

SHORT HISTORICAL REVIEW



Heritage of Leopold Auerbach in the field of morphology of nervous system

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Abstract

Leopold Auerbach (April 27, 1828–September 30, 1897) belongs to world famous figures in medicine, who were born, spent most of their lifetimes and died in Wrocław (Breslau). Auerbach reported for the first time in literature about existence of *plexus myentericus* (*plexus Auerbachi*) including ganglion cells between circular and longitudinal layers of *tunica muscularis propria* in intestinal wall, in 1862. With his publication on muscular hypertrophy, dated on 1871, he provided ground for another eponym: “Friedreich–Auerbach disease”, that refers to facial hemihypertrophy. He was raised in Jewish family, which lived for generations in Wrocław. His elaborative scientific work was his struggle for human dignity and safe social status, which was shared with many other members of the community at the time of Jewish emancipation thorough the whole XIXth century in Germany. The great value of Leopold Auerbach for the Wrocław University – his *Alma Mater* –, which was founded by an Austrian Emperor Leopold I, is even metaphorically coded by the fact, that “AL” are not only initials for *Academia Leopoldina* but also curiously for the name and surname of this brilliant scientist, who led rather a calm and unspectacular life. This paper is the last one from the series of our biographical papers, in which we focused on his output in the field of vascular system, morphology of invertebrates and – in only short one page-long note until now – on the topic of nervous system, so we decided to present a full text report on the latter but the most famous area of his activity.

Keywords: *plexus myentericus*, Friedreich–Auerbach disease, Leopold Auerbach, *Academia Leopoldina*.

Review paper with elements of original biographical study.

☞ Introduction

Leopold Auerbach was one of titans of science that contributed to development of neurology in XIXth century due to his discovery of *plexus myentericus* and his contribution to entity called “Friedreich–Auerbach disease” [1, 2]. However, there is complete lack of comprehensive English written biography, so we took extensive care to reconstruct it in the primary aspect of his studies on nervous system.

☞ Materials and Methods

Actually, there are two German-written basic commemorative papers about Leopold Auerbach that were prepared by his friends and cooperators shortly after his death: an extended seven pages-long obituary by his peer, Ferdinand Julius Cohn (1828–1898), and another biographical paper written by his cooperator, Gustav Jacob Born (1851–1900) [1, 2]. Both of these, primary papers could also be categorized as *in situ* resources, as their authors were direct witnesses of the life of their friend Leopold Auerbach [1, 2] After a hundred of years from being published in German, the access to both of these papers is rather sparse and difficult. Thus, we decided to ground our paper on primary original resources with inclusion of original scientific papers written by Leopold Auerbach.

☞ Results

Biographical note

The date of birth of Leopold Auerbach, which was carved at his tombstone, was April 27 (Figure 1), 1828, but his colleagues, Ferdinand Cohn and Gustav Born, reported April 28, 1828, as his birthday in biographical obituaries of Leopold Auerbach [1–4]. Indeed, the birthday of Leopold Auerbach was formally registered in proper offices on April 28, 1828. Thus, either Born or Cohn, who wrote it down in XIXth centuries obituaries, did not literally make an error in the light of official documents. It was an ordinary habit to register newborns on working days of the week and April 28, 1828, was Monday. He was born in a merchant’s family to his Father Salomon Auerbach (March 22, 1788–July 10, 1870) and Mother Julie nee Danziger in Breslau (Wrocław) in Lower Silesia (at the time German Empire, Poland now). His parents noticed a lot of talents and passion for learning in his child, so he started very early his school education. However, requested by his parents, he left the Wrocław Elisabeth Grammar School (*Breslauer Elisabeth-Gymnasium*) and became an apprentice in their shop [1, 2, 4]. However, he was not prevented by merchant profession from further education, because he soon entered the Matthias-Gymnasium to graduate it after only two years in 1844 with a certificate

