

12

Blood Groups

- Very important
- Extra information
- Terms



﴿ وَمَنْ أَحْيَاهَا فَكَأَنَّمَا أَحْيَا النَّاسَ جَمِيعًا ﴾



Contact us : Physiology435@gmail.com

Objectives

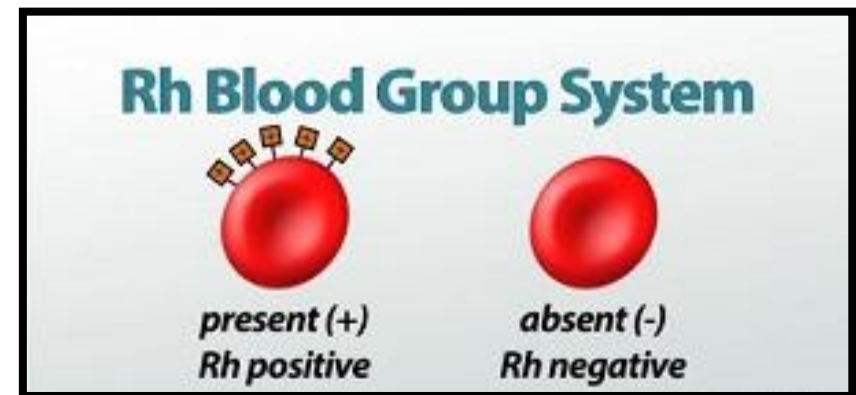
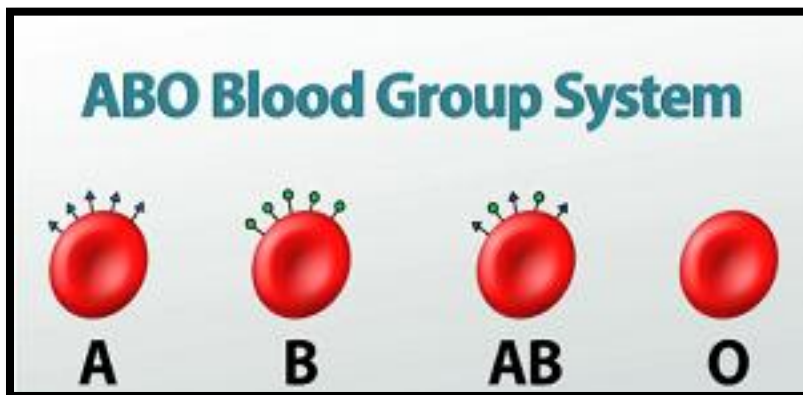
At the end of this lecture you should be able to:

- **Describe ABO blood groups types.**
- **Recognize Agglutinin in plasma.**
- **Describe genetic inheritance of Blood groups.**
- **Recognize transfusion reactions.**
- **Describe Rhesus blood groups.**
- **Describe causes of hemolytic disease of the newborn.**

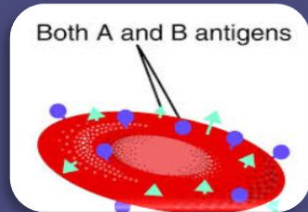
Blood Group Systems

- **Blood Groups are determined by **Antigens** present on the surface of “Red blood cells”**
(antigens are glycoproteins, complex oligosaccharides that differ in their terminal sugar)
- **About 20 blood group systems are known**
(Eg. ABO System, Rh-System MNS System, Kell System, Lewis System, Duffy, Lutheran, KIDD)

Two common systems :

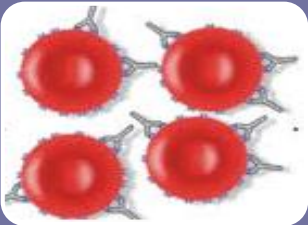


Definitions



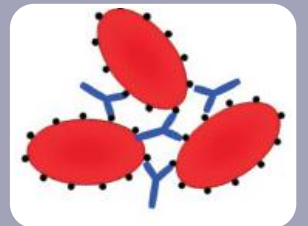
Agglutinogens :

Blood group antigens on RBC membrane (A and B).



Agglutinin :

The respective antibody to the antigen.

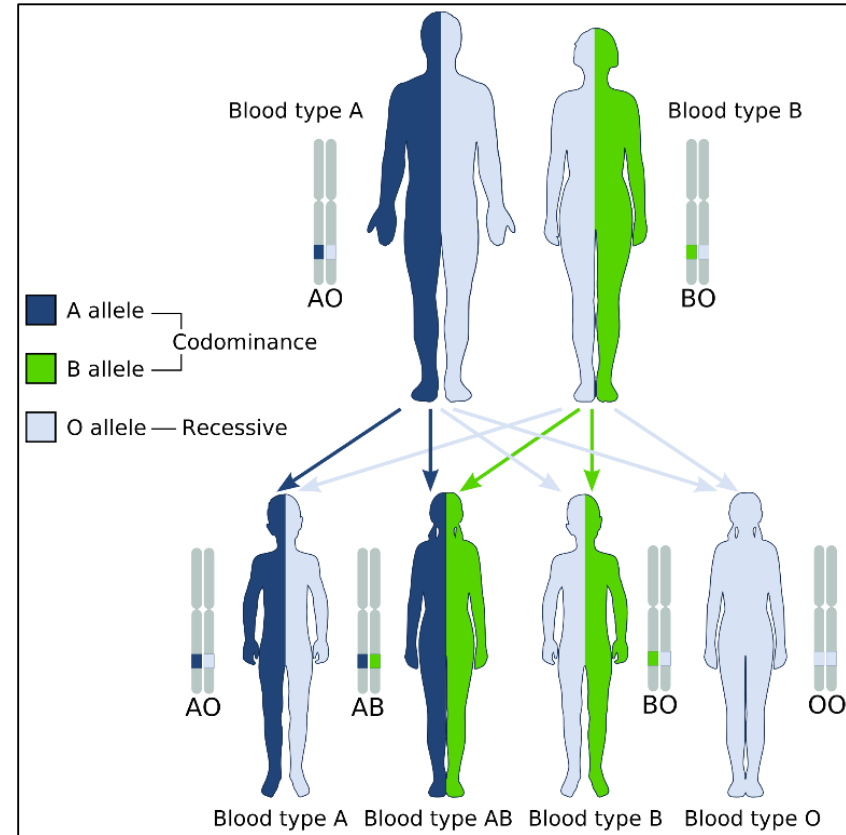


Agglutination :

Reaction between Antigen “agglutigen”
on RBC and the respective Antibody “Agglutinin”.

