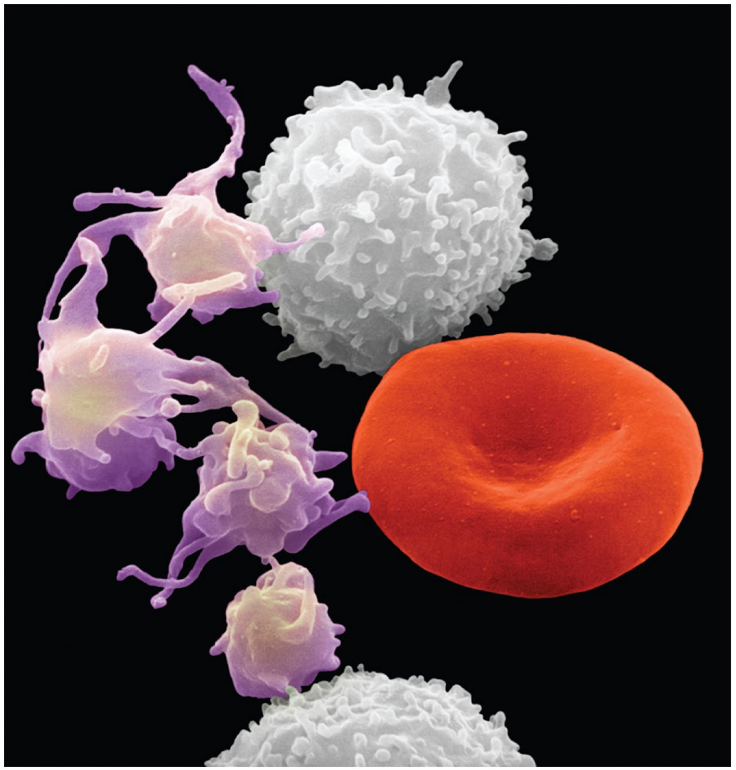
Chapter 18.2

Hemopoiesis

Erythropoiesis & Leukopoiesis

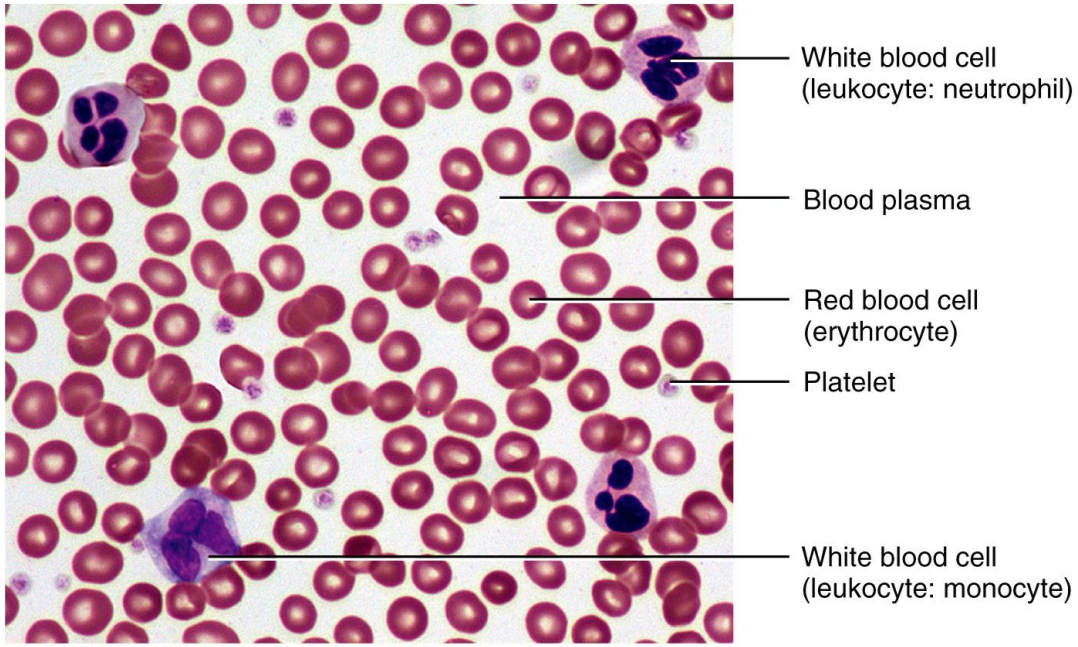


Hemopoiesis is the production of the formed elements of blood.

