

chemistry of the future." Until 1906, this had book reviews and also some abstracts. Indexes are annual, though often several volumes were published in a year; two collective indexes cover the period to 1906, when abstracts ceased.

Journal of physical chemistry, began at Cornell in 1896, and had abstracts till the Chemical Abstracts began in 1907. The annual volume has nine numbers, none in July, August and September.

Journal de chimie physique, founded at the University of Geneva, Switzerland, 1903, was started "to provide a central place of publication." After vol. 4, 1905, the abstracts become merely a subject index to the current literature of physical chemistry. Collective index for vol. 1-10.

The Russian journal of physical chemistry (this is on file at the University of Minnesota) has contained many important papers, some of which were also published in the Journal für praktische chemie.

B. Abstract, index, and review serials.

Here, we must depend chiefly on the general serials of these classes. There are two special ones however.

Biophysikalisches centralblatt, 1905-10, was then made a part of the Zentralblatt für biochemie und physik.

Physikalisch-chemisches centralblatt, 1904-09, and continued as Fortschritte der chemie, physik, und physikalischen chemie; this began at Darmstadt "as an international abstract serial for physical chemistry and the debatable land between chemistry and physics." Series 1 was abstracts, with annual index; series 2, is review in form, and has had one collective index, for vol. 1-5.

#### *Colloid chemistry serials*

There is at present only one, with a supplement containing papers of considerable length. R. Ditmar edited vol. 1 of the Zeitschrift für chemie und industrie der kolloide, 1906. Then it was moved to Germany, Wolfgang Ostwald became editor and has continued to be, except for a period of a year and a half when he was on military duty; then his wife, sister and brother ~~did~~ *edit* it. The name was changed to Kolloid-zeitschrift, in 1913; the supplement is Kolloid-chemische beihefte.

There are some abstracts in the Kolloid-zeitschrift, but not a complete set; much of the earlier work was published in the Zeitschrift für physikalische chemie. To obtain all references to literature, use the general abstract, index, and review serials.

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## LECTURE XI.

### THEORETICAL, PHYSICAL, COLLOID CHEMISTRY: BOOKS

The division between the first and second group is not definite, in all respects. Books will be discussed in the group in which their authors place them:

A. Theoretical

1. Historical

2. General

3. Special

B. Physical

1. General
2. Laboratory manuals
3. Special
4. Tables of data

C. Colloids

1. General
2. Brief, semi-popular
3. Special

A, 1. With regard to the practical value of this division of chemistry, Mendeleef says:

"By summoning adherents to the work of theoretical chemistry, I am confident that I call them to a most useful labor, to the habit of dealing correctly with nature and its laws, and to the possibility of becoming truly practical men." Nernst calls this, the theoretical treatment of practical processes.

Given a logical, orderly arrangement of facts observed and laws deduced in the study of chemical changes, with a historical examination of the chemical ideas and theories, we find in theoretical chemistry, a presentation of the main lines along which chemistry has advanced up to the present time.

Lothar Meyer's *Modernen theorien*, Ed. 1, in German, 1863, was written to justify and explain theory in chemistry to the workers in other sciences and "to prepare the way for physical chemistry." Ed. 5 was dated 1890, and several versions in English have been published. He tried to show that the views and ideas, new then, with hypotheses based upon them were necessary aids to chemical investigation.

Newer, is M. M. P. Muir's *History of chemical theories and laws*, 1907; Muir discusses the history of attempts to answer these questions:

What is a homogeneous substance?

What happens when homogeneous substances interact?

Freund, in her work, takes up the study of chemical composition; "I have tried to show how the empirical knowledge has been obtained, what the initial discoveries were, and how they were established."

A, 2. General

Brief discussions of theory are given in most of the general texts upon chemistry. Mendeleef has something, Willh. Ostwald also in his *Lehrbuch*. One of the larger early works was that of H. Buff, H. Kopp, and F. Zaminer, *Lehrbuch der physikalischen und theoretischen chemie*, Ed. 1, 1857, in which Kopp wrote the theoretical chapters; later as Ed. 2 this was published as vol. 1 of Ed. 4 of Graham-Otto's *Lehrbuch*, 1863. One of the best texts now is the most recent edition in English of Nernst, Ed. 7, first published as the chapters on theory in Dammer's *Handbuch der anorganischen chemie*, 1892. This work, called by its author "a brief presentation of the present state of physical chemistry and its most important aims" took as its title in the first separate edition "Theoretische Chemie" and was then described as a theoretical treatment of chemical processes for the investigator of physical chemistry.

