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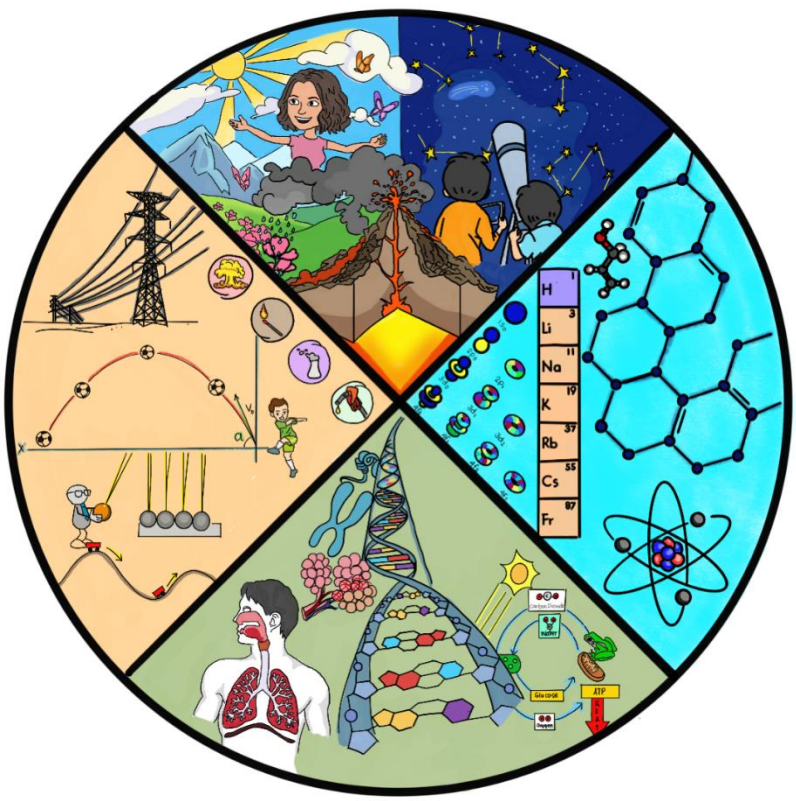
Department of Education
National Capital Region
SCHOOLS DIVISION OFFICE
MARIKINA CITY

Science

Quarter 1-Module 3

Non-Mendelian Patterns of Inheritance



Jordan B. Plopino
Mark John D. Bello

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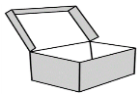


What I Need to Know

The purpose of this module is to help describe the location of genes in chromosomes, explain the different patterns of non-Mendelian and describe the molecular structure of the DNA.

This module contains the following lessons:

- Lesson 1 – Components and Structure of DNA
- Lesson 2 – Genes and Chromosomes
- Lesson 3 – Non – Mendelian Inheritance (Incomplete Dominance and Co-dominance)
- Lesson 4 – Multiple Alleles
- Lesson 5 – Sex - Determination
- Lesson 6 – Sex – Linked and Sex – Influenced Traits

After going through this module, you are expected to **explain the different patterns of non-Mendelian inheritance. S9LT-Id-29**

Specifically, you should be able to:

- describe the location of genes in chromosomes
- explain the chromosomal basis of inheritance
- identify characters whose inheritance does not conform with predicted outcomes based on Mendel's laws of inheritance and
- solve genetic problems related to incomplete dominance, codominance multiple alleles, sex-linked and sex – influenced traits.

What I Know

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. It is a non-Mendelian inheritance wherein traits are expressed independently like the color coat of cats.
   A. multiple alleles
   B. incomplete dominance
   C. sex – linked
   D. co-dominance

2. For blood types, if one parent is heterozygous A and the other parent is heterozygous B, what could be the possible blood types of the children?
   A. A, B, and O
   B. A, AB, and A
   C. A and O
   D. A, AB, B, and O

3. How many percent would be the chance of the children to inherit hemophilia if a mother has hemophilia (X^hX^h) and the father is non hemophilic (X^HY)?
   A. 0% B. 25% C. 50% D. 75%

4. The DNA has a double – helix structure forming a twisted ladder. The backbone and steps of the ladder is composed of individual nucleotides bonded together. What are the important biological compounds that make up the backbone of the DNA molecule?
   A. nitrogen bases
   B. pentose / 5-carbon sugar
   C. pentose and phosphate
   D. phosphate group

5. It is a non-Mendelian trait that results to blended colors of flowers of some plants. What do you call that trait?
   A. sex – limited
   B. incomplete dominance
   C. co-dominance
   D. multiple alleles

6. Bases in a DNA are complementary. Which is true of its complementary base if there are 35 Thymine in the DNA strands?
   A. there will be 35 Guanine bases
   B. there will be 35 Adenine bases
   C. only 25 Adenine, since a DNA is helical
   D. cannot be determined

7. Which is **NOT TRUE** about a DNA nucleotide?
   A. it contains a nitrogen base.
   B. it has a pentose or 5-carbon sugar compound.
   C. it has a phosphate group.
   D. it contains two or more bases.

8. If Roberto's father has hemophilia and his mother is a carrier, what is the chance that Roberto would inherit the disease?
   A. 25% B. 50% C. 75% D. 100%

9. A heterozygous allele shows a phenotype that is intermediate of the two homozygous phenotypes being crossed. Neither allele is dominant over the other. Which Non-Mendelian pattern of inheritance is referred to?
   A. incomplete dominance
   B. co-dominance
   C. multiple Alleles
   D. sex-linked trait

10. Tan colored birds are the result of the cross between a white (W) and a brown (B) colored bird. If the off springs are 50% tan and 50% white, what are the genotypes of their parents?
    A. BB x BB
    B. BB x WW
    C. BW x WW
    D. BW x BW

11. Which **BEST** describes a gene?
    A. It is a DNA
    B. It is smaller than DNA
    C. It is a segment of DNA
    D. It is a tightly coiled DNA

12. Which is **TRUE** to a shape of a DNA molecule?
    A. circular
    B. double-helical
    C. round
    D. straight

13. It is referred to as the union of egg and sperm cells to form a new organism.
    A. mutation
    B. fertilization
    C. zygote
    D. offspring

14. Which of the following happens to form gametes (sex cells) among male and female organism?
    A. meiosis
    B. mitosis
    C. reproduction
    D. fertilization

15. Which of the following determines the sex of an organism?
    A. the female parent
    B. the male parent
    C. both parent
    D. none of the choices

Lesson 1 Components and Structure of DNA

What's In

Let us try how much you know about a cell.

CELL MEMBRANE	CHLOROPLAST	CYTOPLASM
LYSOSOMES	MITOCHONDRION	NUCLEUS

_____ 1. It is an organelle responsible for energy production and is commonly referred to as powerhouse of the cell.

_____ 2. This organelle directs all the cellular activities and is commonly called as the brain of the cell.

_____ 3. They are small sacs which contain the digestive enzymes used by the cell to self-destruct. It is also called as the suicide-bag of the cell.

_____ 4. It serves as the matrix that anchors all organelles inside the cell.

_____ 5. This special type of organelle is common among photosynthetic organisms like plants which is responsible for food making.

What's New

Nucleus is very important part of the cell and the molecule inside the cell's nucleus that functions in building and defining the body structure and function of all organisms in the planet. This biological molecule is called **deoxyribonucleic acid (DNA).**

Can you guess the full word or phrase of the following coded texts? Identify as many as you can. Write your answers on a separate sheet.

143	**SKL**	**B4**	**IDK**	**SML**	**YOLO**
BRB	**LOL**	**2DAY**	**OTW**	**LMK**	

Those coded texts inside the cloud have corresponding longer words or phrases for it to be well-defined and understood. Similarly, you will be dealing with codes when you studied the blueprint of life, the deoxyribonucleic acid (DNA).

What Is It

Deoxyribonucleic acid (DNA) is made up of units called **nucleotides** that are bonded together. A **nucleotide** consists of a nitrogenous base, a pentose sugar and a

phosphate group as shown in the figure 1. DNA is commonly found inside the cell's nucleus that plays a very important role in the body of all organisms. DNA directs many biological and physical functions in the body of organisms. The body structures, functions, growth, development, and survival will never be possible without the presence of this biological molecule in all organisms.

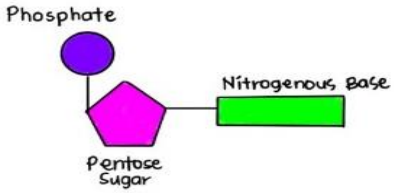


Figure1. A Nucleotide

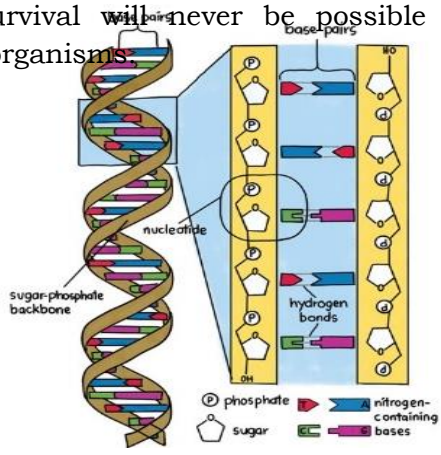


Figure 2. DNA Molecule

Deoxyribonucleic acid is commonly found inside the cell's nucleus. It plays a very important role in the body of all organisms by directing many biological and physical functions. DNA is made up of units called nucleotides. A nucleotide consists of a nitrogenous base, a pentose sugar, and a phosphate group as shown in Fig. 1. The nitrogenous bases in nucleotides have two general types. These are purines that include adenine (A) and guanine (G) and pyrimidines that include cytosine (C) and thymine (T). Adenine is paired with thymine while guanine is paired with cytosine. Such pairing is described as complementary. It is the order of these nitrogenous base pairs that determines the genetic makeup.

The phosphate group and phosphate sugar, which is also called deoxyribose, are the backbone of DNA. In the DNA model developed by James Watson and Francis Crick in 1953, DNA looks like a twisted ladder with two strands that complement each other. Thus, they described the DNA as double helix. Today, we know that DNA is a double helix with strings of nucleotides as shown in Fig. 2.

What's More

Activity 1.1: DNA Modeling

Objectives: At the end of this activity, you should be able to:

1. construct a DNA model through an Origami (paper folding)
2. show the parts and components of a DNA model made.

You will need: copy of the template, coloring materials, pencil

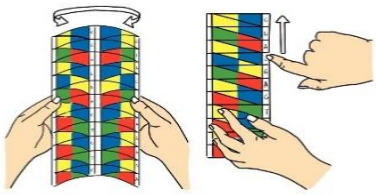
What you will do:

Part I: Coloring

1. Using the blank template, follow the indicated letters and the specific parts where to put colors guided by the small letters r = red, y = yellow, b = blue, g = green.
2. You may photocopy or redraw the blank template.

