

contingency of biological phenomena. Maynard Smith fails to exploit it. The argument runs along the following lines. The unsolved proximal topics, to begin with, are intimately related. As he notes, two are chief among them: development and behaviour. At least since William Harvey and the realization that *omne vivum ex ovo*, development and differentiation has been the great intractable problem. We now see that it subsumes, for higher organisms, the problem of the controls on biochemical activity in the individual cell — for these, directly or at one remove, are special cases of gene expression. We see that the most extreme elaboration of development is presented by the differentiation of the immune system (a problem of the first rank, surely, but not addressed by Maynard Smith) and of the nervous system and brain. We now get the first glimpses of a relationship, at the level of receptors common to lymphocytes and nerve cells, between the immune and nervous systems, whose mutual interactions are giving rise to an unexpected new field, behavioural immunology. We are reminded that receptors on neurones are to be understood — Jean-Pierre Changeux has been pressing this point — as allosteric proteins, which, of course, were first recognized as control elements within the cell. The essence of allosteric proteins is that they permit networking of responses free

of chemical stringencies. All this suggests that the problem of development even implicates the problem of behaviour, so far as that can be approached from the bottom up.

Development and its subsidiary problems are as difficult as they are for at least two reasons: the individuals and systems in which we are most interested are complex beyond imagining, perhaps beyond describing, and the vast blueprint for what we encounter as this proximal complexity is itself a palimpsest, layer upon layer upon ancient layer of alterations each of which could only arise directly from what was available immediately before. In evolutionary biology the most contentious problems are the nature of the changes that have led to speciation and the rates at which evolution has taken place, along with the special case of the evolution of animal and human behaviour. The unifying relationship here returns to the control genes that determine development, in particular how these mutate, perhaps accounting for bursts of evolutionary change. To fathom the proximal we require the ultimate, and the other way around: biology is intrinsically, in part, *ad hoc* — as we were explaining to the amiable physicist. □

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Taking the tablets

Michael Nelson

How to Live Longer and Feel Better. By Linus Pauling. W.H. Freeman:1986. Pp.322. Hbk \$15.95, £15.95; pbk \$7.95, £5.95.

AN ELDERLY relative from America visited me recently in London. At breakfast each morning she swallowed a vast array of vitamin tablets, one "for cholesterol", one "for colds", one "for skin" and so on. "Do you feel any better for taking them?" I asked. "No", she replied, "but I think I ought to and they don't seem to do me any harm".

In *How to Live Longer and Feel Better*, Linus Pauling uses equally unconvincing arguments to try and convince readers of the benefits of the megavitamin treatment of life. He begins by describing "The Regimen" for better health, outlining in declamatory fashion his reasons for consuming anywhere between 10 and 3,000 times the recommended intakes of most known vitamins, with emphasis on the particular value of vitamin C. He then discusses the roles of protein, fat, carbohydrates, energy, water (and, of course, vitamin C) in maintaining health, and

provides some sensible if unoriginal ideas about balanced eating and avoiding fad diets. His emphasis on the protective role of vitamins, however, is at odds with current epidemiological evidence regarding the effects on health of smoking, excess weight and lack of exercise. This first section also contains a number of irritating nutritional inaccuracies (for example that starch is found in all fruit, that vegetarian diets cannot provide the correct balance of essential amino acids, that seeds and nuts are low in vitamins).

Dr Pauling regards vitamins as food, and so makes the absurd suggestion that "It is wise to supplement the vitamin supplements with a good intake of fruits and vegetables" (p.31) — this is standing nutrition on its head. Also, I am instinctively wary of advice which tells me that "swallowing not more than a half-dozen tablets a day" isn't burdensome, and find misguided the remark that a regimen adding £7 to a weekly food bill is inexpensive.

The second section, "The New Nutrition", begins with promise. A history of the discovery of vitamins is followed by an interesting chapter on vitamins and evolution. Unhappily, this degenerates into an attempt to establish optimal levels of vitamin C intake for human beings based solely on comparative physiology. Analo-

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"ACTUALLY I STARTED OUT IN QUANTUM MECHANICS, BUT SOMEWHERE ALONG THE WAY I TOOK A WRONG TURN."

gies with pigs, cats, monkeys and goats provide interesting but unconvincing evidence for the optimal human requirement, and direct evidence from experiments on healthy people is sorely lacking.

The third section on orthomolecular medicine is, frankly, tedious. There is very little here that has not already been said elsewhere. For illness after illness, from the common cold to AIDS, Dr Pauling presents repetitive and wholly one-sided arguments in favour of treatment with massive doses of vitamin C. Those few studies quoted which do not support his contentions are dismissed for having failed to provide sufficiently large and lengthy doses to be effective. This lack of balance lends an evangelical tone to his writing and casts justifiable doubt on his interpretation of others' findings. For example, Knox's data on deaths from heart disease (*Lancet*, I, 1465-1466; 1973) did not, as Pauling claims, show an association with vitamin C "greater than that for any other factor" (p.151). The correlation between regional mortality from heart disease and diet was greatest for calcium ($r=-0.67$), not vitamin C (-0.49), and in a multiple regression analysis, calcium, fat and vitamin D — not C — were the most significantly correlated variables.

This book, then, is for the lay audience which wants to be convinced that life will be happier and longer if Dr Pauling's prescription is followed. It is not for epidemiologists or nutritionists who are looking for reasoned arguments on the merits of vitamins in the prevention of disease. There is a comprehensive bibliography of interest to those who wish to look into the subject themselves and draw their own conclusions. □

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