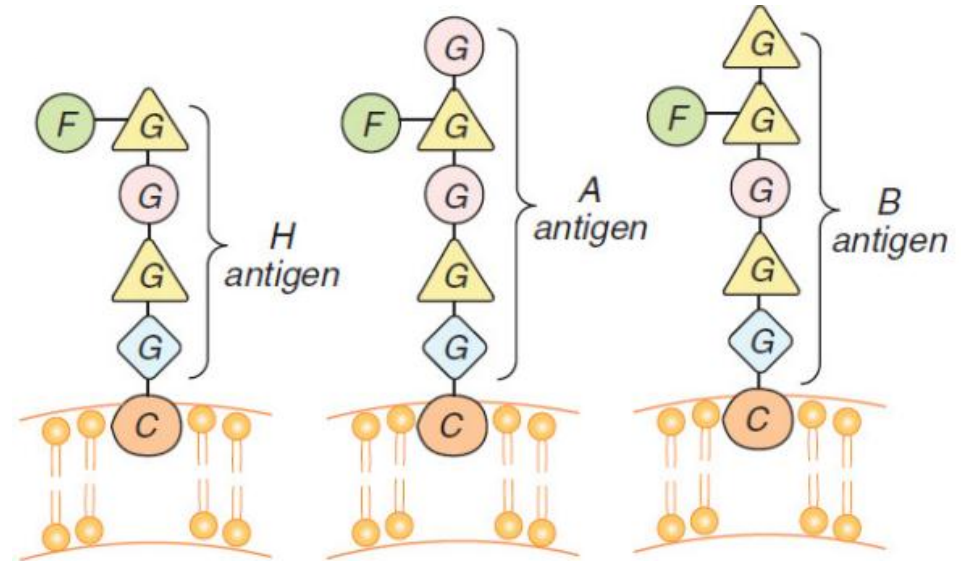
عملية تجميع (تلصيق)


- The **ABO** gene locus is located on the **chromosome 9**
- **A** and **B** blood groups are **dominant** over the **O**
- **A** and **B** group genes are **co-dominant**.
- Each person has two copies of genes coding for their **ABO** blood group. **(one maternal and one paternal in origin).**
- The alleles for **Blood** group are in the same place on the **chromosome 9**.




Inherited Characters


- An H gene codes for a fucose transferase that adds a terminal fucose, forming the **H antigen** that is the foundation upon all blood types are formed.
- A and B genes code for enzymes that add a sugar to the H antigen.





 = fucose

 = N-acetylgalactosamine

 = glucose

 = galactose

 = ceramide

 = lipid bilayer

Fucose is a hexose deoxy sugar.

The ABO and Rh Systems

“The chief blood groups”

The ABO System

- Depends on whether the red cells contain one, both or neither of the two blood antigens **A** and **B**
- Four main **ABO** groups:
A, B, AB, O

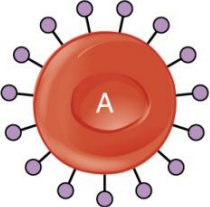
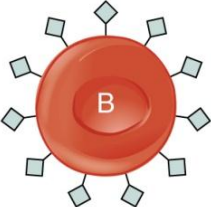
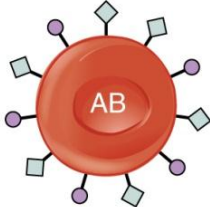
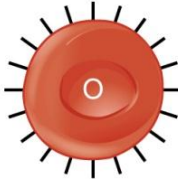






Note: Locus of alleles responsible of **ABO** system is on long arm of chromosome **9** while **Rh** locus is on chromosome **1**

Rh group is determined by:

- Presence or absence of the Rhesus antigen (**D**) on the surface of RBC:
 - Presence of D (individual is Rh+ve) [85%]
 - Absence of D (individual is Rh-ve) [15%]
- Rhesus antigens:
Dd, Cc, Ee (Clinically most important is **D**)
- They were named rhesus antigens or Rh-antigen because the same antigens are present in Rhesus monkey.



Blood Type

	A	B	AB	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
Genotypes	AA or AO	BB or BO	AB	OO

Uses of genotypes:

▶ **Sorting disputes in paternal dispute.**

لا نستطيع إثبات الأبوة من خلال فصائل الدم ولكن نستطيع نفيها.

▶ **Frequency of ABO has ethnic variation**

”الاختلاف العرقي”

■ Anti-A & Anti-B:

Is **naturally occurring** antibodies.

- Not present at birth, **appear 2-8 months after birth.**
- Triggered by A & B antigens in food and bacteria.

■ Anti-D antibody (agglutinin)

Is **not naturally-occurring** and are Acquired by:

- Transfusion of Rh-ve individual with Rh+ve blood.
- Rh-ve pregnancy with Rh+ve fetus “الجنين”.

Landsteiner Law (1900) :

If an agglutino-gen is present on the RBC of an individual, the corresponding agglutinin must be absent in the plasma of that individual and vice-versa. This law is only applicable to ABO blood grouping system.

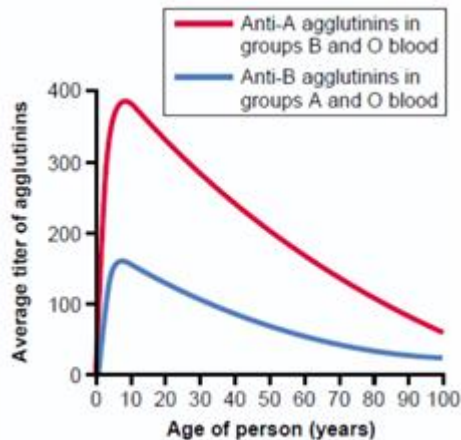
Antibodies in Serum are also known as AGGLUTININS
Antibodies are exist in the plasma
قاعدة : جسم الإنسان يكون أجسام مضادة لأي جسم غريب يدخل عليه.

