BLOOD GROUPS

Red: very important.
Green: only found in males' slides.
Purple: only found in females' slides.
Gray: notes.

Physiology Team 436 – Foundation block lecture 11

Lecture: If work is intended for initial studying.
Review: If work is intended for revision.

Objectives

- 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 System

- **Blood Groups are determined by: Antigens** on **the surface of RBCs.**

  Remember: Antigens can stimulate the immune system to produce antibodies.

- **Examples of antigens:**
  - [glycoproteins, complex oligosaccharides that differ in their terminal sugar.]

- About **20 blood group systems** are known:
  - [E.g. ABO System, Rh-System, MNS System, Kell System, Lewis System, Duffy, Lutheran, KIDD]

- **The two most common blood groups:**
  - ABO Blood group System.
  - Rh (Rhesus)Blood group System.

- **Karl Landsteiner** is an Austrian scientist that:
  - Discovered the ABO Blood group system in 1901
  - Discovered Rh factor in 1930 along with Alexander S. Wiener
  - Noble prize in Physiology/Medicine in 1930

ABO & Rh Blood group systems

ABO System

- **Depends on :** the presence of one or both or neither of the two blood antigens (A) and (B) on the surface of the RBC.
- Four main ABO groups: **A, B, AB, O**
- A and B blood groups are dominant over the O blood group.
- A and B group genes are co-dominant.

(Co-dominance: form of dominance in which the alleles of a gene pair in a heterozygote are fully expressed thereby resulting in offspring with a phenotype that is **neither dominant nor recessive)**

- Each person has two copies of genes coding for their ABO blood group (one maternal and one paternal in origin)
- Locus of alleles responsible for the ABO system is on the long arm of **chromosome9.**

Rh System

- **Depends on:** the 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)**

- Locus of alleles responsible for Rh Factor is on the long arm of **chromosome 1.**

Locus: a particular position or place where something occurs.

- They were named Rhesus antigens or Rh antigens because the same antigens are present in the Rhesus monkey.

Definitions

Agglutinogens

- **It is Blood group Antigens (on RBCs membrane) (A&B)**

Landsteiner Law (1900):

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

Agglutinin

- It is The respective antibody to antigen
- Or It is Antibodies in serum (In Plasma)
- Agglutinins are immunoglobulins (IgM & IgG): Proteins which appear in the plasma or body fluids in response to administration of antigens.

Agglutination

- **It is a Reaction** (clumping) **between Agglutinogens on RBC membrane and the respective AntiBody**
- **In transfusion reaction** If a person with blood group A was transfused with blood of group B which contains anti-A in plasma
- The anti-A in plasma of recipient with blood group B will agglutinate the transfused cell (A).
- The clumped cells plug (block) small blood vessels.
- Sometimes causes hemolysis.

Genetic Determination of Agglutinogens

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

These are genotypes (طراز جيني)

Genotype for each blood group:

A →AA ,AO
B →BB , BO
AB →AB
O →OO

Uses of genotypes:

- Sorting disputes in paternal dispute
- Frequency of ABO has ethnic variation

Agglutinin /Antibodies

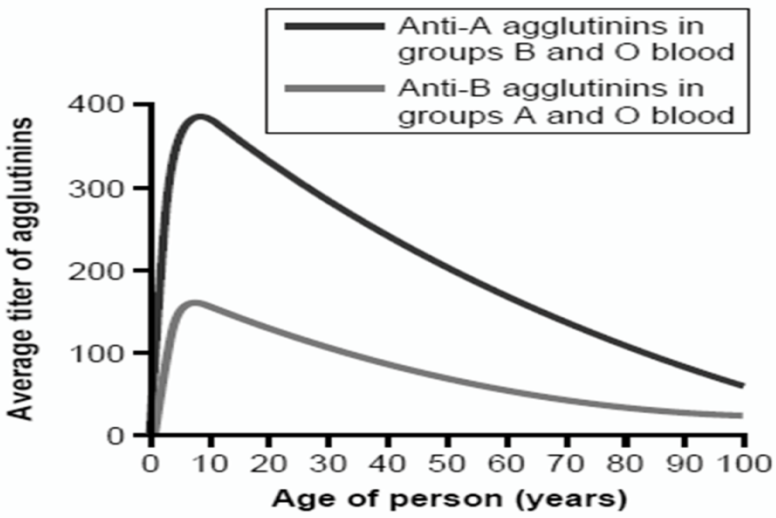
- **Examples of Agglutinins:**

Anti-A & Anti-B antibodies.	Anti-D antibodies.
• Naturally occurring antibodies. • Not present at birth, appear 2-8/12 weeks (2 to 8 months) after birth. • Triggered by A & B antigens in food and bacteria. • Are considered as IgM class.(large molecule) • Cannot cross placenta.	• **NOT** naturally-occurring antibodies. • **Acquired by:** • Transfusion of Rh-ve individual with Rh+ve blood. • Rh-ve pregnancy with Rh+ve faetus. • Are considered as IgG class. • Can cross placenta.

