The Nineteenth Century — The Beginnings of Modern Medicine

PLAN.

1. The Industrial Revolution / inventions.
2. Public Health.
3. Chemistry and Pharmacology.
4. Microscopic Anatomy and Embryology.
5. Anesthesia.
6. Education and Licensure

The Industrial Revolution / inventions

There was a general atmosphere of scientific research and advance.

Louis Pasteur's first commission was to find a **cure for sour wine**, which set him off on his revolutionary course.

Joseph Jackson Lister (Britain: 1826) invented the **multi-lens microscope**, which allowed doctors to see very tiny things accurately.

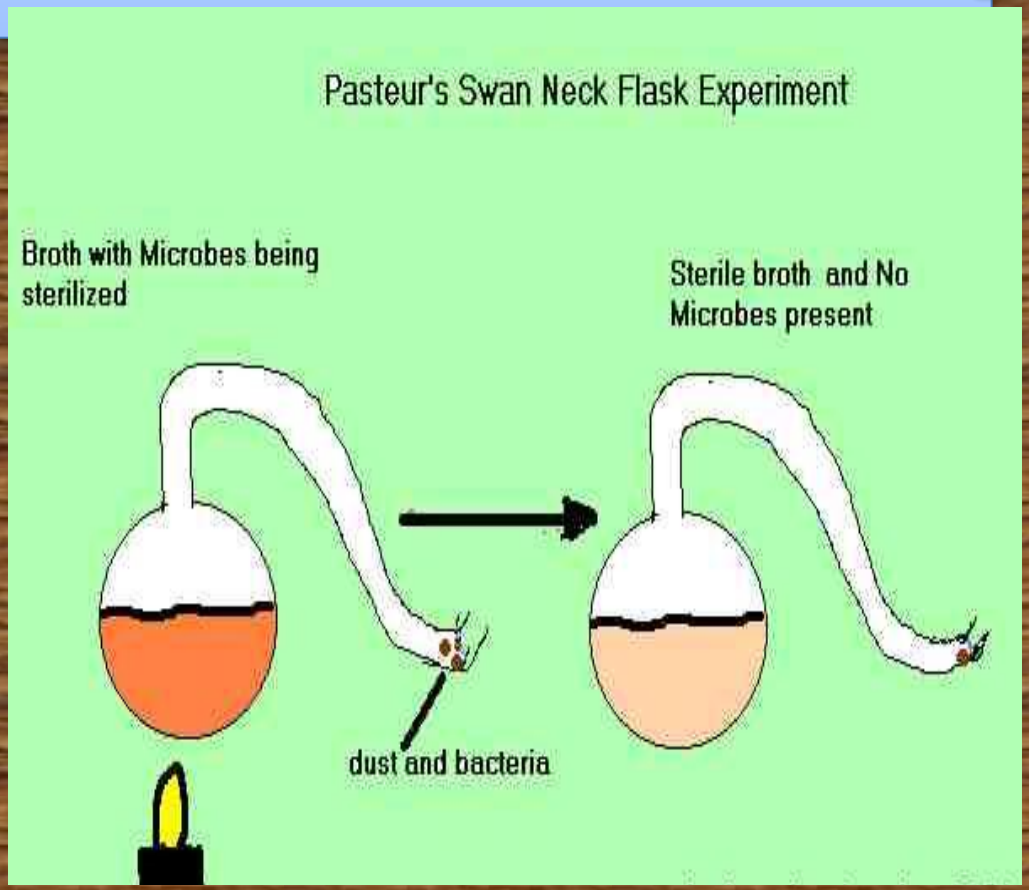
Carl Ludwig (Germany: 1847) invented the kymograph, which allowed more accurate measurement of the **pulse**.

Wilhelm Roentgen (Germany: 1895) discovered **x-rays**.

Willem Einthoven (Holland: 1900) invented
the **electrocardiograph**(measured heart activity).

Louis Pasteur (France: 1860s) discovered (by using a swan-necked flask) that germs cause disease. Before he made this discovery, doctors had noticed bacteria, but they believed it was the disease that caused the bacteria (the so-called theory of 'spontaneous generation') rather than the other way round.

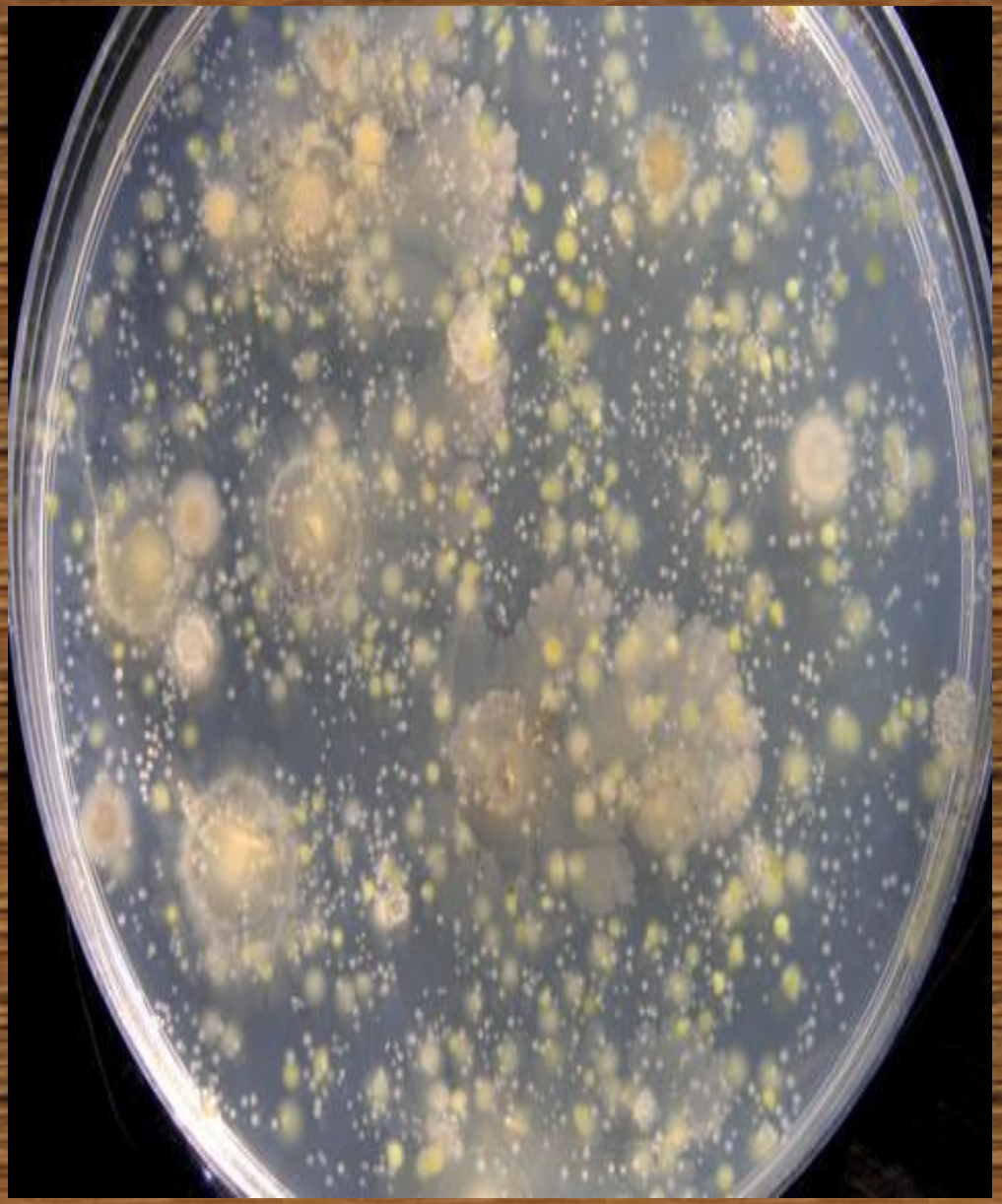
One of the spin-offs of Pasteur's discovery was the *pasteurisation* of milk, which prevented it from going sour by killing the germs and sealing it from the air.



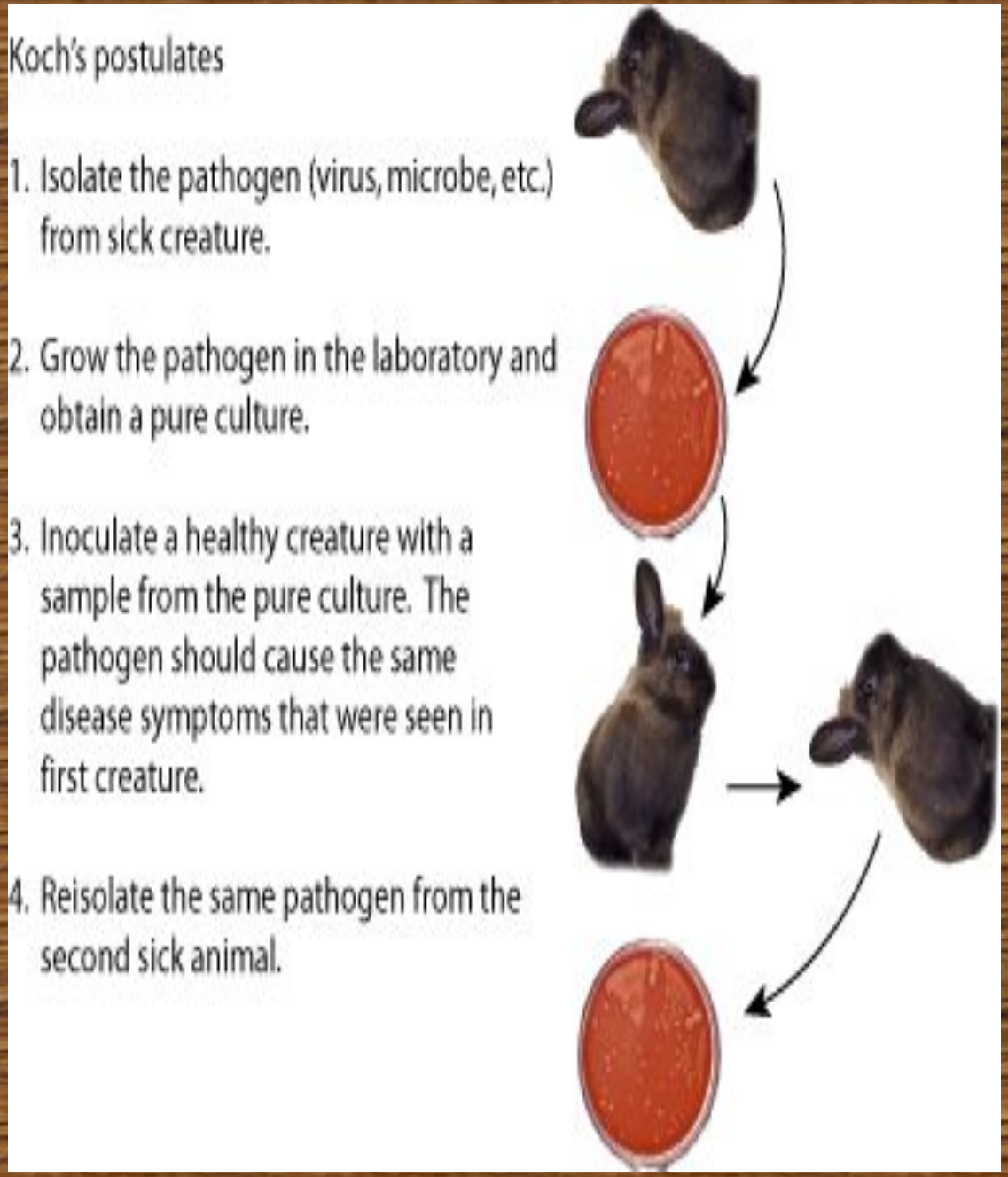
Other scientists also made crucial discoveries, among them:

Robert Koch (Germany: 1878), who discovered how to stain and **grow bacteria** in a Petri dish (named after his assistant Julius Petri). He was thus able to find which bacteria caused which diseases:

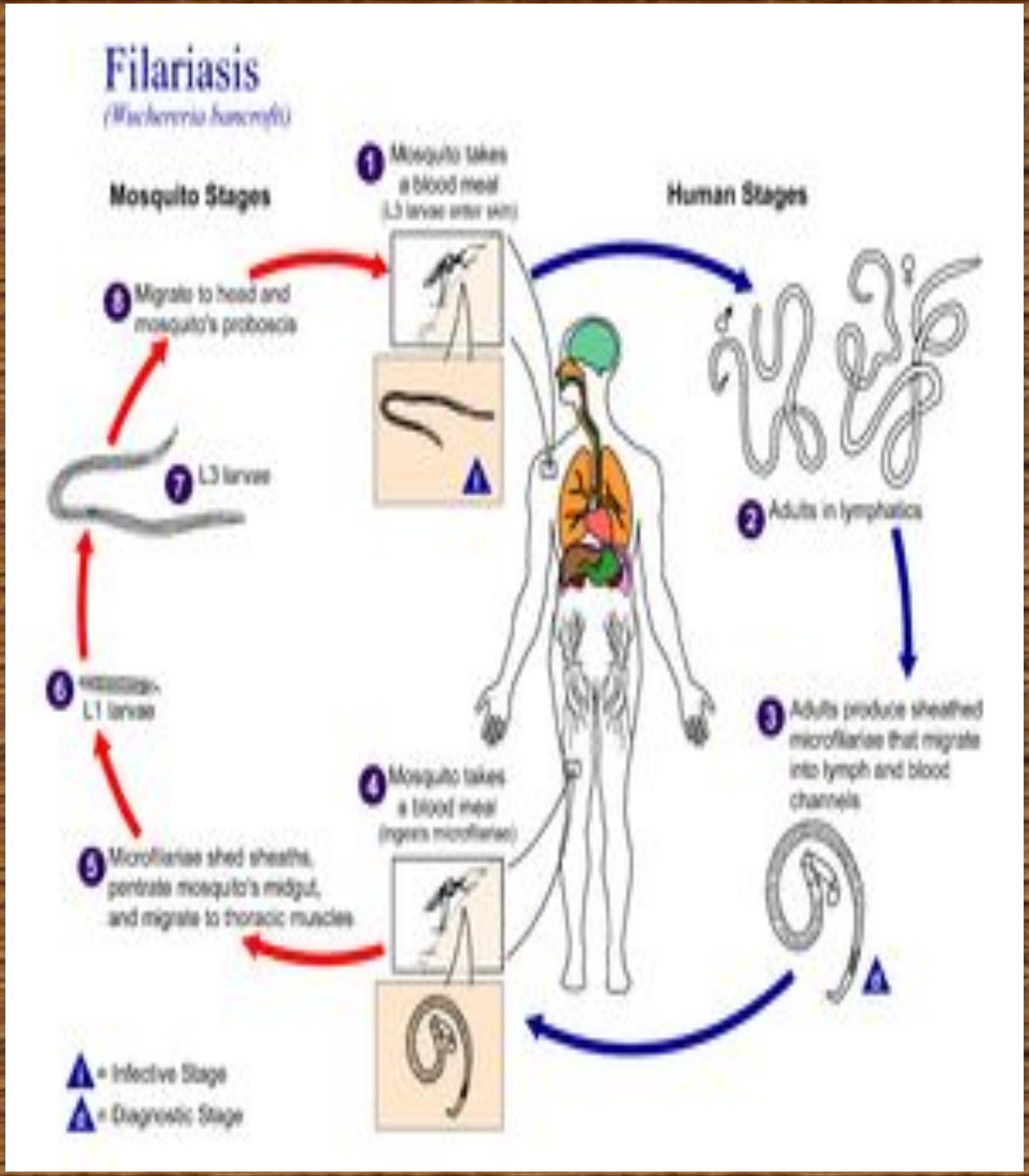
- septicaemia (1878)
- TB (1882)
- cholera (1883).



