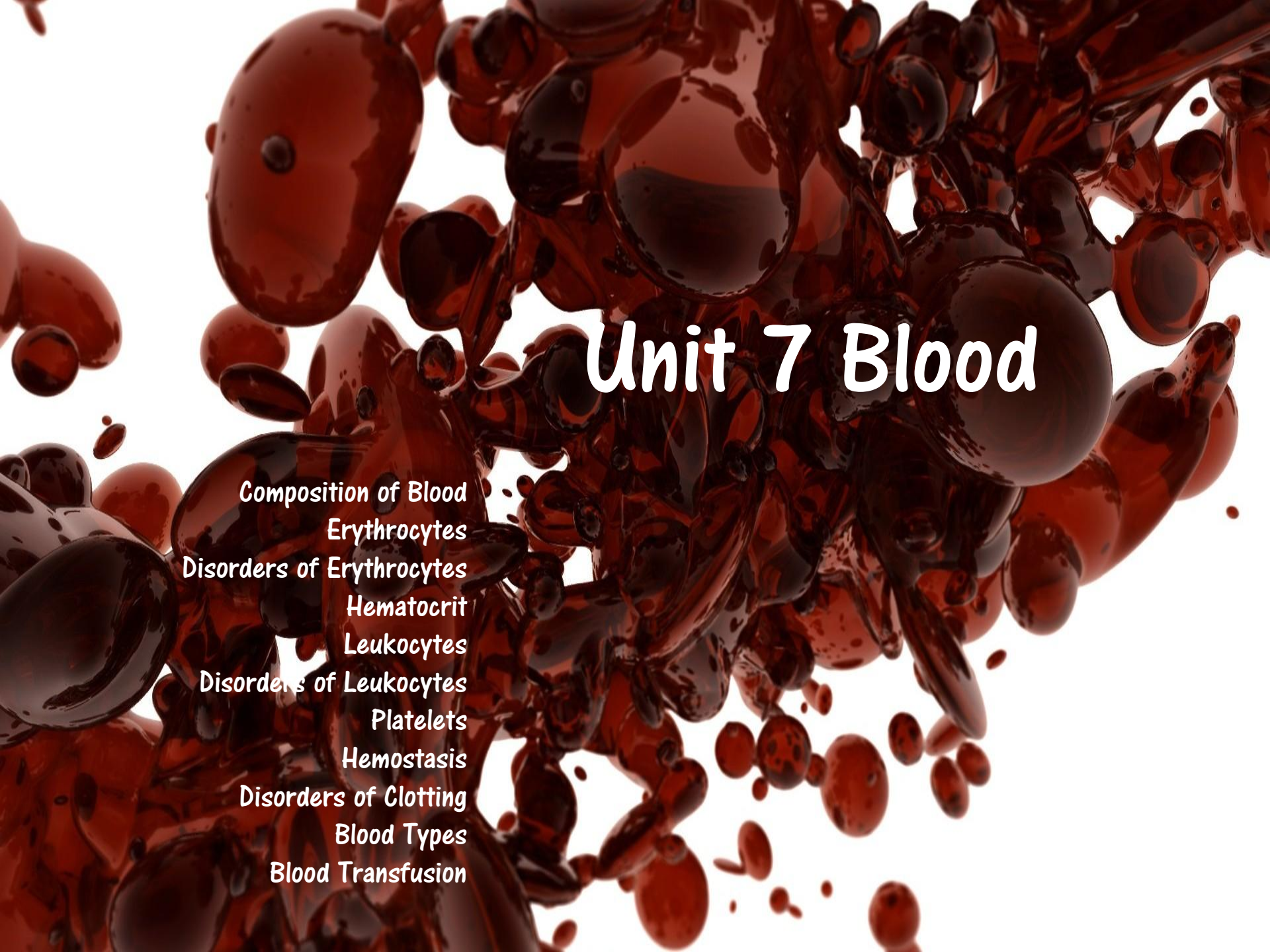


Unit 7 Blood

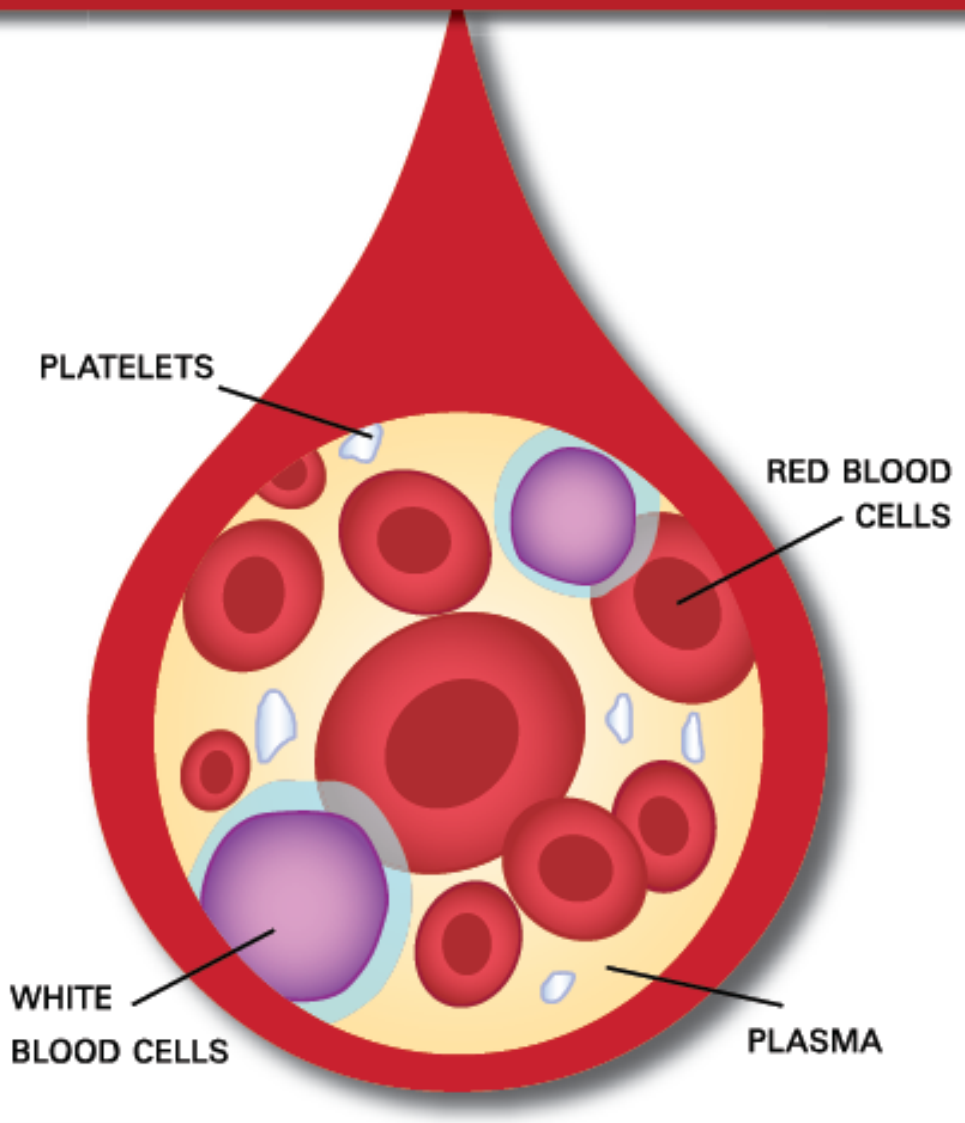
Composition of Blood
Erythrocytes
Disorders of Erythrocytes
Hematocrit
Leukocytes
Disorders of Leukocytes
Platelets
Hemostasis
Disorders of Clotting
Blood Types
Blood Transfusion

AN *Incredible* MACHINE

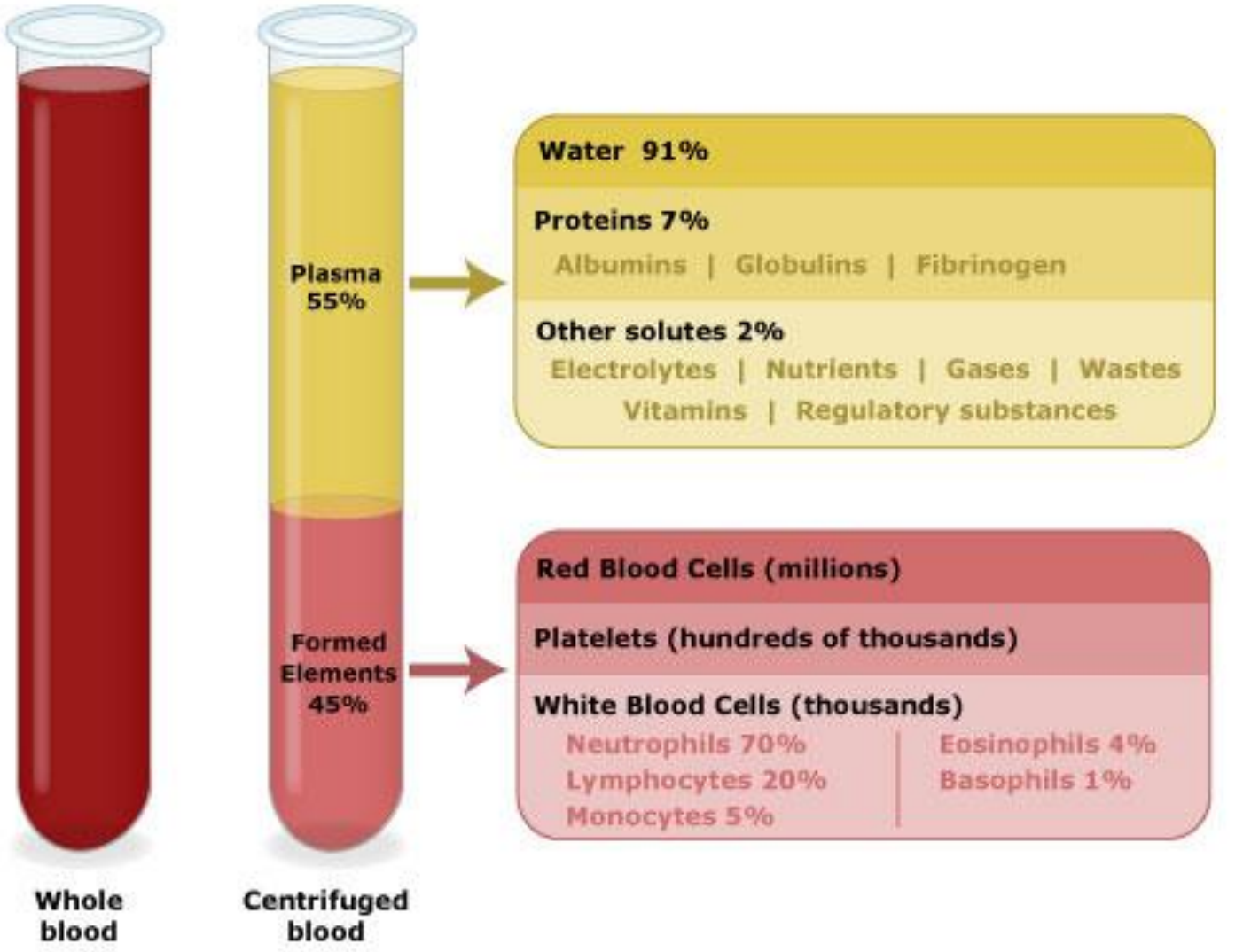
WHAT *is* BLOOD?

BLOOD IS COMPOSED *of* TISSUE CELLS & PLASMA

IT IS **80% WATER, 20% SOLID.**



Composition of Blood



BLOOD CONTAINS 3 TYPES of CELLS

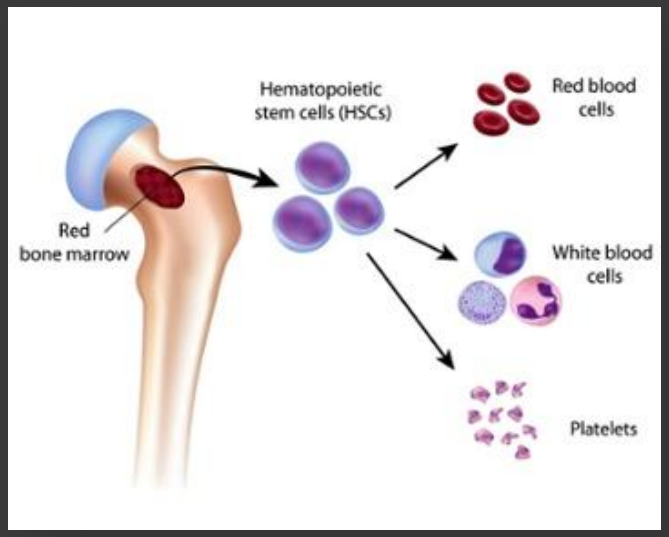
PLATELETS (THROMBOCYTES) 1
HELP BLOOD CLOT

RED BLOOD CELLS (ERYTHROCYTES) 2
CARRY OXYGEN THROUGHOUT THE BODY

WHITE BLOOD CELLS (LEUKOCYTES) 3
HELP FIGHT INFECTION

Component and % of blood	Subcomponent and % of component	Type and % (where appropriate)	Site of production	Major function(s)
Plasma 46–63 percent	Water 92 percent	Fluid	Absorbed by intestinal tract or produced by metabolism	Transport medium
	Plasma proteins 7 percent	Albumin 54–60 percent	Liver	Maintain osmotic concentration, transport lipid molecules
		Globulins 35–38 percent	Alpha globulins—liver	Transport, maintain osmotic concentration
			Beta globulins—liver	Transport, maintain osmotic concentration
			Gamma globulins (immunoglobulins)—plasma cells	Immune responses
		Fibrinogen 4–7 percent	Liver	Blood clotting in hemostasis
	Regulatory proteins <1 percent	Hormones and enzymes	Various sources	Regulate various body functions
	Other solutes 1 percent	Nutrients, gases, and wastes	Absorbed by intestinal tract, exchanged in respiratory system, or produced by cells	Numerous and varied
Formed elements 37–54 percent	Erythrocytes 99 percent	Erythrocytes	Red bone marrow	Transport gases, primarily oxygen and some carbon dioxide
	Leukocytes <1 percent	Granular leukocytes: neutrophils eosinophils basophils	Red bone marrow	Nonspecific immunity
	Platelets <1 percent	Agranular leukocytes: lymphocytes monocytes	Lymphocytes: bone marrow and lymphatic tissue	Lymphocytes: specific immunity
			Monocytes: red bone marrow	Monocytes: nonspecific immunity
	Platelets <1 percent		Megakaryocytes: red bone marrow	Hemostasis

