

Blood Banking & Transfusion Medicine 101

Transfusion Medicine as Applied Immunology

Presented by:
Susan T. Johnson, MSTM, MT(ASCP)SBB^{CM}
Director, Clinical Education & Director, Specialist in Blood Banking (SBB) Program, Versiti
Director, Transfusion Medicine Program, Marquette University
Milwaukee, WI

www.aabb.org

1

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).

www.aabb.org

2

2

Immunology

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



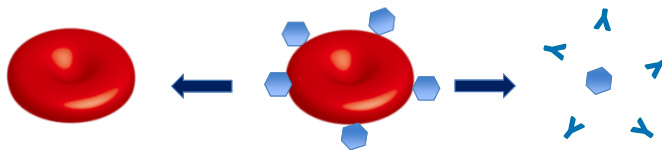
www.aabb.org

3

3

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

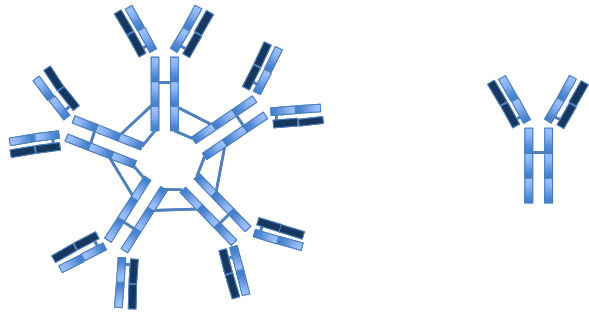


www.aabb.org

4


4

Antibodies



IgM

IgG




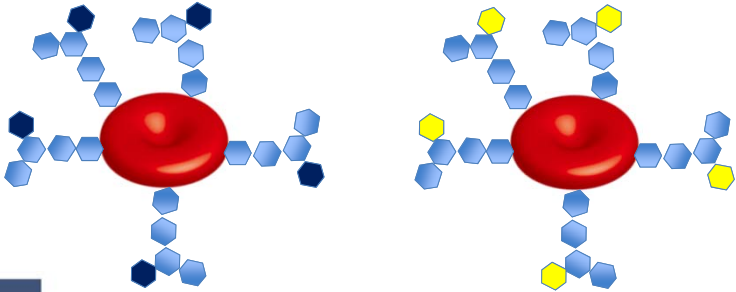
www.aabb.org

5

5

Blood Group

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



www.aabb.org

6

6

Blood Group System

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

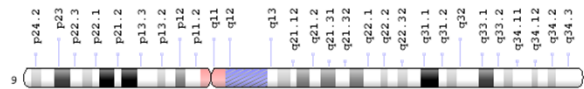


www.aabb.org

7

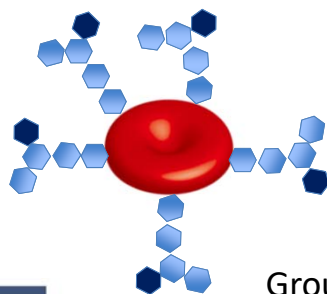
7

ABO Blood Group System

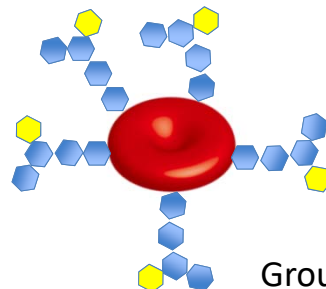


<https://www.ncbi.nlm.nih.gov/genome/tools/gdp>

A, B, O



Group A



Group B



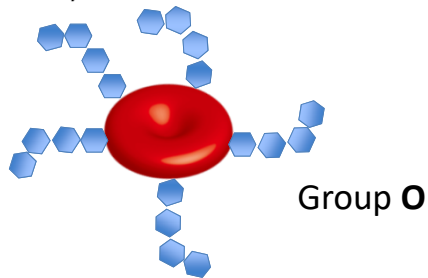
www.aabb.org

8

8

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)

