SHORT HISTORICAL REVIEW

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

ANDRZEJ WINECZIC1), PIOTR WOLTANOWSKI2)

1) Specialist Medical Practice – Pathologist, Warsaw–Marymont, Poland
2) Department of Public Finances and Financial Law, Faculty of Law, University of Bialystok, Poland

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 Wroclaw (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 Wroclaw. His elaborate 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 Wroclaw 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.

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 (Wroclaw) 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 Wroclaw 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].

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 Auerbachii, 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].

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–Fürster 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 Śleżna 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 Michal Bahucki Street) in Wrocław [1, 2]. As Born emphasized, in this place he was indeed gifted with instruments, stuffed with Forefathers’ household items (Mit Instrumenten vollgepflegt, Urvaterhauerst drein gespielt?)! 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 Friedrich (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 Ślęża 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 Wroclaw by Polish ruling dynasty of Piasts. It later became a royal and imperial residence, since Wroclaw 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’ Church in a splendid baroque style. A scepter of Rector of Wroclaw University is another one artifact that 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 Wroclaw 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 Wroclaw 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

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 Wroclaw. 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].

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

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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.

References

[1] Cohn F. Leopold Auerbach – Nekrologe. Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur im Jahre 1897], G. P. Aderholz' Buchhandlung, Breslau, 1898, 75:3–9. https://www.biodiversitylibrary.org/item/176990#page/489/mode/1up

[2] Born G. Leopold Auerbach. Anat Anz, Jena, 1898, 14:257–267. https://www.biodiversitylibrary.org/item/43449#page/271/mode/1up

[3] von Grützner P. Auerbach, Leopold, In: **. Allgemeine Deutsche Biographie (ABD), Band 46, Duncker & Humbolt, 1902, 85–87. https://www.deutsche-biographie.de/pnd116859709.html#dbcontent

[4] Pagel JL. Biographical lexicon of excellent doctors of the nineteenth century: with a historical introduction [Biographisches Lexikon hervorragender Ärzte des neunzehnten Jahrhunderts: mit einer historischen Einleitung], Urban & Schwarzenberg, Berlin–Wien, 1901, 59–60. https://wellcomecollection.org/works/ux7ht5p9/items?canvas=70

[5] Remak R. Über die Ganglien der Herznerven des Menschen- deren-physiologische/630173689/bd

[6] Auerbach L. Die irritaments nervorum studia critica. Inaugural-Dissertation, Universität Berlin, Berolina Types Fratrum Schlesinger, 1849. https://www.worldcat.org/title/die-irritaments-nervorum-studia-critica/oclc/258322094

[7] Auerbach L. About a myenteric plexus, a previously unknown ganglionic apparatus in the vertebrate intestine [Ueber einen Plexus myentericus, einen bisher unbekannten ganglionären Apparat im Darmkamm der Wirbeltiere]. Verlag von E. Morgenstern, Breslau (Wrocław), 1862, 9. https://www.abebooks.co.uk/leber-Ganglien.-Herzner-ven-Menschen-deren-physiologische/630173689/ bd

[8] Auerbach L. De irritaments nervorum studio critica. Jahrbuch der gesammten Naturwissenschaften und Medicin
cultur
dbcontent

[9] Auerbach L. About a myenteric plexus, a previously unknown ganglionic apparatus in the vertebrate intestine [Ueber einen Plexus myentericus, einen bisher unbekannten ganglionären Apparat im Darmkamm der Wirbeltiere]. Verlag von E. Morgenstern, Breslau (Wrocław), 1862, 9. https://www.abebooks.co.uk/leber-Ganglien.-Herzner-ven-Menschen-deren-physiologische/630173689/ bd

[10] Cohn F. Blätter der Erinnerung. Zusammengestellt von seiner Gattin Pauline Cohn. Mit Beiträgen von Professor F. Rosen. J. U. kern’s (Max Müller) Verlag, Breslau, 1901. https://well comecollection.org/works/2y7en7n7/items?canvas=9

[11] Auerbach L. Further communications about the nervous system of the intestine [Fernere vorläufige Mittheilung über den Nervenapparat des Darmes]. Virchows Arch, 1867, 30(3–4): 457–460; Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur im Jahre 1864]. Joseph Max und Komp, Breslau, 1865. https://doi.org/10.1007/BF02280956. https://www.biodiversitylibrary.org/item/177154#page/5/mode/1up