Red Marrow: Hematopoietic



Yellow Marrow: Fat, Cartilage,
Bone Formation

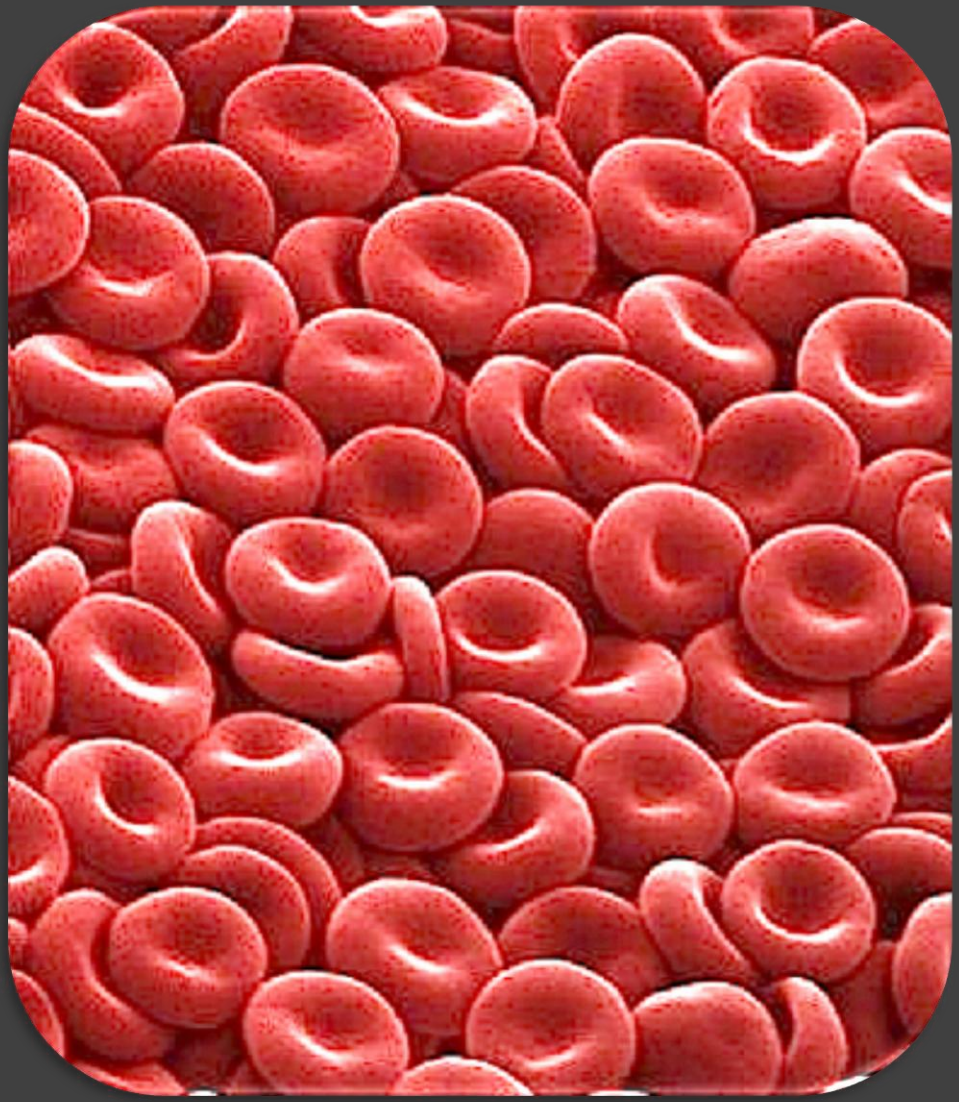
That's a lot of Blood!

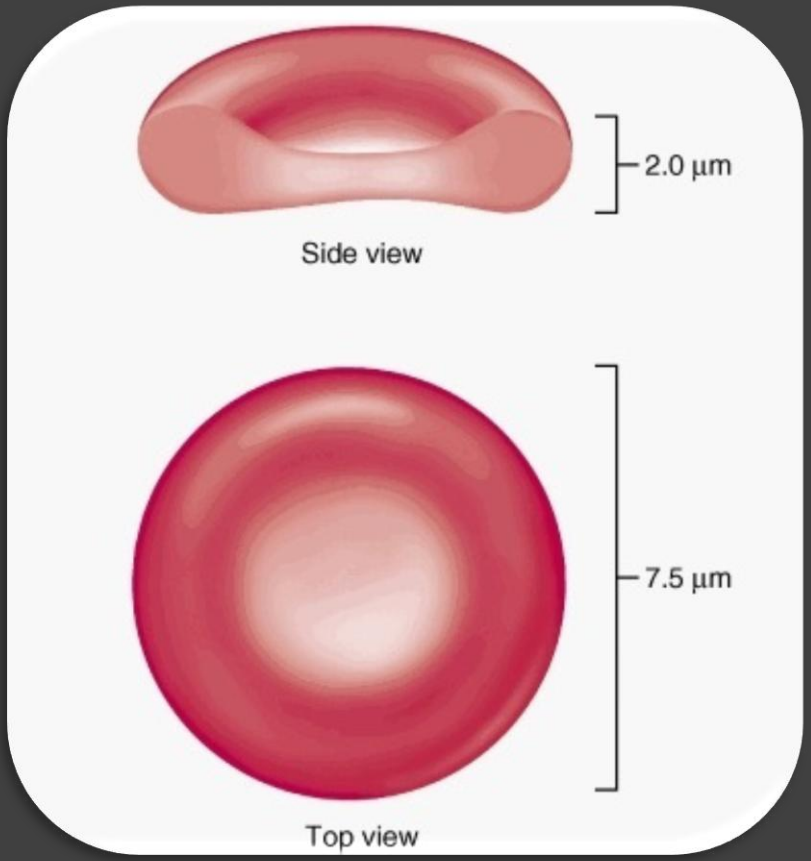
9 Venti's and 1 Grande

Analysis

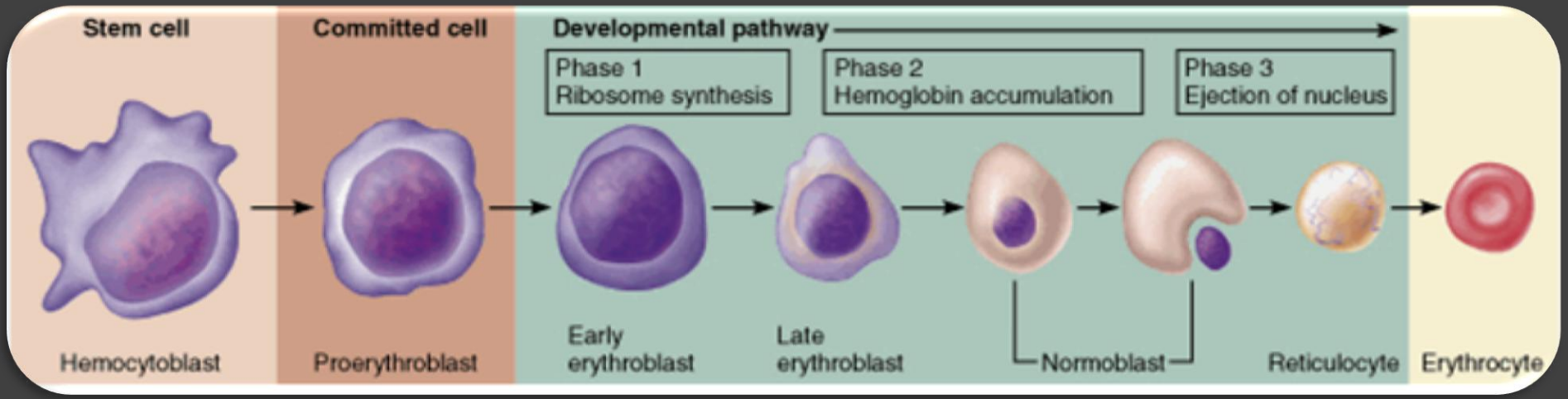
- What two components make up whole blood?
- What is the anatomical term for the formed elements (cells/cell-origin)?
- What is the function of the following in the blood?
  - Water
  - Plasma Proteins
  - Erythrocytes
  - Platelets
- What type(s) of Leukocytes have non-specific immunity?
- What type(s) of Leukocytes have specific immunity?
- Approximately how much blood is in the average human body?
- Name two reasons for higher blood volume?
- Where are Erythrocytes and Leukocytes made in the body?

