



ABO Blood Group

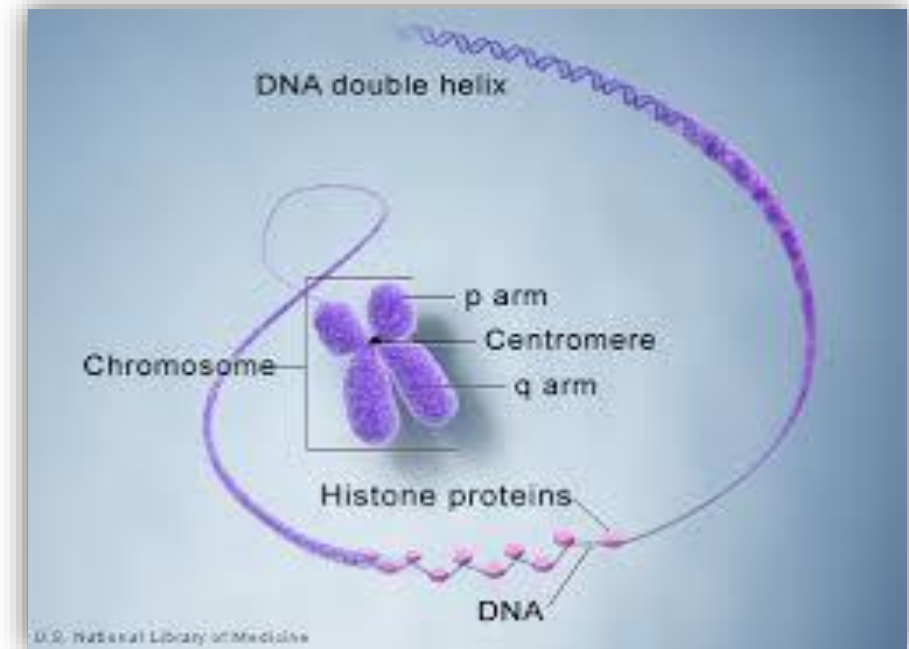
NAHLA BAKHAMIS MSC.

Glossary

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

Chromosomes

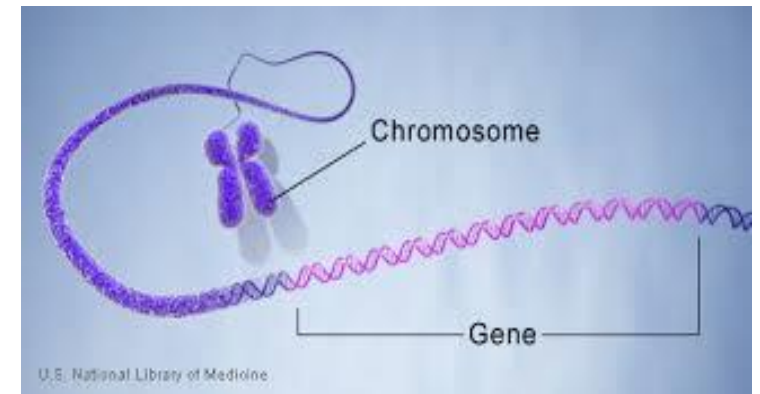
- Made up of DNA
- Make up genes
- Code for proteins



www.ghr.nlm.nih.org

Genes

- a section of DNA code for phenotype
ie. eye colour
- each gene has a coding sequence determine
a production of certain proteins
ie. Blood Ag are determined by different genes