The formed elements are the cells and corpuscles in blood.

Erythropoiesis is the formation of red blood cells.

Leukopoiesis is the formation of white blood cells.



(b) Blood smear (thin film of blood spread on a glass slide)

Where are formed elements produced?

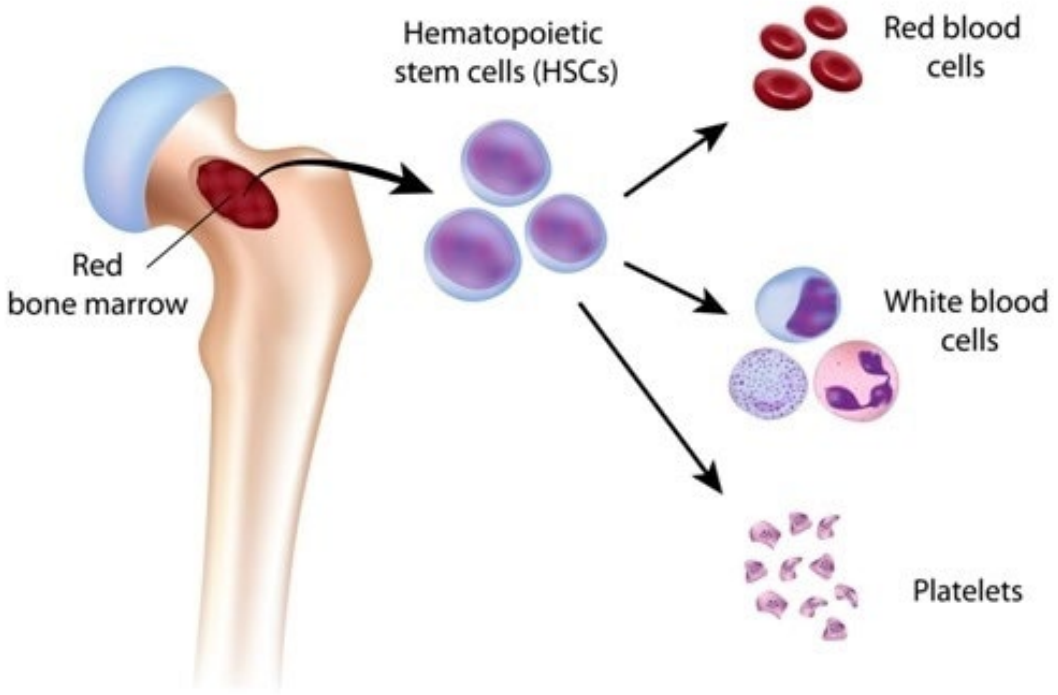
Hemopoiesis

Hemopoiesis = the production of the blood (especially its formed elements)

Red bone marrow produces all nine formed elements /// hemopoietic tissues is red bone marrow

Embryonic development // occurs in yolk sac – an embryonic structure that produces stem cells for first blood cells

Stem cells colonize in all <u>fetal bone marrow, liver, and spleen</u> // liver and spleen stop producing blood cells at birth



