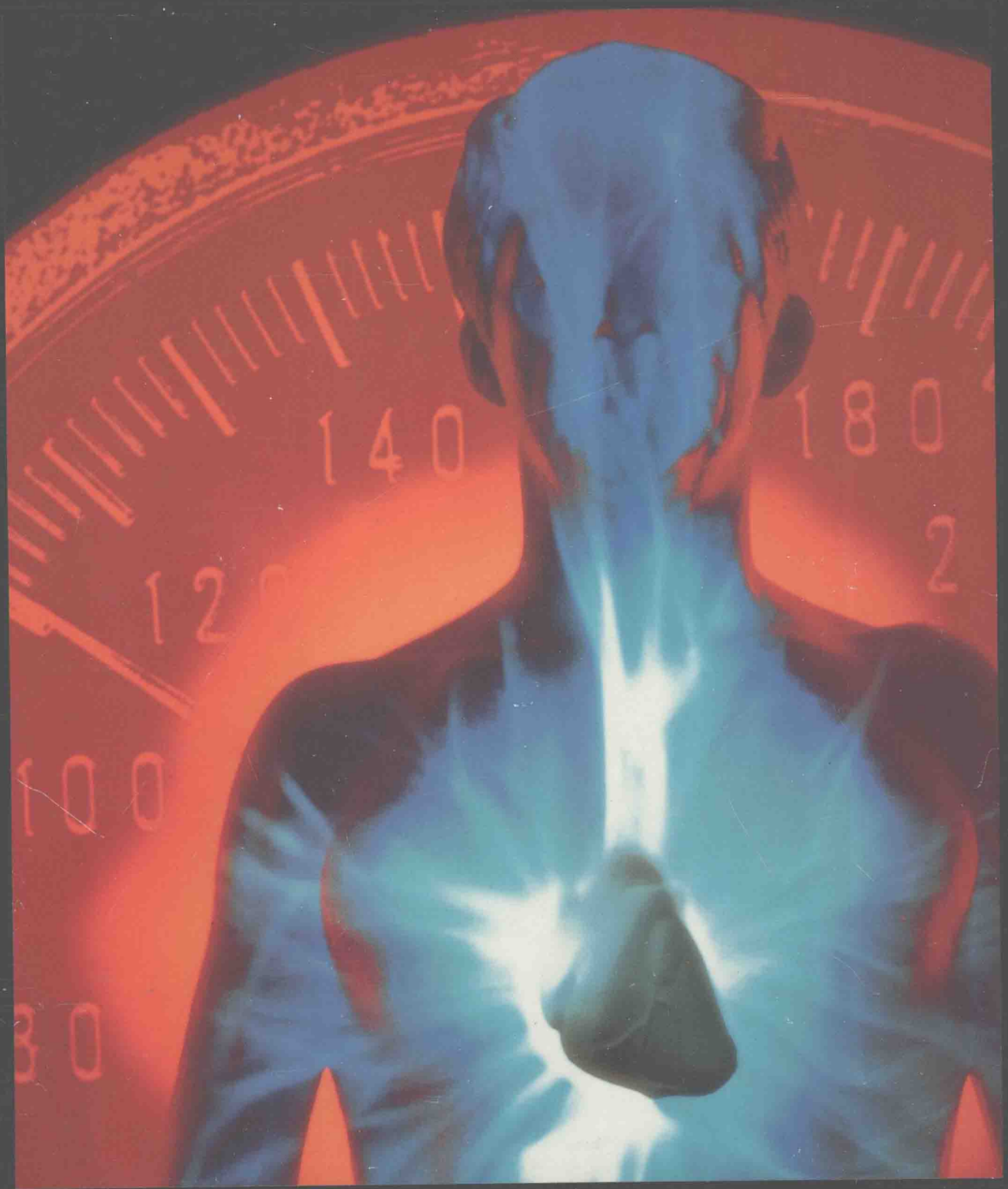
HOW THINGS WORK

MEDICINE



HOW THINGS WORK

MEDICINE

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A healthy human heart—about the size of a closed fist—pumps an average of 1,500 gallons of blood each day throughout the body, beating more than 2.8 billion times during a lifetime. Treating heart disease is one of modern medicine's greatest challenges.

