LET THERE BE SCIENCE

WHY GOD LOVES SCIENCE, AND SCIENCE NEEDS GOD

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FOREWORD

"I wonder as I wander out under the sky"

So begins one of the best-loved Christmas carols. *Wonder*. It is the beginning of both science and the Christian faith. Wonder that the world is as it is, in its beauty, majesty, and glory. Wonder also that "God so loved the world that he gave his only Son, so that everyone who believes in him may not perish but may have eternal life."[1]

Wonder like this can only find expression in praise. As the biblical Psalmist writes, "I praise you, for I am fearfully and wonderfully made. Wonderful are your works; that I know very well."[2] We are indeed wonder-fully made – God has made us to be full of wonder for both him and his works.

Just as Augustine says that "God has made us for himself, and our hearts are restless until they find their rest in him,"[3] God has also made us for this world, and our minds are restless until they find their rest in its truth. For, as we explore and discover more about the world, we come to know more about God's wonder-full works, and so come to know God himself more and more. Thus, in doing science – in seeking the truth about the world around us – we worship God.

And this, then, is why faith provides such a natural environment for science to flourish – as the authors of this book maintain. They show, through stories about faith and science, that rather than faith being the enemy of science (as many of the "cultured despisers" would have us believe) faith *nurtures* science, watering its roots so that it may bear fruit; fruit that will last.

Now, this fruit isn't merely the satisfying of curiosity – the scratching of an intellectual itch – but rather, just as faith leads to action, so does science. God has given us the gift of science, and the gift of faith to nurture it, so that we may actively engage the world, making it a better place not only for ourselves but also for those who come after us. This is part of what it means to be human; and science, along with and supported by faith, is right at the heart of it.

I commend this book to all who would like to know better how faith is fertile ground for the growth of science. But in closing, I would like to say more generally that faith is an environment not only where science thrives, but also where human life thrives. We are

all pilgrims, wandering in this world. There will be a time, however, when our pilgrimages come to an end: in that place of joy which "no eye has seen, nor ear heard, nor the human heart conceived, what God has prepared for those who love him."[4] And there, all our wanderings will cease – for, though "we know now only in part, there we will know fully, even as we have been fully known."[5] And, in turn, science will come to an end; for not only will we know the mind of God, we will see him face to face.

The Archbishop of York, Dr John Sentamu

PREFACE

Dave

The whole thing is almost depressingly predictable. Each school year, the students I teach find out that I believe in God – either because they have asked me outright or because it has turned up in conversation somehow. From then, I can count it down:

3… 2… 1…

"But you're a *science* teacher!"

It isn't their fault, of course. Somehow, even before their mid-teens, they think that you just have to pick a side – God or science. Who has told them this? Science-hating God-people? God-hating scientists?

Either way, it doesn't take long to establish that there hasn't been much real thought involved in their forming of the "it's either God or science" conclusion – it has just sort of happened. A few simple questions expose the truth that they have ended up believing it without really knowing why. I suspect that it is because someone, somewhere, has been doing the media-based equivalent of shouting aggressively at whoever happens to be nearby – and that my students, like everyone else, have picked up the echoes and settled for that.

What might happen, though, if we stopped with all the shouting? What if we just talked, and listened? Might Bible-believing Christians have something to say to scientists that is not just interesting, but actually beneficial to real-world science? Might scientists have something to say to Christians that could help them live out their day-to-day faith more powerfully?

Even in those questions, we see a false split, for there is no need for an individual to be one or the other. There are many scientists who are also committed Christians. The shouters, of course, don't want people to know this, and especially not to think about it; which is precisely why they shout. The problem, however, is that it is a fact, and facts are powerful things – they need to be dealt with.

Yet how can this be done, and done well? The temptation is to join in as loudly as others have – but that is only really likely to make things worse. Shouting sets people up against each other and breaks down both conversation and thought. A handful of teachers encouraging a handful of students to think the God-science issue through more carefully might make a small difference, but it certainly won't bring about wholescale change.

Is there, maybe, a way that we can let all the echoes die down

slightly and start afresh? Can we give everyone – students, scientists, priests and pastors, and none of the above – a new beginning? Might they be gifted the chance to start thinking, in an environment that permits even the gentler voices to be heard, about how God and science relate to each other?

It was with questions like these working their way around my head that I found myself, a few years ago, listening to a lecture on Astrophysics. The talk – "Black Holes, White Holes and Worm Holes" was expertly delivered by Dame Jocelyn Bell Burnell, a legendary figure in physics, known best for her discovery of pulsars. Had justice been done, in fact, she would have a Nobel Prize for it – but, as we will go on to see in this book, the world of science yields up just as many failures and missteps as any other. It was at this lecture's after-party (yes, there really was one) that I first met Professor Tom McLeish.

I had just been having a discussion with Dame Jocelyn about God – thankfully, she is most certainly not a shouter – so my mind was already on such things when Tom walked over and mentioned a book he had just written. It was about Christianity and science, he said. I find myself thinking of this as a divine encounter of some sort – I bought a copy and, in the ensuing months, some wonderful answers to my wonderings about fresh starts began to emerge. To see why, and to get a little more background, it only seems fair to hand over to Tom himself…

Tom

For several years, this scientist and Christian had, like Dave, become increasingly frustrated at the amount of defensive writing in "science and religion". The ever-present, "How can you reconcile the conflict between science and faith?" seemed to start from the wrong place, and assume all the wrong things. I wanted very much to think out loud more about questions that went along the lines, "What is science for *in God's great project?"*

Implied in this "science within Christian belief" approach were two other necessary things. We would need to listen to the great thinkers about the natural world throughout history, especially those whose love of the natural world evidently sprang from their faith. Excitingly for science, this "long view" also shows that it is much more deeply human than the "science is modern" view that I had been sold as a student. It also meant a fresh approach to the Bible. While the book of Genesis is a wonderful document about God's creation and covenant, it dawned on me that it doesn't contain the Bible's simplest creation stories, nor the most important material on how to think about nature. That seemed to be in the less well known (and much *less talked about) "Wisdom" books. Special among them is the even less-well-read Book of Job, whose probing celebration of the natural world*

I love. That all lead to the book, Faith and Wisdom in Science *– the one Dave went and read.*

I wrote that first book with a graduate reader in mind – its language comes from the university world I inhabit and work in day to day. But the message and ideas – that we can think Biblically about science as God's gift, as a talent to turn into many-fold returns as the world, and that this can transform the way we think about science – can be chewed-on by anyone. In particular I had realised that Faith and Wisdom in Science *had serious consequences for education and the media. Andrew Hodder-Williams from Lion Hudson (incidentally an old school friend) had approached me about writing for a wider readership, including those of any age who may not have studied or embraced either science or faith in any meaningful way. I just didn't think I would be able to do it very well. I needed a co-author. If only I could find, say, a school science teacher with a gift for writing and who shared my passion for science within God's Kingdom…*

Dave and Tom

The result of this, hopefully, is a book about what we might be able to hear underneath all of the shouting. It is a book about what Christianity says about science, and about what science says about Christianity – all through stories of interest to readers of all faiths or none. It seeks to pick up on what has, all too often, been drowned out by the noise: that science flows naturally from the Christian worldview, and that it always has.

How sad it is that this extraordinary relationship has been almost completely lost in inaccurate or over-emphasised tales of the prejudices, mistakes, and terrible deeds that have sometimes arisen in the name of either faith or science. For every disaster, there are a multitude of remarkable success stories, nearly all of which seem never to be told.

