Denis Alexander talks to Francis Collins

On 17th March, 2008, the Faraday Institute Director interviewed Dr. Francis Collins on behalf of the magazine *Third Way*. The interview was published in June 2008 in a shorter form and the full transcript is provided below.

In 1993, Dr Collins was invited to succeed James Watson as director of the National Center for Human Genome Research (since 1997, the National Human Genome Research Institute). He oversaw the Human Genome Project, which in April 2003 published an almost complete 'map' of the human genome. The publication of this interview marks the completion of Dr Collins' role as director of the NHGRI.

How did you first become interested in science?

I was raised in a home where learning was valued – my father was a drama professor, my mother a playwright and they were wonderful at inspiring that interest – but science was not really part of my experience. It became real to me at the hands of a wonderful chemistry teacher in 10th Grade,[1] who taught his students the joys of using the tools of science to discover things that you didn't already know. I really caught that fever, and I've still got it.

You embarked on a scientific career pretty early, I believe.

I did. In part because my mother had taught me at home until sixth grade, I ended up two years younger than my peer group and so I went to university at 16 and pretty much took every course in chemistry, physics and mathematics that was available at that point. I guess I was 20 years old when my first scientific paper was published, describing a mathematical approach to a quantum-mechanical problem.

I don't think you were raised as a Christian, were you?

I was not really raised in any particular spiritual worldview. My parents did not denigrate faith, but nor did they consider it particularly important or relevant. It was not something we talked about at the dinner table, nor did I see in my parents any leanings in that direction, although ultimately my father did become a believer.

I was sent to the local Episcopal church, which had a wonderful choirmaster and organist, but my father made it pretty clear that I need not pay attention to the sermons: 'You should be there for one reason, and that is to learn the joys of harmony.'

That was another great gift given to me by my parents, an appreciation for music.

I hear that you still occasionally pick up a guitar and lead a scientific conference in a few songs about the genome?

I'm afraid that's correct – it's one of my little personal indulgences, I guess. There's nothing like music, especially if there is humour in it, to get people to relax.

Did you drift into atheism, then?

I guess I would have called myself an agnostic if I had known the word. When I got to university, there were – for the first time in my experience – these conversations in the dorm about what people believed and whether God existed or not, and there were some strong atheists on my particular dorm who were, I thought, rather effective in their arguments. I decided that I was more in sync with their persuasions than with some of those who tried to argue the truth of their particular faith tradition.

After I got my degree, I decided I would do a PhD in physical chemistry and went to Yale to pursue that; and my life there was all second-order differential equations and quantum mechanics and I got more and more into a deterministic mindset. It seemed quite natural then to assume that there really wasn't anything outside of physics, chemistry and mathematics, and therefore I slipped into a much more atheistic worldview.

I think I left the door slightly open to the idea there might be something outside of what science could teach you – but only slightly. For the most part I was pretty [un]interested in any conversations of that sort and those who started them would encounter a raised eyebrow from me and a suggestion that they were kind of living in past superstitions that they would do better to get past.

Why did you then decide to change direction and go into medicine?

It was a pretty major development, because I had not previously had much leanings towards biology or medicine at all. I took a course in biology in high school that I found quite boring. Then I decided I should broaden my horizons a little in graduate school and I took a course on biochemistry and molecular biology and I realised that I had missed out on some pretty profound things that were happening in the field. Life made sense at the scientific level – the idea that there was this information molecule, called 'DNA', and that that could be the way in which all living forms directed their material processes was truly exciting. Also, I got the sense that this field was breaking wide open and there were going to be consequences for humans in terms of our ability to understand and perhaps treat disease.

And so medicine began to emerge in my mind as an alternative and very attractive career. It's not that I was disappointed or disillusioned with physical chemistry, but medicine seemed ever more to be beckoning to me. It was a radical change – I was already married and had a child and I was already getting into some debt – but, you know, with all of the impetuousness of youth I figured, 'Oh, I can do this!' It seemed like a very exciting way to combine what I loved, which was science and research, with an approach to humanity that increasingly seemed important to me.

Did studying biology incline you more towards atheism – or towards faith?

In the first two years of medical school, which is mostly spent in the classroom, I pretty much sustained my atheistic worldview. I was aware there were believers in my class, and some of them would even try to talk to me about their faith, but I wanted nothing to do with that.

