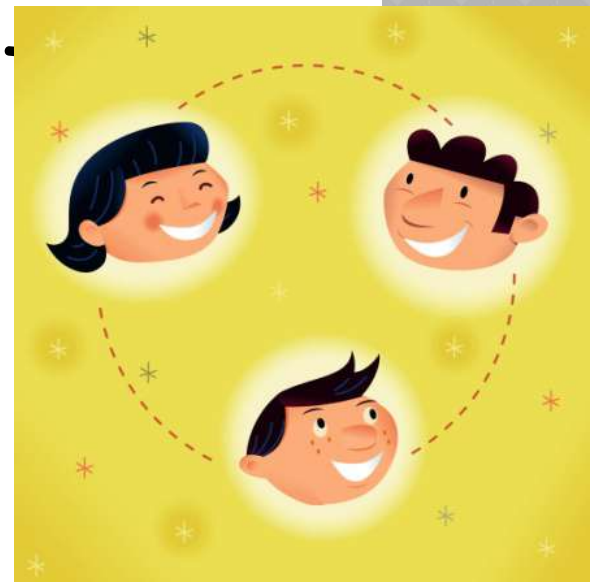
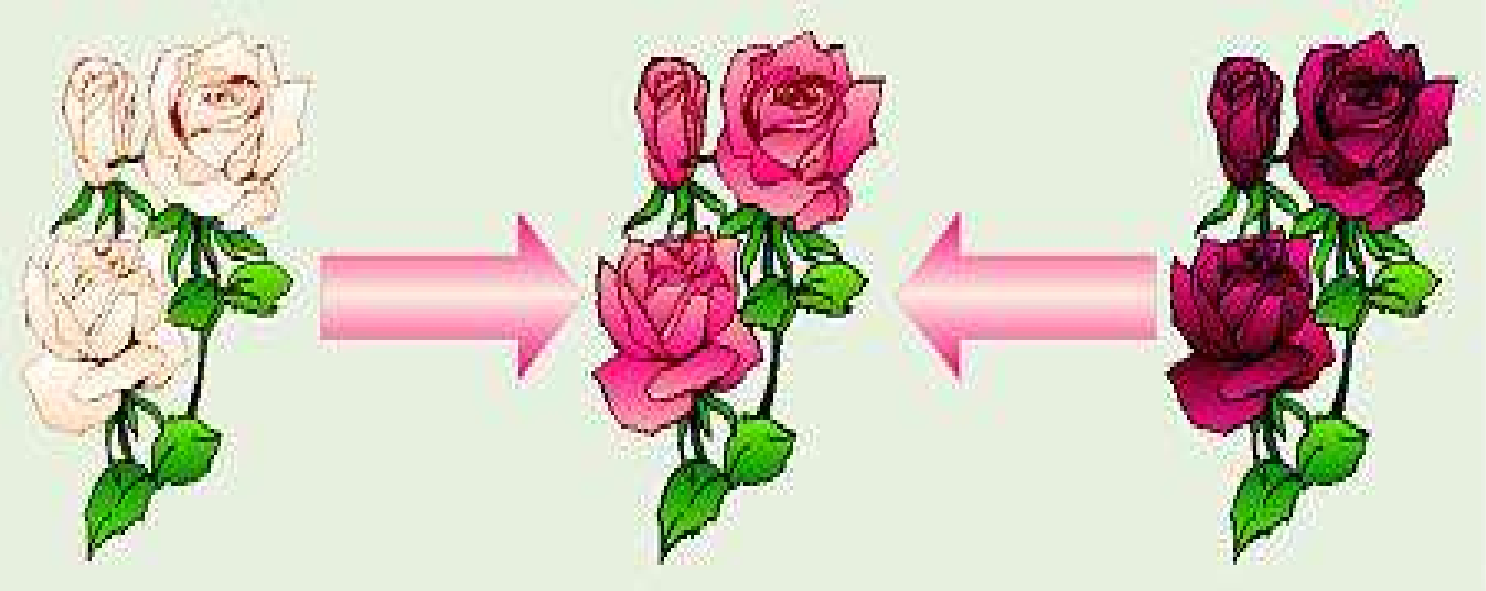
DIFFERENT INHERITANCE PATTERNS

- **Not** all traits are simply inherited by dominant and recessive alleles (Mendelian Genetics). In some traits, neither allele is dominant or many alleles control the trait. Below are different ways in which traits can be inherited from parent offspring.



