DENIS NOBLE FULL INTERVIEW TRANSCRIPT

REDUCTIONISM IN BIOLOGY

David: Can you tell me what reductionism is?

DN: I think reductionism is the idea that from the molecular level you could reconstruct every that, in principle, at the molecular level, everything is there that is needed in order to know h body works, and that cannot be true.

David: But reductionism is very powerful though, isn't it? You're not saying, 'Reductionism, w shouldn't use it'?

DN: Of course it's been hugely successful. It was fantastic, and actually it's given us huge in I'm not an anti-reductionist. I just think that you've got to recognise that there is an integrativ occurring in living organisms, and those functional properties, the meaningfulness, if you like function, because, after all, the rhythm of the heart has meaning; that emerges, and you can from that.

David: Then why are people so wedded to it? Reductionism?

Ard: That's a good question.

David: I mean, you both mix with scientists all the time. Why are they so…?

Ard: Because it is a powerful thing. The fact is you can…

DN: The power is great, yes.

Ard: The power is great. You can take something, break it in to parts, and you can really und For example, you figure out the molecular structure of DNA and suddenly you understand ho types of genetic information are encoded in a digital form.

DN: Yes.

Ard: I think that's an experience that when you have it, it's very natural to think, well, that is s powerful, it must the way of explaining everything. This powerful method is a method we're g use, and we're going to apply it universally.

David: And only that method. That's…

Ard: But I think Denis's point is to say, 'Well, if you just use only that method, then you're mis something.'

DN: That's right, exactly.

Ard: It's not the same as saying that method is wrong, just that the method is not the only me

DN: Exactly so, and where it goes wrong can be illustrated, because what Crick did after tha discovery was to immediately go out to one of the taverns in Cambridge, where he would dri his friends, and he announced in the tavern, 'I have found the secret of life!'

Wow! He had not found the secret of life, because if I take the DNA out of a cell and I put it i dish with as many nutrients as you like, I can keep it for 10,000 years: it'll do absolutely noth can't be the secret of life.

Ard: Right, yes, so this gets to the whole argument about, are genes the recipe for life?

DN: Yes, it does, and the problem with this is that… Recipe is not bad, I mean, it's written do recipe, just like a music score is written down as a music score, but the recipe is not the dish

David: And the score isn't the music.

DN: And the score is not the music. Precisely. And so it's the mistake of thinking that becaus written down, it must be the thing itself.

Ard: Exactly. I think that's a great way of explaining it: it's confusing the recipe with the dish.

DN: With the dish.

Ard: And they're thinking, once you understand the recipe, then you're done.

DN: Exactly so.

And one of my big problems with the reductionists is not so much that their method has not b extremely powerful. It has been superbly powerful. It is the hubris: the certainty that that's all

3:27 - EMERGENT PROPERTIES IN BIOLOGY

David: Can I ask you to define…? Tell me what emergence is and how it's different from the

reductionist programme.

DN: I think that what emerges is functionality. Now that's a difficult one, I know, but you see, remember, I am a physiologist, so what does a physiologist ask as his main question? It is, 'W the function of the heart? What is the function of the liver? What is the function of the leg?' A cannot answer that question if you say, 'It's just a bunch of molecules interacting.' You've got address, therefore, the question: what is its purpose?

David: What's it for?

DN: What's it for? I can't avoid that. Now, I know that people who see all of this from a purely molecular point of view will say, 'But it's just blind chance that has produced all of this, therefo is no function.' But that's to make the mistake of thinking that because the components don't function individually, that therefore the system doesn't have a function.

David: So is emergence concentrating on the system level?

DN: Yes.

David: And saying what about the system, though?

DN: Saying that it serves a purpose because that function has emerged. Now, it might have originally from random action. I don't deny the possibility that life has arisen by purely random chemical reactions initially. I don't know the answer to that. It's a question, and it may be right once you have got a system that constrains the parts, it takes over.

David: The system takes over?

DN: Yes, the system takes over, because you've got… well, in technical terms, you've got wh mathematicians would call an attractor: you've got something that constrains the component were, always go to a particular state.

