REVIEW

The 550th Anniversary of the Universität Basel, 1460 – 2010: Paracelsian Beginnings and Chemistry

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In memoriam Vladimir Prelog (1906 – 1998), *R. Bryan Miller* (1940 – 1998), *Warren R. Biggerstaff* (1918 – 2000), *Irven W. Davies Jr.* (1925 – 2000), *Albert Bottini* (1932 – 2002), *Henry Rapoport* (1918 – 2002), and *Richard P. Ciula* (1934 – 2007)

This year marks the 550th anniversary of the founding of the Universität Basel. After its inception, the development of chemistry has played a major role in its evolution as an academic institution to meet the needs of industry and the educational community. Chemistry evolved in Basel as a dominant industry because of its central location and connection to the Rhine. The dyestuff industry and later the pharmaceutical industry established the Basel location as a major center of distribution. Companies like *Sandoz AG*, *Ciba AG*, *J. R. Geigy AG*, and *F. Hoffmann-La Roche AG* influenced the defining role of chemistry not only in Europe but throughout the world. This article highlights some of the academic personalities that contributed to the development of chemistry in the remarkable history of the Universität Basel since the time of *Paracelsus.*

Introduction. – Today, the Universität Basel has a broad reputation in the chemistry-related sciences but particularly in connection with scientists who have been recognized with the *Nobel Prize*. The earliest *Nobel Prize* recipient was *Paul Müller* (1899 – 1965) who earned his Ph.D. in chemistry in 1925 under Basel professors, *Hans Rupe* (1861 – 1951) and *Friedrich Fichter* (1869 – 1952) [1]. *Müller*'s synthesis of DDT (*Fig. 1*) at the Swiss company, *J. R. Geigy AG* was a world-wide breakthrough in the control of malaria which earned him the *Nobel Prize* for Physiology or Medicine in 1948 [2].

In 1950, Basel Professor *Tadeus Reichstein* (1897 – 1996) received the *Nobel Prize* for Physiology or Medicine for the syntheses of cortisone (*Fig. 2*) and its derivatives to

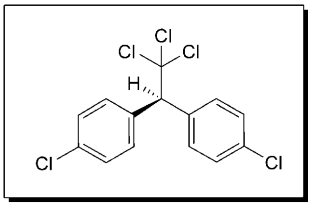


Fig. 1. *DDT* ('dichloro-diphenyl-trichloroethane')

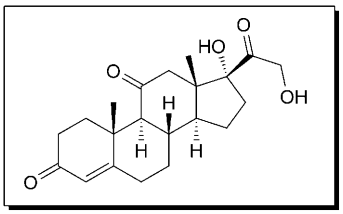


Fig. 2. *Cortisone*

treat rheumatoid arthritis. He received his Ph.D. under ETH chemistry professor and *Nobel Prize* recipient, *Hermann Staudinger* (1881–1965) [3].

Rolf M. Zinkernagel (b. 1944) received his medical degree at the Universität Basel in 1970 and Ph.D. in immunology at the Australian National University, Canberra, in

Fig. 3. *Lehrer und Schüler,* Alexander Zschokke*, Universität Basel at Petersgraben* (Photograph by *G. W. Craig*)

Fig. 4. *Bishop* Johann von Venningen *as Chancellor, Universität Basel, Inauguration in the Münster, 1460*. Courtesy Pharmazie-Historisches Museum, Basel.

1975. His research with *Paul C. Doherty* (b. 1940) concerning the specific recognition mechanism of immune cells garnered them the *Nobel Prize* for Physiology or Medicine in 1996 [4].

More recently, ETH Professor *Kurt Wüthrich* (b. 1938) received the *Nobel Prize* for Chemistry for the development of spectroscopic methods to characterize and understand the function of complex biological macromolecules. He received his Ph.D. degree in chemistry under Professor *Silvio Fallab* (1925 – 1993) at the Universität Basel in 1964 [5].

Certainly, these awards highlight milestones in the development of the chemical sciences at the Universität Basel. Perhaps more astonishing and often forgotten is the realization that the early developments in chemistry at the Universität Basel especially began with alchemy which was more a form of mysticism than a natural science.

Fig. 5. *Untere Collegium at the Rheinsprung* (Photograph by *G. W. Craig*)

1. The Paracelsians and the Botanical Gardens at *Spalentor*. – The Universität Basel, one of the oldest universities (*Fig. 3*) established in Europe, was championed by former Basler, *Aeneas Silvius Piccolomini* (1405–1464), christened Pope *Pius II.*, in 1458 [6]. The official opening of the Universität commenced on April 4, 1460, with a choir performance of *Veni sancta spiritus* in the Münster, a Catholic cathedral overlooking *Klein* Basel (minor Basel) across the river Rhine [7] (*Fig. 4*). The early Universität Basel, then consisted of the *Untere Collegium*, a renovated house at *Rheinsprung* overlooking the Middle Bridge (*Fig. 5*), and the *Obere Collegium*, the current *Naturhistorische* Museum on *Augustinerstrasse*. But in 1529, the Universität Basel suffered a set-back with the exit of a good part of its professors and students as a result of the *Reformation* which spread throughout Europe. Although the government temporarily closed the Universität, it was privately continued by some of its remaining faithful professors until official reopening in 1532.

Earlier in 1526, a young philosopher and early *Naturwissenschaftler* born in Einsiedeln, Canton Schwyz, arrived in Basel by the name of *Theophrastus Bombast von Hohenheim* (1493–1541) or, as he called himself, *Paracelsus* [6][8] (*Fig. 6*). He had taken his doctorate in medicine in 1515 at the Universität Ferrara where the revolutionary astronomer, *Nicholas Corpernicus* (1473–1543) had earlier studied in 1503. In the midst of *Paracelsus*' *Wanderzeit* in central Europe between 1516–1524, he settled in nearby Strassburg to practice medicine where he later treated and cured one

Fig. 6. Paracelsus *or* Theophrastus Bombast von Hohenheim (1493–1541). Courtesy Pharmazie-Historisches Museum, Basel.

of the most influential figures in Basel, *Johannes Froben* (1460–1527) from a life-threatening foot infection [9]. This good fortune allowed *Paracelsus* into *Froben*'s social circle of scholars which included the humanist, *Erasmus von Rotterdam* (1465–1536) [6][10]. Through their influence, *Paracelsus* was appointed professor at the sixty-seven-year-old Universität Basel.

But *Paracelsus* was a controversial figure that actively pursued alchemical or experimental remedies for the problems of latter-day medicinal chemistry. Alchemy from the early Egyptian, Greek, and Arabic cultures pursued the transmutation of precious metals into gold in order to understand the nature of materials [11] (*Fig. 7*). At that time, the alchemical concept for 'material' had a cosmological meaning and was understood to possess a spiritual quality. *Paracelsus* broadened this idealogy and encouraged use of alchemy for the experimental treatment of diseases. He prescribed chemicals such as oxide and sulfide salts of copper, arsenic, antimony, and iron as medicines [12]. But to his peers, *Paracelsus* was a man of contradiction as described by ETH professor, *Hans Eduard Fierz-David* (1882–1953) [13]:

'*He* [*Paracelsus*] *was an alchemist philosopher and simultaneously an opponent of alchemy, he was a doctor and yet opponent of all doctors but he was – what the applied*

Fig. 7. *Alchemy Laboratory.* Courtesy Pharmazie-Historisches Museum, Basel.

science recognized – a practical chemist, the first active in iatrochemistry, a mercurist and magician' ['mercurist reference' to *Hermes Trismegistos*, see *Fig. 8*].

Paracelsus' seminars and his medical reputation strongly influenced the apothecary or pharmacy development in Basel [14]. Fortunately for chemistry, *Paracelsus*' belief in curing the body with the knowledge of the transmutation of the elements had one significant influence. It convinced the educational establishment to revise the duties of medicine to teach not only its medical sciences but also to develop chemical relationships to find medicinal remedies for the body, a Paracelsian philosophy later known as iatrochemistry [15] (*Fig. 9,a*).