A, 3. Here, Werner presents in his *Neuer anschauungen*, ideas upon the structure of inorganic compounds; Henrich, *Theorien der organischen chemie*, 1912, presents what was newest and fairly well accepted then. Studies of more recent date are in Stewart's two volumes on *Recent advances*, in organic, and in physical and inorganic, respectively. See also, Cohen, *Organic chemistry*, Ed. 2, 3 volumes, 1919.

B, 1. Physical chemistry is claimed with some reason by the mathematician, physicist, and the biologist, while the engineer sees it from his own viewpoint. We may assume it to be chemistry, used in other scientific fields.

Ramsay says: "When the laws or generalizations regarding properties of matter depend not merely upon the masses or rates of motion of the objects concerned, but also upon their composition and chemical nature, their consideration falls under the heading 'physical chemistry'." This gives us nearly every problem in science.

Kekulé in the early seventies told his classes at Bonn that chemistry had reached its limit, the dead point, without any prospect then visible, of new advances. This was shortly after disproved brilliantly by one of his own students, van't Hoff, who by his development of structural formulas, gave a new field to the organic chemist.

Stange, 1908, says: "Chemistry by the introduction of physical methods, calculation, measurement, weighings, has been made, in so far, an exact science, and the influence of physics here must not be underestimated; however, that relations exist between the chemical and physical properties of substances, was known long before the time of Lavoisier."

Differentiation of physical chemistry from physics and general chemistry began about 1830, though much work before that forms an important part of the subject. Hermann Kopp, the historian, and 1851-71 one of the editors of the *Annalen*, was one of the early workers here, as instanced by the book noted above, as well as many papers.

Wilhelm Ostwald, Walther Nernst, Beckmann, Berthelot, Ramsay, van't Hoff, Arrhenius, Gibbs, are some of the notable men.

The work of Nernst has been considered the standard; Lewis's *Physical chemistry*, new edition, 1919, 3 volumes, may replace it.

One man deserves special attention, J. H. van't Hoff, 1852-1911, native of Holland, where he had his college training, and later a student under Kekulé, and Wurtz; professor of chemistry at Amsterdam, 1878-95, and at University of Berlin, 1896-1911. He refused to be termed a physical chemist, yet his *Lectures*, Ed. 2, in 3 volumes, and researches did much for it. He was described, when given the degree of LL.D. at the University of Chicago, in 1902, as "Founder of the theory explaining the space relations of atoms, master in the field of dynamic chemistry, investigator of renown in the domain of the modern theory of solutions."

Jellinek began in 1914, to publish what he promises will be a comprehensive reference text of the subject "for mature students of physical chemistry, physics and chemistry, and investigators." Two volumes are here.

Washburn is the most recent one-volume work: older are Bigelow, revised editions of Walker, and Morgan; with Jones, Ramsay, Reychler, and Speyer before 1900.

B, 2. Laboratory manuals. The newer ones include Phillips, Pring, and perhaps the best one Findlay, *Practical physical chemistry*.

#### *Special works*

B, 3. Here may be included Mellor, *Chemical statics and dynamics*, also

Ed. 4 of his text, Higher mathematics for students of chemistry and physics, Partington's similar book, and his text on thermodynamics. Sackur, Planck, van der Waals, have done valuable work. For gas reactions, Haber, and Jellinek; for biology, Höber on cells and tissues, Robertson on proteins, Koranyi and Richter on applications in medicine.

The German series called Handbuch der angewandte physikalische chemie has about 12 volumes, among them being translations of Desch, Metallography, and Findlay, Phase rule. Monographs on physical and inorganic chemistry, a new series in English, edited by Findlay is similar, consisting of special volumes by authorities.

The older English series, edited by Ramsay, Textbooks of physical chemistry, contains, besides many other works, the first editions of Desch, Findlay, and Lewis.

B, 4. Tables of data. Elaborate tables are found in the Landolt-Börnstein, Physiko-chemische tabellen, now in Ed. 4, and this is supplemented by 1910-12 volumes, giving work newly published in those years, of the Tables annuelles, an international undertaking.

The tables by the Société française de physique, 1913, are more recent. A substitute in English is suggested.

Castell-Evans, in two volumes gives considerable material, solubilities are in Seidell, and Comey. The smaller handbooks as Van Nostrand, Chemists' Yearbook, etc., do well, but are not comprehensive.

C. Colloids. This phase of chemistry dates from the work of Graham in the sixties, when he called attention to the colloidal, i. e. glue-like, state of matter; this is characterized by lack of definite form, and peculiar chemical behavior. Various theories have been offered, with designations as dispersion, suspension, solution, etc. Wolfgang Ostwald, in 1906, proclaimed it as "the chemistry of the twentieth century."

