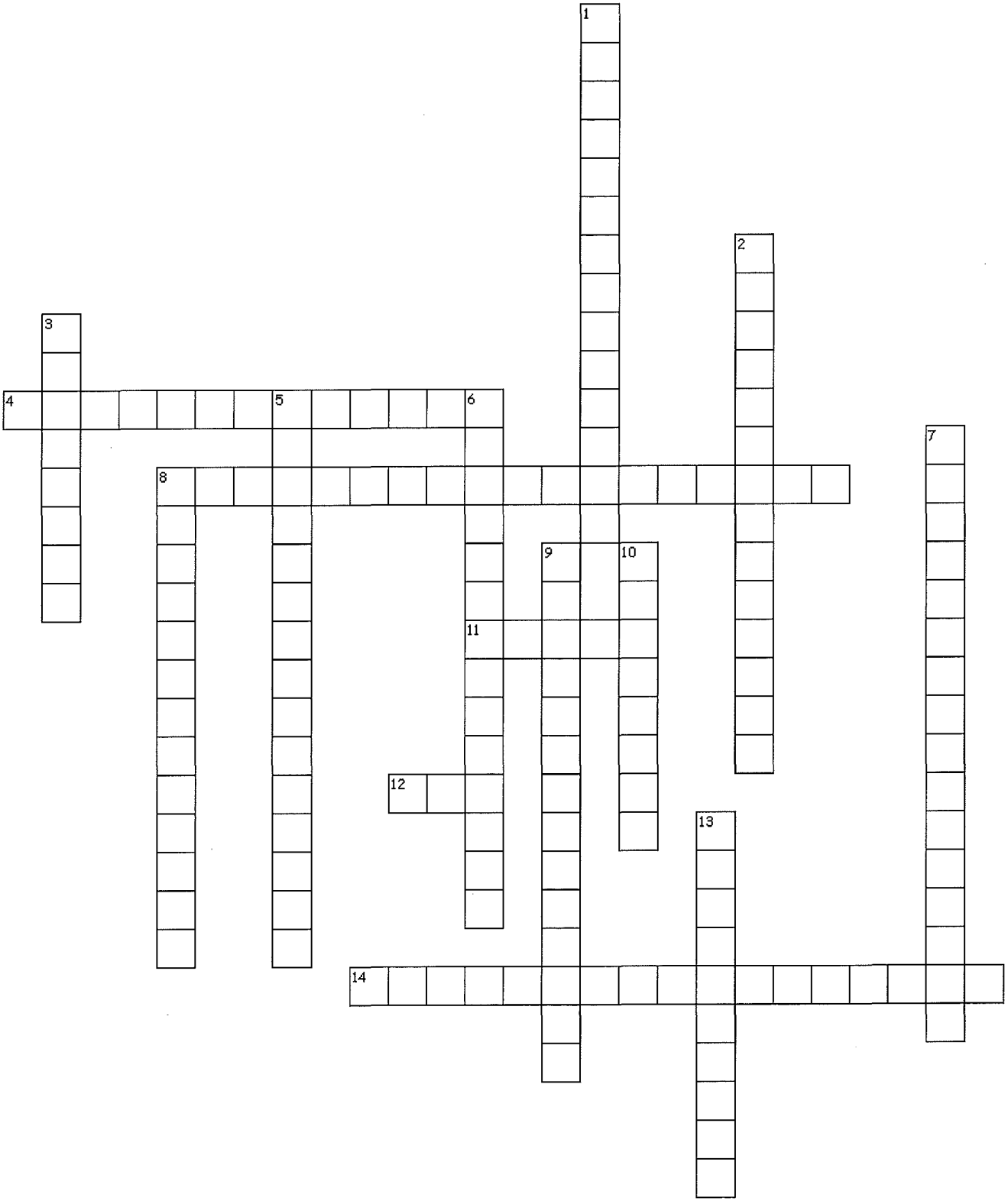
4. **Evaluating Methods** How might banding patterns be important to detecting an inversion mutation?

5. **Evaluating Methods** Some medical labs make karyotypes from several of an individual's cells before drawing conclusions about the individual's health. Do you think this is necessary? Why or why not?

Extensions

1. **Research and Communications** Trisomy occurs when an individual has three copies of the same chromosome. Monosomy occurs when an individual has only one copy of a chromosome. In this lab, you examined a fetal karyotype for the presence of three different trisomies. Find out why monosomies are rarely detected.
2. **Research and Communications** Some individuals have cells that produce both normal and abnormal karyotypes. This condition, in which an individual has both normal and abnormal cell lines, is called *mosaicism.* Find out more about mosaicism, how it is detected, and how it can affect an individual's health.