Ard: What you're saying is if you have an oscillator, like in your heart, and you drill down to th molecular level and you see a protein moving back and forth, and you say, 'Why is that protei moving back and forth?', well, there's no molecular reason for it to move back and forth. The is this collective system level that's channelling information downwards into the cell and not u

DN: Exactly so. And those proteins are proteins that open and close.

Ard: Okay.

DN: And the opening and the closing is controlled by the cell property.

David: So the components build something, but once they've built that something…

DN: It takes over.

David: …that something then has an effect on the components that built it from then on?

DN: Exactly so, yes.

Ard: And so if you ignore the fact that the top-level description is acting on the lower-level…

David: Then you're missing...

Ard: Then you're missing the point.

Ard: So you were a physiologist, and you had what people thought were hare-brained ideas trying to use a computer to calculate the heart, and they didn't let you in. Is that right?

DN: That's correct, and for a very interesting reason: they were thinking totally in reductionis

DN: The question put to me was, 'Where in your equations is the oscillator?' They couldn't th see that the oscillator was going to emerge from the interactions, and if you separated those components of the model out, they wouldn't oscillate. So it's simple. They didn't understand

Ard: So is the story that they let you in only in the morning, or something?

DN: Yes. You remember in those days you had one computer in the whole of London. You ha queue up to use it. So it was running 24 hours a day. I was given between two o'clock and fo o'clock, am.

David: That's slightly unfriendly, isn't it?

DN: Well I was thought to be the person who was least likely to produce a successful compu Six months later I got a paper in *Nature*.

David: But at the time you yourself were a reductionist like everybody else?

DN: Yes, absolutely. That means I couldn't explain to them what I've just said to you. I should said, 'It will emerge from the equations.' Instead, I got a pencil out and scribbled on a bit of p the way that physiologists sometimes do, 'I think this will interact with that, which will interact

that, and, hopefully, something may come out of this that helps me.' But I didn't have the lan those days to say to them, 'This will be an emergent property.'

So I wasn't able to reply to these computer experts that the phenomenon of rhythm would er from the equations representing the proteins in the cell. If I'd done that, I might have got suc more quickly.

David: I think they'd have thrown you out.

DN: Precisely! I think they'd say, 'What on earth is this about?' But I wouldn't even have bee formulate it like that, and yet it is a downward process of causation in which the properties o constrain those proteins to behave differently from what they would do if they were in a Petri

David: I had imagined that when we talked about levels of emergence, that it was just, sort o and then, maybe, thought. Are those levels of emergence, or are you saying there are lots m

DN: Yes, I think they are, but I also think that we have to add many more. Just think of any c body. That kind of cell probably took at least a billion years to emerge, because it is unbeliev complicated. It's made of many different organisms coming together. There's been a proces we call symbiogenesis. Your mitochondria in those cells, which are the energy factories, thos originally bacteria.

David: But each of those levels… Do they then bring a whole new set of rules that come with level?

DN: Yes.

David: Which are rules which weren't there before?

DN: Exactly so. Because that bacterium is no longer free. It's no longer free in the sense tha constrained by the system of which it has become part, and, therefore, it's no longer a bacte

David: Right. So is natural selection an emergent rule?

DN: I think that evolution has evolved. I mean, the process of evolution has evolved and the been many mechanisms at different stages.

David: It makes this link, then, between emergence and the whole discussion about whether have genuine novelty in the world, in the universe.

DN: Yes.

David: Or whether the universe came into being with its rules and that's it. Now we're just wo the consequences.

DN: Yes.

David: You are saying, if I've understood you, because of emergence that, creation is a more thing?

DN: Precisely, yes.

Ard: And new rules are being created…

DN: …as we go along. Once a system has emerged that constrains the components, it is se maintaining.

David: Self-maintaining, right. I think you're saying more than that. It's self-maintaining but th generate new emergence?

DN: Exactly so. Yes, yes.

But to people who say, you know, 'How could all that happen?', part of my answer would be, all, it had a long time in which it could happen. And second, the idea that it happened entirel chance is the wrong way to describe it.

Blind chance might well have been something at the beginning, I don't know. Frankly, I've no what happened at the very beginning. I don't think anybody else does either. But once you h emergence of a property that constrains the rest of the parts, you have the potential for furth novelty.

