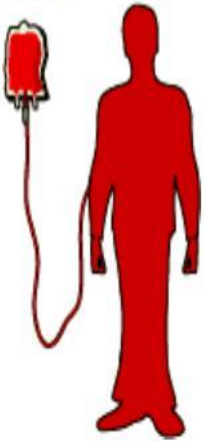

Erythrocyte physiology. Blood groups

Prof. Zaporozhets T.Viber +380972420098



History of Blood Groups and Blood Transfusions

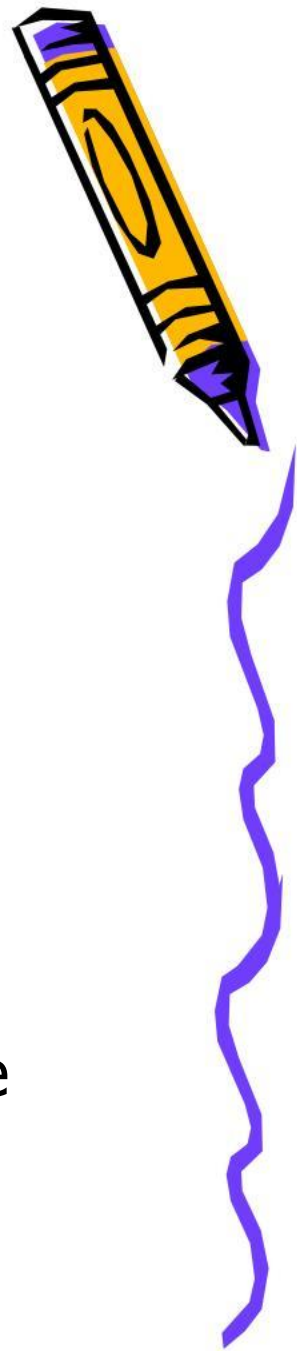


- Experiments with blood transfusions have been carried out for hundreds of years. Many patients have died and it was not until 1901, when the **Austrian Karl Landsteiner** discovered human blood groups, that blood transfusions became safer.

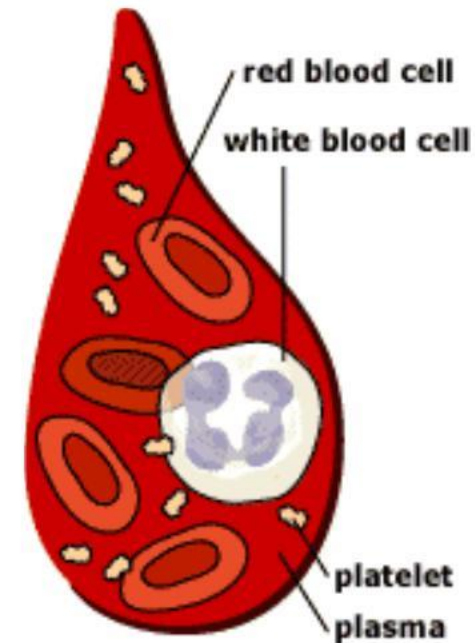
- He found that mixing blood from two individuals can lead to blood clumping. The clumped RBCs can crack and cause toxic reactions. This can be fatal.

History of Blood Groups and Blood Transfusions (Cont.)

- Karl Landsteiner discovered that blood clumping was an **immunological reaction** which occurs when the receiver of a blood transfusion has antibodies against the donor blood cells.
- Karl Landsteiner's work made it possible to determine **blood types** and thus paved the way for blood transfusions to be carried out safely. For this discovery he was awarded the **Nobel Prize** in Physiology or Medicine in 1930.



Of What is Blood Made?



An adult human has about 4–6 liters of blood circulating in the body. Blood consists of several types of cells floating around in a fluid called plasma.

The red blood cells (RBCs), also known as erythrocytes, contain haemoglobin, a protein that binds oxygen. RBCs transport oxygen to, and remove carbon dioxide from the tissues.

The white blood cells fight infection.

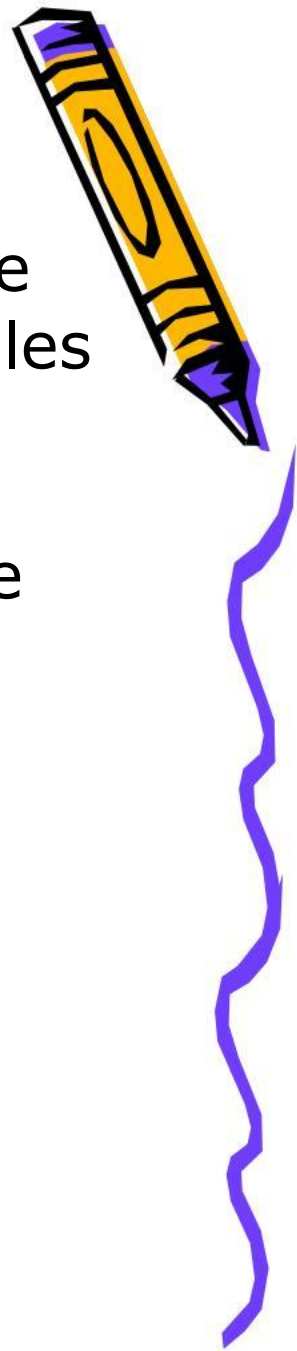
The platelets help the blood to clot, if you get a wound for example.

The plasma contains salts and various kinds of proteins.



What are the different blood groups?