Ch 15 Crossword/ Vocab Flash Cards- complete the crossword and make a flashcard for each term with the word on one side and the definition on the back



Across

4. the process of determining the order of every nucleotide in a gene or genetic fragment
8. a technology in which the genome of a living cell is modified for medical or industrial use
11. an organism, cell, or piece of genetic material that is genetically identical to one that was preexisting; to make a genetic duplicate
12. a technique that is used to make many copies of selected segments of DNA
14. an enzyme that cuts double-stranded DNA into fragments by recognizing specific nucleotide sequences and cutting the DNA at those sequences

Down

1. a pattern of DNA characteristics that is unique, or nearly so, to an individual organism
2. DNA molecules that are artificially created by combining DNA from different sources
3. the study of entire genomes, especially by using technology to compare genes within and between species
5. the process by which electrically charged particles suspended in a liquid move through the liquid because of the influence of an electric field
6. a collection of genetic sequence clones that represent all of the genes in a given genome
7. variations in DNA sequences; used as a basis for comparing genomes
8. the process of determining the relative position of genes in a genome
9. the application of information technologies in biology, especially in genetics
10. a cell that can divide repeatedly and can differentiate into specialized cell types
13. a device that contains a micro-scale, orderly arrangement of biomolecules; used to rapidly test for the presence of a range of similar substances, such as specific DNA sequences

Genomics
Microarray
DNA fingerprint
Genetic engineering
recombinant DNA
clone
stem cell
restriction enzyme
DNA polymorphisms
Electrophoresis
PCR
DNA sequencing
Bioinformatics
genome mapping
genetic library
MGE
GMO
plasmid
STR

EXTRA NOTES

Chapter 15 Gene Technologies and Human Applications

I. **APPLICATIONS OF HUMAN GENETICS**-Genomics and gene technologies have many applications in human healthcare and society.

A. Diagnosing and Preventing Disease

1. A _____ shows which genes are being actively transcribed in a sample from a cell.

2. _____ informs people about the risk of genetic problems that could affect them or their offspring.

3. Various vaccines are now produced through genetic engineering•

B. Treating Disease

1. Some genetic disorders can be treated by supplying a genetically engineered protein.

2. Another possible treatment is _____, to insert a replacement gene into a person's cells by using a genetically engineered virus.

C. Identifying Individuals-DNA fingerprints are now used regularly to confirm the identity of criminals, family members, or dead bodies.

II. **MANIPULATING GENES** -Gene technologies are now widely applied to study organisms in new ways, to alter organisms for human use, and to improve human lives.

1. _____Genetic engineering is the deliberate alteration of the genetic material of an organism.

2. DNA that has been recombined by genetic engineering is called recombinant DNA.

3. Organisms with recombinant genes may be called _____ _____, or _____.

4. In everyday use, they are often referred to as genetically modified organisms (_____).

B. Genetic engineering was first applied to bacteria, viruses, and plants and is now applied to many life forms.

C. Manipulating Cell Interactions

1. Gene technologies are also used to control the expression of genes or to redirect the products.

2. The study of how proteins interact within cells is called _____.

3. Tissue culture cells can be studied closely and experimentally controlled.

III. **MANIPULATING BODIES AND DEVELOPMENT**-Cloning and stem cell techniques are used in research on animal development and have potential for treating certain diseases.

A. _____-A clone is an organism or piece of genetic material that is genetically identical to one that was preexisting. – Making a clone in a lab is called cloning, but the process does also occur in nature.

1. The first clone made from an adult mammal was made using a process called _____ (SCNT).

2. Although scientists have successfully cloned many kinds of animals, only a few of the cloned offspring have survived for long.

3. Some problems with cloning may be related to the ways that eggs and sperm normally develop.

B. Using Stem Cells-A stem cell is a cell that can continuously divide and differentiate into various tissues.

1. Some stem cells have more potential to _____ than others.

2. Adults' bodies have some _____ cells that can be removed, frozen or cultured, and used for medical treatments.

3. The cells of new embryos have more potential uses.

4. The use of embryos for stem cell research poses ethical problems.

5. An alternative source of embryonic stem cells is through SCNT.

IV. **ETHICAL AND SOCIAL ISSUES**-Ethical issues can be raised for every use of gene technologies.

A. Safety

1. GMOs can have unforeseen effects.

2. Ecologists worry that we do not know enough to safely manipulate genes on a large scale.

B. Human Rights

1. The DNA of individuals can be tested for risks of genetic disorders.

2. This possibility raises many ethical questions.

C. Property Laws

1. Gene technologies have also created new issues for old laws.

2. GMOs and specific DNA sequences can be patented.

Question	How scientists are answering the question
How do our genes interact?	Scientists are studying how the proteins made from one gene affect other genes.
How unique are we?	Scientists are comparing the human genome with genomes of other organisms.
Can genetics help us live longer?	Scientists are learning about how genes are involved in diseases.
How do we deal with ethical issues?	Scientists are discussing who should own genetic information and how it should be used.

V. **BASIC TOOLS FOR GENETIC MANIPULATION**-The basic tools of DNA manipulation rely on the chemical nature of genetic material and are adapted from natural processes discovered in cells. These tools include restriction enzymes, polymorphisms, gel electrophoresis, denaturation, and hybridization.

