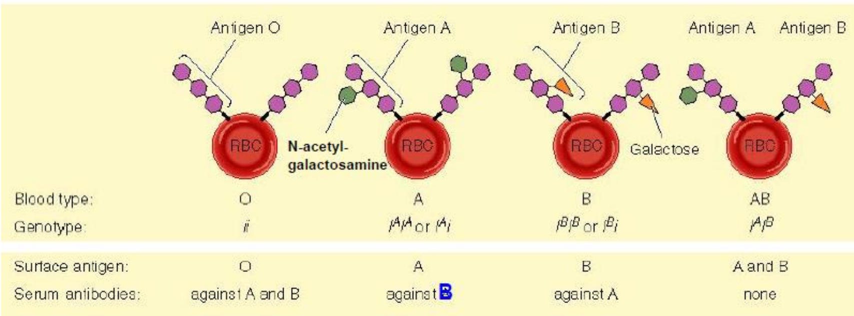
Codominance

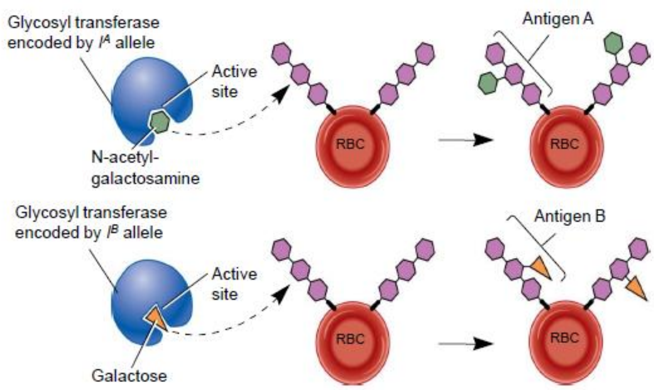
- In Codominance, heterozygotes express the phenotypes of ***both*** parents
- The ABO blood group provides an example
  - Phenotype (A, B, AB or O) is determined by the type of antigen present on the surface of red blood cells
  - Antigens are substances that are recognized by antibodies produced by the immune system
- three different alleles that determine which antigen(s) are present on the surface of red blood cells
  - Allele I^A, adds antigen A to H antigen
  - Allele I^B, adds antigen B to H antigen
  - Allele *i*, doesn't add anything to H antigen

- Allele *i* is recessive to both I^A and I^B
- Alleles I^A and I^B are codominant
  - They are both expressed in a heterozygous individual



- The carbohydrate tree on the surface of RBCs is composed of three sugars (H antigen)
- A fourth can be added by the enzyme glycosyl transferase
  - The *i* allele encodes a defective enzyme
    - The carbohydrate tree is unchanged
  - I^A encodes a form of the enzyme that can add the sugar N-acetylgalactosamine to the carbohydrate tree
  - I^B encodes a form of the enzyme that can add the sugar galactose to the carbohydrate tree

- Thus, the A and B antigens are different enough to be recognized by different antibodies



Formation of A and B antigen by glycosyl transferase

- For safe blood transfusions to occur, the donor's blood must be an appropriate match with the recipient's blood
- For example, if a type O individual received blood from a type A, type B or type AB blood
  - Antibodies in the recipient blood will react with antigens in the donated blood cells
  - This causes the donated blood to agglutinate
  - A life-threatening situation may result because of clogging of blood vessels

TABLE 4.1 POTENTIAL PHENOTYPES IN THE OFFSPRING OF PARENTS WITH ALL POSSIBLE ABO BLOOD GROUP COMBINATIONS, ASSUMING HETEROZYGOSITY WHENEVER POSSIBLE

Parents		Potential Offspring			
Phenotypes	Genotypes	A	B	AB	O
$A \times A$	$I^AI^O \times I^AI^O$	3/4	—	—	1/4
$B \times B$	$I^BI^O \times I^BI^O$	—	3/4	—	1/4
$O \times O$	$I^OI^O \times I^OI^O$	—	—	—	all
$A \times B$	$I^AI^O \times I^BI^O$	1/4	1/4	1/4	1/4
$A \times AB$	$I^AI^O \times I^AI^B$	1/2	1/4	1/4	—
$A \times O$	$I^AI^O \times I^OI^O$	1/2	—	—	1/2
$B \times AB$	$I^BI^O \times I^AI^B$	1/4	1/2	1/4	—
$B \times O$	$I^BI^O \times I^OI^O$	—	1/2	—	1/2
$AB \times O$	$I^AI^B \times I^OI^O$	1/2	1/2	—	—
$AB \times AB$	$I^AI^B \times I^AI^B$	1/4	1/2	1/2	—

Multiple Alleles

- Many genes have multiple alleles
  - Three or more different alleles
  - May display a hierarchy of dominance
  - May display codominance

- An interesting example is coat color in rabbits
  - Four different alleles
    - *C* (full coat color)
    - c^{ch} (chinchilla pattern of coat color)
      - Partial defect in pigmentation
    - c^{h} (himalayan pattern of coat color)
      - Pigmentation in only certain parts of the body
    - *c* (albino)
      - Lack of pigmentation
  - The dominance hierarchy is as follows:
    - $C > c^{ch} > c^{h} > c$
  - Figure 4.4 illustrates the relationship between phenotype and genotype