Robert Koch developed his **Postulates** of how researchers should find a disease. These led to four basic procedures - **make sure** the germ in question is present in the sick specimen - **grow** a culture of that germ - **inject** it into a healthy specimen - **see** if the disease develops.

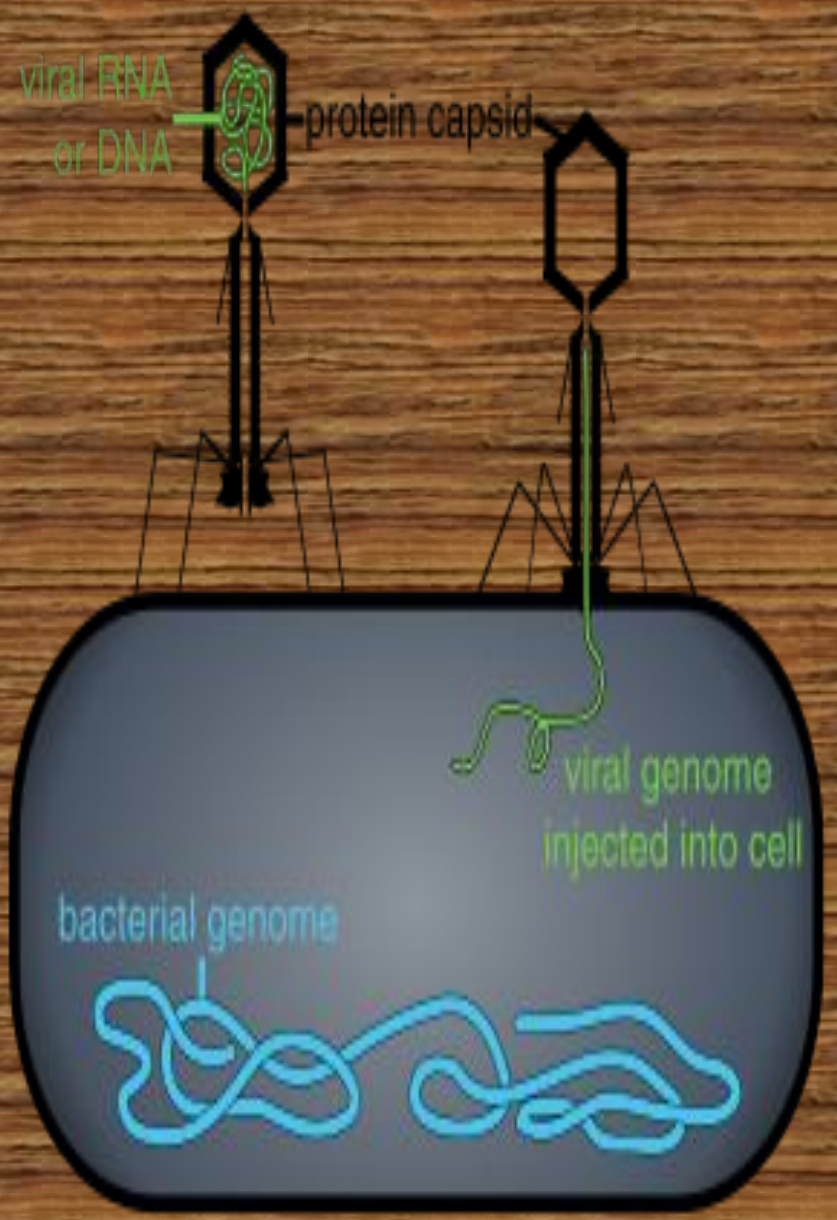


Patrick Manson (Britain: 1876) discovered that elephantiasis was caused by a nematode worm, and that mosquitoes were the vector (carrier). This was a **breakthrough discovery**, because researchers soon found out that other tropical diseases were transmitted by vectors such as mosquitoes (malaria and yellow fever) or tsetse flies (sleeping sickness).



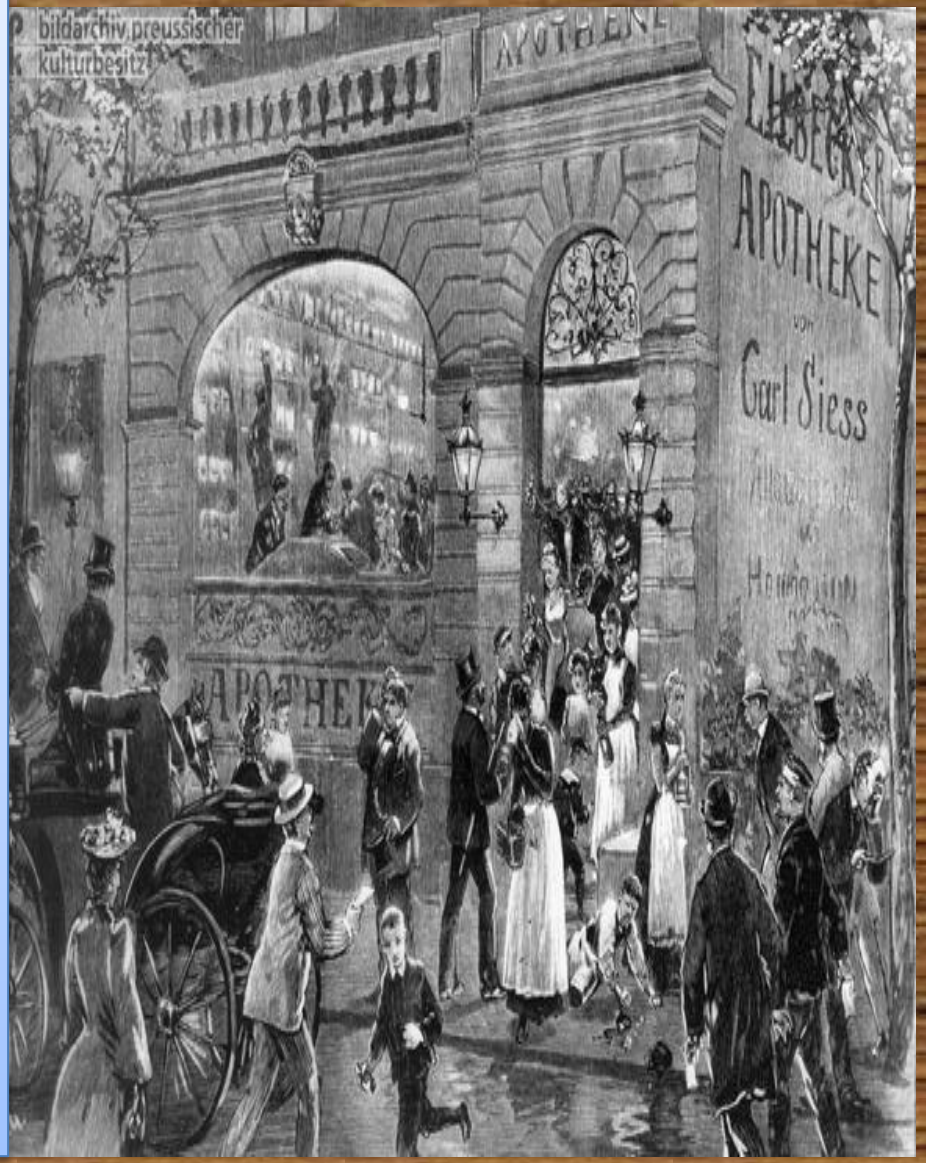
Charles Chamberland

(France: 1884) found that there are organisms even smaller than bacteria that also cause disease - he had discovered **viruses**.

