

TBL 4: Transfusion

PART 1

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Session plan

Part 1 – Blood groups and their clinical significance

- Blood group systems
- RBC antigens and antibodies against RBC antigens
- Haemolytic transfusion reaction
- Haemolytic disease of the fetus and newborn
- Naturally occurring antibodies
- Acquired alloantibodies

Part 2 – ABO and Rh blood group systems

- ABO – Antigens, Antibodies, Selecting blood components for transfusion
- RH – Antigens, Antibodies, Selecting blood components for transfusion
- Other blood group systems

Part 3 – Pre-transfusion compatibility testing

- ABO grouping
- RhD grouping
- Antibody screen
- Crossmatch



Part 4 – Donor selection and testing

- Blood donors
- Tests undertaken on donations

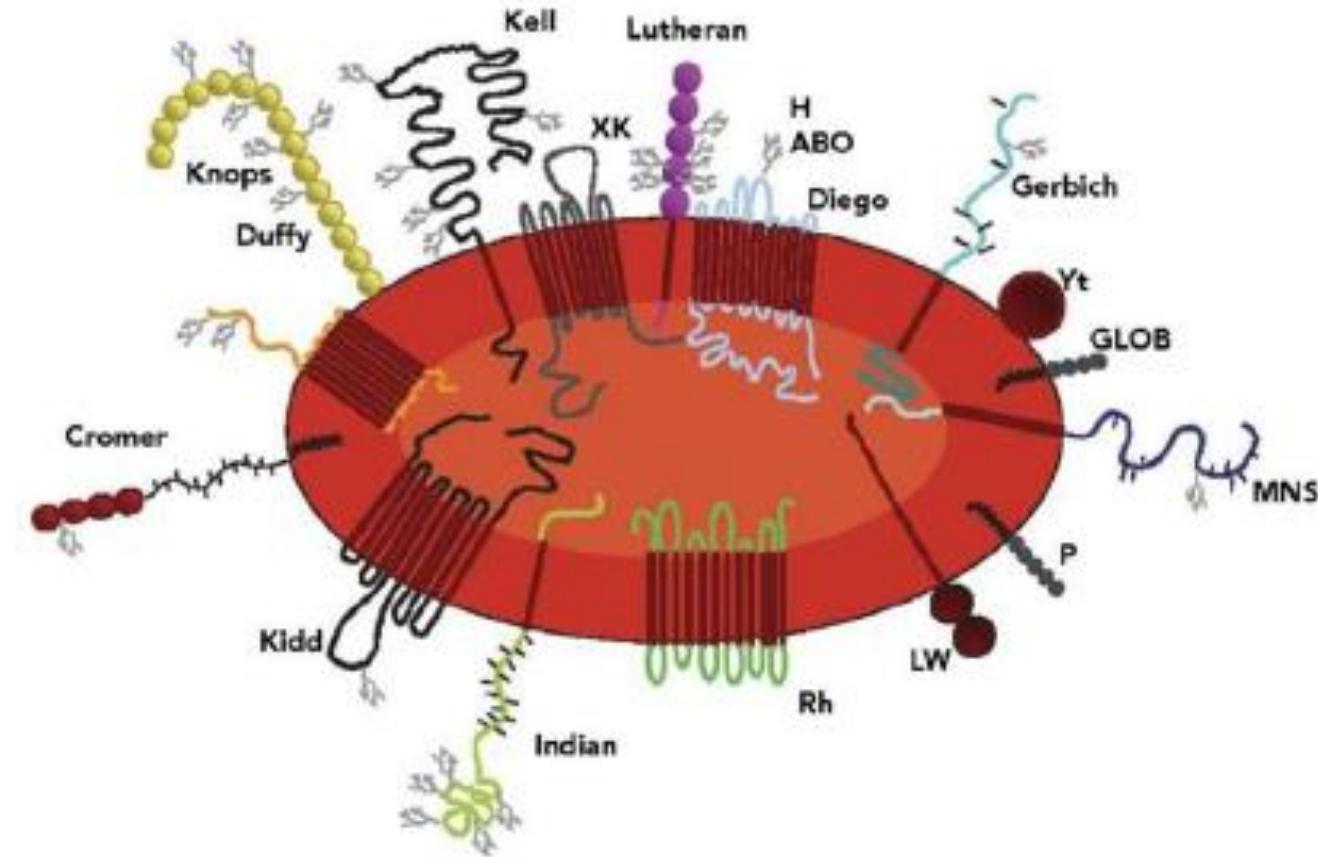
Part 5 – Blood components and why we use them

