I. Definitions

A. Immunity

II. Innate Immunity: Non-Specific Defenses - do not require previous exposure for full activation

A. First Line of Defense
   1. Physical Barrier
   2. Chemical Barrier
      a. Skin and Mucus Membranes
      b. Respiratory and Gastro-Intestinal Tract

B. Second Line of Defense
   1. Phagocytes
   2. Complement System
   3. Inflammation and Fever
      a. Vasodilation / Increased Permeability
      b. Migration of WBC's (diapedesis)
      c. Tissue Repair
   4. Interferon
   5. Natural Killer Cells (NK Cells)

III. Acquired Immunity: Specific Defenses (the Third Line of Defense)

A. Characteristics:
   1. Specific
   2. Recognition of Self
   3. Memory
   4. Versatility

B. Definitions:
   1. Antigen (Ag)
   2. Antibody (Ab) (aka Immunoglobulin)
   3. Cell Mediated Immunity
   4. Humoral Immunity

C. Cells of Specific Immunity
   1. Antigen Presenting Cells (aka Macrophages / Monocytes)
   2. T-Lymphocytes (cell mediated immunity)
   3. B-Lymphocytes (humoral immunity)
D. Basic Mechanism (Five Steps):
   1. Activation
   2. Proliferation
   3. Attack Phase
   4. Suppression
   5. Memory

IV. Cell Mediated Immunity (T Lymphocytes)
   A. Activation
   B. Proliferation
      1. Helper T-Cells
      2. Cytotoxic T-Cells
      3. Suppressor T-Cells
      4. Memory T-Cells
   C. Attack Phase
   D. Suppression (suppressor T-cells)
   E. Memory

V. Humoral Immunity (B Lymphocytes)
   A. Activation
      1. T-cell Dependent
      2. T-cell Independent
   B. Proliferation
      1. Memory B-Cells
      2. Plasma Cells - produce Antibodies
   C. Attack Phase
   D. Suppression (suppressor T-cells)
   E. Memory

VI. Passive vs. Active Immunity
   A. Active immunity
   B. Passive Immunity

VII. Additional Key Terms / Topics (FYI)
    active immunity  antigen presenting cell (APC)  autoimmune  lysis  opsonization
    passive immunity  precipitation
Study Questions – Immune System Physiology:

1. Define “immunity”.
2. Define “non-specific defense” and “specific immune response”.
3. Describe the physical and chemical barriers of the first line of defense. Provide some examples.
4. Describe the different components of the second line of defense:
   a. Phagocytes
   b. Inflammation and Fever
   c. Complement System
   d. Interferon
   e. Natural Killer Cells (NK Cells)
5. Describe the characteristics that define a specific immune response.
   a. Specific
   b. Recognition of Self
   c. Memory
   d. Versatility
6. Define and describe “antigen” and “antibody”.
7. Describe the cells of specific immunity. What is their structure, where do they originate, what is their role in specific immune reactions?
8. Compare and contrast cell mediated and humoral immunity.
9. Describe the predominant way in which T-cells are activated.
10. Describe the different T-cell types produced during the proliferative phase:
   a. Helper T-Cells
   b. Cytotoxic T-Cells
   c. Suppressor T-Cells
   d. Memory T-Cells
11. Describe the mechanism for T-cell destruction of pathogens. What type of pathogens are T-cells effective against?
12. Describe the two predominant ways in which B-cells are activated (T-cell dependent and independent).
13. Describe the mechanism for B-cell destruction of pathogens. What type of pathogens are B-cells effective against?
14. Compare and contrast active and passive immunity.
The Antibacterial Fad: A New Threat

Antibiotics are not the only antimicrobial substances being overexploited today. Use of antibacterial agents—compounds that kill or inhibit bacteria but are too toxic to be taken internally—has been skyrocketing as well. These compounds, also known as disinfectants and antiseptics, are applied to inanimate objects or to the skin.

Historically, most antibacterials were used in hospitals, where they were incorporated into soaps and surgical clothes to limit the spread of infections. More recently, however, those substances (including triclocarbon, triclosan and such quaternary ammonium compounds as benzalkonium chloride) have been mixed into soaps, lotions and dishwashing detergents meant for general consumers. They have also been impregnated into such items as toys, high chairs, mattress pads and cutting boards.

There is no evidence that the addition of antibacterials to such household products wards off infection. What is clear, however, is that the proliferation of products containing them raises public health concerns.

Like antibiotics, antibacterials can alter the mix of bacteria: they simultaneously kill susceptible bacteria and promote the growth of resistant strains. These resistant microbes may include bacteria that were present from the start. But they can also include ones that were unable to gain a foothold previously and are now able to thrive thanks to the destruction of competing microbes. I worry particularly about that second group—the interlopers—because once they have a chance to proliferate, some may become new agents of disease.

The potential overuse of antibacterials in the home is troubling on other grounds as well. Bacterial genes that confer resistance to antibacterials are sometimes carried on plasmids (circles of DNA) that also bear antibiotic-resistance genes. Hence, by promoting the growth of bacteria bearing such plasmids, antibacterials may actually foster double resistance—to antibiotics as well as antibacterials.

Routine housecleaning is surely necessary. But standard soaps and detergents (without added antibacterials) decrease the numbers of potentially troublesome bacteria perfectly well. Similarly, quickly evaporating chemicals—such as the old standbys of chlorine bleach, alcohol, ammonia and hydrogen peroxide—can be applied beneficially. They remove potentially disease-causing bacteria from, say, thermometers or utensils used to prepare raw meat for cooking, but they do not leave long-lasting residues that will continue to kill benign bacteria and increase the growth of resistant strains long after target pathogens have been removed.

