

Think Microscopically, Act on a Grand Scale

the modern life of Rudolph Virchow, part 2



Zeiss IVa continental model, about 1897,
Carl Zeiss, Jena. No. 28495

Virchow may have used similar microscopes

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part 1, Think Microscopically was in September 2023 *Micscape*

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part 2, Act on a Grand Scale

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Abstract

~~Rudolph Virchow was the first modern doctor.~~

~~Virchow was “the father of pathology” and one of the most important and remarkable physicians in all of history. Born in eastern Prussia in 1821, he went to medical school in Berlin and went on to bring medicine into the scientific era, largely via a microscopic view of human anatomy. He made medicine modern.~~



~~Virchow’s medical discoveries were almost endless, as he was one of the first to replace millennia of theories about imbalances of imaginary body fluids with a new, scientific view of bodies being made of cells, and their malfunction causing disease. His 1855 axiom “every cell arises from another cell” seeded a scientific revolution. Virchow started a medical journal, wrote textbooks and taught doctors from around the world. Among his discoveries: leukemia (blood cancer), chordoma (a spinal tumor), thrombosis and embolism (blood clots), myelin (sheath around some nerves), amyloid (an abnormal protein causing disease), chromatin (the stuff that makes chromosomes), cells inside bone, zoonoses (diseases acquired from animals), Virchow’s node (swelling above collarbone from spread of stomach cancer), how to do a proper autopsy, the lifecycle of the parasitic worm Trichinella, microscopic meat inspection, and numerous human skull details and diseases.~~

~~Virchow adopted the microscope from his teacher Mueller. He told his students to “think microscopically” and taught cellular pathology to a stream of visiting professors from around the world, spreading the modern way of medical thinking still used today. But Virchow was much more than a doctor and medical professor. He travelled to a typhus outbreak and investigated tuberculosis, deeming them “social diseases” because they killed the poor much more often than the rich. Advocating sewers and clean water for Berlin, he was the **father of public health**. He was the German **father of anthropology**, and dug for artifacts in Germany, Troy and Egypt. He prescribed democracy and education to improve the health of the masses and became a **reformist politician**. He claimed “politics is medicine on a grand scale”, opposing racism and high military spending. Virchow died in 1902, age 80.~~

~~Virchow wasn’t perfect. He argued against the germ theory of disease and against the theory of evolution, deeply mistaken both times. At least Virchow’s heart was in the right place. Many proponents of evolution, including his own student Ernst Haeckel, used evolution to argue for eugenics, stating undesirable peoples should be sterilized or killed. Half a century later, that pseudoscientific evil led Germany into profound catastrophe.~~

~~Above portrait photo of elder Virchow from Bildarchiv Preußischer Kulturbesitz (Visual Archive of the Prussian Cultural Heritage Foundation) accessed at Britannica.com~~

~~Great image of top end Zeiss microscope shown on title page is from antique-microscopes.com~~

Disclaimers

I am a medical doctor, not a historian. I have worked as an internal medicine doctor in clinics and hospitals, and also a little in public health and in West Africa. I do not know the German language. All quotes from Virchow are translated, often losing part of his meaning in that process.

Every historical reviewer has bias. Everyone makes mistakes, including doctors (they were considered gods until 1980, but I became one in 1986, so I missed that era). I will present historical evidence and attempt rational thought, but this article likely contains mistakes of fact and wrong opinions that will embarrass my future self. I invite your comments and I will try to be grateful when my mistakes are corrected.

Bias

I started with a bias of liking Virchow, and it generally just got worse the more I learned about him. I first heard of Virchow, very favorably, at Johns Hopkins Medical School around 1983, as Virchow strongly influenced that school's founders. My medical student impressions were that Virchow was an amazing scientist and doctor. I was also keen to learn that Virchow founded the field of Public Health. Later I come to appreciate Virchow's cellular pathology even more as a microscope hobbyist.

Virchow learned pathology at the microscope and was radicalized by his experiences of epidemic and revolt in 1848. I started to question everything I had learned about medicine in 2008 when my baby daughter was diagnosed with leukemia (a disease first described by Virchow). My daughter survived and is doing great after a life saving stem cell ("bone marrow") transplant. But at that time I became aware of the lack of scientific evidence behind most medical practices and also of strong evidence that social factors usually predict health better than biological factors do, a truth first explored in depth by Virchow.

This paper visits the theory of evolution, still unpopular in some places in my country. I saw the evidence for evolution first hand around age 10 as I collected Paleozoic invertebrate fossils as a hobby. I was kicked out a college bible study group in Kansas, USA in 1979 because I believed that biological evolution has occurred.



Bust of Virchow from website of his old stomping grounds, Institute of Pathology, Charité Medical University, Berlin



Virchow was born in a small town in the northeastern hinterlands of Prussia. He spent most of his life in the city of Berlin, at the heart of the German empire and at that time the center of worldwide science. Map Britanica.com

Brief summary of Virchow's multitalented science career

(see part 1 of article for details)

Born in 1821, Rudolph Ludwig Karl Virchow was a small town boy who became the most famous medical professor of the 19th century. He went to divinity school in Pomerania then to medical school in Berlin, graduating in 1843, and working with his professors there and publishing scientific papers the next few years. In 1848 he was sent by the federal government to investigate a typhus epidemic in Upper Silesia. He was impressed that poverty was even more fatal than typhus, which he termed a "social disease," and he recommended education and democracy as treatments. Returning to Berlin the same year, he participated in an unsuccessful democratic revolution. Fired from his job at Charité Hospital, he became a professor in Würzburg for 6 years. There he continued exploring with a microscope and refined cell theory, showing the cell is the fundamental unit of life, health and disease. Returning to Berlin in 1856 he worked further on cellular pathology and made numerous additional medical discoveries. He also founded the fields of public health and anthropology, raised a family, was a field archeologist, skull expert and a reformist politician. More about Virchow's scientific career is available in part 1 of this article, in the September 2023 issue of *Micscape*.

Thank Virchow, the father of Cellular Pathology,
for informative and beautiful histopathology slides



Mammal gut, special stain, mucous gland blue,
muscle pink, connective tissue yellow.
40X objective, image ~200 microns across

“Gross” anatomy by dissection was known before Virchow and today we study molecules. Cellular pathology uses microscopes to study disease in tissue slices showing cells, the building blocks of all life, bridging the gap from anatomy to chemistry. Making a slide requires biopsy or autopsy and painstaking laboratory processing. Good histology techniques and good microscopes first arrived in Virchow’s day.

Revolutionary, Politician and Social Reformer

Young radical

As we learned previously, Virchow was strongly influenced by the 3 weeks in 1848 he spent investigating the Silesian typhus epidemic. The biological cause of typhus (a bacterium carried by lice) would not be identified until decades later and even then, Virchow would deny germs cause disease. He quickly did epidemiology and health statistics, noting those who were starving were more likely to get “hunger typhus”. He was impressed that it was mostly the poor and uneducated who suffered and died in the epidemic. His analysis emphasized economic, social, and cultural causative factors, and noted contradictory social forces that prevented a simple solution. He did present plans to temporize the unhealthy conditions in Silesia with emergency food aid. He also considered what was needed to prevent a repeat famine, concluding the needs were political and cultural. Virchow seemed unworried about (or perhaps welcomed?) a fight. Instead of recommending more medical care he outlined a revolutionary program of social reconstruction, including full employment, higher wages, the establishment of agricultural cooperatives, and universal secular education. Only a few years out of Divinity school he showed much traditional moralism, comparing the “cultural decay” in Upper Silesia to that of disenfranchised English factory workers, with both suffering such “extreme deprivation of the spirit, ultimately knowing only two sources of enjoyment, drunkenness and cohabitation”. Yet Virchow advocates for those downtrodden people, feeling empathy for the painful situations the poor must confront. Virchow said his cure for avoiding future famine and typhus in Upper Silesia would of necessity be radical and **“can be summarized briefly in three words: Full unlimited democracy.”** He wrote at age 27 in the most famous parts of his report: **“Medicine is a social science, and politics is nothing else but medicine on a large scale. Medicine, as a social science, as the science of human beings, has the obligation to point out problems and to attempt their theoretical solution: the politician, the practical anthropologist, must find the means for their actual solution... Science for its own sake usually means nothing more than science for the sake of the people who happen to be pursuing it. Knowledge which is unable to support action is not genuine – and how unsure is activity without understanding... If medicine is to fulfill her great task, then she must enter the political and social life... The physicians are the natural attorneys of the poor, and the social problems should largely be solved by them.”** He concluded **“Every individual has the right of existence and health, and the state is responsible for ensuring this.”**

During his career Virchow took his own advice to not only to do the “theoretical” work of a doctor but to at the same time take up the “practical” work of a politician in order to improve the health of the people. Upon coming back to Berlin in 1848 Virchow immediately joined the Democratic forces in their unsuccessful revolution. Revolution broke out in multiple European nations in March 1848. Protestors in Berlin besieged the surprised Prussian king, William Frederick IV, who verbally agreed to demands for elections and a constitution. He later changed his mind and ordered his troops to attack the protesters. A brave, brash young Virchow picked up a borrowed pistol and armed the barricades. By his report Virchow never shot the pistol because the soldiers were too far away, shooting at the students with rifles. 254 protestors were killed before a truce. Elections for a parliament and some other reforms resulted, but the monarchy survived. With Rudolph Leubischer, a psychiatrist colleague, Virchow started a liberal newspaper during the revolution, Die Medizinische Reform (Medical Reform), espousing democracy and exhorting doctors to become advocates for the poor. He wanted the state to track health: 'Medical statistics will be our standard of measurement: we will weigh life for life and see where the dead lie thicker among the workers or among the privileged.' After 1848 Virchow always saw medicine and politics as inextricably linked.

Through his own discoveries Virchow came to know more about the biological causes of disease than anyone else, yet he always emphasized disease is rarely purely caused by biology alone, and is usually socially derived or spread. As with typhus earlier in Silesia, he found mostly the poor and uneducated died of tuberculosis in Berlin. He considered both typhus and tuberculosis “social diseases” to be addressed by political reforms. Recurrent cholera was also a social problem, requiring public investment in water and sewer systems in Berlin.

An unrealistically grand scale? Could we enact Virchow’s radical ideas today?

Virchow made some amazing recommendations in 1848 and throughout his long career. He made practical proposals like creating food stores and setting up local agricultural cooperatives. He also advocated for educational improvements and separation of church and state. And fired up with the passions of a young doctor, some of his most difficult recommendations were directed at his fellow physicians:

“Medicine is a social science... and must point out problems and attempt their theoretical solution “

Doctors as social scientists? Thanks to the biomedical approach discovered by Virchow on his “day job” science has now accumulated thousands of times more knowledge of DNA, cells, physiology and medications than anyone could learn in a lifetime. Medical school is 4 years. Should we really cut back on medical students learning biomedical science in favor of health related sociology and anthropology subjects?

“Physicians are the natural attorneys of the poor, and the social problems should largely be solved by them” Doctors are responsible to fix the social problems of their patients? That’s going to be very hard. Hospitals already hire social workers, but they can only offer Band-Aids for poverty, homelessness and racism.

“Medicine ... must enter the political and social life”

I’d quit if I had to also become a politician to be a doctor. I’ll enter social life some year when I get time.

Realistically, US doctors are not about to add anthropologist, politician and social worker to their job title. A few medical schools might consider looking for candidates who have social science in their background, and teach the fundamentals of the social determination of health in med school. In the US we have doctors (or nonphysician providers, to save money) seeing individual patients, leaving the Public Health to an underfunded side branch of medicine. The US healthcare system costs about twice as much compared to other rich nations, but US health lags behind those other rich countries. We need to change the rules of the healthcare system to prioritize health outcomes over healthy profits. Having a single payer system would improve efficiency over our current system of thousands of insurance plans, each with different rules.

But Virchow is fundamentally right in his analysis that social problems lead to sick societies full of medical problems. Increased efficiency in our standard diagnosis and treatment type of healthcare won’t stop people from getting diabetes and heart attacks from junk food and stress. Modern data by Michael Marmot in the UK and others agrees with Virchow that malfunctioning societies produce sick patients. If we are serious about the public’s health, we need to go beyond medical reforms and telling people to exercise. We need to empower them by offering real chances to live flourishing, healthy lives with good education, good jobs, good benefits, nice neighborhoods, and full unlimited democracy, just like Virchow recommended for Silesia. In other words, his **Social Medicine** and **politics (“which is nothing else but medicine on a grand scale”)**.

How to change society and its politics is a hard question. Those who benefitted from steep social hierarchies opposed change in Virchow’s day and still do. Social revolutions often have bloody costs and may fail to boost health. Perhaps Margaret Mead’s “dedicated people in small groups” is our best hope for positive change.

Public Health vs Social Medicine

Both founded by Virchow, the two fields have similar goals, but somewhat different means to achieve them.

The lofty goal of the American **Public Health** Association is to “promote and protect the health of all people and their communities.” US public health institutions include the CDC (Centers for Disease Control) along with state and local health departments. Public health departments do important work tracking infectious diseases, and prevention work like promoting vaccination, healthy diet and exercise. Anti-tobacco and anti-opiate campaigns are sometimes well funded (by industry money from large lawsuit settlements) but otherwise public health is chronically underfunded. Per government data (CMS.gov) 2021 total public health spending spurred by COVID efforts jumped to 4.4% of \$4.26 trillion total health spending, but was just 2.8% of total spending in the years before COVID hit. The poor stepchild of rich American medicine, the US public health system has lofty preventative goals but largely just augments the bigger individual patient and profit oriented US health industry by tracking and investigating health disasters (HIV, obesity, opiates, COVID) after they happen.

Virchow’s **Social Medicine** goes further, advocating doctors and politicians use social science to achieve the goal of the health of all people. Virchow recommended scientific analysis of poverty and inequality leading to political action to improve population health. Virchow thought doctors would become social scientists (“practical anthropologists”) and politicians themselves. (Doctors have not frequently become high level politicians, although Cuban revolutionary Che Guevara and Chilean presidents Allende and Bachelet were doctors). Note Social Medicine is different than **socialized medicine**, which means government ownership of the healthcare system, as in the UK, most of northern Europe and most socialist and communist countries. Apart from the US most rich nations have some sort of universal healthcare, either by the government or through insurance schemes. Social Medicine goes further, attempting to have the medical system address social problems. Attempts to set up full Social Medicine bureaucracies in communist countries has had largely disappointing results, although Cubans have good population health despite their poverty. In most of the world Social Medicine exists in small enclaves of academics, liberals and international workers (i.e. Dr. Paul Farmer, and Medicines sans Frontières). Given enough resources some variation of Social Medicine might work in the rich world. Social Medicine tends to emphasize **social determinants of health** -early childhood, education, living and working conditions, discrimination, social gradients in wealth- brought back to attention by UK epidemiologist Michael Marmot. He and I believe less than 15% of the health differences between modern societies are due to differences in medical care, the great bulk of ill health being caused by suboptimal social conditions that the biomedical for profit healthcare system is blind to. Social medicine also emphasizes fixing inequities in healthcare (for example pregnant black women suffer both racism and poorer birth outcomes in the US obstetrics system), attention to environmental health (pollution, heat), and developing government policies that would benefit the health of society. Virchow remains correct today that social problems are the biggest causes of illness, but most US doctors lack the ability or inclination needed to address them.

More of Virchow’s 1848 report is excerpted on the following pages, as his (selected, translated) words may help you understand some of his philosophy for yourself, beyond my interpretation. Virchow was writing in the setting of democratic revolution, the emergence of the German Empire, and of Marx and Engels’ socialist writings (*The Communist Manifesto* was published in London in 1848), yet Virchow’s ideas seem fresh today. 19th century Prussians thought and felt, loved and hated, and were forced to choose how to live in ways essentially the same as today. Virchow started cellular pathology and his politics was anchored in economics, rights and power relations but Virchow also knew emotions and culture shape the real world lives of people.

excerpts from Virchow's 1848 Report on the Typhus Epidemic in Upper Silesia, in American Journal Public Health 2006

The present report will have provided the reader with a fairly comprehensive though not altogether complete picture of conditions in Upper Silesia. A devastating epidemic and a terrible famine simultaneously ravaged a poor, ignorant and apathetic population. In a single year 10% of the population died in the Pless district, 6.48% of starvation combined with the epidemic, and, according to official figures, 1.3% solely of starvation. In 8 months, in the district of Rybnik, 14.3% of the population were affected by typhus, of whom 20.46% died. . . . At the beginning of the year, 3% of the population of both districts were orphans. . . .

