# HLS Physio-sheet #5
# ABO And Rh systems
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**correction link: [bit.ly/hlsphysio](bit.ly/hlsphysio)**

All sheet notes begin and end with star(*). I have rearrange some paragraph to make it easier to understand.

## ABO system

The ABO System Discovered in 1901 by Dr. Karl Landsteiner

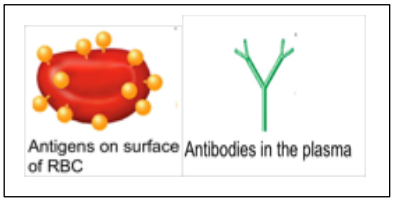
Landsteiner found that mixing blood from two individuals can lead to blood clumping. The clumped RBCs can hemolyzed and cause toxic reactions. This can be fatal. He discovered that blood clumping was an immunological reaction which occurs when the receiver of a blood transfusion has antibodies against the donor blood cells. For this discovery he was awarded the Nobel Prize in Physiology or Medicine in 1930.

The ABO and Rh systems are the most important ones and must be considered in blood transfusions.

Mixing incompatible blood groups leads to blood clumping or agglutination, which is dangerous for individuals.

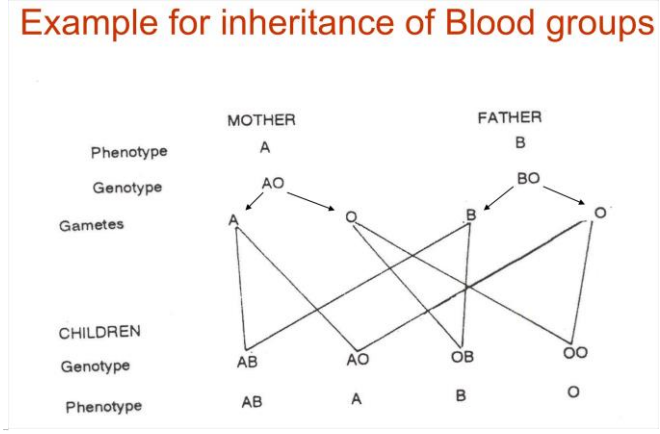
There are 30 common blood group systems -subgroup- (genetically determined) and hundreds rare groups known today. Most of them are weak and are practically not important, *because they don't have that much affect and complications when we make transfusion as ABO or Rh effects*

The differences in human blood are due to the presence or absence of certain protein molecules called antigens (agglutinogens) which is located on the surface of RBCs and antibodies (agglutinins) which is located in the plasma. Individuals have different types and combinations of these antigens and antibodies. The blood group you belong to depends on what you have inherited from your parents.




We have two types of antigens on RBC: 1) A antigen 2) B antigen
There are three gens that effect the expression of these antigens: A, B and O genes which found in pair 9 chromosomes. Any presence of A or B gens lead to expression of their antigens and O gene is functionless. This will lead to 6 possible combinations (genotypes) and four groups
1. AA……..group A 2. AO……..group A 3. AB……..group AB.
4. BB……..group B 5. BO……..group B 6. OO……group O.

Relative frequencies in population of the different blood types O 47% A 41% B 9% AB 3%



Agglutinins (antibodies) Found in plasma, they are mostly of IgM type (gamma globulin)

#**Landsteiner's Law** (for ABO system ) States that if an antigen is absent, the corresponding antibody is present. Conversely, if an antigen is present on the surface of the RBC, the corresponding antibody is absent in the plasma.
*Group O is universal donor, and group AB is universal acceptor.

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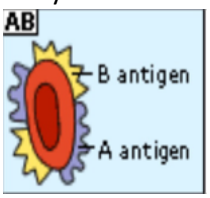
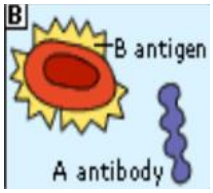
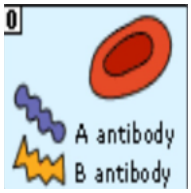
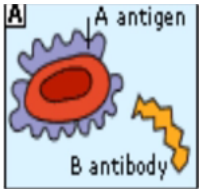
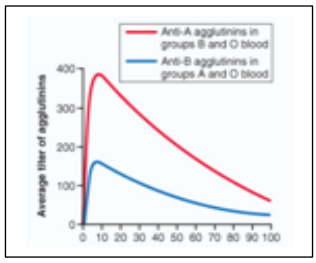
|---|---|---|---|
| Blood group (AB) have both A&B antigens and no anti body   | Blood group (B) have B antigens and A antibodies   | Blood group (O) have no antigens and both A&b antibodies   | Blood group (A) have A antigens and B antibodies.   |

*The antibody and the antigen for same group cannot be together because if they become together there will be a transfusion reaction( explained later).*

## Origin and Development of Agglutinins

At birth there is no agglutinins (antibodies) in the plasma, The antibodies are developed in response to antigens A and B in food and bacteria (these antigens will enter our body). Infants rapidly develop antibodies against the antigens not present in their own cells.
At 2-8 months of age the titer of antibodies starts to increase
Maximal antibodies is found at age 8-10 years of age.
After age 10, the titer is decreased progressively with age

