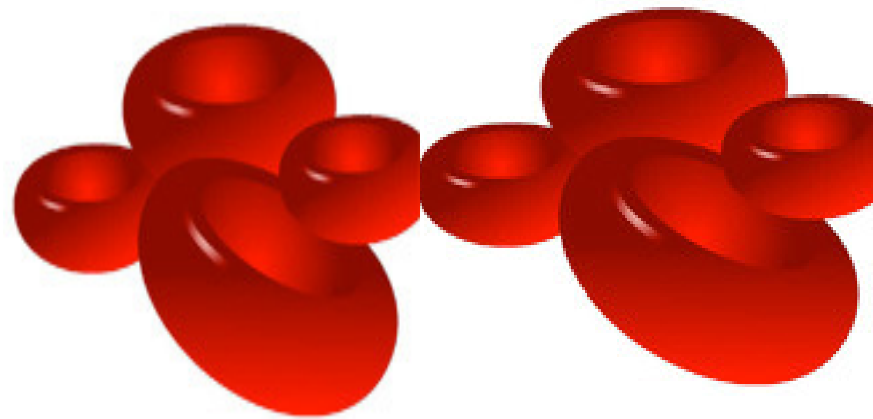


# ABO blood group



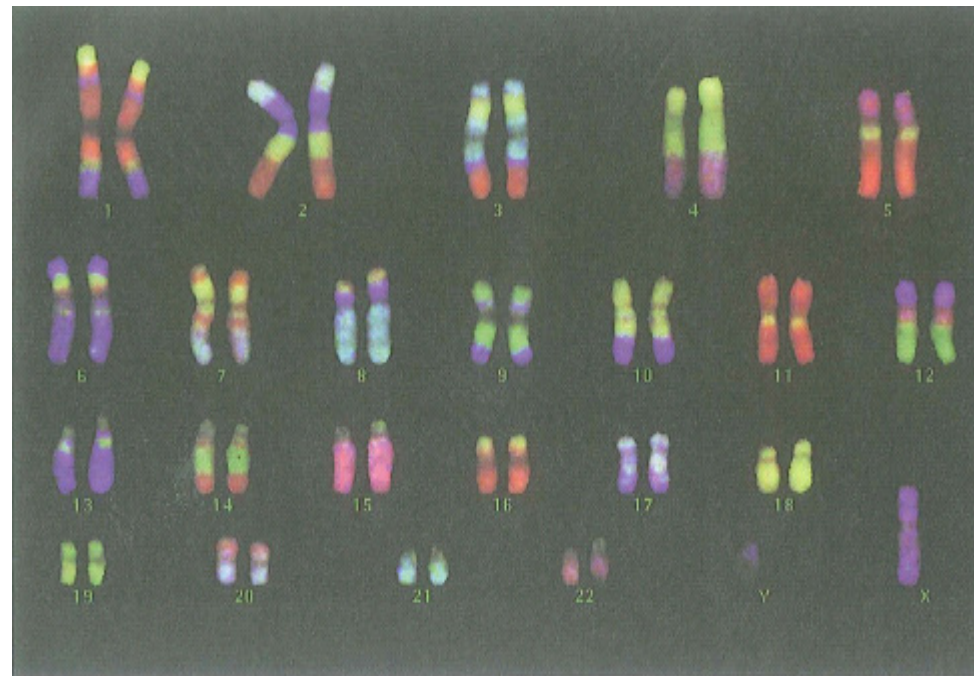
Dr. Abdullah Aljedai

## Glossary

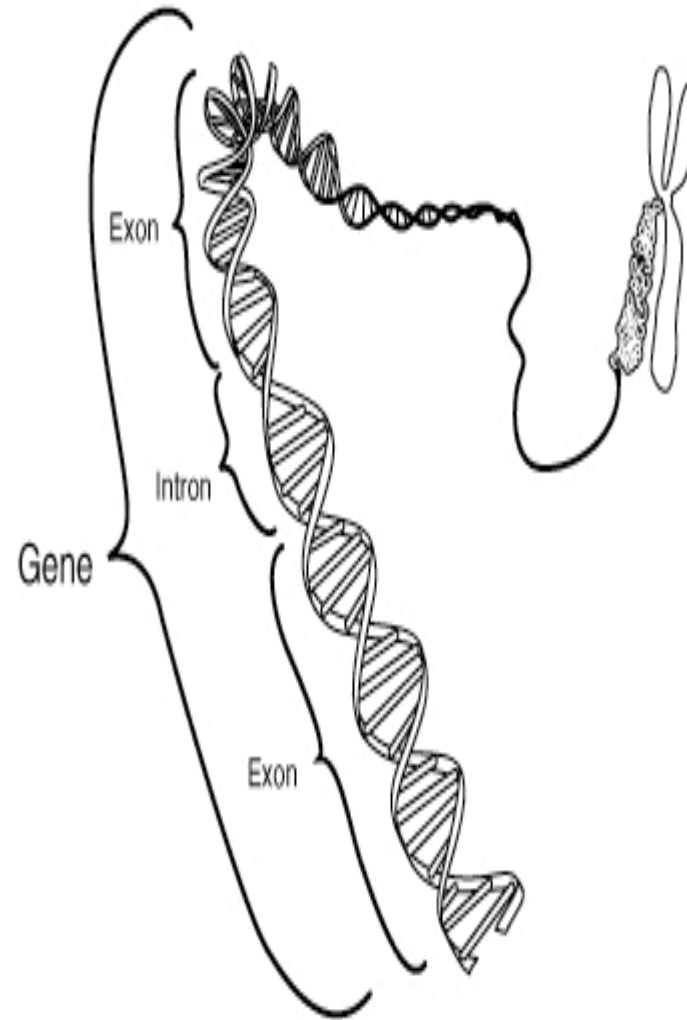
- Gene
- Locus
- Allele
- Heterozygous
- Homozygous
- Phenotype
- Genotype
- Sex Chromosome
- Autosomal Chromosome
- Dominant Gene
- Recessive Gene

# Chromosomes

- Chromosome is a single piece of coiled DNA that contain thousands of genes.
- Genes Code for proteins.