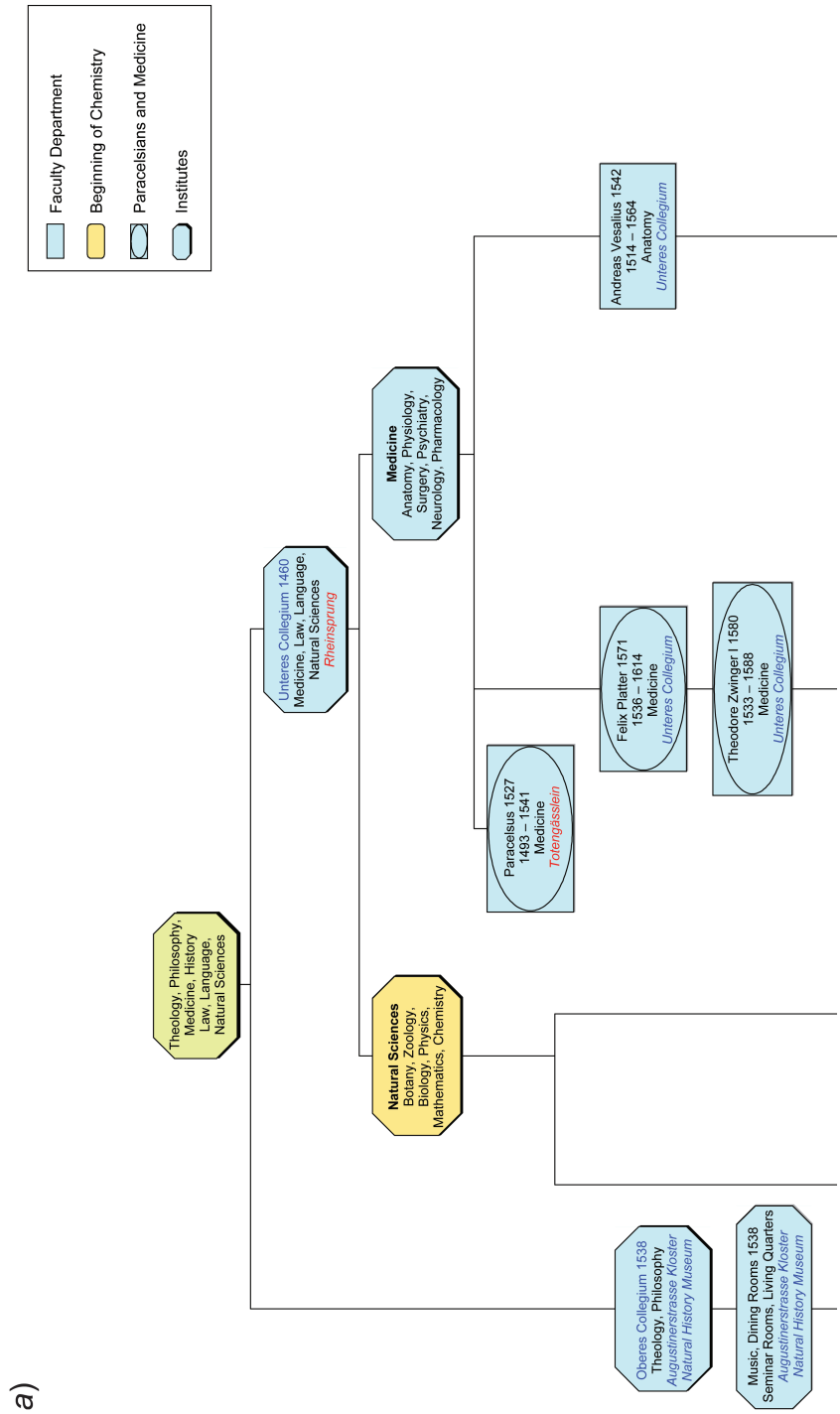
This important revision complemented the ancient tradition that applied herbal or botanical mixtures as medicinal remedies [16]. In this respect, *Paracelsus* was also a noted practitioner in the usage of herbs for healing [17]. The Universität's early botanical garden, *Hortus medicus*, was established in 1588 at the *Untere Collegium* in the Department of Anatomy and Botany by *Caspar Bauhin* (1560–1624) in the same year that he was appointed Professor of Anatomy and Botany. Both *Bauhin Senior* and his son, *Johann Caspar Bauhin* (1606–1685) taught in the Paracelsian tradition (*Fig. 9,a*). Senior *Bauhin*'s dedication was evident in his twelve-volume opus, *Pinax Theatri Botanici*, in which he described a new system of classification of over 6000

Fig. 8. Hermes Trismegistos, *father of alchemy and named for the mythological transformer,* Hermes *or* Mercury. Courtesy Pharmazie-Historisches Museum, Basel.

plants [18]. In efforts to find more space for classrooms, the *Hortus medicus* found a temporary home behind the nearby church, *Predigerkloster*, in 1692, but the gardens were later moved again to the *Stadtspital* (city hospital) in 1836 until it found a permanent home at its current location next to *Spalentor* (formerly *Spalengottesacker*) in 1898 [19]. *Wernhard de Lachenal* (1736–1800) instructed in the *Materia medica* (physician's teachings of medicinals) and the *Ars pharmaceutica* (preparations of medicinals) [9].

Generations of professors of medicine were appointed and educated with the guidance of Paracelsian philosophy. Among them were Professors *Theodor Zwinger I.* (1533–1588), *Felix Platter* (1536–1614), *Johann Jakob Harder* (1656–1711), *Theodor Zwinger III.* (1658–1724), and his son *Johann Rudolf Zwinger* (1692–1777) [1] (*Fig. 9,a*).

Curiously, *Zwinger I.* began as an ardent opponent of *Paracelsus*' philosophy, but as *Zwinger I.* set out to disprove this controversial revolutionist he became more and more convinced of *Paracelsus*' teachings [18]. Professors *Zwinger I.* and *Platter* took up Paracelsian ideas, but especially their students wrote their dissertations inspired with


Faculty Department
Beginning of Chemistry
Paracelsians and Medicine
Institutes
Theology, Philosophy, Medicine, History Law, Language, Natural Sciences
Unteres Collegium 1460
Medicine, Law, Language, Natural Sciences
Rheinsprung
Natural Sciences
Botany, Zoology, Biology, Physics, Mathematics, Chemistry
Medicine
Anatomy, Physiology, Surgery, Psychiatry, Neurology, Pharmacology
Andreas Vesalius 1542
1514 – 1564
Anatomy
Unteres Collegium
Paracelsus 1527
1493 – 1541
Medicine
Totengässlein
Felix Platter 1571
1536 – 1614
Medicine
Unteres Collegium
Theodore Zwinger I 1580
1533 – 1588
Medicine
Unteres Collegium
Oberes Collegium 1538
Theology, Philosophy
Augustinerstrasse Kloster
Natural History Museum
Music, Dining Rooms 1538
Seminar Rooms, Living Quarters
Augustinerstrasse Kloster
Natural History Museum

a)

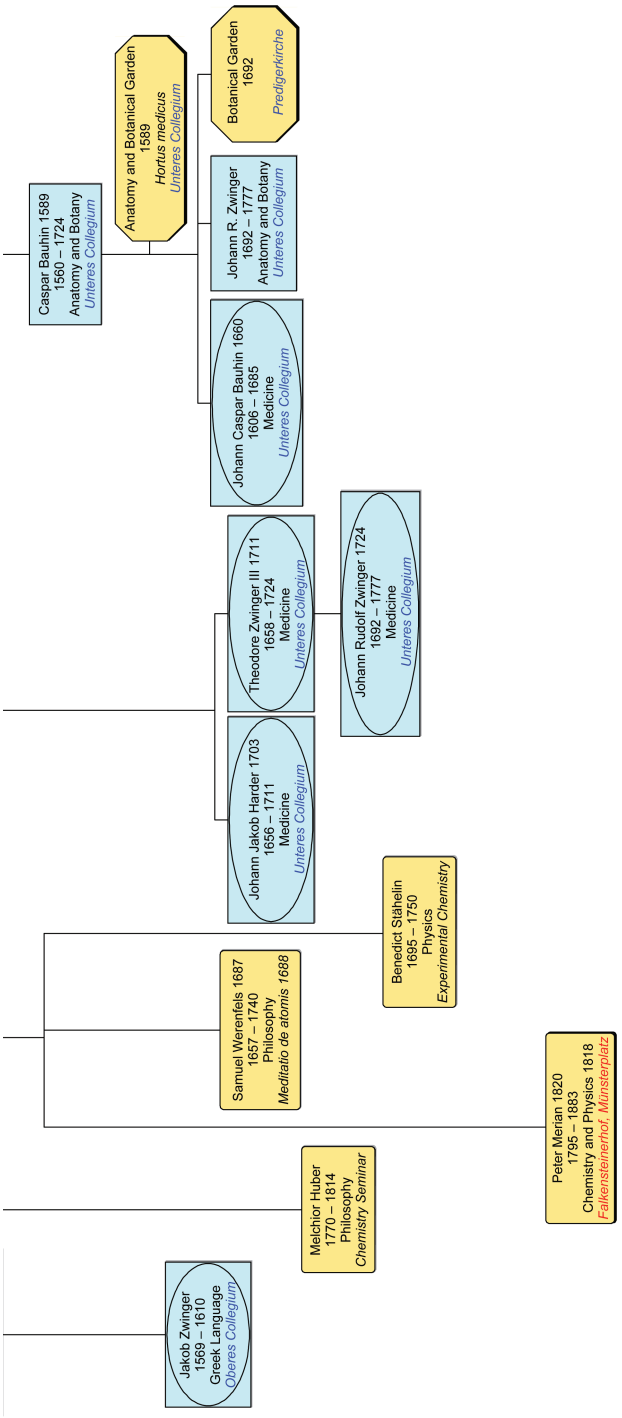
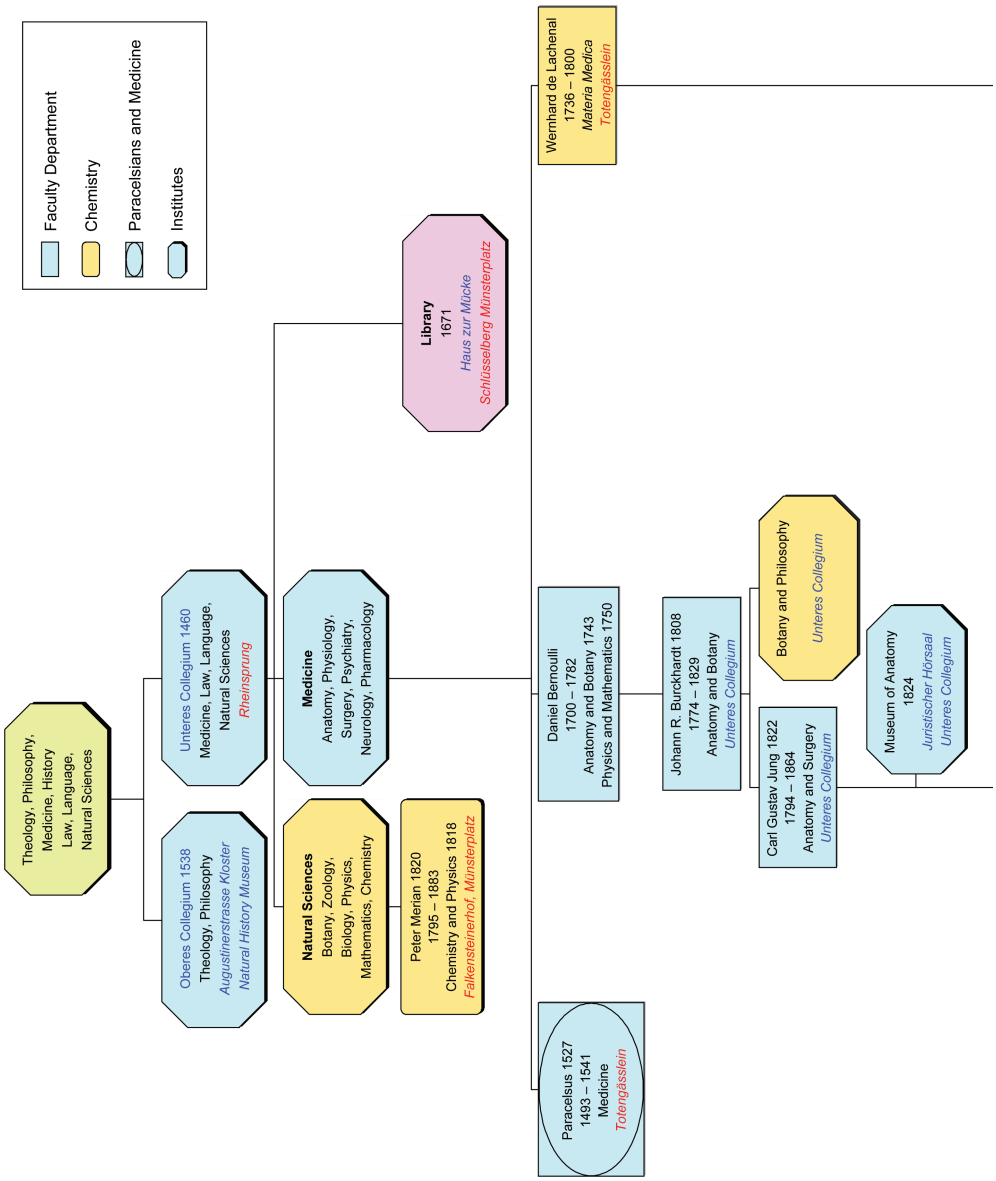


