

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

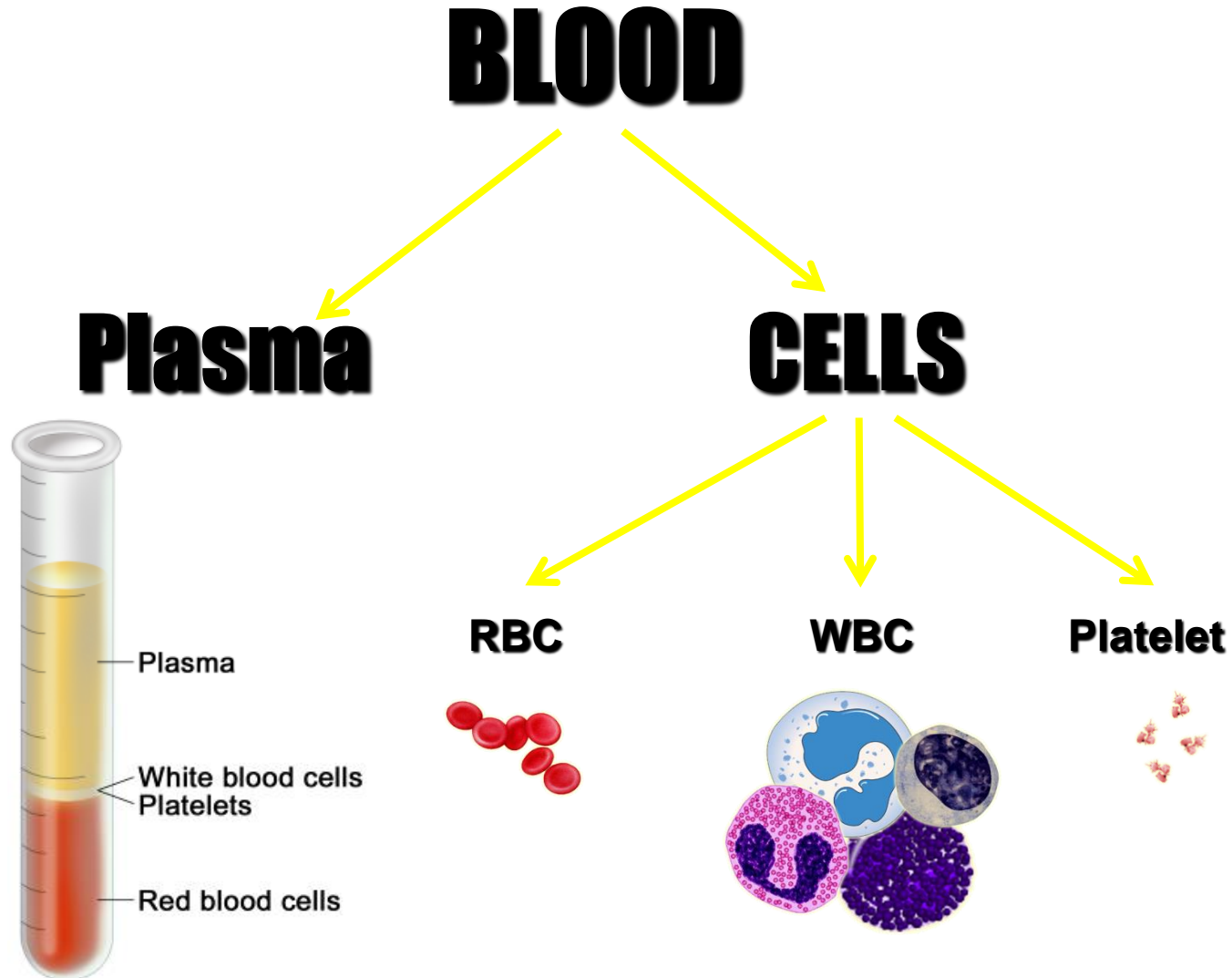
# **Platelet Structure & Function**

**Dr. Abeer Al-Ghumlas**  
**MB.BS, MSc, Ph-D**

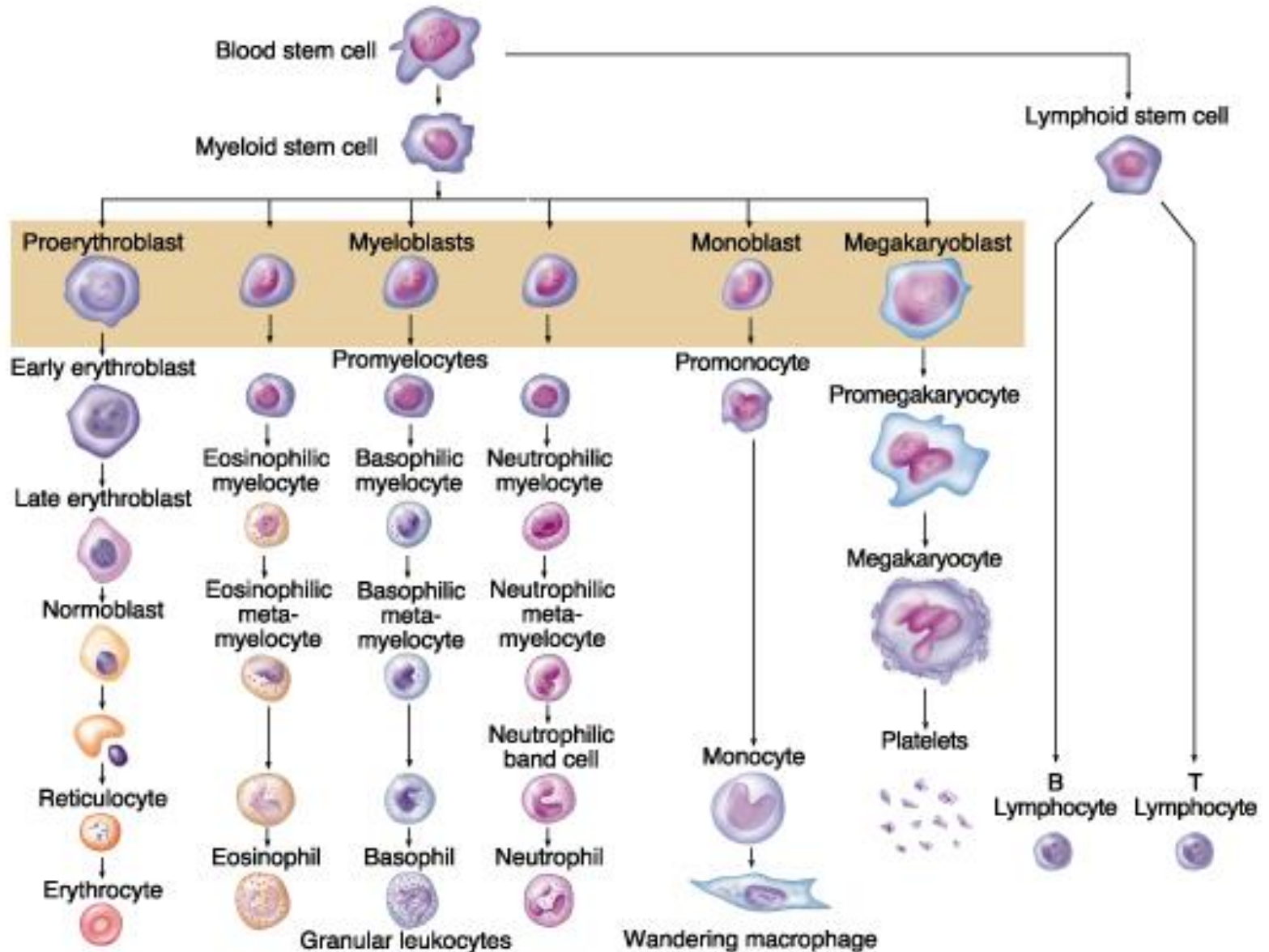
# Objectives

- Understand platelet normal ultrastructure
- Understand the functions of different platelets organelles and surface receptors
- Understand the mechanisms of platelet functions
- 
- Relate membrane receptors and granule content to normal function in hemostasis and bleeding (platelet) disorders

# What are platelets?



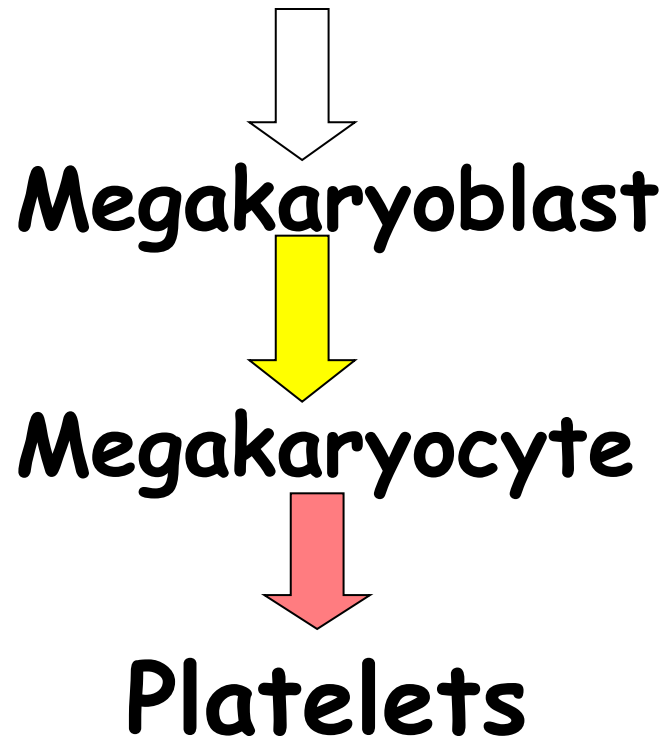
# Megakaryocyte and platelet formation



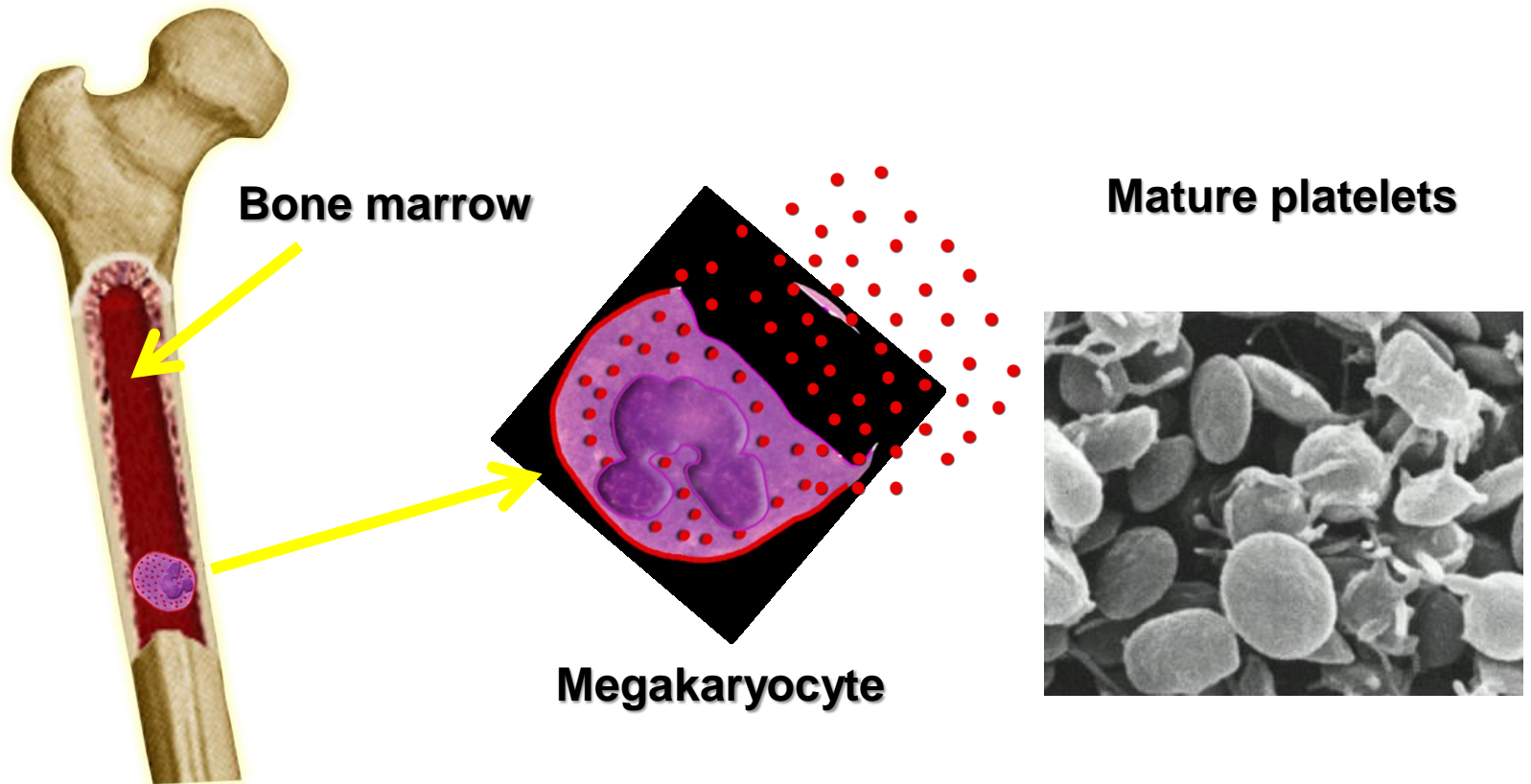
# Platelets - cont.

