Open theism and risk management

OPEN THEISM AND RISK MANAGEMENT: A PHILOSOPHICAL AND BIOLOGICAL PERSPECTIVE

by R. T. Mullins and Emanuela Sani

Abstract. Open theism denies that God has definite exhaustive foreknowledge, and affirms that God takes certain risks when creating the universe. Critics of open theism often complain that the risks are too high. Perhaps there is something morally wrong with God taking a risk in creating a universe with an open future. Open theists have tried to respond by clarifying how much risk is involved in God creating an open universe, though we argue that it remains unclear how much risk is actually involved. We claim that open theists need to start developing theories about how God manages risks in order to bring about His purposes for the universe. In this article, we will take a philosophical and biological perspective on risk management that adds plausibility to open theism. We will consider how God can use different risk-management, surveillance, and redundancy systems in the natural world in order to accomplish His goals.

Keywords: DNA (deoxyribonucleic acid); God; molecular biology; open theism; risk management; RNA (ribonucleic acid)

Within contemporary philosophical theology, there is a debate over a model of God called open theism. In open theism, it is said that God does not know the future, and that God takes various risks when creating a universe. Proponents and critics of open theism disagree over whether or not the God of open theism can guarantee the fulfilment of His purposes for creation. Some worry that God might be morally irresponsible in creating a universe with an open future. We say that open theism lacks clarity on the risks involved, thus lowering the plausibility of their view. Further, we believe that open theists need to develop theories about how God manages risks in order to raise the plausibility of their model of God. Our aim in this article is to defend the plausibility of open theism by considering the kind of universe that God has created. In particular, we examine the

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phenomena of redundancies, risk-management, and surveillance systems in the biological order, and explain how these create the conditions for stability, flexibility, and autonomy that open theism prizes. We then extended this analysis to explore the possibility and plausibility of God using redundancies, risk-management, and surveillance systems in salvation in order to guarantee the fulfilment of His purposes for creation.

In "What is Open Theism?" section of this article, we articulate the basic claims of the open theist model of God, and discuss the confusion over how much risk is involved in God creating an open universe. In "What Kind of Universe Would God Create?" section, we examine the question of what kind of universe God created. There we shall explore the biological phenomena of risk-management, surveillance, and redundancy systems. This is important because discussions on open theism, and providence in general, focus on quantum mechanics and evolutionary biology (Lukasiewicz 2020; Hasker 2020). There has not been much discussion on the insights to be gained from molecular biology that contain risk-management systems.[1] Finally, in "Divine Risk Management, Surveillance, and Salvific Redundancies" section, we identify various theological analogues to these biological systems that God can use in order to manage the risk of creating an open universe, thus demonstrating the plausibility of open theism.

What is Open Theism?

Open theism is one among many competing models of God in contemporary philosophical theology (cf. Mullins 2016). A model of God is a set of unique claims about the nature of God and the God-world relation. A model of God is not a fully developed philosophical or theological system. Yet open theism makes certain unique claims about God and the God-world relation that can provide a basis for developing a theological system (Rice 2020, 135–36). We begin with open theism's understanding of God.

Open theism takes God to be a necessarily existent, eternal being with essential properties like omnipotence, omniscience, perfect moral goodness, perfect rationality, and perfect freedom. This is not unique to open theism, of course, since most models of God affirm such attributes. The first thing that makes open theism unique is its affirmation that God is temporal, mutable, and passible. God is eternal in that God exists without beginning and without end, yet God is temporal in that God has succession in His life as He freely exercises His power to create a universe and interact with it. This entails that God is mutable in that God can change in certain respects. God cannot change with regard to His essential nature, but He can change in how He exercises His power, knowledge, and goodness. Further, God is passible in that God can be causally influenced by things external to the divine nature. This, in part, means that God can be emotionally impacted by what occurs in the world. God has a rich emotional life, but His emotions are always rationally and morally appropriate to the situation at hand (cf. Pinnock 1994; Mullins 2020, chapter 3).

The next unique claim about open theism is that God does not have exhaustive foreknowledge. This is closely related to the open theist's commitment to a presentist ontology of time in which only present events exist, with past events no longer existing, and future events not yet existing. The denial of exhaustive foreknowledge is consistent with divine omniscience. God is omniscient in that God knows of the truth-values of all propositions. The version of open theism that we are interested in claims that truth-values of most propositions about what will happen in the future are false, whereas propositions about what might or might not happen can be true or false.[2]

Notice that we said *most propositions about what will happen in the future*. William Hasker, Dean Zimmerman, and Thomas Jay Oord (2011) write that, "The future is not open in an absolute, unqualified sense, because God retains ultimate control and his designs for his creation will not in the end be thwarted" (2). Open theists claim that God is able to know which parts of the future He has unilaterally determined to bring about (Boyd 2000, 23). God is also able to know the objective probability of different possible futures obtaining (Hasker 2004, 126). We will say more below on how God uses His inexhaustible cognitive power and knowledge to providentially guide history (Hasker 2019, 271). We will also explore how a series of mechanisms established through evolution occurring at the molecular level are able to guide and manage risk.

Open theists affirm divine freedom over creation, and the doctrine of creation *ex nihilo* (Hasker 2004, 166). There is a state of affairs prior to the existence of the universe in which God alone existed. At this prior moment, God was free to create or not create. God was also free to create any kind of universe He liked (Hasker 2000, 218–19). A universe is a collection of spatiotemporally related contingent beings. Prior to God's act of creation, God knows all of the possible universes that He could create. God makes a choice from the range of possible universes.

Open theism also affirms that God knows all of the possible timelines prior to His act of creation. A moment of time is a proposition-like entity that describes the way things are but could be subsequently otherwise. A moment is realized or actual when the events it describes obtain. Otherwise, it is merely a potential moment. A timeline is a particular ordering of a series of abstract moments that tell the story of the world. A timeline is realized or actual when the series of events that it describes obtain. Otherwise, it is merely a potential timeline. Prior to creation, there is a moment that is realized—God alone exists and could be subsequently otherwise by freely creating any number of possible universes. Branching from this realized pre-creation moment are many possible timelines that could subsequently follow. Among the possible timelines, some are good and some are bad. The open theist says that God knows all of these possible timelines prior to creating a universe.

On open theism, God's reason for creating a universe is to actualize certain values that would not exist in the world otherwise (Ward 1982, 85), for example, the value of autonomous biological life. God might have many different reasons for creating a universe, yet open theists put a special focus on loving relationships with other persons that involve trust, cooperation, and mutual appreciation. These goods require that God create persons with libertarian freedom (Holtzen 2019, 6–13). Open theists sometimes call this God's *Most Central Purpose* (MCP) (Rice 2020, 230). Following the lead of different open theists, we define this as follows.

> MCP: God's most central purpose for creating the universe is to enter into friendship with as many human persons as possible.

