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Learning Objectives

After participating in this program you should be able to....

- Define and discuss blood types and their place in the practice of transfusion.
- Describe the process to find compatible blood components.
- Identify how rare blood needs are met (intro of the rare donor program).



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Immunology

- Science of the immune system
- Study of Immune responses
 - Cell-mediated
 - Humoral – antibody-mediated



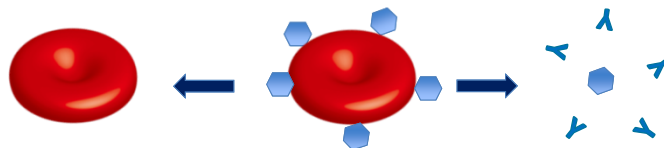
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Applied Immunology

- Carbohydrates (CHO) or proteins are present on RBCs
- These can be ANTIGENS
 - Antigens cause an immune response
 - If someone lacks an antigen (specific CHO or protein) & are exposed to that antigen, they can make antibody

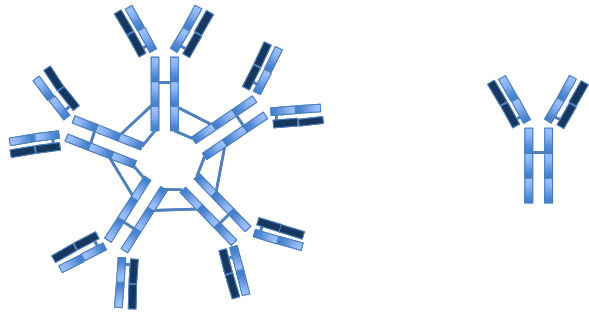


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Antibodies



IgM

IgG




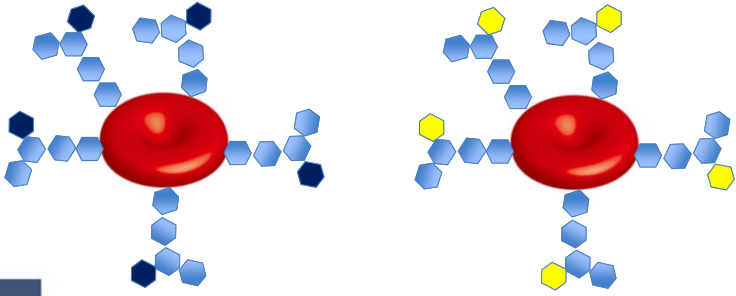
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Blood Group

- CHO and proteins are inherited characteristics
- Variations of the same CHO or protein structure create a blood group



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Blood Group System

- CHO or protein structure is known
- Chromosome location is known
- Gene responsible for each antigen is known

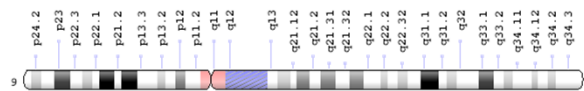


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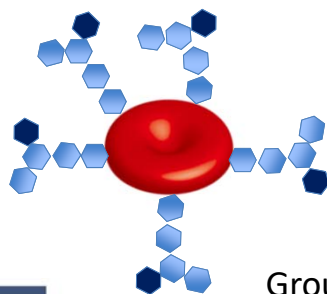
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ABO Blood Group System

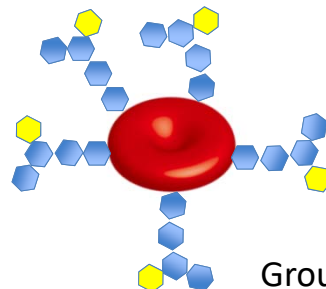


<https://www.ncbi.nlm.nih.gov/genome/tools/gdp>

A, B, O



Group A



Group B



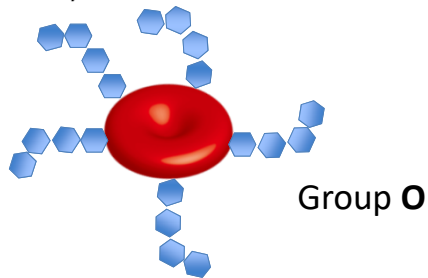
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ABO Group (Type)

- Your blood type is defined by the presence of A and/or B markers (antigens) on your red cells (specific sugars)
- Group O do not have A or B antigens (specific CHOs)

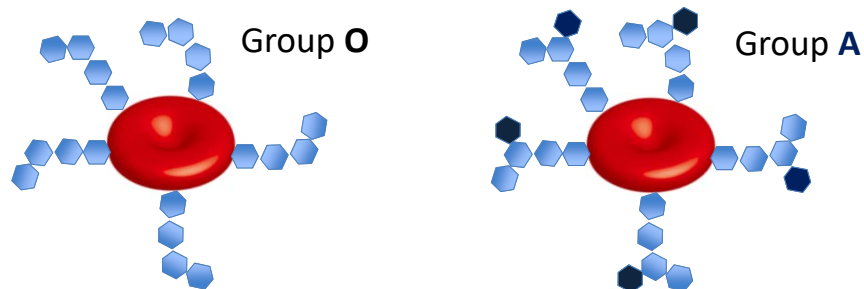


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ABO Group (Type)



