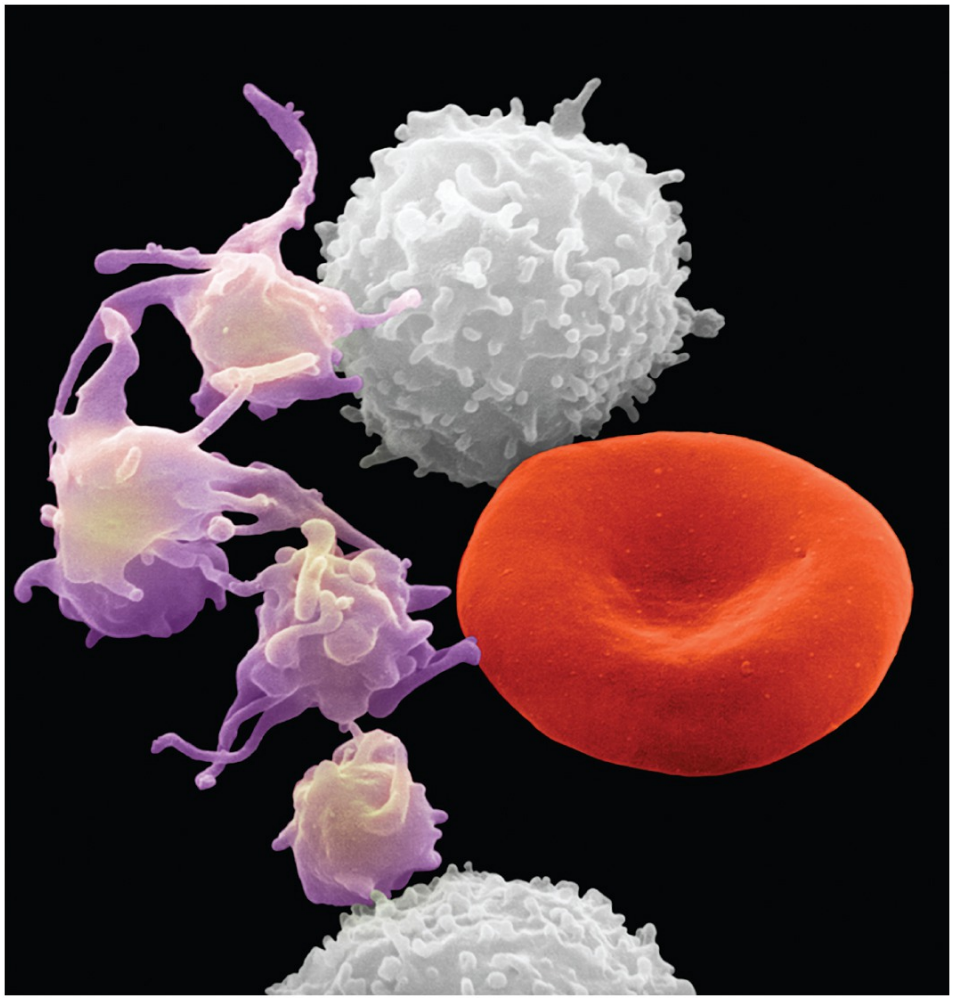
Chapter 18.5

Blood Types



RBC are defined by their antigens.