If we go overboard and try to establish a sterile environment, we will find ourselves cohabiting with bacteria that are highly resistant to antibacterials and, possibly, to antibiotics. Then, when we really need to disinfect our homes and hands—as when a family member comes home from a hospital and is still vulnerable to infection—we will encounter mainly resistant bacteria. It is not inconceivable that with our excessive use of antibacterials and antibiotics, we will make our homes, like our hospitals, havens of ineradicable disease-producing bacteria. —S.B.L.

Some Actions Physicians and Consumers Can Take to Limit Resistance

The easy accessibility to antibiotics parodied in the cartoon is a big contributor to antibiotic resistance. This list suggests some immediate steps that can help control the problem.

—S.B.L.

Physicians
• Wash hands thoroughly between patient visits.
• Do not accede to patients' demands for unneeded antibiotics.
• When possible, prescribe antibiotics that target only a narrow range of bacteria.
• Isolate hospital patients with multidrug-resistant infections.
• Familiarize yourself with local data on antibiotic resistance.

Consumers
• Do not demand antibiotics.
• When given antibiotics, take them exactly as prescribed and complete the full course of treatment; do not hoard pills for later use.
• Wash fruits and vegetables thoroughly; avoid raw eggs and undercooked meat, especially in ground form.
• Use soaps and other products with antibacterial chemicals only when protecting a sick person whose defenses are weakened.

"Don't forget to take a handful of our complimentary antibiotics on your way out."

The Author

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Further Reading


CELL WARS

About one trillion strong, our white blood cells constitute a highly specialized army of defenders, the most important of which are depicted here in a typical battle against a formidable enemy.

VIRUS

Nearing the spring of life, a virus is little more than a package of genetic information that must be bioengineered within a host cell to permit its own replication.

MACROPHAGE

Housekeeper and frontline defender, this cell engulf and digest debris that enters the bloodstream. Encountering a foreign organism, it summons helper T cells to the scene.

HELPER T CELL

As a commander in chief of the immune system, it identifies the enemy and relays to the spleen and lymph nodes, where it stimulates the production of other cells to fight the infection.

KILLER T CELL

Recruited and activated by helper T cells, its job is to kill cells of the body that have been invaded by foreign organisms, as well as cells that have turned cancerous.

B CELL

Biologic arms factory. It resides in the spleen or the lymph nodes, where it is induced to replicate by helper T cells and then to produce potent chemical weapons called antibodies.

ANTIBODY

Engineered to target a specific invader, this Y-shaped protein molecule is rushed to the infection site, where it either neutralizes the enemy or tags it for attack by other cells or chemicals.

SUPPRESSOR T CELL

A third type of T cell, it is able to slow down or stop the activities of B cells and other T cells, playing a vital role in calling off the attack after an infection has been conquered.

MEMORY CELL

Generated during an initial infection, this defense cell may circulate in the blood or lymph for years, enabling the body to respond more quickly to subsequent infections.

1 THE BATTLE BEGINS

As viruses begin to invade the body, a few are consumed by macrophages, which release their antigens and display them on their own surfaces. Among millions of helper T cells circulating in the bloodstream, a select few are programmed to "read" that antigen. Binding to the macrophage, the T cell becomes activated.

2 THE FORCES MULTIPLY

Once activated, helper T cells begin to multiply. They then stimulate the multiplication of those few killer T cells and B cells that are sensitive to the invading virus. As the number of B cells increases, helper T cells signal them to start producing antibodies.

3 CONQUERING THE INFECTION

Meanwhile, some of the viruses have entered cells of the body — the only place they are able to replicate. Killer T cells will sacrifice these cells by chemically puncturing their membranes, letting the contents spill out, thus disrupting the viral replication cycle. Antibodies then neutralize the viruses by binding to them, preventing them from attacking other cells. Additionally, they precipitate chain reactions that actually destroy infected cells.

4 CALLING A TRUCE

As the infection is contained, suppressor T cells help the entire range of immune responses, preventing them from spiraling out of control. Memory T and B cells are left in the blood and lymphatic system, ready to move quickly should the same virus once again invade the body.

A miracle of evolution, the human immune system is not controlled by any central organ, such as the brain. Rather, it has developed to function as a kind of biologic democracy, wherein the individual members achieve their ends through an information network of awesome scope. Accounting for one percent of the body's 100 trillion cells, these defender white blood cells arise in the bone marrow. They fall into three groups: the phagocytes, or "cell eaters," of which the multinucleated macrophage is one, and two kinds of lymphocytes, called T and B cells. All share one common objective: to identify and destroy all substances, living and inert, that are not part of the human body, that are "not self." These include human cancer cells, which have turned from self to nonself, friend to foe.

There are four critical phases to each immune response: recognition of the enemy, amplification of defenses, attack, and slowdown. Each immune response is a unique local sequence of events, shaped by the nature of the enemies. Chemical toxins and a multitude of inert environmental substances, such as asbestos and smoke particles, are normally attacked only by phagocytes. Organic invaders elicit the full range of immune responses. Besides viruses, these include single-celled bacteria, protozoa, and fungi, as well as a host of multicelled worms called helmiths. Many of these enemies have evolved devisive methods to escape detection. The viruses that cause influenza and the common cold, for example, constantly mutate, changing their fingerprints. The AIDS virus, most insidious of all, employs a range of strategies, including hiding out in healthy cells. What makes it fearsome is its ability to invade and kill helper T cells, thereby short-circuiting the entire immune response.