11.6A: Immunodeficiency

Immunodeficiency occurs when the immune system cannot appropriately respond to infections.

Learning Objectives

• Explain the problems associated with immunodeficiency

Key Points

• If a pathogen is allowed to proliferate to certain levels, the immune system can become overwhelmed; immunodeficiency occurs when the immune system fails to respond sufficiently to a pathogen.
• Immunodeficiency can be caused by many factors, including certain pathogens, malnutrition, chemical exposure, radiation exposure, or even extreme stress.
• HIV is a virus that causes immunodeficiency by infecting helper T cells, causing cytotoxic T cells to destroy them.

Key Terms

• phagocyte: a cell of the immune system, such as a neutrophil, macrophage or dendritic cell, that engulfs and destroys viruses, bacteria, and waste materials
• lysis: the disintegration or destruction of cells
• immunodeficiency: a depletion in the body’s natural immune system, or in some component of it
Immunodeficiency

Failures, insufficiencies, or delays at any level of the immune response can allow pathogens or tumor cells to gain a foothold to replicate or proliferate to high enough levels that the immune system becomes overwhelmed, leading to immunodeficiency; it may be acquired or inherited. Immunodeficiency can be acquired as a result of infection with certain pathogens (such as HIV), chemical exposure (including certain medical treatments), malnutrition, or, possibly, by extreme stress. For instance, radiation exposure can destroy populations of lymphocytes, elevating an individual’s susceptibility to infections and cancer. Dozens of genetic disorders result in immunodeficiencies, including Severe Combined Immunodeficiency (SCID), bare lymphocyte syndrome, and MHC II deficiencies. Rarely, primary immunodeficiencies that are present from birth may occur. Neutropenia is one form in which the immune system produces a below-average number of neutrophils, the body’s most abundant phagocytes. As a result, bacterial infections may go unrestricted in the blood, causing serious complications.

HIV/AIDS

Human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS), is a disease of the human immune system caused by infection with human immunodeficiency virus (HIV). During the initial infection, a person may experience a brief period of influenza-like illness. This is typically followed by a prolonged period without symptoms. As the illness progresses, it interferes more and more with the immune system. The person has a high probability of becoming infected, including from opportunistic infections and tumors that do not usually affect people who have working immune systems.

Figure: Image of HIV: scanning electron micrograph of HIV-1 budding (in green, color added) from cultured lymphocyte: Multiple round bumps on cell surface represent sites of assembly and budding of HIV. During primary infection, the level of HIV may reach several million virus particles per milliliter of blood.

After the virus enters the body, there is a period of rapid viral replication, leading to an abundance of virus in the peripheral blood. During primary infection, the level of HIV may reach several million virus particles per milliliter of blood. This response is accompanied by a marked drop in the number of circulating CD4+ T cells, cells that are or will become helper T cells. The acute viremia, or spreading of the virus, is almost invariably associated with activation of CD8+ T cells (which kill HIV-infected cells) and, subsequently, with antibody production. The CD8+ T cell response is thought to be important in controlling virus levels, which peak and then decline, as the CD4+ T cell counts recover.

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Updated: Tue, 15 Jun 2021 08:01:38 GMT
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Ultimately, HIV causes AIDS by depleting CD4+ T cells (helper T cells). This weakens the immune system, allowing opportunistic infections. T cells are essential to the immune response; without them, the body cannot fight infections or kill cancerous cells. The mechanism of CD4+ T cell depletion differs in the acute and chronic phases. During the acute phase, HIV-induced cell lysis and killing of infected cells by cytotoxic T cells accounts for CD4+ T cell depletion, although apoptosis (programmed cell death) may also be a factor. During the chronic phase, the consequences of generalized immune activation coupled with the gradual loss of the ability of the immune system to generate new T cells appear to account for the slow decline in CD4+ T cell numbers.