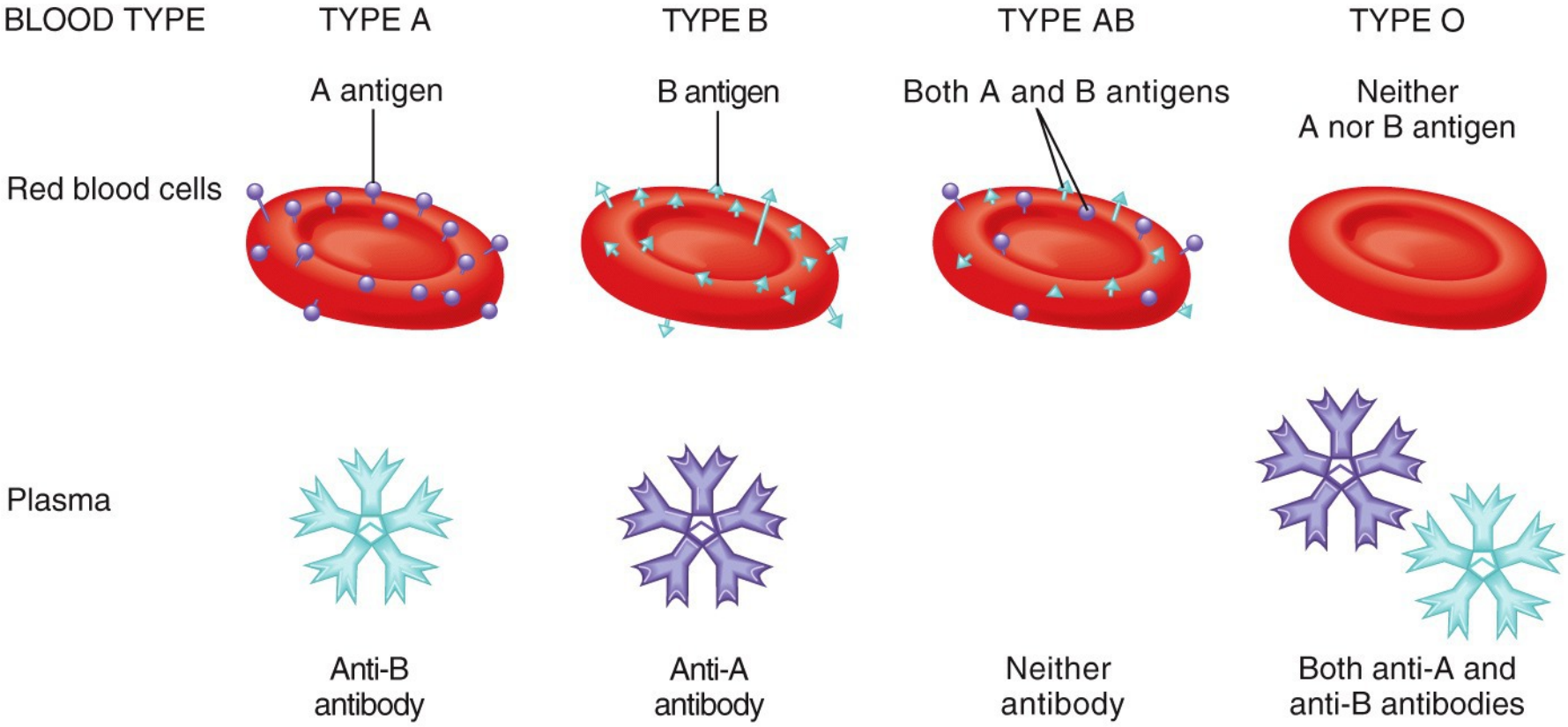
- Antigens are glycoprotein and glycolipid molecules (transmembrane molecules) on the surface of the RBC plasma membrane (i.e. part of the glycocalyx).
- These molecules are embedded in the plasma membrane of our RBC.
- All human cells, microbes, parasites, and viruses have antigen on their outer surface. Antigen on these cells function as an "identity molecule".
- Antigen allow our immune system to recognize between self vs non-self cells. Our immune system will attack non-self antigen and will not attack our cells with self-antigen.
- Red blood cells have a special group of antigens unique to RBC. These antigens are used to classify RBC into different blood groups (e.g. ABO and Rh blood groups). There are many other RBC antigens but the ABO and Rh are the most common and therefore the most problematic in medicine.
- So don't get confused and keep the different types of antigens separated: foreign antigens on pathogens, self-antigens on all our somatic cells, and the RBC antigens for blood cell identification.
- We will look at antigen functions in greater detail when we study the immune system.

Antigen & Antibodies in Blood Types

- Blood transfusion compatibility is dependent upon the interactions between antibodies (in the blood plasma) and antigen (on the RBC)
- Karl Landsteiner discovered blood types A, B and O in 1900 // won Nobel Prize for discovery
- A antigen on type A RBC / B antigen on type B RBC / AB antigens on type AB RBC // if RBC has no antigen then RBC is type O
- Antibodies may be either anti A or anti B
- agglutinogens also called antigens (located on plasma membrane)
- agglutinins also called antibodies (circulating in plasma, lymph, and tissue fluid)

Antigens VS Antibodies

(Agglutinogens VS Agglutins)

