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INTRODUCTION

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Nutrition and Food Science

Holly Steach[a,*] and Michael Cha[b,*]

[a]*Deputy Editor, Department of Immunobiology, Yale School of Medicine, New Haven, CT;* [b]*Deputy Editor, Department of Cell Biology, Yale School of Medicine, New Haven, CT*

The capacity to sense environmental nutrient availability and accordingly modulate growth, energy consumption, and biomass production is critical for competitive fitness and adaptation of unicellular organisms. Multicellular organisms, however, maintain homeostasis through allocation of nutrients based on an integrated economy of availability and need. This is achieved through division of labor amongst various components of cells or of tissues within an organism. However, the use of specialization within economies of food production and distribution can also be observed on larger scales amongst humans and within large industrialized systems to support an increasingly globalized world, all of which are explored throughout this issue.

Eukaryotic cells utilize membrane-partitioned organelles to compartmentalize the anabolism (building up) or catabolism (breaking down) of various nutrients. As discussed in the review by Chen and colleagues, micro- and macronutrients are sources of fuel and substrates for synthesis of biomolecules that serve as building blocks of the cell. However, as the authors point out, they also serve less canonical purposes such as signaling molecules, post-translational regulators of protein function, and epigenetic modifiers to regulate gene expression. Through these processes, individual cells may intrinsically regulate their metabolism, activity, and function in response to nutrients. However, as opposed to unicellular organisms, cell growth and energy consumption are generally initiated by signals from other cells and tissues that allow communication of nutrient status throughout the body.

The specialization of entire tissues for nutrient sensing, metabolism, and storage enables regulation of nutrient availability throughout the body during times of fasting or feeding. The vast spectrum of pathologies associated with dysregulation of nutritional homeostasis elucidates just how integrated metabolism is with other systems. Reviews in this issue discuss effects of nutritional status on the immune system (Shondelmyer *et al.*), mucosal-associated microbiomes (Ricke, Chen *et al.*, Mukherjee *et al.*), behavior and the nervous system (Chen *et al.*), and cancers and other non-communicable pathologies (Donovan *et al.*, Teixeira *et al.*) implicating diet as a critical mediator of overall homeostasis in the body through regulation of the various systems that comprise it.

Economies of food production and allocation are part and parcel of our bodies and our social relationships. It is no wonder that so much of human culture is centered around rituals related to the intake of or abstinence from food, and as emphasized by Marcolini *et al.*, how integrally it is tied to our conceptions of human life. Our relationship with the cultivation and consumption of food is in some ways resonant of the relationship between our diet and our bodies. The industrialized labor of food production, storage, and distribution is partitioned now more so than ever to support the increased demand of growing populations. This is comprehensively reviewed by Morawicki *et al.*, who discuss emerging modes of sustainable food production to support the presumptive 9.2 billion humans predicted to populate the earth by the year 2050.

As Morawicki and colleagues discuss in their review, food production has been tailored to suit not only the dietary needs of the masses, but additionally to suit

*To whom all correspondence should be addressed: Holly Steach, Email: holly.steach@yale.edu; Michael Cha, Email: hyokeun.cha@yale.edu.

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changing societal demands influenced by cultural shifts. Chen *et al.* and Du *et al.* both refer to this phenomenon as "nutrition transition." Emergence of the western diet, highly processed food, fad diets, and concepts such as "super foods" discussed by Abeysiriwardena *et al.* shift the spectrum of food we consume. This not only has significant environmental impacts, but as the timescale of cultural evolution outpaces that of biological evolution, our bodies are subject to diets that they are not adapted to deal with. Thus, we see increased incidence of metabolic-related diseases such as obesity, cardiovascular and autoinflammatory diseases, diabetes, and liver disease. This principle is emphasized by the comparative health benefits discussed by Shondelmyer *et al.* of the ancient *Thali* diet, the nutritional composition of which reflects ancient agricultural practices that may align more with what our bodies have evolved to handle.

Large-scale changes in consumption additionally affect the environment in which we cultivate these food sources, and in turn will have effects on both humans and on other organisms with which we share this world. Morawicki *et al.* identify three pillars of food sustainability: people, planet, and profit, delineating requirements for ethical sustainability to be "economically feasible, environmentally dependable, and socially responsible." These highlight three fundamental aspects of the reciprocity between our culture and our relationship with food that are recurring themes throughout this issue.

For example, ruminant animals, as discussed in the aforementioned review by Morawicki *et al.*, are selected as food sources for their high ratio of energy input to amino acid-rich muscle output and satisfying taste. However, they also happen to produce excessive amounts of greenhouse gases, posing a significant environmental risk. Environmental sustainability is not just limited by effects of farming or cultivation practices on the environment, but also how these practices are subject to other factors such as anthropogenic accelerated climate change. As Abeysiriwardena *et al.* show, increasing ocean temperatures paired with high nitrogen and phosphorus levels promote blooms of Cyanobacteria, changing ocean ecology and contributing to the presence of cyanotoxins in our food and water.

Such problems outlined in this issue clearly violate the terms of sustainability and pose major threats to human health and to the world. However, the caveat of the currently defined three pillar system, as Morawicki *et al.* point out, is that these individual values have been deemed "interchangeable," ultimately meaning that high economic return can compensate and be used to justify social or environmental repercussions.

This brings our focus to the third pillar. The use of the word "profit" emphasizes the relationship between capital and food within the inextricable modern definitions of consumption and culture. This relationship is investigated by Du *et al.*, who critically examine marketing strategies by companies such as Coca-Cola and PepsiCo to specifically target vulnerable populations, such as individuals from low income or under-resourced communities who have limited access to both expensive healthier food options as well as health care. The authors of the perspectives piece emphasize that these sugar-sweetened beverages are incredibly unhealthy and tightly linked to obesity and other non-communicable diseases, however the incentive to generate profit has outweighed the risk that this predatory advertising poses. Boateng and colleagues discuss Vitamin A deficiency as almost exclusively effecting under-resourced or impoverished countries. While GMO-based foods and dietary supplements such as flavonoid-rich *Moringa oleifera* powder seem to provide some benefit, a larger issue is highlighted in the study of malnutrition which is a relationship between wealth and access to food, both in terms of quality and quantity.

Unlike the need-based allocation of nutrients in multicellular organisms, we seem to be stuck on an individualistic competition model: when available, consume as much as possible and grow until nutrient sources become depleted and become scarce for much of the world. This level of overconsumption and inefficient allocation will undoubtedly come at a high cost to the environment and the future of our species on this planet.