

BLOOD DONATION & BLOOD COMPONENTS

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Outline

- Blood donation:

Donor selection criteria

Microbial tests

Serological tests

- Types of donation: whole blood, RBCs, Plasma, Platelets and WBCs.
- Apheresis.
- Whole blood processing.
- Blood components:

Packed RBCs, Plasma and Cryoprecipitate, platelets, WBC concentration

Blood transfusion



- There are two main respected points in blood transfusion:
 - 1- Not cause injury to donors.
 - 2- Provide safe blood for patients.
- In order to achieve these pointes there:
 - 1- Selection criteria for donors.
 - 2- Screening tests on donated blood to avoid transmitted infectious diseases.

Donor selection

- **Donor selection:**

A- For recipients (patients) safety: there are questionnaire should be filled to avoid 'Risk' donors.

Some donors carry microbial risks such as:

- 1- Do risk behaviors such as using drugs, homosexual activity, sharing needles or doing tattoo or piercing recently (WHY??)
- 2- Travel to country endemic with Malaria.
- 3- Also donor should be in good health at the day of donation.
- 4- Use anticoagulant medicine such as aspirin.

B- For donors safety:

Weight should be more than 50 kg, Age 17-65years ,
hemoglobin: more than 12.5g/dl for female and 13.5g/dl for male,
period between whole blood donation is 3 minimum 12 weeks.

Blood donation questionnaire

	Yes	No	In the past 12 months have you	
Are you			12. Had a blood transfusion?	<input type="checkbox"/> <input type="checkbox"/>
1. Feeling healthy and well today?	<input type="checkbox"/>	<input type="checkbox"/>	13. Had a transplant such as organ, tissue, or bone marrow?	<input type="checkbox"/> <input type="checkbox"/>
2. Currently taking an antibiotic?	<input type="checkbox"/>	<input type="checkbox"/>	14. Had a graft such as bone or skin?	<input type="checkbox"/> <input type="checkbox"/>
3. Currently taking any other medication for an infection?	<input type="checkbox"/>	<input type="checkbox"/>	15. Come into contact with someone else's blood?	<input type="checkbox"/> <input type="checkbox"/>
Please read the Medication Deferral List.			16. Had an accidental needle-stick?	<input type="checkbox"/> <input type="checkbox"/>
4. Are you now taking or have you ever taken any medications on the Medication Deferral List?	<input type="checkbox"/>	<input type="checkbox"/>	17. Had sexual contact with anyone who has HIV/AIDS or has had a positive test for the HIV/AIDS virus?	<input type="checkbox"/> <input type="checkbox"/>
5. Have you read the educational materials?	<input type="checkbox"/>	<input type="checkbox"/>	18. Had sexual contact with a prostitute or anyone else who takes money or drugs or other payment for sex?	<input type="checkbox"/> <input type="checkbox"/>
In the past 48 hours			19. Had sexual contact with anyone who has ever used needles to take drugs or steroids, or anything not prescribed by their doctor?	<input type="checkbox"/> <input type="checkbox"/>
6. Have you taken aspirin or anything that has aspirin in it?	<input type="checkbox"/>	<input type="checkbox"/>	20. Had sexual contact with anyone who has hemophilia or has used clotting factor concentrates?	<input type="checkbox"/> <input type="checkbox"/>
In the past 6 weeks			21. Female donors: Had sexual contact with a male who has ever had sexual contact with another male? (Males: check "I am male.")	<input type="checkbox"/> <input type="checkbox"/>
7. Female donors: Have you been pregnant or are you pregnant now? (Males: check "I am male.")	<input type="checkbox"/>	<input type="checkbox"/>	22. Had sexual contact with a person who has hepatitis?	<input type="checkbox"/> <input type="checkbox"/>
In the past 8 weeks have you			23. Lived with a person who has hepatitis?	<input type="checkbox"/> <input type="checkbox"/>
8. Donated blood, platelets or plasma?	<input type="checkbox"/>	<input type="checkbox"/>	24. Had a tattoo?	<input type="checkbox"/> <input type="checkbox"/>
9. Had any vaccinations or other shots?	<input type="checkbox"/>	<input type="checkbox"/>	25. Had ear or body piercing?	<input type="checkbox"/> <input type="checkbox"/>
10. Had contact with someone who had a smallpox vaccination?	<input type="checkbox"/>	<input type="checkbox"/>		Yes No
In the past 16 weeks			26. Had or been treated for syphilis or gonorrhea?	<input type="checkbox"/> <input type="checkbox"/>
11. Have you donated a double unit of red cells using an apheresis machine?	<input type="checkbox"/>	<input type="checkbox"/>	27. Been in juvenile detention, lockup, jail, or prison for more than 72 hours?	<input type="checkbox"/> <input type="checkbox"/>

