

HEALTHY PEOPLE LIBRARY PROJECT

American Association for the Advancement of Science

# *Your Health*



*The Science Inside*



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# *Your Health: The Science Inside*

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American Association for the Advancement of Science

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# INTRODUCTION: YOUR HEALTH IS IN YOUR HANDS

As a citizen of the 21st century, you are living in amazing times. People who are alive today—especially those living in modern, **industrialized** countries like the United States—have far more control over their health, and the health of their families, than any human beings who have ever walked the Earth.

It wasn't always this way. Had you lived in the not-too-distant past, it may have seemed like your health rested largely in the hands of fate. For example, if you cut your hand and got an **infection**, the infection might have worsened until it caused permanent damage. You might have lost your hand, or your entire arm, and you might even have died. Also, many **contagious diseases** (such as **influenza**, **measles**, or **rubella**) that today can be treated or prevented caused many deaths and many more lifelong problems. For women, childbirth was a serious risk. Lastly, if you developed an illness like **cancer**, you probably would not have even known why you felt sick. Even if you knew that it was cancer, nei-



ther you nor your doctor would have had little more than hope to help you fight it.

Of course, people today still suffer from terrible diseases, injuries, and **chronic** health problems. Sometimes, these problems can't be solved. However, we now have powers to maintain and improve our health that our ancestors could only have dreamed of. We can fight infections with **antibiotics** and prevent diseases with **vaccines**.

*People today have more control over their health than ever before.*

## Your Health: The Science Inside



*In many countries, children born today can expect to live years longer than a child born a few generations ago.*

Other medications can control our blood pressure, counteract the effects of **diabetes**, and even treat mental illnesses like **schizophrenia**. Modern surgery saves countless lives every day, and doctors are constantly inventing ways to

reduce the impact of surgery on the body. Finally, our everyday health is better than ever, thanks to improvements in nutrition, cleanliness, and general living conditions. In many countries, a child born today can expect to live years or even decades longer than a child born just a few generations ago.

Yet, linked to the miracles of modern medicine, there is the curse of success. Medical conditions that used to kill people can now be treated, but still not cured. People today live longer lives, sometimes with a chronic disease, such as diabetes. In modern society, patients must now play a major role in how they live with those conditions. They must be partners with their doctors to figure out how to prevent chronic conditions from developing and to live with any conditions they may already have. It is very important to learn as much as possible about your own personal health in order to live the longest, healthiest life you can.

One of the biggest changes to affect human health in the past century, and especially in the past few decades, is that a lot more information is now available to the public. This has come about partly because doctors and scientists have discovered so much recently.

But it also has happened because health information has more ways to reach people than ever before. A century ago, if you wanted to know anything about medicine, you'd probably have to ask a doctor or read a textbook. Today, popular books, magazines, television, radio, and the Internet are loaded with medical advice for everyday people.

All this information can be helpful, but it can also be confusing. Maybe you heard a medical story on the news that seemed to contradict something you had heard before. Maybe you got conflicting advice from two different doctors. Maybe you felt overwhelmed by all the advertisements for prescription drugs you see on television. Maybe you've heard about an exciting new treatment for a health problem that affects you or

your family, but you can't figure out if it's safe or if it really works.

If these situations sound familiar, you're not alone. It's hard work to go through all the options that are available to help you stay healthy. The good news is that the options are there—and if you understand how they came about, you can feel good about weighing and choosing the options that are best for you.

That's what this book is all about. You'll find out how we got to this point in history, how scientists know what they know, and how they look for new information, so you'll be able to think like a scientist when approaching your own health.



# Part 1: Your Health, Then and Now

## A typical story from 1850

Imagine that it is about 150 years ago and you are 10 years old living in a small town in the United States. You are one of three children—three *surviving* children, that is. One of your brothers was stillborn and another died at age two from **diphtheria**. When your little sister was born, your mother caught a fever and died. So now your father and your older sister are raising you and the baby.

Both of your father's parents died when he was still a child. His mother had **tuberculosis** (also known as consumption). His father got hurt in a farming accident and died from an infection. Your other grandfather is

still alive, but because of his old age (he's 61), he is so weak that he can barely stand up.

Your maternal grandmother passed away two years ago. Nobody knows exactly why. She had a lot of pain in her stomach, and near the end,

*In this wood engraving from an 1885 issue of Harper's Weekly, the ghosts of cholera, yellow fever, and smallpox tremble in fear as their way into New York is blocked by a sign that reads "quarantine" and an angel holding a sword and shield that says "cleanliness."*



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*A young boy waits for the village doctor in the middle of the night.*

she could hardly eat. The truth is that she had stomach cancer, but your family had no way to find out—and even if you had, there’s nothing anyone could have done.

There was a measles epidemic in your town last year. You got sick, but you survived, although you have plenty of scars from the measles sores. Two of your classmates died from the disease. Right now, the big scare is **yellow fever**. It seems to come around every summer. Six people have already died this year, including your best friend’s father and older brother.

You’re worried about your own father. He has a bad cough that

won’t go away. He’s been taking some medicine that he bought from a traveling salesman, but it doesn’t seem to be working. The doctor came to visit, but he could not explain what was wrong.

As for you, your health is not so bad. Aside from the measles scars, you have a rotten tooth and a few patches of ringworm. It’s all rather normal. Everyone you know has something not quite right about his or her body.

### A typical story from today

Now imagine that the time is today and you are again 10 years old living in a small town somewhere in the United States. You are one of three children, all of whom are basically healthy. Because your mother was under a doctor’s care during each pregnancy, her high blood pressure was kept under control and each delivery was fine. Your brother was born a few weeks early, but the hospital took care of him until he was strong enough to come home. Now he’s actually big for his age.

Diseases such as measles and mumps are something you read about in old storybooks, but you’ve never known anyone who has had them. That’s because you, your brother and sister, and all of your



friends got vaccines against these diseases while you were babies. You don't remember getting the vaccines, but they've helped to keep you healthy.

All four of your grandparents are alive, and even two of your great-grandparents, who are in their eighties. Your grandmother had cancer a few years ago, but it was caught early and treated. She sees the doctor every few months, and so far, the cancer hasn't come back. Your grandfather has diabetes, but he stays active, eats well, and takes **insulin** and other medications. He goes for a long walk with his dogs every morning and usually feels fine.

You are worried about your father, because he has a bad

*Today it is common to have many generations in a family live longer.*

cough. He has tried many times to quit smoking, but it has never worked. His doctor is worried that he might develop lung cancer or **emphysema**. To prevent this, his doctor helped him enroll in a medical study that is trying out new ways to help people like your father quit smoking. Maybe it will work.

There are some other health problems in your family. Your great-grandmother has **Alzheimer's disease**, which makes her confused and forgetful. Your mother spends a lot of time caring for her, and her doctor is trying out a new drug on her that might keep the disease from getting worse or progressing too quickly. Your mom is

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also about 40 pounds overweight, and it's starting to take its toll. She just started a new exercise program to see if she can get in better shape.

Last year, your father lost his job and his health insurance. It became very expensive for your family to get medical care and prescription drugs. For a while you had to rely on a free clinic, where the lines were long and the doctors didn't have much time for you. Recently, your dad got a new job and things are getting better.

But overall, you are in very good health. You have never had a serious illness, only colds and ear infections that quickly went away with medicine. Your teeth are in good shape, except for one cavity that was filled by your dentist. Your only scar came from falling off the monkey bars at the playground. It's all rather normal. Everyone you know is more or less healthy.



*Getting regular checkups and vaccines helps today's young children grow up to live healthy lives.*

# Part 2: So, What's Changed?

## Then and now

As you can see, things are a lot better than they used to be—at least for most people in the United States and other industrialized countries. Of course, the world is far from perfect. But many of the health problems we face today are relatively minor compared with those of our ancestors. What's more, when faced with serious health challenges, we have a lot more power to fight against them than we used to have. We can cure many diseases that once killed people by the dozens, and although some new diseases (such as **AIDS**) have emerged that cannot be cured, in many cases we understand at least how these diseases are transmitted and how they can be prevented. In fact, it would be reasonable to argue that we have gained more power over our health in the past 150 years than we did in the thousand years prior to that period.

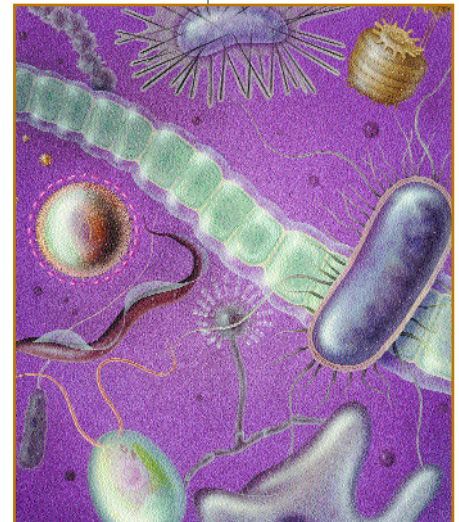
What happened over the last 150 years that has brought us to this new place in human history? The next section will provide some answers to this important question.

## THE FIGHT AGAINST CONTAGIOUS DISEASES

### Understanding the role of germs

Many kinds of illnesses are caused by **microbes**—tiny life-forms that are too small to be seen with the naked eye. There are many kinds of microbes, including **bacteria**, **protozoa**, and **fungi**. Bacteria are simple one-celled creatures. Two kinds of bacteria are ***Salmonella***, a common cause of food poisoning, and ***Streptococcus***, the cause of

*Microbes are tiny life-forms that can cause illnesses.*



### Viruses: Living, Nonliving, or in Between?

Is a dog or a cat a living thing? Sure. A tree? Absolutely. A rock? Of course not.

But a virus? That's a much trickier question.

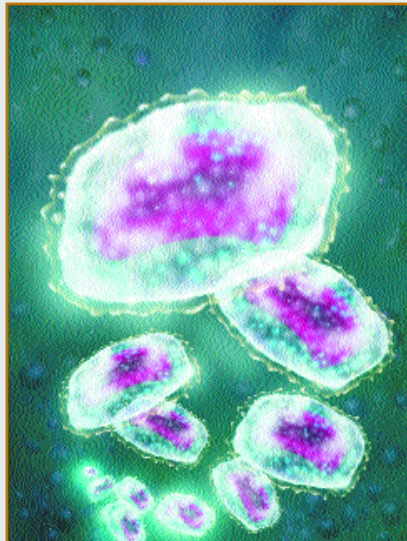
Viruses—which cause illnesses and conditions such as the common cold, influenza, herpes, and rabies—are unlike living things in several important ways. First of all, they do not even have a single **cell**—the basic building block of life. Instead, they are mostly a strand of genetic material curled up inside a tiny bag made of protein. Second, viruses cannot grow or reproduce on their own.

Viruses also can't take in energy: Unlike animals, they don't eat, and unlike plants, they don't use sunlight to make their own food. They can't move on their own, so they have to be carried along in air, water, food, or body fluids, or passed around from one surface to another.

However, viruses do share some characteristics with living things. They contain **DNA** (or a similar chemical called **RNA**), the genetic code for life. They can reproduce with the help of a living cell. (They do this by injecting their DNA into the cell and "hijacking" the cell's own reproductive system, forcing it to make new viruses.) And over time, they can evolve—for example, by developing a resistance to a drug. Some viruses that cause human diseases are rhinoviruses, which cause colds; herpesviruses, which can cause cold sores and blisters; and the **human immunodeficiency virus (HIV)**, which causes AIDS.

Some scientists classify viruses as living things. Others classify them as non-living. Still others believe that they belong to their own unique category. But even if they're not alive themselves, viruses definitely play a big role in life on Earth.

*Smallpox virus*



“strep” throat. Protozoa are also one-celled creatures, but unlike bacteria, protozoa have a **nucleus** inside them. In this way, they are more like animals or people than they are like bacteria. Protozoa are known to cause only a few human diseases, of which two of the most common are **malaria** and **dysentery**. Fungi can grow on or in the body and live by breaking down dead cells or body fluids. Examples of common fungal infections include athlete's foot and yeast infections. Fungal infections can also occur inside the lungs. People with weakened immune systems, including elderly people and patients with AIDS, are especially vulnerable to some kinds of fungal infections.

Some scientists say that microbes include **viruses**, which cause many human diseases, from the common cold to AIDS. Viruses are extremely simple life-forms—so simple that many scientists argue that they are not life-forms at all. Others put them in a class by themselves, somewhere between living and nonliving things. For the purposes of this book, it is easier to lump viruses in with microbes.

The world is full of microbes, and so is your body. A great many of them are harmless to people. Some are even helpful. (For exam-



*Garlic has long been used to fight off illness, but it is only recently that scientists learned it can kill germs.*

ple, the bacteria in your intestines help you digest food.) But other microbes have the potential to cause illness in the human body. We call these disease-causing microbes **germs**. Germs can be spread through food, water, the air, or the environment. They can also be spread by physical contact between two people. Sometimes germs can be spread by physical contact with animals, although many germs that infect animals are slightly different from the ones that make people sick.

Before people knew about germs, they didn't understand how diseases started and spread.

Sometimes they blamed diseases on evil spirits—or, later, on “bad blood,” an idea without any medical source. They would come up with treatments based on these ideas, such as performing exorcisms or deliberately cutting people to drain the “bad” blood. These treatments often failed, and even when they worked, doctors didn't fully understand why. For example, garlic was used for medical purposes in many ancient cultures, but only recently have scientists discovered that it can kill germs.

One of the earliest known suggestions that germs cause disease came from the Italian

### LOUIS PASTEUR



Louis Pasteur (1822–1895), a French chemist, was one of the most important scientists in history. Many of his accomplishments and insights set the stage for modern medicine.

Pasteur increased our understanding of disease by proving the theory of **spontaneous generation**—the belief that some life-forms, such as insects and microbes, could suddenly materialize from nonliving matter—wasn't true. For example, it was thought that the mold that grew on spoiled milk just appeared there from nothing.

People had believed in spontaneous generation since ancient times, and although others before Pasteur had raised objec-

tions, Pasteur's experiments were the most convincing. He proved that molds, fungi, and bacteria were actually present in the air and that they wouldn't grow on anything they couldn't touch.

Not only did Pasteur show that germs were present everywhere, but he also pioneered ways to get rid of them. He proved that boiling liquids like wine and milk killed any germs that were present, and then he demonstrated that quickly sealing them off from air kept new germs from growing. This process is called **pasteurization**, and it's still used today. He also suggested that surgeons boil their instruments before doing surgery, but the idea didn't catch on until later.

Pasteur's work helped to convince other scientists that germs were the cause of contagious diseases. Among his many accomplishments, Pasteur pioneered vaccines for chicken pox, cholera, diphtheria, anthrax, and rabies.

physician Girolamo Fracastoro in the year 1546. But his idea didn't catch on. For one thing, nobody could see these germs—the microscope hadn't been invented yet! And by the time scientists finally began to study bacteria and viruses, Fracastoro's work had been mostly forgotten.

The “germ theory” of disease was really popularized by the French chemist Louis Pasteur in the 19th century. By then, Pasteur was able to show that the presence of germs was linked to certain illnesses. Once this idea was established, scientists started identifying the bacteria and viruses that cause common diseases. As technology improved, so did our ability to find, categorize, and study these microscopic creatures.

Today, scientists have identified many of the germs that cause known human diseases—even the ones that we can't cure. Obviously, knowing what causes an illness is incredibly important to doctors and patients who are trying to fight it, and scientists are working very hard to figure out the nature of more illnesses—like **multiple sclerosis**—so they can identify and help eliminate the viruses that may cause them.

## Curbing the spread of disease

Once people came to understand that germs cause many diseases, they started identifying and blocking the paths along which the germs travel. In many cases, doing this was possible before anyone had any detailed knowledge of the actual germs involved.

One strategy for blocking the spread of infectious disease is **quarantine**, which involves identifying the people who have a contagious disease and separating them from healthy people so that the disease doesn't spread. Quarantines have been used for thousands of years. More recently,

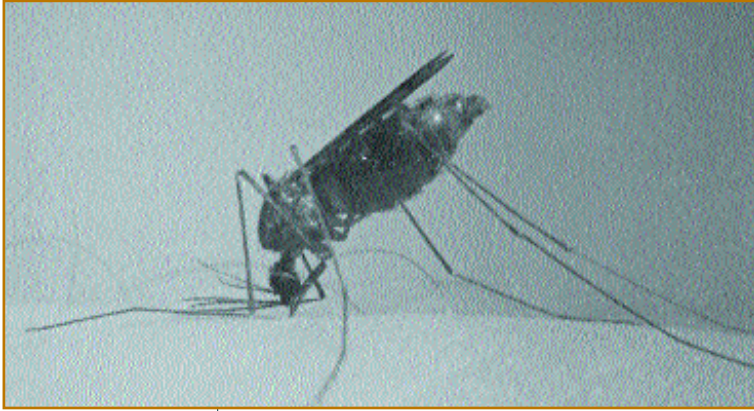
quarantines have helped control diseases like the supercontagious and deadly **Ebola** virus, which has devastated several villages in Africa over the past few decades, and **SARS** (severe acute respiratory syndrome).