www.ghr.nlm.nih.org

Glossary

- **Homozygous**

2 identical chromosomes with same gene on each

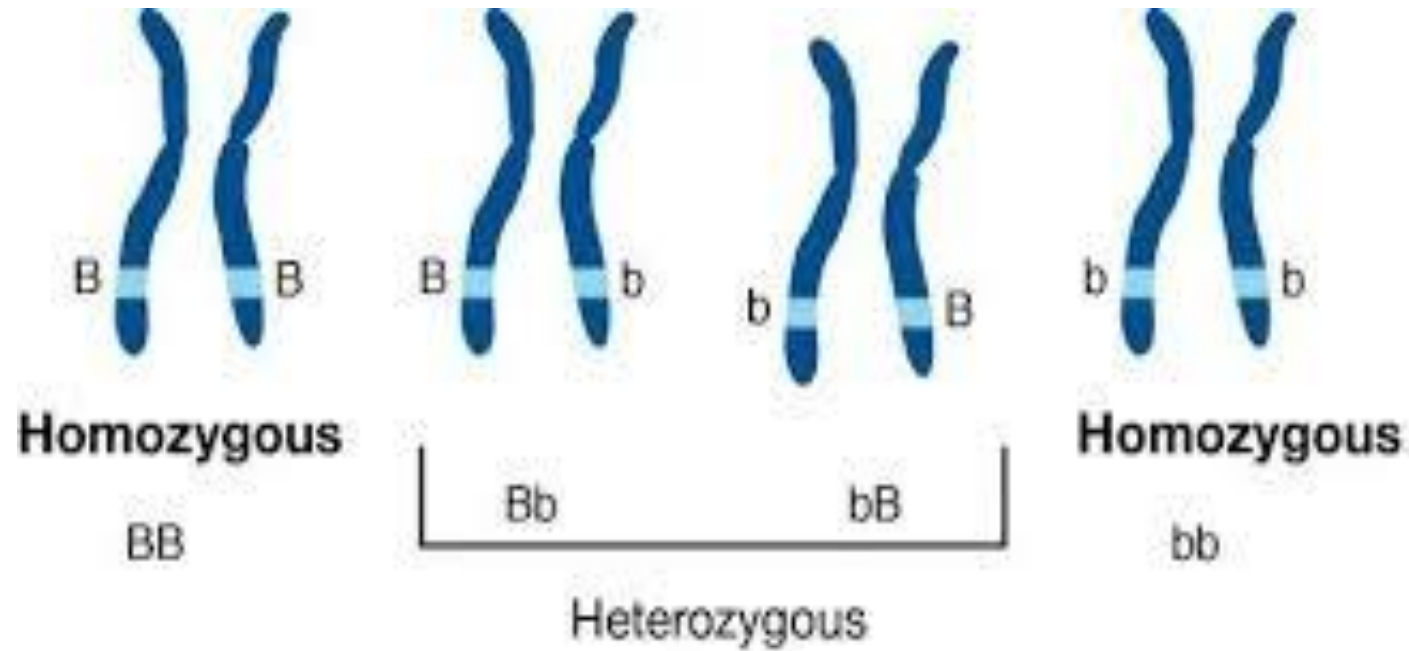
ie. Dominant & Dominant

- **Heterozygous**

2 identical chromosomes with Different Gene types

ie. Dominant & Recessive

Glossary



Genome.org

Glossary

- Locus

location of a gene on a chromosome

- Allele

variation of a gene that produces an alternative phenotype

2 alleles/locus inherited from each parents

Glossary

- **Genotype**

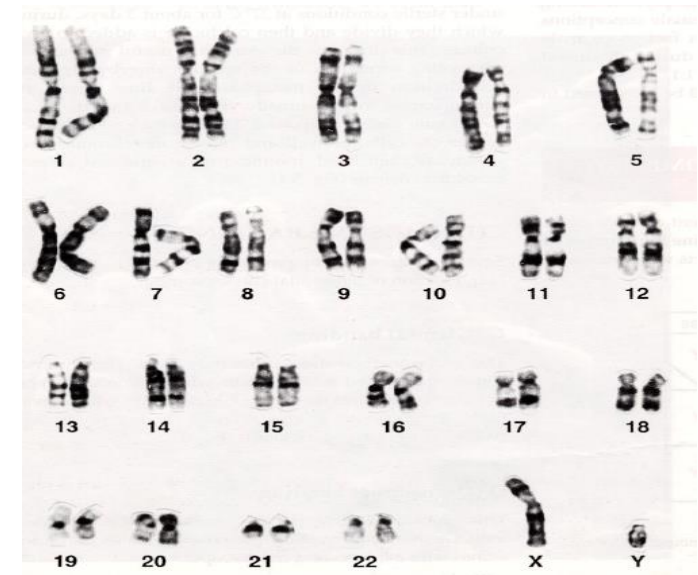
an individual collection of genes that would be revealed by personal genome sequence

- **Phenotype**

the result of expressing a gene

Glossary

- Sex linked chromosomes
determine gender XX,XY
- Autosomal chromosomes
 - any chromosomes that is not a sex chromosome
 - same in male and female



Glossary

- **Dominant gene**

strong gene that expressed phenotypically in heterozygous or homozygous

- **Recessive gene**

weak gene that require 2 copies/sister chromatids to be expressed in autosomal chromosomes. Or on the X in men

The Blood Group Systems



Blood Group Systems

- 600 RBC Ags
- 29 blood group systems
- Most imp ABO and Rh

Landsteiner's rule

Individual who lack a particular blood group Ags in their RBC will have Abs (naturally) specific to the missing Ag in their plasma



History of blood groups

before 1901

- Many patients died bec of Blood transfusions
- mixing blood of 2 individuals – blood clumping – clumped RBC cause toxic reaction – can be fatal



History of Blood groups

- **1901 Austrian Karl Landsteiner** discovered that blood clumping = **immunological reaction** when receiver has Abs against donor RBCs
- made it possible to determine blood types
- safe transfusion
- **1930 Nobel Prize** in medicine



Blood Group Systems

- differences in human blood due to presence/absence of Ags (RBC) and Abs (plasma)
- each person different types and combinations of these
- depends on inheritance

Major Blood Systems

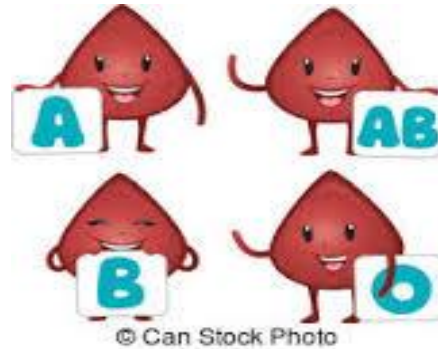
Table 6-1 Major blood group systems (9 of 29)

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

Blood Group Systems

- Not all blood groups are compatible with each others
- mixing incompatible groups – agglutination

ABO Blood Group System



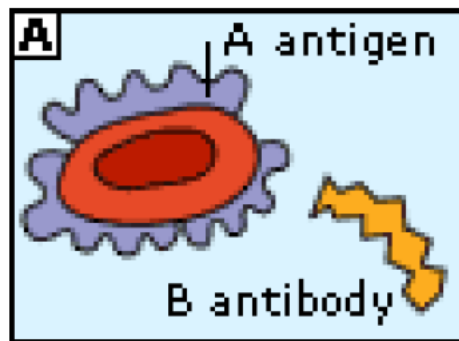
ABO system

- 4 blood types; A B AB O (null)
- classification determines by presence/absence of specific RBC surface Ag (agglutinogens)
- 2 types of Ags; A and/or B
- Genetically determined

ABO system

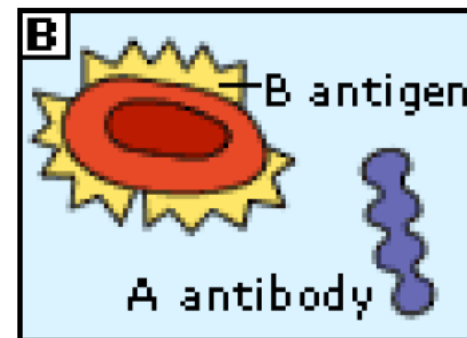
BLOOD GROUP A

- A antigen in the RBC surface
- B Ab in the plasma
- 40% (US population)



BLOOD GROUP B

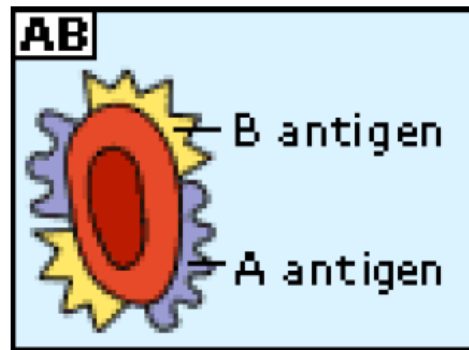
- B antigen in the RBC surface
- A Ab in the plasma
- 10%



ABO system

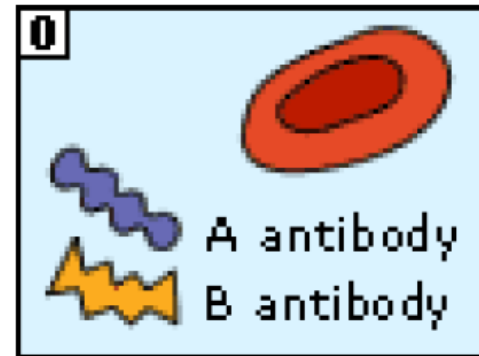
BLOOD GROUP AB

- A and B Ag in the RBC surface
- no A or B Abs in the plasma
- 4%



BLOOD GROUP O (NULL)

- neither A nor B in the RBC surface
- A and B Abs in the plasma
- 46%



ABO system (USA)