Never during the 33 years of peace in Germany had even remotely similar conditions been seen. No one would have thought such a state of affairs possible in a state such as Prussia, which took so much pride in the excellence of its institutions . . . these enormous compilations of misery cannot be disavowed and we must not hesitate to draw all those conclusions that can be drawn. . . . I myself had drawn the consequences when I returned from Upper Silesia, and was determined, in view of the new French Republic, to help in the demolition of the old edifice of our state. I later had no qualms in making known these conclusions. . . . They can be summarized briefly in three words: Full and unlimited democracy.

Prussia was proud of its laws and its civil servants. . . . According to law the proletarian was entitled to demand every means that would preserve him from death by starvation; the law guaranteed work, so that he should earn the wherewithal; the schools, those so much glorified Prussian schools, had been created in order to secure for him the education necessary to his standing; the sanitary police, finally, had the worthy task of watching over his housing and his way of life. And what an army of well-trained civil servants was ready to enforce these regulations! . . . The law existed, the civil servants were there—and the people died in their thousands from starvation and disease. The law did not help, as it was only paper with writing; the civil servants did no good, for the result of their activity again was only writing on paper. The whole country had gradually become a structure of paper, a huge house of cards, to be toppled in a confused heap when the people touched it.

The bureaucracy would not, or could not, help the people. The feudal aristocracy used its money to indulge in the luxury and the follies of the court, the army and the cities. The plutocracy, which draw very large amounts from the Upper Silesian mines, did not recognize the Upper Silesians as human beings, but only as tools or, as the expression has it, "hands." The clerical hierarchy endorsed the wretched neediness of the people as a ticket to heaven.

Any nation that still possessed inner strength and an urge to liberty would have risen up and thrown from its temples all the rubbish of hierarchy, bureaucracy and aristocracy, so that only the sacred will of the people should reign there. In Upper Silesia it was not so. Accustomed for centuries to extreme mental and corporal deprivation, poor and ignorant to a degree rarely found in any other nation of the world . . . the Upper Silesian had lost all energy and all self-determination and exchanged for them indolence, even indifference to the point of death. In Ireland the people rose in arms, and even with the unarmed hand, once its misery had exceeded the limits of tolerance, the proletariat appeared on the battlefield, rebellious against law and property, threatening, in great masses. In Upper Silesia the people silently died of starvation. . . .

Just as the English worker, in the depths to which he had sunk, in the extreme deprivation of the spirit, ultimately knew only two sources of enjoyment, drunkenness and cohabitation, the Upper Silesian population likewise, until a few years ago, had concentrated all its desires and all its striving on these same two things. The consumption of hard liquor and the satisfaction of the sexual impulse reigned supreme, and this explains why the population increased in numbers as rapidly as it lost its physical power and moral content. . . . But now there occurred the unheard of phenomenon that one of these two sources of pleasure yet remaining open to them was blocked by the church when it forbade the consumption of spirits. The people suffered it and accepted this blow in silence also. Its consequence was as strange as it was psychologically important. While one might have thought that now the last source of material enjoyment, i.e., sexual gratification would be more artfully exploited, the opposite occurred; the number of births steadily decreased. In their own way the people had become transcendental, like the Christian ascetics of the first centuries; but they did not neglect the body because of spiritual elevation but due to spiritual depression. The bonds which link man, that bodily lump of matter, to the earth, were loosened in the consciousness of the people; they had become listless to the point of death, by starvation.

This population had no idea that the mental and material impoverishment to which it had been allowed to sink, were largely the cause of its hunger and disease, and that the adverse climatic conditions which contributed to the failure of its crops and to the sickness of its bodies, would not have caused such terrible ravages, if it had been free, educated and well-to-do. For there can now no longer be any doubt that such an epidemic dissemination of typhus had only been possible under the wretched conditions of life that poverty and lack of culture had created in Upper Silesia. If these conditions were removed, I am sure that epidemic typhus would not recur. Whosoever wishes to learn from history will find many examples.

The logical answer to the question as to how conditions similar to those that have unfolded before our eyes in Upper Silesia can be prevented in the future is, therefore, very easy and simple: education, with its daughters, liberty and prosperity. . . . Medicine has imperceptibly led us into the social field and placed us in a position of confronting directly the great problems of our time. Let it be well understood, it is no longer a question of treating one typhus patient or another by drugs or by the regulation of food, housing and clothing. Our task now consists in the culture of 1½ millions of our fellow citizens who are at the lowest level of moral and physical degradation. With 1½ million people, palliatives will no longer do. If we wish to take remedial action, we must be radical. . . . If we therefore wish to intervene in Upper Silesia, we must begin to promote the advancement of the entire population, and to stimulate a common general effort. A population will never achieve full education, freedom and prosperity in the form of a gift from the outside. The people must acquire what they need by their own efforts. . . .

The people must be taught on the broadest basis, on the one hand by means of adequate primary trade and agricultural schools, by popular books and popular journals, and on the other hand there must be freedom to the greatest extent, especially complete liberty of communal life. . . . The absolute separation of the schools from the church, necessary as it is everywhere, nonetheless is nowhere more urgent than in Upper Silesia. . . .

. . . The earth brings forth much more food than the people consume. The interests of the human race are not served when, by an absurd concentration of capital and landed property in the hands of single individuals, production is directed into channels that always guide back the flow of the profits into the same hands.

Constitutionalism will never wipe out these abuses, since it is itself a lie . . . [which] can never truly draw the conclusions to be drawn from the principles of general equality before the law. Therefore, I abide by the doctrine which I have placed at the head of this discussion: Free and unlimited democracy. . . .

The next task will be the improvement of agriculture, horticulture and animal husbandry. . . . These men [small landholders] can only be assisted by popular instruction, by the introduction of better plant strains and better breeds of domestic animals. . . . The people must be made to understand that, when exclusively cultivating potatoes, they will always be exposed to the threat of similar crop failure and that only a certain variety of crops can protect them from a total failure. The more widespread cultivation of maize, legumes, pot-herbs and fruit could give them a better chance of yield. . . .

While the state as such should never be a permanent employer, since this would gradually lead to a new despotism . . . what is necessary and desirable is above all the association of the unpropertied, so that through these associations they can join the ranks of those citizens who are enjoying the bounties of life and thereby at last cease being mere machines for others. . . . People only count as hands! Is this the purpose of machines in the cultural history of nations? Shall the triumphs of human genius serve no other aim than making the human race miserable? Certainly not. . . . Man should work only as much as is required to wrest from the soil, from that crude substance, as much as is needed for the comfortable existence of the whole race, but he should not squander his best powers to amass capital. . . .

Capital and labor must at least have equal rights and the living force must not be subservient to non-living capital. . . . In every case the worker must have part in the yield of the whole, and as, moreover, with reduced taxation and with better education, his will be a happier lot. . . .

These are the radical methods I am suggesting as a remedy against the recurrence of famine and of great typhus epidemics in Upper Silesia. Let those who are unable to rise to the more elevated standpoint of cultural history smile; serious and clear-thinking persons capable of appraising the times in which they live will agree with me. . . .

Politician and Social Reformer

Virchow became a member of the Municipal Council of Berlin in 1859, a post he kept until his death over 40 years later, beginning another concurrent career as a local politician and civic reformer. Otherwise modern Berlin suffered cholera outbreaks and was “the smelliest capitol in Europe” requiring wearing boots because of sewage dumped in the streets or in dung pits to be emptied at night. Agricultural scientist Justus von Liebig opposed draining the sewage of Berlin because of the value of human waste as fertilizer. But Virchow responded with science, including epidemiology research showing Berlin’s infant mortality rose and fell with groundwater levels. Virchow eventually carried the day, and worked with scientists, engineers and builders (some were English, as they had recently pioneered the industrial and hygienic revolutions) on the implementation of clean water supplies and sewers in Berlin, a huge project from 1870 to the 1890’s. He helped establish new hospitals, and helped with schemes for patients too poor to afford care. He advocated for comprehensive education, including physical fitness for both boys and girls. He advocated government support for vaccination (by 1897 vaccines were available for smallpox, rabies, cholera, typhoid and plague, also diphtheria anti-toxin). Virchow advocated for better hygienic standards in schools and slaughterhouses, including microscopic meat inspection to stop trichinosis. As a long established city councilman, Virchow probably gained a fair amount of local power and historians generally consider his four decades as a Berlin politician to be very successful. The young radical became a professor and eventually an elder statesman.

National politics were apparently more difficult, as in that arena Virchow faced historical tumult and multiple powerful enemies. Elected to the Prussian Diet in 1862, Virchow was a founder and leader of the Progressive party, Deutsche Fortschrittspartei. Virchow’s new liberal party struggled against socialist, conservative and radical nationalist political parties. Bismark said “Politics is not an exact science and ... (Virchow had) amateurishly stepped out of his field and into mine, (and) I must say that his politics strikes me as lightweight.” Although Virchow started and helped maintain some progressive ideas in German politics, Bismark and his conservative militant nationalism mostly carried the day. While opposing excessive militarism, Virchow still helped build army hospitals and ambulance services, and organize hygienic improvements for the army in the Franco-Prussian-German wars of 1866 and 1870-71. In 1870 Prussia became the Second Reich, von Bismark’s new German Empire. From 1880 to 1893, Virchow was an elected member of the new Reichstag (lower house of the empire’s parliament). Virchow became chairman of the finance committee in the Reichstag and opposed Bismark’s high levels of military spending.

Advocating politicians (hoping they would be doctors but relatively few joined him) become “practical anthropologists”, Virchow’s ideas seemingly heralded the rise of technocratic governments. It seems progressive, having smart specialists unbiased by politics making decisions. Technocrats may have helped the US as it came out of the Great Depression under Roosevelt’s administration. But as with social medicine, technocracy has often been associated with poorly performing communist regimes. Virchow opposed Bismark’s welfare state, fearing powerful government bureaucracy would limit democratic decision making.

Politics is messy and full of surprises. The first national workers health insurance plan was created in 1883 Germany, pushed by Bismark along with accident insurance and pensions. Ironically Virchow and the liberals opposed the first modern welfare state because of the unchecked power it gave the government bureaucracy. Virchow may have been right to fear letting nationalism and socialism meld together in Germany. Virchow also wanted doctors to be free from state control, and opposed the state choosing doctors’ groups to regulate and discipline errant doctors. Virchow also (unsuccessfully) opposed having insurance cover natural healers.

Random cultural artifacts of Virchow

-quotes/memes

"Omnis cellula e cellula." ("All cells come from cells" in Latin, first published in 1855)

"Belief begins where science leaves off and ends where science begins".

"The task of science is to stake out the limits of the knowable, and to center consciousness within them".

"Physicians are the natural attorneys of the poor".

"Mass disease means society is out of joint".

"Learn to think microscopically".

"Medicine is a social science, and politics is nothing else but medicine on a grand scale".

Rudolf Virchow

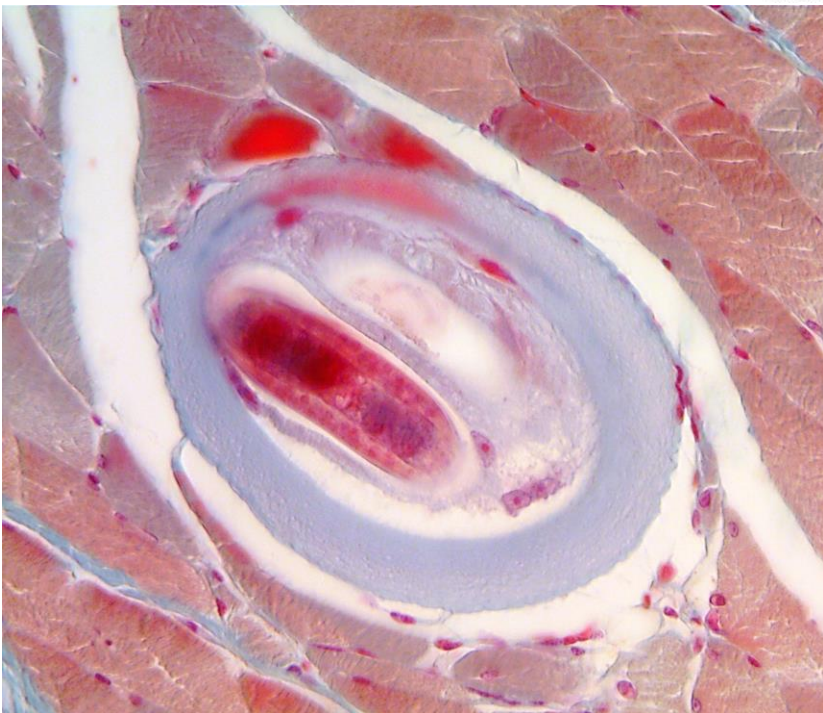
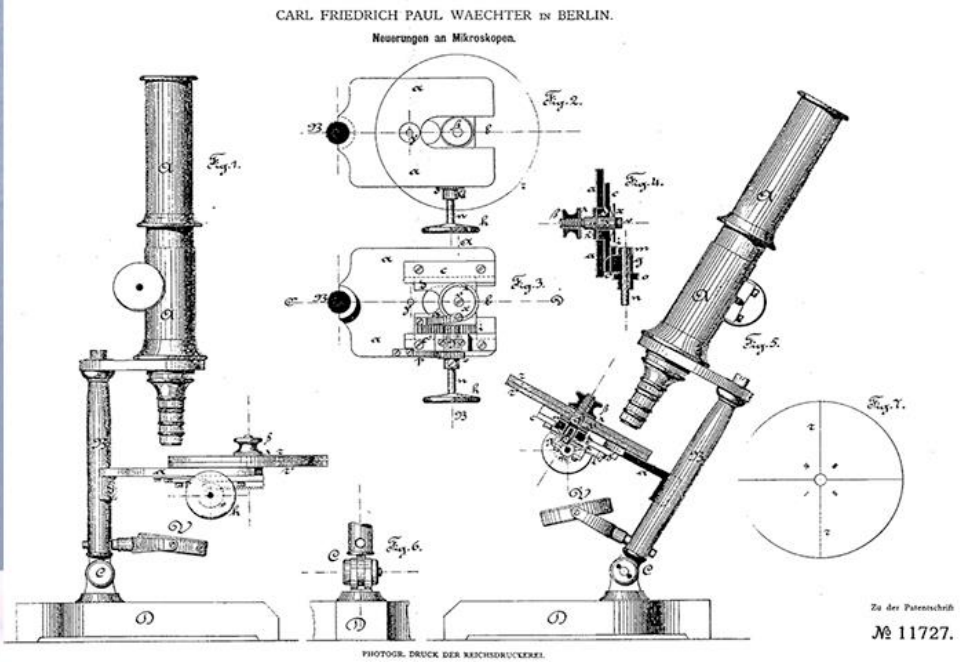


- The Sausage Duel

Image italianculturalcentre.ca

Virchow's liberal ideas were in opposition to one of the most powerful men on earth. The conservative Prime Minister of Prussia (future Chancellor of the German Empire) Otto von Bismarck eventually unified Germany and absorbed Prussia into the new Empire in 1870 after wars with Denmark, Austria and France. In the 1860's Virchow opposed Bismarck's excessive military budget and was a powerful thorn in the Prime Minister's side. Bismarck, "the man of blood and iron", was so angry that he challenged Virchow to a duel in 1865. Most German sources have Virchow declining the duel, or intermediaries negotiating a calming of tensions between the politicians. One account has Virchow choosing scalpels as weapons. The English language stories may be wrong, but are far more entertaining. As the challenged party, it was Virchow's prerogative to choose the weapons for the duel. Virchow asked Bismarck to pick one of two identical appearing sausages, one clean and the other infected with *Trichinella* larvae. The great and powerful von Bismarck didn't want to chance a painful parasitic infection, so "fearing the worst", he backed down. What a great story, even if it is probably not true. Virchow, "the Pope of Medicine" was a powerful figure who inspired apocryphal stories.

