Introduction
Blood

Components of blood

- Blood –collection of fluid and cells
- Fluid component- plasma
- Cells- red cells , white cells and platelets

Components of blood

- Separation of components

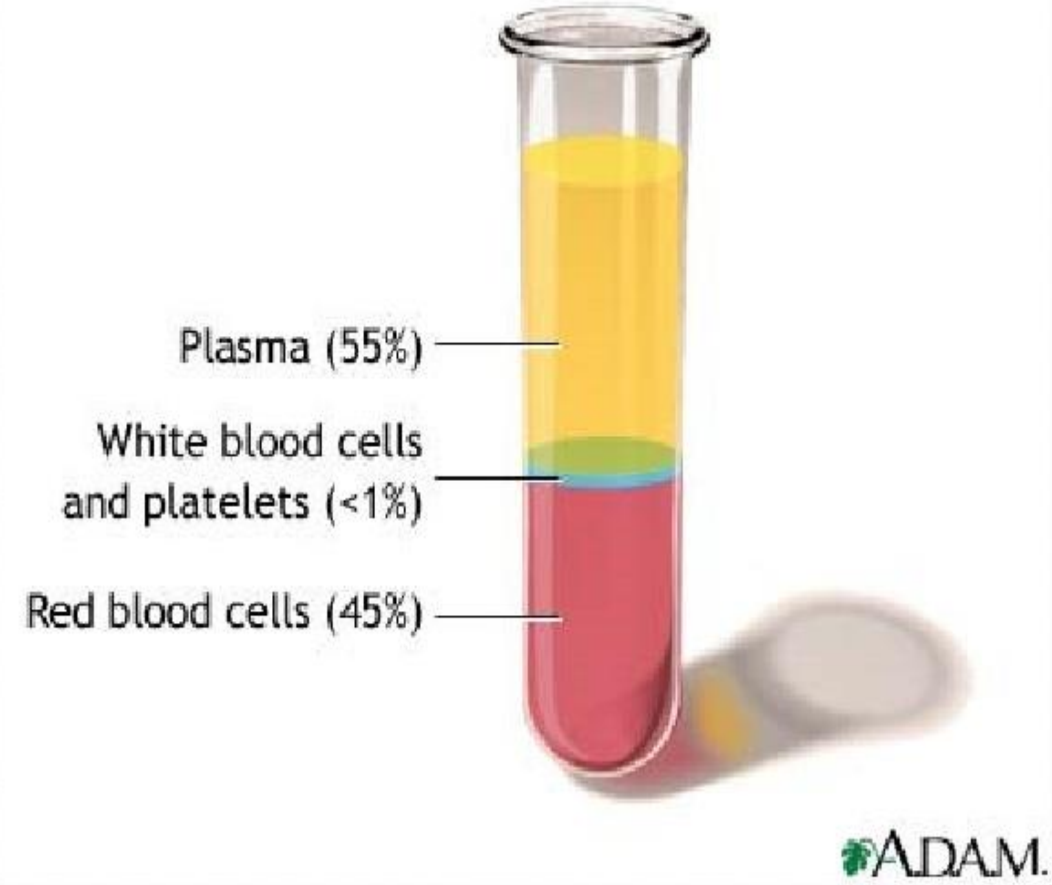
  -Collect blood samples in to a tube and centrifuge it

  -Cells go to bottom

  -Liquid component remains on top of the cell coloumn

Components of blood

- Red cells - 45%
- Plasma - 55%
- White cells - less than 1%
- Plasma containing clotting factors
- Removal of fibrin and clotting factors from plasma results serum


Plasma (55%)
White blood cells
and platelets (<1%)
Red blood cells (45%)
A.D.A.M.