But that changed in my third year at medical school. I was spending afternoons and oftentimes all night long on the hospital wards trying to care for people with very significant illnesses and that made all these questions of life and death much more real. This was no longer reading in a textbook about some molecular process: this was talking to Edna Jones or Harold Smith about their particular diseases, which often were threatening to end their lives. And that was a real eye-opening experience. It was

a growing-up to the realisation that life is short and precious and people are facing terrible challenges every day.

And I was impressed by how many of these people relied on their faith as a rock of support. They talked quite openly about the fact that it brought them a sense of peace and they were not afraid of what was coming – and I imagined myself in their position and thought I would probably be afraid, and maybe even angry. The peace they displayed was impressive and difficult to understand, and that got me a bit curious about this thing called 'faith'. I assumed it was a psychological crutch, but it clearly was a powerful one.

How did curiosity lead to Christianity?

Eventually, one afternoon, one of my patients, a woman with really advanced heart disease, told me about her faith in a very personal way and after she had done so, she looked me straight in the eye and said, 'You know, I've explained to you about my faith and you haven't said anything. What do *you* believe, Doctor?'

Nobody had ever asked me that question so directly, in such a generous, open spirit, and I found myself suddenly intensely uncomfortable. I didn't know how to answer. I stammered something like 'I don't really know' and left the room, feeling very disquieted – and wondering why.

I realised after a bit what the problem was. Her simple question had caused me to admit at some level that I didn't really have a good answer that was based on a consideration of the evidence. I was rather proud of the fact that as a scientist I wouldn't draw a conclusion until I'd looked at the data and tried to draw the best conclusion I could, and I realised that outside of a few little babblings here and there I'd never really tried to understand what was the foundation upon which believers rest their faith. Clearly there must be something there – by that time, I knew people who seemed pretty substantive, including some of my professors, who said that their faith was an important rock for them, and they didn't seem to be crazy or the sort of people that would stick to something just because they'd been told it in childhood. So, there must be something there, and I was aware that I had intentionally avoided pursuing it. Suddenly it was apparent to me that I had exercised what [CS] Lewis would call 'wilful blindness' – and that didn't seem like a good thing. Surrounded as I was on a daily basis by life and death, was it actually defensible to go on another year without considering this most important question: Is there a God?

So, I determined I'd better do something about that. I expected, of course, that I would survey the evidence and find there wasn't much there and that my atheism would be strengthened; but at least I would not feel uncomfortable the next time somebody asked me, 'What do you believe?'

And so began a two-year effort to try to understand what the world religions have to say, and what God must be like if God exists. And ultimately that resulted – to my great surprise, and with a good deal of resistance on my part – in my becoming a Christian at age 27.

What kind of research did you do?

Well, it was not a particularly well-designed search strategy. I started by looking at some of the documents that world religions used as their foundation, including the Bible, and I found it very frustrating and confusing. I had no idea mostly what I was reading.

I did know that down the street from me lived a Methodist minister who seemed like a reasonable fellow, and so I went and asked him a bunch of probably blasphemous questions. He gave me *Mere Christianity*[2] to read, and in the first hour or two reading it I realised that my arguments against faith were really those of a schoolboy and that there was much more substance here than I had ever dreamed. It was uncanny how Lewis addressed my objections to faith one after another. It was as though this Oxford scholar was inside my head. And I guess I began to realise, 'Gosh, this is territory that others have travelled and there's a lot here that I had never been aware of that is actually pretty compelling.'

It probably took me three or four months to get all the way through that little book because it was so unsettling to see the foundations of my atheistic worldview falling apart page by page and leaving me in a position of potentially having to accept the idea of God's existence.

A lot of people – Richard Dawkins springs to mind – think that faith involves a leap in the dark.

Well, I assumed that faith was the opposite of reason and that there would be no evidence to undergird it – it would have to be a blind leap in the absence of evidence, or in spite of it. It surprised me when I found the definition of faith in Hebrews 11:1: 'Faith is the substance of things hoped for, the evidence of things not seen.' It was astounding for me to realise that word 'evidence' was in the very definition of faith.