Quarantines can be effective in controlling some contagious diseases. But there are several big drawbacks. For one thing, it can be hard to identify all the sick people. In many cases, a person might be infected and still be able to spread the disease for quite a while before developing any **symptoms** of the disease. Second, some infected people never get sick at all. But in either case, a person who looks healthy



*A woman in Hong Kong wears a mask to avoid breathing in the SARS virus, which is passed on by close person-to-person contact. Using quarantines helped to contain the disease in 2003.*

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*Mosquitos are the main vectors for malaria, which is caused by a parasite spread through their bites.*

might still be able to pass on his or her germs to others. Quarantines also can't always block other ways that germs might spread—for example, through infected water, food, animals, or insects. Finally, quarantines can mean separating sick people from their jobs, friends, and family, and that can be very hard to do. Today, big quarantines involving lots of people are rare and are used mainly in emergencies.

Another way to control the spread of disease is by controlling the **vectors** that help it spread. A vector is a kind of middleman: a creature which carries a germ that infects people. For example, mosquitoes are the main vectors for malaria (a deadly disease common in the tropics). For centuries, European explorers assumed that the disease was caused by something in the tropical air (in fact, the word “malaria” translates to

“bad air”). But in 1895, the British biologist Ronald Ross discovered that a tiny **parasite** (an organism that lives off another organism) really causes the disease. Three years later, a team of Italian scientists figured out that the parasite was carried by mosquitoes and was spread through their bites. Once people understood this, people in tropical cities were able to reduce the threat of malaria by draining nearby swamps where mosquitoes bred.

The spread of disease can also be controlled through **sanitation**—in other words, keeping our food, water, and environment clean. Many diseases, including **cholera** and **typhoid fever**, which have killed countless people throughout history, are spread through infect-



*Using antiseptics and sterile tools and rooms help make surgery safer than it once was.*

ed drinking water. Other germs and parasites spread through food that's unclean, spoiled, or improperly cooked. Over the past century, humans have learned a lot about preparing and storing food safely and treating public water supplies, and the health payoff has been extraordinary.

Surgery, dentistry, and medicine have also been made much safer, thanks to the use of **antiseptics** (chemicals that kill germs). Antiseptics are used to make a doctor's tools sterile (germfree). Before antiseptics became popular, many patients died from infections that were spread on unclean surgical instruments. In some cases, having surgery was actually more dangerous than the disease itself!

Even the simple practice of washing one's hands has made an enormous difference in the overall health of the public, since it keeps germs from spreading to everything—and everyone—a person touches. Frequent hand washing has become a widespread practice only within the past century or so. While it's especially important for health care workers and food preparers, all people can benefit from washing their hands on a regular basis.

### JOSEPH LISTER



By the middle of the 19th century, surgeons had become fairly skilled at their craft. However, even though the operations themselves went well, half of the patients died in the days or weeks after surgery. The cause was usually some kind of inflammation around the surgical wounds. Nobody quite knew what caused it. Some people thought it was a kind of chemical reaction between open wounds and the oxygen in the air.

British surgeon Joseph Lister (1827–1912) had a different idea. He

believed that the inflammations were caused, not by the air itself, but by some kind of particle carried in it. When he heard about Louis Pasteur's research, he connected it to his own observations. He became convinced that the wounds were being infected by germs that lived in the air.

The problem now was how to get rid of the germs. He had already tried cleaning the wounds, with little success. Finally, he used a chemical called **carbolic acid**, which had been used to treat sewage in a nearby town. After he began cleaning his patients' wounds with carbolic acid, they remained free of infections.

Many people didn't trust Lister's techniques at first, but within a few decades they had caught on. In 1878, his work inspired the German surgeon Robert Koch to sterilize his surgical tools with steam.

Today, surgery is conducted under antiseptic conditions, which means that everything possible is done to keep the patient and the surgical tools free of germs. Without antiseptic surgery, even the simplest operation would still be a very dangerous gamble.



*Washing your hands is an easy way to prevent the spread of germs.*

### The role of antibiotics and vaccines

The last century also saw a revolution in the tools that we have available to fight contagious diseases. Two of the most important are **antibiotics** and **vaccines**.

Antibiotics are a class of drugs that kill germs (usually bacteria) that are in your body. Antibiotics come in many forms: pills or liquids that you swallow, powerful

solutions that a doctor can inject with a needle, and lotions, liquids, and creams that can be applied to your skin or an open wound. There are many different kinds of antibiotics; each one works best against only certain kinds of germs.

Doctors had long searched for ways to fight disease-causing germs directly, rather than just treating the symptoms of the illness. By the early 20th century, several possibilities were being explored, including **sulfa drugs**, which fight bacteria by blocking a chemical they need in order to reproduce. Sulfa drugs were effective against some infections, but weak or useless against others. Another potential treatment was **bacteriophage** therapy.

Bacteriophages are viruses that kill harmful bacteria. To fight an infection, doctors would inject bacteriophages into a patient's bloodstream. But because each kind of bacteriophage kills only certain bacteria, the treatments were very limited.

The first effective antibiotic was discovered, partly by accident, by the Scottish biologist Alexander Fleming, who was searching for something to fight bacteria, which he studied in little culture plates. Fleming also wasn't the neatest person in the world, and one day

he came back from a long vacation to find that some of his culture plates had gotten moldy. Like countless scientists before him, Fleming threw the moldy plates away. But a former colleague, who happened to be visiting Fleming's lab, saved some of the plates and noticed something interesting: No bacteria were growing near the patches of mold. He pointed this out to Fleming, who did some more experiments and isolated a bacteria-killing chemical from the mold that he called **penicillin**.

Fleming published his results in a journal, or scientific magazine, and suggested that penicillin might be useful if it could be mass produced. More than a decade would pass before another scientist, Howard Florey, developed a technique for making penicillin in large quantities.

Penicillin became a “break-through drug,” because it was cheap to make, was generally safe, and worked against a wide variety of infections. It is still used today all over the world. Many more antibiotics were discovered because of it, and, by the middle of the 20th century, antibiotics had become the treatment of choice for diseases caused by infections. It is no exaggeration to say that millions of people are

### ALLERGIES TO ANTIBIOTICS

Not all antibiotics are right for everyone. Some people have allergies to certain antibiotics. For example, about 2 to 5 percent of Americans are allergic to penicillin, one of the most common and inexpensive antibiotics. People can have allergies to other antibiotics as well.

Allergic reactions to antibiotics range from mild rashes to severe hives, tight airways, and difficulty breathing. In some cases, an allergic reaction can be deadly.

However, many unpleasant reactions to antibiotics—such as nausea, rashes, and diarrhea—are not really allergies, only side effects. For example, penicillin and drugs like it can sometimes cause fever, itching, hives, or joint pain. Side effects of more powerful antibiotics like ciprofloxacin (which was used to treat people exposed to anthrax in the fall of 2001) include diarrhea, drowsiness, strange dreams, and blurry vision. Most side effects are uncomfortable, but not life threatening. Also, people sometimes mistake the symptoms of their illness for a reaction to an antibiotic. They may stop taking the antibiotic because they feel sick, when in fact the antibiotic is their best chance to feel better. In fact, recent studies suggest that 80 percent of people who believe they are allergic to penicillin are not really allergic at all.

If you're not sure if you're allergic to penicillin or any other antibiotic, ask your doctor. A simple skin test can give you the answer. If you are allergic, it's important to mention this whenever you get a new prescription or medical treatment. Usually, another antibiotic will be available for you.

alive today only because they received antibiotics at some point in their lives.

Another important weapon against contagious diseases is the use of vaccines. Vaccines are different from antibiotics, because they prevent disease rather than treat it. Vaccines work by stimu-



*A child gets a polio vaccine, which will prevent his getting the disease, at an inoculation clinic.*

lating your **immune system** (your body's natural defense against disease). When you get exposed to a new, harmful germ, your body develops cells called **antibodies** that are custom-made to fight that germ. It's a good system, and it works a lot better than you probably realize (since it's often kept you from getting sick in the first place!). But making those antibodies takes time, and if an infection

is powerful enough, the germs can take advantage of that "lag time" to do a lot of damage or to multiply and spread so much that they're difficult or impossible to defeat.

Vaccines give your body a head start. Usually, a vaccine contains a killed or weakened form of the germ that causes a disease, or just a few important pieces of it.

## Part 2: So, What's Changed?

Whatever the case, it's enough to make your body produce antibodies to the germ, without getting you sick. So in the future, if you're ever infected with the germ, those antibodies are ready to attack it right away, before it gets out of control. Some vaccines, such as the one for **tetanus**, require **booster shots** every so often to keep the antibodies primed and ready. Others last a whole lifetime from just one dose.

Sometimes, the use of vaccines can even protect people who aren't vaccinated. If a lot of people in an area are vaccinated against a particular germ, the germ won't be able to live and grow inside very many people. As a result, the disease-causing germs start to die off.

The earliest form of vaccination was **variolation**, which was practiced in China as early as the 10th century. It was used as a way to prevent the deadly disease **smallpox**. In variolation, healthy people were exposed to powdered smallpox scabs, often by sticking them up their noses! Variolation often caused mild sickness and sometimes resulted in death, but overall it was thought to lower the rates of full-blown smallpox.

## COMMON VACCINATIONS

The Centers for Disease Control recommends a number of different vaccines for children. Different vaccines work best at different ages. Some vaccines can be given to very young infants. Others work better when given to children who are a year old or more.

Some vaccines require only one shot. Others are given in several shots, months or years apart.

Although it is important to vaccinate your children as early as possible, it is never too late. So even if your child has fallen behind schedule, he or she will benefit from being vaccinated as soon as possible.

Here are the vaccinations every child should get and when they should be given:

Vaccine	Number of doses	Age for first dose	Other doses
Hepatitis B	3	Birth–2 mos.	1–4 mos., 6–18 mos.
Hib (meningitis)	4	2 mos.	4 mos., 6 mos., 12 mos.
Polio	4	2 mos.	4 mos., 6–18 mos., 4–6 yrs.
DTaP (diphtheria, tetanus, and pertussis)	5	2 mos.	4 mos., 6 mos., 15–18 mos., 4–6 yrs. <i>Tetanus booster shots recommended every 10 years.</i>
PCV (Bacterial Meningitis)	4	2 mos.	4 mos., 6 mos., 12–15 mos.
MMR (measles, mumps, rubella)	2	12–15 mos.	4–6 yrs.
Varicella (chickenpox)	1	12–18 mos.	
Hepatitis A*	2	2+ yrs	At least six months later

\*Recommended in certain areas; ask your doctor.

## Your Health: The Science Inside

The first real vaccine is credited to an English country doctor named Edward Jenner. He had noticed similarities between smallpox and **cowpox**, a disease found in cows. Humans could catch it, too, but the disease was mild compared with smallpox.

Some of the villagers that Jenner treated claimed that catching cow-



*Dr. Jonas Salk developed the polio vaccine, which he gives to a Pittsburgh boy in 1954.*

pox kept a person from getting smallpox. Jenner began to take detailed notes on the subject and found that the story seemed to be

true. Finally, he decided to test it. In 1796, he deliberately vaccinated a young boy named James Phipps with cowpox. Sure enough, the boy didn't catch smallpox when he was exposed to it.

This kind of vaccination became popular throughout Europe and the United States in the 19th century. However, it wasn't universally accepted. Some people didn't believe it really worked. Others thought it was disgusting and unnatural to be infected with the blood of an animal. Still others objected to laws that made vaccination mandatory. And, of course, the vaccine still caused a sickness, so people had to accept *definitely* getting cowpox just to avoid the *possibility* of getting smallpox. Today, many effective vaccines use viruses that are weakened in some way, making it much less likely that the vaccines will cause disease.

One of the most successful modern vaccines was the one for **poliomyelitis** (or **polio**). This vaccine was invented by Dr. Jonas Salk in 1953. It used an inactivated form of the polio virus that couldn't make you sick.\*

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**\*In 1957, Dr. Albert Sabin began testing a live, but weakened, form of the virus as a vaccine to improve upon Salk's vaccine.**

Before the vaccine, polio caused many deaths and disabilities. (Most famously, it left U.S. President Franklin Delano Roosevelt unable to walk without crutches.) When the polio vaccine was first introduced, people lined up for blocks and blocks to get it.

Over the years, polio and many other serious diseases (including measles, **mumps**, and rubella) have been kept well under control with safe, effective vaccines. Today, a long list of vaccines is recommended for infants and toddlers as soon as they're old enough to handle them, so that they can be protected from these diseases for life.

### THE FIGHT AGAINST INTRINSIC DISEASES

#### What are intrinsic diseases?

Not all illnesses are caused by infections. Many fall into a category called **intrinsic** diseases. ("Intrinsic" means "from within" or "relating to a natural part.") Unlike infectious and transmissible diseases, which are caused by germs that enter the body from the outside, intrinsic diseases are problems that arise within the body. In other words, they are failures of the body's natural functions.

### THE ETHICS OF JENNER'S STUDY

On the surface, Edward Jenner's study may seem unethical. He deliberately inoculated a young boy with cowpox for the sake of a scientific experiment. He probably didn't ask the boy or his parents to sign any legal forms before he did it, either.

However, Jenner was more careful than some people realize. In the years before his experiment, he had taken detailed notes on the effects of cowpox on the villagers. He noted that nobody who had cowpox got smallpox later on, even if he or she had cowpox more than 25 years earlier. What's more, the villagers that Jenner studied routinely variolated themselves with actual smallpox, and young James Phipps was next in line. So vaccinating him with cowpox was no worse than exposing him to smallpox, and, in fact, it kept him from getting sick when he was exposed to the smallpox virus six weeks later.

If Jenner had done his study today, he would have had to clear many more legal and ethical hurdles before actually carrying it out. Still, it's fair to say that Jenner did his best to ensure the safety of his first subject under the circumstances.

*"Direct from the Cow!", 1877. A local inspector is endeavouring to establish whether the woman's son has been vaccinated. There were a number of serious*



*cholera epidemics in the mid-nineteenth century and, following Edwin Chadwick's report into public health, local health officials were appointed and a number of Public Health Acts were passed to reduce disease. The smallpox vaccine had been developed at the beginning of the century by Edward Jenner and it may be this that the inspector was referring to. From "Punch, or the London Charivari", March 24, 1877.*

## Your Health: The Science Inside

Some intrinsic conditions are **congenital**; in other words, you're born with them. Many congenital conditions come from your **genes** (the biological blueprint you inherit from your parents). Among these diseases are hemophilia (which keeps blood from clotting) and color blindness (an inability to distinguish between certain colors or even all colors).

Other congenital conditions have little or nothing to do with genes. Instead, they are caused by things that happen to a **fetus** (a developing baby) inside its mother's body. These things include an infection, an injury, and a problem in the way the mother's body works. **Cerebral palsy**, which makes a person have difficulty moving and speaking, can be caused by an injury or other complication during pregnancy or soon after birth. A fetus can also be harmed when its mother doesn't get the right nutrition, smokes, or consumes alcohol or drugs during her pregnancy. For example, **fetal alcohol syndrome (FAS)** is an all-too-common result of alcohol abuse during pregnancy. Symptoms in children with FAS range from hyperactivity and learning disabilities to serious mental retardation and physical deformities.

Taking illegal drugs can also have devastating effects on an unborn child, including severe mental and

physical disabilities and even death. Some of these babies are actually born addicted to the drugs their mothers took.

Even many prescription or over-the-counter drugs can seriously affect a developing fetus. A particularly horrific example was **thalidomide**, a kind of drug that doctors sometimes prescribed to pregnant women in the late 1950s. Children born to these women suffered from serious **birth defects**, including missing or deformed arms or legs. Today's drugs are well tested to find any possible effects on fetal development. That's why a pregnant woman should always check with her doctor before taking any kind of medication.

Other intrinsic diseases arise later in life. They might result from one or many factors, including your genes, your environment (for example, pollution can contribute to the breathing disorder **asthma**), your diet, or changes that happen inside your body. Cancer is a kind of intrinsic disease that may be caused by any or all of these factors. In cancer, certain cells in your body start to grow and divide out of control. Eventually, these cells form **malignant tumors**: clumps of unhealthy, fast-growing cells that interfere with your body's normal functions. The result is serious illness and, often,

death. (It is important to note that not all tumors are cancerous. Some tumors are slow growing and can be harmless.)

### Improvements in treatment

Today, intrinsic diseases remain a serious challenge to our health. But a lot of progress has been made in treating and controlling them. Many drugs can now counteract the effects of intrinsic diseases. For example, a combination of diet and lifestyle changes and safe, relatively cheap medications can control **high blood pressure**, a common and potentially life-threatening condition. The medications involved relax the arteries so that blood can flow more freely, prevent the arteries from tightening up in the first place, or slow the heart down. An example of a more dramatic medical treatment is **chemotherapy**, which uses powerful, toxic chemicals to kill tumor cells in cancer patients. Although chemotherapy is tough on the body and has many serious **side effects**, it has lengthened many patients' lives.

Surgery has also improved by leaps and bounds in the last century. Doctors have developed sophisticated surgical techniques that are increasingly safe and



*Chemotherapy uses powerful chemicals to kill tumor cells in cancer patients.*

effective. Surgeons today are able to transfer one part of the body to another (for example, an artery from the leg can replace a blocked or damaged artery near the heart), transplant organs (such as a kidney or a liver) from one person to another, and even implant artificial devices into the body (like **pacemakers**, which help regulate a person's heartbeat). All of these techniques have helped patients live longer and more active lives.

Still, even modern surgery still carries risks, and researchers are working hard to make those risks smaller and smaller. One way they're doing that is by making surgery less **invasive**—in other words, less damaging to the body. They can achieve this goal in part by improving their ability to pin-

## Your Health: The Science Inside

point and treat the exact location of the problem. For example, decades ago, most women diagnosed with breast cancer would have one or both breasts removed to keep the cancer from spreading. Today, most patients do just as well with a smaller operation that removes only the tumor and leaves the rest of the breast whole.