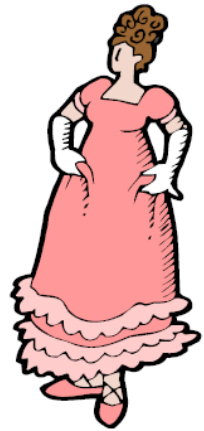
ABO system

- wrong ABO group transfusion could be fatal
- anti-A Ab in group B will attack group A cells ... vice versa
- group O negative different story

ABO inheritance and Genetics

- ABO Gene is Autosomal
- Chromosome 9
- A and B groups dominant over O group
- A and B are Co-dominant ??
- each person has 2 copies of gene coding for ABO

Autosomal Chromosome



Mother



A

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



B



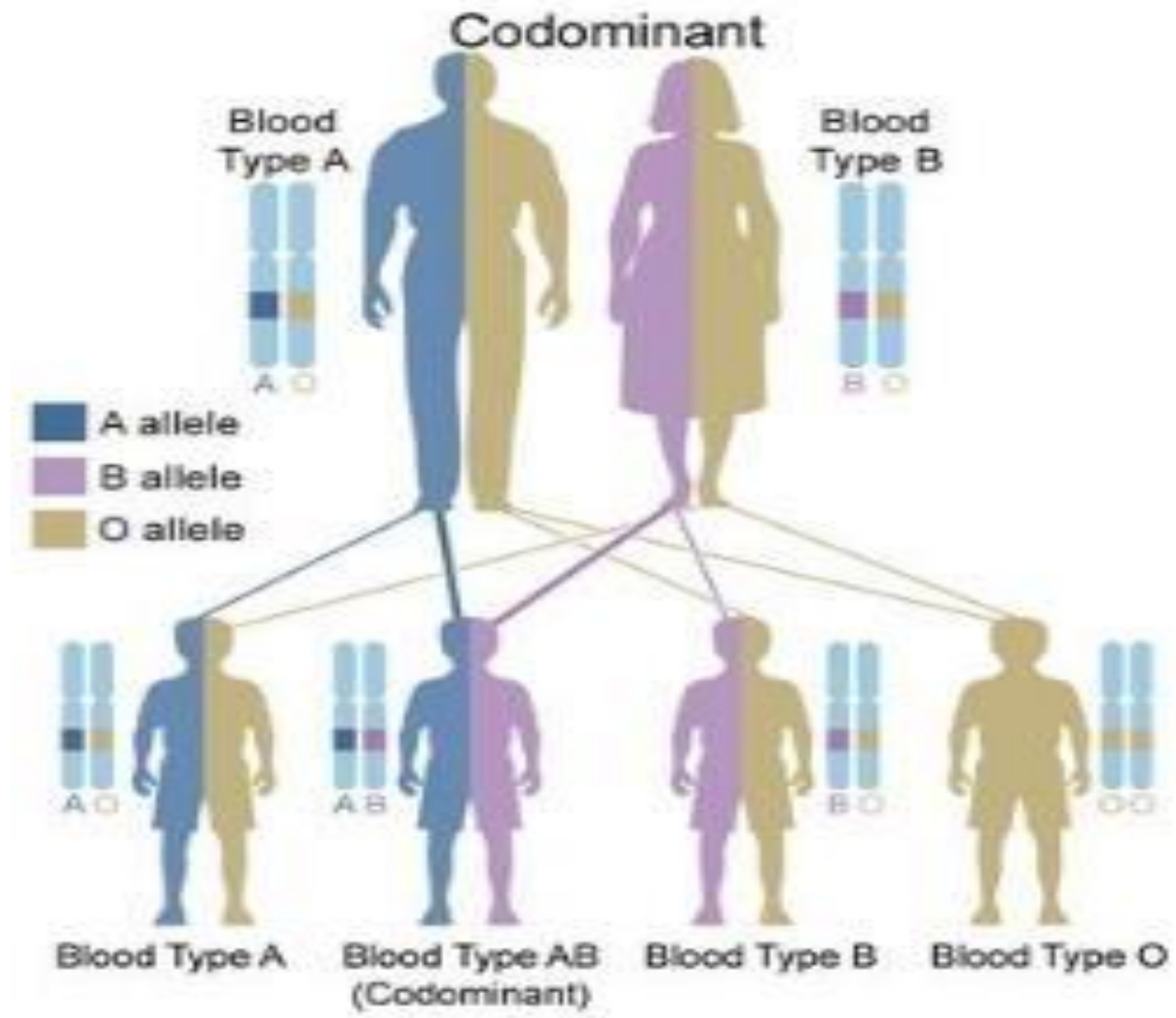
Father

one allele from mother and one from father.

www.slideshare.net

Autosomal Co-dominant

- 2 different alleles (equally dominant) both expressed
- Individual receive one version (allele) from each parent
- eg. A person inherited 1 A gp gene and 1 B gp gene = both A and B Ag on his RBC