Part II: DNA Origami Template. Let the folding begin!

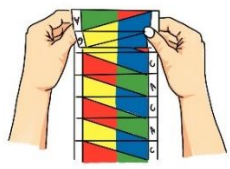
1. Fold in half lengthwise. Make all creases as firm as possible (use your fingernail!)



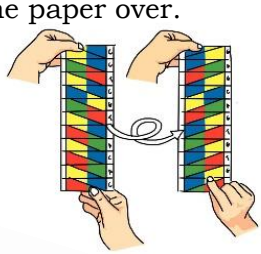
2. Hold the paper so that the thick lines are diagonal, and the thin lines are horizontal. Fold the top segment down and then unfold.

3. Fold the top two segments down along the next horizontal line. Unfold.

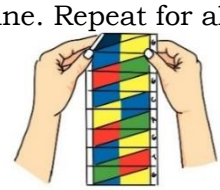
4. Repeat for all segments.



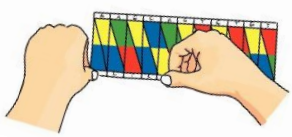
5. Turn the paper over.



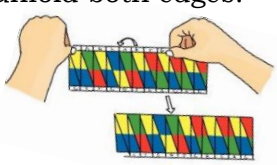
6. Fold along the first diagonal line. Unfold and fold along the second diagonal line. Repeat for all diagonal lines



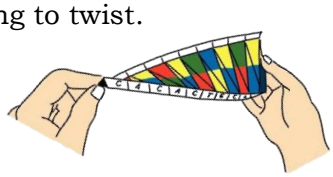
7. Fold the white edge without letters up.



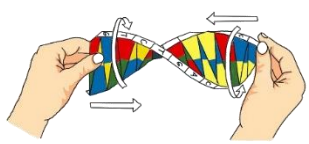
8. Fold the other edge away from you. Partly unfold both edges.

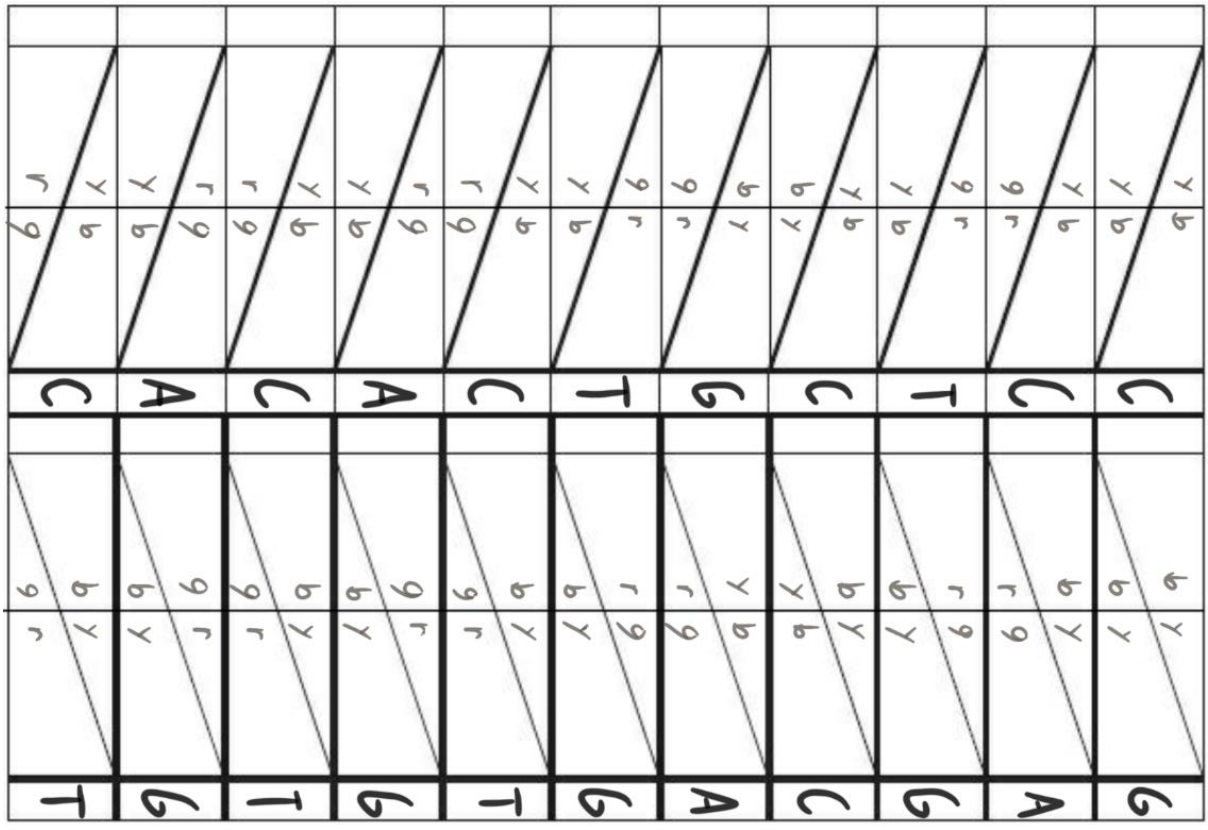


9. You can now see how the model is starting to twist.



10. Twist and turn the paper while pushing the ends towards each other.





The DNA Origami Template

RUBRICS FOR THE MODEL

Criteria	Excellent	Good	Needs Improvement
Accuracy	*The model is correctly labelled, follows the required colors and excellently shaped like the illustration as guide.*	*The model is labelled, colors are followed but there is minimal flaw with the shape/ appearance.*	*The model is not labeled properly and some flaws with the shape/ appearance.*
Creativity	*The model exceeds the expected appearance and accents/ highlights are added.*	*The model follows the expected appearance.*	*The model does not follow the expected appearance.*
Neatness	*All labels can be easily seen and the model is neatly presented.*	*Labels are seen with minimal flaw in the model.*	*Labels are not easily seen and have some flaws in the model.*

Guide Questions:

1. What are the colors indicated for each nitrogenous base from the constructed DNA origami?

   Adenine - _____ Guanine - _____

   Cytosine - _____ Thymine - _____

2. What are the complementary bases pairs for a DNA molecule?

   _____

3. How would you describe the appearance and orientation of a DNA model based on the model you constructed?

_____

4. What do you think is the main function of a DNA molecule in the body of organisms?

_____

What I Have Learned

Test Yourself! Guided by the figure of DNA and nucleotide, complete the paragraph by writing the correct word/s on the space provided for. Write your answers on a separate sheet of paper.

Unwound DNA helix can form a ladder-like structure. The main support of the ladder on both sides are composed of _____1_____ and_____2_____. The _____3_____ comprise the steps of the ladder.

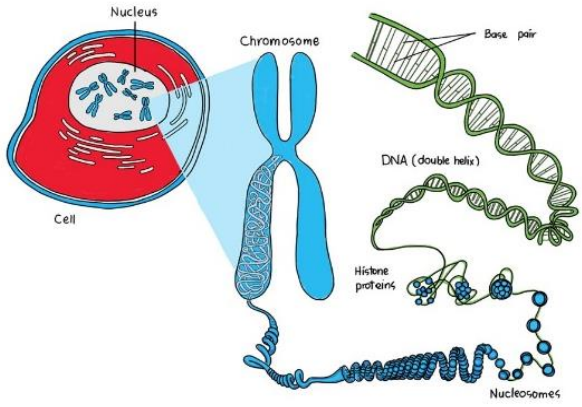


Figure 3. Organization of DNA Molecule in a Cell

The sequence of paired nitrogen bases serves as the code of biological and molecular information for the traits to be expressed in all organisms.

Let us try this.

1. Who were the scientists involved in constructing the first model of the DNA?

_____

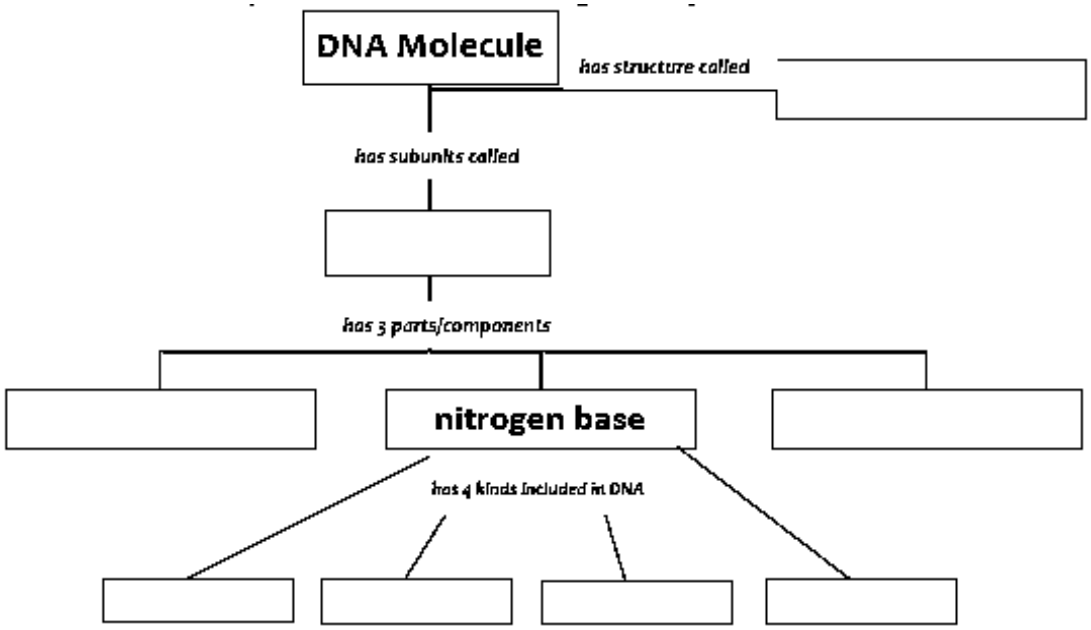
2. What do you call the shape of DNA molecule? _____
3. Give the components of a single nucleotide. _____
4. What do you call the unit of a DNA molecule? _____
5. Give the two general types of nitrogen bases. _____
6. How many pentose sugars is needed to complete and single nucleotide?

_____

7. Give the complementary base pair for the following chains:
   a. CGG – ATA – TTG – AGC _____
   b. TTA – GCG – TGA – AAG _____
   c. ATG – GGT – AAT – CGC _____

What I Can Do

Complete the flowchart. Supply all the related and important terms about the DNA molecule that you have learned including its components and structure.



Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Why is DNA the "blueprint of life"?
   A. it is like a fingerprint
   B. it has a blue color
   C. it can relay messages to other molecules
   D. it contains the instructions for building an organism

2. Which is **NOT TRUE** about **nucleotide**?
   A. It contains a nitrogen base.
   B. It has a phosphate group.
   C. It may contain one or more bases
   D. It contains deoxyribose sugar.

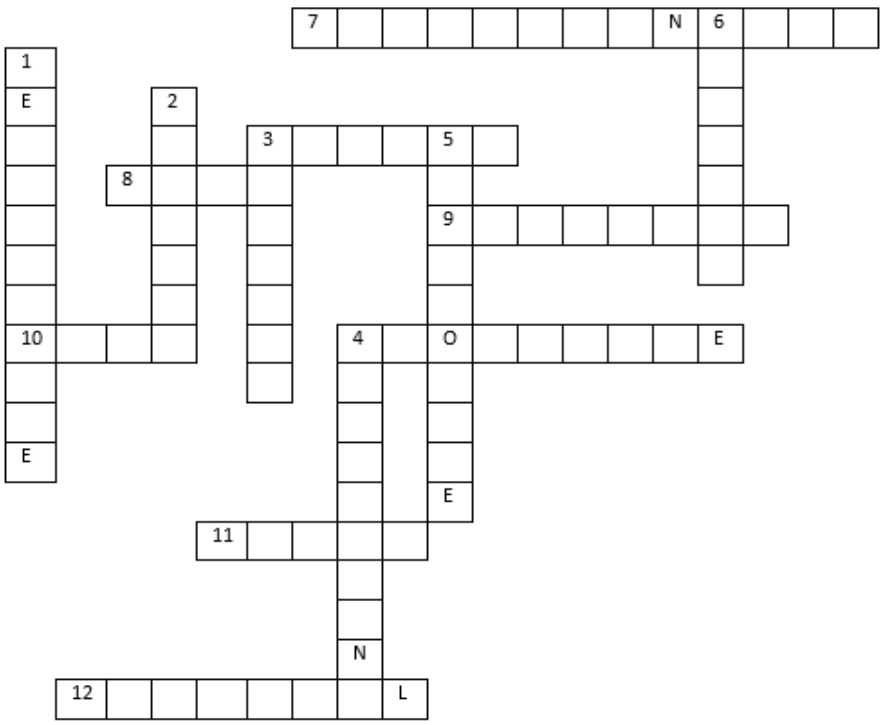
3. Which of the following ideas is **TRUE** about DNA molecule?
   A. DNA is only a single stranded molecule.
   B. DNA is double stranded with helical form.
   C. DNA has Thymine that pairs with Cytosine.
   D. DNA can only direct how organisms reproduce.

4. In a DNA structure, which compounds are responsible for its backbone?
   A. nitrogen bases and phosphate
   B. phosphate and sugar
   C. sugar and nitrogen bases
   D. only nitrogen bases

5. Bases in a DNA are complementary. Which is true about complementary base pairing if there are 20 Guanine in the DNA strand?
   A. there will be 20 Adenine bases.
   B. there will be 20 Cytosine bases.
   C. only 10 Cytosine, since its helical
   D. cannot be determined

Additional Activities

Complete the crossword puzzle below. All the needed word/s are from the lessons discussed about DNA.



DOWN

1. Specific kind of sugar for DNA
2. It complements Thymine
3. A 5-carbon compound
4. It includes cytosine and thymine
5. A single unit of DNA molecule
6. It complements Adenine

ACROSS

3. It includes guanine and adenine
4. One of the components of DNA backbone
7. The main rule for base pairing
8. A segment of DNA
9. It complements guanine
10. Nitrogen-
11. Double-
12. Anti-

Lesson 2 Genes and Chromosomes

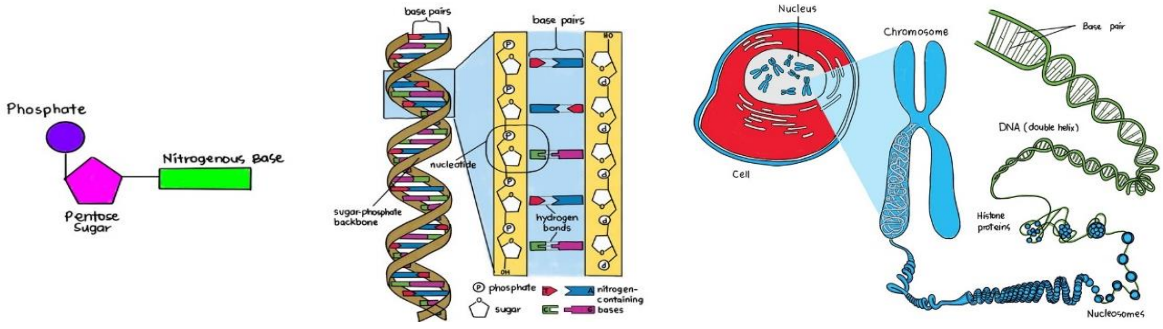
What's In

Rearrange the following jumbled letters to get the correct word guided by the descriptions /definitions below.

_____ 1. **EILOXBDIEYCORNUC DICA** – a double-stranded helical structure comprised of bases that codes the life of all organisms.
_____ 2. **NNEIDEA** – it complements the thymine base in DNA.
_____ 3. **OBEULD IXLHE** – a special structure of DNA molecule.
_____ 4. **NORINTEG SBAE** – includes A, T, C, and G that forms the steps of the ladder of a DNA molecule.
_____ 5. **TYCENIOS** – it can be paired with guanine.
_____ 6. **EPOTESN** – another term for 5 – carbon compound.
_____ 7. **GIEUNAN** – it takes cytosine as its complementary base pair.
_____ 8. **ESPPHOHTA** – it serves as the backbone of the DNA molecule along with the sugar compound.
_____ 9. **NHEMTYI** – in base pairing, it must always take adenine as its pair.
_____ 10. **IEOECLTNUD** – a single unit of DNA molecule with a complete set of sugar, phosphate, and a base.

What's New

Observe the following illustrations:



a.) Nucleotide b.) DNA Molecule c.) DNA in a Cell

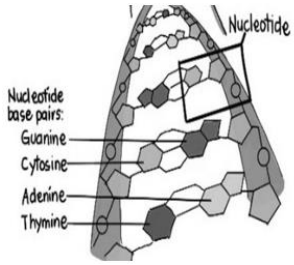
Figure 4. DNA Structure

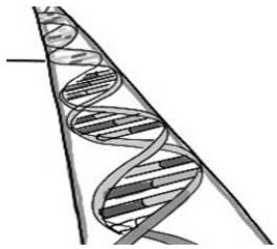
Based on what you have observed in figure 1, make **your description** of a **chromosome** and a **gene** using simple words.

Chromosome - _____.
Gene - _____.

What Is It

The tiny nucleus of a eukaryotic cell encloses long strands of DNA. They are neatly wrapped around the histone (a globular protein) forming chromatin. When the cell is preparing for cell division, histones come together coiling the chromatin and arranging the DNA into thicker and a denser structure called chromosomes.





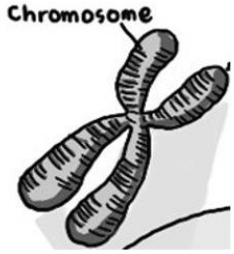


Figure 5. DNA **Figure 6. Gene** **Figure 7. Chromosome**

Chromosomes are rod-shaped structures containing the genes of organisms. It has a p arm and a q arm. P arm is shorter than the q arm. These are identified by the constriction point called the **centromere**. The location of the centromere on the chromosome gives its characteristics and shape. It can also be used to locate the genes (small sequence of DNA) at a specific point along the chromosome. The location of genes in the chromosome is called **locus**.

During the replication stage of the cell cycle, the chromosomes are copied. The old and new copies of chromosomes are held together by the centromere. This structure is called **chromatids.** In the inheritance of genes, a copy of chromatid will be given to the offspring.

In a human cell, there are 23 pairs of chromosomes making a total of 46. The number of chromosomes varies from an organism to the other. A single chromosome contains hundreds to thousands of genes. Each gene represents a specific trait like curly, straight, and wavy hair. These traits are inherited by the offspring from their parents through the direction of genes. Thus, **genes** are also defined as carriers of traits. However, there are times that genes are altered and undergo mutation. It may result in a new and unique trait that can be dangerous or advantageous in the survival of organisms.

Fig. 5. Types of Human Hair

What's More

Activity 2.1: 3D Mode! (Draw – Define – Describe)
Objectives:

1. describe the characteristics of the chromosome, gene, and DNA.
2. draw a simple diagram of the chromosome, gene, and DNA.

What you need: pencil, ruler, and coloring materials.

What to do:

1. Using the figures previously shown as a guide, draw a chromosome, gene, and DNA on the blank boxes.
2. In the second column, complete the following sentences to describe your drawing using your knowledge and keywords inside the box.

23	**segments**	**deoxyribonucleic acid**	**codes**

Diagram	Description
Chromosome	In human cells, there are *1.)*_____ pairs of chromosomes. This counts to a total of *2.)*____ individual chromosomes. Chromosome can contain hundreds to thousands of *3.)*_____. It can also be described as protein-packed *4.)*_____ to fit inside the cell.
Gene	Genes are *5.)*_____ of a DNA molecule that codes for a specific trait of an organism. A gene *6.)*_____ for a specific *7.)*_____.
DNA	DNA is an acronym for *8.)*_____ It is a long chain of units called *9.)*_____ with a combination of 4 *10.)*_____. It has a structure called *11.)*_____.

Guide Questions:

1. Do all organisms have 46 chromosomes on their cells? Explain.

_____

2. What is the importance of genes in our body?

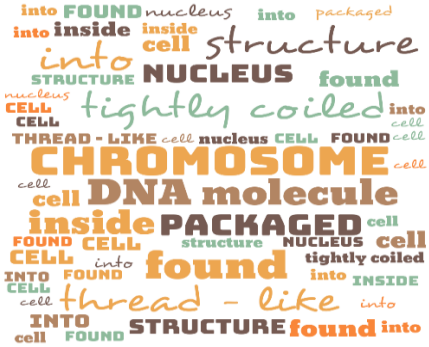
_____

What I Have Learned

Let us do this!

There are two sets of word clouds. Make a complete thought (**sentence**) using the words found in the word cloud to define A. CHROMOSOME and B. GENES. You can add conjunctions or determiners like to, in, at, on, etc.

A.



B.

