

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# **Platelet Structure & Function**

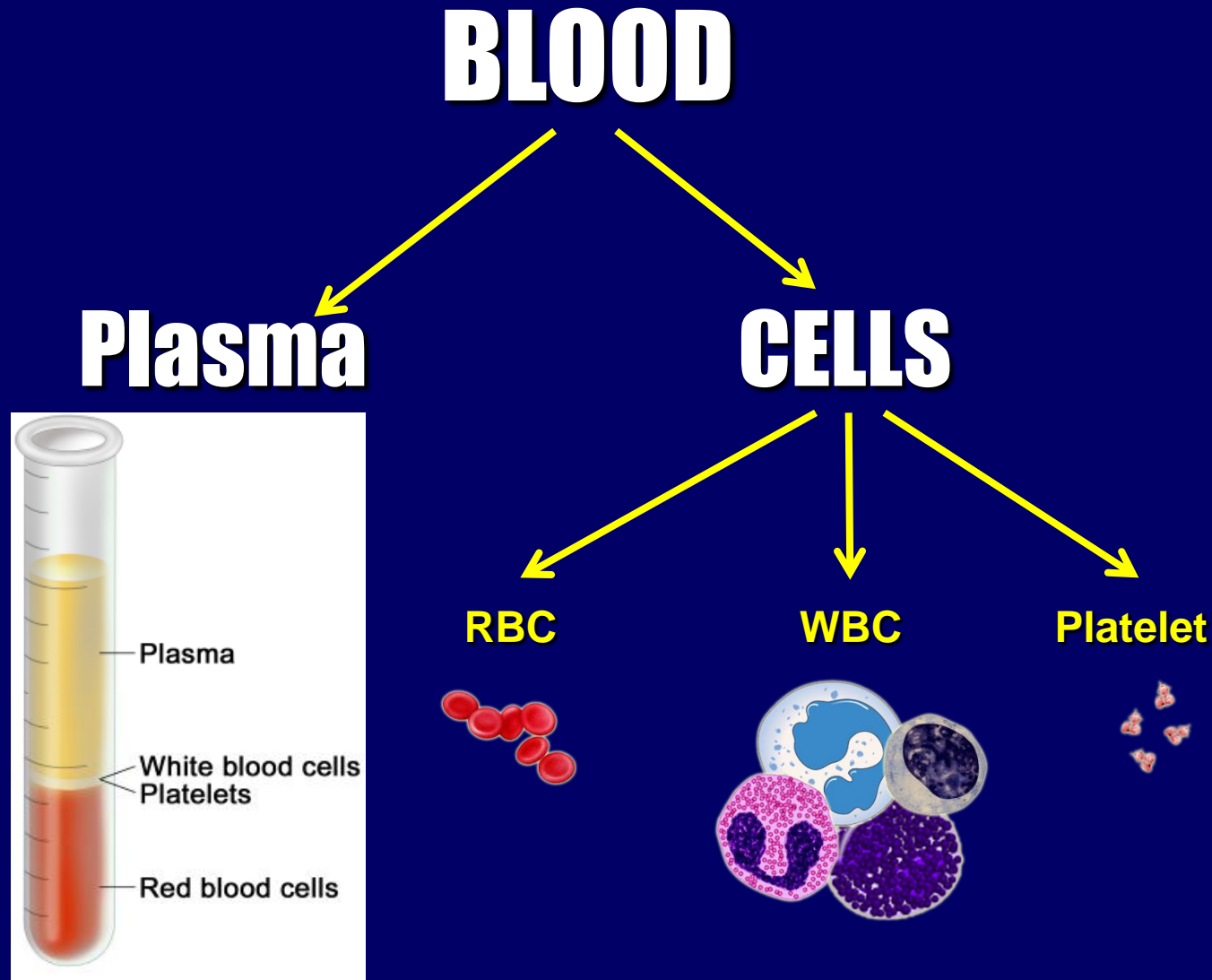
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**MB.BS, MSc, Ph-D**

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**College of Medicine**  
**King Saud University**  
**Riyadh**

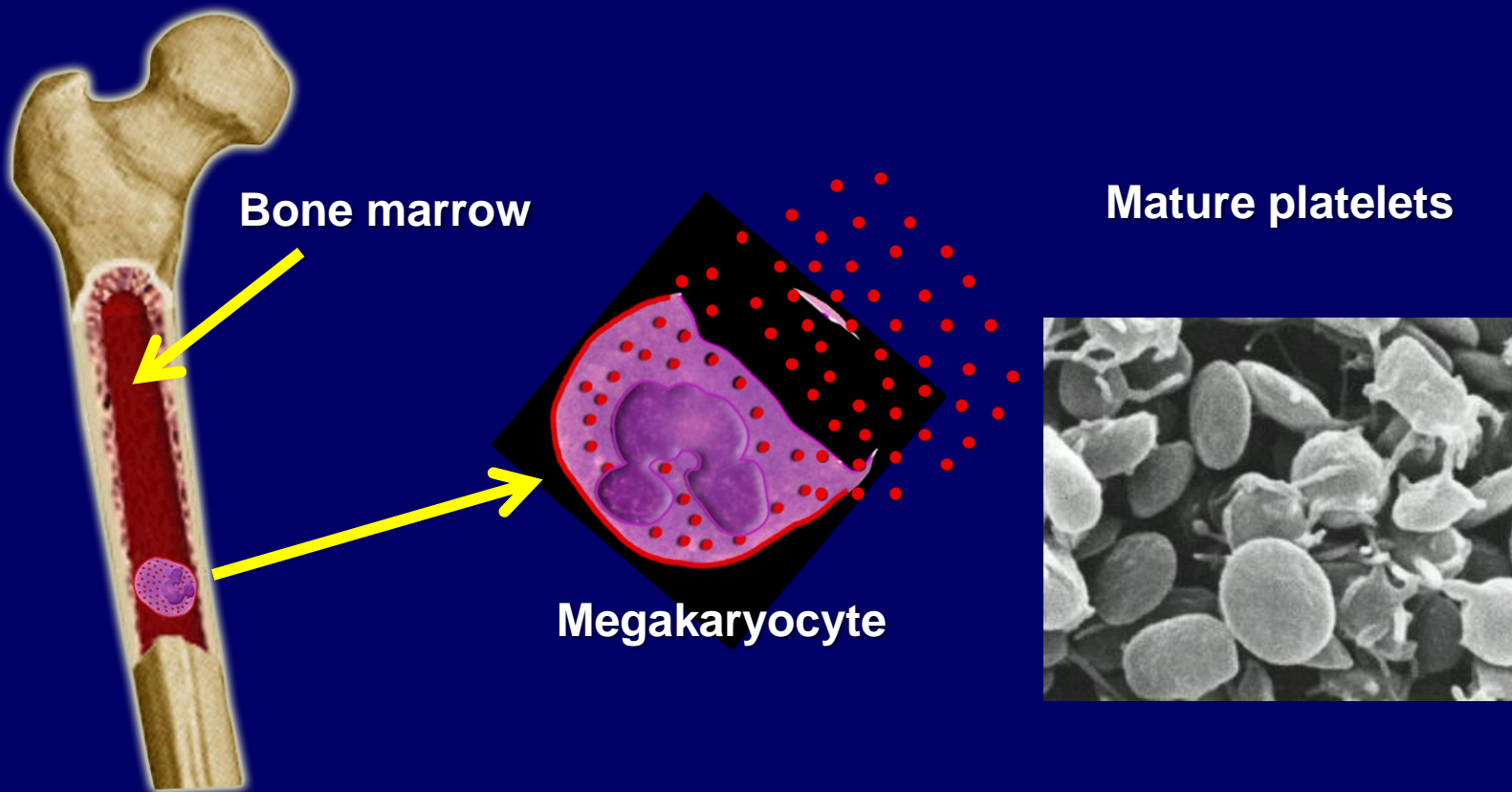
# Objectives

- 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?



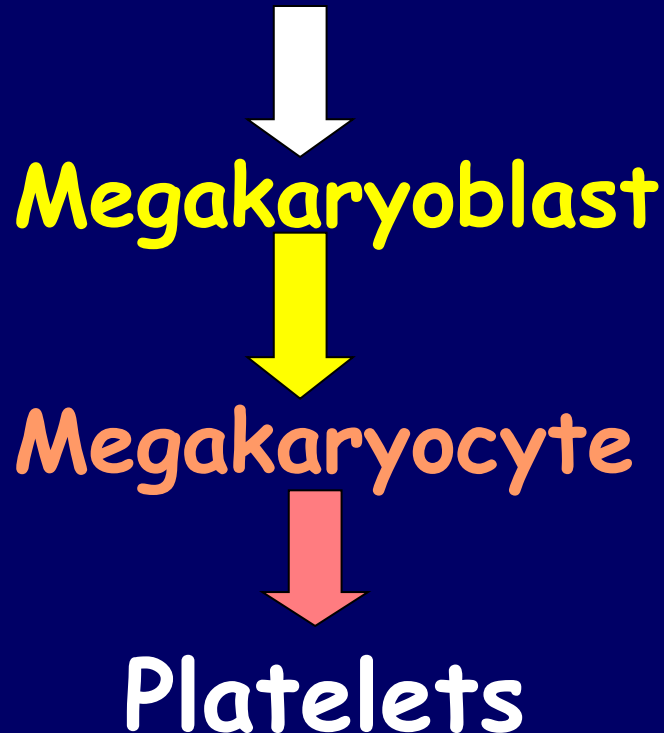
# What are platelets?



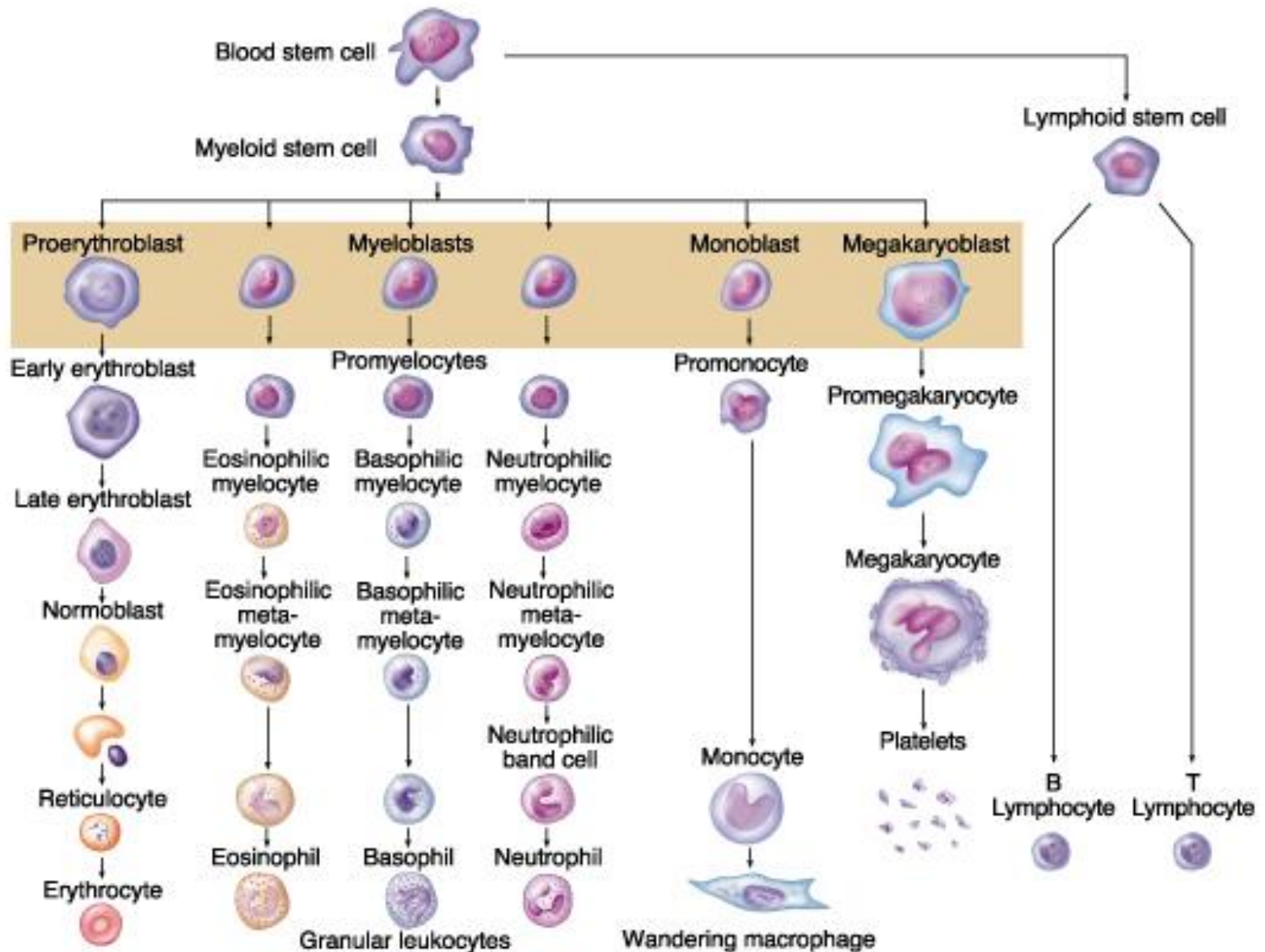
# Platelets - cont.