- Packed cell volume _ haematocrit (PCV-Hct)
  - Height of red cell column as a percentage of total column
  - Done by using Winthrob tube and anticogulted blood
- Rate depends on
  - Number o red cells in plasma
  - Negative charge on red cells
  - Presence of ibrin and **rouleaux f**ormation

ESR

- Erythrocyte sedimentaion rate
- is the rate at which red blood cells sediment in a period of one hour
- Done using anticoagulated blood and wetergen tube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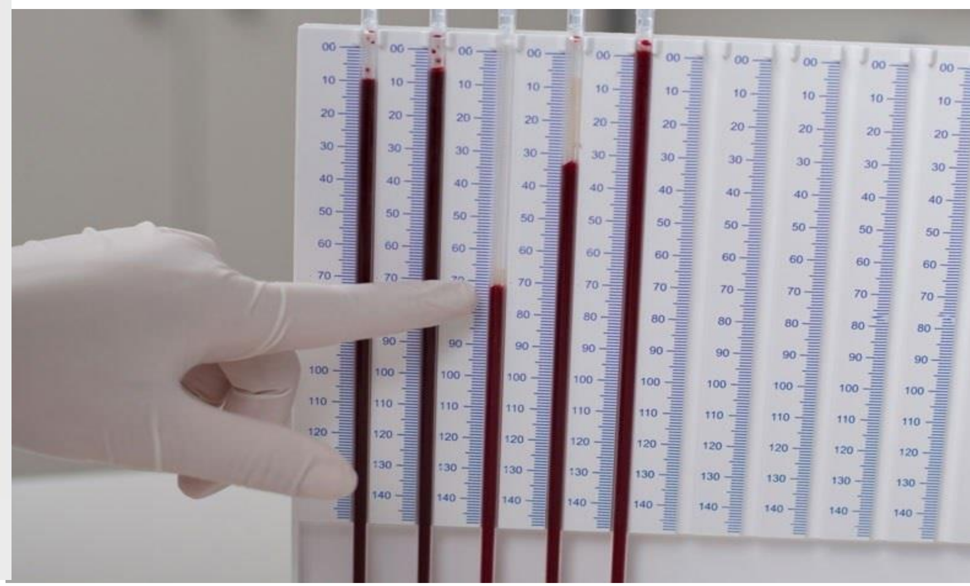


Haematopoiesis

Dr. K. Medagoda

Functions of Blood

- Blood performs a number of functions dealing with:
  - Substance distribution
  - Regulation of blood levels of particular substances
  - Body protection

Blood Functions: Distribution

- Blood transports:
  – Oxygen from the lungs and nutrients from the digestive tract
  – Metabolic wastes from cells to the lungs and kidneys for elimination
  – Hormones from endocrine glands to target organs