Fig. 9. a) *The Paracelsians and Medicine, Universität Basel.* b) *Biological Sciences, Universität Basel.*


Faculty Department
Chemistry
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Oberes Collegium 1538
Theology, Philosophy
Augustinerstrasse Kloster
Natural History Museum
Unteres Collegium 1460
Medicine, Law, Language, Natural Sciences
Rheinsprung
Natural Sciences
Botany, Zoology, Biology, Physics, Mathematics, Chemistry
Peter Merian 1820
1795 – 1883
Chemistry and Physics 1818
Falkensteinerhof, Münsterplatz
Medicine
Anatomy, Physiology, Surgery, Psychiatry, Neurology, Pharmacology
Library
1671
Haus zur Mücke
Schlüsselberg Münsterplatz
Paracelsus 1527
1493 – 1541
Medicine
Toterngässlein
Daniel Bernoulli
1700 – 1782
Anatomy and Botany 1743
Physics and Mathematics 1750
Johann R. Burckhardt 1808
1774 – 1829
Anatomy and Botany
Unteres Collegium
Carl Gustav Jung 1822
1794 – 1864
Anatomy and Surgery
Unteres Collegium
Botany and Philosophy
Unteres Collegium
Museum of Anatomy
1824
Juristischer Hörsaal
Unteres Collegium
Wernhard de Lachenal
1736 – 1800
Materia Medica
Toterngässlein

b)

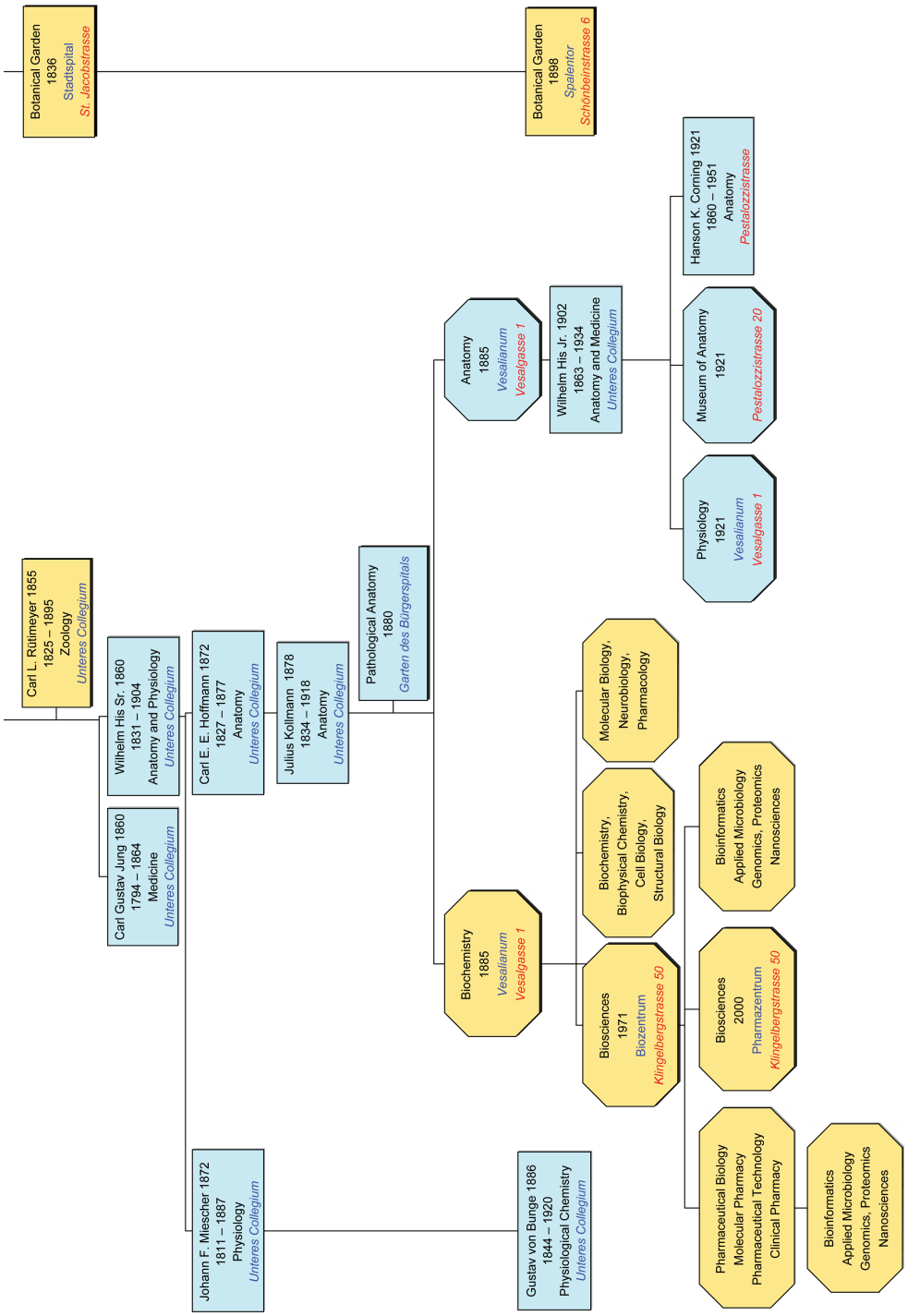

Botanical Garden
1836
Stadtspital
St. Jacobstrasse
Botanical Garden
1898
Spalentor
Schönbeinstrasse 6
Carl L. Rütimeyer 1855
1825 – 1895
Zoology
Unteres Collegium
Wilhelm His Sr. 1860
1831 – 1904
Anatomy and Physiology
Unteres Collegium
Carl Gustav Jung 1860
1794 – 1864
Medicine
Unteres Collegium
Carl E. E. Hoffmann 1872
1827 – 1877
Anatomy
Unteres Collegium
Julius Kollmann 1878
1834 – 1918
Anatomy
Unteres Collegium
Pathological Anatomy
1880
Garten des Bürgerspitals
Anatomy
1885
Vesalianum
Vesalgasse 1
Wilhelm His Jr. 1902
1863 – 1934
Anatomy and Medicine
Unteres Collegium
Hanson K. Corning 1921
1860 – 1951
Anatomy
Pestalozzistrasse
Museum of Anatomy
1921
Pestalozzistrasse 20
Physiology
1921
Vesalianum
Vesalgasse 1
Biochemistry
1885
Vesalianum
Vesalgasse 1
Molecular Biology,
Neurobiology,
Pharmacology
Biochemistry,
Biophysical Chemistry,
Cell Biology,
Structural Biology
Biosciences
1971
Biozentrum
Klingelbergstrasse 50
Bioinformatics
Applied Microbiology
Genomics, Proteomics
Nanosciences
Biosciences
2000
Pharmazentrum
Klingelbergstrasse 50
Johann F. Miescher 1872
1811 – 1887
Physiology
Unteres Collegium
Gustav von Bunge 1886
1844 – 1920
Physiological Chemistry
Unteres Collegium
Pharmaceutical Biology
Molecular Pharmacy
Pharmaceutical Technology
Clinical Pharmacy
Bioinformatics
Applied Microbiology
Genomics, Proteomics
Nanosciences

Fig. 9 (cont.)