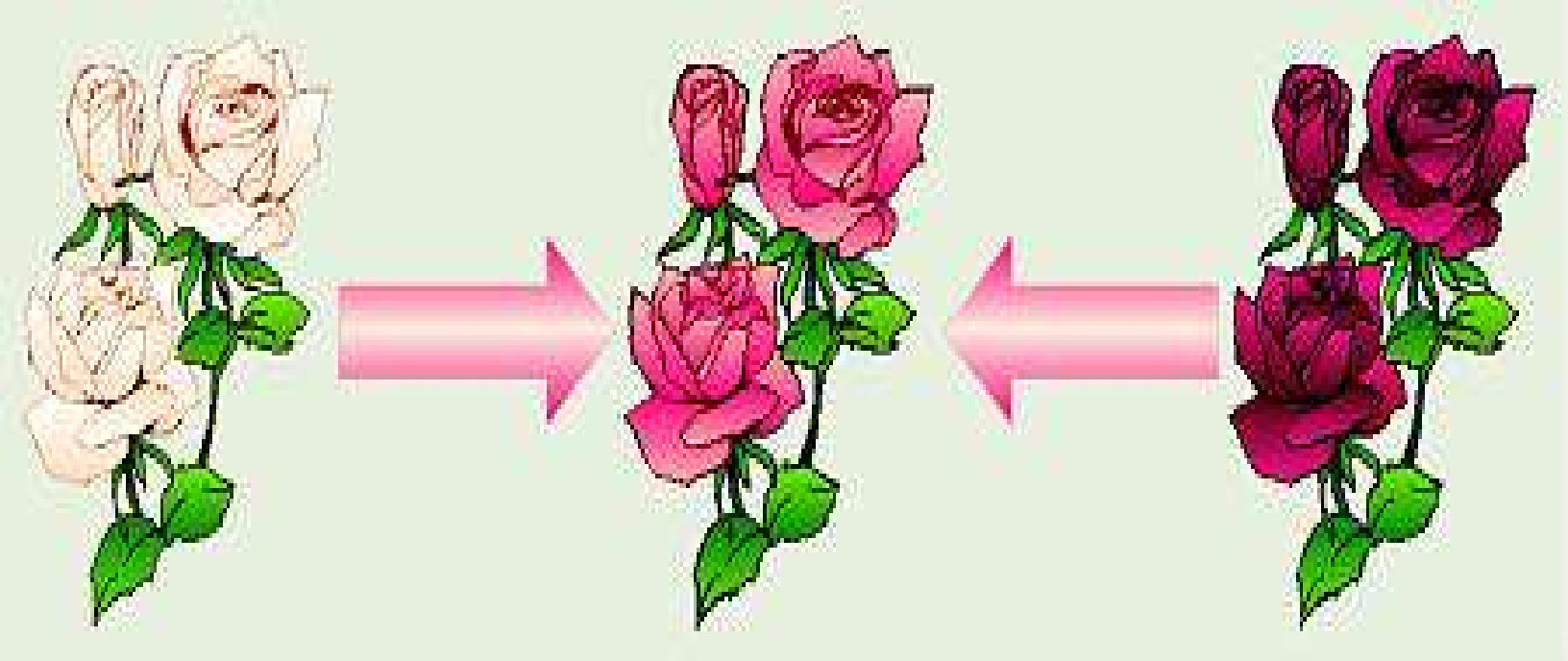
1. INCOMPLETE DOMINANCE

- *Definition:*
  - Neither allele for a gene **dominates**
  - Phenotype of the heterozygous offspring will be a **BLEND** of the 2 homozygous parents.



INCOMPLETE DOMINANCE

- Ex: A **homozygous** white flower crossed with a **homozygous** red flower will produce all **heterozygous** pink flowers.



INCOMPLETE DOMINANCE

- *Notation:*
  - Alleles are all capital letters because NEITHER one **dominates** the other. So one of the alleles has a **prime** (') on it to represent an alternate expression of the gene.

- Always make a **KEY** to show the genotypes and the resulting phenotypes.