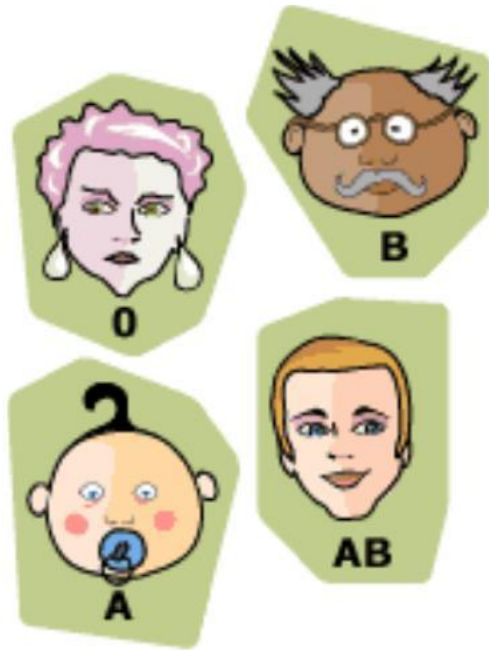
- The differences in human blood are due to the presence or absence of certain protein molecules called **antigens** and **antibodies**.
- The antigens are located on the surface of the RBCs and the antibodies are in the blood plasma.
- Individuals have different types and combinations of these molecules.
- The blood group you belong to depends on what you have inherited from your parents.



What are the different blood groups?

- There are more than 20 genetically determined blood group systems known today
- The **ABO** and **Rhesus (Rh)** systems are the most important ones used for blood transfusions. (They used to type all babies at birth, and blood type was a much bigger deal. It was useful in catching criminals, but DNA is making that obsolete.)
- Not all blood groups are compatible with each other. Mixing incompatible blood groups leads to blood clumping or agglutination, which is dangerous for individuals.





ABO blood grouping system

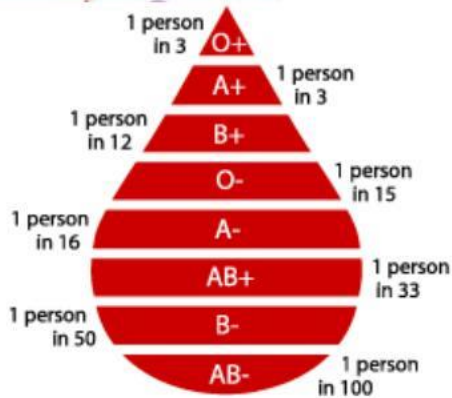
According to the ABO blood typing system there are four different kinds of blood types: A, B, AB or O (null).



Blood Types

The ABO Blood System

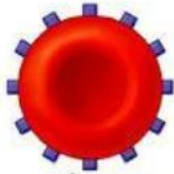
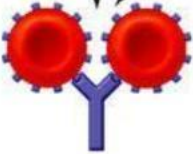
Blood Type (genotype)	Type A (AA, AO)	Type B (BB, BO)	Type AB (AB)	Type O (OO)
Red Blood Cell Surface Proteins (phenotype)	 A agglutinogens only	 B agglutinogens only	 A and B agglutinogens	 No agglutinogens
Plasma Antibodies (phenotype)	 b agglutinin only	 a agglutinin only	 No a or b	

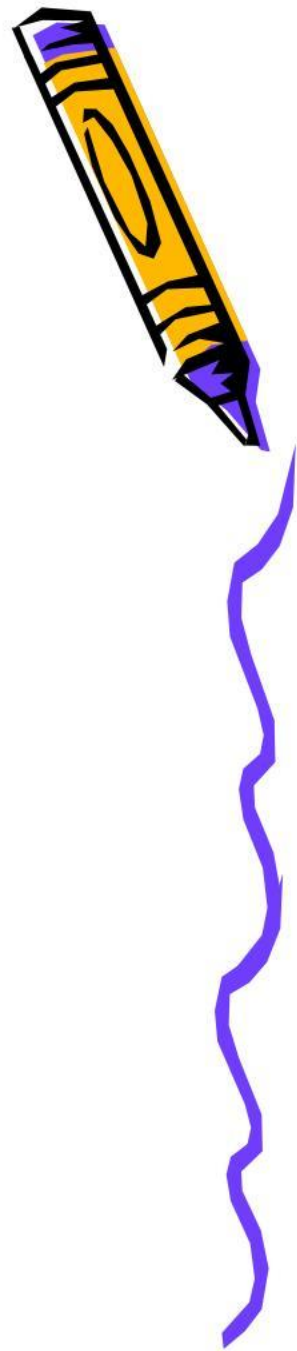


<http://www.bloodbook.com/world-abo.html>

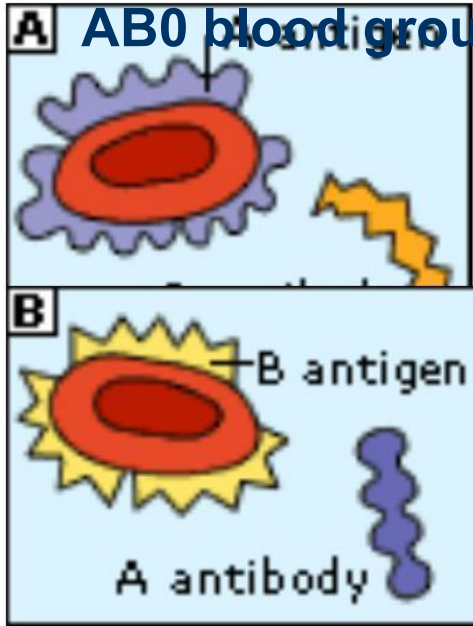


Agglutination Reaction

	Type A	Type B
Antigens on red blood cells		
Antibodies in plasma		
Agglutination reaction		