1. _____A restriction enzyme cuts double-stranded DNA into fragments by recognizing specific nucleotide sequences and cutting the DNA at those sequences.

2. These enzymes can be used to cut up a DNA sample in specific ways and to create sticky ends for splicing DNA.

3. _____Differences between the DNA sequences of individuals are called DNA polymorphisms.

4. Differences of just one nucleotide are called single nucleotide polymorphisms (SNPs).

5. Differences in restriction sites results in restriction fragment length polymorphisms (RFLPs).

6. _____Electrophoresis is a process in which electrically charged particles move through a liquid or semisolid

7. Often, DNA fragments are forced though a gel.

8. Shorter fragments will move faster through the gel.

9. The result is a lane of fragments sorted by size.

10. _____Some conditions can cause DNA to denature, or untwist and split into single strands.

11. Scientists can easily denature and renature DNA for further manipulations. •

12. _____Under the right conditions, complementary segments of DNA or RNA will bind together, or hybridize.

13. Genetic tools that take advantage of this natural process include primers, probes, and cDNA.

Basic tool	Description
Restriction enzymes	Bacteria make **restriction enzymes** to cut DNA from invading viruses. Restriction enzymes cut DNA at specific places called *restriction sites*. Scientists use these restriction enzymes to cut DNA samples in specific ways.
DNA polymorphisms	Differences between the DNA sequences of individuals are called **DNA polymorphisms**. A difference of just one nucleotide is a single *nucleotide polymorphism*. Scientists use polymorphisms to create DNA fingerprints and to compare individuals and species.
Gel Electrophoresis	DNA carries an electric charge. The process of **electrophoresis** uses an electric current to pull DNA fragments through a partly solid material called a *gel*. Shorter fragments move faster through a gel than longer fragments. Scientists use gel electrophoresis to separate DNA fragments by size.
Denaturation	DNA is usually double-stranded. Scientists can use heat or strong chemicals to *denature* DNA. Denaturing splits DNA into two single strands.
Hybridization	Scientists can *hybridize*, or bind, complementary single strands of DNA. Short single strands of DNA, called *primers*, hybridize to denatured DNA to start replication.

VI. **MAJOR GENE TECHNOLOGY PROCESSES**-The major methods for working with genes use some combination of the basic tools and mechanisms of cellular machinery. These methods include PCR, blotting, DNA sequencing, and gene recombination.

A. Polymerase Chain Reaction (PCR)

1. The _____ process is widely used to clone DNA sequences for further study or manipulation.

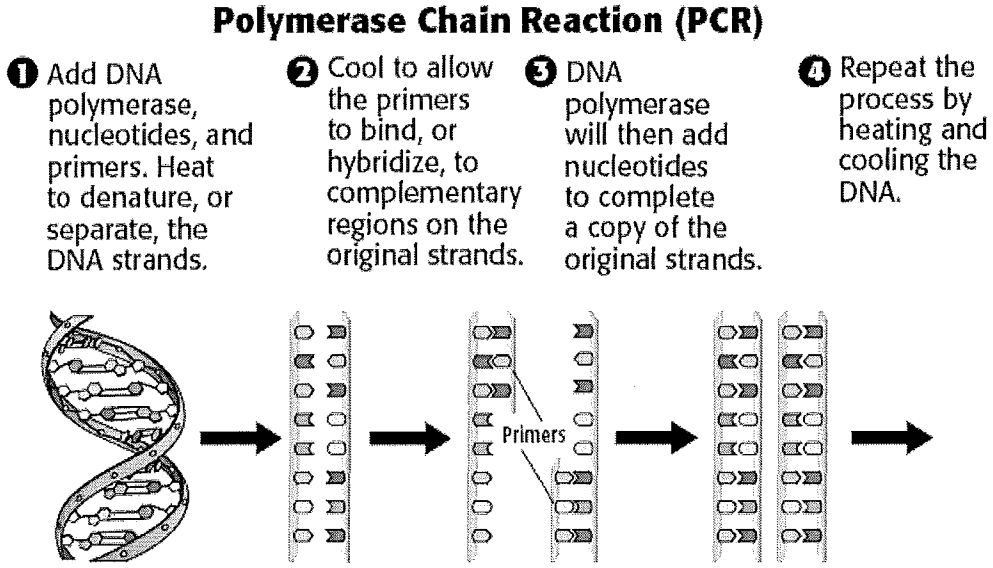
2. _____ imitates the normal process of DNA replication in cells.

3. The process is called a chain reaction because it is repeated over and over.

B. Several gene technologies use a combination of restriction enzymes, gel electrophoresis, and hybridization with probes.

C. **DNA sequencing** is the process of determining the exact order of every nucleotide in a gene. The major modern method is _____.

D. The first attempts at gene recombination and cloning were done by inserting a gene into an organism that replicates easily.



