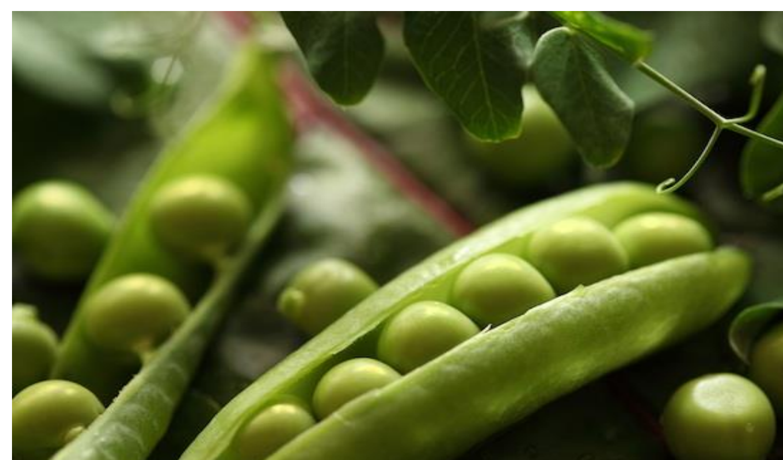
Non-Mendelian Genetics

- **Standard**: Students will analyze how biological traits are passed on to successive generations
- **Element**: Using Mendel's laws, explain the role of meiosis in reproductive variability
- **EQ**: What are some exceptions to Mendelian genetics?

- Gregor Mendel was fortunate to have studied pea plants because of their simple patterns of heredity
- He used these patterns to discover that one trait is always dominant over the other