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ABO Group (Type)

Group B

Group AB



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ABO Blood Group System

Group AB

Group O



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Antibodies to Blood Group Carbohydrates & Proteins

- If exposed to CHOs & proteins different than your own...
 - Bodies immune system sees it as foreign
 - Antibody is made by a type of white blood cell (B cell)



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Antibodies to Blood Group Carbohydrates & Proteins

- Some antibodies are always present
 - Exposed to CHOs in nature
- Other antibodies are produced after exposure to foreign red blood cells through transfusion or pregnancy



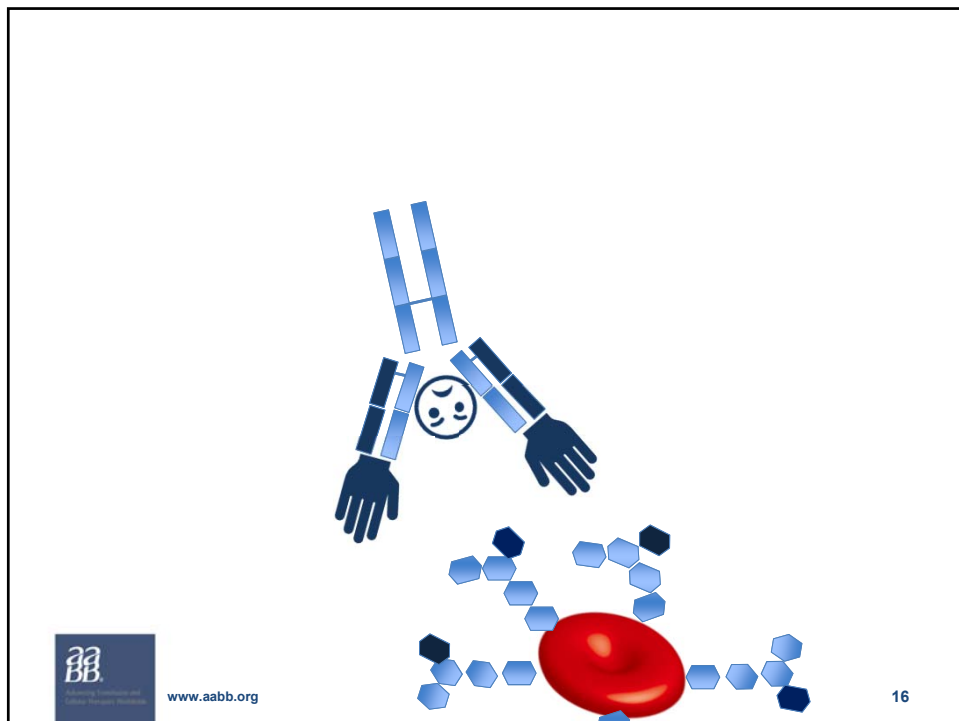
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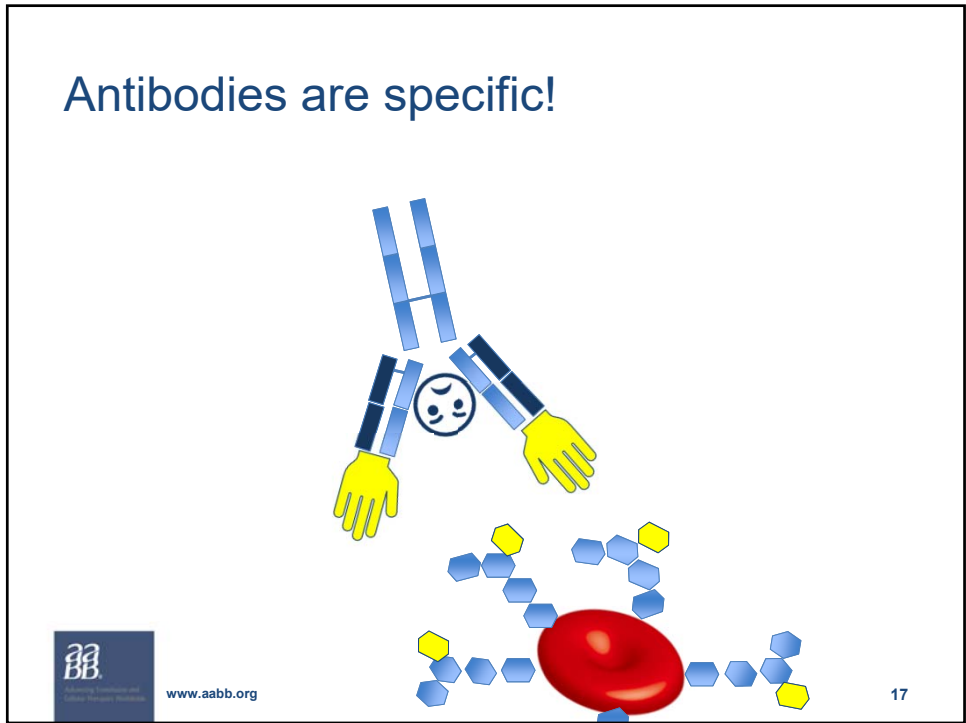
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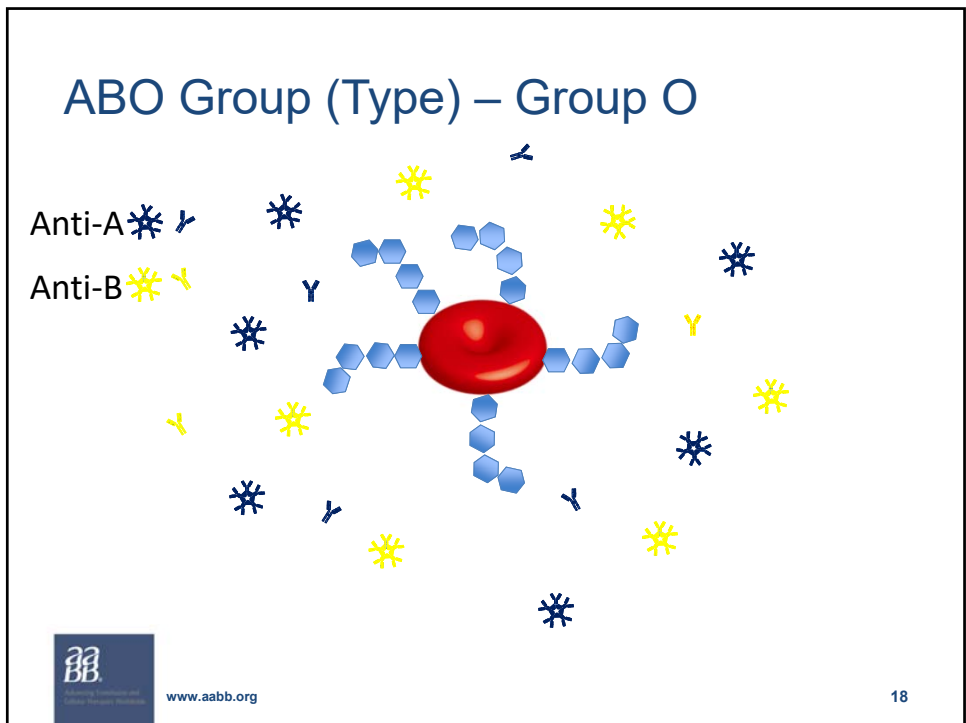
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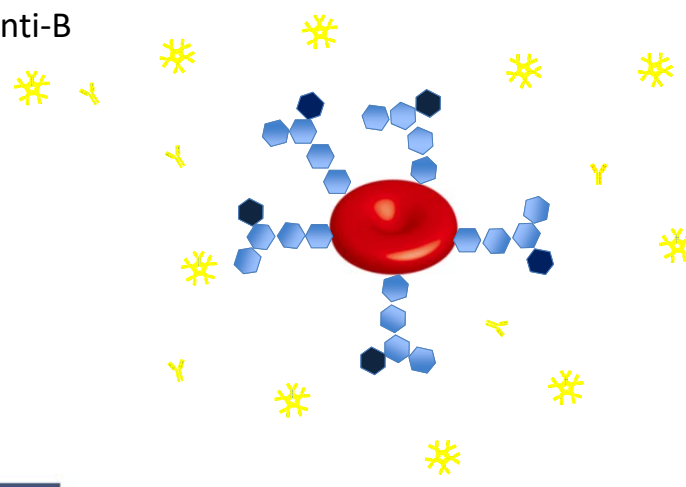
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ABO Group (Type) – Group A

