

# CHEMISTRY

FAITHFUL LEARNING



Daniel R. Zuidema

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*Enriching Your Christian Faith through Academic Studies*

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Daniel R. Zuidema



P U B L I S H I N G

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The quotation on the back cover, attributed to Robert Boyle, is found in John Hudson Tiner, *Exploring the World of Chemistry: From Ancient Metals to High-Speed Computers* (Green Forest, AR: Master Books, 2001), 129.

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I LOVE SCIENCE. I have for as long as I can remember. My dad was a science teacher for forty-three years and successfully passed his love of the subject on to me. I grew up learning to build electric motors and supercooling distilled water to watch it flash freeze, and I had a great chemistry set that I worked with for hours at a time in my basement. I love Jesus. I have for as long as I can remember. My parents raised me in a Christian home where they taught me to love the Lord and taught me the great truths of the gospel at a very young age. I grew up going to church, attending Sunday school, and participating in mission trips. The connection between a love for Christ and a love of the sciences is something I have always known. My upbringing in this environment supplied the fertile soil out of which a deep love for a Christian perspective on the sciences would grow.

As a middle school student, I spent much of my spare time playing with fireworks. While most people would probably view this behavior as typical for an adolescent boy, in hindsight I can see that a young chemist was in the making! Invigorated by my high school chemistry class, I devoted time during the following summer to studying the additional chapters that we did not have the time to cover in school. It was only natural for me to pursue a chemistry major in college. I had known that I wanted to teach chemistry since high school, so I also studied education. Immediately after graduating from college, I taught high school for two years at the same school as my dad—an early highlight in my teaching career. Those two years cemented in my mind the fact that I loved teaching science. I loved the laboratory exercises, I loved the subject matter, I loved doing all those exciting fiery demonstrations,

and I loved the students. However, I missed the research aspect of chemistry, and I strongly felt God's call to pursue graduate studies. What better way to unite my enjoyment of teaching and my love for doing scientific research than to be a college chemistry professor? When I left my high school teaching post, my science division colleagues gave me a plaque that read, "There are old pyros and there are bold pyros, but there are not many old bold pyros!"

So, with this plaque in tow, I went back to school and earned a PhD in organic chemistry, and now I teach full time as a chemistry professor at a Christian college. I also have the opportunity to serve as a part-time science teacher for a Christian high school. In these two positions, I get the privilege of working with a lot of students who have been gifted with scientific abilities. Many of these students are working through a common question: what am I going to do with my life? Most of these young men and women have been raised in the church and earnestly want to dedicate all aspects of their lives to serving their Lord and Savior, careers included. There are many Christian students attending public high schools and universities who share this desire.

## **SO YOU LIKE CHEMISTRY. WHAT ARE YOU GOING TO DO?**

Is there a place for the Christian in the chemistry research laboratory? Is it legitimate for a Christian young person to pursue a chemistry major? Or should Christian young people attending college pursue majors in biblical and theological studies instead, so that they can become pastors, or majors in psychology, so that they might become Christian counselors? Don't Christians have the obligation to serve God in all that they do, including their professions? Is it possible to serve God by mixing chemicals as a research

chemist in a laboratory? Or should Christians instead strive to go into some kind of overtly Christian career?

In developing answers to these questions, we will need to explore some ideas about what a biblical, Christ-centered approach to chemistry looks like. The first half of this volume will be devoted to examining a Christian worldview as it concerns the pursuit of chemistry. Then, in the second half of this volume, we will shift our focus to considering why the study of chemistry is a very appropriate Christian calling to pursue, along with an introduction to some spiritual challenges that arise. Throughout, I will strive to base my claims and arguments on what the Scriptures say. The simple reason for this is that I believe that the Scriptures are the Word of God. As such, they are trustworthy and have authority. “God is a Spirit, infinite, eternal, and unchangeable, in his being, wisdom, power, holiness, justice, goodness, and truth.”<sup>1</sup> If an idea can be shown to be in line with God’s Word, it can surely be trusted. Therefore, we will look to Scripture to derive our understanding of what constitutes faithful learning in chemistry.

