

Differences between Bacteria, Virus and Fungus (Viruses pl., Fungi pl.)

	Bacteria	Virus	Fungus
General overview			
Most common morphologies			<p>The hypha consists of an assembly of linked cells. The linked cells are perforated and thus can exchange cell material through among them.</p>
Size	0.5 – 5.0 μm	Diameter: 20 – 300 nm Length: 20 – 1500 nm	Diameter 2 – 10 μm Length: up to several cm Yeast size: 3 – 4 μm
Motility	Certain prokaryotic cells use a flagellum to move	Viruses do not move on their own. They are transported through air or reside on surfaces.	Do not move. They form spores which can be transported by wind and water
Genetics	DNA	DNA/RNA	DNA
Cell wall or envelope?	Prokaryotic cell walls are constructed from peptidoglycan. Peptidoglycan is a polysaccharide. The cell wall stabilizes the bacterial structure. The capsule consists of polysaccharides which are fixed to the cell wall. The capsule protects the bacteria from	Viruses do not have cell walls. The DNA and the viral proteins are contained within a capsid which is built out of proteins. In some viruses the capsid is additionally contained within a viral envelope which is built out of a lipid membrane.	Fungal cell walls are mainly built from chitin. Various polysaccharides are also used to build fungal cell walls.

	dehydration and helps the cells to stick to surfaces.		
Nutrition	Bacteria take up nutrients (carbohydrates, proteins and fat) to survive, grow and reproduce.	Viruses are not alive and they do not take up nutrients. They invade host cells and replicate.	Fungi usually take up monosaccharides, disaccharides and amino acids to grow.
Reproduction	When the conditions are right (nutrients, temperature), the cells are able to reproduce themselves by binary fission (binary fission resembles mitosis).	<ol style="list-style-type: none"> 1. A virus attaches itself to receptors which reside on the host cell surfaces. 2. The DNA/RNA and proteins of the Virus enter the host cells. 3. The Virus proteins and genetic material takes control of the host cell and replicates itself inside the host cell. 4. The host cell dies and releases multiple copies of the virus. 5. The released virus copies will now attack new host cells. 	<p>Asexually: Cells can break off from the tips of the hypha. These broken off cells can now grow as an individual organism. The cells can be also broken off as spores which can be transported through water and air until they nest in and grow as an individual organism.</p> <p>Sexually Two cells which broke off from two different hypha strains can fuse together to form a new organism.</p>
Nucleus	Prokaryotic cells do NOT have a nucleus. The chromosomal DNA (also genomic DNA) is stored in the cytoplasm of the prokaryotic cell. Non-essential genes are stored in plasmids. Plasmids reside too in the cytoplasm, but are not part of the chromosomal DNA.	Viruses do NOT have a nucleus. Viral DNA, RNA and proteins reside inside the capsid.	Fungi DO contain a nucleus inside which the chromosomal DNA is stored.
Is the organism alive?	Yes	NO. Viruses cannot reproduce themselves outside a host.	Yes
Agents against Bacteria, Viruses and Fungi. (Antibiotics, antivirals, antifungals)	Antibiotics	Antiviral drugs	Antifungal drugs (fungicide, antimycotic)
	<ul style="list-style-type: none"> • β-lactam antibiotics (Penicillins: Ampicillin, Benzylpenicillin and many more) kill bacteria by inhibiting their cell wall formation. • Polymyxin antibiotics (e.g. Colistin) have a long tail which interacts with the phospholipids of the bacterial cell membrane and so disrupts its cell structure. • Tetracycline antibiotics inhibit the protein synthesis. They bind to the 30S 	<ul style="list-style-type: none"> • Viruses are fought off with the help of antiviral drugs. • Antiviral drugs do not destroy the virus, but rather inhibit its proliferation. • Antiviral drugs often target viral proteins. For example they can inhibit DNA polymerase, reverse transcriptase and other protein targets. Proteins of the host are usually not targeted. • A lot of antiviral drugs are nucleoside analogs which bind with a high affinity to 	<ul style="list-style-type: none"> • Polyene antifungals (e.g. Amphotericin B, Candicidin) are large cyclic molecules. One side of the ring is hydrophobic whereas the other side of the ring is hydrophilic, which makes the molecule amphiphilic. This circular amphiphilic molecule binds to ergosterol which resides inside the fungal cell membrane. With a decreased amount of ergosterol, the fungal cell membranes become weaker and leak important minerals, which leads to eventual cell death.