of matriculation being only 16 years old [1, 2]. Auerbach studied medicine for the first four semesters at local university (*Königliche Universität zu Breslau* at the time) in his hometown, Wrocław (Breslau). In this period, his education was much influenced with the most inspiring impact of Bohemian anatomist, Johann Evangelist Purkinje (Jan Evangelista Purkyně) (1787–1869) [2]. To look for next masters for his medical education, in autumn 1846 Auerbach moved to the University of Berlin to enter his clinical studies there [1–4]. However, he still eagerly participated in theoretical and biological seminars and exercises with impact of such broad-minded scientists as a comparative anatomist and microscopist Christian Gottfried Ehrenberg (1795–1876) [1, 2]. Professor of Anatomy and Physiology, Johannes Peter Müller (1801–1858) paid Auerbach's attention to pathological disorders regarding anatomical structure and physiological function, as he had brilliant observations, e.g., in the field of physiology of vision to share with his students at the time [1–4]. However, his student and one of his first biographers (later Professor of Histology and Comparative Anatomy in Wrocław) Gustav Jacob Born recorded that Auerbach managed to develop interpersonal communication only with Robert Remak (1815–1865) [1, 2]. Such an opinion was based on relation of another Breslauer Professor, Ferdinand Julius Cohn (1828–1898), who was called “his and my old friend” by Born [1, 2]. Remak first described non-myelinated peripheral nervous fibers (Remak's fibers) and ganglion cells defined together as Remak's ganglion, located in wall of right atrium [2, 5]. In our view, the eminent master–student relation of Remak and Auerbach was determined by a similar struggle between recognition and rejection in lives of these two Jewish scientists, both with eponymous significance in world medicine [2, 5].

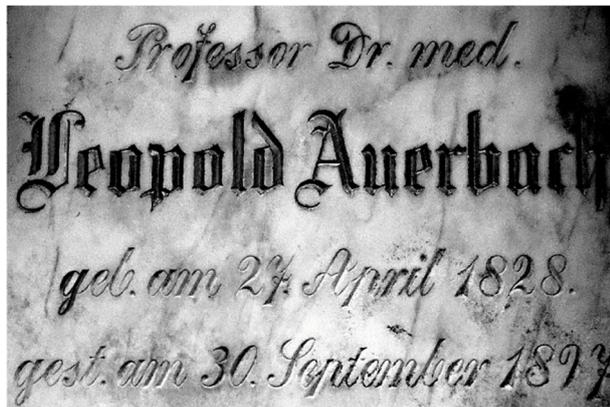


Figure 1 – An inscription on a tombstone of Leopold Auerbach at Old Jewish Cemetery in Breslau from prewar times (Archive of the Author's Family).

Auerbach received his doctorate in Berlin on January 18, 1849 (title of his dissertation: “Kritische Studien über Nervenreize” published primarily in Latin: “*De irritamentis nervorum studia critica*”) [6]. In his doctoral dissertation, he focused on irritability of nerves [6]. He passed the state examination and returned to Wrocław to start medical practice there [1, 2]. Leopold Auerbach focused on neural morphology with appliance of methods of histochemical stainings to result in his world-famous description of *plexus myentericus Auerbachi*, which contained ganglion cells between circular and longitudinal layers of *tunica*

muscularis propria in the wall of intestines [7, 8]. It is usually said that greatness of professors is measured by achievements of their students, and it is particularly true in this case. Namely, Remak discovered ganglion cells in right atrial wall in vicinity of cardiac muscles, Auerbach found groupings of ganglion cells at interface of circular and longitudinal layers of *tunica muscularis propria* [the myenteric plexus (Auerbach's plexus)] [1, 2, 7, 8]. The microscope became the main tool for scientific exploration for Auerbach [1, 2]. In approach to the most concise characterization of Auerbach's scientific heritage, it can be summarized in simplest way that Auerbach studied neural system in relation to its effectors – muscles. Therefore, it is not surprising that in 1863 his habilitation referred to muscular elements of gizzards in some species of birds that had particularly well-developed musculature of their stomachs as evolutionary adaptation [9]. Based on this work, Auerbach obtained associate professorship (private docenture) and was nominated a supernumerary professor (*außerordentlicher Professor*) in 1872 at the University of Wrocław, what meant in German order that he remained in a side-area in a position of Professor without chair (Figure 2) [2, 3].



Figure 2 – Professor Leopold Auerbach.

