

# Overview of Therapeutic Apheresis (TA)

# History



***Apheresis  
(Greek Term) =  
Removal or Withdrawal***

# Definition of a TA Procedure

The removal of a blood component from a patient using apheresis technology for the purpose of removing defective cells or depleting a disease mediator

# Rationale For Performing TA Procedures

- An apheresis procedure can more effectively remove a pathogenic substance in the circulating blood that contributes to a disease state than the body's own homeostatic mechanisms
- The patient may benefit from both the removal of the blood component and the fluid given as replacement

# Types of TA Procedures

- Therapeutic Plasma Exchange (TPE)
- Red Blood Cell Exchange (RBCX)
- Cellular Depletions

# Therapeutic Plasma Exchange (TPE)

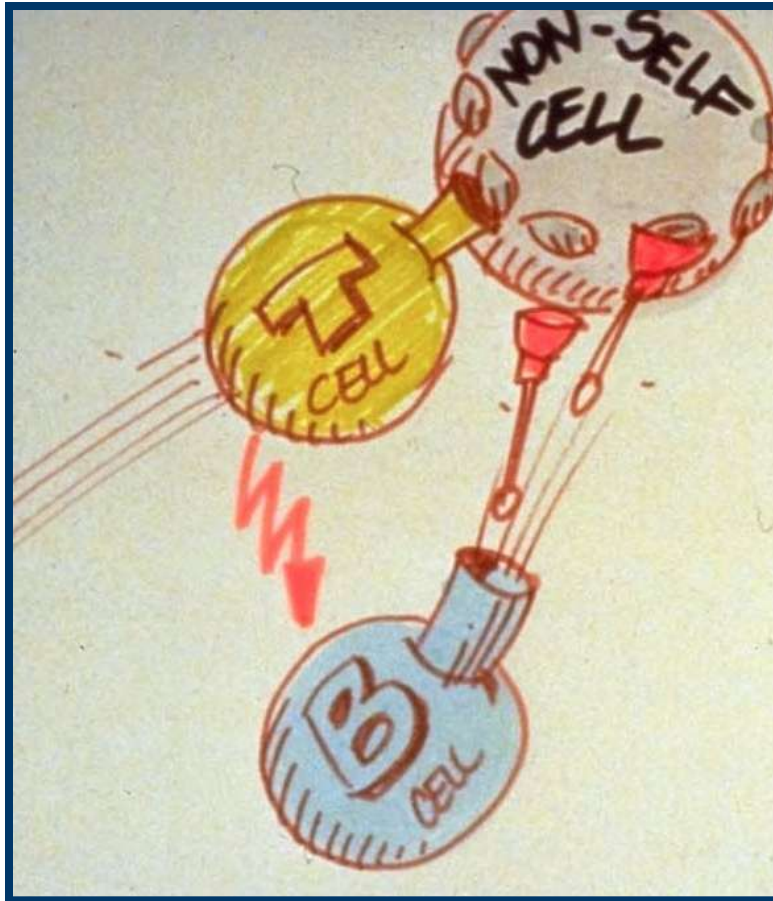
- The removal of large volumes of patient plasma and replacement of the plasma with appropriate fluids
- Specialty areas include:
  - Renal and metabolic diseases
  - Hematologic diseases
  - Neurologic disorders

# Therapeutic Plasma Exchange

- The most common use of TPE is for the treatment of autoimmune or immune mediated diseases or disorders
- TPE removes:
  - Monoclonal antibodies
  - Paraproteins
  - Autoimmune antibodies
  - Antigen-antibody complexes



