The Firing Line 1997 Creation-Evolution Debate

"Resolved: The Evolutionists Should Acknowledge Creation"

For the resolution (affirm):	**Debate Participants**	Against the resolution (oppose):
Phillip E. Johnson, Berkeley law professor **Michael J. Behe**, biochemist Lehigh Univ **David Berlinski**, professor and author **William F. Buckley Jr.**, columnist and host	**"Resolved: The Evolutionists Should Acknowledge Creation"** **Moderated by Michael Kinsley** **Seton Hall University South Orange, New Jersey** **December 4, 1997 (telecast on PBS 12/19/1997)**	**Kenneth R. Miller**, biologist Brown Univ **Michael Ruse**, philosopher of science **Eugenie Scott**, National Center for Science Education **Barry Lynn**, Americans United for Separation of Church and State

BEGIN TRANSCRIPT

[music begins]

Introduction by Moderator

Michael Kinsley (MK): Good evening. Is William F. Buckley, Jr. descended from monkeys? That's one question we face in tonight's special *Firing Line* debate. We come to you tonight from Seton Hall University in South Orange, New Jersey. At Seton Hall, as at all institutions of higher learning, the issue of Mr. Buckley's parentage has been the subject of lively speculation for decades now. [audience laughs] But our official debate topic actually raises that issue only indirectly. The official wording is: "*Resolved: The Evolutionists Should Acknowledge Creation.*"

Now those last two words "acknowledge creation" require some parsing. The word "creation" is shorthand for the proposition that humankind was created by God in His own image as it says in the Bible. Some creationists believe the theory of evolution is simply wrong. While others believe that the theories of evolution and creation are compatible. The word "acknowledge" here can mean a couple of things as well. It could mean that evolutionists should accept the truth of creation theory. Or it just may mean that the theory of creationism is entitled to be treated as an open question, especially in the teaching of biology in high school. We shall see which of these interpretations tonight's debaters have in mind.

The theory of evolution was first enunciated of course by Charles Darwin almost a century and a half ago in his book *The Origin of the Species*. In recent years, Darwin's proposition has been subject to two opposite trends. On the one hand, there has been explosive growth in a field called evolutionary psychology, which applies the theory of evolution not just to physical attributes, but to a wide assortment of human behavior. Your decision to come to this debate tonight in this auditorium was dictated by pressures on our shared human ancestors generations ago. That's only a slight exaggeration of what the evolutionary psychologists believe. On the other hand, religious groups have had growing success in requiring creationism to be taught alongside evolutionary theory in the nation's schools. Just last month, the National Association of Biology Teachers dropped two key words from its official statement on

teaching evolution. The statement used to read: "The diversity of life on earth is the outcome of evolution: an unsupervised, impersonal, unpredictable, and natural process." Those words "unsupervised" and "impersonal" are now gone.

Is the teaching of evolution another example of political correctness where dissident views are being censored? Or are the creationists trying to pass off theology as science? That's more or less the debate. Let's welcome tonight's debaters.

[audience applause while the debaters walk in and sit down on opposite sides of a table]

MK: Captain of the affirmative team is William F. Buckley, Jr. Founder and maximum leader of both *Firing Line* and the *National Review*. Mr. Buckley's latest book is titled *Nearer, My God: An Autobiography of Faith*. His conviction that he is the creation of God is complicated only by his suspicion that he ***is*** God. [audience laughs] Phillip Johnson is a professor of law at the University of California at Berkeley. He is the author of a book entitled *Darwin on Trial*, published several years ago, and another book published just this year called *Defeating Darwinism by Opening Minds*. Michael Behe is professor of biochemistry at Lehigh University. He is the author of *Darwin's Black Box: The Biochemical Challenge to Evolution*, which was chosen as the 1997 book of the year by the magazine *Christianity Today*. David Berlinski has had an eclectic career as a college professor, management consultant, writer of fiction and non-fiction. His fields of expertise according to his biography include systems analysis, differential topology, whatever that is [laughs], biology, and the philosophy of mathematics. His most recent book is called *A Tour of the Calculus*. More to the point though, he is also the author of an article published last year in *Commentary* entitled "The Deniable Darwin."

Captain of the opposition team is an old *Firing Line* favorite, Barry Lynn, executive director of Americans United for Separation of Church and State. Mr. Lynn is both a lawyer and a minister in the United Church of Christ. I think we can all agree that when evolution starts producing ministers who are also lawyers it has gone too far and must be stopped. [audience laughs] Eugenie Scott is executive director of the National Center for Science Education, which describes itself as a pro-evolution, non-profit, science education organization. She holds a Ph.D. in physical anthropology and according to her bio has appeared on Geraldo and the Pat Buchanan Show, which ought to shake anyone's belief in evolution I would think. Michael Ruse is a philosopher of biology, and a professor at the University of Guelph in Canada. He is the author of many books, some of them with titles like *Darwinism Defended*, *Taking Darwin Seriously*, and forthcoming, *Can a Darwinian be a Christian? Evolutionary Theory and Religious Belief*. Kenneth Miller is professor of biology at Brown University. He is the author of many books and articles, including a recent review of *Darwin's Black Box* by Mr. Behe, which did not impress him.

I'm Mike Kinsley, editor of Slate the online magazine. I'm tonight's moderator, and I'll do my best, despite losing my voice to a cold, to keep this debate from evolving out of control. And [coughs], to begin, I call on Mr. Buckley to propose tonight's motion. Mr. Buckley?

Opening Statement by Affirmative

William Buckley (WB): Mr. Chairman, ladies and gentlemen, I retreat from any formulation of tonight's exchange to suggest that everyone on the other side should embrace creation. Not everyone on the affirmative side embraces creation. What we contend is that everyone should acknowledge creation as an alternative explanation for cosmic and biological happenings now thought by so many as naturalist in providence and momentum. Why? Because my colleagues and I judge that the evidence for the naturalist theory of evolution is not merely insubstantial, it is fanciful. If it is so that life as we know it is the ongoing display of punctuated equilibriums, then we pause and ask, what is the theory of natural selection, how it explains macroevolutionary developments? If there is no theory on the grounds that you don't need a theory to account for mere happenstance, then we give it as our judgment that such data as

we have can't come up with a plausible theory under the aegis of natural -- of natural materialism, because what pops up here is chaotic there, contradictory. If chance is the progenitor of the human eye, then chance is so arresting in its stochastic formulations as to warrant something other than scientific complacency, something more like true reverence. But reverence is a swear word in button-down scientific circles, because it sounds too extra-natural. We don't revere the Aurora Borealis, we simply take pleasure in it, as we do in the Goldberg Variations, happy that the cosmos happened to give us that stupendous constellation, happy that the genetic pool gave it -- gave us the art of Johann Sebastian Bach.

I speak only for myself, though some of my confederates may wish to associate themselves with me on this matter, when I say that I am much taken by what goes by the name of the Anthropic view. What it says is that there are a handful of elements that make up the cosmos, and that the balance in which they co-exist has no explanation more plausible than that there's only -- than that's the only way to make possible a human life, whence Anthropic design for man. The nuclear weak force formed is 10 to the 20th the strength of gravity. If it had been just a little bit weaker, the earth would have been without water. Uniquely among the molecules, water is lighter in its solid than in its liquid form. Ice therefore floats. If it weren't so, the ocean would freeze from the bottom up, and the earth would be covered with solid ice. Such data aren't the kind of things that make up my personal library, but how much science do we need to master to qualify as reasonably to affirm that there has to be a reason for you and me and the world we live in? A reason other than acts of raw nature driven by, driven by what?

I'm reminded of the reply by an elderly scientist a hundred years ago, when confronted by an exuberant young skeptic. He said to his student, "I gotta tell you, I find it more reasonable to believe in God, than to believe that Hamlet was deduced from the molecular structure of a mutton chop." So I beg your attention to our resolution tonight, which is that the dogma of evolution should give way to a broader intelligence, which makes way for a First Mover. Thank you.

MK: Thank you, Mr. Buckley. [audience applause] Barry Lynn to propose tonight's motion. Mr. Lynn?

Opening Statement by Opposition

Barry Lynn (BL): Thank you. Thank you, very much. The French philosopher Renee Descartes wrote, "I think, therefore I am." Although I am neither French nor a philosopher, I say I have somehow ended up once again on the set of *Firing Line*, therefore I must have been created *somehow*. In fact, none of us on this team have any doubt that we have all been created *somehow*. Where we disagree with Mr. Buckley and his colleagues is on the relationship between evolution and our current situation. On this team we differ on our answers to some of these great and literally cosmic questions: Is there a God? Is there purpose in the universe? But we all agree that evolution is indeed the only logically coherent and useful explanation for the development of life. Evolution is an explanation of a natural process, it is not an ideology, and nor, Mr. Buckley, is it at all fanciful. Like the theory of gravity or the theory of electromagnetism, evolutionary theory continues to be refined, year by year and month by month. Yet in each case, there has been no fundamental challenge that has been made to any of these scientific doctrines since they were developed.

Tonight you will hear claims asserting fundamental scientific flaws in the notion of evolution. We'll examine such assertions and try to show how those are themselves illogical. More importantly though we'll demonstrate that the arguments made by the other side are based on fundamentalist religious beliefs or discredited philosophical constructs, or what we sometimes refer to as just plain nonsense.

We can't afford, ladies and gentlemen, for this to become too abstract a debate. Because creation science advocates from California to Alabama have already duped school boards and thus required schoolchildren to believe that evolution can somehow be debunked by alternative theories. In so doing, schools are being asked to elevate pseudo-science to the level of genuine science. What's next? Will we find the casting of astrological charts replacing telescope observations in high schools? I hope not, but I

think that's the direction we might end up going. And indeed if our children are not as prepared as those in Japan and Europe to understand what science is, to recognize the difference between a scientific question and a religious question, then they frankly will not be able to compete in the extraordinarily well-developing world of the future.

Now there is that ever-so-slim possibility that in the next two hours we may not put to rest conclusively the debate over evolution and creation. [laughs] But I hope our team does make you consider the implications of this debate. If you're persuaded at a minimum that speculation is much less useful than rigorous scientific analysis, and also that you can even choose to be faithful to theism, to a belief in God, and still accept the biological theory of evolution for what it is. Finally, we're going to insist that Mr. Buckley's team that doesn't believe that evolution is viable, explain then what in the world did happen to bring us to Seton Hall University tonight? As Martin Gardner once put it: "If you claim the world is not round, you are obliged to tell us what shape you think it really is." Thank you.

Phil Johnson vs. Eugenie Scott

MK: Thank you Mr. Lynn. [audience applause] Professor Johnson -- Professor Johnson and Ms. Scott. And Professor Johnson will make an opening statement.

Phillip Johnson (PJ): The issue before the house is essentially simple. Evolutionary science takes its starting point from a philosophical position known as naturalism or materialism. Evolutionary scientists assume that nature is all there is, and that nature is composed of material entities, the particles that physicists study. It follows logically, that science must and can explain the origin of complex living organisms solely by natural causes, meaning unintelligent causes. God may not create directly, nor may God direct evolution, because God is an intelligent Being, and evolution is by definition a mindless process.

And yet, even according to the leading Darwinist Richard Dawkins, "Biology is the study of complicated things that give the appearance of having been designed for a purpose." Is it possible that they appear that way because they actually were designed and there really is a Designer? Evolutionary biologists emphatically answer No, not because of the evidence, but because their philosophy effectively excludes that Designer from reality. They insist, against the evidence, that unguided chemical processes can produce living organisms from non-living chemicals, and that a combination of random mutations and natural selection can, given enough time, produce complex plants and animals from single-celled ancestors through a mindless process.

These far-reaching claims loaded with religious implications are not supported by the scientific evidence. My colleagues and I want to separate the real science from the materialist philosophy that provides the only real support for this Darwinist theory.

MK: Thank you Professor Johnson. An opening statement from Ms. Scott.

Eugenie Scott (ES): Now hearing Phil define evolution is a little bit like having Madalyn Murray O'Hair define Christianity. Let me define evolution the way scientists define evolution, the way we're going to use it on our side of the table. Evolution is used two ways: one, is a bigger idea, that the present is different from the past, that the universe has had a history, that stars, galaxies, the planet earth, plants and animals on it have changed through time. Biological evolution is a subset of the idea of change through time, saying that living things, plants and animals, have shared common ancestors, and have descended with modification from those ancestors.