HOW THINGS WORK

MEDICINE

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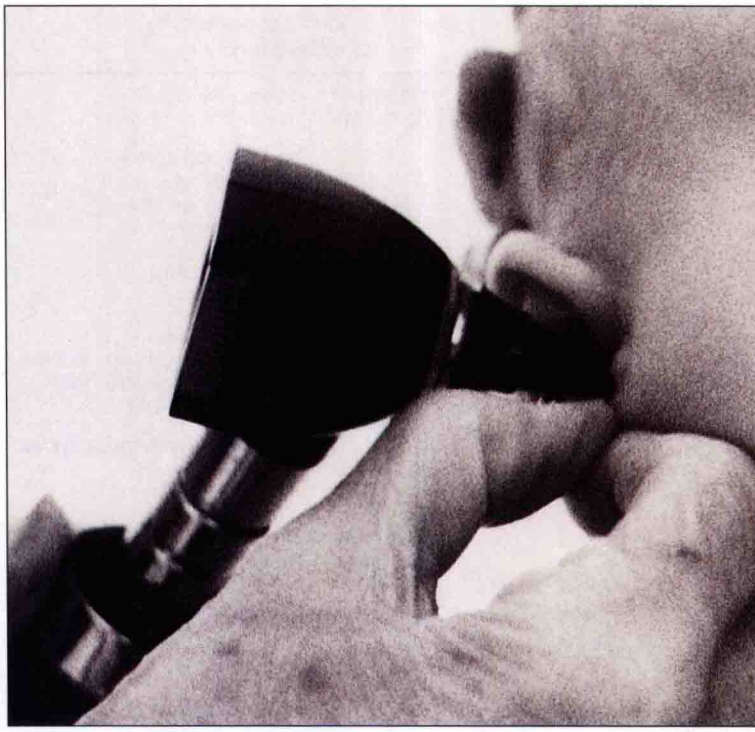
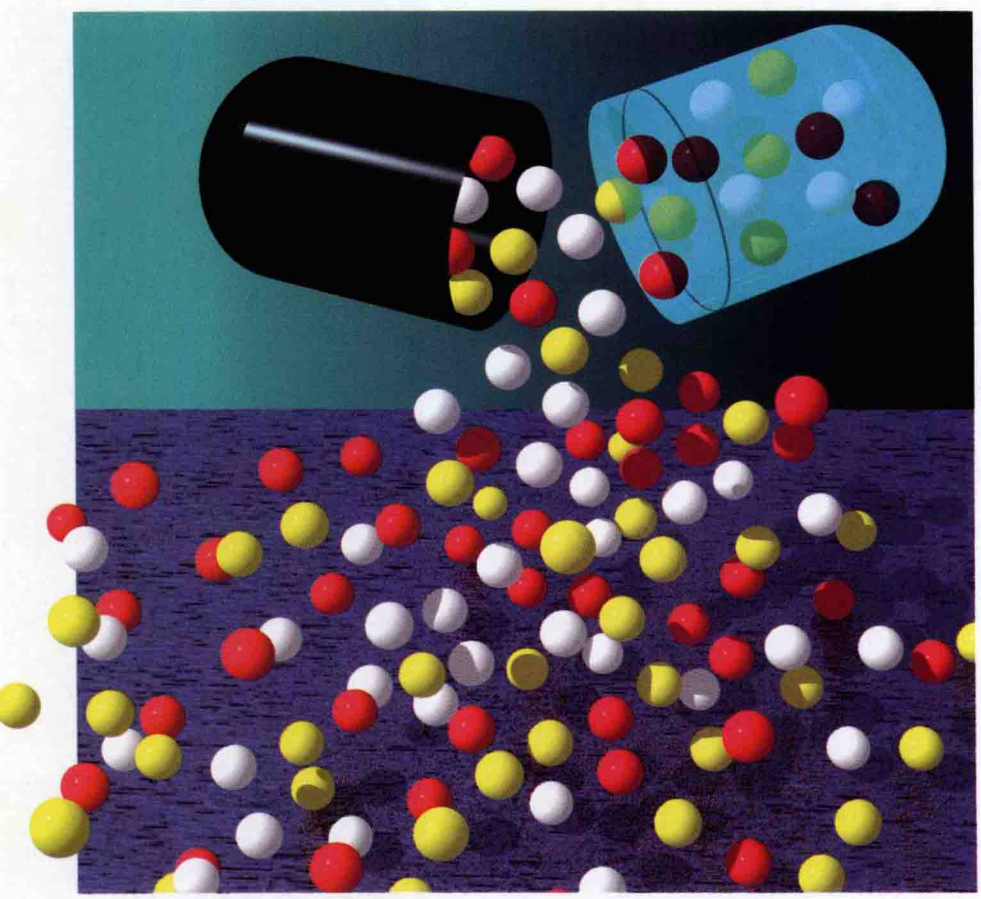
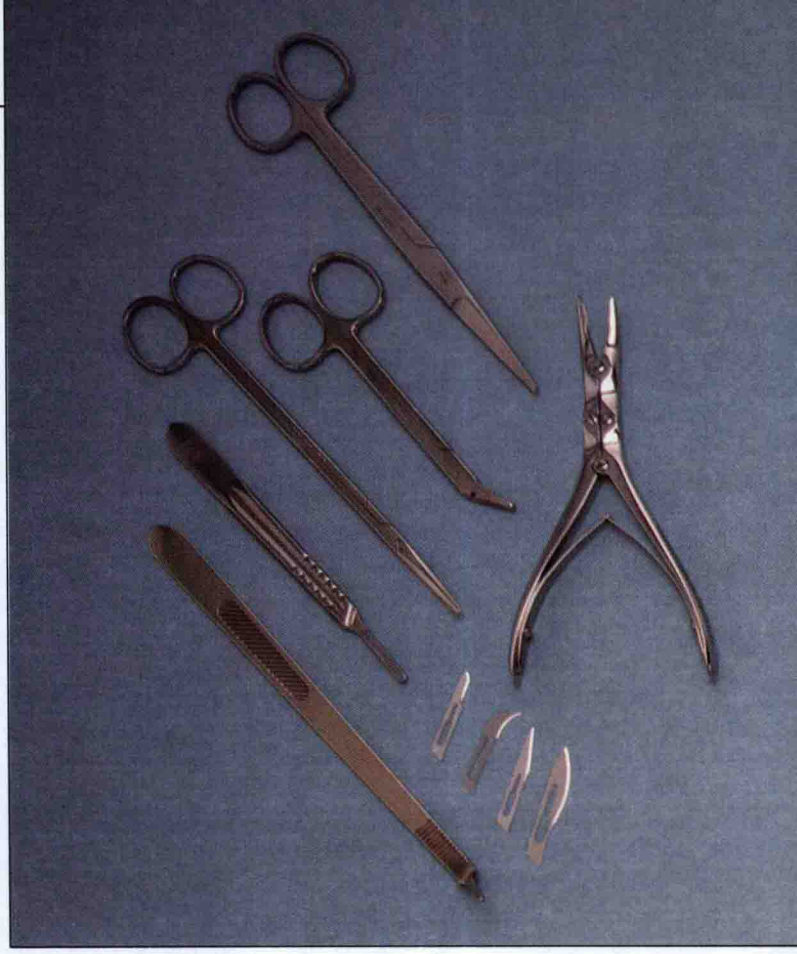


