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Excellence in Pharmacology

Nobel Prize laureates and nominees during the first half of the 20th century

Dissertation

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Synopsis

I.I. Synopsis English

Excellence in Pharmacology - Nobel Prize laureates and nominees during the first half of the 20th century

In an increasingly connected world, the question of "excellence in medicine" is becoming increasingly important. Therefore, methods were developed to identify particularly "excellent" work: impact factor, Hirsch index, and medical prizes. The greatest prize in science, the Nobel Prize, is of particular importance. There are already many works that analyze the Nobel Prize. So far, however, little has been written about the “excellence” of representatives of different medical disciplines in the Nobel Prize context.

This thesis looks behind the awarding structures of the Nobel Prize and targets pharmacologists with a focus on those who have not received a Nobel Prize: Who belongs to the "Nobel population" (all nominated pharmacologists) in pharmacology? Who were the most nominated pharmacologists? How were individual scientists and their achievements presented in the nominations? What do the nominations say about trends in science over time?

Through a systematic search of the Nobel Prize database, the group of nominated pharmacologists in the period 1901-1953 was identified. In-depth studies were carried out on special representatives from this group such as Oswald Schmiedeberg (1838-1921) or John Jacob Abel (1857-1838) with regard to the "excellence" they enacted. For this, their nominations from the Nobel Prize Archive in Stockholm were evaluated and contextualized.

In the first half of the 20th century, the “noble population” consisted exclusively of men. Using the example of John J. Abel, the nomination patterns show that pharmacology had very close ties to chemistry. It also shows that the centers of research were in Central Europe until the mid-1930s. After that, the center moved to America.

The "excellence" of the pharmacologists analyzed in the in-depth studies goes beyond pure research performance. The life's work of the pharmacologists is usually part of the argumentation in the nominations, which also include teaching and the establishment of pharmacology by specialist societies or scientific journals.

With the rise in prizes in medicine and the growing interest in “excellence in medicine”, there will be even more need for research into “excellent” science and scientists in the future. In this way, further social dimensions in medicine are visible, from which valuable conclusions can be drawn.

I.II Synopsis German

Exzellenz in Pharmakologie - Nobelpreisträger und Nominierte während der ersten Hälfte des 20. Jahrhunderts

In einer zunehmend vernetzen Welt wird der Frage nach „Exzellenz in der Medizin“ immer größere Bedeutung zugeschrieben. Daher wurden Verfahren entwickelt, um besonders „exzellente“ Arbeiten zu identifizieren: Impact Faktor, Hirsch-Index und medizinische Preise. Besondere Bedeutung kommt dem größten Preis in der Wissenschaft, dem Nobelpreis, zu. Es existieren bereits viele Werke, die den Nobelpreis analysieren.[1] Bislang wurde jedoch nur wenig über die „Exzellenz“ von Vertretern verschiedener medizinischen Fachrichtungen im Nobelpreiskontext geschrieben.[2]
Diese Arbeit blickt hinter die Vergabestrukturen des Nobelpreises und fokussiert die Pharmakologen mit Schwerpunkt derer, die keinen Nobelpreis erhalten haben: Wer gehört zur „Nobelpopulation“ (alle nominierten Pharmakologen) in der Pharmakologie? Wer waren die am meisten nominierten Pharmakologen? Wie wurden einzelne Wissenschaftler und ihre Leistungen in den Nominierungen dargestellt? Was sagen die Nominierungen über Trends in der Wissenschaft im Laufe der Zeit aus?
Durch die systematische Durchsuchung der Nobelpreis Datenbank, wurde die Gruppe der nominierten Pharmakologen in der Zeit zwischen 1901 und 1953 ausfindig gemacht. Besondere Vertreter aus dieser Gruppe wie Oswald Schmiedeberg (1838-1921) oder John Jacob Abel (1857-1838) wurden in Vertiefungsstudien, hinsichtlich der von ihnen inszenierten „Exzellenz“ weiter analysiert. Dafür wurden ihre Nominierungen aus dem Nobelpreisarchiv in Stockholm ausgewertet und kontextualisiert.
Die „Nobelpopulation“ bestand in der ersten Hälfte des 20. Jh. ausschließlich aus Männern. Die Nominierungsmuster zeigen am Beispiel John J. Abels, dass die Pharmakologie sehr nahe Beziehungen zur Chemie hatte. Es zeigt sich auch, dass sich die Zentren der Forschung bis Mitte der 1930er Jahre in Zentraleuropa befanden. Danach wechselte das Zentrum nach Amerika.

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[1] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press; Crawford E (1990) The Secrecy of the Nobel Prize Selections in the Sciences and Its Effect on Documentation and Research, Proceedings of the American Philosophical Society. Vol. 134, No 4.

[2] Drobietz M, Loerbroks A, Hansson N (2021) Who is who in cardiovascular research? What a review of Nobel Prize nominations reveals about scientific trends, Clinical Research in Cardiology. https://doi.org/10.1007/s00392-021-01813-2

Die „Exzellenz“ der in den Vertiefungsstudien analysierten Pharmakologen geht über die reine Forschungsleistung hinaus. Meist sind die Lebenswerke der Pharmakologen Bestandteil der Argumentation in den Nominierungen, die auch die Lehre, aber ebenso die Etablierung der Pharmakologie durch Fachgesellschaften oder wissenschaftliche Journale umschließen.

Durch den Anstieg von Preisen in der Medizin und das wachsende Interesse an der „Exzellenz in der Medizin“, entsteht in der Zukunft noch mehr Bedarf „exzellente“ Wissenschaft und Wissenschaftler zu erforschen. So werden weitere soziale Dimensionen in der Medizin sichtbar gemacht, durch die wertvolle Rückschlüsse gezogen werden können.

1. Introduction

1.1 Excellence in Medicine

1.1.1 What is excellence in medicine?

If asked how excellence in medicine nowadays is shown, consensus within the scientific community would be "scientometrics": the number of publications, the research output, the number of citations, as well as the impact factor and the Hirsch index.
In addition, excellence can be shown through scientific honors such as honorary degrees and prizes. Prizes differ from scientometrics in that they are not measured in numbers and are more present in the media. One of the most established and well-known prizes, both in academic and public perception is the Nobel Prize.
This work focuses on the research of the greatest prize - the Nobel Prize - and the "excellence" in pharmacology that derives from it. Why the Nobel Prize is referred to as the greatest prize is not completely established, but this research will give reasons why it is a main prize in the landscape of prizes.
While much has been already written about Nobel Prize laureates,[3] [4] so far only a few studies have been carried out on the excellence in the Nobel Prize. The existing excellence studies amount to the fields of surgery[5], cardiology[6], neurology[7], urology[8],

[3] Pratt D (2016) The Secret of Their Success, Brandon Books

[4] Worek M (2010) Nobel: A century of Nobel Prize Winners, Firefly Books

[5] Hansson N, Jones D S, Schlich T (2016) Defining 'Cutting-edge' Excellence: Awarding Nobel Prizes (or not) to Surgeons, Attributing Excellence in Medicine, Brill Rodopi; Leiden Boston, pp 122-132

[6] Drobietz M, Loerbroks A, Hansson N (2021) Who is who in cardiovascular research? What a review of Nobel Prize nominations reveals about scientific trends, Clinical Research in Cardiology. https://doi.org/10.1007/s00392-021-01813-2

[7] Hansson N, Palmen L, Padrini G, Karenberg A (2020) Babinski, Bektherev, Cerletti, Head, and Hitzig: European Neurologists Nominated for the Nobel Prize 1901–1950, 83:542–549. https://doi.org/10.1159/000509078

[8] Hansson N, Krischel M, Halling T, Moll F, Fangerau H (2017) Nobel Prize nominees and the rise of urology in Europe around 1900, World Journal of Urology, 35(8):1291-1295. DOI: 10.1007/s00345-016-1989-x

otorhinolaryngology[9], psychiatry[10] and anesthesia[11]. Researching excellence in the context of the Nobel Prize with a focus on the nominees in the physiology or medicine category, and in the chemistry category, is a relatively new area of research. Research trends will become visible through the critical assessment of what was considered "excellent research" at the time. Highlighting the trends will examine pharmacological research from a new perspective.

This work fills gaps in the literature on Nobel Prize nominees who were never awarded the prize.

The question of how excellence is enacted in science is by no means new. One of the attempts to make structures of excellence visible goes back over 100 years, to the year 1916[12]. Here the members within a social group are rated according to their abilities. Those with the highest capacity are considered to be the most productive and are referred to as the "elite".[13] A clear stratification in science was established in 1973[14]. Stratification in science and its analysis is closely related to the question of how excellence is defined in science, since certain masters of a group function as "evokers of excellence".[15] In year 1977, measured by high income and social prestige, scientists are automatically assigned to the elite when considering complex industrial societies.[16] In order to illustrate a further subdivision of the stratification from the year 1916, American scientists are further classified on the basis of various characteristics ascending the pyramid of elitism: people who call themselves "scientists", members of the National Register of Science and Technical Personnel by the National Science Foundation, people

[9] Hansson N, Drobietz M, Mudry A (2020) Otorhinolaryngologists nominated for the Nobel Prize 1901-1940, European Archives of Oto-Rhiono-Laryngology, 277, pp 1255–1258

[10] Hansson N, Halling T, Fangerau H (2016) Psychiarty and the Nobel Prize: Emil Kraepelin's nobility, Trames, 20(70/65), 4, pp 393–401

[11] Hansson N, Fangerau H, Tuffs A, Polianski I (2016) No Silver Medal for Nobel Prize Contenders: Why Anesthesia Pioneers Were Nominated for but Denied the Award, Anesthesiology, 125:34–38. DOI: https://doi.org/10.1097/ALN.0000000000001099

[12] Pareto V (1916) Tratto di sociologia generale

[13] Pareto V (1935) The Mind and Society, Sentiment in Thinking, Theory of Deviations, Vol. 3, pp 1422-1423

[14] Cole J, Cole S (1973) Social Stratification in Science, University of Chicago Press.

[15] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press. pp 124-127

[16] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press. p 8

whose positions require scientific training, people with a Ph.D. degree, people elected to the National Academy of Sciences, and people who are Nobel Prize Laureates living in the United States. This shows a pyramid-like distribution of scientists within the categories. If one now assumes that the few scientists who belong to the National Academy of Sciences belong to the "elite", the group of Nobel Prize winners can be described as an "ultra-elite". This approach of stratification goes back to one of the first researchers who studied the Nobel Prize, and its structures, the sociologist Harriet Zuckerman.[17]

[17] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press, pp 9-10

1.1.2 Objectives

A lot of literature is already written about the history of pharmacology [18] [19], instead nothing is written about the "excellence" of pharmacologists. The aim of this research project is to investigate how "excellence" in pharmacology is portrayed. Therefore, in-depth analyses of individual pharmacologists regarding their excellence and achievements in the pharmacological field are performed. To illustrate the "excellence" in the context of the Nobel Prize, the characterization of the "Nobel Population in Pharmacology" is fundamental. This group comprises all pharmacologists (laureates and nominees) nominated for the Nobel Prize between 1901 and 1953. This period is chosen because the Nobel Prize database only contains nominations up to 1953 so far. One of the main reasons for this is the 50-year blocking period to which the publication of nominations is subject. Thus, the questions arise: Who belongs to the "Nobel Population" in Pharmacology? Who were the most nominated pharmacologists, so-called "favorite-sons"? How were individual scholars and their achievements depicted in the nominations? What do the nominations say about trends in science over time?

[18] Starke K (1998) A history of Naunyn-Schmiedeberg's Archives of Pharmacology. N-S Arch Pharmacol 358. https://doi.org/10. 1007/PL00005229

[19] Phillippu A (2018) Geschichte und Wirken der pharmakologischen, klinisch-pharmakologischen und toxikologischen Institute im deutschsprachigen Raum: Band V, Autobiographien, II und ausgewählte Biographien. Berenkamp, Wattens

1.1.3 Methods

The Nobel Prize archive has a publicly accessible online database that contains the names of nominators and the nominees for all five categories. This database contains several thousand nominations in the Physiology or Medicine category from the years 1901-1953. In some cases, reasons for the nomination are also given.
From the category “physiology or medicine” in the Nobel Prize database, all 5110 nominations were filtered to find out the nominations for pharmacologists nominated in the above-mentioned period. The results found for the nominations were summarized under the headline “The Nobel Population in Pharmacology”.
Further research was carried out on the pharmacologists who received the highest number of nominations. Afterwards, in-depth studies were carried out on three special representatives from the Nobel Population: Oswald Schmiedeberg (1838-1921), Bernhard Naunyn (1839-1925), and John Jacob Abel (1857-1938). Oswald Schmiedeberg is important in the history of pharmacology because he is referred to as the "founder of modern pharmacology"[20]. Together with Naunyn, he founded the first pharmacological journal, which contributed significantly to the establishment of pharmacology as an independent discipline. Abel arouses interest insofar as he is the main representative of the shift of the pharmacological centers from Central Europe to America, and the establishment of pharmacology on the American continent. Therefore, Abel is also referred to as the “Founder of American Pharmacology”[21]. Also, Abel is the first pharmacologist, who was nominated in both Nobel Prize categories: “physiology or medicine” and “chemistry”. The evaluation of his nominations for both prizes also addresses the question to which discipline pharmacology should be assigned.

[20] Jagdish Prasad P (2010) Conceptual Pharmacology, Universities Press (India) Private Limited, p 2

[21] George CRP (1998) John Jacob Abel reinterpreted: Prophet or fraud?, Nephrology, Vol. 4, pp 217-222

1.1.4 Research about prizes

Understanding “excellence” in science is a complex topic that is viewed from different perspectives. There is the approach that understanding the meaning of the term "excellence" is not possible, since "excellence" is viewed as something that one ascribes to oneself and not others ascribe to someone. As a result, a university tends to describe its own science as "excellent" contrary to the opinion of others.[22] Another perspective regards Nobel Prize laureates as “evokers of excellence”, who have a positive effect on young scientists due to their role model character.[23] As not every excellent scientist can be awarded a Nobel Prize, many scientists naturally remain in the shadow of the limelight. Therefore, other analysis methods are required.

Research about prizes is a new phenomenon and has seen considerable growth in both research and influence in recent years. The reasons for this can be found in a proliferation of prizes which are mostly of an academic nature, but an increasing media interest driven by a globalized world may well warrant further notice. Regardless of whether they are awarded in the fields of film, military or science - awarding prizes follow structures.

Different new research takes up this topic and trys to emphasize the value of the scientific prizes, the correlating networks of prizes, and its relevance.[24] In recent years, the gender of the laureate has become a widely discussed field, too.[25] In the year 2008 Joel Best stated in his research,[26] that an award increases in importance due to the frequency with which it is given. This goes hand in hand with the media interest that the award deserves, but also the respect from the scientific community for the award winners. This generates a role model function or motivation for other scientists. As a result, networks can see that Nobel Prize winners also encourage future winners.

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[22] Moore S, Neylon C, Paul Eve M, et al. (2017) “Excellence R Us”: university research and the fetishisation of excellence, Palgrave Commun 3, 16105. https://doi.org/10.1057/palcomms.2016.105

[23] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press. pp 124-127

[24] Ma Y, Uzzi B (2018) Scientific prize network predicts who pushes the boundaries of science, Proceedings of the National Academy of Sciences 115 (50) 12608-12615. DOI: 10.1073/pnas.1800485115

[25] Meho L I (2021) The gender gap in highly prestigious international research awards, 2001-2020, Quantitative Science Studies, pp 1-14. https://doi.org/10.1162/qss_a_00148

[26] Best J (2008) Prize Proliferation, Sociological Forum, Vol. 23, No 1. https://doi.org/10.1111/j.1573-7861.2007.00056.x

Why the Nobel Prize is so important is not clearly identified. However, there are different approaches existing to justify its crucial position:
Prizes are not only intrinsically valuable as recognition for excellent work but may also lay the groundwork for winning further prizes, certain effects have been identified. This so-called “Matthew effect” of cumulative advantage can also be transferred to the Nobel Prize in the sense of “success breeding success”.[27] There are also arguments that the Lasker Award - often regarded as "America’s equivalent of the Nobel Prize"[28] - tends to predict the future of winning a Nobel Prize[29], the same accounts for the Israeli Wolf Prize[30]. At the same time, certain effects can be observed after a scientist was awarded the Nobel Prize.
Regarding a deeper sphere in which the laureates are categorized and focused, further insights into existing structures can be made visible. The differentiation at the national level must be considered, as well as the individual analysis of laureates or laureates in connection with their research areas. By looking at the nationalities of the laureates, it is possible to draw conclusions about any scientific strongholds such as universities or educational structures.[31]

A significant field of prize research also focuses on the consideration of laureates. This research goes beyond the laureates, it isolates a complete group of nominees within the award (Nobel population) and researches them. To focus further on this group, they can additionally be analyzed regarding diversity: their scientific careers, their socially defined attributes such as age, sex, religion, but also of their ethnicity. It is therefore obvious that social discrimination and social processes also have a considerable influence on scientists.[32] When considering the Nobel Prize, the patriotism[33] that goes

[27] Chan H F, Gleeson L, Torgler B (2014) Awards before and after the Nobel Prize: A Matthew effect and/or a ticket to one’s own funeral?, Research Evaluation, vol. 23, p 210-320. DOI: 10.1093/reseval/rvu011

[28] Thompson G (2014) Pioneers of Medicine without a Nobel Prize, Imperial College Press, p ix

[29] Doherty P (2006) The beginner’s guide to winning the Nobel Prize: a life science, Columbia University Press, p 1

[30] Hargittai I (2002) The Road to Stockholm, Oxford University Press, p 28

[31] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press, pp 25-35

[32] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press. p xiii

[33] Baram-Tsabari A (2018) Global and local “teachable moments”: The Nobel Prize and national pride, Public Understanding of Science, Vol 27 (4) 471-484. DOI:10.1177/0963662518768410

with it must by no means be neglected, as nations have a very keen interest in claiming the laureates as daughters and sons of their country.
In order to describe the excellence emanating from the Nobel Prize, the prestige of this prize must be considered. Nobel Prize laureates receive immense recognition from science and the general public due to their actual research performance. For example, 44 American Nobel Prize winners in 1970 took advantage of their popularity to publish a public commitment against the South Asian war.[34] Similar examples are provided by other laureates who are critical of the Soviet Union[35] or the French government[36] and whose criticism has enormous implications. These examples show the effect of the laureates in public, go beyond the work of scientific research.

It is obvious that Nobel Prize laureates form the tip of the iceberg of renowned researchers, due to the limitation of the award. Therefore, it is interesting to look at the larger group of nominees for the prize. One feature to pay attention to is the presence of a large number of nominations for one scholar. The most nominated pharmacologists are Alfred Newton Richards with 57 nominations, Rudolf Magnus (31), Edward Calvin Kendall (28), Otto Loewi (27), Sir Henry Hallett Dale (21) and Oswald Schmiedeberg (18). These six scientists who have been nominated several times by their colleagues can be summarized under the term "favorite sons" coined by Elisabeth Crawford.[37] This “favorite sons” can then be used to carry out further analyses and identify hotspots, trends, and networks within the specialist disciplines.

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[34] Boffey P M (1970) Dissent Spreads to Nobelists, Industrial Scientists, Science, vol. 168, p 1325. DOI: 10.1126/science.168.3937.1325

[35] Bengelsdorf I S (1973) Letter to Pravda, Science, vol. 182, p 334. DOI: 10.1126/science.182.4110.334

[36] McEhleny V (1965) France Considers Significance of Nobel Awards, Science, vol. 150, pp 1013-1015. DOI: 10.1126/science.150.3699.1013

[37] Crawford E (1984) The beginnings of the Nobel institution: The science prizes 1901-1915), Cambridge and Paris), pp. 140-148

1.2 The Nobel Prize

1.2.1 The history of the Nobel Prize

The chemist and inventor Alfred Nobel (1833-1896) built up an immense fortune through the invention of dynamite. Nobel died unmarried and childless, but he left a will from which it emerges that he wanted to promote science, culture, and society sustainably and internationally with his property.[38]
Alfred Nobel stipulated that funding takes the form of prizes endowed with prize money, which are awarded in the categories of physics, chemistry, medicine or physiology, peace and literature. The Nobel Prize for economics was subsequently donated by the Swedish *Riksbanken* in 1968. The subsequent definition of the individual categories showed that the category "physiology" includes all the basic medical sciences that can be summarized under the term "life sciences". These include the areas of biochemistry and microbiology, cytology, biophysics, and (molecular) genetics. The "medicine" category houses the clinical subjects where theoretical knowledge is applied in practice. These include drugs or vaccines, surgical procedures, or diagnostic techniques.[39]
The instruction in the will about the research to be awarded "during the preceding year" can usually not be implemented verbatim. Some of the most important developments made by researchers date back decades and the derived further developments and implementations are already established.[40]

> "The whole of my remaining realizable estate shall be dealt with in the following way: The capital shall be invested by my executors in safe securities and shall constitute a fund, the interest shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind. The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the

[38] Riha O (2016) Meilensteine der Medizin – Wie der Nobelpreis unser Wissen vom Menschen prägt. Bückle & Böhm, p 9

[39] Riha O (2016) Meilensteine der Medizin – Wie der Nobelpreis unser Wissen vom Menschen prägt. Bückle & Böhm, p 10

[40] Riha O (2016) Meilensteine der Medizin – Wie der Nobelpreis unser Wissen vom Menschen prägt. Bückle & Böhm, p 10

person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature the most outstanding work of an idealistic tendency; and one part to the person who shall have done the most or the best work for fraternity among nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congress.
The prize for physics and chemistry shall be awarded by the Swedish Academy of Sciences; that for physiological or medical works by the Caroline Institute in Stockholm; that for literature by the Academy in Stockholm; and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting (Parliament). It is my express wish that in awarding the prizes no consideration whatever shall be given to the nationality of the candidate, so that the most worthy shall receive the prize, whether he be a Scandinavian or not."

Nobel's will brought with it certain hurdles: the award-giving institutions were not consulted; it was hard for Nobel's relatives to imagine that they would only receive a token inheritance; Nobel was Swedish by birth, but had not had Swedish citizenship since childhood. [41] Furthermore, he named two executors who were not informed: Rager Sohlman (1870-1948) and Rudolf Lilljeqvist (1855-1930). Both executors consulted Carl Lindhagen (1860-1946), a lawyer and politician who contributed to the implementation of Nobel's will.
In May 1897, the Swedish Attorney General declared the dissolution of Nobel's property as a matter of national interest. It was declared that the state assumed judicial responsibility for the statutes but did not play a direct role. Thus, the statutes must be sent to the king-in-council and approved.[42] Nobel's family did not play a role in executing the will.
However, there were still questions that were not answered in the will: Who should nominate candidates? How are candidates selected? Who should review your work?

[41] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 14

[42] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 15

What did Nobel mean by "physics", "chemistry", and "physiology and medicine"? A definition of "greatest benefit on mankind" was also required.[43]
Sohlman and Lindhagen developed answers to these ambiguities and further open questions regarding the awarding were resolved in negotiations between the executors and representatives from the Royal Swedish Academy of Sciences. The final statutes were promptly submitted to the king-in-council. This gave its confirmation on June 29, 1900 and the Nobel Foundation was established. The foundation became legal trustee for Nobel's wealth - an initial fund of 30 million Swedish crowns.[44]
Moreover, in the early years of the awarding, it also became apparent that there were still open questions regarding the interpretation of the bylaws that had been decided. An example of this is the nomination of Emil Fischer (1852-1919) for the Prize in chemistry by Edward Hjelt (1855-1921) in year 1900, and the arising question of how strictly discoveries or improvement “during the last year” was interpreted by the Academy.[45]

The nomination rights are roughly similar in all scientific categories. Since in this study the focus is placed on the categories "physiology or medicine" and "chemistry", the nomination rights for both categories are listed below.

[43] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 19

[44] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 22

[45] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 27

Table 1 Nomination rights in physiology or medicine[46]:

1.	Members of the Nobel Assembly at Karolinska Institute, Stockholm.
2.	Swedish and foreign members of the Medicine and Biology classes of the Royal Swedish Academy of Sciences
3.	Nobel Laureates in Physiology or Medicine and Chemistry
4.	Members of the Nobel Committee not qualified under paragraph 1 above
5.	Holders of established posts as full professors at the faculties of medicine in Sweden and holders of similar posts at the faculties of medicine or similar institutions in Denmark, Finland, Iceland and Norway
6.	Holders of similar posts at no fewer than six other faculties of medicine at universities around the world, selected by the Nobel Assembly, with a view to ensuring the appropriate distribution of the task among various countries.
7.	Scientists whom the Nobel Assembly may otherwise see fit to approach.
8.	No self-nominations are considered.

Table 2 Nomination rights in chemistry[47]:

1.	Swedish and foreign members of the Royal Swedish Academy of Sciences.
2.	Members of the Nobel Committees for Chemistry and Physics.
3.	Nobel Laureates in Chemistry and Physics.
4.	Permanent professors in the sciences of Chemistry at the universities and institutes of technology of Sweden, Denmark, Finland, Iceland and Norway, and Karolinska Institutet, Stockholm.
5.	Holders of corresponding chairs in at least six universities or university colleges selected by the Academy of Sciences with a view to ensuring the appropriate distribution over the different countries and their centers of learning; and
6.	Other scientists from whom the Academy may see fit to invite proposals.

[46] Copy from the official website of the Nobel Prize to illustrate the nomination rights in physiology or medicine. Online access: 1.11.2020: https://www.nobelprize.org/nomination/medicine/

[47] Copy from the official website of the Nobel Prize to illustrate the nomination rights in chemistry. Online access: 1.11.2020: https://www.nobelprize.org/nomination/chemistry/

The nominations can only be submitted by people who have been invited to participate. Since the annual nomination right goes to a large number of nominators, the information obtained in this way can be seen as stable, well distributed basis.[48]

The nominations for physiology or medicine are reviewed by the Nobel Committee for physiology or medicine and candidates for the Nobel Prize are suggested. This Nobel Prize Committee consists of five members and the Secretary of the Nobel Committee and Nobel Assembly. The potential candidates are then proposed to the Nobel Assembly at the Karolinska Institute, and it then decides on the laureates. This body consists of 50 members.

In 1979 the Nobel Assembly took on the responsibility of choosing an award winner. Previously, this decision was the responsibility of the faculty of the Karolinska Institute. In the course of this takeover, all 65 members were automatically transferred from the faculty to the assembly and the number of members was reduced to 50 over the years. The reduction in the number of members stretched out over several years, as the members left either through retirement or for other reasons. It was not until 1985 that a new assembly member was elected.[49]

The nominations for chemistry are reviewed by the Nobel Committee for chemistry and, as in medicine or physiology, candidates are also recommended. However, these are proposed to the Royal Swedish Academy of Sciences. This institution in turn decides on a laureate. Nowadays, the Nobel Committee also consists of six members and two co-opted members, but for many years the Committee had also adjunct members with the same voting rights as members.

The respective Nobel Prize Committee has the opportunity to request detailed reports from experts about candidates.[50] These reports are sometimes prepared over several years in order to receive an up-to-date assessment from various experts.[51] The example

[48] Schlück H, Liljestrand G, Österling A, Sohlman G (1972) Alfred Nobel Der Mann und seine Preise, Coron; 1. Edition, p. 253

[49] Norrby E (2013) Nobel's Prizes and Natural Surprises, World Scientific, pp 113-114

[50] Schlück H, Liljestrand G, Österling A, Sohlman G (1972) Alfred Nobel Der Mann und seine Preise, Coron; 1. Edition, p. 253

[51] Riha O (2016) Meilensteine der Medizin – Wie der Nobelpreis unser Wissen vom Menschen prägt. Bückle & Böhm, p 10

of Sir Frank Macfarlane Burnet (1899-1985), Nobel Prize winner in physiology or medicine, illustrates that despite being classified as prize-worthy, the actual awarding can take years and is not a guarantee. Burnet was nominated 19 times for the first time in 1948 and was declared a potential prize winner on that year. The declaration of being commendable was retained in the following years. The award was presented to Brunet together with Peter Brian Medawar (1915-1987) in 1960. However, Medawar was only nominated in 1958 and 1960[52] but also considered as prize-worthy starting from the first year of his nomination.[53] The 1943 Nobel Prize in Chemistry, George de Hevesy (1885-1966), was also classified as worthy of the award a few years before becoming a laureate. In his case, however, the Second World War was the reason why his awarding of the prize was postponed.[54]

The civil procedure is the same every year for all Nobel Prize categories. Every September, invitations are sent to people and institutions to propose candidates for the award in the next year. Nominations must be received by the relevant committee by January 31st and the nominations are evaluated over the summer. Reports, opinions and proposals are discussed there. Before the end of September, the previously discussed suggestions will be forwarded to the respective section of the Academy. The Academy section will then have time to discuss it until the end of October. The full Academy finally agrees on the final award of a Nobel Prize by mid-November. Every year on December 10th, the anniversary of Nobel's death, the prizes are awarded. The deliberations are generally kept secret and potential protests or appeals are not permitted.[55] The transfer of the prize money is now decided on a subsequent day to December 10th at another appointment at the Nobel Foundation.[56]

1.2.2 The Nobel Prize as a lens

[52] Norrby E (2013) Nobel's Prizes and Natural Surprises, World Scientific, pp 25-32

[53] Norrby E (2013) Nobel's Prizes and Natural Surprises, World Scientific, pp 68-69

[54] Norrby E (2013) Nobel's Prizes and Natural Surprises, World Scientific, pp 161

[55] Friedman RM (2001) The politics of excellence: behind the Nobel prize in science. Freeman and Times Books, Henry Holt & Co, New York, p 24

[56] Norrby E (2013) Nobel's Prizes and Natural Surprises, World Scientific, p 205

For many reasons, the Nobel Prize and the nominations for this prize are particularly suitable for examining the various fields of medicine for their excellence and trends. Many awards in science are only given on a national level, but the Nobel Prize was from the very beginning designed to be an international prize. In the first few years of the award ceremony, the desire for active international collaboration between scientists was repeatedly expressed in speeches.[57] This international endeavor is already evident in the turnaround that although mostly own-country nominations were submitted in the early years from 1901 to 1906, from 1905 to 1915 these turned into international nominations, especially among British and American scientists.[58]
Due to the international nature of the award, the analysis of the Nobel Prize structures enables the evaluation of global as well as national research networks.
In paragraph 10 of the statutes of the Nobel Prize from 1900, it is regulated that all differences regarding the award of a prize should be kept away from the public.

