

HUMAN PHYSIOLOGY Chapter 3

Blood

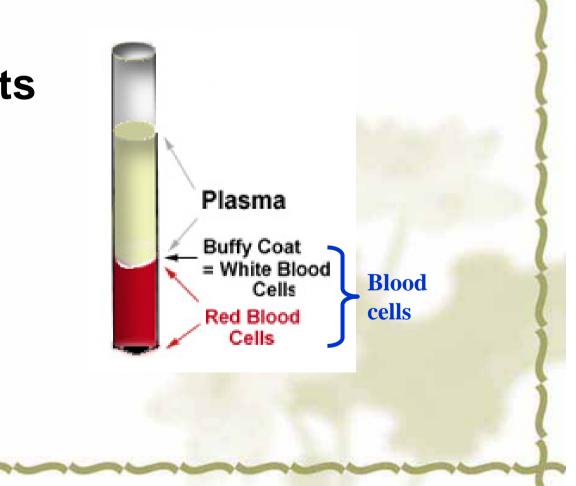
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Functions of blood

- Transportation (gases, nutrients, hormones, wastes)
- Regulation (pH, fluid and ion balance, thermoregulation)
- Protection (immune response, clotting)

Components of blood

PlasmaFormed elements



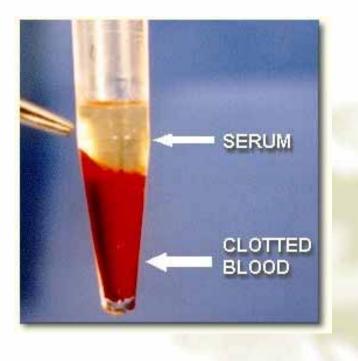
Plasma

mostly water (90% by volume)
proteins (8% by weight)
small solutes: electrolytes, lactic acid, urea

Plasma proteins

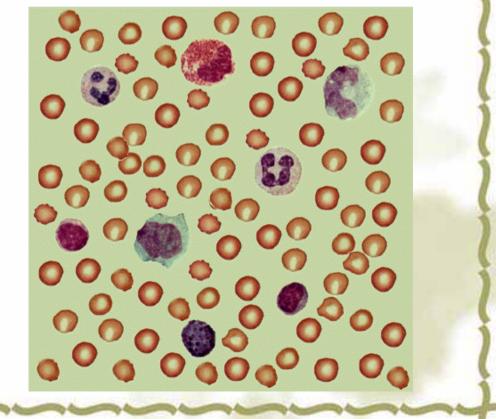
- Albumins (60-80% of plasma proteins)
 - transport
 - maintenance of osmotic balance
- Globulins (α-, β-, γ-)
 - transport of materials through the blood
 - clotting factors
- Fibrinogen
 - important in clotting

Difference between serum and plasma Serum is plasma from which fibrinogen and other proteins involved in clotting have been removed as a result of clotting

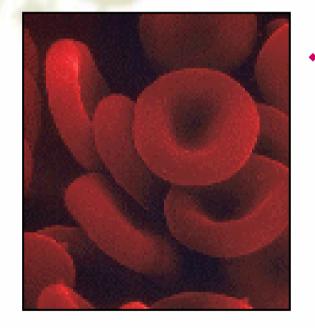


Formed elements

- Red Blood Cells (RBC)
- White Blood Cells (WBC)
- Platelets

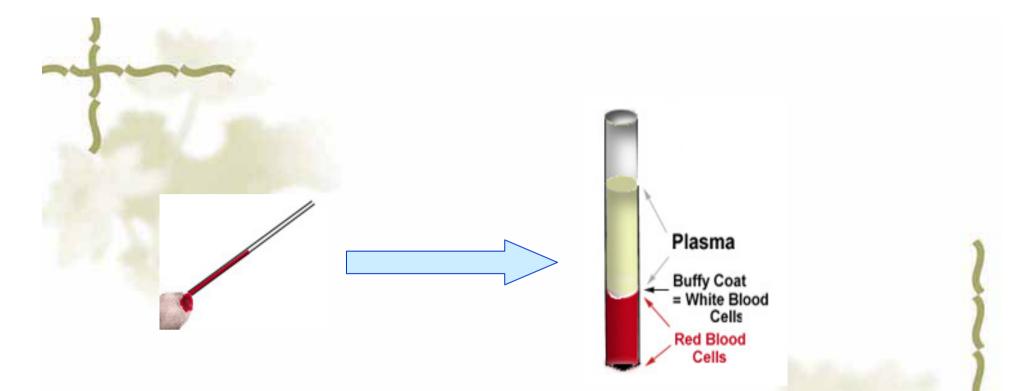


Red blood cells (Erythrocytes)