- Site of formation: **Bone marrow**

- Steps: Stem cell



# Megakaryocyte and platelet formation

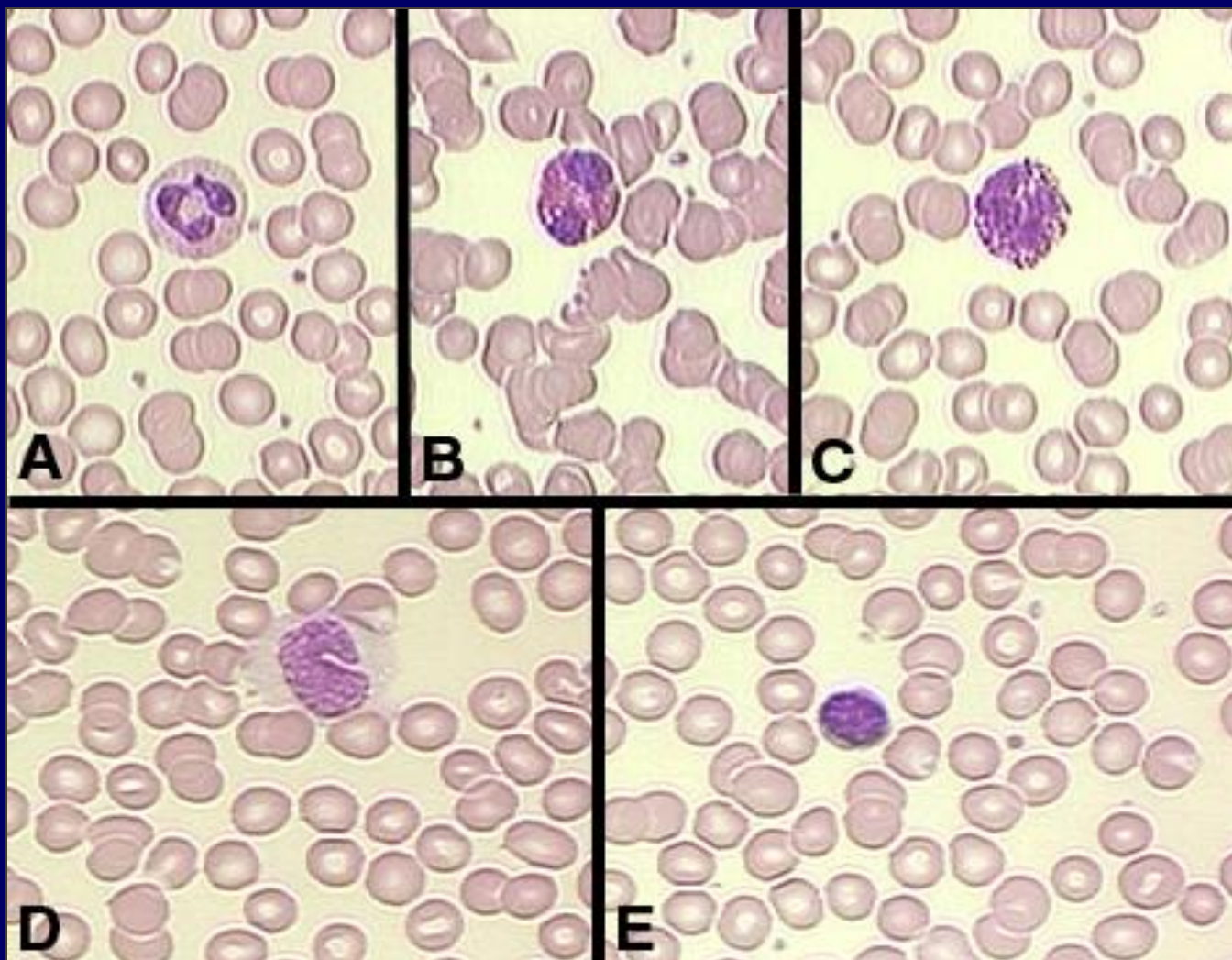


# Platelets Formation (Thrombopoiesis)

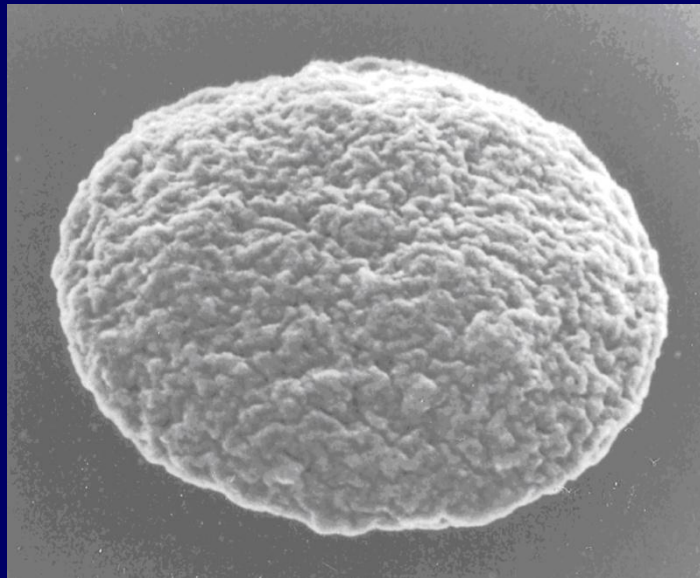
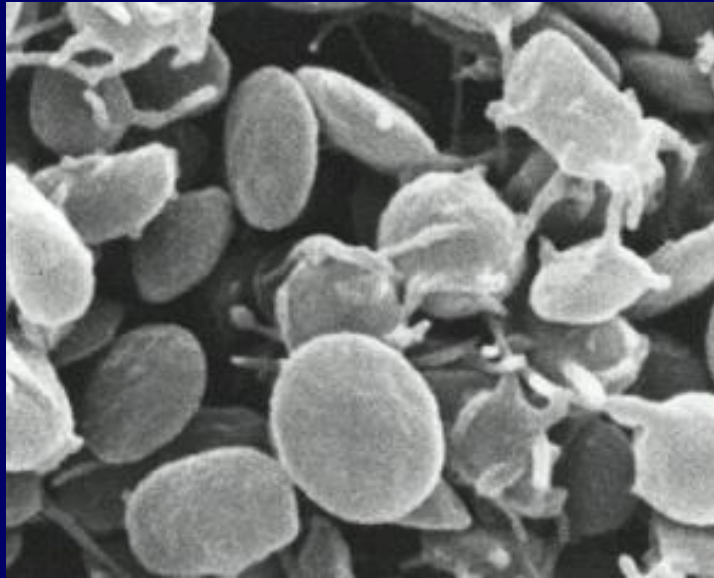
Regulation of thrombopoiesis  
by  
Thrombopoietin

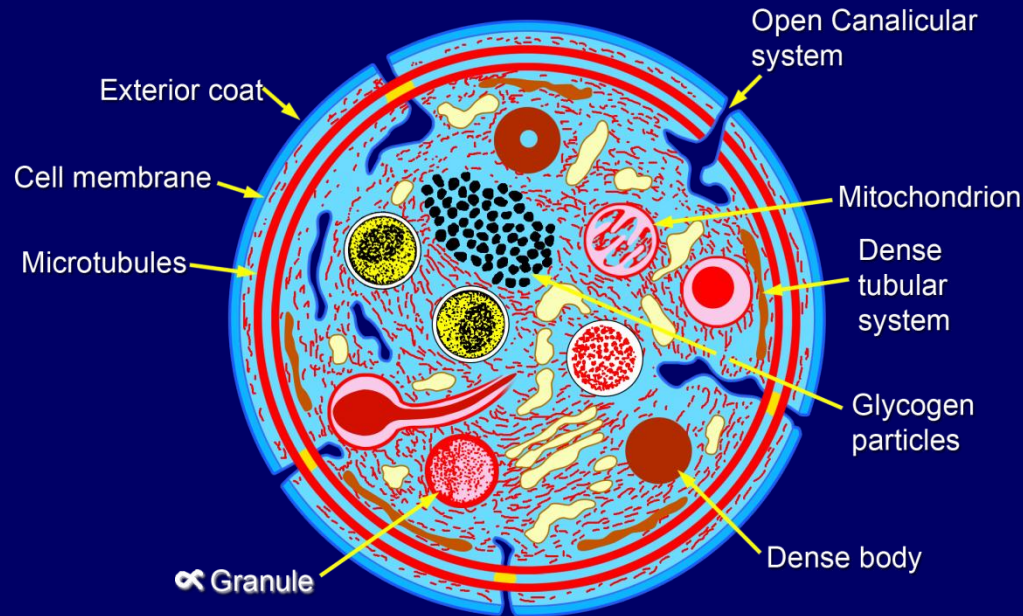


# Platelet ultra-structure



## ■ Anatomy of the platelets

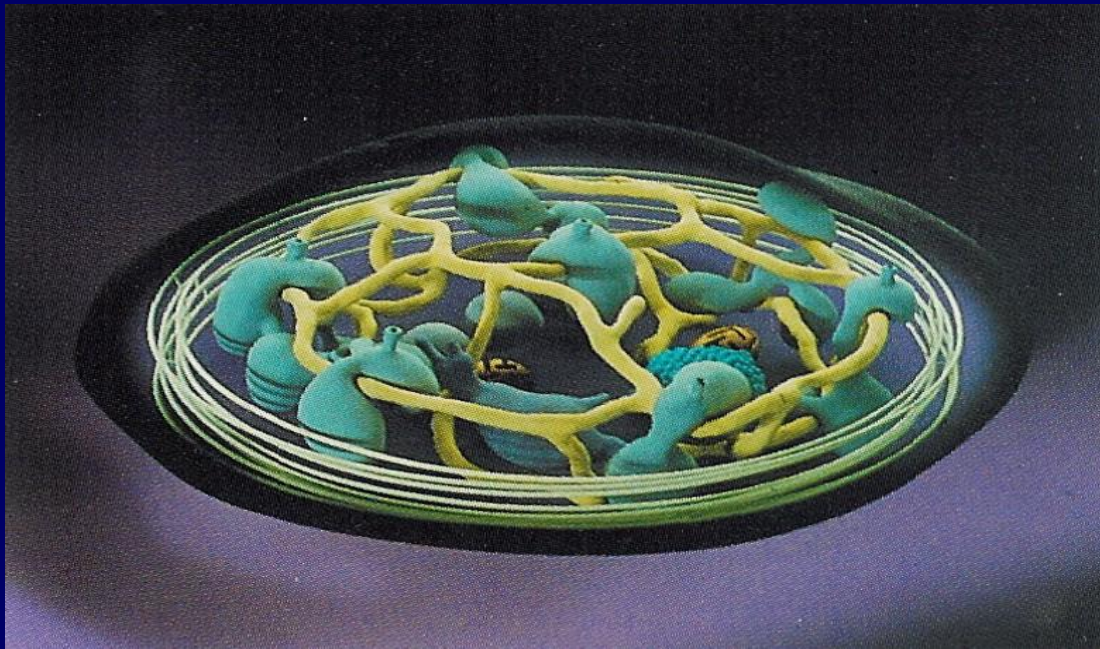
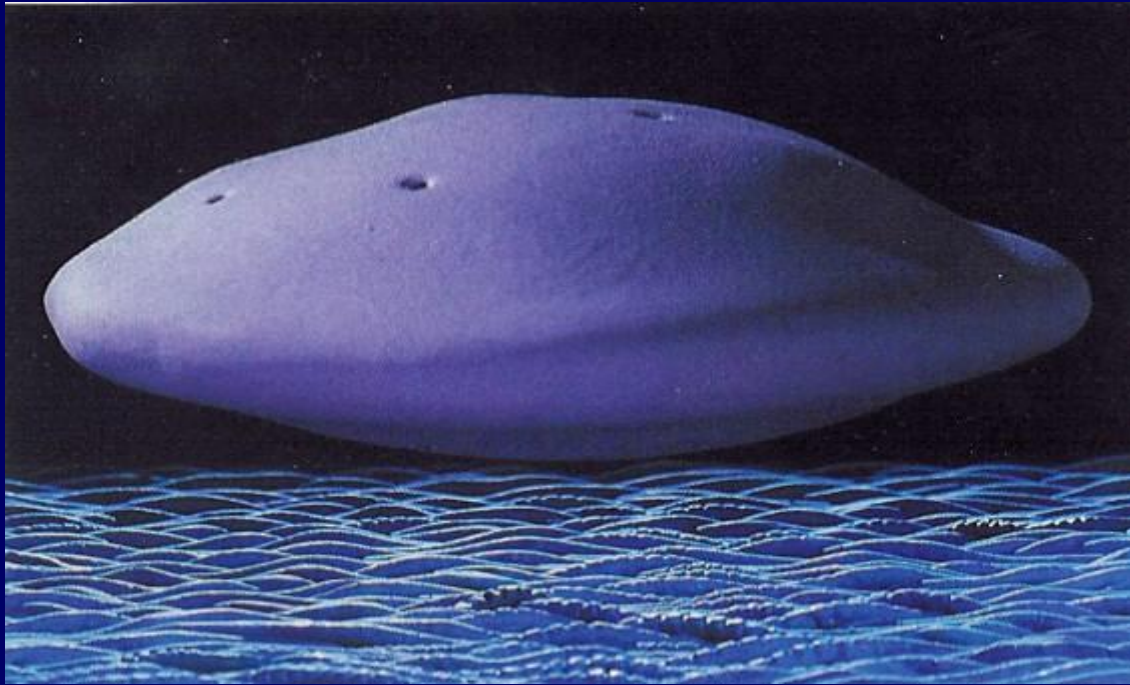