"Against the decision of the adjudicators in making their award no protest can be lodged. If differences of opinion have occurred they shall not appear in the minutes of the proceedings, nor be in any other way made public."[59]

This paragraph 10 was amended in 1974 so that documents at least fifty years old are made available for historical research. The primary purpose of this change, however, was to point out the risk that documents relating to the medical award at the Karolinska Institute, as well as documents relating to the ongoing award process, will become publicly available.[60] This "new" opening enables medical-historical research to find and evaluate excellence in medicine, trends, and other aspects of research about the prize.
In addition to the nomination papers, documents containing expert opinions for potential laureates are of particular interest. This is a valuable source for being able to understand

[57] Crawford E (1988) Internationalism in science as a casualty of the First World War, p 179

[58] Crawford E (1988) Internationalism in science as a casualty of the First World War: relations between German and Allied scientists as reflected in nominations for the Nobel prizes in physics and chemistry, Sociology of science, p. 180. DOI:10.1177/053901888027002001

[59] Washington: Government Printing Office (1906) Status of the Nobel Foundation (Given at the Place in Stockholm on 29th day of June in the year 1900.), Report of the Commissioner of Education for the year ending June 30, 1904. Vol. 2, p. 2339

[60] Crawford E (1990) The Secrecy of the Nobel Prize Selections in the Sciences and Its Effect on Documentation and Research, Proceedings of the American Philosophical Society. Vol. 134, No 4, p 411

decisions in the background and to answer the question as to why a scientist was not awarded the prize. The Nobel Prize reviews show the subjective opinion of the evaluating expert on the future development of the research performance, they also give a judgment on the impact of the candidate, as well as on the impact novelty of the invention. Ultimately, the reviewer speaks out a recommendation for or against the candidate, whether the candidate should receive the award in the current year. [61]
In addition to these features, the general criticism of the Nobel Prize must always be considered during the analysis. An example is the knowledge of existing agreements among nominators[62], or very long periods of membership of committee members, like the case of Göran Liljestrand (1886-1968) shows. It cannot be denied that he had enormous influence within the committee.[63] In the case of laureates, it is also important to question whether their prize-worthy achievement is due to chance and thus belongs to the "serendipity" category. [64]

[61] Hansson N, Fangerau H, Tuffs A, Polianski I (2016) No Silver Medal for Nobel Prize Contenders: Why Anesthesia Pioneers Were Nominated for but Denied the Award, Anesthesiology, 125:34–38. DOI: https://doi.org/10.1097/ALN.0000000000001099

[62] Crawford E (1990) The Secrecy of the Nobel Prize Selections in the Sciences and Its Effect on Documentation and Research, Proceedings of the American Philosophical Society. Vol. 14, No 4, p 414

[63] Norrby E (2010) Nobel Prize and Life Sciences. World Scientific Publishing Co. Pte. Ltd., p 144

[64] Norrby E (2010) Nobel Prize and Life Sciences. World Scientific Publishing Co. Pte. Ltd., p 44

1.3 The history of pharmacology

1.3.1 Establishment of the specialist discipline pharmacology

Modern pharmacology derives from the Materia Medica[65], and the task of Materia Medica was to describe various medicines. The change of Materia Medica to modern pharmacology was accelerated by the increasing influence of analytical chemistry so that in 1847 the world's first pharmacological laboratory was founded by Rudolf Buchheim (1820-1879) in Dorpat (now Tartu, Estonia).[66] Later the first "Pharmacological Institute" developed from it, in which mainly students worked to obtain the "Doctor Medicinae".[67] In the decades that followed, pharmacology evolved into an analytical-experimental discipline that investigated the chemical and physiological effects of drugs within the organism.

Buchheim's successor in Dorpat was his student Oswald Schmiedeberg (1838-1921),. His students – more than 120 students from 20 nations[68] – carried the research and teaching in pharmacology all over the world: John Jacob Abel (1857-1938) to America and Arthur Robertson Cushny (1866-1926) to Great Britain[69] and Hans Horst Meyer (1853-1939) to Austria[70]. More than 40 of his students later also held pharmacological chairs around the world.[71]

Oswald Schmiedeberg founded the "Archive for Experimental Pathology and Pharmacology" (now: Naunyn-Schmiedeberg's Archives of Pharmacology) together with Bernhard Naunyn (1839-1925) and the pathologist and microbiologist Edwin Klebs

[65] Rath G (1963) Zeiteinflüsse der Pharmakologie des 16. bis 19. Jahrhunderts, Sudhoffs Archiv für Geschichte der Medizin und der Naturwissenschaften, Bd. 47, p 3

[66] Parascandola J (1980) Reflections on the History of Pharmacology: The 1980 Kremers Award Address, Pharmacy in History. Vol 22, No 4, p 134

[67] Scheindlin S (2010) Our Man in Dorpat: Rudolf Buchheim and the Birth of Pharmacology, Molecular Interventions, vol 10, No 6, p 332

[68] Muscholl E (1995) The evolution of experimental pharmacology as a biological science: the pioneering work of Buchheim and Schmiedeberg, British Journal of Pharmacology, vol 116, p

[69] Parascandola J (1980) Reflections on the History of Pharmacology: The 1980 Kremers Award Address, Pharmacy in History. Vol 22, No 4, p 134

[70] Schütz W (2018) Einflüsse der Pharmakologie auf die modere Medizin. V&R unipress GmbH Göttingen. p. 725

[71] Muscholl E (1995) The evolution of experimental pharmacology as a biological science: the pioneering work of Buchheim and Schmiedeberg, British Journal of Pharmacology, vol 116, p

(1834-1913). The journal remained the only one of its kind for a long time and served the exchange of pathology and pharmacology, as well as the exchange with physiology.[72] The journal has continued to grow in recent years, for example, bringing together pharmacological publications from more than 30 nations in 2015.[73]

The combination of the specialist disciplines in one journal shows that pharmacology is a borderline science that has countless overlaps with the fields of physiology, chemistry, physics, and pathology[74], but also with the history of medicine[75].

From the 1920s, university pharmacology became increasingly intertwined with the industry, so that industrial locations also became significant in the history of this discipline.[76]

[72] Starke K (1998) A History of Naunyn-Schmiedeberg's Archives of Pharmacology, Naunyn-Schmiedeberg's Archives of Pharmacology. Vol 358, no 1, p 5

[73] Seifert, R (2016) Naunyn-Schmiedeberg's Archives of Pharmacology under new editorship: change and continuity. Naunyn-Schmiedeberg's Arch Pharmacol 389, pp 667–670. https://doi.org/10.1007/s00210-016-1261-3

[74] Rath G (1963) Zeiteinflüsse der Pharmakologie des 16. bis 19. Jahrhunderts, Sudhoffs Archiv für Geschichte der Medizin und der Naturwissnschaften, Bd. 47, p 2

[75] Bickel M H (2001) Medizingeschichte und Pharmakologie: Aspekte einer Geschichte von Beziehungen, Swiss Journal of the history of medicine and sciences. http://doi.org/10.5169/seals-520938

[76] Schütz W (2018) Einflüsse der Pharmakologie auf die modere Medizin. V&R unipress GmbH Göttingen, pp 728-730

1.3.2 Biographies and legacies of the protagonists in pharmacological history

1.3.2.1 Rudolf Buchheim

Rudolf Buchheim (1820-1879) was born in Bautzen, Germany, as the son of a doctor. In 1838, after graduating from high school, Buchheim began to study medicine in Dresden and in 1841 he moved to the University of Leipzig. Here he became an assistant at the institute of the physiologist Ernst Heinrich Weber (1795-1878) and worked as an assistant to the physician and chemist Carl Gotthelf Lehmann (1812-1863). It was during this activity that Buchheim's interest in medicinal chemistry was aroused and he began to work on scientific projects while still studying.[77] In 1845 he married Minna Peschnek with whom he had six children and he also was awarded a doctorate in medicine. This was followed by a few years of literary occupation.

During this activity, he edited the German version of the book "The Elements of Materia Medica" by Jonathan Pereira (1804-1853) over a period of four years. In his editorial work, he added other medicines and edited the texts of medicines that were only briefly described in the original. Furthermore, Buchheim added the chapter “Art der Wirkung” ("Type of effect") to his work, which describes the effect of the drugs on the organs and the organism. This literary activity can thus be seen as his specialization in pharmacology.[78] Furthermore, this literary activity is seen as the scientific and experimental basis of pharmacology.[79]

In 1846, while still working as a writer, he received and followed the call of the University of Dorpat (now Tartu, Estonia) for an extraordinary professorship in pharmacy, dietetics, and history, as well as the encyclopedia of medicine. This call was strongly supported by the recommendation of the physiologist Friedrich Bidder (1810-1894), who was at the faculty in Dorpat at the time.[80]

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[77] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 2. https://doi.org/10.1007/BF02012802

[78] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 3. https://doi.org/10.1007/BF02012802

[79] Loewe, S (1924) Von der Wiege der Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 104, p 2. https://doi.org/10.1007/BF01995434

[80] Muscholl E (1995) The evolution of experimental pharmacology as a biological science. The pioneering work of Buchheim and Schmiedeberg. In- British Journal of Pharmacology, p 2156

In Dorpat, Buchheim was from the beginning a full member of the Medical Faculty and the Academic Council. Shortly after his arrival in Dorpat, Buchheim set up a laboratory for pharmacological tests in his apartment, which he initially financed from private funds. This pharmacological institute was unique in its form for two decades, since other universities only had “pharmacognostic collections”, but no institution for experimental pharmacology.[81] . This laboratory later became a university institute and is accordingly the first pharmacological institute founded by Rudolf Buchheim.[82]

He was named full professor in 1849. The faculty justified the suggestion for the full professorship with the fact that Buchheim “has set up a laboratory in his apartment making significant sacrifices beyond his resources, within which the students not only for pharmacological examinations but also for other chemical work found a privileged environment which is a unique opportunity."[83]

The laboratory staff was mainly doctoral students with whom Buchheim carried out experiments for their dissertations. Hence the number of Buchheim's publications is not great, because he only carried out examinations with his students in his laboratory and the results were then published under the name of the student.[84] However, it can be quantified that under his guidance between 1847-1867 over 100 papers, 80 of which were doctoral theses, were written.[85] In order to describe Buchheim’s work in Dorpat, Oswald Schmiedeberg put together an overview of all the experiments he indirectly and directly masterminded, using doctoral theses from Dorpat, which were mainly written in Latin.[86] However, the original version of this work by Schmiedeberg was not published.

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[81] Reznikov KM (2019) Pharmacological vector of Rudolf Buchheim. Research Results in Pharmacology 5(1): p 104. https://doi.org/10.3897/rrpharmacology.5.32234

[82] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 4. https://doi.org/10.1007/BF02012802

[83] Loewe, S (1924) Von der Wiege der Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 104, pp 3-4. https://doi.org/10.1007/BF01995434

[84] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 1. https://doi.org/10.1007/BF02012802

[85] Reznikov KM (2019) Pharmacological vector of Rudolf Buchheim. Research Results in Pharmacology 5(1): p 105. https://doi.org/10.3897/rrpharmacology.5.32234

[86] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 1. https://doi.org/10.1007/BF02012802

Firstly, Schmiedeberg was concerned that, given the lack of appreciation for pharmacology at the time, its importance, and the importance of pharmacology for medical training failed to materialize. A reason for this was that drug teaching was previously deleted from the curriculum of the medical examination. Secondly, in the end, there was also no time to complete the work at all. Accordingly, Schmiedeberg published a modified version in 1911.[87]

Together with the physiologist and pathologist Georg Friedrich Karl Heinrich Bidder (1810-1894), who also taught in Dorpat, and the doctor and chemist Carl Ernst Heinrich Schmidt (1822-1894), Buchheim formed a portfolio that covered all branches of descriptive and experimental biology. This created a basis for micro-anatomical research, morphology, experimental physiology, pharmacology, as well as physiological chemistry.[88]

In the course of his career, Buchheim was also twice named dean of the medical faculty in Dorpat, each appointment for 3 years. The position gave him the freedom to direct the medical studies independently and made him the highest authority in all medical and pharmacist exams.[89]

In 1859 the second edition of Buchheim's textbook appeared.

One year later, in 1860, after several years of construction, a new building was completed at the University of Dorpat, in which Buchheim was given a laboratory with initially planned three rooms. He himself had considerable influence on the furnishings of these rooms through a position on the building commission and moved into the laboratory before the building was officially completed. It turned out that the laboratory was also much larger than planned at the beginning.[90] This considerable gain in space later also benefited his successors Oswald Schmiedeberg (1883-1921), Rudolf Boehm

[87] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, pp 1-2. https://doi.org/10.1007/BF02012802

[88] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 5. https://doi.org/10.1007/BF02012802

[89] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 12. https://doi.org/10.1007/BF02012802

[90] Loewe, S (1924) Von der Wiege der Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 104, pp 4-5. https://doi.org/10.1007/BF01995434

(1844-1926), Hans Horst Meyer (1853-1939), and Rudolf Kobert (1854-1918) until the Russification period.[91]

In 1863 Buchheim was appointed to the University of Wroclaw (Breslau, now Poland). However, he did not follow this call, as he had already been living in Dorpat for 20 years and did not want to leave the environment consisting of family, friends, and the university.[92]

In 1866 Oswald Schmiedeberg, who a short time later became Buchheim's successor in Dorpat, completed his thesis on “About the quantitative determination of chloroform in the blood” under the supervision of Buchheim. There were also two other calls to the universities of Giessen and Bonn this year. He accepted the call to the University of Giessen because he saw the chance to set up successfully a pharmacological laboratory in Giessen, which he had not seen in Bonn an Wroclaw. Now his family also wanted to return to Germany.[93]

Since there was still no pharmacological laboratory in Giessen, he was given the financial means necessary to set up a laboratory. As in Dorpat, he first set up this laboratory in his apartment.

Buchheim's laboratory activity in Giessen was less active in his laboratory in Giessen than in Dorpat. This was partially due to the lower level of interest shown by students and doctors, but also to the lack of assistants.[94] This in turn enabled Buchheim to work on the third edition of his textbook, which contained further plans for the systematic grouping of medicines.

In addition, Buchheim took over the teaching and examination of pharmacists in Giessen and gave lectures on pharmacognosy. As a result, he developed an immense interest in pharmacy, which he published in two essays entitled „Über die Aufgaben der jetzigen

[91] Loewe, S (1924) Von der Wiege der Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 104, p 5. https://doi.org/10.1007/BF01995434

[92] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 13. https://doi.org/10.1007/BF02012802

[93] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 13. https://doi.org/10.1007/BF02012802

[94] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 13. https://doi.org/10.1007/BF02012802

Vertreter der Pharmazie an den Universitäten“ [95] ("On the tasks of the current representatives of pharmacy at the universities") and „Über pharmakognostische Systeme“ [96] ("On pharmacognostic systems").
Buchheim was about to set up a new pharmacological laboratory in the university’s new building but died of a stroke shortly in the year 1879.
One of Buchheim's most important contributions is the establishment of a natural systemization of drugs and thus of pharmacology in general, as this made systematic research possible.[97] Furthermore, the introduction of experimental research in medicine is attributed to him: at the time of Buchheim's death, almost every clinic was equipped with an experimental laboratory. Buchheim established guidelines for experimental thinking and acting, which were then transferred to bedside observation and practice.[98]
The memories of Rudolf Buchheim are still present: in his honor, a memorial plaque was hung in the pharmacological institute in Giessen and on the house where he was born in Bautzen.

[95] Buchheim R (1879) Über die Aufgaben der jetzigen Vertreter der Pharmacie an den Universitäten, Achriv der Pharmacie, Vol 11. https://doi.org/10.1002/ardp.18792140402

[96] Buchheim R (1876) Über pharmakognostische Systeme, Archiv der Pharmacie, p 481

[97] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, p 9. https://doi.org/10.1007/BF02012802

[98] Schmiedeberg O (1911) Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie. Archiv f. experiment. Pathol. u. Pharmakol 67, pp 14-15. https://doi.org/10.1007/BF02012802

1.3.2.2 Oswald Schmiedeberg

Oswald Schmiedeberg (according to documents from the Latvian National Library: Johann Ernst Oswald Schmiedeberg)[99] was born in Courland, Latvia, in 1883 and is generally seen as the most prominent pharmacologist in the history of pharmacology.[100] Schmiedeberg was the first-born child of the family, on the Laidze manor, near the town of Talsi (German Talsen), a town in western Latvia. His mother was Swiss Anna Louise Bernhardt (1813-1871) and his father Friedrich Wilhelm Ludwig Schmiedeberg (1808-1878) was German. Friedrich Wilhelm Ludwig Schmiedeberg was a district magistrate at the Laizde estate in Courland, where Oswald Schmiedeberg was born.[101]
The roots on the father's side lead back to Oswald Schmiedeberg's great-grandfather, the carter Johann Ulrich Schmiedeberg (1746- unknown). He was born in the Latvian port city of Liepaja (German Lindau) and over time moved to the Latvian city of Ventspils (German Windau). Documents from 1779 state that the family Schmiedeberg was already living in Ventspils on Floßstraße 2 at this time.[102]
Oswald Schmiedeberg grew up in the countryside. At some point in his childhood, Schmiedeberg's family moved to Dorpat (now Tartu, Estonia). In Dorpat, Schmiedeberg started to go to school and excelled there.[103]A written request for permission to study at the University of Dorpat, as well as an extract from his impeccable certificate of good conduct, confirms that there were no obstacles to his admission to the university, where

[99] LNB Reto grāmatu un rokrakstu lasītava, RX12, 2, 5, lpp. 124

[100] Craig C R, Stizel R E (2004) Modern Pharmacology with Clinical Applications, Lippincott Williams & Wilkins, Vol 7. p 5

[101] Академия наук латвийской ССР (1985) Становление науки и научных коллективов, Институт органического синтеза и Советское национальное объединение истории и философии естествознания и техники прибалтики, Рига: Зинатне, pp 267-268

Academy of Sciences of Latvia (1985) The emergence of science and scientific collectives in the Baltics Baltic Institute, Institute of Organic Synthesis and Soviet National Association of Natural Science and Technology, Riga: Zināte, pp 267-268

[102] Академия наук латвийской ССР (1985) Становление науки и научных коллективов, Институт органического синтеза и Советское национальное объединение истории и философии естествознания и техники прибалтики, Рига: Зинатне, pp 267-268

Academy of Sciences of Latvia (1985) The emergence of science and scientific collectives in the Baltics Baltic Institute, Institute of Organic Synthesis and Soviet National Association of Natural Science and Technology, Riga: Zināte, pp 267-268

[103] LNB Reto grāmatu un rokrakstu lasītava, RX12, 2, 5, lpp. 123, p 126

he studied medicine.[104] During his studies he was educated by prominent professors: the pharmacologist Rudolf Buchheim (1820-1879), the biochemist Carl Schmidt (1822-1894), and the doctor Klaus Heinrich Adolf Wachsmuth (1827-1865). Carl Schmidt was particularly important for Schmiedeberg's training in chemistry.[105] The archive of the University of Dorpat keeps files about Schmiedeberg's career as a student, which also contain documents about negative behavior. He was punished with a sentence of two days in the detention room because he wrote an exam in civilian clothes.[106] This did not seem to have an impact on his academic achievements, since he was accepted as a recipient of the Kronsstipendium (Krons Scholarship) from January 1861.[107] This scholarship appears to have been performance-related, as Schmiedeberg reports in his files that the requirements of the scholarship prevented him from pursuing his interest further in physiological chemistry and general pathology.[108]

After Rudolf Buchheim followed the call to Gießen in 1869, Oswald Schmiedeberg was his successor as Professor of Experimental Pharmacology in Dorpat. Buchheim had an enormous influence on Schmiedeberg, who further pursued and disseminated his concepts and methods in pharmacological research.[109] Schmiedeberg's profound influence in pharmacology was completed by his qualities of being an excellent researcher and passionate teacher. [110]

Immediately after being hired as Head of Experimental Pharmacology, Schmiedeberg travelled to Leipzig for a year to learn the methodology of experimental physiology and

[104] LNB Reto grāmatu un rokrakstu lasītava, RX12, 2, 5, lpp. 124

[105] Naunyn B (1921) Oswald Schmiedeberg. Archiv f. experiment. Pathol. u. Pharmakol 90, p II. https://doi.org/10.1007/BF01864758

[106] Archive of University of Tartu, Estonia. EAA.402.2.22064, p. 6

[107] Archive of University of Tartu, Estonia. EAA.402.2.22064, p. 10

[108] Archive of University of Tartu, Estonia. EAA.402.2.22064, p. 11

[109] Barrett J.E., Page C., Michel M.C. (2019) Perspectives of Pharmacology over the Past 100 Years. In: Barrett J., Page C., Michel M. (eds) Concepts and Principles of Pharmacology. p 7 Handbook of Experimental Pharmacology, vol 260. Springer, Cham. https://doi.org/10.1007/164_2019_334

[110] Barrett J.E., Page C., Michel M.C. (2019) Perspectives of Pharmacology over the Past 100 Years. In: Barrett J., Page C., Michel M. (eds) Concepts and Principles of Pharmacology. p 7 Handbook of Experimental Pharmacology, vol 260. Springer, Cham. https://doi.org/10.1007/164_2019_334

further knowledge of chemistry from the German physiologist and anatomist Carl Friedrich Wilhelm Ludwig (1816–1895).[111]
Schmiedeberg in Dorpat received primarily chemical training under Buchheim, as the requirements for animal experiments in Dorpat were not well developed.[112]
In 1872 he was appointed to the German University of Strasbourg, where he belonged to the group of the "founders" of the university. Schmiedeberg is the only "founder" who belonged to the university to the end. In total, he was a member of the German Reich University for almost 50 years.[113]
The call to the University of Strasbourg was significantly influenced by his Leipzig teacher, who strongly recommended Schmiedeberg.[114]

When Schmiedeberg began his work in Strasbourg, there were only three or four rather poorly equipped laboratories for experimental pharmacology in Germany in addition to the one in Dorpat.[115]
Schmiedeberg's colleagues in Strasbourg included Friedrich Daniel von Recklinghausen (1883-1910), Friedrich Leopold Goltz (1834-1902), Georg Albert Lücke (1829-1894), and Ernst von Leyden (1832-1910). Although Schmiedeberg was a few years younger than his colleagues, he was recognized and valued from the start.
Almost at the same time as Schmiedeberg became a professor in Dorpat, Bernhard Naunyn (1839-1925) also came to the university in Dorpat. Naunyn, the Bernese pathologist Edwin Klebs (1834-1913), and Schmiedeberg founded the Archive for Experimental Pathology and Pharmacology in 1872 (today: Naunyn-Schmiedebergs Archive for Experimental Pathology and Pharmacology). In the year 1908 another pharmacological journal was founded by Schmiedeberg's student John Jacob Abel (1857-1938) and Arthur Robertson Cushny (1866-1926), which became the equal of

[111] Naunyn B (1921) Oswald Schmiedeberg. Archiv f. experiment. Pathol. u. Pharmakol 90, p II. https://doi.org/10.1007/BF01864758

[112] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106 .https://doi.org/10.1007/BF01488534

[113] Naunyn B (1921) Oswald Schmiedeberg. Archiv f. experiment. Pathol. u. Pharmakol 90, p V. https://doi.org/10.1007/BF01864758

[114] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106. https://doi.org/10.1007/BF01488534

[115] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106. https://doi.org/10.1007/BF01488534

Schmiedeberg's journal.[116] The name of the journal is “Journal of Pharmacology and Experimental Therapeutics”, which also still exists to this day.

In 1883, Schmiedeberg and his colleagues published the book “Grundriß der Arzneimittellehre”[117] (“Outline of the pharmacology”) which was reprinted seven times over the years. At that time, this book was groundbreaking for the whole of pharmacology because it was a processing of over a hundred pharmacological studies. Likewise, it was also a guide for therapy initiated by doctors.[118]

In 1887 a new large laboratory was assigned to the Pharmacological Institute in Strasbourg. At this time pharmacology was also recognized as being equivalent to the disciplines of physiology and pathology. This is also seen by the approximately 40 pharmacological chairs that now existed and were occupied by Schmiedeberg’s students at the time. [119]

In 1908, on Schmiedeberg's 70th birthday, a book with 59 collected works by his students was published. Less than half of the students came from Germany.[120] Probably the best-known students of Oswald Schmiedeberg are John Jacob Abel (1857-1938) and Hans Horst Meyer (1853-1939). It is said that Meyer - measured by the number of his students who won the Nobel Prize - had arguably the greatest impact on pharmacology.[121] Meyer took over the chair from Schmiedeberg in Dorpat and continued to work in Marburg (Germany), as well as in Vienna and Granz (Austria).

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[116] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106. https://doi.org/10.1007/BF01488534

[117] Schmiedeberg O (1883) Grundriß der Arzneimittellehre, Verlag von F. C. W. Vogel

[118] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106. https://doi.org/10.1007/BF01488534

[119]Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 106. https://doi.org/10.1007/BF01488534

[120] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 107. https://doi.org/10.1007/BF01488534

[121] Muscholl E (1995) The evolution of experimental pharmacology as a biological science: the pioneering work of Buchheim and Schmiedeberg, British Journal of Pharmacology, p 2158. https://doi.org/10.1111/j.1476-5381.1995.tb15047.x

On July 12, 1921, Oswald Schmiedeberg died at the age of 83 in Baden Baden in Germany.

The spread of pharmacology to all countries of the world is counted as part of Schmiedeberg's life's work.[122] Schmiedeberg trained more than 200 pharmacologists from over 20 countries in his 46-year career at the University of Strasbourg.[123] Likewise, his publications on the chemistry of proteins and carbohydrates, their cleavage and synthesis in the organism, and a further number of fundamental discoveries in the field of physiology and pathology. [124] Other important achievements of Schmiedeberg include the observation and the proof that urea is formed in the liver from ammonia made in 1871.[125]

Oswald Schmiedeberg's legacies

The analysis of the nomination letters for Oswald Schmiedeberg show that different arguments are given to dignify his scientific achievements.
The main reason for his nomination is his oeuvre, which becomes visible when looking at his short biography. Since the Nobel Prize is mainly awarded for basic research, it can be stated that this is one of the reasons why Schmiedeberg was not awarded.
Without him, pharmacology would probably not have attained the importance it has today. This example clearly shows that the staging of excellence has many facets – what would generally be described as excellence, was not awarded a Nobel Prize for various reasons. To further contextualize these results, the following discusses the impact of his legacy.

[122] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 107. https://doi.org/10.1007/BF01488534

[123] Barrett J.E., Page C., Michel M.C. (2019) Perspectives of Pharmacology over the Past 100 Years. In: Barrett J., Page C., Michel M. (eds) Concepts and Principles of Pharmacology. p 8 Handbook of Experimental Pharmacology, vol 260. Springer, Cham. https://doi.org/10.1007/164_2019_334

[124] Meyer H H (1922) Oswald Schmiedeberg. Naturwissenschaften 10, p 107. https://doi.org/10.1007/BF01488534

[125] Naunyn B (1921) Oswald Schmiedeberg. Archiv f. experiment. Pathol. u. Pharmakol 90, p VII. https://doi.org/10.1007/BF01864758

Schmiedeberg's eponyms can be found almost exclusively in Germany, with the bust in the Otto Krayer House of the Freiburg University Clinic certainly being one of the most striking pieces. Also of great importance is the O. Schmiedeberg badge, which has been awarded by the German Society for Experimental and Clinical Pharmacology and Toxicology (DGPT) since 1956. The badge will be examined more closely in the following chapter.

A similar honor has been given in Schmiedeberg's country of birth, Latvia, since 1998. Although, Schmiedeberg spent most of his life in Germany, the example of the Latvian award shows that Schmiedeberg is by no means forgotten here either. This is the Oswald Schmiedeberg Medal awarded by the Latvijas Universitate in Riga. This award honors important contributions in the field of pharmacology in Latvia or facilitating the development of the education and research in pharmacology in Latvia. The Latvian award is given in a greater frequency compared to the Oswald-Schmiedeberg badge. Neither the German nor the Latvian award occurs in a predictable fashion. The Latvians certainly award several scientists in the same year, up to 16 scientists. In contrast, the Schmiedeberg badge was only awarded to a maximum of three scientists in the same year.

The establishment and first presentation of the Latvian award in 1998 also shows that Schmiedeberg's excellence has not lost any of its importance over the decades.

The establishment of a new science award shows that Schmiedeberg is still perceived as a "currently" popular and “excellent” character.

The research on muscarine[126] by Oswald Schmiedeberg and his doctoral student Richard Koppe in Dorpat in 1869 is one of Schmiedeberg's important research contributions[127] and can also be found as an argument in the Nobel Prize nominations[128]. This discovery is even referred to as "one of the foundation stones of modern pharmacology".[129]

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[126] Schmiedeberg O, Koppe R (1869) Das Muscarin: Das giftige Alkaloid des Fliegenpilzes (Agaricus Muscarinus L.). Verlang von F. C. W. Voegel Leipzig.

[127] Lee MR, Dukan E, Milne I (2018) Amanita muscaria (fly agaric): from a shamanistic hallucinogen to the search for acetylcholine, The Journal of the Royal College of Physicians of Edinburgh, 48(1), p 86

[128] Nomination by Gaetano Gaglio, year 1908 in Physiology or Medicine, Motivation: Extensive work in pharmacology (digitalis, caffeine, muscarine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, studies on oxidation in the body and nucleic acids).

[129] Bowden K, Mogey G (1955) The story of Muscarine, J. Pharm. Pharmacol., 10, p 145

Initially, a controversial argument about the correctness of the research results and theories broke out.[130] It was only a few years later that the results and assumptions associated with the discovery of muscarine could be corrected. The correction of Schmiedeberg's results consisted essentially of the precise description of the muscarinic and nicotinic effects of acetylcholine.[131] This was done in the 1920s and 1930s by Otto Loewi and Henry H. Dale. They were awarded the Nobel Prize in Physiology or Medicine for this in 1936.[132] The achievements of Schmiedeberg and Koppe respectively Loewi and Dale ultimately led to the identification of the muscarinic receptors[133], which are an essential part of physiology, pathology, and therapy nowadays.

A second major research achievement by Schmiedeberg, which continues to this day, is the research on digitalis from 1874[134]. This can also be found several times as an argument in the nomination papers from 1908, but also in 1918. Schmiedeberg and his team carried out various experiments that described the effects of the active substances on the heart one of these ingredients was from the digitalis plant. Together with the scientists Heinrich Dresser (1860-1924) and Francis Williams (1852-1936), he discovered the increase in the force of contraction in the heart muscle caused by cardiological glycosides.[135] Schmiedeberg also categorized the active substances in the Digitaline Group. A dogma that Schmiedeberg established at the time and that is still valid today is that “all cardio-active glycosides have quantitatively equal effects, which differ only a little quantitatively”. Based on Schmiedeberg's research, the cardiac glycosides are still referred to as digitalis glycosides.[136]

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[130] Von Cyon E, Heusner H L (1907) Die Nerven des Herzens, Springer-Verlag Berlin, Heidelberg GmbH, pp 259-262

[131] Patil P N (2012) Discoveries in Pharmacological Sciences. World Scientific. p 114

[132] Lee MR, Dukan E, Milne I (2018) Amanita muscaria (fly agaric): from a shamanistic hallucinogen to the search for acetylcholine, The Journal of the Royal College of Physicians of Edinburgh, 48(1), pp 86-87

[133] Shah N, Khurana S, Cheng K, Raufman JP (2009) Muscarinic receptors and ligands in cancer, American Journal of Physiology, p 221. https://doi.org/10.1152/ajpcell.00514.2008

[134] Schmiedeberg, O (1874) Untersuchungen über die pharmakologisch wirksamen Bestandtheile der Digitalis purpurea L. Archiv f. experiment. Pathol. u. Pharmakol 3, pp 16–43. https://doi.org/10.1007/BF01958772

[135] Fürstenwerth H (2018) Ouabain a gift from paradise, BoD – Books on Demand, Nordersted, p25

[136] Fürstenwerth H (2015) Strophantin – Die Wahre Geschuchte, BoD – Books on Demand, Nordersted, p28

Through an intensive examination of his life's work, it can be summarized that Oswald Schmiedeberg is predominantly remembered as the "founder of modern pharmacology" today and still enjoys an immensely high reputation. In addition to his fundamental role in pharmacology, his research on muscarine laid the foundation for an essential understanding of medicine. [137] The same can be said of the research on cardiac glycosides, since the knowledge gained at that time is still applicable today.[138]

Table 3 The following is an overview[139] of Oswald Schmiedeberg's international work colleagues who were also present at celebration on his 70th birthday (the year 1908):

Name	**Country***
Max Cloëtta (1868-1940)	Zürich, Switzerland
George B. Wallace (1874-1948)	New York, US
Vladimir Karlovič Lindeman (1868-1933)	Kiew, Ukraine
Léon Herlant (1873-1968)	Brussel, Belgium
Vincenzo Cervello (1854-1918)	Palermo, Italy
Franz Hofmeister (1850-1922)	Praque, Czech Republic
Eduard Rudolf Kobert (1854-1918)	Dorpat, Estonia and Rostock, Germany
Arthur Robertson Cushny (1866-1926)	London, England
Wolfgang Otto Leonhard Heubner (1877-1957)	Göttingen, Germany
Hans Horst Meyer (1853-1939)	Vienna, Austria
Oskar Minkowski (1858-1931)	Wroclaw, Poland

*Country in which people worked in the year 1908

Table 4 This list shows a selection of Schmiedeberg's students who received a chair at a pharmacological institute university after Schmiedeberg's training:

[137] Fürstenwerth H (2018) Ouabain a gift from paradise, BoD – Books on Demand, Nordersted, p25

[138] Fürstenwerth H (2018) Ouabain a gift from paradise, BoD – Books on Demand, Nordersted, p25

[139] Muscholl E (1995) The evolution of experimental pharmacology as a biological science: the pioneering work of Buchheim and Schmiedeberg, British Journal of Pharmacology, pp 2157-2158. https://doi.org/10.1111/j.1476-5381.1995.tb15047.x

Name	Chair at university
Max Cloëtta (1868-1940)	Zurich, Switzerland
Edwin Stanton Faust (1870–1928)	Würzburg, Germany
Rudolf Gottlieb (1864–1924)	Heidelberg, Germany
Erich Harnack (1852–1915)	Halle an der Saale, Germany
Arthur Carl Wilhelm Heffter (1859–1925)	Bern, Switzerland, later in Marburg and Berlin, Germany
Wolfgang Otto Leonhard Heubner (1877-1957)	Göttingen, later in Düsseldorf, Heidelberg and Berlin, Germany
Carl Jacobj (1857–1944)	Göttingen, later in Tübingen, Germany
Jules Alfred Jaquet (1865–1937)	Basel, Switzerland
Hans Horst Meyer (1853–1939)	Dorpat, Estonia, later in Marburg and Berlin, Germany
Eduard Rudolf Kobert (1854–1918)	Dorpat, Estonia, later in Rostock, Germany
Hermann Wieland (1885–1929)	Königsberg (now Kaliningrad, Russia) later in Heidelberg, Germany
John Jacob Abel (1857–1938)	Established the first Institute of Pharmacology in Ann Arbor, Michigan, US. Later Johns Hopkins University in Baltimore, Maryland, US.