What I began to realise is that faith and reason are, in fact, linked together, but faith has the additional element of revelation. At the same time, I began to appreciate that there were pointers to God's existence in the study of nature, some of which I had spent time on without really thinking about it, and that was actually fairly compelling.

Now, don't get me wrong: you cannot *prove* God's existence, but you can get to the point – and I did – of concluding, based on the evidence, that God's existence is a lot more plausible than the denial of God's existence. And that was a great surprise to me.

Based on what sort of evidence?

Things like the Big Bang, like the fact that mathematics actually works to describe the universe (suggesting a designer who's a mathematician), things like the fine-tuning of the universe – and, particularly for me, Lewis's argument about the moral law, a distinct characteristic of humanity that defies an easy explanation from evolution.

All of those brought me to the precipice, but then I really had to learn what the world's religions had to say about the nature of God. I figured that people who had thought about this and had revelations about this over the centuries were worth paying attention to. And it was encountering the person of Jesus, who was different than all other figures in all other religions – and who also solved the problem for me of feeling increasingly like there was an unbridgeable gulf between me and God – that led me to decide to give my life to Christ.

How did your colleagues react?

Upon hearing about that – and I was not quiet about it, I was a young Christian full of excitement, wanting to share it with everybody – my colleagues were generally supportive, albeit a bit puzzled; but a few of them, knowing that I was already on a pathway towards spending my professional career in the field of genetics, suggested that if I allowed this new faith in Jesus and an exploration of genetics and evolution to

come together, my brain was in danger of exploding. That never happened. I think that's one of the reasons I've written *The Language of God*, to try to explain why it need not happen to anybody.[3]

Some people think that the more science understands, the less need we have to believe in God. How do you react to that kind of comment?

Well, if one has used God to explain areas that currently science has no answer for, that does put you in a difficult spot when some of these areas suddenly *are* explained by natural processes. But that's not, I think, the view of many mature believers, who see God as really much too big to be boxed in like that. If you consider, as I do, that God is the Creator of everything and has a plan that goes far beyond anything our puny minds can grasp, and has used these processes, such as evolution, to achieve amazing goals without having to step in and do magical and mysterious things, then every new scientific discovery becomes not a threat to God's omnipotence but an opportunity to appreciate and be in great awe of the nature of that creation.

That's very much how I feel. The opportunity to do science as a believer is an opportunity to peek into God's mind, and science therefore becomes not just a purely naturalistic exercise but an opportunity for worship.

Have you found any particular models of the relationship between science and religion to be especially helpful?

Obviously an area that many people see as a battleground between science and faith is the whole question of how it is that this model of diversity of living things on the planet came to be. The scientific evidence for evolution is now overwhelming – from the study of DNA in particular, where we have a record of what has been happening down through hundreds of millions of years. One can look at that evidence and come away with no other conclusion than that we are descended from a common ancestor.

So, I arrived, early on after becoming a believer, at a perspective that is called by many 'theistic evolution' – the notion that God, in God's awesome intention to create a universe that would support life, and most especially life in God's image that would seek out fellowship with God, used the process of evolution to achieve those goals. An amazing process, an elegant process, a process that to our minds may seem slow and even random, but for God could have been achieved essentially in the blink of an eye and in a way that wasn't random at all.

When you've put that all together, you've achieved what I had hoped to find somewhere: a harmony between science and faith that is completely satisfying. I cannot see any major objections to that synthesis – which is, after all, the one that most biologists who are believers have arrived at, many of them without realising that others have travelled that same path.

Evolution requires a vast amount of both suffering and wastage. Ninety-nine per cent of all the species that have ever lived have died out. How do you reconcile that with the idea of a God of love?

I don't know that there's an easy answer to that. Certainly it's difficult to deny that death is part of the evolutionary process – if it was not, an ever-increasing number of creatures would enter and remain in the world, resulting in an unsustainable model of life. The ugliness of death, you could say, is in a way part of the freedom that God granted to nature. [John] Polkinghorne has argued quite compellingly, I think, that the evolutionary universe is a creation allowed to make itself, and the consequence of that

is a creation that contains both beautiful and wonderful things and some things that we are troubled by.

I think we have to keep in mind the notion that moral consciousness, which we so value in humans as a critical part of who we are, does not necessarily apply – in fact, I don't think it does apply – in other parts of the plant and animal kingdom, and (although this may sound harsh and unfeeling) that may mean that some of the acts that we perceive as being morally unacceptable when applied to humans may be not so in other parts of the natural world.