♦ RBC count
 M: 4.5~5.5 × 10¹²/L

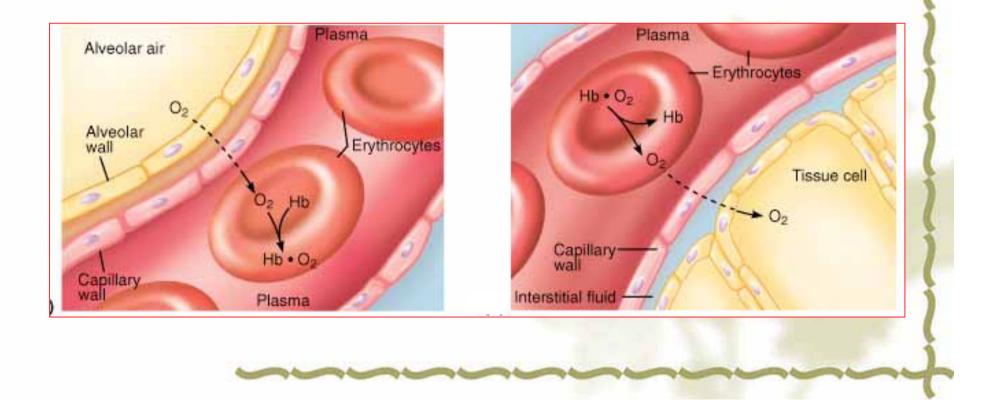
 F: 3.8~4.6 × 10¹²/L



 Hematocrit: the volume of red blood cells as a percentage of centrifuged whole blood
 M: 45%
 F: 42%

Functions

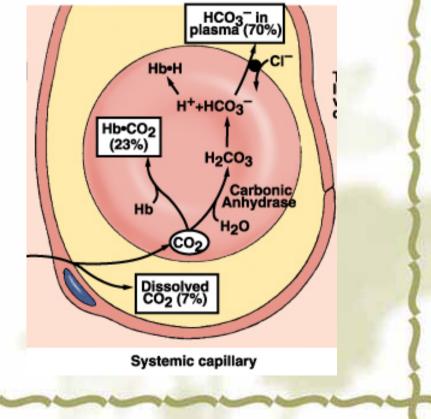
1. Transport of O₂ and CO₂



Hemoglobin is essential for the transport of O₂
Hemoglobin concentration
M: 16 g/dL
F: 14 g/dL

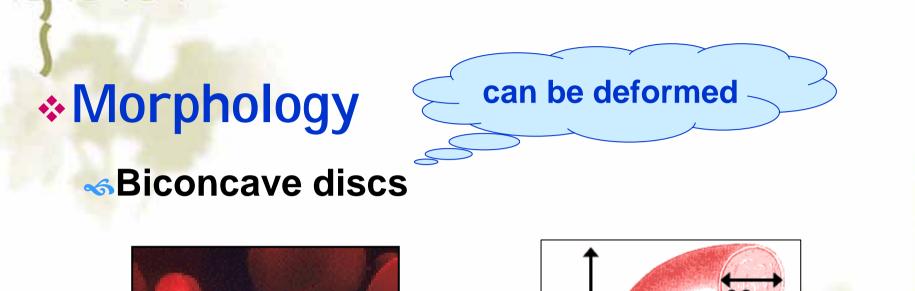
Fe²⁻

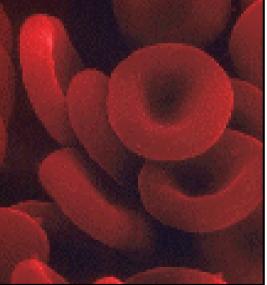
Carbonic anhydrase is critical for transport of CO₂

