

# Understanding Immune Senescence and Age-Related Diseases

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## ABOUT THE STUDY

As individuals age, their immune system undergoes a complex process known as immune senescence, which refers to the gradual decline in immune function. This phenomenon is a major contributor to the increased susceptibility to various age-related diseases and infections.

### Immune senescence

The immune system plays a crucial role in defending the body against pathogens, such as bacteria, viruses, and fungi. It consists of various components, including white blood cells, antibodies, and lymphoid organs, which work together to recognize and eliminate foreign invaders. However, with advancing age, the immune system undergoes significant changes that impair its ability to mount an effective immune response.

One of the primary features of immune senescence is the decline in the production and function of immune cells. For example, the thymus, a gland responsible for the production of T cells, gradually shrinks with age, leading to a reduced output of naive T cells. Additionally, the function of existing T cells becomes compromised, with a decline in their proliferation and ability to recognize and eliminate pathogens.

Moreover, age-related changes in the innate immune system also contribute to immune senescence. Natural Killer (NK) cells, a type of white blood cell involved in the early defense against infections and tumors, exhibit reduced cytotoxicity and impaired cytokine production in older individuals. The phagocytic activity of macrophages, another important component of the innate immune system, also diminishes with age.

### Implications for age-related diseases

**Infectious diseases:** The decline in immune function associated with immune senescence increases the susceptibility to various infectious diseases in older adults. For example, older individuals are more prone to respiratory infections, such as influenza and pneumonia, due to a weakened immune response to viral and bacterial pathogens. Furthermore, the reactivation of latent viral

infections, such as herpes zoster, is more common in the elderly population.

**Autoimmune diseases:** Paradoxically, while immune senescence weakens the immune response to pathogens, it can also lead to the development of autoimmune diseases. Autoimmunity occurs when the immune system mistakenly attacks the body's own cells and tissues. With age, the regulation of the immune system becomes dysregulated, increasing the risk of autoimmune disorders such as rheumatoid arthritis, systemic lupus erythematosus, and autoimmune thyroid diseases.

**Cancer:** Immune surveillance is a crucial mechanism by which the immune system identifies and eliminates cancer cells. However, immune senescence compromises this surveillance process, allowing cancer cells to evade detection and proliferate. The decline in immune function, coupled with age-related genetic mutations, contributes to an increased incidence of cancer in older individuals. Additionally, the effectiveness of cancer treatments, such as immunotherapies, may be reduced in the presence of immune senescence.

**Chronic inflammation:** Another consequence of immune senescence is the development of chronic inflammation, also known as inflammaging. Inflammaging is characterized by persistent low-grade inflammation throughout the body. This chronic inflammatory state contributes to the pathogenesis of several age-related diseases, including cardiovascular disease, neurodegenerative disorders (such as Alzheimer's disease), and metabolic disorders (such as type 2 diabetes).

### Strategies to mitigate immune senescence

While immune senescence is a natural process, there are strategies that can help mitigate its impact on age-related diseases. Here are a few approaches:

**Healthy lifestyle:** Adopting a healthy lifestyle, including regular exercise, balanced nutrition, and adequate sleep, can promote immune function and reduce the risk of age-related diseases. Exercise, in particular, has been shown to enhance immune cell activity and reduce chronic inflammation.

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**Vaccination:** Vaccination plays a crucial role in protecting older individuals from infectious diseases. Vaccines against influenza, pneumonia, and shingles are recommended for older adults to boost their immune response against these pathogens.

**Immunomodulatory therapies:** Researchers are exploring various immunomodulatory therapies to enhance immune function in

older individuals. These approaches include the use of cytokines, such as interleukin-7 and interleukin-15, to stimulate immune cell production, as well as targeting senescent cells for elimination.