VII. EXPLORING GENOMES

A. Mapping Methods

1. Genome mapping is the process of determining the _____ of all of the genes on chromosomes in an organism's genome.

2. To help track genes, any detectable physical, behavioral, or chemical trait can be used as a marker.

3. To determine the relative locations, genome mapping may use several methods– _____ methods identify the relative order of genes along a chromosome.

4. _____ methods determine the exact number of base pairs between specific genes.

5. Human chromosome mapping has mostly used historical family records.

B. Genome Sequence Assembly

1. The process of deducing and recording the exact order of every base and gene in a genome is called _____.

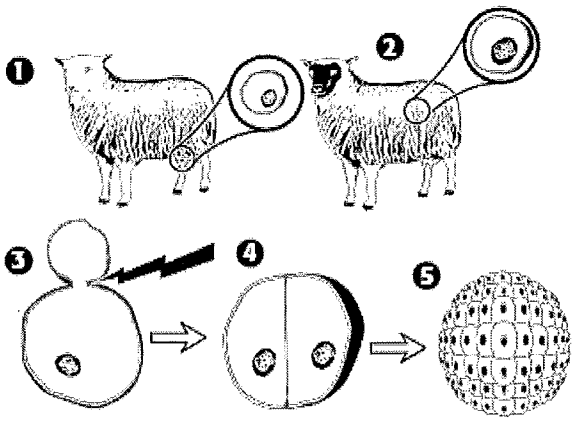
2. A collection of clones that represent all of the genes in a given genome is called a _____.

3. Two kinds of genetic libraries are made: a _____ or an _____ (EST) library.

4. The data can be searched for any specific gene or sequence.

5. Robotic devices are now used to sequence genomes rapidly.

DOLLY



1. Scientists extracted somatic cells from the adult sheep being cloned.
2. Scientists also extracted egg cells from another sheep. They removed the nucleus from these cells.
3. Scientists placed a somatic cell and an "empty" egg cell near each other. They applied an electric shock that caused the two cells to fuse.
4. Scientists then triggered the cell to divide and begin to form an embryo.
5. Scientists implanted the embryo into a surrogate mother where it developed into a baby sheep. This sheep had the same genetic information as the sheep in step 1.

CHAPTER 15 SEC 1 DUE DATE .

1. What was the goal of the Human Genome Project?

2. What percentage of DNA in the human genome does not code for proteins?

3. How can a genome be used to identify a person if the DNA sequence of any two people is 99.9% identical?

4. How are scientists studying how the genes in the human genome interact?

5. Genes code for proteins. Humans have many of the same genes as other species. What does this imply about the proteins in humans and other species?

7. About how many fewer genes do humans have than scientists expected?

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

CHAPTER 15 SEC 2 DUE DATE .

1. What kind of DNA do genetically modified organisms have?

2. How can genetically modified bacteria with human genes be used to treat human diseases?

3. What can a stem cell do that most body cells cannot do?

4. Complete the following table to illustrate the advantages and disadvantages of GMOs, cloning and stem cell research

Technology	**Advantage**	**Disadvantage**
GMOs	GMOs improve the yield and nutrition of food crops and livestock.	
Cloning		Most cloned animals do not develop normally or live long.
Stem cell research	Stem cells enable scientists to create cell types for treating individuals with missing or damaged tissue.	

CHAPTER 15 SEC 3 DUE DATE

1. What basic tools do scientists use to manipulate genetic material?

2. How are denaturation and hybridization used in PCR?

3. What tool of genetic manipulation do bacteria make, and why do they make it?

4. A scientist is separating three fragments of DNA by gel electrophoresis. The first fragment is 500 base pairs long, the second is 5,000 base pairs long, and the third is 1,500 base pairs long. Which fragment will move the fastest through the gel?

5. Name three ways that bioinformatics helps scientists explore genomes.

6. How can scientists determine the location of genes on a chromosome?

Bellringer:Day M T W Th F Date_____Question_____

Answer_____

CHAPTER 15 REVIEW

What was the goal of the Human Genome Project

What is DNA fingerprinting? How can it be useful for solving crimes

What is Genetic Engineering?

What uses do human genes inserted into bacteria have?

What is recombinant DNA? How is this done?

What is cloning?

Who was Dolly? Why was this important?

What are stem cells? What are totipotent stem cells? Omnipotent? Multipotent? Pluripotent?

What are restriction enzymes? How do they work? Where do they come from?