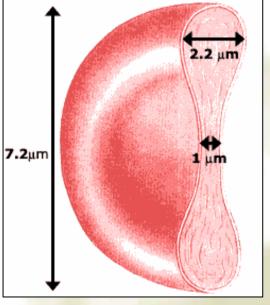


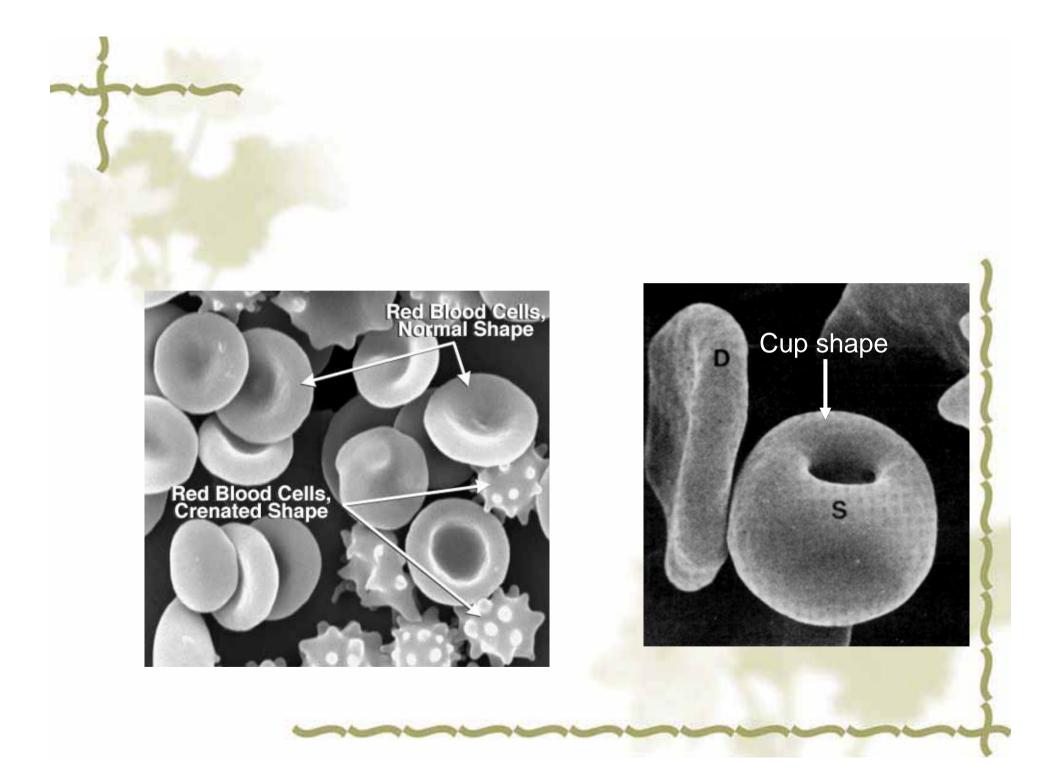
Functions

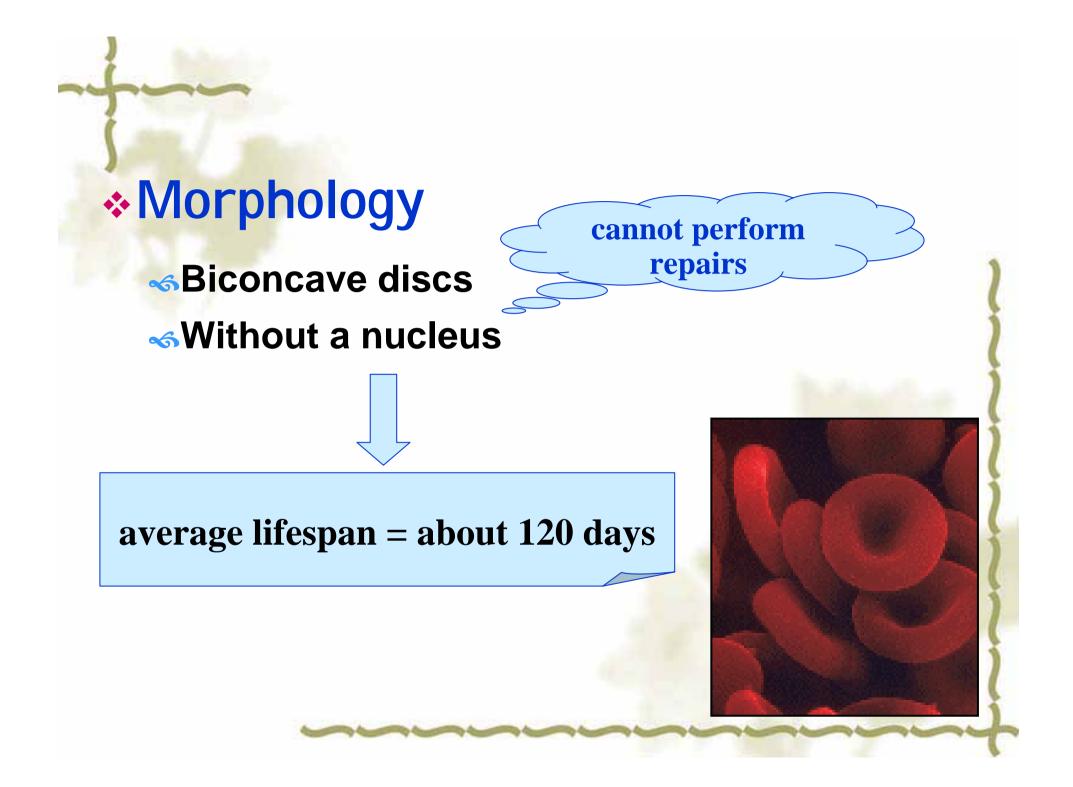
- **1. Transport of O₂ and CO₂**
- 2. Buffering: hemoglobin