Agglutinins (Antibodies)

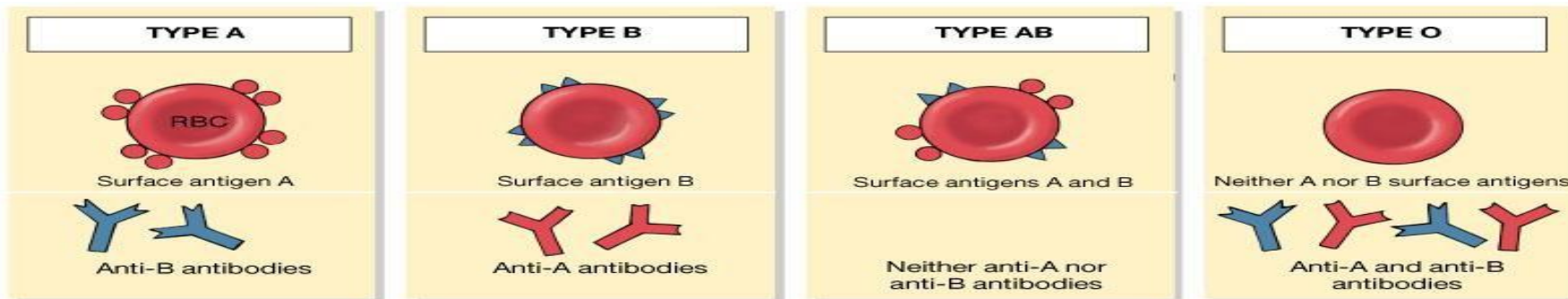
They are immunoglobulins (**IgM & IgG**). Proteins which appear in the plasma or body fluids (Ex. Serum) in response to administration of antigens.

Anti-A & Anti-B antibodies	Rh antibodies
They are of IgM class.	They are of IgG class.
They don't cross the placenta.	They can cross the placenta.

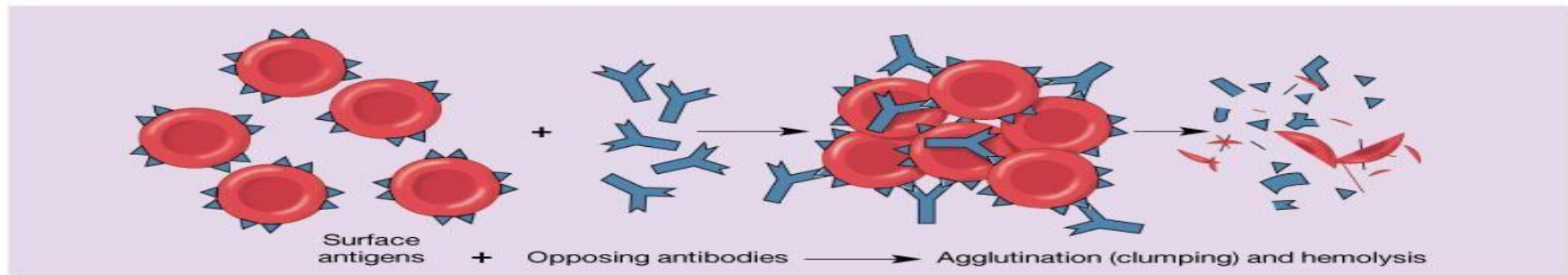
Agglutinins Titer At Different Ages.



- Infant begins to produce agglutinins from two months(8 weeks) to 8 months after birth.
- The maximum rate of agglutinins production is usually at 8 to 10 years of age, and then gradually declines (decrease) throughout life.



(a)



(b)

What will happen for our blood if we have type of surface antigens and the blood which transfused for us have opposing antibodies ?

[Agglutination(clumping)+hemolysis]

For example : Recipient (type A) has (antigen A) & (Antibody B), Donor (type B) has (antigen B) & (Antibody A) :

الأجسام المضادة الموجودة في البلازما ترتبط بالـAntigen الموجود على السطح وبالتالي يحدث تفاعل:

Hemolysis of RBCs > death of RBCs

دائماً في المستقبل (Recipient):

تهمنا الأجسام المضادة الموجودة والجاهزة في البلازما

Antigen المتبرع ما يهمننا هو الـ

(Donor > Antigen / Recipient > Antibody)

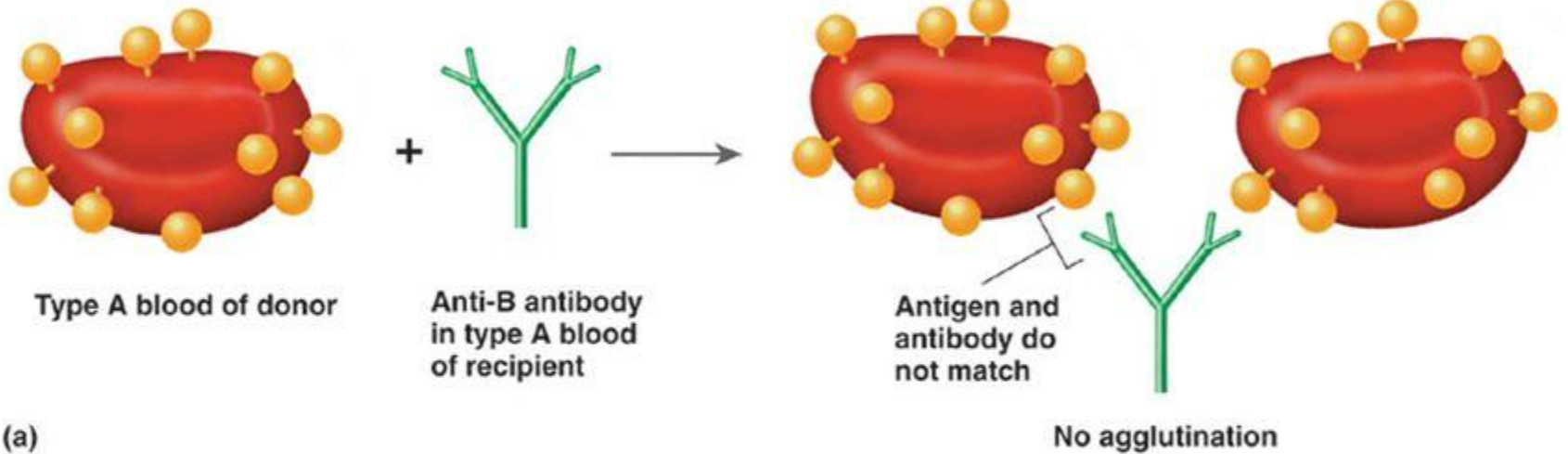
Enjoy with this amazing VID: [3 min](#)