ABO blood grouping system

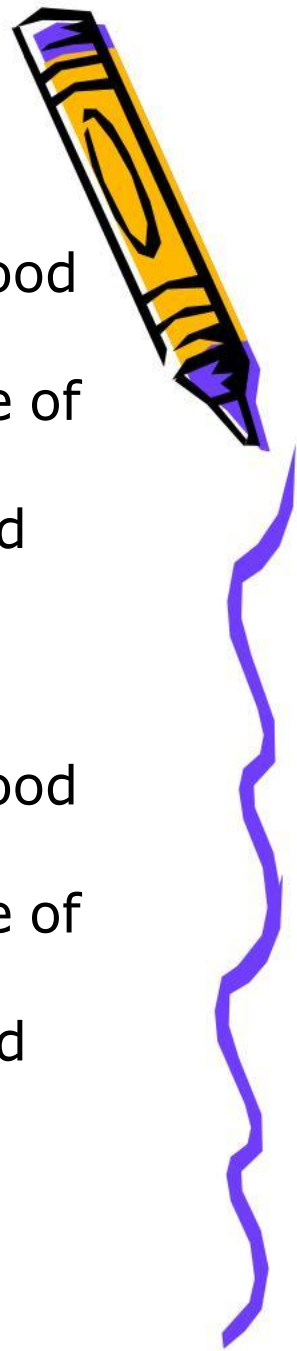


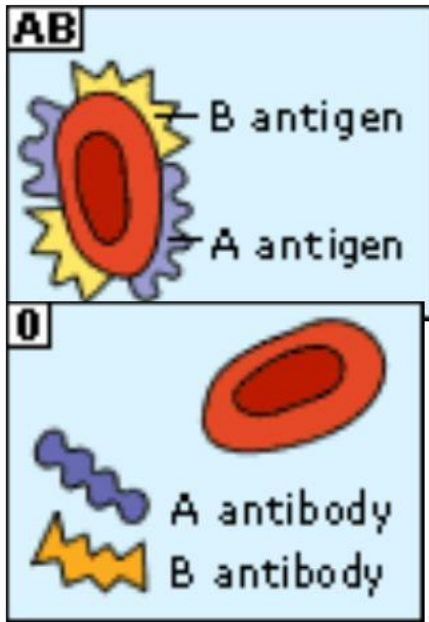
Blood group A

If you belong to the blood group A, you have A antigens on the surface of your RBCs and B antibodies in your blood plasma.

Blood group B

If you belong to the blood group B, you have B antigens on the surface of your RBCs and A antibodies in your blood plasma.



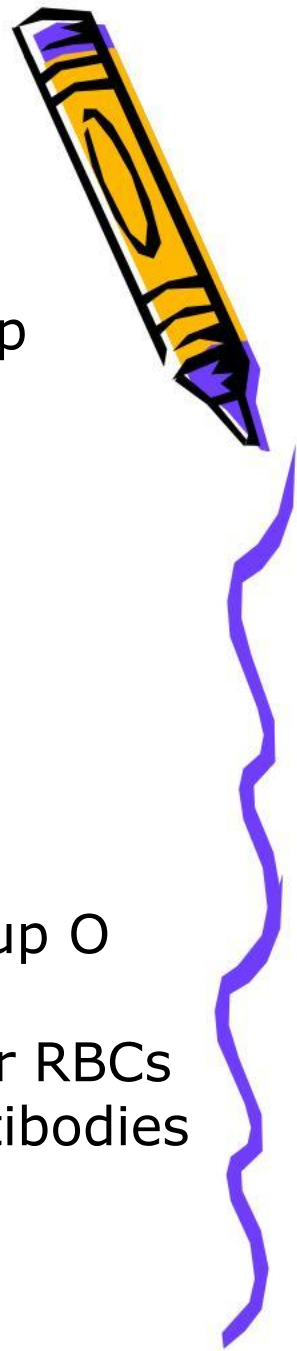


Blood group AB

If you belong to the blood group AB, you have both A and B antigens on the surface of your RBCs and no A or B antibodies at all in your blood plasma.

Blood group O

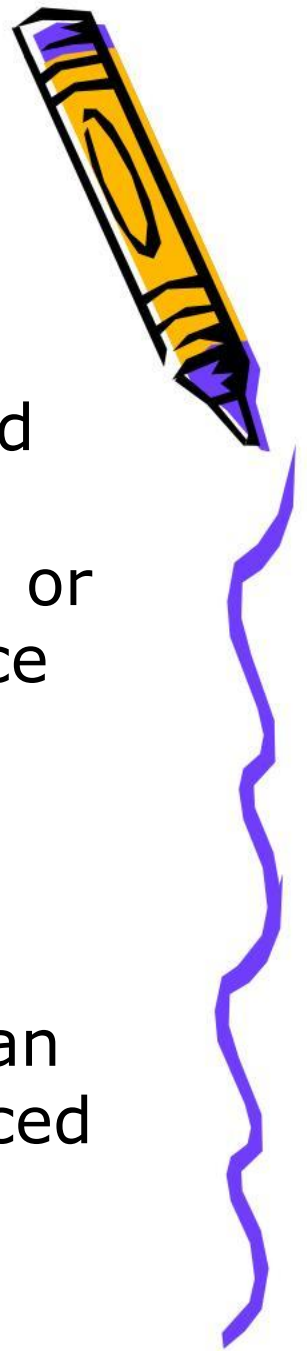
If you belong to the blood group O (null), you have neither A or B antigens on the surface of your RBCs but you have both A and B antibodies in your blood plasma.



