Science & Tech

antibody

biochemistry

Also known as: Ig, immunoglobulin

Written and fact-checked by The Editors of Encyclopaedia Britannica

Last Updated: Sep 28, 2023 • Article History

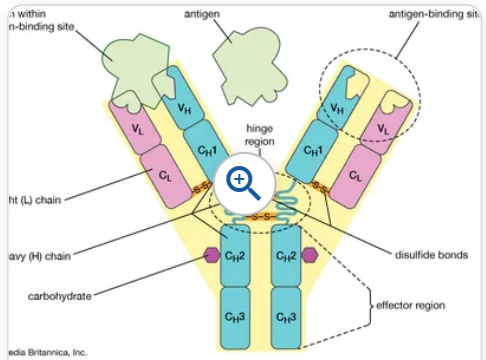
Table of Contents

Recent News

Sep. 27, 2023, 8:37 AM ET (Reuters)

Immunovant shares surge as early antibody treatment data ...

Antibody, also called **immunoglobulin**, a protective protein produced by the immune system in response to the presence of a foreign substance, called an antigen. Antibodies recognize and latch onto antigens in order to remove them from the body. A wide range of substances are regarded by the body as antigens, including disease-causing organisms and toxic materials such as insect venom.



antibody structure

See all media

How antibodies work

When an alien substance enters the body, the immune system is able to recognize it as foreign because molecules on the surface of the antigen differ from those found in the body. To eliminate the invader, the immune system calls on a number of mechanisms, including one of the most important—antibody production. Antibodies are produced by specialized white blood cells called B lymphocytes (or B cells). When an antigen binds to the B-cell surface, it stimulates the B cell to divide and mature into a group of identical cells called a clone. The mature B cells, called plasma cells, secrete millions of antibodies into the bloodstream and lymphatic system.

As antibodies circulate, they attack and neutralize antigens that are identical to the one that triggered the immune response. Antibodies attack antigens by binding to them. The binding of an antibody to a toxin, for example, can neutralize the poison simply by changing its chemical composition; such antibodies are called antitoxins. By attaching themselves to some invading microbes, other antibodies can render such microorganisms immobile or prevent them from penetrating body cells. In other cases the antibody-coated antigen is subject to a chemical chain reaction with complement, which is a series of proteins found in the blood. The complement reaction either can trigger the lysis (bursting) of the invading microbe or can attract microbe-killing scavenger cells that ingest, or phagocytose, the invader. Once begun, antibody production continues for several days until all antigen molecules are removed. Antibodies remain in circulation for several months, providing extended immunity against that particular antigen.

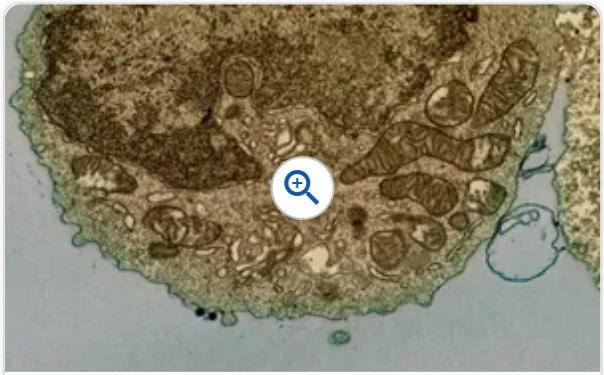
Category: Science & Tech

Also Called: immunoglobulin

Key People: Gregory P. Winter • James P. Allison • Tasuku Honjo • Tonegawa Susumu • Gerald Maurice Edelman

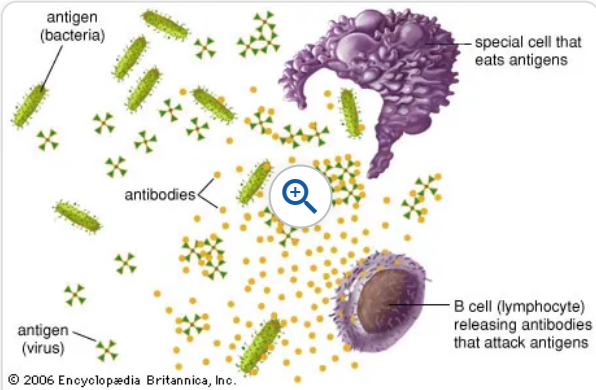
Related Topics: monoclonal antibody • antitoxin • autoantibody • reagin • antinuclear antibody

