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NUTRITION IN THE SCIENCE - TECHNOLOGY CONTINUUM

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Science refers to the discovery of new knowledge by controlled and verifiable experiment, and technology describes the procedures and technical feasibility of obtaining a desired end result. For too long scientists and technologists have tended to stay apart but the total corpus of science and technology can no longer afford this.

Science began with simple observation and evolved into experimentation. Then, particularly from the seventeenth century each discovery led logically and relentlessly to the next so that today we add to a continuity of scientific discovery.

Technology is much older than science and arose from time to time in response to a personal and economic need. Iron is 3,500 years old but cast iron dates only from the fifteenth century A.D. and ushered in a new world - through technology, not science. The Industrial Revolution was technological not scientific, and technology has advanced empirically at times even into the twentieth century.

Twentieth century life exists in a science - technology continuum. Every aspect of modern living derives from science and technology which must be enlisted to clean up the pollution resulting from unthinking commerce.

There is no sharp boundary between science and technology but an interpenetration and overlap and the channel through which science flows to technology is Applied Science, which is essentially a state of mind which seeks and recognizes the difference between what is possible and what is practicable. The applied scientist is distinguished by inter-disciplinary thinking and an understanding of the cost of doing things.

Today, pure research operates within the continuum and is prosecuted mainly in universities. It may produce knowledge for its own sake or results of immediate practical application. Academia is part of the continuum but cannot, unaided, benefit the community.

Industry also exists within the continuum but sometimes fails to acknowledge science. It produces goods in a quality control context and uses Research and Development to enhance its prosperity, but the viability of both Production and Research and Development derives from the same continuum.

Finally, there is not a single department of government that does not use science and technology or rely heavily on its products. Even Treasury uses sophisticated office technology.

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There is between Science and Technology an implied interface. This is good because an interface connotes contact and interchange, but bad also because an interface is a barrier which interrupts a continuum, which gives rise to interfacial tension, and which can only be crossed by the expenditure of energy. There are interfaces between the disciplines of science within universities, and there are interfaces in industry between, for example, Production and Research and Development, Research and Development and Marketing, Marketing and Production, and also between the company and the consumer. Every interface tends to be impermeable, and if there is to be steady ebb and flow of information and application, i.e. a true continuum, then scientist, technologist, technical salesman and consumer must recognise themselves and each other as part of and able to contribute to the total corpus of science and technology, and as able to contribute to the solution of the problems of the interface.

Now that is all very well but where and how does nutrition fit into it? At ANZAAS in 1971 I gave the Presidential Address to what is now Section 18, Food Science and Nutrition. It was entitled "The Interaction of Food Science, Technology and Nutrition" (Search 3, 31, 1972) and on rereading I find that it contains a good deal of what I would like to say now.

Nutrition is an interdisciplinary science depending on food chemistry, particularly analysis, biochemistry, and physiology, and concerning itself very greatly with food technology and sociology. Nutrition is positive, describing what is good and promoting it, but also negative in recognising and describing what is harmful, and warning against it. We shall examine these briefly in terms of the continuum as already outlined.

First, there is continuity in the history of the supply of food and thus of food technology from ancient times. Trial and error differentiated between what was good and bad to eat, and drying, salting, pickling, and fermenting are all ancient processes. Milling, baking, brewing, and heat processing arose, and so on to present day variants of all these.

Second, though nutrition qua nutrition probably only began with Lind in the mid-eighteenth century and progressed only slowly because of its dependence on the other sciences already mentioned, it is established in the stream of modern science and with all its interrelationships is part of the science - technology continuum.

In the paper already referred to I used the story of beri-beri and thiamine as an example of inter-relationships and I summed it up very much as follows:

The development of technology which improved the keeping qualities of rice removing the outer husk, greatly reduced it nutritive value merely through ignorance. Many years of clinical work and experimental nutrition showed that a vital factor, thiamine, had been removed with the husk. Two and a half decades of laboratory science were required to isolate the missing factor and to synthesize it. Chemical technology manufactured it and finally food technology got it back into the diet so that people can have rice in the form they prefer without risk of disease and death. The time cycle was almost a century. In the meantime communities with poorer technology, such as India with parboiling and Indonesia with primitive milling, have suffered far less than the rest of South East Asia. More and more Asian village women will gladly stop pounding the daily ration of rice with crude pestles and mortars and use milled rice as it becomes available to them, and the more efficient the milling the greater the danger to them and to their families unless steps are taken to put the thiamine back.

