Immune System

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RESOURCES

Mastering Medical Terminology
By Sue Walker, Maryann Wood and Jenny Nicol

Essential of Human Anatomy and Physiology
By Elaine Marieb and Suzanne Keller

Atlas of Human Anatomy
By Frank Netter

Mosby’s Dictionary
By Mosby

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Every second of every day, an army of microbes swarms on our skin and invades our inner passageways, but yet we remain healthy most of the time.

The body seems to have developed a single-minded approach toward such foes, means if you’re not with us, you’re against us.

The immune system is a functional system rather than an organ system in an anatomical sense.

Its “structures” are a variety of molecules and trillions of immune cells that inhabit lymphoid tissues and organs and circulate in body fluids.

The most important of the immune cells are lymphocytes, dendritic cells, and macrophages.

Macrophages actually play an important role in both innate and adaptive mechanisms.
<table>
<thead>
<tr>
<th>Combining form</th>
<th>Meaning</th>
<th>Medical term</th>
<th>Meaning of medical term</th>
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<tbody>
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<td>gland</td>
<td>lymphadenopathy</td>
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<td>adenoid/o</td>
<td>adenoids</td>
<td>adenoidectomy</td>
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<td>clumping, gluing, sticking together</td>
<td>agglutination</td>
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<td>vessel</td>
<td>angiogram</td>
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<td>neck, cervix uteri</td>
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<td>lymphoid tissue, lymph gland</td>
<td>lymphangiography</td>
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<td>swallow, eat</td>
<td>phagocytosis</td>
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<td>net like</td>
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<td>tox/o</td>
<td>poison, toxin</td>
<td>cytotoxic</td>
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### Prefix & Suffix

<table>
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<td>ana-</td>
<td>up, towards, apart</td>
<td>anaphylaxis</td>
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<td>against</td>
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<td>auto-</td>
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<td>autoantigen</td>
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<td>between</td>
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<td>mono-</td>
<td>one, single</td>
<td>mononucleosis</td>
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<td>retro-</td>
<td>backward, behind</td>
<td>retropharyngeal</td>
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<table>
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<th>Medical term</th>
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<tr>
<td>-ation</td>
<td>process, action, condition</td>
<td>agglutination</td>
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<tr>
<td>-blast</td>
<td>embryonic, developing cell</td>
<td>lymphoblast</td>
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<tr>
<td>-cyte</td>
<td>cell</td>
<td>phagocyte</td>
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<tr>
<td>-genesis</td>
<td>pertaining to formation, producing</td>
<td>agenesis</td>
<td>allergic</td>
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<tr>
<td>-genic</td>
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<td>-globin</td>
<td>protein</td>
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<td>-globulin</td>
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<tr>
<td>-oid</td>
<td>derived from, resembling</td>
<td>lymphoid</td>
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<tr>
<td>-pathy</td>
<td>disease process</td>
<td>lymphadenopathy</td>
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<td>-phylaxis</td>
<td>protection</td>
<td>anaphylaxis</td>
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<tr>
<td>-poiesis</td>
<td>formation or production of</td>
<td>leucopoiesis</td>
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<tr>
<td>-stitial</td>
<td>pertaining to standing/positioned</td>
<td>interstitial fluid</td>
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<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>AIDS</td>
<td>acquired immunodeficiency syndrome</td>
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<tr>
<td>B-cells</td>
<td>a type of lymphocyte that produces antibodies, which forms and matures in bone marrow</td>
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<tr>
<td>CMV</td>
<td>cytomegalovirus</td>
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<tr>
<td>ELISA</td>
<td>enzyme-linked immunosorbent assay</td>
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<tr>
<td>HAART</td>
<td>highly active antiretroviral therapy</td>
<td></td>
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<tr>
<td>HIV</td>
<td>human immunodeficiency virus</td>
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<tr>
<td>HSV</td>
<td>herpes simplex virus</td>
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<tr>
<td>IgA, IgD, IgE, IgG, IgM</td>
<td>immunoglobulins</td>
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<tr>
<td>MOAB</td>
<td>monoclonal antibody</td>
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<tr>
<td>NHL</td>
<td>non-Hodgkin’s lymphoma</td>
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<tr>
<td>NK cells</td>
<td>natural killer cells</td>
<td></td>
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<tr>
<td>PCP</td>
<td><em>Pneumocystis</em> pneumonia</td>
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<tr>
<td>SLE</td>
<td>systemic lupus erythematosus</td>
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<tr>
<td>T4, T8</td>
<td>T-cell lymphocytes</td>
<td></td>
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<tr>
<td>T-cells</td>
<td>lymphocytes, matured in thymus</td>
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Two Intrinsic Defense Systems

