NATURE'S DESTINY

How the Laws of Biology Reveal Purpose in the Universe

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Contents

Note to the Reader

> Time out of mind it has been by the way of the "final cause," by the teleological concept of end, of purpose or of "design," in one of its many forms . . . that men have been chiefly wont to explain the phenomena of the living world: and it will be so while men have eyes to see and ears to hear withal. With Galen as with Aristotle, it was the physician's way; with John Ray as with Aristotle it was the naturalist's way; with Kant as with Aristotle it was the philosopher's way. . . . It is a common way, and a great way; for it brings with it a glimpse of a great vision, and it lies deep as the love of nature in the hearts of men.
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> —D'Arcy Wentworth Thompson, *On Growth and Form,* 1942

The aim of this book is, first, to present the scientific evidence for believing that the cosmos is uniquely fit for life as it exists on earth and for organisms of design and biology very similar to our own species, *Homo sapiens,* and second, to argue that this "unique fitness" of the laws of nature for life is entirely consistent with the older teleological religious concept of the cosmos as a specially designed whole, with life and mankind as its primary goal and purpose.

Although this is obviously a book with many theological implications, my initial intention was not specifically to develop an argument for design; however, as I researched more deeply into the topic and as the manuscript went through successive drafts, it became increasingly clear that the laws of nature were fine-tuned for life on earth to a remarkable degree and that the emerging picture provided powerful and self-evident support for the tradi-

tional anthropocentric teleological view of the cosmos. Thus, by the time the final draft was finished, the book had become in effect an essay in natural theology in the spirit and tradition of William Paley's *Natural Theology* or the Bridgewater Treatises.

The basic thesis of the book, that the cosmos is uniquely fit for human existence, is of course not novel. For centuries before the birth of modern science, this thesis was one of the foundational axioms of medieval Christianity. More recently, it has begun to reemerge in various fields of science, most notably in physics and cosmology. Readers familiar with the views of physicists such as Freeman Dyson, Fred Hoyle, and Paul Davies will be aware that over the past few decades many physicists have pointed out that the existence of life in the cosmos is critically dependent on the laws and constants of physics having the precise values they do. The values are so critical that several well-known authors have argued that the cosmos gives every appearance of having been very finely adjusted or "prefabricated" for our existence.[1] As Paul Davies points out in his *Accidental Universe:* "If nature had opted for a slightly different set of numbers, the world would be a very different place. Probably we would not be here to see it." In his words: "The impression of design is overwhelming."[2] Because of the perceived support for the traditional teleological worldview of the major religious traditions, the views of Davies and others have received wide publicity.

There is, however, a fundamental problem with any attempt to argue for the biocentricity or anthropocentricity of nature based on evidence drawn only from physics. While such evidence may be sufficient to argue that the cosmos is arranged for "complex chemistry," solar systems, or even intelligence, it is necessarily insufficient to argue that the cosmos is in some sense uniquely fit for the specific type of *biological life as it exists on earth,* that is, for organisms constructed out of carbon compounds based in water and utilizing DNA and proteins for self-replication. And it is completely incapable of providing any support for the notion that our own species, *Homo sapiens,* has any special place in the cosmos.

Davies is careful to distance himself from any claim that humanity is central in the cosmic scheme: "Where do human beings fit into this great cosmic scheme? Can we gaze out into the cosmos, as did our remote ancestors, and declare God made it all for us? I think not."[3] And in his latest book he states explicitly that "I am not saying that we *Homo sapiens* are written into the laws of physics in a basic way."[4] And continues: "We should not expect

extraterrestrial life to resemble our own in its basic chemistry. . . . There is no need, for example, to demand liquid water or even carbon. We could anticipate exotic life forms, such as creatures that float in the dense atmosphere of Jupiter or swim in the liquid nitrogen seas of Titan."[5]

Contrary to Davies and others, I believe the evidence strongly suggests that the cosmos is uniquely fit for only one type of biology—that which exists on earth—and that the phenomenon of life cannot be instantiated in any other exotic chemistry or class of material forms. Even more radically, I believe that there is a considerable amount of evidence for believing that the cosmos is uniquely fit for only one type of advanced intelligent life—beings of design and biology very similar to our own species, *Homo sapiens.* I do not agree with Davies when he claims, "The physical species *Homo sapiens* may count for nothing."[6]

To defend the postulate that the cosmos is specifically fit for biological life *as it exists on earth* necessarily involves consideration of a vast number of natural laws, phenomena, and processes which are quite outside of the areas of physics and cosmology and pertain uniquely to the biological realm, phenomena such as the thermal properties of water, the characteristics of the carbon atom, the solubility of carbon dioxide, the self-assembling properties of proteins, the nature of the cell, and so forth. Although from the evidence of physics we may be able to infer that the cosmos is uniquely fit for chemistry, stars and planets, or even intelligent beings, we cannot infer that it is specifically fit for large, air-breathing terrestrial mammals. Only through biology can our unique type of carbon-based life and especially advanced forms like ourselves lay claim to a central place in the cosmic scheme.