1.3.2.3 Bernhard Naunyn

Bernhard Naunyn was born in Berlin in 1839 and was a German internist and university professor.

He came from a wealthy family of East-Prussian origin.[140]

After graduating from high school in 1858, Naunyn began studying law at the Rheinische Friedrich-Wilhelms-Universität in Bonn (Germany), but he quickly switched to physics and chemistry. In 1860 he returned to Berlin and started studying medicine at the Friedrich Wilhelms University in Berlin.

Naunyn was strongly influenced by the school of the physiologist and anatomist Johannes Müller (1801-1858). Naunyn never met Johannes Müller, but Müller's school was brought to Naunyn by the professors Nathanael Lieberkühn (1821-1887) and Guido Wagner (1822-1896). This took place on the premises of the Berlin University under Müller's successor, Karl Bogislaus Reichert (1811-1883).[141] Friedrich Theodor Frerichs (1819-1885) also had a huge impact on Naunyn and encouraged him to specialize in internal medicine.[142]

After Naunyn submitted his MD thesis on the development of taenia of the Echinococcus hominis in dogs in 1862, he served in the military for 6 months. He then worked as an assistant in the Berlin Charité at the request of Frerichs.

By 1867 Naunyn was an experienced lecturer, but there were difficulties in the relationship between Naunyn and the Charité, which prompted Naunyn to work in East Prussia in a private medical practice.[143]

In 1869, after a successful application to Dorpat University (Estonia), Naunyn was appointed professor for the department of medicine.

In his inaugural address at the University of Dorpat in 1869, he mentioned his maxim, the guiding principles of Müller.[144] In the same year Naunyn achieved results on his

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[140] Loriaux, D L (2006) Bernhard Naunyn (1839-1925), Endocrinologist, Vol. 16, No. 5, p 240. https://doi.org/10.1097/01.ten.0000244933.61128.c4

[141] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p VI. https://doi.org/10.1007/BF01862781

[142] Loriaux, D L (2006) Bernhard Naunyn (1839-1925), Endocrinologist, Vol. 16, No. 5, p 239. https://doi.org/10.1097/01.ten.0000244933.61128.c4

[143] Bernhard Naunyn (1839-1925) Clinician, Teacher, Scientist. JAMA. 1969;208(7), p1182. https://doi.org/10.1001/jama.1969.03160070060019

[144] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p VI. https://doi.org/10.1007/BF01862781

research on the detection of bilirubin in the blood and urine when the bile is not emptied into the intestinal tract, and on the degradation of hemoglobin to bilirubin in the liver. This was later confirmed by Naunyn's assistant Oskar Minkowski (1858-1931).[145] These and other results, including those relating to the formation of gallstones, were collected, and published in 1892.[146]

In Dorpat, he formed a close friendship with Oswald Schmiedeberg, which had a positive effect on the mutual academic cooperation of both.[147]

The professorship in Dorpat was followed by a new position at the University of Bern (Switzerland) in 1871.

In 1872 he moved to the Albertus University in Konigsberg as the successor to the internist Ernst von Leyden (1832-1910), where he set up an adequate laboratory right at the start of his work. He had to face a lot of criticism from other internists, who often portrayed him as a “theoretician” who neglected medical work due to his laboratory work.[148]

Naunyn is known for contributing significantly to the specialization of experimental pathology. He made the criticism that even observation of the patient carried out with the greatest care rarely leads to a clear result, as this is subject to many variables. Likewise, the projection of physiological knowledge does not lead to the goal. Therefore, he aligned the experimental pathology so that only the experiment under constant conditions delivers a precise answer.[149] Thus, in 1872, together with the pharmacologist Oswald Schmiedeberg and the pathologist Theodor Albrecht Edwin Klebs (1834-1913), he founded the journal “Archive for experimental pathology and pharmacology”, which was renamed in 1972 as “Naunyn-Schmiedeberg's Archives of Pharmacology”. Naunyn served as editor of the journal for 53 years, spanning 106

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[145] Bernhard Naunyn (1839-1925) Clinician, Teacher, Scientist. JAMA. 1969;208(7), p 1183. https://doi.org/10.1001/jama.1969.03160070060019

[146] Naunyn B (1892), Klinik der Cholelithiasis, Leipzig

[147] Straub, W (1925) Bernhard Naunyn. Archiv f. experiment. Pathol. u. Pharmakol 107, p i. https://doi.org/10.1007/BF01994592

[148] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p V. https://doi.org/10.1007/BF01862781

[149] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p IV. https://doi.org/10.1007/BF01862781

volumes.[150] Bernhard Naunyn comments on the founding of the journal in his book, saying that it was not about establishing a new specialist discipline, but rather about "naturalizing the pathological questions in the clinics and maintaining the clinic's task of answering these questions independently".[151]

In 1882 Naunyn published together with the internist and university professor Julius Schreiber (1848-1932) a study on the hydrostatic pressure in the ventricles of dogs, which is in equilibrium with the pressure in the spinal cord and the cauda equina.[152]

A few years later, in 1888, Naunyn moved to the Kaiser-Wilhelms-Universität Strasbourg, where he took over the chair of Adolf Kussmaul (1822-1902) and trained the aforementioned Oskar Minkowski there. Minkowski was also the one who, together with Josef Freiherr von Mering (1849-1908), successfully continued Naunyn's research on diabetes.

On his 70th birthday in 1908, a plaque was struck in his honor, on which he chose the phrase himself, the principle by which he always acted: "Die Heilkunde wird Wissenschaft sein oder sie wird gar nicht sein!" ("Medicine will be science or it will not be at all!") With the word "Wissenschaft" ("science") Naunyn meant "Erkenntnis durch exakte Methoden naturwissenschaftlicher Forschung" ("knowledge through exact methods of scientific research"). Accordingly, the aim of his research was also directed towards making the exact methods of natural science available to medicine.[153]

Naunyn died on June 26, 1925, at the age of 86 after a brief illness in Baden-Baden.

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[150] Straub, W (1925) Bernhard Naunyn. Archiv f. experiment. Pathol. u. Pharmakol 107, p i. https://doi.org/10.1007/BF01994592

[151] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p IV. https://doi.org/10.1007/BF01862781

[152] Naunyn B, Schreiber J (1882) Über Gehirndruck. Arch. f. exper. Path.14

[153] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p III. https://doi.org/10.1007/BF01862781

Naunyn's life is shaped by his main works, which are research on diabetes[154] and gallstones[155]. In addition, Naunyn is remembered for the treatment of gastric fermentation, cold water treatment for febrile illnesses, puncture of pleural and peritoneal effusions, the strychnine treatment of paralysis, diseases caused by syphilis on the nervous system, and numerous lectures and publications.[156]
In addition, Naunyn represents the promotion of relationships within the medical disciplines. The exchange between internal medicine and surgery is of great importance here. Naunyn maintained very good contacts with the surgeons Karl Wilhelm Schönbor (1840-1906), Johannes von Mikulicz-Radecki (1850-1905), and Anton Freiherr von Eiselsberg (1860-1939). The latter even maintained personal friendships with Naunyn and his family.[157] With the surgeons mentioned above, Naunyn founded the journal "Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie".[158]

Bernahrd Naunyn's legacy

A topic that is still today the basis of every medical education is the complication of acidosis in severe diabetes, which was identified by Bernhard Naunyn and his colleague Eugen Hallervorden (1853-1914).[159] In addition, Naunyn's training paved the way for his former student Oskar Minkowski (12 Nobel Prize nominations) to provide evidence that the pancreas is directly related to diabetes.[160] Minkowski's discovery created the basis for later internal secretory therapy for diabetes and insulin therapy. [161]

[154] Naunyn B (1898) Der Diabetes Melitus, Alfred Hörler K. U. K. Hof- und Universiätäsbuchhändler

[155] Naunyn B (1921) Die Gallensteine, ihre Entstehung und ihr Bau, G. Fischer

[156] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p V. https://doi.org/10.1007/BF01862781

[157] Eiselsberg A (1939) Lebensweg eines Chirurgen, DEUTSCHER ALPENVERLAG GES. M. B. H., INNSBRUCK, pp 140-141

[158] Minkowski, O. (1925) Bernhard Naunyn, Archiv f. experiment. Pathol. u. Pharmakol 110, p IX. https://doi.org/10.1007/BF01862781

[159] von Engelhardt Dietrich (2013) Diabetes in Medizin- und Kulturgeschichte. Springer Verlag, p 272

[160] Berblinger W, Clauberg C, Kraus E J (1939) Die Bedeutung der inneren Sekretion für die Frauenheilkunde. Verlag von J. F. Bergmann, München, p. 23

[161] Gerabek W, Haage B D, Keil G, Wegner W (2007) Enzyklopädie Medizingeschichte, Walter de Gruyter, Berlin, Band 1, p 994

Table 5 The following list provides information about some of Naunyn's pupils and locations where they worked as professors for internal medicine:

Name	**Position as professors of internal medicine**
Oskar Minkoswski (1858-1931)	Greifswald, Germany Wroclaw, Poland
Adolf Magnus-Levy (1895–1955)	Berlin, Germany Yale University, US
Wilhelm Weintraud (1866–1920)	Berlin and Wiesbaden, Germany Wroclaw, Poland

2. Publications

In February 2021, the surname changed from "Pohar" to "Wiling".

2.1 Pohar M, Hansson, N (2020) The “Nobel Population” in Pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg. Naunyn-Schmiedeberg's Archives of Pharmacology 393, 1173–1185. https://doi.org/10.1007/s00210-019-01807-y

2.2 Pohar, M, Hansson, N (2021) Between two stools? Pharmacologists nominated for Nobel prizes in “physiology or medicine” and “chemistry” 1901–1950 with a focus on John Jacob Abel (1857–1938). Naunyn-Schmiedeberg's Archives of Pharmacology 394, 503–513. https://doi.org/10.1007/s00210-020-01993-0

2.3 Padrini G, Wiling M, Drobietz M (2021) Die deutsche Nobelpreisgeschichte 1901–1953: Kandidaten, Universitäten, Forschungstrends. Hansson N, Angetter D. (editors.) Laureaten und Verlierer – Der Nobelpreis und die Hochschulmedizin in Deutschland, Österreich und der Schweiz, Göttingen: Vandenhoeck & Ruprecht, p 109-125

Naunyn-Schmiedeberg's Archives of Pharmacology
https://doi.org/10.1007/s00210-019-01807-y

ORIGINAL ARTICLE

The "Nobel Population" in Pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg

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Abstract
One way to investigate research trends in pharmacology over time is to study nominations for the Nobel Prize in physiology or medicine. Going beyond the laureates with strong links to pharmacology, this article pinpoints pharmacologist Nobel Prize nominees during the first half of the twentieth century with a particular focus on two co-founders of this journal: Oswald Schmiedeberg and Bernhard Naunyn. Using the Nobel nomination database which contains more than 5000 nominations in the category physiology or medicine from 1901 to 1953, we listed all scholars (Nobel nominees or nominators) who worked in a pharmacological institute. In addition, we collected nomination letters of Schmiedeberg and Naunyn in the archive of the Nobel committee for physiology or medicine in Stockholm to explore nomination networks and motives. The most often nominated pharmacologists from 1901 to 1953 were Alfred Newton Richards with 57 nominations, Rudolf Magnus (31), Edward Calvin Kendall (28), Otto Loewi (27), Sir Henry Hallett Dale (21) and Oswald Schmiedeberg (18). Surprisingly, the lion's share of the nominations was submitted by non-pharmacologists. We observed a decline in German nominations after World War II and an increase in US-American nominations, which indicates shifting centres and peripheries in pharmacological research. Furthermore, in our observed group of pharmacologists, there was no female nominee from 1901 to 1953. Nobel Prize nominations are to date an underused source to explore international scientific trends as well as scientific networks during the twentieth century.

Keywords Pharmacology · Nobel Prize · Excellence in Pharmacology · Bernhard Naunyn · Oswald Schmiedeberg.

Introduction

One way to investigate research trends in pharmacology over time is the systemic study of major awards and their laureates in the field. There are several prestigious prizes with long traditions, but arguably the most important award is the Nobel Prize. This paper goes beyond the Nobel laureates and identifies for the first time the 'Nobel Population' in pharmacology with a focus on nominees (who did not receive the award) and nominators from 1901 to 1953.

It exists a wide range of studies about the history of the Nobel Prize and different disciplines in medicine, such as surgery (Hansson et al. 2019), urology (Hansson et al. 2017) and pediatrics (Hansson et al. 2017), but so far scholars have not yet done in-depth studies about pharmacologists in this context. Few publications have brought up some nominees in the field, most notably pharmacologist Göran Liljestrand in the book *Nobel—The Man and His Prizes* (Liljestrand 1962) and virologist Erling Norrby in books about Nobel Prize history (Norrby 2010; Norrby 2016), but they did not focus on pharmacologists as a group. For example, Liljestrand categorized nominees in groups like chemotherapy, hormones and chemical structure of the body and pharmacologists were found in all of these groups. The purpose of this article is threefold: First, it will highlight Nobel laureates to date with strong links to pharmacology. Second, it will pinpoint pharmacologist nominees and nominators for the award from 1901 to 1953 and focus on the nominations of the two eponymous scholars of this journal (Starke 1998): Bernhard Naunyn (1839–1925) and Oswald Schmiedeberg (1838–1921).

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Which arguments were highlighted in the nominations? How are the two scholars remembered today? Third, we will discuss the relationships between nominee and nominator in terms of nationality and personal networks and relate the findings to other recent results in Nobel history research. The work of several of the nominees has been described in historical compendia, for instance the book series by Athineos Phillippu that reconstruct single biographies and the genesis of pharmacological institutions on German-speaking territory (Phillippu 2018), so that we will not give detailed ergobiographical information in this paper.

Methods

Using the Nobel nomination database which contains 5110 nominations in the category physiology or medicine from 1901 to 1953,[1] this study includes scholars (Nobel nominees and nominators) who worked in a pharmacological institute or laboratory. In addition, we collected nomination letters of Oswald Schmiedeberg and Bernhard Naunyn in the archive of the Nobel committee for physiology or medicine in Stockholm to explore nomination networks and detailed nomination reasons. In the present study, only laureates and nominees for the Nobel Prize in physiology or medicine were listed. In addition, there are scholars with strong pharmacological interests nominated and honored in the history of the Nobel Prize in Chemistry, such as the laureates Brian K. Koblinka (*1955) and Robert J. Lefkowitz (*1943), who received the prize in 2012 for their studies of G protein-coupled receptors.

Results

Table 1 shows all Nobel laureates in physiology or medicine to date who were pharmacologists or had strong links to pharmacology.

Table 2 emphasizes pharmacologist nominees and nominators based on the data on the nomination database of the Nobel Prize for the award from 1901 to 1953. This allows us to draw conclusions about the relationships between nominee and nominator in terms of nationality, gender and personal networks.

As Table 2 indicates, the most often nominated pharmacologist from 1901 to 1953 was Alfred Newton Richards (1876–1966) with 57 nominations followed by Rudolf Magnus (1873–1927) (31), Edward Calvin Kendall (1886–1972) (28), Otto Loewi (1873–1961) (27), Sir Henry Hallett Dale (1875–1968) (21) and Oswald Schmiedeberg. Whereas Loewi and Dale jointly shared the 1936 Nobel Prize "for their discoveries relating to chemical transmission of nerve impulses" and Kendall received it in 1950 for "discoveries relating to the hormones of the adrenal cortex, their structure and biological effects", the other "top nominees" never got it. The nearest miss probably was Magnus, who was judged prizeworthy by the Nobel Committee in 1927, the same year he passed away (and posthumous prizes are not possible according to the statutes). These scholars can be labeled as "favorite sons" in pharmacology, a term Nobel historian Elisabeth Crawford coined, originally to describe candidates who attracted the majority of nominations from a given country (Crawford 1984).

Since both Naunyn and Schmiedeberg (along with the pathologist Edwin Klebs (1834–1913)) are co-founders of this journal founded in 1873, first named "Archiv für experimentelle Pathologie und Pharmakologie", since 1972 "Naunyn-Schmiedeberg's Archives of Pharmacology", their nomination letters will in the following be discussed more in detail. With Pflügers Archive—European journal of physiology (founded in 1868), at least one more scientific journal bears the name of a Nobel Prize nominee. The German physiologist Eduard Pflüger (1829–1910) was nominated more than 30 times during the first decade of the twentieth century, but he never received it (Hansson and Schlich 2014).

The Nobel nominations for Oswald Schmiedeberg

Oswald Schmiedeberg was born in 1838 in Courland (today Latvia) and went to school and university in Dorpat (now Tartu, Estonia). Immediately after his graduation, he became assistant of Rudolf Buchheim (1820–1879), founder of the first laboratory of experimental pharmacology in Dorpat, where Schmiedeberg completed his "habilitation thesis" in 1886. In 1887, Buchheim left Dorpat and Schmiedeberg became his successor as professor for experimental pharmacology. After Schmiedeberg was appointed professor, he took 1 year off and went to study at the physiological institute of Leipzig University (Germany). This step helped him become chairholder of pharmacology at the newly founded university of Strasbourg in 1872 (Meyer 1922). At this time, besides the laboratory in Dorpat, only three to four poorly equipped laboratories for experimental pharmacology existed on German territory, none abroad. Schmiedeberg's huge impact was noticeable in that around 40 of the pharmacology chairs were his students.

[1] Nobel Media AB (2019) Nobel Prize Archive http://nominationarchive.nobelprize.org/nomination/archive/index.html. Accessed December 7, 2019

Table 1 Pharmacologist Nobel Prize laureates in the category of Physiology or Medicine

Year	Name	Motivation	Affiliation at the time of the award:
1936	Otto Loewi, Sir Henry Hallett Dale	For their discoveries relating to chemical transmission of nerve impulses	Graz University, Graz, Austria
1938	Corneille Jean François Heymans	For the discovery of the role played by the sinus and aortic mechanisms in the regulation of respiration	Ghent University, Ghent, Belgium
1939	Gerhard Domagk	For the discovery of the antibacterial effects of prontosil	Munster University, Munster, Germany
1950	Edward Calvin Kendall, Tadeus Reichstein, Philip Showalter Hench	For their discoveries relating to the hormones of the adrenal cortex, their structure and biological effects	Kendall: Mayo Clinic, Rochester, MN, USA Reichstein: Basel University, Basel, Switzerland Hench: Mayo Clinic, Rochester, MN, USA
1957	Daniel Bovet	For his discoveries relating to synthetic compounds that inhibit the action of certain body substances, and especially their action on the vascular system and the skeletal muscles	Istituto Superiore di Sanità (Chief Institute of Public Health), Rome, Italy
1970	Ulf von Euler, Julius Axelrod, Sir Bernard Katz[a]	For their discoveries concerning the humoral transmitters in the nerve terminals and the mechanism for their storage, release and inactivation	von Euler: Karolinska Institute, Stockholm, Sweden Axelrod: National Institutes of Health, Bethesda, MD, USA
1982	John R. Vane, Bengt I. Samuelsson[a] Sune K. Bergström[a]	For their discoveries concerning prostaglandins and related biologically active substances	Vane: The Wellcome Research Laboratories, Beckenham, UK
1988	Sir James W. Black, Gertrude B. Elion, George H. Hitchings	For their discoveries of important principles for drug treatment	Black: London University, King's College Hospital Medical School, London, UK Elion: Wellcome Research Laboratories, Research Triangle Park, NC, USA Hitchings: Wellcome Research Laboratories, Research Triangle Park, NC, USA
1992	Edwin G. Krebs, Edmond H. Fischer[a]	For their discoveries concerning reversible protein phosphorylation as a biological regulatory mechanism	Krebs: University of Washington, Seattle, WA, USA
1994	Alfred G. Gilman, Martin Rodbell[a]	For their discovery of G-proteins and the role of these proteins in signal transduction in cells	Gilman: University of Texas Southwestern Medical Center at Dallas, Dallas, TX, USA
1998	Robert F. Furchgott, Louis J. Ignarro, Ferid Murad	For their discoveries concerning nitric oxide as a signaling molecule in the cardiovascular system	Furchgott: SUNY Health Science Center, Brooklyn, NY, USA Ignarro: University of California School of Medicine, Los Angeles, CA, USA Murad: University of Texas Medical School at Houston, Houston, TX, USA
2000	Arvid Carlsson, Paul Greengard, Eric R. Kandel[a]	For their discoveries concerning signal transduction in the nervous system	Carlsson: Goteborg University, Gothenburg, Sweden Greengard: Rockefeller University, New York, NY, USA
2015	Tu Youyou	For her discoveries concerning a novel therapy against malaria Prize share: 1/2	China Academy of Traditional Chinese Medicine, Beijing, China

The information stated in the table are obtained from https://www.nobelprize.org/prizes/lists/all-nobel-laureates-in-physiology-or-medicine/ (12.10.2019, 20:15)

[a] Laureate who worked on the same topic as the pharmacologists but was not pharmacologists by profession

In the years between 1902 and 1920, Schmiedeberg was nominated 18 times in the prize category physiology or medicine (Table 3). The first nomination letter was written by his former assistant Hans Horst Meyer (1853–1939) in 1908. Meyer attached to his nomination a eulogy of Schmiedeberg's 70th birthday. The main argument Meyer stated were the achievements of Schmiedeberg regarding his work and impact on experimental pharmacology (Fig. 1) .

English translation: "Honoured for the invitation to nominate a scholar and for the 1909 prize in physiology or medicine, I would like to propose Prof. Dr. Oswald Schmiedeberg. The research conducted by him and his school has brought about the most important foundations in experimental pharmacology. As further explanation I attach a short essay that I wrote for his 70th birthday. Yours sincerely, Dr Hans H Meyer".

The second nomination letter was submitted by pharmacology professor Max Cloetta (1886–1940) in 1910. Cloetta also did not point out a single work of Schmiedeberg's achievements, but rather his big impact on educational infrastructure.

Table 2 The "Nobel Population" in Pharmacology 1901–1953 and nominations submitted by pharmacologists during that time period. Additionally, it shows, in italic letters Nobel laureates and the prize year. If nominations were submitted by the same scholar multiple times, the name of the nominator is listed only once. If nominations for a single nominee have been submitted more than once for the same scholar in different years, only one name is listed

Nomination From … to	Number of nominations	Nominee	Nominator	Nominee as nominator
1902–1923	6	Ernst Overton	Justus Gaule, Torsten Thunberg, M von Frey, H von Tappeiner, Albrecht Julius Theodor Bethe	*Sir Charles Sherrington*, NP 1932
1902–1906	3	Joseph Freiherr von Mering	Julius Pohl, K Huppert, Knud Faber	
1902–1920	18	Oswald Schmiedeberg	H von Tappeiner, E Poulsson, Schreiner, Torup, Vogt, Gaetano Gaglio, Hans Horst Meyer, M Cloetta, H Fehling, Torald Sollmann, Bernhard Naunyn, R Stachelin, Edwin Faust	Gustav Hüfner
1912–1938	11	Hans Horst Meyer	H von Tappeiner, Ludwig Aschoff, Friedrich von Müller, Bernhard Naunyn, Albrecht Julius Theodor Bethe, Emil Bürgi, Otto Fürth, Ernst Pick, A Durig, R Wasicky, Leopold Arzt	Max Rubner, Eduard Pflüger, Oswald Schmiedeberg, John Langley, Jacques Loeb, *Julius Wagner-Jauregg*, NP 1927, Eugen Steinach, L Warburg, Paul Weiss, *George Whipple*, NP 1934, Yandell Henderson, *Otto Loewi*, NP 1936, Sigmund Freud
1913	1	Sir Thomas Lauder Brunton	E Riegler	
1914	1	Ivan Doigel	L Darkchevitch	Wassilij Rasumowsky
1922–1927	31	Rudolf Magnus	E Laqueur, Karl Hürthle, Albrecht Julius Theodor Bethe, Bernard Fischer, O Voss, O Loos, Karl Kleist, P Morawitz, P Manasse ,Fritz Verzár, Ferdinand Flury, Felix von Szontagh, Adolf Beck, Rudolf Höber, *Sir Archibald Hill*, NP 1922, J Gunn, H Kleinschmidt, E. v. Hippel, K Reifferscheid, R Stich, W Zeeman, I Snapper, Wolfgang Heubner, A Denker, John James Macleod, Martin Kochmann, Ph. Stöhr, Adolf Jarisch, H Winternitz	*Sir Charles Sherrington*, NP 1932
1922–1951	28	*Edward Calvin Kendall*, NP 1950	Richard Zeynek, Graham Lusk, John Sjöqvist, Louis Wilson, Arthur Hirschfelder, Frank Mann, Shiro Tashiro, Norman Keith, W Lemon, George Eusterman, Keene Haldeman, Robert Platt, John Talbott, H Lisser, CFW Illingworth, Raul Piaggio Blanco, Maxwell Lockie, G Andrieu, Giulio Dogliotti, J Yoffey, *Edward Doisy*, NP 1944, Hamilton Anderson, R Schoen, Erik Jorpes, Domingo Prat	Walter Cannon
1925–1939	12	John Jacob Abel	Hugh McGuigan, E Libman, Robert Lowie, C Bardeen, Charles Mayo, Ross Gortner, Arthur Hirschfelder), William Ford, E Marshall, B Turner, Eben Carey	
1926	1	Hermann Wieland	Paul Hoffmann	
1926–1936	21	*Sir Henry Hallett Dale*, NP 1936	M Ide, Francis Fraser, H Hartridge, *Sir Archibald Hill*, NP 1922, Baird Hastings, Langdon Brown, *Sir Frederick Hopkins*, NP 1929, *Lord Edgar Adrian*, NP 1922, *Sir Charles Sherrington*, NP 1932, E Keeser, Lord Edgar Adrian, J Burn, Jean Demoor, E Starkenstein, George Barger, Adolf Jarisch	*Sir Frederick Hopkins*, NP 1929, *Otto Loewi*, NP 1936, Sir Patrick Laidlaw, Alfred Richards, *Alexander Fleming*, NP 1945, *Howard Florey*, NP 1945, Charles Herbert Best
1927–1936	27	Otto Loewi, NP 1936	E von Brücke, Adolf Jarisch, Geza Mansfeld, Hermann Pfeiffer, Fritz Pregl, Hermann Beitzke, Wilhelm Prausnitz, Langdon Brown, E Gellhorn, *Sir Archibald Hill*, NP 1922, *Sir Frederick Hopkins*, NP 1929, *Lord Edgar Adrian*, NP 1922, *Sir Charles Sherrington*, NP 1932, Gunnar Ahlgren, Sven Ingvar, R McDowall, E Starkenstein, Hans Meyer, *Sir Henry Hallett Dale*, NP 1936, George Barger	Ernest Starling, Sigmund Freud, Edgar Allen, Herbert Evans, Bernhard Zondek, Walter Cannon, Oswald Theodore Avery , Michael Heidelberger, Leonor Michaelis, Charles Herbert Best
1927	1	Wilhelm Roehl	A Weber	
1928–1940	2	Géza Mansfeld	Láscló von Rhorer, Stafan Eusznyak (Rusznyak)	*Otto Loewi*, NP 1936, Hendrik Zwaardemaker, Heinrich Hering, *Corneille Heymans*, NP 1938
1929	1	Paul Trendelenburg	Mich. Gramenitzki	*Willem Einthoven*, NP 1924
1931–1950	57	Alfred Newton Richards)	George William Norris, David Riesman, William Pepper, Harold Austin, A Stengel, C Frazier, D Wilson, Eliot Round Clark, C Norris, Edward Krumbhaar, William Spiller, G Müller, M Jacobs, F Weidman, Herbert Fox, I Ravdin, Alexander Randall, F Keene, *George Whipple*, NP 1934, *George Minot* (, NP 1934, Grier Miller, Harold Austin, Earl Bond, N Winkelman, DeForest Willard, H Bazett, W Addison, Stuart Mudd, Carl Schmidt, Balduin Lucké, *Sir Henry Hallett Dale*, NP 1936, Detlev Bronk, John Dunn, Donald van Slyke, *Sir Archibald Hill*, NP 1922, Paul Govaerts, W Bradley, Walter Elmer, Isaac Starr, *Herbert Gasser* ,NP 1940, J Olmsted, J Bouckaert	*Alexander Fleming*, NP 1945, *Howard Florey*, NP 1945
1931	5	Jean François Heymans	O. Rubbrecht, Alexandre Besredka, F. de Beule, Paul van Durme, N. Goormaghtight	
1931	1	Hugo Schulz	August Bier	

Table 2 (continued)

Nomination From … to	Number of nominations	Nominee	Nominator	Nominee as nominator
1934–1939	8	*Corneille Jean François Heymans*, NP 1938	A Durig, P Hanzlik , B Krishnan, Geza Mansfeld, Alexandre Besredka, J Bouckaert, A Vandevelde, Frans Daels	*Hendrik Dam* NP 1943, Walter Hess, *Bernardo Alberto Houssay* (AR) NP 1947**,** *Alexander Fleming*, NP 1945, *Howard Florey*, NP 1945, Gaston Ramon, Edward Dodds, Dilworth Wayne Woolley, Alfred Blalock, Helen Taussig, Edward Rickes, Lester Smith, James Reyniers, *Ragnar Granit*, NP 1967, *Daniel Bovet* NP 1957, Bernard Halpern, Frédéric Bremer, Carl Wiggers
1934–1935	2	Werner Schulemann	G Giemsa, Bruno Galli-Valerio	
1937	1	Hans Christian Hagedorn	Anne Bourquin	
1938	1	Frederico Nitti	George Raiziss	
1938–1948	3	Jacques Tréfouël	George Raiziss, M Macheboeuf, C Gernez-Rieux	
1938–1953	9	*Gerhard Domagk*, NP 1939	George Raiziss, P Mazé, A Gardner, O Grutz, H Eyer, H Loebell, A Peiper, Max Bürger, Heinrich Bredt	William Feldman, Fritz Mietzsch, H Mauss, Walter Kikuth
1938	1	Bun-ichi Hasama	Albrecht Julius Theodor Bethe	
1939–1947	9	Sir Edward Mellanby	Lyle Cummins, *Sir Frederick Hopkins*, NP, *Charles Sherrington*, NP 1929, J Burn, Lovatt Evans, H Himsworth, Stuart Cowell, H Hartridge, G Cameron	
1941	1	Einar Hammarsten	B Babkin	*Thomas Morgan*, NP 1933, Torbjörn Caspersson, *George Wells Beadle*, NP 1958, *Edward Lawrie Tatum*, NP 1958
1944	1	Arthur L. Tatum	George Roth	Conrad Elvehjem, Harry Goldblatt, Irvine Page, *Joseph Erlanger*, NP 1944, *Herbert Gasser*, NP 1944, John Eyster
1946	16	*Sir Hans Adolf Krebs*, NP 1952	*Otto Meyerhof*, NP 1922, Gerty Cori, Carl Cori, David Greenberg, Francesco Cedrangolo, *Bernardo Alberto Houssay* NP 1947, Arnold Welch, Elísio Milheiro, Melville Arnott, Baird Hastings	Manfred Eigen, C Wagner
1948–1952	4	Ernest Basil Verney	J Burn, Friedrich Rein, J Gaddum, M Schneider	Sir Patrick Laidlaw
1949	1	Edward Joseph Conway	J Donegan	
1949–1952	2	Hans Mauß	Otto Krayer, *Gerhard Domagk*, NP 1939	
1949–1953	11	Fritz Mietzsch	Otto Krayer, *Gerhard Domagk*, NP 1939, J Zange, H Weber, Adolf Butenandt, E Letterer, W Bickenbach, H Gottron, Hans-Hermann Rebel, H Bennhold, Walther Jacobj	
1949–1953	11	Walter Kikuth	Otto Krayer, *Gerhard Domagk*, NP 1939, J Zange, H Weber, Adolf Butenandt, E Letterer, W Bickenbach, H Gottron, Hans-Hermann Rebel, H Bennhold, Walther Jacobj	
1950	1	*Tadeus Reichstein*, NP 1950	J Yoffey, Erik Jorpes	Lester Smith, Karl Folkers
1950–1951	13	*Philip Showalter Hench*, NP 1950	Keene Haldeman, Robert Platt, A McIntyre, John Talbott, H Lisser, CFW Illingworth, Maxwell Lockie, G Andrieu, Giulio Dogliotti, R Schoen, Paul Searles, Domingo Prat, William Murphy	
1950	1	Lyman Craig	Sune Bergström	
1950	3	Miklos Jancsó (Nicholas Jancsó)	Joseph Frigyesi, Béla Issekutz , Sándor Mozsonyi	
1950	1	Ernst Peter Pick	Leopold Arzt	*Karl Landsteiner*, NP 1930, Eugen Steinach, *George Whipple*, NP 1934, Hans Meyer
1951	2	Bernard Naftali Halpern	Jean Pieri, *Corneille Heymans*, NP 1938	
1951–1953	2	*Daniel Bovet*, NP 1957	*Corneille Heymans*, NP 1938, Domenico Marotta	
1952	1	*Ulf Svante van Euler-Chelpin*, NP 1970	J Gaarenstroom	
1953	1	Adolf Jarisch junior	F v. Brücke	*Otto Loewi*, NP 1936, Rudolf Magnus, Adrian de Kleyn, *Sir Henry Hallett Dale*, NP 1936

He highlighted Schmiedeberg as the actual founder of modern pharmacology.