- **Gene**
- A section of DNA made of bases that code for a phenotype. ie eye colour
- Each gene has a coding" sequences that determine the production of certain protein in our body. (eg, blood antigens are determined by different genes)



# Glossary

- **Heterozygous**
- 2 identical chromosomes with **DIFFERENT** Gene types i.e. Dominant & Recessive
- **Homozygous**
- 2 identical chromosomes with the **SAME** genes on each chromosome ie Dominant & Dominant

# Glossary

- **Locus**
- Location of a gene on a chromosome
- **Allele**
- Variation of a gene that produces an alternative Phenotype
- **Phenotype**
- The result of expressing a gene
- **Gene**
- A section of DNA made of bases that code for a phenotype. ie eye colour

# Glossary

- **Sex Linked Chromosome**
- Is either X or Y. Determines gender. Females have XX, males have XY
- **Autosomal Chromosome**
- Pairs of chromosomes that have identical gene location, and are the same in Male and Females. Only the code within the gene varies.

# Glossary

- **Dominant Gene**
- A strong gene that only needs one copy on one chromosome to be expressed.
- **Recessive gene**
- Weak gene that needs a copy on each autosomal chromosome (M&F), or on each XX in women, or on the X in men, to be expressed



# **The Blood Group Systems**

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Inheritance and Genetics

# Red cell antigens and blood group antibodies

- 600 RBC group antigens.
- 29 blood group systems.
- Most clinically important blood groups are ABO and Rh blood groups.
- **Landsteiner's Rule:** Individuals who lack a particular blood group Ag in their red cell will have Abs specific to the missing Ag in their plasma.
- **Blood group Antibodies:** naturally occurring Abs occur in the plasma of subjects who lack the corresponding Ag (eg. Anti-A and Anti-B).

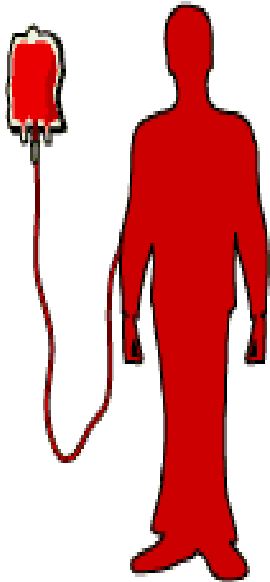
## Ag-Ab reaction

- In blood group serology, the interaction between the antigen sites on the cells and the corresponding antibody is normally detected by observing agglutination.
- Agglutination is the result of the cross-linking of individual red cells by antibody molecules.

## 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 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.

# 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.

# Major blood group systems

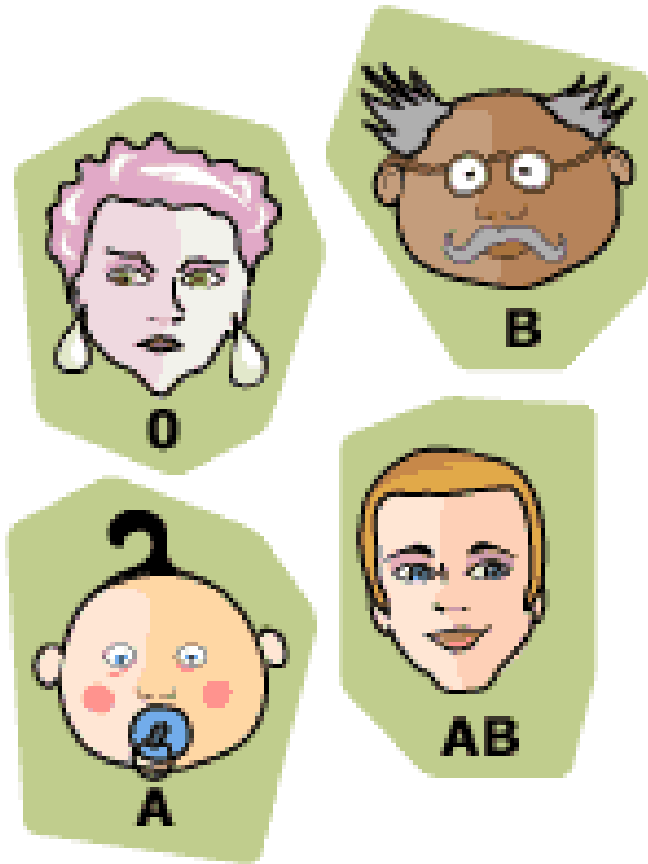
**Table 6-1** Major blood group systems (9 of 29)

ISBT No	Blood group system name	Major antigens	Chromosome location no.
001	ABO	A, B, A <sub>1</sub> B, A <sub>1</sub>	9
002	MNS	M, N, S, s, U	4
003	P	P <sub>1</sub>	22
004	Rh	D, C, E, c, e	1
005	Lutheran	Lu <sup>a</sup> , Lu <sup>b</sup>	19
006	Kell	K, k, Kp <sup>a</sup> , Kp <sup>b</sup> , Js <sup>a</sup> , Js <sup>b</sup>	7
007	Lewis	Le <sup>a</sup> , Le <sup>b</sup>	19
008	Duffy	Fy <sup>a</sup> , Fy <sup>b</sup> , Fy3	1
009	Kidd	Jk <sup>a</sup> , Jk <sup>b</sup> , Jk3	18

# What are the different blood groups?

- There are about 29 genetically determined blood group systems known today
- The **ABO** and **Rhesus (Rh)** systems are the most important ones used for blood transfusions.
- Not all blood groups are compatible with each other.
- Mixing incompatible blood groups leads to blood clumping or agglutination, which is dangerous for individuals.