It is time, now, for this to be remedied. The Bible's message speaks of a God who loves science and of a science that needs God. Again and again, this has been proved to be true in the real world of physics, chemistry, and biology. This is a book about those instances and the wonderful message which is threaded through each of them: that science is a gift from God, one with unlimited potential for good, and we are all to treasure it greatly, whether experts or not.

Great things can happen in relationships whenever people are prepared to stop shouting. Maybe, one day, things could be different in classrooms, laboratories, churches, and pubs. Perhaps we can become a society that thinks and talks about facts, and

not just echoes. That the Big Picture of Christianity and the practice of modern science weave together beautifully is, putting it simply, true.

So, let's seek out these two – science and faith – in all of their fullness, and rediscover that beauty ourselves.

Tom

I'd like to thank Dave for taking this project on and for writing mostly everything (the reader should know this). We'd both like to thank Andrew Hodder-Williams, Jessica Scott, and especially Becki Bradshaw at Lion for their encouragement and hard work. The most loving supporters of projects like this as well as the most sensitive critics are the close family who also have to put up with it; without all that from my wife Julie and our children this wouldn't have happened.

Dave

Since I have never really done anything like this before, I have very many people to thank. Tom, Becki and Andrew have, I feel, taken a risk in working with a newbie like me, and I am hugely grateful for that. Their advice and patience has been much needed. My wife, Emma, has taken much of the brunt of the book – having to read countless excerpts, put up with my absence, listen to my ramblings and humour me almost constantly. She has done this whilst also looking after a toddler (Bethany) and a baby (Chloe), although they have probably caused her fewer difficulties than I have. I couldn't have done any of this without her.

Others who have helped with the manuscript in significant ways are Joshua Crosby, Becki Dean, Ed Hambleton, and Liam Maxwell. Their feedback has been vital in producing what we have all now ended up with. Colleagues at Pocklington School have also been key aids; they shall have to be satisfied with being listed by their initials: IHA, MJA, MJD, AWJH, GJH and LAL. I promised to mention one of my Physics A Level classes, L6Q, who were refreshingly honest with me about whether what I was writing was even remotely interesting. (In return, may I remind them now, they have promised to buy a copy each). Of course, I also owe a huge debt to my parents, in particular for their constant encouragement and prayers. Finally, Lawrence Osborn – our copy editor – was both flexible with timings and wise in his analysis of the text. Thank you to all.

Thank you

1

TURNING THE LIGHT ON

> He who walks in the darkness does not know where he is going.
>
> **Jesus of Nazareth**

> Shin: a device for finding furniture in the dark.
>
> **Steven Wright**

Finding the best path across an unlit and cluttered room in the middle of the night is a potentially tricky business. The horrors of a stubbed toe or of treading on something sharp are only ever one unlucky step away. The solution is obvious, of course, provided it is available: turn the light on. The newly illuminated surroundings can now be taken in – plotting a course is made much easier.

Writing something new about science feels a little bit like this crowded-room scenario, especially since this book will deal with some controversial subject matter. What exactly, we shall ask, *is* science? What is science *for*? Do these questions, interesting though they might be, really make any practical difference? Would knowing the answers actually change anything for the average scientist?

Unsurprisingly, the room these questions occupy is a hazardous one. It is already stuffed full of furniture, and there are oddments all over its floor. Stepping out into it will mean putting feet and shins at serious risk – and only more so if we allow the ideas and language of *faith* to have any involvement.

A thoughtful and careful look at the big-picture story of science, though, shows that the topic of faith is simply unavoidable; it crops up again and again. In fact, at times, faith appears not just to be part of the mix, but central to it. Although this might seem unexpected at first, a bit more exploration reveals what is at least a partial explanation: science – so often presented as a detached, almost robotic undertaking – turns out in reality to be startlingly, and wonderfully, *human*.

When it comes to real-world science, as we shall see, it is no exaggeration at all to say that personality (with its worldviews, instincts, and quirks) has made at least as much difference as rationality. Throughout history, religious beliefs have consistently informed – and sometimes even brought about – new and successful scientific theories. The Christian faith, in particular, seems to be able to provide an environment in which science can positively thrive. If we are serious about answering the big questions laid out above, we cannot really afford to ignore these considerations – on the contrary, we should investigate them further.

As we do so, we will discover that there are many good reasons for the positive effects of faith on scientific endeavour. Chief among these is the provision of a powerful underlying *reason* for doing science in the first place – one that is so powerful that it is unparalleled anywhere else in human thought. This key principle of purpose has led to Christianity being intimately involved with – in some cases being directly responsible for – many of the biggest leaps forward in scientific history.

Maybe, then, it is not actually all that unscientific to hear faith speak as we seek to evaluate and then support science – it could prove to be a more useful travelling companion than some might have thought. Perhaps our seemingly inbuilt love of wisdom about nature really does have some sort of ultimate, faith-related significance. Can Christianity – and its key text, the Bible – help us, in some tangible way, to understand science better? Can it speak on what science *is*? Can it speak on what it is *for*?

Before we start answering these questions, however, it might be wise to ask one more: what ideas are already out there about science? After all, many voices have spoken out about its role or its value or its relationship with human beings, and it would be wise to hear these first. In this opening chapter, therefore, we will do just that.

Let us think of this initial listening process as turning the light on and surveying the room. For only once we have done so, will we be ready to plan out our route; a route which will – if it is the right one – bring us safely to a better place.

Science, Faith, and Hard Words

There is little doubt that the word "science" seems to come with strong images and ideas attached to it. Parents' evenings at schools are full of surprised mums and dads declaring that they "never really *got*

science" after being told their offspring is doing quite well in physics. There is the definite notion that some (odd) people are just "good at science" – unlike the rest of those mere mortals who will work in "normal" areas like retail, manufacturing, the leisure industry, or some form of office work.

Ask people to associate words with "science" and their responses reinforce this idea: "difficult", "boring", "mad scientist" all crop up. This does not necessarily mean that science is unvalued, though, since other answers are "experiment", "proof", and "curing cancer". Instead, it seems that science is viewed as useful, but complicated. Is this true about other complex human activities? What if we try the same process with "music" or "art"?

This time, answers are far more *personal*. They might be a favourite song or a feeling – there is far less sense of distance or threat. When most people talk about science, they do so from a position of wariness – it is part of a different world that they feel they can comment *on* but not really take part *in* – and yet other subjects are seen as more comfortable and accessible. We could, therefore, call science a "hard" idea, and these others "soft".

What about our other key topic, faith? Is it hard or soft? Words like "trust", and "belief" sound somewhat promising, but do not push faith clearly into one category or the other. Expressions like "blind faith" and "extremism", however, are certainly nearer the hard end of the spectrum.

When considering the interaction of faith and science, then, we might be entering grounds in which people have strong ideas, even if they don't have a high level of personal involvement in either area. The atmosphere in which the two meet could be highly charged at times, and this book finds itself right in the middle of it – so paying attention to what has been said before will be very important.