> "*... It is less the classical and outstanding work of the person concerned… it is more the fact that O. Schmiedeberg can be described as the founder of modern pharmacology…*" (Nobel archive, Nomination archive yearbook 1910)[2]

Furthermore, Cloetta referred to the significant number of scholars educated by Schmiedeberg and illustrated this as a multiplicator of Schmiedeberg's worldwide impact. Cloetta dignified the number of pupils as an indicator of his achievements.

> "*...His work is hidden within his pupils, who are successfully transplanting Schmiedeberg's thinking and are scattered all over the world. There are few scientists in medicine who can retrospect on such a successful career…*" (Nomination Archive Yearbook 1910)[3]

Most nominators of Schmiedeberg proposed him for extensive work in pharmacology covering several topics. Although Schmiedeberg belonged to the most often nominated pharmacologists, he never reached the shortlist of the Nobel Committee. One reason probably was that the nominators emphasized his broad interests and life-time achievement, rather than a single great discovery, or as Göran Liljestrand, secretary of the Nobel Prize committee 1918–1968, put it: "prizes are thus given for specific scientific achievements rather than for general merit in medical research" (Liljestrand 1962) (Fig. 2).

Although Oswald Schmiedeberg never received a Nobel Prize, he is remembered in various ways nowadays. The *Deutsche Gesellschaft für experimentelle und klinische Pharmakologie und Toxikologie e.V.* (founded in 1920) awards the O. Schmiedeberg Plakette (eng. O. Schmiedeberg-medal-of-honor). Among the winners are Otto Loewi (1957), Sir Henry Dale (1962), Otto Krayer (1964), and Julius Axelrod (1978). The Latvian Society of Pharmacology also established a "Schmiedeberg Prize": The Oswald Schmiedeberg Medal, awarded since 1998 to honorary members of the society.

Moreover, a bust of Oswald Schmiedeberg manufactured by Carl Seffner (1891–1932) is now displayed in the lecture hall of the Otto Krayer Haus in Freiburg im Breisgau (Germany). The Otto Krayer Haus is part of the University of Freiburg and it houses the pharmacological and toxicological institute of the university. Originally the bust was made for the University of Strasbourg (France) but was relocated to Freiburg via Tübingen (Germany) after the First World War. Pharmacology professor Walther Straub (1874–1944) was essential in bringing the bust to Freiburg (Starke 2004) (Fig. 3).

The Nobel nominations for Bernhard Naunyn

Bernhard Naunyn (1839–1925) was a German internist. He received his education under Friedrich Theodor Frerichs (1819–1885) at Berlin Charité and became professor of the therapeutic clinic of the University of Dorpat in 1869, where he developed a friendship with Schmiedeberg. After employments at the University of Bern (Switzerland), and the University of Konigsberg (now Kaliningrad, Russia), he came the to University of Strasbourg in 1888. In his autobiography, Naunyn described his specific interest centered on metabolic pathologies, especially of the liver, pancreas and diabetes (Naunyn 1925). Another significant part of his research work was devoted to pathologies of the nervous system (Fig. 4).

Naunyn received three nominations for the Nobel Prize (Table 4). The first nomination was submitted in 1910 by the psychiatrist Emil Kraepelin (1856–1926), who gave two reasons for nomination.

First, Kraepelin emphasized the clinical relevance of Naunyn's research that "the science of diabetes mellitus in the way it exists now would not be possible without Naunyn's research findings in the field of acidosis and pancreatic diabetes."

> "*...without Naunyn's research, the science of diabetes mellitus would not be imaginable in the field of acidosis and pancreatic diabetes …*" (Nomination Archive Yearbook 1910)[4]

Second, Kraepelin argued that the cholelithiasis, its structure, and chemical components, as well as Naunyn's approach to brain disorders were invaluable.

[2] Original text in the nomination "… Es sind viel weniger die klassischen und hervorragenden Arbeiten des Betreffenden, ... als vielmehr die Tatsache, dass O. Schmiedeberg als der eigentliche Gründer der modernen Pharmakologie bezeichnet werden kann ..."

[3] Original text in the nomination "… Seine Arbeiten liegen verborgen in denen seiner Schüler, die in der ganzen Welt zerstreut die Schmiedeberg'schen Ansichten fruchtbringend verpflanzt haben. Es gibt wenige Forscher in der Medizin, die auf eine so erfolgreiche Schule blicken dürfen..."

[4] Original text in the nomination "… Lehre von Diabetes mellitus wäre heute ohne Naunyns Forschungen auf dem Gebiet der Azidosen und des Pankreasdiabetes ganz undenkbar ..."

Table 3 Nomination motivation for Oswald Schmiedeberg in chronological order

Year	Motivation	Nominator
1902	The founder of the modern pharmacology	von Tappeiner
1908	Extensive work in pharmacology (digitalis, caffeine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, oxidation in the body)	Poulsson
1908	Extensive work in pharmacology (digitalis, caffeine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, oxidation in the body)	Schreiner
1908	Extensive work in pharmacology (digitalis, caffeine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, oxidation in the body)	Torup
1908	Extensive work in pharmacology (digitalis, caffeine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, oxidation in the body)	Vogt
1908	Extensive work in pharmacology (digitalis, caffeine, muscarine and sedatives) and physiology (the discovery of glucuronic acid, effects of urea synthesis, studies on oxidation in the body and nucleic acids)	Gaglio
1909	Fundamental work on experimental pharmacology	Meyer
1910	The founder of the modern pharmacology	Cloetta
1910	Work on pharmacology	Fehling
1911	General work on pharmacology	Sollmann
1912	Systematical institutional work on pharmacology	Meyer
1913	Founder of the experimental pharmacology, especially the discovery of glucuronic acid, work on the effect of acids and work on digitalis	Naunyn
1914	Important contributions to the foundation of experimental pharmacology	Meyer
1915	A life work on the foundation of the modern pharmacology	Stachelin
1917	Fundamental work on pharmacology	Cloetta
1918	Foundation of the modern pharmacology	Stachelin
1918	Work on oxidative fissions and syntheses in the animal organism, carbamic acid esters and work on the constituents of the digitalis plants	Faust
1920	Work on glucuronic acid, formation of hippuric acid and urea, syntheses and oxidations in the animal organism	Naunyn

"*... the teaching of cholelithiasis. The structure and the chemical composition ... has outstanding value for the teaching of brain disorders...*" (Nomination Archive Yearbook 1910)[5]

Interestingly, Kraepelin added two expert opinions by Friedrich von Müller (1858–1941) and Maximilian von Gruber (1839–1927) to his proposal. Müller substantiated Naunyn's oeuvre by referring to "Naunyn's Gesammelte Abhandlungen", a collection of Naunyn's work which was published at his 70th birthday in 1908 (Minkowski 1925). Müller wrote that Naunyn—after Frerichs—had established the exact chemical approach in the pathology of internal diseases and added that the work on hyperthermia, icterus, acidosis could not have been understood without Naunyn's research. In addition, Müller highlighted aphasia, senile epilepsy and atherosclerotic brain diseases regarding Naunyn's impact on neurology (Figs. 5, 6 and 7).

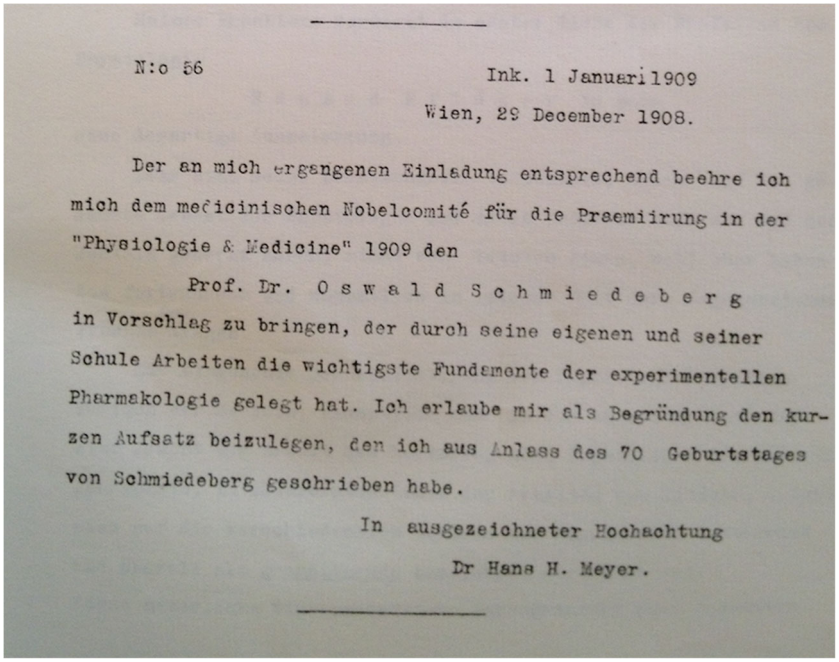
[5] Original text in the nomination "… die Lehre von der Cholelithiesis. Der Aufbau und die chemische Zusammensetzung ... hat auch für die Lehre von Hirnkrankheiten hervorragendes geleistet ..."

English translation

Dear colleague,
The best way to find out more about Naunyn's merits is to look at the collective papers published for the scholar's 70th birthday. In general, it can be said that Naunyn (after Frerichs) introduced the accurate chemical research method into the pathology of internal diseases. This can be seen in his earliest work, for instance in that on the chemistry of transudates and pus. But even until now, Naunyn's clinical laboratory has been a site of the most substantial and at the same time most modern chemical work, as the studies by Minkowski and Beer prove. One of the chief works by Naunyn from earlier times are his works on fever and

Table 4 Nomination motivations for Bernhard Naunyn in chronological order

Year	Motivation	Nominator
1910	Investigations on icterus and diabetes; work on neurology	Emil Kraepelin
1918	Work on icterus, brain pressure, inoculation technique, bile stone and especially work on diabetes mellitus	Julius Schreiber
1925	Work on gallstones	W Ceelen



N:o 56 Ink. 1 Januari 1909

Wien, 29 December 1908.

Der an mich ergangenen Einladung entsprechend beehre ich mich dem medicinischen Nobelcomité für die Praemiirung in der "Physiologie & Medicine" 1909 den

Prof. Dr. Oswald Schmiedeberg

in Vorschlag zu bringen, der durch seine eigenen und seiner Schule Arbeiten die wichtigste Fundamente der experimentellen Pharmakologie gelegt hat. Ich erlaube mir als Begründung den kurzen Aufsatz beizulegen, den ich aus Anlass des 70 Geburtstages von Schmiedeberg geschrieben habe.

In ausgezeichneter Hochachtung

Dr Hans H. Meyer.

Fig. 1 Nomination letter by Hans H Meyer, Vienna, December 29, 1908. Photo by NH

hyperthermia. This is followed by a number of large-scale series of studies dealing with the pathology of jaundice. This research on jaundice was carried out in part by Naunyn himself, but in part at his suggestion by his then Koenigsberg assistants Minkowski and Stadolmann. These investigations have overturned the earlier teaching on haematogenic jaundice, and have shown that even in the case of jaundice produced by blood toxins, e.g. toluylendiamin, only the liver can be considered as an organ that forms bile pigment. The current view of jaundice produced by pleiochromy is based entirely on the teachings of Naunyn's school. Naunyn has also shed new light on the genesis of gallstone disease, partly through his own research and partly through that of his co-workers, and here too Naunyn's teachings about gallstone-forming catarrh have been widely accepted. Naunyn published this research in a special book. However, Naunyn's work in the field of liver diseases is not yet exhausted. Further, it is worth mentioning his compilation about cirrhosis of the liver and cholangitis.

Another area of Naunyn's studies is diabetes, and in this area, Naunyn and his school have largely completely overthrown it. It should be remembered that the two most important discoveries in this area, from pancreatic diabetes and phlorizin diabetes came from Naunyn's school, that the current doctrine of diabetic acidosis or oxybutyric acid poisoning was determined by planned research by the Naunyn School. The last works of Naunyn's assistant Magnus Levy, like von Beer, which crown this building (school) are as much to be traced back to Naunyn's initiative as the experiments in

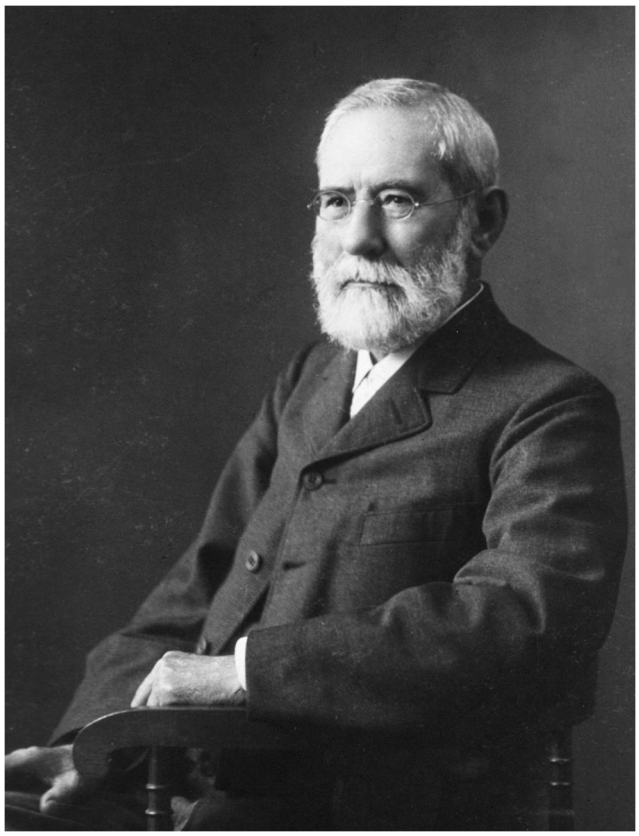


Fig. 2 Oswald Schmiedeberg (Wikicommons)

Fig. 3 Schmiedeberg bust in Freiburg, (Wikicommons)

Königsberg, which took place decades ago. One can say that the whole doctrine of acidosis can be traced back to Naunyn. Naunyn has also provided evidence that protein turnover plays a crucial role as a source of sugar in diabetes and has also drawn the right ramifications for dietetics of diabetes. In general, Naunyn has consistently developed the dietary treatment of diabetes. Naunyn's work on diabetes is summarized in his book on this disease, which is of fundamental importance not only for diabetes but for studies on metabolism as a whole and that is particularly indispensable because of its exemplary literary work.

Fig. 4 Bernhard Naunyn (Wikicommons)

In addition to these areas of work, Naunyn has also cultivated neurology. His work on intracranial pressure on sensitivity disorders in spinal cord disease, on the localization of aphasia, on senile epilepsy and on arteriosclerotic brain diseases, as well as on the summation of stimuli, should be generally well known. Finally, there are a number of papers on heart disease and its therapy.
I believe that you can easily supplement this brief picture of Naunyn's scientific work by reviewing his entire papers (Naunyn's Abhandlungen).
Yours sincerely
F. Müller

The second Nobel Prize nomination of Bernhard Naunyn was submitted by the German professor for internal medicine Julius Schreiber (1848–1932) from Konigsberg (now Kaliningrad, Russian Federation) in 1918. Schreiber emphasized the discovery that the icterus is traced back to processes in the liver, which had been put forward by Naunyn between 1880 and 1890.

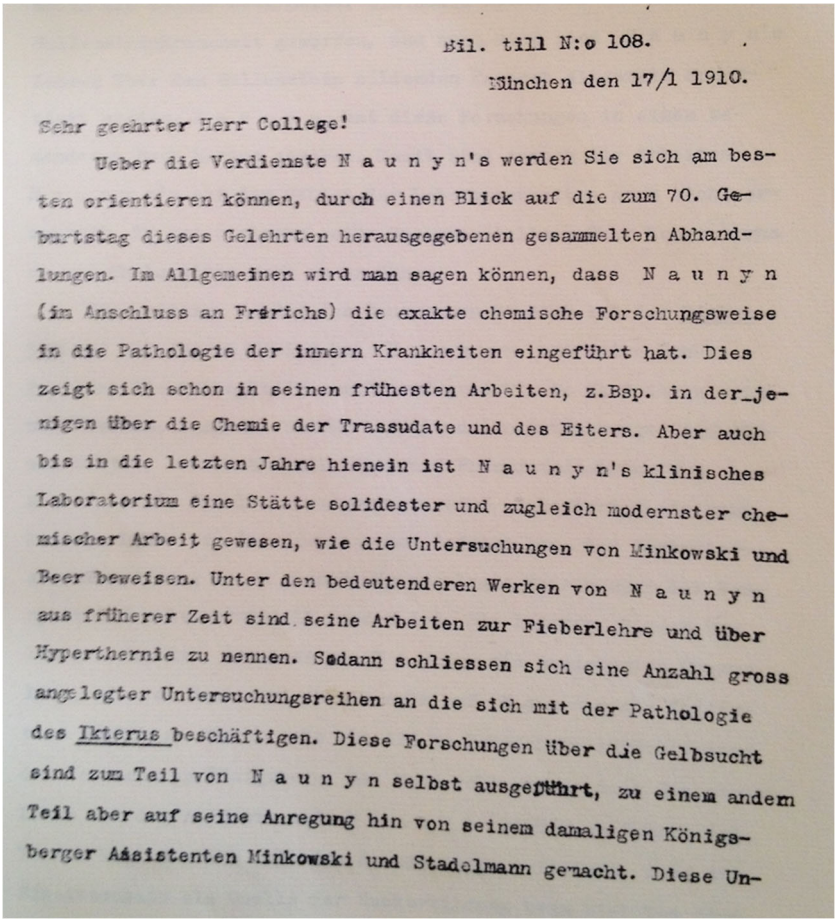
"*... I bring to mind Naunyn's investigations about icterus from the seventies and eighties of the past century ... the consistent genesis of jaundice from the activity in the liver ... proved...*" (Nobel archive, nomination yearbook 1918)[6]

Furthermore, Schreiber mentioned the universality of his work ("Universalität seiner Leistungen"). He focused on the work of fever and intracranial pressure from around 1880. In the nomination, it is mentioned that Naunyn's work had contributed to nearly every big discovery in internal medicine, but the core of the nomination dealt with Naunyn's work on diabetes.

"*… already the universality of his accomplishments makes him worthy ... but if a special accomplishment is needed ... I want to emphasize his merit for the expansion of the teaching of diabetes mellitus.*" (Nomination Archive Yearbook 1918)[7]

[6] Original text in the nomination "… Ich erinnere an Naunyns aus den 70. U. 80-iger Jahren des abgl. Jh. Stammende Untersuchung über den Ikterus ... die einheitliche Entstehung der Gelbsucht aus der Tätigkeit in der Leber ... erwies ..."

[7] Original text in the nomination "…. Schon diese Universalität seiner Leistungen lassen ihn m.E. würdig erscheinen .... wenn es aber dazu einer Sonderleistung bedarf .... seinem Verdienste um den Ausbau der Lehre vom Diabetes mellitus erblicken und diese hiermit hervorheben."



Bil. till N:o 108.

München den 17/1 1910.

Sehr geehrter Herr College!

Ueber die Verdienste N a u n y n's werden Sie sich am besten orientieren können, durch einen Blick auf die zum 70. Geburtstag dieses Gelehrten herausgegebenen gesammelten Abhandlungen. Im Allgemeinen wird man sagen können, dass N a u n y n (im Anschluss an Frérichs) die exakte chemische Forschungsweise in die Pathologie der innern Krankheiten eingeführt hat. Dies zeigt sich schon in seinen frühesten Arbeiten, z.Bsp. in der jenigen über die Chemie der Trassudate und des Eiters. Aber auch bis in die letzten Jahre hienein ist N a u n y n's klinisches Laboratorium eine Stätte solidester und zugleich modernster chemischer Arbeit gewesen, wie die Untersuchungen von Minkowski und Beer beweisen. Unter den bedeutenderen Werken von N a u n y n aus früherer Zeit sind seine Arbeiten zur Fieberlehre und über Hyperthermie zu nennen. Sodann schliessen sich eine Anzahl gross angelegter Untersuchungsreihen an die sich mit der Pathologie des Ikterus beschäftigen. Diese Forschungen über die Gelbsucht sind zum Teil von N a u n y n selbst ausgeführt, zu einem andern Teil aber auf seine Anregung hin von seinem damaligen Königsberger Assistenten Minkowski und Stadelmann gemacht. Diese Un-

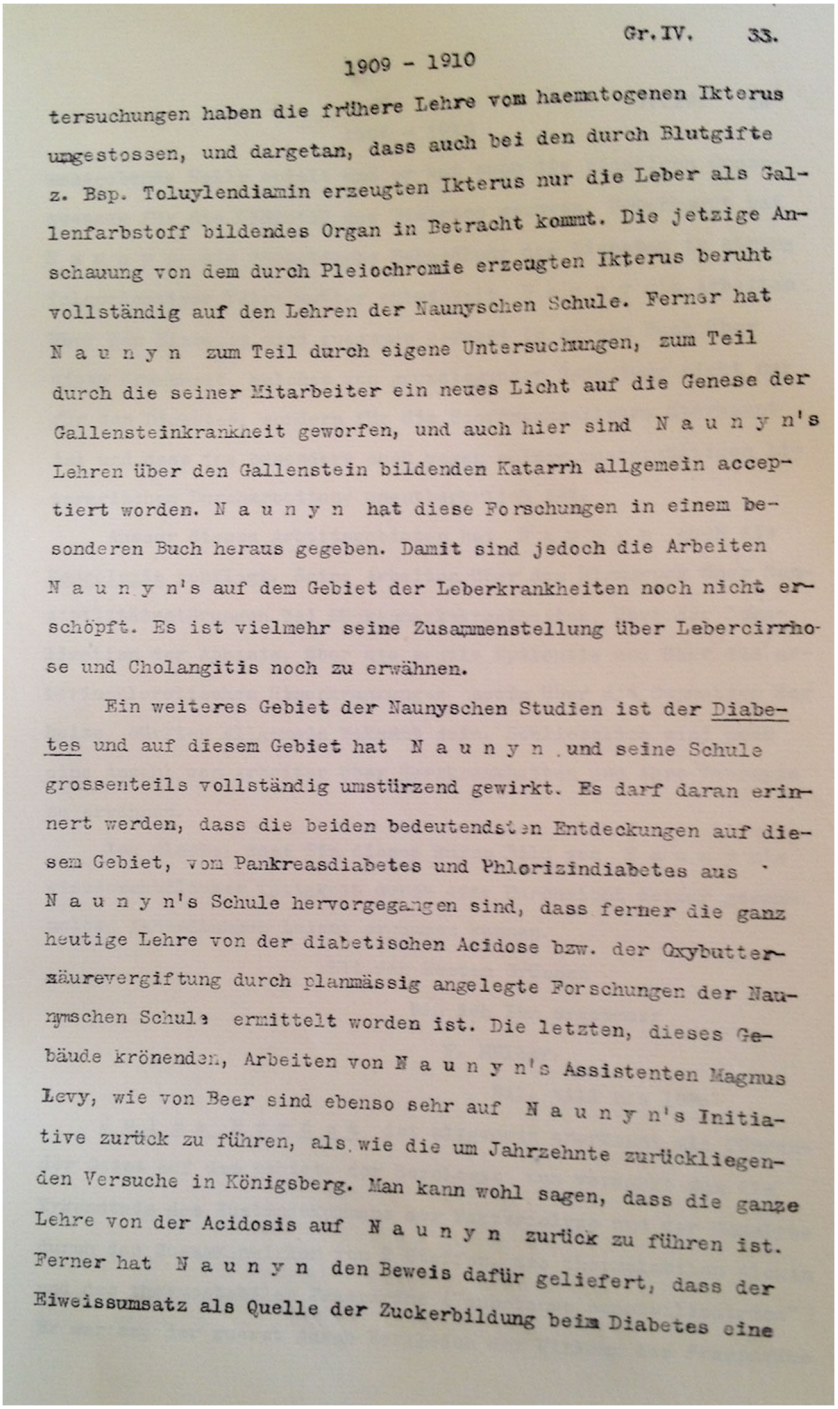
Fig. 5 Nobel nomination for Naunyn by F. Müller, 1910, part 1. Photo by author NH

To honor Bernhard Naunyn, the street "Naunynweg" in Mainz (Germany) is named after him. Moreover, his name has been attached to lecture rooms at congresses in recent years, e.g. at the German congress "Diabetes Kongress 2014–50 Jahre Deutsche Diabetes Gesellschaft" in Berlin, and at the 52nd meeting of the European Association for the Study of Diabetes in Munich (Germany) in 2016. In addition, the German Diabetes Museum in Munich showcases a 9.7 cm medal of Bernhard Naunyn made by Reinhart Heinsdorff (1923–2002) in 1982 (Fig. 8).

Conclusion

Nobel Prize nominations are to date an underused source to explore international scientific trends as well as scientific networks during the twentieth century. This study went beyond the 22 Nobel Prize laureates with strong connection to pharmacology and presented the "Nobel Population" consisting of 43 nominated pharmacologists from 1901 to 1953 to shed light on nomination networks in the field.

This study shows that the social ties between nominee and nominator were significant during the time period, e.g. that of professor-assistant, predecessor-professor or faculty colleagues. These results are in part representative for the entire "Nobel nominee population". The recent study "Effects of homophily and academic reputation in the nomination and selection of Nobel laureates" investigated more than 12,000 individuals and 17,000 nominations and argued that there was a strong tendency of "homophily" in terms of nationality for all Nobel nominations in all prize categories from 1901 to 1965 (Gallotti and De Domenico 2019). As shown in this article, this is also true for the pharmacologist nominees in general. However, this trend was not that distinct during the first decade of the twentieth century, which shows a more diverse international pattern. We can only speculate why the network in pharmacology seems to have been weaker than in other disciplines, but it might be due to the broad and



Gr. IV. 33.

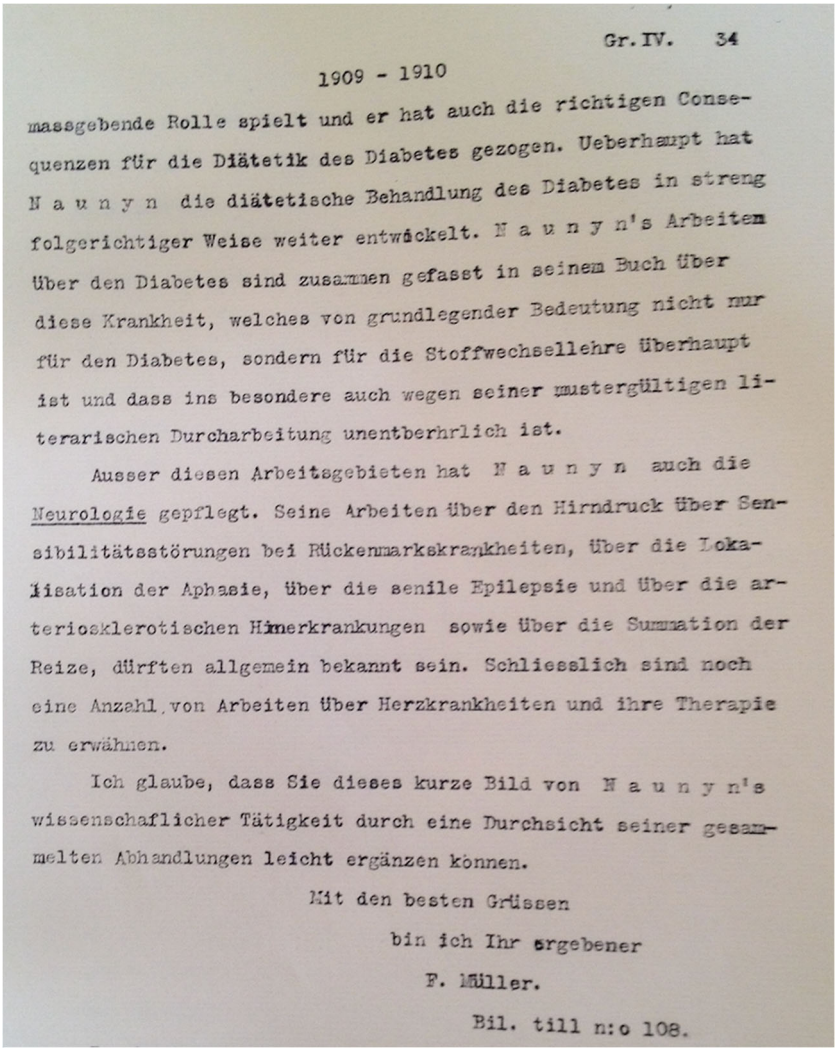
1909 - 1910

tersuchungen haben die frühere Lehre vom haematogenen Ikterus umgestossen, und dargetan, dass auch bei den durch Blutgifte z. Bsp. Toluylendiamin erzeugten Ikterus nur die Leber als Gallenfarbstoff bildendes Organ in Betracht kommt. Die jetzige Anschauung von dem durch Pleiochromie erzeugten Ikterus beruht vollständig auf den Lehren der Naunyschen Schule. Ferner hat N a u n y n zum Teil durch eigene Untersuchungen, zum Teil durch die seiner Mitarbeiter ein neues Licht auf die Genese der Gallensteinkrankheit geworfen, und auch hier sind N a u n y n's Lehren über den Gallenstein bildenden Katarrh allgemein acceptiert worden. N a u n y n hat diese Forschungen in einem besonderen Buch heraus gegeben. Damit sind jedoch die Arbeiten N a u n y n's auf dem Gebiet der Leberkrankheiten noch nicht erschöpft. Es ist vielmehr seine Zusammenstellung über Lebercirrhose und Cholangitis noch zu erwähnen.