www.perkepi.com

ABO genotype

Parent allele	A	B	O
A			
B			
O			

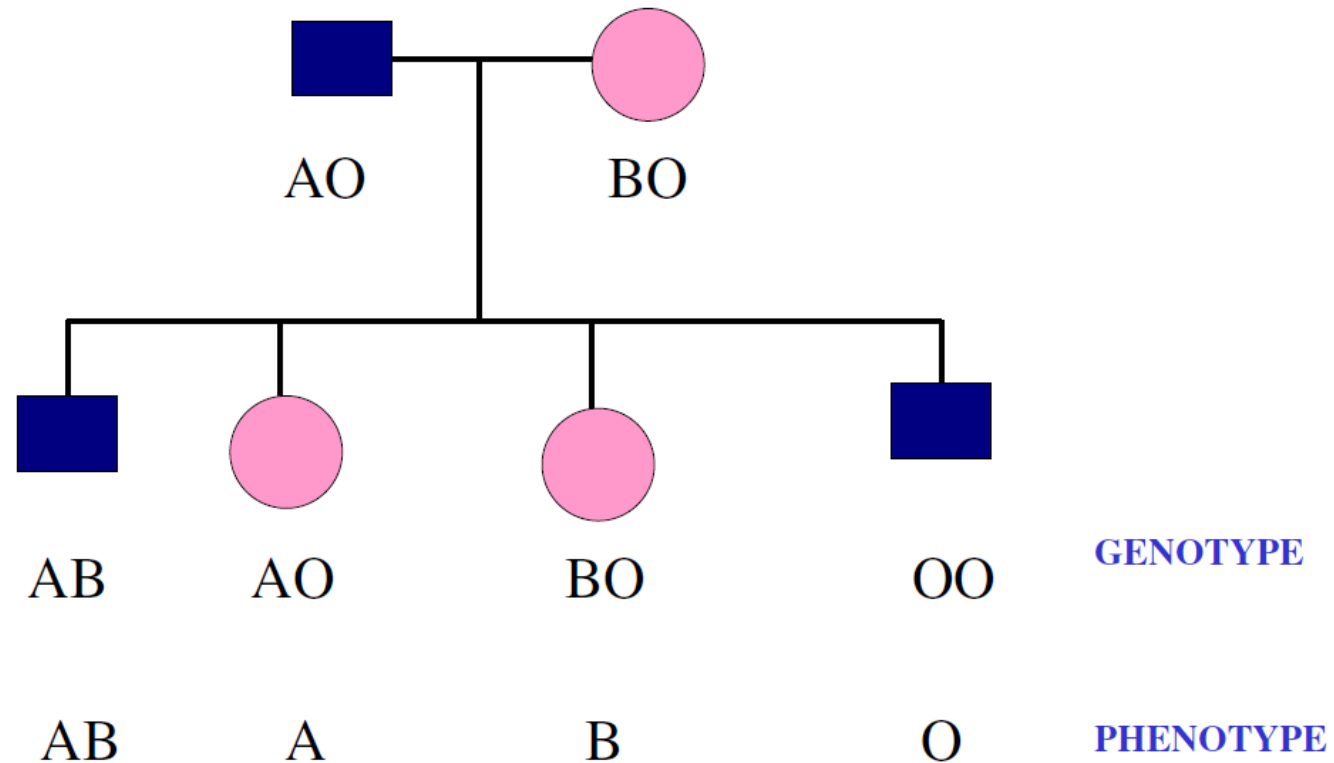
ABO genotype

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

ABO phenotype

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

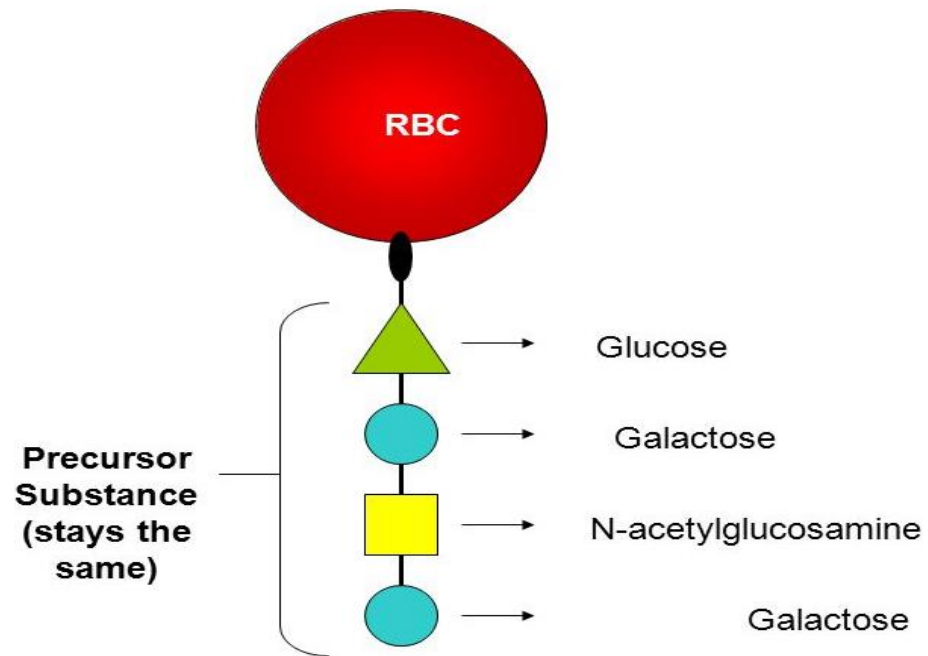
ABO inheritance



Formation of ABO antigens

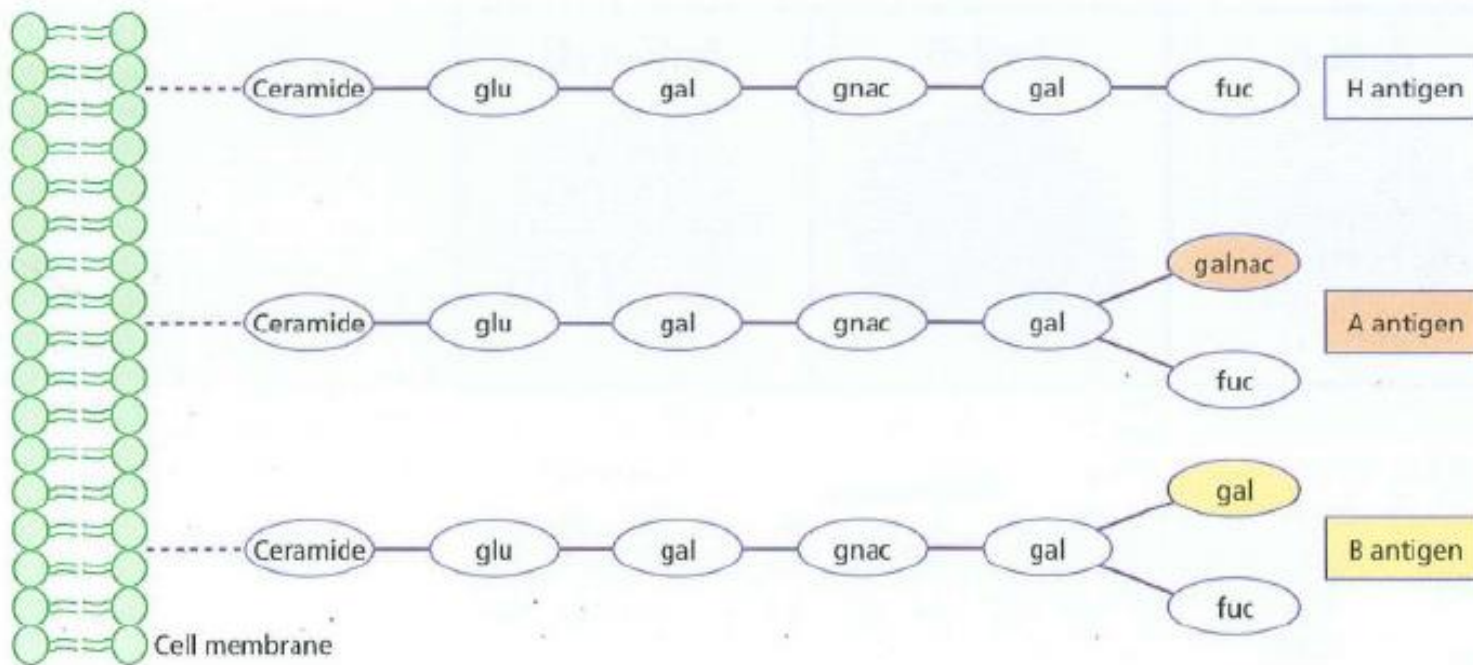
- A and B genes don't directly produce Ags
- produce an enzyme **transferase** attaches sugar molecule to chemical structure of Ag
- sugar molecule responsible for specificity
- O Ag, no transferase = **no Ag production**