Anti-B



The diagram shows a central red blood cell (red sphere) with A antigens (blue hexagons) on its surface. Yellow Y-shaped antibodies (Anti-B) are shown binding to the A antigens. The text 'Anti-B' is positioned above the diagram.



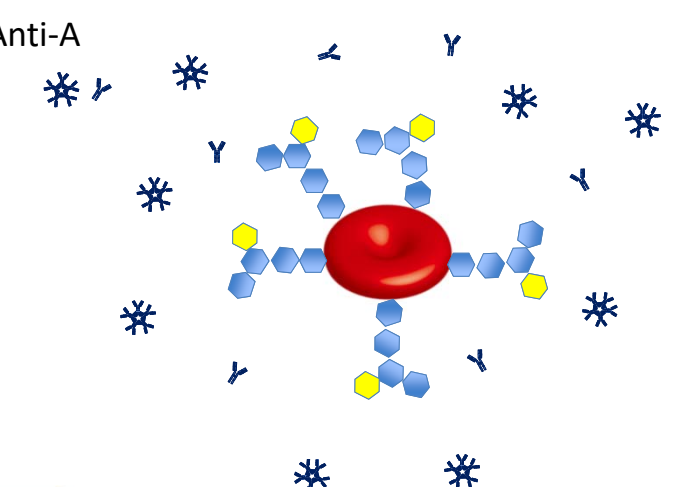
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ABO Group (Type) – Group B

Anti-A



The diagram shows a central red blood cell (red sphere) with B antigens (blue hexagons with a yellow dot) on its surface. Blue Y-shaped antibodies (Anti-A) are shown binding to the B antigens. The text 'Anti-A' is positioned above the diagram.



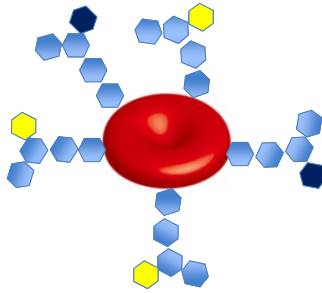
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ABO Group (Type) – Group AB

No ABO antibodies!



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Rh Blood Group System

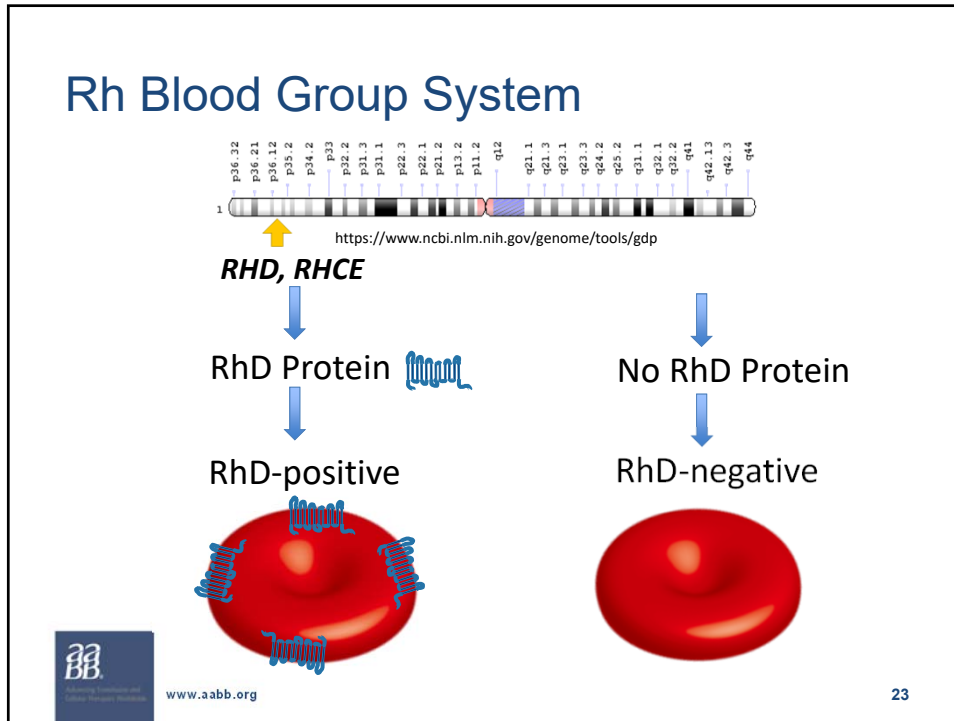
Defining Positive and Negative
in a blood type



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Rh Blood Group System

- Antibody to D (anti-D) is not naturally occurring like ABO
- Anti-D is made when a RhD-negative person is exposed to RhD-positive blood
 - Transfusion
 - Pregnancy
- ~30% - 80% of RhD-negative people exposed to RhD-positive blood make anti-D

The diagram shows several blue Y-shaped antibody molecules (anti-D) scattered below the text. The AABB logo and website (www.aabb.org) are in the bottom left, and the number 24 is in the bottom right.

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Anti-D

- Causes a patient to experience a transfusion reaction to future RhD-positive blood transfusion
- In pregnancy, can destroy baby's RhD-positive blood
 - Known as Hemolytic Disease of the Fetus & Newborn (HDFN)

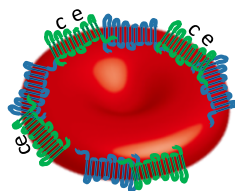


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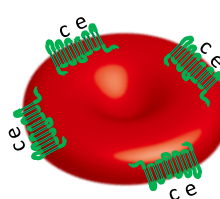
Rh Blood Group System – Other Rh Antigens

- >50 antigens
- Common antigens other than D
 - C, E, c, e

RhD-positive
c+e+



RhD-negative
c+e+



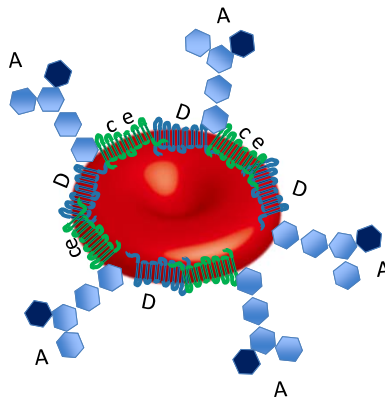
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Putting it all together...