- **Site of formation: Bone marrow**

- **Steps: Stem cell**



# What are platelets?

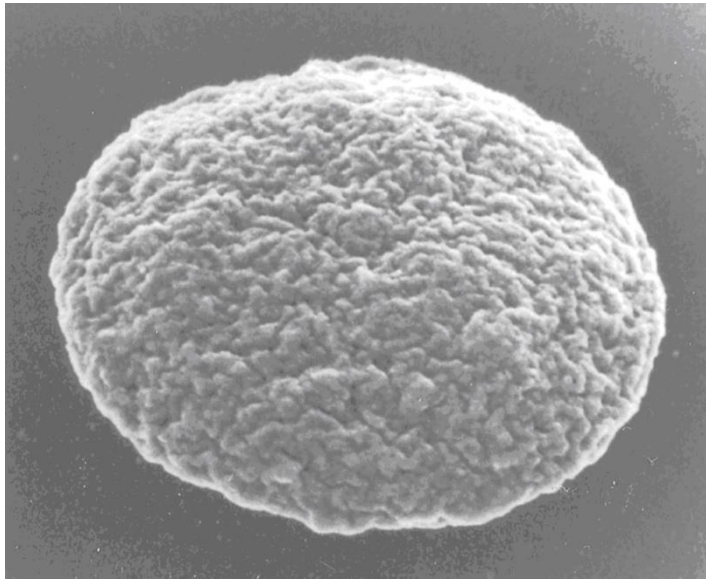
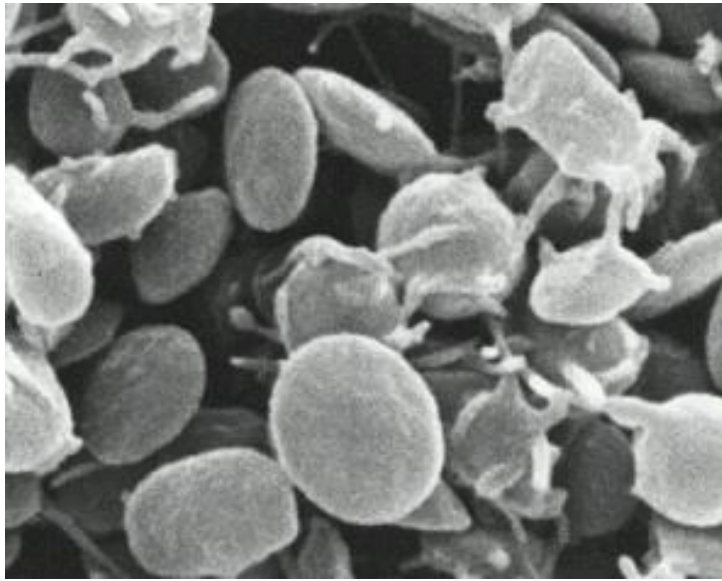


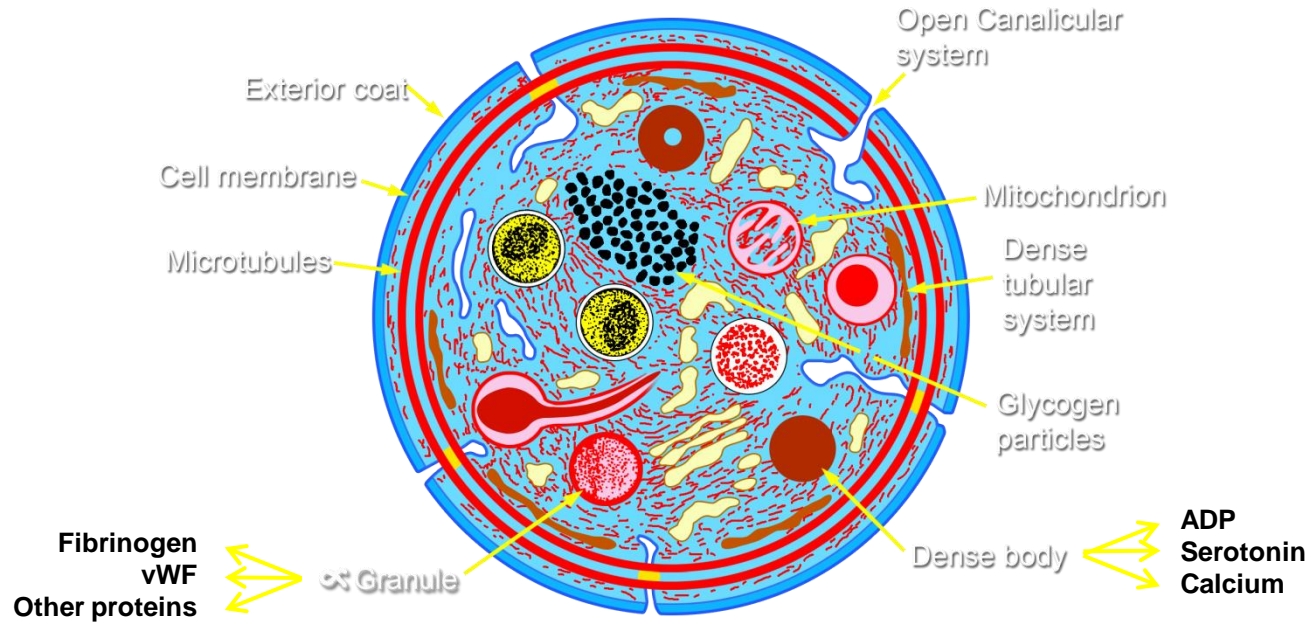
# **Platelets Formation (Thrombopoiesis)**

**Regulation of thrombopoiesis  
by  
Thrombopoietin**



# Platelet ultra-structure

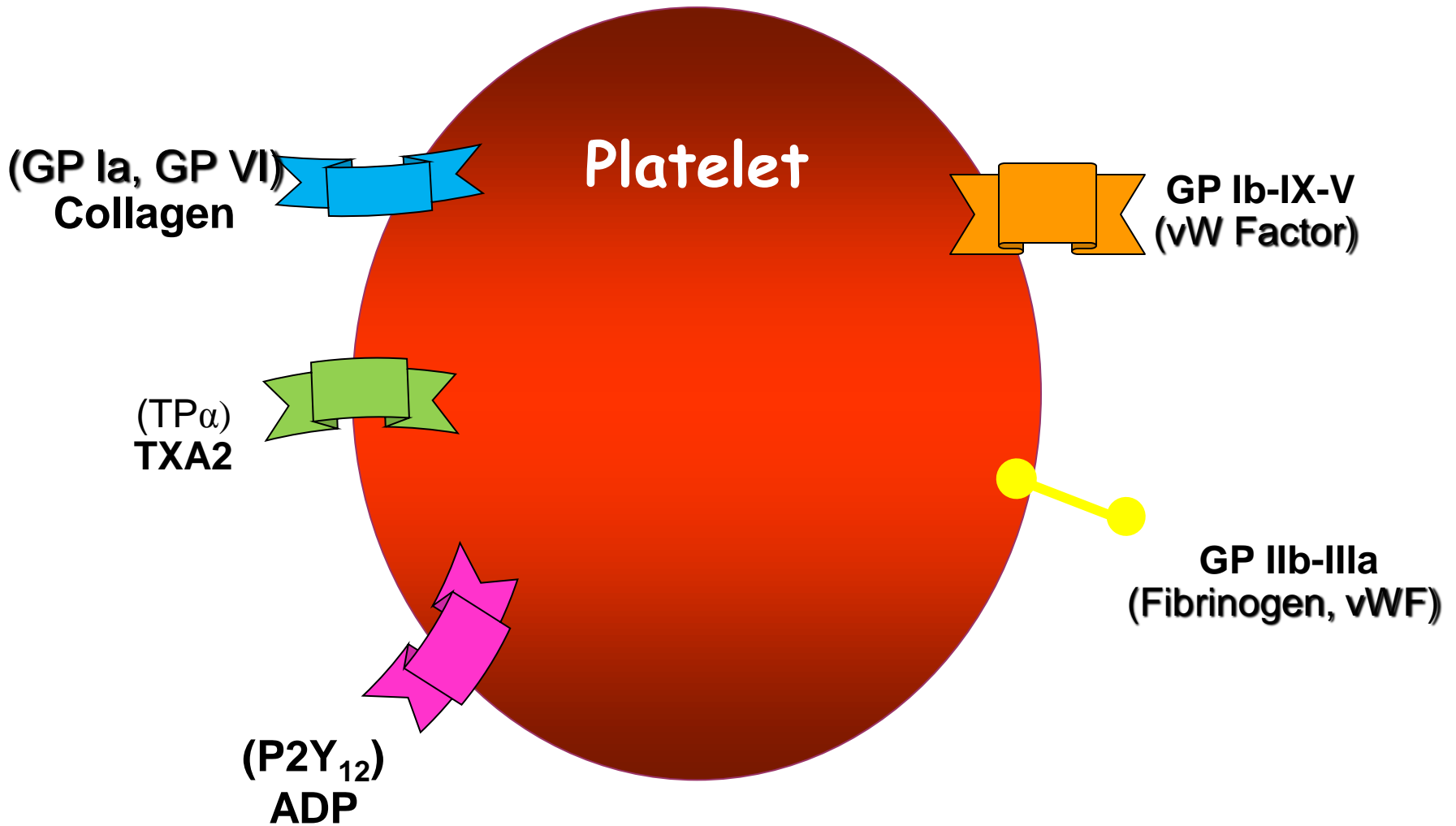


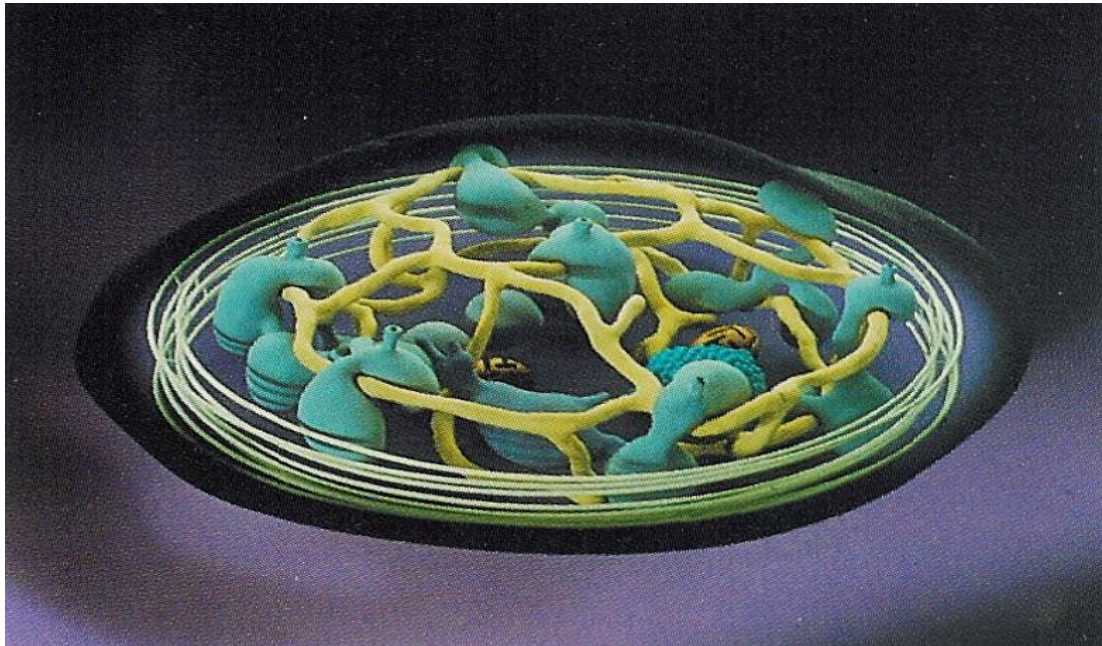
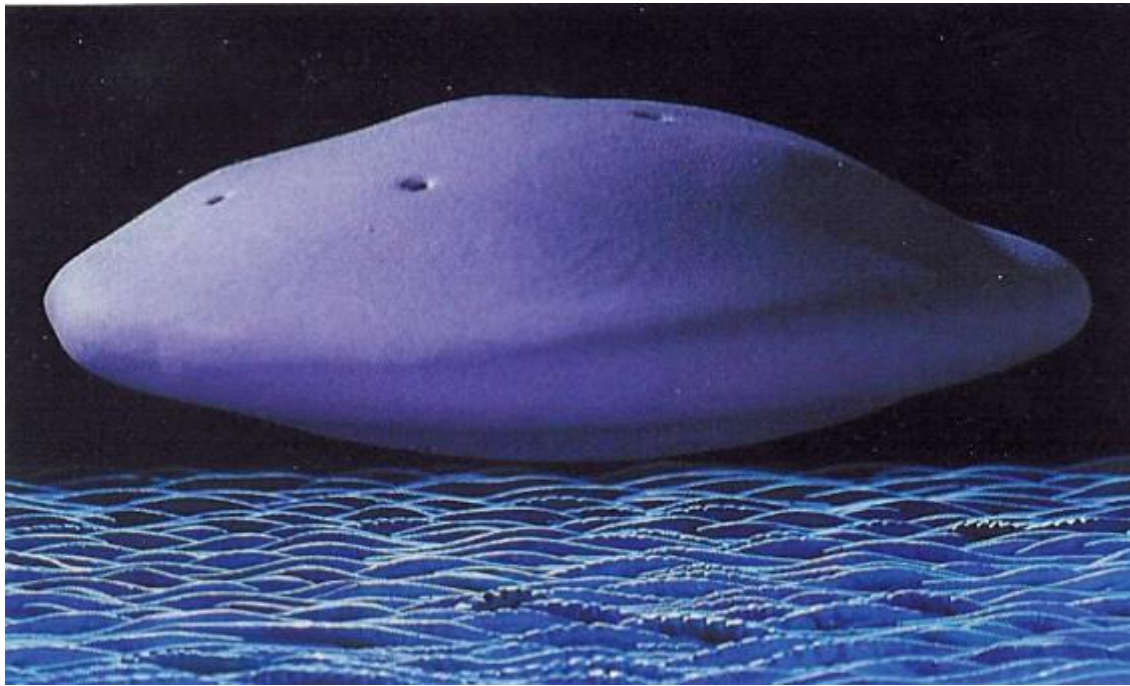