Besides narrowing the targets of their operations, surgeons are developing better ways to perform

the operations themselves. Rather than cutting a patient wide open, surgeons can now perform some kinds of operations (such as kidney transplants) by inserting small remote-controlled instruments through tiny slits in the body. This technique is called **microsurgery**, and it's one of the frontiers of modern medical technology. The smaller the instruments used in surgery, the less destructive the surgery is to the body.

### *SURGERY IN THE WOMB*

Thanks to techniques such as **ultrasound**, doctors can identify many congenital conditions and birth defects before a baby is born. And sometimes the conditions can be treated or corrected before birth as well. In **fetal surgery**, a doctor actually operates on a developing fetus while it is still in the mother's body. The first open operation on a fetus took place in 1981. Since then, fetal surgery has been used to correct a number of serious birth defects, including **bowel obstructions**, **spina bifida**, and even heart defects—and the list keeps growing.

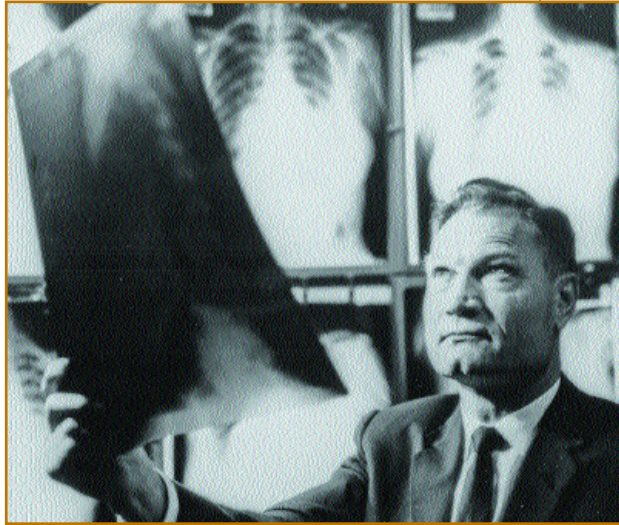


But fetal surgery is not to be taken lightly: It is still on the frontier of modern medicine, so it is risky for both the mother and the developing fetus. Only certain conditions can be treated with fetal surgery, and both the mother and the baby must not have any other health problems that could make the surgery especially dangerous. Fetal surgery requires special surgical facilities, and only some hospitals have the equipment and expertise to handle it. Fetal surgery is generally performed only when it offers much greater hope than any simpler alternative.

### Improvements in detection: Technology-based medicine

Humans are not just better at treating intrinsic diseases than we were in the past; we are also better at detecting them. For thousands of years, the only way to know if you were sick was by the symptoms that you had. Symptoms are changes in your body that you can see or feel, like a blister or a pain in the chest. Unfortunately, in many illnesses, by the time you have any symptoms, a great deal of damage has already been done. Cancer is a good example. A tumor can grow for years without causing any noticeable symptoms. Sometimes symptoms appear only after the cancer has spread throughout the body and brought the patient close to death. Better detection means that doctors are more likely to spot diseases before symptoms appear, or at least before they become serious. Usually, the earlier a disease is caught, the easier it is to treat.

Many recent technologies have contributed to early detection. One of the most significant is the use of **X-rays**, discovered by German physicist Wilhelm Röntgen in 1895 and first used in medicine two years later. X-rays allow doctors to see inside the body without opening it up. As a



*Doctors use X-rays to see inside a person's body without opening it up.*

result, they can diagnose everything from a fractured foot to a stomach tumor. X-rays are used by doctors all over the world.

Besides X-rays, doctors today have a number of **imaging systems** at their disposal. For example, **magnetic resonance imaging (MRI)** uses magnetic fields to take pictures of the body (often the brain); **positron emission tomography (PET)** tracks blood flow using mild radioactive particles injected into the bloodstream; and **laparoscopy** uses long, skinny tubes with tiny video cameras inserted into the body. All of these imaging systems have made it possible for doctors to check what's going on inside us. Imaging systems are just one category of tools that doctors use to



*Doctors can test a person's blood to see if they have certain diseases—everything from diabetes to malaria.*

detect illness. Others include laboratory tests of body fluids such as blood, saliva, and urine. Using sophisticated technologies, doctors can test for the presence of viruses or bacteria, as well as for chemical markers of diseases and levels of important nutrients and minerals, like iron. They can count the number of **white blood cells** in a blood sample to see if your

immune system is healthy. They can check your levels of **cholesterol** (a sticky chemical that the body needs for certain body functions, but that can clog arteries if there is too much of it) to help assess your risk for **heart disease**.

A **biopsy** is another example of a powerful modern diagnostic tool. In a biopsy, a doctor takes a small sample of body tissue—for example, a little piece of skin or a scraping of cells from the **cervix** during

a **Pap smear**—and checks it under a microscope for the presence of cancer cells.

Finally, modern hospitals and doctors' offices are equipped with many electronic monitors that measure normal body functions such as brain waves, heart rate, and breathing rate. These monitors are extremely accurate and can detect dangerous situations within seconds. They're especially important for people who are suffering from critical illnesses or recovering from surgery.

As for congenital conditions and problems in the womb, we are better equipped to detect and deal with those, too. First and foremost, scientists today have a much clearer understanding of what steps expectant mothers need to take to ensure the health of their babies, and this information is available to the public. Also, doctors can check the development of an unborn baby with a **sonogram**—a system that uses sound waves to peek inside the womb. If a genetic disease is a concern, they can perform a procedure called **amniocentesis**. In amniocentesis, the doctor takes a small sample of **amniotic fluid** (the fluid that surrounds a developing fetus) and tests it for signs of disease. Knowing about poten-

tial congenital problems before a child is born can help a mother and her doctor make decisions about the kind of medical care that her child will need.

The past few decades in particular have been significant for the field of **mental health**. Not long ago, common mental illnesses such as **anxiety** and **depression**, along with more serious mental conditions like **bipolar disorder** and schizophrenia, were not seen as true medical conditions. At best, they were generally thought of as personality problems, at worst as signs of demonic possession. People who had mental illnesses, but who still functioned in society, were left to fend for themselves, while those with more serious mental disorders were confined to **asylums**, where many were mistreated or neglected. Often, patients in asylums were forced to undergo drastic treatments, such as a **lobotomy** (an operation in which the nerves connecting the frontal lobes, or thinking areas, of the brain are disconnected from the rest of the brain). Lobotomies often reduced or relieved patients' mental symptoms, but also robbed them of their ability to think and reason. It's like cutting off your whole arm to relieve a pain in your wrist.

Today, our understanding of mental illness is much more sophisticated. Both the medical community and society in general have come to recognize mental illnesses as legitimate medical conditions. As a result, more and more patients are recognizing that they have a mental illness and are seeking effective treatment for it. Besides **psychotherapy** (a form of treatment based on talking with a trained counselor), a great variety of medications are available that can correct chemical imbalances in the brain and restore mental health. Among these medications are **selective serotonin reuptake inhibitors (SSRIs)**, a family of drugs used to treat anxiety and depression that includes the now-famous brand names Prozac, Zoloft, and Paxil. Other drugs, such as **lithium**, can be used to treat bipolar disorder or more serious illnesses. While these drugs are not free of side effects, they are far less invasive and dangerous than earlier drastic treatments. The overall effects of improvements in the nation's mental health include immeasurable increases in productivity and personal well-being, along with the prevention of suicide, which can sometimes result from untreated mental disorders.

### *IMPROVEMENTS IN GENERAL HEALTH*

Today's doctors not only know more than their predecessors about fighting diseases; they also know more about what we need to do to stay healthy and fit.

Now we have not only access to better **nutrition**, but also more understanding of the balance of foods that constitutes a healthy diet, than our ancestors did. In the past, many people were sickened or killed by deficiencies in certain nutrients or **vitamins**, because they didn't have enough of, or the right kinds of, food to eat.

Examples include the diseases scurvy, caused by a lack of vitamin C, and rickets, caused by a lack of vitamin D. In many parts of the world, these diseases still affect people. But in the developed world, most of us can get plenty of healthy food if we seek it out. This includes a great variety of fruits and vegetables, many of which were once available only in certain seasons or in small geographical areas.

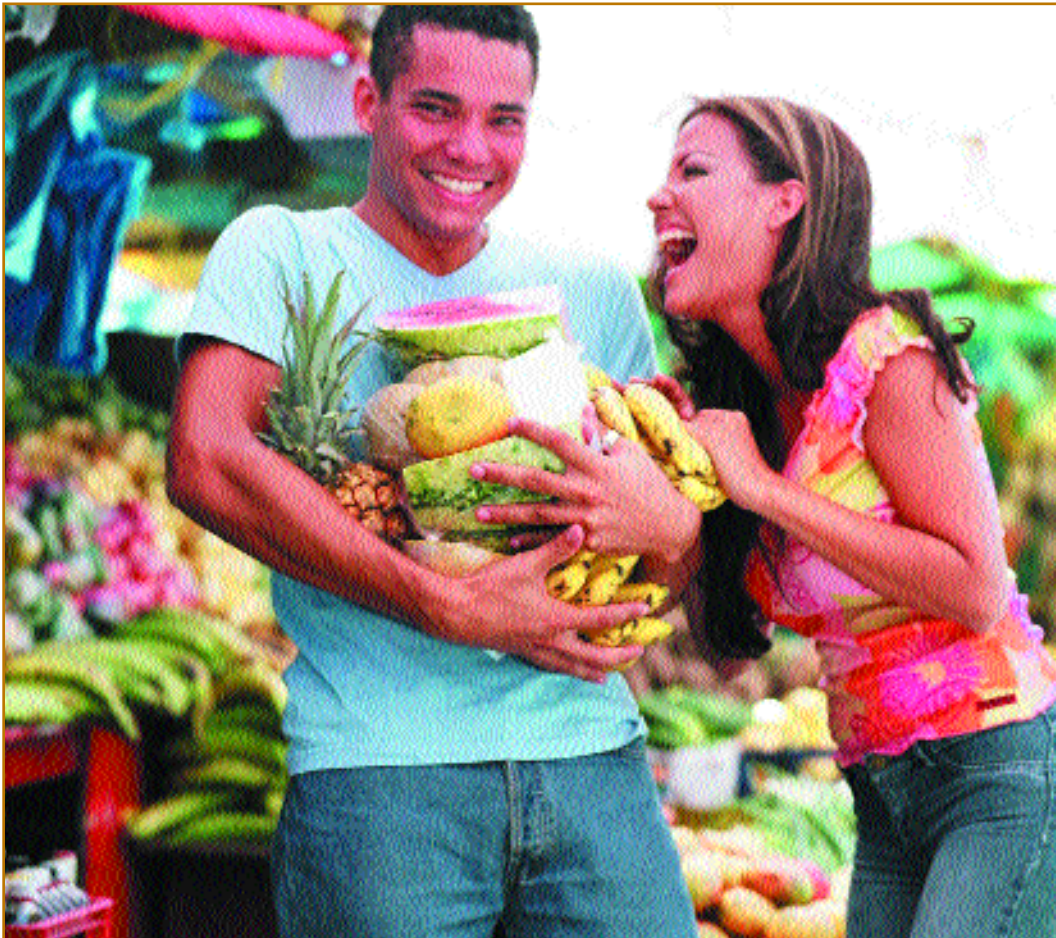
Much of the food we eat is now **fortified** with extra vitamins, minerals, and nutrients. Examples of common fortified foods include bread, breakfast cereals, milk, and fruit juices. Besides that, many of

## Part 2: So, What's Changed?

us take vitamin and mineral **supplements** to round out the nutrition that we need. Thanks to improvements in nutrition, people today are healthier, taller, and longer lived than the average 18th-century person.

Scientists today also have a better understanding of what it takes to stay healthy, including

what we need from our diet, the importance of exercise, and the dangers of things like air pollution, too much sun, or smoking. This information is widely available to the public, which means that we can take an active role in making the best possible choices for our health. Our knowledge is also growing and changing all the time, and the time between when



*Eating a well-balanced diet with lots of vegetables, fruits, and whole grains is a key factor in staying healthy and fit.*

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a scientist first discovers something and when the public can find out about it keeps getting shorter and shorter.

Many people today also have access to good **preventive care**, including regular checkups by a doctor, along with screening tests for many kinds of cancer and other diseases. When people have good preventive care, they find out about possible health problems early, before they get too serious. Usually, the sooner you discover a problem, the easier it is to treat.

Finally, many human beings today enjoy a far better **standard of living** than their ancestors did. Indoor heating, once dependent almost completely on fireplaces or coal-burning stoves, is now much safer and available almost everywhere in the industrialized world. Clean water is also available almost everywhere in the developed world. Better labor laws protect workers from accidents that could result in injury or death. Most machinery in the home and the workplace is also safer to use than the machines our grandparents grew up with.

In short, the industrialized world today is very different from the world of a thousand or even just a hundred years ago. We have advantages that our ancestors never even dreamed of—and we have more power than ever before to take our health into our own hands.

Why have the past few centuries, and the past 150 years in particular, been such a turning point for scientific and medical knowledge? There are many possible answers to this question. But perhaps one of the most significant factors was a shift in thinking that happened in science and medicine not too long ago. This shift did not happen overnight, and cannot be credited to any one person, but it was nonetheless a groundbreaking event in human history. It is the rise of the **scientific method**. Simply put, the scientific method planted the seeds for many of the changes that have shaped the world in the past few centuries—not only the changes in medicine, science, and technology, but also the changes in society, politics, government, and even religion.

# Part 3: The Role of Science-Based Medicine

## Folk remedies and early medicine

The study of medicine did not start with the scientific method. People have been curious about the human body, how it functions, and how to prevent and treat diseases since the dawn of civilization. After all, understanding our bodies and the diseases that threaten us gives us power over the world and over ourselves. Medical knowledge is not just an intellectual exercise: It's literally a matter of life and death.

Many ancient cultures practiced medicine and trained physicians long before they even developed written language. That kind of medicine is generally known today as **folk medicine** and usually involves treating illness-

es with herbs, plants, or natural remedies. Many traditions of folk medicine are spiritual and combine religious rituals with medical practice. The practitioners of folk medicine, known in some cultures as **shamans**, were like priests in some ways, like doctors in others.

Although folk medicine is closely tied to religious beliefs and cultural superstitions, many ancient folk remedies are actually effective. For example, some people (and animals) have been known to eat dirt when they feel sick to their stomachs. This might sound

*Shamans, who practiced folk medicine, treated patients with herbs, plants, and other natural remedies, as well as with religious rituals.*

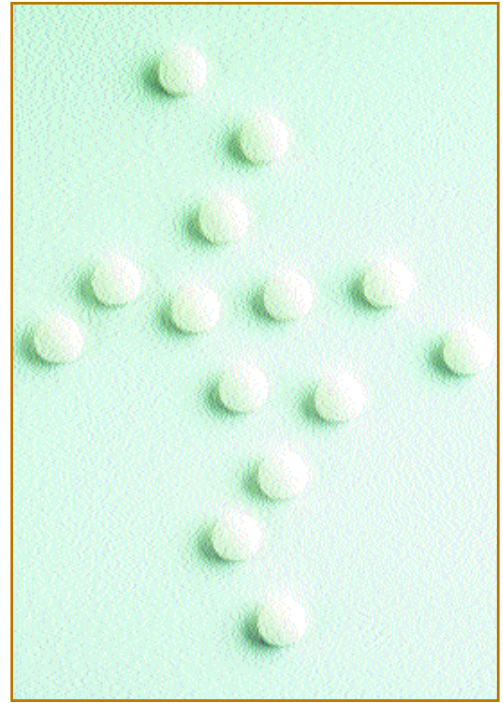


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like the last thing you'd want to do, but it turns out that some kinds of soil contain minerals, such as **kaolin** and **bismuth**, that really can relieve nausea. You have probably consumed one or both of them yourself: For a long time, kaolin was the active ingredient in the over-the-counter medicine Kaopectate, while bismuth is still a key component of Pepto-Bismol.

Another folk remedy involves chewing on the bark of a willow tree (or brewing a tea from the bark) to relieve pain or reduce fever. This was prescribed by the ancient Greek physician Hippocrates and practiced for centuries all over the world. Eventually, scientists isolated a key ingredient from willow bark called **acetylsalicylic acid**. In 1899, acetylsalicylic acid was put on the market as a prescription powder by a German company called Bayer. Later it became popular in tablet form. You know this product by its common name, **aspirin**.

The problem with folk remedies was not that they never worked; as you can see, sometimes they worked quite well. The problem was that the people who practiced it had no organized way of proving whether the treatment worked. Folk remedies were sometimes



*Aspirin originally came from an ingredient in willow bark.*

based on spiritual ideas and myths that had little to do with the way the body or medicines actually function. At best, they were supported by **anecdotal** evidence and general observations. “Anecdotal” means “based on a story”—a story that may be true, but isn’t strong enough on its own to support a scientific idea.

Here’s an example of anecdotal evidence in action: Imagine a village in ancient times. A young woman in the village gets a fever. She goes to the local shaman, or folk doctor, who gives her an herb

to relieve the fever. Her family also makes sure she gets plenty of rest, food, and water. Eventually, the woman's fever gets better and she is healthy again.

Does that mean that the herb cured the woman? Her family, friends, and the shaman might think so. But in reality, the rest, the food and water, or a combination of these might have helped more than the herb did. Or maybe her recovery had nothing to do with any of these things. Maybe she would have gotten better even if she took nothing and walked ten miles a day. Or perhaps it *was* the herb. But from this story alone, there's no way to tell. As you can see, anecdotal evidence might sometimes lead people to incorrect conclusions.

