

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# **Platelet Structure & Function**

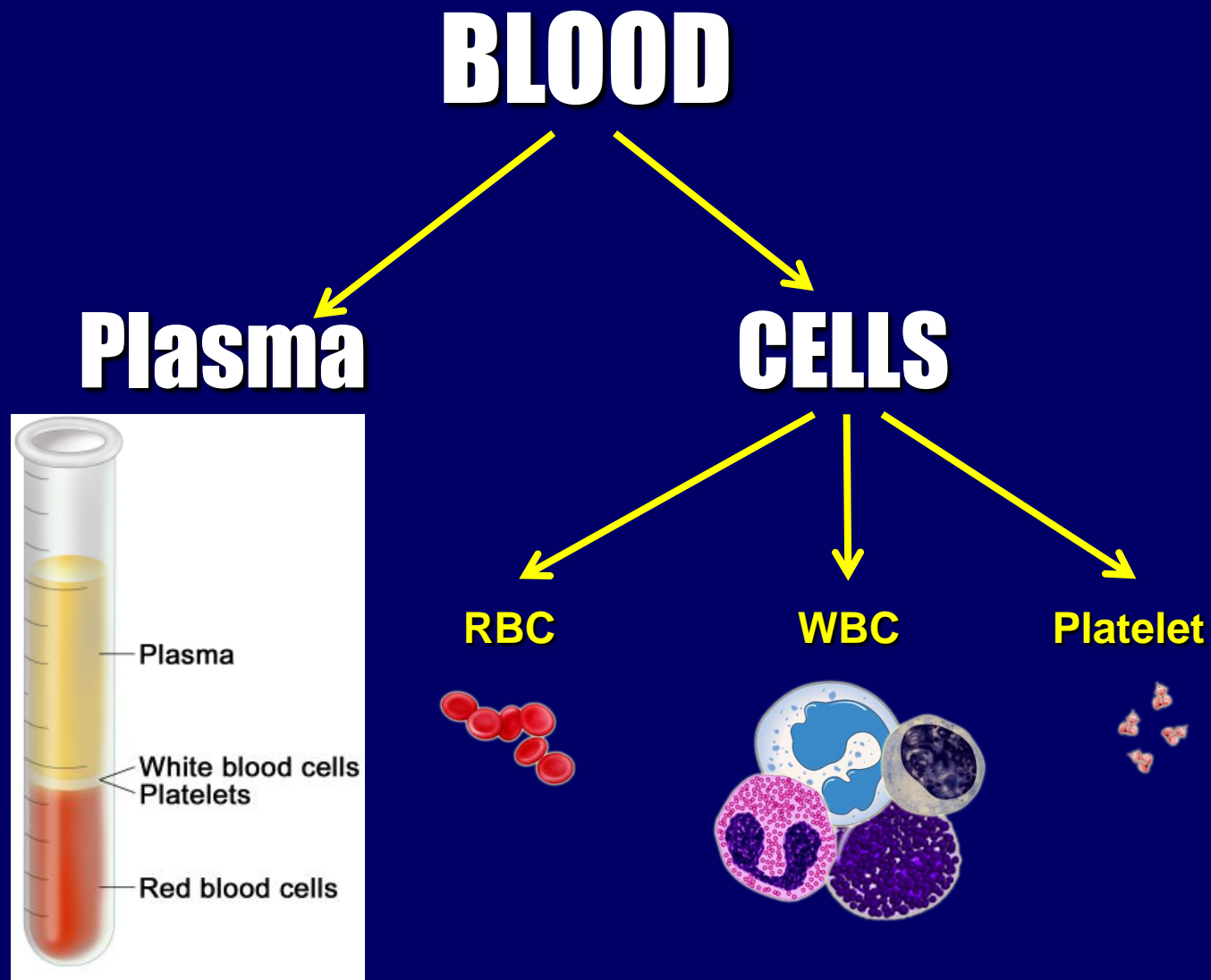
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**College of Medicine**  
**King Saud University**  
**Riyadh**

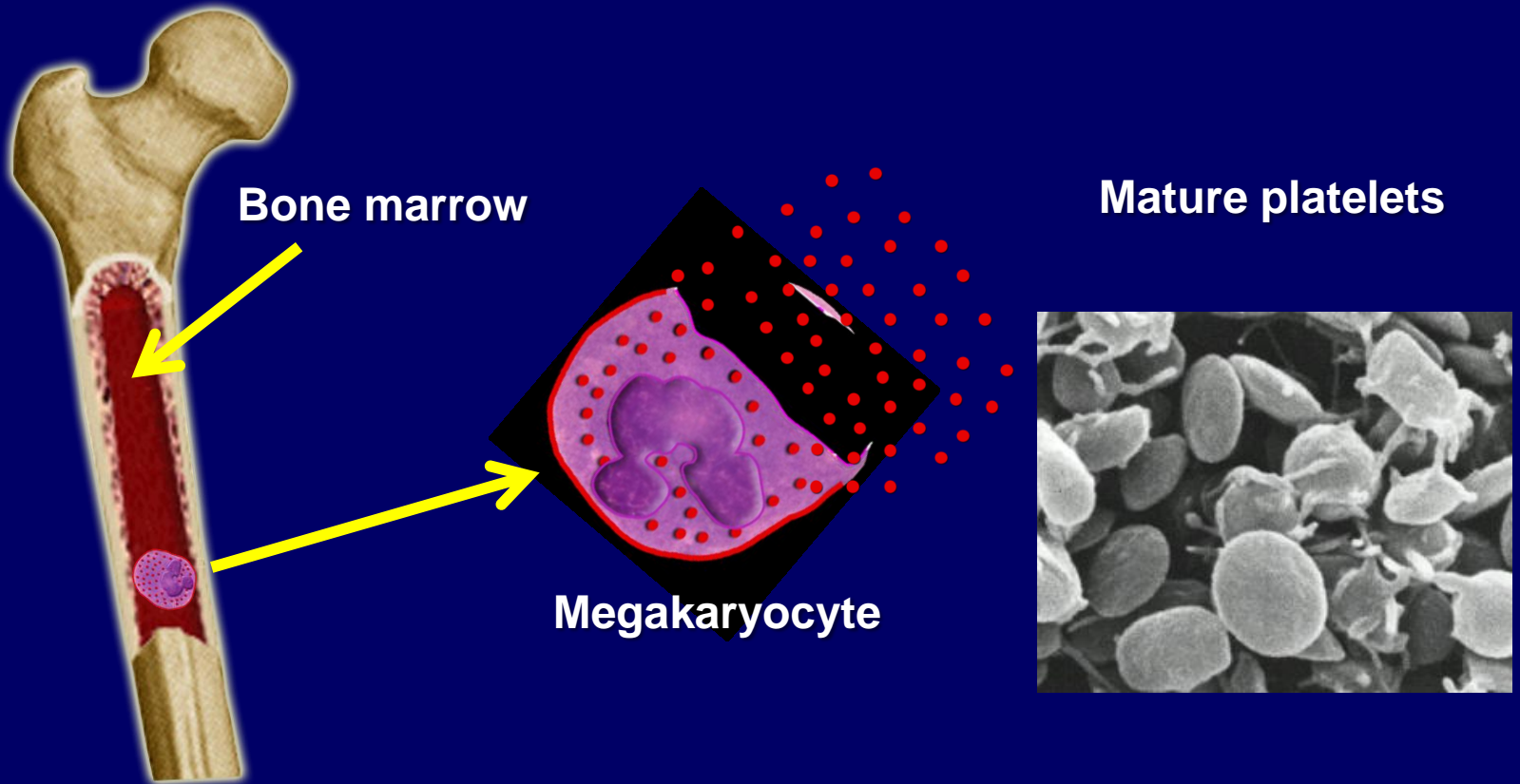
# Objectives

- 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

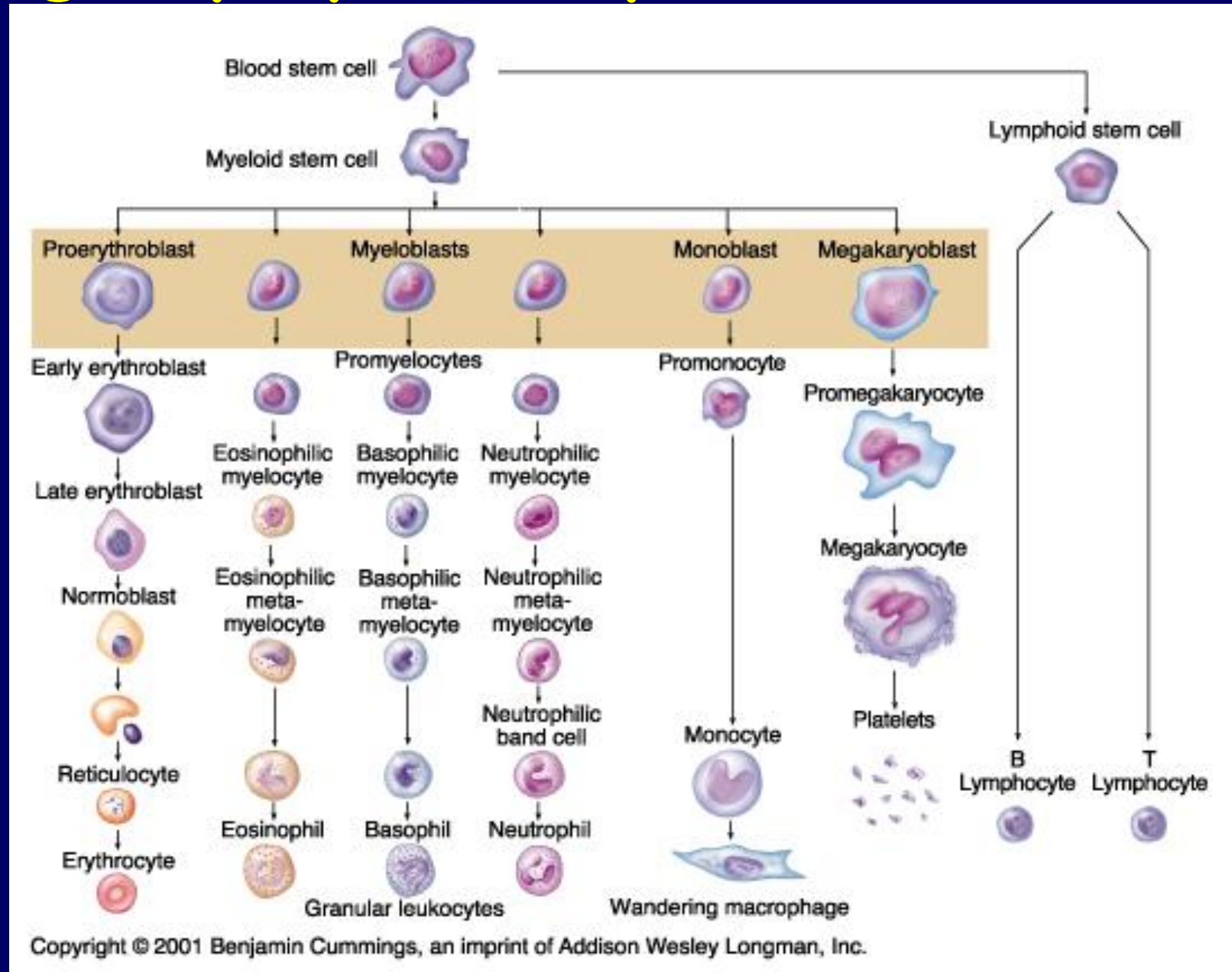
# What are platelets?



# What are platelets?



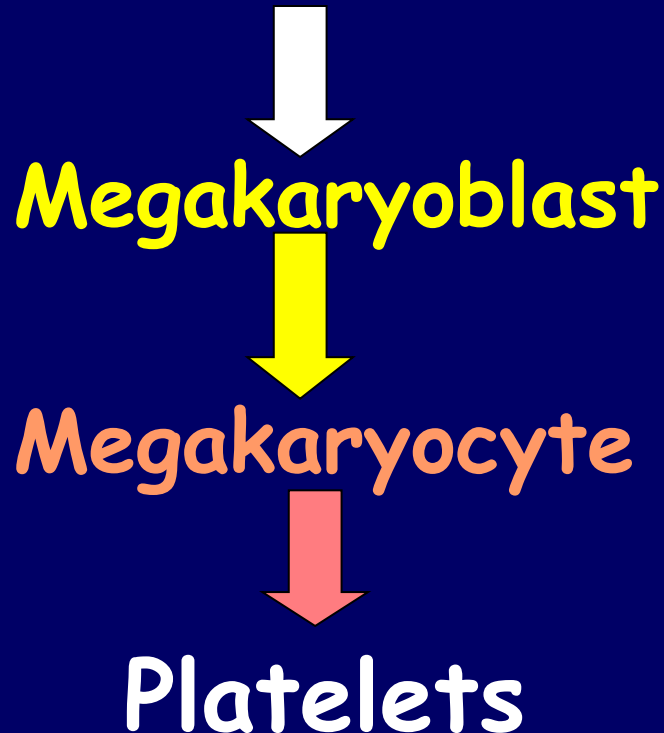
# Megakaryocyte and platelet formation



# Platelets - cont.

- Site of formation: **Bone marrow**

- Steps: **Stem cell**



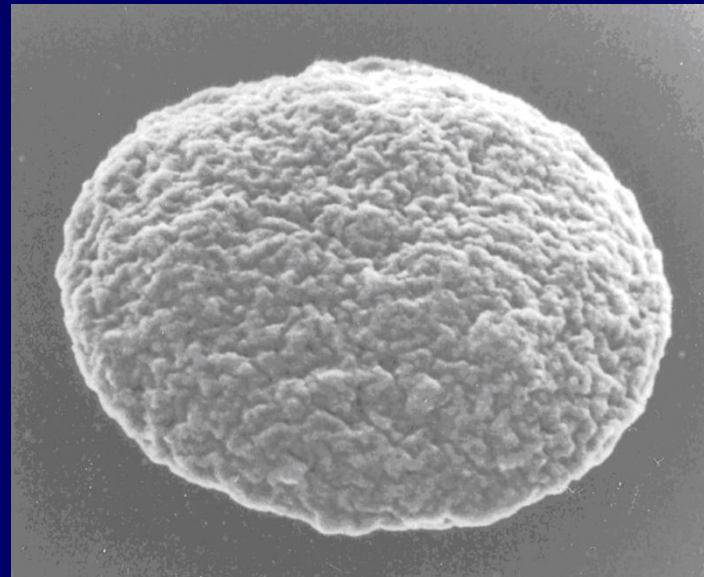
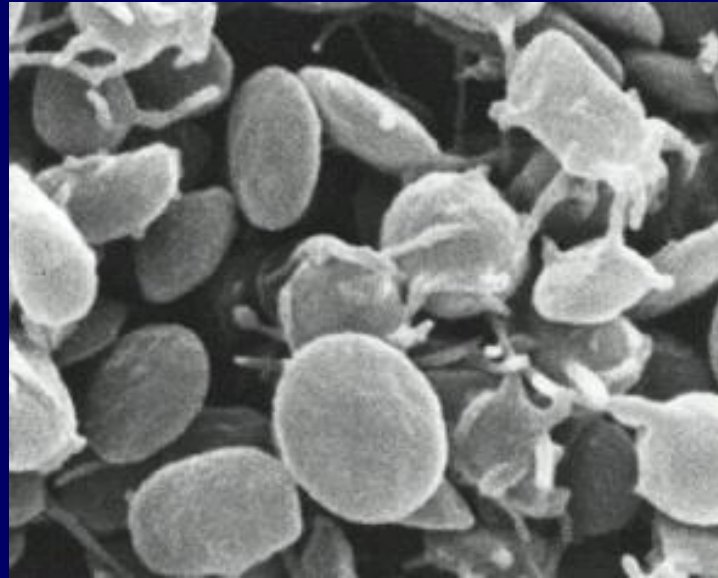
# Platelets Formation (Thrombopoiesis)

