George C. Fahey Companion Animal Nutrition Symposium II: Comparative Animal Nutrition

448 Comparative animal nutrition: An adaptive strategy within a changing environment. M. S. Edwards*, *California Polytechnic State University, San Luis Obispo.*

To survive within a changing environment, organisms adapt their behavior. The dynamics and demographics within animal science departments across the country are shifting along with human-animal interactions. More than 50% of incoming animal science undergraduates express interests in non-production animals including companion and wildlife species. These interests represent a unique opportunity to introduce and engage students to concepts using unique species models. The symposium objectives are to (1) explore the comparative nutrition relationships that exist between domestic and exotic species, and (2) encourage and promote the inclusion of comparative nutrition in animal science programs. The academic genealogy of research scientists and faculty in the field of comparative animal nutrition, as well as professionals practicing in applied programs clearly demonstrates connections to their animal science ancestry. Comparative nutritionists rely on research of animal scientists and others to understand and develop nutrition programs for nondomestic species. The Comparative Nutrition Society (http://www.cnsweb.org/) fosters communication among laboratory and field scientists from various disciplines with interests in comparative nutrition. Animal scientists have routinely invoked the comparative studies of Kleiber, Brody and others when introducing concepts of energy metabolism. These interspecific comparisons across a "mouse to elephant" scale help students visualize the relationships of body mass, surface area, heat production and metabolic rate. Similarly, hummingbirds maybe used as an example demonstrating the impact of expressing a species' nutrient requirements as a dietary concentration or as a function of the species body weight or energy intake. The uniqueness of the species is used to elevated the student's interest to teach a concept that applies across multiple species, production and non-production alike. By integrating these topics into courses, programs can transform students' specific animal interests into a passion for fields of comparative animal sciences.

Key Words: comparative, nutrition, teaching

449 A rhinoceros is not always like a horse: Case studies on using domestic animal nutrition models for zoo animal nutrition. M. L. Schlegel*, *San Diego Zoo Global, San Diego, CA.*

Zoo animal nutritionists rely on domestic animal nutrition to understand digestive physiology, energy requirements, and nutrient requirements. The foundation of animal nutrition applies to all animals, but zoo nutritionists are often formulating diets for a wider variety of species with diets that contain unique food items. While there are many cases when using the domestic animal model works well, there are circumstances when zoo animals differ from their domestic counterparts. Using mare's milk composition to develop a rhinoceros hand-rearing formula has been successful, but using estimates of mare milk production to estimate rhinoceros lactation has not. Estimates of the nutrient requirements of the horse are applicable to the rhinoceros, but there is evidence that black rhinoceros (*Diceros bicornis*) are sensitive to diets high in iron. Dietary nutrient requirements of beef cattle and small ruminants serve as good models for most zoo ruminants, and dealing with copper deficiency in zoo ruminants and dietary mineral interactions are the same. We are learning that ruminant browsers in zoos are prone to sub-clinical acidosis with even a small to moderate amount of dietary starch compared with their domestic cousins. It is difficult to extrapolate the energy requirement for zoo mammalian carnivores and omnivores (felids, canids, ursids) from domestic dogs and cats, but nutrient requirements are very similar. When evaluating nutritional health of zoo animals their serum mineral and vitamins concentrations are very similar to domestic animals, but there are exceptions. While animals are more similar than they are different with respect to nutrition there are individual species cases where zoo animals deviate from their expected domestic animal model.

Key Words: comparative nutrition, domestic models, zoo animal

450 Unraveling the nutritional cost of avian immunity: A comparative approach. K. C. Klasing*, V. J. Iseri, and K. A. Lee, *University of California, Davis.*

Immune systems must protect against pathogens but the nutritional costs of developing, maintaining and using this system impinge on the flow of nutrients to growth and reproduction. Thus immune systems have been selected to be efficient. We have used a combination of domestic, companion, and wild avian species (broiler and layer chickens, ducks, cockatiels, passerines, columbidae) to untangle the costs of immunity and the selective forces that modify these expenditures. To determine the major evolutionary forces that affect the investment in immunity we captured approximately 200 individuals of 40 bird species in tropical and temperate areas of the Americas. There was a direct positive association between body mass and the amount of energy expended and acute phase proteins produced during the acute phase response to *E. coli*. Smaller species invested more in constitutive aspects of immunity and less in pathogen-induced responses. We expected to find that longer lived species invested more, but this was not the case. In adult chickens, the systemic immune system (including all major leukocytes and protective proteins but excluding mucosal leukocytes) at maintenance has the same lysine content as 16% of a medium egg, 332 average sized feathers, or 5% of a pectoralis muscle. The increase in lysine accretion due to injection of *E. coli* was 113% during the acute phase (24 h) and 44% during the adaptive response (5 d). Acute phase proteins contributed 84% to the lysine used during the acute phase and Ig contributed 44% during the adaptive phase. The remainder was due to leukocyte proliferation. However, the lysine accreted in the expansion of the liver for support of the acute phase response was almost 3 times the lysine accreted for the cells and proteins of the immune system, indicating that the liver is the largest contributor to the acute phase response. The adaptive response was completely fueled by the decay of the acute phase response and did not have a net nutritional cost. This research approach illustrates the power of combining natural selection and artificial selection for understanding the basic principles of biology that underlie both.