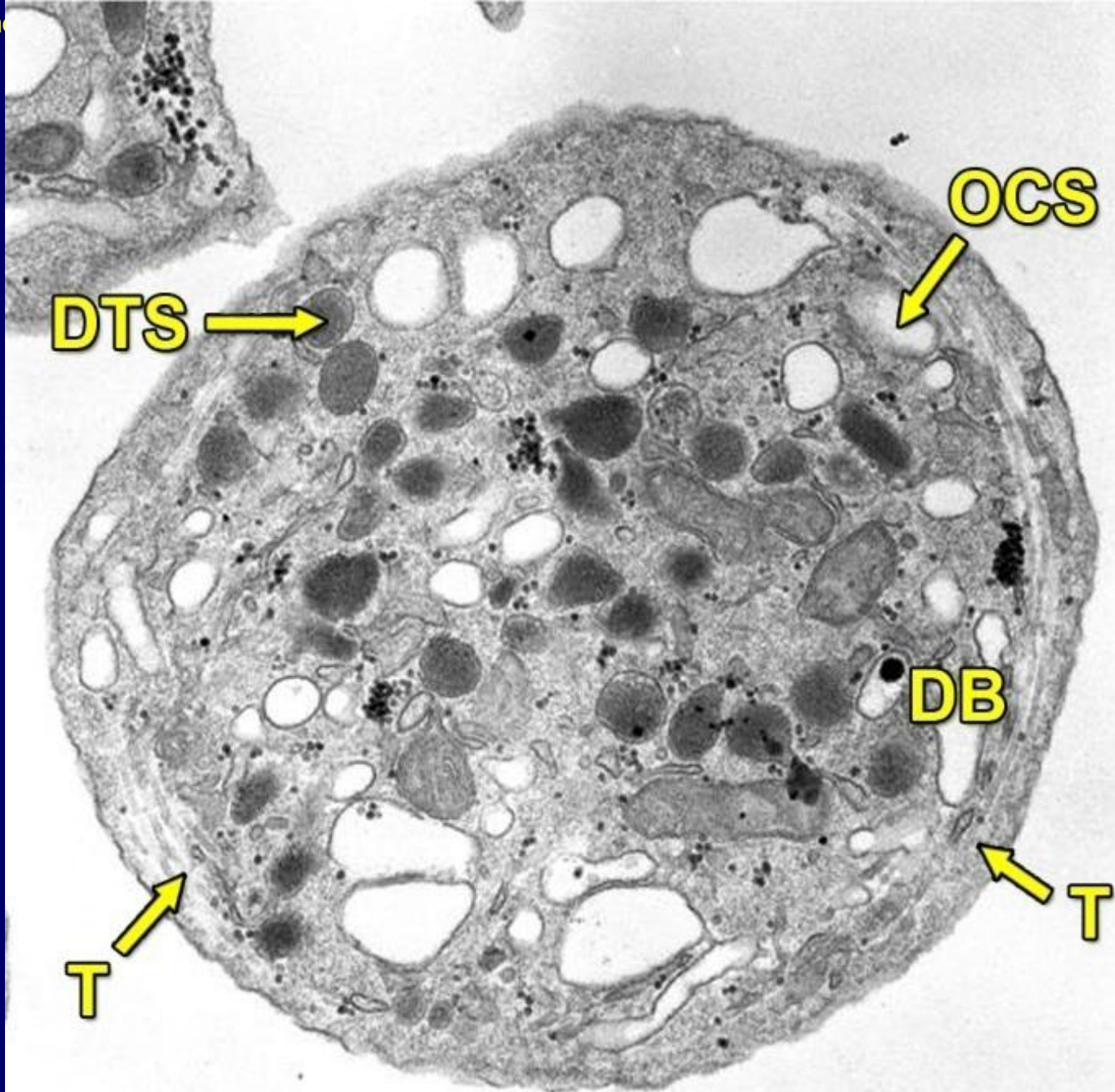
## (Thrombocytes)

- Anuclear and discoid cell → spherical when activated
- **Size: 1.5–3.0  $\mu\text{m}$**
- Life span: 7–10 days
- Sequestered in the spleen; **hypersplenism** may lead to low platelet counts.