	<p>ribosomal subunit of the ribosomal translation complex. As a result, the aminoacyl-tRNA is now hindered to bind to the ribosomal translation complex and protein biosynthesis is inhibited.</p> <ul style="list-style-type: none"> • Sulfonamides antibiotics (e.g. Sulfametoxydiazine) are bacteriostatic; they inhibit the folate synthesis in bacteria. • Aminoglycoside antibiotics (e.g. Kanamycin) bind to the ribosomal complex and disturb protein biosynthesis. Nonoperational proteins are formed and the cells cannot survive. • Quinolone antibiotics (e.g. Ciprofloxacin) inhibit Topoisomerase II ligase enzyme. The inhibited topoisomerase does not deactivate the nuclease activity. The active nuclease degrades DNA. • Chloramphenicol inhibits protein synthesis by inhibiting protein chain elongation. 	<p>the viral DNA-polymerase which leads to an abortion of the polymerase reaction.</p> <ul style="list-style-type: none"> • Sometimes antiviral drugs prevent the attachment of the virus to the host cell. • Other antiviral drugs bind for example to the receptors of the host cells. The virus cannot attach to the receptors of the host cell. • Some antiviral drugs (e.g. Amantadin) hinder the uncoating of the virus. 	<ul style="list-style-type: none"> • Azole antifungals (five membered heterocyclic rings containing nitrogen, e.g. Bifonazole) inhibit ergosterol formation. • Allylamine antifungals (e.g. Butenafine) inhibit ergosterol formation. • Fungi are NOT killed by antibiotics. Often they themselves produce a wide range of molecules which are used as antibiotics, such as penicillines. Yet there exist still some exceptions where some antibiotics have at the same time antibacterial activity and anti-fungal activity. • Echinocandine antifungals (e.g. Micafungin) inhibit glucan synthesis inside the cell walls of the fungi. • Additionally there exist a lot of other antifungal drugs which do not belong to a special molecule category.
<p>Bacteria is killed by antibiotics. Antibiotics do NOT eliminate viruses. Viruses are only eliminated by antivirals. Fungi are usually killed by antifungals. There exist some drugs which have at the same time an antimicrobial (kills bacteria) and an antifungal (kills fungi) effect.</p>			
<p>Diseases</p>	<ul style="list-style-type: none"> • Anthrax • Bacterial meningitis • Caympylobacter • Cholera • Diphtheria • Flesh eating bacteria • Gonorrhea • Heliobacter • Legionnaires Disease • Lyme disease • Plague • Pneumonia • Salmonella 	<ul style="list-style-type: none"> • Chickenpox • Colds • Coxsackie • Dengue • Ebola fever • Flu • Hepatitis • Herpes • HIV/AIDS • HPV (warts) • Measles • Mumps • Polio • Rabies 	<ul style="list-style-type: none"> • Aspergillosis • Blastomycosis • Candidiasis • Fungal meningitis • Ringworm

	<ul style="list-style-type: none"> • Syphilis • Tetanus • Tuberculosis • Typhoid 	<ul style="list-style-type: none"> • Rotavirus • Rubella • Shingles • Viral gastroenteritis • Viral meningitis • Viral pneumonia • Zika fever 	
Transmission	Person to person contact, body fluid, airborne transmission, transmission by insects, contaminated surfaces, food and water		Fungal spores can be transported and spread through the air. Fungi spread also by person to person contact.
Types	<ul style="list-style-type: none"> • <i>Bacillus</i> (rod shaped) • <i>Bordetella</i> • <i>Borrelia</i> • <i>Brucella</i> • <i>Clostridium</i> • <i>Coccobacilli</i> • <i>Coccus</i> (sphere shaped) • <i>Corynebacterium</i> • <i>Diplococcus</i> • <i>E.coli</i> • <i>Leptospira</i> • <i>Meningococcus</i> • <i>Neisseria</i> • <i>Pseudomonas</i> • <i>Shigella</i> • <i>Spirilla</i> (spiral shaped) • <i>Spirochaetes</i> (coiled) • <i>Staphylococcus</i> • <i>Streptococcus</i> • <i>Vibrio</i> (curved rods) • <i>Treponema</i> 	<ul style="list-style-type: none"> • <i>Adenovirus</i> • <i>Arenavirus</i> • <i>Bacteriophage T4</i> • <i>Bunyavirus</i> • <i>Coronavirus</i> • <i>Flaviviridae</i> • <i>Herpesvirus</i> • <i>Infuenza virus</i> • <i>Marburg virus</i> • <i>Orthohepadnavirus</i> • <i>Picornavirus</i> • <i>Poxvirus</i> • <i>Respiratory syncytial virus</i> (RSV) • <i>Retrovirus</i> • <i>Tobacco mosaic virus</i> (TMV) 	<ul style="list-style-type: none"> • <i>Zygomycota</i> (molds, e.g.: on breads) • <i>Ascomycota</i> (yeasts) • <i>Basidiomycota</i> (Mushrooms) • <i>Deuteromycota</i> “<i>Fungi Imperfecti</i>” (used to produce special cheeses such as Roquefort, cause diseases of plants and of animals such as athletes foot)