

# **A guide to childhood vaccinations**

*Vaccination is the most important thing we can do to protect ourselves and our children against ill health.*

NHS

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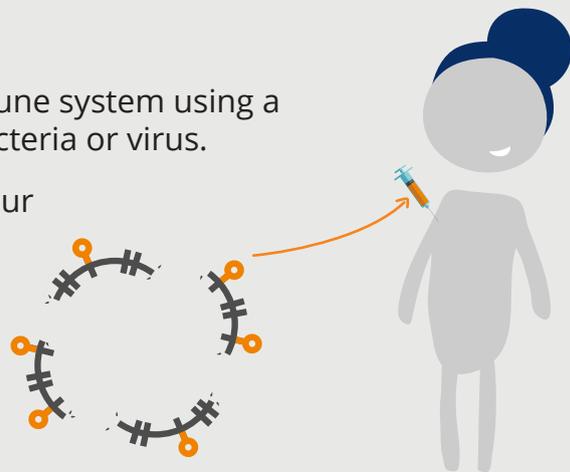
# 1

## How vaccines work & why they're important

### How do vaccines work?

Vaccines train your immune system using a harmless form of the bacteria or virus.

The **vaccine** activates your immune response.



#### B Cells



**B cells** that make highly specific **antibodies** to stop the virus getting into your cells.



#### T Cells

**T cells** that can help stimulate the B cells and kill any infected cells.

#### Antibodies



These cells remember the virus and remain in the body. This is **immune memory**.

If you encounter the real virus in the future, your immune system responds faster and more effectively to prevent infection.

### What is vaccination?

Vaccination is the safest way to protect your child against an infectious disease. Once your child has been vaccinated, they should have the ability to fight off the infection if they come into contact with it. They will have a level of protection, or **immunity**, against the disease.

### How does the immune system fight infection?

The immune system is a network of cells, tissues and organs that work together to help you fight off infection from harmful bacteria or viruses. Such disease-causing agents, including bacteria or viruses, are known as **pathogens**. When a pathogen invades your body, your immune system recognises it as harmful. Your immune system recognises unique features of the pathogen, called **antigens**, which will trigger an immune response.

Your immune system has many ways to fight off an infection. One of the ways is for specialised immune cells called **B cells** to create proteins called antibodies. These **antibodies** act as scouts, hunting down the pathogen, sticking to its antigens and marking it for destruction by the immune system or preventing it from entering your cells. Each antibody is specific to the pathogen that it has detected, matching precisely the shape of the antigen and triggering a specific immune response. Another way the immune system fights off infection is by activating other specialised immune cells called **T cells**, which can attack and kill any cells that are infected with the pathogen.

If your immune system wins the fight against the harmful pathogen, then these specific B cells and their antibodies and T cells will remain in the body after the infection has gone as memory cells. This means that if the same pathogen is encountered again, your immune system has a '**memory**' of the pathogen and is ready to quickly destroy it before you get sick and any symptoms can develop.

Sometimes, however, the immune system doesn't always win this initial battle and you can become very ill with serious complications or in extreme cases die.

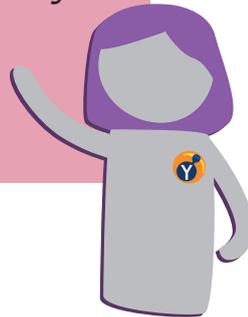
Vaccines have been developed to train your immune system and to protect you against infectious diseases and their serious complications.

### How does vaccination work?

Vaccination is the safest way to gain immunity against a pathogen that your body has yet to encounter. Vaccines contain a harmless form of the bacteria or virus that causes the disease you are being immunised against. Your immune system will still recognise the harmless form of the bacteria or virus in the vaccine without making you sick and will produce a specific immune response to fight it off. The immune system then maintains a memory of the bacteria or virus, so if a vaccinated person encounters the bacteria or virus later, their immune system is already prepared to fight it off quickly and prevent an infection from developing.