## (Thrombocytes)

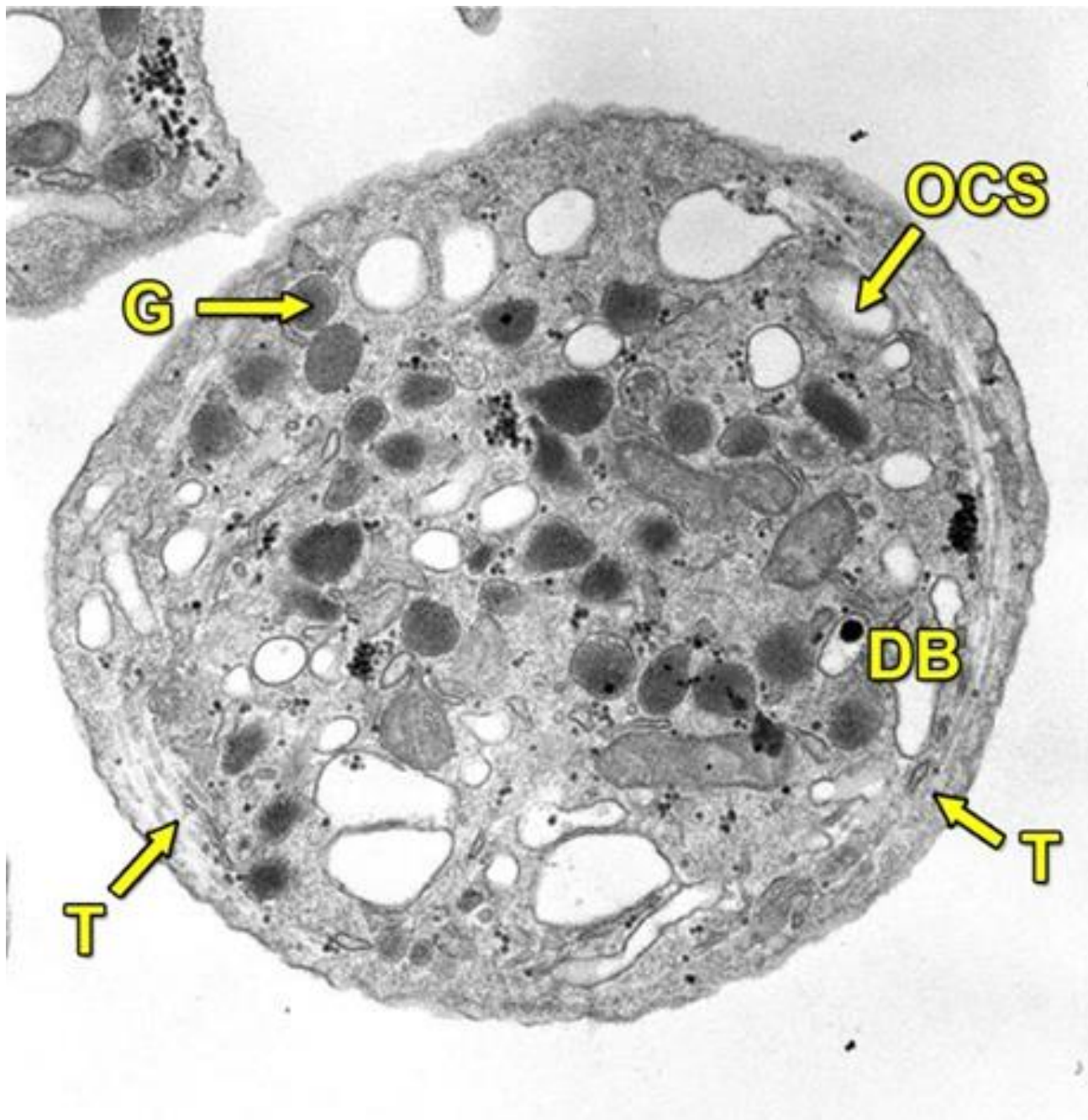
- Anuclear and discoid cell → spherical when activated
- Platelet count =  $150 \times 10^3 - 300 \times 10^3 / \text{ml}$
- Size:  $1.5 - 3.0 \mu\text{m}$
- Life span: 7-10 days
- Sequestered in the spleen; hypersplenism may lead to low platelet counts.

# Platelet Receptors





**Platelet EM**





# Platelet Ultrastructure

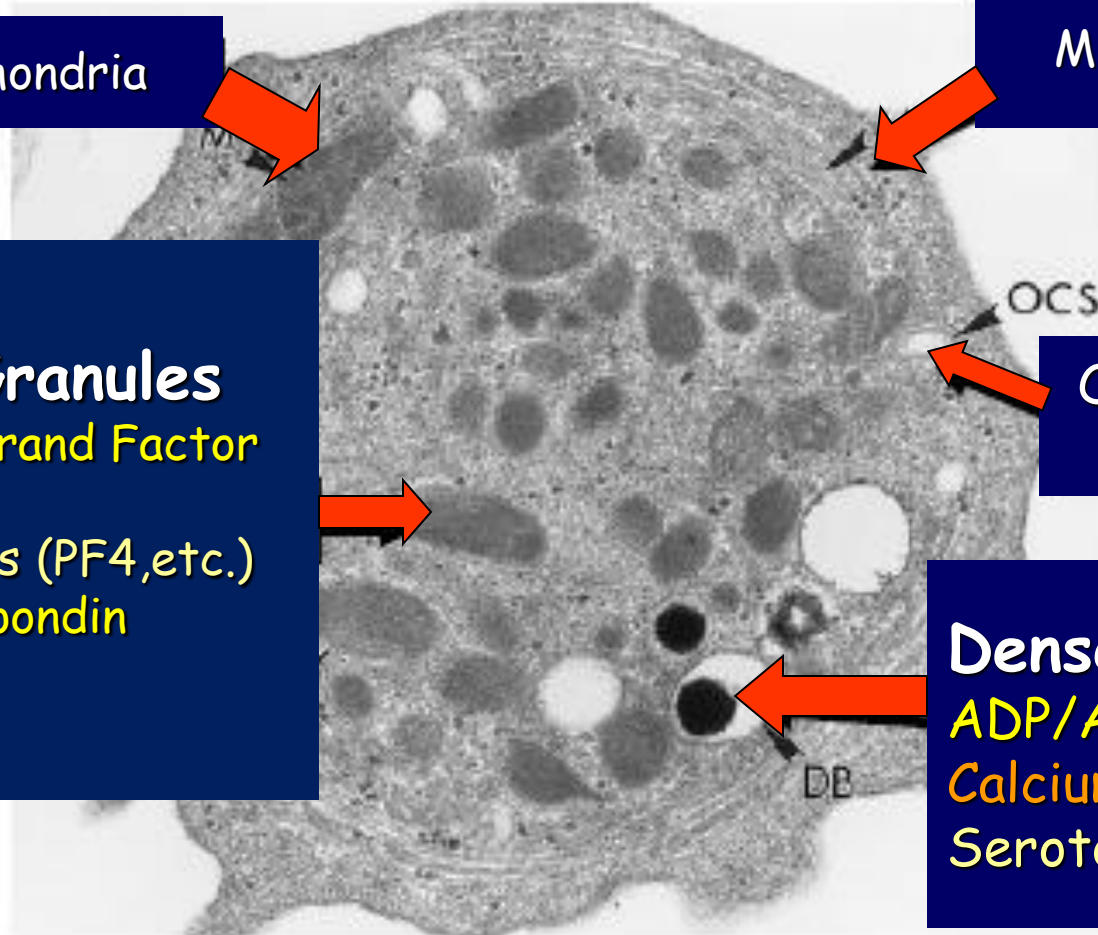
Mitochondria

Microtubules

**Alpha Granules**  
von Willebrand Factor  
Fibrinogen  
Chemokines (PF4, etc.)  
Thrombospondin  
P-selectin

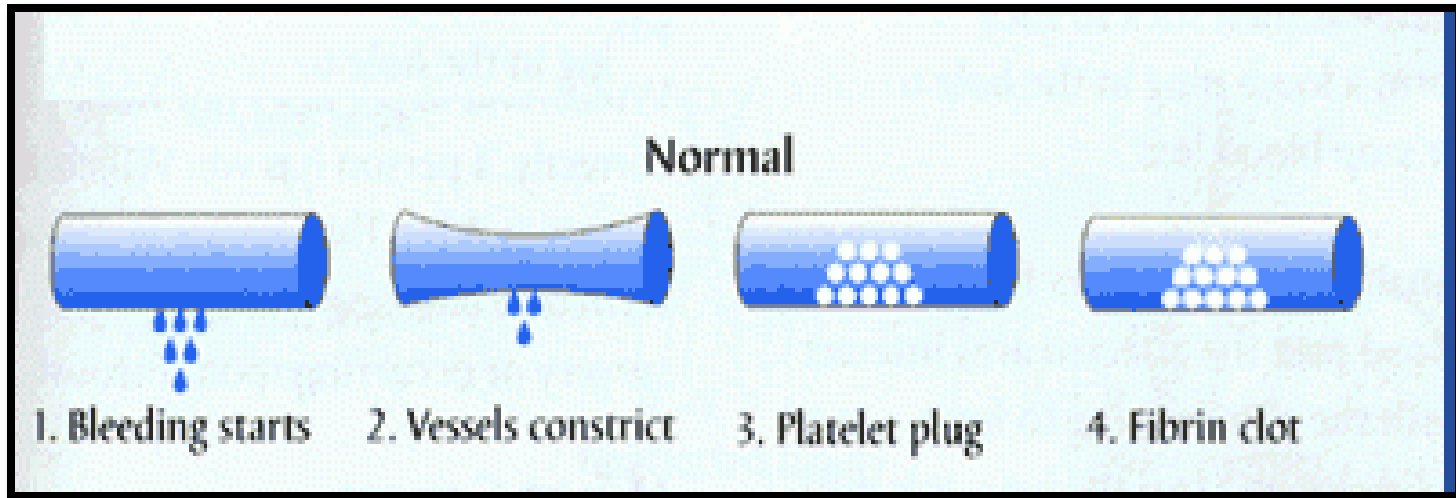
Open canalicular system

**Dense Granules**  
ADP/ATP  
Calcium  
Serotonin



# **General functions of the platelets**

# HEMOSTASIS



1. VASCULAR PHASE

2. PLATELET PHASE

3. COAGULATION PHASE

4. FIBRINOLYTIC PHASE

# Hemostatic Mechanisms

1. Vessel wall
2. Platelet
3. Blood coagulation
4. Fibrinolytic system

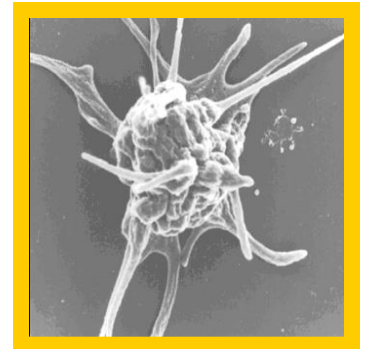
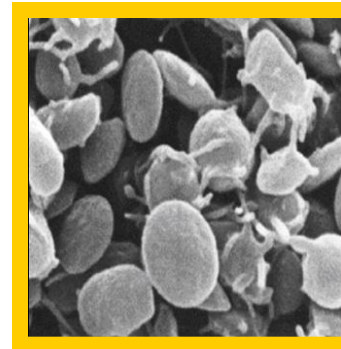
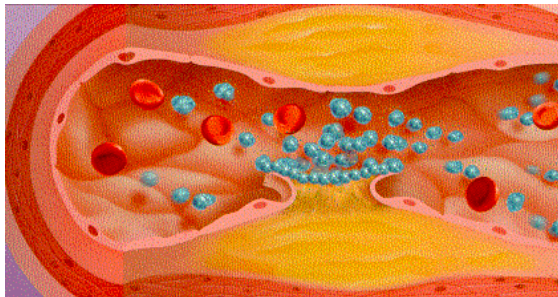
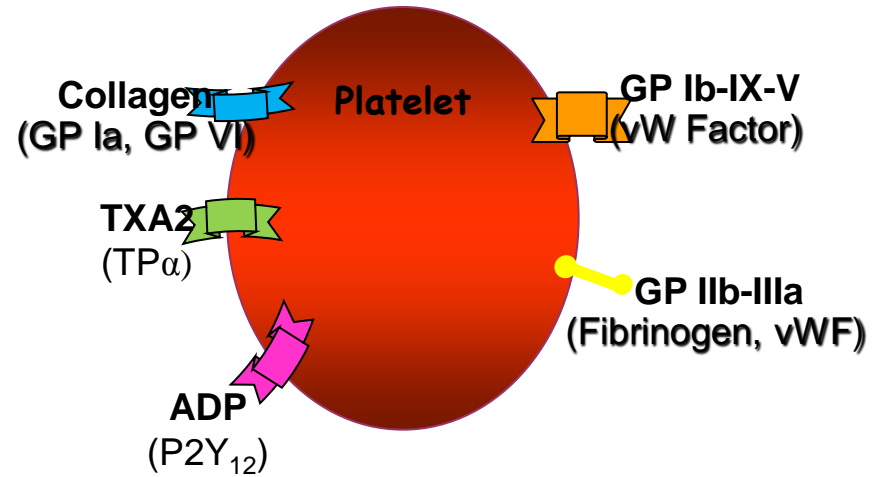
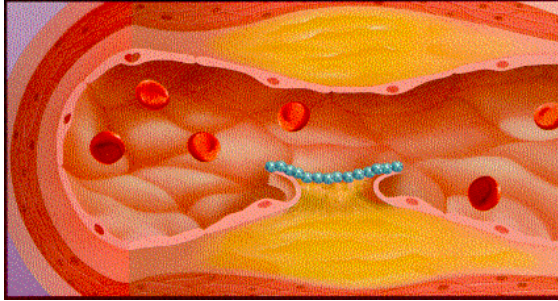
## Platelet activation:

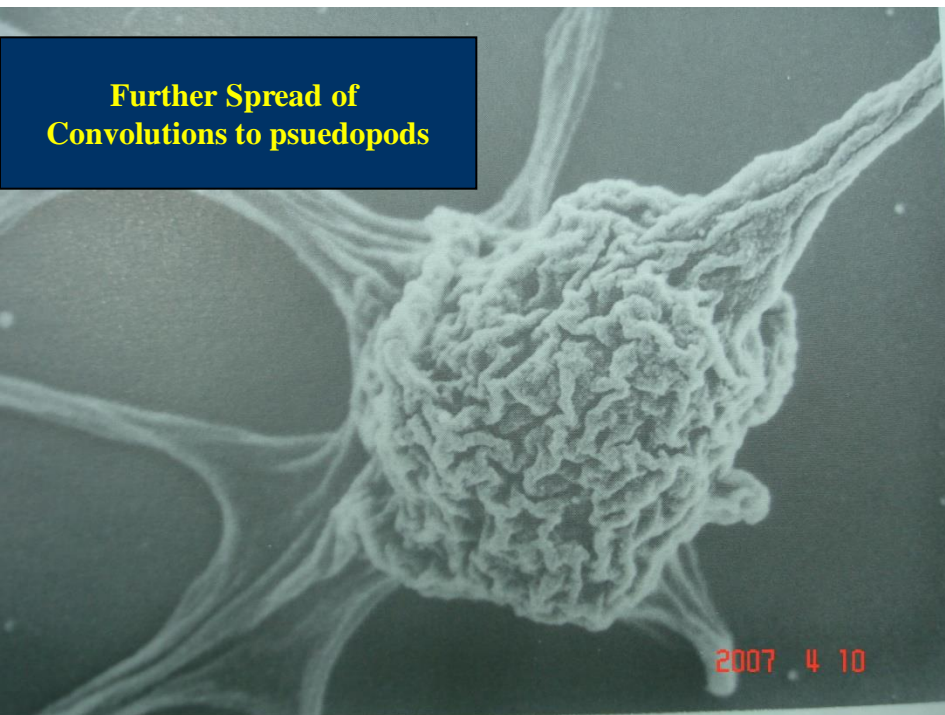
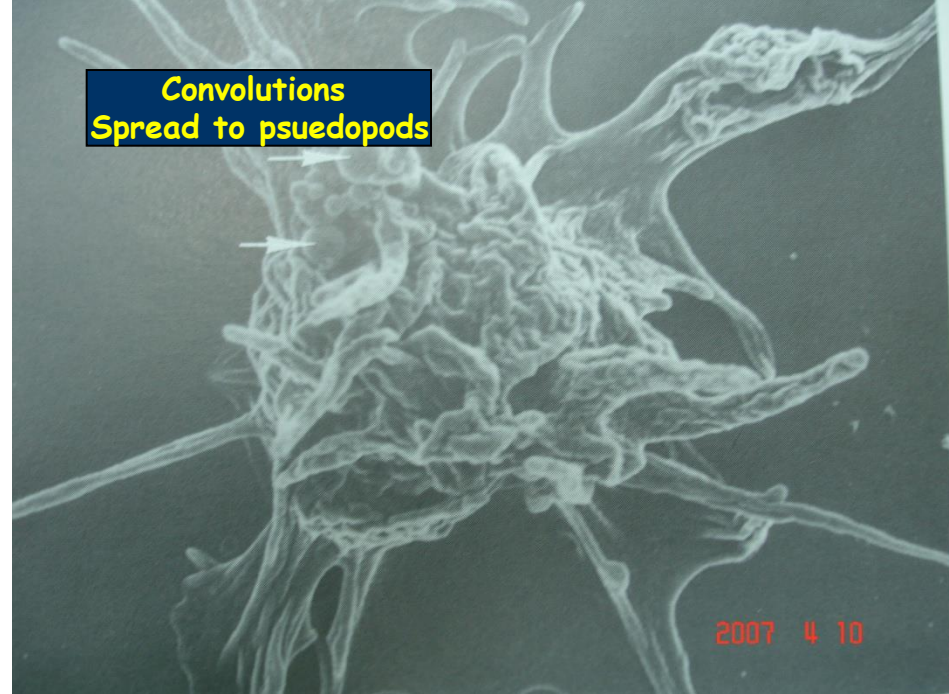
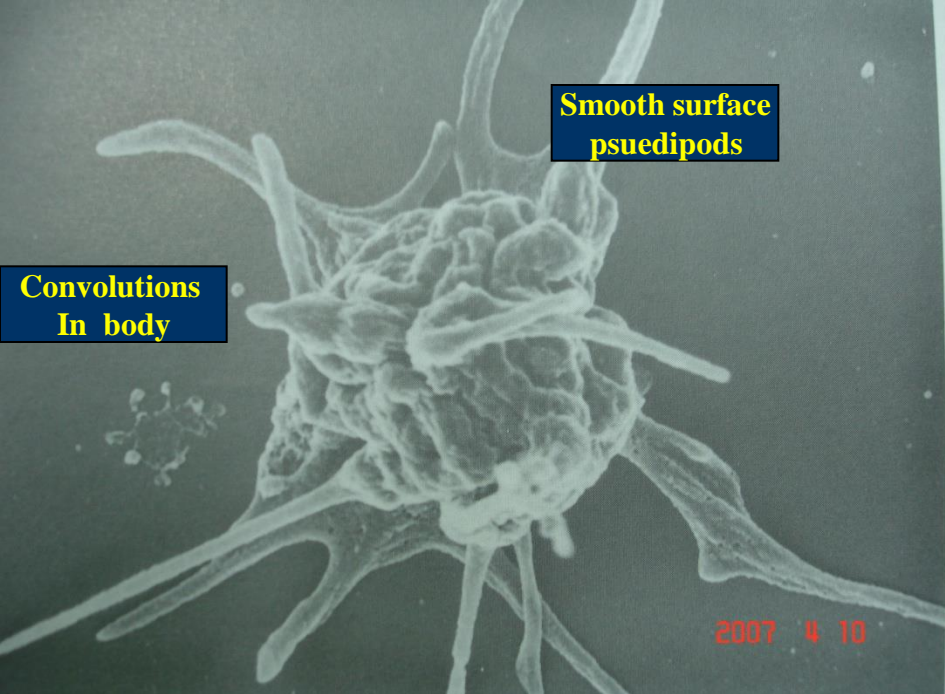
1. Adhesion
2. Shape change
3. Aggregation
4. Release reaction
5. Clot retraction

# Platelet Activation

- **Adhesion**
- **Aggregation**
- **Release**
- **Clot Retraction**

# Platelet function





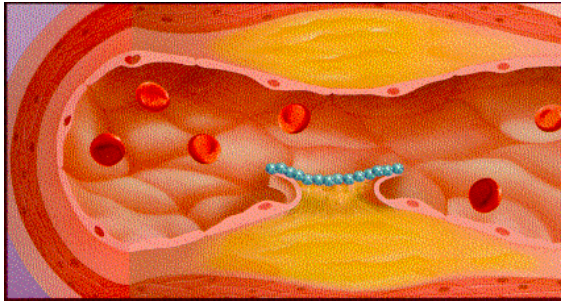
# Platelet Aggregation

- **Aggregation:**

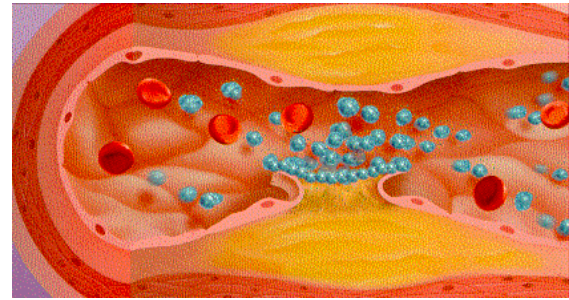
Fibrinogen is needed to join platelets to each other via platelet fibrinogen receptors



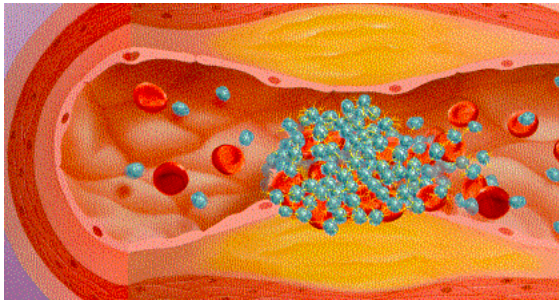
# Platelet function



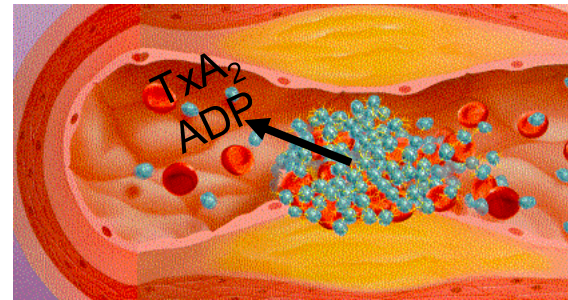
Adhesion



Activation

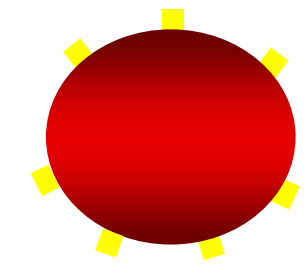


Aggregation



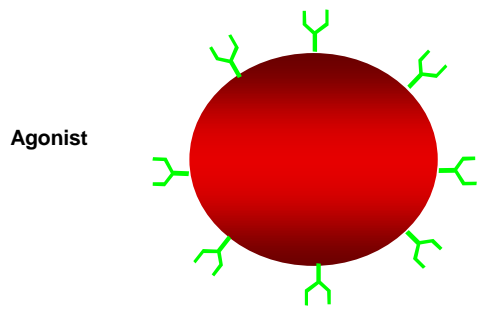
Secretion

**Resting platelet**



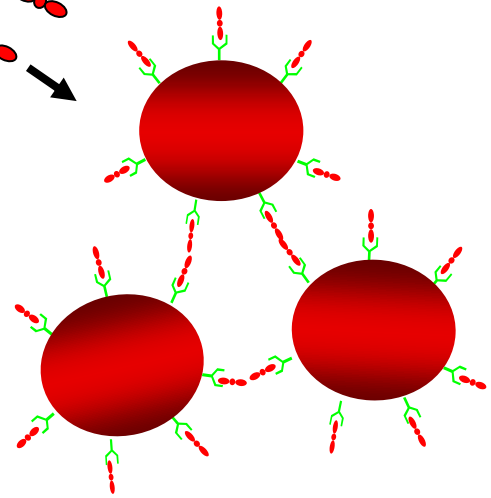
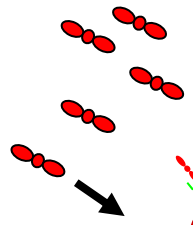
**GP IIb/IIIa receptors**

