

الحقية التعليمية

لمادة نقل الدم

قسم تقنيات المختبرات الطبية/ المعهد التقني الطبي- بصرة

الجامعة التقنية الجنوبية

المرحلة الاولى

م. م هدى قاسم عويد

Subject	Year study	Week hours		
Blood Transfusion نقل دم	First	Theoretical .L	Practical .L	Total
	First course			
		1	2	3
Study language (English	Assistant books	Clinical hematology in medical practice		

.Identification of blood bank properties

Theoretical syllabus	
Weeks	Topics
1	Information of blood transfusion
2	Blood components, blood collection, choosing the donor, .physiological examination, time of collection
3	.Complete the second week principles
4	.Blood group: ABO system, Rh factor, Lewis system
5	(Classification of blood typing (long & short
6	Direct and indirect coomb's test of blood

7	Process of cross matching test, reporting and record the .results
8	Roles of blood transfusion , blood disease
9	Pregnant care , leukemia of infants
10	Complete the principles above
11	.Separation of blood contents, methods of separation
12	.Complete the principle above
13	.Component of blood after storage, anticoagulants
14	.Blood transfusion disadvantage
15	Quality control , Tools ,Persons , Method

Practical syllabus	
Weeks	Topics
1	Instruments used in blood collection, examination and blood .transfusion
2	Donor choosing, how blood is collecting, donor care during .and after blood giving
3	. Methods of blood typing , tube method
4	Methods of blood typing, slide method, the difference . between the long and short method
5	. Coomb's test , direct method

6	.Coomb's test, indirect method
7	.Compatibility tests and report writing
8	.Identification of disadvantage
9	.Blood plasma fraction and pregnant care
10	.Blood fraction methods
11	.Blood fraction methods
12	.Methods of blood storage and components
13	.Quality control
14	.Transfusion instrument and fluids giving
15	.(Refreshing and moves presenting (Blood bank

Introduction to Blood Transfusion

Definition of Blood Transfusion

Blood transfusion is the intravenous administration of whole blood or specific blood components from a donor to a recipient for therapeutic purposes. It is a regulated medical procedure based on principles of immunohematology, hematology, and laboratory medicine.



Transfusion therapy aims to restore oxygen-carrying capacity, maintain hemostasis, or replace deficient blood components when clinically indicated.

Basic Composition of Blood

Blood is a specialized connective tissue composed of cellular elements suspended in plasma.

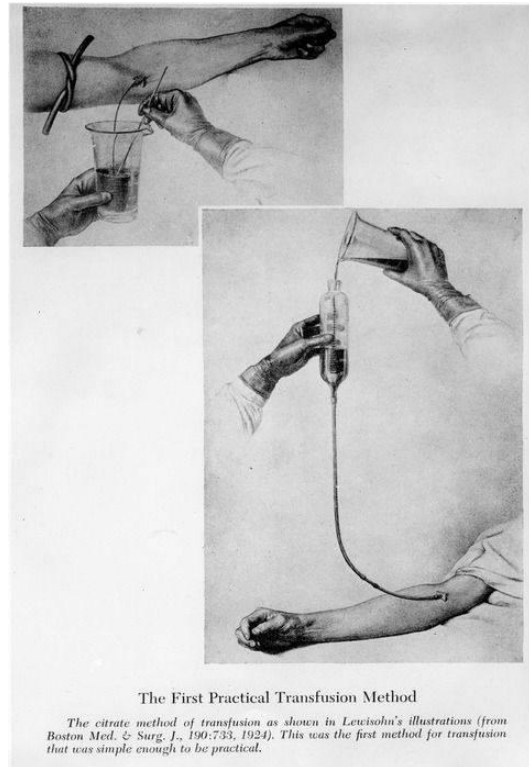
- Red blood cells (RBCs): Contain hemoglobin and are responsible for oxygen transport.
- White blood cells (WBCs): Play a role in immune defense.
- Platelets: Essential for primary hemostasis and clot formation.
- Plasma: The liquid portion containing proteins, clotting factors, electrolytes, and antibodies.

In transfusion medicine, these components can be separated and administered individually according to patient needs.

Historical Background

Safe transfusion practice became the possible after discovery of the ABO blood group system by Karl Landsteiner in 1901. This discovery explained incompatibility reactions and established the scientific basis for blood grouping and crossmatching.

The development of anticoagulants and blood storage techniques later allowed blood to be collected, preserved, and safely transfused, leading to the establishment of modern blood banks.



From Whole Blood to Component Therapy

Modern transfusion medicine is based on component therapy rather than routine use of whole blood. After collection, donated blood is separated into major components:

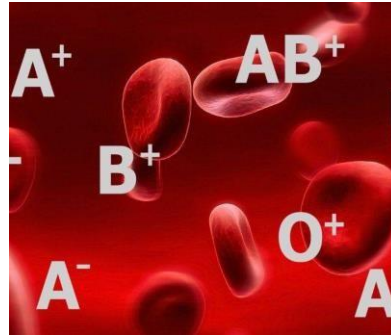
- Packed red blood cells
- Platelet concentrates
- Fresh frozen plasma
- Cryoprecipitate

This approach allows targeted treatment and optimizes the use of donated blood resources.

Overview of Blood Group Systems

Blood group systems are defined by specific antigens present on the surface of red blood cells. More than 30 blood group systems recognized, but two are of primary importance in transfusion practice:

- ABO blood group system
- Rh blood group system



are
in

Understanding antigen–antibody interactions within these systems is essential for ensuring compatibility between donor and recipient. These systems will be studied in detail in subsequent lectures.