Example: if my blood type is B+, I will have antigen B and antigen D, and I will have anti A.

Agglutinin

Titer of Anti- A&B Agglutinins at Different Ages



- 2 to 8 **months** after birth, an infant begins to produce agglutinins.
- A maximum titer is usually reached at 8 to 10 **years** of age, and this gradually declines throughout the remaining years of life.

The Rh immune response

Formation of anti-Rh agglutinin:

Rh +ve blood → **Transfused for the first time** → Rh –ve person

Anti-Rh agglutinins develop slowly (2-4 months).
Once produced they persist for years and can produce serious reactions during 2nd transfusion. (so, it can only be done once).

Titer: the concentration of an antibody, as determined by finding the highest dilution at which it is still able to cause agglutination of the antigen.

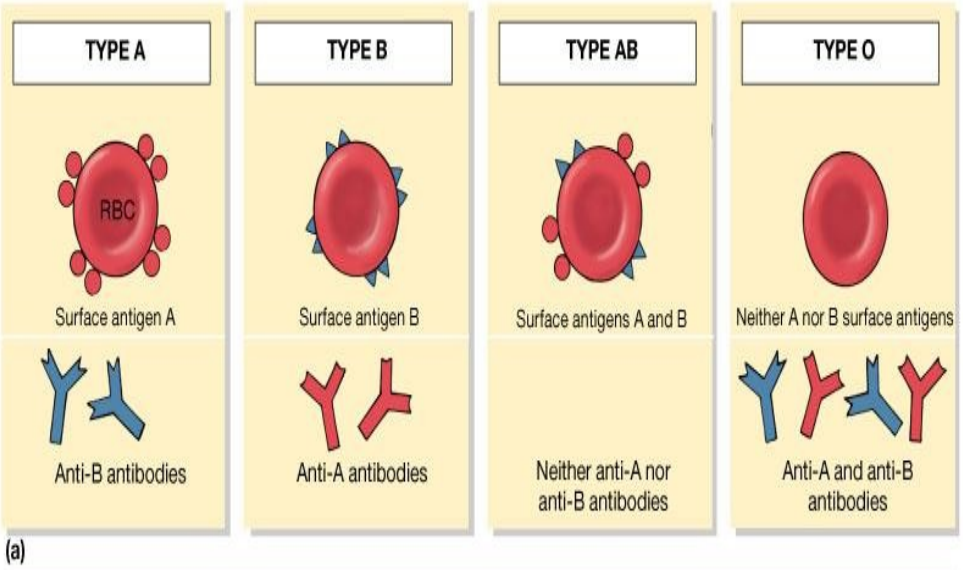
Comparing between Agglutinogens & Agglutinin

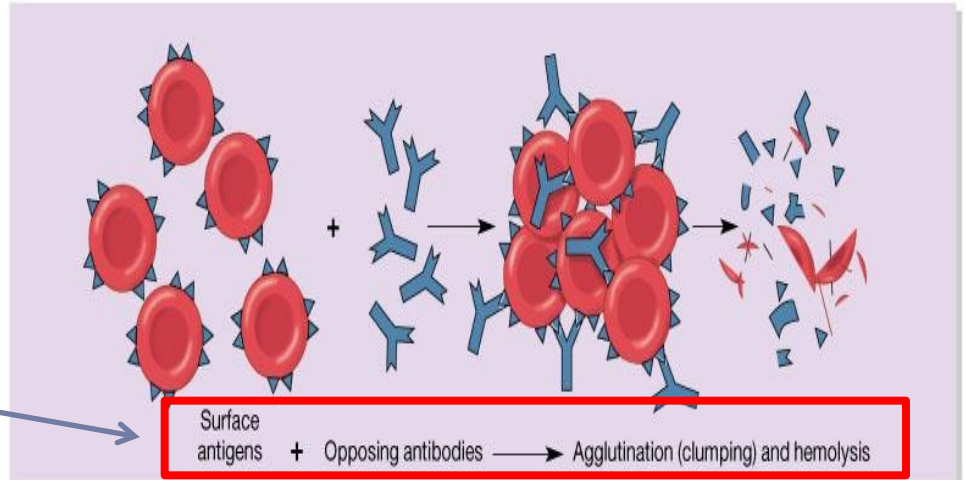
Blood Group	Agglutinogen (Antigen)	Agglutinin (Antibody)
A	A	Anti-B
B	B	Anti-A
AB	A & B	-
O	-	Anti A+Anti B