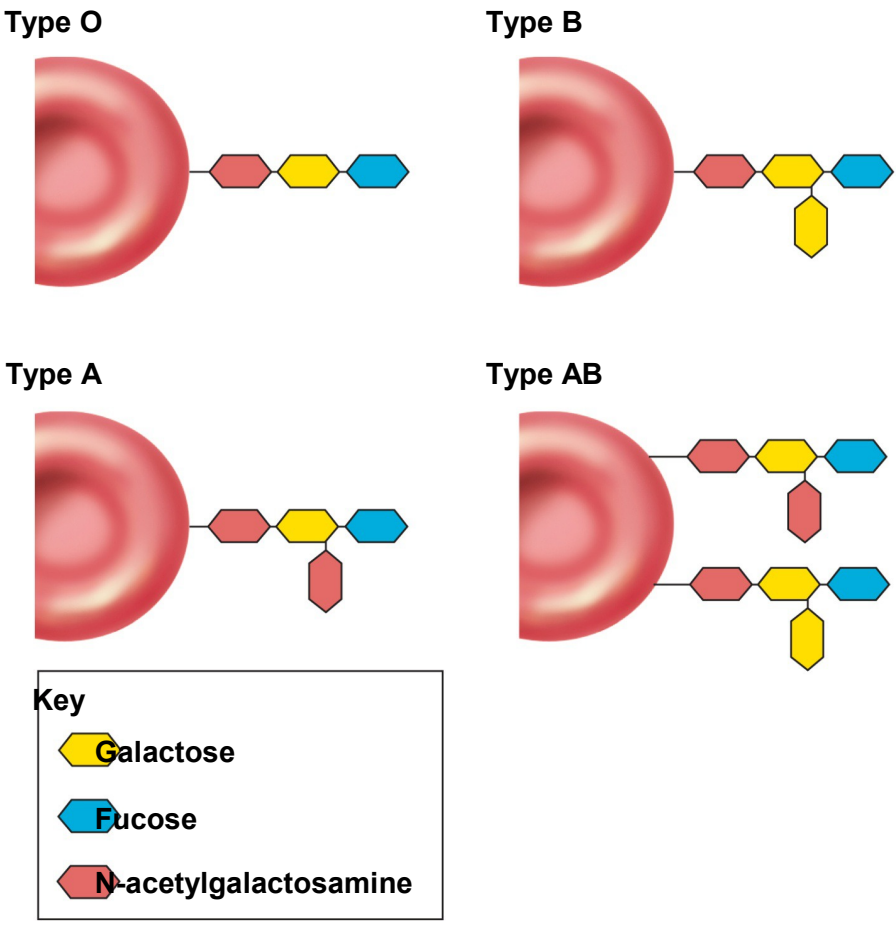


> How many different antigens?
> How many blood types?
> Where is the antigen located?
> How are antibodies matched to RBC antigen?

Agglutinogens VS Agglutins

- antigens are also called agglutinogens // located on outer surface of RBC plasma membrane
  - antigen A or antigen B
  - determined by carbohydrate moieties found on RBC surface

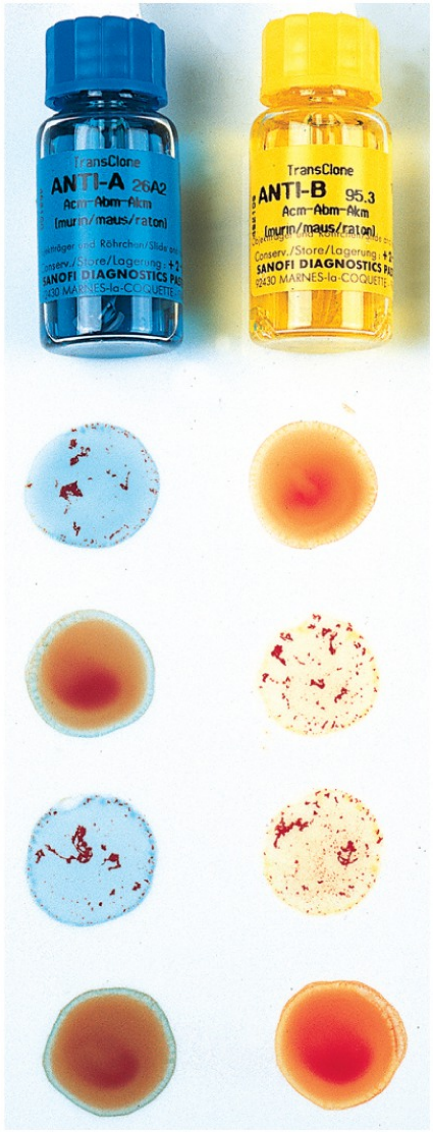
- antibodies are also called agglutinins // found in plasma
  - anti-A and anti-B



ABO Group

- your ABO blood type is determined by presence or absence of antigens (agglutinogens) on RBCs
  - blood type A person has A antigens
  - blood type B person has B antigens
  - blood type AB has both A and B antigens
  - blood type O person has neither antige

ABO Blood Typing



Use purified antibody (Anti A or Anit B) to test and determine the RBC blood group.

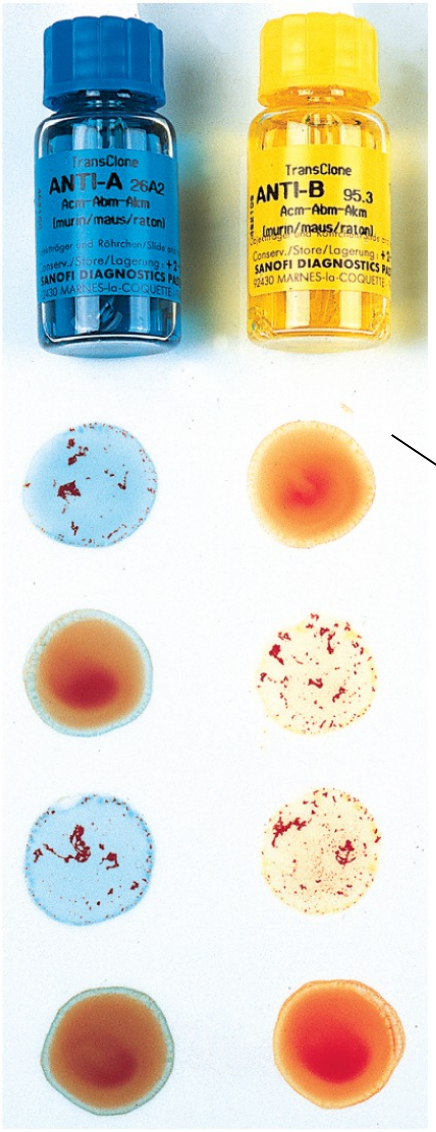
The antibody will only “agglutinate” (clump together) the RBC if the antibody is “matched” to the antigen.

When this occurs the “M class antibodies” wil also initiate a process to break apart the RBC. This releases the hemoglobin from the RBC.