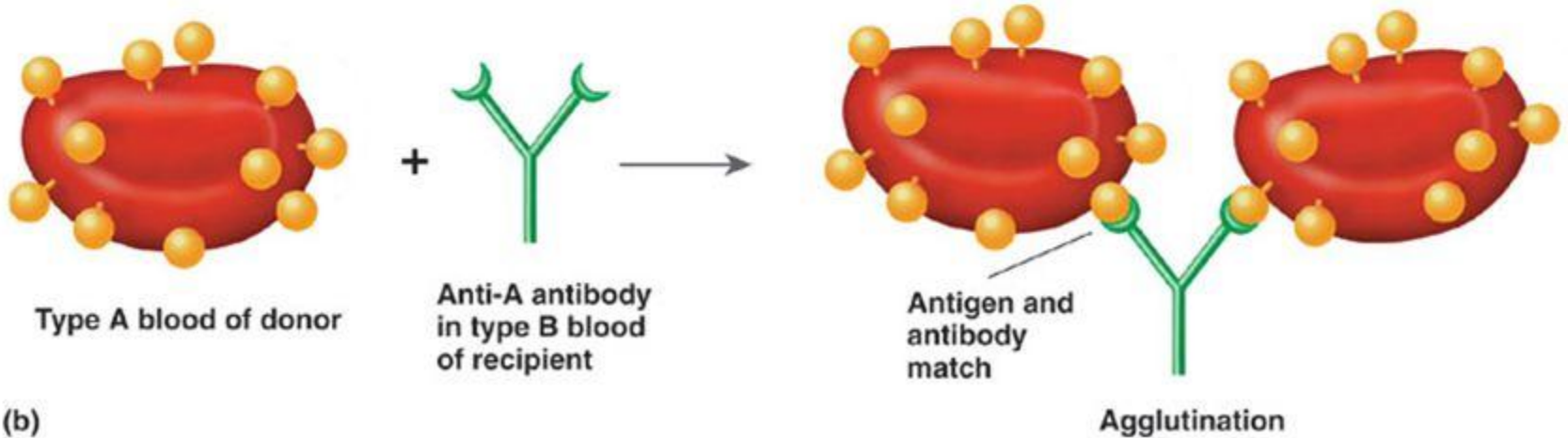
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Agglutination Reaction

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(a)



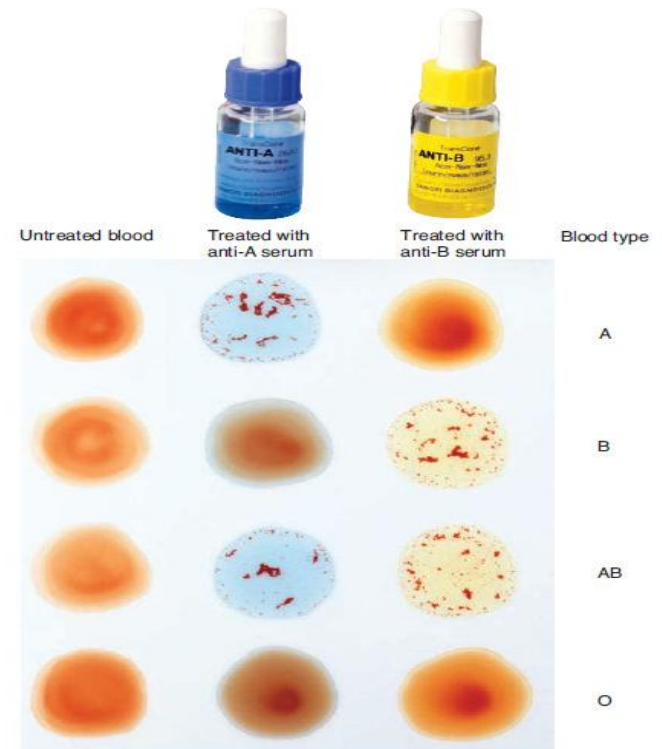
(b)

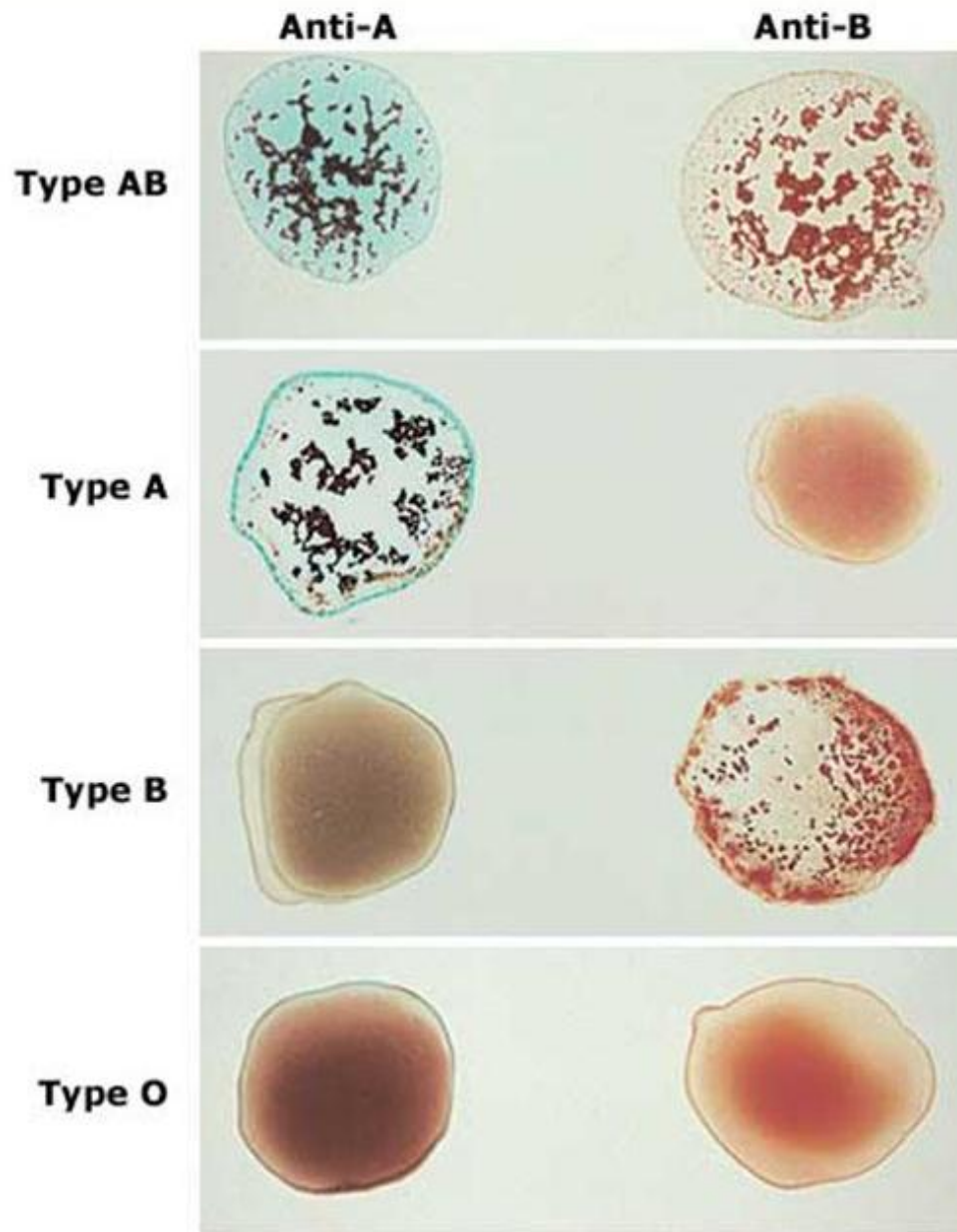
Blood Typing

The aim of blood typing is :to determine the blood groups.