Example:
If a baby has blood group (antigen) A, and is infected with a bacteria with antigen A, nothing will happen.
If the baby is infected with bacteria with antigen B, so he will produce antibody Anti B.

Agglutination

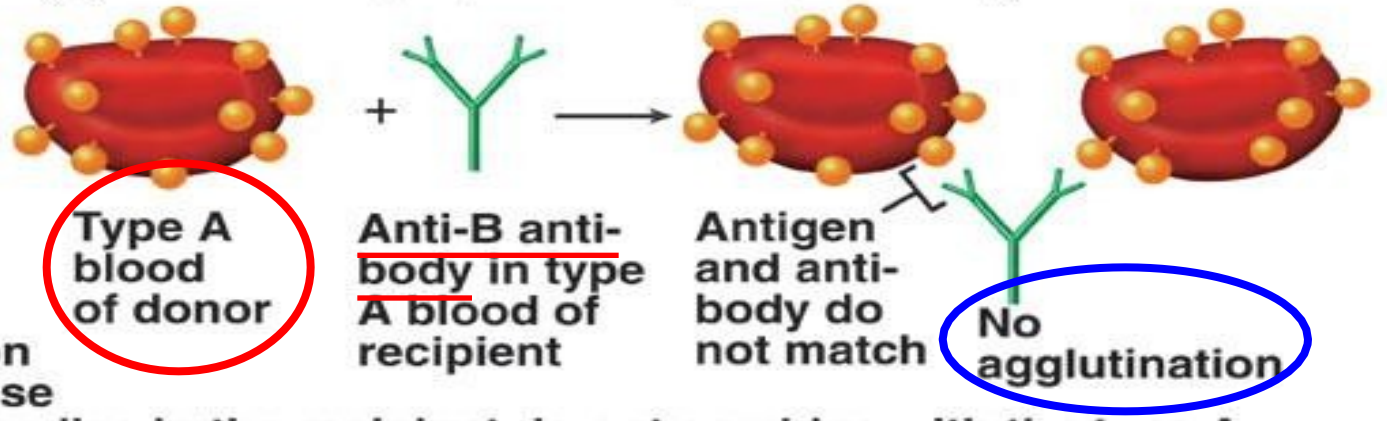
- If there is **agglutination** in the blood drop when Anti-A was used that means the patient's blood group is A.
- Also: Anti-B → **agglutination** → blood group B.
- If there is **agglutination** in the blood drop when we used both Anti-A and Anti-B that means the patient's blood group is AB.
- If 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.



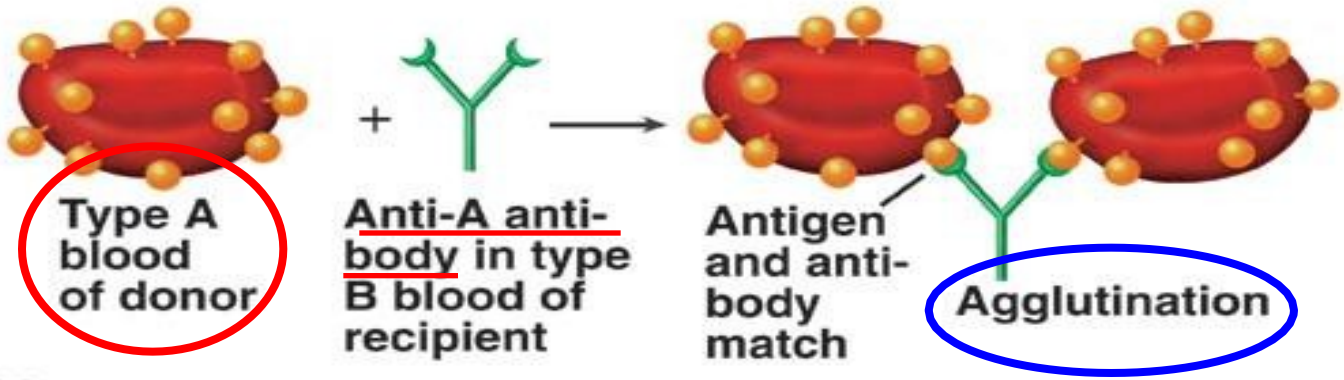


When the antigen and antibody are the same type, it can be dangerous and may lead to anemia.

