Human Disease

INTRODUCTION

Human Disease, in medicine, any harmful change that interferes with the normal appearance, structure, or function of the body or any of its parts. Since time immemorial, disease has played a role in the history of societies. It has affected—and been affected by—economic conditions, wars, and natural disasters. Indeed, the impact of disease can be far greater than better-known calamities. An epidemic of influenza that swept the globe in 1918 killed between 20 million and 40 million people. Within a few months, more than 500,000 Americans died—more than were killed during World War I (1914-1918), World War II (1939-1945), the Korean War (1950-1953), and the Vietnam War (1959-1975) combined.

Diseases have diverse causes, which can be classified into two broad groups: infectious and noninfectious. Infectious diseases can spread from one person to another and are caused by microscopic organisms that invade the body. Noninfectious diseases are not communicated from person to person and do not have, or are not known to involve, infectious agents. Some diseases, such as the common cold, are acute, coming on suddenly and lasting for no more than a few weeks. Other diseases, such as arthritis, are chronic, persisting for months or years, or recurring frequently.

Every disease has certain characteristic effects on the body. Some of these effects, called symptoms and signs, include fever, inflammation, pain, fatigue, dizziness, nausea, and rashes, and are readily apparent to the patient. These symptoms offer important clues that help physicians and other health care professionals make a diagnosis. Many times, however, the symptoms point to several possible disorders. In those cases, doctors rely on medical tests, such as blood examinations and X rays, to confirm the diagnosis.

The course of a disease—that is, the path it follows from onset to end—can vary tremendously, depending largely on the individual and the treatment he or she receives. For example, otherwise healthy people usually recover quickly from a bout of pneumonia if given proper treatment, whereas pneumonia often proves fatal to people with a weakened immune system and to those who do not receive prompt, effective treatment. Some diseases run a different course depending on the patient's age. Chicken pox, for instance, is usually mild in childhood but severe in adults. In the United States, only about 5 percent of chicken pox cases occur in people over the age of 20, but these cases account for 50 percent of all deaths from the disease.

Scientists, public health officials, and other members of the medical community work diligently to try to prevent disease epidemics. The battle is constant and is fought on many fronts. There have been many victories. Once-devastating diseases such as smallpox and diphtheria have been virtually eradicated, and many other diseases that once conferred automatic death sentences can now be either cured or controlled. At the same time, however, new killers have emerged. Acquired immunodeficiency syndrome (AIDS) and hantavirus pulmonary syndrome are among at least 30 diseases that have been identified by scientists since the early 1970s. Other growing challenges, particularly in the affluent societies of industrialized nations, are so-called diseases of choice, such as alcohol abuse, drug abuse, or obesity, that result from addictive behavior, poor eating habits, or

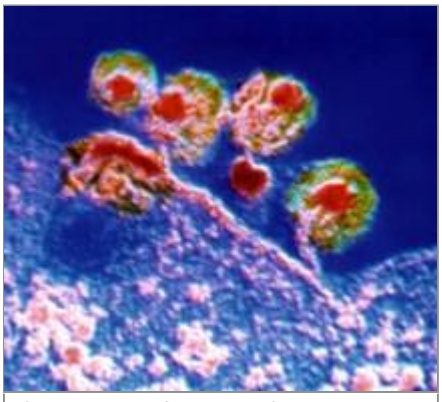
insufficient exercise.

Complicating matters further are societal changes. Increased international travel accelerates the spread of both new and old diseases: A person infected with an unusual virus on one continent can arrive—with the virus—on another continent in a matter of hours. Ships, planes, and trucks can transport disease-carrying organisms just as easily. In 1985 tires imported into Texas from Asia carried larvae of the Asian tiger mosquito, which is a carrier of dengue fever and other tropical diseases. Within five years, Asian tiger mosquitoes were living in 17 states. Changing dietary habits and the availability in local supermarkets of foods from all parts of the world contribute to an increase in food-borne illnesses. Some researchers worry that growing populations and the resulting crowded living conditions will increase the risk of epidemics.

II INFECTIOUS DISEASE

Infectious diseases are caused by microscopic organisms commonly called germs. Physicians refer to these disease-causing organisms as pathogens. Pathogens that infect humans include a wide variety of bacteria, viruses, fungi, protozoans, and parasitic worms. In addition, it has been theorized that some proteins called prions may cause infectious diseases.

A Pathogens



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AIDS Virus

The human immunodeficiency virus (HIV), which causes acquired immunodeficiency syndrome (AIDS), principally attacks T-4 lymphocytes, a vital part of the human immune system. As a result, the body's ability to resist opportunistic viral, bacterial, fungal, protozoal, and other infection is greatly weakened. *Pneumocystis carinii* pneumonia is the leading cause of death among people with HIV infection, but the incidence of certain types of cancers such as B-cell lymphomas and Kaposi's sarcoma is also increased. Neurological complications and dramatic weight loss, or "wasting," are characteristic of endstage HIV disease (AIDS). HIV can be transmitted sexually, through contact with contaminated blood, tissue, or needles, and from mother to child during birth or breast-feeding. Full-blown symptoms of AIDS may not develop for more than 10 years after infection.

