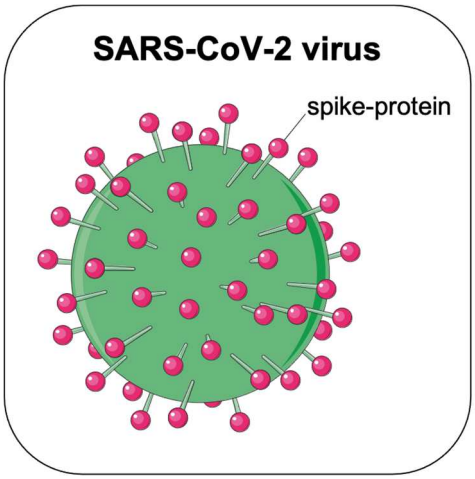
Information on Corona Vaccination

A fact sheet of the German Society for Immunology (DGfI)

The idea of vaccination is to trigger a specific immune response in the body against a pathogen that may occur in the future. Therefore, during a vaccination, a small component of the pathogen is administered to stimulate the immune system. Such an immune response can - in the best-case scenario - protect against disease from a pathogen for a lifetime. The new Covid-19 vaccines are different from conventional vaccines and are either mRNA or vector-based. Because of this novelty, many citizens are concerned and wonder if the new vaccines have been tested enough. Below, we explain what is new and different about the vaccines, the advantage these vaccines have over traditional vaccines, why development has been so rapid, and why it is so important to be vaccinated against Corona.

Why should I be vaccinated? Isn't it better to undergo the infection?

After vaccination, immunity is established in the body. This means that the pathogen causing the disease can be eliminated immediately if it enters the organism. Immunization with the new Corona vaccines involves either mRNA-based or vector-based vaccination (see below). Common to both vaccination strategies is that a vaccine response is elicited against the so-called spike protein of the SARS-CoV-2 virus. Since the spike protein alone, without the other virus components, is used for immunization, there are no disease-causing effects of the SARS-CoV-2 virus to be feared from vaccination. As with any other vaccination, SARS-CoV-2 vaccination elicits only desired immune responses.



Schematic representation of the SARS-CoV-2 virus. The SARS-CoV-2 virus has spike-like protruding proteins on its surface, the so-called spike-proteins. These are not only a characteristic feature of the virus; they also play an important role in the infection and defense of the virus. The head of the spike-protein contains the binding site that is used by the virus to attach to our body cells and to penetrate them. This structure is also recognized by antibodies and is therefore used in the vaccines. Graphics: Servier Medical Art by Servier CC BY 3.0

Why is it so important to be vaccinated against SARS-CoV-2? In the case of a SARS-CoV-2 infection, in many people the virus triggers not only the desired reactions of the immune system, which help to eliminate the virus, but also strong inflammatory responses, which damage our body. This particularly affects patients with severe courses of Covid-19 disease. Here, for example, in addition to the lung tissue, nerves (sense of smell and taste), in some cases the digestive tract, the liver or the kidneys are

damaged. In many cases, this damage (fibrosis) can last for a long time, which is referred to as long- or post-COVID-19 syndrome. As for many other things which we do not know for SARS-Cov-2 yet, we currently do not know, how long this damage can last. This will only become clear with time. A similar damage is also known from other viral diseases, for example Epstein-Barr virus, or SARS-CoV-1 and MERS. The strategy of any virus is to evade the immune response. Viruses are true masters of deception and concealment - this is also true for the SARS-CoV-2 virus. This virus manipulates the finely tuned machinery of the immune system in various ways, hindering a correctly running immune response. Instead, the immune response in an infected person occurs rather chaotically. Moreover, the inflammatory response towards the virus cannot be shut off and is thus harmful for the body.