Now notice in this definition, I talked about what happened. I didn't talk about "who done it," and I didn't talk about "how." Because those are separate issues. Scientists are very much united on what happened. Evolution happened -- to modify a bumper sticker. But *how* it happened is something that we argue about

a lot in science -- how important is natural selection, how important are other mechanisms. "Who done it" is something that as scientists we can't comment on as scientists. We can put on our philosopher's hat and comment as individuals, but as scientists we can't deal with ultimate cause. So I think we have to be very clear about what *we* mean by evolution, what *they* mean by evolution is some sort of a metaphysical system that we do not recognize.

MK: Thank you Ms. Scott. You have five minutes to question Ms. Scott, Professor.

PJ: Yes, do you say that Darwinian evolution does not have a profound religious implication of discouraging belief that there is an intelligent Creator who brought about our existence for a purpose?

ES: I think that to some people, yes. Natural selection -- "Darwinism" is evolution through natural selection -- does cause problems. If your theology requires you to interpret the Bible literally, six 24-hour days, 10000 years ago, and so forth, you're going to have a problem --

PJ: But only for biblical literalists. Not for the proposition that I asked about, which is that a Creator brought about our existence for a purpose.

ES: I don't think so, in the broader sense. Because, for example, there was a survey done not too long ago, of American men and women of science. And one of the questions that they asked was something on the order of -- Evolution occurred -- human beings were -- human beings evolved, but God directed the process. 40% of scientists agreed with that, which is the same as the general public. So clearly the idea of evolution can't be totally --

PJ: Well -- we don't know whether they were evolutionary biologists, do we? They weren't -- we aren't talking about Richard Dawkins, Stephen Jay Gould, Richard Lewontin, in that poll, are we?

ES: There are evolutionary biologists who have made something of a philosophical statement out of evolution. You and I both agree with that. But I think you have to be careful about not tarring all evolutionary biologists with that brush.

PJ: Let's get to that statement. Are you familiar with this kind of a symbol, that --

ES: I am indeed.

PJ: -- the fish here that says "Jesus" in it. You see it on cars. And then you're familiar with this one too?

ES: I am indeed.

PJ: And is it your view that the relationship -- the resemblance between these two is not coincidental? [audience laughs]

ES: Oh, not at all. Not at all.

PJ: Uh, this is what we call "evidence of intelligent design." [laughs]

ES: You might consider it an evolution of the fish. But --

PJ: Yes, and -- now so in fact this is put out to mock the Christian fish symbol, isn't it? With Darwin there right in the place of Jesus.

ES: I suspect some people consider it a form of mockery. I have also, driving around Berkeley, I don't

know how unusual Berkeley is from other cities in the country but -- I have seen the Darwin fish and the Christian fish facing each other on bumpers. So obviously not everybody -- that's a rather ecumenical car there I think. [laughs]

PJ: Well, I notice here I have a letter from the National Center for Science Education, signed by you, and I notice Professor Ruse and Professor Miller are on the letterhead. And it says -- your letter says, "quite a few NCSE members sport the Darwin fish on their cars, and for a $50 donation I'd be delighted to send you something new, a sturdy Darwin fish refrigerator magnet, also good for keeping things in your filing cabinet." So you rather thought that would have quite an appeal to the members of your organization, didn't you?

ES: I sort of wish I was Gerry Brown and I could hold up an 800 number here so you could all call and donate to the National Center for Science Education but -- Yeah, a lot of our members are people who are very concerned about the teaching of evolution in the public schools, so therefore they find the Darwin fish attractive. You'll notice as a member of NCSE and somebody who receives our newsletter, we don't advertise it in the newsletter. We don't make a big point of sort of trying to --

PJ: That's just for the members.

ES: Because some people are offended by it. We're not in the business of offending Christians.

PJ: Now, you are aware, and I think you're quite willing to agree with me on this, that whatever may be the ultimate truth of this, many people do use Darwinian evolution as an argument for atheism.

ES: Correct.

PJ: Uh, and in fact the impression is widely around that this is done with the approval of -- tacit approval at least of the scientific establishment. Richard Dawkins goes around the world arguing this, without being criticized by authoritative sources. And Carl Sagan who did that famous Cosmos series, saying "the cosmos is all there is, or ever was, or ever will be" -- was honored with a public welfare medal by the National Academy of Sciences. So there is some reason for people to think this. And I think your participation in changing the National Association of Biology Teacher's statement also indicated that. Now --

ES: Wait, wait a minute. The statement was changed in the way that you --

PJ: Yes, I understand that but I mean that there was some reason for concern in the --

ES: Yeah, absolutely. Absolutely.

PJ: -- final version of the statement. Yes, I wasn't -- I was just trying to agree with you there.

ES: Correct.

PJ: Now, I'm trying to help you with this credibility problem. [laughs] And what I wonder is, wouldn't it be a good idea at this point if the National Academy of Sciences which so vigorously addressed these issues when it was fighting the legal battle against creation science -- took the issue up again. And developed a panel -- the last time they appointed seven scientists and four lawyers to this panel, so Mr. Lynn and I could both be there -- to address the question what is the message they want to send to the public. Do they want to send the public the message that evolution is an unsupervised, unintelligent, impersonal process? Do they want to send a message that is so effectively used for promotion of atheistic materialism? Or do they want to criticize that as non-science? Wouldn't it be a good idea --

MK: You can answer that question --

PJ: Yes, wouldn't it be a good idea, to take that up?

ES: There are about nine questions --

PJ: Would you agree with me that they should take it up?

ES: Okay, well, I said -- there are things you said that I agree with, and things you said that I don't agree with. Let's start with the places where we agree. I agree that many scientists have been very sloppy about how they use terms like natural selection, purpose, etc -- and I for one, as Phil has kindly pointed out, have criticized this, I've criticized Dawkins. Many other scientists have at all. I am not a believer. I would agree philosophically with Richard Dawkins. But I don't think that he should be confusing his philosophical views with science. He shouldn't be passing his philosophical views about materialism off as if they're inevitably arising from evolution. So I think that, in order to encourage you, I think we are going to see more things like the NABT statement. We're going to see more recognition on the part of the science and education communities, that indeed we have to be more careful with how we use terms. And I accept that.

MK: You can -- you can ask --

ES: The good news is that the National Academy of Science is re-writing the "Science and Creationism" booklet and I am on the committee that's advising --

PJ: Yes, I know. It's a very one-sided movement.

ES: Well, one-sided in the sense we're all in favor of the teaching of evolution. That's doesn't sound too strange.

MK: Take this opportunity to ask some questions.

ES: Yes, sir. In my reading of your materials, Phil, I see that you have argued three things. Evolution, which I have just defined as "descent with modification" -- doesn't happen. A second thing that you argue is that Darwinism which is natural selection -- evolution by natural selection -- Darwin -- natural selection is not a powerful enough mechanism to produce descent with modification. A third thing I see in your writings, is that science and especially evolution, is inherently a metaphysical belief system. Now, lawyers are used to hypothetical questions, so if you don't mind my asking you a hypothetical question?

PJ: Don't mind at all.

ES: If you could wave a wand over this audience, and make everyone here in this audience, agree with one of those points. Which is your most important one? What really grabs you?

PJ: There's no doubt about what the key point is. By the way, of course I don't deny there is such a thing as descent with modification, the question is how much it explains, this descent. But the key question, and the only really important one from a philosophical and cultural standpoint is the mechanism. Can you make those things that look as if they were designed for a purpose, those extremely complicated, irreducibly complex biological organisms through a mindless, material process? Specifically, the accumulation of micro-mutations through natural selection. The mechanism is the big issue.

ES: Number two in other words. If I could follow up with that. Are you aware of the arguments that are going on in evolutionary biology today in which the role of natural selection is debated. There already is

quite a conversation --

PJ: I am very aware --

ES: -- as to how much natural selection explains. Uh, what about the other mechanisms that are suggested to produce evolutionary change?

PJ: There aren't really any other mechanisms, that's why natural selection remains. And you can see this whenever the criticism comes up --

ES: Well --

PJ: It's very effective criticism from Stephen Jay Gould and others. But there is no alternative to do the adaptation-building process. And Gould himself says that in his recent article "Darwinian Fundamentalism."

ES: But even you agree that natural selection is adequate for producing microevolutionary processes?

[see graphic **A** -- Finches from the Galapagos]

PJ: Well, microevolution is misnamed. Natural selection as in, for example, the Finch beak variation example, brings out the variation already present in the gene pool in a fundamentally stable population, it doesn't create anything --

MK: How, how about explaining that?

PJ: Yes, Finch beaks? In a population of birds on an island --

ES: Well, breeds of dogs.

PJ: -- the Finch beaks are a little larger sometimes, a little smaller sometimes, on the average the population is essentially stable, it isn't going anywhere and isn't changing into anything.

ES: What do you -- what is your unit of change that microevolution applies to?

PJ: The question --

ES: What is a "kind" in other words?

PJ: Yeah, the question is the source of genetic information.

ES: No, no, no, there's --

PJ: They're much more complex than a computer program or a spaceship. What is the origin of that information? When you got a gene pool with all that information in it, it can vary within limits.

ES: I'm sorry, Phil, I didn't make my question clear. You talk about species of Finch on an island and the amount of genetic variability in that species. And your argument I think is you just get changed within the kind. What is a "kind" ? I mean, so if dogs are a kind, are wolves part of that kind? If dogs and wolves are part of the kind, are coyotes part of the kind? What's the limit of genetic variability, what's the group, what's the unit that you're talking about in which microevolution can take place?

PJ: Yes, I don't think we know precisely what the limits of variation are. With domestic animal breeding you haven't been able even to get speciation.

ES: Oh, no. [chuckles]

PJ: I think there's good circumstantial evidence there may have been wider change and development at some time in the past by mechanisms that aren't understood. What you clearly don't get, is the classes, the phyla, the major groups, the major innovations and complex organs that way.

MK: Thank you very much, both of you. [audience applause]

Mike Behe vs. Ken Miller

MK: Professor Behe, you're on. An opening statement from Professor Behe.

Michael Behe (MB): Several key scientific discoveries point strongly to the conclusion that the universe and life are the products of intelligent activity. Those discoveries are: first, that the universe had a beginning; second, that the universe is finely-tuned for the existence of life; third, is the intractability of the question of the origin of life; and fourth, is the discovery of massive interactive complexity in the cell. Let me explain this fourth point. The cell is run by molecular machines. For example, in the first figure, it shows the bacterial flagellum, which is literally an outboard-motor that bacteria use to swim, with a rotor, stator, bushings, drive-shaft, and more. The interactive complexity of the parts of the flagellum appears to indicate that the machine was purposely designed. Science should not shy away from that idea.

[see graphic **B** -- The Bacterial Flagellum]

The second figure shows the familiar drawing of very similar embryos of fish, salamander, chicken, and human gradually turning into different forms. Recent work, however, has shown that the drawing is fraudulent, faked by a man named Ernst Haeckel in the 19th century. Thus a big problem that Darwinism was thought to have solved -- embryology -- turns out not to have been solved after all. Such strong challenges both new and old show the need to break out of Darwinian patterns of thought, beginning with the acknowledgement that much of life and the universe appears purposely designed.

[see graphic **C** -- Haeckel's Embryos]

MK: Thank you Professor Behe. [audience applause] Professor Miller?

Kenneth Miller (KM): Michael, I'd like to start out by pouncing upon the notion of irreducible complexity which is a point that you make again and again in your book, *Darwin's Black Box*. On page 43 of this book, you use a mousetrap as an example of irreducible complexity, it's right here in the book. And you point out that a mousetrap has five parts, and like a biochemical system you claim that if you take one of those parts away, it won't work anymore. The five parts include the base, the spring, the clapper which does the business end, a catch, and a little piece to hold the bait. And I have a working mousetrap here, it's actually a rat-trap so I want to be very careful with my fingers. I have here another trap from which I have removed a part. I've taken away the -- the trigger. According to Dr. Behe's analogy of the mousetrap as irreducibly complex, I have now removed a part and therefore it must not work. And this applies to biochemical systems as well. Exercising as much care as I can -- I am going to take the catch -- [the trap slips] whoops a little more care --

MB: Is that relevant to the argument there? [laughter]

KM: It is directly relevant, Mike. And I'm going to set it up, and what I have done is to remove one part

and modify another. I hope the cameras can see this, I want to demonstrate to the audience that the working mousetrap works just fine [Click!] -- and I want to demonstrate to the audience that the one that Dr. Behe said was irreducibly complex, if we remove a part, he says it won't work anymore. [Click!]