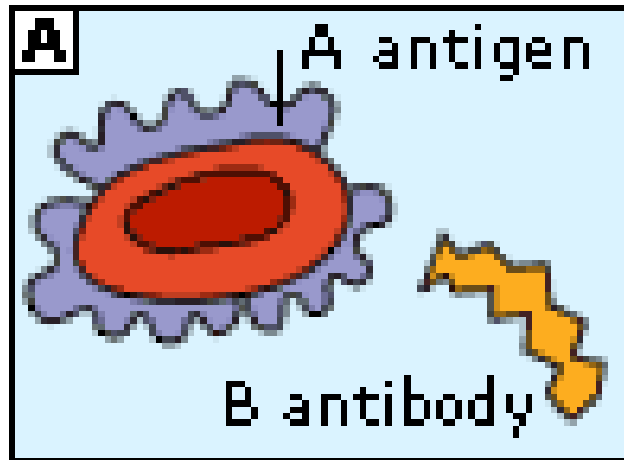




## **ABO blood grouping system**

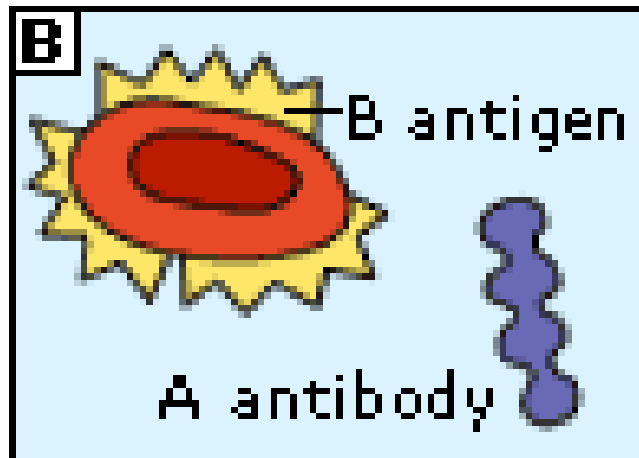
According to the ABO blood typing system there are four different kinds of blood types: A, B, AB or O (null).

## ABO blood grouping system



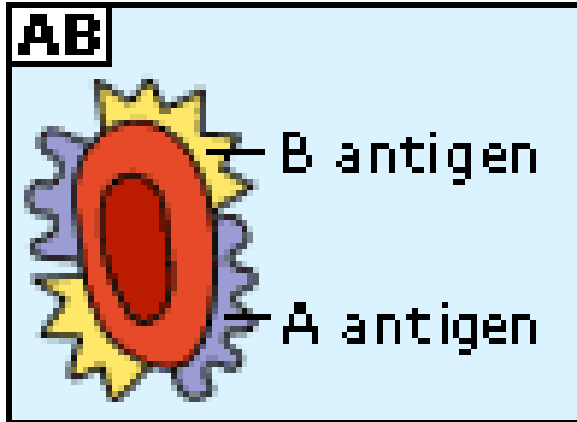
### **Blood group A**

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.



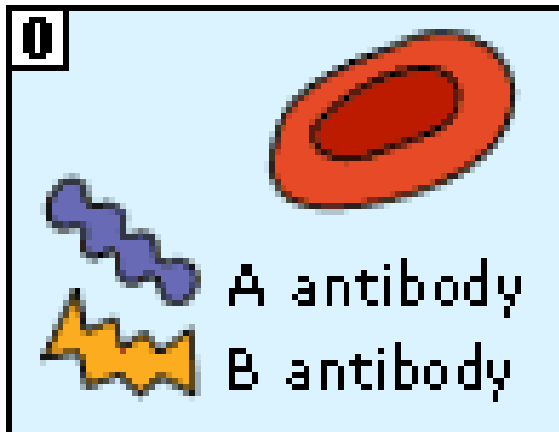
### **Blood group B**

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.

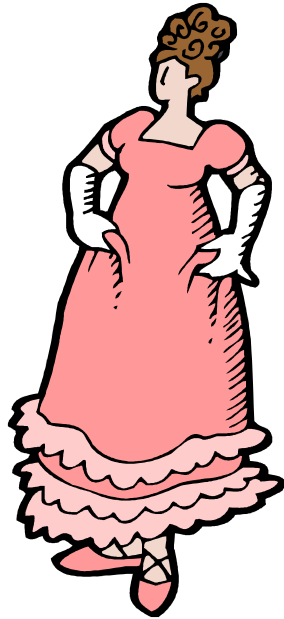
## **Why do individuals produce antibodies to antigens they do not have?**

- 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** (position) 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)

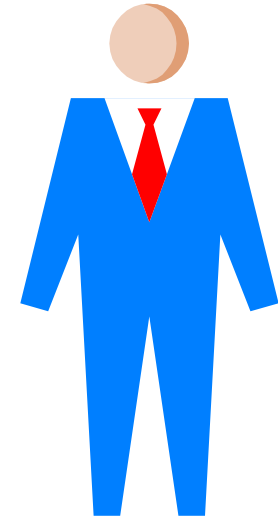
# AUTOSOMAL CHROMOSOME



Mother



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



Father

one allele from mother and one from father.

