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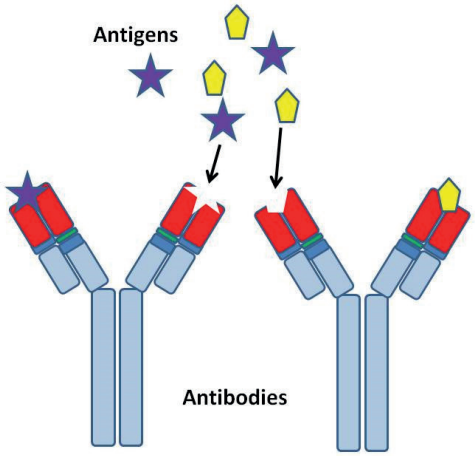
DIFFERENCE BETWEEN AN ANTIGEN AND AN ANTIBODY



ANTIGEN

An antigen is any substance or organism that is unrecognized by our immune system. Any foreign invaders, such as pathogens (bacteria and viruses), chemicals, toxins, and pollens, can be antigens. Under pathological conditions, normal cellular proteins can become self-antigens. An antigen contains distinct sites on its surface, which is called an epitope or antigenic determinant. Antibodies generated against an antigen recognize and interact (in fact, the name is derived from "antibody generators) with specific epitopes via antigen-binding sites (paratopes) to trigger immune responses. Antigens typically trigger an immune response, are classified by their origins:

- **Exogenous -** entering from outside the body
- **Endogenous -** generated from within
- **Autoantigens -** proteins targeted in autoimmune diseases
- **Neoantigens** (or tumor antigens) - resulting from tumor cells.
- **Native antigens -** an antigen which will later be processed by an antigen-presenting cell

Antigens in medical science

Pathogen-specific antigens can be used as diagnostic markers to detect the current infection status of an individual. Rapid antigen tests are immunoassays used to detect the presence of pathogen-specific proteins in biological samples.
Also, pathogen-specific antigens are used in vaccine production. During vaccine production, pathogen-specific antigens are processed so that they can induce desired immune responses without causing disease.
In tumor vaccines, tumor-specific antigens are used to trigger immune cells that specifically target and destroy cancer cells.

ANTIBODY

An antibody, also called an immunoglobulin, is a protective **Y-shaped protein** produced by the immune system in response to the presence of a foreign substance (antigen), such as a pathogen. Antibodies recognize and latch onto antigens to remove them from the body. Antibodies are proteins produced and secreted by **B cells (lymphocytes).**
Antibodies are glycosylated protein molecules present on the surface of B cells (surface immunoglobulins) serving as antigen receptors or are secreted into the extracellular space where they can bind and neutralize their target antigens. A single antibody molecule consists of 4 protein chains: 2 "heavy" (H chains) and 2 "light" (L chains) linked to each other by disulfide bonds. The N terminus regions of the heavy and light chains, which collectively make up the **antigen-binding site**, are where the variability between one antibody molecule and another resides, hence determining specificity.

Antibodies have 3 primary functions:

1) Neutralization:

Antibodies are secreted into the blood and mucosa, where they bind to and inactivate foreign substances such as pathogens and toxins (neutralization). Antibody neutralization is important for protection from viruses, as it can prevent the virus from then being able to enter and infect cells.

2) Opsonization:

Antibodies facilitate phagocytosis of foreign substances by phagocytic cells (opsonization). Antibody binding, for example, will not prevent bacterial replication. Rather, in this setting, the mechanism of enhanced protection through opsonisation will increase phagocytosis by macrophages and neutrophils.

3) Lysis and enhanced chemotaxis:

The third function is antibody activation of the complement system to destroy pathogens through lysis and enhanced chemotaxis.