Bacteria are microscopic single-celled organisms at least 1 micron long. Most bacteria species are harmless to humans; indeed, many are beneficial (*see* eubacteria). But some are pathogens, including those that cause cholera, diphtheria, leprosy, plague, pneumonia, strep throat, tetanus, tuberculosis, and typhoid fever.

Viruses are tens or hundreds of times smaller than bacteria. They are not cellular, but consist of a core of genetic material surrounded by a protective coat of protein. Viruses are able to survive and reproduce only in the living cells of a host. Once a virus invades a living cell, it directs the cell to make new virus particles. These new viruses are released into the surrounding tissues, and seek out new cells to infect. The roll call of human diseases caused by viruses includes mumps, measles, influenza, rabies, hepatitis, poliomyelitis, smallpox, AIDS, and certain types of cancer.

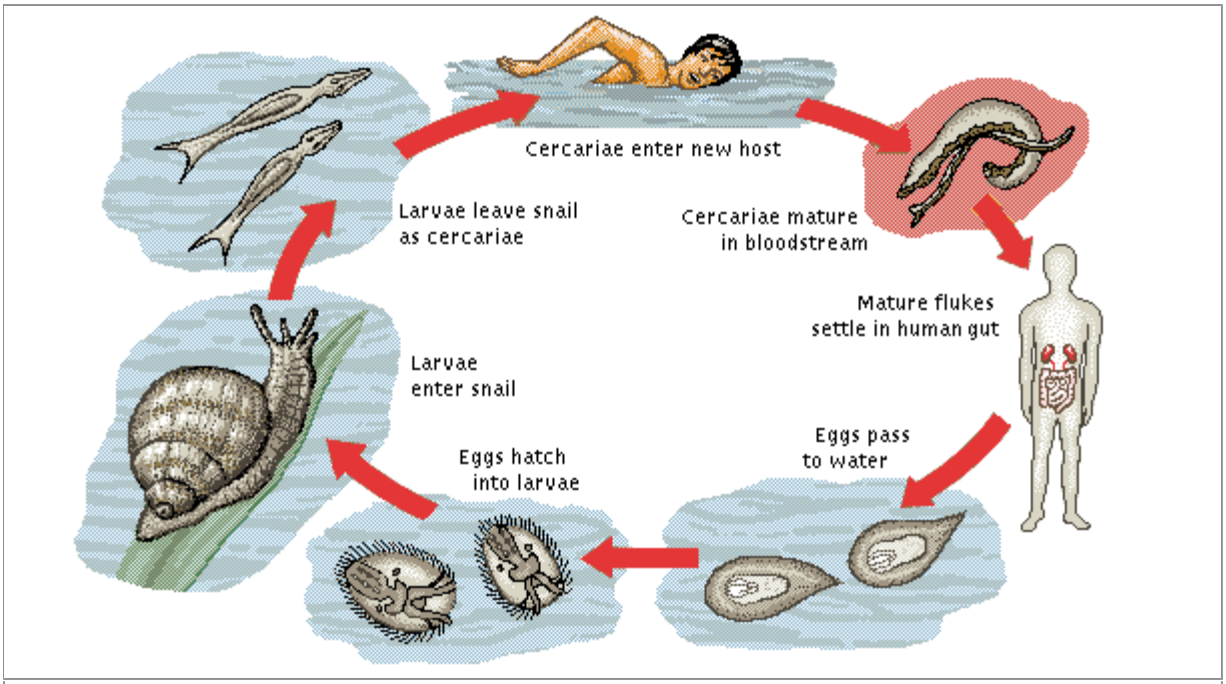
Oxford Scientific Films/London Scientific Films

Helminth Worm

Helminth worms attack the digestive tract and other internal organs of the vertebrate body and cause a wide variety of parasitic diseases. These worms include such diverse forms as the roundworms (nematodes), flukes (trematodes), tapeworms (cestodes), thorny-headed worms (acanthocephalans), and tongue worms (linguatulids). Many species are only able to complete their life cycle by spending time in a variety of animal hosts.

Fungi are a varied group of generally small organisms that get their food from living or dead organic matter. They germinate from reproductive cells called spores, which often have a thick, resistant outer coat that protects against unfavorable environmental conditions. This enables spores to survive for long periods of time, which adds to the difficulty of treating fungal infections. Some fungi are external parasites of humans, causing skin conditions such as ringworm, athlete's foot, and jock itch. Other fungi invade internal tissues; examples include yeast that infect the genital tract and several fungi species that cause a type of pneumonia.

Protozoans are single-celled, animal-like organisms that live in moist environments. Perhaps the most infamous pathogenic protozoans are species of the genus *Plasmodium,* which cause malaria, an infectious disease responsible for over 2 million deaths worldwide each year. Members of the genus *Trypanosoma* produce trypanosomiasis, also known as African sleeping sickness, and Chagas' disease. Other protozoans cause giardiasis, leishmaniasis, and toxoplasmosis.