RBC precursor structure



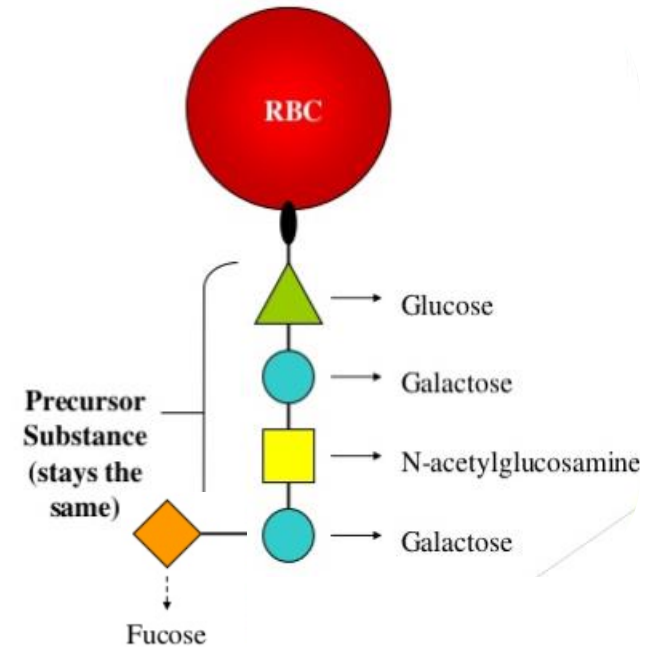
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Biochemical nature of ABO Ags



Formation of H antigen

- H antigen codes for an enzyme that add sugar **fucose** to the terminal sugar of precursor substance
- require to produce either A or B Ags



H antigen

- possible genetic combination HH, Hh or hh
- HH or Hh produce H Ag in 99.99% of Caucasian
- hh doesn't produce H Ag ---- Bombay phenotype (oh)
- Anti H Ab found only in individuals with Bombay blood group

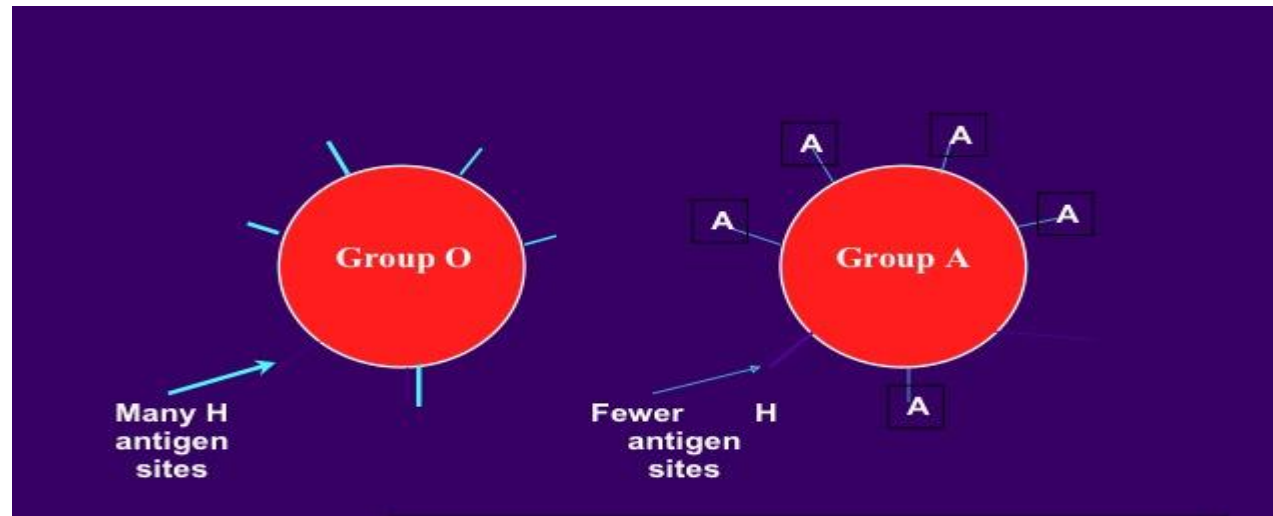
H antigen

- certain blood types possess more H Ag than others;

O > A₂ > B > A₂B > A₁ > A₁B

Why do group O individuals have more H Ag than other groups?