# Normal Immune Response



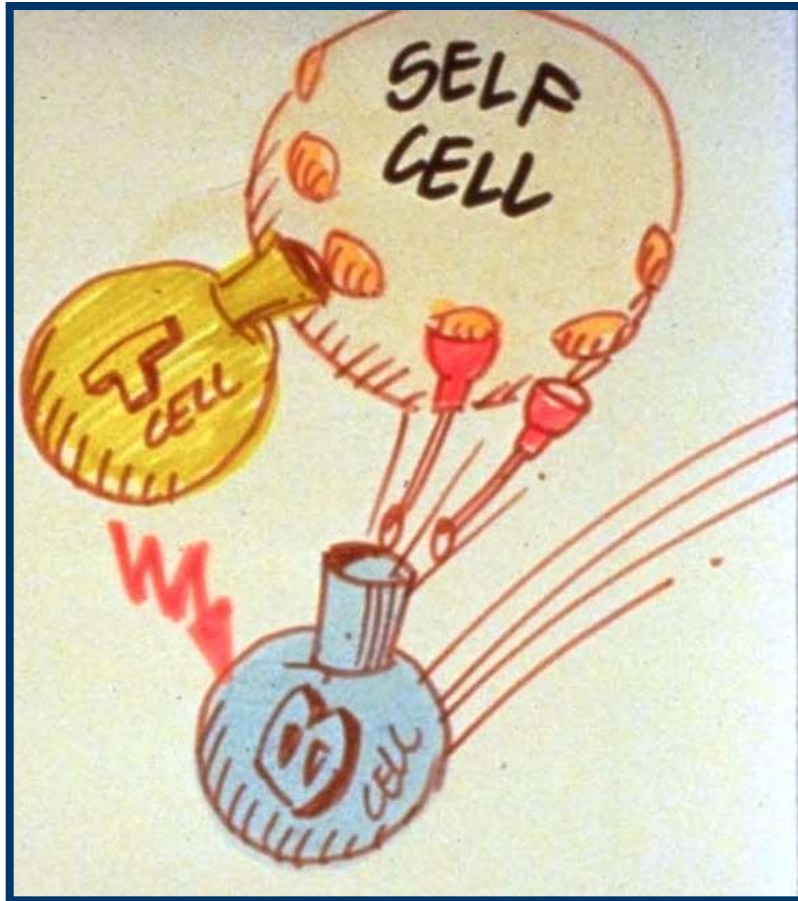
1. Antigen presenting cells(APC's) engulf foreign antigens
2. APCs "present" antigen to T cells
3. T cells initiate cellular immune response and signal B cells to proliferate and produce antibodies
4. Cell and antibody mediated immune responses destroy non-self cell and cause inflammatory effects:
  - Fever
  - Pain
  - Swelling



# Autoimmune Disease

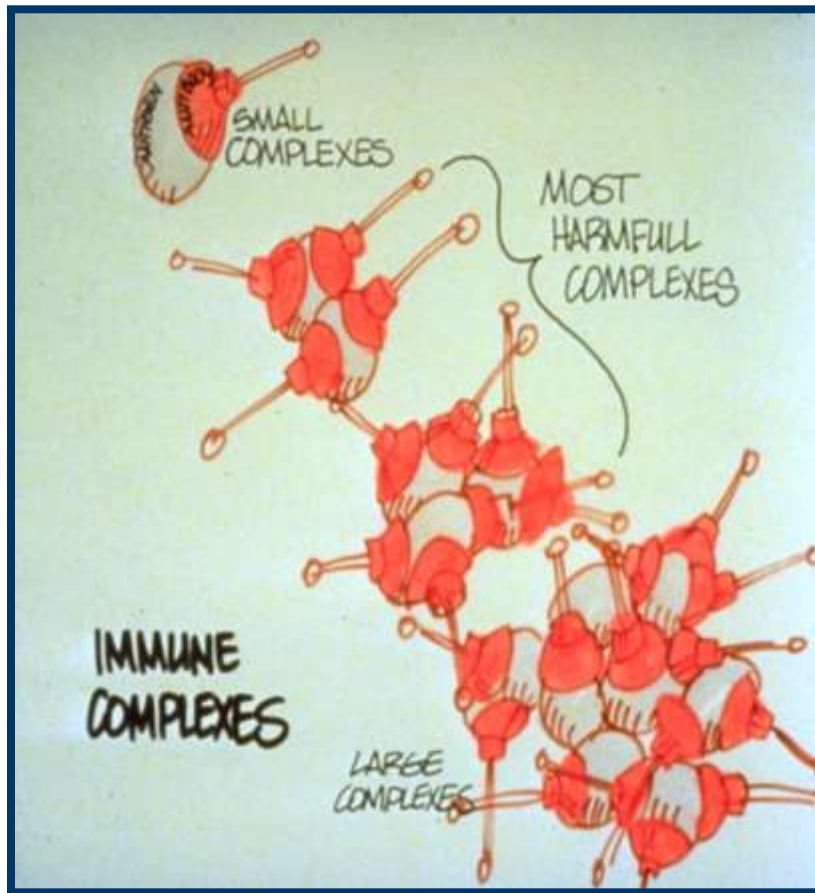
- Autoimmune disease occurs when an immune response is triggered inappropriately against self antigens
- Clearance of antigen by normal immune processes does not occur and the result is a sustained immune response and chronic injury to tissues