When God surveys the possible timelines, God knows which possible timelines would see the realization of the MCP and which would not. We shall call the possible timelines in which the MCP is realized *good timelines*. We shall call the possible timelines in which the MCP fails *dark timelines*. These are timelines in which all humans reject God's offer of friendship, or all humans are prevented from accepting God's offer of friendship. Given that God is perfectly good, God will seek to realize a good timeline, and prevent the realization of a dark timeline.

Yet a particular question arises for the open theist at this point. How much control does the God of open theism have over which timeline comes about? As we discuss in the next section, opinions seem to differ among open theists. Before getting into those disagreements, it will be useful to discuss the open theist's understanding of God's decree, providence, and predestination.

Traditionally, a divine decree refers to God's providential plan to create a specific universe and bring about a particular timeline. God predestines how the entire future of a particular universe will in fact go. The open theist understands predestination and God's decree differently. Since the open theist is committed to an open future, God's decree cannot involve a plan to bring about a particular timeline. Instead, God's decree contains a stated goal for the future history of the universe that God intends to providentially bring about in cooperation with His free creatures. In particular, God's decree includes the MCP. Prior to the act of creation, God selects to create a particular set of initial conditions that will give rise to the kind of universe that God wants. God knows the many possible timelines that branch from this initial state of the universe. Thus, God develops an exhaustive contingency plan for every possible future free action in order to guarantee that He achieves His central purposes for creation (Rice 2020, 47). Part of this contingency plan involves preventing possible timelines where the MCP fails. If history starts to progress toward a dark timeline, God's predetermined contingency plan will involve an intervention to prevent that dark timeline from occurring. In this sense, God's plan rules out the possibility of dark timelines from becoming actual. God's decree includes the policies that God has adopted and the contingency plans that God has put in place in order to providentially govern the world toward the MCP (Sanders 2007, 226; Hasker 2017, 61).[3] In issuing this decree, God predestines, or guarantees, that the MCP shall in fact be realized at some point in the future in one way or another (Rice 2020, 231).

Once God has a plan in place, God creates a universe *ex nihilo*. The open theist says that from among the range of possible universes, God selects a particular universe to create. This is a universe in which God will fully determine the initial conditions of the universe so as to endow it with certain powers and structure that will give rise to the kind of values or goods that He wants from creation (Hasker 2000, 219). This fully determinate set of initial conditions grounds the possible timelines that can subsequently follow. This, we suggest, is a kind of divine risk management.

God can eliminate certain dark timelines by selecting good initial conditions for the universe. For example, there is the much-discussed fine-tuning of the universe (Collins 2012). These discussions reveal that there are many ways for the universe to go wrong in the moments shortly after the Big Bang. In some scenarios, the universe could have collapsed in on itself, thus making biological life impossible. In other scenarios, the universe could have expanded at the wrong rate, again making biological life impossible. If biological life became impossible shortly after the Big Bang, then the MCP would fail to be realized. Thus, God selected favorable initial conditions that would prevent these dark timelines from occurring.

How Much Risk?

Thus far, our description of open theism does not seem to resemble a God who takes morally irresponsible risks. Yet critics of open theism can still wonder how much control God has in bringing about the MCP, even calling into question God's ability to guarantee the success of the MCP (cf. Mawson 2008). It is not difficult for critics to raise this complaint since proponents of open theism themselves often play up just how much risk is involved when God creates a universe. To justify the critic's complaint, one can point to the debate among open theists about whether or not God can guarantee that He will achieve the MCP. We say that the lack of clarity around risk lowers the initial plausibility of open theism.

To understand this debate, Johanness Grössl and Leigh Vicens say that there are two versions of open theism to consider. They call these high-risk open theism and limited-risk open theism. In high-risk open theism, it is metaphysically possible that all creatures reject God's offer of friendship. Grössl and Vicens clarify that the term "high-risk" does not mean that the probability of all creatures rejecting God's offer of friendship is high. In fact, according to them, high-risk open theists say the probability of all creatures rejecting God's offer of friendship is actually so low that it is negligible (Grössl and Vicens 2014, 477–78). This view is high-risk because there are in fact possible dark timelines branching from the beginning of this universe in which the MCP fails. Representatives of this position are said to be thinkers like William Hasker and John Sanders (Sanders 2007).

Grössl and Vicens describe Gregory Boyd's position as a limited-risk open theism because this view says that it is impossible for God to fail to achieve the MCP (Boyd 2011, 2015). They write, "We call this view 'limited-risk' since the risks in which God engages are limited to certain specific undesirable events occurring, and not to the realization of His most central purpose for creation" (Grössl and Vicens 2014, 478). In limited-risk open theism, God is able to guarantee that the MCP will be achieved. There is no risk that all of humanity will reject God's offer of friendship. Of course, there is a risk that various painful and evil events will occur along the way toward God achieving the MCP. But the terms high-risk and limited-risk in the open theist literature are only concerned with the risks surrounding the MCP.

It might seem that critics are able to raise doubts about God's ability to bring about the MCP if one is considering high-risk open theism. However, critics have also tried to raise the same doubts against Boyd's limited-risk open theism (Ware 2000).[4] We take these doubts to be the product of at least two different factors. First, the open theists' own confusing statements over divine risk. Second, the lack of detailed discussion from open theists about how God can mitigate risks. We take each in turn.

Open theists themselves do not seem to have a clear stance on the risks involved when God creates a universe. In fact, we suspect that most open theists actually implicitly affirm the limited-risk view.[5] This is because we find it less than clear that so-called high-risk open theists give a ringing endorsement of the view. For example, in at least two passages, Hasker says that, "even if it is admitted to be possible," the probability of God failing is so overwhelmingly improbable as to be negligible (Hasker 2004, 119, 103). The qualification of *if admitted to be possible* is not a ringing endorsement of high-risk. A more recent discussion comes from the open theist, Richard Rice. Rice explicitly rejects Boyd's claim that God can guarantee the success of the MCP (Rice 2020, 95–96, 182, 230). He states that the probability of divine failure is theoretically possible, but it is so improbable as to be practically remote (Rice 2020, 231). This sounds like a high-risk view, yet Rice also states that the open theist affirms a version of predestination on which God has predestined that a group of people will participate in His MCP. On an open theist version of predestination, the identity of every individual in this group has not been determined in advance. Yet Rice says that an open theist predestination is "the guaranteed fulfilment of God's purposes" (Rice 2020, 47). Rice even states that it is practically certain that God's efforts will not end until the MCP is satisfied (Rice 2020, 231). Given this, we find it difficult to see how Rice can consistently affirm a high-risk view. To us, this looks like a limited-risk view. This kind of confusion over the risk involved lowers the initial plausibility of open theism, and makes the view vulnerable to its critics.