Key Words: nutrition, immunity, cost

451 Comparative study of milk oligosaccharides in mammals. C. B. Lebrilla*, *Department of Chemistry and Department of Biochemistry and Molecular Medicine University of California, Davis.*

Human milk oligosaccharides are the third most abundant dry component in milk. It has been attributed several protective properties to the infants from acting as prebiotic to pathogen block. Milk oligosaccharides have diverse structure with potentially hundreds in human milk. The analysis of other mammalian milk has provided better understanding of human milk. Primates have MOs more similar to human. However, within the primates the similarities do not necessarily follow phylogeny. Milks of primates who live in large social groups tend to be more similar compared with those who are solitary. Human milk is high in fucosylation but low in sialylation. Conversely, animals who are non-primate such as bovine and porcine tend to have very high sialylation and low fucosylation. Understanding the differences in the HMO will be key to understanding the relationship between the different groups and their respective microbiota.

Key Words: human milk oligosaccharide, milk, fucosylation

452 Comparative growth physiology on the land and in the sea: Animal science to marine mammal biology. J. P. Richmond*, *University of North Florida, Jacksonville.*

At first glance, the connection between animal science and marine science may not be obvious. However, the closest terrestrial relatives to cetaceans (whale and dolphin) are ungulates (deer and cattle), and most cetacean species maintain a multi-chambered stomach despite their pisciviorous diet. Other species including seals and sea lions are monogastrics closely related to terrestrial carnivores such as mink and bear. Studies in marine systems often limit access to animals due to remote locations of animals, small population size, endangered species status, or limited ability to capture and restrain animals for sample collection. Research in bovine and porcine systems provide valuable models to study the physiological mechanisms that regulate growth and nutrient partitioning that can then be used to evaluate and interpret physiological status of free-ranging wildlife. Metabolic hormones such as growth hormone (GH) and insulin-like growth factor (IGF)-I, are well studied in domestic species, and are a bridge between growth physiology, sex, developmental age, and nutritional status. Differences in tissue specific growth rate are mediated by changes in the magnitude and timing of the response of these hormones during development. For example, in most species GH concentrations are elevated in neonates and decline with age while IGF-I follows the opposite pattern. Relatively slow growing Steller sea lions follow this typical domestic animal pattern and accumulate approximately 1% of body mass per day while nursing (GH 10 to 20 ng/mL, IGF-I 150 to 200 ng/mL at 4 wk of age). In contrast, rapidly growing hooded seal gain 30% of their body mass per day in the 4 d nursing period. GH is reduced (<5 ng/mL) and IGF-I is elevated (>300 ng/mL) at birth. These concentrations are maintained during nursing and facilitate rapid deposition of adipose tissue. Comparison of the hormonal regulation of growth in species with distinct developmental patterns will enhance our knowledge of the link between physiology, nutrition and life history of diverse species. Animal science provides the foundation on which to build our understanding of comparative growth physiology.

Key Words: comparative growth physiology, marine species

453 Cattle to cats: Comparative carbohydrate nutrition of widely diverse animal species. G. Fahey*, *University of Illinois, Urbana.*

Dietary fiber (structural carbohydrates + lignin) no longer is considered to be merely roughage, or ballast, or filler. Indeed, in human nutrition, it is considered a “shortfall nutrient,” one that is seriously lacking in human diets as evidenced by the diseases that result, in part, from its absence. Likewise, fiber is essential in the diet of ruminants and represents an important component of the diet of non-ruminants. Fiber is one of the more complicated substances studied in the fields of animal and human nutrition. Knowledge of the plant cell wall – its chemical composition, physical properties, structure, organization, potential fermentability, viscosity, density, intake potential, feeding value within select diet matrices, health outcomes related to select fiber fragments – is critical if advancements are to be made in improving its utilization and in understanding physiological and health outcomes associated with fiber inclusion in diets. But it is no longer just about plant cell walls – oligosaccharides, resistant starches, glycemic carbohydrates, novel carbohydrates made from starch, and select bioactive fiber fragments all fall under the “fiber umbrella.” This presentation will briefly recount a 40 year career of using comparative nutrition approaches to the study of this complex ingredient so important to the physiology and health of animals and humans.

Key Words: comparative nutrition, carbohydrate