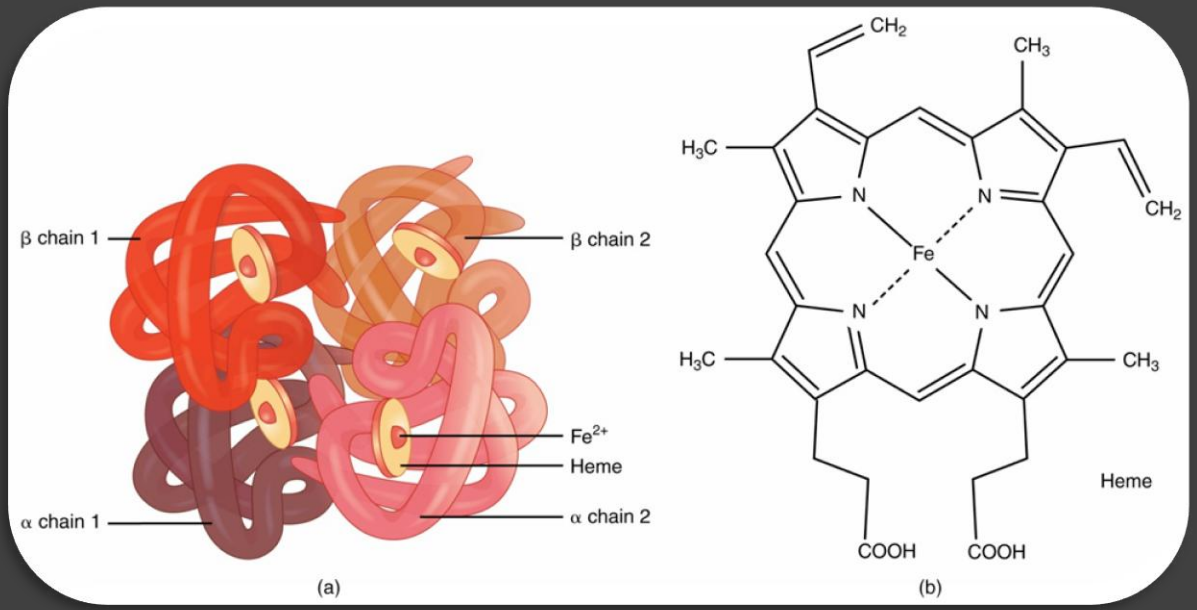
Erythrocytes

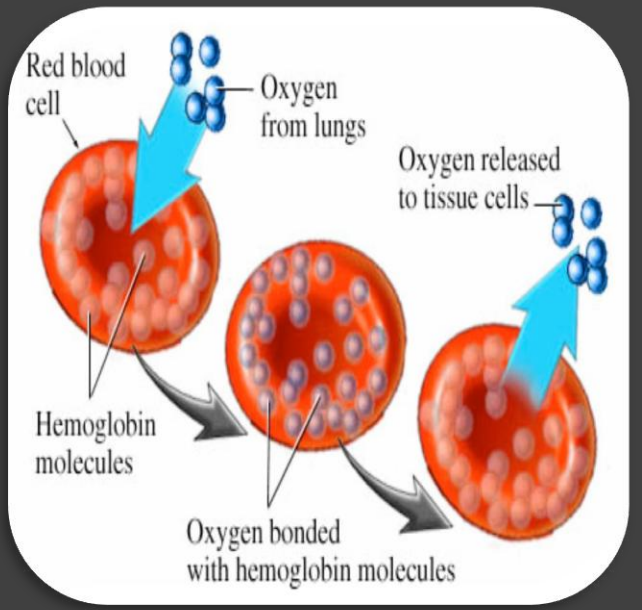




Erythrocytes Development

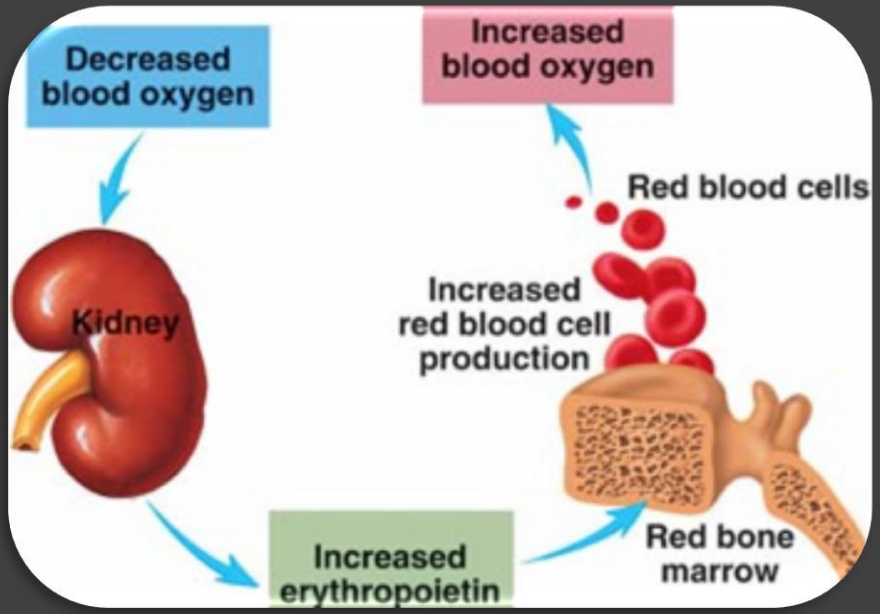


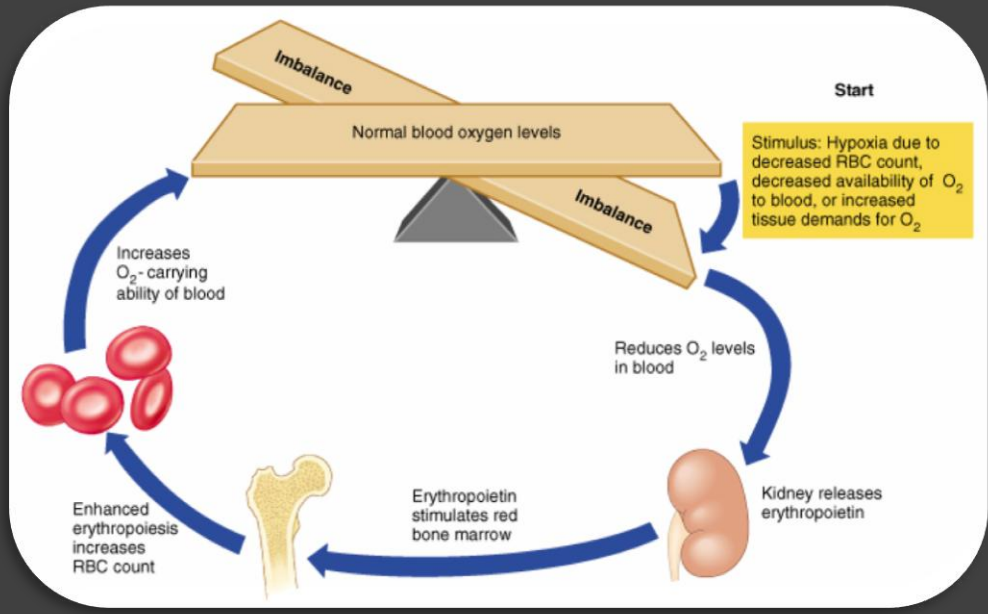




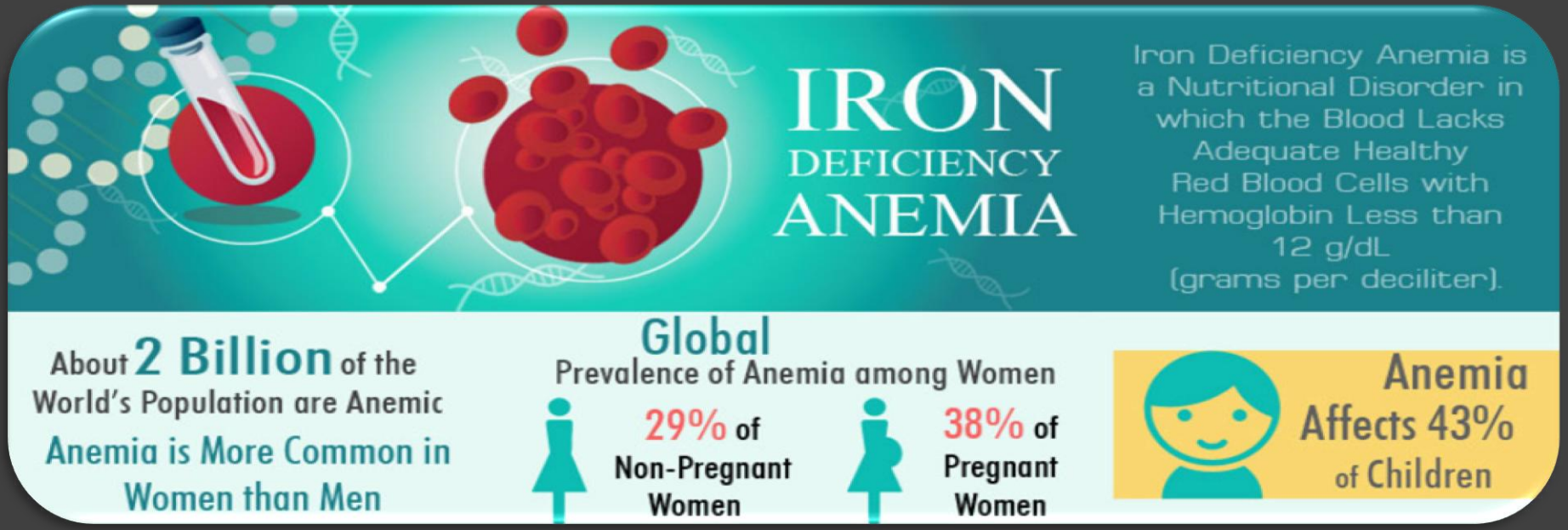
Erythrocytes

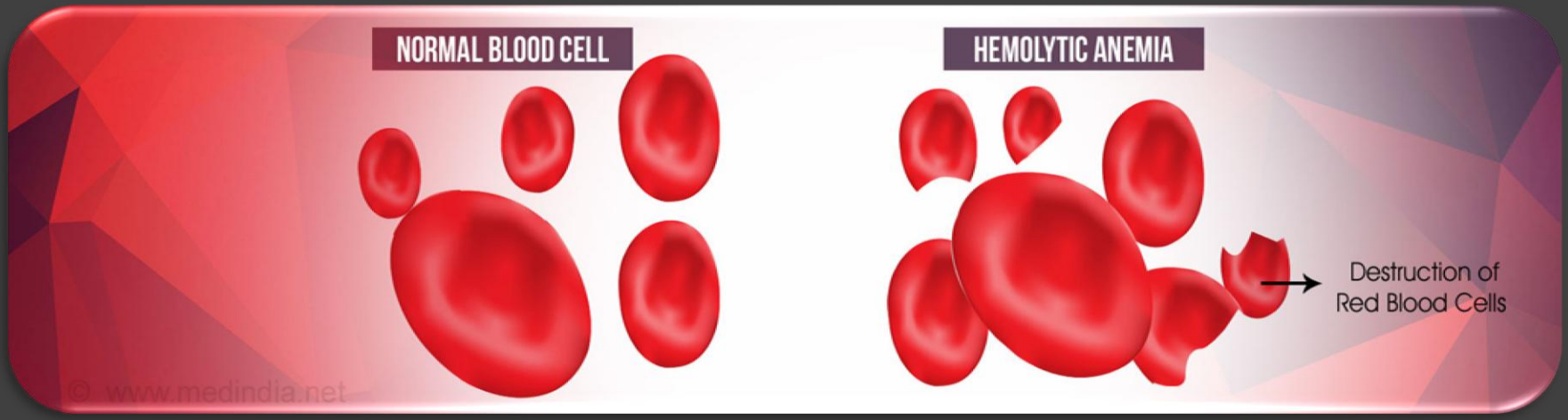
Formed element	Major subtypes	Numbers present per microliter (μL) and mean (range)	Appearance in a standard blood smear	Summary of functions	Comments
Erythrocytes (red blood cells)		5.2 million (4.4–6.0 million)	Flattened biconcave disk; no nucleus; pale red color	Transport oxygen and some carbon dioxide between tissues and lungs	Lifespan of approximately 120 days





Polycythemia vs. Anemia



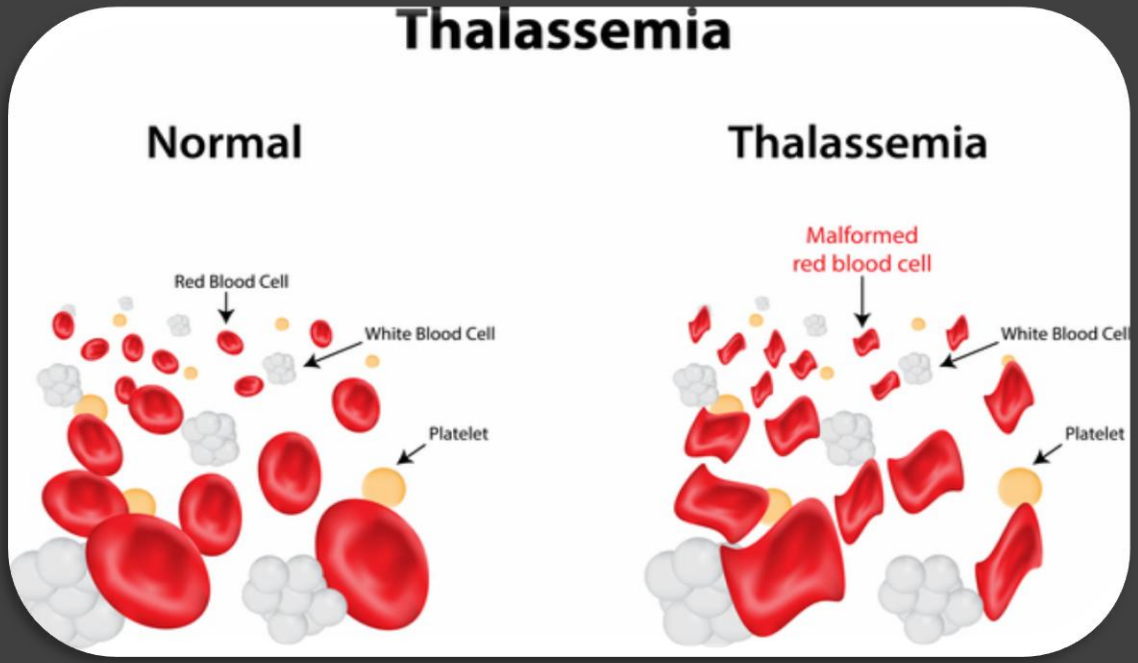


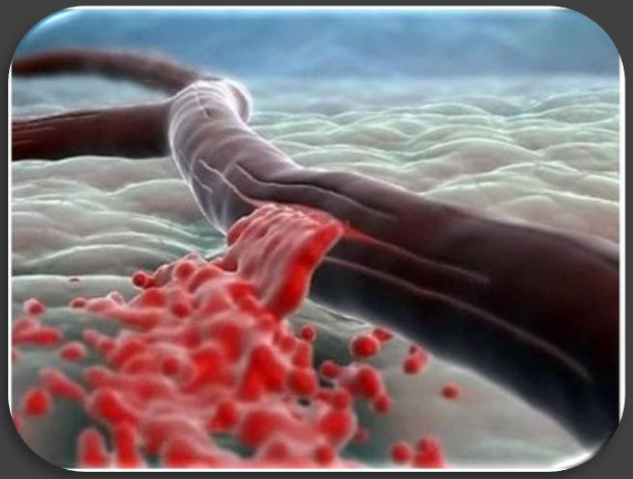
SICKLE CELL TRAIT

WHAT IS SICKLE CELL TRAIT?

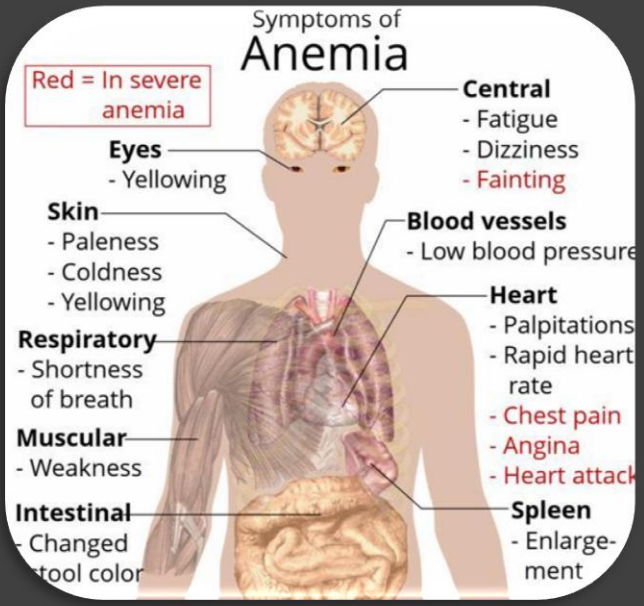
Sickle cell trait is not a disease. Sickle cell trait is the inheritance of one gene for sickle hemoglobin and one for normal hemoglobin. Sickle cell trait will not turn into the disease. Sickle cell trait is a life-long condition that will not change over time.

- During intense exercise, red blood cells containing the sickle hemoglobin can change shape from round to quarter-moon, or "sickle."
- Sickled red cells may accumulate in the bloodstream during intense exercise, blocking normal blood flow to the tissues and muscles.
- During intense exercise, athletes with sickle cell trait have experienced significant physical distress, collapsed and even died.
- Heat, dehydration, altitude and asthma can increase the risk for and worsen complications associated with sickle cell trait, even when exercise is not intense.
- Athletes with sickle cell trait should not be excluded from participation as precautions can be put into place.

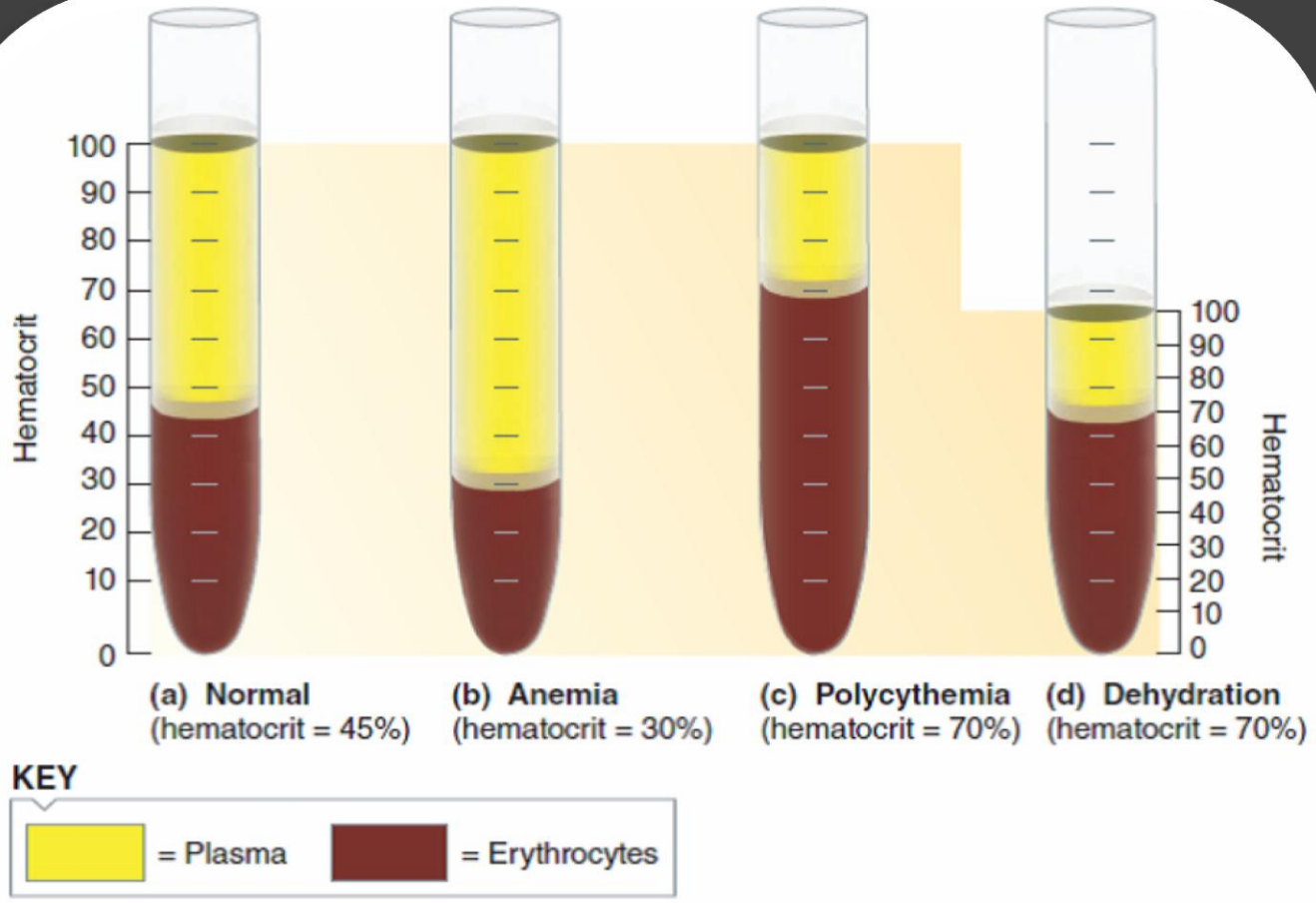




Hemorrhagic Anemia



Determining Hematocrit



› **Figure 11-5 Hematocrit under various circumstances.** (a) Normal hematocrit. (b) The hematocrit is lower than normal in anemia because of too few circulating erythrocytes. (c) The hematocrit is above normal in polycythemia because of excess circulating erythrocytes. (d) The hematocrit can also be elevated in dehydration when the normal number of circulating erythrocytes is concentrated in a reduced plasma volume.