Christians who have been involved in the pursuit of science have long thought about the relationship between their faith and the discipline of science. In 2006, Tim Morris and Don Petcher wrote *Science and Grace*, in which they seek to inform readers about how their underlying theological convictions relate to the way they view the world they study and the way they view their own participation in the scientific endeavor.<sup>2</sup> In 1985, Russell Maatman authored *Chemistry, a*

1. Some readers will recognize this description of God as borrowed from the Westminster Shorter Catechism, Q&A #4 (hereafter cited in the text as WSC, followed by the number).

2. See Tim Morris and Don Petcher, *Science and Grace: God’s Reign in the Natural Sciences* (Wheaton, IL: Crossway Books, 2006; repr., Scotts Valley, CA: CreateSpace, 2013), vii.

*Gift from God*, in which he explores how the science of chemistry has been created by and depends moment by moment upon God.<sup>3</sup> That same year, Albert Wolters popularized the framework of “Creation, Fall, and Redemption” when he wrote *Creation Regained: Biblical Basics for a Reformational Worldview*. It will be helpful to apply this “Creation, Fall, Redemption” model to the human discipline of the study of chemistry.

Before we do this, however, we should note that developing some kind of belief system—*some kind of worldview*—when we study chemistry is unavoidable. Albert Wolters defines a worldview as “the comprehensive framework of one’s basic beliefs about things.”<sup>4</sup> All people have worldviews, but they are often *tacit*—that is to say, they are often unstated and unarticulated in a formal manner. Therefore, no one’s mind is simply a blank slate or an empty canvas. Chemistry cannot be understood from a “neutral” point of view. Everyone approaches any subject of study with a set of presuppositions. Does God exist? If so, can I know him? What is he like? Who am I? What is my purpose here? The answers that a person formulates to these questions inform the purpose behind studying the subject of chemistry, or any other subject for that matter.

When we consider all the different world religions and even all the different Christian denominations, we find a vastly complex array of theological convictions and worldviews. It might therefore seem to be a hopelessly daunting task to consider and evaluate all the different worldviews that people bring to bear on their study of chemistry. But, as he so often does in the New Testament, Christ simplifies

3. Russell Wayne Maatman, *Chemistry, a Gift from God* (Sioux Center, IA: Dordt College Bookstore, 1985), i.

4. Albert M. Wolters, *Creation Regained: Biblical Basics for a Reformational Worldview* (Grand Rapids: Eerdmans, 1985), 2.



the matter when he says, “No one can serve two masters” (Matt. 6:24). How does this statement of Jesus apply to the study of chemistry? Either the subject matter will be understood from a godless perspective or it will be understood from the perspective that the earth is the Lord's and everything in it. But the human heart *was* made to worship; it *will* worship something or someone in whatever it does, studying chemistry included.

I would like to explore some ways that we can apply a Christ-centered perspective to how we view and do chemistry. To accomplish this, I believe it will be helpful for us to think about both the nature of human beings and their study of the discipline of chemistry. We will consider the two simultaneously, for they are closely related. How is this so? The discipline of chemistry is a human undertaking. Therefore, in order to understand something about the nature of chemistry, we need to understand some basic truths about the human condition. What is true about humans generally will also be true about and have a bearing on the academic study of chemistry. First, we will consider how both humankind and the discipline of chemistry are created by God. Then, we will think about how both humanity and the science of chemistry are fallen and tainted by sin. Finally, we will explore how Christ's redemption applies to both humans and chemistry. The content that follows is loosely organized into the conceptual framework of the ideas of creation, fall, and redemption.

