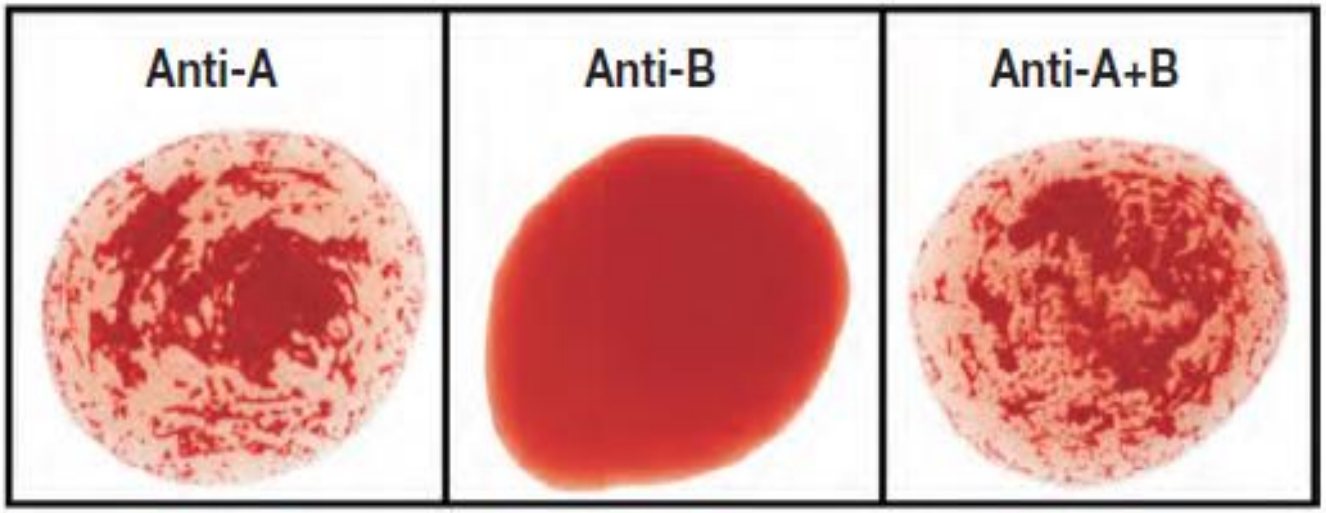
Blood Grouping



(a)

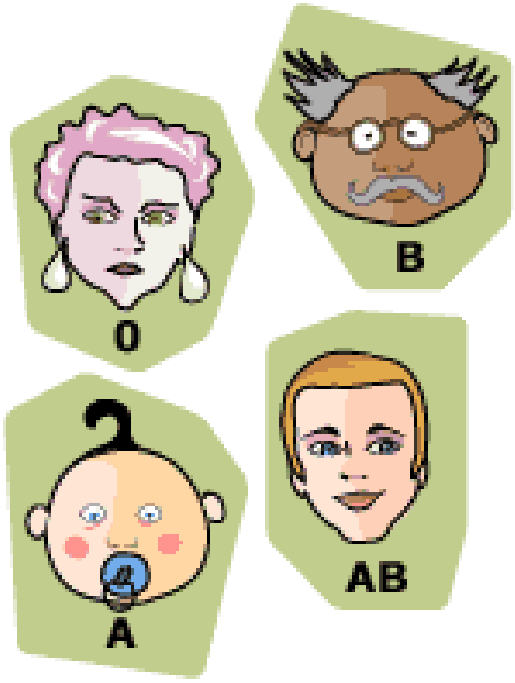
Blood group substances

- RBC membranes have glycoprotein antigens

- These antigens are:
  1. **Unique** to the individual Human Blood Groups
  2. Recognized as **foreign** if transfused into another individual
  3. Promoters of agglutination and are referred to as **agglutinogens**
- Presence or absence of these antigens is used **to classify blood groups**

- Humans have 30 varieties of naturally occurring RBC antigens but the important ones are the **ABO** and the rhesus **(Rh)** blood systems

ABO blood grouping system



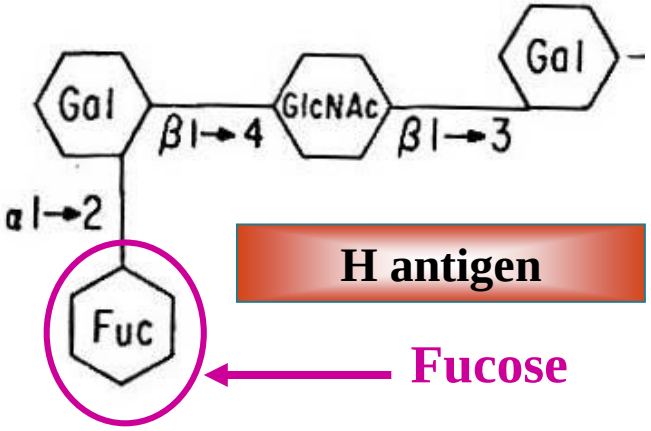
According to the ABO blood typing system there are four different kinds of blood types depending on the antigen of the RBC membrane: **A**, **B**, **AB** or **O**

Synthesis of blood group substances

1. H/O substance (H or O antigen)

- Is the **precursor** of both A substance (A antigen) and B substance (B antigen)

- Is formed by the action of **Fucosyl Transferase** that catalyses addition of fucose residue to the terminal galactose residue of H substance precursor