What Is Transfusion Medicine?

Transfusion medicine is a medical specialty concerned with the collection, testing, processing, storage, and clinical use of blood and blood components.

- Donor selection and blood collection
- Blood grouping and antibody screening
- Compatibility testing (crossmatching)
- Preparation and storage of components
- Support of clinical transfusion services

It integrates laboratory science with clinical practice and plays a critical role in modern healthcare system.

Blood Transfusion

Blood Components

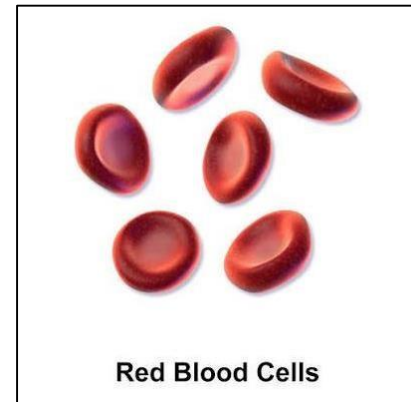
Whole blood consists of multiple components, each with specific physiological functions and clinical indications.

1. Red Blood Cells (RBCs)

Red blood cells are responsible for oxygen transport through hemoglobin. They are primarily used in:

- Acute blood loss
- Symptomatic anemia

RBCs are stored at about 4°C and have a shelf life of approximately 35–42 days, depending on the preservative solution.

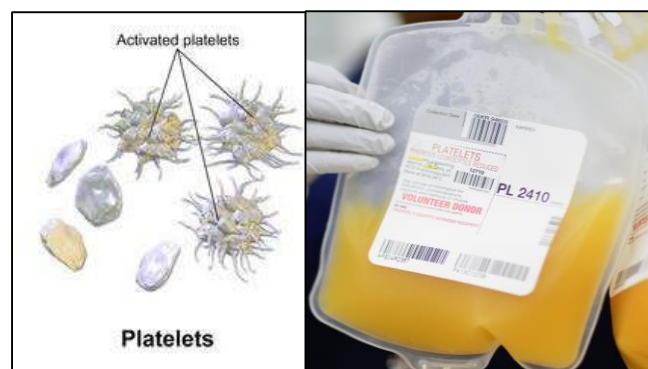
**2. Platelets**

Platelets play a crucial role in primary hemostasis by forming the initial platelet plug at sites of vascular injury.

They are indicated in:

- Thrombocytopenia
- Platelet function disorders

Platelets are stored at 20–24°C with continuous agitation and have a short shelf life of 5–7 days, making their management more challenging.

**3. Plasma**

Plasma is the liquid portion of blood and contains:

- Coagulation factors
- Albumin

- Immunoglobulins

Fresh Frozen Plasma (FFP) is used to treat:

- Coagulation factor deficiencies
- Liver disease
- Massive transfusion

Plasma is stored at -18°C or lower.

4. Cryoprecipitate

Cryoprecipitate is a plasma-derived product rich in:

- Fibrinogen
- Factor VIII
- von Willebrand factor It is mainly used in:
- Hypofibrinogenemia
- Certain bleeding disorders

Blood Collection

Blood collection must be performed under strict sterile conditions to ensure both donor and recipient safety.

The standard volume collected from a donor is approximately 450 ± 45 mL. Blood is collected into bags containing anticoagulant-preservative solutions to prevent clotting and preserve cell viability

The process of blood collection involves several steps:

1. Donor registration and identification
2. Medical history assessment
3. Physical examination
4. Blood collection using sterile equipment
5. Proper labeling and documentation



Donor Selection

Selecting suitable blood donors is one of the most critical steps in transfusion practice. It ensures the safety of both the donor and the recipient.

Basic Eligibility Criteria

A healthy donor should meet the following criteria:

- Age between 18 and 65 years
- Body weight ≥ 50 kg
- Adequate hemoglobin level:

≥ 13 g/dL in males, ≥ 12.5 g/dL in females

- Stable vital signs

Donor Medical Screening

1. Medical History

A detailed questionnaire is used to identify:

- Chronic diseases
 - Risk behaviors
 - Previous infections
 - Medication use
- ### 2. Physical Examination Includes:

- Measurement of blood pressure
- Pulse rate
- Body temperature
- General health assessment



3. Hemoglobin Testing

Ensures the donor is not anemic and can safely donate blood.

Laboratory Testing of Donor Blood

After collection, donated blood must be tested for transfusion-transmissible infections, including:

- HIV/AIDS, Hepatitis B, Hepatitis C, Syphilis

Additionally, blood grouping is performed using:

- ABO blood group system
- Rh factor

This ensures compatibility between donor and recipient.

Timing of Blood Donation: The timing of blood donation is critical to ensure donor recovery and maintain safety.

Donation Interval المدة بين التبرعات

For whole blood donation, the recommended interval is:

- 8–12 weeks (approximately 2–3 months) This allows sufficient time for:
- Restoration of red blood cell mass and Replenishment of iron stores

Frequency of Donation

- Males: up to 4 times per year
 - Females: up to 3 times per year
- Optimal Conditions for Donation** The donor should:
- Be well-rested
 - Have consumed a light meal
 - Be adequately hydrated

Donors should avoid donation when:

Fasting, Ill, Dehydrated

ABO and Rh Blood group systems

Introduction

Blood group systems are essential in transfusion medicine to ensure compatibility between donor and recipient. The most important systems include ABO and Rh systems.

ABO Blood Group System

The ABO system is the most clinically significant blood group system.

