Blood Groups: ABO, Rh Factor, MN, Golden Blood

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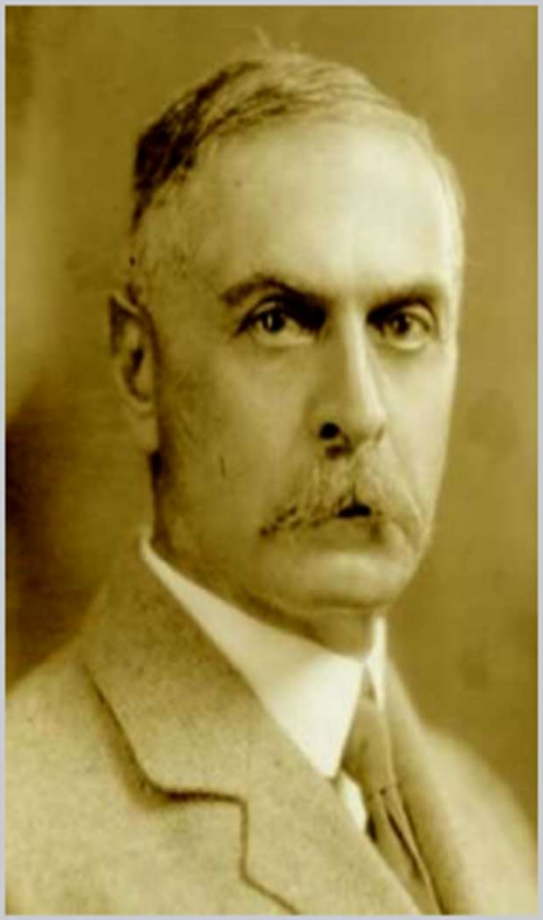
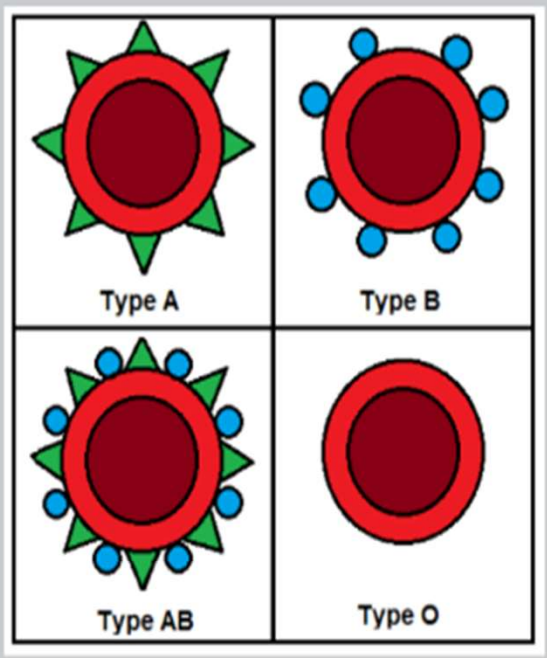
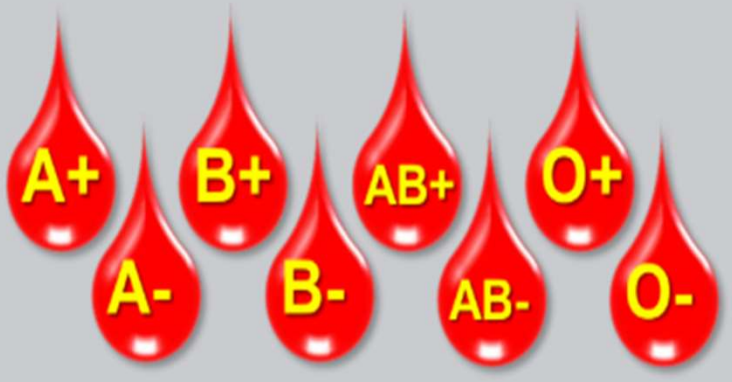
Blood Grouping





Rh+ Rh-



- Blood groups were discovered by Carl Land Steiner.
- It includes ABO grouping & Rh Grouping.

