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EDITORIAL

The biology of energy expenditure

One of the great achievements of the biological sciences in the 20th century was the elucidation of the pathways and processes involved in energy metabolism. Concepts now considered fundamental to biology emerged, as the individual reactions of the major pathways were identified and the enzymes that catalyze them were purified and characterized. New areas of investigation opened up. When allosteric regulation was discovered, recognition of its importance led Monod to refer to it as the '*second secret of life*' (Perutz, 1990). The chemiosmotic theory changed the landscape of bioenergetics. The second messenger hypothesis came from studies of the hormonal control of metabolism and led to the concept of membrane signal transduction. More recently, new approaches, powerful tools and experimental models have come from molecular biology. Control analysis transformed the question 'which step in the pathway is rate-limiting?' into 'what is the degree to which each step limits flux?'.

So much is now known concerning energy metabolism that detailed coverage of it contributes to the overweight condition of many textbooks. Alas, the subject tends to be taught by those who do not study it. As a consequence, energy metabolism is often regarded as a static collection of facts (an Internet search using the words 'glycolysis and boring' yields 12,900 results in 0.12 s!). However, as in other areas of science, the spectacular discoveries made by 20th century biochemists have led to a plethora of new questions and the continued quest for deeper understanding. The study of bioenergetics has evolved to become the more integrative, comparative study of the 'biology of energy expenditure'. As Chantler put it: "*the most noble aim of the biochemist, often discussed when inebriate, seldom when sober, is to relate the* in vitro *to the* in vivo" (Chantler, 1982).

All living things expend energy to build structure as well as to maintain order and homeostasis. Animals expend energy to process information, forage for and digest food, pursue prey or escape predators, migrate long distances, feed their young, generate or dissipate heat. A wide variety of species downregulate energy expenditure as an austerity measure during fasting or to survive anoxia or desiccation. Energy metabolism has evolved to serve the needs of animals in the deepest oceans, the highest mountains, in anoxic ponds, on intertidal rocks, the hottest deserts and the coldest continents. It is increasingly perturbed by climate change and must adapt to ensure survival. Among humans, sedentary lifestyles combined with supermarket diets reduce energy expenditure while increasing energy intake. In certain countries, these result in an epidemic of excess adiposity, often associated with ailments collectively known as the 'metabolic syndrome'.

Clearly, the integrative, comparative study of the biology of energy expenditure continues to be interesting, exciting, of fundamental importance to science and of great relevance to human health and welfare. In recognition of this, we assembled a group of scientists who spoke on various topics related to this theme. The conference site in Mürren, Switzerland, facilitated the optimal synergism of muscular and intellectual exercise. The mix of participants resulted in warm, friendly and highly stimulating fermentation of scientific ideas.

Raul Suarez
Editor

References

Chantler, P. D. (1982). Caged ATP set free in muscle. *Nature* **300**, 682-683.
Perutz, M. (1990). *Mechanisms of Cooperativity and Allosteric Regulation in Proteins*. Cambridge: Cambridge University Press.