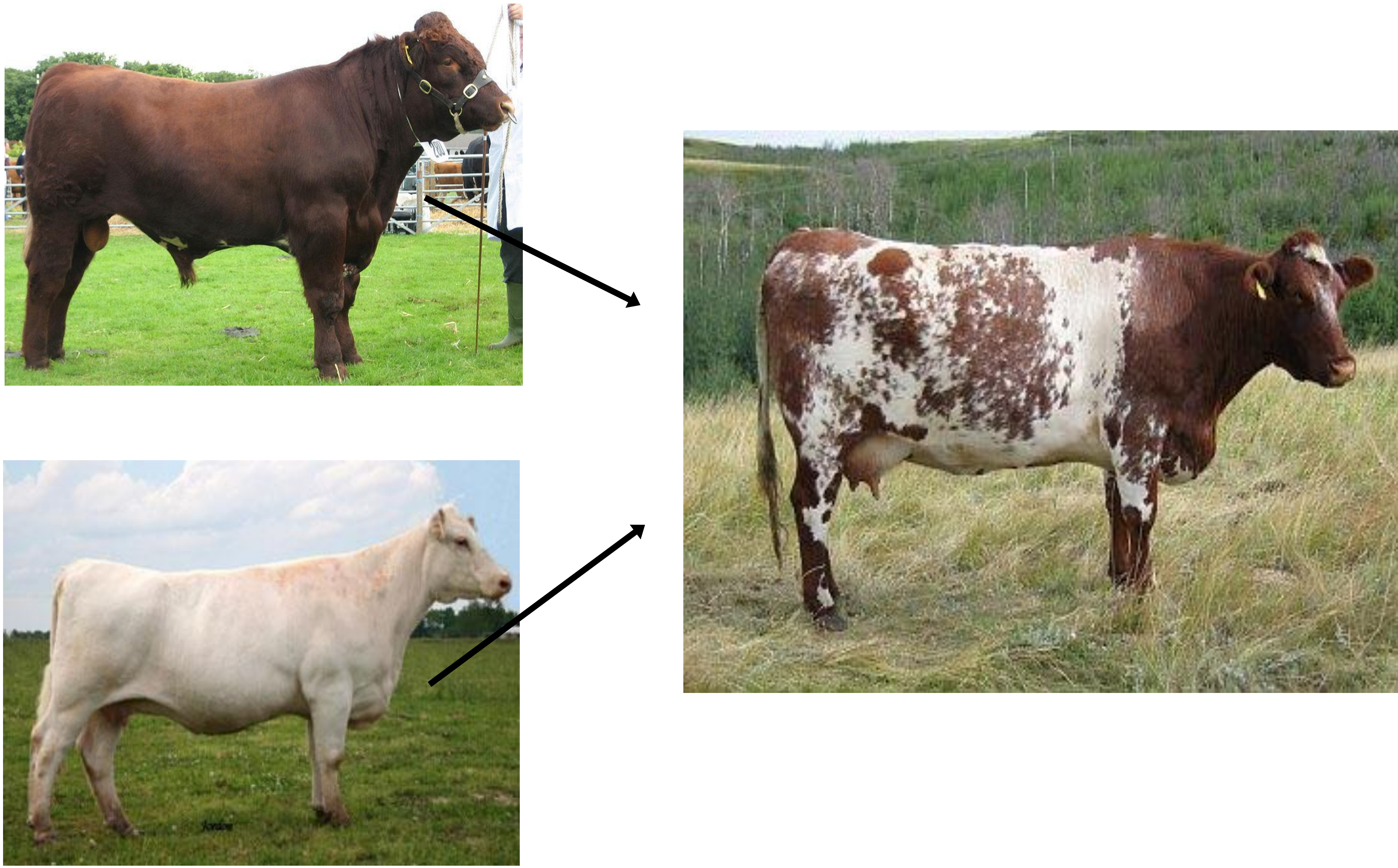


- Sometimes an organism's traits don't follow the rules that Mendel came up with, and today we will learn about some of these cases, called **codominance**, **incomplete dominance**, and **sex-linked traits.**

Codominance

- Occurs when *two alleles are fully expressed* at the same time
- In other words, *both alleles* are **dominant**