You might be familiar with the blood groups. Every individual belongs to a specific blood groups, which might be either A, B, AB, or O. The identification of blood groups depends on the presence of antigen and antibody on the surface of RBC. Agglutination test is used to determine a person's blood group. The process of determining one's blood group is referred to as blood group typing. Blood groups refer to blood systems that contain red blood cell (RBC) antigens. RBCs are used to determine blood types. A recent study published on June 30, 2021, the International Society of Blood Transfusion (ISBT) has identified a grand total of 43 distinct blood types throughout the human population (ISBTweb.org). Blood group information serves several functions, such as helping the study of genetic relationships between populations and migration, as well as examining population traits and diversity. There are two major blood groups system are ABO and Rh.

Blood group typing is determined by the process of agglutination, which occurs when red blood cells (RBCs) carrying certain antigens (such as A, B, AB, or Rh (D)) interact with associated antibodies (such as anti-A, anti-B, anti-AB, anti Rh (D)) present in the plasma. This process serves as an indication of the interaction between the antigen and the antibody. The clumping of red blood cells indicates the presence of the matching blood group. Each individual contains a unique antigen and antibody that are exclusive to their blood group. Antigens are chemicals that elicit an immune response. Antigens, which are encoded by genes located on autosomes or sex chromosomes (X or Y), are naturally occurring polysaccharides or proteins found in blood types. A plasma cell, a specialized B lymphocyte, produces antibodies as proteins in response to an immunological response induced by an antigen.

ABO Blood Group System

Karl Landsteiner first recognized the ABO blood group system in 1901, which includes the A, B, and O blood types. Subsequently, in 1902, de Castello and Steini also identified the AB blood group. Karl Landsteiner has given the nomenclature for identification of the A, B, and O blood groups within the ABO blood group system. He received the Nobel Prize in Physiology or Medicine for his excellent discovery in 1930. The ABO system gene is located on chromosome 9. However, there are four distinct blood groups in the blood system: A, B, AB, and O. The blood groups are classified based on the presence or absence of specific antigens and antibodies. Blood is composed of two main components: antigens and antibodies. Antigens are present on red blood cells, while antibodies are found in blood plasma. Groups A and B are used to label antigens, whereas anti-A and anti-B are used to label antibodies (Fig. 8.7).

An individual classified as a member of Group A exhibits the presence of antigen A and antibody anti-B. Group B individuals are characterised by the presence of antigen B and anti-A antibodies. Individuals belonging to Group O possess both antibodies and lack any antigen, while individuals in Group AB possess both antigens but lack any antibodies.

