In our Time Programme 4
Limits of Science

Melvyn Bragg : Hello,science appears so triumphant now,that increasingly it seems the supreme unchallenged source of truth,knowledge and wisdom about life,it's origins,it's processes,even it's purposes or lack of purpose.

Mary Midgley challenges this in her books and essays,she's a moral philosopher,until her retirement in 1980,the senior lecturer in philosophy at the University of Newcastle.Her books include,"Evolution as Religion",and, "Science as Salvation". I'm also joined by John Gribbin,visiting fellow of Astronomy at the University of Sussex,and a prolific writer of popular books on serious science.His latest,a must in my opinion,is called,"Almost Everyone's Guide to Science".

John Gribbin,you say,pretty much all of science can be understood by the average man on street, and yet Richard Feynmann said,"Nobody understands Quantum Mechanics",so where do we go from there?

John Gribbin : Depends what you mean by "understand"! In the sense that people can and ought to have some knowledge of something that's so profound and important in everyday life,there's no reason why everybody can't get a grasp of what the important parts of science are,and what it's all about.Of course, to do research you need the advanced mathematics and so on,and perhaps when you start talking about the very deep issues,then there is a level at which understanding fails,because science is an ongoing process,we don't know everything,and probably we never will.So I'm really...in this book I'm trying to address an audience that doesn't normally have contact with science and tell them,"Look it's not as scary as you might think".At another level,perhaps it is scary

Melvyn Bragg : You've written a great number of books,almost prostheletising the science,why do you think it's so important that the general reading public knows about science?

John Gribbin : I think it's important at two levels,I mean one is that it is very important in a technological society,it's become a cliché,and if we have issues like genetic engineering,what's going to happen? We just heard on the news about people who have got genetic diseases,how are they going to be treated by insurance companies? Then it's important that the voters should have an informed opinion which they can pass on to the politicians,and that appropriate action is taken,so that's a very, sort of ,practical basic down home-level at which it's important that everyone understands science. But there's also....there's something that I've come increasingly to feel very strongly about in recent years and months,is that science is a very profound way of thinking about the world.You mentioned Richard Feynmann ,I mean my hero,if you like, he also made this point about the way we think about things,the way scientists think about things,the importance of doubt and uncertainty,and not believing things at face value,and of course something else that's important,is understanding things like probability,whether things are happening by chance,that are flukes or not flukes,and that helps you to have an image of the world and what's going on which is very useful,even if you're not a scientist.

Melvyn Bragg : Yes,and I found some....I thought he book was very good,and I enjoyed it a great..... some of it is quite difficult,and over the past few years I've managed to read a few science books,so your idea that this is *simply* set out for people,I think it's written with great lucidity,but I don't think it's as simple as all that. This is not a criticism but an observation.

John Gribbin : Perhaps....well,perhaps I'm being to optimistic ,but I think you have to perhaps be prepared to work at something...

Melvyn Bragg : Sure.

John Gribbin : ....and you may read it through once and find some sticky patches,and I would hope that the reader might then come back and read it again,and again,and absorb that stuff.

Melvyn Bragg : Can I take one of your arguments a bit further,you say in the book,"Everything fits together in the modern scientific world view.The scientific world view is the greatest achievement of the human intellect." ."Everything fits together" that's a phrase that took my attention.Now everything fits....what do you mean....? You obviously mean that,don't you?

John Gribbin : Yes,everything in science,but I argue that science does tell you about everything that's going on in the world.Everything we know about fits together.I'm particularly using that expression because there's been a kind of a backlash of people saying silly things like that, "Astronomers say that the universe is younger than the stars within the universe",things like that.That there are conflicts in science.People who set up these straw men.This debate between people like Stephen J. Gould and Richard Dawkins about how evolution works.It's presented to the public as a big conflict in science,it's not.It's a very small conflict, and when you look at the whole web of the thing,everything does fit together.The way atoms work,the way molecules like DNA work, the way the universe works,it all fits into one pattern.We don't have all the details.