Whatever amount of risk the open theist wishes to affirm, we say that something is missing from the open theist account of reality—divine risk management. If open theism is to be considered a plausible view, open theists need to stop playing up how much risk God takes, and start developing theories about how God mitigates the risks involved in creating a universe with an open future. Hence, in what follows, we explore philosophical and scientific theories that open theists can use to develop accounts of divine risk management. This, we maintain, will raise the plausibility of open theism.

What Kind of Universe Would God Create?

What kind of universe would the God of open theism create? Keeping in mind the MCP, Hasker says that it is good that there should be free, rational, and responsible persons. It is good that persons should have occasion and opportunity to exercise their inherent powers and potentialities in order to develop an individual character. Hasker also says that it is good that persons be joined together into families and communities in which persons are responsible to and for each other. This allows for more opportunities for created persons to develop their individual character in greater and morally significant ways. Finally, Hasker (2017) says that it is good that the structures and processes of human societies develop from within, utilizing the powers, potential, and ingenuity of the members of those societies, rather than those structures being imposed on society by God (71–73). Given all of this, an open theist will say that we should expect God to create a universe that contains all of these goods.

What kind of universe would God need to create in order for these goods to be possible? Hasker says that we should expect God to create a particular kind of universe with stable laws of nature that allow for a variety of creatures with varying degrees of complexity, flexibility, and autonomy. The complexity of creatures ranges from simple atoms to rational animals. The kind of autonomy in view here is the freedom of an entity to operate according to its inherent capabilities without direct control or interference from God. According to Hasker, it is a great good that God should create a universe with component systems that are able to evolve from within by utilizing its inherent powers and potentialities (Hasker 2017, 63–66). The open theist maintains that this is the kind of natural universe that one would expect God to create in order to satisfy various divine purposes in general, but also the MCP. This is because this is the kind of natural universe needed in order to make it possible for created persons with libertarian freedom to exist.

As Hasker and other open theists point out, a universe with natural laws and created persons with libertarian freedom involves various risks. Stable natural laws bring with them the risk of natural disasters occurring. Creatures with significant moral freedom bring with them the risk of immoral actions. Discussion of these matters is commonplace in theology and philosophy of religion. What has not been sufficiently discussed is the potential for God to use redundancies, risk-management, and surveillance systems in the universe in order to lower various risks, and in order to guarantee the MCP.

We say that the open theist needs to add more to the story about the kind of universe that one should expect God to create. God is said to employ exhaustive contingency plans in governing the universe because He anticipates that mistakes can and will occur. Thus, God has good reason to lower the risk by creating redundancies, risk management, and surveillance in the universe's systems. Thus, one ought to expect to find different kinds of systems throughout creation that not only anticipate that mistakes can and will occur, but that correct those mistakes and mitigate risk. In fact, we say that there is good evidence that God has put in place many kinds of these systems. In what follows, we will explain different kinds of systems that exist in the biological world that create stability, flexibility, and autonomy in the universe. Far from removing autonomy, these systems actually set the stage for the exercise of significant creaturely freedom all while anticipating and mitigating the associated risks. After exploring these biological systems, we will argue that open theism ought to affirm different kinds of theological analogues to these systems.

Why Should We Engage with Molecular Biology?

As we noted before, open theists have offered different kinds of engagement with scientific fields like quantum mechanics and evolutionary biology. There has been no significant engagement with molecular biology. We take this to be unfortunate because molecular biology offers a range of risk-management systems that ought to be of interest to the open theist who faces objections about an overly risky God. What we offer in the subsequent sections is a description of molecular mechanisms that actually exist and are well-studied among biologists. Ultimately, we leave it up to the open theist to decide how to fit them in their model of the God-world relationship. Our aim at the moment is to describe the details of the biological phenomena. We take it that anyone who is interested in understanding the world that we are actually living in will appreciate the discussion. Later we will make relevant suggestions for the open theist to consider.

Biological Redundancies

Biological systems are incredibly sophisticated. Imagine all the complex tasks a human body does at any given moment without being aware all the time; from the involuntary heart beating to every individual cell performing its correct function.

At first glance, it may seem that the success of such a system is the extreme level of specialization and optimization in which every biological pathway is efficiently optimized to achieve one clearly defined goal using one efficient and optimal pathway. However, if a system is perfectly tailored for one specific purpose, then every minor change in the system becomes extremely dangerous for the organism. Furthermore, this type of "perfect system" seems not to account for errors and unforeseen circumstances. Thus, making it a less than ideal system for a universe with an open future. An open theist can say that God did not create such a universe. Instead, God created a universe with a certain amount of flexibility that allows for stability and autonomy.

The precise amount of flexibility is difficult specify. However, we argue that a certain degree of autonomy and flexibility appears to be a fundamental requirement for biological success. Consider that over 90% of the living biomass on Earth is composed of sessile organisms like bacteria, fungi, or plants that cannot move or escape from either their environment or predators (Bar-On and Milo 2018).[6] During the day, many crucial parameters like temperature, sun light, humidity, and so on are constantly and unexpectedly changing, forcing these organisms to continually adjust. A rigid system would clearly struggle to cope with all of these unforeseen changes. Therefore, a certain degree of freedom and flexibility appears to be a fundamental requirement for biological success. Of course, the system cannot be too flexible because it will end up in chaos and fail to perform any unified responses against a series of adverse circumstances.

However, our planet Earth is thriving with an incredible variety of life forms that are not just living but flourishing in so many different ecosystems, thus proving their success through evolutionary time. This naturally raises the question, what is the key to their fundamental biological success?

One way to achieve their optimal flexibility is through an extensive use of contingency plans or risk-management, redundancy, and surveillance systems. For example, higher living organisms have evolved a plethora of redundant processes able to complete the same task in different ways by using surveillance systems and error repairing mechanisms that will ensure the correct function in case of failing. However, it must be noted that some simple organisms, like viruses and other unicellular organisms, have gone in the opposite direction by eliminating redundancy. For them, the key of success often lies in their small and compact genome offering a quick replication able to overcome their host responses and conquer many environmental niches.

In the following subsections, we will delve deeper into redundancies, risk control management, error repair mechanisms, and surveillance mechanisms in the biological world.

Biological Redundancy: Many Ways to Achieve a Final Goal

"Redundancy describes a situation in which there is an excess of causal components in a system, above the minimum needed for its proper function" (Laruson, Yeaman, and Lotterhos 2020, 1).

One simple way to maintain flexibility within a system is to establish many ways to achieve the same goal. This is called redundancy. Redundancy offers multiple solutions to a given problem that could be a key of success during the evolutionary process (Laruson, Yeaman, and Lotterhos 2020).

In biology, the concept of "genetic redundancy" has been discussed since the early history of genetics when it was used to describe the phenomenon of duplication of genes or genome. This early definition of genetic redundancy is now included into a more specific understanding of "Functional Redundancy"—a situation where "two or more genes perform the same biochemical function," within an individual (Ascencio and DeLuna 2013). A gene can be defined as a continuous DNA or RNA region that encodes the synthesis of a gene product, either RNA or protein acting as a functional unit of heredity. Genes are inherited from parents to offspring and contain the information needed to specify traits. The genome is the complete set of genes and other genetic material present in a cell or organism.