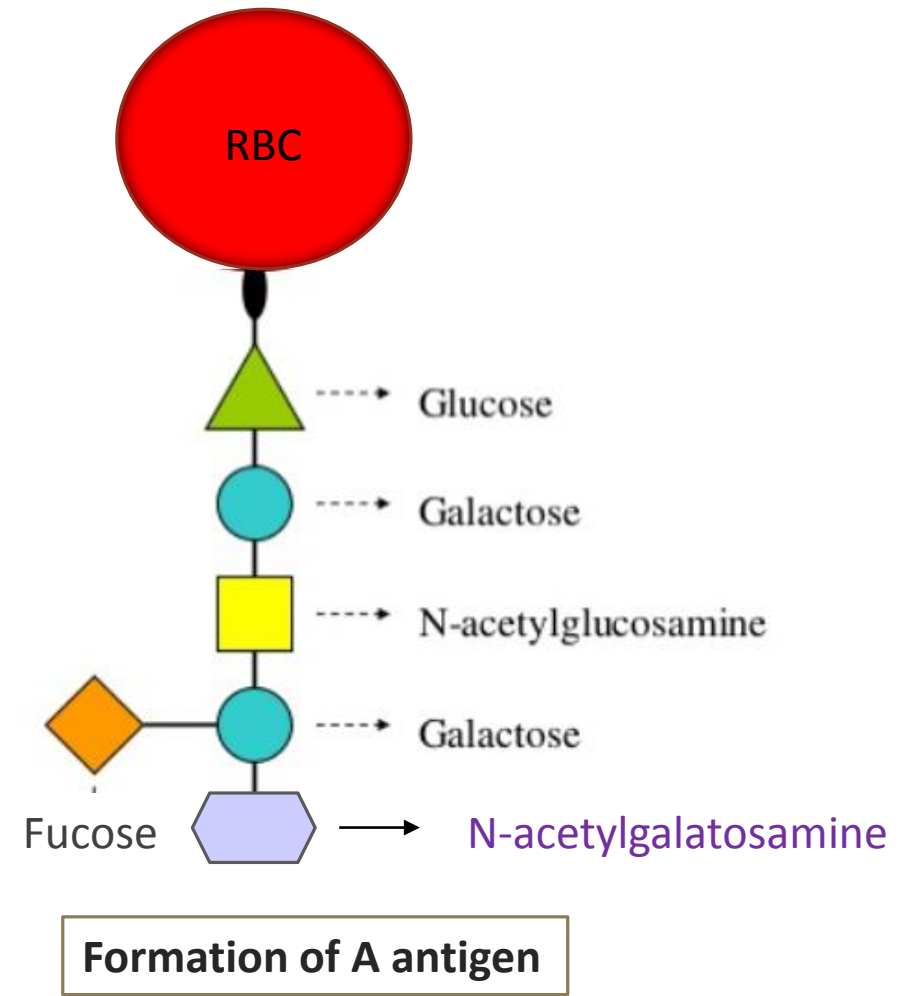
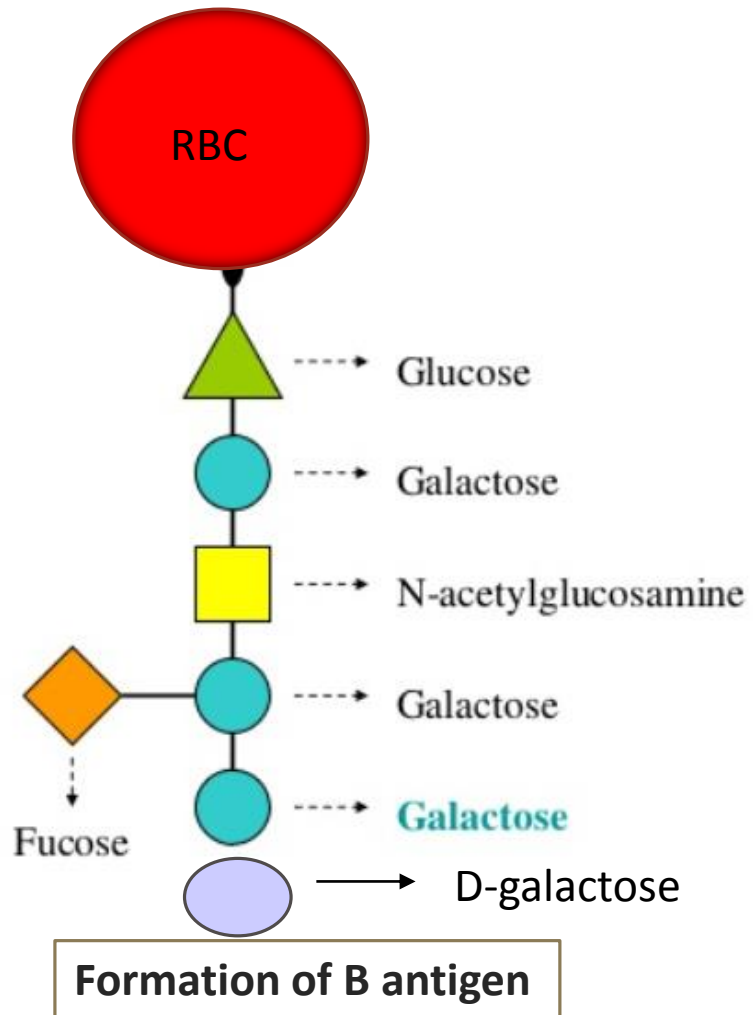
H antigen



Group O posses more H Ag

Formation of A and B antigens

- A gene codes for an enzyme (transferase) to add N-acetylgalactosamine to the terminal sugar of H antigen..?
- B gene codes for transferase to add D-galactose to terminal sugar of H antigen ?



Bombay phenotype

- Also called Oh phenotype
- originally found in Bombay (now Mumbai)
- very rare (130 worldwide)



Bombay phenotype

- don't inherit H gene ... don't express H Ag (hh)
- can't make A or B Ag even if they have A or B group gene
- have anti-H, anti-A, anti-B and anti-AB in the plasma

What ABO blood group would you use to transfuse this patient?

Bombay phenotype

- donate to any ABO group that Rh is compatible (no Ag present)
- **can't** receive blood from any member of ABO group but themselves
(they have very strong anti H, anti A, anti B and anti AB)

Subgroup of A

- A1 and A2
- both react strongly with anti- A
- to distinguish A1 from A2: lectin Dolichos biflorus is used (anti-A1)
- 80% of group A individuals are subgroup A1
- 20% A2 and A2B

A subgroups

- other additional subgroups of A:
anti (intermediate), A3, Ax, Am, Aend, Ael and Abantu

B subgroups

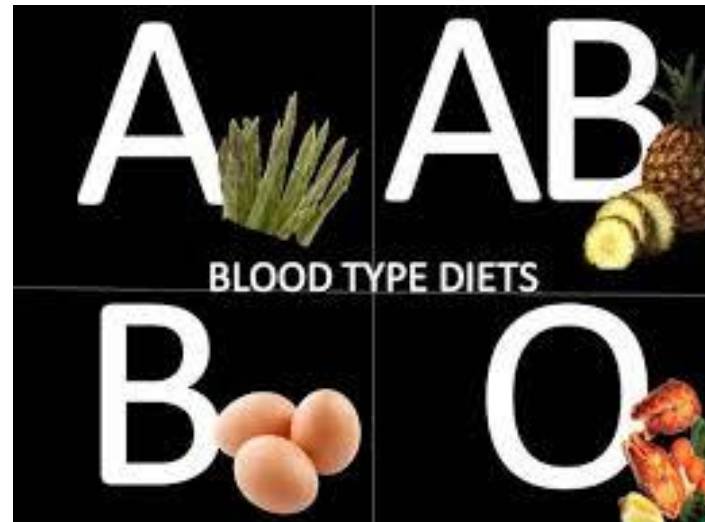
- less than A subgroup
- B3, Bx, Bm and Bel

ABO subgroup

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

Activity



Is there any specific relation between blood type and individual's diet ??