He friendly cooperated with Karl (Carl) Theodor Ernst von Siebold (1804–1885), Professor of Physiology in Breslau, from 1850 to 1853, and the author of the “*Lehrbuch der vergleichenden Anatomie*” (“Manual of Comparative Anatomy”), who inspired Auerbach's further studies on invertebrates and supported Auerbach after Siebold's relocation to Munich [1–4]. Auerbach also interacted actively with Privat-docent of Physiology at Breslau (since 1854 to 1862 until obtaining a professorship at Rostock University) Hermann Rudolph Aubert (1826–1892) author of his “*Physiology of the Retina*” from 1865 and a contributor to description of “Aubert–Förster law” and “Aubert's phenomenon” in the field of physiology of vision [1–4]. From this group of his first Wrocław cooperators, only Ferdinand Julius Cohn – world famous botanist and celebrated microbiologist, laureate of Leeuwenhoek Gold Medal and Gold Medal of the Linnean Society – was that scientific friend who stayed for good in Breslau and was buried even in the same Jewish Cemetery as Auerbach at Ślężna Street (at the time Lohestrasse) in Wrocław (Figure 1) [1, 2, 10].

In his dedication to science, Auerbach made his home a place of work. Namely, on the ground of his own limited resources, he equipped two rooms of his apartment to function as a laboratory on the third floor of tenement house on former Agnesstrasse 2 (now Michał Bałucki Street) in Wrocław [1, 2]. As Born emphasized, in this place he was indeed grafted with instruments, stuffed with Forefathers' household items (*Mit Instrumenten vollgepfropft, Urväterhausrat drein gestopft!*)! The metaphorical "Forefathers (Urväter)" constituted his laboriously gathered collection of the scientific literature. It was the place, where he shared time for his medical practice and scientific explorations [2]. He was completely devoid of conceit in opposition to a frustrating world of buffoons, that turned out to be rather toxic clowns in their academic gowns than real masters of science that would motivate young generations to creative progress. Being himself of calm nature, here at home, Auerbach found silence and peace without feeling a tension of constant competition that can accelerate efforts of the other scientists, but some could recognize it as an unnecessary stress, which can stray some intellectual process. As Auerbach was not given a chance to hold lectures and examinations in the role the head of university department, as well as he was never granted a chair at the university, he was not a spectacular academician as an actor on the stage but rather he was a monk (particularly after departure of his children from home) in the shelter of his mind in a silent temple of a pure science. In comparison to numerous honors of Ferdinand Cohn – his peer –, Auerbach was viewed as rather unsuccessful by contemporary public opinion [1].

Although not comparably celebrated in a public as Cohn, Auerbach enjoyed great happiness and relief in a materially modest but intellectually stimulating family life according to Gustav Born, who was a warmly welcomed guest to the Auerbachs' home [2]. Leopold Auerbach had five children with his charming wife Arabella nee Hess (August 4, 1837–July 2, 1896), a lady of a musical cheerful nature of broad horizons [1, 2]. His wife and children were in the first place in his life of such a dedicated scientist [2]. Namely, a long break lasted from 1875 to 1890 in his scientific activity, which was a period of up-bringing of his offspring until the children grew up and left home to enable old Leopold to come back to pure university science [2]. Just a few years later, he got severely broken down with the death of his wife in 1896 and his mental collapse was so profound that stopped his work completely [1, 2]. In July of the following year, Auerbach started suffering septic fever with seizures to result finally in his death on September 30, 1897 [1–4].

Achievements in the field of neuromuscular system

An already mentioned his first description of the "ganglio-nervous apparatus" (myenteric plexus) within *tunica muscularis propria* of intestines was printed by Morgenstern in Wrocław, in 1862, and in the same year in Carlsbad [7, 8]. In the field of descriptive anatomy, he further remarked on innervations of intestines [11]. Actually, he investigated the mechanisms of neural irritation in relation to hypertrophy of muscles. In continuity of this topic, his habilitation thesis contained a profound description

of ganglion plexus in the avian gizzards [9]. He concluded that such a plexus was located always on the outer side of circular layer of smooth muscles of alimentary tract wall in the dissertation that was published on May 5, 1863, in Breslau [9]. Another eponym, which is associated with him and shared with pathologist Nikolaus Friedreich (1825–1882), is "Friedreich–Auerbach disease" that manifests with facial hemihypertrophy, including tongue and tonsils [12, 13]. He dealt about it in his publication about muscular hypertrophy dated on 1871 [12]. This work was preceded by numerous, other reports about muscle tone in historical perspective, physiology of human muscular contractions under mechanical stimulation or due to topical muscle irritation or even on percussion of the muscles, as well as studies on functions of spinal cord in decapitated frogs [14–18]. He also studied general physiology of muscles, as well as mechanism of sucking, muscle cramp paralysis and muscular relaxation, and he referred once again to muscular hypertrophy, before he focused on dilating effect of the longitudinal muscles of the vessels [19–23]. In perspective of anticipation of a concept of synapse and axon guidance (or axon pathfinding), Auerbach considered nerves in their strict functional aspect to visualize with silver staining that the nerves communicate with their "end bulbs" with the surface neurons of nucleus of facial nerve [24, 25].