## CREATED IN GOD'S IMAGE

Research is a human activity. Therefore, it is important for us to keep in mind what Scripture teaches about the human condition. We are God's image-bearers. God created us “male and female, after his own image, in knowledge,

righteousness and holiness, with dominion over the creatures” (WSC #10). We were created with the ability and desire to know the truth of God. We were also created with the physical senses and mental ability to acquire knowledge and learn truth. Furthermore, we were set apart as holy—created perfect with the ability and desire to worship God in true holiness. In sum, prior to the fall, human beings were created to know God’s will, to serve him only, and to do works of righteousness, ruling over creation in a way that was pleasing to God.

After God finished his creation, he pronounced it “good.” Every created atom, every created molecule has inherent “goodness” associated with it simply because it was created by God! While at first we might be quick to acknowledge this, there are some molecules that might cause us to think a bit. What about ethyl alcohol, the alcohol in beverages? What about cocaine? Do these molecules possess inherent goodness? They are naturally occurring in creation, so they are good! It is only when human sin gets involved (as people use them to get drunk or high) that these molecules get a bad reputation. Out of sin arises the desire to abuse parts of God’s creation and to use them in a way that is displeasing to God. Jesus taught this in Mark 7, where he said,

Nothing outside a man can make him “unclean” by going into him. Rather, it is what comes out of a man that makes him “unclean.” . . . For from within, out of men’s hearts, come evil thoughts, sexual immorality, theft, murder, adultery, greed, malice, deceit, lewdness, envy, slander, arrogance and folly. (vv 15, 21–22)

As an example, consider pseudoephedrine, the active ingredient in many cold and allergy medicines. When used properly, pseudoephedrine is a very effective decongestant,

useful for alleviating the symptoms of colds or allergies. Life is made better through the intended use of the drug. But sadly, some people abuse this medication by taking too much of it at once, in order to get high. Additionally, pseudoephedrine can be converted into methamphetamine with relative ease. Both of these inappropriate uses can prove to be deadly. Whether the drug is being used for God-honoring or God-dishonoring purposes depends on the heart-level attitude and intent of the user.

What about man-made materials? As a graduate student, I had occasion to work with a molecule called methyl fluorosulfonate, a potent methylating agent. It adds methyl ( $-\text{CH}_3$ ) groups to molecules with remarkable ease, earning the nickname “magic methyl”—just add this reagent, and methyl groups “magically” appear on your substrate!<sup>5</sup> The problem is that when *you* get exposed to magic methyl, *you* (or at least the biomolecules that make you up) start getting methylated too.

In preparing to use magic methyl, I did some reading to find out just how toxic the reagent was. What I found disturbed me: a Dutch scientist died after getting exposed to only a small amount in the 1970s.<sup>6</sup> When the much anticipated hour arrived for me to use the magic methyl, I asked all my lab mates to leave the lab—the last thing I needed was to accidentally collide with or be startled by a coworker. I made sure I had my morning coffee, so as not to have shaky hands, then put on two pairs of gloves and two lab coats, working with the material from behind a shield in the fume hood. The trick is to put on enough

5. While this seems an appropriate application of the nickname, the history behind this name is related to the name of the acid from which it is derived: “magic acid.”

6. D. M. W. van den Ham and Devaraj van der Meer, “Vapors Fatal,” *Chemical and Engineering News* 54, no. 36 (August 30, 1976): 5.

personal protective equipment to keep the nasty stuff off you, but not so much that the bulkiness causes you to make a clumsy mistake. Nothing makes the heart pound like the opportunity to use acutely toxic reagents! But, in the end, my reaction gave the desired product in good yield.

What is the point? Would anyone say that magic methyl is an inherently bad substance because it is lethal? I think they would not. Magic methyl can be a useful reagent to a chemist running a synthesis. When used carelessly, it can cause harm. But this does not detract from the “goodness” of the atoms that make up the molecules or from its utility as a tool in synthesis.

What about chemicals that are designed for use in warfare, with the sole purpose of killing and causing human suffering? Surely the use of chemical weapons is repulsive to God, the giver of life. But to say that the molecules (or atoms that make them up) are evil would be like saying that the steel that makes up a handgun is evil. In the hands of sinful individuals, almost anything can be used for evil purposes. Christ teaches us that the sin originates not in external materials, but in the human heart.