[see graphic **D** -- mousetrap]

MK: Uh, can one of you --

KM: It looks like it works fine.

MK: Can one of you explain the significance of irreducible complexity? [laughter]

KM: I would be delighted to since I'm asking the questions.

MB: Is there a question in here somewhere?

KM: The argument -- the question is straightforward. The argument is that when you see a system made up of multiple parts, such as a biochemical system, if you take one of those parts away it will not work, and therefore the separate parts could not have evolved. And what I've just shown you is that your analogy which you used -- to the mice trap -- the mousetrap first of all, is flawed. And secondly, it doesn't apply to biochemistry either because biochemical systems can often function missing one of their parts. Isn't that true?

MB: Well, it turns out it is not true. Since my book has come out, a number of people have Emailed me and sent me letters about ways that perhaps a mousetrap could function without all of those parts. And it turns out that Professor Miller didn't do away with the catch, he used another part of the mousetrap as a catch. The mousetrap still needs those five parts. And the absence of something functioning as a catch, it just doesn't work.

KM: Now, let me --

MB: Other people -- other people have Emailed me that perhaps you can do away with the platform -- you can do away with the platform by nailing all of the parts --

KM: Michael, let me, let me go ahead right now --

MB: -- of the mousetrap to the floor. Just a second.

KM: -- rather than hear your speech about the mousetrap and explain why this is biochemically relevant.

MB: Listen, you asked a two-minute question in my five-minute time --

MK: Yeah, yeah. I agree, I agree. You get some time.

MB: Somebody Emailed me that you do not need the platform either to make the mousetrap work. All you have to do is take the parts and nail them to the floor, and then it works just fine. Well, you know, you're using the floor as the platform. So you can use a rock as a catch, or something. The point is you need all those functions. And in my book, which Ken alluded to, I explain why many biochemical systems are like that too. You need all those functions to make them work.

KM: Now let's see if that's correct. Let's take a real biological example. In the chart that I have here, what I have shown basically is a very complicated chemical pathway in which fucose, a sugar is metabolized. It turns out that if you carry out experiments in which you delete the gene, which produces

the enzyme that metabolizes fucose, under controlled conditions where you can observe them, what happens in a few generations is that the bacteria evolve a new enzyme. They evolve an enzyme that works in the reverse direction, they do it by modification of pre-existing genes, and they evolve a new biochemical pathway. This Michael, I would suggest is the exact thing which you are claiming is impossible and yet it can be routinely observed under laboratory conditions. Again, isn't that true?

MB: Well, I disagree with you. No, that is not irreducibly complex. Additionally --

KM: Can you explain why it's not irreducibly complex? It's got all the parts.

MK: Can someone take a crack at explaining what irreducible complexity is?

MB: Let me do something else. Instead of having a biochemistry lecture here, my book in which I explain these concepts which cannot be explained very well in a few minutes, has been reviewed by a number of scientists. What have they said? In *National Review*, it was reviewed by a --

KM: Excuse me, I would suggest that a discussion of Dr. Behe's reviews is not relevant to the question.

MK: No, no. Well, I'm allowing him 30 or 40 seconds.

MB: James Shapiro, a biochemist -- a professor of biochemistry at the University of Chicago wrote in *National Review*: "There are no detailed Darwinian accounts for the evolution of any fundamental biochemical or cellular system. Only a variety of wishful speculations." So apparently he does not think that this is a relevant example either. Jerry Coyne, an evolutionary biologist at the University of Chicago, wrote in *Nature*, the world's leading science magazine -- science journal: "There is no doubt that the pathways described by Behe are dauntingly complex and their evolution will be hard to unravel. We may forever be unable to envisage the first proto-pathways."

KM: May I ask a question --

MB: *Nobody* has claimed that these things have been explained.

MK: Now guess what, we're out of time. Thanks very much Mr. Behe. [audience applause]

MB: You bet.

MK: Professor Ruse? Professor Ruse, you're up. Professor Ruse will make an opening statement and then submit to questioning.

Michael Ruse vs. Panel

Michael Ruse (MR): I've been told I've got a minute and a half to make an opening statement. I'm a philosopher. I've never said anything in a minute and a half I'm afraid. I can't even get to the verbs in a minute and a half, so let me make my points very quickly. I -- I accept evolution, the fact of evolution, so you know where I stand on that. I believe in a tree-life form all the way up to us, from some 4 billion years ago. I am myself a Darwinian, I think that natural selection is the major mechanism. I recognize that there is significant debate amongst evolutionists as to how far natural selection goes. I think we all accept natural selection probably as the major mechanism. Most don't go as far as I do, and Richard Dawkins do, but certainly I accept natural selection. Creation -- I quite often use the word creation in my writings, and I don't mean it sarcastically any more than Charles Darwin did. However, I don't accept Creationism with a capital "C" -- I think that this is a form of fundamentalist religion. I don't think it's science, I certainly don't think it's good science, but frankly folks, I don't think it's very good religion either, whether you're a Protestant, whether you're a Catholic, or whether you're a Jew or any other of the

major religions. So that's where I stand.

MK: Thank you Professor Ruse. [audience applause] Professor Johnson?

PJ: Michael, in your book *Darwinism Defended*, you say that "Many contemporary Darwinists show a strong liberal commitment in their politics and sexual morality, whereas advocates of creation want to go back to a strict biblical morality." And you conclude the chapter by saying, "Darwinism has a great past. Let us work to see that it has an even greater future." Isn't that something very inappropriate to say of a scientific theory? Do you ever hear anyone say "gravity has had a great past, let's work together to see that it has a great future."

MR: [chuckles] Well, why not Phil? Why not indeed? I mean, I'm all in favor of gravity having a great future. [audience laughter] In fact, I'm taking a plane tomorrow, I'll be very worried if gravity gives up. No, I mean, the point is it's certainly the case that many Darwinians, many evolutionists have been liberal, but by no means all. You know and I know, that there have been many evolutionists who've been, I won't say to the right of Mr. Buckley, but certainly in that corner if you know what I mean. Certainly there have been Darwinians, Sir Ronald Fischer, I mean his social views, you know, make one sort of wake up in the middle of the night and sweat [laughs]. So certainly, well make me anyhow. Certainly, lots of people have held conservative views. I suspect you're probably right, I suspect that most scientists today accept more liberal views than conservative views. But I don't see an absolute connection. But I do agree, I do hope that Darwinism does have a great future, and I hope that you and I can contribute together to do this.

David Berlinski (DB): Well, we're going to do our best to see that it doesn't have a great future.

MR: [chuckles]

DB: You've given a very sonorous description of change in the universe. I'm wondering whether your worldview includes a scientific theory, that would be recognizable by any physicist or a mathematician? Things change I entirely agree, they do change. Is there something to Darwinism beyond that?

MR: I got the kind of feeling that this is the kind of question, if I say "Yes" you're going to catch me --

DB: That's why I asked it.

MR: -- of course, and if I say "No" you're going to catch me too.

DB: That's precisely right.

MR: Of course my worldview accepts scientific theories, my worldview accepts theories of physics, theories of geology, biology --

DB: Yes, but where is the scientific theory of biology that you are proposing to endorse? Where is the theory?

MR: Right. Yes, I think that Darwinism -- Darwinism is a scientific theory. Of course I think --

DB: And the Mississippi is a river, but where is the theory beyond having named?

MR: Where is the theory?

DB: Yes. Where is it? I've never been able to discern it. Simply saying that things change is not a theory.

MR: You and I are both philosophically trained, and you know that we're both into rhetoric at this point. Because you know perfectly well --

DB: That's all there is.

MR: No, no, let's be serious about this for a moment. You know perfectly well, if you look at the works -- say the writings of somebody like Richard Lewontin, you're certainly -- and his mentor Dobzhansky -- you're certainly going to find theories there. Where people are putting forward Mendelian Genetics, they're putting forward the Hardy-Weinberg Law, where people are showing how selection can work on this. Where they went out, studied fruit flies, both in nature and experimentation --

DB: Yes, I agree entirely, the emphasis of the question can always be displaced by the mechanism of fog dispersion. My question is, with respect to the great, aching, global questions of life, where is the theory that you propose as an explanation? Does it go beyond the mantra random mutation and natural selection or is there some solid theory that a physicist would recognize, that an engineer can implement?

MR: [chuckles] Well I don't accept the word "mantra" you see -- once again you're using a persuasive definition which you're slipping in there. Of course it's a global theory. If you go say, to island biogeography, the work that Darwin did, looking at the Finches, looking at the reptiles on the Galapagos. Why are they similar, but different? Similar to South America, not similar to Africa? Because they came there, and they evolved.

MK: Mr Ruse. Mr. Behe, I'm sorry.

MB: Michael, uh --

MR: Michael vs. Michael.

MB: [chuckles] In 1989, the editor of *Nature* magazine John Maddox wrote an editorial with the interesting title "Down with the Big Bang." And in it he wrote: "Creationists, and those of similar persuasions seeking support for their opinions have ample justification in the doctrine of the Big Bang. That they might say is when and how the universe was created." And he didn't like that and declared it to be "philosophically unacceptable," the Big Bang theory. So my question is, as a philosopher, do you think scientists use non-scientific criteria sometimes for their evaluation of theories?

MR: Oh, absolutely, no question about that. But I'm not doing so at the moment. [chuckles]

MB: But John Maddox may have done so in the past?

MR: Well, he's an editor. [chuckles]

MK: Mr. Berlinski, do you want to continue? Or Mr. Buckley?

WB: To what extent do we rely on metaphors in exchanges of this kind? The -- You've resisted Mr. Johnson's saying that -- in such arguments metaphors have been loaded and are tendentious. You say well, you're not doing that. Does that mean you disavow those who do, as a matter of -- as a philosophical matter, or simply as a polemical matter?

MR: No, Mr. Buckley. I take metaphor very seriously. I think that, one uses metaphors in religious contexts, certainly in political contexts, and there's no question but that one uses them in scientific contexts as well. I mean, Natural Selection, Struggle for Existence, Arms Race today, Selfish Gene, I mean these are all metaphors. So I fully accept that science, contemporary science if you like, is loaded with metaphors. I've never denied that. But the question is, where do you go from there? Does that mean

it's purely a human creation? Or does that mean that having devised a theory, whether it's Behe's theory, or somebody else's theory, can we then go out and check it against the world? And I think that one can in science, and I think that despite what Mr. Berlinski says, I think that one can in evolutionary biology. And evolutionary biologists do just that.

MK: Thank you Mr. Ruse. [audience applause] Mr. Berlinski? Mr. Berlinski, it's your opportunity to make an opening statement. It's your opportunity to make an opening statement.

David Berlinski vs. Panel

DB: Darwin's theory of evolution is the last of the great 19th century mystery religions. And as we speak it is now following Freudianism and Marxism into the nether regions, and I'm quite sure that Freud, Marx, and Darwin are commiserating one with the other, in the dark dungeon where discarded gods gather. [audience laughs] The problem facing us at the end of the 20th century with a magnificent body of theoretical accomplishments in physics and mathematics, and a very rich body of descriptive material in biology, is to come to an understanding that when it comes to the large global issues that Darwin's theory is intended to address, we simply do not have a clue. This is a daunting admission to make, but if we're intellectually honest, we should make it. The mechanism that Darwin proposed, that of random search or a stochastic shuffle in known to be inadequate in every domain in which it's applied. It's known to be inadequate in linguistics, and it's certainly inadequate when it comes to the overwhelming complexity of living forms. There is no reason on earth to believe that this mechanism is adequate to the task that it sets itself.

If it should come to pass in the fullness of time that we discover that there is no explanation for life, we will have to accept it. If it should come to pass that we discover in the fullness of time that the only explanation for life is that it is a process designed for transcendental purposes by a transcendental figure, we will have to accept that too. And if that should come to pass, I would like to ask, who among us will genuinely feel diminished? Thank you.

MK: Don't go away. [audience applause]

DB: Don't go away.

MK: Barry Lynn?

BL: Mr. Berlinski, I do want to commend you for the rich description of biological systems and species in your *Commentary* article. You claim that there are some species that have what you at one point refer to as weird characteristics that are nearly unique. For example, only a few plants eat insects, are carnivorous, why aren't all of them? You also ask, if evolution is true, "Then why are women, but not cats, born without the sleek tails that would make them even more alluring than they already are?" [audience chuckles] Well now, aside from aesthetics, you know I saw the Catwoman / Batman film too [chuckles], but aside from that, why -- you don't seem to understand that different ecological environments in the distant past, as well as today, produce different adaptations. Why is that so strange to you that you would find it --

DB: You're right, I don't understand it.