It is perhaps most obvious to start with the scientist most often associated with this meeting-point, Richard Dawkins. He is quoted often, partially because he is so strongly spoken. Take, for instance, his comments during a live webchat on the *mumsnet* website:

> If children understand that beliefs should be substantiated with evidence, as opposed to tradition, authority, revelation or faith, they will automatically work out for themselves that they are atheists.[1]

It is a relatively simple point: *evidence* (which comes from doing science) is *opposed* to *faith* (which, according to Dawkins, contains

no evidence) and leads to the obvious conclusion (since a child can arrive at it) that there is no God. For Dawkins, science and faith are enemies, and science must win out in the world for us to progress. He is far from being alone in this view, with the more active supporters of it being dubbed the "New Atheists". Peter Atkins, a former professor of chemistry at Oxford University, is unafraid of adding his voice to Dawkins':

> It is not possible to be intellectually honest and believe in gods. And it is not possible to believe in gods and be a true scientist.[2]

These bold announcements, however, have been challenged by the very creatures that Peter Atkins does not believe exist: true scientists who do believe. Alister McGrath, himself a professor at Oxford, is both a biophysicist and a theologian. As a former atheist, he writes that the evidence for God can be found repeatedly within science:

> The Christian faith… allows us to see further and deeper, to appreciate that nature is studded with signs, radiant with reminders, and emblazoned with symbols of God, our creator and redeemer.[3]

Such back-and-forth between supposed enemies has generated hundreds of books, YouTube videos, podcasts, and university debates. Some titles give a sense of the discussion: *The God Delusion*, *The Dawkins Delusion*, *Faith vs. Fact*, *Gunning for God: why the New Atheists are Missing the Target*, and so on. Each new publication seeks to build the case further for either the death or the defence of faith, with science being hauled in to flesh out the argument.

As a side-effect, all this has led to a fear of science among some religious communities. Battles have been fought in the USA over exactly what should appear in textbooks and whether certain scientific ideas should be allowed in the classroom, depending on the persuasions of the groups running any particular school.[4] There is a real sense of anxiety, frustration, and sometimes outright anger as those on either side worry about the possibility of wrong ideas damaging young minds.

Although the religion–science tension is a major headline grabber, it is not the only science-related area in which strong opinions are held. We have identified a large piece of furniture in our darkened room, yes – but it is not the only one.

Science the Saviour

To many people, science offers hope. As those clever scientists in white coats work away in the lab, they discover new facts and new techniques which will bring us closer, every day, to a perfect world. The major victories of science in the past remind us that great things can be achieved, and it becomes possible for some to believe that all of our problems will eventually be eliminated by the power of the scientific method. It is a hope that lies behind these words from Pandit Nehru, the first prime minister of India:

> It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.[5]

Here, science itself is the hero. It is easier to hold this view as a non-scientist, since the pressure is firmly placed on the shoulders of those in the profession, but many scientists see things this way too. Royal DSM, a life-sciences company based in the Netherlands has a website entitled "Science can Change the World". It reminds visitors of successes against smallpox, acid rain, and the hole in the ozone layer. This triumphant message champions their staff:

> A handful of inspirational people – that you've probably never heard of – are proving that science doesn't just change the game. It can change our world.[6]

Is this optimism and positivity justified? Is it true that science is the process by which people with big ideas and big brains save the world? Would it be more realistic to say that this is a rather rose-tinted picture, or even a way of handing over responsibility to anonymous laboratory superstars? Whatever the answers to these questions, there is at least one other reason that our governments have put forward for doing science – saving the world, it seems, is not always enough.

Science the Moneymaker

Money talks – and we could hardly expect science to carry on without listening. With eighteen of the top one hundred companies in Britain being directly involved in the sciences[7] (and many others indirectly

linked), there is clearly cash to be made if you can get your experiments to work well. These organizations spend almost unimaginable amounts on squeezing a few more decimal points of efficiency out of their devices, or on updating them with an all-new version.

Take, for example, the average cost of bringing a single new pharmaceutical drug to market: *Scientific American* magazine calculated it to be a staggering £1,700 million in 2014.[8] This many pound coins stacked as a tower would be as tall as 600 Mount Everests; laid out in a line, they would almost completely encircle the Earth. Alternatively, and undoubtedly more usefully, every single person in the world could be given 23 pence.

These extraordinary numbers are not lost on leaders around the world. They know very well that science and money go together. Here is why the UK government thinks it should fund scientific research:

> The mission of each research council has been changed to meet the needs of users and to support wealth creation… thereby enhancing the United Kingdom's competitiveness and quality of life.[9]

This is almost unexpectedly honest. There is no mention of saving the world, unless perhaps that is what is meant by improving quality of life. It could be argued that "meeting the needs of users" could be about winning victories over suffering, but there is no denying the strong economic nature of the statement. The government will put money into science, yes – because it believes it will get even more money back out.

Interestingly, this line of argument is not only found in parliamentary papers: it is also used to persuade young people to study science. The top five subjects for graduate salaries in the UK are all sciences, as are nine of the top ten. The Institute of Fiscal Studies ran a presentation in 2013 with the rather clunky title *Why you should study maths (and science and computing) at A-level*. After working through over thirty slides of monetary calculations, they concluded: "it is very likely to earn you more money!"[10]

Science the Spoiler

Most people would not know the name Val Valentino, but a significant number have seen him at work. He is the Masked Magician who decided to expose the workings of numerous magic tricks commonly

performed by other illusionists. His TV show, *Breaking the Magician's Code: Magic's Biggest Secrets Finally Revealed*,[11] followed a fixed format – the Masked Magician would perform the illusion as it was originally intended and then (after a commercial break, of course) would do it again, this time showing the method.

Watching this programme could bring forth a variety of emotions: excitement and bewilderment at first, speculation and curiosity before the reveal, satisfaction and closure when enlightened. Not everyone, however, felt fulfilled. In fact, many didn't. The final revelation, which seemed to promise so much, often led to disappointment.

The teleporting girl, it turned out, was actually an identical twin. The coin entered the bottle through a secret hole in the bottom. There was a trapdoor under the casket. The levitation used strong, thin wires. The problem with all of this was the loss of a sense of wonder. It is more fun for many, it would appear, *not* to know what is going on. Commenting on a YouTube video of the show, a user called *cromthor* writes:

> In spite of what we all feel (we WANT to know the secret), our pleasure as spectators is to be fooled, to see something that's IMPOSSIBLE! We want to know the secret, but once we do, let's face it: we're disappointed and our pleasure is gone.[12]

Interestingly, some eminent figures from history describe science in almost the same way. John Keats, the great Romantic poet, would probably empathize with *cromthor's* comment. We see the same type of complaint in one of his poems, "Lamia", from 1820:

> Do not all charms fly
> At the mere touch of cold philosophy?
> There was an awful rainbow once in heaven:
> We know her woof, her texture; she is given
> In the dull catalogue of common things.
> Philosophy will clip an angel's wings,
> Conquer all mysteries by rule and line,
> Empty the haunted air, and gnomed mine
> Unweave a rainbow.

Keats's protest is that science is acting like the Masked Magician. It takes elements of the world which inspire wonder and, in explaining them, strips away their magic. As far as Keats is concerned, science ruins things that were once beautifully mysterious, mutating them

into nothing more than boring scientific laws or information. Science, he says, unweaves rainbows.

Science the Monster-Maker

Another Romantic icon – Mary Shelley's *Frankenstein* – is proving to have a far deeper influence within modern, cutting-edge science than might have been expected from a novel written in the 1830s. A cautionary tale, in which a monster is created by Dr Frankenstein using "science", it has been hijacked by mainstream media. They use it to express concerns about the damage scientists might possibly be doing as they meddle with natural processes.

Ignoring the actual point of the book (it is only when the monster is unloved and dismissed that he becomes a threat), the story has now become that science is often unnatural and will lead to disaster of some sort. Playing on this fear, it is now standard journalistic style to add "Franken" to the start of different words, forming a new "science-is-bad" vocabulary. Frankenfoods (those that are genetically modified) are the most common example, but other applications include Franken-tadpoles (with eyes on their tails) and Franken-water (recycled from human waste).[13]

This is a deep-seated narrative in our culture. We worry that "messing with nature" will cost us heavily in the long run. A newly published book by Jean-Pierre Fillard asks whether we might be happily bringing about our own end as a recognizable species – it has the terrifying title *Is Man to Survive Science?*[14]

The hugely successful novel-turned-film *Jurassic Park*[15] grabbed hold of a similar idea and ran with it. The Park's team of technicians use "science" to bring living and breathing dinosaurs into the twentieth century. In a key scene, the man funding all of this research is sternly warned by one of the wisely sceptical heroes: "Your scientists were so preoccupied with whether they could that they didn't stop to think whether they should."[16] As the plot develops, his fear is shown to be valid. Science, we learn, makes monsters.

