Transfusion Medicine

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Transfusion Medicine Objectives

- Describe what “blood group” means
- Describe the antigens, antibodies and genes involved in the ABO blood group system, and explain the weird way the genes are expressed (hint: codominance)
- Explain how blood group antibodies work.
- Describe the antigens, antibodies, and genes involved in the Rh blood group system. How are the antibodies in this system different from the antibodies in the ABO system?
- Know what kind of blood you could transfuse into any patient (eg., what kind of blood could you transfuse into an AB+ patient?)

Transfusion Medicine Objectives

- List the types of transfusion reactions that can occur during or after blood transfusion, and know relatively how common they are (don't memorize numbers!)
- Compare and contrast acute and delayed hemolytic transfusion reactions (clinical presentation, usual blood group antigen responsible, where does hemolysis happen, which is more dangerous?)
- List the infectious agents that can be transmitted through blood transfusion, and know *in general* how common they are (don't memorize numbers!)

Transfusion Medicine Outline

Blood groups

- Introduction
- ABO system
- Rh system

Blood transfusion

- Blood products
- Testing
- Dangers

Transfusion Medicine Outline

Blood groups

- Introduction

Q. What determines a blood group?

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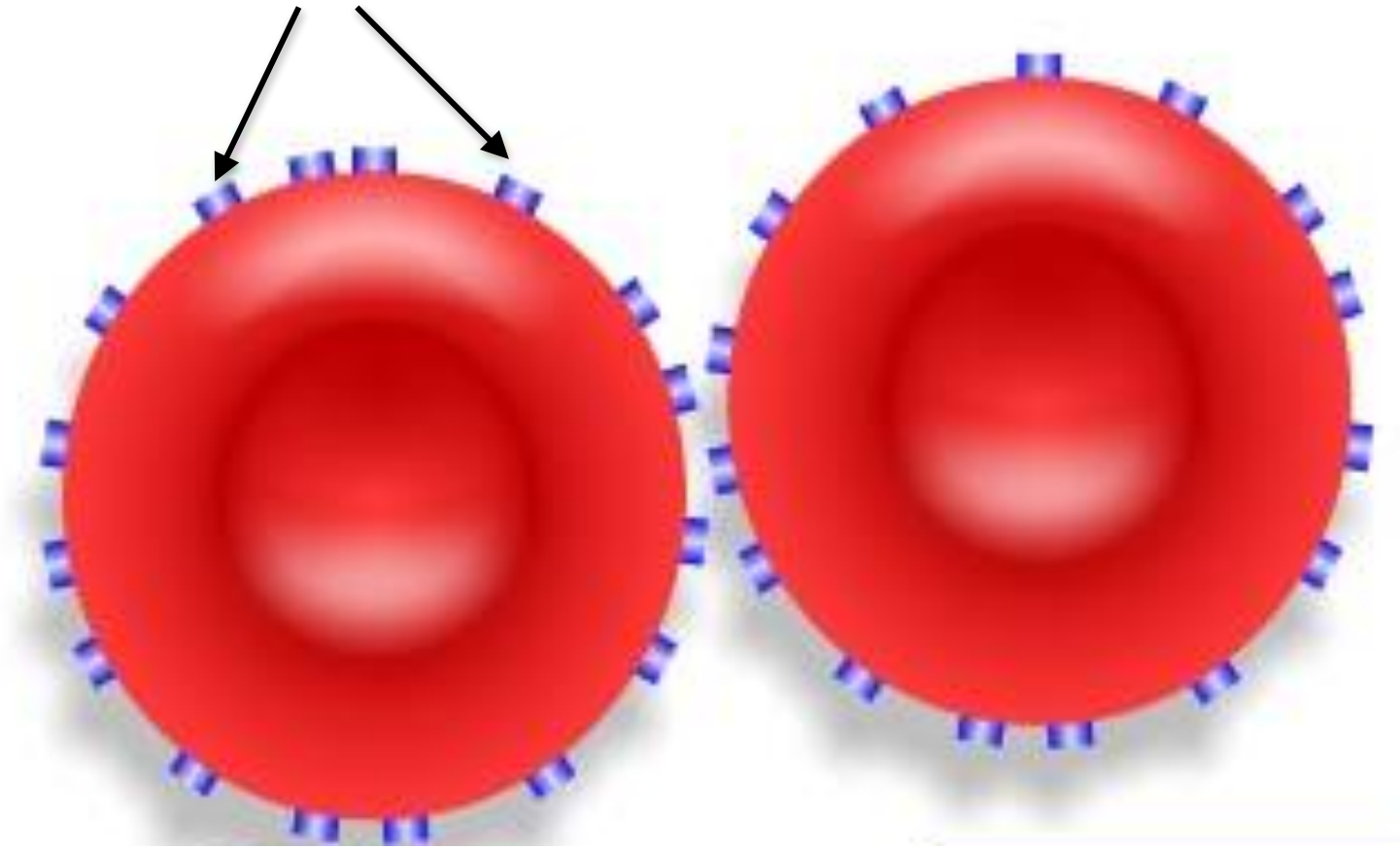
A. The antigens on the surface of the red blood cells!



