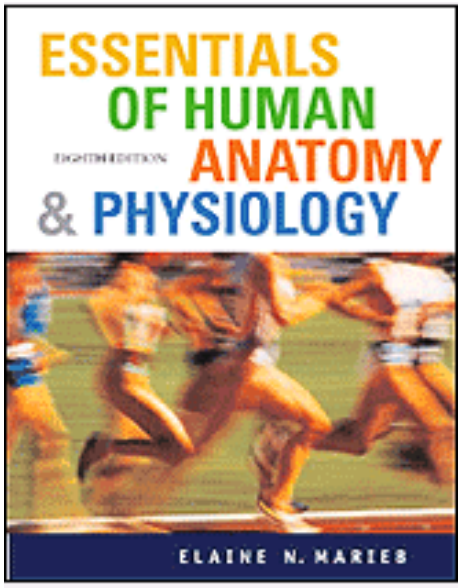
Human Anatomy and Physiology

CLS 224



Reem Alkhamis

Email: ralkhamis@ksu.edu.sa

3rd floor/ office # 113

Blood

1.Composition and function of blood

- Components of blood
- Physical characteristics and volume
- Plasma
- Formed elements-
  (Erythrocytes*Leukocytes*Platelets)
- Hematopoiesis

2. Hemostasis

1. Composition and function of blood

- Components:

It is a complex connective tissue in which blood cells are suspended in plasma.

It is the only fluid tissue.

It has both solid and liquid compartments.

55%

1%

45%

- Physical characteristics and volume:

Sticky, viscous, thick, opaque fluid.

Slightly alkaline pH 7.35-7.45

Its temp. is 38C

Volume in Healthy males 5-6 liters.

- Plasma: 90% of it is water.

1)Transports substances around the body;

nutrients, salts, respiratory gases, hormones, Abs,

Plasma proteins, waste products of cell metabolism..

-Plasma proteins has a variety of functions.

e.g. Albumin maintain the osmotic pressure of plasma

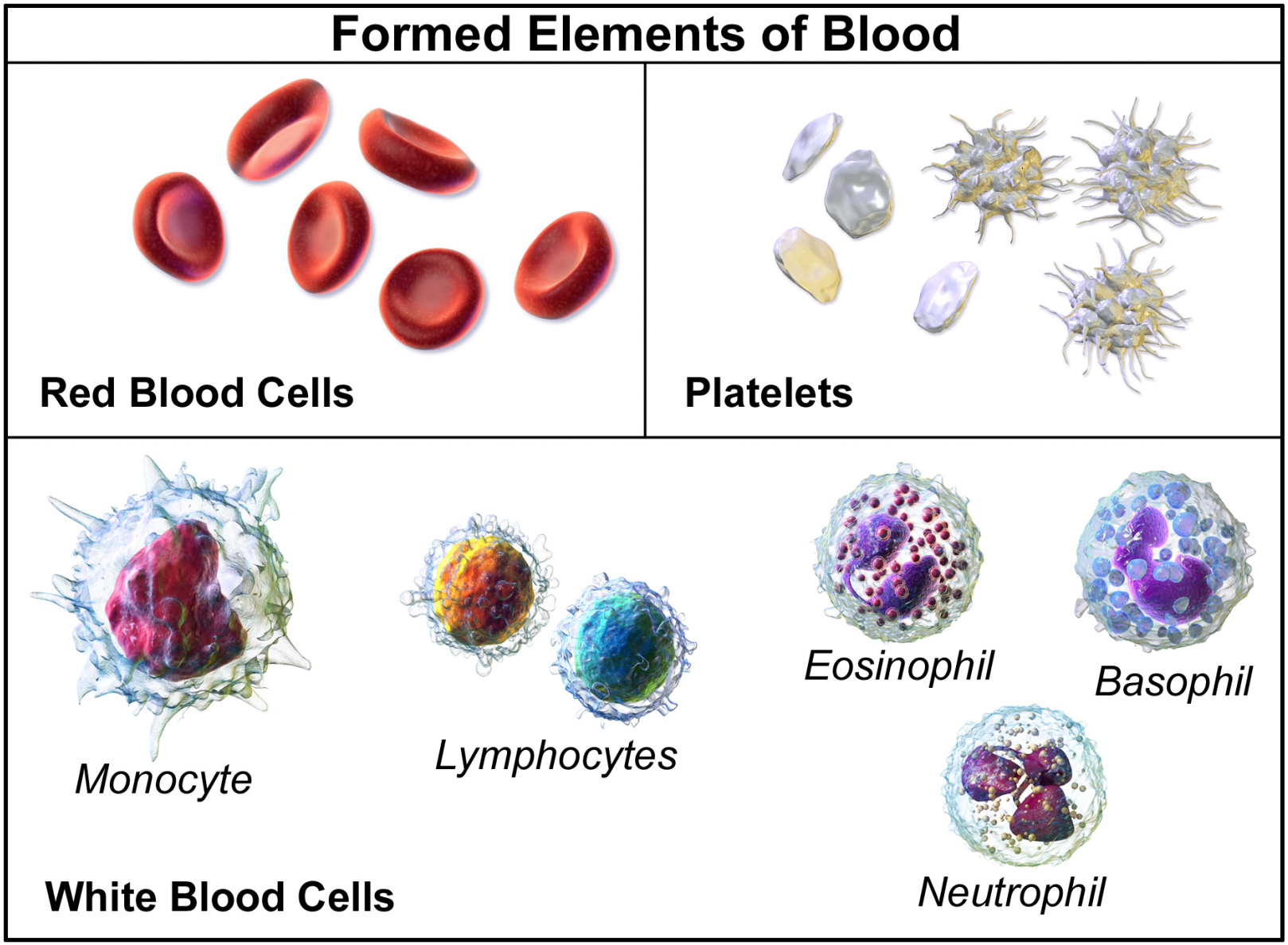
Fibrinogen is essential for blood clotting.