Science the Odd Family Member

It almost seems a rule that, at every extended family gathering, there is one person present who is not quite operating on the same social level as the rest. He or she is welcome, yes, and even enjoyed – but as

some sort of curiosity, almost like an exhibit. The quirky enthusiasm and utterly confusing stories are entertaining for a short while, but are really only tolerated because these gatherings don't happen so often.

This is often the treatment reserved for science and scientists in the media. Take, for example, a recent edition of BBC Radio 4's *Today*.[17] It is not unusual for this programme to deal with very complex and subtle ideas related to the arts, the humanities, or politics, and this one was no exception: it discussed, in depth, the philosophy of a French novelist.

By contrast, when scientists were asked to speak about exploding galaxies on the same programme, they were told off for using "difficult language". The term that caused offence – "a simplifying assumption" – was far more straightforward than many of the earlier philosophical phrases.

Similarly, BBC Radio 5 Live's *Seven Day Saturday*, a quick-fire comedy show covering economics, politics, sociology, and more contains a section introduced with the following jingle: "Here comes the science bit – concentrate!"[18] This is more than just a claim that science is difficult, it seems. The implicit suggestion is that science is somehow *different* to other difficult ideas. Perhaps this explains why science and scientists are often treated as a bit of light relief when they turn up in a studio. They are wheeled in to pronounce some fact or another, and the following interactions with the hosts are usually either awkward or comical. The message is clear: science is not "normal".

Science the Spooker

People can occasionally be hit by a profound revelation: there is an awful lot out there in the world about which they know precisely *nothing*. Questions might range from "how do clouds stay in the sky?" to "who or what am I?" Stopping to think like this can be scary – the questions can get big quite quickly. "What kind of universe do we live in?" "Is there a 'big picture', or not?"

Science is unafraid to tackle questions like these, and it can be tempting to just let scientists get on with it – but, on occasion, there remains the nagging sense that that is not going to be enough. Take the experience of author Bill Bryson, for instance:

> I was on a long flight across the Pacific, staring idly out the window at moonlit ocean, when it occurred to me with a certain

> uncomfortable forcefulness that I didn't know the first thing about the only planet I was ever going to live on.[19]

Not prepared to let this thought go, Bryson decided to do something about it, which resulted in the wonderful book *A Short History of Nearly Everything*. Yet, for every new book spawned, there will be thousands of people who stay quietly spooked as it dawns on them that they don't know the answers to some questions that might just be very important.

George Steiner, the hugely influential thinker, has also been unsettled by the mysteries of the material world around us. He, however, came to the conclusion that scientific study cannot then "unspook" us. Resolution, he says, must be found elsewhere:

> Only art can go some way towards making accessible, towards waking into some measure of communicability, the sheer inhuman otherness of matter…[20]

Steiner is deeply bothered by the "inhuman otherness" of the universe, but has given up on science as the tool to deal with it. Thinking about science, he implies, can certainly get us spooked – but *only art* provides any meaningful answers.

Plotting Our Course

Let us review our findings. What have we seen, now that the light is on? The what-is-science-and-what-is-it-for room has indeed proved to be a cluttered one. Even a quick glance around has revealed several large items that need to be taken into account. To some, science is the enlightened arch-enemy of faith, or the saviour of the world, or a money-spinner. To others it is a rainbow-unweaver, a monster-maker, a quirky uncle, or a quietly haunting spectre.

Our claim in this book – that doing science is a fundamental part of what it means to be human, and that it works best when understood as a gift from God – will have to speak to each of these different views. We need, therefore, to pick out a route that allows it to do so, hopefully without striking our bonier body parts on something hard or sharp.

For this reason, we shall take the approach, throughout, of using *stories*. Stories get us thinking about *people* – their motivations, hopes, or pain; their moments of inspiration or moments of disaster. Stories

are how we best understand ourselves and our beliefs. Stories, as we shall see, can be key in the search for a bigger picture.

In Chapter 2, then, we will consider the history of science. When did science really begin? Was it with the computer? With electric circuits? With gravitational theory? Or, perhaps, might science be much, much older than any of these?

In Chapter 3, we will look at the remarkable fact that human beings can even do science at all, and in Chapter 4 we will investigate the process of scientific revolution – how, in reality, does one theory totally overhaul another? Chapter 5 will address the very real (but often hidden) fact that science does not always go smoothly and is often the cause of great pain – and that, despite this, scientific hope persists.

Chapter 6 deals with the still-developing understanding that, in our world, order consistently emerges from apparent chaos, even at the very deepest levels of our current knowledge. Time and again, we find that the uncertainties in this world also make it a suitable home for us – could this point us to a further, more profound truth?

In Chapter 7 we study the importance in science of asking the right questions and then, in Chapter 8, the even greater importance of *love*.

In each of these chapters, our science stories will intermingle with faith stories – the two are bound together far more tightly than some modern commentators might have us believe. The big pictures painted by the history, the people and the findings of science look very much like those that emerge from the pages of the Bible – and we will go on to find, in Chapters 9 and 10, that this connection might just be of universal significance.

So, we have turned the light on and looked around the room. We have planned our course. It is time, now, to step out and start our journey. What *is* science? What is it *for*? And what, perhaps most significantly of all, does all this have to do with *faith*?

2

AN ANCIENT STORY

> Science is a way of thinking much more than it is a body of knowledge.
>
> **Carl Sagan**

> Is there anything of which one can say, "Look! This is something new"? It was here already, long ago; it was here before our time.
>
> **Koheleth, in Ecclesiastes**

So far we have mostly been listening, without much comment, to what different types of people think of science. To some it is a saviour, while others see it as a complete stranger – or even a worry. We have also identified the path we will take in this book: one which allow us to explore the idea that science is a human activity which thrives in the environment of faith. Our first step on this journey is to ask the question "How *old* is science"?

Before we do so, however, we should discuss why this question is at all relevant. What has the history of science got to do with how things look, right now, in a twenty-first century laboratory? What can we learn from its backstory? Why does it matter how old science is?

The issue is this: science is often presented as something that is relatively *recent*, sometimes even just 300 years young. This version of history would suggest that science does not have any long human tradition and is not, therefore, innate or natural to us at all – which would support the "science is a stranger" idea. On top of this, it could pose a serious problem for our ideas about the centrality of faith in true science.

If science really is this new, it would be very hard to make the case that Christianity is integral to it, because Christianity is very old indeed. It has its origins in Old Testament Judaism, and its central figure – Jesus Christ – walked the earth two millennia ago. If science

arises naturally from this ancient faith, as will be proposed, we should expect to find science stories appearing equally early – not just in the last few centuries.

We can put this the other way around: if science only makes an appearance fairly late in the day, it is far more likely to be a secular construct and far less likely to be related to Christian thinking. It is important, then, to know just how far back in time we can go and still find something recognizable as science – for this will either support or weaken our claim that science flows from faith.