This book is divided into two major parts. In Part 1, evidence is presented that the laws of nature are uniquely fit for the being or existence of the type of carbon-based life that exists on earth. The chapters in this section deal with evidence drawn from many areas of the biological sciences, from molecular biology to mammalian physiology. The physical and chemical properties of the fundamental constituents of the cell, such as water, carbon dioxide, the bicarbonate buffer, oxygen, DNA, proteins, the transitional metals, the cell membrane, etc., are systematically reviewed to show that the existence of carbon- and water-based cellular life depends critically on a number of remarkable adaptations in the properties of many of life's basic constituents. What is

particularly striking is that, in almost every case, each constituent appears to be the only available or unique candidate for its particular biological role and, further, gives every appearance of being ideally fit not in one or two but in all its physical and chemical characteristics. Also reviewed is evidence drawn from other areas of science that attests to the fitness of the earth's hydrosphere, the fitness of the electromagnetic radiation of the sun, and the fitness of the periodic table for the carbon-based type of life as it exists on earth. As the book also shows, the existence of some higher forms of life, such as large warm-blooded, air-breathing terrestrial vertebrates, are critically dependent on the properties of some of the basic constituents of life, such as water, carbon dioxide, and oxygen; in other words, not only are the laws of nature fit for the cell and for simple microbial life, but also for advanced complex organisms very like ourselves.

The argument developed in Part 1, that the cosmos is uniquely fit for *life's being*, leads naturally to the second argument, developed in Part 2, that the cosmos is fit also for the origin and evolutionary development of life—*life's becoming*. It is hard to escape the logic of this connection, for if the first argument is accepted, that the existence of the life forms on earth, both microscopic and macroscopic, depends on a remarkable set of mutual chemical and physical adaptations in the nature of things, the second argument, that the evolutionary development of this same set of life forms was also written into the cosmic script and directed from the beginning, is hard to refuse. Or, put another way: if the laws of nature are so finely tuned to facilitate *life's being* in the form of a unique set of carbon-based organisms, both simple and complex, on the surface of a terraqueous planet like the earth, then it seems conceivable that *their becoming* through the process of evolution might have been determined also by natural law.

At present, the evidence that the cosmos is uniquely fit for *life's being* is certainly far more convincing than the evidence that it is also fit for *life's becoming*. Nonetheless, even though direct evidence for believing that life's becoming is "built in" is lacking, there are many features of the cosmos that make sense if the becoming of life is in some way programmed into the laws of nature. Facts such as the synthesis in stars throughout the cosmos, of carbon and the more complex atoms essential for life, by intricate processes; that interstellar space contains vast quantities of organic carbon compounds[7] and some meteors such as the Murchison meteor contain considerable quantities of amino acids,[8] the building blocks of life; that planets like

the earth which are probably capable of sustaining carbon-based life would appear to be very common if not almost ubiquitous throughout the cosmos[9]—all these make eminent sense if life is a natural phenomenon programmed into nature from the beginning, and fated inevitably to arise and evolve on any suitable planetary environment.

The claim that the constituents of life are uniquely designed for the roles they serve cannot be defended convincingly without detailed discussion of the relevant scientific facts. This is true of any similar type of teleological argument. If we are to argue, for example, that the components of a watch are all specially designed to function together to tell the time, the argument can only be convincing if we have some understanding of the structure and workings of the watch. We have to open up the watch, to observe the mechanisms within, particularly the reciprocal fit of the various cogs to one another and have some comprehension of the way the mechanism works overall. And we need to understand clearly, as William Paley emphasized in his famous discourse on the watch, "that if the parts had been differently shaped from what they are," the watch could never function.[10] The same is true in arguing that the constituents of the cosmos are uniquely fit for life. The argument only works if we have some knowledge of "the machinery of the cell" and some understanding of the many reciprocal adaptations in the nature of its constituents that make life possible. Consequently, the presentation of the argument in a book of this sort is quite challenging, because the nature of these mutual adaptations can only be fully appreciated by a relatively in-depth and detailed presentation of the relevant scientific facts.