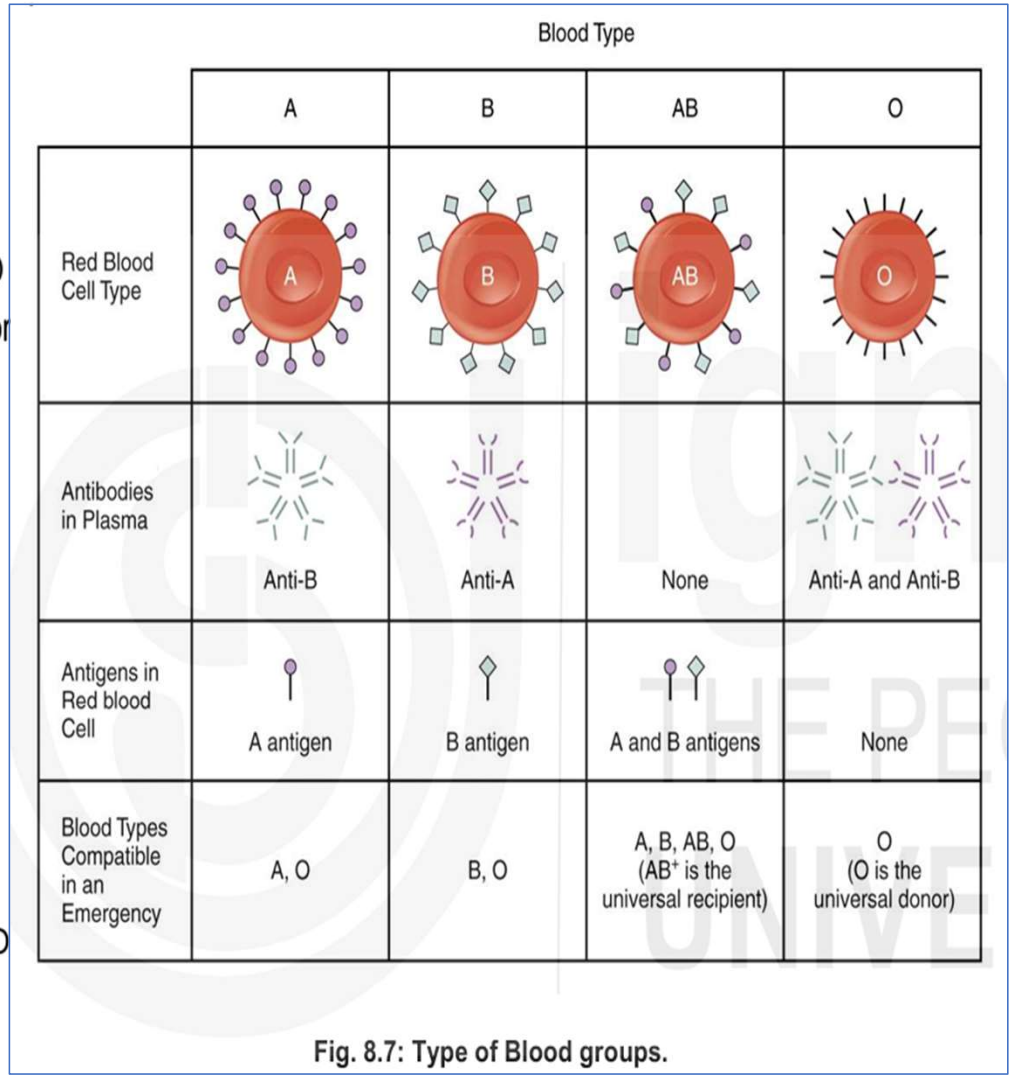
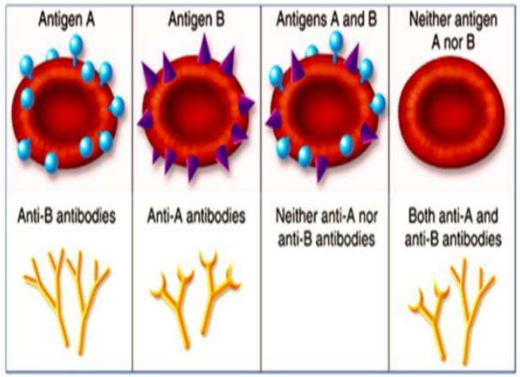


Fig. 8.7: Type of Blood groups.