For example, one of those cells can interact with another cell. One can eat the other, or the o round, or they can come together to combine. Those are new things that couldn't have happ before the emergence of the cell in the first place. So, yes, each stage creates the potential f properties.

David: So when you get life emerging out of chemistry, you have something genuinely new a brings with it its own new rules?

DN: Yes, exactly.

David: So if you knew everything about chemistry, would you be able to predict everything al

DN: I think the best way to put that answer is actually to refer to chemistry itself. Let's take th molecule. It's got oxygen; it's got two hydrogens, and we know the properties of oxygen and hydrogens. From that alone you'd find it very difficult to predict the properties of water.

Now, the theoretical chemist will reply to that and say, 'I know enough about quantum mecha know enough about the movement of electrons around atoms, that I can show how, when yo produce the interaction between oxygen and the two hydrogens, I get the properties of wate even think in terms of computing that entirely from quantum mechanical descriptions.'

My reply to the theoretical chemist was to say, 'But you've already introduced the interaction saying that you will compute what happens when those two hydrogens and oxygens come to Because although you're saying that from your quantum mechanical equations, you can, in p calculate the behaviour and the emergence of water, what you're failing to understand is it's because you have introduced those constraining factors, which are the relationships of thing together.

David: But did you realise how big an idea, or as fertile an idea it has been in your life? Beca has been a major… I mean, in some sense it set the course of your life.

DN: It set the course.

David: When did you realise that that was the power of the idea?

DN: I think these kinds of realisations take 20, 30, 40 years, because it upsets everything. Ev I came to write the little book, *The Music of Life*, nearly ten years ago, I wasn't there yet, and process is continuing. But there was still a process to occur which enabled me to start answe questions: where does the meaning come here? Because life is a meaningful process, it has You have to address that question. I don't think there's any way of avoiding it.

14:10 - CONSCIOUSNESS IS NOT A THING.

Ard: There's a famous quote by Francis Crick I think in his book, *The Astonishing Hypothesis* he says essentially, you – your joys, your sorrows, your free will, your memories – are nothin collective motions of neurons and molecules.

DN: Yes, yes.

Ard: What's your response to that kind of statement?

DN: Well, first of all, it's sort of a mixture of humour and sadness. If he really thinks that, I'm

If it's play, then maybe it's humour. I think Crick did both, actually. I think he really believed w was saying, and I think he was also partly joking. People do that to provoke.

Ard: And if you'd never thought, or questioned it? If you were to take your brain, for example freeze it in a vat and then, with future…

DN: When they can resurrect me, yes!

Ard: At some point in the future when science has progressed, we can, you know, thaw it ag resurrect you…

DN: Yes.

David: I thought it was only Californians who did that!

Ard: It's a thought experiment.

DN: They're doing it already. There are frozen brains, yes.

Ard: So if you froze your brain and then later thawed it and resurrected you, would that still b

DN: No.

Ard: No?

DN: Quite definitely not. No.

Ard: And why not?

DN: Well, the mistake is to think that there's some physical thing here that is the seat of my consciousness: that my consciousness is somehow a process that's occurring only inside he

First of all, that can't be right because my consciousness and my interaction – I'm talking ab awareness and so on, not just about whether I'm awake – that depends on interactions with everybody else. So it cannot be the case that it's only situated here. And it cannot be the cas another reason too.

It is not a thing: consciousness is a process.

David: Process, yeah.

DN: And I think the big problem with this approach – and it's a big problem with the reductio

approach in general – is that it is mistaking processes for things.

David: Yes. I mean, isn't reductionism essentially a commitment to say everything will be exp a thing?

DN: Yes.

David: Things are made of smaller things, which are made of smaller things, and once we ur the things, then we understand everything. As you say, it pretends that processes don't happ

DN: Exactly so. And one can prove that very simply. At the point when I die, my molecules w essentially, still there. My consciousness will not. Simple.

David: There's another lovely example from your book… I know we keep asking you to reha book, but when you were talking about reductionism, you used the example of pointing.

DN: Yes, yes.

David: Would you run through that for us?

DN: Yes, well, David, can you point now?

David: Yeah, okay.

DN: Thank you. You put the arm back and I put a set of electrodes here. And imagine also th such a good physiologist that I know exactly how to excite your brain to make you point. I tel what will happen is, you'll do that.