Do you think that Christians sometimes tend to pick out the beautiful bits and ignore the bits that aren't so nice?

I think that's probably true, and I think it has to be said that God's purposes are not always served by having everything be completely rosy. And that applies to our own daily experiences: if we lived in a world that lacked any evidence of suffering, including our own experience every day, would we, in fact, learn very much about who we are and who God is? Is suffering – and even death – an important part of the way the universe is put together to help us focus on the fact that we're here for a blink of an eye and that the little time we have here ought not to be spent just on 'having a good time'?

The Intelligent Design movement, especially in the United States, has focused on parts of nature that seem to be especially complex and used them to argue that there must be a Designer. What is your take on that?

I think it was an interesting development. Unfortunately, I think it's turning out not to be a positive one. It's important to note that the movement did not arise out of the scientific community: it really came from a small group of believers who were troubled that the increasing dominance of evolution in scientific discourse was spilling over into worldviews and threatening the idea that God is the Author of all.

There are some interesting ideas there that should cause anybody who figures that evolution has already solved all its problems to step back and scratch their head a bit; but ultimately their arguments have shown increasingly severe cracks. The idea that, for example, nano-machines like the bacterial flagellum (which is the poster child of Intelligent Design) could not have come about by gradual small changes supported by natural selection is not really defensible. And therefore ID falls into this unfortunate category of 'God of the gaps' – and now knowledge is advancing very rapidly and ID is in deep trouble scientifically. It's also, I think, fair to criticise ID for having no real scientific agenda of how to test its theory. It doesn't seem to get you anywhere – it's a scientific dead-end.

Unfortunately, many believers see ID as a potential way to fight off what they perceive as an onslaught of atheistic evolution and are reluctant, I think, to give it up. In the United States, there are still battles to try to teach it in schools, battles that I think ultimately will not bring credit to the church but will actually cause people to shake their heads and wonder why it is that believers can't accept such clear data. It almost seems to suggest that they are afraid that science is a threat to God – and for me, as a scientist who's a believer, that's rather hard to imagine. God gave us the great gift of the intelligence to try to understand how the universe was put together, and the idea we might discover something that would threaten [belief in] God's existence makes no sense at all.

Do you think that the aggressively atheistic agenda of evolutionists such as Richard Dawkins has actually stimulated ID, and indeed creationism?

Absolutely. Michael Ruse – who's not exactly himself likely to be a great defender of belief – famously pointed out to Dawkins and [Daniel] Dennett that their position is probably the greatest gift that the ID community has had, by creating this impression that you have to oppose evolution or the natural consequence is a harsh and rigorous atheism. So, we see, as we often do in human discourse, a polarisation of perspectives, where those who take a fairly extreme view seem to have the microphone and instead of really trying to find some way of putting these worldviews together in a harmonious fashion, we see an escalation of fundamentalism on both sides. And I think it's fair to call atheism a form of fundamentalism: it doesn't seem able to look carefully at the opposing view in a fashion that allows much discourse.

And of course there's fundamentalism in the church as well, and over the course of the last couple of decades the fundamentalists of both types have been railing at each other increasingly loudly. Most people don't really identify with those extremes, but if that's all you're hearing, it may seem as if those are the only choices. And that, I think, is one of the great tragedies of the current era, that it has been polarised in such a way. And many people are wondering whether it's possible to actually sustain both worldviews or whether one has to win and the other has to lose.

You took over from Jim Watson as head of the Human Genome Project and this has involved heading up one of the major scientific projects – some would say, *the* major project – of the 20th century to generate this complete human genome sequence. Did you jump at the challenge?

I resisted it at first. I was very happy at the University of Michigan, running a research lab, taking care of patients and teaching medical students. But the idea of leading this unique project, which was only going to happen once in all of human history, ultimately became irresistible. I took it on at a very early stage, when a lot of the scientific community was opposed to the effort and there was great scepticism about whether it could ever succeed. There were some pretty white-knuckle views there in the early parts of this effort, trying to develop the technology (which hadn't really been invented yet) to make it possible to live up to this promise of reading out all three billion letters of the human DNA instruction book within 15 years.