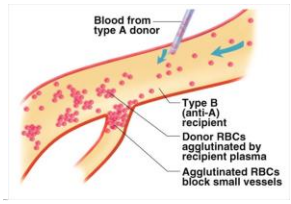


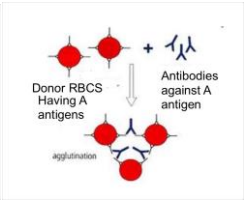

*A student ask a good question: why the body cannot produce antibodies to his own antigens while he can do this to any foreign one? Doctor didn't answer so hear is a one from google: Antibodies that recognize our own antigens are actually generated. However, selection processes early in the developmental pathways for immune cells eliminate those cells that react strongly with self-antigens. immature B cells (which produce the plasma cells and the last one produce the antibodies) that bind strongly to self-antigens expressed on tissues are signaled to commit suicide by apoptosis, removing them from the population. Any problem with this can lead to immunological disease.
I think this explains way some antibodies that products to attack foreign bodies, attack body own tissues because of the similarity between the antigen on the foreign bodies and the antigens on body tissues (I write "I think" because I am not sure about this information.)*

## Transfusion of mismatched blood (transfusion reaction)

If blood group A is given to a person whose blood group is B, donor RBCs will be attacked by antibodies (anti A agglutinin) which are already present in the recipient blood. The donor RBCs agglutinate (forming a mass). This can cause:
1-Agglutination of donor RBCs (which can block small blood vessels) followed by delayed hemolysis (resulted from phagocytosis of agglutinated RBCs by macrophages).
2-Immediate hemolysis of donor RBCs (occurs if the titer of the antibodies (of IgM type) is high and if complements system is activated).
Consequences (outcome) of hemolysis of RBCs followed transfusion reaction:
1.The hemolyzed RBCs will liberate Hb which is eventually converted to bilirubin. If bilirubin level is increased jaundice will develop * a medical condition with yellowing of the skin or whites of the eyes, arising from excess of the pigment bilirubin and typically caused by obstruction of the bile duct, by liver disease, or by excessive breakdown of red blood cells*.
2. A possibility of acute renal shutdown (renal failure). This occurs in large hemolysis. There is three mechanisms for developing renal failure:
A) Some of liberated Hb can be carried by plasma protein called haptoglobin. If haptoglobin is saturated, the free Hb filtered through glomerular membrane and precipitates in renal tubules closing them and causing renal failure.
B) Release of toxic substances from hemolyzed RBCS. These substances cause vasoconstriction in renal vessels and less filtration and less urine production.

C) Large hemolysis causes circulatory shock and a decrease in blood pressure and this leads to less urine formation.



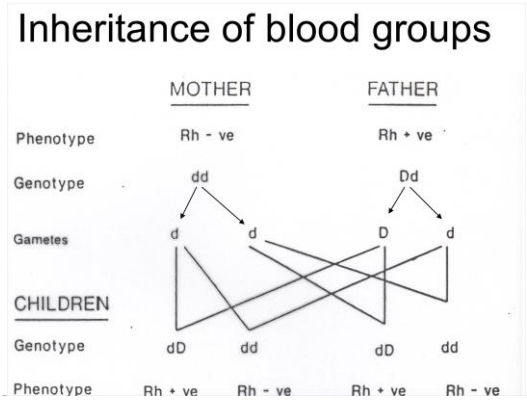

*We gave perfusion very slowly and keep seeing if their is any reaction will happen. Not because only miss matched in ABO system but also sub-group can also have some complications.*

*Before we give patients blood we do cross match by mixing donor and recipient blood, then if clot happen, their is mismatching. **(this will not exclude all possible transfusion reactions, as we will se later Rh antibodies need long time to produced)*

*The main and the most common manifestation of mismatched transfusion is renal shutdown. Most of the time it will be acute (for a period of time) but it can be a chronic (continues) shutdown

## Rh factor blood grouping system

Discovered in 1940 after work on Rhesus monkeys (the reason for the name) • Antigens – C,D,E (only in RBCs) *(there is also “c” and “e” lowercase antigen but they are rare and usually common in Africa, so we will study only D antigen)* **(there is no “d” lowercase antigen and it refers to absence of D antigen)** . D is the most antigenic component. Rh positive individuals have agglutinogen D and Rh negative persons have no D antigen. All people have no antibodies against antigen D in the plasma as Rh- people did not receive a blood from Rh+ one. A person with Rh+ blood can receive blood from a person with Rh- blood without any problems. The majority of people have Rh+ blood