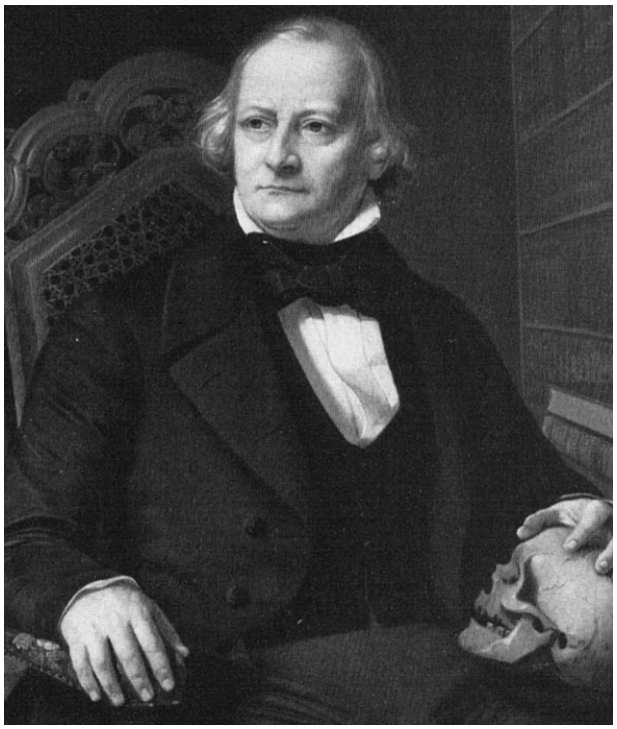


Fig. 10. Carl Gustav Jung (1794–1864)

this viewpoint [14]. Senior *Zwinger*'s eldest son, *Jakob Zwinger* (1569–1610), was appointed *Ausserordentlicher* (Associate) Professor for Greek, but *Jakob* further studied for his doctorate in medicine and opened a medical practice as alchemist in Basel [14]. Later in his medical seminars, Senior *Zwinger*'s grandson, *Theodor Zwinger III.* introduced the first chemistry course in 1685 [1]. *Samuel Werenfels* (1657–1740), Professor for Logic, applied Cartesian mathematics and philosophy to support the existence of atoms, in *Meditatio de Atomis* published in 1688 with his doctoral student *Amadeus le Fort* [1][20]. *Franciscus Sylvius* (1614–1672) completed his Basel doctorate in medicine in 1637, and as Professor of Medicine in Leyden he became an avid defender of this new alchemical science named iatrochemistry [20].

2. Biological Sciences, Iatrochemistry, and the Museum of Anatomy. – *Noel G. Coley* noted, '*chemistry became a* handmaid *to medicine*,' but also to mineralogy, physics, physiology, and particularly to apothecary before it branched off as a separate science [21]. But as historian *William H. Brock* (b. 1936) concluded,

'*Iatrochemical doctrines became extremely popular during the seventeenth century and not unlinked with this was a rise in the social status of the apothecary. Both in Britain and on the Continent there was a compromise in which the chemical remedies were adopted without committment to the Paracelsian cosmology*' [22].

Fig. 11. Andreas Vesalius (1514–1564), *father of 'modern' anatomy.* Courtesy Pharmazie-Historisches Museum, Basel

The development of the biological sciences, institutes, library, and botanical gardens of the Universität Basel are portrayed in *Fig. 9,b*. *Carl Gustav Jung* (1794–1864), grandfather of the famous psychiatrist, was appointed Professor of Anatomy and Medicine in Basel [23] (*Fig. 10*). *Jung* acquired a reputation for his intricate anatomical demonstrations which followed a tradition first established by *Andreas Vesalius* (1514–1564), father of 'modern' anatomy who gave a series of guest lectures at the *Untere Collegium* in 1543 [24] (*Fig. 11*). Although *Jung* established the renowned Museum of Anatomy in Basel in 1824 in the *Untere Collegium*, the museum later relocated to *Pestalozzistrasse* [23] (*Fig. 12*). *Jung*'s famous grandson, *Carl Gustav Jung* (1875–1961), who investigated not only 'dream interpretation' but also alchemical philosophy. He concluded that alchemy was the '*human-being's effort toward self-realization*' [11][25].

Fig. 12. *The Anatomy Institute* (Photograph by *G. W. Craig*)

Physiology like medicine evolved as a *chaperone* to chemistry with the appointment of Basel professors *George Meissner* (1829–1905), *Wilhelm His Sr.* (1831–1901), son *Wilhelm His Jr.* (1863–1934), and Senior *His*' successor, *Johann Friedrich Miescher* (1844–1895; *Fig. 13*). *Miescher* who received his medical degree in 1868 was the first person to discover and isolate DNA (deoxyribonucleic acid). It was a remarkable achievement and a reflection of *Miescher*'s earlier chemical training in Tübingen under Professor of Medicine, *Ernst Hoppe-Seyler* (1825–1895) [20]. In 1885, *Gustav von Bunge* (1844–1920), holder of a medical degree and Ph.D. in chemistry, was appointed as the first Professor of Physiological Chemistry [1]. *Miescher* later taught at the newly erected Institute for Anatomy and Physiology, christened in 1885 the *Vesalianum,* after the father of modern anatomy [19] (*Fig. 14*).

Despite *Paracelsus*' official status as *Stadtartz* (city medical officer), Lecturer and Professor of Natural History and Medicine, *Paracelsus* provoked the establishment with his discussions normally in German rather than in scholarly Latin [13]. His often heated debates with his faculty colleagues gave him the nickname '*Lutherus medicorum*' and eventually led to his hasty exit from Basel during the beginning of the Reformation period. *Paracelsus* continued his passion for travel and study which led him to the Alsace (France), Bayern (Germany), St. Gallen (Switzerland), Tirol (Austria), and finally to Salzburg where he died in 1541.

Fig. 13. Johann Friedrich Miescher (1844–1895). Courtesy Pharmazie-Historisches Museum, Basel.

3. Chemistry: Early Beginning at *Falkensteinerhof*. – The development of chemistry began with the appointment of the Swiss, *Peter Merian* (1795–1883) who first taught geology and later paleontology [1] (*Fig. 15*). In his service, *Merian* dominated the development of the natural sciences through his position as professor, and Chairman of the *Naturforschende Gesellschaft* (Nature Research Society). He was the driving force for the later construction of the Naturhistorisches Museum near Münsterplatz [26] (*Fig. 16*). But *Merian*'s additional responsibility as appointed Professor of Chemistry and Physics in 1820 lasted only eight years due to his appointment as Chancellor of the Universität in 1825, 1835, and 1860. The development of chemistry, institutes, and the pharmacy museum are portrayed in *Fig. 17*.

Suffering from a failing voice, *Merian* summoned the German chemist, *Christian Friedrich Schönbein* (1799–1868) to instruct chemistry and physics at the Universität Basel (*Fig. 18*). *Schönbein* did not hesitate to accept this offer. Although *Schönbein*'s early laboratory was not more than a washroom at the *Falkensteinerhof*, his prolific studies led to impressive results. *Schönbein* determined the principle of the fuel cell in 1838, investigated the chemistry of hydrogen peroxide, synthesized ozone using electrolysis, and later identified ozone to be an allotrope of oxygen in 1839. Remarkably, this was all achieved without any support from the chemical industry which had not yet blossomed [1]. Even serendipity lent a hand in *Schönbein*'s fortuitous invention of gun cotton or nitrocellulose in 1846 which later evolved into *Collodion*, a medicinal application for open wounds [22]. *Schönbein* attained the rank of *Ordinarius* (Full) Professor in 1835. During his dedicated service, chemistry and physics became

Fig. 14. *The Vesalianum* (Photograph by *G. W. Craig*)

independent fields. After becoming a naturalized Swiss citizen in 1840, *Schönbein* was elected to the Kantonrat (Canton parliament) in 1848, and in 1851 to the Stadtrat (city parliament). He later died and was buried in Baden-Baden (Germany) in 1868 [1][27].