As humans, we possess two copies of each gene making our whole genome duplicated. We are so-called diploid organisms. Other organisms, called polyploid organisms, can have multiple copies. For example, the humble potato ranges from two to six copies depending on the species. Viruses and bacteria have very small genomes with no or few duplicated genes and as a result a single mutation often destroys several functions simultaneously (Krakauer and Plotkin 2002).

From an evolutionary perspective, having multiple copies of the same gene is a powerful move to combat destructive mutation and promote biological success. If one gene is affected, the organism will have other functioning copies that will buffer the effect of the mutation. Consequently, the possibility to tolerate mutations can also be viewed as a mechanism to accumulate beneficial mutations and raise their evolutionary potential, hence allowing the mutations to persist in the population (Fisher 1935; Krakauer and Plotkin 2002). Thus, making this kind of redundancy a significant evolutionary advantage. In fact, it has been shown that for a significant proportion of gene duplication, this kind of redundancy has been an extremely stable feature across evolutionary time scales. Some cases have 80–100 million years of evolutionary conservation of this kind of redundancy. What this means is that these genes were duplicated during the era of the dinosaurs, and these duplications are still present today in many living organisms. Thus, giving us a clear example of their importance for the success of an organism (Kafri, Springer, and Pilpel 2009).

It is the combination of genetic redundancy, mutational robustness, and the potential arising of new characteristics that give an organism the ability to survive the environmental changes and ultimately to generate a new diversity of traits in the population. Yet the use of redundancies is not only present in genes, but also in cells.

From a cell biology perspective, redundancy is crucial in accomplishing the vast biochemical functions that the cell has to perform. Biological pathways are a series of interactions among molecules that leads to a certain change or product in a cell. Most biological pathways require sophisticated and optimized components in order to function, but their flexibility is still guaranteed through many levels of redundancy that ultimately will all lead to the same result.

A wide range of redundancy systems acting at the molecular level has been proposed by Ghosh and O'Connor (2017) and is defined as follows:

- Molecular redundancy: This occurs when at least two effectors use the same molecular mechanism to modify the same target. The effector can be a duplicated gene or redundant protein codified by different genes but with the same functionality. Here, the effectors can replace each other's functions because their activity has the same effect.
- Target redundancy: The effectors can modulate the same component in a pathway by using different molecular mechanisms. In this case, the effectors are so different that they cannot replace one another, but they act on the same component of the same pathway modulating it synergistically.
- Pathway redundancy: It defines effectors that modulate a single pathway but target different components of the pathway. This set of effectors is acting at different levels in modulating the same pathway and using different mechanisms, but the outcome of that modulation serves to achieve the same goal.

- Cellular process redundancy: This occurs when sets of effectors can compensate one another by targeting several complementary pathways that all lead to a single cellular process.
- System redundancy: It defines effectors that modulate very different biological pathways, but that lead to the same results. In biology, cell death is a single event that is governed by multiple processes. Each process is triggered by different signals. The process mechanisms are all biochemically different, but all together they all lead to the same outcome of cell death.

Taken together, all of these possible redundancies show how biological systems can arrive at a final goal using a variety of solutions. An open theist should consider that all of these mechanisms can be seen as a solid foundation toward biological success that can potentially guarantee the flexibility to adapt to an unknown future. With this understanding of redundancy before us, we now turn to discuss the phenomena of risk management in the biological order.

Risk Control Management in Biology: A Lesson from Two Fundamental Molecular Mechanisms

Living organisms have developed numerous systems of checks and balances in order to thrive at best in their environment. For example, control of flowering in plants is regulated not only by temperature, but also by the length of the day. Plants sense the passing of seasons due to an intricate network of molecular sensors able to measure repetitive amounts of cold received during the cold months. They also sense the amount of light they received during the day through their circadian clock in their leaves that will transmit the message to the shoots apex and initiate the flowering transition. Such an elegant control system will account for an exceptional warm season and will prevent them from flowering at the wrong time (Johansson and Staiger 2015; Bloomer and Dean 2017).

The open theist says that God employs contingency plans in providentially governing the universe. Hence, the open theist might say that it should be no surprise that a system of contingency plans and risk management is present at any molecular level down to the most fundamental biochemical pathways involving DNA and RNA synthesis. We leave it to the open theist to decide if she does in fact want to say this.

Cells have mastered a remarkable network of surveillance and error repairing mechanisms able to correct functions, even in cases of failing in producing the so-called building blocks of life.

Before explaining these mechanisms, we will briefly describe DNA and RNA.

DNA and RNA are nucleic acid molecules forming chains made of basic structures of four kinds of nucleotide bases, a phosphate group, and a sugar molecule; all three together compose a nucleotide. There are four possible nucleotides and they pair in a specific manner: adenine with thymine (uridine for RNA), and guanosine with cytosine. DNA, or deoxyribonucleic acid, is composed of a double helix structure and is the hereditary material in humans and almost all other organisms. RNA, or ribonucleic acid, is a single-strand molecule with several roles in the cells, including to act as a messenger carrying instructions from DNA for controlling the synthesis of proteins. Proteins are large molecules composed of smaller units called amino acids linked to each other to form long chains. There are 20 different types of amino acids that can be combined to make a protein. With this understanding, we begin by looking at DNA error repair mechanisms, and then turn to discuss RNA surveillance.

DNA Error Repair Mechanism. DNA is a molecule that contains the instructions an organism needs to develop, live, and reproduce. These instructions are found inside every cell and need to be copied every time the cell divides. In a human body, there are several hundreds of millions of cells and over 200 cell types, but not all our cells can divide, nor are they synchronized in their division. It seems obvious that for each cell division there is a risk that the information is copied incorrectly, however, evolution has shaped several error repair mechanisms that prevent DNA to be copied inaccurately.

The human genome contains 6 billion base pairs in each cell and the enzyme that copies the whole genome prior to cell division is called DNA polymerase. This enzyme has an estimated error rate in the nucleotide incorporation step of about once every 10^4–10^5 insertions, making an estimate of 120,000 mistakes every time the cell divides. Though biologists say that this is still quite efficient, this really shows that errors are expected to be a natural part of DNA replication (Pray 2008; Hsieh and Zhang 2017).

However, cells have extremely sophisticated mechanisms that are able to fix most of the errors. Most of the mistakes are immediately rectified during replication by the proofreading mechanism, while others require recruitment of enzymes after the replication is concluded by the mismatch repair mechanism (Kunkel and Erie 2015; Hsieh and Zhang 2017).