Microbial testing

Tests in Saudi Arabia	Markers
Hepatitis A virus	Antibody to HAV
Hepatitis B virus	Hepatitis B surface antigens (sAg)
Hepatitis C virus	screening for either a combination of HCV antigen and antibody or HCV antibodies
Human immunodeficiency virus 1 and 2 (HIV-1 and HIV-2).	Antibody to HIV-1 and HIV-2 in combination with HIV Ag.
Gonorrhoea (bacteria)	Neisseria gonorrhoeae
Malaria (parasite)	Antibody to plasmodium falciparum
Syphilis (bacteria)	Antibody to Treponema pallidum

- **For each infection, which specific marker(s) are to be screened for? And which first marker can be detected?**
- **Are suitable screening assays available?**

Sources of contamination

- **Sources of contamination are:**

1. Donors: They may have asymptomatic or chronic infections.
2. Donor skin (more common): During penetrating the needle connected to the donation unit, small piece of skin may go inside the unit leading to bacterial growth during storage.
3. During processing: Blood components may be contaminated during preparation.

Serological tests

- Serological tests are done on all donation to identify the blood group (A, B, AB or O) and for RhD typing.
- Also, all donations are screened for clinically important Abs. Any donation found to have a high titer should not be used for transfusion.

Types of donations

- There are different types of donation:

1-Whole blood (most common): Donors donate around 450ml of blood. Period between donations is 12 weeks minimum.

- The blood is collected into a sterilize bag contains anticoagulant (citrate, phosphate, dextrose-adenine (CPD-A)) to prevent blood from clotting. The principle of this anticoagulant is that citrate inactivates the coagulation cascade by inactivating calcium (calcium is important in coagulation process).

Citrate -> inactivate calcium -> NO coagulation



Types of donations con.

- The blood unit is usually leucodepleted (blood is filtered to remove 99% of WBCs) (WHY??)
- WBCs is removed because they may cause some transfusion complications such as:
 - A. Alloimmunisation: patients may develop Abs against human leucocytes Ags (HLA).
 - B. Transmission of leukocyte borne viruses, such as Cytomegalovirus (CMV),
- After leucodepletion, blood units are centrifuged then blood is separated into its components and storage. (WHY??)
- This is because each component need different storage conations . Also, to give patients what they need because a patient may just need plasma, for example.