***Vaccines work by training our immune system to recognise pathogens and protect us from potentially serious diseases.***

*Louisa James,  
BSI vaccine champion*



### Is it better for my child to gain immunity through infection?

No. The only way to gain immunity would be through infection with the bacteria or virus that causes the disease. Infection poses a serious risk to your child's health, potentially making them very ill and causing long-term health effects. Some diseases, such as measles and meningitis, can also be fatal. Infection also enables the disease to spread from your child to those around them, increasing the risk of others getting ill.

Vaccination allows your child to build up immunity in a safe and controlled way without becoming ill with the disease and passing it to others.

### How effective is vaccination?

Vaccination is considered one of our greatest global health achievements and is estimated to save 3.5–5 million lives a year.<sup>1</sup>

Thanks to vaccines, life-threatening diseases that used to be common in young children in the UK, such as diphtheria, whooping cough and polio, are now relatively rare. Looking at the history of vaccine-preventable disease, there is a huge drop in the number of cases of a disease following the introduction of a vaccine against it. Through vaccination, some diseases have even been eradicated completely, for example smallpox. If smallpox had not been eradicated, it would cause 5 million deaths worldwide a year!<sup>2</sup>

***Immunisation is a global health and development success story, saving millions of lives every year.***

*World Health Organization*

## Have vaccines made a difference?

Year the vaccine was introduced	Disease	Cases per year in England and Wales before the vaccine	Cases per year now (post vaccine)
1942	Diphtheria	50,804	7
1957	Pertussis (whooping cough)	92,407	282
1968	Measles	460,407	444
1991	Hib	862	10
1998	MenC	883	16

### If these diseases are so rare, why does my child need to be vaccinated?

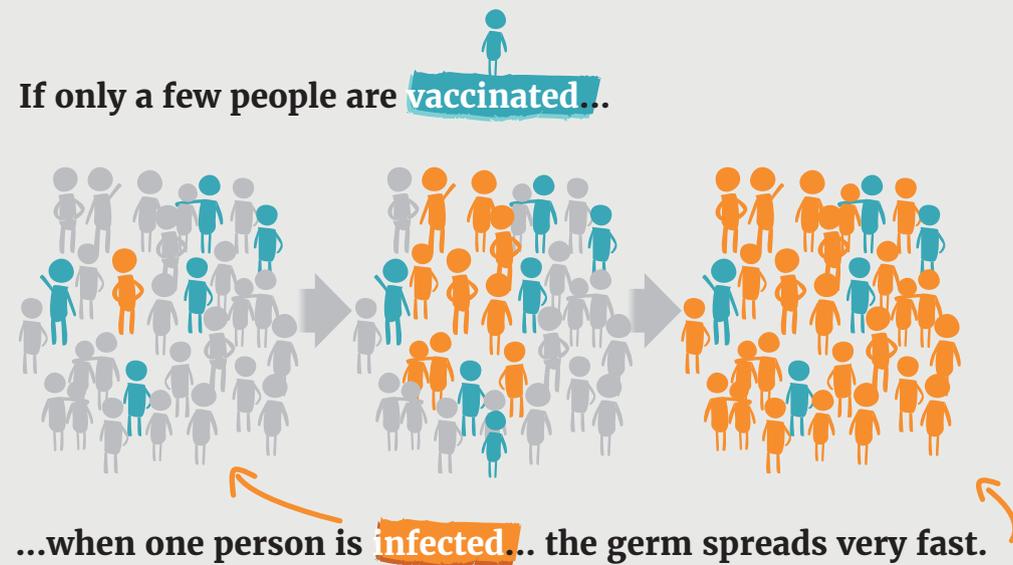
All of the diseases that we vaccinate against exist in the world today. Therefore, if your child has not been vaccinated, there is still a risk that they could get the disease and become very sick. We know that decreases in vaccination uptake can result in outbreaks of diseases such as measles.<sup>4</sup> Regular vaccination is needed to keep our children healthy, prevent outbreaks from occurring and to eventually eradicate these diseases altogether.