A. CHROMOSOME - _____.
B. GENES - _____.

What I Can Do

Answer the following briefly. Please be guided by the concepts learned from the previous lesson in writing your answers.

1. A gene is a segment of DNA molecule that codes and directs a certain trait or characteristic of an organism. What do you think will happen if the codes for a trait are incorrectly reproduced in the body of an organism?

   _____

2. Why do you think there is a need for a DNA molecule to be coiled tightly?

   _____

3. If every cell in the human body can host 46 chromosomes, does it mean that it has also 46 strands of DNA? Prove your answer.

   _____

Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Which **BEST** describes a gene?
   A. it is a DNA
   B. it is smaller than DNA
   C. it is a segment of DNA
   D. it is a tightly coiled DNA
2. Which is **TRUE** about a chromosome?
   A. it is a double helix molecule
   B. it is a protein-packed DNA
   C. it is a segment of DNA
   D. it is smaller than a gene
3. It is an alteration on the coded instructions of DNA that may produce a positive or negative result in an organism's body.
   A. mutation
   B. tight coiling
   C. gene alteration
   D. DNA organization
4. Which is **TRUE** about the number of chromosomes in humans?
   A. 46 pairs, 23 total
   B. 23 pairs, 23 total
   C. 23 pairs, 46 total
   D. 46 pairs, 46 total
5. It is a physical and functional unit of heredity.
   A. nucleotide B. DNA C. chromosome D. gene

Additional Activities

Chromosome and Gene Model

Objectives: Apply the knowledge gained from the lesson on chromosome and gene.
Make a simple model of chromosomes and genes.

What you need:

- blue, green and red yarn with 50-cm measure each
- glue
- 8x8 inches cardboard or "karton"

Figure 6. Chromosome and Gene Model

What to do:

1. Let the yarn represent the DNA molecule.
2. Connect the three yarns.
3. Coil it (see Figure 6) on the cardboard to form a single chromosome using the glue.
4. Each color will represent the gene for a trait. Label each color with the following traits: blue – wavy hair, green – fair skin color, red – brown eyes.

RUBRICS FOR THE MODEL

Criteria	Excellent	Good	Needs Improvement
Accuracy	*The model is correctly labelled, follows the required colors and excellently shaped like the illustration as guide.*	*The model is labelled, colors are followed but there is minimal flaw with the shape/appearance.*	*The model is not labeled properly and some flaws with the shape/appearance.*
Creativity	*The model exceeds the expected appearance and accents/highlights are added.*	*The model follows the expected appearance.*	*The model does not follow the expected appearance.*
Neatness	*All labels can be easily seen and the model is neatly presented.*	*Labels are seen with minimal flaw in the model.*	*Labels are not easily seen and have some flaws in the model.*

Lesson 3 Incomplete Dominance and Co-dominance

What's In

Match column A with the appropriate description on column B.

A	B
_____1. Visible expression of a genotype. e.g., brown eyes or attached earlobes.	A. Punnett Square
_____2. Alternative form of a gene; alleles occur at the same locus or homologous chromosomes.	B. Homozygous C. Dominant
_____3. Allele that exerts its phenotypic effect in the heterozygote; it masks the expression of the recessive allele.	D. Phenotype E. Genotype
_____4. Allele that exerts its phenotypic effect only in the homozygote; its expression is masked by a dominant allele.	F. Heterozygous G. Recessive
_____5. Possessing two identical alleles for a particular trait.	H. Allele
_____6. Possessing unlike alleles for a particular trait.	I. Monohybrid
_____7. Genes of an organism for a particular trait or traits; often designated by letters – for example Bb or Aa.	
_____8. Visual representation developed by Reginald Punnett that is used to calculate the expected results of simple genetic crosses.	

What's New

Read the text carefully and do the task that follows.

Incomplete dominance is when one allele for a certain trait is not completely dominant over the other. The result, which is seen in offspring, may be a merged phenotype. What does this mean? The traits of each parent are neither dominant nor recessive. The two alleles in a partial dominance, resulted in third phenotype and it is a blended of phenotypes of the two homozygotes; this is often described as an "intermediate form of inheritance." The alleles do not blend, but partial dominance is often referred to as "blending" because traits are mixed and happen to be "blended."

Atoy can have black, white, or gray hair. The allele that controls this trait is INCOMPLETELY DOMINANT, where gray hair is produced by the heterozygous condition. A cross between a black hair & a white hair produce offspring that are gray hair. The color hair is determined by just two alleles.

Black Hair(BB) × White Hair (WW) = Gray Hair (BW)

https://bit.ly/3y38yL3

https://bit.ly/35ZYkPi

https://bit.ly/3h4LohP

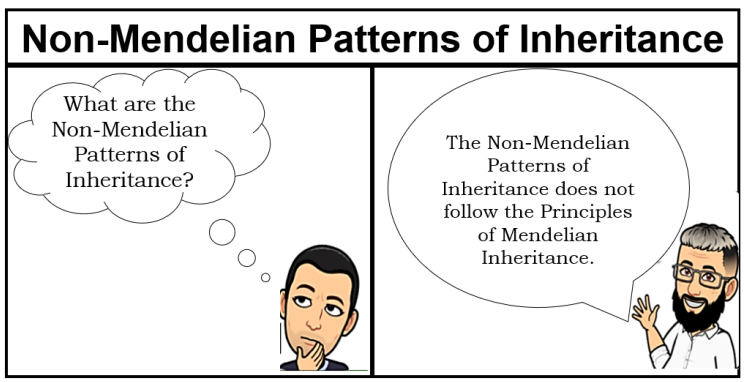
Figure 7. Different Hair Color

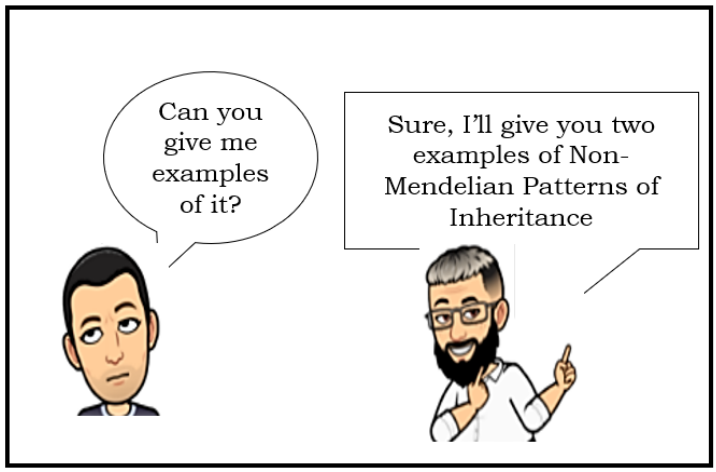
Fill in the blanks:

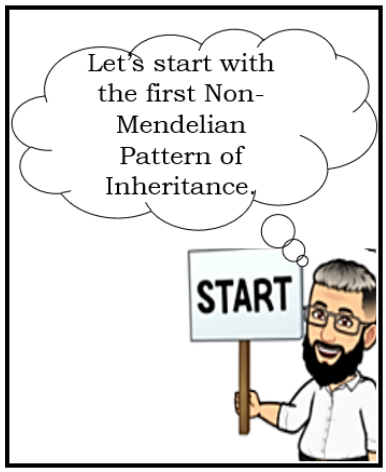
1. Atoy can have black, white, or gray hair. The allele that controls this trait is _____, where gray hair is caused by the heterozygous condition.
2. The genotype for black hair offspring is _____.
3. The phenotype for the cross of black and white hair is _____.

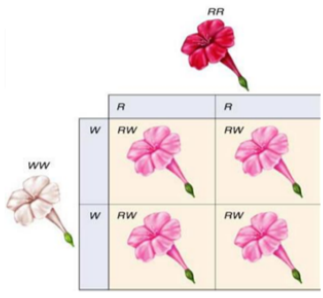
What Is It

Read this comic strip and find out more about the Non-Mendelian Patterns of Inheritance.









Source:buffonescience9.wikispaces

FOUR O'CLOCK FLOWER PLANT

INCOMPLETE DOMINANCE

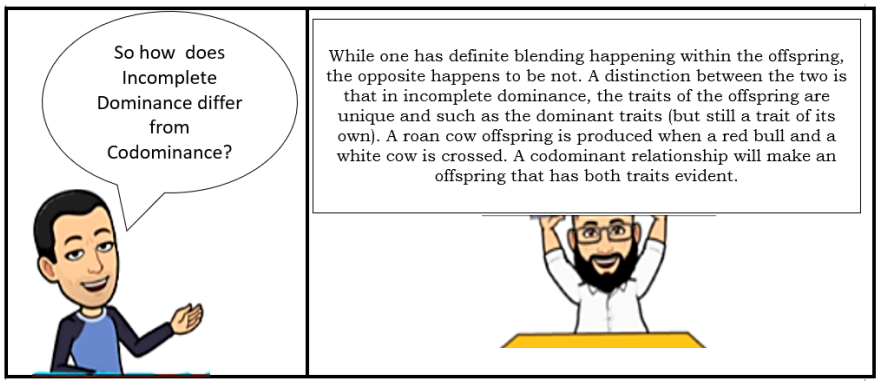
In incomplete dominance, a heterozygote indicates a phenotype that is midway among the two homozygous phenotypes. Neither allele is dominant across the other. The four o'clock plant on the left is illustrates incomplete dominance. When a pure white four o'clock flower plant is crossed with a pure white flower, the offspring will give neither red nor white flower. Instead, all flowers are pink.

CO-DOMINANCE

Another pattern of inheritance is codominance. In a codominant relationship, neither allele is recessive nor hidden by another allele. Combining shows a part in a codominant relationship, and both alleles are uniformly expressed, and their characteristics are both present in the phenotype. The resulting heterozygote exhibit the traits of both parents, a good example of codominance is a roan cow. The offspring will be red (RR=red hair), white (WW=white hair), or roan (RW= red and white hairs together).

ROAN COW

Source: www.biologycorner.com



Identify the terms being described below.

1. A pattern of inheritance that does not follow the Mendelian Principle of Inheritance.

   _____

2. It occurs when the phenotype of a heterozygote offspring is somewhere in between the phenotypes of both homozygous parents.

   _____

3. It occurs when both alleles are expressed equally in the phenotype of a heterozygote.

   _____

4. When a cross between a red and white four o'clock flower plant is done it resulted to offspring with _____ flowers
5. A roan cow offspring is produced when a cross between a _____ and white cow is done.

What's More

Activity 3.1: Incomplete Dominance of Snapdragon Flower Plants

Objectives:

- Explain incomplete dominance.
- Illustrate incomplete dominance through a Punnett square

What to do:

1. Read the given problem:

In Snapdragon flower plants, a cross between a homozygous white flowered plant (WW) and homozygous red flowered plant (RR) will produce pink flowers (RW).

