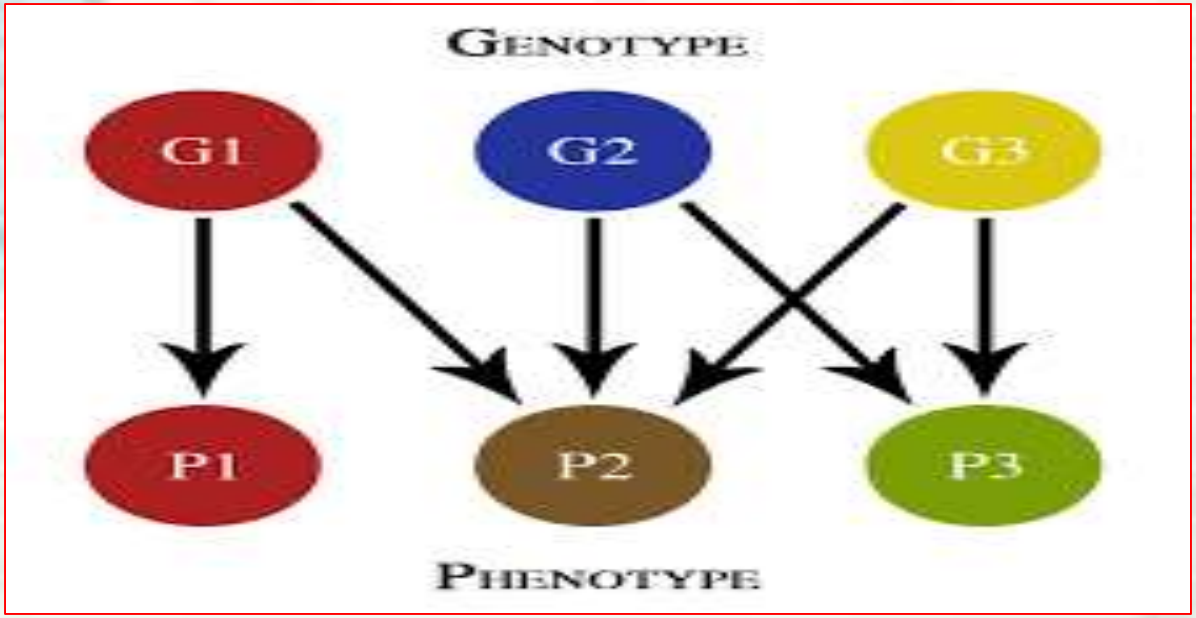
# Pleiotropism, Pseudo-alleles and Multiple alleles




**Dr. Pratibha Bisen**
**Dept. Plant Breeding & Genetics**
**College of Agriculture, Balaghat**
**JNKVV Jabalpur (M.P.)**

# Pleiotropism

✓The term pleiotropie was coined in a 1910 by **Festschrift** .

