2nd semester
Immunology I

Innate Immune system: The innate immune system is the body's first line of defense against invading pathogens such as bacteria, viruses, and fungi. The innate immune system includes anatomical and physiological barriers that work together to prevent these pathogens from entering the body or to eliminate them once they have entered.

Anatomical barriers are physical structures that prevent pathogens from entering the body. These barriers include the skin, mucous membranes, and hair in the nose and ears. The skin acts as a physical barrier, preventing pathogens from entering the body. Mucous membranes, which line the respiratory, digestive, and reproductive tracts, secrete mucus that traps pathogens and prevents them from entering the body. Hair in the nose and ears also helps to trap pathogens and prevent them from entering the body.

Physiological barriers are biological processes that prevent pathogens from surviving or multiplying in the body. These barriers include stomach acid, enzymes in tears and saliva, and the natural microbiota of the body. Stomach acid, for example, is highly acidic and kills many pathogens that enter the body through food or water. Enzymes in tears and saliva also help to kill pathogens. The natural microbiota of the body, which includes beneficial bacteria in the gut and on the skin, help to prevent harmful pathogens from colonizing and growing in the body.

In summary, the innate immune system includes anatomical and physiological barriers that work together to prevent pathogens from entering the body or to eliminate them once they have entered. These barriers are the first line of defense against invading pathogens and play a critical role in protecting the body from infection and disease.

Hematopoiesis is the process by which new blood cells are produced. This process occurs primarily in the bone marrow, although some blood cells are also produced in other tissues such as the liver and spleen. Hematopoiesis involves the differentiation of hematopoietic stem cells into the various types of blood cells, including red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes).

The process of hematopoiesis is tightly regulated by various growth factors and cytokines, which are produced by cells within the bone marrow and other tissues. These signaling molecules act on hematopoietic stem cells and their progeny to promote their differentiation and proliferation.

Hematopoiesis is a complex and highly regulated process that is essential for the maintenance of normal blood cell counts and for the body's immune system to function properly. Dysregulation of hematopoiesis can lead to a variety of hematologic disorders, including anemia, leukemia, and lymphoma.

The cells of the myeloid and lymphoid systems are important components of the immune system and are involved in the defense against pathogens, as well as in tissue repair and maintenance. These cells include:

Myeloid cells:

Basophils: They are a type of granulocyte that plays a role in allergic reactions and in the defense against parasites.

Neutrophils: They are the most abundant type of white blood cell and play a role in the defense against bacterial and fungal infections.

Eosinophils: They are a type of granulocyte that plays a role in the defense against parasites and in allergic reactions.

Monocytes: They are a type of white blood cell that can differentiate into macrophages and dendritic cells, which are important for phagocytosis and antigen presentation, respectively.

Mast cells: They are a type of granulocyte that plays a role in allergic reactions and in the defense against parasites.

Lymphoid cells:

T cells: They are a type of white blood cell that play a key role in the cell-mediated immune response, including the recognition and elimination of infected or abnormal cells.

B cells: They are a type of white blood cell that produce antibodies, which are proteins that recognize and neutralize specific pathogens.

Natural Killer (NK) cells: They are a type of white blood cell that plays a role in the innate immune response, including the recognition and elimination of infected or abnormal cells.

Dendritic cells: They are a type of antigen-presenting cell that plays a critical role in the initiation and regulation of the adaptive immune response.

Overall, these cells work together to protect the body against infection and maintain tissue homeostasis.

Phagocytosis and respiratory burst:

Phagocytosis is the process by which cells such as neutrophils, monocytes, and macrophages engulf and digest invading microorganisms or foreign particles. During this process, these cells release reactive oxygen species (ROS) such as superoxide anion, hydrogen peroxide, and hydroxyl radicals, which are collectively known as the respiratory burst. This burst of ROS helps to kill and digest the engulfed particles by generating highly reactive molecules that can damage the pathogen's DNA, proteins, and other components.

Inflammation:

Inflammation is a complex biological response to injury, infection, or tissue damage. The clinical signs of inflammation include redness, heat, swelling, pain, and loss of function in the affected tissue. Inflammation is initiated by the release of chemical mediators, such as cytokines, chemokines, and prostaglandins, from cells such as mast cells, macrophages, and endothelial cells.

These mediators attract immune cells to the site of injury or infection, where they can remove damaged cells and invading pathogens. The increased blood flow to the area, along with increased vascular permeability, also allows immune cells and nutrients to reach the affected tissue. In addition, these mediators also activate cells involved in phagocytosis and respiratory burst to help eliminate the invading pathogens.

Overall, inflammation is a complex process that involves many cells, molecules, and signaling pathways, and is essential for the body's defense against infection and tissue damage. However, excessive or chronic inflammation can lead to tissue damage and is associated with many chronic diseases such as arthritis, diabetes, and heart disease.

Organs of immune system – primary (bone marrow, thymus) secondary (lymph node, spleen, MALT).

The immune system is composed of various organs, tissues, cells, and molecules that work together to defend the body against pathogens and other harmful substances. The organs of the immune system can be broadly classified into primary and secondary lymphoid organs.

Primary lymphoid organs:

Bone marrow: It is the site of hematopoiesis, where hematopoietic stem cells give rise to all types of blood cells, including lymphocytes. B cells mature in the bone marrow, where they develop their antigen receptors.

Thymus: It is a small organ located in the upper chest, where T cells mature and undergo selection to ensure that they are able to recognize and respond to foreign antigens without attacking the body's own tissues.

Secondary lymphoid organs:

Lymph nodes: They are small, bean-shaped organs distributed throughout the body, where immune cells are activated and immune responses are initiated. Lymph nodes contain B cells, T cells, dendritic cells, and macrophages, among other cell types.

