Under the covers or under a lens

Designing babies
by Roger Gosden
W. H. Freeman: 1999. 260 pp. $24.95

Carl Djerassi

Both the author of this book and readers ought to know my personal biases from the outset. As a chemist, deeply involved and interested in human conception over four decades, I have become so intrigued during the past few years by the cultural and operational effects of assisted reproductive technologies, including IVF techniques such as intracytoplasmic sperm injection (ICSI), and the separation of sex (under the covers) and fertilization (under the microscope), that I even wrote a novel and a play about the subject. So I opened Gosden's book with a tinge of competitive curiosity, even looking for authorial mis-steps or omissions. But I closed it with unambiguous admiration. "Read this book!" is my warm recommendation, because these topics are covered well.

Gosden surveys in a readable, breezy fashion all the high points of the reproductive revolution that started 21 years ago in Britain with the birth of the first IVF baby, Louise Joy Brown. His prose is straightforward enough not to lose general readers but not so simple as to turn off scientifically sophisticated ones. He is remarkably up-to-date, covering research results until late 1998, as can be seen from an admirable bibliography. And he addresses, perhaps a tad too optimistically, all the contentious issues, from sex predetermination to preimplantation analysis and cloning.

His speculations on how to get men pregnant, however, even by equipping them with uteri, is likely fodder for reproductive Luddites who will simply exclaim "I told you so" and not pay attention to the other issues raised here, 98 per cent of which are truly important. I am not sure whether getting men pregnant and converting them into functioning androgenic mothers is currently a high priority for anybody but a tabloid newspaper. But we do need a vigorous debate on the implications of 100 per cent certain sex predetermination, once effective separation of Y and X sperm has become a routine procedure in humans (a topic thoroughly discussed by Gosden). Or on the *fait accompli* of using sperm aspirated after death from a man — even after storing it for months or years — to produce a live child via ICSI.

The best written, and in my opinion also most significant, section is the one dealing with the issue of ageing mothers. In the Western and increasingly geriatric world, first-time motherhood is being postponed. A woman is born with her supplies of immature eggs, 90 per cent of which are gone by the time she is 35. As Gosden states succinctly: "Nature has carried out an act of biological sabotage on women" in that the ovary ages faster than any other organ — even though the uterus doesn't. Postmenopausal pregnancies are thus perfectly feasible, provided a source of young, healthy eggs is still available.

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Prodigy synthesis: reproduction taken to its limit.

The author covers in detail the various options for accomplishing that aim, from surrogate eggs to the preservation of ovarian tissue and its possible subsequent transplantation. But he seems rather dismissive of the already feasible preservation of young mature eggs with concomitant use of IVF. He tends to downplay that approach because of the expense associated with any IVF technology, yet ignores the fact that still-unrealized approaches such as ovarian transplant are likely to be even more costly. He makes a convincing case for why women should be entitled to the choice of later motherhood, even beyond the menopause. The real problem with all of these approaches is, of course, that for a long time to come only the affluent people in the affluent countries will be able to take advantage of such options.

The book is replete with examples of technology being developed for one purpose, but then used by society for very different ones. The direct injection of a single sperm into an egg under the microscope (ICSI), followed by transfer of the two-day-old embryo back into the woman's uterus was developed by Belgian scientists in 1991 to treat male infertility, primarily in men with insufficient sperm. The first baby born of such a technique is now only eight years old, but more than 10,000 such babies have been born since then and by no means all the fathers have been lacking sperm.

In the end, the reproductive optimists will have to accept Gosden's statement, so typical of many practising specialists in reproductive medicine: "I believe the primary goal of reproductive medicine and biology is to help people bear a child with the best possible start in life — physically and psychologically — and to bring diversity to family life." We all know that life is a terminal disease and that the production of genetically identical offspring is the only indirect way of prolonging it. Gosden makes a good case for how far science, technology and apparently also society are willing to go to satisfy that drive — a subject meriting continuing debate.

