

## Types of donation

Blood donations are divided into groups based on who will receive the collected blood

1. An allogeneic (homologous ) : when donor gives blood for storage at blood bank for transfusion to unknown recipient
2. Directed donation : when a person “ often family member “ donates blood for transfusion to specific individual , its rare when an established supply exists
3. A replacement donor : a friend or family member of the recipient donates blood to replace the stored blood used in transfusion ,ensuring a consistent supply
4. An autologous donation : when person has blood stored that will be transfused back to same person at later date ,usually after surgery , the blood of which not always screened because the donor is the only person will receive the blood
5. Make medications : blood can made from allogeneic donations or from donations exclusively used for manufacturing These products are typically created by taking pooled plasma donations and separating the proteins through a process called fractionation such Alpha-1 Antitrypsin to Prevent emphysema (lung damage) and liver disease.OR Hepatitis B Immune Globulin): Given after exposure to Hepatitis B
6. Blood is sometime collected using similar methods for therapeutic phlebotomy , similar to ancient practice of bloodletting ,which is used to treat conditions such as hereditary hemochromatosis or polycythemia Vera , this blood sometime treated as a blood donation ,but may be immediately discarded if cannot be used for transfusion or further manufacturing

**Blood drive or blood donor session:** an event where donor come to donate allogenic blood, these can occur at blood bank but they are often set up at location in the community such as a shopping center ,workplace ,school or house of worship

## Obtaining of blood

There are two main methods for obtaining blood from donor ,the most frequent is to simply take the blood from a vein as

1. Whole blood : the most common method of blood donations , the amount of blood drawn varies from 200 ml to 550 ml depended on the country but a typical donation is 450 ml of whole blood ,though 500 ml donations are also common . The blood is usually stored in flexible plastic bag that contain sodium citrate , phosphate ,dextrose and sometime adenine to keep blood from clotting and preserves blood during storage . blood is typically separated into parts , usually red blood cells (packed RBC) and plasma ,since most recipients need only specific component for transfusion , plasma from whole blood can be used to make plasma for transfusion or also be processed into other medications using a process called fractionation .this was a development of the dried plasma used to treat the wounded during ww2 and variant on the process are still used to make variety of other medications
2. Apheresis this is the other method of blood donation where draw blood from donor ,separate it using centrifuge or filter ,stored desired part and return the rest to the donor, usually the component return is RBCS , its often done with a machine specifically designed for this purpose ,apheresis is especially common for plasma and platelets. Using this Method an individual can donate plasma or platelets much more frequently than the can safely donate whole blood .these can be combined ,with a donor giving both plasma and platelets in same donation

Platelets can be separated from whole blood but they must be pooled from multi-donation .from 3 to 10 units of whole blood are required for a therapeutic dose while platelet apheresis provide at least one full dose from each donation

**\*plt apheresis other name is single donor plt**

**\*plt from whole blood named Random-Donor Platelets**

Plasma apheresis is frequently used to collect source plasma that used for manufacturing into medications much like the plasma from whole blood

**\*concurrent plasma** : plasma collected at same time as platelet apheresis

3. Direct transfusion : a vein can be used but blood may be taken from an artery instead , in this case blood is not stored but is pumped directly from donor into recipient , this was an early method for blood transfusion and is rarely used in modern practice it was phased out during ww2 because of problems with logistics

### **Site preparation and drawing blood**

Blood is drawn from a large arm vein close to skin ,usually the median cubital vein on the inside of the elbow ,the skin over the blood vessel is cleaned with antiseptic such iodine or chlorhexidine to prevent skin bacteria from contaminating the collected blood and prevent infections where needle pierced the donor's skin

A large needle (16-17 gauge) is used to minimize shearing forces that may physically damage red blood cell as they flow through the needle

A tourniquet is sometime wrapped around the upper arm to increase the pressure of blood in the arm veins and speed up the process

The donor may also be prompted to hold an objective and squeeze it repeatedly to increase blood flow through the vein

### **Recovery and time between donations**

- Donors are usually kept at the donation site for 10–15 minutes after donating since most adverse reactions take place during or immediately after the donation. Blood centers typically provide light refreshments or a lunch allowance to help the donor recover.
  - The needle site is covered with a bandage and the donor is directed to keep the bandage on for several hours.
  - In hot climates, donors are advised to avoid dehydration (strenuous games, alcohol) until a few hours after donation.
- Donated plasma is replaced after 2–3 days.
- Red blood cells are replaced by bone marrow into the circulatory system at a slower rate, on average 36 days in healthy adult males. In one study, the range was 20 to 59 days for recovery. These replacement rates are the basis of how frequently a donor can donate blood.