Why do individuals produce antibodies to antigens they do not have?

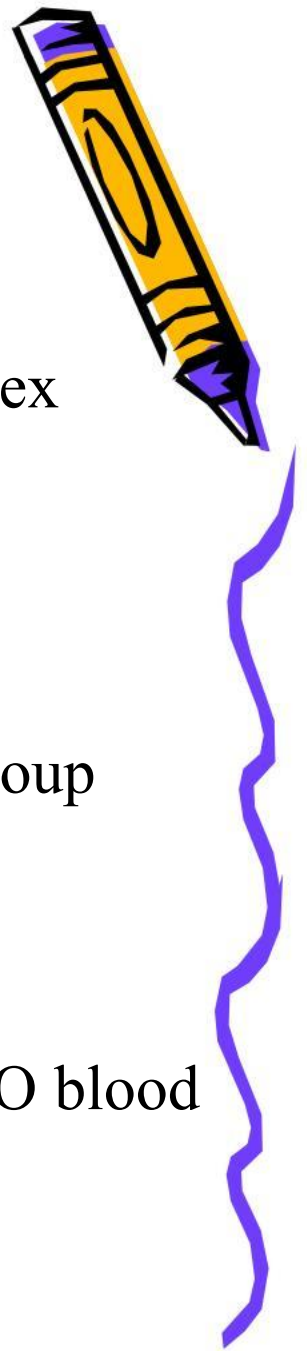
- The "A" and "B" antigens are also produced by some other plants and microorganisms. Thus, individuals who do not recognize one or more of these antigens as "self" will produce antibodies against the plant or microbial antigens.

- These antibodies will also react with human antigens of the same kind whether introduced via a blood transfusion or a tissue graft.

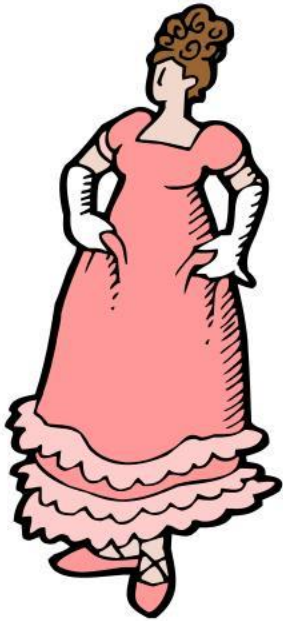


ABO inheritance and genetics

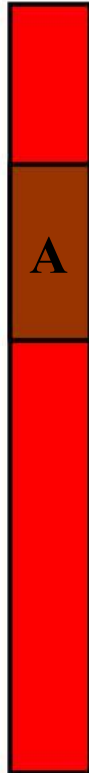
- The **ABO** gene is **autosomal** (the gene is not on either sex chromosomes)
- The **ABO** gene locus is located on the **chromosome 9**.
- **A** and **B** blood groups are **dominant** over the **O** blood group
- **A** and **B** group genes are **co-dominant**
- Each person has **two copies of genes** coding for their ABO blood group (one maternal and one paternal in origin)



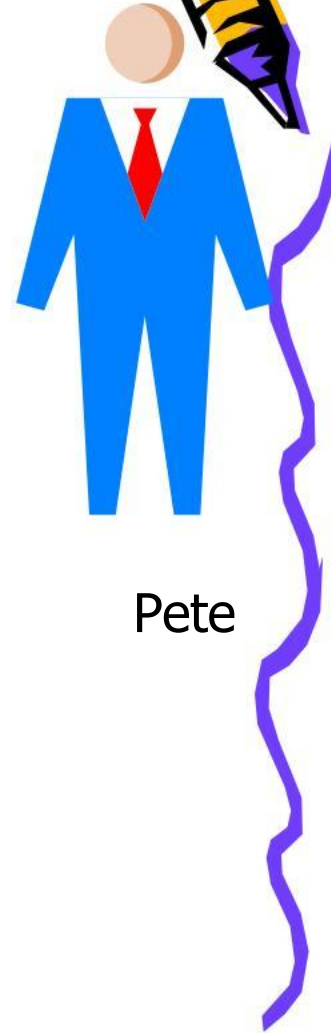
AUTOSOMAL CHROMOSOME



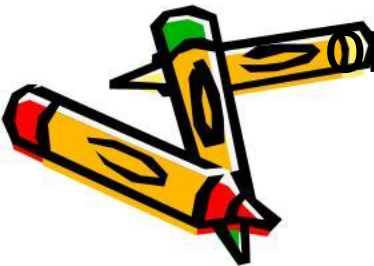
Susan



The alleles for Blood group are in the same place on the chromosome 9. However the genes have a different code giving the different blood group



Pete



One alleles from Pete and one from Susan.

What do co-dominant genes mean?

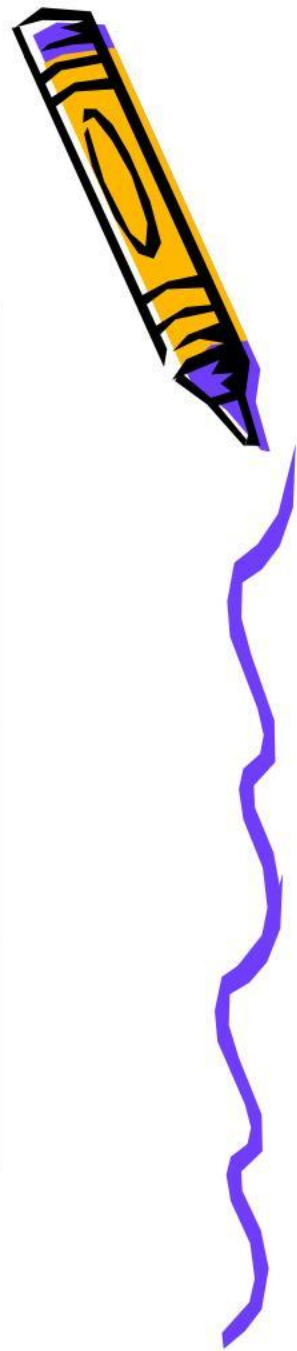
This meant that if a person **inherited one A group gene and one B group gene** their red cells would **possess both the A and B blood group antigens**.