BL: -- as a failure of evolution?

DB: You're right, I don't understand it. It makes no sense scientifically.

BL: You don't understand that different ecological spaces require different adaptability? They're the same kind --

DB: No.

BL: You don't? Well it seems fairly easy to figure out, that if you're living in a desert --

DB: That is the difficulty with the Darwinian --

BL: -- finding water would be more --

DB: -- it's always easy to persuade yourself that you've understood something when you haven't understood a thing. The issue before us is not whether retroactively we can explain an adaptation, but whether we can draw that adaptation from general principles. This is what Darwinian theory cannot do, and this is -- this is the requirement of normal science.

BL: Well, I think --

DB: If I'm doing astrophysics I have a dynamical theory. I can simulate the evolution of the universe and I know where the theory agrees with the data and where it does not. I cannot do that in biology. Whatever happens, happens.

BL: Well, with a simple sentence you could: random selections which make a species -- a species more likely to survive are beneficial. That's a very simple idea and it explains why in fact some species survive and others do not.

ES: I mean, adaptive differential reproduction is the definition of natural selection. Why is this a problem? Why is this a problem?

DB: Que sera sera. What will happen, will happen. That could not be the locus in which you repose your trust. What will happen, will happen. Big deal.

ES: No, no, no, that's not -- No, adaptive differential reproduction is not "what will happen, will happen." Let me ask another question.

MK: Explain -- why don't you explain what that term means.

ES: Well, I don't know, it may just -- it may not necessarily enlighten our listeners actually because it is technical. But that's the whole point.

DB: It's not technical. It's just means what survives, survives. We know that.

ES: One of the reasons -- one of the reasons why people like me who deal with the creation-evolution issue all the time, get very frustrated dealing with say, Institute for Creation Research people and so forth, is because they are constantly saying "X" didn't happen, and then it takes a great deal longer to explain why "X" did happen, gaps in the fossil record or whatever. Let me ask you a question about your *Commentary* article. The major -- you said in your *Commentary* article, page 20, "the major transitional sequences in the fossil record are incomplete."

DB: Yes, they are.

ES: And you cited as your reference, Romer's hot-off-the-press 1966 article. Now, are you -- Romer. Romer is a very great man and very knowledgeable. 1966 is not exactly cutting-edge paleontology. Are you familiar sir --

DB: You're absolutely right. Let's turn to Carroll --

ES: No, no, no. Let's -- Are you familiar with the research that's been done in the last 31 years?

DB: Hm, hm.

ES: I can't imagine that [audience chuckles] because you would realize that the major argument going on among paleontologists dealing with the reptile-mammal transition is, where the hell do you draw the line? These things grade insensibly into each other --

DB: Is there a question that I can answer?

ES: -- and they have no ability to say, these guys are mammals, these guys are reptiles, because they roll into each other.

DB: Yes, I agree with the tail-end of your question, late reptilian transition to mammal is well documented in the record, although nowhere near as well as Darwinian theory requires. That's a big distinction. But if you dislike the citation to Romer who's a great figure in paleontology, let's look at Carroll's new book on chordate paleontology, hot-off-the-presses, page 4, left side of the page, Evolution heading, third paragraph, second sentence, what does he say? He says the evidence shows that major transitions are missing from the fossil record just as Eldredge, Gould, and Stanley claim.

ES: In reference to the chordates. Now the fact that we don't have --

DB: But that's the strongest case. That's the strongest case.

ES: -- all the information -- The fact that we don't have all the infor -- No, I was talking about the reptile-mammal transition. The chordates are very very much earlier than that.

[several talking at once]

DB: If you turn to the insects, the situation is catastrophic. There is no fossil documentation, none whatsoever.

ES: Of what?

DB: For the insects.

ES: There is very good fossil documentation --

DB: Very poor. Butterfly, Lepodoptera? Bang.

ES: -- of the relationship between ants and wasps. There's excellent transitions -- oh, but we won't count those -- let's talk about the missing, the ones we don't have --

DB: Yes, there's lateral transitions -- but Lepodoptera, spiders, major insect groups? They simply appear.

BL: Mr. Berlinski, you're never going to be satisfied.

DB: You're right.

BL: Every time we find 16 new things, new fossils to fill in the so-called fossil record that was missing,

you just say, fine --16 more -- so my question to you is how many 16 to the what power do we have to discover before you accept this as true?

DB: I'll tell you exactly, here's what Darwinian theory rigorously requires. For every significant -- every significant morphological or physiological feature in a modern species we should have a panoply of intermediate forms that explains how they arise.

ES: No, no, [chuckles] that's not what Darwinian theory requires.

DB: We don't have them for some good reasons, but we have nothing like an explanation for the gaps that exist --

BL: The fog is rolling in again.

DB: I'm telling you, the species aren't there.

ES: We were talking first of all about evolution, descent with modification, now we shift over to mechanisms of evolution --

DB: No, I haven't mentioned mechanisms.

MK: And we're out of time. [audience applause] Thank you very much Mr. Berlinski. Professor Miller? Professor Miller, it's your chance to make an opening statement.

Kenneth Miller vs. Panel

MK: With more props.

[see graphic **E** -- Geological Periods]

KM: Can't live without them. I can't tell you how much I enjoyed Dr. Berlinski's statement, because he focused in on one of the major deficiencies of the four people on the other side of the table who argue against evolution, and that major theoretical deficiency is they have no explanation for natural history. And to me as an experimental biologist I am frustrated if I do not see a theoretical framework into which the past can be explained. We know something about the past, and there are facts about the fossil record, and I'll tell you in a very general way one of those facts. And that is that fossils show a succession of types over time.

Now we know the other side advocates intelligent design as a primary characteristic of the fossil record. Let's explore the primary scientific characteristic of intelligent design when it is squared with the fossil record. The fossil record, and I can give you specific examples, is characterized best by a sequence of appearances and disappearances. Now think what that means. What that means is that the characteristic that best describes the intelligent designer who would have designed this fossil record is incompetence. Because everything the intelligent designer designed, with about 1% exception, has immediately become extinct. Intelligent design has ***no*** explanation for the successive character of the fossil record. Evolution has a perfect explanation, and that is the appearance of new forms and the extinction of others. And if you see a scheme for the natural history of intelligent design presented by the other side tonight, you should treasure it, because they've never announced one before.

MK: Thank you Mr. Miller, don't go away. [audience applause] Mr. Behe?

MB: Ken, in my introductory remarks I showed a picture of Haeckel's Embryos, those little drawings of embryos looking the same and gradually turning into --

KM: Indeed you did, and I'm going to give you a hand, because the picture that you have right here, I have brought an enlarged copy just to help you out.

[see graphic **C** -- Haeckel's Embryos]

MB: Okay, thanks very much.

KM: Anything, Mike, anything I can do. [audience chuckles]

MB: And, and you'll notice that it says in *Science* magazine of a couple months ago, "Haeckels Embryos, Fraud Rediscovered."

KM: Absolutely.

MB: And which it says, not only did Haeckel add or omit features, Richardson and his colleagues report, but he also fudged the scale, and the author of the report says, "it looks like it's turning out to be one of the most famous fakes in biology." Now in your very good biology textbook --

KM: Thank you.

MB: -- for high school, it reproduces Haeckel's drawings, and it uses them in the section of how we know evolution occurred, and it points to them as saying that embryos should be preserved in the early stages. Now my question is --

KM: Embryos should be *preserved* in the early stages?

MB: Well, embryos -- *conserved* in the early stages.

KM: Okay, I think we should all be preserved in our early stages.

MB: [chuckles] My question is this, you know, you were victimized by Haeckel's fraud --

KM: Indeed.

MB: -- as was everybody else, but should -- do you think your publisher should notify school districts to have them tell teachers to point this mistake -- or this fraudulent activity out to students?

[see graphic **F** -- True Embryos]

KM: Oh absolutely. And I will do better than that. First of all, the letters to my publisher changing these figures are already off, and secondly what I have done for the textbook -- and I appreciate the commercial for this, and I'd be glad to give the URL for those of you who are interested -- is Joe Levine and I, my co-author have set up an Internet web site in which we keep scientific updates to our textbook. And this is something which will go up in the web site in a matter of days as a scientific update. I think it's very significant and I appreciate your support on this.

MB: That's great. I just have one more question if I can squeeze it in --

MK: Okay, maybe we'll get back to you. Mr. Berlinski? Professor Johnson?

PJ: In my discussion with Eugenie we talked about the mechanism as the all-important thing, and the creative power of the mutation selection mechanism as to produce all this genetic information.

KM: Indeed.

PJ: What is the most powerful demonstration in your opinion that the Darwinian mechanism of natural selection has this great creative power?

[see graphic **G --** Hawaiian Moth/Butterfly]

KM: Well, I would give you -- you asked me for *the* most powerful one, and I will give you two. The first one that I will give you are the repeated observations of random mutation and natural selection as you like to call them in your own terms, producing new species. And I can give you several examples of new species that have emerged within human observation. The best example that I can give you is the butterfly, the genus of butterfly known as Hedylepta. Hedylepta is a genus of butterfly that feeds on various plants, it's endemic to the Hawaiian Islands, which means it's only found there. And there turn out to be two species of Hedylepta with mouthparts that only allow them -- only allow them to feed on bananas. Now why is that significant? It is significant because bananas are not native to the Hawaiian Islands. They were introduced about 1000 years ago by the Polynesians, we know this from the written records of the Hawaiian kingdom. And what that means is, that by mutation and natural selection, these two species have emerged on the Hawaiian Islands within the last 1000 years. And I think that's a very good case in point.

And I'll give you another one if you would indulge me -- but I figured, you only asked for one. Want another?

PJ: Sure, go ahead. [audience chuckles]

KM: Okay, here's another. In the November 7th or November 14th issue of *Science* magazine, a number of investigators wanted to test the Darwinian hypothesis that you folks say is never tested. And the way in which they did this was to take the receptor protein for the human-growth hormone, it's a receptor to which the human-growth hormone fits in precisely. And they did it a terrible genetic disservice. They mutated -- they cut out an essential amino acid, right in the middle of the receptor called Tryptophan. With that gone, just like that mousetrap, it wouldn't have been expected to work. They then allowed a natural selection process to take place to see whether the cells under their own observation could mutate the receptor gene sufficiently to bind the receptor. And after seven generations, lo and behold, there it was. And it illustrates beautifully the ability of natural selection to respond to mutations and proteins to co-evolve.

MK: Mr. Behe?

MB: I'd like to ask a different question -- I do not find that result impressive, but we can talk about that later --

KM: When you say you don't find it impressive, that's what Richard Dawkins calls, "the argument from personal incredulity" -- which is my evidence --

PJ: But you realize -- No -- [audience chuckles]

KM: -- my evidence against evolution is that I don't believe it.

PJ: Well, it's because -- it's because as far as what it has to do. It has to create this immense amount of genetic information, much more complex than any --

KM: Indeed, sir -- Philip, you're right --

PJ: -- and without recording it in the fossil record. That's why it's not impressive.

KM: -- you know what Phil, I just gave you two examples, and that's still not enough.

MB: May I ask another question related to Haeckel's embryos?

KM: Oh absolutely.

MB: You not only showed these embryos in your book, but like other people, you said that things should be that way. You said in your book, uh -- "mutations that affect early stage of development are likely to be lethal or deadly." And that "mutations that cause less drastic changes would occur at later stages." Again, you're not alone in this. Bruce Alberts, who wrote *Molecular Biology of the Cell*, says much the same thing. Now we know that is not the case, and that early embryos can in fact change. Because you and Bruce Alberts, the president of the National Academy of Sciences --

MK: Is there a question?

MB: Yes, here it is. [chuckles] Because you two did not -- because you thought Darwinism would produce this result which is now shown to be fraudulent, is it safe to say that no scientist in the world understands how Darwinism could affect embryology?

KM: Oh absolutely not. May I answer even though we are out of time?

MK: Very briefly.

KM: Okay very brief answer is, you read a quote and you pretended it meant something else. The quote that you read was mutations in the early stage are "less likely" to survive, not impossible, and then you pretended to say that it meant that it couldn't survive. The fact that something is less likely --

MB: You pointed to the figure --

KM: -- the fact that something is less likely, I'm answering -- the fact that something is less likely does not rule it out. I agree with that, Alberts would agree with that, and I think everyone in the audience would agree --

MK: Thank you. Thank you Professor Miller. [audience applause]

KM: Thank you.