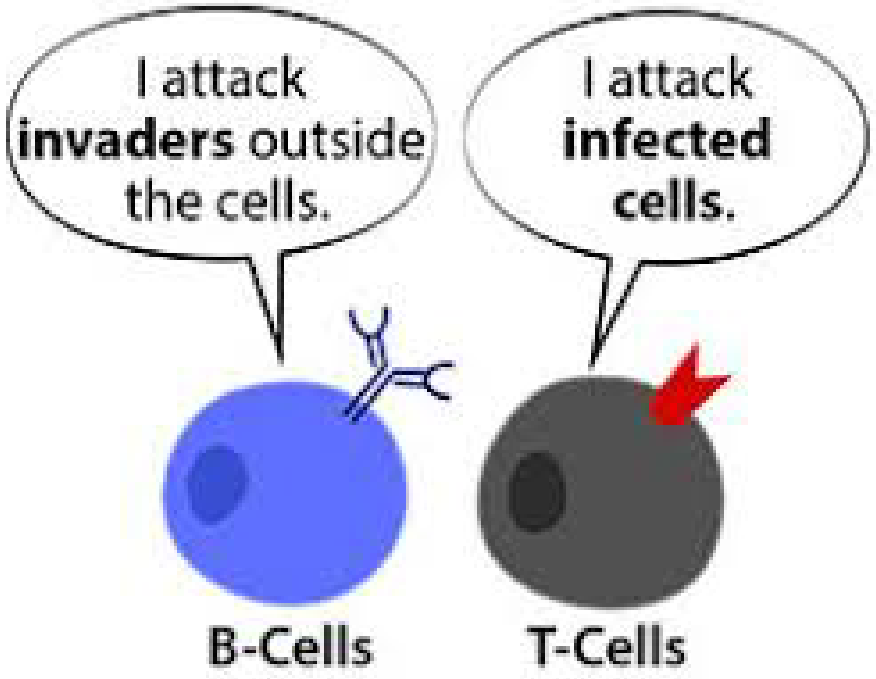
Hemopoiesis

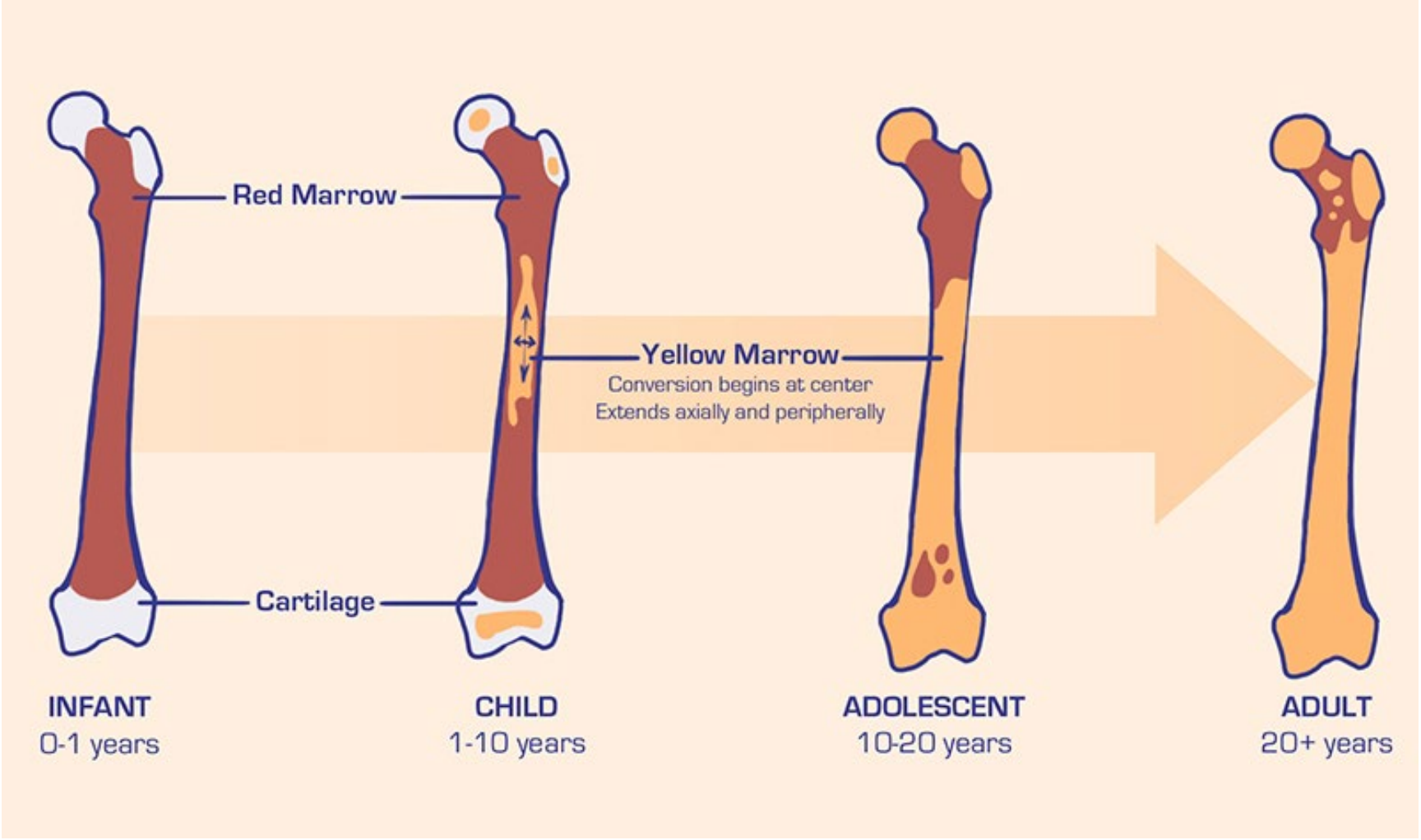
As an adult, all formed elements "are only born" in red bone marrow of axial skeleton plus proximal ends of femur and humerus