Ein weiteres Gebiet der Naunyschen Studien ist der Diabetes und auf diesem Gebiet hat N a u n y n und seine Schule grossenteils vollständig umstürzend gewirkt. Es darf daran erinnert werden, dass die beiden bedeutendsten Entdeckungen auf diesem Gebiet, vom Pankreasdiabetes und Phlorizindiabetes aus N a u n y n's Schule hervorgegangen sind, dass ferner die ganz heutige Lehre von der diabetischen Acidose bzw. der Oxybuttersäurevergiftung durch planmässig angelegte Forschungen der Naunynschen Schule ermittelt worden ist. Die letzten, dieses Gebäude krönenden, Arbeiten von N a u n y n's Assistenten Magnus Levy, wie von Beer sind ebenso sehr auf N a u n y n's Initiative zurück zu führen, als wie die um Jahrzehnte zurückliegenden Versuche in Königsberg. Man kann wohl sagen, dass die ganze Lehre von der Acidosis auf N a u n y n zurück zu führen ist. Ferner hat N a u n y n den Beweis dafür geliefert, dass der Eiweissumsatz als Quelle der Zuckerbildung beim Diabetes eine

Fig. 6 Nobel nomination for Naunyn by F. Müller, 1910, part 2 Photo by author NH

interdisciplinary character of the field. Moreover, we observed a decline in German nominations after World War II and an increase in US-American nominations, which indicates shifting centres and peripheries in pharmacological research. There were several reasons for this shift, e.g. the expulsion of Jewish scientists from Germany in the 1930s, but the trend seems to have begun earlier. Scholars have argued that the research infrastructure in medicine and natural sciences in the USA surpassed Germany already at the turn of the twentieth century (Reingold 1991). Finally, until 1953, there were no female nominees and no female laureates among the nominated



Gr. IV. 34

1909 - 1910

massgebende Rolle spielt und er hat auch die richtigen Consequenzen für die Diätetik des Diabetes gezogen. Ueberhaupt hat N a u n y n die diätetische Behandlung des Diabetes in streng folgerichtiger Weise weiter entwickelt. N a u n y n's Arbeitem über den Diabetes sind zusammen gefasst in seinem Buch über diese Krankheit, welches von grundlegender Bedeutung nicht nur für den Diabetes, sondern für die Stoffwechsellehre überhaupt ist und dass ins besondere auch wegen seiner mustergültigen literarischen Durcharbeitung unentberhrlich ist.

Ausser diesen Arbeitsgebieten hat N a u n y n auch die Neurologie gepflegt. Seine Arbeiten über den Hirndruck über Sensibilitätsstörungen bei Rückenmarkskrankheiten, über die Lokalisation der Aphasie, über die senile Epilepsie und über die arteriosklerotischen Hirnerkrankungen sowie über die Summation der Reize, dürften allgemein bekannt sein. Schliesslich sind noch eine Anzahl von Arbeiten über Herzkrankheiten und ihre Therapie zu erwähnen.

Ich glaube, dass Sie dieses kurze Bild von N a u n y n's wissenschaflicher Tätigkeit durch eine Durchsicht seiner gesammelten Abhandlungen leicht ergänzen können.

Mit den besten Grüssen

bin ich Ihr ergebener

F. Müller.

Bil. till n:o 108.

Fig. 7 Nobel nomination for Naunyn by F. Müller, 1910, part 3. Photo by author NH

pharmacologists, compared to 76 female nominees and one female laureate in the category physiology or medicine (Mahmoudi et al. 2019). Commentators have discussed the lack of women among the nominees for the physiology or medicine-prize during the first half of the twentieth century (Hansson and Fangerau 2018). Among the few female candidates with multiple nominations for this prize category were renowned scholars such as the neurologist Cécile Vogt (1875–1962) and the cardiologist Helen B. Taussig (1898–1986) (Hansson and Schlich 2015). The first female laureate in pharmacology was Tu Youyou (2015). Further research aims at taking other prestigious prizes in pharmacology into account to get a more nuanced picture of research trends and various meanings of excellence in the field from the early twentieth century onward.

Fig. 8 Naunyn medal, courtesy of Werner Naumann

Acknowledgements The authors thank the Nobel Committee for physiology or medicine for providing nomination letters and information. The authors translated quotes from German and Swedish into English.

Author contribution NH collected the archival material. NH and MP conceived and designed research. MP and NH wrote the article. Both authors approved the manuscript.

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ORIGINAL ARTICLE

Between two stools? Pharmacologists nominated for Nobel prizes in "physiology or medicine" and "chemistry" 1901–1950 with a focus on John Jacob Abel (1857–1938)

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Abstract
Since the early stages of its academic professionalization, pharmacology has been an interdisciplinary field strongly influenced by the natural sciences. Using the Nobel Prize as a lens to study the history of pharmacology, this article analyzes nominations of pharmacologists for two Nobel Prize categories, namely "chemistry" and "physiology or medicine" from 1901 to 1950. Who were they? Why were they proposed, and what do the Nobel dossiers say about excellence in pharmacology and research trends? This paper highlights the evaluation of "shortlisted" candidates, i.e., those candidates who were of particular interest for the members of the Nobel Committee in physiology or medicine. We focus on the US scholar John Jacob Abel (1857–1938), repeatedly referred to as the "Founder of American Pharmacology." Nominated 17 times in both categories, Abel was praised by his nominators for both basic research as well as for his influential positions as editor and his work as chair at Johns Hopkins University. The Abel nominations were evaluated for the Nobel Committee in chemistry by the Swedish professor of chemistry and pharmaceutics Einar Hammarsten (1889–1968), particularly interested in Abel's work on hormones in the adrenal glands and in the pituitary gland. Eventually, Hammarsten did not view Abel's work prizeworthy, partly because other scholars had done—according to Hammarsten—more important discoveries in the same fields. In conclusion, analyses of Nobel Prize nominations help us to better understand various meanings of excellence in pharmacology during the twentieth century and beyond.

Keywords Artificial kidney · Epinephrine · Excellence in pharmacology · John Jacob Abel · Nobel prize · Pharmacology · Posterior pituitary hormones

Introduction

Since the early stages of its academic professionalization, pharmacology has been an interdisciplinary field strongly influenced by the natural sciences (Phillippu 2018; Starke 1998). While the German pioneers of pharmacology—Rudolf Buchheim (1820–1879), Oswald Schmiedeberg (1838–1921), and Bernhard Naunyn (1839–1925)—had studied medicine, several of their close colleagues had earned a PhD instead of a MD. Using the Nobel Prize as a lens to study the history of pharmacology, the aim of this paper is to take a closer look at pharmacologists nominated for two Nobel Prize categories, namely, for "chemistry" and for "physiology or medicine." Who were they? Why were they proposed? What was deemed excellence in pharmacology in a Nobel context from 1901 to 1950?

Four scientists have been awarded two Nobel Prizes: Marie Curie (1867–1934), Linus Pauling (1901–1994), John Bardeen (1908–1991), and Frederick Sanger (1908–2013), the latter relevant also for pharmacology since he was awarded his first Nobel Prize in chemistry "for his work on the structure of proteins, especially that of insulin." This group of double laureates is well known, but not much research has looked into scholars who were nominated for more than one Nobel Prize category (Gross and Hansson 2020). None of the double laureates have so far both "physiology or medicine" and "chemistry" Nobel medals.

Our research group has previously traced Nobel Prize nominees by analyzing nominations and Nobel committee

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evaluations within the category "physiology or medicine," e.g., in surgery (Hansson et al. 2019), cardiology (Drobietz et al. 2020), and neurology (Hansson et al. 2020) to investigate the attribution of credit in medicine. In a previous paper, we provided an overview of the "Nobel population of pharmacologists," i.e., nominees and nominators for the Nobel Prize in physiology or medicine (Pohar 2020). These studies showed certain patterns regarding credit allocation in medicine, e.g., that there were strong social ties between the nominee and the nominator, such as between professor and assistant or faculty colleagues. In addition, we reconstructed a shift of "Nobel" hotspots in pharmacology, places where most nominees and nominators worked, from Central Europe to the USA around 1930. Due to his training in Europe and the USA, pharmacologist John Jacob Abel (1857–1938) contributed to this shift. He was nominated 17 times from 1925 to 1939 for two Nobel Prize categories ("physiology or medicine" and "chemistry"). While much has already been written about Abel, the story of his "Nobel career" has not yet been told. How was he portrayed in nominations and in committee evaluations—and why did he never receive the prize? Furthermore, we intend to show the importance of pharmacology in the context of the Nobel Prize, based on the evaluation of "shortlists," i.e., those candidates who were of particular interest for the members of the Nobel Committee in physiology or medicine.

Which Nobel fields in science and medicine are trending over time? In a recent paper, Ioannidis et al. (2020) suggested that most Nobel Prizes in physiology or medicine, chemistry, and physics from 1995 to 2017 could be attached to only few scientific domains such as particle physics, cell biology, atomic physics, neuroscience, and molecular chemistry. Reviewed in a longer period of time, we argue that pharmacology, too, has been a major Nobel field since the inception of the Nobel Prize. So far, 13 prizes have strong ties to this discipline in the category physiology or medicine, but these point at only a fraction of the nominated pharmacologists. There are several reasons why promising nominees never received the prize. Science historian, Robert Marc Friedman (2001), analyzed the influence behind the scenes for the Nobel Committee in chemistry. Friedman referred to Svante Arrhenius (1859–1927, Nobel Prize laureate in 1903), who used his influence in the Nobel committee to prevent the awarding of prizes in chemistry to Walther Nernst (1864–1941). Nernst was nominated 58 times in the years 1906–1921. Friedman also showed that one committee member, Ludwig Ramberg (1874–1940), opposed the award of biochemical achievements in the chemistry category.

Methods

In a previous article, we isolated the group of pharmacologists using the Nobel Prize database with its 5110 nominations in the category physiology or medicine from 1901 to 1953 (Pohar 2020). This article compares this group with nominated pharmacologists for the prize category chemistry from 1901 to 1950, including pharmacologists who were nominated for both categories. We then compared the nominations of the double nominees in order to draw conclusions about trends in pharmacology research and focused on shortlisted nominees to explore what was considered to be excellent research in the context of the Nobel Prize.

The article is based on John Jacob Abel's Nobel Prize nominations and special investigations, his own publications, and secondary literature. These nominations dossiers were provided through collaboration with Prof. Karl Grandin, Stockholm, Director of the Center for History of Science at the Royal Swedish Academy of Sciences. We also reviewed the Nobel Prize database "nobelprize.org" with the directory of all nominations in chemistry and physiology or medicine.

Results: "Nobel" networks in pharmacology

Reviewing nomination dossiers of the Nobel committee for chemistry and the Nobel committee for physiology or medicine, we found—next to Abel—several scholars who were nominated for both prize categories, including Nobel laureates such as the previously mentioned Svante Arrhenius, but also Emil Fischer (1852–1919), Eduard Buchner (1860–1917), Paul Ehrlich (1854–1915), Albrecht Kossel (1853–1927), Fritz Pregl (1869–1930), Adolf Windaus (1876–1959), Otto Warburg (1883–1970), Hans Fischer (1881–1945), and candidates who never received the prize such as Fritz Kögl (1897–1959), Rudolf Schoenheimer (1898–1941), Gustav Embden (1874–1933), Choh Hao Li (1913–1987), Jacques Tréfouël (1897–1977), Emil Abderhalden (1877–1950) (Halling et al. 2018), Sachachiro Hata (1873–1938), Sören Sörensen (1868–1939), and Carl Neuberg (1877–1956). They had networks both in chemistry and the life sciences and nominators who emphasized their contributions to both juries to boost their Nobel Prize chances. Several of the proposed pharmacologists during the first half of the twentieth century worked on topics in the gray zone between chemistry and physiology or medicine (Table 1).

John Jacob Abel (1857–1938): A biographical note

John Jacob Abel was born into a family of German origin who migrated to the USA in the early 1850s (George and Eknoyan 2012) (Fig. 1). After graduating from the University of Michigan, he briefly worked as a principal of a high school and of the public schools at La Porte, IN. Abel earned a PhD in 1883 (University of Michigan) and then received postdoc

Table 1 Nominated pharmacologists nominated for the Nobel Prize in chemistry and in physiology or medicine

Name	Number of nominations in chemistry and years	Number of nominations in physiology or medicine and years	Nobel Prize laureate
John Jacob Abel (1857–1938)	5 (1925–1927)	17 (1925–1939)	
Edward Calvin Kendall (1886–1972)	1 (1949)	27 (1922–1950)	Physiology or medicine, 1950
Jacques Tréfouël (1897–1977)	9 (1940–1951)	3 (1938–1948)	
Sir Hans Adolf Krebs (1900–1981)	7 (1946–1950)	16 (1946–1953)	Physiology or medicine, 1953
Edward Joseph Conway (1894–1968)	2 (1950–1959)	1 (1949)	
Tadeus Reichstein (1897–1996)	15 (1943–1950)	13 (1950–1951)	Physiology or medicine, 1950
Lyman Craig (1906–1974)	28 (1952–1965)	1 (1950)	
Bernard Naftali Halpern (1904–1978)	1 (1966)	2 (1951)	

training under the physiologist H. Newell Martin (1884–1896) (Marshall 1926) for 1 year in the Biology Department at Johns Hopkins University in Baltimore.

From 1884 to 1891, J. J. Abel traveled to Central Europe to study medicine and chemistry. During these "Wanderjahre," he had several renowned teachers such as in Leipzig: Carl Ludwig (1816–1895) (physiology), Rudolf Boehm (1844–1926) (pharmacology); in Strassburg: Adolf Kussmaul (1822–1092) (medicine), Bernhard Naunyn (1839–1925) (pathology), and Oswald Schmiedeberg (1838–1921) (pharmacology); in Heidelberg: Vincenz Czerny (1842–1916) (surgery) (Hansson and Tuffs 2016); and in Vienna: Hermann Nothnagel (1841–1095) (medicine) (George 1998). Some of these international contacts, first and foremost Schmiedeberg, had a major impact on his career.

In 1888, Abel was awarded the MD (Dr. med.) by the Kaiser Wilhelm University in Strassburg (now Strasbourg). In January 1891, Abel returned to North America, where he was offered the first full professorship of pharmacology in the USA at the University of Michigan at the recommendation of Oswald Schmiedeberg. In 1893, Abel left Michigan University and was appointed chair in pharmacology at the medical school at Johns Hopkins University, where he worked until his retirement 33 years later in 1932 (until his death in 1938, he continued to serve as director of endocrinological research). It has been put forward that Abel helped many of his students and assistants to important positions in medicine and science, including Reid Hunt (1870–1948) (professor of pharmacology, Harvard Medical School), Carl Voegtlin (1879–1960) (professor of pharmacology Johns Hopkins Medical School), Henry Gray Barbour (1886–1943) (professor of pharmacology, Yale University, Montreal University, University of Louisville), and Eli Kennerly Marshall (1889–1966) (professor of pharmacology, Washington University in St. Louis and Johns Hopkins University). Parascandola (1992) also emphasized that Abel shaped the discipline through his students at other US universities such as PA and Columbia. Therefore, it is not surprising that Abel has repeatedly been described as the "Founder of American Pharmacology" (George 1998), corresponding to the oeuvre of Oswald Schmiedeberg as "Father of modern Pharmacology" (Van Ree and Breimer 2008, but also in a Nobel nomination for Schmiedeberg by Max Cloëtta (1886–1940) as early as in 1910). Abel's achievements include, for instance, the foundation of the Journal of Experimental Medicine in 1896, the Journal of Biological Chemistry in 1905, and the Journal of Pharmacology and Experimental Therapeutics in 1906. The American Society of Biological Chemists (since 1987 American Society for Biochemistry and Molecular Biology) (ASBMB) in 1909 and the American Society of Pharmacology and Experimental Therapeutics (ASPET) in 1908 were also created under his direction. In 1906, Abel became the first vice president of ASBMB (Kregse 2008), and president of ASBMB in 1908, as well as the first president

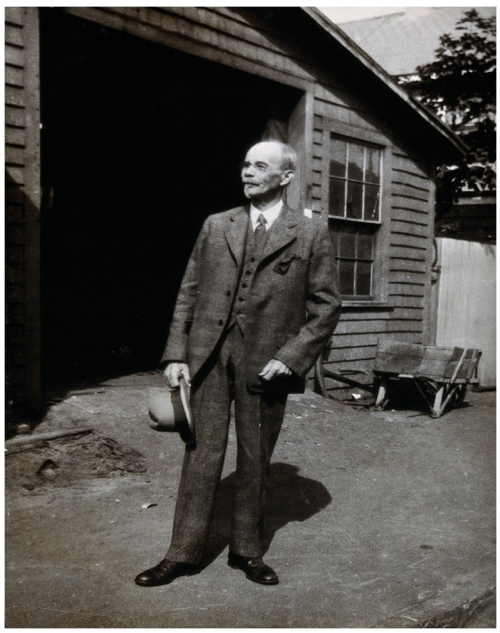


Fig. 1 Photograph of John Jacob Abel (Source: Credit: John Jacob Abel. Credit: Wellcome Collection. Attribution 4.0 International (CC BY 4.0))

of ASPET from 1909 to 1912. Next to these gate-keeping positions, Abel had several scientific interests. He is remembered for having contributed to the isolation of epinephrine (Abel 1901; Abel 1903; Abel and Taveau 1904) and insulin (Abel et al. 1925; Abel 1926; Abel et al. 1927; Parascandola 1992) and for work research on posterior pituitary hormones (Abel 1919; Abel and Rouiller 1922; Abel et al. 1923; Abel 1924; Abel 1930). These interests were reflected in the nomination letters for Abel (Table 2).

Media attention and criticism

The work on vividiffusion (dialysis) apparatus and plasmapheresis, a dialysis precursor have been attributed to him, and Abel has been described as the first person who had the idea of passing blood of a living animal through a dialysis membrane to wash out certain substances (George and Eknoyan 2012). This discovery attracted media attention, for example in the London Times (August 11, 1913) and the New York Times (January 18, 1914). Media celebrated Abel's work as groundbreaking and referred to it as the "Artificial Kidney," which created headlines like "New Poison Test" (Times, Watertown, NJ), "Artificial Kidney Poison Detective: Professor of Johns Hopkins University invents device to check for suicide" (New York Herald), "Reveals Poisons in Blood" (New York Evening Post), "The Artificial Kidney" (New York Times), and "La Purification Du Sang" (Le Petit Niçois, Paris) (George 1998). Abel himself objected the term "artificial kidney" but welcomed the description by his German colleague George Haas (1886–1971), who spoke about "dialyzing patients" (George and Eknoyan 2012). Although Abel did not make a breakthrough with the idea and the first clinically successful hemodialysis in a human was only successfully established by Willem Kolff (1911–2009) 30 years later (Gottschalk and Fellner 1997), Abel is considered to have been an indirect influence on Kolff (George and Eknoyan 2012). However, critics accused Abel and his colleagues of non-transparent behavior regarding the

Table 2 Nominations for John Jacob Abel for the Nobel Prize in chemistry and physiology or medicine

Year	Name nominator	Reason for nomination
Nobel Prize nominations for JJ Abel in chemistry		
1925	Charles Walcott	Demonstration of active principle of adrenal gland. Work on pituitary gland. Work on chemotherapy.
1926	Charles Walcott	Demonstration of active principles of adrenal gland, preparation and isolation of active principle. Work on pituitary. Work on chemotherapy.
1927	George Hale	Isolation of insulin; chemical nature of insulin and separation in crystalline from.
1927	Henry Fairfield Osborn	No reason expressed.
1927	James Norris	Study of ductless glands—basic nature of adrenal gland, preparation of the active principle. Work on insulin and crystalline preparation.
1927	Charles Walcott	Demonstration of active principles of adrenal gland, preparation and isolation of active principle. Work on pituitary. Work on chemotherapy.
Nobel Prize nominations for JJ Abel in physiology or medicine		
1925	Hugh McGuigan	Studies of the endocrine glands, and isolation of epinephrine.
1925	Emanuel Libman	Studies of the endocrine glands, and of elective excretion of dyes.
1927	Robert Lowie	Preparation of crystalline insulin.
1928	Charles Russell Bardeen	Notable contributions in the field of hormones.
1930	Charles Mayo	Work on the introduction of epinephrine and the crystallization of insulin.
1930	Emanuel Libman	Work on epinephrine, elective excretion of dye-stuffs, and the nature and identification of the active principle of the pituitary gland.
1931	Ross Gortner	Work on epinephrine, vividiffusion and insulin.
1931	Arthur Douglass Hirschfelder	Work on epinephrine and insulin.
1932	William Ford	Work on the crystallization of insulin.
1932	Eli Kennerly Marshall	Work on the crystallization of insulin.
1934	Benjamin Brecknell Turner	Work on the isolation of hormones (insulin, epinephrin), and the active unitary principle from the posterior lobe of the pituitary body.
1939	Eben James Carey	Work on the isolation, purification and crystallization of the hormones from the glands of internal secretion.

publication of precise data. They questioned if the investigated substances were toxic at all and meant that the safety of the dialysis apparatus to use for patients was inadequate. Later, Abel was inspired by the topic of plasmapheresis and started researching it by performing experiments with dogs (George 1998). He concluded that the method clearly improved the conditions of the dogs. He then applied the technique on a female patient, who suffered from complications after the treatment. Observers of the procedure accused Abel later to not maintain adequate hygiene standards and the performed plasmapheresis was described as harmful. After this incident, Eli K. Marshall (1889–1966) from Abel's laboratory examined the study results and concluded that the safety of this method remained unclear. However, Abel still continued to praise plasmapheresis and dialysis in his lectures, for instance in his Mellon Lecture in February 1915 (George 1998).

Publications and citations

Abel published more than 50 scientific articles in different journals, predominantly in the Journal of Pharmacology and Experimental Therapeutics (20), where he served as editor for 23 years, and the Bulletin of the Johns Hopkins University (12), with a first authorship in 49 and last authorship in 3 articles. According to Web of Science, Abel's article citations reached a peak in 1945 with 45 citations that year, but his work is still mentioned on a regular basis: Altogether, his articles were cited more than 250 times between 2010 and 2020 (Web of Science October 1, 2020). Would it have been greater if he had received the Nobel Prize? It still is an open research question whether the canonization as Nobel laureate has a major influence on the number of citations. A previous study on the Nobel laureate John C. Eccles (1903–1997) did not find a clear-cut Nobel effect in the citation pattern (De Sio et al. 2019).

Table 3 lists Abel's ten most often cited articles. They mirror major topics for which he was proposed for the Nobel Prize (crystalline insulin and research on the pituitary gland), but also work that was not brought up by nominators, such as laxatives, (phthaleins and their behavior as purgatives, 1909) and tetanus. The two to date most cited publications deal with dialysis, both published in 1914. Dialysis ("vividiffusion") was only once explicitly mentioned in a proposal by Ross Gortner (1885–1942) in 1931 as one of the several motives of nomination. One reason for the relatively high number of citations might have been the media interest at the time. The "top ten" publications include both early and late-career work. One of these articles was published in the year of his death (1938).

Nobel prize nominations

Abel's hormonal research was a key argument in the letter of nomination for the Nobel Prize in chemistry by Charles D. Walcott on November 19, 1925. Walcott added a statement by Dr. Reid Hunt, Department of Pharmacology, Harvard Medical School, to strengthen his line of reasoning:

> "... he first demonstrated the basic nature of the active principle of the adrenal gland and prepared a benzoyl derivative of the active principle; this constituted the first isolation of the active principle in pure form. As regards his recent work on the pituitary, he has shown that the various physiological actions are due to a single substance and not to a number as other workers had believed." (Nobel Committee for Chemistry 1926)

Another milestone in Abel's research was pointed out in the same proposal:

> "... His work with Rowntree on the Chemotherapy of Organic Antimony compounds is the most important which has been done since the original work with tartar emetic*." (Nobel Committee for Chemistry 1926)

*Tartar emetic: Antimony potassium tartrate; used in schistosomiasis and leishmaniasis because of its emetic action.

Even if the "artificial kidney" caused a lot of media attention, Abel was nominated exclusively for his other achievements for the Nobel Prize in chemistry, as it can also be seen from Georg Hale's nomination on November 24, 1926:

> "... In my judgment, his discovery of the chemical nature of insulin and its separation in the crystalline form would amply justify the award to him ... When his previous work is also taken into account, his position as a leading professor in physiological chemistry becomes apparent..." (Nobel Committee for Chemistry 1927)

In another nomination by Charles D. Walcott on December 17, 1926, Walcott listed the arguments in his previous nominations again. He focused on research on the adrenal gland, pituitary and work on chemotherapy, expanding his arguments with a new argument:

> "..... He also discovered methods by which more selective preparations can be secured than had been obtained previously…." (Nobel Committee for Chemistry 1927)

This time, Walcott attached a list of "the titles of Doctor Abel's papers."

Another nomination by James F. Norris, the former President of the American Chemical Society (1925–1926) and then acting Vice President of the International Union of

Table 3 Ten of Abel's most cited key papers*

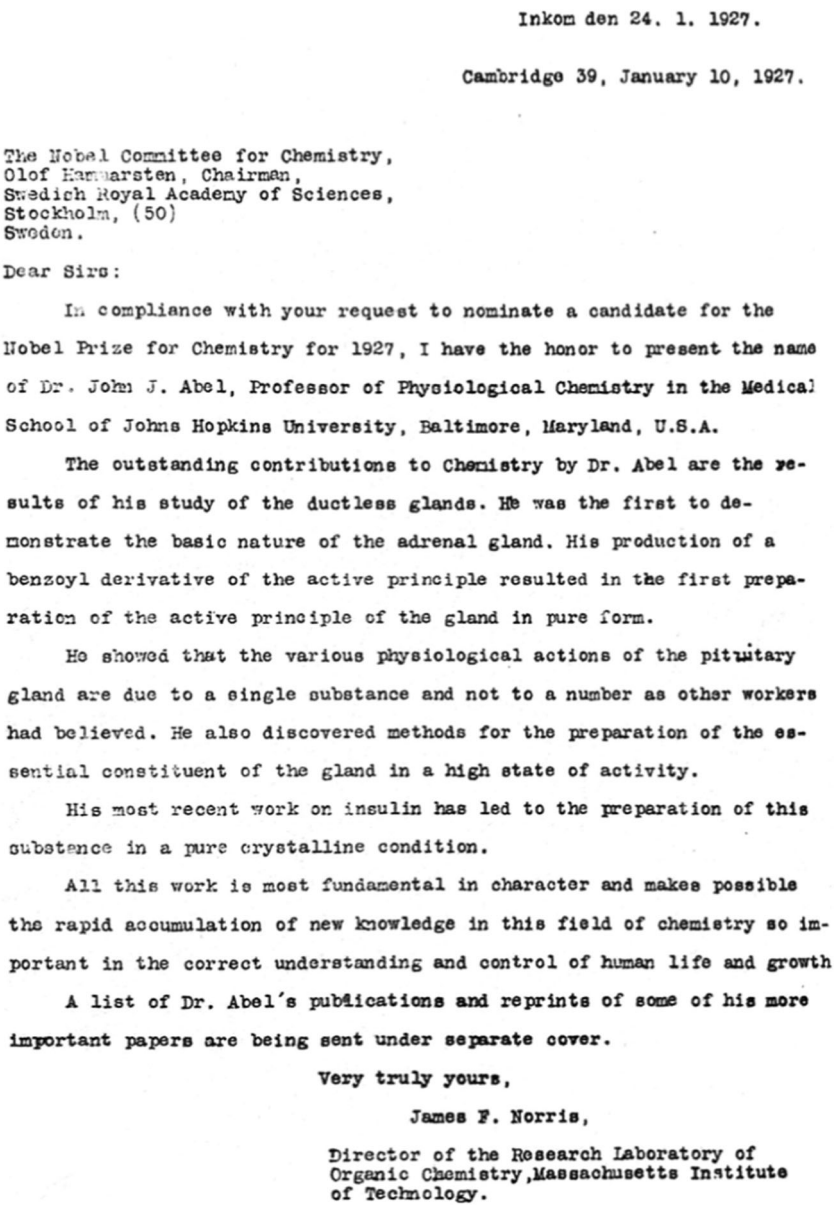
	Year	Number of citations	Author	Name publication	Name journal	Position in journal
1	1914	257	Abel, JJ; Rowntree, LG; Turner, BB	On the removal of diffusible substances from the circulating blood of living animals by dialysis	Journal of Pharmacology and Experimental Therapeutics	Volume: 5, Issue: 3, Pages: 275–316
2	1914	166	Abel, JJ.; Rowntree, LG; Turner, BB	Plasma removal with return of corpuscles	Journal of Pharmacology and Experimental Therapeutics	Volume: 5, Issue: 6, Pages: 625–641
3	1926	138	Abel, JJ	Crystalline insulin	Proceedings of the National Academy of Sciences of the United States of America	Volume: 12, Pages: 132–136
4	1909	107	Abel, JJ; Rowntree, LG	On the pharmacological action of some phthaleins and their derivatives, with especial reference to their behavior as purgatives I	Journal of Pharmacology and Experimental Therapeutics	Volume: 1, Issue: 2, Pages: 231–264
5	1919	98	Abel, JJ; Kubota, S	On the presence of histamine (beta-iminazolylethylamine) in the hypophysis cerebri and other tissues of the body and its occurrence among the hydrolytic decomposition products of proteins	Journal of Pharmacology and Experimental Therapeutics	Volume: 13, Issue: 3, Pages: 243–300
6	1927	76	Abel, JJ; Geiling, EMK; Rouiller, CA; et al.	Crystalline insulin	Journal of Pharmacology and Experimental Therapeutics	Volume: 31, Issue: 1, Pages: 65–85
7	1935	59	Abel, JJ; Evans, EA; Hampil, B; et al.	Researches on tetanus II. The toxin of the bacillus tetani is not transported to the central nervous system by any component of the peripheral nerve trunks	Bulletin of the Johns Hopkins Hospital	Volume: 56, Pages: 84–114
8	1938	52	Abel, JJ; Firor, WM; Chalian, W	Researches on tetanus IX. Further evidence to show that tetanus toxin is not carried to central neurons by way of the axis cylinders of motor nerves	Bulletin of the Johns Hopkins Hospital	Volume: 63, Issue: 6, Pages: 373–403
9	1935	50	Abel, JJ; Hampil, B; Jonas, AF	Researches on tetanus III. Further experiments to prove that tetanus toxin is not carried in peripheral nerves to the central nervous system	Bulletin of the Johns Hopkins Hospital	Volume: 56, Pages: 317–33
10	1935	48	Abel, JJ; Hampil, B	Researches on tetanus IV. Some historical notes on tetanus and commentaries thereon	Bulletin of the Johns Hopkins Hospital	Volume: 57, Issue: 1, Pages: 343–372

*The list is obtained by the access to Web of Science on September 29, 2020

Pure and Applied Chemistry (1925–1928) can also be found in the Nobel Prize Archives (Fig. 2). Norris took up the same arguments from Walcott's nomination from the 1927 yearbook. He ended with the summarizing statement:

> *"... All this work is most fundamental in character and makes possible the rapid accumulation of new knowledge in the field of chemistry so important in the correct understanding and control of human life and growth..."* (Nobel Committee for Chemistry 1927)

As stated in Alfred Nobel's last will, the Nobel Prizes shall be awarded for work "of the greatest benefit to mankind." The Nobel committee has clarified that a candidate—at least in physiology or medicine—is not supposed to be awarded for a lifetime achievement, but for a single important discovery: "prizes are thus given for specific scientific achievements rather than for general merit in medical research" (Liljestrand 1962). Thus, nominators that proposed Abel for activities, as 'science manager' and underlined that he had established scientific societies and journals were counterproductive.