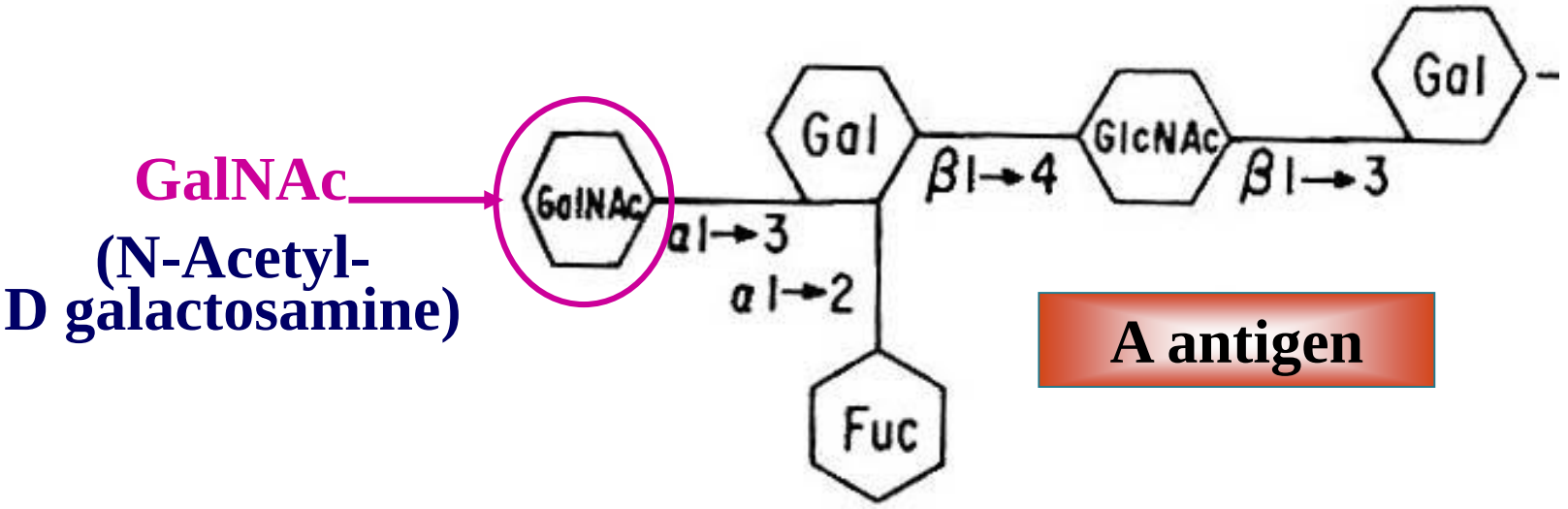


Added by Fucosyl transferase

Synthesis of blood group substances

2. A substance

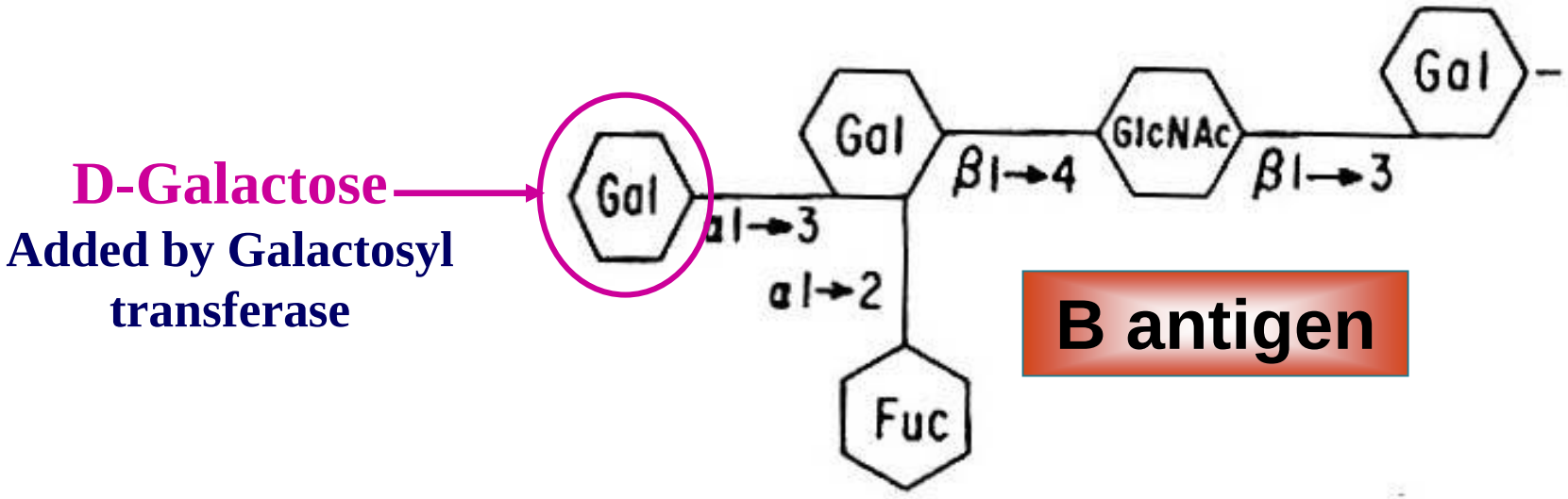
- Is formed by the action of **N-acetyl-D GalactosamineTransferase** (GalNAC transferase) that catalyses addition of GalNAC to the terminal Gal residue of H substance.



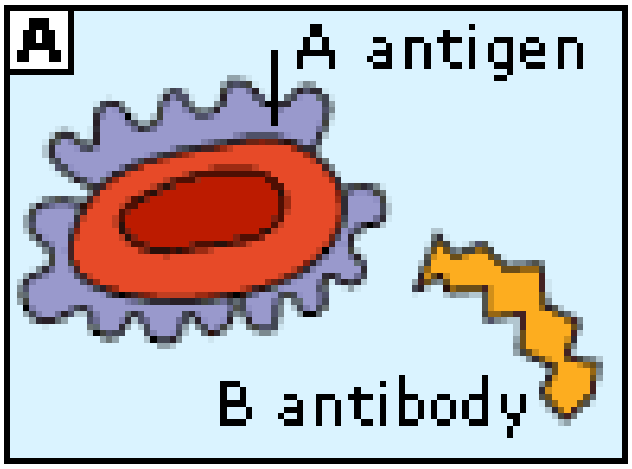
Synthesis of blood group substances

3. B substance

- Is formed by the action of **Galactosyl Transferase** that catalyses the transfer of Gal residue to the terminal galactose residue of H substance

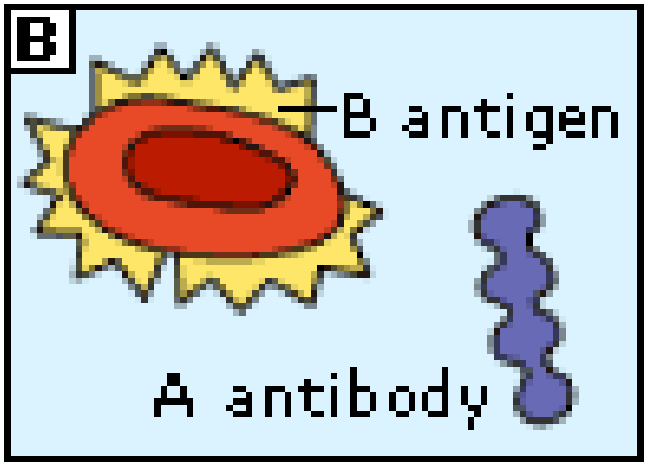


AB0 blood grouping system



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



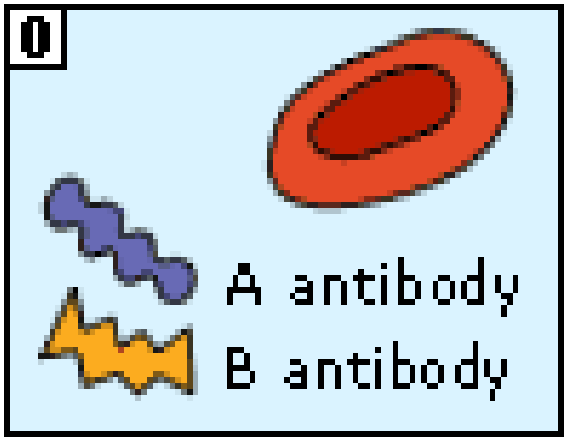
Blood group B:

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

AB0 blood grouping system

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

How common is your blood type?