Life Cycle of Human Blood Flukes

Flukes of the genus *Schistosoma* parasitize two hosts. The young hatch from their eggs in rivers and lakes and enter a specific kind of aquatic snail, where they develop into tadpolelike larva called cercariae. When the cercariae leave the snail, they burrow through the skin of a human host swimming or wading in infested water. Adult flukes mature in the host ŝ bloodstream and settle in the veins of the gut. Their eggs, deposited in the lining of the human intestine and bladder, pass back into water via the sewage system, and the cycle begins again. More than 200 million people worldwide suffer from schistosomiasis, a disease characterized by the abscesses and bleeding caused by the flukes 'infestation.

Parasitic flatworms include tapeworms, which live in the intestines of a host organism. They have a ribbon-like body that may be up to 9 m (30 ft) in length, depending on the species. Hooks and suckers on the head attach a tapeworm to the intestinal wall, and a tough outer coating protects against the host's digestive juices. Another group of parasitic flatworms is flukes, which are responsible for several serious tropical diseases, most notably schistosomiasis. *See* Parasite.

Roundworms, or nematodes, are small, tubelike worms that are pointed at both ends. Species that infect human intestines include pinworms, hookworms, threadworms, and members of the genus *Ascaris*. *Trichinella spiralis* can invade human muscle tissue, often from eating infected pork that has been improperly prepared, causing a disease called trichinosis.

Prions are extremely tiny protein particles found in the brain, nerve, and muscle cells. A controversial

theory states that prions cause disease by changing normal proteins into an abnormal shape. These mutated proteins in turn force other proteins to change shape, leading to destruction of tissue, primarily in the brain. Some researchers have hypothesized that prions cause transmissible spongiform encephalopathies, a group of rare infectious diseases that includes Creutzfeldt-Jakob disease in humans, scrapie in sheep, and bovine spongiform encephalopathy (commonly known as mad cow disease) in cattle. Some evidence suggests that prion-related disease can be transmitted through food infected with mutated proteins.

B Spread of Infectious Disease

Oxford Scientific Films/David Shale

South African Tsetse Fly

The South African tsetse fly, common to parts of central Africa, is responsible for transmitting the parasitic protozoan that causes sleeping sickness, which can be fatal to humans and domestic cattle. The fly uses its mouth parts to bite and draw blood from its host. If it draws blood from an individual infected by sleeping sickness, the fly can then transmit the infection to other hosts in subsequent bitings.

Some pathogens are spread from one person to another by direct contact. They leave the first person through body openings, mucous membranes, and skin wounds, and they enter the second person through similar channels. For example, the viruses that cause respiratory diseases such as influenza and the common cold are spread in moisture droplets when an infected person coughs or sneezes. A hand that was used to cover the mouth while coughing contains viruses that may be passed to doorknobs, so that the next person to touch the doorknob has a chance of picking up the infectious agent. The bacteria that cause some sexually transmitted diseases, including gonorrhea and syphilis, are transmitted during sexual contact.

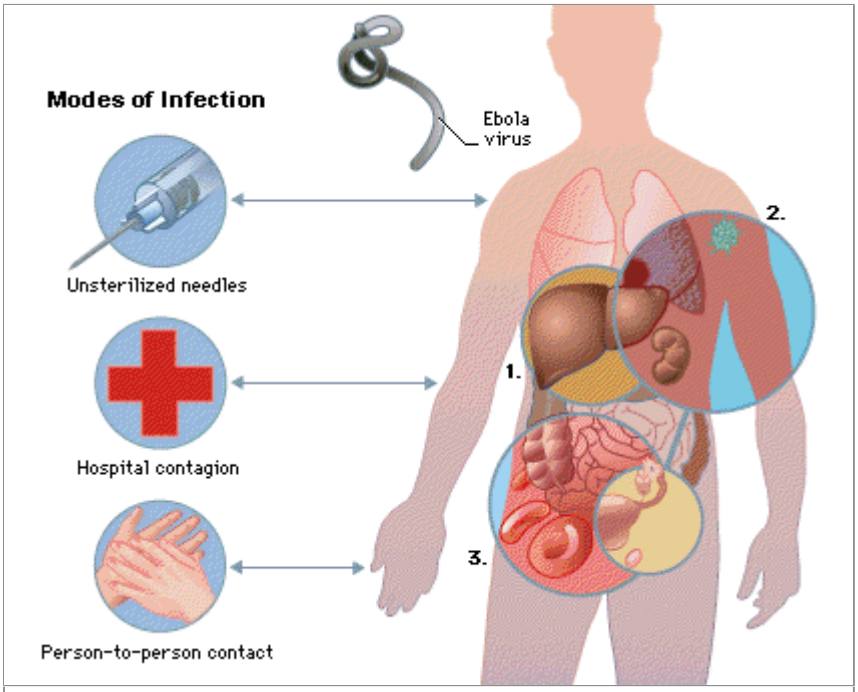
Other pathogens involve an intermediary carrier, such as an insect. The malarial parasite, for example, spends part of its life cycle in mosquitoes, then enters a person's bloodstream when the mosquito bites the person. Many pathogens are spread through contaminated food and water. Cholera bacteria, for example, are spread through food and water contaminated with the excrement of infected people.

C New Infectious Diseases

In 1978 the United Nations adopted a resolution that set goals for eradicating infectious disease by the year 2000. This lofty goal proved impossible to achieve. The years since the resolution was adopted have seen the emergence of new killers and a rise in the incidence of such ancient scourges as malaria, yellow fever, and tuberculosis.