[12] Auerbach L. True muscle hypertrophy [Ein Fall von wahrer Muskelhypertrophie]. Virchows Arch, 1871, 53(4):234–266. https://doi.org/10.1007/BF01957191

[13] Friedreich N. About congenital half-sided head hypertrophy [Ueber congenitale halbseitige Kopfhypertrophie]. Virchows Arch, 1863, 28(5–6):474–481. https://doi.org/10.1007/BF01942817

[14] Auerbach L. About the nature of muscle tone, historical and experimental aspects [Ueber die Natur des Muskeltonus, Historisches und Experimentelles]. Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur im Jahre 1856], 1856, 34:32–33, 127–130. https://www.biodiversitylibrary.org/item/176947#page/36/mode/1up https://www.biodiversitylibrary.org/item/176947#page/131/mode/1up

[15] Auerbach L. About muscle contractions through mechanical stimulation in living people [Ueber Muskelkontraktionen durch mechanische Reizung am lebenden Menschen]. Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur], 1859, 37:134–140. https://www.biodiversitylibrary.org/item/178570#page/146/mode/1up

[16] Auerbach L. About the effects of topical muscle irritation [Ueber die Wirkungen topischer Muskelreizung]. Treatises of Silesian Society for Native Culture [Abhandlungen der Schlesischen Gesellschaft für vaterländische Cultur. Abtheilung für Naturwissenschaften und Medicin], G. P. Aderholz' Buchhandlung, Breslau, 1861, 291–326. https://www.worldcat.org/title/abhandlungen-der-schlesischen-gesellschaft-fur-vaterländische-cultur-abtheilung-für-naturwissenschaften-und-medizin/oclc/632518904&referer=brief_results

[17] Auerbach L. About percussion of the muscles [Ueber Percussion der Muskeln]. Z Ration Med [Zeitschrift für rationelle Medicin], 1862, 14:215–231. https://archive.org/details/s2495d13795957/page/214/mode/2up

[18] Auerbach L. XLI. About mental activity of the spinal cord [XLI. Ueber psychische Thätigkeiten des Rückenmarks], Z Klin Med [Zeitschrift für Klinische Medicin], 1853, 4,452–496. https://www.digitale-sammlungen.de/de/view/bbd10086906#page=466

[19] Auerbach L. About general muscle physiology [Zur allgemeinen Muskel-Physiologie]. Tageblatt der 48. Versammlung deutscher Naturforscher und Aerzte in Glatz vom 18. bis 24. September 1875, Leuschner & Lubensky, K. K. Univ. Buchhandlung, Graz, 1875, 106. https://books.google.ro/books?id=dm7mQ7N-sCA&printsec=frontcover&source=gbs_ge_summary_r&cad=0 #v=onepage&q&f=false

[20] Auerbach L. Sucking (Saugen). Recueil des opérations de la chirurgie générale, vol. 17, Urban & Schwarzenberg Verlag, Wien–Leipzig, 1889, 330–336. https://books.google.ro/books?id=4nUcHvXmYkHylRaWOC&printsec=frontcover&redir_esc=y#v=onepage&q&f=false

[21] Auerbach L. Cramp and paralysis [Ueber Schreikrampf und Schreiblähmung]. Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur im Jahre 1870]. Joseph Max und Komp, Breslau, 1871, 48:172–173. https://www.biodiversitylibrary.org/item/120733#page/180/mode/1up

[22] Auerbach L. On the question of real or apparent muscle hypertrophy [Zur Frage der wirklchen oder scheinbaren Muskelhypertrophie]. Centralblat Med Wis (Centralblatt für die medizinischen Wissenschaften), 1889, 9, November, 27(45):802–803. https://archive.org/details/centralblattdr26unkenko/page/n810/mode/2up

[23] Auerbach L. The dilating effect of the longitudinal muscles of the vessels [Ueber erweiternde Wirkung der Längsmuskeln}
der Gefässe]. Nachtrag zum Jahresbericht der Schlesischen Gesellschaft über das Jahr 1875. Sitzung der medicinischen Section am 17. December 1875, Breslau, November 1877. Annals of Silesian Society for Native Culture [Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur im Jahre 1876], G. P. Aderholz’ Buchhandlung, Breslau, 1876, 53:232a–232b. https://www.biodiversitylibrary.org/item/114216

[24] Auerbach L. 2. Nervenendigung in der Centralorganen. Neurol Centralbl [Neurologisches Centralblatt], 1898, 15. Mai, 17(10): 445–454. https://archive.org/details/neurologischescentralblatt. v.17.1898.urc/page/n451/mode/2up