- Whole blood donation
- Apheresis
- Red cells
- Platelets
- FFP
- Cryoprecipitate
- Plasma derived medicinal products



Blood groups

- Red blood cell (RBC) antigens are specific sites on different proteins and glycoproteins that form part of the RBC membrane
- An individual's 'blood group' refers to the combination of RBC antigens present
- RBC antigens differ depending on their specific sequence of oligosaccharides or amino acids but can be collated into different 'blood group systems'
- A 'blood group system' is a collection of one or more RBC antigens under the control of a single gene or a cluster of closely linked homologous genes.



**Figure: RBC membrane with blood group antigens
(Image taken from ISBT Science Series 2020 – Blood group systems)**



Blood group systems

- Currently identified: 47 blood group systems (genetically determined by 52 genes) containing 366 red cell antigens (ISBT Oct 2024)
- There are 10 major blood group systems.
- The **ABO** and **Rh** blood group systems are the **most clinically significant**.

ISBT no.	Name of blood group system	Major antigens	Chromosome location no.
001	ABO	A, B, A ₁	9
002	MNS	M, N, S, s, U	4
003	P1PK	P1, P ^k	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
027			6

Figure: The 10 major blood group systems
(Image taken from ISBT Science Series 2020 – Blood group systems)



RBC antigens and antibodies against RBC antigens

- The clinical importance of a blood group system depends on the capacity of **antibodies against the specific RBC antigens** to cause **haemolysis** (destruction) of the RBCs.
- Not all antibodies against RBC antigens can cause haemolysis.
- **Antibodies against RBC antigens are clinically significant if they can cause haemolysis resulting in either:**
 - **haemolytic transfusion reactions (HTRs)**

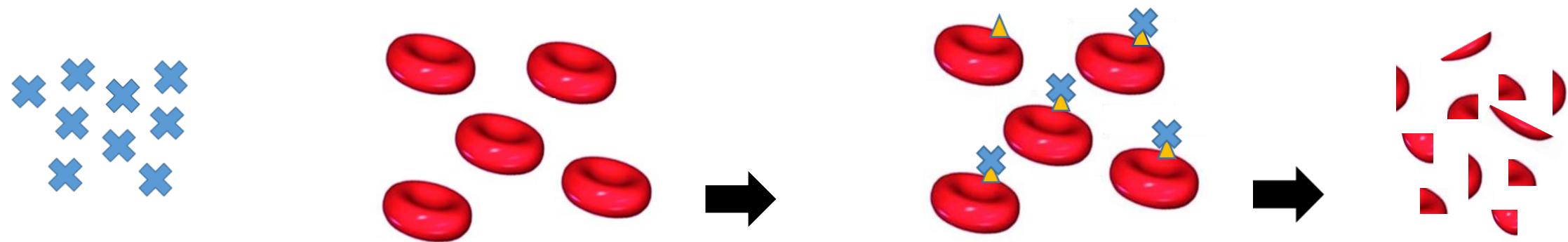
OR

- **haemolytic disease of the fetus and newborn (HDFN)**
- The interaction between RBC antigens and antibodies against RBC antigens also forms the basis of the serological pre-transfusion compatibility tests.



