Blood Types

- Determined by the presence or absence of surface antigens (agglutinogens)
  - Antigens A, B and Rh (D)
- Antibodies in the plasma (agglutinins)
- Cross-reactions occur when antigens meet antibodies
Blood Types and Cross Reactions

(a) Blood Types

- **TYPE A**: Surface antigen A, Anti-B antibodies
- **TYPE B**: Surface antigen B, Anti-A antibodies
- **TYPE AB**: Surface antigens A and B, Neither anti-A nor anti-B antibodies
- **TYPE O**: Neither A nor B surface antigens, Anti-A and anti-B antibodies

(b) Cross Reactions

Surface antigens + Opposing antibodies → Agglutination (clumping) and hemolysis

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Blood Types and Cross Reactions

<table>
<thead>
<tr>
<th>Blood sample</th>
<th>Anti-A</th>
<th>Anti-B</th>
<th>Anti-D</th>
<th>Blood type</th>
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Blood Group Distributions

<table>
<thead>
<tr>
<th>Population</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>RH^+</th>
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<td>U.S. (AVERAGE)</td>
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<td>40</td>
<td>10</td>
<td>4</td>
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<td>29</td>
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<td>3</td>
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<td>56</td>
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Rh Factor and Pregnancy

First pregnancy
- Maternal blood
- Fetal tissue
- Placenta
- Mother Rh^-
- Fetus Rh^+

Second pregnancy
- Maternal blood
- Fetal tissue
- Hemorrhaging at delivery
- Maternal antibody production (anti-rh)
White Blood Cells: Leukocytes

WBCs in order of abundance:
- Never (neutrophils)
- Let (lymphocytes)
- Monkeys (monocytes)
- Eat (eosinophils)
- Bananas (basophils)

How do I remember the relative percentages?
60 + 30 + 6 + 3 + 1
(i.e., 60% neutrophils, 30% lymphocytes, 6% monocytes, 3% eosinophils & 1% basophils)
White Blood Cells: Leukocytes

Granulocytes

- Granulocytes – neutrophils, eosinophils, and basophils
  - Contain cytoplasmic granules that stain specifically (acidic, basic, or both) with Wright’s stain
  - Are larger and usually shorter-lived than RBCs
  - Have lobed nuclei
  - Are all phagocytic cells

Neutrophils

- Neutrophils have two types of granules that:
  - Take up both acidic and basic dyes
  - Give the cytoplasm a lilac color
  - Contain peroxidases, hydrolytic enzymes, and defensins (antibiotic-like proteins)
- Neutrophils are our body’s bacteria slayers
White Blood Cells: Leukocytes

Eosinophils

- Eosinophils account for 1–4% of WBCs
  - Have red-staining, bilobed nuclei connected via a broad band of nuclear material
  - Have red to crimson (acidophilic) large, coarse, lysosome-like granules
  - Lead the body’s counterattack against parasitic worms
  - Lessen the severity of allergies by phagocytizing immune complexes

Basophils

- Account for 0.5% of WBCs and:
  - Have U- or S-shaped nuclei with two or three conspicuous constrictions
  - Are functionally similar to mast cells
  - Have large, purplish-black (basophilic) granules that contain histamine
    - Histamine – inflammatory chemical that acts as a vasodilator and attracts other WBCs (antihistamines counter this effect)
White Blood Cells: Leukocytes

Agranulocytes

- Agranulocytes – lymphocytes and monocytes:
  - Lack visible cytoplasmic granules
  - Are similar structurally, but are functionally distinct and unrelated cell types
  - Have spherical (lymphocytes) or kidney-shaped (monocytes) nuclei

Lymphocytes

- Account for 25% or more of WBCs and:
  - Have large, dark-purple, circular nuclei with a thin rim of blue cytoplasm
  - Are found mostly enmeshed in lymphoid tissue (some circulate in the blood)
- There are two types of lymphocytes: T cells and B cells
  - T cells function in the immune response
  - B cells give rise to plasma cells, which produce antibodies
White Blood Cells: Leukocytes

Monocytes

- Monocytes account for 4–8% of leukocytes
  - They are the largest leukocytes
  - They have abundant pale-blue cytoplasms
  - They have purple-staining, U- or kidney-shaped nuclei
  - They leave the circulation, enter tissue, and differentiate into macrophages

Macrophages

- Are highly mobile and actively phagocytic monocytes
- Activate lymphocytes to mount an immune response
### White Blood Cell Synthesis

- **Leukopoiesis** is stimulated by chemical messengers called interleukins and colony-stimulating factors (CSFs)
  - Interleukins are numbered (e.g., IL-1, IL-2), whereas CSFs are named for the WBCs they stimulate (e.g., granulocyte-CSF stimulates granulocytes)

- Macrophages and T cells are very important sources of cytokines (include interferons and interleukins)

- Cytokines influence cell development, differentiation and responses in the immune system

- Many hematopoietic hormones are used clinically to stimulate bone marrow (such as EPO and CSF’s)

### White Blood Cell Synthesis

- All leukocytes originate from hemocytoblasts
- Hemocytoblasts differentiate into
  - Myeloid stem cells (via GM-CSF stimulation)
  - Lymphoid stem cells (via IL-7)
  - Myeloid stem cells become myeloblasts or monoblasts
  - Lymphoid stem cells become lymphoblasts
- Myeloblasts develop into the granulocytes (eosinophils, neutrophils, and basophils)
- Monoblasts develop into monocytes via M-CSF stimulation
- Lymphoblasts develop into lymphocytes
White Blood Cell Synthesis

White Blood Cell Abnormalities

**Leukemia**

- Leukemia refers to cancerous conditions involving WBCs
- Leukemias are colonies of a single clone and are named according to the abnormal WBCs involved
  - Myelocytic leukemia – involves myeloblasts
  - Lymphocytic leukemia – involves lymphocytes
- Acute leukemia involves blast-type cells and primarily affects children
- Chronic leukemia is more prevalent in older people
White Blood Cell Abnormalities

Leukemia

• Immature WBCs are found in the bloodstream in all leukemias
• Bone marrow becomes totally occupied with cancerous leukocytes
• The WBCs produced, though numerous, are not functional
• Death is caused by internal hemorrhage and overwhelming infections
• Treatments include irradiation, antileukemic drugs, and bone marrow transplants

White Blood Cell Abnormalities

Leukopenia?

Leukocytosis?

Mononucleosis?