A Rh-positive



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Other Blood Group Systems

- 39 Blood Group Systems
 - ABO
 - Rh
 - 37 others!
- 330 different blood group antigens
 - ABO 4
 - Rh 55
 - Others 271



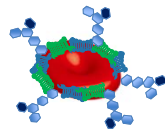
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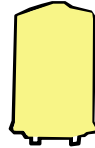
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Summary

- Antigenes are attached to RBCs



- Antibodies are in the plasma



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Compatibility

Making sure the right blood
is given to the right patient



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Donor Testing

- ABO Group
 - A, B, AB or O
- RhD Type
 - RhD-positive
 - RhD-negative
- Antibody Detection Test (Screen)
- Other Antigen Typing (phenotype or genotype) on selected donors



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Pretransfusion Testing on Patient

- ABO Group
- RhD Type
- Antibody Detection Test (Antibody Screen)
 - Does patient have antibodies to any blood group antigen?
- Crossmatch
 - Patient plasma/serum vs. Donor RBCs to make sure blood chosen is compatible



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**Universal Donor / Universal Recipient
(Common Definition)**

↓

Only applies to RBCs!

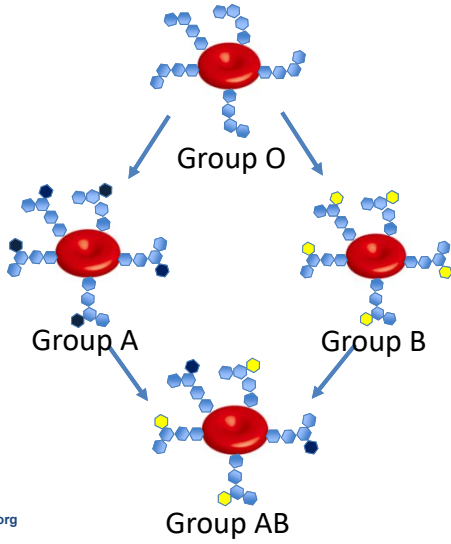



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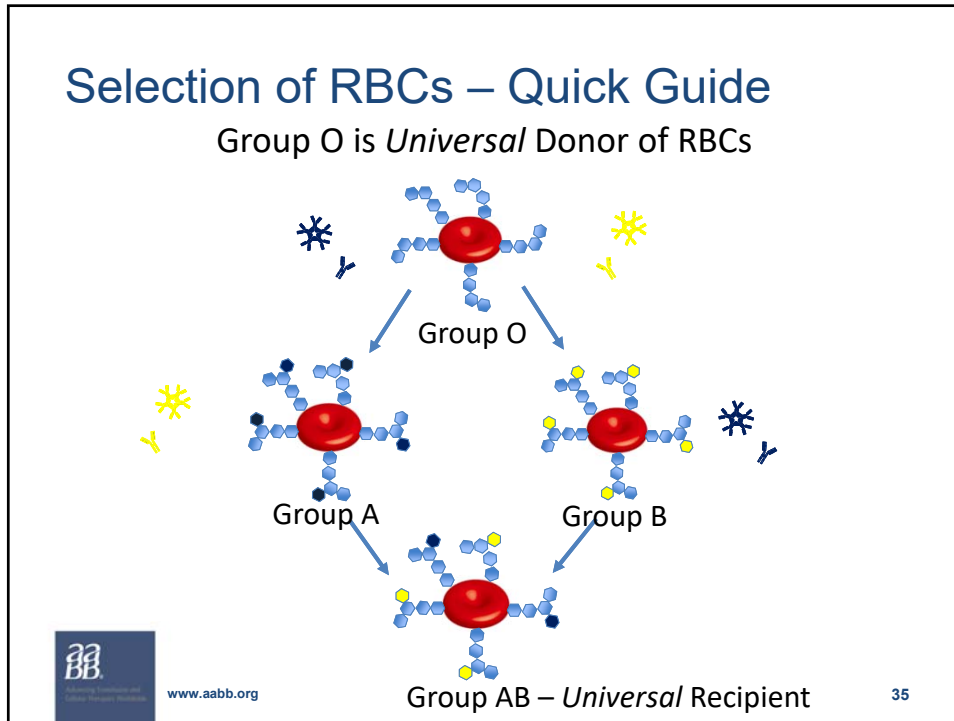
Selection of RBCs – Quick Guide