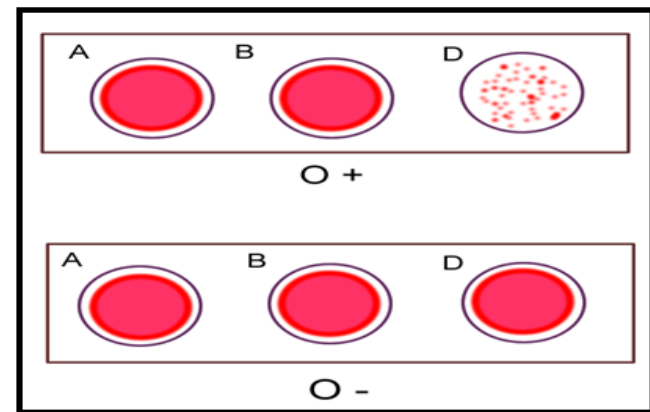
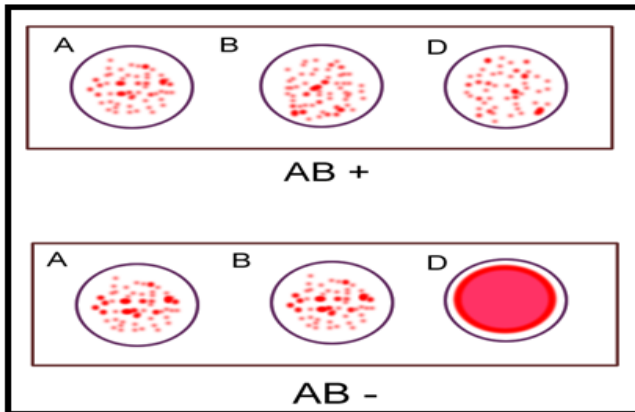
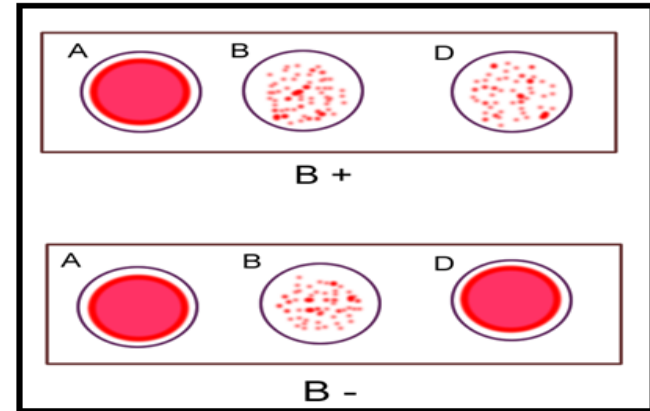
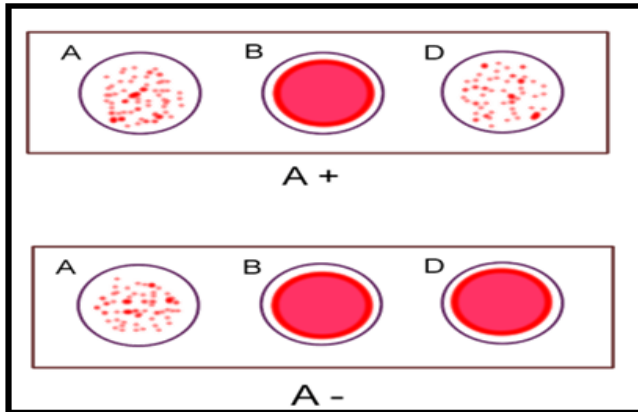
- There are three antibodies (fluids) that used to determine the type of blood group by agglutination: **Anti-A, Anti-B and Anti-D**.

- If there is agglutination in the drop patient blood when we used **Anti-A** only that mean patient's blood group is **A**.
- Same thing for **Anti-B** →(agglutination)→ **B**.
- If there is agglutination in the drop patient blood when we used both **Anti-A** and **Anti-B** that mean patient's blood group is **AB**.
- If there **isn't** agglutination in the drop patient blood when we used both **Anti-A** and **Anti-B** that mean patient's blood group is **O**.
- **Anti-D** serum determines Rh⁺ and Rh⁻
“Serum : plasma which contains antibodies”.





The Result WITH D(+,-)



Importance of blood groups

1. Blood transfusion.
2. Preventing hemolytic disease $\xrightarrow{\text{Caused by}}$ [Rh incompatibility].
3. Paternity disputes (to determine the father of neonate).
4. Medicolegal cases.
5. To Know susceptibility to a disease :

For example: Group O $\xrightarrow{\text{can have}}$ Duodenal cancer.

Group A $\xrightarrow{\text{can have}}$ Carcinoma of stomach, pancreas & salivary glands.

Agglutination in transfusion reaction:

- Group A patient $\xrightarrow{\text{transfused}}$ with group B blood $\xrightarrow{\text{lead to}}$ agglutinate group B blood cells by Anti-B in the patient plasma.

Outcomes:

- The agglutinated cells (clumped) plug (Block) small blood vessels. [Kidney shut down].
- Sometimes, causes immediate hemolysis.

Note: same idea when group A person transfused to patient's B blood group.

The Rh immune response

Rh+ve
blood



Rh-ve
person



Anti-Rh agglutinins
develop slowly
(2-4 months).

**So, we can do it only
one time**

- Once produced they persist for years and can produce serious reactions during 2nd transfusion.
- (Rh-ve) person has never before been exposed to (Rh+ve) blood, transfusion of (Rh+ve) into that person will cause **NO** immediate reaction. On the next transfusion of (Rh+ve) into the same person, who is already immunized against the Rh-factor, the transfusion reaction can be immediate and srvere.

- If the mother **Rh-** , and the baby **Rh+** , then :

First fetus	Second fetus
<ul style="list-style-type: none"> - Fetal (Rh+) cross to maternal blood - Mother develop (Anti D) after delivery. - Fetus is safe. 	<ul style="list-style-type: none"> - (Anti D) of mother crosses placenta and destroy fetal (Rh+) RBC . - Fetus will be hemolytic (hemolytic disease of the newborn) .