Morphology Biconcave discs Without a nucleus Without mitochondria

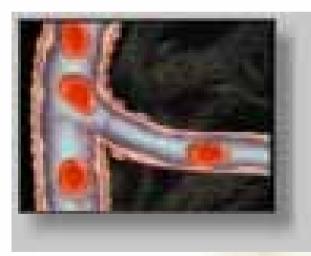
anaerobic metabolism



Properties of erythrocytes

1. Permeability

2. Deformability



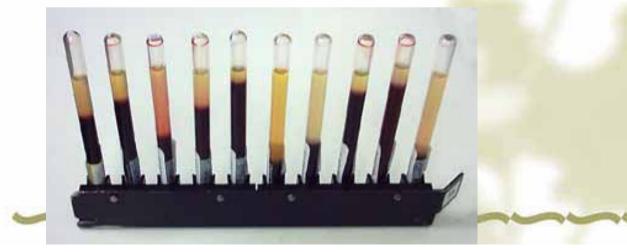
See video: Deformability of Erythrocytes

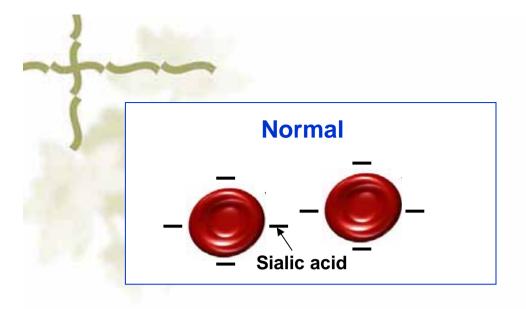
3. Suspension stability

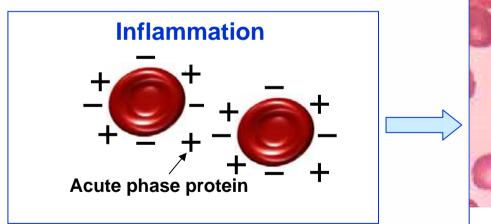
Erythrocyte Sedimentation Rate (ESR): the distance that red blood cells settle in a tube of blood in one hour

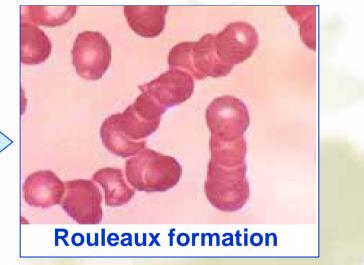
Normal values:

- M: less than 15 mm/h
- F: less than 20 mm/h





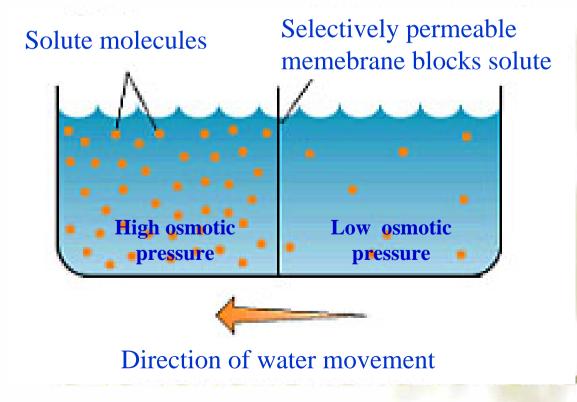




4. Osmotic fragility

* the susceptibility of a red blood cell to break apart when exposed to saline solutions of a lower osmotic pressure than that of the plasma

Osmotic Pressure: ability of a fluid to hold or attract water



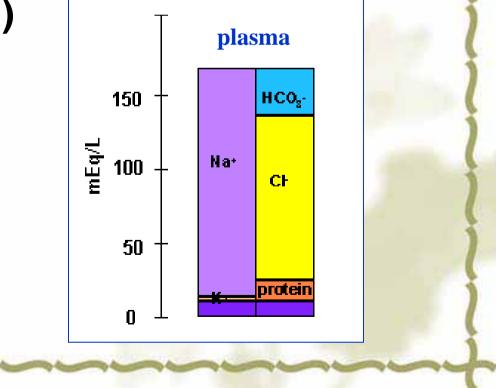
 Osmotic pressure depends only on the number of solute molecules or ions, NOT on their chemical composition and size
 1M glucose=1 Osm
 1M NaCl =2 Osm



Crystalloid Osmotic Pressure

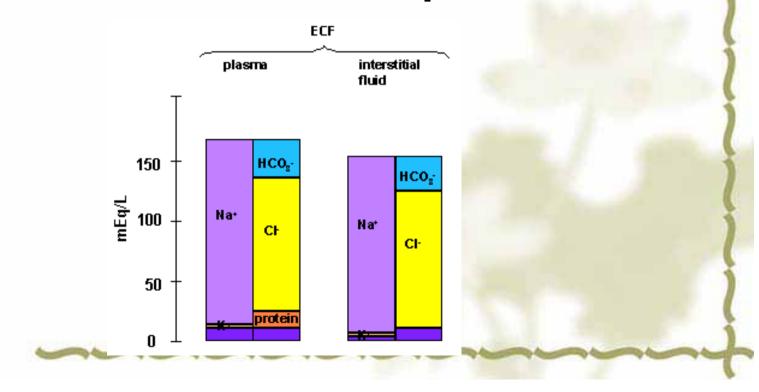
Colloid Osmotic Pressure (0.5% of the total)