Agglutination



(a) No agglutination reaction. Type A blood donated to a type A recipient does not cause an agglutination reaction because the anti-B antibodies in the recipient do not combine with the type A antigens on the red blood cells in the donated blood.



(b) Agglutination reaction. Type A blood donated to a type B recipient causes an agglutination reaction because the anti-A antibodies in the recipient combine with the type A antigens on the red blood cells in the donated blood

- Girls slide : circles from doctor

Importance of blood groups

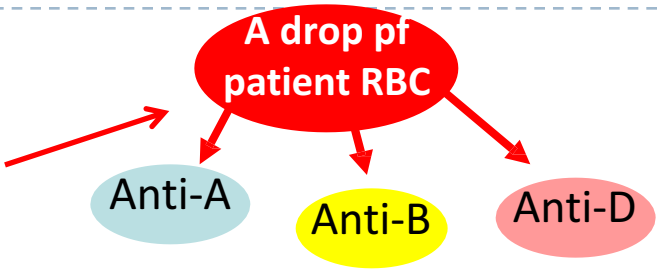
1. In blood transfusion.
2. In preventing hemolytic disease (Rh incompatibility between mother and fetus)
3. In paternity disputes (to determine the father)
4. In medicolegal cases (الجرائم)
5. In knowing susceptibility to disease:
   - Group O: duodenal cancer.
   - Group A: carcinoma of stomach, pancreas & salivary glands.

* Color just to make it clear for the next slides

1. Blood Transfusions (Donors and Recipients)

- Blood test before transfusion :
  - Blood group type of patient (recipient)

    (next slide)



  - Cross-matching : donor RBC + recipient's (patient) serum (plasma)

You Can Receive								
If Your Type Is	O-	O+	B-	B+	A-	A+	AB-	AB+
AB+	YES	YES	YES	YES	YES	YES	YES	YES
AB-	YES		YES		YES	YES		
A+	YES	YES			YES	YES		
A-	YES				YES			
B+	YES	YES	YES	YES				
B-	YES		YES					
O+	YES	YES						
O-	YES							

People with blood group O are called "universal donors"
people with blood group AB are called "universal recipients".

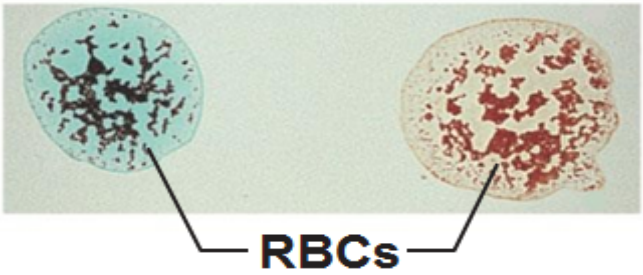
Blood group type of patient

serum

Blood being tested

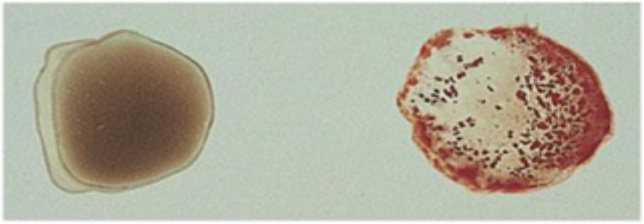
Anti-A **Anti-B**

Type AB (contains agglutinogens A and B; agglutinates with both serum)



Type A (contains agglutinogen A; agglutinates with anti-A)

Type B (contains agglutinogen B; agglutinates with anti-B)



Type O (contains no agglutinogens; does not agglutinate with either serum)

2. Complications of Blood Transfusions

1- **Immune reaction:** incompatible blood transfusions leading to immediate or delayed reaction, fever, hemolysis, allergic reaction. (appears within 10 to 15 minutes of transfusion)

2- **Transmission of diseases:** malaria, syphilis, viral hepatitis, and AIDs virus.