# Autoimmune Disease



1. Self cells are inappropriately identified as non-self cells
2. T cells activate B cells to produce antibodies against the self cells
3. An immune response is initiated with resulting inflammatory effects:
  - Fever
  - Pain
  - Swelling
4. Self cell is destroyed

# Immune Complex Disease



1. An antibody and an antigen combine to form a complex
2. Middle-size complexes become entrapped in blood vessels, kidneys, or joints

## Effects:

- Vasculitis
- Nephritis
- Arthritis

# Autoimmune Therapy

## Purpose:

- Suppress the abnormal immune response
- Remove the causative factor
- Relieve/eliminate symptoms

## Therapy:

- Drugs
- Surgery
- Drugs and TPE



# Therapeutic Plasma Exchange

- Removing the plasma removes disease mediators circulating in the patient's plasma, including:
  - Alloantibodies, autoimmune antibodies and antigen-antibody complexes
  - Abnormal or increased amount of plasma protein
  - Very high cholesterol levels
  - High levels of plasma metabolic waste products or plasma-bound poisons or drugs
- Decreasing levels of disease mediator can relieve symptoms, but is not curative

# Therapeutic Plasma Exchange

- Also removes normal plasma components important in the maintenance of homeostasis:
  - Immunoglobulins (IgG, IgM, IgA)
  - Cholesterol
  - Albumin
  - Fibrinogen
  - Creatinine, uria
  - Electrolytes
  - Plasma-bound drugs

# Red Blood Cell Exchange

- Removal of large volumes of abnormal patient red blood cells and replacement with normal donor red blood cells
- RBCX removes RBCs containing abnormal hemoglobin, infected RBCs, abnormal short lived RBCs that contribute to iron overload



# Cellular Depletion

- Rapid reduction of a greatly elevated number of cells from the intravascular space to decrease the risks associated with vascular stasis
- According to the ASFA evidenced based guidelines, cellular depletions are generally considered when:
  - Leukocytosis:  $> 100,000/\mu\text{L}$  white blood cells (WBC)\*
  - Thrombocytosis:  $> 500,000 - 1,000,000$  platelets\*
  - Erythrocytosis:  $> 60\%$  hematocrit\*
- Supportive therapy used in combination with drugs or chemotherapy

\*or when the patient is symptomatic

# WBC Depletion

- Considered when symptoms occur due to the large number of circulating WBCs
- Symptoms generally occur at WBC concentrations greater than  $100 \times 10^3/\mu\text{L}$  but will vary depending on individual patient variables and disease
  - Symptomatic leukocytosis reported range is  $50 \times 10^3/\mu\text{L}$  (AML) to  $300 \times 10^3/\mu\text{L}$  (CLL)

# Platelet Depletion

- Platelet depletions are performed in order to prevent recurrent or progressive thrombotic or hemorrhagic events or to quickly reduce elevated counts in high risk or symptomatic patients

# Red Blood Cell Depletion

- Erythrocytapheresis or RBC depletion is defined as the rapid reduction of a greatly elevated number of RBCs to:
  - Reduce blood viscosity
  - Reduce red cell volume
  - Reduce iron overload and maintain normal iron levels