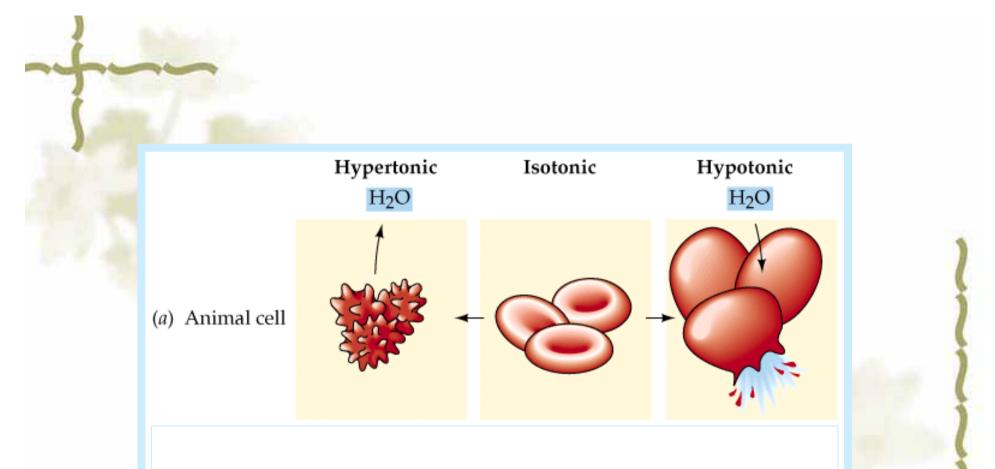
osmotic pressure)



Crystalloid Osmotic Pressure: important in maintaining fluid balance across cell membranes

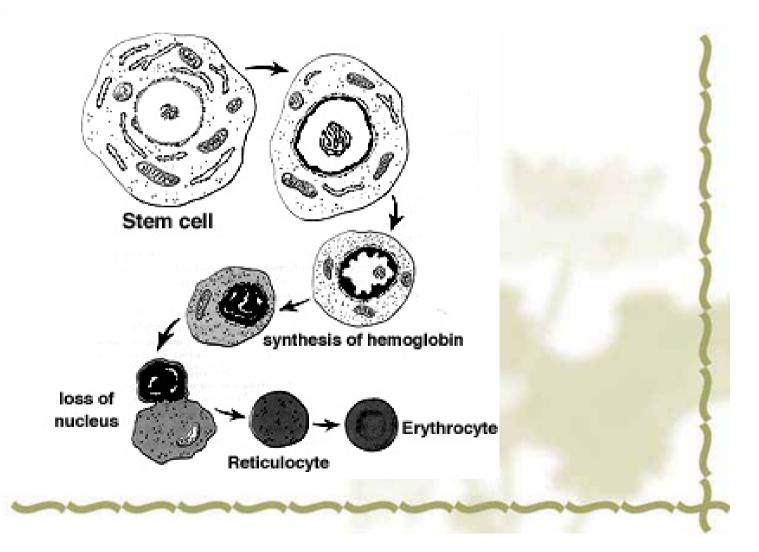
 Colloid Osmotic Pressure: important in fluid transfer across capillaries





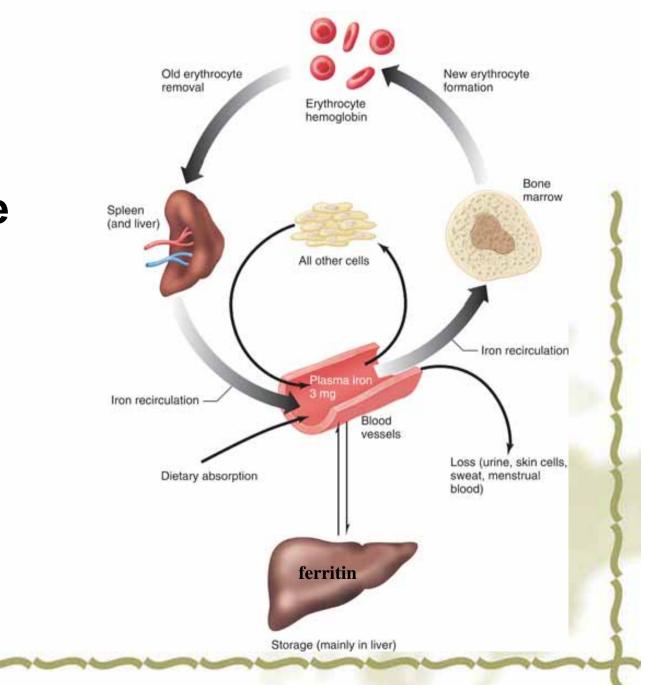
Only substances which act as impermeant molecules can be used to make isotonic solutions

Production of RBC (Erythropoiesis)