Regulation of thrombopoiesis  
by  
Thrombopoietin

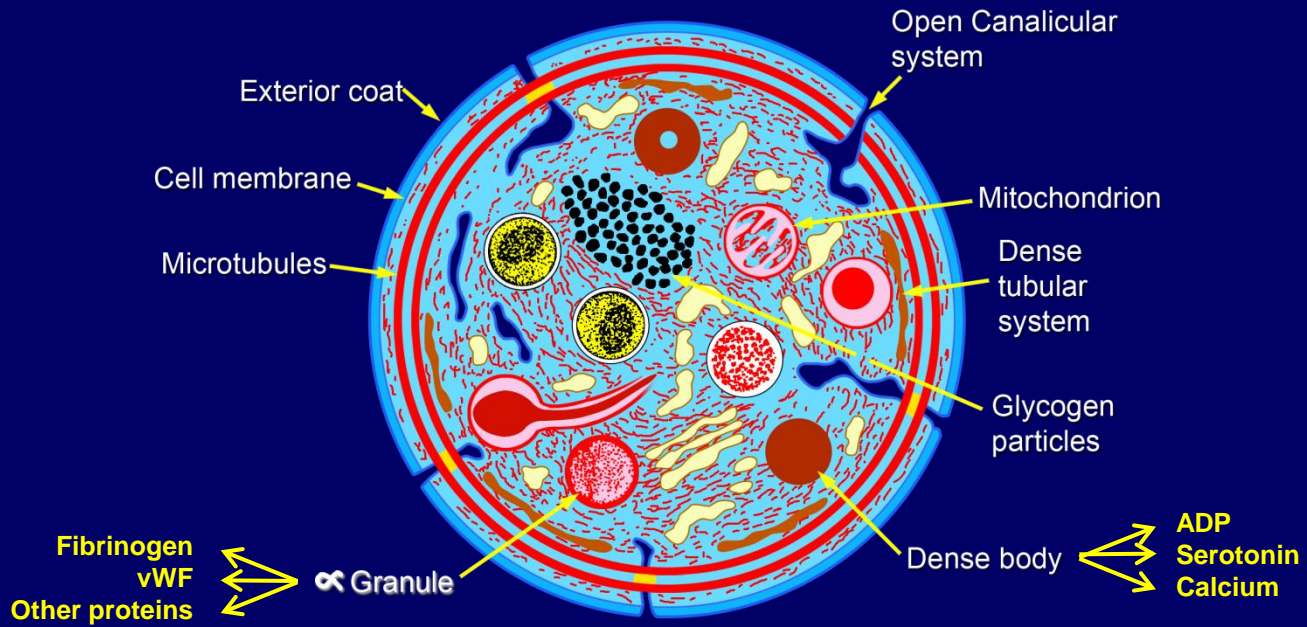


# Platelet ultra-structure

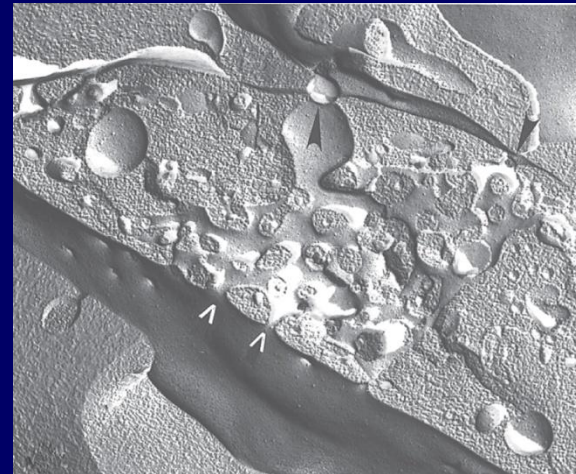
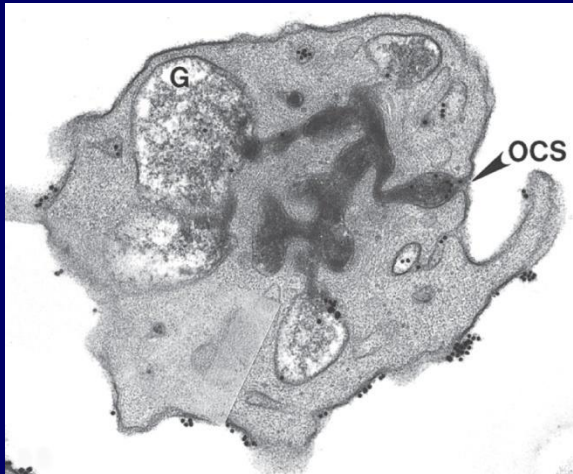
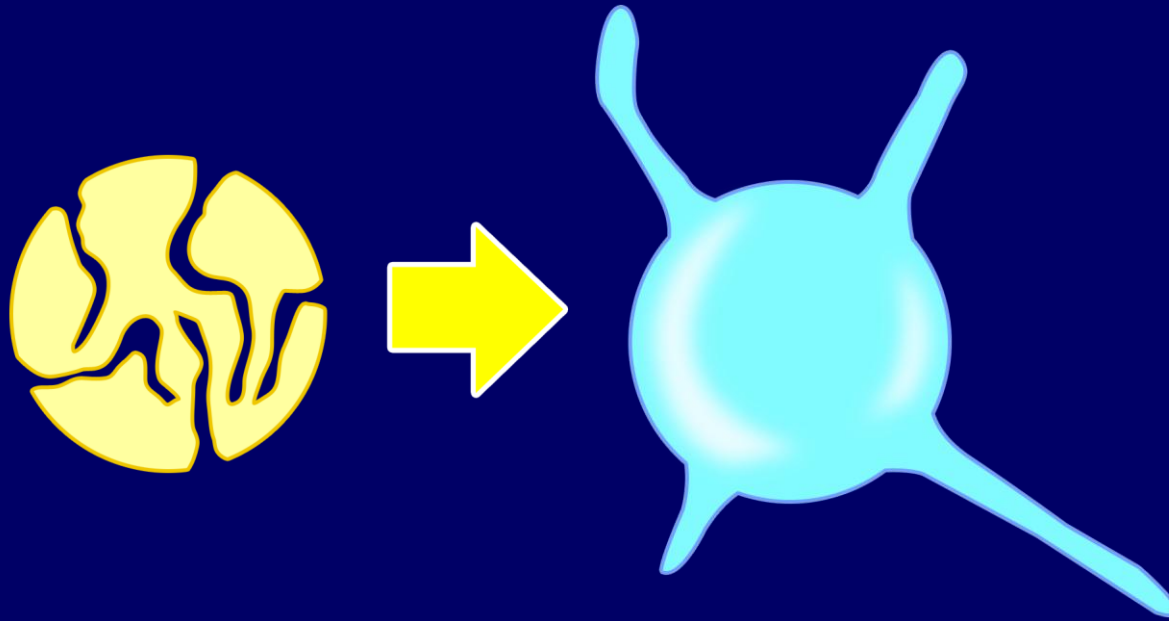
■ Anatomy of the platelets



