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*Shaping Lives...
Empowering Communities...*

ABO and Rh blood grouping

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Multiple Allele System

- A system in which one gene has more than two allelic states at the same locus in different members of the population.
- T. H. Morgan in 1910 described the first case of multiple alleles of a gene controlling eye colour in *Drosophila* during his studies on mutation.



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Historical context



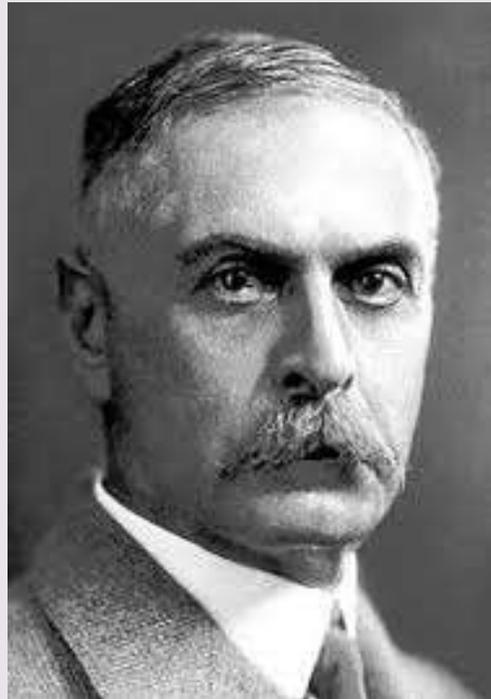
- Czek serologist Jan Jansky first to classify blood into 4 types (A, B, AB and O).
- Did not receive a nobel prize. His work left unnoticed.



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Karl Landsteiner (1869-1943)



- ABO Blood group system first discovered in 1900.
- Received Nobel Prize in Physiology or medicine in 1930.



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How he did it?

- Took blood samples from different people.
- Separated their red cells from the colourless serum or plasma, and then mixed them up in various ways.
- Found that the red cells derived from one sample would mix smoothly with the serum of that person.
- And red cells of a person is mixed with plasma of another person, either the two mix well or there would be clumping of red cells.



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- Later on Landsteiner found that erythrocytes carry on human their surface two distinct types of proteinaceous antigens A and B which can stimulate the production of specific antibodies.



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• **Bernstein** in 1924 found that the blood group antigens are controlled by an autosomal gene designated as *I* (isohemagglutinin) which has 3 alleles I^A , I^B and I^O or i .

Phenotype	Genotype
O	ii
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$



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- In this system, the I^A and I^B alleles are **codominant** heterozygotes.
- The i allele is **recessive** to both the I^A and I^B alleles.
- All the three alleles are found at appreciable frequencies in human populations, thus the I gene is said to be **polymorphic**.



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	Group A	Group B	Group AB	Group O
Red blood cell type	<p>A</p>	<p>B</p>	<p>AB</p>	<p>O</p>
Antibodies in Plasma	<p>Anti-B</p>	<p>Anti-A</p>	<p>None</p>	<p>Anti-A and Anti-B</p>
Antigens in Red Blood Cell	<p>A antigen</p>	<p>B antigen</p>	<p>A and B antigens</p>	<p>None</p>

