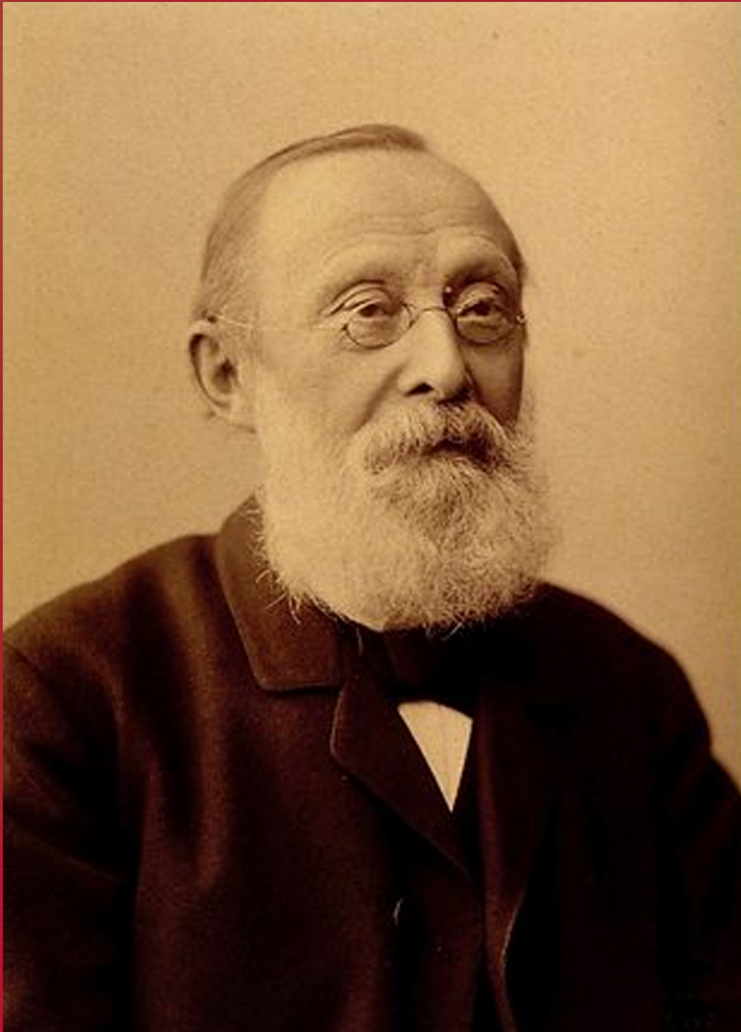


Dr Rudolph Virchow, the Father of Pathology



Robert A. Norman

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**Cambridge
Scholars
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VIRCHOW TIMELINE AND NOTABLE FACTS

Timeline

- Virchow was the first Chair of Pathological Anatomy at the University of Würzburg in 1849.
- His scientific writings alone exceed 2,000 in number. Among his books, Cellular Pathology, published in 1858, is regarded as the root of modern pathology.
- He was the first to develop a systematic method of autopsy based on his knowledge of cellular pathology.
- Virchow was the first to describe and name diseases such as leukemia, embolism, thrombosis, chordoma, and ochronosis.
- He coined biological terms including chromatin, parenchyma, neuroglia, agensis, osteoid, amyloid degeneration, and spina bifida.
- In June 1859, Virchow was elected to the Berlin Chamber of Representatives.
- In 1860, he was elected official member of the Königliche Wissenschaftliche Deputation für das Medizinalwesen (Royal Scientific Board for Medical Affairs).
- In 1861, he was elected as a foreign member of the Royal Swedish Academy of Sciences.
- He was elected to the Prussian House of Representatives in March 1862.
- In 1869, Virchow co-founded the German Anthropological Association.
- He was elected to the Prussian Academy of Sciences in 1873. He declined to be ennobled as “von Virchow,” but he was nonetheless designated Geheimrat (“privy councilor”) in 1894.
- In 1880, he was elected member of the Reichstag of the German Empire.
- In 1881, the Rudolf Virchow Foundation was established on the occasion of his 60th birthday.
- In 1885, he launched a study of craniometry, which gave surprising results contradictory to contemporary scientific racist theories on the “Aryan race”.
- In 1892, he was appointed Rector of Berlin University.
- In 1892, he was awarded the Copley Medal of the British Royal Society.

More on Virchow

- The Rudolf Virchow Center, a biomedical research center in the University of Würzburg, was established in January 2002.
- The Rudolf Virchow Award is given by the Society for Medical Anthropology for research achievements in medical anthropology.
- The Rudolf Virchow lecture, an annual public lecture, is organized by the Römisch-Germanisches Zentralmuseum Mainz, for eminent scientists in the field of paleolithic archeology.
- The Rudolf Virchow Medical Society is based in New York and offers the Rudolf Virchow Medal.
- There is a hospital named after him—Campus Virchow Klinikum, Cardiology Center.
- Campus Virchow Klinikum (CVK) is the name of a campus of the Charité hospital in Berlin.
- The Rudolf Virchow Monument, a muscular limestone statue, was erected in 1910 at the Karlsplatz in Berlin. The monument was created by Fritz Klimsch from 1906 to 1910, and is located on Karlsplatz in Berlin-Mitte, Germany.
- The Langenbeck-Virchow Haus was built in 1915 in Berlin, jointly honoring Virchow and Bernhard von Langenbeck. Although originally a medical center, the building is now used as a conference center of the German Surgical Association (Deutsche Gesellschaft für Chirurgie) and the Berlin Medical Association (BMG-Berliner Medizinische Gesellschaft).
- The Rudolf Virchow Study Center was founded by the European University Viadrina to compile the complete works of Virchow.
- Virchow Hill in Antarctica is named after Rudolf Virchow.

Eponymous Medical Terms

- Virchow's angle: the angle between the nasobasilar line and the nasosubnasal line.
- Virchow's cell: a macrophage in Hansen's disease.
- Virchow's cell theory: *omnis cellula e cellula*: every living cell comes from another living cell.
- Virchow's concept of pathology: comparison of diseases common to humans and animals.
- Virchow's disease: leontiasis ossea, now recognized as a symptom rather than a disease.
- Virchow's gland; Virchow's node.

- Virchow's Law: during craniosynostosis, skull growth is restricted to a plane perpendicular to the affected, prematurely fused suture and is enhanced in a plane parallel to it.
- Virchow's line: a line from the root of the nose to the lambda.
- Virchow's metamorphosis: lipomatosis in the heart and salivary glands.
- Virchow's method of autopsy: a method of autopsy where each organ is taken out one by one.
- Virchow's node: the presence of metastatic cancer in a lymph node in the supraclavicular fossa (the root of the neck left of the midline), also known as Troisier's sign.
- Virchow's psammoma: psammoma bodies in meningiomas.
- Virchow–Robin spaces: enlarged perivascular spaces (EPVS), often only potential, that surround blood vessels for a short distance as they enter the brain.
- Virchow–Seckel syndrome: a very rare disease also known as “bird-headed dwarfism.”
- Virchow skull breaker: a chisel-like device used to separate the calvaria from the rest of the skull to expose the brain in autopsies.
- Virchow's triad: the classic factors which precipitate venous thrombus formation—endothelial dysfunction or injury, hemodynamic changes, and hypercoagulability.

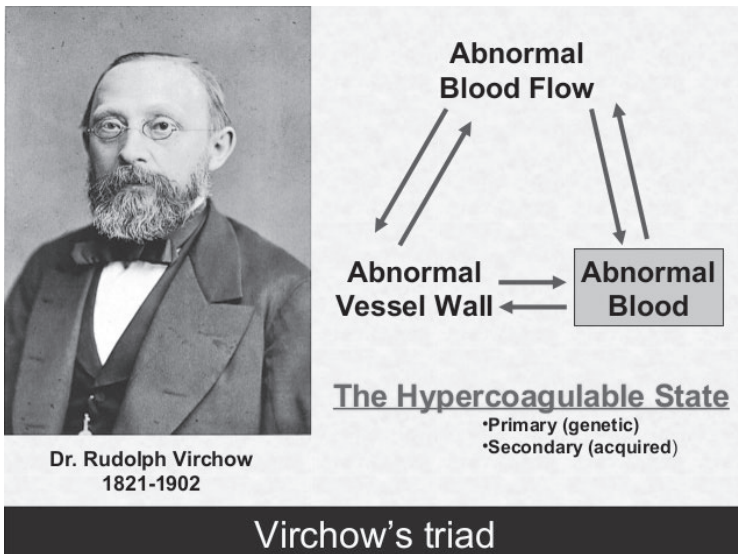


Figure 1: Virchow's triad. www.slideshare.net

PROLOGUE

On a cool spring day in April 1858, more than 100 well-dressed men of science and medicine sat with rapt attention in a lecture hall in the new Pathological Institute of the University of Berlin. Although filled to capacity, the hall was mostly silent, except for the clear and calm voice of the speaker as he offered insights into the latest advances in the field of pathology. At the podium was Dr. Rudolf Virchow, tasked with providing easy-to-understand talks to capture the interest of every level of practitioner. The lessons from the esteemed Professor Virchow had begun two months earlier and were condensed into twenty consecutive lectures and delivered biweekly.

In the front row sat Herr Langenhaun, who Virchow had hired to take down detailed lecture notes in shorthand. Virchow, after what he called “but slight alterations,” published the lectures in a book titled *Cellular Pathology* in the late summer of the same year. In the preface, he wrote that his intention was “to give a concise view of a comprehensive subject.”

Given the enormous interest in his groundbreaking book, he published another edition in less than a year. The first paragraph in the second edition reads,

“The present attempt to bring the results of my experience, which are at variance with what is ordinarily taught, before the notice of the medical public at large, in a connected form, has produced unexpected results; it has found many friends and vigorous opponents. Both of these results are certainly very desirable; for my friends will find in this book no arbitrary settlement of questions, nothing systematical or dogmatical, and my opponents will be compelled at length to abandon their fine phrases and to set to work and examine the matters for themselves. Both can only contribute to the impulsion and advancement of medical science.”

Almost a century later, Edward Krumbhaar, Professor of Pathology at the University of Pennsylvania and a distinguished historian in his field, wrote, “This book deserves to be placed with Vesalius’ *Fabrica*, Harvey’s *De Motu*, and Morgagni’s *De Sedibus* as the greatest tetrad of medical books since Hippocrates.”



Figure 2: Virchow lecturing. gettyimages.com

William Welch, who was often called the dean of American medicine and had traveled to Germany to train under Virchow, wrote in 1902 that Virchow's doctrine of cellular pathology was the "greatest advance which scientific medicine had made since its beginning."

Welch wrote, "What Virchow accomplished in *Cellular Pathology* was nothing less than to enunciate the principles upon which medical research would be based for the next hundred years and more. In one sweeping declaration, he cleared the medical air of all residue of humors and humbug."

Many of the attendees of Virchow's twenty lectures certainly had their own opinions on the pathology of disease. But I believe that Virchow's talks were the springboard for not only a fascinating and powerful book on the role of the cell in disease, but also allowed every attendee to access a wealth of knowledge that would forever dictate how they did their research and practiced medicine.

A 19th-century Renaissance man, physician, academic, writer, biologist, scientist, anthropologist, politician, and public health advocate, Rudolf Virchow (1821–1902) was perhaps best known for his significant achievements in pathology and social medicine. Virchow was a leading figure in the medical, political and intellectual life of Germany in the second

half of the 19th century. Virchow wrote numerous books and edited several prestigious journals, including “Virchow’s Archive,” and was a member of numerous professional societies.

The words and research of Rudolf Virchow have been used not only to describe disease but to save countless lives throughout the world. In his most famous textbook, *Cellular Pathology*, he argued that the study of disease should focus on cellular abnormalities and that cells arise only from other cells, disagreeing with the predominant theory of spontaneous generation. Virchow discovered the nematode that caused trichinosis (all pork eaters please now applaud) on his journey to revolutionizing pathology.

This biography explores the historical interaction between Virchow and his patients, and disease and health care officials. It also gives details of his personal letters, his many innovations and discoveries, and his life in politics, all set in the context of his extraordinary time. Between his birth in Poland and his death in Berlin, Germany, Virchow’s accomplishments could readily fill a 10,000-page volume. The only child born to a poor family in the town of Schivelbein, which is today in Poland but then was part of Prussia, he was later trained in the Prussian Military Academy. An excellent, highly driven student, Virchow gained entrance to the prestigious Friedrich-Wilhelms Institut medical school.

What is perhaps most characteristic of Virchow is that he looked at life in the most microscopic detail (he was called the “Father of Pathology”) and simultaneously from a much larger cultural and public health perspective. One of the most celebrated statements spoken by the 19th-century German physician, Rudolf Virchow, was: “Medicine is a social science, and politics is nothing more than medicine on a grand scale.”

He saw medicine as a metaphor for understanding all of society and looked at it as an ailing patient that needed fixing. Virchow treated society as a whole with a disease model and later in life added insights from anthropology and social science.

Virchow’s life was fascinating for many reasons and I will try to explore each one. A particular fascination is the role Virchow played in studying morphology and race during the time of an emergent socialist movement, rising anti-Semitism, and cultural superiority in Germany. Virchow supervised a study of seven million German schoolchildren and disproved the existence of a predominantly blond-haired, blue-eyed Aryan racial type. He was a teacher of Franz Boas who used his new insight to promote new ideas within anthropology, including an expansion of Virchow’s research on cranial measurement and race, for which he won international acclaim.

Virchow’s passion for knowledge and discovery took in all aspects of human beings and included archeology and physical anthropology. While

excavating with the noted archeologist Heinrich Schliemann, he arranged for ancient treasures to be located in museums in Berlin. He was the editor of Germany's most important scholarly journal of ethnology and in 1869, he founded the Society for Anthropology, Ethnology and Prehistory. What is perhaps most characteristic of Virchow is that he looked at life in the most microscopic detail and simultaneously from the much larger cultural and public health perspective.

Among his amazing works that boosted his universal fame were his contributions to humanity that were fueled by his social crusades. He always searched for the truth and at times ran into roadblocks, both personal and scientific, that would frustrate his efforts. His political ambitions and attempts to disprove contemporary scientific racist theories were often met with fierce resistance. He was never satisfied with the status quo and believed in observation confirmed by clinical experimentation. "Experiment," he wrote, "is the ultimate court of the science of pathologic physiology."

Another crucial chapter began when Virchow left Germany and found a new life in New York and began to gain global acclaim. All of these wonderful events, original and compelling, are included between the covers of this book.

The book will also highlight ways in which Virchow was unable to see early on what he later recognized. Despite the oratory of Louis Pasteur and Robert Koch, he did not believe in the gospel of the germ theory of disease and instead pointed to abnormal internal cell activities instead of outside pathogens. Virchow espoused that the cell was the fundamental unit of life, only recently refuted by gene theory. Dr. James Byers, in his book, *From Hippocrates to Virchow: Reflections on Human Disease*, wrote "(Virchow's) concept of the cell as the center of all pathological changes was critical in reorganizing our thinking on the mechanisms of disease." Virchow opened the door to our understanding of all the physiological changes that took place when a person contracted a disease.

Virchow's life as a physician and academic continues to inspire. My task is to provide insight into his complex life and present the story as a cohesive and organic whole. I believe that Virchow was a man who lived five interweaving lives—as a physician, scientist, anthropologist, pathologist, and politician. None of these five were fully distinct or sequential, but each one formed enough to constitute a fully developed life. Included in these lives was work as a researcher, professor, public health expert, and a medical historian/writer/biographer. He had many other lives, as a student, a husband, a father, a son, a traveler, among others. The complexity and persistence of his character, set in one of the most amazing times in our history, will be highlighted on each page.

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CHAPTER ONE

A CHILD OF PRUSSIA

The Beginnings of a Physician Scientist

Rudolf Ludwig Carl Virchow was born on October 13, 1821, in the small Pomeranian town of Schivelbein, located in the German kingdom of Prussia, about thirty-five miles south and a little west of Köslin (Koszalin) where he attended a gymnasium from 1835-1839. As with so many other European towns and cities that were swept up in political and geographic upheaval, names changed, and now the town is in Poland and called Świdwin.



Figure 3: Schivelbein [Świdwin] (Virchow's birthplace).

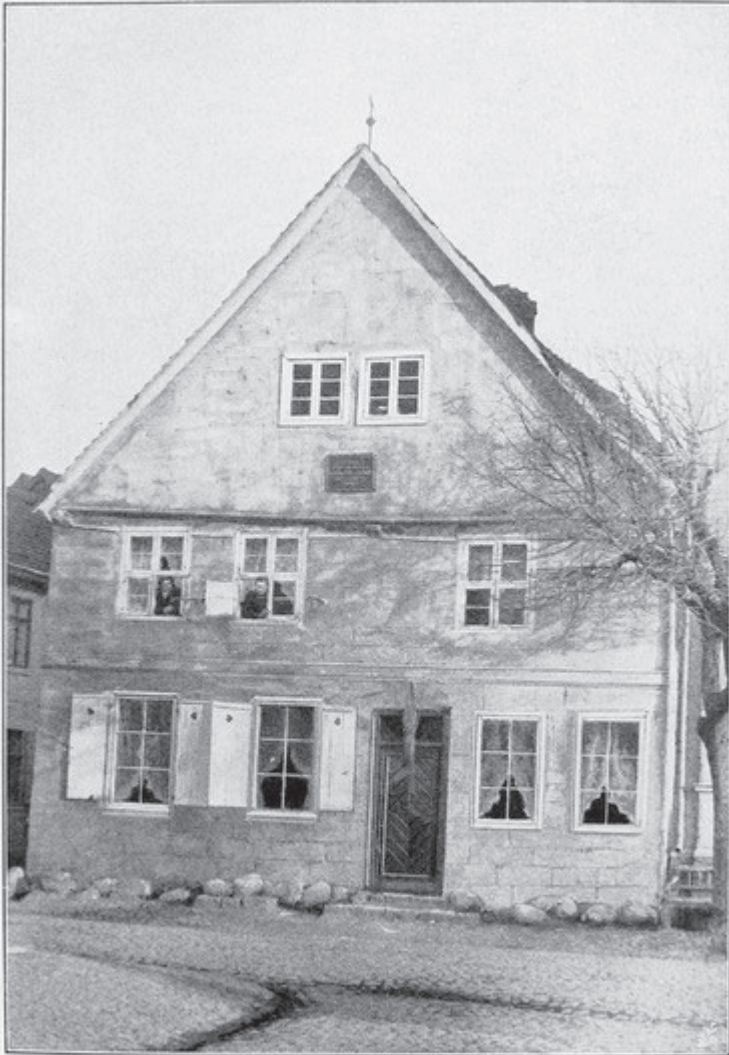


Figure 5: Map of Pomerania (late 1800s).

Rudolf was an only child, born to Carl Christian Siegfried Virchow and Johanna Maria Hesse. Carl was a farmer and butcher and the town treasurer of Schivelbein. According to historic records, the family was often short of funds. His parents were noted to have instilled a love of the natural world in Rudolf, taking him on bird watching trips and other adventures in the countryside.

Virchow-Briefe

Zu Seite 10



Rudolf Virchow's Geburtshaus in Schivelbein

Figure 6: Virchow's house in Schivelbein.

All records indicate that the young Rudolf was a brilliant student. If you had walked into his classroom, I imagine he would have been the one asking challenging questions and pushing his curiosity to his youthful limits. In 1835, he enrolled at the Friedrich-Wilhelms Institut, a unit of the University of Berlin that offered free tuition. The school's primary purpose was to train medical officers for the Prussian army. By the time he came to Köslin (Koszalin) at the age of thirteen, he had already mastered Latin in addition to his native German. Later, he would add Greek, Hebrew, English, Arabic, French, Italian, and Dutch, skills that would help him achieve a stellar place on the international stage.

The school, although tough and rigid with little time or funds for frivolous pursuits, offered an outstanding education and an essentially pre-medical curriculum.

Among the notable teachers in the institute's faculty was Europe's most renowned physiologist, Johannes Peter Müller. Although only thirty-eight years old at the time of Virchow's entrance, Müller had already produced many fine works that would propel him to the heights of German scientific medical research. In addition to his noted teaching skills, he was a biochemist, pathologist, biologist, comparative anatomist, and psychologist. Many of the greatest scientists of nineteenth-century European medicine were pupils of Johannes Müller. Müller offered Virchow a rare opportunity to observe how someone with high ambition, intelligence, and drive could produce great accomplishments in a wide variety of disciplines.

The young Virchow embarked on an outstanding secondary school career that saw him graduate at the head of his class in 1839. He wrote a thesis titled, "A Life Full of Work and Toil is not a Burden but a Benediction" (see Appendix A). As Sherwin Nuland wrote, "In the title of his graduation thesis, there is a portent of things to come—it seems to foretell not only his attitude about his own career, but the emergence as well of a social conscience that exalted the labor of one's hands."

During his last year at the gymnasium, Rudolf also wrote an essay that included his reasons for choosing medicine as a career: "First, it must be a pleasure to study the human body, the most miraculous masterpiece of nature, and to learn about the smallest vessel and the smallest fiber. But second and most important, the medical profession gives the opportunity to alleviate the troubles of the body, to ease the pain, to console a person who is in distress, and to lighten the hour of death of many a sufferer." Virchow knew that German medicine was creating a big wave worldwide and he appeared to have a prescient sense that someday, he would be riding the crest of that glorious wave.

In His Time

Take yourself back in time with Virchow. All around you are political, medical and other dramatic societal changes, including the founding of the German Empire and Bismarck's Prussia rising to the top of the hierarchy of power in Continental Europe. Robert Koch, Nobel Prize recipient in Physiology or Medicine, postulated a bacteriological theory of disease, locating the bacilli for cholera and tuberculosis. In his textbook, *Cellular Pathology*, Virchow famously argued that the study of disease should focus on cellular abnormalities and that cells arise only from other cells, disagreeing with the predominant theory of spontaneous generation.

Who were some of the other scientific luminaries who shared this time with Virchow?

Charles Robert Darwin was born on February 12, 1809. The famous English naturalist, geologist and biologist was best known for his contributions to the science of evolution. Darwin did not publish his theory of evolution until his 1859 book, *On the Origin of Species*. Virchow had strong sentiments about Darwin's theories and often disagreed.

Louis Pasteur was born a little more than a year after Virchow, on December 27, 1822, in the eastern part of France. His work in microbiology and bacteriology and his contribution to the germ theory of diseases helped lead to the invention of antibiotics and new vaccines. Virchow disagreed with Pasteur's germ theory of disease and instead emphasized cellular abnormalities.

In the middle of the 19th century, Michael Faraday, Hans Christian Ørsted, and André-Marie Ampère were rocking the views of electromagnetic theory and physics. The Crimean War exploded European politics and shifted the expansion of colonization toward the Far East, igniting conflicts such as the Second Opium War. John Snow investigated and found the source of an outbreak of cholera in London in a contaminated water pump and epidemiology burst onto the scene. In Neanderthal, Germany, the discovery of fossils led to a new branch of man's descent. In the United States, railroads replaced canals to transport goods and fueled mass migration in the direction of the American West.

All in all, it was an amazing time to live in such a robust scientific era and Virchow's plentiful intellectual energy and ambition propelled him into the center of the action. I believe the time of Virchow was at least as inventive and intoxicating as our own. And in certain cases, such as with Pasteur, Darwin, and Faraday, and later in life for Virchow and others, these scientific heroes were clearly recognized on a larger scale. The scientific entrepreneurs who accomplished amazing achievements, such as Virchow

and his contemporaries, would change the world forever in positive, lasting and world-revolutionizing ways. The political revolutions of the time would fade into the dust of collective memory.

Virchow was unique, given his multiple, and at times conflicting, exuberances of his drives and passions. Many who wrote about his life were saddened when he died and announced that they had lost four great men, not just one. He was a physician, public health advocate, anthropologist, and politician, all living as one radiant character—Rudolf Virchow. Although often seen as reductionist in his views on cell biology, he appeared to see the micro and macro pictures simultaneously, as if he had eyes in the back of his head as he stared down the barrel of his microscope. Out in the world, I picture him shifting his eyes to focus on what was important to capture in the scene in front of him, but also keeping an open mind to ideas and possibilities where he could provide assistance and find a way to improve on what he was seeing. As he cast his net ever wider, he paid particular attention to the social sciences as important ways of accomplishing change in the world. Although we now know much of the tragic potential of science, in his time, Virchow was a dreamy visionary who promoted science as the vehicle to world peace.

In his talk on “Anthropology in the last Twenty Years” (Anthropological Papers of 1891), Rudolf Virchow wrote, “If different races would recognize one another as independent co-laborers in the great field of humanity, if all possessed a modesty which would allow them to see merits in neighboring people, much of the strife now agitating the world would disappear” (see Appendix).

Over and over, while writing this book, I reflected on how prescient Virchow was about our current times, ones filled with highly charged political and medical turmoil. At the present time, we have concluded four years of political divisiveness in our presidency and our nation, and at the end of 2019, a nasty viral character arrived center stage—Covid 19. Virchow’s statement that “politics is nothing more than medicine on a grand scale” echoes across our world, and many are doing everything they can in terms of using public health techniques and developing vaccinations to prevent more deaths. Common sense has often lost out to political agendas and bizarre theories of disease origin. In the next chapter, I will explore the beginnings of Virchow’s career as a physician.

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CHAPTER TWO

EARLY DAYS AS A PHYSICIAN

“Medical education does not exist to provide a student with a way of making a living, but to ensure the health of the community.”

“Wealth, education and liberty depend on one another and thus, conversely, do hunger, ignorance and servitude.”

—Rudolf Virchow

Report on the Typhus Epidemic in Upper Silesia, 1848.

Following his rigorous medical school training, Virchow was now ready to launch himself into the heart of his medical apprenticeship, which would be his springboard for a long and highly successful career. Sherwin Nuland noted,

Upon receiving his M.D. degree in 1843, Virchow was appointed to the equivalent of today’s rotating internship at Berlin’s Charité Hospital. Although the short, thin, blond-haired physician enjoyed his work on the wards, he found himself increasingly drawn to the research of the autopsy pathologist, Robert Froriep, in whose laboratory he improved his ability to use the microscope. Because Froriep was the coeditor of a journal that published summaries of foreign medical studies, Virchow soon made himself familiar with the latest work that was being done in the more advanced medical environments of France and England.

Virchow often wrote to his father, and included here are sample letters to place Virchow in context:

Charité

Friday, May 9, 1845

Dear Father,

This time it is you who make me wait for a letter; it seems that you wish to pay me back in my own coin. Meanwhile, Friedrich-Wilhelm festivities were celebrated on May 3 and I delivered my speech. I believe I have already written to you that it contained a formal declaration of medical faith with not altogether ineffective attacks upon opponents of the modern school. Eck

had read through the speech beforehand with uncommon generosity, leaving untouched virtually everything that I would have struck out in the work of another had I been in his position. He was critical only of my overall stance and emphasis on certain points; it often sounded, he said, as if I were a member of the French Academy. You know this old fault. Nonetheless, the impression it made on the military physicians present – and the audience was entirely composed of such people – did not appear unfavorable. Many of them expressed their approval afterwards. Neither of the two Generalstabsärzte, Wiebel and Lohmayer, was present. Wiebel, who has been ill for some time, invited me two days later to read the speech to him. I met Lohmayer in his anteroom and he held out his hand to me and said: “I have read your excellent speech with the greatest pleasures.” Wiebel, who was very communicative and held me for more than two hours, asked about my relationship with your brother and then remarked that we were both making our family quite “famous!” – to which I remarked that our objective was service and not fame, etc. Things thus seem to be going well so far. Nothing has yet been decided about publishing the speech, but Eck seems disinclined to sponsor the publication of views which he otherwise supports. My next efforts will be directed toward obtaining private quarters in the Charité and permission from the medical staff to complete the teaching examination in the winter. As I wrote you recently, honorable efforts are underway to relieve me of my military obligations so that I may perform research and become an instructor. This affair has again a pecuniary side, which I regretfully must take up with you yet again. Among other things, there are two reasons for my wanting to take the state examinations as soon as possible. First, once I have successfully completed the examinations, there will be no further obstacle to my writing what and how I wish to write; second, I will be able to conduct private courses, which are in great demand and for which I have sufficient material. In either case, I can recover at least part of the money. Completing my examinations will, moreover, make my position more secure. The question thus boils down to whether you can place a sum of 80 thaler at my disposal around November, if I obtain permission to take the examinations. As things stand, I believe I could manage comfortably with this sum. I have considered the matter carefully, since I would gladly have wished to spare you such an expense; but all things taken into account, this course seems to me the best. With my fondest regards, dear Father, and a hearty farewell.

Your Rudolf

As Leslie Dunn notes in her book, *Now You Know His Name*, two months after his speech, it sat ill with Virchow that not a word had yet been published, a common practice of the time. It especially distressed him that Minister of Culture Eck commended the speech both before and after its

presentation. While Eck encouraged and supported Virchow's views, no doubt he was criticized for permitting the radical a public forum.

Wednesday, August 27, 1845

Dear Father,

August 2 went very well. Mine was a difficult task, that of speaking in between two such experienced orators as Histiographer Preuss and Oberstabsarzt Eck. Nevertheless, I made my theme as provocative as possible, and the views I expressed on phlebitis were absolutely new so they had to be heard. In the evening, there was a great feast at Kroll's house, not to speak of an unlimited supply of beverages. Here I had the opportunity of speaking to members of the audience and receiving their judgments. The old military physicians were profoundly shocked at the new wisdom. That life was to be given such a mechanical interpretation seemed to them quite revolutionary – or at any rate quite un-Prussian. There must be a kind of halo roundabout, which affects our vision and prevents us from seeing things clearly. Privy Councilor Busch, director of the obstetrical clinic, remarked: "Well now, have you heard? It seems we know nothing at all!" In contrast, I had the pleasure of being defended by a very eminent scholar whose views are entirely free from prejudice – Privy Councilor and Regimental Surgeon Betschler, director of the obstetrical clinic, not of Charité, but of Breslau. He defended with great energy and biting eloquence my ideas against the followers of obscurantism, or those whose policy is to withhold knowledge from the general public. Ideler, the director of our lunatic asylum at the Charité who is always ridiculing me on account of my 'newfangled ideas,' conceded that my line of thought, followed strictly, must lead to significant results, even if it is not the only correct one. The ramifications of this discussion occupied us from 10 to 12 at night. The day was doubly fruitful for me; first, because of the recognition I received, which is always flattering and so difficult to achieve, especially at the beginning of a career; second, because it became clear to me on this occasion that people were duller than I had previously supposed. Not a single deductive leap is permitted; every conclusion must inexorably follow from fixed premises; the only way lies in defining one's own premises, not those of another. A day like this comes only once; I could never have made up for it if I had let it pass unused. Opportunity must be seized by the forelock. Would it not be possible for you to provide me with 40 thaler for the time being? The other half can wait until the new year. Please do not take this letter amiss because I have only talked about myself. I wish you good health and prosperity.

Your Rudolf

Leslie Dunn writes that in December of 1845,

Rudolf's superior, Medizinalrat Froriep, Director of the Morgue, confided in Rudolf the two reasons for his plans to retire from Charité: entering into the publishing field and accepting the position as Physician-in-Ordinary of the Grand Duke. Recognizing Virchow as a serious contender in the field of medicine, Froriep urged Rudolf to apply for the position as Director of the Morgue. If chosen, it would place Rudolf, only two years post-graduation, in charge of both the Chemistry/Microscopic Lab and Morgue with full access to the most advanced research equipment and no shortage of diseased bodies on which to perform investigations—a gruesome, yet serendipitous combination for the young researcher. It must be noted that Rudolf's apprenticeship at his father's knee as a butcher desensitized him to the presence of dead flesh, yet his mother's theological teachings endowed Virchow with a reverence for living things.

Virchow succeeded Froriep as Prosector in Pathology at the Charité in 1846. The following year, along with his friend Benno Reinhardt, the two published the first volume of their newly minted medical journal, *The Archive of Pathological Anatomy and Physiology and Clinical Medicine*.

What was Virchow's aim in his "Archive"? He clearly stated:

The standpoint we propose to adopt and which is already manifested in this first issue is simply that of natural science. Practical medicine as applied theoretical medicine, and theoretical medicine as an embodiment of pathological physiology, are the ideals toward which we shall strive so far as lies within the scope of our powers. Pathological anatomy and clinical work, although we fully recognize their justification and their independence, are both mainly regarded as the sources of new problems whose answers must be supplied by pathological physiology. Since, however, these problems must for the most part be formulated by means of a laborious and comprehensive study of detailed phenomena in the sick and upon the postmortem table, we maintain that a precise and purposive development of anatomical and clinical experiences is the first and most important requisite of the day. Through an empiricism of this sort, there will gradually be brought into being a genuine theory of medicine, a pathological physiology.