DNA replication stalls when an incorrect nucleotide is added because a wrong molecular group (–OH) is exposed, and the DNA polymerase can recognize the mistake and make the appropriate change. However, even if the mistake is not recognized, a second mechanism reduces the final error even more. An incorrect base insertion will create deformities in the final rigid double helix structure, and these are recognized by the mismatch repairing system that will excise and substitute the incorrect nucleotide with the appropriate one.

At this point, surely the open theist will be tempted to say that this is the kind of universe that we should expect God to create. The God of open theism would include some sort of proofreading mechanisms when planning to create a universe with an open future. We, however, will leave it to the open theist to decide if they want God to design the universe with these particular mechanisms in mind, or if God just puts in place more general guidelines for how the universe could evolve.

RNA Surveillance. The other fundamental molecule of life is RNA. According to the RNA world theory, RNA is the best candidate to be the first self-replicating molecules to undergo natural selection (Alberts et al. 2002, chapter 6).[7] Let us not forget that some viruses, like coronavirus, still use RNA as their hereditary material to this day. Given the long evolutionary history of RNA and its intrinsic flexibility, it is not surprising that cells have gained several different types of RNAs with different specialized functions and their synthesis can be quite complex, as we shall explain shortly. Given this high complexity, *messenger RNA* (*mRNA*) *surveillance pathways* have evolved to quality control the RNAs at all different stages of their production. Interestingly, this system is mostly conserved from yeast to humans over the course of evolutionary history when they diverged around 1 billion years ago. Clearly, this system has been working for a long time.

Before explaining this complexity, we note that the greater general complexity of RNAs entails a significantly large range of errors. Given the greater potential for error, a more complex surveillance system is needed. We start by explaining some of the general complexity of RNA that leads to the greater potential for errors before turning to the surveillance system.

As previously mentioned, a cell contains several RNA types that provide the machinery for protein production, but also program various cellular activity. For example, let us consider the type of RNA that contains the information for making proteins named mRNA because it carries the information, or message contained in the DNA. In the process known as *transcription*, the information stored in the DNA is copied into a single-stranded RNA molecule that can travel outside the nucleus and then serve as templates for making the proteins.

We have previously defined genes as continuous regions of DNA. However, within a gene the DNA is composed of sequences called *exons* that codify for proteins along with *introns* that are not codifying for proteins. Because introns do not contain information to produce proteins, they must be removed through a process called *splicing* that will lead to the mRNA.

RNA polymerase is the enzyme able to synthesize RNA molecules using DNA as a copy template to synthesize a preliminary pre-mRNA molecule, which is then processed by a complex of hundreds of factors called *spliceosome*, which cut (splice) the intron regions and then join the ends of the exons to form a continuous mRNA molecule. Moreover, in order to be a functional transcript, the mRNA is further modified through a maturation process.

For this, additional modifications are added to both loose ends of the mRNA transcript: on one end a 7-methylguanosine cap structure and on the other end, a stretch of a repeated nucleotide forming the poly-adenylated or poly(A) tail. At the same time, specialized proteins bind and then package the mRNA making it ready for its export outside the nucleus.

It is clear that this intricate process involves several assembling pathways and numerous factors, and this contributes to further increase the possibility of introducing more defects and several levels of errors into the mRNA.

The first level of error is introduced by the RNA polymerase itself. This enzyme has an estimated error rate over four orders of magnitude higher than that of DNA polymerase. "These mistakes are rare, but because cells make thousands of mRNAs, a single human cell can make 10–100 transcription errors per second" (Carey 2015, 2).

The second level of errors is the process complexity, for this the surveillance machinery monitors along the wide range of processing, from transcription, to splicing, from maturation to nuclear export to confirm that the mRNA produced is not defective and suitable for translation. Otherwise, this pathway will destroy aberrant mRNAs that could potentially produce defective proteins and be deleterious to cells (Wagner and Lykke-Andersen 2002; van Hoof and Wagner 2011).

Given these levels of errors, this initially seems like a lot of risk. However, there are various surveillance mechanisms in place to correct these errors. For example, the mRNA surveillance is composed of three biological pathways known as nonsense-mediated decay (NMD), nonstop decay (NSD), and the more recently described no-go decay (NGD) (Bicknell and Ricci 2017). All of these mechanisms recognize and destroy aberrant RNAs. Among these pathways, NMD is the most studied and best described since its first discovery in 1979 (Chang, et al. 1979). Hence, we shall focus on this.

It is estimated that the NMD pathway alone is targeting between 5% and 20% of the RNA transcripts depending on the cell type and organism (He and Jacobson 2015). NMD has been first discovered as the pathway that degrades transcripts with premature termination codons. This mistake arises frequently in case of incorrect splicing or RNA polymerase synthesis. mRNAs codifying proteins are ending with a specific sequence that identify their termination. This is a signal to stop the protein formation. If this signal is missing or misplaced, truncated or defective proteins will be produced with possible devastating consequences.

NMD also keeps control of the RNAs homeostasis by regulating the physiological level of mRNAs and appropriate gene expression in response to cellular needs, deciding when is the moment to degrade specific gene products because they are no longer needed (Kurosaki and Maquat 2016). The mRNA decay pathway is also targeting events of "transcriptional noise" in which mRNA production is due to stochastic interaction between random components of the transcriptional machinery to the DNA (Urban and Johnston 2018). Finally, NMD is also responsible to modulate "pervasive transcription." In this phenomenon, some RNA called noncoding RNA (ncRNA, because they do not codify for proteins) are transcribed in positions of the genome that are not containing any genes, or they are transcribed backward in respect to the normal direction of RNA polymerase. These molecules are synthesized in huge numbers, but also constantly cleared by rapid degradation by the surveillance system. These ncRNAs have great gene regulatory purpose, and they can be a great source of genetic variability and ultimately are extremely important from an evolutionary point of view (Bresson and Tollervey 2018).

Interestingly, for this ubiquitous characteristic of RNA surveillance systems, some scientists have begun to look at these mechanisms differently. Bresson and Tollervey (2018) affirmed that the maturation process is the result of an addition of protective features that increase RNA stability, but also protect the mRNAs from the attack of the surveillance system, which by default is targeting almost all RNAs. This model implies that the cell's status is expecting everything to be made wrong and therefore a correction system is always in place. This new view raises the cell to a master of contingency plans.[8]

Taking Stock

We started this section by describing the basic features of the universe that one should expect the God of open theism to create. Those features included stable laws of nature that allow for a variety of creatures with varying degrees of complexity, flexibility, and autonomy. Also, a universe that contains various systems that anticipate errors and mitigate the associated risks. What we have just described in the biological order is a vast system of successful redundancies, surveillance, and risk-management systems that fully anticipate countless errors. In the next section, we argue that if God can use such systems in the biological order, then surely God can use analogous systems to achieve the MCP.

Divine Risk Management, Surveillance, and Salvific Redundancies

Given God's use of redundancies, risk management, and surveillance to achieve His purposes in the biological order, we think it probable that God would use analogous systems to achieve His MCP. In this final section, we will identify a range of possible policies and systems for God to adopt in order to eliminate dark timelines.