Globulin participate in immune system.

-Most plasma proteins are made by the liver. They aren't taken up by cells to be used as nutrients.

2) Plasma distributes body heat throughout the body.

- Formed elements:



Erythrocytes (RBCs):

- Structure-

Contain hemoglobin molecules.

Anucleated.

Biconcave discs.

Contain very few organelles, Lack mitochondria.

- Function-

Carry oxygen in blood to all cells of the body. (gas exchange)

Perfect example on how structure fits function.

What determines how well the erythrocytes are performing their role of oxygen transport?

- Number-

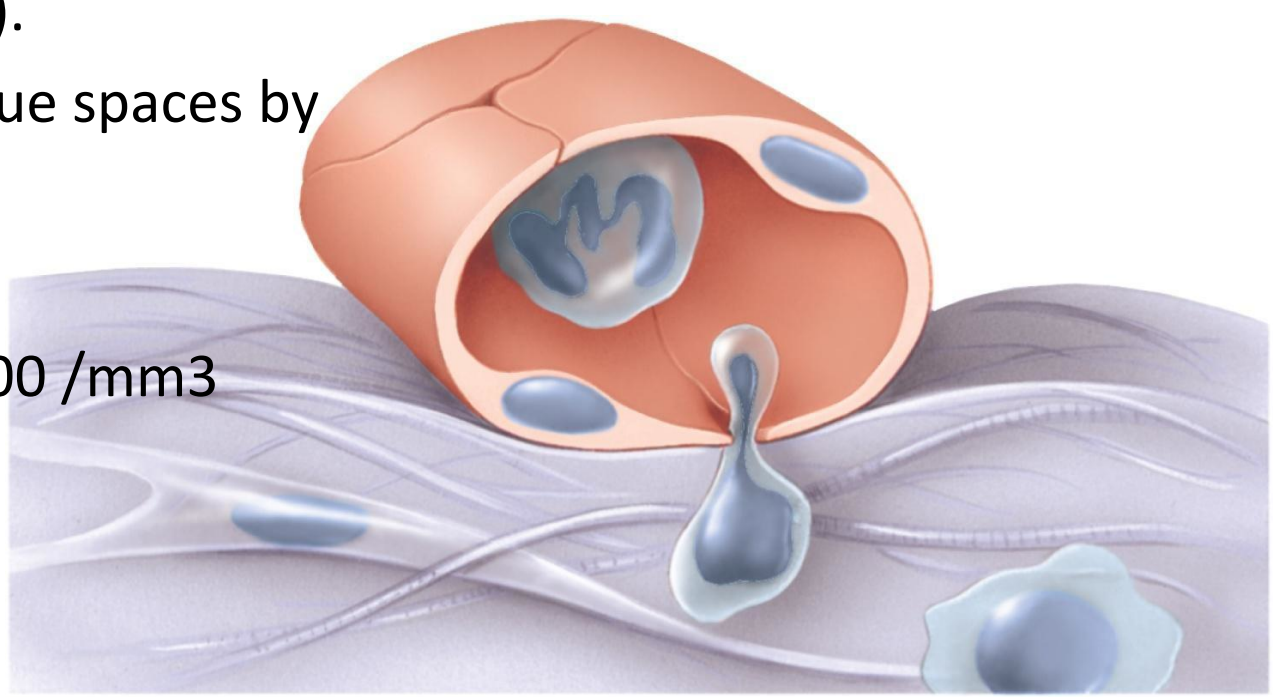
5 million /mm3 (outnumber WBC 1000:1)

Leukocytes (WBCs):

- Structure- The only complete cells in blood
- Function- Form a protective movable army that Defends the body against disease or damage caused by bacteria, viruses, parasites, and tumor cells.

Unlike RBC, WBC can slip into and out of the BV, process called diapedesis. They can locate areas of tissue damage or infection by responding to certain chemicals that damaged tissue produce (positive chemotaxis).