David: Right. So you flick a switch and I go [points arm]…

DN: Yes, that's right. However, you would then say, 'Denis, this is different. I didn't point. Sor made me point.' That means that the motion of doing that pointing isn't the explanation for m intention to point.

David: Yes, everything in my body would have happened the same way.

DN: Exactly so.

David: But I didn't have anything to do with it.

Ard: But you weren't really pointing, you were…

David: Well, I didn't think, 'I'll point at him'. So you're saying that there's this thing called inte

DN: Yes.

David: Which isn't a thing?

DN: Well, a process which isn't a thing: it's a process.

David: I can't find intention.

DN: You can't find it in here because it isn't a thing. Exactly so.

Ard: It's a process.

DN: Yes, it's a process. Once you've got that explanation, you don't need trillions of recordin nerve cells to ask the question, 'Why did Denis Noble point?'

David: You pointed because you had an intention.

DN: Precisely. And an intention is part of those processes that are processes that are interpe that are therefore, in a sense, jumping outside my body, and I don't mean that in a ghostly se obviously.

Ard: But to understand them, if you localise them in your brain, you've misunderstood.

DN: Exactly so, which is why if you just freeze it and a hundred years later you bring it out of freezer, you won't have the same person.

David: It does sound, doesn't it, that you're committed to the idea that ideas are real in some and have this ability to make things happen?

DN: Absolutely.

David: What you call causation.

DN: And the way that happens is what I would call contextual logic.

Ard/David: Okay.

DN: Because what I'm doing at the moment, in interacting with you, is that everything I say is dependent on what you say, which is dependent on what I say, which is… and so it goes on, cannot be outside that process.

19:05 - THE MATHEMATICAL BODY

David: We've been talking about the notion that some ideas are just there, like mathematics idea.

DN: Ah, that's very interesting, mathematics. Where is that?

David: Yes, thank you. Precisely!

DN: Where is it?

Ard: I just think, 'Where is it?' is the wrong question.

DN: Exactly. It's the wrong question.

David: The wrong metaphor?

DN: The where question is the wrong question.

David: Okay.

DN: There is a sense in which it exists, because mathematicians discover, they don't invent.

David: Discover?

Ard: We sense very deep in our bones that we discover. We were talking about Paul Dirac e used mathematics to look at the electron, and what happens if the electron goes fast, and fr mathematics came anti-matter: that's something that you discover, it's not something that yo

DN: Exactly so.

David: But then this notion of discovering makes me think, in my metaphorical misery over h you discovered this realm of ideas. Where are these ideas?

DN: Okay. Realm is okay, provided we don't think it is a where.

David: No, okay.

DN: I cannot go to the realm where ideas are.

David: Okay. But exist in what way then? Because conkers exist as conkers and plants exist plants, in a reductionistic, material world.

DN: But the square root of minus one does not exist.

David: Yes! How does that exist?

DN: Now, you see, that's a lovely example, because go back to my rhythm in the heart: if you describe that, interestingly enough, one of the ways of describing that is to use in your mathe the square root of minus one. Now the square root of minus one clearly does not exist, but th has a fantastic utility in mathematics. So I think you've got to see those ideas as tools.

Ard: Yeah, it's a nice example. Because the square root of minus one…

David: It's an imaginary number.

Ard: .It's an imaginary number, and yet in oscillations it's incredibly helpful and useful.

DN: Absolutely, yes.

Ard: And, actually, it has a kind of explanatory power that allows us to peer much more deep the universe than we would have been able to without it. And yet, there it is.

David: But you can see my problem, though, can't you? How do ideas exist? Because they c in the same way that reductionists like.

DN: Indeed so. But doesn't that, as it were, induce a sense of humility?

21:35 - NATURE: A DIFFERENT BEAUTY

Ard: For a physicist like myself, beauty plays a large role in understanding the world. Paul Di famously says his fundamental belief was that the world is described in terms of beautiful eq

DN: Yes.

Ard: For a biologist, is it the same kind of beauty? Or is that beauty metaphor story only reall physics?

DN: I think it's universal, but it gets to be interestingly different in different domains of scienc seems to me.

Ard: Okay.