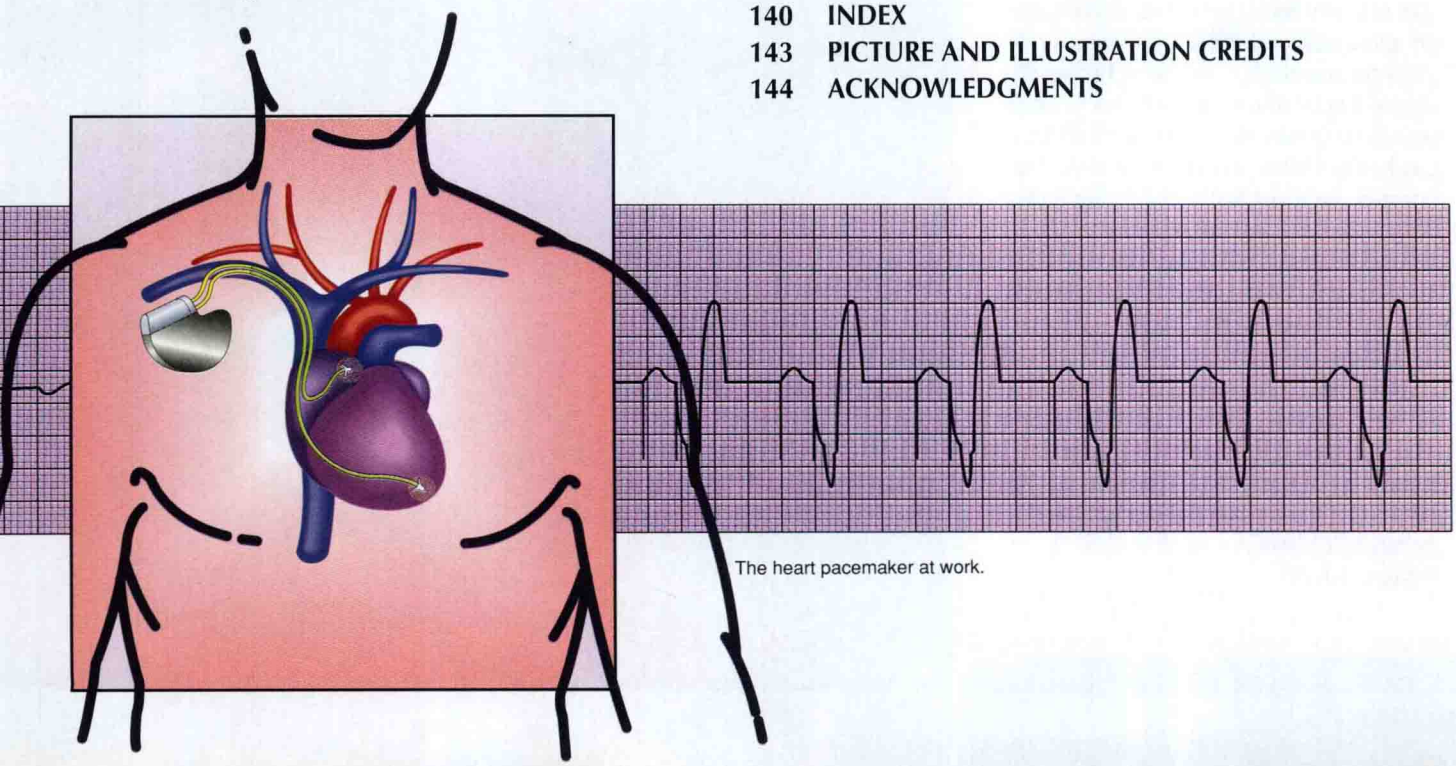
An otoscope is used to examine the ear.



