which is printed across the top of the page, not its number. To locate a note it is necessary to flick back through the book to find out the number of the chapter then go to the endnotes and locate the note. At the very least, the headings for each section of endnotes should give both the chapter number and its title, for example "Chapter 8, Pyramids of Light," but even better, the headings of the notes pages could be made more informative by giving the page numbers to which they refer, for example, "Notes to pages 64–85."

I read this book with great interest and pleasure. I recommend it to anyone who is interested in the history of the Renaissance and the fascinating period when science and the method of empirical inquiry were coming into being but still conceived of in a holistic and organic spirit, before science took a mechanistic path in the 17th century, which has continued ever since. Capra raises the question of what would have happened if Leonardo's insights had been published and had formed part of the growth of science. Would they have helped science develop in a more holistic manner from the outset? We cannot know. But this book makes it very clear that science is not just a private but a collective enterprise. As the historian of science Patricia Fara has observed, "Being right is not always enough: If an idea is to prevail, people must see that it is right." Leonardo's secrecy was not in the spirit of subsequent science, and that is why most of his insights lay dormant until very recently when they were discovered by scholars. Capra does an excellent job in making them more widely available.

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Quantum Aspects of Life edited by Derek Abbott, Paul C. W. Davies, and Arun K. Pati. Imperial College Press, 2008. 468 pp. $104.00 (hardcover) and $58.00 (paper). ISBN 978-1-84816-253-2 (hardcover) and 978-1-84816-267-9 (paper).

This book is a collection of contributed chapters by different authors, plus several transcripts of debates (as Appendices), arising from a 2003 NASA-sponsored conference on the role Quantum Mechanics (QM) plays in Biology. Because QM describes the behavior of the fundamental building-blocks of the Universe, it is necessarily a cornerstone of all processes, living and non-living. This is the "trivial" sense in which biology and quantum physics intersect. The book is dedicated to examination of the "non-trivial" claim, which is that biological systems make use of specific aspects of QM that are not accessible to purely classical processes: tunnelling, coherent wavelike nature of matter,

entanglement, and intrinsic spin. Another way of formalizing this thesis is that biologists will need to understand QM, in the way that they currently study statistics, electrochemistry, and game theory, to truly understand important chunks of their subject matter. This claim is controversial, and having settled on this definition as the basis of argument, the contributions in the book fall fairly cleanly on the side of pro or con.

Each of the chapters presents the case for or against this claim, with more direct interactions among the participants transcribed at the end as debates. The book is a very interesting read, containing pieces from some of the key players in this area. One point to note is that, as the contributors are expert physicists and theoreticians working on quantum computation or chemistry, they never bother to give a layman's definition of what all the fuss is about: what is so special about QM? A chapter introducing readers to the basic experiments in QM, to get their heads properly spinning and out of the classical realm, would have been welcome. On the other hand, so many excellent introductions to this field have been published recently (Bruce, 2004; Davies & Brown, 1986; Herbert, 1987; Lloyd, 2006; Lockwood, 1989) that this omission is not much of a problem. Do not pick up this book if you are interested in "quantum spiritual healing" or the role of nonlocal synchronicity in interpersonal psychology. Some of the chapters are quite accessible to the well-read amateur, while others (e.g., the discussion of quantum dynamics in photosynthesis) are extremely specialized. Overall, this is a very crisp, no-nonsense, high-level discussion of the possible role of QM phenomena in biology. Readers with a good understanding of the basics of QM and of the big questions in biology will get the most out of it. There are many details, formulas, and concepts from quantum computing throughout the text. Readers hoping for a conclusive feel-good message of general applicability to their everyday lives will be disappointed. Those interested in a state-of-the-art discussion of where QM stands in biology will not be.

Some of the persistent themes throughout the discussion include the following: 1) Is it only emergent complexity that gives life its special character, or are true QM effects manifest at the macroscopic level? 2) Can such effects survive the "hot, wet" environment of the living cell and avoid decoherence, which reduces underlying quantum properties to the familiar, macroscopic and classical behaviors? 3) Can living structures take advantage of massive superposition to carry out true quantum computations? And 4) what are the right scales, structures, and phenomena in which to look for evidence of QM involvement?

The con side relied on basic calculations showing that the answer to theme 2 is no, that the elusive entanglement and superposition that give QM its magic cannot possibly survive the frequent interactions and warm temperatures of the living state. Contributors on the con side remind the reader that successful QM and quantum computation experiments are done in a vacuum, at very low temperatures, and with a very small number of particles involved. Moreover, they challenge the pro side to come up with any examples in biology where true QM is necessary to understand a biological problem. It should also be noted that

in a few places, the attention of the reader is drawn to the fact that QM not only provides new capabilities for enhancing life, it also imposes new limits (Wigner inequalities, Heisenberg's uncertainty principle).

The pro side supplied arguments to show that such effects can indeed be preserved in specialized biological structures (e.g., DNA and tubulin). Since QM provides such useful possibilities for living systems, it was argued that surely biosystems have learned to capitalize on them, as they have learned (through evolution) to exploit other aspects of physics (thermodynamics, mechanics, materials properties, etc.). It was also suggested that QM would be a crucial component at the origin of self-reproducing systems—a key component of life, since the optimization process of evolution cannot get off the ground until self-reproducing systems with a mode of heredity are formed.