Designing Babies may soon require a new edition, given the rapid advances in reproductive medicine, in which case I have two recommendations. The present index is so inadequate that it should be improved or deleted. There are entries for the Nazi party, Shakespeare and Woody Allen, but not for ApoE, BRCA1, PGD or dozens of other highly germane words that are discussed in the text. The glossary is better, but makes no mention of many IVF techniques such as GIFT and SUZI, and makes the error — grating to a chemist — of defining "oestrogen" as "a steroid hormone produced by the ovary". Oestrogen is a generic classification, but there is no such specific hormone (in contrast to oestradiol, oestriol and the like). While one may forgive the popular press for such a misuse, an expert of Gosden's calibre should not perpetuate it. Nor should the author indulge in one-upmanship with buddy references to "Ian", "Steve" and "Arnie". I will offer a good bottle of Californian wine to the first *Nature* reader who can identify all three of Roger's pals without first having read the book. □

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Life as we don't know it

Worlds Without End: The Exploration of Planets Known and Unknown
by John S. Lewis
Perseus: 1998. 236 pp. $24, £16.50

Joseph A. Burns

The highly controversial claim three years ago that early microbial life once resided in the martian meteorite ALH84001 stunned most scientists with its audacity. But, viewed in another way, this 'evidence' was simply another step in an accelerating continuum of

findings that suggest extraterrestrial life might be ubiquitous. After all, space images had been interpreted as indicating that Mars and Europa might be or have been suitable abodes for life. And, starting in late 1995, the first planets around main-sequence stars were discovered; dozens, including members of another planetary system, are now known.

During the past decade, biologists also contributed to the controversy with their remarkable success in constructing the genealogical roots to the family tree of life, which led to the inference that terrestrial life arose rapidly 3.8–4.0 billion years ago in a hot, oxygen-free environment. This alien environment may or may not have been on Earth: terrestrial organisms have, after all, been found in extreme environments such as the Antarctic dry valleys, seething ocean vents and areas deep in the Earth.

Authors rushed to explain the new insights. Proliferating nearly as rapidly as the identifications of extrasolar planets themselves, a spate of popular books on planet detections appeared. Within 18 months of the initial discoveries, the searches had been described in the words of the scientists involved by Ken Croswell (*Planet Quest: The Epic Discovery of Alien Solar Systems*, Free Press). And the various techniques that ultimately yielded success were reviewed by Donald Goldsmith (*Worlds Unnumbered: The Search for Extrasolar Planets*, University Science Books) and Paul Halpern (*The Quest for Alien Planets: Exploring Worlds Outside the Solar System*, Plenum).

Following the distinguished tradition established by I. S. Shklovskii and Carl Sagan in their classic *Intelligent Life in the Universe* (Holden-Day), planetary researchers and astronomers, including Armand Delsemme (*Our Cosmic Origins: From the Big Bang to the Emergence of Life and Intelligence*), Bruce Jakosky (*Strangers in the Night: A Brief History of Life on Other Worlds*), S. Ross Taylor (*Destiny or Chance: Our Solar System and its Place in the Cosmos*, all Cambridge University Press) and Paul Davies (*The Fifth Miracle: The Search for the Origin and Meaning of Life*, Simon & Schuster), summarized the recent discoveries about the origin of life and then discussed their implications. All authors except the last give a resounding 'yes' to the question, 'Is extraterrestrial life abundant?'.

In *Worlds Without End*, John S. Lewis, a noted planetary scientist and author of both semi-popular books and technical texts, covers much the same territory as the above books, at the level of *Nature*'s News and Views section. He elegantly describes the constituents of our Solar System as they are known today. But, as he himself admits, "the planets of the Solar System ... offer a very limited sample of reality, and are an inadequate guide to the range of possible worlds. Worlds unknown vastly outnumber the worlds we know." So he outlines current ideas about the formation of our Solar System, and reviews the now-overwhelming evidence for the existence of planets about other stars. Lewis's unique contribution is to combine basic physics and chemistry with examples from within the Solar System to predict the likely nature of distant planets and their satellite systems, especially with regard to their potential habitability.

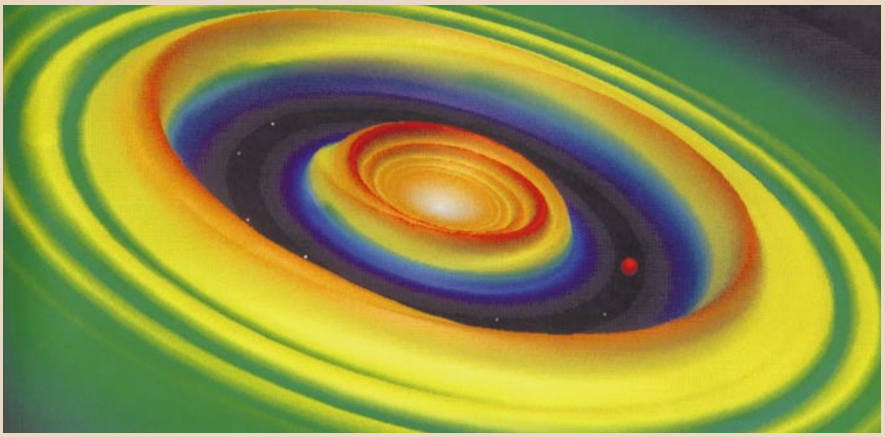
Not surprisingly, coming from a cosmochemist whose influential research three decades ago elucidated the gross distribution of compounds and mineralogy across our Solar System, Lewis believes that "we can do a better job [of understanding] alien chemistry than alien biology". In this vein, he uses thermodynamic arguments to constrain the chemical make-up of other planetary worlds.

