Blood Types and Genetics

- Human blood type is determined by co-dominant alleles. An allele is one of several different forms of genetic information that is present in our DNA at a specific location on a specific chromosome.

- **Blood Types** There are three different alleles for human blood type:

Types	Simplified
I^A	A
I^B	B
i	O

- **Genotypes** Each of us has two ABO blood type alleles, because we each inherit one blood type allele from our biological mother and one from our biological father.

- Since there are three different alleles, there are a total of six different genotypes at the human ABO genetic locus on chromosome #9.

Allele from parent #1	Allele from parent #2	Genotype (offspring)	Blood Type
A	A	AA	A
A	B	AB	AB
A	O	AO	A
B	A	AB	AB
B	B	BB	B
B	O	BO	B
O	O	OO	O

- A blood test is used to determine whether the A and/or B characteristics are present in a blood sample. It is not possible to determine the exact genotype from a blood test result of either type A or type B.

- If someone has blood type A, they must have at least one copy of the A allele, but they could have two copies. Their genotype is either AA or AO. Similarly, someone who is blood type B could have a genotype of either BB or BO.

- A blood test of either type AB or type O is more informative. Someone with blood type AB must have both the A and B alleles. The genotype must be AB. Someone with blood type O has neither the A nor the B allele. The genotype must be OO.

- Each biological parent donates one of their two ABO alleles to their child. A mother who is blood type O can only pass an O allele to her son or daughter. A father who is blood type AB could pass either an A or a B allele to his son or daughter. This couple could have children of either blood type A (O from mother and A from father) or blood type B (O from mother and B from father).

- The Rh factor genetic information is also inherited from our parents, but it is inherited independently of the ABO blood type alleles. There are 2 different alleles for the Rh factor known as Rh+ and Rh-.

- Someone who is "Rh+" has at least one Rh+ allele, but could have two. Their genotype could be either Rh+/Rh+ or Rh+/Rh-. Someone who Rh- has a genotype of Rh-/Rh-. (homozygous recessive)

- Just like the ABO alleles, each biological parent donates one of their two Rh alleles to their child. A mother who is Rh- can only pass an Rh- allele to her son or daughter. A father who is Rh+ could pass either an Rh+ or Rh- allele to his son or daughter. This couple could have Rh+ children (Rh- from mother and Rh+ from father) or Rh- children (Rh- from mother and Rh- from father).

- The human *ABO* gene on chromosome 9 has three common variants of the gene. Different variants are called *alleles*.
- The A allele encodes *N*-acetylaminogalactosyltransferase and this enzyme makes the A antigen that confers blood type A. The B allele makes B antigen - blood type B.
- The O allele encodes a defective enzyme that doesn't make either antigen.
- Absence of both A antigen and B antigen - blood type will be O.

- Type A – A antigen makes antibodies against B (Can receive A or O)

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

- Type B – B antigen makes antibodies against A (Can receive B or O)

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

- Type AB has A & B antigens, makes no antibodies against A or B (would destroy itself) (Can receive A, B, AB, O)

  $I^A I^B$ (Universal recipient)

- Type O has no antigens, makes antibodies against A & B

  ii (Can receive only O)

  (Universal donor)

- Rh blood type - important for pregnant women.
- Problem - woman who has Rh-negative blood becomes pregnant with a baby (fetus) that has Rh-positive blood.
- If the blood of an Rh-positive baby mixes with the blood of an Rh-negative mother during pregnancy or delivery, the mother's immune system makes antibodies.
- Can destroy the baby's red blood cells.

- Blood must be compatible or the antibodies will make it clump when mixed
- This happens immediately and can result in death

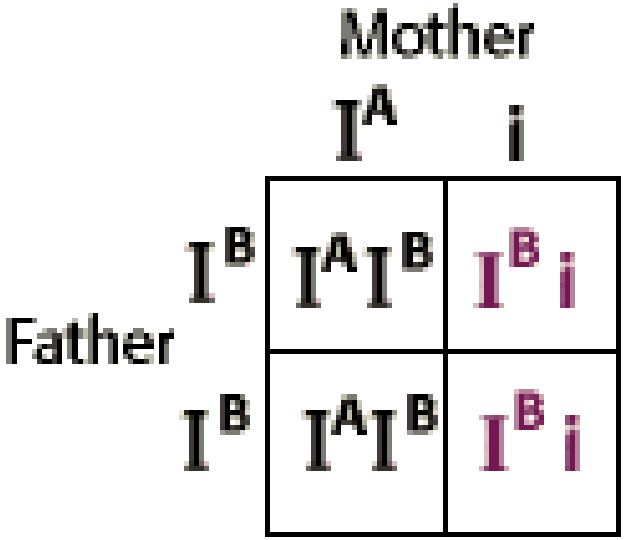
- http://waynesword.palomar.edu/aniblood.htm

