

Introduction to Immunology

Introduction to Immunology – Study Guide

1. What Is Immunology?

- **Definition:** The branch of biomedical science that studies the immune system—its structure, function, development, and disorders.
 - **Purpose:** Understand how the body defends itself against pathogens, how immunity can be harnessed (vaccines, immunotherapy), and why immune failures occur (autoimmunity, immunodeficiency).
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2. Core Concepts

Concept	Key Points
Self vs. Non-self	The immune system distinguishes the body's own cells (self) from foreign entities (non-self). Failure of this discrimination leads to autoimmunity.
Innate Immunity	First-line, rapid, non-specific defense. Includes physical barriers, phagocytes, complement, cytokines, and pattern-recognition receptors (PRRs).
Adaptive Immunity	Slower, highly specific, generates memory. Mediated by B cells (antibody-producing) and T cells (cell-mediated).
Immunological Memory	After an initial encounter, the immune system mounts a faster, stronger response upon re-exposure. Basis of vaccination.
Tolerance	Mechanisms that prevent immune attack on self-antigens (central & peripheral tolerance).

3. Components of the Immune System

3.1 Physical & Chemical Barriers

- **Skin** – keratinized epithelium, acidic pH, antimicrobial peptides.
- **Mucosal surfaces** – mucus, cilia, secretory IgA, lysozyme.

3.2 Cellular Elements

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Cell Type	Primary Functions
Neutrophils	Rapid phagocytosis, release of ROS and NETs.
Macrophages	Phagocytosis, antigen presentation (MHC-II), cytokine production.
Dendritic Cells	Professional antigen-presenting cells; bridge innate and adaptive immunity.
Natural Killer (NK) Cells	Detect and kill virus-infected or transformed cells without prior sensitization.
B Lymphocytes	Differentiate into plasma cells (antibody secretion) and memory B cells.
T Lymphocytes	• CD4⁺ helper T cells (Th1, Th2, Th17, Tfh, Treg) • CD8⁺ cytotoxic T lymphocytes (CTLs)

3.3 Soluble Factors

- **Complement system** – cascade of plasma proteins that opsonize, lyse pathogens, and recruit immune cells.
 - **Cytokines & Chemokines** – signaling molecules that modulate cell activation, differentiation, and trafficking.
 - **Antibodies (Immunoglobulins)** – IgM, IgG, IgA, IgE, IgD; each with distinct roles and distribution.
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4. Innate Immunity in Detail

1. **Recognition** – PRRs (e.g., Toll-like receptors) bind pathogen-associated molecular patterns (PAMPs).
2. **Effector Mechanisms**
 - **Phagocytosis** (neutrophils, macrophages).
 - **Inflammation** – vasodilation, increased permeability, recruitment of leukocytes.
 - **Complement activation** – classical, lectin, and alternative pathways.
 - **Antimicrobial peptides** – defensins, cathelicidins.
3. **Link to Adaptive Immunity** – Dendritic cells process antigens and migrate to