**Innate (nonspecific) system**
- It responds quickly and consists of:
  - First line of defense – intact skin and mucosae prevent entry of microorganisms.
  - Second line of defense – antimicrobial proteins, phagocytes, and other cells.
    - Inhibit spread of invaders throughout the body.
    - Inflammation is its hallmark and most important mechanism.

**Adaptive (specific) defense system**
- Third line of defense – mounts attack against foreign substances.
- Takes longer to react than the innate system.
- Works in conjunction with the innate system.
- The innate immune system responds immediately to protect the body from all foreign substances, whatever they are.
- The innate immune system has a number of first line barriers to infection that are in place to prevent the entry and growth of pathogens.
- We are born with our innate immune, which include intact skin and mucous membranes, the inflammatory response, and a number of proteins produced by body cells.
- These innate mechanisms reduce the workload of the adaptive defense mechanisms by generally preventing the entry and spread of microorganisms throughout the body.
Barriers

Physical (surface) Barriers

- These barriers provide a physical block against pathogens from entering the immune system.
- The barrier comprises of the:
  - Skin, which has a large surface area and covers the majority of the external surfaces of the body.
  - Mucous membranes of the mouth, respiratory tract, GI tract and urinary tract also line the areas of the body that are in contact with the external environment, preventing pathogens from crossing.
  - The bronchial cilia that form a mucociliary escalator which allows gradual removal of pathogens from the respiratory system.

Physiological Barriers

- Diarrhea
- Vomiting
- Coughing
- Sneezing

Biological Barriers

- The main biological barrier to pathogens is the normal flora (non-pathogenic microbes) found within the body:
  - Nasopharynx, Mouth and throat, Skin, GI tract and Vagina
- These compete with pathogens for attachment sites and resources, and may even produce antimicrobial chemicals and essential vitamins, such as Vitamin K and B12.
Epithelial Chemical Barriers

- Epithelial membranes produce protective chemicals that destroy microorganisms.
  - Skin acidity (pH of 3 to 5) inhibits bacterial growth.
  - Sebum contains chemicals toxic to bacteria.
  - Stomach mucosae secrete concentrated HCl and protein-digesting enzymes.
  - Saliva and lacrimal fluid contain lysozyme.
  - Mucus traps microorganisms that enter the digestive and respiratory systems.

Respiratory Tract Mucosae

- Mucus-coated hairs in the nose trap inhaled particles.
- Mucosa of the upper respiratory tract is ciliated.
  - Cilia sweep dust- and bacteria-laden mucus away from lower respiratory passages.
The body uses nonspecific cellular and chemical devices to protect itself.

- Phagocytes and natural killer (NK) cells.
- Antimicrobial proteins in blood and tissue fluid.
- Inflammatory response (redness, heat, pain and swelling).
Phagocytosis is the process where a cell (phagocyte) engulfs a solid particle to form an internal compartment called a phagosome.

The membrane of the phagocyte forms a crater shape around the particle that is to be phagocytized.

Within the phagosome, the particle can then be degraded.

In the immune system, it is a major mechanism that the body uses to remove pathogenic material.

