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Blood groups and transfusion

Objectives

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

1.Describe ABO blood groups types
2.Recognize Agglutinin in plasma
3.Recognize transfusion reactions
4.Describe Rhesus blood groups.
5. Describe causes of hemolytic disease of the newborn.

Blood groups

Determine by:

Antigens: (glycoprotein) on the surface of RBC

- Blood is typed (grouped) based on surface antigens RBC surfaces are marked by
- genetically determined antigens (Agglutinogens).

- The ABO and Rhesus (Rh) systems of antigens are of major clinical importance as they are associated with transfusion reactions when mismatched

The chief blood groups are: (Clinically most significant)
1–A-B-O System
2-Rh (Rhesus) System

What is the Importance of blood group?

Blood transfusion	Rh incompatibility between mother and fetus

Definitions

Agglutinogens

Blood group antigens on RBC membrane (A and B)

Agglutinin

The respective antibody to the antigen

Agglutination

Reaction between agglutinogen on RBC and the respective Ab.

agglutination in transfusion reaction :

If a patient of blood group A transfused with blood of group B The anti-B in plasma will agglutinate the transfused group B cells

Outcome:
– The clumped cells plug small blood vessels kidney shut down – Sometimes causes immediate hemolysis

A-B-O system

Antibodies

(in the plasma"serum"):
naturally occurring antibodies
-Anti-A and Anti-B Present
few months after birth
(appear 2-8/12 month)
-Triggered by A and B antigens in food or bacteria

Depends on whether the red cells contain one, both or neither of the two blood antigens:

A and B.
•there are four main ABO groups:
A, B, AB, O

A & B antigens

(on the surface of RBCs):
•They are genetically determined

•Appear in the early fetal life and remained unchanged throughout life

Rh Rhesus System

Rh factor D antigen-D:

Rhesus antigens:
Dd, Cc, Ee Clinically most important is D

Rh factor (antigen) was first discovered in blood of Rhesus monkey.
This protein is also present in the blood of some people.Other people, however, do not have the protein.
Rh factors only detectable on RBCs
Determined by:

- Presence or absence of the Rhesus antigen (D) on the surface of RBC

- RBCs with antigen-D = Rh+

- RBCs without antigen-D = Rh–

Rh Anti-D antibody agglutinin:

(explained more in the next slide)
Is not naturally-occurring

-Can be acquired by: Transfusion of Rh-ve individual with Rh+ve blood

-Rh-ve pregnancy with Rh+ve fetus

85% of caucasians, 95% of black Americans, 99% of chinese and nearly 100% of black Africans are Rh+

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

Genetic Determination of ABO Antigens

genotypes	Blood types	Agglutinogens
OO	O	-
OA or AA	A	A
OB or BB	B	B
AB	AB	A and B

Uses of genotypes

Sorting disputes in paternal dispute

Frequency of ABO has paternal dispute

❏ Two genes one maternal and one paternal in origin, one on each of the two paired chromosomes number 9, determine theO-A-B blood type.

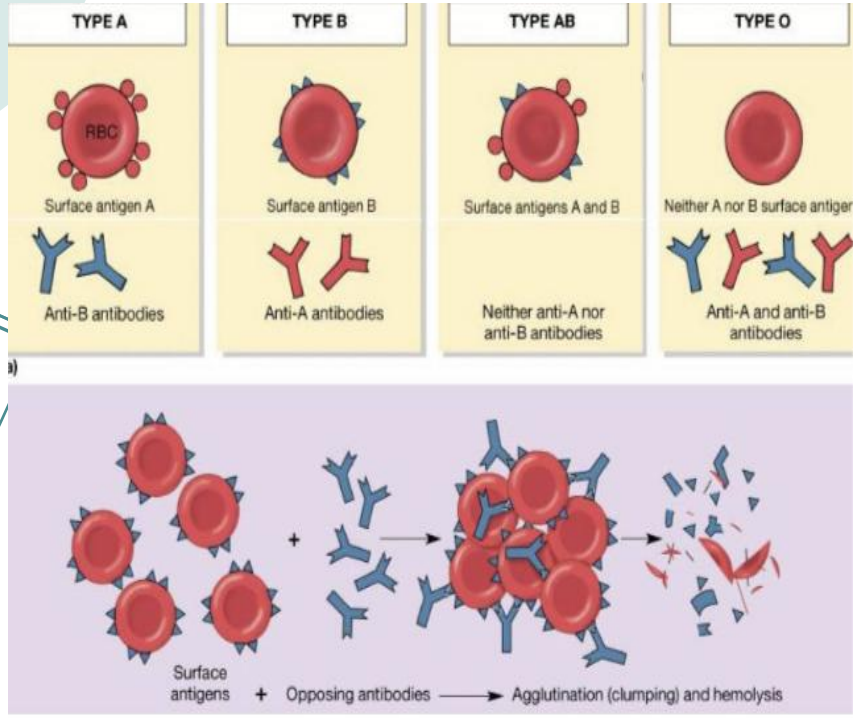
❏ These genes can be any one of three types but only one type on each of the two chromosomes number 9: type O,type A, or type B.

