nothing as bad followed even the extinction of the dinosaurs. Morton briefly reviews the alternative sources for the energy consumption to which humankind is so addicted. The problem with such sensible words is that the reader still feels that no rational course will ever be adopted until the very tragedies that we seek to avert have come to pass. Of several recent accounts of what might happen to climate in the next decades, Morton's is among the most balanced, but I am still left crossing my fingers and recycling a few plastic bags. As T. S. Eliot remarked, humankind cannot bear very much reality.

Morton's account of the ubiquitous importance of photosynthesis is an original viewpoint for looking at the world. It is written with verve and an eye for detail. His breadth of scholarship could leave other science writers green — with envy.

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*Oliver Morton is *Nature*'s chief News and Features editor.

Science and the Supreme Court

The Nine: Inside the Secret World of the Supreme Court
by Jeffrey Toobin
Doubleday: 2007. 384 pp. $27.95

Henry T. Greely

The United States Supreme Court is one of the more unusual aspects of a very unusual country. An unelected body that is expressly nonpolitical, its membership is subject to bitter political struggles and its decisions can have profound political consequences — sometimes even changing history. Its nine members are famous but faceless, oddly impersonal in the midst of a culture of celebrity. These nine people work painstakingly at a difficult job that is usually routine and often obscure.

Jeffrey Toobin is a staff writer at *The New Yorker* and a legal analyst for CNN. His latest, very readable book is one of several efforts in the past few decades to personalize the Supreme Court and its members. He does so through a close examination of the past 20 years of its membership and decisions. The inside stories of the famous cases he discusses are not shocking, they are intriguing — particularly the discussion of *Bush vs Gore*, which prematurely ended Al Gore's challenge to George W. Bush's 2000 election. The book's strength, though, is not its account of the court's history, but what it reveals about the men and women who wear the robes. It is enlightened and enlivened by insights gleaned from Toobin's many interviews. Toobin focuses particularly on the rise to prominence of Justice Sandra Day O'Connor and the likely conservative future of the Supreme Court after her 2006 retirement.

Nearly 30 years ago, I had the good luck, and honour, to serve as a law clerk for a justice of the Supreme Court. Toobin's portrayal of the court generally feels right to me, although he overemphasizes the influence of public opinion on it and slights its less dramatic aspects. Many of the cases have no liberal or conservative side, which may help to explain why even the deeply divided court of recent years decides about a third of its cases unanimously.

Just as science clocks up more drudgery than 'Eureka!' moments, Supreme Court justices spend most of their working lives reading yet another claim that a prisoner's attorney was incompetent, or writing and rewriting another background paragraph for a case that will attract no attention. In some ways, a justice's work resembles a scientist's. Both examine lots of inputs — laws, precedents and arguments for the justice; data and hypotheses for the scientist. And they try to make sense of them, to find a solution that will work. Both know they will have to defend their solution by the authority of their positions and by their reasoning. Scientists' papers are scrutinized for any weaknesses by friends and rivals; justices face external and internal critics, sometimes being the targets of stinging dissent from their colleagues on the Supreme Court

In most cases, no verifiable (or falsifiable) truth underlies the Supreme Court's decisions. As Toobin illustrates nicely, every justice has a different view of the law, and the world. The justices (and their law clerks) are intelligent, hard-working and dedicated, weighing and re-weighing every word. Technically, 30 years ago and today, the justices usually do an excellent job, but their different perspectives often lead to different decisions. The book shows that these views are complex and can be only poorly summarized as 'conservative' or 'liberal'; the effects of those views are also complicated.

In ways that non-lawyers do not always understand, the Supreme Court is the weakest part of the US government. It has no power over the laws of the 50 states unless those laws run foul of the regulations, statutes or Constitution of the federal government. It cannot overturn actions by Congress unless they violate the Constitution, or of the president unless they violate the Constitution or statutes. Even when such issues arise, the court is forced to be responsive, not active. Justices who want to decide an important issue have to wait for it to be argued in a real case that reaches them through a chain of lower courts. Then they have to hope that they can persuade at least four colleagues to agree with them, on both the result and the reasoning.

Still, the Supreme Court has plenty of power and that power will sometimes involve science. It applies patent and copyright laws in ways that affect high-tech industries and universities. It can interpret the First Amendment to judge attempts to limit the teaching of evolution. It can decide what kind of scientific evidence a court can admit. But most of what is important to 'science' itself is not within the Supreme Court's jurisdiction. For example, President Bush's restrictive stem-cell funding policy or California's expansive policy could come before the court only on claims that they violated the Constitution, but no such claim is plausible. The Supreme Court will not rule on whether human actions are changing the climate: at most, it might decide whether state regulation of industries to limit climate change interferes with powers reserved to the federal government.

J. S. APPLEWHITE/AP

George W. Bush nominated two of the current nine Supreme Court judges.

