I. Introduction

A) Blood: Liquid Connective Tissue
   (1) Components:
      (a) Matrix:
      (b) Cells:
         1) Erythrocytes
         2) Leukocytes
         3) Thrombocytes

B) General Functions
   (1) 
      (a) Respiratory gases
      (b) Nutrients
      (c) Salts/ions
      (d) Cellular wastes
   (2) 
      (a) Antibodies
      (b) Phagocytosis
      (c) Clotting
   (3) 
      (a) Body fluid pH
      (b) Body temperature

C) Plasma
   (1) Water:
      (a) universal solvent
      (b) Absorbs heat
   (2) Salts (ions)
      (a) Osmotic balance
      (b) pH buffering
      (c) Examples: Na⁺, Cl⁻, K⁺, Ca^{2+}, bicarbonate
   (3) Proteins
      (a) ______________________ osmotic balance, buffer
      (b) ______________________ clotting
      (c) ______________________ defense
   (4) Transported substances:
      (a) Nutrients (monomers and vitamins)
      (b) Metabolic waste (urea)
      (c) Respiratory gases
(d) hormones

D) Formed elements

(1) Erythrocytes:
   (a) Structure
      1) Biconcave disc
      2) Nonnucleated
      3) Filled with Hemoglobin
   (b) Function: transport respiratory gases
      1) Oxygen $\text{O}_2$
      2) carbon dioxide $\text{CO}_2$

(2) Leukocytes:

   (a) Diapedesis: capable of moving out of blood vessels to enter body tissues to carry out function

   (b) Granulocytes
      1) Cytoplasmic granules contain chemicals used in functions

2) Agranulocytes
   a) Lack cytoplasmic granules

(3) Granulocytes:

   (a) Neutrophils
      1) 3-7 lobed nucleus
      2) 40-70% WBC
      3) Granules
      4) 

   (b) Eosinophils
      1) Bilobed nucleus
      2) 1-4% WBC
      3) 

   (c) Basophils
      1) U or S-shaped nucleus
      2) 0-1% WBC
3) 

(4) Agranulocytes:

(a) Lymphocytes
   1) Large, spherical nucleus
   2) Very little cytoplasm
   3) 20-45% WBC

4) Immunity
   a) __________________ produce antibodies
   b) __________________ viral, cancer, tissue rejection

(b) Monocytes
   1) Kidney-shaped nucleus
   2) 4-8% WBC
   3) 

E) Blood Cell Formation

(1) Red Bone Marrow of spongy bone
(2) Infants: all bones
(3) Adults: skull, ribs, sternum, vertebrae and pelvic bones

(4) 
   (a) Mitotic cells
   (b) Undifferentiated cells that give rise to other cells that can differentiate into other specific cell types

(5) 
   (a) Extremely large cells pinch off bits of cytoplasm and membrane
   (b) Results platelet/thrombocytes

(6) 
   (a) Hormone produced by kidney
   (b) Produced in response to low oxygen
   (c) Results in increased RBC production

(7) 
   (a) Condition where body not getting enough oxygen
   (b) Pernicious anemia (deficient vitamin B-12)
   (c) Lack hemoglobin (dietary deficiency folic acid)
   (d) Sickle-cell anemia (mutation in hemoglobin gene)
(1) Blood vessel damaged--Damaged cells release molecules and exposed collagen that

(2) Vascular Spasms Smooth muscle of blood vessel wall constricts to

(3) Platelet Plug Formed—temporary seal

(4) Simultaneously, clotting cascade begins—series of chemical reactions of blood proteins

(5) Clotting Cascade/coagulation
   
   (a) prothrombin Inactive enzyme (circulates in blood) that’s activated by injured tissues

   (b) thrombin Active enzyme—builds fibrin mesh

   (c) Fibrinogen: inactive blood protein

   (d) fibrin: mesh seals damaged area by trapping RBCs until blood vessel repaired

(6) Anticoagulants:
   
   (a) ____________________________ blocks platelet aggregation preventing platelet plug formation

   (b) ____________________________ blocks thrombin—fibrinogen fails to be activated/converted to fibrin

   (c) ____________________________ interferes with Vitamin K activity (liver enzymes cannot produce clotting plasma proteins)
G) Blood Typing

(1) ________________ surface molecule that identifies cells (recognition markers) and causes an immune response

(2) ________________ blood proteins produced by the lymphocytes that binds a specific antigen

(3) ________________ antibody binds antigen causes clumping of the red blood cells, clogs small blood vessel

(4) ABO Blood groups: based on a specific carbohydrate group (antigen) attached to the surface of red blood cell

(a) Type A
   1) A Antigen
   2) Anti-B Antibodies

(b) Type B
   1) B Antigen
   2) Anti-A Antibodies

(c) Type AB
   1) A and B Antigen
   2) Type O
   3) Anti-A and Anti-B antibodies

(d) Universal blood donor

(e) Universal blood recipient

---

**Blood being tested**

<table>
<thead>
<tr>
<th>Serum</th>
<th>Anti-A</th>
<th>Anti-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type AB</td>
<td>![Image](Type AB.png)</td>
<td>![Image](Type AB.png)</td>
</tr>
<tr>
<td>(contains antigens A and B); agglutinates with both sera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B</td>
<td>![Image](Type B.png)</td>
<td>![Image](Type B.png)</td>
</tr>
<tr>
<td>(contains antigen B); agglutinates with anti-B serum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type A** (contains antigen A); agglutinates with anti-A serum

**Type O** (contains no antigens); no agglutination occurs
(5) **Rh Factor**
   
   (a) Rh antigen on RBCs

   (b) Anti-Rh antibodies only made upon exposure to antigen

   (c) **problem: mom Rh- and baby Rh+**

   (1) fetal blood mixes with moms last stages of pregnancy
   (2) 1\textsuperscript{st} Rh+ child normal, mom produces anti-Rh
   (3) 2\textsuperscript{nd} Child, anti-Rh antibodies cross placenta and cause agglutination (hemolytic disease of newborn)
   (4) mom injected RHOGAM-injection of antibodies that binds childs RBC Rh antigen preventing mom from producing own antibodies