William Buckley vs. Panel

MK: Mr. Buckley will now submit to questioning from the opposition team.

MR: Um, let me kick off Mr. Buckley. I guess my basic question is, why are you on that side rather than ours? [audience chuckles] I mean, are your objections religious? Are you against evolution? Are you against natural selection? Are your objections religious? Are they social, or what?

WB: Well, I -- I object to the way in which your confederates -- we'll leave you out of it, as a matter of politesse -- conduct themselves. They conduct themselves by simply assuming that people who argue the contrary, are naives or ignorant. It seems to me manifestly they are not. But my objection to your position is its ideological fixity. What you're speaking from is a dogmatic position, from which everything else derives, as one would expect. Right? [audience chuckles]

MR: I can't help feeling that at Seton Hall University, speaking from a dogmatic position is not necessarily a fault. Um -- [chuckles]

WB: Well, no. That's -- that's quite correct. If you could give us a progenitor more conclusive than Darwin, we might accept his dogmas. The notion that all dogmas are equal is -- what?

MK: False.

WB: Well, at least false. But it's also -- it's also a disguise really for -- for unmethodical thought, I would guess. Go ahead, what -- what line are you pursuing?

MR: Well, I -- I -- basically I'm trying to understand why it is that you're against evolution. I mean, I could well understand -- is it because Richard Dawkins has linked evolution with atheism? Is it because some evolutionists have been socialists? Why? Because if it is, we'll give you a list that you'd like.

WB: No, let's not be silly. The -- for scientific materialists the materialism comes first, the science comes thereafter. So my quarrel, and that of most of my colleagues is with the -- the extent to which you seek to imperialize over the entire question to the point of opposing creationist thought in scientific departments within the schools. It seems to me quite unnecessary in order to advance your own postulates.

MK: Ms. Scott?

ES: Is it necessary to invoke the hand of the Almighty in something like understanding cell division, or understanding an internal combustion engine?

WB: No --

ES: If not, why is it necessary in understanding the history of life?

WB: It is so frustrating to say something then to have to say it again. I said in my opening statement, the second sentence, was that we don't demand that you acknowledge creation and displace evolution. We demand that you acknowledge creation as an alternative explanation, one which we find more plausible. Now this is as far as I am ready to go in this exchange. I am a practicing Catholic. Under the circumstances I've made certain commitments. But none of what I have said yet derives exclusively from that position. Mr. Berlinski is himself not a believer, and he's certainly eloquent in his dissent from your position.

ES: I think the -- well go ahead, Ken.

KM: Let me ask a question along those lines, because you bring up your faith. And I have to tell you that over the weekend, looking for a weakness, I read *Nearer, My God* your recent book, which I much admire. I thought it was a marvelous explanation of the faith that you and I share. And I want to read a quotation to you. And as everyone in the audience will know, I came tonight with the hope to be remembered as "the guy with the placards." [audience chuckles] And the quotation -- the quotation is an important one: "*...new knowledge has led to the recognition of more than a hypothesis in the theory of evolution. It is indeed remarkable that this theory has been progressively accepted by researchers following a series of discoveries in various fields of knowledge. The convergence, neither sought nor fabricated, of the results of work that was conducted independently is in itself a significant argument in favor of this theory.*" Would you care to speculate who said that, sir?

WB: [chuckles] Well, the answer is -- I have no quarrel with it. Within ten years after Darwin died, they were able to document to a point that he hadn't, in the 20 years since he had visited the Galapagos, certain phenomena. I have no quarrel with those phenomena. But I think it's correct to classify them as

microevolutionary, not macroevolutionary.

KM: Well, in that point I think you're in disagreement with Pope John Paul II, who made that statement.

WB: No, no, now wait a minute. Pope John Paul II said that he could not countenance any -- any explanation which sought to account for the forces of living matter other than -- as mere epiphenomena of the matter, and therefore incompatible with the truth about the man. I have no quarrel with --

KM: And as a Catholic I agree completely with that. And also as an evolutionary biologist I accept evolution as the scientific explanation for life's diversity.

MK: Thank you. [audience applause] Thank you, you're dismissed, yes. Barry Lynn, captain of the opposing team will submit to questioning from the affirmative team. Mr. Berlinski, would you like to start?

Barry Lynn vs. Panel

PJ: First question? Um -- Mr. Lynn, in the *New York Review of Books* this year, the famous Harvard biologist Richard Lewontin, who has a very low opinion of much of what passes as evolutionary science -- the work of Richard Dawkins for instance -- explained why he nonetheless believed in essentially that kind of scientific explanation. And he said it's because "we," meaning scientists like himself, "have a prior commitment, a commitment to materialism. It is not that the methods and institutions of science compel us to accept a material explanation but on the contrary that we are forced by our *a priori* adherence to material causes, to create a set of concepts that produce material explanations." And he said that commitment to materialism must be absolute, "for we cannot allow a divine foot in the door." That's a direct quote from Lewontin. What I want to ask you is that -- if he were to teach that in the public schools as a doctrine, that is, the truth of materialism as equivalent to rationality, would that be an establishment of religion in violation of the Constitution?

BL: No, it just would be bad teaching, because it's an illogical assumption. The truth is that one can be a theistic believer in evolution, as I am, and have absolutely no embarrassment about either side of that equation. I think that the doctor should have probably given me a call and I would have explained that you do not have to accept this materialism in order to be a believer that evolution is the best and only credible description of this magnificent thing we call evolution of life.

PJ: By evolution do you have in mind a system which employs only material causes without any guidance from a pre-existing intelligence to produce all of these living things, up to and including human beings?

BL: No, I certainly find it thrilling that my concept of God actually permits a God who could choose to start a process called evolution and develop in the process an incredible number of species all of which fit in to a unique ecological niche. I find that one of the thrills of my theology. It's nothing that's --

PJ: Are you speaking of God-guided evolution then?

BL: I'm -- Of course I am because most Americans as we noted earlier do in fact find no difference with that because unlike the members of your panel, they understand that there are some questions that are theological, some are scientific, and that scientific questions don't involve "Does God exist?" That's not what the scientists should --

PJ: Well you then support my effort that I've invited Eugenie Scott into already, to get the National Academy of Sciences to explain clearly whether God-guided evolution is in fact permissible in the scientific area.

BL: No, because science does not speak to that question at all. What you want science to do, is to be able to --

PJ: If they speak to it all the time, they say it's unguided.

BL: No, excuse me I think they took that word out, didn't they?

PJ: The National Association of Biology Teachers took it out because it was too explicit. They imply the same thing pervasively throughout the statement and so do all the other major -- major textbooks --

BL: I don't have any problem with them taking it out because it does have the implication that you suggested. I just think that what you want to do is make it impossible for someone to say with honesty and integrity, that one believes in a divine creative process, a start, a foot in the door, maybe more, all the way up to the knee in the door, and still believe that nothing -- literally nothing that you have said, or any of you have written in fact degrades the basic idea of evolution.

MK: David Berlinski?

DB: My interest in divine creation is negligible. But I do have a scientific question to ask you, in fact two scientific questions, the second logical. Everyone familiar with the paleontological literature -- every significant paleontologist says that there are gaps in the fossil record. Do you have a particular reason for demurring?

BL: No, there are gaps in the fossil record --

DB: So you agree.

BL: -- of course because the fossil record's only been examined for 130 years --

DB: I didn't ask whether there was an explanation for the gaps. I asked whether you agree that the fossil record is full of gaps.

BL: Of course it has gaps.

DB: Okay, so to that extent the evidence does not support Darwin's theory of evolution.

BL: No, that is absolutely wrong.

DB: It follows as the night and the day.

BL: Of course not. How could you have a cell for example, ladies and gentlemen, hundreds of millions of years old, that would leave a fossil record? It would disintegrate, it would quite literally not be able to be found in the fossil record --

DB: I did not insist -- I never suggested that there may not be explanations of the gaps. But the fact that the fossil record does not on its face support Darwin's theory of evolution, is a fact.

BL: It does, no it does. It's just you -- your question was does it prove everything yet? --

DB: -- that maintains that two hypotheses are in contradiction --

BL: -- and the answer is it doesn't prove anything yet. And once again I say, how many times do we have

to find those intermediate fossils? How many more steps in the progress from ancient horse to modern horse do we have to show you?

DB: I gave you a quantitative answer what would satisfy a scientifically respectable temperament. And you spurned it. All I'm asking for is enlightenment on a significant point. Darwin's theory requires a continuous, a multitude of continuous forms. We do not see that in the fossil record, in fact, major transitions are utterly incomplete. Would you accept that as an empirical fact?

BL: No, you sound like a guy who is writing a story about baseball, comes in in the fourth inning, and says well "you know, I'm going to write about the fourth inning on, the first three innings didn't happen because I wasn't there to see them." The fact that we can't find every one of those --

DB: We can't find any of them. We can't find any of the major transitions between the fish and the amphibio --

BL: -- intermediate fossils yet, in 150 -- of course we find them. It's just that when we find them doctor, you say it's still not enough.

MK: Thank you Mr. Lynn. Thank you Mr. Berlinski. [audience applause] Mr. Behe and Mr. Ruse. The two Michaels, Professor Ruse and Professor Behe. And Mr. Behe will start the questioning.

Michael Behe vs. Michael Ruse

MB: Michael, I love your writings. Um -- and in a recent article in the *Journal of Theoretical Biology*, you talked about origin of life studies. And you said, a couple of quotes: "A great deal of the underpinning of discussions on the origin of life have been more philosophical than anything based in brute experience." And also, in *Origin of Life Studies*, "One ought to be alert for more than pure science, and that more may well be philosophical or metaphysical." And you say that -- you say "*Caveat Emptor*." I agree with you. Should students be taught this?

MR: Should what?

MB: Should high school students be told about your writings?

MR: About my writings? Or about origin of life --

MB: Yeah -- about the philosophical --

MR: Well, I hope so, goodness gracious yes. Um -- I think that certainly there's a place for that. Whether one were going to discuss something like origin of life, say in a high school biology class, I think would be a different matter. Of course in my country in Canada for instance, we have state-supported church-schools so there would be certainly no constitutional objection to that. I'm not sure that though -- that for instance, given a lot of the things which are said about origin of life, whether it's Sagan, or Lynn Margulis, or that sort of thing -- it would be appropriate at a high school biology level. But -- you know that and I know that.

MB: Well now Ken has written a good book. And it really is an excellent book. Uh, but it does --

KM: I appreciate these endorsements.

MB: [chuckles] Yeah, I do like it. I do like it. I urge people to look at it.

MK: Haven't Ms. Scott and Mr. Lynn written good books?

MB: [chuckles] Uh, No, haven't. [chuckles] Great books, great books.

ES: Great articles --

MB: [chuckles] But in Ken's book he does talk about Stanley Miller's stuff, about protenoid theories. Do you think in discuss -- when high school books do talk about origin of life stuff they should consider the philosophical aspects as well?

MR: I certainly think that they should cover it. I mean, at what level, at what depth? I think you have to take it on a case-by-case basis. If for instance, you were going to ask high school students to, say accept Haldane's Marxism, as part of the theory, obviously not. If on the other hand, one were going to talk about evolution, and say well these are some of the well-known experiments. These are some of the things they've done. But look folks, be very careful, people tend to read a lot of things into this. And I hope that a good teacher would do this. I -- I'm quite comfortable with that. I mean, high school kids are pretty bright you know, and pretty intelligent, and pretty with it. I don't think that we should dumb down biology for them.

MB: Good. Very good. Um -- now about 15 years ago, you in a federal court of the United States, I think you said that one of the characteristics of science -- a scientific theory is that it's falsifiable. Is that correct?

MR: Yes I did.

MB: Can you tell me -- I put up a picture of the bacterial flagellum earlier in this discussion. Can you tell me how one could falsify the assertion that it was Darwinian natural selection working on random mutation that produced that flagellum?

MR: Well I would have thought that, for a start, you'd look at some of the molecular evidence. And see for instance whether or not that -- flagell -- flagellum, is that how you pronounce it?

MB: Yes it is.

MR: For instance whether or not the molecular evidence -- whether it at a molecular level, it's homologous, it looks similar to things that we want to put in the same class, or the same grouping. Or, for instance, does it come out more like a human, or something like that. I would have thought that, if for instance, your flagell -- am I pronouncing --

MB: Flagellum. Like flagulate.