The idea that science is young is mainly due to two slightly vague "stories" about its supposed past. These two stories are rarely told as a whole, as they will be below; instead, bits and pieces of them float around out there in the ether – allowing grand, overarching ideas to build up in our minds. These fragments can be found inhabiting Internet forums, classrooms, media interviews, and even the occasional book or video, each doing their little bit to contribute. When these are all combined, we end up with the following:

> Story One – In the past, philosophers (especially Greek ones) believed that the universe was made up of both the physical and the spiritual. The physical was imperfect: spoiled and dirty somehow. The spiritual, on the other hand, was pure and wholesome. In some versions of the story, the physical was thought of as a "damaged" version of the spiritual. When pursuing truth, therefore, it was considered far more important to think about the spiritual "ideals" than it was to investigate anything more "earthy".
>
> For this reason, philosophers (such as Aristotle) would not actually carry out experiments, but would instead discuss ideas. As an example, if someone wanted to know how a ball might move through the air when thrown, the last thing he or she would do was actually throw a ball. The preferable course of action was to sit down and talk through different theories until the most elegant or beautiful "truth" was agreed upon.
>
> This way of thinking was held to so strongly that it was only much, much later, when brave new scientists (such as Galileo in the seventeenth century) were prepared to do experiments, that we really learned anything.

A Google search of "Galileo vs Aristotle", for instance, opens up a whole world of variations on this story. For now, though, let us move on to our second science-is-new narrative.

> Story Two – In the past, the reason that people were "religious" was that they did not know very much. They only had God or gods to explain the things that they observed, so they made up mystical stories and, over time, these solidified into rigid spiritual doctrines with little or no evidence to support them.
>
> Nowadays, though, we use science to explain those same things. The scientific method has overpowered the old religion and superstition, finally leading us to the truth. This process – so the story goes – of brave new scientists freeing us from the shackles of fairy-tale faith began in earnest in the seventeenth and eighteenth centuries, a period known as the Enlightenment or the Age of Reason. It has continued since then, and victory after victory has been won over the naive mysticism that held humanity back for so long.

Are either of these stories accurate? Both claim that real science is a relative newcomer. Both claim that real science had to wait for centuries before it could eventually push philosophy and/or religion out of the way. Is this right, or wrong, or simply misleading?

Well, there is certainly much to be said in favour of Story One. In *The Republic*, the ancient Greek philosopher Plato (428–348 BC) describes some prisoners chained to the wall of a cave, a state they have been in from birth. On this wall they can see moving shadows – cast by a fire – of the people and objects outside the cave. This is the only information they have to determine what they can about the wider world.

Should one of them be freed, however, he or she would now be able to explore this greater reality fully – and Plato then argues that a good philosopher does just that. The shadows, he says, represent the physical world we live in; the objects casting them stand for a deeper, spiritual realm.

Story One claims that this theory permeated Western thought, thereby promoting philosophy and inhibiting hands-on science. Alfred North Whitehead (1861–1947), the mathematician, scientist, and philosopher, agrees: "The safest general characterisation of the European philosophical tradition is that it consists of a series of footnotes to Plato."[1]

There is further support available for Story One. It is true, for instance, that Galileo helped to popularize the use of real, physical experiments when determining scientific laws. This can be seen from his 1638 work, *Two New Sciences*, which contains a fictional exchange between three characters.[2] These are *Simplicio*, who follows the old ways of Aristotle, and *Salviati* and *Sagredi*, who speak (here) for

Galileo. On the topic of whether two balls of different mass would fall at different speeds, *Salviati* says:

> I greatly doubt that Aristotle ever tested by experiment whether it be true.

Simplicio wants to defend Aristotle, but his argument is rather weak:

> His language would seem to indicate that he had tried the experiment, because he says: "We see the heavier"; now the word see shows he had made the experiment.

Sagredi, however, then applies the killer blow:

> But I, Simplicio, who have made the test, can assure you that a cannon ball weighing one or two hundred pounds, or even more, will not reach the ground by as much as a span ahead of a musket ball weighing only half a pound.

Galileo is saying that scientific experiment beats idealistic philosophy because it is prepared to get its hands dirty. If you want to know the truth, he claims, you have to try things out in practice. Story One would have us believe that this is how science slowly started to get going. Before this, philosophical concepts were more important than actual evidence. Real science, therefore, began a few hundred years ago – science is "new". Can Story Two reinforce this finding?

Once again, we can quickly find some evidence for its central assertion: that religion squashed science until the seventeenth-century Enlightenment. After all, Martin Luther (1483–1546), one of the spiritual leaders of the Christian Reformation, has some astonishingly strong negative views on "reason":

> [Luther] called reason the "devil's bride," a "beautiful whore," and "God's worst enemy" and said: "There is on earth among all dangers no more dangerous thing than a richly endowed and adroit reason." Again: "Reason must be deluded, blinded, and destroyed" and "faith must trample under foot all reason, sense and understanding".[3]

We can contrast this with a quote from David Hume (1711–76), one of the key figures of the Age of Reason. He champions reason, saying that only rational thought and evidence will do:

> If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning, concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion.[4]

Even from these quotes alone, we can feel the weight of Story Two. In the first, we hear a religious leader utterly dismiss any idea of free thought, study, or logical analysis. In the second, we hear a courageous critic of religion taking a stand, declaring boldly that only statements which have been subjected to scientific testing should hold any authority. It really does sound like science is at war with religious belief – that it is fighting to tear itself free.

Putting these two stories together, then, seems to paint a rather straightforward picture – that science is a relatively new thing. Kept at bay for most of human history by groundless philosophy and religion, it has only made an appearance fairly recently. The overall argument is a clear one: "science" arrived a few centuries ago; "science" has made fantastic, faultless progress since then; science will – one day – win out completely.

We should be wary, though, of drawing any final conclusions without a more careful look. As the biblical book of Proverbs advises us: "The one who states his case first seems right, until the other comes and examines him."[5]

Is science really only a recent development? Can science only flower once faith is vanquished? To answer these questions, we will first need a definition of "science" to work with. Once we have one, we shall look at some modern scientific work to make sure our definition is reasonable. From there, we will begin to go backwards in time, searching for older and older science stories. How far back can we get?

Science: A Definition

Where can we find a workable definition of science? Thankfully, we are not the first to ask that question, and there are some key ideas that are widely agreed upon already – the Wikipedia entry for "scientific method" provides a helpful synopsis, for example.

The general consensus is this: observations should be made; there should be an attempt to explain them; there should be some evidence

both of further experiment and of analysis. Some have suggested that mathematics is essential too, but we shall come back to that issue shortly.

The associated term "scientist" does arrive fairly late in history, and is first used in the 1830s. It would be hasty, however, to conclude that there could not have been scientists before the word itself existed. Various characters from history have been put forward as the "first scientist", but the simple fact that there is no one candidate upon which experts agree suggests that the lines cannot be drawn as clearly as some might like.

In his book – which is actually entitled *The First Scientist* – Brian Clegg argues that the honour should go to Roger Bacon, who was born in AD 1214. He gives the following reason, among others: "He would not accept pure argument; everything should be subjected to experiment."[6]

Clegg also uses Bacon's embracing of mathematics as evidence for supporting his case. This already takes us back long before the 300 year age of science in Story One. If we are not careful, however, we could find ourselves ruling out whole periods of history and hundreds of individuals if we make our definition too tight. Any idea that there was neither "science" nor "scientists" before AD 1200 might turn out to be unnecessarily extreme.

Is it possible, then, that we can take a slightly different approach and broaden the definition out a little, without compromising our essence of observation, explanation, and experimentation? The answer to this is a resounding "yes". We can do it by considering an older name for science; a name that some would say is actually a far better one.

The British scientist Isaac Newton (1642–1726) is reckoned by many to be the greatest human mind in history. He made many leaps forward that are still taught in classrooms today. His laws of motion are in the specifications of every high school physics course worldwide, and his work on gravity revolutionized the way people have thought about our universe ever since. Incidentally, Newton rules himself out of the running for "first scientist" status, acknowledging that he had built on the work of others before him. He wrote in a letter to his colleague Robert Hooke (1635–1703) that: "If I have seen further it is by standing on the shoulders of Giants."

