INDIAN NATIONAL SCIENCE ACADEMY INSA PLATINUM JUBILEE By: Arvind Gupta Pix: Karen Haydock

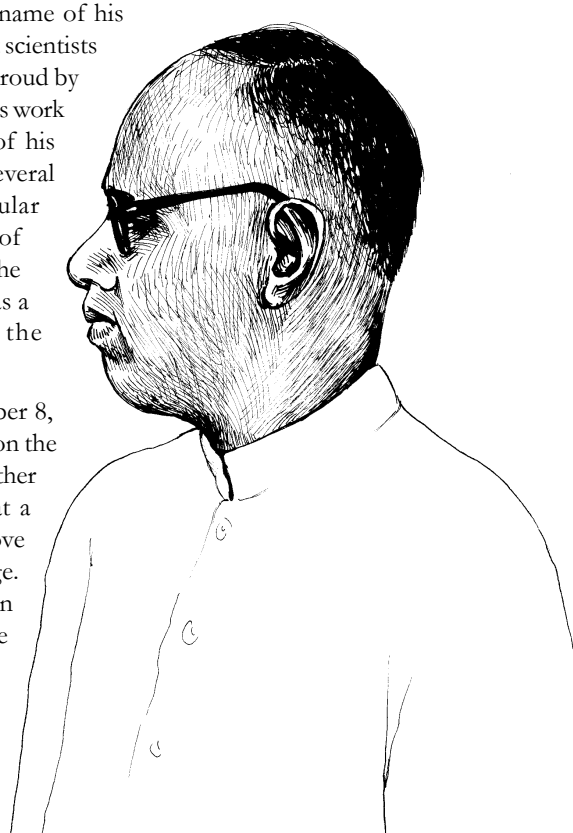
G. N. Ramachandran

(1922 – 2001)

"If you think you know it, then you do not know it, and if you know that you cannot know it, then you know it".

– G. N. Ramachandran

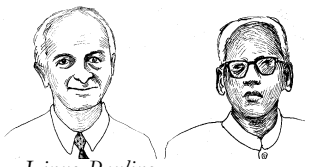
G. N. Ramachandran ('G' stands for Gopalasamudram, his native town, and 'N' stands for Narayana Iyer, the name of his father) was one of the most brilliant scientists of the 20th century who did India proud by his research. Ramachandran did all his work in India following the footsteps of his mentor C.V. Raman. He made several important discoveries in molecular biophysics, especially in the study of protein structure. His discovery of the *triple helical* structure of collagen was a fundamental advance in the understanding of peptides.



Ramachandran was born on October 8, 1922, in a small town near Cochin, on the south-western coast of India. His father was a Professor of Mathematics at a local college and gave young Ram a love for mathematics at a very young age. He would bring books on mathematics from the library and give

Ram a challenging theorem to prove every day. He would write equations and ask Ram to solve them. So, Ram was quite well versed in advanced maths from his young days. No wonder he got a perfect score of 100 in all his mathematics examinations. Ramachandran graduated in 1942 topping the BSc course of the University of Madras. Among the teachers in St. Joseph's College who stimulated Ramachandran's interest in physics were P.E. Subramaniam and a Jesuit priest, Father Rajam.

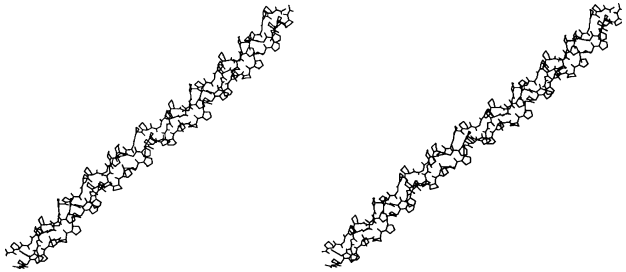
His father wanted him to join the Indian Civil Service, but it did not interest him. Later he was packed off to Delhi to appear for the Indian Railway Engineering Service Examination, in which he deliberately performed badly and failed. In 1942, Ramachandran joined the Master's program in Electrical Engineering at the Indian Institute of Science at Bangalore. But he was soon brought into the physics department by Sir C. V. Raman. Within a week of joining Raman gave him Rayleigh's paper and an important problem to solve. Within a day Ramachandran wrote the mathematical equations and worked out a rigorous proof. This made Raman very happy. Under Raman's guidance Ramachandran did post-graduate research in the areas of optics and X-ray topography. Raman was overjoyed by the brilliance of his student.



Linus Pauling
Is a name to conjure with,
In chemical bonding
And whatever forthwith
Follows for all matter,
Both inanimate and alive
Their nature and character
And how they will behave.
His great alpha helix,
That opened the path
For the solution of structures
Of all biopolymers,
Is a star that will adorn
The firmament of Science,
For it has revealed to biologists
Completely new ways.

