20.5A: Antigens and Antigen Receptors

Antigens are molecules that initiate the immune response and can be bound by antibodies.

LEARNING OBJECTIVES

Distinguish between antigens and antigen receptors

KEY TAKEAWAYS

Key Points

- An antigen is a molecule that initiates the production of an antibody and causes an immune response.
- Antigens are typically proteins, peptides, or polysaccharides. Lipids and nucleic acids can combine with those molecules to form more complex antigens, like lipopolysaccharide, a potent bacterial toxin.
- An epitope is a molecular surface feature of an antigen that can be bound by an antibody. A paratope is the molecular surface feature of an antibody that binds to an epitope.
- Antigens are classified as exogenous (entering from outside) endogenous (generated within cells), an autoantigen, a tumor antigen, or a native antigen.
- Antigenic specificity is the ability of host cells to recognize an antigen by its unique molecular structure, such as the relationship between antigen epitopes and antibody paratopes.
Key Terms

- **antigen**: A substance that induces an immune response, usually foreign, but self antigens and internally produced antigens exist as well.
- **autoantigen**: Any antigen that stimulates auto antibodies in the organism that produced it. These are "self" antigens that are involved in autoimmune disease pathogenesis.

EXAMPLES

Fluorescein, along with other haptens such as biotin, is used in various cell and molecular biological techniques. Fluorescein is often conjugated to a protein to allow scientists to examine its location using a fluorescent microscope.

In immunology, an antigen is a substance that evokes an immune response. Formally they are defined as a substance that causes the production of antibodies specific to that antigen, however they also cause T cell mediated immune responses, and may lead to an inflammatory response. The substance may be from the external environment or formed within the body. The immune system will try to destroy or neutralize any antigen that is recognized as a foreign and potentially harmful invader. "Self" antigens are usually tolerated by the immune system; whereas "non-self" antigens can be identified as invaders and can be attacked by the immune system.

Molecular Structure of Antigens

At the molecular level, an antigen is characterized by its ability to be “bound” at the antigen-binding site of an antibody. Antibodies tend to discriminate between the specific molecular structures presented on the surface of the antigen. Antigens are usually either proteins, peptides, or polysaccharides. This includes parts (coats, capsules, cell walls, flagella, fimbrae, and toxins) of bacteria, viruses, and other microorganisms. Lipids and nucleic acids are antigenic only when combined with proteins and polysaccharides. For example, the combination of lipids and polysaccharides are lipopolysaccharides (LPS), which are the primary component of gram negative bacterial endotoxin. LPS forms the cell wall of gram negative bacteria and causes a powerful immune response when bound. Cells present their immunogenic-antigens to the immune system via a major histocompatibility (MHC) molecule. Depending on the antigen presented and the type of the histocompatibility molecule, several types of immune cells can become activated due to an antigen.

Antigens have several structural components of interaction that may be bound by different classes of antibodies. Each of these distinct structural components is considered to be an epitope, also called an antigenic determinent. Therefore, most antigens have the potential to be bound by several distinct antibodies, each of which is specific to a particular epitope. The antigen binding receptor on an antibody is called a paratope, and is specific to the epitope of the antigen. Using the "lock and key" metaphor, the antigen itself can be seen as a string of keys – any epitope being a “key” – each of which can match a different lock.

Types of Antigens

Antigens are categorized into broad classes of antigens based on their origin. So many different molecules can function as an antigen in the body, and there is considerable diversity even within these categories.
These are the main classes of antigens that are involved in immune system activation. Their diversity is analogous to the immense diversity of the diseases that the immune system works to overcome.

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**Exogenous Antigens**

Exogenous antigens are antigens that have entered the body from the outside, for example by inhalation, ingestion, or injection. Exogenous antigens are the most common kinds of antigens, and includes pollen or foods that may cause allergies, as well as the molecular components of bacteria and other pathogens that could cause an infection.

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**Endogenous Antigens**

Endogenous antigens are that have been generated within previously-normal cells as a result of normal cell metabolism or because of viral or intracellular bacterial infection (which both change cells from the inside in order to reproduce). The fragments are then presented on the surface of the infected cells in the complex with MHC class I molecules.

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**Autoantigens**

Autoantigens are normal “self” protein or complex of proteins or nucleic acid that is attacked by the host’s immune system, causing an autoimmune disease. These antigens should, under normal conditions, not be the target of the immune system, but due to mainly genetic and environmental factors, the normal immunological tolerance for such an antigen has been lost.

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**Tumor Antigens (Neoantigens)**

These antigens are presented by MHC I or MHC II molecules on the surface of tumor cells. These antigens result from a tumor-specific mutation during malignant transformation of normal cells into cancer cells. Despite expressing this antigen, many tumors have developed ways to evade antigen recognition and immune system killing.

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**Native Antigens**

A native antigen is an antigen that is not yet processed by an APC to smaller parts. T cells cannot bind native antigens, but require that they be digested and processed by APCs, whereas B cells can be activated by native ones without prior processing.