Primed for Divine Friendship: Human Cognitive Equipment

If one of God's goals is to create human persons who can enter into a genuine friendship with Him, then God will need to ensure that humans have a certain set of cognitive equipment that is primed for friendship. The open theist is already committed to the claim that libertarian freedom is essential to friendship. Yet, there are certain other cognitive powers that are needed in order to make possible genuine relationships between God and humans to ensure that dark timelines are eliminated. A standard package of cognitive mechanisms will also include the powers of rationality, emotion, empathy, and a theory of mind.

We start with the theory of mind, which is the ability to recognize other minds. The theory of mind has been much discussed in the literature on psychology and philosophy of religion (Visala 2018, 104–05). Alvin Plantinga has famously extended theory of mind to a faculty for an innate awareness of God called the *sensus divinitatis* (Plantinga 2000).[9] Endowing humans with such a faculty would help eliminate dark timelines because without this faculty, humans would be unable to be aware of God.

Yet simply recognizing other minds, like God, would not be enough to ensure the success of the MCP. Humans endowed with the ability to recognize other minds and perform free actions is not sufficient for accepting God's offer of friendship. To enter into genuine relationships, creatures will need to have the cognitive powers of rationality and emotion. These cognitive powers are said to enable people to share ideas, take responsibility for their actions, and develop trust and cooperation (Visala 2018, 104). All of which are important for friendship.

Rationality and emotion go hand-in-hand (cf. Clore 2011). The power of rationality is the ability to be responsive to reasons for acting (Pearson 2018, 122). There are different kinds of roles that reasons play in our free actions such as justifying, motivating, and explaining the actions of an agent (Pearson 2018, 68). Often, reasons for acting are values or disvalues in a given situation. Emotions play a crucial role in helping agents identify reasons for action because emotions involve evaluations (cf. Brady 2013). Emotions are felt evaluations of situations that involve perceiving various values or disvalues in a given circumstance (Roberts 2013, 114–15; Todd 2014, 706). When one has an emotion, one is perceiving the value of the object of her emotion to be an object that is worthy of her attention and worthy of her action (Helm 2001, 195). Thus, there is a close connection between the emotional evaluations and acting for a reason. If an emotional response fails to properly track the value of the object, the emotional response is not rational. If an emotional response properly tracks the value of the object, the emotional response is rational (Todd 2014, 704).

We say that God endowing humans with these cognitive powers is a great example of a risk-management system built into the psychology of human nature. Open theists claim that God is the supreme object of value. By endowing humans with the cognitive powers of reason and emotion, God has enabled humans to be capable of recognizing God's value and appropriately respond to God's value. Thus, enabling humans to accept God's offer of friendship. If humans lacked these cognitive powers, they would be unable to accept God's offer of friendship, and the MCP would fail.

Along with a theory of mind, rationality, and emotion, humans will need the capacity for empathy in order to enter into friendship with God. The capacity for empathy is a person's ability to understand what it is like for another person to feel the way that they do. In empathizing with others, a person comes to know what others care about and their reasons for acting as they do. Empathy plays a large role in the development of genuine relationships (cf. Betzler 2021). Human persons naturally want to be understood because there is a kind of loneliness that comes when others cannot understand why you are feeling as you do. This is because humans do not bond with people who do not understand them, whereas humans do bond with people who do empathetically understand them (Morton 2017, 183–84). The natural human desire to be understood can draw creatures to seek out the empathetic God of open theism (McConnell 1927, 121–22). By endowing human persons with these cognitive powers, God has ensured that humans are primed to genuinely accept His offer of friendship. Thus, God is able to eliminate a large number of dark timelines in which the MCP fails.

Contingency Plans and Risk-Management Systems

Thus far, we have identified some rather generic risk-management systems that God might put in place in order to secure the MCP. As stated before, open theism is a model of God, and not a systematic theology. It is a model of God that has garnered interest from proponents in different world religions, not just Christianity, and from those of no particular religious persuasion (Lodahl 2009; Todd 2011; Lebens 2020, 96). An open theist can rely on her other theological commitments in order to identify more risk-management systems that God might employ. In what follows, we briefly identify other mechanisms that God might put in place in order to ensure the success of the MCP. The mechanisms that we identify below start out with relatively generic religious doctrines, and then progress to more religion specific doctrines. We leave it to the open theist to decide which religious doctrines she wishes to draw from.

In the biological order, we described systems that anticipate countless errors, and that have mechanisms in place to correct those errors. We say that the sending of prophets is a theological analogue. Many of the world's religions affirm that God sends prophets in order to instruct humans on matters pertaining to moral and religious life. Prophets can function as a kind of surveillance system that corrects things happening in the world, thus preventing history from heading down a dark timeline. For example, within Judaism, God is said to have sent Moses to the Hebrew people in order to establish an initial covenant relationship with God. God sent subsequent prophets in an effort to bring them back toward a right relationship with God during times of trouble and disobedience. Within Hinduism, prophets or wise sages are also sent into the world during times of trouble and disobedience in order to turn the world away from a path of chaos. A prophet's life is limited of course, but a successful prophet establishes a worship community where regular rituals are practiced to ensure the surveillance and correction of potential errors for many generations to come. An open theist can say that part of God's exhaustive contingency plan for creation involves a policy to send prophets in order to ensure that humanity has access to salient knowledge about God. Further, God might adopt a policy to send more prophets if history begins to head toward a dark timeline. An open theist can even say that God sends multiple prophets as a kind of redundancy system. Thus, eliminating dark timelines where the MCP fails.

Another potential risk-management system is a theophany. A theophany is when God temporarily takes on human form in order to communicate with human persons directly. An open theist can affirm that God's risk-management policies include theophanies in order to successfully establish worship communities. Theophanies appear in different Jewish, Islamic, and Hindu scriptures. Christianity goes further by claiming that God became incarnate for the purpose of drawing human persons closer to Him. Since open theism is not a systematic theology, an open theist is able to draw on her own religious tradition to identify further ways that God manages risk in an open universe.

Yet there are other potential mechanisms that God might put in place. We suggest that death might be one such mechanism. At first glance, this might seem like an odd mechanism, but it has various benefits. According to the open theist, Richard Swinburne, God has the duty to ensure that humans have a life that is overall good (Swinburne 1998, 224). For Swinburne, God must create a world in which human persons are given the powers of rationality, freedom, and emotion in order to achieve the greatest possible good, which is union with God. Yet Swinburne thinks that God is obligated to ensure that any human who suffers an overall bad earthly life, not as result of their own free action, must be compensated with a good afterlife (Swinburne 1998, 232). There is a potential problem, however, with suffering from a bad earthly life. Some suffering that humans endure could prevent them from entering into healthy relationships with others, including God. Swinburne maintains that God is under an obligation to ensure that no human suffers to such an extent in their earthly life so as to prevent friendship with God. One such mechanism to ensure this is death. According to Swinburne, "God only allows humans to suffer at each other's hands or by natural processes for periods of up to eighty years or thereabouts" (Swinburne 1998, 232).