- Plasma-pheresis and platelet-pheresis donors can donate much more frequently because they do not lose significant amounts of red cells. The exact rate of how often a donor can donate differs from country to country. For example, plasmapheresis donors in the United States are allowed to donate large volumes twice a week and could nominally give 83 liters (about 22 gallons) in a year, whereas the same donor in Japan may only donate every other week and could only donate about 16 liters (about 4 gallons) in a year.
- Red blood cells are the limiting step for whole blood donations, and the frequency of donation varies widely depending on the type of donor and local policies. For example, adult men in Hong Kong can donate once every three months, women every four months, and youth aged sixteen or seventeen only every six months. In Canada and the United States it is 56 days for any type of donor.

### **Complications of blood transfusion**

Donors are screened for health problems that would put them at risk for serious complications from donating. 'First-time donors, teenagers, and women are at a higher risk of a reaction. One study showed that 2% of donors had an adverse reaction to donation. Most of these reactions are minor. A study of 194,000 donations found only one donor with long-term complications.

1. Bruising three days after donation: Bruising of the arm from the needle insertion is the most common concern.
2. Hypovolemic reactions can occur because of a rapid change in blood pressure.
3. Fainting is generally the worst problem encountered.
4. A number of less common complications of blood donation are known to occur. These include arterial puncture, delayed bleeding, nerve irritability/nerve injury, tendon injury, thrombophlebitis, and allergic reactions.
5. Donors sometimes have adverse reactions to the sodium citrate used in apheresis collection procedures to keep the blood from clotting. Since the anticoagulant is returned to the donor along with blood components that are not being collected, it can bind the calcium in the donor's blood and cause hypocalcemia. These reactions tend to cause tingling in the lips,

but may cause convulsions, seizure, hypertension, or more serious problems. Donors are sometimes given calcium supplements during the donation to prevent these side effects.

6. In apheresis procedures, the red blood cells are returned. If this is done manually and the donor receives the blood from a different donor, a transfusion reaction can take place. Manual apheresis is extremely rare in the developed world because of this risk and automated procedures are as safe as whole blood donations.
7. The final risk to blood donors is from equipment that has not been properly sterilized. In most cases, the equipment that comes in direct contact with blood is discarded after use. Re-used equipment was a significant problem in China in the 1990s, and up to 250,000 blood plasma donors may have been exposed to HIV from shared equipment.

### **Storage and blood shelf life**

The collected blood is usually stored in a blood bank as separate components, and some of these have short shelf lives. The limited storage time means that it is difficult to have a stockpile of blood to prepare for a disaster. The World Health Organization recognizes World Blood Donor Day on 14 June each year to promote blood donation. This is the birthday of Karl Landsteiner, the scientist who discovered the ABO blood group system. The theme of the 2012 World Blood Donor Day campaign, "Every blood donor is a hero" focuses on the idea that everyone can become a hero by giving blood.

- The longest shelf life used for platelets is seven days because there are no storage solutions to keep platelets for extended periods of time.
- Red blood cells (RBC), the most frequently used component, have a shelf life of 35–42 days at refrigerated temperatures. for (relatively rare) long-term storage applications, this can be extended by freezing the blood with a mixture of glycerol, but this process is expensive and requires an extremely cold freezer for storage.
- Plasma can be stored frozen for an extended period of time and is typically given an expiration date of one year and maintaining a supply is less of a problem.

## **Donor health benefits**

1. In patients prone to iron overload, blood donation prevents the accumulation of toxic quantities.
2. Donating blood may reduce the risk of heart disease for men, but the link has not been firmly established and may be from selection bias because donors are screened for health problems.
3. blood donation is effective in reducing blood pressure, blood glucose, HbA1c, low-density lipoprotein/high-density lipoprotein ratio, and heart rate

Donated blood is usually subjected to processing after it is collected, to make it suitable for use in specific patient populations. Collected blood is then separated into blood components by centrifugation: red blood cells, plasma, platelets, albumin protein, clotting factor concentrates, cryoprecipitate (fibrinogen concentrate, and immunoglobulins (antibodies).

