**Curriculum vitae for CHARLES J. ARNTZEN**

Emeritus Professor

Biodesign Institute and School of Life Sciences

Arizona State University

**Education**

University of Minnesota, Minneapolis Plant Physiology B.S., 1965

University of Minnesota, Minneapolis Plant Physiology M.S., 1967

Purdue University, Lafayette, Indiana Cell Physiology Ph.D., 1970

**Employment History**

1969-80 Assistant, Associate to Full Professor, Department of Botany, University of Illinois, Urbana

1973-74 Research Scientist, Laboratoire de Photosynthèse du CNRS, Gif-sur-Yvette, France

1976-80 Plant Physiologist, USDA/SEA, Urbana, Illinois

1976 NATO Scientist, Laboratoire de Photosynthèse du CNRS, Gif-sur-Yvette, France

1980-84 Director, MSU-DOE Plant Research Laboratory, Michigan State University

1981 ANU Fellow, Australian National University, Canberra, Australia

1983 Visiting Scientist, Academia Sinica, Beijing, China

1984-88 Director, Plant Science and Microbiology, DuPont Central Research & Development Department, and Director, Biotechnology Research, DuPont Agricultural Products Division, Wilmington, DE

1988-95 Deputy Chancellor for Agriculture, Dean, College of Agriculture and Life Sciences, Director, Texas Agricultural Experiment Station, Texas A&M Univ., College Station, Texas; Professor, Dept. of Biochemistry and Biophysics; Director, Plant Biotechnology Program, Institute of Biosciences and Technology, Texas A&M Univ., Houston, TX

1995-2000 President and CEO, Boyce Thompson Institute for Plant Research, Inc. and Adjunct Professor, Cornell University, Ithaca, NY

2000-2017 Florence Ely Nelson Presidential Chair in Plant Biology and Regent’s Professor, Arizona State University, Tempe, AZ

2017 Professor Emeritus, Arizona State University.

**Scholarly and Professional Honors and Awards**

1979 Charles Albert Shull Award for Outstanding Research in Plant Physiology

1980 Award for Superior Service, US Department of Agriculture

1980 Award of Excellence, Weed Science Society of America

1983 Elected Member of the National Academy of Sciences, USA

1984 Elected Fellow of the National Academy of Sciences, India

1985 Elected President, American Society of Plant Physiologists

1990-1997 Member, Board of Governors of the University of Chicago for Argonne National Laboratory. Member Executive Comm.; Chair of Scientific/Technical Advisory Board

1991-1993 Member and Chairman, NIH Biotechnology Policy Board

1991-1998 *SCIENCE,* Editorial Board Member

1994 Dennis Robert Hoagland Award, American Association of Plant Physiologists

1994 Elected Fellow, AAAS

1997 Doctor of Science *honoris causa.*, Purdue University, School of Science

2001-2009 President George W. Bush’s Council of Advisors on Science and Technology, and Presidential appointee to the National Nanotechnology Advisory Board (in 2004)

2003 Doctor of Science *honoris causa*., University of Minnesota

2004 American Society of Plant Biology Leadership in Science Public Service Award

2006 Botanical Society of America Centennial Award

2007 Elected Fellow of American Society of Plant Biologists

2008 Doctor of Science *honoris causa.,* Hebrew University of Jerusalem

2009 USDA Sterling Hendricks Memorial Lecturer for 2009

2011-2012 Chair, Section O "Agriculture, Food, and Renewable Resources", American Association for the Advancement of Science (AAAS)

2015 Award by Fast Magazine for “The Most Creative Person in Business in 2015”

2015 Elected Member, National Academy of Inventors, USA

**Research Activities; an Emeritus Professor's perspective.**

My research career evolved over 40 years, but always focused on basic research in plant molecular biology and protein engineering. I have utilized plant biotechnology with a goal of enhancing food quality and value, for expression of pharmacologically products in transgenic plants, and for overcoming health and agricultural constraints in the developing world. In the recent past I have devoted time to national and international policy issues related to the adoption of GM crops (Arntzen et al., 2003)

From 1967 to 1990 my research centered on chloroplast structure and function in higher plants, with a strong interest in using this information for agricultural improvements. I began with studies of factors that influence the quantum efficiency of photosynthesis. After providing evidence that photosystems I and II exist in discrete polyprotein complexes, we found that proteins are phosphorylated in chloroplast membranes (Allen et al., 1981) – one of the first pieces of evidence for the existence of protein phosphorylation in plants – and that the kinase activation was controlled by membrane redox potential – also a novel idea. This phosphorylation altered chloroplast thylakoid surface charge and thereby regulated spatial positioning of photosystem reaction centers and light harvesting pigment-protein complexes to modulate and optimize solar energy capture (Staehelin and Arntzen, 1983). My studies of chloroplast membrane organization led to a collaboration with agronomists who had discovered herbicide-resistant weeds. Knowing that some of these herbicides acted by blocking photosynthetic electron transport, my team showed that triazine herbicides bind to a specific protein in the photosystem II complex; this was the first molecular target known for a commercial herbicide (Steinback et al., 1981). We learned that a mutation of a single amino acid in this binding pocket could completely block herbicide binding and action (Hirschberg et al., 1984). This discovery was at the time when genetic transformation was just being developed for plants, and our team was influential in pioneering the concept of engineering a crop for herbicide resistance.