### The rise of logic and deductive reasoning

As far back as 4,000 years ago, medicine had become a serious intellectual discipline in some parts of the world. The ancient Egyptians, Babylonians, Chinese, and Greeks all established medical schools that were highly respected throughout their civilizations. Many key medical techniques were pio-

### HIPPOCRATES, THE FATHER OF MEDICINE

Hippocrates (c. 460 B.C.–c. 377 B.C.), an ancient Greek physician, is widely known as the “father of medicine.” Although he was far from the first person to practice medicine, he paved the way for modern medical science by emphasizing that knowledge should be based on observable facts. He also developed ethical guidelines for surgery and a code of conduct for doctors. Today's doctors make a pledge called the **Hippocratic oath**, which is based on Hippocrates's code.



### FOLK MEDICINE TODAY

Folk medicine is still practiced by many cultures around the world, including our own. (Your own family may have one or two “home remedies” for aches, pains, or sniffles.) And many modern scientists take it quite seriously. In fact, a branch of science called **ethnobotany** is devoted to studying the traditional uses of plants in cultures around the world. Some ethnobotanists are especially interested in the scientific properties of plants used in folk medicine.

Also known as “traditional” or “alternative” medicine, folk medicine has become a multibillion-dollar industry. More and more patients are using **herbal extracts** and **dietary supplements** to treat everything from headaches and colds to serious illnesses. Unfortunately, the problems that plagued folk medicine long ago still apply to many alternative therapies today: claims about their effectiveness are often based on anecdotal evidence or even on superstitious ideas that have no scientific support. And yet these products can still affect your body—perhaps in ways that you wouldn't

expect. That's why it's important to discuss with your doctor any herbal medicines you might be taking, just as you would with any other drug.

The fact that many traditional remedies haven't been tested scientifically is also the topic of a political debate. Some people think they should be studied more, but that the medical research community doesn't want to study them. They argue that medical research is heavily influenced and funded by big drug companies, which would lose money if the studies showed that folk remedies were just as effective as their drugs. They also point out that a number of conventional medicines, including the active ingredients in aspirin (found in the bark of the willow tree) and the heart drug **digoxin** (found in the purple foxglove plant), have their roots in folk medicine. In the wake of this criticism, a number of new scientific studies of traditional medicine have begun in the last few years.



*The heart drugs digoxin and digitalis come from the leaves of the foxglove plant.*

neered at these schools, including the dissection of human corpses to understand anatomy, the use of the pulse to diagnose physical fitness, and therapies such as **acupuncture**, a Chinese technique in which thin needles are inserted into specific points on the body.

The Greeks, whose culture greatly influenced Europe and America, were interested not only in knowledge itself, but also in the way knowledge was developed. Their ideas and styles of thinking provided the foundation for science and medicine in the Western world. One key idea was proposed almost 2,500 years ago by the Greek doctor Hippocrates. He suggested that all diseases are caused by nature, not by magic or other supernatural forces. Hippocrates probably wasn't the first person to think of this, but he helped the idea gain acceptance with the physicians of his time.

The idea that diseases have natural causes allowed doctors to separate medicine from superstition and myth, and freed them to make conclusions on the basis of what they saw, not just what they believed. This went a long way toward making medicine more fact-based and scientific.



*Acupuncture is an ancient Chinese technique in which thin needles are inserted into specific points on the body to help relieve pain and discomfort.*

It also probably removed some blame from the culture of illness. People who thought that diseases were caused by angry gods or evil spirits could easily conclude that a sick person did something to deserve his or her illness or that another person with supernatural powers caused it (through witchcraft or the evil eye). If, however, you accepted the idea that diseases have natural causes, it would be harder to blame the victim (although this sometimes happens even today).

Ancient Greek **philosophers**, while not physicians themselves, also strongly influenced the way scientists thought. Perhaps the most influential of these philosophers was Aristotle, who was very interested in **logic** and **rea-**

### ARISTOTLE, AN ORIGINAL MIND

Aristotle (384 B.C.–322 B.C.) was one of the most significant pioneers of Western thinking. The son of a physician, he studied philosophy for 20 years under Plato, another great thinker. After Plato's death, Aristotle traveled for several years and became the private tutor of a boy named Alexander, who later became Alexander the Great, the world conqueror. Eventually, Aristotle returned to Athens and founded his own school, the Lyceum.

Aristotle wrote and taught on practically every subject under the sun, including logic and reasoning, physics, mathematics, the stars and planets, the Earth, weather, the biology and history of animals, the human body, the nature of the mind and the soul, memory and dreaming, politics, poetry, drama, morals, and ethics.

Aristotle didn't get all of his facts right, but his styles of thinking laid the foundation for many aspects of science and medicine. For example, unlike most philosophers who came before him, Aristotle believed that we could and should use our senses, rather than just our minds, to discover facts about the world. Modern scientific experiments are still based on this principle. Aristotle himself put it into practice by dissecting plants and animals and examining their parts. By doing this, he was able to make educated guesses about the functions of organs and categorize living things into groups called **species**, a term that is still used today.



**soning.** He developed sophisticated rules for using logic to solve problems and gain knowledge. He wrote down his ideas and taught them in prestigious academies. Many of Aristotle's rules of logic are still taught today. You probably follow some of them yourself without even knowing it.

In his teachings, Aristotle mainly emphasized one kind of reasoning, called **deductive reasoning**. In deductive reasoning, you start with general ideas and then draw specific conclusions. For example, if you know that your brother is a man, and that men cannot have babies, then you can *deduce* that your brother cannot have babies. You can also deduce that other things that are true of men will be true of your brother as well: that he will grow a beard, that his voice will change in adolescence, and so on.

As you can see, deductive reasoning is a useful tool. Scientists today use deductive reasoning all the time. But it has its limitations. For example, deductive reasoning works only if you start from an idea that is **universally** true (or at least true in all cases that are relevant to your problem). Unfortunately, Aristotle believed many things to be true that were not true at all. For

example, he believed that men had more teeth than women do. (They don't.) He also believed that the Earth was the center of the universe and that it did not move, and he deduced all sorts of ideas about astronomy from those principles. Today we know that the Earth is *not* the center of the universe and that it is in constant motion—so some of Aristotle's conclusions turned out to be wrong.

Aristotle drew many other faulty conclusions over the course of his career, because he deduced them from beliefs about how he thought the world *ought* to be, rather than on proven facts about the way it really *is*. Nevertheless, his ideas and styles of thinking reigned in the Western world for nearly two thousand years. It would take another major shift in thought before medicine could take its next leap forward.

### Inductive reasoning and the scientific method

In the 16th and 17th centuries, another style of thought began to replace some of Aristotle's techniques. We call it **inductive reasoning**. It's basically the opposite of deductive reasoning.

Instead of starting from a general idea and deducing specific conclusions, inductive reasoning begins with specific observations and uses them to build general ideas about the way the world works.

Here's an example of inductive reasoning from everyday life: Suppose you bought a new pair of rubber boots. The first few times you wear them, your feet stay perfectly dry. But one day, you go for a long walk in the rain, and your left foot ends up soggy. The next time you wear the boots, the same thing happens. Eventually, you would decide that your left boot must have a hole in it somewhere. You would probably draw this conclusion even if you hadn't seen the hole, because the new *evidence* (your soggy foot) changed your general *belief* about the boots (that they were in good shape).

Human beings have used inductive reasoning for as long as we have been able to think. But believe it or not, applying inductive reasoning to science and medicine was revolutionary. The rise of inductive reasoning defied the very deep, ancient belief that certain things were absolutely true and that those truths could be discovered through casual

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observation, pure reasoning, or just plain “common sense.”

Instead, it said that *nothing* could be “known” unless it was supported by carefully collected evidence—and even then, the knowledge could be overturned if new evidence contradicted it. Inductive reasoning suggested that many things in the world were not what they seemed to be or did not work as they seemed to work. In a very real sense, inductive reasoning took thousands of years’ worth of “scientific” beliefs and made them all just disappear.

By the 17th century, inductive reasoning was becoming a powerful force in science and philosophy. From the principles pioneered by Copernicus and Galileo and developed further by the philosophers Francis Bacon and René Descartes came a set of guidelines that we know today as the scientific method.

The scientific method laid out a basic procedure for using inductive reasoning to learn about the world. No one person invented the scientific method, and there’s no document sitting in a museum that says exactly what it is. But if you ask a scientist what the scientific method is, you’ll probably hear something like this:

1. Ask a *question*. (This may come

from your own curiosity or from something you have seen.)

2. Make *observations* relating to the question.
3. Form a ***hypothesis*** (an educated guess) or two that might answer the question. *Deduce* what we should expect to observe *if* one of these hypotheses is true.
4. Test each hypothesis with careful, controlled *experiments*.
5. If the experiments contradict a hypothesis, reject it or modify it. Go back to step 4.
6. If the experiments support a hypothesis, test it again, under different conditions if possible.
7. If a hypothesis is supported by many different experiments, develop a ***theory***. A theory is an answer to a scientific question. A theory is stronger than a hypothesis because it is supported by more evidence.
8. Define the limits of the theory. In other words, determine when the theory does and does not apply. Most scientific theories apply only to certain situations.

Many theories have lots of evidence to support them, dating back for decades or centuries. Yet scientists must be willing to

let go of any theory, no matter how widely accepted, if powerful evidence against it comes to light. However, this doesn't mean that a strong theory can be overturned by any old experiment. The stronger the evidence is behind a theory, the more convincing the evidence against it must be in order to change or disprove it.

Sometimes a scientific mystery is explained by several competing theories, each with its own body of evidence behind it. Good scientists may disagree about which theory best explains all the observable facts. It may take decades or even centuries for one theory to rise to the top, and usually even the "winning" theory will be changed many times along the way.

Guided by the scientific method, researchers have challenged old assumptions and misconceptions, tested new ideas, and gained far more confidence in their knowledge of the natural world, including the human body.



### Medical research and clinical trials

How is the scientific method used in medicine? For one thing, it is used to guide medical research. Much of what we know about medicine is learned outside of clinics and hospitals. It's learned in laboratories, where scientists study the functions of our cells, tissues, and organs. They also learn about bacteria, viruses, and other causes of disease. They test potential treatments for illnesses **in vitro** (literally, "in glass," meaning test tubes and petri dishes) and in laboratory animals before trying them out on human subjects.

Two main categories of research are **basic** and **applied research**. Basic medical research focuses on learning more about the body, dis-

*Scientists and researchers use the scientific method every day to test new ideas and to gain knowledge.*

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eases, the causes of disease, and how all these things normally work. Basic research might include a study of white blood cells and how they help us fight off germs. It might also include research into the **genetic** makeup of a deadly virus. Some kinds of human studies would also fall under the cate-

gory of basic research—for example, a study that compared blood pressure rates in two different ethnic groups just to see if there were any differences between them.

Although basic research does not directly cure diseases or produce new medicines, the knowledge

### *ANIMAL RESEARCH*

Many medical experiments are tried in animals before being tested in humans. One reason for this approach is human safety: New, untested medical procedures could have severe side effects and might even be deadly. Rather than risk these new procedures on a human patient, doctors are required to test them extensively on laboratory animals first.

Another reason is that many animals are genetically similar to humans, but simpler to study. They can be raised from birth in the laboratory under identical conditions, which means that it's easier to compare them in experiments. It's also easier to control their behavior, their food, and how they live. By contrast, differences in lifestyle, personality, diet, exercise, and even social status can affect how humans respond to a medical treatment.

Mice and rats are perhaps the most commonly used animals in medical experiments, but researchers have also used larger animals, such as sheep, dogs, and monkeys. Although researchers may take more risks with animals than they can with humans, they are still required to follow ethical guidelines in any experiments involving animals. The guidelines cover how the animals are raised, what they are fed, what steps must be taken to ensure that they are as comfortable as possible, and even how they must be euthanized (humanely killed) if necessary.



The standards for using animals are different in different situations. For example, it is generally acceptable to deliberately expose animals to a disease in order to study a potentially lifesaving drug, but it would be less acceptable to do so as part of a classroom demonstration.

Some people (and organizations) believe that animals should not be used in experiments at all. They argue that it is not acceptable to cause harm or pain to animals through experimentation, even if there are potential benefits to human health or human life. On the other hand, most scientists insist that the progress of science and medicine would be greatly slowed if we eliminated animal experiments and that humans participating in experiments would be at greater risk.

gained from basic research is essential for more targeted experiments. When scientists conduct experiments with an eye toward solving a specific practical problem, they are performing applied research. An example of applied research is a laboratory test to see if a chemical from the bodies of sharks can shrink tumors. (This research has actually been done!)

Often, medical research is conducted on other life-forms, including monkeys, rats, mice, leeches, fruit flies, and even bacteria. That's because living things share many basic functions, and it's much easier to study simpler life-forms than humans. There are several reasons for this: The simpler forms' bodies are less complicated, so it's easier to look at certain processes; their life spans are shorter, so it's possible to study several generations in a few years or even weeks; and they can be raised from birth under identical conditions, which makes it easier to compare them. Finally, although experiments involving animals must follow ethical guidelines, the standards are not as strict as they must be for experiments on human subjects.

Of course, medical research sometimes requires human subjects. Studies that test new drugs or

medical treatments on human beings are called **clinical trials**. Clinical trials are a specific kind of applied research, and they are governed by strict procedures and ethical standards. By the time a drug or treatment even begins clinical trials, it has been tested extensively in laboratory and animal studies and shown to be promising and reasonably safe.

The goal of a clinical trial is to determine whether a new drug or treatment is both safe and effective. Clinical trials are divided into four **phases**, each of which involves a new set of experiments. A new drug or treatment must perform well in each set of tests in order to move on to the next phase.

The purpose of a phase I trial is to test the treatment's basic safety, to observe possible side effects, and to figure out the ideal drug dosage or method of treatment. Because this is the first time the drug or treatment is given to humans, the number of subjects in a phase I trial is small (usually less than 100). Subjects are closely monitored for any possible reactions, and the first doses are kept very low to minimize the risk to the volunteers. If no serious problems appear, the dose may be increased. If the phase I studies continue to demonstrate

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safety at higher doses, the trial may proceed to phase II.

Phase II involves more subjects, perhaps a couple of hundred. Again, the safety of the treatment is evaluated, this time across a greater number of subjects and in closer detail. The researchers also start to collect data on how well the treatment works. By phase II, subjects are randomly assigned either to an **experimental** or a **control** group. The experimental group receives the new treatment, while the control group receives either a **placebo** (a pretend treatment, like a sugar pill or an injection of plain saline solution) or another drug or treatment that has already been approved. This way, the researchers can accurately compare the effects of the new treatment with either an existing treatment or nothing at all.

If possible, the subjects are not told which group they were assigned to. Even the researchers themselves may not know this until after the experiment is over. When neither the patient nor the researcher knows which treatment is being used, the experiment is called **double blind**. Double-blind experiments separate the effects of just *knowing* you got the new treatment from the effects of the treatment itself. For example, if you knew that you were getting

the new treatment instead of an old one, you might become more optimistic, and this in itself could improve your health. Or maybe you would be scared, and that would make your health worse. Either way, the researchers could not be 100 percent sure that the treatment itself was responsible for how you were feeling. A double-blind study also prevents researchers from acting differently around patients who are getting the new treatment, a behavior that could also affect the results.

In phase III, the treatment is studied yet again, this time in a much larger group that might include thousands of subjects. Phase III trials are meant to confirm the results of promising phase I and II studies and to look for subtle or rare complications that can be noticed only in larger groups of people. During phase III, the method of treatment is refined further, so that future doctors will know how to adjust the dosage for specific patients or whether to recommend or avoid the treatment in certain situations.

If the treatment succeeds again in phase III trials, then and only then may it be made available to the general public. By this point, the treatment will usually have several years of testing behind it.

### THE PLACEBO EFFECT

Have you ever been sick, taken medicine, and felt better as soon as you took it? Chances are, the medicine wasn't able to work instantly. But just knowing that you were taking it may have made you feel better.

This is known in medicine as the **placebo effect**. A placebo is a sham treatment or fake medication, like a sugar pill. It has been shown that, in many cases, the mere act of treating a patient, whether through medicine, physical treatments, or surgery, can improve the patient's health and well-being. The patient not only may feel better, but may actually get better, too. Placebos can affect everything from minor aches and pains to serious illnesses.

When you read about a drug's effectiveness or side effects, you often hear them compared with a placebo. In studies of new drugs and treatments, it is common for one group of subjects to receive the new drug and another to receive a placebo. The placebo is designed to look, taste, smell, or feel just like the real treatment. It is delivered in the exact same way. In order to be considered effective, a new treatment must not only make patients feel better; it must be significantly more effective than a placebo. Similarly, side effects of drugs are often compared with those (if any) of placebos to show how much of the side effect is really caused by the treatment itself, rather than just the idea of getting the treatment.

The placebo effect is still mysterious, but it's important to remember that it's not "all in your head." Our bodies seem to respond to cues from our mind and the world around us, and they react in very real ways to what we think, feel, see, hear, and believe.





Researchers test new medicines and treatments very carefully and over many years before they are allowed to use them on the general public. Here a doctor works on a smallpox vaccine.

After that, studies may continue into phase IV, in which the treatment's effectiveness and side effects are monitored over many years, across large populations. If, at some point, the treatment appears to be unsafe in certain situations, in certain types of people, or over long periods, the treatment may be modified, restricted, or taken off the market entirely.

