BOOKS & ARTS

Power for life

Did the humble mitochondrion — the powerhouse of the cell — play a key role in the evolution of life?

Power, Sex, Suicide: Mitochondria and the Meaning of Life
by Nick Lane
Oxford University Press: 2005. 320 pp.
£18.99, $30

John F. Allen

How living things obtain, store, convert and use energy once aroused intense debate. Careers and reputations were built and destroyed in the 'ox-phos wars' about the mechanism of oxidative phosphorylation, in which electron transport is coupled to the phosphorylation of ADP, storing energy in the form of ATP. Today there is a tendency to see the problem as solved, and oxidative phosphorylation as worthy but dull. A few abstruse mechanistic details may be unresolved, but these are for obsessives, because we know, broadly, how mitochondria make ATP. It is by the chemiosmotic mechanism proposed long ago by Peter Mitchell. So mitochondria attract the molecular biologist's damning epithet 'housekeeping'. And what could be duller?

One complication is that mitochondria have genes. However, there is no cause for alarm. These genes are few, are all for housekeeping, and have survived from the symbiotic bacteria that first brought respiratory electron transfer and ATP synthesis to the otherwise fully formed eukaryotic cell. This idea, too, was once controversial. But all is now settled, and mitochondrial origins can be left to those with a taste for theoretical biology, untestable hypotheses, and the pondering of distant, one-off events.

Admittedly, mitochondria occasionally capture the headlines. They are inherited solely through the mother, so their genomes sometimes provide decisive forensic evidence and tease modern humans about their ancestry. Then there is the production of oxygen free radicals, which can promote ageing. Furthermore, reproductive cloning must overcome the irritation of mitochondrial genomes, but these can probably be replaced from the healthy cells of a donor — a third genetic parent. In Britain, the Human Fertilisation and Embryology Authority has recently given the green light to John Burn of the Institute of Human Genetics at the University of Newcastle upon Tyne to do just this. "My belief is that we are changing a battery that doesn't work for one that does…changing the mitochondria won't affect the important DNA," states Burn confidently. "Mitochondria are not part of the genetic material that we consider makes us, as human beings" (*The Times*, 9 September 2005).

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Bad for your elf? In *The Lord of the Rings*, Arwen chose love and marriage rather than immortality. But is our own immortality limited by our mitochondria?

The central thesis of Nick Lane's book *Power, Sex, Suicide* is the antithesis of Burn's view. I'm with Lane here: mitochondria have everything to do with what makes us who we are. Lane's audacious introduction, which describes mitochondria as "clandestine rulers of the world", heralds "striking new insights into why we are here at all, whether we are alone in the universe, why we have our sense of individuality, why we should make love, where we trace our ancestral roots, why we must age and die — in short, into the meaning of life."

I have mentioned Lane's title to several colleagues, and they smiled, as I did. Provocative, yes; memorable, yes; but seriously over the top. Isn't it time popularizers of science sobered up a bit and stopped shouting for attention? Lane has a point, of course: power means the rate of doing work, or expending energy; sex refers to the odd, unexplained fact of maternal inheritance; and cell suicide is apoptosis. But this book delivers vastly more than lurid synonyms for dry, scientific terms. These three horsemen are connected, by mitochondria, and not accidentally. That still leaves "the meaning of life". I fear that sheer embarrassment will impede this book's citation in journal articles. This is unfortunate, because parts of it qualify as primary literature, by announcing at least two major, original and testable hypotheses. I scribbled "He should publish this" in the margin, before realizing that he had.

One new hypothesis explains "why there are two sexes". Lane proposes that a tuning, or dialogue, occurs between the nuclear and mitochondrial genetic systems during the formation of egg cells. Thus the real distinction between male and female is that male gametes (sperm) have mitochondria that must be eliminated so as not to interfere with this specific, carefully selected rapport. Perhaps egg mitochondria may also be pure genetic templates, and energetically disabled, as outlined in Lane's previous book *Oxygen* (Oxford University Press, 2002). To my mind, Lane's proposal suggests that reproductive cloning, no matter how 'healthy' the mitochondria, is taking out a genetic mortgage that future generations will have to repay, and with interest, as donated mitochondria will not have been selected to be compatible with the nucleus. A further proposal is that genetic imprinting is a consequence of having tuned only half of the fertilized egg's nuclear genes: those from the mother. Another new idea is that damaged mitochondria might be replaced, by intracellular selection, during ageing.

The general reader is here forewarned that Lane comes down decisively in favour of some theories that are still regarded as 'fringe', and against others that have influential and highly cited ('respectable') proponents. I am

sure this book will be attacked elsewhere as unbalanced. Bear this in mind when you read about Mike Russell's superb scenario for the chemiosmotic properties of the earliest cells, established by geothermal convection. Consider it, too, when reading of "the hydrogen hypothesis for the first eukaryote" from Bill Martin and Miklos Müller. Believe me, people get angry at the idea of the primordial eukaryote being a methane-producer in partnership with a hydrogen-excreting anaerobe that was ancestral to both the mitochondrion and the obscure hydrogenosome. Perhaps the 'hydrogen hypothesis' is an affront to eukaryotic dignity. Personally, I think it is a liberating idea, and one that will stand the test of time.