Virchow did discover the parasite that causes trichinosis and developed ways to prevent it. Coincidentally, both Virchow and Charles Darwin ate meat but thought everyone would become vegetarian in the future.



The trichinoscope above was patented c1880 in Berlin by Paul Waechter, former Zeiss employee. Enjoy bacon without fear of painful parasitic infection? Thank Virchow. He figured out trichinosis was caused by parasitic worm larva in pork, and started microscopic meat inspections to prevent it. Trichinoscopes are simple microscopes used for examining meat to prevent trichinosis, usually having glass plates to squash the specimen. Trichinosis was the first human disease found to be transmitted by animals, and thus is termed a “zoonosis” (a term coined by Virchow). Image from Brain Stevenson, microscopist.net

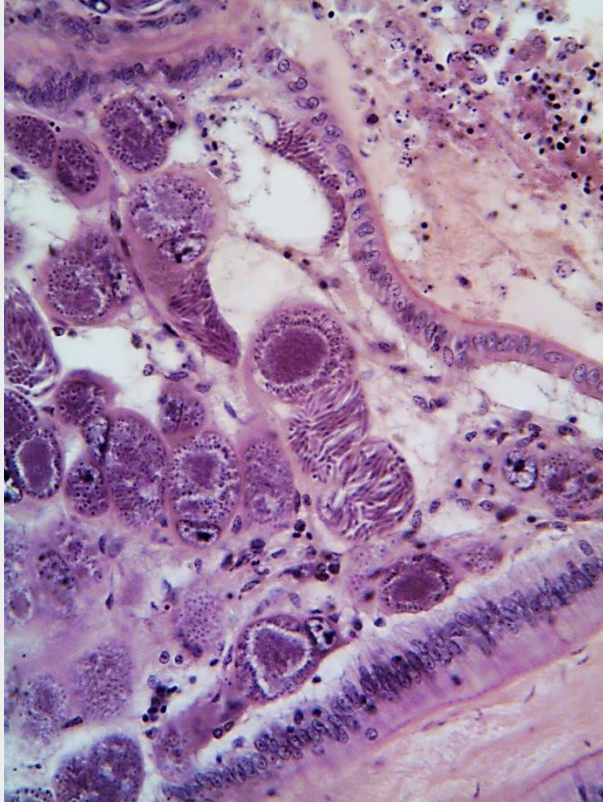
Trichinella spiralis parasitic nematode, coiled worm larva encysted in muscle. Slide by Ward's, 40X objective, cyst ~0.15 mm



Women using trichinoscope microscopes to inspect fresh pork in a Chicago, USA meat packing plant, 1896 photo published 99 years later, *Science* 8 Feb 1985

Father of Parasitology?

Not quite, as intestinal worms were noticed by the ancients and Leuwenhoek saw *Giardia* with his microscope in the 1600's. But Virchow may have been the first to understand a complex parasitic life cycle. His work with *Trichinella* helped Virchow earn the monikers Father of Public Health and Father of Veterinary Pathology. He was the first to show humans can acquire diseases from animals, which he called zoonosis, the term still used today. He was a founder of the "One Health" idea, stating "between animal and human medicine, there is no dividing line—nor should there be".



Left: coccidian protozoan **endoparasite** *Eimeria tenella*, in chick gut, 1948 slide from "J Hopkins School of Hygiene Parasitology", 40X objective, image ~200 microns wide

Ectoparasite: *Haematopinus suis*, hog louse, ~4mm long insect, modern slide by L Bircham, 4X objective, stitched



Parasite Basics

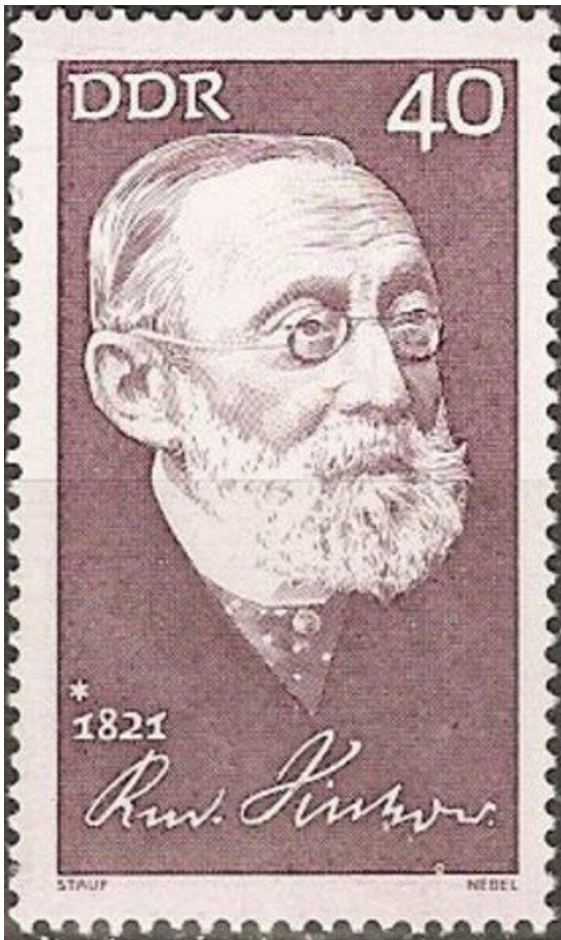
Life spreads and adapts to everywhere it can survive, including inside and outside the bodies of other organisms. Evolution thus produces endoparasites (like intestinal worms) and ectoparasites (like lice). Some parasites give a false appearance of being experts in anatomy, often travelling between different organs and different animal species at different life stages. Most wild animals carry parasites, and most humans used to have them, although most individuals are not harmed. In poor and tropical areas many people are still harmed and killed, including over 600,000 annual deaths from malaria. Some members of many different branches of life have become parasitic: protozoans, flatworms, round worms, arthropods (including ticks, crustaceans, insects) and others. Parasites can also act as vectors to spread the bacteria and viruses that cause Lyme disease, viral encephalitis, typhus and the plague. Parasites can also harm people by heavy infestation or complications. Nearly half of humans may have parasites, most commonly helminths (intestinal worms) although they don't make most of them sick. The burden of parasites is highest in the tropical and poor areas of the world. We need to continue life saving efforts to control malaria, worms, and other neglected tropical diseases. Still, most of you reading this need not fear parasites. Anxiety about parasites is far more common than parasite disease in the developed world. Parasites are also part of the balance of nature, which might be harmed if we continue to extinct parasite species faster than we can discover them.

- Virchow postage stamps



above_both Germany 1942
below left Berlin, Germany 1952
below right Hungary 1989
[images from stampboards.com](http://imagesfromstampboards.com)





DDR, the former East Germany
left 1960, below 1971
images from stampboards.com



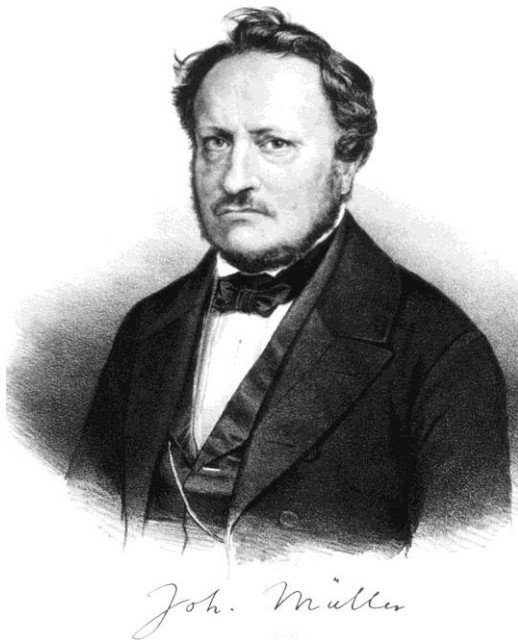
With Virchow's advocacy Berlin went from no covered sewers to an elaborate modern system of 11,000 kilometers of tunnels (per pci.at)
Berlin manhole cover image from Wikimedia

Virchow's Teachers

Two were particularly prominent in their effects on Virchow.

Johannes Peter Müller (1801 –1858) physiologist, comparative anatomist, he was Virchow's doctoral professor and introduced Virchow to the microscope. Müller was son of a poor shoemaker and studied to be a priest before changing to science. He did extensive comparative anatomy with marine animals, often using microscopes. The Müllerian ducts, also called paramesonephric ducts (embryonic structures that develop into fallopian tubes and uterus) are named in his honor. Müller opposed the 1848 revolution and kept Virchow from returning to Charité Hospital in 1849. Later they made amends, and Virchow delivered the eulogy at Müller's funeral.

Robert Friedrich Froriep (1804 –1861) prosector (dissecting bodies for teaching displays) and conservator of the pathological museum at Charité Hospital in Berlin, Virchow was at first his assistant then succeeded him. Foreip was a skilled artist known for his anatomic drawings and also for translating and publishing French and English medical works. Froriep helped Germany catch up in science, and his student Virchow helped Germany leap ahead in medical and social sciences.



Virchow's teachers, dates unknown
left Johannes Peter Müller
right Robert Friedrich Froriep
images Wikipedia and alchetron

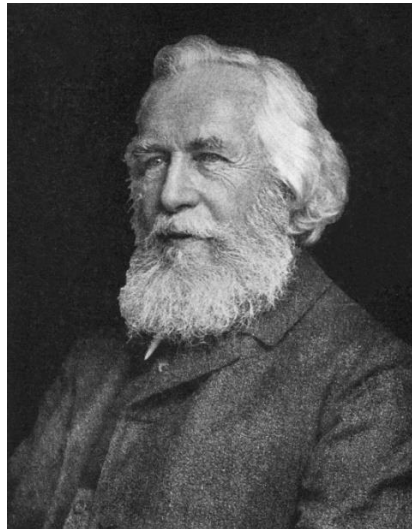
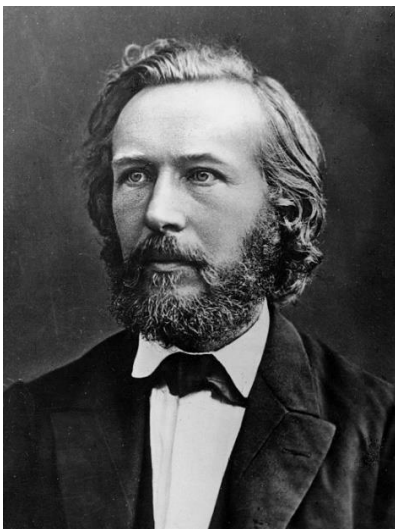
Virchow's Lasting Influence

Rudolph Virchow shaped our modern world in many ways. Virchow's new discoveries and his more rigorous scientific method set medicine on the track to become our modern bioscientific medicine. Virchow was a prolific scientific publisher in his own *Archives* and other medical journals. He also published articles in Anthropology journals, a total of over 2000 scientific articles plus multiple medical textbooks in his long career. He taught many students in person. Large amphitheater type class rooms were built for this purpose in Berlin. Some students became assistants and worked with him for years. Several of his students in Germany then went overseas disseminating Virchow's knowledge and methods. Other students came to Berlin from overseas, then returned home, spreading the word of the Pope of Medicine.

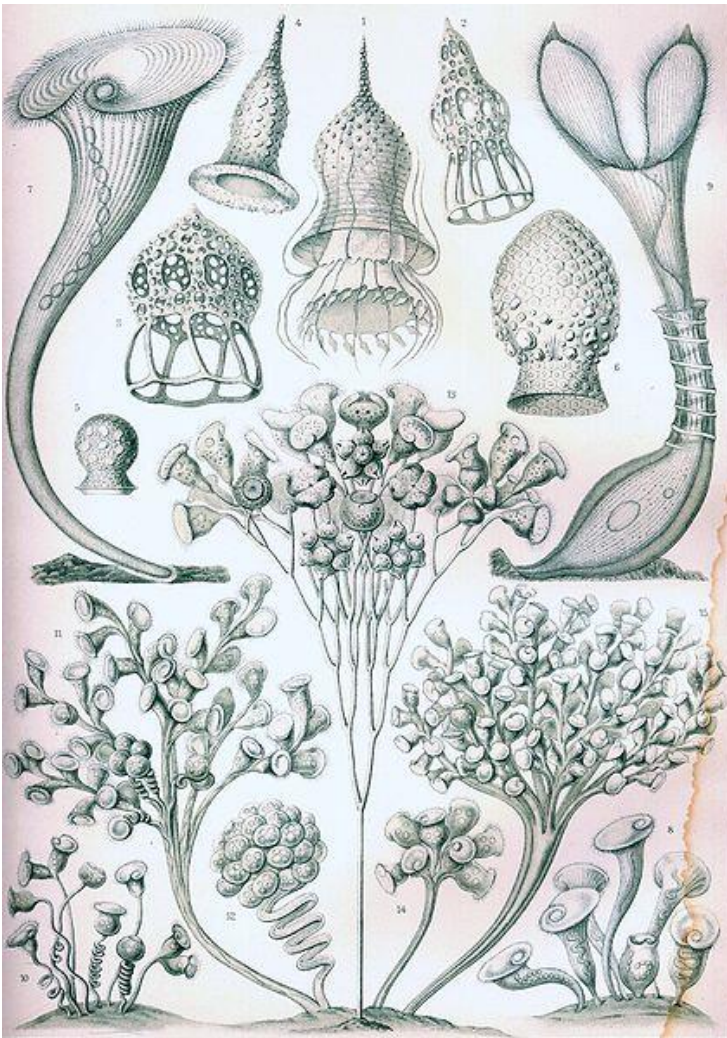
A prominent student who challenged the master

Ernst Haeckel (1834 –1919) was a German marine biologist, philosopher, physician and artist. A fascinating figure, he embraced Darwin's theory of evolution, stridently defending it to the world (successfully) and to his old teacher Virchow (unsuccessfully). Haeckel's famous "ontogeny recapitulates phylogeny" isn't fully correct, but it does demonstrate some of the ways all life is related. He invented and named the science of "ecology". Haeckel's love of nature comes through in his amazing color illustrations of marine invertebrates and single celled "protists" (his name, still used today). He created his own religious philosophy, "monism", blending scientific materialism with 19th century German Romantic nature worship (it didn't catch on). Unfortunately, he was also a warmonger, eugenicist and "scientific racist" who came up with a crazy classification of humans into 12 distinct species which independently evolved from apes, with Europeans of course being the most superior race. (Although the definition of "species" was evolving it was clear to other observers that man is a single species. The social distortions of racism make different "races" appear more different than they objectively are. If different human races were independent species one would not expect them to be able to easily interbreed, which of course they can, unless prevented by racism). Haeckel believed blonde haired blue eyed Aaryan Germans should conquer the world. He openly encouraged them to do so, blaming England for "World War 1" (Haeckel's name for the war) in 1914, as what everyone else called the Great War was just beginning.

Virchow ended up clashing strongly with Haeckel over evolution and whether it should be taught. My German friends had never heard of Haeckel, Germany being good at national guilt and in undoing national socialism.



[far left, Ernst Haeckel in 1860](#)
[near left, date unknown](#)
[images Wikimedia Commons](#)



Ernst Haeckel was a genius, for good and for bad. His beautiful art is mostly scientifically accurate, except where he veers into evolution and then produces awful racist caricatures.

