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**Section:** Infectious Disease

# CAST OF CHARACTERS

**A brief guide to agents of infection**

**Viruses**

Viruses come in myriad symmetrical shapes but share a general structure: a core of RNA or DNA surrounded by a protein shell. With no metabolic functions of their own, viruses can survive for limited periods outside the body of the host. Only when they infiltrate living cells do they begin to replicate, usurping the cell's genetic machinery to produce a profusion of viral particles. These "progeny" may burst out of the infected cell or simply bud off the cell membrane, repeating the process until they either destroy the host or are overcome by the immune system.

For a single-celled host organism, such as a bacterium, viral infection is usually lethal (see "Do Viruses Control the Oceans?" page 48). Plants, too, are extremely susceptible: viruses rank second only to fungi as crop destroyers. In humans, viral illnesses run the gamut from inconsequential to major. At least thirty-five types of papilloma viruses are responsible for warts. Rhinoviruses produce the universal and incurable common cold. Measles, HIV/AIDS, influenza, dengue hemorrhagic fever, and hepatitis B--all caused by viruses--kill millions annually worldwide (see "The World's Top Ten Infectious Killers in 1997," page 46). Less widely known is the fact that 15 to 20 percent of cancers (including malignancies of the cervix and liver) are of viral origin (see "Catching On to What's Catching," page 34).

In response to a viral invasion, animals produce antibodies that can, if the host survives, confer immunity to subsequent infection by that virus. Vaccination with a weakened or noninfectious form of the virus also stimulates production of immunity conferring antibodies.

**Bacteria**

Bits of cytoplasm surrounded by a membrane, bacteria are the most abundant living things on earth. These unicellular beings comprise two kingdoms--the archaebacteria, found in extreme environments (such as hot seafloor vents), and the eubacteria, ubiquitous in soil, water, and both on and in the bodies of animals. More so than plants, animals are appealing habitat for bacteria, providing the moisture, food, and substrates that these microbes require for survival. Millions harmlessly colonize our skin and orifices as well as our respiratory and intestinal tracts. Some gut bacteria are useful house guests, providing essential vitamins and keeping fungi and harmful bacteria in check by competing for space and nutrients.

Bacteria that are innocuous in one part of the body may cause problems elsewhere--as when intestinal bacteria escape into the urinary bladder or peritoneal cavity. But most disease bacteria come from the outside--such as tuberculosis bacilli that are inhaled in moisture droplets. Some bacteria cannot survive in air; Clostridium tetani, for example, secretes its deadly nerve toxins only

after gaining access to the body's internal tissues through punctures, burns, and surgical wounds. Pathogenic Escherichia coli a different strain from the E. coli that normally inhabits our intestines) causes internal hemorrhaging when consumed in contaminated food.

Of the ten major types of infection killing humans today, five--acute lower respiratory infections, tuberculosis, diarrheal diseases, whooping cough, and tetanus--are caused by bacteria.

**Fungi**

Fungi--the yeasts, molds, smuts, mushrooms, and mildews--constitute their own kingdom in the natural world. As purveyors of human misery, they take a backseat to bacteria and viruses. Some live harmlessly in the dead cells of our nails, hair, and feet, but most are soil dwellers. The few that regard humans as habitat cause annoying maladies such as yeast infections, athlete's foot, and the misleadingly named ringworm. As for the rest, we (and other animals) manage to fend them off with naturally occurring substances in our skin, blood, sweat, and saliva.

A little over a decade ago, however, a key study signaled a change: researchers found that nearly 40 percent of patients dying from hospital-acquired infections were being felled by fungi. The reason was a good news/bad news tale. Most people with compromised defenses--those with AIDS, cancer, organ transplants, and severe burns (as well as premature babies)--were surviving longer because of improved treatments. But fungi such as Candida (a common inhabitant of our mouth and other orifices) were taking advantage of catheters, needles, and incisions to enter the tissues of these immune-suppressed patients.

Plants are more vulnerable than animals to infection by fungi. Wind-borne fungal spores have caused such well-known and devastating epidemics as Dutch elm disease and the potato blight that led to the great Irish famine of the 1840s. Lesser known but economically significant ailments of today include karnal bunt disease in wheat and root rot in trees.

Fungi, which compete with other microbes for niches in the ecosystem, produce chemical defenses to ward off their bacterial rivals--a conflict that benefited humans when fungal defense chemicals were used to create penicillin, the mighty antibiotic that cures bacterial diseases from pneumonia to syphilis.

**Prions**

American biochemist Stanley Prusiner won a Nobel Prize in 1997 for his work on proteinaceous infectious particles, which he nicknamed prions. Unlike all other pathogens, prions have neither DNA nor RNA. They are rogue forms of normal proteins found in the brains of healthy birds and mammals. Once a prion appears (either by mutation or by transmission from an infected individual), it spreads by inducing its nearby normal counterparts to undergo a similarly malign metamorphosis. Over the long run, the accumulation of prions destroys the brain, riddling it with holes.