ABO Blood Typing

Aglutinin A

(antibody A)

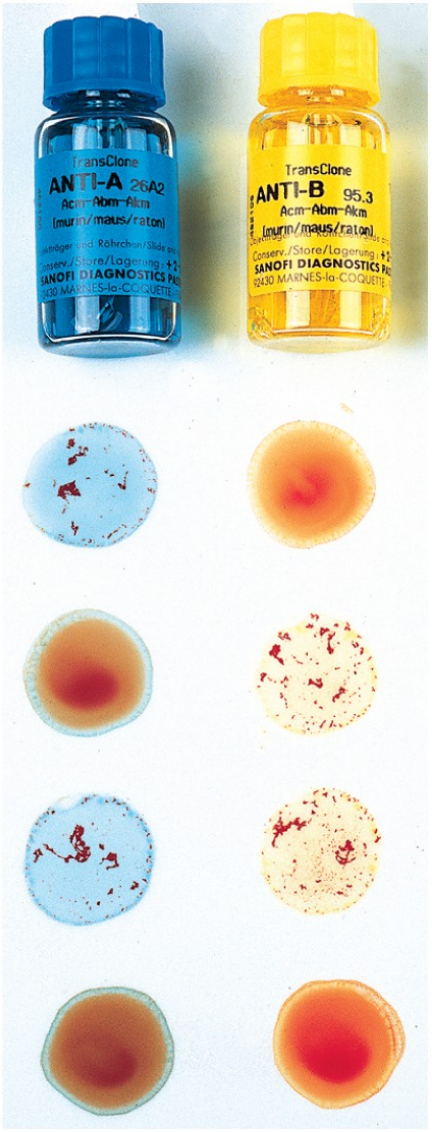


Aglutinin B

(antibody B)

What is the blood type of these blood samples?

ABO Blood Typing



Type A

Type B

Type AB

Type O

Blood Antigens and Antibodies

- Agglutinogens (antigens)
  - complex molecules on surface of cell membrane that are unique to every individual (accept identical twins!)
  - special group of agglutinogens (antigens) on the surface of the RBC is the basis for blood typing
  - foreign antigens are able to generate an immune response
  - RBC antigens are A or B.
  - Possible cominations: A, AB, B,
  - Type O = no antigen

