

## **DIFFERENCES BETWEEN BACTERIA AND VIRUS**

### **I. DEFINITION:**

**Bacteria** (bacterium, singular), microorganisms that lack a nucleus and have a cell wall composed of a protein–sugar molecule. Bacteria are the most common organisms on earth and are intimately connected to the lives of all organisms. Most bacteria are less than 1 micron (0.001 mm/0.00004 in) in length. However, colonies of bacteria, can be viewed easily without a microscope.

**Virus** infectious agent found in virtually all life forms, including humans, animals, plants, fungi, and bacteria. Viruses consist of genetic material either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) surrounded by a protective coating of protein. Viruses are between 20 and 100 times smaller than bacteria and hence are too small to be seen by light microscopy. Viruses vary in size from the largest poxviruses of about 450 nanometers (about 0.000014 in) in length to the smallest polioviruses of about 30 nanometers (about 0.000001 in). Viruses are not considered free–living, since they cannot reproduce outside of a living cell; they have evolved to transmit their genetic information from one cell to another for the purpose of replication.

### **II. CLASSIFICATION:**

**Bacteria**, Bacteria are described as prokaryotes, organisms whose cells lack nuclei, to distinguish them from eukaryotes, organisms such as fungi, plants, and animals, whose cells contain nuclei. Bacteria are placed in their own kingdom, Kingdom Monera, also called Kingdom Prokaryote.

Bacteria are often classified on the basis of their physical shapes. Bacteria can be spherical (cocci), rod–shaped (bacilli), or corkscrew–shaped (spirochetes). Another classification system divides bacteria, according to whether or not they require oxygen to survive. Bacteria that require oxygen are called aerobic bacteria, or aerobes. Bacteria that live without oxygen are called anaerobic bacteria, or anaerobes. Fermentation, the process used by most bacteria, typically takes place in an anaerobic environment. A variety of fermentation pathways are utilized by different species of bacteria, and each produces unique byproducts, including alcohol, carbon dioxide, lactic acid, formic acid, or acetic acid.

**Viruses:** are classified according to their type of genetic material, their strategy of replication, and their structure. The International Committee on Nomenclature of Viruses (ICNV), established in 1966, devised a scheme to group viruses into families, subfamilies, genera, and species. The ICNV report published in 1995 assigned more than 4000 viruses into 71 virus families. Hundreds of other viruses remain unclassified because of the lack of sufficient information.

### **III. STRUCTURE:**

**Bacteria:** Like all cells, contain genetic material known as deoxyribonucleic acid (DNA). However, the DNA of bacteria is arranged in a single circular chromosome, unlike the DNA of eukaryote cells, which is arranged in several to many rod–shaped chromosomes. Bacteria also often have additional DNA in the form of smaller rings called plasmids. Bacterial DNA is not enclosed in a nucleus, as is the DNA of eukaryotic cells. Like eukaryotic cells, bacteria have ribosomes, structures active in protein synthesis, but they are smaller and have a slightly different molecular structure.

**Virus:** Individual viruses, or virus particles, also called *virions*, contain genetic material, or *genomes*, in one of several forms. Unlike cellular organisms, which have only DNA, viruses have either DNA or RNA. Like cell DNA, almost all viral DNA is double–stranded, and it can have either a circular or a linear arrangement.

Almost all viral RNA is single-stranded; it is usually linear, and it may be either segmented (with different genes on different RNA molecules) or nonsegmented (with all genes on a single piece of RNA).

The viral protective shell, or capsid, can be either *helical* (spiral-shaped) or *icosahedral* (having 20 triangular sides). Capsids are composed of repeating units of one or a few different proteins. These units are called *protomers* or *capsomers*. The proteins that make up the virus particle are called structural proteins. Viruses also carry genes for making proteins that are never incorporated into the virus particle and are found only in infected cells. These viral proteins are called nonstructural proteins; they include factors required for the replication of the viral genome and the production of the virus particle.

*Viroids* and *prions* are smaller than viruses, but they are similarly associated with disease. Viroids are plant pathogens that consist only of a circular, independently replicating RNA molecule. The single-stranded RNA circle collapses on itself to form a rodlike structure. The only known mammalian pathogen that resembles plant viroids is the deltavirus (hepatitis D), which requires hepatitis B virus proteins to package its RNA into virus particles. *Co-infection* with hepatitis B and D can produce more severe disease than can infection with hepatitis B alone. Prions are mutated forms of a normal protein found on the surface of certain animal cells. The mutated protein, known as a prion, has been implicated in some neurological diseases such as Creutzfeldt–Jakob disease and Bovine Spongiform Encephalopathy. There is some evidence that prions resemble viruses in their ability to cause infection. Prions, however, lack the nucleic acid found in viruses.

#### **IV. REPRODUCTION:**

**Bacteria:** reproduces by means of a process called binary fission. In binary fission, the single chromosome is replicated, the bacteria divides into two cells, and each cell receives one chromosome. The two cells are thus genetically identical.

Binary fission does not provide bacteria with a way to acquire genetic diversity. Such diversity is necessary to enable a species to withstand changing environments. Many higher organisms gain genetic diversity through the union of reproductive cells from two parents. Lacking this capability, bacteria shuffle DNA between cells by several processes, including transformation, conjugation, and transduction.