Group O is *Universal* Donor of RBCs

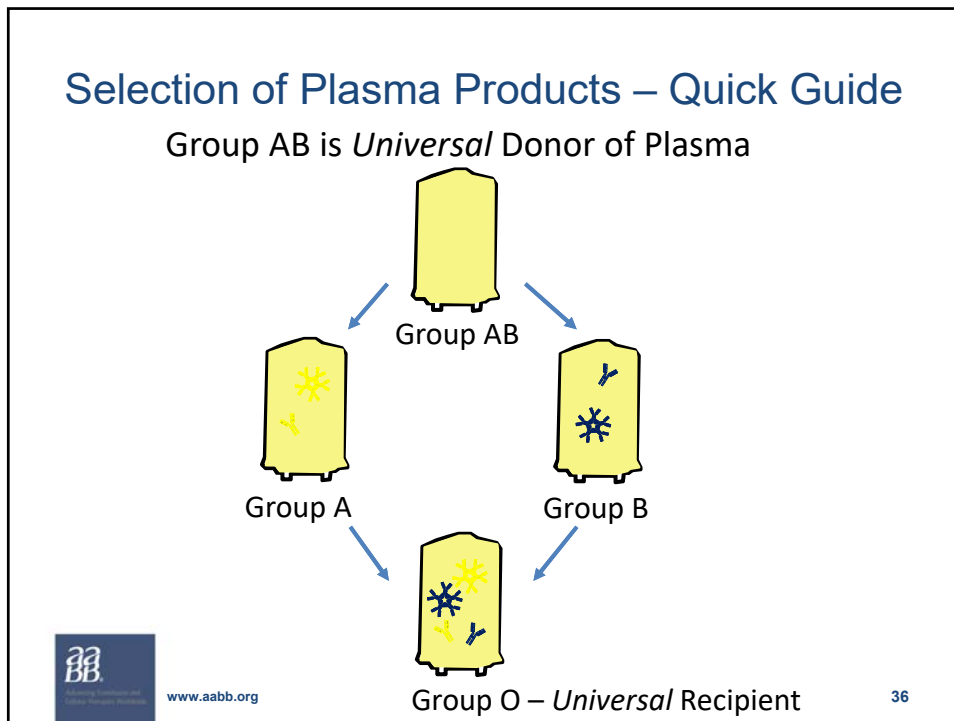


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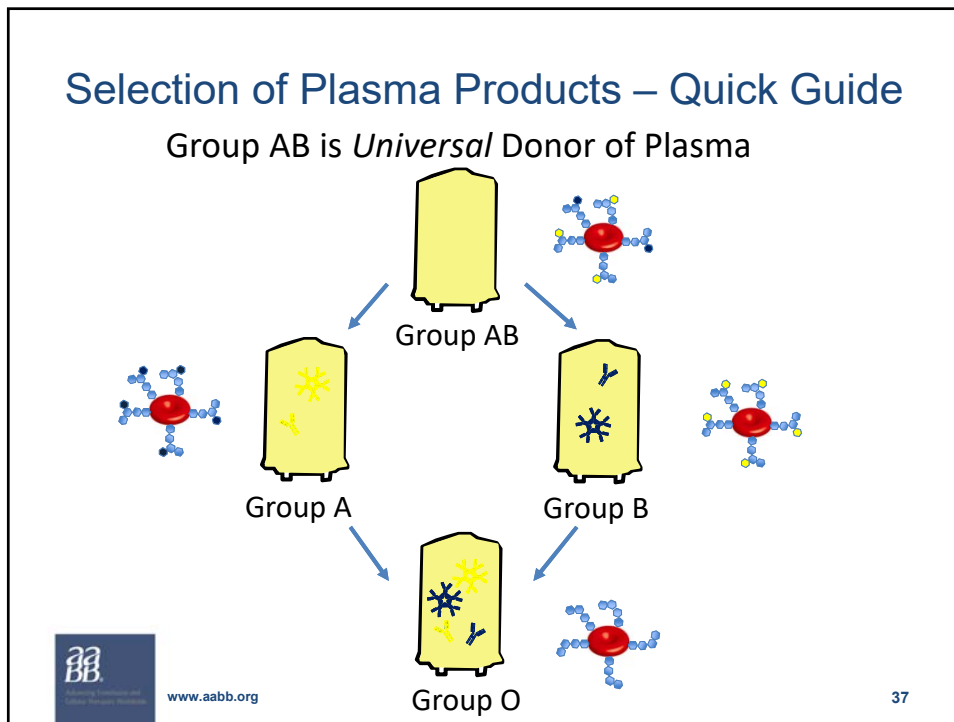
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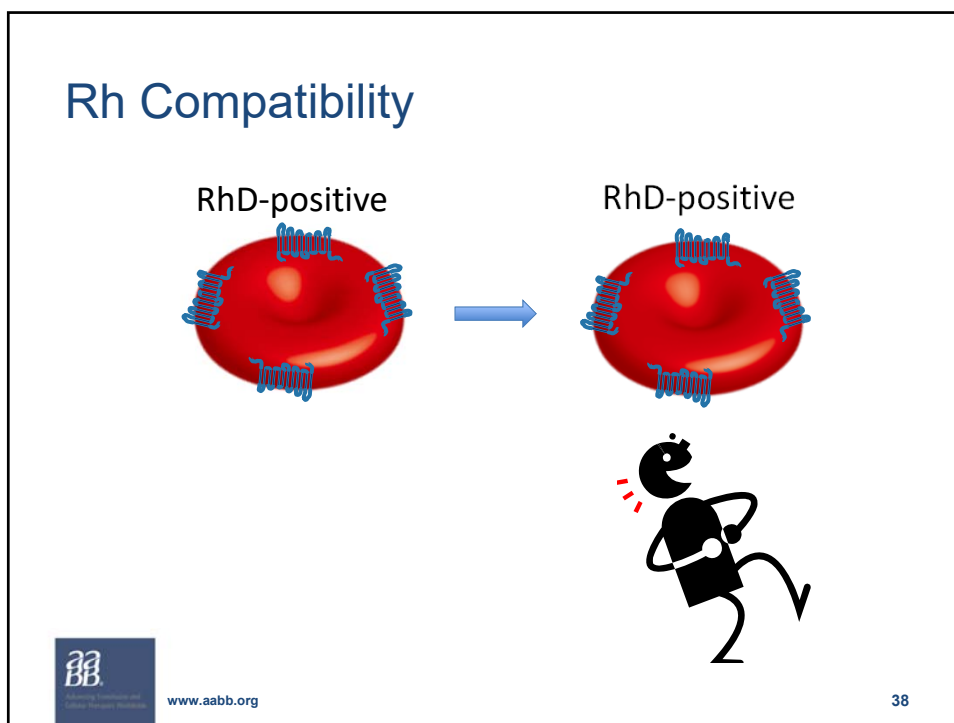
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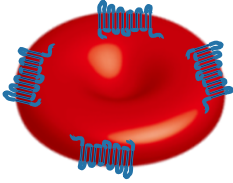
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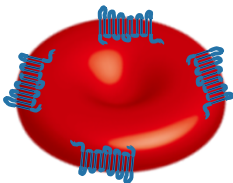
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Rh Compatibility