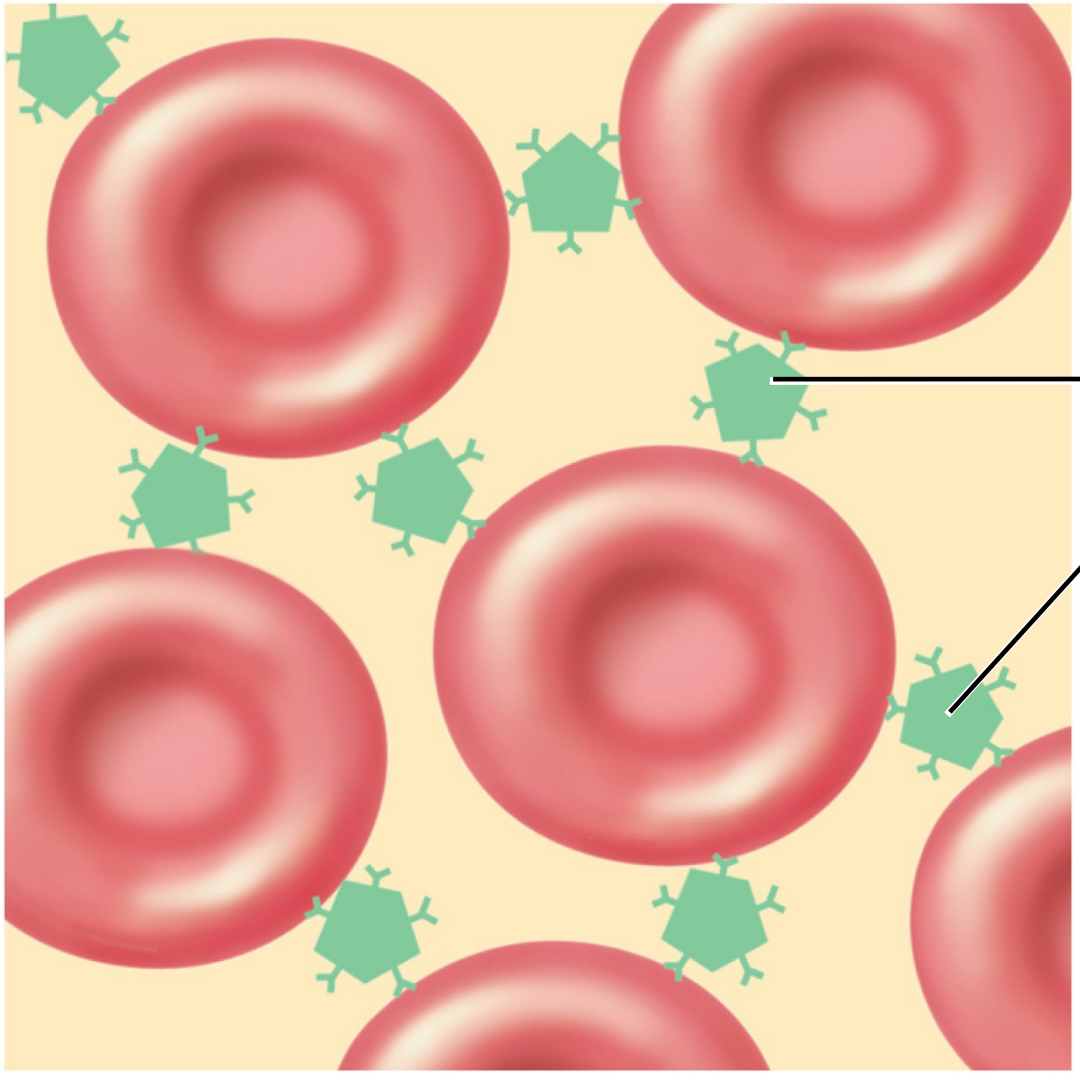
Blood Antigens and Antibodies

- Aglutinin (antibodies) associated with blood typing
  - In blood chemistry we make antibodies only if we do not have the antigen on our RBC!
  - if RBC has neither A or B aglutinogen then we will have both antibody A and antibody B circulating in our blood
  - mismatch blood transfusions can lead to organ damage and death // agglutinins in the recipient's plasma will bind to donor's RBC

Blood Antigens and Antibodies

- Agglutination
  - antibody molecule binding to antigens (e.g. A antibody binds to A antigen) // one M class antibody can bind to 10 different RBC
  - causes agglutination of red blood cells
  - clumped cells block capillaries // infraction occur to damage organs // kidneys especially vulnerable to this type of damage
  - agglutinated RBCs block small blood vessels
  - antibodies hemolyze RBC and release hemoglobin from RBC over the next few hours or days // fever
  - Hb blocks kidney tubules and causes acute renal failure