MR: Thank you very much. As I say I'm a philosopher. So I'm not very good -- I'm good at long sentences, but not long words. [audience laughs] Um, I would have thought that if this -- microorganism, let me cover myself there, came out with DNA which looked more like humans, than humans look like --

MB: We're talking about the flagellum, not the DNA.

MR: You asked me for an example of falsifiable -- Come on, let me finish.

MK: Answer this question, and then go on the offensive. Answer this question, then go on the offensive.

MR: Well I am answering the question. I said, that if it looked -- if the DNA of that microorganism were closer to human beings, than human beings are to chimpanzees, I think that Darwinians would need a

long night down at the local bar, quite frankly. [audience chuckles]

MK: Now it's your turn to ask questions.

MR: Oh goodo. [chuckles] Well I'm a little -- you know, it's a little mean, nobody seems to be plugging my books quite as much as I'm plugging other people's books -- but I did want to talk about Michael Behe's wonderful book, *Darwin's Black Box*, where I take it that -- One of the things I want to compliment you on Michael -- and this is not just rhetorical but -- is the fact that unlike so many creationists, certainly creationists in the past, you haven't just attacked other people, or other people's theories, but that you've tried to explain some views of your own. And I gather -- well I know that you've put forward this view about design and complexity. You describe it in terms which, well the modesty factor doesn't seem to be too high: "The result of these cumulative efforts to investigate the cell, to investigate life at the molecular level, is a loud, clear, piercing cry of *design*. The result is so unambiguous, so significant, that it must be ranked as one of the greatest achievements in the history of science. The discovery rivals those of Newton and Einstein, Lavoisier and Schroedinger, Pasteur and Darwin" --

MK: What's the question?

MR: That's, you know, pretty heavy stuff. Tell us about this theory, tell us I mean now -- for instance Newton's theory enables us to quantify, to make predictions -- what is your theory?

MB: Well, it's that you can detect intelligent design in the interaction of parts of systems. And it's not really, you know the -- suppose you were out walking in a woods with a friend of yours, and all of a sudden the friend of yours was pulled up by the ankle by a vine wrapped around it. And as he was left dangling, you pulled him down and you could reconstruct it and you saw that the limb was covered over with leaves, and that the vine was staked down. You would immediately know, that that was designed. It was not a -- it was not an accidental arrangement of parts --

MR: So design means a designer. Are we talking about God now?

MB: Well, most people think so. I think so. But I want to leave it open, and not just because I'm being coy.

MR: Now are we talking about a good God now?

MB: Well, let me answer your first question. [chuckles] Let me answer your first question. Francis Crick in 1972, wrote a paper entitled "Directed Panspermia." And the burden of the paper was essentially that problems with imagining an undirected origin of life on earth were so severe, that perhaps we should consider the hypothesis that space aliens sent a rocketship filled with spores to seed life on earth a long time ago. Now if Francis Crick looked at the bacterial flagellum, or the inter-cellular transport system, or the blood-clotting system, and said he thought it was designed by a space alien, I would have no scientific quarrel with him. I argue that you can tell who the design -- that a system was designed, but the identity of the designer is a more difficult question.

MR: But is this designer responsible when things go wrong? Or for parasites, these complex parasites?

MB: Well, that's the "argument from evil" -- that is, bad things happen to good people, and it's been discussed in religious literature for many many years, going back to the Book of Job --

MR: What about complex parasites? Did this designer design complex parasites? Or is that evolution?

MB: No -- [chuckles]

MR: I mean, do you get all the "good" things and evolutionists get all the "bad" things?

MK: All right, thank you. That's a very good line and we'll end on that note. Mr. Buckley and Mr. Lynn? Mr. Buckley, it's your opportunity to question Mr. Lynn.

William Buckley vs. Barry Lynn

WB: Yeah, Mr. Lynn I'm frankly a little bit emasculated by the approach of you and your colleagues tonight, which is really very ingratiating, and it really delights me -- but it seems to me that you're conveying the impression that the evolutionist theory is other than what most people know it to be, which is materialist philosophy. Now it's wonderful that notwithstanding your affinity for that explanation of things, you still believe in the possibility of a Creator, indeed even of a Christian Creator -- but what would you make of the following statement of Richard Lewontin: "the primary problem," he means of the current confusion, "is not to provide the public with the knowledge of how far it is to the nearest star, and what genes are made of, rather the problem is to get them to reject irrational and supernatural explanations of the world -- the demons that exist only in their imagination -- and to accept a social and intellectual apparatus: science as the only begetter of truth." Now that is the public voice as I understand it of the materialist evolutionist. Do you transcend it, or do you disavow it, or do you consider it inauthentic, or what?

BL: No, I just disavow it, because I think that it is obviously possible to believe in the idea of a God, a God who has a presence and an interest in humanity, without rejecting the overwhelming data that supports evolution. And the failure of anything, Mr. Buckley, to in fact contradict it. In other words, you have picked a few squabbles with evolution but you haven't even suggested for a moment what the mechanism is with which you would replace it.

WB: Well, what if one simply advances basic intelligence? And says, some such thing as that -- in fact, a lot of monkeys turned loose over an infinite number of time could not, would not reproduce Shakespeare. Does that sound as an arrogant rejection of -- of a random explanation for what we see about us?

BL: No, not at all. I think that one of the great things about randomness and chance is that they are used in this process of evolution, as I personally view it, as remarkable tools within that toolbox of God's creative interest. I mean to reject the idea that chance is something that could be used by the divine is to limit the power of the divine considerably. The divine is not sitting a bunch of monkeys in a building with a bunch of typewriters. I think we're a little more sophisticated than that, and I think that the process of evolution is far more creative than that.

WB: I think you are -- I think you are more sophisticated manifestly from -- by my criteria. But Richard Lewontin is a man of very substantial *bona fides* in your community. So if we want jointly to excommunicate him from rational paternity, I think we should do so piously.

BL: But we Congregationalists of course don't excommunicate. [audience laughs] That's one of the differences between us.

WB: So therefore -- therefore we will do what with some? Simply point to that as the excesses to which some nice people nevertheless go?

BL: I think frankly, Bill, that the truth on this side is that the folks who represent the position that we've been articulating, have been very good about going to conferences and trying to separate people's scientific views from their religious ones. And I wish that the other side did the same thing. And I wish fundamentally that we could understand that some questions are theological questions, others are scientific, and we work better at solving and resolving and even discussing those questions when we realize that there are two kinds of language, and two kinds of issues. There's nothing extreme about that

position.

MK: You can now ask philosophical and scientific questions of Mr. Buckley.

BL: Okay, well Mr. Buckley, you know I have heard it said that even God does not know the mind of William F. Buckley. [audience chuckles] But my question is the adverse: do you know the mind of God so well that you could rule out the possibility that God conceived evolution as the process to bring His design to fruition?

WB: Well, I decline to answer that question because --

BL: On what grounds?

WB: -- because my imagination is finite, and the Creator's is not. Under the circumstances I simply pass -- not only for tactical reasons but for reasons of profound belief. I do find it -- well I can't answer, go ahead.

BL: No, but let me -- that only goes to half of the question. Because the truth is that if you are saying that you cannot imagine that a God could be that creative, that imaginative, then aren't you limiting in a very severe fashion, your construct of God? I think that's a very serious question, and I think you should have an answer after 37 books.

WB: No, because I believe that there are mysteries. And that it is impossible to parse all of God's movements by applying to them the substantially resourcelessness of our own minds. I don't doubt if you ask me a simple one -- can I account for the five-year-old who before we finish tonight will have fallen in from a rooftop and be killed? No, I can't account for it. On the other hand, I don't think that -- I don't think that the abundance of incidents of that kind causes -- are sufficient grounds for rejecting revelation.

BL: Well, I'm not sure I would either -- but I'm not sure that that addresses the question. But let's move from the theological to the scientific which is what Michael suggested I could do. I'm trying to figure out now what it is about evolution that you find so intellectually challenging that you reject it. Every single major scientific development over the past many decades that could have demonstrated that evolution was fundamentally flawed, every one of them proves quite the opposite. You all remember Gregor Mendel's bean experiments in terms of experimenting on inherited characteristics, we all studied that in high school. Carbon dating that shows that the earth is billions of years old. Had it proved that it was very young, we would have had many evenings at the bar to discuss that. [audience chuckles] And even DNA research that shows that the DNA in chimpanzees and gorillas and humans is so close to being the same --

WB: So your question is?

BL: -- that we must have had a common ancestor. With all this evidence on one side, what line of science contradicts those powerful lines in support of our argument?

WB: Well, what is -- what is in my judgment has happened is an -- a rejection of the materialist explanation of everything that has happened. At the time that Darwin spoke, he seemed to give us a facile explanation for a lot of phenomena which we couldn't otherwise explain. But I think the developments of the last 100 years have given us a perspective, and that perspective makes increasingly unrealistic the notion that there is a materialist explanation for everything that is happening around us. Remember you're saddled with some heavy baggage, Mr. Dawkins who says, "we have a prior commitment, a commitment to materialism" --

BL: Yeah but Mr. Dawkins isn't here, so we are not yet saddled with him.

WB: -- we don't -- sorry?

BL: He is not here, we are not saddled with him. I am just asking you a question about science which might make you more comfortable than the questions about theology.

WB: Well, you better get used to -- you better practice the excommunicative arts.

BL: [chuckles] Well one final question. Fifteen years ago before Pope John Paul II made his most recent pronouncement, he said this: "Sacred Scripture wishes simply to declare that the world was created by God." He continued: "the Bible does not wish to teach how heaven was made, but how one goes to heaven." Do you have any fundamental problem with that?

WB: None whatever.

BL: Well neither do I. And I would once again offer you the same opportunity offered earlier by Michael, to join this side and to separate the two kingdoms. [audience chuckles and applause]

MK: Thank you very much both of you. Professor Johnson? Professor Johnson, it's your opportunity to be -- or opportunity if you wish to think about it that way, to be interrogated by the opposition team. Who would like to start?

Phillip Johnson vs. Panel

BL: Mr. Johnson, your career seems built on picking alleged fleas off of the dog of evolution, but when it comes down to picking the fleas off, you find they're just pieces of lint, not really a serious problem for the dog. But you never seem to want to discuss *your* dog. So I'd like to talk to you a little bit about religion. Talk about Noah's Ark for example, do you believe that there were dinosaurs on Noah's Ark, at least baby dinosaurs --

PJ: No, I don't make any reference to the Bible or biblical authority. I don't -- deal with that at all and I really don't have an opinion about it.

BL: You don't have an opinion, okay. Well let's say, this book, which is widely distributed in creationist circles, and used in schools, home schools and religious schools at this point --

PJ: Has nothing to do with me.

BL: -- has a picture here -- well I'm going to ask you about, why you don't do something that those of us on this side do -- here is a little picture, man and the dinosaur, "Adam wasn't scared to watch dinosaurs eat, because all of the creatures ate plants and not meat." Now, do you think that's good biology, number one. And number two -- [audience chuckles]

PJ: I -- I do not. And in fact, I have said on many occasions and have urged persons of the conservative Christian community, to put aside the whole Bible issues and let us ask the question: what is actually known from scientific evidence as opposed to materialist philosophy, about the claims of evolution.

BL: -- you're a great lawyer, you are a great lawyer but you didn't answer the question. I want you to know if -- to tell us if you think that this is not so silly, and dangerous kind of ideas to plant in the hands of high school students, that in fact the Flintstones are some kind of documentaries. [audience laughs] That's pretty dangerous --

PJ: Yeah, yeah, that is -- yeah, the kind of thing, I haven't seen this, but the kind of thing you're

caricaturing certainly is silly, just almost as silly as the work of Richard Dawkins, and as damaging.

MK: Professor Miller?

PJ: And I mean that, you see, Dawk -- and the work of those who say that material processes can explain the entire living world.

MK: Go ahead, Ms. Scott.

ES: No, that's all right.

KM: Okay, um -- I'm sure it will surprise no one, I have one more chart. [audience laughs] And we have heard, over and over again, that there are gaps in the fossil record, there are missing forms. And it's been implied, the only reason they could be there is because evolution is not the explanation. I want to show you a very famous gap. It's a gap between Mesonychid mammals, land-dwelling carnivores that lived oh 55-60 million years ago, and Archeocetes which are the oldest whales. We know from skull and dentition patterns, that as it turns out, these whales are very closely related to Mesonychids. And my colleague directly across from me, Michael Behe, once wrote, "if random evolution is true, there must be a large number of transitional forms between Mesonychid and the ancient whale," and much in the way that Dr. Berlinski has said, he said "Where are they?" Well they're right here. One, two, three. [flipping over the pictures]

MR: He wants sixteen.

