point singularities it would be helpful to remark that there are two ways to tackle the multi valuedness of functions involving logarithms or fractional powers, either by suitably restricting or by extending the complex plane by endowing it with an appropriate Riemann sheet structure. In this context, it would also not be amiss to include a reference to a recent book by A. K. Kapoor, *Complex Variables: Principles and Problem Sessions* (World Scientific, 2011) for further details.

- In the section on eigenvalues and eigenvectors of a matrix in the chapter on linear vector spaces, there is no indication that an arbitrary $n \times n$ matrix may not have n linearly independent eigenvectors. Further, inclusion of only those examples where the eigenvectors do indeed form a basis, may mislead a student into believing that this is always so. Again, in the section on simultaneous diagonalization of matrix, for emphasis, a remark to the effect that the ensuing discussion presumes that the matrices in question can be diagonalized individually would be helpful. Further, in the section on matrix representations of linear operators, before proceeding to representations in an orthonormal basis it would be appropriate to note that while a linear operator can be represented by a matrix in any basis, its abstract properties are more manifest in its representation in an orthonormal basis: unitary operators are represented in an orthonormal basis by unitary matrices, self-adjoint matrices by hermitian matrices, etc. Also in the discussion on transformations of operators on page 249, a few lines on active and passive points of views would be in order.
- In chapter 3, which deals with series solutions of second order differential equations, it would be appropriate to introduce the Gamma function right away rather than wait till chapter 5 and tell the reader then and there how to write down the solution of essentially one step recursion formulae with polynomial coefficients in terms of Gamma functions. This would not only save space in the text but also save the reader from working out each individual term and then guessing the structure of a general term.
- The opening section on boundary value problems could do with some remarks on partial differential equations, boundary conditions and their classification in a more general setting. Similarly in the chapter on special functions some effort should be made to present a unified view of all classical orthogonal polynomials rather than treating each system case by case.
- In putting together the postulates of quantum mechanics as done on page 253, it should be made clear that the discussion therein applies to systems with one (or more) cartesian degrees of freedom . This is essential as otherwise a naive reader may be led to believe that one has a commutation rule as in equation (7.147) even for finite state quantum systems. As a matter of fact I would rather leave a detailed discussion on postulates of quantum mechanics to a more specialized book and confine myself to outlining, in a qualitative way, how the notions of wave-particle duality eventually found place in the Hilbert space structure of quantum mechanics.

These remarks notwithstanding, which, as noted earlier, are meant for future use, the book under review in its present form is a useful and a quality text book on mathematical physics designed to cater to the needs of physics students at B Sc honours and M Sc level in almost all Indian universities. The publishers would add enormously to its value by having it carefully proof read. I for one would be more than willing to supply them my compilation of the typographical errors as a step towards this worthy cause.

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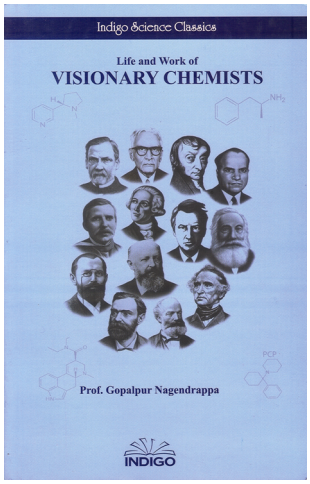


Life and Work of Visionary Chemists. Gopalpur Nagendrappa. Indigo Science Classics, Bangalore. 2014. 203 pp. Price: Rs 160.

Consider the following statements:

1. All substances are made up of atoms of elements.
2. When a substance burns in air, it undergoes a reaction with oxygen.
3. When a plant grows, it assimilates carbon from the air; not from the soil.

To most people, these would seem like common knowledge. But, if you think about it, they are not simple observational facts like 'the sky is blue' or 'the length of days is shorter in winter than summer'. In fact, they were absolutely not obvious 300 years ago. The genesis of each of them involved a long and very interesting set of events: a history intertwining human creativity, social circumstances and serendipity.

Life and Works of Visionary Chemists takes the readers through this history, looking at the lives of scientists who helped formulate the statements above and many other chemistry concepts that we take for granted today. The book is a collection of articles on thirteen scientists who lived between 1743 and 1981 and participated in significant moments in the history of modern chemistry (chemistry after the mid eighteenth century). Each article combines the biographical sketch of a scientist with his contributions to the field. (Women's contributions to chemistry, with rare exception, are not mentioned – unsurprising given the period that the book considers.) The foreword by the author describes the primary goals of the book as presenting chemistry as a human activity, locating scientific ideas

in their historical contexts and inspiring young students through scientists' stories. To this end, the biographical information and the scientific ideas are presented in a manner accessible to students and lay readers. To add interest, the author includes images of postal stamps commemorating most scientists. Together, the articles also give insight into interlinks between scientific developments and larger socio-political history.

The biographies are arranged chronologically by date of birth and begin in the mid-eighteenth century with Antoine-Laurent Lavoisier who is considered the 'Father of Modern Chemistry'. This period of the gradual invalidation of alchemical beliefs is an appropriate and traditional starting point for the development of modern chemistry. The alchemist's research lacked preciseness in the procedures that were followed and had elements of mysticism and immeasurable quantities like phlogiston. Lavoisier's contributions helped develop the logic of chemistry to be closer to what we have today. His achievements, the highlights being disproving the existence of phlogiston, and discovery of the role of oxygen in combustion (1789), are described well as is the context of the French revolution when he lived and worked.

The next several biographies look at discoveries that have fundamentally shaped the way chemists understand the material world. While the biographies focus on contributions and breakthroughs of individuals, also apparent are the manner in which scientists learnt from their seniors and peers, and scientific knowledge moved across Europe. Germany, France and England are the key locations where chemistry evolved until the late nineteenth century.