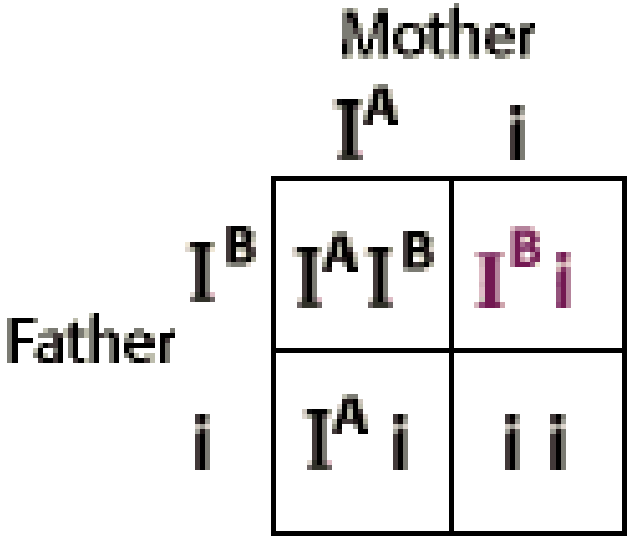
Blood Test is done:

- **Before a person gets a blood transfusion.**
- **Before a person donates blood.**
- **Before a person donates an organ for transplantation.**
- **Before surgery.**
- **When a woman is planning to become pregnant or first becomes pregnant.**
- **To show whether two people could be blood relatives.**
- **To check the identify of a person suspected of committing a crime.**

Problems:

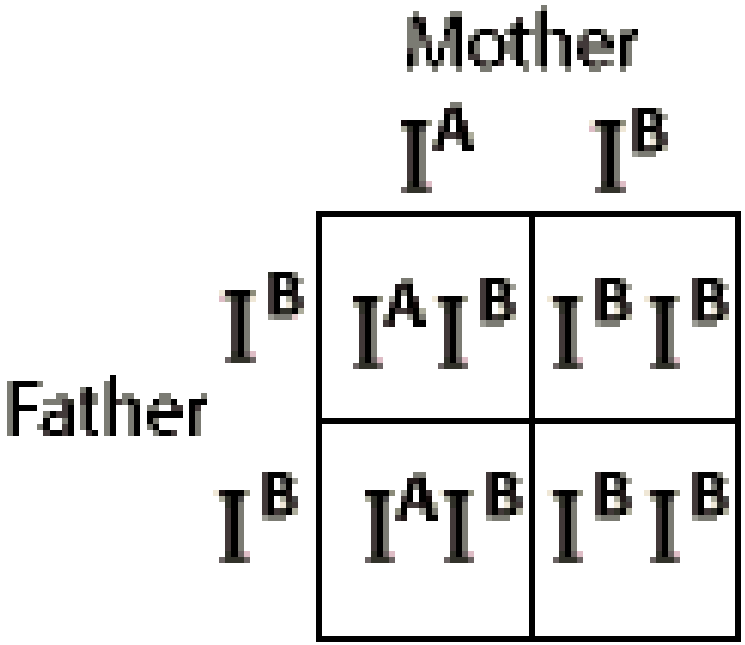
- Mom is type A
- What are the types that the fathers would have to be in order for a child to be a B+?

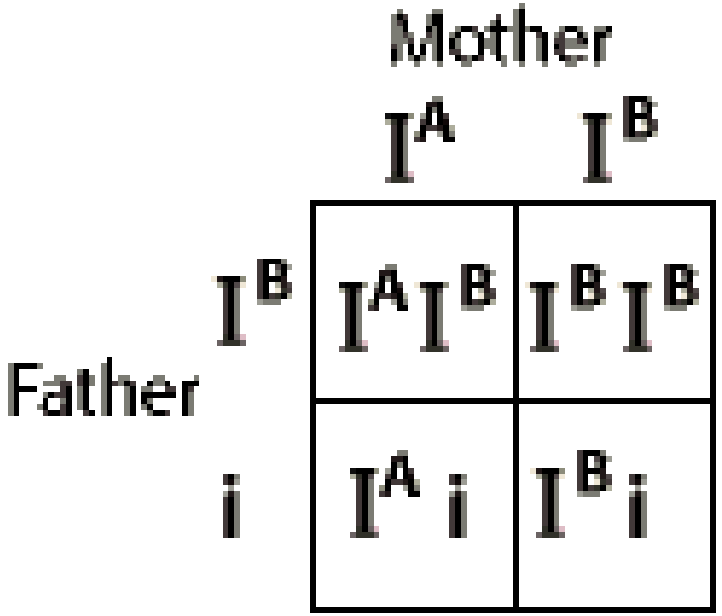

Mother
I^A
i
Father
I^B
I^B
I^AI^B
$I^B i$
I^AI^B
$I^B i$


Mother
I^A
i
Father
I^B
i
I^AI^B
$I^B i$
$I^A i$
i i

- Could a man with type B blood and a woman with type AB produce a child with type O blood?"

- The possible genotypes of a man with blood type B are BB or BO and the genotype of a woman with blood type AB is AB. The child would receive an A allele or a B allele from the mother and a B allele or an O allele from the father. Therefore, the child could not possibly be of blood type O.


Mother
I^A I^B
Father
I^B $I^A I^B$ $I^B I^B$
I^B $I^A I^B$ $I^B I^B$


Mother
I^A I^B
Father
I^B $I^A I^B$ $I^B I^B$
i $I^A i$ $I^B i$