TYPE	DISTRIBUTION	RATIOS	
O +	1 person in 3	38.4%	46.1%
O -	1 person in 15	7.7%	
A +	1 person in 3	32.3%	38.8%
A -	1 person in 16	6.5%	
B +	1 person in 12	9.4%	11.1%
B -	1 person in 67	1.7%	
AB +	1 person in 29	3.2%	3.9%
AB -	1 person in 167	0.7%	

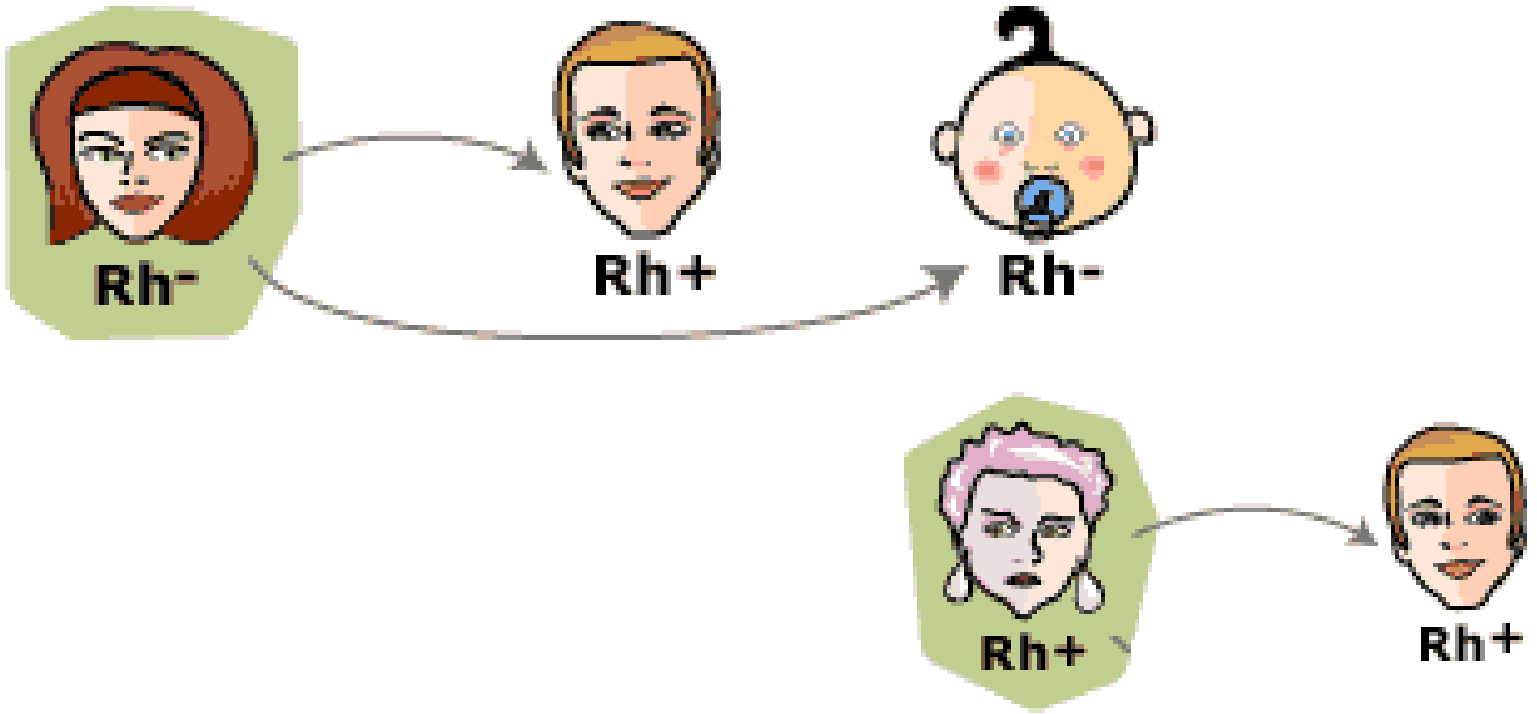
http://www.bloodbook.com/type-facts.html

Rhesus (Rh) Blood Groups

- Is **the second most significant** blood group system in human transfusion
- Rh antigens are **transmembrane proteins**
- The D antigen (**RhD**) is the most important
- If it is present, the blood is **RhD positive** (~80% of the population) , 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

Rhesus (Rh) Blood Groups

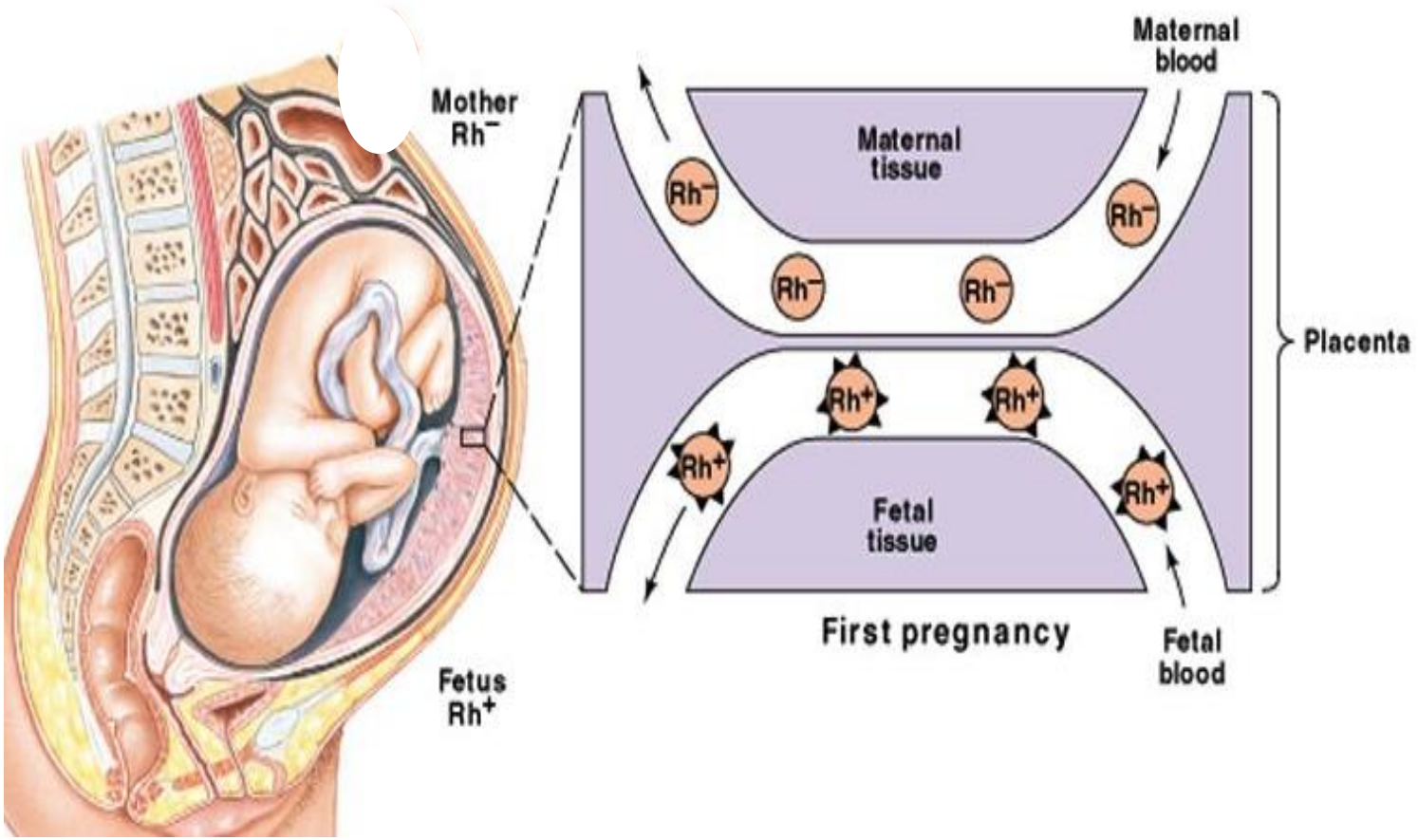
- A person with Rh+ blood can receive blood from a person with Rh- blood without any problems