When we get vaccinated, none of these undesirable and negative reactions caused by the virus, occur. After vaccination there is no severe inflammation, nor is there a undirected immune response. Vaccination establishes a protective immune response, enabling the person's immune system to fight off any future infection with the SARS-CoV-2 virus. This involves the formation of protective antibodies against the spike-protein, as well as the activation of so-called cytotoxic T cells. The latter are the killer cells among immune cells that can directly target and destroy SARS-CoV-2-infected body cells. In the event of a subsequent infection with the virus, it can therefore be quickly detected and immediately eliminated. Therefore, vaccination is clearly preferable to natural infection.

Will the vaccine protect? How long will protection remain established?

Studies to date show that most available vaccines provide over 90% protection. This is significantly more than the annual flu vaccine, which offers only about 70% protection. How long the vaccine protection lasts has not yet been conclusively determined, but initial study participants have been shown to have protective antibodies for months. The immune response of these study participants will continue to be monitored. Based on the current state of knowledge, it is assumed that even a survived Covid-19 disease will probably not provide lasting protection against a new infection. Therefore, it will be necessary to refresh the vaccination, as is common practice for the influenza vaccination, for example.

Is the vaccine safe? Are there any long-term effects?

Before a vaccine is approved, it undergoes extensive regulatory evaluation. This includes preclinical and clinical studies, a regulatory review, compliance with regulatory and marketing approval requirements, and post-approval surveillance. To receive regulatory approval, the quality, safety and efficacy of the vaccine must be demonstrated. In addition, its benefits must clearly outweigh its risks. Even after marketing authorization, continuous monitoring ("surveillance") is carried out to record efficacy and possible rare side effects. In Germany, side effects and vaccination reactions are recorded centrally - and independently of the manufacturer - by the Paul Ehrlich Institute (PEI).

The term long-term consequences is often misunderstood in the context of vaccinations. "Long-term" does not mean that common side effects continue to occur months or even years after vaccination. Long-term effects are rare side effects, and might occur within a few weeks after vaccination. "Long-term" refers to the period of time necessary to vaccinate enough people to reliably attribute such rare side effects to the vaccine. Long-term observations for all drugs take place after approval, as part of surveillance.

For the current vaccines against SARS-CoV-2, the number of vaccinated participants in Phase III trials, with several tens of thousands of volunteers, was strikingly large, compared to usual vaccine trials. The necessary number of vaccinated persons for the detection of side effects was thus reached very quickly. Normally, such studies include much fewer participants - from several thousand to about 10,000 participants. No serious side effects have been observed in the study participants vaccinated so far. However, since the volunteers are mostly not members of high-risk groups, vaccination might trigger more severe vaccine reactions and side effects in high-risk groups.

According to current knowledge, the following side effects are to be expected:

- 66 - 84 % pain at the injection site (mainly after 1st vaccination).
- 55 - 62 % fatigue and headache (rather after 2nd vaccination)
- 38 % muscle pain (more likely after 2nd vaccination)
- 32 % chills (rather after 2nd vaccination)
- 15 % fever (more likely after 2nd vaccination)

All these symptoms are a sign that the immune system is working. Such symptoms also occur with other vaccinations and usually subside on their own after 2-3 days. Since the known sequelae of the infection (possible lifelong fibrosis) are certainly more severe than the above-mentioned expected side effects of vaccination, vaccination is preferable to infection (risk-benefit balance).

How could vaccines be developed so unusually quickly?

Novel platform technologies for vaccine production (e.g., RNA or vector vaccines) have been developed in research laboratories over many years and have been extensively tested for their efficacy and safety in cell cultures and animals. Data regarding humans is also already available. For example, for the first time back in 2013, an mRNA vaccine (rabies vaccine from the company Curevac) was tested in healthy volunteers. The corresponding phase I trial was very successful. In addition, the scientists were able to use preliminary work on two similar coronaviruses (SARS 2002/2003 and MERS 2012). Thus, the fact that production of vaccines against SARS-CoV-2 is now moving so quickly is because manufacturers were able to use their knowledge from the past. Further, due to immense government support and third-party funding, they were able to place much more money into vaccine development than usual. This sped up vaccine development and allowed for parallel processing of otherwise sequential development steps. Regulatory agencies are also bringing forward the processing of applications for approval of a Covid-19 vaccine. However, vaccine safety remains the top priority.