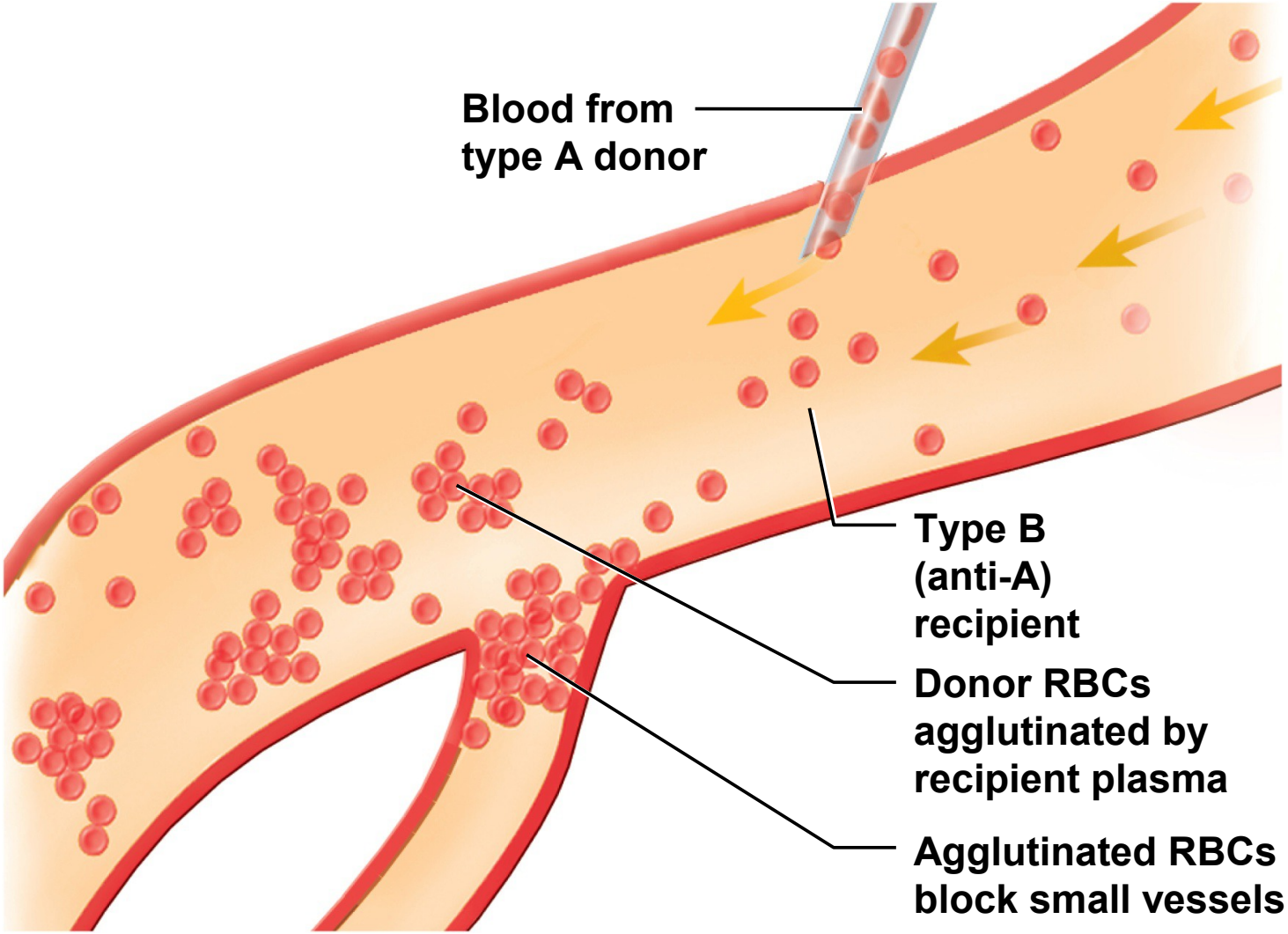
Agglutination of Erythrocytes



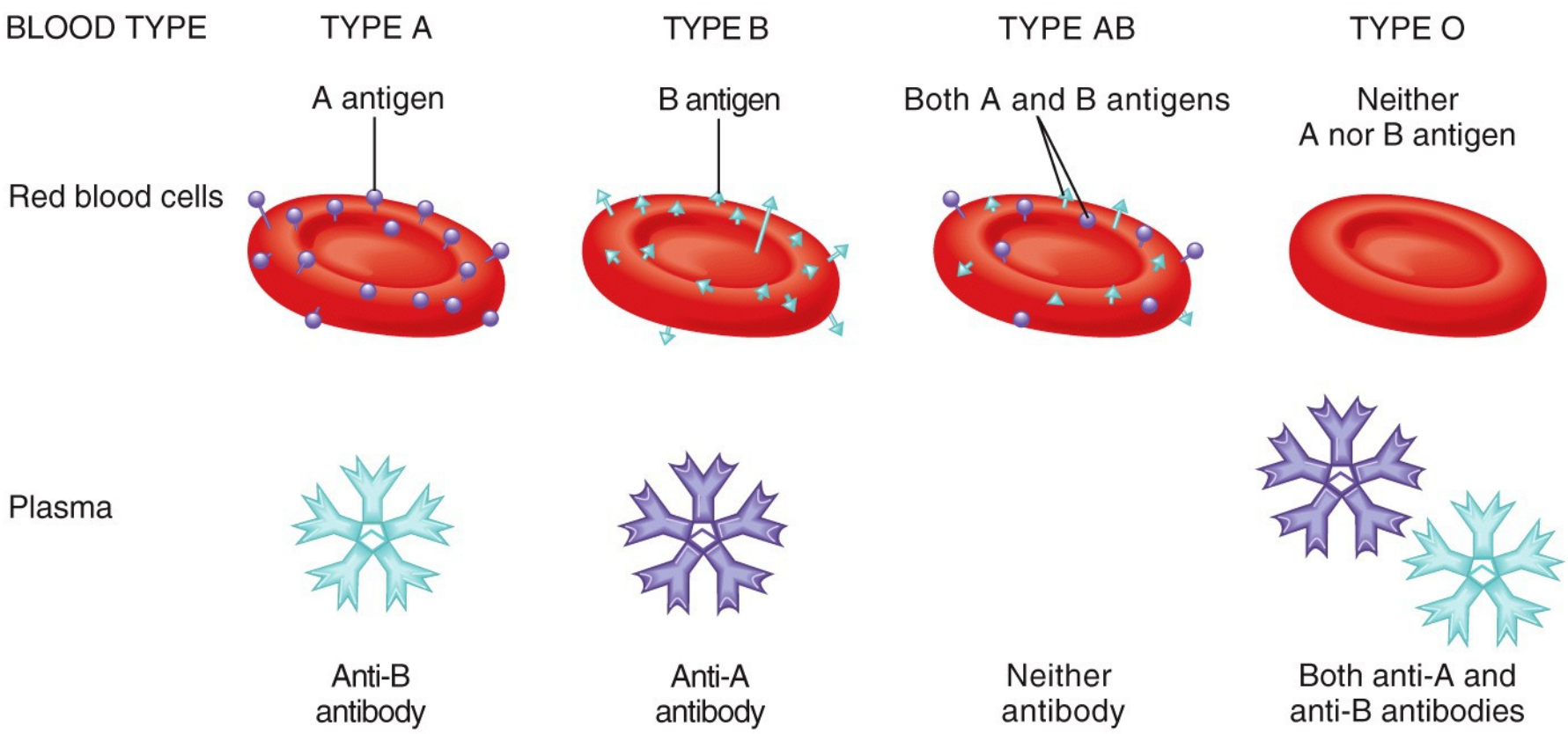
Antibodies (agglutinins)

An M class antibody complex is made by joining five antibodies together. Each antibody may bind two antigens or clump together 10 RBC

Transfusion Reaction



Agglutinogens VS Agglutins



Universal Donors and Recipients

- Universal donor
  - Type O // most common blood type
  - No antigen on RBC
  - However, this donor's plasma will have both plasma antibodies (anti-A and anti-B)
  - To minimize affect of antibodies give packed cells (minimum or no plasma volume)

Universal Donors and Recipients

- Universal recipient
  - Type AB // rarest blood type
  - Host does not have any plasma antibodies
  - No anti-A or anti-B