However, despite the technical nature of many sections of the book, I believe that most areas covered can be easily grasped by anyone with a high-school knowledge of biology and chemistry. And even a committed reader with no scientific training should be able to grasp the essence of the argument in most of the chapters, even if this necessitates skipping some of the more highly technical sections. There are several chapters which require very little scientific background. And most chapters include at the beginning an introductory section requiring very little specialized knowledge, in which I have attempted to explain the main theme of the chapter.

I have also tried to organize the presentation of the evidence so that many of the chapters represent a fairly independent module which can be read and understood without reference to other chapters or arguments in other sections of the book. I hope this makes the book easier for a nonspecialist to

handle. Finally, as mentioned above, each chapter begins with an italicized précis that may allow nontechnical readers to skip ahead.

Further, as with any such argument because the argument is essentially accumulative, deriving its power from the sheer number of the adaptations observed, it is essential that as many as possible of these are presented and discussed. The conclusion is convincing primarily because so many independent arguments, each drawn from a great number of different areas of science, all appear to point in the same direction. This inevitably involves a degree of repetition that will be a problem for some readers. However, a degree of repetition is the very essence of the whole line of attack.

Because the validity of the argument depends on so many independent lines of evidence, the conclusion is not materially threatened because the whole picture is not yet complete or because this or that phenomenon such as the origin of life or the mechanism of evolution is not understood. Just as the meaning of a jigsaw puzzle may be obvious long before all the pieces are perfectly placed, so too my argument does not necessitate that everything be explained. Nevertheless, critics of the argument will have certain clear avenues of attack. They can argue (correctly) that I have been selective in my topics. The burden of disproof will, however, rest on them to show that an area I ignored somehow opens up the possibility of either nonearthlike life in the cosmos or a superior alternative to one of the constituents of life—for example, water, carbon dioxide, etc. Or they may argue that my position merely reflects a lack of imagination and that I have not discussed possible alternatives in depth. But again, the burden of proof will be on them to offer specific alternatives. I do not see how I can be accused of omitting discussion of alternative forms of life, based in silicon or liquid ammonia or within the field of nanotechnology, when no detailed blueprints for such hypothetical life forms have ever been developed.

Although there has been little debate or interest in the question of the fitness of the cosmos for life in mainstream biology since the Darwinian revolution, and indeed the idea has been very unfashionable in many circles in the English-speaking world, interest in the question has never been completely extinguished. Throughout the twentieth century, a number of first-rate biologists have kept the tradition alive. These have included Lawrence Henderson, professor of biological chemistry at Harvard University during the first quarter of the century and author of the great classic *The Fitness of the Environment* (1913);[11] D'Arcy Wentworth Thompson, author of an-

other great classic, *On Growth and Form* (1942);[12] George Wald, professor of biology at Harvard in the fifties and sixties, discoverer of the role of vitamin A in vision, who was one of the leading authorities on the chemistry of photoreception;[13] A. E. Needham, Oxford zoologist and author of an excellent and comprehensive review, *The Uniqueness of Biological Materials* (1965);[14] and Carl Pantin, professor of zoology at Cambridge during the sixties and author of the widely acclaimed *The Relations Between the Sciences,* published in 1968.[15]

My chapters on the properties of water, carbon, oxygen, and carbon dioxide borrow heavily from Henderson's *Fitness* and can be considered to a large degree an update of that great classic in the light of modern knowledge. Another major source cited in several chapters is Needham's *The Uniqueness of Biological Materials.*

One recent book that invites some comparison is Stuart Kauffman's *At Home in the Universe,* in which he argues that much of the course of evolution has been determined and driven by self-organizing and emergent properties of complex systems.[16] There is certainly more than a whiff of teleology about Kauffman's arguments, and his overall conclusion is consistent with my own when he claims, for example: "We will have to see that we are all natural expressions of a deeper order. Ultimately, we will discover in our creation myth that we are expected after all."[17] And further: "We may be at home in the universe in ways we have hardly begun to comprehend."[18]

Another book that also invites comparison is *Vital Dust* by the biologist and Nobel laureate Christian de Duve. De Duve has also "opted in favour of a meaningful universe"[19] and argues that the cosmos is fit for the origin and evolution of life and that the progress of evolution from simple to complex life forms was largely inevitable. However, de Duve's position falls a long way short of defending the traditional anthropocentric view of the cosmos. The unique fitness of the laws of nature for the biology of higher, air-breathing life forms such as ourselves is not discussed in any depth and nowhere does de Duve argue that the pattern of evolution was directed specifically toward the human race. Regarding man's place in the cosmos, de Duve concludes in his final chapter, "The human mind may be only a *side link* in an evolutionary saga far from completed."[20] (My emphasis.)