✓Greek word ***Pleion***=more and ***tropos***= character

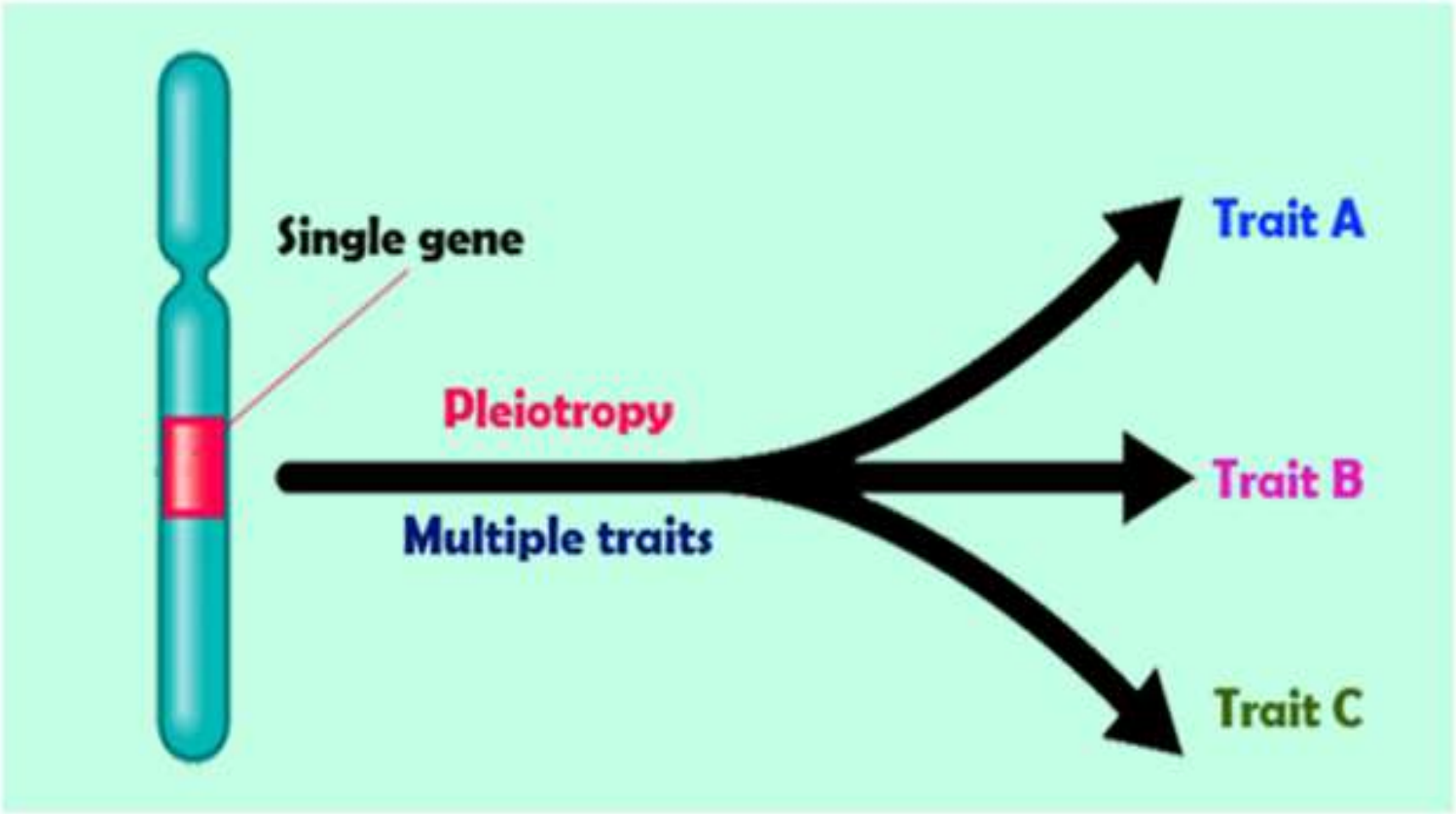
✓Pleiotropy refers to the expression of multiple traits by a single gene.

✓These expressed traits may or may not be related.

✓Pleitropy was first noticed by geneticist Gregor Mendel, who is known for his famous studies with pea plants.

✓Mendel noticed that plant flower color (white or purple) was always related to the color of the leaf axil (area on a plant stem consisting of the angle between the leaf and upper part of the stem) and seed coat.

✓The study of pleitropic genes is important to genetics as it helps us to understand how certain traits are linked in genetic diseases.


Single gene
Pleiotropy
Multiple traits
Trait A
Trait B
Trait C

**Pleitropy can be spoken of in various forms:**

✓**Gene pleiotropy** is focused on the number of traits and biochemical factors impacted by a gene.

✓**Developmental pleiotropy** is focused on mutations and their influence on multiple traits.

✓**Selectional pleiotropy** is focused on the number of separate fitness components affected by a gene mutation.

✓**Antagonistic pleiotropy** is focused on the prevalence of gene mutations that have advantages early in life and disadvantages later in life.