RhD-positive




RhD-positive

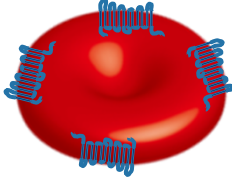



Emergency/Urgent Need

RhD-negative



RhD-negative




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Detailed description: This diagram illustrates the process of RhD conversion in an emergency. It shows two rows of red blood cells. The top row shows two RhD-positive cells, each with blue Y-shaped antigens on its surface. A blue arrow points from the first to the second. The bottom row shows two RhD-negative cells. The first is a smooth red disc without antigens, and the second is a red disc with blue Y-shaped antigens on its surface. A blue arrow points from the first to the second. The text 'Emergency/Urgent Need' is centered between the two rows. In the bottom left corner is the AABB logo and the website 'www.aabb.org'. The number '39' is in the bottom right corner.


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Rh Compatibility

RhD-negative



RhD-negative Women <50 y/o



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Detailed description: This diagram shows the selection of RhD-negative blood for RhD-negative women under 50 years old. It features two identical red blood cells, each a smooth red disc without surface antigens. A blue arrow points from the left cell to the right cell. The text 'RhD-negative' is above the left cell, and 'RhD-negative Women <50 y/o' is above the right cell. In the bottom left corner is the AABB logo and the website 'www.aabb.org'. The number '40' is in the bottom right corner.


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Rh Compatibility Emergent/Massive Transfusion

RhD-negative RhD-negative
Male or Woman >50 y/o

1st Choice


RhD-positive **Emergent/MTP**

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Rh Compatibility for Plasma

It doesn't matter 😊

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Other Blood Group Systems

- 330 different blood group antigens
 - ABO Matched
 - Rh Match for 1 of 55
 - Others 271
- Antibody Detection Test (Antibody Screen)
 - Detect antibodies to other 325 antigens
 - After detection, antibody(ies) is(are) identified



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Antibody Detection Test (Screen)

- Test patient's plasma for possible antibodies
 - Group O RBCs from 3 different donors

	Rh				MNS				P	Lewis		Kell		Duffy		Kidd			
	D	C	E	c	e	f	M	N	S	s	P ₁	Le ^a	Le ^b	K	k	Fy ^a	Fy ^b	Jk ^a	Jk ^b
1	+	+	0	0	+	0	+	+	+	0	0	+	0	0	+	0	+	0	+
2	+	0	+	+	0	0	+	0	+	+	+	0	+	+	+	+	+	+	0
3	0	0	+	+	0	0	0	+	0	+	+	0	+	0	+	+	0	0	+