KM: There turn out to be -- there turn out to be three transitional forms, including a complete skeleton named *Ambulocetus Natans* which turns out to be an extraordinary intermediate. And here's the point that I want to ask you, it turns out that all of these fossils are found in the area where the Indus river empties into the Indian ocean, they're all in the right sequence, and furthermore they form a transitional series. Now here's what I want to know, Phil. You keep saying, where are the transitional forms? Paleontologists dig them up, what's the matter with them?

[see graphic **H** -- Ambulocetus Natans]

PJ: Here's what the matter is. The most important point to me, is that the fossil record is most conclusively un-darwinian just where it's most complete, in marine invertebrates. And that is why it is shocking that one finds that where it's the most incomplete, and where the imagination can have free play, that's where you get the examples. We don't know that these form a transitional sequence at all --

KM: Phillip, you're changing, you're changing --

PJ: -- and you don't know how it could have happened, and by what mechanism. And I -- and if you do I wish you'd publish the paper on it because I'd love to see it torn to bits.

KM: Hang on for a second. I don't want anyone to miss the point. Dr. Behe said, where's the transition? Philip Gingerich and others dug up, not one, not two, but three transitionals --

PJ: Are they transitionals? We don't know that.

KM: And immediately -- you know I would think in a fair fight, you'd say, you know, "darn it, we were wrong on that one. You guys got the evidence, okay here's one for your side." But what's happening is --

PJ: I can quote you from an article in *Science* that says that they are not -- cannot be placed in an ancestor descendent sequence.

MK: No, no, no. Well, we're going to have to miss it. Thank you very much, Professor.

PJ: I'm done.

MK: You're done. You're free. Thank you very much. [audience chuckles and applause]

PJ: Time flies when you're having fun.

MK: Yeah. Ms. Scott? Ms. Scott it's your turn. Who would like to begin the questioning? Mr. Berlinski? All right, go ahead Mr. Behe.

Eugenie Scott vs. Panel

MB: I asked the captain. He said okay. In a recent fund-raising letter of National Center for Science Education, you state that "when the ACLU wants to know what's this Intelligent Design stuff, we're there to inform them that it is indeed a religiously-based alternative to evolution, completely outside of science." Okay, now let me give you a quote from an astronomer named Fred Hoyle who discovered things called resonance energy levels for carbon, oxygen, and helium, and found that they are arranged exactly as they must be to support life. Hoyle wrote: "A common sense interpretation of the facts suggests that a super-intellect has monkeyed with physics, as well as with chemistry and biology. The numbers one calculates from the facts seem to me to be so overwhelming as to put this conclusion almost beyond question." How is his concluding intelligent design from the facts of astronomy, different than concluding intelligent design from the facts of say, the bacterial flagellum? And second, are you going to sic the ACLU on Fred Hoyle?

ES: [chuckles] Fred Hoyle is a distinguished astronomer, as you pointed out. When he speaks about biological phenomena, I would not say that he speaks *ex cathedra*.

MB: He was speaking about astronomy --

ES: As a matter of fact, one of the statements that Fred Hoyle made with Chandra Wickramasinghe, is that actually insects are smarter than -- than we think they are, but they're just not letting us know --

MB: He was speaking about astronomy in this quotation.

ES: -- I mean there were -- he has rather strange views about evolution --

MB: But he's talking about astronomy here --

ES: -- and I would not consider him an authority.

MB: But he was concluding intelligent design from astronomy.

MK: Mr. Berlinski?

DB: Dr. Scott I find myself vexed by your cavalier attitude toward the evidence especially with respect to the fossil record. And that's the only evidence that your side has presented with great vigor. Would you agree, as almost everyone else affirms, that the overwhelming pattern of the fossil record is sharply discontinuous?

ES: Is shh -- what? I'm sorry.

DB: Sharply discontinuous.

ES: Sure it's discontinuous.

DB: Okay, so we agree on that. Could I ask you to give us your best estimate of the number of changes required to take a dog-like mammal to a sea-going whale?

ES: Can we first of all distinguish, which was confused I think during the questioning of Phil. Evolution is descent with modification, we all are quite convinced that this happened.

DB: I'm not.

ES: Darwinism -- well on my side of the table --

DB: That's for sure.

ES: Um --

DB: But I had a specific question.

ES: I'm finishing. Um, Darwinism -- evolution by natural selection is one of the ways by which evolution can take place. The argument that has been presented so frequently from your side of the table is that if you -- all we have to do is disprove Darwinism, and we disprove evolution. That's nonsense. Another point, I will try to answer your question, I'm sorry --

DB: No, no, no. I'm trying to anchor the discussion in something factual and concrete like a number.

ES: Why do you assume that the fossils are the only source of data for evolution?

DB: I certainly don't, you're absolutely right. But I'm talking about the whale, all right, large sea-going mammal. The thesis is that there's a Darwinian progression, and the evidence is three or four intermediates. I'm asking you to give us your best estimate of the number of changes required to take a dog-like mammal to a sea --

ES: The number of genetic changes?

DB: -- morphological, physiological, just give us a number. Is it three, is it ten --

ES: That's an absurd question.

DB: Why?

ES: None of us, none of us on the evolution side of this argument has ever proposed that we can come up with "the number of changes" -- that's a ridiculous question --

DB: Then how on earth can you commend the mechanism, if you are unsure whether it's adequate to the result --

ES: Why are you so fixated on the mechanism of natural selection?

DB: Because that's the heart of your doctrine. It's a theory, it's a scientific theory.

ES: It is -- Would you agree with me that if you disprove evolution -- excuse me, if you disprove natural selection, you therefore disprove evolution?

DB: Sure.

ES: You're wrong.

DB: Why?

ES: Because evolution -- because natural selection is only a way by which evolution can take place. The evidence would still be there --

DB: There is no other attribute of the theory. Go back --

ES: -- from homology, from anatomical homologies, biochemical homologies, and the fossil record. We're not dependent on the fossil record.

DB: Dr. Scott, focus on my question, I'm begging you. We have a theory --

ES: I answered it.

DB: -- the theory is a theory of random mutation and natural selection. I'm asking you to apply it to the case of the progression from a dog-like mammal to a sea-going whale --

MK: I'm begging you not to, so -- [audience chuckles] Thank you very much, Ms. Scott. Mr. Berlinski? Mr. Berlinski you're up. And Mr. Berlinski will question Professor Miller, and then Professor Miller will question Mr. Berlinski.

David Berlinski vs. Ken Miller

DB: Should I go first?

MK: Yes.

DB: Professor Miller, would you agree with the statement, that "nothing in biology makes sense except in the light of evolution" -- it's very often quoted?

KM: The statement you're making is made by Theodosius Dobzhansky --

DB: It's often attributed to Ernst Mayr also?

KM: Fair enough. And in a simple way, so I don't have word-games played on me, no I would not agree with that. I think there are things in biology that are perfectly sensible even if evolution is not correct. However, the interrelationship -- our understanding of the interrelationships between organisms, phylogeny and natural history, does indeed *only* make sense in light of evolution.

DB: But in terms of your own very fine work in cell biology, evolutionary theory plays no role whatsoever?

KM: Does evolutionary theory play a role in my work?

DB: -- proton transport.

KM: First, thank you for complimenting my work. The answer is no, that's not correct. And the reason for that is, a few years ago an investigator discovered a very interesting microorganisms of prokaryote called prochloron. Prochloron turned out to be the very first prokaryote -- organism without a nucleus discovered -- that had both chlorophyll A and B. This suggests very strongly that in an evolutionary sense, prochloron is the evolutionary ancestor of the chloroplasts of higher plants. This organism was sent to me because of the kind of structural work I do, with the idea, "let's put it to the test." Because what we did in my lab was to investigate the structure of photosynthetic membranes, and lo and behold we found out that they were enormously similar to higher plant chloroplasts. If they had been dissimilar, it might have been an argument against evolution -- it turned out not to be the case.

DB: I am certainly persuaded that you've been invigorated by the shade of Charles Darwin. But the fact is that in your published scientific papers, the term "evolution" occurs as frequently as the term "Presbyterian" which is to say, not at all.

KM: Well, I have to tell you once again sir, you are wrong on the fact.

DB: All right.

KM: None of my 75 plus published referred papers uses the term Presbyterian, at least three of them use the term evolution.

DB: I stand corrected. [audience chuckles]

KM: The details -- the details --

DB: The odds are 75 to 3 against the usefulness of evolution in your own scientific life. Let's leave that question aside, and let's pass to another one since I don't see any way of resolving that particular issue --

KM: I still -- I still reject it on the terms. You say evolution is not useful -- the very reason why we study the translocation of proteins in "lower organisms" such as yeast, is because we believe we learn something about how our own cells work, by studying other organisms. And the underpinning assumption for that is in fact evolutionary biology.

DB: That's nonsense, and you know it. You study it because it's an interesting and accessible question, that's the only --

KM: Well sir, the only thing I can tell you is if it really was nonsense, the significant sections I write in the end of my grant applications to the National Institutes of Health would no longer be successful.

DB: Could well be. Let's turn to the question I so vainly tried to pump an answer from Dr. Scott. How many -- how many morphological changes do you think were required to affect the transition those charts of yours were set to document?

KM: Okay, now you're -- I will give you a straight answer. And the straight answer is that when you look at two species that are separated by five million years of geological time, the number of changes must be very very large. However --

DB: Give us an estimate.

KM: However, recent studies of speciation -- and I'm sorry to pick this specific species -- but it's relevant to your question. Recent studies of speciation in sunflowers have shown conclusively that a new species can be established in terms of the speciation-like isolation mechanism, with as few as ten genetic changes. That's your answer.

DB: Yes, I've read the same science papers you have but those are very close. A dog-like mammal and a whale are very far --

KM: Ah, that's right, and the other end of the room is very far away. And it should not surprise you that I get there with one step at a time, and that's what we're talking about.

DB: Can I conclude that you refuse -- [audience applause] -- No matter the number I give you, you will neither assent nor disagree with the number? If I say there are 100,000 morphological changes required to take a dog-like mammal living on the land to a whale --

KM: Oh sorry, yes I will answer that. That's way too high. We believe that organisms -- well, I shouldn't say we believe -- The good genetic evidence is that there are about 100,000 genes in a human being. I would best guess there's somewhat fewer in whales. What you're telling me is to change from one similar organism, an organism that looks more like a whale than any terrestrial animal that has ever lived, to a whale that looks more like a terrestrial animal than any whale has ever lived, would require every gene to change.

DB: No, I haven't even talked about genes.

KM: Sir, you asked me for a number, and I said, on that basis --

DB: Morphological changes, changes to the organism --

KM: -- on that basis, 100,000 is too high.

DB: All right, 50,000?

KM: All right, my turn. Okay. Now I have a question for you.

DB: Yes.

KM: Um, you have said again and again and again, the transitions are missing. And I hope no one in the audience missed the fact that Dr. Scott pointed out that the transition from reptiles to mammals, and looking around the room I see I'm surrounded by mammals, this should be a point of interest to us --

MK: There are a few reptiles too.

KM: -- that that transition is exceedingly well documented. Now once again you said, all the transitionals are missing, and I'm confused. If this transition is very well documented, how can you on the same face say, they're all missing?

DB: You know very well I didn't say that. I agree that the late reptile-to-mammal sequence is well documented. No question about it.

[see graphic **I** -- Elephant Evolution]

KM: Okay, let me go a little further. [audience laughs] Horses and Elephants. The -- I picked these organisms because they are large, because they're recently evolved, and because they are recent, we have got lots of fossils, they are easy to pick out. The fossil record of horses and elephants is extremely well documented. Now, you said at the other end of the table you deny that descent with modification is correct. So here's what I'd like to know --

DB: I didn't say that, I said I didn't believe it.

KM: Yes you said, I'm not convinced by it. I believe sir you did.

DB: That's a big difference. I said I'm not convinced.

KM: So here's -- So here's my question. If not descent with modification, please tell me your explanation for the temporal appearance of these extremely closely related, in morphological terms, organisms over time?

DB: Okay, two points. First of all, I neither affirmed nor denied descent with modification. I said I have no opinion. I don't happen to have an opinion on that issue, it's vexed in my opinion. Second of all, you have chosen three, and the only three examples in the fossil record where there's a plausible Darwinian sequence: the dog-like mammal to whale sequence, the elephant sequence, and the horse sequence.