Drug pellets tumble from an opened capsule.



Tools employed in surgery.



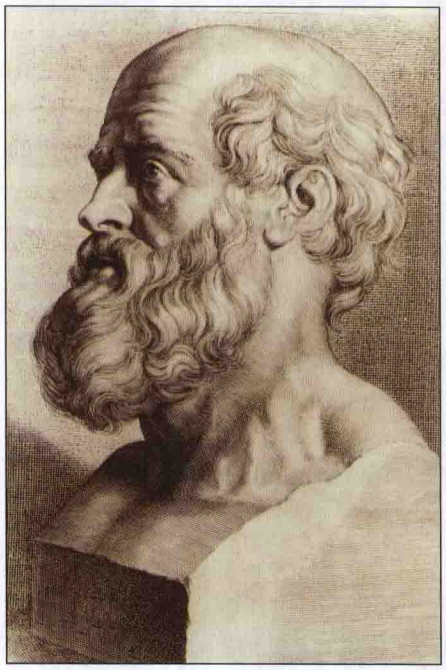
The heart pacemaker at work.

Medicine Meets Science

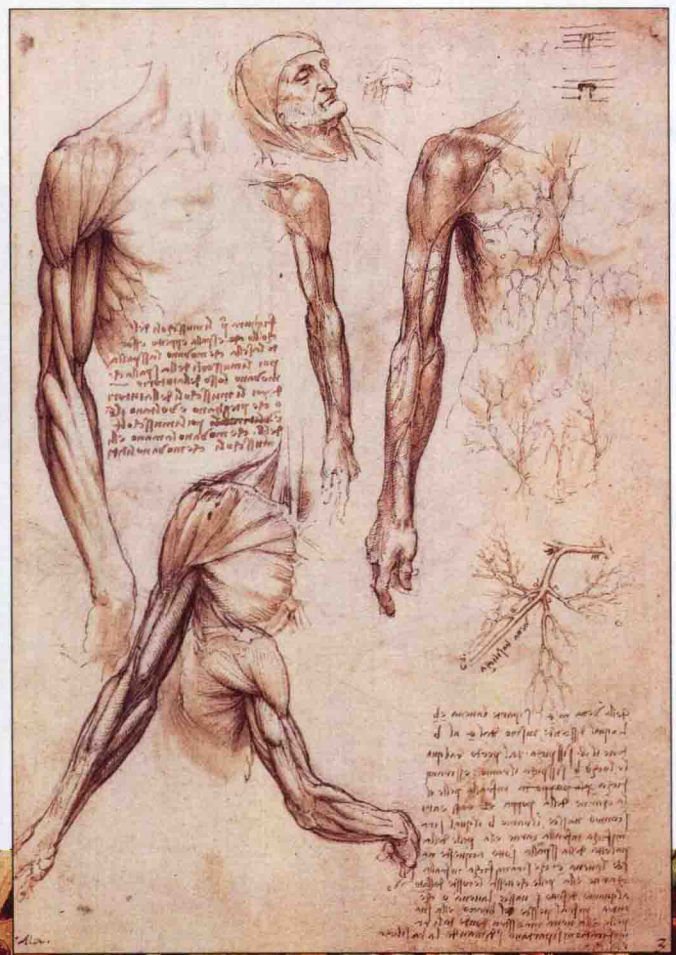
The history of medicine follows a tortuous route, from colorful ancient myths that attempted to explain disease to the astounding capabilities of medicine today. The art of healing underwent a significant transformation in roughly the 4th Century B.C., adopting a rational, scientific approach to the diagnosis and treatment of disease. At the forefront of this new philosophy was a compassionate and methodical Greek doctor named Hippocrates, believed to have contributed to an influential collection of books called the *Corpus Hippocraticum*—Hippocratic Collection. While the methods and theories in this collection appear rudimentary today, their insistence on acute observation and the interpretation of physical evidence were revolutionary, providing the logical base upon which modern medicine rests.