Blood Grouping

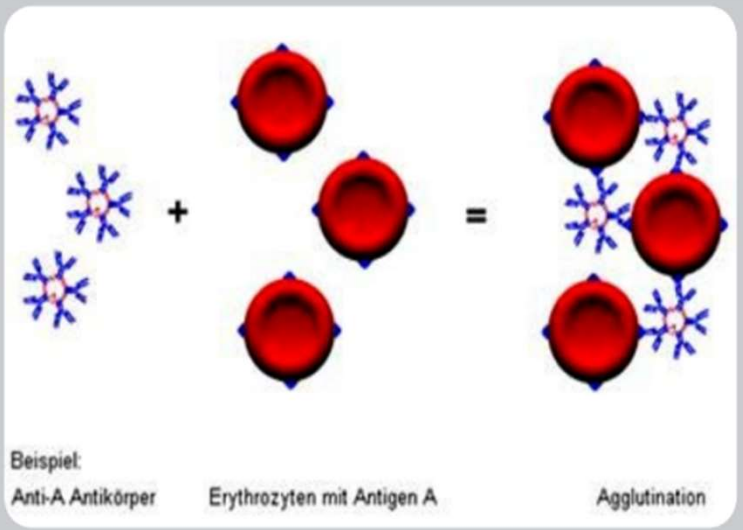
1. ABO grouping



- It is based on presence or absence of 2 surface antigens (chemicals that induce immune response) on RBCs namely A & B.
- Similarly, plasma contains 2 antibodies (proteins produced in response to antigens) namely anti-A & anti-B.

ABO Blood Grouping

Blood group	Antigens on RBC	Antibodies in plasma	Can donate blood to	Can receive blood from (Donor's group)
A	A	Anti-B	A and AB	A, O
B	B	Anti-A	B and AB	B, O
AB	A, B	Nil	AB only	A, B, AB & O
O	Nil	Anti-A & Anti-B	A, B, AB & O	O only



- Antigen A reacts with anti-A.
- Antigen B reacts with anti-B.
- Mixing of bloods with interactive antigens & antibodies causes clumping (agglutination) of RBCs.

O-group: Universal Donor

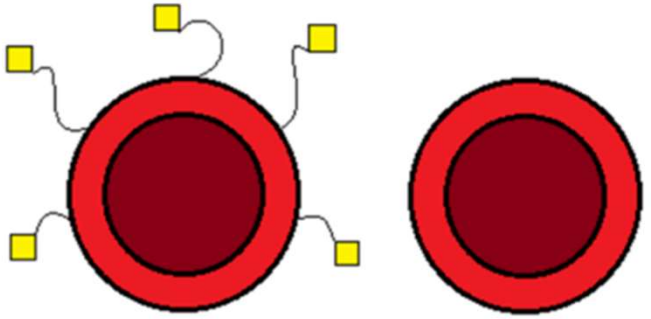
AB-group: Universal Recipient

- O group persons are called Universal donors as they can donate blood to persons with any blood group.
- AB group persons are called Universal recipients because they can accept blood from all groups.

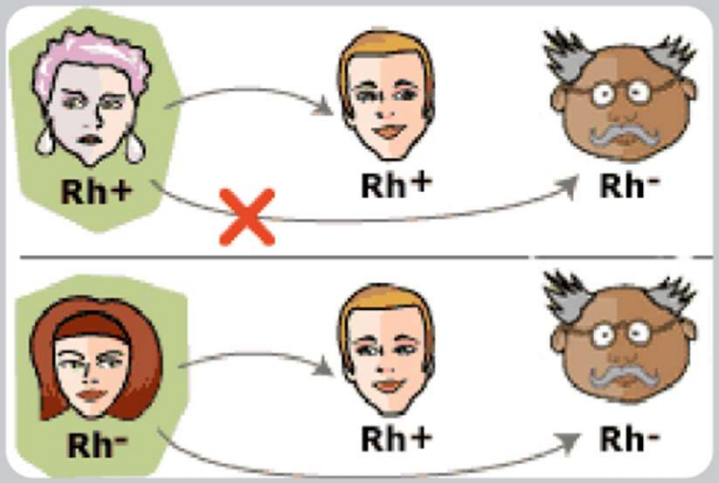
Rh Blood Group

There is another Rh blood group which is characterised by the presence of D antigen on the RBC surface. It is the second blood group after the ABO blood group system. In 1940, Landsteiner and Wiener discovered the Rh factor in Rhesus monkey. The person who have D Rh antigen on RBC surface know as Rh positive (Rh^+) and those who lack it are Rh negative (Rh^-). The Rh gene encodes the Rh protein (D antigen). This specific blood group causes hemolytic conditions due to erythroblastosis fetalis. The plasma of a mother with a Rh-negative blood type produces IgG antibodies, which are responsible for the Rh D antigen. During the labor process, the antibodies enter the fetus via the placenta, causing hemolysis, which then leads to anemia and finally the fetus' death.