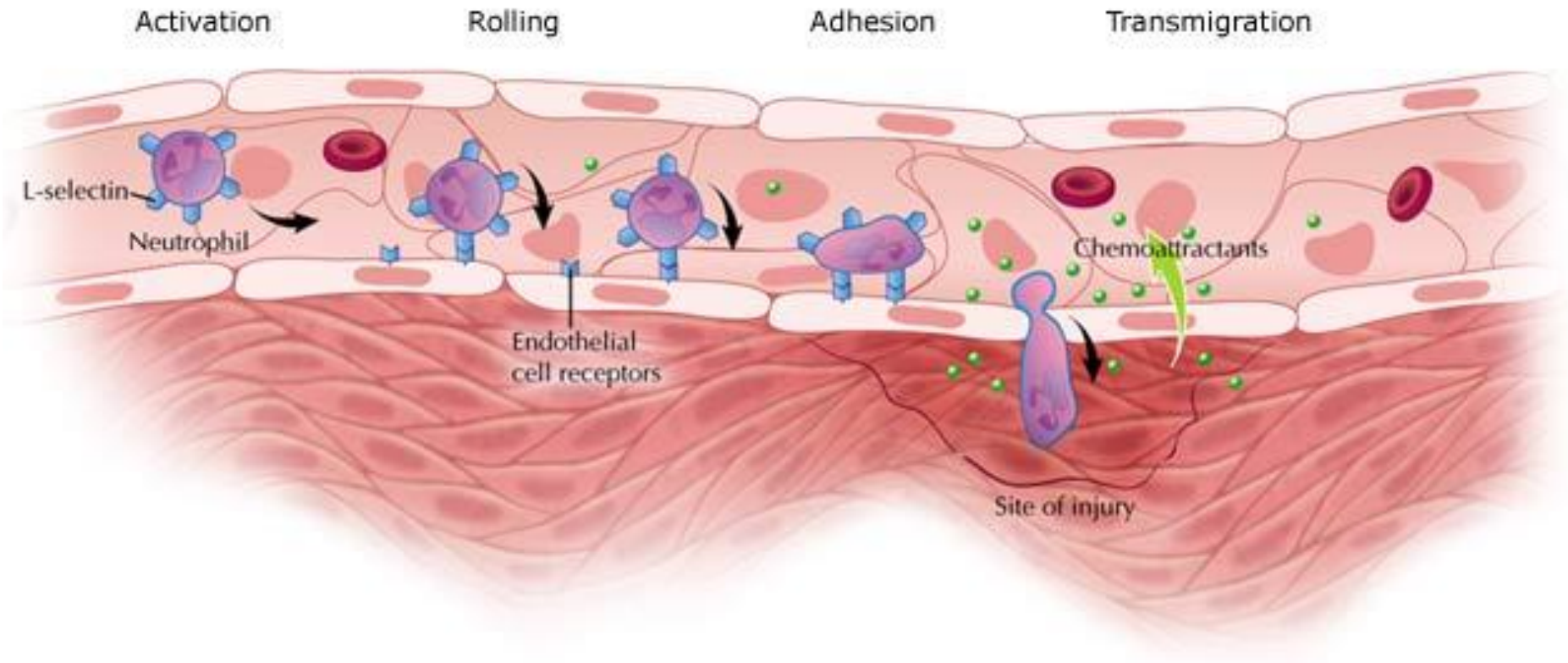
WBC move through tissue spaces by ameboid motion



- Number- 4,000-11,000 /mm3

Leokocytosis?

Leukopenia?


Activation
Rolling
Adhesion
Transmigration
L-selectin
Neutrophil
Endothelial
cell receptors
Chemoattractants
Site of injury

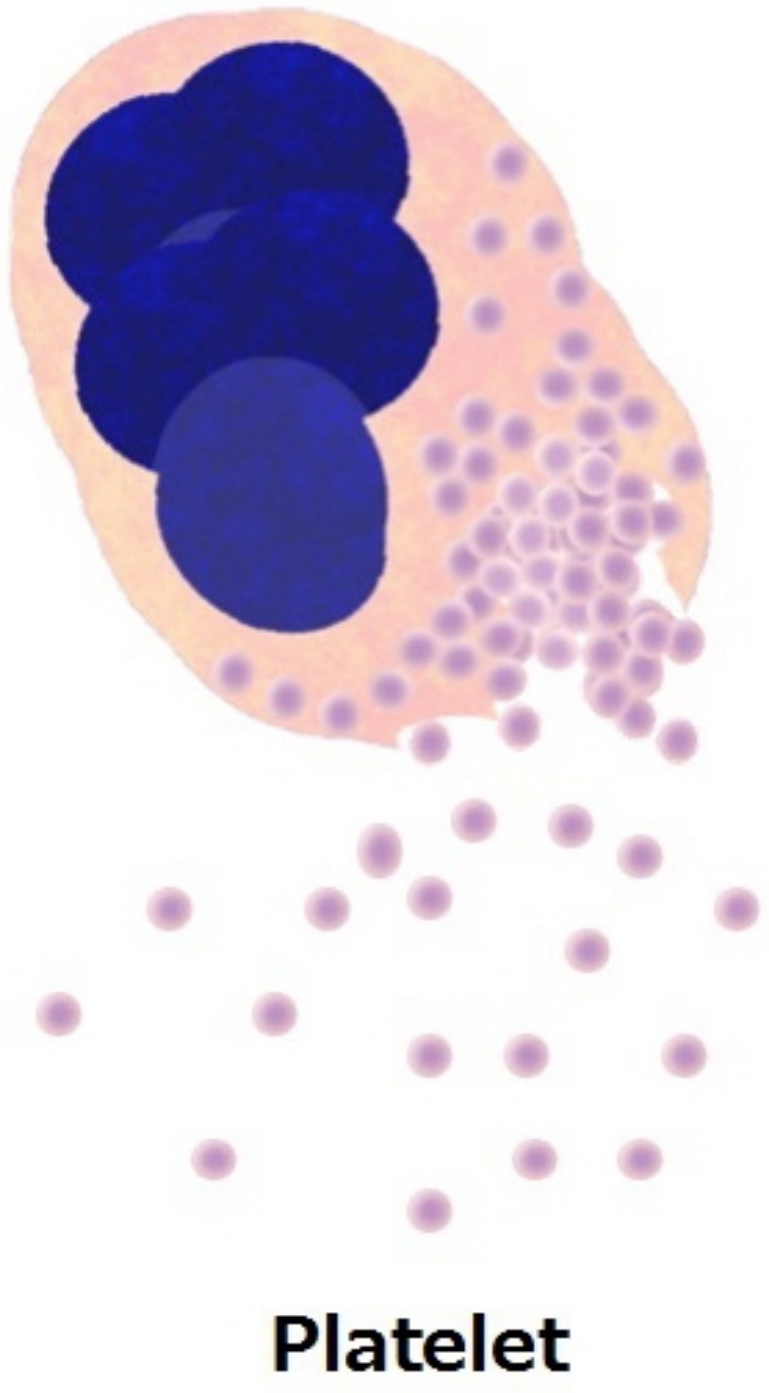
Cell type	Occurrence in blood (per mm^3)	Cell anatomy*	Function
• Neutrophils 	3000–7000 (40–70% of WBCs)	Cytoplasm stains pale pink and contains fine granules, which are difficult to see; deep purple nucleus consists of three to seven lobes connected by thin strands of nucleoplasm	Active phagocytes; number increases rapidly during short-term or acute infections
• Eosinophils 	100–400 (1–4% of WBCs)	Red coarse cytoplasmic granules; figure-8 or bilobed nucleus stains blue-red	Kill parasitic worms; increase during allergy attacks; might phagocytize antigen-antibody complexes and inactivate some inflammatory chemicals
• Basophils 	20–50 (0–1% of WBCs)	Cytoplasm has a few large blue-purple granules; U- or S-shaped nucleus with constrictions, stains dark blue	Granules contain histamine (vasodilator chemical), which is discharged at sites of inflammation
Agranulocytes			
• Lymphocytes 	1500–3000 (20–45% of WBCs)	Cytoplasm pale blue and appears as thin rim around nucleus; spherical (or slightly indented) dark purple-blue nucleus	Part of immune system; one group (B lymphocytes) produces antibodies; other group (T lymphocytes) involved in graft rejection, fighting tumors and viruses, and activating B lymphocytes
• Monocytes 	100–700 (4–8% of WBCs)	Abundant gray-blue cytoplasm; dark blue-purple nucleus often kidney-shaped	Active phagocytes that become macrophages in the tissues; long-term "clean-up team"; increase in number during chronic infections such