Nuland writes,

The very first article in the Archive created an uproar among the physicians of Germany. In it, Virchow outlined his perception that disease is not an aberration engrafted onto a healthy organism but is simply health disordered. The dominant theorists of his day viewed sickness as a condition quite foreign to the normal functioning of tissues, arising within the body or entering from without, living an enervating existence like some foreign parasite sucking out the strength of its unwilling host. To them, pathological

tissues were produced *de nova* from a theoretical mother-substance gone wrong, or perhaps by deposition from the blood itself. By this formulation, diseased structures are so different from healthy ones that nothing can be learned about the one by studying the other, and it was this formulation that Virchow challenged in that first essay, 'Points of View in Scientific Medicine,' articulating his definition of that critical term 'scientific medicine'.

In the Archive, Virchow wrote:

Scientific medicine has for its subject the changed conditions under which the diseased body or the particular ailing organs exist, the identifications of deviations in the phenomena of normal life which occur under specifically altered conditions, and, finally, the discovery of means for abolishing the abnormal conditions. This presupposes therefore a knowledge of the normal course of the phenomena of life and the conditions which make this normal course possible. Hence, the basis of scientific medicine is physiology. There are two parts to scientific medicine: pathology, which should provide information about altered conditions and altered physiology, and therapy, which seeks out the means of restoring or maintaining normal conditions. Essentially, clinical medicine is not scientific medicine, not even when practiced by the greatest master; clinical medicine is the application of scientific medicine.

As I often tell my students, we, as clinicians, are the jockeys of research. We ride on top of the hard work and thousands of intense hours of training and investigating that the researchers have put in to allow us to treat our patients from a basis of scientific facts and understanding.

Virchow wrote,

It must be recognized that this is not the time for systems, but the time for detailed investigations...The final decision in these matters rests with a science which thus far exists only in its earliest beginnings and which appears destined to replace general pathology. I refer here to the science of pathologic physiology...Pathologic anatomy is the doctrine of deranged structure; pathologic physiology is the doctrine of deranged function. A science of pathologic physiology is necessary...Pathologic physiology derives its questions in part from pathologic anatomy, in part from bedside medicine; it obtains its answers partly from observation at the sickbed and partly from animal experiment. Experiment is the ultimate court of the science of pathologic physiology.

Let us not deceive ourselves about the present state of medicine. It is undeniable that our spirits are exhausted by the innumerable hypothetical



Figure 7: Portrait of R. L. K. Virchow as a young man.

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<https://wellcomecollection.org/works/n6yp2w8t>

systems which are constantly being cast to the winds and replaced by new ones. A few more mishaps, however, and this time of disturbance will have passed by and it will be understood that only dispassionate, diligent, and steady work, true work of observation or experiment, has permanent value. The science of pathologic physiology will then gradually fulfill its promise, not as the creation of a few overheated heads, but from the cooperation of many painstaking investigators—a pathologic physiology which will be the stronghold of scientific medicine.

Nuland wrote,

With this statement, the twenty-six-year-old researcher had laid out his credo for the medical world to see. He had also laid out the program for his life: alterations in structure provide clues to alterations in function; the key to understanding and treating sickness is to understand the ways in which normal function becomes abnormal. It is therefore in the study of pathophysiology that disease is to be conquered. Observation, experiment, hard work, and a steadfast disavowal of unjustifiable speculation, these were the intellectual weapons for the battle. They were inherited from Vesalius, and Harvey, and Hunter, and Laennec. Rudolf Virchow, an indefatigable student of medical history, acknowledged his debt to each of them.

In 1848, Virchow was sent by the Prussian government to Upper Silesia to study a typhus epidemic in the famine and poverty-ridden province and found filthy conditions. The epidemic, along with a concurrent famine and inaction by the local authorities, resulted in increased mortality for the region's peasants. The trip would prove to be one of the most defining times in Virchow's life, creating a springboard for his future political and socioeconomic views. In a letter to his father, Virchow wrote, "This distress in Silesia is such a disgrace to the government that all their excuses cannot change it in the least. Nothing can mitigate the scandal which is created by the deaths of thousands. From the medical standpoint, the epidemic is so interesting that I have the strongest desire to see it close at hand."

Berlin
Sunday, February 20, 1848

Dear Father,
The wish that I mentioned in my last letter was soon fulfilled. I wrote to you that I would like to see the epidemic in Upper Silesia, and now I have been accorded the great privilege to do so. Minister Eichhorn, unable to find time to busy himself with a scientific study of the disease, has entrusted me with the task of studying more precisely its nature and origin. I will be leaving very soon. The journey will perhaps be over in two to three weeks.

I have three thalers (dollars) as my daily allowance, and so I think I can manage. Give my regards to Mother; I have so little time that I cannot write more. Farewell.

Your most loving son,
Rudolf

For Virchow, the problem could instantly be noted—the government authorities. He filed a report with accusations of corruption and neglect of the poor and pinned the typhus epidemic on extreme social faults and advised, “democracy, education, freedom, and prosperity.”

Dear Father,

Since yesterday, we have been in the midst of the affected area. The misery is endless and one sees here quite clearly what can become of masses ground down by the Prussian bureaucracy. This animal servility is frightful. The country is, for the most part, quite like some regions in Pomerania; mostly fertile soil, at times sand, rarely earth closely mixed with coarse gravel. The towns look passable, but the villages are very wretched. The rooms of the houses are very small, animals and humans sharing the same accommodation with windows not meant to be opened; the stove and the beds occupy most of the room. The people, however, are horrible, pitiable figures, moving barefoot in the snow, feet swollen, and faces pale, eyes dull. They kiss your arm, the hem of your coat, your knee, all in one breath. Enough, it is horrible.

It is certain that the famine and typhus did not appear separately, but that the latter spread on such a scale only because of the famine. The extent of the epidemic is terrible: the number of orphans in the villages of both Rybnik and Pless is officially estimated to be about 3,000. Large rooms have been arranged to accommodate them. Staying in these well-aired and heated rooms on an adequate diet, they are so satisfied that not only do they not mourn the loss of their parents but are even happy about it.

Everyone gets a daily ration of half a kilogram of flour, and some salt. If this continues for six months, they will obviously ruin their stomachs and die. In this district of 59,000 inhabitants, 20,000 will have to be fed for six months. The government has taken no further steps, apart from supplying flour. The effectiveness of the monks-hospitallers, however much as it may be praised in the newspapers, has been relatively insignificant. There are still many villages without a physician; not until the government sends four times as many physicians as there are at present can we talk of adequate treatment. That this misery could never have reached such proportions had sensible preventive measures been taken, and that the government, especially Finance Minister von Bodenschwingh, due to his disbelief and stubbornness,

has sacrificed as many people as would be lost in a minor war is absolutely certain. And yet the government does nothing more than send flour, and here and there a physician, and use up a lot of paper in writing. It is horrible, disgusting.

Farewell and many greetings to Mother.

Your Rudolf

Nuland wrote,

Within a week of Virchow's return from Silesia, the popular uprisings that history has given the name Revolutions of 1848 exploded on the boulevards of Berlin. The brief victory of the forces of democracy allowed the young firebrand to make violent speeches to large audiences of eager revolutionaries, with the result that he was elected to the new Prussian Diet. Being under the parliamentary age, he could not take his seat, but he created for himself a pulpit almost as bully as the one he was forced by his youth to relinquish. He founded a journal called *Medical Reform*, whose pages he filled with both his scientific and his political beliefs. During this heady period of his life, there emerged a quality in Rudolf Virchow that was almost deliberately dangerous to his career. Not only were many of his political speeches overtly inflammatory, but he seemed at times to make a point of abrading the sensibilities of the conservative authorities in ways that he knew to be particularly offensive to them. In a community of the religiously orthodox, where loyalty to church was equated with loyalty to crown, he openly proclaimed his agnosticism. He fired off snidely clever anti-Hohenzollern jibes that were repeated many times with pleasure among his supporters, but provoked neck-reddening Prussian rage when they reached the ears of the royalists.

The German revolutions of 1848–49 were known as the March Revolution. Virchow and thousands of his fellow liberals erected barricades in the streets against the government troops, in much the same manner as had been happening in the other capitals of Europe. Most of the protests and rebellions occurred in the states of the German Confederation, including the Austrian Empire, and supported pan-Germanism. The protestors voiced a popular discontent with the traditional, mostly autocratic political structure of the thirty-nine independent states of the Confederation that had inherited the German territory of the former Holy Roman Empire after its dismantlement as a result of the Napoleonic Wars. The majority of the middle-class participants in the uprisings favored liberal principles, including the unification of the German people, a more democratic government, and guarantees of

In a letter home, Virchow provided details of what he had witnessed and heard:

Sunday, March 19, 1848

...The King was already so weak that he was unable to offer any opposition to these vehement demands; he yielded; a declaration in a high-flown style appeared, which you will read, and there was general rejoicing. Everyone gathered in front of the palace cheered and called; the King appeared. He agreed to relaxation of censorship, held out the prospect of a new constitution, and made other concessions, and everyone shouted hurrah. The citizens had only one other wish – that the military be withdrawn from Berlin. The King found this too much. He asked General Mollendorf to ensure quiet; the Prince of Prussia gave orders to clear the square in front of the palace. Suddenly, drawn sabers of dragoons (a military unit comprised of heavily armed and mounted troops) dispersed the unsuspecting people. In one of the King's declarations touching on this incident, which you will read in the newspapers, stands the lie that the dragoons charged with their sabers unsheathed; this is a direct lie. For the first time since the beginning of German history has it happened that a king fired at his subjects with cannons; small-arms fire was not enough—no, grapeshot and grenades were hurled at the people. The fighting raged simultaneously at three points: near the palace, in Königsstadt and in Friedrichsstadt. Shot after shot sounded for twelve hours, and at 4 o'clock in the morning, no more than four of the people's barricades had been taken. On the other side of the barricade behind which I was stationed, there was the King's regiment from Stettin firing on us with two cannons; in our barricade, there were only twelve rifles, yet the military were thrown back for more than two hours. The colonel, Count Schulenburg, is dead, one major is fatally wounded, three or four officers and nineteen other ranks have died. By morning, the King's regiment had expended all its ammunition, yet the troops had managed to take only four or five barricades. The Berliners fought like lions; so many heroic deeds accomplished that one cannot speak of them individually. Let me assure you that I am completely uninjured. That was the state of affairs, when at about 4 a.m., General Mollendorf was captured in Königsstadt where a very strong-willed man, Urban (a newspaper editor) was in command. The general was brought to the guardhouse, where he signed an order to the Kaiser Franz and Alexander regiments directing them to cease fire and withdraw to their barracks. At the same time, the King was given to understand that if another shot were fired at the citizens, the General would immediately be executed. From that moment on the firing stopped, and this morning saw the removal of the minister, the amnesty, the summoning of the Landtag, Federal State Parliament. The King is now so hard-pressed that at about 10 a.m., when the folk brought coaches bearing the dead bodies of the citizens killed in front of the palace, he and the queen were forced to appear on the balcony and view them under the maledictions of the people.

The protestors shouted, "Take your hat off," and the King complied. On March 21, he paraded through the streets of Berlin wearing black, red, and golden sashes. But concessions did not suffice. A partially armed deputation from the barricades of Königsstadt, headed by editor Urban, made its appearance in front of the palace at about 11 a.m. and gave the King its ultimatum to decree a general amnesty and general arming of the citizenry by 4 p.m.; meanwhile, the barricades were maintained and renewed in the direction of the palace. Around 4 p.m. there also began the distribution of weapons to the citizens from the arsenal; the military left its posts, withdrew to the barracks and is now for the most part outside of the city. The citizens have occupied all posts, including those in the palace. Thus far we have come with this King. In Charité, there are 52 wounded and 11 dead civilians, 24 dead lie in the Werder church, and in the palace, etc. 256 civilians perished in all. The damage done to the buildings, especially by cannon fire, is very substantial; the streets look frightful, and wagons can only pass through a very small part of the city. Atrocities on the part of the people are unknown, whereas the soldiers have done the most brutal things. Specifically, when the combatants were chased into houses, the soldiers slaughtered them like bandits. We will be meeting tomorrow at Councilor Mayer's place. He, too, is a doctor at Charité but one of great standing and of strong intent. A general arming of all householders with carbines and a gun-club has already been decided upon. You can rest assured, moreover, that I will not uselessly sacrifice myself, either physically or in respect of my position. I think that you, knowing your son, will not expect him to be shamefully unconcerned when the most sacred and honorable rights of citizens of the state have to be upheld. Please calm Mother, do not allow her to distress herself too greatly on my account.

Your Rudolf

Virchow had become friendly with Dr. Carl Mayer's 16-year-old daughter, Rose, and the beginning of a relationship had bloomed. The Mayers had seven children, five of whom were girls, and Rose was the third daughter. The next letter home seemed to be infused with both an elation about the renewal of Berlin and his growing fondness toward Rose.

Charité
Friday, March 24, 1848

Dear Father,

The look of Berlin today, compared with what it was 14 days ago, is something truly fantastic. Everywhere life, everywhere arms, everywhere free and public speech. All Berlin is hung with German banners, and the

streets have a colorful and lively appearance. People have been coming in crowds from all sides to see the place of the battle; whole delegations from towns and corporations appear in order to show how happy they are over these glorious victories. The Berliners themselves are naturally filled with the pride of victory and every street boy behaves as though he had encountered many soldiers. What is something entirely new, and perhaps the most important thing in the affair, is that we have now won a feeling of self-esteem, self-respect and self-confidence. These traits are the foremost requirement for self-government, which constitutes the only form of state worthy of the people. Let us hope that we will not have to use the force of arms again to achieve self-government, for a second battle would surely be far bloodier than the first. The army would be less dangerous in it than the armed bourgeoisie would; it would be a real civil war. Farewell and stay healthy.

Your, Rudolf

Virchow followed about five weeks later with:

Charité

Monday, May 1, 1848

Dear Father,

I am using the first quiet evening to write you a few lines; it may, perhaps, turn out to be the last quiet evening in the coming two weeks, for the matter of the election has been keeping us constantly occupied. The election of delegates must have kept you busy today, too. Here the outcome has been extremely varied, especially as regards time, for there are voting constituencies where even at this moment voting is taking place. We, the 87th voting constituency, with 2,971 souls and 990 primary voters, needed ten hours to finish with our ten electors, who will, however, be reduced to seven, as three were simultaneously chosen for the German and Prussian delegation. I also belong to the latter; in the first secret ballot, I won (obviously as an elector) an absolute majority for Berlin as well as for Frankfurt. My declaration of faith is very simple: democratic monarchy, i.e., a republic with a hereditary president. Germany can no longer avoid becoming a republic; I am as strongly convinced of this as I am of my own existence. Either Germany becomes a republic, or it ceases to be Germany. This revolution is not merely political but essentially social. All our present political activity is only a way of bringing about social reform, a means of transforming the structure of society down to its foundations. I am sure you will not be angry that I have told you what I think in plain words. I am now no longer a half man, but a whole man in that my medical credo is absorbed in my political and social credo. As a scientist, I can only be a republican, for the realization that the laws of nature, derived from the nature of the human being, can only be

achieved in a republican state. But, as I said earlier, my concern is not with a democracy that has an elected president; rather I accept even a democratic hereditary king. As soon as the election to the delegation is over, we shall immediately proceed with medical reform and I hope it will be radical. Here, too, the pigtail must be lopped off and the democratic element taken into account. More next time. Please bear with my somewhat stormy and abrupt way of presentation. Kind regards. Farewell.

Your most loving son,
Rudolf

Twenty-six-year-old Rudolf's political involvements brought his mother to hysterics. Despite the miles between them, she clearly saw the danger he was in and she believed it unnecessary. During these times, Rudolf reminded his beloved mother to turn to friends for comfort, and if that failed, to draw on her faith. He appealed to her with his sense of the extreme injustice of the working poor and his worthy, though lofty, goal:

Charité
Tuesday, May 2, 1848

Dear Mother,

It was not possible for me to write earlier, for we had large or small meetings every day in the mornings and evenings concerned with preparations for the elections. Every day from nine in the morning until 12 or 2 in the night, I am on my feet. This will continue next week since we delegates must busy ourselves with the preliminary preparations for the elections of representatives. There are also meetings for medical reform, to which I was delegated as a committee member; meetings of the general physicians where I am vice president; district meetings of the Friedrich-Wilhelmstadt; meetings for founding a new club; and finally public meetings to oppose the recall of Prince William of Prussia. In the meantime, I have to take the greatest pains to prepare my official report on typhus in Upper Silesia. You say that you failed to understand what all this meant, and I wish to explain it to you. Now this is not so easy, but I will try to set forth the basic tenets of what we want. The majority of human beings have long ceased to believe in the existence of hell; at present, they are beginning to consider even heaven highly doubtful. Hence, we wish that the poor and oppressed, who bear their sufferings on this side of the grave, would have a happier lot here on earth instead of waiting for heavenly joys. This improvement in the welfare of the poor or, which means the same thing, of the working classes, has not been possible under the existing constitution, for there the King's will alone is law, and the working classes (Klassen) had no means of asserting themselves. The privileged classes (Stände) always oppressed them. Therefore, we have

overthrown the old constitution. The King should have no other will than the will of the people (Volk); there should be no privileged classes, in fact, no classes at all. Instead, everyone should have the same rights in the state, as is natural and reasonable; we want to form from now on a united people, composed of human beings, all with equal rights. Our new constitution, which the representatives whom we will now elect are supposed to work out, will establish this requirement first of all. Once we have this constitution, the next step will be to educate the people more thoroughly, and there has to be an altogether different kind of public education. We hope to achieve this by excluding religion from the schools and by freeing the state from concern with the beliefs of the individual citizen; instead, useful things should be taught in schools. In order to ensure that the people keep this new constitution safe, they will have to be armed, so that should the King or anybody else suddenly decide to diminish their liberties, they may be in a position to defend their freedom with force. Now, if the people are educated and free, every individual will best appreciate his own interests and achieve what he lacks, and everybody will have the maximum possible happiness. This is the primary aim of our present endeavors. Other than a slight hoarseness from much public speaking, I am perfectly well. Regardless of the outcome of the elections, I plan to resume teaching my class on Thursday following the elections. Write soon and tell me what the Schievelbeiners are doing. Farewell, and have no worries about me.

Your Rudolf

When the middle-class and working-class components of the revolution split, the conservative aristocracy swooped down and defeated it. Liberals were often forced into exile to escape political persecution. They became known as the “Forty-Eighters.”

Following the failed revolution, many Germans emigrated to the United States, including many physicians and nurses. Lenox Hill Hospital, a nationally ranked non-profit, tertiary, research, and academic medical center located at the Upper East Side of Manhattan, New York City, was formally known as the German Hospital. In 1857, it was founded as the German Dispensary. In the 1850s, nearly one million Germans immigrated to America, one of the peak periods of German immigration. In 1854 alone, 215,000 Germans arrived in this country. By 1860, an estimated 1.3 million German-born immigrants resided in the United States and 200 German-language magazines and newspapers were published here.

Virchow was caught in the middle of fierce political struggles and lived in a sort of microcosm of what was happening throughout Europe. His strong liberal views, empathy for the indigent and disease-stricken, and rapid ascent into the upper echelon of medicine made him a target for those opposing his position.



Figure 9: Fighting at a barricade in a Berlin street during the revolution of 1848. gettyimages.com

“By openly thumbing his nose at the government in his writings and widely acclaimed speeches, Virchow was daring the authorities to revoke his appointment at the Charité,” Nuland wrote. “They took the dare. Not

even his brilliant research on leukemia, embolism, and thrombosis sufficed to save his job. He was ordered to resign.”

Nuland continued, “The resignation lasted one week. Realizing that the forces of reaction were once more in the ascendancy, and that his radicalism would mean the end of his all-important research, Virchow became very pragmatic. When he was offered his job back in return for signing a statement promising to forgo the open expression of his political convictions, he agreed to sign.”

The authorities were still filled with distrust and searched for ways to get him out of Berlin, although they appeared to want to keep in German’s medical mainstream. “The ideal opportunity presented itself in the form of a specially created Chair of Pathology at the University of Würzburg. Würzburg’s Professor of Obstetrics, Friedrich Scanzoni, who was a contemporary and an old friend, interceded with the government ministers to establish the post for Virchow, thus providing him with a warm and welcoming medical environment into which to be banished,” wrote Nuland.

Berlin, May 29, 1849

Dear Father,

At last, the official notification from the Senate of Würzburg University has arrived. It states that my “excellent achievements in the field of pathologic histology” have attracted attention, that for this reason a request for my appointment at the University was sent to the Ministry of Culture, and that permission has been granted. Therefore, I am now being asked to give a definite answer as to whether I wish to take over the public, regular University professorship of pathologic anatomy along with the direction of hospital postmortem examinations, in which case an annual salary of 1200 fl. is offered, with an obligation to deliver a course of lectures on pathologic histology once a year. This course of lectures up to now carried an honorarium of 10 fl.; it was up to me whether I desired to tap further sources of honoraria by giving private courses.

I replied to this letter at once, without ado, stating that I was prepared to start at Würzburg in the next winter semester. Now only the appointment by the King of Bavaria is necessary, and I believe that under the circumstances, it is sure to follow.

For my part, I have done everything to keep the affair in order, and you will see for yourself that I am as cautious as is possible. I would certainly not be so frivolous as to put my future and your own at stake, nor will I adopt dishonest means to further my personal desires. Thus, on this score, you can continue to rely on me as much as before.

But even now I am of the opinion that there are circumstances in which it is dishonorable to place one's personal interests before the general, and I do not hesitate to tell you that in another such case I would act as I have acted so far, and as the situation demands.

In the present circumstances, it is useless, or at least almost so, to involve oneself with general causes other than where it seems reasonable, given the disadvantages for the individual arising thereby. Where it is useful, in medical reform, I continue my opposition without concern, as you perhaps know from the *Kruzzzeitung*. The statement recently cited in it is, by the way, a total distortion.

How the general course of politics will take form may perhaps become clearer in a few days' time, for the French chamber opened yesterday. Once again there is talk of the constitution of the Reich and of election legislation in the *Staatsanzeiger*, which comes out tonight, but I don't think this will happen unless the government receives telegraphic communications from Paris.

We hear nothing about our political prisoners. All that has been spread abroad so far about Waldeck consists of lies or guesses. In any case, there is as yet no serious aggravation and it will perhaps be necessary to withdraw the charges. Should anyone be called to appear before a jury or a court martial, God help him! The structure of both is such that an acquittal is hardly to be expected. These are our constitutional achievements. Now we want to see how long they will hold out in this glory vis a vis the 217 socialists of the French chamber and the mood in the eastern departments.

Your much loving son,

Rudolf

In the next three letters, you can witness Virchow's tumultuous trials and how Rose appeared to be the glue that kept his world together in turbulent times.

Berlin,
August 6, 1849

Dear Father,

You are surely delaying your writing to me, and as for me, I am waiting in Munich. My affair has encountered new complications that have kept me in great suspense, and whose resolution I expect any day. Namely, when the *Spenersche Zeitung* started provoking me to an explanation, it was pointed

out to me from various sides that from here, there were operations against me in Munich. As time passed and I received no news, I wrote to Wurzburg and asked how matters stood. There came the prompt reply that the Ultramontane Party was greatly upset by my appointment, and that it had gone so far as to inform the minister in its organ, the *Augsburger Postzeitung*, that he would be guilty of "high treason" if he were to forward my nomination to the King. Now the minister has in fact worked himself into a state of rage and has written to the Wurzburg Senate that he will appoint me only if I change my views and provide guarantees that I will not make Wurzburg "a playground for my hitherto demonstrated radical tendencies." The Senate has decisively rejected the first demand; the second, however, it has put to me. I have replied that I have no intention of acquiring a playground for radical tendencies. To this, there has so far been no answer, and I am calmly awaiting the development of things since the matter is not at all a question of life or death for me. Besides, the members of the Wurzburg faculty have informed me that they regard the matter as one of honor, and I can therefore do nothing further about it. Given the state of Bavarian politics, it is quite impossible to anticipate how this affair is going to end. The mood in the Bavarian chamber is very undecided, and the Ultramontane Party is even flirting with radicalism, in order to have a strong backing for the particular aims of the House of Wittelsbach. Even the deputies from the Pfalz, who were involved in the revolt, are not being held in abhorrence. In any case, you need not worry about me, for even if the whole affair comes to nothing, I shall still manage to make my way.

My circumstances here have undergone no change. I have announced my lectures at the University for the next semester as well, and if nothing comes of the Wurzburg affair, I will lecture here as if nothing had happened. I have not given up my position either at the University or at the *Charité*, and I hope therefore that no obstructions are being readied for me there. On the contrary, if I stay here, I will request the Ministry, which by that time may even have changed, for money for scientific purposes.

I have significantly limited my literary activity. The "Reform" has been discontinued for a month now, since the realization of democratic demands even in medicine will have to wait a long time and perpetual opposition would only make my position difficult. The *Archive*, on the other hand, continues to appear, and recently the first issue of the third volume was published. In the winter, I shall in any case start writing a major work on pathologic anatomy; publication preliminaries have already taken place. In politics, there is now not much to be done. Our party must confine itself to exploiting the mistakes of our opponents. The reaction itself is causing the greatest harm, and the more it rages, the greater damage it does to itself. It must again present to the nonplussed people an image of absolutism, as in a mirror, with all its horror. All these passions, all this personal filth must be emptied out, so that people will feel a loathing for it. Let them imprison the

noblest of the people and then search in vain for grounds of accusation, let them shoot and kill in Berlin, let them break their own promises in Schleswig in the worst way – never mind! It will be to our advantage. It will finally be understood that with us constitutionalism is a lie.

Cholera is still widespread and severe. With the great number of cases and the pace at which it develops, I find myself at times obliged to treat patients, although I thereby lose time that is very precious to me. But nothing else remains. If necessary, I could certainly conduct a practice even in Berlin, as I see here. There is thus no dearth of resources for me.

I am enclosing 50 thaler in the form of treasury bills. Harvest time has come and Michaelmas is not far off. I am sure you will need some money. Give my kindest regards to Mother; I shall write to her as soon as news comes from Munich.

Your much loving son,

Rudolf

Berlin,
August 21, 1849, 7 p.m.

My dear Father,

I have just received a note from Wurzburg reporting that the letter of appointment for me has arrived. The note is from Prof. Rinecker, the reviewer in the affair, and, therefore, reliable. The official notification can be expected in the next few days.

At last, it appears that this long drawn out matter is coming to an end. I say appears, though I do not see anything that can still come in the way. The change is immense. It was only yesterday that the letter to Mother in which I discussed my faint hopes was mailed. I add that they were even fainter than I had depicted them. As far as I see the situation, I will carry out my plan in the way that I wrote to Mother. I arrive home in October, lecture here in September and go to Wurzburg in November.

These days we really experience vicissitudes of fate. Today we stand on a peak and tomorrow we lie in an abyss, only to be up and about again on the following day. The Hungarian reports are only too well confirmed. All hopes of the past months have been destroyed, and Napoleon was right in maintaining that the world was going to be “Cossackish” for some time. This

is also the only way of educating half-men and bringing them to their senses. "Cossackdom" is bound to lead to a victory for democracy. The rest later. Many hearty greetings to Mother, who will, I hope, now be at peace for a while. I was really extremely worried when the damned Kreuzzeitung kept repeatedly calling attention to me. How triumphant it would have been, had I not been accepted! But you were wrong to say that this would have been a dementi for me. Certainly not a dementi, only a loss and at the same time an acknowledgment.

Now farewell. Looking forward to an early and happy meeting again.

Your much loving son,

Rudolf

Wurzburg, November 30, 1849

My dear Father,

Now at last I find myself in a well-confirmed and recognized position as professor in the prosperous Main University. Today I reported for duty in the Julius Hospital, and on Monday I will begin my lectures. This is the end of a long train of events packed into the last days, about which I still owe you some details. You will find it natural if I first speak of my engagement.

Privy Councilor Mayer is not, as you said, a high official but an ordinary practicing physician who bears the title of Privy Sanitary Councilor without office. You need therefore have no fear of him, and you can rest assured that as a man without office, he is in any case more honorable and charming. I have already written to you about his family, but you have no doubt forgotten this in part, and I want therefore to give the family background.

Mayer has a brother, who is a court gardener in Monbijou (Berlin), and a sister who is married to the court gardener, Fintelmann, in Charlottenberg. His wife's maiden name is Martins. The well-known jurist and defense attorney Martins, former Oberlandsgerichtsath and at present a member of the Upper House (opposition), and Oberbergrath Martins in Halle, are Mayer's uncles. Two of her brothers are artificers (Pistor and Martins). One of her sisters is married to Geh. Cabinetsrath Illaire, another to his brother, secretary of the royal household in the office of the court martial, and a third to Professor Dage (painter and member of the Academy of Art).

The Mayers have seven children, five of whom are or were girls. The eldest daughter is married to the physician Dr. Ruge in Berlin, brother of the well-

known Arnold Ruge; the second is married to Geh. Finanzrath Seydel; Roschen is the third, and there are two younger ones. Of the sons, the oldest is at the moment studying medicine at Halle, in the first semester; the second is still in high school.

These are the external relationships of the family. If you ask after their outside possessions, I have no answer. I have never asked whether Rose was going to be provided with a dowry, rather I have hesitated to offer her my hand until I believed that I myself was in a position to support a wife. I do not think that Mayer has or will assemble a great fortune, although he may be quite well off. With the number of children, no very large shares remain for them individually. It will always have to be more or less my care to keep house with Rose, and I rejoice in this.

I have known Mayer since the beginning of 1846. He is and was even then the most sought-after obstetrician and gynecologist in Berlin and was Chairman of the Society for Obstetrics when I first made his acquaintance; we soon became confidants and then friends. I came to know his family much later, in the course of the next year, the summer of 1847. Roschen was then still almost a child and concerned me not at all, but her mother soon grew to like me, and a confidential relationship took form between us, particularly since March 1848, which in its development had given her a motherly attitude toward me even before there was any talk of Roschen. Not a week passed when I did not visit the Mayers one, two or even three times; I generally arrived late and did not leave before midnight. We had long conversations, philosophized, and talked politics. Mother Mayer, even though she held different opinions on essential points, on balance, however, subscribed to views that her husband and I held, so that a third person would have gathered the impression that we were in complete agreement. Hence aristocratic members of the family have long since complained that I was lowering the tone of the Mayers, and my eventual engagement has aroused great alarm in these circles.

Now as for Rose, it took a long time before we came close to each other, and as late as the beginning of this year, it would have caused me little regret to part from her. Rose is very quiet when she feels no need to speak, and so in my talks with her mother, with her parents in general, she was more a listener than a participant. But in this listening, she paid such careful attention to me, and in a sense was educated by me, that I can think of no one who better understands me. And as for me, I have grown fond of her; I don't know how and when, but one fine day I noted that she had unexpectedly grown into my heart and spread herself into its every corner. This came at a very sad time. On the last day of March, the very same day that Roschen was confirmed, I received the ministerial decree of my dismissal.

At that time, I considered it a point of honor to conceal my feelings for Roschen...

So, I remained cold, even after my appointment had come, and yet I could not leave Berlin. When I finally saw that Roschen was day by day less and less able to hide her troubled feelings, when I saw that she was suffering, and dearly on my account, I could no longer restrain myself. On Monday I went there to say goodbye, and by noon we were in each other's arms.

That is how it happened. Much more could be said of the details...

So much for today. Next, I'll write to Mother, probably through Roschen.

Your,

Rudolf

“There was one item of great urgency to be attended to before the newly appointed professor left Berlin. Throughout his life, he was known for his lack of attention to schedules, and for leaving or arriving at the last possible instant. Affairs of the heart were no exception,” wrote Nuland.

As Erwin Ackerknecht writes,

In November 1849, Virchow left Berlin for Würzburg, becoming engaged on the day of his departure to Rose Mayer, a girl eleven years his junior. In his words, “the probably most decisive year of his life was over.” Through good luck and strength of character, he had avoided catastrophe that befell so many in this year. His life, never quiet, was now nevertheless to proceed in calmer channels. He was twenty-eight years of age and his apprenticeship was finished. He had overcome the handicaps of his lowly origins and had risen to a respected position. He had launched the Archives and formulated his basic scientific philosophy and program. If we summarize with von Recklinghausen his contribution in pathology in the four words thrombosis, embolism, cellular pathology, metaplasia, then two of his main contributions were already made. In Upper Silesia and in the revolutionary meetings in Berlin, his ideas on public health, epidemiology, self-government, and anthropology had crystallized. He was no longer alone; he had won a group of faithful and devoted friends. The storms of the revolution called forth only more strongly those personal traits that made him a leader of men, wherever he went.

