

José N. Onuchic

José Onuchic grew up in São Carlos, Brazil, where his parents were both mathematics professors at the local campus of the Universidade de São Paulo. There he obtained bachelor's degrees in electrical engineering (1980) and physics (1981), followed by a Master of Science in applied physics in 1982.

Onuchic studied for his Ph.D. at the California Institute of Technology (Caltech) with John Hopfield as his supervisor. After graduating from Caltech in 1987, he returned to Brazil as an assistant professor at the Universidade de São Paulo. In 1990, he was recruited by the physics department at the University of California, San Diego (UCSD) to establish a theoretical biological physics group.

Since 2002, Professor Onuchic has co-directed the Center for Theoretical Biological Physics (CTBP). CTBP is an NSF Physics Frontiers Center that encompasses a broad spectrum of research and training activities at the forefront of the biology-physics interface; including molecular biophysics, statistical biophysics, and biological dynamics at the cellular/multicellular scale. This interdisciplinary approach includes physicists, chemists, mathematicians and biologists and it has created a better understanding of the underlying mechanisms governing complex biological systems.

Onuchic joined the faculty at Rice University in July of 2011 where he relocated the NSF Physics Frontiers Center - the Center for Theoretical Biological Physics. Currently, Onuchic is the Harry C. & Olga K. Wiess Professor of Physics and Astronomy, Professor of Chemistry and Professor of Biosciences. He is also a CPRIT Scholar in Cancer Research. CPRIT is the Cancer Prevention and Research Institute of Texas.

Onuchic's research looks at theoretical and computational methods for molecular biophysics, chemical reactions in condensed matter, genome structure and gene expression, gene networks and theoretical modelling of cancer. His first scientific contribution focused on the theory of chemical reactions in biological electron transfer reactions. These reactions are central to the bioenergetic pathways in living organisms. In the mid 1980's he created the concept of tunneling pathways and the methodology which described proteins as a combination of relevant tubes of pathways that provide new ways of designing electron transfer proteins. This theoretical framework has been confirmed and utilized by many experimental groups. This combined theoretical and experimental effort has substantially improved the understanding of electron transfer processes in biology and also chemistry.

Protein folding is, however, the area in which Onuchic's contributions have led the field. His research group introduced the concept of protein-folding funnels to show the types of amino acid sequences that can fold into a unique protein structure. Convergent kinetic pathways, or folding funnels, guide folding to a unique, stable, native conformation. Energy landscape theory and the funnel concept provide the theoretical framework needed to pose and to address the questions of protein folding and function mechanisms. These theoretical advances have guided much of the experimental research in protein folding during the last three decades. Onuchic is a tireless advocate of using advanced techniques of statistical physics to tackle biological problems, arguing that this is the key insight that has revolutionized our understanding of protein landscapes and that has also the potential for revolutionizing the physics approach to higher level of biology.

For example, the impact of energy landscape theory and the funnel concept is not limited to protein folding. Cells contain a large number of molecular machines that control and maintain cellular functions with exquisite precision. He has used this energy landscape theoretical approach to understand the underlying mechanisms governing molecular motors such as kinesin and myosin.

During the last 20 years, Onuchic has broadened his interests to stochastic effects in genetic networks with emphasis in bacteria and cancer. In nature, bacteria live in large colonies. He has been interested in understanding how bacterium make decisions using a specialized network of genes and proteins. This network enables bacteria to make choices when faced with different stresses and environment conditions. Generalizing and expanding these ideas about decision-making to mammalian cells has moved his group towards searching for mechanisms governing cancer. It is important to highlight that the mechanism and networks in mammalian cells are much more complex and sophisticated.

More recently, further expanding his ideas coming from energy landscapes for protein folding, his group is now exploring chromatin folding and function. He is currently very interested in understanding how the genome structure and dynamics affect gene expression and other functions in the cell nucleus. An entire new field and an entire new life that I hope to connect with our work on cancer modeling in the near future.

One of the leaders in theoretical biological physics, Onuchic has received much recognition for his scientific achievements. He was elected to the National Academy of Sciences in 2006 for his contributions to understanding of protein folding and electron tunneling inside proteins. He received the International Centre for Theoretical Physics Prize in honor of Werner Heisenberg in Trieste, Italy (1989) and the Beckman Young Investigator Award (1992). He is a fellow of the American Physical Society (1995), the American Academy of Arts and Sciences (2009), the Brazilian Academy of Sciences (2009), and the Biophysical Society (2012). He was awarded the Einstein Professorship by the Chinese Academy of Sciences (2011). In 2014 he received the Diaspora Prize from the Ministry of Foreign Affairs and the Ministry of Industrial Development and Foreign Trade from Brazil. In 2015 he was awarded The International Union of Biochemistry and Molecular Biology (IUBMB) Medal. In 2017 he was elected fellow of the American Association for the Advancement of Science (AAAS) and in 2018 he was admitted to the Grã-Cruz class of the Ordem Nacional do Mérito Científico by the Brazilian Government. In 2019 he received the Max Delbrück prize in Biological Physics of the American Physical Society and he received the title of Honorary Professor from his alma mater, Instituto de Física de São Carlos. In 2020 he was appointed by Pope Francis as an academician at the Pontifical Academy of Sciences.

Onuchic has also been heavily involved in advising funding agencies, foundations, universities and the scientific community at large. A few examples include: he was the chair of the advisory committee for the Biological Sciences Directorate of the National Science Foundation and a member of the council of the American Physical Society. He served as a member on the advisory committee for the Mathematical and Physical Sciences Directorate, the Molecular Biophysics Panel for the National Science Foundation and the American Physical Society's Panel of Public Affairs and as a member of the council, the National Academy of Sciences Board of Physics and Astronomy. He was also the director of the College in Biophysics for the International Centre for Theoretical Physics at Trieste and as the president of the Biological Physics Commission of the International Union of Pure and Applied Physics. He has been involved in the editorial board of many journals such as PNAS and the Biophysical journal and until recently he was the Deputy Editor for Reports on Progress in Physics. He is currently a member of the committee preparing the National Academy of Sciences Decadal Survey in Biological Physics/Physics of Living Systems.