# ■ Anatomy of the platelets

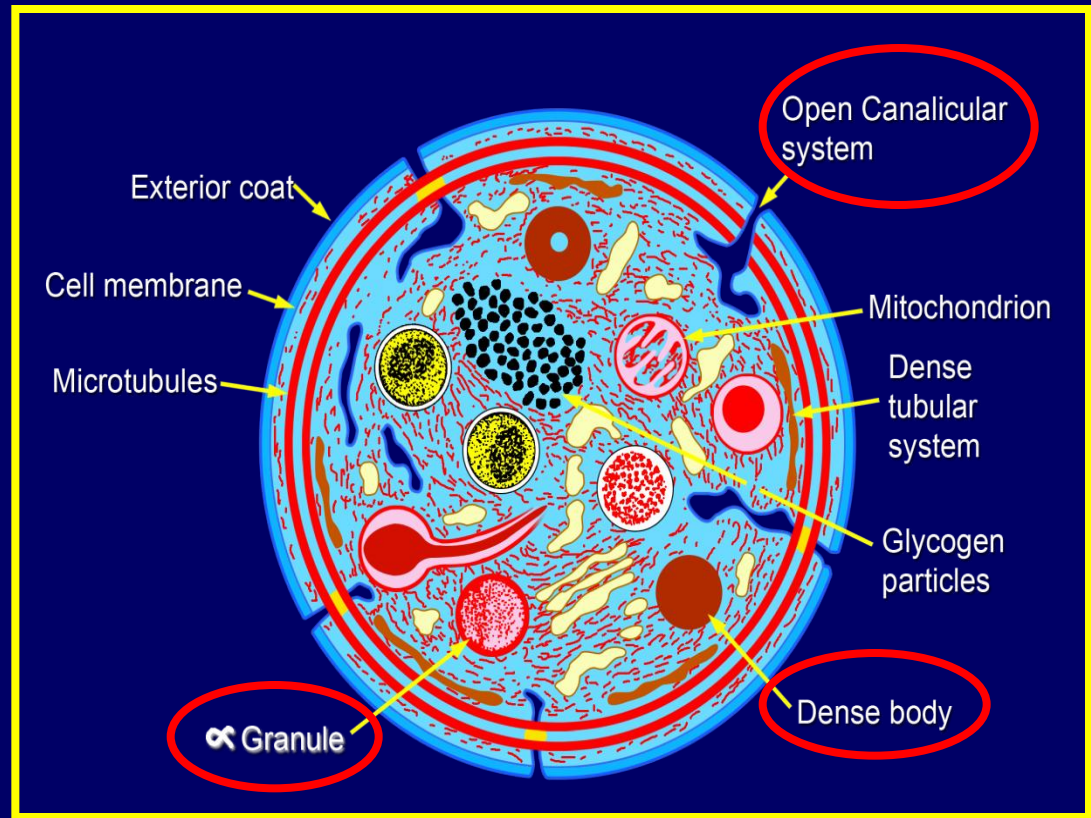


# OCS

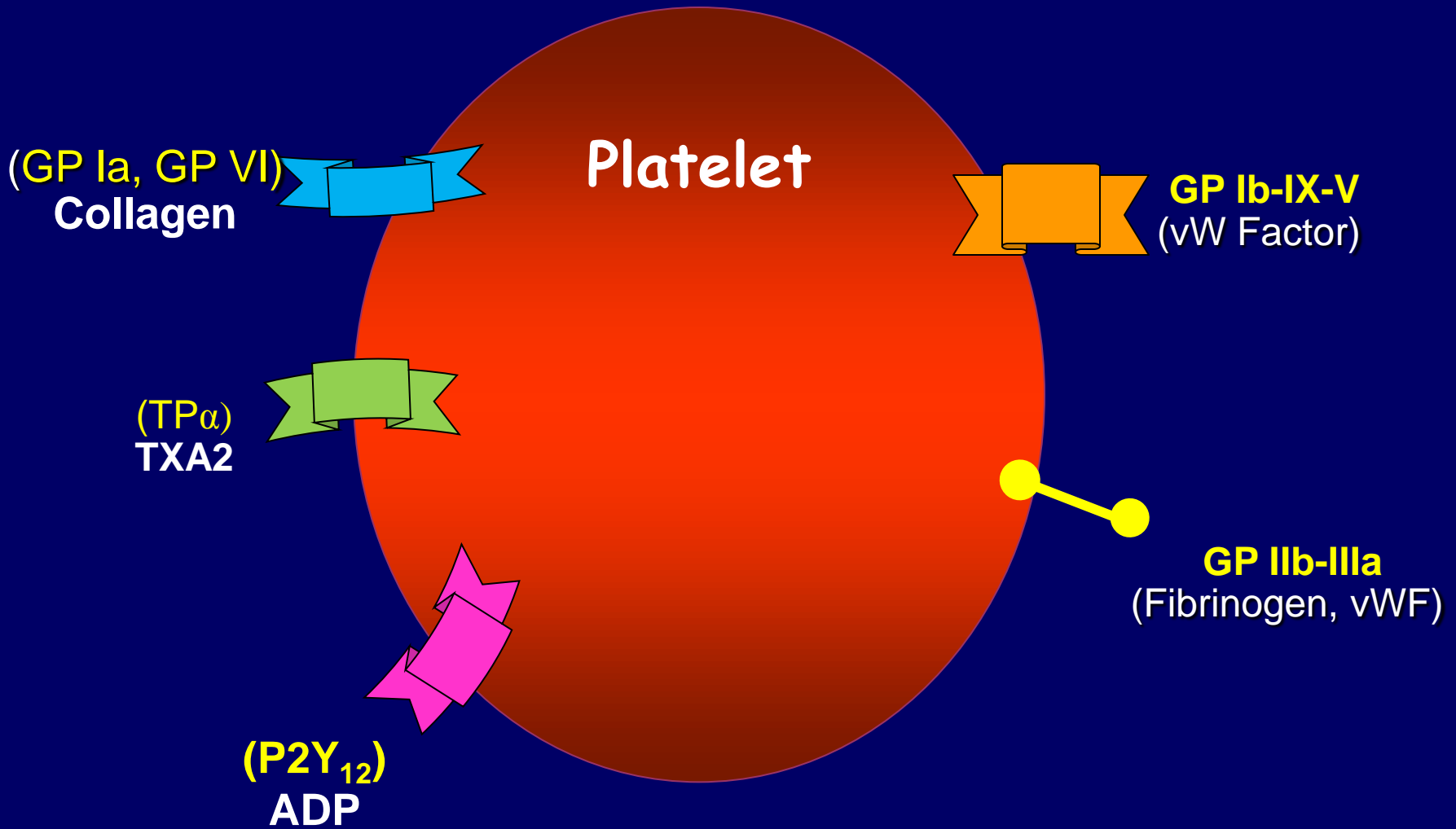


## (Thrombocytes)

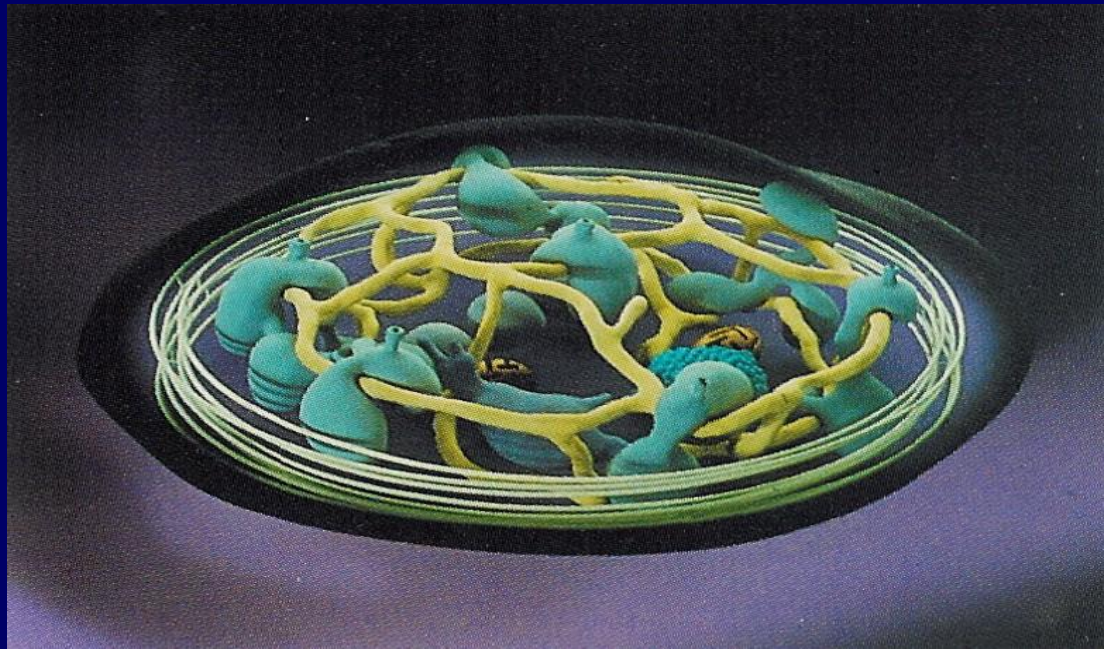
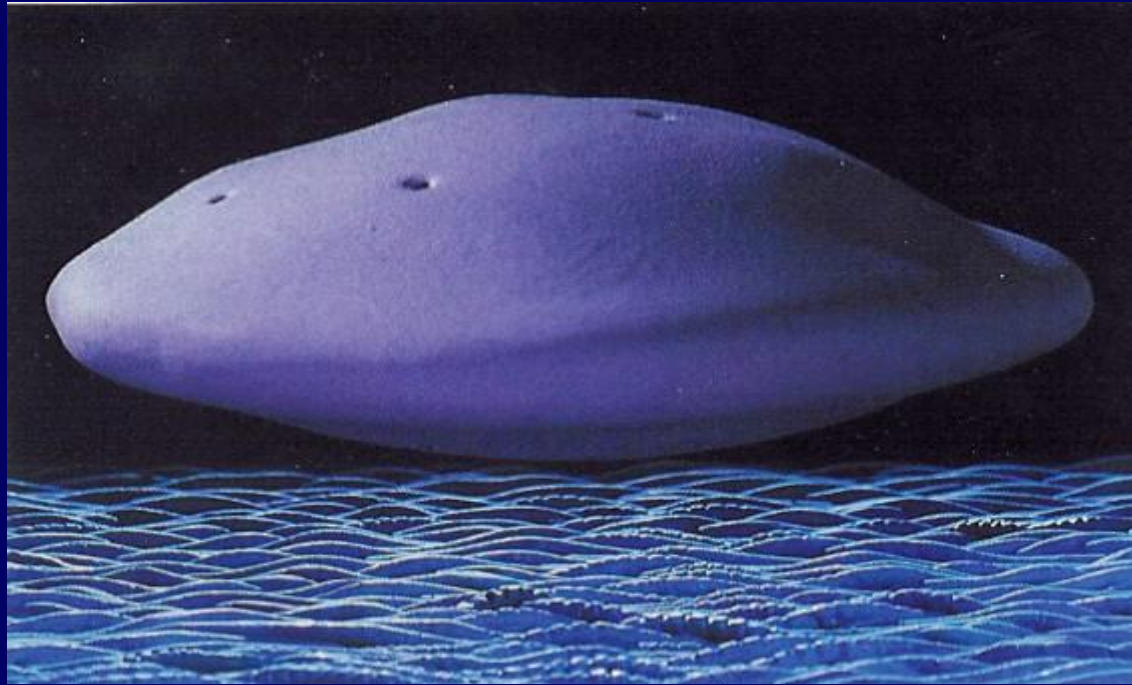
- Anuclear and discoid cell  
→ spherical when activated
- Size: 1.5–3.0  $\mu\text{m}$
- Life span: 7–10 days
- Sequestered in the spleen; **hypersplenism** may lead to low platelet counts.



