Enzymes, involved in the metabolism of glucose and fatty acids and in energy homeostasis, are crucial in maintaining life, and may be variable among animal species, tissues, and various physiological and nutritional status of a given animal. In particular, elevations in MDH activity and MDH/LDH (M/L) ratio likely indicate heightened energy metabolism, as MDH of the malate-aspartate shuttle, contributes to the coupling of glycolysis with ATP production via the transport of cytosolic NADH into mitochondria. The malate-aspartate shuttle, one of the NADH shuttles, transports cytosolic NADH, a key molecule for oxidative metabolism and ATP production, into mitochondria, and plays an important role in the regulation of mitochondrial metabolism in animal cells.

Enzyme activities of energy metabolism, such as MDH, M/L ratio, glutamate dehydrogenase (GLDH), and fructokinase (FK) of the feline leukocytes were compared against those of the canine leukocytes. Significantly lower MDH, M/L ratio, GLDH, and higher FK, pyruvate kinase, and G6PD may reflect the unique demands and usages of nutrients and energy sources in cats with higher incidence of obesity, insulin resistance, and diabetes mellitus compared to dogs. Elevations in cytosolic and mitochondrial MDH and the resultant cytosolic M/L ratio are noted in cells that may be experiencing increased mitochondrial ATP productions. Elevated ATP productions, in turn, provide for increased energy demands (intense exercise, neoplastic cell growth, acute weight gain). Type 1 diabetic dogs with higher plasma glucose concentrations, showed lower levels MDH, M/L ratio, as well as AST, as compared to the healthy control dogs. These reflected the defect in glucose usage and uptake as energy source in the peripheral tissues, resulting in increased circulating plasma glucose concentrations seen in diabetic patients. Decreased activity levels of MA shuttle enzymes may be one of the characteristics of energy metabolism in diabetic dogs, and may be useful as a diagnostic indicator to monitor the overall metabolic condition of the diabetic patients, identify those at risk, and predict the treatment outcome. Racehorses demonstrated higher plasma MDH and LDH activities, and

significantly higher plasma M/L ratio as compared to those of the riding horses. Moreover, racehorses demonstrated significantly higher levels of lipid metabolites as compared to those seen in riding horses. Racehorses, under intense training, may have adapted to the demands of higher activity levels by increasing muscle mitochondrial respiration, oxidative capacity, and fat utilization of the skeletal muscles as energy source in order to process and consume energy more efficiently. In experimentally overfed dogs with acute weight gain, significant elevations were noted in lipid metabolites, glucose, leukocytic MDH and LDH. Although not significant, plasma and leukocytic M/L ratios showed mild increase in the over-fed group after the feeding trial. In conclusion, M/L ratio in plasma and leukocytes reflected positive energy balance and increase in energy metabolism associated with overfeeding.

A better grasp of trends in shifts of the energy metabolism enzymes may help understand the species-species differences in energy production and usage, and early detection and prevention of energy metabolism dysregulations such as diabetes, neoplasia, and obesity. Further studies on various disease models and metabolic states in different species may assist in a better understanding of their clinical usage.