Platelets:

Derived from ruptured multinucleated megakaryocytes.

- Function - Needed for the clotting process that occurs in plasma when BVs are ruptured or broken.

- Number- 300,000/mm3



Hematopoiesis

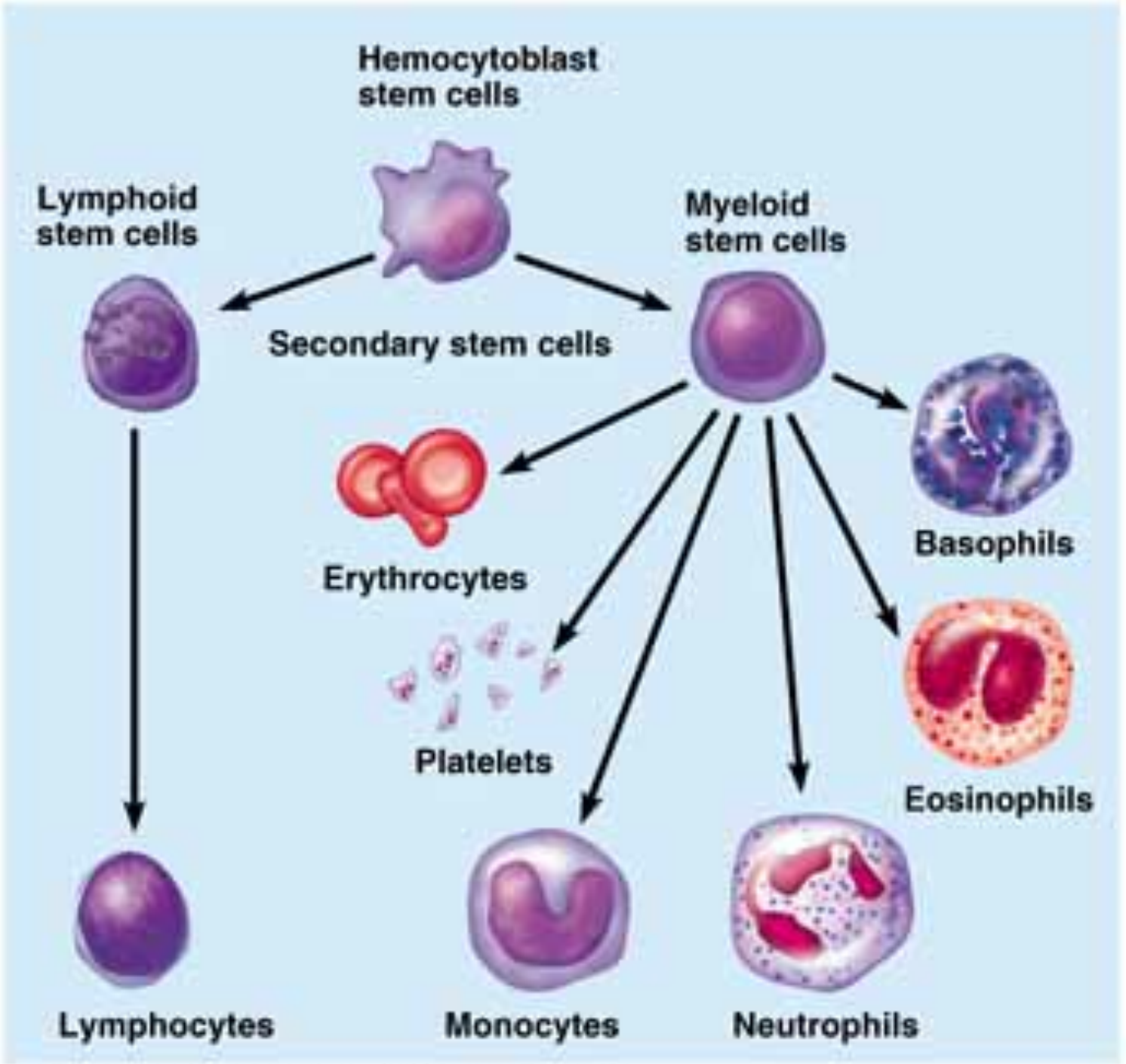
- Blood cell formation
- Occurs in red bone marrow-

(flat bones: skull, ribs, spine, pelvis and sternum/ proximal epiphyses: humerus and femur).

- All blood cells are derived from a common stem cell (hemocytoblast).
- Hemocytoblast differentiate into

1) Lymphoid stem cell: produces lymphocytes.