# Platelet Receptors

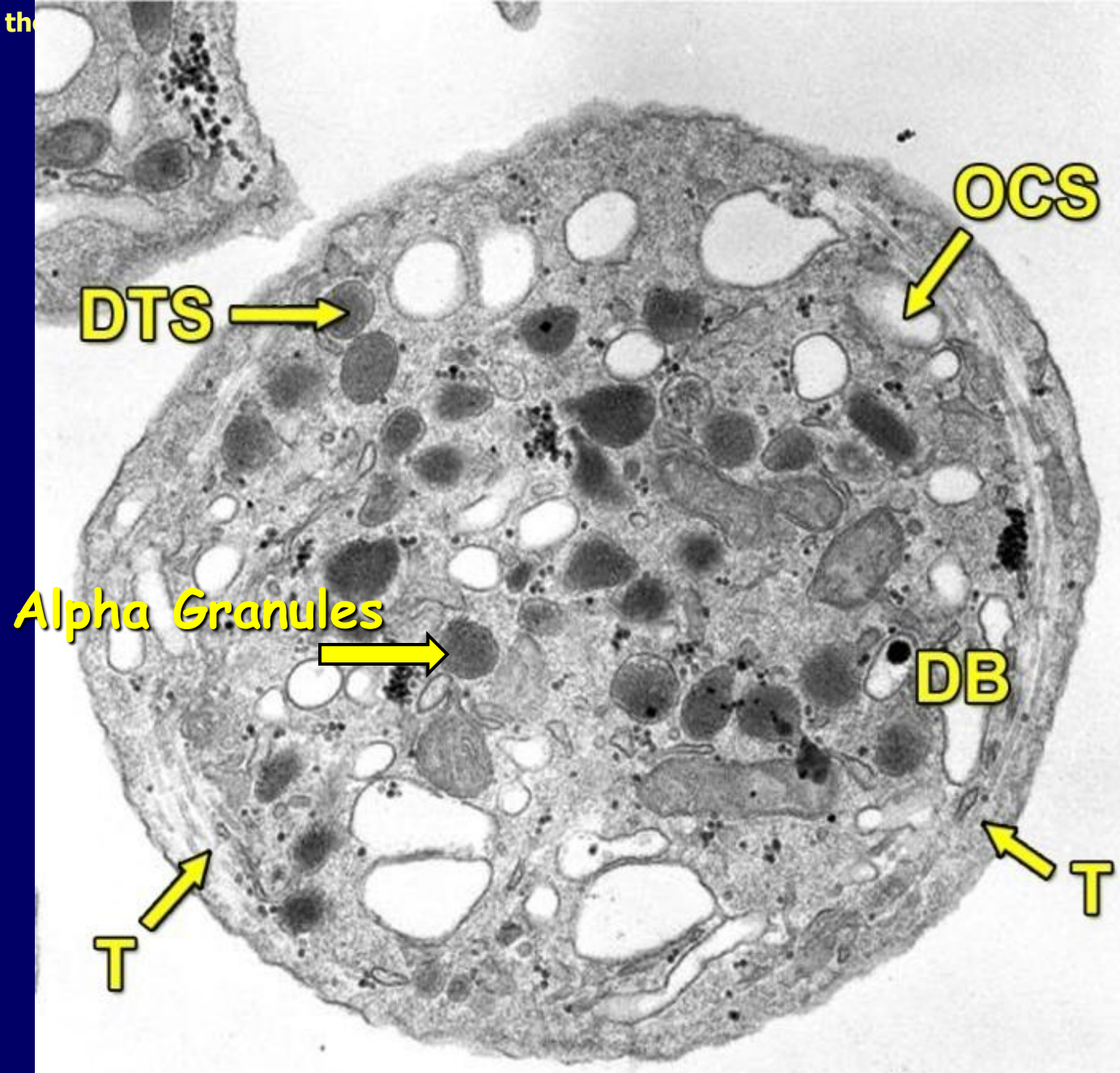






# Platelet EM





# Platelet Ultrastructure

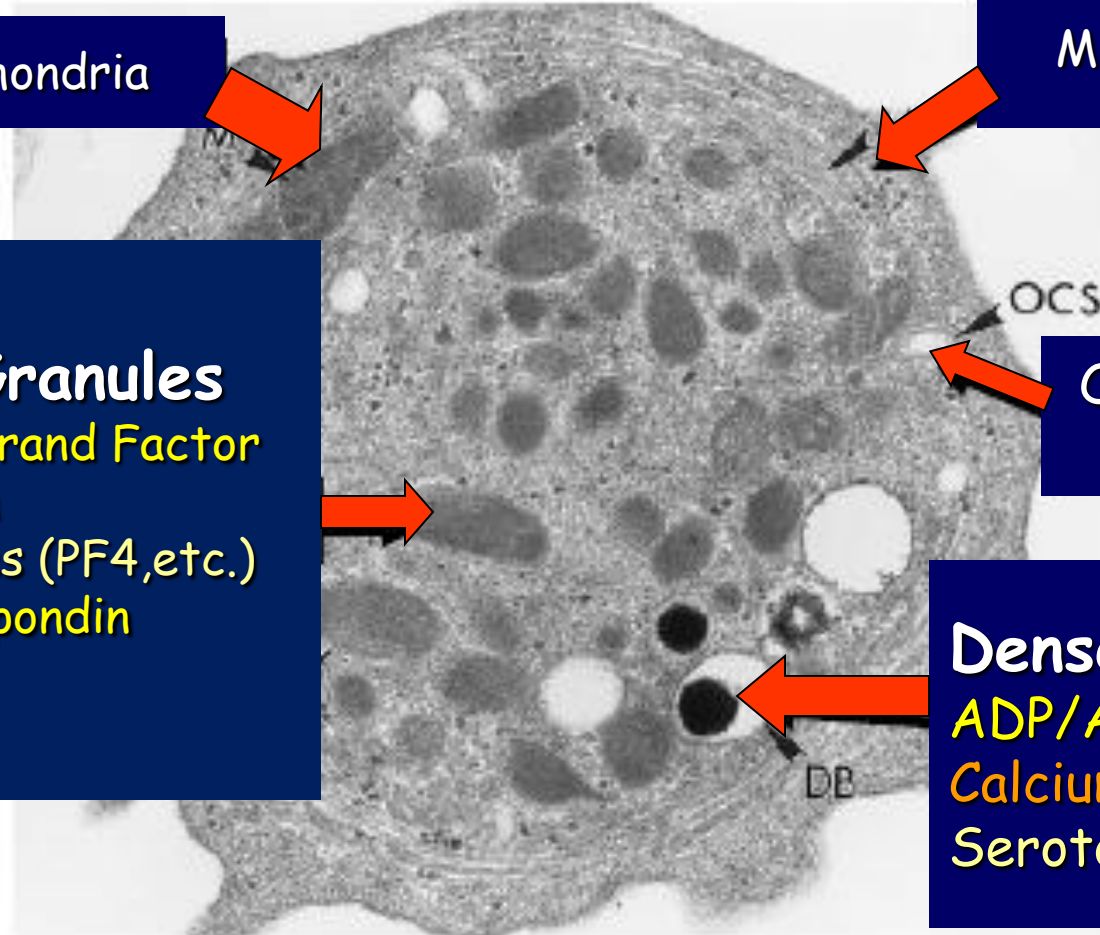
Mitochondria

Microtubules

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

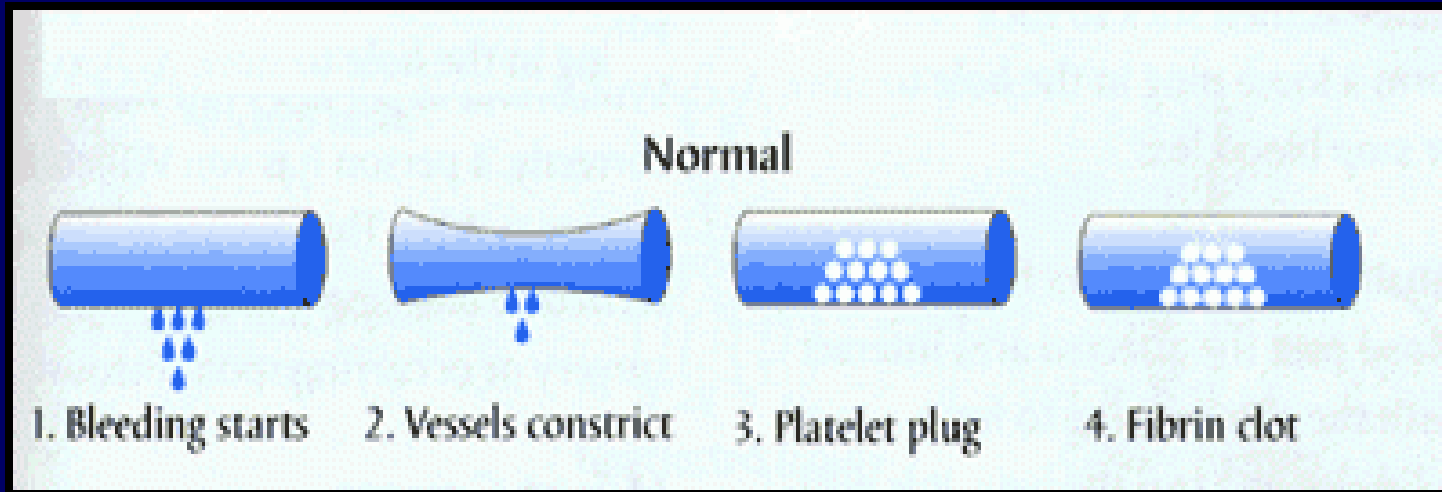
Open canalicular system

**Dense Granules**  
ADP/ATP  
Calcium  
Serotonin



# General functions of the platelets

# HEMOSTASIS



1. VASCULAR PHASE

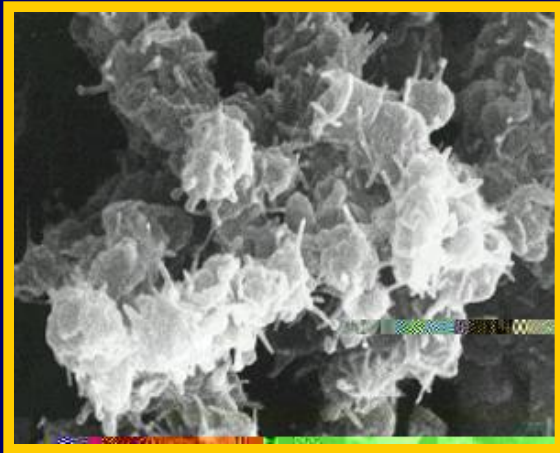
2. PLATELET PHASE

3. COAGULATION PHASE

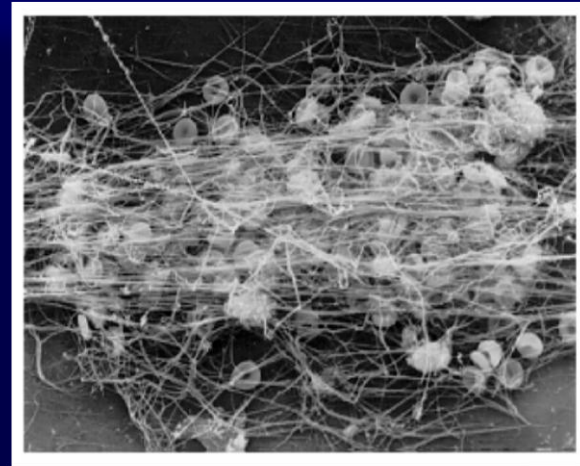
4. FIBRINOLYTIC PHASE

## 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

# Hemostatic Mechanisms

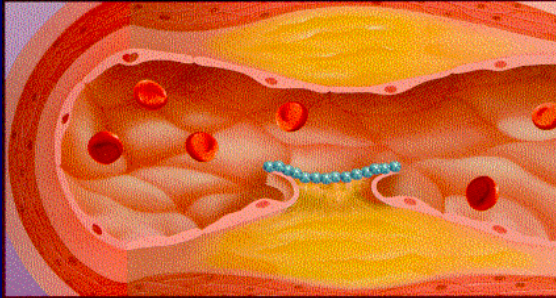
1. Vessel wall
2. Platelet
3. Blood coagulation
4. Fibrinolytic system

## Platelet activation:

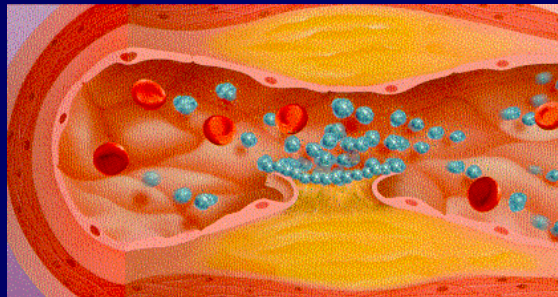
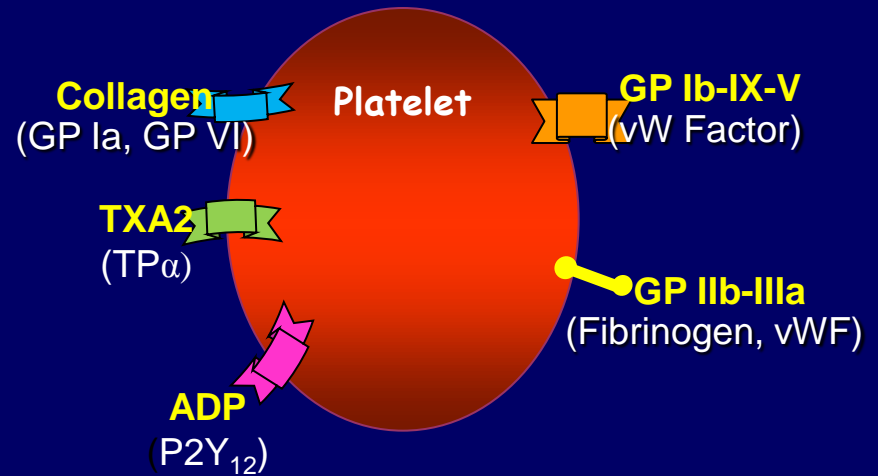
1. Adhesion
2. Shape change
3. Aggregation
4. Release reaction
5. Clot retraction



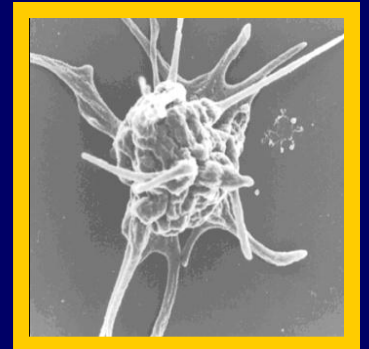
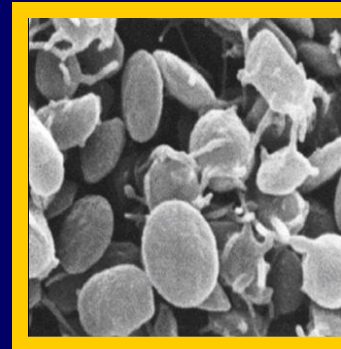
# Platelet function

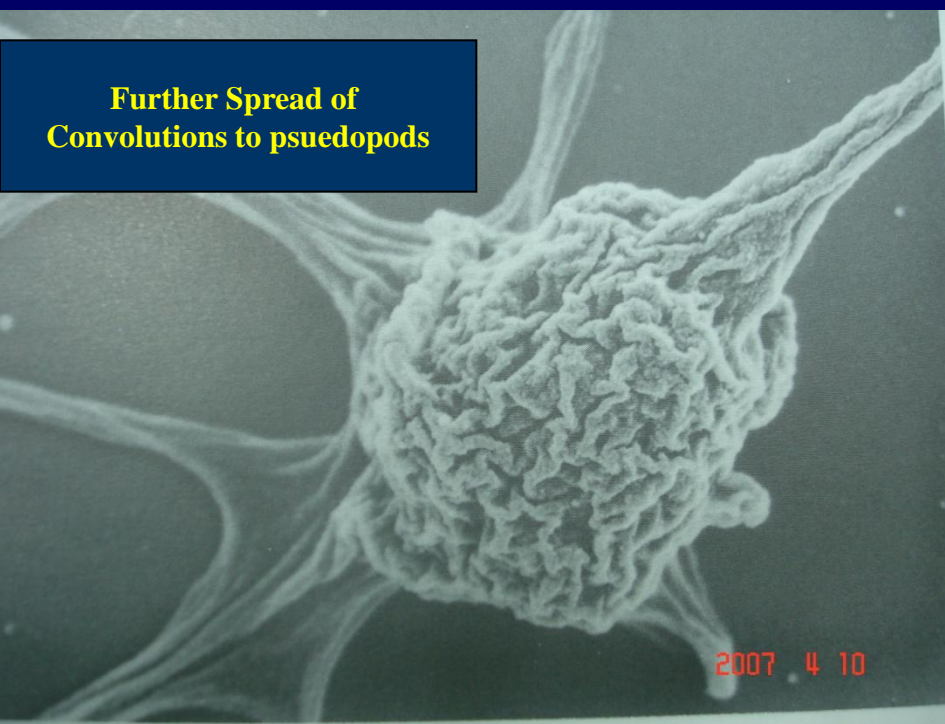
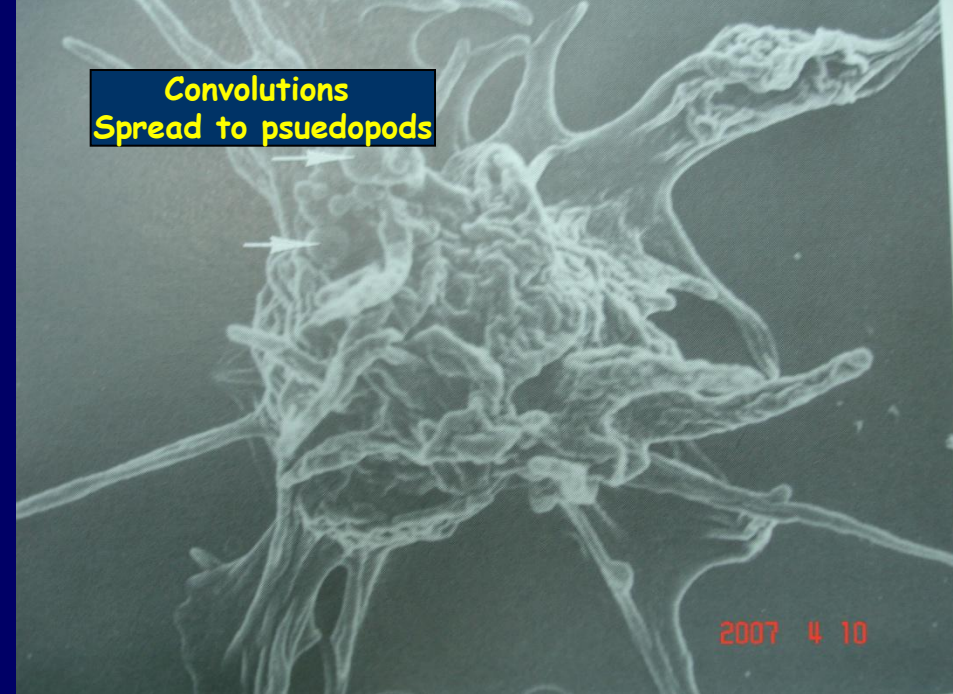
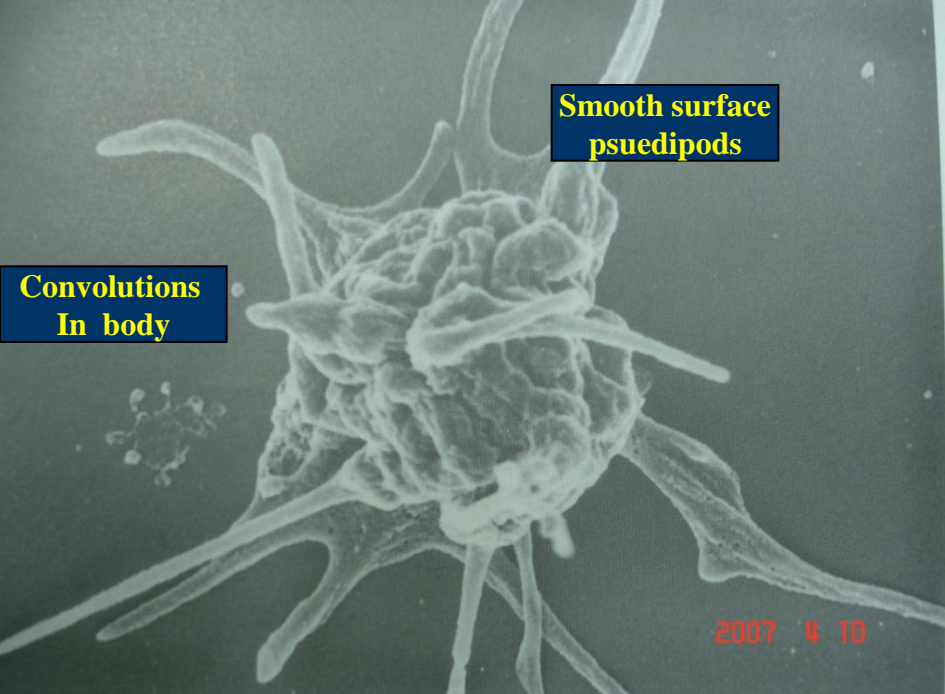