What exactly could QM be used for in living systems (Jibu & Yasue, 1995; Josephson & Pallikari-Viras, 1991; Stapp, 1993)? The information-processing capabilities of quantum computers and the backwards-causation that has been explored in QM suggest that QM may provide a way to search through truly vast solution spaces in tractable time-scales, or to provide a bit of teleology in selecting favorable outcomes to some processes (inverse Zeno effect). It is argued, for example, that Grover's algorithm (a search that occurs faster than possible with classical systems) could be carried out by biological systems and does not require fragile entanglement. The identification of improbable but useful solutions crops up at every level of biology (from protein folding to evolution of complex structures), and while more conventional explanations exist for most of these solutions, QM may indeed turn out to be involved. This is especially relevant to the origin of life itself, as argued by Paul Davies, who suggests the origin of life not in complexity but in the unique properties of quantum events that can replicate and process information. Whether this event is extremely improbable, requiring the special features of QM (Davies, 1999), or an inescapable feature of some sort of chemistry that we do not yet understand (Eigen & Schuster, 1979) is under significant debate. Similarly, Seth Lloyd argues that the essential discrete, digital, probabilistic nature of QM events guarantees emergence of the auto-catalyzing, information-processing phenomenon we call life.

Another place where a role for QM is proposed is in explaining the coherent nature of conscious experience (the "binding problem"). Hameroff argues that the tubulin proteins in the cellular cytoskeleton perform quantum computation and thus serve as the substratum of information processing in living systems. This view has been expounded in greater detail in the work of Penrose (1991, 1996), although much work in basic philosophy of mind/cognitive science would have to be done to make it clear how QM can solve the "hard problem of consciousness" (Chalmers, 1996): why would a Bose-Einstein condensate automatically enjoy first-person experience or intentionality? There is a brief mention of free will as another place where QM may be involved, although it should be kept in mind that it is not at all clear how *in principle* random outcomes would give us what we understand as free will (Dennett, 1984).

This book is a very mainstream discussion between the dominant paradigms in quantum computation, chemistry, and evolutionary biology. There are no anomalous or fringe areas discussed; in particular, the PEAR-type of experiments suggesting effects of living systems on quantum processes *outside* of their bodies (Jahn & Dunne, 1987; Schmidt, 1973) are not mentioned at all. The authors stick closely to quantitative arguments, discussing only things that have a precise definition. While this necessarily reins the discussion closer to what we know, it provides a welcome degree of grounding, and most of the contributors write in the context of needing to falsify large areas of the possibility space in this field, so that tractable, informative experiments can be performed.

In the end, the argument is left wide open, and the details are technical enough so that it is not really feasible for non-experts to have opinions one way or the other. The discussion is spirited and energetic; I highly recommend the book to anyone interested in these questions and willing to do the necessary background homework to really understand the issues involved. It is clear that much work remains to be done in the fields of quantum computation and chemistry to understand what is possible and what might be occurring in living systems. At the same time, biologists have to keep an eye open for effects that might require true QM to be properly explained. Significant experiments have been proposed and the burden is now on the pro side to illustrate conclusively that QM is relevant for the macroscopic domain of life. It is not yet crucial for biologists to understand QM, but it may well be so in the future; if so, some extremely fascinating biology will result, with implications for evolution, cell biology, and cognitive science.

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Medicine, Miracles, & Manifestations: A Doctor's Journey through the Worlds of Divine Intervention, Near-Death Experience, and Universal Energy by John L. Turner, foreword by Robert F. Spetzler. Franklin Lakes, NJ: Career Press, 2009. 256 pp. $15.99 (paper). ISBN 978-1-60163-060-5.

This book is written by a neurosurgeon who has a degree in engineering and who did his surgical residency at the Cleveland Clinic and went on to practice in Hilo, Hawaii. The format of the book is a series of case presentations along with intermittent discussions on metaphysical principles and his subjective musings about each case. Some of these cases are simplistic in the sense that they represent a neurological procedure where Dr. Turner either prays or has a dream about the patient during his or her recovery period.

His discussions on the actual surgical procedures are accurate, and often the details of the surgical procedures themselves are quite engrossing. The loss of some of his patients caused him to evaluate in more detail near-death experiences, and particularly the work done by Dr. Raymond Moody. In one case, Dr. Turner was involved in the issues of karma and its effect on the surgical course of one of his patients, and in particular, the apparent spontaneous remission and cure of a brain tumor. In his subsequent chapter on "soul travel," Dr. Turner turns to an academic discussion on Dr. Moody's work as a medical student, on subsequent medical research which has emerged including studies reviewing activity in the angular gyrus of the brain, and on the work of Dr. Rick Strassman on the possible role of dimethyl tryptamine as a possible neurotransmitter during near-death experiences.

Dr. Turner reports on many of his own personal experiences trying to induce out-of-body experiences including experimentation with electronic devices delivering audio tones to the brain in order to synchronize various brainwave activities.

Dr. Turner later began experimenting with astral projection under the instruction of a Master and then proceeded to attend Buddhist meditation; he writes of his personal experiences of dissociated awareness during chanting meditation. Further into the book he writes about his experiences when he was approached by a Japanese group that looked at healing from a distance, the Mokichi Okada