Cells of the Immune System

Objectives
- Cells of the Immune System
  - Identify the 4 cell lineages
    - Recognize cells from each type based on morphology, location, & function
  - Identify function of each cell type
  - Identify innate vs. adaptive cell types

Blood
- Contains two main elements: plasma and cells
- Three kinds of cells: red blood cells, white blood cells, and platelets
- This presentation will focus on white blood cells (leukocytes)

Four Major Cell Lineages
- Lymphoid (lymphocytes) Thymus & Bone Marrow
- Erythroid (erythrocytes)
- Myeloid (granulocytes & mononuclear phagocytes) Colony Stimulating Factors in the bone marrow
- Megakaryocytic (platelets)
Lymphoid Cell Lineage

- T lymphocytes
- B lymphocytes
- Natural Killer (NK)
- Dendritic

B cells
- Produce abs to neutralize or remove microbe

T cells
- Cell-mediated effects to kill (CTLs) or activate (helper) accessories to remove antigen
- Natural Killer
  - Non-adaptive killing of infected cells in body

T lymphocytes
- Subsets of T lymphocytes
  - Three Types:
    - Cytotoxic = CD8
    - Helper = CD4 (Th1 & Th2)
    - Suppressor
  - Regulators of the immune response
- Cell mediated immunity, cytotoxicity
- Assist humoral immunity as well
  - Help B cells make Ab response
- Mitogens: ConA, PHA & PWM (both)

B lymphocytes
- Specifically recognize antigen (with Ab molecule)
- "Bursal or bone marrow" dependent
- Transform into plasma cells which produce antibodies
- Humoral immunity
Natural Killer (NK) cells
- LGL morphology – lymphocyte-like
- No specific antigen recognition
- No TcR or Ab receptors for antigen
- 15% circulating blood lymphocytes
- Recognize altered or decreased MHC proteins

Natural Killer Cells
- Recognize altered MHC proteins
  - Kill tumor and virus-infected cells, which decrease MHC on the surface of cells (ADCC; release IFN)
- Cells expressing “normal” MHC are protected against lysis by NK Cells
- Regulation of hemopoiesis & immune responses by cytokine secretion

Dendritic Cells
- Professional antigen presenting cell (APC)
- Least abundant white blood cell, but the most potent
- Long, fingerlike projections increase their size, which improves their mobility and ability to find antigens
- Unique: can capture and absorb many types of foreign antigens
- Migrate to the lymph nodes, where they “activate” large number of T cells through antigen presentation

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Myeloid: Granulocytes
- PMNs
- Eosinophils
- Mast cells & Basophils
- Mononuclear Phagocytes:
  - Monocytes & Macrophages
Neutrophils
- Also known as Polymorphonuclear (PMN) Cells
- "First responders", acute inflammation
- Most common leukocyte in circulation
- Phagocytes that exhibit chemotaxis
- No antigen specificity
- Killing of intracellular pathogens
- Contain defensins – broad-spectrum antimicrobials & the most abundant protein type in neutrophils

Neutrophils
- Short-lived, 60-70% of peripheral leukocytes
- Have a multilobed nucleus
- Phagocyte deficiencies lead to severe infections
- Granules contain antibacterial enzymes & proteins, phagolysosomes

Eosinophils
- 2-5% of WBCs in the peripheral circulation, degranulation to outside (MBP & ECP)
- Important defense against parasitic infections, degranulation onto surfaces (see pic)
- Dampen allergic & inflammatory responses (histaminase & aryl sulfatase)
- No antigen specificity

Eosinophils
- Crystalloid granule

Mast Cells & Basophils
- Mast cells protect mucosal surfaces & tissues
- Basophils circulate
- Involved in allergic reactions (IgE), degranulation, no antigen specificity
- High affinity IgE receptors
- Granules contain heparin, leukotrienes, histamine & ECF-A

(c) Basophil
**Mononuclear Phagocytes**

- **Macrophage**: fixed phagocytic cells
  - Remove particulate antigens, antigen presenting cells
  - Kill intracellular pathogens
  - No antigen specificity, chemotaxis
  - Named according to location; Kupfer cells, alveolar macrophages, etc.
- **Monocytes**: circulating phagocytic cells
  - Antigen presenting cells
  - No antigen specificity

**Macrophage**

- Extends thin pseudopodia to engulf foreign objects

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**Mononuclear Phagocytes**

- Reticuloendothelial System (with tissue endothelial cells)
  - Functions: removal & killing of particular Ag (phagocytosis) & Antigen presentation to Th lymphocytes (LN, spleen, mucosa, skin)
  - No Ag specificity (no specific Ag receptors)
  - MHC II (APC) present on immune cells
  - Receptors: Fc, sugars, C', cytokines (IFN, IL2 & TNF)
  - Chemotaxis, Opsonization, Adherence

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**Megakaryocytic - Platelets**

- 30% sequestered in spleen
- Blood clotting; aggregation at sites of vascular endothelial cell damage
- Receptors & adhesion molecules
- Granules contain serotonin & fibrinogen
- Increased capillary permeability, complement activation & leukocyte chemoattraction; inflammation & immune response
In Summary

• Be able to differentiate between cell types
• Understand the function of each cell type
• Which cell types help the adaptive immune response vs. innate immunity?

Self-Test Questions: Cells

• What cells are part of the innate system?
  (hint: not specific for antigen)
• What cells are part of the adaptive system?
• What cells are “first-responders”?
• What cells are professional antigen presenting cells?
• What is the function of each lymphoid cell type?