2) Myloid stem cell: produces other formed elements.



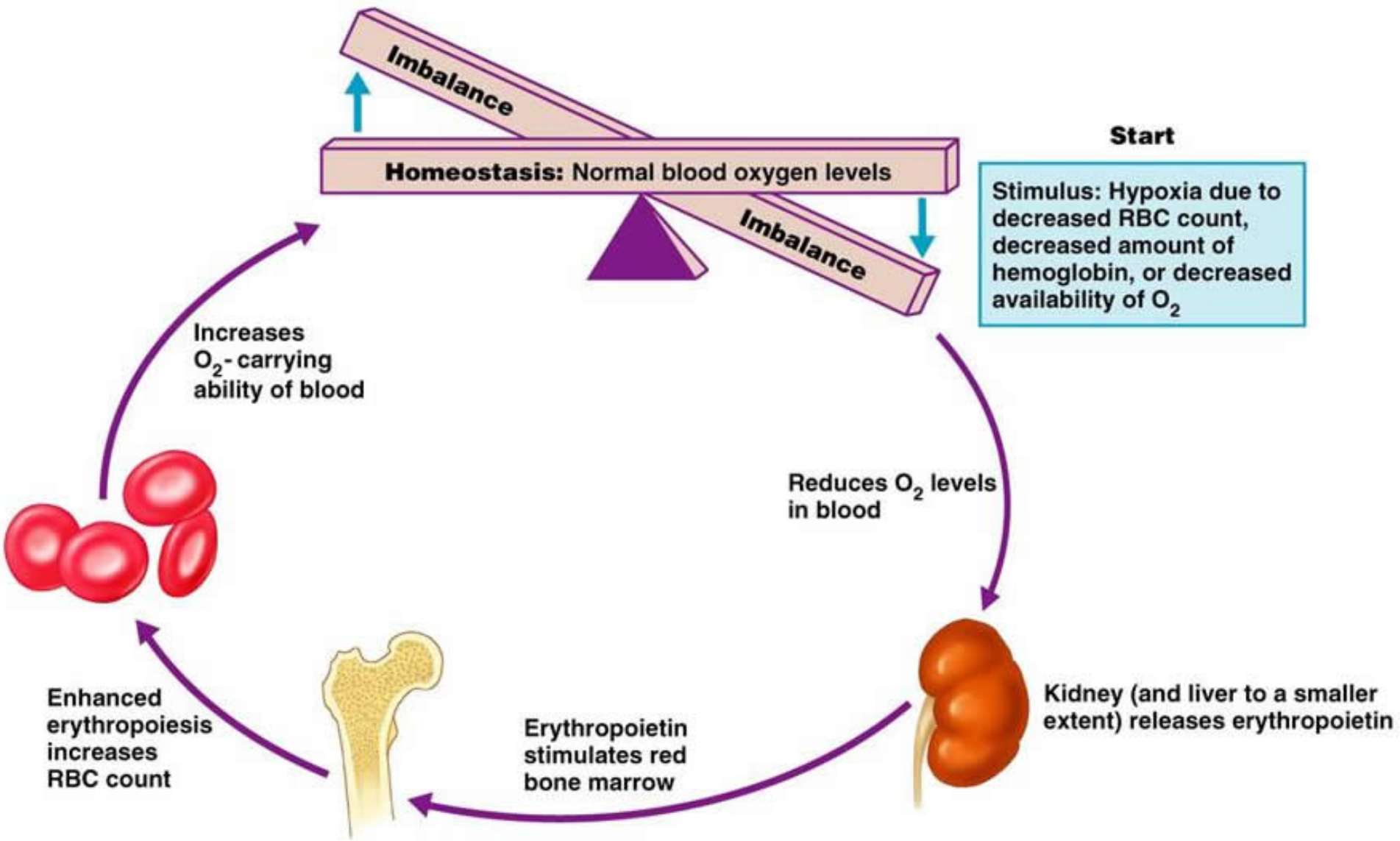
Fate of Erythrocyte

- Unable to divide, grow, or synthesize proteins. (?)
- Wear out in 100 to 120 days.
- When worn out, they are eliminated by phagocytes in the spleen and liver.
- Lost cells are replaced by division of hemocytoblast.

Control of Erythrocyte production

- Rate of production is controlled by a hormone called (erythropoietin).
- Kidneys produce most erythropoietin as a response to reduced oxygen levels in blood for any reason.
- Erythropoieten targets the bone marrow .

Hemeostasis (balance)



1. Composition and function of blood

Objectives:

- Indicate the composition and volume of whole blood.
- Describe the composition of plasma, and discuss its importance in the body.
- List the cell types making up the formed elements, and describe the major functions of each type.
- Explain the role of the hemocytoblast.

2. Hemostasis

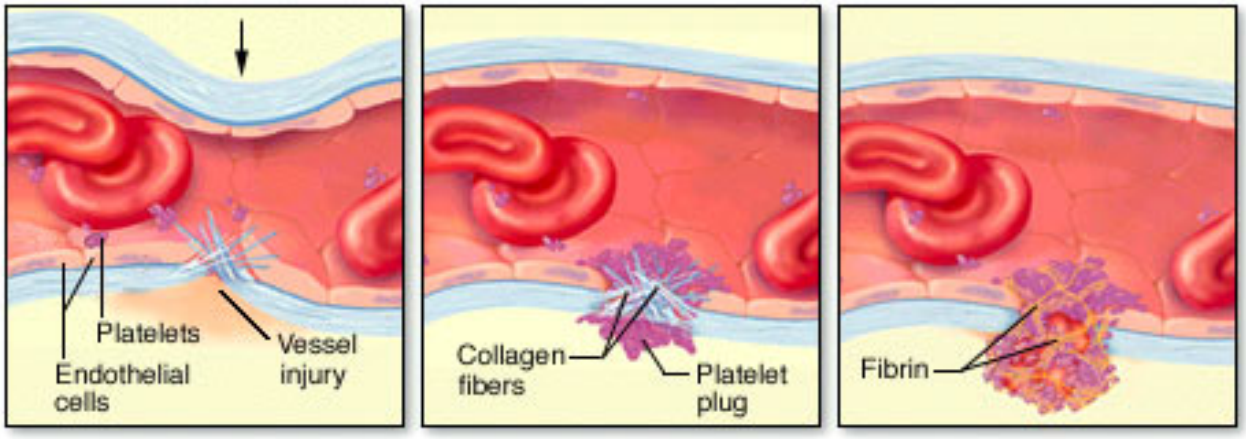
- Stoppage of blood flow when a blood vessel wall breaks.
- Fast and localized reaction.