[25] Wincewicz A, Woltanowski P. Leopold Auerbach’s achievements in the field of vascular system. Angiogenesis, 2020, 23(4):577–579. https://doi.org/10.1007/s10456-020-09739-5 PMID: 32719962

[26] Graetz H. History of the Jews (1923 historical reproduction, one volume abridged edition edited by Randolph Parrish). Resource Publications, 2002; Graetz H. Volkstümliche Geschichte der Juden [Popular History of the Jews]. Band I–III, Verlag von Oskar Leiner, Leipzig, 1888; Graetz H. Geschichte der Juden von den ältesten Zeiten bis auf die Gegenwart. Band I–XI, Verlag von Oskar Leiner, Leipzig, 1900 (reprint of the edition of last hand, Berlin, 1998), 11853–11875. https://www.digitalsammlungen.de/de/view/bib10570421?page=8

[27] Habsburg L. (Leopoldus I) Aurea Bulla Fundationis Universitatis Leopoldinae Wratisslaviensis. Vienna, Austria, 1702. http://www.bibliotekacyfrowa.pl/dlibra/publication/2903/edition/5316/content?ref=desc

[28] Kozuschek W. History of the Faculty of Medicine and Pharmacy of the University of Wrocław and the Medical Academy in Wrocław in the years 1702–2002 [Historia Wydziałów Lekarskiego i Farmaceutycznego Uniwersytetu Wrocławskiego oraz Akademii Medycznej we Wrocławiu w latach 1702–2002; Geschichte der Medizinischen und Pharmazeutischen Fakultäten der Universität Breslau sowie der Medizinischen Akademie in Wrocław in den Jahren 1702–2002]. Wrocław University Press, Wrocław, Poland, 2002. https://tezeusz.pl/historia-wydzialow-lekarskiego-i-farmaceutycznego-universytetu-wroclawskiego-oraz-akademii-medycznej-we-wroclawi-w-latach-1702-2002-2148651

[29] Boehm L. [Academy idea and Curiositas as leitmotif of the early modern Leopoldina]. Acta Hist Leopoldina, 2008, (49): 63–114. PMID: 20617610

[30] Jewish Telegraphic Agency. Professor Auerbach and wife commit suicide. Jewish Daily Bulletin, 1933, March 2, X:1. http://pdfs.jta.org/1933/1933-03-02_2488.pdf?ga=2.23162327.1880202943.1583838734-1783996947.1583838734

[31] Bârsu DC. A parallel between two important Romanian histologists of twentieth century: Alexandru Tupa (1886–1956) and Corneli Crișan (1895–1959). Rom J Morphol Embryol, 2017, 58(1):301–306. PMID: 28523337

[32] Mohan AG, Sâceleanu MV, Marinescu AA, Popescu M, Cirea AV. Neurosurgery in Romania in the century of the Great Union (1918–2018). Rom J Morphol Embryol, 2018, 59(4):1299–1303. PMID: 30845316

[33] Wincewicz A, Woltanowski P, Leopold Auerbach. Lancet Neurol, 2020, 19(9):723. https://doi.org/10.1016/S1474-4422(20)30266-0 PMID: 32822630

[34] Wincewicz A, Woltanowski P. Leopold Auerbach’s heritage in the field of morphology and embryology with special emphasis on gametogenesis of invertebrates. Rom J Morphol Embryol, 2020, 61(2):587–593. https://doi.org/10.47162/RJME.61.2.32 PMID: 33544814 PMCID: PMC7864296

[35] Wincewicz A, Woltanowski P, Jelen M. Bridging neighboring civilizations at academic grounds: a story of Zygmunt Albert – Rector Illustissimus ac magnificus Academiae Medicae Wratistaviensis – a pathologist who visualized gamma-glutamyl transpeptidase. Rom J Morphol Embryol, 2019, 60(3):1043–1051. PMID: 31912122

Corresponding author
Andrzej Wincewicz, Associate Professor, MD, PhD, Fellow of European Board of Pathology (FEBP), Specialist Medical Practice – Pathologist, Non Public Health Care Unit, Department of Pathology (NZOZ Zakład Patologii Spółka z o.o.), 70 Jagiellońska Street, 25–734 Kielce, Poland; Phone +48 41 368 47 87, Fax +48 41 366 17 81, e-mail: ruahpolin@yahoo.com, andwinc@gmail.com

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