- If the mother is transfused with Rh+ blood before , the first fetus **will be affected** because she has Anti D in her blood .

**Female who has (Rh-ve) married to (Rh+ve) person
IF the baby is (Rh+) then :**

The first pregnancy :

دم الأم ودم الجنين لا يختلطان , كريات الدم الحمراء للجنين تحتوي على (D-antigen) أما الأم فلا تمتلكها , أثناء الولادة يختلط دم الأم مع دم الجنين وتتمزق المشيمة بالتالي الـ (D-antigen) في الجنين تتسرب إلى دم الأم , ويبدأ جسم الأم بتكوين أجسام مضادة نظراً لأن هنالك جسم غريب , مر الطفل الأول بسلام وبدون أية مشاكل المشكلة تكمن عندما عند الحمل الثاني للأم بطفل أيضاً (Rh+ve)

Second pregnancy :

دم الأم لا يختلط مع دم الجنين ولكن الأجسام المضادة التي تكونت بعد الحمل الأول قادرة على اختراق المشيمة و التوجه نحو دم الجنين بالتالي :

Reaction > Agglutination > Hemolysis > Hemolytic anemia > Jaundice and Erythroblastosis fetalis “bone marrow releases immature blood cells : Reticulocytes, Erythroblasts”

غالباً : إجهاض.

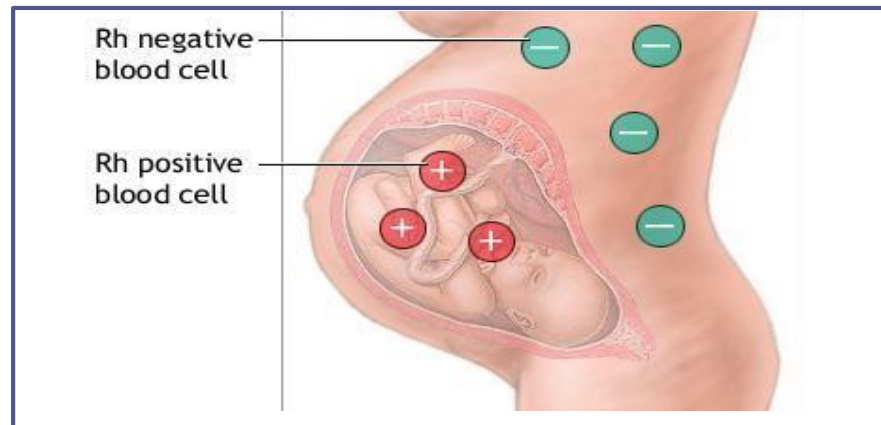
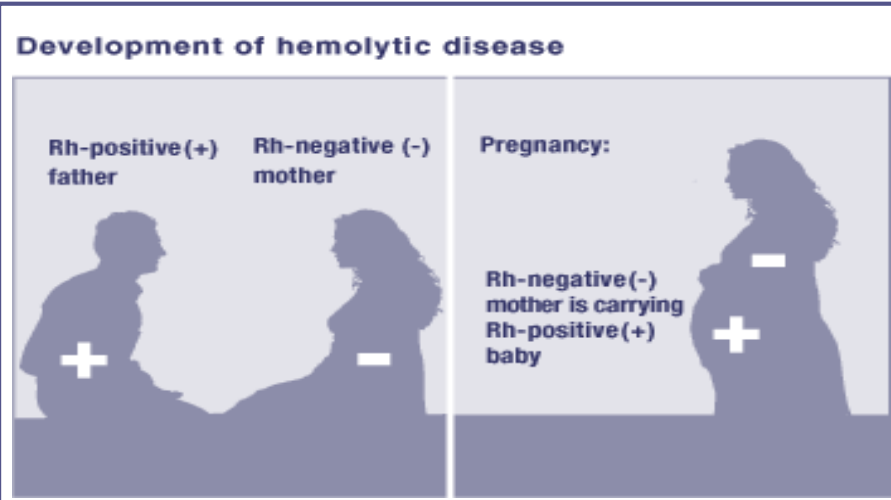
Treatment :

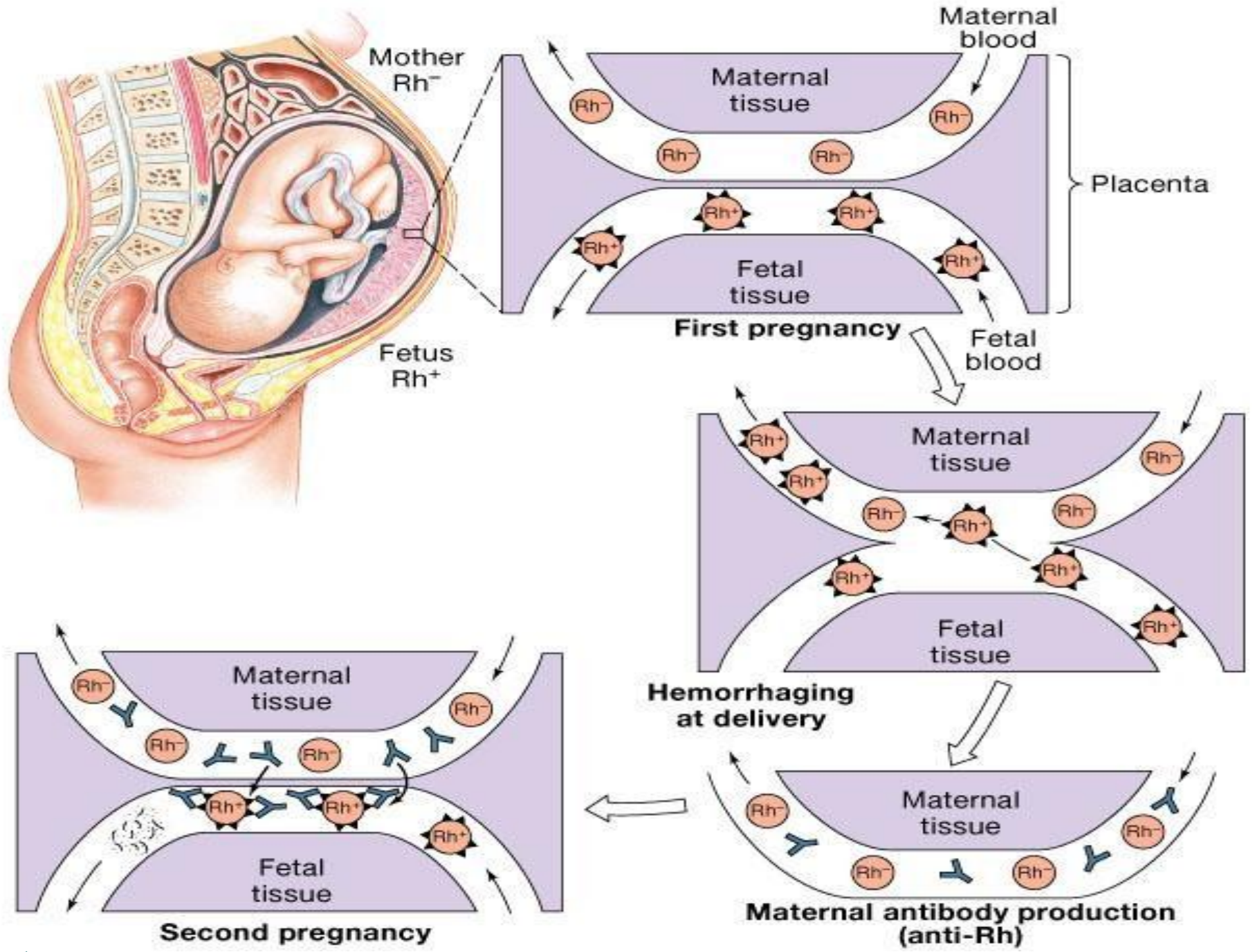
تحقن الأم بـ (Anti-D) بعد الولادة بيومين أو ثلاث أو حتى أثناء الولادة