See all related content →



human B cell

Antibodies and B cells



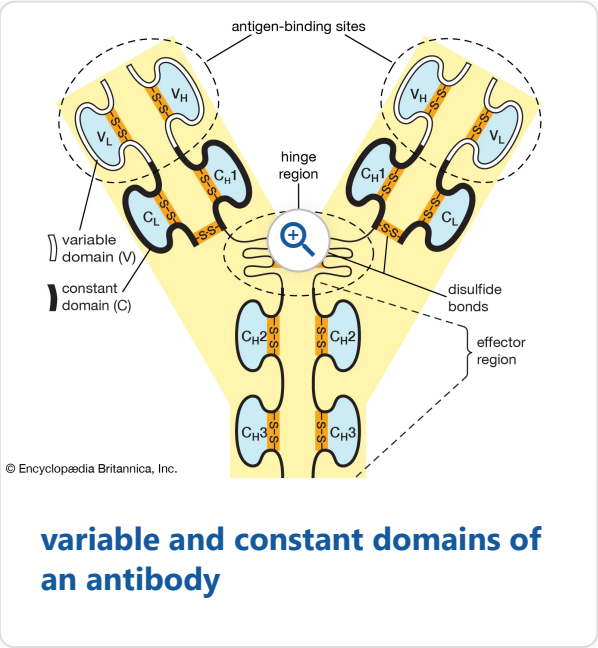
antigen, antibody, and lymphocyte

B cells and antibodies together provide one of the most important functions of immunity, which is to recognize an invading antigen and to produce a tremendous number of protective proteins that scour the body to remove all traces of that antigen. Collectively B cells recognize an almost limitless number of antigens; however, individually each B cell can bind to only one type of antigen. B cells distinguish antigens through proteins, called antigen receptors, found on their surfaces. An antigen receptor is basically an antibody protein that is not secreted but is anchored to the B-cell membrane.

All antigen receptors found on a particular B cell are identical, but receptors located on other B cells differ. Although their general structure is similar, the variation lies in the area that interacts with the antigen—the antigen-binding, or antibody-combining, site. This structural variation among antigen-binding sites allows different B cells to recognize different antigens. The antigen receptor does not actually recognize the entire antigen; instead it binds to only a portion of the antigen's surface, an area called the antigenic determinant or epitope. Binding between the receptor and epitope occurs only if their structures are complementary. If they are, epitope and receptor fit together like two pieces of a puzzle, an event that is necessary to activate B-cell production of antibodies.

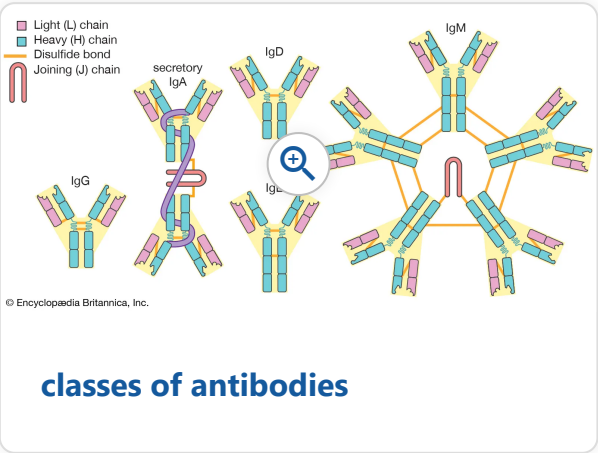
Antibody structure and classes

Each antibody molecule is essentially identical to the antigen receptor of the B cell that produced it. The basic structure of these proteins consists of two pairs of polypeptide chains (lengths of amino acids linked by peptide bonds) that form a flexible Y shape. The stem of the Y consists of one end of each of two identical heavy chains, while each arm is composed of the remaining portion of a heavy chain plus a smaller protein called the light chain. The two light chains also are identical. Within particular classes of antibodies the stem and the bottom of the arms are fairly similar and thus are called the constant region. The tips of the arms, however, are highly variable in sequence. It is these tips that bind antigen. Thus each antibody has two identical antigen-binding sites, one at the end of each arm, and the antigen-binding sites vary greatly among antibodies.



