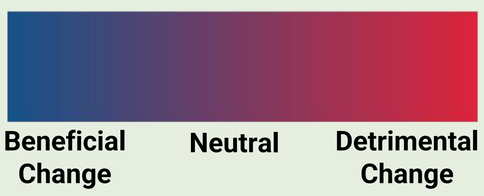
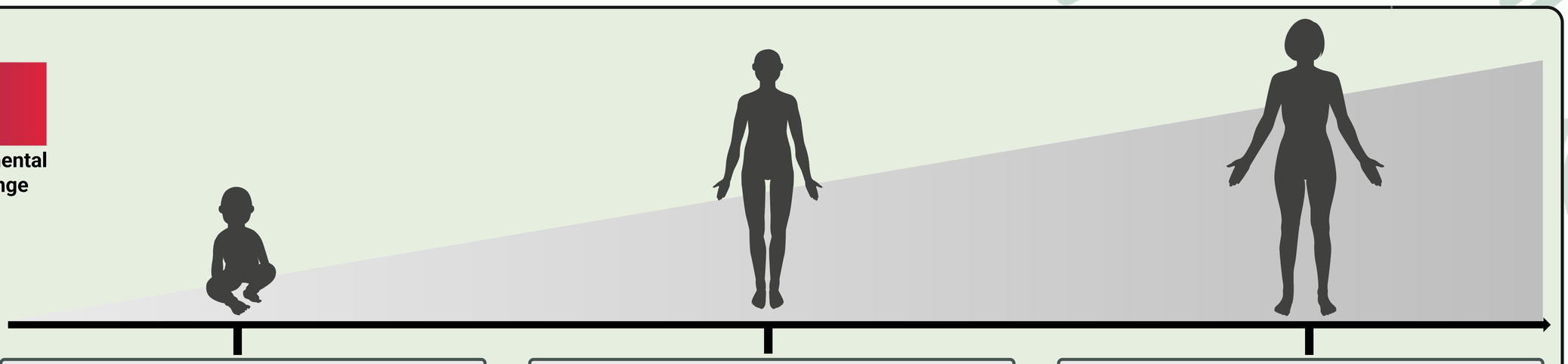
The Immunology of Life

What happens to your immune system as you age?

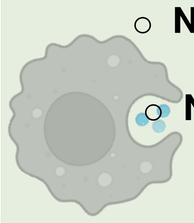
The immune system is composed of a ***multitude of different cells*** that interact with each other, either directly or through signaling proteins, to protect you from foreign organisms and maintain the necessary balance (**homeostasis**) of your body. As you grow and undergo experiences in life, ***many changes occur in your immune system*** that influence how you may respond to environmental stimuli. We share some of the changes that occur during life below.





Innate System

- **First line of defense**
- **Non-specific response**
- **No immune memory generated**

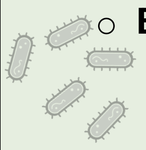


Adaptive System

- **Slower response time**
- **Highly specific response**
- **Generates immune memory**

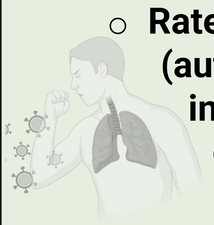
Environmental Factors

- **External impacts on the immune system**



Disease Susceptibility

- **Rate of disease (autoimmune, infections, cancer)**



Sex-related Differences

- **Immune changes based on sex**

Physiological Changes

- **Changes to organ functions**

Infancy

- Higher chance of **viral and bacterial infections** due to **lower innate system function**

- Reduced innate cell function includes:
  Neutrophils – **poor bacteria killing abilities**
  Monocytes and Macrophages – **weak tissue repair** and **ingestion of invading pathogens**

- **T cells:** Initial T-cell stock **built in early life**
- **B cells:** **Limited neonatal antibody production**

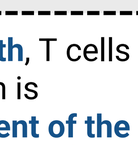
- **Maternal antibodies** (transferred to the fetus through the placenta before birth) **serve as protection after birth for several months**, until the adaptive immune system develops more

- **Initial exposures to diverse microbes** (e.g. via birth mode, food, and environment) that **colonize mucosal surfaces** help **shape the immune system** and **reduce risk** of certain **diseases**

- An **underdeveloped immune system** leads to **increased susceptibility to infections**, **decreased vaccine effectiveness**, and **increased risk of developing allergies and/or asthma** in early infancy due to improper protein recognition by the immune system

- **Males:** **stronger innate immune responses**
- **Females:** **greater T helper cell populations** (cells that assist other cells to generate immune reponses) but **lower cytotoxic T cell populations** (cell that directly kill infected cells)

- The **thymus** is **largest at birth**, T cells develop in the thymus which is important for the **development of the adaptive immune system**



Adolescence

- During puberty, **there is a maturation of innate immune cells in the central nervous system** (e.g. microglia) that support puberty associated brain development

- Maturation and functional activation of innate cells continues until adulthood

- **T cells:** T cell **production, selection and maturation** continues throughout childhood but slowly ceases after puberty
- **B cells:** Approaching adulthood, antibody reponses are **quicker, stronger, more specific and more durable** than those elicited in infants

- **Challenges to the immune system** (social stress, drug use, injury) **affect cell development**, such as microglia in the central nervous system which can alter behaviour in adulthood

- From now into adulthood, females have **higher incidences of developing inflammatory diseases and of autoimmune diseases** (e.g. Type 1 Diabetes, Multiple Sclerosis, Psoriasis), while males have **higher cancer incidence** and **severe infection outcomes**

- Sex hormones regulate immune function and **cortisol levels that can lead to immune suppression**
- **Males:** **stronger cell-based immune responses**

- **Females:** more **effective antibody responses**

- There is an **achievement of fertility** and the development of **secondary sex characteristics**
- In later adolescence, **the thymus**, a primary immune tissue, **begins to shrink and is replaced with fat**

Adulthood and Old Age

- **Chronic inflammation** due to the presence of pro-inflammatory proteins (***cytokines***) known as **inflammaging**

- **Reduced function of innate immune cells** (e.g. macrophages, neutrophils) that are a necessary first line of defense

- **Enhanced repertoire of memory cells** for ongoing immunity against harmful organisms (***pathogens***)
- **T cells:** More dysfunctional. Impact immune function and **increase risk of infections**
- **B cells:** **Inflammatory B cells** and **antibody producing cells** can expand during aging and contribute to inflammaging

- **Viral infections during life** can negatively impact **immune cell function with age**

- **Changes to microbes in the gut** are linked to **inflammation in older adults**

- Reduced immune function can lead to **an increased susceptibility to infections**
- **Reduced protective immune responses to vaccination**

- **Adults experience an increase in chronic diseases** (e.g. diabetes) that may be impacted by immunity

- **Males:** worsened **decline in T cell function and higher pro-inflammatory cytokine levels**
- **Females:** have **stronger antibody (*humoral*) responses** which can be **beneficial** (prevent infection) or **detrimental** (autoimmunity)

- During aging, **there is increased tissue scarring and reduced division of cells**, **disruptions in the metabolism of several tissues**, and **alterations to cognitive and behavioural patterns** which all impact health

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