Hemostasis involves three phases:

1) Platelet plug formation

2) Vascular spasms

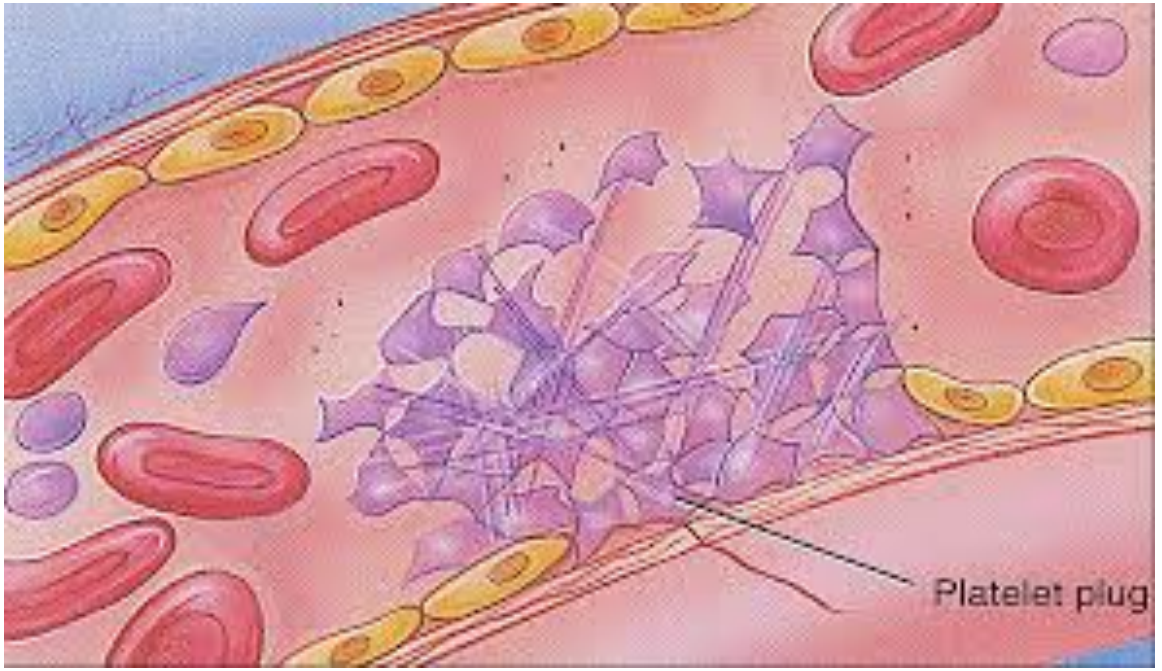
3) Coagulation (blood clot, fibrin clot)



1) Platelet plug formation

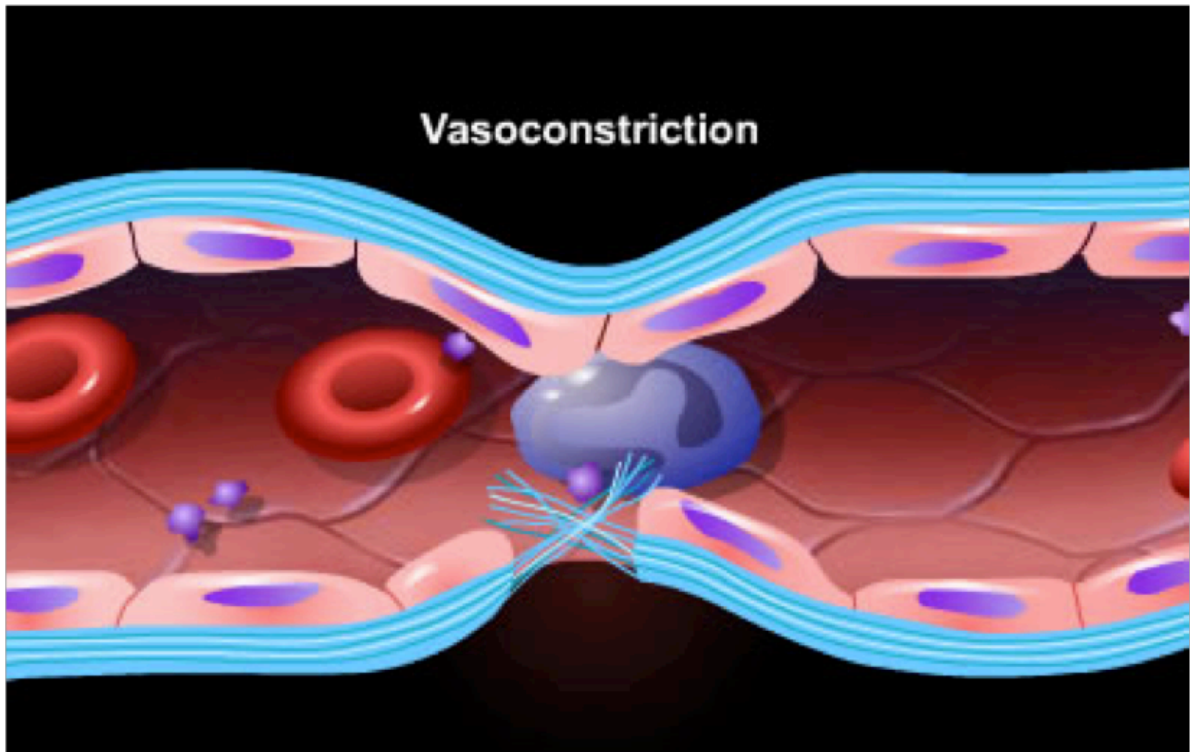
- Collagen fibers are exposed by a break in a BV.
- Platelets become “sticky” and cling to fibers (damaged site).
- Anchored platelets release chemicals to attract more platelets to the site.
- Platelets pile up to