Whole blood separation process



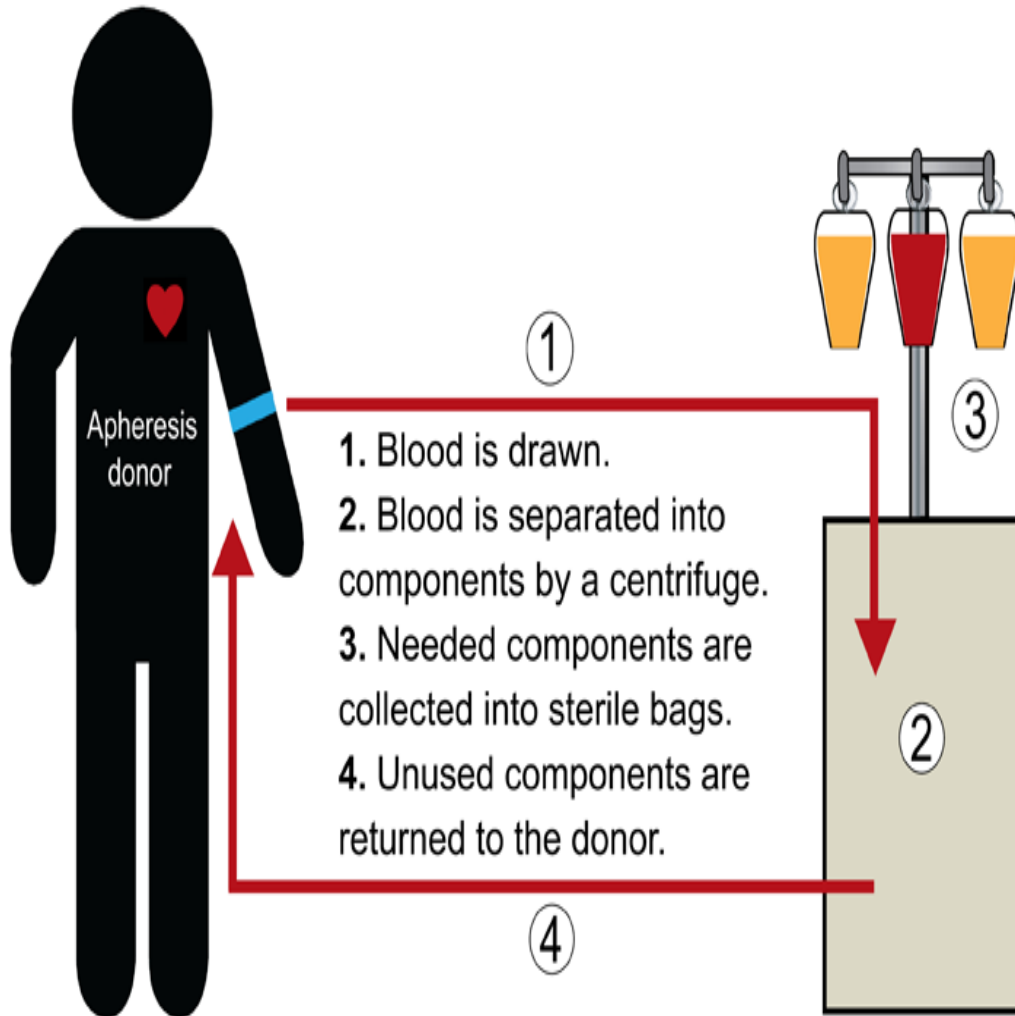
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