Figure 4. Snapdragon Flower
https://bit.ly/3djErXJ

2. Using the Punnett square show the probable outcome of the cross between a white flower plant and pink flower plant.

Guide Questions:

1. What are the genotypes of the parents in the problem?

   _____

2. What is the phenotype of a heterozygous snapdragon flower plant?

   _____

3. What are the probable phenotypes of the offspring after the cross of the parents on the given problem?

   _____

4. What are the probable genotypes of the offspring after the cross of the parents in the problem?

   _____

Activity 3.2: Finding Foals (Baby Horse)

What to do:

1. Analyze the situation:

Mang Pedro owns a purebred chestnut horse (reddish) while Mang Berting horse are white and a roan horse (red and white color). Help Mang Pedro and Mang Berting to produce new foals (baby horse) by matting their livestock.

Figure 5. Red Roan Horse
https://bit.ly/3quEEwr

2. Determine the possible traits of the foals if:

- (Problem 1) a chestnut horse (RR) is mated with white horse (WW).
- (Problem 2) a chestnut (RR) horse is mated with a roan (RW) horse
- (Problem 3) a roan (RW) is mated with a white (WW) horse.

3. Illustrate your answers using a Punnett square.

Problem 1:

Problem 2:

Problem 3:

Guide Questions:

1. What are the possible phenotypes of the foal horse for each problem?

_____

2. Do you think Mang Pedro and Mang Marcelino will be happy about the outcome?

_____

3. How would you apply what you have learned on breeding livestock in your area?

_____

What I Have Learned

Place a checkmark on the box if the statement describes INCOMPLETE DOMINANCE OR CO-DOMINANCE.

	INCOMPLETE DOMINANCE	CO-DOMINANCE
Appearance of a third (new) phenotype in the heterozygous form as a COMBINATION of the dominant and recessive phenotypes.		
In the heterozygous condition, both alleles are expressed with NO mixing!		
Pink 4o'clock flowers are obtained from a cross betweeen pure bred red flower plant (RR) and white flower(WW) plant.		
A chestnut and white colored horse produces a palomino,a creamy golden horse.		
A cross among a black cat & a tan cat gives a tabby design (black & tan hair together).		
A homozygous black bird is cross over with a homozygous white bird. The offspring are all bluish gray.		
Roan cow has a coat with primarily red with white hairs is an offspring of red and white cow.		
It is a condition where two non-identical alleles of a pair specify two different phenotypes, yet one cannot mask the expression of the opposite (blood types in humans)		

What I Can Do

Analyze the given situation and solve the following problems.

Ligaya loves growing flowers for her pal Luna! She prefers rose flowers of red, blue, and purple colors.

1. Write the correct genotype for each color.
   If R represents a red gene and B represents a blue gene.
   Purple is - _____
2. What Will be the result if Ligaya crossed a rose of red flowers and blue colors. Complete the Punnett square to find out the possibilities of the cross.
   a. Give the genotypes and phenotypes of the offspring. _____
   b. What percentage of the plants would have red flowers? _____

c. What percentage of the plants would have purple flowers? _____

d. What number of the plants would have blue flowers? _____

3. In some chickens, the gene for feather color is dominated by co-dominance. The allele for black is B while the allele for white is W. The heterozygous phenotype is erminette (black and white spotted).

a. What's the genotype for black chickens? _____

b. What's the genotype for white chickens? _____

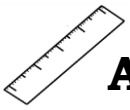
c. What's the genotype for erminette chickens? _____

4. If an erminette chicken and a white chicken are crossed, what is the probability that:

a. they may have a black chick? _____

b. they may have a white chick? _____

c. they would have an erminette chick?_____



Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. A cross between a black cat and a tan cat produces a tabby pattern (black & tan fur together). What pattern of inheritance does this illustrate?

A. codominance
B. incomplete dominance
C. Mendelian inheritance
D. my own inheritance

2. In the heterozygous condition, both alleles are expressed equally with NO blending! It is represented by using two DIFFERENT capital letters.

A. codominance
B. incomplete dominance
C. Mendelian inheritance
D. my own inheritance

3. A third (new) phenotype appears in the heterozygous condition as a BLEND of the dominant and recessive phenotypes is a condition called_____.

A. codominance
B. incomplete dominance
C. mendelian inheritance
D. my own inheritance

4. Which of the following is an example of co-dominance pattern of inheritance?

A. When a long-furred Angora rabbit and a short-furred Rex rabbit reproduce, the result can be a rabbit with fur longer than a Rex, but shorter than an Angora.
B. When a black and a white chicken reproduce and neither allele is completely dominant, the result is a blue-feathered bird.
C. About dogs, lots of labradoodles have wavy hair. Just like humans, that comes from having straight-haired and curly-haired parents. The result is an intermediate inheritance: the wavy-haired labradoodle.
D. In some chickens, the heterozygous genotype leads to a phenotype known as erminette, feathers which are speckled with both black AND white.

5. In shorthorn cattle, when a red bull (RR) is crossed with a white cow (WW), all the offspring are roan (RW) a spotted, red and white or milky red color. What is the percentage of the offspring will produce a roan cow if the parents are a red bull and a roan cow respectively?

A. 25 % B. 50% C. 75% D. 100%

Lesson 4	Multiple Alleles

What's In

Can you recall the incomplete dominance and co-dominance pattern of inheritance and describe each one of them?

1. _____
2. _____

Incomplete dominance and Co-dominance involve a combination of alleles to express a certain trait. This time, you will be dealing with more than two alleles for the inheritance of a trait. An example of this is the blood types in humans. How can a person inherit blood types of his/her parent and have an A, B, AB, or O blood types?

What's New

Just Give It A Try! Since we will be talking about blood types, can you guess the possible blood type of a child, given the blood types of both parents?

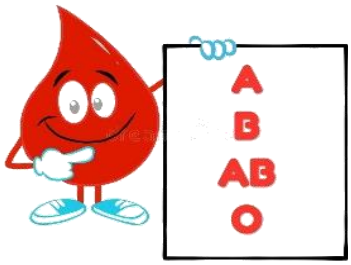


FATHER	MOTHER	CHILD
A	**B**	**1. _____**
O	**O**	**2. _____**
AB	**B**	**3. _____**
B	**O**	**4. _____**
O	**AB**	**5. _____**

Is there a possibility that there could be other resulting blood types from the one you have identified? How many possible combinations of alleles that can be formed in human blood group? Let us explore the next lesson!

What Is It

If there will be more than two alleles available, it will also lead to more than two phenotypes expressed. This type of inheritance is called **multiples alleles or multiple allelism.** The **ABO blood group system** is a very common example of inheritance with multiple alleles.



	Group A	Group B	Group AB	Group O
Red blood cell type	A	B	AB	O
Antibodies in plasma	Anti-B	Anti-A	None	Anti-A and Anti-B
Antigens in red blood cell	A antigen	B antigen	A and B antigens	None

Figure 6. Blood types and antigens

There are three alleles to indicate the blood system: I^A I^B i This indication of ABO blood group is determined by the absence or presence of two antigens on allele ***I: A*** and ***B***. **Antigens** are proteins or complexes of sugar molecules which helps in identifying the blood types in humans. An allele ***i*** does not code for an antigen. In the table below, there are **six (6) combinations of alleles** to form **six (6) genotypes**, and the **phenotypes** that will be expressed are **four (4).**

Blood Types (Phenotypes)	Allele Combinations (Genotypes)
AB	$I^A I^B$
A	$I^A I^A$ $I^A i$
B	$I^B I^B$ $I^B i$
O	ii

Take note that there are still alleles that will act as dominant over the other. In this case, I^A and I^B act as dominant over the i allele. Whenever alleles I^A and I^B are inherited at the same time, they become codominant to each other wherein that are both expressed equally. Blood types **A** and **B** have 2 possible genotypes or combination of alleles: **homozygous A ($I^A I^A$) or B ($I^B I^B$)** and **heterozygous A ($I^A i$) or B ($I^B i$).**

In the medical field, when we talk about blood transfusion, there is a need to consider the compatibility of blood between the recipient and the donor. Generally, people with **blood type AB** can receive any of the four blood types because they have no antibodies for A or B making it the **universal recipient.** As for people with blood type O, they can only receive **type O** but can donate blood to all blood types because they have no antigens A or B making it the **universal donor**.

What's More

Activity 4.1: Blood Type Analysis

Objectives:

1. Identify the possible blood types of a person given the blood types of their family members.
2. Solve genetics problems on multiple alleles.

What you need: pen, paper

What to do:

1. Complete the table by identifying the possible blood types (phenotypes) of the mother given the blood types of the father and child.



FATHER	MOTHER	CHILD
A	_____	**A**
O	_____	**B**
AB	_____	**AB**
B	_____	**O**

2. **Let's Cross It!** Solve the following genetics problems using a Punnett square and identify the resulting phenotypes.

a. If the mother has a blood type of A and the father has AB, what could be the resulting blood types of the children. (*Note that there are two possible crosses)*

b. If the father has blood type O and the mother has AB, what could be the possible blood types of the children? (*Note that only one cross can be made)*

♂ / ♀		

Guide Questions:

1. What are the possible resulting **blood types** on the first problem (a)?

_____

2. Give the possible **genotypes** and **blood types** on the last cross (b). Include the percentage probability of the resulting blood types.

_____

What I Have Learned

Give what is asked in the following items.

1. How many **phenotypes** are there for blood group system?

_____

2. Give all the **phenotypes** from your answer in question #1.

_____

3. How many **genotypes** are there for blood group system?

_____

4. Give all the **genotypes** from your answer in question #3.

_____

5. Which blood type can be compatible with all the other blood types?

_____

What I Can Do

Solve the mystery! Candara has blood **type A** and his husband, Caslon, has **type B**. They were shocked when they found out that their first child has type O and thought that a switch at the hospital might have happened. Can the baby be theirs? Explain ε **rm a cross (Punnett square**) to **show your results**.

Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Which is **TRUE** about inheritance with multiple alleles?
   A. It uses only the dominant allele.
   B. It involves two alleles for a single trait.
   C. It involves more than two alleles for a trait.
   D. None of the choices

2. Which is TRUE about blood type O?
   A. It has a heterozygous allele.
   B. It has only A antigen.
   C. It is a universal donor.
   D. It has A and B antigens.