### Protecting patients in clinical trials

Obviously, participating in a clinical trial involves some degree of risk. The risk cannot be eliminated entirely—even taking well-studied medications involves a risk—but

the medical community has developed several practices that are designed to protect the participants in clinical trials as much as possible.

One of these practices is **informed consent**. In the United States and many other countries, no one may participate in a clinical trial unless he or she is informed about it *in writing*. This means that doctors cannot give people experimental treatments without their knowledge or without informing them that they are participating in an experiment. The doctors must also provide as much detail as possible about the methods they will use, how long the study will last, and any risks and side effects the experimental treatment might have. The volunteers must sign documents stating that they received and understand all the relevant information.

Informed consent does *not* allow volunteers to know ahead of time whether they will be assigned to an experimental or control group. However, volunteers do have the right to find out which treatment they received after their part of the study is over.

Other guidelines protect volunteers from problems that might arise during the experiment.

Volunteers almost always receive all medical care relating to the study for free. This includes anything that might be required to counteract the side effects of the treatment. If a volunteer's health becomes seriously threatened because the experimental treatment is either dangerous or ineffective, the researchers must stop the experiment and switch the affected person over to an established treatment. If a patient's life is in danger, and the danger can be removed by a known treatment, doctors cannot substitute an experimental treatment just for the sake of a study. If, however, a new treatment

proves to be far superior to existing treatments during the course of a study, the experiment may be stopped so that all the patients can be switched over to the new treatment.

To make sure these standards are met, every clinical trial is supervised by an **institutional review board (IRB)**. This is a council of doctors, nurses, social workers, ethical experts, and other consultants, hired by whatever institution is running the study (usually a hospital, clinic, university, research center, or government agency). The researchers who are conducting

the study report regularly to the IRB and keep its members informed about the methods used in the study, the progress of the experiment, the number of volunteers involved, and any problems that arise during the study. The researchers also provide statistical information about



*Doctors cannot give people test drugs or treatments without telling them in writing that they are taking part in an experiment or without getting their written consent.*

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the volunteers. On the basis of the reports and the statistical information, the IRB continues an existing study, advances a study to

the next phase, or stops a study at any time. The IRB also has the authority to approve or reject a new study.



*In 1997, President Bill Clinton apologized on behalf of the U.S. government to the survivors of the Tuskegee Experiment, a group of African-American men and their loved ones who were denied syphilis diagnoses for 40 years and for whom treatment was not provided. Herman Shaw, 94, was one of those men.*

### *TUSKEGEE AND THE INFORMED-CONSENT RULE*

One of the most important pillars of the code of medical ethics is informed consent, the idea that all participants in a study are told that they are participating in an it, that they choose to do so willingly, and that all risks of participation are fully explained. No one can participate in a clinical trial today without signing an informed-consent form.

The informed-consent rule has been shaped by a number of historical incidents, including an infamous 40-year study that began in Tuskegee, Alabama, in 1932. The U.S. Public Health Service wanted to study the effects of the sexually transmitted disease **syphilis** in black Americans. In a nutshell, the agency wanted to see what happened to people when syphilis was left untreated. They hoped to use the study to justify treatment programs aimed specifically at black populations. So, at a time when there was already an effective treatment available, they began tracking 399 poor, mostly illiterate African-American men who had the disease and who were never given treatment during the course of the study.

The first unethical aspect of this study is that the researchers did not ask their subjects' permission. Although the men involved received free medical care, meals, and burial insurance, none of them were told that they were part of a medical study or what the real purpose of the study was. In fact, many of them did not even know that they had syphilis! Because they did not understand what was causing their symptoms, and because the doctors deliberately withheld that information from them, the men were unable to take important steps to protect their own health and the health of their loved ones.

Although there was no reliable cure for syphilis when the study began, by the 1950s a cure was available: the antibiotic penicillin. Even though penicillin was inexpensive and effective, it was not given to the men in the Tuskegee study. The researchers felt that it was more important to let their disease progress so that they could study its effects. Government reviewers upheld this opinion, and the study continued for 20 more years. It

ended only when its details were leaked to the news media, which embarrassed the U.S. government. By that time, as many as 100 of the men in the study had died of syphilis, some of whom might have been saved if they had been given proper treatment.

Today, the Tuskegee study is held up as an example of medical ethics at its worst. Its subjects were not given the chance for informed consent, were placed at an unnecessary risk, and were denied treatment when an effective treatment was available.

The Tuskegee study is also considered unethical because it placed an undue burden of risk on a specific population. In other words, although the knowledge gained from the study would benefit everybody, only this small group of African-American men was put at risk. A wealthy white person from the same area who contracted syphilis was in no danger of being enrolled in the study and, as a result, denied treatment. The study therefore not only harmed the lives of those who unknowingly participated, but also dealt a blow to the integrity of the U.S. government and deepened the national resentment caused by institutionalized racism. It also damaged public attitudes toward human medical experiments, particularly among ethnic minorities. Many people have been unwilling to participate in later studies as a result of the Tuskegee scandal.

In 1974, the U.S. government passed a law called the National Research Act that was designed to prevent the ethical failures of the Tuskegee study from occurring again. The law established the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, which would create basic standards of conduct for researchers using human subjects and suggest ways to make sure that those standards were followed. Other laws were also passed that required all researchers using human subjects for studies conducted under the then Department of Health, Education, and Welfare to get the written informed consent of their participants.



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# Part 4: Twenty-First Century Health Challenges

As we move into the 21st century, we still have many health challenges to face. Some, such as cancer, are old problems that we have never completely solved. Others, like high blood pressure, heart disease, and diabetes, have become more common because of our modern lifestyle, while still others, such as Alzheimer's disease, have become more visible because people today are living longer. Finally, some problems, including SARS, antibiotic-resistant germs, and anthrax attacks, are fairly new, the result of either the ongoing evolution of dangerous germs or the destructive side of scientific research.

## Our aging population

In the year 1900, only about 4% of the people in the United States were over 65 years old. In the year 2000, that figure was up to nearly 13%. By the year 2030, it is estimated that more than 20%

of the U.S. population will be over the age of 65.

The increase in the nation's elderly population is a good sign that our overall health is improving. However, now that more and more people are living to old age, age-related diseases that our



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ancestors rarely lived to see are also more common. One of the most devastating is Alzheimer's disease, in which the nerve cells in the brain clump into tangled, knotty **plaques** that interfere with memory, thought, and ultimately, even movement. The risk of developing Alzheimer's disease increases dramatically between the ages of 50 and 80. About 4.5 million Americans had Alzheimer's disease in the year 2000. By 2050, that number is expected to be somewhere between 11 and 16 million.

Beyond specific diseases that are associated with aging, older people tend to need more frequent and expensive medical care than younger people do. When people get very old, they may become physically weak and need assistance with their day-to-day living. Over the next few decades, the average age of the population will get older, since the birthrate has leveled off and will probably remain steady in the years to come. As this happens, we will certainly face serious challenges in caring for the needs of our growing elderly population.



*Eating fried, fatty foods in jumbo portions puts you at risk for obesity.*

### Our unhealthy lifestyle

In many ways, life today is much healthier than it was in the past. But for too many modern Americans, the advantages of medical technology are outweighed by unhealthy habits that are all too common in our society.

One of the biggest problems lies in our modern diet. For tens of thousands of years, our human ancestors lived in conditions where food was scarce and precious. So our bodies have evolved to extract as much energy as possible from the food we eat, to burn only what's needed, and to store the leftovers as fat to protect us from starvation.

Over the past century, however, food has become astonishingly plentiful. Unfortunately, now our problem is not a *lack* of food, but *too much* food, or too much of the wrong kind of food.

Americans today are eating more than ever before. In restaurants and at home, our portion sizes (the amount of food we eat at one sitting) have gotten larger and larger over the past few decades. For example, in many fast-food restaurants, what was called a large order of French

fries 30 years ago is the smallest size available today. A typical bagel has grown to about twice its original size and is smeared with nearly a whole package's worth of cream cheese. All-you-can-eat buffets and huge servings at popular restaurant chains have trained us to believe that when it comes to food, more is always better. (Think of how many times words like "extra-large," "jumbo," "king-size," and "supersize" pop up on menus and food packages and in advertisements.) Unfortunately, more food also has more calories—and calories add up fast: If you tack on just 150 calories to each of your meals (that's about the number of calories in a 12-ounce can of soda or half a candy bar), you'll take in over 164,000 extra calories per year. That's enough to put on 47 pounds of fat!

We're not only eating more than before—we're also eating worse. Many popular foods today are highly processed, full of unhealthy **saturated** and **trans fats**, refined sugars and flours, excess **sodium**, and countless additives and preservatives. Fast foods and pre-packaged supermarket foods are the biggest culprits. These foods are also typically low in vitamins, nutrients, **antioxidants**, and

**dietary fiber**—all of which improve health and fight against cancer and heart disease. Too many Americans rely far too heavily on these products and not enough on fresh, whole foods such as fruits, vegetables, beans, nuts, fish, and lean meats.

All these poor and excessive food choices have consequences, including rampant **obesity**. “Obese” means “extremely overweight.” In 2001, more than 20% of Americans were obese—nearly twice the rate from just a decade earlier. Obesity is dangerous because it leads to poor circulation, heart disease, high blood pressure, diabetes, heat exhaustion, and a lot of other problems. It is estimated that as many as 300,000 deaths per year in the U.S. are related to obesity. A recent report by the Centers for Disease Control said that obesity is ready to overtake tobacco as America’s leading cause of preventable death.

Apart from playing a role in obesity, a poor diet can affect us in other ways. Diets that are high in unhealthy fat and low in fiber, essential nutrients, and antioxidants have been linked to several kinds of cancer. Poor dietary choices can also cause bad forms of cholesterol to build up in your arteries, increasing your blood pressure and eventually leading to a heart

attack. Improper nutrition can lower your body’s natural defenses against disease and make you feel sluggish and weak. It’s hard to believe, but many Americans are both obese and undernourished at the same time!

Besides taking more calories in, we’re burning fewer calories off than ever before. Over a century ago, your great-great-grandparents expended lots of energy every day, by lifting heavy loads, working in fields or in factories, building and fixing things with their hands, and walking almost everywhere they needed to go. Even housework used to be a vigorous workout. It was a hard life, but all that challenging physical activity helped to keep their bodies fit.

Nowadays, many of us can get through a whole day scarcely lifting a finger. We wake up and get right into a car, bus, or subway that takes us to work. We might spend the entire working day behind a desk or a counter, moving only a few steps at a time. People who work in factories or in the home have many kinds of machines that do the hardest work for them. At night, we can order a pizza delivered to our front door and eat it while watching TV—using a remote control so we don’t even have to get up to change the channel!



*Getting more exercise helps to burn calories and lose weight. It is particularly important for people who are at risk for certain diseases, like diabetes, to get their weight under control.*

As you can see, our modern lifestyle is very convenient, but it's cut way down on the amount of exercise we normally get in a day. In order to burn calories and stay physically fit, most of us need to go out of our way to exercise, whether it's by walking, jogging, swimming, playing a sport, riding a bike, or going to a gym. Unfortunately, many people don't exercise at all. If you're one of them, you're not alone. Maybe your job or your family leaves you with little or no free time.

Maybe your neighborhood isn't safe. Maybe you don't feel energetic enough to exercise. Maybe you've thought about it, but just haven't made it a priority. Maybe you're overwhelmed and you don't know where to start.

The good news about lifestyle-related health problems is that people have a great deal of control over them. It takes discipline, willpower, and some background research, but anyone can improve his or her diet, get more

exercise, and benefit from the results. The changes might be very simple. For example, if you live or work in a building with an elevator, you might start taking the stairs every day instead. You could walk, rather than drive or ride, to run nearby errands. You could do exercises in your apartment while you watch TV. You could save up to a thousand calories a week by swapping carrots or celery for french fries at lunchtime.

For those who are seriously overweight or who might have trouble sticking to a fitness plan, many support groups and weight-loss or nutrition programs are available to help. If you think you need to find one, ask your doctor for recommendations. Even finding a friend to diet and exercise with can make a big difference. In extreme cases, there are medical treatments, ranging from prescription drugs to surgery, that can help combat obesity and overeating.

### New challenges from infectious diseases

Although a number of diseases that afflicted our ancestors (such as polio, **scarlet fever**, and **bubonic plague**) are practically unheard of now, today's humans

are facing new germs and illnesses, or tougher versions of old ones, that are every bit as challenging to us as these older killers were to our great-grandparents.

Because bacteria and viruses have such short life spans, they can **evolve** and **adapt** much faster than humans or animals can. Every year, new bacteria and viruses emerge just by chance. If they're hardy enough, these new germs can begin to spread in nature. Eventually, they can find their way into the human population and cause new illnesses that doctors don't know how to treat.

One of the most famous examples of a new, deadly virus is the human immunodeficiency virus (HIV), which causes acquired immune deficiency syndrome (AIDS). HIV and AIDS were not diagnosed until the early 1980s, although scientists now know the virus had been around for many decades in Africa. When the first reports of AIDS appeared in Western medical journals, doctors had no clue that it represented the beginning of an **epidemic** that would soon touch every corner of the globe.

As of December 2001, more than 800,000 cases of AIDS had been reported in the United States, and over half of these patients had



*A pharmacist fills a prescription for AZT, a drug used in the treatment of AIDS.*

died. In the early days of the AIDS epidemic, nearly all the patients died quickly. Today, the outlook is not quite so grim. Treatments are available that have kept some patients in reasonably good health for 15 years or longer. However, these treatments are very expensive and complicated to follow, and many people, from low-income Americans to people in developing countries, do not have easy access to either the drugs or the doctors who can help treat them.

There is still no cure for AIDS or effective vaccine for HIV, although doctors have been working on both for more than 20 years. HIV is tricky, because it attacks the body's immune system—the very system that vaccines normally use to help fight off a virus. HIV also has **mutated** several times since it was first discovered, creating several different subtypes of the virus,

each of which requires a somewhat different strategy to fight. Because of factors such as these, it is likely that HIV will continue to be a strong enemy in the decades to come.

AIDS is certainly the most famous and far-reaching of the newer diseases, but there are many others. One is **bovine spongiform encephalopathy (BSE)**, also known as mad cow disease. This brain-wasting disease, which was found mainly in British cattle in the 1980s and 1990s, has been linked to a simi-

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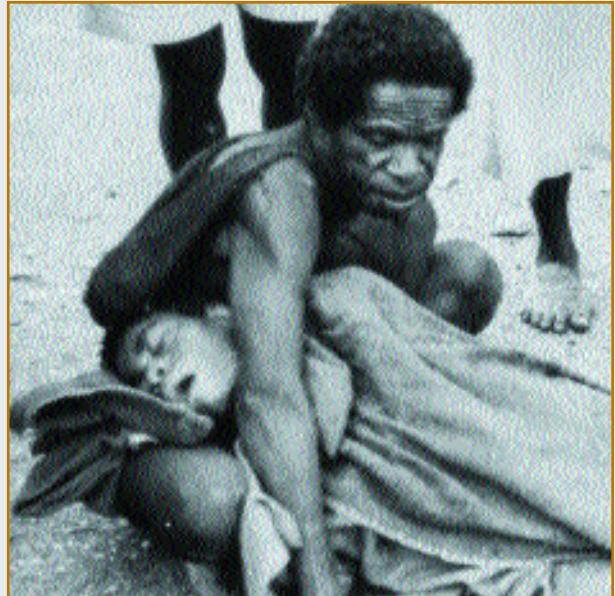
lar human disease called **variant Creutzfeldt-Jakob disease**, or v-CJD. Both diseases are caused by mysterious molecules called **prions**, which are infectious forms of **protein**. For reasons that scientists do not fully understand, prions seem to trick the body's normal proteins into folding up into

useless knots. As of this writing, only a handful of people have died of v-CJD, but the disease is 100% fatal in those diagnosed with it. Scientists worry that many other people may have been exposed to the illness through contaminated meat, but will not show symptoms for years or even decades.

### *KURU, OR LAUGHING SICKNESS*

Another disease caused by prions is **kuru**, also known as laughing death. Kuru is a very rare disease that flared up among the Fore people of New Guinea in the 1950s. The symptoms began with a shivering that sometimes resembled laughing. Eventually, the victim was left unable to walk, talk, or even eat.

For a while, people thought kuru was a genetic disease. But medical researcher Carleton Gajusek, who had spent time among the Fore, believed that it was spread from one person to another by eating—not by dirty dishes, but by one person actually eating another.



Cannibalism was a ritual among the Fore people at the time. They didn't hunt each other for food, but when someone died, his or her relatives would butcher the body and eat parts of it. (Believe it or not, this was an honor.) When a person died of kuru, all the prions that infected his or her brain were passed on to those who ate the brain.

Because kuru has a long **incubation period**—usually, many years—the Fore people did not connect the disease to the ritual cannibalism. Gajusek believed that the disease was caused by a slow-acting virus. Later, researchers found that the cause was not a virus at all, but a prion. When the connection was proven, the ritual cannibalism fell out of practice. Today, kuru is very rare again, thanks to this knowledge and a different funeral menu.

As this book was being written, a brand-new infectious disease called **severe acute respiratory syndrome (SARS)** was causing scares around the world. First identified in China, the disease appears to be caused by a previously unrecognized virus. Doctors began work on a vaccine almost immediately, but at best it may be a year or two before one is available to the general public.