It is important to emphasize the fact that God created and values physical stuff. As Christians, we often think about spiritual matters. But we must avoid the dualistic trap of thinking that the spiritual is somehow more important than the physical. Christ took on a physical body when he came to earth. He healed the sick as well as forgave their sins. God sustains his physical universe. When we say we believe that God is immanently involved in his creation, we mean that he takes an active role in governing his universe. God numbers the hairs on our heads, feeds the birds of the air, makes grass grow on the hills—we could go on! What is more, in Genesis God commanded Adam to fill the earth and subdue it. Adam and his race were charged

with being stewards and caretakers of creation. Therefore, it is entirely appropriate for God's people to take a great interest in studying and understanding the creation. This is why I believe it is a great understatement to say that there is a place for Christians in the sciences, as if the sciences can "make room for" or "accommodate" Christians. There is a sense in which God gave the work of studying, understanding, using, and caring for creation to his people in the very beginning.

In our family, my wife and I have a tradition in which we give our kids a bike with training wheels on their fourth birthday. Not long ago, the big day arrived for one of my sons. You can imagine how happy we were to see him immediately climb up on the bike and start riding it around. He rode that bike for much of the day and even wanted to bring it inside the house when it was time for bed!

When you give a gift to someone, you like to see him or her do something with it. You want to see this person use it and enjoy it. It will probably not surprise anyone to hear that there have been occasions when my kids have left their bikes outside in the rain or down the street at friends' houses. Of course, as their dad, I am unhappy to see this. Why? Because I want to see them value and take good care of the gifts they've been given. To complete the analogy, I believe that our heavenly Father would be disappointed if his children neglected his creation. On the other hand, I believe that our heavenly Father delights in his children exploring his creation, "playing" with it and enjoying it as a gift.

Furthermore, participation in scientific research is an expression of the fact that humans are created in the image of God. As anyone who is a parent has experienced, children mimic their parents. Although I do not consider myself to be handy around the house, occasionally I'll need to do a

minor project. As soon as I get my tools out, it is not long before my kids find their toy tools and crowd around me to “help.” Whenever I go outside to mow the lawn, I am sure to have some young helpers following me with toy mowers and weed eaters. As long as they are safe, I am happy to have them there. Why? Is it because they are so helpful and that “many hands make light work?” Not usually. It is because their desire to be like me and be around me is endearing—a sign of their love for me. I mentioned earlier that I went into the field of science partly because I wanted to be like my dad. He taught science, and since I respected and loved him—and it looked so appealing—I wanted to do the same! In a similar manner, we mimic our heavenly Father when we perform scientific research.

For instance, God carries out the synthesis of natural products in living organisms via a process known as biosynthesis. Many research projects in organic chemistry are devoted to carrying out what are called *biomimetic* syntheses—syntheses carried out in the laboratory that mimic the way the same synthesis is carried out within the living organism. Here we see an instance in which chemists admittedly *mimic* the method through which a given chemical is synthesized by God’s providence in a living system. What do I mean by the term *providence*? “God’s works of providence are, his most holy, wise, and powerful preserving and governing all his creatures, and all their actions” (WSC #11). Certainly under the umbrella of “all their actions” falls an organism’s (creature’s) biosyntheses of metabolites! Is it possible that my heavenly Father found it endearing when I was doing biomimetic polypropionate synthesis for my PhD dissertation research? I believe so.

From the previous example, it is possible to see that even unbelieving scientists glorify God when they do research, although they do so unwillingly and unknowingly. This

is not to say that in this process the unbeliever is doing anything that is ultimately pleasing to God, as only that which is done out of true faith can be considered good in God's sight (see John 15:5; Heb. 11:6). However, by God's *common grace* it is possible for unbelieving scientists to make valuable and wondrous discoveries—discoveries that have the potential to greatly benefit human beings. A brief discussion of common grace is in order at this point.