Several types of cells in the immune system use phagocytosis to engulf microorganisms, some major ones include:

- **Neutrophils** – these are abundant in the blood and are dominant in acute inflammation. It become phagocytic when encountering infectious material.
- **Macrophages** – these are closely related to monocytes in the blood. They live longer than neutrophils and are the dominant cell type in chronic inflammation.
- **Dendritic cells** – these cells are involved in the amplification of specific immune responses.
- **B-lymphocytes** – these cells require some phagocytosis to transform into antibody producing plasma cells.
- **Eosinophils** - are weakly phagocytic against parasitic worms.
- **Natural killer cells (NK cells)**, are a type of cytotoxic lymphocyte critical to the innate immune system.

- Cells that can lyse and kill cancer cells and virus-infected cells.

- Natural killer cells:
  - Are a small, distinct group of large granular lymphocytes.
  - React nonspecifically and eliminate cancerous and virus-infected cells.
  - Kill their target cells by releasing perforins and other cytolytic chemicals.
  - Secrete potent chemicals that enhance the inflammatory response.
Fever

- Abnormally high body temperature in response to invading microorganisms.
- The body’s thermostat is reset upwards in response to pyrogens, chemicals secreted by leukocytes and macrophages exposed to bacteria and other foreign substances.
- High fevers are dangerous as they can denature enzymes.
- Moderate fever can be beneficial, as it causes:
  - The liver and spleen to sequester iron and zinc (needed by microorganisms).
  - An increase in the metabolic rate, which speeds up tissue repair.
The adaptive defense system, or specific defense system, fights invaders that get past the innate defenses by mounting an attack against one or more particular foreign substances.

The adaptive immune system is antigen-specific, systemic, and has memory.

It has two separate but overlapping arms.

- Humoral, or antibody-mediated immunity.
- Cellular, or cell-mediated immunity.

By recognizing the particular antibody of a type of pathogen, the acquired immune system can act against it and produce a maximally effective response.

The action of vaccinations represents acquired immunity.

It has a higher specificity and a lower response time than innate immunity.

It is further subdivided into humoral and cellular components.
Humoral immunity deals with extracellular antigen detection and processing.

- Bone marrow lymphocytes (B lymphocytes) possess immunoglobulins on their cell surfaces.
- The variable portion of the immunoglobulin has the capacity to bind a wide variety of antigens.
- However, each B lymphocyte can only bind to a specific set of antigens.
- Binding of the B lymphocyte to the foreign antigen will result in an increase of antibodies specific to the inciting agent.
- These antibodies will subsequently opsonize the pathogens and facilitate complement activation.
- Helper T lymphocytes also participate in the humoral pathway.
- After binding with the antigen on the antigen presenting cells, helper T lymphocytes can induce macrophage activity, stimulate the inflammatory cascade by promoting release of cytokines and inciting the proliferation of more B and T lymphocytes.
Cellular immunity does not involve antibodies.

Rather, cell mediated immunity is the activation of phagocytes, antigen-specific cytotoxic T-lymphocytes, and the release of various cytokines in response to antigen.

Cellular immunity is most effective against cells infected with viruses, intracellular bacteria, fungi and protozoans, and cancerous cells.
- Substances that can gather the immune system and induce an immune response.
- The ultimate targets of all immune responses are mostly large, complex molecules not normally found in the body (nonself).
Two types of lymphocytes:
- B lymphocytes – humoral immunity.
- T lymphocytes – non-antibody-producing cells that constitute the cell-mediated arm of immunity.

Antigen-presenting cells (APCs):
- Do not respond to specific antigens.
- Play essential auxiliary roles in immunity.
Immature lymphocytes released from bone marrow are essentially identical.

Whether a lymphocyte matures into a B-cell, or a T-cell depends on where in the body it becomes immunocompetent.