Red cells, plasma and platelets can also be donated individually via a more complex process called apheresis. All donated blood is tested for infections (detection methods) [The current protocol tests donated blood for HIV-1, HIV-2, HTLV-1, HTLV-2, Hepatitis B, Hepatitis C, Syphilis (*Treponema pallidum*), Chagas' disease (*Trypanosoma cruzi*), and West Nile Virus. In addition, platelet products are also tested for bacterial infections due to its higher inclination for contamination due to storage at room temperature. All donated blood is also tested for ABO and Rh groups, along with the presence of any red blood cell antibodies.

[Presence of Cytomegalovirus (CMV) is also tested because of risk to certain immunocompromised recipients if given, such as those with organ transplant or HIV. However, not all blood is tested for CMV because only a certain amount of CMV-negative blood needs to be available to supply patient needs. Other than positivity for CMV, any products tested positive for infections are not used.]

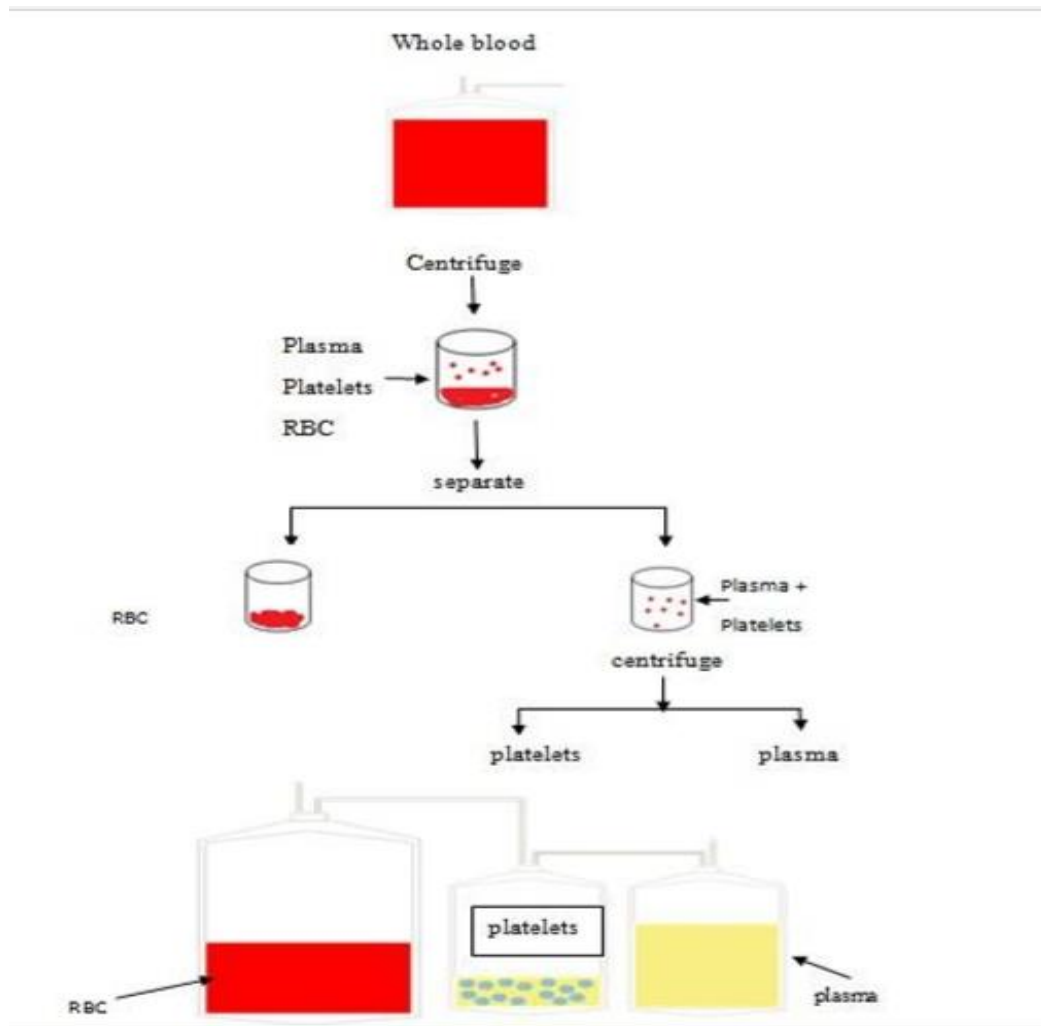
**Leuko-reduction** is the removal of white blood cells by filtration. Leuko-reduced blood products are less likely to cause HLA alloimmunization (development of antibodies against specific blood types ) ,febril non-hemolytic transfusion reaction ,cmv and platelets transfusion refractoriness . pathogen reduction treatment that involves for example ,the addition of riboflavin with subsequent exposure to UV light has been shown to be effective in inactivating pathogens (viraus , bacteria ,parasites and WBCs )in blood products .by inactivating WBC donated blood products , riboflavin and UV light treatment can also replace gamma-irradiation as method to prevent graft versus host disease