Inkom den 24. 1. 1927.

Cambridge 39, January 10, 1927.

The Nobel Committee for Chemistry,
Olof Hammarsten, Chairman,
Swedish Royal Academy of Sciences,
Stockholm, (50)
Swoden.

Dear Sirs:

In compliance with your request to nominate a candidate for the Nobel Prize for Chemistry for 1927, I have the honor to present the name of Dr. John J. Abel, Professor of Physiological Chemistry in the Medical School of Johns Hopkins University, Baltimore, Maryland, U.S.A.

The outstanding contributions to Chemistry by Dr. Abel are the results of his study of the ductless glands. He was the first to demonstrate the basic nature of the adrenal gland. His production of a benzoyl derivative of the active principle resulted in the first preparation of the active principle of the gland in pure form.

He showed that the various physiological actions of the pituitary gland are due to a single substance and not to a number as other workers had believed. He also discovered methods for the preparation of the essential constituent of the gland in a high state of activity.

His most recent work on insulin has led to the preparation of this substance in a pure crystalline condition.

All this work is most fundamental in character and makes possible the rapid accumulation of new knowledge in this field of chemistry so important in the correct understanding and control of human life and growth

A list of Dr. Abel's publications and reprints of some of his more important papers are being sent under separate cover.

Very truly yours,

James F. Norris,

Director of the Research Laboratory of Organic Chemistry, Massachusetts Institute of Technology.

Fig. 2 Nobel Prize nomination for JJ Abel by James F Norris in 1927. (Credit: Royal Academy of Sciences, Stockholm)

Verdict by the Nobel committee

Abel's nomination in 1926 gave rise to an in-depth analysis by Nobel Prize committee member, the Swedish professor of chemistry and pharmaceutics, Einar Hammarsten (1889–1968), who worked at the Karolinska Institute from 1928 to 1957. This kind of special investigation was made for potentially prizeworthy achievements. Of particular interest to Hammarsten was Abel's work on hormones in the adrenal glands and in the pituitary gland. Regarding adrenalin, or epinephrine as Abel called it, the first hormone that was produced in pure form, Hammarsten was not enthusiastic. He wrote that Abel's research was quite old ("conducted more than twenty years ago"), and that Abel was not the first to isolate adrenalin, but the Japanese chemist Jokichi Takamine (1854–1922) and Thomas Aldrich (1861–1938) in 1901. Furthermore, Hammarsten continued, Friedrich Stolz (1860–1936) and Ernst Joseph Friedmann (1877–1957) had from 1904 to 1906 also made significant discoveries with regard to the constitution and synthesis of adrenalin. Therefore, Hammarsten did not view Abel's work as truly pioneering, and he reached the same conclusion regarding his research on hormones in the pituitary gland. Hammarsten's verdict: "The result of my review of Abel's research on hormones is that it is not of the greatest importance and it has not been carried out on an outstanding scientific level, so that I cannot recommend Abel for a Nobel Prize in chemistry." Instead, the Nobel committee agreed on the Austrian scholar Richard Adolf Zsigmondy (1865–1929) "for his demonstration of the heterogeneous nature of colloid solutions and for the methods he

Table 4 Evaluated pharmacologists by the Nobel committee for physiology or medicine between 1901 and 1949 and reasons for nomination of candidates on shortlist

Year	Pharmacologist	Name of nominator	Reason for nomination	Nobel Prize laureate (links to pharmacology)
1902	Ernest Overton (1865–1933)	Justus Gaule (1849–1939)	Work on osmosis in plant and animal cells, and on anesthesia.	
1906	Ernest Overton (1865–1933)	Justus Gaule (1849–1939)	Work on the osmosis in muscles and nerves.	
1922	Edward Calvin Kendall (1886–1972)	Kendall: Richard Zeynek (1869–1845)	Kendall: The purification of thyroxine and description of its structure.	
	Rudolf Magnus (1873–1927)	Magnus: Ernst Laqueur (1880–1947)	Magnus: Work on the nervous system and in the area of the mechanics of the intestines.	
1927	Rudolf Magnus (1873–1927)	Magnus:	Magnus:	
	Otto Loewi (1873–1961)	Sir Archibald V Hill (1886–1977)	Studies of posture and its dependence on the labyrinths and proprioceptive pathways from muscles and joints.	
		Alfred Denker (1863–1941)		
		John James Macleod (1876–1935)		
		Martin Kochmann (1878–1936)	Work on posture, especially as described in his work "Die Körperstellung" (J. Springer, Berlin, 1924).	
		Phillipp Stöhr (1891–1979)		
		Adolf Jarisch (1891–1965)		
		Hugo Winternitz (1868–1934)	Work on posture, muscle tonus and tonic reflexes.	
		Loewi:		
		Ernst Willhelm von Brücke (1880–1941)	Work on posture, muscle tonus and tonic reflexes.	
		Adolf Jarisch (1891–1965)	Work on posture, muscle tonus and tonic reflexes.	
			Studies of posture and its dependence on the labyrinths and proprioceptive pathways from muscles and joints.	
			Work on posture, muscle tonus and tonic reflexes.	
			Loewi:	
			Discovery of an hormonal system controlling action of the heart.	
			Chemical transmission of nerve impulses in the heart.	
1934	Corneille Jean François Heymans (1892–1968)	Arnold During (1872–1961)	Work on the regulation of respiration and blood circulation.	
		Paul John Hanzlik (1885–1951)		
			Demonstration that the reflexes from the trunk and head are physiologically important in the control of respiration and circulation; and the importance of these reflexes in pharmacological reactions.	
1936	Otto Loewi (1873–1961)	Loewi:	Loewi:	Loewi, Dale: For their discoveries relating to chemical transmission of nerve impulses.
	Sir Henry Hallett Dale (1875–1968)*,	Robert John Steward McDowall (1892–1990)	Work on humoral transmission of nervous impulses to tissues.	
	Corneille Jean François Heymans (1892–1968)	Ernst Willhelm von Brücke (1880–1941)	Work on the humoral transmission of nervous impulses.	
		Emil Starkenstein (1884–1942)	Work on humoral transmission of nervous impulses to tissues.	
		Hans Horst Meyer (1853–1939)	Work on the humoral transmission of nervous impulses.	
		Sir Henry Hallett Dale (1875–1968)	Work on the humoral transmission of nervous impulses.	
		George Barger (1878–1939)		
		Adolf Jarisch (1891–1965)	The discovery of the humoral transmission to the heart from the vagus nerve.	
		Gunnar Ahlgren (1898–1962)		
		Sven Ingvar (1889–1947)	Work on humoral transmission of nervous impulses to tissues.	
		Heymans:		
		B T Krishnan	Work on the humoral transmission of nervous impulses,	
			Work on the humoral transmission of nervous impulses.	
			Heymans:	
			Work on the influence of sinus caroticus on the rate of the heartbeat, and on blood pressure and respiration.	
1939	Gerhard Domagk (1895–1964)	Domagk:	Domagk:	

Table 4 (continued)

Year	Pharmacologist	Name of nominator	Reason for nomination	Nobel Prize laureate (links to pharmacology)
	Sir Edward Mellanby (1884–1955) Alfred Newton Richards (1876–1966)	Arthur Duncan Gardner (1884–1977) Mellanby: Stevenson Lyle Cummins (1873–1949) Sir Frederick G Hopkins (1861–1947) Sir Charles S Sherrington (1857–1952) Joshua Harold Burn (1892–1981) Richards: Donald D van Slyke (1883–1971) Sir Archibald V Hill (1886–1977)	Discovery of the antibacterial effects of Prontosil. Mellanby: Work on dietary deficiencies, rickets and the nervous conditions produced by lack of vitamin A. Rickets and the nervous conditions produced by lack of vitamin A. Rickets and the nervous conditions produced by lack of vitamin A. Rickets and the nervous conditions produced by lack of vitamin A. Richards: Work on the physiology of the kidneys (mechanism of renal secretion). Work on the physiology of the kidneys.	Domagk: For the discovery of the antibacterial effects of prontosil.
1940	Alfred Newton Richards (1876–1966)	Paul Govaerts (1889–1960)	Physiology of the kidney.	
1941	Edward Calvin Kendall (1886–1972)	Norman M Keith (1885–1976) Willis S. Lemon (1878–1954) Frank C Mann (1887–1962) George B Eusterman (1882–1966)	Work on the chemical composition and physiologic action of the hormones of the adrenal cortex Work on the chemical composition and physiologic action of the hormones of the adrenal cortex. Work on the chemical composition and physiologic action of the hormones of the adrenal cortex. Work on the chemical composition and physiologic action of the hormones of the adrenal cortex.	
1945	Alfred Newton Richards (1876–1966)	W N Bradley Alexander Randall (1883–1951) Carl F Schmidt (1893–1988) Edward B. Kumbhaar (1882–1966) Walter G Elmer (1872–1960) Henry C Bazett (1885–1950) Isaac Starr (1895–1989)	Assisting materially in the development of the production of penicillin. Work on the physiology of the kidneys. Assisting materially in the development of the production of penicillin. Richards was also nominated (in the same letter) for his work in spreading the use of pennicillin. Work on the physiology of the kidneys. Work on the physiology of the kidneys. Work on the physiology of the kidneys. Work on the physiology of the kidneys. Richards was also nominated (in the same letter) for his work in spreading the use of penicillin.	
1949	Edward Joseph Conway (1894–1968) Walter Kikuth (1896–1968) Hans Mauß (1901–1953) Fritz Mietzsch (1896–1958)	Joseph F Donagan (1893–1972) Kikuth: Otto Krayer (1899–1982) Mauß: Otto Krayer (1899–1982) Mietzsch: Otto Krayer (1899–1982)	Work on the permeability of the cell wall for ions, and ionic equilibrium. Kikuth: Discovery of Atabrin (quinocrin hydrochloride), an antimalarial agent. Mauß: Discovery of Atabrin (quinocrin hydrochloride), an antimalarial agent. Mietzsch: Discovery of Atabrin (quinocrin hydrochloride), an antimalarial agent.	

*Laureate who worked on the same topic as the pharmacologists but were not pharmacologists by profession

used, which have since become fundamental in modern colloid chemistry."

Although he never received the Nobel Prize, he got several other medals and awards, such as the Gold Medal (Society of Apothecaries) London in 1928, the Conné Medal, New York Chemists' Club in 1932, and the Kober Medal in 1934 (MacNider 1946).

As mentioned above, Abel was far from the only pharmacologist who was evaluated by the Nobel committee. Table 4 shows the pharmacologists that were shortlisted in 1901–1949. The relatively high number of pharmacologists listed shows the importance pharmacology had in the context of the Nobel Prize.

In order to be able to deduce which research topics that were of particular importance, we listed the reasons for nomination in the year of the shortlist (Table 4). The double nominees were proposed between 1925 and 1939.

Discussion: Culture of remembrance

Abel is remembered for acting as a hub in the international scientific community in the field of pharmacology even after his retirement: On the day of his death, he was elected member of the Royal Society (George 1998). Several scholars payed tribute to Abel and his works, for instance with the presentation of a biographical memoir at the annual meeting of the National Academy of Sciences of the USA in 1946 (MacNider 1946) or in a celebration in 1957 due to the centennial of the Society of Pharmacology and Experimental Therapeutics. This took place in the form of an exhibition containing Abel letters, notebooks, and various articles. At this exhibition laboratory notes about the first isolation of epinephrine from its benzoyl derivate, the chemical isolation of crystalline insulin and recordings of his "artificial kidney" were made available to the public, and pictures of his laboratory colleagues were shown (Marshall 1958). In the same year, an article was published in JAMA summarizing Abel's life and oeuvre, ending with "Dr. Abel's contributions to the development of basic medical science in America were truly outstanding, and his influence on contemporary workers was lasting and profound. Practicing physicians may well join with their academic colleagues in paying homage to this great scientist and teacher." (NN 1957).

In 2008, a game called "What is your Abel number" was played at the celebration of ASPET's centennial (Parascandola 2007). Here, ASPET members tried to be as closely related to John Jacob Abel as possible in a ranking of numbers from 1 to 6. Furthermore, the John Jacob Abel Award (first awarded in 1947) is annually given to scientists who have been recognized for excellence in pharmacology.

This paper shows that Abel was the first scholar nominated for the two Nobel Prize categories chemistry and physiology or medicine. He is an ideal example to illustrate the close ties of pharmacology between two categories in a Nobel Prize setting. In the end, he was not deemed prize-worthy in either category. He embodied another kind of scientific excellence, attributed to him in different contexts, ranging from eponymous discoveries like the description of the principle of the adrenal gland, his work on pituitary hormones, and on insulin, his more than 30-year career as full professor at prestigious universities, and founder of journals like the Journal of Experimental Medicine, the Journal of Biological Chemistry, and the Journal of Pharmacology and Experimental Therapeutics.

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Author contribution MP and NH collected the archival material. NH and MP conceived and designed research. MP and NH wrote the article. Both authors approved the manuscript. The authors declare that all data were generated in-house and that no paper mill was used.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Giacomo Padrini / Michael Wiling / Marie Drobietz

Die deutsche Nobelpreisgeschichte 1901–1953: Kandidaten, Universitäten, Forschungstrends

Abstract
Bislang haben sich nur wenige Veröffentlichungen ausführlich mit der Geschichte des Nobelpreises in Deutschland befasst. Dieser Beitrag analysiert die in der digitalen *Nobel database* verzeichneten Nominierungen für die Kategorie „Physiologie oder Medizin" von 1901 bis 1953 in Deutschland. Da Wissenschaftler während ihrer Karriere häufig an unterschiedlichen Einrichtungen tätig waren, werden für diesen Beitrag alle Kandidaten als „deutsch" angesehen, die zum Zeitpunkt ihrer Nominierung in Deutschland wirkten.
Zunächst stellt dieser Artikel die meistnominierten Forscher, beliebte Forschungsthemen sowie Universitäten vor, deren Mitarbeiter besonders häufig für den Nobelpreis vorgeschlagen wurden. Als Nobel „hotspots" stechen im betrachteten Zeitraum besonders Berlin, Frankfurt (Main) und Freiburg (Breisgau) hervor. Am häufigsten nominiert wurden die Nobelpreisträger Paul Ehrlich (1854–1915) und Robert Koch (1843—1910), sowie die „close calls" Max Rubner (1854–1932) und Ferdinand Sauerbruch (1875–1951). Auf diesem Überblick folgt eine genauere Analyse der Netzwerke und Dynamiken um Nobelpreiskandidaten und Nominatoren in der Pharmakologie und kardiovaskulären Forschung. In beiden Disziplinen ging die Anzahl deutscher Kandidaten seit den 1930er-Jahren zurück, statt Deutschland nehmen die USA seitdem eine führende Rolle im Nobelpreiskontext ein.

So far, only few publications have dealt extensively with the history of the Nobel Prize in Germany. This paper analyses the nominations for the Nobel Prize in physiology or medicine in the digital *Nobel database*, focusing on the German nominees from 1901 to 1953. Since scholars often conducted research in several cities and countries during their „Wanderjahre", we considered all researchers, who were working in Germany at the time of their nomination.
First, the article provides an overview of scholars, research trends and universities during the examined time period. In terms of nominations, Berlin, Frankfurt (Main), and Freiburg (Breisgau) were Nobel „hotspots" during the first half of the 20th Century, and as the most often nominated scholars we pinpointed the subsequent laureates Paul Ehrlich and Robert Koch, as well as „close calls" like Max Rubner and Ferdinand Sauerbruch. Second, it takes a closer look at nomination networks and dynamics of Nobel Prize nominees and laureates within two fields, cardiovascular and pharmacological research. In both disciplines, the

number of German scholars nominees declined during the 1930's and the still ongoing phase of US dominance in a Nobel Prize context was introduced.

Keywords
Nobelpreis, Medizin, Charité, Pharmakologie, Kardiologie
Nobel Prize, medicine, Charité, pharmacology, cardiology

Obwohl der Nobelpreis von Beginn an explizit als internationaler Preis ausgelegt war, ist ein zunehmender Patriotismus zu beobachten, welcher durch die jährliche mediale Aufmerksamkeit befeuert wird.[1] So schmücken sich Forschungsstätten gerne mit den Namen „ihrer" Preisträger, und Zeitungen hoffen, dass endlich wieder ein Forscher ihrer Stadt geehrt wird.[2]

Auch in der Wissenschaft zeigt sich das große Interesse am Nobelpreis. Während zahlreiche Studien zu einzelnen Kandidaten und Laureaten sowie zur Geschichte der Nobelpreise innerhalb eines Fachgebiets existieren, liegt ein systematischer Überblick der deutschen Nobelpreisgeschichte bisher nicht vor. Dieser Beitrag, auf aktuellen Dissertationsprojekten zur Geschichte des Nobelpreises für Physiologie oder Medizin aufbauend, beleuchtet die deutschen PreisträgerInnen, KandidatInnen, „Nobel-Hotspots" sowie Forschungstrends in der ersten Hälfte des 20. Jahrhunderts.[3] Da Wissenschaftler zu dieser Zeit oft in mehreren Städten und Ländern forschten, werden dabei all jene Wissenschaftler betrachtet, die zum Zeitpunkt ihrer Nominierung in Deutschland tätig waren. Wer wurde wann, wo und von wem für den Nobelpreis nominiert? Nach einem statistischen Überblick nehmen wir zwei Themenfelder unter die Lupe: Wie sahen die „Nobelpopulationen" in der Pharmakologie und der kardiovaskulären Forschung aus?

Die KandidatInnen – ein statistischer Überblick

Um netzwerkrelevante Angaben rund um das Nominierungsverfahren zu rekonstruieren, ist die umfassende digitale Nominierungsdatenbank der Nobelstiftung eine zentrale Quelle.[4] Wir haben die in der *Nobel database* verzeichneten

1 Vgl. Ayelet Baram-Tsabari/Elad Segev, Global and local "teachable moments": The role of Nobel Prize and national pride, in: *Public Understanding of Science* 27 (2018) 4, 471–484.
2 Vgl. Torsten Harmsen, Wann wird endlich mal wieder ein Forscher aus Berlin geehrt? (4. 10. 2020), Berliner Zeitung, URL: https://www.berliner-zeitung.de/politik-gesellschaft/nobelpreise-wann-geht-endlich-wieder-mal-ein-preis-nach-berlin-li.107662 (abgerufen am 27. 3. 2021).
3 Für eine ausführliche Beschreibung zum Nominierungs- und Auswahlprozedere weisen wir auf den Beitrag von Ragnar Björk in diesem Band hin.
4 Vgl. N.N., NobelPrize.org, Nobel Media AB 2020, URL: https://www.nobelprize.org/nomination/archive/ (abgerufen am 7. 12. 2020).

Nominierungen für KandidatInnen von 1901 bis 1953 in Deutschland extrahiert. In diesem Zeitraum sind 207 ForscherInnen (darunter nur eine Frau, Cécile Vogt (1875–1962))[5] vorgeschlagen worden, für die insgesamt 1.205 Nominierungen eingereicht wurden. Dabei erhielten in der Preiskategorie Physiologie oder Medizin 24 Wissenschaftler (12 % aller KandidatInnen) mehr als zehn Nominierungen. Möglicherweise wurden sie so oft vorgeschlagen, weil sie den Preis nicht erhielten und viele Nominatoren weiterhin von der Preiswürdigkeit ihrer Arbeiten überzeugt waren. Die Zahl übermittelter Nominierungen erreichte zwischen 1906 und 1910 ihren Höhepunkt, während in den 1930er- und 1940er-Jahren, auch aufgrund des Nobelpreisverbots Hitlers (siehe unten), nur vereinzelt Kandidaten aus Deutschland nominiert wurden.

Tabelle 1: Zum Zeitpunkt ihrer Nominierung in Deutschland tätige Wissenschaftler, die laut der *Nobel database* die meisten Nominierungen in der Kategorie „Physiologie oder Medizin" erhielten.

Platz	Nominierungen	Kandidat	Begründung
1	75	Paul Ehrlich	Immunologie
2	60	Robert Koch	Bakteriologie, Immunologie
3	54	Max Rubner	Energetik, Metabolismus
3	54	Ferdinand Sauerbruch	Chirurgie, Prothetik
5	48	Otto Warburg	Zellatmung, Tumorzellen
6	48	Emil Abderhalden	(Abwehr)-Fermente, Immunologie
7	45	August von Wassermann	Syphilis (Wassermannreaktion)

Während eine kleine Gruppe von Wissenschaftlern mehrere Nominierungen erhielt, reichten nur wenige Forscher eine große Zahl an Vorschlägen ein: Lediglich neun Wissenschaftler schickten mehr als fünf Nominierungsbriefe nach Stockholm. Dabei ist davon auszugehen, dass Absprachen zwischen Nominatoren stattgefunden haben.[6] So kam es vor, dass mehrere Wissenschaftler einer Universität in einem Jahr denselben Kandidaten mit jeweils identischer Begründung benannten (meist gehörten die Nominatoren verschiedenen Instituten einer Universität an). Mitunter erhielten Kandidaten durch dieses Vorgehen eine große Anzahl an Nominierungen, ohne dass sie von Wissenschaftlern unterschiedlicher Universitäten oder Länder vorgeschlagen wurden. Auf diese Weise erhielt der Kieler Meeresbiologe Victor Hensen (1835–1924) insgesamt 16 Nominierungen. Acht Wissenschaftler nominierten ihn 1906, sieben davon waren

5 Vgl. Nils Hansson/Heiner Fangerau, Female physicians nominated for the Nobel Prize, in: *Lancet* (2018), Mar 7.

6 Vgl. Nils Hansson/Udo Schagen, „In Stockholm hatte man offenbar irgendwelche Gegenbewegung" – Ferdinand Sauerbruch (1875–1951) und der Nobelpreis, in: *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 22 (2014) 3, 133–161.

Kieler Kollegen, die Begründung in den Nominierungsbriefen war jeweils sehr ähnlich. Sieben weitere Nominierungen erhielt er 1912, alle ebenfalls aus Fakultäten der Universität Kiel.

Tabelle 2: Die „fleißigsten" Nobelpreisnominatoren für den Nobelpreis für Physiologie oder Medizin aus Deutschland 1901–1953

Platz	Nominierungen	Nominator
1	10	Albrecht Bethe
2	9	Vincenz Czerny
2	9	Georg Lockemann
4	8	Ludwig Aschoff

Zentren und Peripherien: Wo wirkten die Nobelpreiskandidaten in Deutschland?

Ungefähr die Hälfte aller Nominierungen (49 %) im Zeitraum 1901–1953 galt Forschern in Berlin, Frankfurt (Main) und Freiburg (Breisgau). Ein wichtiges Zentrum medizinischer Wissenschaft stellte Berlin mit seinen zahlreichen renommierten Forschungsstätten, wie dem Robert-Koch-Institut, dar. 1891 als Preußisches Institut für Infektionskrankheiten für die Forschungen Robert Kochs (1843—1910) gegründet, wurde das heutige Robert-Koch-Institut schnell zu einem führenden Forschungszentrum.[7] Neben Koch wurden sechs weitere Wissenschaftler während ihrer Tätigkeit an dieser Institution für den Nobelpreis vorgeschlagen, darunter August von Wassermann (1866—1925) und Friedrich Loeffler (1852—1915). Auch die Preisträger Paul Ehrlich (1854–1915) und Emil von Behring (1854–1917) waren an Kochs Institut tätig, bevor sie für den Nobelpreis nominiert wurden. Kern der klinischen und insbesondere chirurgischen Arbeit war das Umfeld der Charité, zu dem auch weitere Kliniken gehörten, die stets eng mit der Charité verbunden waren und später in diese integriert wurden. Eine dieser Kliniken war die Königliche Chirurgische Universitätsklinik in der Ziegelstraße, an der August Bier (1861–1949) wirkte. An der Charité selbst war Ferdinand Sauerbruch (1875–1951) tätig.[8] Auch Mitarbeiter des Rudolf-Virchow-Krankenhauses, des heutigen Max-Planck-Instituts, sowie der Landwirtschaftlichen Hochschule Berlin wurden für den Nobelpreis nominiert. Insgesamt

7 Vgl. Christoph Gradmann, *Krankheit im Labor Robert Koch und die medizinische Bakteriologie*, Göttingen: Wallstein Verlag 2005.

8 Vgl. Hansson/Schagen, In Stockholm hatte man offenbar irgendwelche Gegenbewegung, 133–161.

erhielten Forscher der Berliner Institute und Kliniken von 1901 bis 1953 so 403 Nominierungen.

In Frankfurt (Main) waren mehrere Nobelkandidaten am Königlichen Institut für Experimentelle Therapie angesiedelt. Hervorzuheben ist unter diesen Paul Ehrlich, der für seine Forschungen, insbesondere zu Themen der Immunologie und Serumtherapie, mehr als 70 Mal nominiert wurde (siehe Tab. 1).[9]

Tabelle 3: Städte, in denen der Nobel database zufolge die meisten Kandidaten tätig waren.

Platz	Anzahl Nominierungen	Stadt
1	403	Berlin
2	103	Frankfurt (Main)
3	83	Freiburg (Breisgau)
4	77	Halle (Saale)
4	77	Breslau (PL)
6	72	München
7	53	Bonn

Die Nominierungen für deutsche Kandidaten wurden dabei primär von deutschen Nominatoren eingereicht. Mehr als die Hälfte (68 %) aller im betrachteten Zeitraum für in Deutschland wirkende ForscherInnen eingereichte Nominierungen stammten aus Deutschland, 77,8 % aus Deutschland, Österreich oder der Schweiz. Dabei sind in dieser Übersicht die Nominierungen stets den Staaten zugeordnet, zu dessen Hoheitsgebiet die Wirkungsstätte der Nominatoren zum Zeitpunkt der Nominierung gehörte (so werden etwa Nominierungen aus Breslau bis 1945 als „deutsch" gewertet). Außereuropäische Nominierungsschreiben kamen nur vereinzelt vor, etwa von argentinischen, chinesischen, ägyptischen und japanischen Wissenschaftlern. Diese Nominierungen sind in der Regel auf persönliche Beziehungen der Nominierten zu den ausländischen Universitäten oder Nominatoren zurückzuführen. So wurde Ferdinand Sauerbruch 1926 von seinem in Fukuoka tätigen Schüler Haryari Miyake (1866–1945) nominiert.[10] Erich Hoffmann (1868–1959), 1936 nominiert von Shini-ichi Matsumo (1884–1984) aus Kyoto, war Mitbegründer des Deutsch-japanischen Forschungsinstituts Kyoto-Bonn. Von 1938 bis 1949 wurden keine Vorschläge von in Deutschland lebenden Nominatoren eingereicht. Die seit der Auszeichnung des KZ-

9 Vgl. Axel Hüntelmann, Paul Ehrlich und der Nobelpreis. Die Konstruktion wissenschaftlicher Exzellenz, in: *Berichte zur Wissenschaftsgeschichte* 41 (2018) 1, 47–72.

10 Vgl. Nils Hansson/Udo Schagen, The limit of a strong Lobby: Why did August Bier and Ferdinand Sauerbruch never receive the Nobel Prize?, in: *International Journal of Surgery,* (2014) 12, 9.

Inhaftierten Carl von Ossietzky (1889–1938)[11] deutliche Ablehnung des Nobelpreises seitens der NS-Führung zeigte so seine Wirkung.

Tabelle 4: Nach Staaten sortierte Herkunft der Nominierungen für in Deutschland tätigen Wissenschaftler (Nobelpreis für Physiologie oder Medizin) 1901–1953.

Platz	Anzahl Nominierungen	Staat
1	817	Deutschland
2	71	Österreich
3	50	Schweiz
4	38	Schweden
5	33	USA

Beliebte Themen im Zeitverlauf

Das Gros der Nominierungen führte Arbeiten im klinischen Bereich (z. B. Chirurgie, Serumdiagnostik) als Motivation an, während Laureaten meist für Entdeckungen in der Grundlagenforschung oder für Werke, die sowohl Grundlagenforschung als auch die praktische Anwendung der Erkenntnisse umfassen, ausgezeichnet wurden. So erhielt Emil von Behring den ersten Nobelpreis 1901

> „for his work on serumtherapy, especially its application against diphtheria, by which he has opened a new road in the domain of medical science and thereby placed in the hands of the physician a victorious weapon against illness and deaths“[12].

Einige Nominatoren gaben das „Lebenswerk“ eines Forschers oder die generelle Arbeit auf einem Themengebiet als Begründung an, ohne eine spezifische Entdeckung als alleinigen Nominierungsgrund zu benennen. Ein Beispiel dafür ist der schweizerisch-deutsche Anatom Albrecht von Kölliker[13] (1817–1905), nominiert 1901 und 1905. All das schmälerte im Hinblick auf die Kriterien, die in

11 Vgl. Birgitta Almgren, Der Nobelpreis – ehrenvolle wissenschaftliche Auszeichnung oder unfreundlicher Akt? Wissenschaft zwischen Integrität und Anpassung, in: Nils Hansson/Thorsten Halling (Hg.), *It's Dynamite – Der Nobelpreis im Wandel der Zeit,* Göttingen: Cuvillier 2017, 27–38. – Sven Widmalm, Hitler's Boycott: Cultural Politics and the Rhetoric of Neutrality, in: Nils Hansson/Thorsten Halling/Heiner Fangerau (Hg.), *Attributing Excellence in Medicine: The History of the Nobel Prize*, Brill 2019, 59–77.

12 Ulrike Enke, „Der erste zu sein.“ – Über den ersten Medizinnobelpreis für Emil von Behring im Jahr 1901, in: *Berichte zur Wissenschaftsgeschichte* 41 (2018) 1, 19–46.

13 Vgl. Pedro Mestres-Ventura, Albert von Kölliker, Santiago Ramón y Cajal and Camillo Golgi, the main protagonists in the Neuron Theory debate, in: *European Journal of Anatomy* 23 (2019) 1, 9—18.