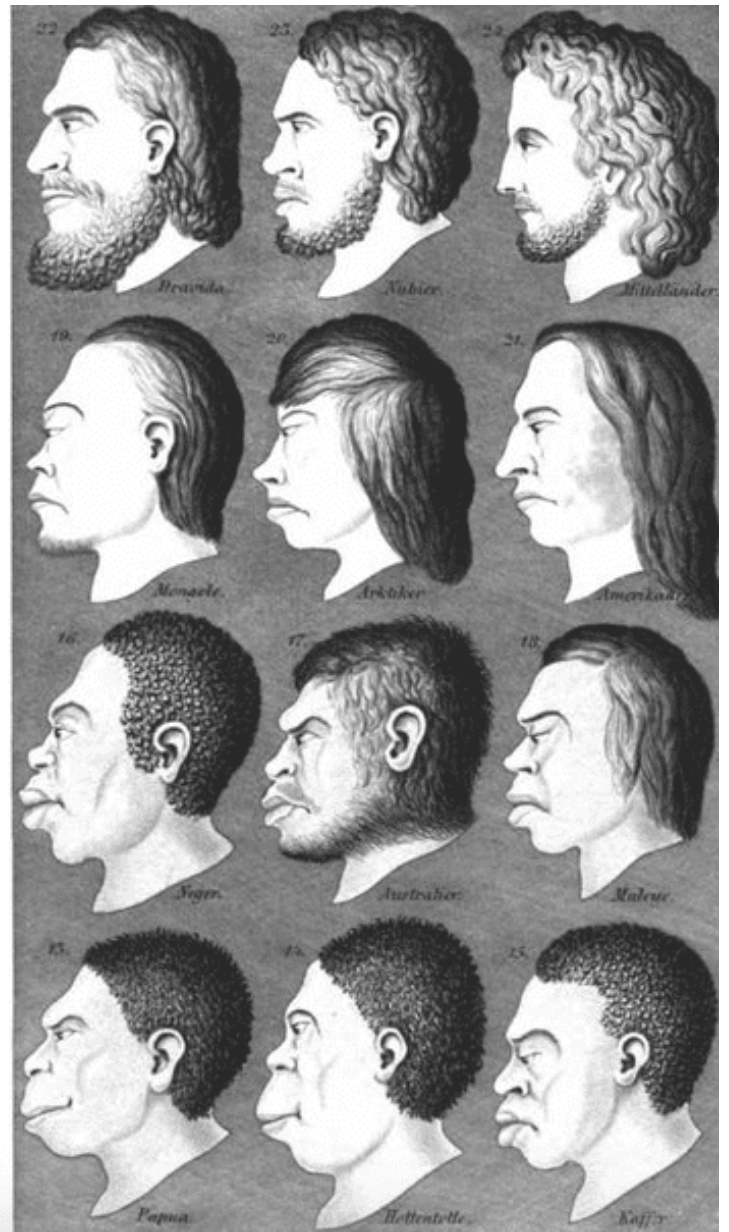
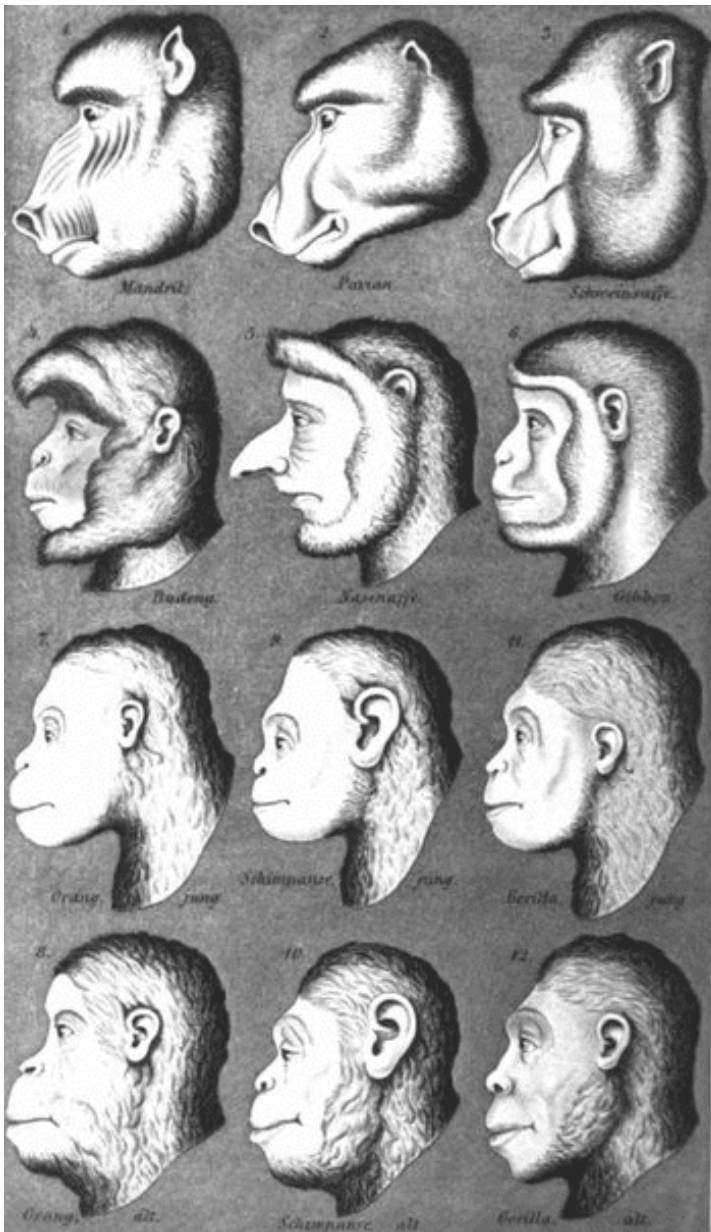
left: mostly ciliate protozoa (drawn from microscope) Haeckel noted it can be hard to divide single celled protists into animal and plant types and proposed a separate kingdom of life for them, an idea that eventually took hold.

below: sea anemones, cnidarians

Haeckel produced thousands of scientific illustrations and a popular 1904 art book *Kunstformen Der Natur* translated in English as *Artforms in Nature*

Images Wikimedia Commons

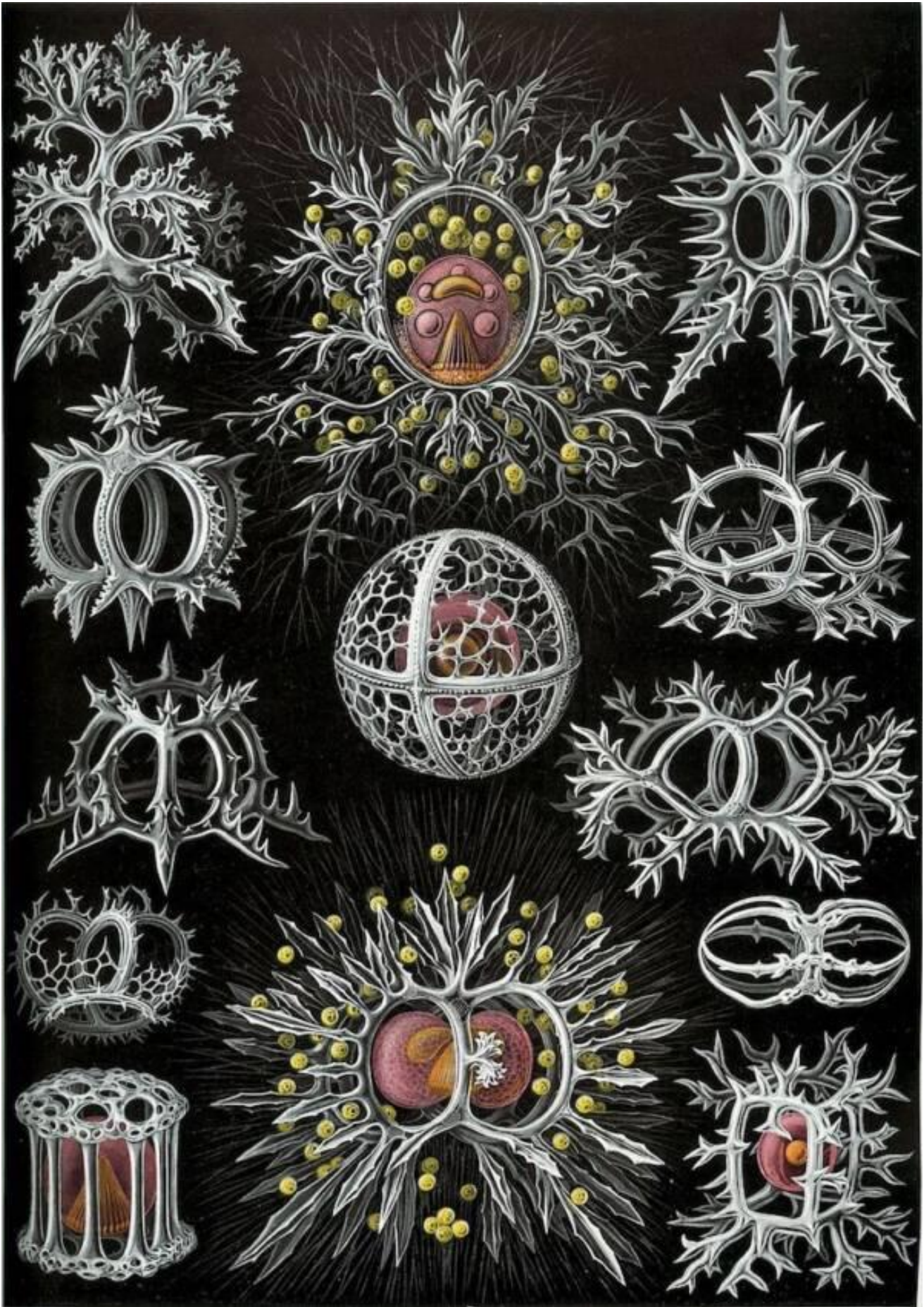




12 ancestral ape species, leading to "12 species" of man
 frontispiece from Haeckel's 1870 popular science book on evolution

next page Radiolarians, amoebic protozoa that live in intricate silica (glass) shells,
 painted from microscopic views, another illustration from *Kunstformen* 1904

Images Wikimedia Commons



More of Virchow's prominent students

Edwin Klebs (1834 –1913) was a German-Swiss microbiologist who embraced the nascent germ theory of disease, laying groundwork for Louis Pasteur and Robert Koch. He identified the bacterium (now called *Corynebacterium diphtheriae*) that causes diphtheria. Unfortunately, he also identified an imaginary soil bacterium he called *Bacillus malariae*, as the cause of malaria in 1879, just a year before Frenchman Charles Laveran correctly discovered that malaria was caused by a mosquito borne protozoan parasite. The acceptance of the real cause of malaria was delayed for 18 years because of Klebs' blunder.

Axel Key (1832- 1901) was an important Swedish pathologist. Key did doctoral work with Virchow in 1861 then returned to Sweden, establishing modern pathology, studying child health, and reforming medical schools. Key was also a liberal politician and president of second chamber of the Swedish parliament for a time.

Adolf Kussmaul (1822 – 1902) German physician with great clinical acumen. Described deep breathing in diabetic ketoacidosis, the paradoxical jugular pulse of restrictive pericarditis, and the signs and symptoms of polyarteritis nodosa. These are sometimes respectively called Kussmaul's breathing, sign and disease.

Franz Boas (1858 –1942) was a German-American anthropologist who has been called the "Father of American Anthropology". He trained with Virchow, did work with Inuit and Pacific Northwest indigenous peoples in North America and became professor of anthropology at Columbia University. Boas developed the idea of cultural relativism: beliefs and behaviors are best understood based on a person's own culture, not your own. He believed non-western cultures are not inferior, just different. True to his teacher Virchow, Boas said research evidence should come before developing theories.

Max Westenhöfer (1871 –1957) was a German pathologist who spent years in Chile teaching pathology and the reform of public health in Chile. One of Westenhöfer's students was **Salvador Allende**, who became a pathologist and a doctor's union labor activist, and was later elected president of Chile in 1970. After 3 years of political turmoil including nationalization of multiple industries, Allende was killed by a CIA supported coup on September 11, 1973 that installed military dictator Augusto Pinochet. So Latin America's first elected Marxist President was a pathologist, Virchow's own academic grandson, and was killed with aid of US intelligence services.

Other Virchow students included Friedrich Daniel **von Recklinghausen** (1833–1910), who described neurofibromatosis and Julius Friedrich **Cohnheim** (1839–1884), who discovered leucocyte extravasation.



Left to right: Edwin Klebs, Axel Key, Adolph Kussmaul, Franz Boas, Max Westenhöfer
images from Wikipedia, cropped slightly, as is the group portrait on next page

William H. Welch (1850–1934) and **William Osler** (1849–1919) were two of the four founding fathers of Johns Hopkins School of Medicine in Baltimore, Maryland, USA. Welch was the first dean of the medical school and founded the Johns Hopkins School of Hygiene and Public Health, the first school of public health in the USA. Osler was born and went to medical school in Canada, then decided to go to Europe to learn more, including attending Virchow's lectures and demonstrations in Berlin in 1873. Osler was the greatest diagnostician of the age, started Hopkins School of Medicine and is called the "Father of Modern Medicine" for his scientific knowledge and wisdom. Founded in 1893, Hopkins Medical School modelled itself after European universities at a time when most American medical schools were mere trade schools. For decades Hopkins required a college degree plus knowledge of German and French languages to apply to medical school.



The founding fathers of Johns Hopkins Medical School, 1905 portrait by JS Sargent, image from hopkinsmedicine.org
Left to right: pathologist William Welch, surgeon William Halstead, internist William Osler, gynecologist Howard Kelly

Hopkins medical school went on to become a powerful modernizing influence on all of American medical education. In 1910, teacher Abraham Flexnor, sponsored by the Carnegie Foundation, published a scathing report on US medical education. He criticized almost all the medical schools of the day as unscientific, money making diploma mills that taught little about the real causes of health and disease, producing quack doctors who sold snake oil. Flexnor recommended closing most US med schools and reorganizing the remaining schools after the scientific example of Johns Hopkins med school. In the decade following Flexnor's report the number of US med schools dropped from 160 to 85 and US medicine was reformed, entering the scientific age.

Over time Virchow had profound effects on the world through his research, writings, and his many students.

Virchow's mistakes, my conclusions

Mistakes, and some possible reasons why

In his many medical discoveries Virchow sometimes missed some things we know today. Given how little was known by doctors when Virchow arrived on the mid-19th century medical scene, his errors were relatively few and understandable. He knew the importance of inflammation but did not see that white blood cells moved to those areas (his student Cohnheim made the discovery). Virchow discovered blood clots moved to become emboli, but missed that cancer metastasizes by the movement of cancer cells. He thought amyloid deposits were carbohydrates rather than proteinaceous. No big deal, given that he got 99% of his vast new medical knowledge right. But a few of his mistakes were doozies. Virchow denied the two greatest breakthroughs in late 19th century biology: Darwin's theory of evolution, and the germ theory of disease. Rudolph Virchow was surprisingly stubborn for being agnostic. He was unsure if God himself existed, but seemed cocksure about everything else. It almost seems Virchow preferred his own discoveries over those of others. Perhaps Virchow just presumed he was right because he knew he was always smartest person in the room.

- the prince's cancer

Sometimes a little mistake can have big consequences. One of Rudolph Virchow's mistakes possibly led to world war. It seems like a classic case of medical malpractice: failure to diagnose cancer. The smartest doctor saw the most important patient in the world, but he didn't know enough to save him. **The unfortunate patient was Crown Prince Frederick William**, seen in 1887. Prince Frederick, loved by the people as Prince Fritz, was liberally educated at university and married to the English Princess Vicky. Although militarily experienced he was known to strongly favor international diplomacy, trade and peace. His father the Kaiser was elderly and weak, deferring to militaristic von Bismarck. Prince William was a chain smoker and became hoarse in January 1887. At first doctors attributed this to smoking, but he worsened and they feared laryngeal cancer (although they didn't tell the patient). In May prominent German surgeon Ernst von Bergmann favored curative surgical removal of the entire larynx, at a time when German surgeons were clearly the best in the world. But a laryngectomy would permanently take away the future king's voice, so a limited vocal cord surgery was done instead. A second opinion was requested from an English laryngologist, Morrell Mackenzie. He did a small biopsy. Virchow was consulted and read the biopsy as negative. The Prince got worse and Mackenzie removed more laryngeal tissue in June. The world's best pathologist, Virchow again diagnosed verrucous laryngitis, not cancer. By November 1887 the Prince couldn't speak at all and von Bergmann told him the truth: the Crown Prince was dying of cancer. Prince Fritz took it stoically, thanking all the doctors and wrote "learn to suffer without complaining." By February a tracheostomy was done to keep the Prince breathing a while longer. His father, the Emperor, died March 9 (a few days short of the age of 91) and a terminally ill Prince Frederick became Kaiser Frederick III for just 99 days, until he died June 15, 1888 at age 56.