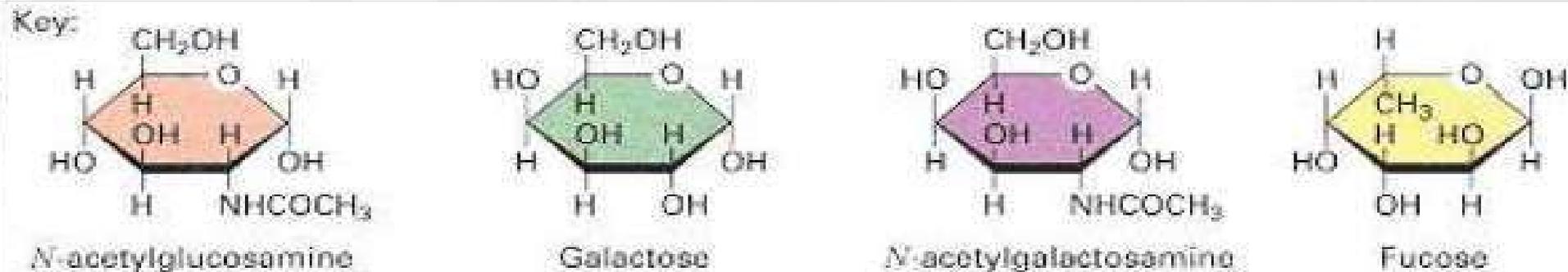
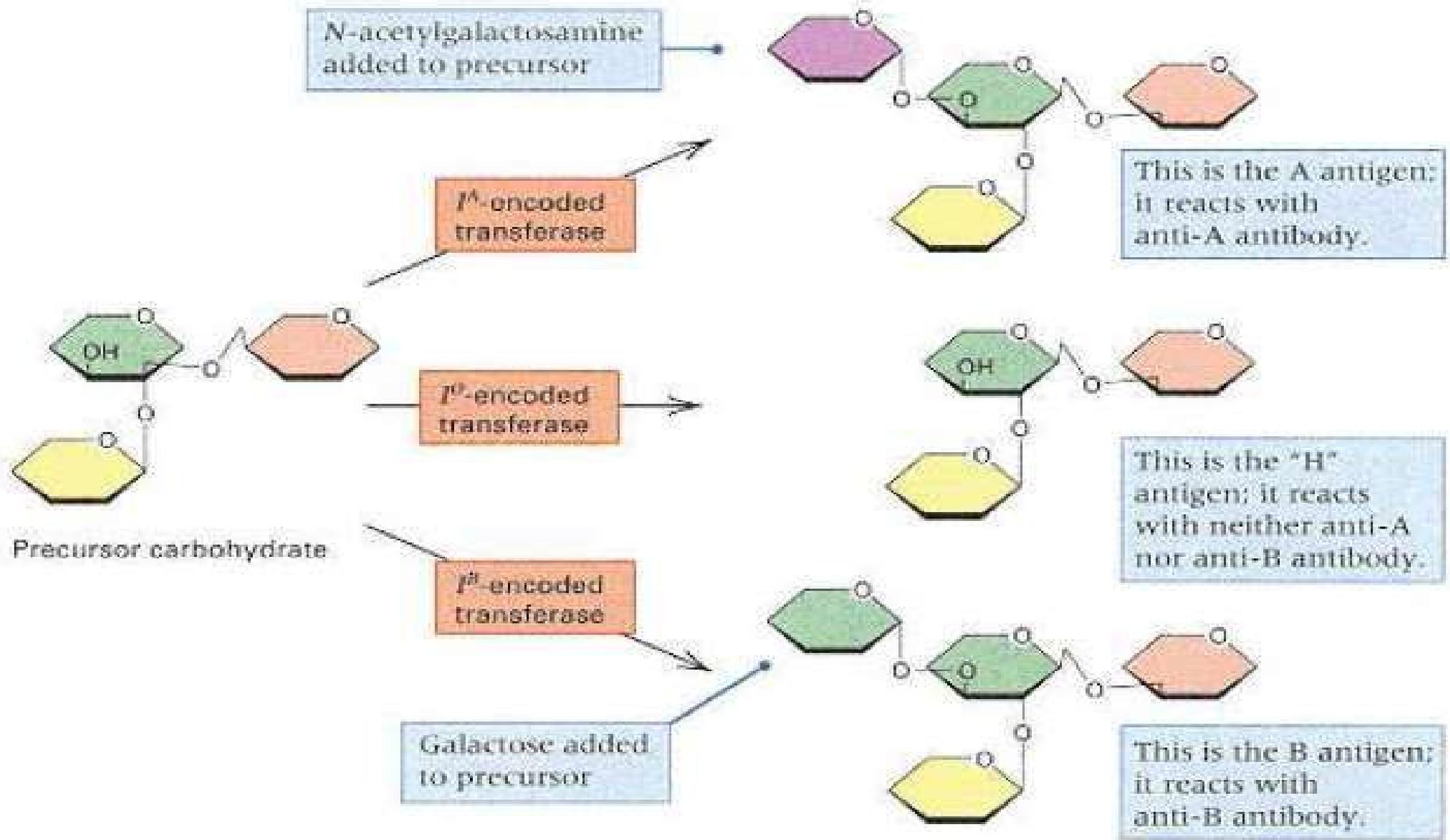


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How are the blood types determined?

- By the patterns of molecules (polysaccharides) on the surface of red blood cells.
- The sugar is the antigen, which is the molecule that the immune system recognizes.
- I^A and I^B alleles encode for transferase enzymes which modifies a precursor carbohydrate to form the A and B antigens respectively.
- $I^A I^A$ / $I^A I^O$ - A polysaccharide only
- $I^B I^B$ / $I^B I^O$ - B polysaccharide only
- $I^A I^B$ - A & B polysaccharides
- $I^O I^O$ – Lack both A & B polysaccharides





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- The I^A allele encodes an enzyme that adds N- acetylgalactsamine to the precursor.
- The I^B allele encodes an enzyme that adds galactose to the precursor.
- Allele I^O codes for an inactive enzyme and leaves the precursor unmodified called the H substance.
- Other coloured sugar units are N- acetylglucosamine and fucose



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Blood Type	Antigens on rbc's	Antibodies in blood	Safe transfusions	
			To	From
A	A	B'	A, AB	A, O
B	B	A'	B, AB	B, O
AB	A, B	-	AB	A, B, AB, O
O	-	A', B'	A, B, AB, O	O

- AB – Universal recipient
- O - Universal donor



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Rh Factor

- Antigen present in RBC.
- Discovered by Weiner and Lansteiner in 1940.
- First found on the surface of red blood cells of the Indian brown monkey (*Macacus rhesus*).



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How did they find Rh factor?

- Injected blood of rhesus monkey into rabbits and guinea pigs → Ab produced in blood serum of these animals agglutinate RBC of rhesus monkey.
- When the same antiserum is added to human blood, red cells of 85% of the persons tested were also agglutinated.
- It was thus revealed that human blood contained the same Rh antigen as in rhesus monkey.



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- There are many Rh antigens.
- But only D (autosomal dominant gene) is more antigenic in human.
- Other Ags present- C, E, c & e.
- Persons with D Ag – Rh positive
- Persons without D Ag – Rh negative
- Among Asian population, 85% are Rh +ve and 15% are Rh –ve.



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- Different from ABO grouping as the Ag D doesn't have corresponding natural Ab (anti D).
- If Rh +ve is transfused to Rh -ve – anti D is formed.
- No risk of complications if Rh +ve receives Rh -ve blood.