Range of Normal Hematocrit Levels

- Newborn 55%-68%
- 1 Month 37%-49%
- 1 Year 29%-41%
- Ten Years 36%-40%
- Adult Males 42%-54%
- Adult Males High Altitude 45-61%
- Adult Women 38%-46%
- Adult Women High Altitude 41%-56%
- Adult Pregnant Women 31%-41%

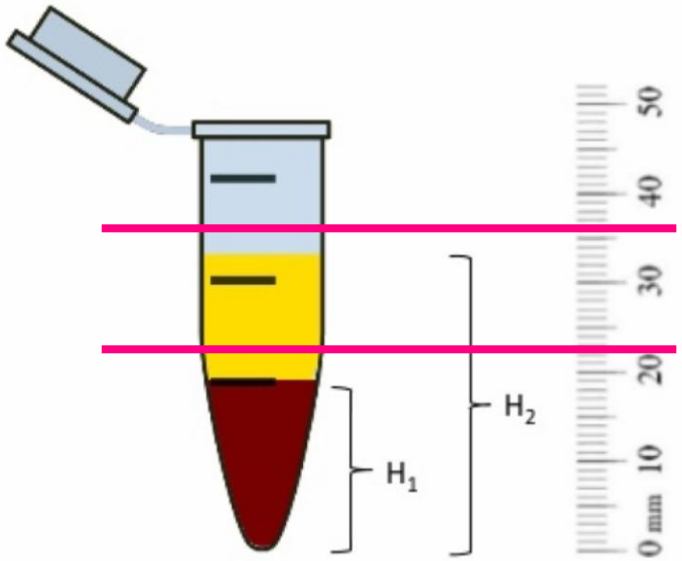
Factors that Affect Hematocrit

- Gender
- Age
- Pregnancy
- Hydration
- Smoking
- Disease/Illness
- Altitude
- Disorder that affect RBC & Hemoglobin
  - Polycythemia & Anemia

How to Calculate Hematocrit

Height of RBC/Total Height of RBC + Plasma

Hematocrit Determination



Where:

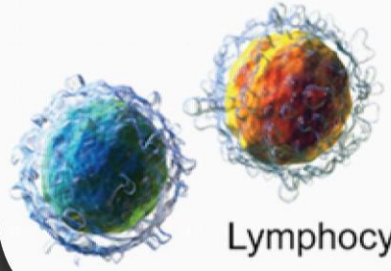
- H_1 = height of the RBC column
- H_2 = height of the RBC + height of the plasma column
- Calculate Hc% (hematocrit) value

Analysis

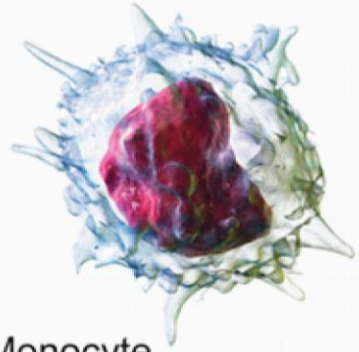
- What is the difference between an Erythroblast and Erythrocyte?
- What is the shape of the Erythrocyte?
- Where does an Erythrocyte carry oxygen?
- Where does an Erythrocyte carry carbon dioxide?
- Approximately how long does it take for the bone marrow to secrete erythrocytes?
- Approximately how long does an average erythrocyte live in the blood stream?
  - Why do you think an erythrocyte doesn't live any longer than that?
- What hormone stimulates the production of Erythrocyte?
- In the absence of this element, erythrocyte production decreases.
- What is polycythemia?
  - What is blood doping?
- What is anemia? Symptoms?
  - What is iron-deficient anemia?
  - Hemolytic anemia?
  - Thalassemia?
  - Hemorrhagic anemia?
  - Sick-Cell Anemia?
- What is a Hematocrit?
- How do you calculate a Hematocrit?
- What can a Hematocrit tell you about the health, gender, age and environment of a patient.

Leukocytes

agranular

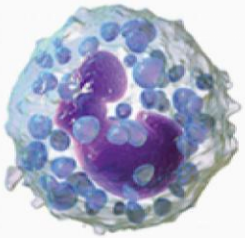


Lymphocytes
20-25%

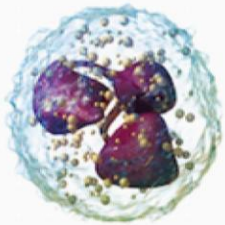


Monocyte
3-8%

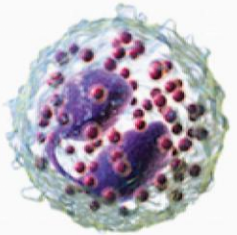
granular



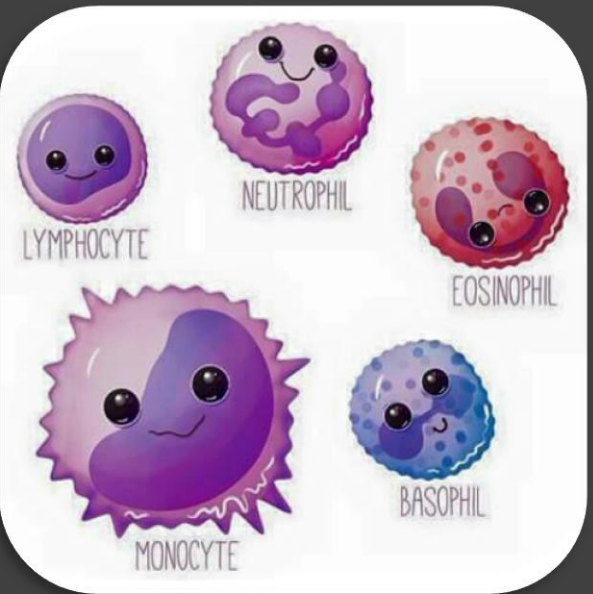
Basophil
0.5-1%

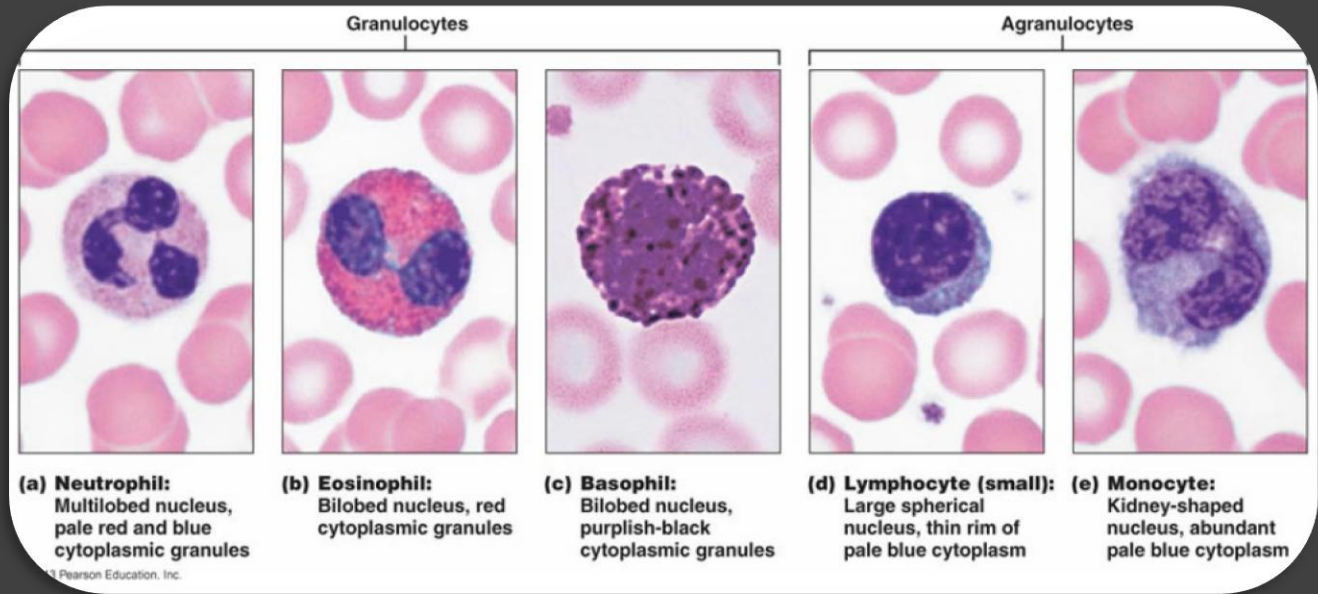


Neutrophil
60-70%

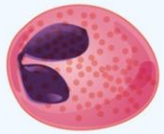
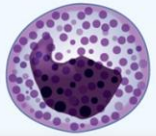


Eosinophil
2-4%



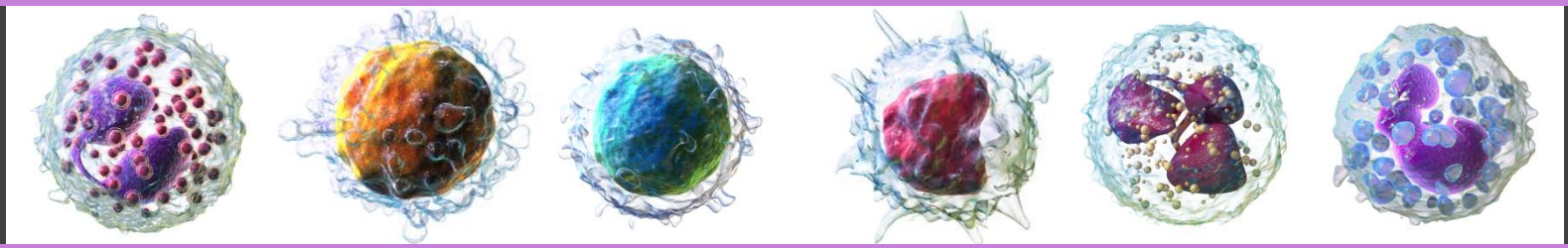


Leukocytes--Granulocytes

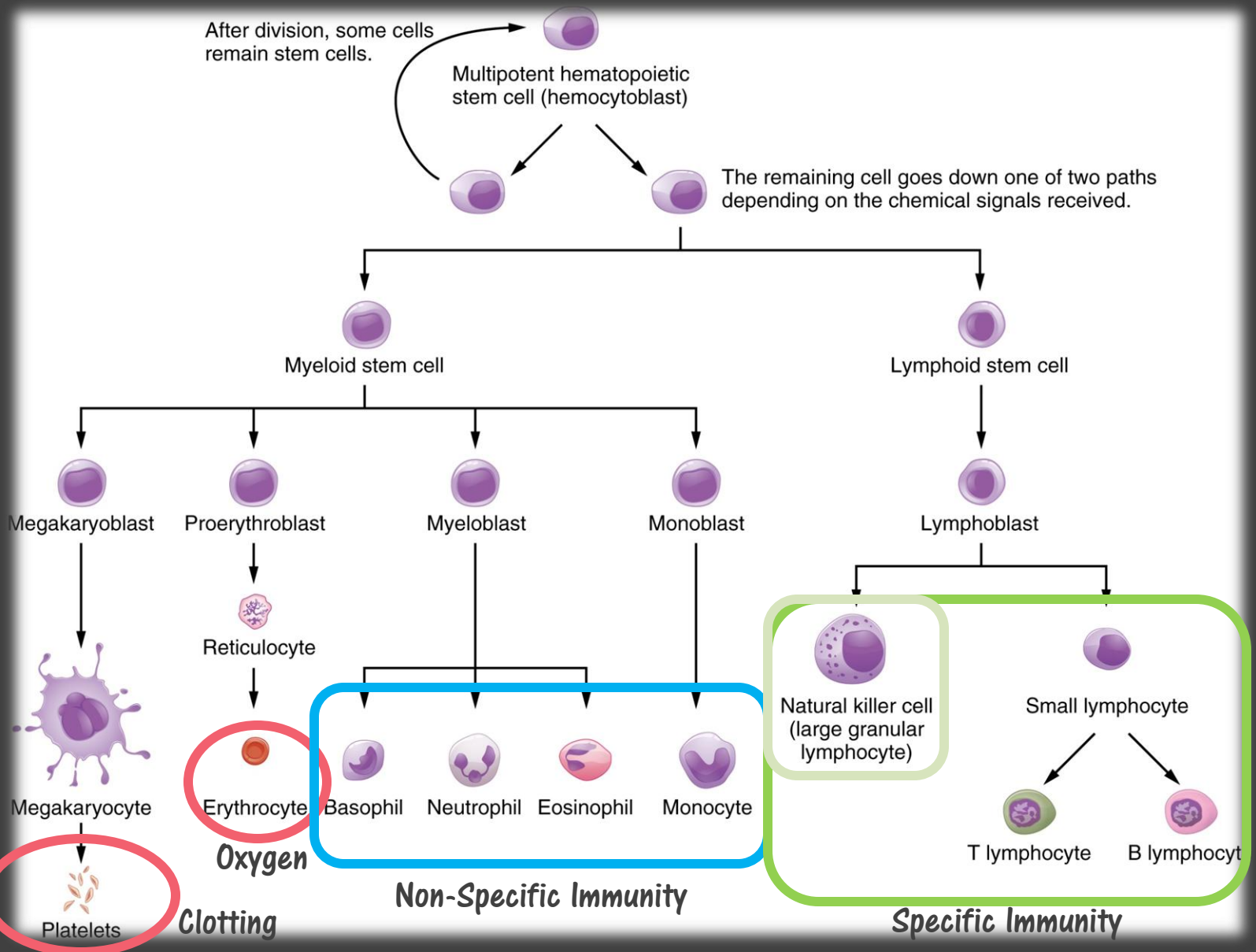
Formed element	Major subtypes	Numbers present per microliter (μL) and mean (range)	Appearance in a standard blood smear	Summary of functions	Comments
Leukocytes (white blood cells)		7000 (5000–10,000)	Obvious dark-staining nucleus	All function in body defenses	Exit capillaries and move into tissues; lifespan of usually a few hours or days
	Granulocytes including neutrophils, eosinophils, and basophils	4360 (1800–9950)	Abundant granules in cytoplasm; nucleus normally lobed	Nonspecific (innate) resistance to disease	Classified according to membrane-bound granules in cytoplasm
	Neutrophils 	4150 (1800–7300)	Nuclear lobes increase with age; pale lilac granules	Phagocytic; particularly effective against bacteria. Release cytotoxic chemicals from granules	Most common leukocyte; lifespan of minutes to days
	Eosinophils 	165 (0–700)	Nucleus generally two-lobed; bright red-orange granules	Phagocytic cells; particularly effective with antigen- antibody complexes. Release antihistamines. Increase in allergies and parasitic infections	Lifespan of minutes to days
	Basophils 	44 (0–150)	Nucleus generally two-lobed but difficult to see due to presence of heavy, dense, dark purple granules	Promotes inflammation	Least common leukocyte; lifespan unknown