B cells are born and receive "B cell receptors" in the red bone marrow. T cells are born in the bone marrow but receive "T cell receptors" in the thymus.

T cells travel in the blood to the thymus to complete their development /// then enter blood as naive immunocompetent T cells

Adult daily production = 400 billion platelets / 200 billion RBCs / 10 billion WBCs




Red Marrow
Cartilage
Yellow Marrow
Conversion begins at center
Extends axially and peripherally
INFANT
0-1 years
CHILD
1-10 years
ADOLESCENT
10-20 years
ADULT
20+ years

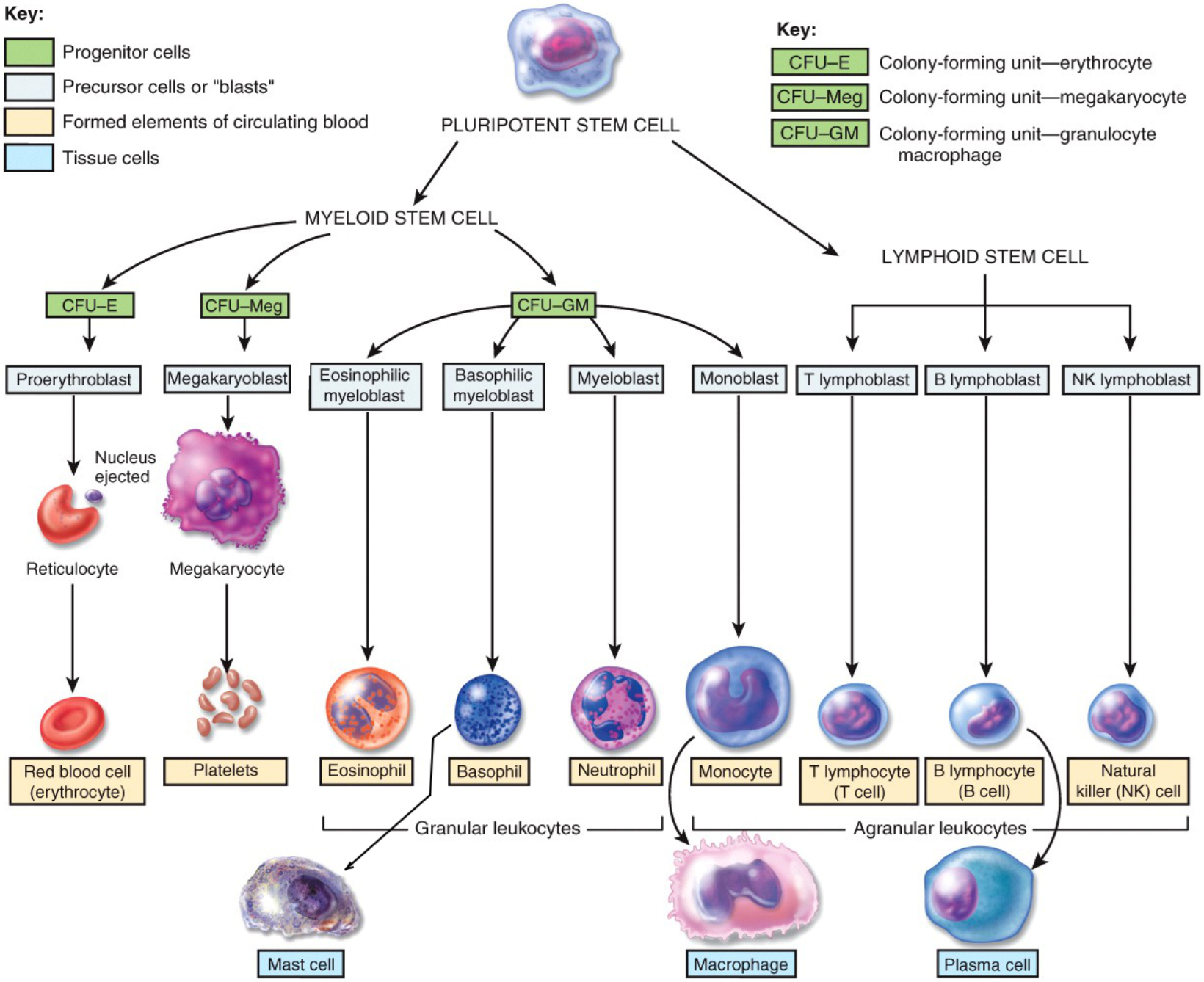
Hemopoiesis

Pluripotent stem cells (PPSC) // formally called hemocytoblasts or hemopoietic stem cells // PPSC generate specific colony forming units for each formed element

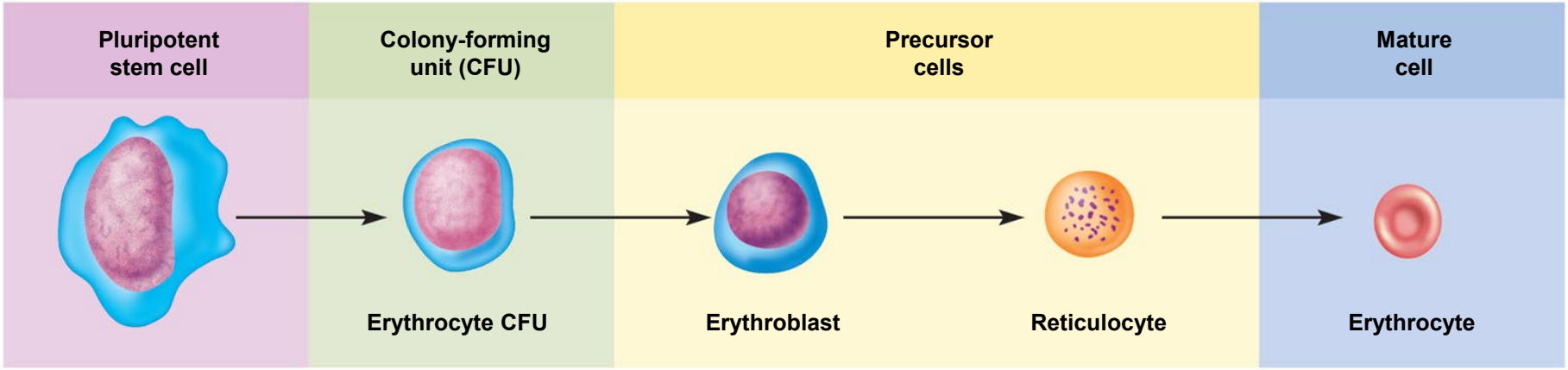
Colony forming units – specialized stem cells producing one formed element of blood

Myeloid hemopoiesis – blood formation in the red bone marrow (note: sometimes called myeloid tissue or hemopoetic tissue)