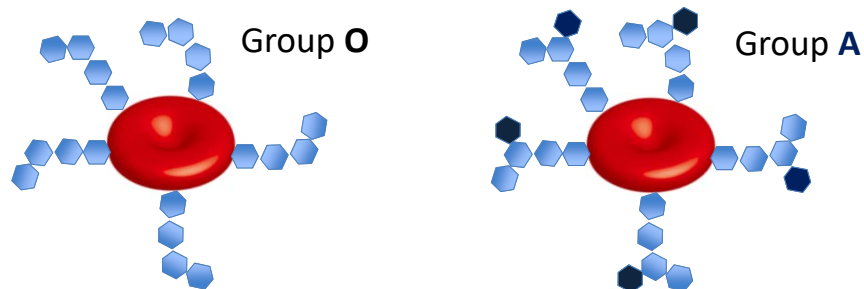


www.aabb.org

9

9

ABO Group (Type)



www.aabb.org


10

10

ABO Group (Type)

Group B

Group AB



www.aabb.org


11

11

ABO Blood Group System

Group AB

Group O



www.aabb.org

12

12

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)



www.aabb.org

13

13

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



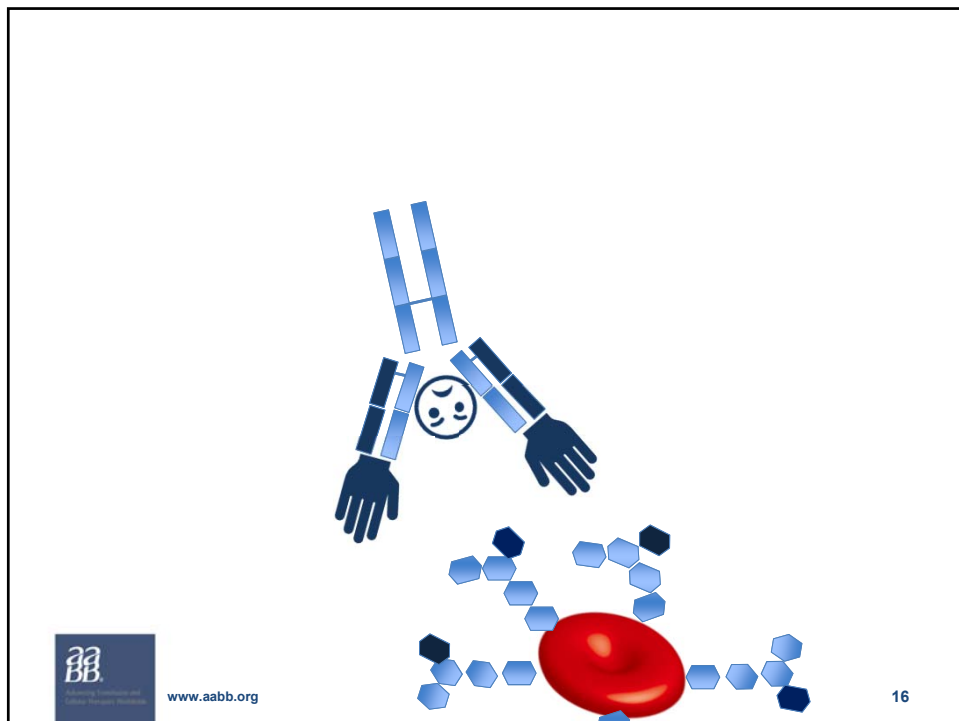
www.aabb.org

14

14



15



16

Antibodies are specific!

The diagram illustrates the specificity of antibodies. A Y-shaped antibody molecule, composed of blue and yellow segments, is shown with its arms reaching towards a red blood cell. The red blood cell is depicted as a red sphere with a blue chain of hexagons representing antigens. One of the antibody's arms is bound to one of these hexagons. A sad face is drawn on the antibody's stem, indicating that it is not binding to the correct antigen. The AABB logo and website address (www.aabb.org) are in the bottom left, and the number 17 is in the bottom right.

17

ABO Group (Type) – Group O


The diagram shows a red blood cell (red sphere) with a blue chain of hexagons (antigens) attached to its surface. Surrounding the cell are several Y-shaped antibody molecules. Some are blue with a small 'Y' on their stem, and others are yellow with a small 'Y' on their stem. The antibodies are scattered around the cell, but none are bound to the antigens on the cell. The AABB logo and website address (www.aabb.org) are in the bottom left, and the number 18 is in the bottom right.