These alleles were termed A (which produced the A antigen), B (which produced the B antigen) and O (which was "non functional"and produced no A or B antigen)



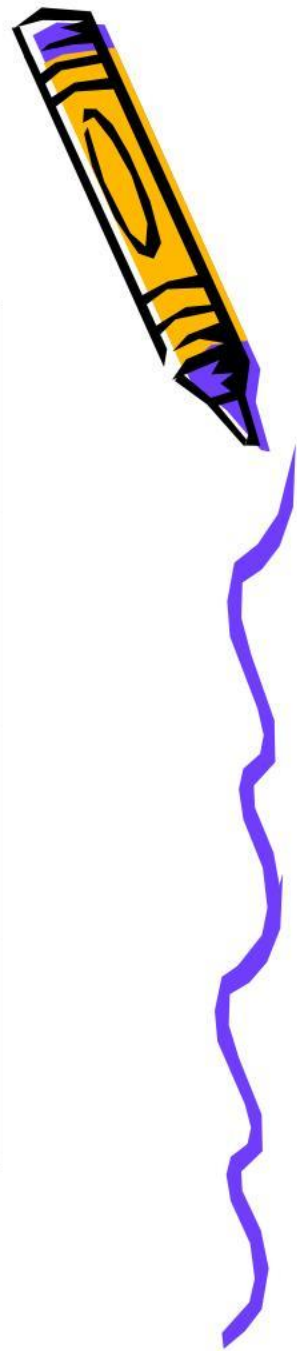
Possible Blood group Genotypes

Parent Allele	A	B	O
A			
B			
O			



Possible Blood group Genotypes

Parent Allele	A	B	O
A	AA	AB	AO
B	AB	BB	BO
O	AO	BO	OO



The ABO blood groups

- The most important in assuring a safe blood transfusion.
- The table shows the four ABO phenotypes ("blood groups") present in the human population and the genotypes that give rise to them.

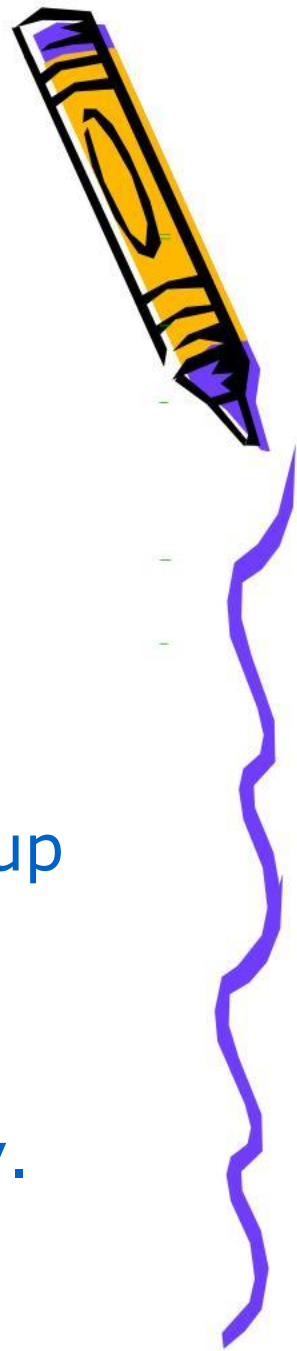
Blood Group	Antigens on RBCs	Antibodies in Serum	Genotypes
A	A	Anti-B	<i>AA</i> or <i>AO</i>
B	B	Anti-A	<i>BB</i> or <i>BO</i>
AB	A and B	Neither	<i>AB</i>
O	Neither	Anti-A and anti-B	<i>OO</i>

Why group A blood must never be given to a group B person?

Giving someone blood from the wrong ABO group could be fatal.

The anti-A antibodies in group B attack group A cells and vice versa.

- Blood group O negative is a different story.



The Rhesus (Rh) System

Well, it gets more complicated here, because there's another antigen to be considered - the **Rh antigen**.

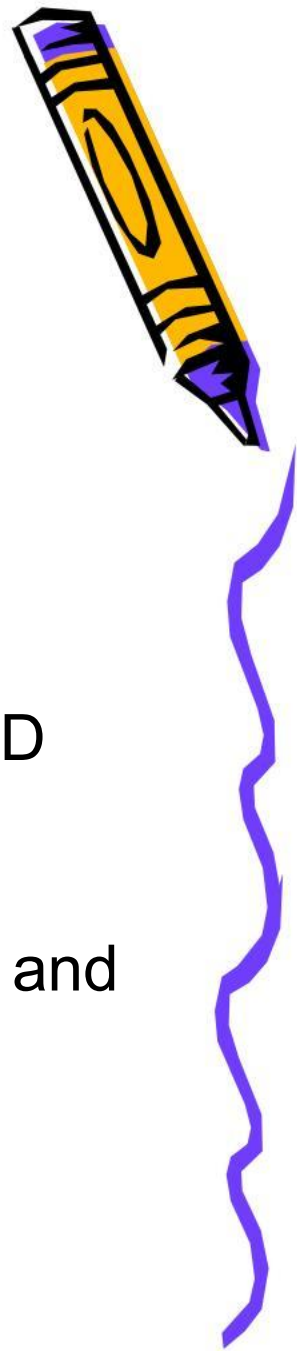
Some of us have it, some of us don't.