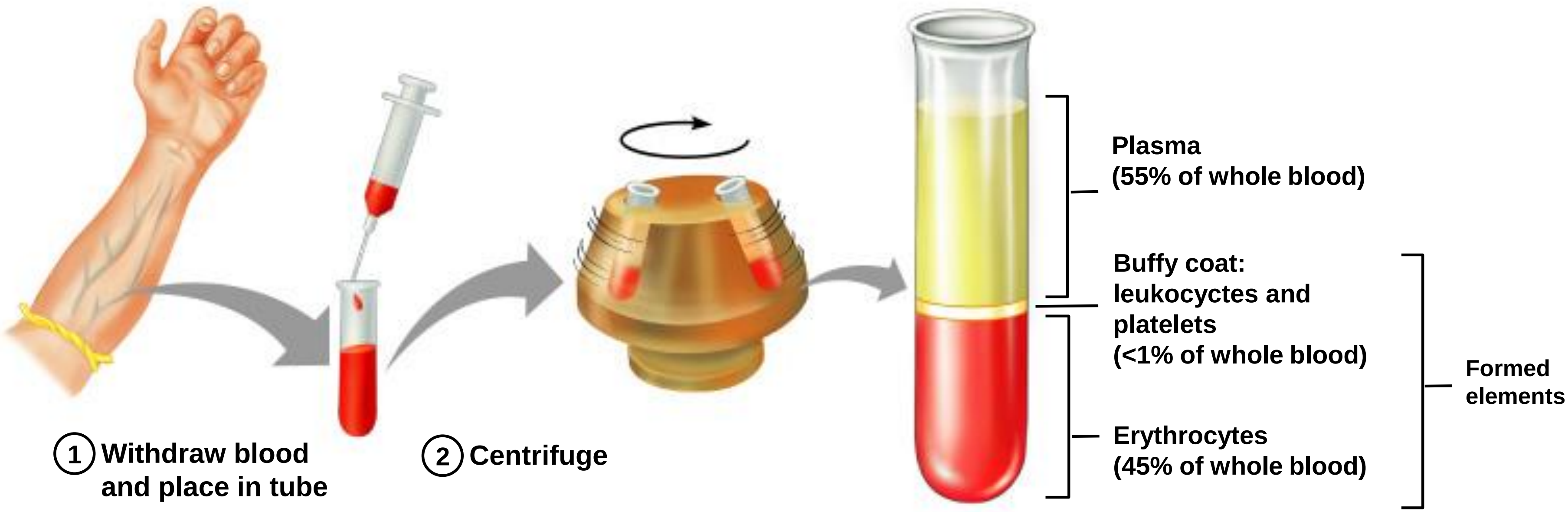
Blood Functions: Regulation

- Blood maintains:
  - Appropriate body temperature by absorbing and distributing heat to other parts of the body
  - Normal pH in body tissues using buffer systems
  - Adequate fluid volume in the circulatory system

Blood Functions: Protection

- Blood prevents blood loss by:
  - Activating plasma proteins and platelets
  - Initiating clot formation when a vessel is broken
- Blood prevents infection by:
  - Synthesizing and utilizing antibodies
  - Activating complement proteins
  - Activating WBCs to defend the body against foreign invaders

Components of Whole Blood



- Hematocrit
  - Males: 47% ± 5%
  - Females: 42% ± 5%

Formed elements in blood

- Formed elements comprise 45% of blood
- Erythrocytes, leukocytes, and platelets make up the formed elements
  - Only WBCs are complete cells
  - RBCs have no nuclei or organelles, and platelets are just cell fragments
- Most formed elements survive in the bloodstream for only a few days
- Most blood cells do not divide but are renewed by cells in bone marrow

Erythrocytes (RBCs)

- Biconcave disc
  - Folding increases surface area (30% more surface area)
  - Plasma membrane contains *spectrin*
    - Give erythrocytes their flexibility
- Anucleate, no centrioles, no organelles
  - End result - no cell division
  - No mitochondria means they generate ATP *anaerobically*
    - Prevents consumption of O_2 being transported
- Filled with hemoglobin (Hb) - 97% of cell contents
  - Hb functions in gas transport
    - $Hb + O_2 \longleftrightarrow HbO_2$ (oxyhemoglobin)
- Most numerous of the formed elements
  - Females: 4.3–5.2 million cells/cubic millimeter
  - Males: 5.2–5.8 million cells/cubic millimeter

Erythrocytes (RBCs)