Among the diseases new to science are AIDS, Ebola hemorrhagic fever, Legionnaires 'disease, and Lyme disease. AIDS has been the most deadly of all the new diseases, but even it has not taken as high a toll as malaria, tuberculosis, and other diseases that have been around for centuries. Some newly identified disease-causing agents for diseases that have been recognized for a long time include Human T-lymphotropic virus I (HTLV-1), which can cause some cases of non-Hodgkin s lymphoma, a type of cancer originating in the lymphatic system; and HTLV-2, which is associated with hairy-cell leukemia, a rare type of cancer of the blood.

In most cases, the reasons for the emergence of a new disease are unknown. One exception is Legionnaires 'disease. It is caused by a bacterium that was not identified until after an outbreak in 1976 at an American Legion convention in Philadelphia, Pennsylvania. Once identified, however, scientists were able to retrospectively identify earlier epidemics of the disease, and realized that each year the bacterium is responsible for thousands of cases of pneumonia.



Ebola Virus Infection

The Ebola virus is highly infectious and can spread through the use of unsterilized needles or through contact with an infected individual or the corpse of someone who has died from the disease. About one week after infection, the virus begins attacking blood and liver cells *(1)*. As the disease swiftly progresses, the virus may destroy vital organs such as the liver and kidneys *(2)*, leading to massive internal bleeding *(3)*. Shock and respiratory arrest soon follow, then death.

Environmental changes may be responsible for some new diseases. Scientists speculate that the

viruses for some of the deadly hemorrhagic fevers that have surfaced in Africa, such as Ebola and Marburg disease, have long existed in certain wild animals. As people have encroached on wilderness areas they have come into contact with the infected animals, and the viruses have jumped from their traditional animal host to a new human host, with deadly consequences.

In addition to new diseases, well-known pathogens may change, or mutate, creating new, virulent strains. Influenza viruses are among those that mutate frequently, which explains why flu shots—vaccines that use modified or killed versions of the influenza agent to stimulate a protective immune response in the body—are given annually, and why epidemics of influenza periodically occur. The strains of flu virus that were most prevalent one year differ from those that bedevil humans the next year. Vaccines that protected against last year's flu virus may need to be altered to be effective against today's most common strains.

A similar problem occurs when mutations in infectious agents result in resistance to medicines that had been effective treatments. The bacteria that cause bronchitis, meningitis, tuberculosis, and pneumonia are among many that have developed strains that are resistant to at least some antibiotics. As a result, doctors have fewer options for treating the diseases and preventing their spread.

III NONINFECTIOUS DISEASE

Photo Researchers, Inc./Van Bucher

Mad Hatter

The Mad Hatter depicted in *Alice in Wonderland* was a grim reflection of environmental diseases in the workplace. The term "mad hatter" dates from the 19th century, when felt hatmakers showed effects of mercury poisoning resulting from their exposure to mercury salts during the production process.

Diseases not known to be caused by infectious agents include the three leading killers in the United

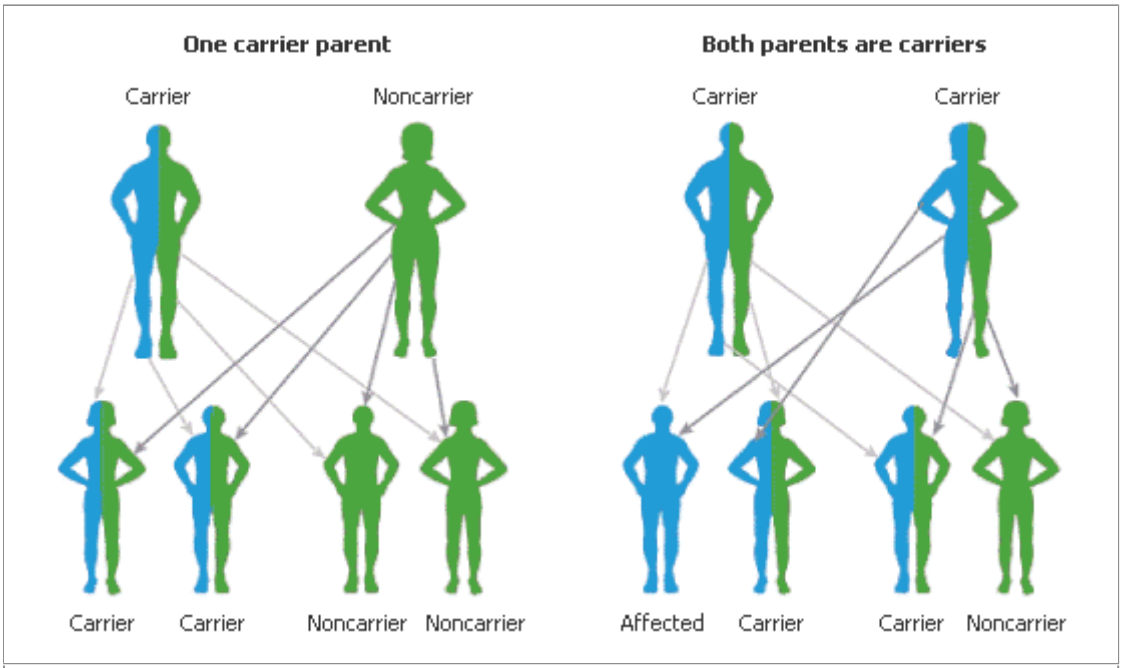
States and other developed countries: heart disease, most cancers, and cerebrovascular disease (decreased blood circulation in the brain). Noninfectious illnesses include disorders as terrifying as Alzheimer's disease, which robs victims of their memory and their ability to reason, and as pesky as poison ivy.