Yet, despite the lucid reasoning of the *Corpus*—and in similar early works by the Egyptians and the Chinese—a conspicuous gap in its teachings is a sound knowledge of the human body. The young sciences of anatomy and physiology remained cloaked in speculation through the Greco-Roman period and much of the medieval era, as religious and moral edicts forbidding human dissection forced pioneer researchers to make educated guesses. Even when the 14th Century brought increased dissection of human corpses—with or without official sanction—often doctors were only capable of seeing what they had already learned from the texts of Galen, a 2nd-Century Greek scientist whose human anatomy studies had been based on animal models.

Bruegel's Triumph of Death *(c. 1556) captures the horror of the bubonic plague. Known as the* Black Death, *the disease decimated Europe after being introduced to Italy by Crusaders returning from Crimea in 1348.*



Hippocrates, the "Father of Medicine," is regarded as the most influential medical teacher in history. Thought to have lived between 460 and 355 B.C., he wrote and compiled contemporary works on the art of healing.



Perhaps the most enduring of all medical misconceptions was the Greek notion that health depended on the proper balance of four liquid elements, or humors: blood, phlegm, yellow bile and black bile. Each was associated with a dominant organ and a certain personality type, as illustrated below. Even though Leonardo da Vinci sketched very accurate anatomical drawings in the 15th Century (left), *doctors still had much to learn about the human body.*

Blood

Heart : Cheerful

Phlegm

Brain : Unexcitable

Black bile

Spleen : Depressive

Yellow bile

Liver : Hot-tempered

Medical Renaissance

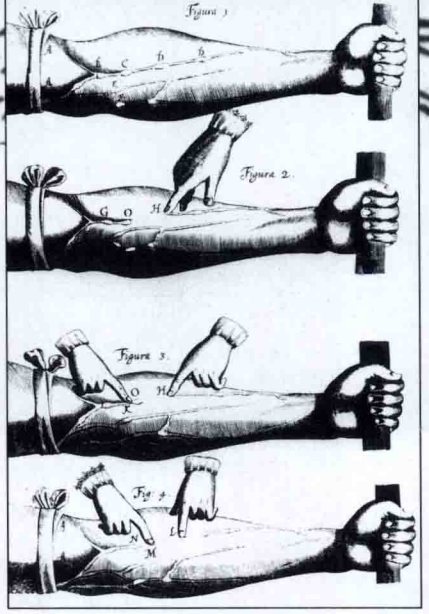
Science flourished in the 16th and 17th Centuries, as the Protestant Reformation permitted ideas that the medieval church would have condemned as heresy. Anatomists explored the human body in ever-greater depth, and the adventurous minds of the European Renaissance embraced theories that—while often seeming as incredible as medieval superstitions—were to prove scientifically viable.

A new explanation of infection, for example, was proposed by the Italian physician Girolamo Fracastoro; he hypothesized that plagues were carried by agents—invisible to the eye. Although he had no means of verifying the existence of these microorganisms, Fracastoro's theory was correct.

Physicians were repositories of an ever-increasing body of knowledge. With their new learning, doctors demanded higher fees for their services, and often catered to a wealthy urban clientele; sick people from poor and rural populations took their illnesses to apothecaries or to barbers whose services included surgery.