Following Lavoisier (France) are the stories of Amedeo Avagadro (Italy) and then Justus Frieherr von Liebig (Germany). Liebig's contributions as a scientist and as an educator are discussed in great detail. Liebig is regarded as the first scientist to institutionalize chemistry research in groups with assistants headed by a professor – a model that is practiced even today. His work on isomerism sowed the seeds of representing molecules by structural formula. Also included is the biography of Liebig's student, Kekule (Germany), who developed this research further; direct quotations from Kekule's description of his dreams make that piece interesting. Louis Pasteur's (France) biography includes a lucid discussion of his insight in 1849 to attribute the two opposite optical rotation properties of molecules with the same molecular formula to different structures.

These first five biographies, describing closely linked scientific advances, offer a fairly coherent picture of the field of chemistry from the mid-eighteenth to the mid-nineteenth century. The following chapters are less interwoven, beginning to read more as a collection of unrelated biographies of chemists rather than a continuous narrative. However, some loose themes emerge.

The next three scientists included are Alfred Nobel (Sweden and France), and organic chemists Adolf von Baeyer (Germany) and William Henry Perkin (England). A shared significance among the three is their involvement in the industrial application of chemistry research. Nobel's biography straddles his research to make a socially relevant product – dynamite, its astute business application, and the social outcry against its destructive consequences that ultimately led to the founding the Nobel Prize. Baeyer's work of synthesizing indigo is told in the context of its political repercussions in India: the invention made indigo farmers in India undergo severe economic hardship, and led to the country's first civil disobedience movement headed by Mahatma Gandhi against the British government in 1917. Even before Baeyer, Perkin had accidentally synthesized the first chemical dye – Mauveine – and patented it in 1857, after which he continued to research and manufacture dyes.

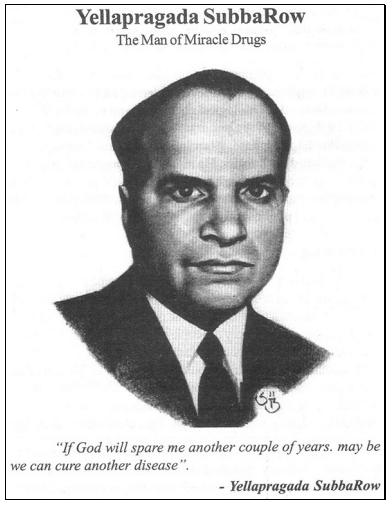
Three Nobel Prize winners are discussed in the subsequent chapters: Jacobus Henricus van't Hoff (Holland and Germany) known for his contributions to physical chemistry; Hermann Emil Fischer (Germany) whose research was on purines; and Ernest Rutherford (New Zealand and England) who proposed the 'nuclear atom model' in 1911. (Incidentally, Fischer was a student of Baeyer who also received the Nobel Prize). Beginning in the mid-nineteenth century and ending in the second decade of the twentieth, the shadows of the changing political landscape loom large in these six biographies – from the Crimean war to the World War I.

The last two chapters are on two Indian chemists, Yellapragada SubbaRow and Krishnaswami Venkataraman, whose scientific contributions were made in the mid-twentieth century. SubbaRow's work on folic acid and antibiotics is well detailed as is the strife of his life as an Indian in the American academic world of the early twentieth century. Venkataraman, who worked on dyes, is presented primarily as an institutional builder and administrator.

In presenting biographies of certain scientists, the chapters also gesture towards the history of certain concepts in chemistry as well as of its institutional development: emergence of sub-disciplines such as organic chemistry and physical chemistry; standardization of research groups and laboratory design; beginning of publications, patents and prizes; the role of entrepreneurial and industrial activity; the establishment of research institutions in independent India, etc.

As a work of science communication by a practising chemist, the book is an appreciable gesture that perhaps other scientists should emulate. However, as an introduction to eminent scientists or to the field of chemistry, the book has acute shortcomings. Given the prominence of first eleven chemists, it is not difficult in today's networked age to find information on their biographies or their work. The publication of a book on the subject would have been more valuable had it drawn upon primary sources or come together as one narrative to tell a coherent history of chemistry – which *Visionary Chemists* does not.

As it stands, the book suffers from a lack of clarity as to why a particular set



of scientists was included, why other equally significant ones were omitted, or what overarching narrative it aims to follow. Further, the selection of scientists leans towards the subject of organic chemistry, perhaps reflecting the author's enthusiasm for the subject rather than key developments in chemistry. Overall, the book remains limited to a large extent to being just the sum of its parts – a compilation of previously published articles by the author.

The absence of an efficient editorial hand is felt throughout. The lack of uniformity in the format across the thirteen chapters adds to their disjointedness. It would have helped for the chapters to be heavily edited to adhere to a particular order of presentation, kinds of biographical details or even chapter lengths. The book is also full of editorial errors to the point of distracting an interested reader. Spelling mistakes and typos are common. The most glaring oversights are in the last chapter on Krishnaswami Venkataraman where information is repeated, almost verbatim. See, for example, the last paragraphs on pages 187 and 193, and sentences about Venkataraman's nickname being 'the father of dyestuff research in India' on pages 189 and 192. An entire page, number 181 is missing.

Despite these flaws, the publication is valuable as a printed book (rather than an online source) for young readers. As a compilation of short, accessible biographies, it may serve to pique the readers' interest to further study chemistry (or science) in its historical contexts. Excerpts from the book can also prove useful as supplementary readings in high school science classes. Given the lack of contextual information in school and early college science curricula, books such as these can play an important role in helping students appreciate the bigger picture within which science operates.

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