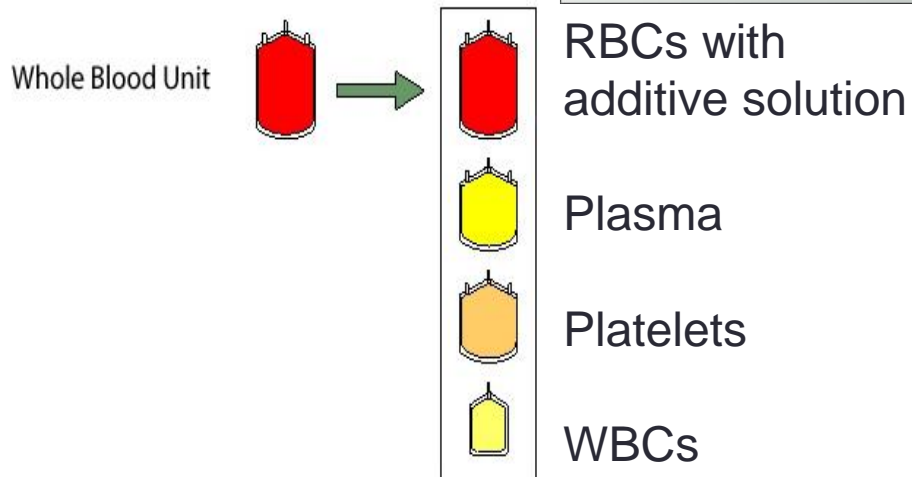
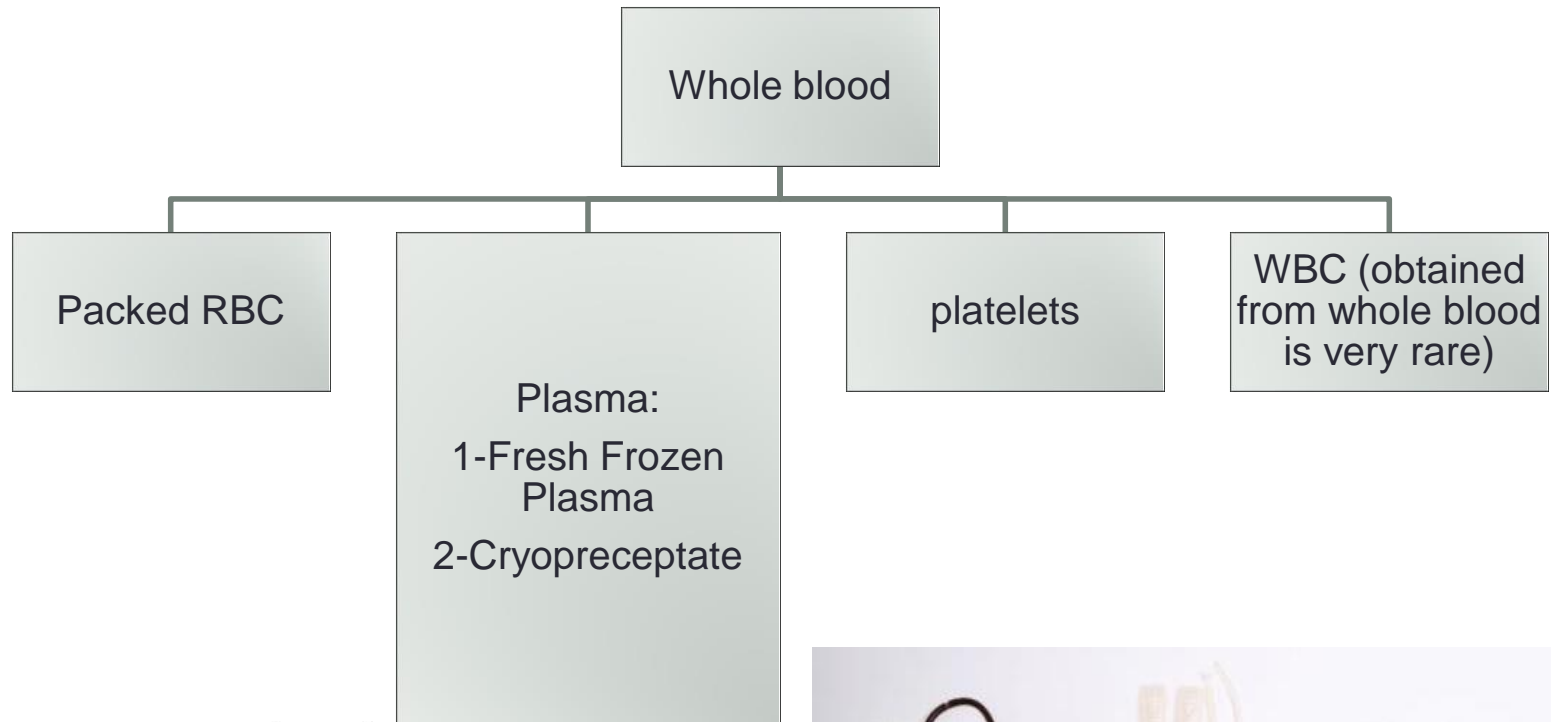
Types of donations con.