## What do co-dominant genes mean?

This means 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

<b>Parent Allele</b>	<b>A</b>	<b>B</b>	<b>O</b>
<b>A</b>			
<b>B</b>			
<b>O</b>			



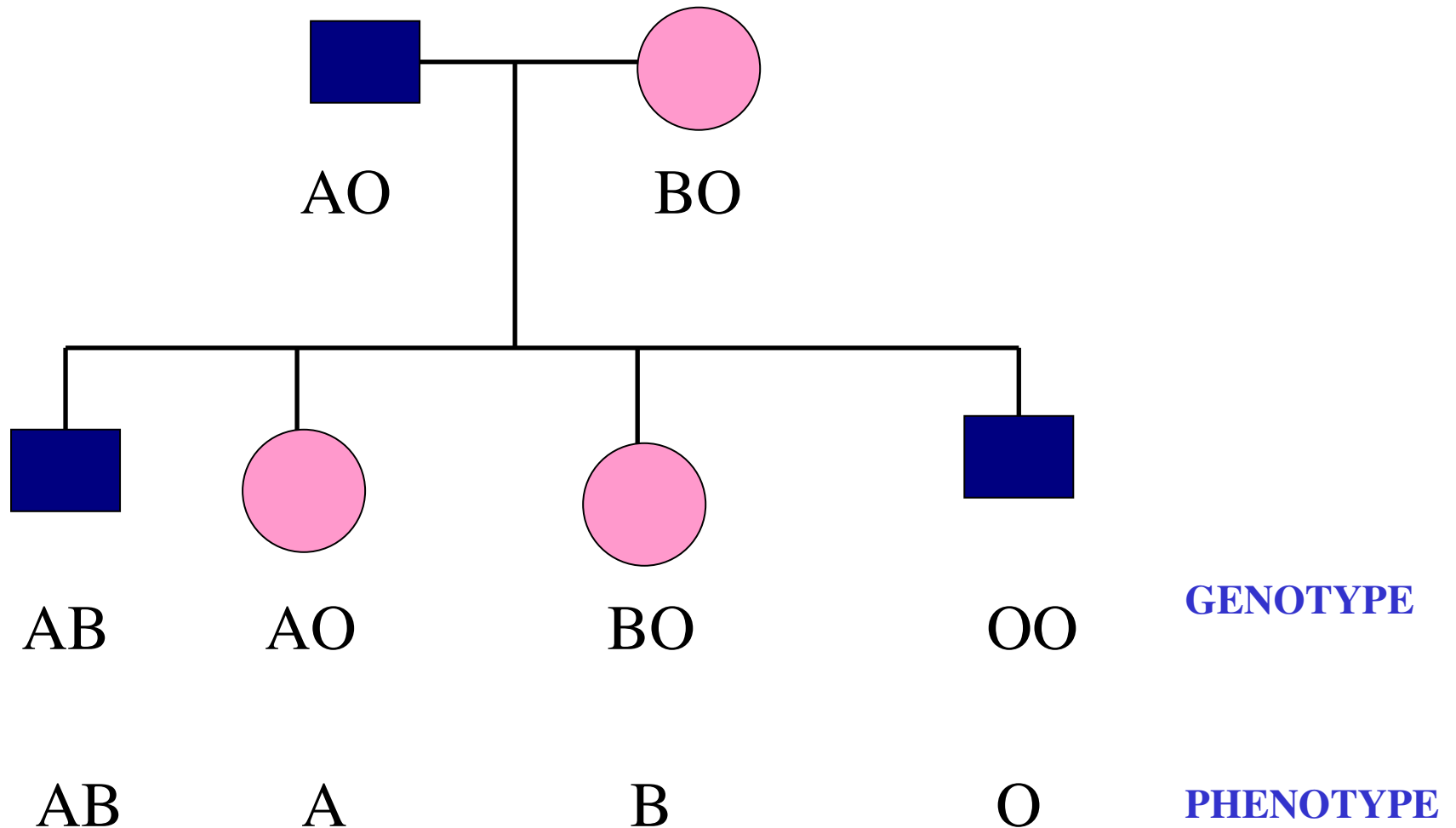
## Possible Blood group Genotypes

<b>Parent Allele</b>	<b>A</b>	<b>B</b>	<b>O</b>
<b>A</b>	<b>AA</b>	<b>AB</b>	<b>AO</b>
<b>B</b>	<b>AB</b>	<b>BB</b>	<b>BO</b>
<b>O</b>	<b>AO</b>	<b>BO</b>	<b>OO</b>

