

(2016) which Tyson cowrote with Richard Gott and Michael Strauss.

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EVERY LIFE IS ON FIRE: How Thermodynamics Explains the Origins of Living Things by Jeremy England. New York: Basic Books, 2020. 272 pages. Hardcover; \$28.00. ISBN: 9781541699014.

Physicist Jeremy England's unique book on the latest developments in origin-of-life research is scientifically fascinating and refreshingly devoid of the typical faith/science antipathy that plagues much work in this field. What England offers is essentially a down-to-earth primer on statistical thermodynamics which enables the nonphysicist reader to understand current developments in non-equilibrium thermodynamics, such as "dissipative adaptation," that have much to say about what life is and what needs to occur for life to start naturally (i.e., spontaneously from natural precursors).

England discusses at length the precariousness of life and the improbability of a living organism being thrown together at random, but contra the Intelligent Design (ID) movement, he takes this as evidence not of its impossibility but, rather, that non-equilibrium thermodynamics must be involved in any scientific explanation. England directly addresses ID only once in a footnote:

... of course, whenever we do not yet understand something, we always have the option of throwing up our hands and declaring that intelligent contrivance is the only way things could be this way, but we also have the option of trying harder to understand, often with a successful result ... (p. 245)

Far from offering a mechanism for how life began, however, England instead examines the necessary prerequisites for what we instinctively call "life," including energy consumption, replication, and anticipating changes in the environment, and stresses that these distinctive aspects of life cannot all come from one mechanism. Through variegated collections of matter responding to flows of energy impinging on them, non-equilibrium states can be created and sustained in a manner that looks for all the world like intelligent design but can be explained by new ideas in non-equilibrium thermodynamics. The ability for an organism to live in a high-energy, non-equilibrium state without being consumed by the "fire" of energy surrounding it is not necessarily related to an organism's ability to reproduce, and

neither stability nor self-replication necessarily guarantees an ability to predict environmental variables and respond to them in a self-preserving fashion. England argues that having multiple mechanisms operating and evolving in parallel for the somewhat independent qualities that constitute life makes the natural emergence of living things less improbable than hitherto imagined.

While non-equilibrium thermodynamics can help us better understand how living things may have arisen naturally from inanimate matter, the book also argues that we still need to look beyond science for why a living pile of molecules has more meaning than a pile of ashes. England, who states his personal commitment to the Jewish faith, looks to the Hebrew Bible for grounding and inspiration when wrestling with the questions of "What is life?" and "How did life begin?" He finds in the signs God gives to Moses on Mt. Horeb (Exodus 3), including his staff turning into a snake, a rich treasure-trove of wisdom regarding life, its meaning, and its intimate connection with the natural world. Thus, while the book is mostly an explication of recent insights from physics regarding what it means to be alive, it is woven together in a fascinating way with biblical wisdom gleaned from the Torah. The rich allusions and connotations England impressively draws from the Mt. Horeb signs provide another example of the deep wisdom that scripture offers in its timeless narratives.

What especially sets this book apart from other faith-based origin-of-life discussions is the fact that England himself is a leading researcher in the current science of non-equilibrium thermodynamics. He was a physics prodigy who has now established a career bridging academia and industry, and much of the book is based on his own groundbreaking work. In this regard, he carries a distinctly authoritative voice that is perhaps best compared to Francis Collins or John Polkinghorne—leading scientists whose scientific work directly overlaps the theological waters they wade into. There is some risk that the nonphysicist may feel bogged down by the detailed scientific lessons and explanations, but England does an impressive job of explaining things in everyday terms, including balls rolling down hills, springs, and snowflakes. He is also careful to include helpful summaries along the way. The accessibility of the scientific ideas and the originality of the theological reflections make Jeremy England's *Every Life Is on Fire* a must-read for anyone interested in origin-of-life issues.

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