Melvyn Bragg : But you are talking....I'm just moving to a final point before I ask Mary Midgley to join in,you are talking about something which is comprehensible in terms of science,and I think you quote with approval the remark by Einstein that,"The eternal mystery of the world is it's comprehensibility".

John Gribbin : Yes,I mean,the fact....there are two ways of looking at this.One is that in roughly 300 years from Newton and Galileo to the present day,we've gone from knowing scarcely anything about the way the world works to knowing almost everything about it,and the other that in the span of a single human lifetime,or about 10 years you go through University and learn all this stuff,and that's amazing that it is possible to comprehend in such simple terms.

Melvyn Bragg : What's your reaction to this Mary Midgley,this idea of the comprehensibility, afforded us by science?

Mary Midgley : No,no,sorry I do want to start by saying John I'm a fan of your work.I have,over the years got great profit from reading your clear statements about scientific things.I' am very impressed with the way you take seriously the need to explain these things to the rest of us.I think what you just say is dead right that we do need,and can have these things explained.It is hard work for the explainer, as I well understand.It's also a bit of work for the reader,but it's got to be done,and I have you as a pin up on my wall for doing it!
Thus,I am rather shocked by the remark,and the line,which Melvyn's just mentioned,"Everything fits together in the modern scientific world view",now every scientist I know who thinks about this kind of thing is deeply worried about discrepancies between general relativity and quantum mechanics.I don't understand those,but I hear from a great number of people who do that they don't fit together, that they are actually in their present state incompatible.This isn't a scandal.

It's the sort of thing that you would expect with any big,ongoing,intellectual enterprise,but you seem to me,to be slurring over it.Similarly...I'm sorry,I'm going to say a couple of these things before.... (laughs) shutting up! It is not a trifling matter,the debate between Richard Dawkins and his "Selfish Gene" and Stephen J.Gould and view of evolution in which the organism is the central thing,it's an extremely important matter in everyday thought,and in the science that goes with it.
Again,it's not a scandal that there should be this big dialectic going on,something's going to come out of it,but you know,of course the idea that "in the end we're aiming at a unified system" is essential.

But the thought that we've got it seems to me quite unreal.Third one,you start with a chapter saying,"If it disagrees with experiment,it is wrong",laying that down as I think Karl Popper did,as an absolute principle,you then actually quote later,Arthur Eddington saying,"If your theory disagrees with.....if experiment seems to disprove your theory,that doesn't matter very much,it only matters if it conflicts with the second law of thermodynamics",without comment! Now I know you could...you know,you could explain that what they do when there is disagreement with experiment,as happens all the time, they disregard the experiment and wait and alter the interpretation,and eventually something gives,but I do think that this is so oversimple after all the pointing out that there has been in the last 20 years of how "it's not as simple as that",that it's really misleading even to your very simple reader.

Melvyn Bragg : I think you must feel like (indistinct)and the revenge,with all the ships turning their (indistinct) on their .....

Mary Midgley : Sorry,but I feel strongly about this...!

Melvyn Bragg : It's perfectly alright....no,no,you certainly do,I'm going to sit back,and you answer that John Gribbin! (laughter)

John Gribbin : Okay well I..the first one,the physicists you've been talking to about general relativity and quantum physics are out of date,I mean there is no conflict,they....at one level they apply to different things,and and at another level,at the very exciting level that's going on at the moment,the theory of strings,they do fit together,and there is an emerging picture of how quantum physics and general relativity do emerge from the same paradigm ,if you want to use those terms,and that's explained in another of my books,but I won't go into that.

Mary Midgley : But I think you ought to have mentioned it and said so,if so.

John Gribbin : Well there's only room for so much.I have written another book about that,so ...to cater for that particular interest,and I do takeissue with you about the importance of the .....for want of a better term,the Dawkins/Gould debate.I think it's....it really is a strom in a teacup,neither of them disagrees on the basics of how evolution works,how genetics works,how natural selection works,there's just a....what seems to me,a mild disagreement about the pace of change and so on,and the business about Eddington's quote,well of course,I mean I succumbed,as writers tend to do,to a juicy quote,from Eddington,to emphasise how important the second law of thermodynamics is.But I do,very much,subscribe to the view which,again,Richard Feynmann very strongly subscribed to,"if it disagrees with experiment it is wrong",and of course it is very important to appreciate that we're talking here about the *best* scientists,there are always people who want to defend their theory to the death ,(indistinct),but the top people do try to live by those rules.