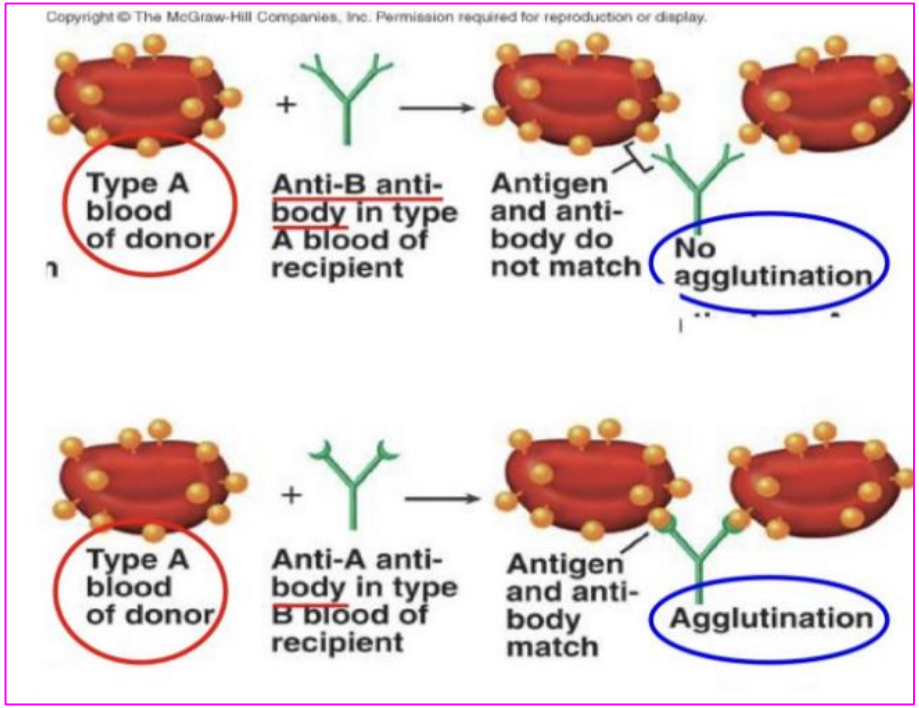
❏ The type O gene zero gens is either functionless or almost functionless, so that it causes no significant type O agglutinogen on the cells. Conversely, the type A and type B genes do cause strong agglutinogens on the cells.

❏ The type A and type B genes are co-dominant This meant that if a person inherited one type A gene and one type B gene, their red cells would possess both the A and B antigens

Agglutination reaction

This picture only found in females slides





Surface antigen + Opposting antibodies= Agglutination (clumping) & hemolysis

Rh Anti-D antibody (agglutinin):

Anti-Rh antibodies IgG : develop only in Rh-blood type and only with exposure to the antigen:
– transfusion of positive blood.
– during a pregnancy with a positive blood type fetus.

Anti-Rh antibodies are not spontaneously formed in Rh- individuals, However, in an Rh–individual receives Rh+blood, anti-Rh antibodies form Sensitization

Anti-Rh agglutinins develop slowly 2-4 months. Once produced they persist for years and can produce serious transfusion reaction during 2nd transfusion.

This immune response occurs to a much greater extent in some people than in others, With multiple exposures to the Rh factor, an Rh-negative person eventually becomes strongly sensitized to Rh factor.

This is just in girls slides

Paternity

- Blood types can’t be used to prove paternity.
- Blood types can disprove paternity

Doesn’t prove paternity 100%

Possible Blood group Genotypes :

Parent allele	A	B	O
A	AA	AB	AO
B	AB	BB	BO
B	AO	BO	OO

Examples on paternity

This is just in girls slides

A woman who has blood (type A) gives birth to a daughter blood (type B). The possible father is blood type O.
can he be the father?
No he can't

	A	O
O	AO	OO
O	AO	OO

Example : Nora blood type A and Ahmad blood type B Have a baby blood type O
Can Ahmed be the father?
YES HE CAN

Phenotype	Possible genotype
Noura:A	AA or AO
Ahmad:B	BB or BO
Baby:O	OO

Important slide

Blood Group	Agglutinogens (Antigens)	Agglutinins (Antibodies)	Can receive from	Can give to
A	A	Anti-B	O and A	A and AB
B	B	Anti-A	O and B	B and AB
AB	A and B	None	A,B,AB,O	AB
O	None	Anti-A + Anti-B	O	A,B,AB,O

AB is a Universal recipient because it has no Antibodies

O is a Universal donor because it has no antigens

An unconscious patient is admitted into the ER, he has lost so much blood what type of blood do we give him??