**activated platelet**



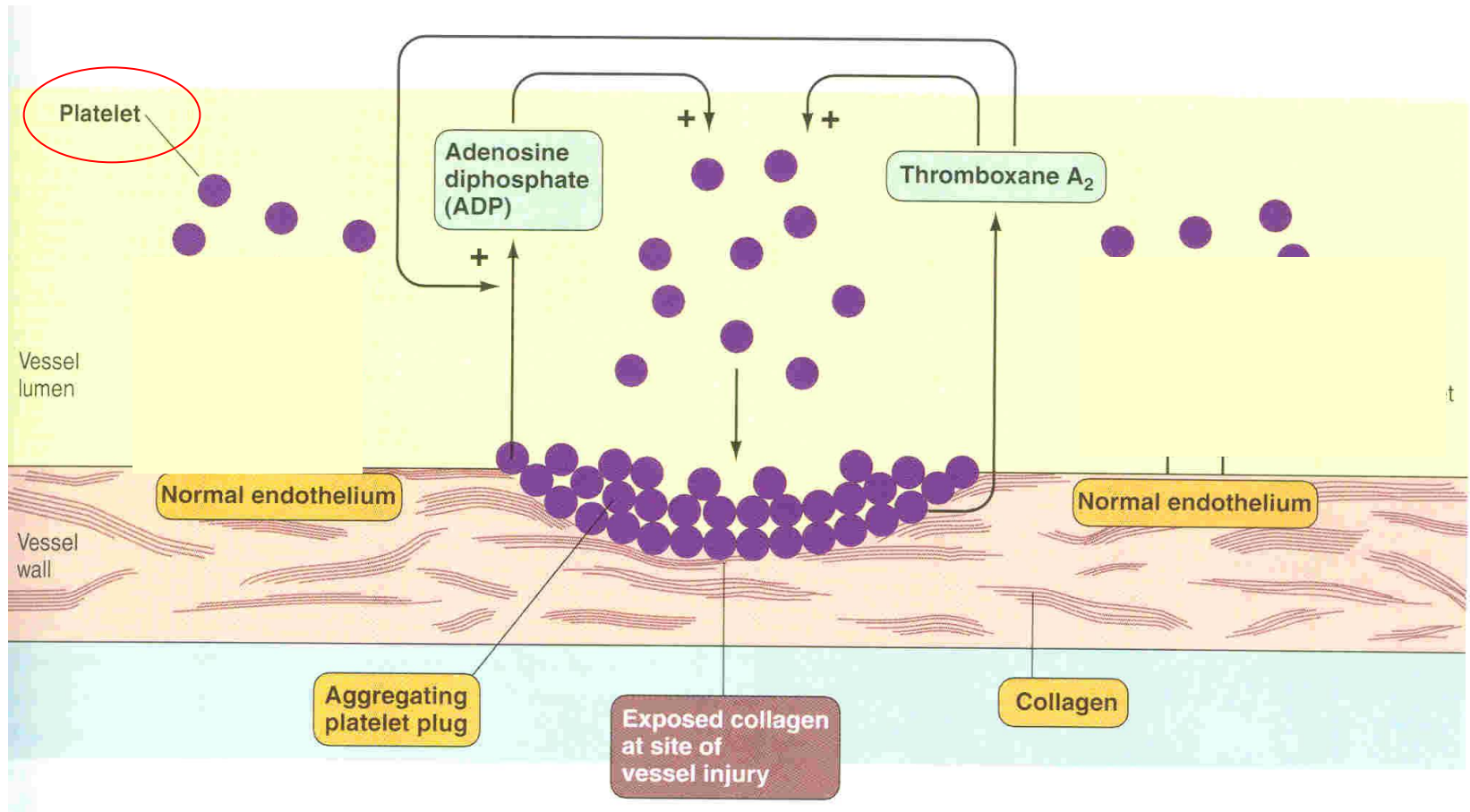
**Agonist**

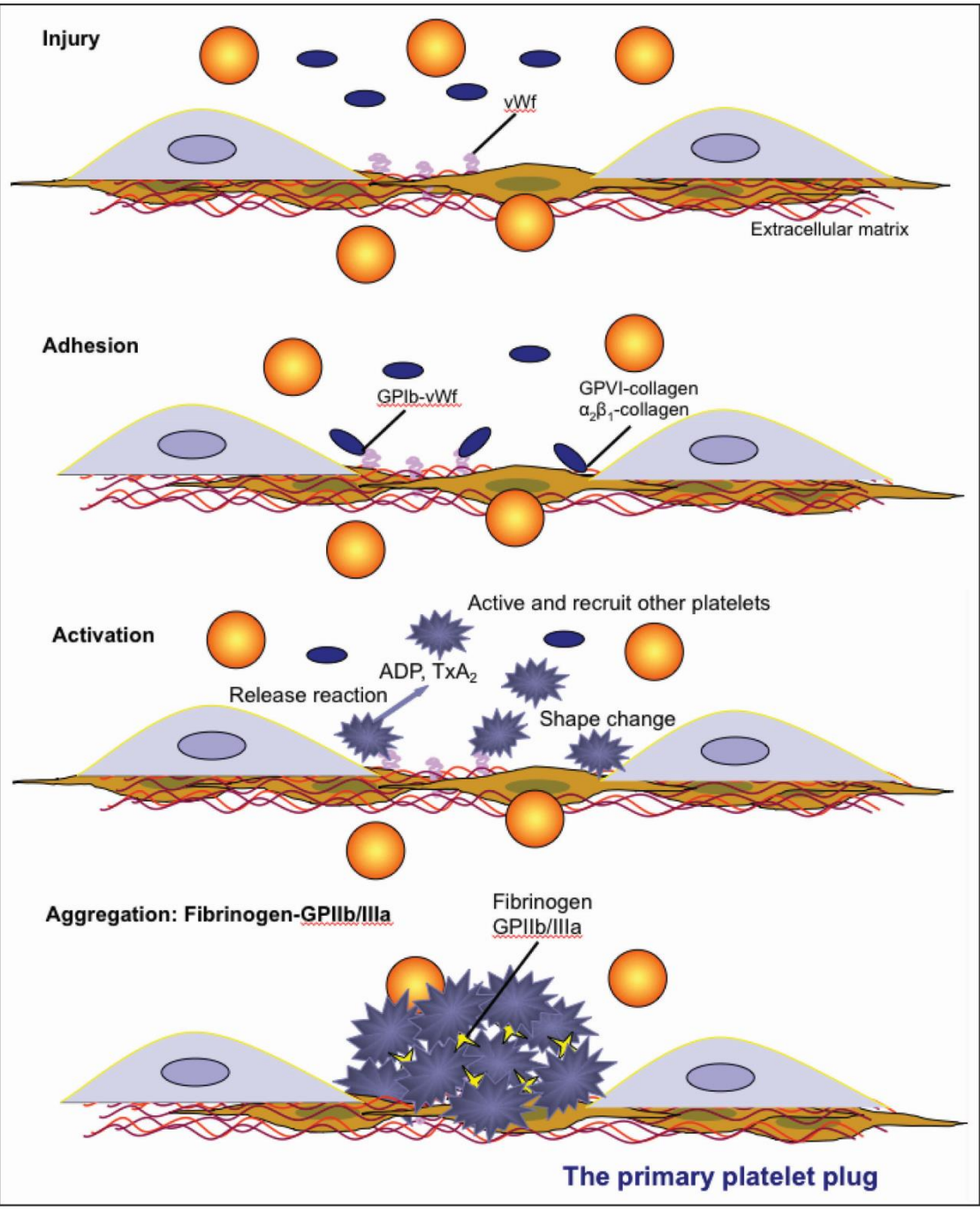
**Fibrinogen**

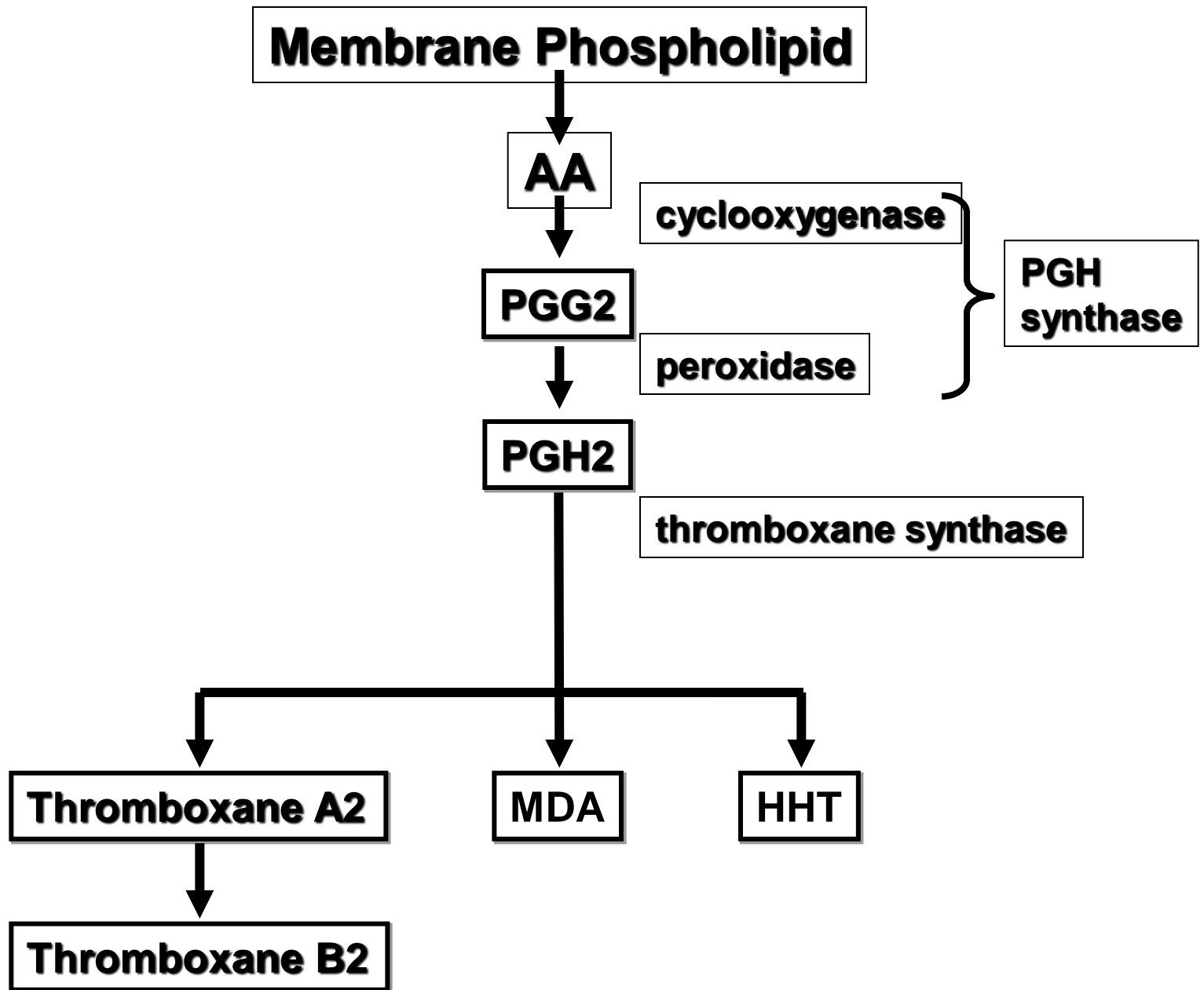


**Aggregating platelets**

# Platelets aggregation







# Activated Platelets

## Secrete:

1. ADP
2. 5HT → vasoconstriction
3. Platelet phospholipid (PF3) → clot formation
4. Thromboxane A2 (TXA2) is a prostaglandin formed from arachidonic acid

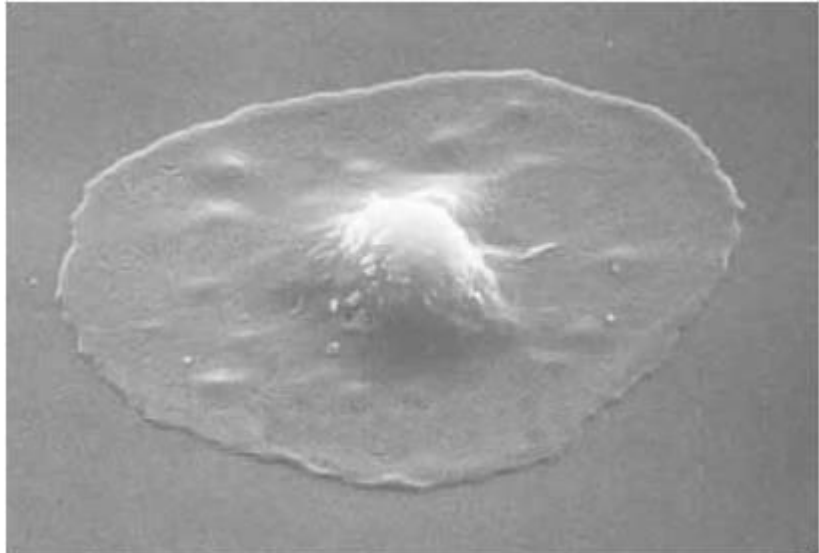
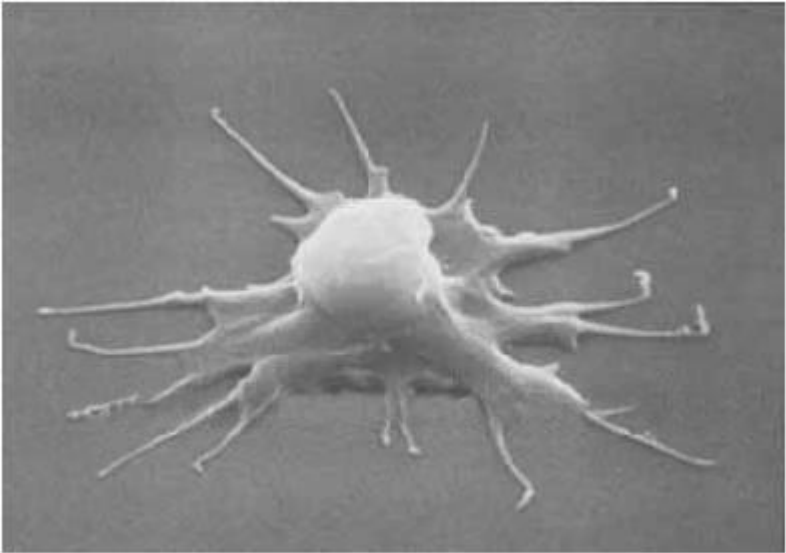
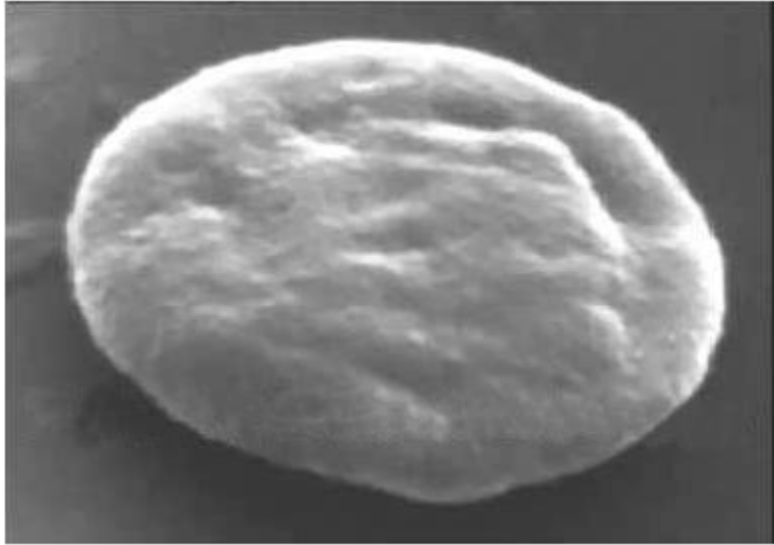
## Function:

- vasoconstriction
  - Platelet aggregation
- (TXA2 inhibited by aspirin)

# Platelet Activation

- **Clot Retraction:**

Myosin and actin filaments in platelets are stimulated to contract during aggregation further reinforcing the plug and help release of granule contents