variable and constant domains of an antibody

Antibodies are grouped into five classes according to their constant region. Each class is designated by a letter attached to an abbreviation of the word *immunoglobulin*: IgG, IgM, IgA, IgD, and IgE. The classes of antibody differ not only in their constant region but also in activity. For example, IgG, the most common antibody, is present mostly in the blood and tissue fluids, while IgA is found in the mucous membranes lining the respiratory and gastrointestinal tracts.



classes of antibodies

Antibodies in medicine and research

Antibodies have important applications in medicine and research. Preformed antibodies, for example, which are derived from the blood serum of previously infected people or animals, are often administered in an antiserum to

another person in order to provide immediate, passive immunization against fast-acting toxins or microbes, such as those in snakebites or tetanus infections. Vaccines confer active immunity against a specific harmful agent by stimulating the immune system to attack the agent. Once stimulated by a vaccine, antibody-producing B cells remain sensitized and ready to respond to the agent should it ever gain entry to the body.

Monoclonal antibodies, which are produced artificially through genetic engineering and related techniques, are especially valuable in research and medicine, owing to their ability to recognize individual antigenic sites on almost any molecule, from drugs and hormones to microbial antigens and cell receptors. The specificity of monoclonal antibodies and their availability in quantity have made it possible to devise sensitive assays for an enormous range of biologically important substances and to distinguish cells from one another by identifying previously unknown marker molecules on their surfaces. For example, monoclonal antibodies that react with cancer antigens can be used to identify cancer cells in tissue samples.

Monoclonal antibodies also have been used experimentally to deliver cytotoxic drugs or radiation to cancer cells. They have shown great promise in the immune destruction of cancer cells, particularly via strategies aimed at abolishing inhibitory signals that block T cells from killing the targets they recognize. The potential effectiveness of this approach has been demonstrated with ipilimumab, a monoclonal antibody approved for the treatment of advanced melanoma that binds to and blocks the activity of cytotoxic lymphocyte associated antigen 4 (CTLA4). CTLA4 normally is a powerful inhibitor of T cells. Thus, by releasing the inhibitory signal, ipilimumab augments the immune response, making tumour destruction possible. Similar effects have been achieved with inhibitors of programmed cell death 1 (PD-1), a protein expressed on the surface of T cells that negatively regulates T cell activity and that is overexpressed in many cancers. Anti-PD-1 therapies, such as nivolumab and pembrolizumab, have proven beneficial in patients with melanoma and certain other cancer types.

The Editors of Encyclopaedia Britannica

Science & Tech

dietary supplement

Written by Bill Gurley
Fact-checked by The Editors of Encyclopaedia Britannica
Last Updated: Oct 5, 2023 • Article History

Table of Contents

Dietary supplement, any vitamin, mineral, herbal product, or other ingestible preparation that is added to the diet to benefit health.

Dietary supplements are used worldwide and represent a broad category of ingestible products that are distinguishable from conventional foods and drugs. In the United States, dietary supplements are defined as products (other than tobacco) intended to supplement the diet that contain at least one of the following ingredients: vitamin, mineral, herb or botanical (including extracts of herbs or botanicals), amino acid, metabolite, or any combination thereof. In short, products such as multivitamins, garlic tablets, fish oil capsules, probiotics, natural weight-loss aids, and certain types of energy drinks are examples of dietary supplements.

omega-3 fatty acid dietary supplement

See all media

Category: Science & Tech

In the United States, dietary supplements must be labeled as such and must be intended for oral administration only, whether as tablets, capsules, powders, or liquids. In addition, dietary supplements must not include chemical compounds that have been approved as drugs or licensed as biologics, unless the compound was previously marketed as a dietary supplement or a food. Supplements are often sold alongside conventional over-the-counter medications in retail outlets. While dietary supplements are not intended to treat, cure, mitigate, or prevent any disease, many consumers often view them as substitutes for conventional medications.