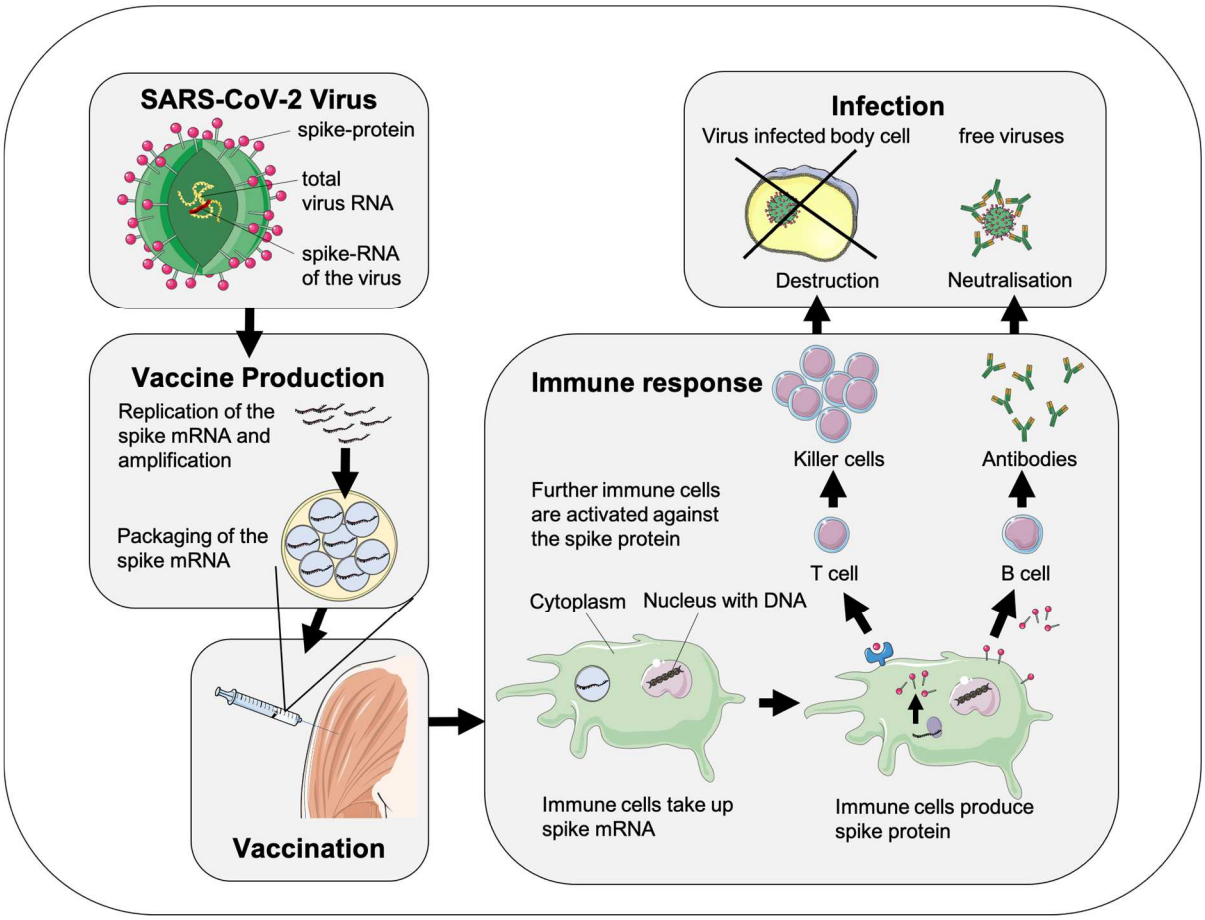
What is a vector vaccine?