Example of Codominance: Roan Cattle



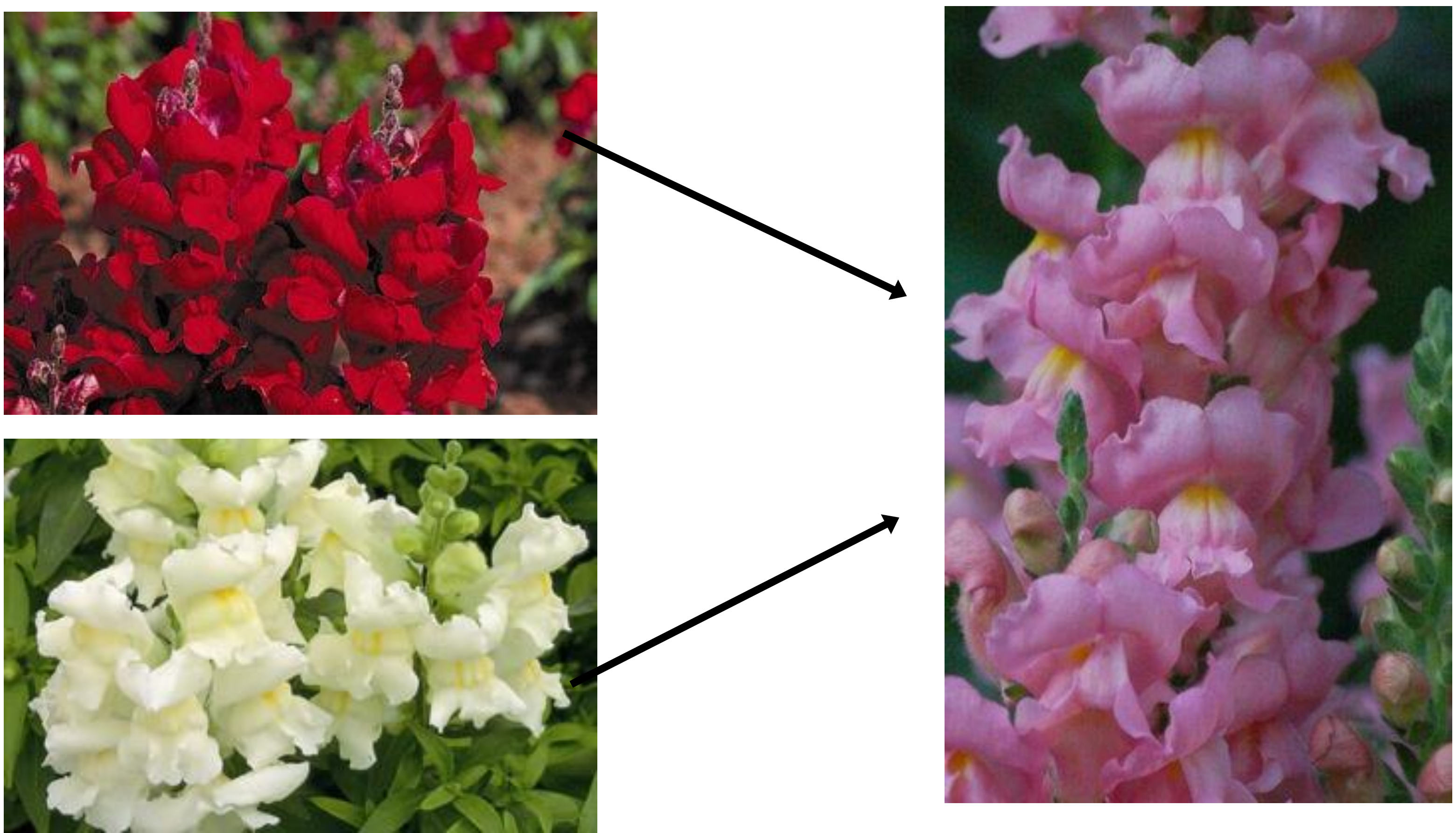
Punnett Square with Codominant Alleles

- Since both alleles are dominant, each needs to be represented by a **capital letter**. Since they are both capital, we need two **different** letters to tell the two alleles apart
- IN the roan cow example, we can use the letter **R** for the red allele and the letter **W** for the white allele
- A cow with a **heterozygous** genotype would be **RW** which would result in the roan coloration

- That means we have three possible genotypes for coat color, each with a different phenotype:
- <u>Genotype:</u> <u>Phenotype:</u>
  - WW White
  - RR Red
  - RW Roan
- Make a Punnett square for a cross between a white cow and a roan bull:
  - What are the possible phenotypes of the offspring?

Incomplete Dominance

- Occurs when the offspring's trait is a combination of the two parents' traits.
- In this case **<u>neither allele</u>** is fully dominant



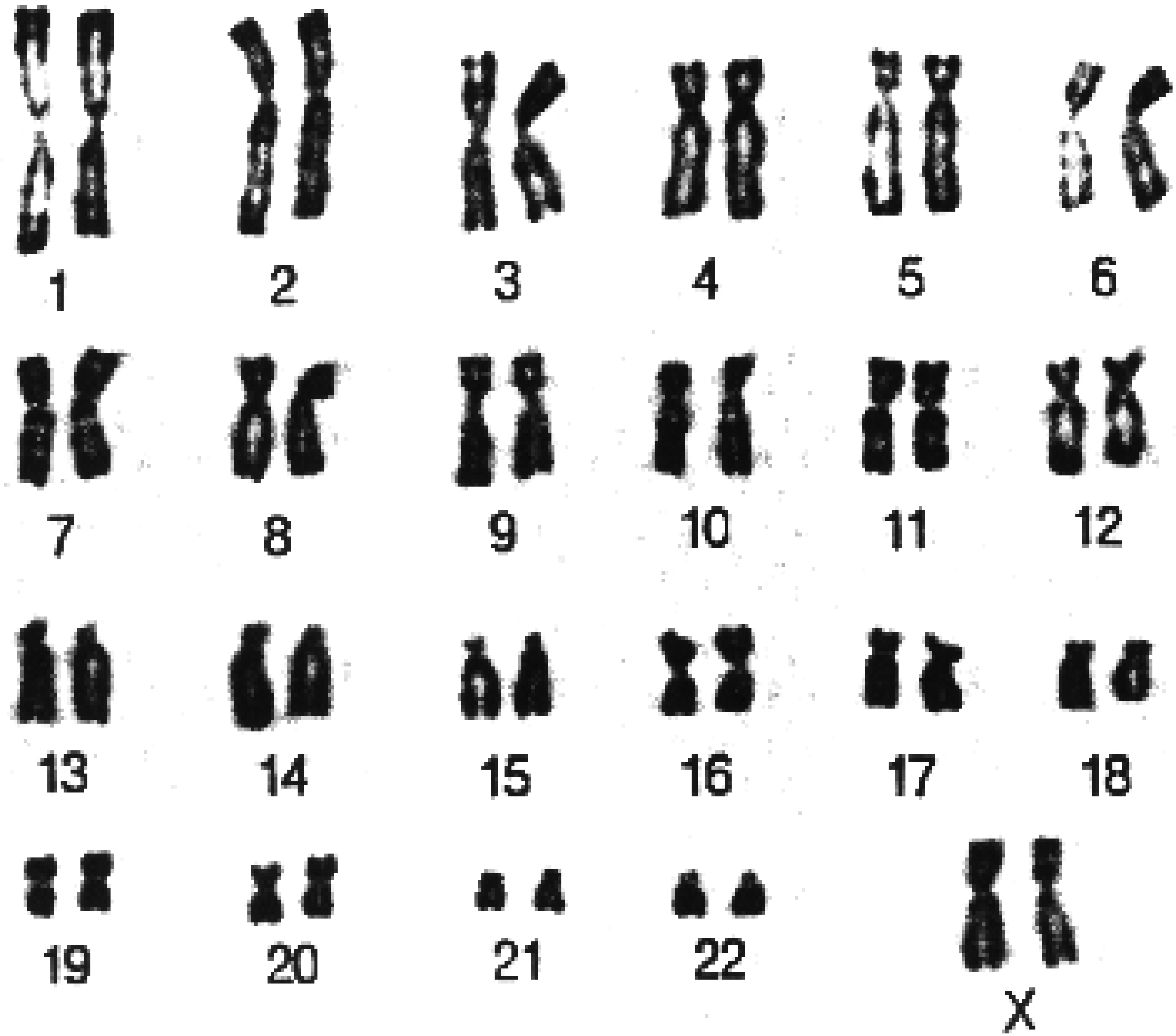
Punnett Square with Incompletely Dominant Alleles