- Still supports Mendel's Law of Independent Assortment

- *Ex. 1) In a certain species of flowers, snapdragons, the combined expression of both alleles for flower color produces a new phenotype- pink. A red snapdragon is homozygous and is crossed with a homozygous white snapdragon. What are the genotypic and phenotypic ratios of this cross?*

Key:

Red = RR

White=R'R'

Pink = RR'

P cross = RR x R'R'

	R	R
R'	RR'	RR'
R'	RR'	RR'

G: 100% RR'

P: 100% PINK

- *Ex. 2) Then cross the F_1 generation and what are the genotypic and phenotypic ratios of this cross?*

Key:

Red = RR

White=R'R'

Pink = RR'

P cross = RR' x RR'

	R	R'
R	RR	RR'
R'	RR'	R'R'

G: 1RR:2RR':1R'R'

P: 1Red:2Pink:1white

2. CODOMINANCE

- *Definition:*
  - Both **alleles** are expressed **EQUALLY**

CODOMINANCE

- Phenotypes of heterozygous offspring are showing both traits!
  - Ex: red cows crossed with white will generate roan cows. **Roan** refers to cows that have red coats with white blotches.

CODOMINANCE

- *Notation:*
  - 2 **different** alleles (capital letters) are used
  - Always make a **KEY** to show the genotypes and the resulting phenotypes

- In chickens, black-feathered is not wholly dominant over white-feathered, so heterozygous chickens are black and white checkered. Cross two heterozygous chickens. What would the appearance of their offspring be?

Key:

Black= BB

Checkered= BW

P cross = BW x BW

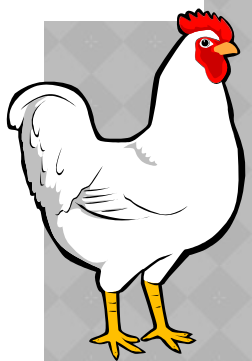
	B	W
B	BB	BW
W	BW	WW

Phenotype:

1Black:

2 Checkered:

1white



- *In shorthorn cattle, the hybrid between red and white is called a roan. What phenotypes would result in the cross of a roan and a white?*

Key:

Red= RR

Roan= RW

P cross = RW x WW

	R	W
W	RW	WW
W	RW	WW

Phenotype:

2 Roan: 2 white

3. MULTIPLE ALLELES

- *Definition:*
  - **More than 2 alleles** for a single gene can control a trait.
- Multiple alleles must be studies by looking at the entire population of species.

MULTIPLE ALLELES

- Each individual carries only 2 alleles for any gene (one on each homologous chromosome).
  - In this form of inheritance, a trait can have 1 gene, but **100 alleles** for that gene.

MULTIPLE ALLELES

- Ex: The human blood group can be any combination of A, B, and O

MULTIPLE ALLELES

- The alleles are I^A, I^B, and **i**
  - Alleles **A** and **B** are **CODOMINANT**
  - Alleles **i** ("O") is **RECESSIVE**

Notation:

- The possible genotypes/phenotypes:

GENOTYPES	PHENOTYPES
I^AI^A	type A blood
I^Ai	type A blood
I^BI^B	type B blood
I^Bi	type B blood
I^AI^B	type AB blood
ii	type O blood

MULTIPLE ALLELES

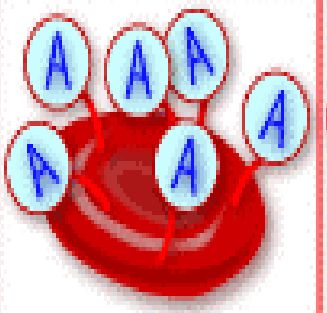
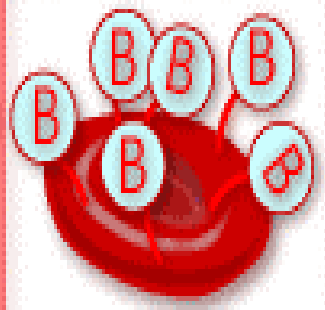
- *NOTE:* the "**i**" is dropped from the genotype of A and B when the **phenotype** is written.

- (Genotype $\mathbf{I^Ai}$ is type ***A*** blood)

INTERESTING FACT:

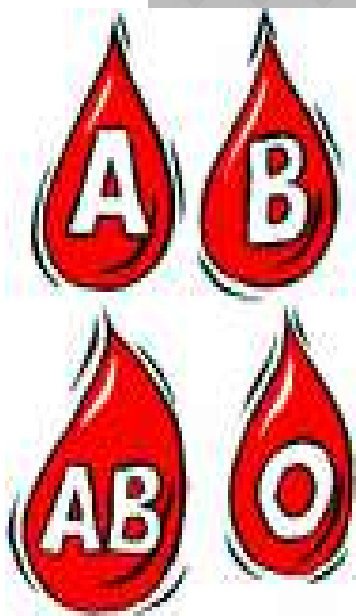
- In the U. S., about 45% of the population is type O, 42% type A, 10% type B, and only 3% type AB.