The reason for introducing Newton at this early stage of the book – he will be mentioned again – is actually so we can consider a term that is very helpful in understanding what true science might really mean. Newton's mammoth three-book masterpiece, for which he is

best known, is given the Latin title *Philosophiae Naturalis Principia Mathematica* or, when translated into English, *Mathematical Principles of Natural Philosophy.*

The reason for this is that "natural philosophy" was used to mean "science" long before the word "science" was coined. In fact, we can go further – "philosophy" is Greek for "the love of wisdom", so the full meaning of natural philosophy is "the love of wisdom about the things in nature".

This is a wonderful way to describe science. "Loving wisdom about nature" is a great picture for us to have in mind when we think about science working to its full human potential. Watching the world at work, thinking about how it might be happening, testing out ideas, and using them for something new is the dream scenario for scientists. The "Eureka!" moments of discovery, when wisdom about nature is won, are what all scientific professionals (and amateurs) hope for. This term – natural philosophy – is perfect for guiding us towards a good definition of science.

Here we go, then: we will count something as true science if – and only if – we can show it meets three distinct criteria. First, there must be observation of something in nature. Second, there must be a discussion of a possible physical cause. Third, there should be some form of analysis or testing involved. This last requirement might be through planned experiment, physical interaction, or by further observation.

We must bear in mind that, just as with music or art or any human activity, what was done many centuries ago might look very different to its descendants today. A twelfth-century painting, for instance, follows many artistic "principles" not used now, but we would never reject it as art. Similarly, the science we find far in the past might also "look" different in some ways, but if it meets our three criteria, it is science nonetheless.

In light of this, we will not treat the use of accompanying mathematics as strictly necessary. It is the attitude, aim, and approach of those involved that we are concerned with – the Carl Sagan quote from the beginning of this chapter captures this well. The science we are looking for is really driven by "*a way of thinking*".

Science is a curiosity that leads to actually doing something. It is being dissatisfied with not knowing something and chasing down the answers. It is natural philosophy. When people look at the world around them and ask how it works "on the inside" (in a real and practical sense), this is scientific thinking. When they try their ideas out, analyse the results, and draw conclusions, this is scientific

practice. Whenever and wherever we can identify these sorts of human behaviour – regardless of historical style, language, or fashion – we can be confident in calling it a love of wisdom about nature. We can be confident in calling it *science*.

Now that we have a definition in place, we can begin our trip back through time, starting with a thoroughly modern example of natural philosophy.

AD 1997 – The Jelly That Shouldn't Have Been There

Most people will (hopefully) be able to remember from their school days the key idea that physical matter is made up of particles. These particles, as the lessons explain, can be arranged in different ways, forming solids, liquids, or gases. There are, however, other possibilities. Many different types of particle arrangements exist, and some of these could be described as being "in between" these famous three – like jellies, the subject of our first study.

It is tempting, initially, to think of a jelly as a solid. However, the edible jellies that we leave to "set" in a fridge should help us realize that this is incorrect. These desserts are made mostly of water, and water is a liquid at fridge temperatures. This means that the jelly – or at least, nearly all of it – is also a liquid. Why, then, does it not flow away? The answer lies in its particles, and in the unusual way that they are arranged.

In a jelly, a few of the particles are joined together in very long, tough strings, called macromolecules. These long strings are criss-crossed over each other in all directions, forming a network. This network holds the overall structure of the jelly in place, with the liquid particles free to move and slide within it.

Provided there are enough macromolecules about, the liquid can be held in any shape – hence jellies shaping to the mould. The tangled networks still allow flexibility, which gives rise to the characteristic "wobble". This is all reasonably well understood: scientists working in the field can actually calculate the number of macromolecules needed to form any given jelly, for instance.

When, therefore, a young graduate student studying in the 1990s managed – accidentally – to turn a liquid into a jelly without adding any macromolecules at all, it caused great surprise and great confusion. Having ruled out the possibility of an error, this new jelly suddenly found itself in need of explanation. The student had indeed added something to the liquid: a set of minuscule objects called *peptides*.

Peptides, however, are molecules only a few atoms long. They are nowhere near the length of the macromolecules; they have no hope whatsoever of "trapping" liquids.

A perplexed – but utterly fascinated – group of chemists called in both physicists and biologists for help. After a while, it was actually an inspired guess that opened up the way to solving the problem. Perhaps, it was suggested, the short peptides were "turning into" long macromolecules via some unknown process. Sure enough, upon further investigation, it was found that the tiny peptides were constantly "jiggling around" in the liquid – more on this jiggling later – and, at times, were actually *sticking* to one another.

Over a long enough period of time, the peptides would glue themselves together into long "tapes". These tapes then tangled up and around each other, mimicking the role of macromolecule strings, and forming the jelly. All this happened without any extra intervention from the scientists. The peptides did it all by themselves; they bounced around and crashed into each other over and over again. Each collision held a small chance of sticking – add these chances up, though, and whole tapes appear.

With the use of high-detail imaging equipment designed to see individual molecules, the resulting structures were ultimately seen "on camera", and a previously unknown physical process had been formally identified. Subsequently, the formation and behaviour of these tapes has been found helpful in understanding Alzheimer's disease, during which similar structures self-assemble and cause damage to the brain.

Can we count this story as science? How does it match up to our definition? Well, there was certainly observation. There was also a suggested cause, based on an initially hidden interior structure. There was testing and there was further analysis. It matches what we said we were looking for, so we can reasonably refer to it as science – a conclusion which will be of great relief to the journal *Nature*, the publisher of the findings.[7]

Before we move on, we can note a few more brief points. First, the outcome of the jelly story was the ownership of more wisdom about nature. Second, this was both a frustrating and joyful episode, which indicates the presence of deep human involvement – even, maybe, of *love*. We have, therefore, seen our first instance of natural philosophy in its truest sense. We shall now jump back more than a century and see if we can find any more.

AD 1828 – The Jiggling That Wouldn't Stop

Robert Brown (1773–1858) has the unfortunate distinction of being best known for a discovery that he never managed to fully understand. His shortfall was not through lack of effort, as we shall see, but more due to the fact that the scientific world was not yet ready to provide an appropriate explanation. Brown died in 1858; his hugely important observation was eventually made clear in 1905. So what was it?

A hugely talented botanist, Brown mainly concerned himself with the science of plants. It was he who first noticed that plant cells contained a nucleus, providing a key moment in biology. As significant as this observation was, many would say that it is surpassed by one of his others, a story that began when he spotted something odd about pollen grains.

Brown wanted to study the behaviour and structure of these little objects up close, so he put them in water and watched them intently as they hung there, suspended in the clear liquid. As he examined them, he spied some even smaller particles, ejected from the grains. These tiny specks were doing something strange: they jiggled around, with no discernible pattern. Waiting for them to settle down, Brown found, was pointless; the jiggling never stopped. Extraordinary as it might be, these miniature particles appeared *alive* – had the naturalist managed to find the building blocks of life itself?

It did not take long for Brown to decide that he hadn't; some simple tests ruled it out. He tried the same experiment with non-living material like chalk dust, and it jiggled around too. Clearly, this unpredictable and unending movement was due to something other than the particles themselves. One by one, he ruled out possible causes: light, magnetism, vibration in the room, convection currents in the water, electricity, and more.

Over time, Brown began to realize that he was not going find an answer. He knew in his heart that this jiggling was incredibly important and suspected – rightly – that it would become a foundation stone for future science. As a result, he did something incredibly selfless: he wrote up all his results and resisted the temptation to give any explanation at all. Displaying extraordinary self-control, Brown kept back his own speculative theories for fear of misleading those who followed him.