- Alleles are represented by **two different capitol letters**
- In the snapdragon example, we can use the letter **R** for the red allele and the letter **W** for the white allele
- A flower with a **heterozygous** genotype would be **RW** which would result in pink petals

- That means we have three possible genotypes for flower color, each with a different phenotype:
- <u>Genotype:</u> <u>Phenotype:</u>
  - WW White
  - RR Red
  - RW Pink
- Make a Punnett square for a cross between a pink snapdragon and a red snapdragon:
  - What are the possible phenotypes of the offspring?

Sex-Linked Trait

- In this case, the inheritance of a trait depends on the **sex** of the individual
- Before we talk about how to make a Punnett square for sex-linked traits, we must discuss the **two** different types of chromosomes, **autosomes** and **sex chromosomes**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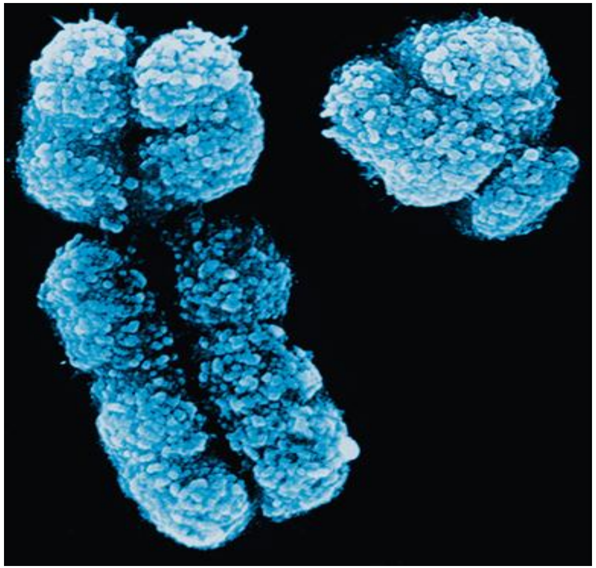
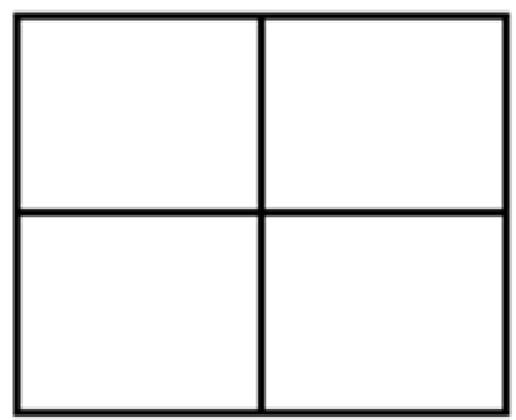
- The chromosomes in an organism that determine its sex are called **sex chromosomes**.
- The rest of the chromosomes do not affect the sex of the organism. These are called **autosomes**
- Humans have 22 pairs of autosomes and a single pair of sex chromosomes. The sex chromosomes are called **X** & **Y**
- Females have the genotype **XX**
- Males have the genotype **XY**



