Linus Carl Pauling

Born in Oswego, Oregon, USA on 28 February 1901. Bachelor's degree in Chemical Engineering from Oregon Agricultural College at Corvallis.

Ph.D. at California Institute of Technology, under the guidance of R G Dickinson. Solves many mineral structures.

Pauling tours Europe in 1927 just after the formulation of quantum mechanics. Meets leading physicists like Sommerfeld, Bohr, Pauli, Schrödinger and Bragg. Gets first hand knowledge of Heitler and London's classic work on the hydrogen molecule.

Joins CalTech as an Assistant Professor in 1928. He begins with a spectacularly creative year, with three major contributions:

(i) In a paper entitled 'The coordination theory of the structure of ionic crystals' , he formulates the rules governing the structures of complex ionic crystals. The first rule: 'A coordinated polyhedron of anions is formed about each cation, the cation-anion distance being determined by the radius sum and the coordination number of the cation by the radius ratio'. He goes on to provide a table of ionic radii and the preferred coordination numbers and geometries for various ions.

(ii) In a review, Pauling points out that the Heitler-London treatment provides a quantum mechanical basis for the electronic theory of the covalent bond proposed empirically by G N Lewis. Pauling emphasises the importance of exchange energy in covalent bond formation and uses the term *resonance*.

(iii) In another paper, Pauling introduces the concept of orbital hybridisation. He notes that the quantised energy levels for atoms which physicists use for interpreting atomic spectra are unsuitable for describing shapes and stability of simple molecules. He suggests the use of hybrid orbitals which lead to stronger bonds with directional character.

From 1931, Pauling publishes a series of papers on the nature of the chemical bond. He begins with the rules for forming 2-centre 2-electron bonds. He uses the idea of resonance involving covalent and ionic structures to interpret the properties of partially ionic compounds. He proposes the concept of electronegativity and provides a quantitative scale (whose basic features have remained intact despite numerous modifications over the years by other workers). Pauling provides a simple description of bonding in aromatic compounds, like benzene and naphthalene using resonance. He uses experimental thermochemical data to derive resonance energies for a large number of conjugated systems. He discusses the anisotropy of magnetic susceptibilities in aromatic compounds. He recognises the planarity of the amide bond, and, of course, its origin (resonance).

He summarises his theories in the classic book *The Nature of the Chemical Bond* in 1939. With virtually no equations (has them all in another book, co-authored with E B Wilson, *Introduction to Quantum Mechanics, with Applications to Chemistry*, published in 1935), he gives a comprehensive

account of various types of bonds and their implications for structures and energies. He does not leave out weak interactions like van der Waals forces and hydrogen bonds, but ignores molecular orbital theory.

With the strong belief that all biological phenomena must have a molecular origin, he begins to investigate oxygen binding to haemoglobin using magnetic measurements. In 1940, he proposes the template theory for antibody diversity. The same year he publishes a seminal paper with M Delbruck with the suggestion that active sites of enzymes are complementary to reaction transition states (and not just to the substrate). This insight opens up the field of catalytic antibodies four decades later. In 1949, he proves that sickle cell anemia is a 'molecular disease', a single mutation being responsible for the profound physiological disorder. Pauling's lasting contribution to molecular biology is his systematic analysis of polypeptide structures. The α-helix and β-sheet motifs which he identified have proved to be important structural elements in proteins.

In 1954 Pauling is awarded the Nobel Prize in Chemistry "for his research into the nature of the chemical bond and its application to the elucidation of the structure of complex substances".

In the 1950's, Pauling actively protests against nuclear testing and warns the world community of the dangers of nuclear radiation. He comes out with the book *No More War!* in 1958. He sends an appeal to the United Nations on nuclear test ban and disarmament. He invites the wrath of the establishment by his participation in the peace movement.

Linus Pauling, "campaigner, especially for an end to nuclear weapons test" is chosen for the 1962 Nobel Prize for Peace (awarded in 1963). The award increases official harassment. He quits CalTech in 1964.

In 1970, Pauling springs back to public prominence through his monograph *Vitamin C and the Common Cold*. Many prestigeous medical institutions dispute the benefits of megadoses of ascorbate and even cite possible harmful effects. Pauling answers with the book *Vitamin C, the Common Cold and the Flu*. The debate becomes acrimonious after his next book (co-authored with E Cameron) *Cancer and Vitamin C*. The simple remedy of supplemental usage of ascorbate is advocated which would 'not only make the patients more resistant to their illness but also protect them against some of the serious and occasionally fatal complications of cancer treatment '. Pauling is denounced by the medical establishment, but wins popular support. After all, at 86, he can write the book *How to Live Longer and Feel Better*. In 1990, the National Cancer Institute, Bethesda, USA sponsors a conference on 'Ascorbic acid: biological functions and relation to cancer'. A summary of 90 studies concludes favourably on the protective effects of vitamin C. Pauling also presents a paper.

In 1994, the greatest architect of modern chemistry, a founder of molecular biology, and an irrepressible crusader for peace, breathes his last.

J Chandrasekhar