When Do Plasma Antibodies Form

- appear in plasma 2-8 months after birth
- maximum concentration at 10 yr.
- You will never form antibodies matched to the antigen on your RBC
- you will only make plasma antibody that are not present on your RBC
- these rules apply to the ABO system
- different rules apply for Rh factor antigen and Rh antibodies

Rh Antigen = Blood Type +

- Rh agglutinogens (antigens) discovered on rhesus monkey's RBC in 1940 // other "minor" RBC antigen-antibodies have been discovered
  - after the ABO system the Rh D is the most problematic of these RBC antigens
  - Patient considered blood type Rh^+ if they have D antigen (agglutinogens) on their RBCs
  - Rh frequencies vary among ethnic groups
  - You may have the A and B antigens with the Rh antigen // the presence of the Rh factor is denoted by the positive symbol (eg. A+)

Rh Blood Type

- Rule 1 = Anti-D agglutinins (antibodies) are never present in the blood at birth. This is true both for Rh+ and Rh- individuals.

- Rule 2 = Only an Rh negative person may be sensitized after birth by being exposed to a RBC with the Rh antigen.

- Exposure to RBC with Rh antigen will cause the Rh negative person to make Rh antibodies in their plasma. Now, if more RBC with Rh antigen enters their blood the Rh antibodies will attack these cells.

- Rh negative individuals may be sensitized to form anti-D antibodies in these two situations:

  - 1 = Rh^- woman carries an Rh^+ fetus / at birth fetal blood sensitizes mother.

  - 2 = Rh negative person receive transfusion from a Rh^+ donor

  - There is no problem at time of this first exposure /// It takes time to develop antibodies // only after Rh negative person has time to make antibodies and there is a second exposure to Rh+ RBC will there be an agglutination condition

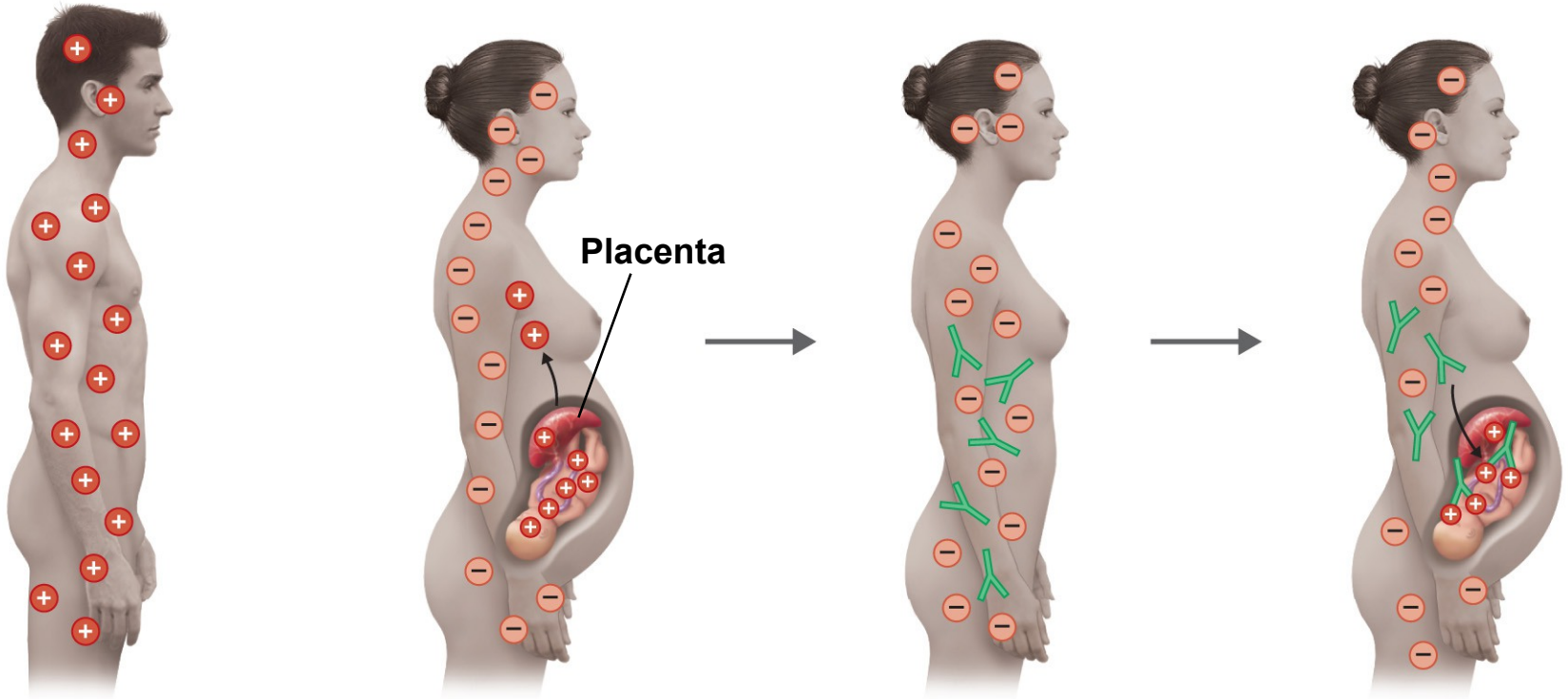
Hemolytic Disease of Newborn

- Two conditons may cause this situation
  - Rh- pregnant woman sensitized by her Rh^+ fetus // anti-D antibodies can cross placenta
  - received blood transfusion Rh+ RBC
  - forms antigen-antibody complex in fetal blood / hemolyze fetal RBC