Adhesion



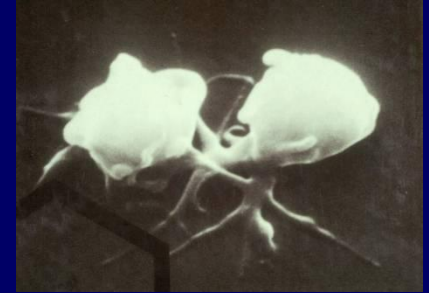
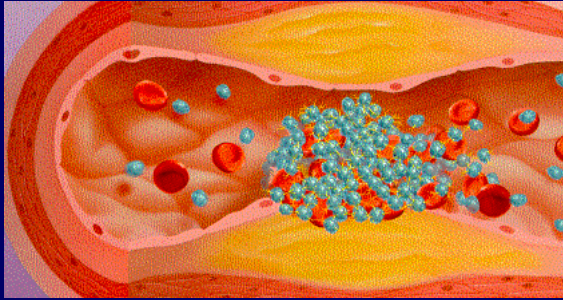
Shape change



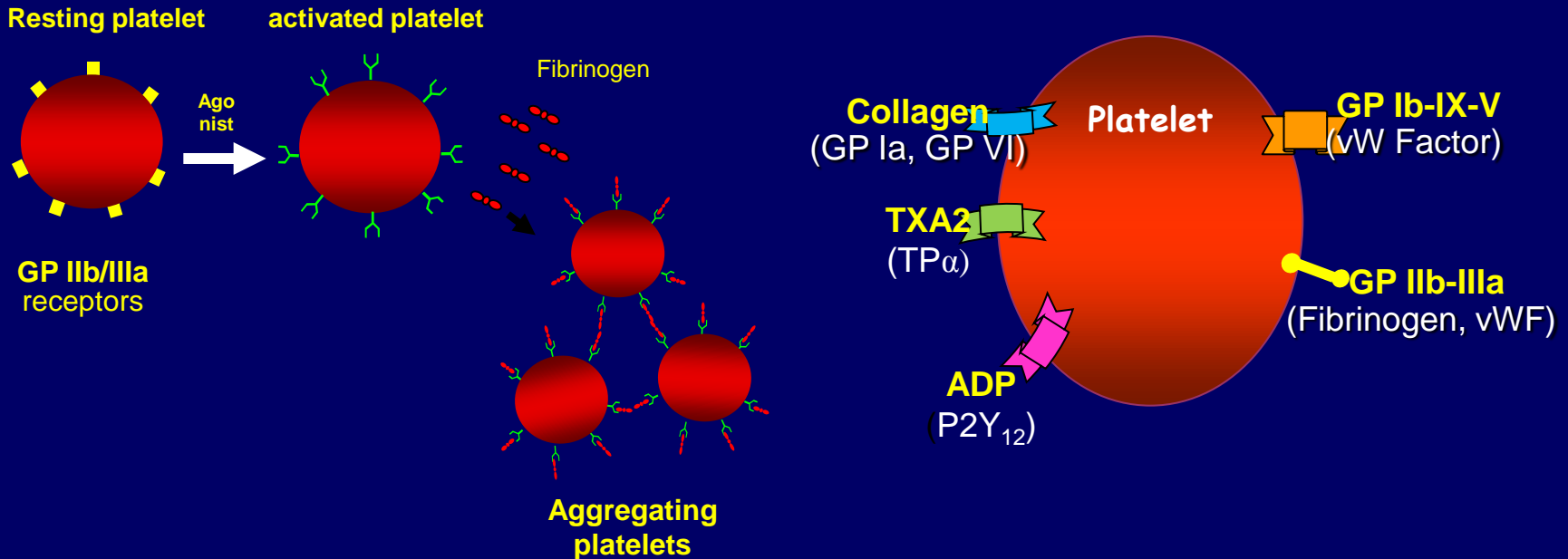




# Platelet function



## Aggregation

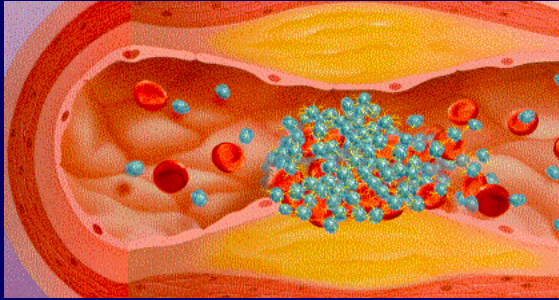


# Platelet Aggregation

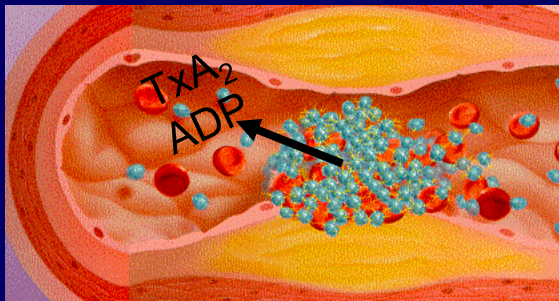
- Aggregation:

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

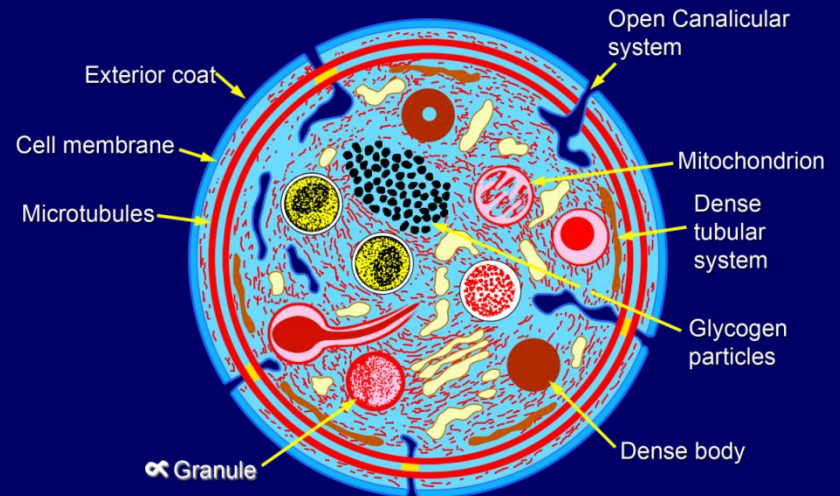
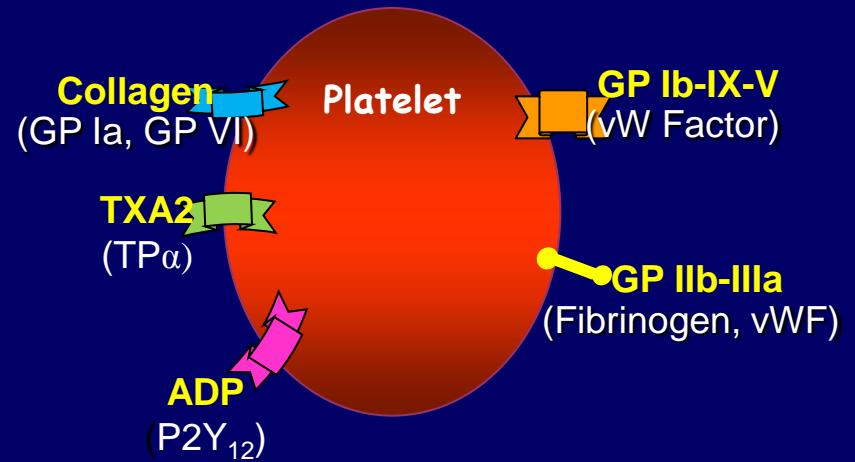
# Platelet function

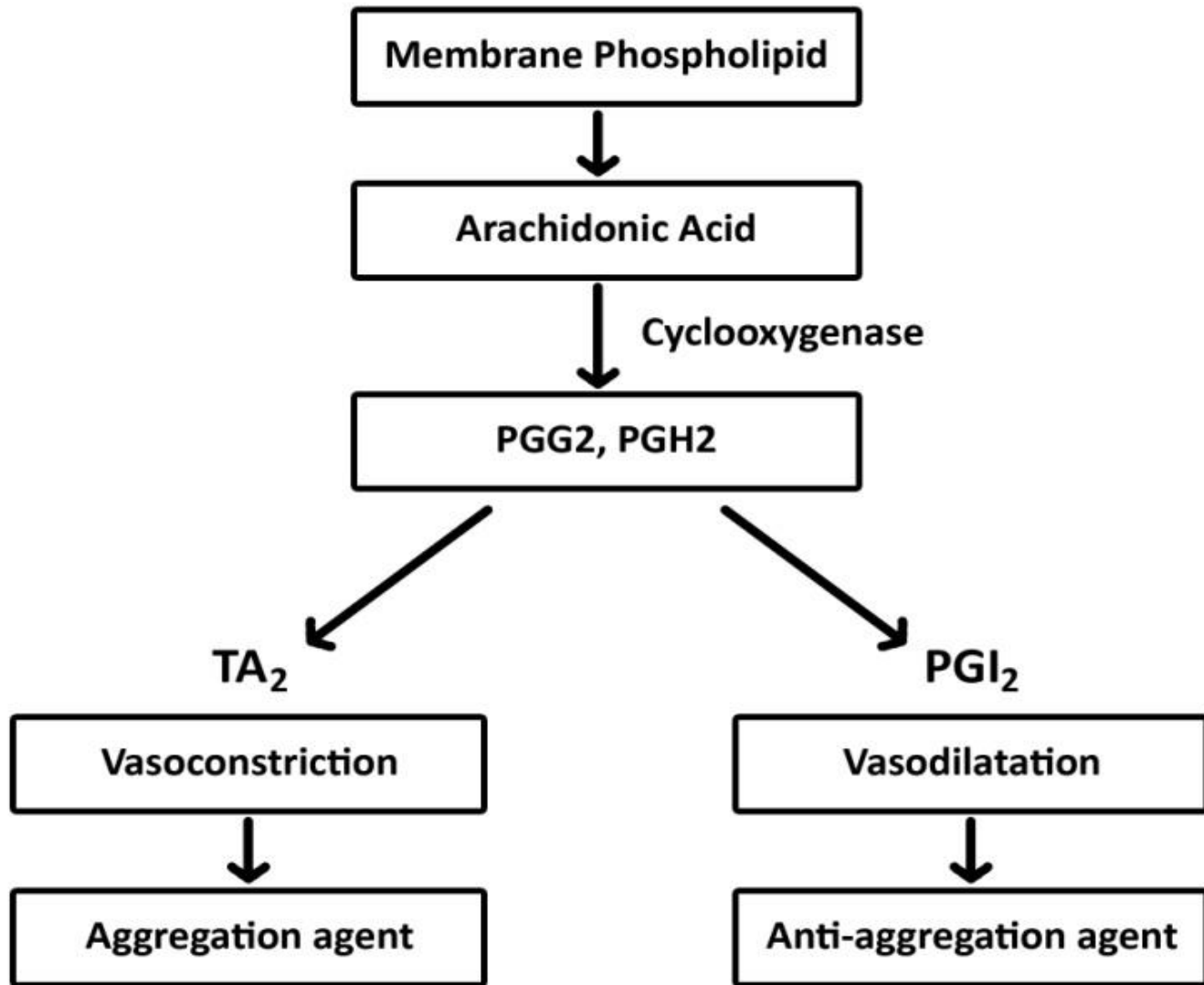


Aggregation



Secretion





# 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)

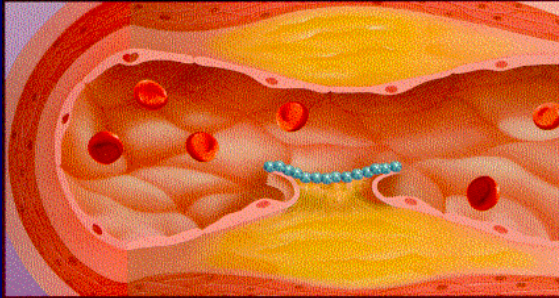
# Platelet Activation

- Clot Retraction:

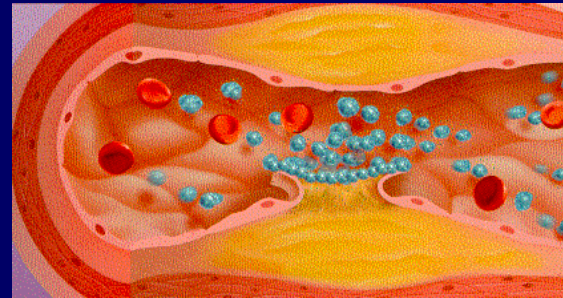
**Myosin** and **actin filaments** in platelets are stimulated to contract during aggregation further reinforcing the plug and help release of granule contents