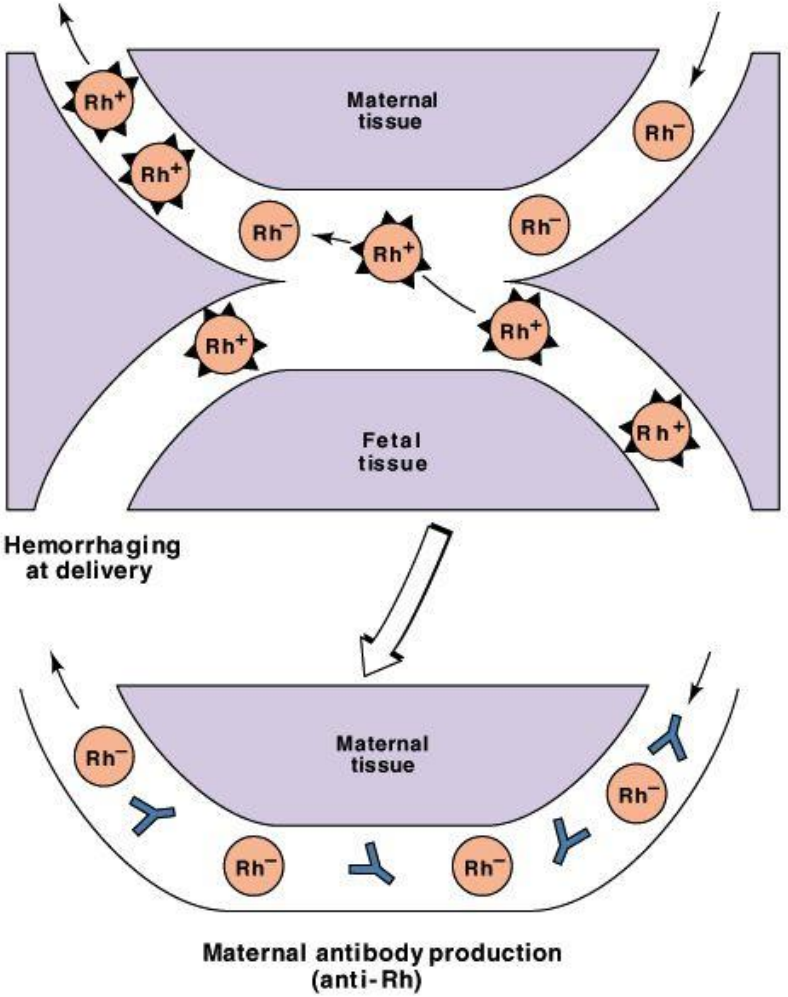
Rhesus (Rh) Blood Groups

- 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

Hemolytic Disease of the Newborn
(Erythroblastosis Fetalis)

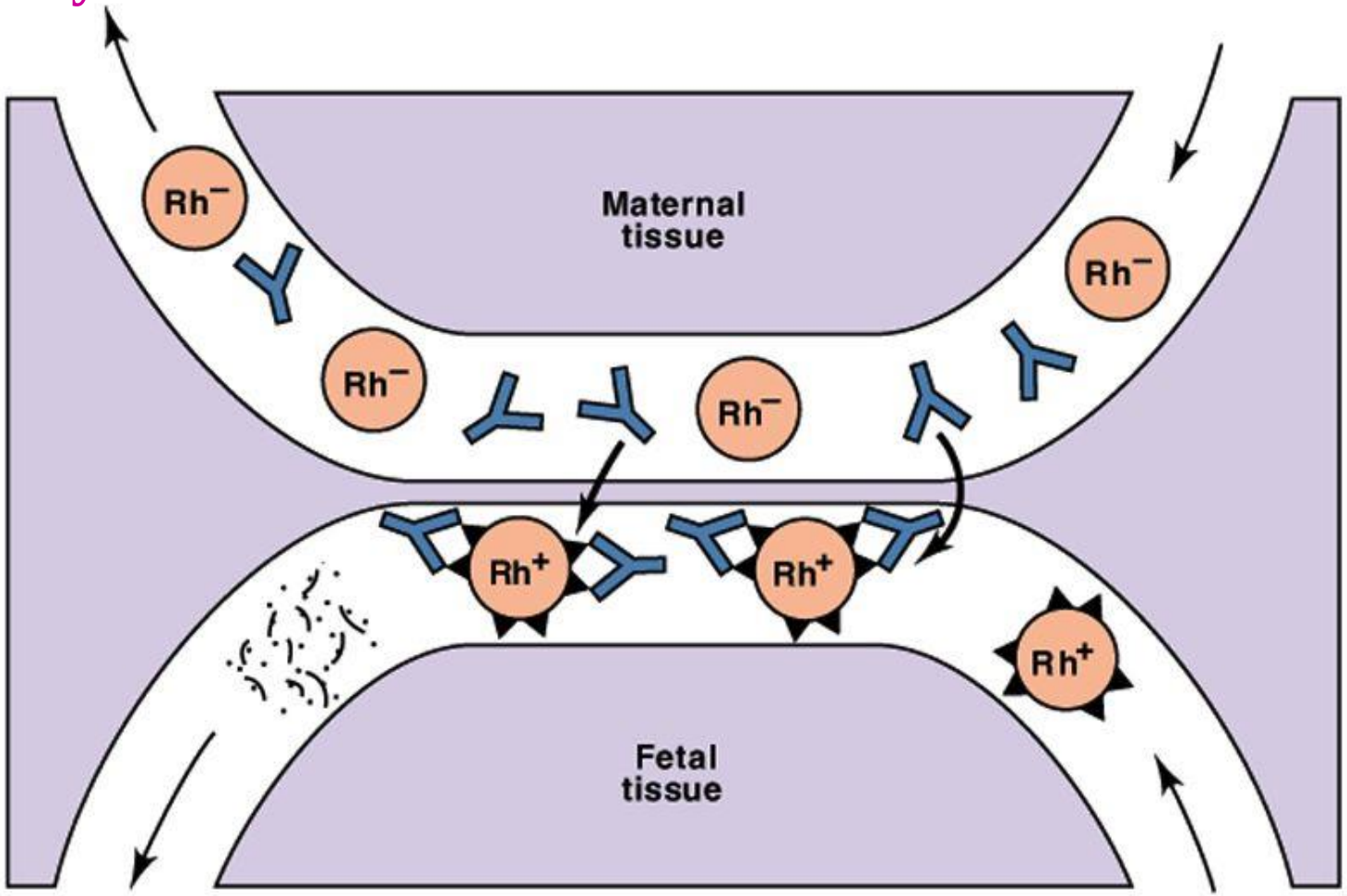


Rh^+ Fetal cells enter mother's circulation at delivery



Second pregnancy: Maternal anti-Rh IgG antibodies can cross placenta to attack fetal RBCs

→ Hemolysis



hemolysis

Second pregnancy

Hemolytic Disease of the Newborn (Erythroblastosis Fetalis)

- Mother is Blood type Rh^-
- Father and fetus are Rh^+
- First pregnancy = **sensitization** at delivery due to hemorrhage
- Second pregnancy = Anti-Rh IgG antibodies can cross placenta to attack fetal RBCs → **hemolysis**

Hemolytic Disease of the Newborn

(Erythroblastosis Fetalis)

- Rh^- mothers who have had a pregnancy with/are pregnant with a Rh^+ infant are given Rh immune globulin (RhIG) at 28 weeks during pregnancy and within 72 hours after delivery to prevent sensitization to the D antigen.