DN: I can understand why a physicist says the equations are beautiful. And if you look at the

equations of relativity theory, my goodness are they beautiful! So that kind of beauty I can fu understand.

What seems to me to be the problem is that people then go on to think that that's the only ki beauty there can be in science and in hypothesising.

When I found what I thought was a good explanation for the rhythm of the heart, in terms of interactions between the various protein molecules and the membranes and cell system, I ha that I had something beautiful there. Of course, it was, as it were, with equations, but actuall were pretty miserable equations: they were differential equations requiring all sorts of initial a boundary conditions. This is not the beauty of the equations of relativity theory! But if you loc beyond the equations themselves, there is a beauty there that can happen.

Ard: And so do you think that kind of richer beauty that you're looking at in this biological sys that a guide to the truth about the system?

DN: I think when you find that you've got that kind of beauty, it is a guide in a similar way, tho operating in quite the same way as happens with seeing a beautiful equation. But it still seer to be not a bad guide because you get excited by it, because you really do think you got to, a part of the truth.

David: Because it's beautiful?

DN: Because it's beautiful in the sense of saying, 'My goodness, the logic of that is so nice. I be like that.' Now, you might be wrong, of course, and this has to be done with the humility o admitting that one might always be wrong. But it's hard to avoid that feeling that this is logica works because of seeing the logic of how it works. And that, for a scientist, is what makes or appreciate the beauty of it. But it doesn't have to be the beauty of a very simple equation like

David: But it's still very odd, though, don't you think? Why should the human mind find truth t beautiful? Why should these two things overlap? Don't you find that strange? I mean, why sh be the case? Why should things that we find beautiful also turn out to be true of the universe

DN: Yes, it's like asking the question, 'How is it that mathematics can be applied to the unive

David: Well, it makes it worse.

DN: It makes it worse, precisely.

David: The fact that it does is strange to start with, and then that it's beautiful as well adds ar

level of strangeness.

DN: Yes, indeed, and my reaction to that is humility. I'm puzzled.

25:05 - THE INESCAPABILITY OF NARRATIVE AND METAPH

David: Can I ask about this notion whether knowledge, or truth, to use a more difficult word, science particularly, is just a big sand heap or facts, or whether you can have a kind of know and kind of truths that are more like writing: more a narrative, a story that you tell. In other w all the truth just contained in the individual grains of fact? What do you think?

DN: I think you have to have the story, because I can't go into the laboratory without an idea no way in which I can test a hypothesis without there being a hypothesis, and if I can't test a hypothesis, I don't think I'm doing science.

David: Can a hypothesis be a metaphor? Like, you can go in to, say, are genes selfish?

DN: Well, except that that one, I'm afraid, is empty.

David: Well, all right!

DN: That one's not even testable. But, no, much more generally, you're right. And in fact the you do is to ask, 'How would I test this hypothesis? Is it a hypothesis that is testable?' I think the first step in a scientific experiment. Otherwise you're just chasing after something that yo test.

David: So are you saying that knowledge can be more than just the individual grains of fact?

DN: It has to be. Not just that it can be, it has to be, yes. The individual grains of fact are no than that.

David: So it's not doing some violence to the facts of the world?

DN: No, because the facts are still there.

David: To put them into a story, to write a book?

DN: Yes, why do you write a book? Yes, exactly.

Ard: You've written in your book about the metaphor of the selfish gene, and whether an exp can adjudicate between that metaphor and other metaphors for looking at life.

DN: Yes. First of all, no experiment could possibly distinguish between that metaphor and, fo example, a cooperative gene. The reason for that is very simple.

Ard: Between a selfish gene and a cooperative gene? There's no difference? You can't distir

DN: There's no difference empirically.

Ard: Empirically. It's conceptual?

DN: It is a conceptual question, yes, that's right. And I think we can illustrate this in the follov the modern definition of a gene, and notice, incidentally, I said 'modern', because that was n original definition.

The modern definition of a gene is a sequence of DNA. A sequence does not have meaning dependent on the context.