Antigens:

- A antigen
- B antigen

Blood Groups:

- Group A: A antigen on RBCs, anti-B antibodies in plasma
- Group B: B antigen on RBCs, anti-A antibodies in plasma
- Group AB: A and B antigens, no antibodies
- Group O: No antigens, both anti-A and anti-B antibodies

Antibodies:

- Naturally occurring (mainly IgM)

Blood Transfusion

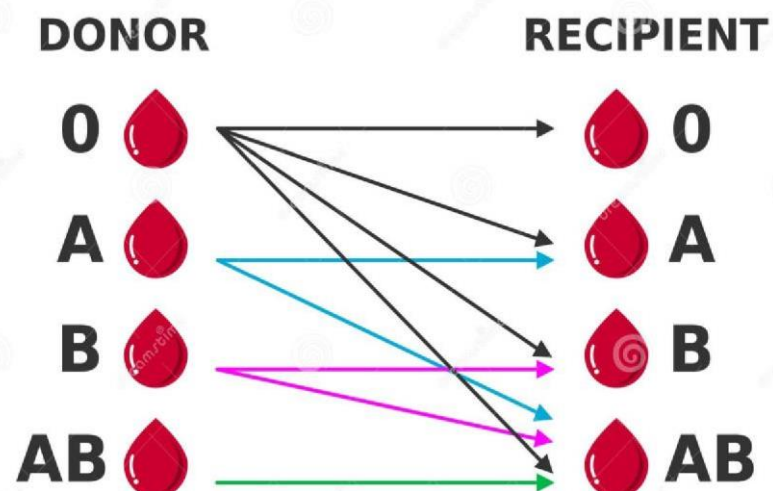
- Can cause immediate hemolytic transfusion reactions

ABO BLOOD GROUP SYSTEM

BLOOD GROUP	A	B	AB	O
RED BLOOD CELL TYPE				
ANTIGENES IN RED BLOOD CELLS	 A ANTIGEN	 B ANTIGEN	 A AND B ANTIGEN	NONE
ANTIBODIES IN PLASMA	 ANTI-B	 ANTI-A	NONE	 ANTI-A ANTI-B

Clinical Importance:

- Incompatible transfusion leads to severe hemolysis
- Group O is universal donor (RBCs)
- Group AB is universal recipient

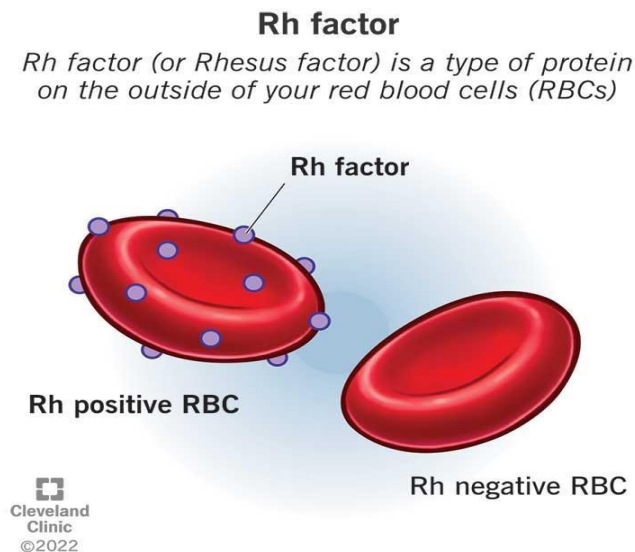


Rh (Rhesus) Blood Group System

The Rh system is the second most important system. It consists of over 50 antigens, but the 'D' antigen is the most immunogenic and clinically relevant.

Types:

- Rh positive: D antigen present
- Rh negative: D antigen absent



Clinical Significance:

Rh antibodies are typically IgG and are produced only after exposure (transfusion or pregnancy). They can cross the placenta, leading to Hemolytic Disease of the Fetus and Newborn (HDFN) if an Rh- mother carries an Rh+ fetus.

Prevention:

- Anti-D immunoglobulin is given to Rh-negative mothers

Blood Typing: Classification into Short and Long Testing Methods

Introduction

Blood typing is a fundamental procedure in transfusion medicine used to determine the compatibility between donor and recipient blood. Incorrect blood transfusion can lead to severe and potentially fatal reactions. Therefore, accurate blood typing and compatibility testing are essential before any transfusion.

Blood typing methods can be broadly classified into:

- **Short (Rapid) Blood Typing**
- **Long (Complete / Extended) Blood Typing**

Short Blood Typing (Rapid Typing)

Short typing refers to quick and basic blood group determination, usually limited to:

- ABO typing
- Rh typing

Methods Used

- Forward typing (Cell typing):
- Patient red cells are tested with anti-A and anti-B sera
- Rapid slide or card methods

Characteristics

- Fast (results within minutes)
- Simple to perform
- Used in emergency situations

Limitations

- Does not detect unexpected antibodies
- May miss weak or rare antigens
- Does not confirm full compatibility

Clinical Use

- Emergency transfusion
- Initial blood group identification
- Situations where time is critical

Long Blood Typing (Complete / Extended Testing)

Long typing refers to comprehensive pre-transfusion testing that ensures maximum safety.

Components

1. ABO Typing

- Forward typing (cells)
- Reverse typing (serum)

Blood Transfusion

2. Rh Typing

- Detection of D antigen

3. Antibody Screening

- Detects unexpected antibodies in patient serum

4. Crossmatching

- Mixing:
- Patient serum
- Donor red blood cells

To check for compatibility

5. Additional Testing (if needed)

- Extended blood group systems:
- Kell
- Kidd
- Duffy

Characteristics

- More accurate and reliable
- Detects hidden incompatibilities
- Takes more time and resources

Clinical Use

- Routine transfusion
- Patients with previous transfusions
- Pregnant women

Importance in Clinical Practice

- Prevents hemolytic transfusion reactions
- Ensures safe blood transfusion
- Detects clinically significant antibodies
- Reduces risk in high-risk patients

Summary

- Blood typing is essential for safe transfusion.
- Short typing is used for rapid, initial assessment.
- Long typing provides complete compatibility testing.