Leukocytes--Agranulocytes

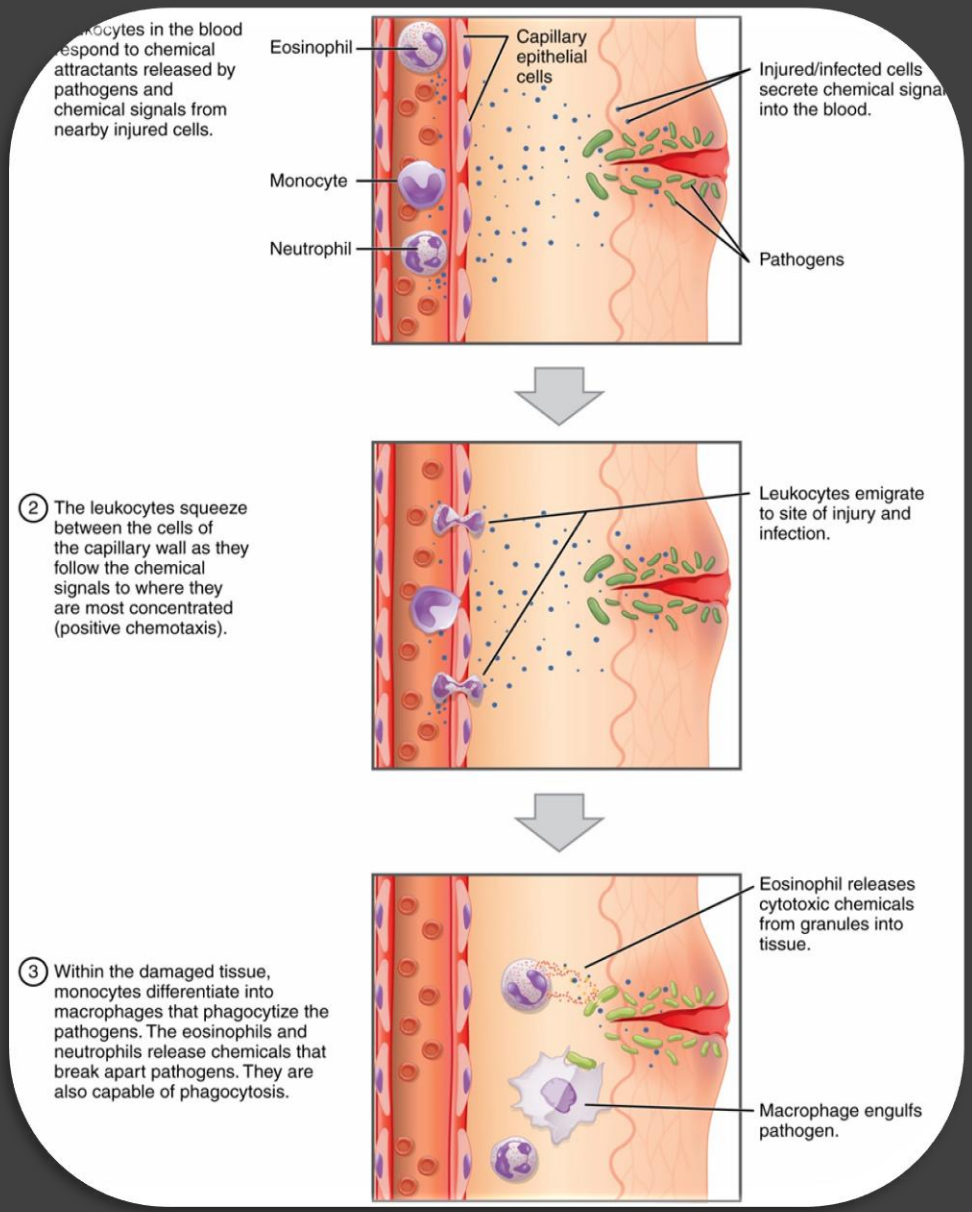
Formed element	Major subtypes	Numbers present per microliter (μL) and mean (range)	Appearance in a standard blood smear	Summary of functions	Comments
	Agranulocytes including lymphocytes and monocytes	2640 (1700–4950)	Lack abundant granules in cytoplasm; have a simple-shaped nucleus that may be indented	Body defenses	Group consists of two major cell types from different lineages
	Lymphocytes 	2185 (1500–4000)	Spherical cells with a single often large nucleus occupying much of the cell's volume; stains purple; seen in large (natural killer cells) and small (B and T cells) variants	Primarily specific (adaptive) immunity: T cells directly attack other cells (cellular immunity); B cells release antibodies (humoral immunity); natural killer cells are similar to T cells but nonspecific	Initial cells originate in bone marrow, but secondary production occurs in lymphatic tissue; several distinct subtypes; memory cells form after exposure to a pathogen and rapidly increase responses to subsequent exposure; lifespan of many years
	Monocytes 	455 (200–950)	Largest leukocyte with an indented or horseshoe-shaped nucleus	Very effective phagocytic cells engulfing pathogens or worn out cells; also serve as antigen-presenting cells (APCs) for other components of the immune system	Produced in red bone marrow; referred to as macrophages after leaving circulation

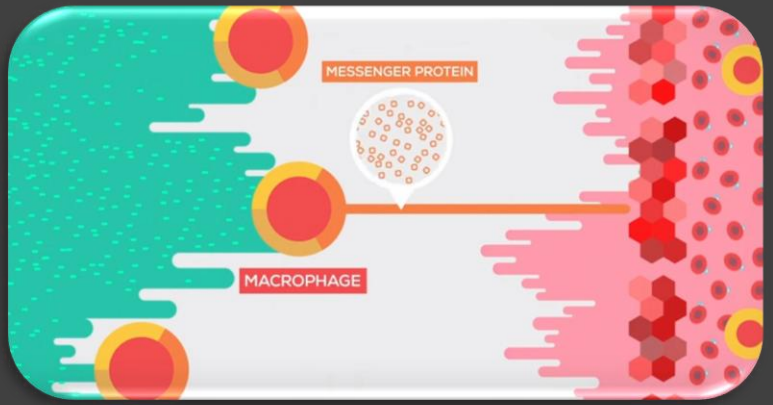


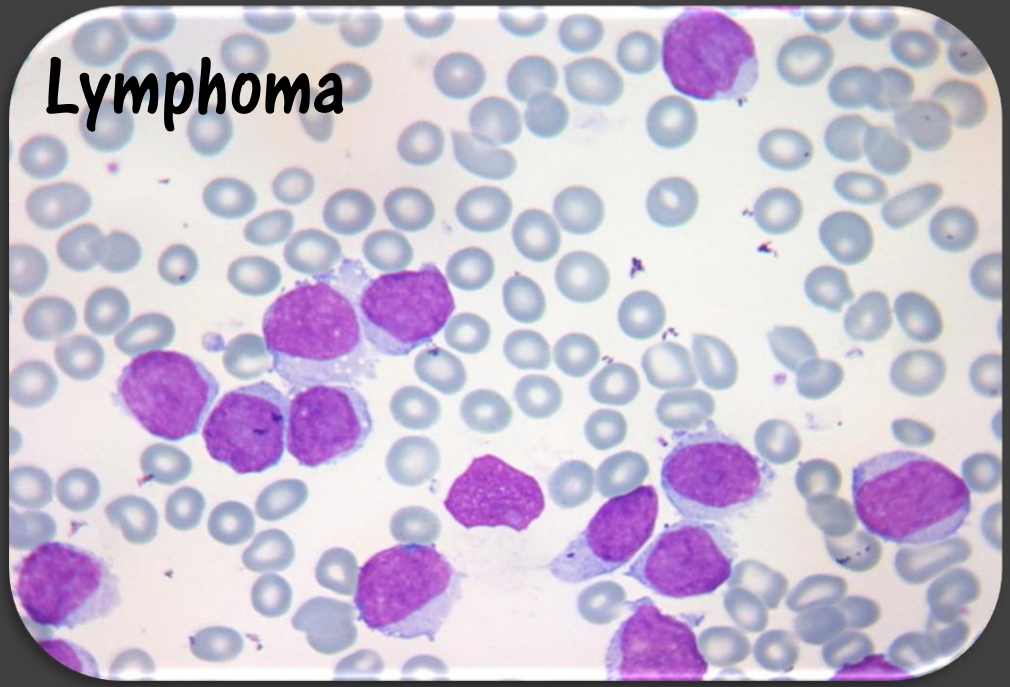
Stem Cell Origin of Formed Elements

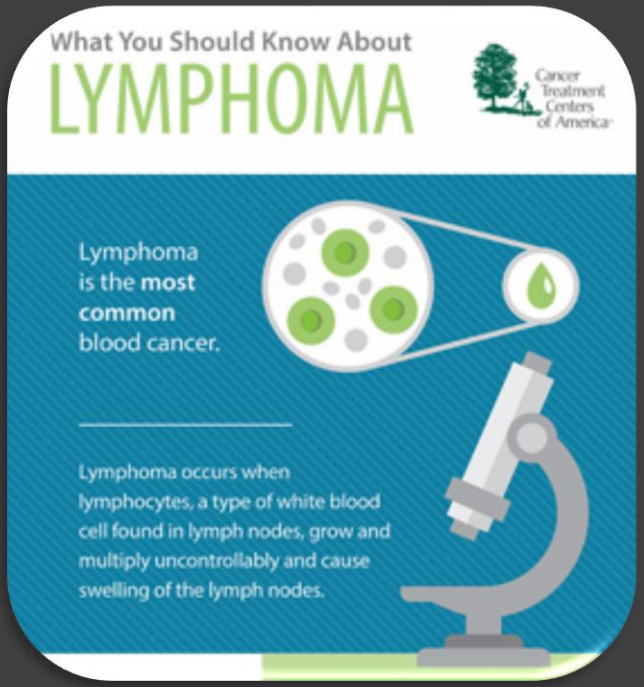


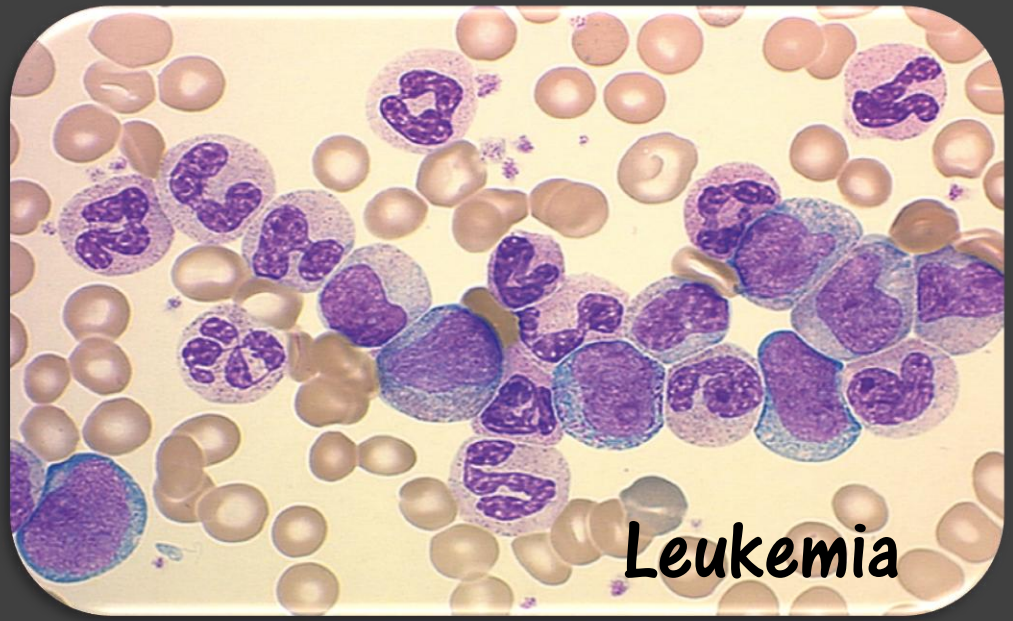
How does the body know to mount a defense?

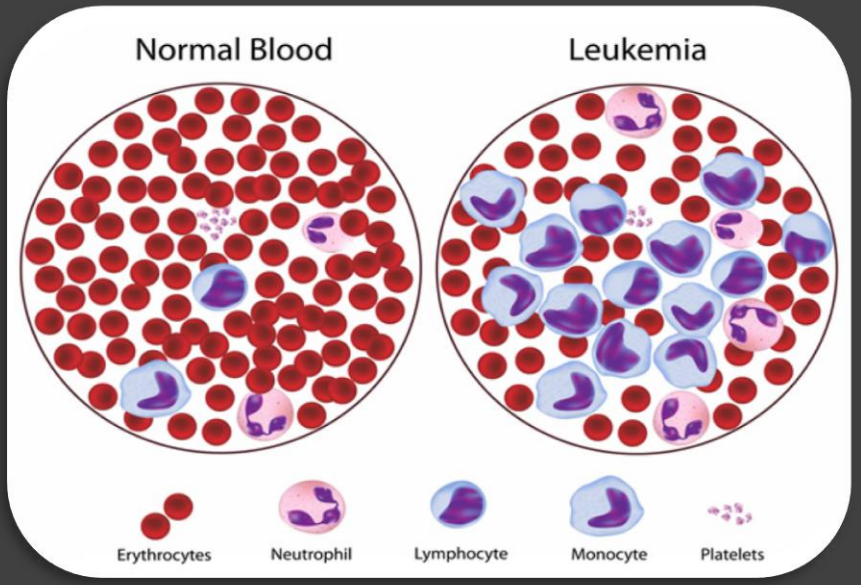





Lymphoma


What You Should Know About
LYMPHOMA
Cancer Treatment Centers of America
Lymphoma is the most common blood cancer.
Lymphoma occurs when lymphocytes, a type of white blood cell found in lymph nodes, grow and multiply uncontrollably and cause swelling of the lymph nodes.


Leukemia

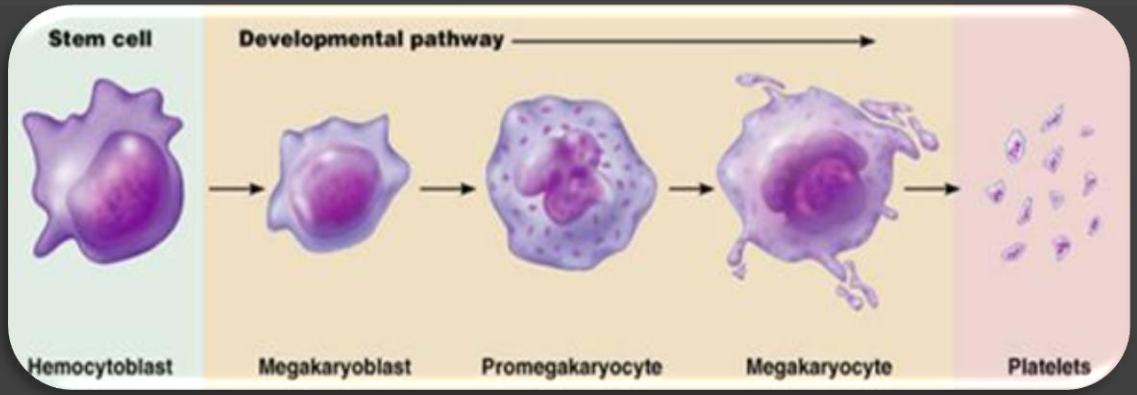

Normal Blood
Leukemia
Erythrocytes
Neutrophil
Lymphocyte
Monocyte
Platelets

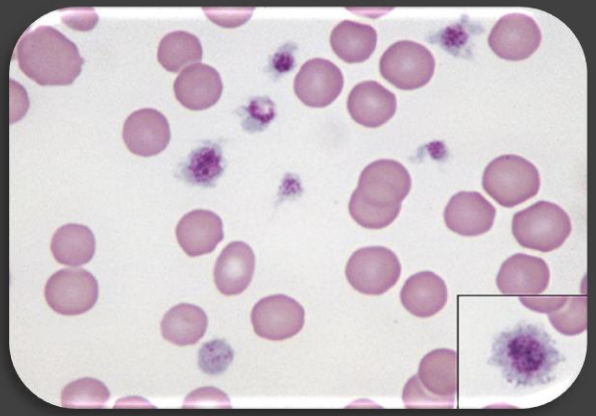
Analysis

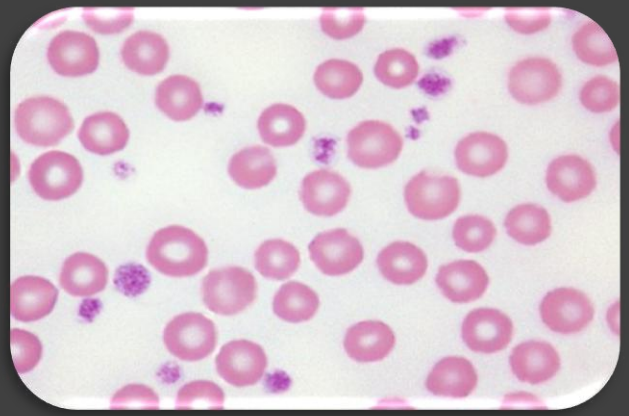
- Can you identify the physical differences between:
  - Monocytes
  - Lymphocytes
  - Neutrophils
  - Eosinophils
  - Basophils
- Can you explain the functional difference between:
  - Granulocytes/Agranulocytes
  - Non-Specific Immunity/Specific Immunity
  - Monocytes (M-M-M)
  - Lymphocytes (NK, T & B Cells)
  - Neutrophils
  - Eosinophils
  - Basophils
- How does the immune system work together to detect and manage infection?
- What type of stem cell gives rise to cells/cell types except lymphocytes?
- Monocytes and Lymphocytes are both agranular, however their origin is very different—why?
- What will lymphoma look like under the microscope? Why?
- What will leukemia look like under the microscope? Why?