### What is 'herd immunity'?

Infectious diseases are often easily passed from person to person and entire communities can rapidly become infected. If a high enough proportion of a community is protected by vaccination, it makes it difficult for the disease to spread because the number of people who can be infected is so small. This type of protection is known as 'herd immunity'. Herd immunity is particularly crucial for protecting some individuals who are unable to receive vaccines, such as those that are too young or undergoing certain medical treatment (such as for cancer). By vaccinating your child, you're not only protecting them, but you are also protecting those most vulnerable in your community.

For herd immunity to work, a high percentage of the community needs to be vaccinated. Although average vaccination rates in the UK are relatively high, there are still pockets of the UK where rates fall significantly below what is required for herd immunity.<sup>5</sup> Declines in herd immunity caused by decreased vaccination rates have recently caused outbreaks of measles and whooping cough in the UK.<sup>6,7</sup> If the vaccination rates in your community are not high enough, it leaves the most vulnerable at greater risk.

## What is 'herd immunity'?



# 2

Routine vaccination schedule recommended by the NHS



## When and how many vaccines does my child need?

When?	What?
<b>8 WEEKS</b>	<ul style="list-style-type: none"> <li><b>6-in-1 vaccine</b> protects against diphtheria, tetanus, whooping cough, Hib, HepB and polio, first dose</li> <li><b>Rotavirus vaccine</b> first dose</li> <li><b>Meningococcal group B (MenB) vaccine</b> first dose</li> </ul>
<b>12 WEEKS</b>	<ul style="list-style-type: none"> <li><b>6-in-1 vaccine</b> second dose</li> <li><b>Rotavirus vaccine</b> second dose</li> <li><b>Pneumococcal (PCV) vaccine</b> first dose</li> </ul>
<b>16 WEEKS</b>	<ul style="list-style-type: none"> <li><b>6-in-1 vaccine</b> third dose</li> <li><b>MenB vaccine</b> second dose</li> </ul>
<b>1 YEAR</b>	<ul style="list-style-type: none"> <li><b>Hib/MenC vaccine</b> given as single vaccine against MenC (first dose) and Hib (fourth dose)</li> <li><b>MMR vaccine</b> protects against measles, mumps and rubella, first dose</li> <li><b>PCV vaccine</b> booster</li> <li><b>MenB vaccine</b> booster</li> </ul>
<b>2-10 YEARS</b>	<ul style="list-style-type: none"> <li><b>Nasal flu vaccine</b> yearly</li> </ul>
<b>3 YEARS, 4 MONTHS</b>	<ul style="list-style-type: none"> <li><b>MMR vaccine</b> second dose</li> <li><b>4-in-1 pre-school booster</b> protects against diphtheria, tetanus, whooping cough and polio</li> </ul>

### Why are changes made to the immunisation schedule?

The immunisation schedule is continually monitored to ensure that the timing and type of vaccination is as beneficial to your child as possible. Improvements to the schedule may involve changing the recommended age a vaccine is given at, the number of doses required, or introducing a new vaccine combination. Following extensive research, trials and analysis, new vaccines will also be added to the schedule to increase the number of diseases that your child can be protected from.

The most important thing to remember is that any change to the immunisation schedule is there to help keep your child as safe as possible, by protecting them from more diseases and ensuring a vaccine is as effective as possible.

### Why does my child need to be vaccinated at specific times? Can I wait until they're older?

The immunisation schedule has been designed so that your child can be vaccinated as soon as possible, at a time when each vaccine will be the most effective.

It is important to vaccinate your child at the age advised to make sure that they are protected from an early age. Babies and young children are the most vulnerable to disease and the longer you wait to vaccinate your child, the greater the possibility of them catching the disease and becoming ill.

If you miss an appointment you can still get your child vaccinated after the recommended age and catch up with the schedule. It is never too late to start vaccination. However, keep in mind that the longer you wait, the longer you leave your child unprotected and vulnerable to disease. Please speak to your health visitor, practice nurse or GP for further information about vaccinating your child outside of the recommended times.