Several decades later, Albert Einstein made the breakthrough that Brown couldn't – although he did have several significant advantages over his predecessor. Atomic theory was far better established by

now, and the idea that matter (including water) was made up of atoms was widely accepted. Importantly, the accompanying maths predicted that atoms would writhe around in a state of constant, haphazard motion and that they would be invisible – even under a microscope. The wriggling motion, Einstein showed, gives rise to the property of "heat".

Could this always-moving-atoms idea be the key to Brown's mysterious jiggling? Einstein wondered if the hyperactive water atoms might somehow be energetic enough to move particles far larger than themselves – perhaps even chalk dust. Amazingly, his calculations showed that they would be. The chaotic, non-stop motion that Brown had recorded was being caused by chaotic non-stop motion on an even smaller scale – one that could not be seen.

As time has gone on, this ever-present movement of atoms has been proved to be more and more vital. This will be discussed further in Chapter 6, but for now it is worth making the following point: many biological processes are utterly dependent on this tumbling, erratic behaviour. Without it, we would not be here. In that sense, we can offer encouragement to Brown: he had indeed found one of the building blocks of life.

AD 1225 – The Bishop 700 Years Ahead of His Time?

The word "medieval" is often used to describe something that is backward, or cruel, or simply embarrassing. History exalts the intellectual prowess of the ancient Greeks and delights in the thinking of the Enlightenment – everything in between, though, seems rather a waste of time.

Thankfully, this common picture has increasingly been coming under challenge, and Robert Grosseteste, a former Bishop of Lincoln, is one of the reasons. In fact, Grosseteste has also been lauded as a potential "first scientist". Astonishingly, during the first half of the thirteenth century, he managed to write about early forms of both "wave–particle duality" in matter – a key feature of quantum mechanics – and cosmology's "big bang" theory.

The initial idea that matter might be composed of tiny little particles called atoms had existed from at least 400 BC, so there was nothing novel about it by the time that Grosseteste began his scientific career. Despite this, there was a problem that refused to go away – that of solidity.

It is clear that a chair or a book is solid – it takes up space, and it

is not (obviously) compressed when a force is applied to it. But why does it behave like this? One simple answer is that atoms themselves are solid. This, however, was hardly satisfactory. It just pushed the problem one stage further: why are atoms solid?

Grosseteste decided to take this problem on, and not just by philosophy: he would apply observation and possibly experiment. The key step in his work *De luce* ("*On light*") was to consider the behaviour of light – and compare that to the behaviour of atoms.

Grosseteste demonstrated that light could "fill up" spaces as part of its normal behaviour. Open a shutter in a dark room, for instance, and the light would "expand" in some sense, filling the room. He saw this as a type of "natural extension" of light. Perhaps something like light was allowing matter made of tiny point-like atoms to do something similar, expanding by a process like this until the mixture of atoms and light took up space and was solid?

This might sound very odd indeed – and it is – but it is not all that far from the truth. Quantum mechanics (more detail in Chapter 4) describes particles as behaving like light; sometimes even spreading out when passing through gaps, very close to the behaviour Grosseteste guessed. Beyond any doubt whatsoever, Grosseteste engaged in science. He observed, he experimented (he writes about using different materials to obtain different colours of light), and he formed theories. It is little wonder, then, that he made another extraordinary leap.

Connecting the expansive behaviour of light with solidity in materials, Grosseteste then suggested that the universe might have begun with an explosion of expanding light, eventually leading to the formation of solid matter. Once again, his instincts were correct. They match up quite remarkably with some of the main ideas of the big bang theory, an idea which now dominates our thinking about both space and time.

This is no unscientific mysticism. Grosseteste opened shutters, sat on chairs, tried things out, and then formulated functional models which would surface once more, centuries later, in "modern" physics. This might not quite be science as we would recognize it, but it is most certainly science *as a way of thinking*.

it is of more than just physical composition. Because of this, there can be hope that the mind will live on, even if the body does not.

Regardless of what we think about this argument or its conclusions, the water jar description is clearly *science*. We have observation, theory, experiment, and even the notion of "seeing" with the mind what the eye cannot – all in the fourth century AD.

A final observation remains before we move on: Gregory writes all this after Macrina's death, which came very soon after this discussion. He confirms later on that he was greatly comforted by her words. Here, then, we see science playing a healing role in the real world of hurt and struggle.

This is a theme which we will find ourselves revisiting many times in this book. Is it possible that science – in the connecting, contemplating way we have defined it – might be able to touch people in ways that they had not perhaps considered before? Can it *heal*? Leaving this thought for now, though, we shall continue our journey back through time.

AD 30 – The Digestive System and Morality

During his three-year teaching ministry, Jesus of Nazareth spoke every bit as much to ordinary townspeople as he did to committed followers or influential thinkers. A gifted and charismatic teacher, he often used analogies from everyday life to make a point. This is particularly helpful to us if we are interested in knowing about life and thought at the time – and, perhaps surprisingly to some, that includes scientific thought.

In the passage below, Jesus – surrounded by onlookers – is addressing accusations that his disciples have broken laws about eating and are therefore "unclean":

> "Listen to me, everyone, and understand this. Nothing outside a person can defile them by going into them. Rather, it is what comes out of a person that defiles them." After he had left the crowd and entered the house, his disciples asked him about this parable. "Are you so dull?" he asked. "Don't you see that nothing that enters a person from the outside can defile them? For it doesn't go into their heart but into their stomach, and then out of the body." (In saying this, Jesus declared all foods clean.)[10]

After this, Jesus goes on to explain that *what comes out of a person* – qualities such as greed or arrogance – are far more important to God than what they eat. This is clearly a theological teaching, so what is it doing in a science book?

Of note to us here is that Jesus uses a scientific argument to support his message: he talks about the biological functions of the organs. Jesus differentiates between the role of someone's digestive system – their *stomach* – and the moral quality of their overall being. What someone eats, he says, is independent of their goodness. He even implies that this is testable, although the test would not necessarily be a pleasant one.

He does, however, also reference the *heart*, so should we chalk that up as an error? No – the association of the heart with our actions or emotions is not meant here as an anatomical one. It is, rather, a bit like when we talk about being heartbroken or about feeling things in our "gut" or our "bones". The stomach claim is scientific in nature; the heart claim isn't.

Of particular interest to us is this: Jesus makes a clear reference to a known biological fact and uses it to reinforce a spiritual point. He binds science and faith together. One does not squash or hinder the other. This is the type of interaction that has proved so fruitful in the past, as we will come to see. This working together might be seen more often if the core message of this book were to be embraced. Here we have an example of how to use good science to improve our understanding of ourselves – and of our interaction with nature.

Helpful references to scientific ideas and principles pop up elsewhere in the Bible's New Testament, and we will consider more of these in future chapters. Now, though, we will move on to its "prequel", the Old Testament. Since we have, perhaps, become better at spotting science in places that it could previously have been missed, can we find more?

600 BC – Ancient Detox

The Babylonian Empire of Nebuchadnezzar II enjoyed significant development in agriculture, economics, and art. It emerged out of civil war in the region that now encompasses countries such as Iraq, Kuwait, and Syria. As it consolidated, vast quantities of learning were first gathered and then acted on in new, highly effective ways.

Not all the power of the Empire was creative, however. The unfortunate Jews were among many people groups brutally conquered

by the Babylonian armies, and the Jewish Temple was ransacked. The bravest and best of their young men were carried off to Babylon, where they were put into the service of Nebuchadnezzar. In the Old Testament book of Daniel, we find the story of four Jews who were hand-picked for the king in this way.