DN: Just as the words in a language… Take 'but' in English and make it 'but' in French. Exac same sequence means something totally different. 'But' to us is obvious. 'But' in French is a

So the sequence itself cannot possibly tell you what the meaning is. So no possible experim tell you whether this sequence is selfish or cooperative other than in the context of the rest o system. But then the metaphor fails because it isn't the sequence itself that is selfish or coop is its interactions with the rest of the system. And once you've done that, you've taken the po the metaphor – the selfish gene – away.

David: But, I mean, metaphors… You need them in science. Science seems to be littered…

DN: Absolutely.

David: And they are very useful, aren't they?

DN: Yes. Yes, absolutely. The up and down metaphor, which…

David: Yes, we've been using that all morning.

DN: The body as a whole: the top, as it were, and the molecules down here. Well, my molec everywhere. My genes are everywhere. You know, my cells are everywhere. That is obvious metaphor.

DN: And we wouldn't be able to do without it. Without the concept of levels, and up and dow could we manage? We couldn't even talk about circular causality.

David: So using metaphor is a very powerful tool?

DN: Precisely so.

David: A metaphor isn't a failed fact?

DN: No, exactly.

David: I mean, you… everyone… all scientists…

Ard: You can't think without metaphors.

DN: No, that's right. Exactly. The advice here is essentially, be careful, don't get trapped by y metaphors.

David: Yes. If you know you're using a metaphor, then you're using it. If you don't, it's using y

DN: Then it's using you and you fall into the conceptual hole that's waiting for you to go into.

29:35 THE MATHEMATICS OF MUSIC

David: The laws of harmony. This link between music and mathematics. It's a completely diff subject, but…

DN: Yes.

David: If you would do that basic job of explaining that there is this sort of Pythagorean deep between mathematics and music.

DN: Yes, very much so, because I play the guitar, so I sort of experience this almost every da practise or perform. And I know, as a matter of fact, that if I stop the string at this point, and I something like that, to get what we call a harmonic, I get a totally different sound from what I get if I tapped the string just at that point normally.

And I get a different sound because I've divided the string exactly into two. I jump an octave beautiful. You get lovely bell-shaped sounds out of that. I mean, if you don't think that's beau don't know what is! And, as you say, it comes out of the equations of the vibrations of that str

DN: Those are both E's. That one is a high E because I'm dividing the string by exactly 50 pe its length. I can play it in a different way to get what are called octave harmonics which are u halving principle in a way that produces a very different kind of note.

David: And that's Pythagoras: that's the mathematics.

DN: Absolutely so, yes. And you can do the same of course by dividing up into thirds, fifths a which is how you get chords that are harmonic and pleasing to the ear.

David: Can you show us a third or a fifth.

DN: For example, if I do here, those two notes sound nice together. So do those. Those all s nice, because they are related by the mathematics of the way in which the string is working.

David: So that's a link. That's your mathematics and beauty then.

DN: Exactly so, and you can put a whole chord together with those, you see. It's the relation enable all of that to happen: it's not the individual notes. I can play individual notes, nothing's Together you get a totally different flavour and you can only say that that is beautiful, but the individual notes on their own are not.

David: Is it stretching it then to say that the music emerges out of the individual notes when them together.

DN: Not only that, but it emerges when you put them together in relation to each other, just a hydrogen and oxygen together to form water. It's also the case that the way I play this in eve concert is different, so it depends on your mood and so many other things. The way in which play that will be different each time: it will never be the same.

David: And yet the music is the same, the score.

DN: The notes, the chords are the same. What's written in the score is the same, but a perfo never performs it exactly the same way.

David: Does this metaphor then of music… it seems like it's helped you to formulate your ide powerful metaphor for you?

DN: For me it's an extraordinary powerful metaphor, because after all we are dealing here w things you can give a nice, reductionist, scientific account, which is if I do that [plays two not an octave, and if I do the thirds and the fifths, I get what I get. So all of that looks nice and reductionist: the individual notes. But it is really only when I put it together that I get somethi beautiful.

Ard: And the beauty is in those variations.

DN: Exactly so. In fact that beauty comes out of what is *not* in the score. Precisely. It's a crea process, and I think the evolutionary process has been a creative process that is built on eac as it's arisen to build meaning into the process of how it has all changed and evolved. So yo have to ask the question, where does the meaning all come from? You can ask that questior want, and if you are of a particular disposition of a particular metaphysical kind you will do th you don't have to ask that question in order to see the meaning. The meaning is there, obvic as in the heartbeat – I'm pretty clear about the purpose of the heartbeat. As a physiologist I c be anything other than clear.