We are also facing new challenges from old foes. A number of germs that have been successfully fought with antibiotics have fought back—by mutating into new, **antibiotic-resistant** strains. Here's how it happens: Usually, when an infected person is treated with antibiotics, the disease-causing bacteria are killed. But once in a while, a few bacteria might survive because they happen to have genes that help them resist that particular antibiotic. (This situation is more likely if the patient stops taking the antibiotics too early, before all of the bacteria are destroyed.) If the surviving bacteria reproduce, their offspring will probably be resistant, too. Eventually, nearly all of the bacteria floating around will be of this new, resistant type—and doctors will need to find new antibiotics to fight them.

Antibiotic resistance is a big problem today. It affects diseases such as **pneumonia** and tuberculosis. Because of resistance, many older antibiotics, like penicillin, no longer work against most of the germs that cause certain illnesses. The problem of resistance has been accelerated because doctors in the past were so impressed by antibiotics that many prescribed them even when they weren't necessary. Today, doctors try to be more selective in giving out antibiotics, because they know that every time they use them, they nudge along the evolution of resistant germs.

The human population is also jeopardized by something that would have been unimaginable not too long ago: human-manipulated diseases. Many germs, such as anthrax (a deadly spore found in certain types of soil), can be made into powerful weapons. (Powdered anthrax was used in the terror attacks operated through the U.S. mail in the fall of 2001.)

A great number of countries, including the United States, ran government-sponsored germ warfare programs at one time or another. Although many of these programs have been discontinued, there are fears that some of

their products have slipped through security and into the hands of terrorists. Smallpox was virtually eliminated from nature after an aggressive, worldwide vaccination effort in the mid-20th century. Unfortunately, it has returned to haunt us as a potentially devastating human-made plague after samples of the virus, once held in scientific labs, were reported missing. It is ironic that the advances in knowledge and technology that have saved us from many diseases also threaten to inflict old diseases upon us in the coming years.

*Smallpox and other diseases that can be manipulated by humans are a threat to the world in the hands of terrorists.*



### The unequal impact of disease

Aside from these obstacles, there is another growing challenge facing America and the rest of the world: how to make sure that everyone has equal access to all the medical advantages available today.

Right now, there are big differences between the lives of those who have great access to top-quality health care and those who don't. This situation is generally referred to as a **health gap**. Health gaps exist between many different groups. For example, people who live far from major cities are more likely to die from injuries than people who live in large metropolitan areas. They also have higher rates of cancer and heart disease and are less likely to follow preventive health routines such as exercise programs.

Within a metropolitan area, people in poorer neighborhoods generally have more health problems than people in wealthy areas. Studies have found that this link holds true even for better educated or richer people in the neighborhood. Still, this fact doesn't mean that money doesn't matter: In one recent study, peo-

### *THE SOUTH AFRICAN BIOWEAPONS PROGRAM*

Many countries, including the United States, had biological weapons programs sometime during the 20th century. (Some still have them.) But perhaps the most infamous is one called Project Coast that was run by South Africa's apartheid government.

Under apartheid, the minority white South African government oppressed and segregated the majority black population. In the 1980s and early 1990s, the apartheid government was under intense national pressure to end its racist policies. But for many years, it did not back down. During this time, it recruited scientists loyal to the apartheid regime to develop chemical and biological weapons specifically designed to attack the country's black population.

For over a decade, Project Coast pursued many technologies that were designed to eliminate the country's black population. Their ideas ranged from the ordinary (poisoning chocolates) to the diabolical (tainted vaccines that would make black women infertile and lethal bacteria that would kill only black people). Thankfully, none of the project's most horrific ideas were ever carried out.

In 2002, the alleged leader of Project Coast, Dr. Wouter Basson, was cleared of 46 criminal charges by a South African high court. The state has appealed the ruling to the highest court in South Africa; as this book went to print, the court was considering the request for a retrial.



ple in the lowest income bracket were five times as likely to report their health as “fair” or “poor” compared with people in the highest income bracket.

Health gaps also exist among ethnic groups. The gaps vary from disease to disease. For example,

African Americans are 30 percent more likely than whites to die from heart disease. Hispanics, American Indians, and Alaska natives have twice the rate of diabetes as non-Hispanic whites. A health gap also persists between the sexes: Men, on average, die six years sooner than their female

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counterparts, even as both genders continue to live longer and longer.

What contributes to these health gaps? The answers are as varied as the gaps themselves. Some of the differences are genetic: A disease-related gene may be more common in one population than another. For instance, the gene for **cystic fibrosis** is more common in whites than in other ethnic groups. Other gaps can be partly explained by simple geography. For instance,



*Health gaps, a lack of health insurance, and the high cost of prescription drugs are some of the challenges that still need to be faced in the 21st century.*

people who live in rural areas have to travel farther to get to a doctor or a hospital than people who live in more densely populated regions. Therefore, they are less likely to get to a hospital in time in an emergency and less likely to get regular checkups.

In other cases, the economics of a neighborhood factor in: Poor urban neighborhoods usually have fewer doctors than wealthy ones, and they also have more violent crime, which increases rates of death and injury and can limit outdoor activities. What's more, poorer neighborhoods tend to have many fast-food restaurants and liquor stores, but few quality grocery stores or exercise facilities (such as YMCAs, gyms, parks, or community centers)—making it harder for people who live in these neighborhoods to maintain a healthy lifestyle. In some neighborhoods, a person might be walking distance from 10 different double cheeseburgers, but miles from the nearest decent stalk of broccoli.

Finally, the economic background of an individual often strongly influences his or her health. Wealthier people have access to more health care choices, as they are more likely to have jobs that provide health insurance and to earn incomes that can cover what



isn't insured. They can afford to shop in high-quality grocery stores that sell fresher, healthier food. They also have a greater variety of exercise options available to them, including joining a gym and participating in sports (such as skiing or tennis) that use expensive equipment or facilities. They also tend to be more educated, which sometimes (but not always) goes along with knowing more about their bodies and where to get good health information. Because they have so many options, affluent people talk about their health in a different way, with an eye toward the latest advances in prevention and physical fitness, rather than just coping with chronic problems or treating emergencies.

*Poorer families face challenges in finding safe places to exercise and access to equipment.*

Obviously, if people from poorer neighborhoods or disadvantaged economic backgrounds could enjoy the same standard of health care and physical fitness as the wealthiest Americans, the overall picture of the nation's health would change dramatically. How to achieve that is a question which is debated fiercely in communities, medical conferences, and the highest offices of the nation's government. Some people think that governments should invest more in making lower income neighborhoods more "health friendly," by providing economic incentives for grocery

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stores and medical facilities to open there and by limiting the growth of “unhealthy” businesses. Doing this, of course, requires money and tremendous organizational resources. Others advocate improving health education in “high-risk” areas, so that people will have more power to make better choices on their own. But such education can go only so far if people’s choices are limited.

A larger issue in America, and indeed across the entire world, is how to deal with the rising cost of health care. America is widely considered the world’s leader in medical innovation, from state-of-the-art surgical procedures to revolutionary new drugs. But all this technology doesn’t come cheaply, and too often, the best treatments are out of reach to lower income patients. Health insurance helps, but millions of Americans have no insurance, and even those who do can face hefty sums for the coverage itself, as well as for expenses that aren’t covered.

Some people think that America should move to a form of universal, low-cost, government-sponsored health insurance like the kind used in Canada and many Western European countries. Others disagree, saying that such a system in a country as large as the United

States would put medical decisions in the hands of government administrators, cost billions of dollars in taxes, and be difficult to manage.

Another popular argument is that the current health insurance system should stay, but with more regulation of how much doctors, hospitals, and drug companies can charge the insurance companies and how much the insurance companies can charge the patients. But some people say that any further regulation will limit the quality of care and progress of medical research, because the people providing the care and doing the research will need to cut costs.

The conflict between making health care affordable and providing the highest quality of care possible is playing out all across America. Some people are suing their health insurance companies because the companies didn’t cover a procedure or a drug that a doctor recommended. The insurance companies, in turn, often end up raising their rates to cover their legal expenses. Drug companies are fighting to extend the **patents** on medications they invent, which usually keeps the cost high. Doctors are quietly dropping out of popular insurance programs, especially **health maintenance organizations** (HMOs), because

### GENERICS: WHOSE DRUG IS IT ANYWAY?

When you drop off a prescription at a pharmacy, you might be asked “Is generic okay?” If you’ve ever thought, “How should I know?” you’re not alone. Here are some quick facts about generic drugs:

When a new drug is invented, the company that invented it can file a patent on the drug. A patent is a kind of copyright for an invention. As long as a product is under patent, it cannot be copied and sold by anyone other than the original manufacturer.

Drug patents expire after a certain amount of time (usually seven years). After the patent expires, other companies can make generic versions of the drug. They still can’t give it the same name, but they can use the same ingredients at the same strength and work in the same way. In fact, they have to—otherwise it’s considered a new drug, and it has to go through new clinical testing.

Generic drugs have the same active ingredients as brand-name drugs, but they’re usually much cheaper. When you buy a brand-name drug, you are paying partly for the drug, partly for the advertising, and partly for the research that went into inventing the drug. Generic drugs are not advertised, and the companies that make them don’t have the same research costs to recover. So they can charge less money for the essentially the same product.

The issues raised by generic drugs and patent limits is hotly debated in the medical and pharmaceutical industry. Some



people want generic drugs to be available sooner, because brand-name drugs are very expensive. Drug companies want their patents to last longer. They argue that without enough patent protection, companies will have no incentive to develop new and better drugs, because their formulas will only be copied by other companies that can sell them at a lower price. Many health insurers are stepping in and pressuring doctors and patients to use generic drugs whenever possible. If you take any prescription medications, it’s useful to keep informed about generic equivalents that may be available and how they might benefit you.

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they feel that the insurance companies are too stingy or that HMOs interfere with the care the doctors provide. People without insurance often go to the emergency room (E.R.) for nonemergency treatment, because they know that they'll be guaranteed treatment, even though visits to the E.R. are very expensive, both to the hospital and to the patients. Or they avoid seeking basic preventive care and wind up in the emergency room for conditions that might have been treated easily earlier. Finally, as more and

more Americans get older, they are requiring more expensive medical care to stay alive.

There are no easy answers to any of these problems. Solutions that help in one area require hard compromises in others. The fact is that medical innovation costs a lot of money and someone has to pay for it. Deciding exactly who should pay what is a subject that will continue to divide the nation in the years ahead.

# Part 5: Working Together to Advance Health

How can you use all the information from this book to improve your own health and the health of your community? There are several answers to this question.

## Taking charge of your own health

The most important priority is to take charge of your own health and the health of your family.

With so many doctors, treatments, and health care decisions to be made, you need to learn what it takes to keep you healthy and to make sure that whatever is necessary to improve your health gets done.

### **Develop a healthy lifestyle.**

Learn all you can about keeping a healthy diet, and make that a priority. Avoid eating too many sweets, fats, and processed foods.



*Make eating a healthy diet a priority.*

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*Think about health information carefully and critically. Get regular checkups and don't be afraid to talk about your health or your family's health history with your doctor or nurse.*

Increase your intake of fresh fruits and vegetables. Build exercise into your daily schedule. Even adding a 20- to 30-minute walk every day, taking the stairs instead of the elevator, or exercising while you watch TV can make a difference in your physical fitness. If you are overweight, work with your doctor to develop a plan for weight loss.

**Create an active relationship with your doctor.** The first step is obviously to find a doctor if you do not have one. If you are insured, ask your insurance company for a list of its providers. If you are uninsured, look for med-

ical options in your area that may be affordable to you. Most major cities operate free or inexpensive health clinics. You may also be eligible for **Medicaid** (government-assisted medical care). To find out more, call the Centers for Medicare and Medicaid Services toll free at 1-877-267-2323. Many U.S. states and private agencies also offer medical assistance programs for children.

Once you find a doctor, tell him or her all you know about your health and medical history. Do research on any conditions that you have, any diseases that run in

your family, and any medications you are taking. Ask questions whenever something isn't clear. Ask about the range of treatment options that are available to you. When you are given a medication or treatment plan to follow at home, be sure you understand exactly what you are supposed to do. Don't be afraid to ask more questions if you don't understand.

**Learn to examine health information critically.** These days, it's easy to *find* health information, but hard to know what to trust. When you come across a new piece of medical information, ask critical questions before changing your behavior. Where is the information coming from? Is it based on anecdotal evidence, or were careful experiments conducted? Is it from a trustworthy university or research center, or from a fringe organization with a specific agenda? Is it being played up on the news just to get ratings? How does it compare with the information that is already out there? Has the idea been thoroughly tested, or is it just a promising hint from a single preliminary study? What does your doctor think of it? It's important to adapt to new insights, but it's just as important not to blindly follow every trendy suggestion that comes along. Remember, the stronger the original theory was,



*Consider taking part in clinical trials.*

the more powerful the new evidence must be to overturn it.

Critical thinking is especially needed when you look for information on the Internet. When you type words into a search engine, the results that come up are not necessarily based on research.

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Sometimes a company that wants to sell you its product may have created the page, and the product may not be based on scientific research or may not even be safe for you!

You should always question where information on the Internet comes from. Web sites from the government generally give good information, as do the sites listed in the “Resources” section of this book on page 79. You can also always ask a librarian if you have questions about whether a Web site is a good one to trust or not. [See Appendix 2 on page 75 for more information about how to examine health advertisements critically.]

**Weigh your choices.** Not every medical decision you will make will be clear cut. For example, if

you were seriously obese, you might be asked to consider **gastric bypass surgery**, a radical procedure in which most of the digestive system is bypassed, so you can’t eat very much, and what you do eat must be chosen very carefully. The surgery, or another procedure like it, might offer you a better chance for more dramatic, longer-lasting results than diet and exercise alone can give you. On the other hand, the surgery is risky, greatly alters your body, requires major changes in lifestyle, and is irreversible. Only you and your doctor can decide the best course of action, based on your own priorities and your specific medical situation. Make sure that you fully understand all the benefits and side effects of each alternative before deciding on a treatment.

**Develop an informed sense of risk.** In life, we sometimes take chances that are unnecessary and dangerous. Other times, we worry about things that are really not very likely at all. This is especially true of choices that affect our health and safety. For example, some people are afraid to get a flu shot because they’ve heard that some people have bad side effects. However, the chances of getting the flu if you *don’t* get a shot are much higher than having any serious reaction to the shot itself.

*Make your neighborhood a healthier place to live.*



Other people might be excessively worried about everyday germs—for example, they may use tissues to open doorknobs—but don't adequately protect themselves against **sexually transmitted diseases (STDs)** such as HIV, syphilis, and **herpes**. Still others might be afraid to fly on an airplane, but refuse to wear a seat belt in the car. (You're much more likely to die in a car crash.) In making choices about your health, it's important to separate how you *feel* about the risk from what the risk actually *is*. Your doctor can help you weigh the risks.

**Volunteer for research.** If you want to help advance your own health, the health of your children and grandchildren, and the health of the entire world, one way to help is to volunteer for medical research. Hospitals, universities, and research labs are always looking for people to participate in basic medical research and clinical trials. Today, they have a particular interest in studying women and ethnic minorities, because older studies often focused mainly on white men. Usually, each study will be looking for people of a particular age, gender, ethnic background, or medical history. Studies often advertise for volunteers in newspapers, on buses and in subways,

or on community bulletin boards. The hospital or medical school in your area may have an office that provides information about volunteer opportunities.

Volunteering for research has many benefits. You can know that you are contributing to the world's medical knowledge. You will usually receive free medical care as part of the study, and you might be paid for your time. You might find out more about your own health because you participated in the study. If you have a chronic medical condition, you might even discover a new treatment that works for you.

If you do volunteer for a study, you should take the informed consent agreement very seriously. Make sure that you carefully read any documents you have to sign and that you fully understand the time commitment and possible consequences of participating in the study. Some studies involve nothing more than answering a questionnaire or having a few simple tests done. Others involve repeated visits to a research center, spanning months or even years, and complicated medical procedures that may not have all the bugs worked out. Always go into a study with your eyes open to its potential risks and benefits.

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**Work for community improvement.** Does your community provide every opportunity for its citizens to stay healthy? Are there lots of good facilities for medical care, exercise, and healthy food shopping? Are the air and water as clean as they can be? Is the neighborhood safe? Are there opportunities for uninsured people to receive decent care?

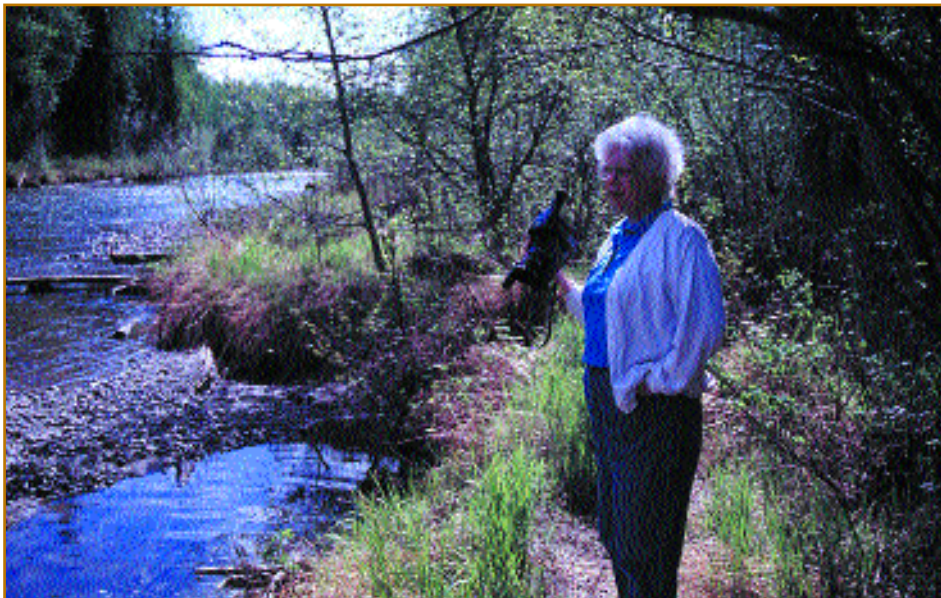
If you feel that your community could be a healthier place, get involved! Find other people in your neighborhood or in your faith community who feel the same way, or look for organizations that are working to make the kind of improvements you would like to see. Volunteer your time, or get people together to work for change. Like your own health, your community's health will improve much faster if you take an active role in shaping it.

