Blood

Biol 105
Lecture Packet 13
Chapter 11

Outline
I. Overview of blood
II. Functions of blood
III. Composition of blood
IV. Composition of plasma
V. Composition of formed elements
VI. Platelets
VII. White blood cells
VIII. Red blood cells
IX. Blood types
X. Clotting
XI. Disorders

Blood: An Overview

- Blood
  - A fluid connective tissue
  - Made up of:
    - 55% plasma (liquid)
    - 45% cellular components = formed elements

Blood: Functions

1. Transportation
2. Protection against invasion
3. Blood clotting
4. Regulation

Blood: Functions – Transport

1. Blood is the primary transport medium.
   - Transports oxygen, carbon dioxide, nutrients, waste

Blood: Functions – Defense

2. Blood defends the body against invasion by pathogens.
   - Blood contains white blood cells and antibodies

Blood: Functions – Blood clotting

3. Blood clotting prevents blood loss due to injury

Blood: Functions - Regulation

4. Blood has regulatory functions
   - Temperature
   - Salts
   - pH
   - Water
Composition of Blood

- **Plasma**
  - Liquid portion of blood (55% of blood volume)
  - Made up of 93% water and 7% dissolved substances.

- **Formed elements** (45% of blood volume)
  - Solid portion of blood
  - Made of cells and platelets

Composition of Plasma

1. Plasma proteins
2. Nutrients
3. Ions
4. Salts
5. Dissolved gases
6. Hormones
7. Waste products

Plasma Proteins - Types and Functions

- **Albumins** - Needed for the water-balancing properties of plasma
- **Globulins** - Transport lipids and fat-soluble vitamins
- **Clotting proteins** – example: fibrinogen
- **Lipoproteins**: HDL and LDL - Transport cholesterol
- **Antibodies** - provide immunity

This type of lipoprotein carries cholesterol away from the liver

1. HDL
2. LDL

LDL is considered _____ cholesterol

1. Good
2. Bad

The ratio between plasma and formed elements is:

1. 35:65%
2. 65:35%
3. 55:45%
4. 45:55:

Composition of Formed Elements

1. Platelets – aid in blood clotting
2. White Blood Cells (WBC) – fight infection
3. Red Blood Cells (RBC) – carry oxygen

- **Stem cells** give rise to all the formed elements
- **Stem cells** are in the red bone marrow

Formed Elements
Formed Elements - Platelets

- Platelets are also called thrombocytes
- They are fragments of larger precursor cells called megakaryocytes
- Life span: 5 to 10 days
- Function: Essential to blood clotting

Formed Elements - White Blood Cells

- Some squeeze through pores in the capillary wall therefore are also found in tissue fluid and in lymphatic system

Plasma and Formed Elements

- White blood cells (WBCs) – also called leukocytes
- Life span: a few hours to a few days
- Functions:
  - Help defend the body against disease
  - Remove wastes, toxins, and damaged and abnormal cells

Formed Elements - White Blood Cells

- Neutrophils
- Eosinophils
- Basophils and Mast cells
- Monocytes
- Lymphocytes – T cells, B cells, NKC

Types of WBCs

- Most abundant and often the first to respond to an infection.
- Phagocytes – engulf microbes (bacteria).
White Blood Cells: Eosinophils

- Eosinophils
- Defend against parasitic worms
- Lessen the severity of allergies and asthma

White Blood Cells: Basophils and Mast cells

- Basophils
  - Release histamine
    - A chemical that attracts other white blood cells
    - Causes the blood vessels to dilate and become more permeable
    - Also play a role in some allergic reactions

- Mast cells are similar to basophils but are found in tissues

White Blood Cells: Lymphocytes

- Lymphocytes
  - B-cells protect us by producing antibodies
  - T-cells destroy any cell that is foreign
  - Natural Killer cells attack virus infected cells and tumor cells

White Blood Cells: Monocytes

- Monocytes
  - The largest of the formed elements
  - Develop into macrophages
  - Phagocytic cells that engulf invading microbes, dead cells, and cellular debris