Antibodies have 3 primary functions:

An important feature is that each antibody recognizes a specific antigen, a phenomenon called "antibody specificity." For example, an antibody that recognizes the mumps virus cannot recognize the measles virus and can only recognize one particular binding site on the mumps virus. There will likely be multiple antibodies to multiple different binding sites on an antigen such as a virus. For example, some antibodies to COVID-19 will target binding sites on proteins in the outer shell while some may target nucleic acid binding sites, but each will be specific and unique. Only when 2 different, but similar, viruses have identical structures will cross-reactivity occur. For example, if multiple strains of a coronavirus have maintained regions of nucleic acid that have not undergone mutation, an antibody that targets that region in one may target the identical region in another. Conversely, an antibody that recognizes the measles virus generally cannot recognize the mumps virus.

Classes of antibodies

Five isotypes, or classes, of antibodies (IgM, IgD, IgG, IgA, and IgE) exist. They can act as 'flags' to direct the immune system to foreign material for destruction and form part of the innate / humoral immune response.
The five subclasses of antibodies are:

1. **Immunoglobulin A (IgA) -** found in high concentrations in the mucous membranes, particularly those lining the respiratory passages and gastrointestinal tract, as well as in saliva and tears.

2. **Immunoglobulin G (IgG) -** the most abundant type of antibody, is found in all body fluids and protects against bacterial and viral infections.

3. **Immunoglobulin M (IgM) -** found mainly in the blood and lymph fluid, is the first antibody to be made by the body to fight a new infection.

4. **Immunoglobulin E (IgE) -** associated mainly with allergic reactions (when the immune system overreacts to environmental antigens such as pollen or pet dander). It is found in the lungs, skin, and mucous membranes.

5. **Immunoglobulin D (IgD) -** exists in small amounts in the blood, is the least understood antibody.

Factors that affect antigen-antibody interaction

The impact of the antigen on the host body depends on the interaction between the antigen's chemistry and the host's physiological state. There are a wide number of factors that can impact the nature of the antigen-antibody interaction:

I. Optimum Temperature;

II. pH antigen-antibody reaction being strongly inhibited at both sides of the maximum pH (6.5 and 8.4);

III. Antigen zygosity;

IV. Duration of incubation;

V. Concentration of antigen and antibody; and

VI. Serum/cell ratio.

ANTIGEN VS ANTIBODY DIAGNOSTIC TESTS

What is an Antigen test?

What it does: This test identifies people who are currently infected with the coronavirus. It may be used as a quick test to detect active infections. Initially it will not be used to diagnose disease, but it may be used to screen people to identify those who need a more definitive test.

How it works: Antigen tests can identify virus in nose and throat secretions. It does this by looking for proteins from the virus (as opposed to the diagnostic test, which looks for genetic material). This is the same technology used in your doctor's office for rapid strep testing.

How quick is it: These tests should provide results in just a few minutes. As a result, they could be used to screen people in hospitals, certain workplaces, or in other instances where it is important to find out quickly whether someone is currently at risk of spreading the disease. But unless these tests are proven to be highly accurate, physicians would still need to follow up a positive result with a PCR test to make a medical diagnosis.

What is an Antigen test?

What it does: Antibody tests identify people who have previously been infected with the coronavirus. They do not show whether a person is currently infected. The antibody test is not checking for the virus itself. Instead, it looks to see whether your immune system -- your body's defense against illness -- has responded to the infection. This is primarily a good way to track the spread of the coronavirus through a population.
You may also hear it called a Serology test.

How it works: A technician will take a bit of your blood, like through a finger prick. The test looks for one or both kinds of antibodies to SARS-CoV-2, the virus that causes COVID-19:

- **IgM antibodies -** happen early in an infection. IgM antibodies are the largest antibody. They are found in blood and lymph fluid and are the first type of antibody made in response to an infection. IgM antibodies are about 5% to 10% of all the antibodies in the body.

- **IgG antibodies -** are more likely to show up later. IgG antibodies are found in all body fluids. They are the smallest but most common antibody (75% to 80%) of all the antibodies in the body. IgG antibodies are the only type of antibody that can cross the placenta in a pregnant woman to help protect her baby (fetus).