The book was written for anyone interested in some of the most profound questions of twenty-first-century science. The central proposals of *Power, Sex, Suicide* are clearly and forcefully propounded, are serious, have far-reaching consequences — and may even be correct. After all, not so long ago, the chemiosmotic and endosymbiont hypotheses were championed only by those thought to be mad, bad and dangerous to know. Now we read that "the dynamics of the respiratory chain are a force that has shaped the whole trajectory of life". This is a new take on why we are here. Perhaps all genes are 'housekeeping' genes, and vectorial electrons and protons were the authors of evolution — and are still its movers and shakers. Perceptions change. Do, please, read this book. ■

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THEATRE

Two exiles

Einstein's Gift
by Vern Thiessen, directed by Ron Russell
Acorn Theatre, New York, until 6 November 2005

Alan Packer

If a writer wants to dramatize chemist Fritz Haber's remarkable and agonizing story, there is one sure-fire way to attract a general audience: bring Albert Einstein on stage as the narrator and build your work around the friendship between the two men. This is savvy marketing, and has the advantage of being true to life, as Einstein and Haber were indeed friends and colleagues. The tension between their two personalities is the driving force in Vern Thiessen's prize-winning play, *Einstein's Gift*, which has just received its US premiere in an absorbing and well-acted production.

It doesn't take much artistic licence to generate an air of tragedy around the facts of Haber's life. Born in 1868 to a Jewish family in the Prussian city of Breslau, he was baptized at the age of 24. A bulldog of a man, he held, in dangerous combination, an uncritically patriotic view of Germany and a devotion to science as a means to serving it. His major scientific achievement — the Haber–Bosch process for nitrogen fixation, for which he won a Nobel prize — was immense, allowing fertilizers to yield crops that now feed billions of people.

Hoping to hasten the end of the First World War, Haber pioneered the development of chlorine gas as a battlefield weapon, and oversaw its use near the town of Ypres in Belgium. This event, with its obvious implications for warfare during the rest of the twentieth century, had personal consequences as well. It was quite possibly the trigger for his wife Clara's suicide. After the rise of the Nazi party in the 1930s, Haber, being Jewish, was cast aside by the country to which he had devoted his life. Exiled to Switzerland, depressed and in failing health, he died in a Basel hotel room in 1934.

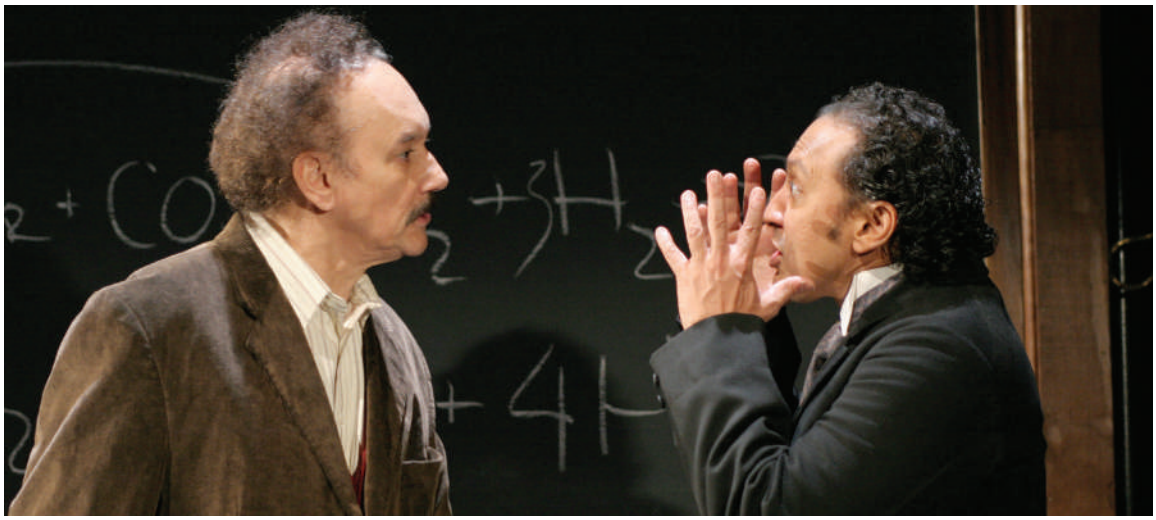
As Daniel Charles makes clear in *Between Genius and Genocide*, his fine new biography, which will be reviewed shortly in *Nature*, Haber's ambition had a somewhat desperate quality to it. Thiessen captures this aspect of Haber's character from the very beginning, with a scene introducing Haber's relationship with fellow exile Einstein. Haber, convincingly portrayed by Aasif Mandvi, has political connections, and revels in the upper hand he holds over his less worldly counterpart, who cares little for the approval of the nation of his birth, and for whom the life of the mind is its own reward.

Haber's courtship of Clara, the philosophical tug-of-war that constitutes his relationship with Einstein, the moment of insight in his work on the production of ammonia, and the horrifying scene at Ypres are all written and staged with eloquence and flair. A climactic scene, in which Haber resigns his post rather than fire scores of Jewish scientists on his staff, is gripping. Thiessen is also aided by John McDermott's set, which, with its period chalkboards and central spiral staircase, lends an air of authenticity throughout.

Yet it must be said that a certain heavyhandedness hovers over several moments in the play. In their final meeting, Einstein's gift to the dying Haber is a tallit (a Jewish prayer shawl). Symbolically this brings the play full circle, but there is no evidence that Haber's lifelong distance from his religion caused him more pain than did his exile from Germany. The play also begins and ends with a simulated nuclear detonation. This is less subtle than it needs to be. After the final flash, Einstein wanders across the stage in anguish, wondering aloud if it is possible to go back in time. "Am I to censor all of my thoughts?" he wonders. That's an excellent and necessary question — a gift in itself. But its relevance to Haber, who was an active participant in the creation of the military–industrial complex, is not at all clear.

Despite these discordant notes, *Einstein's Gift* brings Haber's unhappy story powerfully to life. ■

Alan Packer is senior editor at *Nature Genetics*.



Einstein's Gift **explores the relationship between Einstein (Shawn Elliott, left) and Fritz Haber (Aasif Mandvi).**