Nutritional Requirements for Erythropoiesis
 Protein
 Folic acid, VitB₁₂
 Iron
 Vitamin C

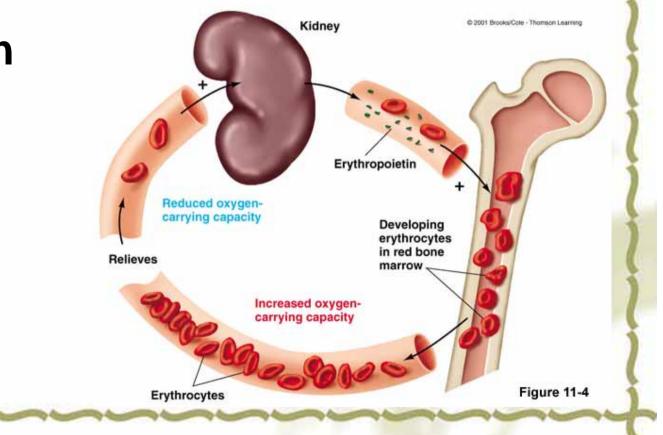
Iron balance



Regulation of Erythropoiesis

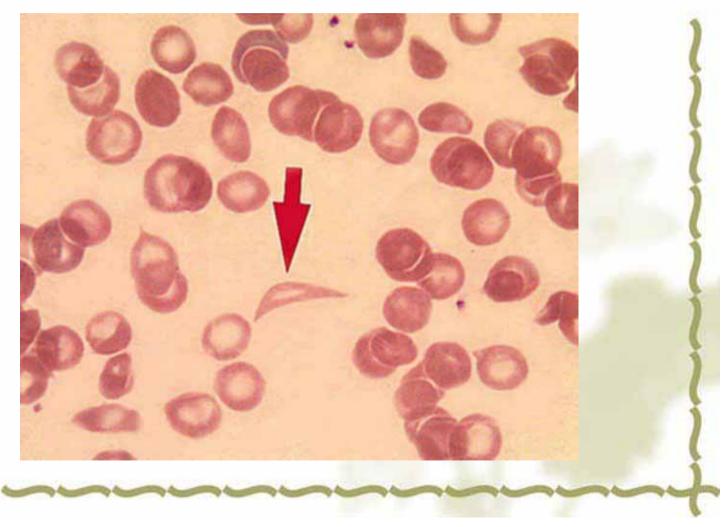
1. Erythropoietin

2. Androgen



 Anaemia: a reduction in the ability of the blood to carry oxygen
 Deficiency of iron
 Defective production of erythropoietin
 Hemorrhage
 Mutation in hemoglobin

Sickle-cell anemia



White blood cells (Leukocytes)

Types of WBC

Polymorphonuclear granulocytes Monocytes Lymphocytes Neutrophils Eosinophils Basophils Image: Strain			Leukocyte	S	
Neutrophils Eosinophils Basophils Image: Second Action of the	Polymorphonuclear granulocytes			Monocytes	Lymphocytes
	Neutrophils	Eosinophils	Basophils		

WBC count

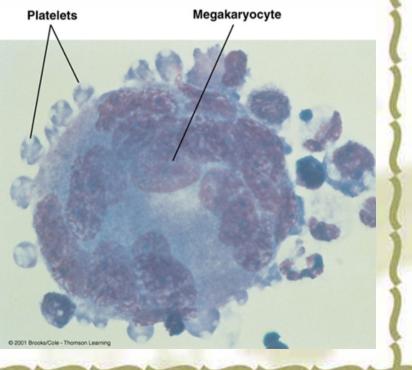
Total leukocytes = 7000 per mm³ of blood Percent of total leukocytes: Polymorphonuclear granulocytes Neutrophils 50–70% Eosinophils 1–4% Basophils 0.1–0.3% Monocytes 2–8% Lymphocytes 20–40%

Functions of WBC

- Neutrophils, eosinophils, basophils, and monocytes contribute to the body's *nonspecific defenses*
- <u>Lymphocytes</u> are responsible for *specific defenses*

Platelets (Thrombocytes)

Formed in the bone marrow from cells called megakaryocytes

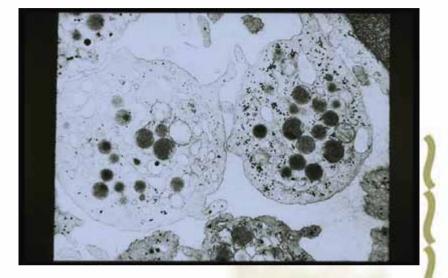


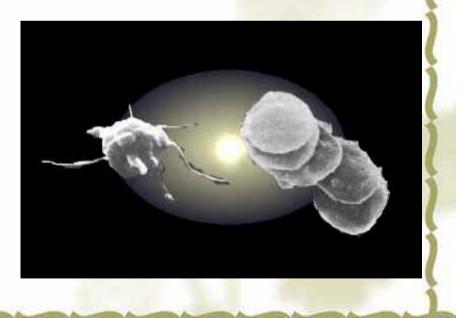
Platelets (Thrombocytes)

