

New Frontiers' of "Science on Foods"

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Summary

Why does mankind eat? The scientific answer to this question is that man is a heterotroph. There are two types of life-style (Fig.1). One is 'autotrophic', as exemplified by plants, featuring synthesis of organic compounds from carbon dioxide with some form of energy input (plants use solar energy), and uses the synthesized organic compounds to form its bodies. This type of organism is called an autotroph. Homo sapiens and other 'heterotrophic' creatures cannot produce organic compounds by themselves, but need to rob plants and other autotrophs of vital substances to survive. These are called heterotrophs. Humans and animals evolved with no method to generate organic compounds by themselves, and therefore are literally dependent on organic compounds produced by plants to survive.

Nutrition is thus a matter of survival for living things. This survival implies not only reproduction to secure future generations but also death and finally turnover of waste bodies. Nutritional elements refer to substances required for the survival of a living organism. Though a question like, 'Is love an essential nutrient for humans?' will make a good topic for discussion at a party with my students, I will not expand my argument along this line here, as my answer may have to flexibly vary according to the students' arguments.

Generally speaking, most animals can only afford to stay alive to reproduce. Individuals are rarely allowed to survive after losing reproductive functions, as their living environment is severe and food is scarce. Apes and other primates are relatively close to humans, but males that are stripped of leadership can seldom stay in the group. The case is drastically different with humans (Fig.2). It is common that most remain 'socially' active, for a considerable length of time after completing the most important function as a living thing. Japanese people have a very long life expectancy, partly due to their healthy eating tradition, and they often live long even after completing most of their 'social' life. I am participating in a project named "Do! Japan" which focuses on serious discussion of how to coordinate our eating life, to stay active as long as possible in society, and pass away quickly afterwards to avoid long suffering.

Modern nutritional science has been concentrated on nutritional elements, their functionality and other related subjects, all through its evolution and development. Just like all other modern sciences originating in Western civilization, nutritional science has been always element-

reductive, striving for divisional analysis and comprehension of constituents. The designation of 'nutritional elements' shows clearly this reductive tendency in itself. 'Nutrigenomics', proposed by Prof. Soichi Arai, of Tokyo University of Agriculture, and Prof. Keiko Abe, my colleague at the University of Tokyo (cf. P.6, 'On the Tenth Anniversary of Inauguration', *FFI Journal* No.205), is deemed as an ultimate form of modern reductive science, in that it aims to reveal the complex functions of living things by reduction to the genome, or the genetic information that creatures carry.

However, considering the original implications of 'nutrition' as I mentioned earlier, the essence of eating should lie in surviving, or maintenance of a healthy body. In this sense, I suspect that it may also be indispensable to develop a total, comprehensive and integrated picture of how to eat in general for the retention of health, besides the popular detailed reductive analysis of food. Traditional food fads in the Orient and the balanced organization of cuisine in Japan must have derived from a holistic attitude toward food and life. I have felt this way increasingly strongly, and have felt repulsion from the flood of information about 'good' food with effects on this and that, diffused by the media, since if we ate all those 'good' foods they recommend, we would definitely die from, say, overeating. Rather, we must take up a more holistic approach, considering what and how much to eat in a day as a whole.

The relationship between holistic and reductive approaches is similar to that of music and constituents of an orchestra. No one will care about how many stringed instruments, wind instruments and players compose the orchestra, and various other details, when they want to enjoy and appreciate the music it performs. We would rather like to simply listen to the music as a whole. It is, therefore, clear that we should take a holistic attitude toward music, except for such occasions when special criticism is required.

Can we adopt a similar attitude toward food and eating? Dr. Akio Yamanoi, of Ajinomoto Co., Inc., wrote recently about integrating reductive science with the skill of masters for delicious food (p.771, 'Preface', *Kagaku to Seibutsu*, Vol.40, No.12, 2002). Reading the article, I was encouraged to find that a great professional in the field thought the same way as myself. Dr. Yamanoi argues that pursuit of truly good food requires incessant exchange between the left-brain science of reductive approach and the right-brain art of the master's hand.

I currently focus my scholarship on complex microbiological systems. Though my primary targets are the constitution and functionality of microbial groups that affect the circulation of organic resources and the manufacturing process of fermented food, such microbial groups cannot be fully understood through the study of individual constituent microbes, and I need to look at the groups as a whole, including complex interactions. My goals cannot be attained without pursuing the comprehensive organization and functionality of these groups.

We must note, nevertheless, that no matter how much we realize the limitations of reductive

science, we cannot simply switch to a holistic approach. The major reason for this inability is the lack of methodical institutions. While we have established specific analytic systems for reductive sciences, we have not yet discovered persuasive techniques for holistic studies. A measure we can take, then, to oppose complete dependence on the reductive approach, is to continue our studies on a reductive basis, but be well aware of its limitations, and promote a holistic way of thinking in some way or another. We may wonder why a certain microbial group functions steadily and efficiently as a whole, why a certain food tastes good in total, or how a food benefits human health and leads to healthy life after all.

Returning to the concept of nutrigenomics, an ultimate nutrition science that reductively pursues nutrition at the genetic level can be considered holistic at the same time, as long as it aims to list all genetic information regarding nutrition. This also reminds us of supplements, which are attracting growing interest in the domain of food science. Supplements are supposed to supplement lacks in nutrition, assuming an ideal total balance of food and nutrition to maintain human health, and analyzing the nutritional elements that are actually consumed. This notion definitely represents an exchange and integration of reductive and holistic approaches.

The exchange and integration of reductive and holistic approaches have already been discussed and implemented by Dr. Yamanoi and other professionals in the pursuit of good taste. We must now aim for discussion and implementation of studies of functionality (e.g. not the functionality of each constituent, but of a food as a whole), safety, productivity (e.g. total impact of genetic engineering on these qualities), and preservability (e.g. how additives affect food distribution in general) of food and nutrition, which have almost exclusively been studied by way of the reductive method. I hope that the introduction of a holistic approach into these fields will eventually lead to fruitful scientific discussion of how and what humans should eat, to experience long and healthy lives.