# CaridianBCT Apheresis Devices



Spectra Optia®  
Apheresis Sytem

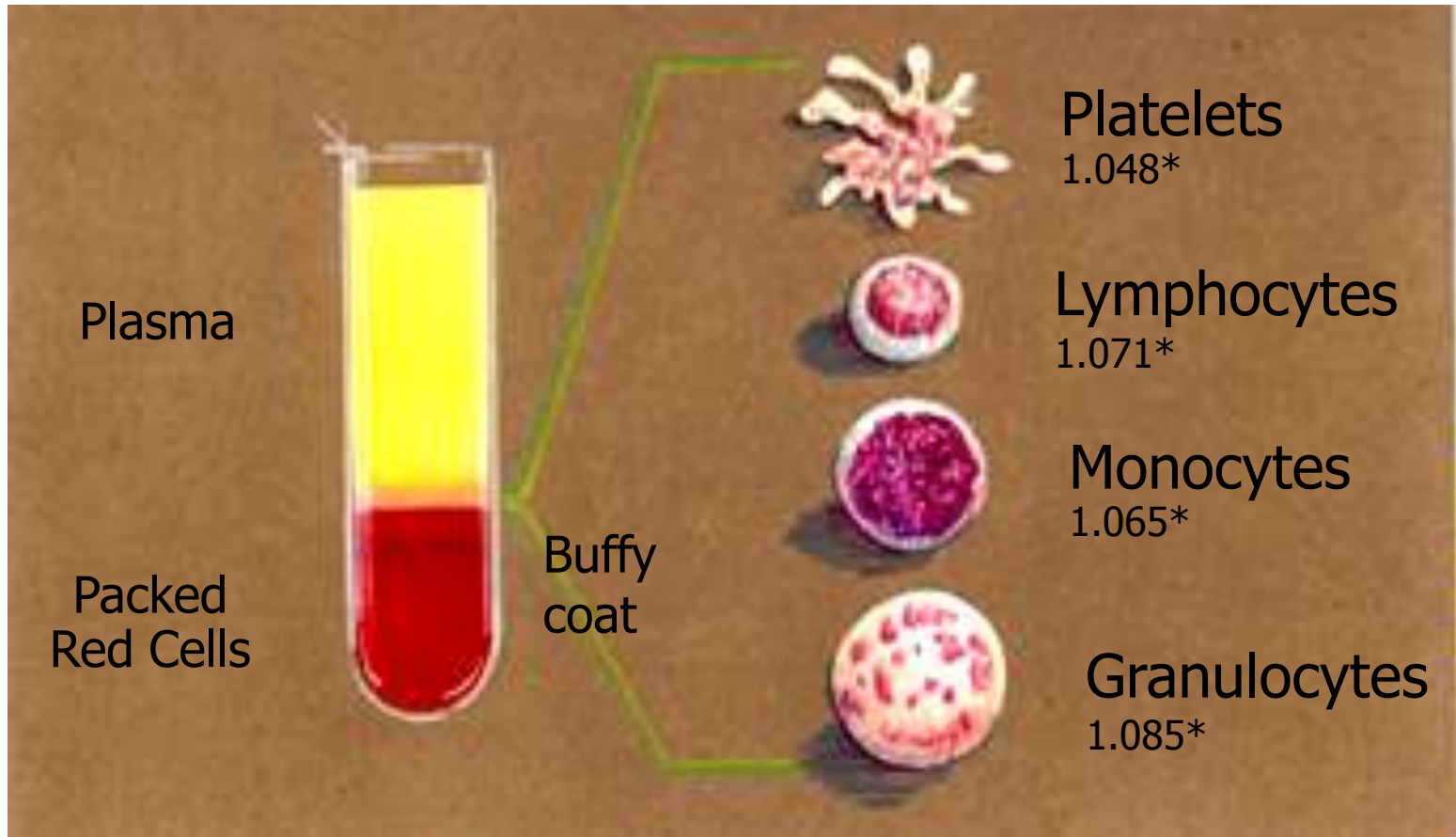
COBE® Spectra  
Apheresis System



*Therapeutic Plasma Exchange and Mononuclear Cell Collection protocols on the Spectra Optia apheresis system are available in selected markets. Contact your CaridianBCT representative for local availability.*