3. How many phenotypes are there in a human blood group system?
   A. 3 B. 4 C. 6 D. 8

4. The following are allele combination of human blood types, **except:**
   A. I^AI^A B. I^AI^B C. Ii D. ii

5. A father of four children has blood type A. The mother has blood type O. Predict the possible blood type(s) of the children:
   A. blood Type A Only
   B. blood Type O Only
   C. blood Type B & O
   D. blood Type A & O

Additional Activities

Problem Solving: Read and analyze the problem below:

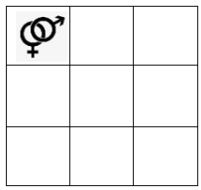
A. Corsiva has type **A** blood and her husband Roman has type **B** blood. Their first child, Lucida, has type **O** blood. Their second child, Perpetua, has type **AB** blood.

1. What is Corsiva's **genotype**? _____

♀♂		

2. What is Roman's **genotype**? _____
3. Show and prove your answers using a Punnett square.

B. A father of four children has blood **type B homozygous**. The mother has blood **type A heterozygous**.



1. Write the Father's **genotype**? _____
2. Write the Mother's **genotype**? _____
3. Predict the possible **blood types** of their children. ____
4. Show how you found the answer by completing the Punnett square.

Lesson 5 Sex Determination

What's In

Supply the missing letters to complete the words guided by the descriptions/definitions below.

1. __ __ __ O __ __ __ O __ __	It is a rod-shaped structure inside the cell's nucleus that carries the genes.
2. __ __ __	It is divided into two main categories (male and female) in most organisms that include humans.
3. __ __ __ T __ __ __ Z __ __ __ __ N	It commonly refers to the union of egg cell and sperm cell to form zygote
4. __ __ M __ __ E	It is the general term that is also used to mean sex cells (male or female).
5. __ __ E __ __ __ E __ __ -	It is the male sex cell

What's New

Complete the paragraph by supplying correct words/concept/numbers on the space provided guided by the words inside the box.

23	**46**	**nucleus**	**body**	**sex**	**92**	**male**

The 1.) _____ of the human cell contains a total of 2.) _____ chromosomes that may also come in pair. Both males and females have 3.) _____ pairs. The 22 pairs are classified as somatic or 4.) _____ chromosomes while the 23rd pair consists of 5.) _____ chromosomes.

Male organisms that include humans and other mammals have non-identical sex chromosomes. The indication for male sex chromosome is XY. Females on the other hand have identical sex chromosomes indicated as XX. Now the question is, how is the sex of an organism determined and inherited? What is the chance that a mother and a father can produce a female or male offspring?

What Is It

Study the table below:

Table 1. Formation of gamete of the sex chromosomes.

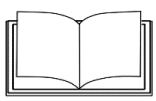
	Male		Female	
Sex Chromosomes	X	Y	X	X
Meiotic Cell Division Occurs				
Resulting **Gametes (Sex Cells)**	X	Y	X	X

Take note of the gamete formation as shown in table 1. Let us indicate first the sex chromosomes of the male and female. After meiosis, all **egg cells** both received X chromosomes while the **sperm cells,** half of it received an X and the other half with Y chromosomes.

Table 2. Determination of Sex

Parent	Male (sperm)		Female (egg)	
Gametes	X	Y	X	X
Fertilization				
Zygote	XX	XX	XY	XY
	Female	Female	Male	Male

Table 2 shows the possible results of fertilization involving the male and female gametes. **Fertilization** refers to the union of sperm and egg cell which results to a **zygote.** As you can see in table 2, if an egg is fertilized by a sperm with X chromosome, the offspring is female. The offspring results to a male when an egg is fertilized by a sperm carrying a Y chromosome.



What's More

Activity 5.1: What Sex Is It? (The word GENDER must not be used)

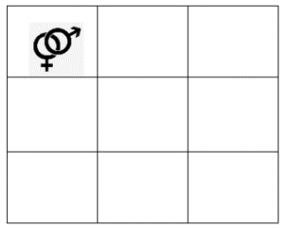
Objectives:

1. Determine the probability or chance to have male or female sex.
2. Make a Punnett square to show the cross between the parents.

What you need: pen, paper

What to do:

1. Identify the correct indication of sex chromosomes for **male** and female**.**
2. **Make a Punnett square** to cross the male and female parents using the indicated sex chromosomes.



MALE (XY) x **FEMALE (XX)**

Guide Questions: Write your answers on a separate sheet of paper.

1. How many percent in the cross resulted to female? Male?

_____

2. What will be the sex of the child if an egg cell is fertilized by a sperm with Y chromosome?

_____

3. What type of sperm cell is needed to fertilize an egg that will result in a female child?

_____

4. Give the sex chromosome that is present on both male and female.

_____

What I Have Learned

Try this! WORD BOX! Complete the paragraph by writing the correct word/s or figures on the space provided. Pick your answers inside the box.

Both males and females have 44 1._____ chromosomes and 2._____ sex chromosomes. The male's sex chromosomes are indicated with 3._____ and 4._____ while for females they have both 5._____ . The 6._____ determine the sex of the children. The number of chromosomes in each cell of an

Heredity	**body**	**sex**	**X**	**males**	**Y**	**2**	**46**	**females**	**genes**

individual is 7._____ These chromosomes contain the 8._____ that serve as the unit for 9._____.

What I Can Do

Answer the following briefly.

1. What do you think will happen if there will be an extra chromosome in the human cell making it 47? Would this condition be still normal for a human? Why?

   _____

   _____

2. Do you think the sex chromosomes of females (XX) makes it an advantage for them to produce more female offspring than the male one? Why?

   _____

   _____

Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Which of the following concepts is **CORRECT**?
   A. males and females have 44 sex chromosomes
   B. females have 2 sex chromosomes, XY
   C. females have 2 body chromosomes, XX
   D. males have 2 sex chromosomes, XY
2. Which conditions will result to a female child?
   A. an egg cell is fertilized by a sperm with X chromosome
   B. a sperm that is fertilized by an egg with Y chromosome
   C. an egg that is fertilized by a sperm with Y chromosome
   D. none of the choices

3. It is referred to as the union of egg and sperm cells to form a new organism.
   A. mutation B. fertilization C. zygote D. offspring

4. Which happens to form gametes (sex cells) among male and female organism?
   A. meiosis B. mitosis C. reproduction D. fertilization

5. Which of the following determines the sex of an organism?
   A. the female parent C. both parent
   B. the male parent D. none of the choice

Additional Activities

Find all the science words listed below that are hidden on the puzzle grid. The words maybe hidden in any direction.

FERTILIZATION	MALE	ZYGOTE
GAMETES	GENES	SEX CELLS
SEX	SPERM CELL	CHROMOSOMES
FEMALE	EGG CELL	OFFSPRING

N	O	I	T	A	Z	I	L	I	T	R	E	F	I	K
H	O	H	E	R	E	D	I	T	Y	T	S	E	T	L
F	F	Z	Y	G	O	T	E	K	I	L	A	W	L	O
S	F	X	V	E	D	I	K	E	L	A	M	E	F	S
E	S	E	N	E	G	F	E	S	G	H	C	A	F	E
T	P	S	S	A	D	G	A	F	O	M	D	F	L	R
E	R	D	F	G	H	Y	C	C	R	M	V	O	Q	E
M	I	S	L	L	E	C	X	E	S	R	A	F	T	T
A	N	G	H	J	K	Y	P	E	L	E	E	T	G	H
G	G	G	A	B	G	S	D	D	E	L	R	K	I	H
R	O	L	E	S	E	M	O	S	O	M	O	R	H	C

Lesson 6	Sex – Linked and Sex – Influenced Traits

What's In

You have already talked about how sex (male or female) is determined and inherited. Humans have a total of 46 chromosomes in each cell which also exist as a pair. Meaning, there are 23 pairs of chromosomes for both male and female. The 22 pairs are called somatic or body cells while the remaining 1 pair (23rd pair) is called sex chromosomes. These sex chromosomes are indicated by letters X and Y. For male, it has a pair of XY while for female it would be XX. Write your answers on a separate sheet of paper.

1. What type of chromosome is in pair number 23? _____
2. What is the genotype of a female human? Male? _____
3. How many pairs of chromosomes are in a human cell? _____

What's New

Rearrange the following jumbled letters to form science words that you will be using in understanding the succeeding lesson. The first and last letters are given as a hint.

Jumbled Letters	What's the SCIENCE WORD?	
1. ANDSBLSE	**B**	**S**
2. ONOLRBIDCL	**C**	**D**
3. SIVEECRES	**R**	**E**
4. ERTEOSTTNSEO	**T**	**E**
5. NDTOINMA	**D**	**T**
6. MREHNOO	**H**	**E**
7. HPIAIHEOML	**H**	**A**

What Is It

SEX – LINKED TRAIT

Genes located on the X chromosomes are called **X-linked genes**. Genes on the Y chromosomes are called **Y-linked genes**. An example of an X-linked trait in humans is **hemophilia**. A person suffering from hemophilia could die from loss of blood even from a small wound because the blood either clots very slowly or does not clot at all (as shown in fig. 2 &3). Another example of an X-linked trait is **color blindness.**

Figure 7. Colorblindness
https://bit.ly/3AfiYsW

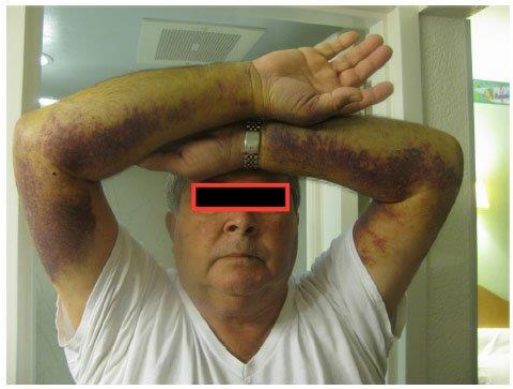


Figure 8. Bleeding associated with acquired hemophilia A
https://bit.ly/35ZjqgO

There are some people who have difficulty in recognizing specific colors (as shown in fig. 1), depending on the severity of their condition. Some can only see mono color, while some have only difficulty in perceiving certain colors like red, blue, green and the like.

Let us study tables 1 and 2 below. Hemophilia is caused by a recessive sex – linked gene represented by X^h. As for colorblindness, a recessive sex – linked gene is represented by X^c.

GENOTYPE	PHENOTYPE
X^HX^H	Non-hemophilic female
X^HX^h	Non-hemophilic female but carrier
X^hX^h	Hemophilic female
X^HY	Non-hemophilic male
X^hY	Hemophilic male

Table 1. Genotype and Phenotype for hemophilia

GENOTYPE	PHENOTYPE
X^CX^C	Female w/ normal color vision
X^CX^c	Female w/ normal color vision but carrier
X^cX^c	Colorblind female
X^CY	Male with normal vision
X^cY	Colorblind male

Table 2. Genotype and Phenotype for colorblind.