18

ABO Group (Type) – Group A

Anti-B

The diagram illustrates a red blood cell (red sphere) with A antigens (blue hexagons) on its surface. Anti-B antibodies (yellow Y-shapes) are shown binding to the B antigens (black hexagons) on the surface of another red blood cell, demonstrating agglutination. The A antigens on the red blood cell are not bound by the anti-B antibodies.



www.aabb.org


19

19

ABO Group (Type) – Group B

Anti-A

The diagram illustrates a red blood cell (red sphere) with B antigens (yellow hexagons) on its surface. Anti-A antibodies (black Y-shapes) are shown binding to the A antigens (blue hexagons) on the surface of another red blood cell, demonstrating agglutination. The B antigens on the red blood cell are not bound by the anti-A antibodies.



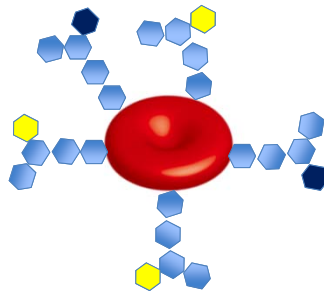
www.aabb.org

20

20

ABO Group (Type) – Group AB

No ABO antibodies!



www.aabb.org

21

21

Rh Blood Group System

Defining Positive and Negative
in a blood type



www.aabb.org


22

22


Rh Blood Group System

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

RHD, RHCE


RhD Protein 


RhD-positive



No RhD Protein

RhD-negative

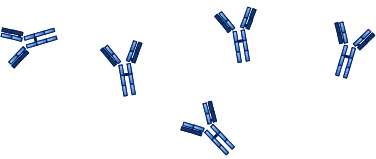




www.aabb.org
23

23

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




24

24

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)

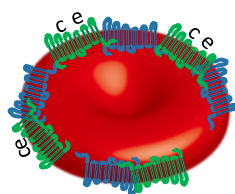


25

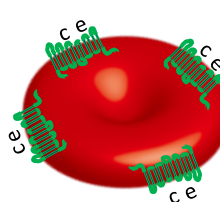
Rh Blood Group System – Other Rh Antigen

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

RhD-positive
c+e+



RhD-negative
c+e+



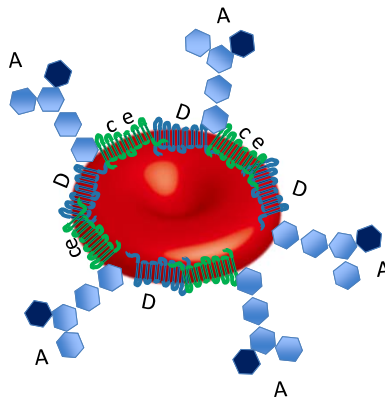
www.aabb.org

26

26

Putting it all together...

A Rh-positive



www.aabb.org

27

27

Other Blood Group Systems

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



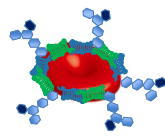
www.aabb.org

28

28

Summary

- Antigenes are attached to RBCs



- Antibodies are in the plasma



www.aabb.org

29

29

Compatibility

Making sure the right blood
is given to the right patient



www.aabb.org

30

30

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



www.aabb.org

31

31

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



www.aabb.org


32


32

Universal Donor / Universal Recipient
(Common Definition)

↓

Only applies to RBCs!

