to describe the basic physics with few equations. Hurricane formation, energetics and ocean interaction are all clearly explained. The fundamentals of numerical weather prediction using computers, including chaos theory and its relevance to forecasting, are also well treated. The only minor criticism I have is that each of the forces that control the behaviour of hurricanes is treated separately. It would have been nice if the effects of all the forces had been summarized, particularly in the section on numerical weather prediction, where only the sum of all the forces is noted.

Emanuel has recently been in the public eye as a result of his recent letter in *Nature* (**436,** 686–688, 2005), in which he suggested that any further warming of the troposphere might increase the destructive potential of tropical cyclones. His book ends with some further provocative thoughts on hurricanes and climate. ■

Howard B. Bluestein is at the School of Meteorology, University of Oklahoma, Norman, Oklahoma 73019, USA.

Fetal affliction

The Fetal Matrix: Evolution, Development and Disease
by Peter Gluckman & Mark Hanson
Cambridge University Press: 2005. 272 pp. £50, $90 (hbk); £24.99, $39.99 (pbk)

Michael Sargent

The idea of the womb as a tranquil nursery, untroubled by worldly pressures, is charming but wrong: the unborn baby reacts and adapts to its unique environment, with profound consequences for later life. This is the view that emerged in the 1990s from some remarkable investigations led by David Barker at the University of Southampton. Retrospective studies of cohorts of people born in the 1920s indicated that babies that were small for their gestational age were more susceptible than average in middle age to coronary heart disease, type 2 diabetes, hypertension and osteoporosis.

The Fetal Matrix by Peter Gluckman and Mark Hanson is a fascinating and important book about the responses of the mammalian fetus to its environment. Building on Barker's proposals, the authors suggest that the fetus can respond to a potentially harsh nutritional landscape by scaling down the developmental enterprise to create a 'survival phenotype' — a small, lean body with undiminished capacity for reproduction. Visceral organs are underdeveloped relative to the brain because fewer cells are allocated to capillaries in muscle, to nephrons, to the liver or to insulin secretion. Energy is conserved by avoiding unnecessary muscle growth and using any excess to create fat deposits that can be mobilized when food is scarce. For most of human history, the survival phenotype has been an important and appropriate adaptation when food and population were in a delicate malthusian balance.

About sixty years ago, when food became available in unprecedented abundance in the developed world and work became less physically demanding, the survival phenotype began to be a liability for some people. Those affected were likely to develop abdominal fat, high blood pressure and reduced responsiveness to a glucose surge (insulin resistance) — all signs of the 'metabolic syndrome'.

Womb for improvement? Events before birth can have huge consequences for health in later life.

EDELMANN/SPL

Barker's view of the fetal origins of disease is not universally accepted. Unfortunately, readers of this book who want to disentangle the arguments for themselves will be frustrated by the unsatisfactory link between the text and specific references. But compelling support for the concept, less dependent on fine statistical judgements, comes from work using experimental animals. This shows that the survival phenotype and its pathological consequences, hypertension and insulin resistance, can be induced *in utero* when the mother's diet is deficient in protein or micronutrients, or by treatment with the stress hormone cortisol.

The survival phenotype can be provoked in the fetus by undernutrition, by the physical constraint imposed by having a small mother, or by cortisol crossing the placenta causing growth restriction and accelerated maturation. A constraint on birth weight is inevitable in small mothers and is repeated again when their daughters (also small) become pregnant. This epigenetic phenomenon is seen with special poignancy in some parts of India, where persistent malnutrition generates a population of phenotypically small mothers whose babies are among the smallest known. The long-term effect on unborn babies of a period of malnutrition of precise intensity and duration is best known from the Dutch *Hongerwinter* of 1944–45. Many babies conceived during this episode developed the survival phenotype but were often only marginally underweight.

What provokes the survival phenotype? Maternal nutritional deficiency or exposure to cortisol causes the promoters of certain genes to remain unmethylated in the early embryo, precipitating changes of gene expression that confer an altered phenotype that persists into adult life. These genes affect activities as diverse as apoptotic remodelling of the embryo and the capacity to groom offspring, and it is a fair bet that more important examples will emerge. Offspring with the survival phenotype that gain weight quickly during childhood are prone, as adults, to the characteristic pathology of the metabolic syndrome. In countries that are now undergoing rapid economic development, a serious issue of public health is unfolding that is likely to affect people whose standard of living is increasing. Indeed, the World Health Organization has predicted that in 20 years' time, 5% of the world's population will develop type 2 diabetes.

This book is a thought-provoking account of a topic in which developmental biology, physiology and clinical medicine intersect. It focuses on the idea that the development of the mammalian fetus normally anticipates the postnatal environment, triggering a "predictive adaptive response", but may misjudge the situation. A fetus with the survival phenotype that enters an unexpectedly bounteous world starts on a developmental trajectory that may predispose the individual to ill health.

The authors convey admirably the physiological implications of an important idea, but they are less forthcoming about other dimensions of the subject that might appeal to a non-specialist reader. For example, the literature suggests that the status of the immune system and the inflammatory response, and possibly certain behavioural and psychological characteristics, are affected by events in the uterus. Similarly, investigations by historians into trends in human physique are not included. These are immensely interesting records that are an important barometer of life experience resulting from physiological decisions taken *in utero*.

I was glad to learn that 'fetus' — Latin for 'offspring', and used in English since the fourteenth century — is the correct usage and that 'foetus' is a recent pseudo-Greek affectation. More obscurely, the 'matrix' of the title alludes to a surprising dictionary definition (it means 'womb') and perhaps to the set of variables that can have such far-reaching consequences for the fetus. ■

Michael Sargent is a developmental biologist at the National Institute for Medical Research, Mill Hill, London and the author of *Biomedicine and the Human Condition: Challenges, Risks and Rewards*.