# Platelet haemostatic plug formation

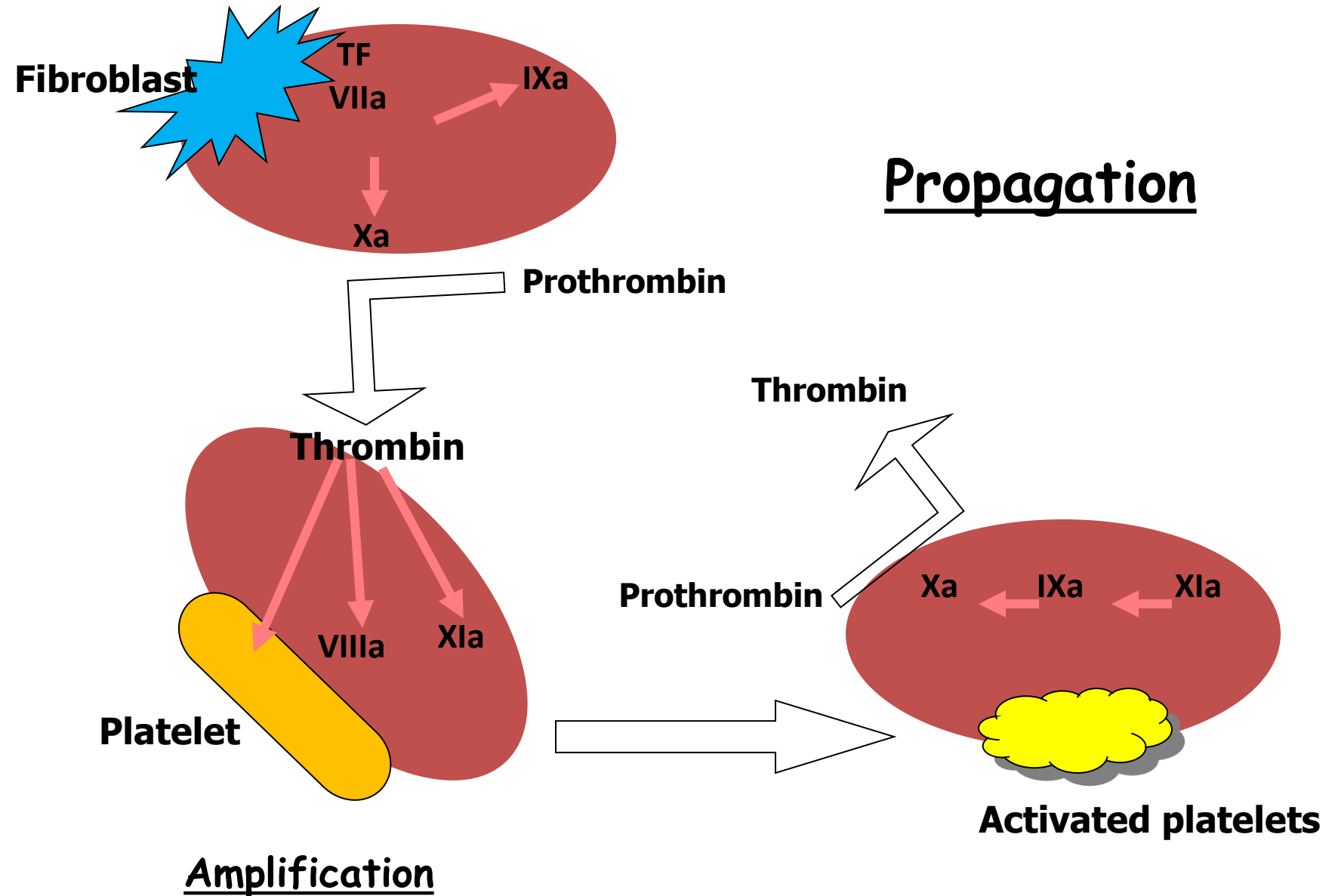
- Platelets activated by adhesion
- Extend projections to make contact with each other
- Release:  
thromboxane A<sub>2</sub>, serotonin & ADP >>> activating other platelets
- Serotonin & thromboxane A<sub>2</sub> are vasoconstrictors decreasing blood flow through the injured vessel.
- ADP causes stickiness and enhances aggregation

# **Functions of the platelets..cont**

## **Role of platelet in blood coagulation**

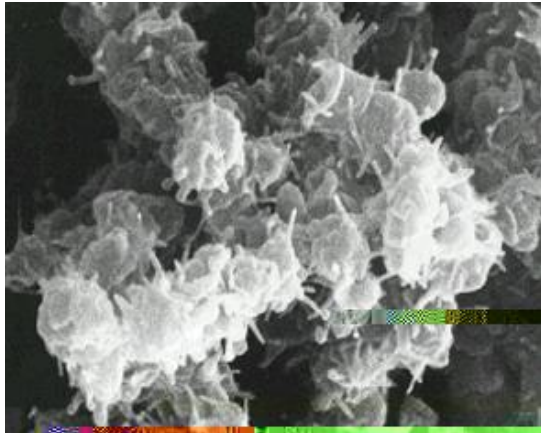
**(The cell based model of blood coagulation)**

# Cell based model

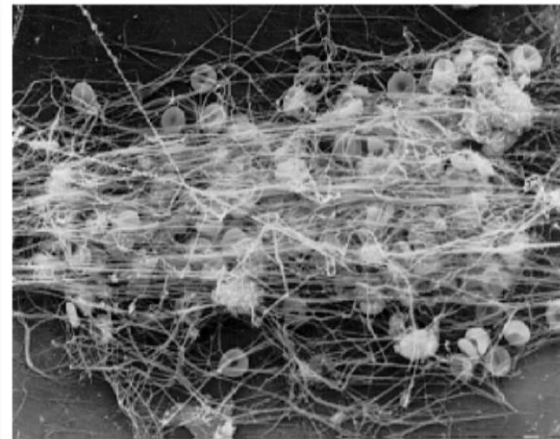


## **Platelet function: Maintenance of vascular integrity**

➤ Initial arrest of bleeding by platelet plug formation

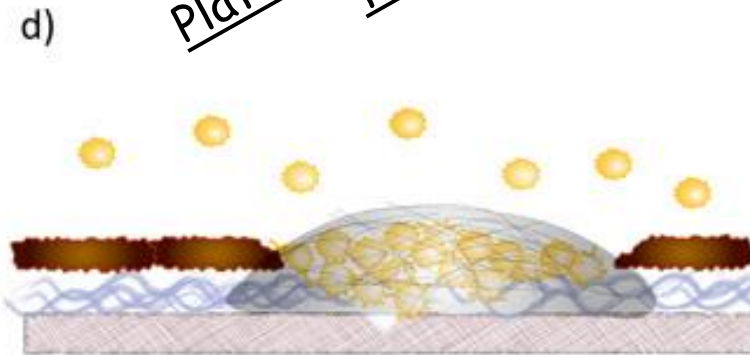
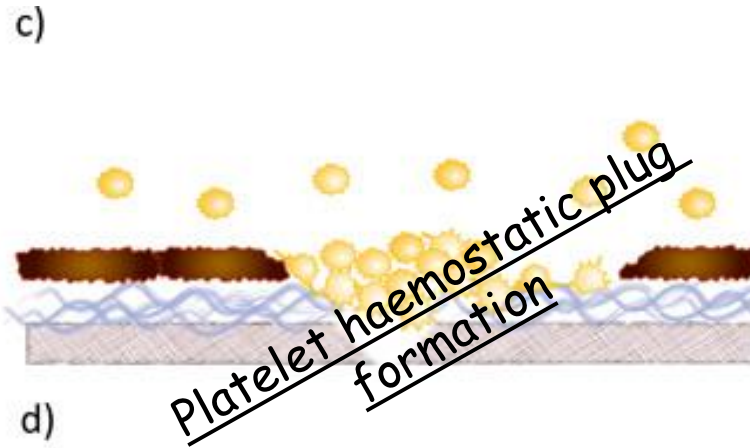
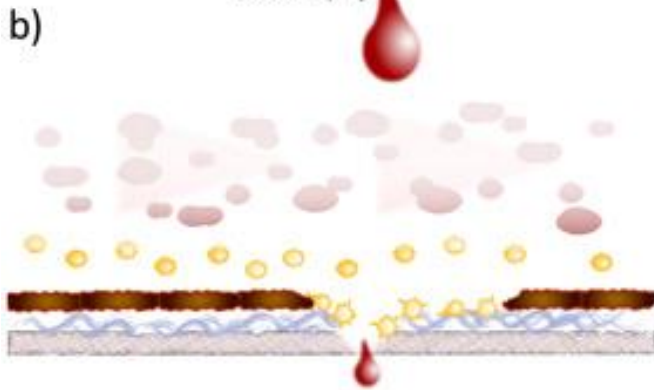
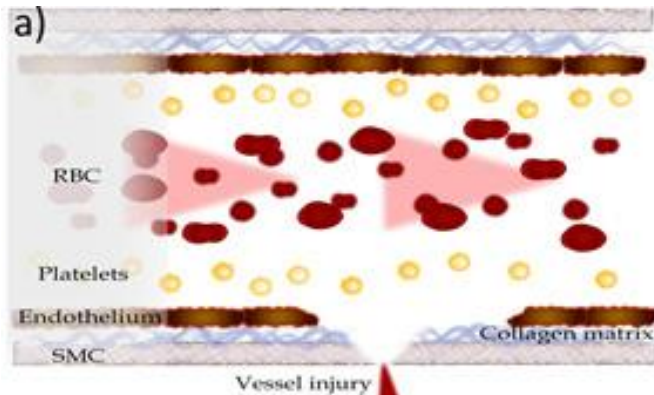