If it is present, the blood is RhD positive, if not it's RhD negative.

So, for example, some people in group A will have it, and will therefore be classed as A+ (or A positive).

While the ones that don't, are A- (or A negative).

And so it goes for groups B, AB and O.



The Rhesus (Rh) System (Cont.)

- **Rh antigens** are **transmembrane proteins** with loops exposed at the surface of red blood cells.
- They appear to be used for the transport of carbon dioxide and/or ammonia across the plasma membrane.
- They are named for the **rhesus monkey** in which they were first discovered.
- RBCs that are "Rh positive" express the antigen designated **D**.
- 85% of the population is RhD positive, the other 15% of the population is running around with RhD negative blood.



Rh Blood Group and Rh Incompatibility

A person with Rh- blood does not have Rh antibodies naturally in the blood plasma

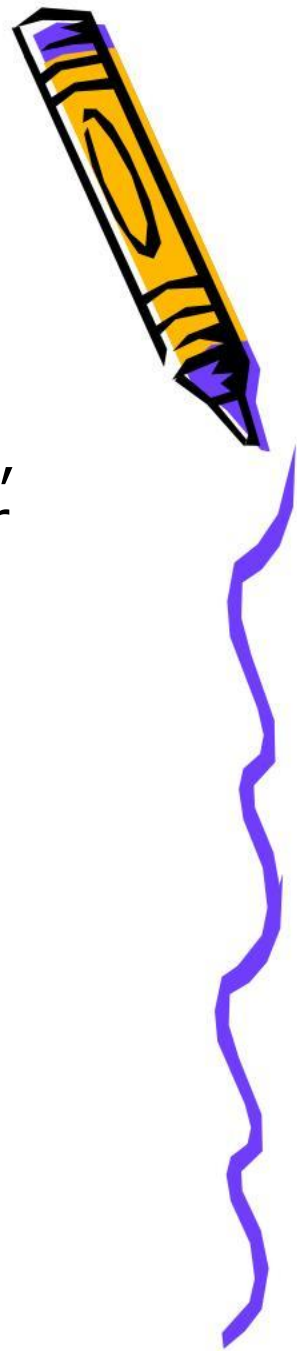
Blood Type	Genotype	Alleles Produced
Rh positive	RR	R
	Rr	R or r
Rh negative	rr	r



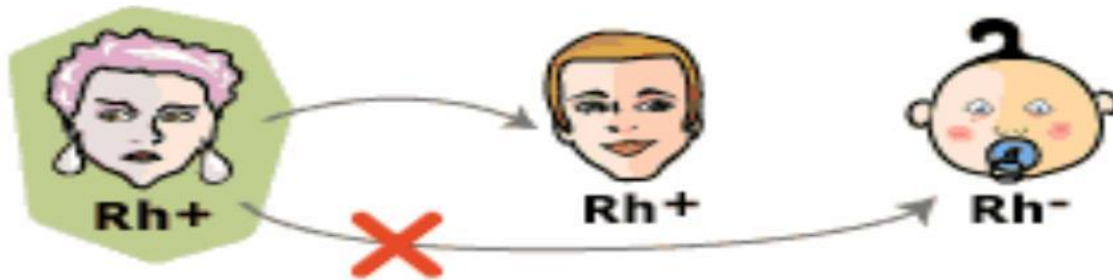
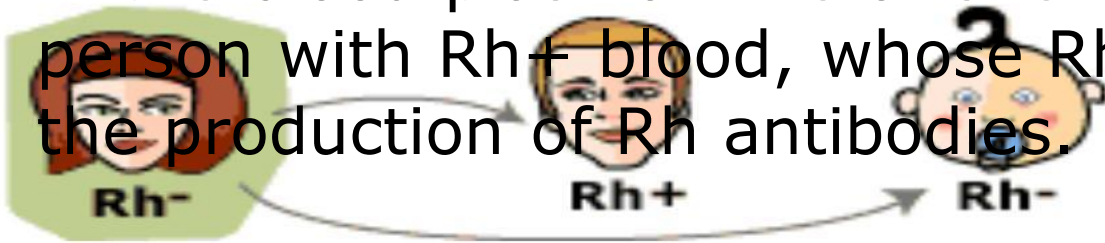
Do you know which blood group you belong to?

A Rh+	B Rh+	AB Rh+	O Rh+
A Rh-	B Rh-	AB Rh-	O Rh-

According to above blood grouping systems, you can belong to either of following 8 blood groups:



- A person with Rh- blood can *develop* Rh antibodies in the blood plasma if he or she receives blood from a person with Rh+ blood, whose Rh antigens can trigger the production of Rh antibodies.



- A person with Rh+ blood can receive blood from a person with Rh- blood without any problems.



Why is an Rh incompatibility so dangerous when ABO incompatibility is not during pregnancy?

- Most anti-A or anti-B antibodies are of the IgM class (large molecules) and these do **not** cross the placenta.
- In fact, an **Rh- / type O** mother carrying an **Rh+ / type A, B, or AB** foetus is resistant to sensitisation to the Rh antigen.
- Her anti-A and anti-B antibodies destroy any foetal cells that enter her blood before they can elicit anti-Rh antibodies in her.