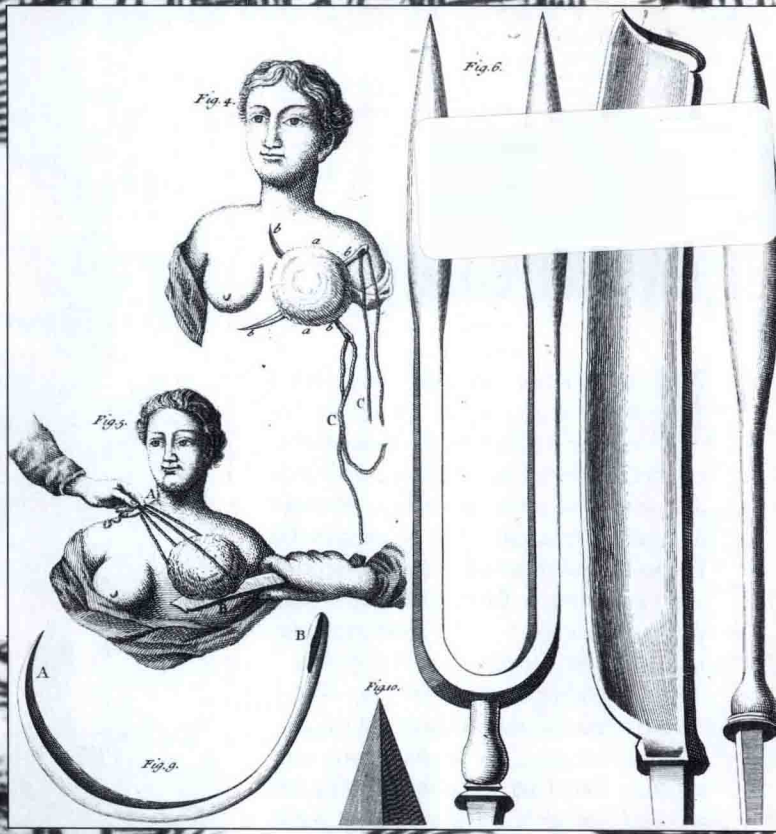
Forerunners of modern-day pharmacists, early apothecaries were grocers who also stocked the herbs, spices and minerals prescribed by doctors. Barber-surgeons, after a long tradition outside the margins of respectable medicine, applied the scientific knowledge of the day to ailments such as fractures, wounds, tumors and skin disease. Battlefield emergencies spawned a number of surgical innovations, and the textbook *A Universal Surgery*, by the French Army surgeon Ambroise Paré, elevated the practice to a new level of effectiveness.

This woodcut, from the surgical text Opus Chirurgicum, *suggests the vigorous atmosphere in a Renaissance hospital. Whereas physicians had traditionally taken their apprenticeship exclusively in universities, hospitals were becoming an increasingly important training ground.*



Today's understanding of the circulation of blood was first presented to the medical world in 1628, when William Harvey published On the Movement of the Heart and Blood in Animals, *from which the woodcut* (left) *is extracted. The illustration was used to prove the complementary role of arteries and veins. Ceramic apothecary jars such as this one, from 16th-Century Italy* (right), *contained increasingly exotic drugs as travel increased between Europe, Asia and the Americas.*

The practice of surgery made great strides during the Renaissance, both in technique and respectability. This page (right) from a later surgical text illustrates techniques of mastectomy, as well as displaying some of the instruments employed.



Fighting the Invisible Enemy

With the late-17th-Century invention of the microscope, by Dutch experimenter Anthony van Leeuwenhoek, doctors could see visual evidence of the existence of bacteria; the role of these microbes as agents of contagious disease remained to be proven. While advances continued on all fronts of medicine—the development of anesthesia, for example—many breakthroughs during the next two centuries related to infection.

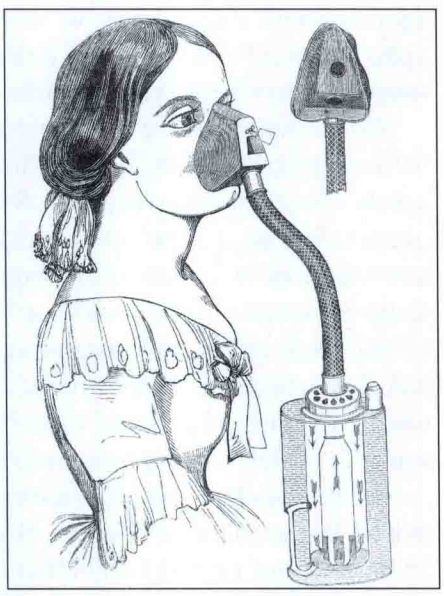
The combined work of three individuals clarified the relationship between microscopic invaders—such as the smallpox virus—and infection. Louis Pasteur, a French chemist, first ascribed biochemical actions, such as putrefaction, to bacteria. British surgeon Joseph Lister, who used sterilization to kill microorganisms in the operating room, reduced the ravages of surgical infection. And Robert Koch, a German doctor, spearheaded the identification of specific bacteria associated with communicable diseases.