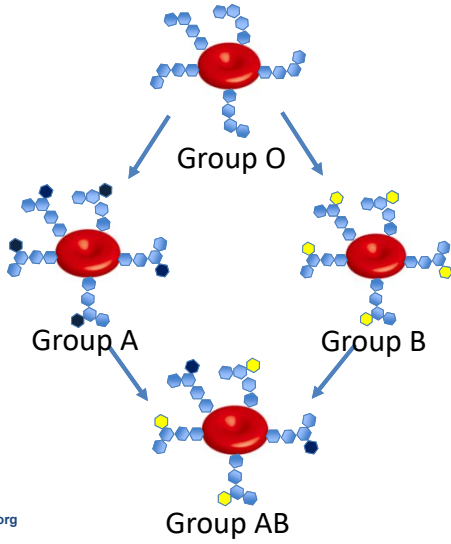



 www.aabb.org 33

33

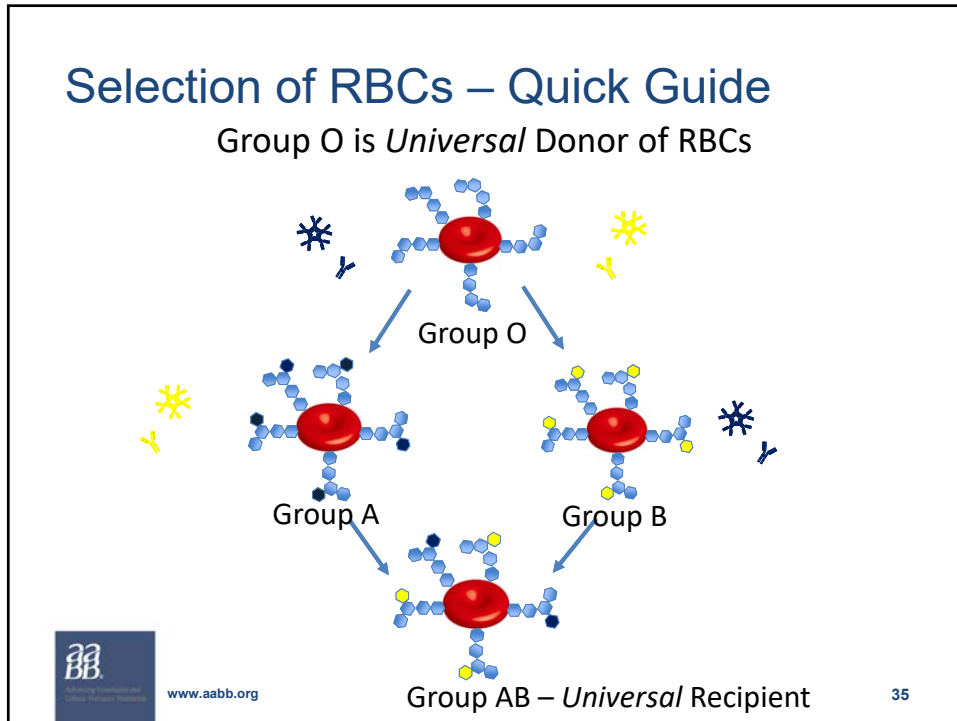
Selection of RBCs – Quick Guide

Group O is *Universal* Donor of RBCs

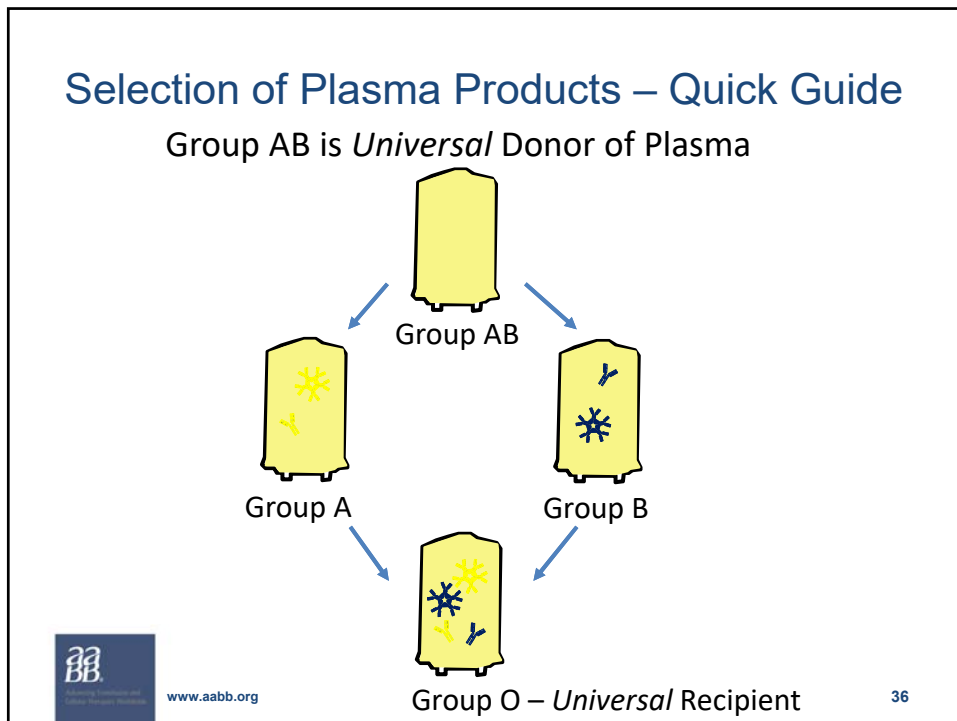


 www.aabb.org 34

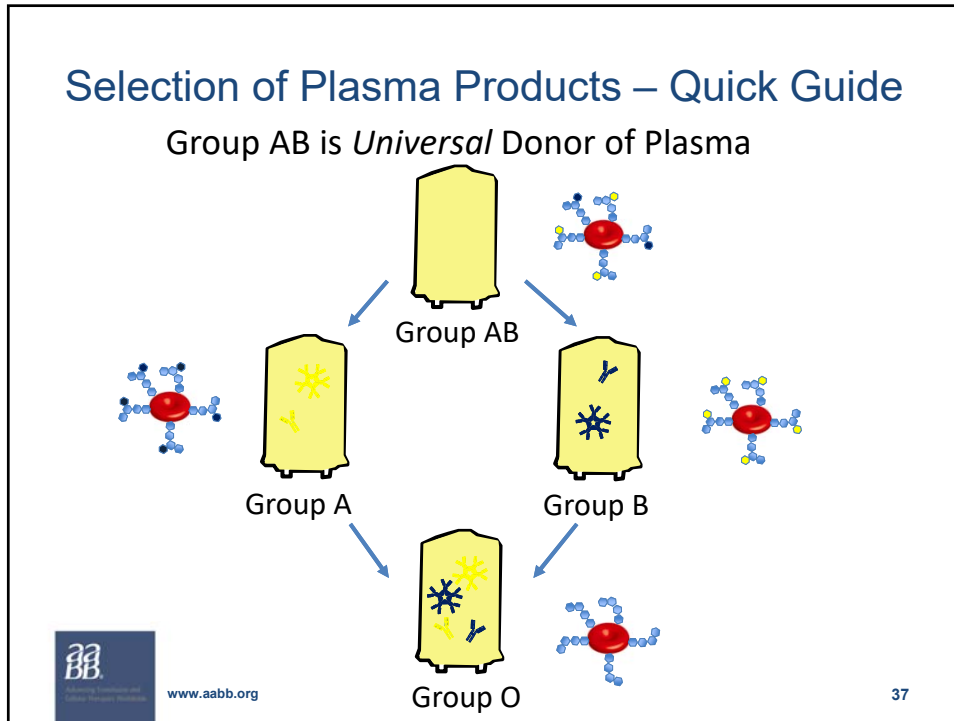
34



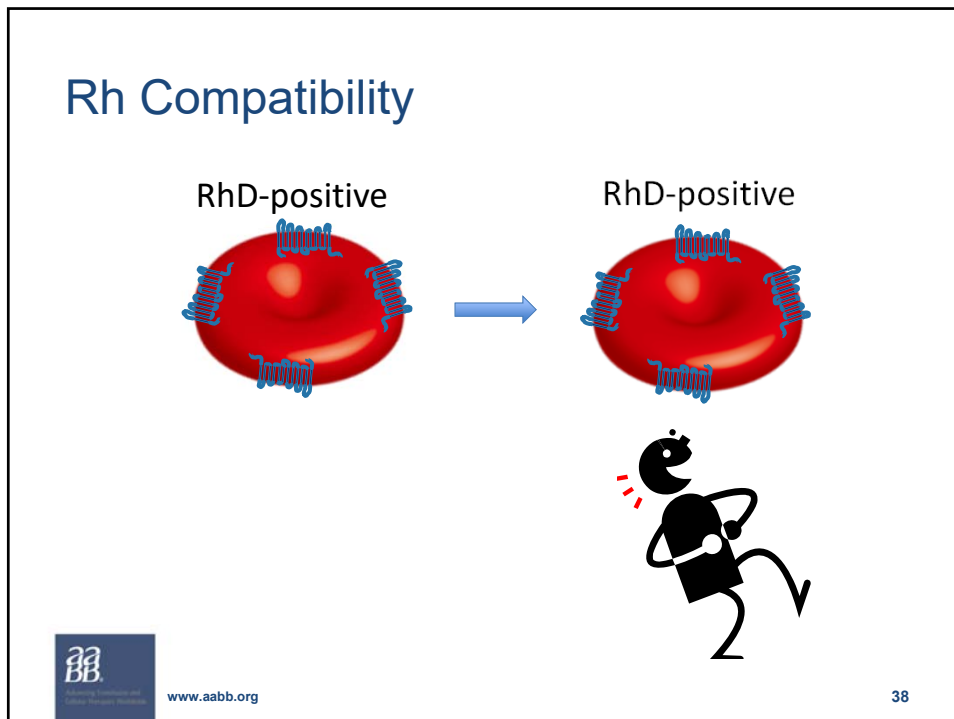
35



36



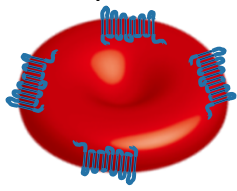
37



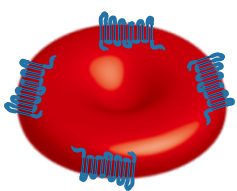
38

Rh Compatibility

RhD-positive




RhD-positive

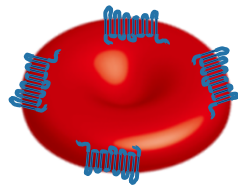



Emergency/Urgent Need

RhD-negative



RhD-negative




 www.aabb.org 39


39


Rh Compatibility

RhD-negative



RhD-negative
Women <50 y/o



 www.aabb.org 40


40

Rh Compatibility Emergent/Massive Transfusion

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

1st Choice


RhD-positive **Emergent/MTP**

 www.aabb.org 41

41

