Bacterial Chimeras and Reversible Phosphorylation: The Work of Walther Stoeckenius

In 1971, Walther Stoeckenius discovered that *Halobacterium halobium* contains a purple pigment that is chemically similar to rhodopsin and works as a light-driven proton pump. This discovery set Stoeckenius on a research path centered on bacteriorhodopsin, which included the creation of a bovine-soybean-halobacteria chimera that was able to produce ATP when exposed to light and the discovery of a class of proteins that are phosphorylated in a light-dependent manner.

Reconstitution of Purple Membrane Vesicles Catalyzing Light-driven Proton Uptake and Adenosine Triphosphate Formation

Light-regulated Retinal-dependent Reversible Phosphorylation of *Halobacterium* Proteins

Walther Stoeckenius was born in 1921 in Giessen, Germany. He earned an M.D. degree from the University of Hamburg in 1950, after which he spent 18 months doing clinical work as an intern. In 1952, he began postdoctoral work at the Institute for Tropical Medicine in Hamburg, using electron microscopy to study the development of pox viruses. Two years later, he joined the Department of Pathology at the University of Hamburg as an assistant professor and became Docent for Pathology in 1958. At Hamburg, Stoeckenius continued to use electron microscopy to explore the fine structure of cells and the lipid membrane.

In 1959, Stoeckenius left Germany to become a research associate in Keith Porter’s laboratory at Rockefeller University. After a few months, he became an assistant professor at Rockefeller, remaining there for 8 years and eventually becoming an associate professor. He continued to work on membrane structure, studying *Halobacterium halobium*, until he accepted a professorship at the University of California, San Francisco in 1967.

In San Francisco, Stoeckenius focused more on biochemical techniques rather than electron microscopy. In collaboration with Dieter Oesterhelt, he discovered that *H. halobium* contains a purple pigment (bacteriorhodopsin) that is chemically similar to rhodopsin (1) and plays an important role in light energy storage in halobacteria, working as a light-driven proton pump (2).

This discovery led to a collaboration with *Journal of Biological Chemistry* (JBC) Classic author Efraim Racker (3) in which Stoeckenius and Racker created a thoroughly unnatural vesicle. As reported in the first JBC Classic reprinted here, they used sonication to recombine membrane lipids from soybeans, bacteriorhodopsin from halobacteria, and ATPase from beef mitochondria. The resulting artificial vesicles were able to produce ATP when exposed to light. The chimeric vesicles also formed a simple model system for a biological proton pump capable of generating ATP from ADP and P₃.

Stoeckenius continued to study bacteriorhodopsin and its light-driven proton uptake in bacteria. As reported in the second JBC Classic reprinted here, he discovered that phosphorylation is regulated by light absorbed by bacteriorhodopsin (4). Using [³²P]orthophosphate pulse labeling, Stoeckenius and John Spudich identified a class of phosphoproteins in *H. halobium*. Exposing labeled whole cells to light resulted in rapid dephosphorylation of two of the proteins, which were rapidly rephosphorylated upon darkening of the cells. The light
sensitivity of the proteins was responsive to the presence of retinal, indicating that the dephosphorylation depended on rhodopsin-like (retinal-containing) photoreceptors.

Stoeckenius currently is Professor Emeritus in the Department of Biochemistry and Biophysics and the Cardiovascular Research Institute at the University of California, San Francisco. He was elected to the National Academy of Sciences in 1978.

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REFERENCES

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