White Blood Cells: Neutrophils

- Neutrophils
  - Phagocytic cells that engulf invading microbes

These WBCs release histamines

1. Eosinophils
2. Basophils
3. Neutrophils
4. Lymphocytes

These WBCs fight parasite infections

1. Eosinophils
2. Basophils
3. Neutrophils
4. Lymphocytes

The largest WBCs are

1. Lymphocyte
2. Eosinophils
3. Monocytes
4. Neutrophils

Red Blood Cells

25% 25% 25% 25%

Table 11.1 (3 of 3)
Red Blood Cells

- Red blood cells (RBCs) - also called erythrocytes
  - Most numerous of the formed elements
  - Transport oxygen to the rest of the cells
  - Carry about 23% of the total carbon dioxide
  - Shaped like biconcave disks and are very flexible
  - Life span: about 120 days – removed by liver and spleen (see page 203-204)
  - Mature RBCs have no nucleus

RBCs contain Hemoglobin

- A protein that binds to oxygen, making oxyhemoglobin
- Hemoglobin has a much greater affinity for carbon monoxide, an odorless and tasteless gas

What is the role of oxygen in the body?

- Oxygen is the final electron acceptor of the electron transport chain in cellular aerobic respiration

Which of the following produces erythropoietin

1. Bone marrow
2. Kidneys
3. Anterior Pituitary
4. Hypothalamus

Production of Red Blood Cells

- When the body detects a low level of oxygen, the kidneys produce a hormone called erythropoietin
- Erythropoietin is a hormone that speeds up maturation of stem cells that are in the process of becoming RBC.
- The target of erythropoietin is the bone marrow, where red blood cells are formed

What hormone increases production of RBC

1. Renin
2. Erythropoietin
3. Leptin
4. RBCH

Red Blood Cell Formation
Blood Types A, B and O

- Genetically determined by the glycoproteins found on the surface of RBCs
- Named by the antigen found on the surface of the cell
  - A
  - B
  - AB
  - O

Blood Typing

- Most common blood type: Type O
- Rarest blood type: Type AB
- Universal donor blood type: Type O
- Universal recipient blood type: Type AB
- The ABO system is used to determine the compatibility of donor’s and recipient’s blood.

Blood Types

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigen protein</th>
<th>Antibodies</th>
<th>Blood that can be received</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>A and B</td>
<td>None</td>
<td>A, B, AB, O</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
<td>B, O</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
<td>A, O</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
<td>Anti-A and Anti-B</td>
<td>O</td>
</tr>
</tbody>
</table>

Blood Types - Rh factor

- People only develop anti-Rh antibodies if they are exposed to the Rh factor antigen.
- These antibodies are small enough to pass through the placenta.

Blood Types – Rh Factor

- Rh factor
  - Another important antigen on RBCs
  - Becomes critical during pregnancies of Rh-negative women
- Individuals who have Rh antigens on their RBCs are Rh-positive

Agglutination = clumping

- Occurs when someone’s antibodies contact a foreign cell
Blood Types
- Rh-negative person will not form anti-Rh antibodies unless he or she has been exposed to the Rh antigen
  - Tranfusion
  - Having given birth to a Rh-positive baby

Rh Factor
- An Rh+ man and an Rh- woman could have an Rh+ baby.

Rh Factor
- First pregnancy: At birth some of the Rh+ blood of the fetus may enter the mother’s circulation.

Rh Factor
- After delivery: The mother forms anti-Rh antibodies over the next few months.

Blood Types
- Hemolytic disease of the newborn
  - Anti-Rh antibodies can develop in the mother
  - They can cross the placenta, destroying the Rh-positive fetus’s RBCs
  - The baby may die or be very anemic

Blood Types – Rh factor
- Rhogam
  - A serum containing antibodies against the Rh antigens
  - Given to Rh- mothers to prevent the production of anti-Rh antibodies

Blood Clotting
- When a blood vessel is cut, a series of events occur to stop the bleeding.
  - There are more than 30 steps in the process of forming a clot.

Blood Clotting
1. Vessel damage occurs.
2. Blood vessel constricts/spasms
3. Platelets adhere to damaged site
4. Clotting factors are released at the site of the injury
5. The clotting factors activate inactive proteins in a cascade
Blood Clotting

7. At the end of the cascade, fibrin strands form and trap blood cells, and platelets form a meshwork forming a clot and sealing the damaged vessel.
8. Clot contracts and pulls damaged edges together, further sealing the opening.