Spleen: It is the largest secondary lymphoid organ in the body, located in the upper left part of the abdomen. The spleen filters the blood and removes damaged or old red blood cells, as well as providing a site for immune responses against blood-borne pathogens. It contains B cells, T cells, dendritic cells, and macrophages, among other cell types.

MALT (mucosa-associated lymphoid tissue): It is a collection of lymphoid tissues located at various mucosal surfaces throughout the body, such as in the respiratory, digestive, and genitourinary tracts. MALT contains B cells, T cells, dendritic cells, and other cell types, and is involved in immune responses against pathogens that enter the body through

Lymph and lymphatic system

The lymphatic system is a complex network of vessels, tissues, and organs that helps to maintain the body's fluid balance and fight against infections. Lymph is a clear fluid that circulates throughout the lymphatic system, carrying white blood cells, proteins, and other substances.

The lymphatic system plays a crucial role in the immune system by filtering and removing harmful substances from the body, such as bacteria, viruses, and cancer cells. It also helps to transport fat and other nutrients from the digestive system into the bloodstream.

The lymphatic system includes several organs, such as the lymph nodes, spleen, thymus, and tonsils, as well as tissues such as the lymphatic vessels, which are similar to blood vessels but carry lymph instead of blood.

When lymphatic vessels are damaged or blocked, lymph can accumulate in tissues and cause swelling, a condition known as lymphedema. This can happen due to surgery, radiation therapy, infection, or other causes.

Maintaining a healthy lymphatic system is important for overall health and can be supported by staying hydrated, exercising regularly, and avoiding tight clothing that restricts lymph flow. Massage therapy and compression garments can also be used to manage lymphedema.

Hostpathogen interaction, Toll like Receptors,

Host-pathogen interactions refer to the complex molecular interactions that occur between a host organism and a pathogen, such as a virus, bacterium, or parasite. These interactions can lead to the development of infectious diseases.

One key component of the host's immune response to pathogens is the recognition of pathogen-associated molecular patterns (PAMPs) by the host's pattern recognition receptors (PRRs). Toll-like receptors (TLRs) are a family of PRRs that play a critical role in recognizing PAMPs and initiating an immune response.

There are 10 different TLRs in humans, each recognizing specific types of PAMPs. For example, TLR4 recognizes lipopolysaccharide (LPS), a component of the outer membrane of gram-negative bacteria, while TLR3 recognizes double-stranded RNA, a viral PAMP.

When a TLR recognizes a PAMP, it triggers a signaling pathway that activates immune cells, such as macrophages and dendritic cells, to release cytokines and chemokines. These molecules attract and activate other immune cells, such as T cells and B cells, which work together to eliminate the pathogen.

TLRs are also involved in the development of inflammation, which is a critical component of the immune response to pathogens but can also contribute to tissue damage and disease. Dysregulation of TLR signaling has been implicated in the pathogenesis of a variety of inflammatory and autoimmune diseases.

Overall, understanding the role of TLRs in host-pathogen interactions is important for developing new therapies for infectious diseases and other immune-related disorders.

Basic concept of cytokines

Cytokines are a group of small proteins that play an important role in regulating the immune response, inflammation, and cell signaling in the body. They are produced by a wide range of cells, including immune cells, and act as chemical messengers that allow cells to communicate with each other.

Cytokines can have both pro-inflammatory and anti-inflammatory effects on the body, depending on the context in which they are produced and the specific cytokine involved. For example, some cytokines, such as interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF-alpha), are pro-inflammatory and can promote the immune response to infections, while others, such as interleukin-10 (IL-10), have anti-inflammatory effects and can help to dampen the immune response and prevent tissue damage.

Cytokines are involved in a wide range of physiological processes, including cell growth and differentiation, wound healing, and the regulation of the body's metabolism. They also play a role in the pathogenesis of many diseases, including autoimmune disorders, cancer, and infectious diseases.

Researchers have developed a variety of cytokine-based therapies to treat these diseases, such as interferon-alpha for hepatitis C virus infection and IL-2 for certain types of cancer. However, these therapies can have significant side effects and are still being refined to maximize their therapeutic potential.

Overall, understanding the basic concept of cytokines is critical for understanding the immune response and the pathogenesis of many diseases, as well as for the development of new therapies for these conditions.

Complement system – pathways

The complement system is a complex network of proteins that plays a critical role in the immune response to pathogens. It is a part of the innate immune system and acts as a first line of defense against microbial infections. The complement system is composed of over 30 proteins that work together to identify, mark, and eliminate pathogens.

There are three main pathways of the complement system:

The classical pathway is activated by the binding of antibodies to antigens on the surface of pathogens. This binding triggers a series of enzymatic reactions that result in the production of the C3 convertase enzyme, which cleaves C3 into C3a and C3b.

The alternative pathway is activated by the presence of foreign substances, such as bacterial cell wall components or viral proteins, on the surface of pathogens. This pathway leads to the production of the C3 convertase enzyme, which cleaves C3 into C3a and C3b.

The lectin pathway is activated when mannose-binding lectin (MBL), a type of protein that binds to carbohydrates, binds to microbial surfaces. This binding activates a series of enzymatic reactions that result in the production of the C3 convertase enzyme, which cleaves C3 into C3a and C3b.

In all three pathways, the cleavage of C3 into C3a and C3b leads to the activation of the downstream components of the complement system, resulting in the formation of the membrane attack complex (MAC). The MAC is a complex of complement proteins that forms a pore in the membrane of the pathogen, causing cell lysis and death.