• normal value: (150~350) x 10⁹/L
 • Average lifespan=7~14 days

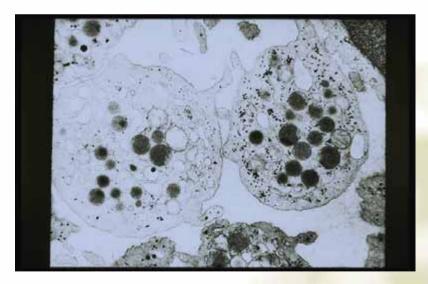
Platelets

 Morphology
 without a nucleus
 contain numerous
 granules
 contain actin and myosin





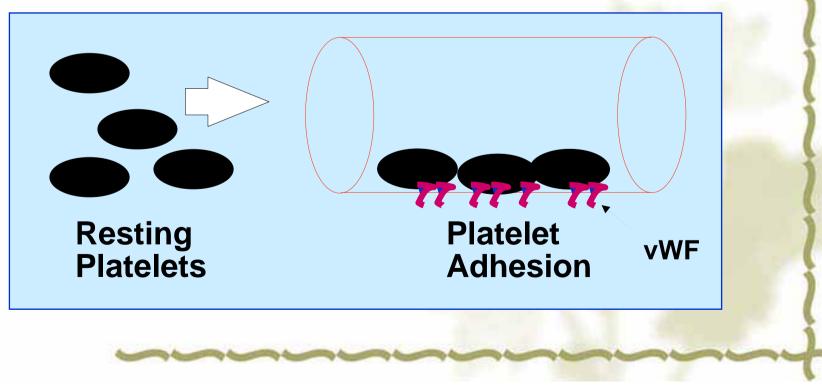
Function of platelets Play an important role in hemostasis

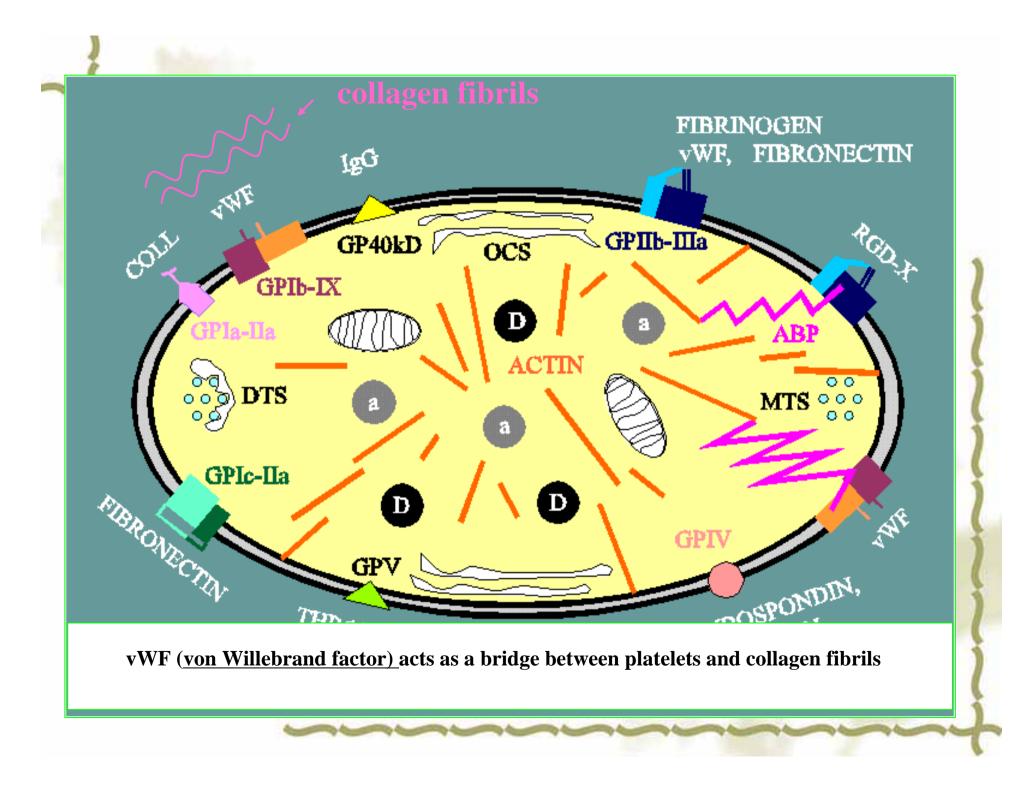


Physiological properties of platelets

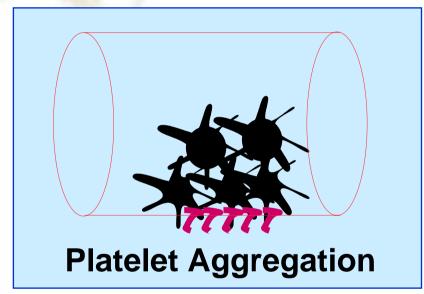
1. Adhesion:

Platelets adhere to the vessel wall at the site of injury





2. Aggregation



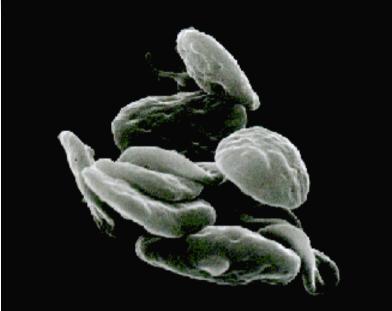
 Platelets stick to each other at the site of injury

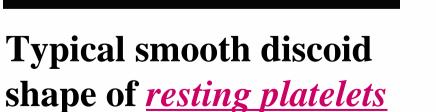
 Activation of platelets is required

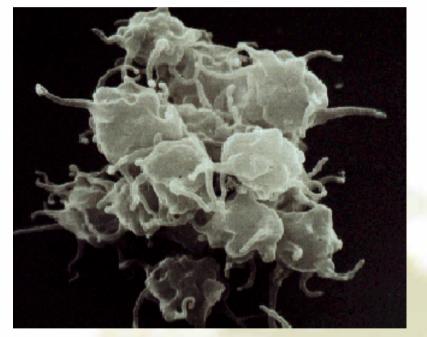
Platelet activator

- 1. Thrombin
- 2. Collagen
- **3.** Thromboxane A₂ (TXA₂)
- 4. Adenosine diphosphate (ADP)

Platelet Activation shape changed

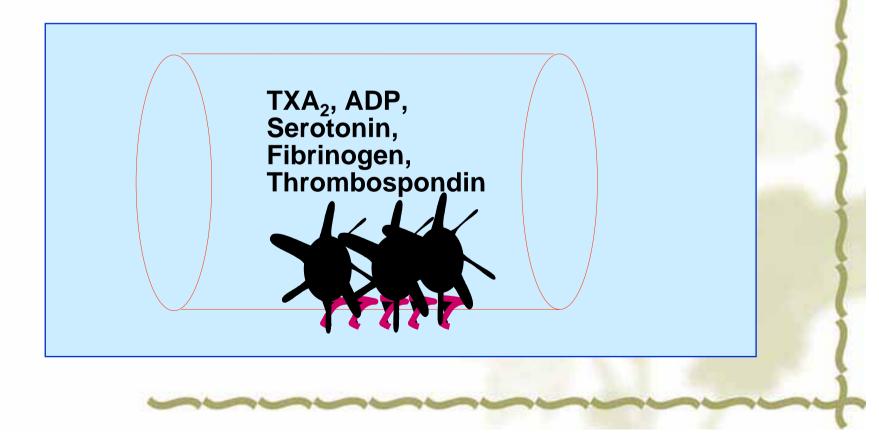




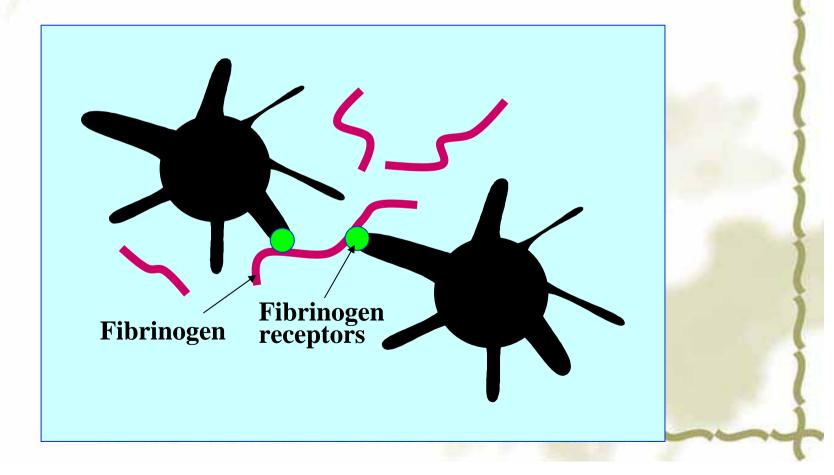


Typical spiny spheric shape of *activated platelets*

Platelet Activation shape changed release secondary platelet agonists



Mechanism of aggregation Fibrinogen receptors are activated and allow platelets to become cross-linked by fibrinogen



3. Contractile property

- * <u>Contractile proteins</u> largely consist of myosin and actin filaments
- Compression and strengthening of the platelet plug

Summary

- Terms:

 - Colloid osmotic pressure
 - Service sedimentation rate
 - Erythropoietin
- Summarize the functions of red blood cells
- Describe the physiological properties of platelets