Coombs Test and Crossmatching

1- Coombs Test (Antiglobulin Test)

The Coombs test is a laboratory procedure used to detect antibodies that may lead to the destruction of red blood cells (hemolysis).

Principle

The test identifies antibodies (such as IgG) or complement proteins that are either:

- Directly attached to the surface of red blood cells (**Direct Coombs Test**).
- Free-floating in the serum that can bind to red blood cells (**Indirect Coombs Test**).

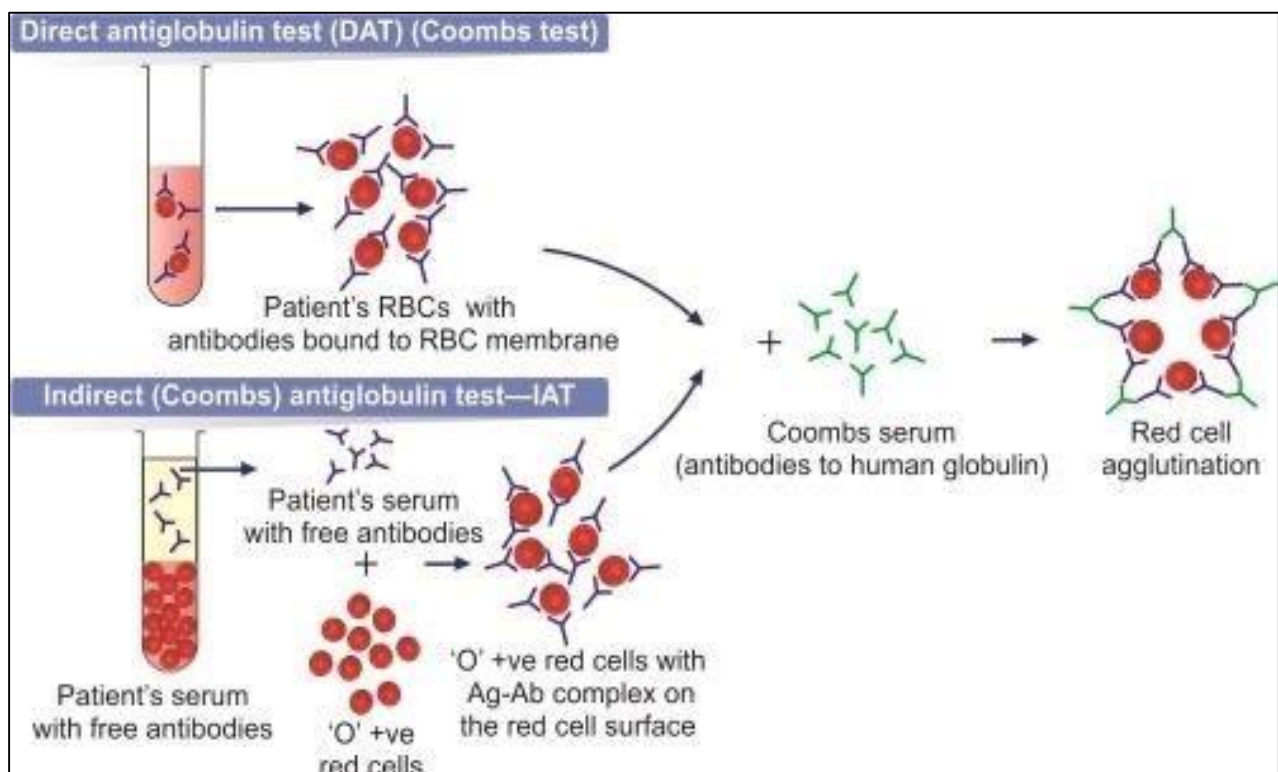
Direct Coombs Test (DAT)

- Red blood cells are isolated and washed to remove unbound proteins.
- Coombs reagent (anti-human globulin) is added.
- If agglutination occurs, the test is positive, indicating the presence of bound antibodies.
- Detects antibodies already bound to red blood cells.
- **Used** in conditions such as hemolytic transfusion reactions, hemolytic disease of the newborn, and autoimmune hemolytic anemia.

Indirect Coombs Test (IAT)

The patient's serum is incubated with red blood cells of known antigenicity.

- Coombs reagent is added.
- Agglutination indicates the presence of antibodies in the serum
- Detects free antibodies present in serum.
- **Used for** blood transfusion testing and antibody screening.
- A positive result indicates agglutination after mixing serum with RBCs and adding Coombs reagent.