- **2- Platelets:** donors donate platelets by apheresis machine. Period between donation is around two weeks.
- **3- Plasma:** donors donate plasma by apheresis machine. Period between donation is around one month.
- **4- WBC:** donors donate WBC by apheresis.
- **5-Double RBCs:** donors donate double amount of packed RBCs that normally obtained by whole blood donation. Done by apheresis.
- **Apheresis:** is a medical technology that separates blood into its components. It is allowing to take the target component (such as platelets) and retain the rest to the donor.
- **Criteria of apheresis donors:**
 1. It should be healthy (like in whole blood donation).
 2. Known donor (donated before so know it has no microbial infection)
 3. male (it is preferable than women because women may have human leucocyte antibodies (HLA) due to be pregnant. This Ab may cause transfusion reactions).
 4. Weight is more than 60kg.
 5. Has large vein.

Apheresis



Blood components



Packed RBC



- Following leucodepletion, RBC is separated from plasma by centrifugation (more than 90% of plasma is removed). RBC have the higher density among the other components so they sediment while the plasma has the lightest. Then the concentrated RBCs are resuspended in an additive solution to maintain the viability of the cells during storage. There are many different types of additive solutions such as saline adenine glucose mannitol (SAGM) where saline works as buffer, adenine used for synthesis ATP, glucose for cell metabolism, mannitol to prevent cell lysis.
- Red cell in SAGM can be store for 35 days. Red cell units are storage at 2-6 °C. (WHY??).
- There are two main reasons for this:
 1. Preserve red cell functions by reducing red cell metabolism .
 2. Reduce bacterial growth.

Also potassium (K) increase outside red cell.

Packed RBC

- **Types of red cells units:**

1. Standard unit.
 2. Washed red cell: red cell are washed with saline to remove most of plasma. This is performed for specific patients who have allergy to plasma proteins.
 3. Irradiated red cell: to inactivate WBC that may remain after filtration.
 4. Frozen red cells. Prepared to store rare RBC phenotypes. It can be stored for 10 years.
- The therapeutic dose of packed RBC is one unit (220-340ml). One unit is expected to increase the Hb level 1g/dl immediately after transfusion.

- **Clinical applications:**

1. RBC units are given to patients with low hemoglobin level (7-8 g/dl). The main aim of red cell transfusion is supply enough oxygen to hear muscle (60% of oxygen is up taken by heart, 30% by brine).
2. Massive blood loose.

Packed RBCs labeling

The process of blood donation is usually controlled by barcode system. This reduces the chance of mislabelling or human mistakes. Also allowing for traceability.



Plasma processing



- The separation of blood into its component is done by centrifugation. First, soft spin separates the whole blood unit into two layers: plasma rich in platelets (PRP) and packed RBCs. Then the unit can be spin hard to separate the PRP into two layers: platelets concentration and plasma (this plasma known as platelets-poor plasma [PPP]).
- Plasma then frozen at less than -18°C , so it is called fresh frozen plasma (FFP). It can be stored for three years.
- Plasma is rich in coagulation factors and if not kept at very low temperature these factors deteriorate.

Plasma unit

- There is only some conditions require plasma, cryoprecipitate or cryosupernatant transfusion.
- The therapeutic dose of plasma is 10-20 ml/kg. NOT one plasma unit which usually is 200-340 ml. For example, a person weight is 75kg ($75 \times 15 = 1125$ ml so he need this amount which requires $1125/200\text{ml} \sim 6$ units of plasma.
- Recipient of FFP should be giving compatible ABO group to prevent a transfusion reaction due to anti-A or anti-B that normally present in plasma.

- **Clinical applications:**

Because plasma contain coagulation factors, it is used mainly for coagulation defects such as:

1. Massive transfusion,
 2. Disseminated intravascular coagulation (DIC) (in this condition great consumption of coagulation factors are occur and many clots are formed).
 3. Liver disease (the liver is the site for synthesis most of the coagulation factors).
- There is no reason for using plasma as volume expander because crystalloid (which is aqueous solutions of mineral salts or other water-soluble molecules are effective and safer.

Cryoprecipitate

- Cryoprecipitate production:

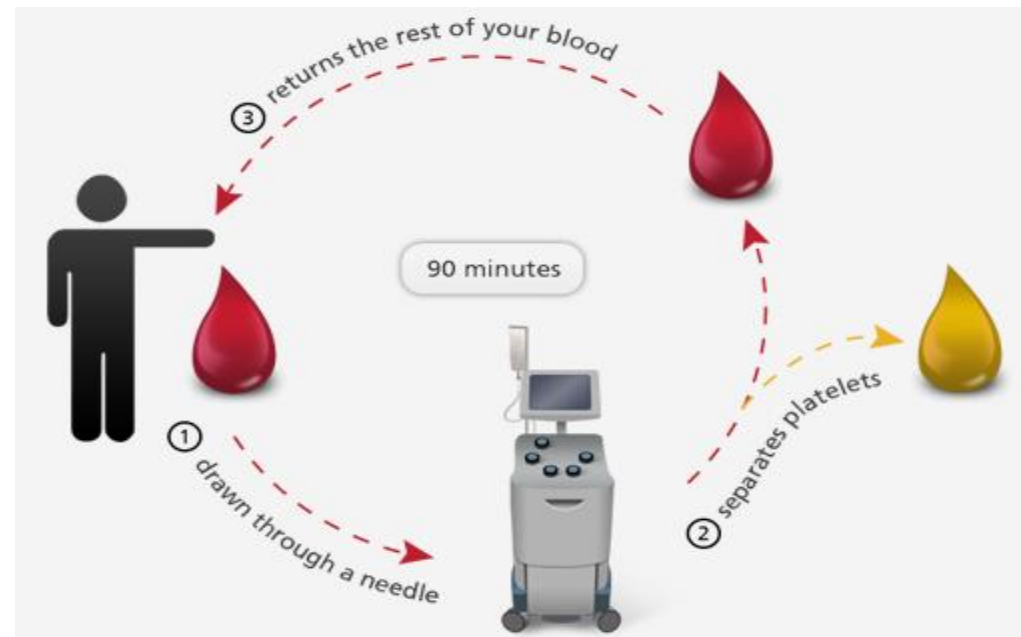
Plasma can be further process to produce cryoprecipitate. In this process, FFP is thawed at 4 °C overnight. Then centrifuged and the supernatant is removed and plasma precipitate (white precipitate) is collected. Then refrozen at below -18 °C. It can be stored for one year. Four to six Plasma units are required to produce one cryoprecipitate unit.