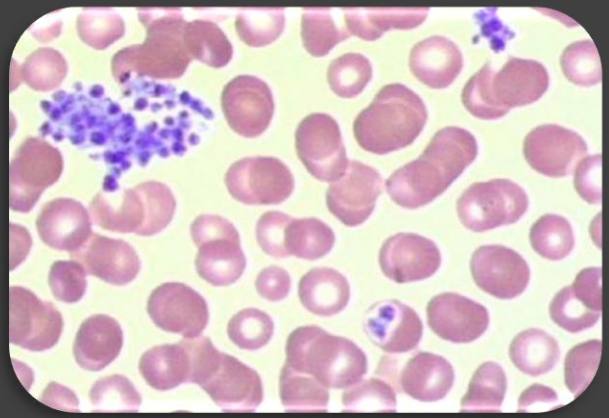
Platelets--Thrombocytes

Formed element	Major subtypes	Numbers present per microliter (μL) and mean (range)	Appearance in a standard blood smear	Summary of functions	Comments
Platelets		350,000 (150,000–500,000)	Cellular fragments surrounded by a plasma membrane and containing granules; purple stain	Hemostasis plus release growth factors for repair and healing of tissue	Formed from megakaryocytes that remain in the red bone marrow and shed platelets into circulation

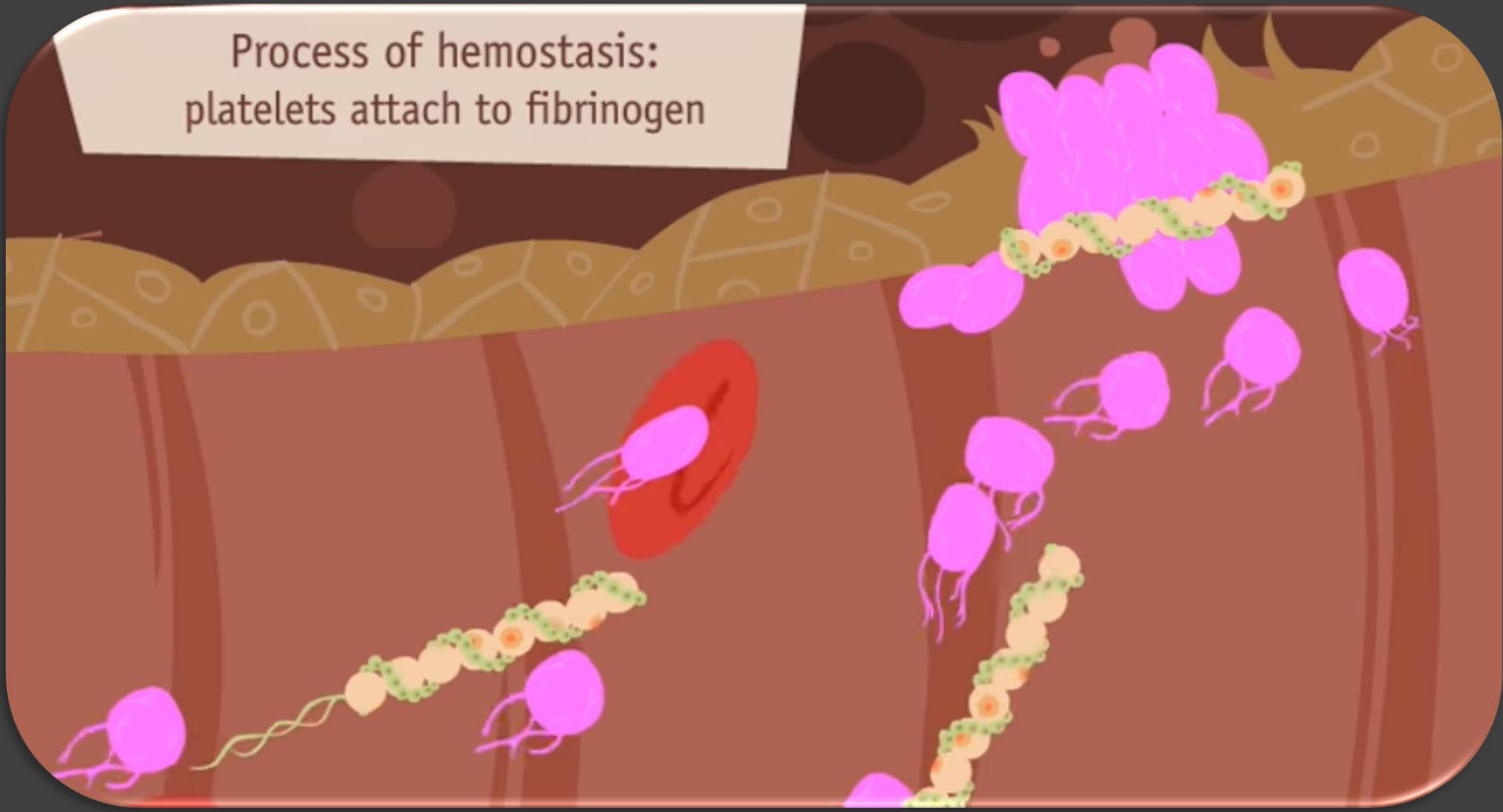




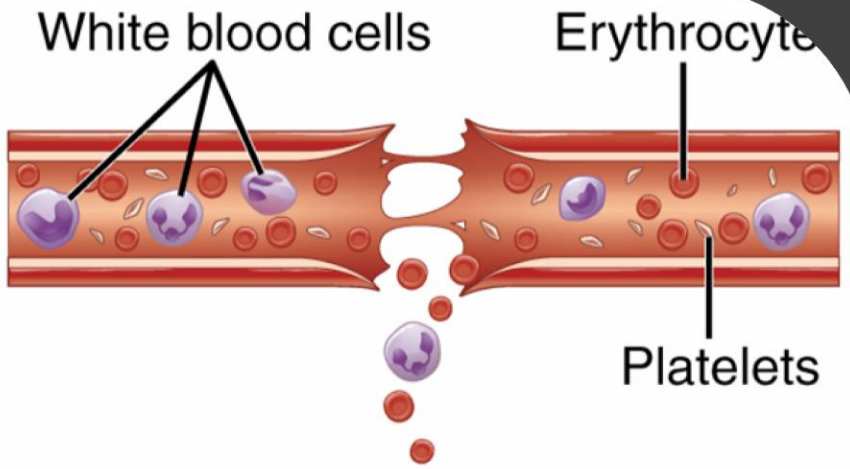




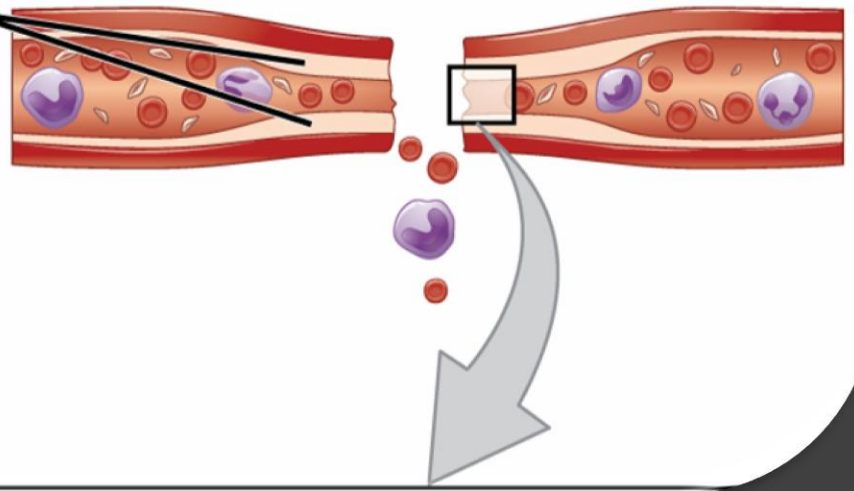
Hemostasis



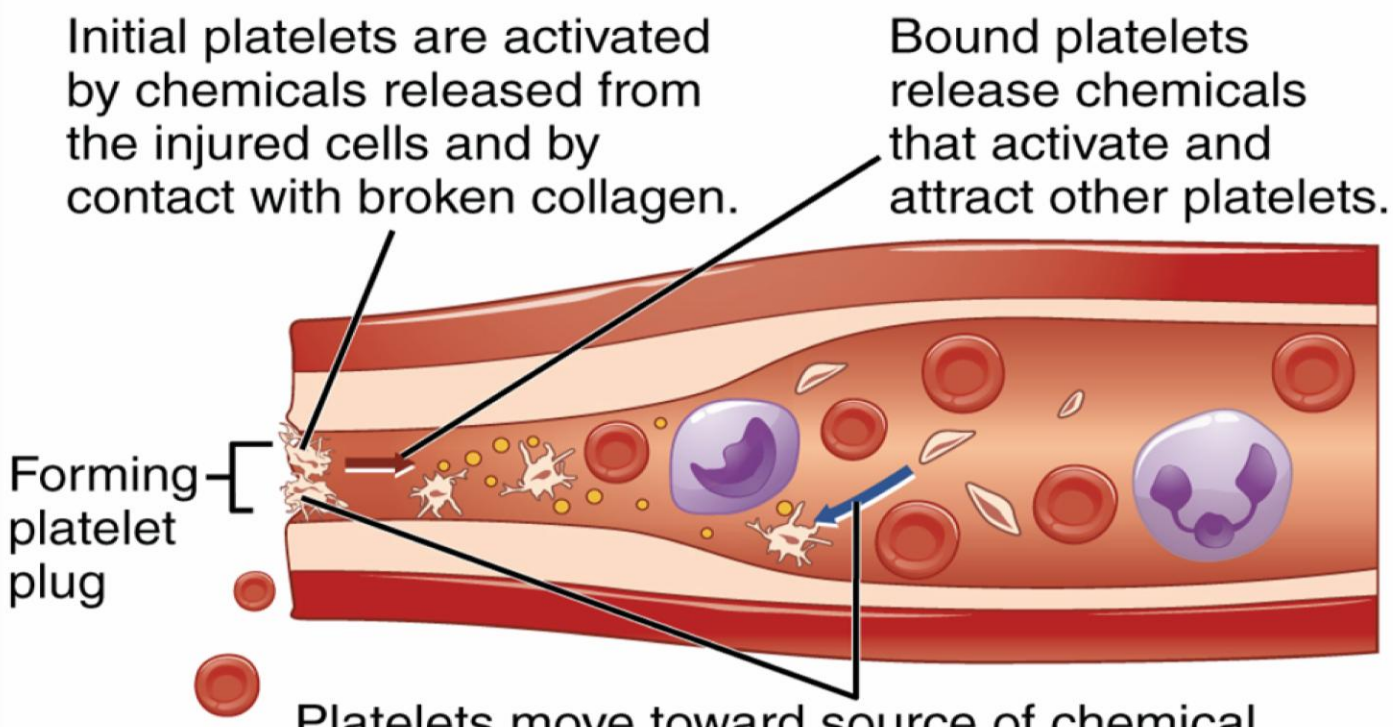
1 **Injury.** A blood vessel is severed. Blood and blood components (e.g., erythrocytes, white blood cells, etc.) are leaking out of the breaks.



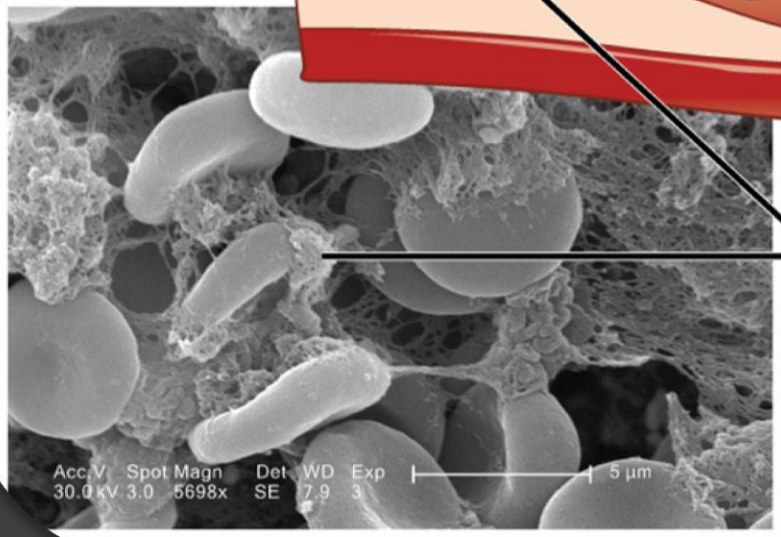
2 **Vascular spasm.** The smooth muscle in the vessel wall contracts near the injury point, reducing blood loss.



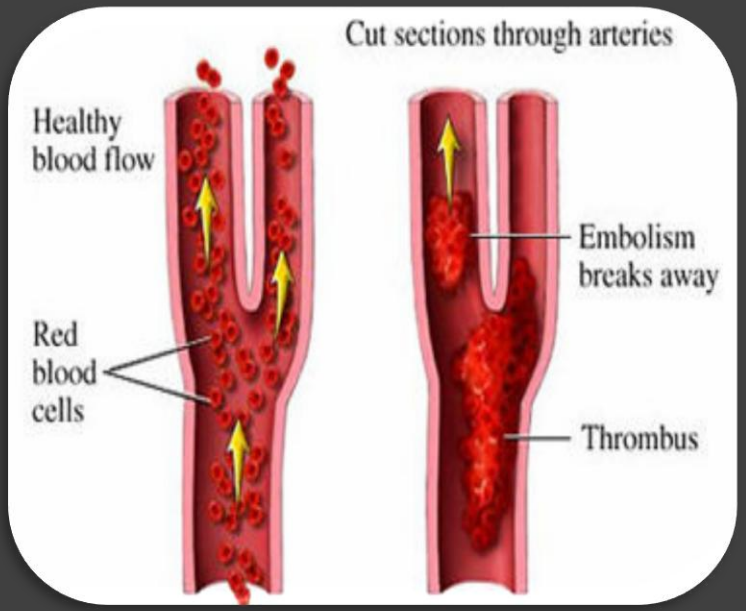
3 **Platelet plug formation.** Platelets are activated by chemicals released from the injury site and by contact with underlying collagen. The platelets become spiked and stick to each other and the wound site.

