

UNIT VI
Chapter 36:

GUYTON AND HALL
TEXTBOOK OF **MEDICAL PHYSIOLOGY**
THIRTEENTH EDITION



Blood Types; Transfusion; Tissue
and Organ Transplantation

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Early transfusions

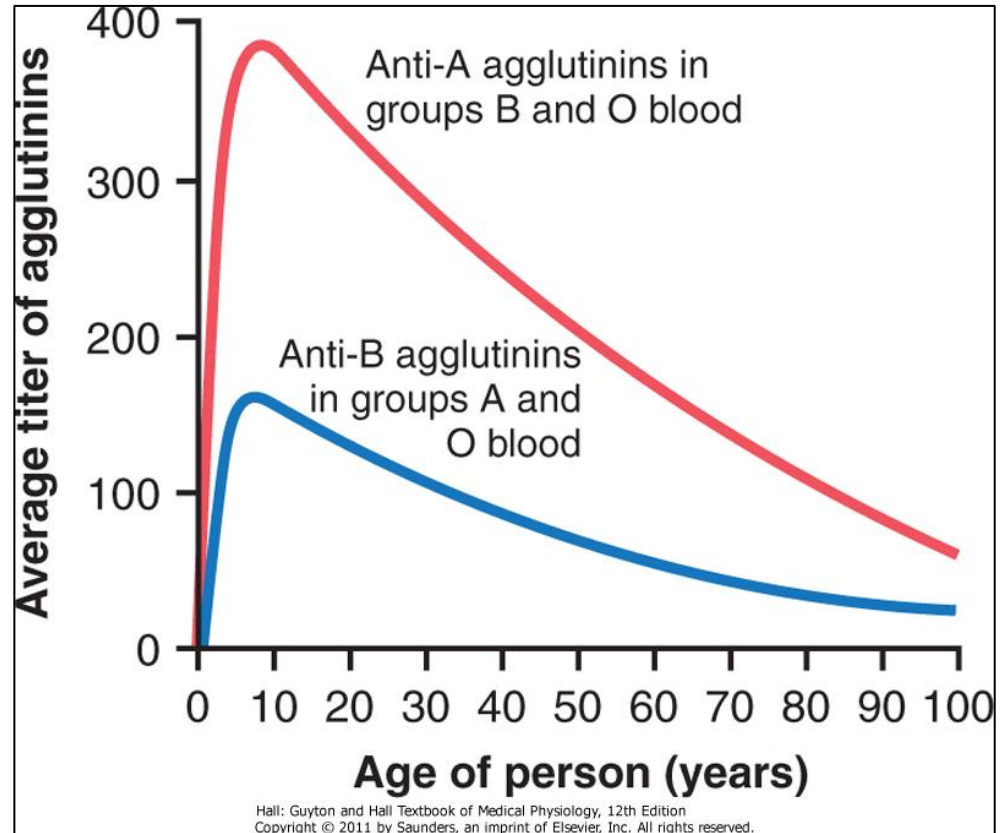
- **Red cell agglutination and lysis**
- **Severe transfusion reactions, often fatal**
- **In other cases, well-tolerated and beneficial**
- **Led to the discovery of red blood cell antigens and the practice of cross-matching**
- **>30 common antigens, many rare ones**

The ABO System

- **Red blood cell surface antigens: glycolipids or glycoproteins**
- **Present on all cells in the body, not just blood cells**
- **Agglutinogens: surface antigens (A,B)**
 - **Genes: A, B, O (maternal, paternal alleles)**
 - **Genotypes: OO, OA, OB, AA, BB, AB**
- **Agglutinins (immunoglobulins): anti-A, anti-B**
 - Occurance:
 - O: 47%
 - A: 41%
 - B: 9%
 - AB: 3%

Agglutinins

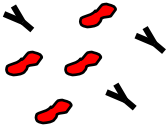
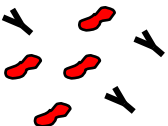

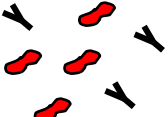
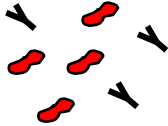



- **Antibodies, mostly IgM and IgG**
- **Begin developing age 2-8 months, peak ~age 10 years**
- **Response to A and B antigens in foods, bacteria; initial exposures are environmental**