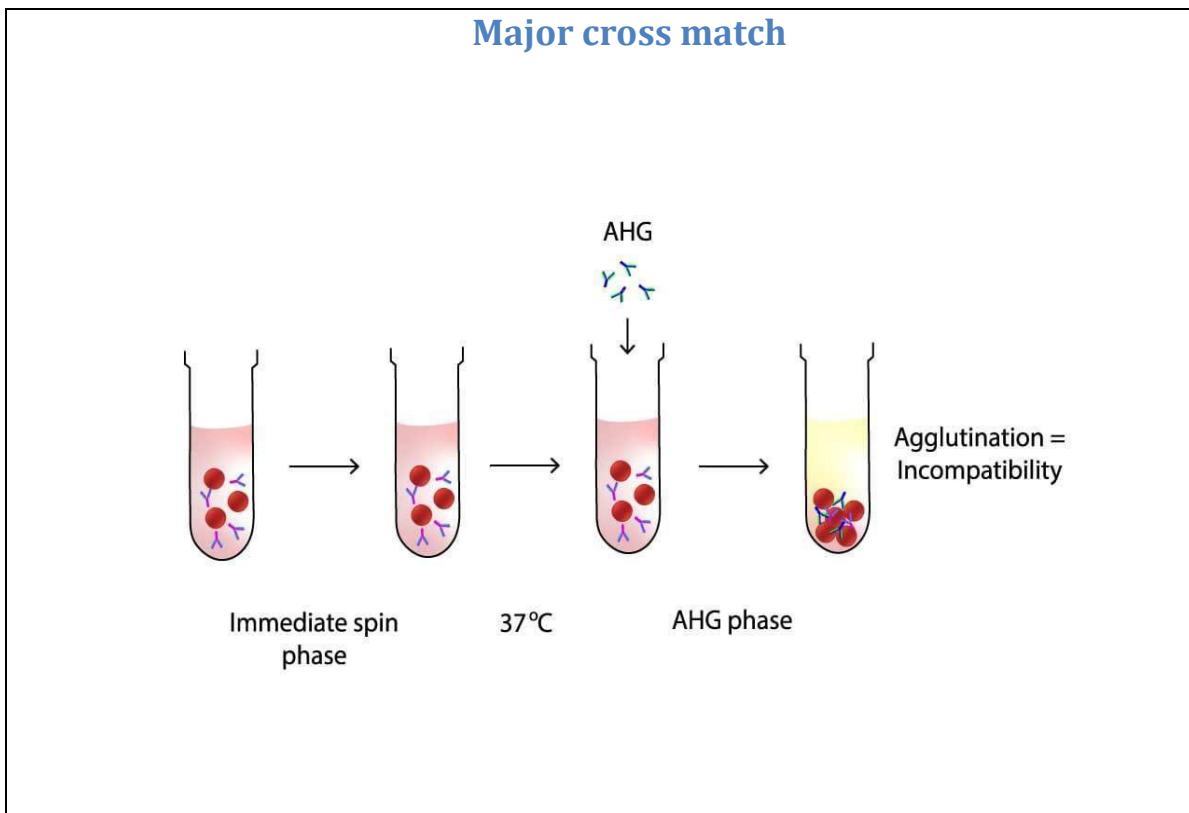


2- Crossmatching

Crossmatching is a laboratory test performed before blood transfusion to ensure compatibility between donor and recipient.

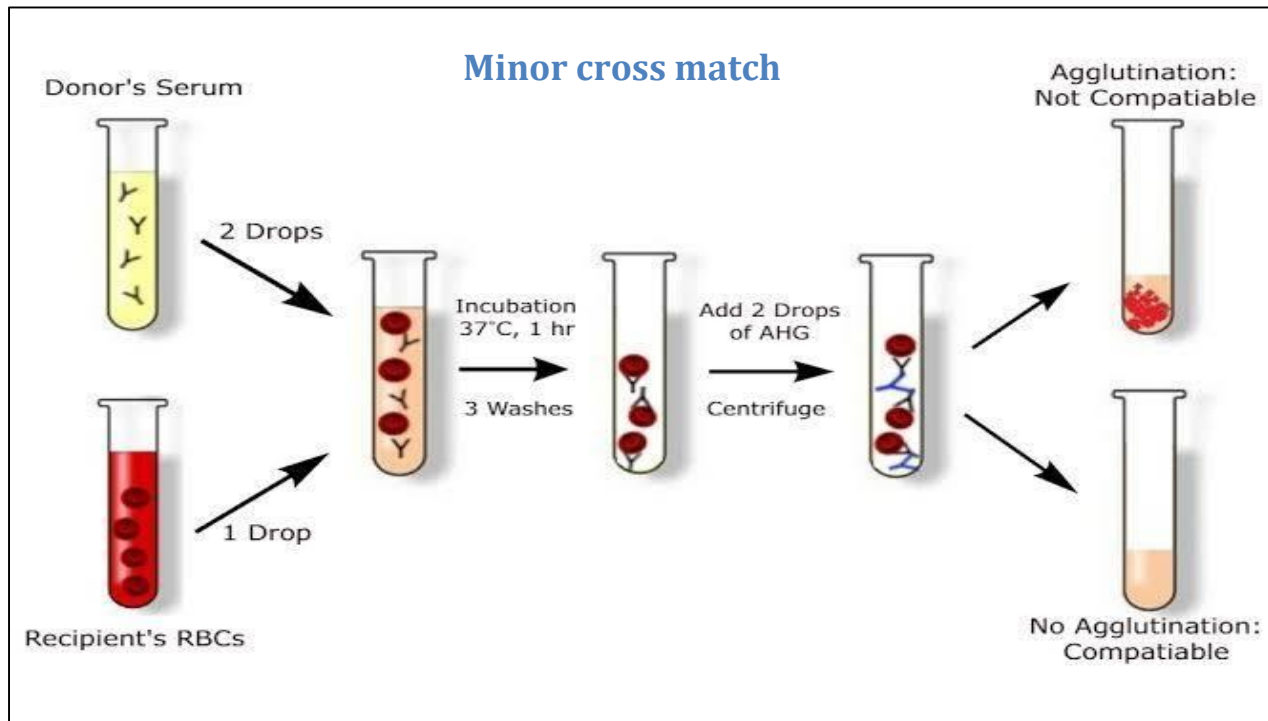
Major Crossmatch

- Mixing recipient serum with donor red blood cell then add AHG .
- This is the most important test.
- Detects whether recipient antibodies will attack donor RBCs.