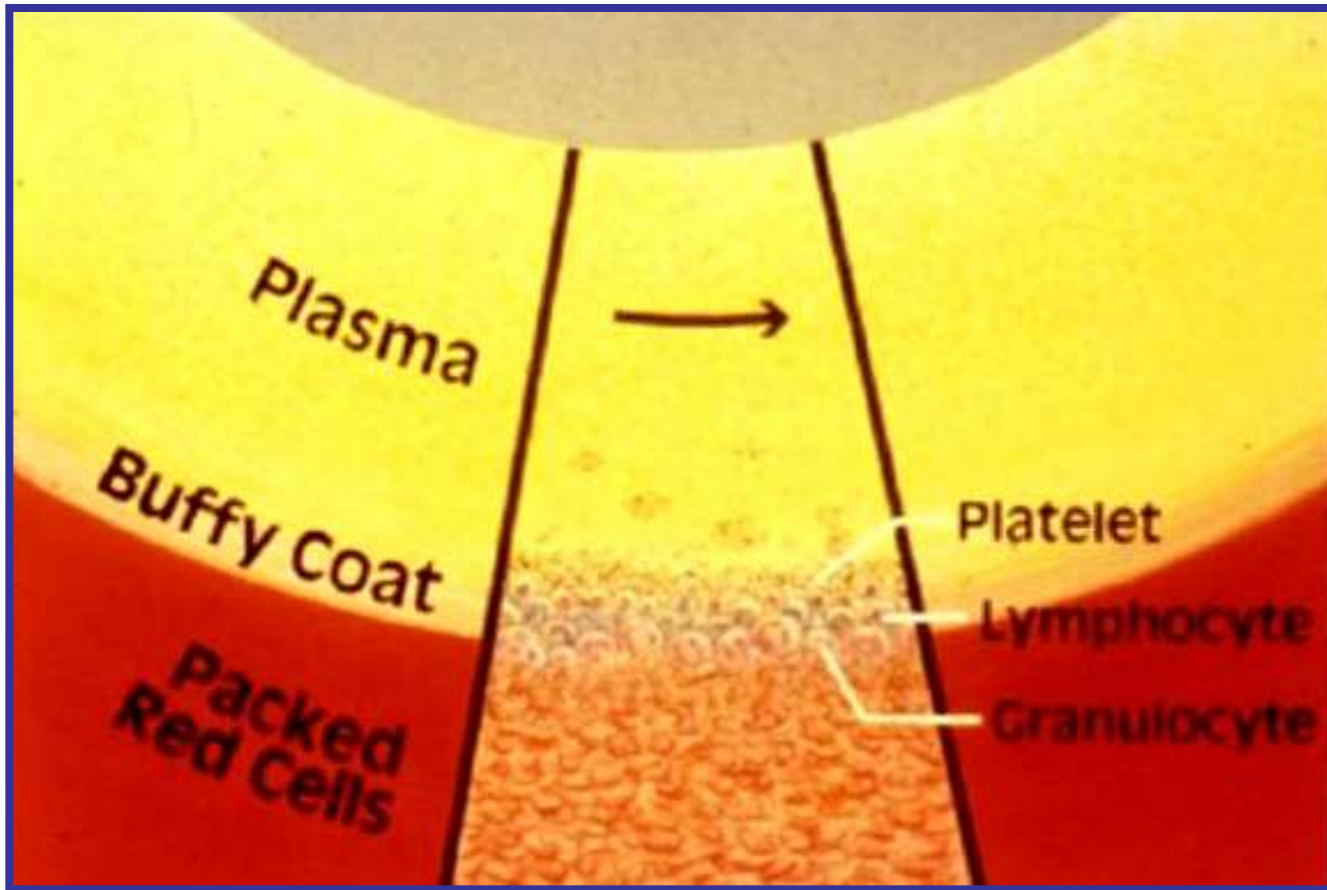
# Separation of Blood Components

Centrifugal force separates cells based on their specific gravity



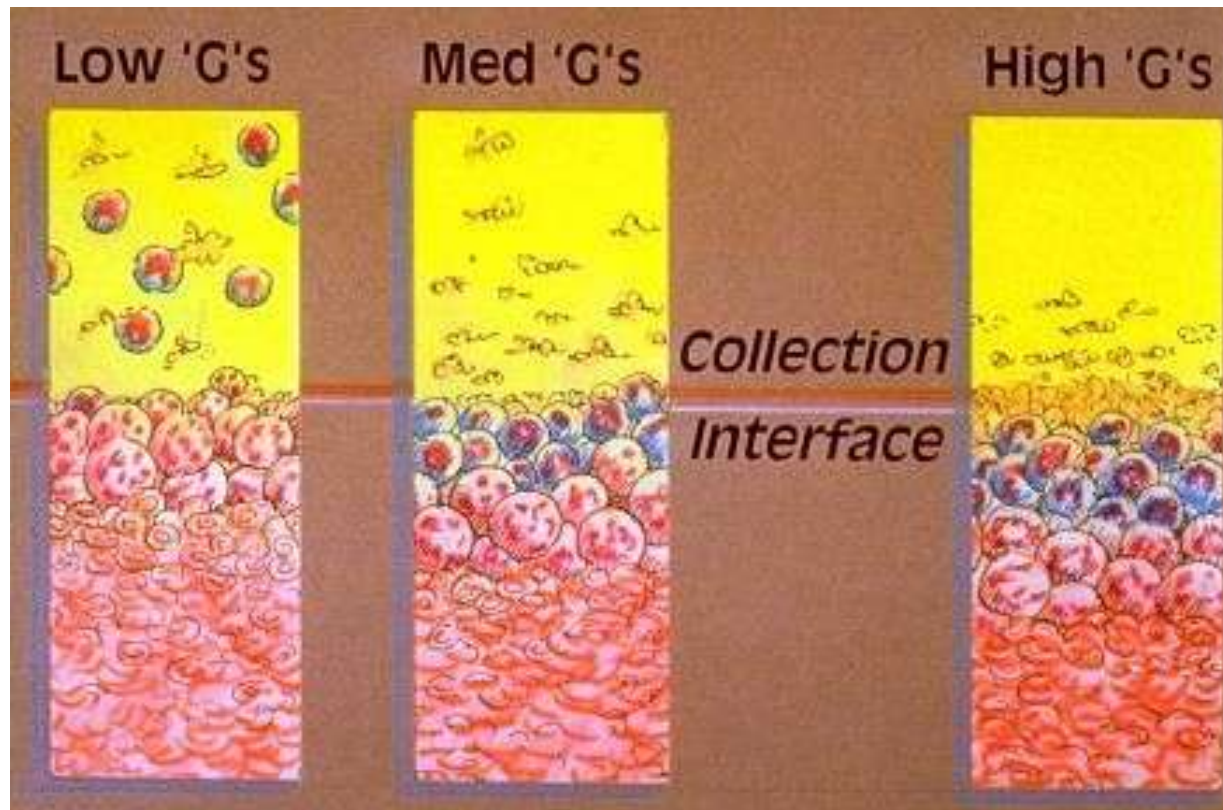
\*Average specific gravity of cell type shown

# Separation of Blood Components





# Effects of G-Force on Separation



# Procedural Elements of TA

- Vascular access
- Anticoagulation
- Replacement fluids
- Treatment frequency
- Potential side effects

# Vascular Access

- Antecubital/peripheral venipuncture
- Femoral catheter
- Subclavian catheter
- Jugular access
- Ports
- Arteriovenous fistula or graft

