Non-Mendelian Inheritance

I Lesson

In this lesson, you will learn the different patterns of Non-Mendelian inheritance. This is a type of inheritance wherein the patterns of phenotypes does not coincide with those that was presented in the Mendelian Laws of inheritance. It also describes the inheritance of traits linked to a single gene in the chromosomes.

To better understand the patterns of non-Mendelian inheritance it is important to note the key terms like:

Term	Meaning
Incomplete dominance	Pattern of heredity in which one allele is not completely dominant over another
Codominance	Pattern of heredity in which both alleles are Simultaneously expressed in the heterozygote
Multiple alleles	A gene that is controlled by more than two alleles
Pleiotropy	When one gene affects multiple characteristics
Lethal allele	Allele that results in the death of an individual
Polygenic trait	Traits that are controlled by multiple genes

There are different activities that you can explore in this lesson. You will be able to analyze monohybrid crosses involving incomplete dominance, co-dominance and sex linkage. You will also describe the complex patterns of in-heritance and analyze monohybrid crosses of blood types.

Some traits are controlled by sex-related inheritance. In humans, sex is determined by XX chromosomes for females and XY chromosomes for males. Sex-related in heritance can be categorized in three ways: (a) sex-linked traits which are determined by genes located on the sex chromosome, (b) sex-influenced traits which occur when phenotypes are different between males and females with the same genotype and (c) sex-limited traits are those traits that can only be expressed in one sex or the other.

Sex-limited traits are generally autosomal, which means that they are not found on the X and Y chromosomes. Sex-limited traits are those that are expressed exclusively in one sex however sex-influenced traits are expressed in both sexes but more frequently in one than in the other sex.

Several sex-linked genes were also discovered in human beings. An example is color blindness. The ability to discriminate between the colors red and green is controlled by the gene located in the X chromosome. Inability to distinguish between the two colors is due to a recessive allele of this gene. Sex - Linked traits are inherited through the sex chromosomes. Males have only one X chromosome. Thus, if they inherit the affected X, they will have the disorder. Females have two X chromosomes. Therefore, they can inherit or carry the trait without being affected if it acts in a recessive manner.

Learning Task 1: Examine the sample problem given below. Use the same genotypes to determine the offspring's of the crosses between X^bY male and female with X^bX^b. Find the genotypes, phenotypes, genotypic and phenotypic ratio of the offspring.

Male-pattern baldness is a recessive sex linked trait in which affected people become bald

Sample Test Cross: male with X^bY mated female with X^BX^b genotype

Genotypes: X^B = no baldness (dominant)

X^b=male-pattern baldness (recessive)

Using Punnet Square:

	X^b	Y
X^B	X^BX^b	X^BY
X^b	X^b X^b	X^bY

Genotypes	**Phenotypes**
X^BX^b	Female normal
X^b X^b	Female bald
X^BY	Male normal
X^bY	Male bald

Genotypic ratio: 25% X^BX^b ; 25% X^b X^b ; X^BY and 25% X^bY

Phenotypic Ratio: 25% female normal, 25% female bald; 25% male normal and 25% male bald

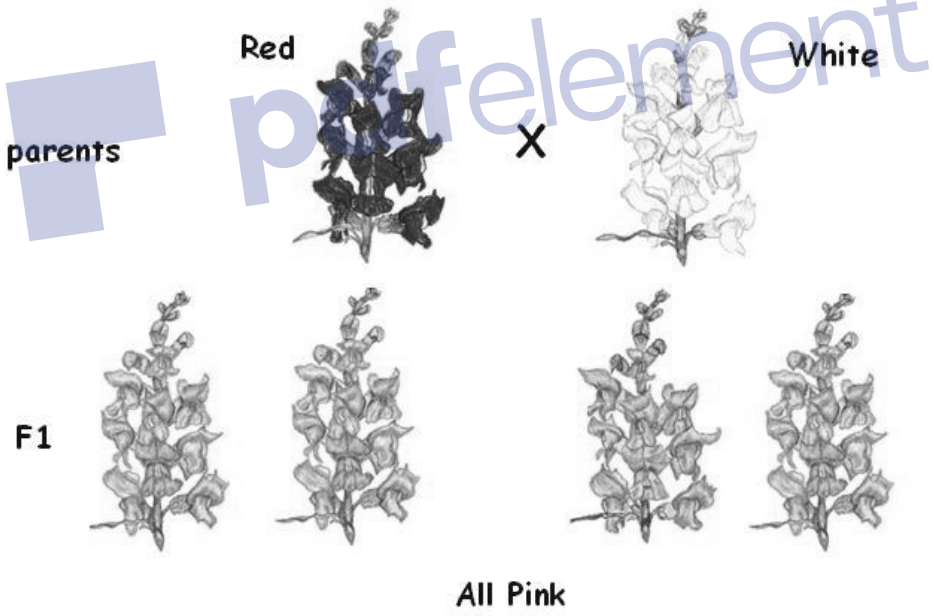
Learning Task 2: Read the handout about exploring snapdragon. Answer the guide questions in your notebook.