On that day his son, Wilhelm II, became the last German Emperor (the monarchy was abolished upon losing the war in 1918). Wilhelm was born traumatically breech with a "chip" on his crippled (birth injured) shoulder and also possibly suffered mild anoxic brain injury at birth (his screaming mom was anesthetized with heavy chloroform), leading to erratic behaviors later. Young Wilhelm immersed himself in hypermasculine Prussian military culture and eventually surpassed even Bismarck in war mongering. If not for the throat cancer, his father Frederick might have survived for decades longer, stood up to Bismarck and stopped the build up to the Great War. It is very possible that a missed laryngeal cancer caused World War I with its terrible after effects.



Hybrid verrucous laryngeal carcinoma, presumed H&E stain, magnification not stated but similar to 20X objective view. A difficult pathological diagnosis as most of the tumor is made of nests of well behaved (benign looking) verrucous (warty) carcinoma as seen right and left. Arrowed extension is moderately differentiated squamous cell carcinoma that could be missed. The background of heavy inflammation also sometimes hides bits of squamous cell carcinoma.

Image from López, et al (2017). How phenotype guides management of non-conventional squamous cell carcinomas of the larynx?. Archives of Oto-Rhino-Laryngology. 274. 10.1007

Rudolph Virchow was wrong about Prince Frederick's diagnosis, but his reading of the biopsy as verrucous laryngitis is now thought to be correct for the time. Modern experts believe Frederick had hybrid verrucous carcinoma, a very rare form of laryngeal cancer, not identified for the first time until 1948. No medical diagnostic test is perfect. Perhaps even the best pathology knowledge of Virchow's time could not have correctly diagnosed the Crown Prince.

- selective religious intolerance

Rudolph Virchow and Otto von Bismarck were long time political enemies, to the point of Bismarck wishing to kill Virchow in a duel. But they could agree on one thing: they were both terribly **Anti-Catholic**. In the three and a half centuries between Luther's Reformation and Virchow's time, Prussia had become majority Protestant (64% Lutheran in 1880, Germany is slightly less than half Protestant today). The new German Empire established by von Bismarck in 1870 opposed the old power of the Catholic church. In 1872 Bismarck launched what Virchow approvingly named **Kulturkampf** ("culture struggle") against the Catholic Church of Pope Pius IX. The harsh "May Laws" of 1873 and related rules gave the German state exclusive control of education, banished all Jesuit priests from the empire, and regulated who could be appointed to leadership positions in the Catholic Church (requiring public university education). Many Catholic churches and seminaries closed. Germany became increasingly anti-French and anti-Polish, as they were Catholic nations. Kulturkampf was against Germany's Constitution (they had to amend it) and against Virchow's own avowed belief in freedom of religion. Kulturkampf was ultimately an unsuccessful overreach. By the end of the 1870's Bismarck had managed to unite the various Catholic Churches in Germany into a stronger union than ever before. Bismarck eventually backed down, needing Catholic support to fight a growing Socialist Democrat Party. The anti-Catholic May Laws were slowly repealed over two and a half decades; the last was struck down in 1905.

- rejection of evolution

Virchow was **anti-evolution** and rejected early fossils of ancestral species that preceded modern man. English genius Charles Darwin's discovery and masterful explanation of the theory of evolution by natural selection excited and divided European science in the last half of the 19th century. In 1860 Virchow's student Ernst Haeckel read *On the Origin of Species* and was immediately hooked. Tens of thousands of species fell into their places on a great tree of life instead of forming a random rubbish heap. Haeckel enthusiastically promoted evolution and its teaching. German high school teacher Hermann Müller was denounced by multiple German and international newspapers in 1877 for corrupting young minds with evolution. The same year both Haeckel and Virchow spoke at the 50th Conference of Natural Scientists and Physicians in Munich. In the October 1877 issue of *Nature* Haeckel published "The Present Position of Evolution Theory", and Virchow responded in the next issue with "The Liberty of Science in the Modern State". Haeckel argued passionately in favor of the teaching of evolution in public schools. Virchow spoke strongly against it, arguing evolution was an unproven theory and a threat to good morals. Evolution continued to be controversial in Germany, and the Ministry of Education banned teaching of all of biology in 1882, amid fears teaching of evolution would promote atheism and socialism, weakening the Empire. It was not until 1925 that the teaching of biology and evolution became compulsory in Germany.

The US lagged further behind, with teacher John Scopes being convicted and fined for teaching evolution in the state of Tennessee in 1925, the same year Germany restored teaching evolution. Polls show over half of Americans did not consistently accept evolution until 2016. Unlike in modern America, Virchow's opposition to evolution was not religious. Virchow was agnostic, writing "faith does not admit of a scientific discussion, for science and faith exclude each other. Not to such an extent, however, that one of them renders the other an impossibility." Having shown all cells come from cells and denying miracles Virchow might have seen the inevitability of evolution, but he missed it.

Over time most scientists accepted evolution, especially after exciting discoveries and descriptions of ancient fossil man-like species. Neanderthal remains were first found in a cave in the Neander Valley in Germany in 1856 and in multiple other European and Middle Eastern sites from the last Ice Age (about 50 to 150 thousand years old) in the decades following. The fossils included brutish appearing skulls and thick limbs, now known to be from an extinct subspecies of man, *Homo sapiens neanderthalensis*. Later, Java man was first found in the Dutch East Indies in 1891 and had a smaller brain and other ape like features. Those fossils are older (about 0.7 to 1.5 million years) and represent a different species of widespread extinct human ancestor, *Homo erectus*.

Rudolph Virchow examined the original Neanderthal skeletal remains in 1872. He said the bones were of a modern human affected by the disease rickets and arthritis, and judged the skull as deformed by injury. Later, in 1895, DuBois, the discoverer of Java Man, displayed his specimens in the Netherlands. Virchow examined Java Man and pronounced the fossils as not human at all, but “an animal, a giant gibbon”. Being the world’s leading expert in human anatomy, skulls, and prehistory, Virchow set back the acceptance of Neanderthals and Java Man as extinct relatives of man, and delayed the acceptance of evolution in general. Virchow angrily denounced his former student Haeckel as a “fool” and Darwin as an “ignoramus”. Later other scientists found more fossils that were intermediate between modern species (“missing links”), and as the vast majority of scientists came to accept evolution Virchow softened his views on evolution a little. Virchow eventually accepted the evolution of non-human animals, but he never accepted human evolution. In 1901, the year before his death, Virchow wrote “The intermediate form is unimaginable save in a dream... We cannot teach or consent that it is an achievement that man descended from the ape or other animal”.

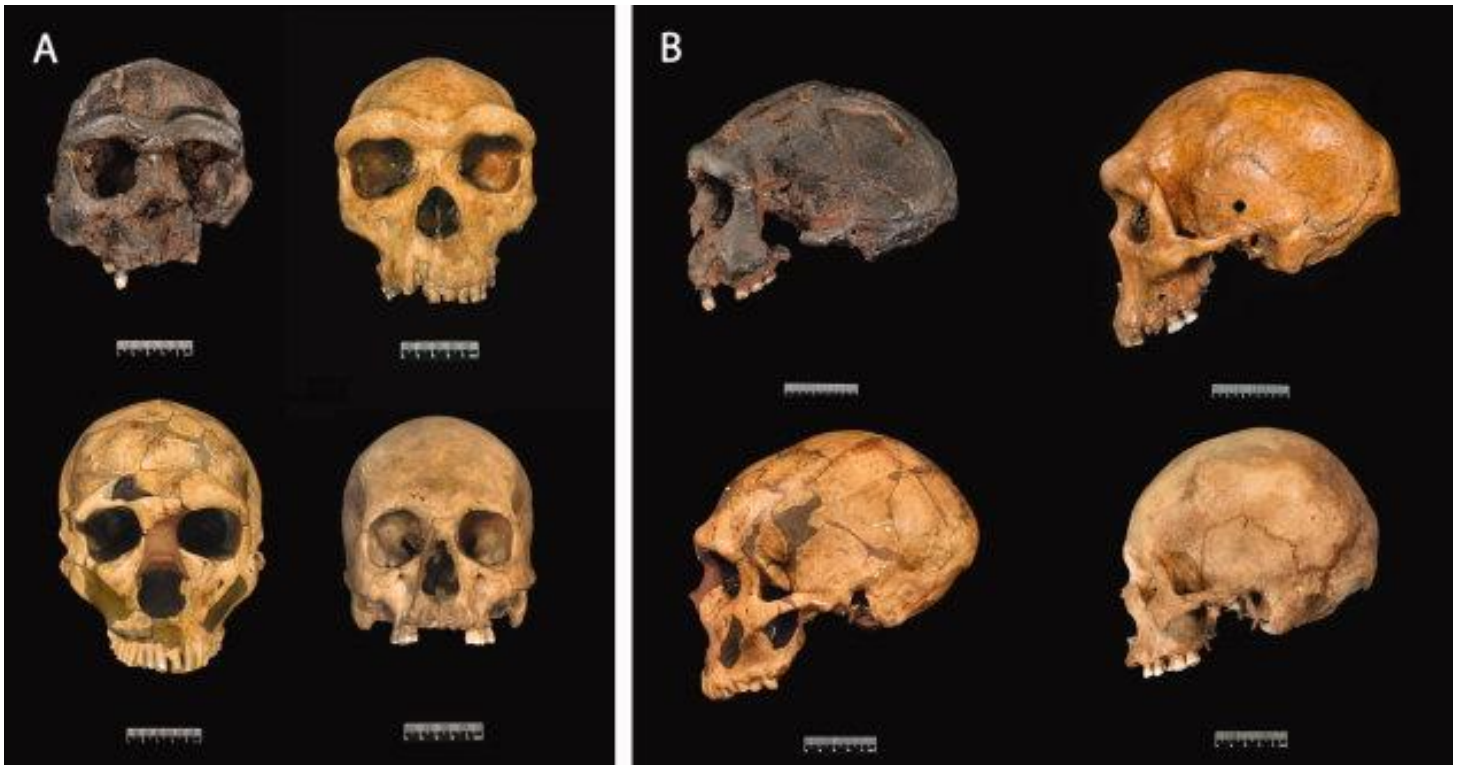


The first remains recognized as an extinct human ancestor came from the Neander Valley, Germany in 1856. A skullcap and several limb bones were seen by Virchow, and incorrectly identified as modern. Images Don’s Maps, specimen LVR-LandesMuseum Bonn



A partial skull, femur and tooth of Java Man were the oldest known hominid fossils when found in 1891 and 1892 on the island of Java. Virchow incorrectly identified the bones as those of a giant extinct gibbon. Image from Wikipedia, specimens held at Naturalis Center, Leiden, Netherlands





Virchow saw only bits and pieces. More fossils finds came later. From top left clockwise crania of *Homo erectus* (Java man), *Homo heidelbergensis*, a Neanderthal (now sometimes called *Homo sapiens neanderthalensis*) and *Homo sapiens*, a modern human. Virchow, the world's leading human skull expert, incorrectly attributed remains of Java man to a giant gibbon and of Neanderthal to a diseased modern man. Image Natural History Museum, London

The reference to “the intermediate form” seems to be pointing out what he thought was a lack of fossil evidence at the time, but also may be a criticism of Haeckel’s claim against the unity of man. Haeckel thought different races comprised 12 different species of humans, and the “lower races” were intermediates between apes and northern Europeans. The Theory of Evolution had created a deep divide in the international scientific community. Charles Darwin, Thomas Huxley and Franz Boas all rejected “social Darwinism” and affirmed the unity of man, but Francis Dalton in England and Ernst Haeckel in Germany were scientific racists who promoted eugenics (sterilization of “inferior” peoples). Eugenics became a very popular pseudoscience, especially in early 20th Century America, with the most prominent US geneticists and physical anthropologists joining the American Eugenics Society when it started in 1926. By being anti-evolution, Virchow steered clear of one of the most tragic wrong turns in the history of modern science. So despite being agnostic and the very definition of an objective modern scientist, perhaps Virchow was more swayed by the perceived moral hazard of accepting evolution than by the hard evidence of the fossil skulls he held in his hands.

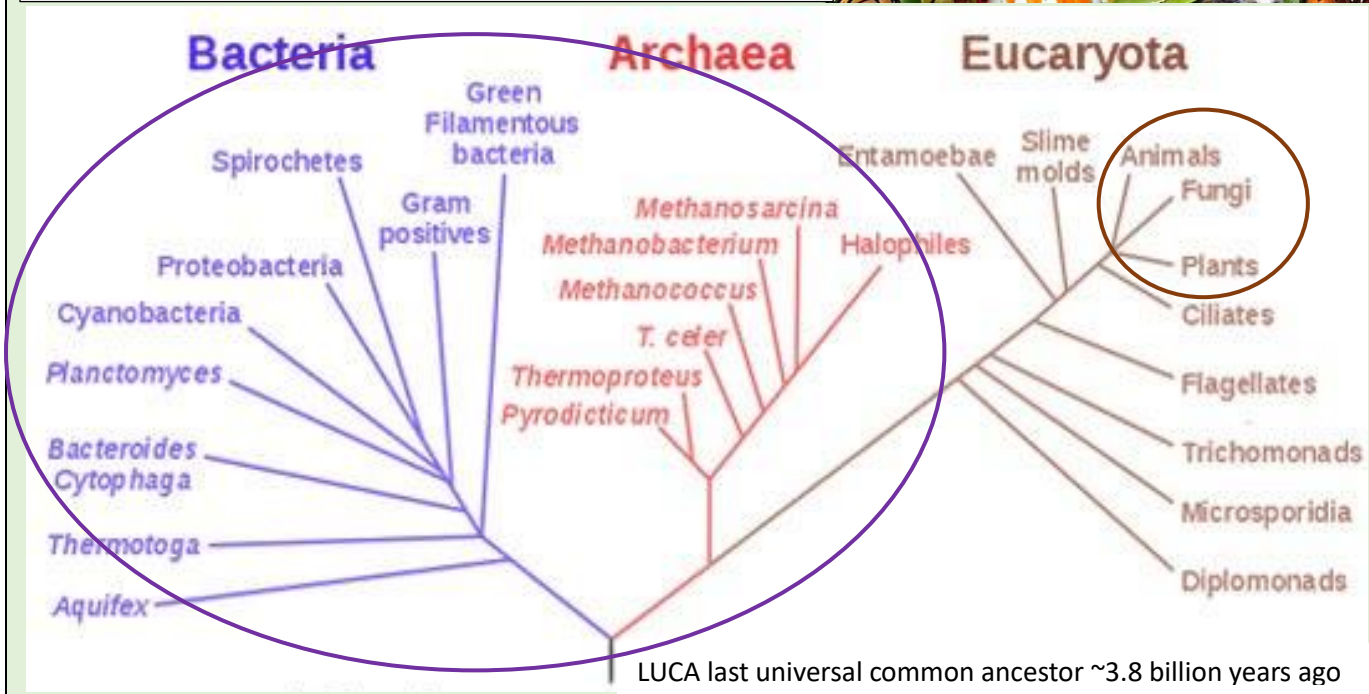
Still it is hard to overstate how deeply wrong Virchow was in his rejection of the theory of evolution, and as we will discuss later, the germ theory of disease. Virchow is almost akin to an imaginary Noble Prize winning scientist who is the most gifted nuclear physicist on earth, yet thinks that the earth is flat and the space program is a sham. Today, electronic social media has fragmented our society into groups that get fed different information about the world. But in his century Virchow had access to the best science data, and even had a gifted student and a colleague who were proponents for evolution and germ theory, yet he missed the biggest revolutions in biological science. Virchow went to his grave in 1902 still denying both evolution and the germ theory of disease. No explanation for Virchow’s deepest scientific blunders is completely satisfactory.