# Anticoagulation



- ACD-A
- Heparin

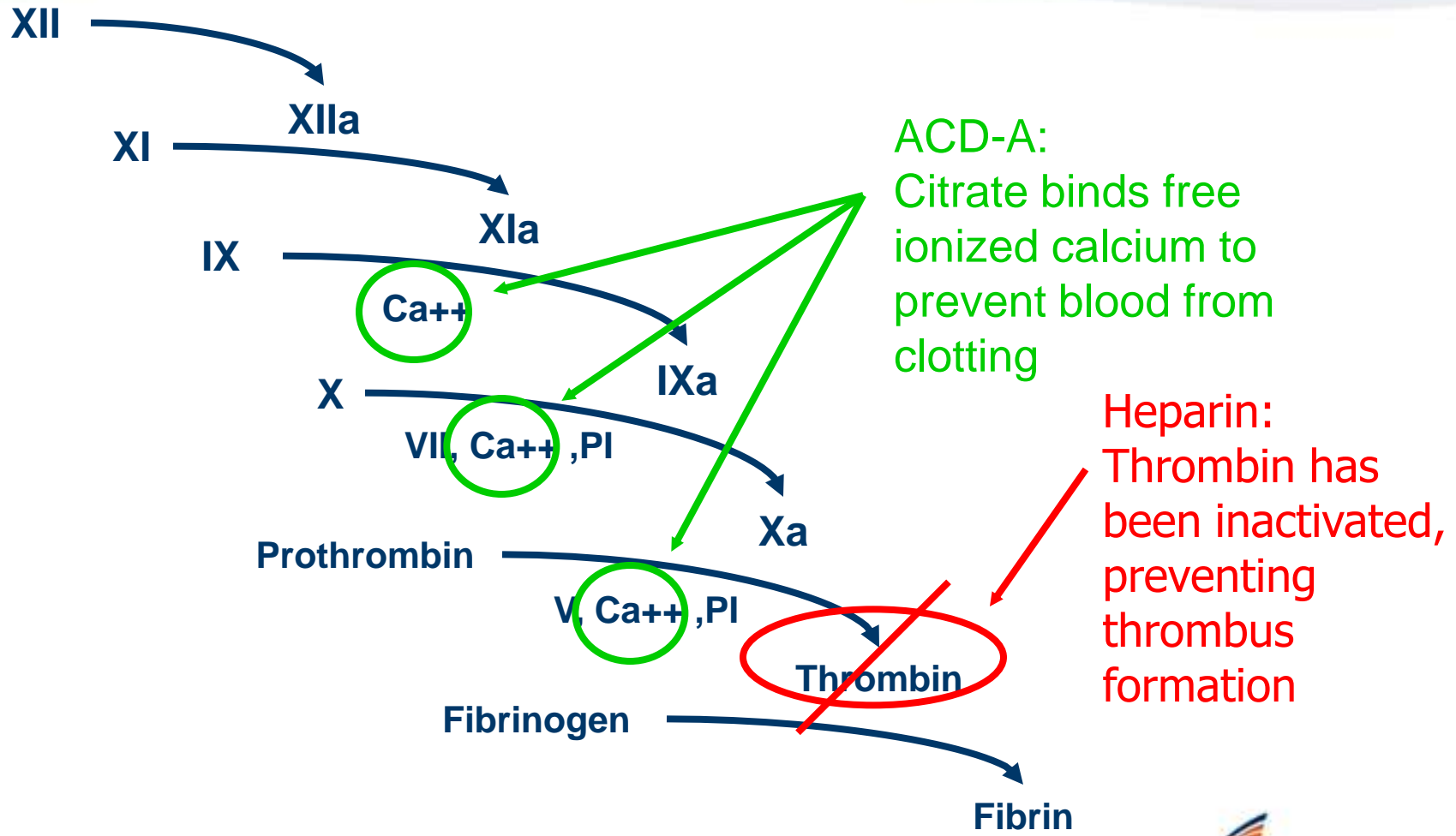
# ACD-A (Acid Citrate Dextrose-Formula A)

- Binds to ionized calcium
- Lowers the pH of the blood
  - Inhibits platelet clumping
- Anticoagulates extracorporeal blood circuit
  - Is rapidly metabolized
- May cause hypocalcemia

# Heparin

- Complexes with antithrombin and increases its activity, which inactivates thrombin and other factors and prevents thrombus formation<sup>1</sup>
- Anticoagulates systemically
  - Metabolized slowly (1 to 2 hours)
- Can cause heparin-induced thrombocytopenia

# Clotting Cascade





# Replacement Solutions

## TPE procedures:

### Crystalloids (contain no protein)

- 0.9% sodium chloride
  - In combination with 5% albumin replacement

### Colloids (contain macromolecules)

- 5% albumin
- Fresh frozen plasma/cryo-poor plasma
- Hydroxyethyl starch (HES)

# Replacement Solutions

## RBC exchange procedures:

- Packed red blood cell units

## Cellular depletion procedures:

- Saline and/or 5% albumin, according to physician's order

# Treatment Frequency

## Acute disease

- Rapidly progressive
- Requires frequent treatments (every 24 to 48 hours, sometimes every 12 hours)

## Chronic disease

- Slowly progressive
- Requires less frequent treatments (weekly or monthly)

# Potential Side Effects

- Hypocalcemia
- Other electrolyte imbalances
- Hypotension
- Vasovagal syncope
- Allergic reactions
- Transfusion related acute lung injury (TRALI)

# How Does TA Impact the Lab/Blood Bank?

- Possible increased inventory of plasma or cryo-poor plasma for ongoing TPE procedures
- Capacity for thawing large amounts of plasma
- Possible increase in transfusion reaction work ups due to transfusion of multiple units of blood products
- Type and crossmatch needed for replacement RBC units for RBCX procedures

# How Does TA Impact the Lab/Blood Bank?

- Screening RBC units for sickle cell trait, if patient has sickle cell disease
- Apheresis staff may request a hematocrit on each of the replacement RBC units for RBCX procedures

# How Does TA Impact the Lab/Blood Bank?

- For depletion procedures, the apheresis staff may request a cell count from the product to help determine the efficiency of the procedure
  - Sample may need to be further diluted by the laboratory



# Overview of Therapeutic Apheresis

Questions?