Melvyn Bragg : Mary,could I direct our attention to something that you said about,your great worry about the reductionist tendency of science.Could you explain what you mean by that,and why you have a great worry about it?

Mary Midgley : Oh! Sorry,you're picking on something particular that I've said,there are so many angles?

Melvyn Bragg : Yes,yes,you've said that.....you've questioned the reductionist view of science,that our bodies and our minds are machines ,and that science can reduce the working,our working to parts that can be explained in this way.

Mary Midgley : Well,erm reductionism,I'm sorry,I'm hesitating because reduction can mean a great many different things.The simplest kind of reductionism is the idea that you can explain the working of any whole by taking it to pieces,that it's smallest parts will always explain what's going on in the whole.This is often,indeed,linked with the machine image ,as though one were putting together the cogs,and since one makes the machine oneself,of course one then knows how the cogs are being put together.This has,of course,been a very useful way of discovering a lot about the physical working of things,but the more complicated the wholes get the less satisfactory it is,.Perhaps I should pick on the example here,that I am chiefly engaged with,in a way,at the moment,namely the idea of Gaia of the Earth as a whole self-regulating,and self-maintaining whole,that has shocked many scientists and scientifically minded people because it proceeds outwards first,rather than inwards,because in looking for the explanation of something that's going on,on the Earth,it looks to the whole of the Earth and fits it into that larger whole.

I think it is perfectly clear that explanation isn't always done by cutting things up.If a biologist is presented with a leaf,you see,he doesn't only,does he cut up,boil it down,put it under the microscope, he also asks "In what tree? In what forest? In what climate? On what soil?",you know,"In what ecosystem?",this leaf is growing,and this is so taken for granted,as part of the way that people do normally investigate anything that they come across,that I think it is sometimes forgotten in investigating human affairs,this is obviously still more true,because the complexes we have,the cultures and the historical situations we live in,are so complicated,there is a temptation to say,"We have explained a human action by chopping up and boiling the brain",and we now have such very good ways of chopping up and boiling the brain,and observing thngs that we didn't used to be able to,that there's terrific faith in this eventually producing *the* explanation of what's going on.

The most distressing,kind of,example of this at present,I think,is the tendency to look for "the cause". To explain alcoholism or autism or mental illness generally,by investigating the brain,rather than looking at the situation.I saw lately some **statistic** which I can't quite remember about a very high **number** of the people in prison suffering from mental illness,and the need therefore to diagnose them medically.Now the first thing,it seemed to me,was needed

there,was to see what the prison was like,you know! (laughs) I'm going on,rather,Melvyn,I wasn't quite sure which way to start,but I mean, you know.....this is a quite general.....a general objection to *only* investigating things by chopping them up,it is *not* an objection to that kind of investigation being alright and important,it often is.

Melvyn Bragg : But to move it on though,John,would you say,with Dawkins,because Dawkin's view of Gaia is very different from Mary's.I mean he just....he thinks,that it.....that everything working for everything else is a nonsense,really,things work together for reasons of their own,you know.But would you say that science is moving towards.....one of the things that science might do,because you're quite hesitant,is to explain everything,that everything will be explained by the analysis of the.... what the particles do,the neurons do,and so on,and so forth.Do you believe that,that is happening

John Gribbin : I do believe that,that is a part of it ,but that you have to look at how things interact with one another.

Mary Midgley : Yes.

John Gribbin : Now whether you're talking about you know,cells in the body,or the living parts of Gaia...

Melvyn Bragg : But are you talking about physical interreactions,because Mary's talking about something else,you see.

John Gribbin : Yes.No,I mean I think one of the really interesting things that's happening at the moment is the study of what's called "complexity".

Mary Midgley : Yes.