(Anti-D) bind to RBCs of fetus.

(D-antigen) الموجودة داخل جسم الأم تقوم بتكسير الـ RBCs antigens

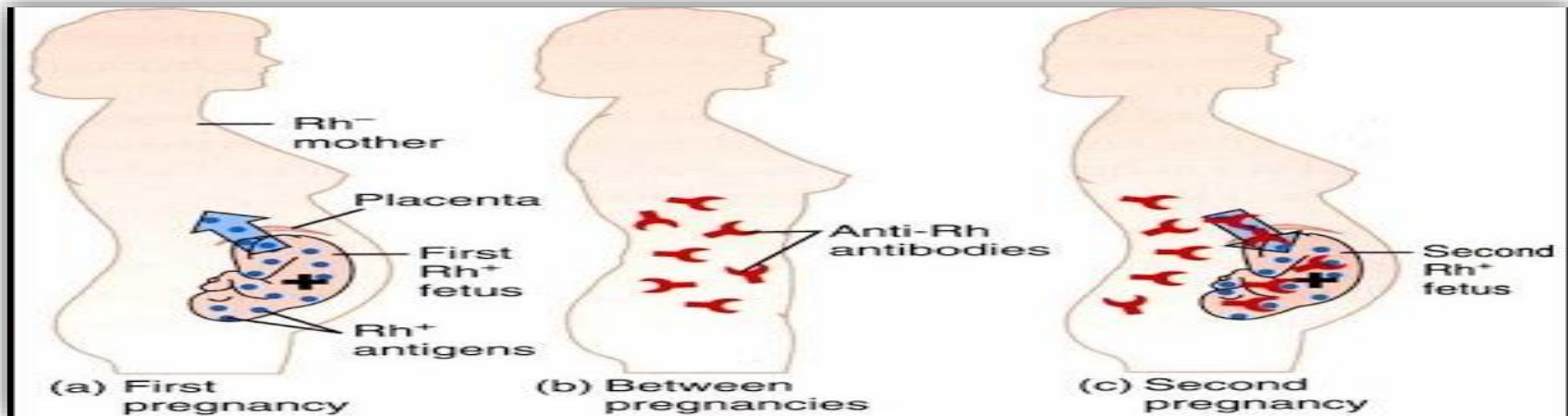
قبل وصولها إلى الـ Immune system للأم , بالتالي نقضي عليها قبل أن تتكون لها أجسام مضادة





Hemolytic disease of the newborn (erythroblastosis fetalis)

- **If sever** treated with exchange transfusion.
(replace the baby blood with Rh-ve RBCs several times)
- Can lead to **hydrops fetalis** (death in utero).
- **Prevention** : injecting the mother with **anti D antibody** immediately after 1st childbirth to prevent sensitization of mother to D antigen (**Antenatal prophylaxis**) - action taken to prevent disease during pregnancy -



Etiology

- **Exposure of the mother to the fetal RBC antigens.**
- **Production of antibodies against foreign antigens in maternal circulation.**
- **Maternal resensitization in the subsequent pregnancy.**
- **Free passage of antibodies through the placenta.**
- **Fetal red cell hemolysis.**

❖ Clinical Features :

- Anemia
- Jaundice
- Hepatosplenomegaly [What is it?](#)
- Generalized edema
- Immature RBC in circulation
- Kernicterus [what is it?](#)

❖ Treatment :

- Exchange transfusion
- Phototherapy
- Drugs

❖ Diagnosis :

- Rapidly rising Rh antibody level in the mother during pregnancy.
- Amniotic fluid showing high levels of bilirubin.
- +ve coombs test on fetal cord blood

Indications

- Blood loss as a whole or as a result of hemorrhage or a surgery.
- Disease.
- Anemias.

Test done before transfusion

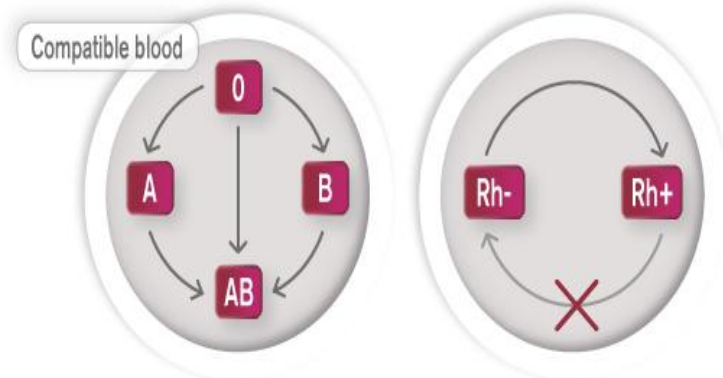
- ABO & Rh grouping of donor and recipient.
- cross-matching :
donor cells +recipients (patient)serum
- Screening of donor plasma.