Hemolytic Disease of Newborn

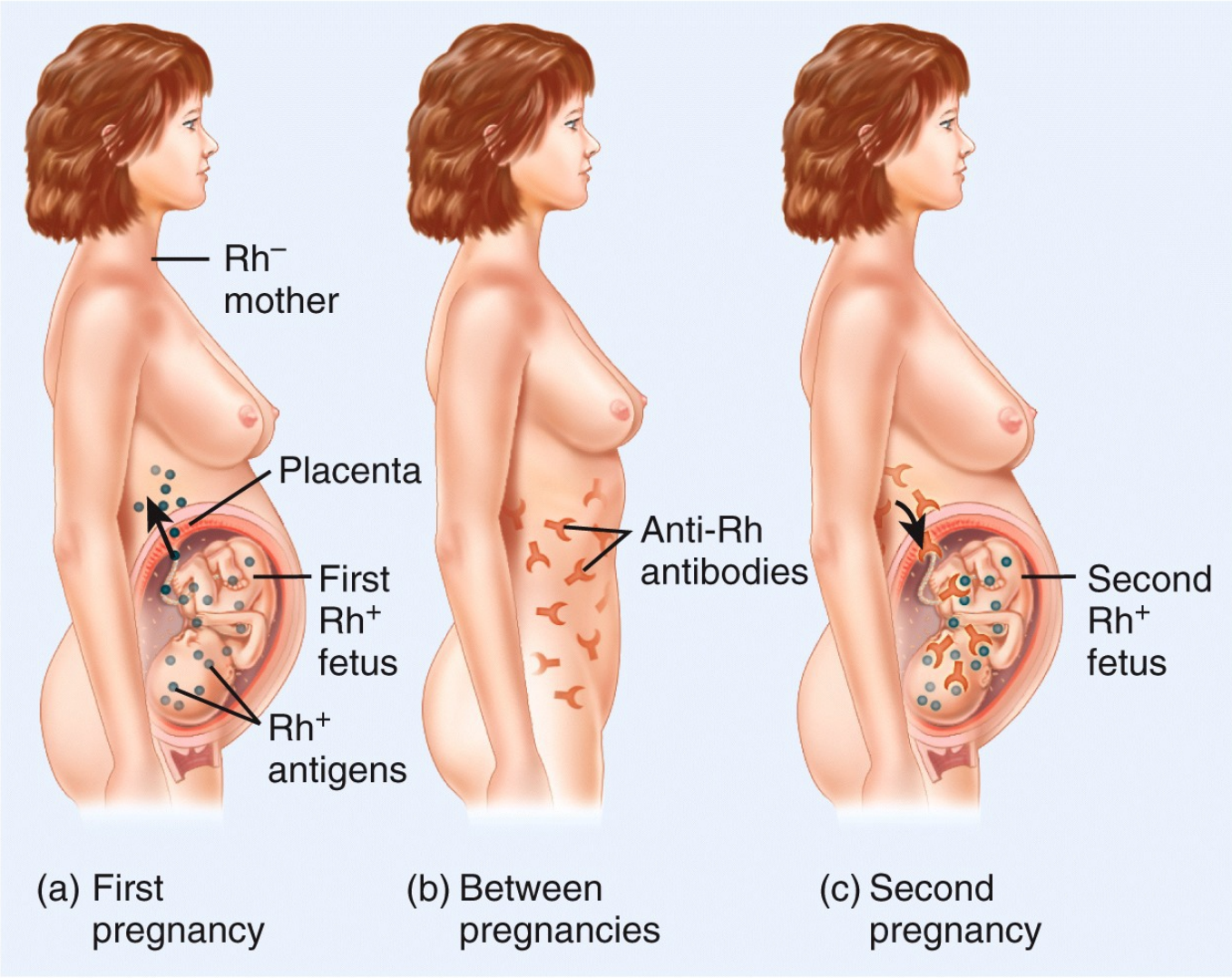
- How do we to prevention this condtion?
  - RhoGAM // given to pregnant Rh^- women right before delivery
  - RhoGAM binds any fetal Rh antigen that may mix with maternal blood
  - Rh+ RBC can not sensitize (expose) mother to antigen (RhoGam binds to antigen and covers the Rh antigen so it is not able to sensitize mother during delivery)
  - Mother will not make Anti-D antibodies

Hemolytic disease of the newborn.



1. Rh^+ father.
2. Rh^- mother carrying her first Rh^+ fetus. Rh antigens from the developing fetus can enter the mother's blood during delivery.
3. In response to the fetal Rh antigens, the mother will produce anti-Rh antibodies.
4. If the woman becomes pregnant with another Rh^+ fetus, her anti-Rh antibodies will cross the placenta and damage fetal red blood cells.

Hemolytic Disease of Newborn



- Rh antibodies attack fetal blood

causing severe anemia and toxic brain syndrome // erythroblastosis fetalis