Virchow married Ferdinande Rosalie Mayer in August 1850 in Berlin. “Rose considered her role to be that of helpmeet to the great man she had married. She nurtured no ambitions for herself save to smooth the path for him,” Nuland writes. “Very little has been written about her except that apparently no strains in her relationship with Virchow ever disturbed the

serene course of their marriage, or the stable home in which their three sons and three daughters were raised.”

Nuland continued,

Freed from political distractions, Virchow made his tenure in Würzburg the most productive period of his life. He was surrounded by a small group of able researchers, with whom he quickly proved his ability to work in harmony, even though he had criticized the work of several of them prior to joining their company. He was teaching himself English, which, with his ability to speak French, Italian, and Dutch, gave him a mastery of the five languages in which were written everything that was of any importance in contemporary science; his Greek, Latin, Hebrew, and Arabic were good enough to allow familiarity with older sources as well. Another inevitability was that the preeminence Rudolf Virchow had by this time attained in European science would ordain his being lured back to a professorship in Berlin. He had been sought out by other universities, but, happy and productive in the idyllic academia of Würzburg, he refused them all. The *gemutlich* collegiality of his fellow teachers and his separation from the prickles of politics calmed his natural pugnacity. He had three children and the most supportive of wives. In Würzburg, he had allowed himself to grow up. The Rudolf Virchow who in 1856 received the call to the Chair of Pathology in Berlin was a much wiser and more mature man than the fiery bridegroom whom the police of that city had tried to expel when he returned for his wedding six years earlier.

Würzburg
April 25, 1856

Dear Father,

I am sure you have long been waiting for more detailed news, and I must confess that my sloth alone is chiefly to blame. We arrived here safely on Sunday evening, and on subsequent days we had such lovely weather that we spent as little time as possible indoors. Everything is blossoming here: cherries, plums, pears, peaches, even apples are beginning. I have never seen such a magnificent spring here. The grain in some places is as high as 1 ½ ft., the meadows are of a magnificent fresh green, and it is so warm that the children are jumping around outside without coats. We begin our lectures only next Monday, so that there is still some time left for enjoyment.

But you must be looking forward to hearing more about Berlin than about our spring. I had to wait until Thursday morning for a talk with the authorized representative of the minister. On Friday evening I was granted an audience by His Excellency himself, and on Saturday morning I had the official letter of appointment in my hands. Now only the consent of the King is lacking, which may possibly be delayed due to the influence of the Minister of Finance or of some other minister. It was agreed to give me 2000

thaler as salary, to construct a new institute of pathology and to add another department to the Charité. In Berlin as well as here the decision has caused a great sensation; in Berlin, mainly because no one could understand how it was that none other than the Minister of Culture took me on without any conditions of a political nature; here, because they had not reckoned on so early a conclusion. It appears also that attempts will still be made here to change my mind. But this is out of the question as long as there is no possibility of problems arising in Berlin, to which I am not going to make any contribution. In any case, I will not move before autumn... Here everything is fine. Little Adele is recovering from her pox, and the boys look splendid. Best regards to Mother.

Your Rudolf

From the ebullient and heady tone in his letter, it was obvious that his abundant confidence had not waned. Nuland wrote:

He agreed to accept the post that was now so entreatingly offered, but he laid down conditions. If the University of Berlin was to have him back, it was to be on his own terms. A pathological institute must be built for him, in which the practical work of research and hospital pathology would be done. The building was rapidly erected, and Virchow returned in triumph to be recognized as the most influential figure in German medicine. From this time on, a trend which had been increasingly evident over the course of the previous decade became a fact—captured by Rudolf Virchow, the baton of medical leadership passed from France to the German-speaking countries. There it would remain until the early part of the twentieth century, when it was wrenched away by war and the ascendancy of American science.

In the next chapter, we will explore the path that Virchow created to lead him to be the “Father of Pathology.”

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CHAPTER THREE

CELLULAR PATHOLOGY

Virchow, the chief founder of modern scientific medicine... will rank for all mankind and for all time to come as one of the greatest figures in science... the establishment by Virchow of the principles of cellular pathology marked the greatest advance which scientific medicine had made since its beginning.

—William Welch, 1902

In his 1858 book, *Cellular Pathology*, he collected a series of lectures for practicing physicians in Berlin at the Institute of Pathology. The goal of the book was to provide:

A view of the cellular nature of all vital processes, both physiological and pathological, animal and vegetable, so as distinctly to set forth what even the people have long been dimly conscious of, namely the unity of life in all organized beings in opposition to the one-sided humoral [...] tendencies which have been transmitted from the mythical days of antiquity to our own.

“His influence in initiating an orderly study of tissues in various diseases by systematic autopsies and by rigorously examining histologic sections was crucial in allowing the development of a coherent, organized system for classifying and studying diseases. His basic approach is still applied,” wrote Byers. He emphasized the “application of histology to pathology to obtain a recognition of the fact that the cell is really the ultimate morphological element in which there is any manifestation of life.”

The history of medicine is ripe with examples of using ill-proven methods based on previous practices. Blood and bleeding had been the source of many theories that have directed human behavior. Galen, the ancient Greek physician and physiologist, wrote in his treatise *Mixtures*: “Blood is potentially flesh, as it requires only the smallest change in order for flesh to be produced.” Bleeding proved that women had the potential to conceive; blood was believed to form the baby and then nourish it in the womb. Hippocrates (ca. 460 BCE–370 BCE) is often given credit for the theory of the four humors that directly influence the body and its emotions—blood, yellow bile, black bile, and phlegm.

Sherwin Nuland, in his book, *Doctors: The Biography of Medicine*, writes,

Some of the systems-makers, the Exorcisers and Mystics, for example, plainly went beyond the constraints of orderly reason, but others, such as the Natural Philosophers and Humoral Pathologists, built their intellectual structure on objectively verifiable evidence that had been observed and studied by physicians for millennia. The members of the latter group were, in fact, heirs to the ancients' theory of the four humors, four humors now refined into a quasi-scientific formulation that sought the key to disease by postulating the existence of a set of hypothetical disordered body fluids. Although the nineteenth-century humoralists were possessed of far more facts than their long line of predecessors, they continued nevertheless to confound their interpretation of what they saw by using all the old errors of interpolation, extrapolation, and conjecture.

Miasma (μίασμα, Ancient Greek: "pollution") was described as a noxious form of "bad air" emanating from rotting organic matter. Considered to be a poisonous vapor or mist filled with particles from decomposed matter (miasmata), it was identifiable by its foul smell. The theory posited that diseases were the product of environmental factors such as contaminated water in marshes and standing water, foul air, and poor hygienic conditions. Such infections, according to the theory, were not passed between individuals but would affect those within a locale that gave rise to such vapors. If a fever arose from the bodies of the sick, it would be called contagion.

According to Nuland,

There was a single simple reason for the ignorance: in spite of every philosophical system that had ever been constructed, no one, but no one, knew for sure what caused disease. The Greeks had taught that a person gets sick because a combination of factors has gone askew, involving an interplay between one's basic nature, one's environment, and a set of external stimuli. Effective treatment, therefore, should consist of removing the insalubrious stimuli, and restoring the balance between the various factors. By the logic of this system, an entire individual gets sick, not just a part of him and not just an organ.

Let us step back in time and look at those researchers, busy and hard-working, who laid the groundwork for Virchow. All around were the miasmatic thoughts of miasmatic theorists who primarily blamed harmful, external forces for the diseases of man, hanging like a black cloud that hindered the scientific methods of objective researchers searching for visual and palpable answers to the diseases of man. We can witness how a funneling down in serious bodily disease investigation began, going from

the entire individual and his environment to organs, to tissues, to cells, beginning most prominently with Vesalius.

Andreas Vesalius (1514–1564), the Flemish anatomist and physician, was carried on the shoulders of Hippocrates and Galen before him. His work on the vascular and circulatory systems was considered his greatest contribution to modern medicine. Vesalius was the author of one of the most influential books on human anatomy, *De Humani Corporis Fabrica Libri Septem* (On the Fabric of the Human Body). He is often referred to as the founder of modern human anatomy.

As Roy Porter notes,

Since Vesalius, practitioners had pursued gross anatomy, and greater attention be the connexions between the sick person and the disease signs afforded by the corpse...The conviction that postmortem investigation was the key to the bodily changes brought about by disease (not least, cause of death) was largely due to Giovanni Battista Morgagni (1682–1771), professor of anatomy at Padua, who, aged almost eighty, published *De sedibus et causis morborum* (1761) [On the Sites and Causes of Disease].

Morgagni utilized his observations on some 700 autopsies to describe the effect of disease on bodily organs. *De sedibus* is one of the most fascinating works of medicine. Divided into five sections, it included diseases of the head, the chest, the abdomen, surgical conditions, and addenda in the form of seventy letters to friends. When I read the myriad and captivating case reports of Virchow in his book, *A Description and Explanation of the Method of Performing Postmortem Examinations in the Dead House of the Berlin Charité Hospital*, I could visualize Virchow fastidiously studying the comprehensive symptoms and autopsy results described in the case histories of Morgagni in *De sedibus* to use as inspiration for his own work.

As Porter notes,

Morgagni's discoveries were numerous. He described the anatomical phenomena observable in angina pectoris and myocardial degeneration, the fibrinous clots found in the heart after death, and the heart-block syndrome now termed Stokes-Adams. He associated cyanosis (blueness of the skin) with pulmonary stenosis (narrowing of vessels) and made major observations on arteriosclerosis of the coronary and cerebral arteries and hypertrophy of the heart in mitral stenosis. He pointed out that apoplexy or stroke was not caused by a lesion of the brain but by alteration in the cerebral blood vessels [...]. *De sedibus* shifted emphasis from symptoms to site. Thinking anatomically, he demonstrated that diseases were located in specific organs,

that symptoms tallied with anatomical lesions, and that such morbid organ changes were responsible for disease.

The prominent British physician-researcher Matthew Baillie (1761–1823) was handed Morgagni’s baton and ran with it. As Roy Porter writes, “Arranged by organs, Baillie’s *Morbid Anatomy of Some of the Most Important Parts of the Human Body* (1793) discussed the pathological changes caused by diseases. Working from autopsy evidence, Baillie confined himself to what he could see with his eyes without speculating on the ultimate causes of disease or bringing in symptom-based nosologies.”

Marie Francois Xavier Bichat (1771–1802) proposed to set medicine on a sound anatomical basis. His *Traité* and his *Anatomie générale* (1801) focused attention on structures comparable in texture but found in different organs. As Porter writes,

Bichat’s key innovation was the doctrine of tissues: he described twenty-one such membranes, including connective, muscle, and nerve tissue, distinguished by appearance and vital qualities. The most widespread were cellular tissue, nerves, arteries, veins, absorbent and exhalant vessels; these were found intermeshed in most other tissue systems. More restricted ones included skeletal muscle, involuntary muscle, gland, cartilage, bone, mucous and serous membranes. These, he proposed, should be the analytical building blocks of anatomy, physiology and pathology, rather as elements were in Lavoisier’s new chemistry, and he set about delineating their structure, properties, abnormalities and responsiveness. Bichat dismissed ‘souls’ or ‘vital spirits’ as metaphysical will-o’-the-wisps and avoided microscopes as machines of error. Tissues would provide a new map of the body, and henceforth diseases were to be lesions of specific tissues rather than simply of organs.

The vital properties of tissues formed the focus of Bichatian physiology. Bichat saw pathology with fresh eyes. “The more one will observe cases and open cadavers,” he wrote, “the more one will be convinced of the necessity of considering local diseases, not from the aspect of the complex organs (as with Morgagni) but from that of the individual tissues.” Bichat’s work laid the foundations for nineteenth-century patho-anatomy. In his most famous textbook, *Cellular Pathology*, Virchow argued that the study of disease should focus on cellular abnormalities and that cells arise only from other cells, disagreeing with the predominant theory of spontaneous generation.

Virchow’s observation was that a whole organism does not get sick and disease was limited to only certain cells or groups of cells. In 1855, at the age of 34, his now-famous aphorism “*omnis cellula e cellula*” (“every cell

stems from another cell”) was published, launching the field of cellular pathology. Virchow’s contention was that all pathology ultimately is cellular pathology and led to microscopically examining disease entities with more productive observations.

As Reese wrote in his book *Fundamentals: Rudolf Virchow and Modern Medicine*,

The power of his scientific approach became clear as one puzzle after another fell to his method. By the 1850s Virchow had become the preeminent physician scientist in Europe, and in recognition of his accomplishments, he finally was offered a professorship at the University of Berlin, his alma mater. Upon assuming the Chair of Pathology at the world’s leading school of medicine, Virchow was about to make his most important contribution to medical science: the idea that cells are the fundamental units constituting all tissues and organs, and that disease in the organism results when cells fail to perform their normal, specialized functions. The concept of cells as the building blocks of the organism and the locus of disease may seem self-evident to modern physicians and scientists, but it was revolutionary in mid-19th-century Europe. When cells are recognized as the essential components of life, no place remains for theories of disease relying on notions of evil humors, strange fluxes, disturbed animisms, or other supernatural explanations of illness.

As I volley back and forth between Porter, Reese, Nuland and others, you can note how public health, scientific discoveries and treatments at the time influenced all medical theories and clinical implementation, as it does during every era. In the case of Virchow, he also showed how contemporary notions of disease and clinical practice were deeply influenced by socioeconomic discrepancies and access to pertinent and helpful information. Late 18th-century diseases included yellow fever outbreaks that devastated major populations in Europe, America, and elsewhere, and the 19th century was a time in which myriad diseases arose such as tuberculosis, smallpox, measles, chickenpox, cholera, whooping cough, bubonic plague, and influenza. Little was known about disease transmission. No immunizations and limited medical remedies were offered. In modern times, we have had AIDS and Covid-19 which have been major killers that have created enormous societal upheaval and public health measures. No immunization exists for AIDS at the time of this writing.

Nuland wrote,

Perhaps they were simply too impatient; in the absence of information to fill the gaps in their knowledge, they demanded to understand things before their science had yet wrested from Nature enough of her secrets. Among the

believers in the systems of Natural Philosophy, Humoral Pathology, and several other of the sects were some of the century's most prominent students of biology and medicine. They were gifted, they were attentive, and they were genuine in intent; their error was in leaping before enough looking had made it possible to step safely from one verifiable point to the next.

Virchow's major research emphasis was that diseases needed to be observed both by the patient's symptoms and by searching for what cells or groups of cells had become sick. He rejected the theory of spontaneous generation which posited that cells and organisms could arise from inanimate matter. During Virchow's microscopic studies, he devised the major tenets of his cell theory. He observed cells dividing into two equal parts and ascertained that all living things are made of one cell or more and that cells are the basic units of life. One of Virchow's famous phrases was "The task of science is to stake out the limits of the knowable, and to center consciousness within them."

Virchow followed the work of the botanist Matthias Schleiden and physiologist Theodor Schwann, both working in Germany. As Porter notes,

Modern cell theories began in botany. The Jena botanist Matthias Schleiden (1804–81) declared that plants were aggregates of cells, existing as self-reproducing living units. Exploring analogies between animals and plants in structure and growth, Schwann took up this idea maintaining that all these phenomena could also "be demonstrated animal structures": living cells were basic to living things.

Although his father was the municipal physician of Hamburg, Schleiden pursued legal studies at the University of Heidelberg in Germany. He graduated in 1827 and established a legal practice in Hamburg. After a period of emotional depression and attempted suicide, he changed his profession. He began his studies in natural science at the University of Göttingen in Germany, but in 1835, he transferred to the University of Berlin in Germany, to study plants.

Schleiden worked in the laboratory of zoologist Johannes Müller, where he met Theodor Schwann. Both Schleiden and Schwann studied cell theory. Together they focused on phytogenesis, the origin and developmental history of plants, with a common goal of finding organisms common to the animal and plant kingdoms. With their collaboration and success, Schleiden and Schwann helped give rise to the foundations of cell theory based on the theory that all living organisms were built out of structures called cells.

Theodor Schwann (1810–82), famous for discovering the enzyme pepsin and the use of microorganisms in putrefaction, posited that new cells were formed out of blastema in embryological development and in certain

pathological situations such as inflammation or tubercle formation. Similar possibilities were proposed by Carl von Rokitansky (1804–78), a pathological anatomy master who reportedly performed 60,000 autopsies over his career. As Porter notes,

He speculated that conditions affecting the blood sometimes caused the blastema to spawn abnormal cells, leading to disease. He developed a neo-humoralism which held that diseases originated in an imbalance of protein substances such as fibrin and albumin in the blood. This was partly to explain the awkward fact that autopsy often revealed no evident gross pathological changes sufficient to account for death.

The theories appeared in Rokitansky's *Handbuch der pathologische Anatomie* (1846) [Handbook of Pathological Anatomy], and made blastema theory the cornerstone for a comprehensive haemato-humoral pathogenesis.

Timeline

- Mathias Schleiden – (German botanist – 1804-1881)
 - all plants are made of cells
- Theodor Schwann (German zoologist – 1810-1882)
 - all animals are made of cells
- Rudolf Virchow (German physician – 1821-1902)
 - concluded that all cells come from other cells

Figure 10: Schleiden, Schwann, and Virchow. www.slideshare.net

Along with Robert Remak (1815–65), Virchow distrusted all such ideas and maintained that cells always arose from pre-existing cells through cellular division. Virchow soon abandoned blastema theory altogether and asserted that “there is no life but through direct succession,” and created his potent aphorism: *omnis cellula a cellula* (each cell from a cell). “All cells

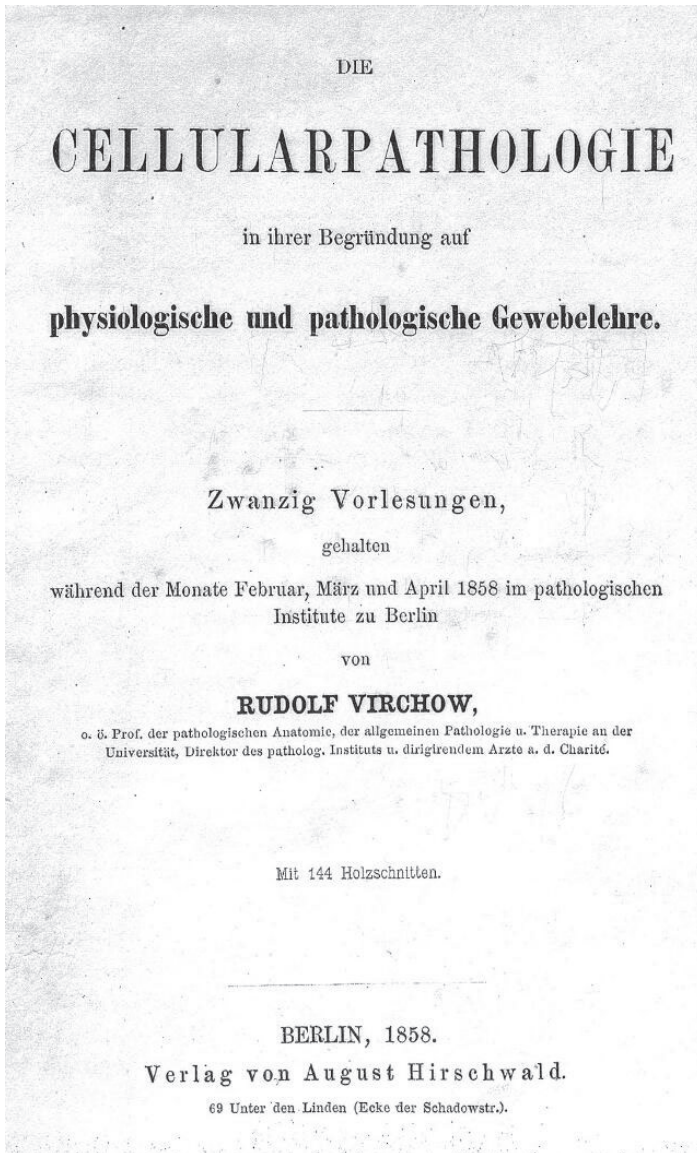


Figure 11: Cellular Pathology. Welcomecollection.org

were multiples of one original; back through an ancestral line, life was a hereditary succession of cells. Drawing a pointed political analogy, cells lived in what Virchow called a ‘cellular democracy’ or ‘republic of the cells’,” wrote Porter.

Having been forced from Berlin following his courageous support for the 1848 liberal revolution, Virchow’s exile to Würzburg allowed a seven-year concentrated devotion to the study of cells. He formulated his theories that cells explained pathology and diseases and came from abnormal changes within cells, and abnormal cells subsequently multiplied through division. Diseases were the result of disturbances in the body’s cellular structures and cell analysis was fundamental to the understanding of tumor formation and cancer metastasis. Virchow approached the cell as the sun of the scientific universe, the basic building block in all of life and disease that all else revolved around. “Morgagni had highlighted the organ, Bichat the tissue; Virchow had now given pride of place to the cell,” Porter wrote.

Each generation built on the previous one, and each researcher strived to make a mark in the world of science and medicine. The constraints of the particular time, the limits of nature, and the energy and inventiveness of the individual researcher, parameters true in every moment in history, combine to create the possibilities of discovery.

Nuland wrote,

A major element in the confusion was everyone’s attempt to create some sense of order out of the burgeoning clutter of observations that scientific-minded investigators were then pouring into the increasingly chaotic storehouse of knowledge [...]. The proponents of each system thought that theirs would prove to be the eventual edifice of healing, by which the storehouse of knowledge might become the stately mansion in which medical science would dwell.

George Washington, the retired commander-in-chief, woke up at 2 a.m. at his Mount Vernon home in Fairfax County, Va., on 14 December 1799, with a sore throat and difficulty breathing. Three doctors were summoned to attend to the 67-year-old. A series of medical procedures followed in rapid succession, including the draining of nearly 40 percent of his blood. The application of a painful “blister of cantharides,” better known as “Spanish fly,” to Washington’s throat, was used based on “counter-irritation,” a notion of medicine dating back to antiquity. Blisters raised by the toxic irritant would theoretically draw out the deadly humors that had brought on the throat inflammation. Washington died that evening. Controversy continues as to the exact etiology of the sore throat and

subsequent breathing issues, but it appears that the drastic measures taken certainly did not help to improve the General's health.

Nuland wrote,

No matter the sophistication of Laennec's method of physical examination or Hunter's understanding of inflammation and injury, neither of them had very effective therapy to offer the sick people who came to them for a cure. When they chose weapons from their therapeutic arsenals, they had to fall back on vague concepts of humors, fluxes, and altered states of irritability. Much of what they offered was based on some uncertain attempt to restore an ill-understood balance that had become jangled. They bled their patients, and they puked them and purged them and blistered them as their professional forefathers had always done; they confused the metabolisms of the sick with dazzling combinations of botanicals whose real actions were only partially known, and often not known at all. They stimulated in cases whose cause was thought to be too little excitation, and they tried to introduce a touch of torpor when the opposite was the case. In short, except when the need for amputation or lancing was obvious, the healers didn't really know what they were doing.

Nuland continued,

This was the underlying difficulty which the physicians of the mid-nineteenth century still faced. The ultimate seats, or sites, of disease had not yet been localized; in what elemental structure, whether solid or fluid, does the very first thing go wrong? How does that first thing result eventually in the visible abnormalities that the new generation of pathologic anatomists were describing in increasing numbers of autopsies? Only when that initiating site had been identified would research be able to turn its attention away from conjecture, and toward the problem of specific therapy for a specific process.

The previous paragraphs were filled with verbal foreplay for the upcoming historical climax. Where is Virchow in all this? Wait for it... Nuland wrote,

To one scientist goes the credit of tracking down that elusive focus, that basic unit in which disease begins. That focus is, of course, the cell, and it was the supreme accomplishment of the German pathologist Rudolf Virchow that he discovered not only that the cell is the basic unit of disease, but also that it is the basic unit of health, and of life itself.

And here Nuland sets the record straight. He explains how Virchow created the springboard for medicine to go forward using pattern recognition

and rational scientific methods. Virchow rejected the Romantic concept that disease was a “living entity.” He correlated disease symptoms with cellular effects and reaffirmed his morphological approach to pathology.

Once the cell theory took hold, there was no longer any need to speculate about altered body fluids, over- or under-supplies of irritability, or the effects of ill-defined stimuli. After Virchow, it was time to study the events that go on in a cell by which it maintains healthy life, what is called its normal physiology. Once that was understood, the cell’s alterations in disease, its *pathologic* physiology or pathophysiology, could be elucidated. Pathologic physiology, and therefore disease, becomes thus reducible to a set of disordered bio chemical phenomena susceptible to correction by highly specific therapeutic agents, or by the extirpation of the groups of cells, tissues, or organs in which the pathological event is occurring. That is the basis of twentieth-century medicine. It is the legacy left to us by Rudolf Virchow.

Virchow was part of an important team that was tackling the problems of disease and helping to eradicate the miasma theory. As noted earlier, miasma was the belief that a poisonous vapor or mist made up of particles from decomposing material could cause disease and was identified by its foul smell. The miasma theory of disease originated in the Middle Ages and persisted for centuries. During the Great Plague of 1665, some buildings and swamps were drained to get rid of the bad smells. Using only bad smell as an indicator of disease failed in the winter and rigorous sanitation was lessened. Still popular in the 1800s, miasma led to the “Bad Air theory” (lethal agents traveling by air) that lasted until the 1860s and 1870s and prevented many doctors from adopting new practices like washing their hands between patients.

If malaria was from bad air, what was the derivation of the bad air? The big debate in science was between contagionism and anti-contagionism. Where did Virchow fall in this spectrum of ideas? How do you then ascertain the etiology of something like cholera that required no direct contact? As noted in many primary medical sources of the time, cholera killed thousands throughout the world and filled the beds of the few established hospitals. Bleeding and purging, along with a myriad of other odd treatments such as nicotine injections, for cholera patients already nutritionally depleted and severely dehydrated, resulted in disaster.

As with many times of destruction and disease, we humans do attempt to learn and improve. The miasma theory provided some correlation between dirtiness and disease and the encouragement of cleanliness paved the way for public health reform. We still fight bad air (pollution and climate change) but we understand more specifically how it affects our breathing

and overall health. In addition, the miasma theory kindled the interest of Virchow and other scientists in analyzing decaying matter, eventually leading to the identification of microbes as agents of infectious disease.

Next, we will explore the scientific medicine of the nineteenth century and include a few of the scientific luminaries from previous years.

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CHAPTER FOUR

SCIENTIFIC MEDICINE OF THE NINETEENTH CENTURY

Step back to Soho, London, England in the year 1854. John Snow (15 March 1813–16 June 1858) was in hot pursuit of the source of a cholera outbreak. Already an established leader in the development of anesthesia and medical hygiene, he was fast becoming a founder of modern epidemiology. Snow was caught between two periods of time, the long-standing theory of miasma and noxious forms of “bad air,” and germ theory, which had not yet been developed. Being a skeptic of the then-dominant miasma theory that was believed to contribute to diseases such as cholera and bubonic plague, he relied on the most fundamental of scientific virtues—observation of the evidence. He did not understand the mechanism by which disease was transmitted and even with a detailed microscopic and chemical examination of a water sample from the Broad Street pump, he was unable to be sure of the source of the disease. Snow discounted miasma as he created a dot map that traced the source of a cholera outbreak and also used statistics to highlight the connection between the water quality of the water source and the eruption of cholera cases. He convinced the local Vestry (the people responsible for the poor of the parish), to remove the handle of a water pump located on Broad Street which he maintained, with his scientific acumen, allowed access to what he considered among the most virulent contaminated waters. The Reverend Henry Whitehead had extensive knowledge of the local community and helped Snow discover the geography and etiology of the cholera outbreak.

Snow wrote:

On proceeding to the spot, I found that nearly all the deaths had taken place within a short distance of the [Broad Street] pump. There were only ten deaths in houses situated decidedly nearer to another street pump. In five of these cases, the families of the deceased persons informed me that they always sent to the pump in Broad Street, as they preferred the water to that of the pumps which were nearer. In three other cases, the deceased were children who went to school near the pump in Broad Street.

With regard to the deaths occurring in the locality belonging to the pump, there were 61 instances in which I was informed that the deceased persons used to drink the pump water from Broad Street, either constantly or occasionally.

The result of the inquiry, then, is that there has been no particular outbreak or prevalence of cholera in this part of London except among the persons who were in the habit of drinking the water of the above-mentioned pump well.

I had an interview with the Board of Guardians of St James's parish on the evening of the 7th [7 September] and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed on the following day.

Many of the infected wells were taking water from sewage-polluted sections of the Thames. Snow's findings were among the first steps in improving the water and waste systems of London and improving general public health around the world. He first published his theory in an 1849 essay, *On the Mode of Communication of Cholera*, and followed with a more detailed treatise in 1855 that included his investigation of how he pinpointed the disease-containing wells in the 1854 Soho epidemic.

Although Snow was convinced of the proof that cholera was water borne, a significant percentage of the world did not abandon its tight hold on miasma. A much bigger study based on similar principles of Snow's groundbreaking study, and a further epidemic in 1866, provided more convincing evidence. Snow would not witness the fruits of much of his labor. He died in 1858 at the age of 45.

Just as Snow could not identify a pathogen in London's drinking water but formulated a cogent and successful theory, the Hungarian obstetrician Ignaz Semmelweis (1818–1865) and his insistence on hand washing was based on acute observation. As authors K. Codell Carter and Barbara Carter wrote,

Medical advances are purchased by two kinds of sacrifice: the sacrifice of researchers trying to understand disease and the sacrifice of patients who die or are killed in the process. [One] particular advance was purchased, in part, by the sacrifice of hundreds of thousands of young women who died, following childbirth, of a terrible disease known as childbed fever, a disease that was rampant in the charity maternity clinics of the early nineteenth century.

Prior to the discovery that harmful microorganisms were the causes of disease, other physicians and public health officials had espoused the value of cleanliness in preventing infection.

In 1847, while working in Vienna General Hospital's First Obstetrical Clinic, Ignaz Semmelweis proposed the practice of washing hands with a chlorinated lime solution. He noted that the doctors' wards had three times the mortality of midwives' wards and that physicians routinely worked on cadavers before examining patients or delivering babies. He observed that puerperal fever was rare among women who gave birth at home or in the streets, and he proposed that harmful particles of some kind were being passed on from the cadaver to the women. He instructed the hospital staff to religiously wash their hands in chlorinated disinfecting solution before touching the pregnant women. With his supervision, the number of deaths dramatically decreased to below one percent.

Semmelweis was most recognized for his early systematic studies. He published a book of his findings in *Etiology, Concept and Prophylaxis of Childbed Fever*.

Although the results of his work were quite convincing that hand washing reduced mortality, Semmelweis's observations were often rejected by the established scientific and medical community of the time. Semmelweis reportedly suffered a nervous breakdown instigated by the verbal abuse of his colleagues based on the absence of an acceptable scientific explanation for his findings. He was committed to an asylum and was beaten viciously by the guards. He died two weeks later from a gangrenous wound on his right hand. Only years after his death, following the work of Louis Pasteur and Joseph Lister, did Semmelweis's practice earn widespread acceptance.

Virchow disagreed with Semmelweis. Ackerknecht wrote,

Virchow has been justifiably blamed for not recognizing the merits of Semmelweis' great 1847 discovery and for having stuck to outmoded climatic and predisposition theories of puerperal fever. In all fairness, it must nevertheless be stated that Virchow shares this blame with 99.99 per cent of his medical contemporaries and that his own personal role in blocking the spread of Semmelweis' discovery was extremely small.

Ackerknecht wrote,

These episodic attitudes should not be taken as Virchow's total outlook on bacteriology. If we continue here our scrutiny where we left off, we find him in the 1880s in his medical report on an Egyptian archeological expedition as "germ conscious" as any child of the period. He praises his experiences with Listerism and tells of observing dysentery amoebas (under the guidance of Kartulis) and fly transmission of infectious conjunctivitis. In Moscow in

1897, he calls the knowledge of bacteria, as compared to the knowledge of cells, “another, not less, *perhaps even more important* product of the scientific endeavors of our times.” Half of his Huxley lecture of 1898, ‘Recent Progresses in Science and Their Influence on Medicine and Surgery,’ is devoted to a positive review of the achievements of bacteriology. He emphasized the “immortal merits, the stupendous success” of Pasteur’s work that have “opened new avenues to medicine and technology.” He praised Koch’s discovery of the cholera and tuberculosis bacilli. Virchow’s last great medical address at the International Medical Congress in Paris in 1900 on “Traumatism and Infection” fully appreciates the role of bacteria, especially in osteomyelitis.

