Blood

The liquid connective tissue that transports substances throughout the body

- Transports nutrients and oxygen to the cells and carries away the cell's CO_2 and other wastes
- Blood also contains cells and proteins that fight infections
- Blood is composed of plasma (a liquid) and formed elements (cells)

Fig 18.2

Plasma

The liquid part of the blood; It transports dissolved molecules

- Mostly water, with the following dissolved molecules:
  - Salts (ions/electrolytes)
    - √ examples: Na^+, K^+, Ca^{2+}
  - Nutrients and monomers
    - √ examples: Glucose, fatty acids, amino acids
  - Cellular wastes
    - √ examples: CO_2, urea
  - Proteins
    - √ Examples: Albumin (for osmotic balance and pH buffering), antibodies (for binding foreign cells and other substances that have infected the body), and clotting proteins (for forming blood clots when we have been cut)
  - Hormones

Fig 18.2; Table 18.3

Formed elements

The blood cells

There are three major blood cell types: Red blood cells, white blood cells, and platelets.

- Erythrocytes (red blood cells, RBCs) = Cells that carry O_2
  - √ Flat round cells with an indent on each face
  - √ No nucleus or other major organelles
  - √ RBCs are filled with the protein hemoglobin, which binds O_2
  - √ They are the most numerous of the formed elements

- Leukocytes (white blood cells, WBCs) = Five blood cell types that fight infections and cancer

- Platelets = Tiny, irregular cell fragments that aid in blood clotting

Figs 18.3, 18.5, 18.6, 18.7, and 18.13; Table 18.3

Formation of blood cells

All blood cells are formed from stem cells in the red marrow of bones

- Mostly in ribs, sternum, pelvis, and skull bones
- Blood cell formation is controlled by hormones
  - √ Example: The hormone erythropoietin increases RBCs

Figs 3.34 and 18.4

Anemia

Weakness due to inability of blood to carry sufficient O_2;
Possible causes:

- Loss of erythrocytes through bleeding
- Chemotherapy
- Lack of iron in diet
  - √ Hemoglobin uses iron to bind the oxygen it carries
- Hemolytic (bursting RBCs) diseases
  - √ Examples: Malaria, sickle cell anemia

Leukocytosis

Increase in white blood cell count

- Normally caused by infection
- Rarely, symptom of leukemia (bone marrow cancer)

Hemostasis

The series of events that stops blood from flowing out of a broken blood vessel

Hemostasis begins with platelets binding to the exposed collagen in the connective tissue around the vessel

(1) Vasocontriction (constriction of the blood vessel) occurs to slow blood flow
- Vasoconstriction is caused by molecules released from the platelets bound to the collagen

(2) A platelet plug forms
- The platelets in the cut stick to the collagen and to each other

(3) Coagulation (formation of a solid clot that stops the bleeding and covers the break until the tissues are repaired)
- The blood clot is a web of fibrin protein with trapped RBCs and platelets

- Fibrin = A large sticky protein made by linking smaller fibrinogen proteins together

- Thrombin = The blood enzyme that links fibrinogen together to make fibrin

√ Thrombin is made from prothrombin (an inactive precursor)

√ Molecules released from torn cells and tissues activate a series of clotting factor proteins, which in turn activate prothrombin to become thrombin

Fig 18.14

Disorders of hemostasis:

- Inability to stop bleeding
    - √ Causes: Hemophilia (genetic lack of a clotting factor), deficiency in vitamin K, low platelet count
- Thrombus = A clot that forms in an unbroken blood vessel
    - √ Embolus = Anything that can block a blood vessel, such as a dislodged thrombus that travels in the blood stream
    - √ Heart attacks are usually caused by a thrombus blocking a blood vessel in the heart
    - √ The drug TPA is given to dissolve a thrombus

Blood thinners

Medicines that inhibit hemostasis

- Usually given to decrease risk of heart attacks
- Examples: Coumadin, warfarin, aspirin

Antigen

Molecules (usually proteins, carbohydrates, and lipids on the surface of a cell) that the immune system can interact with

- Foreign antigen = A molecule that does *not* occur naturally the body
  - √ The immune system attacks foreign antigens using proteins called antibodies
- Self antigen = A molecule that does occur naturally in the body
  - √ The immune system does not attack cells that have self antigens

Blood groups

Different types of blood caused by different antigens on RBCs

- Receiving a transfusion of blood with foreign antigens can be fatal
  - √ The RBCs with foreign antigen are torn apart by the patient's antibodies
  - √ The cellular debris clogs the patient's blood vessels
- Never give a patient blood cells that have a foreign antigen to that patient

Fig 18.17; Table 18.2

There are 3 major RBC antigens: A antigen, B antigen and Rh antigen

- Each person's RBCs may have all, some, or none of the three RBC antigen types. This means there are 8 possible blood types.

- The eight possible blood types are:

  A+, A-, B+, B-, AB+, AB-, O+, and O-

- The symbols used in blood types:

  A = Has A antigen

  B = Has B antigen

  O = Does not have antigen A and does not have antigen B

  + (positive) = Has Rh antigen

  - (negative) = Does not have Rh antigen

Fig 18.17; Table 18.2

An Rh^- person develops antibodies to the Rh antigen only after an exposure to the Rh antigen

- An Rh- woman will be exposed to Rh antigen if she gives birth to an Rh+ baby

  √ The Rh^- woman's immune system will then make antibodies against the Rh antigen. These antibodies will attack her *second* Rh^+ baby as it develops in inside her womb.

Fig 21.30