What are red cell antigens?

- Antigens are inherited (Mendelian pattern)
- Real function unknown
- Damn important during transfusion
- Lots of antigens exist, grouped into systems)
- Most important systems: ABO and Rh

Transfusion Medicine Outline

Blood groups

- Introduction
- ABO system

What are the antigens in the ABO system?

- A and B
- Some people have A antigen (“type A”)
- Some people have B antigen (“type B”)
- Some people have both A and B (“type AB”)
- Some people have neither A nor B (“type O”)

Type A

Type B

Type AB

Type O

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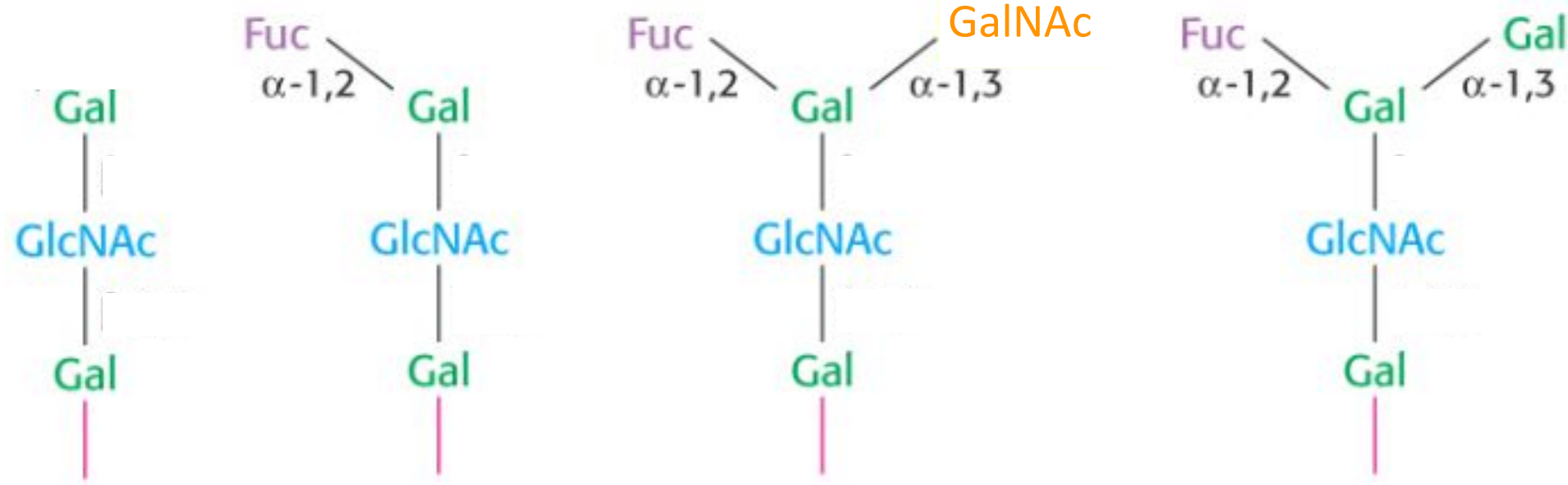
How do you make the antigens?

- Start with a protein precursor
- Add fucose to make H antigen
- Add N-acetylgalactosamine to H Ag to make A Ag
- Add galactose to H Ag to make B Ag

How do you make the antigens?



Precursor H antigen A antigen B antigen

Don’t memorize these molecular structures!
Just know that you start with a precursor molecule, then make H antigen, then A and/or B antigen depending on your genotype.

What are the genes in the ABO system?

H gene

- Everyone* has this gene
- Encodes the enzyme that makes the H antigen

A gene

- Encodes the enzyme that makes the A antigen

B gene

- Encodes the enzyme that makes the B antigen

O gene

- Encodes something clinically unimportant

*Almost! There are rare people who lack this gene.
Their red cells lack H, A, and B antigens, and are called “Bombay” phenotype

How does the gene inheritance work?