In his book *The Evolution of Modern Medicine*, Sir William Osler wrote,

Each generation has its own problems to face, looks at truth from a special focus and does not see quite the same outlines as any other. For example, men of the present generation grow up under influences very different from those which surrounded my generation in the seventies of the last century, when Virchow and his great contemporaries laid the sure and deep foundations of modern pathology. Which of you now knows the ‘Cellular Pathology’ as we did? To many of you, it is a closed book, to many more Virchow may be thought a spent force. But no, he has only taken his place in a great galaxy. We do not forget the magnitude of his labors, but a new generation has new problems, his message was not for you, but that medicine today runs in larger molds and turns out finer castings is due to his life and work. It is one of the values of lectures on the history of medicine to keep alive the good influences of great men even after their positive teaching is antiquated. Let no man be so foolish as to think that he has exhausted any subject for his generation. Virchow was not happy when he saw the young men pour into the old bottle of cellular pathology the new wine of bacteriology.

Virchow, like many people of amazing appetites and conviction, had his own strong feelings and disagreed with certain ideas of many researchers of his time, perhaps most famously, Charles Darwin. Over a long life, he was able to re-examine many of his previous assertions and often modified his assumptions. I will explore this further in my chapter on anthropology.

In 1864, Louis Pasteur (1822–1895), established that specific diseases are caused by specific microbes, rocking the world of science. In today’s times, we know the importance of clean water, use various antibiotics to treat disease, wash our hands to prevent the spread of infection, and hopefully follow an immunization regimen throughout our lives. We owe a debt of great gratitude to the pioneering research of the French chemist and microbiologist Pasteur who discovered microorganisms as the etiology of

many diseases, leading to the causes and preventions of many illnesses and the germ theory of disease.

Among his many accomplishments, Pasteur created a vaccination for rabies. He also showed that heating of food and drink to a specific temperature for a period of time destroyed microbial growth. Pasteurization is named after Louis Pasteur, who in the 1860s, demonstrated that abnormal fermentation of wine and beer could be prevented by heating the beverages to about 57°C (135°F) for a few minutes.

Although Pasteur was certainly a scientific star who revolutionized medicine and public health, he was not the first person to suggest that disease was caused by invisible creatures. In 36 B.C., the Roman scholar Marcus Terentius Varro published a warning for people living too close to swamps, “because there are bred certain minute creatures which cannot be seen by the eyes, which float in the air and enter the body through the mouth and nose and cause serious diseases.”

Joseph Lister (1827–1912), a British surgeon and medical scientist, was the founder of antiseptic medicine and a preventive medicine pioneer. The abiding principle of Lister—that harmful bacteria must never be allowed to gain entry into any operation wound—remains true in the world of surgery today. Lister dramatically decreased postoperative infections by using carbolic acid, now called phenol, to sterilize wounds and surgical instruments. *The Butchering Art* is a book that explores in detail the convergence of science and medicine and the dogmatic pursuit of life-saving answers by Lister that led to the discovery of antiseptics. The writer Erik Larson noted,

In *The Butchering Art*, Lindsey Fitzharris becomes our Dante, leading us through the macabre hell of nineteenth-century surgery to tell the story of Joseph Lister, the man who solved one of medicine’s most daunting and lethal puzzles. With gusto, Dr. Fitzharris takes us into the operating theaters of yore as Lister awakens to the true nature of the killer that turned so many surgeries into little more than slow-moving executions.

Fitzharris wrote,

In the 1840s, operative surgery was a filthy business fraught with hidden dangers. It was to be avoided at all costs. Due to the risks, many surgeons refused to operate altogether, choosing instead to limit their scope to the treatment of external ailments like skin conditions and superficial wounds. Invasive procedures were few and far between, which was one of the reasons why so many spectators flocked to the operating theater on the day of a procedure. In 1840, for instance, only 120 operations were performed at Glasgow’s Royal Infirmary. Surgery was always a last resort and only done in matters of life and death.

In addition to infection and filth, surgery was often unbearably painful. Although in 1772, the chemist Joseph Priestley first synthesized nitrous oxide (“laughing gas”) and it could be effective for pain relief, it was not often used in surgery due to unreliable results at that time in history. Eventually, the unimaginable agony of surgery would be diminished by new advances in anesthesia.

Fitzharris wrote that the physician Thomas Percival,

advised surgeons to change their aprons and to clean the table and instruments between procedures, not for hygienic purposes, but to avoid ‘everything that may incite terror.’ Few heeded his advice. The surgeon, wearing a blood-encrusted apron, rarely washed his hands or his instruments and carried with him into the theater the unmistakable smell of rotting flesh, which those in the profession cheerfully referred to as ‘good old hospital stink.’ At a time when surgeons believed pus was a natural part of the healing process rather than a sinister sign of sepsis, most deaths were due to postoperative infections. Operating theaters were gateways to death. It was safer to have an operation at home than in a hospital, where mortality rates were three to five times higher than they were in domestic settings. As late as 1863, Florence Nightingale declared, ‘The actual mortality in hospitals, especially in those of large, crowded cities, is very much higher than any calculation founded on the mortality of the same class of diseases amongst patients treated out of the hospital would lead us to expect.’ Being treated at home, however, was expensive.

Working in Paris and India in the 1890s, Waldemar Mordecai Haffkine created the world’s first vaccines for cholera and plague. “What is remarkable, and is often lost in the story, is that after the initial resistance, people began to queue in the slums in Calcutta for Haffkine’s cholera vaccine; they queued for the whole day,” said Professor Pratik Chakrabarti, the Chair in History of Science and Medicine at the University of Manchester. “He would spend hours and whole days in those slums working with Indian doctors. He would start vaccinating in the morning before people went to work, and continue after they came back in the evenings, sitting by an oil lamp in the slum.”

The laborious, painstaking and detailed analysis that led to germ theory helped to put nails in the coffin of miasma theory.

Here I want to include a few important items that have been under-reported in many of the papers and books I have read about Virchow and other scientists of the 19th century. As with other major technical discoveries, how can we measure the importance of the microscope in Virchow’s trained and prepared hands? The microscope represented a convergence of physics,

pathology, and medical application and was a tool for enormous accomplishments by Virchow and his students.

The first compound microscopes (using more than one lens) dated to as early as 1590 and were an advantage over most single magnifying lenses or glasses. The word “microscope” first appeared in print in 1625. The microscope provided no noted scientific breakthrough until 1661 when Marcello Malpighi discovered capillaries in the dried lung of a frog, work impossible without a microscope.



Figure 12: Robert Hooke.
Britannica.com.

Published in 1665, Robert Hooke’s famous book *Micrographia*, filled with tiny illustrations of “microscopic” creatures, improved the reputation and the importance of the new technology for direct observation of previously unseen organisms and objects. Hooke also coined the word “cell” for the structures he discovered in cork bark.

A bit about Hooke needs to be included. In Stephen Inwood’s wonderful book, *The Forgotten Genius: The Biography of Robert Hooke 1635-1703*, he begins with, “As Isaac Newton said in a famous letter to Robert Hooke, most of what each of us achieves is built upon the work of others.” Perhaps not in temperament or personality, but in terms of varied interests and occupations, Hooke and Virchow had much in common. Hooke worked as a scientific researcher, astronomer, geologist, Professor of Geometry, architect and surveyor, author, Curator to the Royal Society, public health administrator, and at a variety of other tasks.

Dutch naturalist Antoni van Leeuwenhoek (1632–1723) worked as a draper in his youth, founded his own shop in 1654 and became well known in municipal politics. He developed an interest in lens making, and in the 1670s, he started to explore microbial life through his microscope. His work on the microscopic discovery of microorganisms (animalcule) was one of the notable achievements of the Golden Age of Dutch exploration and discovery (c. the 1590s–1720s).

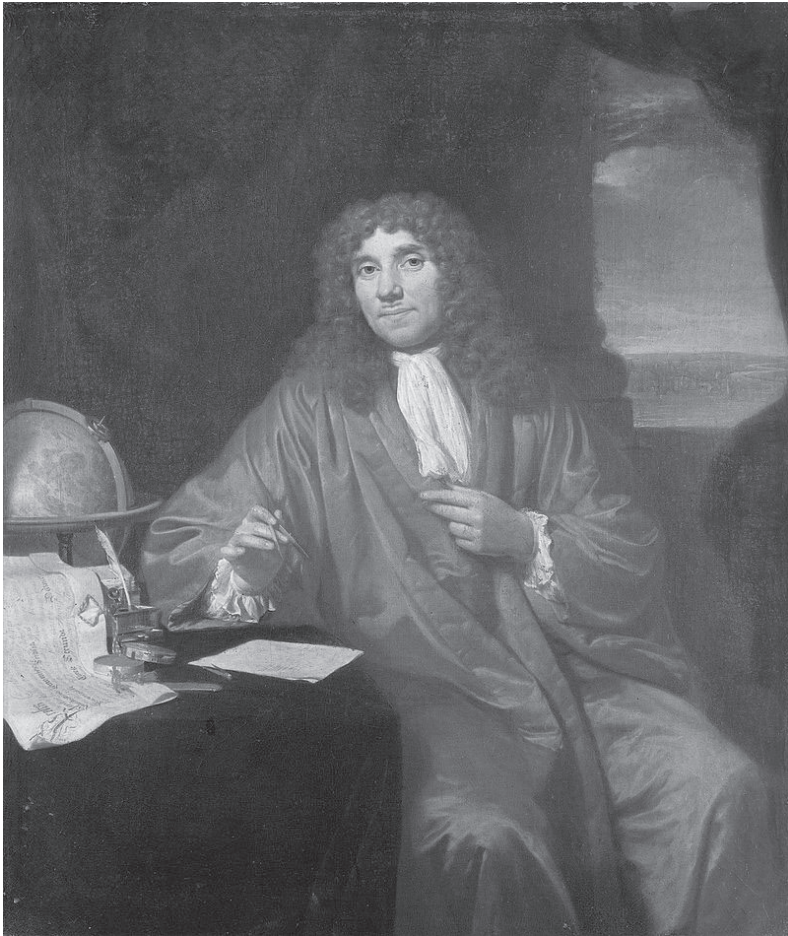


Figure 13: A portrait of Antonie van Leeuwenhoek (1632–1723) by Jan Verkolje.
<http://www.rijksmuseum.nl/collectie/SK-A-957> (public domain)

Porter wrote,

Paris teachings turned the morgue into a shrine. Another site of medical worship emerged, challenging and to some degree supplanting the hospital as the hub of discovery: the laboratory. By 1850, laboratories were creating a new physiology and pathology and beginning to reshape medical education. Laboratory medicine was of course not new, it went back at least to the seventeenth century, but nineteenth-century laboratory lions prided themselves on creating a distinct scientific medicine based on microscopy, vivisection, chemical investigations and everything else measurable, weighable and testable in its uniquely controlled environment.”

Although the hospital was fine for observing, the laboratory was tailor-made for experiments. The stethoscope was thus challenged by the microscope, whose improvements ushered in a new discipline, histology, which bridged anatomy and physiology.

“Learn to see microscopically,” Rudolf Virchow told his pupils and insisted that “experiment is the final and highest court of pathological physiology, for experiment alone shows the specific phenomenon in its dependency on specific conditions, for these conditions are arranged by choice.”

Joseph Jackson Lister (1786–1869), the father of the illustrious surgeon, produced an instrument in 1826 with a far superior high magnification. In Germany, “microscopy was most warmly welcomed, spurring the new cell biology and pathology which were quite unthinkable without it. Though German lens making initially lagged, in 1846, Carl Zeiss (1816–88) established his workshop in Jena, and within half a century, the firms of Zeiss and Leitz had achieved industrial supremacy. Before long, Germany was envied for its instruments, which became cheaper and simpler to handle, and thus were suitable for student use,” Porter writes.

Another scientific trailblazer was Jacob Henle (1809–85), one of Johannes Müller’s many proteges. He held anatomy chairs successively at Zurich, Heidelberg and Göttingen. Henle’s three-volume *Handbuch der systematischen Anatomie des Menschen* (1866–71) [Handbook of Systematic Human Anatomy] addressed the body from an architectural standpoint and described its macro- and microscopic structure.

Porter wrote,

As the discoverer of the tubules of the kidney, and the first to describe the muscular coat of the arteries, the minute anatomy of the eye and various skin structures, Henle gained a name as the Vesalius of histology, but his real importance was as an educator. He was among the first to make the microscope a tool used by students themselves, thus pointing to experimental physiology as central to medical training.



Figure 14: Virchow looking through a magnifying glass.
gettyimages.com

And what about all the other processes that accompanied the rise of microscopy? Porter commented that,

Expert fixing of tissues, to render specimens permanent and highlight their parts, was established by about 1870, while color-staining was standard by 1880; sectioning of specimens was achieved soon after, and formaldehyde was introduced in 1893. Together, these provided the necessary preparative techniques. Even so, the practical challenges facing microscopists demanded great skill and patience.

In his *Collected Essays on Public Health and Epidemiology*, Virchow wrote:

I certainly do not contest the right of researchers in pathology to direct their strivings to the *sedes morbi* as the anatomical basis of disease. Least of all would I question that it is correct to give diseases anatomical designations according to their position. But I cannot say that I consider this sufficient. Although our new medicine is most of all indebted to pathological-anatomical research, I have always held the view that this did not meet all requirements. Pathological-anatomical studies are not the only means of knowledge.

Let us examine how investigation has to be conducted. Scientific considerations must always be based on anatomy, no matter whether judgments are made at the bedside or at the autopsy table, because processes, functions, also relate to an anatomical basis. Every kind of change that we perceive occurs in a certain given part of the body; it is not present in the body everywhere in a generalized way, but at some spot, in a definite location. There it has its site; and from there it spreads. May the changes be ever so physiological and living, we yet have the obligation to refer them to a certain part of the body, to localize them in a certain focus of effectiveness. In this sense, I believe, the postulate of an anatomical basis does not mean that the sole basis for medical knowledge should be founded on results of pathological-anatomical studies. The clinician, too, must base himself on an anatomical foundation if he wants to think physiologically. However, he frequently does this only contemplatively, only in the mind, but not in reality, as does the pathological anatomist. We may require that processes in the anatomical sector should be studied physically or chemically, but the first requirement will remain that every physician should think anatomically and that he should investigate where the disease is localized.

I believe most physicians can agree with Virchow's concern. If I receive a biopsy report on one of my patients, I always try to correlate it with my clinical findings and question whether the results fall in line with what I am observing. Perhaps most of all, I am concerned with how the pathology fits in with the overall, organic nature of what is going on with my patient.

Rudolf Virchow was a major force in uniting the experimental medicine of his time with the clinical practice of physicians. When his views on the cell—the center of all pathological changes—took center stage, medicine underwent a paradigm shift in thinking about disease etiology. Virchow’s punctilious approach to both clinical and microscopic tissue observations was a springboard for today’s most successful scientific discoveries.

Next, we will explore how Virchow modified and standardized one of the most important procedures of pathology—the autopsy exam.

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CHAPTER FIVE

AUTOPSY

For those fans of TV crime shows, where an autopsy appears in almost every episode, you will gain a greater understanding of the importance of the autopsy and the role of Rudolf Virchow.

In the translator's preface of *A Description And Explanation Of The Method Of Performing Postmortem Examinations In The Dead House Of The Berlin Charité Hospital* (1880) by Rudolf Virchow (Author), T. P. Smith (Translator) wrote:

In the following work, Prof. Virchow gives some account of his early experience as Prosecutor in the dead house of the Berlin Charité Hospital, and traces the subsequent development, under his auspices, of a systematic method of conducting postmortem examinations. Lest the length of the notes should seem excessive, Prof. Virchow expressly states that three hours are sufficient, even for complicated cases. It will be obvious, on referring to the details, that only by following out a systematic plan could a thoroughly complete examination be performed in that time. Such an examination, however, would be infinitely more satisfactory than one in which important points were overlooked, and discovered only on subsequent investigation.

Virchow also includes the German Government Regulations for the guidance of medical jurists in performing postmortem examinations for legal purposes and his comments. In his introduction Virchow wrote:

On taking up my appointment, in the year 1844, assistant to Robert Froriep, the Prosecutor at the Charité, I found that the autopsies were at that time somewhat irregularly and unmethodically performed. The Prosecutor himself made but few examinations, and these only by special requisition; the greater number were performed, without any technical plan, by the Charité surgeons—young medical men, subsequently styled "assistants," who had not yet passed the State examination. No minutes of the proceedings were made at the time, and only when the examination was over were notes taken down from memory. Froriep himself but very rarely gave a course on postmortem examinations; he did so only once during my experience. Notwithstanding his eminent scientific attainment and great manual dexterity,

there was but little thoroughness in Froriep's method; in many respects, indeed, it was so ill-adapted for the purpose, that it was a matter of difficulty to make any discoveries by its means.

Virchow pointed out an example of Froriep's longitudinal dissection of the spinal cord. Although it took great practice and care and made for a very elegant section, it had very little use. Froriep's focus was on the nerve membranes and roots and "the commonest and most important alterations in the white substance remained unnoticed." Virchow wrote:

I therefore had a double task to perform, especially after I became Prosector in 1846. On the one hand, I aimed at causing the autopsies to be made by one person, at introducing a system of regular note-taking, and of collecting these notes in order to obtain a useful series of reports. This was a matter of no great difficulty, after many startling incidents had shown how thoroughly erroneous were the results obtained in the absence of technical skill. It very soon happened that every clinical teacher and class director became interested in the fact that the postmortem examinations were made by my hand. When, in the year 1849, I accepted the call to Würzburg, I left behind me a large collection of reliable reports. Unfortunately, only a few fragments of these were forthcoming when I was recalled to the Charité in 1856.

Virchow's description and explanation of performing postmortem examinations would not be complete if I did not take the liberty of providing a sense of what one's senses must have experienced in the dead house. I choose to include the description offered by Fitzharris, as I believe it sets the scene in a most illustrative way.

Unlike today, students could not escape the dead during their studies and often lived side by side with the bodies they dissected. Even those who did not live immediately adjacent to an anatomy school carried with them reminders of their gruesome activities, because neither gloves nor other forms of protective gear were worn inside the dissection room. Indeed, it was not uncommon to see a medical student with shreds of flesh, gut, or brains stuck to his clothing after his lessons were over. The cadaver tested the courage and composure of anyone who dared set foot inside the dead house.

Dr. David Hayes Agnew (1818–1892) wrote *The Principles and Practice of Surgery*, a three-volume set that he published from 1878–1883, covering fifty years of medical experience. The famous painting, "The Agnew Clinic" by Thomas Eakins (1889) depicts Agnew conducting a mastectomy operation before a gallery of students and doctors.



Figure 15: A group of doctors in training in the late 19th century examine a dissected human body laid out on a wooden table. [gettyimages.com](https://www.gettyimages.com)

Agnew wrote, “What a charming task, to sit quietly down in the apartment and take apart this masterpiece of workmanship; to call each piece by its proper name; know its proper place and work; to wonder over the multitude of organs pressed together, so diverse in operations, yet each executing its appointed task in the grand confederation.”

In his book *The Emperor of all Maladies*, Siddhartha Mukherjee wrote about the Scottish physician John Bennett, who in 1845 described an unusual case of a twenty-eight-year-old slate-layer with splenic swelling:

He is of dark complexion, usually healthy and temperate; [he] states that twenty months ago, he was affected with great listlessness on exertion, which has continued to this time. In June last he noticed a tumor in the left side of his abdomen which has gradually increased in size till four months since, when it became stationary.

As Mukherjee wrote,

the patient’s constitutional troubles only accelerated. Over the next few weeks, Bennett’s patient spiraled from symptom to symptom—fevers, flashes of bleeding, sudden fits of abdominal pain, gradually at first, then on a tighter, faster arc, careening from one bout to another. Soon the slate-layer was on the verge of death with more swollen tumors sprouting in his armpits,

his groin, and his neck. He was treated with the customary leeches and purging, but to no avail.

When performing the autopsy a few weeks later, Bennett was convinced that he had found the etiology of the wretched disease—blood filled with white blood cells led to a pus-filled overwhelming infection within the vascular system. Despite meticulous investigation, he could not find the source of the pus and simply called the case “A suppurating of blood.” As Mukherjee points out, although the link between microorganisms and infection had not yet been established, Bennett was aware that pus-filled wounds could lead to sepsis and death.

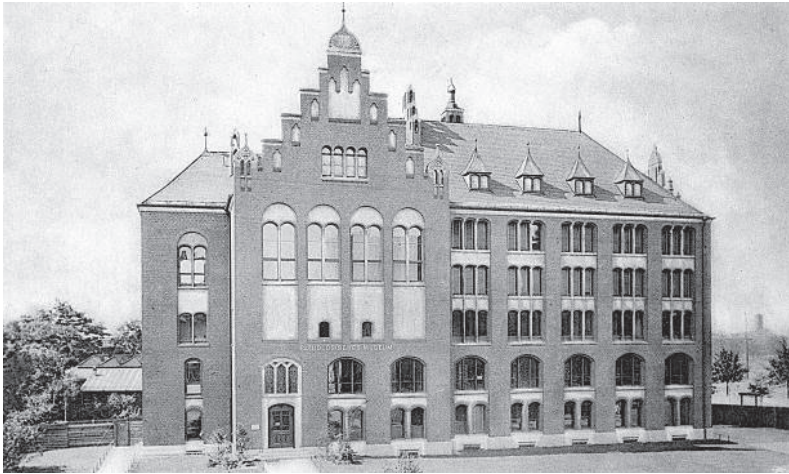


Figure 16: Berlin: Charité, Institut of Pathology, ca. 1900. gettyimages.com

“A little over four months after Bennett had described the slater’s illness, a twenty-four-year-old German researcher, Rudolf Virchow, independently published a case report with striking similarities to Bennett’s case,” Mukherjee wrote. “Virchow’s patient was a cook in her mid-fifties. White cells had explosively overgrown her blood, forming dense and pulpy pools in her spleen. At her autopsy, pathologists had likely not even needed a microscope to distinguish the thick, milky layer of white cells floating above the red.”

Although Virchow knew of Bennett’s case, he did not accept Bennett’s theory. Virchow argued that blood could not randomly transform into pus. And why the massively enlarged spleen and no identifiable source of the

pus? Virchow pinned the disease on the blood itself being abnormal. He had no specific etiology for the malady and chose the name *weisses Blut*, or “white blood.” A couple of years later, Virchow changed the name of the white blood disease to “leukemia” from the Greek word for white—“leukos.”

Providing a name to a disease or problem is perhaps one of the greatest gifts we can give to a patient or to those who study disease. With a name, a curious person can look up details about the disease, ask more specific questions, and have a handle to open the door to more knowledge. Without a name, the patient may feel like someone hanging on desperately to a buoy floating without direction in a turbulent sea. For researchers, it allows pattern recognition to emerge and permits a comparison between disease types. No matter the discipline—botany, astronomy or a thousand others—naming is the springboard for gaining an understanding and for further exploration.

“An illness, at the moment of its discovery, is a fragile idea, a hothouse flower, deeply, disproportionately influenced by names and classifications,” Mukherjee wrote. “Like Bennett, Virchow didn’t understand leukemia. But unlike Bennett, he didn’t pretend to understand it. His insight lay entirely in the negative. By wiping the slate clean of all preconceptions, he cleared the field for thought.”

When Virchow entered medicine in the early 1840s, “nearly every disease was attributed to the workings of some invisible force: miasmas, neuroses, bad humors, and hysterias. Perplexed by what he couldn’t see, Virchow turned with revolutionary zeal to what he could see: cells under the microscope,” wrote Mukherjee.

Virchow maintained that all cells come from cells (*omnis cellulae e cellula*). He proposed his essential hypothesis, as Mukherjee wrote,

If cells only arose from other cells, then growth could occur in only two ways: either by increasing cell numbers or by increasing cell size. Virchow called these two modes hyperplasia and hypertrophy. In hypertrophy, the number of cells did not change; instead, each individual cell merely grew in size like a balloon being blown up. Hyperplasia, in contrast, was growth by virtue of cells increasing in number. Every growing human tissue could be described in terms of hypertrophy and hyperplasia.

Fat and muscle usually grow by hypertrophy and the liver, blood, the gut, and the skin all grow through hyperplasia. Virchow’s explanation fueled a new understanding of both normal growth and pathological growth.



Figure 17: Rudolf Ludwig Karl Virchow. Photograph by Barraud.
Credit: Wellcome Collection. Attribution 4.0 International (CC BY 4.0)
<https://wellcomecollection.org/works/jb4rj88a>. [gettyimages.com](https://www.gettyimages.com)

Mukherjee continued:

Virchow soon stumbled upon the quintessential disease of pathological hyperplasia—cancer. Looking at cancerous growths through his microscope, Virchow discovered an uncontrolled growth of cells—hyperplasia in its extreme form. As Virchow examined the architecture of cancers, the growth often seemed to have acquired a life of its own, as if the cells had become

possessed by a new and mysterious drive to grow. This was not just ordinary growth, but growth redefined, growth in a new form. Presciently (although oblivious of the mechanism) Virchow called it neoplasia—novel, inexplicable, distorted growth, a word that would ring through the history of cancer. Virchow did not coin the word, although he offered a comprehensive description of neoplasia.

Virchow's work also included forensics, which he integrated into several of his detailed case reports. He was reported to have been the first to analyze hair in criminal investigations in a forensic report in 1861. Virchow was called in on a murder case as an expert witness and analyzed and presented hair samples collected from the victim. He wrote about the individual characteristics of hair, but at that point in time, noted that evidence based on hair analysis was inconclusive.

Virchow opened the door to our understanding of all the physiological changes that took place when a person contracted a disease. He was never satisfied with the status quo and believed in observation confirmed by clinical experimentation. "Experiment," he wrote, "is the ultimate court of the science of pathologic physiology."

Virchow's work on autopsy reflects a key point in examining his life. In almost every endeavor he undertook, he would first study the situation to gain a certain level of expertise. Then he would participate, labor, and observe and take extensive notes on his work and insights. And along the way, he would add his contributions to the field to make improvements. Not only is this a consistent trait in those who excel in a specific field and enrich our lives, but it also represents a model which all of us should strive to mimic.

In the next chapter, we continue the narrative of Virchow's life by looking at his role as a medical professor.

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CHAPTER SIX

THE PROFESSOR

In an article by Carl Vernon Weller titled “Rudolf Virchow—Pathologist” published in 1921 in *The Scientific Monthly*, Weller describes a visit by Dr. Samuel Gross in 1868 to see Virchow. Gross stated,

Early in the morning of the second day after our arrival, I went to the Allgemeines Krankenhaus in search of Virchow, the illustrious pathologist and accomplished statesman, a professor in the University of Berlin, and a member of the German parliament. The great man, upon my entrance, was in the midst of his pupils, engaged in a postmortem examination. As my presence attracted some attention, I deemed it my duty, although the moment was not the most opportune, to pass my card to the professor, at the same time apologizing for the intrusion. He at once saluted me with a gracious bow, and, shaking me cordially by the hand, introduced me to his pupils and expressed his gratification at seeing me. After a few minutes spent in conversation, he resumed his knife and completed his examination. He showed me his laboratory, his lecture room, and many of his more interesting pathological specimens, most of them prepared by his own hands. His collections of diseased hearts of children, the result of inherited syphilis, is the largest in the world, and, as he explained specimen after specimen, he became not only enthusiastic but eloquent. The laboratory, or workshop as it may be termed, of Professor Virchow is a model in its way, admirably adapted to the wants of the student for improvement in the use of the microscope and the examination of morbid specimens. Microscopes are provided in great numbers, and, in fact, every facility is afforded for the acquisition of knowledge. Such a room with the necessary appliances ought to exist in every well-organized medical institution in the United States.

Virchow is a most patient and laborious investigator and yet he never seems to be in a hurry. His dissections [autopsies] seldom occupy fewer than two and a half or three hours each. Every organ of the body is thoroughly explored. For years past, his habit has been to open, every Monday morning, a cadaver in the presence of his private pupils with a view of day morning, instructing them in the art of conducting autopsies—holding the knife, using the saw, and taking notes, the whole being supplemented by microscopic inspections of the more important diseased structures. In these dissections he is, if possible, more patient even than Rokitansky, his great Viennese

prototype. Virchow is a thin, slender man, about medium height, with a fine forehead, although the head is not large, and handsome black eyes, concealed by a pair of glasses. He is deliberate in his movements, a good talker, very affable, courteous and warm-hearted—in a word, a gentleman of the higher type.



Figure 18: Virchow in 1901. gettyimages.com

Dr. Gross reported that the evening before he left Berlin, he had,

further occasion to appreciate Virchow's splendid courtesy. While he was the guest of honor at Virchow's own table...the host drew from under the table a large book, which proved to be the second edition of Gross's "Elements of Pathological Anatomy," and, rising, took his guest by the hand and in a graceful speech, referred to the text as one from the study of which he had derived much useful instruction and one which he always consulted with much profit.

Gross continued to describe Virchow and his international appeal.

American medicine has too seldom received that full appreciation in Berlin and Vienna that Virchow was always willing to give. In reviews and abstracted articles edited by him, one is struck by the large number of English and American references included. Nearly twenty years after the visit of Gross to Berlin, we find Sir William Osler a pilgrim in Virchow's laboratory. Perhaps it has been the growing breadth of vision during those years, but not unlikely, it is the wonderful catholicity of interests possessed by the great visitor himself which changes the character of the pen picture.

As a professor, Virchow proved prescient in his dogmatic teachings about the cell. "As physiological as well as epigenetic studies abundantly show, DNA expression is conditioned by the cell machinery and by the environment that influences it," Saracci wrote,

In Virchow's vision, diseases are altered conditions of cell life affecting a large number of cells and "cellular territories"—tissues and organs—which constitute the next levels of integration. Against concepts, still common in his time, of diseases as theoretically classified entities invading the body as a whole, Virchow soundly founded pathology on observable lesions of specific cells, while at the same time stressing the multiplicity of inter-related processes involving these lesions at the integrated level of the whole organism. Virchow's "triad" brilliantly illustrates this concept. Cellular lesions in the endothelial wall of a vein, jointly with a mechanical factor (stasis) and a physical-chemical factor (blood hypercoagulability), may cause thrombosis in a lower limb vein; this is the origin of the distant effect, pulmonary emboli, first elucidated by Virchow. The individual, however, is not the higher level of observation: Virchow always sees people, their health and diseases in the context of their material and social circumstances.

Nuland wrote that Virchow,

held the first Chair of Pathological Anatomy in Germany; he and Kolliker, who had come to the university only the year before, attracted a large

number of students. In fact, some of Virchow's biographers opine that had he done nothing else, the galaxy of stars he trained during this time would have sufficed to establish him as one of the greatest teachers in the history of medicine. The students had good reason to congregate in ever-increasing numbers. Not only was their professor a scholar of high attainment, but he was engaged in projects of the sort that fascinated the young physicians who had come to learn the new scientific medicine.

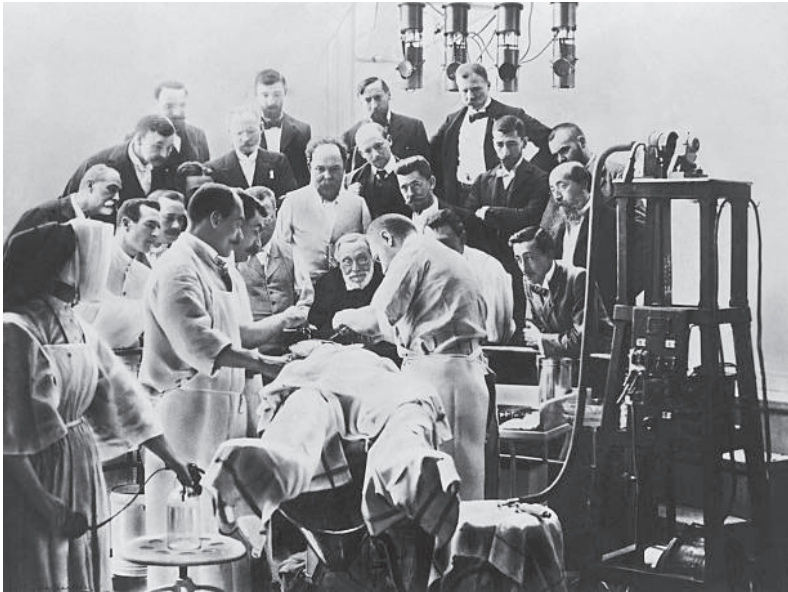


Figure 19: Virchow in the center with beard and glasses, observing a cerebral operation in the Sorbonne in Paris, August 1900. gettyimages.com

Many anecdotes were recorded about Virchow and his teaching methods. Nuland wrote,

During the Würzburg years, Virchow also developed some of the pedagogical methods he would use throughout his teaching career. Most memorable among them was his so-called table railroad, the moving track that passed the demonstration microscopes from student to student so that each might peruse the slides set up by their teacher. The rattling of the mounted instruments as they traveled along the conveyance system was frequently punctuated by Virchow's injunction, "Learn to see microscopically."