God's common grace consists of several aspects, including the delay of judgment, the restraint of sin in the world, the preservation of some sense of truth, morality, and religion in humanity, the natural blessings that we enjoy on earth, and our ability to perform acts of outward good.<sup>7</sup> Let us consider some of the ideas just mentioned. We should start by stating that God is completely independent and free. His actions are not contingent upon human desire or will; rather, the opposite is true. This principle is illustrated in Daniel 4, among other places. After Nebuchadnezzar is humbled to the point of eating the grass of the field for seven years, he acknowledges,

All the peoples of the earth  
are regarded as nothing.  
He does as he pleases  
with the powers of heaven  
and the peoples of the earth.  
No one can hold back his hand  
or say to him: "What have you done?" (v. 35)

Clearly, God does not owe anyone anything. By definition of who he is, whatever God does is right. As the psalmist

7. An excellent discussion of the subject of common grace can be found in Louis Berkhof, *Systematic Theology* (repr., Grand Rapids: Eerdmans, 1996), 432–46.

recognizes in Psalm 115, “Our God is in heaven; he does whatever pleases him” (v. 3). The distinction between the Creator and the creature is very great indeed. When we sin, we commit an offense against God’s holiness. A perfectly holy and just God cannot and will not allow sin to go unpunished. God would be perfectly within his right to cast sinners into hell immediately. The American theologian and minister Jonathan Edwards once preached, “You have reason to wonder that you are not already in hell.”<sup>8</sup> Many scientists make great discoveries and have tremendous scientific insights and then turn to mock God to his face, denying his existence. The fact that God does not execute judgment immediately, but rather delays judgment, is gracious.

Another dimension of the common grace idea is that God “causes his sun to rise on the evil and the good, and sends rain on the righteous and the unrighteous” (Matt. 5:45). Unbelievers as well as believers benefit from the discoveries of science. The same anti-arthritis drugs are available to non-Christians and Christians alike. God allows the unrighteous to enjoy good things in this life. This is gracious of God.

All humans have been created in the image of God and therefore share some of his attributes to an extent. God has been pleased to allow all people (believers and unbelievers alike) to use their senses and minds to gain some understanding of his truths. These are often referred to as “common grace insights.” Just because certain scientific discoveries are achieved by unbelieving scientists does not make the insights gained through them any less true. Christians derive much benefit by studying textbooks published by unbelieving authors. When choosing chemistry textbooks for my courses, I do not specifically search for chemistry

8. Jonathan Edwards, “Sinners in the Hands of an Angry God” (sermon, Enfield, CT, July 8, 1741).



“From a knowledge of his work, we shall know him.”

ROBERT BOYLE, founder of modern chemistry

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## FAITHFUL LEARNING IN CHEMISTRY

DO YOU LIKE TO STUDY how the world around you works? Have you always enjoyed experimenting with a chemistry set? Many Christian students who are skilled with chemistry wonder whether they truly belong in a research lab, tempted to justify it as a stepping-stone to more “godly” pursuits. Are sciences like chemistry only a means to an end, or should they be studied for their own sake?

Daniel R. Zuidema argues that Christians not only have a place in the sciences but should be there front and center, fulfilling our calling as stewards and caretakers of creation! Learn why studying chemistry doesn’t need to be “justified”—and how discovering and proclaiming new things about creation glorifies the God who made it in the first place!

**THE FAITHFUL LEARNING** series invites Christian students to dive deeper into a modern academic discipline. The authors, scholars in their fields, believe that academic disciplines are good gifts from God that, when understood rightly, will give students the potential to cultivate a greater love for God and neighbor.

DANIEL R. ZUIDEMA (PhD, Wake Forest University) is professor of chemistry and chair of the chemistry department at Covenant College in Lookout Mountain, Georgia, where he has taught since 2005.

  
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