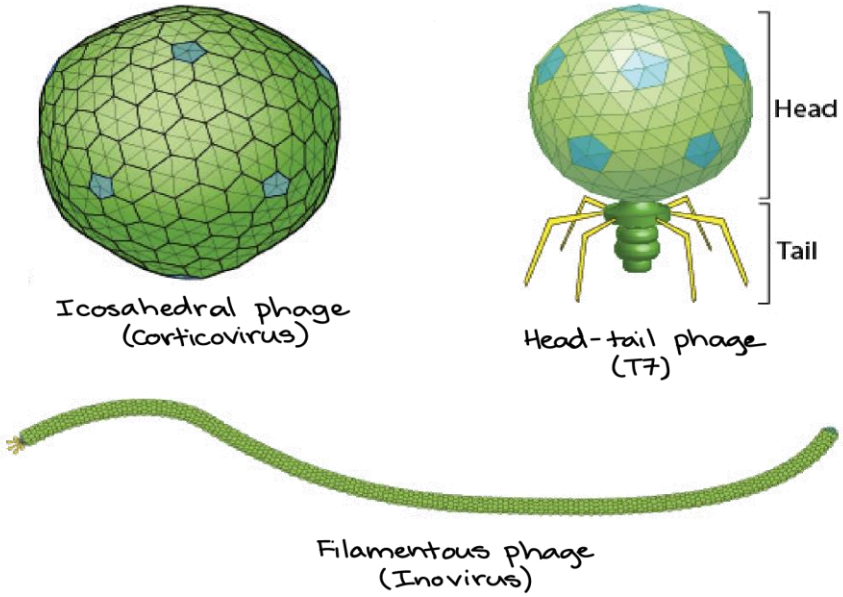
A bacteriophage

A bacteriophage also known informally as a ***phageis*** a virus that infects and replicates within bacteria and archaea. The term was derived from "bacteria" and the Greek φαγεῖν (phagein), "to devour". Bacteriophages are composed of proteins that encapsulate a DNA or RNA genome, and may have relatively simple or elaborate structures .

Phages are widely distributed in locations populated by bacterial hosts, such as soil or the intestines of animals. One of the densest natural sources for phages and other viruses is seawater, where up to $9x10^8$ virions per millilitre have been found in microbial mats at the surface, and up to 70% of marine bacteria may be infected by phages. They have been used for over 90 years as an alternative to antibiotics in the former Soviet Union and Central Europe as well as in France. They are seen as a possible therapy against multi-drug-resistant strains of many bacteria (see phage therapy) Nevertheless, phages of Inoviridae have been shown to complicate biofilms involved in pneumoniaand cystic fibrosis and shelter the bacteria from drugs meant to eradicate disease, thus promote persistent infection.

The capsid of a bacteriophage can be icosahedral, filamentous, or head-tail in shape. The head-tail structure seems to be unique to phages and their close relatives (and is not found in eukaryotic viruses).



Some phages can only reproduce via a lytic lifecycle, in which they burst and kill their host cells. Other phages can alternate between a lytic lifecycle and a lysogenic

lifecycle, in which they don't kill the host cell (and are instead copied along with the host DNA each time the cell divides).

Let's take closer look at these two cycles. As an example, we'll use a phage called lambda (\lambdaλ), which infects *E. coli* bacteria and can switch between the lytic and lysogenic cycles.

A vaccine

A vaccine is a biological preparation that provides active acquired immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins, or one of its surface proteins. The agent stimulates the body's immune system to recognize the agent as a threat, destroy it, and to further recognize and destroy any of the microorganisms associated with that agent that it may encounter in the future. Vaccines can be prophylactic (example: to prevent or ameliorate the effects of a future infection by a natural or "wild" pathogen), or therapeutic (e.g., vaccines against cancer are being investigated)