The *Waadtländer* (the French-speaking region of Switzerland), *Jules Piccard* (1840–1933; *Fig. 19*) [1] studied at the Universität Heidelberg where he determined the atomic weight of rubidium under *Robert Wilhelm Bunsen* (1811–1899). He was enlisted and trained as *Schönbein*'s 1869 successor. During this period, the Universität expanded throughout the city in its continual quest for space. Consequently, *Piccard*'s chemistry classes were relocated to *Augustinerstrasse* at the current Naturhistorische Museum. Finally, with the rise of the Basel chemical industry, the construction of the *Bernoullianum*, (named after the famous *Bernoulli* family of mathematicians) was completed in 1874 to satisfy the overcrowded conditions of the Universität (*Fig. 20*). In his research, *Piccard* investigated substances such as resorcine, nitrocresol, anthraquinone, chrysin, and the monoterpene cantharidine, which were areas of interest shared by the chemical industry. *Piccard*'s two sons, physicist *Auguste Piccard* (1884–1962) and chemist *Jean Felix Piccard* (1884–1963) later developed exemplary careers in science [28].

In 1861, *Friedrich Goppelsroeder* (1837–1919) instructed chemistry following his *Habilitation* (qualification as university lecturer) in Basel and was appointed assistant professor in 1872 (*Fig. 21*). He pioneered new methods in analytical chemistry

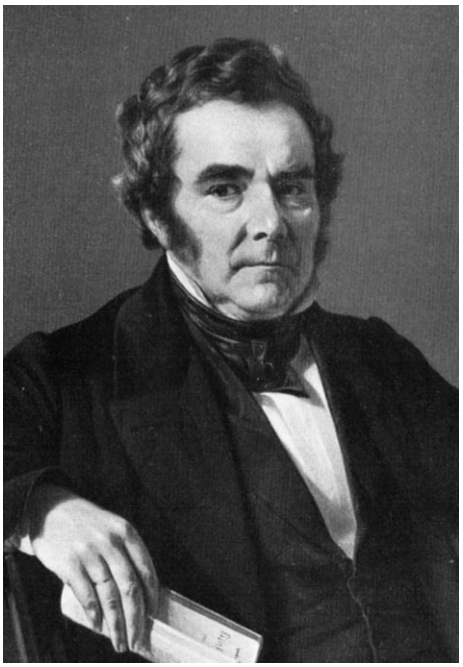
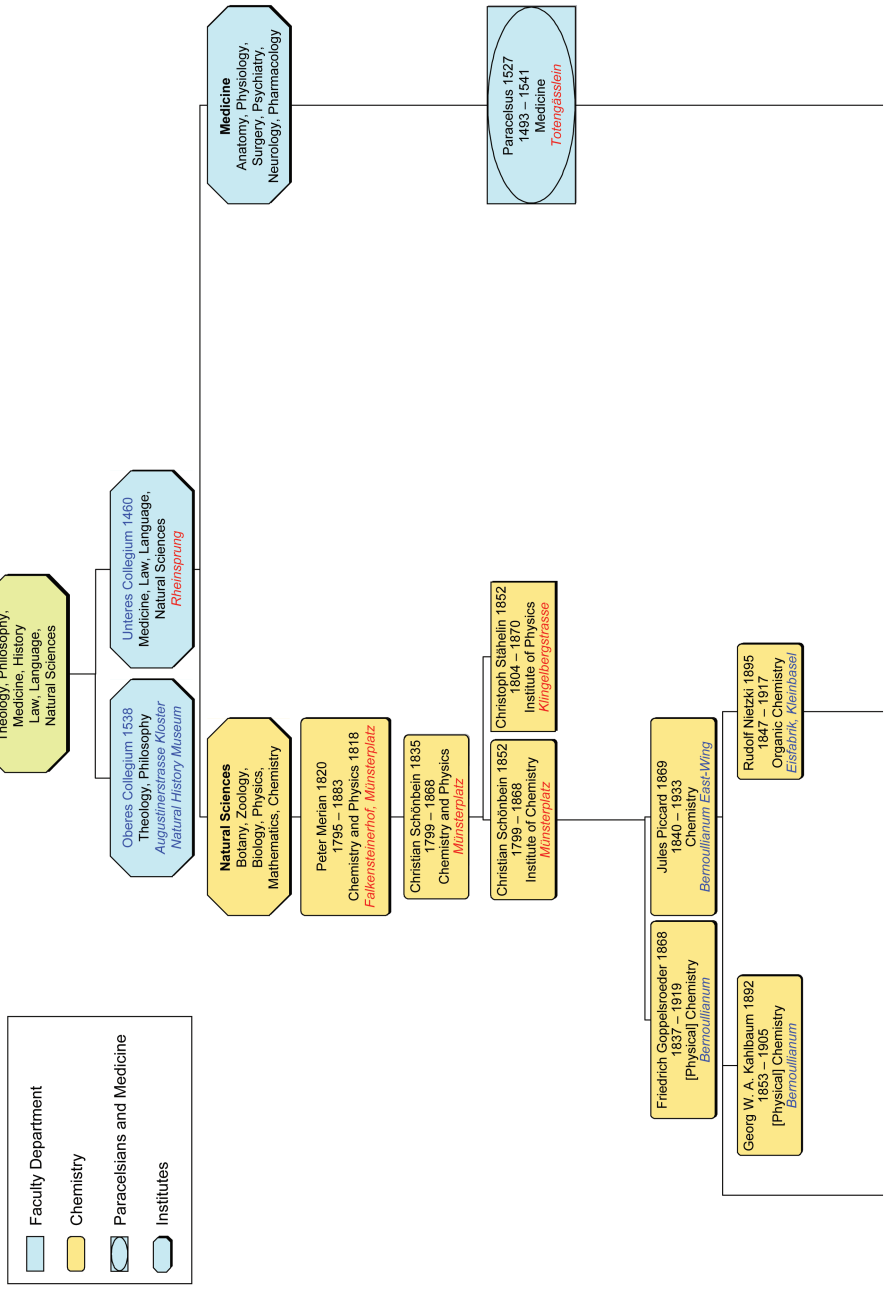


Fig. 15. Peter Merian (1795 – 1883)

Fig. 16. *Naturhistorisches Museum* (Photograph by *G. W. Craig*)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Oberes Collegium 1538
Theology, Philosophy
Augustinerstrasse Kloster
Natural History Museum
Unteres Collegium 1460
Medicine, Law, Language, Natural Sciences
Rheinsprung
Medicine
Anatomy, Physiology, Surgery, Psychiatry, Neurology, Pharmacology
Paracelsus 1527
1493 – 1541
Medicine
Totengässlein
Natural Sciences
Botany, Zoology, Biology, Physics, Mathematics, Chemistry
Peter Merian 1820
1795 – 1883
Chemistry and Physics 1818
Falkensteinerhof, Münsterplatz
Christian Schönbein 1835
1799 – 1868
Chemistry and Physics
Münsterplatz
Christian Schönbein 1852
1799 – 1868
Institute of Chemistry
Münsterplatz
Christoph Stähelin 1852
1804 – 1870
Institute of Physics
Klingelbergstrasse
Jules Piccard 1869
1840 – 1933
Chemistry
Bernoullianum East-Wing
Friedrich Goppelsroeder 1868
1837 – 1919
[Physical] Chemistry
Bernoullianum
Georg W. A. Kahlbaum 1892
1853 – 1905
[Physical] Chemistry
Bernoullianum
Rudolf Nietzki 1895
1847 – 1917
Organic Chemistry
Eisenkirk, Kleinbasel