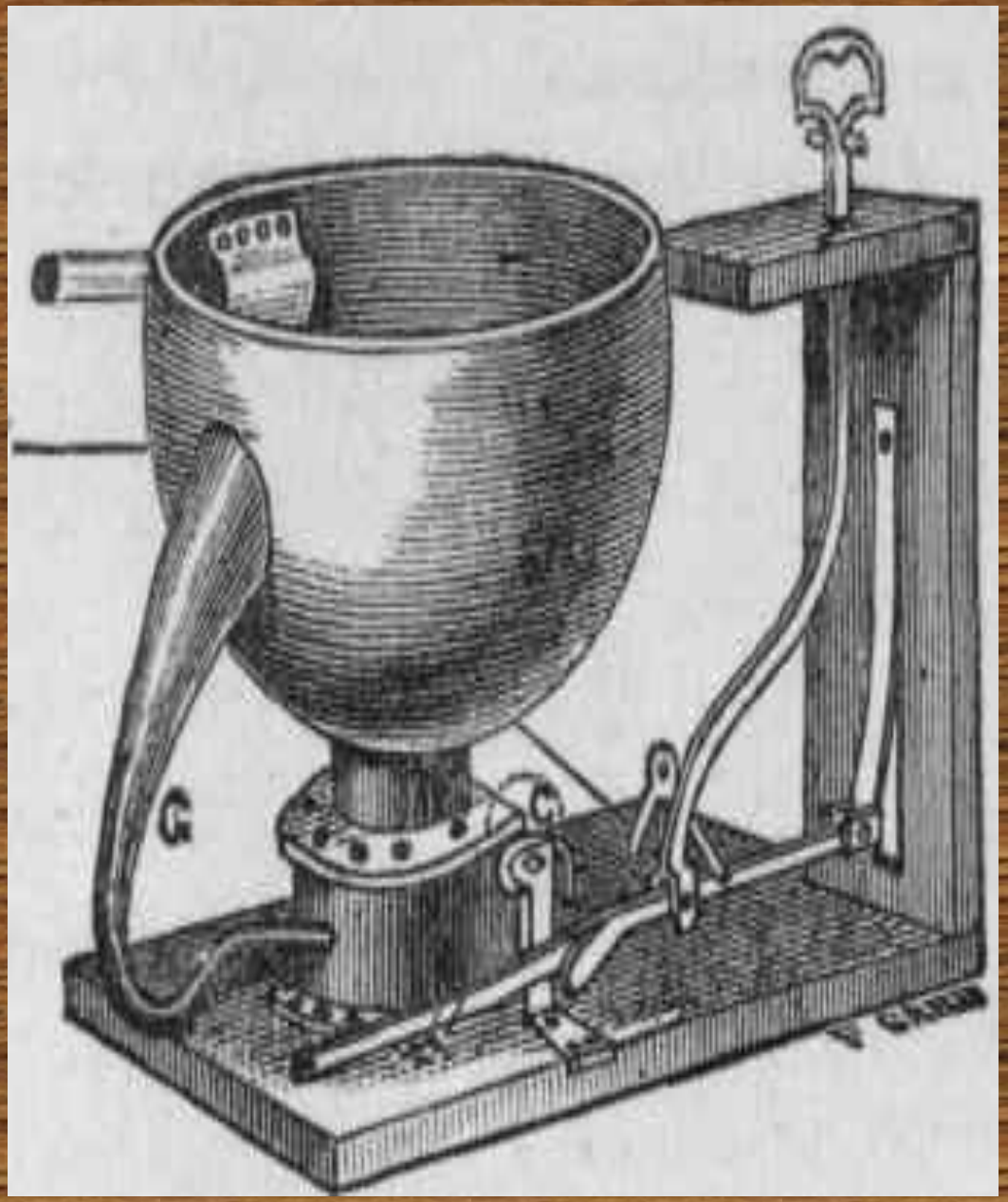


Public Health

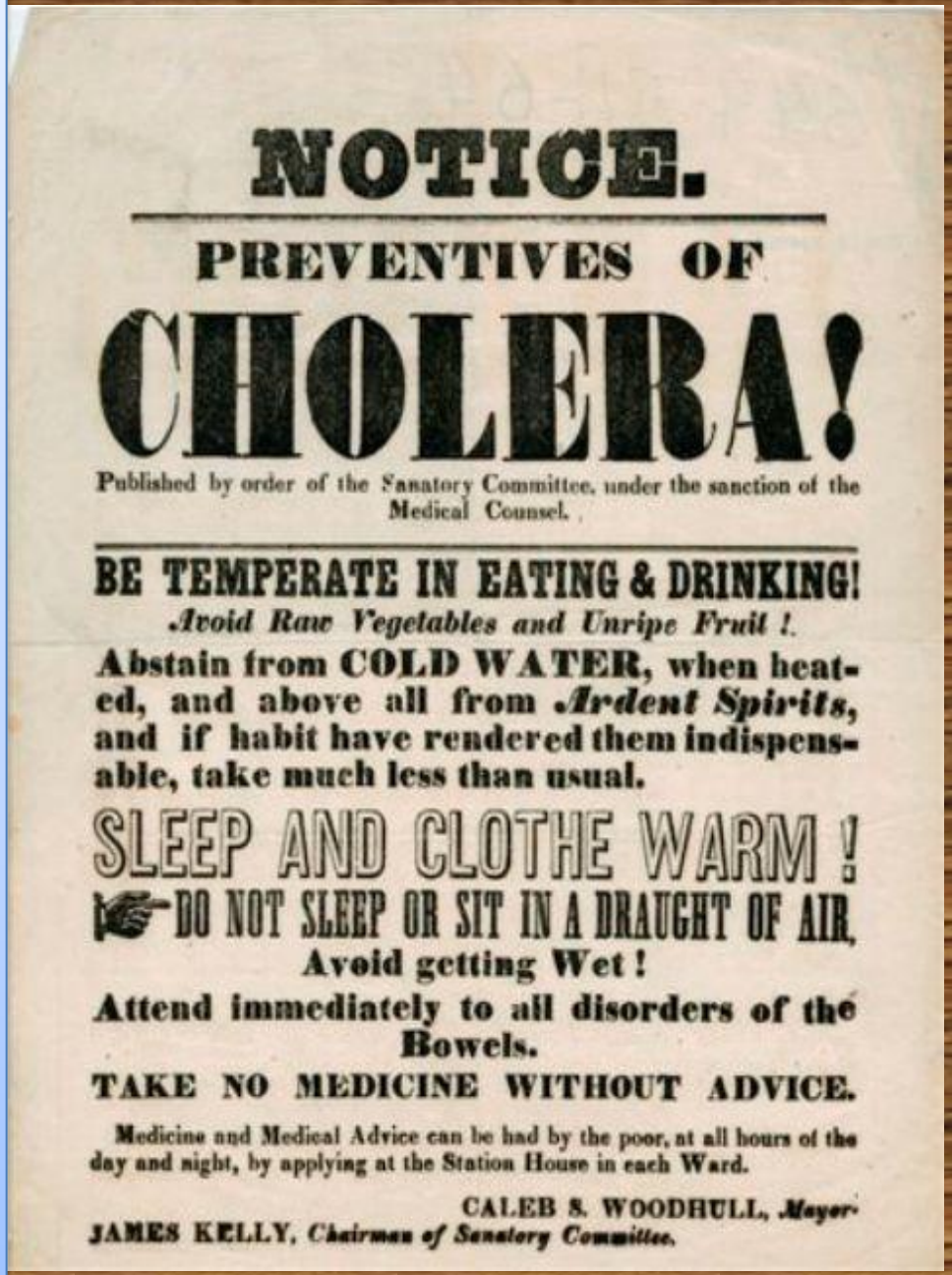
The conditions of factory workers, the spread of slums, and the interdependence of communities and nations also affected medical practice.



Before the discovery of bacteria as the causes of disease, the principal focus of preventive medicine and public health had been on sanitation



Epidemics continued to devastate cities and countriesPlanned attacks on cholera, typhoid fever, and other pestilences only became feasible after the causes were discovered in the bacteriological era.



NOTICE.

PREVENTIVES OF

CHOLERA!

Published by order of the Sanatory Committee, under the sanction of the Medical Counsel.

BE TEMPERATE IN EATING & DRINKING!

Avoid Raw Vegetables and Unripe Fruit !.

Abstain from COLD WATER, when heated, and above all from *Ardent Spirits*, and if habit have rendered them indispensable, take much less than usual.

SLEEP AND CLOTHE WARM !

DO NOT SLEEP OR SIT IN A DRAUGHT OF AIR.

Avoid getting Wet !

Attend immediately to all disorders of the Bowels.

TAKE NO MEDICINE WITHOUT ADVICE.

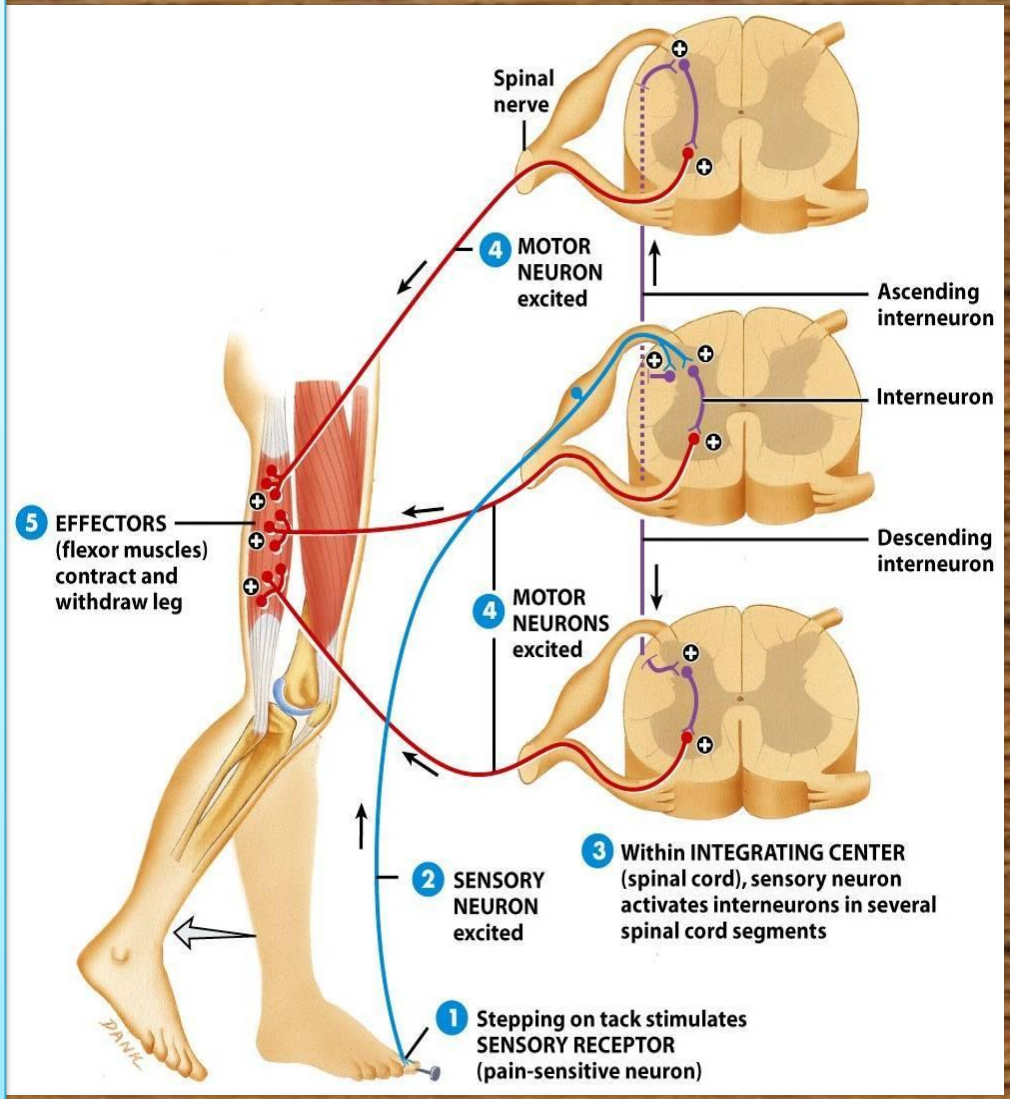
Medicine and Medical Advice can be had by the poor, at all hours of the day and night, by applying at the Station House in each Ward.

CALEB S. WOODHULL, *Mayor.*

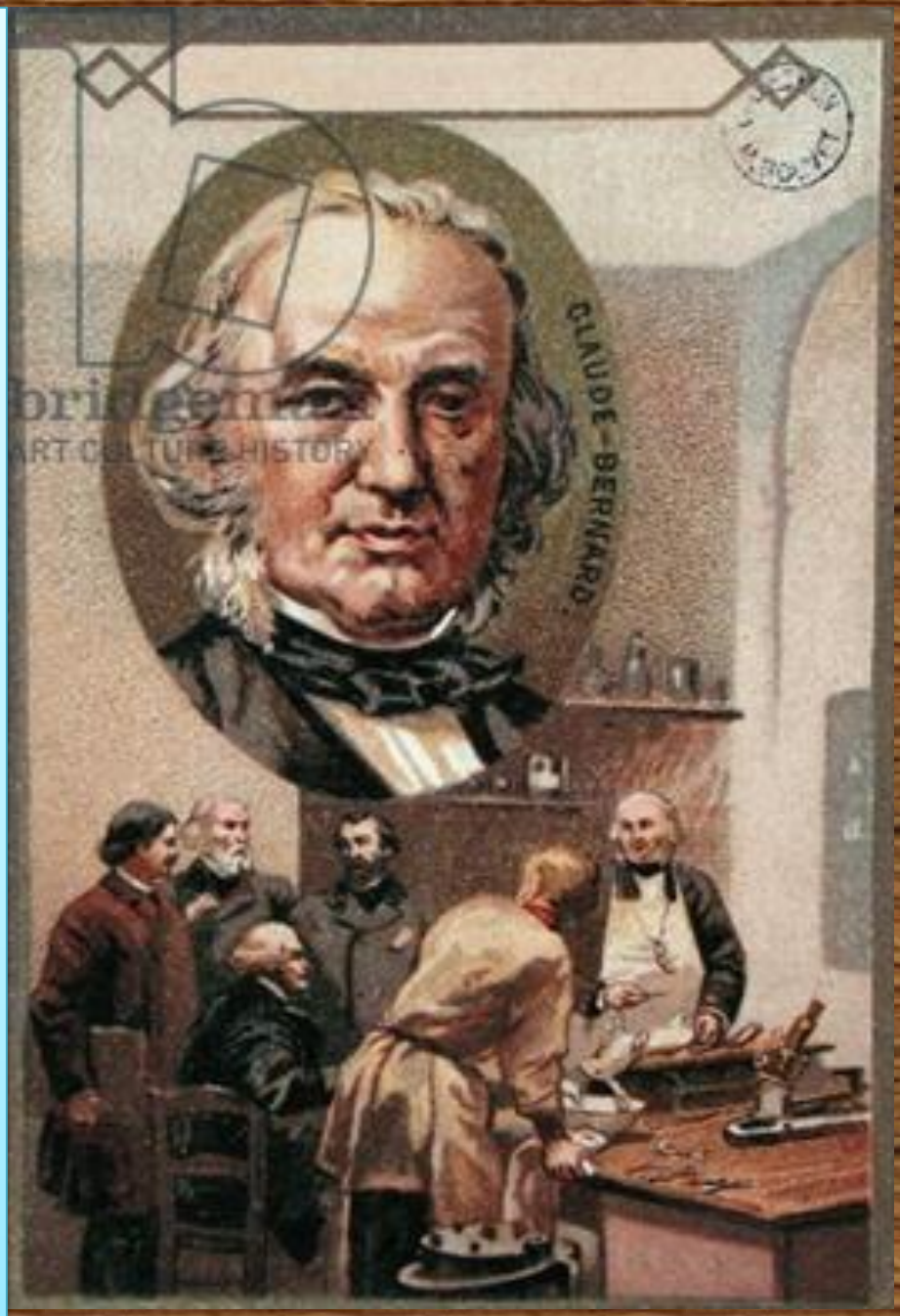
JAMES KELLY, *Chairman of Sanatory Committee.*

Physiology

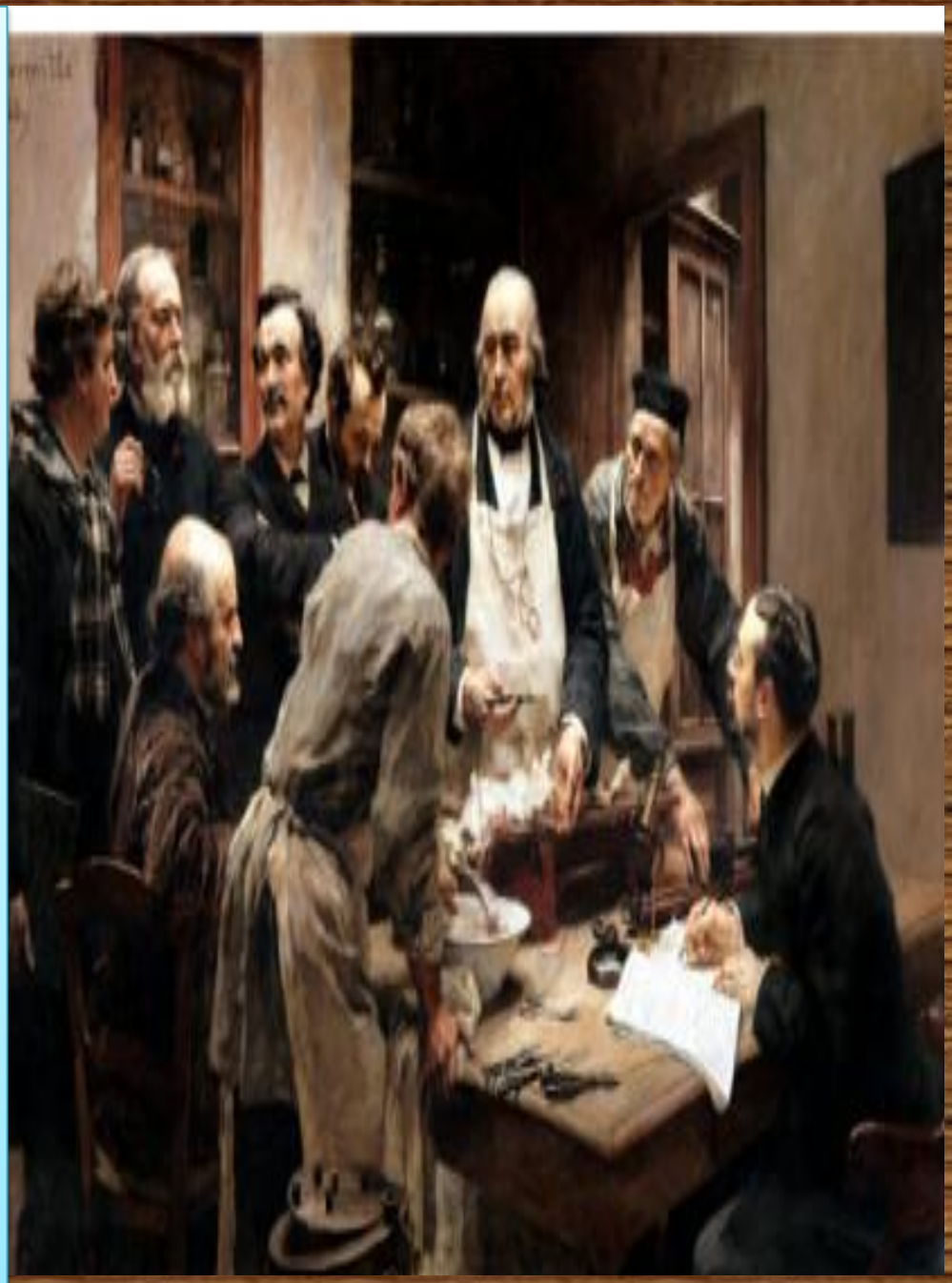
"Bell-Ma gendie law."