John Gribbin : How lot's of simple things working together produce complex systems.But I think that can be understood in terms of simple physical rules.They're are slightly less simple than the ones we've been used to,and since Newton we've worked our way down,if you like,and worked out all the basics,now we can work upwards,with that knowledge of the basics and see how complex things work.But I don't think you need anything new ,and I agree that there are more than one factor involved in many things. There's a debate that I'm involved with,about climate change,and global warming,and there are people who say,"Well it's not just carbon dioxide" ,they say,"It's not carbon dioxide at all,it's caused by the sun,or by volcanoes",or whatever,and of course there's a bit of truth in all of that,there's more than one factor involved,and what you do find is that people prostheletise for their own view of the world and say,"It's all so and so",and it's not,it's complicated,and Gaia,I'm fascinated by Gaia,I think it's a really wonderful paradigm that's enabling people to think about the planet in different ways,but then you're not talking about each component acting for the good of the whole.Each component acts for the good of that component,in feedback with all the other components,and that's what produces the interesting complexity.

Melvyn Bragg : But your still talking about things being explained through things,and as I understand it Mary,you say there are other explanations.One of the things you say is that,"The trouble with science is not that it tells unwelcome truths,but that its prestige obscures other truths that are every bit as well established and important".Could you develop that?

Mary Midgley : Yes,sticking with people and animals for the moment,if you want to explain somebody's action,it seems to me that the question that your asking,is often a question in terms of motives,and in terms of beliefs.Why somebody suddenly abandoned his job and went off to live alone in a hut,I'm deliberately making a rather obscure one,it maybe true,and I don't wish to deny it,that somebody who chopped up his brain,or investigated his brain would find some kind of mechanical procedures,and possibly would be able to generalise say these mechanical procedures are found in people who do that kind of thing.But this would not explain,in the sense that is wanted,the kind of explanation that is wanted for that sort of action,is an understanding of it,which is a sort of sympathetic understanding.I mean when we feel we know why somebody did something,we ourselves feel an analogue of the feeling that they felt.

If we can't do that,we say,"I still don't understand it",even though I daresay it was physically caused.We need that all the time,when we are interacting,even in the most automatic and boring things like buying newspapers.I mean the

trouble with poor autistic people is,they apparently haven't this sense of how it is that other people are feeling,are the sort of motives that they have.So for them, other people are a constant puzzle because the kind of understanding that's needed isn't there.

Now it seems to me no insult to science to say,it's not the business of science,to provide that.History ought to be done with that in mind.When people give historical explanations of why people who acted, they should provide explanations which are open to that sort of inwardness from the person holding them.I don't think this is superstitious or (indistinct),John,if you think it is,do say so.I'm allowing you see,that this in a way may go parallel to some physical explanation,which in principle may be got.But of course,the physical explanation is always much harder to get,and it's not really on the cards that your going to get universal laws for it,because people don't.....

Melvyn Bragg : Can we...sorry,I just want to bring John in,at this point,because we're going a long way down here.....

Mary Midgley : Yes.Yes...yes.

Melvyn Bragg : ...which is fine.

Mary Midgley : You did ask me.

Melvyn Bragg : I want you to come in to.....

John Gribbin : Sure,I think I would say that all those things *are* within the province of science,and that science *can* hope to understand them,not necessarily in terms of specifically why a particular individual will make a particular decision at a particular time,but in terms of how the brain arrives at those kinds of decisions.How complicated networks work,which is where a lot of work is being done now ,and you have situations where a very small change in one part of a network will send a sweeping change right through the whole network .So a small trigger can profoundly change something as simple as a pile of sand on a table,or the decision that you make.

Melvyn Bragg : But your still coming in with this mechanical explanation....

Mary Midgley : Yes.

John Gribbin : Sure.

Melvyn Bragg : ...which I think is very interesting.

Mary Midgley : Answer to a different question.

Melvyn Bragg : But Mary has said something else in one of her essays,in which she said,"The whole world contains electrons and elections,toothaches,money and dreams,and they can all be explained,but the explanations are various"

Melvyn Bragg : Now what do you make of that John? This phrase "The explanations are various"? It struck me as a very good phrase,and was telling,but if they are various,what other explanations can you imagine, besides the explanations that you attribute to science?