Final remarks

XIXth century was a period of Jewish emancipation from any sorts of previous discrimination and such civilian liberation of this ethnic group was certainly paved by their extraordinary activity in industry, trade, banking as well as in science at the time [26]. The hostile reaction was apparently evident to this transformation. It was in Breslau (Wrocław) at the beginning of the XIXth century, where – being emblematic for this phenomenon – the primitive farce titled "Unser Verkehr" was written by Breslauer playwright and anti-Semitic, medical doctor Karl Borromäus Alexander Sessa (December 20, 1786–December 4, 1813), who maliciously described a Jewish family aspiring to a middle class. Wrocław was also presumably the place for the action of the anti-Jewish and anti-Polish roman "Soll und Haben" by Gustav Freytag (July 13, 1816–April 30, 1895). In this book, a prosperous career of an honest and hard-working, ethnic, German merchant was destroyed with financial frauds of his Jewish competitor, while veterans of Polish Uprisings were presented as brigands and bandits of modest intellectual properties. Such a populist propaganda conditioned the ground for anti-Jewish riots that took place in 1830, in 1831, and in 1844 in Wrocław [26]. If we took a glance on tombstones of the Auerbachs' Family at Old Jewish Cemetery at Ślężna Street (previously Lohestrasse) in Wrocław (Breslau), the lifespan of scientist and medical doctor Leopold Auerbach (died at the age of 69) was much shorter than the life of his father, the merchant Salomon Auerbach (died at the age of 82). Thus, one can conclude that it was privately more advantageous and wiser to be a relatively rich merchant as in case of Salomon, who even bought the first microscope for his son than to struggle with all obstacles as the scientist with relatively low income and to die before the age of 70, which was an

example of Leopold. However, in the spiritual aspect, the perspective could be a bit different. Namely, the scientific heritage of Leopold Auerbach is overwhelming and eternal. Personally, it was bitter and breaking down for him to interact with those individuals, who turned out to be unworthy and untrustworthy people that only pretended to be true academicians in their oppressive nature of Prussian regime. Nevertheless, his university employment was recognized as a promotion in the society and even a kind of nobility. Indeed, it was the time of emancipation of his whole ethnic group that advanced on the way of liberation from any sorts of discrimination. Leopold I Habsburg (1640–1705) founded Breslau University in *Golden Bull*, in 1702, to add Holy Roman imperial splendor from the very start of this institution, which was later *Alma Mater* of a significant number of great figures in World Science, e.g., Nobel Prize laureate in Physiology or Medicine Paul Ehrlich (1854–1915) or a celebrated physicist and mathematician Max Born (1882–1970), 1954 Nobel Prize winner in Physics, and the son of anatomist Gustav Born, biographer of Leopold Auerbach [27, 28]. In addition, the main edifice of this University was founded on remains of one the two castles that were built at opposite banks of one of branches of River Odra (Oder) in Wrocław by Polish ruling dynasty of Piasts. It later became a royal and imperial residence, since Wrocław was ruled by kings of Bohemia and the Holy Roman Emperors (*Kaiser des Heiligen Römischen Reiches Deutscher Nation*). The only one architectural artifact of that castle is red-painted sacristy of the Holy Name Jesus Church that was built as the Jesuits' University Church in a splendid baroque style. A scepter of Rector of Breslau University is another one artifact that honors and gives prestige to workers of Wrocław University and in this number to Leopold Auerbach in a special way. The initials "AL" are placed on the chest of two-headed imperial eagle from the top of scepter of Rector of Wrocław (Breslau) University, which was made by Wrocław goldsmiths E. Grische and Ch. Plackwitz in the year of foundation of the University, in 1702 (Figure 3).