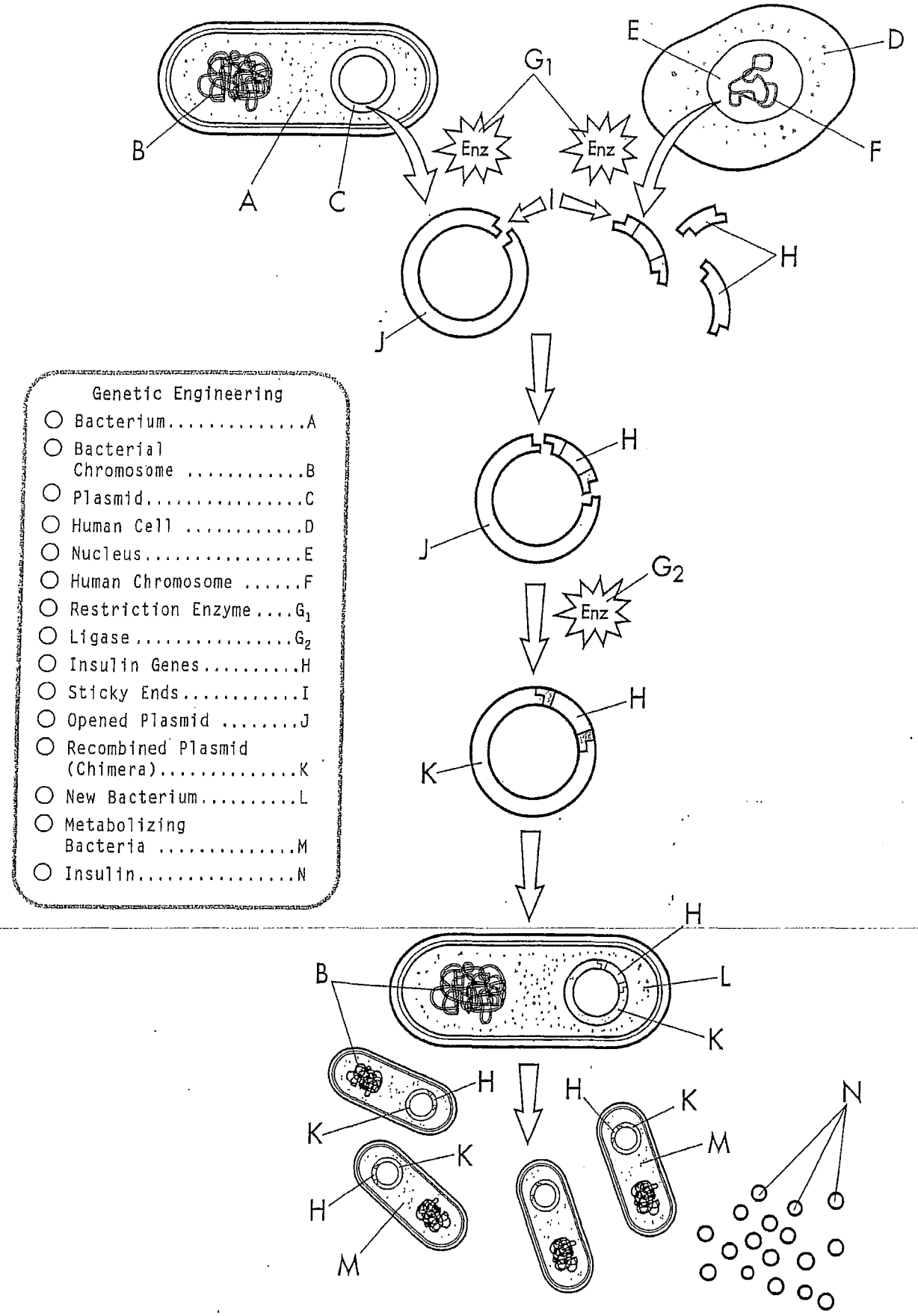
DNA made to match mRNA is called _____

Radioactive or fluorescent-labeled RNA or single-stranded DNA pieces that are complementary to the gene of interest and are used to confirm the presence of a cloned gene are called _____

How are genetic engineewring experiments carried out? What do they usually start with?

What are plasmids? How are they useful?

A technique that uses radioactively labeled DNA to identify specific genes in a piece of DNA is called the _____