In 1984 I joined the DuPont Company to help create their program in crop biotechnology, with a strong focus on creation of herbicide and insect resistance *via* introduction of new proteins into the crop plants. This was my first intensive interaction with scientists working at the forefront of gene expression in plants. DuPont was also a setting where I could learn the discipline needed for product development and management of multidisciplinary projects that dominated my subsequent research. It was a very exciting time.

I was lured away from Dupont by an offer from Texas A&M University that made it possible to lead their creation of a research center in the Texas Medical Center in Houston. As the doors opened to this new Institute, my goal was to find a project area with a very direct medical focus and draw upon my prior expertise. This led to our efforts to produce (and possibly deliver) plant-made protein pharmaceuticals. Our first publication, entitled "Expression of Hepatitis B Surface Antigen in Transgenic Plants" (Mason et al., 1992), initiated the field of research relating to production of subunit vaccines in plants. We had a primary emphasis on mucosal immunization, which led to conducting 3 human clinical trials using antigens produced in plants and delivered as unprocessed plant tissue. These “edible vaccines” were a validation of the ability of plant cells to make functional immunogenic proteins as candidate antigens for oral delivery (Arntzen et al., 2005). With a team of colleagues (Santi et al. 2006), we devised new viral vectors for a cost-effective biomanufacturing platform with an ultimate goal of production of highly purified antigens from plant tissue for traditional vaccine delivery. We have also developed expression vectors, based upon plant viruses, for production of monoclonal antibodies (mAbs) and mAb-fusion proteins in tobacco. We utilized this system to design and test a therapeutic to treat Ebola (Arntzen, 2015), which lead to scale up development by corporate collaborators. An outcome of this work was recognition by Fast Magazine of my role as “The Most Creative Person in Business in 2015” for leadership in development of ZMapp, the leading therapeutic for Ebola. They designated me as the “godfather of a growing field of research called pharming.”

**References**

**Arntzen, C.J., A Coghlan, B. Johnson, J. Peacock,and M. Rodemeyer.** 2003.GM Crops: Science, Politics and Communication. Nature Reviews 4: 839-843.

**Allen, J.F., J. Bennett, K.E. Steinback and C.J. Arntzen.** 1981. Chloroplast protein phosphorylation couples plastoquinone redox state to distribution of excitation energy between photosystems. Nature 291: 21-25.

**Staehelin, L.A. and C.J. Arntzen.** 1983. Regulation of chloroplast membrane function: Protein phosphorylation changes the spatial organization of membrane components. Journal of Cell Biology 97: 13271337.

**Steinback, K.E., L. McIntosh, L. Bogorad and C.J. Arntzen.** 1981. Identification of the Triazine Receptor Protein as a Chloroplast Gene Product. Proc. Natl. Acad. Sci. USA 78: 7463-7467.

**Hirschberg, J., A. Bleecker, D.J. Kyle, L. McIntosh and C.J. Arntzen.** 1984. The Molecular Basis of Triazine-Herbicide Resistance in Higher-Plant Chloroplasts. Z. Naturforsch. 39c: 412-420.

**Mason, H.D., M.-K. Lam and C. J. Arntzen**. 1992. Expression of hepatitis B surface antigen in transgenic plants. Proc. Natl. Acad. Sci. USA 89: 11745-749.

**Santi L, Giritch A, Roy CJ, Marillonnet S, Klimyuk V, Gleba Y, Webb R, Arntzen CJ, Mason HS.** (2006) Protection conferred by recombinant Yersinia pestis antigens produced by a rapid and highly scalable plant expression system. Proc Natl Acad Sci U S A. 2006 103(4): 861-866.

**Arntzen, C.J., S. Plotkin, B.Dodet.** (2005) Plant-derived Vaccines and Antibodies: Potential and Limitations. Vaccine 23: 1753-1756.

**Arntzen, C.J.** 2015. Plant-made pharmaceuticals: from ‘Edible Vaccines’ to Ebola therapeutics. Plant Biotechnology 13(8): 1013-1016