34:43 LETTING GOD BACK IN

Ard: Here's an interesting question: do you think that some of the resistance you've faced fro reductionists has been that kind of fear of religion? That they're worried you are going to sne back in?

DN: Yes, and not only that. I found in a Novartis Foundation symposium – organised by one great reductionists at UCL in about 1997, Lewis Wolpert – I was one of the few to argue aga reductionist case, and I expected two others to help me. One did, another didn't, and he cam me in the coffee break and said, 'Denis, I would support you if I didn't think that that brings G in.'

David: That's so weird.

DN: And I looked at him and I could not begin to understand what he was saying. Though I c understand the fear. Of course, in the neo-Darwinist context it's the fear of all those creationi Somehow or other, if you let this structure collapse, and I think it is collapsing, incidentally: it' house of cards built on some very bad concepts and some very poor science: poor because insistence that it is the only truth. If you let that crumble, what then happens? The creationist have a field day saying you are all wrong.

David: Do you think that is a major objection to accepting a challenge to reductionism and ta about emergence?

DN: I believe that's part of the problem. It is as though you have to be reductionist in order to those ideas.

David: Where do I fit in then? Because I don't believe in God, and I'm not a reductionist eithe

DN: Well, of course, there are many who do believe in God who don't think that it's necessar

creationist, who don't think it's necessary to suppose that some very strange events have ha
When the Archbishop of Canterbury debates with Richard Dawkins, they don't disagree abou
kind of question at all.

Ard: The metaphysics?

DN: It's the metaphysics, and, of course, there will be many metaphysics depending on what
views and feelings are about the deepest questions of the nature of life. So I think we should
more tolerant of each other. There are many different views.

To, as it were, stop the process or interfere with the natural development of science on the g
that this will lead to particular religious beliefs, is, I think, just a misunderstanding of what the
of science is about.

David: Isn't it also just the inverse of what the Church did at the time? 'You can't believe in sc
because it will lead to not believing in God.'

DN: But even there you've got to be careful.

David: Now science is doing the same thing but the other way around.

DN: I think you have to be careful even there. There were some very major theologians who
agree with what many atheists say. Now, there's a problem: atheism or anti-theism? They ar
same. And I think part of the problem is that people have been throwing the baby out with th
bathwater. They have been throwing out concepts like spirituality, which I think is a form of c
novelty of the ability to give meaning to things. That is spirituality: to be able to give meaning
things. And they have been throwing that out as though it has been necessary to throw that
order to resolve an issue which I don't think science can resolve anyway. At least that's my b
can, I'll be amazed.

Ard: I think it's much better for science if it could disconnect itself…

DN: From those kind of metaphysical questions…

Ard: Because it does make people afraid, and they start battening down the hatches. Thoma
talks about the fear of religion in his critiques of reductionism, and I think science can't answ
kind of questions, and the minute you realise that, then it actually frees science rather than r

David: I agree with you that it is better for science, but it's also better for us. I like your point
there's this big thing, 'We've got to get rid of God', they say, and they throw out spirituality wi

DN: Yes, exactly so.

David: I don't believe in God, but I do think the spiritual is a part of us. I think it's a part of bei human animal. I just don't think it's got anything to do with God.

DN: Absolutely. That is why I like the quotation from Waddington in 1957 in *The Strategy of t Genes* where he points out that it – and he means Neo-Darwinism – has been damaging to spirituality. Now that's a very, very strong statement, but remember he was not religious.

David: You as a biologist… You would expect a biologist to bridle at that, but you don't.

DN: Well, I don't because I think it's obvious that there is a spirituality to man. I know the wo spirituality produces all kinds of notions of there being strange stuff out here. But you don't h suppose that at all. If you are dealing with the relationships and the processes, that's spiritua the sense it's not material, but that's what spiritual means. If you go back to it, it comes from which is breath and all the rest of it. It's a natural process. You don't even have to worry abo whether the word has got some strange connotations that you're not happy with. Just bring i and let it be a natural word in science. So I am with Waddington on that.