Rh Compatibility for Plasma

It doesn't matter 😊

 www.aabb.org 42

42

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



www.aabb.org

43

43

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	+



www.aabb.org

44

44

Antibody Identified

- Commonly Seen Antibodies

- Anti-E



- Anti-K



- Anti-Fy^a



www.aabb.org

45

45

Finding Compatible Blood

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



www.aabb.org

46

46

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



www.aabb.org

47

47

Rare Donor

Definition & Locating in Time of Need



www.aabb.org

48

48

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

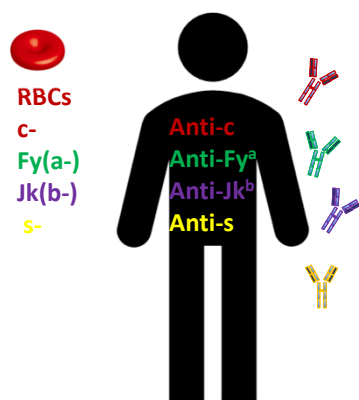


www.aabb.org

49

49

Patient with Rare Blood Type



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

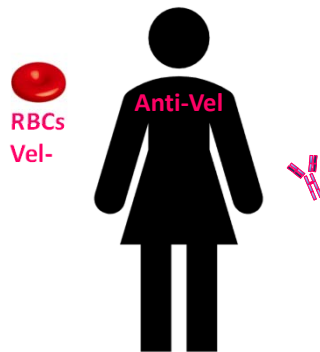


www.aabb.org

50

50