Basics of Evolution

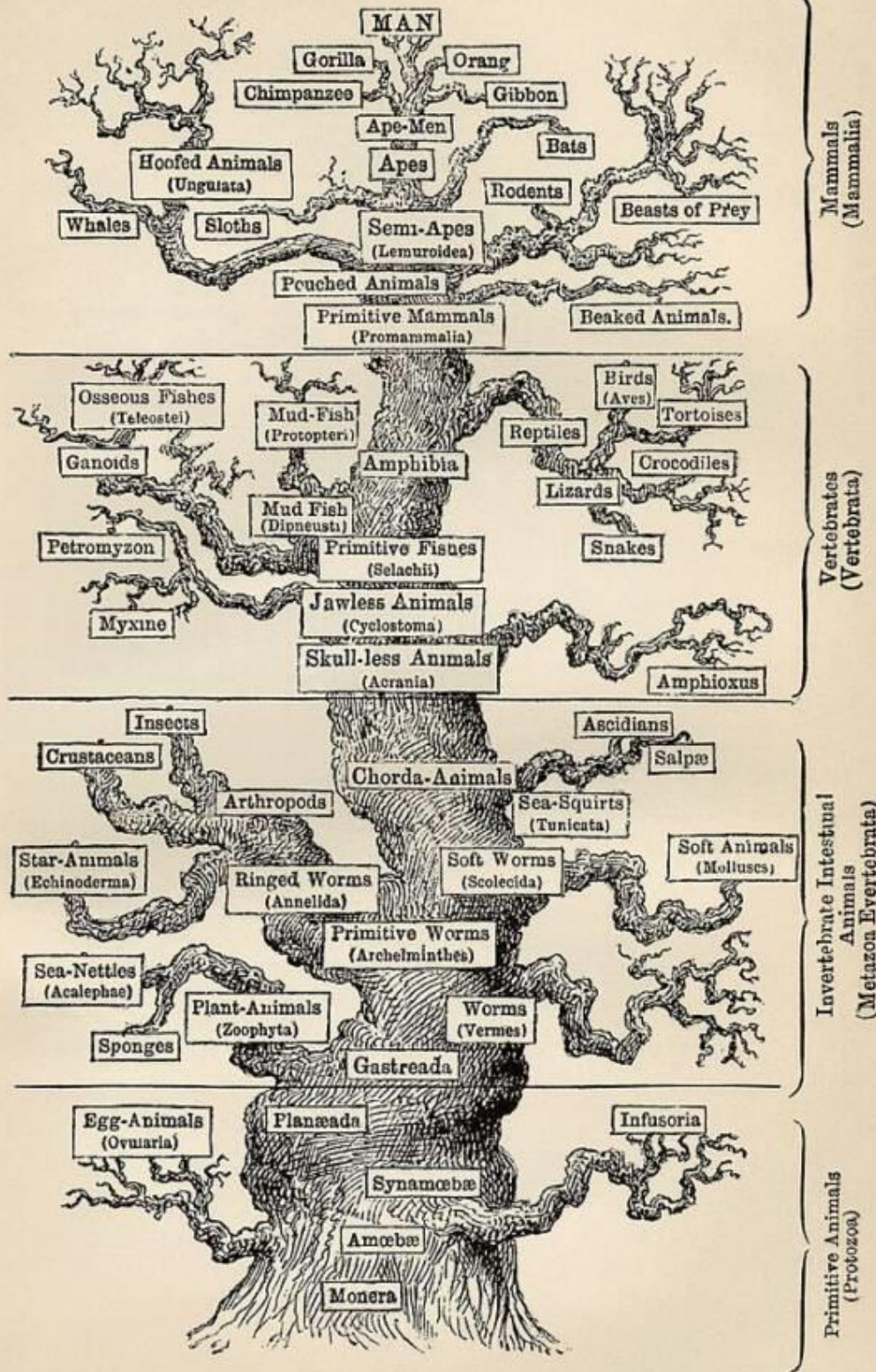
In Virchow's time evolution was a new theory, laid out in clear, logical and humble detail by Charles Darwin in his 1859 book *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. Darwin had gathered thousands of his own and others' observations about the varieties of life, but known fossils were few and the mechanisms of inheritance were unknown (actually Czech monk Gregor Mendel discovered the laws of genetics in pea plants in the 1860's but no one knew it). Evolution is now a proven fact: millions of new bits of evidence show life slowly evolved into a myriad of different forms on planet earth. Evolution remains also a powerful and changing theory (all science is subject to modification as we get additional information) that can be used to interrogate new evidence in biology and medicine. I've seen evolution in action in the hospital on a tiny scale as pathogenic bacteria evolve to be resistant to our most commonly used antibiotics.

Darwin's theory is amazing in that upon careful reflection it seems inevitable. He knew people created different breeds of dogs, pigeons and other domesticated animals through selective breeding. He showed nature does much the same thing. It can be observed that all organisms come from the reproduction of past organisms ("all cells come from other cells"), that there are differences between individuals in a group (some are faster or slower than others), and that parents reproduce imperfect copies of themselves (we now know genes are shuffled and sometimes mutate). Darwin noticed that there is a struggle in nature for organisms to survive and produce offspring. In real circumstances (gazelles being chased by cheetahs for example) survival is not just random but favors certain bodily abilities (i.e. faster) so the next generation comes from selected (faster) surviving parents and so is likely to be slightly different. Over deep time (the earth is now known to be about 4.5 billion years old) a single cell became all the amazing life on the planet today, from bacteria to *Paramecium* to grass to mushrooms to worms to you. Every living thing becomes finely tuned for its way of life, making life look like it was designed, yet there was no designer, just the logical results of how natural life processes (based on chemistry and physics and math) work out.

Most life is prokaryotic, i.e. bacteria and archaea on the left, no nucleus. Metazoans (multicellular organisms) are the small circle upper right. "In between" are diverse single celled organisms with a nucleus, we call protists. Relationships per Carl Woese based on ribosome RNA. Tree NASA Astrobiology, E Gaba 2006



PEDIGREE OF MAN.



Evolution makes perfect sense, turning homologous body structures (and now the DNA sequences) of millions of different organisms into data points in a unified scheme.

Modern trees of life are more abstract, but this one by Virchow's student Haeckel made the point well in its day.

Ernst Haeckel's tree of life from English version of his *The Evolution of Man*

Anthropocentric, and taxonomy has changed, but very good for 1879.

Monera is bacteria, and infusoria is mostly protists. Vertebrates are now known to be most closely related to echinoderms, as evidenced by comparative embryology, a field started by Haeckel.

Image from Wikimedia commons

- rejection of the germ theory of disease

As wrong as he was about evolution, the central theory of all biological science, perhaps Virchow's even bigger mistake was missing the most common causes of illness and death. Virchow advanced our thinking about the causes of disease into the modern age with cellular pathology and autopsies. Yet, to his dying days, **Virchow never believed bacteria cause disease, and dismissed the idea of handwashing to prevent disease.** This is surprising, given the multiple conclusive experiments done by colleagues in his city, in his lifetime. He was the "Father of Pathology" who invented the proper modern autopsy, yet he missed the underlying cause of the majority of deaths. In the long history of mankind since prehistory, most people died of infections (until the late 20th century when heart problems and other chronic diseases first exceeded infectious deaths worldwide). The Germ Theory of disease was presented and proved in Virchow's day, somewhat by Louis Pasteur in France (he discovered fermentation was biological and experimentally disproved spontaneous generation in 1857 and 1861), and Joseph Lister in England (he developed aseptic surgery in 1867) but most especially by Virchow's German colleague Robert Koch. Virchow's time and place, the end of the 19th Century in Germany, saw **the Golden Age of Microbiology**, with multiple breakthrough discoveries in just a few years:

1876- Koch discovers *Bacillus anthracis*, cause of anthrax

1879- Neisser discovers *Neisseria gonorrhoeae*, aka gonococcus, cause of gonorrhea

1882- Koch discovers *Mycobacterium tuberculosis*, cause of TB

1883- Koch discovers *Vibrio cholerae*, cause of cholera

1883- Klebs discovers *Corynebacterium diphtheriae*, cause of diphtheria

1884- Gram discovers his stain, Escherich discovers *E coli*, the most common bacteria in the human gut

1887- Petri discovers his dish

1890- von Behring makes diphtheria anti-toxin, and thereby a great fortune

Although the existence of germs seems obvious today, bacteria are really tiny (*E coli* is 1-2 microns long) and can be hard to see under the microscope without special stains or lighting tricks. Many kinds of bacteria grow everywhere and at the beginnings of microbiology results were often ruined by the contamination of cultures. Four rules to make sure germ theory was hard science were formulated by Koch and Loeffler in 1884 and refined and published by Koch in 1890. In order to prove with certainty a specific bacterium causes a disease,

Koch laid down his 4 postulates:

#1 The microorganism must be found in abundance in all organisms suffering from the disease, but not in healthy organisms.

#2 The microorganism must be isolated from a diseased organism and grown in pure culture.

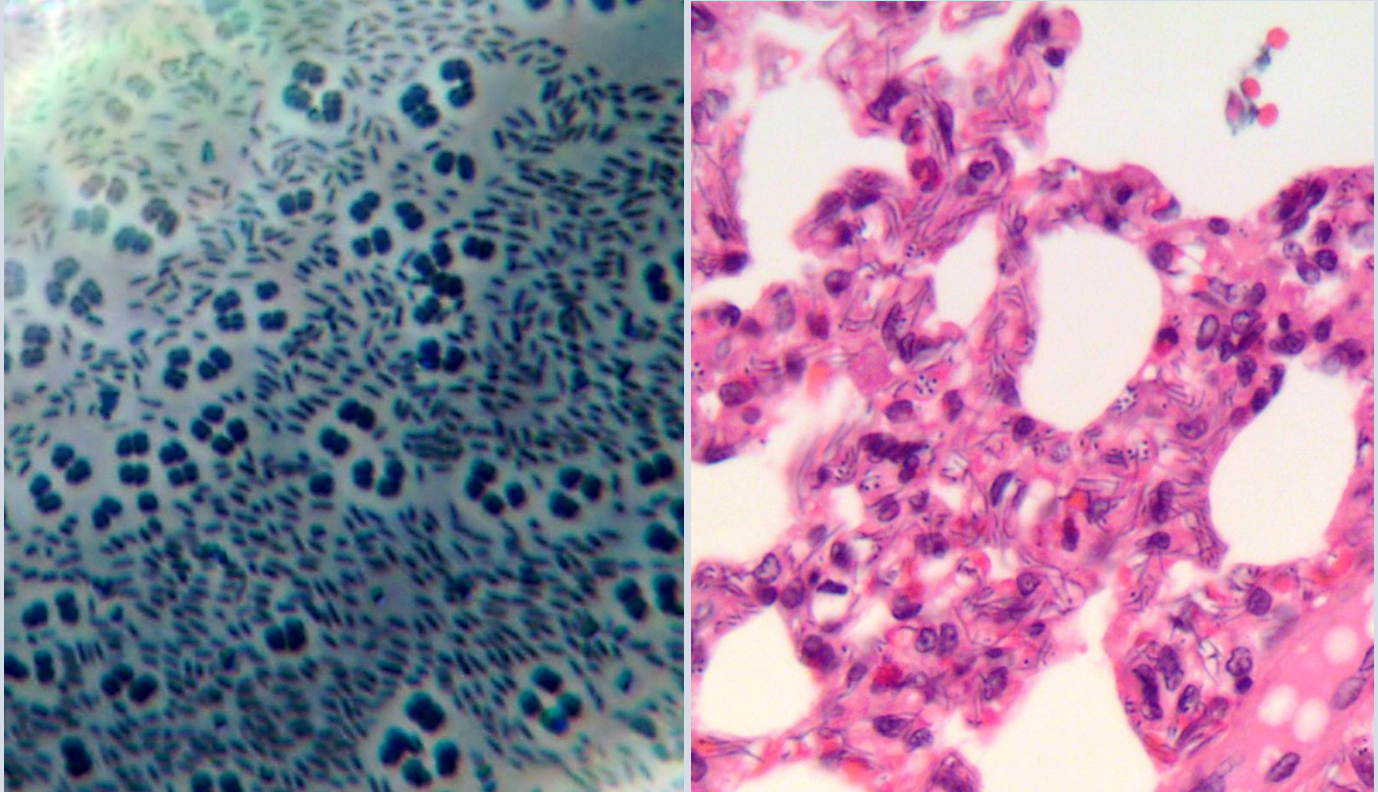
#3 The cultured microorganism should cause disease when introduced into a healthy organism.

#4 The microorganism must be reisolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.

Koch's postulates are not completely correct in our modern understanding, but they advanced science greatly at the time. We sometimes carry harmful bacteria (*Pneumococcus*, *Staphylococcus* and others) in or on our body without getting sick. Viruses were poorly understood at the time and can't be cultured on agar, even though Pasteur developed a vaccine treatment for rabies virus. Doing the new science of bacteriology rigorously was hard. After his success with *C. diphtheriae*, Klebs blundered badly in malaria research.

Microbiology Basics

Virchow's contemporaries didn't yet know what kind(s) of microscopic life forms caused infections. They had the most success at first with bacteria. We now know Bacteria and Archaea are the simplest and oldest kind of fully living organisms. Called prokaryotes, they lack a nucleus and are mostly small, perhaps 1/500th of a mm or less, but visible with high power microscopes. Most bacteria can process food and divide on their own, so can often be grown in broth. This allowed Koch to study the anthrax bacterium in 1876. Harmless bacteria are everywhere.

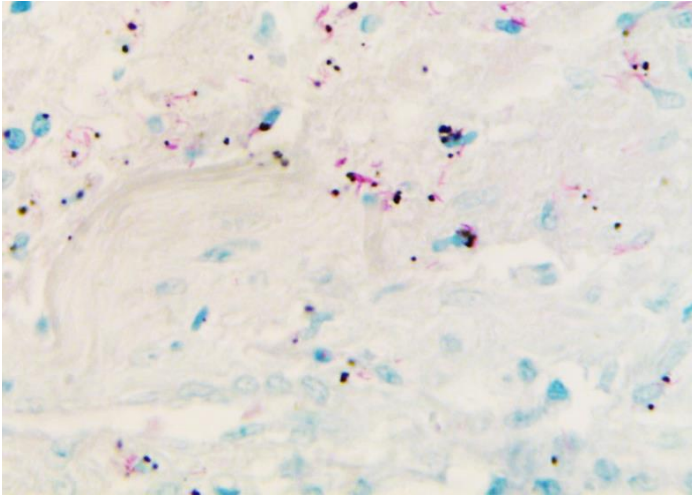


Left: different kinds of **free-living bacteria** (blue dashes and dots) forming a biofilm in old pond water sample
Right: ***Bacillus anthracis*** (very thin rods) in infected lung tissue. Both photos with taken with 40X objective, cropped to be equivalent to 80X, each image is about 100 microns wide. Bacteria are hard to see without lighting tricks or stains. Left is phase contrast lighting. Right is a stained histopathology slide, labelled Gram's (? H and E).

Much smaller are viruses, which early researchers called "filterable agents" since they could pass through a ceramic filter, being perhaps 1/200,000th of a mm in size. They are just bits of RNA or DNA plus a few proteins and can't live or reproduce outside a host cell. Without being able to see or culture the virus, Pasteur was still able to pass rabies from rabbit to rabbit to produce a vaccine. (Virus particles were first seen with an electron microscope around 1935, leading to a Nobel Prize). Protozoa are yet another kind of life, eukaryotes, "big" cells with a nucleus, mitochondria and a more complex structure. Also called protists (Haeckel's name) they live as single cells, and many are about 1/100th (malaria plasmodium) to a giant 1 mm (i.e. *Stentor* in pond water). Some fungi (relatives of yeast and mushrooms) and some tiny animals (such as parasitic worms) can also cause infection. They are metazoans (multicellular, made of thousands to trillions of eukaryotic cells) and are far bigger than other pathogens. All viruses live inside other cells but many cause no illness.

Viruses and a small minority of bacteria, protists, fungi and animals cause many thousands of kinds of plant and animal infections. In a modern hospital I diagnose infections with a combination of typical symptoms (i.e. cough, fever), cultures of blood or body fluids, blood tests (white blood counts, antibodies or DNA) and sometimes X-rays. Antibiotics are often given just in case, although many infections I see are viral and not helped by them.