Claude Bernard further developed the precepts of his teacher Magendie, postulating questions that could be answered only through experimental vivisectional techniques, which he perfected into elegant experiments.

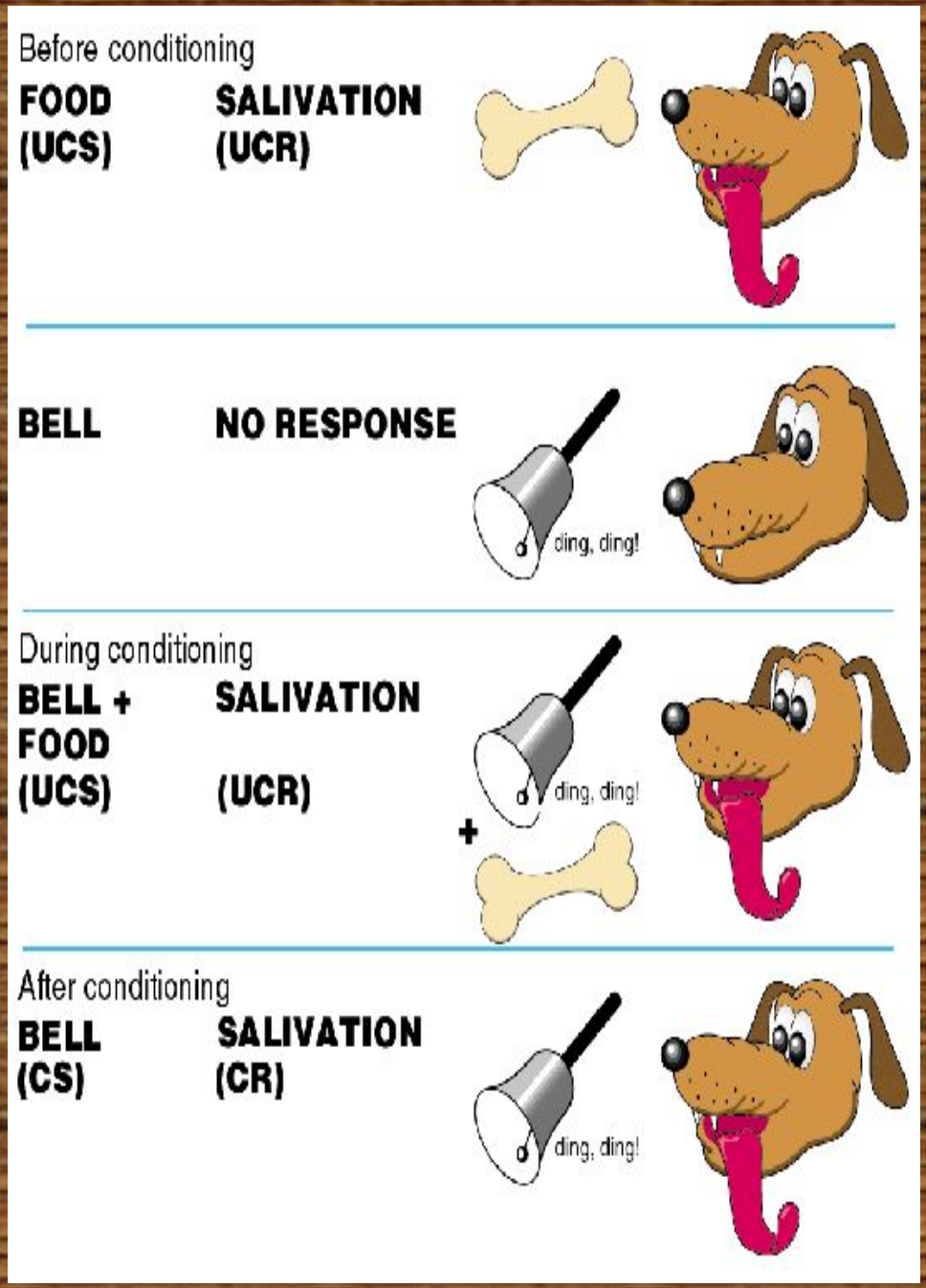


Bernard clarified the multiple functions of the liver, studied the digestive activity of the pancreatic secretions and the association of the pancreas with diabetes, and pointed out the connection of the nervous system with the constriction and dilation of the smaller arteries.



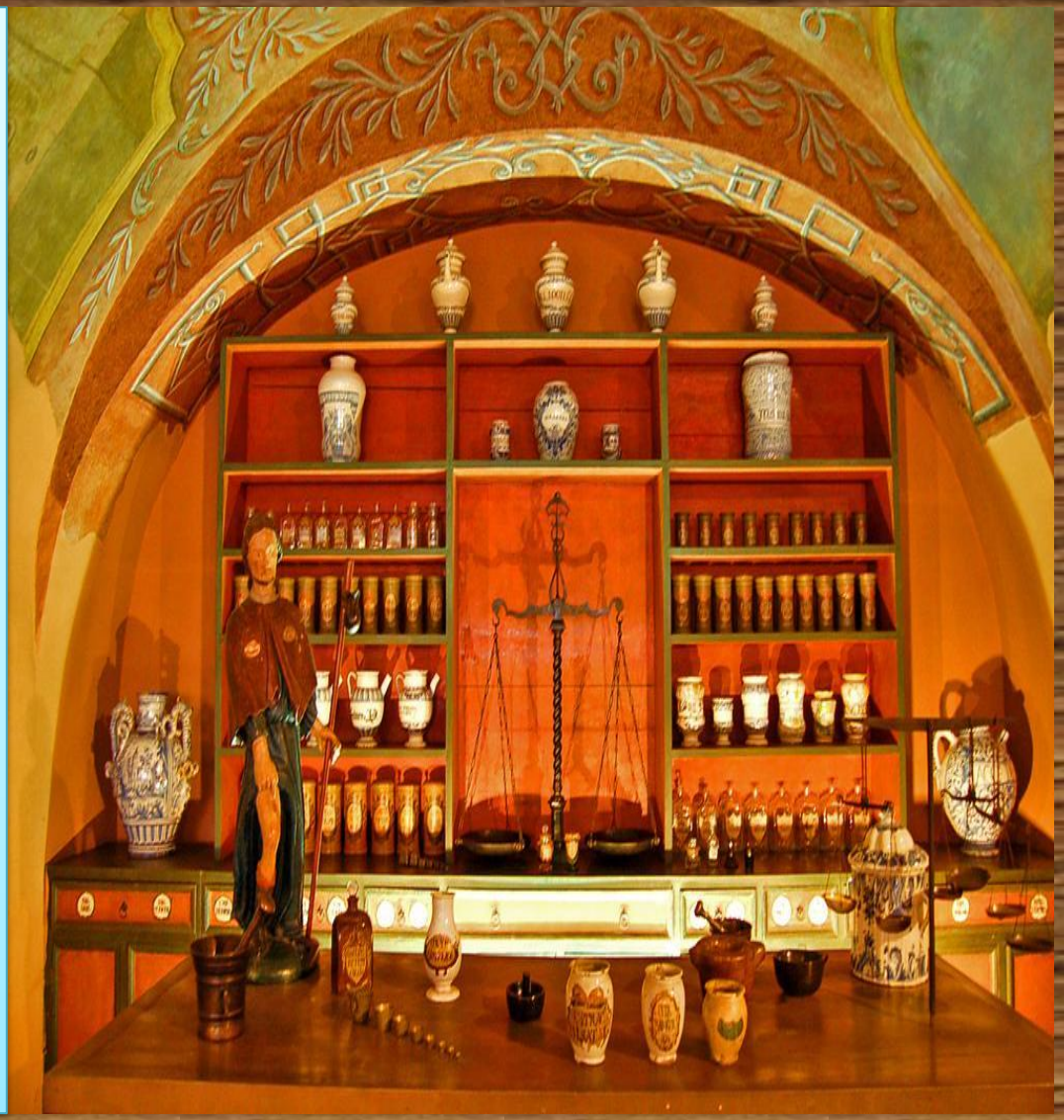
Charles Edouard Brown-Sequard (1817-94) is sometimes considered the founder of endocrinology.

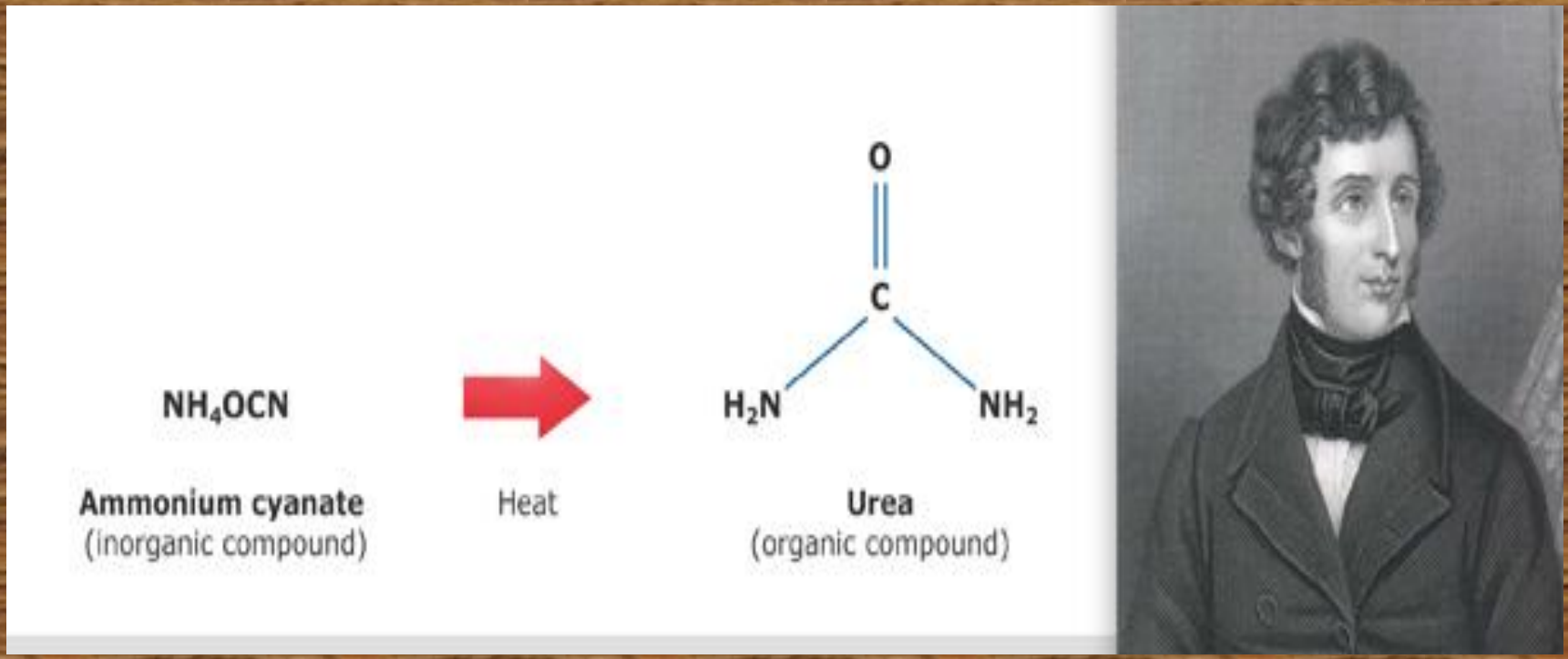
A far-reaching influence on physiology and on subsequent attitudes toward behavior came from the experiments on animals by Ivan Pavlov in Moscow.