William Osler wrote:

In 1884, on returning to Berlin for the first time since my student days, I took with me four choice examples of skulls of British Columbian Indians, knowing well how acceptable they would be. In his room at the Pathological Institute, surrounded by crania and skeletons, and directing his celebrated diener, who was mending Trojan pottery, I found the professor noting the peculiarities of a set of bones which he had just received from Madeira. Not the warm thanks, nor the cheerful, friendly greeting which he always had for an old student, pleased me half so much as the prompt and decisive identification of the skull which I had brought, and his rapid sketch of the cranial characters of the North American Indian. The profound expert, not the dilettante student has characterized all of his work in this line. As an illustration of his capacity for varied work, I recall one day in 1884, in which he gave the morning demonstration and lecture at the Pathological Institute, addressed the Town Council at great length on the extension of the canalization scheme, and made a budget speech in the House, both of which were reported at great length in papers of the next day.

Virchow's key role as a statesman is the focus of the next chapter.

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CHAPTER SEVEN

THE STATESMAN

Medicine is a social science, and politics nothing but medicine at a larger scale.

—Rudolf Virchow

As Ackerknecht points out, Virchow had revolutionary beginnings and his earliest known political remarks are contained in a letter to his father dated December 21, 1840 (see previous letters). He comments on the new king, Frederick William IV, who had just succeeded his father, Frederick William III, the notorious partner of the Holy Alliance. The nineteen-year-old Virchow demonstrates his critical political insight.

“Virchow’s early historical publications of 1842 reveal him as an adversary of feudal institutions and privileges and of their modern counterparts, monopolies,” Ackerknecht writes.

Virchow’s concern with economic abuses, one of the key traits of his political views, shows up first in a remark written in 1845:

“At a railroad, a young man of my age earns as much during a day as I do during a month. Of course, I wouldn’t change with them, as I love medicine now more than ever. But you will realize that this extraordinary proletarianization makes me examine the causes of such a situation” (Briefe, p. 94).

Virchow’s letters reflect satisfaction with the growth of the opposition in 1845. “He continues his radical activities as a member of electoral colleges and democratic and labor associations, till the victory of the reaction drives him into temporary exile and political inactivity. But his political convictions remain unshaken,” Ackerknecht wrote.

Virchow’s most outstanding personal contributions to the revolution of 1848 were his report on Upper Silesia and his work to improve public health and medical reforms. He always memorialized his life as he participated. Virchow reflected on his tasks and turbulent times as a political activist in his letters and articles in his *Medical Reform* journal.

Virchow's republic was to be based on the equal rights of all citizens and founded on a maximum of self-government. He became most eloquent when discussing social inequalities:

Is it so difficult to understand that our movement is a social one, and that the task is not to write instructions [against cholera] that pacify the wealthy bourgeois? We must make provisions that protect through improvement of their conditions the poor who lack fine bread, soft meat, warm clothes, and a bed, who can't work while living on broth and tea, the poor who are hit hardest by the epidemic. Let the nice people remember, when they sit at the warm stove and give Christmas sweets to their little ones, that the men who carried coal and sweets, have died from cholera. Alas, how sad it is that thousands have to die in misery so that a few hundred may live well. And when it is the turn of another hecatomb all that the hundreds do is write another regulation (20 brief p. 25 Werke und Briefe).

Nuland writes that Virchow's "belief in the mutual dependence of the basic units of social organization extended itself to the body politic." After Virchow returned to Berlin, "he returned also to the insistent rumblings of his liberal conscience. In his later years he would become known as 'the Pope of German medicine,' but he was another kind of Pope as well, in his dedication to the English poet's proposition that the proper study of mankind is man."

Although the word "humanism" can be confusing, Nuland writes that, "Virchow saw humanism as having evolved since the Renaissance to allow for the insights of science." Virchow states that humanism is the "scientific knowledge of the manifold and various relations of the thoughtful individual person to the ever-changing world." Nuland points out that such a definition,

included cells, psyche, and social status. It included the health of each organ, the health of the entire person, and the health of the society. Man was to be studied not only with the microscope, but with the macroscopic view that sees the universal vision of his humanity. To this end, it was necessary for Virchow to return to politics.

Virchow was elected a member of the Berlin City Council in 1859. He would hold the office for forty-two years. In 1862, he was elected to the Prussian House of Deputies, where he became one of the founders of the radical German Progressive Party. Virchow was a member of the Reichstag from 1880 to 1893. Much of his work was to help reform hospital and sanitation systems, and more details will be presented in the chapter on Public Health.

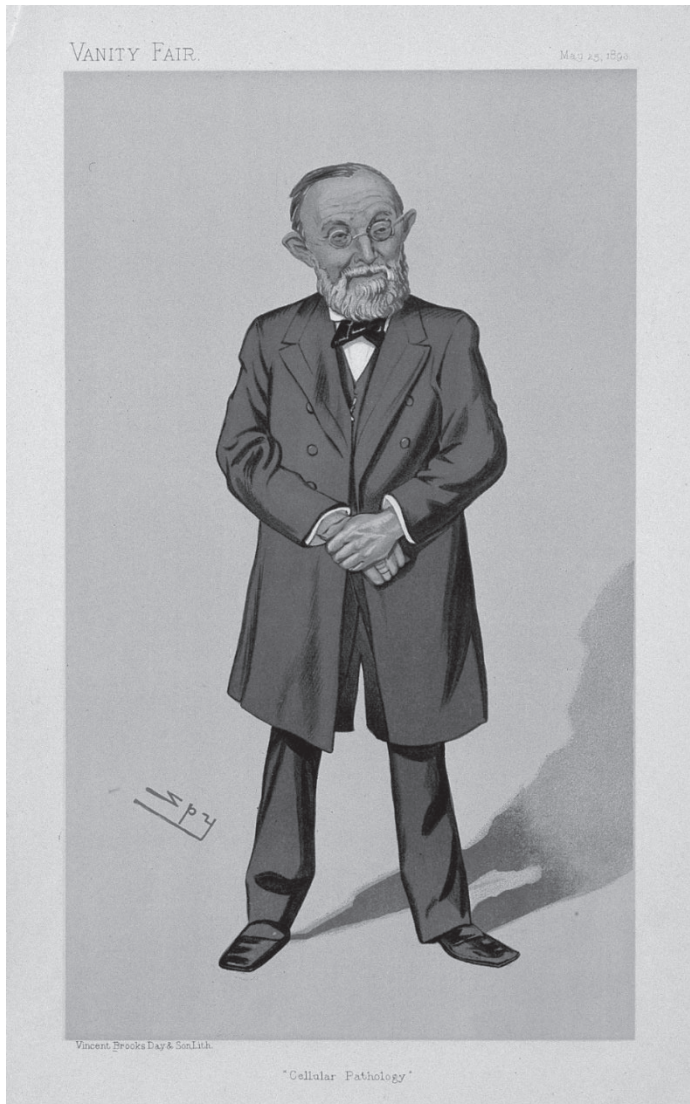


Figure 20: Rudolf Ludwig Karl Virchow.
Color lithograph by Sir L. Ward [Spy], 1893. Credit: Wellcome Collection.
Attribution 4.0 International (CC BY 4.0) R. Burgess, Portraits of doctors & scientists in the Wellcome Institute, London, 1973.

Virchow's many lives often overlapped. Given the title of my book, I do not intend to imply that he had five distinct sequential times in his life. All the work seemed to overlap and there may have been weeks when all five lives were carried out to some capacity. If you wanted to stretch Virchow's accomplishments, he may have had ten or fifteen lives, given his diverse activities. He never seemed too scattered and appeared able to hyper-focus on what was most important to him at that moment. Of course, no one knows what occurs in the private life and thoughts of another, and I am sure that there were many frantic moments among more controlled times. It is difficult to compartmentalize when one is juggling five or more balls in the air at one time.

All of Virchow's lives seemed to inform one another. Politics and public health were exceptionally intertwined and both were built on his strong foundation in medicine and pathology. He seemed to be able to listen and grasp the key problems in many disciplines, contribute, and improve on what he had first found. Although clearly filled with a confidence that could lead to boastfulness at times, he did not seem to exhibit illusory superiority or an egocentric attitude toward his colleagues and students.

Virchow used his intuition and reasoning to put himself in the most productive place at any time. As a highly skilled and trained physician, his ability to form a clear differential diagnosis in medicine, in particular in pathology, allowed him to come to the conclusion about the etiology of a disease. He could use his aptitude as a diagnostician to clearly delineate the issue at hand and make an informed decision in any field he engaged himself. When considering a public health issue or a political problem, he looked at it as if society or the state was in need of a fix and correction was possible by a similar problem-solving method as he utilized in his medical work. Virchow could carefully and intelligently funnel down from many choices to a few choices to one, and this same skill was used in many parts of his life.

Nuland wrote,

Most of his work on the City Council dealt with public health matters, largely in an attempt to solve the problems that existed at the time in the hospital system and in the sanitation of the municipality. Most Berliners had no indoor toilets or central water supply. The toilets that did exist emptied into deep gutters leading to the city's canals and the fouled depths of the sluggish Spree River. Some observers have called mid-nineteenth-century Berlin a city built on a sewer.

Virchow was clearly among the most ambitious and energetic of the reformers on the City Council. Nuland wrote,

Driven along by the vigor of his enthusiasms, the civic authorities adopted his programs for improving the sewage system, revamping the old ineffective hospital organization, and setting new criteria of hygiene for the public schools. He was responsible also for instituting stricter methods of food inspection and elevation of the standards for the training of nurses. During his four decades of service to the city, his influence wrought major changes in every area of public health. By the turn of the century, the individual units who were his fellow Berliners were surrounded in all aspects of their lives by an environment far more nourishing and sanitary than the milieu in which he found them when he took up his labors in 1859. The entire organism of Berlin was healthier by far.

In an essay from Robert Sapolsky called “My Personal Hero: Robert Sapolsky on Rudolf Virchow,” he wrote about Virchow’s ongoing dispute with Bismarck. “As a politician, he became the leader of the left-leaning radical party in the Reichstag. It was during his attempts to decrease the size of the military budget that he called none other than the Minister President of Prussia, Otto von Bismarck, a liar, resulting in the sausage duel.”

Otto Edward Leopold, Count von Bismarck (1815–1898) was Chancellor of Prussia and architect of modern Germany. His ambition was to unify the various independent German states into a single nation under Prussian leadership. The catalyst to bringing this about was the Franco-Prussian War of 1870 when the other German states fought alongside the Prussians. France was defeated, and in 1871, the German Empire was established, with Bismarck as Chancellor.

Sapolsky wrote,

Germany, 1865. A man, wealthy and powerful, gets into an argument with a colleague who calls him out for being the habitual liar that he is. Enraged, he challenges his accuser to a duel. The challenger has a military background and is no stranger to weapons and dueling. The challenged, a meek physician scientist, has probably never been around anything more menacing than a Bunsen burner. This is no match; the blowhard military man is virtually guaranteed to kill the scientist. As per custom, the challenged gets to choose weapons. Pistols? Swords? Fencing foils? No, the challenged had a better idea: sausages. In his laboratory, the scientist studies the parasitic roundworm *Trichinella spiralis*. His response shifts the odds from 1,000-to-1 to 50-50. One sausage will be injected with saline, the other with a hefty dose of a live culture of *Trichinella*, and the challenger chooses which one to eat, while the other eats the remaining sausage. Bummer if you get the one filled with the parasite. With that dose, you’ll have massive inflammation of your muscles, lungs, heart, and brain, probably followed by multi-organ system failure and a horrible death. Faced with even chances, instead of a bully’s advantage, the challenger quickly withdraws his challenge.



Figure 21: Otto von Bismarck, German statesman, c.1880.

Although this duel has been written about in many texts, it could be apocryphal. But it clearly adds to Virchow's legend. Sapolsky wrote,

That alone would make the scientist, Rudolf Virchow, one of my heroes. But more importantly, Virchow almost single-handedly invented the notion that good science can be a weapon in the service of social justice, at a time when there was damn little good science or social justice. In the process, he generated one of my all-time favorite quotes. In it, he uses "physician" in the broad, 19th-century sense of the word, which means that it includes the biomedical scientist and researcher, along with the clinical physician. The quote concerns the adverse effects, scars, and pathologies caused by being poor, by being a chronically subordinated human mired in the corrosive psychosocial stress of poverty. 'Physicians,' Virchow wrote, 'are the natural attorneys of the poor.' As a neurobiologist and primatologist who studies what the stress of social inequality does to health, Virchow's quote could serve as the rationale for my career.

In the next chapter, we will look at Virchow's role in improving the public health of Germany.

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CHAPTER EIGHT

PUBLIC HEALTH SPECIALIST

Ackerknecht writes that “Virchow’s work in public health was so extensive and many-sided that one might fairly state that the average German of 1900 had benefited from it in almost every phase of his life from the cradle to the grave, whether eating or drinking, going to school or working, whether healthy or sick in a hospital.”

In the abstract to his article, “Politics is nothing but medicine at a larger scale: reflections on public health’s biggest idea”, J. P. Mackenbach writes,

Virchow was convinced that social inequality was a root cause of ill-health, and that medicine therefore had to be a social science. Because of their intimate knowledge of the problems of society, doctors, according to Virchow, also were better statesmen. Although Virchow’s analogies between biology and sociology are out of date, some of his core ideas still resonate in public health. This applies particularly to the notion that whole populations can be sick, and that political action may be needed to cure them. Human health and disease are the embodiment of the successes and failures of society as a whole, and the only way to improve health and reduce disease is by changing society by, therefore, political action.

Ackerknecht notes that Virchow was “a great helper and saver of lives...he was one of the greatest contributors to ‘mass therapy,’ to public health and preventive medicine which have preserved more lives during the past hundred years than all our spectacular progress in individual therapeutics combined. It is significant that Virchow himself, at the end of his life, emphasized this aspect of his work more than any other.”

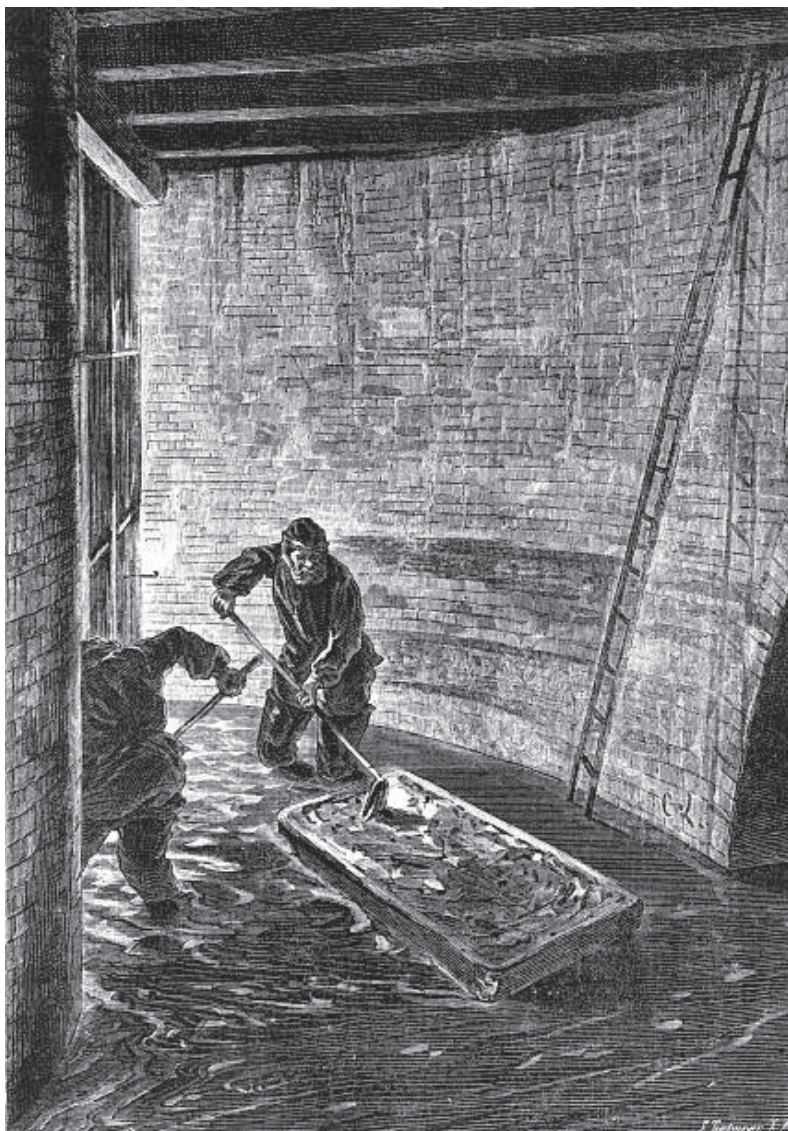


Figure 22: Engraving depicts sanitation workers as they shovel in a brick-lined sewer, Berlin, Germany, 1882. gettyimages.com

Virchow's work and report in Upper Silesia helped him create his own new epidemiological approach. In 1848 and 1849 he wrote the following passages:

Epidemics resemble great warning signs on which the true statesman is able to read that the evolution of his nation has been disturbed to a point which even a careless policy is no longer allowed to overlook.

Don't crowd diseases point everywhere to deficiencies of society? One may adduce atmospheric or cosmic conditions or similar factors. But never do they alone make epidemics. They produce them only there where due to bad social conditions people have lived for some time in abnormal situations.

Why otherwise would individual diseases as well as epidemics be of a milder nature today than in the Middle Ages? Only because classes do now participate in living conditions from which they were then almost totally excluded. Only because the upper classes are now used to living in hygienic conditions while they then spent their lives in dirt, gluttony, and discomfort.

Abnormal conditions always produce abnormal situations. War, plague and famine condition each other, and we don't know any period in world history where they did not appear in a more or less large measure either simultaneously or following each other.

Sapolsky wrote that "showing his focus wasn't just on the miniscule and reductive in science, he (Virchow) was also a pioneer in the field of public health. His roundworm research on how meat could be a vector for trichinosis helped spawn the concept of meat inspection."

Virchow focused on *Trichinella spiralis* in swine, which he discovered caused the parasitic disease trichinosis when humans consume raw or undercooked pork. As Kearn wrote,

This relationship, as well as the findings of parallel human and animal microbial pathogens by others, including Louis Pasteur and Robert Koch, led Virchow to the idea that there was a relationship between human and animal diseases which he termed zoonosis. Many credit him as a founder of comparative pathology because of this work.

On the Prevention of Animal Epidemics and Expert Opinion on the Most Effective Method for Disposing of Human Wastes in Berlin are included in the Appendix.

Next, we will explore Virchow's impact in the world of anthropology.

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CHAPTER NINE

ANTHROPOLOGY

If different races would recognize one another as independent co-laborers in the great field of humanity, if all possessed a modesty which would allow them to see merits in neighboring people, much of the strife now agitating the world would disappear.

Rudolf Virchow

By the late 1860s, Virchow's interest shifted from pathology to anthropology, as the focus of the younger generation pivoted from pathological anatomy to bacteriology.

As Ackerknecht writes,

Virchow was active in the founding of the German Anthropological Society in 1869 and founded, in the same year, the Berlin Society of (physical) Anthropology, Ethnology, and Prehistory, over which he presided to the time of his death. The journal of the latter, the *Zeitschrift fuer Ethnologie*, which became the leading German journal in the field, was edited by him almost singlehanded (proofreading included) throughout the rest of his life. He was a guiding spirit in the national and international meetings of these new sciences.

Theories on evolution were in abundance wherever anyone turned during those times and Virchow was in the middle of the mix. In his work on *The Cranial Affinities of Man and the Ape*, Virchow wrote,

the question touching the descent of man from the ape, takes now such a prominent place in the thoughts of so large a number of living persons, that in a manner it has come to be regarded as a necessity for us to make ourselves more intimately acquainted with the reasons inducing so many to follow up the inquiry. In endeavoring to do this, it is naturally impossible to overlook either the striking resemblance of the ape to the human being, or the fact that it has not been reserved for us to furnish the first anatomical demonstrations of the existence of that likeness. In the second century after the birth of Christ, Galen, the most celebrated medical writer of antiquity,

earnestly recommended all such as were desirous of preparing themselves for acquiring the knowledge of man and his diseases, to apply themselves to the study of the anatomy of some apes that are “nearest man”; and this counsel was so conscientiously adhered to, till near to the close of the Middle Ages, that it may be said almost all the anatomical knowledge of the physicians of those times rested on the study of the structure of the ape.



Figure 23: Rudolf Virchow, Portrait im Arbeitszimmer, Charité Berlin, 1896. [gettyimages.com](https://www.gettyimages.com)

Virchow continued,

It therefore excited no astonishment whatever, when, in the seventeenth century, the first ape possessing a human resemblance in the stricter sense, was brought to Europe to hear that it was called by the natives of Borneo, Orang-Outang, that is “man of the woods.” Nor were any objections raised a century later, when the celebrated naturalist Linnæus, in his zoological system, which struck out an entirely new path, ranged man under the scientific name of *homo sapiens*, with the monkeys and some other mammals, in one great division known as the Primates (*Quadrumana*). Since that time, the distinctions between the ape and the human being have formed the subject of diligent research; for the system demands a correct exposition of all the differing, but for that reason, characteristic signs, of each class and species. It came to be seen that the different classes of apes differed in many respects more from each other than they did from man. This fact became more evident as the apes bearing a close resemblance to man, increased in number, bringing an influx of specimens to Europe; and especially since the year 1847, when the first certain intelligence reached us of the most remarkable of all, the gorilla.

Physical anthropology was closest to Virchow's professional background. While still in Würzburg, Virchow started his work in physical anthropology with studies on the skulls of cretins in 1851. Here he did most of the work for his book, *Researches on the Development of the Cranial Basis*, an important contribution to anthropology. In the 1870s, he oversaw a nationwide racial survey of school children, the first of this kind ever undertaken. I will cover more details of this story in the next chapter.

Virchow's interest in German archeology dated from his student days and his activities would eventually spread out into the Near East. Ackerknecht writes,

Sponsoring Schliemann, the self-made discoverer of the ruins of Troy, and providing him with trained help, he made Schliemann scientifically respectable, and saved his collections for Germany. Virchow excavated with Schliemann in Hissarlik in 1878. In 1888 he went with him and Schweinfurth to Egypt. In 1881 and 1894 he did his own field work in the Caucasus. He was least active as a researcher in ethnology, where his friend Bastian took the lead, but furthered this field tremendously in administrative ways in sponsoring expeditions, and especially in obtaining the erection of the splendid Berlin Ethnological Museum in 1886 and of the Folklore Museum in 1888.

In the preface to the book *Ilios; the city and country of the Trojans* by Virchow's friend and fellow adventurer, Dr. Henry Schliemann, Virchow writes,

A special chance allowed me to be one of the few eye-witnesses of the last excavations at Hissarlik, and to see the "Burnt" City emerge, in its whole extent, from the rubbish-heaps of former ages. At the same time, I saw the Trojan land itself, from week to week, waking up out of its winter's sleep, and unfolding its natural glories in pictures ever new, ever more grand and impressive. I can therefore bear my testimony, not only to the labors of the indefatigable explorer, who found no rest until his work lay before him fully done, but also to the truth of the foundations, on which was framed the poetical conception that has for thousands of years called forth the enchanted delight of the educated world.

Next Virchow defends his friend and states,

And I recognize the duty of bearing my testimony against the host of doubters, who, with good or ill intentions, have never tired of carping alike at the trustworthiness and significance of his discoveries. It is now an idle question, whether Schliemann, at the beginning of his researches, proceeded from right or wrong presuppositions. Not only has the result decided in his

favor, but also the method of his investigation has proved to be excellent. It may be that his hypotheses were too bold, nay arbitrary; that the enchanting picture of Homer's immortal poetry proved somewhat of a snare to his fancy; but this fault of imagination, if I may so call it, nevertheless involved the secret of his success. Who would have undertaken such great works, continued through so many years, have spent such large means out of his own fortune, have dug through layers of debris heaped one on the other in a series that seemed almost endless, down to the deep-lying virgin soil, except a man who was penetrated with an assured, nay an enthusiastic conviction? The Burnt City would still have lain to this day hidden in the earth had not imagination guided the spade.

Virchow adds, "The excavations at Hissarlik would have had an imperishable value, even if the Iliad had never been sung. Nowhere else in the world has the earth covered up so many remains of ancient settlements lying upon one another, with such rich contents within them."

In Virchow's talk on *Anthropology in the Last Twenty Years* (please see the Appendix for the full transcript) at the University of Berlin, he said, "Hypothetically from every piece of skin, a monkey may be constructed; no anatomist ever doubted this. But the differences between man and monkey are so wide that almost any fragment is sufficient to diagnose them. Much is still lacking for a demonstration of the theory of descent."

As mentioned earlier in the book, Virchow and Darwin had different ideas:

At the time of our coming together twenty years ago, Darwinism had just made its first triumphal march through the world. At that time, it was hoped that the theory of descent would conquer, not in the form promulgated by Darwin, but in that by his followers—for we have to deal now not with Darwin but with Darwinians. No one doubted that the proof would be forthcoming, demonstrating that man descended from the monkey and that this descent from a monkey or at least from some kind of an animal would soon be established. This was a challenge which was made and successfully defended in the first battle. Everybody knew all about it and was interested in it; some spoke for it, others against it. It was considered the greatest question of Anthropology.

Virchow said,

Let me remind you however at this point that natural science, as long as it remains such, works only with real existing objects; a hypothesis may be discussed, but its significance can only be established by producing actual proofs in its favor, either by experiments or direct observations. This Darwinism has not succeeded in doing. In vain have its adherents sought for connecting links which should connect man with the monkey; not a single

one has been found. The so-called pro-anthropos which is supposed to represent this connecting link has not as yet appeared. No real scientist claims to have seen him; hence the pro-anthropos is not at present an object of discussion for an anthropologist. Some may be able to see him in their dreams, but when awake they will not be able to say that they have met him. Even the hope of a future discovery of this pro-anthropos is highly improbable, for we are not living in a dream, or an ideal world, but in a real one.



Figure 24: Virchow (1900) examining a giant in his Institute of Pathology. [gettyimages.com](https://www.gettyimages.com)

Franz Uri Boas (1858–1942), the German-American anthropologist and a pioneer of modern anthropology who has been called the “Father of American Anthropology,” was a student of Virchow. Boas was heavily influenced by Virchow and was a prominent opponent of scientific racism. He proposed race as a biological concept and that human behavior was best understood through the typology of biological characteristics. He introduced the ideology of cultural relativism that proposes that all humans see the world through the lens of their own culture. Other students included Margaret Mead and Zora Neale Hurston.

Virchow’s role in fighting anti-Semitism is highlighted in the next chapter.

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CHAPTER TEN

MORPHOLOGY, RACE, AND VIRCHOW'S FIGHT AGAINST ANTI-SEMITISM

Dr. Virchow played a significant role in studying morphology and race during the time of an emerging socialist movement and rising anti-Semitism in Germany. Andrew Zimmerman wrote,

One of the major events in the history of German anti-Semitism has been, if not entirely overlooked, then misunderstood and misrepresented. In the 1870s, the professor of medicine, liberal politician, and anthropologist, Rudolf Virchow, directed a study of the skin, hair, and eye color of 6,758,827 German school children. Historians have been virtually unanimous in viewing this study as a blow against anti-Semitism, as a demonstration that there was neither a Jewish nor a German "race."

Virchow concluded that Jewish children are physically indistinguishable from non-Jewish children. He was particularly adamant in pointing out the arrogance and unfounded convictions that certain observers used to differentiate between humans based on their politically biased beliefs regarding historical and racial backgrounds instead of looking at the natural wonders and complexity of our species. By studying medicine, pathology, and anthropology, he expanded his mission to find the true scientific basis of human origins and diversity. Zimmerman wrote,

This interpretation has survived, I believe, because it supports and rests on a commonly held conception of racism as primarily an intellectual phenomenon, as a set of more or less explicit propositions held in the minds of individuals. Virchow, a well-known opponent of political anti-Semitism, was never motivated by hostility to Jews in conducting this research. Indeed, he understood his focus on Jews as simply a race (rather than as a religion or a culture) to indicate that the study was not anti-Semitic. Paradoxically, the study that Virchow designed and oversaw may have unintentionally provided an important practical basis for German racial anti-Semitism and marked "Jews" and "Germans" as racially different and trained a generation

of Germans to perceive these differences both as real and as of political significance.

Over the decades that followed Virchow's death, the worst of humanity became manifest. The delusions of Hitler and the Nazis rose to a horrifying culmination in the Holocaust and the deaths of innocent millions. Nazi doctors tried to isolate genetic abnormalities in their victims to promote a delusional state of Aryan grandeur. Virchow's study on German schoolchildren was twisted and manipulated by the Nazis to highlight superior aspects of the Aryan race, even though the science proved this completely wrong.

Zimmerman wrote,

Virchow's interest in politics and pathology led him to anthropological investigations. He was famous for his interest in humans with rare pathologies and was often called on by the popular press to explain noteworthy freak shows in Berlin. Virchow was a vocal opponent of Darwinism. Thus, when the Darwinist Carl Vogt asserted that microcephalies (known in circus sideshows as "pinheads") were atavistic returns to an intermediary race of ape-men, Virchow demonstrated to the satisfaction of most that microcephaly was an individual pathological phenomenon. Similarly, when the Darwinist Hermann Schaaffhausen asserted that a skull fragment discovered in the Neander valley represented an intermediary race between apes and humans, Virchow demonstrated that the skull belonged to a diseased and severely injured, but otherwise normal, human. He also argued against the notion that human races could be viewed as successive steps in a development from monkey to man, so that some races were closer to apes than others. Virchow, like most German anthropologists of his time, saw race as a fixed type, perhaps influenced by environmental conditions in a distant past, but immutable in the present. German anthropologists generally believed that race was an essential and unvarying characteristic of human populations, although they were not polygenists and generally opposed the idea that different races had fundamentally different mental abilities. This interest in human racial variation, as well as a growing interest in German prehistory, led Virchow increasingly toward anthropological subjects.

In his book *The Jewish Body*, Melvin Konner writes that even if a Jew converted to Christianity (based on the threat of death), he or she was still considered a Jew genetically, biologically, and physically by German racial theorists and subject to the horrors of persecution. Virchow spent years of his life studying skull size and physical comparisons to provide us with his own theories on race and nationality.

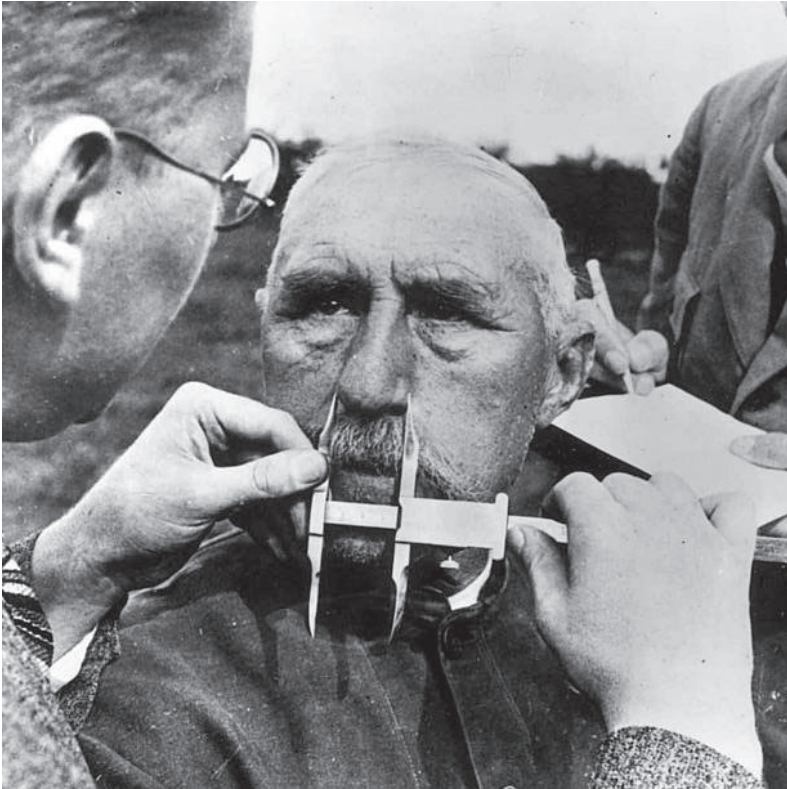


Figure 25: A man having his nose measured during Aryan race determination tests under Nazi Germany's Nuremberg Laws that were applied to determine whether a person was considered a "Jew." [gettyimages.com](https://www.gettyimages.com)

As Konner wrote,

Even many who know quite a lot about the Holocaust don't realize that it was in essence a public health project. Jews were diseased, of course, but more importantly, they were a disease. "Modern science" taught that genes are the foundation of all health, and Jewish genes were destroying the health of the German race. Inter-marriage between Jews and other Germans had increased. "Pure" German birthrates had declined. Jews were contaminating other Germans with many viral and bacterial diseases, but worst of all they were contaminating the German race with their genes. These things were measurable, measured, and aggressively brought to the attention of the German people.

