RIGHT OF REPLY

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I am greatly touched and honoured that The Royal Society of Victoria has seen fit to organize this symposium and equally touched – not to say amazed, that so many friends and colleagues have given up a precious Saturday to be here. This applies doubly to the presenters who have put so much time (they haven't got) into preparing the material we have been privileged to hear today. I also acknowledge gratefully the generous support of The University of Melbourne and La Trobe University.

I thank the Society and all of you most warmly for giving me a day to remember. Whereas today has been marvellous for me, especially to see so many old friends, but you too have been rewarded by listening to a masterly analysis of a wide range of topics in science, technology and tertiary education – all areas where contrary opinions and vigorous debate, abound. It will not have escaped your notice that these topics relate to many of the fields in which I have had an interest over some 60 years.

This points up that my career could hardly be called focused. I'm perhaps better classed as a patchily educated, peripatetic, opportunistic, amateur biologist. I have worked largely on the microbial scale investigating disorders of cider, persuading a mould to make citric acid, bacteria to degrade cineol, tolerate cadmium, or convert hydrocarbons into single cell protein. Nothing daunted, however, I have found myself frequently addressing issues and problems on an environmental scale, for example the waters of Port Phillip Bay, the huge lagoons at Werribee, the muds of Westernport Bay, Victoria's Park's system, the safety of our food supply and the release of live genetically modified organisms (GMOs). Further, for 13 years I chaired a CRC that focused its funds on the research that underpins the provision of safe, potable water for large urban communities. Finally, of course, I've had the great privilege and challenge of teaching university students in the days when they could see the whites of your eyes, you could talk to them instead of being glued, google eyed to the green screen.

Since I ceased to be a staff member, the Department has allowed me to occupy an office – an enormous privilege as vacant offices don't last a millisecond in our crowded, busy Department – many thanks to Roy and Jim.

Five years after retiring, I had the very rewarding experience of being Chancellor of La Trobe University for 14 years during which time I observed the research output of La Trobe increase very significantly while, at the same time, they provided improved opportunities for tertiary education at their regional campuses at Bendigo, Albury/Wodonga, Beechworth, Mildura and Shepparton.

MICROBIAL INTERESTS

I was fascinated by the way the environment influences the physiology of organisms and how you can manage this to have them accumulate products of interest or degrade unwanted ones.

In addressing problems on the large scale you are very aware of the need for the fundamental knowledge that informs the many factors that influence the behaviour of the whole – you need help!! I have benefited enormously from the contributions of col-

leagues from disciplines as diverse as chemistry, chemical engineering, agriculture, botany, law, epidemiology, genetics, ecology, taxonomy, mathematical modelling and ethics.

The production of a pharmaceutical by a microbe on a large scale was my first real appreciation of what is involved in scaling up from 5-10 ml in the lab to say 200,000L in a stainless steel tank. My epiphany came in 1963 in Tokyo when an American biotechnologist Fulbright, a very mathematically oriented Japanese chemical engineer and I put on the first course on biotechnology in Japan. Later (6,000 miles apart) we combined to publish the course as a text, *Biochemical Engineering,* (Aiba et al. 1965). Our hope was that it would help biologists and chemical engineers come to a mutual appreciation of the biological constraints required in the environment for growth and maximum product formation (the strict limits tolerated in temperature, pH, dissolved oxygen, nutrients), and the engineering constraints in the design of tanks with 200,000L capacity, "perfectly" mixed, held free of contamination, in the provision of sterile medium and air and the ability to add solutions and take samples, aseptically. All seals of cooling and heating coils and stirring shafts must be leak proof and autoclavable. It really is no job for a mere physiologist or a gene joc, especially as scaling-up is strictly governed by the cost of labour and materials and future maintenance.

Fermentation processes are relatively simple systems. When you are out there in natural environments, you have a real challenge, and multi-discipline teams of scientists, well versed in the fundamentals of the relevant disciplines, are essential.

So many of my environmental interests have been blessed by contact with experts who have been willing to share their knowledge and this symposium gives me the chance to thank them which I do most sincerely – their contributions gave depth, quality and credibility to the work over the years.