Laboratory determination of ABO

ABO grouping

- **Forward grouping:**

Testing of patient's cells (unknown group) with known antisera to determine presence/absence of A and/or B Ag

- **Reverse grouping:**

Testing of unknown serum/plasma to determine presence/absence of Abs corresponding to Ag lacking on red cells

Forward grouping

- antisera manufactured from human sera

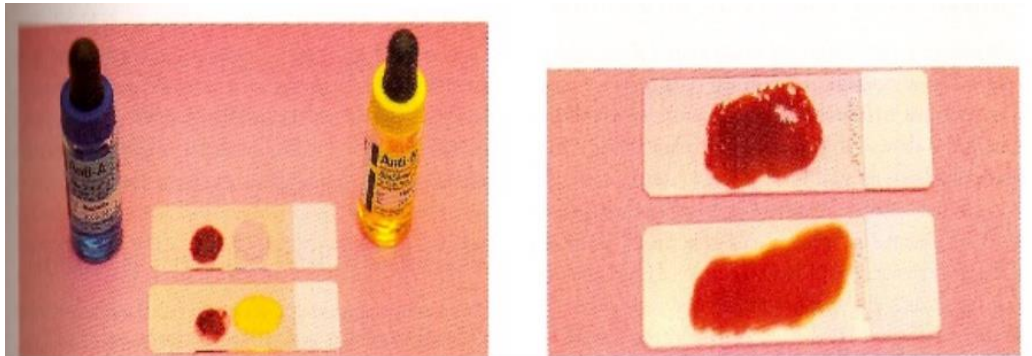
Anti-A blue in colour manufactured from Group B donor