Blood Groups

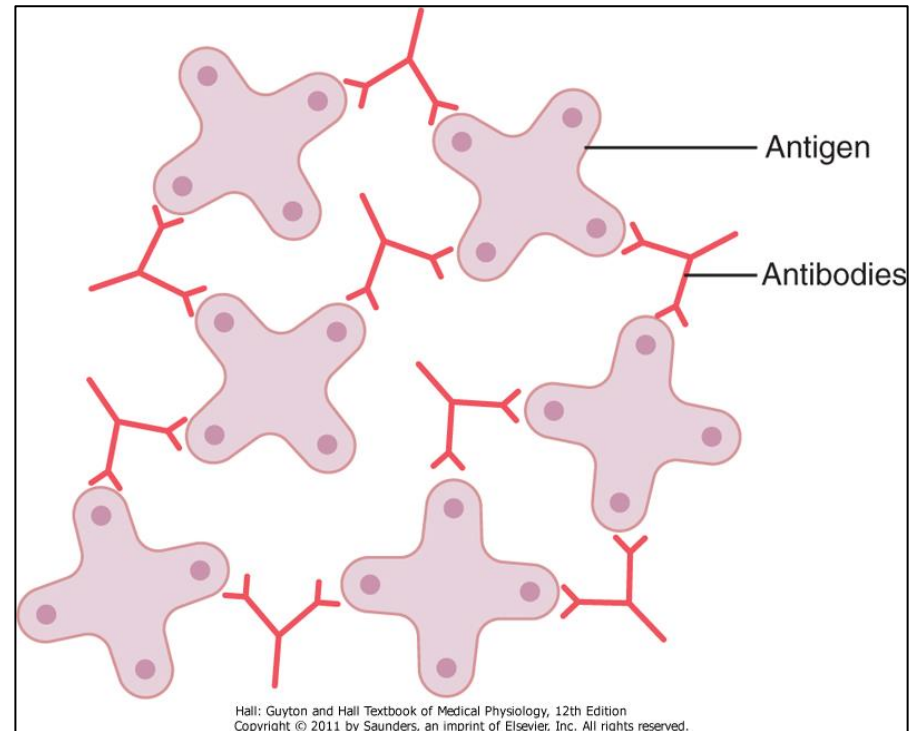
Genotype	Blood Type	Agglutinogens	Agglutinins
OO	O	-----	ANTI-A and ANTI-B
OA or AA	A	A	ANTI-B
OB or BB	B	B	ANTI-A
AB	AB	AB	-----

Blood Typing

Blood Type	Anti-A	Anti-B
O		
A		
B		
AB		

Transfusion reactions

- Red cells agglutinate
- Plug small vessels
- Physical distortion,
phagocytic attack
→ hemolysis
- In some cases,
immediate,
complement-
dependent hemolysis
(depends on Ig type
...IgM
“hemolysins”)



The Rh (rhesus) antigens

- **Requires prior exposure to incompatible blood**
- **Six common antigens (“Rh factors”)
C, D, E, c, d, e**
 - **Each person is CDE, CDe, Cde, CdE, cDE, cDe, or cde**
- **D (“Rh positive”) is prevalent (85% EA, 100% Africans) and particularly antigenic**
- **C and E can also cause transfusion reactions, generally milder**

Anti-Rh Transfusion Reactions

- **Rh+ blood into Rh- recipient:**
 - **delayed mild transfusion reaction**
 - **sensitization to further Rh+ transfusion**
 - **agglutinins peak after 2-4 months**
- **50% of Rh- are sensitized by 1st exposure**
 - **20% after a second exposure**
 - **30% are non-responders**
- **Rh matching to prevent immunization**

Anti-Rh Transfusion Reactions

- **Naïve Rh- recipient**
 - usually no reaction initially
- **Within 2-4 weeks sufficient Ig for agglutination**
 - delayed reaction, usually mild hemolysis within tissue macrophages
- **Any subsequent transfusion with Rh+ blood**
 - potentially severe transfusion reaction