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Crucial disputes about the funding of science, or on the influence of industry on agency actions supposedly based on science, simply will not come within the Supreme Court's reach. Its decisions about abortion and sexual freedom will influence public health, but will not, on either side, involve much science. I am unhappy about the Bush administration's general attitude towards science and its selection of Supreme Court justices, as two separate harms; a conservative counter-revolution on the Supreme Court would change the United States (for the worse, in my view) but is unlikely to have a major effect on science.

Will that counter-revolution take place? Observers have proclaimed its coming since at least 1969, when Chief Justice Burger replaced Chief Justice Warren — Toobin himself details other such failed reversals in the past 20 years. The Supreme Court's future course depends largely on its future members, who in turn depend on future presidents and senators — and the public opinion to which they all, in part, respond. It also depends on the current 'nine' and how (not if) they change during their years on the court.

Toobin's book is an excellent introduction to today's Supreme Court, but readers must bear in mind that part of the "secret world" of the court is its own future course. ■

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The real 'theory of everything'

Four Laws that Drive the Universe
by Peter Atkins
Oxford University Press: 2007. 128 pp. $19.95

Mark Haw

Ask a science graduate to name their favourite subject, and few will say thermodynamics. My own undergraduate memories of the subject include a baffling proliferation of nineteenth-century science grandees — James Clerk Maxwell, Lord Kelvin and James Prescott Joule — some exhaustively squeezed gases and a forest of incomprehensible partial derivatives I couldn't imagine how to measure.

Thermodynamics ought to be the cornerstone of any scientist's understanding of nature. Forget superstrings and grand unified theories: thermodynamics is the original 'theory of everything'. Or perhaps the 'theory of what everything does and how it does it'. Thermodynamics explains the transformation of energy, and nothing happens without that.

In his new book *Four Laws that Drive the Universe*, Peter Atkins aims squarely at the fundamental logical and physical structure of thermodynamics. Atkins's systematic foundations should go a long way towards easing confusion about the subject. He dissects the laws one by one, tying each firmly to its partner fundamental quantity, be it temperature, internal energy or entropy.

There is no shortage of books on thermodynamics — indeed Atkins himself is a veteran of this particular publishing niche. The thing that distinguishes this quasi-textbook (for popular science it definitely isn't) from the others is its almost complete absence of mathematics. Hang on, where are the partial derivatives? Where are Maxwell's relations? This is Atkins's masterstroke: without the encumbrance of equations that are never actually going to be applied, readers may begin to grasp what energy and entropy are really about.

Therein lies a difficulty: should you need to derive the back legs off the thermodynamic donkey, *Four Laws* would have to be supported by a more traditional text. If deep understanding is what you want, this book is the better choice. There is a need in many fields, from atomic physics to cell biology, for books with a similar brief to this one. Too many prime their readers with facts and figures to avoid the challenge of properly illuminating the underlying concepts.

And just suppose you were setting out on such a crusade, to promote understanding of

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Entropy increases as order collapses in melting ice.

scientific ideas as an alternative to feverishly memorizing the technical details in the hope of passing an exam or sounding clever at a conference — then thermodynamics is a good place to start.

The development of thermodynamics in the nineteenth century was the most wide-reaching and fundamental advance since Newton's mechanics. It underpinned (albeit some time after the event) the Industrial Revolution, and led the way to statistical mechanics (and hence to statistical quantum mechanics) and to an understanding of phase behaviour, chemical reactions, the astrophysics of stars…to everything, in other words.

Or almost everything. Atkins never treads beyond the limitations of nineteenth-century thermodynamics, which can be summed up in three words — equilibrium, isolation and big. His 'four laws' work for systems at (or very near) equilibrium, systems isolated from (or at least connected in a very controlled way to) their surroundings, and systems that are, well, big. Big enough that the averages of macroscopic thermodynamics tell the whole story, big enough that fluctuations from the average don't matter.

A flavour of the subject beyond these limitations would have rounded out the book — highlighting the striking fact that, in this centenary year of the death of its great pioneer Lord Kelvin, thermodynamics is still very much in business. For instance, the latest research into the energetics of small systems, such as proteins, is potentially revolutionary. Proteins do the same job for life that steam engines did for Victorian industry. Unlike a railway engine, however, the cell is a profoundly non-equilibrium place. And proteins are not isolated but inextricably bound to the world around them, inescapably prey to brownian motion.

Understanding the microscopic, non-equilibrium, open-system thermodynamics of these 'life engines' could usher in fascinating discoveries: how life works as a physical process, how we might borrow life's technology to make our own nanoengines, and how we might transform medicine by replacing broad-spectrum chemical cocktails with medical engineering of proteins. All this requires twenty-first-century developments in thermodynamics that are no less revolutionary than the nineteenth-century theory.

Even without this excursion into the future, Atkins has written an engaging book, just the right length (and depth) for an absorbing, informative read. Those for whom the word 'entropy' still induces cold sweats may at last get a proper glimpse of the real 'theory of everything'. ■

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