❖ Blood Separation, Preservation and Storage

As can be seen in the below diagram, a single donation of whole blood has supplied three separate components (packed red blood cells, platelets, fresh frozen plasma) that can potentially benefit three different patients.

Proper storage of whole blood and blood components is essential:

- Both whole blood and PRBC's can be stored for up to 42 days at 1 - 6 degrees C.
- Platelets can be stored at room temperature for a maximum of 5 days.
- Fresh frozen plasma can be kept frozen for up to 1 year.



## Human blood groups

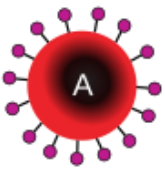
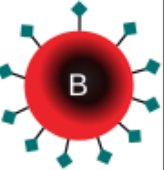
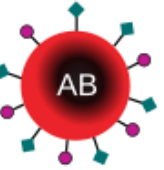



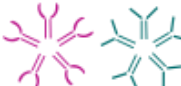



❖ A blood type (also called a blood group) is a classification of blood based on the presence and absence of inherited antigenic substances on the surface of red blood cells and also based on the presence or absence of antibodies in plasma.

❖ Rhesus (Rh) factor: is an inherited protein found on the surface of red blood cells. If your blood has the protein, you're Rh positive. If your blood lacks the protein, you're Rh negative. The ABO blood group antigens are one of the most important topics in blood transfusion to evaluate the compatibility of donor blood cells with recipient blood cells.

❖ Blood type test is done:

- Before a person gets a blood transfusion or organ for transplantation.
- Before surgery.
- In pregnancy women.

❖ The structure of Blood group antigens: Blood group antigens are either sugars or proteins, and they are attached to various components in the red blood cell membrane. For example, the antigens of the ABO blood group are sugars. In contrast, the antigens of the Rh blood group are proteins. The figure below shows the red blood cell membrane and some of the blood group antigens attached to it.

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

## ❖ Determination of ABO blood groups:

The ABO blood group is determined by the presence of A and B antigens on the surface of the red blood cells, and of anti - A or anti - B antibodies in the serum or plasma as below:

1. Blood group A : Individuals have the A antigen on the surface of their RBCs , and blood serum containing Anti-B antibodies . Therefore , a group A individual can only receive blood from individuals of groups A or O ( with A being preferable ) and can donate blood to individuals of groups A or AB .

2. Blood group B : Individuals have the B antigen on their surface of their RBCs , and blood serum containing Anti-A antibodies . Therefore, a group B individual can only receive blood from individuals of groups B or O (with B being preferable) and can donate blood to individuals of groups B or AB.

3. Blood group AB: Individuals have both A and B antigens on the surface of their RBCs, and their blood serum does not contain any antibodies against either A or B antigen .Therefore , an individual with type AB blood can receive blood from any group ( with AB being preferable ) , but can only donate blood to another group AB individual . (Universal recipient)

4. Blood group O : Individuals do not have either A or B antigens on the surface of their RBCs , but their blood serum contains Anti- A and Anti-B antibodies . Therefore , a group O individual can only receive blood from a group O individual , but they can donate blood to individuals of any ABO blood group ( A , B , O , or AB ) . (Universal donor) .

