## Proposed Research: Life requires energy and its transformation and flow link all levels of biological organization. Although energy is a key currency linking processes throughout biological systems, little research has explicitly examined how energy usage has changed through time. The allocation of energy to different organismal functions is manifest in the allometric scaling of physiological, ecological, and life history relationships. Changes in allometries can reflect evolutionary change in the energy budgets and life-history strategies of species. To fully understand the processes that drive the dynamics of energy usage and allometry, we need to shift to a truly tree-based approach. While previous research has documented clade-level differences in allometries, we lack the necessary tools to study the evolution of allometry itself across phylogenies directly. The proposed research seeks to uncover the long-term macroevolutionary dynamics of energy usage, as revealed by allometric scaling relationships, among vertebrate clades. Specifically, phylogenetic relationships will be used to uncover the evolutionary history of metabolic scaling with size along with other prominent energetic scaling relationships (e.g. longevity, growth rate, home range). Novel Bayesian comparative regression tools will be developed to study the evolution of these allometric scaling relationships.

## Intellectual Merit: These aims will address novel questions regarding the dynamics of evolution in energy budgets of organisms at macroevolutionary scales, while simultaneously providing powerful, general tools for applying the phylogenetic comparative method to studying adaptation and evolution. Specifically, the developed methods will differ from previous methods in that they will simultaneously 1) allow identification of shifts across species scaling relationships without predefining clades 2) realistically account for the process of adaptation in a Bayesian framework and 3) identify both intrinsic and extrinsic factors influencing metabolic scaling relationships. By doing so, the project seeks to elucidate the macroevolutionary drivers of change in energetic relationships and open new avenues of research in macroevolution and macroecology. Furthermore, the methods and software will provide a powerful, flexible and extensible framework for modeling adaptive evolution on phylogenies that will have broad applicability to a wide-range of empirical questions.

## Broader Impact: The public outreach component focuses on curriculum development. The target audience will be middle, high school and college biology courses with the goal of introducing evolutionary concepts and having students engage in inquiry based activities with real data sets. This goal aligns with both the Vision and Change report which is guiding college level biology education reform, and the Next Generation Science Standards (NGSS). We plan to work specifically with BioQUEST and the QUBES project (a collaboration has been initiated) to develop curriculum materials . The project proposes to design curricula and activities using web-based software to allow students to explore trait evolution across the tree of life. By connecting the software to OpenTree API’s, students will be able to custom select phylogenies for taxa of interest, match these data to phylogenetic trees, and dynamically visualize the evolution of phenotypic traits.