John Gribbin : I can't ,my imagination perhaps,is failing.But I don't see.....

Mary Midgley : John,I'll give you a very simple case.....

Melvyn Bragg : Hold on let him finish Mary.

John Gribbin : I don't see any problem at all in explaining,in principle,in explaining everything in terms of science,bearing in mind you have to use statistics sometimes.

Melvyn Bragg : So just a second.....one second,so why people,sort of,fall in love....?

John Gribbin : Sure.

Melvyn Bragg : That can be explained through science?

John Gribbin : Yeah.

Melvyn Bragg : Why some people get obsessed by someone that their in love with? That can....?

John Gribbin : I'd be entirely happy with that.

Melvyn Bragg : You'd be entirely happy?

John Gribbin : Yes.

Mary Midgley : It's a causal explanation.

Melvyn Bragg : Why people imagine plays? Why people....? This is all.....? There's no other?

John Gribbin : *Yes.*

Melvyn Bragg : So outside our skulls as it were,everything....when....we'll eventually probe the brain and that wil eventually tell us about everything including being able imagine billions of miles across the universe,and that will all be explained?

John Gribbin : I think so...I

Melvyn Bragg : So Einstein's "The eternal mystery is the comprehensibility"? We will comprehend mysteries?

John Gribbin : Well we may not ever get that far,it's a big subject,and there is....when you get to a certain level of complexity,it's very difficult to understand it,wothout having something bigger.You can't....

Melvyn Bragg : Because I think that what Mary's saying,is that there is this physi....I don't want to talk for Mary Midgley (laughter),I am not talking for Mary Midgley,I can't say.....(Imitates tape rewinding).....tape goes back,were not live,yes sir....(laughter).This is the brain,and that's fine,but there is also the mind.....

Melvyn Bragg : ....as far as I can.....and the mind,actually is consciosuness,knows things that we don't know the brain can know,now does that.....?

Mary Midgley : Well,yes because it's...sorry...it's a different sort of question that arises.Can I give a very simple example,John? Football game going on,somebody who doesn't understand football is standing watching,says "Why has he been sent off?".Now the explanation of that has to be the rules of football....

Melvyn Bragg : It depends which Ref it is!

Mary Midgley : ....and what he....you see? (laughs) This is social.This is a social pattern ,that is being asked for,and until you have that social pattern,the story about what's happened inside their heads isn't ever going to make that sense.

John Gribbin : But there are....

Mary Midgley : You can't explain football in terms of....

John Gribbin : There are straightforward reasons..... yes you can,you can explain why we have games,as a substitute for warfare,why people are aggressive,why someone does kick someone in the head....

Mary Midgley : This is causal...

John Gribbin : ...and get sent off.

Mary Midgley : This is causal.You are not telling the person about football,until they know the rules of football,none of that's any good. Most of human life consists of conventions of that kind,if you don't know the conventions,you aren't going to be able to act suitably.The motives have indeed a physical side,and I honestly am not saying that there's anything fishy about the way the stuff works,or that there's an extra soul there,you know,anything of that kind.It's just that a different kind of question is being asked.Melvyn seems to see this.Yes.

Melvyn Bragg : Yes I do,well can we develop those different kinds of questions,and see if John will take....? Is it a religious question that's being asked? And if so where does that religious question come from?

Mary Midgley : About football?

Melvyn Bragg : No,about the various explanations,the various questions.

Mary Midgley : You mean,why are we asking this question now? (laughter)

Melvyn Bragg : Yes,yes.

Mary Midgley : Because,because we have a confused belief system ,and we.....

Melvyn Bragg : But why do we have a confused belief system?

Mary Midgley : Oh,because it's quite difficult to get clear ideas about the world.You see...

Melvyn Bragg : But John would say that's because we haven't actually tapped into quite enough knowledge about the neurons and everything else whizzing around inside,trying to make sense of this morning's programme.

Mary Midgley : Look John,it appears that it's only physical science and not social science,that your putting forward to do this job,is it,your not just saying,psychologists by making better experiments could understand it better.You're really saying that it's the movements in the brain that are going to be the only explanation?