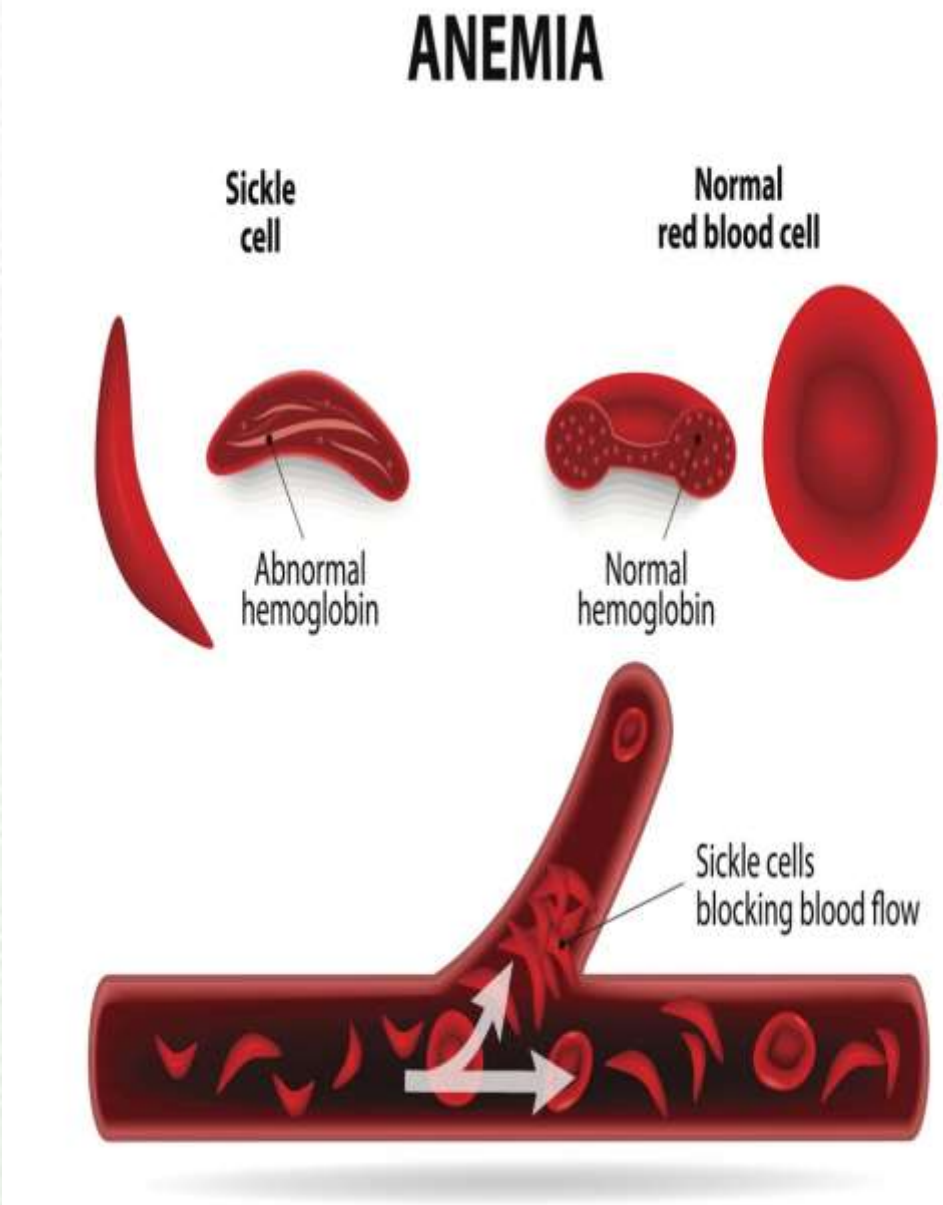
# Pleiotropy Examples

✓**Sickle cell disease**

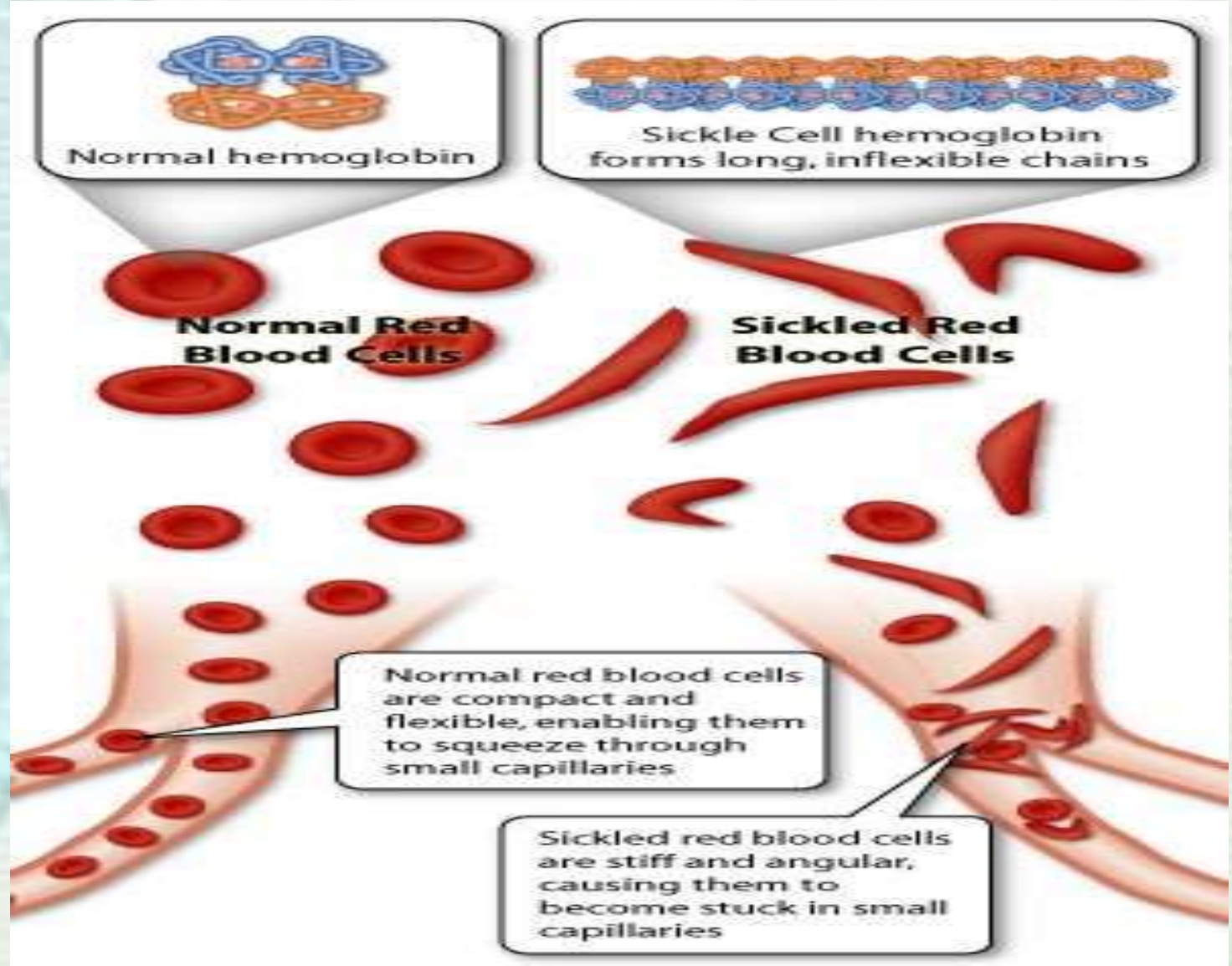
✓ Sickle cell disorder results from the development of abnormally shaped red blood cells.

✓Normal red blood cells have a biconcave, disc-like shape and contain enormous amounts of a protein called hemoglobin.

✓Sickle cell is a result of a mutation in the beta-globin gene. This mutation results in red blood cells that are sickle-shaped, which causes them to clump together and become stuck in blood vessels, blocking normal blood flow.



✓The single mutation of the beta-globin gene results in various health complications and causes damage to multiple organs including the heart, brain, and lungs.



# Pseudoalleles

✓**Pseudoallelism** is a state in which two genes with similar functions are located so close to one another on a chromosome that they are genetically linked.

✓Term given by **Morgan 1928** and **Lewis 1948**.

✓This means that the two genes (pseudoalleles) are nearly always inherited together. Since the two genes have related functions, they may appear to act as a single gene.

✓ In rare cases, the two linked pseudoalleles can be separated, or recombined. One hypothesis is that pseudoalleles are formed as a result of gene duplication events, and the duplicated genes can undergo gene evolution to develop new functions.