- There are three genes (besides H): A, B, and O
- Everyone inherits 2 genes, one from each parent
- So there are 6 possible genotypes:
  AA, AO, AB, BB, BO, and OO

The genes show codominance!

Neither gene is dominant or recessive - you express both.

(Remember: the O gene doesn't make an antigen)

Genotype	Antigens	Blood type
AA	A	A
AO		
BB	B	B
BO		
AB	A and B	AB
OO	None	O

So what?

- None of this would really matter much…except that we *automatically* have antibodies against the antigens we don't have!
- Anti-A antibodies lyse type A red cells.
- Anti-B antibodies lyse type B red cells.
- This is very important during blood transfusion.

	Red cells	Serum antibodies
Type A blood		
Type B blood		
Type AB blood		
Type O blood		

Genotype	Antigens	Blood type	Antibodies
AA	A	A	anti-B
AO			
BB	B	B	anti-A
BO			
AB	A and B	AB	none
OO	None	O	anti-A anti-B

Compatible blood types

Recipient blood type	Donor blood type
A	A or O*
B	B or O
AB	AB, A, B, or O
O	O

*Type O is the universal dOnor

The most important thing is to avoid giving donor red cells that will react against the recipient's antibodies!

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What are the antigens in the Rh system?

- Most important antigen: D!
- The D antigen is sometimes called “Rh factor”.
- “Rh” because discovered using Rhesus monkeys.
- Two genes: D and d.
- The D gene makes D antigen (these cells are called Rh+.)
- The d gene doesn’t make anything important (these cells are called Rh-)

Genotype	Antigens	Blood type
DD	D	Rh +
Dd	D	Rh +
dd	none	Rh -

What about anti-D (anti-Rh) antibodies?

- Antibodies in this system are *acquired*!
- To make anti-D you must:
  1. lack the D antigen on your red cells
  2. get exposed to D + blood
- Donor and recipient are tested for the D antigen.

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Blood transfusion

- Blood products

What do you mean, products?

- In olden times, there was only whole blood.
- Now, we separate blood into its components
- Better for the patient (less exposure to stuff you don't need - so you don't make unnecessary antibodies)
- Conserves blood supply

What are the products?

- Whole blood
- Red cells
- Platelets
- Granulocytes (basically, just neutrophils)
- Fresh frozen plasma (acellular)
- Cryoprecipitate (mostly just coagulation proteins)

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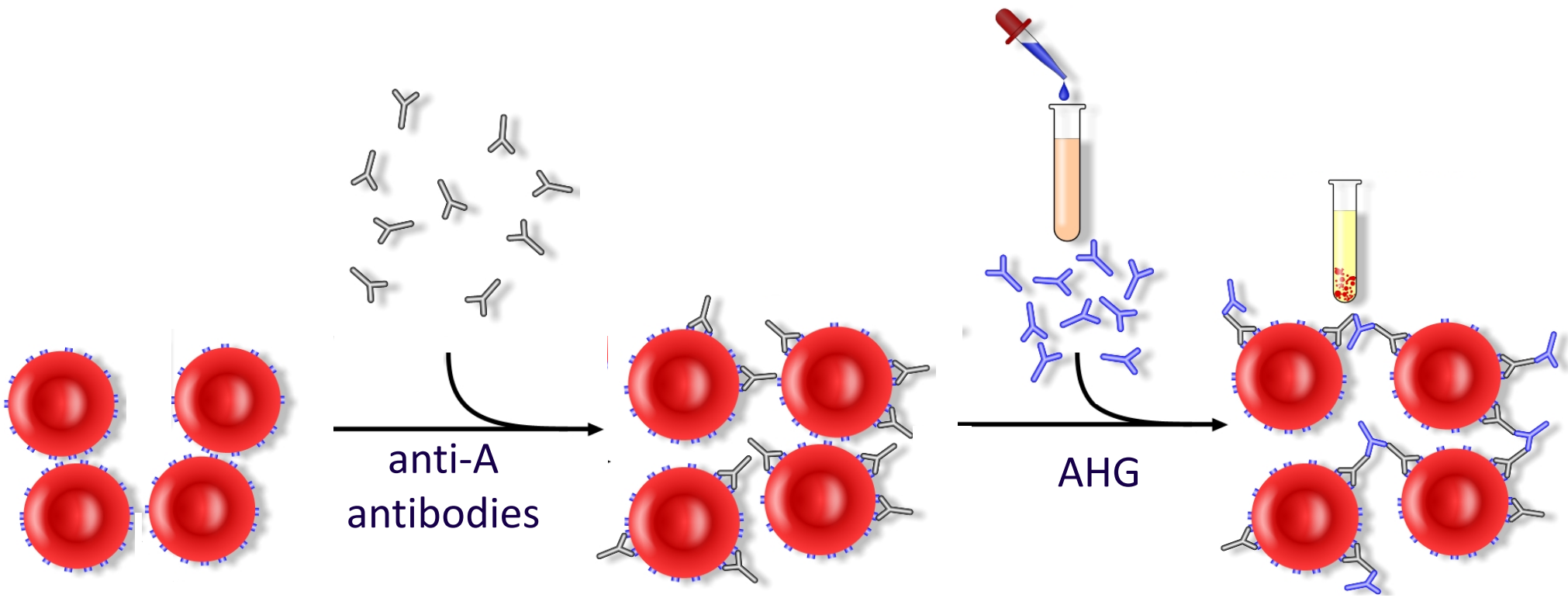
Forward Typing