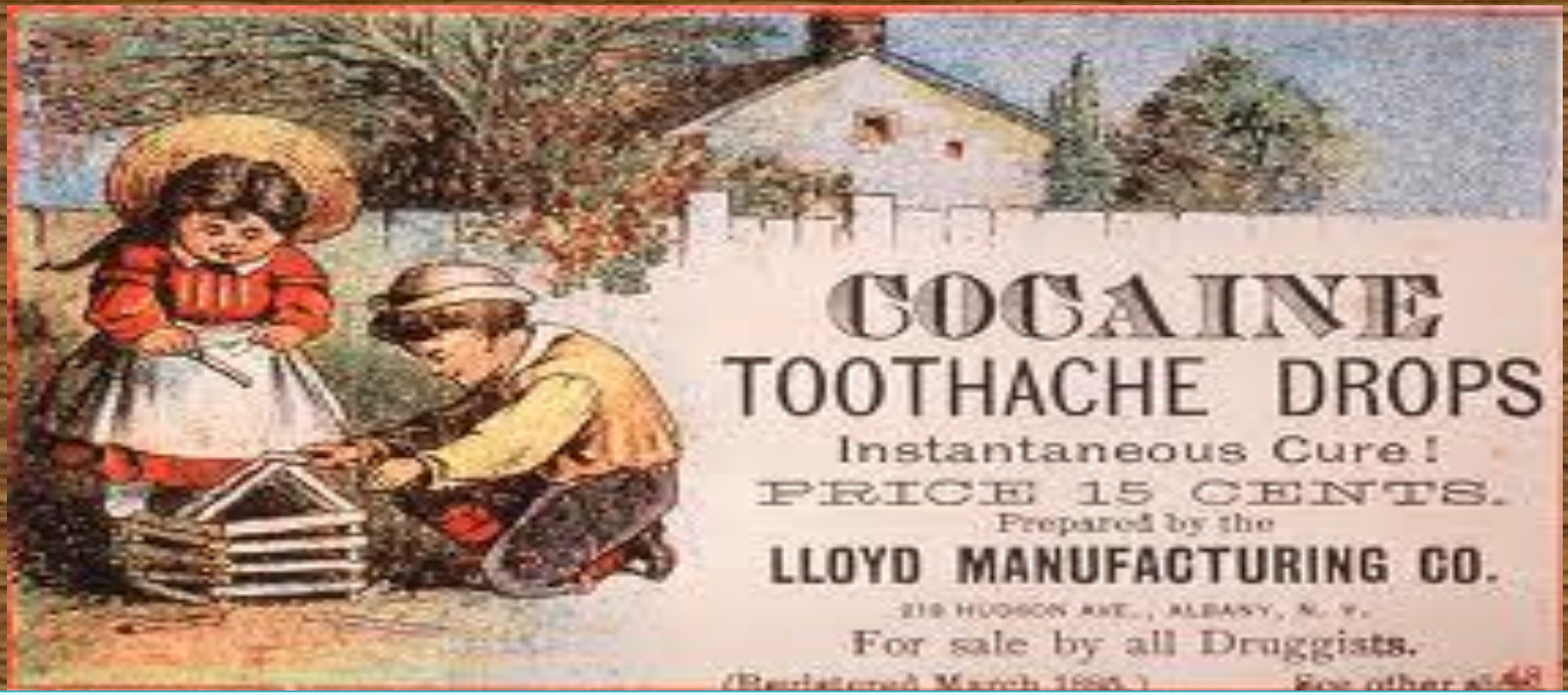
Chemistry and Pharmacology

By the middle of the nineteenth century, examinations of blood and urine were routine.



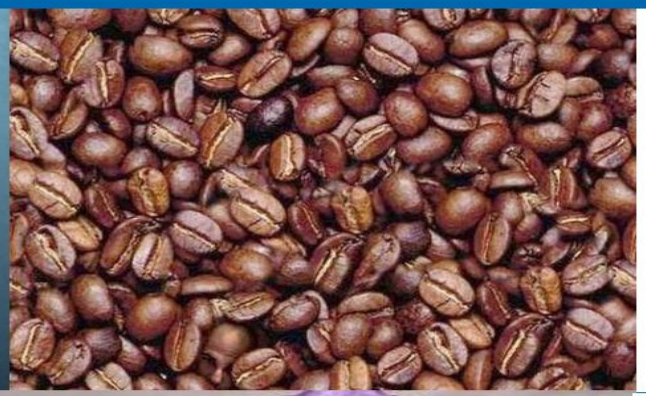


One of the most significant accomplishments was the synthesis by Friedrich Wohler of urea, a natural product of the body, from an inorganic compound, ammonium carbonate.



Pierre Robiquet was another of the many pharmacist-chemists in France and Germany who discovered and isolated the new plant alkaloids so important to medicine—among them atropine, colchicine, and cocaine.

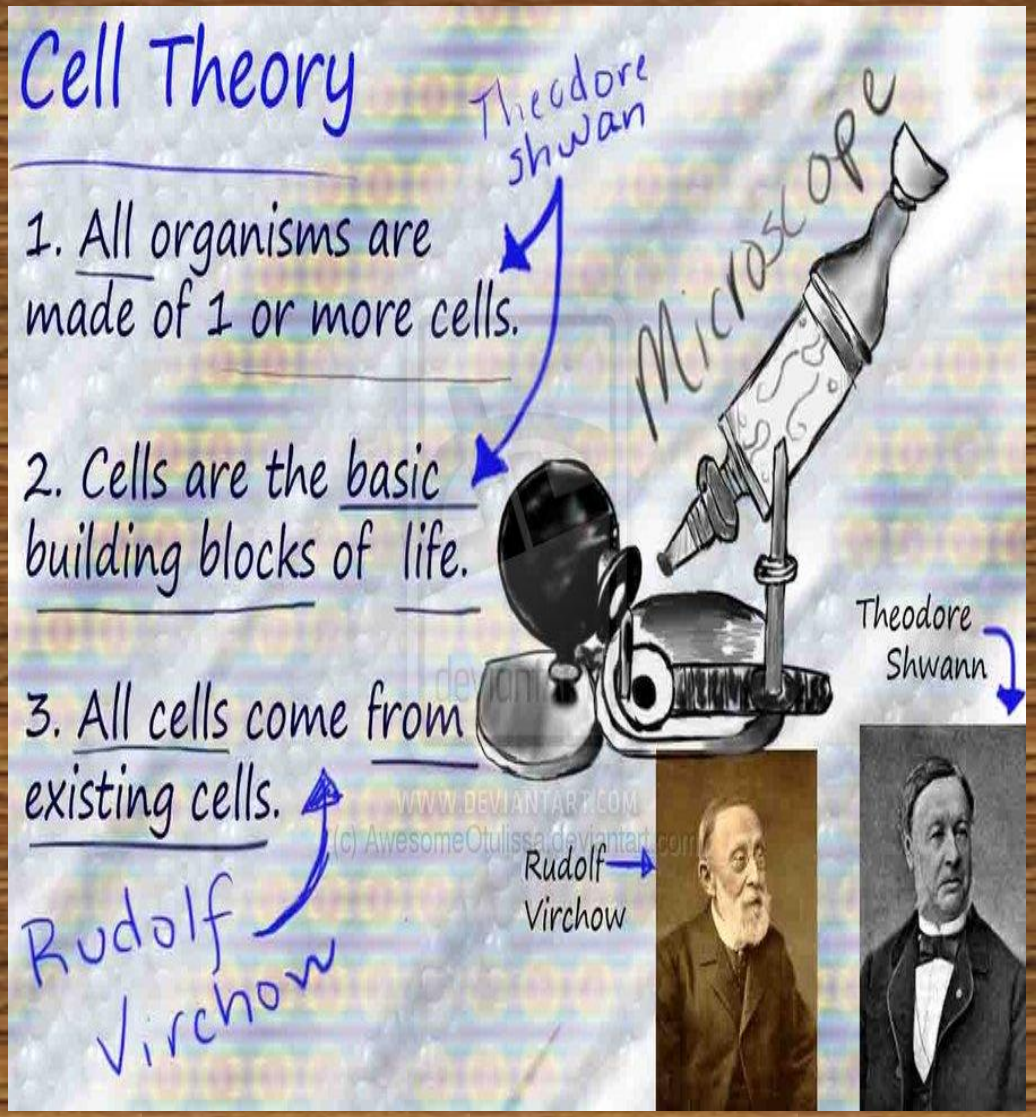
ALKALOIDS



In England Alexander Crum Brown (1838-1922) and Thomas Frazer advanced the discipline by correlating the actions of drugs with their chemical composition. As more and more drugs were isolated and their chemical nature understood, it became possible to create therapeutic compounds by building them from basic units. Alkaloids and antipyretics (fever-lowering compounds) were among the first drugs synthesized.

Cell Theory

Matthias Schleiden (1804-81) and Theodor Schwann (1810-82), developed one of the most important



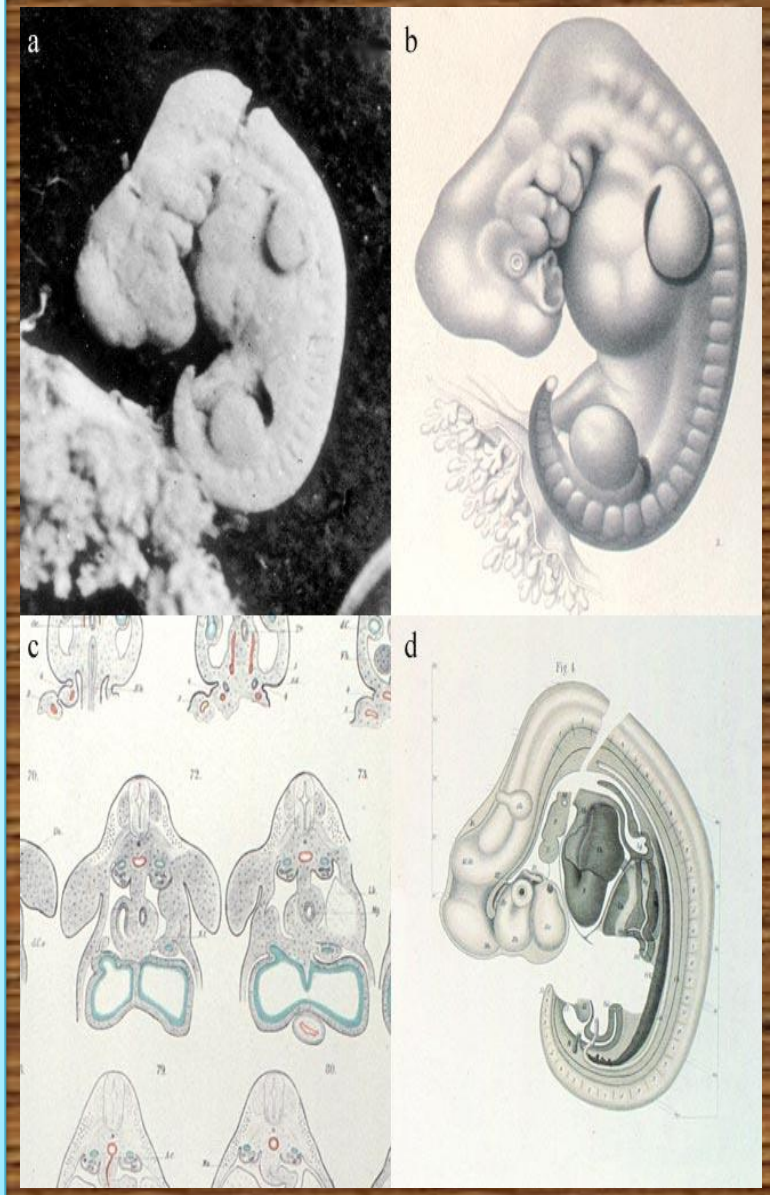
Rudolf Virchow established the proposition that cells arise only from preexisting cells.

"Disease is not something personal and special, but only a manifestation of life under modified conditions, operating according to the same laws as apply to the living body at all times, from the first moment until death."

Rudolf Virchow

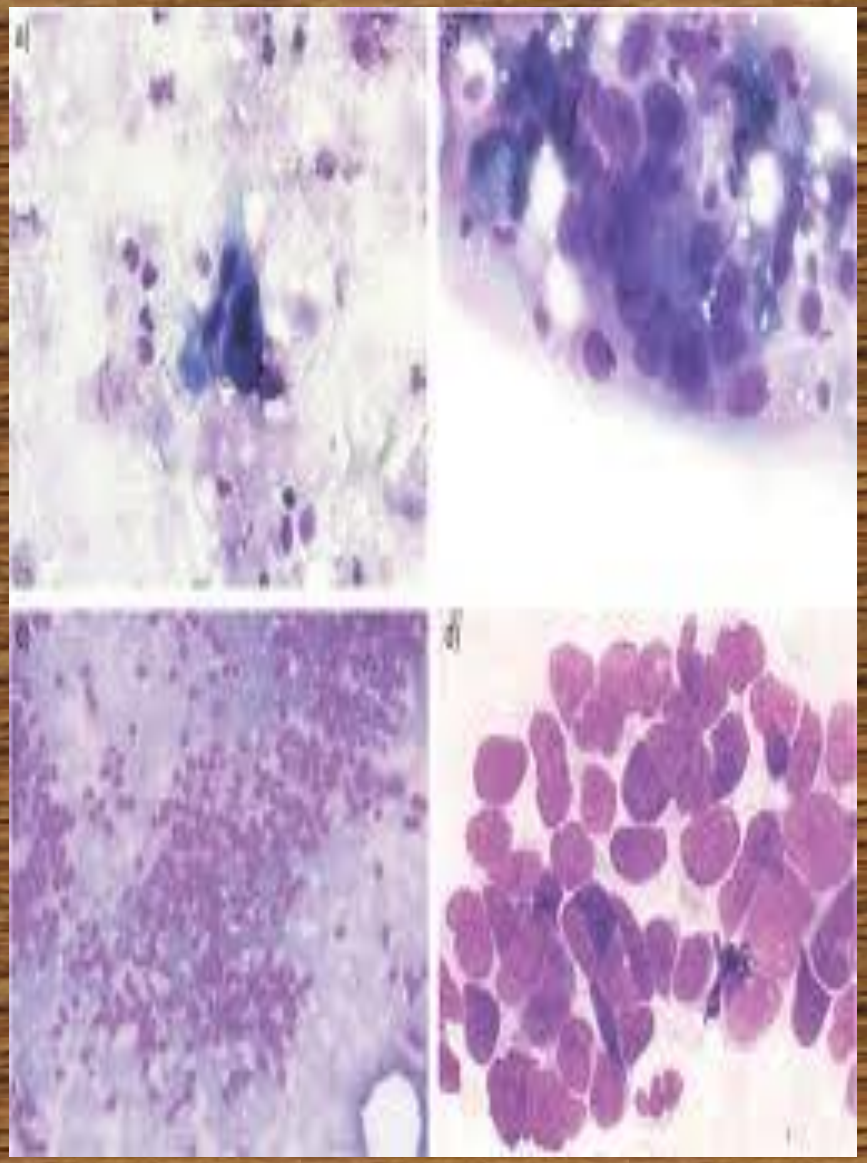
Microscopic Anatomy and Embryology

- Robert Remak classified tissues according to their embryological origin into three primary systems (germ layers): ectoderm, mesoderm, and entoderm.
- The mechanism of cell division, the means by which the embryo enlarges, organs increase, and tissues regenerate was reported by Walter Fleming in 1882.