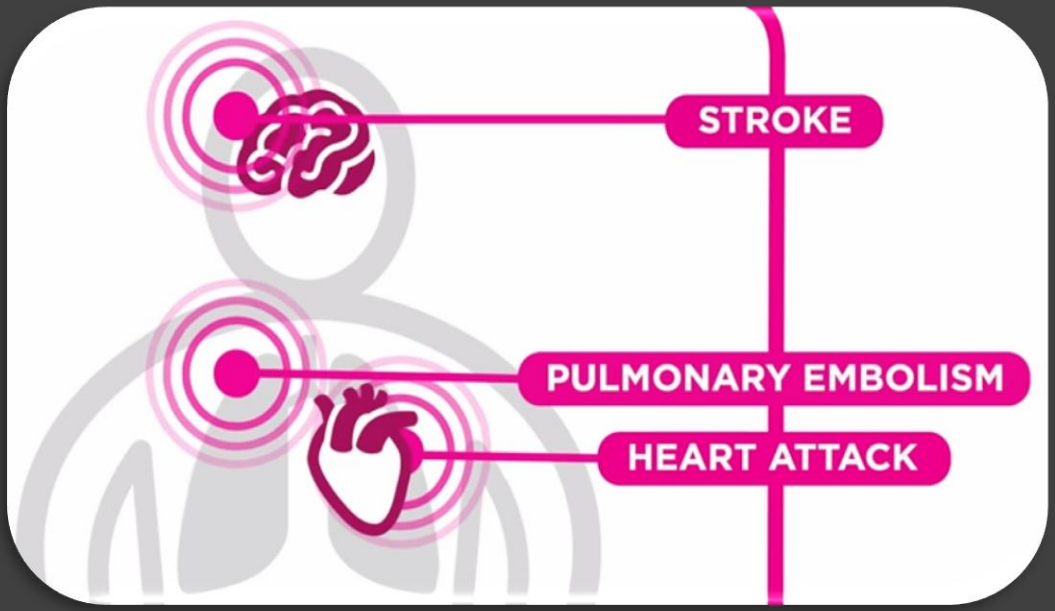


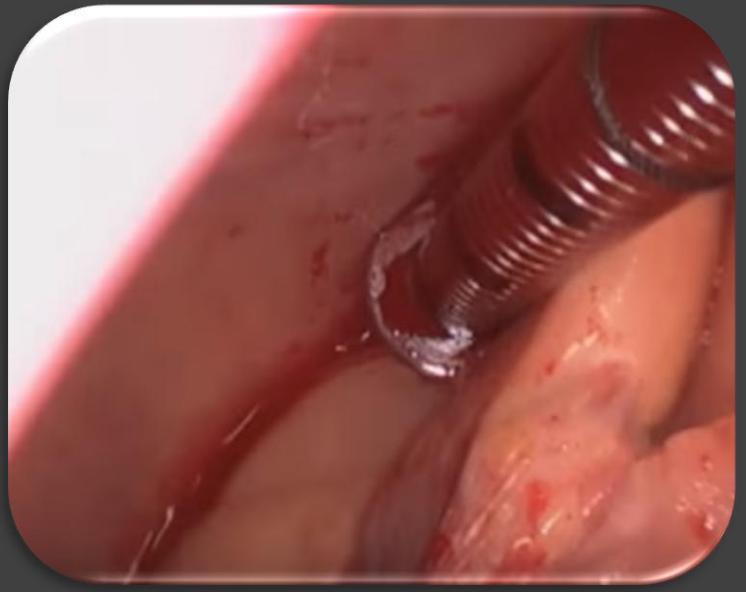
4 **Coagulation.** In coagulation, fibrinogen is converted to fibrin (see part b), which forms a mesh that traps more platelets and erythrocytes, producing a clot.



Fibrin strands secure platelets and erythrocytes, effectively plugging the break.


Cut sections through arteries
Healthy blood flow
Red blood cells
Embolism breaks away
Thrombus

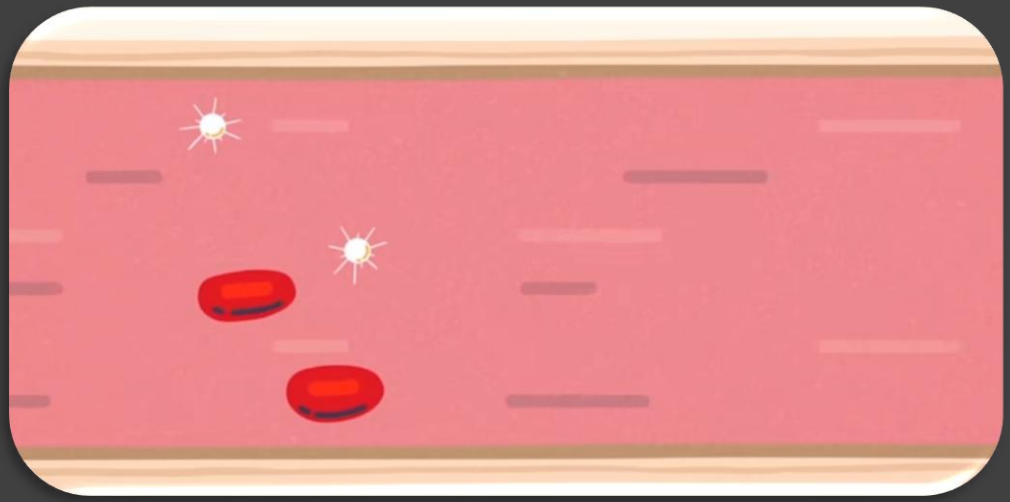

STROKE
PULMONARY EMBOLISM
HEART ATTACK



Clotting is an Issue?

- Innate

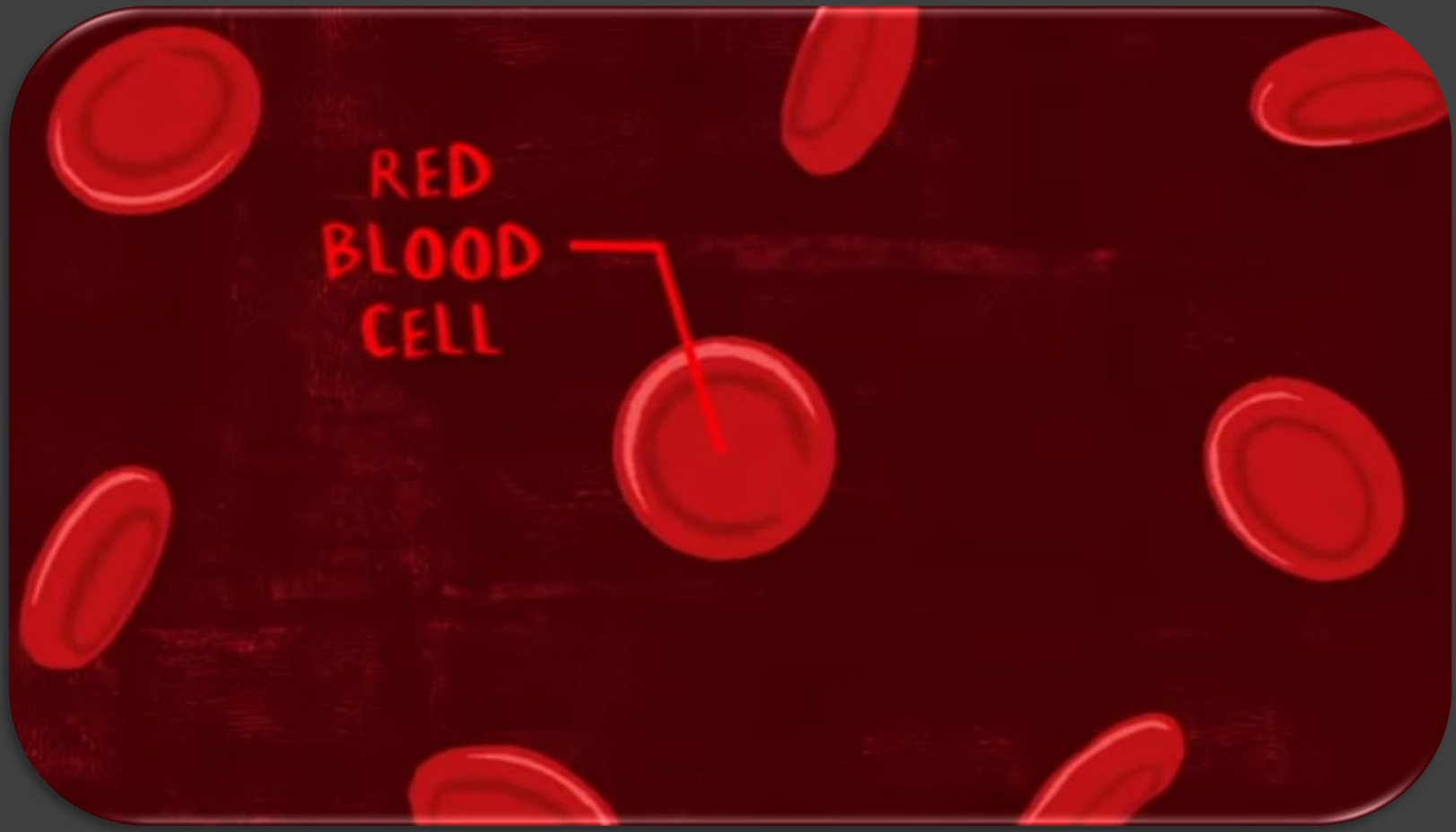
- Acquired



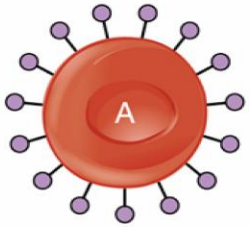
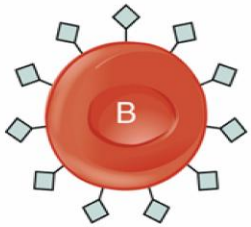
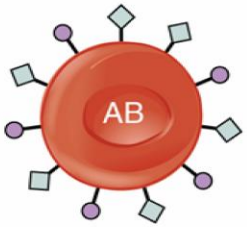
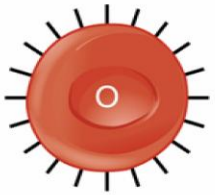
Analysis

- What specialized type of cell produces platelets (thromocytes?)
- Are platelets true cells?
- What is hemostasis?
- How does the body know to send platelets and fibrogen to an injured site?
- Why are platelets in active/non-active forms?
- What is the difference between an activated and inactivated platelet?
- What is the difference between fibrogen and fibrin?
- Why can't fibrin just exist in the blood stream?
- What is the difference between an embolus and an thrombus?
- What are the issues with thrombus in the veins vs. arteries?
- What is innate hemophila? Are there different types?
- Why do people acquire clotting issues?
- What is the treatment for various types of hemophilia?

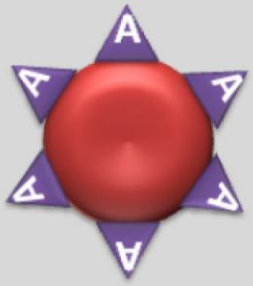
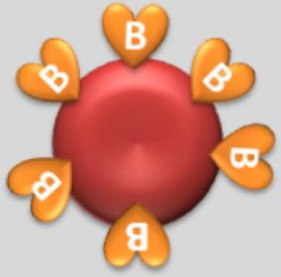
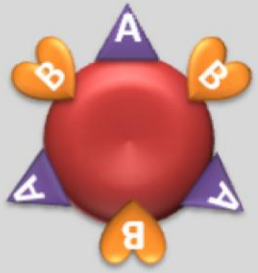
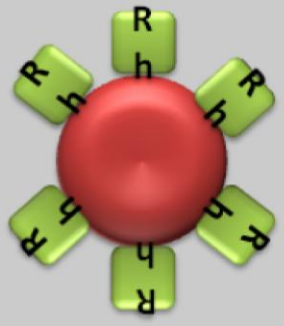
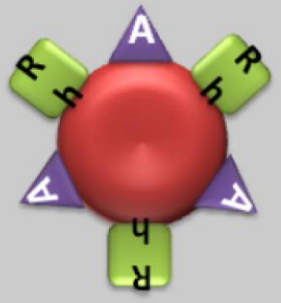
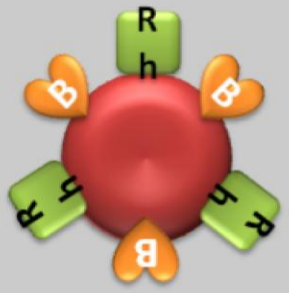
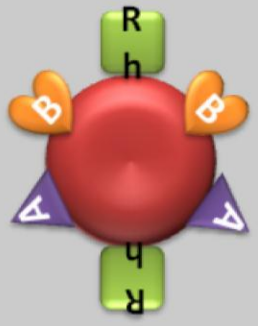
Blood Types



Blood Types
Antigens and Antibodies

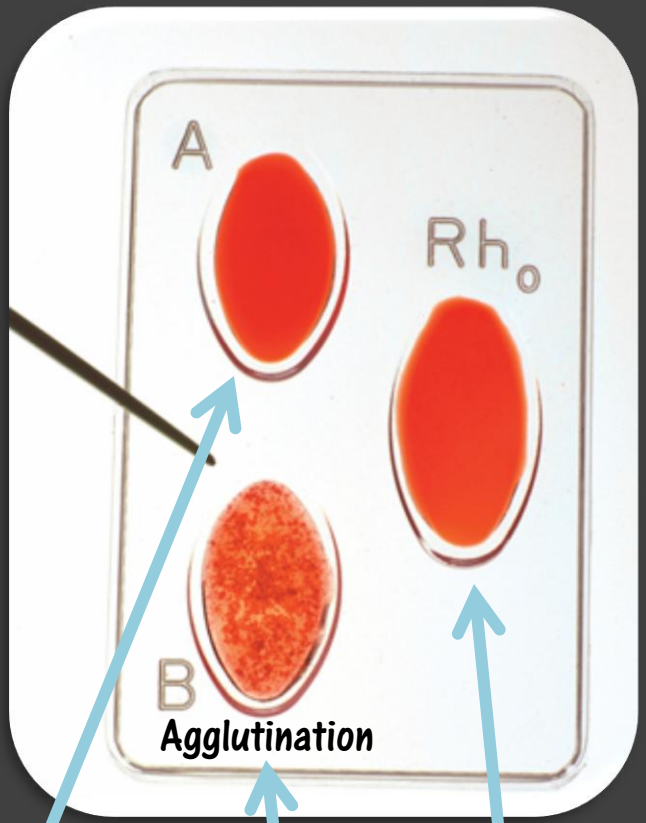
	Blood Type			
	A	B	AB	O
Red Blood Cell Type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red blood Cell	 A antigen	 B antigen	 A and B antigens	None
Blood Types Compatible in an Emergency	A, O	B, O	A, B, AB, O (AB^+ is the universal recipient)	O (O is the universal donor)