Lewis's language is playful at times, as in his tutorial about stellar astrophysics, or when he invents "Earthissmos" and "Earthlets" (large and small Earths), "Europoids", "Titanoids", etc. to explore the planetary possibilities. As this book shows, it is downright fun to try to wonder "about life as we don't know it". Generally speaking, these places sound a lot like home, and their inhabitants much like us. That is to say, many of Lewis's arguments come, at least in part, from their similarity to the Solar System. One must question whether such an extrapolation is justified. Surely the clearest message from Voyager's gradual unveiling of the outer Solar System was that "terrestrial chauvinism is unwarranted and misleading in the Universe at large". Already, the unexpected orbital character of the detected extrasolar planets — as compared with predictions — screams out: never believe theorists, whose forecasts are almost always drably unimaginative.

Cognizant of the critical part played by stellar class and age, Lewis argues that life is most likely to be found around single stars of spectral classes G and K, extending perhaps into the F and M ranges. Even population I, but not II, brown dwarfs may successfully host life-supporting objects. He accepts James Kasting's idea of a habitable zone, a region around an astronomical unit or so where planets with appropriate spins can have clement climates. He maintains that planets of roughly Earth size to several Earths will have the temperatures and oceans that are a prerequisite for life. Lewis also suggests that life might, however, be found on a Europa-like body orbiting a giant planet or a brown dwarf; in the former case, a broader range of stellar classes is acceptable.

The book contains occasional jokes and asides on topics such as ice-skating well outside its scope. After opening with a choppy, brief survey of science fiction and historical ideas about exobiology (which has been bettered elsewhere), the book is technical in content, has no tables (some would have been preferred to paragraphs dense with numbers), and no equations or diagrams. In fact, it is remarkably devoid of space images or space art, normally commonplace in such books.

Lewis ends by addressing the ingredients needed for life. He concludes that water, the best of all possible solvents, is the medium in which the requisite chemistry occurs for life to originate and be sustained. He also maintains that, even in other worlds, carbon compounds — ideal carriers of complex information — will form the backbone of biological molecules, the actual structural material



Circles of creation

How do planets form? This model of planetary formation, to be found in Santa Cruz, California, represents a Jupiter-sized planet that has carved out a groove in a disk of gas and dust around a young star. The planet's presence is sending ripples through the nebula, which might lead to the formation of more worlds. *The Planets*, by David McNab and James Younger (Yale University Press, $35), in which this picture may be found, chronicles our planetary travels, and describes how our understanding of the Solar System has developed from the first star-gazers in ancient times to Galileo and today. Space-race archives have been plumbed, and the book contains pictures from the Apollo, Voyager, Pioneer and Viking missions.

out of which life's blueprints are made. Or is this just another example of terrestrial chauvinism? □

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More on life beyond Earth

Planetary Dreams
by Robert Shapiro
Wiley, £22.50, $27.95

Energetic Victorians

The Science of Energy: A Cultural History of Energy Physics in Victorian Britain
by Crosbie Smith
University of Chicago Press: 1999. 385 pp. $25, £19.95

John Meurig Thomas

Writing about Hermann von Helmholtz in *Nature* (1876–77), James Clerk Maxwell asserted: "The scientific importance of the principle of the conservation of energy does not depend merely on its accuracy as a statement of fact, nor even on the remarkable conclusions which may be deduced from it, but on the fertility of the methods founded on this principle. It gives us a scheme by which we may arrange the facts of any physical science as instances of the transformation of energy from one form to another. It also indicates that in the study of any new phenomenon our first inquiry must be, 'How can this phenomenon be explained as a transformation of energy?' "

In 1847, Helmholtz had published his acclaimed *Über die Erhaltung der Kraft* ("On the Conservation of Force"); at that time, the law of conservation of energy had not been enunciated. In the intervening years there was an abundance of confusion and debate. Individuals whom scientists and historians now revere felt it necessary to indulge in a strange amalgam of innuendo, intemperate accusation and occasional bursts of vituperation, so strongly did they feel about the correctness of their own views and the misconceptions or deceptions of others. It surprised me to discover that religious preferences and (mildly) xenophobic sentiments were also brought into the cockpit of debate. Ultimately, however, "the baleful giant of Force" (to use the author's words) was dislodged by the "rightful monarch, Energy".

