Andrew Alm Benson

Birth and Parents
Andrew Alm Benson was born in Modesto, California, September 24, 1917, son of Carl Bennett Benson, M.D. and Emma Carolina Alm Benson, schoolteacher.

Early Education
Benson attended elementary schools in Escalon and Modesto. He graduated Valedictorian from Modesto High School in 1935; Hall of Fame, 1943.

Undergraduate Education
During 1935–1939, Chemistry, University of California at Berkeley, obtained a B.S. degree in 1939. His major professors were: Joel H. Hildebrand, Wendell M. Latimer, T.D. Stewart and W.F. Giaque.

Graduate Education
During 1939–1942, Chemistry and Neurobiology, California Institute of Technology (Caltech). Major Professors: Carl Niemann, Linus Pauling, Lazlo Zechmeister, Howard Lucas, and C.A.G. Wiersma. Doctoral thesis: *Synthesis of fluorinated analogs of thyroxin II. Oxidative degradation of sphingosine analogs. III. Peripheral neuro-inhibition in the slow muscle of Pecten*. PhD degree awarded May 1942, by Robert A. Millikan.

Professional Experience

1942–1943: Appointed Instructor, Chemistry Department, University of California at Berkeley. With Sam Ruben and Martin Kamen, he studied photosynthesis with C-11 and S-35. Ruben and Kamen discovered C-14 in 1940. With the world's supply of long-lived C-14, Benson began investigations on the path of carbon in photosynthesis. With Ruben he studied the biochemical toxicology of phosgene that he synthesized from radioactive C-11 labeled carbon dioxide.

1944–1945: Benson was drafted in 1943 for Civilian Public Service fighting forest fires in Nevada and USFS aerial photogrammetry and related fieldwork. He was transferred to antimalarial research as a Research Associate in the Department of Chemistry, Stanford University, working with F.W. Bergstrom, on antimalarial drug synthesis; this was followed by antimalarial drug research with J.B. Koepfli, at California Institute of Technology.

1946–1954: Benson returned to UC Berkeley as a Research Associate and Assistant Director of Bio-organic Group, Radiation Laboratory with Melvin Calvin. There he discovered ribulose 1.5 bisphosphate and identified other intermediates in the *Path of Carbon in Photosynthesis*. After completing this work, he was 'dismissed' from the laboratory, 1954.

1955–1961: Benson was appointed first as an Associate Professor and then as a Professor in the Department of Agricultural and Biological Chemistry at the Pennsylvania State University. While there, he discovered two major membrane lipids: *phosphatidyglycerol* and *sulfoquinovosyl diglyceride*.

1960-1961: Benson served as the Chairman of the Central Pennsylvania Section of the American Chemical Society.

1961–1962: Professor-in-Residence in the laboratory of Nuclear Medicine and Radiation Biology, Departments of Biophysics and Physiological Chemistry, School of Medicine, University of California, Los Angeles (UCLA), studying "hot atom" chemical reactions until 1962, when he transferred to the Department of Marine Biology in Scripps Institution of Oceanography, University of California, San Diego, La Jolla, (UCSD).

1962–1988: As Professor of Biology in Scripps Institution of Oceanography, UCSD, Benson's research on lipid metabolism continued. With Judd C. Nevenzel and Richard F. Lee he recognized wax ester as a major energy source for oceanic animals and as "Nature's Starvation Insurance." With continuing support for expeditions and funds from Robert O. Peterson, Benson studied coral metabolism, Pacific salmon aging and the production and function of calcitonin in salmon and other fishes. During this period, specific coral lipids were recognized as an important medium for energy transfer in the coral reef ecosystem. Other areas included: studies of mangrove physiology and metabolism; study of calcitonin regulation of calcium transport in the spawning Pacific salmon; discovery of the non-toxic metabolic intermediates of arsenic metabolism in algae and aquatic plants.

At the Scripps Institution of Oceanography, Benson's administrative activities included:

1965–1969	Chairman, Marine Biology Research Division;
1965–1988	Trustee, Foundation for Ocean Research, San Diego;
1966–1970	Associate Director for Biology, Scripps Institution of Oceanography;
1966–1988	Vice President, Board of Trustees, Foundation for Ocean Research;
1970–1971	Chairman, Department of Marine Biology and Chairman, Research Council San Diego Zoological Society, San Diego Zoo;
1970–1977	Director, Physiological Research Laboratory (Scholander Hall);
1977–	Member, Council of Advisors, The Cousteau Society;
1980–1988	Board of Trustees, Laboratory for Comparative Biochemistry, San Diego.

1989-- : In 1989, Benson became Professor emeritus. He discovered growth-stimulating effects of methanol on algae and higher plants. Since 1990, he has been a member of the advisory board of the Marine Biotechnology Institute Co., Ltd. Tokyo

Honors and Awards

1950: Sugar Research Foundation Award for 1950, co-recipient with Melvin Calvin. For elucidation of the sequence of intermediates for sucrose synthesis in plants.

1951-1952: Fulbright award. Visiting Professor, Agricultural College of Norway.

1962: Ernest Orlando Lawrence Memorial Award of the Atomic Energy Commission. For development of radiotracer methods in biology.

1965: Phil. D. h.c., University of Oslo. For developments in lipid biochemistry and

photosynthesis.

1965: Fellow, American Association for the Advancement of Science.

1972: Stephen Hales Award, American Society of Plant Physiologists (now Biologists).

1973: Member United States (US) National Academy of Sciences.

1979: Senior Queen's Fellow in Oceanography. Australian National University, Australian Institute of Marine Science.

1981: Fellow American Academy of Arts and Sciences.

1984: Elected member, Royal Norwegian Society of Sciences and Letters.

2009: Lifetime Achievement Award of the Rebeiz Foundation for Basic Biology, 2008, Presented in October, 2009.

Summary of Explorations and Discoveries

- **1943:** Benson used the first available radioactive carbon, C-14, for his study of the path of carbon in photosynthesis.

- **1947:** He discovered and identified the first product of photosynthesis, phosphoglyceric acid, with Melvin Calvin.

- **1950:** Benson discovered and identified the compound which absorbs carbon dioxide from the air to produce all the compounds of plants and chemoautotrophic bacteria: ribulose diphosphate (ribulose bisphosphate).

- **1957:** With Bunji Maruo, he discovered and identified the major membrane phospholipid on Earth, phosphatidyl glycerol, an important membrane component of bacteria and of all algae, and green leaves

- **1958:** Benson developed Neutron Activation Paper Chromatographic Analysis.

- **1961:** He discovered and identified the sulfolipid of plants, effective replacement of membrane phospholipids and probably the best detergent molecule in Nature.

- **1968:** Benson utilized spawning salmon as a model for the study of degenerative process of aging humans. With Gérard Milhaud, he recognized the importance of Calcitonin in calcium regulation in the salmon.

- **1970:** With Judd C. Nevenzel and Richard F. Lee, he recognized Wax as a major marine nutritional energy source and its role in providing for survival of marine animals.

- **1979:** Benson discovered the intermediates of arsenic metabolism in aquatic plants and the unique arsenolipid produced by these plants.

- **1981:** He discovered the highest concentration of arsenic known to accumulate in animals, in the kidneys of the giant clams of the Great Barrier Reef, Australia.

- **1982:** Benson suggested application of benzylidene ascorbate in successful treatment of human tumors.

- **1992:** Benson is the co-discoverer of methanol stimulation of plant growth and productivity of agricultural crops.