In 1947, Ramachandran went to the Cavendish Laboratory headed by Sir Lawrence Bragg. At Cambridge he worked with W. A. Wooster and H. Lang on crystallography and developed a mathematical theory for determining the elastic constants of crystals from measurements of diffuse X-ray reflections. He received a PhD from Cambridge University in 1949. While in Cambridge, Ramachandran met Linus Pauling and was deeply influenced by his lectures on modelling studies of peptide chains. He even wrote a poem on Pauling (at right).

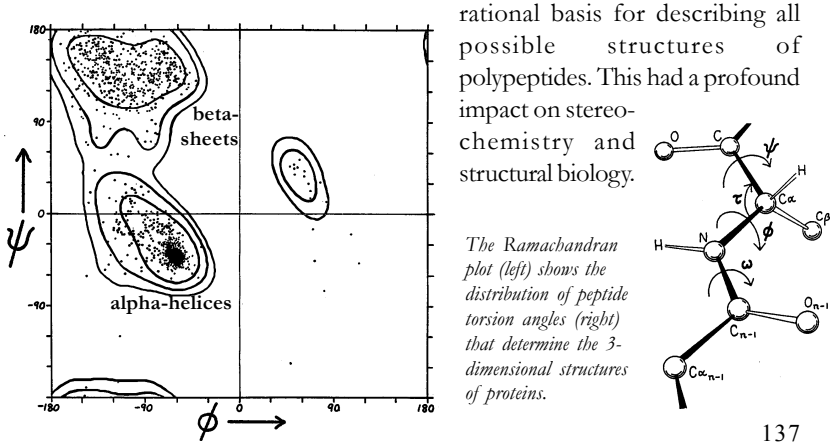
Ramachandran returned to Bangalore in 1949 and worked as an assistant Professor in Physics until 1952. At that time Sir A. L. Mudaliar, the Vice-Chancellor of the University of Madras and a visionary wanted to start an experimental physics division at Madras and invited Sir C. V. Raman. Raman declined and recommended Ramachandran for the position. Thus in 1952, Ramachandran became a professor of physics at the University of Madras at a young age of 29. The generous assistance and support provided by Sir Mudaliar enabled Ramachandran to set up a fully equipped modern X-ray crystallographic laboratory at Madras.



This is a stereo-view of the molecular structure of the backbone of collagen. If you cross your eyes while looking at it, you should be able to see the structure in 3-dimensions. You can see the three strands of polypeptides that wind around each other to make the helix.

Ramachandran concentrated on solving the structure of collagen, the most abundant protein connective tissue. Using collagen samples from kangaroo tail tendon, and assisted by his first post-doc student, Gopinath Kartha, he produced X-ray diffraction patterns from the collagen fibres. Using experimental data they built a ball-and-stick model of collagen structure and published a paper in *Nature* in 1954. Subsequently they revised the model giving rise to the now famous coiled coil structure.

Ramachandran and his colleagues laid the foundations for the analysis of polypeptide chains. They introduced a two dimensional map what is today known in bio-chemical literature as the *Ramachandran plot*, which provide a rational basis for describing all possible structures of polypeptides. This had a profound impact on stereo-chemistry and structural biology.



The Ramachandran plot (left) shows the distribution of peptide torsion angles (right) that determine the 3-dimensional structures of proteins.

Ramachandran resigned from Madras in 1970 and then spent two years as a visiting professor at the Biophysics Department of the University of Chicago. During this visit he devised a new method to reconstruct three-dimensional images from two-dimensional data, thus laying the foundations of computerized tomography. On his return from Chicago Ramachandran joined the IISc and set up the Molecular Biophysics Unit (MBU). In 1977 he visited the National Institute for Health in Bethesda, Maryland, USA as a Fogarty Scholar. In the same year he was elected a Fellow of the Royal Society, London. He retired from MBU in 1978 but continued as a Professor of Mathematical Philosophy at the IISc until 1989.

From the early 1980's he developed Parkinson's disease and was cared for by his wife Rajam whom he married in 1945. In 1998, Rajam suddenly died of a heart attack and this was a grievous shock from which Ramachandran never recovered. In 1999, the International Union of Crystallography awarded him the 5th Ewald Prize for his outstanding contributions to crystallography. In 1999 he had a cardiac arrest and since then remained in the hospital until his death on 7, April 2001. He is survived by two sons, Ramesh Narayan (Professor of Astrophysics at Harvard University) and Hari (Institute for Plasma Research, Ahmedabad) and a daughter Vijaya (Professor of Computer Science, University of Texas at Austin).

Ramachandran was a man of many talents. He was deeply interested in classical music – Indian and Western as well as the philosophical systems of India and the West. He suffered serious psychiatric problems during most of his adult life. Fortunately they did not impact on his scientific creativity or productivity. Ramachandran was clearly a *Nobel Class* scientist and it is surprising that he was not given any civilian award by the Government of India. Because collagen is the basic component of leather, the Central Leather Research Institute (CLRI) in Chennai has named the building housing its auditorium *Triple Helix* after the triple helical structure of collagen discovered by Ramachandran in 1954.