- This product is a source of: 1- Factor IIIIV (one of coagulation factors) 2- Fibrinogen 3-Von Willebrand factor (vWF).
- It is mainly used for treat fibrinogen deficiency.



Platelets unit

- One platelets adult therapeutic dose is prepared by pool around four platelets units obtained from four whole blood units.
- Platelets can also be obtained by using apheresis, in this case a donor who donate by apheresis machine can give one or more therapeutic dose.



Platelets units

- Store at 20-24 °C with agitation. This temperature is ideal for bacteria growth. Platelets transfusion has the highest incidence of transfusion transmission infections among other blood products. Most bacterial infection events were happen to platelets recipients.
- It can be stored for 5 days.
- It also can be stored up to 7 days if there is a bacterial monitoring system such as by using BACT/Alert.

Bact/Alert:

Sample taken from platelets units and injected into a special bottle contains growth media. If there is bacterial contamination, bacterial grow and consume O_2 and produce CO_2 . the production of CO_2 changes the media pH leading to change the color of the disc from green to yellow. So, bacterial contamination can be detected. There are false positive and false negative results.



Platelets unit

- **Platelets can be storage only for short time because:**

1-its life span only seven days

2-they are easily activated and clumping

3-the storage conditions are optimal for bacterial growth.

- ABO and RhD compatible units should be used as far as possible. RhD negative individual very rarely develop anti-D when received RhD+ platelets as a result of present RhD+ RBC in the platelets units.

Clinical applications:

- Normal platelets count is $150-450 \times 10^3 /l$.

Platelets transfusion is valuable for patients who suffer from thrombocytopenia (sever decrease in platelets count, less than $50 \times 10^9 /l$). Also for patients with inherited disorders of platelets function. It is given to these patients if they bleeding or as prophylaxis.