Minor Crossmatch

- Mix donor serum with recipient red blood cells.
- Less important in modern practice.



Interpretation

- No agglutination: Compatible (safe for transfusion).
- Agglutination: Incompatible (unsafe for transfusion)

The Role of Blood Transfusion in Clinical Medicine

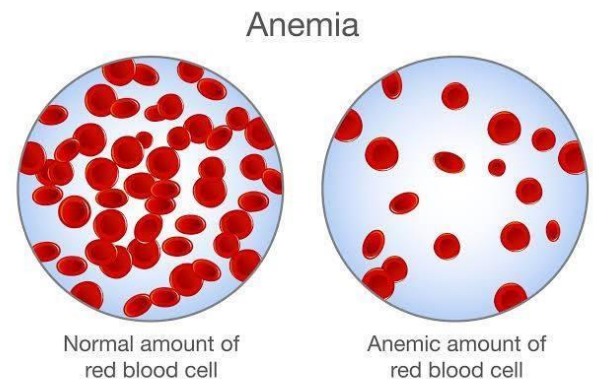
General Importance of Blood Transfusion

The primary goal of blood transfusion is to restore normal physiological function. This can be achieved by:

- Increasing oxygen-carrying capacity (through red blood cells)
- Preventing or stopping bleeding (through platelets and plasma)
- Correcting clotting factor deficiencies

1- Role in Hematological Disorders a- Anemia

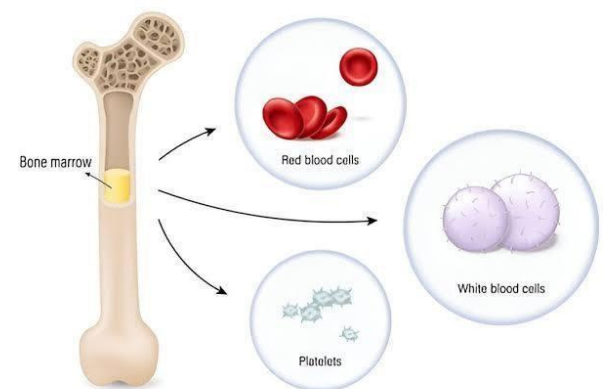
In severe anemia, the body cannot deliver enough oxygen to tissues. Transfusion of red blood cells restores oxygen delivery.



b- Bone Marrow Failure

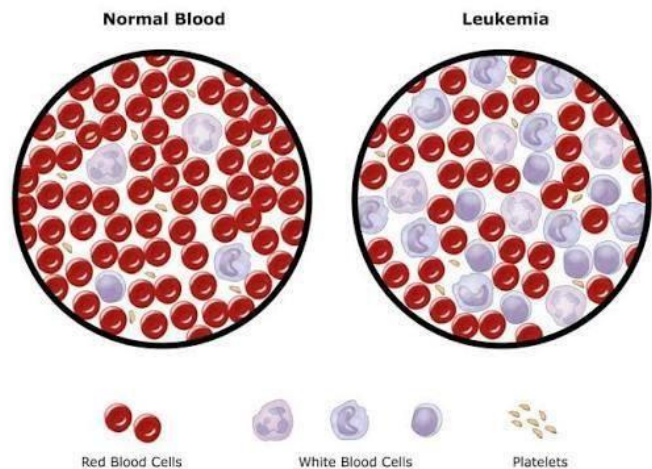
When the bone marrow does not produce enough blood cells:

- Red cells are given to treat anemia
- Platelets are given to prevent bleeding



c- Leukemia

Leukemia is a cancer of blood-forming tissues where abnormal cells replace normal ones.



Transfusion is necessary because:

- Bone marrow fails to produce normal cells
- Chemotherapy suppresses production further

Given components:

- Red blood cells to treat anemia
- Platelets to prevent bleeding

2- Role in Neonates (Newborns)

Newborns may require transfusion due to:

- Immature bone marrow
- Blood loss
- Hemolytic conditions

Exchange transfusion may be used in severe jaundice.

3- Role in Pregnancy and Maternal Care

a. During Pregnancy

Severe anemia can harm both mother and fetus.

b. Hemolytic Conditions

Maternal antibodies may destroy fetal RBCs

c. During Delivery

Postpartum hemorrhage is life-threatening and requires urgent transfusion.

4- Role in Surgery and Emergency Medicine

In trauma or major surgery:

- Blood loss may be severe
- Transfusion maintains circulation and oxygen delivery

d Transfusion

Blood Components Separation in Transfusion Medicine

Introduction

Blood transfusion practice has evolved from whole blood transfusion to component therapy. Component separation allows clinicians to transfuse only the specific blood component needed, improving patient outcomes and reducing risks.

Methods of Blood Component Separation

1- Centrifugation Method

Centrifugation is the most widely used method for separating blood components based on density differences.

- Light spin (soft spin): Separates plasma from red cells.
- Heavy spin (hard spin): Further separates platelets from plasma.

Steps:

1. Whole blood is collected in anticoagulant bags.
2. Blood is centrifuged at controlled speed and time.
3. Layers are formed: RBCs (bottom), buffy coat (middle), plasma (top).
4. Components are expressed into satellite bags.