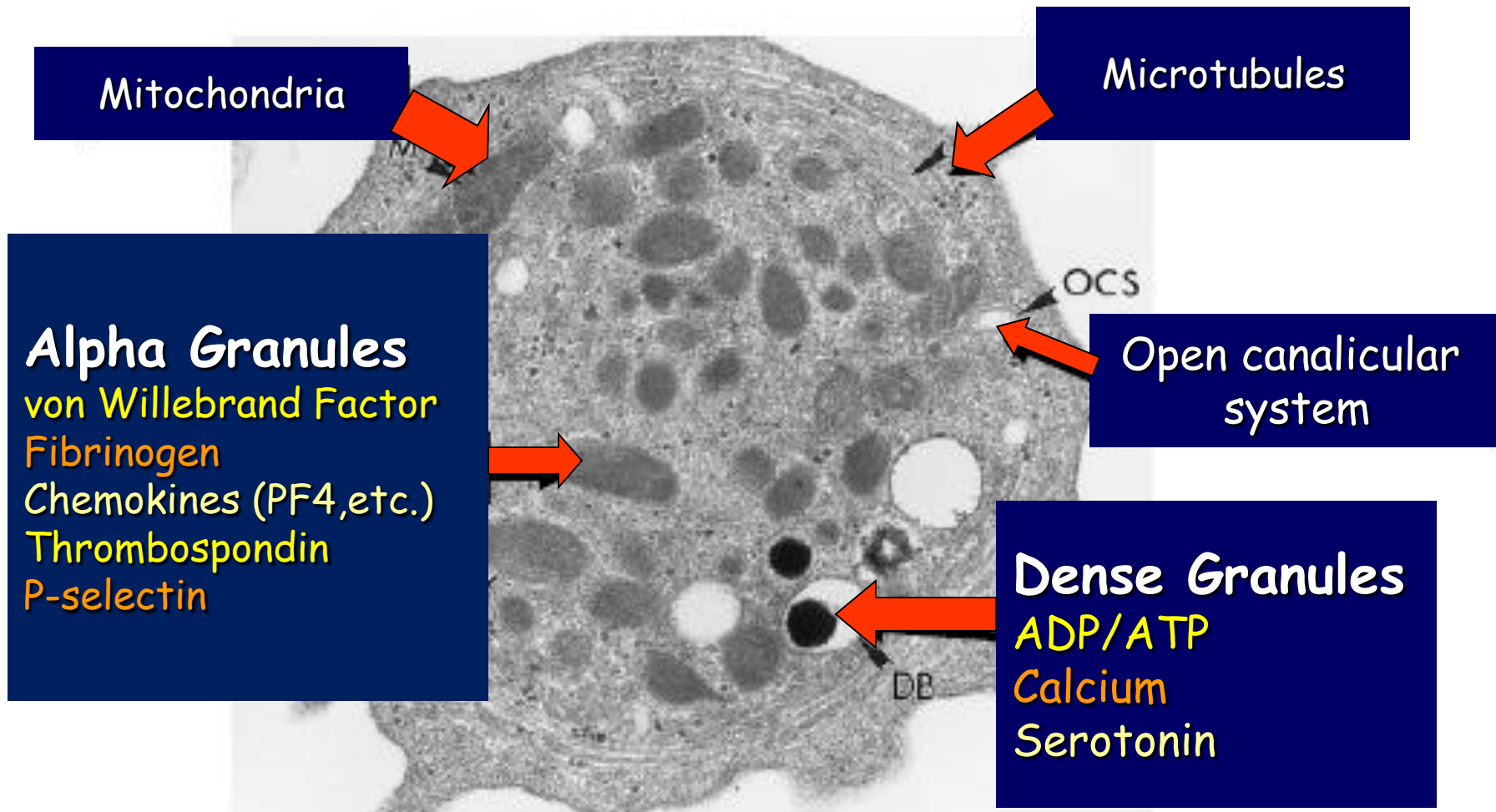


Platelet EM



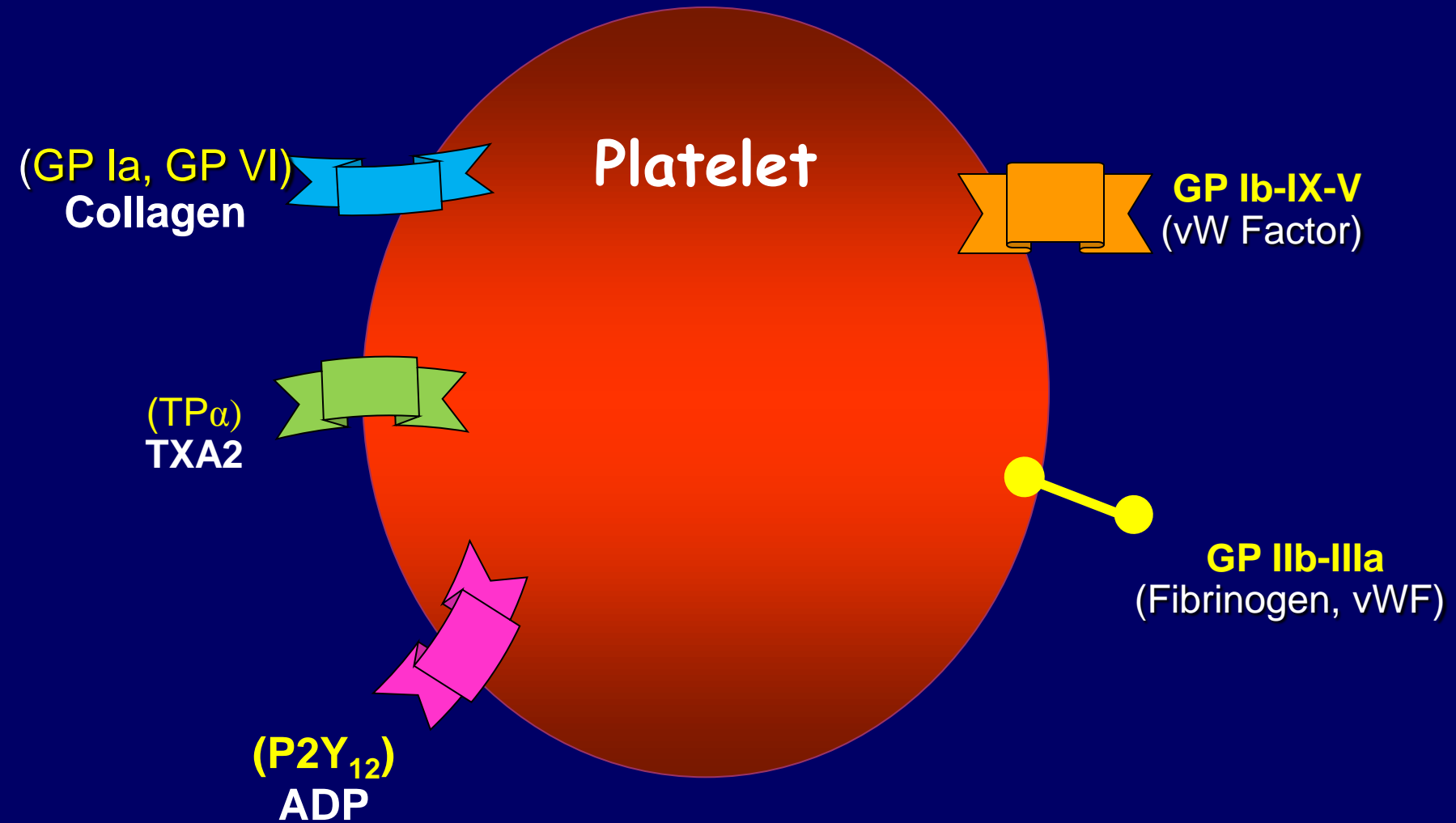


# Platelet Ultrastructure





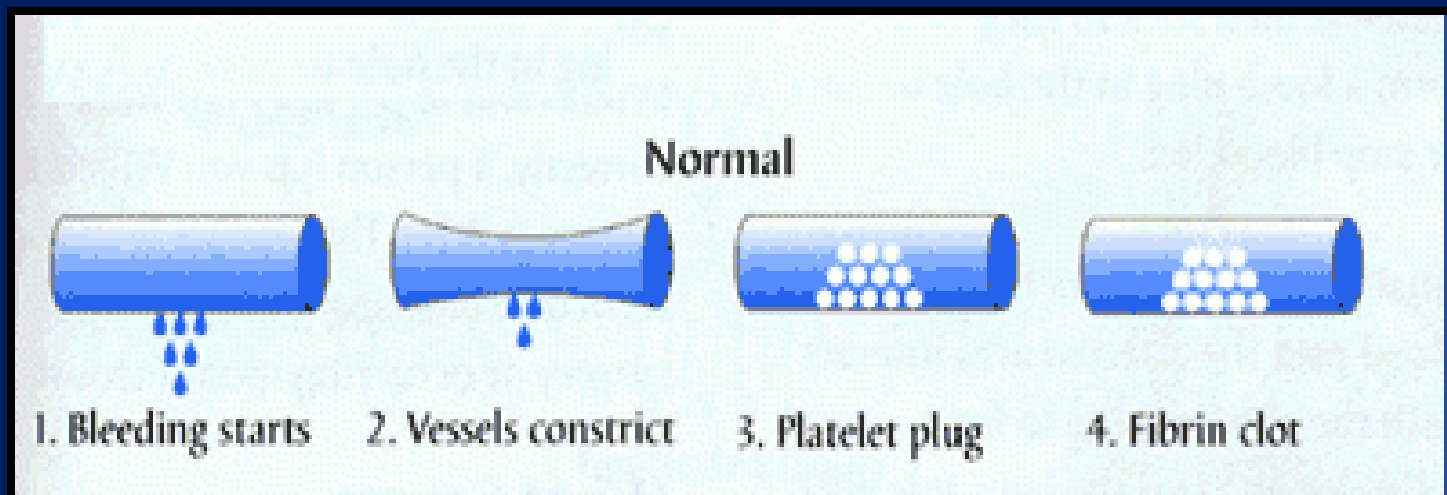
# Platelet Receptors



# General functions of the platelets

# HEMOSTASIS

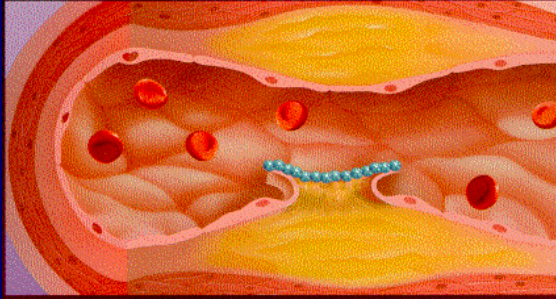
1. VASCULAR PHASE
2. PLATELET PHASE
3. COAGULATION PHASE
4. FIBRINOLYTIC PHASE



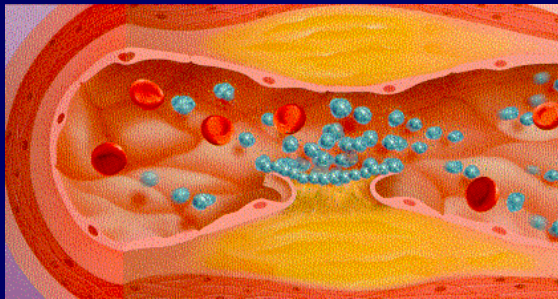
# Platelet Activation

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

# Platelet function

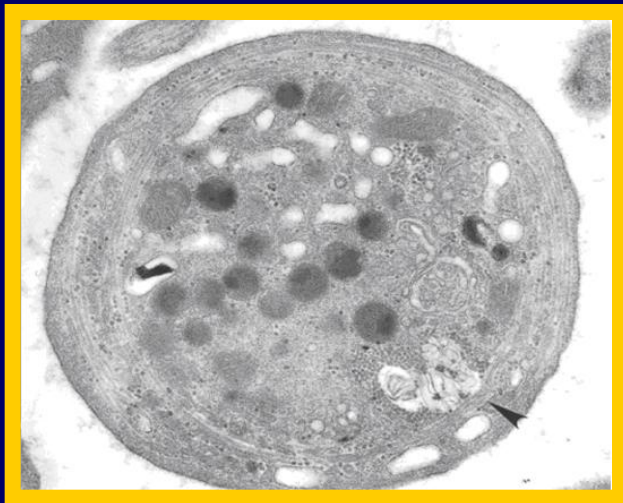
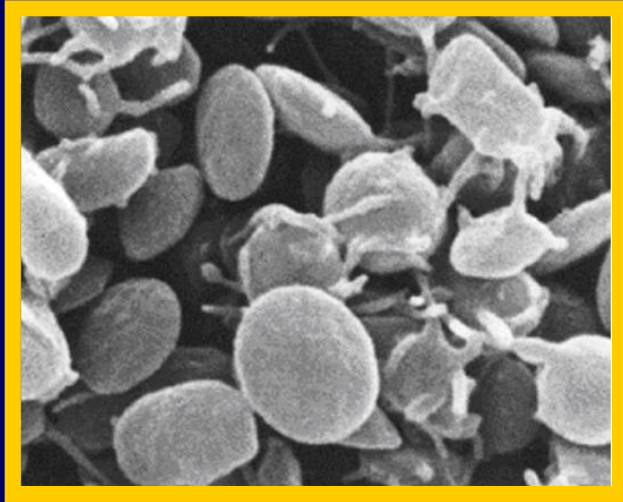


Adhesion

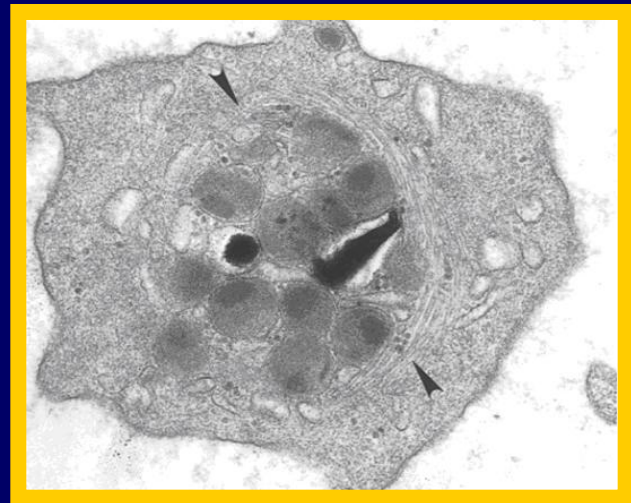
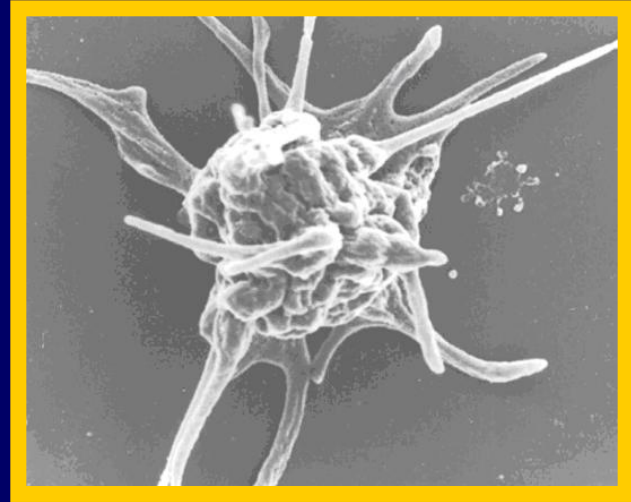


Activation

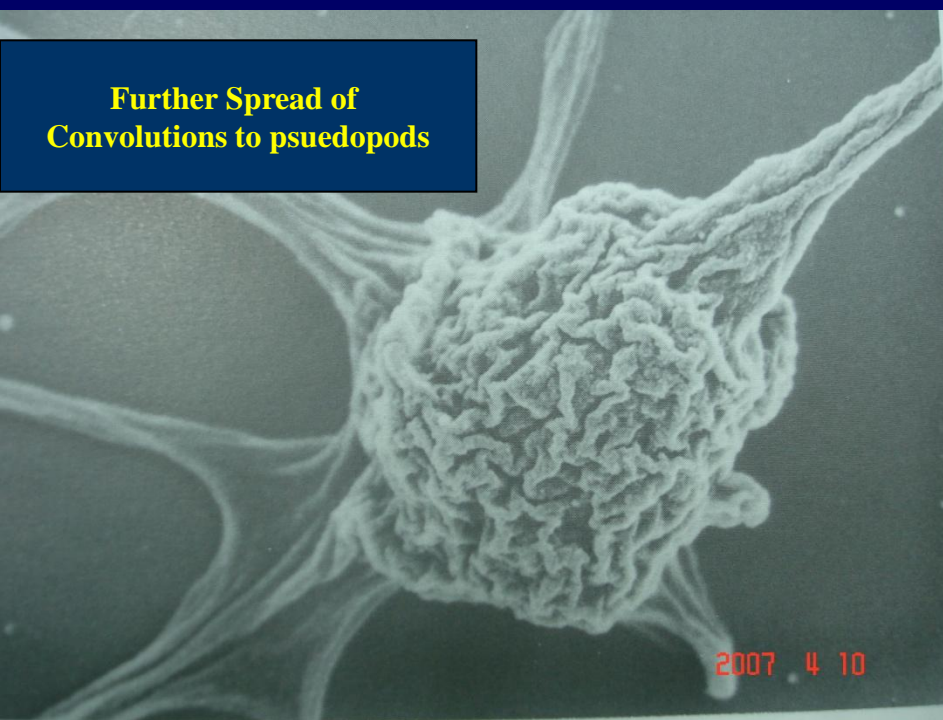
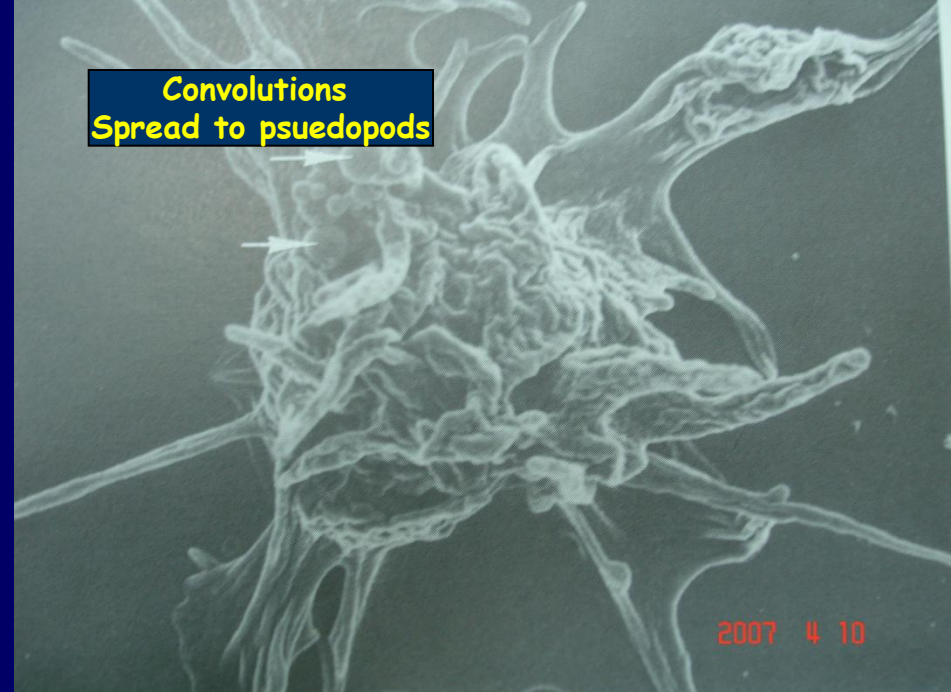
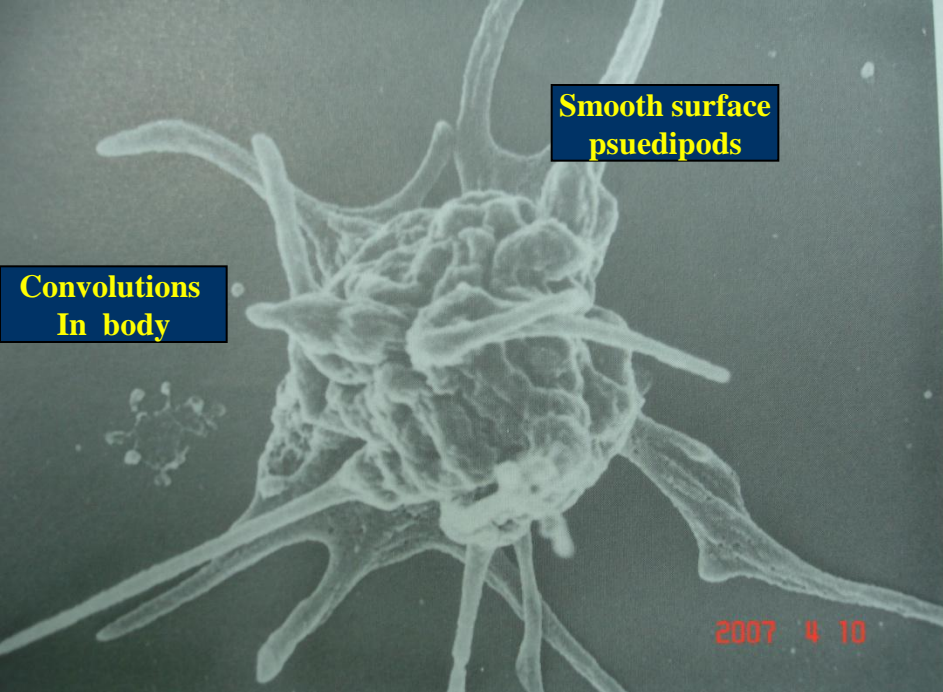
# Resting platelet



