Rising feed costs, global competition, and societal concerns about energy policy and the environment have created new economic challenges for the beef industry. Feed efficiency is therefore an important trait to include in selection programs that seek to identify cattle that are more economically and environmentally sustainable to produce. Recent developments have provided opportunities to improve the genetic merit in cattle for feed efficiency: (1) development of an alternative efficiency trait (residual feed intake: RFI) that facilitates selection for efficient cattle independent of level of production, (2) advances in RFID-based technologies to measure feed intake and other physiological traits (e.g., heart rate, temperature, feeding behavior) to quantify interanimal variation in biologic processes that impact feed efficiency, and (3) advances in animal genomic technologies. Measuring RFI phenotypes in cattle remains expensive despite the use of new RFID technologies. Thus, discovery of gene markers and biomarkers (e.g., serum IGF-I) that are predictive of RFI will greatly enhance our ability to more accurately and cost-effectively identify cattle with favorable RFI phenotypes.

While RFI has been well characterized in growing cattle, scientists have limited knowledge of the associations between RFI measured in growing calves confined to feedyards and efficiency of mature grazing cows. Moreover, little is known about the impact of selection for RFI on other economically relevant traits (e.g., reproduction, meat quality) or the molecular and cellular mechanisms associated with genetic variation in RFI. Understanding the mechanisms responsible for interanimal variation in RFI will provide insight into likely RFI genotype by environment interactions and will drive the search for novel biomarkers and DNA variants associated with candidate genes linked to RFI.

Experimental Approach
The research's central hypothesis is that a large fraction of observed interanimal variance in feed intake that is unexplained by differences in level of production (RFI) can be linked to variation in biologically-relevant processes that impact energetic efficiency of beef cattle. Sire-identified calves (700–800 per year) will be phenotyped for RFI, growth, temperament, feeding behavior, and carcass traits. Within study, calves with divergent RFI phenotypes will be used to systematically explore interanimal variations in physiologic and metabolic processes associated with feed efficiency.

Outcomes
In vivo techniques will be used to determine if cattle with divergent RFI phenotypes differ in rate and extent of nutrient digestibility, energy expenditure, methane production, and hepatic mitochondrial bioenergetics. Carcass composition and beef tenderness traits, as well as feeding behavior and physical activity traits (e.g., meal frequency and duration), will be examined for associations with RFI. Blood samples will be collected to examine associations between RFI and endocrine (e.g., IGF-I, cortisol), immune function, and metabolites (e.g., glucose, NEFA) concentrations. Tissue samples will be collected for protein and mRNA expression of candidate genes associated with metabolism. DNA will be collected for discovery and validation of genetic marker panels for feed intake, RFI, temperament, meat quality traits.