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# Conclusion: Your Life, Your Health

Staying fit and healthy isn't always easy. But everyone has the power to make informed, positive choices that can boost his or her quality of life. You should approach your own health with the same attitude that has driven medical research over the last few centuries. Be curious. Be skeptical. Accept ideas based on

solid evidence, not on wishful thinking or untested guesses. Don't expect perfection, but always strive for improvement. If you follow these guidelines, your health can advance with the same success that medical science has: making progress one step at a time.



*Your health is one of your most valuable possessions. Take good care of it.*



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# Appendix 1: Taking Part in Research Studies—Questions to Ask

A research study is a way of finding answers to difficult scientific or health questions. Here are some important questions you should ask of anyone who wants you or members of your family or community to be part of a research study:

1. What is the study about?  
Why are you doing the study?  
Why do you want to study me or people like me? Who else is being studied?  
What do you want to get out of the study?  
What will you do with the results?  
Have you or others done this type of study ever before? Around here?  
What did you learn?
2. Who put the study together?  
Who is running or is in charge of the study?  
Whose idea was the study?  
How were people like me part of putting it together?  
Who are the researchers? Are they doctors or scientists? Who do they work for?  
Have they done studies like this before?  
Is the government part of the study? Who else is a part of the study?  
Who is paying for the study?  
Who will make money from the results of the study?
3. How can people like me share their ideas as you do the study?  
How will the study be explained in my community?  
Who among people like me will look at the study before it starts?  
Who among people like me are you talking to as you do the study? A Community Advisory Board?  
Who from the study can I go to with ideas, questions, or complaints?  
How will people like me find out about how the study is going?
4. Who is going to be in the study?  
What kinds of people are you looking for? Why?  
Are you trying to get minorities into the study?  
Are you including people younger than 18 years old?  
How are you finding people for the study?  
Is transportation or day care provided for people who take part in the study?

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Do I need to sign anything in order to participate?

Will you answer all of my questions before I sign the consent form?

Can I quit the study after signing the consent form? If I quit the study, will anything happen to me?

5. What will I get out of the study?

What are the benefits?

Is payment involved? How will I be paid?

Will I get free health care or other services if I participate?

For how long?

Will I get general health care or psychological care if I participate?

For how long?

6. How will I be protected from harm?

Do I stand a chance of being harmed in the study? In the future?

Does the study protect me from all types of harm attributable to it?

If I get harmed, who will take care of me? Who is responsible?

If I get harmed in any way, will I get all needed treatment? Who pays for treatment?

7. How will my privacy be protected?

Who is going to see the information I give?

Will my name be used with the information?

What happens to the information I gave if I quit the study?

Is there a written guarantee of privacy?

8. What do I have to do in the study?

When did you start the study? How long will it last?

How much of the study have you already done?

Have there been any problems so far?

Will I get treated the same as everyone else?

What kinds of different treatments are offered in the study? Are there both real and fake treatments?

9. What will be left behind after the study is over?

What will happen to the information people give? How will it be kept?

What are you going to do with the results of the study?

How will the public learn about the results? Will results be in

places where the public can see them?  
Are you going to send me a copy of the results? When?  
What other studies are you planning to do here?

*The questions above are from a pamphlet developed by Project LinCS (Linking Communities and Scientists), Community Advisory Board (Durham, N.C.), and Investigators (University of North Carolina Center for Health Promotion and Disease Prevention) in cooperation with the Centers for Disease Control and Prevention, Atlanta, Ga. For copies of this brochure, contact the CDC National Prevention Information Network at 1-800-458-5231.*

## Appendix 2: 10 Things to Know about Evaluating Medical Resources on the Web

The number of Web sites offering health-related resources grows every day. Many sites provide valuable information, but others may have information that is unreliable or misleading. This short guide contains important questions you should consider as you look for health information online. Answering these questions when you visit a new site will help you evaluate the information you find.

### 1. Who runs the site?

Any good health-related Web site should make it easy for you to learn who is responsible for it and the information it gives out. For example, “National Center for Complementary and Alternative Medicine” (NCCAM) is clearly marked on every major page of their government-run site, along with a link to the NCCAM home page.

### 2. Who pays for the site?

It costs money to run a Web site. The source of a Web site’s funding should be clearly stated or readily apparent. For example, a Web address ending in “.gov” means it’s a federal government-sponsored site. You should know how the site pays for its existence. Does it

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sell advertising? Is it sponsored by a drug company? The source of funding can affect what content is presented, how the content is presented, and what the site's owners want to accomplish on the site.

### **3. What is the purpose of the site?**

This question is related to who runs and pays for the site. An "About This Site" link appears on many sites; if it's there, use it. The purpose of the site should be clearly stated and should help you evaluate the trustworthiness of the information presented.

### **4. Where does the information come from?**

Many health and medical sites post information collected from other Web sites or sources. If the person or organization in charge of the site did not create the information, the original source should be clearly labeled.

### **5. What is the basis of the information?**

In addition to identifying who wrote the material you are reading, the site should describe the evidence the material is based on. Medical facts and figures should have references (such as to articles in medical journals). Also, opinions or advice should be clearly set apart from information that is "evidence based" (based on research results).

### **6. How is the information selected?**

Is there an editorial board? Do people with excellent professional and scientific qualifications review the material before it is posted?

### **7. How current is the information?**

Web sites should be reviewed and updated on a regular basis. It is particularly important that medical information be current. The most recent update or review date should be clearly posted. Even if the information has not changed, you want to know whether the owners of the site have reviewed it recently to ensure that it is still valid.

### **8. How does the site choose links to other sites?**

Web sites usually have a policy about how they establish links to other sites. Some medical sites take a conservative approach and

don't link to any other sites. Some link to any site that asks or pays for a link. Others only link to sites that have met certain criteria.

### **9. What information about you does the site collect, and why?**

Web sites routinely track the paths visitors take through their sites to determine which pages are being used. However, many health Web sites ask for you to “subscribe” or “become a member.” In some cases, they do this so that they can collect a user fee or select information for you that is relevant to your concerns. In all cases, membership or subscription will give the site personal information about you.

Any credible health site asking for personal information should tell you exactly what it will and will not do with the information. Many commercial sites sell “aggregate” (collected) data about their users to other companies—information such as what percentage of their users are women with breast cancer, for example. In some cases, they may collect and reuse information that is “personally identifiable,” such as your ZIP code, gender, and date of birth. Be certain that you read and understand any privacy policy or similar language on the site, and don't sign up for anything that you are not sure you fully understand.

### **10. How does the site manage interactions with visitors?**

There should always be a way for you to contact the owner of the site if you run across problems or have questions or feedback. If the site hosts chat rooms or other online discussion areas, it should tell visitors what the terms of using such a service are. Is the service moderated? If so, by whom, and why? It is always a good idea to spend time reading the discussion without joining in, so that you feel comfortable with the environment before becoming a participant.

*Adapted from the National Institutes of Health's National Center for Complementary and Alternative Medicine Clearinghouse. For more information contact the clearinghouse by phone at 1-888-644-6226, 301-519-3153 (international), or 1-866-464-3615 (TTY); by email at [info@nccam.nih.gov](mailto:info@nccam.nih.gov); by fax at 1-866-464-3616; or by mail at NCCAM Clearinghouse, P.O. Box 7923, Gaithersburg, MD 20898-7923. This publication can be found online at <http://nccam.nih.gov/health/webresources/>.*



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# Resources

## **ClinicalTrials.gov**

*A web-based resource for finding clinical trials in need of volunteers.  
[www.clinicaltrials.gov](http://www.clinicaltrials.gov)*

## **Combined Health Information Database**

*A web-based service that combines resources on health and disease topics from several federal agencies. A service of the National Institutes of Health.  
[chid.nih.gov/simple/simple.html](http://chid.nih.gov/simple/simple.html)*

## **Healthy People 2010**

*A nationwide health promotion and disease prevention campaign sponsored by the Department of Health and Human Services. One of the goals of the campaign is to reduce health disparities.  
Office of Disease Prevention and Health Promotion  
1101 Wootton Parkway, Suite LL100  
Rockville, MD 20852  
[www.healthypeople.gov](http://www.healthypeople.gov)*

*For information on the Healthy People 2010 Microgrant program that finances community-based prevention activities:  
[www.healthypeople.gov/implementation/community/](http://www.healthypeople.gov/implementation/community/)*

## **MEDLINEplus**

*A comprehensive source of health information provided by the National Library of Medicine.  
[www.nlm.nih.gov/medlineplus/](http://www.nlm.nih.gov/medlineplus/)*

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### **National Center for Chronic Disease Prevention and Health Promotion**

*Sponsored by the CDC, the center promotes the transfer of research knowledge into actual prevention and treatment strategies. Provides information to the general public.*

Centers for Disease Control and Prevention  
4770 Buford Highway, NE, Mailstop K13  
Atlanta, GA 30341-3724  
770-488-5080  
[www.cdc.gov/nccdphp/](http://www.cdc.gov/nccdphp/)

### **National Center on Minority Health and Health Disparities**

*Promotes the health of racial and ethnic populations through research and education and through support of minority involvement in research careers. Affiliated with the National Institutes of Health.*

6707 Democracy Blvd., Suite 800  
MSC 5465  
Bethesda, MD 20892-5465  
(301) 402-1366/TTY: (301) 451-9532  
[ncmhd.nih.gov](http://ncmhd.nih.gov)

### **National Institute of Mental Health (NIMH)**

*The branch of the National Institutes of Health that focuses on researching and informing the public about mental health.*

6001 Executive Blvd., Room 8184, MSC 9663  
Bethesda, MD 20892-9663  
301-443-4513/TTY: 301-443-8431  
[www.nimh.nih.gov](http://www.nimh.nih.gov)

### **Native American Research Centers for Health**

*Research centers that link the Native American community with health research and that work to increase the number of Native American scientists and health professionals.*

The Office of Public Health Support  
Indian Health Service  
801 Thompson Ave., TMP, Suite 450  
Rockville, MD 20852  
(301) 443-6622  
[www.ihs.gov/MedicalPrograms/Research/narch.cfm](http://www.ihs.gov/MedicalPrograms/Research/narch.cfm)

### **New York Online Access to Health**

*A searchable health information resource in English and Spanish.*  
[www.noah-health.org/index.html](http://www.noah-health.org/index.html)

### **Office for Human Research Protections**

*A source of information on the guidelines and ethics of research studies with humans.*

Department of Health and Human Services  
1101 Wootton Parkway, Suite 200  
Rockville, MD 20852  
(866) 447-4777/301-496-7005  
[www.hhs.gov/ohrp](http://www.hhs.gov/ohrp)

### **Office of Minority Health Resource Center**

*Serves as a national resource and referral service on minority health issues. Affiliated with the U.S. Department of Health and Human Services.*

P.O. Box 37337  
Washington, D.C. 20013-7337  
1-800-444-6472  
[www.omhrc.gov/omhrc/](http://www.omhrc.gov/omhrc/)

### **World Health Organization**

*The United Nations agency that focuses on international health issues.*

Pan American Health Organization  
525 23rd Street, NW  
Washington, DC 20037  
[www.who.org](http://www.who.org)



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# Glossary

**a·ce·tyl·sal·i·cyl·ic a·cid:** scientific name for the pain-relieving ingredient in *aspirin*. It occurs naturally in the bark of the willow tree.

**ac·u·punc·ture:** ancient Chinese medical practice in which thin needles are inserted into points in the body.

**a·dapt:** to change over time. In medicine, the term can describe ways that the body adjusts to an injury, a drug, or pressures such as heat or starvation. It can also describe the way disease-causing organisms like *bacteria* and *viruses* become resistant to certain drugs over many generations.

**AIDS (ac·quired im·mune de·fi·cien·cy syn·drome):** disease of the *immune system* caused by the presence of *HIV*. It is passed on through sexual intercourse and exposure to infected blood.

**Alz·hei·mer's dis·ease:** brain disease that gradually damages the victim's memory and ability to think and move. It usually strikes elderly people.

**am·ni·o·cen·te·sis:** a test of the fluid that surrounds the developing fetus. It is usually performed between weeks 15 and 20 of pregnancy. Cells from the fetus are used to detect genetic disorders such as sickle cell anemia, and *cystic fibrosis* and abnormalities such as *spina bifida*. Also detects the sex of the fetus.

**am·ni·o·tic flu·id:** fluid that fills the womb during pregnancy. It provides a cushioned environment for the fetus.

**an·ec·dot·al:** based on stories or personal experiences, rather than carefully recorded facts.

**an·ti·bi·o·tic:** drug that kills *bacteria*.

**an·ti·bi·o·tic re·sis·tant:** no longer affected by certain antibiotic drugs.

**an·ti·bod·ies:** disease-fighting agents in the blood.

**an·ti·ox·i·dant:** helpful chemicals that clear certain harmful chemicals from the body. Found in certain foods.

**an·ti·sep·tic:** chemical that kills germs. The word can also describe an environment, such as an operating room, or an object, like a surgical tool, that is free or mostly free of germs.

**anx·i·et·y:** excessive worrying. When someone has so much anxiety that it is difficult to function normally, the condition is called an anxiety disorder. Treatments include *psychotherapy* and *SSRI* medications.

**ap·plied re·search:** research that asks a practical question—for example, whether a certain chemical can kill cancer cells.

**as·pi·rin:** pain-relieving drug made from the chemical *acetylsalicylic acid*.

**asth·ma:** disease of the lungs that can cause difficulty in breathing.

**a·sy·lum:** old-fashioned term for an institution for people with severe mental illnesses. In the past, many asylums had terrible conditions and neglected or abused their patients.

**bac·te·ri·a:** tiny organisms that survive on living and nonliving surfaces, performing many chemical functions. Some bacteria cause diseases in people.

**bac·te·ri·o·phage:** a kind of *virus* that kills *bacteria*. Bacteriophages are sometimes used to treat diseases.

**ba·sic re·search:** research that asks a question about how some aspect of the world normally works—for example, how certain *cells* in the stomach help us digest food.

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**bi·op·sy:** technique in which a small sample of *cells* is taken from the body and is closely examined for signs of disease.

**bi·po·lar dis·or·der:** *mental illness* in which a person goes back and forth between explosive, restless energy and extreme *depression*. It can be treated with medications like *lithium*.

**birth de·fect:** disease or condition that is present at birth, such as *cystic fibrosis* or *spina bifida*.

**bis·muth:** mineral found in soil and used to treat nausea or indigestion. See *kaolin*.

**boost·er shot:** extra shot of a *vaccine* taken after the first dose. Some vaccines require booster shots after a certain amount of time has passed or after possible exposure to a disease.

**bo·vine spon·gi·form en·ceph·a·lop·a·thy (mad cow dis·ease):** An infectious brain disease found in some cattle.

**bow·el ob·struc·tion:** blockage in the intestines that prevents normal bowel movement.

**bu·bon·ic plague:** deadly infectious disease that killed one-third of the population of Europe in the Middle Ages.

**can·cer:** disease in which the body's own cells start to grow and divide in an out-of-control manner. Left untreated, cancer cells can spread and shut down the body's functions.

**car·bol·ic ac·id:** an *antiseptic* chemical used by Dr. Joseph Lister in his surgical practice.

**cell:** the smallest unit of production in a living thing.

**cer·e·bral pal·sy:** condition caused by a prenatal brain defect or by brain injury during birth; characterized by spasms and difficulty in controlling the muscles.

**cer·vix:** the necklike part of the uterus that extends into the vagina. It becomes the beginning of the birth canal.

**che·mo·ther·a·py:** a treatment for *cancer*. In chemotherapy, one or more drugs are given that stop cells from dividing and reproducing. The drugs also affect some healthy cells, but these cells can usually repair the damage, whereas cancer cells cannot and eventually die. Chemotherapy is effective, but has many strong *side effects*.

**chol·er·a:** an *infectious disease* often spread through unclean water.

**cho·les·ter·ol:** a waxlike substance found in human cells. Some cholesterol is needed for certain body functions, but too much can build up in blood vessels and block the flow of blood.

**chron·ic:** long lasting and ongoing. *Diabetes* and *high blood pressure* are chronic diseases.

**clin·i·cal tri·al:** research performed on people in order to test the success of a medical treatment, medicine, or prevention strategy. A clinical trial usually is conducted only after testing has been successful in the laboratory and on animals.

**con·gen·i·tal:** present at birth.

**con·ta·gious dis·ease:** disease caused by a *germ* that you can catch from another person. Contagious diseases are spread in many different ways. For example, some can be spread through the air, others only through close physical contact.