2. Rh grouping

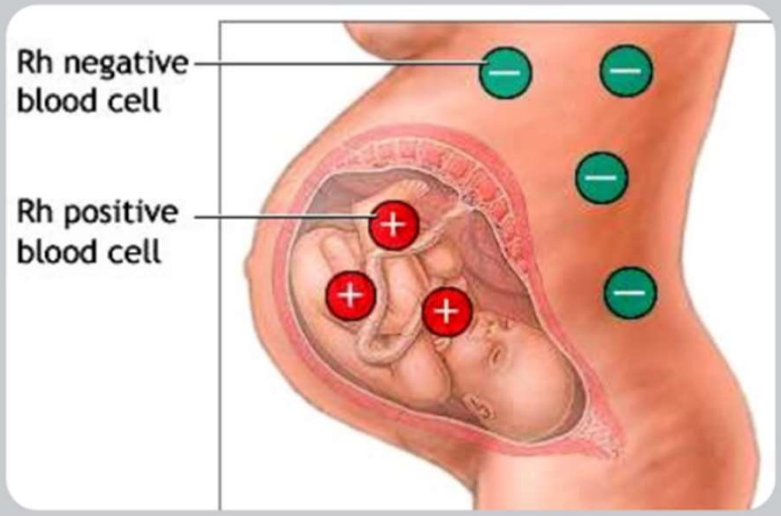


- **Rhesus (Rh) factor** is an antigen found on RBC.
- **Rh+ve** means the presence of Rh factor and **Rh-ve** means absence of Rh factor.
- Nearly **80%** of humans are Rh+ve.

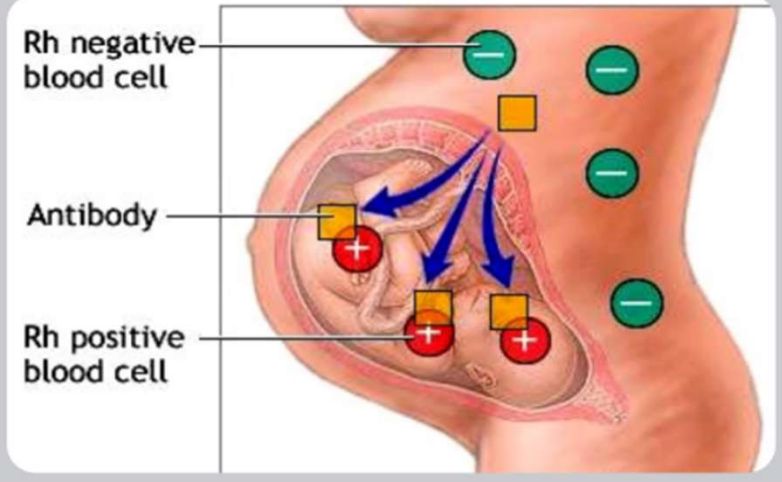


- **Anti-Rh antibodies** are not naturally found. So Rh-ve person can receive Rh+ve blood only once but it causes the development of anti-Rh antibodies in his blood. So a second transfusion of Rh+ve blood causes ***agglutination.***
- Therefore, Rh-group should be matched before transfusion.