3- **Iron overload:** due to multi-transfusion in case of sickle cell anemia and thalassemia.

4- **Acute kidney failure:** (reaction to mismatched transfusions)

Hazards (Risks) of Mismatched Transfusions

- 2 Types:

Immediate:

- Agglutination
- Hemolysis
- Fever
- Allergic reaction
- Acute renal shutdown
- Renal vasoconstriction
- Circulatory shock
- Tubular blockage

Delayed:

- Sensitization
- Thrombophlebitis

3. Rh incompatibility between mother and fetus

- Mother is Rh –ve and the first baby is Rh +ve (has D antigen) :

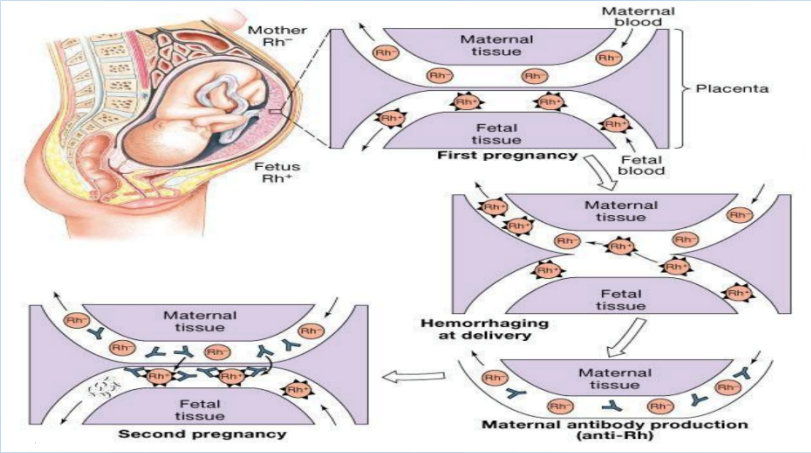
(father is +ve which is more dominant therefore : baby is +ve)

- **At delivery:**
  - Fetal Rh +ve RBC cross to maternal blood.
  - The mother will develop anti-D after delivery.
  - First child escapes & is safe.

If it was the opposite: mom is positive and baby is negative, nothing will happen.

If the mother was transfused before with Rh +ve blood before, the first child will be affected.

- **Second fetus (baby): Rh +ve**
- If Rh +ve: Antibody-D crosses placenta from mom to baby and destroys fetal Rh +ve RBCs.
- **Outcome:**
- Hemolytic disease of the newborn.



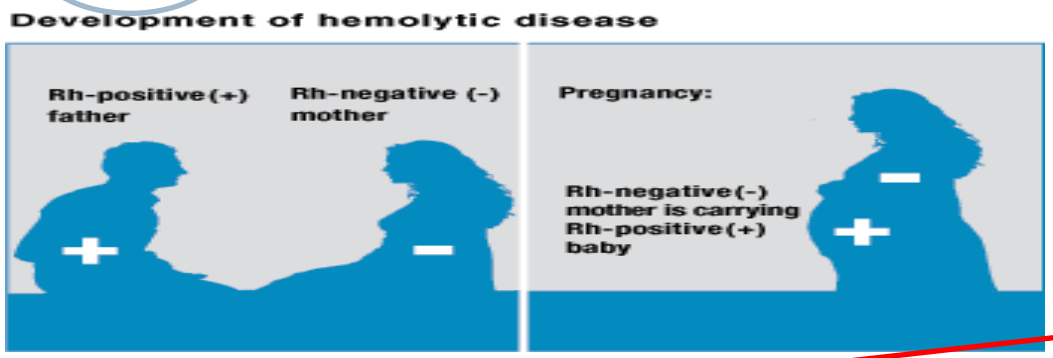
Extra explanation for the previous slide

الفكرة هنا ان بالولادة الأولى او بنقل الدم الأول للدم المختلف (+ و -) ما يصير شيء لأن الجسم ما قد تعرض لمثل هذا الاختلاف فما كون اجسام مضادة ، لكن بعد ما تعرض لها يكون اجسام مضادة وبكذا لما يتعرض لها من جديد يبدأ يحاربها ولهذا يمر الحمل الأول بسلاسة و الثاني أما يفشل او يسبب مشاكل للأم والطفل . (لأن جسم الأم كون اجسام مضادة)