### Is there a situation when a child shouldn't be vaccinated?

If a child is unwell with a fever, then vaccination will usually be postponed until they are better. Otherwise, it is very rare that a child is unable to be vaccinated. Only children with a weakened immune system, caused by a medical treatment such as chemotherapy, an allergy to the vaccine or its components, or certain medical conditions affecting the function of their immune systems are unable to receive all the vaccines recommended in the immunisation schedule. Please speak to your health visitor, practice nurse or GP if you are concerned about whether your child is able to receive all the vaccines on the immunisation schedule.

### What is a booster vaccine and why does my child need one?

A booster vaccine is a repeated dose given to boost the immune response against the bacteria or virus. Immunity against some bacterias and viruses can fade over time and further exposure to the vaccine is required to increase immunity to maintain strong protection for a longer time. It is important to keep up to date with your child's booster vaccines to ensure they are as protected as possible.

### Can I have vaccines when I am pregnant?

Yes. Some vaccines, such as the inactivated flu vaccine and whooping cough vaccine, are offered to pregnant women to protect them and their unborn child.<sup>8,9</sup> These vaccines are safe and extremely effective at preventing serious illness from these infectious diseases. Inactivated vaccines do not contain any live version of the bacteria or virus they are protecting against.

During pregnancy, a woman's natural immune system is weakened. This may make it more difficult for them to fight infection and increases their risk of harm from

common diseases, such as flu. Therefore, pregnant women are among a group that are especially vulnerable to flu complications, something which the vaccine can protect against.

Whooping cough, or pertussis, is a very serious infection and young babies are the most at risk. During pregnancy, vaccination against whooping cough will lead to the production of antibodies which will be passed on to the baby during the last three months of pregnancy through the placenta.<sup>9</sup>

Therefore, vaccines not only protect the mother during pregnancy, but also protect their unborn and newborn child.

If a vaccine is made up of a live, but weakened, version of the virus, pregnant women will usually be advised to wait until after birth to receive these. It is important that you speak to your midwife, practice nurse or GP if you are concerned about vaccines during pregnancy.

# 3

## Common questions & concerns

*Concerns over vaccine safety have allowed misconception and misinformation about vaccination to spread. However, the large amount of unverified information available on the internet about vaccination can make it difficult to distinguish the facts from the myths. Here are answers to some of the most common questions and concerns about vaccines.*

### How do I know vaccines are safe?

Before any vaccine can be given to the population it must go through rigorous testing. Like all medicines, vaccines undergo extensive clinical trials, where they are administered and monitored in groups of volunteers. In the UK, the results of the trials are then assessed by the Medicines and Healthcare products Regulatory Agency (MHRA).

No medicine can ever be completely risk free or 100% effective. However, strong licensing processes and safety tests ensure that the health benefits of medicines and vaccines being given through the NHS greatly outweigh any risks. As vaccines are given to healthy people, these regulatory measures are even stricter, meaning that the level of 'acceptable risk' for vaccines is much lower than it would be for other medicines.<sup>10</sup>

Even once a vaccine becomes part of the vaccination schedule, it is continually monitored for safety and effectiveness by the MHRA. Any suspected side effects are reported by medical providers or patients to the MHRA using the yellow card scheme (see additional resources).

### What are vaccines made of?

Each vaccine will be made up of slightly different ingredients depending on how the vaccine has been developed. The active ingredient in a vaccine is a very small amount of a harmless form of the bacteria or virus you are vaccinating against, which cannot cause disease. The role of the active ingredient is to deliver antigens to your immune system to generate a specific immune response.

The most abundant ingredient in a vaccine is water. The other ingredients in a vaccine are present in very small amounts and there is no evidence that they cause harm in these quantities (with the rare exception of people with severe allergies to some specific ingredients).

Vaccines contain very small amounts of preservatives and stabilisers, such as sorbitol and citric acid, to maintain quality and ensure the vaccine is safe to be transported and stored. These ingredients are often naturally found in the body or in food at much higher levels than in a vaccine. Preservatives are added to vaccines to prevent unwanted contamination, much like they're used in food products to stop them from spoiling. Stabilisers are also used in vaccines to stop the components separating or sticking to the vial during transportation and storage.