The development of the smallpox vaccination stands as one of the most important medical achievements of all time. Until the English physician Edward Jenner courageously vaccinated a healthy boy with noxious matter from a cowpox pustule—thereby putting the immune system on guard against other poxes—this disfiguring and often fatal virus had taken a dreadful toll.

Medical science had made great strides since the days of Hippocrates, laying the groundwork for even more astonishing innovations in diagnosis and restorative treatment. Today, on the eve of the 21st Century, medicine's progress is no less astounding.

Two pillars of modern surgery, anesthesia and sterile technique, can be observed in this early 20th-Century operating room: An anesthesiologist holds a gauze mask containing anesthetic, and all members are dressed in sterile garb. Despite these advances, questionable patent medicines, such as the French anemia cure (above left), *grew in popularity.*

Louis Pasteur observes as an assistant vaccinates a young patient in 1885. Best known for proving that bacteria and viruses are a cause of disease, the French chemist made several contributions to medicine, including refinements to immunization.



This chloroform inhaler, from an 1858 textbook, was one of the earliest devices used to administer anesthesia. Medicine entered a new era in 1846 when the medical community witnessed a demonstration of surgery without pain.

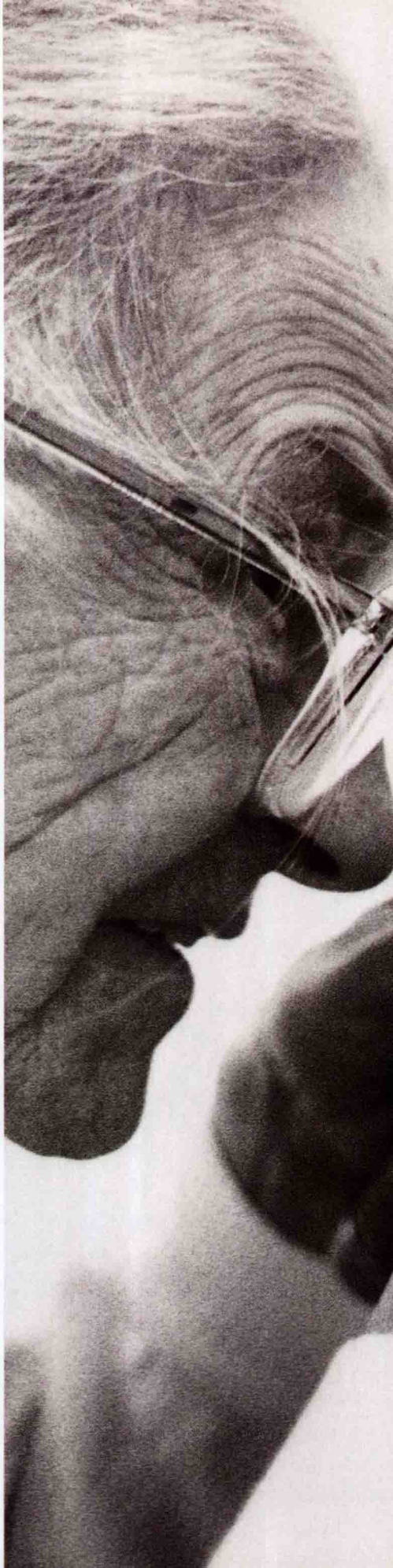
DIAGNOSTIC DEVICES

At first, it appeared to be simple infant crankiness. But over the next few weeks, the baby's periodic whines yielded to inexplicable outbursts of crying, giving her perpetually tired eyes. Recently, her skin has become pale, her play listless; her appetite has diminished steadily over the last 10 days and today she is running a fever. Even at this stage, it may be nothing serious, but the parents prefer to consult a doctor.

Such vague ailments have challenged medicine since the days of Hippocrates. In the past, physicians relied mainly on their former experience and their senses when making a diagnosis. They prodded and squeezed, put their heads against patients' chests to hear the rush of air and the swish of fluids. They listened to the creaks of the joints and the rumble of the intestines, smelled the breath and sometimes even tasted patients' urine—sweetness was a sure sign of diabetes.