Pathology

In keeping with the spirit of correlating the clinical manifestations of illness with the pathological findings in organs, autopsies were the major focus in medicine.



CLINICAL SCHOOLS AND THE CLINICIANS

The outstanding characteristic of nineteenth-century medicine was the correlation of discoveries in the laboratory and autopsy room with observations at the bedside.

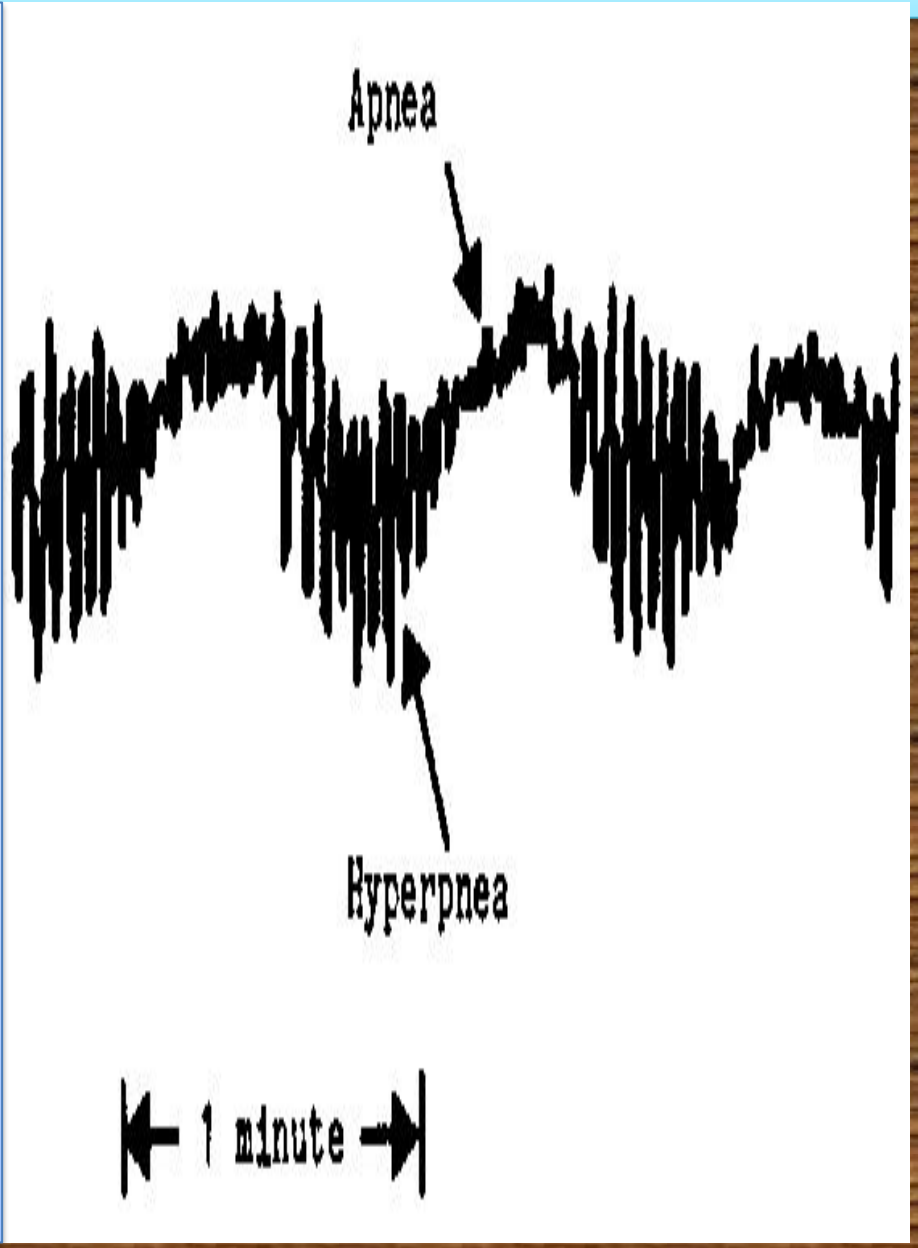
Paris

The hospital became more important as the focus of medical activity, public health measures were seen as a duty of government, and medical practice was open to all classes.

Philippe Pinel's close observation of people with mental illness and his astute evaluation of the results of treatment led him to advocate a change in insane asylums from forcible restraint to gentleness, persuasion, and a cheerful environment which benefited from the influences of family and friends.

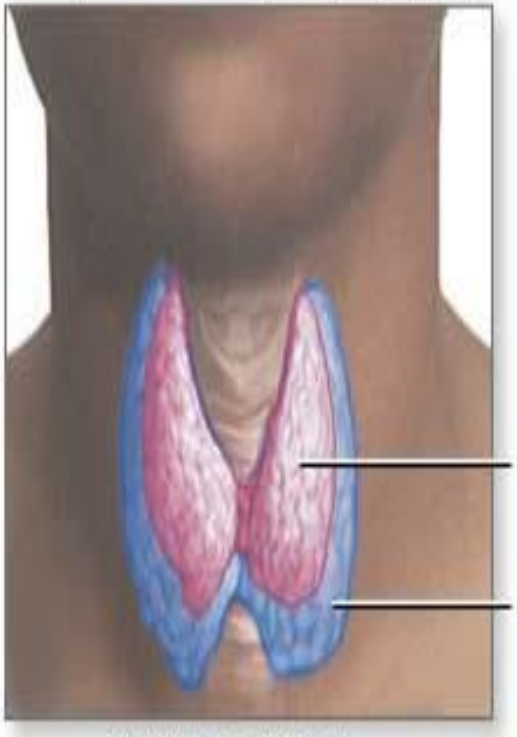
Dublin

John Cheyne (1777-1836), detailed accounts of a variety of diseases and his writings on education gained him a worldwide reputation as a great teacher and practitioner. The term "Cheyne-Stokes respiration," a type of irregular breathing, has remained in medical parlance.



The most famous teacher of the Dublin group was Robert James Graves (1796-1853), He is the eponym ("Graves' disease") for that combination of thyroid enlargement, nervousness, sweating, and pronounced stare referred to as "toxic exophthalmic goiter." It was Graves who overturned the past dietary restrictions for patients with fever by urging a full, nutritious diet for all ill patients. He suggested that his own epitaph could well read, "He fed fevers."

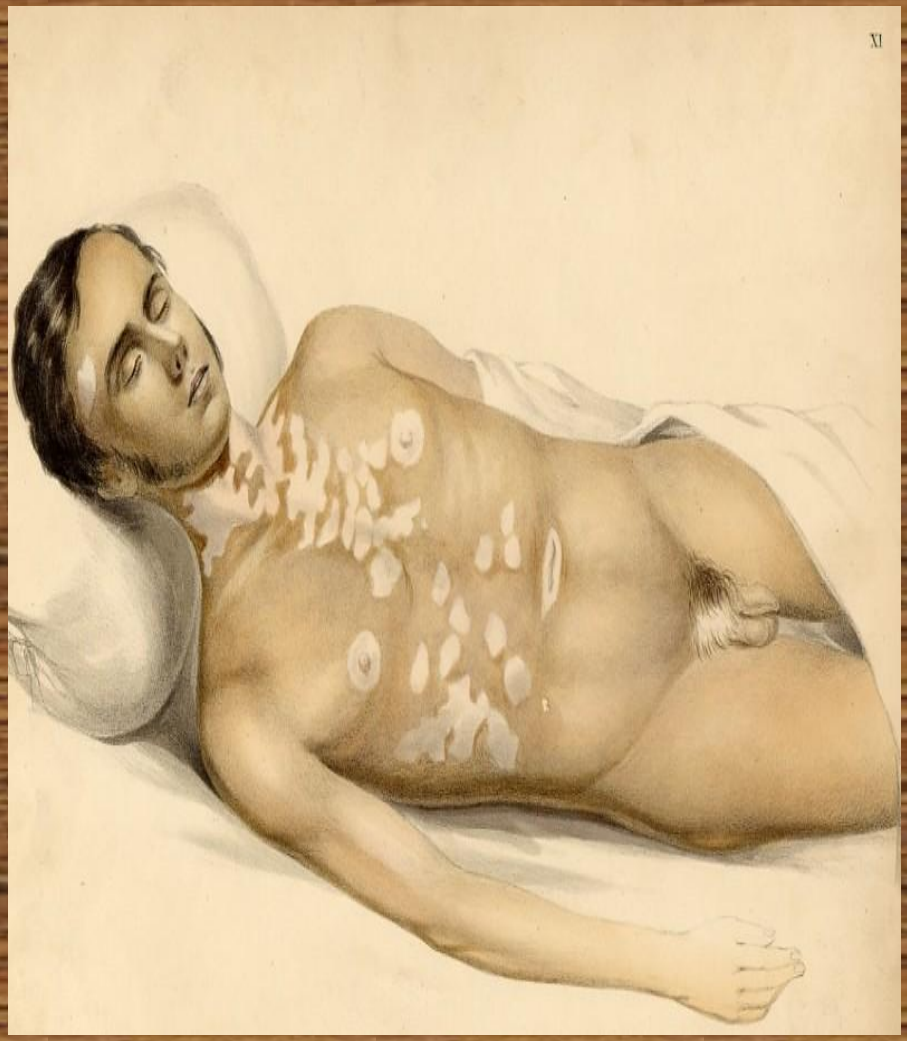
Exophthalmos (bulging eyes)



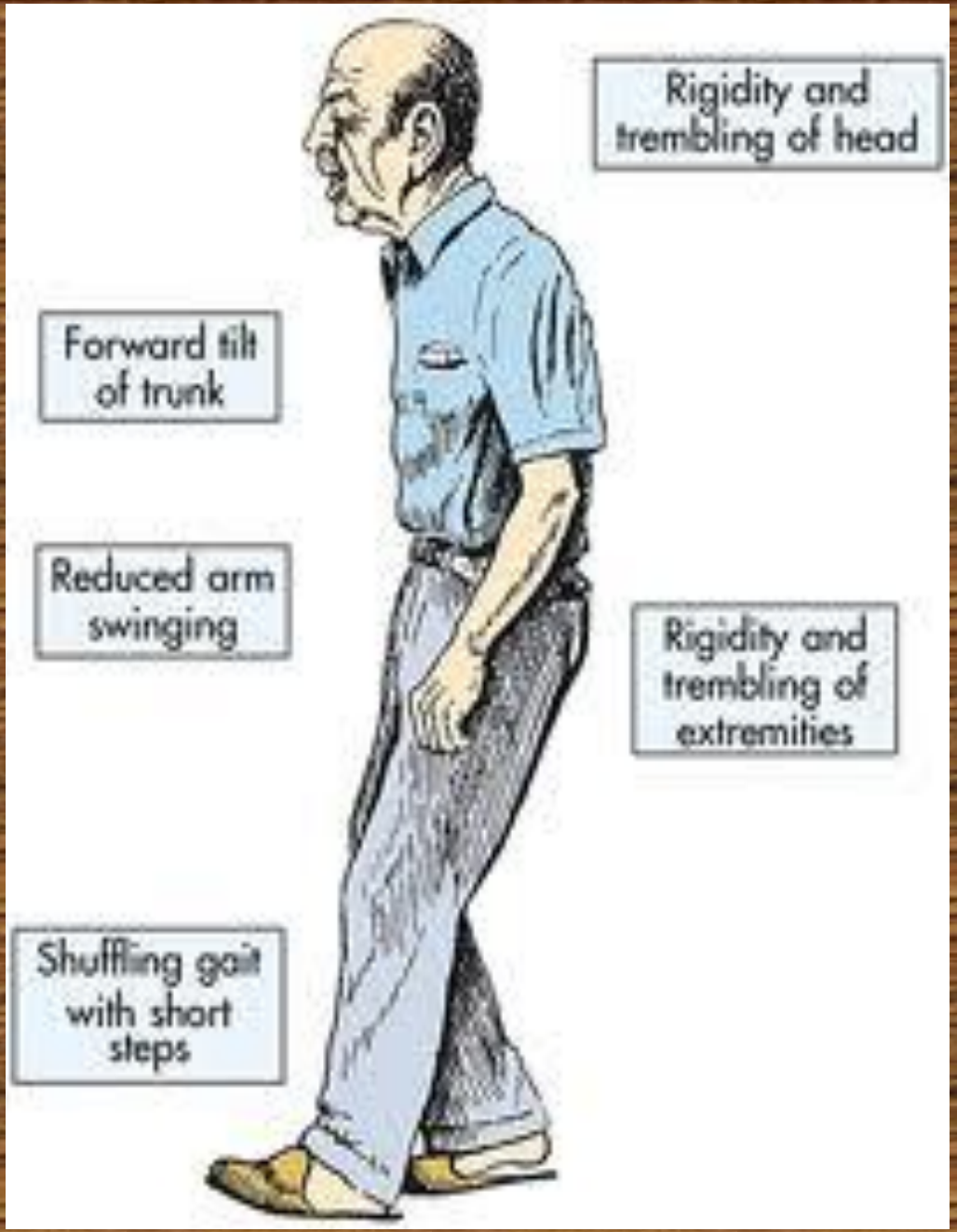
Graves' disease is a common cause of hyperthyroidism, an over-production of thyroid hormone, which causes enlargement of the thyroid and other symptoms such as exophthalmos, heat intolerance and anxiety

London and Edinburgh

Thomas Addison (1793-1860), whose severe, pompous manner, precisely chosen words, and physically impressive appearance struck fear into students. His thorough examinations and perceptive analyses earned him the awestruck respect of his colleagues. Pernicious anemia and adrenal insufficiency are both still referred to as "Addison's anemia" and "Addison's disease of the adrenals."



James Parkinson (1755-1824), gained recognition for his description of a neurological disorder now known as "Parkinson's disease.



Antiseptics

1847: Ignaz Semmelweiss (Hungary) cut the death rate in his maternity ward by making the doctors **wash their hands** in calcium chloride solution before treating their patients.