2- Buffy Coat Method

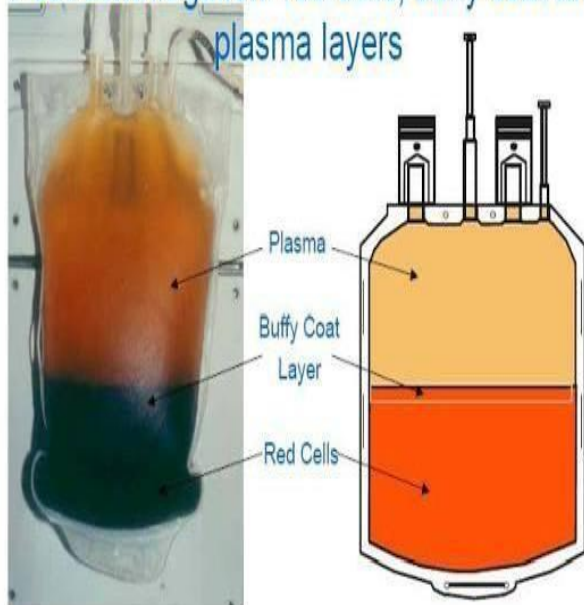
In this method, the buffy coat layer is used to prepare platelet concentrates.

- After centrifugation, buffy coat is separated.
- Multiple buffy coats can be pooled to prepare platelet units.

Advantages:

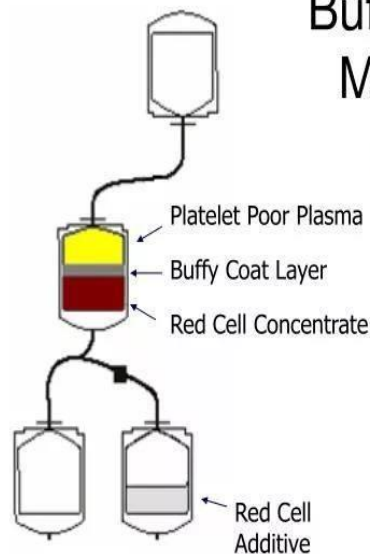
- Higher platelet yield.
- Reduced plasma volume.

Post-centrifugation: red cells, buffy coat and plasma layers



Buffy Coat Method

Step 1: Whole Blood is collected into a top and bottom pack and is centrifuged (hard spin) to produce platelet poor plasma, red blood cells and a buffy coat

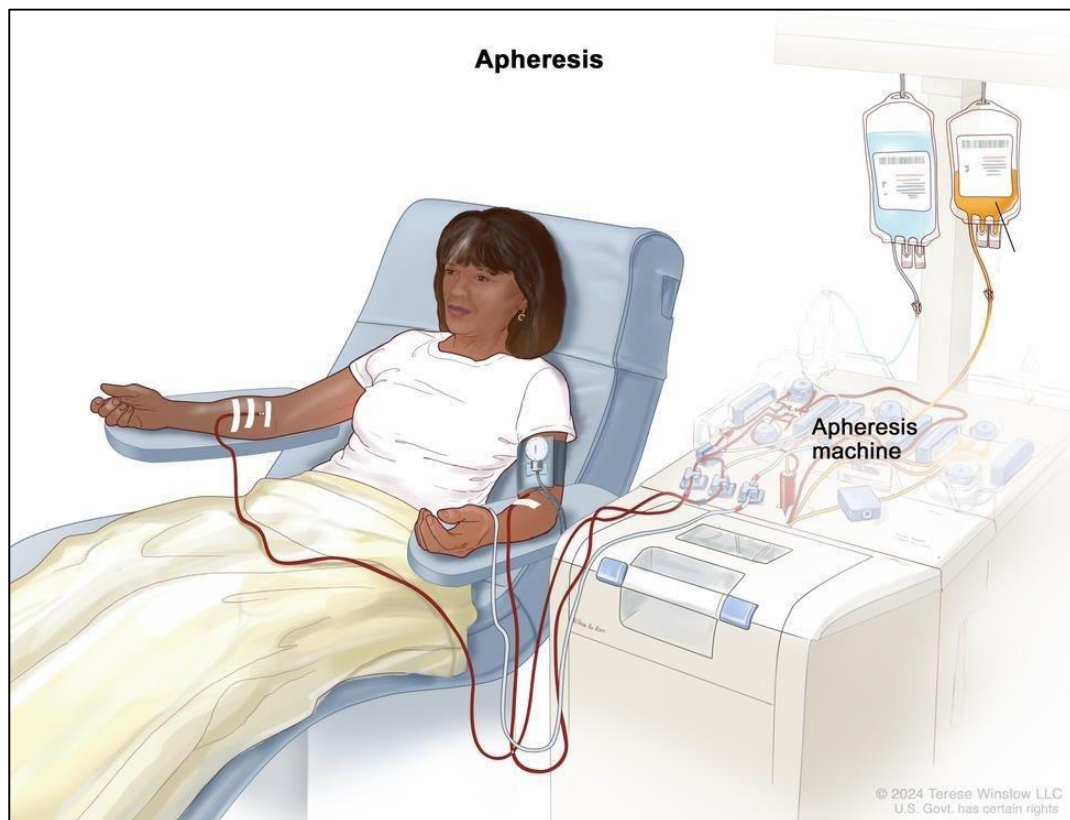


3- Apheresis Method

Apheresis is an automated method where blood is drawn from the donor, processed, and specific components are collected. - Types: Plateletpheresis, plasmapheresis, leukapheresis.

Advantages:

- High purity components.
- Single donor exposure.
- Better control of component collection.



Advantages of Component Separation

- Maximizes use of donated blood.
- Reduces transfusion risks.
- Allows tailored therapy.

Anticoagulants Used in Blood Collection and Storage

Anticoagulants prevent clotting and preserve blood components during storage.