If he were alive today, Virchow would certainly have marveled at all the advances in genetics, having learned that the genetic songs of life were orchestrated by complex metabolic pathways and provided almost unlimited species variations. He would have convulsed at how the Nazis manipulated his work and utilized willing scientists and physicians to carry out their horrifying crimes.

Konner wrote,

In essence, this was a public health crisis, and German physicians and scientists rose to the occasion. Doctors were among the first, most enthusiastic, and most loyal of Nazis, after, that is, they had purged their ranks of Jewish colleagues. German medical scientists were *the* most important intellectual pillars of the Nazi war against the Jews. Dr. Josef Mengele, M.D., Ph.D., was not stationed at Auschwitz just to decide who should be murdered by gassing immediately and who looked healthy enough to be worth working to death. He was there as a medical, public health, and racial expert, to certify that every Jew sent to the gas chambers was murdered for health reasons—the health of the pure German race. Nazi mass murder needed a doctor's signature on what was, in effect, a prescription for German health.

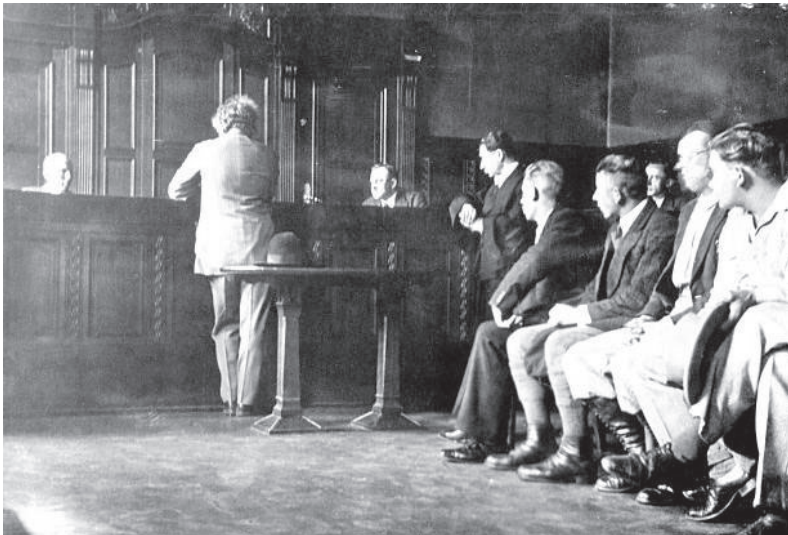


Figure 26: Albert Einstein in front of a Justice Court of Nazi Germany, in early 1933. His home had been vandalized and he had resigned from the Academies of Prussia and Bavaria. In March, he decided to leave Germany for the United States. [gettyimages.com](https://www.gettyimages.com)

Although I grew up in a mid-sized, predominantly Christian, Midwestern town, I had a very strong sense of my Jewish heritage. My parents had met at nine years old, both living in a Jewish orphanage in Cleveland, Ohio, and had varying degrees of Jewish education. I remember learning a couple of certainties of life—death and taxes. A third certainty was the Holocaust, having heard the soul-crushing stories and seen the tattoos etched on the skin of survivors I would see when I was in Chicago and Detroit. The Holocaust made up the third leg of the foundational stool of my life, and the fact was inescapable. Once the death, destruction, and evil of man against man had entered my heart and mind, it could never go away. That part of the triad has informed everything else in my life.

Konner wrote,

Real public health measures were constantly conflated with racist theory. Health care was to be replaced by health leadership, curative measures by preventive ones, and personal by racial hygiene. This was not some small fringe group of German doctors and scientists but the overwhelming majority. The countless courses they taught on genetics and public health at the best universities, the richly supported journals, laboratories, and institutes, the thousands of “studies” they conducted to “test” these vacuous theories made the Nazi view of the Jewish body the intellectual norm throughout Germany, and later throughout the vast Nazi empire. The Reich Health Publishing House boasted that in 1939 alone, it used some 924 metric tons of paper (ninety-two boxcar loads), enough to stretch three-fourths of the way around the earth. “Scientific” books and articles presented “evidence” that Jews were more afflicted by many diseases than non-Jews were, and that their inferior genes were responsible.

Hitler, in his early memoir *Mein Kampf* (My Struggle), put his hatred of the Jews and fear of the Jewish racial threat center stage:

With every means he tries to destroy the racial foundations of the people he has set out to subjugate. Just as he himself systematically ruins women and girls, he does not shrink back from pulling down the blood barriers for others, even on a large scale. It was and it is Jews who bring the Negroes into the Rhineland, always with the same secret thought and clear aim of ruining the hated white race by the necessarily resulting bastardization, throwing it down from its cultural and political height, and himself rising to be its master.

During a tour of the permanent exhibit of the Holocaust Museum in St. Petersburg, Florida, I noted the online study guide that reads,

The roots of hatred are deeply entrenched in human history, especially the singular form of hatred known as anti-Semitism. Anti-Semitism long precedes the Third Reich. Early Christian teachings associated Jews with a plague on society. Throughout the Middle Ages and early modern Europe, Jews were persecuted, and a number of nations exiled them. Entrenched anti-Semitism was one of the major factors that contributed to the Holocaust with the mass murder of millions of European Jews. As Adolf Hitler wrote in *Mein Kampf*, “No one need be surprised if among our people the personification of the devil, as the symbol of all evil, assumed the living shape of the Jews.”

Sander Gilman wrote,

The construction of the Jewish body in the nineteenth and early twentieth centuries is linked to the underlying ideology of anti-Semitism, to the view that the Jew is inherently different [...]. Thus, it is of little surprise that the image of the Jewish body shifts from the rhetoric of religious anti-Judaism to the rhetoric of the pseudoscience of anti-Semitism. By the nineteenth century, with the establishment of the hegemony of “science” within European (and colonial) culture, there is no space more highly impacted with the sense of difference about the body of the Jew than the public sphere of “medicine.” No aspect of the representation of the Jewish body in that sphere, whether fabled or real, is free from the taint of the claim of the special nature of the Jewish body as a sign of the inherent difference of the Jew.

By the latter half of the nineteenth century, Western European Jews had become indistinguishable from other Western Europeans in matters of language, dress, occupation, the location of their dwellings, and the cut of their hair. Indeed, if Rudolf Virchow’s extensive study of German schoolchildren published in 1886 was accurate, they were also indistinguishable in terms of skin, hair, and eye color from the greater masses of those who lived in Germany. Virchow’s statistics sought to show that wherever a greater percentage of the overall population had lighter skin or bluer eyes or blonder hair, a greater percentage of Jews also had lighter skin or bluer eyes or blonder hair. But although Virchow attempted to provide a rationale for the sense of Jewish acculturation, he still assumed that Jews were a separate and distinct racial category. George Masse commented,

the separateness of Jewish schoolchildren, approved by Virchow, says something about the course of Jewish emancipation in Germany. However, rationalized, the survey must have made Jewish schoolchildren conscious of their minority status and their supposedly different origins. Nonetheless,

even though they were labeled as different, Jews came to parallel the scale of types found elsewhere in European society.

One of Virchow's former students, Haeckel, also applied the hypothesis of polygenism to the modern diversity of human groups. He became a key figure in social Darwinism and a leading proponent of scientific racism, stating for instance:

The Caucasian, or Mediterranean man (*Homo Mediterraneus*), has from time immemorial been placed at the head of all the races of men, as the most highly developed and perfect. It is generally called the Caucasian race, but as, among all the varieties of the species, the Caucasian branch is the least important, we prefer the much more suitable appellation proposed by Friedrich Müller, namely, that of *Mediterranese*. For the most important varieties of this species, which are moreover the most eminent actors in what is called "Universal History," first rose to a flourishing condition on the shores of the Mediterranean [...]. This species alone (with the exception of the Mongolian) has had an actual history; it alone has attained that degree of civilization which seems to raise men above the rest of nature.

Haeckel divided human beings into ten races, of which the Caucasian was the highest and the primitives were doomed to extinction. In his view, "Negroes were savages and Whites were the most civilized"; for instance, he claimed that "[t]he Negro had stronger and more freely movable toes than any other race, which, he argued, was evidence of their being less evolved, and which led him to compare them to four-handed apes."

The school statistics had a discernible, if difficult to measure, impact on the German public. Although Virchow's conclusions were not officially published for ten years, local newspapers reported the findings for their region as soon as they were calculated. Almost immediately, the color of the Jewish and non-Jewish students, as well as the number of Jews in a given area, became public knowledge.

According to Pulzer, the anti-Semitic petition presented to Bismarck in 1882 demanded a restoration of the special census for Jews, as well as the exclusion of Jews from public positions and the end of Jewish immigration. See Peter, Pulzer, *The Rise of Political Anti-Semitism in Germany and Austria* (1964; London, 1988).

Although he did not grasp the specifics of Virchow's argument, Friedrich Nietzsche did use Virchow's "ethnographical maps of Germany" in his 1887 *On the Genealogy of Morals* to differentiate "a blond race," which he called "the conqueror and master race, the Aryan," from an inferior race, which he characterized by its peculiar "coloring" and "shortness of skull." On the basis of this distinction, Nietzsche suggested that socialism represented

a primitive, pre-Aryan, social form, a “monstrous atavism [imgeheuern Nachschlag], and an attempt of the brown people to rule the blond.”

Zimmerman wrote,

These ideological influences of the school statistics are, however, only the tip of the iceberg: beneath them, hidden from the view of the historian of ideologies, is an enormously significant level of tacit skills that this study conveyed to ordinary Germans. Far more important than the beliefs that Germans may have derived from these skills are the skills themselves, for without them ideological tracts could not have made sense, and the practical regimes that would later so distinguish German anti-Semitism could not have been implemented.

In his *Ontogeny and Phylogeny*, Harvard paleontologist Stephen Jay Gould wrote: “[Haeckel’s] evolutionary racism; his call to the German people for racial purity and unflinching devotion to a ‘just’ state; his belief that harsh, inexorable laws of evolution ruled human civilization and nature alike, conferring upon favored races the right to dominate others [...] all contributed to the rise of Nazism.”

Now, back to Virchow, who wrote,

The “great thought” (as I put it) of love for all one’s neighbors, and of the solidarity of the community, from which I derive the development of the public care of the ill would have survived in the young Christian community only so long as the latter was still anchored in Judaism. If we bear in mind that the history of hospitals, in the precise sense, begins with the fourth century “Basilia,” the time during which the Christian community was still anchored in Judaism would have to be rather widely conceived indeed. It suffices me to know, and I hold it my duty to say, that the Christian community founded the public care of the ill in a form now indispensable to modern society precisely by the consequent application of principles handed down from the founding of the new religion.

Edmund Burke was considered one of the most influential orators in the House of Commons because as a member of the British Parliament, he defended the rights of the American colonies and strongly opposed the slave trade. He wrote, “All that is necessary for evil to triumph is for good men to do nothing.”



Figure 27: A woman stands in front of a memorial plaque with the names of the victims on the wall of the synagogue in Halle, eastern Germany, on October 9, 2020, on the first anniversary of the anti-Semitic attack on the synagogue. The attack came during Yom Kippur, the holiest day in the Jewish calendar, and was one of the worst acts of anti-Semitic violence in Germany's post-war history. Two people were shot dead after a neo-Nazi extremist tried and failed to storm a synagogue.

Virchow's exemplary life can be used as a role model of a good man doing hard work to help others and for the task of *tikkun olam*, helping to repair the world. All of us must keep in mind our moral obligations as human beings. Decades after the Holocaust, anti-Semitism remains an ever-present force in too many areas of the world and must be constantly recognized and eliminated.

Virchow's work as a medical historian and writer is featured in the next chapter.

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CHAPTER ELEVEN

MEDICAL HISTORIAN, WRITER, AND BIOGRAPHER

As Ackerknecht pointed out,

Among Virchow's many contributions to various fields of medicine that deserve mention and analysis are those made in medical history. As Virchow had started his career as a writer with some perfectly competent pieces of original research on the history of his hometown, it is not surprising that throughout his life his writings were full of remarks emphasizing the value of medical history.

Among his many comments on medical history, Virchow wrote:

Medicine needs historical knowledge more than any other science.

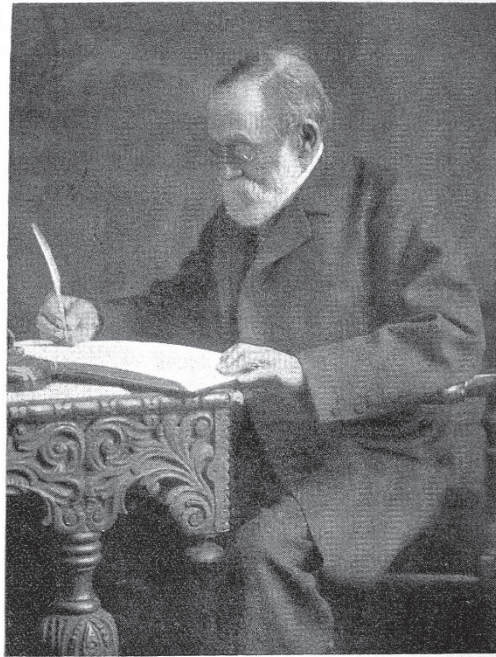
The history of medicine is an integral part of cultural history and can be understood only in connection with the general history of mankind.

The neglect of the history of medicine has produced that desolating circular movement in medical science which, almost without any metabolic changes, again and again produces the same material.

The history of wars is only the external history of nations. Their internal history starts from very different sources: the progress of human insight and cultural history; on the other hand, the memory of the painful suffering of humanity, the history of medicine, known only to few, but therefore a no less instructive part of general history.

It is a great progress that men of peace have started during the last years to use medico-historical materials, [a progress] that is to open this rich and carefully guarded treasure house of humanity.

Only historical knowledge is true knowledge.



R. Virchow

Figure 28: Portrait of R. L. K. Virchow seated. Credit: Portrait of R. L. K. Virchow. <https://wellcomecollection.org/works/xm8sbrk9>

Ackerknecht wrote,

Virchow published many articles on medical history in his Archives. To think historically was an absolutely natural approach for Virchow, as his thought started so often as an antithesis. His salutary critical skepticism, that was based in later years on the direct experience of a long life where he had seen so many theories, methods, and fashions come and go, rested in his earlier years largely on his great familiarity with medical history, [and] the collective memory and experience of the medical profession. Virchow possessed not only an extensive knowledge of medical history, but he thought also in a truly historical fashion insofar as he did not regard all previous history of medicine as a collection of nonsensical errors, like many of his “modernist” contemporaries did, but freely confessed to the “fault”

that he regarded the ancients as able observers and considered many of their formulations meaningful for the present.

Virchow's importance as a medical historian is also highlighted by basic concepts he developed through systematic research. "His most concentrated effort lies in the field of the history of hospitals and leprosaria, especially those in Germany," Ackerknecht writes. "His trip to Norway in 1859 aroused his interest in the latter. In 1860-61, he published a series of articles on the history of leprosaria in Germany which all together covers over 220 pages." According to Ackerknecht,

Virchow's most ambitious literary undertaking was his three-volume book on tumors, *Die krankhaften Geschwuelste*, which started to appear in Berlin in 1868. Like *Cellular Pathology*, it was based on a series of lectures, this time delivered in the midst of the hottest political battles of Virchow's whole life in the winter of 1862/63. The second half of the third volume, which was to contain the last five of the thirty lectures and among them the one on cancer (carcinoma), failed to appear during the remaining thirty-five years of the author's life. It has been surmised that Virchow's doubts in his own connective tissue theory of cancer prevented him from finishing the job. Even in its unfinished form, the work is most impressive and unduly forgotten. Its eighteen hundred pages are a storehouse of information. No subject offered itself better to a discussion in terms of cellular pathology. Virchow's theory of cellular pathology obtained some of its finest triumphs in the field of tumors, changed this field more profoundly, and dominated it longer than any other theory. In the course of the years, Virchow had piled up a tremendous number of observations, published and unpublished, on tumors in man and animals.

Virchow had analyzed a wide variety of tumors and developed new concepts and terms in the field. All this Virchow drew together into an imposing structure. The book reflects clearly the change that Virchow had experienced from physiological pathology to pathological anatomy or morphology, not only microscopical but macroscopical. Even the illustrations reflect Virchow's change toward macroscopical pathology. The influence that Virchow exerted on oncology is borne out by the fact that many of his chapter headings and much of the contents of his book parallel modern texts in the field. Virchow himself was fully aware of the provisory and arbitrary character of the "tumor" notion of his time. His introductory chapter contains the famous phrase: "I do not think that a living human being can be found that even under torture could actually say what tumors really are."

Having had misconceptions about true tumors in the pre-bacteriological era was not surprising and many descriptions have since been revealed as the product of chronic infection like syphilis, tuberculosis, and leprosy.

Virchow went far beyond his teacher, Mueller, who held tight to a basic classificatory principle of benignity vs malignancy. “It could not form the basis of a scientific classification, as little as a scientific classification of plants could be based on their being poisonous or edible. A scientific classification of tumors had to be anatomical and genetic,” Ackerknecht wrote. He continued,

During the first seven years of his second Berlin period, Virchow produced many of his major pathological books: *Cellular Pathology* in 1858, the three-volume work on tumors that began appearing in 1863, and the little book on trichinosis in 1863. All of this is more amazing in view of the fact that in 1859, Virchow had re-entered political life, this time as one of the major actors of the drama, and that up to the 1870s, his political activity was, in the context of his total biography, the most significant of his many endeavors.

I will conclude with a chapter on Virchow’s legacy, followed by an Appendix of many of his key writings.

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CHAPTER TWELVE

VIRCHOW'S LEGACIES

On his eightieth birthday celebrations, Virchow wrote,

My feeling of obligation is too strong to express it in adequate terms. I am too old to promise new accomplishments which would be a worthy compensation. *I will not tire of working as long as my forces last.* All I can promise is to try bringing several larger projects, started when I was young, to an end, useful to the world.

Even if it were true that the world is ungrateful, it would be very ungrateful on my part to recognize ungratefulness as a common human quality. Nobody can count on finding or ask for more affection than I have found in all classes of our nation and even abroad. I did not ask for such affection, it was given voluntarily; I did not count on such affection, but all the more did it surprise me pleasantly and oblige deeply.



Figure 29: Virchow's 80th birthday medallion. [gettyimages.com](https://www.gettyimages.com)

One of the celebrations he enjoyed most was with the Workman's Association (*Handwerkerverein*) he had once helped found.

Such is the gratefulness of the people, and that is why I say to everybody: trust the people, work for them; the recompense will not be lacking, as much as the destruction of many institutions, the disappearance of many men, the complete change of our public life reminds us of our mortal nature. This is my faith, and this, I trust, will suffice me, as long as I live.



Figure 30: Virchow-Krankenhaus, 1910. [gettyimages.com](https://www.gettyimages.com)

According to Ackerknecht,

Virchow seemed indestructible. He bore the strain of the 1901 celebrations very well. But on January 4, 1902, he broke his femur when jumping from a streetcar. The fracture united as he had prophesied, but in the forced inactivity of the sick bed, he declined rather rapidly and died from cardiac disease on September 5, 1902. He was survived by his wife, three sons, three daughters, and nineteen grandchildren. The city of Berlin, for which he had done so much, gave him a public funeral attended by large masses of the population.

Semon wrote,

We shall not see him anymore in the flesh: the little, slightly bent, lithe man with the parchment-like, somewhat yellowish, much-wrinkled face and the slightly grizzled hair, which remained practically unchanged during the thirty years I have known him, with the small, piercing eyes covered by spectacles, which he always pushed up when reading or when about to make one of his caustic remarks; with his dry, sarcastic, somewhat monotonous voice; with his rapid gait, with his quiet, unostentatious demeanor.



Figure 31: The inscription on the monument reads: A life full of hardship and work is not a burden, but a benefit. <https://www.gettyimages.com/photos/rudolf-virchow>.



Figure 32: Virchow and his wife Rose. [gettyimages.com](https://www.gettyimages.com)

Ackerknecht wrote,

Tremendous as Virchow's scientific contribution is, to the observer familiar with the work of others preceding and following him, it is likely to become more the link in a great chain than a lonely monument. What seems most unique in Virchow's contribution is his ability to do outstanding work in so many fields simultaneously—an ability in general lost in nineteenth-century scientists—the Faustian urge to explore continuously new things, and the extraordinary quantity of his achievements. Besides his research, crystallized in more than two thousand papers and books, besides his academic and popular teaching, his traveling, his political and administrative work, besides his editorial and organizational activities, he still found time to arrange and label with his own hands more than twenty thousand preparations and four thousand skulls for his Institute collection. There is something inhuman or superhuman in this dynamism, this tireless energy, this ceaseless work. Although his life looks in many ways uneventful in its regularity, security, and continuity, the incessant movement that fills it gives it an almost demonic quality. And at that, Virchow seemed never to be in a hurry!

And what of Virchow's health and zest for science? Ackerknecht wrote,

Virchow was favored by nature, not only through superior intelligence, but through an iron health. He never was seriously ill before his eighty-first year. Virchow's most precious gift from nature was perhaps his abnormally low need for sleep. He could do with five hours, occasionally with no sleep at all. This easily added twenty more years to his active life. Virchow's work was apparently never arrested by fear or by doubts in his abilities and in the righteousness of his cause.

Ackerknecht continued,

Virchow also continued his medical activities. He continued publishing original observations up to the very last; in 1874 he published his standardized autopsy technique. But his main role in medicine became now more and more that of the arbiter of international medicine. He participated in international leprosy and cholera conferences like those in Moscow in 1871 and in Stockholm in 1874; he made a leprosy survey of Spain and Portugal in 1880. He was no longer a leading figure only in the German *Naturforscherversammlungen*, but also in the International Medical Congresses of London (1881), Copenhagen (1884), Berlin (1890), Rome (1894), Moscow (1897), and Paris (1900). His linguistic abilities—he knew not only Latin, Greek, Hebrew, and Arabic, but spoke fluently English, French, Italian, and Dutch—were very helpful on such occasions.

HISTORY OF PATHOLOGY

PLATE XXXIII



THE WÜRZBURG PATHOLOGICAL INSTITUTE IN VIRCHOW'S TIME

Courtesy of Prof. Otto Lubarsch

Figure 33: The Pathological Institution at Würzburg in Virchow's time. Credit: <https://wellcomecollection.org/works/by6r2sm6>

Here is a wonderful story Ackerknecht included in his biography.

Virchow's tremendous international influence is reflected in the story of Ramon y Cajal's entrance into the Spanish Academy. In 1897 Virchow asked a Spanish dignitary passing through Berlin, "And what is Ramon y Cajal doing now?" The dignitary, who had never heard of Cajal though the latter was then already internationally recognized, informed himself immediately after his return and had Cajal elected to the Academy. Cajal used to say jokingly that he had entered the Academy "on the nomination of Virchow."

Many noted scholars who Virchow mentored added to his original foundational teaching. Among his notable students were Edwin Klebs, Adolph Kussmaul, Friedrich Daniel von Recklinghausen, and Max Westenhöfer. Kussmaul described medical signs and diseases which have eponymous names that remain in use. Among those are Kussmaul disease (also called Kussmaul-Maier disease) or Polyarteritis nodose, named after Rudolf Robert Maier (1824–1888). Kussmaul was noted to be the first to describe dyslexia in 1877 and called it "word blindness."



Figure 34: Virchow.

see [https://commons.wikimedia.org/wiki/Category:Rudolf-Virchow-Denkmal_\(Berlin\)](https://commons.wikimedia.org/wiki/Category:Rudolf-Virchow-Denkmal_(Berlin)) and <https://www.gettyimages.com/photos/rudolf-virchow.gettyimages.com>

The Rudolf Virchow Center (RVZ) is the DFG Research Center for Experimental Biomedicine of the University of Würzburg. It was started in 2001 as one of three German Centers of Excellence funded by the German Research Foundation, DFG. The founding chairman is Martin J. Lohse, a former coworker of Robert Lefkowitz at Duke University.

On the website, it is noted,

The center derives its name from Dr. Virchow, who was a professor in Würzburg from 1849 to 1856 and was the first to postulate that diseases originated in dysfunctions of cells. Researchers at the Rudolf Virchow Center aim to trace diseases back to dysfunctions of proteins. These are called target proteins because they may serve as targets for diagnostic tools or for therapeutic drugs. The Rudolf Virchow Center also organizes a graduate program and several undergraduate programs in biomedicine and experimental medicine and its Public Science Center offers courses for children and high school students and public events.



Figure 35: Rudolf Virchow Krankenhaus.

see [https://commons.wikimedia.org/wiki/Category:Rudolf-Virchow-Denkmal_\(Berlin\)](https://commons.wikimedia.org/wiki/Category:Rudolf-Virchow-Denkmal_(Berlin)) and <https://www.gettyimages.com/photos/rudolf-virchow>
gettyimages.com

The website continues,

The Charité – Universitätsmedizin Berlin, Europe's largest University clinic, is affiliated with both Humboldt University and Freie Universität Berlin. The beginning of scientific pathology at the famous Charité started in 1831. After the appointment of Rudolf Virchow as professor of Pathological Anatomy at the Charité in 1856, the first pathological institute of Germany was founded and Virchow established a dissection house. The Institute of Pathology of the Charité is still in the building which had been built to Virchow's specification. Finished in 1906, the building now bears the name of its founder, "Rudolf-Virchow-Haus." The collection of pathological specimens initiated by Virchow is part of the exhibition at the Berliner Medizinhistorisches Museum. More than half of all German Nobel Prize winners in Physiology or Medicine, including Emil von Behring, Robert Koch, and Paul Ehrlich came from the Charité. Even now, its medical school is one of the most prestigious and competitive in Germany, with admission rates lower than 5%.

In 1852, Rose gave birth to the couple's only son, Hans Virchow.

Hans studied medicine in Berlin, Bonn, Strasbourg and Würzburg, Germany. In the years 1877 to 1882, he was at the Anatomical Institute of the University of Würzburg. In 1884, he became a Privatdozent at the University of Berlin, and in 1889, a professor of anatomy. From 1886 to 1920, he taught anatomy at the Akademie der Künste.



Figure 36: Hans Virchow at the University of Berlin in 1902.



Figure 37: Virchow's grave.

Virchow's Personal Life & Legacy.

He married Ferdinande Rosalie Mayer in Berlin in August 1850. The couple had six children.

Their three sons were Karl Virchow, born on August 1, 1851, Hans Virchow, born on September 10, 1852, who went on to become an eminent anatomist, and Ernst Virchow, born on January 24, 1858.

The three daughters of the couple were Adele Virchow, born on October 1, 1855, Marie Virchow, born on June 29, 1866, and Hanna Elisabeth Maria Virchow, born on May 10, 1873.

On September 5, 1902, he died of heart failure and was buried in "Alter St. Matthäus-Kirchhof" in Schöneberg after a state funeral, which was held on September 9 in the "Berlin Town Hall" (www.thefamouspeople.com).

References

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- Semon in *British Medical Journal*, II (1902), 802.
- Most of Virchow's important medical and anthropological writings are enumerated chronologically in a small "Festschrift" edited by J.

Schwalbe on the occasion of the physician's 80th birthday: *Virchow-Bibliographie 1843-1901* (Berlin, 1901) covers close to 2,000 titles, and contains a valuable subject index. Pertinent archival material can be found in the "Nachlass Rudolf Virchow" of the Literatur-Archiv, Institute für deutsche Sprache und Litgeratur Deutsche Akademic der Wissenschaften, East Berlin (Gunter B. Risse).

EPILOGUE

Virchow used his immense curiosity and research skills to uncover the mechanisms of embolism, myelin, amyloid, and other entities. His boundless energy provided the springboard to cast a wider net due to his skills in microscopy. Virchow's adventures in microscopical pathology led him to discover leukemia and connective tissue disorders.

Virchow's work observing and reporting on inflammation set the tone for all future medical research. In the last few decades, our modern medical world has promoted inflammation as the central character in all of medicine and disease etiology. New terms have arisen, such as *inflammaging*, a chronic low-grade inflammation that develops with aging and accelerates the process of biological aging and worsens many age-related diseases.

Virchow was an excellent biologist, oncologist, and parasitologist and used his skill as a keen observer of the past to improve autopsy procedures and disease detection. As a professor and teacher, he poured out his wisdom to his students who would often come from all over the world to train with the Pope of Medicine and Father of Modern Pathology.

Virchow changed the course of all medicine with his reverence and disciplined work in cellular pathology and *Omnis cellula a cellula*. His cellular orientation and mantra to "think microscopically" had consequences for the future of medicine that are still reverberating today. Specialists in gene editing and the personalized medicine of modern chemotherapy give a respectful nod to Virchow for focusing on the primacy and elevated importance of the cell.

His work and research during a typhus epidemic in Upper Silesia in 1848 launched his social approach to medicine and epidemiology. His sensibility in politics and public health allowed him to treat society using a medical model. Virchow was one of the leaders against Bismarck in the constitutional conflict of 1862–66 and fought against militarism and anti-socialist laws.

Once Virchow put his energy into the world of Anthropology, he performed as he always did in any endeavor—making new discoveries, writing key papers, and forming unifying societies. He made important discoveries in comparative anatomy and skull growth. He carried out fieldwork to uncover prehistoric structures in northeast Germany and worked with Schliemann at Troy. One of Virchow's most important projects

was to undertake a major study of the racial composition of the German nation and to provide scientific structure to combat anti-Semitism.

“Into Virchow’s later years, in the years after 1870, fall great changes in German life and mentality,” Ackerknecht wrote. “Though Virchow was one of the last universalists and individualists in Germany, even he shows signs of the new times. After him, a sort of highly specialized and efficient obsequious anonymity would more and more hold the field.”

Throughout his life, he followed the words of an essay he wrote as a youth and proved that the spirit gains even greater strength in the process of striving, and that they thus attain even greater confidence and strength of character! I feel privileged to have “lived” with Dr. Virchow over the last four years. He has taught me that if you have drive and passion, for one or many subjects, you may be able to make wonderful new discoveries and leave the world a better place than when you arrived.