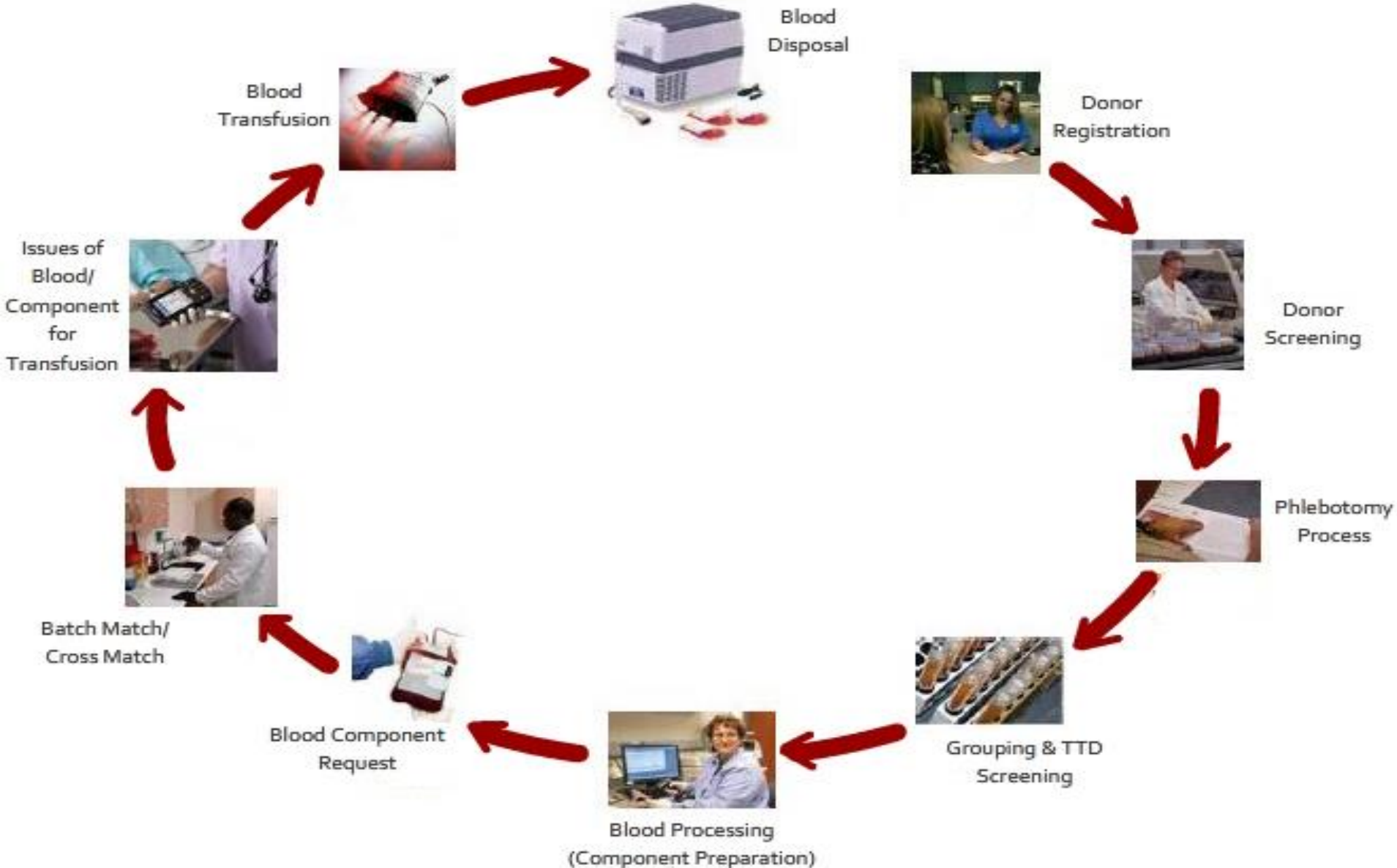
- One therapeutic dose can increase the platelets count $30-50 \times 10^9/l$ immediately after transfusion. If there are no increase in the count, platelets refractoriness which can be happen for immunogenic (present of anti-platelets Abs, for example) or non-immunogenic (disseminated intravascular coagulation, for example) reasons.

Granulocytes units



- One adult therapeutic granulocyte unit can be collected from buffy coats of 10 whole blood donations.
- Granulocytes also can be collected by apheresis from either donors stimulated with G-CSF (a drug stimulates bone marrow to produce more granulocytes) or non-stimulated donors.
- Granulocytes unit should be kept at 20-24 °C without agitation and transfused as soon as possible. The expiry date is only 24hours.
- Normally neutrophil have short circulation half life, 6–8 hours.
- ABO and RhD compatible units should be used. Also compatibility test against recipients' serum should be done because the are many RBCs in granulocytes units.
- Granulocyte transfusion is valuable for patient who suffer from neutropenia (less than $0.5 \times 10^9 /l$, normal neutrophil count is $2-7) \times 10^9 /l$) after chemotherapy to protect them from fungal infection. Also for patient with disorders of abnormal neutrophil function.

Let us start our story...



Summary

- Donors selection criteria.
- Serological tests: ABO, RhD and Abs titer.
- Microbial tests: viruses, bacteria, parasites.
- Types of donations: whole blood or a component (by apheresis).
- Whole blood processing: collection, filtration, separation, storage.
- For each component we study: how to prepare, optimal storage conditions, therapeutic dose and clinical applications.