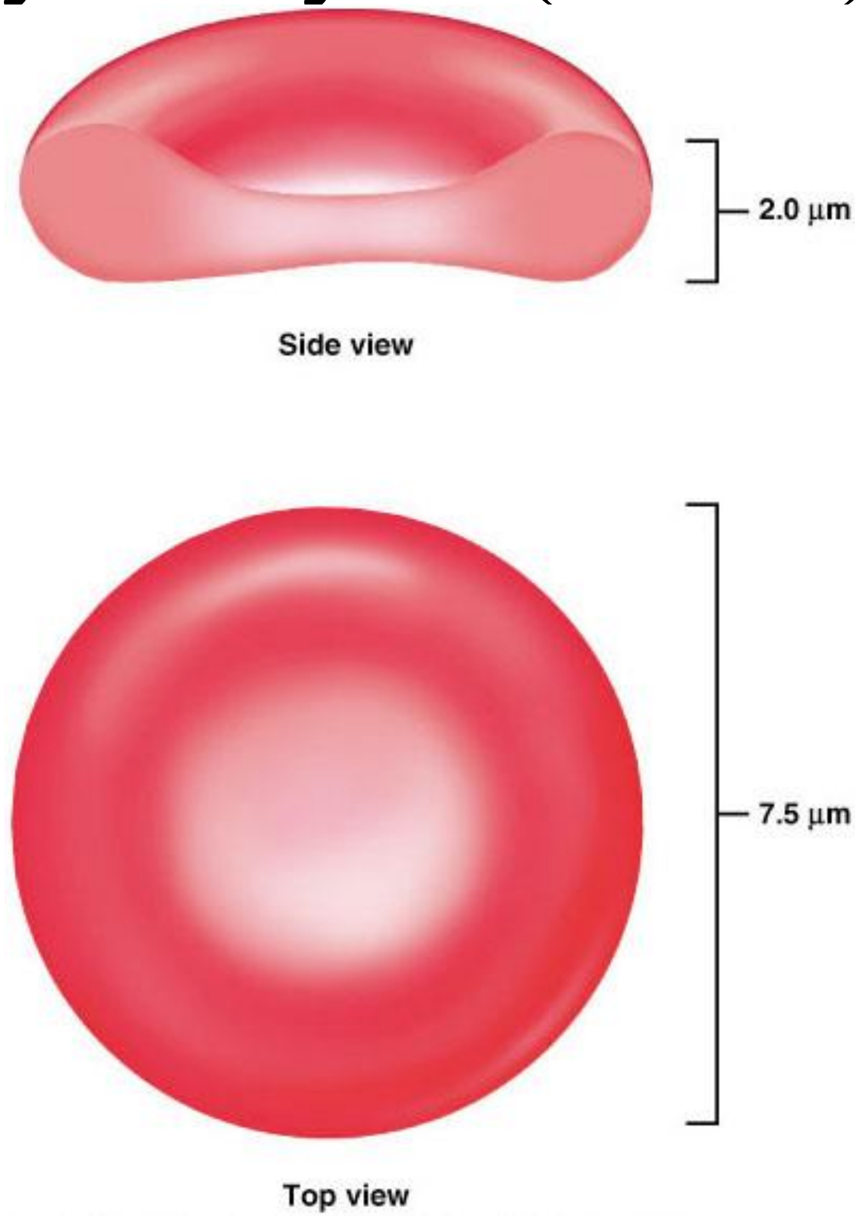


Figure 17.3

Fate and Destruction of Erythrocytes

- The life span of an erythrocyte is 100–120 days
- Old erythrocytes become rigid and fragile, and their hemoglobin begins to degenerate
- Dying erythrocytes are engulfed by macrophages
- Heme and globin are separated
  - Iron is removed from the heme and salvaged for reuse
    - Stored as hemosiderin or ferritin in tissues
    - Transported in plasma by beta-globulins as *transferrin*

Haematopoiesis

- Formation of red cells , white cells and platelets
- Occurs in the bone marrow
  - Medullary erythropoiesis
- Haematopoiesis – blood cell formation
  - Erythropoiesis – formation of red cells
  - Granulopoiesis- formation of white cells

Erythropoiesis – formation of red cells

- Occurs in the red bone marrow
  - Axial skeleton and girdles
  - Epiphyses of the humerus and femur
  - Marrow contains immature erythrocytes
  - Composed of reticular connective tissue

- Extra-medullary erythropoiesis
  - Formation of blood cells in the liver and spleen
  - Normally in fetal life
  - Abnormal in adult life
- Active marrow-red marrow
- Inactive marrow – yellow marrow

- Bone marrow has
  - Myeloid series – white cells producing precursors
  - erythroid series – maturing red cells