Lymphoid hemopoiesis – describes blood formation in the lymphatic organs


Key:
Progenitor cells
Precursor cells or "blasts"
Formed elements of circulating blood
Tissue cells
Key:
CFU–E
Colony-forming unit—erythrocyte
CFU–Meg
Colony-forming unit—megakaryocyte
CFU–GM
Colony-forming unit—granulocyte macrophage
PLURIPOTENT STEM CELL
MYELOID STEM CELL
LYMPHOID STEM CELL
CFU–E
CFU–Meg
CFU–GM
Proerythroblast
Megakaryoblast
Eosinophilic myeloblast
Basophilic myeloblast
Myeloblast
Monoblast
T lymphoblast
B lymphoblast
NK lymphoblast
Nucleus ejected
Reticulocyte
Megakaryocyte
Red blood cell (erythrocyte)
Platelets
Eosinophil
Basophil
Neutrophil
Monocyte
T lymphocyte (T cell)
B lymphocyte (B cell)
Natural killer (NK) cell
Granular leukocytes
Agranular leukocytes
Mast cell
Macrophage
Plasma cell

Erythropoiesis



Production of RBC requires 3 to 5 days to complete (test benchmark 5 days!)

Stimulus to start erythropoiesis = hypoxia

Hypoxia signals kidney to release erythropoiet

Erythropoietin = hormone

Hormone receptors on erythrocyte CFU

Regulating Erythrocyte Homeostasis

Negative feedback regulation

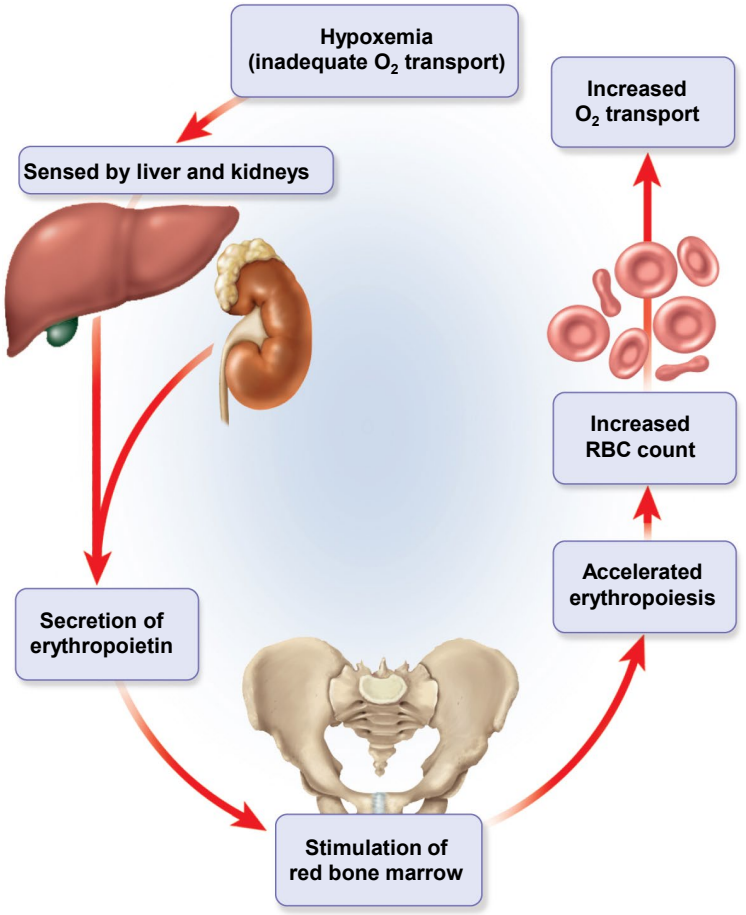
A drop in RBC count causes hypoxemia (low oxygen in blood) // hypoxia low oxygen level in tissue // this is the the stimulus for kidneys

Hypoxemia causes kidney to produce and release the hormone erythropoietin // receptor on RBC-CFU