People with blood group
“O” are called
(Universal donor)

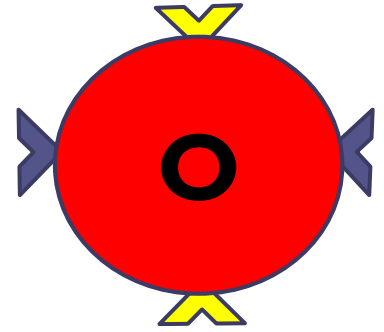
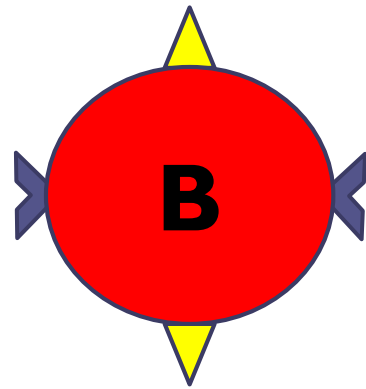
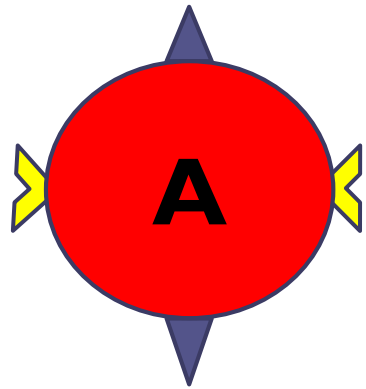
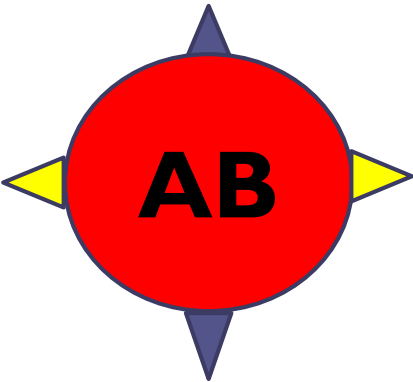
الفئة الكريمة





while people with blood group
“AB” are called
الفئة البخيلة

(Universal recipient)






























DONORS AND RECIPIENTS



-  Antigen B
-  Antigen A
-  Antibody B
-  Antibody A

Rh + → Can receive + or -
Rh - → Can only receive -

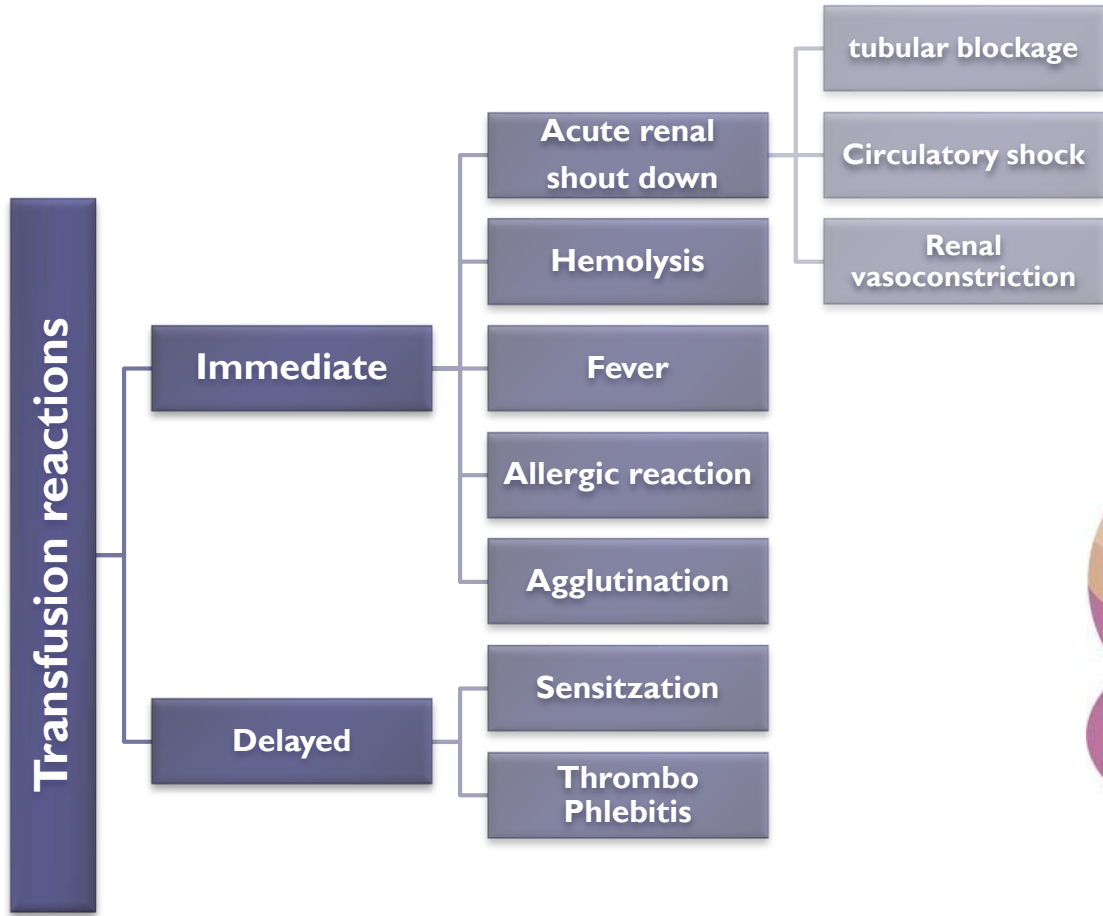
Donor

Type	O-	O+	B-	B+	A-	A+	AB-	AB+
AB+								
AB-								
A+								
A-								
B+								
B-								
O+								
O-								

Recipient

- ❖ **Immune reaction :**
incompatible blood transfusion leading to immediate or delayed reaction
(**fever, hemolysis, allergic reaction**).
- ❖ **Transmission of disease :**
(**malaria, syphilis, Aids, Viral hepatitis**).
- ❖ **Acute kidney failure**
(reaction to mismatched transfusions)
- ❖ **Iron overload due to multi-transfusion :**
In case of **sickle cell anemia & thalassemia**.

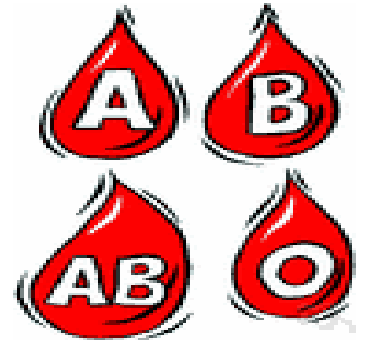
Complications of blood transfusion



Check your understanding !
[Quiz1](#) & [Quiz2](#)

Blood typing game :
[Click here](#)

Blood types (video) :
[click here](#)



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- خولة العماري
- الهتوف الجلعود
- إلهام الزهراني
- رغد النفيسة
- نورة القحطاني
- منيرة الحسيني
- منيرة السلولي
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