Recipient of the 2005 International Prize for Biology

Professor Nam-Hai Chua

Date of Birth: 8 April 1944

Citizenship: Republic of Singapore
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Position: Andrew W. Mellon Professor and Head
Laboratory of Plant Molecular Biology
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Education and Career:

a) Education

	University of Singapore, 5/62 - 2/65 B.Sc. in Botany and Biochemistry, June 1965
	Harvard University, 9/65 - 6/69 A.M. in Biology, June 1967 Ph.D. in Biology, June 1969 Prof. R.P. Levine, Thesis Advisor

b) Previous employment history

July 1988 - present	**Andrew W. Mellon Professor and Head** Laboratory of Plant Molecular Biology The Rockefeller University
July 1981 - June 1988	**Professor and Head,** Laboratory of Plant Molecular Biology The Rockefeller University
July 1977 - June 1981	**Associate Professor,** Cell Biology Department The Rockefeller University
July 1973 - June 1977	**Assistant Professor,** Cell Biology Department, The Rockefeller University
Oct 1971 - June 1973	**Research Associate,** Cell Biology Department The Rockefeller University Profs. P. Siekevitz, G.E. Palade, Advisors
Sept 1969 - Sept 1971	**Lecturer,** Biochemistry Department University of Singapore Medical School

Awards and Distinctions:

1988	Fellow of The Royal Society, UK
1988	Associate Fellow of the Third World Academy of Sciences, Italy
1988	Fellow of the Academia Sinica, Taiwan, China
1992	Honorary Member, Japanese Biochemical Society
1998	Fellow, Singapore National Academy of Science, Singapore

RESEARCH ACHIEVEMENTS

Photomorphogenesis of Plants, Mechanism of Chloroplast Formation, and Rhythm of the Biological Clock

Chloroplasts, the photosynthetic device of plants, are necessary to normal plant morphogenesis. For the chloroplasts to function, proteins synthesized by genes encoded in the cell nucleus must be transported to them. Dr. Chua took as a sample protein rbcS, the small subunit of ribulose 1,5-bisphosphate carboxylase (the carbon-fixation enzyme at the center of photosynthesis), and investigated where the information needed for transport into the chloroplast is located in its amino acid sequence. He did this by synthesizing the precursor rbcS protein *in vitro*, mixing it with isolated chloroplasts, and establishing an experimental system in which transport into the chloroplasts occurred. Using this system, he made a close study of factors essential for protein transport and discovered that it requires ATP, in contrast with the extracellular protein secretion response, which is coupled with the protein translation response and which does not require ATP. He further found that this observation could be generalized to protein transport into other intracellular organelles, such as the mitochondria. He also discovered a structure essential to transport which is present in the amino terminal region of rbcS and named it the "transit sequence," a term that remains in wide use today.

In the course of this work on chloroplasts, Dr. Chua was the first to discover, using transformed tobacco, that the transcription (synthesis of messenger RNA) of the rbcS genes in beans and the chlorophyll-binding protein (cab) genes in wheat is light-induced. This discovery developed into the research introduced below on the molecular mechanism by which light irradiation induces gene transcription. He also found that the messenger RNA accumulation of these genes shows an independent 24-hour circadian rhythm. This was the first demonstration that the level of gene transcription is regulated by the biological clock.

Next, Dr. Chua studied the molecular machinery by which the transcription of rbcS and cab genes is induced by light. He carried out systematic research employing a wide array of new technologies, especially transformed plants, which had begun to be disseminated in the mid-1980s. For example, he studied the location within the gene DNA structure of the information required for light-induced transcription and found that a short sequence, about one-hundredth of the full-length gene, held the key. He then identified the proteins that bind to this sequence and elucidated the mechanism of gene transcription in response to light. This work has served as the important basis for all subsequent research on the molecular mechanisms of photomorphogenesis.

Dr. Chua's work on the molecular mechanism of transcription has not been limited to light-responsive genes; he also identified the necessary structures, such as a 21 base-pair DNA sequence, in other types of gene that are transcribed in the cells of many plant tissues. The information yielded by this research is universal for gene transcription in plant cells, and Dr. Chua's findings have since been utilized in every field of plant science.

2. Research on Plant Body Axis and Pattern Formation

Dr. Chua has led the way toward an understanding of axis formation in plants. The establishment of the basal-apical axis, which runs from the tip of the root to the tip of the stem, is pivotal to plant morphogenesis. It has long been known that a major role in the establishment of this axis is played by "polar transport," the unidirectional movement of a phytohormone, auxin, from the top of the plant to its base. Using a method which he devised for culturing plant embryos of the family Cruciferae in vitro, Dr. Chua discovered that the basal-apical axis is established during a very early phase of embryogenesis, the globular embryo stage. He further demonstrated for the first time that auxin polar transport is essential to the formation of bilateral symmetry in the plant embryo. Typically, he did this work using the classical techniques of tissue culture and materials other than Arabidopsis, which is currently the preferred material in plant science; in this approach, we see Dr. Chua's individual and creative research style.

3. Research on Morphogenesis Mediated by Plant Hormones

Lateral roots are essential to support of the plant, and they are also an important organ for root function. Their formation is controlled by the plant hormone auxin. Dr. Chua studied the molecular mechanism of lateral root formation and determined that it requires the NAC1 protein and that, moreover, it involves a novel protein degradation system. Recently, he discovered that expression of the NAC1 gene is controlled by microRNA (molecules that break down messenger RNA and repress the level of gene expression).

Thus, even today, in his sixties, Dr. Chua continues to pursue research at the frontiers of plant morphogenesis.