This is done to find out what antigens are present on the patient's red cells



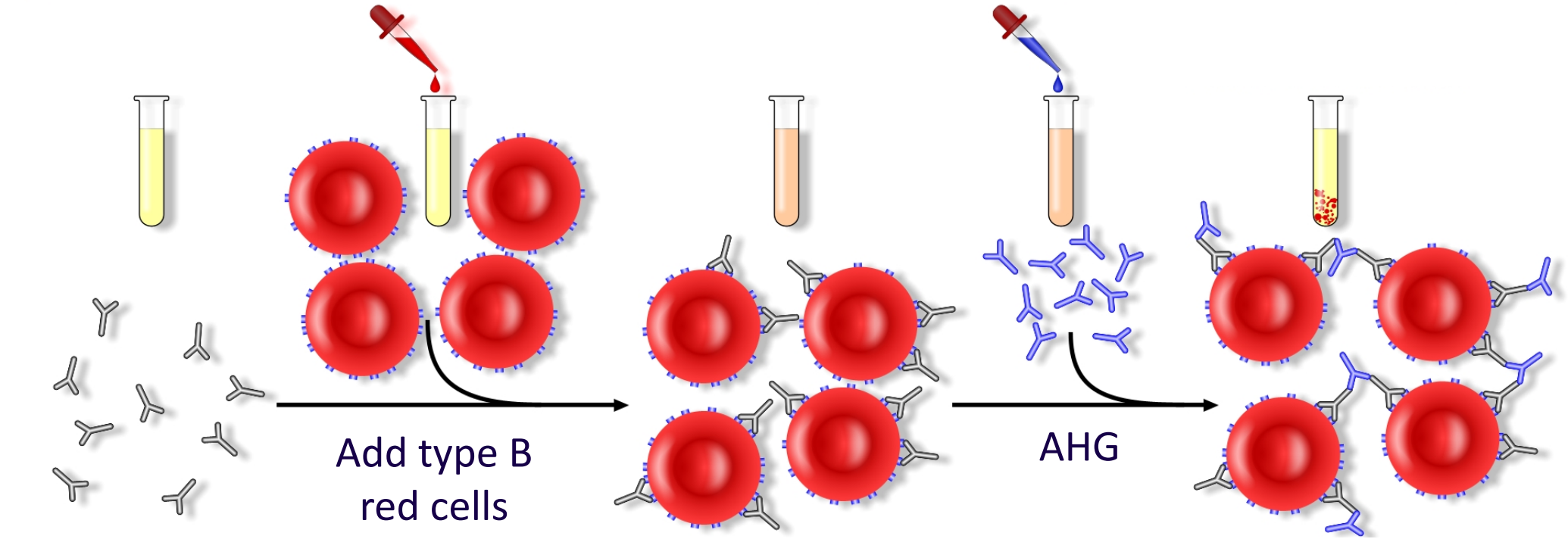
patient red cells (type A)

Positive test result: clumping of patient red cells!

Forward typing is done twice - once using anti-A antibodies, and then again using anti-B antibodies!