1854: Standards of hospital cleanliness and nursing care rose rapidly under the influence of Florence Nightingale.

1865: Joseph Lister (Scotland) - basing his ideas on Pasteur's Germ Theory cut the death rate among his patients from 46 to 15 per cent by spraying instruments and bandages with a 1-in-20 solution of **carbolic acid**.

1890: Beginnings of aseptic surgery - surgeons started boiling their instruments
to **sterilise** them - WS Halstead (America) started using rubber gloves when operating - German surgeons started to use face masks.

More causes for improvements in surgery

The number of operations grew hugely through the century, and surgeons became skilled at internal operations (1880s: first appendectomy; 1896: first open-heart surgery) and even tried (unsuccessfully) to transplant organs such as thyroid glands and testicles. Various factors pushed the process along:

The Industrial Revolution / inventions

Wilhelm Roentgen discovered **x-rays** - helped internal surgery.

Public demonstrations (eg of anaesthesia) allowed knowledge of new procedures to spread.

More causes for improvements in surgery

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Scientific knowledge

The scientist Humphrey Davy had first discovered that **laughing gas** was an anaesthetic when working on the properties of gases in 1800.

Joseph Lister lectured in King's College London, and published his findings in 'The Lancet'.

Social factors

Queen Victoria **gave birth** to her children under **anaesthesia** (after which the general public's fear of anaesthesia lessened). Edward VII's appendectomy helped reduce fear of operations.

War

The needs of **army surgeons** treating soldiers injured in battle (often requiring amputations) stimulated advance.

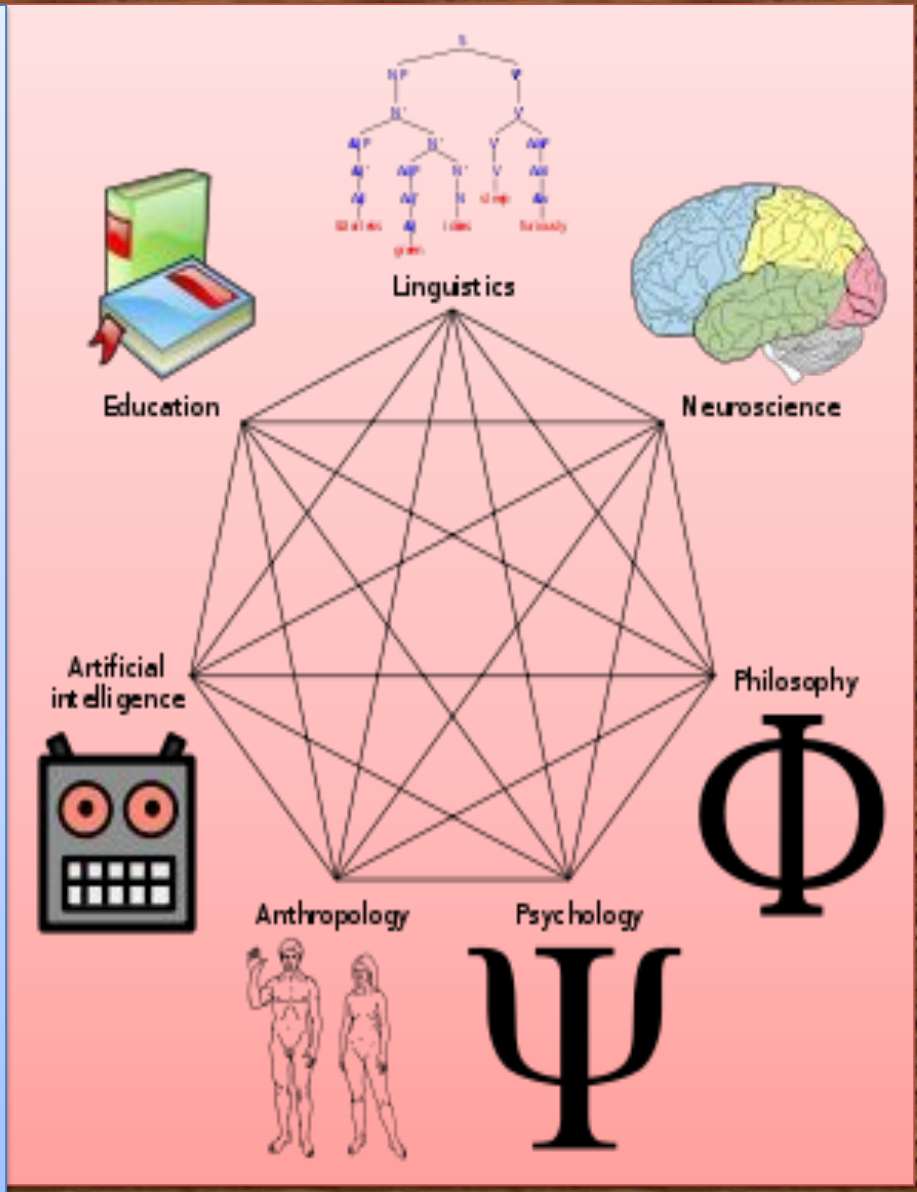
The **Crimean War** led to the development of nursing (Florence Nightingale at Scutari).

World War One led directly to the development of the National Blood Transfusion Service.

James Young Simpson (1811-70) introduced chloroform as an anesthetic. One evening Simpson and friends inhaled the substance at home and found they all had been rendered unconscious. Impressed by its effectiveness and pleasant smell, he tried it for operations and deliveries. For the next half-century, chloroform was the most frequently used anesthetic in Great Britain. Simpson also made many other contributions

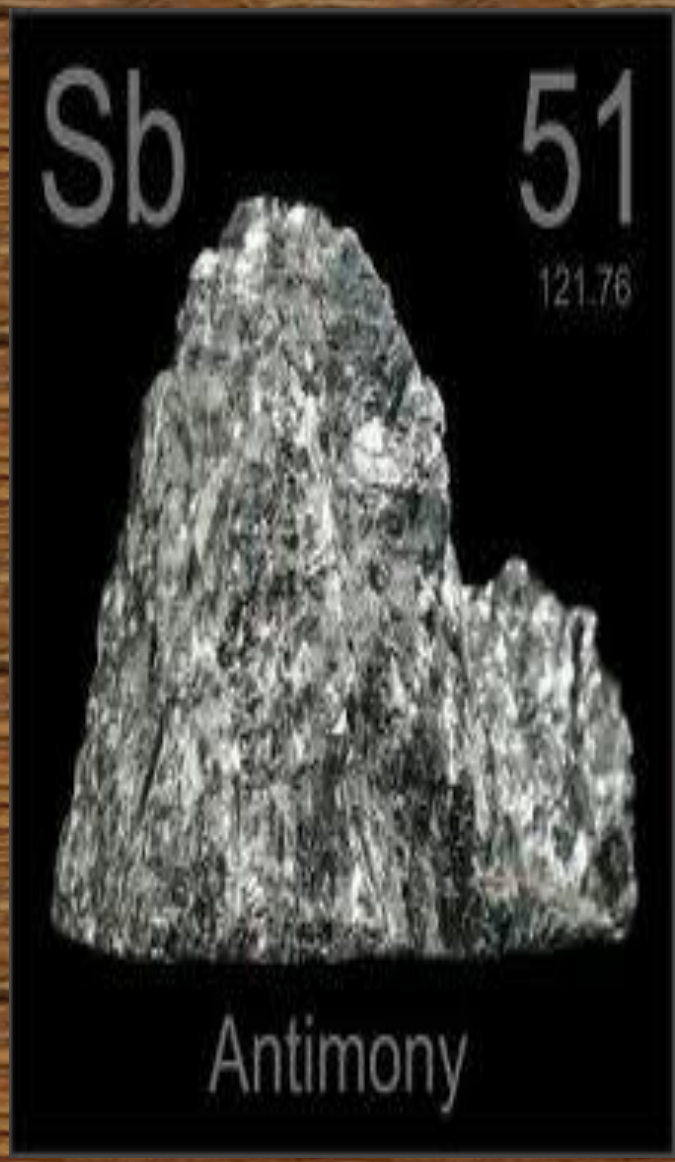
Germany

The theorizing, mystical Naturphilosophie which enveloped scientific and medical thinking in Germany in the early part of the century gradually gave way to direct observation and experiment, with the establishment of laboratory studies on body functions.



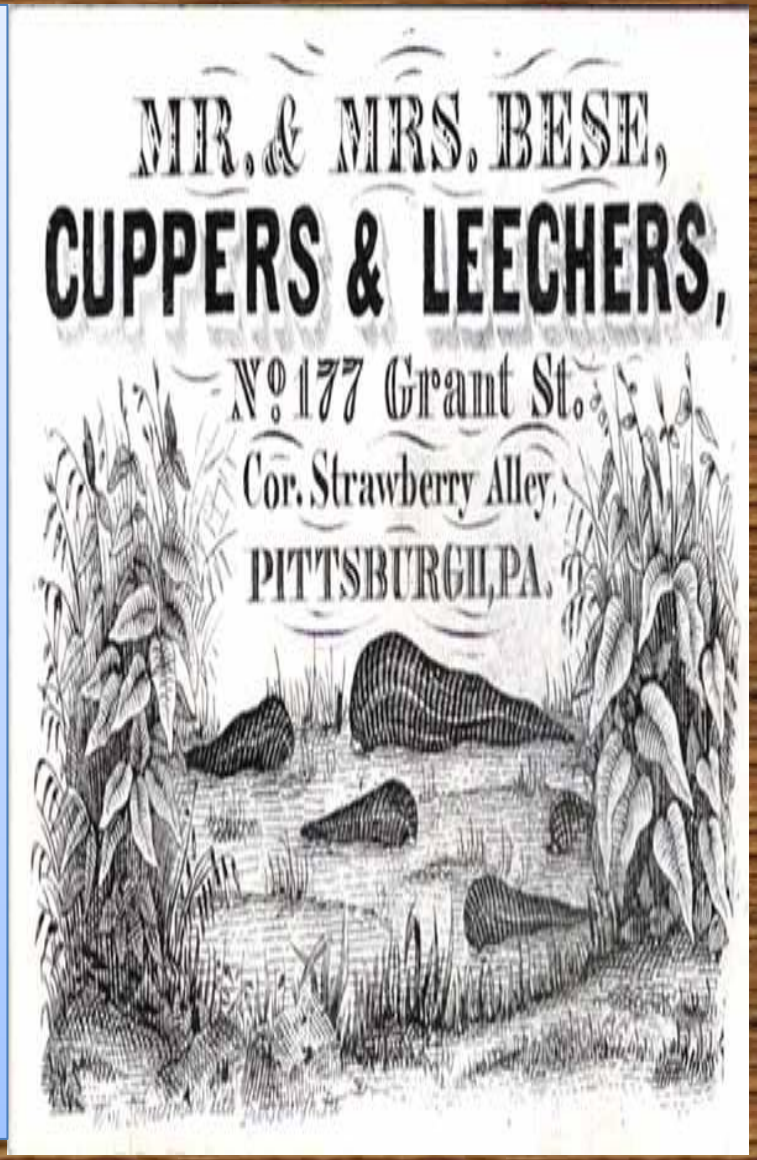
METHODS OF TREATMENT

In the 19 c, the principal therapies open to European and American physicians were general regimens of diet, exercise, rest, baths and massage, bloodletting, scarification, cupping, blistering, sweating, emetics, purges, enemas, and fumigations. There were multitudes of plant and mineral drugs available, : quinine for malaria, digitalis for heart failure, colchicine for gout, and opiates for pain.



METHODS OF TREATMENT

"desperate diseases require desperate measures”

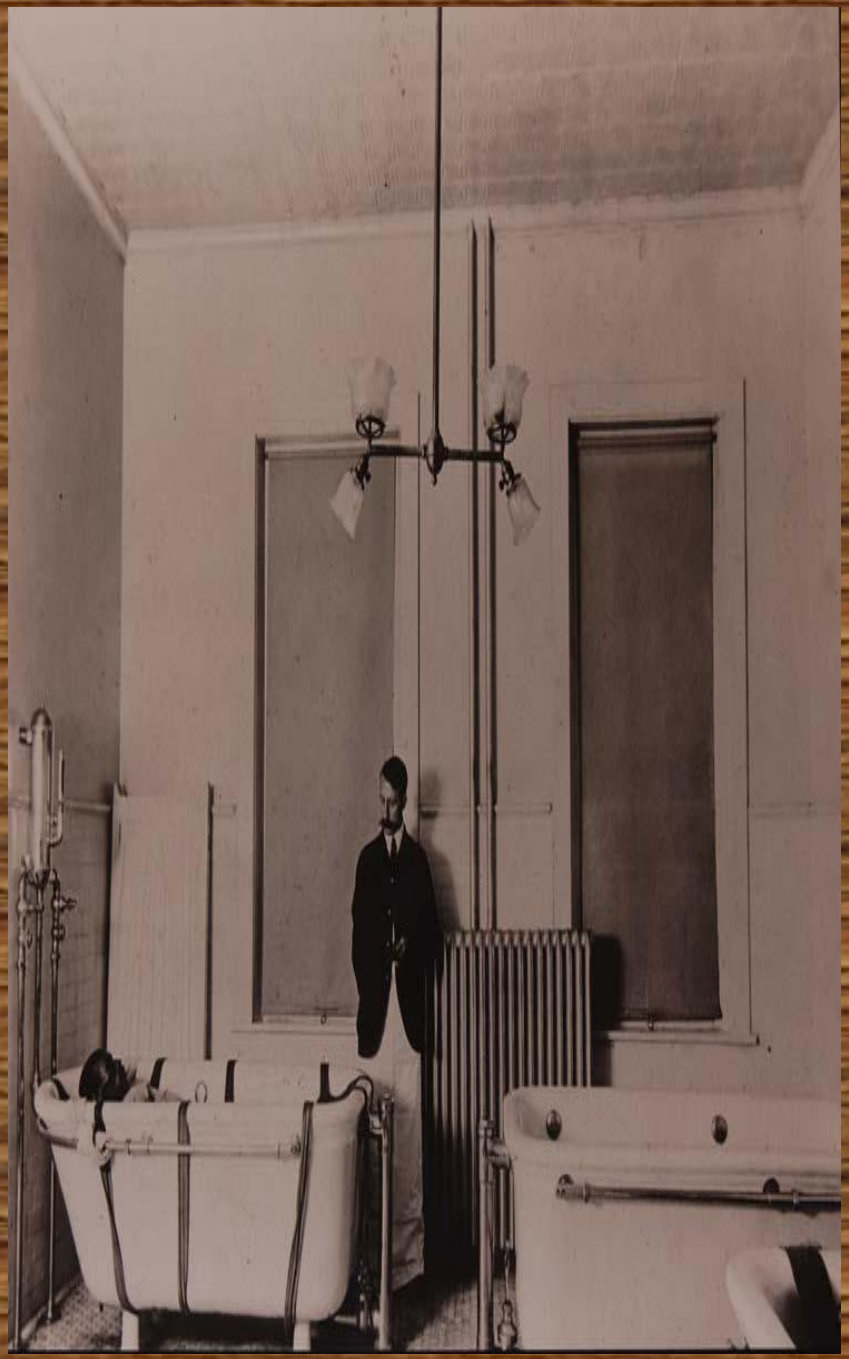


Medical Systems

Perhaps the most influential system was homeopathy, a creation of Samuel Hahnemann (1755-1843) which taught that drugs which produced symptoms in a person resembling those of a specific illness would cure the patient if used in smaller amounts.