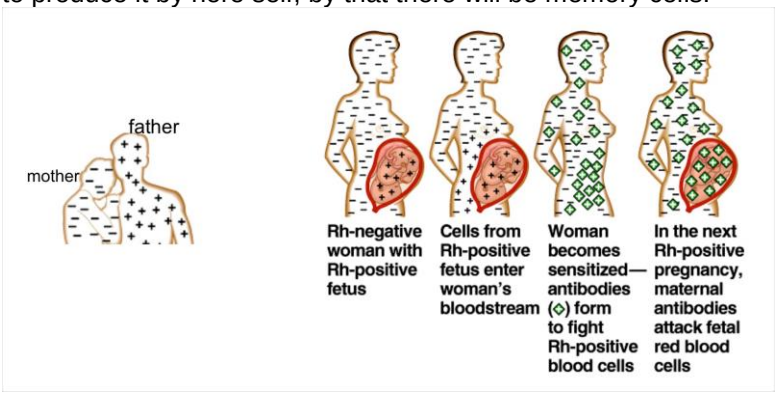



**The Characteristics of transfusion reaction due to Rh factor**

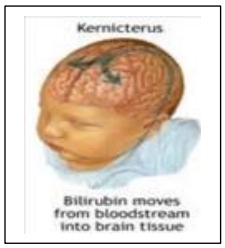
It is possible in Rh- person only If Rh- person is injected by Rh+ RBCs, the body produces antibodies against Rh factor in 2-8 weeks. If these antibodies are in sufficient amount they can cause agglutination of donor RBCs. If that Rh- person (who developed antibodies from previous transfusion) receives Rh+ RBCs, a strong transfusion reaction occurs (between antibodies in the plasma and transfused RBCs) causing agglutination of these cells and subsequent hemolysis. *( here we can give rise to two questions: 1. Why it is need too long time to develop the antibodies (2-8 weeks)? 2. Why if he receive Rh+ blood for the second time that will lead to strong transfusion reaction? The answer will be after the following paragraph)*

Problems associated with Rh antibodies in pregnancy (erythroblastosis fetalis): *if Rh- woman have an Rh+ fetus, there will be no problem in the first pregnancy, but after deliver baby, some blood from the placenta will go to the mother. After that mother will produce antibodies for antigen D at fetus blood. Then when the mother have a 2nd Rh+ child. The possibility of reaction is increased with successive pregnancies. Rh antibodies can cross placenta and attack fetal blood causing severe anemia (agglutination and hemolysis of the fetal RH+ RBCs).
** as we shall understand from the previous paragraph, the second fetus develop erythroblastosis fetalis, because mother now have antibodies for Rh+ RBCs of the fetus, That means if mother has a past Rh+ blood transfusion, even the first

fetus could have erythroblastosis fetalis. So doctor should see if mother's blood have D antibodies even in the first pregnancy.
Now here is an interesting information, doctor can save fetus if he gave the mother Rh immune globulin injection before and after deliver (if mother does not start to produce D antibodies), and Rh immune globulin injection mainly made of D antibodies!. The explanation of the that answer the first two questions. As we said before, normally, people do not have D antibodies in plasma, so when we get D antigens in our blood, so acquired immune system is the responsible to produce them (B cells—>memory cells+(plasma cells —> antibodies)) And this need a lot of time (2-8 weeks). So now D type transfusion reaction will be fast as the one in the ABO system (means the second time will have strong transfusion reaction). This answer the first two questions. Now why we give the mother D antibodies? Simply because we don't want to produce it by here self, by that there will be memory cells.**




### Clinical picture of erythroblastosis fetalis:




1. Hemolysis of RBCs leading to anemia and jaundice. Jaundice could lead to KERNICTERUS (bilirubin crosses blood brain barrier and deposited in motor areas of the brain causing permanent motor and mental abnormalities).
2. Because of loss of RBCs, the process of hematopoiesis is greatly accelerated (in attempt to replace the hemolyzed RBCs) leading to: a. appearance of erythroblasts in blood b. liver and spleen regain their ability to produce RBCs and their size increases (hepatomegaly and splenomegaly).

## Transplantation of tissues or organs

Every cell in our body has it's antigenic properties. If tissue or organ from one person is transplanted in other person, the transplanted tissue or organ will be rejected.
Types of transplanted tissues:
**1.Autograft:** tissue from a person is transplanted into the same person. The chance of rejection is zero. Both recipient and donor have same antigens
**2.Isograft**: tissue from one identical twin is transplanted to other identical twin. The chance of rejection is zero. Both recipient and donor have same antigens
**3.Allograft:** tissue from one person to another. If proper matching is done the chance of graft survival is high (*tissue typing-HLA complex of antigens).
**4.Xenograft**: From animal to human (E.g: when we transplant a valves from pig to human)

### Tissue typing- HLA complex of antigens:

Cell membrane of all body cells has complex called human leukocyte antigens (HLA). There are six of these HLA found in the cell membrane and are responsible for graft rejection.

Matching of these HLA between the recipient and donor is important for successful transplant.

The HLA are screened in T lymphocytes because these lymphocytes are responsible for attacking and destroying the transplanted tissues.

*It is hard to have the same HLA in two person, so 30%-50% matching is acceptable, they also gave these patients immune suppressors but by that they can easy get infections.*