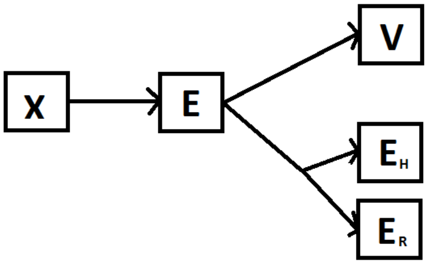
The Dynamic Energy Budget Theory

Florida Group- Sarah Burgan

Learning about the DEB theory during this course has given me an insightful glance into the complexity of individual organisms. As a graduate student in the fields of disease ecology and ecoimmunology, I had not experienced this level of intricacy as it relates to understanding how organisms obtain and use energy in order to survive. This tele-course has given me a new perspective on organismal biology, and how it relates to my own research.

DEB theory provides a quantitative framework for understanding the biological organization of organisms from embryo to death, based on acquisition, metabolism, and allocation of energy and nutrients. The energy budget of organisms changes over time, as the result of individuals acting as dynamic system. This theory relies on certain principles, such as the division of biomass into reserve and structure, and the concepts of strong and weak homeostasis. Strong homeostasis mandates that the chemical composition of pools is constant, while weak homeostasis suggests that structure and reserve have similar compositions. The basic DEB framework studies the energy fluxes and mobilization of resources from food in the environment (X), into reserve (E), and then allocated to either structure (V), reproduction (E_R), maturity (E_H), or maintenance. As such, food can be metabolized by organisms for growth, reproduction, maturity, or for somatic or maturation maintenance.



Although the DEB theory is complex, it has advantages over other theories, such as the metabolic theory of ecology (MTE). Both theories are based on the understanding of energy budgets in organisms, however MTE uses the ¾ exponent to scale resource supply to body mass and DEB uses surface area and volume-based scaling. DEB theory has more detailed parameters than MTE, and takes more factors into consideration, thus giving a better fit to empirical data within individuals. For instance, DEB theory is able to fit more intricate, non-normal growth curves. Teixeira and colleagues (2014) were able to provide a good fit to the irregular growth patterns of Wandering Albatross chicks using DEB theory. Whereas most organisms have positive growth during the juvenile stages, albatross chicks experience a period of decreased mass when the adults stop provisioning food; thus, their maximum hatchling mass is typically much heavier than their mass as fledging. This example depicts the success of DEB models in accurately fitting abnormalities within growth curves that MTE, or other growth models, may have missed.

Although my research interests do not directly align with the DEB theory, it may be useful in certain aspects. For instance, understanding the DEB in host-parasite systems (in my case, songbirds and mosquitoes) may provide insight into the allocation of energy and resources to the immune system (or away from growth, reproduction, and maturity) in the event of a parasite exposure. This information could be gained by applying DEB theory to different individuals or populations of birds- some in a parasite-rich environment, and some in a parasite-poor environment. Comparison of the growth models or inclusion of a parasite-structural component within the model could help elucidate the cost of parasites within hosts. Ultimately, continued investigation into DEB theory will enrich my understanding of individuals from a physiological perspective.