Now, physicians have at their command diagnostic tests and equipment exceeding anything known to the house-calling general practitioner of yore. Today's therapeutic armory embraces the very latest in medical technology, from biochemical assays to massive, computer-driven machines and electronic "eyes" that can peer into every nook and cranny of the body. There are systems for counting blood cells, gauging hormone levels, monitoring blood toxins and measuring the balance of essential body chemicals. Electronic sensors compile graphic records of heart function, nerve impulse and brain activity. Viewing systems for probing the body's interior go well beyond the basic X-ray camera, employing everything from sound waves to nuclear particle beams and delivering live-action photos.

Machines aside, a good diagnostician requires the skills of a master detective. Indeed, the paradigmatic Sherlock Holmes was modeled on a late-19th-Century Scottish doctor named Joseph Bell, whose celebrated diagnostic skills had impressed the young medical student and future author, Arthur Conan Doyle. Like the mythic Holmes—and real-life Bell—medical sleuths are masters of deduction, alert to little clues that conglomerate to form a total picture: Expressionless face,



The art of doctoring assumes not only an encyclopedic knowledge of the human body—such the form and function of this young patient's inner ear—but also keen powers of observation and deduction, as well as gentleness and compassion.

shuffling gait, hand tremors, along with the peculiar muscular stiffness known as cogwheel rigidity? Elementary, my dear Watson, the patient seems to have a neurological disorder, perhaps Parkinson's disease. A warm, moist handshake? Possibly a hint of hyperthyroidism. A "cold fish" handshake? Quite probably nervous tension. Slumped shoulders, sad expression, avoidance of eye contact: signs of depression. Fidgeting, clenched fists, leaning forward in chair: anxiety. Observant physicians start gathering evidence as to the state of their patients' health from the moment the office door opens.

Once the cause of a patient's complaint has been identified, the physician can call upon an impressive arsenal of tools and techniques to bring about a cure. Today's pharmacopeia is light years beyond the herbal elixirs used by physicians even a century ago. The development of antibiotics has revolutionized medical practice so that rheumatic fever, typhoid fever, syphilis and many other infectious diseases no longer carry a probable death sentence. The list of available antimicrobials numbers in the thousands, with new ones being added weekly. At the same time, drug researchers ply other spheres in search of new cures. They analyze the juices of tropical plants, restructure the molecules of proteins and petrochemicals, and call upon the advanced techniques of genetic engineering to synthesize everything from the insulin needed by diabetics to the interferon being used in experimental cancer treatment.

Sometimes even a preliminary diagnosis will send a patient straight to the operating table. The symptoms of heart disease, for example, can range from a burning sensation in the chest and throat, shortness of breath, or violent pains in the left shoulder and arm, to nothing more than a strange, ill-defined lethargy. After a number of preliminary tests, the doctor will have a reasonably sure idea where the problem lies. Then, to gauge its severity, he may call for an angiogram. This is an X-ray procedure that reveals the exact location and degree of blockage in the patient's coronary arteries, leading to the heart. Should the constriction appear life threatening, the patient may find himself booked into the hospital for a procedure known as balloon angioplasty. Guided by a moving X-ray image, a tiny balloon will be threaded by catheter into an artery in the patient's leg, then up to the occluded artery. At the target site, the balloon will be inflated, compressing the buildup of fatty material against the artery's walls so that blood can once again flow freely to the heart.

In emergencies, of course, physicians may have to apply treatment even before the cause of the problem has been found. Every day, thousands of people check into hospital emergency rooms, and though in most cases the reason is obvious, quite often it is not. Some have cuts and bruises apparent to the eye, others, broken bones immediately detectable by examination or X ray. Food poisoning and most common illnesses can usually be identified by a quick physical check and by questioning the patient.

But what if the patient arrives in a coma? Perhaps his heartbeat is diminished or his breathing has stopped. All effort is directed at cardiopulmonary resuscitation: the chest is massaged, a breathing tube is inserted and an injection of drugs may be given in an attempt to revive the heart. Then, when the patient has been temporarily stabilized, he can be tested for the underlying condition so that doctors can begin addressing it.

THE BODY'S SYSTEMS

Although it is most commonly perceived as a single functioning unit, the human body is, in fact, a collection of interdependent physiological teams, each with its own responsibilities and potential ailments. The two branches of the musculoskeletal system work in concert to form a mobile structure for the body. Even while that system is at rest, others remain in constant activity: The nervous and endocrine systems, for example, as well as the circulatory, respiratory, digestive and urinary systems, operate without cease to keep the body alive. When presented with symptoms of ill health, the diagnostician's first task is to assess which of the body's systems is at fault.