2. Rh incompatibility between mother and fetus

الشريحة مجرد توضيح للي ما فهم السلايد رقم 17

1



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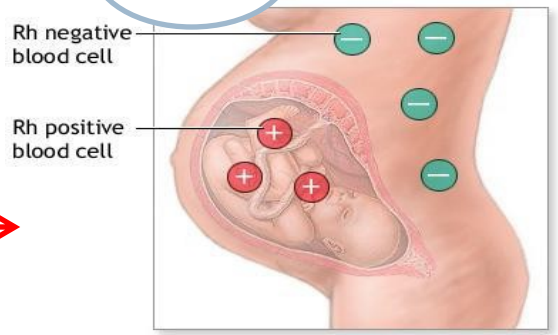

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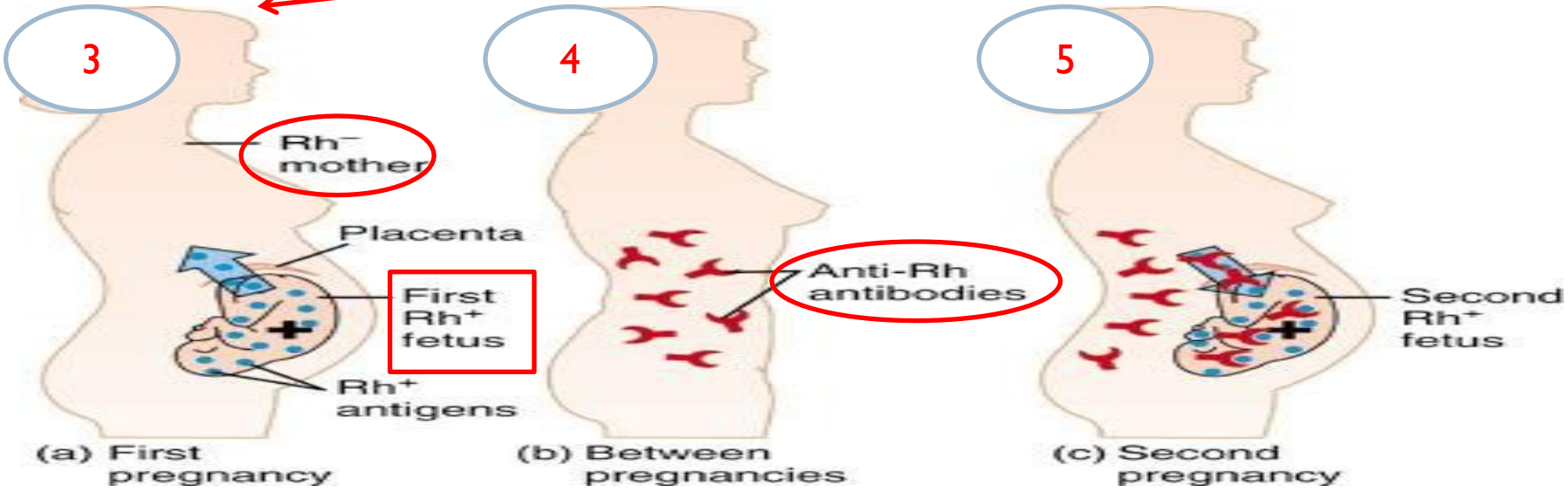
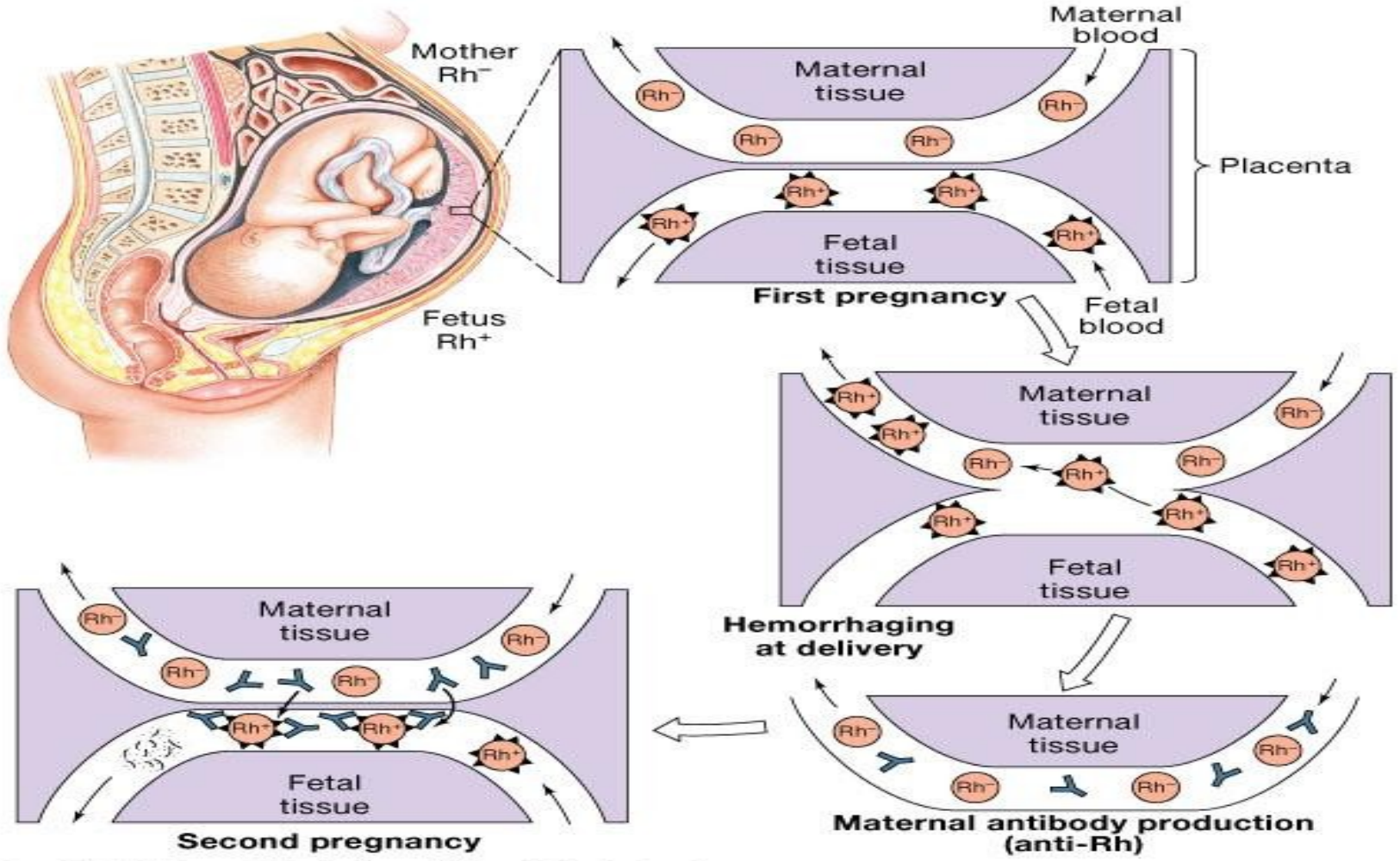


