**PRL Director, MSU Foundation Professor**  
Departments of Biochemistry & Molecular Biology and Plant Biology

**Education**  
Ph.D. 1991, Michigan State University  
M.S. 1986, Albert-Ludwigs Universitaet, Freiburg, Germany

**Research**  
Research in the Benning laboratory focuses on lipid metabolism in photosynthetic organisms. One area of particular interest is the assembly and maintenance of the photosynthetic membrane in plants and algae. The photosynthetic membrane contains a unique set of polar lipids. Their specific functions in photosynthesis, especially during dynamic conditions, is investigated by applying state-of-the-art phenotyping to Arabidopsis and Chlamydomonas lipid mutants.

New Fig. 1 (will be provided by Yang Yang shortly)

Different membranes cooperate in the synthesis of lipid precursors needed for the assembly of the photosynthetic membrane. Thus, the lipid transport mechanisms involving chloroplast envelope membranes are investigated.

Fig 2 (old Fig. 1).

Photosynthetic organisms are exposed to a changing environment which can lead to stress inhibiting growth. Lipid remodeling in response to freezing or nutrient deprivation is an area of intense study in the Benning lab. Nutrient-deprived algae enter a state of cellular quiescence. Cell divisions cease and metabolism is redirected to accumulate storage lipids. The Benning laboratory is identifying factors governing entry into, and exit from quiescence in single-celled algae. Approaches ranging from biochemistry, genetics, and systems biology to modeling are used to gain insights into this process with the goal to optimize algae for biofuel production.

Fig 3 (old Fig 2)

The Benning laboratory is also involved in the design of novel biofuel plants with enhanced energy density in their vegetative tissues through the induction of storage oil accumulation. Storage lipids are deposited in lipid droplets and their mechanism of formation is investigated in algae. Moreover using a synthetic biology approach, the Benning laboratory is exploring lipid droplets as an enzyme assembly platform for the synthesis of novel compounds.

Fig. 4 (old Fig 3)