All diseases presumed to be caused by prions are slow acting and fatal. They have been identified in many vertebrates, including humans, cats, mink, deer, and farm animals. The most common is scrapie, transmitted to sheep and goats either in contaminated fodder or passed from mother to offspring. Bovine spongiform encephalopathy, perhaps better known as mad cow disease, is a variant of scrapie. Creutzfeldt-Jakob disease--a rare brain affliction of humans believed by many to be another scrapie variant--can be inadvertently transmitted during brain surgery and organ transplantation. Kuru, a prion-associated disease discovered in a New Guinean tribe in the 1950s, was attributed to the ritual practice of eating the brains of the dead. When the practice was abandoned, kuru virtually disappeared.

**Protists**

Protists, also called protozoa, comprise a kingdom of single-celled organisms that range in appearance from whip-tailed flagellates to bloblike amoebas. On average, protists are about a thousand times larger than bacteria and also differ from them in that their single cell contains a nucleus. Found worldwide in soil, oceans, and freshwater, most protists live by preying on other, smaller microbes. By doing so, they check the growth of ground-water bacteria and foster soil fertility.

Many of the protists are free-living, while others cannot survive unless they colonize animal hosts. The flagellate Streblo mastix, example, lives symbiotically in the intestines of termites, gaining food and shelter and simultaneously helping its host digest wood. Naegleria fowleri lives independently in North American lakes and streams but is an opportunist that can cause a life-threatening brain infection if it

enters the nose of a human swimmer.

Infection by parasitic protists is not always serious; a large proportion of people in the United States, for instance, have been infected by Toxoplasma without even knowing it. Some protists, like Pneumocystis carinii, run rampant in hosts with weakened immune systems. Still others are mass killers, devastating the blood, respiratory, and gastrointestinal systems of their hosts. Leishmania, a protist transmitted to humans by sand flies, damages the spleen and liver of hunderds of millions of people worldwide. Sleeping-sickness trypanosomes in the bloodstream afflict from 5 to 10 million people (and countless livestock) in Africa, and the plasmodia that cause malaria are estimated to kill 2.7 million people annually in the Tropics.

**The World's Top Ten Infectious Killers 1997[*] #1**
**Haemophilus influenzae and other bacteria** (acute lower respiratory infections). Caused 3.7 million deaths from pneumonia and other lung infections in 1997. Airborne transmission. Major killer of children in developing countries. Increasing in incidence because of poverty-related risk factors, such as malnutrition. Treatable with antibiotics.

**#2**
**Mycobacterium tuberculosis** (tuberculosis). Caused 2.9 million deaths in 1997. Bacterium is airborne in respiratory droplets. Ninety-five percent of victims live in developing countries. Treatable with antibiotics, but multi-drug-resistant strains have eme

**#3**
**Vibrio cholerae and other pathogens** (diarrheal diseases). Caused 2.5 million deaths from cholera and other diarrheal diseases in 1997. Contaminated water and foods are primary vectors. Most victims are under five years of age and live in developing countries. Death preventable with oral rehydration therapy, proper nutrition, and antibiotics.

**#4**
**Human immunodeficiency virus** (AIDS). Caused 2.3 million deaths in 1997. Sub-Saharan Africa thought to have two-thirds of the world's cases. Transmissible through contact with infected body fluids, such as blood and semen. More than 30 million people now infected. No cure or vaccine, but a combination of drugs can prolong life.

**#5**
**Plasmodium falciparum and related protozoans** (malaria). Caused 1.5-2.7 million deaths in 1997. Transmitted by infected female Anopheles mosquitoes. Endemic in 100 countries; highest incidence in sub-Saharan Africa. Strikes up to 500 million people per year. Prevention includes eradicating mosquitoes. Curable with early diagnosis and prompt treatment, but protozoa may evolve resistance to drugs.

**#6**
**Morbillivirus** (measles). Caused 960,000 deaths in 1997. Victims primarily children; highest incidence in Africa. Deaths usually due to complications such as pneumonia and encephalitis. Airborne in droplets from nose and mouth. Preventable with vaccine.

**#7**
**Hepatitis B virus.** (hepatitis) Caused 605,000 deaths in 1997. Transmitted by blood and other body fluids and through sharing unsterilized needles. Endemic in Africa, South America, Eastern Europe, the eastern Mediterranean, Southeast Asia, China, and the smaller Pacific islands. Victims with acute form usually recover; chronic carriers risk active hepatitis, cirrhosis, and primary liver cancer. Vaccine available.