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Antibody Identified

- Commonly Seen Antibodies

- Anti-E



- Anti-K



- Anti-Fy^a



Advancing Transfusion and
Other Therapeutic Practices

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Finding Compatible Blood

- RBCs must lack antigen that antibody is specific for
- Donor's type must match patient's type
 - ABO
 - Rh
 - Antigen Negative



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Finding Compatible Blood - Example

- Patient ABO, RhD type is O RhD-negative
- Antibodies identified in their plasma are anti-E, anti-K & anti-S
- Donor blood selected must
 - O RhD-negative
 - E negative
 - K negative
 - S negative



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Rare Donor

Definition & Locating in Time of Need



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Rare Donor Definition

- Occur in <1 in 1,000 individuals
- Lack multiple common antigens
 - c-, Fy(a-), Jk(b-), s-
- Lack a high prevalence antigen
 - >99% of population has the antigen

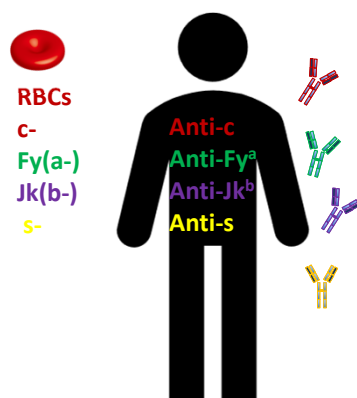


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Patient with Rare Blood Type



- Negative for multiple antigens
 - Made multiple antibodies
 - Needs blood that lacks multiple antigens

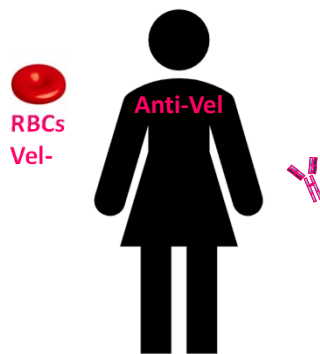


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Patient with Rare Blood Type



- Negative for high prevalence antigen
 - Made antibody to high prevalence antigen
 - Needs blood that lacks the high prevalence antigen



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What's rare varies by region

- RhD-negative is rare in China or East Asia
- Fy(a-b-) occurs in ~33% of individuals with African background, rare in almost all other populations
- Rare in all populations
 - Vel- 1:4,000
 - Kp(b-) 1:10,000



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Rare Donor Program in the USA - History

- Tibor J Greenwalt, MD
 - 1959 Founded AABB Rare Donor File in Milwaukee



- 1967 Founded ARC Rare Donor Registry



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American Rare Donor Program



- AABB file & ARC registry merged
- November 1, 1998



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International Rare Donor Panel

- World Health Organization (WHO) & International Society of Blood Transfusion (ISBT) collaboration
 - >25 participating countries



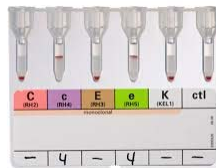
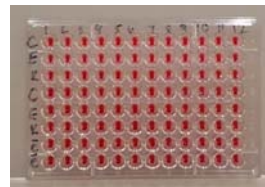
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Rare Donor Programs / Blood Supplier

- Dedicated program to phenotype and/or genotype blood donors



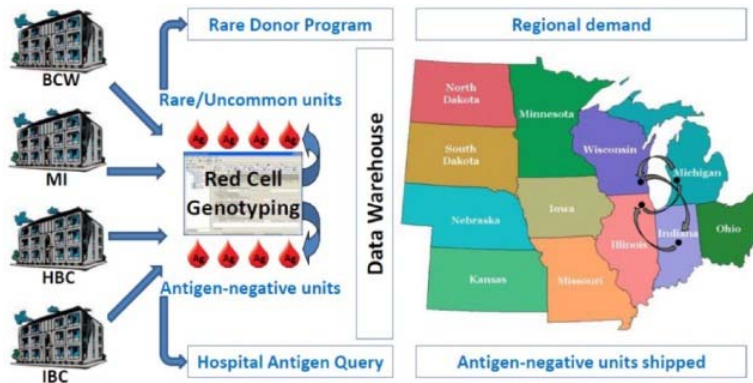
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Red Cell Genotyping Program Example

GA Denomme, et. al. [Ther Adv Hematol](#). 2017 Oct; 8(10): 277–291



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5638177/#>



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Rare Donor Programs / Blood Supplier

- Software Solution
 - Manage rare donor records
 - Store phenotype/genotype information
- Blood Establishment Computer Software (BECS)
 - Manage donors and units



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Learning Objectives

- Define and discuss blood types and their place in the practice of transfusion.
- Describe the process to find compatible blood components.
- Identify how rare blood needs are met (intro of the rare donor program).



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THANK YOU!!



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