We suggest that the open theist can see death as a sort of repair mechanism that God puts in place in order to eliminate dark timelines. Death prevents a kind and level of suffering that would turn all humans away from God, and thus prevents the failure of the MCP. Yet, notice that the mechanism of death is linked to the notion of a good afterlife in Swinburne's thought. Swinburne is working within a Christian tradition, but an open theist need not be a Christian. Various doctrines of the afterlife can be identified as risk-management systems.

For example, Jews, Christians, and Muslims can appeal to different versions of the doctrine of purgatory as a form of a redundancy mechanism. On different versions of the doctrine, purgatory functions as a place where humans are given further opportunities to accept God's offer of friendship after their death. The open theist can say that this kind of salvific redundancy allows for the optimal opportunity to accept friendship with God. Thus, further eliminating dark timelines in which the MCP fails. If an open theist is more attracted to Hinduism, she can replace the doctrine of purgatory with the doctrine of reincarnation as a redundancy system. She can argue that eventually everyone will come to accept God's offer of friendship after enough reincarnations.

Concluding Thoughts

To be sure, open theism is a controversial model of God that faces different challenges and objections. In this article, we have sought to consider one debate over the amount of risk involved in open theism. In the past, open theists have oversold the amount of risk involved when God creates a universe. We suggest that open theists in the future down play just how risky God's behavior is, and instead speak of God's infinite intelligence in employing the resources of risk-management systems.

Notes

1. One notable exception is Alexander (2017).

2. For a defense, see Rhoda (2011) and Boyd (2015).

3. The language of "policies" is directly taken from Sanders and Hasker. We are in no way implying some sort of neoliberal economics when using the term "policy."

4. For a response to Ware, see Boyd (2015).

5. According to Thomas Jay Oord, majority proponents of open theism and relational theism, like John Sanders, now affirm universal salvation (see Oord 2021).

6. However, it should be noted that there are some bacteria that can be described as mobile.

7. Also available at https://www.ncbi.nlm.nih.gov/books/NBK26876/

8. Yet this raises a question of what would be the most rational system for God to put into place. Would God create a system of contingency plans that assumes things will most likely go wrong? Or would God create a system of contingency plans that assumes that things will more often than not go right? We leave this question for future philosophical and biological research to consider.

9. For an introductory debate over this cognitive mechanism within evolutionary psychology, see Bulbulia (2013) and Murray and Schloss (2013).

References

Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. *Molecular Biology of the Cell*, 4th ed. New York: Garland Science.

Alexander, Denis. 2017. *Genes, Determinism and God*. Cambridge: Cambridge University Press.

Ascencio, Diana, and Alexander DeLuna. 2013. "Genetic Redundancy." In *Encyclopedia of Systems Biology*, edited by Werner Dubitzky, Olaf Wolkenhauer, Kwang-Hyun Cho, and Hiroki Yokota, 824–27. New York: Springer.

Bar-On, Yinon M., and Ron Milo. 2018. "The Biomass Distribution on Earth." *Proceedings of the National Academy of Sciences of the United States of America* 115:6506–11.

Betzler, Monika. 2021. "The Relational Value of Empathy." In *The Value of Empathy*, edited by Maria Baghramian, Meline Papazian, and Rowland Stout, 15–41. London: Routledge.

Bicknell, Alicia A., and Emiliano P. Ricci. 2017. "When mRNA Translation Meets Decay." *Biochemical Society Transactions* 45:339–51.

Bloomer, R.H., and C. Dean. 2017. "Fine-tuning Timing: Natural Variation Informs the Mechanistic Basis of the Switch to Flowering in Arabidopsis Thaliana." *Journal of Experimental Botany* 68:5439–52.

Boyd, Gregory A. 2011. "God Limits His Control." In *Four Views on Divine Providence*, edited by Dennis W. Jowers, 183–208. Grand Rapids, MI: Zondervan.

———. 2000. *God of the Possible: A Biblical Introduction to the Open View of God*. Grand Rapids, MI: Baker Books.

———. 2015. "The Open Future, Free Will and Divine Assurance: Responding to Three Common Objections to the Open View." *European Journal for Philosophy of Religion* 7 (3): 207–22.

Brady, Michael S. 2013. *Emotional Insight: The Epistemic Role of Emotional Experience*. Oxford: Oxford University Press.

Bresson, Stefan, and David Tollervey. 2018. "Surveillance-Ready Transcription: Nuclear RNA Decay as a Default Fate." *Open Biology* 8:170270.

Bulbulia, Joseph. 2013. "Bayes and the Evolution of Religious Beliefs." In *Debating Christian Theism*, edited by J.P. Moreland, Chad Meister, and Khaldoun A. Sweis, 223–241. Oxford: Oxford University Press.

Carey, Lucas B. 2015. "RNA Polymerase Errors Cause Splicing Defects and Can be Regulated by Differential Expression of RNA Polymerase Subunits." *ELife* 4:e09945.

Chang, J. C., G. F. Temple, R. F. Trecartin, and Y. W. Kan. 1979. "Suppression of the Nonsense Mutation in Homozygous β0 thalassaemia." *Nature* 281:602–3.

Clore, Gerald L. 2011. "Psychology and the Rationality of Emotion." *Modern Theology* 27:325–38.

Collins, Robin. 2012. "The Teleological Argument: An Exploration of the Fine-Tuning of the Universe." In *The Blackwell Companion to Natural Theology*, edited by William Lane Craig and J. P. Moreland, 202–281. Oxford: Blackwell.

Fisher, R. A. 1935. "The Sheltering of Lethals." *The American Naturalist* 69:446–55.