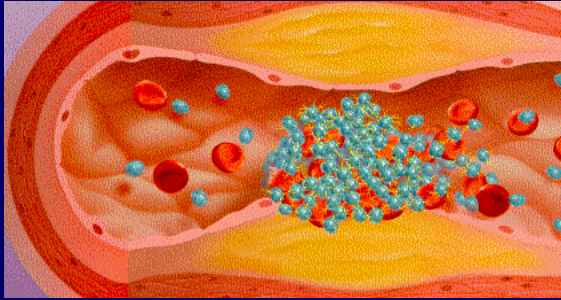
# Activated platelet



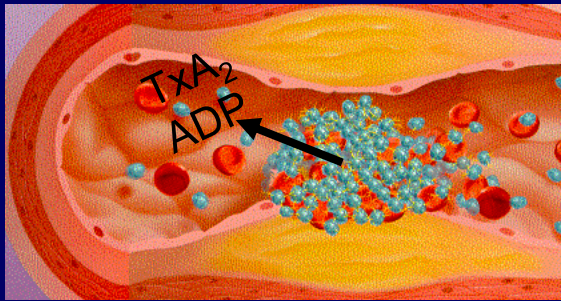




# Platelet function



Aggregation



Secretion



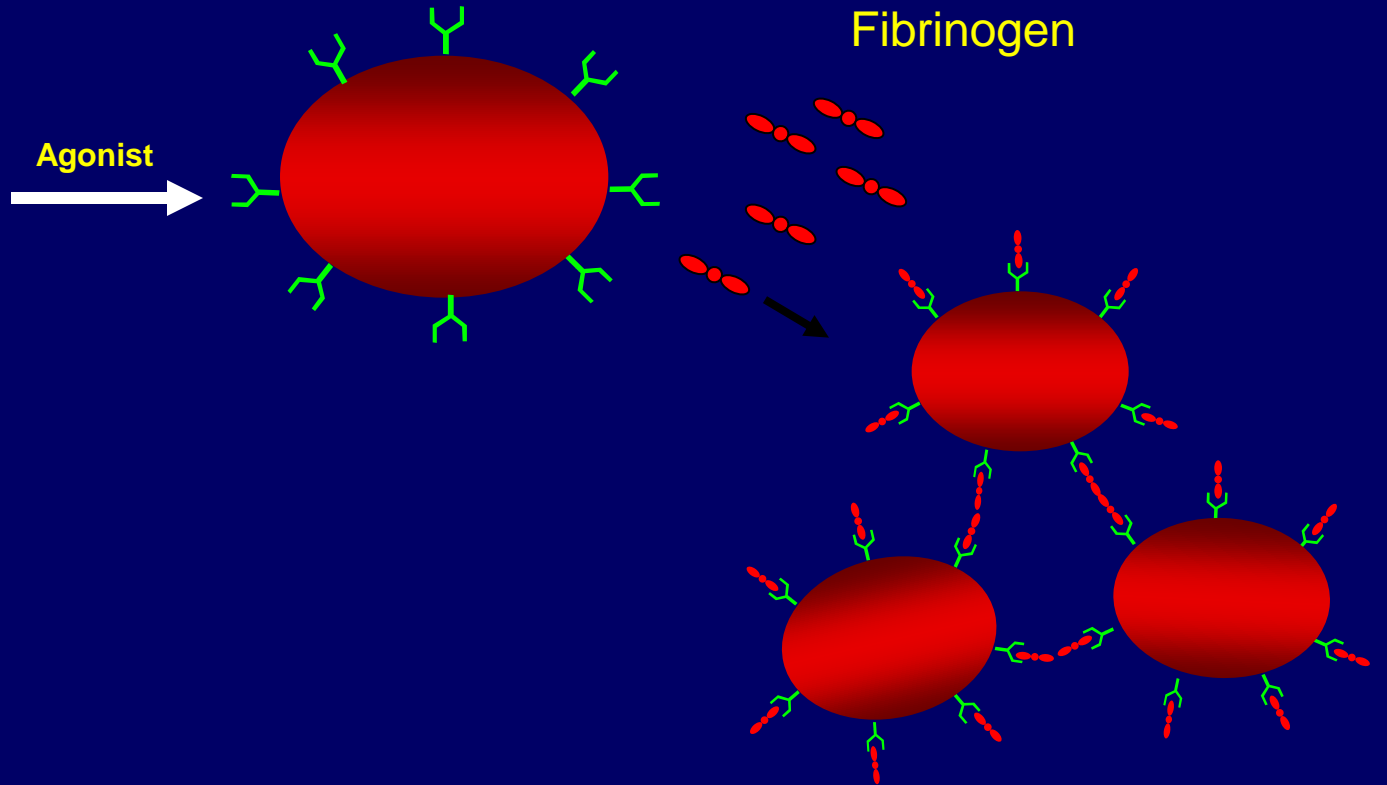
# Platelet Aggregation

- Aggregation:

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

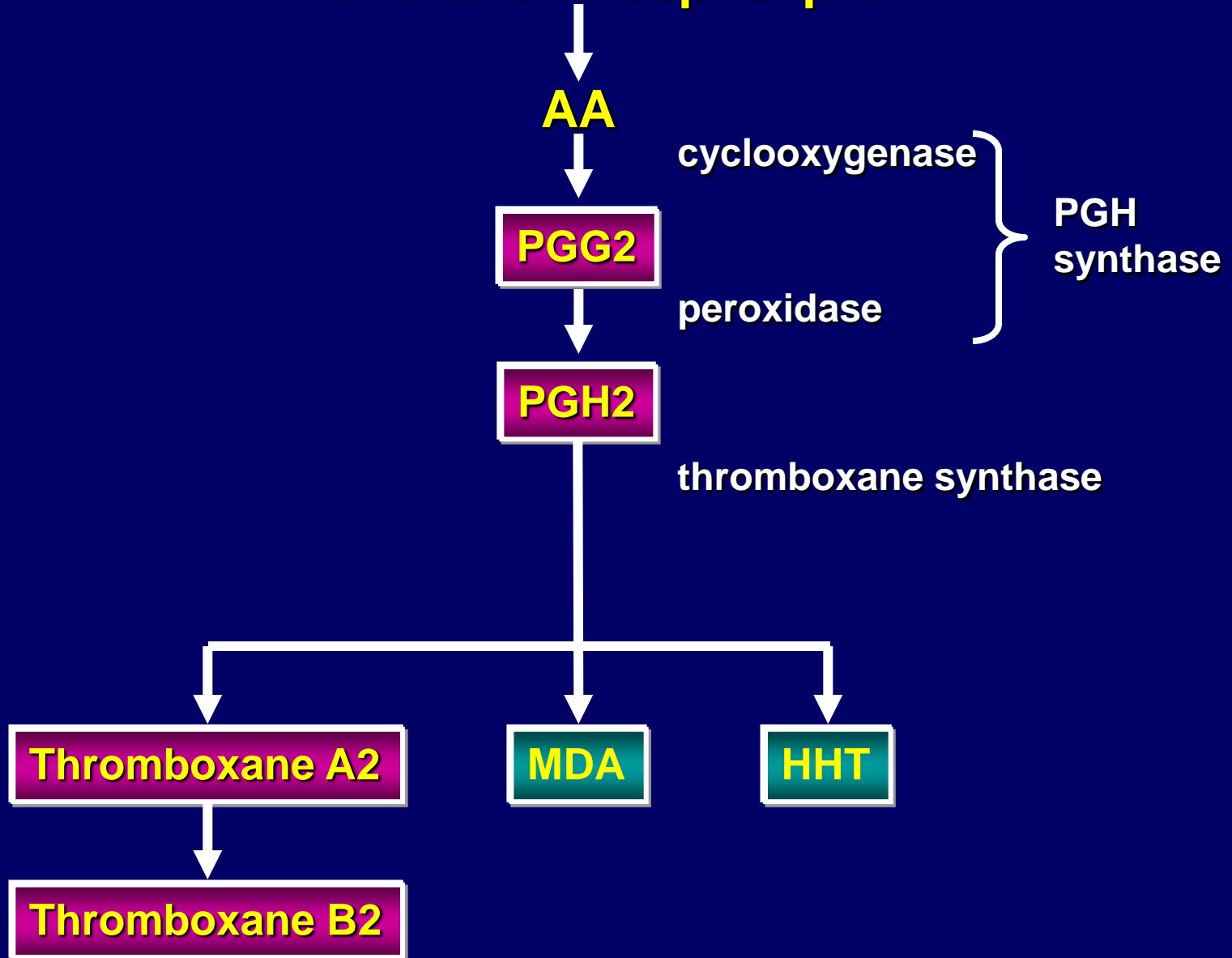
**Resting platelet**

**activated platelet**



**Aggregating platelets**

# Membrane Phospholipid



# Activated Platelets

## Secrete:

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

## Function:

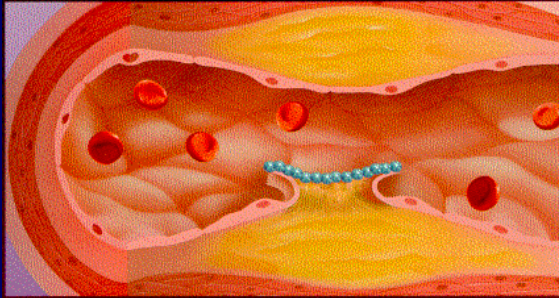
- vasoconstriction
- Platelet aggregation  
(TXA2 inhibited by aspirin)

# Platelet Activation

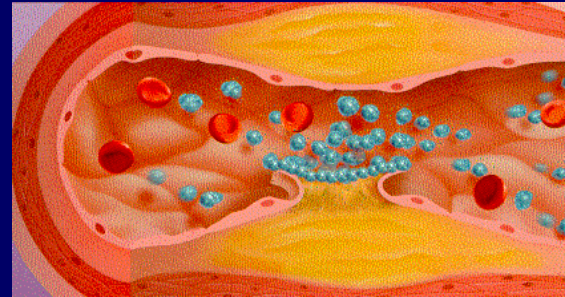
- Clot Retraction:

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

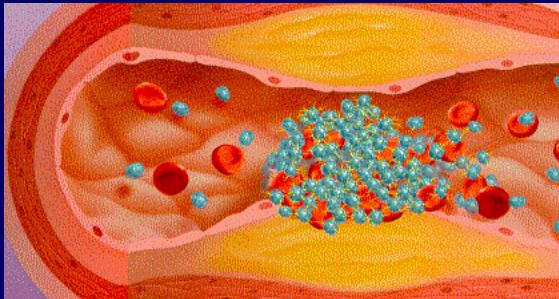
# Platelet function



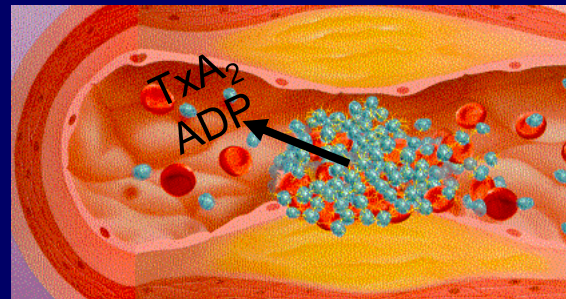
Adhesion



Activation



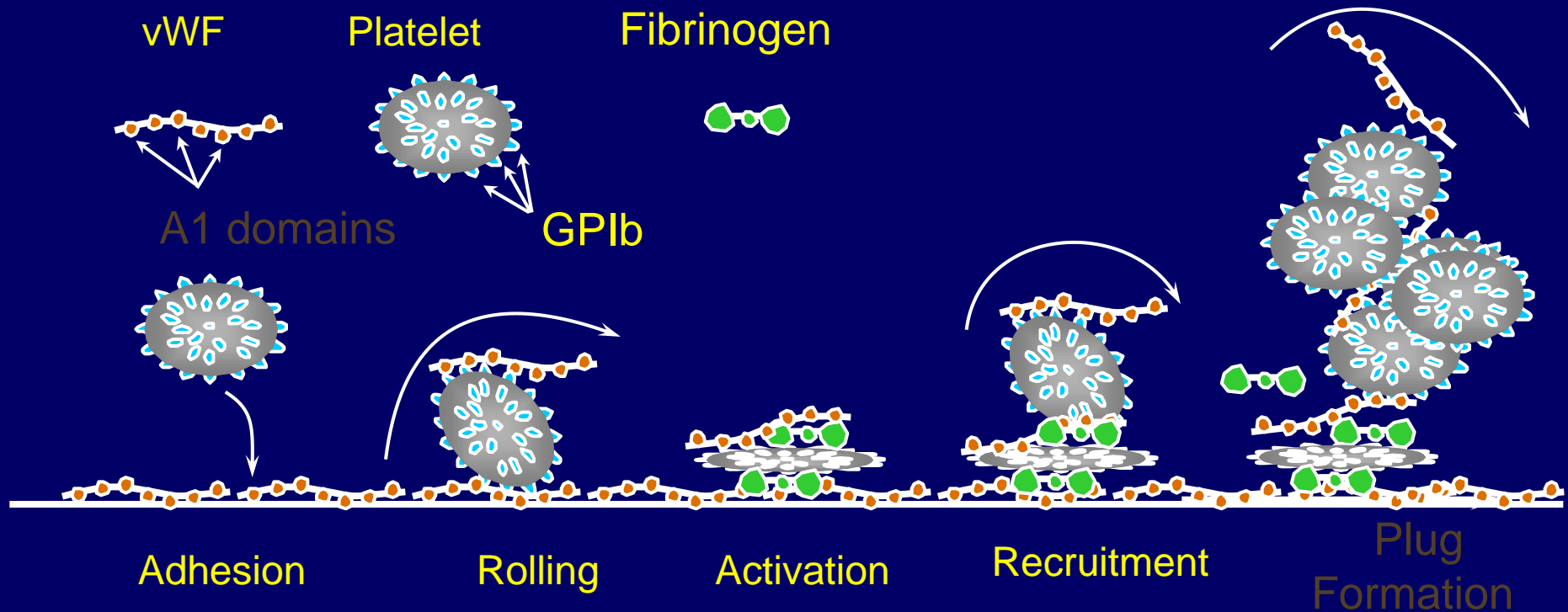
Aggregation

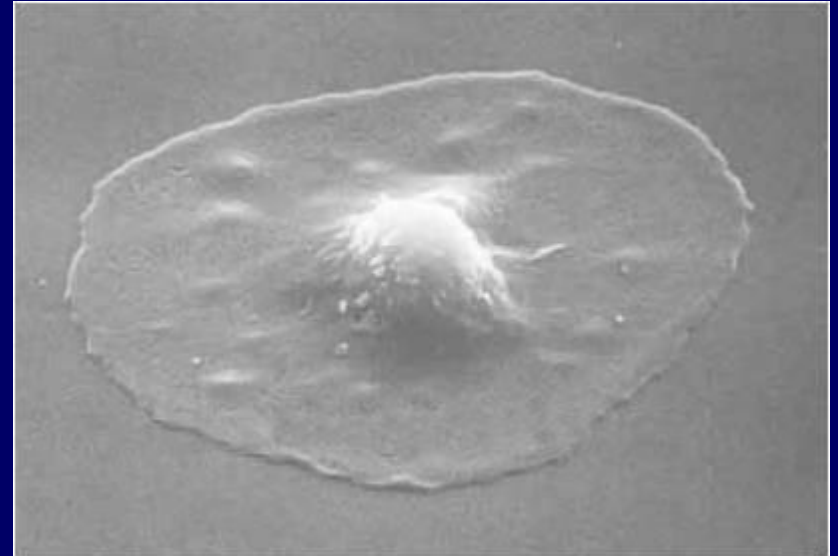
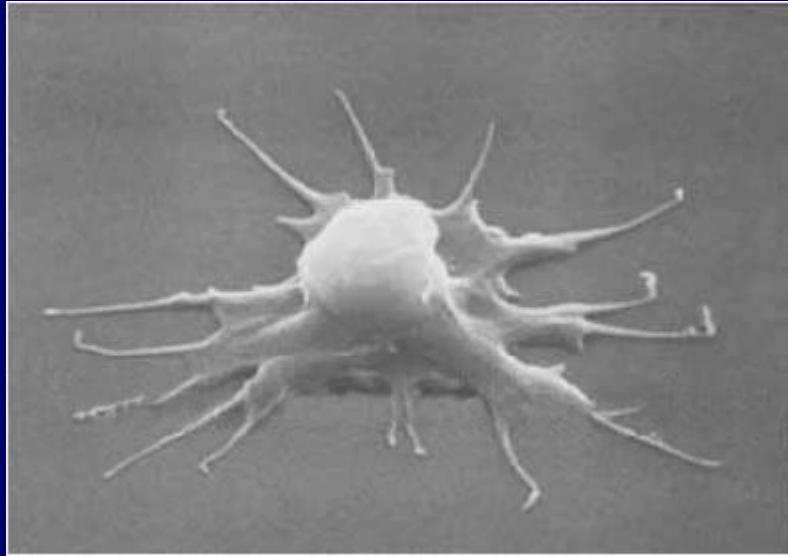
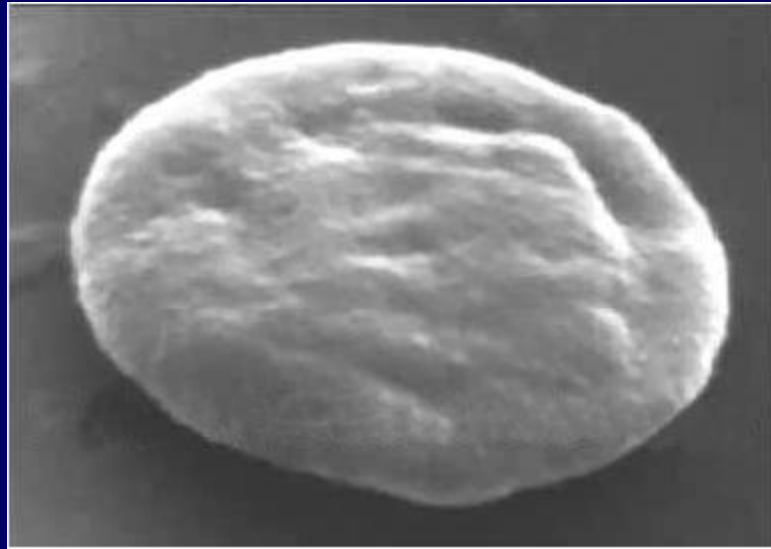


Secretion

# vWF and Platelet Adhesion

Blood Flow







# 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

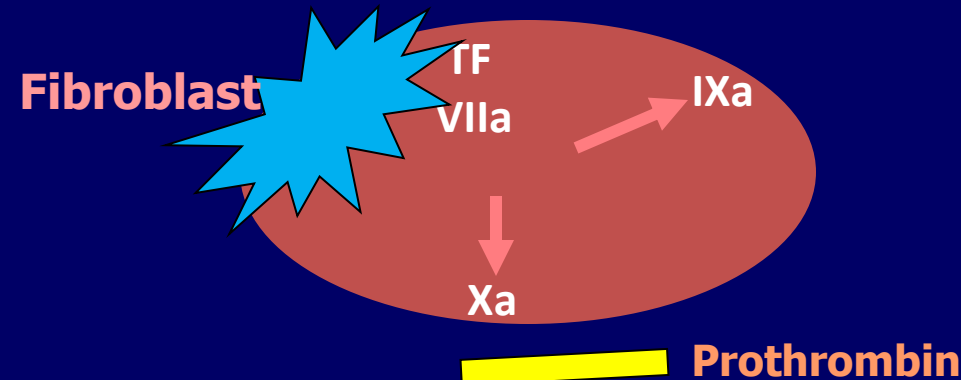
# **Functions of the platelets..cont**

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

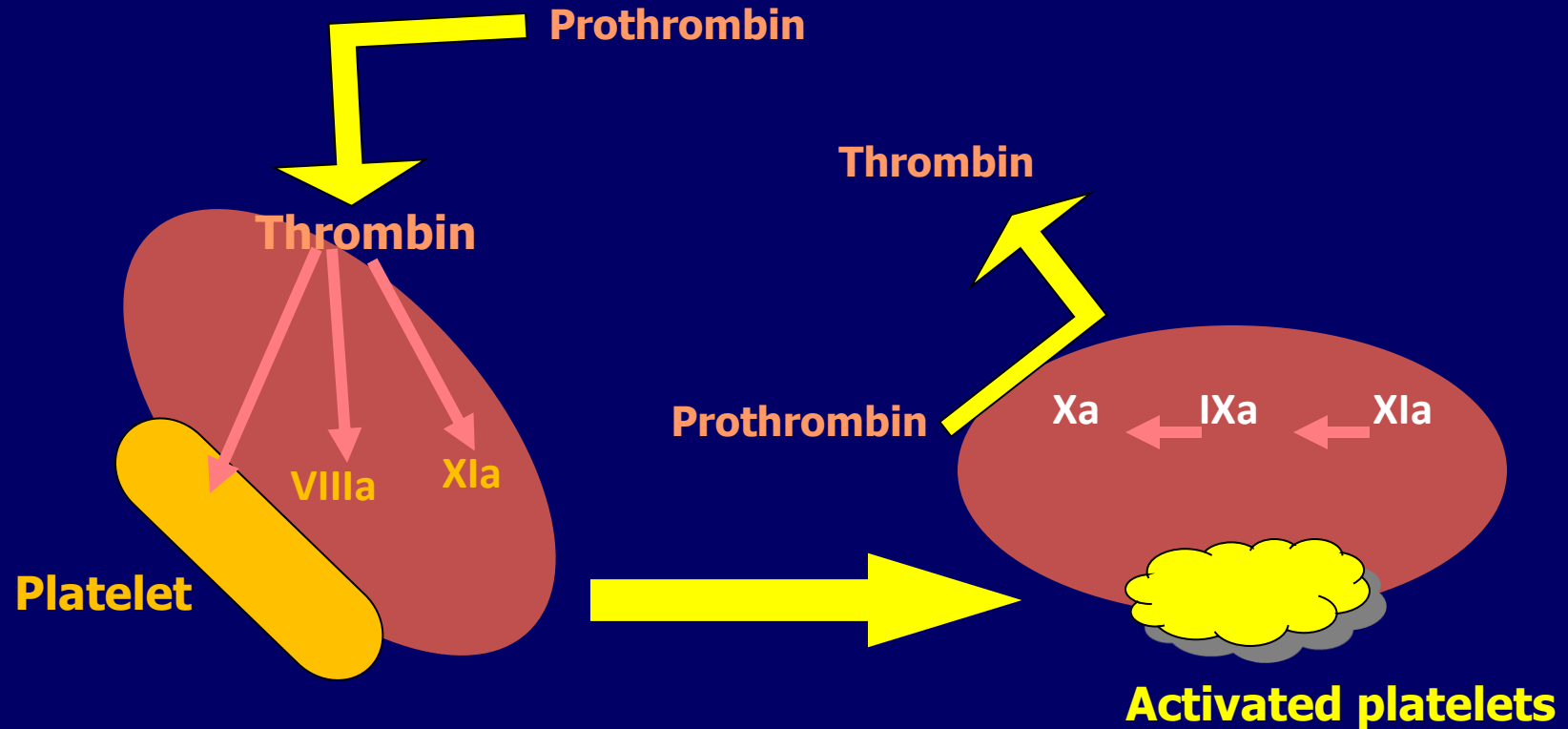
**(The cell based model of blood coagulation)**

# Initiation

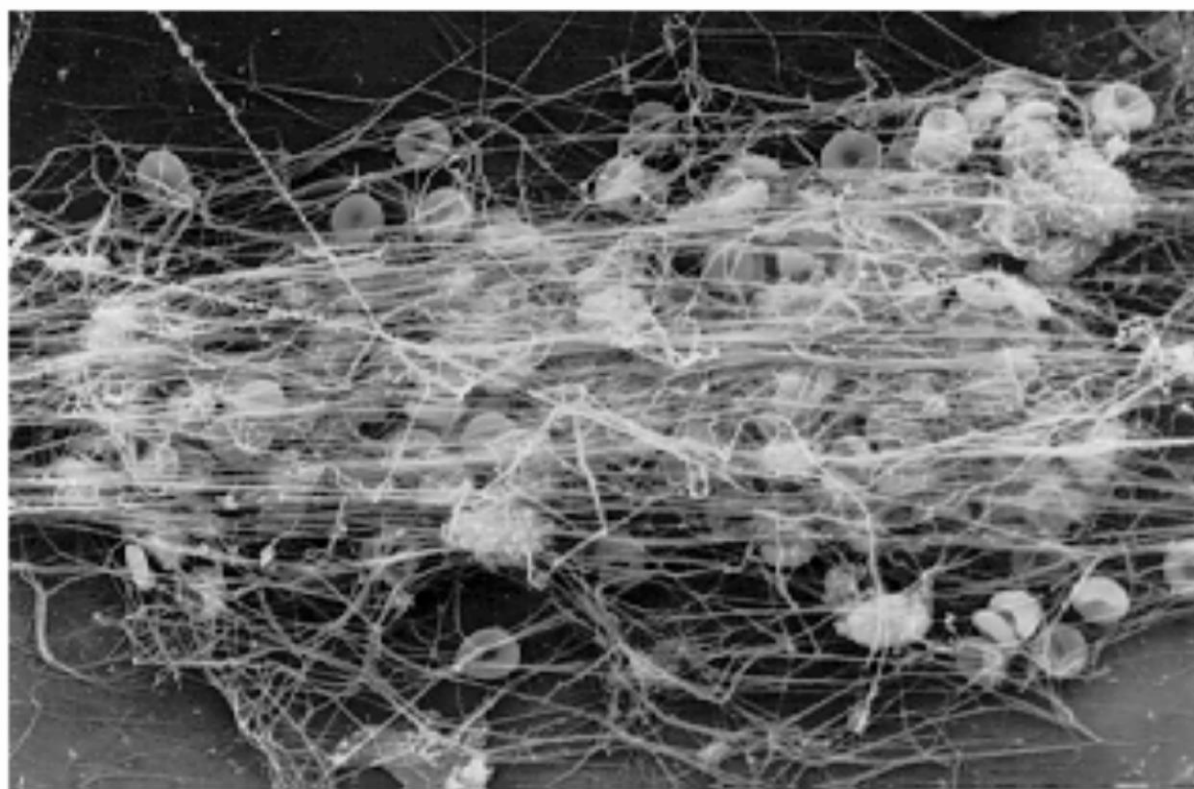
# Cell based model



# Propagation



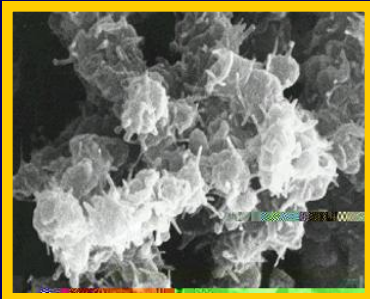
# Amplification



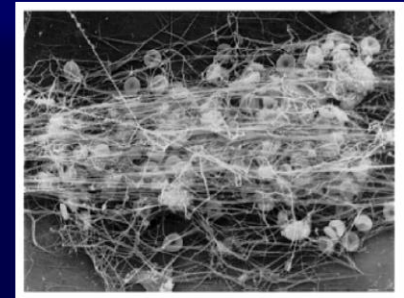
## Maintenance of vascular integrity

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

Initial arrest of bleeding by  
platelet plug formation

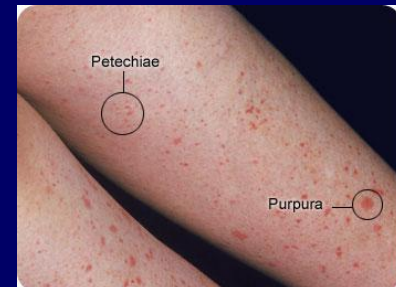


Stabilization of hemostatic plug  
by contributing to fibrin formation



# Bleeding disorders

**abnormal number  
or function of platelet**



# 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)

# **Platelet function tests**



# Laboratory Testing of Platelet Functions

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

# Bleeding Time



# Laboratory Testing of Platelet Functions

## ■ Platelet Aggregation (in PRP):

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 (+ Dose responses)