## ABO blood group genotype & phenotype

Group	Genotype	phenotype
A	AA AO	A
B	BB BO	B
O	OO	O

# Inheritance of the ABO blood group system

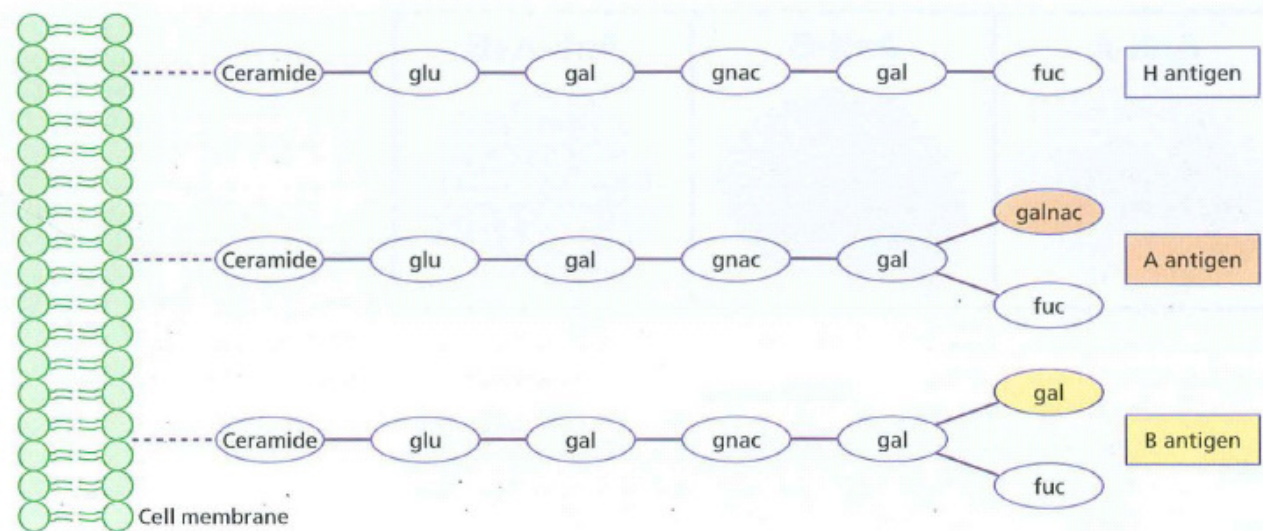


## ABO blood group genotype & phenotype

Table 6-5 ABO group/phenotype and possible genotypes (simplified)

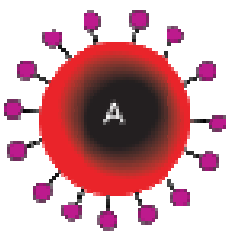
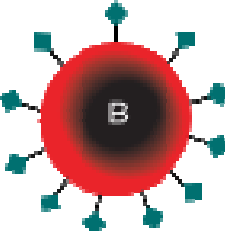
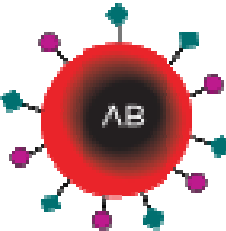
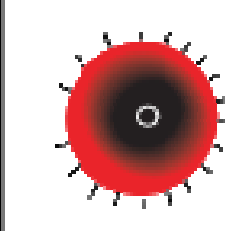



Blood group/phenotype	Possible genotypes
$A_1$	$A^1A^1, A^1A^2, A^1A^3, A^1A^x, A^1A^m, A^1O$
$A_2$	$A^2A^2, A^2A^3, A^2A^x, A^2A^m, A^2O$
B	$BB, BO$
AB	$A^1B, A^2B, A^3B, A^xB, A^mB$
O	$OO$

## Biochemical nature of ABO antigens



-ABO system consists of three allelic genes: A, B and O.

-The A and B genes control the synthesis of specific enzymes (transferase) responsible for the addition of single carbohydrate residues (N-acetyl galactosamine for group A and o-galactose for group B) to a basic antigenic glycoprotein or glycolipid with a terminal sugar L-fucose on the red cell, known as the H substance

	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 present	 <p>Anti-B</p>	 <p>Anti-A</p>	None	 <p>Anti-A and Anti-B</p>
Antigens present	A antigen	B antigen	A and B antigens	No antigens

## 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.

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



# Activities

**- Is there any scientific relation between blood type and individual's diet?**

# **The ABO Blood Group System**

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## **Laboratory Determination of the ABO System**

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# ABO grouping

ABO grouping involves:

## **1- Forward grouping:**

The testing of red cell suspensions of unknown group to determine the presence or absence of A and/or B antigens.

## **2- Reverse grouping:**

Testing the unknown serum/plasma to determine the presence or absence of antibodies corresponding to the antigens lacking on the red cells.

# ABO antisera



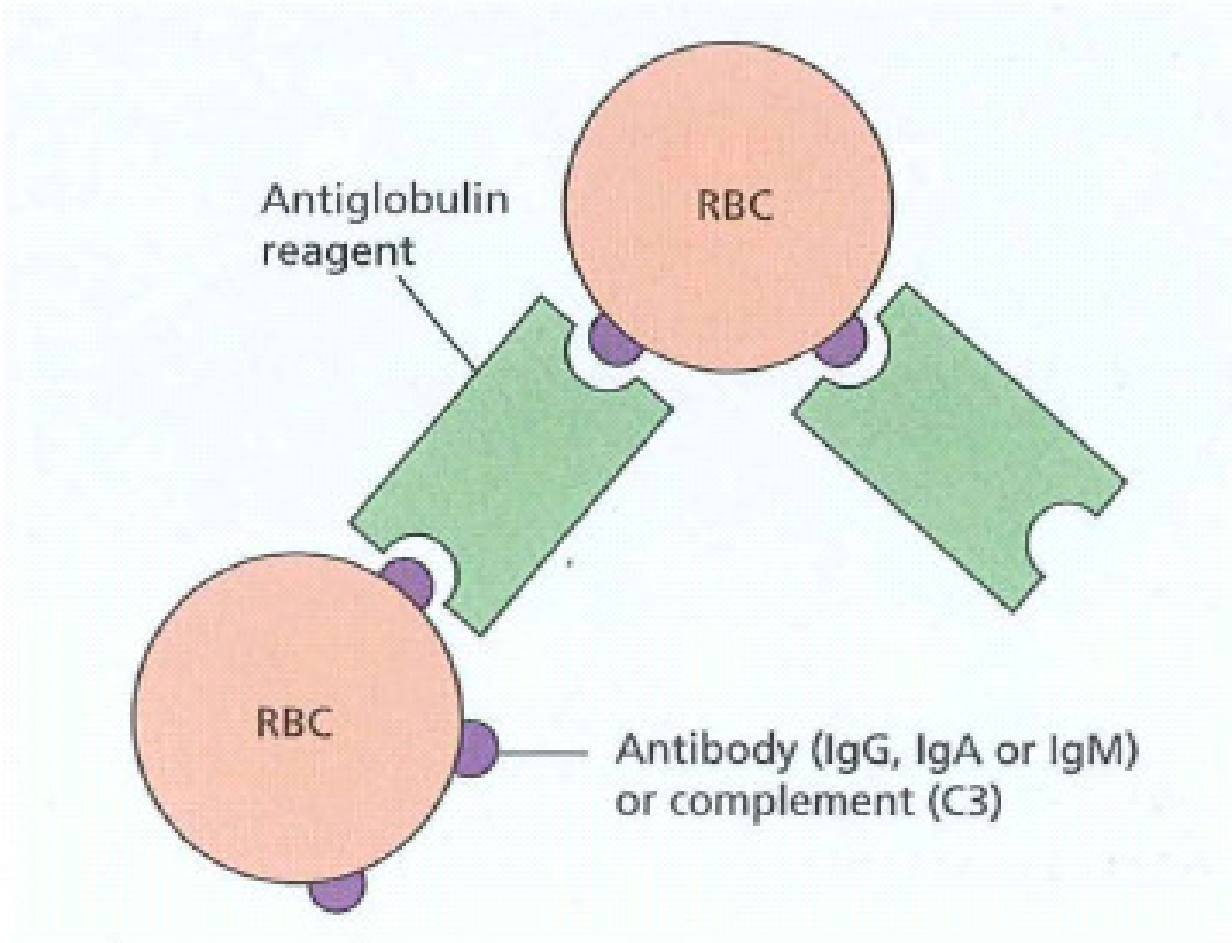
Several methods for testing the ABO group of an individual exist. The most common method is:

**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.**

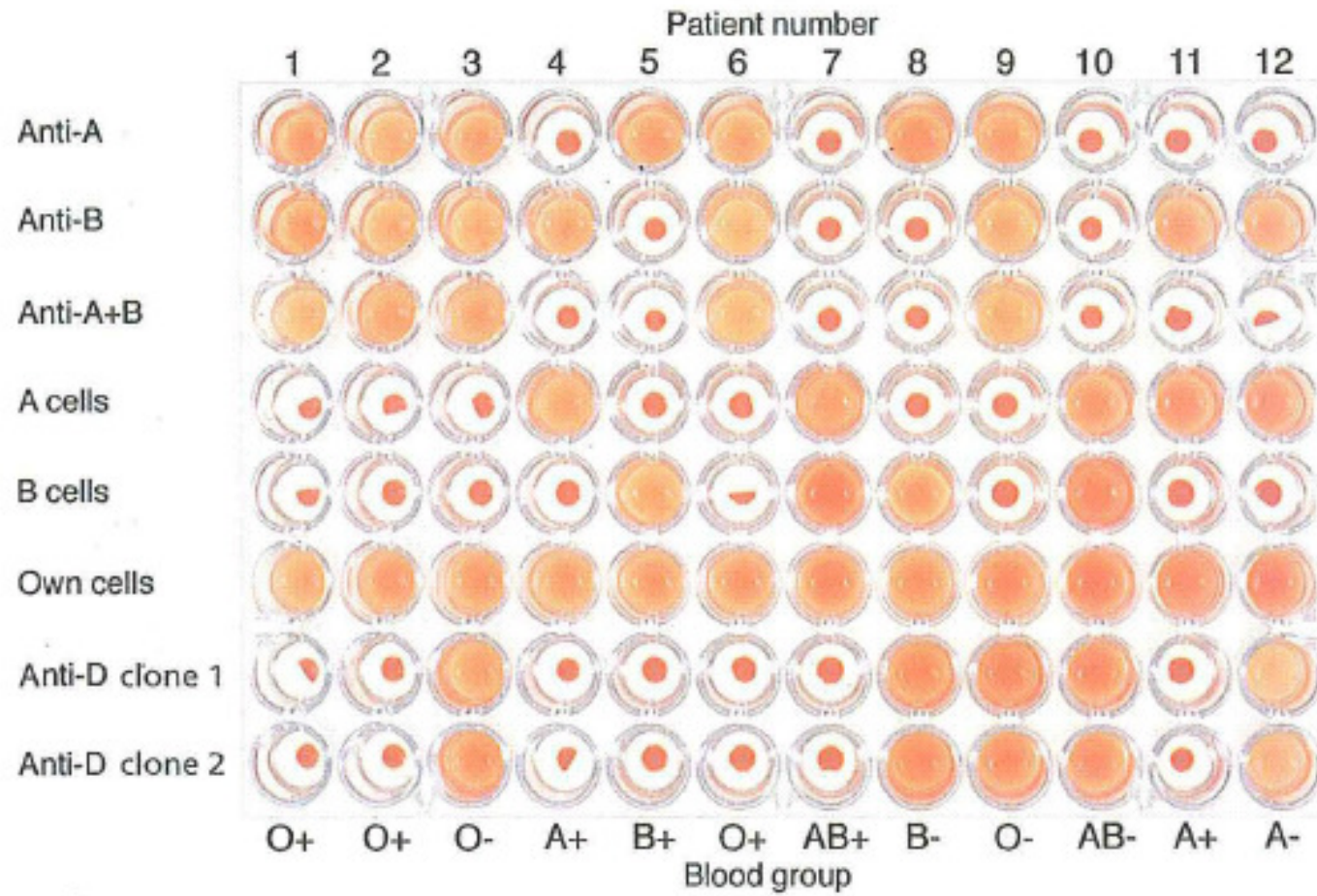
**b) Cells that are of a known ABO group that are agglutinated by the naturally occurring antibodies in the person's serum.**