Ghosh, S., and T. J. O'Connor. 2017. "Beyond Paralogs: The Multiple Layers of Redundacy in Bacterial Pathogenesis." *Frontiers in Cellular and Infection Microbiology* 7:1–14.
Grössl, Johanness, and Leigh Vicens. 2014. "Closing the Door on Limited-Risk Open Theism." *Faith and Philosophy* 31:475–85.
Hasker, William. 2000. "An Adequate God." In *Searching for an Adequate God: A Dialogue Between Process and Free Will Theists*, edited by John B. Cobb Jr. and Clark H. Pinnock, 39–52 and 215–245. Cambridge: William B. Eerdmans.
———. 2004. *Providence, Evil and the Openness of God*. London: Routledge.
———. 2017. "An Open Theist View." In *God and the Problem of Evil: Five Views*, edited by Chad Meister and James K. Dew, 57–76. Downers Grove, IL: IVP Academic.
———. 2020. "How to Make a World." *Roczniki Filozoficzne* 68:35–53.
———. 2019. "Infinite God, Open Future." In *The Infinity of God: New Perspectives in Theology and Philosophy*, edited by Benedikt Paul Gocke and Christian Tapp, 258–75. Notre Dame, IN: University of Notre Dame Press.
Hasker, William, Dean Zimmerman, and Thomas Jay Oord. 2011. "Introduction: Open Theism and the Challenge of Science." In *God in an Open Universe: Science, Metaphysics, and Open Theism*, edited by William Hasker, Thomas Jay Oord, and Dean Zimmerman, 1–14. Eugene, OR: Pickwick Publications.
He, Feng, and Allan Jacobson. 2015. "Nonsense-Mediated mRNA Decay: Degradation of Defective Transcripts is Only Part of the Story." *Annual Review of Genetics* 49:339–66.
Helm, Bennett W. 2001. "Emotions and Practical Reason: Rethinking Evaluation and Motivation." *Nous* 35:190–213.
Holtzen, Wm. Curtis. 2019. *The God Who Trusts: A Relational Theology of Divine Faith, Hope, and Love*. Downers Grove, IL: IVP Academic.
Hsieh, Peggy, and Yongliang Zhang. 2017. "The Devil is in the Details for DNA Mismatch Repair." *Proceedings of the National Academy of Sciences of the United States of America* 114:3552–54.
Johansson, Mikael, and Dorothee Staiger. 2015. "Time to Flower: Interplay Between Photoperiod and the Circadian Clock." *Journal of Experimental Botany* 66:719–30.
Kafri, Ran, Michael Springer, and Yitzhak Pilpel. 2009. "Genetic Redundancy: New Tricks for Old Genes." *Cell* 136:389–92.
Krakauer, David C., and Joshua B. Plotkin. 2002. "Redundancy, Antiredundancy, and the Robustness of Genomes." *Proceedings of the National Academy of Sciences of the United States of America* 99:1405–9.
Kunkel, Thomas A., and Dorothy A. Erie. 2015. "Eukaryotic Mismatch Repair in Relation to DNA Replication." *Annual Review of Genetics* 49:291–313.
Kurosaki, Tatsuaki, and Lynne E. Maquat. 2016. "Nonsense-Mediated mRNA Decay in Humans at a Glance." *Journal of Cell Science* 129:461–67.
Laruson, Áki J., Sam Yeaman, and Katie E. Lotterhos. 2020. "The Importance of Genetic Redundancy in Evolution." *Trends in Ecology & Evolution* 35 (9): 1–14.
Lebens, Samuel. 2020. *The Principles of Judaism*. Oxford: Oxford University Press.
Lodahl, Michael. 2009. "The (Brief) Openness Debate in Islamic Theology: And Why that Debate Should Be Different Among Contemporary Christians." In *Creation Made Free: Open Theology Engaging Science*, edited by Thomas Jay Oord, 53–68. Eugene, OR: Wipf and Stock.
Lukasiewicz, Dariusz. 2020. "Divine Providence and Chance in the World." *Roczniki Filozoficzne* 68:5–34.
Mawson, T. J. 2008. "Divine Eternity." *International Journal for the Philosophy of Religion* 64:35–50.
McConnell, Francis J. 1927. *The Christlike God: A Survey of the Divine Attributes From the Christian Point of View*. New York: The Abingdon Press.
Morton, Adam. 2017. "Empathy and Imagination." In *The Routledge Handbook of Philosophy of Empathy*, edited by Heidi L. Maibom, 180–89. London: Routledge.
Mullins, R. T. 2020. *God and Emotion*. Cambridge: Cambridge University Press.
Mullins, R. T. 2016. "The Difficulty of Demarcating Panentheism." *Sophia* 55:325–46.
Murray, Michael J., and Jeffrey P. Schloss. 2013. "Evolutionary Accounts of Religion and the Justification of Religious Belief." In *Debating Christian Theism*, edited by J. P. Moreland, Chad Meister, and Khaldoun A. Sweis, 242–60. Oxford: Oxford University Press.

Oord, Thomas Jay. 2021. *Open and Relational Theology: An Introduction to Life-Changing Ideas*. Grasmere, UK: SacraSage Press.

Pearson, Olley. 2018. *Rationality, Time, and Self*. Cham, Switzerland: Palgrave Macmillan.

Pinnock, Clark H. 1994. "Systematic Theology." In *The Openness of God: A Biblical Challenge to the Traditional Understanding of God*, edited by Clark H. Pinnock, Richard Rice, John Sanders, William Hasker, and David Basinger, 101–25. Downers Grove, IL: InterVarsity Press.

Plantinga, Alvin. 2000. *Warranted Christian Belief*. Oxford: Oxford University Press.

Pray, Leslie A. 2008. "DNA Replication and Causes of Mutation." *Nature Education* 1:214.

Rhoda, Alan R. 2011. "The Fivefold Openness of the Future." In *God in an Open Universe: Science, Metaphysics, and Open Theism*, edited by William Hasker, Thomas Jay Oord, and Dean Zimmerman, 69–93. Eugene, OR: Pickwick Publications.

Rice, Richard. 2020. *The Future of Open Theism: From Antecedents to Opportunities*. Downers Grove, IL: IVP Academic.

Roberts, Robert C. 2013. *Emotions in the Moral Life*. Cambridge: Cambridge University Press.

Sanders, John. 2007. *The God Who Risks: A Theology of Divine Providence*. Downers Grove, IL: InterVarsity Press.

Swinburne, Richard. 1998. *Providence and the Problem of Evil*. Oxford: Oxford University Press.

Todd, Cain. 2014. "Emotion and Value." *Philosophy Compass* 9:702–12.

Todd, Patrick. 2011. "Geachianism." In *Oxford Studies in Philosophy of Religion*, vol. 3, edited by Jonathan L. Kvanvig, 222–50. Oxford: Oxford University Press.

Urban, E.A., and R.J. Johnston. 2018. "Buffering and Amplifying Transcriptional Noise During Cell Fate Specification." *Frontiers in Genetics* 9:591.

van Hoof, Ambro, and Eric Wagner. 2011. "A Brief Survey of mRNA Surveillance." *Trends in Biochemical Sciences* 36:585–92.

Visala, Aku. 2018. "Human Cognition and the Image of God." In *The Christian Doctrine of Humanity: Explorations in Constructive Dogmatics*, edited by Oliver D. Crisp and Fred Sanders, 91–109. Grand Rapids, MI: Zondervan.

Wagner, Eileen, and Jens Lykke-Andersen. 2002. "mRNA Surveillance: The Perfect Persist." *Journal of Cell Science* 115:3033–38.

Ward, Keith. 1982. *Rational Theology and the Creativity of God*. Oxford: Basil Blackwell.

Ware, Bruce A. 2000. *God's Lesser Glory: A Critique of Open Theism*. Leicester: Apollos.