Handout: Exploring Snapdragons

In this activity you will investigate the genetic trait of a flower color in snapdragons which does not follow Mendel's Law of Dominance

Recalling Mendel's Law of Dominance, one allele can mask the expression of another allele when they are joint together. Therefore, if a person has a heterozygous genotype (i.e. one dominant allele and one recessive allele), he/she will show the dominant phenotype (i.e. physical trait).

In snapdragons, there are two alleles for flower color - one coding for red color and one coding for white color. When purebred red plants and purebred white plants are crossed, the resulting offspring (i.e. the F1 generation) are all pink. When the pink offspring are crossed to create a third generation (i.e. the F2 generation), 25% of the offspring are red, 50% are pink, and 25% are white. These results are summarized in the next page.



Guide Questions :

1. State Non-Mendellian`s Law of Inheritance.
2. What are the two alleles for flower color in snapdragon?

Learning Task 3: Given the genotypes and phenotypes of flower color for P and F_1, solve for the genotypes and phenotypes of F_2 generation .

Exploring Snapdragons

Prove how the following flower color was produced in the F^1 and F^2 generation.

Generation	Flower Color
P (parent)	Red x White
F_1	100% Pink
F_2	25% Red 50% Pink

Legend:

Red flower - F^R

White flower - F^w

Pink flower - F^RF^W

	F^R	
F^w	F^RF^w	F^RF^w
F^w	F^RF^w	F^RF^w

→ 100% F^RF^w Pink flower

F^1 (example)

Offspring with corresponding %

→

F^2Offspring with corresponding %

D

Learning Task 4: Answer the following questions. Write your answer in your notebook.

Guide Questions

1. Based on the results of the genetic crosses , why do you think the red and white flower alleles can "interact with one another? Explain both the F^1 and F^2 generations.

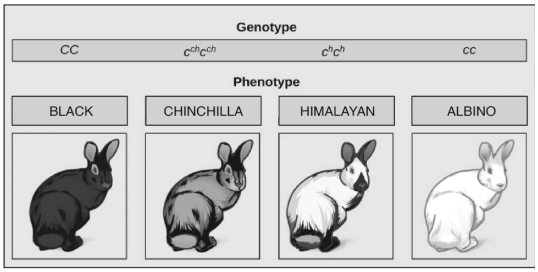
2. How are the results of the crosses differ if the red allele was dominant over the white allele? Explain both the F^1 and F^2 generations.

E

Learning Task 5: Read and understand the pattern of inheritance in multiple alleles**.** Answer the guide question in your notebook.

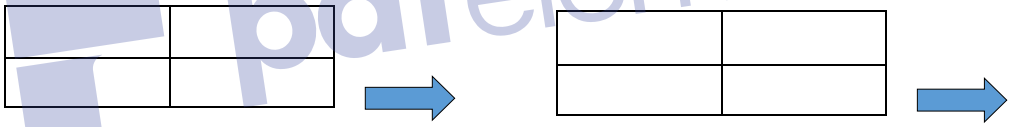
Multiple Alleles

Mendel studied just two alleles of his pea genes, but real populations often have multiple alleles of a given gene. In this activity you will learn how to crossed the gene for coat color in rabbits (the C gene) which comes in four color alleles (C, C^{ch}, C^{h}, c) as shown by the figure below.



Using the given genotypes, find the F^1 and F^2 generation of the crossed between black rabbit and chinchilla, the crossed of himalayan and albino. Use the Punnet squares below to guide you.

A. Black (CC) x Chinchilla ($C^{ch}C^{ch}$)



F^1 Offspring with corresponding % **F^2 Offspring with corresponding %**

Guide Question

1. Based on the results of the genetic crosses you have shown, how do you think the red and white flower alleles can "interact with one another? Explain both the F^1 and F^2 generations.
2. How are the results of the crosses differ if the red allele was dominant over the white allele? Explain both the F^1 and F^2 generations.

A

Learning Task 6: Create a family tree showing the F1 and F2 generations of your mother and father side. Describe the dominant traits that appear in both families. Illustrate your answer in your notebook.