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

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

# Forward and reverse grouping





**Table 4-10** Interpretation of ABO groups, including use of anti-A,B reagent and group O red cells

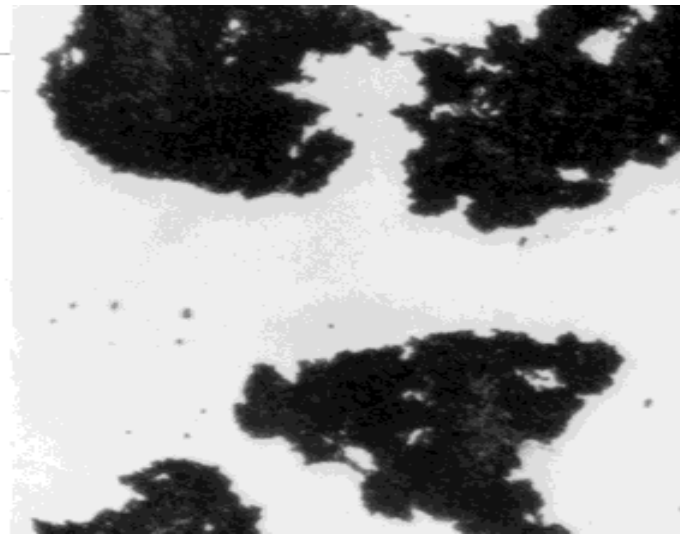
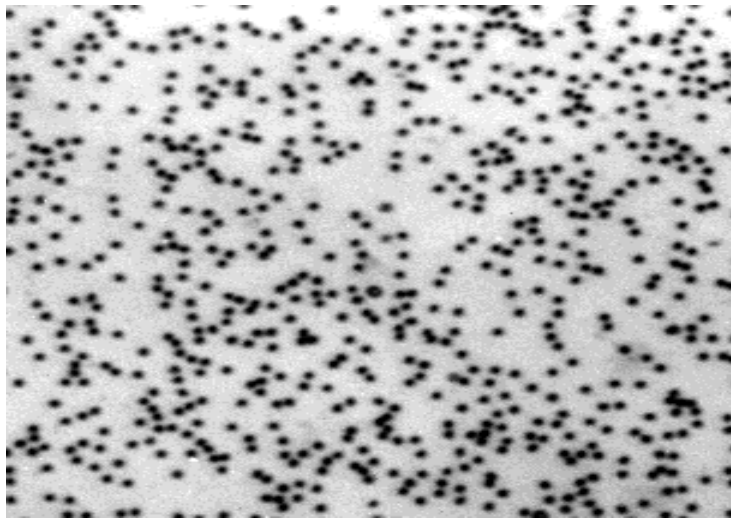
Forward grouping			Reverse grouping			Interpretation Group
Anti-A	Anti-B	Anti-A,B	A cells	B cells	O Cells	
4	0	4	0	4	0	A
0	4	4	4	0	0	B
0	0	0	4	4	0	O
4	4	4	0	0	0	AB

**Forward grouping:** testing for antigens on patient red cells.

**Reverse grouping:** testing for antibodies on patient serum.

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.

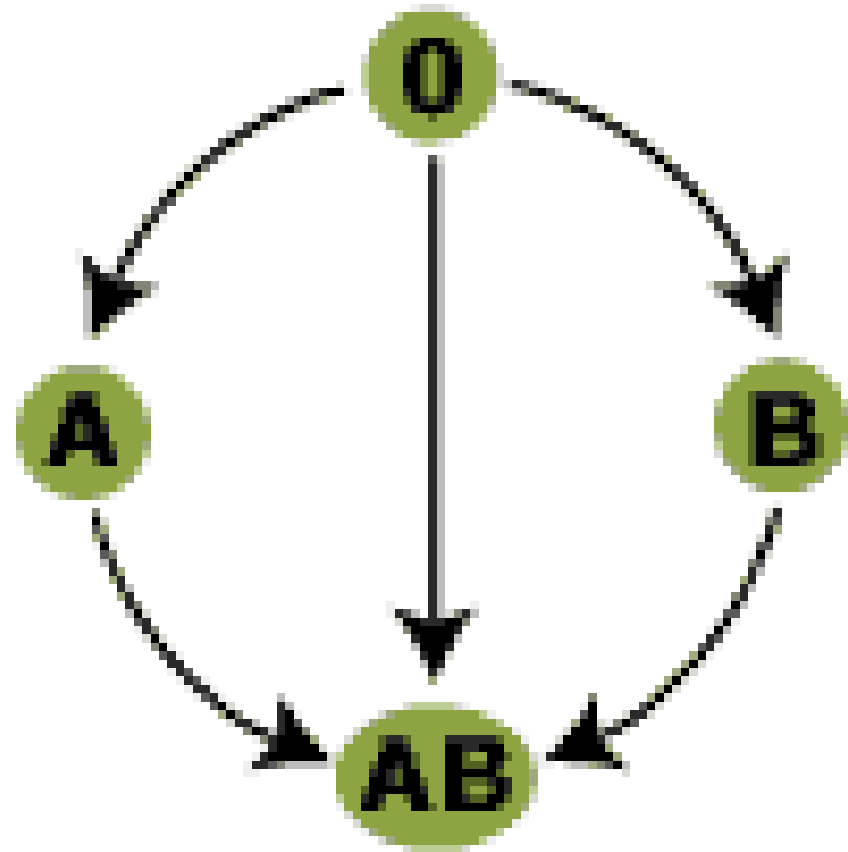
Human RBC before (left) and after (right) adding serum containing anti-A antibodies. The agglutination reaction reveals the presence of the A antigen on the surface of the cells.