Because this book presents a teleological interpretation of the cosmos which has obvious theological implications, it is important to emphasize at the outset that the argument presented here is entirely consistent with the

basic naturalistic assumption of modern science—that the cosmos is a *seamless unity which can be comprehended ultimately in its entirety by human reason and in which all phenomena, including life and evolution and the origin of man, are ultimately explicable in terms of natural processes.* This is an assumption which is entirely opposed to that of the so-called "special creationist school." According to special creationism, living organisms are not natural forms, whose origin and design were built into the laws of nature from the beginning, but rather contingent forms analogous in essence to human artifacts, the result of a series of supernatural acts, involving God's direct intervention in the course of nature, each of which involved the suspension of natural law. Contrary to the creationist position, the whole argument presented here is critically dependent on the presumption of the unbroken continuity of the organic world—that is, on the reality of organic evolution and on the presumption that all living organisms on earth are natural forms in the profoundest sense of the word, no less natural than salt crystals, atoms, waterfalls, or galaxies.

In large measure, therefore, the teleological argument presented here and the special creationist worldview are mutually exclusive accounts of the world. In the last analysis, evidence for one is evidence against the other. Put simply, the more convincing is the evidence for believing that the world is prefabricated to the end of life, that the design is built into the laws of nature, the less credible becomes the special creationist worldview.

Ironically, both the Darwinian and the creationist worldviews are based on the same fundamental axiom—that life is an unnecessary and fundamentally contingent phenomenon. Where the creationist sees organisms as the artifacts of God the supreme engineer, the Divine watchmaker, Darwinists see them as the artifactual products of chance and selection. That both should view life as contingent is not so surprising considering that both doctrines developed in the early nineteenth century, the heyday of the machine age, when organisms were widely seen to be analogous in some way to machines. Clearly, if life's design is indeed embedded in the laws of nature and the major paths of evolution are largely determined from the beginning, then neither creationism nor Darwinism can possibly be valid models of nature.

My argument may be unpalatable for completely different reasons to certain liberal theologians. Academic theology in the twentieth century has largely abandoned traditional natural theology. Many have held the view

"that theological propositions and scientific propositions somehow occupy different epistemological realms. Hence the neo-orthodox wall between religion and science."[21] Some liberal theologians have recently explored the relationship between science and theology,[22] showing how, in Arthur Peacocke's words, "God creates in the world through what we call 'chance' operating within the created order."[23] Yet nowhere do they attempt to present a natural theology (they may even object to the term) along traditional lines. The aim of their work is to show how it is *possible to believe in God* while at the same time accepting the findings of science. It is not to argue that the *facts of science provide evidence* that the laws of nature are uniquely prefabricated for life as it exists on earth, including complex forms such as our own species.

Another final point that perhaps should be clarified here at the outset is that I am using the term "anthropocentric" throughout the text in the generic sense. The cosmic "telos" I have in mind is advanced carbon-based humanlike or humanoid life. It is not specifically our own unique species *Homo sapiens.* At present, there is insufficient evidence to argue that the laws of nature are uniquely fit for *every detail* of human biology exactly as found in our own species today. However, I believe that the current evidence points strongly in this direction and that future scientific advances will confirm the absolute centrality of mankind in the cosmic scheme.

In the last analysis, the teleological perspective presented and defended here is good for science, because it renders scientific knowledge relevant to human existence. In the doctrine of final causation, science unites man and cosmos. The pursuit of scientific knowledge becomes no longer of merely practical value but also vital and central to the spiritual and intellectual life of man.

—Michael J. Denton
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Prologue

> The ancient opinion that man was microcosmos, an abstract or model of the world, hath been fantastically strained by the alchemists, as if there were to be found in man's body certain correspondences and parallels which should have respect to all variety of things, as stars, planets, minerals, which are extant in the great world.
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> —Francis Bacon, *The Advancement of Learning*, 1605

Living as we do in the late twentieth century, in a culture that has rejected the traditional teleological view of man as the center and purpose of the cosmos, which views our human existence as in essence a matter of profound contingency, it is fascinating to recall just how different was the medieval worldview in the late fifteenth century, shortly before the birth of modern science.

For both Christian and Islamic philosophers and theologians of the Middle Ages, the cosmos was a unique whole specially designed by God with man as its central focus and purpose. All facets of reality found their explanation in this central fact. Man was the inner microcosm. Every aspect of his being reflected the outer macrocosm, the universe in its entirety and all it contained.