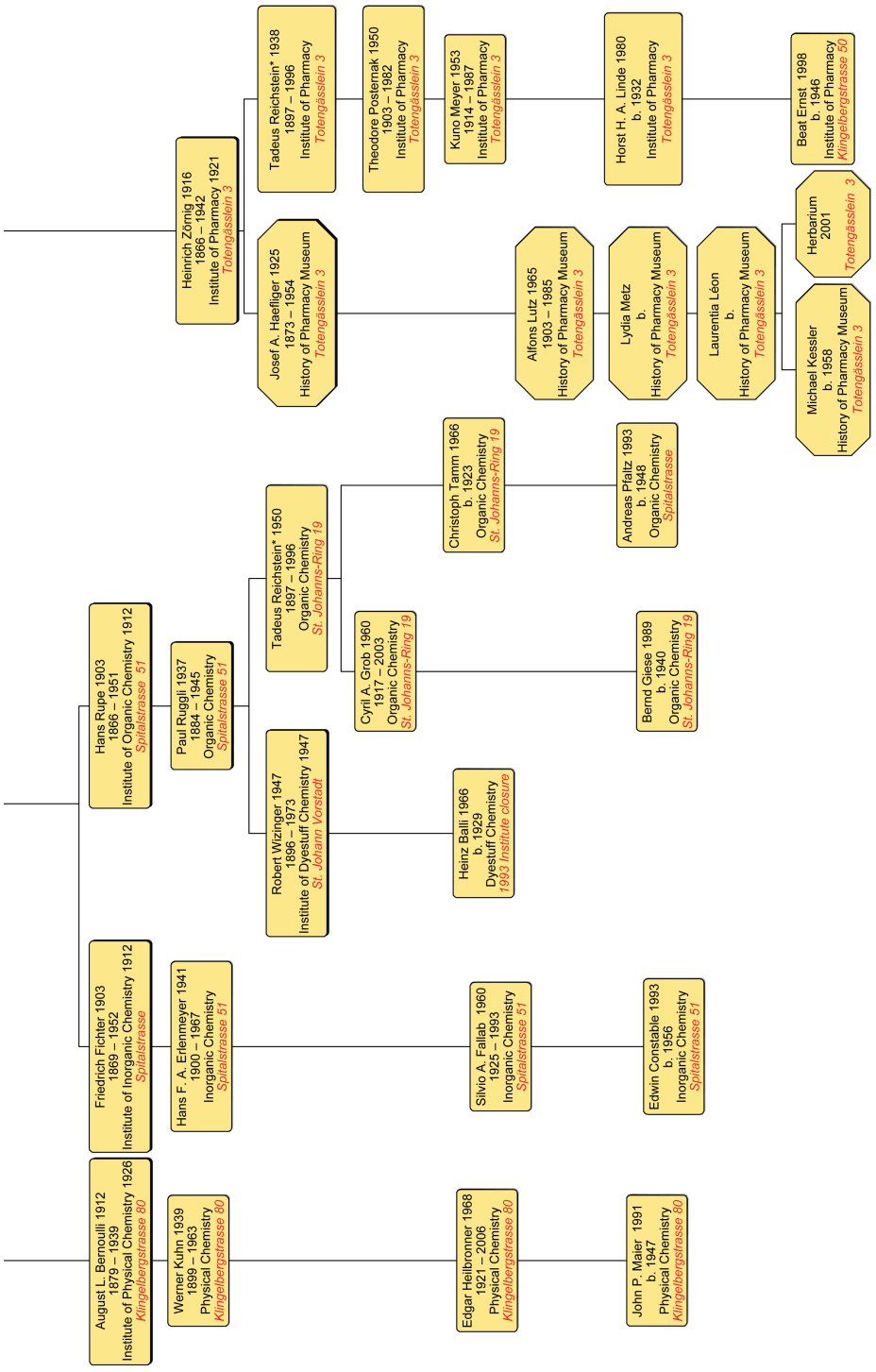

Fig. 17. *Chemistry at the Universität Basel, 1818–2010*

Fig. 18. Christian Friedrich Schönbein (1799–1868)

Fig. 19. Jules Piccard (1840–1933)

Fig. 20. *The Bernoullianum* (Photograph *G. W. Craig*)

primarily concerned with the application of capillary principles to paper chromatography [1][29]. In 1869, he became Director of the *Basler Chemische Gesellschaft* (Basel Chemical Society) which later developed into an important forum for the chemical community [30]. Before this period, there was little interaction between industry and academia.

4. Institute of Physical Chemistry at the *Bernoullianum*. – *Georg Wilhelm August Kahlbaum* (1853–1905) habilitated in 1887, the same year that *Wilhelm Ostwald* (1853–1932) was appointed to the first Chair of Physical Chemistry in Leipzig (*Fig. 22*). *Kahlbaum* was appointed assistant professor in chemistry in 1892 and *Ordinarius* Professor in 1899 [1]. During this period, he became intensely involved in the determination of physical constants, vapor pressure, and the distillation of metals [31]. Through *Kahlbaum*'s initiative, physical chemistry was established in the Universität's chemistry curriculum. In his early career, *Kahlbaum* had an extension built onto his apartment in the *Steinenvorstadt* with his own funds to provide laboratory instruction to five *Pratikanten* (beginning students) [32]. But after his death in 1905, the Universität regrettably took several years to appoint his successor which almost caused *Kahlbaum*'s vision of physical chemistry to disappear from the Universität Basel [31].

The further development of physical chemistry can be traced to *August Leonard Bernoulli* (1879–1939), who first studied in Basel and later obtained his Ph.D. in

Fig. 21. Friedrich Goppelsroeder (1837–1919)

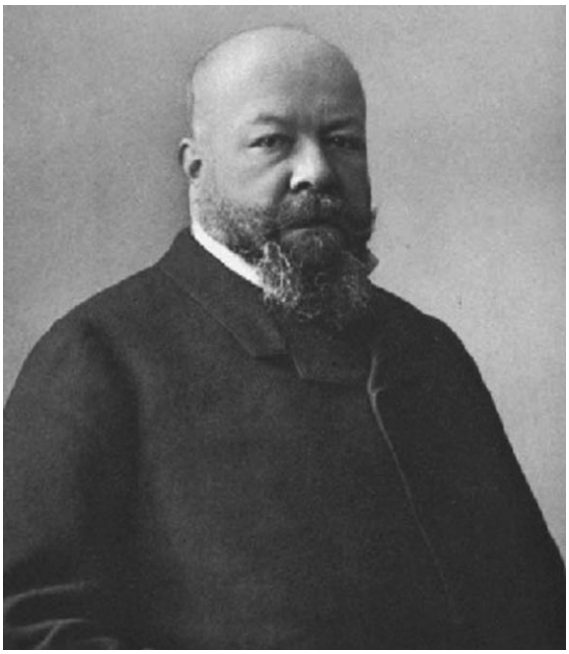

Fig. 22. Georg Wilhelm August Kahlbaum (1853–1905)

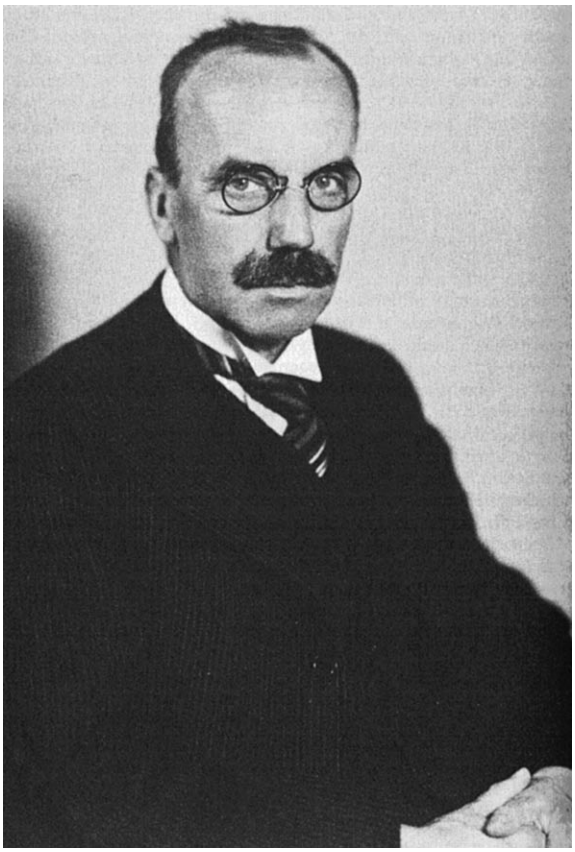

Fig. 23. August Leonard Bernoulli (1879–1939)

physics in 1903 under *Nobel* laureate *Wilhelm Röntgen* (1845–1923) in Munich (*Fig. 23*). Following habilitation at the *Technische Hochschule* Aachen, *Bernoulli* was summoned to the Universität Basel in 1912 as assistant professor and *Kahlbaum*'s successor [31]. *Bernoulli*'s research introduced thermochemistry, reaction kinetics, and experiments in optics into the curriculum [30]. He attained the rank of full professor in 1917 and was appointed the first Director of the Institute of Physical Chemistry in 1920 [7].

Werner Kuhn (1899–1963) was appointed Director of the Institute of Physical Chemistry in 1939 as *Bernoulli*'s successor [31]. As a former professor at Universität Kiel, *Kuhn* brought to Basel his pioneering research interests in polymer chemistry, biophysical chemistry, and the separation of D_2O and H_2O using chromatography [30][31]. In those days the existence of polymers was still a controversial subject!

Edgar Heilbronner (1921–2006) received his Ph.D. in 1940 under Professor of Organic Chemistry, *Placidus Plattner* (1904–1975) at the ETH. His doctoral research on azulene led to recognition of the then unusual tropylium cation [33]. *Heilbronner*'s

pioneering work expanded the understanding of aromaticity of cyclic polyenes in the *Hückel* system ($4n+2$ electrons). He demonstrated that an anti-aromatic ($4n$ electrons) or unstable system became aromatically stable by the introduction of a structural twist or node in the molecule resulting in a *Möbius* strip [34].

As a young doctoral candidate, *Heilbronner* had seriously considered working for ETH Professor of Analytical Chemistry, *William D. Treadwell* (1885–1959) but changed his mind because he was afraid that his tasks would require him to regularly hike into the Swiss Alps to analyze ozone concentrations [35]. *Heilbronner* habilitated in 1954, became assistant professor in 1959 and professor in 1964 at the ETH. As *Kuhn*'s successor, *Heilbronner* moved to Basel in 1968 as Director of Physical Chemistry at the Universität Basel and remained until his retirement in 1988 [36].