Alfred Nobels Testament festgelegt wurden[14], die Preischancen. Einige Wissenschaftler schlugen sich sogar selbst vor, wie Vincenz Czerny (1842–1916) 1907, Paul Grawitz (1850–1935) 1928 und Heinrich Wieland (1877–1957) 1928.

Eine Betrachtung der in den Nominierungsbriefen aufgezählten Arbeiten der Kandidaten lässt aus mehreren Gründen nicht immer einen direkten Schluss auf zum Zeitpunkt der Nominierung beliebte Forschungsfragen zu. So waren einige Wissenschaftler zum Zeitpunkt ihrer Nominierung bereits emeritiert und am Ende ihrer wissenschaftlichen Laufbahn angelangt. Die für preiswürdig befundenen Arbeiten hatten sie viele Jahre zuvor angefertigt. Außerdem ist die in der *Nobel database* angegebene Begründung häufig zu ungenau, um festzustellen, auf welche Aspekte des Werks eines nominierten Wissenschaftlers seitens des Nominators Bezug genommen wird. So beschäftigte sich Max Rubner (1854–1932) über Jahrzehnte hinweg mit der Ernährungsphysiologie[15], die in der *Nobel database* in vielen seiner Nominierungen führende Motivation „Nutrition" zeigt jedoch nicht genauer auf, auf welche seiner Entdeckungen und Schriften sich der jeweilige Nominator berief. Trotz dieser Einschränkungen konnten mit Hilfe der *Nobel database* einige Themenfelder und konkrete Arbeiten identifiziert werden, die von den Nominatoren besonders oft als Begründung genannt wurden. Mehrfach vorgeschlagen wurden bis in die frühen 1930er-Jahre, insbesondere aber in den ersten zehn Jahren des untersuchten Zeitraums, Arbeiten zu Infektionskrankheiten, Bakteriologie und Immunologie. Während zunächst Arbeiten zu Cholera, Tuberkulose, Diphterie und zu allgemeiner Bakteriologie in den Nominierungen am häufigsten vertreten sind, wurden ab ca. 1906 insbesondere Arbeiten mit Bezug zu Geschlechtskrankheiten (hauptsächlich Syphilis) als Begründung angeführt. Die große Bedeutung, die Arbeiten auf diesen Gebieten zugemessen wurde, verdeutlicht die Aktualität infektionsbiologischer und bakteriologischer Fragestellungen zu Anfang des 20. Jahrhunderts und zeigt, dass weite Teile der Wissenschaft rasch von der Validität der Entdeckungen der ersten Bakteriologen wie Robert Koch überzeugt waren.

Über die Jahre häufig als Nominierungsgrund aufgeführt wurden Arbeiten zur Krebs- und Tumorforschung. Während zunächst die chirurgische Entfernung von Tumoren im Vordergrund stand, rückten ca. 1926, aufbauend auf neue, biochemische Erkenntnisse, Nominierungen zum Stoffwechsel von Tumorzellen in den Fokus. Im Nobelkontext nahm hier Otto Warburg (1883–1970), der von nationalen und internationalen Wissenschaftlern nominiert wurde, eine zentrale Rolle ein.

14 Vgl. N.N., NobelPrize.org, Nobel Media AB 2020, URL: https://www.nobelprize.org/alfred-nobel/full-text-of-alfred-nobels-will-2/ (abgerufen am 7. 3. 2021).

15 Vgl. Eberhard Wormer, Rubner, Max, in: *Neue Deutsche Biographie* 22, Berlin: Duncker & Humblot, 2005, 158—159.

Weitere, über einige Jahre hinweg beliebte Themen waren die Forschung an Diabetes, zur Chemie und Physiologie des Muskels sowie zu Hormonen. In einigen Jahren sorgten mehrfache Nominierungen eines Kandidaten dafür, dass ein bestimmtes Forschungsthema zu den häufigsten Themen gehörte, ohne dass mehrere Kandidaten zu diesem nominiert worden wären. Dazu gehören beispielsweise die „Abwehrfermente" des in Deutschland tätigen Schweizers Emil Abderhalden (1877–1950), für die er insgesamt mindestens 48 Mal nominiert wurde.[16]

Laureaten für Physiologie oder Medizin aus Deutschland

Tabelle 5: Deutsche Nobelpreislaureaten in der Kategorie Physiologie oder Medizin 1901–1953

Jahr	Name	Thema	Stadt	Nominierungen
1901	Emil von Behring	„for his work on serum therapy, especially its application against diphtheria, by which he has opened a new road in the domain of medical science and thereby placed in the hands of the physician a victorious weapon against illness and deaths"	Marburg	13
1905	Robert Koch	„or his investigations and discoveries in relation to tuberculosis"	Berlin	60
1908	Paul Ehrlich	„in recognition of their work on immunity"	Frankfurt (Main)	75
1910	Albrecht Kossel	„in recognition of the contributions to our knowledge of cell chemistry made through his work on proteins, including the nucleic substances"	Heidelberg	7
1922	Otto Meyerhof	„For his discovery of the fixed relationship between the consumption of oxygen and the metabolism of lactic acid in the muscle"	Kiel	2
1931	Otto Warburg	„for his discovery of the nature and mode of action of the respiratory enzyme"	Berlin	48
1935	Hans Spemann	„for his discovery of the organizer effect in embryonic development"	Freiburg (Breisgau)	21
1939	Gerhard Domagk	„for the discovery of the antibacterial effects of prontosil"	Elberfeld	8

16 Vgl. Thorsten Halling/Ragnar Björk/Heiner Fangerau/Nils Hansson, Leopoldina: Ein Netzwerk für künftige Nobelpreisträger für Physiologie oder Medizin?, in: *Sudhoffs Archiv* 102 (2018), 211–233.

Bei den deutschen Nobellaureaten[17] von 1901 bis 1953 zeigt sich kein Zusammenhang zur Anzahl an Nominierungen, die für die Wissenschaftler eingereicht wurden. So wurde Otto Meyerhof (1884–1951) trotz nur zwei erhaltener Nominierungen 1922 mit dem Nobelpreis ausgezeichnet. Nach Erhalt eines Nobelpreises wurden die ausgezeichneten Wissenschaftler in den folgenden Jahren seltener, in den meisten Fällen jedoch überhaupt nicht mehr vorgeschlagen. Des Weiteren wurden zwischen 1901 und 1953 vier Wissenschaftler nominiert, die den Nobelpreis in Physiologie oder Medizin nach 1953 erhalten haben: Werner Forßmann (1904–1979), Laureat 1956, Feodor Lynen (1911–1979), Laureat 1964, Karl von Frisch (1886–1982), Laureat 1973, sowie Konrad Lorenz (1903–1989), Laureat 1973.

Bei einigen Kandidaten scheint die Bedeutung ihrer Arbeit anerkannt gewesen zu sein, weniger eindeutig scheint jedoch die Zuordnung zu einer der Kategorien, in welcher der Nobelpreis vergeben wird. Insgesamt sieben im betrachteten Zeitraum für den Nobelpreis in Physiologie oder Medizin vorgeschlagene Wissenschaftler erhielten diesen in einer anderen Nobeldisziplin. Dabei wurden Wilhelm C. Röntgen (1845–1923), Emil Fischer (1852–1919), Eduard Buchner (1860–1917) und Heinrich Wieland (1877–1957) für den Nobelpreis in Physiologie oder Medizin nominiert, nachdem sie bereits andere Nobelpreise erhalten hatten, Hans Fischer (1881–1945) und Adolf Butenandt (1903–1995) hingegen vor dem Erhalt eines Nobelpreises.

Tabelle 6: Kandidaten für den Nobelpreis in Physiologie oder Medizin, die als Laureaten in einer anderen Nobeldisziplin ausgezeichnet wurden

Name	Nominierungen Med.	Andere Preise	Motivation
Wilhelm C. Röntgen	5	Physik 1901	„in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays subsequently named after him“
Emil Fischer	5	Chemie 1902	„in recognition of the extraordinary services he has rendered by his work on sugar and purine synthesis“
Eduard Buchner	3	Chemie 1907	„for his biochemical research and his discovery of cell-free fermentation“

17 „Deutsche Nobellaureaten“ umfasst hier alle Laureaten, die im digitalen Nobelarchiv deutschen Universitäten zugeordnet sind, abrufbar unter: N.N., URL: https://www.nobelprize.org/prizes/facts/lists/affiliations.php (abgerufen am 23. 2. 2021).

(Fortsetzung)

Name	Nominierungen Med.	Andere Preise	Motivation
Heinrich Wieland	1 (1928)	Chemie 1927	„for his investigations of the constitution of the bile acids and related substances“
Adolf Windaus	1 (1928)	Chemie 1928	„on account of his work on the constitution of sterols and their connection with vitamins.“
Hans Fischer	1 (1929)	Chemie 1930	„for his researches into the constitution of haemin and chlorophyll and especially for his synthesis of haemin“
Adolf Butenandt	13 (1935/36)	Chemie 1939	„for his work on sex hormones“

Deutsche Pharmakologen als Nobelpreiskandidaten

Die Pharmakologie besitzt einen großen Stellenwert im Nobelpreiskontext. Die Zugehörigkeit zu diesem Fach erhöhte – zumindest im Rückblick betrachtet – die Chance mit einem Nobelpreis ausgezeichnet zu werden. Dementsprechend brachte diese Disziplin bereits mehr als 13 Nobelpreisträger in der Kategorie Physiologie oder Medizin und weitaus mehr Nominierte hervor.[18] Die Schlüsselposition spiegelt sich auch durch die mindestens 43 nominierten Pharmakologen zwischen 1901 bis 1953 wider. Von den 43 Nominierten stammten 13 zum Zeitpunkt der Nominierung aus Deutschland und auch ein Großteil der insgesamt über 300 Nominierungen für Pharmakologen kam von deutschen Nominatoren.

Zu Beginn der europäischen Professionalisierungsgeschichte der Pharmakologie, gegen Ende des 19. Jahrhunderts, spielte Dorpat (heute Tartu in Estland) eine herausragende Rolle. Obwohl Dorpat nie zum deutschen Hoheitsgebiet zählte, nutzen deutsche Wissenschaftler diesen Standort, um hier ihre akademische Karriere zu beginnen. Die Universität Dorpat setze sich seit ihrer Wiedergründung im Jahr 1802 bis in die Anfänge des 20. Jahrhunderts ebenfalls aus

18 Vgl. Michael Pohar/Nils Hansson, The „Nobel Population“ in pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg, in: *Naunyn-Schmiedeberg's Archives of Pharmacology* 393 (2020), 1173–1185. – Dies., Between two stools? Pharmacologists nominated for Nobel prizes in „physiology or medicine“ and „chemistry“ 1901–1950 with a focus on John Jacob Abel (1857–1938), in: *Naunyn-Schmiedeberg's Archives of Pharmacology* 394 (2021), 503–513.

vielen deutschen Studenten zusammen, die in der Unterrichtssprache Deutsch gelehrt wurden.[19]

Der deutsche Rudolf Buchheim (1820–1879) lehrte von 1856 bis 1866 in Dorpat. Dort legte er den Grundstein für die experimentelle Pharmakologie in Form des weltweit ersten pharmakologischen Instituts.[20] Zu Buchheims Schülern in Dorpat zählt der ebenfalls deutschstämmige Oswald Schmiedeberg (1883–1921), der immer wieder als „Vater der modernen Pharmakologie"[21] beschrieben wird, sowie seine deutschen Nachfolger Hans Horst Meyer (1853–1939) und Rudolf Boehm (1844–1926). Schmiedebergs akademische Laufbahn führte ihn über Dorpat nach Leipzig und schließlich an die Kaiser-Wilhelm-Universität in Straßburg. An dieser Universität verbrachte er 46 Jahre, in denen er mehr als 200 Pharmakologen aus über 40 Ländern ausbildete.[22] Genau dieses internationale Netzwerk rund um Schmiedeberg[23] war ein zentrales Argument in Schmiedebergs 18 Nobelpreisnominierungen zwischen 1902 und 1918.[24] Unter den Schülern Schmiedebergs in Straßburg befanden sich viele Pharmakologen, denen in der Geschichte der Pharmakologie und der des Nobelpreises große Bedeutung zukommt. Dazu zählt zum einen John Jacob Abel (1857–1938) – „Der Vater der amerikanischen Pharmakologie"[25], der ebenfalls auf deutsche Wurzeln[26] zurückblicken kann, und zum anderen der in Deutschland geborene und viele Jahre lehrende Hans Horst Meyer.

Meyer prägte maßgeblich die Wiener Medizin im 20. Jahrhundert.[27] Zudem lehrte und forschte er, neben Straßburg, Dorpat, und Wien, auch 20 Jahre lang in Marburg. Meyer bildete fünf spätere Nobelpreisträger in Physiologie oder Me-

19 Vgl. Ilo Käbin, *Medizinische Forschung und Lehre an der Universitat Dorpat/Tartu 1802–1940: Ergebnisse und Bedeutung für die Entwicklung der Medizin,* Lüneburg: Nordostdeutsches Kulturwerk 1986.

20 Vgl. Oswald Schmiedeberg, Rudolf Buchheim, sein Leben und seine Bedeutung für die Begründung der wissenschaftlichen Arzneimittellehre und Pharmakologie, in: *Archiv für experimentelle Pathologie und Pharmakologie* 67 (1911), 1–54.

21 Vgl. Jan M. van Ree/Douwe D. Breimer, Pharmacology in the Netherlands: past, present and future, in: *Trends Pharmacological Sciences* 29 (2008) 4, 167–169.

22 Vgl. James Barrett/Clive Page/Martin Michel, Perspectives of Pharmacology over the Past 100 Years, in: Dies. (Hg.), *Concepts and Principles of Pharmacology, Handbook of Experimental Pharmacology*, Cham: Springer 2019, 13–16.

23 Vgl. Hans Horst Meyer, Oswald Schmiedeberg, in: *Naturwissenschaften* 10 (1922), 105–107.

24 Vgl. Pohar/Hansson, The „Nobel Population", 1173–1185.

25 Vgl. Charles George, John Jacob Abel reinterpreted: prophet or fraud?, in: *Nephrology* 4 (1998) 4, 217–222.

26 Vg. Charles George/Garabed Eknoyan, John Jacob Abel, in: Todd Ing/Carl Kjellstrand/Mohamed Rahman (Hg.), *Dialysis History, Development and Promise,* Singapore: World Scientific 2012, 27–35.

27 Vgl. Leopold Arzt/Richard Übelhör, In memoriam Hans Horst Meyer, Professor der experimentellen Pharmakologie in Wien (1904–1924), in: *Wiener Klinische Wochenzeitschrift* 35/36 (1949) 4, 545–546.

dizin aus: Otto Loewi (1873–1961), Carl Ferdinand Cori (1896–1984) und Gerty Cori (1896–1957), Corneille Heymans (1892–1968) und George Hoyt Whipple (1878–1976). Auch Meyer wurde in der Zeit zwischen 1912 bis 1938 elf Mal für den Nobelpreis nominiert, jedoch vergeblich. Hauptargument in den Nominierungen war Meyers Forschung über Narkose, die unter anderem heute noch als „Meyer-Overton-Korrelation" allgegenwärtig ist.[28] Meyers Lebenswerk besteht darüber hinaus in der Verbreitung der Pharmakologie und den Brückenschlägen zwischen der Pharmakologie und Physiologie[29] sowie zur Biologie[30].

Zu Beginn des 20. Jahrhunderts lagen die „Hotspots" der Pharmakologie in Dorpat und Straßburg, im Nobelkontext spielten später auch die Standorte Marburg[31], Freiburg[32] und Leipzig[33], der Industriestandort Wuppertal[34] und Wien wichtige Rollen.

Tabelle 7: Deutsche Pharmakologen als Nobelpreiskandidaten 1901–1953

Kandidat	Zeitraum der Nominierungen	Anzahl der Nominierungen	Primäre Wirkungsstätte
Ernst Overton	1902–1923	6	Würzburg, Lund (SE)
Joseph Freiherr von Mehring	1902–1906	3	Straßburg, Halle
Oswald Schmiedeberg	1902–1920	18	Dorpat, Straßburg
Hans Horst Meyer	1912–1938	11	Dorpat, Marburg, Wien (AT)
Hermann Wieland	1926	1	Würzburg
Wilhelm Roehl	1927	1	Frankfurt, Wien, Wuppertal

28 Vgl. Daniela Angetter/Birgit Nemec/Herbert Posch/Christiane Druml/Paul Weindling (Hg.), *Strukturen und Netzwerke. Medizin und Wissenschaft in Wien 1848–1955. (= 650 Jahre Universität Wien – Aufbruch ins neue Jahrhundert* 5), Göttingen–Wien: V&R, Vienna University Press 2018, 725.

29 Vgl. Adolf Jarisch, Hans Horst Meyer, in: *Ergebnisse der Physiologie, biologischen Chemie und experimentellen Pharmakologie* 43 (1940), 1–8.

30 Vgl. George Baehr, In Memoriam, Hans Horst Meyer, in: *Bulletin of the New York Academy of Medicine* 16 (1940), 260–261.

31 Vgl. Wolfgang Legrum/Adnan Al-Toma/Karl Netter, *125 Jahre Pharmakologisches Institut der Philipps-Universität Marburg, Fachbereich Humanmedizin*, Marburg: N. G. Elwert Verlag 1992.

32 Vgl. Klaus Starke, *Die Geschichte des Pharmakologischen Instituts der Universität Freiburg*, Berlin–Heidelberg: Springer Verlag 2004.

33 Vgl. Ingrid Kästner, Rudolf Boehm (1844–1926) und die Gründung des Institutes für Pharmakologie an der Leipziger Universität, in: Jürgen Kiefer (Hg.), *Parerga – Beiträge zur Wissenschaftsgeschichte: In memoriam Horst Rudolf Abe*, Erfurt: Verlag der Akademie gemeinnütziger Wissenschaften zu Erfurt 2007, 299–311.

34 Vgl. Hans Schadewaldt/Frank-Joachim Morich, *100 Jahre Pharmakologie bei Bayer 1890–1990: Geschichte des Instituts für Pharmakologie in Wuppertal-Elberfeld*, Leverkusen: Bayer AG, Sektor Gesundheit 1990.

(Fortsetzung)

Kandidat	Zeitraum der Nominierungen	Anzahl der Nominierungen	Primäre Wirkungsstätte
Paul Trendelenburg	1929	1	Freiburg, Dorpat (Tartu), Rostock, Berlin
Hugo Schulz	1931	1	Greifswald
Werner Schulemann	1934–1935	2	Düsseldorf, Bonn
Gerhard Domagk NP 1939	1938–1953	9	Münster, Wuppertal
Hans Mauß	1949–1952	2	Wuppertal
Fritz Mietzsch	1949–1953	11	Dresden, Leverkusen, Wuppertal, Bonn
Walter Kikuth	1949–1953	11	Hamburg, Wuppertal, Düsseldorf

Ab etwa 1938 verlor Deutschland als ein Zentrum der pharmakologischen Forschung an Bedeutung. Dazu trug ebenfalls das von Adolf Hitler initiierte Nominierungsverbot aus dem Jahr 1937 bei. So reiste der Nobelpreisträger und Mitglied des Nobelpreiskomitees Hans von Euler-Chelpin (1873–1964) unmittelbar nach der Bekanntgabe des Verbots nach Berlin um das persönliche Gespräch mit Hermann Göring (1893–1946) zu suchen. Von Euler-Chelpin verglich das Verbot mit einem Bruch mit der internationalen Wissenschaft, durch den sich Deutschland kulturell und wissenschaftlich isolieren würde.[35] Es folgte eine globale Verlagerung des Forschungszentrums nach Amerika, das sich deutlich durch die gesunkenen Nobelpreisnominierungen für Pharmakologen aus Deutschland und den wiederum gestiegenen aus Amerika bemerkbar macht. Eine Ausnahme bildet jedoch der bereits erwähnte deutsche Mediziner und Nobelpreisträger Gerhard Domagk (1895–1964).

Domagk arbeitete in leitender Funktion in der Pharmakologischen Abteilung für die Wuppertaler I.G. Farbenindustrie AG und auch als Professor in Münster. Er wurde insgesamt neun Mal für den Nobelpreis nominiert. Drei dieser Nominierungen fallen in die Jahre 1937 und 1938, alle weiteren erfolgten nach 1950. Im Jahr 1939 wurde Domagk als Nobellaureat für die Entdeckung der antibakteriellen Wirkung des Sulfonamids Prontosil bekanntgegeben. Auf Drängen der Nationalsozialisten war es ihm nicht gestattet, den Preis anzunehmen. Erst im Jahr 1947 wurde ihm die Nobel-Medaille und eine Urkunde ausgehändigt.[36]

Heutzutage sind zu Ehren der Pioniere der Pharmakologie viele Preise, Institute und Straßen benannt worden. So gilt die Schmiedeberg-Plakette als die

35 Vgl. Almgren, Der Nobelpreis, 27–38.
36 Vgl. ebd.

höchste Auszeichnung der Deutschen Gesellschaft für experimentelle und klinische Pharmakologie und Toxikologie e.V. Auch ein Hans-Horst-Meyer Preis wird von der Österreichischen Pharmakologischen Gesellschaft jährlich verliehen. Dieser ehrt besondere Leistungen auf dem Gebiet der Grundlagenforschung der experimentellen, klinischen und toxikologischen Pharmakologie.

Deutsche Herz- und Kreislaufforscher als Nobelpreiskandidaten

Die fächerübergreifend gezeigte führende Rolle deutscher Forscher, welche von 1901 bis in die Mitte der 1930er-Jahre im Nobelpreiskontext demonstriert wurde, findet sich auch in der Disziplin der Herz- und Kreislaufforschung. In Deutschland etablierte sich die kardiovaskuläre Forschung als medizinische Fachrichtung im Jahr 1927 mit der Gründung der deutschen Gesellschaft für Kardiologie- Herz- und Kreislaufforschung (DGK) und rangiert damit im europäischen Zeitvergleich auf dem Spitzenplatz, während die American Heart Association in den Vereinigten Staaten bereits 1924 gegründet worden war. Die Nominierungen der 1927 vorangegangenen wie nachfolgenden Jahre umfassen gleichwohl Arbeiten bezüglich Struktur und Funktion von Herz und Gefäßen, den Grundlagen des Blutflusses und der Blutzirkulation sowie der Diagnose und Therapie kardiovaskulärer Erkrankungen.

Während sich die Nominierungen für deutsche Forscher fächerübergreifend insbesondere im ersten Jahrzehnt des 20. Jahrhunderts häuften, wuchs die Anzahl der Nominierungen für die kardiovaskulär tätigen Forscher in den ersten Jahren jedoch allmählich und erreichte ihren Höhepunkt, analog zur Etablierung der kardiologischen Gesellschaft 1927, in den 1920er- Jahren. Von den zwischen 1901 und 1953 insgesamt 53 nominierten internationalen Forschern mit kardiovaskulärer Nominierungsmotivation war ein Viertel der Kandidaten deutscher Nationalität und/oder in Deutschland tätig. Der Anteil deutscher kardiovaskulärer Forscher gemessen an allen kardiovaskulären Nominierungen war insbesondere in den ersten Jahrzehnten des 20. Jahrhunderts noch prägnanter.[37] Dies änderte sich jedoch in den 1940er-Jahren, in denen sich der Anteil deutscher Nominierungen im Nobelpreiskontext stark rückläufig zeigt. Hitlers „Nobelpreis-Vendetta“[38] wirkte sich auch auf die deutsche kardiovaskuläre Wissenschaft aus: Mit Ausnahme des Göttinger Physiologen Hermann Rein (1898–

37 Vgl. Marie Drobietz/Adrian Loerbroks/Nils Hansson, Who is who in cardiovascular research? What a review of Nobel Prize nominations reveals about scientific trends, in: *Clinical research in Cardiology* (2021), URL: https://pubmed.ncbi.nlm.nih.gov/33675420/ (abgerufen am 30. 3. 2021).

38 Vgl. Elisabeth Crawford, German Scientists and Hitler's Vendetta against the Nobel Prizes, in: *Historical Studies in the Physical and Biological Sciences* 31 (2000) 1, 37–53.

1953), welcher vor allem für seine Arbeiten zur Blutverteilung und Messung des Blutflusses in Gefäßen nominiert wurde, wurde in den Jahren des „Dritten Reichs“ kein deutscher kardiovaskulärer Wissenschaftler für den Nobelpreis vorgeschlagen.[39] Die 1940er-Jahre besiegelten mit dem Thementrend der Herzchirurgie die Verschiebung der Nominierungswelle für deutsche und westeuropäische kardiovaskuläre Forscher zugunsten von US-amerikanischen WissenschaftlerInnen.

Die „goldenen Zeiten“ der deutschen Herz- und Kreislaufforscher begannen dagegen allmählich schon 1901 mit der allerersten kardiovaskulären Nominierung, welche dem Pathologen Richard Thoma (1847–1923) aus Heidelberg galt. Zu dem Forschungsspektrum Thomas zählte neben der Physiologie der Blutstrombahn auch die Pathologie von Gefäßveränderungen, insbesondere im Rahmen der Atherosklerose.[40]

Neben der Atherosklerose, deren Entstehungsprozess sich auch der Pathologe Ludwig Aschoff (1866–1942) (siehe Tabelle 8) widmete, wurden die deutschen Herz- und Kreislaufforscher insbesondere aufgrund der Entwicklung klinischer Diagnoseverfahren (z. B. der Internist Friedrich Martius (1850–1923) für die Zuordnung der Herztöne), der Entdeckung des Zusammenhangs zwischen Nervenphysiologie und Herzfunktion sowie ihrer Erkenntnisse in Bezug auf Hämodynamik und Blutverteilung als nobelpreiswürdig erachtet. In mehr als 60 % der Nominierungen mit kardiovaskulärem Bezug stammten auch die Nominatoren aus Deutschland, weitere 25 % gehen aus den Nominierungen deutscher Nachbarstaaten hervor. Lediglich 15 % der Nominierungen für deutsche kardiovaskuläre Forscher ergeben sich aus dem erweiterten europäischen sowie US-amerikanischen Raum.

Die Popularität der Nobelkandidaten im deutschen Raum spiegelt sich auch in nationalen repräsentativen Auszeichnungen. Die seit 1932 vergebene Carl-Ludwig-Ehrenmedaille gilt als die deutschlandweit prestigeträchtigste kardiologische Auszeichnung, welche für langjährige herausragende wissenschaftliche Arbeiten auf dem Gebiet der Herz- und Kreislaufforschung vergeben wird. Unter den Preisträgern der Carl-Ludwig-Ehrenmedaille finden sich mit Ludwig Aschoff (Preisträger 1936), dem Herz- und Kreislaufphysiologen Otto Frank (1865–1944) (Preisträger 1937) und Hermann Rein (Preisträger 1951) auch die „Top 3“ der deutschen kardiovaskulären Wissenschaftler mit den meisten Nobelnominierungen.

39 Vgl. Nils Hansson/Serge Daan, Politics and physiology: Hermann Rein and the Nobel Prize 1933–1953, in: *The Journal of Physiology* 15 (2014), 2911–2914.

40 Vgl. Wilhelm Doerr, Über wenig beachtete Pioniertaten eines Pathologen der Jahrhundertwende. Erinnerungen an Richard Thoma, in: *Arzt und Krankenhaus* 11 (1992), 405–411.

Tab. 8: Kardiovaskuläre Forscher aus Deutschland mit den meisten Nobelpreisnominierungen

Platz	Nominierungen im Zeitraum (von–bis)	Kandidat	Begründung
1	9 (1917–1934)	Ludwig Aschoff	Atherosklerose und Pathologie des Herzens
2	9 (1933–1951)	Hermann Rein	Haemodynamik
3	8 (1928–1937)	Otto Frank	Haemodynamik
4	6 (1932–1937)	Heinrich Hering	Blutdruckregulation
5	4 (1913–1920)	Johannes von Kries	Nervenphysiologie&Herztätigkeit

Die fächerübergreifend gezeigten Nominierungsnetzwerke aus verschiedenen Nominatoren einer Universität, welche sich gebündelt für einen Kandidaten ausgesprochen haben, kommen in den kardiovaskulären Nominierungen nicht zum Vorschein. Es findet sich jedoch auch hier eine Form der Netzwerkstruktur, die offenbart, dass freundschaftliche Beziehungen als Motivation für Nominierungen eine Rolle spielen können. Ein prominentes Beispiel bildet der deutsche Vertreter der kardiovaskulären Nobellaureaten, der Chirurg und Urologe Werner Forßmann. Er erhielt den Nobelpreis für Physiologie oder Medizin des Jahres 1956 für seinen Beitrag zur Entwicklung der Herzkatheterisierung.[41] Das Privileg als Nobelpreisträger würdige Kandidaten zu nominieren, nutzte Forßmann 1958 und 1959 zugunsten seines Freundes Hugo Knipping (1895–1984) aus Köln, den er in den höchsten Tönen für seine Entwicklungen der Spirometrie pries.[42]

Prominente Standorte innerhalb Deutschlands, an denen kardiovaskuläre Nominierte forschten und lehrten, decken sich insgesamt mit den Erkenntnissen der fächerübergreifenden Forschungsschwerpunkte in Deutschland. So zeigt sich ein großer Anteil an Nominierten, welche in Berlin, z. B. der Physiologe Theodor Wilhelm Engelmann (1843–1909), Freiburg, wie z. B. der Pathologe Ludwig Aschoff oder der Physiologe Johannes von Kries (1853–1928) und Heidelberg, z. B. der Internist Ludolf von Krehl (1861–1937) tätig waren.

41 Vgl. Nils Hansson/Lisa-Marie Packy/Thorsten Halling/Dominik Groß/Heiner Fangerau, Vom Nobody zum Nobelpreisträger? Der Fall Werner Forßmann, in: *Der Urologe* 54 (2015) 3, 412–419.

42 Vgl. Marie Drobietz/Friedrich Moll/Nils Hansson, „Ein vornehmer und nobler Charakter“: Die Nobelpreisnominierungen für Hugo W. Knipping, in: *Der Kardiologe* 14 (2020) 4, 316–320.

Fazit

Die Analyse der im Nobel-Archiv verzeichneten Nominierungen für in Deutschland wirkende medizinische Forscher ermöglicht, einen Überblick über die deutsche Forschungslandschaft der ersten Hälfte des 20. Jahrhunderts zu erhalten.

Dabei werden die wichtigsten Städte und Kandidaten im Nobelpreiskontext aufgezeigt und einige Forschungstrends im Laufe der ersten Hälfte des 20. Jahrhunderts skizziert. Dennoch bleibt es bei einigen Kandidaten wie auch Nobelpreisträgern, schwierig, eine klare Zuordnung zu einer Nation zu treffen. So wirkten Forscher anderer Nationalitäten in Deutschland, deutsche Forscher wanderten aus oder begaben sich für Forschungsaufenthalte ins Ausland. Hinzu kommt, dass sich die Landesgrenzen Deutschlands im betrachteten Zeitraum mehrfach änderten. Die Biografien der prominenten Pharmakologen Hans Horst Meyer und des Nobelpreisträgers Otto Loewi (1873–1961) aus der Geschichte der Pharmakologie verdeutlichen beispielsweise den Wissenschaftstransfer zwischen Deutschland und Österreich. Beide Pharmakologen wurden in Deutschland ausgebildet und erbrachten große wissenschaftliche Leistungen in Österreich.