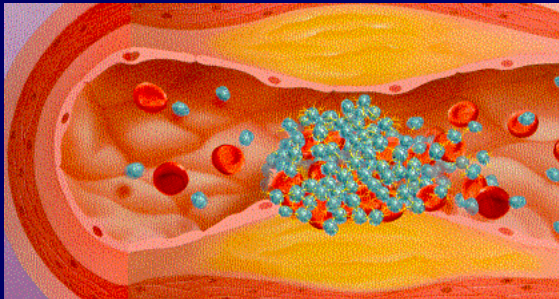
# Platelet function



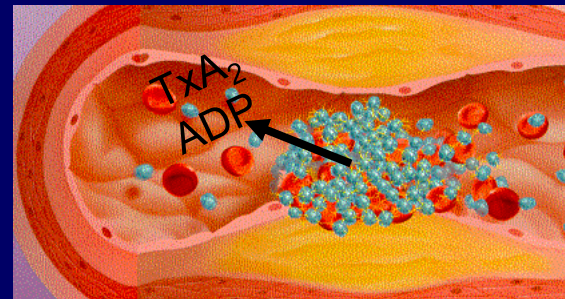
Adhesion



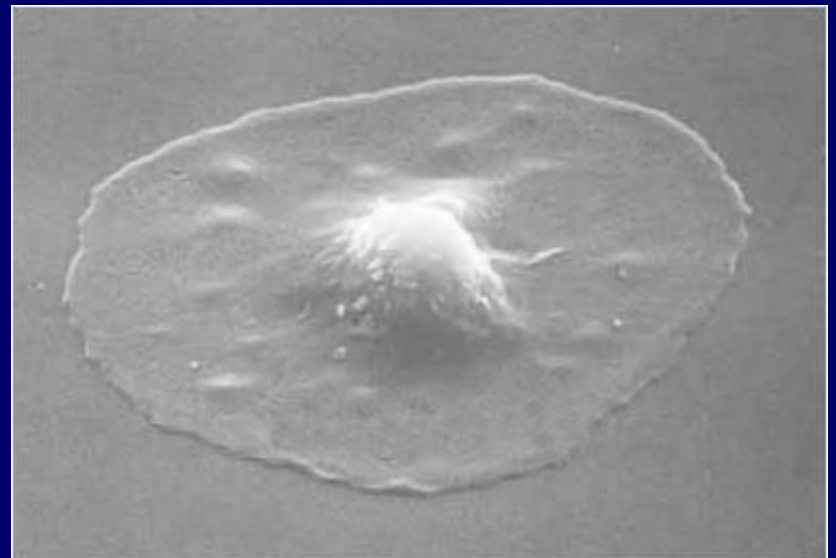
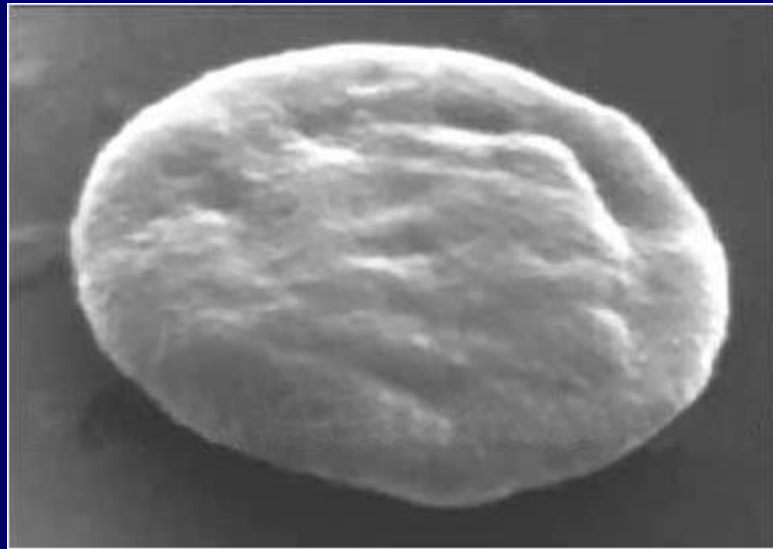
Activation



Aggregation



Secretion



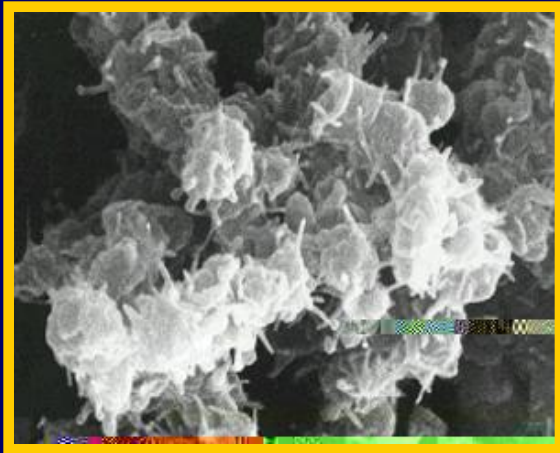


# Platelet haemostatic plug formation

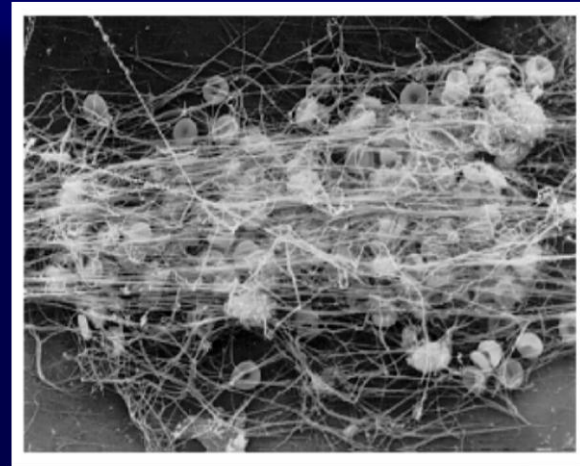
- Platelets activated by adhesion
- Extend projections to make contact with each other
- Release:  
thromboxane A<sub>2</sub>, serotonin & ADP >>> activating other platelets
- Serotonin & thromboxane A<sub>2</sub> are **vasoconstrictors** decreasing blood flow through the injured vessel.
- ADP causes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

## 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

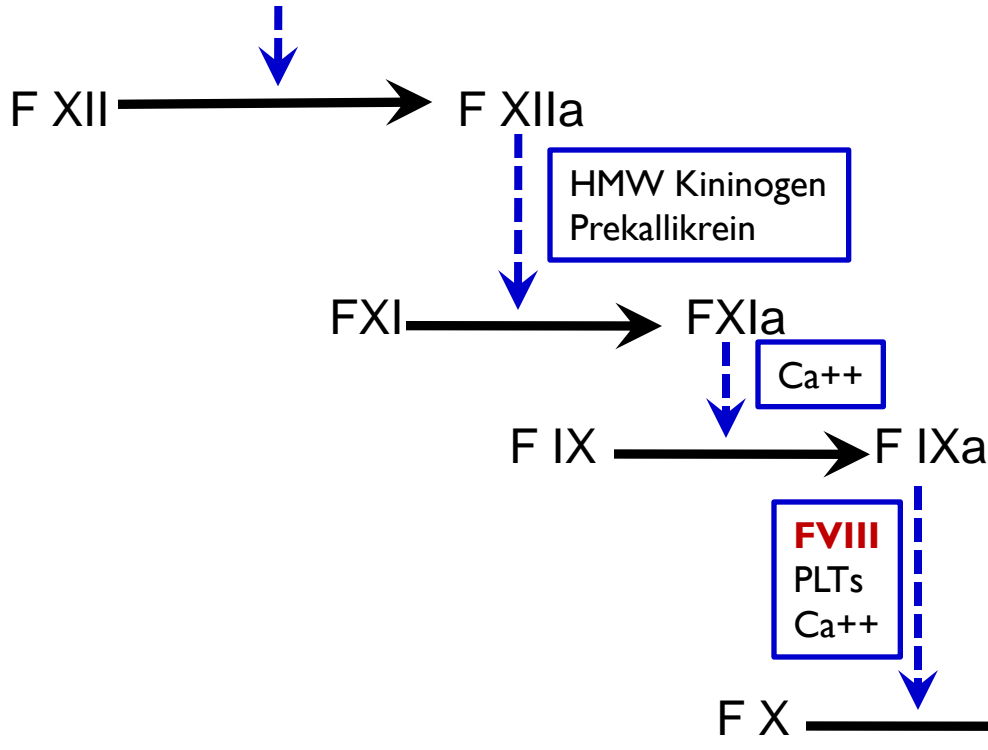
# **Functions of the platelets..cont**

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

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

# The Intrinsic Pathway

Blood trauma  
or contact  
with collagen



# The Extrinsic Pathway

Tissue trauma

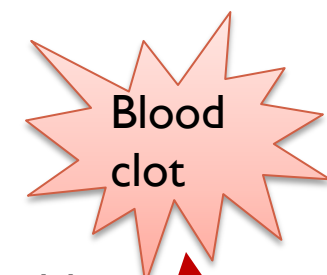
Tissue factor (TF)

