Vaccination and antibodies

Since the introduction of widespread vaccination programmes, millions of people have been protected against potentially fatal diseases, and countless lives have been saved.

Vaccines prepare your immune system to fight disease by taking advantage of the fact that the immune system can ‘remember’ infectious organisms. Vaccination gives us immunity without us having to experience the disease or its symptoms.

What's 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 won’t make you ill, the part of the organism that stimulates your immune system to respond (the antigen) is still present.

What is an antigen?

An antigen is any substance that is recognised as foreign and stimulates the production of antibodies, for example an antigen may be a ‘foreign’ protein on the surface of a bacterium. An antigen specifically induces the production of antibodies which can bind to it and neutralise it.

While most vaccines work by inducing B lymphocytes to produce antibodies (see below), activation of T-cells — another type of immune system cell that helps protect against disease — is also important for some vaccines.

What happens after vaccination?

After you have been vaccinated, some of the cells that are responsible for protecting you against disease — your B lymphocytes — detect the antigens in the vaccine. The B lymphocytes will react as if the real infectious organism was invading your body. They multiply to form an army of identical cells that are able to respond to the antigens in the vaccine. The cloned cells then evolve into one of 2 types of cells:

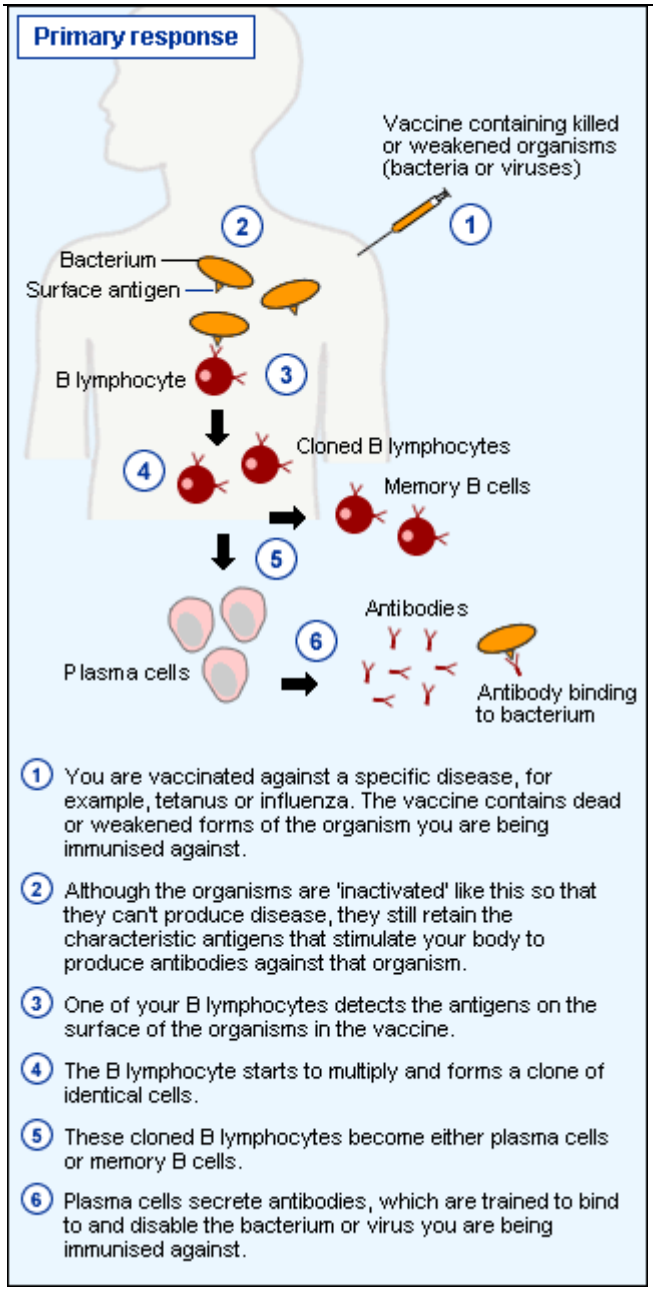
1. Plasma cells; or

2. Memory B cells.

The plasma cells produce antibodies (Y- or T-shaped molecules), which are trained specifically to attach to and inactivate the organism you are being vaccinated against.

This response from your immune system, generated by the B lymphocytes, is known as the primary response. It takes several days to build to maximum intensity, and the antibody concentration in the blood peaks at about 14 days.

Your body continues making antibodies and memory B cells for a couple of weeks after vaccination. Over time, the antibodies will gradually disappear, but the memory B cells will remain dormant in your body for many years.