A- CPD (Citrate Phosphate Dextrose):

Citrate binds calcium to prevent coagulation.

Phosphate acts as buffer; dextrose provides energy for RBC metabolism. **B-**

CPDA-1 (Citrate Phosphate Dextrose Adenine):

Contains adenine to maintain ATP levels and extend RBC shelf life to 35 days.

C- SAGM (Saline, Adenine, Glucose, Mannitol):

Additive solution that improves RBC survival and extends storage up to 42 days.

D- Heparin:

Used mainly for short-term storage or laboratory procedures; not suitable for long-term storage

Complications of Blood Transfusion

1. Early (Immediate) Reactions

– Acute Hemolytic Reaction:

Happens when the wrong blood type is given. It is very dangerous and can cause kidney failure or death.

– Fever Reaction:

The patient gets fever and chills. It is common but usually not serious.

– Allergic Reaction:

Skin rash or itching. In rare cases, severe allergy (anaphylaxis) can happen.

2. Late (Delayed) Problems

– Delayed Hemolysis:

Mild destruction of red blood cells days after transfusion.

– Alloimmunization:

The body makes antibodies, which makes future transfusions harder.

– Graft-versus-Host Disease:

Very rare but usually fatal. Donor immune cells attack the patient.

3. Infection Risk

Today, blood is carefully tested, so risk is very low:

– Viruses: HIV, Hepatitis B, Hepatitis C

– Bacteria: more common in platelets

4. Non-Immune Complications

– TACO (fluid overload):

Too much fluid → breathing problems, especially in elderly.

– TRALI (lung injury):

Serious lung reaction, can be life-threatening.

– Iron Overload:

Happens in patients who receive many transfusions over time.

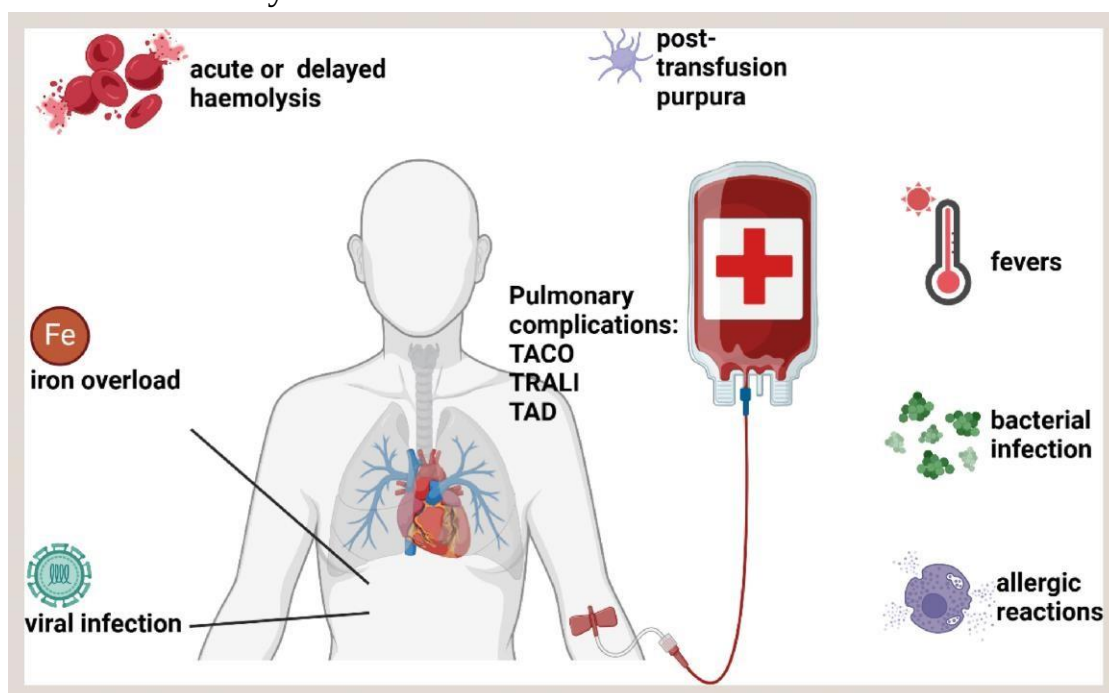
5. Other Effects

– High potassium

– Low calcium

– Low body temperature

These are more likely in massive transfusion.



Quality Control in the Laboratory

1. Introduction to Quality Control (QC) Definition:

Quality Control (QC) is a systematic process used in laboratories to monitor and evaluate the accuracy, precision, and reliability of test results.

Purpose of QC:

- Detect errors in the analytical process.
- Ensure test results are valid and reliable.
- Improve confidence in patient results.
- Comply with accreditation and regulatory standards (e.g., ISO 15189, CAP).

2. People Involved in QC

Role :	Responsibility
--------	----------------

Laboratory Technologist:	Daily QC checks, documentation, following SOPs
---------------------------------	--

QC Officer / Supervisor:	Review QC charts, identify trends or issues
---------------------------------	---

Laboratory Manager :	Ensure QC system is in place and staff are trained
-----------------------------	--

External Auditors:	Conduct external reviews and audits
---------------------------	-------------------------------------

Quality Manager : Oversees implementation and compliance with quality standards

3. Tools of Quality Control

Tool :	Purpose
---------------	----------------

Levey-Jennings Chart:	Visualize daily QC values against control limits
------------------------------	--

Westgard Rules:	Detect systematic or random errors in QC results
------------------------	--

Standard Operating Procedures :	Ensure standardized methods are used
---------------------------------	--------------------------------------