RBC count increases in 3 - 5 days

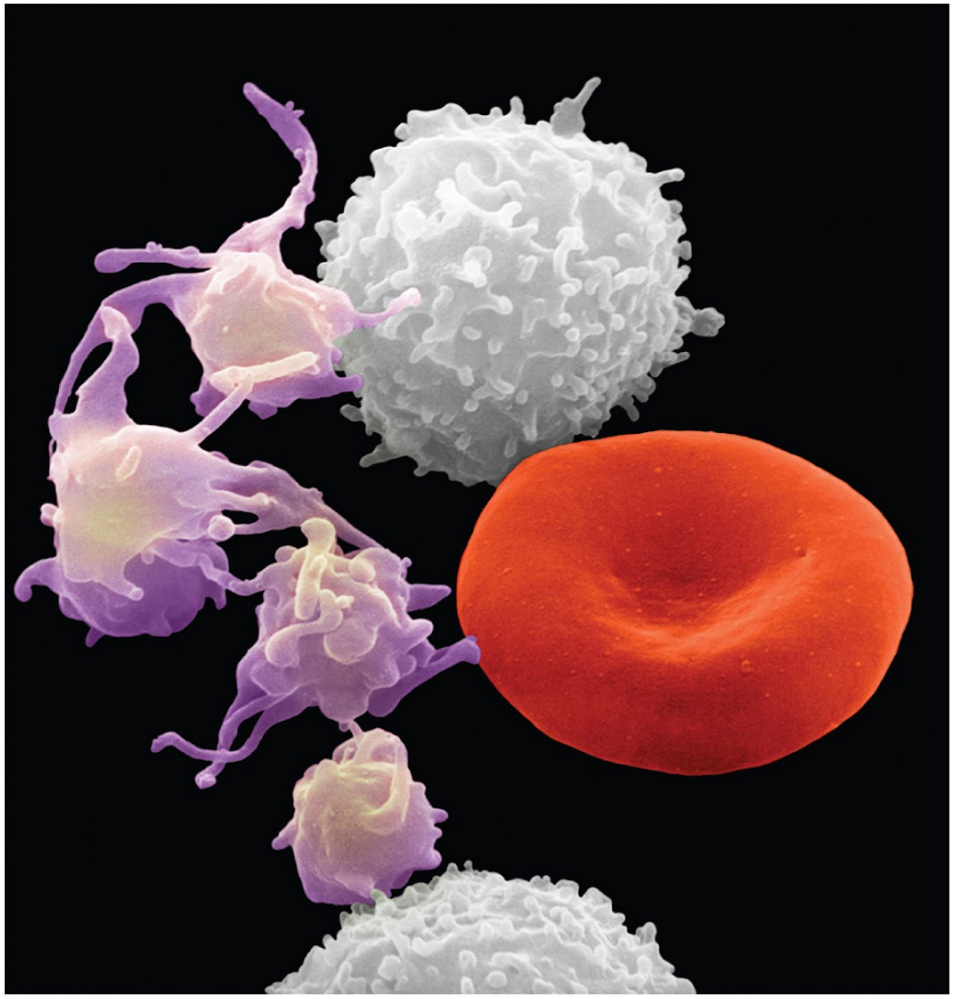
Stimulus causing hypoxemia

- high altitude
- increase in exercise
- emphysema



Note: emphysema is a disease that reduces the respiratory membrane surface area making it harder to bring oxygen into the blood. Cigarette smoking is the primary cause of this disease.

Leukopoiesis



Leukopoiesis

Leukopoiesis – production of white blood cells

Red bone marrow produce and releases into blood granulocytes (neutrophills, eosinophils, basophils) and agranulocytes (monocytes and lymphocytes)

Myeloid stem cell produce monocytes (macrophage) and the NEBs

Lymphoid stem cells produce B cells, T cells, natural killer cells

Lymphocytes produce cells important to the immune sysem

B cells // born in red bone marrow, “educated” in red bone marrow, and released from RB marrow into blood as immuno-competent cells

T lymphocytes born in red bone // travels in blood to thymus where it T cells are “educated” then re-enters blood as fully developed T cell.