How quick is it: These tests generally produce results in a few minutes, based on a drop of blood taken from the finger. Some research labs use a more sophisticated antibody test, called an Elisa (Enzyme-linked immunoassay) that are more accurate but are not as widely available.

What are the Difference between a Coronavirus Test and an Antibody Test?

A coronavirus test, sometimes called a diagnostic test, looks for signs of an active virus. But it tells you only if you have the virus in your body at the moment when you are tested.
An antibody test shows that you had the virus at some point in the past. There could be no traces of it, or you could still be contagious.

Why Do We Need Antibody Testing?

You could have SARS-CoV-2 and not know of it. Not everyone who gets it has symptoms. Experts hope antibody tests can give health officials a better idea of how common the virus is.
Once scientists know who has had the virus, they can find out how sick it makes most people. And they can study what happens if people who have had it come into contact with it again. Along with other scientific information, this can help researchers understand who might be immune to the virus.
It is important to note that some tests can mistake IgM antibodies from other coronaviruses, such as common cold strains, for SARS-CoV-2 antibodies.

What is in a vaccine?

Each vaccine contains a killed or weakened form of the organism (usually a virus or bacterium) that causes a particular disease. Even though the organism in the vaccine has been altered so that it will not make you ill, the part of the organism that stimulates your immune system to respond **(the antigen)** is still present.
While most vaccines work by inducing B lymphocytes to produce **antibodies,** activation of T-cells — another type of immune system cell that helps protect against disease — is also important for some vaccines.

Antibodies as Therapeutics

Since the Nobel-prize winning work of Kolher and Milstein in the 1970's, (which enabled the infinite production of monoclonal antibodies in culture using hybridoma technology) the quest to develop therapeutic antibodies has been on. In the last few years, therapeutic antibodies have become the main class of new drugs in development, and by December 2019, 79 therapeutic monoclonal antibodies had been approved by the US FDA.
The range of conditions they can be used to treat includes: several types of **cancers, autoimmune conditions, and infectious diseases such as Zika.** A number of studies are currently investigating their potential as a treatment for COVID-19, including via convalescent plasma therapy.
Therapeutic antibodies work by binding with high specificity to the target antigen and stimulating an immune response, which may involve inhibition of ligand binding or tagging the cell for binding by cytotoxic T cells.

Types of therapeutic antibodies:

- Immunoglobulins
- Antibody fragments
- Antibody-drug conjugates
- Bi-specific antibodies
- Radioimmunoconjugates

Antibodies can be produced using a variety of techniques, including **hybridoma technologies, transgenic mice, and in vitro display technologies.** The evolution of antibody engineering has led to the development of increasingly humanized antibodies, with the benefit of low immunogenicity.

Difference between an antigen and an antibody

Characteristics	Antigen	Antibody
Definition	An antigen is any substance that triggers in immune response in the body	An antibody is a blood protein that is produced against specific antigen
Synonym	Also called **Immunogens**	Also called **Immunoglobins**
Molecular type	Can be either proteins, carbohydrates, lipids or nucleic acids	Glycoproteins
Origin	Within the body or externally.	Within the body.
Parts	Highly variable with different structural conformations and is usually composed of different epitopes.	Composed of three main parts: -Two light chains -Two heavy chains -Four polypeptides
Prevalence	Exists in all types of cells; mostly found in viruses, bacteria, and fungi.	Only present in some types of cells.
Source	Usually from a foreign substance (viruses, and bacterial and fungal toxins).	Naturally produced by the body (B lymphocytes or B cells).
Specific binding site	Interacting domain with the antibody is called the **epitope**	The variable region of the antibody that specially binds to an epitope is called **paratope.**
Effect	Cause either **disease** or **allergic reactions**	**Protect** the body from antigens either by **immobilizing** the antigen or **lysing** the pathogen
Kinds	There are three basic kinds of antigens. **Exogenous,** **Endogenous** **Autoantigens**	There are five basic kinds of antibodies. **(IgM, IgG, IgE, IgD and IgA)**