Degenerative disorders, including arthritis, Parkinson disease, and Alzheimer's disease, involve the progressive breakdown of tissues and loss of function of parts of the body. Joints gradually become stiff; bones become brittle; blood vessels become blocked by deposits of fat. The incidence of these problems increases with age (*see* Aging), and, in at least some cases, progression can be slowed by good health habits.

Environmental factors play critical roles in numerous noninfectious diseases. Exposure to carbon monoxide can have long-term effects on the heart and vision. Lead in drinking water can impair children's mental abilities and increase blood pressure in adults. Occupational exposure to coal dust, cotton dust, and asbestos predisposes workers to black lung, brown lung, asbestosis, and other respiratory diseases (*see* Occupational and Environmental Diseases). Other diseases are caused by an addiction to a harmful substance. Tobacco smoking is a prime culprit in emphysema, as well as lung cancer and other respiratory diseases. Excessive use of alcohol can lead to liver disease, brain damage, and nutritional disorders.

Repetitive stress injuries result from repeating certain motions, usually from a fixed or awkward posture. Twisting items on a factory assembly line, carrying bulging mailbags, using vibrating tools such as pneumatic hammers, or practicing the piano or a tennis stroke for hours on end can all result in pain, inflammation, and permanent nerve damage.

A Hereditary and Congenital Diseases



Recessive Gene Transmission

Some genes that cause genetic diseases interact in a dominant-recessive pattern. In these cases, two copies of the recessive gene are required for the disease to occur. A person who has just one copy of the recessive gene is termed a *carrier,* since he or she carries the gene but is not affected by it. In the illustration above, the dominant gene is represented in green, and the recessive in blue. For the couple on the left, the father has one copy of the dominant gene and one copy of the recessive gene. The mother has two copies of the dominant gene. Each parent can contribute just one gene to the child. The four children shown on the lower left represent the probabilities (not the actual children) for the combinations that can result from their parents. The children on the far left received the recessive gene from their father and the dominant gene from their mother, and are therefore carriers. For any child born to these parents, there is a 50 percent chance that the child will be a carrier. Since none of the children can inherit two copies of the recessive gene, none of the children will develop the disease. When both parents are carriers, however, as shown by the couple on the right, there is a 25 percent chance that any child born has the disease, a 50 percent chance that a child is a carrier, and a 25 percent chance that a child does not have the disease and is not a carrier.

Hereditary diseases such as hemophilia, sickle-cell anemia, Huntington's disease, muscular dystrophy, and Tay-Sachs disease are caused by mutated genes inherited from one or both parents (*see* Genetic Disorders). Certain other diseases, such as diabetes mellitus, hypertension, and some types of cancer, often run in families, which suggests that heredity is at least partially responsible for their development.

Congenital diseases, or birth defects, are disorders that are present at birth. Some are hereditary, others develop while a baby is in its mother's uterus or during the process of delivery. For example, if the mother contracts German measles, or rubella, during the early stages of pregnancy, her child may be born with heart defects, eye cataracts, deafness, or mental retardation. Use of alcohol during pregnancy can cause fetal alcohol syndrome, characterized by mental and physical retardation. Abnormal development of any body part in a fetus may produce a congenital defect; for example, if walls that separate the chambers of the heart fail to form completely, the baby is born with congenital heart disease.

B Immunological Diseases

Photo Researchers, Inc./Science Source

Dust Mite

The dust mite is a microscopic arthropod that lives in human homes, where it feeds on the dust produced by human and animal skin. Dust mites are not harmful in themselves, but their droppings, which contain left-over digestive enzymes, are a significant cause of asthma and other allergic diseases.

Immunological diseases occur when the immune system, which normally protects against infections, malfunctions. The most common types of immunological diseases are allergies, autoimmune diseases, and immune deficiencies.

An allergy is an abnormal reaction of the immune system to foreign substances, such as plant pollen, fungal spores, animal danders, medications, and foods. Rhus dermatitis is an allergy caused by contact with urushiol, an oil resin produced by poison ivy, poison oak, and poison sumac.

Autoimmune diseases develop when the immune system goes awry and attacks the body's own tissues. Autoimmune disorders includes lupus erythematosus, rheumatoid arthritis, juvenile-onset diabetes, and myasthenia gravis. The causes are unknown, although some scientists suspect the diseases may be triggered in some cases by a pathogen, such as a virus, or other environmental factor.

Immune deficiency diseases develop when the immune system becomes impaired, resulting in more common, frequent, or severe infections. The immune system may be damaged by a genetic abnormality or by illness, injury, the use of a strong drug such as those used in chemotherapy, or malnutrition.

