

PowerLecture:

Chapter 39

Immunity

Section 39.0: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online

Videos: CNN

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➤ Biology, 2003, Vol. 7, *Global AIDS* (2:18)

➤ Biology, 2002, Vol. 6, *Small-pox Threat* (5:12)

Impacts, Issues: **The Face of AIDS**

➤ By 2004, AIDS had killed about 20 million in Africa, leaving 12 million children orphaned

➤ At least 40 million are presently infected with HIV, the virus that causes AIDS

➤ We are still without a vaccine

Impacts, Issues: **The Face of AIDS**

➤ The first vaccine was against smallpox

➤ Edward Jenner injected cowpox material into the arm of a healthy boy, and six weeks later injected smallpox material

➤ The cowpox induced immunity to smallpox because the two are closely related

Impacts, Issues: **The Face of AIDS**

➤ Pasteur demonstrated that heating could kill microorganisms in food and beverages

➤ Koch linked a microorganism with a specific disease (anthrax)

Impacts, Issues Video

Section 39.1: Weblinks and InfoTrac

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Three Lines of Defense

➤ Barriers at body surfaces

➤ Nonspecific responses

➤ Immune responses

Innate and Adaptive Immunity

Chemical Weapons in Immunity

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Barriers at Body Surface

- Intact skin and mucous membranes
- Lysozyme
- Normal bacterial flora
- Flushing effect and low pH of urine

Barriers at Body Surface

Nonspecific Responses

- Lymph nodes trap and kill pathogens
- Natural killer cells attack a range of targets
- Inflammation

Complement System

- Plasma proteins that take part in both specific and nonspecific response

- Activation of one triggers cascade of reactions that activate others

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Attack Complexes

Attack Complexes

Complement proteins

Acute Inflammation

- Nonspecific response to foreign invasion, tissue damage, or both
- Destroys invaders, removes debris, and prepares area for healing
- Characterized by redness, swelling, warmth, and pain

Inflammation

- Mast cells release histamine
- Capillaries dilate and leak
- Complement proteins attack bacteria
- White cells attack invaders and clean up

Inflammation

Inflammatory response

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Features of Immune Responses

- Self/nonself recognition
- Specificity
- Diversity
- Memory

Memory and Effector Cells

- When a B or T cell is stimulated to divide, it produces more than one cell type
- Memory cells - set aside for future use
- Effector cells - engage and destroy the current threat

Steps in Immune Response

- Recognition of an antigen
- Rounds of cell division that form huge populations of lymphocytes

- Specialization of lymphocytes into effector and memory cells that have receptors for one kind of antigen

Key Components of Immune Response

- MHC markers
- Antigen-presenting cells
- T cells
- B cells
- Natural killer cells

Formation of Antigen-MHC Complex Antigens

- “Nonself” markers on foreign agents and altered body cells such as tumors

- Trigger division of B and T cells

Interactions Between Responses Immune Responses

Immune responses

Lymphocyte Battlegrounds

Lymphatic System

Human lymphatic system

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Antibody Structure

- Consists of four polypeptide chains
- Certain parts of each chain are variable; impart antigen specificity

Antibody Structure

Antibody structure

5 Classes of Immunoglobulins

Overview of Interactions

Antigen-Receptor Diversity

- Gene sequences get shuffled, extensively and randomly, before they are expressed

- Each B cell or T cell bears only one type of antigen receptor

Antigen Receptor Diversity

Gene rearrangements

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Antibody-Mediated Response

- Carried out by B cells
- Targets are intracellular pathogens and toxins

- Antibodies bind to target and mark it for destruction by phagocytes and complement

Clonal Selection

Clonal Selection

Clonal selection of a B cell

Immunological Memory

- Memory cells specific for an antigen are quickly activated to divide upon subsequent exposure to that antigen

Immune Memory

Immune Memory

Antibody-Mediated Response

Antibody-Mediated Response

Antibody-mediated response

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Cell-Mediated Response

Cell-Mediated Response

Cell-mediated response

Antibody-Mediated Response

Cell-mediated response

Organ Rejection

- Cytotoxic T cells can contribute to rejection
- They recognize a portion of the donor cell's MHC complex as self, view a portion as foreign
- Treat the combination as an antigen-MHC complex and attack donor cells

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- A&P, 2003, Vol. 7, *Custom Cancer Vaccine* (3:10)

Monoclonal Antibodies

- Manufacture antibodies against tumor-specific antigens
- First created by fusing antigen-producing B cells from mice with cells from B cell tumors
- Now made in genetically engineered cells

Lymphokine-Activated Killers

- Lymphocytes are extracted from tumors
- Extracted cells are exposed to a lymphokine, an interleukin
- Large population of tumor-infiltrating, activated lymphocytes is then reinjected into patient

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See the latest Weblinks and InfoTrac articles for this chapter online

Videos: CNN

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➤ A&P, 2004, Vol. 8, *Whooping Cough Immunization* (1:52)

➤ A&P, 2004, Vol. 8, *Peanut Allergies* (1:33)

➤ A&P, 2004, Vol. 8, *Juvenile Arthritis* (2:02)

Immunization

- Process that promotes immunity
- Active immunization -
 - Antigen-containing material is injected
 - Confers long-lasting immunity
- Passive -
 - Purified antibody is injected
 - Protection is short lived

Allergies

- Immune reaction to a harmless substance
- Genetic predisposition
- IgE responds to antigen by binding to mast cells and basophils
- These cells secrete the substances that cause symptoms

Anaphylactic Shock

- A life-threatening allergic reaction
- Caused by the release of histamine by many mast cells and basophils
- Airways constrict and blood pressure drops as capillary permeability soars

Autoimmune Disorders

- Immune system makes antibodies against self antigens
- Grave's disease
- Myasthenia gravis
- Rheumatoid arthritis

SCIDs

- Severe combined immunodeficiency
- Body's ability to make lymphocytes is impaired or nonexistent
- High vulnerability to infection
- ADA deficiency is a heritable SCID
- Has been successfully treated using gene therapy

Gene Therapy

Section 39.10: Weblinks and InfoTrac

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Videos: CNN

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- A&P, 2002, Vol. 6, *AIDS Update* (2:10)

AIDS

- Combination of disorders that follows infection with HIV
- Includes
 - Yeast (*Candida*) infections
 - *Pneumocystis pneumonia*
 - Kaposi's sarcoma

Global Cases of AIDS/HIV

HIV Life Cycle

HIV Life Cycle

HIV replication cycle

T Cell Decline

- Release of new viral particles kills the host T cell
- The body is constantly making new T cells, but cannot outpace the rate of destruction
- As infection proceeds, T cell numbers inevitably decline

Effect of T Cell Decline

- CD4 helper T cells play a vital role in immune function
- They are required for both cell-mediated and antibody-mediated immunity
- Infected individual becomes vulnerable to other infections, which eventually result in death

Transmission of HIV

- HIV does not live long outside human body
- Most often spread by exchange of bodily fluids with an infected person
- In the U.S., anal intercourse and needle sharing are main modes of transmission

Transmission of HIV

- Less commonly transmitted by vaginal intercourse and oral sex
- Can travel from mothers to offspring during pregnancy, birth, or breast-feeding
- Not known to be transmitted by food, air, water, casual contact, or insect bites

Treatment

- No cure
- Once HIV genes are incorporated, no way to get them out
- AZT and other drugs slow the course of the disease and increase life span
- Researchers continue to develop drugs and to work toward an AIDS vaccine