John Paul Maier (b. 1946) received his Ph.D. in 1972 in chemistry under *David W. Turner* (b. 1927) at Oxford [37]. After postdoctoral research at the Universität Basel, *Maier* was appointed as *Heilbronner*'s successor in 1992. Today, using modern lasers *Maier* investigates interstellar galaxies for 'chemical footprints' in the form of fullerene (C_{60}) molecules that hypothetically form during a super-nova explosion [38].

5. Institute of Pharmacy at *Totengässlein.* – In 1916, *Karl Heinrich Zörnig* (1886–1942), *apothecary* (pharmacist) in Munich, was called to Basel to begin the establishment of a modern Institute of Pharmacy [9]. Appointed the Director of the Institute of Pharmacy at *Totengässlein* in 1917, *Zörnig* was successful in the promotion of 46 doctoral students in pharmacy. Under his leadership, pharmacy was partially taught with examination in physics, botany, and inorganic and organic chemistry at the Universität Hospital established in 1865 [39].

Zörnig's successor, *Reichstein* was appointed the Director of the Institute of Pharmacy in 1938 which enabled *Reichstein* to continue his research to discover new active cortisone analogs for medicine (*Fig. 24*). His ground-breaking development of the first synthesis of vitamin C was completed while at the ETH (Eidgenössische Technische Hochschule), Zürich. *Reichstein*'s intense interest in the chemistry of water-soluble steroids had brought him into an academic conflict with similar chemistry studies by his ETH supervisor, Professor *Leopold Ružička*. Hence, it was a perfect solution for *Reichstein* to accept the chairmanship at the Universität Basel [40]. Although *Reichstein*'s approach was not exactly iatrochemistry as prescribed by *Paracelsus*, *Reichstein* continued his childhood interests in the Paracelsian philosophy. As a child, *Reichstein* had attempted to convert iron shavings into gold using chemical reactions after reading about alchemy [9]. In adulthood, *Reichstein* still retained his childhood curiosity and lectured openly about alchemy while he occupied the Institute of Pharmacy, the very building, *Haus zum Sessel*, previously occupied by *Johannes Froben* [9][41]. A landmark plaque marks the entrance of the Institute directly across the courtyard from the *Pharmazie-Historisches* Museum [14] (*Fig. 25*).

Théodore Posternak (1903–1982), who investigated the chemistry and biochemistry of cyclotols at the Université Geneva, was appointed *Reichstein*'s successor, Director of the Institute of Pharmacy, in 1950. But in 1953 *Posternak* left to accept the Chair for Biochemistry in Geneva, and *Kuno Meyer* (1914–1987) accepted the Chair for the Institute of Pharmacy in Basel. With *Meyer*'s appointment, a number of building renovations were realized in the Institute [30]. *Meyer*'s successor was *Hörst Heinrich*

Fig. 24. Tadeus Reichstein (1897–1996) *with his assistant,* Josef von Euw. Courtesy Pharmazie-Historisches Museum, Basel.

August Linde (b. 1932) who investigated terpene chemistry [39]. *Beat Ernst* (b.1946) succeeded *Linde* as Director of the Institute of Pharmacy currently located at the *Biozentrum*, home of many other biologically related sciences. His research involves the syntheses of glycosides and glycomimetics for the investigation of carbohydrate–receptor interactions [42].

6. *Pharmazie-Historisches* Museum and the *Herbarium*. – Under the auspices of the Universität Hospital, the chief pharmacist, *P. Fleissig* led the instructional education until 1918 but, following his death, his successor *Josef Anton Häfliger* (1873–1954) took charge of the seminars in pharmacy in 1924 (*Fig. 26*). During this decade, *Häfliger* also became internationally involved in the History of Pharmacy. In 1924, his rich library collection became the foundation of the Pharmazie-Historisches Museum established in Basel (*Fig. 27*). In 1957, the Swiss Society for the History of Pharmacy was established. In 1965, *Alfons Lutz* (1903–1985) was appointed curator [39]. This was followed by a number of former Basel doctorates, *Lydia Mez-Mangold*,

Fig. 25. *Plaque at the Institute of Pharmacy, Totengässlein* (Photograph by *G. W. Craig*)

Fig. 26. Josef Anton Häfliger (1873–1954). Courtesy, Pharmazie-Historisches Museum, Basel.

Fig. 27. *Pharmazie Museum Archive with assistant* C. Eichenberger (Photograph *G. W. Craig*)

Laurentia Leon, and today's Curator *Michael Kessler* (b. 1958), former chemistry doctoral student of *Christoph Tamm*. In 2001, the *Herbarium* was opened to provide herbal mixtures in the atmosphere they were previously prepared in the time of *Paracelsus* [9][43] (*Fig. 28*).

7. Institute of Organic Chemistry at the *Eisfabrik*. – The early beginning of organic chemistry at Universität Basel can be traced to the *Ostpreusse*, *Rudolf Nietzki* (1847–1917; *Fig. 29*) who arrived in Basel and habilitated in 1884 under *Piccard*. He received his Ph.D. in 1874 under *August W. von Hofmann* (1818–1892) in Göttingen. Unfortunately, *Nietzki*'s promotion to *Honorar* (Adjunct) Professor of Chemistry in Basel left him little possibility to remain at the *Bernoullianum*, because *Piccard* was the official *Ordinarius* Professor. Therefore, *Nietzki* privately funded a laboratory on the third floor of the *Eisfabrik* on the opposite bank of the Rhine in *Klein* Basel and directed the laboratory instruction for organic chemistry for eleven years [1][44][45]. During this period, he researched quinone dyestuff chemistry and developed the azo dyestuff, Alizarin yellow. In 1889, *Nietzki* published his compendium, '*Chemie der organischen Farbstoffe*' which was a classic textbook of the dyestuff chemistry [45].

Hans Rupe (1861–1951; *Fig. 30*) received his Ph.D. *summa cum laude* in 1889 under the famous chemist *Adolf von Baeyer* (1835–1917) in Munich. After arrival in Basel,

Fig. 28. *Herbarium*. Courtesy, Pharmazie-Historisches Museum, Basel.

Rupe became *Nietzki*'s assistant and began independent research [20][46–48]. Among his many studies, *Rupe* investigated a novel rearrangement reaction and a nickel catalyst which both bear his name today [49][50]. His research group investigated the optical properties of terpenes and their structural connection to smell which, he speculated, pointed to the existence of an *osmophore* group [33]. *Rupe* was appointed assistant professor in 1903. The institute was divided into two separate Chairs for Inorganic Chemistry and Organic Chemistry in 1912, which led to the appointment of *Rupe* as Director of Organic Chemistry, a position he held until his retirement in 1937 [1][48].

The 1922 appointment of *Paul Ruggli* (1884–1945) as assistant professor was a double blessing for organic chemistry and the then developing dyestuff industry which laid the foundation for the Institute of Dyestuff Chemistry established later. *Ruggli*

Fig. 29. Rudolf Nietzki (1847 – 1917)

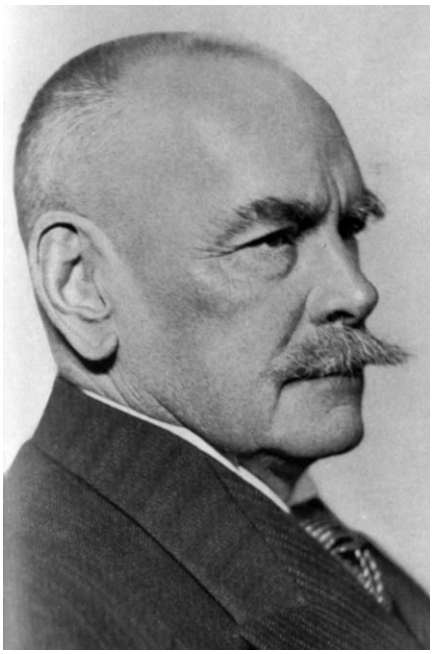

Fig. 30. Hans Rupe (1861 – 1951)

received his Ph.D. in Leipzig under *Arthur Hantzsch* (1857–1935), who later mentored *Nobel* Laureate *Alfred Werner* (1866–1919) at the Universität Zürich. In Strassburg under *Johannes Thiele* (1865–1918), *Ruggli* studied intermolecular cyclization of *ortho*,*ortho*′-diaminotoluene with 1,7-heptadicarbanoyl chloride to then an unusual twelve-membered ring system using high-dilution methods [49][51][52]. After habilitation in 1919, *Ruggli*, moved through the ranks of chemistry to associate professor in 1937 [20]. His research led to the first synthesis of β-alanine [53]. But his primary passion was concerned with special azo dyestuffs which contributed to 61 published chemistry articles [54][55]. In 1937, *Ruggli* was appointed Professor for Organic Chemistry but he abruptly died in 1945 just prior to the creation of the Institute of Dyestuff Chemistry in 1948 [20] (*Fig. 31*).

Tadeus Reichstein accepted simultaneous duties to lead the Institute of Organic Chemistry following *Ruggli*'s death and eventually relinquished his duties as Director of the Institute of Pharmacy in 1950 described earlier [9][56]. But during his tenure, *Reichstein* fought for an upgrade in laboratory conditions and renovation of the chemistry building at *Spitalstrasse* [57].