FVIIa ← FVII

Ca<sup>++</sup>

**FVIII**  
PLTs  
Ca<sup>++</sup>

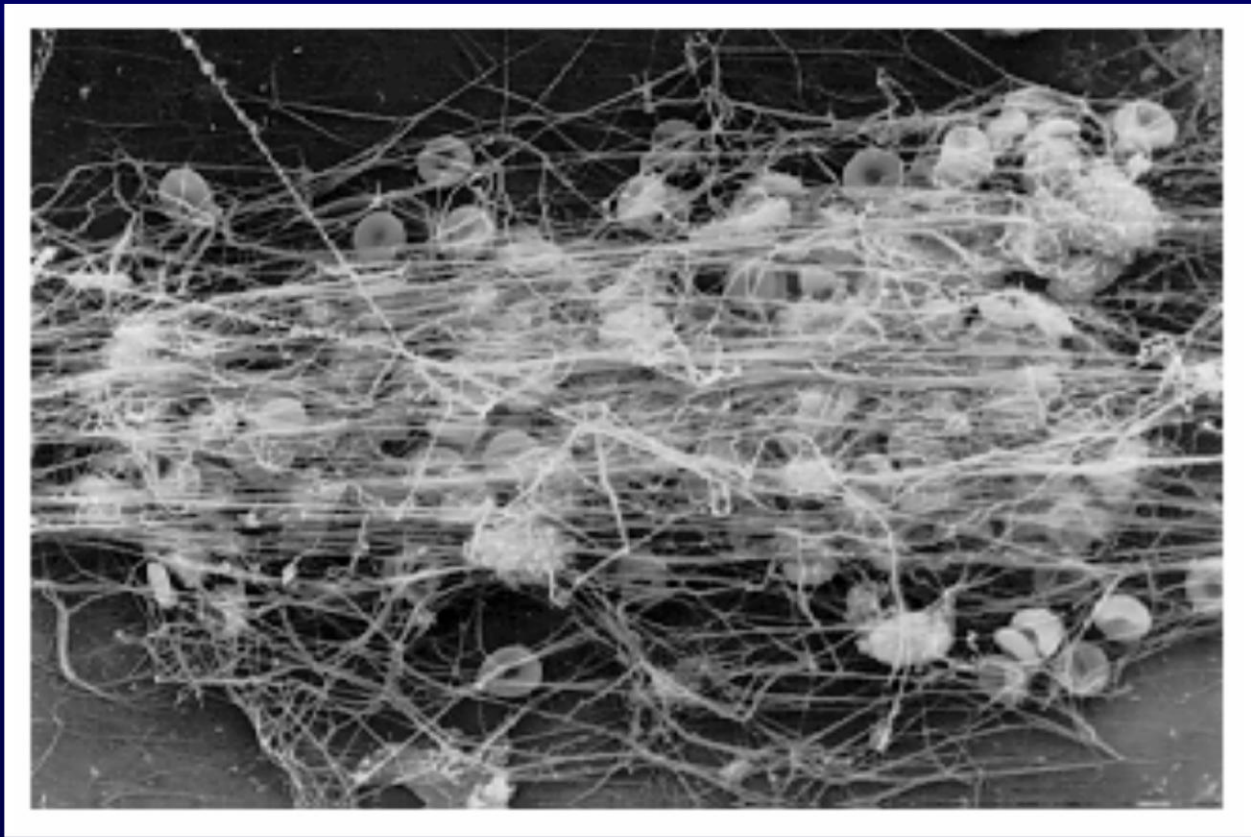
**FV**  
PLTs, Ca<sup>++</sup>



Prothrombin → Thrombin

Fibrinogen → Fibrin

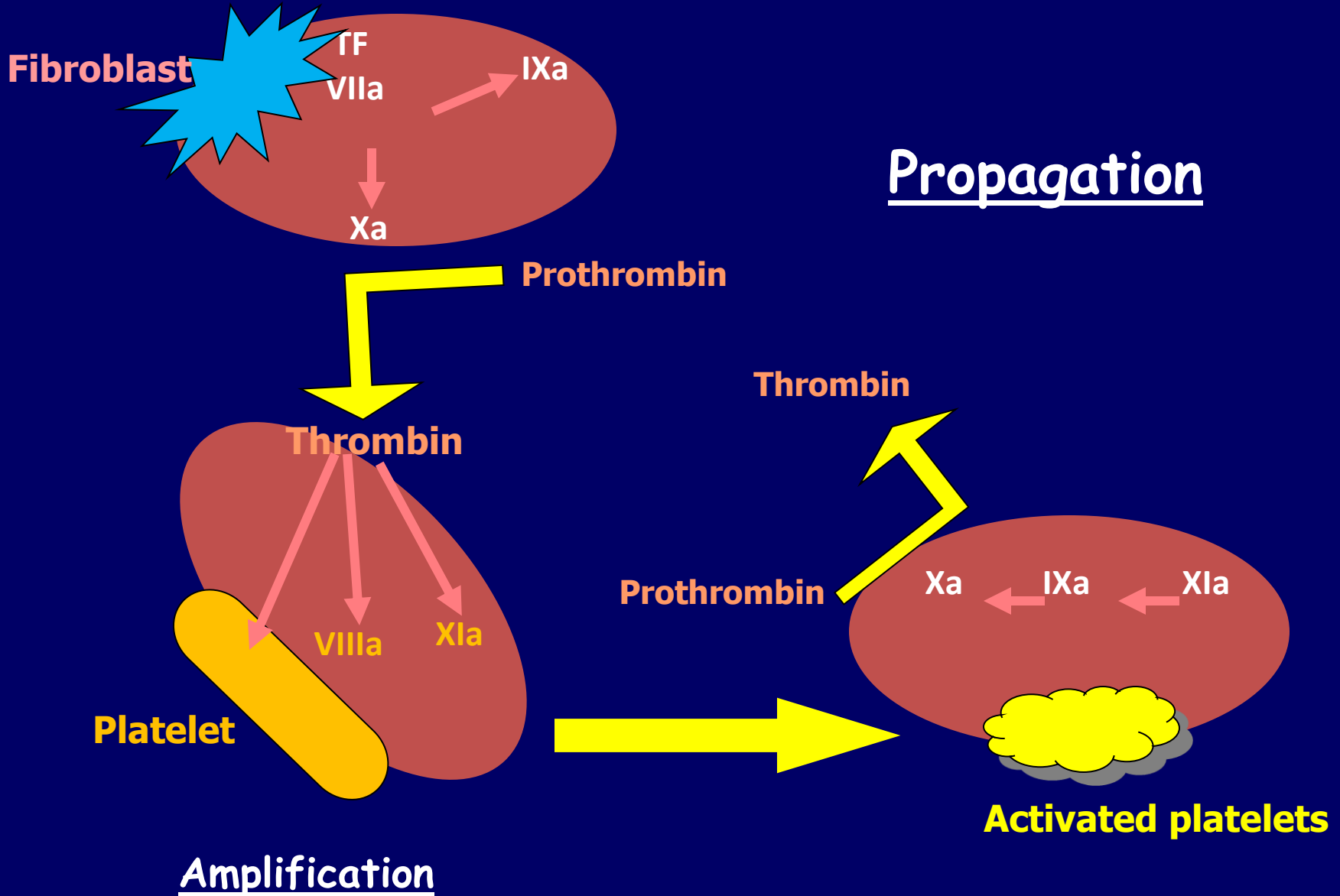
Blood  
clot



# Initiation

# Cell based model

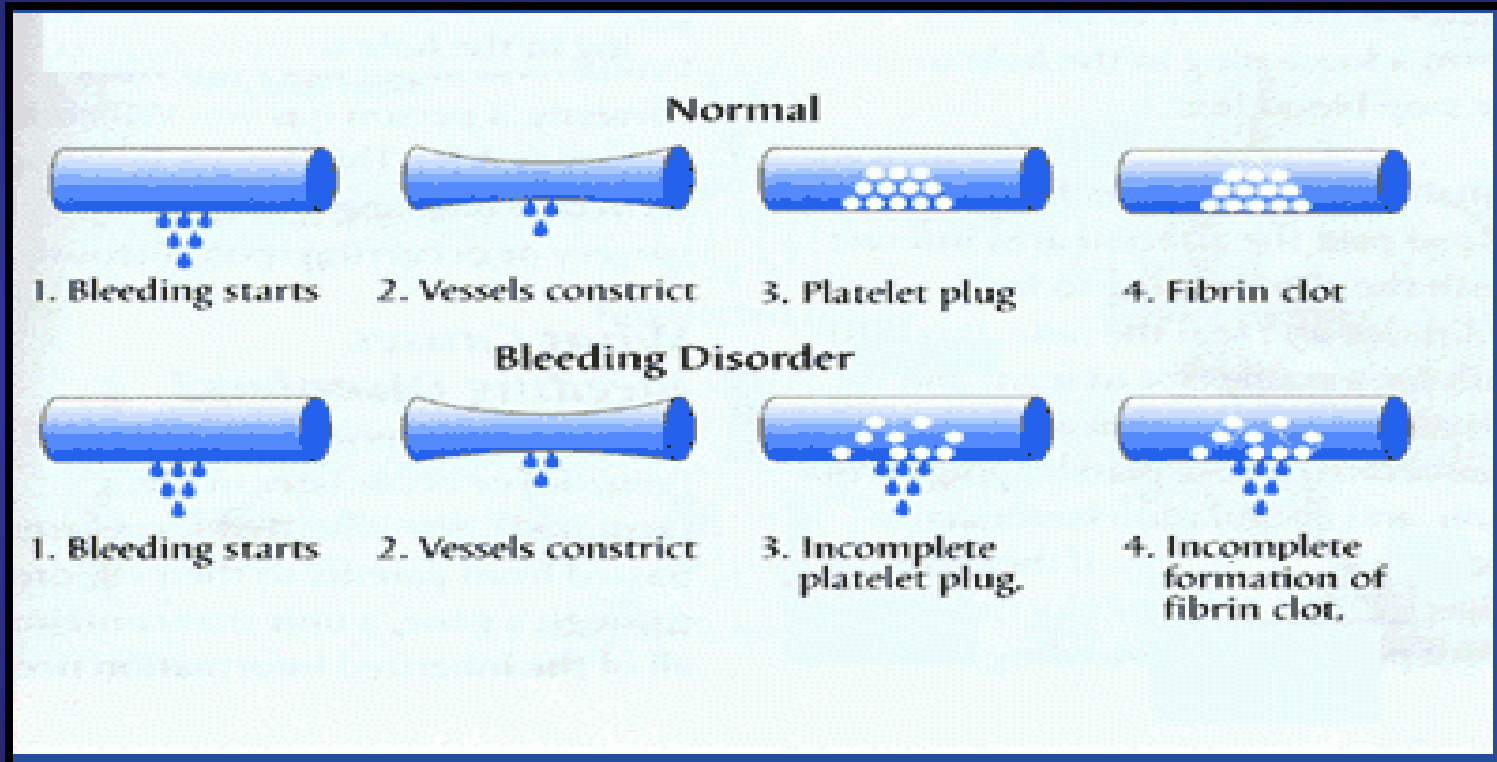
# Propagation



# 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 Disorders

- **Bleeding can result from:**
  - **Platelet defects:**
    - **Deficiency in number (thrombocytopenia)**
    - **Defect in function (acquired or congenital).**

# 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)

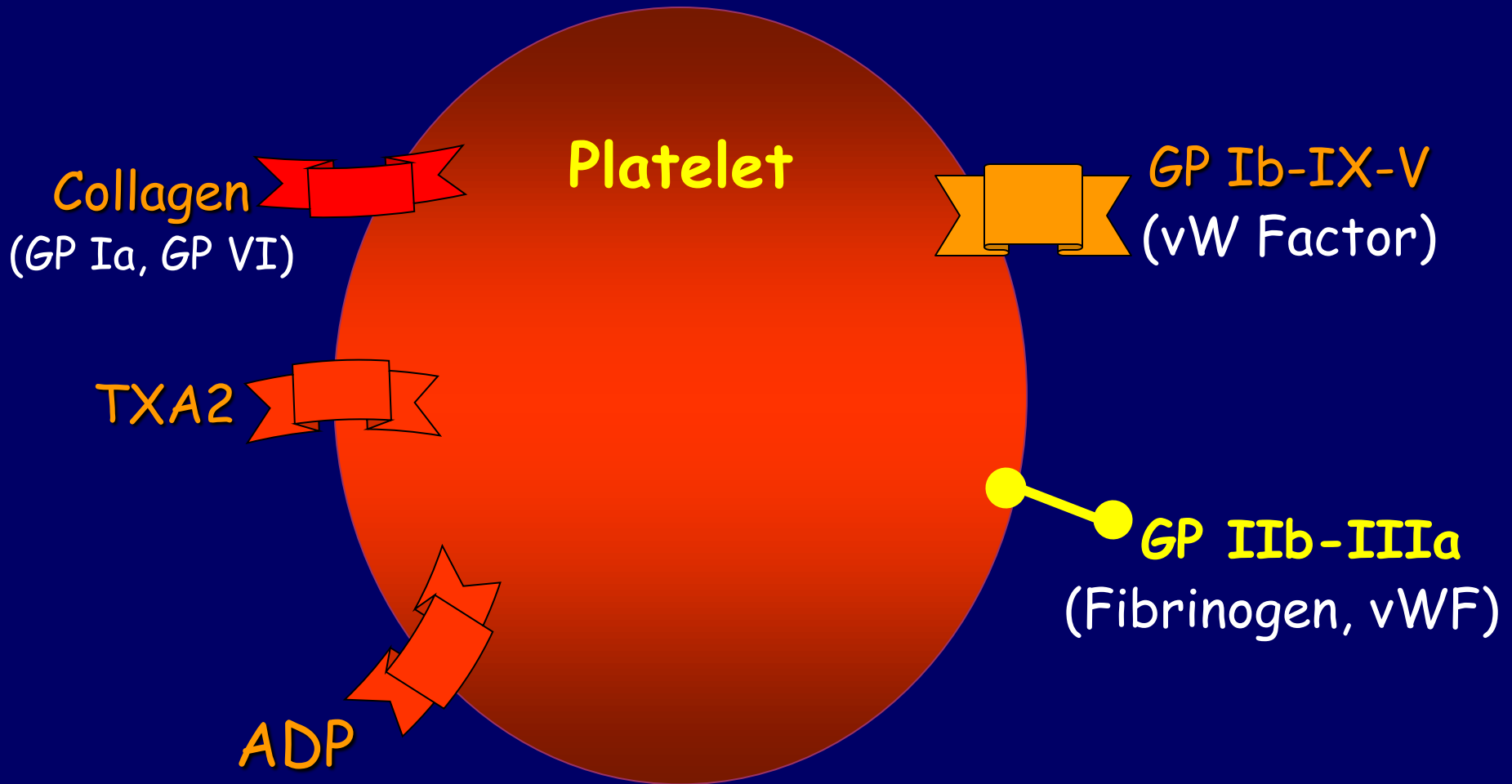
## Disorders of Production:

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

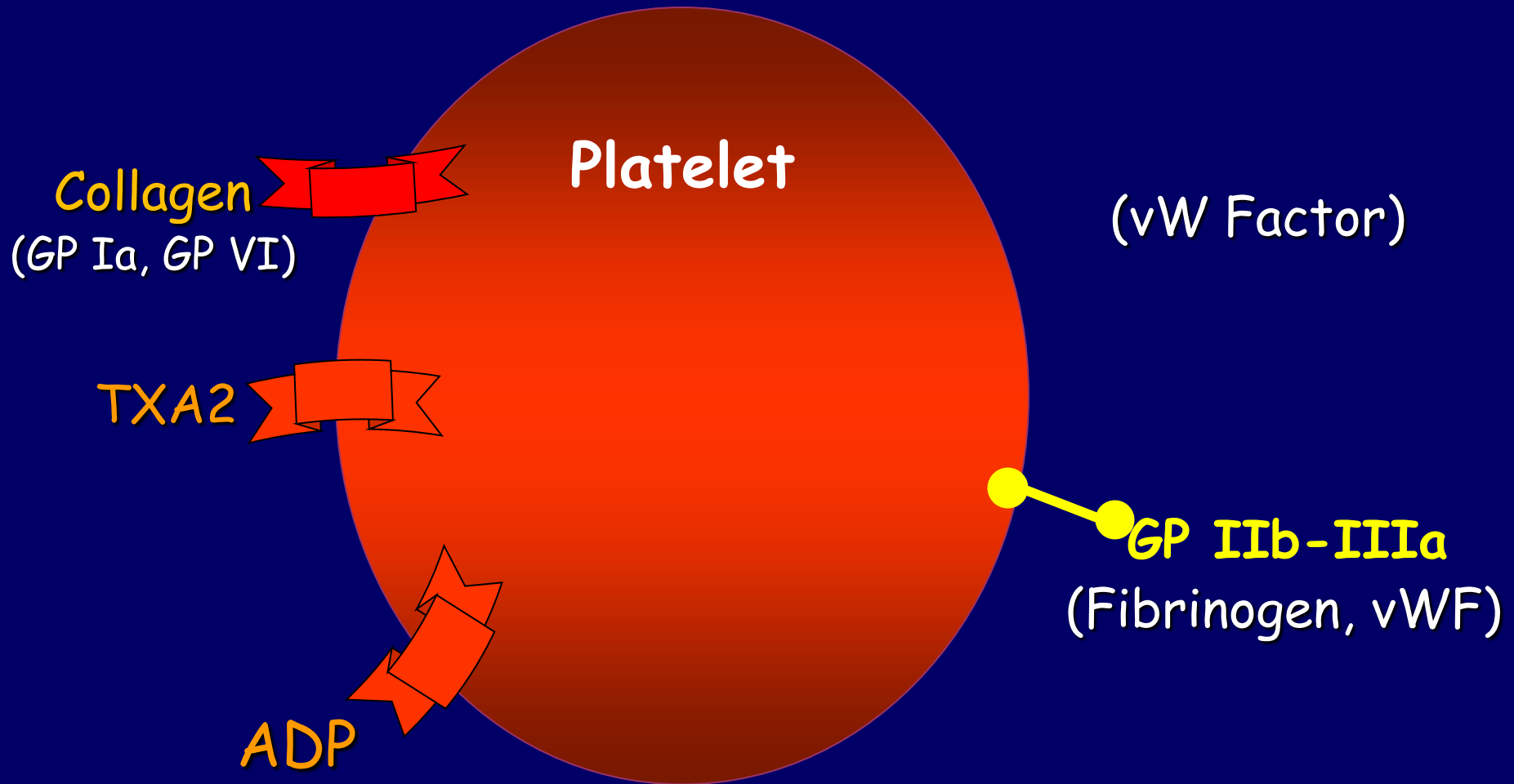
# Platelet Activation

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

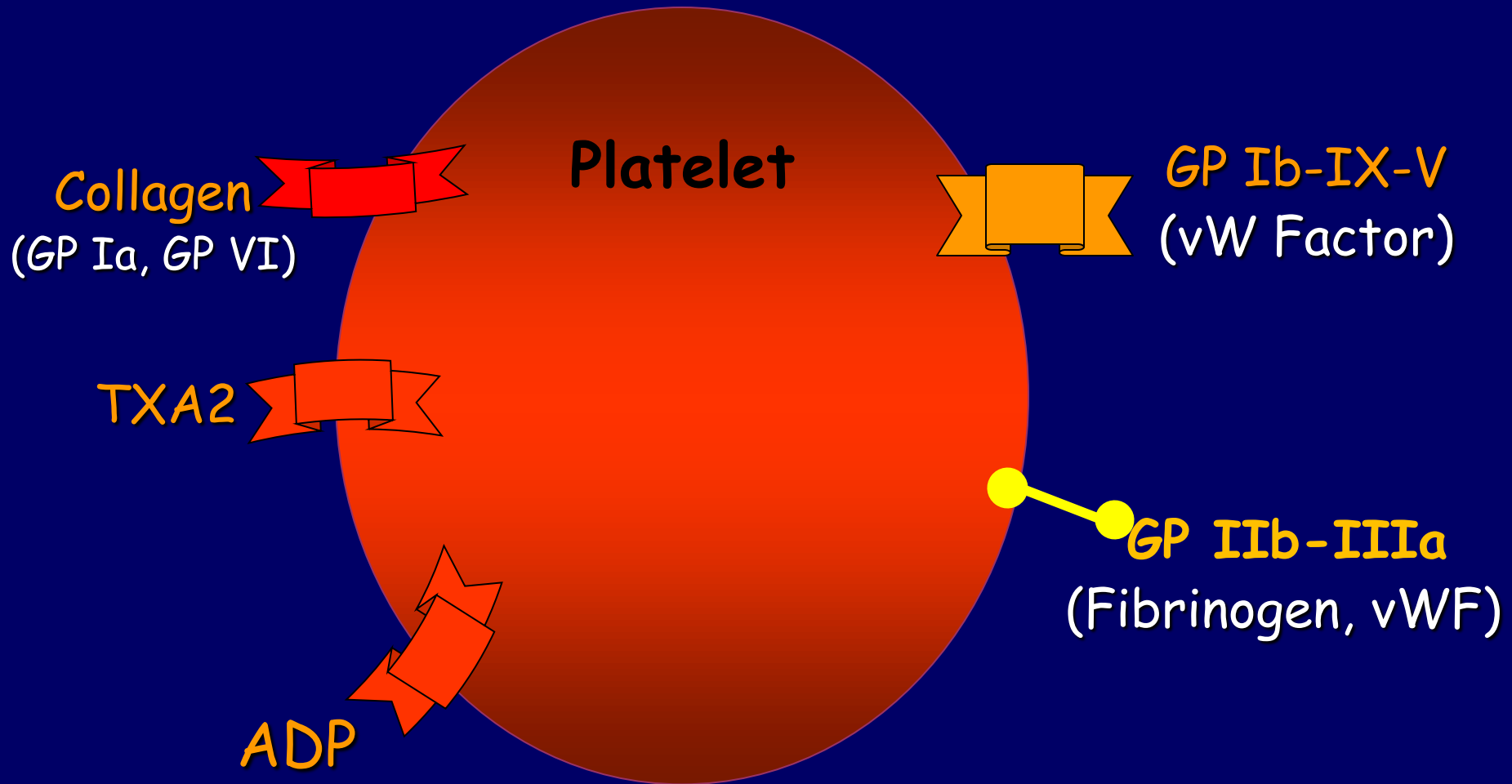
# Bernard-Soulier Syndrome



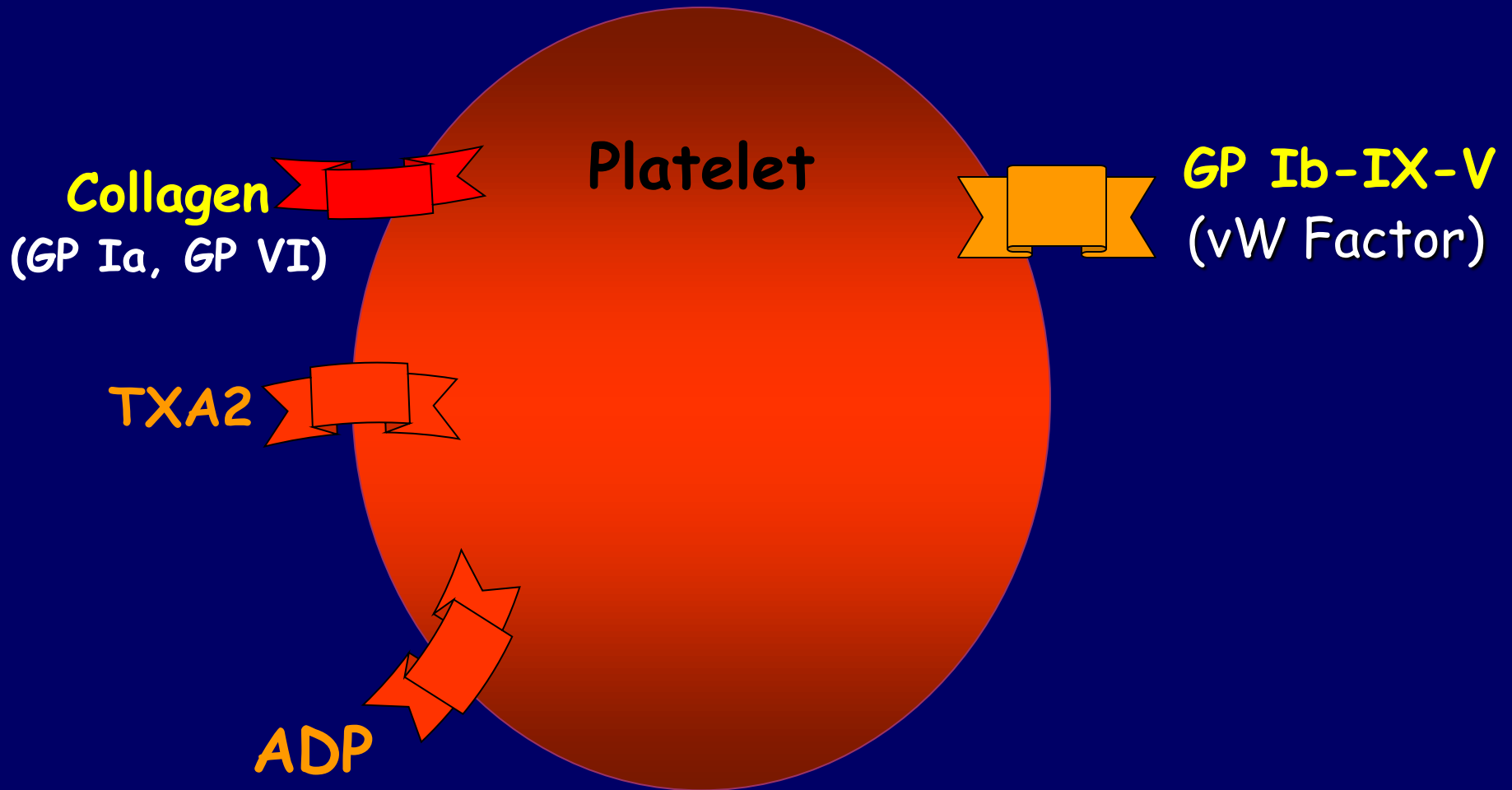
# Bernard-Soulier Syndrome



# Glanzmann Thrombasthenia

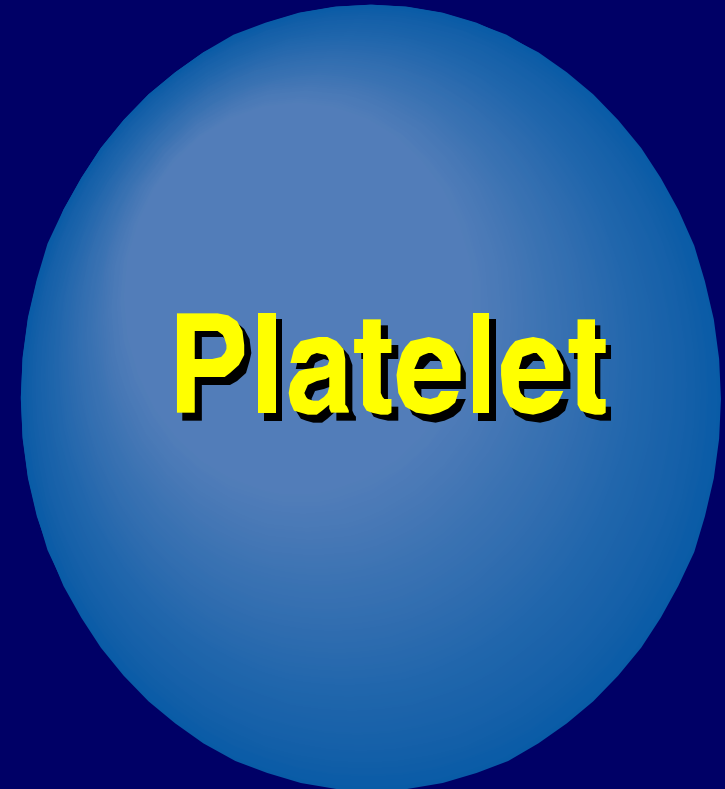
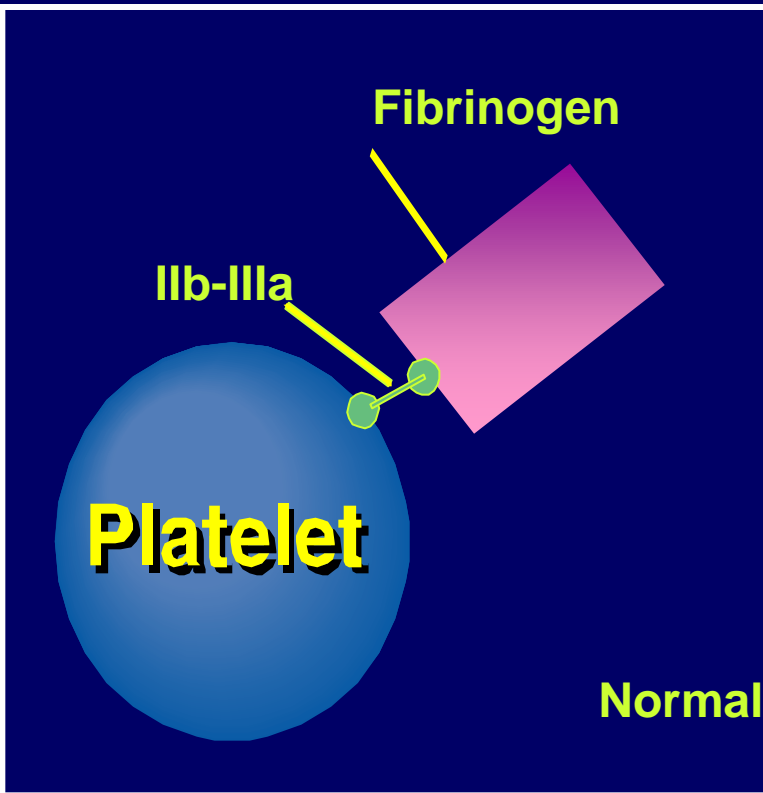


# Glanzmann Thrombasthenia





# Glanzmann Thrombasthenia



No Gp IIb-IIIa Receptors

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

**Platelet function tests**

# 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



# 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 function test

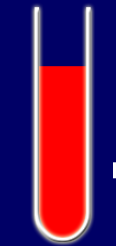
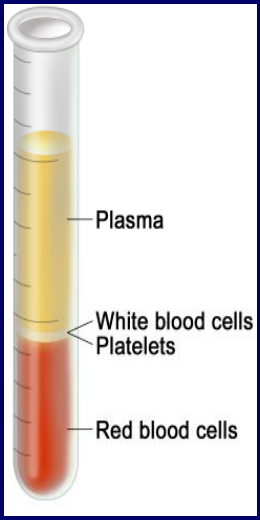
## Platelet Aggregometry



# Platelet Aggregation

## Agonists:

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



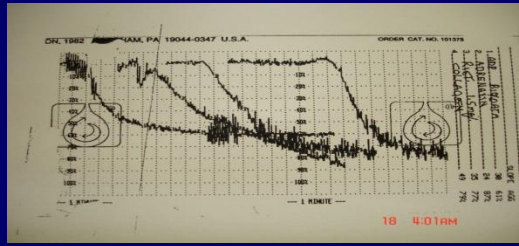
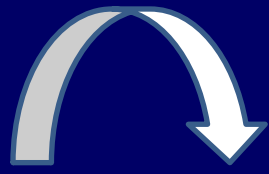
Whole blood



RBC

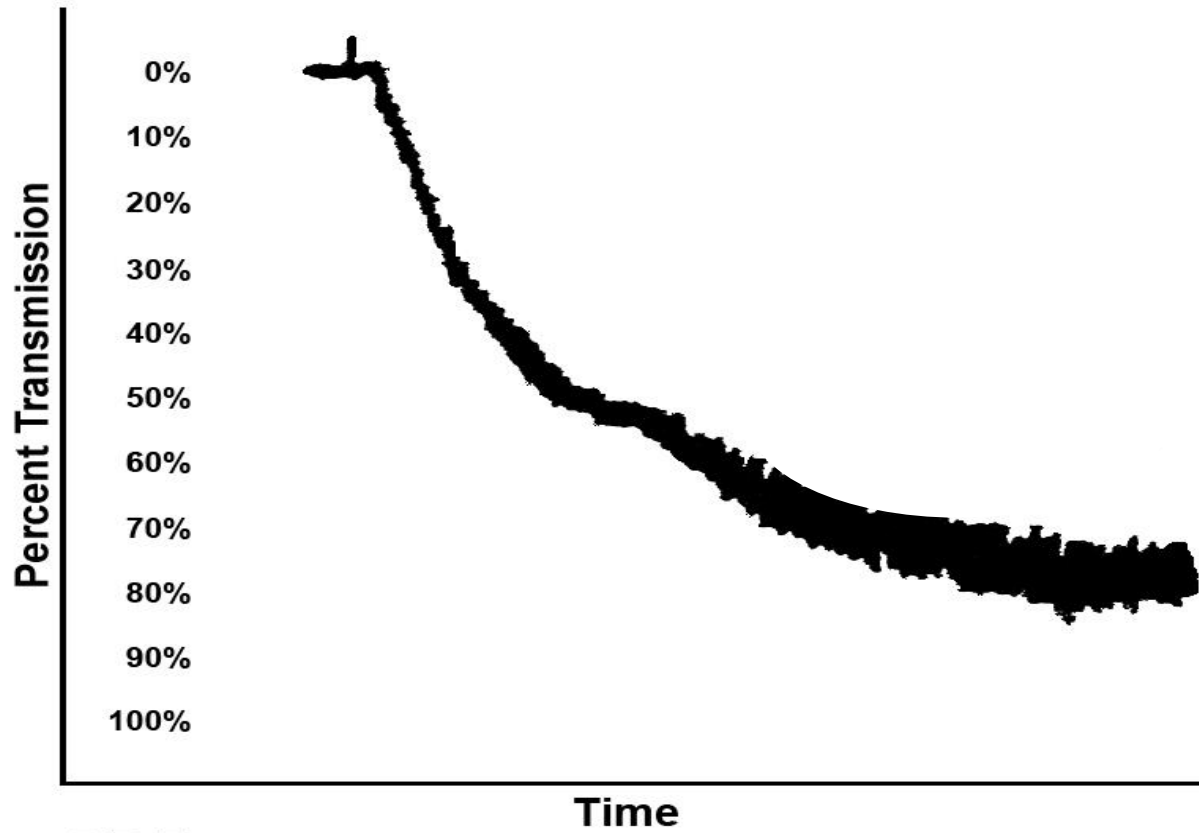


PRP





# Normal platelet aggregation



**ADP**

Time

# 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 of a river flowing through a valley with tall mountains and a forest. The text "THANK YOU" is overlaid in yellow.

**THANK YOU**