Genetic Engineering
Bacterium.....A
Bacterial Chromosome .....B
Plasmid.....C
Human Cell .....D
Nucleus.....E
Human Chromosome .....F
Restriction Enzyme....G1
Ligase.....G2
Insulin Genes.....H
Sticky Ends.....I
Opened Plasmid .....J
Recombined Plasmid (Chimera).....K
New Bacterium.....L
Metabolizing Bacteria .....M
Insulin.....N
B
A
C
G1
Enz
Enz
E
D
F
I
H
J
H
J
G2
Enz
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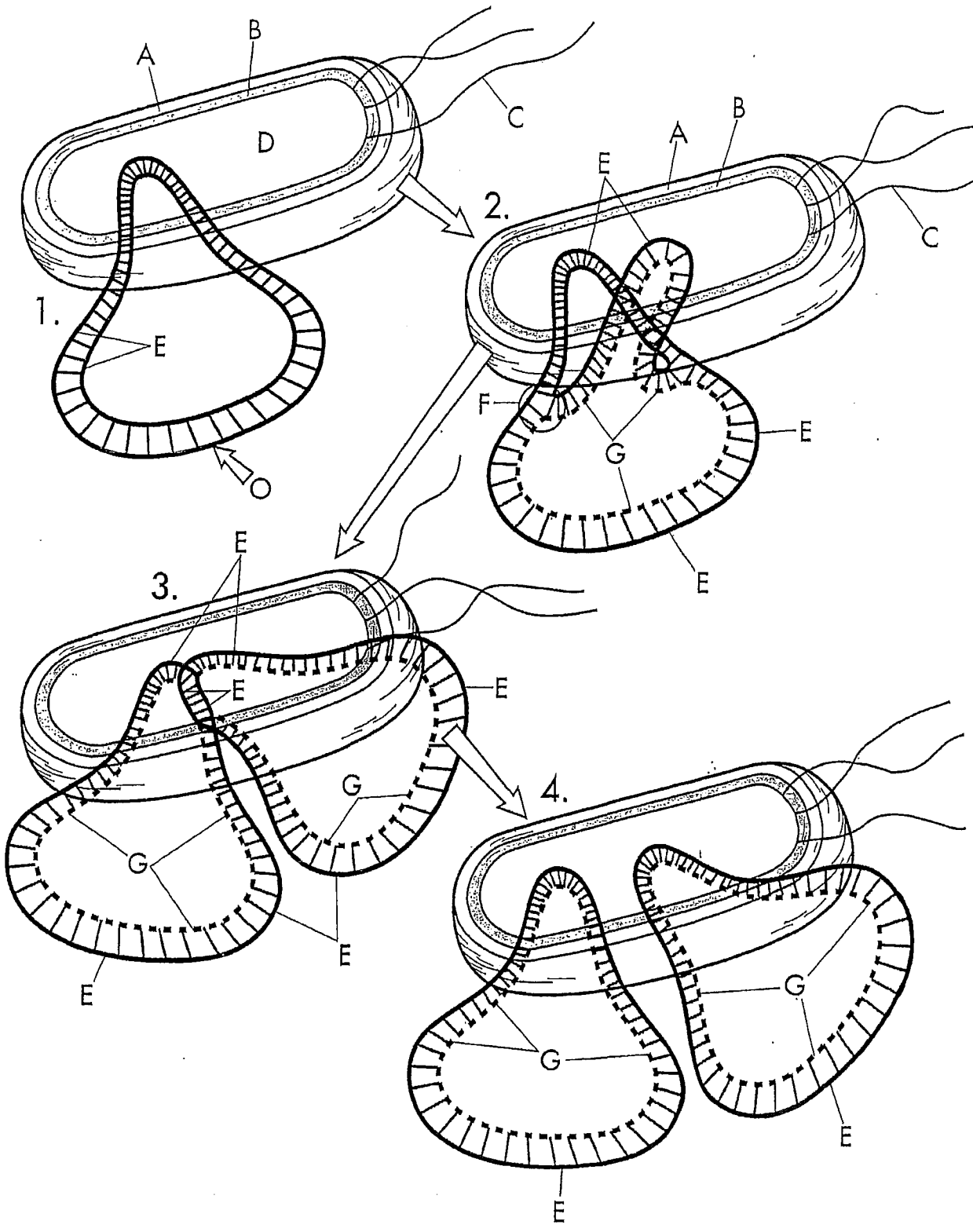
N

Prokaryotic DNA Replication



Forensic DNA Fingerprints

DNA "fingerprinting" is useful in forensics because it can be performed on a sample of DNA from body tissues such as hair or blood. Samples can be compared to find genetically identical or closely related people. Identical segments of DNA will form identical patterns of bands in the columns of a DNA fingerprint, as shown here.

Analysis

1. **Identify** the number of individuals whose DNA samples are being analyzed in this DNA fingerprint.

2. **Critical Thinking Interpreting Graphics** Identify the suspect sample that matches the sample from the crime scene.

3. **Critical Thinking Analyzing Methods** Column 6 shows an array of DNA segments sorted by increasing length. Propose a purpose for these columns in this method.

DNA Whodunit

In the early 1970s, scientists discovered that some bacteria have enzymes that are able to cut up DNA in a sequence-specific manner. These enzymes, now called *restriction enzymes*, recognize and bind to a specific short sequence of DNA, and then cut the DNA at specific sites within that sequence. Biologists found that they could use restriction enzymes to manipulate DNA. This ability formed the foundation for much of the biotechnology that exists today.

DNA *fingerprinting* is one important use of biotechnology. With the exception of identical twins, no two people have the same DNA sequence. Because each person has a DNA profile that is as unique as his or her fingerprints, DNA fingerprinting can be used to compare the DNA of different individuals.

