

Blood Groups, Types, Components, Disease Links, Importance

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Blood Groups are classifications that determine the existence or absence of specific antigens located on the surface of red blood cells. These Blood Group categories are- A, B, AB and O when combined with the Rh factor, play an important role in medical science. The Blood Groups are the foundation for transfusion practices, organ transplantation and maternal fetal health, helping doctors prevent dangerous immune reactions and safeguard human lives during the times of medical emergencies and procedures. In this article, we are going to cover Blood Groups, their types and components.

Blood Groups

Blood Groups are important categories that depend on the presence of antigens on red blood cells and antibodies circulating in the plasma. The ABO system separates the blood into four primary categories. Type A contains A antigens, Type B consists of B antigens and Type AB contains both antigens and Type O contains none. Along with this, the Rh factor determines whether the blood is positive (Rh+) or negative (Rh-). For example, an individual can have A+, A-, B+ or O-. This categorisation helps in understanding blood compatibility and its success rate in transfusion and organ transplants. If incompatible blood is introduced, the immune system can launch a severe and

often life-threatening reaction. A well-known example is that O– blood is universally accepted as a donor type, while AB+ is universally compatible as a recipient. Understanding these distinctions allows for safe, effective medical interventions.

Blood Groups Types

The ABO and Rh systems form the basis of modern transfusion medicine. The eight main blood types derived from these systems are: A+, A–, B+, B–, AB+, AB–, O+, and O–.

ABO Blood Group System

- Type A
 - Antigen present: A
 - Antibody present: Anti-B
- Type B
 - Antigen present: B
 - Antibody present: Anti-A
- Type AB
 - Antigens present: Both A and B
 - Antibody present: None
 - Known as the universal recipient
- Type O
 - Antigen present: None
 - Antibodies present: Both Anti-A and Anti-B
 - Known as the universal donor

Rh Factor

- Rh Positive (Rh+): Indicates the presence of the D antigen on red blood cells.
- Rh Negative (Rh–): Indicates the absence of the D antigen.

This combination of ABO and Rh factors provides the eight recognized blood types that guide clinical decisions in medicine.

Blood Groups Components

The blood groups depend on specific molecules and immune markers present in red blood cells and plasma.

Antigens

These are proteins or sugars available on the surface of red blood cells. Their composition decides an individual's blood type.

- A Antigen is present in Type A blood

- B Antigen is present in Type B blood
- Both A and B Antigens is found in Type AB blood
- No Antigens is found in Type O blood
- Rh Antigen (D) determines whether a blood group is positive or negative

Antibodies

Found in plasma, antibodies target foreign antigens to prevent harmful reactions.

- Anti-A is found in Type B and O blood
- Anti-B is found in Type A and O blood
- No Antibodies is found in Type AB blood

Plasma

Plasma is the liquid portion of blood that carries antibodies, nutrients, waste products, and hormones. It supports immune activity and nutrient transport.

Red Blood Cells

Red Blood cells are specialized cells that carry oxygen and carbon dioxide. Their antigenic surface determines blood group identity. These elements interact to maintain compatibility and prevent transfusion-related complications.

Blood Groups Linked Diseases

Blood groups help in the understanding of certain diseases and health risks. These diseases include:

Cardiovascular Diseases

Individuals with blood groups AB or B have a higher risk of heart-related conditions due to elevated clotting factors and inflammatory markers. By contrast, O group individuals are generally less vulnerable to coronary artery disease.

Thrombosis

Blood groups A, B, and AB carry a greater chance of developing venous thromboembolism, largely because of higher levels of clotting proteins such as Factor VIII.

Malaria

Interestingly, blood group O offers some resistance to severe malaria infections, whereas group A increases susceptibility, allowing parasites to adhere more easily to red blood cells.

Gastric and Peptic Ulcers

Group O individuals are at higher risk of *Helicobacter pylori* infections, often linked to stomach ulcers. On the other hand, group A is correlated with gastric cancer, showing a different disease connection.

Cancer Risks

Blood group A has been observed to carry a higher risk for cancers of the stomach and pancreas, owing to unique antigen-related mechanisms.

Autoimmune Disorders

Blood groups may affect the likelihood of developing autoimmune conditions. For example, AB group individuals show a slightly increased risk due to immune complexity.

Hemolytic Disease of the Newborn (HDN)

Occurs when an Rh– mother carries an Rh+ fetus, causing her immune system to attack fetal red blood cells. Modern medicine now prevents this with targeted injections.

By studying these links, doctors gain valuable insights for personalized healthcare and preventive medicine.

Blood Groups Recently Discovered

Medical science has uncovered many additional blood group systems beyond the normal ABO and Rh categories. These discoveries are important for patients requiring rare transfusions.

- **Langereis (Lan) System:** Defined by the presence of the Lan antigen. Lan-negative individuals are extremely rare and require special blood donors.
- **Junior (Jr) System:** Based on the Jr antigen. Jr-negative cases are mainly concentrated in specific ethnic communities.
- **Vel Blood Group:** Identified by the Vel antigen. Vel-negative individuals are vulnerable to severe transfusion reactions due to the scarcity of compatible blood.
- **Er Blood Group:** Recently discovered in 2022, linked to variations in the PIEZO1 protein. It includes five antigens — Er1, Er2, Er3, Er4, and Er5.
- **FORS Blood Group:** Characterized by the Forssman antigen (FORS1). Rare and less globally distributed.

Blood Groups Significance

- Blood groups form the foundation of modern medicine, governing transfusions, organ transplantation, and maternal-fetal health.
- While the ABO and Rh systems remain central, recent discoveries like Lan, Vel, and Er groups emphasize the growing complexity of immunohematology.
- Understanding these classifications is not only about safe transfusion practices but also about embracing the diversity of human biology.
- Enhance the safety of transfusions by identifying previously unknown incompatibilities.
- Provide valuable insights into rare diseases and organ transplant compatibility.

- Support the advancement of personalized medicine, where treatment is tailored to a patient's specific blood phenotype.
- Ongoing research may reveal even more systems, deepening our understanding of human genetic diversity.

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