C Deficiency Diseases

Photo Researchers, Inc./AFIP/Science Source

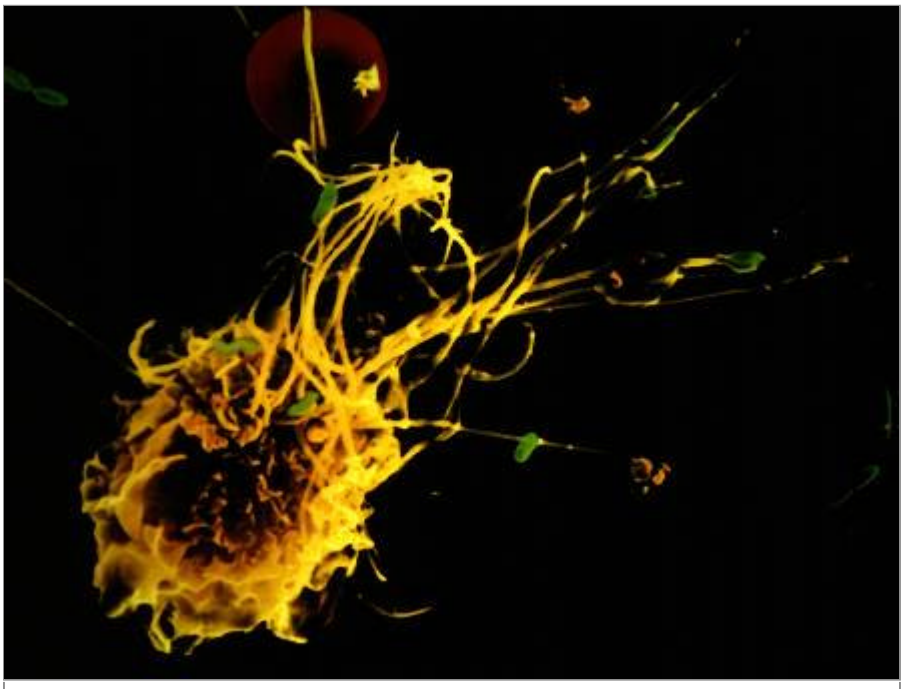
Goiter

Iodine deficiency in the body can cause goiter, a disease characterized by the enlargement of the thyroid gland. In some cases goiter results in extreme enlargement of the thyroid and may also result in either lowered or elevated levels of basal metabolism. Treatments include the ingestion of small doses of iodine, or, in extreme cases, the removal of the thyroid gland.

Deficiency diseases result from insufficient amounts of various healthful nutrients in the diet. Examples include scurvy, caused by a deficiency of vitamin C, or ascorbic acid; pellagra, caused by a deficiency of niacin; and osteoporosis, caused at least in part by a lack of calcium. Deficiency diseases are most prevalent in poverty- or war-stricken areas of the world, where malnutrition is widespread. Deficiency diseases are also found in more affluent nations where food is prevalent but people's food choices or behavior do not provide well-rounded nutrition, resulting in such disorders as anorexia nervosa, bulimia, and anemia.

IV THE FIGHT AGAINST DISEASE

A Natural Defenses



Phototake NYC/Dennis Kunkel/CNRI

Macrophage Engulfing Bacterium

A macrophage, in yellow, engulfs and consumes a bacterium. Macrophages are immune cells that wander through the body consuming foreign particles such as dust, asbestos particles, and bacteria. They help protect the body against infection.

The skin and mucous membranes form the body's first line of defense against disease. Most microscopic pathogens, or microbes, cannot pass through unbroken skin, although they can easily enter through cuts and other wounds. Mucous membranes protect internal organs that are connected with the outside of the body. These membranes, which line the respiratory, digestive, urinary, and reproductive tracts, secrete a sticky fluid called mucus, which traps microbes. The mucus may then be expelled from the body, perhaps in a cough or sneeze or in feces. If the mucus is swallowed, digestive juices kill the microbes.

Small hairlike projections on the lining of the nose, throat, and bronchial tubes work in conjunction with mucus to trap and remove foreign substances. In the ears, tiny hairs plus a sticky wax defend against the entry of germs. Tears secreted by the lachrymal gland wash away germs and other small objects that may enter the lid area of the eye. Tears also contain a protein that kills certain germs.

If a pathogen breaches the body's outer barriers, the defenses of the immune system spring into action. Some of these defenses are effective against a variety of invaders, while others are tailor-made to fight a specific organism. White blood cells called phagocytes constantly travel through the bloodstream on the lookout for foreign objects. If they come upon a microorganism, they surround, engulf, and digest it.

If the infection persists and there are too many organisms for the phagocytes to fight by themselves, the immune system produces proteins called antibodies. Each antibody is designed to combat a particular antigen, or foreign protein. Two types of white blood cells are involved in this process. B cells release the antibody, which attaches to the outer covering of the antigen, marking it for destruction. T cells attack the tagged antigen and also stimulate B cells into action. Once the body has produced antibodies to a specific microorganism, it generally is immune to future invasions by that organism. That is why people who have had chicken pox or measles as a child will not get the disease again as an adult. The reason people get one cold after another is that each cold is caused by a different virus strain.