In the first step of DNA fingerprinting, known and unknown samples are obtained and then digested, or cut into small fragments, by the same restriction enzyme. These short fragments are called *restriction fragment length polymorphisms (RFLPs)*. The next step in DNA fingerprinting is to separate the RFLPs by size. This is done with a technique called *gel electrophoresis*. The DNA is placed on a jellylike slab called a gel, and the gel is exposed to an electrical current. DNA has a negative electrical charge, so the RFLPs are attracted to the positive pole when an electric current is applied. Smaller fragments travel farther through the gel than longer ones. The length of a given DNA fragment can be determined by comparing its mobility on the gel with that of a sample containing DNA fragments of known sizes. The resulting pattern is unique for each individual.

In this lab, you will model experimental procedures involved in DNA fingerprinting and use your results to identify a hypothetical murderer.

OBJECTIVES

- **Use** pop beads to model restriction enzyme digestion and agarose gel electrophoresis.
- **Evaluate** the results of a model restriction enzyme digestion (DNA fingerprint).
- **Identify** a hypothetical murderer by analyzing the simulated DNA fingerprints of suspects and DNA samples collected at the scene of the crime.

MATERIALS

- pop beads, blue (cytosine) (15)
- paper gel electrophoresis lane
- paper, legal size (8.5 × 14 in.)
- plastic connectors (hydrogen bonds) (30)
- pop beads, green (guanine) (15)
- pop beads, orange (thymine) (15)
- pop beads, red (phosphate) (60)
- pop beads, white, 5-hole (deoxyribose) (60)
- pop beads, yellow (adenine) (15)
- restriction enzyme card Jan I
- restriction enzyme card Ward II
- ruler

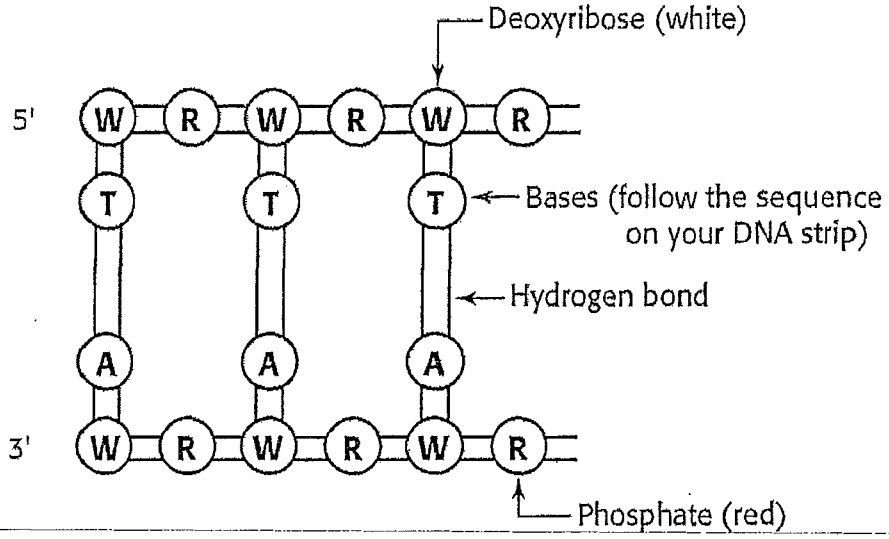
Procedure

1. Read the following scenario.

   The police are investigating a murder. Blood stains of two different types were found at the murder scene. Based on other forensic evidence, the police have reason to believe that the murderer was wounded at the time of the murder. The police currently have five suspects for the murder. You have been provided with the DNA from a blood sample of one of the five suspects, or the DNA from one of the two blood stains found at the crime scene.

2. Assemble the DNA you were assigned with pop beads, using the DNA strip given to your group as a blueprint. Use **Figure 1** to guide you in your assembly of your DNA "molecule." Be sure to assemble the beads in the precise pattern indicated, or your results will be incorrect. The assembled chain represents your subject's DNA.

FIGURE 1 PATTERN FOR ASSEMBLY OF POP BEADS



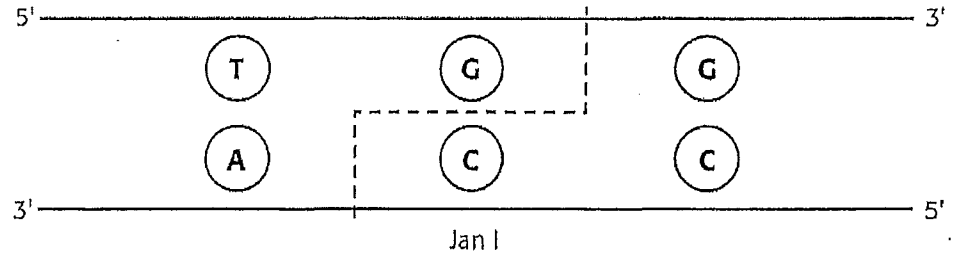
3. Place the DNA "molecule" you have just assembled on your work area so that the 5' end is on the top left side, as shown below. Be sure that the three orange beads (thymine) are in the following position on your work area:

5' 3'
TTT, etc.....G
AAA, etc.....C
3' 5'

