



Providing life support for human exploration is a major challenge as we venture to Mars and beyond. Our hypothesis is that we can revolutionize life forms by selectively expressing in plants extremophile genes that will collectively enable functional life in inhospitable environments. For our phase I proposal, we demonstrated for the first time that an archaeal gene, superoxide reductase from *Pyrococcus furiosus*, could be transcribed and translated in a model eukaryotic system to produce a functional enzyme which retained the properties of the original archaeal protein. In our phase II proposal, we will extend our studies to the whole plant and will include a suite of genes from the *P. furiosus* reactive oxygen species (ROS) detoxification pathway that together will confer resistance to oxidative stress. Furthermore, we will increase reduced glutathione by introducing the glutathione reductase (GR) gene from a psychrophilic extremophile *Colwellia psychrerythraea* in order to address a major problem facing Earthbased organisms on Mars, stabilizing protein structure during the rapid changes in temperature that will be encountered even in enclosed environmental chambers. We will cross plants producing the heat stable ROS and cold functional GR enzymes to generate a hybrid plant tolerant of extreme environments, including cold, drought, heat and radiation. After each T4 generation transgenic plant has been produced, the plants will be distributed to NASA-funded labs for more complete physiological testing in space environments. In addition, we will work with investigators to introduce the genes into breeding programs to revolutionize breeding programs for crops to be grown in space. Finally, our road map includes working with an honors undergraduate class to investigate the use of novel genetic approaches to generate plants resistant to radiation damage to DNA.