Still, bacteriology made the supreme achievement of scientifically discovering the causes of many awful, very common ways to die. It happened right under Virchow's nose in Berlin, and yet he missed it. Not taking to the new field of bacteriology or believing germs caused diseases, Virchow thought there was no reason for doctors to wash their hands. Virchow (along with everyone else) ignored the dramatic work of Ignaz Semmelweis in preventing fatal puerperal fever. Semmelweis lowered childbed fever mortality from an average of over 15% a month (up to 30% some months) to less than 5% in the obstetrics ward in Vienna by instituting chlorinated lime handwashing in 1847. Virchow dismissed Semmelweis as having not proven anything, saying "explorers of nature recognize no bugbears other than individuals who speculate."



Mycobacterium tuberculosis (purple dashes) in lung, acid fast stain, light green counterstain 40X objective cropped to 80X equivalent. Virchow might have seen something like this, but still never accepted the germ theory. TB is hard to stain, but by around 1890 the Ziehl-Neelsen acid fast method we use today was developed.

Virchow and a few others criticized germ theory as speculative. Virchow was more than smart enough to have understood the evidence. Many diseases came in outbreaks suggesting contagion. Using his microscope Virchow had seen for himself bacteria inside tissues of ill patients. Through careful laboratory work with bacterial cultures, microscopes and animal experiments, his own colleague (in anthropology at least) Robert Koch conclusively, experimentally proved particular germs caused wound infections, sepsis and pneumonias. This was the exact kind of objective experimental work promoted by Virchow in his own scientific journals over "old and new theories". Yet it was Virchow who clung to the ancient Roman theory of "miasma", believing outbreaks of malaria and cholera were caused by breathing "bad air", gasses that came from smelly swamps and rotting materials. Robert Koch had the valid experimental data. Virchow attributed the bacteria seen in diseased tissues to bacteria moving in after other cellular processes had damaged the tissue, rather than germs being the cause of the damage. He was accused of emphasizing the social determination and treatment of diseases to the point of downplaying any other causes. He did acknowledge that typhus, tuberculosis and some other epidemic diseases were contagious, leading in some cases (but not all) for him to recommend hygienic improvements. He discovered *Trichinella* and admitted "vegetable and animal parasites are among the causes of disease." But somehow Virchow still maintained that no "agent" had been proven to cause infectious diseases. He considered germ theory a wrong idea that distracted from the correct ways to treat diseases.

Virchow was probably right in his analysis of treatments at the time. Virchow admitted "We have no rational therapeutics". He supported general hygienic measures, while still denying that the scientific theory of germs. Virchow advocated for the use of the vaccines available at the time and worked tirelessly to bring clean water supplies and covered sewers to Berlin. Virchow was dead wrong about Semmelweis' handwashing and Lister's surgical asepsis. But doctors who believed in germ theory had nothing else additional to give their patients at the time. Although the germ theory of disease, cellular pathology and other modern scientific medical beliefs were established by Virchow and his contemporaries, good therapeutics lagged behind for many decades.

There was no scientific way to treat infections in 1880. Behring discovered serum therapy in 1900 (rarely used today) and Ehrlich discovered salvarsan for syphilis in 1901 (a toxic arsenic-based drug). Good antibiotics did not come into widespread use until penicillin arrived in pharmacies in the late 1940's.

- other issues

Virchow was smart and he knew it. In his late career the "Pope of Medicine" had considerable academic and political power. Historians describe him as autocratic, and prone to anger when riled by opponents. Still Virchow treated most other scientists with respect, including Pasteur, even with their disagreements about germs and the tensions of the German-Franco wars. A potential rival that Virchow ignored was Carl von Rokitansky (1804-1878) founder of the Vienna school of pathology. He did even more autopsies than Virchow but never fully abandoning humoral theory he was eclipsed by Virchow's work on Cellular Pathology.

In contrast, Emil von Behring, clashed harshly with Virchow. Behring won the 1901 Nobel in Medicine (the first such prize) for the discovery of serum therapy. Behring commercialized diphtheria anti-toxin and made a fortune. Some accused him of cheating Erlich out of fame and fortune. Both had worked in Koch's laboratory. Behring angrily attacked Virchow as being an obstacle to progress with his denial of germ theory and also of Virchow's insistence that disease is never purely biological but always has social dimensions. Behring espoused a belief in hard cause and effect science, "one cause, one disease" and believed medical treatments would soon completely eliminate diphtheria. Anti-toxin did not, but vaccination eventually did stop diphtheria in the developed world. Some modern TV writers are on Virchow's side, as was the Berlin Medical Society, which made a statement supporting Virchow in 1894. A 2017 German TV historical drama *Die Charité* reportedly portrays Virchow as a good guy and Behring as a drug addict. Still it has to be said again that Virchow was completely, stubbornly wrong in his denial of the germ theory of disease right up to the end of his life. Virchow did many autopsies, but rejected scientific proof of what was causing the greatest number of deaths.

In 18th and 19th century doctors hiring grave robbers was common (i.e., causing the 1788 Anatomy Riots in New York), but I was not able to determine how prosector Virchow got the bodies to teach anatomy. Virchow also collected skulls and organs by the tens of thousands. Many were gathered overseas and from indigenous peoples. Seeing photographs of the smug looking imperial white man with his bone collections makes us cringe today. Although ahead of his time, Virchow was still a man of his time in other ways. Social norms have changed, and nearly every historical figure can be criticized for acts that would be unacceptable today.

His 2000 scientific publications raised very few questions of propriety. The brother of the late English physician Sir John Goodsir claimed Virchow stole cell theory, but the Royal Society of England found Virchow blameless. Polish German embryologist Robert Remak published a paper on binary cell division in 1852 but also thought cells arose from a "blastema". Many people were working on parts of cell theory, and Virchow put it together.

- some concluding thoughts on a great master's mistakes

Despite being the smartest doctor on earth and multi-talented in seemingly everything else, Rudolph Virchow did make some small and a few big mistakes. Surely, he must have been smart enough to know he was not infallible. If he had a second chance, what mistake would he choose to correct? Virchow's own answer: none of them! Instead, he would have doubled down on one of his biggest mistakes:

"If I could live my life over again, I would devote it to proving that germs seek their natural habitat -diseased tissue- rather than being the cause of dead tissue. In other words, mosquitoes seek the stagnant water, but do

not cause the pool to become stagnant." (this Virchow quote is popular on Chiropractor and Naturopath websites that continue to deny the germ theory of disease to this day.)

Virchow was generous in spreading his new found knowledge, teaching doctors who came from around the world to Berlin. Liking Virchow, it would be satisfying to defend his mistakes regarding evolution and germs as stemming from a scientific conservatism, wanting to make sure all theories are proven before they gain widespread acceptance. But it seems Virchow was just sometimes wrong. We have few reports about his daily personality. Did he make time for his family? He reportedly demonstrated anger and stubbornness on those few instances when he was wrong. Some historians describe him as harsh, unyielding and ill-humored (I wonder if evil genius Ernst Haeckel was warm and charming). We are all flawed, but very few are super geniuses. Virchow was smart and well meaning, did much good in the world, and therefore I think he can be excused for his relatively few mistakes. Rudolph Virchow was a super genius, flawed by stubbornness. Fundamentally, despite his flaws, I praise Virchow for applying brilliant thinking for the good of all humanity.

Virchow's place in the history of human health and ethics

Homo sapiens has been around for perhaps 300,000 years, living in small groups of nomadic foragers for almost all of that time. Hunter gatherers lived out in nature, in groups of about 50 to 150 friends and family. They were likely to be healthy, believed in many different spirits, and probably made decisions by collective consensus.

About 10,000 years ago humans domesticated plants and animals, leading to surplus for the first time. Populations grew, built cities and became hierarchical as a few kings lorded over masses of peasants. Health declined, with average life expectancy dropping to about 40 years. Priests represented a single god who threatened sinners with hell. Men subjugated women, and about 10 million Africans were enslaved. Plague and other epidemics raged repeatedly.

About 300 years ago a few enlightened thinkers considered that perhaps people should have rights, and soon coal fired the start of industrial revolution, creating even more surplus goods. Cities and human populations grew faster.

When Virchow was in Berlin 150 years ago, Germany was the epicenter of scientific and social progress. Virchow's cellular pathology put medicine on a scientific basis and Koch showed many deadly diseases were explainable by infections. Soon labor movements that began in Germany (Marx and others) raised millions of desperate factory workers into less fatal levels of poverty. After modern medical science and labor reform spread at the beginning of the 20th century, average US life expectancy surged from 40 years in 1900 to 68 years in 1950. Cellular pathology and germ theory eventually led to life saving treatments, but Virchow's public health efforts and social reforms had more to do with the surge in human health in the 5 decades following his death. Clean water, sewers and less crowded housing fought cholera and the "social disease" tuberculosis. Antibiotics were not widely used until the 1940's. Eventually the last half of the 20th century saw effective antibiotics and cardiovascular drugs, adding 7 more years to average US life expectancy (just 1/4 of the gains of the earlier social reforms). Progressive social reforms and, to a much lesser degree medical science boosted average health. Even as US health has lagged behind in the 21st century, the social democracies of northern Europe, including liberal again Germany, remain some of the healthiest of all nations today.

Considering foraging, then early civilization and now modern times, humans have certainly had our ups and downs. Life probably went from pleasant and long, to brutish and short, to recently better again, yet tenuous. Today there are 8 billion of us, with longer lives, but still hurting each other and fouling mother earth in so many ways. The great and the scary part of modernity is that the outcome will be what we collectively decide. Science has repeatedly shown itself as the best way to understand and manipulate the world, but is morally neutral. The best decisions will come from applying science for the benefit of all humanity, not just for old rich white men. Rudolph Virchow was not only a revolutionary medical scientist but also a political revolutionary fighting poverty, racism and militarism with education and democracy. Rudolph Virchow believed in both objective science and in the fundamental unity of all humans.

Virchow was a founder of modern medicine, and his progressive politics were part of a historic arc towards inclusivity.

Virchow's death

Virchow broke his hip (femoral neck) in January 1902, jumping off a tram on his way to an archeology society meeting. At first, he seemed to be recovering, but then his mobility declined. He died of what was said to be heart failure (some modern doctors suspect it was pneumonia) 8 months later at the age of almost 82 years old, leaving his wife, three sons and three daughters. Rudolph and Rose Virchow (who died a decade later) are buried together in Berlin.



Grave of Rudolf and Rose Virchow in old St. Matthew churchyard in Berlin-Schöneberg, image from Wikipedia

Virchow was a thinker, altruist, and a modern success story

What an amazing person Rudolph Virchow was. A gifted polymath, showing genius in multiple emerging sciences. Rebellious, original thinking, rational, curious, driven, and confident to a fault. He guided the first scientific revolution powered by the microscope, that of Cell Theory and Cellular Pathology. He was a master of objective science down to the cellular and chemical levels, yet was thinking also about the grand scale picture of whole societies of people past and present. He said physicians should practice politics, and true to himself, he entered the political fray. He did what he thought was morally right, even when that lost him his government job at Charité Hospital, or put him at odds with new science. Virchow was way ahead of his time. He both benefited from the many new scientific discoveries of the age and contributed far more than his share of original scientific discoveries.

Unlike older historical figures, Virchow came along after the printing press (and photography, invented in 1826). We don't have to rely just on stories of those who knew him, written down decades or centuries later. Virchow published what he thought in over 2000 scientific articles, and also in political writings and letters. But the huge volume of Virchow's writing combined with my losing the full meanings in English translation does lead to a problem. 2000 articles comprise a sort of scripture of the Pope of Medicine, and like the bible, one can sort through it to find support for almost any belief. **I probably succumb to my own bias**, for when I study Virchow, his philosophy and beliefs seem to be suspiciously close to my own. Whether real or imagined, just seeing my own thoughts in a mirror, I cannot but help greatly admiring the lofty ideals stated by Virchow.

Rudolph Virchow was **staunchly anti-racist**, fighting against the undercurrents of racial supremacy in German society (advanced by his student Haeckel, among others) that would evolve into National Socialism and give pseudoscience support to the most evil acts of the 20th century. Virchow was one of the first to apply unbiased science to the question of race, including careful objective measures of skulls, which he called "craniometry." He was unable to define any different races in Europe from their skulls, telling the 1885 Anthropology Congress that the so called "Aryan Race" was just "Nordic mysticism". His collaborator in craniometry, Josef Kollmann, added that the "results of craniology ... struggle against any theory concerning the superiority of this or that European race." Virchow also led a study of the skull size, body weight, hair, skin, and eye color of 6,758,827 German schoolchildren trying to identify the Jews and Aryans. His results presage the modern view that race is a socially defined label. As he reported in 1886: "It is almost embarrassing that we must admit that in terms of ethnic groupings, Celts, Germans, Slavs, Jews, we are unable to identify any typically identifying features that allows distinguishing one group from another or to which nationality they could belong. **In the last analysis, the differences between any two individuals are greater than any differences between the races.**"

Rudolph Virchow's establishment of both **Public Health and Social Medicine** is more important than most medical professionals realize. Classic Public Health working on communicable diseases, smoking and lifestyle is important and saves lives. But Virchow's even bigger Social Medicine idea of addressing the health of whole societies has been mostly ignored. In the US in particular, doctors are trained to care for the individual patient in front of them, without regard to thinking about the costs or the health of large populations. I lived most of my medical career before seeing that more can be learned by comparing the health of different societies than by comparing health between individuals. Virchow had figured it out 160 years before I did.

Virchow demonstrated an impressive **sympathy for the masses**. Virchow cared deeply about his fellow men, especially the downtrodden. My heart sunk the first time I read Virchow say the residents of Upper Silesia had fallen into seeking only liquor and sex. But Virchow was not passing judgment, as I had feared. He clearly cared

about the people in their misery, and did not blame them for behaviors that followed from severe deprivation brought on by economic exploitation. His judgement instead falls on rich landowners (which perhaps was justified). Although Virchow didn't believe in Christianity or become a pastor, I suspect he may have honed his moral compass in Divinity school. Virchow was like one of the pastor scholars of ages past, yet he was one of the most modern thinking of people. He hated bureaucracy, seeing all the offices and paperwork as a house of cards that couldn't keep the people of Upper Silesia from starving in a famine. Virchow wanted to help people.

I greatly admire Virchow's stated core values: rational thought, careful science based on observation and experiment, the reduction of poverty through self empowerment, championing "**education, with its daughters, liberty and prosperity**" leading to "**free and unlimited democracy**" and on to better health for the most people. Virchow tried to share a growing chance of material comfort with as many different kinds of people as was possible. Like the rest of us he didn't always perfectly live up to his own values, but he did so far better than most people. Personally agnostic, he advocated for a pluralistic society with freedom of religion, and he defended Jewish people in an increasingly antisemitic German society. He also advocated for freedom of language, recommending Polish children be taught in their own Polish language. Democrat to the core he refused the offered royal title of von Virchow. Although he was a politician for half his life, he never left science to become a full time politician. Virchow seems to have avoided the trap of seeking power for its own sake. Rather, Virchow was granted power by others because of the knowledge he had gained.

In addition to Virchow's intelligence and motivation, luck and other factors may have helped him earn greatness. What if his uncle hadn't gained him a scholarship to military medical school? What if the government hadn't sent him to Upper Silesia? What if there was not an attempted Democratic Revolution in 1848? What if Virchow had not been born in a time of scientific and social progress?

Somehow, Virchow developed an ability to remake business as usual. Rudolph Virchow was one of the first to see that two thousand years of western medicine needed to be thrown out and completely reformed using the modern scientific approach of proof by evidence and experiment. Virchow did that with a career of groundbreaking medical discoveries, and established the biomedical scientific framework for understanding disease pathology that I still use every day in my medical practice. More important than his individual discoveries, Virchow got medicine onto a path of **continuous improvement by using the scientific method**. Virchow also saw past the basic science level to discover common health problems were caused by social factors such as poverty and discrimination. He seemed motivated in this by a deep desire to make people's lives better. He bravely entered the political fray to attempt to improve the lives of average people. Rudolph Virchow was not just smart, but also altruistic and courageous. He believed rational scientific thinking must be applied for the betterment of all mankind. An early humanist, **Virchow demonstrated both brains and heart**.