Hydrotherapy, an all-purpose therapy, was based on the ancient concepts of the humors—the necessity for expelling excesses.

The opposite view—using only dry foods and substances—also had advocates, but they were few.



Another medical therapy was cranioscopy, ϕlso called phrenology, the doctrine was promulgated by Franz Joseph Gall (1758-1828 He taught that the shape and irregularities of the skull were projections of the underlying brain and consequently indications of a person's mental characteristics—a conclusion with no basis in fact.

"Universal Pills"

Mesmerism, or "animal magnetism" also played a part in opening minds to the possibilities of making people insensitive to pain.

Anesthesia

Surgery made steps forward very slowly, limited as it was by lack of effective pain control during operations and by devastating postoperative infections. Both of these obstacles were substantially lifted by the discovery of anesthesia and the proof that germs caused infection.

In 1772, Joseph Priestley discovered nitrous oxide gas. Later, whiffs of nitrous oxide (soon called "laughing gas") were indulged in at "revels" for social amusement and the euphoria produced. Noting a reduced sensitivity to pain in these "revelers," Humphry Davy (1778-1829) suggested that "laughing gas" might be useful to surgery, but no one followed up his suggestion.

Other means of preventing pain through the loss of consciousness were also put forth from time to time. Henry Hill Hickman in 1824 produced a state of "suspended animation" in animals through asphyxia achieved by inhalation of carbon dioxide, which permitted him to perform operations without causing pain. He recommended this technique for use on humans but could not convince scientists.

As anatomical knowledge and surgical techniques improved, the search for safe methods to prevent pain became even more pressing. The advent of professional dentistry added a new urgency to this quest because of the sensitivity of mouth and gums. Although death as an alternative frequently drove patients to the surgeon, few people were known to die from toothache. The urge to see a dentist was easily resisted, so it may be more than coincidence that dentists seized the initiative in the quest for freedom from pain.

By 1831 all three basic anesthetic agents—ether, nitrous oxide gas, and chloroform—had been discovered, but no medical applications of their pain-relieving properties had been made. In all likelihood the first man to apply his social experiences with laughing gas to surgery was Dr. Crawford W. Long (1815-78) of Georgia. In 1842 he performed three minor surgical procedures using sulfuric ether. Apparently not realizing the significance of what he had done, Long made no effort to publicize his discovery until several years later when anesthesia had been hailed as a major breakthrough.

A Connecticut dentist, Dr. Horace Wells (1815-48), on learning of the peculiar properties of nitrous oxide in 1844, tested them by having one of his own teeth removed while under the influence of the gas. Delighted with the results, he administered it to several patients, and then demonstrated his procedure before Dr. John C. Warren's medical class at Harvard. For some inexplicable reason, the patient cried out, and Wells was booed and hissed. Following Wells's failure, his friend and fellow dentist William T. G. Morton (1819-68) began experimenting with sulfuric ether. Encouraged by its effectiveness in his dental practice, he, too, contacted Dr. Warren and in 1846 gave the first public demonstration of surgery without pain. News of this momentous event spread rapidly throughout the Western world, and a new era for surgery began. Until Oliver Wendell Holmes supplied the name "anesthesia," the Boston medical community had been at a loss for a term to describe the condition brought on by this new agent.

After ether was widely accepted, James Simpson in Edinburgh abandoned it for chloroform because of its disagreeable odor, irritating properties, and long induction period. For about a century, chloroform continued to be the choice agent in Britain until its unmanageable toxicity and delayed damage to the liver was appreciated. In Germany, even when in 1894 the superior safety of ether over chloroform had been clearly shown (a more than five times higher mortality for chloroform), chloroform remained the favored anesthetic for almost twenty-five years.

Other anesthetic agents were introduced near the end of the century. Ethyl chloride was sprayed locally to induce insensitivity. Cocaine by topical application to the eye was reported by Carl Koller in 1884. Sigmund Freud had earlier studied the anesthetic properties of cocaine but did not pursue the work. The injection of cocaine into nerve trunks to block sensation was investigated by William Halsted in the United States. Cocaine was also the first drug injected into the spinal canal in 1898 to produce anesthesia, but once its dangers were realized other less toxic and nonhabituating agents were developed. Numerous methods of administering anesthetics were tried, and the rectal route was introduced by Pirogov in Russia. Ore of France originated the intravenous method in 1874. After Fischer in 1902 had synthesized veronal, this barbiturate and other safer and more manageable agents for intravenous use were developed.

The "open" method of dripping the anesthetic on a gauze mask was replaced by "closed" systems in which an airtight mask could deliver a precisely measured amount of vapor and remove the exhaled carbon dioxide through absorption by a calcium compound. Advantages were also perceived in the insertion of tubing through the mouth and voice box into the trachea, thereby preventing the aspiration of secretions and controlling the patient's respiration. The twentieth century saw refinements in endotracheal anesthesia which permitted an anesthetist to control the flow of air, oxygen, and other gases into the lungs and thus have complete mastery over breathing during an operation.

Muscle-relaxing drugs were also put to use in placing the anesthetist in control of respiratory movements and the surgeon in a position to perform manipulations through a totally relaxed abdominal wall.

Surgery

When anesthesia had become commonplace and the limitations of pain had disappeared, surgical procedures multiplied in number and complexity. No longer did the operator have to place the first emphasis on speed and to limit his manipulations mainly to surface areas of the body and the skeletal system. Yet the potential benefits of surgery were overshadowed by the frequent, devastating infections which often resulted in death. Outstanding surgeons everywhere were continually plagued by the dread complications of postoperative purulent infection and gangrene. Only when the bacterial origin of disease had been discovered and the necessity for keeping germs away from the operative field had been proved, notably by Lister, could surgery enter with safety the interior regions of the body. Every country participated in the new age of surgical progress, but the German-speaking countries were early at the forefront.

Joseph Lister

When Joseph Lister began his medical and surgical career, anesthetics were just beginning to be developed. This, of course, made the surgery a horrible experience for the patient. Of even greater significance was the lack of sterile surgical techniques. The concept that infections were caused by identifiable organisms (germ theory) was not yet known. So, when Lister began to sterilize his surgical instruments and dressings, his colleagues viewed him with great skepticism. But, Lister was convinced of his theories and he persisted. His experiments proved him to be right and, thanks to the "Father of Modern Surgery," sterile surgical procedures became the standard practice we enjoy today.

Surgery in Lister's time was a risky business. The term "Hospitalism" was coined to describe the collection of life threatening infections that often occurred following surgery. Though 50 percent of all surgical patients died, both surgeons and society accepted this as being an unpleasant, but unavoidable, side effect. It's hard to imagine the conditions that existed, given today's strict adherence to sterile surgeries. Surgeons actually felt a sense of pride in wearing blood-covered surgical garments, seeing them as a status symbol. The never even considered washing their hands between surgeries, or before examining the next patient. They felt this way because they believed the transmission of disease was, literally, out of their hands. There were two prevailing theories of disease the surgeons clung to, neither of which pointed to them having any involvement in the spread of infections. The first was "miasma," the belief that disease was carried about by noxious gases floating in the air. Their second theory was that the infections in the patient's wounds occurred spontaneously, being generated by some unknown, and unavoidable, action within the flesh itself. Both theories meant the surgeons had no responsibility in causing their patient's infections - and the death tolls continued to rise.

Lister had other ideas. He was appointed director of the Glasgow Royal Infirmary's new surgical building in 1861. The building had been erected in hopes of reducing the widespread surgical deaths at the existing facility. But, the deaths continued, with a mortality rate of close to 50 percent during Lister's first four years. Then Lister observed a phenomenon that captured his attention. Patients with simple fractures (those not piercing the skin) survived, but patients with compound fractures (those in which the bone pierces the skin) often died. He wanted to know why, and he began to formulate a theory. He hypothesized that the infections were not spontaneous, but were caused by an outside agent. So, Lister began to wear clean surgical garments and to wash his hands before surgery. Then, after being given a research paper by Louis Pasteur, Lister had his breakthrough. Pasteur had shown that faulty fermentation of wine, which resulted in undrinkable sour wine, was caused by outside germs entering the wine. Lister made the immediate connection to his own quest. He knew if infections arose spontaneously from the wounds there was nothing that could be done to cure them. But, if they developed because of a germ entering from the outside of the wound, there was hope - they could be prevented. Lister had heard that carbolic acid (phenol) was being used to safely kill parasites found in sewage. So, he began using a formulation of diluted carbolic acid to wash his surgical instruments, his hands, and wound dressings. He also instructed his surgeons to spray the air in the operating rooms with the carbolic acid mixture, to eliminate airborne germs. His techniques were remarkably successful.

He announced his success at a meeting of the British Medical Association in 1867: his surgical wards had been free of sepsis (an infection spreading throughout the body) for a miraculous nine months. This was unheard of in surgical wards, where death tolls continue to soar. Still, his breakthrough didn't lead to immediate acceptance. It would take well over a decade before his sterile techniques were widely adopted. Germanyled the way, in the 1870s, employing Lister's techniques during the Franco-Prussian war. But it was Lister himself, after successfully demonstrating his antiseptic surgical technique in London, which finally turned the tide. The news of the surgery caused intense interest, especially among Lister's critics. When the patient survived, without developing an infection, his critics could resist no longer. Lister's antiseptic surgical techniques became common practice

THE PROFESSION

In the early half of the century, advances in physiology, pathology, and chemistry were not reflected in medical practice, for the physician's equipment was still limited. Doctors were even considered useless or harmful by large segments of the public conditioned by the failure of bleedings, purgings, and other manipulations to affect illness or stem epidemics and by the extravagant but convincing claims and cures promised by quacks. Attacks on nostrums and patent medicines were unpopular and generally ignored.

A dichotomy existed, especially in England, between those who favored mandatory licensing control over all healers, including physicians, and those who strongly advocated allowing anyone to practice medicine, giving patients a choice from among many practitioners and claimants. Political progressives believed that regulation would lead to domination and self-serving restriction of others by the medical profession; conservatives preached that only official bodies could or should determine who was fit to treat people.

Education and Licensure

By the eighteenth century in England, medical education was entirely in the hands of individual doctors, mostly but not exclusively surgeons, who had their own private schools which dealt principally with anatomy and surgery until other subjects were later added. Although the teachers, such as the Hunter brothers, often imparted a high order of instruction, the students received their clinical education by walking around the wards observing the leaders in the great institutions of London: St. Bartholomew's, St. Thomas's, St. George's, Guy's, London, and Middlesex hospitals. In contrast, Edinburgh had a regular medical school, operational since 1736, with formal courses of instruction which included regular lectures and bedside teaching.

The first medical school in America to lead the reform movement was associated with Lind University in Chicago (later Chicago Medical College and presently Northwestern University). In 1859 Lind raised its entrance requirements and lengthened its academic year to five months. The school received no support in its fight to raise educational standards until 1871, when Harvard overhauled its medical school and instituted a three-year graded course, a nine-month academic year, and written and oral examinations. Despite a better than forty percent drop in enrollment, Harvard persisted, and within a few years Pennsylvania, Syracuse, and Michigan swung into line.

In France, the decrees of Napoleon in 1803 categorized those who could practice medicine into doctors of medicine, doctors of surgery, and health officer doctors, each division with its own educational prerequisites and licensing examinations. Schools for apothecaries were built and a system ordered for inspecting the shops of apothecaries, druggists, and spicers. Tuition at all of the four state medical schools was kept low to permit students of limited means to enter the medical profession.

In Germany, the regulations varied in the different principalities. In the Duchy of Nassau, for instance, before it was taken over and surgeons were in one body under by Prussia, the physicians the state, and although strict examinations had to be passed to practice medicine a university degree was not essential. In Prussia, in 1825, three classes of licensed doctors were recognized: graduate physicians (who had to spend four years at a university and pass rigorous state examinations—including an additional test for those who entered surgery); wound doctors, first class (with fewer years of schooling and less difficult examinations); and wound doctors, second class (with even less education and less rigorous examinations). Obstetricians, ophthalmologists, and public health doctors also had separate requirements.

State practice of medicine and social insurance were also seen in the German principalities, where the physicians were paid by the state but were also permitted some private practice. In Prussia, the proportion of doctors who depended on state stipends became less and less. Bismarck finally turned to medical and social insurance as a means of receiving the support of the general populace in his aim of unifying Germany.

In Russia, after 1864, local governmental organizations, the zemstvo, were responsible for medical service to the poor and mentally ill and acted as public health overseers. The feldsher, a combination of male trained nurse and pharmacist who went out into the countryside, was also a provider of health care. Regular physicians continued to be trained in the large city universities.

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