- It works by binding any fetal red cells with the D antigen before the mother is able to produce an immune response and form anti-D IgG

Hemolytic Disease of the Newborn

(Erythroblastosis Fetalis)

- Maternal antibodies destroy fetal red blood cells
  - Results in anemia
  - Anemia limits the ability of the blood to carry oxygen to the baby's organs and tissues.
- Baby's responds to the hemolysis by trying to make more red blood cells very quickly in the bone marrow and the liver and spleen.
  - Organs enlarge - hepatosplenomegaly.
  - New red blood cells released prematurely from bone marrow and are unable to do the work of mature red blood cells.

Hemolytic Disease of the Newborn

(Erythroblastosis Fetalis)

- As the red blood cells break down, bilirubin is formed.
  - Babies unable to get rid of the bilirubin.
  - Builds up in the blood (hyperbilirubinemia) and other tissues and fluids of the baby's body resulting in jaundice.
  - The placenta helps get rid of some of the bilirubin, but not all.

Complications During Pregnancy***

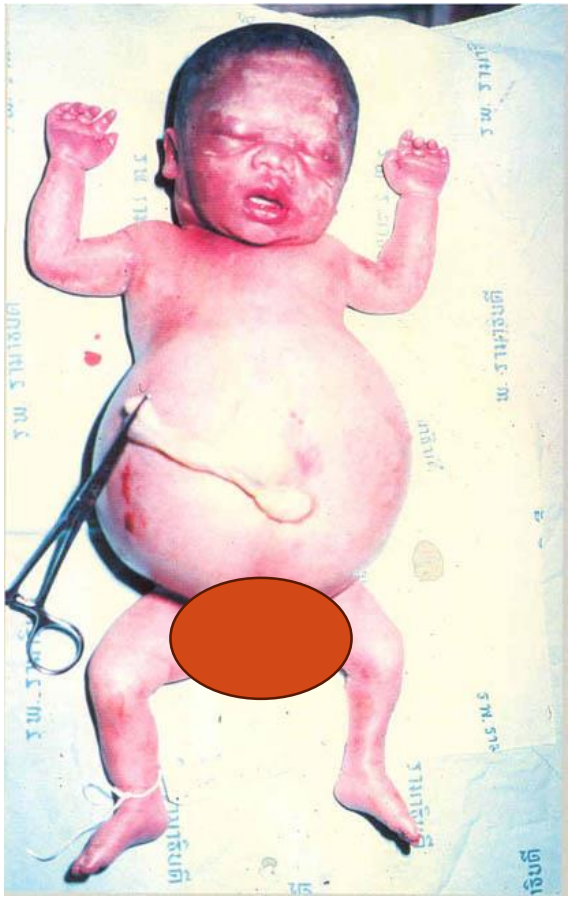
- **Severe anemia with enlargement of the liver and spleen**

When these organs and the bone marrow cannot compensate for the fast destruction of red blood cells, severe anemia results، and other organs are affected

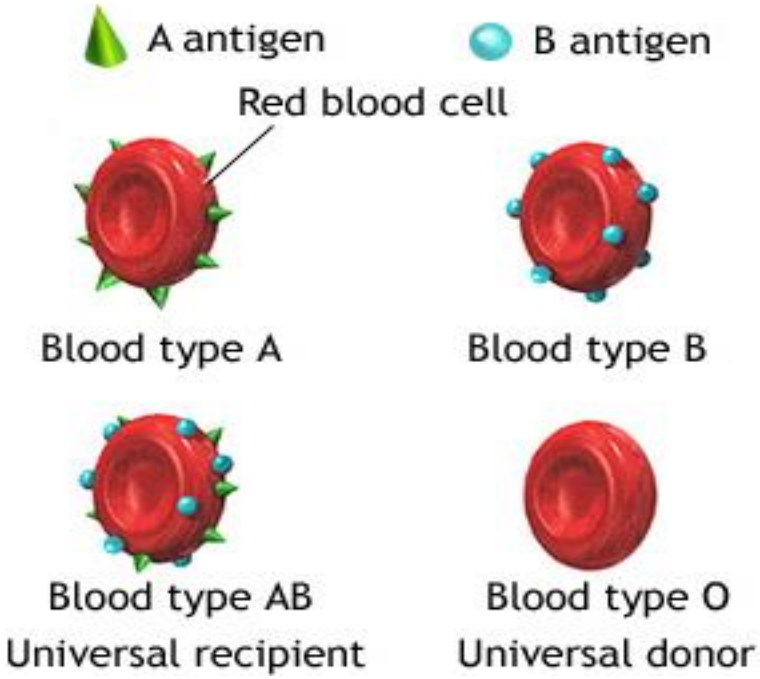
- **Hydrops Fetalis**

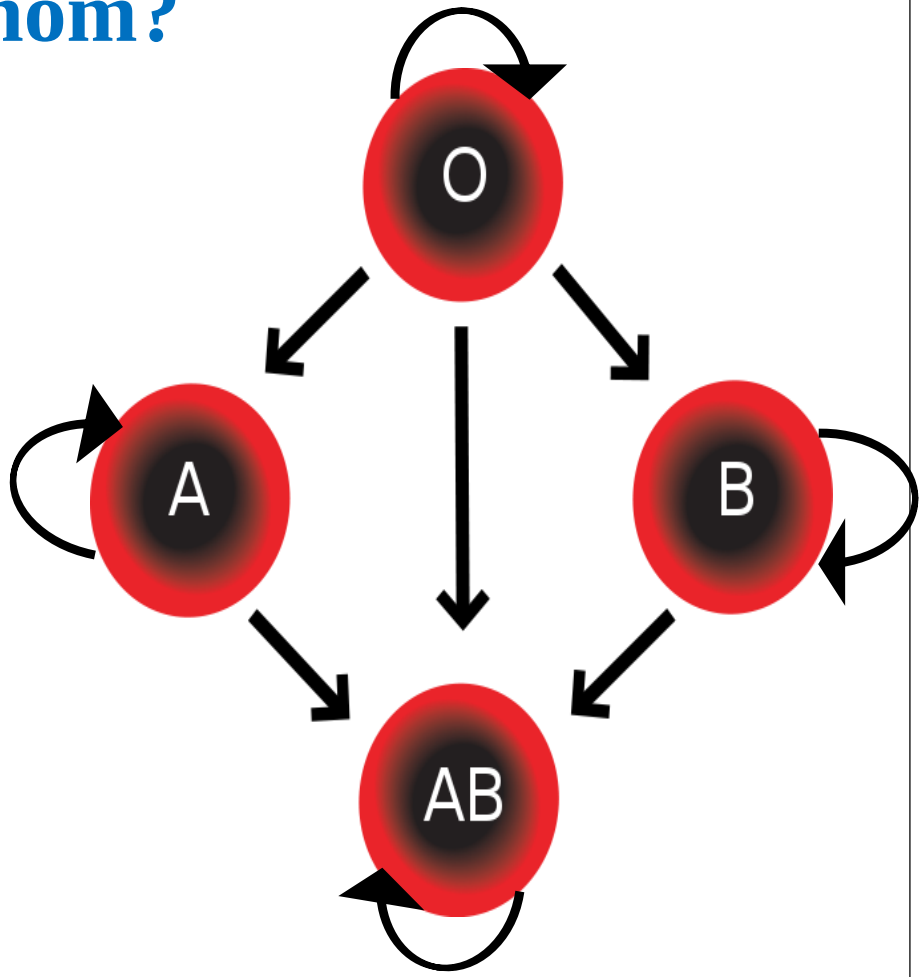
This occurs as the baby's organs are unable to handle the anemia. The heart begins to fail, and large amounts of fluid build up in the baby's tissues and organs. A fetus with hydrops is at great risk of being stillborn.