➤ Stabilization of hemostatic plug by contributing to fibrin formation

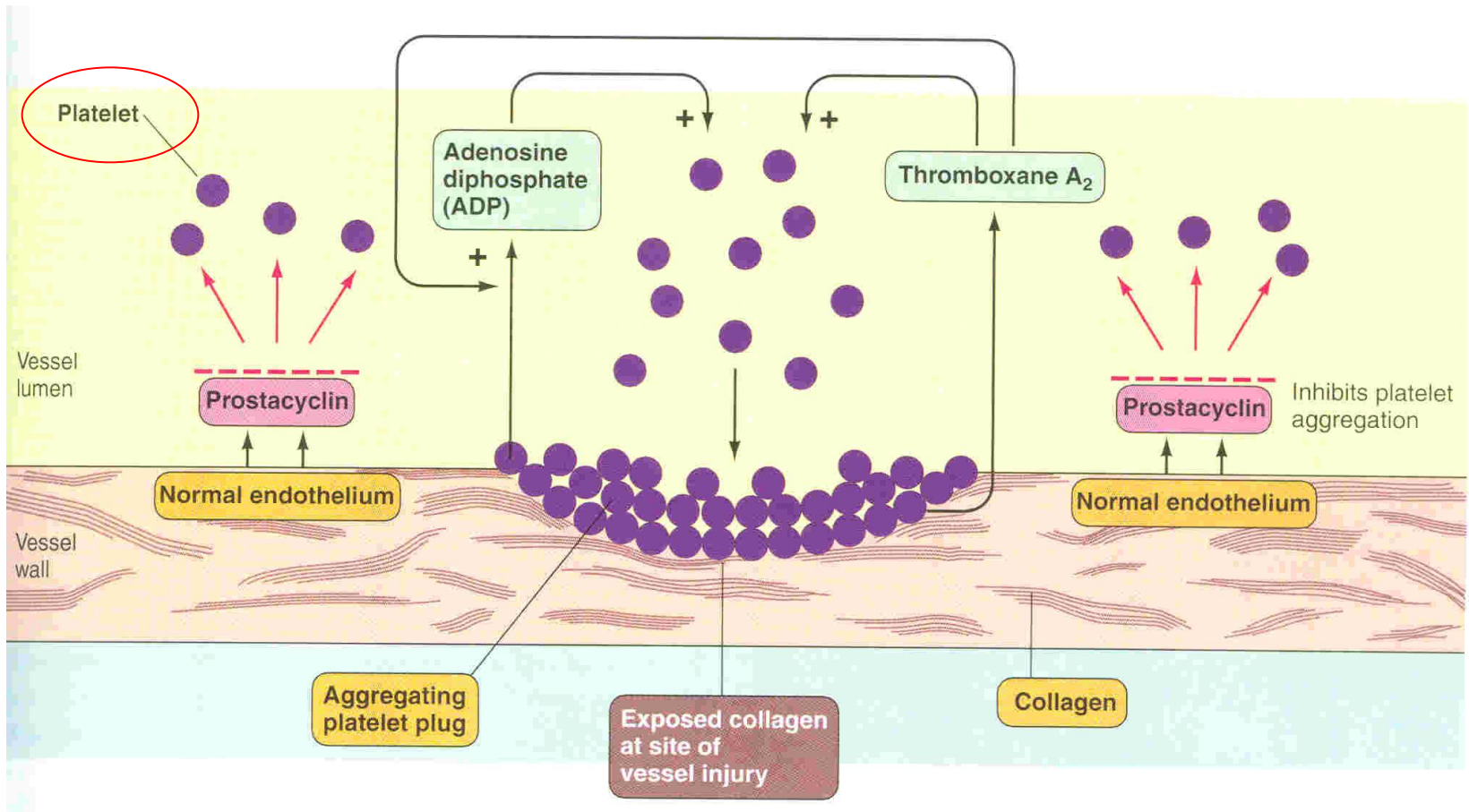


**Adequate number and function of  
platelet is essential to participate  
optimally in haemostasis**

# Platelet haemostatic plug formation



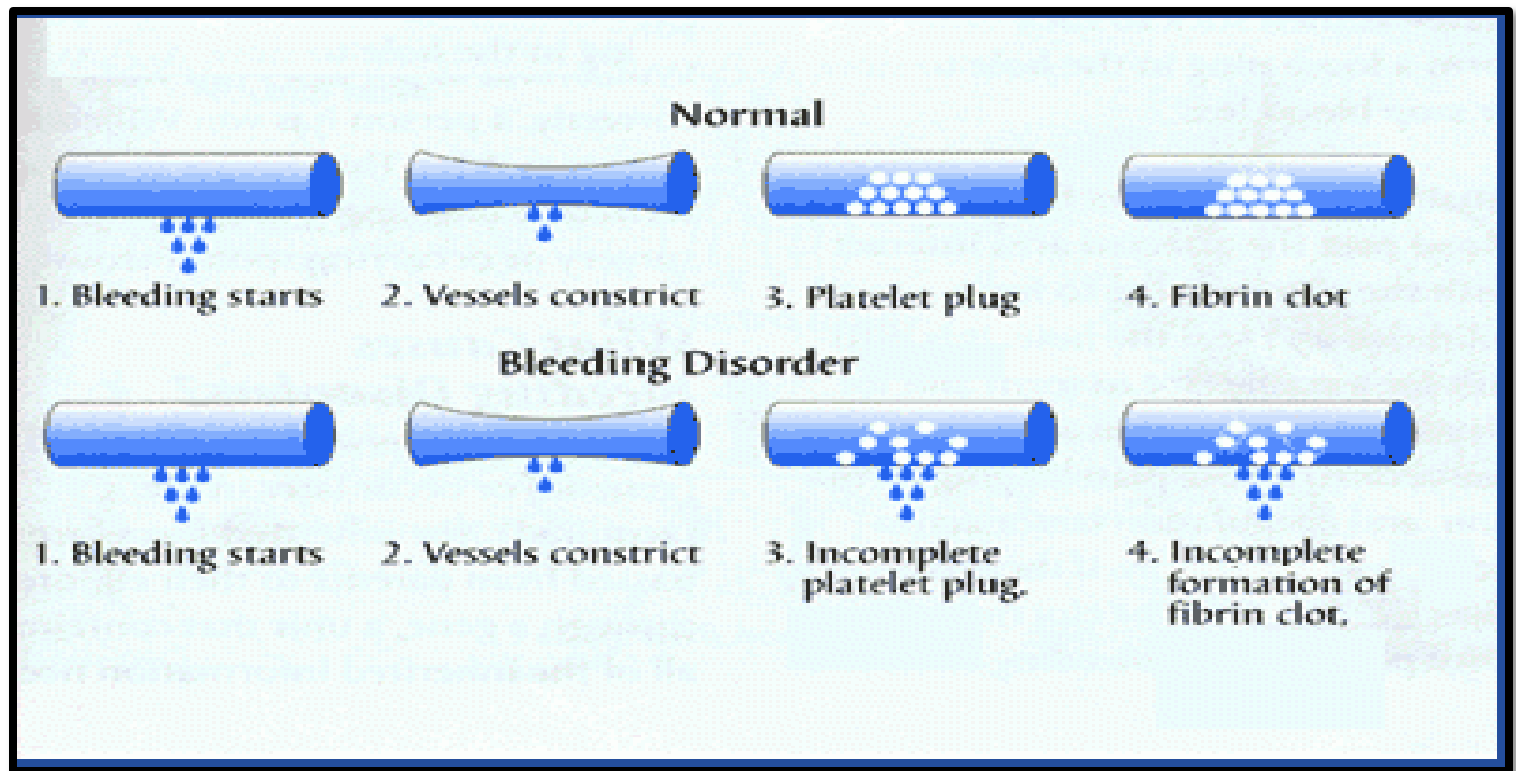
# Platelets aggregation



# **Platelet Activation**- summary

- **Platelets are activated when brought into contact with collagen exposed when the endothelial blood vessel lining is damaged**
- **Activated platelets release a number of different coagulation and platelet activating factors**
- **Transport of negatively charged phospholipids to the platelet surface; provide a catalytic surface for coagulation cascade to occur**
- **Platelets adhesion receptors (integrins): Platelets adhere to each other via adhesion receptors forming a hemostatic plug with fibrin**
- **Myosin and actin filaments in platelets are stimulated to contract during aggregation further reinforcing the plug and help release of granule contents**
- **GPIIb/IIIa: the most common platelet adhesion receptor for fibrinogen and von Willebrand factor (vWF)**

# Bleeding Disorders





- **Bleeding can result from:**
  - **Platelet defects:**
    - deficiency in number (thrombocytopenia)**
    - defect in function.**

# Congenital Platelet Disorders

## Disorders of Adhesion:

- . Bernard-Soulier

## Disorder of Aggregation:

- . Glanzmann thrombosthenia

## Disorders of Granules:

- . Grey Platelet Syndrome
- . Storage Pool deficiency
- . Hermansky-Pudlak syndrome
- . Chediak-Higashi syndrome

## Disorders of Cytoskeleton:

- . Wiskott-Aldrich syndrome

## Disorders of Primary Secretion:

- . Receptor defects (TXA<sub>2</sub>, collagen ADP, epinephrine)

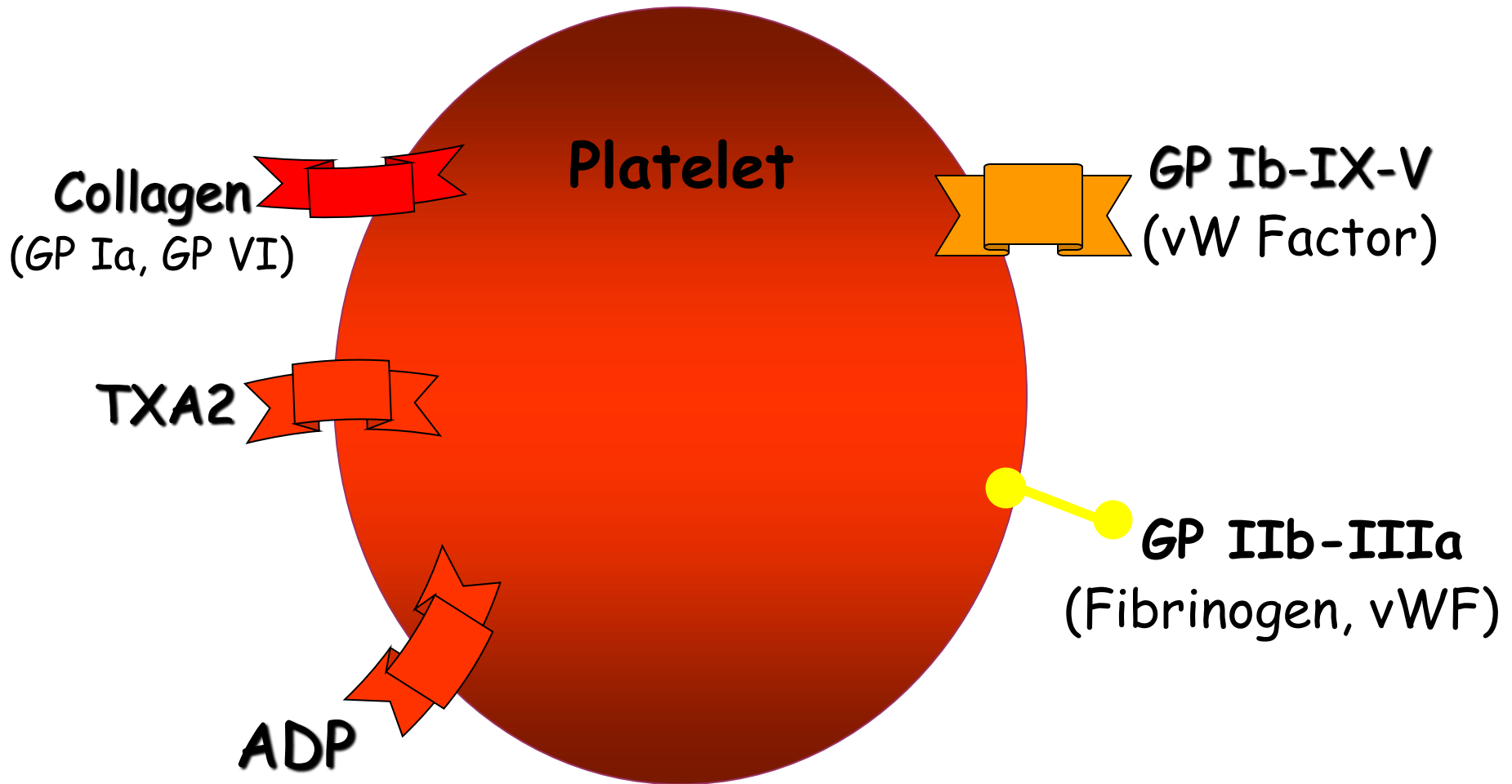
## Disorders of Production:

- . Congenital amegakaryocytic thrombocytopenia
- . MYH9 related disorders
- . Thrombocytopenia with absent radii (TAR)
- . Paris-Trousseau/Jacobsen

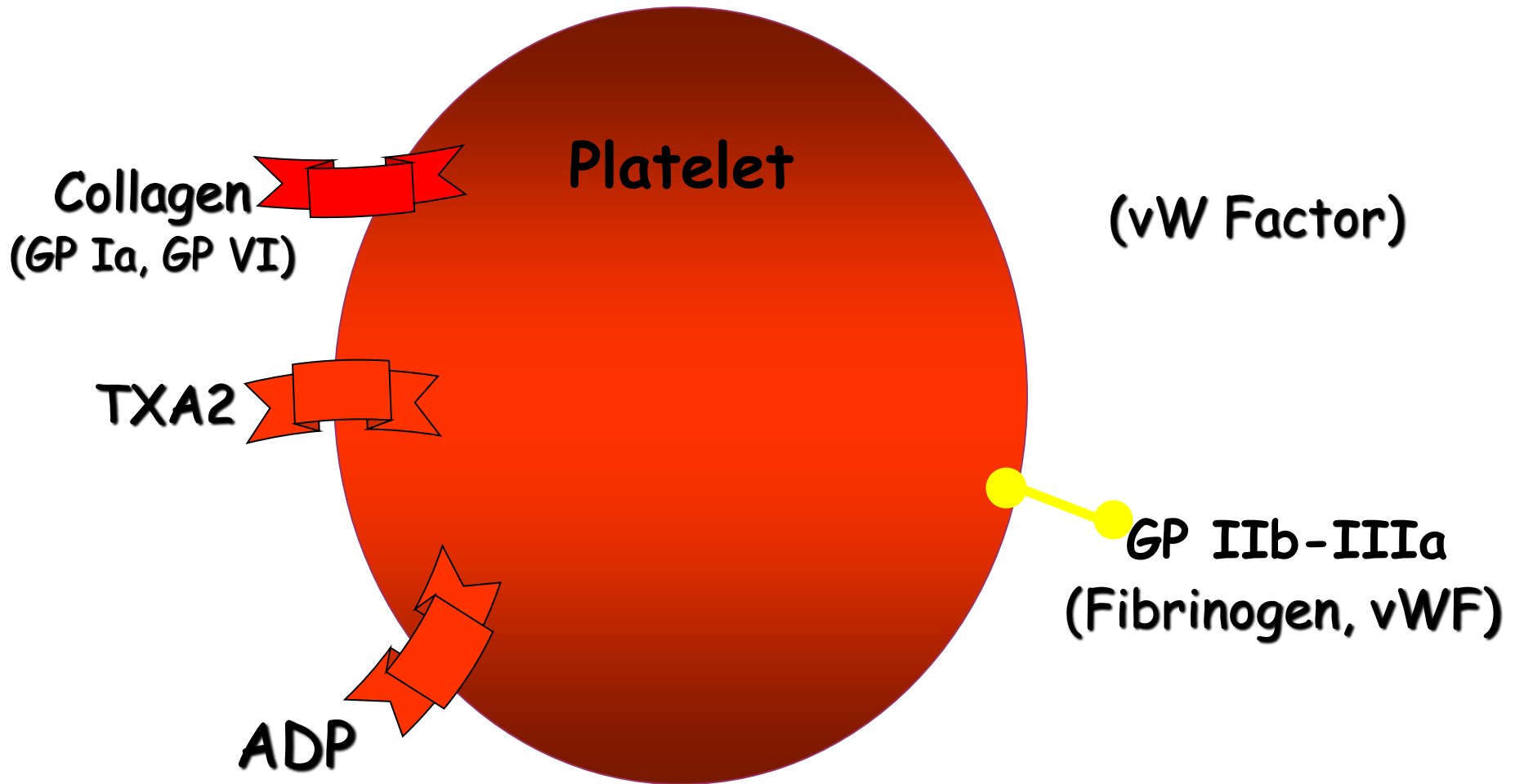
# Platelet Activation

- **Adhesion:**
- **Shape change**
- **Aggregation**
- **Release**
- **Clot Retraction**