APPENDIX ONE

Early Work

Announcement for Graduation Examination
Easter, 1839

I, Rudolf Ludwig Carl Virchow, was born on the 13 October 1821, at Schivelbein, the son of Virchow the town treasurer there. My early years were uneventful and without any significant event that could have had a major impact on the future course of my life; few or almost no lasting memories therefore left an impression on my mind. I only know from stories of my parents that I was seriously ill at the time of cutting my teeth and that later on, I suffered from pneumonia. What I do dimly remember is that at a very early age, I used to look carefully at books with copperplates, and that their meaning impressed me, especially when they were of animals or plants. Whatever little story my nurse told me remained in my memory, and I would then repeat it with great delight. Due to my great thirst for knowledge, I learned to read and write almost as a game from my father, in whose study I therefore loved best to spend my time. Thus prepared, I came to the town school in my seventh year, where I easily won the satisfaction of my teachers, but by mixing with rougher classmates, I also acquired certain vices. Although it was often distasteful to be in their company, the affection they bestowed on me captured my youthful love of honor, and I was especially pleased by the title of king. I gradually advanced to the highest grade, which was taught by the headmaster, and in a short time, I became the first among my classmates. At this time, the rector himself gave me private lessons in foreign languages, Latin and French. Since his knowledge of these subjects was limited, my father, who was greatly concerned about my intellectual and physical development, induced the minister, Mr. Benekendorff, now senior Protestant minister, to set up a private school that I too would attend. In this school, I received a good foundation in such subjects as religion, history and Latin, although I was still very young (at that time I was not yet nine years old). However, when Mr. Benekendorff was moved to close down this school after two years, I had no choice but to return to the rector's school. The rector, who evidently overestimated my knowledge, left it to me to teach some beginners the elements of the Latin language, and while doing so, I myself forgot the little I had learnt. My father, who realized the ineffectiveness of such teaching, finally succeeded in persuading the minister, Mr. Gantzkow, to give me and a few others

private lessons. After having accompanied my father on a long journey to Falkenburg, Dramburg and Kallies, I entered this school in the autumn of 1832. After Mr. Gantzkwow had taught us for six months, during which he had to start from the very beginning in each subject, the disparity among his pupils made him decide to close his school. At my father's request, however, he agreed to give me alone further private lessons. For two years I had the pleasure of these lessons, and the pains my esteemed teacher took will certainly always be a blessing to me and ensure to him my sincere gratitude. I made excellent progress in the classical languages and in French, so that I encountered no great difficulty in reading Caesar and Ovid, the *Odyssey*, and the French *Robinson*. At last, the moment came when my honored teacher declared that he had kept his word and that I was now mature enough to enter the *Tertia* of a *Gymnasium*. That was a time I had yearned for but would also have liked to postpone; a time when I had to leave my beloved parents, dear teachers, playmates, the house where I was born, the corridors where I had played—in short, everything that was dear to me and from which I had hardly ever been separated. So, on May 1, 1835, I left my home with mixed feelings, to travel with my father to Koslin, where I was to attend the *Gymnasium*. After I had passed the tests, I was allotted the last place in *Tertia*. The hustle and bustle of a larger town and the excitement of life there helped me to bear the separation from my dear ones. The new, or at least newly treated, subjects stimulated my interest to the utmost, and the praise I received from some of my teachers encouraged me to seek the same from the others. I had my greatest difficulties in mathematics, because on one hand, I knew nothing of the theory of equations, and on the other, I was completely without practice in applying planimetric theorems for constructing geometric figures. Yet my teachers were kind enough to overlook my various shortcomings, and on St. John's day, they placed me higher in the hierarchy of the class. On St. Michael's day of the same year, I was promoted to *Sekunda*. Since this happened after the holidays, it came about that I could celebrate my birthday, the presence in Koslin of my dear mother and my promotion on the same day. The latter was of the greatest significance to me. Elated by the confidence my teacher placed in me, impelled by my ambition to be held in esteem in the new class and attracted by the novelty that characterized all the subjects, I did my utmost to see my efforts crowned with success. After the first semester, I was promoted to *Obersekunda*. While I speak of my progress and knowledge, I ought not to conceal the fact that I too had been infected by the bad spirit that prevailed in *Sekunda* at the time, and on more than one occasion, I offended my dignified teachers. Only too soon, though well in time for me, I experienced the consequences of such very frivolous conduct. It was at Christmas in 1836 that the worthy faculty deemed it necessary to be guided only by the quality of conduct in determining the new hierarchy in the class and I must confess to my shame that, although once placed second in the class, I was demoted to the last place in *Obersekunda*. This just treatment made the deepest impression on me, and from then on, I watched more carefully to dispel all bad thoughts

from my heart. To this contributed the fact that on St. Michael's day in 1836, I started attending the confirmation class of the chief clergyman, Mr. Naatz. Here I was constantly encouraged to purify my heart and sentiments. At Easter 1837, I was the first among the pupils promoted to Prima. On Palm Sunday, the day of confirmation, I was given the privilege of reading in the Church of Our Lady the confession of faith on behalf of all those being confirmed. I now felt extremely elated and gained greater self-confidence. While I was in Prima, I studied less than I could have, but I never failed to do my homework. I was often distracted by the many new acquaintances I made on entering Prima and was sometimes hindered in my private studies. However, I can certify that even while amusing myself, I always saw to it that I kept within bounds and, most of the time, with success. Further, I never indulged in amusements to the extent of letting my homework suffer or, for that matter, endangering my health. The good spirit prevailing among most of the members of Prima was a constant help in my endeavors and I could, therefore, often devote some time to my favorite studies, namely science, history and geography. I could also improve myself by reading such classical authors as Cicero, Sallust and Sophocles as well as modern German and French writers. This exercise made me realize how little I really knew, but my personal circumstances compelled me to sign up for the school-leaving examination so as to be able to begin the study of medicine as soon as possible.

Graduation Examination at the Köslin Gymnasium

Easter, 1839

German Essay

Subject: A life full of work and toil is not a burden but a blessing

Ask the warrior when he returns from a bloody battlefield, with his strength drained by combat, whether he would still be willing to return again to the horrors of war; the longing for hearth and home, for peace and rest, will surely override his lust for battle, even in the midst of the intoxication of victory. And after he is back in his native fields and has exchanged the blood-stained sword of Mars for the peaceful plow of Ceres, ask him on the evening of a hot summer day, when he comes back to his village as weary and exhausted as his bullocks, whether he looks forward to still another such day of labor and whether he is happy to undergo such hardships; I am sure that he will wish that a beneficent providence had been kinder to him and bestowed on him a more favorable and peaceful lot. For men are so made that they consider a life full of work and toil a burden. When confronted with problems they often sigh and wish them miles away. They fail to realize that it is precisely in this way that He who is all goodness and wisdom guides our destiny and provides for all. You may ask the whole human race, but you will scarcely find one person who does not share such views. Even the businessman and the scholar, whose higher education should make them

more receptive to the wise guidance of God, would, when weighed down by work, only too frequently conform to the general view, even though in their leisure time they may express a contrary opinion. Such is the corrupt tendency of so many of our contemporaries that while the proverbial honey drips from their mouths, their hearts are filled with sharp knives. They may even talk of the merciful hand of God, and in their hearts doubt His existence. But had they defined their concepts with more clarity, they would realize that the hand of God necessarily shows itself in what seem to be chance events, and also that He had provided for their well-being in the best possible manner by allotting them a life full of work and toil.

Let us now consider the physical welfare of man. What could be more pleasant and desirable for him than to be perfectly healthy? What other feeling can exalt a man more than the one that fills his bosom when he walks the earth with the full vigor of youth or manhood? And how else can he maintain and improve his health if not by dint of perseverance and incessant labor? Hard work steels his arm and toughens his fist, it increases his stamina, ensures purity of the blood—in short, it favors the enhancement of all his energies, improves his health in all respects and protects him from disease. Of course, a scholar or a businessman might say, “of course it is true that a farmer, who is continuously exposed to the vitalizing effect of fresh air will keep fit if he is constantly engaged in work, but does this also apply to us? Just see how our bodies are degenerating! how weak we have become! how the constant sitting in a musty room pales our cheeks and extinguishes the fire in our eyes!” Fools, who notice physical degeneration alone, which might be more rapid than would have otherwise been the case, and fail to see that the spirit gains even greater strength in the process of striving, and that they thus attain even greater confidence and strength of character! Is it to be considered no reward that even in the face of physical degeneration their spirits soar ever higher? For not only must the lower faculty, the memory, be trained to function more effectively, but also, and more importantly, our intelligence must be developed to the peak. This constant process of learning and sharing, combining and separating, processing and developing various thoughts, of which we have so far only a vague notion but have not acknowledged the full import, must in the course of time lead to a certainty of ideas, a clarity of concepts and sharpness of intellect that may be considered the highest achievement of human intelligence. It is by incessant work that we learn about real life; it is thus that we gather over the years, a far richer store of experiences and draw on deep, unfathomable treasures of wisdom accessible only to the initiated and not to lazy and idle persons given to rest and ease. Whereas the latter sink ever deeper in the mire of indolence, the spirits of the former soar ever higher to the clear light; whereas they may be led by their enervating fantasy to indulge in dreams and create myriad forms to stimulate their sensuality and perhaps trap themselves in a whirlpool of vices, in others the fantasy creates bold images of power and determination, of purity and beauty, thus

inspiring them to exalted deeds that benefit humanity. Their cravings subside and the pull of the material world that threatens to peg them to the ground and hold them back, given over to the reign of sensuality, and to hamper the free flight of their spirits, becomes weaker. Their character becomes all the more pure; purged of all impurities it sparkles, reflecting virtue and sublimity; pure and luminous, it appears to us as the divine and sacred will of the Creator [as he] wanted it to appear and, notwithstanding a blot or two of human weakness, we cannot but look up to it with great respect. It seems to us an apostle of the Highest, equipped with supernatural purity and sent to us sinners to be a wondrous example of how we should lead our lives so as to become more morally perfect; it stands before us as an initiate of Divinity who, with clear and vivid perception, dissipates those impenetrable clouds that hide the unknowable Divinity and restrict the mortal view to little more than the narrow sphere of the solar system. But such perfection, such moral strength, is unreachable by the ordinary man, indeed almost unthinkable. But this ought not to alarm him; instead, he must at least strive to approach such perfection as closely as possible. For it is, after all, the greatest happiness for a man to know that his soul is free from coarser blemishes, that the greatest triumph of his mortality comes when he can say that he has only rarely acted in a manner other than he should have acted. Is it not the supreme blessing of God which He bestows on human beings, that through work and toil they may reach this pinnacle of life? Will a mere mortal now undertake to dispute the will of the Highest and seek to master it? No, let him peacefully submit to the will of God, let him learn to perceive it in all clarity, and his zeal is bound to yield the finest fruits! Strong and healthy as the energetic youth of Rome and Sparta, clear-sighted and wise as the eminent thinkers of Hellas, exalted and morally distinguished as the Judean prophets, he will stand there, a shield to his contemporaries and a beacon to posterity. Even if he fails to achieve all this at once, his ambitious striving will at least provide and even increase his health and intelligence, and this he must struggle to attain with all his strength and effort. He may indeed thereby still be far from achieving his goal, for "life is a serious business," and the palm of morality must not be missing if he wishes someday to face the throne of the Almighty in all dignity. However hard he may find the battle against sensuality in his heart, let him bravely wage the war, and glory to him if he comes forth from it as victor!

APPENDIX TWO

Cellular Pathology (excerpt)
RUDOLF VIRCHOW
CELLULAR PATHOLOGY
[From Cellular Pathology, Chapter 1]
THE CELL THEORY

The present reform in medicine, of which you have all been witnesses, essentially had its rise in new anatomical observations, and the exposition also, which I have to make to you, will therefore principally be based upon anatomical demonstrations. But for me it would not be sufficient to take, as has been the custom during the last ten years, pathological anatomy alone as the groundwork of my views; we must add thereto those facts of general anatomy also, to which the actual state of medical science is due. The history of medicine teaches us, if we will only take a somewhat comprehensive survey of it, that at all times permanent advances have been marked by anatomical innovations, and that every more important epoch has been directly ushered in by a series of important discoveries concerning the structure of the body. So it was in those old times, when the observations of the Alexandrian school, based for the first time upon the anatomy of man, prepared the way for the system of Galen; so it was, too, in the Middle Ages, when Vesalius laid the foundations of anatomy, and therewith began the real reformation of medicine; so, lastly, was it at the commencement of this century, when Bichat developed the principles of general anatomy. What Schwann, however, has done for histology, has as yet been but to a very slight degree built up and developed for pathology, and it may be said that nothing has penetrated less deeply into the minds of all than the cell theory in its intimate connection with pathology.

If we consider the extraordinary influence which Bichat in his time exercised upon the state of medical opinion, it is indeed astonishing that such a relatively long period should have elapsed since Schwann made his great discoveries, without the real importance of the new facts having been duly appreciated. This has certainly been essentially due to the great incompleteness of our knowledge. With regard to the intimate structure of our tissues which has continued to exist until quite recently, and, as we are sorry to be obliged to confess, still even now prevails with regard to many points of histology to such a degree, that we scarcely know in favor of what view to decide.

Especial difficulty has been found in answering the question, from what parts of the body action really proceeds—what parts are active, what passive; and yet it is already quite possible to come to a definitive conclusion upon this point, even in the case of parts the structure of which is still disputed. The chief point in this application of histology to pathology is to obtain a recognition of the fact that the cell is really the ultimate morphological element in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell. Before you, I have no particular reason to justify myself, if in this respect I make quite a special reservation in favor of life. In the course of these lectures, you will be able to convince yourselves that it is almost impossible for anyone to entertain more mechanical ideas in particular instances than I am wont to do, when called upon to interpret the individual processes of life. But I think that we must look upon this as certain, that, however much of the more delicate interchange of matter, which takes place within a cell, may not concern the material structure as a whole, yet the real action does proceed from the structure as such, and that the living element only maintains its activity as long as it really presents itself to us as an independent whole.

In this question, it is of primary importance (and you will excuse my dwelling a little upon this point, as it is one which is still a matter of dispute) that we should determine what is really to be understood by the term cell. Quite at the beginning of the latest phase of histological development, great difficulties sprang up in crowds with regard to this matter. Schwann, as you no doubt recollect, following immediately in the footsteps of Schleiden, interpreted his observations according to botanical standards, so that all the doctrines of vegetable physiology were invoked, in a greater or less degree, to decide questions relating to the physiology of animal bodies. Vegetable cells, however, in the light in which they were at that time universally, and as they are even now also frequently regarded, are structures, whose identity with what we call animal cells cannot be admitted without reserve...

...It is only when we adhere to this view of the matter, when we separate from the cell all that has been added to it by an after development, that we obtain a simple homogeneous, extremely monotonous structure, recurring with extraordinary constancy in living organisms. But just this very constancy forms the best criterion of our having before us in this structure one of those really elementary bodies, to be built up of which is eminently characteristic of every living thing—without the pre-existence of which no living forms arise, and to which continuance and the maintenance of life is intimately attached. Only since our idea of a cell has assumed this severe form, and I am somewhat proud of having always, in spite of the reproach of pedantry, firmly adhered to it, only since that time can it be said that a simple form has been obtained which we can everywhere again expect to

find, and which, though different in size and external shape, is yet always identical in its essential constituents.

In such a simple cell we can distinguish dissimilar constituents, and it is important that we should accurately define their nature also. In the first place, we expect to find a *nucleus* within the cell; and with regard to this nucleus, which has usually a round or oval form, we know that, particularly in the case of young cells, it offers greater resistance to the action of chemical agents than do the external parts of the cell, and that, in spite of the greatest variations in the external form of the cell, it generally maintains its form. The nucleus is accordingly, in cells of all shapes, that part which is the most constantly found unchanged. There are indeed isolated cases, which lie scattered throughout the whole series of facts in comparative anatomy and pathology, in which the nucleus also has a stellate or angular appearance; but these are extremely rare exceptions, and dependent upon peculiar changes which the element has undergone. Generally, it may be said that, as long as the life of the cell has not been brought to a close, as long as the cells behave as elements still endowed with vital power, the nucleus maintains a very nearly constant form....”

APPENDIX THREE

One Hundred Years of General Pathology (1895) (Excerpts)

THE CENTURY WHOSE TERMINATION the Friedrich Wilhelm Institute of Medicine and Surgery intends to celebrate brought to medicine the greatest transformation that it has ever undergone. To pursue this transformation through the many branches of science that we group together under the name of medicine would be so great an undertaking that it would not be suited to the present *Festschrift*. The task whose accomplishment will be attempted here must therefore be more narrowly bounded; it will be limited to a presentation of the transformation in scientific fundamentals requisite for the development of all branches of medicine.

A change approaching this in magnitude had taken place only once before in the history of our science, when the old school of humoral pathology collapsed in the sixteenth century. More than two thousand years had passed by without an essential transformation of the basic viewpoint regarding the nature of disease. The repeated attacks of the solitary pathologists had passed by without touching the roots of the system, though not without leaving behind visible traces. The doctrines of the school of Kos had become established in the minds of men, and their dogmatic development by Galen had, with each century, become more and more recognized as the correct presuppositions of medical thought. Indeed, they dominated the popular viewpoint as well, to such an extent that they even attained the sanction of the ruling churches, oriental as well as occidental. In the Middle Ages, the great Dogmatist was without cavil given the rank of a Father of the Church; his writings were missing from no monastic school.

It is no accident that this tremendous changeover occurred at the time when the reformation of the Church was stirring all minds to their depths. Vesalius and Paracelsus were no less fortunate in their attacks on medical dogmatists than Luther and Calvin in their battle against those of the Church. Indeed, their success was even greater, for there was no country that afterwards continued to grant the old humoral pathology a secure right of domicile. Both men are usually called medical reformers; in reality, they were more, for they created a complete *tabula rasa*. Their achievement would surely have been called revolutionary if it had taken place in the political realm.

In the minds of later generations, appreciation of this revolution has greatly weakened; this is probably the reason why it has been passed off as no more than a reformation. On the one hand, this is due to the circumstance that neither of the two men devised a substitute for the firmly wrought doctrines of the humoral pathologists. Vesalius limited himself to purging human anatomy of the errors of Galenism and creating a generally valid basis, elaborated in a purely scientific spirit, for a conception of the human being. Paracelsus, to be sure, went further, but his doctrine, which rested primarily on alchemistic presuppositions, even in the beginning lacked the security required for permanence; more and more of its statements proved untenable as more and more was learned about the composition of bodies during the transformation of alchemy into genuine chemistry. On the other hand, the necessity for some new kind of medical system could not be repressed. The first firm basis for such a system was believed to have been found a century later, when William Harvey demonstrated the circulation of the blood and thus taught us of a fluid that constantly streams through the body, reaches all parts, and influences them to a greater or lesser extent—thereby satisfying the demand for a homogenous material common to the whole body and to all process[es] in it.

... Disease will always have to be considered an altered vital state of larger or smaller numbers of cells or cell-territories, and, whether the cause of the disease circulates in the blood or arrives directly at the cells, our evaluation of the relationship of the primary causes to the cells will not change. Even immunization must in the last instance be related to living cells, regardless of where they are to be found. Science will surely discover the means to solve this problem.

Thus, we see ourselves now at the conclusion of a century of hard work, not at the goal, but amidst a constantly increasing group of eager workers and in possession of new and highly improved methods and tools for investigation. Our understanding of disease is in accordance with the strictest demands of exact scientific investigation, and if the possibility of its interruption from time to time by arbitrary interpretations and speculative reveries has not been excluded, yet our science has become strong enough to follow the path unerringly in spite of all hindrances. May the coming century not stumble on this path! May a later generation, even after another one hundred years, still hold the banner of natural-scientific investigation as high as it is now held! Though that time may see advances still greater than those on which we labored together, yet no one will deny this expiring century a significant place in the history of medicine, a place more significant than that achieved by any earlier century.

The Berlin Pathological Institute can be regarded as an indicator of official esteem. From what was fifty years ago nothing more than the “morgue of

the Charité," with extremely modest facilities, the Pathological Institute became in 1856, after the very incomplete attempt I made in Würzburg, the first great independent pathological institute in the world. In spite of considerable enlargement and improvement in 1876 and thereafter, we face once again the necessity of rebuilding in order to satisfy the greatly increased demands of instruction and investigation. In the course of a few decades, every German university had added a pathological institute, and foreign countries are gradually beginning to follow this example. Simultaneously, numerous clinical institutes have been provided with scientific laboratories. Thus, the new century begins with the confident hope that the path of independent pathological investigation is permanently secure.

APPENDIX FOUR

ANTHROPOLOGY IN THE LAST TWENTY YEARS

By Dr. RUDOLF VIRCHOW, of the University of Berlin.

Translated by Rev. C. A. Bleismer.

Nearly twenty years ago, the foundation of our present union meeting was laid on Austrian soil. A few men attending an association of naturalists, at Innsbruck in 1869, formed themselves into a separate section, which held its session in a small auditorium of the university.

Of that number, my countryman, Koner, has since died, but the rest are still living, among them Karl Vogt, Professor Semper (first general secretary of the German Anthropological Society), Professor Seligman, of Vienna, and some others.

And as I see with us Count Enzenberg, the secretary of that section, there are here at least two representatives of that memorable day.

Every member of that little gathering was fully convinced that Germany and Austria ought to be united in anthropological matters and that only through united work could any success be expected in anthropological investigations. A call was published for the establishment of a General German Anthropological Society, which should unite all German workers, including the German Swiss and the Germans in Austria.

At a subsequent meeting held in Mayence, in May 1870, for the purpose of drafting a constitution, a number of Austrians participated and the articles were purposely framed in such a manner as to include German Austrians. But circumstances are frequently more powerful than the intentions of men.

The current of opinion during the period following this meeting was contrary to our purpose, which represented ideas based upon an unprejudiced consideration of events. Previously, in 1869, there had been formed an Anthropological Society in Berlin, the first one in Germany, also a separate society in Vienna, but only the Berlin society became a branch of the General German Society. It seemed impossible for some time to find any direct point of contact with the society in Vienna, although there was no variance between them and us. Individual members—as I most gratefully admit, (among whom our president, Baron von Andrian, is one)—often expressed their regret at our lack of union.

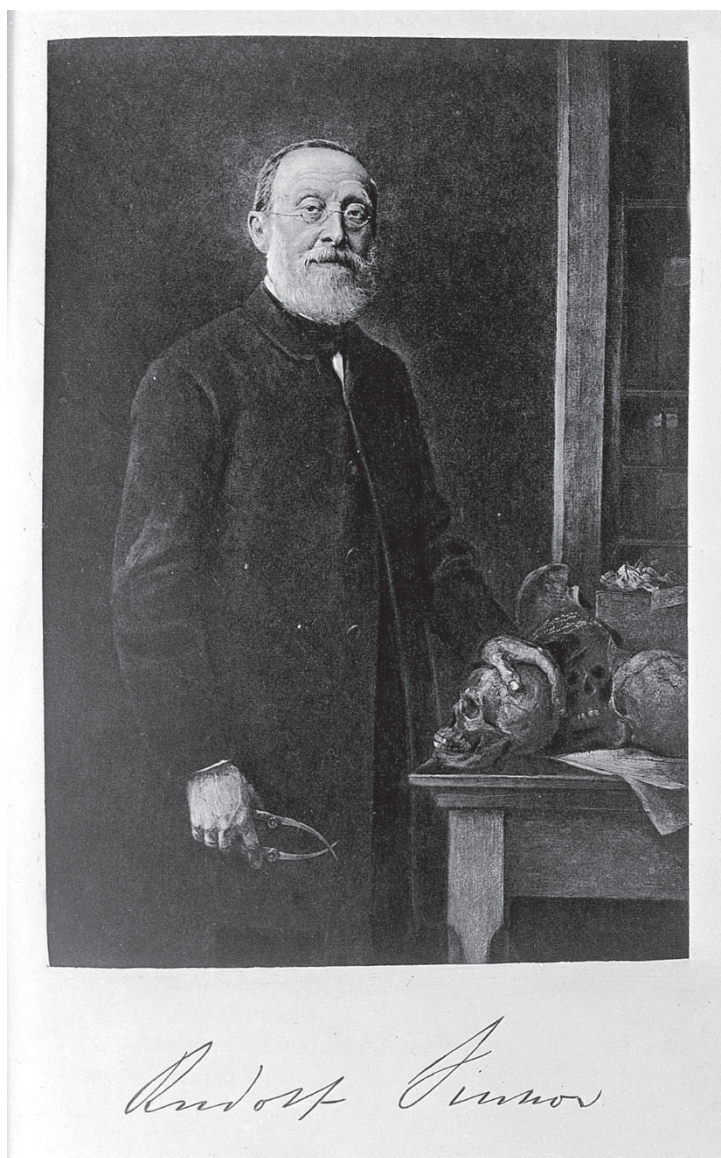


Figure 38: Portrait of R. L. K. Virchow from a brochure issued in 1901 for the dinner in honor of the eightieth birthday of Pr. Virchow. Credit: <https://wellcomecollection.org/works/kcums9kw>

In 1881, the first attempt to bring about a union was made when the German and the Austrian anthropologists held their general meetings successively at Regensburg and Salzburg, both attending each other's session. Since that time, the idea of union gained strength until it was realized in our present joint meeting; and may a sentiment of union be developed that shall complete the work which we began.

You all understand that this question of nationality is a very important one in an anthropological sense.

We must always start from what is known; our question is that of habitat. And here we differ from the zoologist, who is only to a limited degree concerned about this question. Not until we know whence a person came and where he lived is he a legitimate subject of anthropological investigation. This holds true also with respect to a human skull. An unknown skull may be momentarily of some interest, but from a scientific standpoint, it is of no importance until its habitat has been determined.

It is a very difficult matter to make collectors of skulls understand that not merely skulls, but skulls of persons or tribes are needed, that can be identified as regards their habitat. Then only are they of any anthropological value to the investigator.

A skull per se is of very little account to us, but when its nationality is known, it begins to exist, so to speak. We must not forget, moreover, that our conceptions of nationality are largely based upon our present relationships, and that these become of less value the further back we go, and that they are of no value at all when we reach the period in which clearly defined nationalities are not known.

Every evidence of nationality ceases in prehistoric times; it is then a mere abstraction. There, nationality has to be made up and a nomenclature adopted which can be at best only a designation for a certain period, valueless in itself and unintelligible to future times. To be sure, to talk about a race of Cannstatt or of Cro-Magnon may sound very learned, but I hope that ere long such a phraseology will be discarded.

At present, questions of nationality can be settled only with great difficulty. We may be sure of being tolerably successful if we select some island of the Pacific Ocean. There, nationality is fully developed and its people are tangible; every one of them is easily recognized as belonging to a distinct nationality, and our experience is similar to that of the geologist who can construct a whole species from a single, or at most only from a few skulls of animals, or who at any rate can determine from a single skull the craniology of the whole species. It would be very pleasant to be able to trace the history

of a whole tribe whenever a skull is found, but unfortunately, we are too often confronted with such complicated variations that we lose all data for making out the nationality. But in an island of the Pacific Ocean, which possesses much more scientific interest than political importance, we find an analogy with animal races, viz: races of men, developed in circumscribed surroundings, with definite characteristics, easily pointed out, who represented a distinct type. Much to our regret, this can be done only very infrequently in the case of continental tribes or nations. To determine the question of nationality with regard to a European would take many days.

Permit me to emphasize right here that we as anthropologists have little right to thrust into the foreground the idea of nationality, in a narrow sense of the word. We know that every nationality, take for instance, the German or the Slavonic, is of a composite character, and that no one can say, on the spur of the moment, from what original stock either may have been developed. We usually call the Germans blonde and the Slavonians brunette, yet just as great variations in this respect can be found among the Germans as among Slavonians. Indeed, northern, southern, eastern, and western groups of either nation present such a large number of variations that it is just as difficult to assert that the Germans came from a common stock, as is the case with the Slavonians. Consanguinity and heredity have been urged as an explanation of these differences, but it has been proven that certain Slavonic groups are more nearly related to the Germans than to their own Slavonic brethren. If we compare the blonde element among the Poles and Galicians with the brunette Slavonians of the south, it is found that they not only differ with respect to color of skin, of eyes, and of hair, but also in a very marked degree in the structure of their skull; so much so indeed that the former show a greater affinity to our German tribes than to the Slavonian. In Northern Germany, matters are still more intricate. There, in some of the old burial fields, skulls are found which might be called Germanic, were it not that they clearly possess Slavonic added character, so that for the present at least, these fields must be considered Slavonic burial places. To make the case still stronger, there are found in the famous grave-rows (*Reihengräber*) of the period of the Franks or of the Merovingians, with their characteristic ornaments and weapons, skulls which very distinctly present the peculiarities of the Germanic type. Corresponding to these in an anthropological sense, a large number of graves have been opened in the east of Germany where similar types of skulls are found; but these are lacking in Frankish peculiarities and are characterized by Slavonic marks. Greater contrasts than these cannot be imagined.

It is at present an impossibility and probably will be for all times to trace back to a common type either the Slavonic or the German tribes. When we compare the short and thick skulls of our Alemannic brethren with the long and low skulls of the Frisians and Hanovefians, it is evident that they differ more from each other than is the case with skulls of certain Slavonic or

German tribes. Consequently, we must give up the idea of an original consanguinity in respect to each one of the historic nationalities. We do not possess as yet any known conclusive series of observations by means of which it can be demonstrated that from dolichocephalous families there have been developed brachycephalous individuals, such as we find among Slavonic or Germanic tribes. It may be possible by means of cross-breeding to develop in the process of time from a dolichocephalous family a brachycephalous one, but actual proof of this has not as yet been produced. Hence, we are compelled to adopt as a solution the theory of "mixed races." A mixed race is one whose elements are people of different blood, not of one blood: it is one which cannot appeal to a common origin but which in the course of time was made up of elements of different original races. This theory causes us, as you easily see, to attach but little importance to nationalities as such existing at present. It will be our task to determine the localities of the original elements of this mixture, and to ascertain whence came these brachycephalous and these dolichocephalous peoples. Somewhere there must be a starting point for each of these categories, since upon an anthropological map these distinctions are marked with geological clearness. This difficulty not only exists in Germany or Austria but also in Russia. What are now called Russians are made up of a very composite mass of elements, derived from the farthest parts of Asia from Turanian and Mongolian stocks. Hence our colleagues in the East are in no less a quandary than ourselves. They too meet wide differences between north and south, east and west.

In the popular mind, these questions are very easily considered to be concerned merely with a single nationality, but we must not only try to solve them in respect to one nation, but for the whole of Europe. In attempting to do this, our investigations carry us further and further from a consideration of their special relation to individual nations. I may be permitted to say right here, that we are all especially interested to see such investigations carried on in this Austrian Monarchy; for Austria in its peculiar development has preserved in greater purity the remnants of old nationalities than any other state in Europe. Everywhere else, the change of former environments has gone on to a larger extent; the remains of antiquity have been crowded back so far that at present it is very difficult to make collections of the very oldest remains.

We are now occupied with the establishment of a museum in Berlin for German costumes and domestic utensils; we intend to preserve in it everything that can yet be saved from destruction. In some localities, the very last relic has been secured for our museum. Here and there we meet with lingering recollections of primitive days, but these cannot be compared with the living realities in so many districts of Austria.

A reference to dead and living languages will make plain this contrast referred to. For while a dead language may indeed be studied, the investigation of a living language secures to a greater degree a comprehension of its fundamental elements, than the mere study of authors, each one of whom expresses his own individuality. So that we lose sight of the fact that this individuality of the author studied cannot be the portrait of the thoughts of the people to whom he belongs. On this account, we notice with especial gratitude the efforts along that line, which are gradually spreading throughout all Austria and of which the late Crown Prince Rudolf was the acknowledged leader.

Extensive labors were carried on under his direction and by reason of his personal participation in them promised to yield rich returns of trustworthy reports taken from life concerning the nationalities of Austria. Today the place is vacant in which he hoped to stand; at the throne we were considering the establishment of this congress; and it is fitting that I should voice the sorrow of all on account of the loss which this great country has sustained in him who seemed to be one of the most humane princes of this century. We trust that the idea bequeathed to us in his words will not be lost, but prove a precious heritage to Austria, which will be carried on by her to completion. It will be our aim to do all in our power to foster a spirit of union with our neighbors, which is so essential to the success of such an undertaking.

In the department of archeology, you have made large advances during the last few years, completely overshadowing the rather slow progress of former years, which caused at times a little feeling of impatience in the bosom of your superintendent. Those of us who saw yesterday your new buildings and your finely arranged collections were obliged to ground their weapons. We can no longer keep up our rivalry in view of such magnificence and completeness. Such a palace of science as your Imperial Natural Historic Museum can be found nowhere else, and we too, though strangers, must praise most highly the beneficent plans of His Majesty the Emperor, as well as of the Government, which have been executed in such an admirable manner. Here we find revealed the incredible riches of prehistoric materials belonging to Austria. Scarcely can there be found anywhere else a museum surpassing this one.

We are always sure to see in Austria, every possible effort made to put into execution any views which have fully gained ascendancy. I hope therefore that under the direction of Mr. von Hauer, with the assistance of such accomplished investigators as are here to be found, a further development of the prehistoric archeology of Austria may take place and reach such a degree of perfection that the different branches of local types will be arranged into a comprehensive whole.

Several years ago, we differed widely concerning the interpretation of certain local finds. At that time, the most noted Austrian investigators thought that the original seat of European civilization must have been in the mountains of Austria, while the Germans contended that the starting point must be looked for farther south. I myself, although recognizing the importance of this local development, was in favor of the German theory. It seems to me that every day, the bonds are made stronger of a definite connection among the nations of the north and south as regards their civilization.