Haemolytic transfusion reaction (HTR)

▲ = RBC antigen
✖ = Antibody against RBC antigen



Recipient antibodies
against a RBC antigen

Transfused red cells
with the corresponding
RBC antigen

Antibodies bind to
RBC antigens

Haemolysis
• Intravascular
• Extravascular

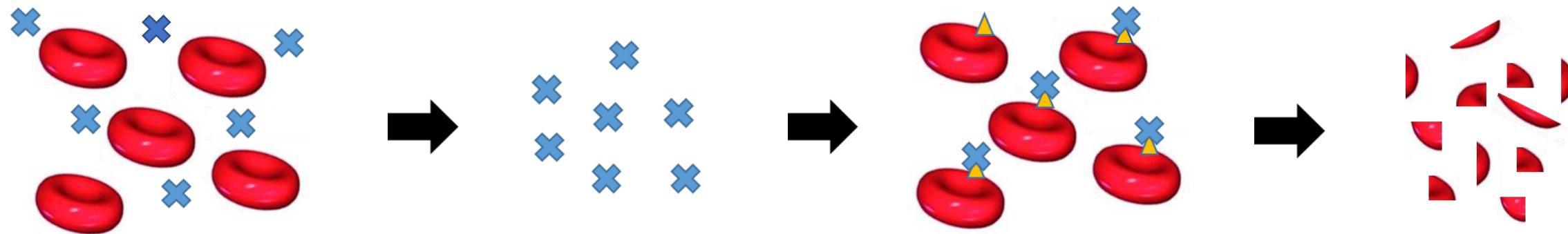
Destruction of transfused red cells due to incompatible blood transfusion

- e.g. Recipient with group A red cells (anti-B antibodies) transfused with group B red cells
- e.g. Recipient with group B RhD negative and anti-D antibodies transfused with group B RhD positive red cells



Haemolytic disease of the fetus and newborn (HDFN)

Maternal antibodies (IgG) against a RBC antigen can cross the placenta and bind to baby's red cells if they have the corresponding RBC antigen
e.g. baby is group O RhD positive



Maternal blood with antibodies
against a RBC antigen
e.g. mum is group O RhD negative
and has anti-D antibodies

Antibodies bind to RBC
antigens leading to
haemolysis of baby's red
cells

Destruction of baby's red cells by maternal red cell antibodies due to incompatibility between maternal and baby RBC antigens

▲ = RBC antigen
✖ = Antibody against RBC antigen



Antibodies against RBC antigens

2 types:

- **Naturally occurring antibodies**
- **Acquired alloantibodies**



Antibodies against RBC antigens – naturally occurring

2 types:

- **Naturally occurring antibodies**
- Acquired alloantibodies

ABO antibodies: anti-A, anti-B

- Production of ABO antibodies is stimulated when the immune system encounters the ‘missing’ ABO blood group in foods or in microorganisms
 - Happens within the first few months of birth because sugars that are identical to, or very similar to, the ABO blood group antigens are found throughout nature
- ABO antibodies are mostly **IgM antibodies** that **remain as IgM antibodies** throughout life and do not class switch
 - IgM antibodies are made up of 5 Y-shaped units forming a pentameric structure
 - The interaction between the pentameric IgM antibody and RBC antigens *in vitro* produces direct easily visualised clumping (**agglutination**) of red cells which is the basis of ABO blood grouping
- IgM ABO antibodies can cause **acute HTRs** through activation of the **complement** system resulting in **massive intravascular haemolysis**
- IgM ABO antibodies **cannot cross the placenta** to cause HDFN



Antibodies against RBC antigens - acquired

2 types:

- Naturally occurring antibodies
- Acquired alloantibodies

- Acquired alloantibodies are formed as a result of active immunisation (**alloimmunisation**) to 'non-self' RBC antigens following exposure to RBCs from another individual
 - Exposure arises due to incompatible blood transfusion or during pregnancy when some fetal RBCs can enter the maternal blood system (fetomaternal haemorrhage)
- Acquired antibodies can potentially be produced against antigens of all the other blood group antigen systems, which the individual lacks on their own RBCs
 - However, **not all alloantibodies are clinically significant**
 - **Alloimmunisation to the Rh system is particularly important clinically**
- Acquired alloantibodies are usually **IgG antibodies**
 - IgG antibodies have a Y-shaped structure
 - *In vitro*, the interaction between the IgG antibody and RBC antigens cannot be directly visualised so demonstrating their presence requires a different approach that forms the basis of the 'antibody screen'
- IgG antibodies generally do not cause massive intravascular haemolysis and death but do still cause **haemolysis (mainly extravascular)** resulting in **delayed HTRs**
- IgG antibodies are also **able to cross the placenta** and cause HDFN