# Bernard-Soulier Syndrome



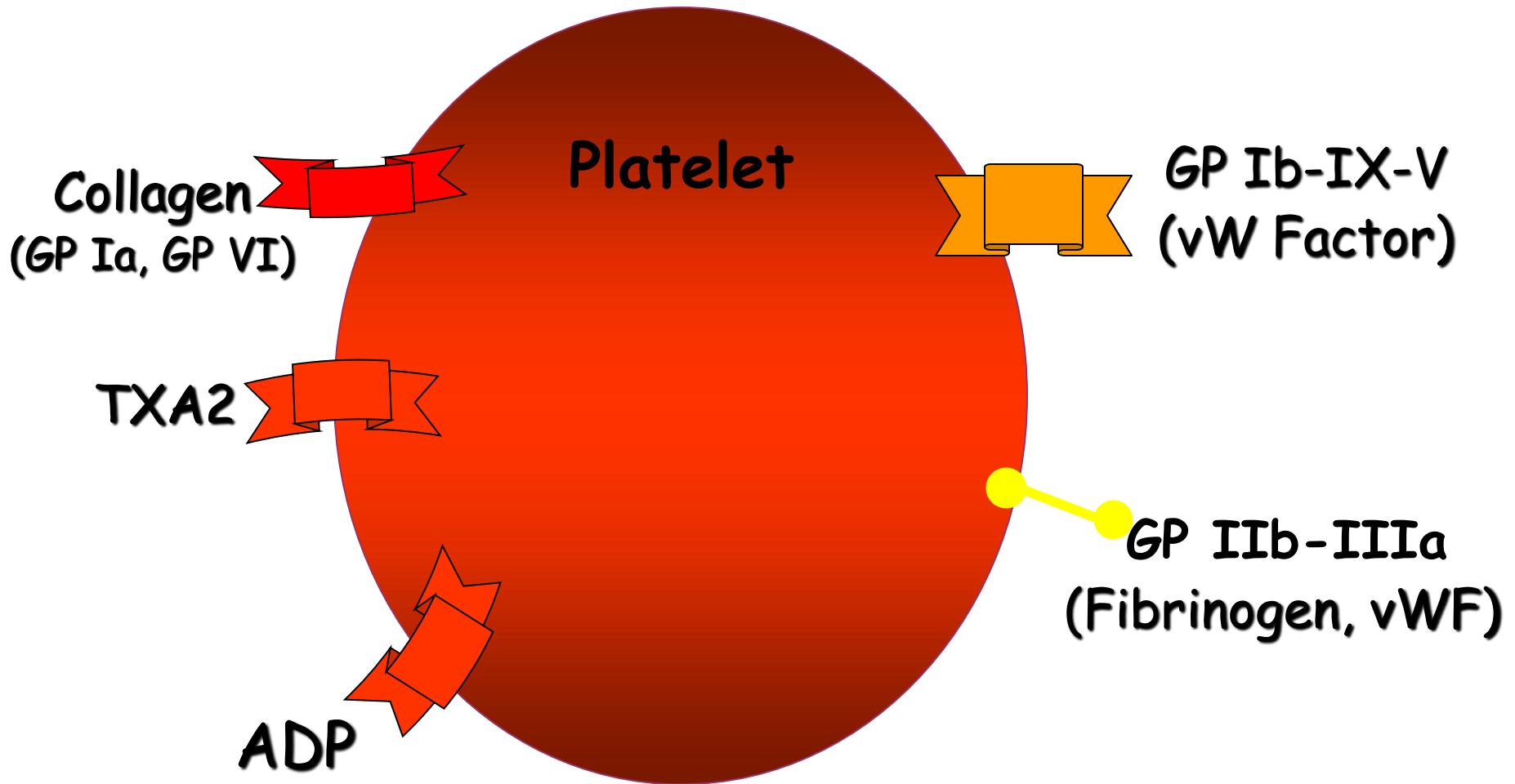
# Bernard-Soulier Syndrome



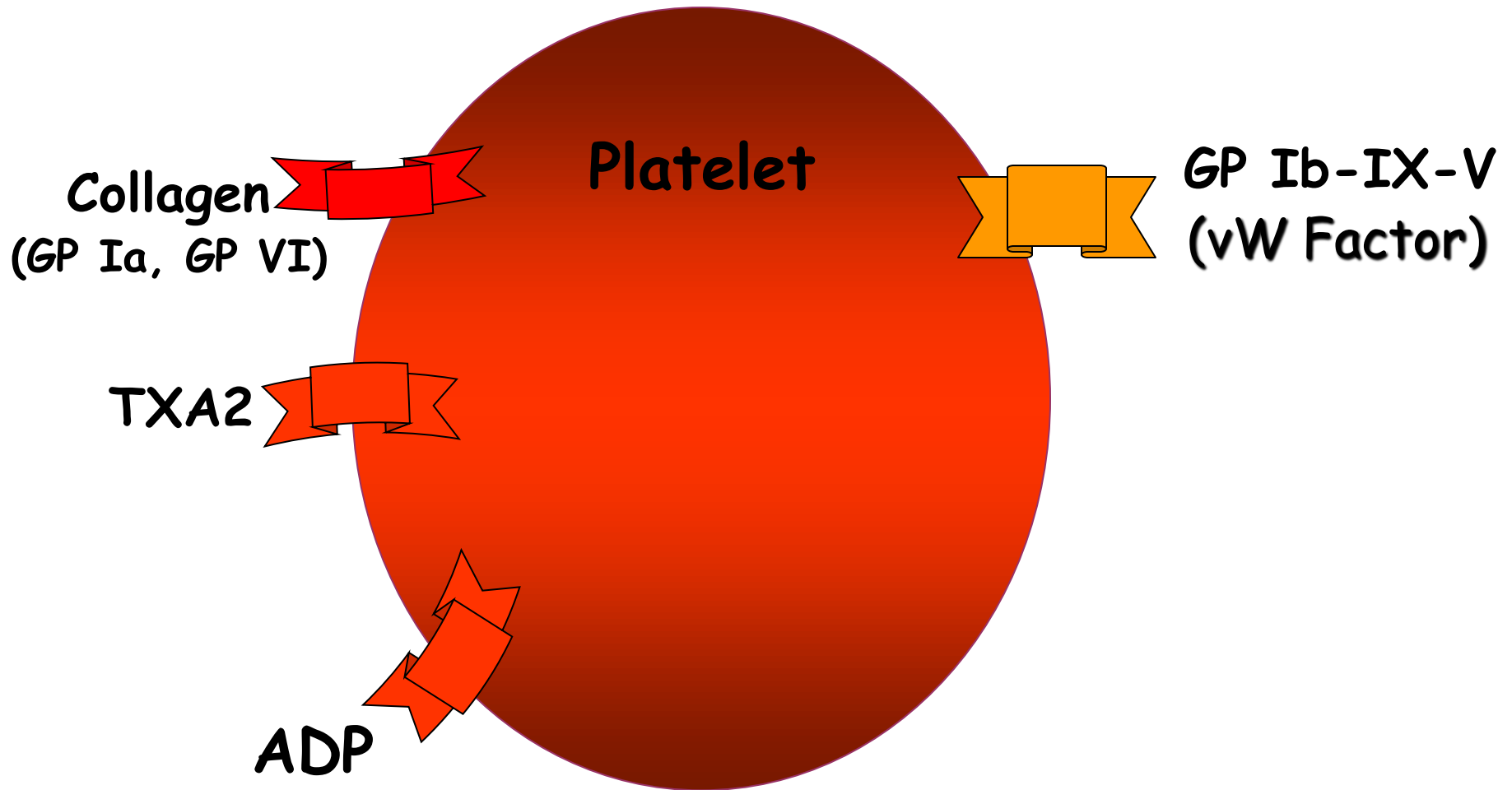
# Platelet Activation

- **Adhesion:** Bernard-Soulier Syndrome (BSS)
- **Shape change**
- **Aggregation**
- **Release**
- **Clot Retraction**

# Glanzmann Thrombasthenia



# Glanzmann Thrombasthenia





# Platelet Activation

- **Adhesion:**
- **Shape change**
- **Aggregation**      **Glanzmann Thrombasthenia**
- **Release**
- **Clot Retraction**

**How to investigate for a  
platelet disorder?**

# Laboratory Testing of Platelet Functions

- Platelet count (& shape)
- Electron-microscopy
- Bleeding time
- Platelet Aggregation
- Platelet Function Analyzer (PFA-100)
- Flow-cytometry
- Granule release products

# Bleeding Time



platelet function test

## **Platelet Aggregometry**



# Laboratory Testing of Platelet Functions

## Platelet Aggregation

in (PRP) Platelet rich plasma):

Provides information on time course of plat. activation.

### Agonists:

ADP

Adrenaline

Collagen

Arachidonic acid

Ristocetin

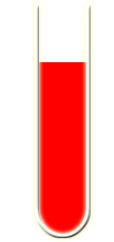
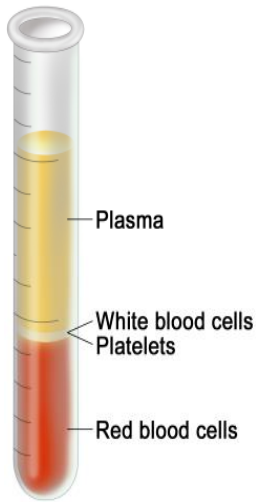
Thrombin

Reference ranges need to be determined for each agonist

# Platelet Aggregation

## Agonists:

- ADP
- Adrenaline
- Collagen
- Arachidonic acid
- Ristocetin
- Thrombin



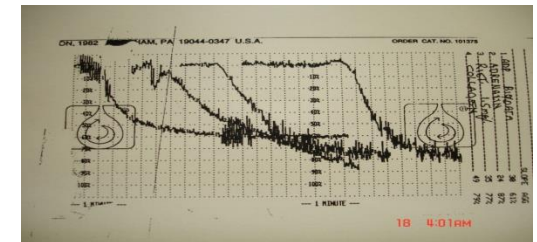
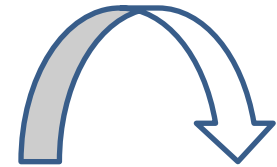
Whole blood

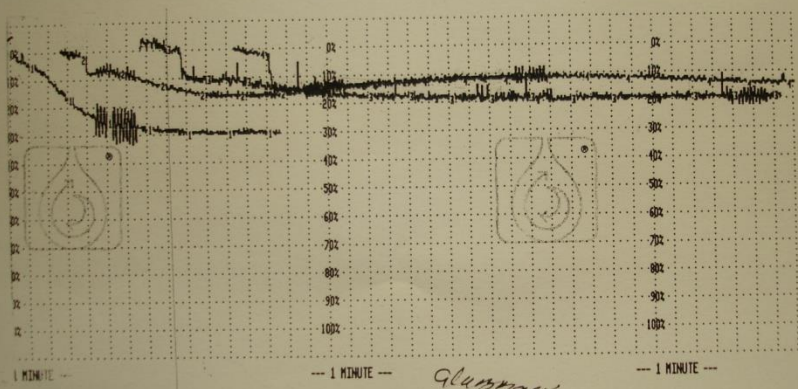


RBC



PRP



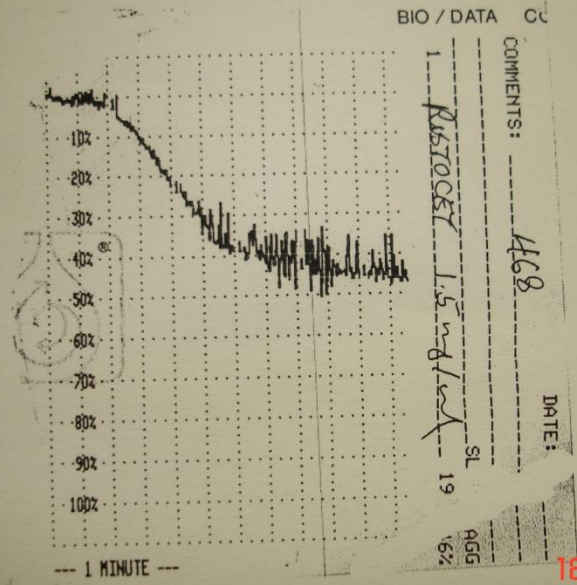


1. ADP RIV/DATA  
 2. ARACHIDONIC  
 3. ADRENALIN  
 4. COLLAGEN

SLOPE AGG  
 13 38%  
 84 11%  
 86 28%  
 83 15%

*Glumman's*

18 4:02AM



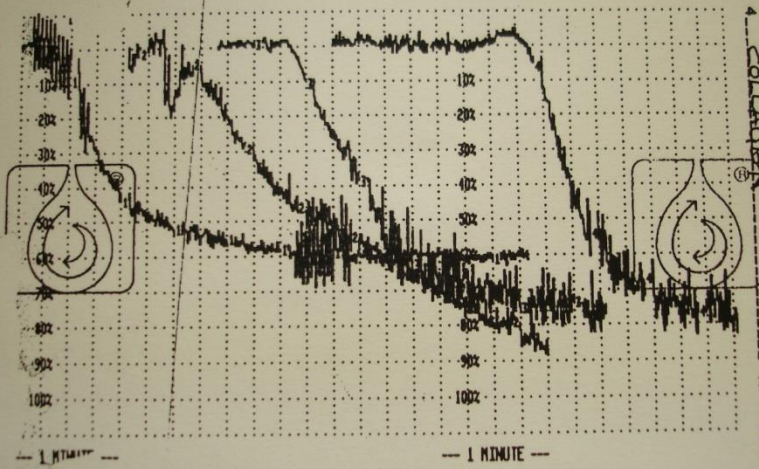
BIO / DATA CC

COMMENTS: \_\_\_\_\_  
 DATE: \_\_\_\_\_

1. RUSTOCEI 1.5 mg / day SL 19  
 AGG 16%

18 4:04AM

ON, 1982 MORSHAM, PA 19044-0347 U.S.A. ORDER CAT. NO. 101375



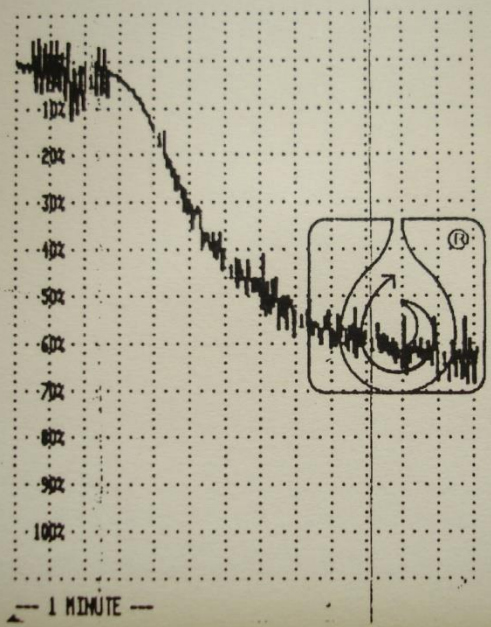
1. ADP BIO/DATA  
 2. ADRENALIN  
 3. RIV-D 1.5 mg  
 4. COLLAGEN

SLOPE AGG  
 30 61%  
 24 87%  
 35 77%  
 49 79%

*ECU 201*

18 4:01AM

© BIO/DATA CORPORATION, 1982 MORSHAM, PA 19044



COMMENTS: \_\_\_\_\_  
 DATE: \_\_\_\_\_

1. ARACHIDONIC  
 SLOPE AGG  
 28 65%

18 4:02AM



# summary

- platelets are cell fragments derived from megakaryocyte in the bone marrow.
- Platelets play a pivotal role in haemostasis by arresting bleeding from an injured blood vessels

Bleeding can result from: Platelet defects acquired or congenital

A scenic landscape featuring a wide river flowing through a valley. In the background, there are towering, rugged mountains with a waterfall cascading down one of the peaks. The valley is filled with a dense forest of tall evergreen trees. The sky is filled with dramatic, grey clouds, with some light breaking through. In the foreground, a large, weathered log lies across the river. The text "THANK YOU" is overlaid in the center of the image in a bold, yellow, sans-serif font, with a reflection effect below it.

**THANK YOU**