The ABO Blood System

Blood Type (genotype)	Type A (AA, AO)	Type B (BB, BO)	Type AB (AB)	Type O (OO)
Red Blood Cell Surface Proteins (phenotype)	 A agglutinogens only	 B agglutinogens only	 A and B agglutinogens	 No agglutinogens

- The positive and negative of a blood type is called the **Rh factor**, it is a totally separate **gene** with Rh^+ (RR or Rr) and Rh^- alleles (rr)
  - If you have the protein = Rh +
  - If you DO NOT have the protein = Rh –

- In the U. S., about 85% of the population is Rh^+ and 15% Rh^-.
- Thus the chances of someone being O- [having both ii and rr] would be 45% × 15% = 6.75%.



- The most rare blood type would be **AB-**, about 0.45% of the population.
  - **O** is the universal donor
  - **AB** is the universal receiver

- 1) If a person of blood group AB marries one belonging to group O, what could be the possible genotypes and phenotypes of their offsprings' blood types?

- P cross = $I^A I^B$ x ii

	I^A	I^B
i	$I^A i$	$I^B i$
i	$I^A i$	$I^B i$

Genotypes:

2 $I^A i$: 2 $I^B i$

Phenotypes:

2 Type A: 2 Type B

- *If a father is homozygous blood type A and the mother is heterozygous blood type B. What could be the possible genotypes and phenotypes of their offspring's blood types?*

- P cross = $I^A I^A$ x $I^B i$

	I^A	I^A
I^B	$I^A I^B$	$I^A I^B$
i	$I^A i$	$I^A i$

Genotypes:

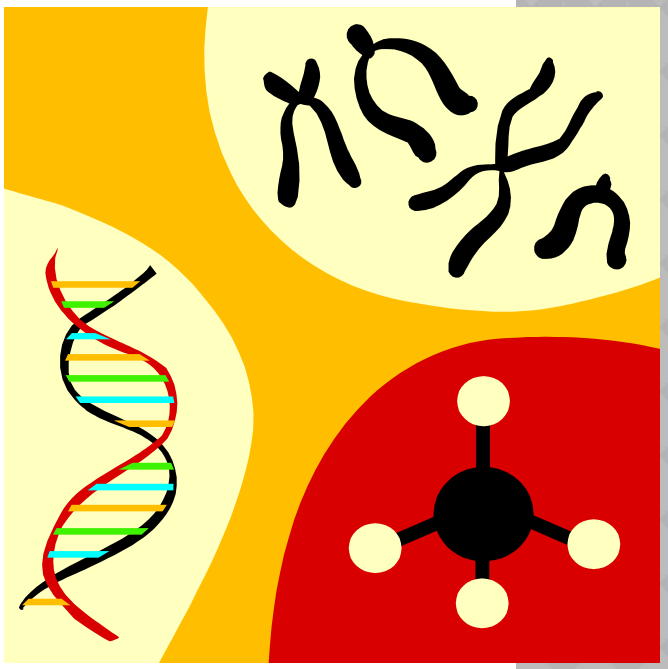
2 $I^A i$: 2 $I^A I^B$

Phenotypes:

2 Type A: 2 Type AB

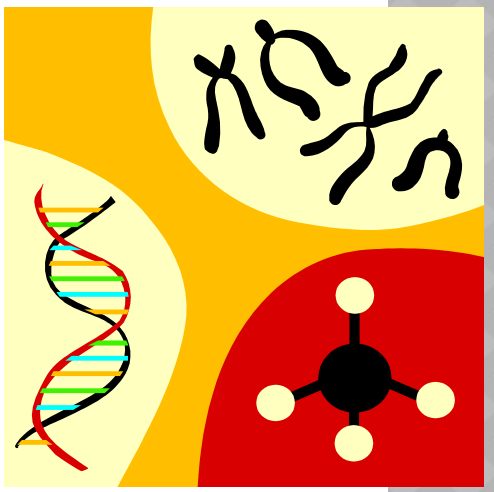
2 Types of Chromosomes:

- 1. **Sex chromosomes**- last pair of chromosomes—23rd pair for humans
  - XX = **female**
  - XY = **male**



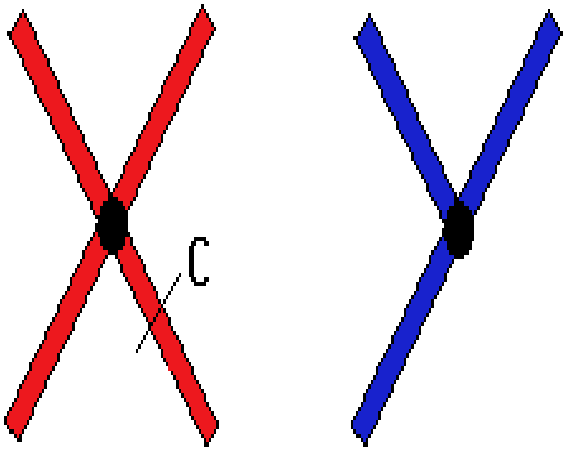
- **Autosomal chromosomes** or **Autosomes**

- All other pairs of chromosomes – 1 -22nd pair in humans



4. SEX-LINKED TRAITS (X-LINKED)

- Other genes besides the alleles for sex are located on the sex chromosomes.

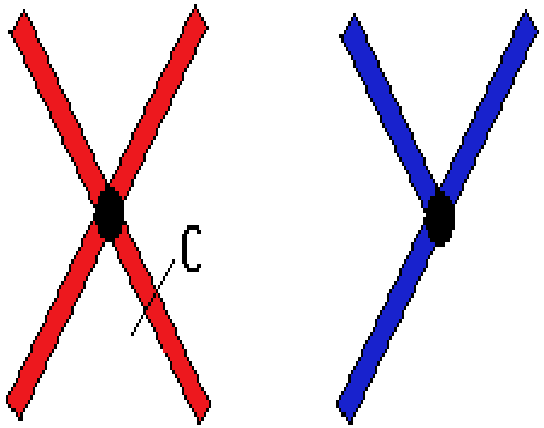


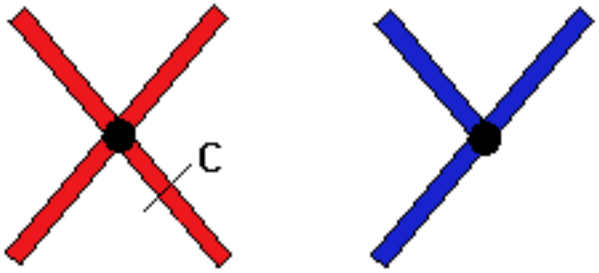
- *Definition:*

- These traits will occur **MORE** frequently in males than females, such as color blindness and hemophilia.

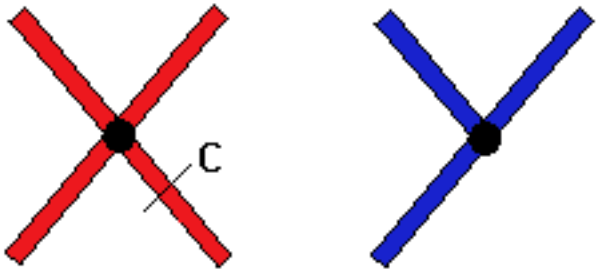
WHY?

- Alleles for a gene may be present on the X chromosome but **absent** on the Y. These are called sex-linked genes.

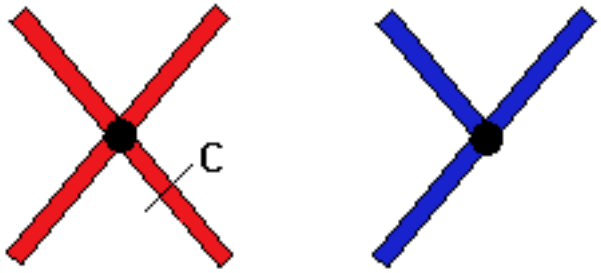




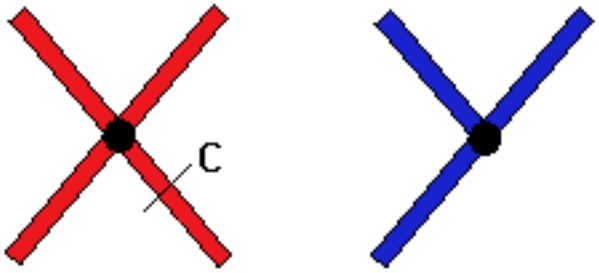
- This means that **males** may inherit just **one** allele for a characteristic and that allele will be expressed, whether it is dominant or recessive, because it is the **only** allele present on their X chromosome.