Figure 3 – A detail from Rector Scepter of Breslau University (Academia Leopoldina with its initials "AL") by Wrocław goldsmiths E. Grische and Ch. Plackwitz in the year of imperial foundation of the University, in 1702, in its prewar documentation.

Letter "A" (for *Academia*) is formed by graphical composure of two partially crossed initial letters "L" (for *Leopoldus*: Leopold) and together this is abbreviation for *Academia Leopoldina* as the Emperor formulated "*Academia et Universitas*" in the act of foundation of Wrocław University [1, 2, 25, 28].

Actually, the term *Academia Leopoldina* has been mainly associated with completely different institution of magnificent significance and prestige for German Civilization, namely the German National Academy of Natural Sciences Leopoldina (*Deutsche Akademie der Naturforscher Leopoldina*), originally founded in 1652 and located in Halle, but elevated to its imperial rank by the same Holy Roman Emperor Leopold I, in 1687 [29]. Anyway, curiously enough initials for *Academia Leopoldina* are the same as for Auerbach Leopold. Maybe, that is why, parents of Leopold Auerbach had chosen a forename of Austrian Emperor for his son [1, 2].

The life story of Professor of Medicine at Breslau University Leopold Auerbach was ended with his natural death. Thus, persecution of Jews did not reach culminating point in his life, having tragic apogee in the death of his son. Namely, his own son, a celebrated physicist Felix Auerbach (1856–1933) with his wife Anna – instead of emigration from Germany – committed suicide on February 26, 1933, at their home in Jena, shortly after Adolf Hitler came to power [30]. The constant struggle can be read from professional efforts in at least a few examples of eponymous German scientists in world medicine that lived in Wrocław. The story of Leopold Auerbach is also a great call for respect and honor to true teachers of medical profession [1, 2]. There can be important parallels in lives of Remak and Auerbach as it was in life stories of two Professors of Histology, Alexandru Țupa (1886–1956) and Cornel Crișan (1895–1958), to conclude that such a comparative perspective provides a significant insight in methodology of medical history [31]. Indeed, the strong relation between the world-famous tutor and his diligent pupil is exemplified and turns out to be of a key significance in numerous instances in medical history [32]. This was in case of Dumitru Bagdasar (December 17, 1893–July 16, 1946) the organizer of Neurosurgery Center in the capital city of Romania, Bucharest, who was privileged to train under guidance of world-famous pioneer of neurosurgery Harvey Cushing (April 8, 1869–October 7, 1939) [32]. Similarly, the professional influence of Remak on Auerbach resulted in an apparent progress of science, in its continuity in exploration of neuromuscular system. The example of Remak and Auerbach grounds also the thesis that Berlin University had the most potent impact on development of Breslau University in XIXth and XXth centuries, until the World War II, as even prewar medical faculty campus was built in Wrocław in a neo-gothic reminiscent style that was similar to Charité – the historical university hospital campus buildings in Berlin [1, 2, 25, 28, 33–35]. Such ties among Berliner and Breslauer academicians grounded a capital significance of Wrocław University not only in the province of Lower Silesia due to magnitude of world-famous eponymous surnames of Breslauer Professors as Waldeyer, Alzheimer, etc. [28]. Thus, nowadays, the lesson for medical practitioners including medical morphologists

is still: never give up. This paper is the last one from the tetralogy of our biographical papers about Auerbach, in which we focused on his heritage in the field of vascular system, morphology of invertebrates and – in only short one page-long note until now – on the topic of nervous system, so we decided to provide a present a full text report on the latter but the most famous area of his activity [25, 33, 34].

Conflict of interests

The authors declare that they have no conflict of interests.

Acknowledgments

Piotr Woltanowski is indebted to his Father, Professor of History at Warsaw University, Andrzej Woltanowski (1942–1996), a close Tutor that grounded his reports on primary original archives, for all lessons of meticulousness and academic honesty.

As Leopold Auerbach focused on integrity of science, Andrzej Wincewicz would like to dedicate this paper to everlasting memory of the Hohenzollern–Sigmaringen Family, whose Members in roles of Kings of Romania cared for the integrity of the whole State, and particularly to Princess Helen of Greece and Denmark, Queen Mother of Romania (May 2, 1896–November 28, 1982), whose determination saved thousands of Jews from Holocaust.

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Received: January 6, 2021

Accepted: August 3, 2021