But it was exhilarating, too. It was one of the more interdisciplinary kinds of science that had ever happened in biology, because it needed automation experts and chemists and physicists and bioethicists as well as physicians and biologists – everybody had to get together on this. And it was a wonderful experience in the sociology of science in that this could only succeed by an international effort where all of the participants basically agreed to put their shoulders to the same wheel.

And there were opportunities to really change the way in which this kind of science was done, not least by making the decision to give the data away, which we did early in the project in a fashion that was truly unprecedented, not even waiting for publication but basically saying, 'This is a common inheritance of the whole world's humanity and we should not be sitting on it for even 24 hours. All of this should be immediately posted in a place where anybody with an internet connection can start working with it.'

And that was a pretty drastic change, and one that has now really spread through many areas of biomedical research that previously were much more closed in terms of data access.

I believe you have some pretty strong views about patenting genes.

Well, indeed. I don't know that it is a moral issue, although some people try to make it so. I think it is really a practical, legal issue of what you can do with a discovery that is going to most benefit the public. That's the point. In fact, patents were invented to try to increase public benefit by providing an incentive for people who had discovered or invented something to turn that into a useful product and then to have confidence that their product would, at least for a time, not be unfairly competed with. But the gold rush that went on in the 1990s to try to patent genes didn't really fit that ethic. Basically, people were grabbing any old piece of DNA and saying, 'That one's mine' without any clear idea of what it did or how it might turn into a useful product – and as a result those patents became more disincentives for further research than incentives, turning the whole thing on its head.

Unfortunately, we have not really recovered from that. There is a thicket of intellectual-property constraints, probably involving as much as 30 per cent of the human genes, which can be quite a problem, at least for some applications like development of diagnostics and therapeutics in the private sector.

The media sometimes call this sort of science 'playing God', and some people – perhaps especially Christians – fear that we are guilty of hubris. What do you say to that as a Christian?

Well, I do think that hubris is always the risk for us humans – we've been over the centuries pretty reliably capable of demonstrating that kind of arrogance and I'm sure there are good opportunities to do that here as well. But as a physician I have to say that the idea that we would slow down the study of genetics and DNA doesn't appeal to me neither, because I deal every day with people whose lives are devastated by illnesses that we could potentially understand and prevent [or] treat if we moved this research forward quickly. We can already see the fruits of that in some instances, particularly in cancer, where a lot of new developments are based very exactly on an understanding of the genome, which is giving us insights into ways to cure this disease that are truly exciting.

But with that comes a responsibility to determine what the boundaries ought to be for applications of this new-found knowledge. One of the things I'm proudest of with the Human Genome Project was the decision early on to invest a substantial fraction of the budget into studying the ethical, legal and social implications of this research. That had never really been done before – scientific revolutions in the past had sort of happened and then one day somebody would say, 'Wait a minute! Why didn't we think about the negative implications this might have?'

But a lot of the negative implications or applications of genomics that people worry about are not that scientifically reasonable. People talk about whether we're going to use these discoveries not just to cure disease but to improve ourselves and make ourselves better than God intended. Most of these scenarios are not all that well grounded, because they assume that genes are deterministic in a way that they really aren't. If you wanted to come up with a designer baby scenario to optimise things like athletic ability or musical talent or intelligence, you would be pretty disappointed, in that all of those things are so heavily influenced by non-genetic factors such as good parenting and education.

What are the positive applications you are most enthusiastic about?

Well, it has been a glorious year, building on the success of the Human Genome Project, which completed all of its goals in 2003. We now have the tools to go in and search through those three billion letters of the human genome and find the rare glitches that play a role in risk of heart disease and diabetes and cancer and high blood pressure and mental illness and a very long list of conditions that had previously been poorly understood and therefore poorly managed. In the last 12 to 18 months there have been a hundred of these discoveries made, which point in a very surprising and interesting way towards pathways that apparently are involved in these diseases that we've never previously suspected. Our understanding of most common diseases is undergoing a complete revolution as a result.

The clinical applications will not come overnight but they will come, and these revelations will put us in a position to practise prevention in a much more effective, individualised way if we can identify for each person what their most significant risks of illness are and help them to focus on lifestyle and diet and medical surveillance, to focus on staying well.