Form a **platelet plug**.



2) Vascular Spasm

- Anchored platelets release serotonin which causes BV muscles to spasm.
- Spasms narrow the BV at that point decreasing blood loss until clotting occur.



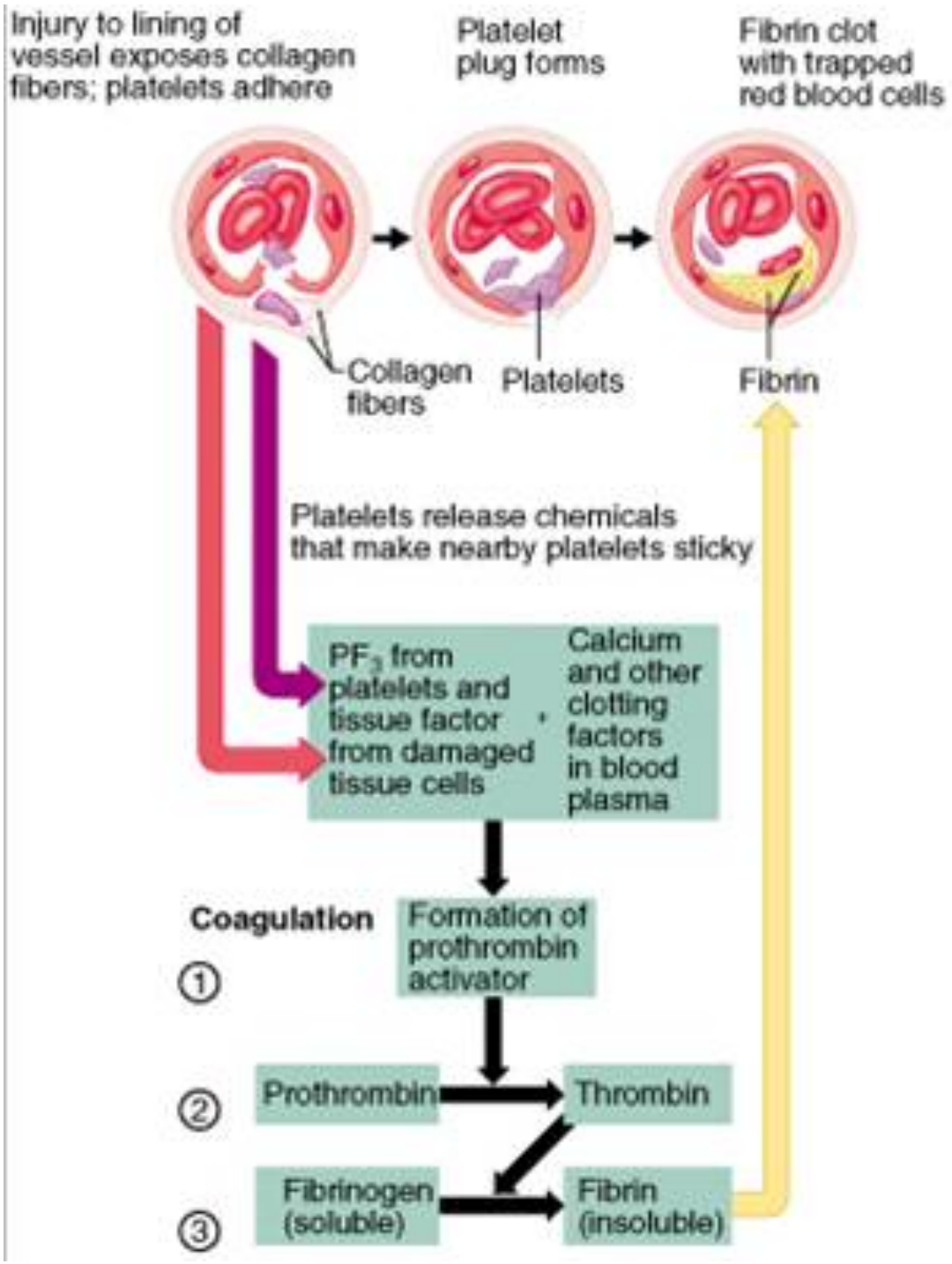
3) Coagulation

- Injured tissue tissue factor (TF).
- PF3 (a phospholipid) coating platelets interacts with TF, vitamin K, and other blood protein clotting factors, and calcium ions to form an activator that triggers the *clotting cascade.*
- Prothrombin activator converts prothrombin to thrombin (an enzyme).
- Thrombin joins soluble fibrinogen

