cells had the capacity to settle down and participate in completely normal tissue and organ development if given a chance in a normal embryonic environment. The embryologists Ralph Brinster, Beatrice Mintz and Richard Gardner proved him right by producing chimaeric mice derived from a mixture of normal embryo cells and embryonic carcinoma cells.

If this were the whole story, teratomas would have remained no more than interesting medical oddities. But, in 1981, Martin Evans and Matthew Kaufman of Cambridge University, and Gail Martin at the University of California, San Francisco, independently grabbed the reins of development when they extracted embryonic stem cells directly from mouse embryos and kept them growing in culture indefinitely without differentiating. In 1998, the same process was perfected for use with human embryos, and the age of regenerative medicine was initiated. The goal now is to discover the factors and conditions that will transform embryonic-like cells into whatever tissue is required to overcome a particular disease or human condition.

Parson engages the debate between supporters and opponents of human embryo research by allowing the main players to speak for themselves. She doesn't advocate for or against, although the book's subtitle leaves no doubt as to her own position. The final chapter provides a balanced assessment of the therapeutic potential of stem cells in both the short and the long term, disease by disease and organ by organ. All in all, Parson admirably brings to life the stem-cell story from a tiny Maine fishing village to the battle for the American presidency in 2004. ■

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Food for thought for geneticists

Why Some Like It Hot: Food, Genes and Cultural Diversity
by Gary Paul Nabhan
Island Press: 2004. 223 pp. $24

T. Colin Campbell

It's not that we are what we eat, proposes Gary Nabhan, but rather, we are what foods our ancestors ate and what genes they gave to us. In *Why Some Like it Hot*, Nabhan argues that natural selection and other evolutionary processes mediated by food choices unique to each geoclimatic and cultural domain have played important roles in generating human genetic diversity.

According to Nabhan, the time period for this evolution is likely to have been much shorter than is generally supposed. Our unique gene profiles evolved within the past few thousand years or so, perhaps as mutations caused by secondary compounds in staple foods and culinary herbs that were indigenous to certain geoclimatic regions. These genomic profiles could have been moulded by food choices, and by pressure from endemic diseases, to reduce the risk of disease.

This view departs from the darwinian idea that our current gene pool resulted from a very slow process of random selection to maximize individuals' survival. The fact that 99.9% of our genome is shared by all humans, present and past, is cited as evidence of an exceptional genetic stability that arose many millennia ago, perhaps during and before Palaeolithic times.

This observation of early genetic similarity and stability has suggested to some observers that there is a one-size-fits-all diet, perhaps one that was commonly used during Palaeolithic times, but Nabhan challenges this view. He points out, as others have, that of the 3 billion nucleotides in the human genome, 3 million of them (0.1%) have remained in play and can be used to create genetic diversity. A change of only one nucleotide can make a substantial difference.

Nabhan identifies a group of 26 'disease genes' that are likely to have been fashioned by food factors and endemic diseases. He cites adult-onset diabetes, lactose intolerance and heritable food allergies as examples of interactions between genes, food and disease. He goes on to say that a large number of us are subject to one or more of these genetic 'disorders', as some would call them — indeed they are so common that they should be considered normal.

He discusses in considerable depth the extensively studied link between malaria, sickle-cell anaemia, the consumption of fava beans, and glucose 6-phosphate dehydrogenase (G6PD) deficiency, in order to illustrate how a careful study of biology, culture and history can be much more rewarding than one of these disciplines alone. He takes the reader on a trail of discovery, visiting the Mediterranean island of Sardinia, where malaria has long been endemic. Here the traditional springtime consumption of fava beans offers those with the genetic disorder of G6PD deficiency some protection against the mosquito-borne disease. Coupling cultural, biological and historical analyses in this way is the basis for the field of nutritional ecogenetics.

Nabhan also cites examples that tend to be found in regions of the world, particularly islands, where the resulting interactions became reasonably well established and remained stable. For example, on the island of Crete and elsewhere in the Mediterranean region, a high-fat diet is associated with a lower risk of heart disease than would be expected from studies of other Western subjects. His travels to these regions and his discoveries are presented as engaging personal experiences. He ends his book with a particularly notable example of the remarkable clinical experiences of Terry Shintani and colleagues, who have studied the food sensitivities now suffered by indigenous Hawaiians as they adopt a modern Western diet.