Blood Clotting

- Vitamin K is needed for the liver to synthesize several clotting factors.
- Aspirin inhibits platelets from sticking together.
- There are genetic disorders, including hemophilia, which interfere with the clotting process.

Vitamin K is needed for the liver to synthesize several clotting factors.

Aspirin inhibits platelets from sticking together.

There are genetic disorders, including hemophilia, which interfere with the clotting process.

Can blood type A donate to blood type B?

1. Yes
2. No

Can blood type AB donate to blood type B?

1. Yes
2. No

Can blood type A donate to blood type AB?

1. Yes
2. No

Universal recipient blood type is

1. Type A
2. Type B
3. Type AB
4. Type O

Blood Disorders

- Anemia
  - Iron deficiency anemia
  - Hemolytic anemias
  - Sickle-cell anemia
  - Pernicious anemia
  - Leukemia

Blood Disorders - Anemia

- Anemia
  - Several types
  - The blood’s ability to carry oxygen is reduced
  - Can result from too little hemoglobin, too few red blood cells, or both
- Symptoms
  - Fatigue, headaches, dizziness, paleness, breathlessness, and heart palpitations
Blood Disorders - Iron deficiency Anemia

- Iron deficiency anemia
  - Most common
  - Leads to inadequate hemoglobin production
- Causes
  - A diet that contains too little iron
  - An inability to absorb iron from the digestive system
  - Blood loss

Blood Disorders - Hemolytic Anemia

- Hemolytic anemias
  - Occur when red blood cell destruction exceeds production
- Causes
  - Infections
  - Defects in the membranes of RBCs
  - Transfusion of mismatched blood
  - Hemoglobin abnormalities

Blood Disorders - Sickle-cell Anemia

- Sickle-cell anemia
  - An example of a hemolytic anemia
- Caused by genetically abnormal hemoglobin
  - RBCs form a sickle shape when the blood’s oxygen content is low
- Results in RBCs that are fragile and rupture easily, clogging small blood vessels and promoting clot formation

Blood Disorders - Pernicious Anemia

- Pernicious anemia
  - Occurs when there is insufficient production of red blood cells
  - RBC production depends on the availability of vitamin B₁₂
  - Absorption of vitamin B₁₂ depends on a protein called intrinsic factor
  - Lack of vitamin B₁₂ due to the lack of intrinsic factor secretion from the stomach lining

Blood Disorders - Leukemia

- Leukemia
  - A cancer of the WBCs that causes the number of WBCs to increase
  - These cells do not function as normal WBCs

Important concepts

- What is the ratio of blood plasma versus formed elements
- What is the composition of blood, plasma, and formed elements
- What are the functions of blood

Important concepts

- What are examples given in class of the proteins found in blood, and what are the functions of these blood proteins
- Know the function of lipoproteins, difference between LDL and HDL
- Where are blood cells formed
- What type of cell gives rise to platelets by breaking into fragments
- How do white blood cells leave the blood vessels and enter tissues

Important concepts

- What organelle is missing in mature RBCs, how is their production regulated, what hormone regulates their production, what organ produces this hormone
- What is the effect of carbon monoxide poisoning?
- What are the characteristics, functions, and life span of Red Blood Cells, White Blood Cells, Platelets
- How and where are RBCs destroyed
- What are the types of white blood cells and their functions

Important concepts

- In detail, be able to discuss how is a blood clot formed – know the abbreviated steps of clot formation
- What vitamin is necessary for clotting to occur
- What common drug inhibits clotting
- What is an example of a genetic disorder that affects blood clotting.
Important concepts

- What are the major blood types, what are their differences, what antigens do they have, what antibodies do they have. What blood types can donate to each other. What is the universal donor, and the universal recipient.
- What is the Rh factor, what problems does it cause in pregnancy and blood donation, how does the body mount a defense to Rh factor. What drug is given to Rh negative pregnant women, why is this drug given, what is the effect of this drug.
- What is the result of a reaction to a foreign blood type antigen
- Know all the blood disorders discussed in class

Definitions

- Plasma, formed elements, hemoglobin, oxyhemoglobin, Stem cells, thrombocytes, megakaryocytes, leukocytes, phagocytes, histamine, dilate, permeable, erythrocytes, biconcave, erythropoietin, bilirubin, glycoproteins, homeostasis, agglutination, antibodies, antigen, lipoproteins, High density lipoproteins, Low density lipoproteins,