The administration of vaccines is called vaccination. Vaccination is the most effective method of preventing infectious diseases; widespread immunity due to vaccination is largely responsible for the worldwide eradication of smallpox and the restriction of diseases such as polio, The terms vaccine and vaccination are derived from Variolae vaccinae (smallpox of the cow), the term devised by Edward Jenner to denote cowpox. He used it in 1798 in the long title of his Inquiry into the Variolae vaccinae known as the Cow Pox, in which he described the protective effect of cowpox against smallpox. In 1881, to honor Jenner, Louis Pasteur proposed that the terms should be extended to cover the new protective inoculations then being developed

vaccine type	Vaccines of this type on U.S. Recommended Childhood (ages 0-6) Immunization Schedule
Live, attenuated	Measles, mumps, rubella (MMR combined vaccine) Varicella (chickenpox) Influenza (nasal spray) Rotavirus
Inactivated/Killed	Polio (IPV) Hepatitis A

oxoid (inactivated toxin	Diphtheria, tetanus (part of DTaP combined immunization)
Subunit/conjugate	Hepatitis B Influenza (injection) *Haemophilus influenza* type b (Hib) Pertussis (part of DTaP combined immunization) Pneumococcal Meningococcal

Vaccine type	Other available vaccines
Live, attenuated	Zoster (shingles) Yellow fever
Inactivated/Killed	Rabies
Subunit/conjugate	Human papillomavirus (HPV)

Types of vaccines

1.Live, Attenuated Vaccines

Attenuated vaccines can be made in several different ways. Some of the most common methods involve passing the disease-causing virus through a series of cell cultures or animal embryos (typically chick embryos). Using chick embryos as an example, the virus is grown in different embryos in a series. With each passage, the virus becomes better at replicating in chick cells, but loses its ability to replicate in human cells. A virus targeted for use in a vaccine may be grown through—"passaged" through—upwards of 200 different embryos or cell cultures. Eventually, the attenuated virus will be unable to replicate well (or at all) in human cells, and can be used in a vaccine. All of the methods that involve passing a virus through a non-human host produce a version of the virus that can still be recognized by the human immune system, but cannot replicate well in a human host.

2.Killed or Inactivated Vaccines

One alternative to attenuated vaccines is a killed or inactivated vaccine. Vaccines of this type are created by inactivating a pathogen, typically using heat or chemicals such

as formaldehyde or formalin. This destroys the pathogen's ability to replicate, but keeps it "intact" so that the immune system can still recognize it. ("Inactivated" is generally used rather than "killed" to refer to viral vaccines of this type, as viruses are generally not considered to be alive.)

Because killed or inactivated pathogens can't replicate at all, they can't revert to a more virulent form capable of causing disease (as discussed above with live, attenuated vaccines). However, they tend to provide a shorter length of protection than live vaccines, and are more likely to require boosters to create long-term immunity. Killed or inactivated vaccines on the U.S. Recommended Childhood Immunization Schedule include the inactivated polio vaccine and the seasonal influenza vaccine (in shot form).

3.Toxoids

Some bacterial diseases are not directly caused by a bacterium itself, but by a toxin produced by the bacterium. One example is tetanus: its symptoms are not caused by the Clostridium tetani bacterium, but by a neurotoxin it produces (tetanospasmin). Immunizations for this type of pathogen can be made by inactivating the toxin that causes disease symptoms. As with organisms or viruses used in killed or inactivated vaccines, this can be done via treatment with a chemical such as formalin, or by using heat or other methods.Immunizations created using inactivated toxins are called toxoids. Toxoids can actually be considered killed or inactivated vaccines, but are sometimes given their own category to highlight the fact that they contain an inactivated toxin, and not an inactivated form of bacteria.

4.Subunit and Conjugate Vaccines

Both subunit and conjugate vaccines contain only pieces of the pathogens they protect against.Subunit vaccines use only part of a target pathogen to provoke a response from the immune system. This may be done by isolating a specific protein from a pathogen and presenting it as an antigen on its own. The acellular pertussis vaccine and influenza vaccine (in shot form) are examples of subunit vaccines.Another type of subunit vaccine can be created via genetic engineering. A gene coding for a vaccine protein is inserted into another virus, or into producer cells in culture. When the carrier virus reproduces, or when the producer cell metabolizes, the vaccine protein is also created. The end result of this approach is a recombinant vaccine: the immune system will recognize the expressed protein and provide future protection against the target virus. The Hepatitis B vaccine currently used in the United States is a recombinant vaccine.