- Normally
  - 75% of the marrow belongs to myeloid series
  - 25% erythroid series
- The difference reflects life span of the respective cells

- In children the marrow cavities of all bones actively produced blood cells
- By age 20 the marrow cavities of long bones become inactive.
  - Except – humerus and femur

Erythropoiesis- cell series

- Multipotent uncommitted stem cells

    committed stem cells

    Early erythroblast

    Pronormoblast

    Early normoblast

    Late normoblast

    Reticuloyte

    Erythrocyte

Erythropoiesis- cell series

- Multipotent uncommitted stem cells
  - Can differentiate in to committed stem cells
- Committed stem cells
  - Differentiate in to various cells types
    - Erythroid cells
    - Granulocytes
    - Monoytes
    - Megakaryocytes

- Normal red cell maturation involves
  1. Successive increase in number of cells
  2. Diminution of cell size
  3. Reduction of nuclear size and condensation of chromatin
  4. Extrusion of nucleus
  5. Loss of cytoplasmic RNA
  6. concurrent production of haemoglobin

Erythropoiesis- cell series

- Early erythroblast
  - Finely depressed chromatin and basophilic cytoplasm
- Pronormoblast
  - The earliest morphologically recognizable precursor of red cell series
    - Basophilic cytoplasm
    - Early condensation of chromatin