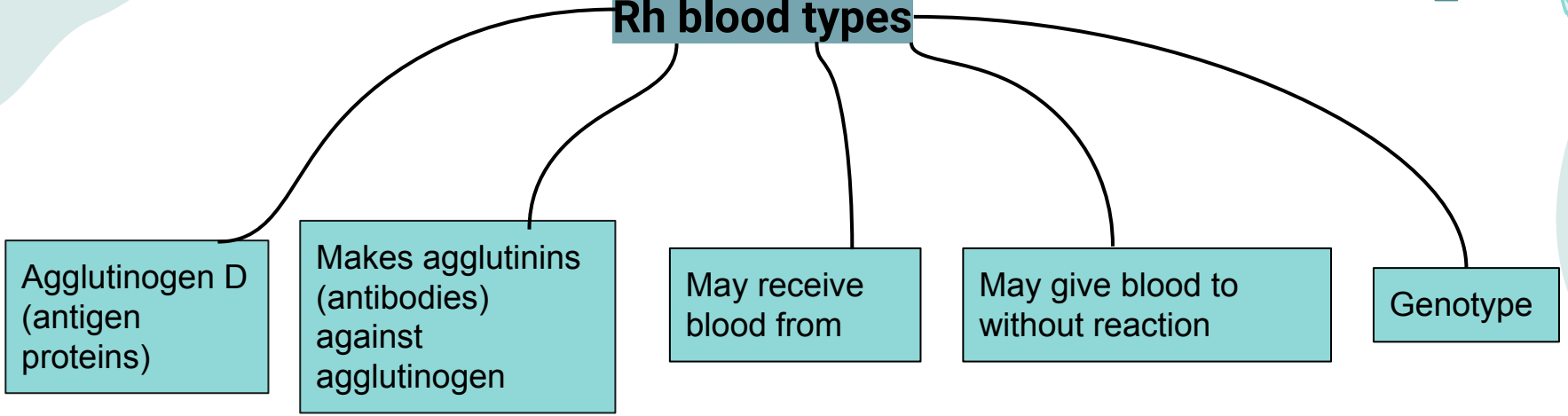
In emergency Blood group O, Rh negative can be given to A, B, or AB negative or positive, (O-) it's the ultimate universal donor. Antibody concentration may be high, so it may not be suitable if large volume of plasma is required.

Plasma compatibility table				
Recipient	Donor			
	O	A	B	AB
O	OK	OK	OK	OK
A		OK		OK
B			OK	OK
AB				OK

When considering a plasma transfusion, keep in mind that plasma carries the antibodies but no antigens. For example, you can't give Type O plasma to A, B, or AB, because the O's plasma has A and B Antibodies which would make the recipient have an immune response. But on the other hand an AB donor can give his plasma to anyone because it has no Antibodies.

This is just in boys slides

Rh blood types



Rh+	Present	No	Rh+ and Rh-	Rh+	DD or Dd
Rh-	absent	yes	Rh-	Rh- and Rh+	dd

1- Rh- only makes antibodies after exposure to Rh+ cells
2- Transfusion of Rh- individual with Rh+ blood results in production of anti-D agglutinins; sensitizers person to Rh factor may result in anaphylaxis (حساسية مفرطة) if exposed a second time, erythroblastosis develops when Rh- mother who had been exposed to Rh+ and is carrying an Rh+ fetus

Indications and complications of blood transfusion

Indications (boys slides)

- Acute hemorrhage
- Severe anemia (if Hb decreased below 7 g/dL)
- Erythroblastosis fetalis: if exchange transfusion is done
- To supply a necessary elements: platelets, packed RBCs, and some clotting factors

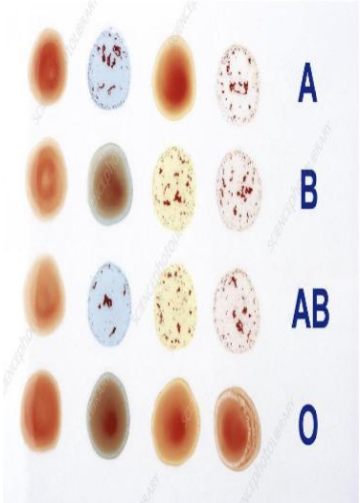
Complications (girls slides)

- Immune reaction: incompatible blood transfusion leading to immediate or delayed reaction, fever, haemolysis, allergic reaction
- Transmission of diseases (malaria, syphilis, viral hepatitis, AIDS).
- Acute kidney failure
- Iron overload due to multi-transfusion in case sickle cell anemia or thalassemia.