Reverse Typing

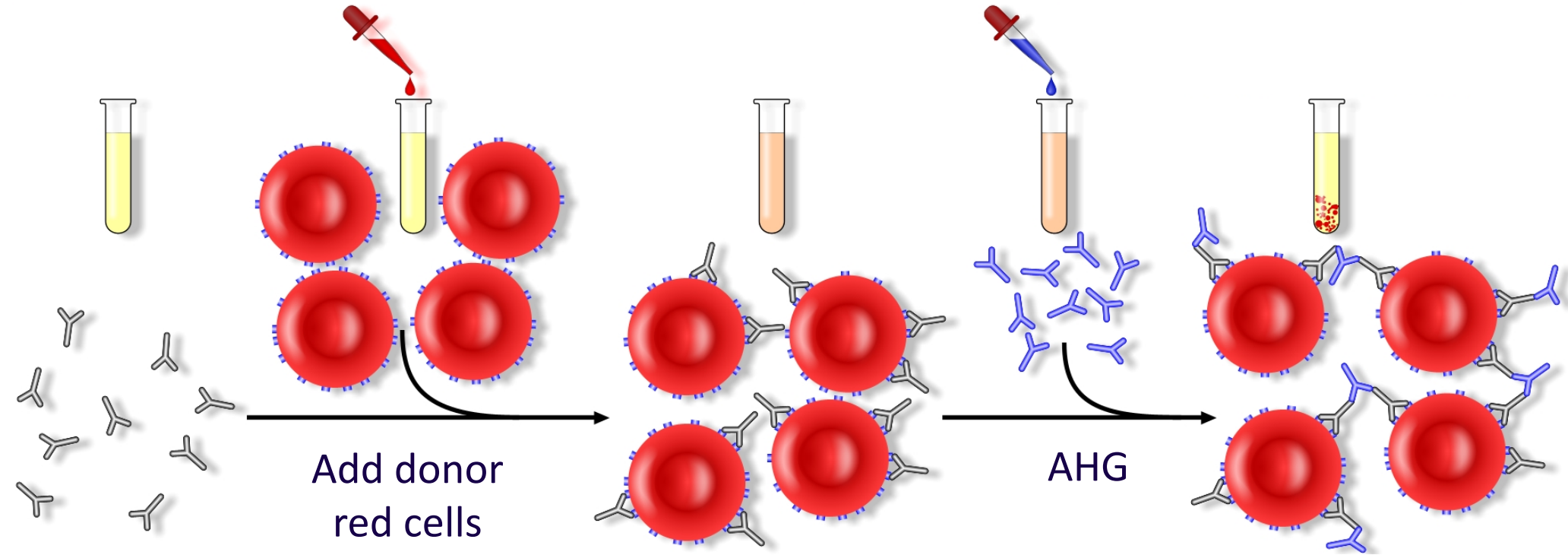
This is done to find out what antibodies the patient has in his/her serum!



Reverse typing is done twice - once using type A red cells, and then again using type B red cells!

Crossmatch

This is like a little mini-transfusion, done in the lab.



patient serum

Oh no!!
Clumping!

If you do a crossmatch, and it results in clumping of donor red cells,
you CAN'T give the patient those donor red cells!