Während eine nationale Zuordnung für die Forschungsergebnisse der betroffenen Wissenschaftler sowie auch für die Auswahl von Nobelpreisträgern zunächst wenig Bedeutung hat, wäre es vor dem Hintergrund des medialen und lokalen Patriotismus jedoch bedeutsam zu diskutieren, wie Preisträger und prominente Kandidaten am besten einer Nation zuzuordnen sind, wenn die Einteilung der Biografie und dem Werk der betroffenen Forscher gerecht werden soll. Für Österreich greift der Beitrag von Daniela Angetter in diesem Buch *„Am I from Austria"? Oder „über die Kunst ein österreichischer Nobelpreisträger/eine Nobelpreisträgerin zu sein"* diese Frage auf und diskutiert anhand einiger Österreich verbundener Nobelpreisträger verschiedene Aspekte einer solchen Zuordnung und deren Sinnhaftigkeit. Eine ähnliche Analyse ist für Deutschland noch ausstehend.

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3. Discussion

3.1 Comparison of the results with related studies

Similar studies that consider the same period, such as those on cardiologists[162] , surgeons[163], neurologists[164] or ENT doctors[165] come to similar results as the present study on pharmacologists.

The study results unilaterally agree that women were underrepresented in Nobel Prizes. Pharmacologists lack female Nobel Prize candidates completely, since no woman appeared there until 1953. This makes pharmacology one of many disciplines without nominated women, especially since between 1901 and 1953 respectively 1966 (in physics and chemistry) generally only 2.2% of nominees were women.[166]

There is no tendency towards a change in the gender distribution seen even as the Chinese pharmacologist Tu Youyou (*1930) was awarded the Nobel Prize for her work in 2015. She is the only pharmacologist to date to who has been awarded the Nobel Prize. It is therefore not surprising that criticism of the gender distribution of the award winners continues.[167] There are also studies that look at the background of female candidates and draw conclusions about the female scientist's mother role alongside that of the scientist as an influencing factor on the career.[168] The Nobel Prize Committee is aware of this point of contention and tries to promote diversity in terms of gender and

[162] Drobietz M, Loerbroks A, Hansson N (2021) Who is who in cardiovascular research? What a review of Nobel Prize nominations reveals about scientific trends, Clinical Research in Cardiology, https://doi.org/10.1007/s00392-021-01813-2

[163] Hansson N, Tuffs A (2016) Nominee and nominator, but never Nobel Laureate: Vincenz Czerny and the Nobel Prize, Langenbeck's Archives of Surgery. 401(8):1093-1096. doi: 10.1007/s00423-016-1511-3

[164] Hansson N, Palmen L, Padrini G, Karenberg A (2020) Babinski, Bektherev, Cerletti, Head, and Hitzig: European Neurologists Nominated for the Nobel Prize 1901–1950, 83:542–549. https://doi.org/10.1159/000509078

[165] Hansson N, Drobietz M, Mudry A (2020) Otorhinolaryngologists nominated for the Nobel Prize 1901-1940, European Archives of Oto—Rhiono-Laryngology, 277, pp1255–1258

[166] Mahmoudi, M, Poorman J A, Silber J K (2019) Representation of women among scientific Nobel Prize nominees, The Lancet, Vol. 394, p 1905. https://doi.org/10.1016/S0140-6736(19)32538-3

[167] Lunnemann, P, Jensen, MH, Jauffred, L (2019) Gender bias in Nobel prizes. Palgrave Commun 5, p 46. https://doi.org/10.1057/s41599-019-0256-3

[168] Charyton, C., Elliott, J. O., Rahman, M. A., Woodard, J. L.,, DeDios, S. (2011) Gender and Science: Women Nobel Laureates, The Journal of Creative Behavior, 45(3), pp 203–214. doi:10.1002/j.2162-6057.2011.tb01427.x

geography through appropriate measures. Göran Hansson, secretary-general of the Royal Swedish Academy of Sciences, emphasized this in an interview with the journal Nature in 2019.[169]
The results of the study on pharmacologists are therefore also suitable for addressing the current problem of diversity and in the long run contributing to change.

The previously mentioned conflict between the definition of which discipline a scientist should be assigned to, which is listed under the heading “Research stances and weaknesses”, can be seen when comparing the results of related studies. The pharmacologist and cardiologist Otto Loewi is listed in both cardiological research[170] and pharmacological[171] studies. He was awarded the Nobel Prize in 1936 for “heart hormones and chemical transmission of nerve impulses in the heart”.
When looking at the reasons for awarding of the Nobel Prize in both disciplines, it is confirmed that the majority of the Nobel Prize is awarded for basic research.

Within the ultra-elite circle of scientists who were nominated for medical Nobel Prizes was a close-knit network since colleagues nominated each other. This created social ties.[172] [173] Several inherent structures in nomination lead to social ties having an influence on nominations. This is replicated in other disciplines due to the procedures. The surgeon Vincenz Czerny (1842-1916), who was nominated himself and also acted as a nominator, wrote in one nomination letter “the value of a piece of work can often

[169] Gibney Elizabeth (2019) More women are being nominated: Nobel academy head discusses diversity, Nature. https://doi.org/10.1038/d41586-019-02988-5

[170] Drobietz M, Loerbroks A, Hansson N (2021) Who is who in cardiovascular research? What a review of Nobel Prize nominations reveals about scientific trends, Clinical Research in Cardiology, https://doi.org/10.1007/s00392-021-01813-2

[171] Pohar M, Hansson, N (2020) The “Nobel Population” in Pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg. Naunyn-Schmiedeberg's Archives of Pharmacolology 393, pp 1173–1185. https://doi.org/10.1007/s00210-019-01807-y

[172] Drobietz M, Moll F, Hansson N (2019) „Ein vornehmer und nobler Charakter“: Die Nobelpreisnominierungen für Hugo W. Knipping, Der Kardiologe. https://doi.org/10.1007/s12181-019-00371-2

[173] Pohar M, Hansson, N (2020) The “Nobel Population” in Pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg. Naunyn-Schmiedeberg's Archives of Pharmacolology 393, pp 1173–1185. https://doi.org/10.1007/s00210-019-01807-y

only be evaluated after several years and sometimes a small pamphlet is of more value than a heavy text".[174] This statement referred to the dilemma of having to nominate someone prize-worthy and having to evaluate the contribution of their research at the same time. To do this, it is essential to have excellent knowledge of the field of research to be nominated. In addition, the nominator must also be able to make a forecast about the future worth of the invention. Therefore, it follows that the nominator and nominee often work in the same discipline because such a high level of competence is required. In addition, the benefit of a good network of the nominee is also noticeable. This is very strongly influenced both personally and professionally.[175] By looking at the nominations of Oswald Schmiedeberg, nominations of pharmacologists, close colleagues and partially friends are noticeable – Bernhard Naunyn (nomination 1920) and Hans Horst Meyer (nomination 1914).

It is logical that elite pharmacologists will most likely find their network mainly in pharmacology. However, a joint journal can establish good relationships between two disciplines – like experimental pharmacology and pathology -, which are reflected in nominations letters, too. A connection between the internist Naunyn and the pharmacologist Schmiedeberg can be found in the joint journal "Naunyn Schmiedeberg's Archives of Pharmacology" in 1872, and Naunyn also nominated Schmiedeberg for the Nobel Prize in 1920.

Another correspondence between the various Nobel Prize studies can be observed in the shift from Central Europe to America.[176] This can be seen from the nomination patterns. This shift arose in the mid 1930s due to political change. The national socialist ideologies in Germany were harmful to science and Jewish scientists. That America was able to establish itself as a future science center that has so far produced the most laureates[177], is also confirmed from statements by some Nobel Prize Laureates. They

[174] Hansson N, Tuffs A (2016) Nominee and nominator, but never Nobel Laureate: Vincenz Czerny and the Nobel Prize, Langenbeck's Archives of Surgery. 401(8):1093-1096. DOI: 10.1007/s00423-016-1511-3

[175] Drobietz M, Moll F, Hansson N (2019) „Ein vornehmer und nobler Charakter": Die Nobelpreisnominierungen für Hugo W. Knipping, Der Kardiologe. https://doi.org/10.1007/s12181-019-00371-2

[176] Padrini G, Wiling M, Drobietz M (2021) Die deutsche Nobelpreisgeschichte 1901–1953: Kandidaten, Universitäten, Forschungstrends. Hansson N, Angetter D. (editors.) Laureaten und Verlierer – Der Nobelpreis und die Hochschulmedizin in Deutschland, Österreich und der Schweiz, Göttingen: Vandenhoeck & Ruprecht, p 121

[177] Norrby E (2010) Nobel Prizes and Life Sciences. World Scientific Publishing Co. Pte. Ltd., p 27

state that the move from Germany to America has given them research advantages, as they found an active and hospitable research climate in America. [178]

[178] Zuckerman H (1977) Scientific Elite – Nobel Prize in the United States. The Free Press, pp 70-71

3.1.1 The Schmiedeberg badge

In connection with the interpretation of the research results, a separate look is required at the Deutsche Gesellschaft für Experimentelle und Klinische Pharmakologie und Toxikologie e.V. (DGPT) (German Society for Experimental and Clinical Pharmacology and Toxicology), which awards the O. Schmiedeberg badge since the year 1956.
The DGPT is the umbrella organization of three specialist societies in Germany. It is made up of the Deutsche Gesellschaft für Pharmakologie (DGP) (German Society for Pharmacology), the Gesellschaft für Toxikologie (GT) (Society for Toxicology) and the Deutschen Gesellschaft für klinische Pharmakologie und Therapie e.V. (DGKliPha) (German Society for Clinical Pharmacology and Therapy) together. The society has its origins in the founding of the Deutschen Pharmakologischen Gesellschaft (German Pharmacological Society) in 1920. Over the years, the aforementioned components of the society have been founded and incorporated into the DGPT accordingly. The DGPT has had its current structure since 2008.

The O. Schmiedeberg badge is the highest award of the DGPT[179] and therefore warrants a closer examination. The consideration of the winners of this award gives conclusions about the prestige that this award has and confirms the unlikely high reputation of Schmiedeberg within medical profession. Among the winners of the O. Schmiedeberg badge are the Nobel Prize winners Otto Loewi (Award 1957, NP 1936), Sir Henry Dale (Award 1962, NP 1936), Corneille Heymans (Award 1962, NP 1938), Julius Axelrod (Award 1978, NP 1970) and Ulf van Euler (Award 1968, NP 1970). In addition, there are also other high-ranking pharmacologists among the award winners, such as Ernst Peter Pick (1957), Otto Krayer (1964), Wilhelm Siegmund Feldberg (1968), Ulrich Trendelenburg (1998) and Erich Muscholl (2010). A total of 42 scientists have been honored with it since the award was first established.

The evaluation of the awarding structure of the O. Schmiedeberg badge shows that Schmiedeberg is still an icon in pharmacology and makes his excellence visible. On the one hand, this view is reinforced by the fact that the award bears his name, on the other hand, that elitist and ultra-elite scientists in pharmacology are among the laureates.

[179] Oelschläger H, Ueberall S (2006) Die Pharmazie an der Universität Frankfurt am Main im Wandel der Zeiten (1914-2004), Franz Steiner Verlag. Vol 1, p 143

3.1.2 Honorary degrees of John Jacob Abel

An honorary doctorate can be defined as “an academic degree conferred by a university institution, at its own initiative, without cost to the recipient, to honor someone renowned for his or her merits in the field of science, culture, politics, economics, religion or defense, without examinations or dissertations, but also without any rights connected to the degree ”.[180] This definition leaves a lot of leeway to justify the motivation for awarding such a title. It is hardly surprising that many honorary degrees have been awarded on a diplomatic background.[181] Due to the significant war events in the first half of the 19th century, the first and second half of this century must be viewed separately from each other. A detailed examination of the background is necessary to demonstrate a corresponding level of excellence. The honorary doctorates of John Jacob Abel are awarded in the first half of the 20th century. Using the example of the University of Cambridge, the award of the honorary title can be considered with geopolitical events in order to be able to draw conclusions about the motivation for the award of Abel. John Jacob Abel was awarded the title "Doctor of Law" by Cambridge University in 1920. A year earlier, the university awarded 25 honorary degrees, including 19 to military figures.[182]

Immediately after the Second World War, for example, the honorary degrees from the English universities of Cambridge and Oxford were also used to strengthen alliances between the USA and Western European allies, especially between Germany and France. [183] This led to increased awards immediately after the war, with the numbers falling afterward.[184]

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[180] Dhondt P (2013) Pomp and Circumstance at the University: The Origin of the Honorary Degree, European Review of History: Revue euroéenne d’historie. 20:1, p 117, DOI: 10.1080/13507486.2012.742876

[181] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), pp 391-399. DOI:10.1007/s11024-007-9065-8

[182] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p. 392. DOI:10.1007/s11024-007-9065-8

[183] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p 400. DOI:10.1007/s11024-007-9065-8

[184] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p 403. DOI:10.1007/s11024-007-9065-8

In order to make the impact of the honorary doctorate visible, the frequency of awarding the titles must also be included. This shows that significantly more titles were awarded in the first half of the 19th century.[185]

The current award of honorary degrees takes place according to strict guidelines and only the most internationally renowned academics and civil servants are honored; accordingly, far fewer people are honored.[186] Likewise, the policy of the Universities of Cambridge and Oxford has meanwhile changed in such a way that political independence is clearly in the foreground when awarding the degrees.[187]

Thus, it can be stated that the honorary doctorate is perceived differently today than in the early 20th century.

It can be assumed that Abel was not awarded the title of Cambridge University because of political motivation, but because of his academic achievements. This is reinforced as there is almost no literature on Abel's political stance, in contrast to a lot of literature on his academic achievements.

In the critical examination of honorary degrees from the University of Cambridge, the study identifies an “even more exclusive club” [188], which includes people who have received honorary degrees from both Cambridge and Oxford. Although John Jacob Abel does not have a title from Oxford University, he has one from the Ivy League colleges Yale and Harvard, among others. With this title, he belongs to a much more exclusive and therefore a circle of excellent people or ultra-elite.

Table 9 Honorary title of John Jacob Abel [189]

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[185] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p 391. DOI:10.1007/s11024-007-9065-8

[186] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), pp 391-392. DOI:10.1007/s11024-007-9065-8

[187] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p 415. DOI:10.1007/s11024-007-9065-8

[188] Heffernan, M., & Jöns, H. (2007). Degrees of influence: the politics of honorary degrees in the universities of oxford and cambridge, 1900–2000. Minerva, 45(4), p 415. DOI:10.1007/s11024-007-9065-8

[189] Parascandola J, Keeney E (1983) Sources in the History of Maerican Pharmacology, American Institute of History of Pharmacy. Madison, Wisconsin, p 27

Year	Degree and awarding university
1903	M.A. (Master of Arts) from University of Michigan,
1912	Sc.D. (Doctor of Science) from University of Michigan,
1915	Sc.D. (Doctor of Science) from University of Pittsburgh,
1920	LL.D. (Doctor of Law) from University of Cambridge
1925	Sc.D. (Doctor of Science) from Harvard University
1927	Sc.D. (Doctor of Science) from Yale University
1927	M.D. (Doctor of Medicine) from University of Lwow, Poland
1932	LL.D. (Doctor of Law) from University of Aberdeen

3.1.3 Evaluation of the nomination patterns

The following section focuses on certain nomination patterns such as political, gender, nationalistic, and prestige homophily. These criteria were established in a study[190] from the journal Nature in 2019 which examines the entire population of nominators, nominees, and laureates in the Nobel Prize system. These categories are assigned to the received and awarded nominations of the discussed Nobel nominees to see which nomination patterns arise.

For this, the incoming and outgoing nominations for Oswald Schmiedeberg (Table 10), Bernhard Naunyn (Table 11), John Jacob Abel (Table 12), and Hans Horst Meyer (Table 13) regarding the gender of the nominee/nominator, the origin at the time the nomination (with reference to the current national borders at the time of nomination) and the academic orientation are categorized.

The results of the homophily study[191] about the political homophily are largely applicable to the obtained results of the pharmacological research. The homophily study listed commonalities of countries that have the same views on world politics, economic or social issues. The pharmacologists Schmiedeberg and Meyer, but also the internist Naunyn, show a majority connection to Austria and Germany. Moreover, there are also nominations for Schmiedeberg from Scandinavia and Switzerland. The ideology of both countries, especially in the first part of the 19th century, diverged from that of the German and Austrian. However, the list again shows the close ties between German pharmacology and Austria and Switzerland, which are highlighted in another study. [192]

The gender homophily is applicable, too. The nominations of the protagonists were made exclusively by men for men. At this point, it becomes clear once again that women are clearly underrepresented.

The consideration of the nationalistic homophily confirms the shift from Central Europe to America. Schmiedeberg, Naunyn, and Meyer were and nominated almost exclusively

[190] Gallotti R, De Domenico M (2019) Effects of homophily and academic reputation in the nomination and selection of Nobel laureates. Sci Rep 9, 17304. https://doi.org/10.1038/s41598-019-53657-6

[191] Gallotti R, De Domenico M (2019) Effects of homophily and academic reputation in the nomination and selection of Nobel laureates. Sci Rep 9, 17304. https://doi.org/10.1038/s41598-019-53657-6

[192] Padrini G, Wiling M, Drobietz M (2021) Die deutsche Nobelpreisgeschichte 1901–1953: Kandidaten, Universitäten, Forschungstrends. Hansson N, Angetter D. (editors.) Laureaten und Verlierer – Der Nobelpreis und die Hochschulmedizin in Deutschland, Österreich und der Schweiz, Göttingen: Vandenhoeck & Ruprecht, pp 109-125

Central Europeans. John Jacob Abel an American-born scientist, who spent a lot of time in Germany, was nominated exclusively by Americans.

The consideration of the professional or academic reputation of the nominated and nominators is of great importance. This is broadly diversified. It is true that all persons are natural scientists, but they come from the most diverse areas of medicine or chemistry. This shows once more the key role of pharmacology and its importance in the context of the Nobel Prize and in the medical field in general. Pharmacology has a great impact on physiology, internal medicine, surgery, and chemistry.

Table 10 Data from nomination archive: Oswald Schmiedeberg

Nominations

Year	Name nominator	Sex	Country, city	Profession
1902	Hermann von Tappeiner (1847-1927)	M	Germany, Munich	Pharmacologist
1908	Poul E. Poulsson (1858-1935)	M	Norway, Oslo	Anatomist
1908	Kristian E. Schreiner (1874-1957)	M	Norway, Oslo	Pharmacologist
1908	Sophus C. F. Torup (1861-1937)	M	Norway, Oslo	Physiologist
1908	Ragnar Vogt (1870-1943)	M	Norway, Oslo	Psychiatrist
1908	Gaetano Gaglio (1858-1926)	M	Italy, Rome	Pharmacologist
1909	Hans H. Meyer (1853-1939)	M	Austria, Vienna	Pharmacologist
1910	Max Cloëtta (1868-1940)	M	Switzerland, Zurich	Pharmacologist
1910	Hermann Fehling (1847-1925)	M	Germany, Strasbourg	Gynaecologist
1911	Torald H. Sollmann (1874-1965)	M	Norway, Oslo	Pharmacologist
1912	Hans H. Meyer (1853-1939)	M	Austria, Vienna	Pharmacologist
1913	Bernhard Naunyn (1839-1925)	M	Germany, Strasbourg	Internist
1914	Hans H. Meyer (1853-1939)	M	Austria, Vienna	Pharmacologist
1915	Rudolf Staehelin (1875-1943)	M	Switzerland, Basel	Internist
1917	Max Cloëtta (1868-1940)	M	Switzerland, Zurich	Pharmacologist
1918	Rudolf Staehelin (1875-1943)	M	Switzerland, Basel	Internist
1918	Edwin S. Faust (1870-1928)	M	Germany, Würzburg	Pharmacologist
1920	Bernhard Naunyn (1839-1925)	M	Germany, Strasbourg	Internist

Nominee

Year	Name nominator	Sex	Country, city	Profession
1901	Gustav von Hüfner (1840-1908)	M	Germany, Tübingen	Chemist

Table 11 Data from nomination archive: Bernhard Naunyn

Nominations

Year	Name nominator	Sex	Country, city	Profession
1910	Emil Kraepelin (1856-1926)	M	Germany, Munich	Psychiatrist
1918	Julius Schreiber (1848 – 1932)	M	Germany, Konigsberg	Internist
1925	Wilhelm F Ceelen (1883-1964)	M	Germany, Bonn	Pathologist

Nominator

Year	Name nominee	Sex	Country, city	Profession
1913 Physics	Albert Einstein (1879-1955), **NP 1921**	M	Germany, Berlin	Physicist
1914 Physics	Albert Einstein (1879-1955), **NP 1921**	M	Germany, Berlin	Physicist
1922 Physics	Albert Einstein (1879-1955), **NP 1921**	M	Germany, Berlin	Physicist
1923 Physics	Arnold Sommerfeld (1868-1951)	M	USA, Wisconsin	Physicist
1913 Chemistry	Walther H. Nernst (1864-1941), **NP 1920**	M	Germany, Berlin	Physicist, Chemist
1914 Chemistry	Richard Willstätter (1872-1942), **NP 1915**	M	Germany, Berlin	Chemist
1920 Chemistry	Walther H. Nernst (1864-1941), **NP 1920**	M	Germany, Berlin	Physicist, Chemist
1923 Chemistry	Otto Hahn (1879-1968), **NP 1944**	M	Germany, Berlin	Chemist

1902	Paul Ehrlich (1854-1915), **NP 1908**	M	Germany, Frankfurt	Histologist, Hematologist
1910	Heinrich I. Quincke (1842-1922)	M	Germany, Kiel	Internist
1913	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist
1914	Emil Abderhalden (1877-1950)	M	Germany, Berlin	Physiologist
1915	Emil Abderhalden (1877-1950)	M	Germany, Berlin	Physiologist
1920	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist
1922	Wilhelm C. Röntgen (1845-1923)	M	Germany, Munich	Physicist
1923	Hans H. Meyer (1853-1939)	M	Austria, Vienna	Pharmacologist

Table 2 Data from nomination archive: John Jacob Abel

Nominations

Year	Name nominator	Sex	Country, city	Profession
1925 Chemistry	Charles Walcott (1850-1927)	M	USA, Washington D. C.	Paleontologist
1926 Chemistry	Charles Walcott (1850-1927)	M	USA, Washington D. C.	Paleontologist
1927 Chemistry	George E. Hale (1868 – 1938)	M	USA, Chicago	Astronomist
1927 Chemistry	James F. Norris (1871-1940)	M	USA, Massachusetts	Chemist
1927 Chemistry	Charles Walcott (1850-1927)	M	USA, Washington D. C.	Paleontologist
1925	Hugh A. McGuigan (unknown – 1926)	M	USA, Chicago	Pharmacologist
1925	Emanuel Libman (1872-1946)	M	USA, New York	Internist
1927	Robert H. Loewi (1883-1957)	M	USA, Berkeley California	Anthropologist
1928	Charles R Bardeen (1871-1935)	M	USA, Wisconsin	Anatomist
1930	Charley H. Mayo (1865-1939)	M	USA, Minnesota	Surgeon
1930	Emanuel Libman (1872-1946)	M	USA, New York	Internist
1931	Ross A. Gortner (1885-1942)	M	USA, Minnesota	Biochemist
1931	Arthur D. Hirschfelder (1879-1942)	M	USA, Minnesota	Cardiologist
1932	William W. Ford (unknown)	M	USA, Baltimore	Bacteriologist

1932	Eli K. Marshall (1889-19669	M	USA, St. Louis, IL	Pharmacologist
1934	Benjamin B. Turner (unknown)	M	USA, Indianapolis	Pharmacologist
1939	Eben J. Carey (1889-1947)	M	USA, Marquette	Anatomist

Table 13 Data from nomination archive: Hans Horst Meyer

Nominations

Year	Name nominator	Sex	Country, city	Profession
1912	Hermann von Tappeiner (1847-1927)	M	Germany, Munich	Pharmacologist
1917	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist
1921	Friedrich von Müller (1858-1941)	M	Germany, Munich	Internist
1923	Bernhard Naunyn (1839-1925)	M	Germany, Strasbourg	Internist
1923	Albrecht J. T. Bethe (1872-1954)	M	Germany, Kiel	Physiologist
1933	Emil Bürgi (1872-1947)	M	Switzerland, Bern	Pharmacologist
1938	Otto Fürth (1867-1938)	M	Austria, Vienna	Chemist
1938	Ernst P. Pick (1872-1960)	M	Austria, Vienna	Pharmacologist
1938	Arnold Durig (1872-1961)	M	Austria, Vienna	Physiologist
1938	Richard Wasicky (1884-1970)	M	Autria, Vienna	Pharmacology
1938	Leopold Arzt (1883-1955)	M	Austria, Vienna	Dermatology

Nominator

Year	Name nominator	Sex	Country, city	Profession
1902	Max Rubner (1854-1932)	M	Germany, Berlin	Physiologist, Hygienist
1902	Eduard Pflüger (1829-1910)	M	Germany, Poppelsdorf	Physiologist
1909	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist

1912	John N. Langley (1852-1925)	M	England, Cambridge	Physiologist, Histologist
1912	Jaques Loeb	M	USA, New York	Physiologist, Biologist
1912	Max Rubner (1854-1932)	M	Germany, Berlin	Physiologist, Hygienist
1912	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist
1914	Max Rubner (1854-1932)	M	Germany, Berlin	Physiologist, Hygienist
1914	Oswald Schmiedeberg (1838-1921)	M	Germany, Strasbourg	Pharmacologist
1925	Julius Wagner-Jauregg (1857-1940), NP 1927	M	Austria, Vienna	Psychiatrist
1925	Max Rubner (1854-1932)	M	Germany, Berlin	Physiologist, Hygienist
1930	Eugen Steinach (1861-1944)	M	Austria, Vienna	Physiologist, Sexologist
1936	Yadell Henderson (1873-1944)	M	USA, New Heaven	Physiologist
1936	Otto Loewi (1873-1961), **NP 1936**	M	Austria, Vienna	Pharmacologist
1937	Sigmund Freud (1856-1939)	M	Austria, Vienna	Neurophysiologist
1937	Yadell Henderson (1873-1944)	M	USA, New Heaven	Physiologist

3.2 Research strengths and weaknesses

The strengths and weaknesses of this work are both extrinsic and intrinsic.
Extrinsic refers to the available data from the Nobel Prize Archives or the data from the database (nobelprize.org). Some of these are incomplete, as can be seen from the example of John J. Abel's nominations. There are 5 nominations for Abel in the database in the chemistry category. Working with the Stockholm archival material, another unlisted nomination, that of Herny Fairfield Osborn (1857-1935) in 1927, was found.[193] Intrinsic sources of error relate to the conduct of the research. When drawing up the "Nobel Prize Population in Pharmacology", we list all scientists who worked in a pharmacological institute.[194] On the one hand, due to the large data set of 5110 in physiology or medicine, as well as a high number of listed nominations in chemistry, pharmacologists may have been overlooked. On the other hand, the definition of pharmacologists leaves room for interpretation - the decision criterion of "working at a pharmacological institute" theoretically also gives "non-pharmacologists" the opportunity to be mentioned here, a grey-zone is created. Gerhard Domagk (1895-1964), head of the pharmaceutical laboratory of I.G. Farben Industries in Elberfeld, is one of the scientists (Nobel Prize laureate 1939, Physiology or Medicine) to whom the definition of "pharmacologist" does not apply so well, who, however, based on his research, can be said to have a certain proximity to this discipline. Gerhard Domagk worked closely together with the pharmacologist Fritz Mietzsch (1896-1958), in the development of Prontosil (sulfonamide) as antibiotics, for which description of action and implementation in chemotherapy Gerhard Domagk was honored with the Nobel Prize in 1939.[195] Domagk was nominated in 1938, the last year a German scientist was nominated during the Nazi rule. In 1937 Adolf Hitler had forbidden Germans to accept the Nobel Prize. In November 1939, Domagk was arrested on the personal order of

[193] Pohar, M, Hansson, N (2021) Between two stools? Pharmacologists nominated for Nobel prizes in "physiology or medicine" and "chemistry" 1901–1950 with a focus on John Jacob Abel (1857–1938). Naunyn-Schmiedeberg's Archives of Pharmacology 394, 503–513. https://doi.org/10.1007/s00210-020-01993-0

[194] Pohar M, Hansson, N (2020) The "Nobel Population" in Pharmacology: Nobel Prize laureates, nominees and nominators 1901–1953 with a focus on B. Naunyn and O. Schmiedeberg. Naunyn-Schmiedeberg's Archives of Pharmacolology 393, 1173–1185. https://doi.org/10.1007/s00210-019-01807-y

[195] Henecka, H (1994) Mietzsch, Fritz, Neue Deutsche Biographie, vol. 17, 485, [Online-Version]; URL: https://www.deutsche-biographie.de/pnd117028754.html#ndbcontent (27.10.20, 19:10)

Adolf Hitler, who accused him of receiving the prize through banned international contacts.[196]

The strengths of the project lie in the basic structures. The focus is on the assessment of the Nobel Prize nominations. Through the connection of Prof. Hansson to Sweden and the Nobel Prize Institute and their staff in Stockholm, the best conditions for the analysis of the archive material were created. Since pharmacology has its origins in the Baltic States, the connection to the Latvian co-supervisors Prof. Juris Salaks and Prof. Lībiete creates excellent conditions to evaluate materials from the Baltic States. Due to the constellation of full-time studies at the Riga Stradins University in Latvia and the doctorate at the Heinrich Heine University in Düsseldorf, I occupied a key position between the supervisors and countries.

Although the Nobel Prize database is occasionally faulty reliable results can be determined because of the dataset size of several thousand nominations. When individual research was conducted, the available archive material was used to rule out sources of error.

[196] Crawford E (2000) Scientists and Hitler‘s Vendetta against the Nobel Prize, Historical Studies in the Physical and Biological Sciences, Vol. 31, No. 1, p 45

3.3 Conclusion – Importance of the work for pharmacology

This work is an addition to the processing of the history of pharmacology and the history of the Nobel Prize, and the first attempt to define the "excellence" of the main representatives in pharmacology.

One of the central findings is that pharmacology occupies a key position in the Nobel Prize context. In retrospect, scientists who are attributed to this scientific domain have a higher chance of being awarded a Nobel Prize.

Two educational strongholds can be identified: in the early years of the Nobel Prize, the hotspot was in Central Europe. In the 1930s it shifted to the United States of America. This is reflected in the high number of Nobel Prize nominations in physiology and medicine for pharmacologists assigned to central European countries and later to American universities. In addition, the study confirms the important role of German speaking universities[197] at that time and in the dissemination of pharmacology worldwide.

The study illustrates the lack of equality between men and women in nominations and awards. With one exception of Tu Youyou, all pharmacologists are male and mostly from Western world countries.

The analysis of arguments in the nomination letters for the Nobel Prize led to the conclusion that "excellence" in pharmacology is multifactorial. Besides evidencing "excellent" research, the Nobel Prize nominations include arguments of successfully establishing pharmacology as an independent discipline within medicine. The successful establishment of pharmacology is illustrated by the high number of students, the worldwide dissemination of pharmacological laboratories and of international journals that still exist today, full-time professorships, numerous academic honors, and eponyms of leading pharmacologists.

Furthermore, additional systematic research into "excellence" is necessary for other medical specialties. Just as the history of pharmacology benefits from this study, other disciplines will benefit similarly from future research into "excellence in medicine".

[197] Kuschinsky G (1968) The Influence of Dorpat on the Emerge of Pharmacology as a Distinct Discipline, Journal of the History of Medicine and Allied Sciences, Vol 23, p 271

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1. National Library Latvia, Riga, Latvia:
   Files about Oswald Schmiedeberg and his family:
   LNB Reto grāmatu un rokrakstu lasītava, RX12, 2, 5, lpp. 124-126

2. Archive of the University of Tartu, Estonia:
   EAA.402.2.22064 – Oswald Schmiedeberg

3. For the published articles:
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