Cassuto, 1911, says: "Investigation of colloids depends on the solution of this problem (first proposed by Wolfgang Ostwald) 'To determine in what manner the chemical and physical properties of a substance depend upon the degree of its dispersal'—", meaning by dispersal the fineness of division and degree of separation from each other in space of the most minute particles.

C, 1. Wolfgang Ostwald is perhaps the leading authority today on colloid chemistry. His book is here in English and in German. Taylor, Chemistry of colloids, 1914, and Cassuto, 1913, are general works.

C, 2. Brief texts, available in English are Poschl, 1901, for ceramists; Rohland, 1913; Hatschaek, Ed. 2, 1916.

C, 3. Special works. Perrin's Studies of the Brownian movement of particles, first published in Annales de chimie, are also in book form in English and German. Bemmelen's volume upon absorption and soil colloids, has an introduction by Wolfgang Ostwald.

Solid solutions are discussed by Bruni, and inorganic colloids by Lottermoser in vol. 6 of Ahrens' Sammlung, 1901. Müller, in Zeit. f. anorg. chemie, 1904, gives a select bibliography of 356 titles, while Arrhenius, 1913, adds to his Theory of solutions a 12-page list of select references on colloids. Burton, Col-

loidal solutions, 1916, is one of a new English series on physics, but several volumes are of interest to chemists.

Colloids in relation to biology and medicine are taken up by Bechhold, 1912, Pauli on muscles, Freundlich in his *Kapillarchemie*, and in the work on physical chemistry by Koranyi and Richter, 1907-09.

Arndt, Ed. 2, 1911, touches on some uses of colloids in the industries, and more is given in the second part of Zsigmondy and Spear, *Chemistry of colloids*, 1917. The possibilities in the way of technical applications have not been developed.

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## LECTURE XII.

### BIOCHEMISTRY (PHYSIOLOGICAL CHEMISTRY)

The literature for this phase, the chemistry of living matter is, like that of theoretical and organic, scattered through all the serials in general, and even in some of the pharmacological serials.

The class number assigned to it most specifically puts it with physiology, 612.01, and serials in 612.05, but some books are attracted to 547, and some to 615, while some serials have been placed in 540.5, because the chemical side was emphasized in the title, preface, or first number.

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| A. Books.   | 1. <b>General</b>                      | 2. Laboratory manuals    |
|             | 3. <b>Monographs on special topics</b> | 4. Encyclopedic works.   |
| B. Serials. | 1. <b>Original papers.</b>             | 2. Abstracts and reviews |

A, 1. Books, **General**. The most recent now is Ed. 2 of Mathews; the new edition of Abderhalden *Lehrbuch* in two volumes, is in German only as yet; Hammarsten, in the most recent English version is good. Lambling, 1911, is small, but the latest edition of Long is rather too old. Bottazzi, 1902, is only in German here.

Hoppe-Seyler-Thierfelder, in the 8th German edition, is a reference book rather than a general text, being almost a miniature Beilstein for biochemistry.

A, 2. Laboratory manuals. Some of the newer ones are Hawk, Ed. 1918; the new revision, 1918, of Plimmer called *Practical organic and biochemistry*. A few years older, and much less in size are Cole, and Salkowski, in English, and Abderhalden's *Physiologische praktikum* in German.

A, 3. Monographs. Here we must consider as most important the series, in English, of *Monographs on biochemistry*, published by Longmans, Green & Co., small, moderate in price, re-edited often, with excellent literature lists, and covering nearly all the more general fields of biochemistry.

There are a host of other works, on metabolism, pharmaceutical effects of drugs, enzyme action, dynamic biochemistry, nutrition and its special problems, amino acids, too many to be enumerated here.

Similar to the English series noted is the German one published as Oppenheimer's *Handbuch der biochemie*, but its less easily revised form makes it not quite so nearly kept up to the recent advances.

A, 4. Encyclopedic works. Here Abderhalden is responsible as editor for the two largest. His Handbuch der biochemisches arbeitsmethoden duplicates some parts of Oppenheimer, but in the main it is a working encyclopedia for all sorts of procedures in biochemistry. The nominal 8 volumes make a shelf full.

The Biochemisches handlexikon, with its continuing supplements, is modelled after Beilstein in part, but it goes into more detail, and is more recent for many organic substances; it has no collective index. The volume indexes, and references for each substance are both very complete. Structural formula are given in many cases.

B, 1. Serials, containing chiefly original papers. Before 1877, there was no important special serial. In that year, Hoppe-Seyler's Zeitschrift für physiologische chemie was started. In the first ten volumes there were some brief abstracts, but none since. There are one to four volumes a year with two collective indexes, covering the first 60 volumes. Hofmeister's Beiträge für physiologische und pathologische chemie, original papers only, 1902-08 in eleven volumes, with collective index for v. 1-10, was then merged in the Biochemische zeitschrift, 1906 to date. The latter has had 11 volumes in a single year, has two collective indexes, for the first sixty volumes.