B Medical Defenses

Photo Researchers, Inc./Andrew McClenaghan/Science Source

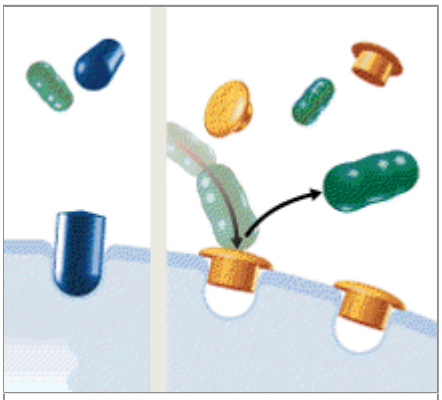
***Penicillium* Growing in Agar**

Penicillin is an important antibiotic derived from the mold *Penicillium notatum,* pictured here. Penicillin is effective against a wide range of disease-causing bacteria. It acts by killing bacteria directly or inhibiting their growth.

Much of early medicine was practiced by trial and error, but ancient peoples also looked for causes and cures for disease by studying the body and observing the sick. In Greece during the 5th century BC, the physician Hippocrates stressed that medical care was a science that could be learned through clinical observation and experimentation. The connection between health and hygiene was made in several ancient cultures, including those of India and Rome. The Romans drained marshes where malaria-carrying mosquitoes bred, and they built underground sewers and aqueducts to carry clean water in the cities. Laws governed the cleanliness of streets and the storage of food.

Because of limited contact between cultures, most early knowledge of the efficacy of various measures did not spread from place to place. With the collapse of the Roman Empire around AD 400, much medical knowledge was lost, to be replaced by superstition. It was not until the 14th century that a medical renaissance began. Thereafter, progress occurred exponentially. Accurate descriptions of the structure and functioning of the human body were made, and the invention of the printing press in the middle of the 15th century enabled this information to be published and easily disseminated. The development of microscopes in the late 16th century prompted the discovery of microorganisms, although it was not until the 19th century that scientists were able to show that bacteria and other microbes caused disease. Also in the 19th century, people recognized the importance of sanitation and

cleanliness, improving the survival rate in hospitals. Anesthesia was discovered and the first vaccines were produced.



Drug Mode of Action

Certain drugs work by interacting with receptors, special sites on the surface of body cells. Drugs may bind to a specific receptor, possibly preventing naturally occurring chemicals from binding to the receptor. In so doing, if a drug enhances cell activity, it is called an *agonist*; if it blocks cell activity, it is called an *antagonist*.

During the 20th century, the importance of vitamins and other nutrients in preventing disease was recognized. Antibiotics, sulfa drugs, blood types, and genes that cause disease were discovered. A host of diagnostic and surgical tools were created that incorporated inventions such as X rays, fiber optics, lasers, and computers. Techniques such as organ transplantation (*see* Medical Transplantation), kidney dialysis, dental implants, gene therapy, and fetal surgeries were introduced. Thousands of new drugs were developed to treat everything from ulcers to zinc malabsorption.

The list of medical techniques for fighting disease continues to grow. More effective methods are expected to be introduced in the coming years as scientists gain a better understanding of such subjects as the molecular biology of normal and abnormal cells, gene structure and action, and the relationship between environmental stresses and disease.

V PREVENTING DISEASE

It is much less costly, in terms of both human suffering and economics, to prevent disease than to treat it. Public health services and medical professionals play critical roles in helping people avoid disease. In addition, each individual plays a vital role in protecting his or her personal health.

Public health services are charged with protecting community health. Their activities include provision of adequate clean water and the sanitary disposal of sewage and other wastes. Food supplies—on farms, at food processing plants, and in supermarkets and restaurants—are inspected for microorganisms. Pesticide spraying programs are undertaken to control populations of mosquitoes and other carriers of disease. Public facilities, such as schools and hospitals, are inspected to ensure that they meet appropriate standards of cleanliness and safety. Education and surveillance programs alert

physicians and other medical workers to disease threats.

Physicians, dentists, and other medical experts have a number of preventive tools at their disposal. Among the most effective are vaccines, which stimulate the immune system to produce antibodies against particular antigens. A vaccine may contain killed or weakened pathogens, parts of the pathogens, or modified toxins produced by the pathogens, which are strong enough to arouse the immune system to fight off new invading pathogens but not powerful enough to cause disease themselves. Thanks to vaccines, polio is rare today, smallpox has been eliminated, and diseases such as diphtheria and whooping cough, which once killed many young children, have largely been brought under control.

Regular medical check-ups are another important preventive tool. These help doctors to find disease in its early stages, when it is easier to treat and before it causes significant damage. For example, during a check-up a dentist will remove plaque, a sticky bacterial coating on teeth. Left undisturbed in hard-to-reach areas, such as between the teeth and along the gums, plaque can lead to periodontal disease, which can destroy the tissues that anchor the teeth in the mouth (*see* Dentistry).

Even the finest public health and medical services are of limited value to people who have poor health habits. Numerous studies have proven that physical health and longevity are linked to the following: eating a balanced diet, maintaining proper weight, exercising regularly, using condoms and limiting the number of sexual partners, avoiding tobacco, and avoiding alcohol or consuming it in moderation. People who fail to follow these guidelines increase their risk of cardiovascular disease, cancer, AIDS, hepatitis, and other lethal diseases.