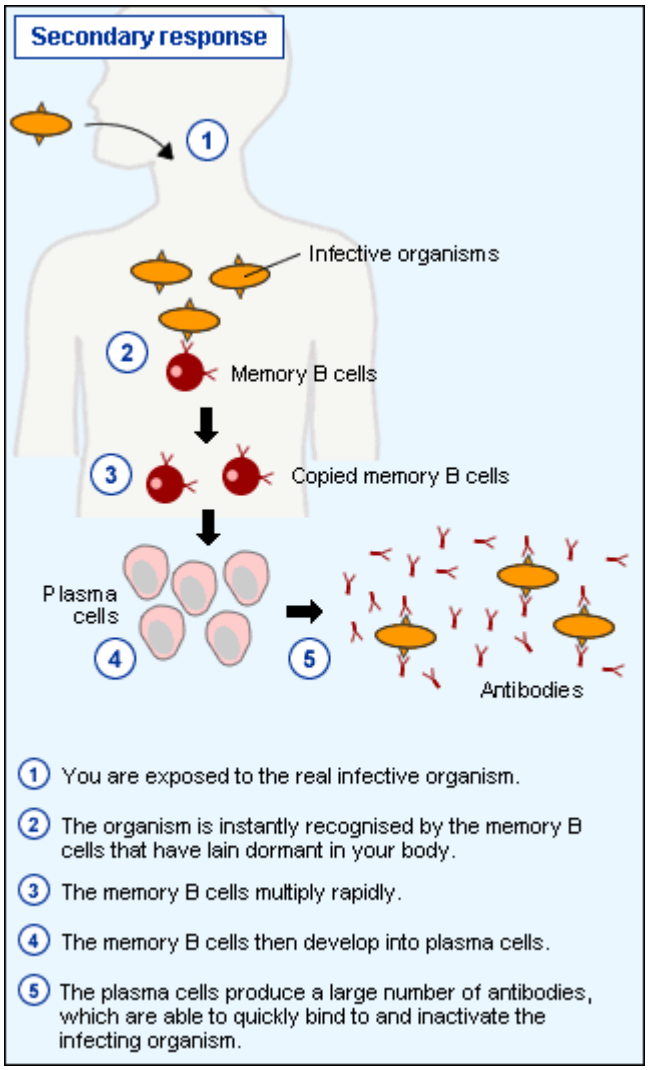


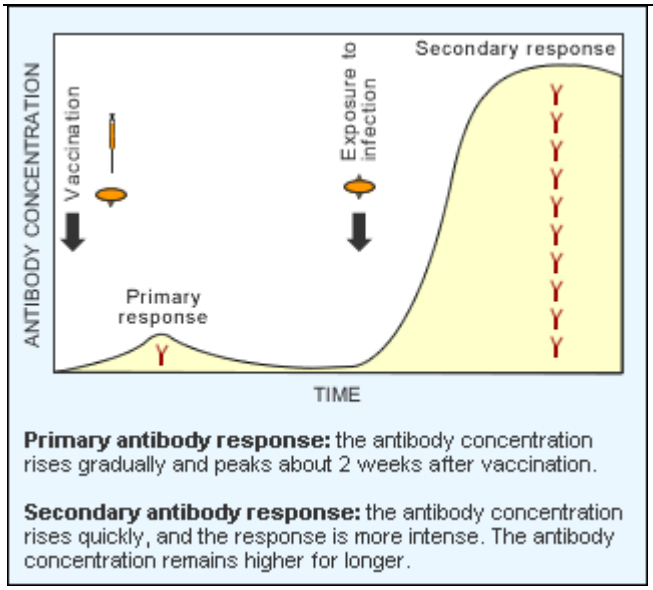
How does vaccination prevent disease?

The memory B cells (as the name implies) keep a memory of the organism that you were vaccinated against. If you are ever exposed to that organism, the dormant memory cells will recognise it straight away, and rapidly start multiplying and developing into plasma cells. Because the plasma cells have already been trained to produce antibodies against the organism, they are able to produce a large number of antibodies very quickly (within hours).

The antibodies attach to the invading organisms and prevent them from attacking your healthy cells. And because the antibodies are produced so quickly, they are able to fight the disease before you even get sick.

This accelerated and more intense immune response generated by the memory B cells is known as the secondary response. It is faster and more effective because all the preparations for the attack were made when you were vaccinated.





Primary antibody response: the antibody concentration rises gradually and peaks about 2 weeks after vaccination.

Secondary antibody response: the antibody concentration rises quickly, and the response is more intense. The antibody concentration remains higher for longer.

Different types of vaccines

Most vaccines are injected, but some can be given as a liquid that is swallowed. There are 4 main types of vaccines:

- live attenuated vaccines, which contain a living, but weakened, form of the germ (organism);
- inactivated vaccines, which contain a killed form of the organism;
- subunit vaccines, which contain just the part of the organism that stimulates an immune response (the antigen); and
- toxoid vaccines, which contain an inactivated bacterial toxin (toxoid).

While the live vaccines can provide lifelong immunity after only one or 2 doses, periodic booster doses are needed to maintain immunity with some of the other types of vaccines.

Vaccine Ingredients

Today's vaccines use only the ingredients they need to be safe and effective.