Virchow was deeply committed to objective science, stating plainly in 1845 "life itself is but the expression of a sum of phenomena, each of which follows the ordinary physical and chemical laws". The Father of Cellular Pathology he humbly knew there was a reality even more basic: "Cellular pathology is not an end if one cannot see any alteration in the cell. Chemistry brings the clarification of living processes nearer than does anatomy. Each anatomical change must have been preceded by a chemical one". Very rare and humble among doctors, he knew and admitted none of his therapies were scientific, hence his advocacy for social measures to reduce illness. **He repeatedly staked out boundaries for science**, stating "belief begins where science leaves off and ends where science begins", a generous sentiment for an agnostic. Modern rationalists and humanists sometimes think science provides its own set of morals, but Virchow disagreed. Virchow was clear science had

to be actively committed to helping people. Guided by liberal, democratic values he fought the weaponization of evolution that would eventually become National Socialism and lead to Germany using the world's best science and engineering to commit industrial scale genocide a few decades after Virchow's death.

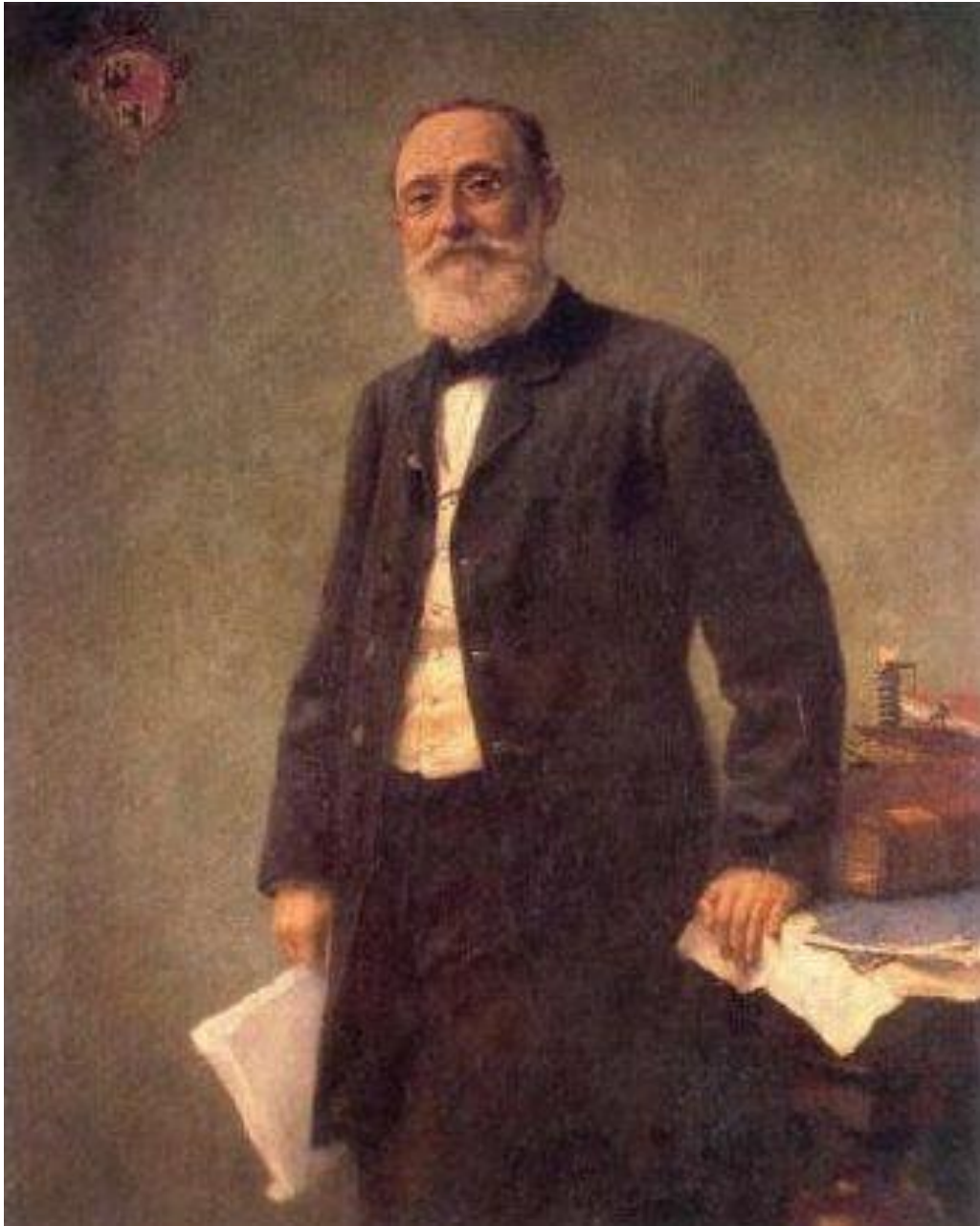
Virchow was a thoroughly modern man. It is only in a few times and places that the son of a farmer could have become the greatest medical professor of the century. Human societies have not been modern in that way for very long. For the first roughly 300,000 years all humans were nomadic hunter gatherers, then came 10 thousand years of farming and wars and civilizations. People in the past didn't question what to do in life. They learned their parent's skills and grew up to do the same thing in the same way. But then along came the Enlightenment and the Industrial Revolution. It is a modern luxury for people to have the right of self determinism, to question what kind of life they want. Late 19th century Germany was blessed with a liberal streak in its spirit (that thankfully has returned to Germany today). Rudolph Virchow used and magnified that new freedom, inventing the modern system of medicine and promoting democracy. Even today, traditional societies value obedience over curiosity and innovation, but I think freedom is winning. In terms of both technology and social organization, Virchow's 19th century Germany was near the beginning of the technologically modern and largely democratic world we "in the West" live in today. We take it for granted that scientists and engineers will do research to improve our health and invent machines to make life better and more comfortable. We take it for granted elected politicians are supposed to be looking out for the interests of the people (and we complain when they don't). We take for granted the freedom to find a job that uses our skills and training (and if we are paying attention, we lament the loss of talent that comes from others being left out). We take democracy itself for granted (to the point many are now apathetic, and some have started to doubt democracy).

Virchow used his powerful intellect for the benefit of humanity. Rudolph Virchow learned to think objectively, even microscopically, then went on to act on a grand scale in promoting health, liberalism and democracy. Our healthier lives and our political freedoms are both in part due to his enlightened legacy.

Virchow didn't take anything for granted. He used his talents and freedom to question the science and politics of the day, and to remake them better than before. What will you do with your modern luxury of freedom?

Think Microscopically,
Act on a Grand Scale
the modern life of
Rudolph Virchow part 2

Ed Ward MD
Minnesota, USA
Oct 2023



[Portrait of Rudolf Virchow](#)
[by Hugo Vogel, 1861](#)
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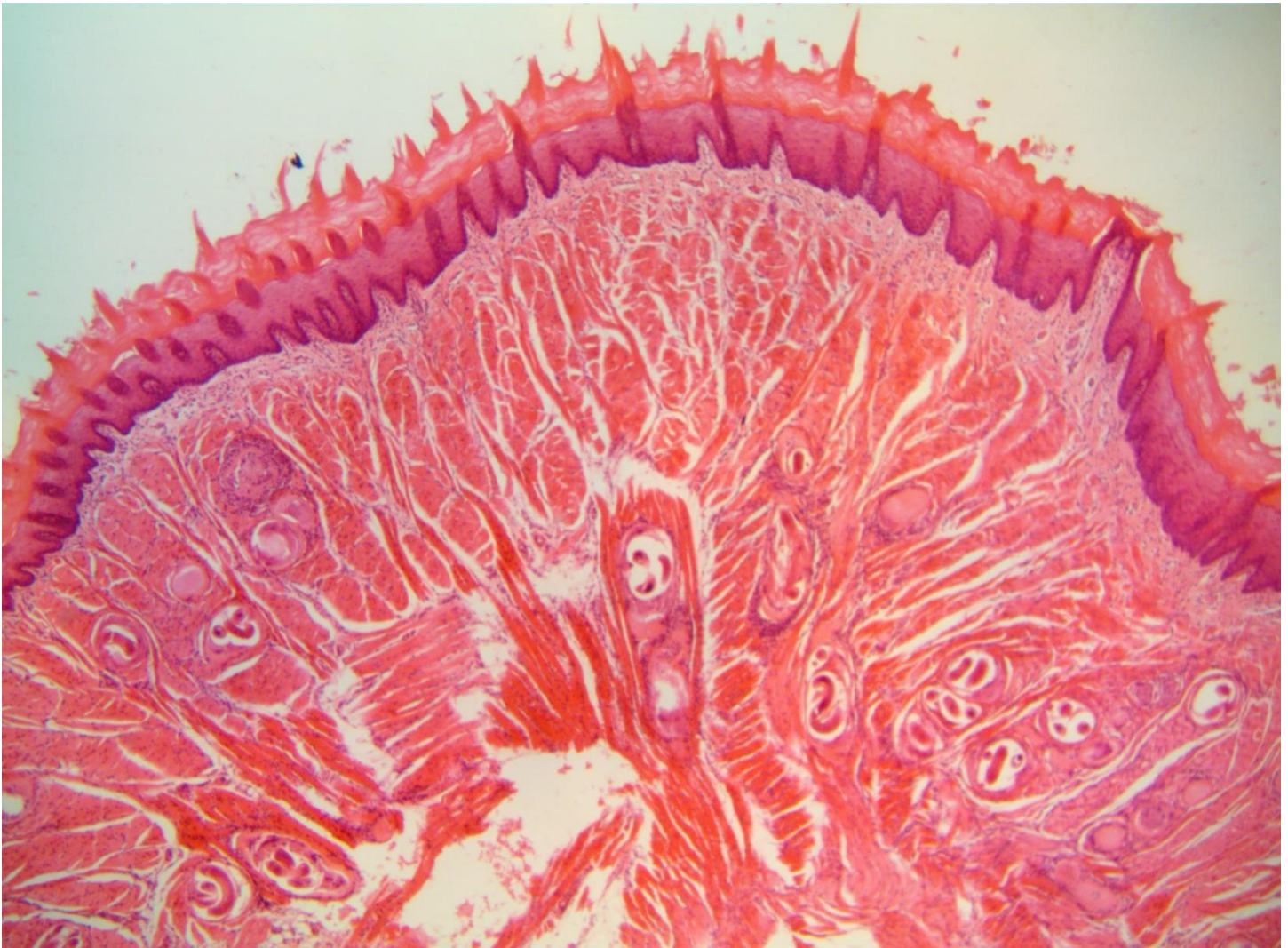
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Walter, E, and Scott M. The life and work of Rudolf Virchow 1821–1902: “Cell theory, thrombosis and the sausage duel.” *Journal of the Intensive Care Society*. 2017;18(3):234-235. doi:10.1177/1751143716663967

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Pathology slide of trichinosis, a zoonotic disease researched in depth by Virchow. *Trichinella spiralis* in rat tongue, hand labelled slide by unknown mounter, circa 1950. 4X objective, imaged area spans 3 mm across. Unless noted otherwise photomicrographs by author, using AO/Reichert Diastar microscope and simple USB camera

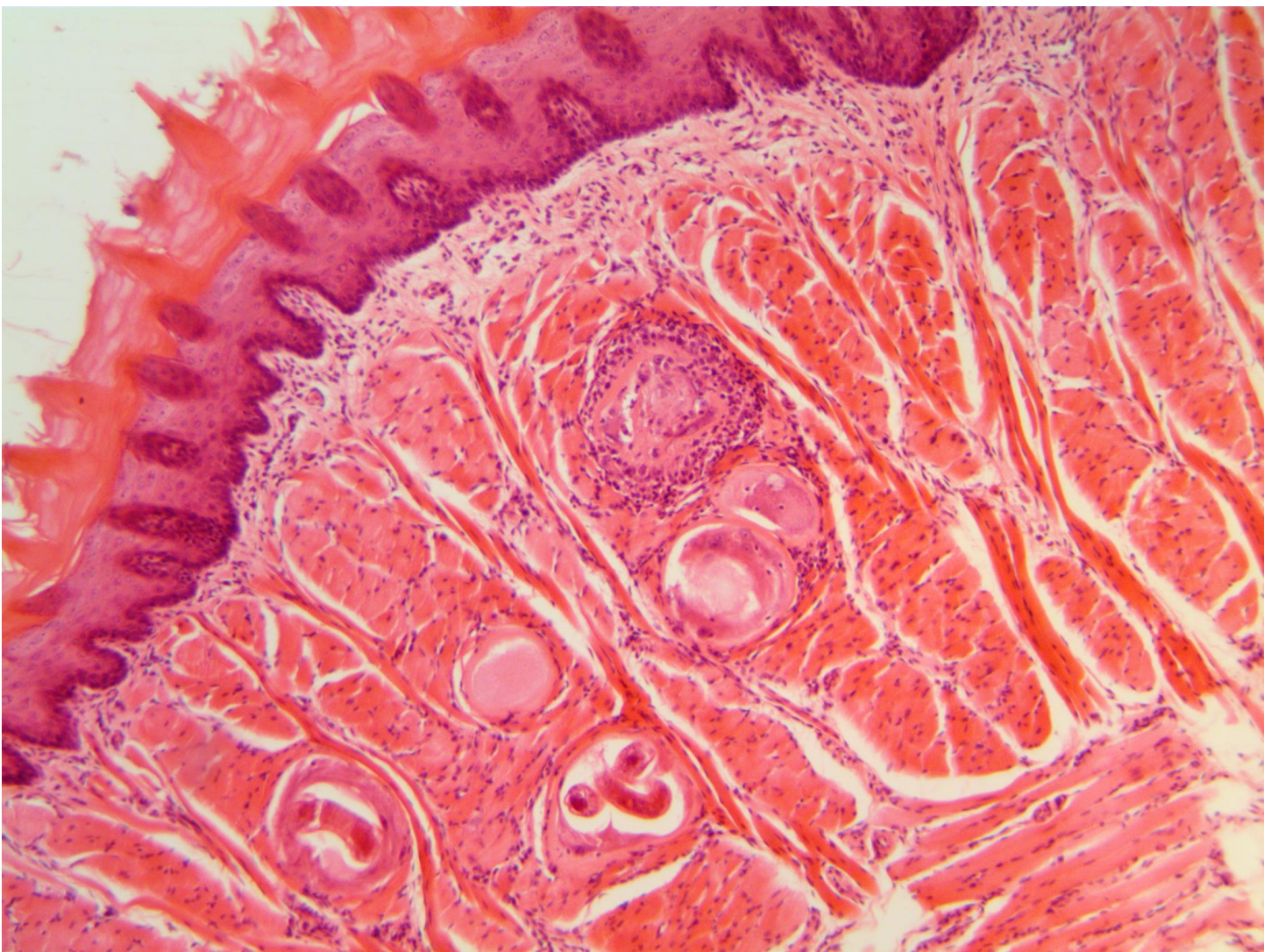
Micscape always has lots of good information for amateur microscopists wanting to learn more about how to do it yourself. After learning so much from *Micscape* over the years, I wish to give something back to the community here. I plan to write more articles about parasites and other fascinating subjects (to me, at least) under the microscope.

I could not help myself from adding some additional scientific context to the second part of my Virchow historical article. The microscope has greatly advanced human knowledge by extending our vision into a smaller realm. Science has proven itself many times over to be the best way to understand and manipulate the world. It has also shown its ability to be used for either good or for evil. I hope to continue to write some articles that touch on the history and results of science.

If you find an error, or an opinion in my writing with which you disagree, please feel free to email me.

Ed Ward, comments welcomed, email – [eward1897 AT gmail DOT com](mailto:eward1897@gmail.com)

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Trichinella spiralis larvae in rat tongue, by unknown mounter c1950. Trichinosis was discovered by Virchow, who also initiated control measures. Thank Virchow, Father of Pathology and Public Health, that you need not fear eating meat. 10X objective, imaged area 1.1 mm across. Reddish objects inside about 0.15 mm cysts are coiled nematode worms. Apart from image on page 25, all photomicrographs by author, using AO/Reichert Diastar microscope and USB camera