The vaccine from Astra-Zeneca/Oxford Institute is a vector vaccine. In a vector vaccine, an attenuated virus is used as a means of transport (vector). The genetic information of the attenuated virus also contains the blueprint for the spike-protein of SARS-CoV-2. In the body of the vaccinated person, the blueprint is translated and a harmless version of the spike protein is produced. This causes an immune response that protects the body from true infection with SARS-CoV-2. Disease is not induced by the vector vaccine. Vector vaccines have already been approved, e.g., against Ebola.

What is an RNA vaccine?

mRNA (messenger ribonucleic acid) serves as a blueprint that our cells use every day to produce proteins. The translation of mRNA into protein takes place within the cell. This is a process that occurs daily in all cells of the body and ensures the maintenance of the cellular system. The Corona vaccines contain an artificially produced mRNA that harbors the blueprint for the spike-protein of the viral envelope.

Our body uses this blueprint to make its own harmless version of these spike-proteins. Various immune cells then react against the spike proteins. The harmless viral protein does not make us sick, but it fools the body into thinking that we are infected, which means that the spike protein is recognized as 'foreign' and an immune response is stimulated. An optimal result of this immune response involves, on the one hand, the formation of protective antibodies that bind to the virus in case of infection and, on the other hand, the formation of so-called T cells that can destroy virus-infected body cells. This prevents disease in the event of actual infection with the SARS-CoV-2 virus.



Immune response against SARS-CoV-2 virus with mRNA vaccine. mRNA vaccines contain a blueprint (mRNA) for the spike-protein of the SARS-CoV-2 virus. Because the mRNA is highly unstable, it is packaged in a protective envelope for vaccination. The administered mRNA is taken up by immune cells and resides in the cytoplasm of the cell. It serves as the basis for protein production. Fragments of the spike-protein are presented on the cell surface (like on a plate) to the cells of the immune system. This activates T cells. These can recognize and eliminate infected cells. In addition, B cells produce protective antibodies against the spike-protein. These vaccine-activated B and T cells protect us in the event of infection with the actual SARS-CoV-2 virus. Graphics: Servier Medical Art by Servier CC BY 3.0

Can an RNA vaccine alter the genetic material?

The vaccines from BioNTech/Pfizer and Moderna are RNA vaccines. A common misconception is that the artificial mRNA could alter our genetic material. It is important to know that the mRNA used for immunization does not enter the cell nucleus at all. The genetic material of the cell, the so-called DNA (deoxyribonucleic acid), which is located in the cell nucleus, is therefore not changed. DNA and RNA also have a different chemical structure, which prevents RNA from being incorporated into DNA. Artificial mRNA taken into the cell cannot be converted into DNA either. In addition, mRNA is not very stable and is very quickly degraded by the body or decays on its own. The claim that vaccination would change a person's genetic material is false.

Can the RNA vaccine cause infertility and prevent pregnancies?

The claim that mRNA vaccines cause permanent infertility in women via cross-reactions with the syncytin-1 protein is false. Syncytin-1 is an important protein that is critically involved in the formation of the placenta in the uterus during pregnancy. The assumption that the antibodies generated after vaccination cause an immune reaction not only against the spike protein of the Sars-CoV-2 virus, but due to protein similarities, also against the endogenous syncytin-1 protein is not valid.

The spike protein and the syncytin-1 protein are so different that an adverse immune reaction (cross-reaction) against the syncytin-1 protein is highly unlikely. In fact, the two proteins are similar in only 4 amino acids. According to experts, this similarity is too short to plausibly trigger an autoimmune reaction, as 50 to 80 amino acids are required for this. For example, Lennart Randau, professor of microbiology at the University of Marburg and head of the RNA biochemistry study group of the Society for Biochemistry and Molecular Biology, told ARD Tagesschau that the spike-protein is unique and specific for the coronavirus. "It is the structural protein with the highest divergence and was chosen, among other things, to minimize cross-reactions with other cold or diarrhea coronaviruses."