Fig. 31. *The former Institute of Dyestuff Chemistry now the Institute für Natur-, Landschafts- und Umweltschutz* (Photograph *G. W. Craig*)

Cyril A. Grob (1917–2003), who received his ETH doctorate in 1943 under *Nobel* recipient *Leopold Ružička* (1887–1976), completed habilitation in 1948 under *Reichstein* at the Institute of Pharmacy. His chemical interests in fragmentation reactions and inductive effects brought him international acclaim [58]. *Grob* succeeded *Reichstein* as Director of the Institute of Organic Chemistry in 1960 and retired in 1987 [59].

Christoph Tamm (b. 1923), former doctoral student under *Reichstein* was appointed assistant professor in the Institute of Organic Chemistry in 1955. His research focused on the isolation, clarification of the structure, and the biosynthesis of complex natural products [60]. In 1977, he was appointed Chancellor at the Universität Basel [61].

Bernd Giese (b. 1940) received his doctoral degree in 1969 under Professor *Rolf Huisgen* (b. 1920) at the Universität Munich. After habilitation in 1976 at the Universität Freiburg, *Giese* was appointed assistant professor. He moved later to the Technical Universität Darmstadt and attained the rank of professor. In 1989, he was appointed Professor of Organic Chemistry at the Universität Basel. During his years of research, he pioneered the theory and application of free-radical reactions in organic synthesis and investigation of biological processes [62].

Andreas Pfaltz (b. 1948) followed as chairman of Organic Chemistry. He completed his doctoral degree in 1978 under Professor *Albert Eschenmoser* (b. 1925) at the ETH in Zürich. *Pfaltz*'s major research interests in asymmetric catalysis garnered him the prestigious *Werner Prize* in 1989 and the *Prelog Medal* in 2003 [63].

8. Institute of Dyestuff Chemistry at *St. Johanns-Vorstadt.* – The early Swiss chemical companies such as *Sandoz AG*, *J. R. Geigy AG*, and *Ciba AG* were first founded on the development of new synthetic dyestuffs in the late 19th century. As Europe made a slow recovery following World War II., *Robert Wizinger* (1896–1973) was appointed in 1948 Director of the Institute of Dyestuff Chemistry in Basel. He had obtained his Ph.D. in Bonn under *Paul Pfeiffer* (1875–1951), former Universität Zürich assistant to Professor *Alfred Werner* (1866–1919) [54][64]. *Wizinger*'s research was concerned with the mechanism of substitution reactions but also the theory of color and its relationship with molecular structure.

Heinz Balli (b. 1929), doctoral student of Professor *Siegfried Hünig* (b. 1921) at Marburg, was appointed as *Wizinger*'s successor in 1966 [54][65]. *Balli*'s major research interests involved the study of bis-diazonium complexes, diazo-transfer reactions, and oxocarbon molecules. In 1973, Basel hosted an international symposium on dyestuff development [66]. But following *Balli*'s retirement and the waning chemistry applications in the dyestuff industry, the Institute of Dyestuff Chemistry was closed in 1993.

9. Institute of Inorganic Chemistry at *Spitalstrasse.* – Although inorganic chemistry was first taught at the *Bernoullianum* in 1874, the Institute of Inorganic Chemistry was first established in 1912 at *Spitalstrasse*. *Friedrich Fichter* was appointed the Institute's first director (*Fig. 32*). A native *Basler*, *Fichter* studied for his Ph.D. under *Rudolph Fittig* (1835–1910) in Strassburg and returned later to Basel to habilitate in 1896 under *Piccard* [1]. *Fichter*'s chemistry interests were chiefly concerned with electrochemistry, but he also assisted in the establishment of the Swiss chemistry journal, *Helvetica*

Fig. 32. Friedrich Fichter (1869–1952)

Chimica Acta in 1918 where he remained editor until 1948. In 1932, he became Chancellor of the Universität Basel [33][67][68].

Hans F. A. Erlenmeyer (1900–1967) represented a third-generation member of the family of noted chemists. *Erlenmeyer* had learned chemistry from his father, *Friedrich Gustav Karl Erlenmeyer* (1864–1921) in Berlin and his grandfather, *Richard August Karl Emil Erlenmeyer* (1825–1909), who developed the familiar conical flask [28]. In 1925, *Erlenmeyer* became *Fichter*'s research assistant and completed habilitation in 1927. *Hans Erlenmeyer* pioneered the early use of radioactive tracers for the study of biological processes [68][69].

Silvio Arthur Fallab (1925–1993), *Hans Erlenmeyer*'s doctoral student, received his Ph.D. in 1950 at the Universität Basel. *Fallab* left for a postdoctoral study to the Massachussetts Institute of Technology with *Nobel* laureate *John C. Sheehan* (1915–1992) and returned to Basel to complete his habilitation in 1955. After promotion to assistant professor in 1960 and to associate professor in 1966, he was appointed Director of the Institute of Inorganic Chemistry following the death of *Erlenmeyer* in 1967 [51]. *Fallab*'s research established a prodigious school of inorganic chemistry focused on oxygen-binding effects to coordination complexes. Pioneers such as *Hans Brintzinger* (b. 1935), *Klaus Bernauer* (b. 1938), *Thomas Kaden* (b. 1939), *Helmut Sigel* (b. 1938), and *Andreas Zuberbühler* (b. 1940) developed their technique and insight here before embarking on their own fruitful careers in chemistry [70].

In 1993, *Edwin C. Constable* (b. 1956) was appointed Director of Inorganic Chemistry. His major research interests continue in the syntheses of multinuclear metallodendrimers for the investigation of their catalytic, magnetic, and redox properties [71].

Conclusions. – The entire Universität Basel occupied many diverse quarters of the city during its 550 years of time in history (*Fig. 33*). Especially, the development of chemistry at the Universität Basel initiated constant expansion to satisfy the growing needs from the chemical industry. In addition, it can be seen that at several periods professors took it upon themselves to address the ever increasing lack of space for classes, particularly for chemistry laboratories from the 18th to the 20th centuries.

Perhaps it was appropriate that the *Renaissance* in alchemy began here in Basel, a city of the *Reformation*. In *Paracelsus*' quest to discover and understand nature through his experiments, arguments, and meticulous but often cryptic notes, he forged a bond between alchemy and medicine and transformed alchemy into iatrochemistry, an important step in defining chemistry later as an independent natural science. In this regard, *Paracelsus* may be considered the father of chemistry and the first chemistry professor at the Universität Basel. However, chemistry was to remain a relatively passive companion to the revered medicinal and biological sciences until the 18th century.

Today, modern-day alchemists are the astrochemists who study the transmutation of elements in far away galaxies to understand how the stars and the universe were created. Alchemy completes its illuminating round trip journey as a companion to

Fig. 33. *Sun Dial at Wettstein Platz* (Photograph *G. W. Craig*)

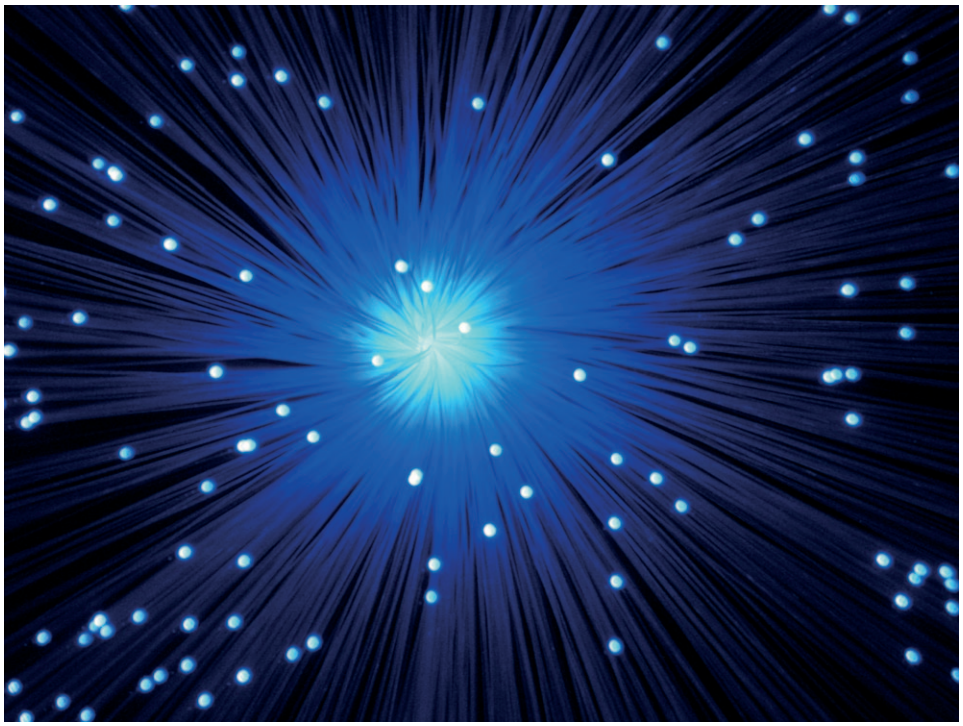

Fig. 34. *Modern Alchemy and the Cosmological Galaxy Blue Star* (Photograph by artist and musician *Jean-Claude Bannier*, Basel)

cosmology (*Fig. 34*). Today, alchemy is the search for the spiritual meaning of the universe.

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