Natural killer cells (NK) // immune surveillance

Leukocytes (WBCs)

WBC least abundant of all the formed elements // 5,000 to 10,000 WBCs/μL (the overwhelming number of these cells are neutrophils)

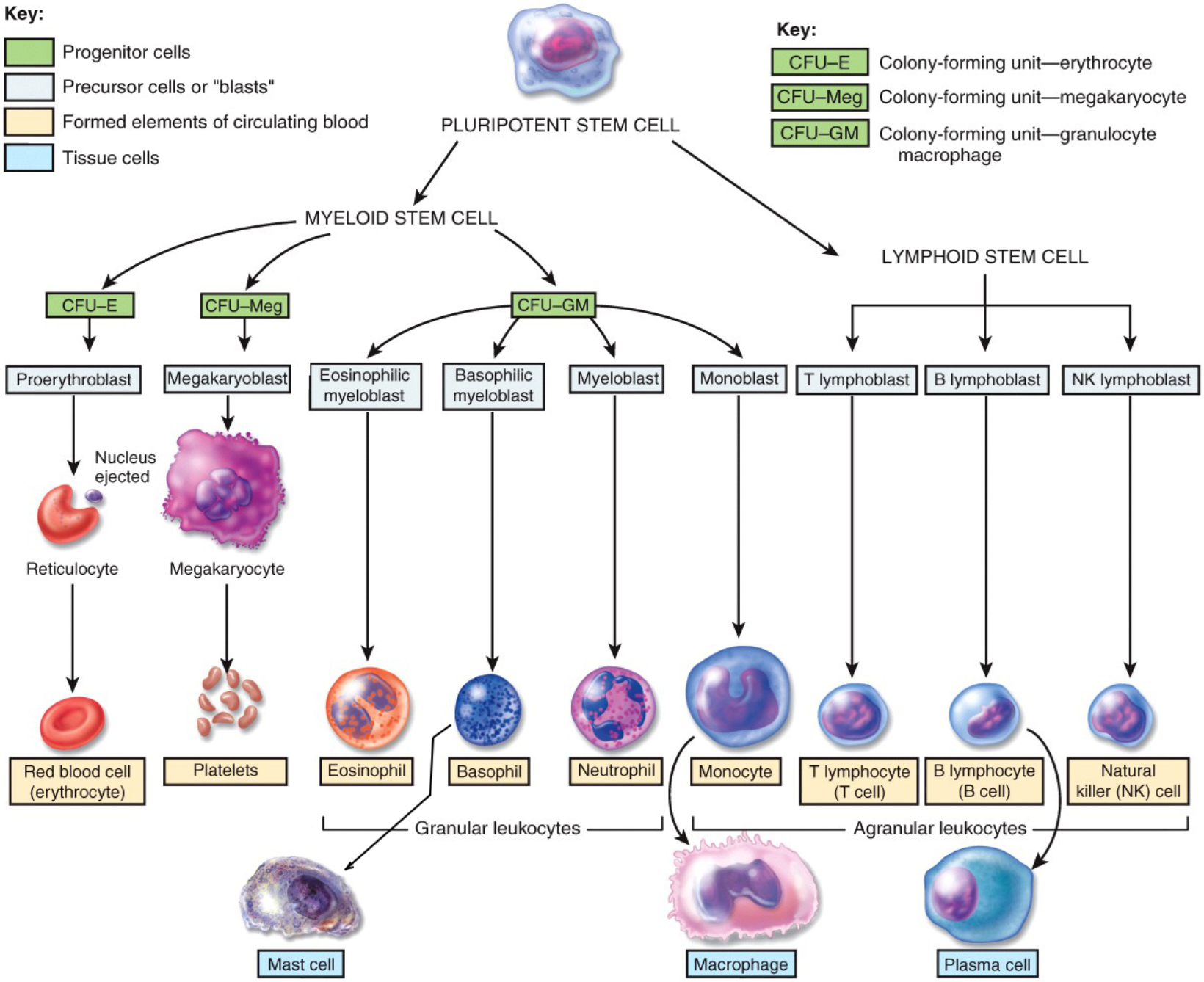
Primary function of neutrophils = protect against infectious microorganisms and other pathogens present in blood // able to emigrate into tissue spaces if bacterial is present // called the "first responders"

WBCs have conspicuous nucleus

WBCs spend only a few hours in the blood stream before migrating out of blood and into the interstitial space

WBC use connective tissues of the body to "wander" throughout our bodies (i.e. reticuloendothelial system)

Retain their organelles for protein synthesis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