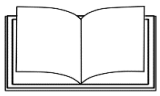
Notice that for a female to become color-blind, she must have a combination of recessive alleles (X^cX^c) while for male, when the X chromosome possesses the recessive allele, he becomes colorblind.

SEX – INFLUENCED TRAIT. This trait targets the **body chromosomes (autosomes**), which means that genes are not on the sex chromosomes. Again, what makes these traits unusual is the way they are expressed phenotypically. In this case, the difference is in the ways the two sexes express the genes. An example of this trait is **pattern baldness,** which is not only limited to males. Baldness, whether male or female, is caused by a **dominant gene B** as shown in table 3. However, in females the heterozygous genotype expresses a non-bald phenotype while in males it is still bald. The sex hormones of the carrier influence this difference in expression. The male hormone **dihydrotestosterone (DHT**) triggers the trait. Only small amounts of DHT is

secreted by women. Thus, they do not go bald unless they carry both alleles for the trait.

Male Genotypes	Male Phenotypes
XYBB	Male bald
XYBb	Male bald
XYbb	Male non-bland
Female Genotypes	**Female Phenotypes**
XXBB	Female bald
XXBb	Female non-bald
XXbb	Female non-bald

Table 3. Expression for pattern baldness.



What's More

Activity 6.1: It's a Cross: Colorblind and Hemophilia

Objective:

1. Solve problems related to sex-linked traits.

What you need: pen and paper

What to do:

1. Read the given problem:

A. Color blindness is a recessive, sex-linked disorder in humans. A man who is color blind has a child with a woman who is a carrier of the disorder.

B. A man who has hemophilia has a child with a woman who is non-hemophilic.

KEY: X^C= ***normal vision*** X^c = ***color blind***

X^H= ***non hemophilic*** X^h = ***hemophilic***

2. Illustrate using a Punnett square the probability of having children who will have normal vision and children who will be color-blind.

Guide Questions: (Separate answers for A and B)

A. Color blindness

♂ / ♀	X^c	Y
X^C		
X^c		

B. Hemophilia

♂ / ♀	X^h	Y
X^H		
X^H		

1. What is the genotype of the male? _____
2. What is the genotype of the female?_____
3. What is the chance that the child will be color-blind/hemophilic?

_____

4. Will there be a color-blind/hemophiliac female? _____
5. Will there be a carrier? _____

Activity 6.2: Who's Bald and Who's Not?

Objective:

1. Solve problems related to sex-influenced traits.

What you need: pen and paper

What to do:

1. Read the given problem:
   A. A bald male (XYBB) is crossed with a female who is heterozygous non-bald (XXBb).
   B. A man who is heterozygous bald (XYBb) is crossed with a female who is bald (XXBB)
2. Illustrate using a Punnett square the probability of having children who will have normal vision and children who will be color-blind.

A. XYBB x XXBb

♂ / ♀	XB	YB
XB		
Xb		

B. XYBb x XXBB

♂ / ♀	XB	Yb
XB		
XB		

Guide Questions: (Separate answers for A and B)

1. What are the possible genotypes of male? _____
2. What is the percentage that there will be a bald child? _____
3. What is the percentage that there will be a non-bald child? _____
4. Will there be a bald female? _____
5. Will there be a bald male? _____

Let's Study and Analyze!

The two crosses made from activity 4.1 showed probability or chances of the children to inherit the trait for color blindness or hemophilia in the family. Figure 9 shows an example of Ishihara's Test Plates. It is the most well – known colorblind test. There are plates presented wherein each has set of colored dotted plates, showing either a number or a path.

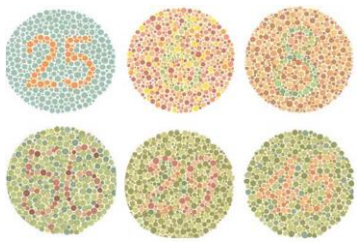


Figure 9. Ishihara's test
https://bit.ly/3x1FLGB

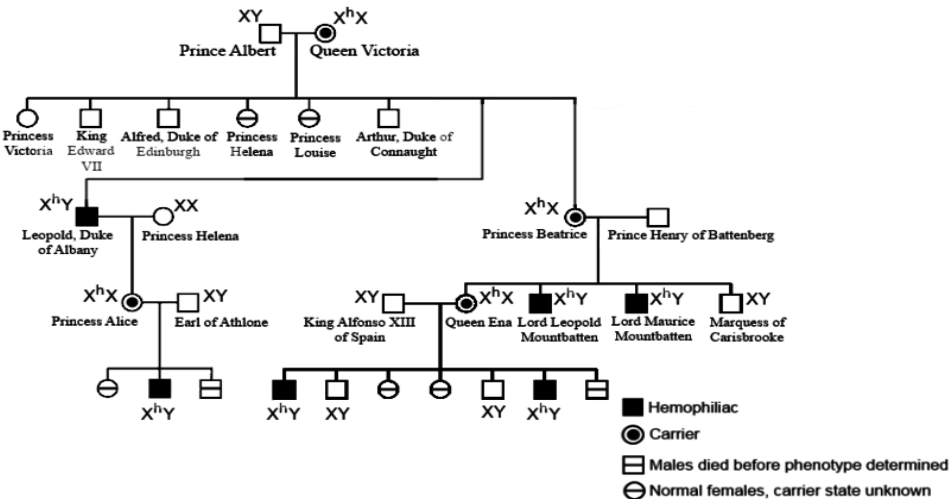


Figure 10. Queen Victoria Pedigree Carriers

https://bit.ly/3qsZ6xK

As for hemophilia, it has been called a "royal disease". Figure 6 shows the Pedigree analysis of Queen Victoria's lineage. Of her children, one son, Leopold, had hemophilia, and two daughters, Alice and Beatrice, were carriers. Beatrice's daughter married into the Spanish royal family. She passed the gene to the male heir to the Spanish throne.

Figure 11. Hairy Ears (Hypertrichosis pinnae auris)

https://bit.ly/3wd4fv2

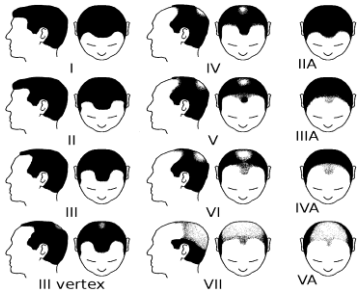


Figure 12. Male Pattern Baldness

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Figure 11 is an example of a Y-linked trait, hypertrichosis pinnae auris, a genetic disorder in humans that causes hairy ears. Since the trait is found in the Y chromosome, then only males can have the trait. Figure 12 shows the pattern baldness among men. Remember that it is most common among male because of the called hormone **dihydrotestosterone (DHT**) that is secreted by male at large amount compared to female.

What I Have Learned

Compare and contrast: Put a **check** on a box that correctly corresponds to the description or examples for sex – linked and sex – influenced traits.

Description/Examples	SEX -LINKED	SEX – INFLUENCED
1. Targets sex chromosomes		
2. Targets body chromosomes		
3. Color – blindness		
4. Pattern baldness		
5. Hemophilia		
6. Hypertrichosis pinnae auris		
7. Is affected by male hormone(testosterone)		
8. Usually produces a carrier for a trait.		

What I Can Do

Read and solve the following genetic problem. Make a Punnett square for each item. Indicate the percentage probability of a trait to be inherited by the children.

KEY: X^C= ***normal vision*** X^c = ***color blind***

X^H= ***non hemophilic*** X^h = ***hemophilic***

1. (Color blindness) A man who is normal is crossed with a woman who is colorblind.
2. (Hemophilia) A man who has hemophilia is crossed with a woman who is a carrier.
3. (Baldness) A man who is normal is crossed with a woman who bald.

♂ / ♀	X^C	Y
X^c		
X^c		

♂ / ♀	X^h	Y
X^H		
X^h		

♂ / ♀	Xb	Yb
XB		
XB		

Assessment

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Which is an example of sex - influenced trait among humans?
   A. pattern baldness B. colorblindness C. hemophilia D. sex-linked

2. It is an inheritance that is both expressed on both sexes but more frequently in one than in the other sex.
   A. sex-influenced B. colorblindness C. hemophilia D. all of the choices

3.What happens when sex chromosomes of males have a gene for colorblindness?
A. males sometimes become colorblind or carrier
B. males have still normal vision and not colorblind
C. males will become colorblind
D. males are normal vision

4. Which sex-related inheritance includes hypertrichosis pinnae auris or hairy air among men?
A. color blindness B. sex-linked C. sex-influenced D. hemophilia

5. If one of the two X chromosomes in females has an allele for hemophilia, what would be her phenotype?
A. normal
B. hemophiliac
C. non-hemophilic but carrier
D. none of the choices

Additional Activities

Solve the following crosses and identify the correct phenotypes and percentage using a Punnett square.
1. If a **father is hemophilic** and a **mother is non-hemophilic but carrier,** what could be the possible phenotypes and its percentage (children)?
2. If a **father has normal vision** and a **mother is colorblind**, what could be the possible phenotypes and its percentage (children)?
3. If a **father is heterozygous for baldness** and a **mother is heterozygous non-bald**, what could be the possible resulting phenotypes and its corresponding percentages (children)?

Posttest

Read and understand each item carefully and encircle the letter corresponding to the word or group of words that completes the sentence.

1. Bases in a DNA are complementary. Which is true of its complementary base if there are 35 Thymine in the DNA strand?
   A. there will be 35 Guanine bases
   B. there will be 35 Adenine bases
   C. only 25 Adenine, since a DNA is helical
   D. cannot be determined

2. Which is **NOT TRUE** about DNA nucleotide?
   A. it contains a nitrogen base.
   B. it has a pentose or 5-carbon sugar compound.
   C. it has a phosphate group.
   D. it contains two or more bases.