- B cells mature in the bone marrow.
- T cells mature in the thymus.
Immunodeficiencies

- Congenital and acquired conditions in which the function or production of immune cells, phagocytes, or complement is abnormal.
- As the immune system may exaggerate its response to an offending agent, it may also be inefficient against the noxious entity.
- Immunodeficiencies are states in which the host’s immune system is unable to adequately mount a defense.
- It can be classified as congenital (primary) or acquired (secondary) immunodeficiencies.
- The congenital immunodeficiencies may be further be subclassified based on the component of the immune system.
- **Hodgkin’s disease** – cancer of the lymph nodes leads to immunodeficiency by depressing lymph node cells.

- **Acquired immune deficiency syndrome (AIDS)** – cripples the immune system by interfering with the activity of helper T (CD4) cells.
  - Characterized by severe weight loss, night sweats, and swollen lymph nodes.
  - Opportunistic infections occur, including pneumocystis pneumonia and Kaposi’s sarcoma.
Caused by human immunodeficiency virus (HIV) transmitted via body fluids – blood, semen, and vaginal secretions.

HIV enters the body via:
- Blood transfusions.
- Contaminated needles.
- Intimate sexual contact, including oral sex.

HIV:
- Destroys T-helper cells.
- Depresses cell-mediated immunity.

HIV multiplies in lymph nodes throughout the asymptomatic period.

Symptoms appear in a few months to 10 years.

Treatments include:
- Reverse transcriptase inhibitors (AZT).
- Protease inhibitors (saquinavir and ritonavir).
- New drugs currently being developed that block HIV’s entry to helper T cells.
Autoimmune diseases occur when the body does not recognise its own tissues and the immune system turns against itself causing the body to produce auto-antibodies that attack and destroy its own tissues.

In patients with an autoimmune disease, the immune system cannot distinguish between healthy body tissue and antigens.

The associated immune response destroys normal body tissues.

Examples include multiple sclerosis, myasthenia gravis, Graves’ disease, Type I diabetes mellitus, systemic lupus erythematosus (SLE), glomerulonephritis, and rheumatoid arthritis.
A hypersensitivity reaction refers to an excessive immune response to a particular antigen that can cause harm to the patient.

The hallmark features of hypersensitivity reactions are such that:

- The body is damaged by the immune system in the same way that an invading pathogen would have been during a normal response.
- They often result from disruption of the immunomodulators that regulate the normal immune response.
- They can be activated by both endogenous and exogenous antigens.
- It is often linked to susceptible genes inherited by the progeny.
An allergy is an exaggerated reaction by the immune system in response to contact with certain foreign substances called antigens.

Usually these antigens are seen by the body as harmless and no response occurs in non-allergic people.
Anaphylaxis (also called anaphylactic shock) is a severe, life-threatening, generalised allergic reaction that requires immediate medical treatment.

- It occurs after exposure to an allergen to which the patient is already sensitive.
- This stimulates a severe immune response and release of histamine.
- The most common triggers are certain foods such as peanuts, eggs or crustaceans, insect venom such as bee or wasp stings, certain medications.
- Usually the reaction occurs within 20 minutes of exposure.
Tests & Procedures
- A computed tomography or CT scan is a diagnostic test to identify disorder of organs such as lymph nodes, spleen, and thymus gland.
- Images are taken in the transverse plane using a computer in conjunction with x-ray beams.
The enzyme-linked immunosorbent assay (ELISA) test is used to detect immune responses in the body.

The test detects substances such as hormones, antigens and antibodies and is used for the identification of antibodies to HIV antigens that are of a specific molecular weight.
- It is a test that involves the separation and identification of proteins in the blood and their reaction to antibodies.
- The test is used to detect an abnormal level of antibodies.
It involves the use of knowledge of the body’s immune response and immune technologies to treat or prevent diseases such as cancer, allergies and transplanted organ rejection.
- A lymphadenectomy is a surgical procedure to remove one or more lymph nodes.
- It is generally performed with other surgical procedures used in the management of cancer.
Questions?

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