Key People: James Lind • George Richards Minot • George H. Whipple • William P. Murphy • Sir Gilbert Blane, 1st Baronet

Related Topics: nutraceutical • probiotic • protein concentrate • nutrient • fish protein concentrate

See all related content →

More than 50 percent of the U.S. population uses some type of dietary supplement on a regular basis. Surveys of supplement usage in other countries indicate that between 40 and 60 percent of Asian respondents use dietary supplements, and about 30 percent of consumers in Europe and Latin America report regular use of these products.

Regulation and classification of dietary supplements

Regulation of dietary supplements varies widely by country. In the United States, supplement regulation was outlined in the Dietary Supplement Health and Education Act (DSHEA) of 1994. As a result of DSHEA, the U.S. Food and Drug Administration (FDA) has regulated dietary supplements as foods, not as drugs; however, they are regulated differently from conventional foods. Even though supplement ingredients may exhibit either health benefits or occasional undesirable side effects, they—unlike drugs—are not evaluated for safety or efficacy prior to their release onto the market. Once a dietary supplement has been marketed, it is the FDA's responsibility to prove that the product is not safe in order to restrict its use or remove it from the market. The FDA relied on a MedWatch program, through which health care providers reported adverse events that occurred with supplements. Consumers, on the other hand, were expected to report suspected supplement-related adverse events directly to the FDA. In other countries, however,

certain dietary supplements, especially botanical formulations, and drugs were regulated similarly, and only those supplements that had been proved safe were sold without a prescription.

echinacea (*Echinacea purpurea*)

Classification of a product as a dietary supplement depends on its intended use, details about which can sometimes be derived from information on the product label. Labels on dietary supplements also serve as a mechanism by which manufacturers can make claims about their products. Such claims generally fall into one of three categories: health-related, nutrient content-related, or structure/function-related. Claims related to health typically focus on assertions about the ability of particular ingredients in supplements to lower the risk for certain diseases or conditions. Claims associated with nutrient content generally are concerned with relative amounts of nutrients or other ingredients. Structure/function claims describe the effects of products on the body; however, manufacturers are not permitted to make assertions about their products' effects on specific diseases. For example, a structure/function claim for calcium supplements may say that they are "for maintenance of bone health," but it may not say that they are "intended to cure osteoporosis." Supplement labels with structure/function claims are required to include the disclaimer "This statement has not been evaluated by the FDA. This product is not intended to diagnose, treat, cure, or prevent any disease."

In other countries, the definition of a dietary supplement may or may not be as inclusive as that adopted in the United States. In Australia and Canada, supplements and drugs are regulated similarly, and only ingredients deemed acceptable by the Therapeutic Goods Administration of Australia or the Natural Health Products Directorate of Canada can be sold as dietary supplements. In the European Union, supplement regulation often follows a case-by-case basis, depending upon the individual country and the available safety evidence for the ingredient. In China and Japan, botanicals have a long history of use as traditional medicines. Despite this, in China in particular, regulations regarding supplements are relatively stringent.

Efficacy, safety, and quality of dietary supplements

vitamin E

Whether dietary supplements provide measurable health benefits has long been a topic of scientific debate. As a result, the general public often receives mixed signals from the supplement industry and the scientific community regarding the effectiveness of dietary supplements. A significant body of scientific evidence clearly supports the role of vitamins and minerals in maintaining good health, yet studies have called into question the safety and efficacy of the prolonged use of certain vitamins, particularly vitamin E. Vitamin D, on the other hand, has gained popularity as a “miracle vitamin” that may play a role in preventing a variety of chronic diseases. Substantiation of health claims for most botanical dietary supplements, however, remains less convincing.

Inconsistency in dietary supplement efficacy can often be traced to variability in product quality. Many dietary supplements may not contain the exact amount of specific ingredients that are claimed on the label. On rare occasions, dietary supplements may be adulterated with prescription medications or contaminated with heavy metals or

pathogenic microbes. Surveys have indicated that at least 15 percent of nutritional sports supplements may be adulterated with synthetic drug products. In such instances, the safety of dietary supplements is compromised. The implementation of current Good Manufacturing Practices (cGMPs) for the dietary supplement industry in the United States was expected to help resolve some of these issues.

Another concern has involved interactions between conventional medications and dietary supplements. Although uncommon, some botanical dietary supplements (e.g., Saint-John's-wort) can render conventional medications less effective, and other supplements may increase the toxicity of certain drugs.

Saint-John's-wort

> *Bill Gurley*