Some vaccines have a very small amount of a substance added to them to help create a stronger immune response to that vaccine. These are called adjuvants. Aluminium hydroxide is an adjuvant found in vaccines, which boosts the immune response.<sup>11</sup> Aluminium is found naturally in nearly all food and drinking water and the amount in a vaccine is extremely small. Adjuvants pose no significant risk to health in the very small quantities used in a vaccine and are often found in foods and other medicines at much

larger quantities. Research has found that in an infant's first year of life, the total amount of aluminium in both vaccines and diet is less than the weekly safe intake level.<sup>12</sup> Aluminium is also found in many other medicines, such as heartburn medication.<sup>13</sup>

Formaldehyde is used in the manufacture of vaccines. It is an organic compound which is found in many living things and humans produce formaldehyde naturally as part of the metabolic process. While it is true that high levels of formaldehyde can be harmful to humans, the residual trace amounts present in any vaccine are fifty times smaller than that found in a pear.<sup>11</sup>

For a more extensive list of ingredients in each individual vaccine, you can refer to the Patient Information Leaflet (PIL) or Summary of Product Characteristics (SPC) sheet that comes with each vaccine. Both can also be found online.

### Are animal products used in vaccines?

Some live vaccines, such as the MMR vaccine, contain gelatine, which is derived from pigs. This is used to stabilise the vaccines so that they can be stored safely at different temperatures. The gelatine used is highly purified and broken down into very small molecules so that no pig DNA remains. Members of some faiths may however be concerned about vaccines containing pig-derived gelatine. According to Jewish laws, porcine ingredients in non-oral products, including vaccines, cause no concern.<sup>14</sup> Similarly, many Muslim leaders have ruled that the presence of gelatine in vaccines does not break religious dietary laws due to its high purification and non-oral administration.<sup>15</sup>

## What's in a vaccine?



### Active ingredient

A very small amount of a harmless form of the bacteria or virus you are immunising against.



### Adjuvants (only found in some vaccines)

Create a stronger immune response to the vaccine. Pose no significant risk to health in the very small quantities used.



### Preservatives and stabilisers

Maintain vaccine quality, safe storage and prevent contamination.



**Residual traces** of substances that have been used during vaccine manufacture, measured as parts per million or billion in the final vaccine.



### Water

The main ingredient.

## Why do some children still get the disease even after they've been vaccinated?

Vaccines are the most effective medical intervention we have for preventing disease. However, no medicine can ever be 100% effective and the effectiveness of the vaccine will differ depending on how it is made and the disease it is protecting you from.

Variations in individual immune systems mean that the protective capacity of the vaccine will vary between different people, and in a very small number of cases, immunity against the disease will not fully develop. However, vaccination is extremely effective for the majority of people. If a high enough proportion of people are vaccinated, those who have not developed immunity from the vaccine will be protected by herd immunity.<sup>16</sup> Even if your child does catch the disease after they have been vaccinated, their symptoms are likely to be much milder in comparison to those in children who have not received the vaccine.<sup>17</sup>

## Can receiving multiple vaccinations overload the immune system?

No. Your child's immune system fights off millions of germs every day. The amount of bacteria or virus in a vaccine is very small in comparison and will put no extra strain on your child's immune system. Even if your child received several vaccines at once, they would still only be using less than a thousandth of their immune system's capacity.<sup>18</sup>

### Is it safer to receive vaccines separately rather than in combination?

Multiple vaccines are given in a single healthcare appointment to make sure that your child is protected from a disease as soon as possible and to avoid you having to make multiple appointments. There is no medical benefit to spreading vaccinations out over multiple appointments.

Some vaccines are combined into a single shot to limit the number of injections your child has to receive; for example the 6-in-1 vaccine reduces the number of injections from six to one. The combined vaccines have been shown to be as effective as the individual vaccines and they do not pose any safety concerns or greater risk to your child.