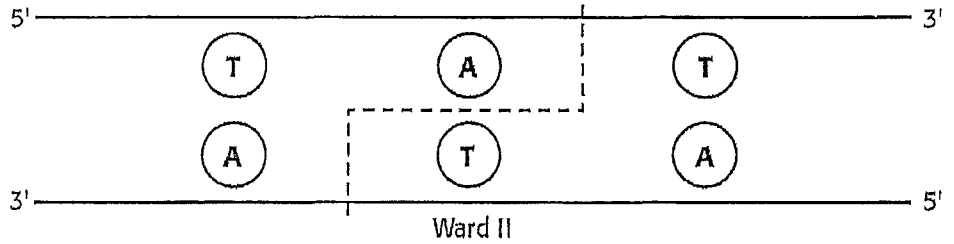
Note: From this point on, it is important to keep the beads in this orientation. Do not allow the chain to be turned upside down or rotated. The 5' TTT end should always be on the top left of the molecule. If your chain is accidentally turned upside down, refer to your DNA strip to obtain the correct orientation.

4. Use the model restriction enzymes Jan I and Ward II to chop up the DNA. Look at your two Restriction Enzyme Cards; they look like the cards in **Figure 2.** These "enzymes" will make cuts in the DNA in the manner indicated by the dotted lines.

FIGURE 2 RESTRICTION ENZYME CARDS



Jan I



Ward II

5. Place Restriction Enzyme Card Jan I on top of the left side of the DNA chain so that its label is right side up.
6. Move the card along the surface of the DNA until you match the precise sequence shown on the card. When you reach a sequence that matches the card, stop and break the beads apart in the manner indicated by the dotted lines.
7. Move the enzyme card until you reach the right end of the DNA. Double check the sequence with the enzyme card to ensure that you have made all the possible cuts.
8. Repeat the procedure on the remaining DNA fragments using the restriction enzyme card Ward II. Be sure to keep the DNA fragments in the orientation described above (5' orange thymine beads on the top left) throughout this exercise. In reality, the fragments created in steps 6 and 7 might be thousands of base pairs long.
9. Create a gel electrophoresis area out of a legal size (8.5 by 14 in.) sheet of paper. On the left side of the paper, use a ruler to mark one inch increments from the bottom of the paper to the top of the paper. Starting at the bottom mark, label each mark from "0" (for the bottom mark) through "24" (for the top mark).

10. Write a plus sign (+) at the bottom of the page and a minus sign (–) at the top of the page. Label the *Y*-axis (left hand margin) "Length of RFLPs (number of nucleotides."
11. Place the RFLPs at the negative pole of the gel electrophoresis page, taking care to retain the proper 5' to 3' orientation. Remember, DNA has a negative electrical charge, so the RFLPs are attracted to the positive end of the gel/page when an electric current is applied.
12. Simulate separating the RFLPs by electrophoresis by sliding your RFLPs along the gel/page. Shorter fragments are lighter and move farther than longer fragments. To determine the final position of each RFLP, count the number of nucleotides on the longest side of each fragment. Place each measured RFLP next to its corresponding length marked on the gel/page.
13. In the nine gel electrophoresis lanes in **Figure 3**, sketch dark bands at the correct positions in the gel lane reserved for your sample. Also, record the position of your bands on the seven lanes your teacher has provided for class data (on the blackboard).
14. Obtain the banding patterns for each of the other DNA samples by copying them from the blackboard after each team has recorded their data.

FIGURE 3 GEL ELECTROPHORESIS LANES

Victim's Blood	Suspect 1	Suspect 2	Suspect 3	Suspect 4	Suspect 5	Crime Scene Sample 1	Crime Scene Sample 2
22	22	22	22	22	22	22	22
20	20	20	20	20	20	20	20
18	18	18	18	18	18	18	18
16	16	16	16	16	16	16	16
14	14	14	14	14	14	14	14
12	12	12	12	12	12	12	12
10	10	10	10	10	10	10	10
8	8	8	8	8	8	8	8
6	6	6	6	6	6	6	6
4	4	4	4	4	4	4	4
2	2	2	2	2	2	2	2

Analysis

1. **Examining Data** Are the RFLPs of the other DNA samples the same length as yours? Explain why or why not.

2. **Identifying Relationships** Explain the role that restriction enzymes and gel electrophoresis play in DNA fingerprinting.

Conclusions

1. **Drawing Conclusions** Based on class data, which of the suspects is probably the murderer? Explain.

2. **Interpreting Information** How did you show that the other sample found at the crime scene did not belong to the murderer?

3. **Interpreting Information** Imagine you are on a jury and that DNA fingerprinting evidence is introduced. Explain how you would regard such evidence.

Extensions

1. **Research and Communications** Look through newspapers and news magazines to find articles about actual court cases in which DNA fingerprinting was used to determine the innocence or guilt of a suspect in a crime. Share the articles with your classmates.
2. **Research and Communications** Do library research or search the Internet to find out more information about restriction enzymes and what role they play in bacteria.