## Characteristic of pseudoalleles:

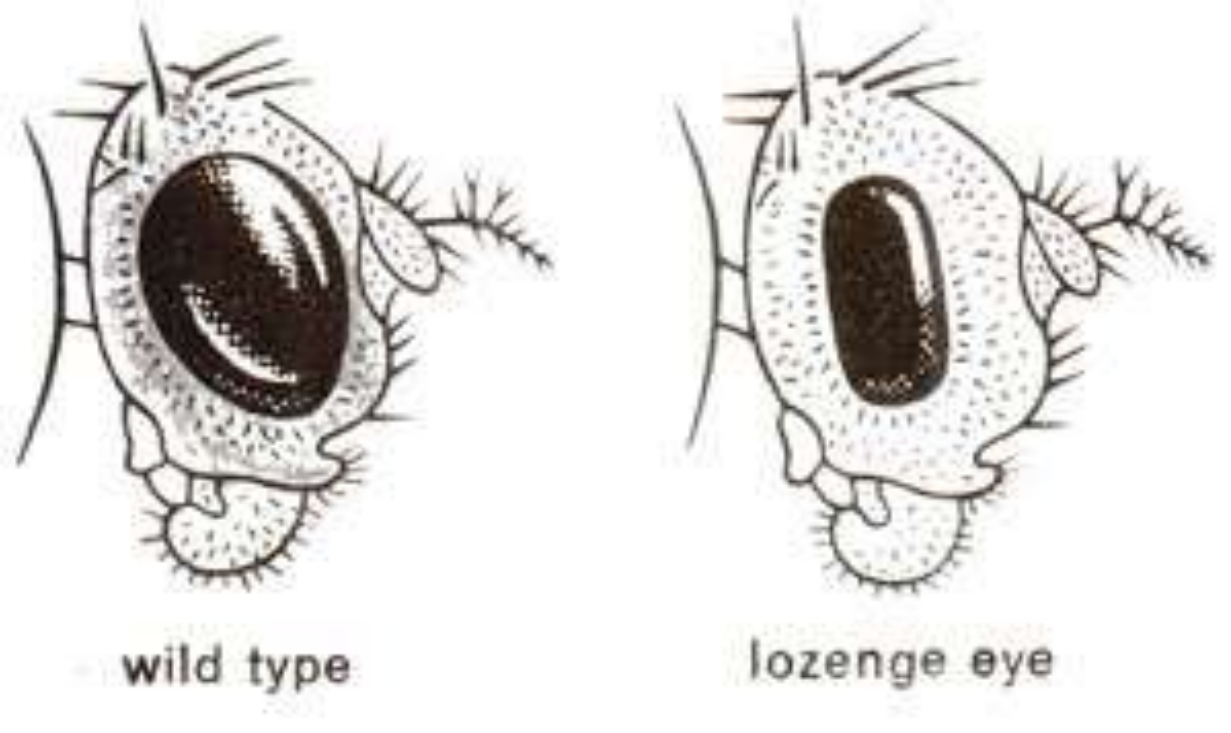
- These are closely linked allele within which crossing over occur.
- They affect the same character.

**Example**:

✓Red eye colour of *Drosophila* has different mutants like white and apricot.

✓They affect pigmentation i.e., affect the same character. So, they are allelic.

✓They can undergo recombination, i.e., they are nonallelic.



# Multiple alleles

✓ The word allele is a general term to denote the alternative forms of a gene or contrasting gene pair that denote the alternative form of a gene is called allele.

✓**Gene mutations** may produce many different alleles of a gene.

✓All such altered alternative forms of a gene, whose number is more than two, are called multiple alleles.

✓Any **two** of these can be present in the genome of diploid organism, but a haploid or a gamete can have just **one** of them in its genome.

✓Multiple alleles always occupy the **same locus** on the chromosome.

✓Multiple alleles always influence the **same character**.

✓**No crossing over** among the member alleles of the same Multiple alleles series.