TALKING TO THE PUBLIC

I have tried to convey the facts about controversial science – related issues to general audiences, but in particular about the acceptance of genetic engineering and the augmenting of potable water supplies.

To gain acceptance of GMOs you must set out in simple terms what is involved in the technology. What steps are taken to identify potential hazards, establish the probability of the hazards occurring, estimate how terrible it would be if they did occur, what can you do if the worse happens, and of course, why do you want the novel construct in the first place!? For 25 years Australia had a non-statutory surveillance system but in 2000, the Commonwealth passed the Gene Technology Act so that the technology is now regulated by law. I must say that when this change occurred it was not because the technology was suddenly more dangerous, but was a response to pressure groups. Acceptance of genetic engineering is a fascinating story of inconsistency. Medical applications gain ready acceptance by almost everyone, even procedures that require the GMO to be injected but, for a vocal minority, genetically modified food is totally unacceptable. All food contains DNA, we have no evidence that humans or other animals express the genes of the food they eat (you haven't noticed pointed ears and a curly tail as a result of eating a pork chop). Environmentally and agronomicly, the benefits are substantial – fewer applications of more benign biocides, the plant cultivars can be made virus resistant, more tolerant of drought and frost and more efficient at sequesting nutrients from the soil. In addition, the product can be enriched in minerals and vitamins or have a better profile of amino acids or fatty acids. I believe the government has moved to acknowledge the views of those who object to genetically modified food by requiring food containing novel DNA or novel protein to be so labelled. Choice is thus provided to consumers to avoid GM products, while farmers can choose to grown GM crops that have been licenced by the Gene Technology Regulator.

WATER CRISIS

Reduced run off to our catchments since 2000 has focused water authorities on balancing supply and demand and though Melburnians have significantly reduced their use per head per day from >400L in the 1990s, it is still not enough. Melbourne Water has set us a target of 155L/head/day (contrast this with 331L in 2005). The problem of supply is exacerbated by the expectation that the population of greater Melbourne will be 1.3 – 1.5 M larger by 2050, and that climate change will persist.

The government has stated that no new dams are to be built (even if there were an available suitable site), so what's to be done? The most realistic options capable of consistently delivering significant volumes are:

- desalinated seawater
- effluent further treated to Class A and used to spare potable water in industry and for irrigation, sports fields and environmental flows
- effluent treated to meet Australian Drinking Water Guidelines (ADWG) added to reservoirs receiving conventional raw water and the whole treated as usual.

Most people accept the prospect of drinking appropriately treated seawater but the "Yuk" factor springs to the mind of many at the proposal to add appropriately treated effluent to the potable supply. Their attitude does not change, despite data showing that recycled water meeting the ADWG is arguably, superior in quality to many conventional raw water sources. On the other hand, sparing potable water by substituting recycled Class A water for particular purposes is widely supported. Currently, the Victorian government has decided to adopt the desalination option and to recycle Class A water to spare potable water. Melbourne Water has set a target for 20% of Class A effluent to be recycled by 2010.

I have laboured these two examples of non-acceptance by the public of the application of novel technology in their everyday lives and I contrast these cases with the absolute "love-in" everyone has with mobile phones, whose workings, I am sure, are understood by <0.01% of the population, why is it so?

Is it because we all know about food and water, the very stuff of life, and we are intensely combative with anyone who challenges our cherished beliefs? I don't know the answer to this conundrum, so instead, I ask you to enter the public arena and engage in rational debate, be willing to challenge the specious statements you so often hear. It's a bruising process, but to walk away and leave the field to those peddling mis-information is not the way to go. I ask you to remember this quote I came across some time ago

> "given enough pressure by skilful activist groups, what does not make sense, has an excellent chance of becoming public policy."

I will stop on that evangelical note and thank you all, once again, for coming.

REFERENCES

Aiba, S., Humphrey, A.E. and Millis, N.F., 1965. *Biochemical Engineering*. Tokyo University Press, Tokyo, Japan.