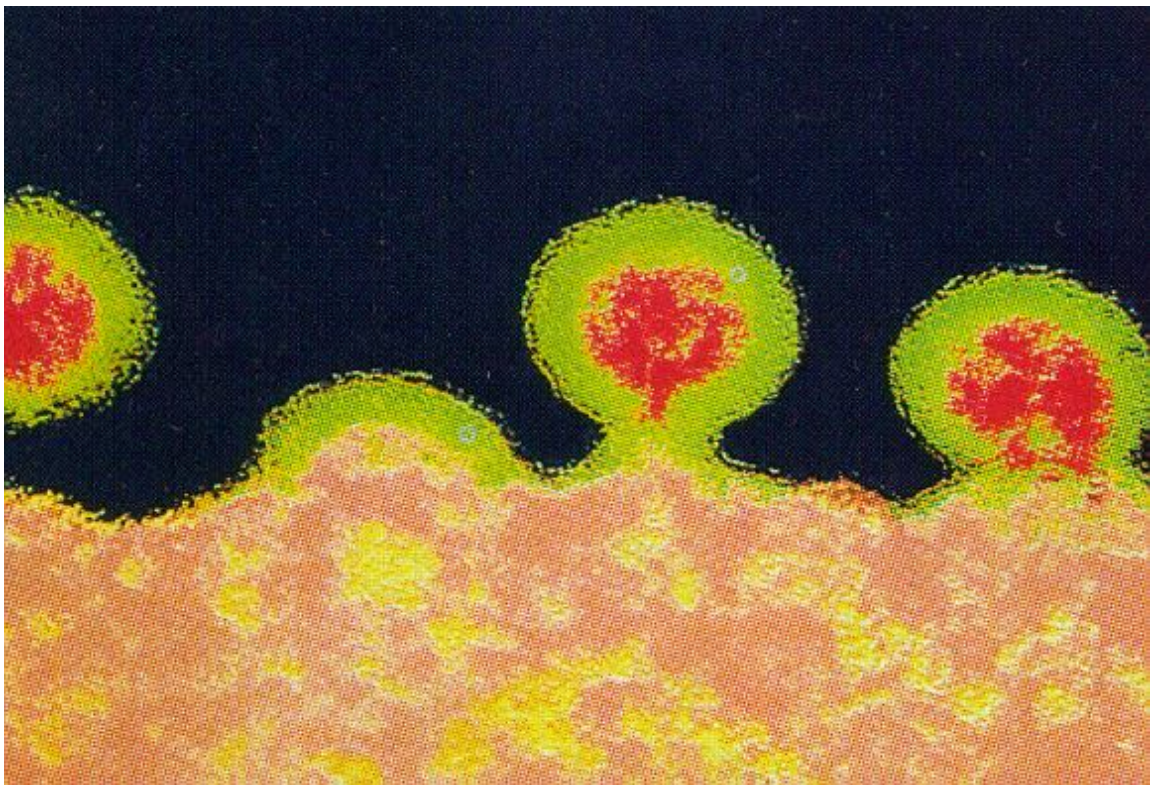
**#8**
**Bortadella pertussis** (whooping cough). Caused 410,000 deaths in 1997. Bacteria airborne in respiratory droplets. About one-half of cases occur in children under age two. Endemic worldwide. Vaccine available for infants but not adults. Treatable with erythromycin.

**#9**
**Clostridium tetani** (tetanus). Caused 275,000 deaths in 1997. Main victims are babies with infected umbilici. Bangladesh, China, India, Indonesia, Nigeria, and Pakistan account for 75 percent of deaths. Preventable by sterile practices and immunization. Spores are ubiquitous, especially in animal waste.

**#10**

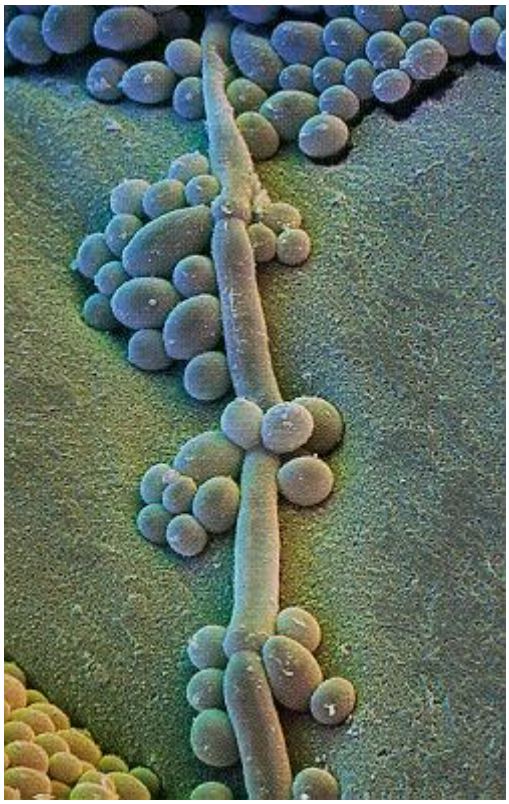
**Flavirus** (dengue/dengue hemorrhagic fever). Caused 140,000 deaths in 1997. Virus is transmitted by mosquitoes. With increasing urbanization, dengue epidemics are becoming more common--especially in Southeast Asia and Latin America. The hemorrhagic form of the disease is responsible for fatalities, mostly in children under ten.

PHOTOS (COLOR): The World's Top Infectious Killers in 1997[*]



*Budding immundefeciency viruses*

PHOTO (COLOR): Streptococcus faecalis



*Candida albicans*

*Trypanosomes among blood cells*

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By Rachel Zoffness

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