Abderhalden is chief editor of the Internationale zeitschrift für physikalisch-chemische biologie, and his own Fermentforschung, both dating from 1914, the latter particularly for work on the protective ferments.

Much work on physiological chemical topics has been published in the German serials on physiology and medicine, notably these:

Archiv für die gesamte physiologie (Pflüger),  
Archiv für pathologische anatomie und physiologie (Virchow)  
Archiv für experimentelle pathologie und physiologie  
Archiv für physiologie (Bu Bois-Reymond)  
Ergebnisse der physiologie  
Zeitschrift für klinische medicin.

In English, the oldest and most valuable serial, for this field only, is the Journal of biological chemistry, founded by C. A. Herter and J. J. Abel in 1905. It has only original papers, has a collective index for vol. 1-25, and publishes several volumes a year. It has usually contained the proceedings of the American society of biological chemistry, pagged separately.

Biochemical bulletin, 1911-16, quarterly from Columbia university has not appeared for nearly three years, and seems dead. It had some abstracts, more like a mere index by subjects though, and gave news items, personal largely. The Biochemical journal, 1906 to date, University of Liverpool, no abstracts, collective index for vol. 1-10, pays much attention to plant chemistry.

The Journal of physiology (English) and the American journal of physiology contain, especially for earlier years, much on physiological chemistry.

The Journal of laboratory and clinical medicine, published in St. Louis, 1915 to date, has some excellent physiological chemistry material. The Journal of pharmacology and experimental therapeutics is likewise nearly physiological chemistry.

Stray papers on the subject appear in nearly every one of the serials on general chemistry, but this holds chiefly for the time before 1910.

B, 2. Abstract, review and index serials for biochemistry. The principal index serial to be considered is the Index Medicus, 1879 to date; it is particularly helpful for papers appearing on pathological topics, and those not in the usual biochemical serials.

The section in the International catalogue to scientific literature: chemistry, has some good material for the time it covers, being very complete, 1901 to 1913. References may be found also in the Index-catalogue of the U. S. Surgeon-General's office, since this includes serial articles as well as books.

Abstract serials, before 1870, were not specialized; use the general ones for chemistry, medicine and physiology.

The oldest biochemical one is Jahresbericht über die fortschritte der tierchemie . . ., annual volumes with annual and ten-year indexes. It is very complete, but like the Jahresbericht (Liebig and Kopp) for general chemistry, because of its completeness, is late to appear. It includes theses as well as books and serial articles, listing everything and abstracting the more important papers.

The Zentralblatt für biochemie und biophysik, 1902-date, formerly Biochemisches zentralblatt, had for the first few years, one long review or original article in each number, but has now only abstracts. There are volume indexes and one for vol. 1-9. A special feature is the giving the titles in the language of the original paper.

The serial now called Zentralblatt der experimentelle medizine, started in 1900 as Centralblatt für stoffwechsel- und verdauungskrankheiten, has good abstracts, always with emphasis on the side of nutrition and metabolism. It has annual or semi-annual indexes, but no collective ones.

In French, good abstracts are found in the Journal de physiologie et de pathologie générale, and in Archives italiennes de biologie; both these are in the Natural History library.

In English, the Journal of the chemical society abstracts, the U. S. Experiment station record for 1889 to date, the Chemical abstracts, all are useful. Physiological abstracts, vol. 1, 1916, is the best in English at present.

#### INTERLIBRARY LOANS

There is at present among practically all American scientific and university or college libraries, a system of loans, by which books are made available to more users. Intelligent use of this requires some idea of where the books on a given subject may be had. For example, the University of Minnesota takes the Russian journal of physical chemistry. Probably the best general collection of all sciences, west of Washington, is at the John Crerar library in Chicago. The Lloyd library, a private collection in Cincinnati, is particularly rich in pharmacology. The Carnegie library in Pittsburgh has a very well equipped technology department, which also publishes a Technical book review index, mainly to index reviews as a guide to purchases.

They prepare subject bibliographies on technical topics, and have published a subject index to their classed catalog for technical literature.

Serial lists, on the cooperative plan, showing what serials are taken and in

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which libraries they are, have been published for Chicago, Washington, and several other cities and centers for education and research.

The University of Illinois serial list, of 1911, is helpful here; it is being revised to bring it up to date. A copy is on the desk in the Chemistry library, with the location of those serials, most often called for by chemists, showing which department library they are in.

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*Knowing books exist is not enough—they must be used.*