Anti-B yellow colour manufactured from Group A donor

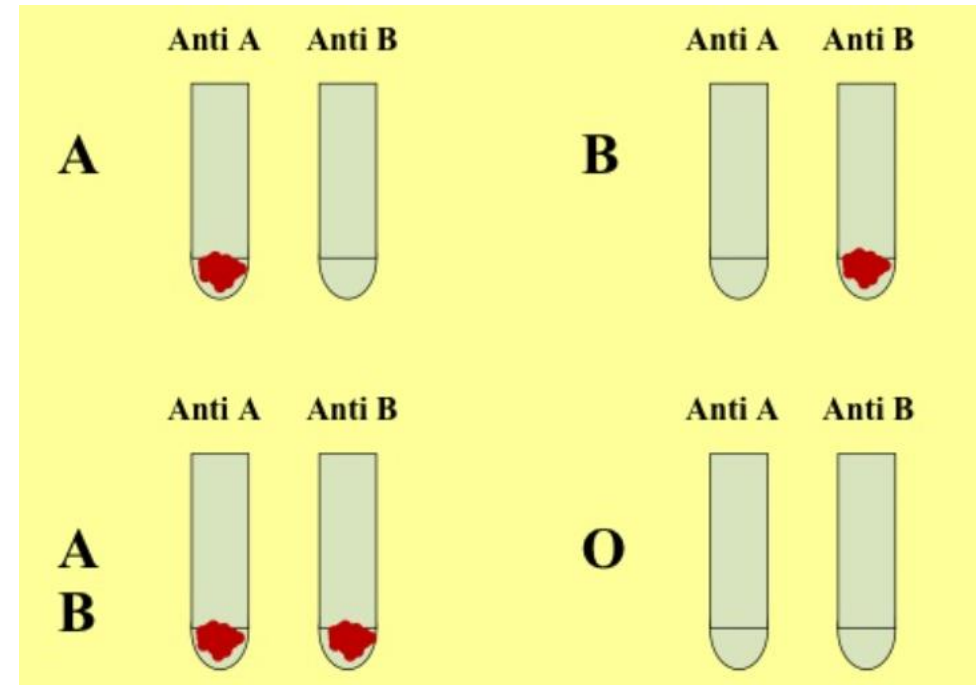


Forward typing

SLIDE METHOD

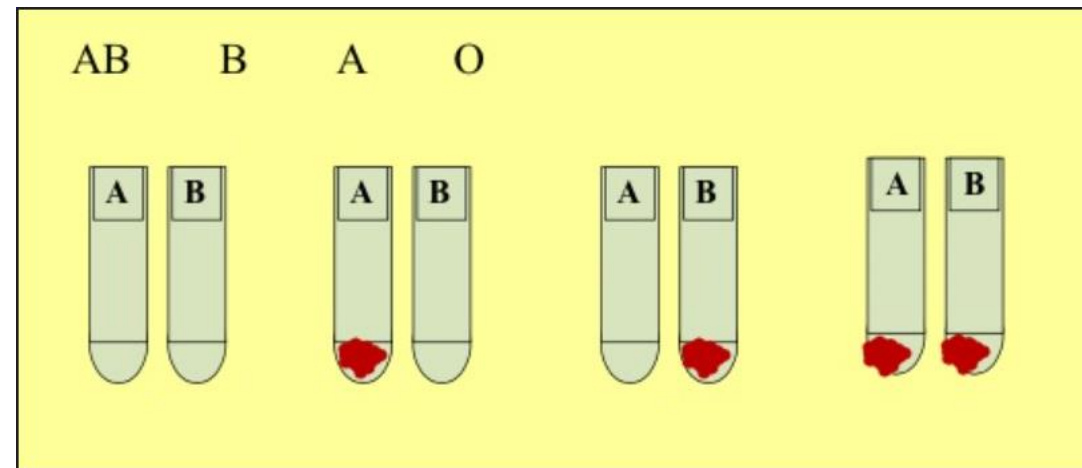


TUBE METHOD



Indirect/reverse typing

- commercially available A and B cells added to 2 tubes of serum



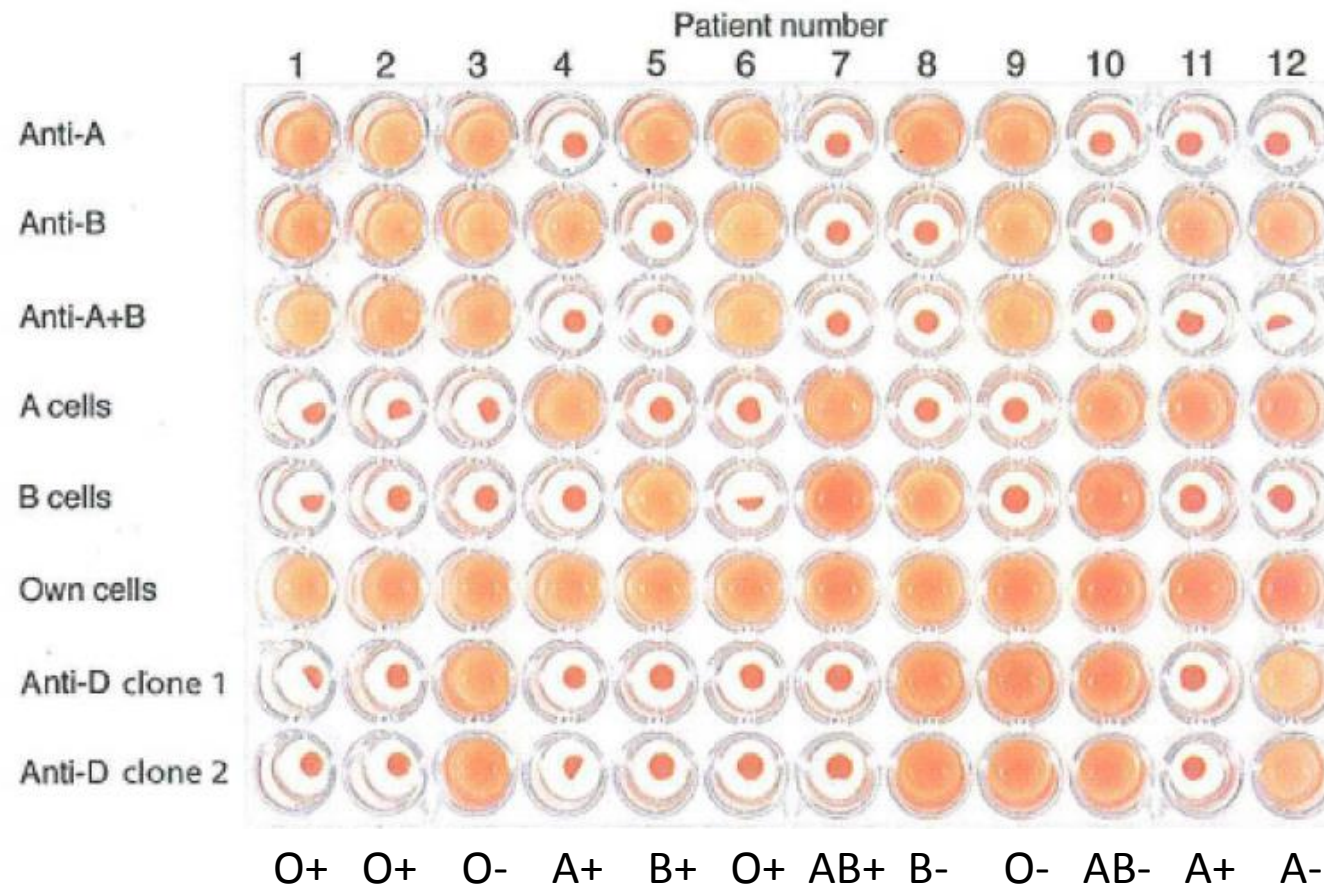
Interpretation of forward & revers





























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

Serology

- most common method in blood transfusion centres and blood banks
- direct detection of ABO Ag
- involve 2 components:
 - a. Abs specific at detecting particular ABO Ag on RBCs
 - b. Cells of known ABO group that agglutinating with naturally occurring Abs in person's serum

Forward and revers



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

<http://www.bh.rmit.edu.au/mls/subjects/abo/resources/genetics1.htm>

Gel cards

- the card containing specific typing reagents (monoclonal Abs to various RBC Ag



Gel card

- Interpretation of results
 - positive reaction recorded when RBC retained in or above gel column after centrifugation
 - negative reaction recorded when distinct button of cells sediment to the bottom of column after centrifugation

Discrepancies in ABO testing

1. technical problems:

- incorrect ID recording
- pt/donor serum not added
- reagent contamination
- over centrifugation
- haemolysis
- warming of test mixture

Discrepancies in ABO testing

B. Serum:

- Roleaux formation ???

increase plasma proteins, myeloma, infections, liver & connective tissue diseases

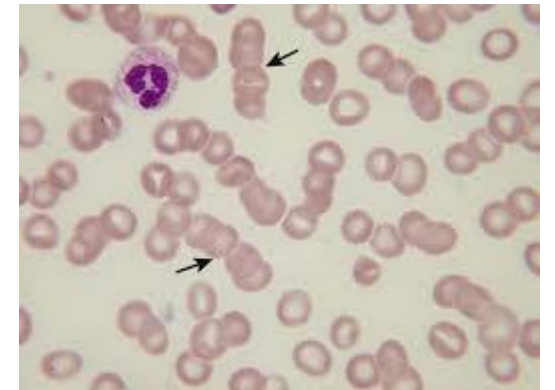
- expected Ab absent/inactive (weak)

hypogammaglobulinemia, extreme ages, immunosuppression

c. RBC factor:

Polyagglutinable RBC:

post transfusion incompatibility, autoimmune haemolytic anaemia



Discrepancies in ABO

Example 1:

Forward grouping: anti-A = O, anti-B = O, anti-AB = O

Reverse grouping: A1 cells = O, B cells = O

False –ve

Blood group: O

Possible discrepancy: Missing Abs, failure to add serum or reagent

Discrepancies in ABO

Example 2:

Forward grouping: anti-A +4, anti-B +2, Anti-AB +4

Reverse grouping: A cell +4, B cell +4

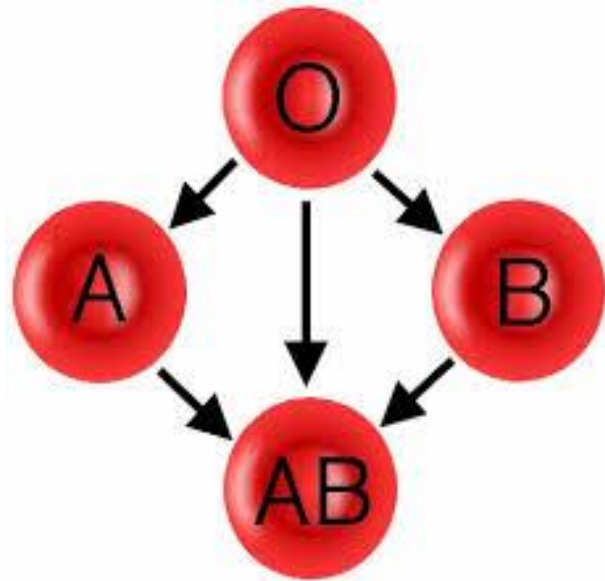
False +ve

Blood group A

Possible discrepancies: Rouleaux formation

Solution: wash RBC with saline

Blood transfusion



O group called universal donor
AB group called universal receiver

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

Importance of ABO grouping

- must be done before blood transfusion
- severe blood transfusion reaction if not properly matched blood is transfused
- avoid giving patient an Ag he does not already have
- in emergency, O packed RBCs given as universal donor

Take Home Messages



50

- ✓ Landsteiner's rule
- ✓ ABO classification
according to Ag on RBC,
- ✓ ABO inheritance;
autosomal chr 9
- ✓ Co-dominant ?
- ✓ ABO genotype and phenotype
- ✓ formation of A, B and H
(N-acetylgalactosamine) (D-galactose) (fucose)
- ✓ Bombay blood group;
 - no H Ag, very rare give to any ABO blood gp (same Rh)
 - Cant receive from any but them selves
- ✓ ABO sub groups;
 - A more common than B, A1 sites is more than A2 sites,
 - lectin *Dolichos biflorus* to distinguish bet A1 and A2
- ✓ Differences between forward and reverse
- ✓ Interpretation of gel card results
- ✓ Blood transfusion; O universal donor, AB universal recipient

Thanks for your patience