So far, there is also no evidence that the vaccine, due to cross-reactions with the body's own proteins, causes infertility. For example, there was no evidence of infertility in vaccinated women during clinical trials of the mRNA vaccines. According to the University of Chicago Medicine, 23 women became pregnant after receiving the vaccine. In addition, women infected with SARS-CoV-2 would also have to be infertile, since infection sets off the same immune response to produce antibodies against the spike protein as the vaccination. According to Marion Kiechle, director of the gynecological clinic at the Klinikum rechts der Isar in Munich, a member of the Leopoldina and former minister of state, more than 40,000 cases of Corona-positive pregnant women have been published in the United States. If antibodies against the spike protein would cause a cross-reaction with the syncytin-1 protein, an increased rate of miscarriages and pregnancy complications would have been observed at this stage. This is not the case.

Can the vaccine cause autoimmune diseases or cancer?

In autoimmune diseases, the immune system mistakenly attacks the body's own structures. In the case of vaccination, vaccine components would therefore have to have very similar structures to the body's own structures. However, such autoimmune reactions are extremely rare upon vaccination. In contrast, viral infections can trigger autoimmune diseases (as in the case of SARS-CoV-2). Furthermore, vaccination excludes the possibility that components of the current vaccines can be

incorporated into the genetic material in the cell nucleus. Therefore, it can be assumed that the vaccines do not contribute to the development of cancer.

Do the vaccines contain dangerous additives?

Adjuvants are used in vaccinations to stimulate the immune system more strongly. This allows for a lower dose usage of the vaccine. Adjuvants are, for example, oil-in-water emulsions or aluminum hydroxide, which has been used for over 90 years. Adjuvants can sometimes cause side effects, but usually mild ones. They are not themselves a drug but are tested and approved with the vaccine. Since foreign mRNA itself stimulates the immune system, the vaccines from BioNTech/Pfizer and Moderna do not require adjuvants. Vector vaccines also do not require an adjuvant.

Where can I find reliable information on the SARS-CoV-2 virus?

Relying on misinformation when dealing with the SARS-CoV-2 virus can lead to risky dis- and misinformation. Especially via social networks, many false reports are currently spread. Therefore, it is important to obtain information on the SARS-CoV-2 virus from reliable sources:

- **Federal Foreign Office**
  e.g., travel warnings
- **Federal Institute for Drugs and Medical Devices (Bundesinstitut für Arzneimittel und Medizinprodukte, BfArM)**
  e.g., Tasks of the BfArM in the context of COVID-19 (only in German)
- **Federal Ministry of Health (Bundesministerium für Gesundheit BMG)**
  e.g., political activities, Corona warning app
- **Federal Centre for Health Education (Bundeszentrale für gesundheitliche Aufklärung BZgA)**
  e.g., Hygiene and behavioral recommendations for the prevention of infections, explanatory videos, leaflets (only in German)
- **European Medicines Agency, EMA**
- **Health Innovation Hub of the Federal Ministry of Health (BMG)**
  e.g., Telemedicine providers, Charité and Robert Koch Institute information
- **Paul-Ehrlich-Institute (PEI) – Federal Institute for Vaccines and Biomedicines**
  e.g., regulatory and research tasks in the context of COVID-19
- **Robert Koch-Institute (RKI)**
  e.g., officially confirmed COVID-19 cases, epidemiological information on the coronavirus SARS-CoV-2

Status: 22.1.2021

About the German Society for Immunology (DGfI)

The German Society for Immunology e.V. (DGfI), founded in 1967, brings together leading natural scientists and physicians to research the mechanisms of the body's own defenses. This provides an important foundation for the diagnosis and treatment of diseases. Through national training courses (Academy of Immunology) and in exchange with international professional societies, the DGfI particularly promotes young scientists and clinicians. Increasing the acceptance of immunological research in the general public is also an important concern of the DGfI. With more than 2,300 members, the DGfI is the fourth largest national society for immunology worldwide. For more information, visit www.dgfi.org.