**con·trol group:** in a medical experiment, a group of patients who do not receive the new drug or treatment, but who go through all the motions of the experiment. Comparing patients who receive a new treatment with a control group allows the researchers to learn whether the treatment is safe and effective. See *experimental group*.

**cow·pox:** disease in cows that is similar to smallpox, but less harmful to humans.

**cys·tic fi·bro·sis:** hereditary disease that results in serious respiratory and other health problems, as well as early

death (often in the teens or early twenties, although, because of medical advances, the average life span for someone with the disease is now 30 years).

**de·duc·tive rea·son·ing:** kind of thinking that starts with a general idea and then uses *logic* to draw specific conclusions from that idea. Also known as “top-down” reasoning. See *inductive reasoning*.

**de·pres·sion:** a mental illness. People with depression feel sad, bored, or tired over long periods of time and have trouble enjoying things or functioning at home or at work. Depression can be mild or severe, but can usually be treated with *psychotherapy* or medications like *SSRIs*.

**di·a·be·tes:** a set of illnesses caused by improper amounts of glucose in the blood.

**di·e·tar·y:** Relating to diet.

**dig·ox·in:** A steroid found in the leaves of the foxglove plant used to treat heart disease.

**diph·the·ri·a:** a contagious disease that can be prevented by a *vaccine*.

**DNA (de·ox·y·ri·bo·nu·cle·ic ac·id):** a kind of molecule that is a part of *genes*, which are the basic blueprint for all life.

**dou·ble·blind:** Relating to an experimental procedure in which neither the subjects nor the experimenters know who is in the *control group* and who is in the *experimental group*.

**dys·en·tery:** An illness caused by a *protozoa* that results in pain, fever, and severe diarrhea.

**E·bo·la:** a severe, deadly, fast-acting contagious disease caused by a *virus*. As of this writing, it has been seen only briefly in certain remote parts of the world.

**em·phy·se·ma:** disease caused by damage to the tissues in the lungs and trachea (windpipe). Smoking is the leading cause.

**ep·i·dem·ic:** a rapidly spreading and increasing problem, such as a disease that is gaining hold in more and more people.

**eth·no·bot·a·ny:** the study of traditional uses for plants in cultures around the world.

**e·volve:** to change gradually over many generations. When a species evolves, certain traits become more or less common in its general population. Species with short life spans (such as *bacteria*) evolve much more quickly than species with long life spans (such as humans) because many more generations pass in a very short time.

**ex·per·i·men·tal group:** in a medical experiment, the group of patients who receive the new treatment or drug. See *control group*.

**fe·tal al·co·hol syn·drome (FAS):** a group of *birth defects*, suffered by babies born with alcohol in their bloodstreams, that include mental retardation, heart problems, and abnormal brain development.

**fe·tal sur·ger·y:** surgery performed on a developing baby while it is still inside the mother’s body.

**fe·tus:** an unborn child still in the womb.

**fi·ber:** mostly indigestible food material that stimulate the intestines; roughage.

**folk med·i·cine:** medicine that is practiced outside the boundaries of traditional science. It usually relies on naturally occurring chemicals and treatments that can be performed without advanced technology.

**for·ti·fied:** describes foods that have extra vitamins or nutrients added to them by the companies that make them.

**fun·gi:** living things that decompose dead plant and animal material.

**gas·tric by·pass sur·ger·y:** an operation that makes the stomach smaller and bypasses some of the stomach and

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intestines in the digestion process. This is a radical way to lose weight if you are obese.

**genes:** units of hereditary information contained in each cell of the body.

**ge·net·ic:** inherited.

**germ:** a living thing that directly causes a contagious disease in another living thing. Includes *bacteria*, *viruses*, and some *fungi*.

**health gap:** the uneven impact of a health problem between groups of people.

**health main·te·nance or·gan·i·za·tion (HMO):** a kind of health insurance plan in which participants must choose from a preapproved list of doctors and hospitals.

**heart dis·ease:** illness of the heart.

**herb·al ex·tract:** a dietary supplement that is based on or made from herbs that is used for health benefits.

**her·pes:** a viral disease that causes painful sores on the skin. Some kinds of herpes are transmitted through sexual contact.

**high blood pres·sure:** a condition in which blood is pushed through the body's blood vessels with a force greater than normal. Also known as hypertension, it is can lead to tiredness, heart attack, stroke, and other health problems.

**Hip·po·crat·ic oath:** a pledge taken by all doctors in which they promise not to harm their patients and to give them the best care possible.

**HIV (hu·man im·mu·no·de·fi·cien·cy vi·rus):** a virus that attacks the immune system and that can lead to *AIDS*. It is passed on through sexual intercourse and exposure to infected blood.

**hy·poth·e·sis:** a possible answer to a scientific question. A hypothesis must be tested and retested through careful experiments in order to gain acceptance. See *theory*.

**im·ag·ing sys·tems:** specialized machinery and techniques used to look at internal body organs, tissues, or cavities for diagnostic purposes.

**im·mune sys·tem:** the combined set of coordinated responses of the body that together serve to protect it against outside invaders such as *viruses* and *bacteria*.

**in·cu·ba·tion pe·ri·od:** the time in between when a person is infected with a germ and when the first *symptoms* of the illness begin. It can last anywhere from hours to years. Diseases are often highly contagious during this time.

**in·duc·tive rea·son·ing:** kind of thinking in which specific observations are used to form general ideas and a general idea must be modified or rejected if the evidence doesn't fit. See *deductive reasoning*.

**in·dus·tri·al·ized:** term describing countries or areas, such as the U.S., Canada, Australia, Japan, and the nations of Western Europe, with widespread access to sophisticated technology, advanced medicine, and a generally high *standard of living*.

**in·fec·tion:** invasion of body tissue by a *virus* or harmful *bacteria*, resulting in disease.

**in·flu·en·za:** contagious disease caused by a virus and commonly known as "the flu." Though deadly in past centuries, it rarely leads to death today in *industrialized* countries, thanks to *vaccines* and good medical care.

**in·formed con·sent:** a volunteer's agreement to participate in a research study, based on a full and complete understanding of what the study is about. It includes information on the risks for the volunteer, the rights of the volunteer, and the ways in which the volunteer will be protected from harm.

**in·sti·tu·tion·al re·view board (IRB):** a committee hired by a hospital, university, or research center to oversee a *clinical trial* and ensure that its possible

benefits outweigh any risk to the participants. The committee also makes sure that the study is conducted according to ethical standards.

**in·su·lin:** hormone released by the pancreas that regulates blood sugar levels by helping body tissues take in glucose (sugar) to be used for energy.

**in·trin·sic:** said of a disease that begins inside the body and is not caused by a *germ*.

**in·va·sive:** describes a procedure or treatment (usually surgery) that requires doctors to open up, or invade, the body. Open-heart surgery is an example of an invasive procedure.

**in vi·tro:** describes an experiment performed in the laboratory (literally, “in glass”), rather than in animals or people. The opposite is **in vivo** (“in life”), which describes experiments conducted on, or observations made in, living things.

**ka·o·lin:** mineral found in natural clay and used as a treatment for nausea or indigestion. See *bismuth*.

**ku·ru:** disease caused by a *prion* and spread by eating human brains.

**lap·a·ros·co·py:** operation in which long, slender tubes with tiny video cameras are inserted into the abdomen to take pictures.

**lith·i·um:** drug used to treat some mental illnesses, including *bipolar disorder*.

**lo·bot·omy:** an operation in which the nerves connecting the frontal lobes, or thinking areas, of the brain are disconnected from the rest of the brain.

**log·ic:** careful, procedural kind of thinking used to answer questions and draw conclusions. It treats ideas as math problems that can be solved. It also separates thinking from belief and superstition.

**mag·net·ic res·o·nance im·ag·ing:** the use of a special machine to produce electronic images of specific atoms and

molecular structures in human cells, tissues, and organs.

**ma·lar·i·a:** serious tropical disease caused by a *parasite* and spread by mosquitoes.

**ma·lig·nant:** tending to cause sickness or death.

**mea·sles:** Once a common and sometimes deadly viral disease of childhood. Has become rare in *industrialized* countries thanks to *vaccines*.

**Med·i·caid:** nationally funded health insurance program for people with low incomes.

**men·tal health:** health of your mind, emotions, and ability to think clearly and reasonably. Once considered separate from physical health, it is now treated more like other medical conditions.

**mi·cro·be:** tiny living thing, too small to be seen with the naked eye, and usually made up of only one *cell*.

**mi·cro·sur·ger·y:** kind of surgery done with very small instruments. It is becoming popular because it is less *invasive* than traditional surgery.

**mul·ti·ple scle·ro·sis:** a disease that affects the brain and nervous system and that usually results in partial or complete paralysis and a jerky muscle tremor.

**mumps:** infection of the glands that produce saliva (spit). Like *measles*, it used to be common in childhood, but is now rare thanks to *vaccines*.

**mu·tate:** undergo a change in genes from one generation to the next.

**nu·cle·us:** a part of the cell containing DNA and RNA and responsible for growth and reproduction.

**nu·tri·tion:** the process of taking in and using food to help the body grow and live.

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**o·be·si·ty:** the condition of being overweight. It is a risk factor for many diseases and other conditions.

**pace·mak·er:** electronic device sometimes implanted in people with heart disease to help keep their heartbeat regular.

**pap smear:** routine medical test for women in which a doctor scrapes off a small sample of *cells* from the cervix and checks them for signs of *cancer*. Adult or sexually active women should have this test at least once per year. See *biopsy*.

**par·a·site:** an organism, such as *viruses*, most *bacteria*, and some worms, that lives off of another organism.

**pas·teur·i·za·tion:** technique in which *germs* are killed in liquids like milk or wine through rapid heating. The containers are then sealed off to prevent air (and new germs) from getting in.

**pat·ent:** copyright for an invention.

**pen·i·cil·lin:** *antibiotic* drug made from a chemical produced by mold. It was the first widely used, successful antibiotic.

**phase:** part.

**phi·los·o·pher:** a specialist in logic, ethics, aesthetics, metaphysics, and knowledge.

**pla·ce·bo:** fake treatment or drug that looks, tastes, or feels just like the real thing.

**pla·ce·bo effect:** the tendency of some patients to feel better after receiving a *placebo*. For a drug or treatment to be considered effective, it must work much better than the placebo effect.

**plaque:** a lesion of brain tissue that consists of a dense core often surrounded by a cluster of degenerating nerve parts.

**pneu·mo·nia:** a disease marked by inflammation of the lungs.

**po·li·o:** highly contagious disease caused by a virus. It can sometimes lead to physical disability, but has been almost completely eliminated thanks to *vaccines*.

**pos·i·tron e·mis·sion to·mog·ra·phy (PET):** a way to track blood flow using mild radioactive particles injected into the bloodstream.

**pre·ven·tive care:** medical care for people who feel well or who have only mild *symptoms*. It is much cheaper than care for urgent conditions and can spot and prevent problems before they get out of hand.

**pri·on:** a strange kind of protein that causes disease by making other proteins fold in the wrong way. Cause of *bovine spongiform encephalopathy* along with the human version of the disease.

**pro·tein:** a fundamental part of living cells made up of carbon, hydrogen, oxygen, nitrogen, and usually sulfur. It is essential for the growth and repair of tissue.

**pro·to·zo·a:** *microbes* made up of only one cell that resemble an animal or plant cell. See *bacteria*.

**psy·cho·ther·a·py:** treatment for mental illness based on talking with a trained counselor.

**quar·an·tine:** enforced isolation to prevent the spread of disease.

**ra·bies:** a deadly viral infection common in some animals and capable of being spread to people through bites. It can be prevented in humans if the person receives a *vaccine* immediately after being exposed.

**rea·son·ing:** the use of evidence or arguments in thinking or argumentation.

**RNA (ri·bo·nu·cle·ic ac·id):** molecule similar to *DNA* and used by *viruses* as their genetic code.

**ru·bel·la:** a common childhood disease carried by a *virus*. It can infect the bloodstream of the fetus and cause both complications in pregnancy and *birth defects*. Also known as German measles.

**sal·mo·nel·la:** *bacteria* that are poisonous to people and that can cause food

poisoning and more serious conditions, including *typhoid fever*.

**san·i·ta·tion:** disposal of sewage and other garbage.

**SARS (se·vere a·cute res·pi·ra·to·ry syn·drome):** A strange, unexplained flu-like breathing disease that was first recognized in Asia in 2003. It is spread through close person-to-person contact.

**sat·u·rat·ed fats:** fats that raise the cholesterol level.

**scar·let fe·ver:** a disease caused by *bacteria*. *Symptoms* include a deep red rash that gives the disease its name. Once a frequent killer of children, it is less common today and can be treated with *antibiotics*.

**schiz·o·phre·ni·a:** a severe, disabling *mental illness*. People with the condition often hear voices that are not real and believe that other people are doing strange and frightening things to them. It is *not* a “split personality” disease (although many people wrongly believe it to be) and can often be treated with medication and therapy.

**sci·en·tifi·c meth·od:** step-by-step procedure for testing beliefs about the way the world works. Developed mostly in the 19th century, it is the basis of most experiments done today.

**se·lec·tive se·ro·to·nin re·up·take in·hib·it·or (SSRI):** drug used to treat mental illnesses such as *anxiety* and *depression*. Includes the brand names Prozac, Zoloft, Paxil, Celexa, and many others.

**sex·u·al·ly trans·mit·ted dis·ease:** disease caused by *viruses* and *bacteria* that are passed on through sexual intercourse.

**sha·man:** healer who combines folk medicine with spiritual or religious rituals.

**side effect:** any unintended effect or *symptom*, such as nausea, headache, diarrhea, sleeplessness, or hair loss,

caused by a medical treatment or drug. Most side effects are uncomfortable or unpleasant, and some are even harmful. They must be weighed against the benefit of a drug or treatment.

**small·pox:** serious and often deadly contagious disease caused by a *virus*, and, thanks to vaccines, eliminated from nature in 1977. Today, there are fears that stolen laboratory samples of the virus could be used as weapons.

**so·di·um:** a metallic element often found in salt. Too much sodium in a diet can damage your kidneys and lead to illness.

**son·o·gram:** image of the inside of the body created by high-frequency sound waves. It is often used to take pictures of a developing fetus during pregnancy.

**spe·cies:** a biological category of organisms.

**spi·na bif·i·da:** *birth defect* in which the tissue surrounding a baby’s developing spinal cord does not close properly. Also called “open spine,” it affects the backbone and the spinal cord and can cause paralysis of the legs, as well as problems with bladder and bowel control.

**spontane·ous gen·er·a·tion:** old, incorrect belief that germs, insects, or other small creatures could materialize out of thin air. It was disproven in experiments by Louis Pasteur.

**stan·dard of liv·ing:** general term for the quality of housing, sanitation, medical care, food, education, and technology that the average person in a particular area has access to. Of course, not every individual in that area will have the same access. See *industrialized*.

**strep·to·coc·cus:** bacteria that cause diseases in humans, including strep throat and scarlet fever.

**sul·fa drugs:** certain drugs used to fight diseases caused by bacteria. More popular early in the 20th century, before *antibiotics* like *penicillin* became widely used, they are still used today to treat some illnesses.

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**sup·ple·ments:** vitamins, minerals, or other natural chemicals that are taken in addition to food. Because they are not regulated in the same way that drugs are, their contents and effects are sometimes uncertain.

**symp·tom:** a sign of a problem, such as a disease.

**syph·i·lis:** slow-acting, deadly sexually transmitted disease that can be treated today with *antibiotics*.

**tet·a·nus:** a bacterial disease that affects the nervous system. It can be prevented with *vaccines*. A *booster shot* must be given every 10 years or soon after exposure to the *bacteria*.

**tha·lid·o·mide:** a drug commonly prescribed in the late 1950s as a sleeping pill and a treatment for morning sickness. It was later discovered to cause serious *birth defects*.

**the·o·ry:** scientific explanation that has been supported by a number of careful experiments. It must be changed or discarded if new, powerful evidence is found that disproves it. See *hypothesis*.

**tu·ber·cu·lo·sis:** a highly contagious bacterial disease, that usually attacks the lungs.

**tu·mor:** a clump of unhealthy, fast-growing cells that interfere with your body's normal functions.

**ty·phoid fe·ver:** a serious disease of the digestive system, usually spread through unclean food or water. It is found mostly outside the United States.

**ul·tra·sound:** an *imaging* tool used to monitor a developing *fetus*.

**u·ni·ver·sal·ly:** in all cases, situations, and conditions.

**vac·cine:** medical treatment that prevents disease by giving the patient *germs* that have been killed or made harmless. The patient's immune system learns to recognize the germ, and is able to fight them off later if the patient is ever exposed to them.

**var·i·ant Creutz·feldt·Ja·kob dis·ease (v·CJD):** a fatal disorder involving rapid mental decline. It is caused by exposure to mad cow disease (bovine spongiform encephalopathy).

**var·i·o·la·tion:** early form of vaccination in which people were deliberately exposed to small samples of a disease-causing *germ* in order to trigger their immune system.

**vec·tor:** something that carries disease-causing germs and spreads them to people. Rats are vectors for *bubonic plague*. Mosquitoes are vectors for *malaria*.

**vi·rus:** a tiny organism that carries disease. It spreads throughout the body by using the body's cells to make copies of itself.

**vi·ta·min:** substance that provides the body with essential nutrients.

**white blood cells:** an important part of your *immune system*. They detect and attack *germs* that enter your body.

**X-ray:** technology that uses invisible rays of light to see inside the body.

**yel·low fe·ver:** a serious disease caused by a *virus* and found mostly in tropical areas.

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