Hemolytic Disease of the Newborn
(Hydrops Fetalis)



Blood transfusions – who can receive blood from whom?





- People with blood group O: **"universal donors“**
  - People with blood group AB: **"universal receivers"**

Type of Blood Transfusion

- Whole Blood
- Blood Component

  RBC; PLT(platelets); FFP (Fresh Frozen Plasma); Leukocyte; concentrate.

Using the whole blood is a waste of resources.

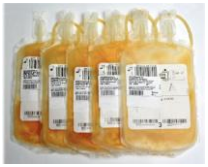
The preparation of blood components from whole blood

Whole blood

Cellular components

- Red cells
- Platelets
- White cells

Fresh plasma



Fresh frozen plasma

Cryoprecipitate

Factor VIII

Concentrate

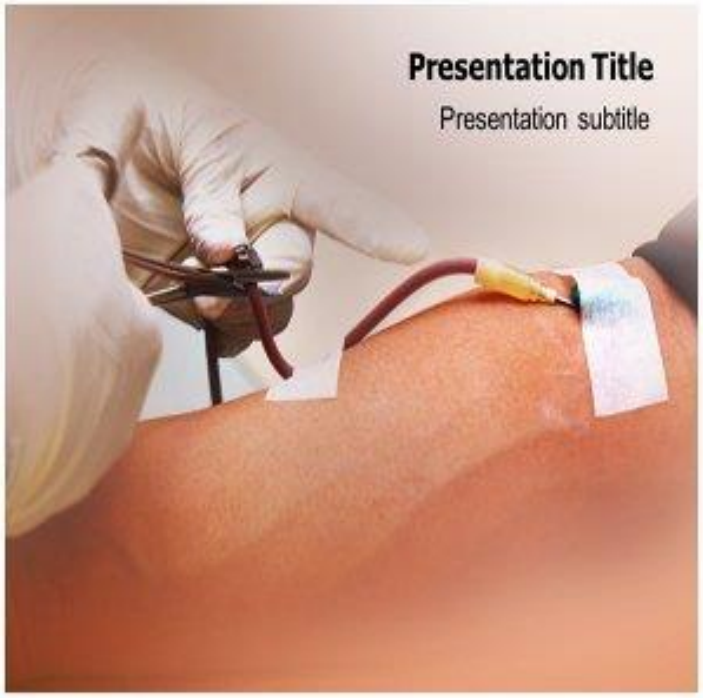
Cryosupernatant

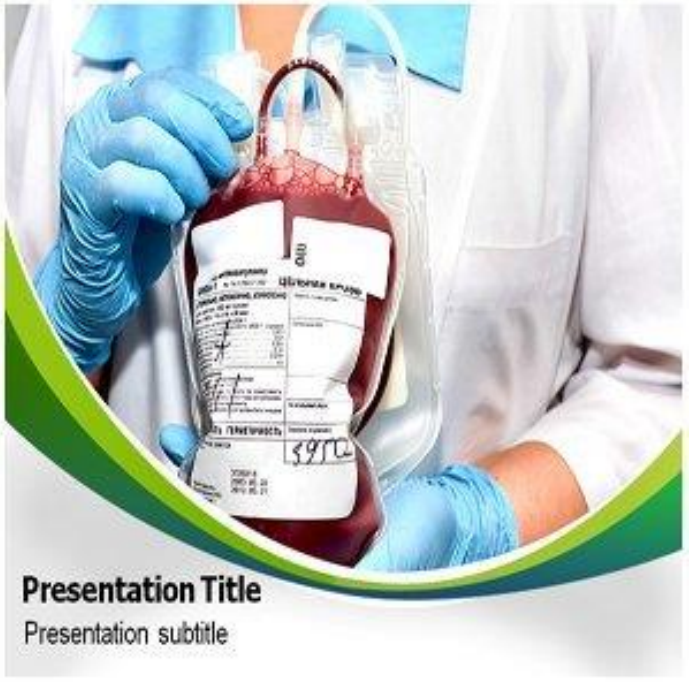
Albumin

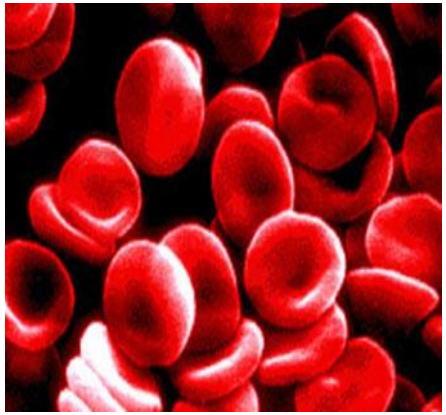
Immunoglobulins

other concentrates

Blood transfusion







Blood transfusion

- Blood transfusion involves the infusion of whole blood or a blood component from one individual (donor) to another(the recipient).
- Compatibility between donor red cell antigens and the recipient's plasma antibodies must be ensured, otherwise potentially fatal haemolytic reactions may occur.

Blood Types

- Categorized according to antigens on red blood cells

  Type A: A antigens

  Type B: B antigens

  Type O: no antigens (universal donor)

  Type AB: A and B antigens (universal recipient)

- D antigen, third antigen; may be present on the red blood cells

- a. Rh factor positive: D antigen is present
- b. Rh factor negative: D antigen is not present