John Gribbin : Yes,of course ,I don't see how....there's nothing else in the world except for in our perceptions,there's nothing else in out perceived world,except movements in the brain.Electrons moving about,and so on.

Mary Midgley : This is something which in fact we very rarely perceive.I mean what's in our ordinary perceived world is things like money,and tables and clocks and food and apples.

Much larger objects,and the ways in which *they* interact,are what we need to know about,and the ways in which the whole person interacts.If you didn't know that....if you were...you see a scientist,an alien scientist sitting in a lab,whose been shown all these physical details,conveyed to him,her,it,about what's happening inside our heads,but who does *not* understand the social conventions by which people are moving,or what it feels like to be them,you would understand,okay you'd go on understanding the connection between the neurons,but this is never going to tell you what football is or what money is,or why somebody does something,because that all takes place on a quite different scale,and it's not only a different causal item that's being put in,but it's that the relations between things at the macro scale are themselves of a different kind.

Melvyn Bragg : It's quite difficult to catch your attention!

Mary Midgley : Sorry,I,I,I

Melvyn Bragg : You tend to think with your eyes shut.Mary,it's perfectly alright! (laughter)

Mary Midgley : Yes. Okay.

Melvyn Bragg : It's very.....I'm enjoying it no end! I just wish we could go on all morning.I'm just trying to say,let John get in!

Mary Midgley : Sorry,yes,carry on John.

John Gribbin : No,I think...I come back to the analogy that the complexity people use,the pile of sand.You can understand the physics of a grain of sand,and the friction,and how it rubs against another grain of sand,but if you just make a big pile on the table and keep dropping sand on it,it piles up to a level where it makes a certain critical angle,and then you get avalanches,and you get pretty patterns,and it stays at that angle,but it's the same laws of physics,just because it's a big pile with pretty patterns.....

Melvyn Bragg : But Mary's on to something very important.

Mary Midgley : This is never denied.

Melvyn Bragg : Nobody denies that. You're still not addressing her main point John,and we've only got a couple of minutes,(laughs) just answer the problems of the world in two minutes!
The thing is,why do we have consciousness of what we're doing? Why do we have what seems to be....

John Gribbin : Because we're complex.That's all there is to it.You've got a lot of neurons,stuck together and bingo you get consciousness,and it'll happen when you put together electronic computers to that level...

Melvyn Bragg : You think so?

John Gribbin : Yes

Melvyn Bragg : You think artificial intelligence will eventually have consciousness?

John Gribbin : Absolutely ,yeah,and soon within 50 years.

Mary Midgley : This isn't quite....(laughs) the point I was.....explanation now,you know,as you go round today you'll want a lot of things explained,and you'll explain them,in terms of the interaction of moderate sized things like us.You won't find that an incomplete explanation ,unless,you know,if you want more about why somebody did something,you'll want more about what it feels like,and the like.When you give the physical explanation of what's happening in the neurons,that's something coming in from a quite different angle.
I given ....can I rest this moment? ....the analogy of a great big,what do you call those great big things with water in and fish?

John Gribbin : Aquarium?

Mary Midgley : Aquarium...(laughs) ....sorry,yes,which your looking in at,you see,through a lot of different holes,and different corners.You look in one hole and your seeing this about the inside of the head.You look in from a hole on the *other side*,and you see the fish actually moving about.Now that's something which is not substituted by the details.

John Gribbin : There's a lot more we need to know,but we're getting there,and it will add up to make a coherent picture,I'm sure.

Mary Midgley : Good luck to you!

Melvyn Bragg : We needn't end there,we've got another 20 seconds! (laughter) We could...the way we're going we could actually revoutionise physics....okay,well thankyou both very much for that gallop.John Gribbin's book is called "Almost everyone's guide to science: The universe,life and everything",that's just been published.Mary Midgley is speaking at a conference for Gaia at the Linean Society,in London ,that's part of the Royal Academy,at

London this evening. Thanks both very much indeed.I've enjoyed it,and I hope to see you both soon.