Much of the content of this meticulously researched, fascinating, fluently presented (but by no means flawless) book traces the genesis and growth of thermodynamics, especially the emergence of its first law. It also outlines the lives and arguments of the various protagonists who brought forth the whole science of energy. It is a cultural history, right enough, and I was surprised to be exposed to so much biblical exegesis and social comment. The doctrine of "the universal dissipation of mechanical energy" we are told, could be read by Presbyterian students "as fully compatible with a traditional vision of a fallen world which was subject, like unregenerate souls, to depravity and death"!

Scottish natural philosophers, including the towering William Thomson (Lord Kelvin), P. G. Tait and Maxwell, and Scottish engineers such as William Macquorn Rankine and Henry Fleeming Jenkin, rightly loom large in the landscape painted by Crosbie Smith. But rather too much is made of the differences that existed in Victorian Britain between the Anglican academic establishment, with its Oxbridge axis, and the radical dissenting entrepreneurs (among them James Prescott Joule) of the industrializing North. After all, Kelvin, Tait and Maxwell entered Peterhouse (which the author persists in calling "St Peter's College") as undergraduates and all of them flourished as Fellows in Cambridge.

It is intriguing to note that, at about the time when Helmholtz was preparing his monograph "On the Conservation of Force", 26-year-old Kelvin — newly appointed to the chair of Natural Philosophy in Glasgow and preparing his undergraduate lectures there — had read a new edition of Thomas Young's *Course of Lectures on Natural Philosophy and the Mechanical Arts* (first published in 1807) and focused on Young's use of the word "energy". He subsequently championed and sharpened the definition of this word. Sixty years later, after the law of conservation of energy had long been accepted, the aged Kelvin, in a letter to his friend Joseph Larmor, disparaged the eminent German physical chemist Wilhelm Ostwald: "I do not know if (he) knows that energy is a capacity for doing work".

I was rather surprised to learn what Tait, in 1892, said of Henri Poincaré's *Thermodynamique,* which he denounced as a text "which exhibits a lavish, almost reckless use" of mathematical power, rendering it of little value to the student. And it was unexpected that in his 1875 lecture at the Royal Institution, Lord Rayleigh should have judged Josiah Willard Gibbs' paper "On the Equilibrium of Heterogeneous Substances" to be "too condensed and too difficult for most, I might say all, readers". Mercifully Maxwell did not think so, as the author reminds us, and this was a key factor in helping the early physical chemists to take full advantage of the phase rule and chemical potential.

The introductory chapter of this book is the least satisfactory. It makes far too much of the fact that innovators of science 'stage-manage' their credibility. Few working scientists, unlike historians of science, will be persuaded by the thesis that they go about their research animated by a quest for credibility. There are recurrent references in this text to "ascending and descending spirals of credibility", "credibility cycles" and the like. Most practising scientists pursue their research because they want to know answers to key questions. True, they are conscious of building up their reputations, but that is incidental to uncovering new knowledge. In

New in paperback

Korolev: How One Man Masterminded the Soviet Drive to Beat America to the Moon
by James Harford
Wiley, £13.99, $17.95

First published in 1997. "Harford has produced a competent, earnest biography of Korolev, based mostly on secondary sources, that does not rise much above the derivative eulogy. Nor does it help very much our understanding the larger dilemmas that surround space activity at the end of the twentieth century". Alex Roland, *Nature* **392,** 143–145 (1998).

The Fifth Miracle: The Search for the Origin of Life
by Paul Davies
Penguin Press, £8.99

"Davies's book is a small miracle in itself. In a little more than 200 pages he pursues the Mother of All Questions — 'What is life?' — in a way that should be deeply satisfying to physicists, chemists and biologists alike, and he does this in a clear and potent style that should make the book equally stimulating to non-scientists … Davies has little patience with those who take for granted that as soon as there are Earth-like conditions, life will sprout. This may be true, he says, but then we're making a gigantic assumption that should not be taken lightly. To explore this assumption, he takes the reader on an intellectual joyride up and down the entropy slope, along the way pointing his sharp flashlight at often murky concepts, such as order, organization, chance, randomness, specificity, language and semantics." Stefan Bengtson, *Nature* **395,** 560 (1998).

Silent Spring
by Rachel Carson
Penguin, £7.99

The Edge of the Sea
by Rachel Carson
Penguin, £7.99

Fevered Lives: Tuberculosis in American Culture since 1870
by Catherine Ott
Harvard University Press, $16.95