2 Foundations in Immunology

Roland Jacobs and Reinhold E. Schmidt

2.1. Introduction
2.2. Cells of the Immune System
2.3. Lymphocytes
   2.3.1. B Lymphocytes
   2.3.2. Structure and Function of Different Antibody Classes
   2.3.3. Antibody Classes
   2.3.4. T Lymphocytes
2.4. NK Cells
2.5. Cell Surface Molecules
2.6. Binding of Antigens
2.7. Signal Transduction
2.8. Cytokines
2.9. Complement
   2.9.1. Alternative Pathway
   2.9.2. Classical Pathway
   2.9.3. The Cytokine Reaction and the Membrane Attack Complex
2.10. Immunological Defense
2.11. Allergies
   2.11.1. Anaphylactic Hypersensitivity: Type I Reaction
   2.11.2. Antibody-Dependent Cytotoxic Hypersensitivity: Type II Reaction
   2.11.3. Immune Complex-Mediated Hypersensitivity: Type III Reaction
   2.11.4. Cell-Mediated Hypersensitivity: Type IV Reaction
2.12. Glossary

Roland Jacobs and Reinhold E. Schmidt · Department of Clinical Immunology, Hannover Medical School, D-30625 Hannover, Germany.

2.1. Introduction

The real importance of the immune system is evident when it does not function well. Nowadays perhaps the most well-known immune defect is the acquired immunodeficiency syndrome (AIDS). This disease made it clear to the public that we are permanently surrounded by pathogens like bacteria, protozoa, fungi, and viruses. All of these infectious agents are challenging the body and when they are not stopped, these particles will invade and make us ill.

How does a healthy body prevent infectious organisms from invading? The first line of defense is the physical barrier of an intact skin. In addition, a special milieu on the skin is maintained by apathogenic microorganisms, preventing pathogens from settling there. Special types of outer skins are the mucous membranes that line the lung, intestine, and oral cavity. Mucous makes it more difficult for bacteria and viruses to penetrate these outer membranes. In addition, there are antimicrobial components in the mucus and in the saliva. The latter fluid is supplemented with proteins designed for binding pathogens. These proteins are the immunoglobulins, or antibodies, and will be discussed below. However, when this protective layer is disrupted or the skin is wounded, the second line of defense becomes the focus of attention: the immune system.

The immune system is comprised of billions of so-called white blood (leukocytes) and tissue cells. The first contact between intruder and the immune system is established unspecifically by phagocytes. These cells are relatively large cells that are able to move around and ingest pathogens. There are different types of phagocytes: The skin is infiltrated by Langerhans cells, in the bloodstream there are monocytes and granulocytes. The liver is populated by Kupffer cells, the brain by glia cells, and the lung by astrocytes. These phagocytes do not simply eat up any kind of unknown substances, but also offer parts of these substances to other more specialized cells of the immune system on their surfaces. This feature of phagocytes is called processing. In parallel, a lot of mediators are produced and released during this process, tempting other cells to initiate an inflammatory reaction.

We now turn to introducing the specific arm of the immune system. One should keep in mind, however, that terms such as innate or unspecific immune system do not relate to the capabilities of the involved cells. Moreover, an effective innate defense is indispensable for the development of a specific response. Unlike the phagocytes attacking all foreign particles, each cell of the specific immune response is optimized to recognize unique molecules (antigens) of the intruders. Therefore, a cell that can recognize a particular antigen of a pathogen will bind to it or react to it, but will leave another one alone.

The main source of such specialized cells are the lymphocytes. This cell type comprises about 30% of all white cells in peripheral blood. Lymphocytes can be divided roughly into three subpopulations. Besides the more popular B and T cells, there are also the natural killer (NK) cells. To a certain extent, NK cells take their position between the innate and specific immune defense.

2.2. Cells of the Immune System

In a brief outline the most important cells of the immune system, and their features, will be described here. For a more detailed description and images of the different cell types, refer to Chapter 1.

The majority of the phagocytosing cells are comprised of monocytes/macrophages and