My own travels in places of ancient human civilization, as well as a study of recent literature, convince me that the numerous finds made in Egypt and Babylonia prove conclusively that the origins of our civilization are to be found only to a small degree in our own country, or that they have arisen out of individual necessities, but that on the contrary, there exists a connection with the prehistoric times of those nations of ancient civilizations, and that from them there have been derived our present lines of culture. I will not say anything further concerning this point, only to call your attention to a publication of investigations in our *Berliner Zeitschrift für Ethnologie* concerning old weights and measures. These investigations demonstrate again the fact that our present weights and measures existed in all their details in remotest antiquity and were at that time in common use, that our modern measures correspond to the old as far as one-tenth of a gram, and that we therefore have not made any advancement in respect to them since 4000 B.C.

I have stated elsewhere that only a few people can be called inventors. At times it happens indeed that similar inventions are made at the same time in different places, and that the same ideas make their way in different directions, and it is said at such times, "these things were in the air." But it is not in the air but in living human beings where such things exist. Yet if at times two men arrive at the same thing, a closer study proves that after all, there is a difference. Everywhere, whenever we can follow the history of human culture in individual things, we find that it was not the work of the masses which determined the great lines of civilization, but the work of individuals, or of individual tribes, or of individual nations, if you please. Not only in our study but in other matters, however, we met with numerous contradictions which for a long time impeded the discovery of the true direction of civilization in general, and the connections of the civilization of different countries. This difficulty is so great because first of all, a mass of antiquated traditions remaining until the present must be discarded in order to determine this question aright. There are in Europe, perhaps three or four museums in which Caucasian antiquities are more richly represented than anywhere else, and among them your Imperial Museum here in Vienna occupies a prominent place.

Until a very recent period when these collections came to Europe, it was a rigid dogma of philologists and archeologists that the bronze vulture had its origin in the Caucasus. Its impossibility has now been proven, for we do not find bronze of a primitive form or mixture in the Caucasus, but of the same composition as that found in Greece and Italy, and at the same time in an advanced state of development that clearly proves it to be an importation. Whether single articles were imported or only patterns and a knowledge of the art of making bronze matters little. At any rate, the invention must have been made in another place.

By examining different countries and nations, we succeed in narrowing the territory until by keeping on, we may find the point of beginning of bronze manufacture. We shall probably be unable to find the original inventor, but we shall learn the steps which mankind has taken in its advance regarding bronze manufacture.

It may be mentioned at this point, that just such considerations as these enable us to cast a retrospective glance upon the last twenty years, and to exhibit the progress made by us in the science of archeology. The science of prehistoric archeology twenty years ago had reached in but few places its full development. At that time, the museum at Copenhagen was so far ahead of all others that it was considered as an unattainable prototype; next to this was the one at Lund, and later on the one at Bergen. Here there was exhibited a seemingly circumscribed field of civilization which was called for brevity the Scandinavian. The Scandinavians indeed went so far as to believe that their remote ancestors had invented these things, and that only at the time of the Romans had there taken place an influx from without. The aged Nilsson with his Phoenician hypothesis stood all alone. Matters have changed considerably since then. Many Scandinavians to be sure still defend the old view, by pointing out the great development which the older bronze exhibits in the north, but none of them seriously believe that the invention of bronze was really a northern achievement, even though the manufacture in bronze shows numerous northern peculiarities. We take in like manner Chinese patterns and copy them, but although by modifications, the style may be called at last German or Austrian, the Chinese origin never disappears entirely. Among us scarcely anyone believes in the Scandinavian origin of bronze. At present we may assume that our Scandinavian friends are convinced that bronze came to them as a finished thing. The formula of its composition was invented before it came to the north. Although special peculiarities have been developed and although the art of bronze manufacture seemed to flourish more independently in the north than in the south, nevertheless they must admit that their ancestors were not the inventors of bronze. Here I think lies the main difference between the former and the present theory. Formerly it was thought that the secret lay concealed in the north, that there the origin of our metallurgical art was to be found and that there had lived the original smith from whom our people had inherited

their technique. During the last two decades, another view has found much favor, and for many good and strong reasons, it is called the Indo-German or Aryan theory. Interesting investigations were made to prove how the Indo-Germans, in their immigrations from the east and from the central parts of the mountains of Asia, had brought with them on their advance toward Europe all sorts of things and formulas, not only the knowledge of the smelting of bronze, but also precious stones like nephrite and jadeite. But this Indo-Germanic theory has received lately some very damaging blows and none more destructive than from the quarters of prehistoric archeology.

In spite of much care, we have not as yet succeeded in finding any patterns in the supposed Asiatic home of bronze. I myself have made strenuous efforts to find original Indian bronzes, but have not obtained types which would justify the statement that this importation alluded to ever took place. Not even sufficient proof can be found for saying that the classic formula of 90 parts of copper and 10 parts of tin was in use in India. This formula remained as constant as the measures of weight and length. Both facts present a good argument for the existence of a continuous communication of knowledge from one generation to the next.

Indian bronzes are zinc bronzes, like mixtures found in our country belonging to the time of the Roman empire. There are no authentic specimens of them found in Europe dating before the Christian era. Prehistoric archeology therefore at the present offers the poorest kind of testimony for the Indo-Germanic origin of bronze. Moreover, the routes of migration of the Indo-Germans are mapped out differently. Some authors put them northward of the Aral and Caspian Sea, others to the south. The northern route must be considered an entirely arbitrary hypothesis, for there have never been found any Aryan tribes in those regions. On the other hand, we find along the supposed southern route of the Indo-Germans mainly a population of brachycephalous peoples, which fills the Caucasus and the Armenian highlands, Thrace, and Illyria. All these differ materially from those inhabiting the north, especially from the Scandinavians. This Indo-Germanic hypothesis is attended with still another difficulty. Existing races in this region not only differ among themselves in their physical composition and are crossed in various ways, but they also diverge widely in many of the conditions of life.

Archeological researches have nowhere led to the beginning of a common civilization in an indisputably Aryan territory. Of course, this does not necessitate an attempt to locate the origin of the Aryan race in Germany or Belgium, as has been proposed in the case where the race of Cannstatt or of Neanderthal (a dolichocephalous people) is said to represent the original central stock.

The prehistoric theory of the much-abused skull of Cannstatt has been much shattered; it does not fit into that far off period into which our French neighbors place it. Too little attention has been paid to the proposition: that international intercourse is a more important factor archeologically considered than we are wont to think. With an increasing conviction of its truth, a greater value will be attached to proofs which show that there has been a transmitting of culture from one race to another. Nothing has given me greater joy than the discovery of those large burial fields in the most southern parts of the Austrian Alps, along the coast and in Istria for which we are indebted to the energy of Messrs. De Marchesetti and Szombathy. A number of new links have thus been welded into the chain of the old system of transmission, and the result of these researches will doubtless be embodied in a series of papers, and given to the public.

Let me emphasize right here that these finds are most valuable because they prove a prehistoric international intercourse (not migrations, for this cannot be established); and because they exhibit the directions which civilization has taken. They will also beget in our international intercourse a little more modesty and amiability than seems to exist at times on account of a too great sensitiveness about this idea of nationality.

If different races would recognize one another as independent co-laborers in the great field of humanity, if all possessed a modesty which would allow them to see merits in neighboring people, much of the strife now agitating the world would disappear.

A far greater revolution than that which took place in the sphere of archeology has been brought about in anthropological science. At the time of our coming together twenty years ago, Darwinism had just made its first triumphal march through the world. My friend Karl Vogt, with his usual vigor, entered the contest and through his personal advocacy secured for this theory a great adherence. At that time, it was hoped that the theory of descent would conquer not in the form promulgated by Darwin, but in that by his followers, for we have to deal now not with Darwin but with Darwinians. No one doubted that the proof would be forthcoming, demonstrating that man descended from the monkey and that this descent from a monkey or at least from some kind of an animal would soon be established. This was a challenge which was made and successfully defended in the first battle. Everybody knew all about it and was interested in it; some spoke for it, others against it. It was considered the greatest question of Anthropology.

Let me remind you, however, at this point that natural science, as long as it remains such, works only with real existing objects; a hypothesis may be discussed, but its significance can only be established by producing actual proofs in its favor, either by experiments or direct observations. This, Darwinism has not succeeded in doing. In vain have its adherents sought for

connecting links which should connect man with the monkey; not a single one has been found. The so-called pro-anthropos which is supposed to represent this connecting link has not as yet appeared. No real scientist claims to have seen him; hence the pro-anthropos is not at present an object of discussion for an anthropologist. Some may be able to see him in their dreams, but when awake, they will not be able to say that they have met him. Even the hope of a future discovery of this pro-anthropos is highly improbable, for we are not living in a dream, or an ideal world, but in a real one.

At our meeting in Innsbruck, it looked as if it might become possible to demonstrate amid the excitement, the descent of man from the monkey or some other animal. At present, to our regret, we do not even possess the means to prove a descent of the individual races from one another. It was not known at that time how difficult it is to prove that all men are brethren, nevertheless, laborious attempts were made to show the unity of mankind. There was an inclination to single out individual skulls and skeletons found among the remains of men in caves, as for instance in the caves of the "Maasthal," as representative types, and from them make up the races of primitive ages. Some claimed the original race to have been Mongoloid, others contended that the first man was Australioid. It all depended on the question of whether the Mongolians or the Australians were the lowest race. The first European must have looked like one of them, it was said. But the first European has not yet been found. At present we know that judging from his remains, primitive man did not resemble a monkey any more than do men of today. The ancients were well formed, they bore the same characteristic marks which we find in men of our times; not a single one was so poorly developed as to justify us in saying that he possessed the lowest form of skull.

Twenty years ago, little was known of the skull forms of the lowest primitive nations. This accounts for hasty judgments passed; the wildest ideas were afloat about the make-up of the lowest tribes. No one possessed any exact idea concerning the physical construction of the Eskimos, Patagonians, etc. Today there is scarcely upon our earth a tribe which might be called entirely unknown. There is only one place where there is some possibility of new discoveries—I mean the peninsula of Malacca—but even in this place, we have an energetic agent at work. Its inhabitants, according to the results of the researches of some, seem to satisfy most nearly the demands made for a lowest race. Aside from these, we know them all—Patagonians, Eskimos, Bushmen, Veddas, Laplanders, Australians, Polynesians, Melanesians; about many of them we really know more than of European nations.

If for instance you take the case of individual islanders and compare them with Albanians, I may say that more investigations have been made concerning the Polynesian natives than concerning separate groups of

Albanians. All these uncivilized nations, which stand so low in their mental development, are becoming gradually known to us. Of most of them, we have in Europe good typical examples, concerning whom the most exact observations in respect to their whole organization have been made. Not a few of these died in Europe, and on that account were more especially noticed. We possess greater knowledge concerning the brains of a Patagonian than about the brains of the civilized nations of Asia.

Not one of these examples resembled the monkey any more than (if indeed as much as) it does our own. Now the systematic naturalist determines the lines separating genera and species in the following manner: Whenever he finds that the totality of points of one group equals that of the other, he separates both from related genera or species. If, however, the respective sums of their points are equal, he draws a line between them and makes of each a separate genus or species. Such a dividing line is drawn between man and monkey. Every living race of men is as yet purely human; not one has been found which might be called pithecoïd, or which might be considered an intermediate race between man and monkey.

I must however admit that there exists a series of peculiarities found among men which are called pithecoïd, and these cannot be explained as mere disturbances or hindrances of their normal development. Let me illustrate: The higher apes exhibit frequently an especial development of the skull in the region of the temples. Just as in the case of man, several bones join in the depression beneath the muscles covering this part. From below, the upper edge of the great wing of the sphenoid bone joins the parietal bone; the squamous portion of the temporal bone to which the ear is attached touches this spot from behind, and the frontal bone is joined anteriorly to the other three bones just mentioned. These four bones come together in such a manner that the parietal and the sphenoid bone, joining each other, keep the frontal and the temporal bone apart by being thus unitedly wedged in between them. Now in the skull of the monkey, a long process of the temporal bone is frequently found wedging itself in as far forward as the frontal bone, thus separating the parietal and the wing of the sphenoid bone. This constitutes a marked difference of great value, since this does not occur in man, as a rule, but there exist isolated cases where this same peculiarity is found.

As we examine large collections of skulls and formulate the result, we find that certain races show these peculiarities more than others. So far as we can tell, three races especially exhibit them. We find them first of all among the Australian and African, the black races; then among the yellow in the Malay Archipelago, especially on that chain of islands which connects New Guinea with Timor, and to which are joined the Molucca Islands in the north and Australia in the south.

I lectured only a little while ago (Transactions of the Berlin Anthropological Society, 1889, page 177) concerning a number of skulls of Alfuros, of Tenimber, among which this peculiarity was noticeable. At the same time, another characteristic was observed, namely, the enormous development of the jaws, as shown in a greatly projecting ridge of the arch of the jaw and of the teeth. Associated with this prognathism there is found an inward curving of the nose, together with the extreme flattening, as if somebody had sat on it. In this case, sometimes the nasal bones grow into one, which scarcely ever takes place in other races of man. These forms also are especially characteristic of catarrhine apes. Hence this catarrhine nose is a kind of pithecoïd element (Thermorphy). In certain localities, this occurs more frequently than in others, and there may have existed a greater propinquity of relation with apes. It is not without importance to remember that among the anthropoid apes, the gorilla and chimpanzee are found in Africa, and the orang and the gibbon in the Indian Archipelago. But if you inquire further, may not the Australian and the African blacks or the Malay and the Alfures be the sought-for connecting links which bridge the chasm between man and the ape? No one can answer with an absolute no. It might be possible, but the possibility is a great way from reality. For temporal processes, catarrhine noses, and prognathous jaws, do not make an ape; a number of other characteristics are necessary to produce a monkey.

Hypothetically, from every piece of skin, a monkey may be constructed; no anatomist ever doubted this. But the differences between man and monkey are so wide that almost any fragment is sufficient to diagnose them. Much is still lacking for a demonstration of the theory of descent.

How necessary it is then as we may look at the problems of the future, to make still more far-reaching researches in this particular branch of science which has to do with the earlier developments of the human race. Especially should there be made careful investigations concerning prehistoric man in Australia, and also in Indonesia. If anthropologically-trained physicians would stay there continuously and make researches, perhaps essential and important proofs might be found.

At present they are still lacking, and we can study the early state of man only by means of what old graves, a few caves, and lake-dwellings, and what the present can furnish us. I would not pass over in silence the fact that from all these sources mentioned only specimens of man have been discovered of which we need not be ashamed and whom we may fully acknowledge as brethren. Through the kindness of Swiss colleagues, I was enabled to make comparative examinations of nearly all the existing skulls of the lake-dwellers. It became evident to me that even in those times, differences existed between tribes which probably came upon the scene of action one after the other. None of them however was constructed in such a manner as to lie outside of the physical form of our present nationalities.

Again, it cannot be said that all races have descended from a single human pair. This matter does not lie within the province of natural science proper. Everybody may decide that to suit himself. Those who, on account of their religious convictions, need a first pair, will encounter no objection from us. A possibility exists, we acknowledge, that all races and tribes may have sprung from a single pair by means of transmutations. But no one has actually demonstrated that negroes descended from white parents, or *vice versa*. Whenever a black tribe is found the naturalist supposes that there were negroes before, and where a white tribe is located that such a tribe always has been white. Of course, all this is likewise a mere supposition, which cannot be established. In short, every proof is lacking to show that a nation or a tribe is capable of a total transmutation. This is seen in Egypt. I thought that I could find by means of comparative examinations of the living and the remains and pictures of the dead some points establishing a change of ancient Egyptians into Egyptians of historic times, but I have returned with the conviction that ancient Egypt and its neighboring countries have not essentially changed during all these periods. If Menes really existed, there were in his time negroes, since quite old mural paintings show negroes with all their peculiarities. Nor do the native Egyptians offer any data to speak of. The Egyptian of today possesses still the forms of the ancient one. Unfortunately for us, Egyptian skulls and skeletons are not as ancient as we might wish. There has never a skull been seen belonging to the three oldest dynasties. Hence there is no possibility of a continuous list. But anyhow the register goes as far back as 3000 B.C. with positive certainty, which gives us in all some 5000 years. During this long time, only one difference has been noticed, namely: An appearance of brachycephalous men in the old kingdom in contrast with dolicho- and meso-cephalous people of the new kingdom. At any rate, definite proof is not wanting that since the beginning of the new kingdom, 1700 BC, no noteworthy change of type has taken place. A permanence of type accordingly during thirty-five centuries is established.

It does not look unreasonable to assume a certain influence of climate and occupation. In this respect, both the straightest orthodoxy and the purest Darwinism agree. Their thesis is the same. The former goes as far back as the first human pair, the latter beyond it to the first pair of animals; aside from this, they both accept the transmutation of a primitive race into different races. Those cannot sustain scientifically their position in the case of man, and these as regards the monkey. If you should ask me whether the first pair was white or black, I must confess I do not know. We have no foundation upon which to base any decision. It cannot be supposed that there lived, e. g., in France at the time of the troglodytes all negroes with woolly heads and that from these sprung white and straight-haired people. For other reasons, moreover, it is not clear to me how or where this could have happened. The very oldest remains show already differences. It sounds very plausible that the north made man light complexioned. But in America

where similar conditions exist, we do not find any blonde natives. The primitive Germans as well as the Finns of Mongolian origin are blonde, why these should be thus, while the rest of the Mongolians became black or deeply brunette is a question which we cannot answer. It must not be forgotten that language does not stand in correlation with outward physical phenomena. On the contrary, they are related to each other in a similar manner as a process of the forehead which may appear as a single mark without its necessitating a corresponding similarity in all the rest of the given characteristics; nor can we say that underneath a light skin there is always one and the same arrangement of internal organs. It may be entirely different.

In this particular direction, I have tried from the very first appearance of Darwinism to modify the doctrine of heredity. I recognize as truth the law of heredity, but I ever emphasized, and do so again today, that heredity in man is only a partial one. Man is not subject to a general heredity by means of which all peculiarities are developed in him from generation to generation. If botanists have begun upon a basis of local variations to establish subdivisions, and in that way have instituted within the same genus individual sub-genera or variations with hereditary character, it is a very easy matter to form out of these sub-genera new genera. But the fact that within the same genus there occur individual variations which appear to be hereditary, only proves that the same individual may be the possessor of different hereditary peculiarities.

It is indeed well known that one may inherit peculiarities from both father and mother and thus unite in himself a double heredity; or he may even exhibit characteristics which belonged to his grandparents while at the same time marks may be present which were inherited from his parents. In the same individual may unite then the aggregate of partial heredities, which are more or less limited. There may be many of these parts, but that cannot be established. Only in the case of twins it sometimes happens they cannot be distinguished without much painstaking observations; whenever they can be distinguished it is done by means of marks peculiar to each one of them. Hereditary characteristics under some circumstances may appear with such prominence that the resulting shape actually differs from the type.

Often people are born with six fingers and six toes. These transmit this peculiarity and whole families of this description come into existence. If this peculiarity were cultivated by in-breeding one might get a whole tribe with six fingers. Something like this exists in the dynasty of Hadramaut in Southern Arabia where only six-fingered descendants have any right to the crown. Certainly, these are peculiar formations, but it cannot be said on that account that in primeval times all mankind had six fingers. The negroes in the neighborhood of the Congo River have often web-membranes between their fingers and since fishes have not only five but many more single rays

in their fins, between which there is found such membrane, while the rays show, also, articulation, the thought suggests itself that web-membranes of the negro must have been produced by a kind of retrograde movement. There are to be found such retrograde movements whether we believe it or not. If for instance a child has the nose of his grandfather, we say that atavism is clearly existing, and everybody is satisfied with it. But if the six fingers are traced back to the six rays of the fins of a ray it is looked upon as an imputation. There are great difficulties connected with this subject which can be overcome only by means of heroic effort. I refer especially to the relation between atavistic peculiarities and those acquired by external circumstances. Acquired peculiarities are not atavistic, even when they prove to be hereditary.

During recent years, a subject has been very popular which I would recommend for further study, viz, the tailless cats. On the island of Man there is found a race of cats without tails. It has not as yet been explained whether these cats are indebted for their taillessness to a fault of their original parents and by reason of acquired characteristics are propagated in this way or whether there has intervened a disturbance in their development. As to the fact of this taillessness there is no doubt, for we find very frequently similar occurrences at other places, *e.g.*, in Scotland, but how this heredity has taken its rise is entirely unknown. Perhaps the original mother was run over by a wagon and in this way lost her tail and then brought forth tailless cats!

We do not even know how far this law of heredity extends. On account of this uncertainty, the question becomes very complicated in its relation to human circumstances. Climate and life may influence human development, although at present no convincing reasons can be given which show such a change in respect to human beings living in our age either in their totality or as individuals through the influence of local climate prevailing at their homes. In these particulars then we are deficient today in our knowledge. You may possibly say that it is a strange thing to have gone backward and to know less than people knew twenty years ago.

We know indeed less, but it is our pride that we have our knowledge in such a shape that we really know what we claim to understand. Twenty years ago, many things were supposed to be known when people were really ignorant of them. We have made this supposed knowledge the object of scientific tests and natural science has now really taken possession of its wide domain, and we can now say that much that was formerly asserted to be true is no longer admissible. It was supposed by faith, but it never belonged to science. Now the question before us is whether it is not possible with all the auxiliaries to observation and experiment to discover a kind of plan in the natural history of man. Whether we shall ever get to a point where we can show that the home of the negro was the submerged land, which according

to English zoologists was the original home of man, the so-called Lemuria, or that this place was the river Rhine, where some claim to have found the most ancient remains of primitive man—all this we leave for our successors to decide after another twenty years shall have passed.

I can only say today we have no debts; we have not borrowed from any hypothesis-framer; we do not go about oppressed by a fear that the things to which we hold will be overturned. What we now determine has stability and will prove a foundation for further researches. We have leveled the ground so that succeeding generations may make as much use as possible of these means furnished them by us. It is our confidence based upon the recognition given us by our rulers and the sympathy of the people that in the future there will be no lack of material for work.

Gentlemen, it is now our duty to go to work unitedly and with more zeal than ever before, so that all these questions may be solved which are of such importance to man for his understanding of self, and for his social and political development. Let us take hold then so that real and abiding progress may be ours.

I would propose as our aim to be attained in the coming twenty years that we obtain such an insight into the anthropology of European nations as to be able to present some valuable points concerning the connection of European tribes and to succeed in showing the reasons for existing differences among them.

This much I wanted to say today. I beg pardon for speaking so long. Anthropology is surrounded by a dense fog of traditions, a large number of them useless. Much labor is necessary to bring out its nucleus, just as it is the case with many of our fruits, whose little living kernel is surrounded by thick woody coverings. These germs are to be found in the field of anthropology and they must be opened up in the coming days. May they find as much appreciation from a circle of such interested hearers as I see before me today.

*Opening address delivered before the twentieth general meeting of the German Anthropological Association (of Germany and Austria) in Vienna, August 5, 1889. (From the *Correspondenz—Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte*, xx. Jahrgang, No. 9, September, 1889, pp. 89-100.)

APPENDIX FIVE

Expert Opinion on the Most Effective Method for Disposing of Human Wastes in Berlin (Expert opinion of the Scientific Committee for Medical Affairs. First referee, Virchow. Vierteljahrsschrift für gerichtl. u. öffentl. Medicin. Neue Folge, 1868, vol. 9, p. 1.)

Since the end of the last century, the question of how far the state of gutters and drains in Berlin, as well as the pollution of the Spree with human and other wastes, is harmful to the health of its inhabitants has been discussed by medical experts. But this discussion has never led to the establishment of definite facts whereby this influence could be positively demonstrated. The well-known investigations of Albert Magnus in 1841 concluded that the state of the "Cloaken" (the drainage canals) gave rise at most to some concern, and that they should be given special attention. The very comprehensive studies conducted a short time ago in Paris, namely by Parent-Duchatelet, resulted more in toning down concerns than in establishing their factual basis. The consequence was that both here and in France special precautions for guarding against the supposed harmful agents have been taken only incompletely and very slowly.

Medical investigations in England followed another course. Not only was the context of certain minor and major epidemics, especially of mass illnesses in typhus (typhoid fever), established with a high degree of probability by a series of local studies, but also public attention has been focused even more sharply on the relatively high mortality rates in towns, especially in the large ones.

Between 1850 and 1859 mortality in towns was still 26.7 per thousand population versus 1804 in rural areas. Indeed, in some towns, for example in Liverpool and Manchester, these figures attained the high level of 35.37 and 35.70 per thousand. It was concluded, and correctly too, that a relatively greater number of unfavorable living conditions is present in town, and that their elimination could save many lives. Work was at once energetically undertaken to rectify as many of these evils as possible. The law enacted in 1848 for improving public health takes as its standard the average mortality of the country as a whole, and the law permits compulsory action by health authorities wherever the mortality exceeds 23 per thousand.

Since that time, an increasing number of towns in England has been provided with extensive and systematically laid drainage canals. The effectiveness of these canals is favored by the numerous water closets, which were introduced into England a long time ago. The state of public health has improved and the mortality rate considerably decreased in several towns, most notably in Liverpool. Here the mortality figure has dropped from 36 per thousand to 29 and 26, and in 1860 even to 24.2 per thousand. But it should be noted that these encouraging results are not by any means attributable to canalization *alone*. During those years Liverpool spent three million pounds sterling in order to better living conditions in various ways, particularly in respect of housing.

The English example is decisive for the next steps to be taken by us. But it must be remembered that an interest in sanitation in Germany has by no means been the decisive and guiding factor that it was in England. Quite different needs have been paramount. First and foremost, we face the difficulty, due to the slight differences in ground elevation in Berlin, of arranging sufficient drainage for the gutters. Liquids stagnating in these gutters decompose and pollute the air in many places, and in times of heavy rainfall, the gutters do not suffice to ensure adequate outflow of the accumulated water. Deep set gutters had as a necessary consequence interference, even dangerous, to the flow of traffic as the town grew. The great number of projects that have claimed the attention of officials and citizens since 1816 have mainly been concerned with the channeling of larger quantities of water into the gutters, although some took account of its regulated outflow into special containers. None of them found unanimous acceptance. When the water mains built in 1852 also proved inadequate for maintaining the gutters in a satisfactory state of cleanliness, the commerce minister decided to send privy chief building advisor Wiebe to check arrangements elsewhere. The results of this journey appear in a work published in 1861, *Ueber die Reinigung und Entwiisserung der Stadt Berlin*.

By comparison with earlier ones, Mr. Wiebe's project, which closely follows newer designs in English towns, has considerably broadened the stand point from which such installations are judged. In that it calls for an extensive canal system, almost independent of the Spree insofar as it touches the city, it not only solves the problem of ensuring sufficient slope for the gutters, of keeping the course of the river within the city clean, and of adjusting the width of gutters to the width of roads, but also it tackles the incomparably more difficult task of removing human wastes and liquid refuse as quickly as possible from the houses and from the town itself. It thus includes, so to speak, both the previously more obvious task of the construction authorities and the newly apparent task of the sanitary authorities. For it cannot be doubted that the problem of the rapid removal of human, animal and plant wastes is an important one in the domain of the sanitary authorities.

The two aspects of the problem that the project of Mr. Wiebe attempts to solve together obviously need not necessarily be combined in this manner. The opposition, relying on the interests of agriculture that Liebig has moved to the forefront, aims precisely at separating the drainage of rain and house water from the removal of human wastes and other refuse. The commission deputed by the minister for agricultural matters also declared in its report of 1865 for the separation of these two tasks. On the one hand, the report calls for an installation of drains for rainwater and house water, and on the other for the organization of a comprehensive scavenger service for all wastes. In particular, with reference to the latter, the commission suggests that for all new and possibly also all renovated buildings, there be introduced a definitely prescribed container system for fecal wastes.

It is not our task to examine the projects on both sides in relation to their importance for agriculture or—what partly hangs together with it—in relation to finance. It is our opinion that considerations of public health, as is generally recognized in England, must be the absolutely deciding factor, and that the question of greater or lesser expenditure has little significance insofar as saving human lives is the best financial investment for the state and the community. In England, the value of the reduced mortality and incidence of illness has been assessed in terms of money according to completely justifiable principles, and an annual profit of 617,500 pounds sterling reckoned for Liverpool. It would be difficult to match this with a similarly favorable calculation from the standpoint of agriculture. Manchester, which has the most comprehensive scavenger system, incurs an annual expenditure of over one thaler per house, and the state of health there is quite unsatisfactory.

APPENDIX SIX

In light of COVID 19, I include the following:

On the Prevention of Animal Epidemics

Gentlemen, I would like to use this opportunity to make some remarks on the question of epidemics among animals. With regard to these creatures, we are in the happy position that each individual state can counter the spread of their diseases by means of rigorous quarantine as well as by slaughtering the animals. I therefore believe it appropriate here to emphasize as forcefully as possible that the legislation of any state lags behind the requirement of modern science when it does not prescribe with maximum stringency measures serving to confine the spread of animal epidemics within its own limits.

At the present moment, we find ourselves only at the beginning of such legislation. I can say with pleasure that the stringency with which the English have begun to protect themselves from without, and which has had the most brilliant results for England itself, has given us the guidelines along which the general legislation of all civilized states must proceed. In recent years we in Prussia have followed the path of English legislation and adopted the strictest measures. In particular, the administration has made available abundant means to compensate owners for animals unjustifiably killed. This makes it possible to kill without delay in places where only the mere suspicion of disease has reached a certain height, and at present the slaughter of horses affected with glanders has been carried out with all thoroughness.

I believe that this is the time to take note that many European states have stopped at an essentially less drastic mode of action, even with respect to diseases that carry the greatest dangers beyond their boundaries. I may say that we are entitled to expect that legislation in Russia will soon proceed more energetically against rinderpest, and that the Russian government too will decide to take measures in its own land similar to those taken elsewhere, so that the extraordinary dangers which continually threaten us from that land will, at last, be set aside.

In this connection, I want to mention lung sickness in particular. We have proceeded as categorically in lung sickness as we have in the other epidemic

diseases, and we have at this time adopted rather strict measures against Holland and Belgium. For my part, I am not quite convinced that the standpoint from which these measures were taken is the right one.

It is commonly held that lung sickness is a purely contagious disease, i.e., that it spreads from animal to animal as does the pox, and that spontaneous new occurrence of the disease does not take place, at least not within the limits of the Reich. Now in my opinion it would be a matter of great importance for observers to direct more attention to ascertaining whether the disease arises spontaneously anywhere, and whether such spontaneous occurrence is tied to certain localities, perhaps as we assume is the case for anthrax.

We would thereby obtain much more certitude for the legislative and administrative measures that must be taken against the spread of this disease, one that affects an animal of great importance in human nutrition; we would perhaps proceed with more justice could science fill this gap, which, in my opinion, exists everywhere but could be filled in short order by the combined activity of the physicians and veterinarians of Europe.

I shall refrain from discussing other disease relationships. In conclusion, I would like to direct attention briefly to just one more point, namely to the question now much ventilated in Germany as to how far one of those diseases of ruminants hitherto regarded as purely spontaneous in origin, bovine tuberculosis, is a communicable disease, and in particular one communicable to man. If so, it would follow that far more stringent sanitary measures must be directed against this disease than heretofore.

The inoculation of other animals with substances from animals that died of bovine tuberculosis first established, just as in the case of inoculation of tuberculosis, that this disease is communicable. In Germany, no doubt remains about the matter.

A further question is whether the consumption of substances from animals with bovine tuberculosis can cause similar diseases in human beings, tuberculosis in particular. This question comprises two major points: to what extent contagion can take place by consuming flesh, to what extent by consuming milk. In the case of flesh, the danger is less because meat is generally cooked, but the question of whether such flesh is suitable for human consumption still remains. The question in relation to milk is of greater importance. A series of practical experiments carried out by Mr. Gerlach, director of our veterinary school, seems to have shown that the consumption of such milk is indeed harmful, and that it is even capable of causing tuberculous affections of the intestines, mesenteric glands and other parts of the body.

The minister for agricultural affairs has therefore arranged for a larger series of experiments, to be conducted simultaneously at veterinary schools and universities in the state of Prussia. A number of these experiments have already been carried out, but they have as yet yielded no definite results. It has been established however that under suspicious circumstances a large number of the animals fed develop tuberculous affections. Hence here is the place to direct the attention of those from other countries to this extremely important question of human nutrition, particularly in relation to the newborn.

(Congres international d'hygiene, de sauvetage et d'economie sociale. Brussels, 1877, vol. 1, p. 464.)