According to the biblical account, Daniel, Hananiah, Mishael, and Azariah were selected by the king's courtiers because they were "handsome, showed aptitude for every kind of learning, were well informed, and quick to understand". During their training in the language, literature, and wisdom of the Empire they were treated very well indeed, with no expense spared. Lavish banquets were provided, with exotic food and drink being imported from all over the Babylonian territories. These feasts, however, presented a major problem to Daniel and his friends.

Being Jews, their diets were tightly regulated by the law of Moses – a law which they believed had been written in person by God – and much of the food on offer in Babylon was banned. The result was a dilemma for Daniel: should he refuse the king's hospitality and, in so doing, risk his very life?

In what would prove to be an inspired decision, Daniel actually proposed a scientific investigation to resolve the issue: a formalized study of the effects of different diets. In his excellent book, *Bad Science*,[11] Ben Goldacre describes this event as the "first clinical trial". The Bible tells us that Daniel said:

> Please test your servants for ten days: Give us nothing but vegetables to eat and water to drink. Then compare our appearance with that of the young men who eat the royal food, and treat your servants in accordance with what you see.[12]

The king's servant agrees to this. At the end of the experiment, he notes that the four men "looked healthier and better nourished". As a result, the diet for all of the participants in the training programme is changed, whether they are Jews or not.

Not only is this clearly science, it is strikingly modern. Many current food-related schemes take this exact approach in their advertising. Many of today's diets or products urge comparison against the alternatives. Daniel – an Old Testament character – intertwined recognizably well-founded scientific methodology with his faith. And, as we shall now discover, he is not alone.

1150 BC – God the Laboratory Technician

Long before the Babylonians successfully conquered the Jews, plenty of other groups had given it a pretty good go. The Midianites and Amalekites were two who had cracks at it, employing nasty strategies such as the systematic destruction of any newly planted crops. As the beleaguered Jewish nation reached desperation point, a young Israelite had a visit from God himself, telling him to take up arms and fight off these oppressors. This man – Gideon – had his doubts. Was this "messenger" really God? Was his message to be trusted? Donning his white lab coat (metaphorically), Gideon devised an experiment to find out:

> "If you are truly going to use me to rescue Israel as you promised, prove it to me in this way. I will put a wool fleece on the threshing floor tonight. If the fleece is wet with dew in the morning but the ground is dry, then I will know that you are going to help me rescue Israel as you promised." And that is just what happened. When Gideon got up early the next morning, he squeezed the fleece and wrung out a whole bowlful of water.[13]

Not content with this result, Gideon designed a follow-up:

> "Let me use the fleece for one more test. This time let the fleece remain dry while the ground around it is wet with dew." So that night God did as Gideon asked. The fleece was dry in the morning, but the ground was covered with dew.

Isn't this just a typical myth from early humanity about an imaginary God and preposterous miracles? Isn't it as far removed from scientific rigour and modern insight as it is possible to be? The existence of God, miracles, or even Gideon himself, however, is entirely beside the point – all we are asking (for now) is this: is it science?

It would appear so, for Gideon begins the process with a hypothesis. If God is *not* interacting with me, he thinks, the fleece and ground will behave the same way: both will be wet or both will be dry. Why? Because that is what normally happens. Scientists call this the "null hypothesis" – the outcome you would expect if there was no "extra" effect present. Gideon's null hypothesis is based on his own observations of the world – of the ordinary behaviour of dew.

After the experiment Gideon analyses the results, finding that there is far more water in the fleece than the null hypothesis predicted.

Like all good scientists should, Gideon then runs a repeat. This time, he allows for the possibility that some unknown but entirely natural process might have made the fleece wet, so he reverses his demand. By doing this, Gideon is ruling out other factors from influencing his results, something all professionals seek to do in the laboratory. Once again, his (new and improved) criteria are met by God. Conceding that the most likely explanation for all this is a divine rather than purely naturalistic one, he forms a conclusion and acts accordingly: "So Gideon and his army got up early and went."

Let us repeat the important point that readers do not need to believe this story (although many, including scientists, do) to see science in it. The Gideon account meets the standards of our definition – in fact, with its null hypothesis, its repeats, and its refinements, it could even be argued to go somewhat beyond them.

Some Bonus Extras

The Old Testament talks scientifically in other places. Sometimes this is in the creation accounts of Psalms, sometimes in the descriptions of metallurgy or of construction, and sometimes in the agricultural pictures given by the Prophets. An example of the latter can be found in Isaiah:

> Caraway is not threshed with a sledge,
> nor is a cartwheel rolled over cumin;
> Caraway is beaten out with a rod,
> and cumin with a stick.
> Grain must be ground to make bread;
> so one does not go on threshing it for ever.[14]

At first, the connection with science is not obvious, but we must remember that agricultural knowledge like this is accumulated through observation, theory, and experiment. Any objection that the process is really only simple trial-and-error can be met with an important counter-argument: much of modern science is trial-and-error, as we shall see. Isaiah's words also remind us that there is a productive relationship to be had between humanity and nature – one that has to be worked at, but can yield much good when pursued properly.

Our last stop on our time-travel adventure is one the oldest books of the Bible – Job. An ancient and poetic story, it centres on Job – a

chimpanzees are *very nearly human*. After all, 99 per cent is pretty much the whole game, isn't it? We are in the same great-ape club, we have the same basic body plans, chimpanzees use tools, and so on. This is all such old news that it can be sounded out over the tour speaker without anyone on board so much as batting an eyelid.

With a little more thought, though, some questions emerge. Does our DNA crossover with any given animal really tell us the "humanness" of it? Is humanness more than just biological information? The fact that human beings were on a man-made diesel boat, touring a man-made island, listening to a man-made broadcast would suggest that, in reality, the gap between the chimps and them might be far more than just 1 per cent. But how so?

Rather than asking what we have in common with other creatures we will, in this chapter, consider what is different about being human. This is by no means an attempt to detract from the wonder of the flora and fauna we share this planet with; we will discover reasons to treasure and care for them later in this book. For now, the question that will occupy us is this: what is it that makes human beings stand out? Three winding threads of human curiosity and ingenuity will lead us into this chapter. The rather unlikely trio of moth larvae, schoolbook geometry, and pomegranates will guide us through some of the key mathematical and scientific revolutions that have shaped our world, leading ultimately to the finest technological achievement of them all.

Like threads on the visible reverse of a half-made tapestry, the picture they make might at first seem rather tangled. At times, we will jump from one part of it to another, leaving some threads loose and hanging as we do. At the end of the journey, though, we should be able to step back and view the whole image clearly.

Once there, we can look again at the biblical account of Job, and at the possibility that it is *God* who made us different – that *he* has placed within us the enquiring and creative spirit that brings so much wonderful scientific success.

You're not Going Out Wearing That!

Sometime in China between 4000 BC and 3500 BC, someone decided to take the cocoon of a moth larva, warm and soften it in water, and unravel it into a single, almost invisible thread. This person (or a successor in the craft) then twisted this thread around itself again and again until the fibre was strong enough to make garments out of. The

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20. Colossians 1:15–17.
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22. Matthew 9:4.
23. Matthew 9:28.
24. Matthew 14:31.
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4. 1 Corinthians 13:4–8.
5. 1 John 3:16, 17.
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20. Louis E. Van Norman, *Poland: The Knight Among Nations* (Fleming H. Revell, 1907), p. 290.

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3. John 17:20–25.
4. Genesis 2:15.
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6. Genesis 1:31.
7. Francis Schaeffer, *Genesis in Space and Time* (InterVarsity Press, 1972), p. 98.
8. Schaeffer, *Genesis in Space and Time*, p. 100.
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