**Independent Project**

**Introduction**

The biological phenomena of hibernation have long been a subject of mystery causing many questions. The thirteen-lined ground squirrel (*Ictidomys tridecemlineatus*) has gained significant attention as a significant subject for investigation amongst the diverse array of mammals. These Small mammals exhibit the amazing capacity to endure the challenges associated with hibernation, a process known to significant decreases in metabolic function, body temperature, and overall energy usage.

Our central focus revolves around brown adipose tissue (BAT) and its associated metabolites. BAT, which is largely known for its function in thermoregulation, is essential in the hibernation process of thirteen-lined ground squirrels. [2] During this time frame, the squirrels exhibit significant physiological changes to endure the harsh winter conditions. [1] BAT, a distinct type of adipose tissue, is essential in the hibernation process as it produces the necessary heat to maintain the core body temperature of the thirteen-lined ground squirrel.[4]

Understanding the role of BAT and its metabolites in relation to the hibernation of thirteen-lined ground squirrels is of great value across multiple domains. This offers a distinct perspective on the complex mechanisms that regulate metabolic flexibility and the preservation of energy. The capacity of these small-sized mammals to effortlessly shift between states of dormancy and activity provides significant insights into prospective applications in the field of human medicine. [2,3] This comprehension has the potential to be extremely beneficial in tackling the complexities associated with obesity, metabolic illnesses, and the requirements of extended space voyages, where the management of metabolism is of utmost importance.

Hibernation is an extraordinary adaptation that allows animals to withstand the most severe winter conditions while maintaining their physiological well-being and reproductive capacity. [1] This research not only enhances our understanding of metabolic control and its potential for human health but also provides valuable insights into the ways that animals use to overcome severe environmental obstacles.

**Objectives**

1. **Data Visualization with R.**

To generate meaningful visualizations from the Mass Spectrometry (MS) data collected, employing R for graph creation.

1. **Metabolomics Data Analysis with R.**

To perform a comprehensive analysis of the metabolomics data obtained through MS and apply statistical methods using R for in-depth exploration and interpretation.

**Methods**

The data was collected from ground squirrels throughout the months of September (SEPT), October (OCT), November (TOR), January (IBA), and March (MAR). It is crucial to acknowledge that the data in question was not personally acquired by the author, but rather, it originated from the laboratory of Dr. Matt Andrews unpublished data (rotation project).

The main aim of this research is to acquire expertise in the analysis of metabolic data, practical abilities in data analysis utilizing R, and construct a diverse range of graphs for the purpose of visualizing trends in metabolites. The primary objective is to analyze the variances in metabolite profiles during several months, specifically SEPT, OCT, TOR, IBA, and MAR, to determine the metabolites that play a critical role in the hibernation process.

The variables being examined, which represent the metabolites, are the primary focus of our analysis. This analyzes the specific metabolic pathways that could potentially be triggered during these crucial time periods and the potential mechanisms that underlie the ground squirrels' exceptional capacity to adapt to the demanding conditions of hibernation.

**References**

[1]Anderson, Kyle J et al. “Proteogenomic Analysis of a Hibernating Mammal Indicates Contribution of Skeletal Muscle Physiology to the Hibernation Phenotype.” Journal of proteome research vol. 15,4 (2016): 1253-61. doi:10.1021/acs.jproteome.5b01138

[2]Andrews, Matthew T. “Molecular interactions underpinning the phenotype of hibernation in mammals.” The Journal of experimental biology vol. 222,Pt 2 jeb160606. 25 Jan. 2019, doi:10.1242/jeb.160606

[3]Ballinger, Mallory A et al. “Enhanced oxidative capacity of ground squirrel brain mitochondria during hibernation.” American journal of physiology. Regulatory, integrative and comparative physiology vol. 312,3 (2017): R301-R310. doi:10.1152/ajpregu.00314.2016

[4]Ballinger, Mallory A, and Matthew T Andrews. “Nature's fat-burning machine: brown adipose tissue in a hibernating mammal.” The Journal of experimental biology vol. 221,Pt Suppl 1 jeb162586. 7 Mar. 2018, doi:10.1242/jeb.162586