Blood Group	Antigens on cell	Antibodies in plasma	Transfuse with group
<b>A</b>	A	Anti-B	A or O
<b>B</b>	B	Anti-A	B or O
<b>AB</b>	A and B	None	AB, A, B or O
<b>O</b>	None	Anti-A & B	O

### **The common percentage of blood groups:**

ABO Type	Percent%
O	45%
A	40%
B	11%
AB	4%

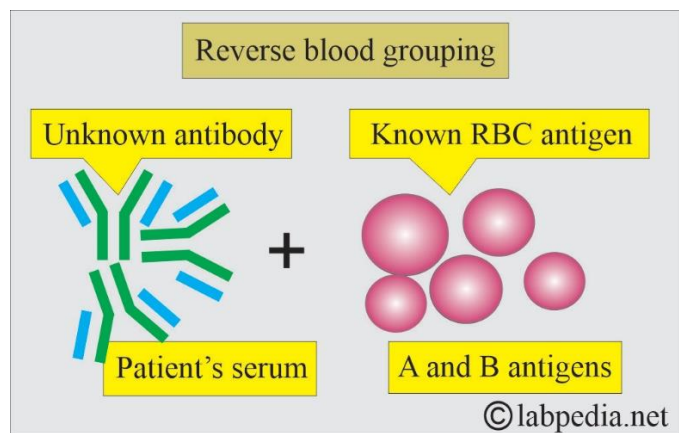
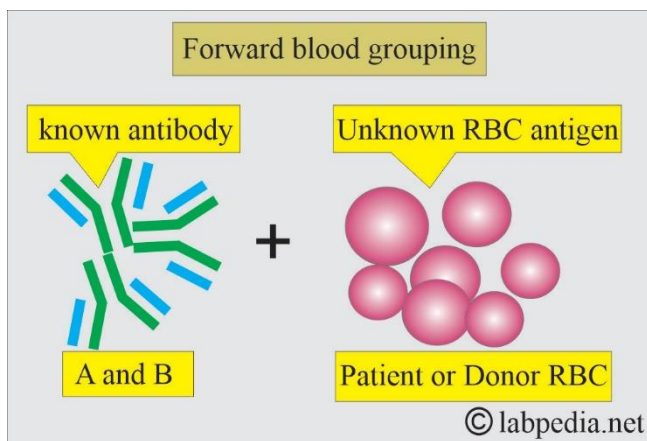
Methods for ABO and Rh grouping:

- Tube method
- Slide method (white ceramic method)
- Microplate method
- New trends (Gel technology)

## Tube method

### What is forward grouping & Reverse grouping?

- Karl Landsteiner performed the forward grouping and reverse grouping:
  1. **forward grouping** is defined as using a known source of antibodies to detect the antigens in the red blood cells.
  2. **reverse grouping** is defined as using the reagent cells with known ABO antigens and testing the patient's serum for ABO group antibodies.



## Reagents and Materials Required

Item	Purpose
Anti-A, Anti-B, Anti-D antisera	For forward grouping
Known A cells and B cells	For reverse grouping
Test tubes (10×75 mm)	For reactions
Isotonic saline (0.9% NaCl)	For washing cells
Pasteur pipettes / droppers	For adding reagents
Centrifuge	To accelerate agglutination
Microscope / agglutination viewer	For reading results
Clean slides, labels, marker	For organization



## Sample Preparation

- Collect **EDTA blood** or **clotted sample**.
  - For forward grouping → prepare **3–5% RBC suspension** in normal saline.
  - For reverse grouping → use **serum** or **plasma**.
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## PROCEDURE

### A. Forward Grouping (Cell Typing)

Tube	Add	Add	Mix
1	1 drop Anti-A	1 drop RBC suspension	Mix
2	1 drop Anti-B	1 drop RBC suspension	Mix
3	1 drop Anti-D	1 drop RBC suspension	Mix

1. Mix gently by tapping.
2. **Centrifuge** for 15–30 seconds at ~1000 rpm (or leave for 5–10 min at room temp).
3. Observe for **agglutination** macroscopically; if doubtful, confirm microscopically.