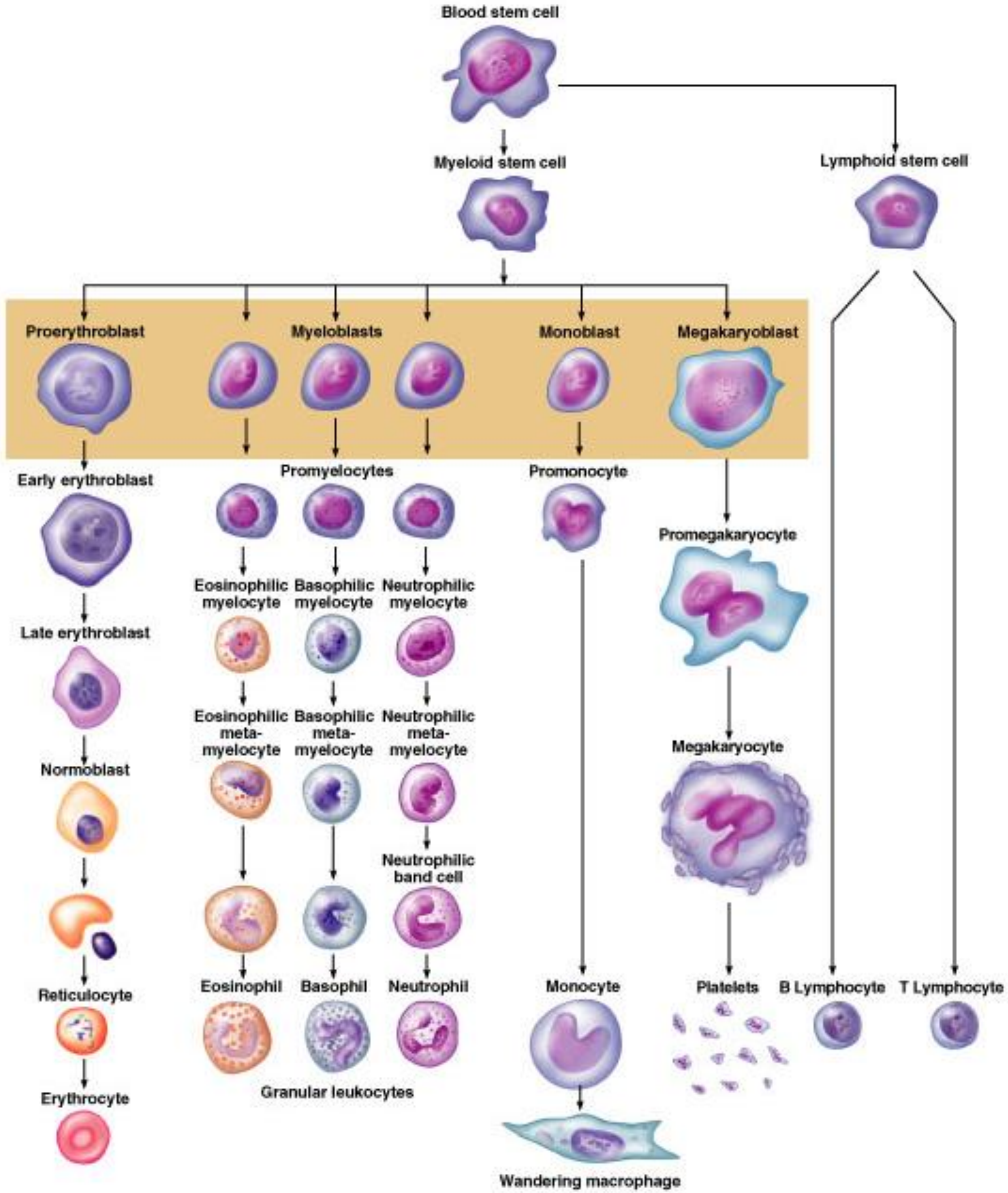
Erythropoiesis- cell series

- Early normoblast
  - Basophilic cytoplasm
  - Well marked condensation of chromatin
- Late normoblast
  - Haemoglobinisation
  - Marked nuclear condensation
  - Shred the nucleus to become a reticuloyte
- Reticuloyte
  - Immature red cell following extrusion of nucleus
  - Maturation takes 48-72 hours
- Erythrocyte – mature red cell

- Reticuloyte
  - Immature red cell following extrusion of nucleus
  - Maturation takes 48-72 hours
  - Final 24hours in the circulation
- Contains
  - Polyribosomes, RNA and mitochondria
  - Gives polychromasia with Romanowsky staining

- Reticulocytes make up about 1 -2 % of all circulating erythrocytes
  - Reduced in marrow failure
  - Increased in when there is increased red cell production

Stages of Differentiation of Blood Cells



Erythropoiesis

- The developmental pathway consists of three phases
  - Phase 1 – ribosome synthesis in early erythroblasts
  - Phase 2 – hemoglobin accumulation in late erythroblasts and normoblasts
  - Phase 3 – ejection of the nucleus from normoblasts and formation of reticulocytes

- Reticulocytes then become mature erythrocytes
  - Reticulocytes make up about 1 -2 % of all circulating erythrocytes

Regulation and Requirements for Erythropoiesis

- Circulating erythrocytes – the number remains constant and reflects a balance between RBC production and destruction
  - Too few red blood cells leads to tissue hypoxia
  - Too many red blood cells causes undesirable blood viscosity
- Erythropoiesis is hormonally controlled and depends on adequate supplies of iron, amino acids, and B vitamins

Hormonal Control of Erythropoiesis

- Erythropoietin
  - A glycoprotein
  - Released from kidney and the liver
- Erythropoietin (EPO) release is triggered by:
  - Hypoxia due to decreased RBCs
  - Decreased oxygen availability
  - Increased tissue demand for oxygen
- Enhanced erythropoiesis increases the:
  - RBC count in circulating blood
  - Oxygen carrying ability of the blood