into hair-like insoluble fibrin,

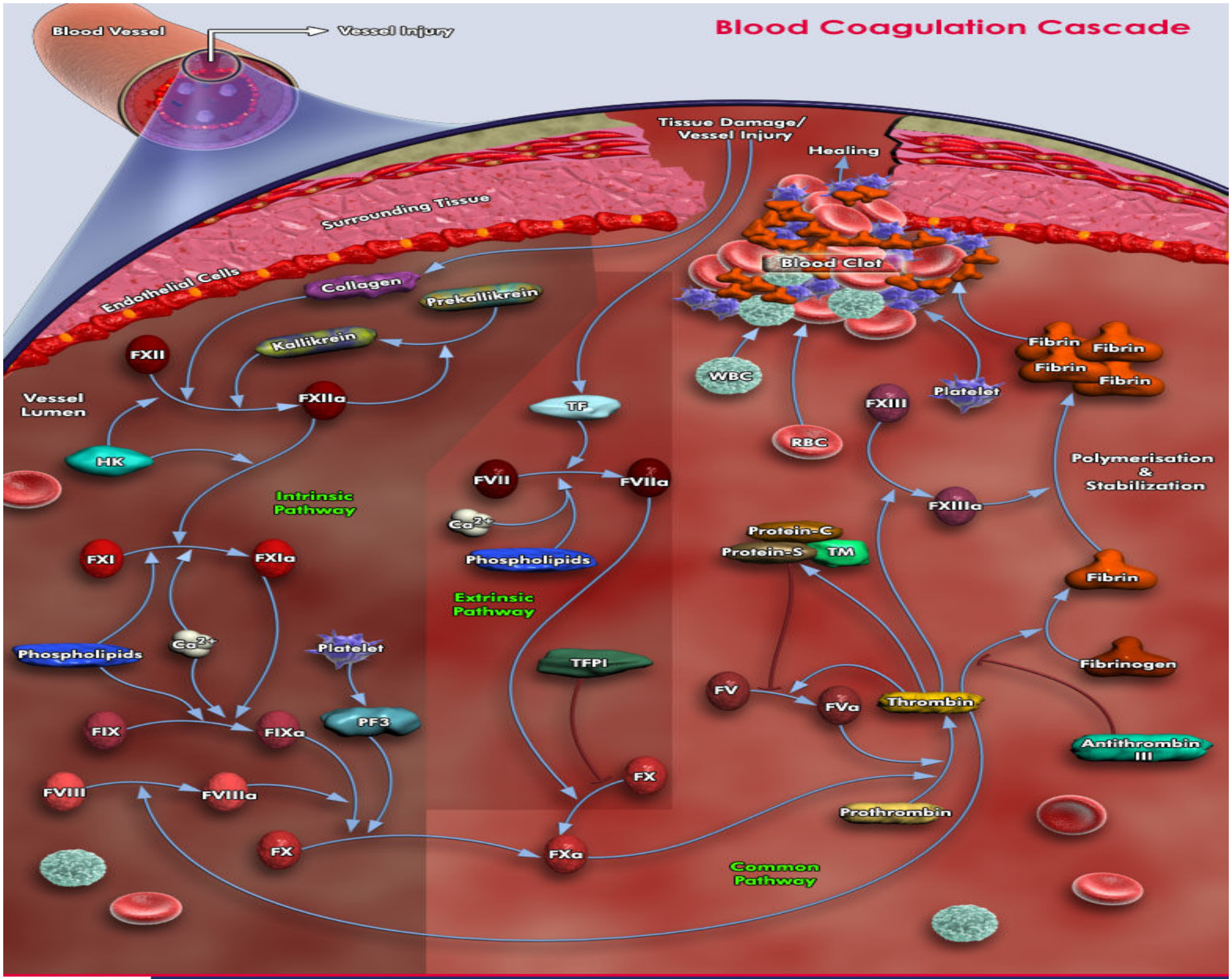
which forms a Meshwork that traps

the RBCs and forms the basis of the clot.


Injury to lining of vessel exposes collagen fibers; platelets adhere
Platelet plug forms
Fibrin clot with trapped red blood cells
Collagen fibers
Platelets
Fibrin
Platelets release chemicals that make nearby platelets sticky
PF3 from platelets and tissue factor from damaged tissue cells
+
Calcium and other clotting factors in blood plasma
Coagulation
Formation of prothrombin activator
1
Prothrombin
Thrombin
2
Fibrinogen (soluble)
Fibrin (insoluble)
3

Blood clotting

- Blood usually clots within 3-6 minutes.
- Once the clotting cascade has started, the triggering factors are rapidly inactivated to prevent widespread clotting.
- The clot remains as endothelium regenerates.
- The clot is broken down after tissue repair.


Blood Coagulation Cascade
Blood Vessel
Vessel Injury
Tissue Damage/
Vessel Injury
Healing
Surrounding Tissue
Endothelial Cells
Collagen
Prekallikrein
Kallikrein
FXII
FXIIa
Vessel
Lumen
HK
Intrinsic
Pathway
FXI
FXIa
Phospholipids
Ca2+
Platelet
PF3
FIX
FIXa
FVIII
FVIIIa
FX
FXa
TF
FVII
FVIIa
Ca2+
Phospholipids
Extrinsic
Pathway
TFPI
FX
Common
Pathway
Blood Clot
WBC
RBC
Platelet
FXIII
FXIIIa
Fibrin
Fibrin
Fibrin
Fibrin
Polymerisation
&
Stabilization
Protein-C
Protein-S
TM
FV
FVa
Thrombin
Prothrombin
Fibrin
Fibrinogen
Antithrombin
III

Undesirable clotting

- Thrombus:

A clot in an unbroken BV. Can be deadly in areas like the heart.

- Embolus:

A thrombus that breaks away and floats freely in the bloodstream. Can later clog vessels in critical areas such as the brain

2. Hemostasis

Objectives:

- Describe the blood clotting process.