3. If Roberto's father has hemophilia and his mother is a carrier, what is the chance that Roberto would inherit the disease?
   A. 25% B. 50 %* C. 75% D. 100%

4. A heterozygous allele shows a phenotype that is intermediate of the two homozygous phenotypes being crossed. Neither allele is dominant over the other. Which Non-Mendelian pattern of inheritance is referred to?
   A. incomplete dominance C. multiple Alleles
   B. co-dominance d. sex-Linked trait

5. Tan colored birds are the result of the cross between a white (W) and a brown (B) colored birds. If the off springs are 50% tan and 50% white, what are the genotypes of their parents?
   A. BB x BB B. BB x WW C. BW x WW D. BW x BW

6. Which of the following **BEST** describes a gene?
   A. It is a DNA. C. It is a segment of DNA.
   B. It is smaller than DNA. D. It is a tightly coiled DNA

7. Which is **TRUE** about a chromosome?
   A. it is a double helical molecule C. it is a segment of DNA
   B. it is a protein packed DNA D. it is smaller than a gene

8. It is referred to as the union of egg and sperm cells to form a new organism.
   A. mutation C. zygote
   B. fertilization D. offspring

9. Which of the following happens to form gametes (sex cells) among male and female organism?
   A. meiosis C. reproduction
   B. mitosis D. fertilization

10. Which of the following determines the sex of an organism?
   A. the female parent C. both parent
   B. the male parent D. none of the choices

11. It is a non-Mendelian inheritance wherein traits are expressed independently like the coat color of cats.
   A. multiple alleles C. sex – linked
   B. incomplete dominance D. co-dominance

12. For blood types, if one parent is heterozygous A and the other parent is heterozygous B, what could be the possible blood types of children?
    A. A, B, and O
    B. A, AB, and A
    C. A and O
    D. A, AB, B, and O

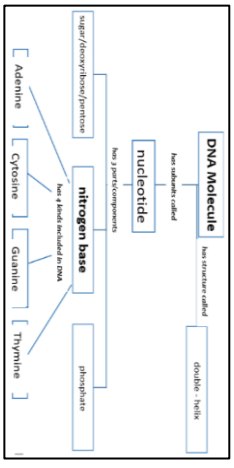
13. How many percent would be the chance of the children to inherit hemophilia if a mother has hemophilia (X^hX^h) and the father is non-hemophilic (X^HY)?
    A. 0%
    B. 25%
    C. 50%
    D. 75%

14. The DNA has a double – helical structure forming a twisted ladder. The backbone and steps of the ladder is composed of individual nucleotides bonded together. What important biological compounds that make up the backbone of the DNA molecule?
    A. nitrogen bases
    B. pentose / 5-carbon sugar
    C. pentose and phosphate
    D. phosphate group

15. It is a non-Mendelian trait that results to blended colors of flowers of some plants.
    A. sex – limited
    B. incomplete dominance
    C. co-dominance
    D. multiple Allele

Answer Key

LESSON 1



What I Know
1. d
2. d
3. c
4. c
5. b
6. b
7. d
8. b
9. a
10. c
11. c
12. b
13. b
14. a
15. b

What's In
1. mitochondrion
2. nucleus
3. lysosome
4. cytoplasm
5. chloroplast

What's New
143 – I love you
Lol – laughing out loud
J4f – just for fun
Idk – I don't know
OTW – on the way
Yolo – you only live once

What's More
1. A = green, G = yellow, C = blue, T = red
2. sugar, phosphate, base
3. A – T, C – G
4. Double-helix
5. It serves as the blueprint of life that contains codes needed for growth, development, and reproduction of all organisms.

Assessment
1. C
2. C
3. B
4. B
5. B

What I have Learned
1. Phosphate
2. Pentose
3. Nitrogen bases

Let us try this
1. Watson and Crick
2. Double-helix
3. Phosphate, pentose, base
4. Nucleotide
5. Purine and pyrimidine
6. 1
7. GCC-TAT-AAC-TCG
   CGG-AGT-TGC-TAC
   TAC-CCA-TTA-GCG

Additional Act
1. deoxyribose
2. adenine
3. pentose
4. pyrimidine
5. nucleotide
6. thymine
7. purines
8. phosphate
9. cytosine
10. base
11. helix
12. parallel

LESSON 2

What's In

1. DEOXYRIBONUCLEIC ACID
2. ADENINE
3. DOUBLE HELIX
4. NITROGEN BASE
5. CYTOSINE
6. PENTOSE
7. GUANINE
8. PHOSPHATE
9. THYMINE
10. NUCLEOTIDE

What's More

1. 23
2. 46
3. genes
4. DNA
5. segment
6. codes
7. trait
8. deoxyribonucleic acid
9. nucleotide
10. bases
11. double-helix

G.Q.

1. No, every organism in the planet has unique and specific counts of chromosomes
2. Genes code for all

What I Have Learned

Possible answers

1. It has a rod -shaped structure, DNA that is packed tightly
2. It is a small part or sequence of a DNA molecule.

What I can do

Possible answers

1. If there are incorrectly reproduced gene it may result to abnormalities in the body of organism. This instance will fall under the negative effects of mutation.
2. DNA must be coiled tightly to easily fit inside the cell's nucleus. This will also help facilitate the cell division among organisms.
3. Yes. 46 chromosomes mean there are also 46 DNA strands that are tightly coiled.

Assessment

1. C
2. B
3. A
4. C
5. D

LESSON 3

What's In	What's More	What I Have Learned:
1. Phenotype 2. Allele 3. Dominant 4. Recessive 5. Homozygous 6. Heterozygous 7. Genotype 8. Punnett square **What's New** 1. Incompletely Dominant 2. BB 3. Gray Hair **What is it?** 1. Non-Mendelian 2. Incomplete Dominance 3. Co-Dominance 4. Pink 5. Red	**Act. 3.1** 1. WW and RW 2. Pink 3. White and Pink 4. 50 % WW and 50% RW **Act. 3.2** 1. In problem1: roan In problem 2: chestnut and roan In problem 3: roan and white 2. YES 3. Possible answer: Animal breeders can cross breed animals in order for them to get the desired traits that will improve livestock in terms of meat quality and milk production.	1. Incomplete 2. Co-dominance 3. Incomplete 4. Incomplete 5. Co-dominance 6. Incomplete 7. Co-dominance 8. Co-dominance **What I Can Do** 1. Red-RR, Blue-BB, Purple-RB a. Genotype: 100% RB b. Phenotype: 100% Purple c. 100% d. 0% 2. a. BB b. WW c. BW 3. a. 0 % b. 50% c. 50% **Assessment:** 1. A 2. A 3. C 4. D 5. B

LESSON 4

Mother's blood types

AB, A, B, O
B, AB
AB
B, A

What's In

1. Incomplete dominance results to intermediate inheritance of a trait
2. Codominance results to a dominant expression of both alleles.

What's New

1. A, B
2. O
3. AB, B
4. B, O
5. O, AB

What's more

	I^i	I^i
I^A	I^AI^i	I^AI^A
I^B	I^BI^i	I^BI^B

G.Q.

1. AB, A
2. I^AI^A, I^BI^i

50% A and 50%

Continuation:

a.)

	I^A	I^B
I^A	I^AI^A	I^AI^B
I^i	I^AI^i	I^BI^i

b.)

	I^A	I^B
I^A	I^AI^A	I^AI^B
I^B	I^AI^B	I^BI^B

What I Have Learned

1. 4
2. A, AB, B, O
3. 6
4. I^AI^B, I^AI^A, I^AI^i, I^BI^B, I^BI^i, ii
5. O

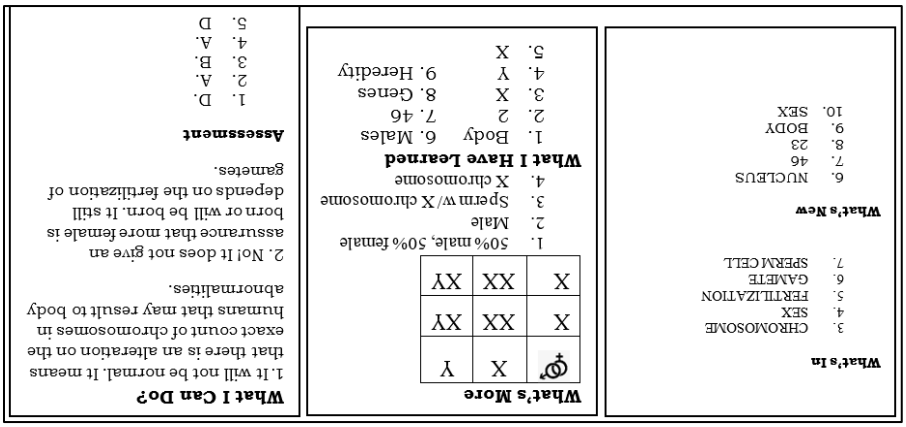
What I Can Do

There is a chance that the child is theirs because their genotypes could heterozygous to both types. If that is the case, blood type O is possible.

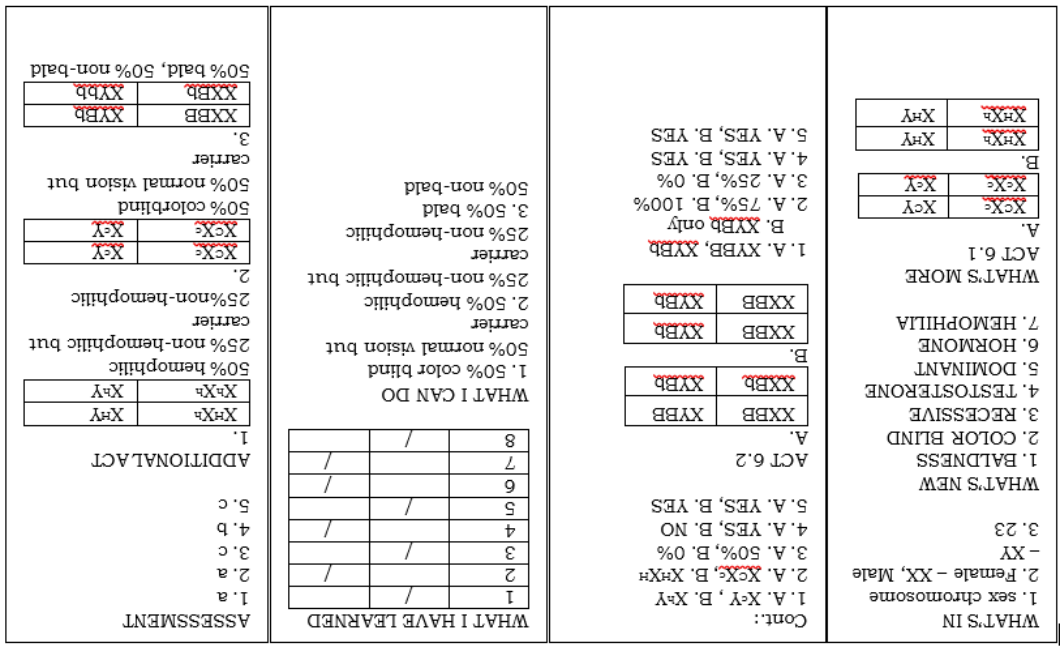
Assessment

1. C
2. C
3. B
4. C
5. D

LESSON 5



LESSON 6



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