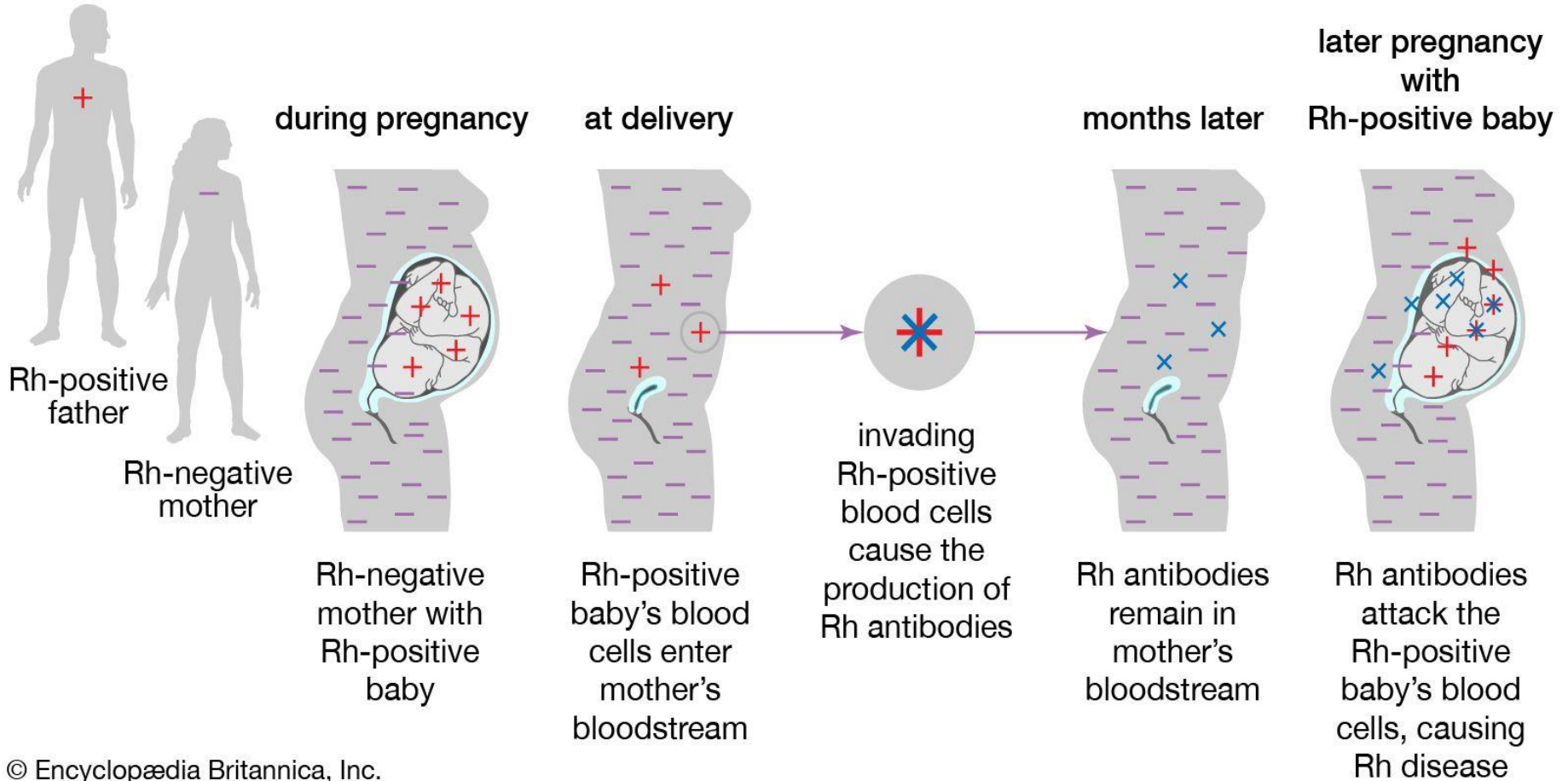
Clinical
Perspective

Hemolytic Disease of the Newborn (Erythroblastosis fetalis)

- **ABO incompatibility (O mother and A or B fetus)**
 - **Unusual:**
 - **Most anti-A is IgM, does not cross placenta**
 - **ABO antigens not well developed in fetus**
- **Rh incompatibility (RhD+ fetus and Rh- mother)**
 - **Immunization due to fetal-maternal bleeding during delivery**
 - **Mother develops Anti-D agglutinins**
 - **Usually not a problem with first pregnancy**
 - **Worse with subsequent pregnancies**
(3% EF second pregnancy, 10% with third)

Hemolytic Disease of the Newborn (Erythroblastosis fetalis)

How Rh hemolytic disease develops





Clinical
Perspective

Hemolytic Disease of the Newborn (Erythroblastosis fetalis)

- **Maternal antibodies cross the placenta and cause agglutination and lysis of fetal erythrocytes**
- **Fetal macrophages convert hemoglobin to bilirubin → jaundice**
- **Anemic at birth; continued hemolysis 1-2 months**
- **Hepato- splenomegaly from extramedullary erythropoiesis**
- **May have permanent neurologic damage from deposition of bilirubin in neural tissues (“kernicterus”)**



Clinical
Perspective

Hemolytic Disease of the Newborn: Treatment

- **Repetitive removal of Rh-positive blood, replacement with Rh negative (400 ml exchange over 90 minutes)**
- **May be done several times over a few weeks**
- **Maternal antibodies disappear over 1-2 months so newborn's Rh-positive cells cease to be a target**



Clinical
Perspective

Hemolytic Disease of the Newborn: Prevention

- **Provide exogenous anti-D antibodies to the mother in late pregnancy and just after birth**
- **These bind to D antigenic sites on fetal erythrocytes that enter the mother's circulation, preventing an immune response**



Clinical
Perspective

Blood Component Transfusion

- **Single donation is 450 ml**
- **Processed into components**
 - **Packed Red Cells; Stored ~ 30- 40 days**
 - **Plasma (clotting factors); Frozen**
 - **Platelets; Stored for 8-10 days**
 - **White blood cells; Rarely used**

Transfusion Reactions

- **Occur because of mismatched blood**
- **Recipient antibodies react against donor antigens**
- **Either immediate or delayed agglutination and hemolysis**
- **Fever, chills, shortness of breath; potentially shock, renal shutdown**
- **Macrophages produce bilirubin**
- **With normal liver function, no jaundice unless ≥ 400 ml blood hemolyzed in < 1 day**



Clinical
Perspective

Acute Renal Failure After Transfusion Reaction

- **Products of hemolysis cause powerful renal vasoconstriction**
- **Immune-mediated circulatory shock**
- **Free hemoglobin can leak through glomerular membranes into tubules**
 - **high quantities may block tubules**
- **May require acute or even chronic hemodialysis**