- A gene is sex-linked if it is found **on a sex chromosome.**
- This usually means it will be on the **X chromosome** because the Y chromosome is very small and doesn't contain many **genes**
- So when we use Punnett Squares for sex-linked traits, we always use X and Y as the alleles, but we add a **superscript** to show the different traits
- $\mathbf{X^A}$: sex-linked, dominant
- $\mathbf{X^a}$: sex-linked, recessive

Punnett Squares with Sex-Linked Traits

- Hemophilia is a recessive sex-linked disorder so $\mathbf{X^H}$ would be the **normal** allele and $\mathbf{X^h}$ would be the allele that **causes the disease**
- Draw a Punnett Square for a man who has hemophilia and a woman who is homozygous dominant
- **Genotypes:**
  – **Man**:________
  – **Woman**:_________



- Remember, females have **two** X chromosomes. Males only have **one** X (and one Y).
- If one X chromosome is defective, a female will have **another copy**, which is most likely normal. That means sex-linked traits affect **males** more than females.
- A female with one normal X and one defective X (for example XX) is said to be a **carrier** of the trait
- A carrier might pass the defective allele to her offspring even though she **does not have the disease.**

- Suppose a normal man and a woman who is a carrier for hemophilia have a child. What is the chance of this child having hemophilia?
- **Genotypes:**
  - **Man:______**
  - **Woman:______**

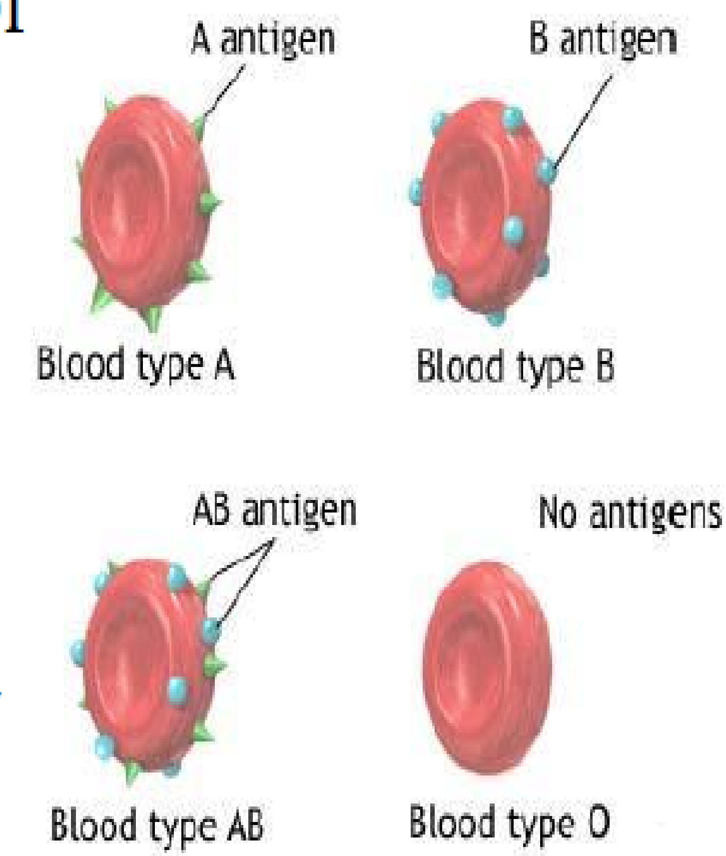
Multiple Alleles

Multiple Alleles

Instead of just one dominant and one recessive allele, some characteristics are controlled by **three or more alleles**.

One common example of multiple alleles is the determination of human blood type. There are four major types of blood: Types **A, B, AB,** and **O** (these types can also be + or – which results from a different gene for a protein known as Rh factor).

To make a Punnett square for multiple alleles, you need to know something about the inheritance pattern (what is dominant/recessive, what is codominant?). In the ABO blood group example, A and B are **codominant** and O is **recessive.**



That means we have six possible genotypes for blood type, but four different phenotypes:

Genotype:	Phenotype:
AA	Type A blood
AO	Type A blood
BB	Type B blood
BO	Type B blood
AB	Type AB blood
OO	Type O blood

- Make a Punnett square for a cross between a person with AB blood and a person with type O:
- What are the possible blood types of the offspring?
- NOTE: Even though there are multiple alleles present in the population, each individual can only inherit TWO alleles (one from each parent).