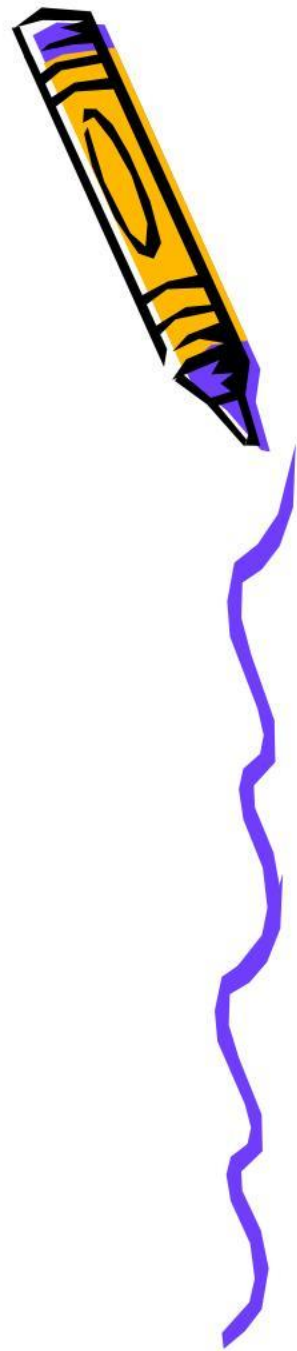
Rh incompatibility during pregnancy (cont.)

- This phenomenon has led to an effective preventive measure to avoid Rh sensitisation.
- Shortly after each birth of an Rh⁺ baby, the mother is given an injection of anti-Rh antibodies (or **Rhogam**).
- These passively acquired antibodies destroy any foetal cells that got into her circulation before they can elicit an active immune response in her.



The ABO Blood Group System

Laboratory Determination of the ABO System



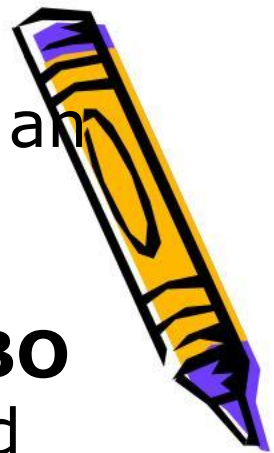
Several methods for testing the ABO group of an individual exist. The most common method is:

Serology: This is a direct detection of the **ABO antigens**. It is the main method used in blood transfusion centres and hospital blood banks.

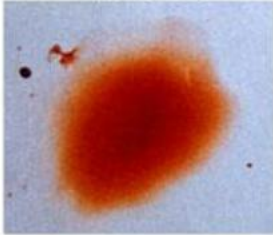
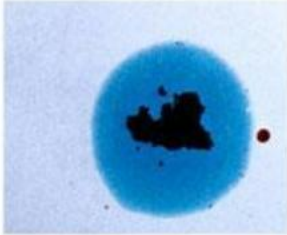
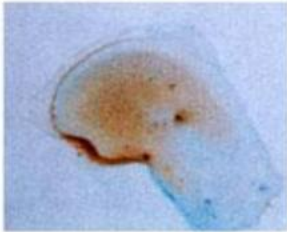
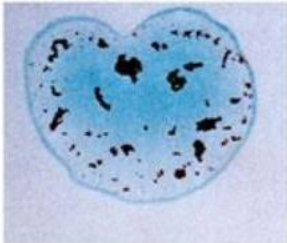
This form of **testing involves two components**:

a) Antibodies that are specific at detecting a particular ABO antigen on RBCs.

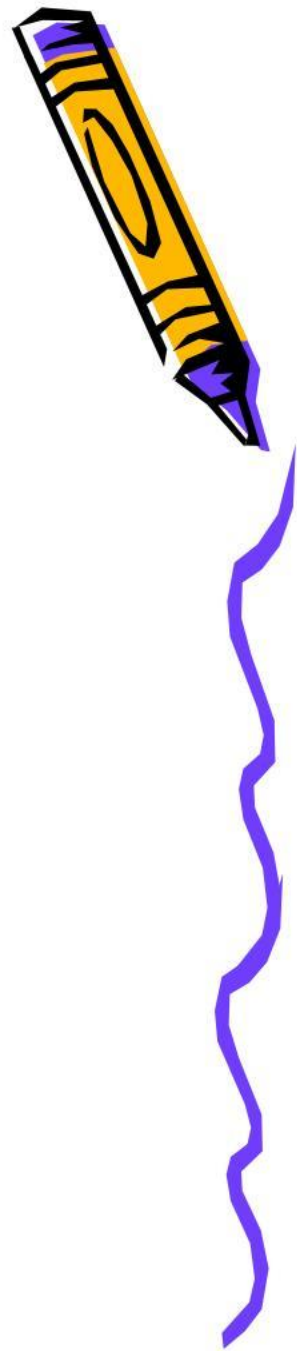
b) Cells that are of a known ABO group that are agglutinated by the naturally occurring antibodies in the person's serum.