Each ingredient in a vaccine serves a specific purpose. For example, vaccine ingredients may:

- Help provide immunity (protection) against a specific disease
- Help keep the vaccine safe and long lasting
- Be used during the production of the vaccine

Ingredients provide immunity

Vaccines include ingredients to help your immune system respond and build immunity to a specific disease. For example:

- **Antigens** are very small amounts of weak or dead germs that can cause diseases. They help your immune system learn how to fight off infections faster and more effectively. The flu virus is an example of an antigen.
- **Adjuvants**, which are in some vaccines, are substances that help your immune system respond more strongly to a vaccine. This increases your immunity against the disease. Aluminum is an example of an adjuvant.

Ingredients keep vaccines safe and long lasting

Some ingredients help make sure a vaccine continues to work like it's supposed to and that it stays free of outside germs and bacteria. For example:

- **Preservatives**, like thimerosal, protect the vaccine from outside bacteria or fungus. Today, preservatives are usually only used in vials (containers) of vaccines that have more than 1 dose. That's because every time an individual dose is taken from the vial, it's possible for harmful germs to get inside. Most vaccines are also available in single-dose vials and do not have preservatives in them.
- **Stabilizers**, like sugar or gelatin, help the active ingredients in vaccines continue to work while the vaccine is made, stored, and moved. Stabilizers keep the active

ingredients in vaccines from changing because of something like a shift in temperature where the vaccine is being stored.

Ingredients are used during the production of vaccines

Some ingredients that are needed to produce the vaccine are no longer needed for the vaccine to work in a person.

These ingredients are taken out after production so only tiny amounts are left in the final product. The very small amounts of these ingredients that remain in the final product aren't harmful.

Examples of ingredients used in some vaccines include:

- **Cell culture (growth) material**, like eggs, to help grow the vaccine antigens.
- **Inactivating (germ-killing) ingredients**, like formaldehyde, to weaken or kill viruses, bacteria, or toxins in the vaccine.
- **Antibiotics**, like neomycin, to help keep outside germs and bacteria from growing in the vaccine.

Vaccines are safe and effective. Because vaccines are given to millions of healthy people — including children — to prevent serious diseases, they're held to very high safety standards.

Vaccine Types

There are several different types of vaccines. Each type is designed to teach your immune system how to fight off certain kinds of germs — and the serious diseases they cause.

When scientists create vaccines, they consider:

- How your immune system responds to the germ
- Who needs to be vaccinated against the germ
- The best technology or approach to create the vaccine

Based on a number of these factors, scientists decide which type of vaccine they will make. There are 4 main types of vaccines:

- Live-attenuated vaccines
- Inactivated vaccines

- Subunit, recombinant, polysaccharide, and conjugate vaccines
- Toxoid vaccines

Live-attenuated vaccines

Live vaccines use a weakened (or attenuated) form of the germ that causes a disease.

Because these vaccines are so similar to the natural infection that they help prevent, they create a strong and long-lasting immune response. Just 1 or 2 doses of most live vaccines can give you a lifetime of protection against a germ and the disease it causes.

But live vaccines also have some limitations. For example:

- Because they contain a small amount of the weakened live virus, some people should talk to their health care provider before receiving them, such as people with weakened immune systems, long-term health problems, or people who've had an organ transplant.
- They need to be kept cool, so they don't travel well. That means they can't be used in countries with limited access to refrigerators.

Live vaccines are used to protect against:

- Measles, mumps, rubella (MMR combined vaccine)
- Rotavirus
- Smallpox
- Chickenpox
- Yellow fever

Inactivated vaccines

Inactivated vaccines use the killed version of the germ that causes a disease.

Inactivated vaccines usually don't provide immunity (protection) that's as strong as live vaccines. So you may need several doses over time (booster shots) in order to get ongoing immunity against diseases.

Inactivated vaccines are used to protect against:

- Hepatitis A
- Flu (shot only)
- Polio (shot only)
- Rabies

Subunit, recombinant, polysaccharide, and conjugate vaccines

Subunit, recombinant, polysaccharide, and conjugate vaccines use specific pieces of the germ — like its protein, sugar, or capsid (a casing around the germ).

Because these vaccines use only specific pieces of the germ, they give a very strong immune response that's targeted to key parts of the germ. They can also be used on almost everyone who needs them, including people with weakened immune systems and long-term health problems.

One limitation of these vaccines is that you may need booster shots to get ongoing protection against diseases.

These vaccines are used to protect against:

- Hib (*Haemophilus influenzae* type b) disease
- Hepatitis B
- HPV (Human papillomavirus)
- Whooping cough (part of the DTaP combined vaccine)
- Pneumococcal disease
- Meningococcal disease
- Shingles

Toxoid vaccines

Toxoid vaccines use a toxin (harmful product) made by the germ that causes a disease. They create immunity to the parts of the germ that cause a disease instead of the germ itself. That means the immune response is targeted to the toxin instead of the whole germ.

Like some other types of vaccines, you may need booster shots to get ongoing protection against diseases.

Toxoid vaccines are used to protect against:

- Diphtheria
- Tetanus