In the longer term – maybe 10 or 15 years if we stick to our guns and don't short-change this effort – these same discoveries will lead us to treatments for disease that are much more precisely targeted to the fundamental molecular problem instead of treating some secondary effect that ultimately doesn't provide all that much benefit. As a physician, I can tell you it's fairly rare to be able to treat a disease and be absolutely sure that the treatment you're offering is optimal, and genetics and the study of the genome give us a new window into developing those treatments in a way that is likely to be much more effective and less toxic. I'm enormously excited about that.

I think some people are really worried that our growing knowledge about human genes will encourage more active eugenics programmes, so that people who have particularly risky genetic profiles will be eliminated before they get a chance to live. How do you address that kind of concern?

Well, that is a concern, and particularly the increasingly widespread application of pre-implantation genetic diagnosis or PGD, which allows a couple using in-vitro fertilisation to choose which ones to reimplant. This procedure was initially used for rare, very severe early-onset lethal childhood conditions like Tay-Sachs disease, but increasingly is being considered for use in other situations where the threat is not nearly so great – and even, in some circumstances, for sex selection, which is certainly a troubling development in that we would all agree that gender is not a disease.

Whether this will become useful in the context of common diseases like diabetes or heart disease … In some instances people might think so, but actually it would be quite difficult, because a disease like diabetes (for instance) is mediated by 12 or 20 different genes, each of which has a small effect. The chance with any given set of five or six embryos of optimising for all of those is statistically extremely remote, and so, while this might be something that will continue to find its place in single-gene disorders, where there is a high likelihood that one particular measurement is going to make a very strong prediction about the outcome, it's going to be pretty lousy for applications to things that people more commonly are worried about in their own families. So, I'm less concerned about that broadening of application, just because the science won't really make it very feasible.

Some people are worried that genetic research might be used to fuel racism. There is, after all, a bad history of the use of genetics in racism.

There is a bad history, that's absolutely true, and the last thing one would want would be for this science to provide ammunition for prejudice – which is a part of human nature, although it's one of the uglier parts, to be sure. We currently have a project just getting underway to determine the DNA sequence of a thousand people from 12 different populations around the world. The motivation is a benevolent one, to try to understand why it is that some diseases occur more frequently in some groups than others – for instance, in some Native American tribes more than half the adults have diabetes, and you feel some urgency to try to sort that out. But of course there is a risk that people may use that information in other ways. When the data is there, people will try to twist it.

I think that this science is actually a strong antidote for prejudice, though, in that we learn just how similar we all are at the genetic level – more than 99 per cent of each person's DNA is identical to any other person, and that is true regardless of where you look in the world. We are all one family, descended from a common set of quite recent ancestors. Our science shows us just how similar we are, more similar to each other than most other species on this planet could claim to be. And we need to keep saying that.

What difference does it make to you as a scientist that you are a Christian?

Well, I'm a believer in the notion that the moral law, the knowledge of right and wrong, is a free gift to all of humanity, and it is in fact the case that when we get into some of these ethical dilemmas believers and non-believers often come to similar conclusions. I believe that's because we have all been given this remarkable knowledge of right and wrong – which I cannot completely explain on naturalistic grounds – and a desire to do the right thing. But, for me as a believer, all of that has a foundation that it would not have if I were an atheist, and I find that quite reassuring.

I think it has been a great gift to have the chance as a scientist to see God's hand at work in the things we're discovering. And one of the things that I've found most gratifying, especially since the publication of *The Language of God*, has been the chance to talk to others who are struggling with how to put this together, particularly young people, seeking answers to the question of whether God exists or not. I've recently spoken on the topic of science and faith at Stanford University and some 2,300 students turned up to discuss it. At Berkeley the night before, there were 1,600; at MIT a few months earlier, there were 1,500 students. This is clearly an issue that is coming to the forefront, particularly on university campuses, and I think that's wonderful.

Maybe the ferment about whether science and faith can be compatible – and maybe it *is* being whipped up by the voices at the extremes – will ultimately lead to a good thing, as people think about these issues instead of setting them aside.

Notes

1 In British terms, Year 11 or S5

2 First published in 1952

3 *The Language of God: A scientist presents evidence for belief* (Simon & Schuster, 2006)