Result

الشريحة مجرد توضيح للي ما فهم السلايد رقم 17



Hemolytic disease of new born (Erythroblastosis fetalis)

1. **Hemolytic anemia:**

   If severe: is treated with exchange transfusion:

   Replace baby's blood with Rh –ve RBC (several times).

2. **Hydrops fetalis:** (death in utero)

3. **Kernicterus**

   Kernicterus : is a brain damage in newborn with sever jaundice (jaundice : caused by high level of bilirubin in baby's blood))

Prevalence of disease:
1st pregnancy: 0%
2nd pregnancy: 3%
3rd pregnancy: 10%

Prevention:

After 1st childbirth : Injecting the mother with antibody-D immediately after 1st childbirth.

Antenatal (during pregnancy) : prophylaxis.

3. Paternity (to determine the father)

Blood groups cant be used to prove paternity, but can be used to disprove it.

Question 1:

Nora: blood type A and Ahmad: blood type B
Have a baby: blood type O. Can Ahmad be the father?

Phenotype	Possible genotypes
A	AA or AO
B	BB or BO
O	OO

Answer 1:

Ahmad **can** be the father, but not 100% sure

Red : what we are sure about from question Blue: we solved		Mother	
		A	O
Father	B		
	O		Baby OO

Answer 2:

The father can NOT be type O. Here we disproved paternity.

Red : what we are sure about from the question		Mother	
		A	O or A
Father	O		
	O		Baby B O/B

Question 2:

Mother: blood type A Daughter: blood type B
Can the father be blood type O?

Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمعة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

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