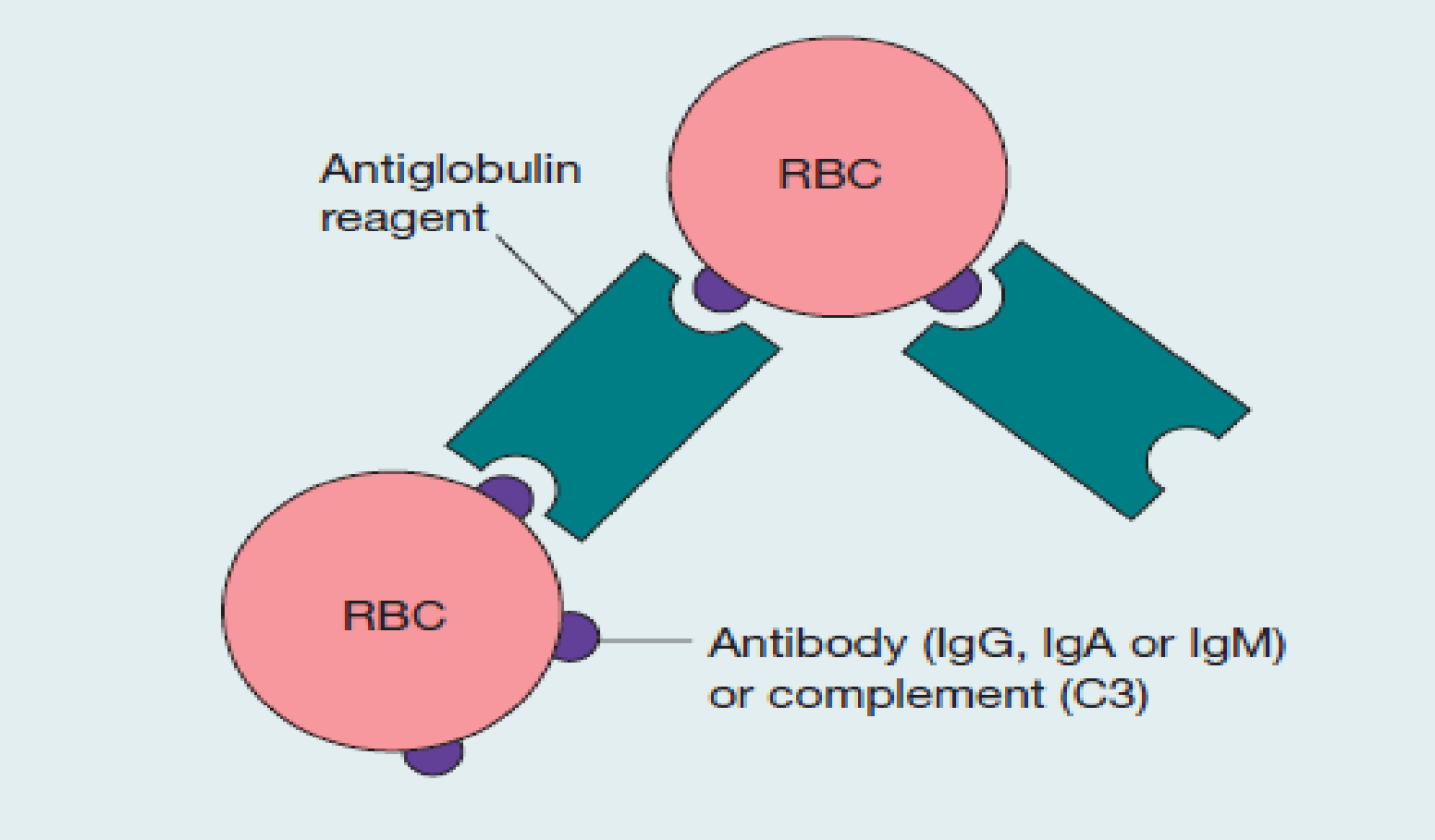
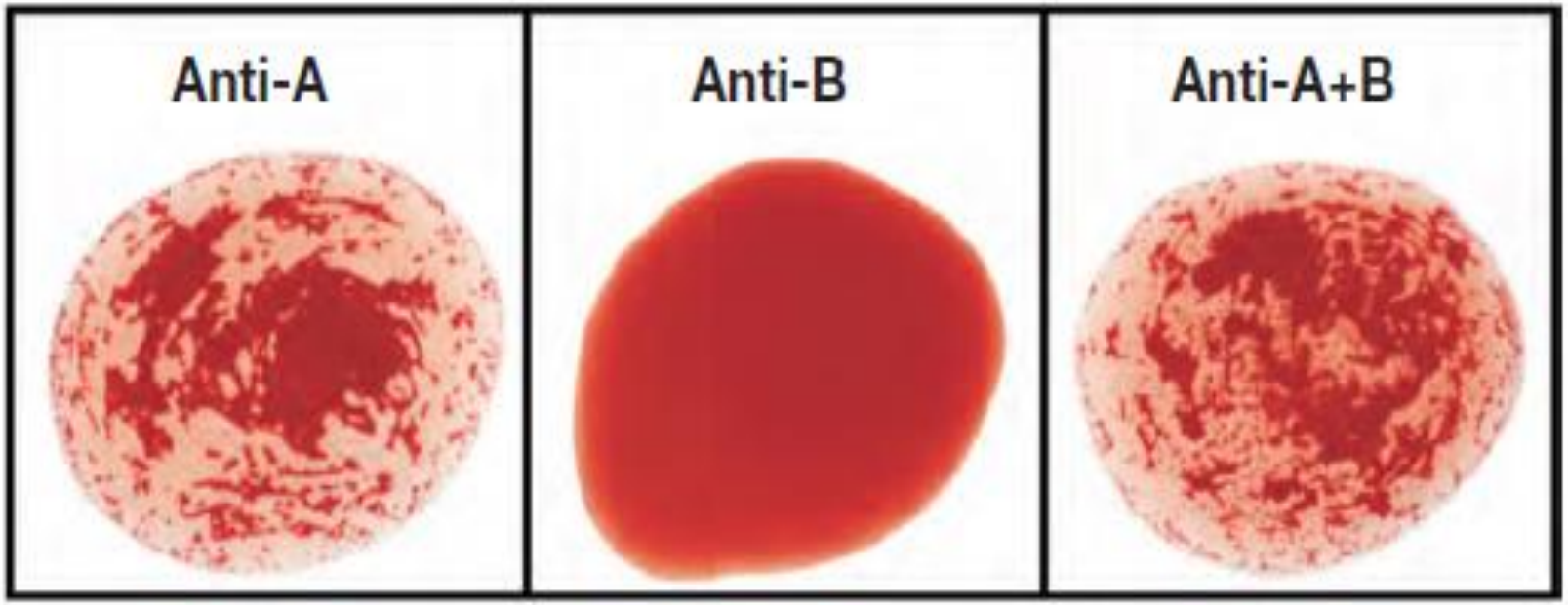
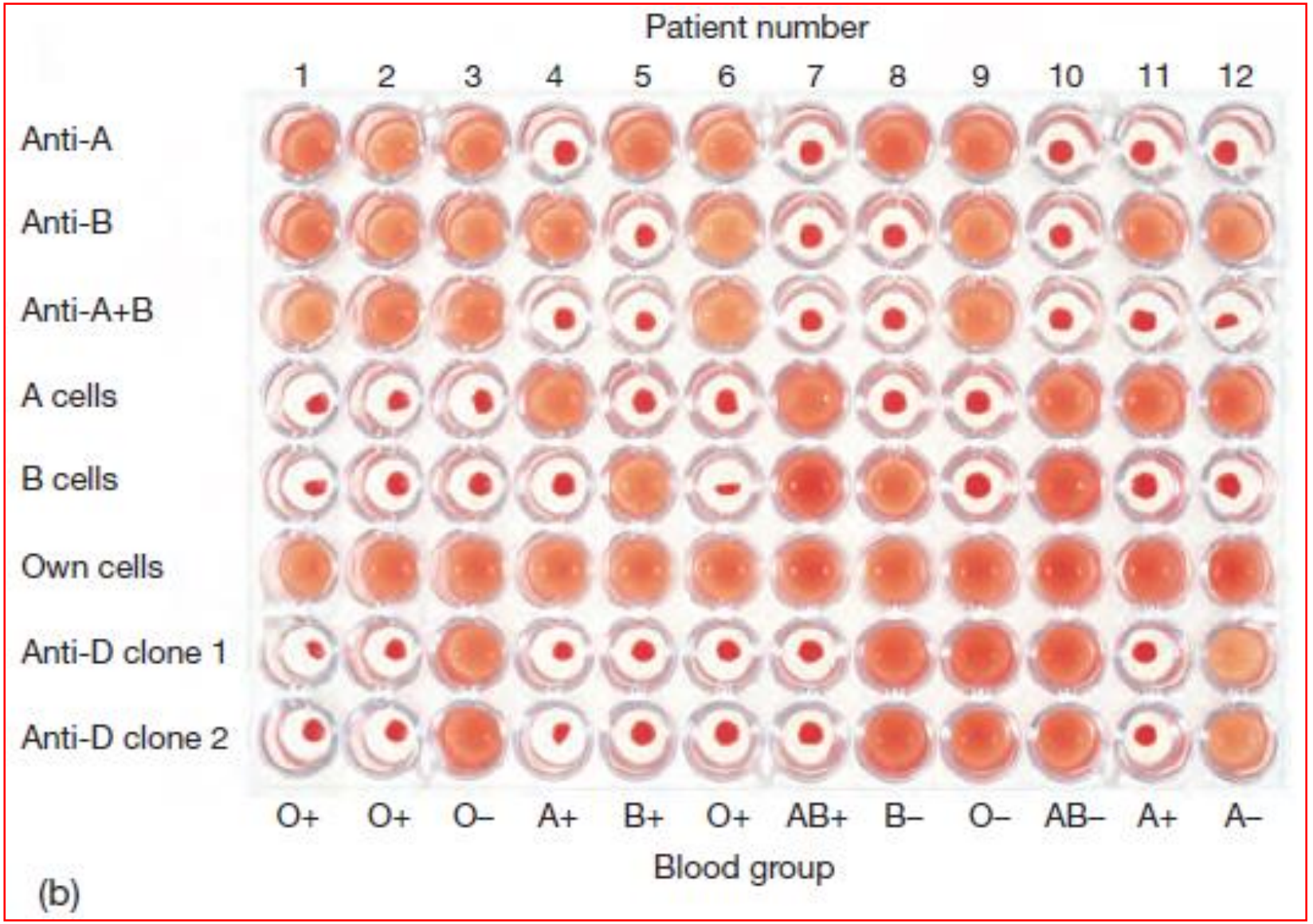