Blood Typing

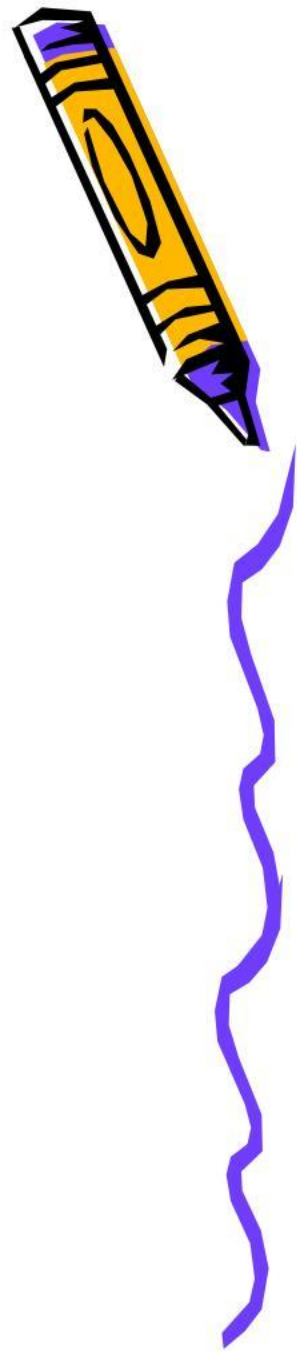
	Anti-B	Anti-A
Type A		
Type B		
Type AB		

Copyright Stuart Fox

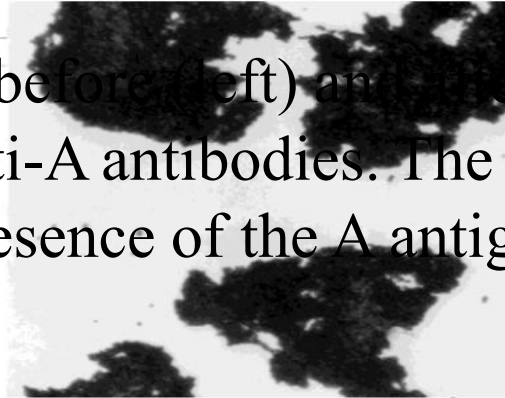


- Illustration of the forward and reverse grouping reaction patterns of the ABO groups using a blood group tile

	Anti-A	Anti-B	Anti-AB	Anti-O	Anti-A	Anti-B	Anti-AB
A							
B							
AB							
O							



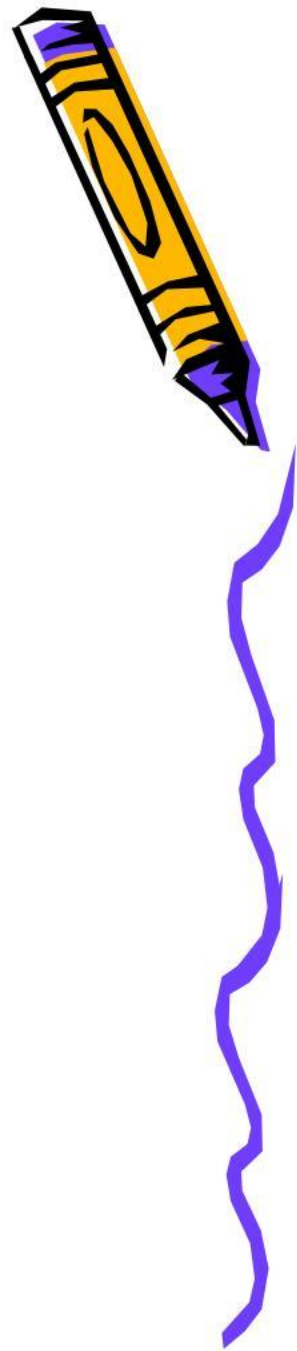
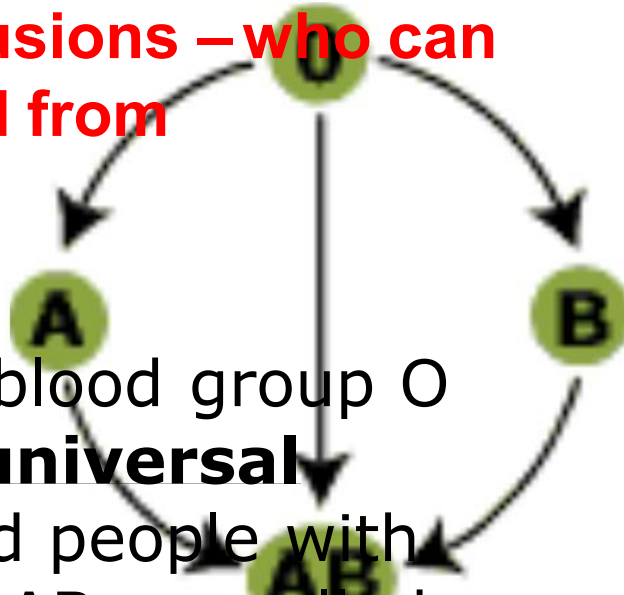
When RBCs carrying one or both antigens are exposed to the corresponding antibodies, they agglutinate; that is, clump together. People usually have antibodies against those red cell antigens that they lack.



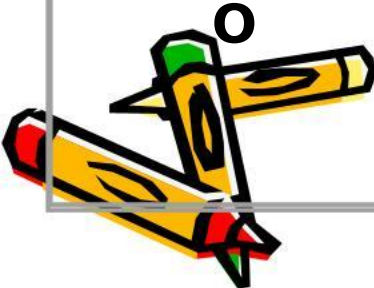
Human RBC before (left) and after (right) adding serum containing anti-A antibodies. The agglutination reaction reveals the presence of the A antigen on the surface of the cells.

Blood transfusions – who can receive blood from whom?

People with blood group O are called "**universal donors**" and people with blood group AB are called "**universal receivers.**"



Blood Group	Antigens	Antibodies	Can give blood to	Can receive blood from
AB				
A				
B				
O				



Blood Group	Antigens	Antibodies	Can give blood to	Can receive blood from
AB	A and B	None	AB	AB, A, B, O
A	A	B	A and AB	A and O
B	B	A	B and AB	B and O
O	None	A and B	AB, A, B, O	O