For Christian scholars, the biblical revelation, and particularly the Incarnation, sanctioned the profoundly anthropocentric character of their medieval worldview. The extraordinary anthropocentricity of the culture of the Christian Middle Ages was wonderfully conveyed by Aron Gurevich in his classic work *Categories of Medieval Culture:*

> The effort to grasp the world as a single unified whole runs through all the medieval summae, the encyclopaedias and the etymologies. . . . The philosophers of the twelfth century speak of the necessity of studying nature; for in the cognition of nature in all her depths, man finds himself . . . underlying these arguments and images is a confident belief in the unity and beauty of the world, and also the conviction that the central place in the world which God has created belongs to man.
>
> The unity of man with the universe is revealed in the harmony interpenetrating them. Both man and the world are governed by the cosmic music which expresses the harmony of the whole with its parts and which permeates all from the heavenly spheres to man. *Musica humana* is in perfect concord with *musica mundana.* Everything that is measured by time is bound up with music. Music is subordinate to number. Therefore both macrocosm and man-made microcosm are ruled by numbers which define their structure and determine their motion. . . . It is in numbers that the secret of the beauty of the world lies; for the medieval mind the concepts "beauty," "orderliness," "harmony," "proportion," "comeliness," and "propriety" were very close to each other if not identical.[1]

So intensely anthropocentric was their conception of nature that, as Gurevich points out:

> Each part of the human body corresponded to a part of the universe: the head to the skies, the breath to the air, the stomach to the sea, the feet to the earth; the bones corresponded to the rocks, the veins to the branches of the trees.[2]

The presumption that the entire cosmos was man-centered, that every facet of reality and all the laws of nature reflected this central reality, was the overriding axiom upon which the whole civilization of medieval Europe was built. Not even the slightest deviation from such an all-embracing man-centered teleology was compatible with the Christian revelation. For the Bible implied that the great drama of human history was central to the purpose of God in creation. The earth was the unique and divinely chosen stage for the drama, and God himself had taken on the form of a man to bear the sins of creation.

Even after the medieval period, for many early modern thinkers such as Francis Bacon, whose scientific philosophy, with its emphasis on experiment, had an empirical tendency that was quite similar to that of modern

science, mankind's teleological centrality in the natural order was presumed without question. The following section from Bacon's *De sapientia veterum* illustrates Bacon's commitment to an intensely anthropocentric framework:

> Man . . . may be regarded as the centre of the world . . . if man were taken away from the world, the rest would seem to be all astray, without aim or purpose . . . leading to nothing. . . . the whole world works together in the services of man . . . in so much that all things seem to be going about man's business and not their own.[3]

The anthropocentric perspective was not, of course, restricted to the West. It was highly developed in the Islamic world in the ninth and tenth centuries. And Judaism, Hinduism, and Buddhism also view mankind as significant in the cosmic scheme. In ancient Indian thought, for example, the general ethos was "one of an integrated man-spirit-cosmos view, a wide and comprehensive view of nature in which the *Homo sapiens,* or man, the thinker, occupied a distinct place."[4] According to the eleventh-century neo-Confucianist philosopher Shao Yung, "Man is central in the universe, and the mind is central in man. . . . Man occupies the most honoured position in the scheme of things because he combines in him the principles of all species. . . . The nature of all things is complete in the human species."[5]

The idea is practically universal, being expressed in all human cultures, as John Barrow and Frank Tipler summarize:

> the idea that humanity is important to the cosmos and indeed the idea that the material world was created for man both seem to be present in many cultural traditions; they may even be universal . . . a cursory search of the anthropological literature shows teleological notions defended in Mayan, Zuñi (New Mexican Indian) . . . Sumerian, Bantu, ancient Egyptian, Islamic-Persian, and Chinese.[6]

It is remarkable to think that only five centuries separates the current skeptical ethos in the West from this profoundly teleological view of reality.

The anthropocentric vision of medieval Christianity is one of the most extraordinary—perhaps the most extraordinary—of all the presumptions of humankind. It is the ultimate theory and in a very real sense, the ultimate conceit. No other theory or concept ever imagined by man can equal in boldness and audacity this great claim—that everything revolves around

human existence—that all the starry heavens, that every species of life, that every characteristic of reality exists for mankind and for mankind alone. It is simply the most daring idea ever proposed. But most remarkably, given its audacity, it is a claim which is very far from a discredited prescientific myth. In fact, no observation has ever laid the presumption to rest. And today, four centuries after the scientific revolution, the doctrine is again reemerging. In these last decades of the twentieth century, its credibility is being enhanced by discoveries in several branches of fundamental science.