Patient with Rare Blood Type



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



www.aabb.org

51

51

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



www.aabb.org

52

52

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



www.aabb.org

53

53

American Rare Donor Program



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



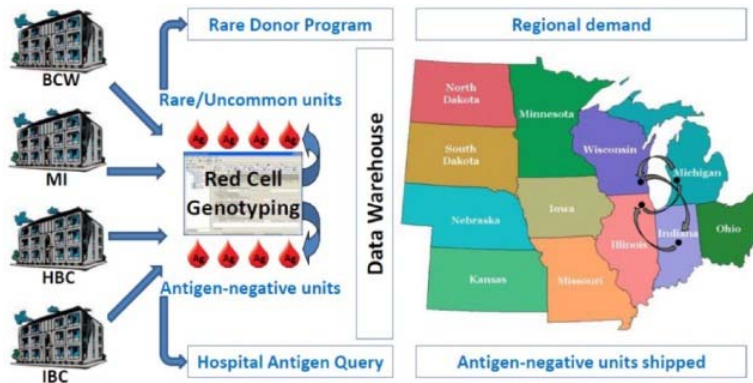
www.aabb.org

54

54

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/#>



www.aabb.org

57

57

Rare Donor Programs / Blood Supplier

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



www.aabb.org

58

58

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).



www.aabb.org

59

59

THANK YOU!!



www.aabb.org

60

60

Questions?

Contact
AABB eLearning Team
eLearning@aabb.org



www.aabb.org

Program is copyright 2020 by AABB with All Rights Reserved

61

61