# ■ Platelet Aggregation

## Agonists:

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



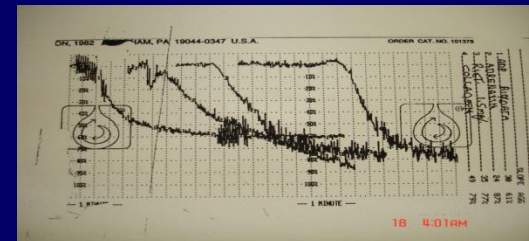
Whole  
blood

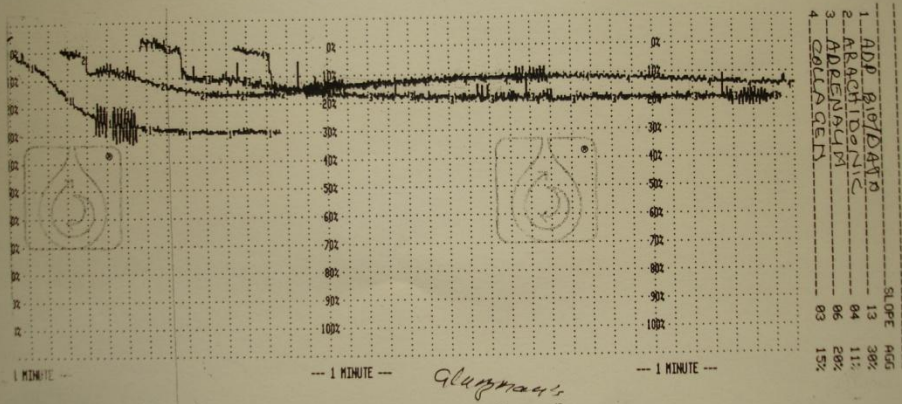


RBC



PRP

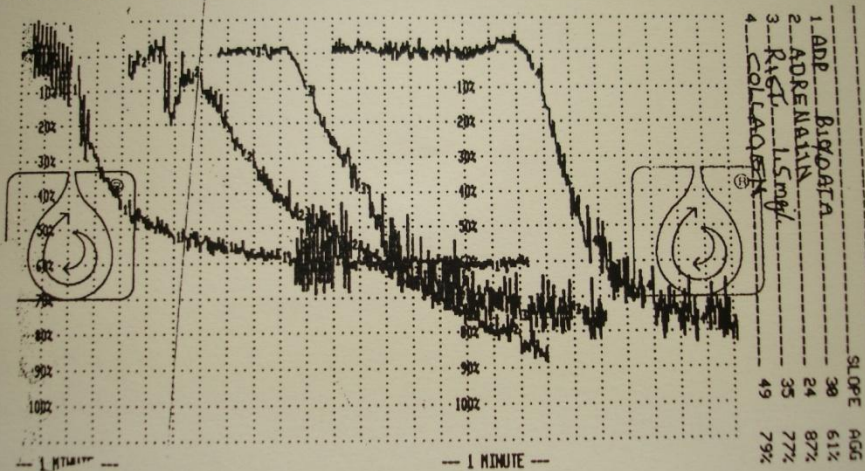




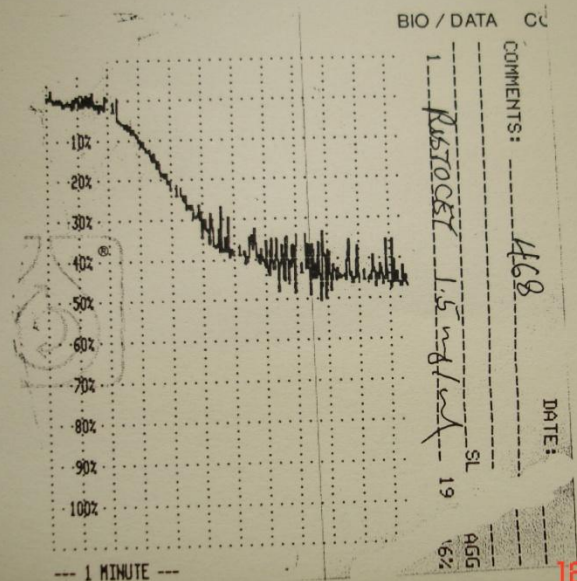
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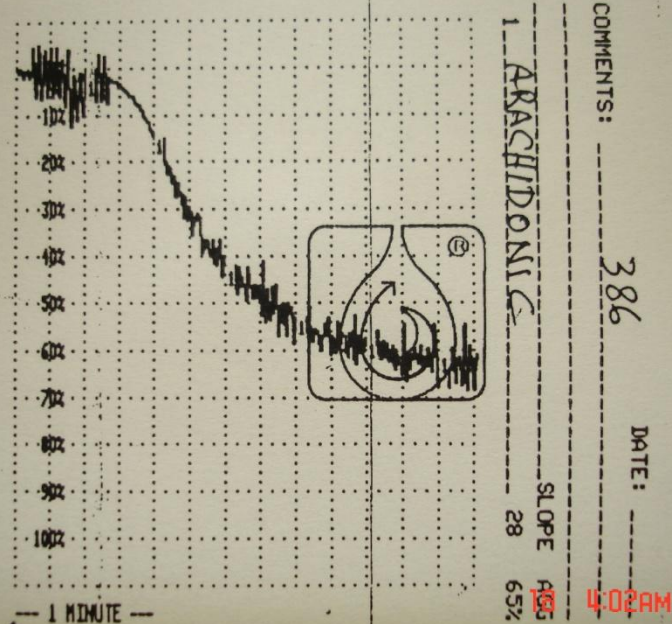


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# Congenital Platelet Disorders

## 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

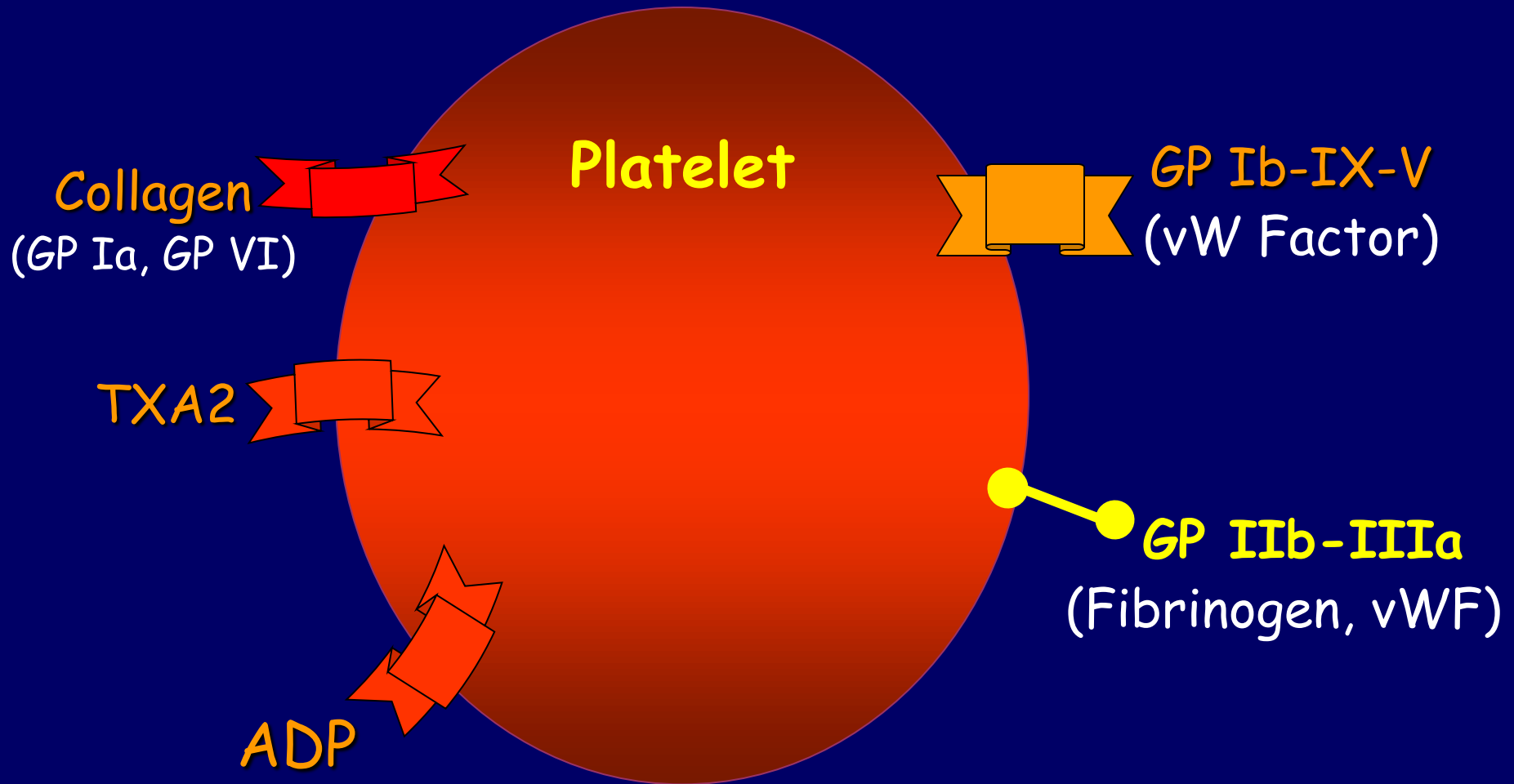


# Platelet Activation

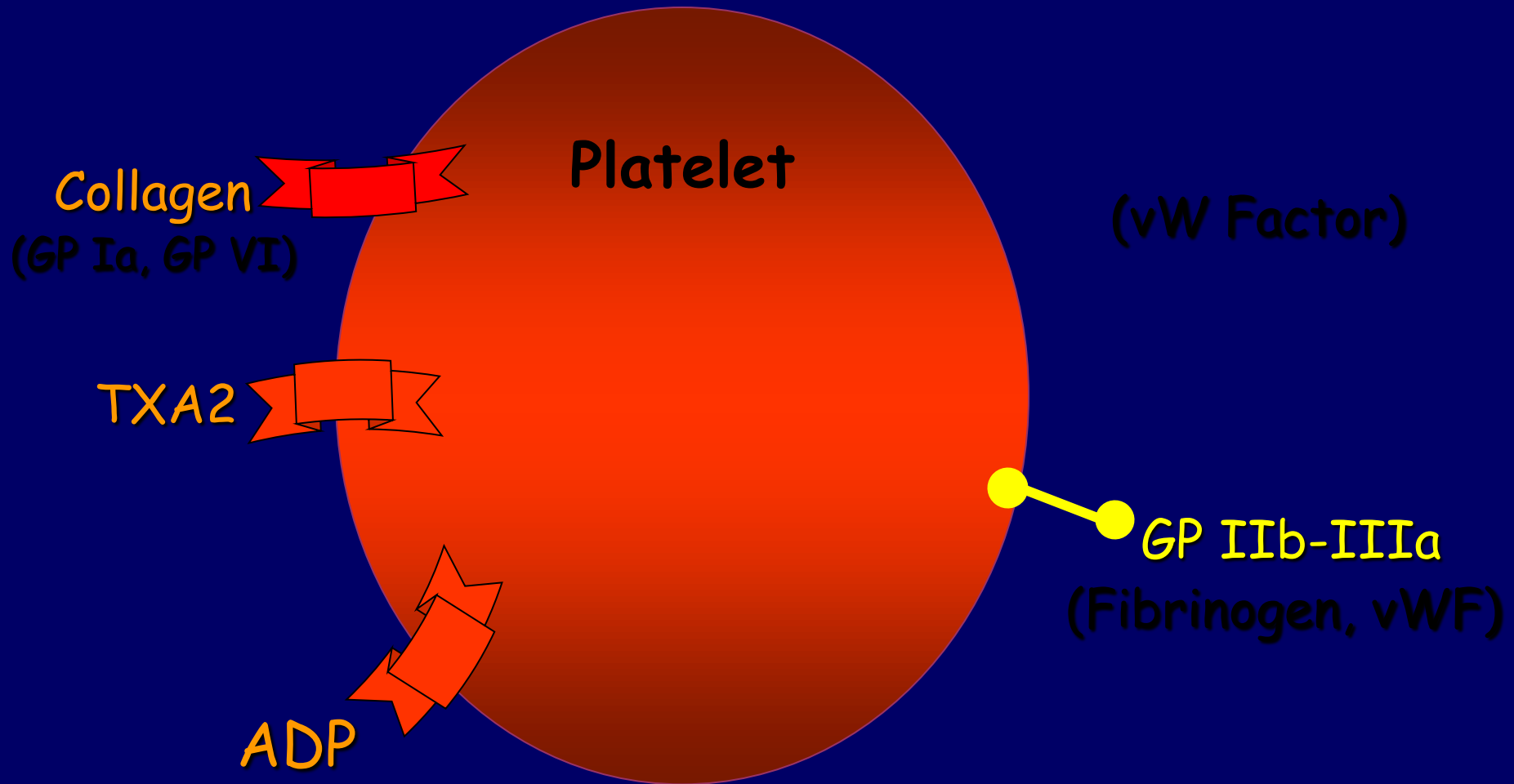
- Adhesion: Bernard-Soulier Syndrome (BSS)
- Shape change
- Aggregation
- Release
- Clot Retraction