Erythropoietin Mechanism

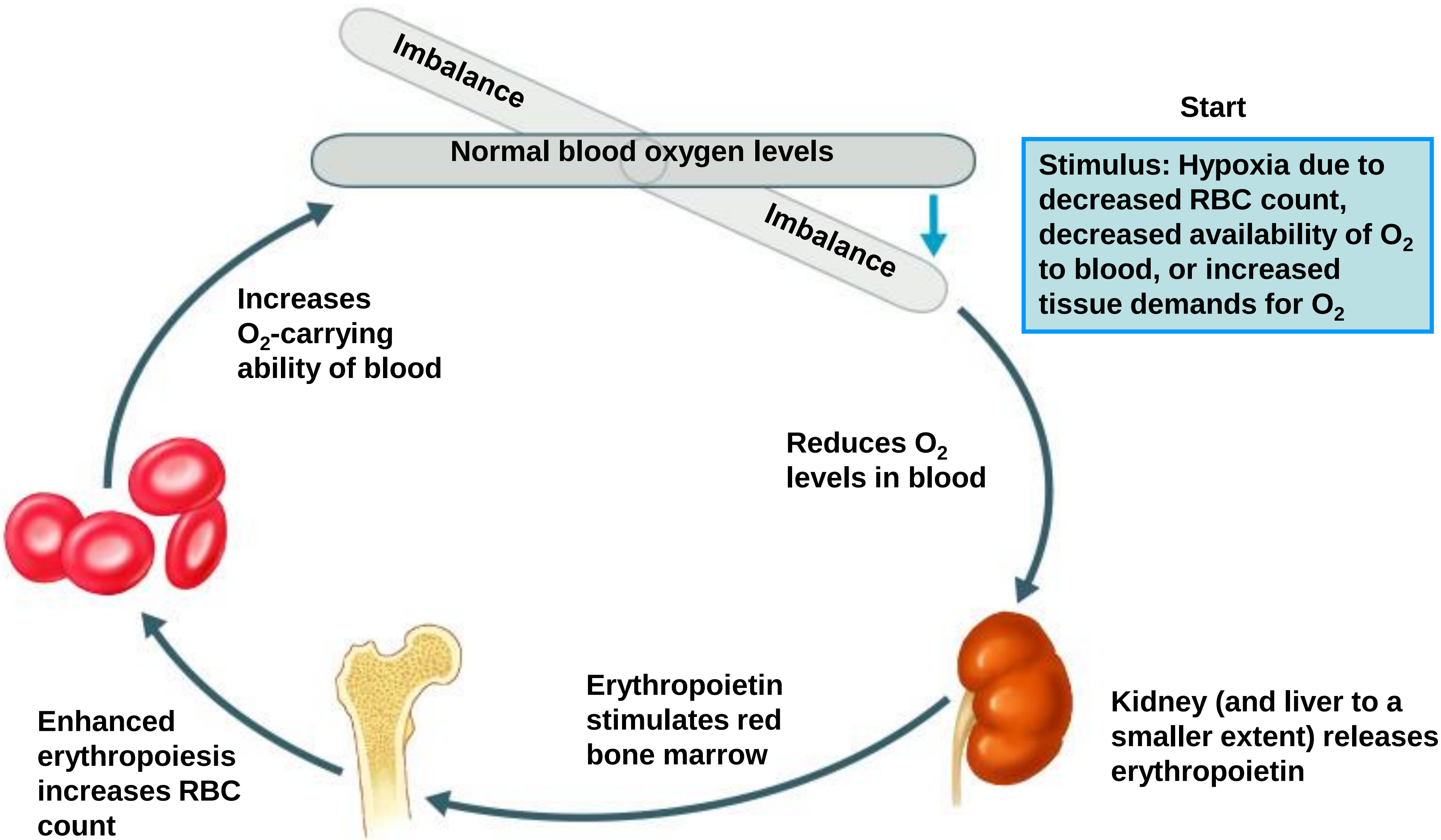


Figure 17.6

Requirements for Erythropoiesis

- Erythropoiesis requires:
  - Proteins, lipids, and carbohydrates
  - Iron, vitamin B_{12}, and folic acid
  - Trace metals – cobolt
  - Hormones – androgens and thyroxine
  - interleukins

- The body stores iron in Hb (65%), the liver, spleen, and bone marrow

- Intracellular iron is stored in protein-iron complexes such as ferritin and hemosiderin

- Circulating iron is loosely bound to the transport protein transferrin