## Important Examples of Multiple Alleles:

- ✓Wings of Drosophila
- ✓Coat Colour in Rabbit
- ✓Self-Incompetebiliyt in Plants
- ✓Blood Groups in Man
- ✓The ‘Rhesus’ Blood Group in Man

**Allele**

| | | | |
|---|---|---|---|
| $C$ | $c^{ch}$ | $c^{h}$ | $c$ |

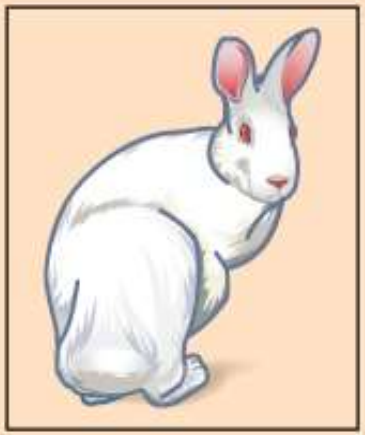
**Genotype**

| | | | |
|---|---|---|---|
| $CC$ | $c^{ch}c^{ch}$ | $c^{h}c^{h}$ | $cc$ |

**Phenotype**

| | | | |
|---|---|---|---|
| WILD TYPE: Brown fur | CHINCHILLA: Black-tipped white fur | HIMALAYAN: White fur with black paws, nose, ears, tail | ALBINO: White fur |



**Four different alleles exist for the rabbit coat color (*C*) gene.**

# ABO blood-type system in humans

✓The antigen-antibody relationship is one of the great specificity like that between lock and key.

✓Each antigen and its associated antibody has a peculiear chemical configuration.

✓**Landsteiner** discovered in 1900 that when the red cells of one person are placed in the blood serum of another person, the cells become clumped or agglutinated.

✓If blood transfusions were made between persons of two such incompatible blood groups, the transfused cells were likely to clump and shut out the capillaries in the recipient, some times resulting in death.

✓The $I^A$ allele codes for A molecules on the red blood cells, the $I^B$ allele codes for B molecules on the surface of red blood cells, and the *i* allele codes for no molecules on the red blood cells.

✓In this case, the $I^A$ and $I^B$ alleles are codominant with each other and are both dominant over the *i* allele.

✓Although there are three alleles present in a population, each individual only gets two of the alleles from their parents.

✓ This produces the genotypes and phenotypes shown in the figure below.

Notice that instead of three genotypes, there are six different genotypes when there are three alleles. The number of possible phenotypes depends on the dominance relationships between the three alleles. We will analyze how to do this in more detail in a section about non-Mendelian Punnett squares.

**Inheritance of the ABO Blood System in Humans**

| | $I^A$ | $I^B$ | $i$ |
|---|---|---|---|
| $I^A$ | $I^A I^A$ A | $I^A I^B$ AB | $I^A i$ A |
| $I^B$ | $I^B I^A$ AB | $I^B I^B$ B | $I^B i$ B |
| $i$ | $i\ I^A$ A | $i\ I^B$ B | $i\ i$ O |

| PARENTS | | CHILDREN | |
|---|---|---|---|
| Phenotypes | Genotypes | Phenotypes | Genotypes |
| O X O | ii X ii | O | ii |
| O X A | ii X $I^AI^A$ or $I^Ai$ | O, A | ii, $I^Ai$ |
| O X B | ii X $I^BI^B$ or $I^Bi$ | O, B | ii, $I^Bi$ |
| O X AB | ii X $I^AI^B$ | A, B | $I^Ai$, $I^Bi$ |
| A X A | $I^AI^A$ or $I^Ai$ X $I^AI^A$ or $I^Ai$ | A, O | $I^AI^A$, ii |
| A X B | $I^AI^A$ or $I^Ai$ X $I^BI^B$ or $I^Bi$ | A, AB, O, B | $I^Ai$, $I^AI^B$, ii, $I^Bi$ |
| A X AB | $I^AI^A$ or $I^Ai$ X $I^AI^B$ | A, B, AB | $I^AI^A$, $I^Bi$, $I^AI^B$ |
| B X B | $I^BI^B$ or $I^Bi$ X $I^BI^B$ or $I^Bi$ | B, O | $I^BI^B$, ii |
| B X AB | $I^BI^B$ or $I^Bi$ X $I^AI^B$ | A, B, AB | $I^AI^A$, $I^BI^B$, $I^AI^B$ |
| AB X AB | $I^AI^B$ X $I^AI^B$ | A, B, AB | $I^AI^A$, $I^BI^B$, $I^AI^B$ |

**Table showing possible blood types of children from parents of various blood groups**

# THANK YOU