### Does the MMR vaccine cause autism?

There is now overwhelming evidence that the MMR vaccine does not cause autism. There are multiple studies, involving large numbers of children, that show no evidence of any link between the MMR vaccine and autism.<sup>19,20,21,22</sup>

### Is there mercury in vaccines and will this be toxic for my child?

No vaccines used in UK routine vaccinations contain mercury. Extensive research shows that there is no link between the levels of mercury, also referred to as thiomersal, used in vaccines and conditions such as brain damage and autism in children. Nevertheless, in an effort to reduce global environmental exposure to mercury, US and EU regulators have phased out thiomersal use in vaccines.<sup>23,24</sup>

### Do vaccines cause allergies and autoimmune disease?

The occurrence of autoimmune diseases, such as rheumatoid arthritis, and allergies has increased over the last few decades and it is still unclear why this is happening. Vaccination rates have also increased during this time, which has led some people to believe that vaccines could be the cause. However, many large-scale studies have not found any evidence that vaccination triggers allergies or causes autoimmune disease.<sup>25,26</sup> The rise in allergies and autoimmune diseases has been more closely linked to lifestyle and environmental changes.

**Reliable, evidence-based answers to questions and constructive conversations about vaccines can help everyone make an informed decision.**

*Erika Aquino,  
BSI public engagement and  
vaccine champion*



## Additional resources

To access the references in this guide  
[www.immunology.org/childhood-vaccine-guide/references](http://www.immunology.org/childhood-vaccine-guide/references)

British Society for Immunology  
[www.immunology.org](http://www.immunology.org)

UK Health Security Agency – routine childhood immunisation schedule  
[https://bit.ly/routine\\_schedule](https://bit.ly/routine_schedule)

NHS website – vaccinations and when to have them  
<http://bit.ly/NHSvacc>

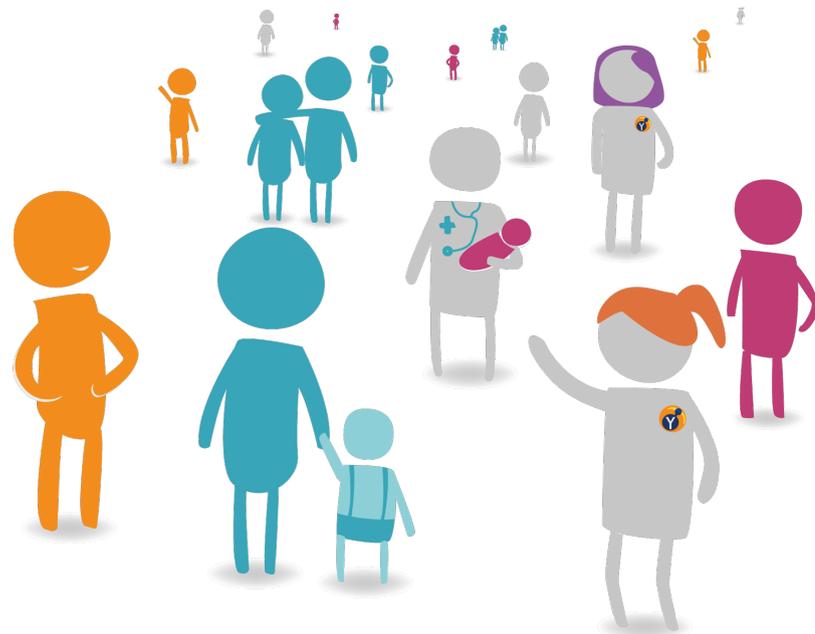
NHS website – why vaccination is safe and important  
<http://bit.ly/NHSsafe>

Vaccine Knowledge Project (University of Oxford)  
<http://vk.ovg.ox.ac.uk>

UK Health Security Agency – immunisation at one year of age  
[https://bit.ly/UKHSA\\_year1](https://bit.ly/UKHSA_year1)

MHRA yellow card scheme  
<https://yellowcard.mhra.gov.uk>

If you have any questions about vaccines, ask your GP, nurse or other healthcare professional.



The British Society for Immunology's mission is to support our immunology community in driving scientific discovery and making a positive impact on health.

We are grateful to all our members who contributed to and reviewed this booklet.

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