In transformation, bacteria take up fragments of DNA released into the soil or water as dead bacteria are decomposed. Transduction involves the transfer of DNA fragments between bacteria cells by a bacteriophage, a virus that infects bacteria. Through mixing genetic material, bacteria develop new traits, including the ability to withstand changes in acidity and temperature, and resistance to antibiotics.

**Virus:** reproduction is called replication. The first contact between a virus particle and its host cell occurs when an outer viral structure docks with a specific molecule on the cell surface. After binding to an appropriate cell, a virus must cross the cell membrane. Once inside the cell, the virus replicates itself through a series of events. Viral genes direct the production of proteins by the host cellular machinery. The first viral proteins synthesized by some viruses are the enzymes required to copy the viral genome. Using a combination of viral and cellular components, the viral genome can be replicated thousands of times. Late in the replication cycle for many viruses, proteins that make up the capsid are synthesized. These proteins package the viral genetic material to make newly formed nucleocapsids.

To complete the virus replication cycle, viruses must exit the cell. Some viruses bud out of the cell's plasma membrane by a process resembling reverse endocytosis. Other viruses cause the cell to lyse, thereby releasing newly formed virus particles ready to infect other cells. Still other viruses pass directly from one cell into an adjacent cell without being exposed to the extracellular environment. The virus replication cycle can be as short as a couple of hours for certain small viruses or as long as several days for some large viruses.

Some viruses kill cells by inflicting severe damage resulting in cell lysis; other viruses cause the cell to kill itself in response to virus infection. This programmed cell suicide is thought to be a host defense mechanism to eliminate infected cells before the virus can complete its replication cycle and spread to other cells. Alternatively, cells may survive virus infection, and the virus can persist for the life of its host. Virtually all people harbor harmless viruses. The viral genome is replicated every time the host cell replicates its DNA and is thus passed on to daughter cells.

## **V. DISEASE:**

**Bacteria:** Of the thousands of bacterial species on the earth, only a small fraction cause diseases of people with human feces that harbor the bacteria. Cholera epidemics erupted repeatedly in the 1800s in Europe and Asia, claiming thousands of lives, and the epidemic in South America in the early 1990s caused over 6000 deaths. The bacterium *Mycobacterium tuberculosis* has caused tuberculosis in millions of people throughout human history. Although the incidence of tuberculosis greatly declined during the mid–20th century, the disease has recently become a major worldwide problem again. One of the primary drugs originally used to cure it, streptomycin, is ineffective today because the overuse of antibiotics has enabled resistant strains of bacteria to evolve. Other bacterial diseases such as certain forms of pneumonia and strep throat are also proving resistant to antibiotics, a cause of grave concern among physicians and other health care professionals.

Bacteria are also important recyclers. Like fungi, many bacteria feed on dead and dying organisms, breaking down their tissues and cells into nutrient–rich molecules, some of which remain in the soil or water. Further, without decomposition, fallen trees, leaves, and other refuse would simply pile up. Bacteria also strongly influence the movement of key elements, such as sulfur, iron, phosphorus, and carbon, around the globe. The weathering of rocks, which releases elements into the soil and atmosphere, is substantially enhanced by the metabolic activities of certain bacteria.

There is a bacterial species involved with the production of many familiar products. Foods such as cheese and yogurt are developed through the metabolic processes of bacteria, it has gained enormous importance throughout the biotechnology industry, where they are used in genetic engineering to develop new medications.

**Viruses** often damage or kill the cells that they infect, causing disease in infected organisms. A few viruses stimulate cells to grow uncontrollably and produce cancers. Although viruses cause many infectious diseases, such as the common cold, there are no cures for these illnesses. The difficulty in developing antiviral therapies stems from the large number of variant viruses that can cause the same disease, as well as the inability of drugs to disable a virus without disabling healthy cells. Although viruses cannot be treated with antibiotics, which are effective only against bacteria, the body's immune system has many natural defenses against virus infections. Infected cells produce *interferons* and other *cytokines* (soluble components that are largely responsible for regulating the immune response), which can signal adjacent uninfected cells to mount their defenses, enabling uninfected cells to impair virus replication. B lymphocytes produce specific antibodies that can bind and inactivate viruses. Cytotoxic T cells recognize virus–infected cells and target them for destruction. However, many viruses have evolved ways to circumvent some of these host defense mechanisms.

The development of antiviral therapies has been thwarted by the difficulty of generating drugs that can distinguish viral processes from cellular processes. Therefore, most treatments for viral diseases simply alleviate symptoms, such as fever, dehydration, and achiness. Nevertheless, antiviral drugs for influenza virus, herpesviruses, and HIV are available, and many others are in the experimental and developmental stages.

Prevention has been a more effective method of controlling virus infections. Viruses that are transmitted by insects or rodent excretions can be controlled with pesticides. However, polio has not been eradicated, partly because the virus can mutate and escape the host immune response. Influenza viruses mutate so rapidly that new vaccines are developed for distribution each year. Viruses undergo very high rates of mutation (genetic alteration) largely because they lack the repair systems that cells have to safeguard against mutations. A high mutation rate enables the virus to continually adapt to new intracellular environments and to escape from the host immune response. Co-infection of the same cell with different related viruses allows for genetic reassortment (exchange of genome segments) and intramolecular recombination. Genetic alterations can alter virulence or allow viruses to gain access to new cell types or new animal hosts.

"Bacteria," Microsoft® Encarta® Online Encyclopedia 2001  
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"Virus (life science)," Microsoft® Encarta® Online Encyclopedia 2001  
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