The story told by Nabhan is thought-provoking. He implies that each of us, as individuals, should consider our food choices and their health effects with reference to our own evolutionary past. However reasonable this argument seems, it leaves unanswered the critical question of how such information can be used to create contemporary dietary advice for the public. Most people now are a heterogeneous mixture of genes and food habits that will be virtually impossible to untangle in a way that can tell us what we should be eating to be healthy. Even if we knew the evolutionary pedigree of our contemporary genes — which is most improbable — we would be hard put to match our genetic predispositions with the specific foods likely to make us most healthy. I dread to think what the marketplace will make of this account.

In decrying the one-size-fits-all diet proposal promoted by some dietary advocates, Nabhan seems to ignore the remarkable nutritional range and food choices that exist within such supposedly monolithic diets. For example, the recommended low-fat, whole-food, plant-based diet neither connotes an unvarying diet nor implies exactly the same health benefits for all consumers. It allows for, and even encourages, the consumption of a wide variety of such foods. But the diversity for different regions and different groups of people can still be used to generate most of the same health benefits. This is the beauty of the work of Shintani and his colleagues, who have produced remarkable health benefits when obese and diabetic native Hawaiians are re-introduced to their native whole-plant-based foods, which are low in fat and high in fibre and antioxidants. In a similar way, a range of different plant-based foods can be used to control or even reverse a variety of serious diseases.

It is remarkable that meaningful genetic adaptation can occur in a few thousand years or so, but even more so that genetic-like adaptations can occur within only one or two lifetimes. Dietary experiences before or shortly after birth, either direct or maternal, can imprint substantial biochemical and morphological changes that become stabilized well into adulthood as if they were genetic — yet they are more likely to be post-transcriptional or post-translational. Such is the nature of dietary adaptation, a process that is continually at work, short term and long term, minimizing harm and making the most of what food and other resources are available.

Despite these minor criticisms, the book is well worth reading, for it should stimulate an important debate about what constitutes dietary adaptations and sensitivities. ■

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The sincerest form of flattery

Imitation of Life: How Biology is Inspiring Computing
by Nancy Forbes
MIT Press: 2004. 176 pp. $25.95, £16.95

John Doyle and Marie Csete

Generations of engineers have recognized that, in many respects, biology does it better. *Imitation of Life* is a whirlwind history, richer even than its subtitle suggests, through various computational disciplines inspired by biology. This is an ambitious undertaking for such a short book but, although it ignores some important unifying principles, its brevity is also a virtue. The inspirations from biology are scattered throughout the book, and their collective impact is felt best when the book is digested whole, at one sitting. The early chapters on biology as a metaphor are the least satisfying, and any reader who stops there may never return for the genuine delights that follow.

Some historians argue that the inspiration provided by avian feathers and flapping may have delayed heavier-than-air flight for centuries. Critics would argue that artificial neural nets, genetic algorithms, cellular automata and artificial life, which are covered in the first four chapters, are the modern equivalents of flapping, whereas advocates see them as mature fields no longer in need of review. Nancy Forbes is generous about their successes, but does little to resolve the issue. Only later are there brief discussions of hierarchy, modularity, layers of control, and system architecture — key concepts in computing that could help to inform a more thorough analysis.

In contrast to the earlier sections, which use biology as a metaphor, the chapters on DNA computing and biomolecular self-assembly describe the direct use of biological chemistry or materials to create technological artefacts that have little or nothing to do with biology. Forbes is clearly more interested in these topics, and this enthusiasm may well spread to readers; the section on the intriguing computational power in the organization of DNA is particularly well presented. These chapters start to make it clear that understanding biological principles in some depth is an essential part of profitable imitation. Making DNA computing work requires a firm grasp of the principles and careful design, but now anyone can download cellular automata or genetic algorithm software and run laptop artificial-life experiments.

The chapters on amorphous computing, computer immune systems and biologically inspired hardware further underscore the idea that, as biology is better understood, inspiration can proceed more from mimicry than metaphor, and contribute more directly to solving difficult computational tasks. What makes this work (and these chapters) more compelling is the fact that engineers in these fields have crossed disciplinary lines to gather a deep and practical understanding of biology and biological experimentation. The recent explosion in our detailed knowledge of biology, and the glimpses this provides of its organizing principles, has considerably enriched biologicaly inspired computing.

The final chapter reverses direction and