This story is a good illustration of the overlap and interpenetration within the science - technology continuum. One can go further and broaden the concept. Technology shows how to modify and process biological raw materials to produce food which may be stored and transported. Science gives a deeper understanding of the constituents of food and their inter-relationship. It explains why most of the changes brought about by technology occur and thus gives rise to newer technology and to a greater variety of food products. Technology sometimes leads to a demonstrable reduction in nutritive value or to positively harmful results, nutrition demonstrates this and sounds the warning. It is then the task of science to show how the adverse effect can be overcome. Nutrition may also demonstrate a need and it is then the task of technology, with or without science, to supply it.

Nutrition has made great strides. The elements of good nutrition are clearly understood - the British experience during the Second World War when overall health improved with rationing was evidence of that - though there is still vigorous discussion about the size of recommended daily allowances, for example, and recent drastic revision downwards of protein requirements is evidence of that. It is important that these recommended allowances be kept under constant review because they relate to world food supplies and therefore impinge on strategies for agriculture and the whole corpus of agricultural technology including energy supply. If nutrition is basically understood then so also is under-nutrition i.e. the lack of one or more of the basic food requirements. Malnutrition is referred to elsewhere in this symposium but I would like to refer briefly to what we may call negative nutrition for this is a part of the continuum overlapping with other disciplines.

I define negative nutrition as the recongition and understanding of the constituents of food which are harmful when ingested.

Trace metals have recently become very prominent. While some trace metals are essential for good health, the story of Minamata Bay and increasing concern about cadmium and lead is sufficient warning of the dangers of the absorption of harmful trace metals by food in the growing period of the food organism, and constitute a continual warning against the pick-up of various trace metals during the progress of food from the field to the consumer's plate.

Pesticides have been of concern for many years and recent attempts to curtail their use in the agricultural industry are evidence of growing community disquiet. Residues of agricultural chemicals are sometimes harmful and this has led to regulatory authorities throughout the world writing strict upper limits for all kinds of pesticide residues.

More recently concern has been expressed about the migration of organic and inorganic substances from packaging materials into the food, the most publicized being VCM, vinyl chloride monomer, and in recent years we have seen also the recognition in food of naturally occurring toxicants. Of these, perhaps those of most concern to the food industry are the mycotoxins, aflatoxin being the best known example; but the products of the metabolism of moulds are under scrutiny all over the world and are of great concern to all whose professional interests are with food.

Of all these various substances one can say that modern concern has arisen merely because of the demonstration of their presence. This has followed from the increasing sophistication of analytical procedures and the recognition that once the presence of a potentially harmful substance has been demonstrated then it must be accounted for. However, there is no need to remind this audience that the human body is an exceedingly resilient organism, and that, provided potentially harmful substnaces are kept below certain demonstrated concentrations, then the body is capable of dealing with them: but at this point nutrition marches with toxicology.

If the emphasis of what I am saying is on human nutrition, I may be forgiven, I hope, for, for 38 years, my professional concern has been with food science. In this symposium we have heard something of animal nutrition also and if I may refer simply in so many words to the story of coast disease and cobalt and the great economic benefits flowing to the pastoral industry therefrom we have yet another illustration of the symbiosis of nutrition with other disciplines within the continuum.

Nutrition as with other sciences takes information from the laboratory and from the clinic and attempts to relate it to every-day life. In order to do this the nutritionist must talk with the doctor, the food manufacturer, and the consumer, and there are inherent within this progression interfaces about which we have already been speaking. Nutrition has interfaces with other disciplines of science. Nutrition has interfaces with man, with animals and with plants. Nutrition has interfaces with medicine, with industry and with consumers, as I have already stated.

The food processor is very sensitive to what may be called the overt negative aspect of food quality, viz. that he may be using in his food something which is harmful. He is less sensitive to criticism of foods which may be accused of the promotion of, for example, dental caries, and he is for the most part insensitive altogether to marginal losses of nutritive value during the processing of his products. This, in essence, is a short description of the kind of interface between the nutritionist and the food industry, an interface across which information must be made to flow.

Even more difficult will probably be the interface between nutritionist and the consumer. The consumer may be ignorant, such as the woman who boiled the orange juice for her baby, which therefore got scurvy; conservative, clinging to the food habits of her grandparents; suspicious of the exaggerated harm which newspapers tell her may be done to her family by modern processed foods; or just plain lazy, feeding her children an unbalanced diet consisting very largely of snacks. This interface brings nutrition squarely into a relationship with sociology which describes behaviour patterns and how to change them, and changes will only occur as information crosses the interfaces and action follows from the information. The concept of the increase of entropy with the increase of fragmentation and the decrease of energy is well known to us all. The same mathematical relationship exists between information and fragmentation except that it is an inverse relationship - information decreases with fragmentation and increases with energy input.

The nutritionist is an applied scientist through whom research findings flow to man, to animals, and to plants. He and his activities are only specific examples of the science - technology continuum in action. Getting results and getting them accepted depends solely on energy input : in other words they depend on that nasty four letter Anglo-Saxon word - work.