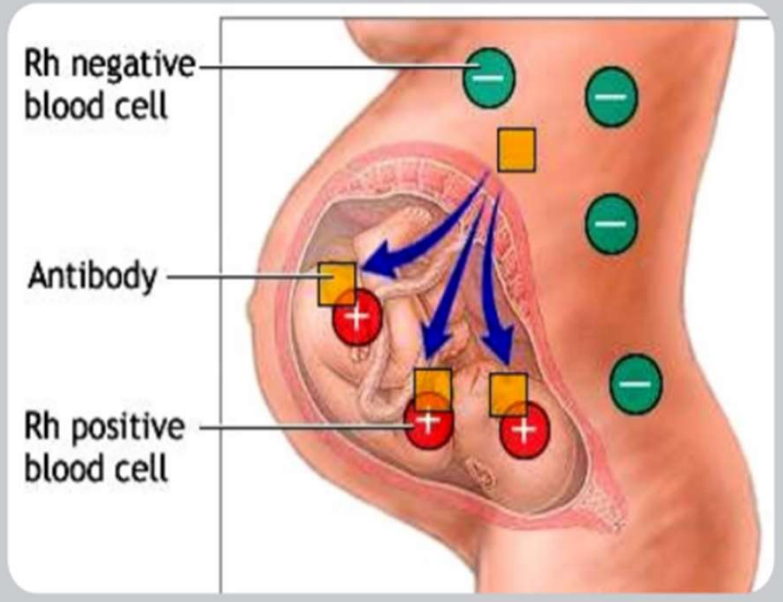
Erythroblastosis foetalis



- It is an **Rh incompatibility** between the Rh-ve blood of a pregnant mother and Rh+ve blood of the foetus.
- Rh antigens do not get mixed with maternal blood in first pregnancy because placenta separates the two bloods.



- But at the time of first delivery, there is a possibility of exposure of the maternal blood to small amounts of the Rh+ve blood from the foetus.
- This induces the formation of Rh antibodies in maternal blood.



- In case of her subsequent pregnancies, Rh antibodies from mother leak into the foetal blood (Rh+ve) and destroy the foetal RBCs. This is fatal to foetus or cause severe anaemia and jaundice to the baby. This condition is called **Erythroblastosis foetalis.**

- Erythroblastosis foetalis can be avoided by administering **anti-Rh antibodies** to the mother immediately after the delivery of first child.

M-N blood group system

- This system was discovered by Land Steiner and Levine(1927)
- Antigens M and N are encoded by polymorphic genes GYPA and GYPB

The system has three blood types:

- MM blood group
- NN blood group
- MN blood group

MN Blood Group System

genotype	phenotype	antigen present on red bc
$L^M L^M$	M	M
$L^M L^N$	MN	M and N
$L^N L^N$	N	N

MN Antigens Vs Antibodies

- M and N antigens are weakly immunogenic for humans
- Antibodies against M and N antigens are rare
- Little clinical significance in blood transfusion