# Bernard-Soulier Syndrome



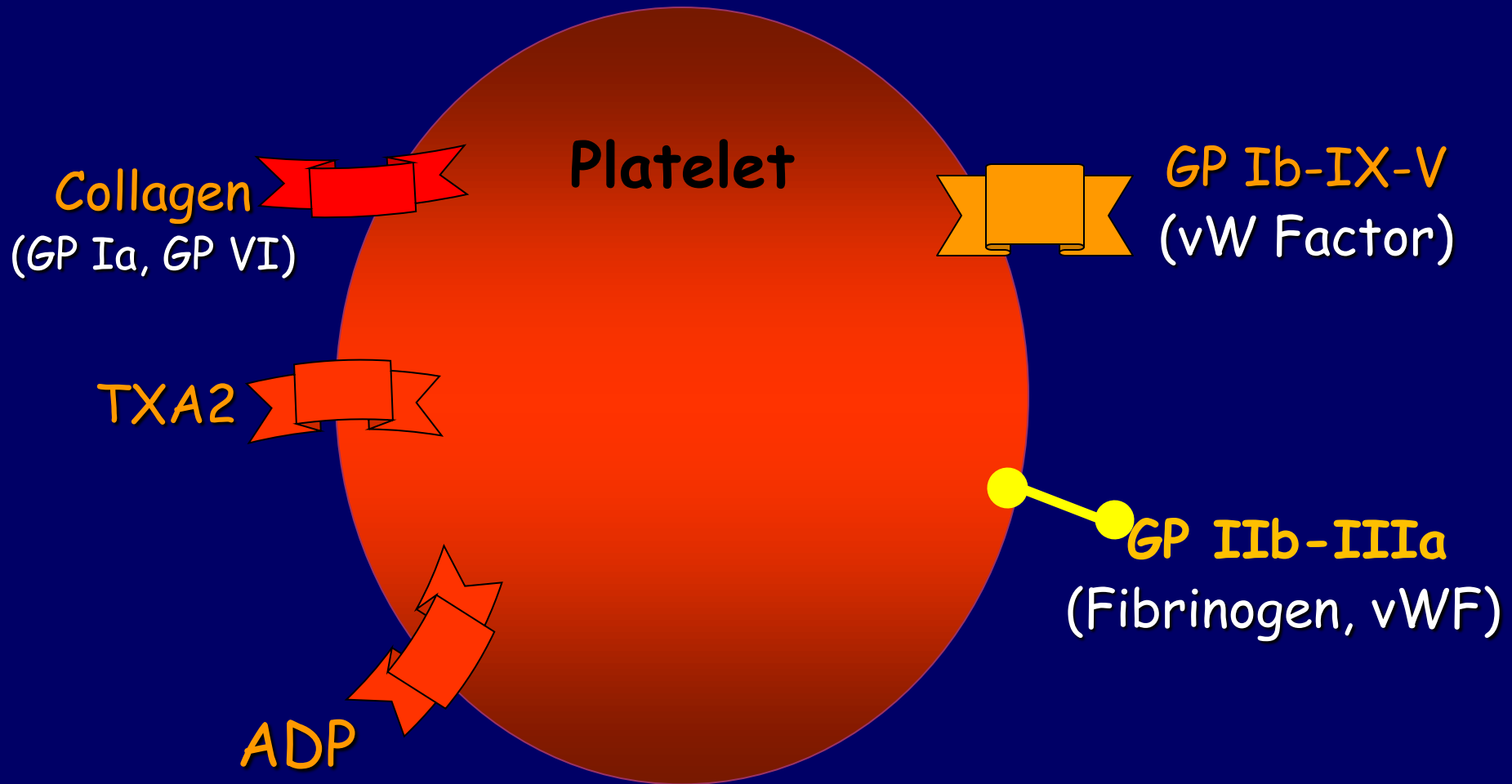
# Bernard-Soulier Syndrome



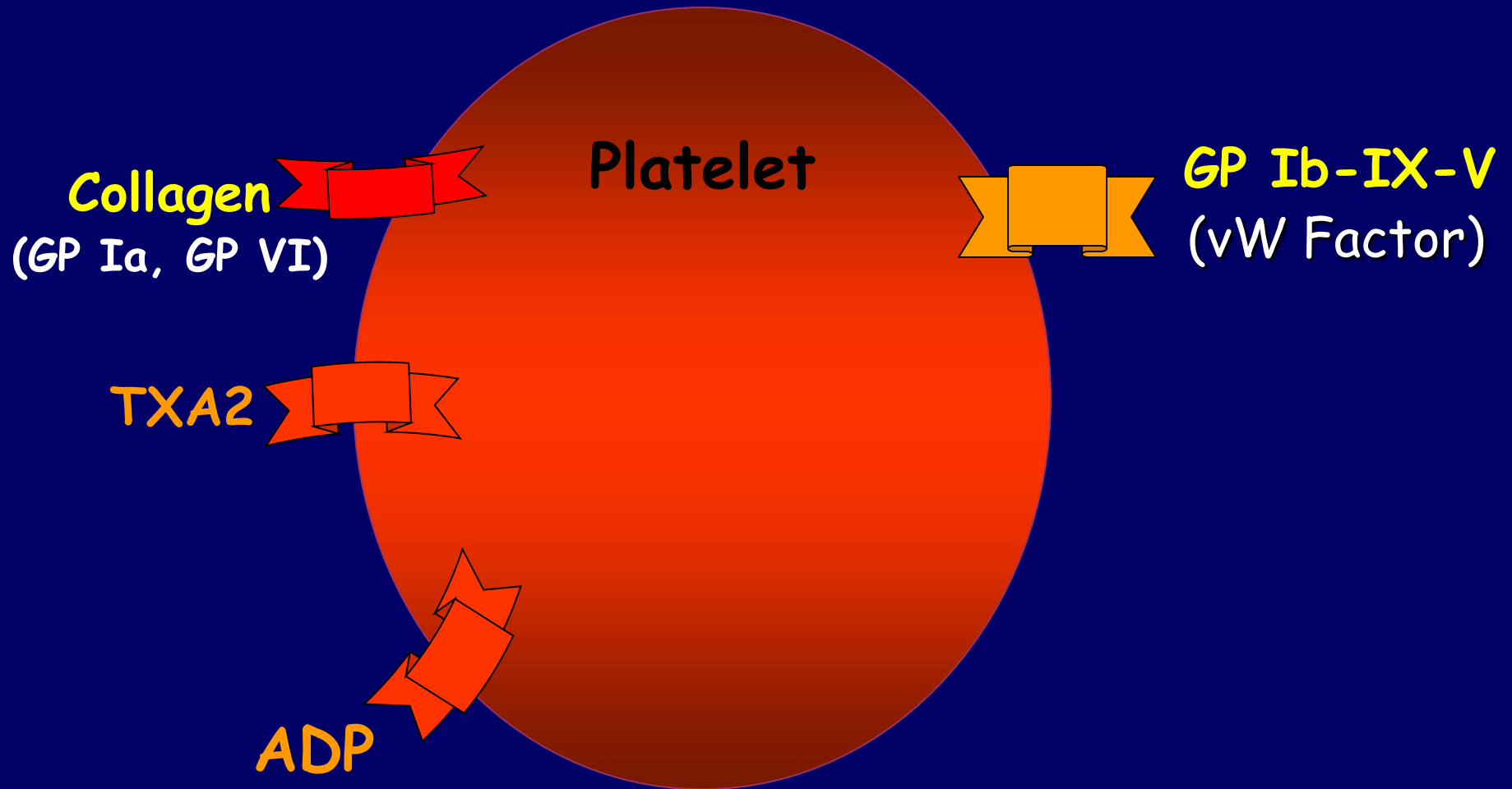
# Platelet Activation

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

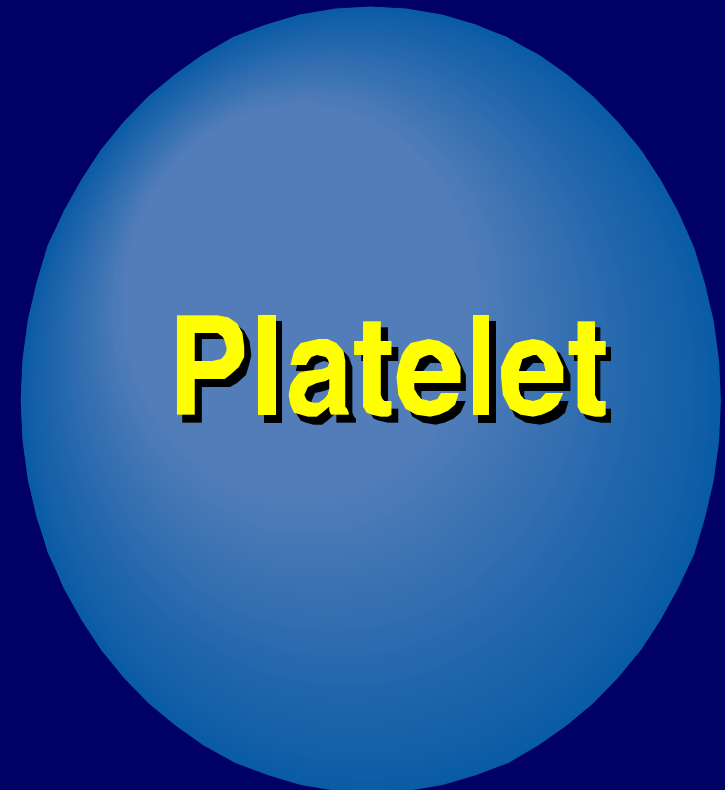
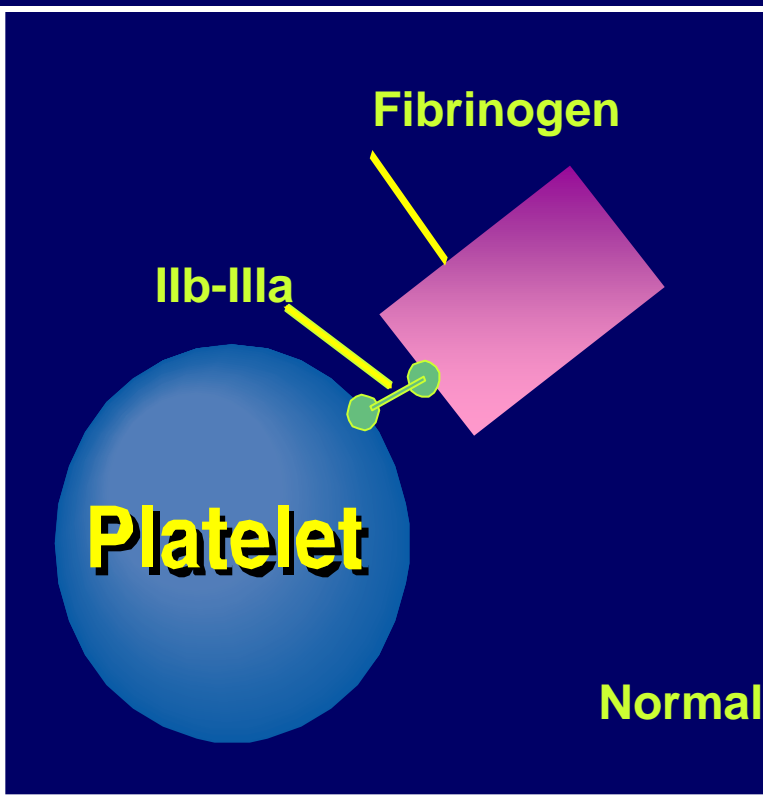
# Glanzmann Thrombasthenia



# Glanzmann Thrombasthenia



# Glanzmann Thrombasthenia



No Gp IIb-IIIa Receptors

# Objectives

- Understand platelet normal ultrastructure
- Understand the functions of different platelets organelles and surface receptors
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**THANK YOU**