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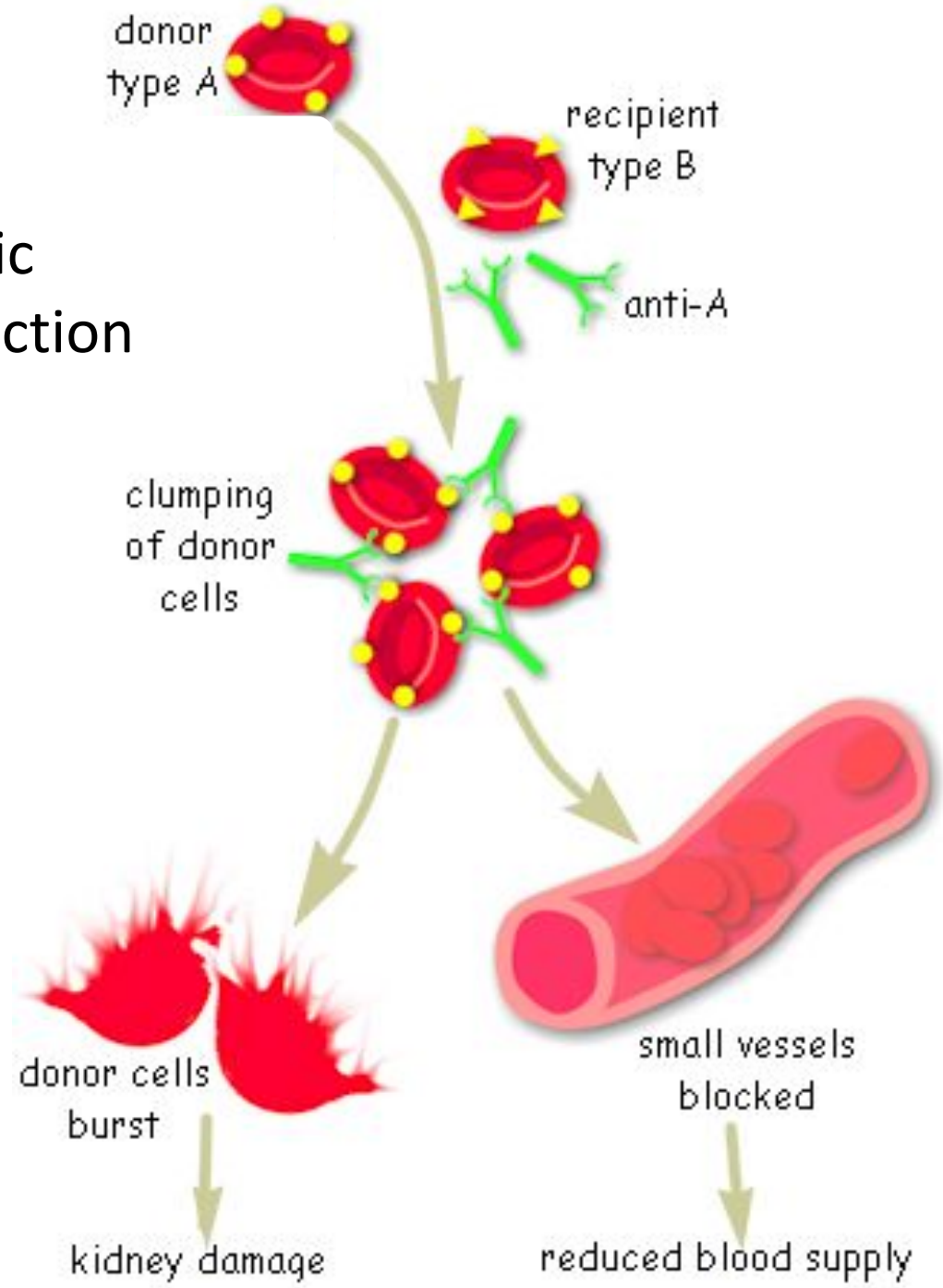
What can go wrong?

- Hemolytic transfusion reactions
  - Acute
  - Delayed
- Non-hemolytic transfusion reactions
  - Febrile
  - Allergic
- Infections

Acute hemolytic transfusion reactions

- Happen when patient has ABO antibodies against the donor red cells.
- Most common reason: clerical error!
- Symptoms: fever, chest pain, hypotension.
- Hemoglobin in serum, urine.
- Labs: ↓ haptoglobin, ↑ bilirubin, DAT positive.

Acute hemolytic transfusion reaction



Delayed hemolytic transfusion reactions

- Hemolysis occurs days after transfusion.
- Caused by antibodies to non-ABO antigens.
- Hemolysis usually happens in the spleen.
- Presentation: falling Hgb after transfusion.
- Usually not severe.

Non-hemolytic transfusion reactions

- Febrile (caused by recipient antibodies against donor WBC).
- Allergic (probably a reaction to donor plasma proteins).

What's the risk of transfusion reactions?

Complication	Risk
Allergic reaction	One in 100 (severe: one in 20,000)
Febrile reaction	One in 300,000
Delayed hemolytic transfusion reaction	One in 4,000 (fatal: one in 4 million)
Acute hemolytic transfusion reaction	One in 20,000 (fatal: one in 600,000)

Don't memorize exact numbers! Just know relative risk.

Infections

- Donor tests: HIV, HTLV, Hepatitis B and C, syphilis.
- Despite testing, these diseases can still transmitted.
- Other transmissible infections:
  - bacteria (dangerous!)
  - viruses (EBV, CMV)
  - parasitic diseases (malaria, Lyme disease)

What's the risk of infection?

Bug	Risk
Bacterial infection	One in 50,000 - 500,000 *
Hepatitis B	One in 300,000
Hepatitis C	One in 2 million
HIV	One in 2 million

Don't memorize exact numbers! Just know relative risk.

* 1 in 50,000 platelet transfusions; 1 in 500,000 RBC transfusions