GOLDEN BLOOD TYPE

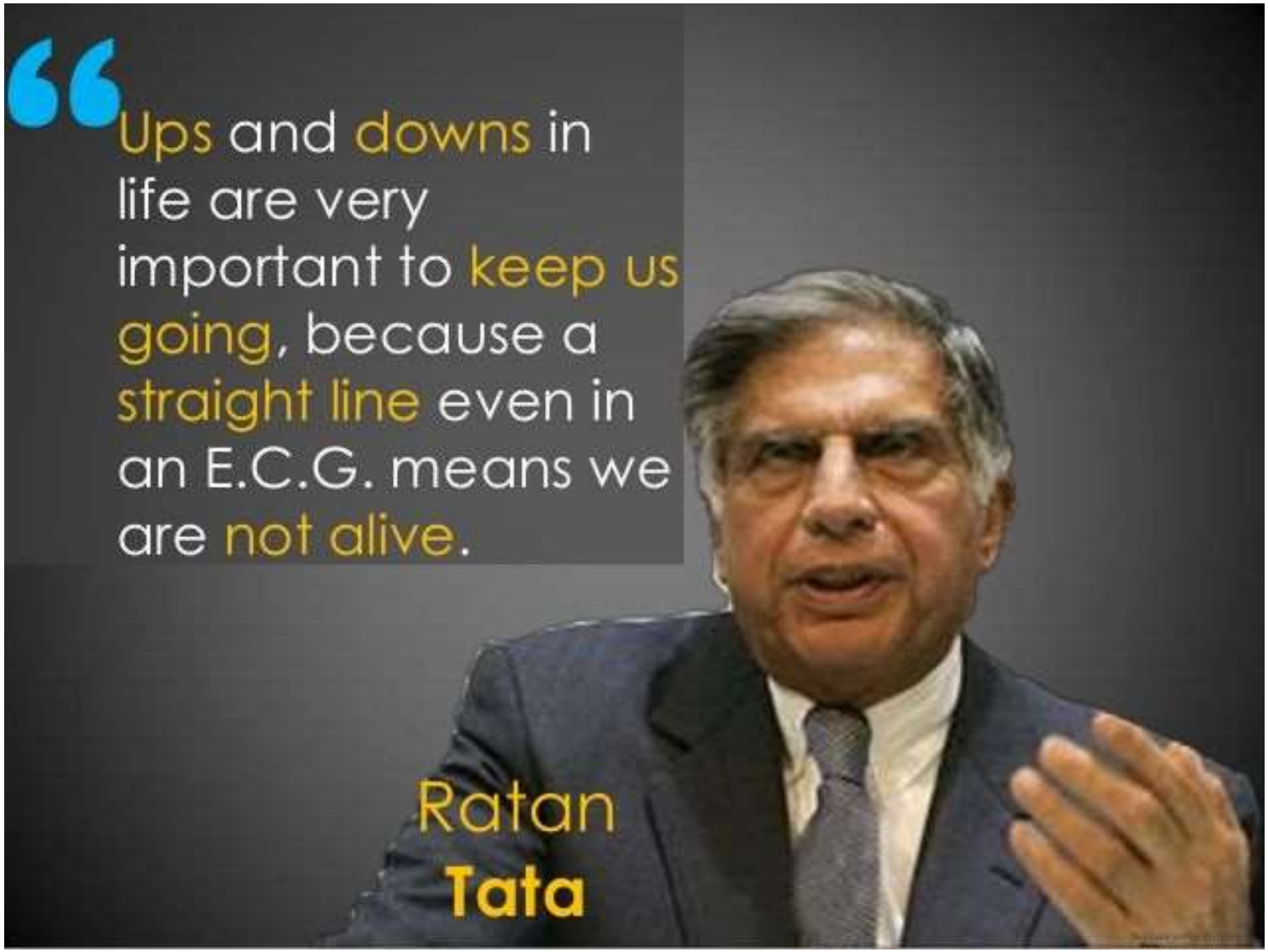
The golden (Rh null) blood is the rarest blood group, lacking Rh antigens in the red blood cells (RBCs). Learn more about the golden blood type, other rare blood types, and blood charts.

Proteins known as Rhesus (Rh) factors or antigens are completely absent in the red cells of people with the golden blood type or Rh null blood group. This is the rarest blood group in the world, with less than 50 individuals having this blood group. Golden blood type was first discovered in an Australian Aboriginal woman in 1961.

Our red blood cells have sugars and proteins called antigens on their surface membranes. Depending on the mix of antigens present, blood is categorized into different blood types, and we have A, B, O, or AB blood types. The ABO system has a further distinction as Rh-positive or Rh-negative depending on the presence or absence of the "Rh-D" factor in the cells.

A person with the golden blood type, or the Rh null blood type lacks all the Rh antigens whereas a person with the Rh-negative blood group lacks only Rh-D antigen.

The worry with the golden blood type is that donations of the Rh null blood type are incredibly scarce and difficult to obtain. An Rh null person has to rely on the cooperation of a small network of regular Rh null donors around the world if they need blood. Across the globe, there are only nine active donors for this blood group. This makes it the world's most precious blood type, hence the name "golden" blood.


“Ups and downs in life are very important to keep us going, because a straight line even in an E.C.G. means we are not alive.
Ratan
Tata