- X-linked traits most likely will be **RECESSIVE** to the normal condition and the Y chromosome lacks the gene for a trait, so males have a higher chance of having the disorder.

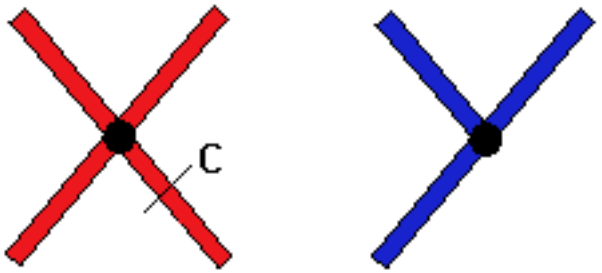


- These traits *generally* do NOT show up in **females** since females have genes on both their X chromosomes.



- *Notation:*
  - The alleles for these traits are written as **superscripts** on the **X** chromosome ONLY.

- **No** alleles are written on the Y chromosome!
  - Ex: Colorblind male = X^bY and Normal male = X^BY
- **Heterozygous** FEMALES are known as **carriers**, X^BX^b



- *Ex.1) Color blindness is a sex-linked trait that is caused by a recessive allele. A colorblind man marries a woman that is homozygous for normal vision.*

- P cross X^NX^n x X^nY

	X^N	X^n
X^n	X^NX^n	X^nX^n
Y	X^NY	X^nY

What possible types of vision could be found if they had ***boys?*** ***Normal***

What possible types of vision could be found if they had ***girls?*** ***Normal***

- *Ex.2) A girl of normal vision, whose father was colorblind, marries a colorblind man. What types of vision could be found in their children?*

- P cross = X^NX^n x X^nY

What types of vision could be found in their children?

	X^N	X^n
X^n	X^NX^n	X^nX^n
Y	X^NY	X^nY

Normal vision and colorblindness

5. POLYGENETIC INHERITANCE

- Traits are determined by **MANY genes**
- They may or may not be found on the same chromosome
- Each gene may have more than 2 alleles

- The phenotypes may vary depending on the number of dominant and recessive alleles in the genotype

- Traits that show **great variability** are a result of polygenic inheritance

  - Ex: eye color, skin color, height, facial features

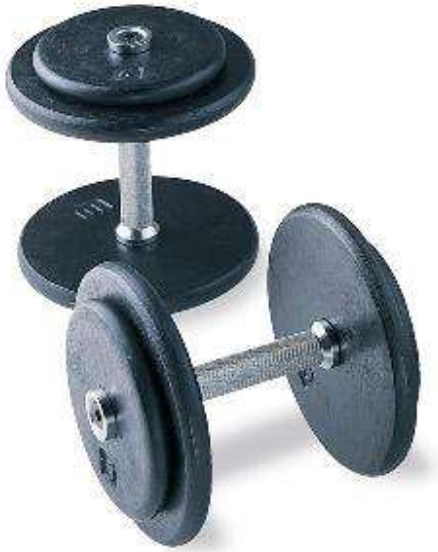
ENVIRONMENT & GENES

- The **environment** can determine whether or not a gene is fully expressed or expressed at all.

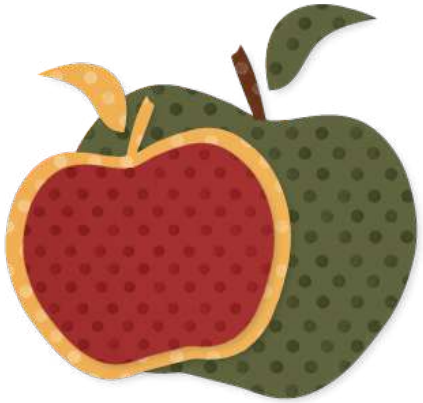
- Internal and external environments can affect phenotypes:

1. Influence of ***internal environment:***

~ **Hormones** based on sexes (testosterone, estrogen)



2. Influence of ***external environment:***



~Temperature

~Light

~Infectious agents (viruses, bacteria)

~Chemicals

~Nutrition

- All of these can influence the expression of genes.