Requirements prior to blood transfusion

1- Identify blood group

Group	Anti-A	Anti-B
A	Agglutination	Nil
B	Nil	Agglutination
AB	Agglutination	Agglutination
O	Nil	Nil



2- Test for diseases

- Hepatitis B and C virus
- Antibody to HIV
- HIV Antigens
- Syphilis
- Cytomegalovirus

3- Cross matching

Donor cells + recipient's serum
Mixing of incompatible blood causes agglutination: Formation of antigen-antibody complex.
Leading to renal obstruction (shut down) and hemolysis.

Hemolytic Disease of Newborn

First pregnancy
A mother (Rh-ve) pregnant with her first (Rh+ve) child, The fetus' RBCs might cross to the mother's blood circulation during the pregnancy or mostly at the delivery, which will cause her to develop antibodies (IgGclass) against RhD antigen.
(The first baby will escapes safely)
But what will happen to the second?

Second pregnancy
The antibodies (IgG class) that was developed will now cause hemolysis of the fetal RBCs------> Anemia and jaundice
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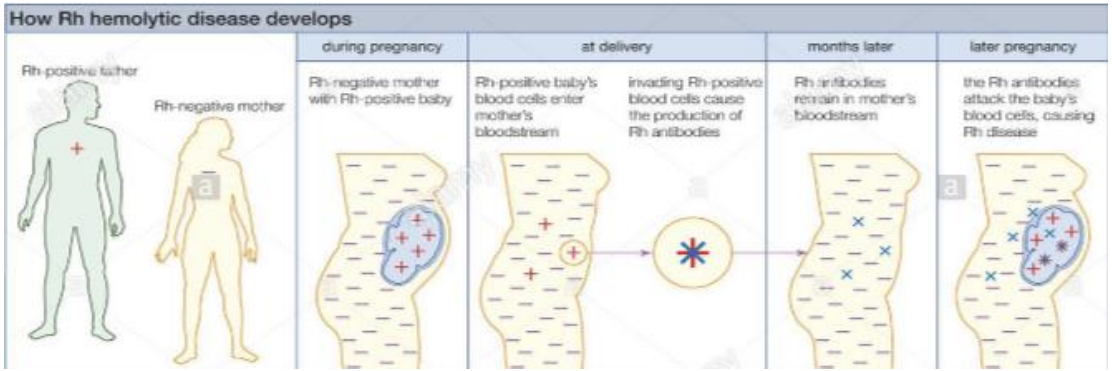


Hemolytic disease of newborns

Hemolytic anemia

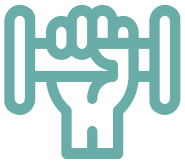
Treated with exchange transfusion, replace baby's blood with Rh-ve (several times).

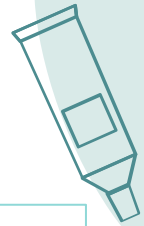
Kernicterus

(mental retardation due to bilirubin deposition in the brain). (bilirubin is a yellowish pigment that is made during normal breakdown of RBCs, Study more in path cellular accumulation).

Hydrops fetalis

Death in utero





Prevention: (prophylaxis)

- Injecting the mother with anti-D immediately after 1st childbirth (immunoglobulin)
- Antenatal (before birth, during pregnancy) prophylaxis (prophylaxis in medicine means to prevent something from happening, inhibits the formation of antibodies)

Rh immune globulin (RhIg) or Rhogam or anti-D:
- Shortly after each birth of a Rh+ baby the mother is given an injection of anti-Rh antibodies.
- These antibodies destroy any Rh+ fetal cells that got into the maternal circulation before the mother's body stimulates an active immune response.
- This treatment has reduced the incidence of the disease by 90%.

Treatment: phototherapy or exchange blood transfusion.

Fetal incompatibility:
Most anti-A or anti-B antibodies are of the igM class and these don't cross the placenta. ((macro) too big to go through the placenta, it can prevent the Rh+ slightly but it's not reliable) (Rh is IgG class).

- Thus, an Rh-/type O mother carrying an Rh+/type A, B or AB child, is resistant to sensitization to the Rh antigen.
- Her anti-A and anti-B antibodies destroy any fetal cells that enter her blood before they can stimulate anti-Rh antibodies in her

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