<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/B/BloodGroups.html>

## 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.**"

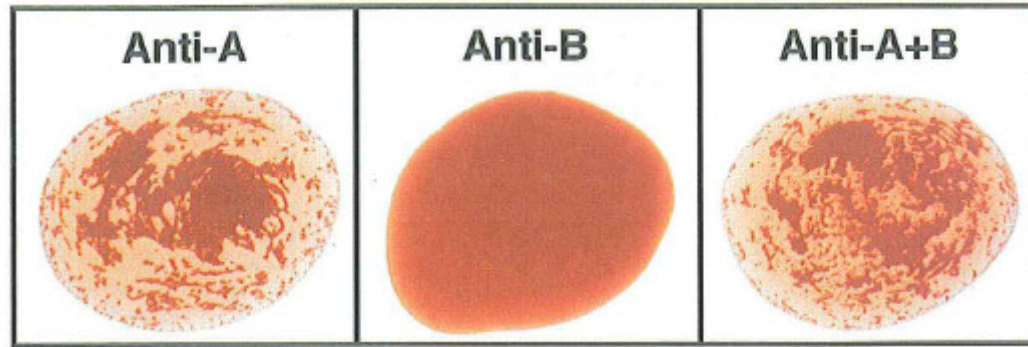


<b>Blood Group</b>	<b>Antigens</b>	<b>Antibodies</b>	<b>Can give blood to</b>	<b>Can receive blood from</b>
<b>AB</b>				
<b>A</b>				
<b>B</b>				
<b>O</b>				

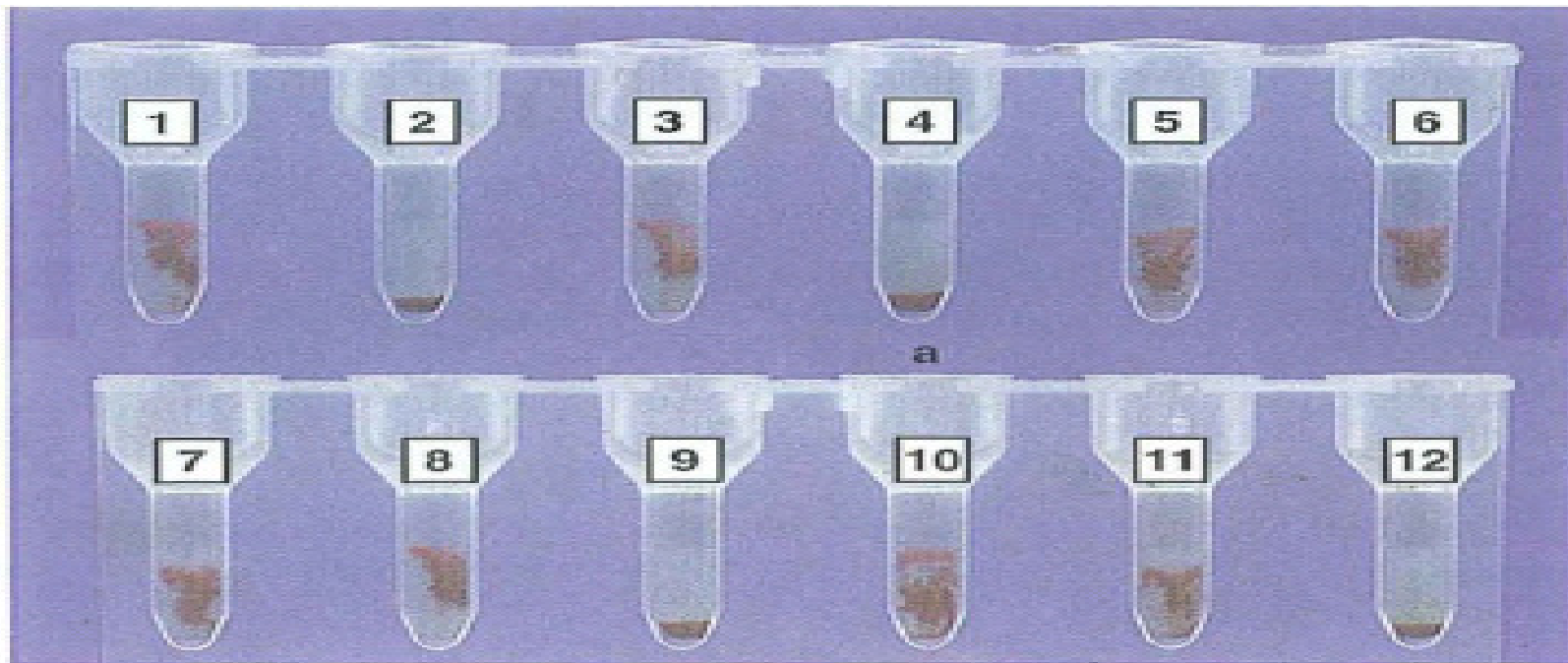
<b>Blood Group</b>	<b>Antigens</b>	<b>Antibodies</b>	<b>Can give blood to</b>	<b>Can receive blood from</b>
<b>AB</b>	<b>A and B</b>	<b>None</b>	<b>AB</b>	<b>AB, A, B, O</b>
<b>A</b>	<b>A</b>	<b>B</b>	<b>A and AB</b>	<b>A and O</b>
<b>B</b>	<b>B</b>	<b>A</b>	<b>B and AB</b>	<b>B and O</b>
<b>O</b>	<b>None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

Table 27.3 The ABO blood group system.

Phenotype	Genotype	Antigens	Naturally occurring antibodies
O	OO	O	Anti-A, anti-B
A	AA or AO	A	Anti-B
B	BB or BO	B	Anti-A
AB	AB	AB	None



**What blood group do you think we have here?**



**Fig. 27.6** Patient antibody screening using the microcolumn (gel) system: 10 tests with two controls (tube 11 is the positive control and tube 12 the negative control) are shown. The patient's serum is tested against screening cells with known red cell phenotype. Tubes 1, 3, 5–8 and 10 show positive results. The patient's serum contained anti-Fy<sup>a</sup>. (Courtesy of Mr G. Hazlehurst)