Blood Types and Rh Factor

O-	A-	B-	AB-
			
O+	A+	B+	AB+
			

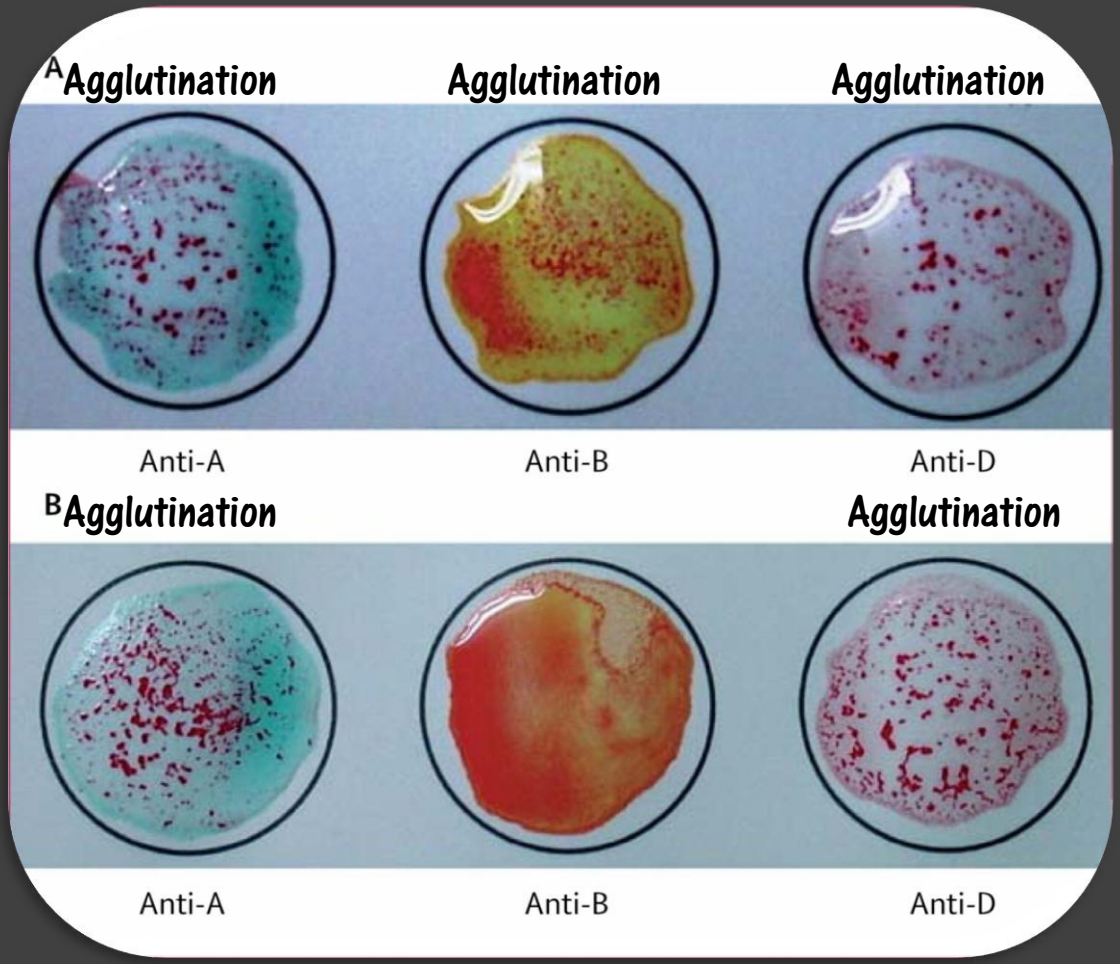
Performing Blood Typing Test

Add blood to each reaction well



Add Antibody A Add Antibody B Add Rh Antibody

Add Drop of Blood Add Drop of Blood Add Drop of Blood



Add Antibody A Add Antibody B Add Rh Antibody

Blood Type Inheritance

Blood Type	Genotype	Alleles Produced
Rh positive	RR	R
	Rr	R or r
Rh negative	rr	r

Blood Type	Genotype		Can Receive Blood From:
A	$i^A i$ $i^A i^A$	AA AO	A or O
B	$i^B i$ $i^B i^B$	BB BO	B or O
AB	$i^A i^B$	AB	A, B, AB, O
O	$i\ i$	OO	O

♀ ♂

	R	r
R	RR	Rr
r	Rr	rr

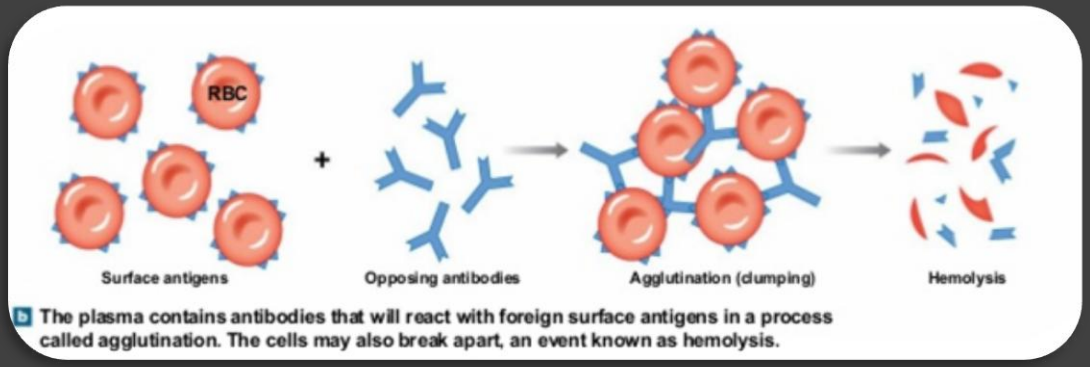
♀ ♂

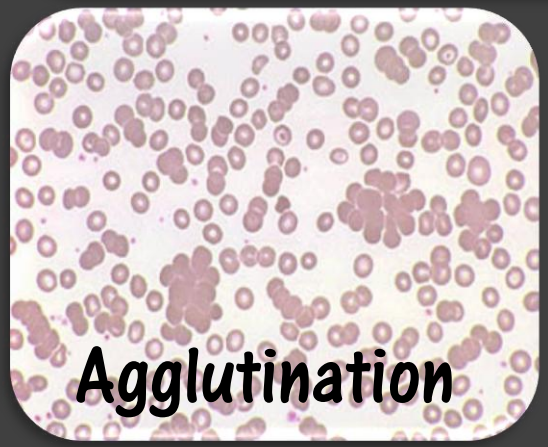
	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

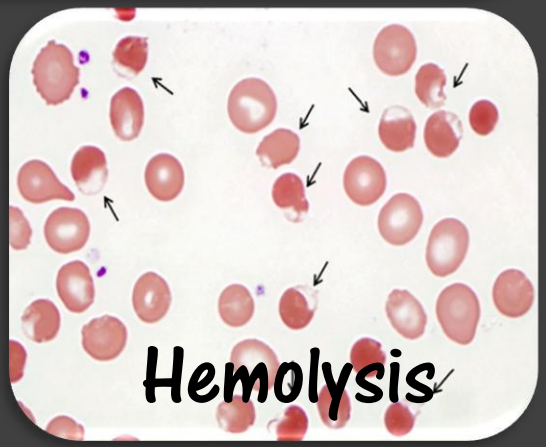
♀ ♂

	I^AR	I^Ar	iR	ir
I^BR	I^AI^BRR	I^AI^BRr	I^BiRR	I^BiRr
I^Br	I^AI^BRr	I^AI^Brr	I^BiRr	I^Birr
iR	I^AiRR	I^AiRr	iiRR	iiRr
ir	I^AiRr	I^Airr	iiRr	iirr

Blood Incompatibility Antibody, Antigen Reactions

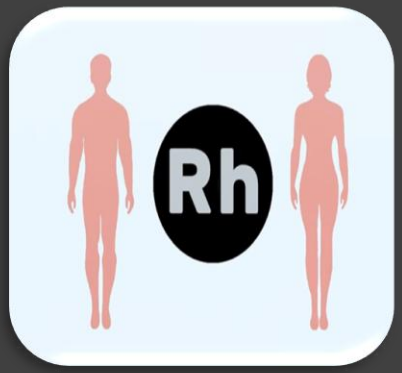


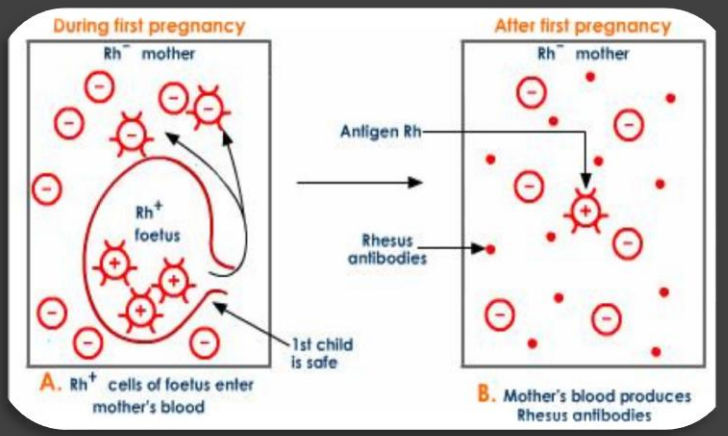




Immediate Reaction

Rh Factor





Delayed Reaction

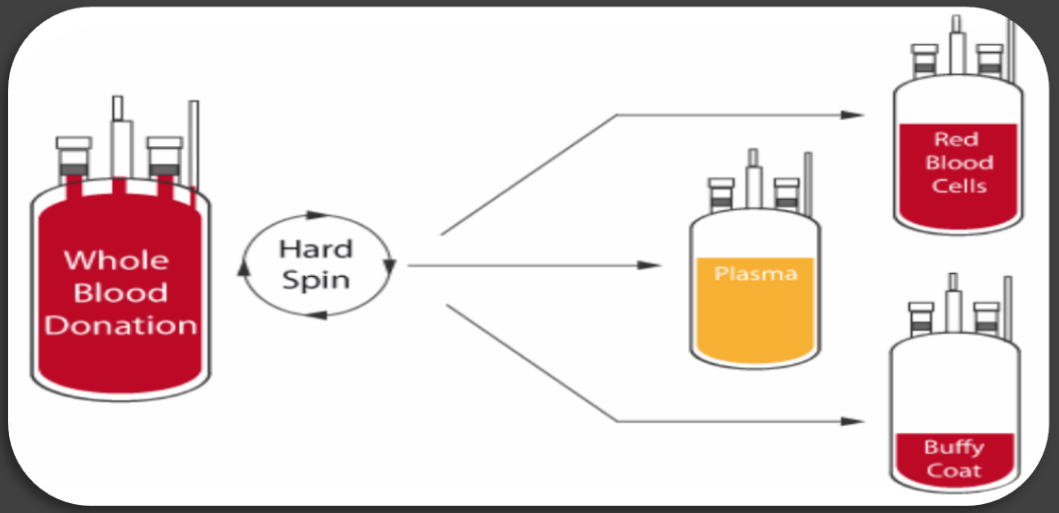
Blood Donations & Transfusions

Whole Blood: Typical Donation. Can be used as is or separated for erythrocytes, thrombocytes and plasma.

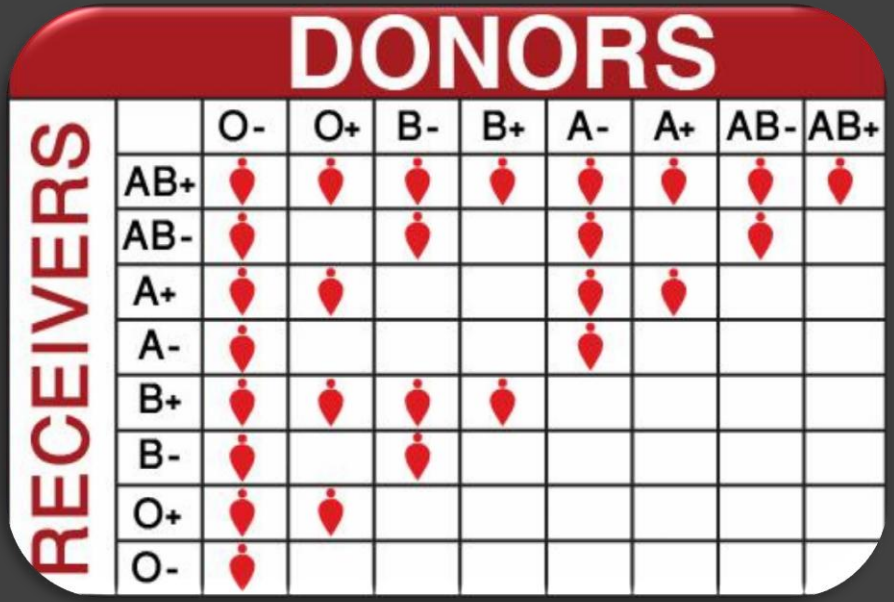
Power Red: Donate 2x the amount of erythrocytes, keep your plasma and platelets!

Plasma: Donate your plasma, keep your erythrocytes and platelets! Amount depends on weight of donor.

Platelets: Donate your platelets, get your erthrocyes and plasma back.

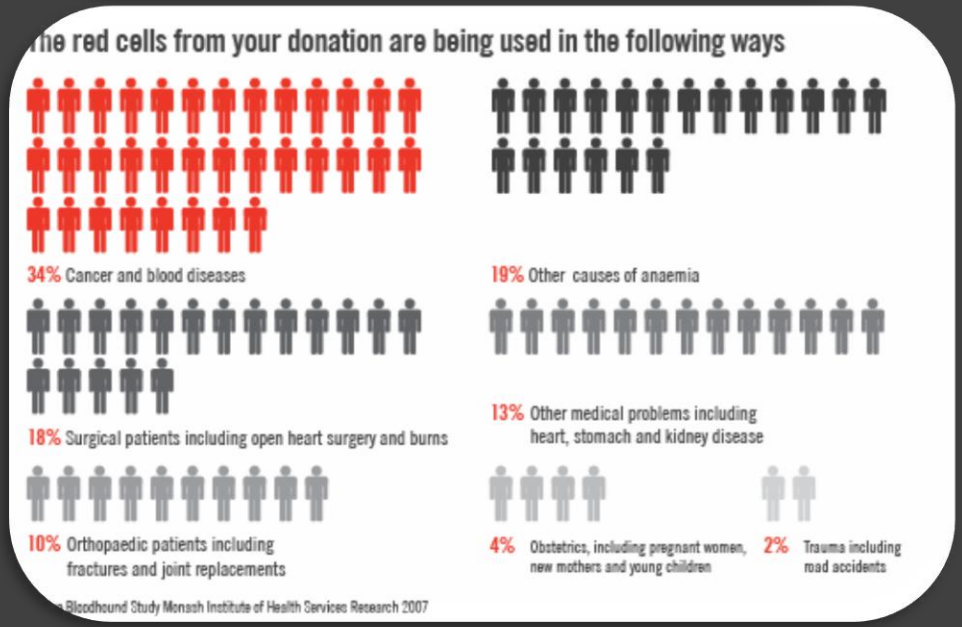


Donating Blood



Donation Type	Donation Frequency*
Blood (whole blood)	Every 56 days
Platelets	Every 7 days, up to 24 times / year
Plasma	Every 28 days, up to 13 times / year
Power Red	Every 112 days, up to 3 times / year

**If more than one donation type is donated, this will affect the number of allowable donations per year due to red cell and plasma loss limit guidelines. Final eligibility will be determined by the American Red Cross at the time of donation.*



Common Reasons that Prevent Donation

Temporary reasons for not being able to donate blood:

- Too young, underweight
- illness, anemic, currently on antibiotics

In the last 12 months have you…

- Received a new tattoo
- Engaged in male-male intercourse
- Body Piercing
- Visited a country which has Malaria?

Conditions in which you can never donate blood:

- Have HIV/AIDs or other chronic viral condition
- Diabetes
- Hemophilia
- Have ever contracted Ebola

Analysis

- How many blood groups/types exist?
- How many blood types affect blood compatibility? Organ Compatibility?
- What are the genetic terms to describe blood types?
  - Allele
  - Genotypes of A+, A-, B+, B-, AB+, AB-, O+, O-
  - Phenotypes of Blood Types
  - Monohybrid (Blood Type or Rh separately)
  - Dihybrid (Blood and Rh combined)
- For each blood type, determine the specific antibodies and antigens present:
  - A+, A-, B+, B-, AB+, AB-, O+, O-
- Describe the interaction between all possible blood types donated and recipients in terms of antibody, antigen and agglutination.
- What is the difference between agglutination, coagulation and hemolysis?
- How does the Rh Factor complicate pregnancies for Rh – mothers?
- What are the 4 types of blood donation?
- What benefits might be found in plasma of young adults?
- What blood type is considered a universal donor?
- What blood type is considered a universal acceptor?
- What are common reasons to delay or prevent people from donating blood?