Figure 30.5 The antiglobulin test for antibody or complement on the surface of red blood cells (RBC). The antihuman globulin (Coombs') reagent may be broad spectrum or specific for immunoglobulin G (IgG), IgM, IgA or complement (C3).



(a)

Figure 30.3 (a) The ABO grouping in a group A patient.



(b) Routine grouping in a 96-well microplate. Positive reactions show as sharp agglutinates;

Blood Donation

- In emergencies, there are certain exceptions to the rule that the donor's blood type must match the recipient's exactly: Blood type O negative is the only type of blood that people of all other blood types can receive. This is helpful in emergency situations when the patient needs a transfusion, but their blood type is unknown. Because of this, **O** negative donors are called "**universal donors**." People who have type **AB** blood are called "**universal recipients**" because they can safely receive any type of blood.

Blood Donation

- Blood is mostly donated as whole blood by inserting a catheter into a vein and collecting it in a plastic bag (mixed with anticoagulant) via gravity.
- The collected blood is then separated into components to make the best use of it.

Blood Donation

- Improvements in the quality of transfused blood, by, for example, the removal of white blood cells, eliminate the theoretical risk that transfusion might lead to cancer recurrence or postoperative infection.
- ABOand RhD blood groups, red cell antibody screen and serological tests to exclude syphilis, hepatitis B surface antigen , hepatitis Cvirus (HCV) and HIV.
- Blood is stored at 4-6 Cº.

Who Can Donate Blood?

- To donate blood, donors should be at least 17 years old and weigh more than 110 pounds (49.8952 kg). Also, they must be in good health and will be screened for certain medical conditions, such as anemia.
- People who meet the eligibility requirements will need to give their medical history and pass a physical exam before donating.

Blood Transfusions:

Blood transfusions can be grouped into two main types depending on their source:

- Homologous transfusions, or transfusions using the stored blood of others.
- Autologous transfusions, or transfusions using one's own stored blood.

Cross-Matching and Pre-transfusion Tests

- A number of steps are taken to ensure that patients receive compatible blood at the time of transfusion:
  - From the patient :
    1. The ABO and the Rh blood group is determined.
    2. Serum is screened for important antibodies by an indirect antiglobulin test on a large panel of antigenically-typed red cells.
  - From the donor:
    1. An appropriate ABO and Rh unit is selected.

Cross-Matching and Pre-transfusion Tests(cont.)

- At the cross-match:

The patient's serum is added to donor red cells and spun down to exclude agglutination(the immediate spin). Techniques used in compatibility testing. Donor cells tested against recipient serum and agglutination detected visually or microscopically after mixing and incubation at the appropriate temperature.

Risk associated with blood transfusion:

- Transmission of viral infection –hepatitis B, hepatitis C, HIV.
- Anaphylactic reactions

❖ Acute hemolytic reactions, acute onset within minutes or 1-2 hours after transfuse incompatible blood ABO-incompatible transfusion).

- Volume overload
- Iron overload

Acute Hemolytic Transfusion Reaction

Pathophysiology

Ab (in recipient serum) + Ag (on RBC donor)

↓

-Neuroendocrine responses

-Complement Activation

-Coagulation Activation

- Cytokines Effects

↓

Acute hemolytic transfusion reaction

Blood transfusion

- If a patientís haemoglobin level is greater than 145 g/l then for most common operations autologous blood should not be collected, as 90% would only be discarded.

- Improvements in the quality of transfused blood, by, for example, the removal of white blood cells, leucodepletion, eliminate the theoretical risk that transfusion might lead to cancer recurrence or postoperative infection.

Complications of Blood Transfusion

- Bacterial contamination of packed RBCs occurs rarely, possibly due to inadequate aseptic technique during collection or to transient asymptomatic donor bacteremia.

- Malaria is transmitted easily through infected RBCs. Many donors are unaware that they have malaria, which may be latent and transmissible for 10 to 15 years.

Complications of Blood Transfusion(cont.)

- Massive transfusion is transfusion of a volume of blood greater than or equal to one blood volume in 24 h (eg, 10 units in a 70-kg adult), when a patient receives stored blood in such large volume, the patient's own blood may be, in effect, “washed out.”
- Viral transmission hepatitis may be caused by one of the hepatitis viruses, CMV(cytomegalovirus) and EBV (Epstein virus).

Complications of Blood Transfusion(cont.)

- Transfusion-related acute lung injury is an infrequent complication caused by anti-HLA and/or anti-granulocyte antibodies in donor plasma that agglutinate and degranulate recipient granulocytes within the lung. Acute respiratory symptoms develop, and chest x-ray has a characteristic pattern of noncardiogenic pulmonary edema.

- Post-transfusional iron overload, repeated red cell transfusion over many years in the absent of blood loss, cause deposition of iron.

Transfusion transmitted infections reported to SHOT

	1995	1996	1997	1998	1999	Total
Hepatitis A	-	1	-	-	-	1
Hepatitis B	1	1	-	2	1	5
Hepatitis C	-	1	-	1	1	3
HIV	-	3	-	-	-	3
Bacteria	1	1	3	1	5	11
Malaria	-	-	1	-	-	-