The interplay among public health measures, medical practices, and personal responsibility is exemplified in the fight against tooth decay. Caused by bacteria that feed on food debris in the mouth, tooth decay can be virtually eliminated through a combination of three steps: the addition of fluoride to public drinking water supplies; the professional coating of teeth with a plastic sealant, which fills microscopic pits where bacteria can collect and cause decay; and regular brushing and flossing of teeth.

VI HISTORY OF HUMAN DISEASE

Humans have always had to deal with disease. Skeletons more than 12,000 years old show evidence of tuberculosis and other diseases. The 9400-year-old mummified remains of Spirit Cave man, found in Nevada in 1940, indicate that he suffered from back problems and tooth abscesses. The remains of Ramses V, ruler of Egypt around 1150 BC, show that his face was disfigured by smallpox scars.

Disease has had a dramatic impact on human history. For most of the 250,000 years that humans have been on the earth, disease has played a central role in limiting population growth. As ways to combat disease were discovered, people lived longer and had more children, who lived long enough to have children of their own. The human population slowly increased and then exploded. By 1804 the human population reached 1 billion. Just over 100 years later, in 1927, after the advent of the first vaccines and the recognition of the importance of sanitation and safe water supplies, the population had doubled to 2 billion. By 1974 it had doubled again to 4 billion. Since then, recognition that the

earth's environment has a limited capacity to support an ever-increasing population has led to concerted efforts to limit population growth. Nevertheless, as the 20th century neared its end, the population had reached 6 billion. It is expected to rise to more than 8 billion by 2021.

A Epidemics

Photo Researchers, Inc./Science Source

Effects of the Black Death

The Black Death, an epidemic of plague in Europe that lasted from 1347 to 1351, resulted in the deaths of almost one-quarter of Europe's population. The Black Death was the first in a cycle of plagues in Europe that continued into the 18th century. Shown here, the French city of Marseille is devastated by a later outbreak of plague.

Periodically, devastating outbreaks of infectious disease occur, affecting many people in a region at the same time. Such outbreaks are called epidemics. Those of widespread proportions, such as the current AIDS epidemic, are often referred to as pandemics.

People have always been fearful of epidemics and their effects. In China in the 13th century BC, the ruler of Anyang asked his diviners, "Will this year have pestilence and will it be deaths?" In Egypt around 2000 BC, a writer compared fear of the Pharaoh with fear of epidemics. The Old Testament of the Bible refers to several epidemics, including one that affected the Philistines, purportedly as punishment for seizing the Ark of the Covenant. The British Isles were hit by at least 49 epidemics between AD 526 and 1087.

Epidemics can reshape societies, affect the course of military events, and change the balance of power among different groups of people. An epidemic in Athens in 430 BC created chaos in the city and contributed to defeat in its war with Sparta. Among the best known of all epidemics was the Black Death, an epidemic of bubonic plague that broke out in Europe in AD 1347. By 1351 an estimated 25

to 50 percent of the people in Europe had died from the disease. The Black Death depopulated once-flourishing cities, left villages vacant, and caused a decline in cultivated land.

When Europeans began to explore the Americas in the 15th century, they carried along pathogens unknown in the new lands. Smallpox and measles raced through native populations with devastating results. For example, by 1568, only 50 years after Hernán Cortés first reached Mexico, the population of central Mexico had fallen from about 17 million to about 3 million. It is doubtful that Cortés could have conquered the Aztecs as easily as he did had this disaster not befallen the Aztecs.

B Stigma of Disease

Black Star/Richard Falco

Gay Pride Parade

Members of the activist group ACT UP (AIDS Coalition to Unleash Power) rally at a gay pride parade in New York City. Such groups have helped raise public awareness and dispel some of the myths about acquired immunodeficiency syndrome (AIDS), which affects millions of people worldwide.

Fears of disease, often coupled with ignorance, have led to horrifying treatment of the afflicted. Outbreaks of plague in Europe were often blamed on Jews, who were beaten and driven from their homes. During an epidemic in 17th-century Italy, people suspected of being carriers of the plague were tortured and burned alive. Through the ages people with leprosy were often isolated in leper houses, forbidden to marry, and forced to wear a distinctive cloak or shake a rattle to announce their presence.

Even in supposedly advanced cultures, the stigma of disease remains. In recent years, people with AIDS have heard that their illness was God's punishment for immoral behavior. Many have been ostracized by family, friends, and even physicians who are fearful of contagion. People with AIDS have

also been denied housing, medical treatment, and the right to travel to foreign countries.

VII LIFE SPAN

At the beginning of the 20th century, people in the United States had an average life span of about 50 years. By the time the century neared its close, average life span had risen to 76 years. Other developed countries experienced similar increases. Much of the credit for these longer life spans—and for the good health that accompanies them—is due to the conquering of diseases, thanks to vaccines, antibiotics, sophisticated surgical tools, and other medical miracles. The challenges ahead include bringing the benefits of this medical knowledge to all peoples of the world, and expanding on current knowledge in order to understand, treat, and prevent the diseases that still confront us.

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