KM: Are you absolutely sure I can't pick up a fourth placard? [audience chuckles]

DB: No, of course not. Each one is seriously questioned in the literature. The elephant sequence --

KM: Could you point out, for the benefit of the audience, what the question is? You said they're seriously questioned in the literature.

DB: The question is, do we have a plausible sequence of morphological changes that lead to the late fossil form from the early fossil form by a route that makes morphological sense --

KM: And I would argue, yes we do, and I hope you've read Bruce MacFadden's marvelous book on the --

DB: It's an excellent book, and I cite it in my *Commentary* article.

KM: It's an excellent book and he has put enormous effort into documenting those changes. So in legal terms sir, case closed, we got it.

DB: But look at what we see in the horse sequence -- No, it's not closed. This isn't scientific argument, this is mere rhetoric. The horse sequence is proved vexed to everyone who looks at it. And the term of choice is that it's an astonishingly bushy sequence. We don't know --

KM: Please explain -- please explain the problem. I'm waiting for the answer --

DB: When you look --

MK: Could you explain what a bushy sequence is?

DB: Yeah, this is a term that's occurred very often in the literature. When we look at the horse sequence, we have dozens and dozens of species entering the record suddenly, and departing from the record suddenly, just as abruptly as they entered. We do not really know, whether the modern horse has ancestral patterns with the dozens of other species that we find in the fossil record.

KM: So what that means is --

DB: If we look closely -- wait a second --

KM: Sure, go ahead.

DB: If we look closely at some of the amazing structures for instance in the horses' hoof, we find it very difficult -- I'm sorry, we find it very difficult to find specific antecedents. The more we study such structures, the less plausible it is that they have an ancestral pattern in the record --

KM: Okay, let me suggest -- let me suggest to the audience that what Dr. Berlinski just said is in fact not correct. And I can recommend articles and books in which you can find not only a series of transitional forms, but also good evolutionary morphological explanations for it.

DB: Yes, I agree with that.

KM: Now here's the question that I have for you.

DB: I agree with that. Let's get it on the record.

KM: Once again, to someone who advocates -- another question -- to someone who advocates intelligent design.

DB: I don't.

KM: The fact -- To someone who advocates intelligent design, does the sequence of these organisms in the fossil record simply mean, that the intelligent designer was incompetent -- he kept making things and they went extinct. Or that he was restless -- I'll try this, I'll try that, I'll try the other thing. Or does it mean, that in fact these organisms are related with descent -- by descent with modification?

DB: I have no idea. It's not a question I'm prepared to answer one way or another. I don't see why I'm obliged to answer that. I'm coming here under the large tent of objurgation. I find scientific flaws with the Darwinian theory, I don't have a replacement.

KM: Okay, the point that I think is extremely significant, is in this case one side argued from authentic evidence, and the other side said it's not enough to convince me. And I think that's a good way to end the discussion.

MK: All right, thank you very much. [audience applause] Closing arguments. Closing arguments. First, Barry Lynn closing for the opposition.

Closing Statement by Opposition

BL: Well, I hope that our side at least has done what I promised we would do from the beginning. And that is, we have asked for alternative explanations for evolution and we have gotten none. What have we gotten? Well we have Mr. Berlinski who has literally moments, seconds ago said he doesn't really have an alternative. We asked Mr. Behe, he said well a lot of people would say it was God, but we're not quite sure -- I'm not sure at least whether he's prepared to say it's God with any sense of authority. Mr. Johnson says, well I don't know about the biblical answer as an alternative, we'll work that out after we debunk evolution, which I think will be some time from now. We've made it clear that evolution is not a philosophy, it's not a religious idea, it's not an ideology, it's the best, indeed it's the *only* scientific explanation for the fact that there is change in the natural order.

We asked about intelligent design and got I think the best answer from Mr. Behe. Mr. Behe has of course compared -- like it or not, compared the extraordinary complexity of the human cell to the mousetrap. He said if we look at that mousetrap it was created by a human. In fact, Mr. Miller improved on it, as you saw earlier tonight. Therefore, if that's complicated, then indeed the cell must also have been designed by

an intelligence. And as I thought about it tonight, it's a little bit -- we were all talking about nature analogies -- it's a little bit like looking at a mole build a molehill. You say, that's very interesting. Then we walk out into the woods the next day and we notice a big mountain off in the distance. And we say, "Good grief, that's enormously large, a really big mole must have built that." [audience chuckles]

The truth of the matter is it's not logical. We should be looking for different forces that result in different things. Your mousetrap was built by human hands, because its components are inanimate objects. Cellular life is living, vibrant, breathing, changing matter. You're not just comparing apples to oranges, you're comparing plastic apples to organic oranges. And I think therefore, this analogy fails.

Let me close by saying, and speaking only for myself, because we do have a difference of religious opinion, I draw upon a scriptural passage which is dear to both Mr. Johnson and to myself. It comes from the first chapter of John's Gospel. It reads: "In the beginning was the word...." Indeed that word just might turn out literally to have been a command: "Evolve!" Thank you very much. [audience applause]

MK: Mr. Buckley?

Closing Statement by Affirmative

WB: Ah, Mr. Chairman, ladies and gentlemen, I compliment the negative on the way in which their arguments have been framed. What is it that we set out to say here? Namely, that the notion of creation has not been invalidated by whatever loyalty is shown to the idea of evolution. That is to say, we use the word "intelligent design" in order to reach for something that is not biblical in dimension but nevertheless suggests that the miracles with which we are familiar are most probably miracles that didn't happen simply by chance. I think we all have reason to celebrate in effect the repudiation of materialist explanations that have been so studiously observed by our eloquent adversaries.

So let me just close by reading one paragraph from an essay written 20 years after Darwin. In 1864, there was a diocesan conference at Oxford. There chanced at this time to be in the neighborhood a man who was neither priest nor scientist. A man given to absurd freaks of intellectual charlatanry, yet showing at times also such marvelous and sudden penetration into the heart of things as would come only to genius. It was Disraeli. He began in his usual effective manner slowly and rather pompously as if he had nothing to say beyond the perfunctory platitudes, and then turning to the presiding officer, he uttered one of his enigmatic and unforgettable epigrams. "What is the question now placed before society? The question is this: Is man an ape or an angel? I, my Lord, am on the side of the angels." The audience not kindly disposed to the speaker, applauded the words as a jest. They were carried the next day over the whole land by the newspapers. They have often been repeated as an example of Disraeli's brilliant but empty wit. I suspect that beneath their surface glitter and hidden within their metaphor, these words contain a truth that shall someday break the pieces of the new philosophy, which Huxley spent his life so devotedly to establish. Thank you.

MK: Thank you Mr. Buckley. [audience applause] Well, I'm glad that's settled. [chuckles] Um, I'd like to thank our debaters, and I'd like to thank Seton Hall University. And I'm not going to tax anyone with my voice any longer, I apologize for that. And I guess we'll know in a few million years who's right and who's wrong about this. [chuckles] Thank you very much. [audience applause]

[music and credits]

END TRANSCRIPT

Recommended Reading:

Darwin's Black Box: The Biochemical Challenge to Evolution by Michael Behe (1996)
Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution by Kenneth R. Miller (1999)
Darwinism Defeated? The Johnson-Lamoureux Debate on Biological Origins by Phillip E. Johnson and Denis Lamoureux (1999)
Debating Design: From Darwin to DNA edited by William Dembski and Michael Ruse (Cambridge Univ Press, 2004)
Uncommon Dissent: Intellectuals Who Find Darwinism Unconvincing edited by William Dembski (ISI Books, 2004)

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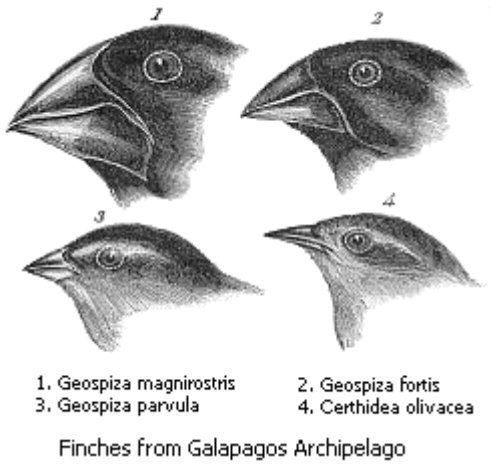
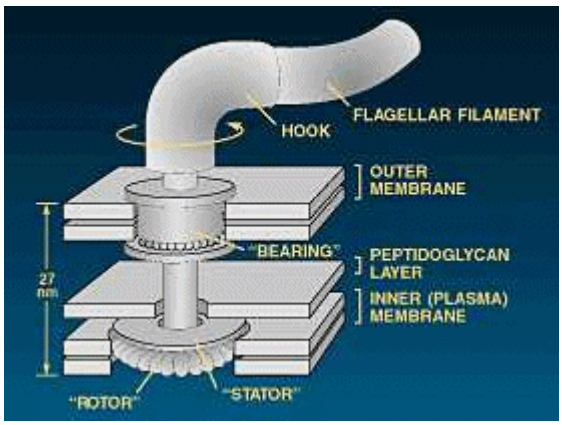
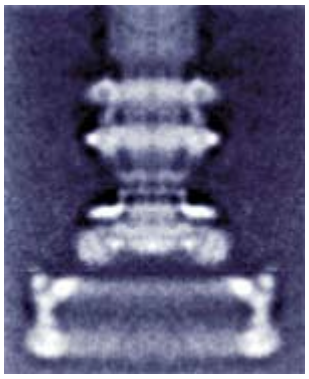
Graphic A: Finches from the Galapagos



Finches from Galapagos Archipelago

Graphic B: The Bacterial Flagellum

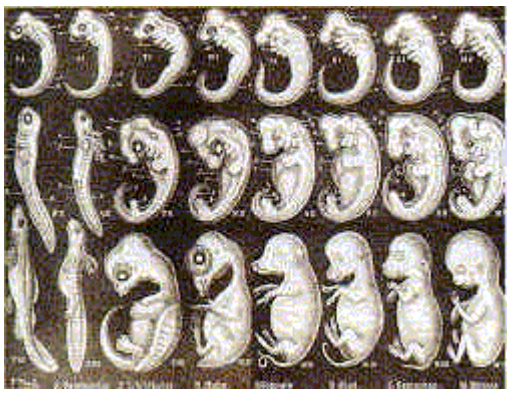




The flagellum is an organelle that has three parts. There is a basal body consisting of a reversible rotary motor embedded in the cell wall, beginning within the cytoplasm and ending at the outer membrane. There is a short proximal hook, which is a flexible coupling or universal joint. And there is a long helical filament, which is a propeller. Torque is generated between a stator connected to the rigid framework of the cell wall (to the peptidoglycan) and a rotor connected to the flagellar filament. The proteins MotA and MotB are thought to constitute the elements of the stator; FliF, G, M, and N (the MS and C rings) those of the rotor; FlgB, C, F, and G those of the drive shaft; and FlgH and I (the L and P rings) those of the bushing that guides the driveshaft out through the outer layers of the cell wall. Electron micrograph and rings seen in the image are the L ring, P ring, MS ring, and C ring.

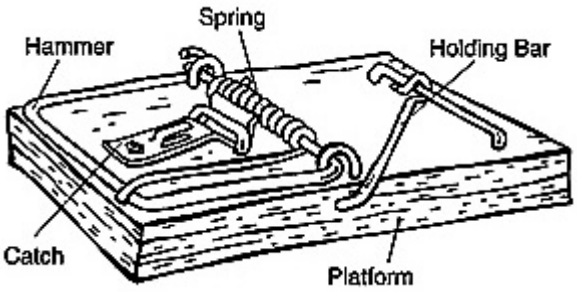
Graphic C: Haeckel's Embryos (1874)

Not only did Haeckel add or omit features, Richardson and his colleagues report, but he also fudged the scale to exaggerate similarities among species, even when there were 10-fold differences in size. Haeckel further blurred differences by neglecting to name the species in most cases, as if one representative was accurate for an entire group of animals. In reality, Richardson and his colleagues note, even closely related embryos such as those of fish vary quite a bit in their appearance and developmental pathway. "It (Haeckel's drawings) looks like it's turning out to be one of the most famous fakes in biology," Richardson concludes. (source: Elizabeth Pennisi, et al "Haeckel's Embryos: Fraud Rediscovered," Science, 5 September, 1997 -- Science 1997 277: 1435)

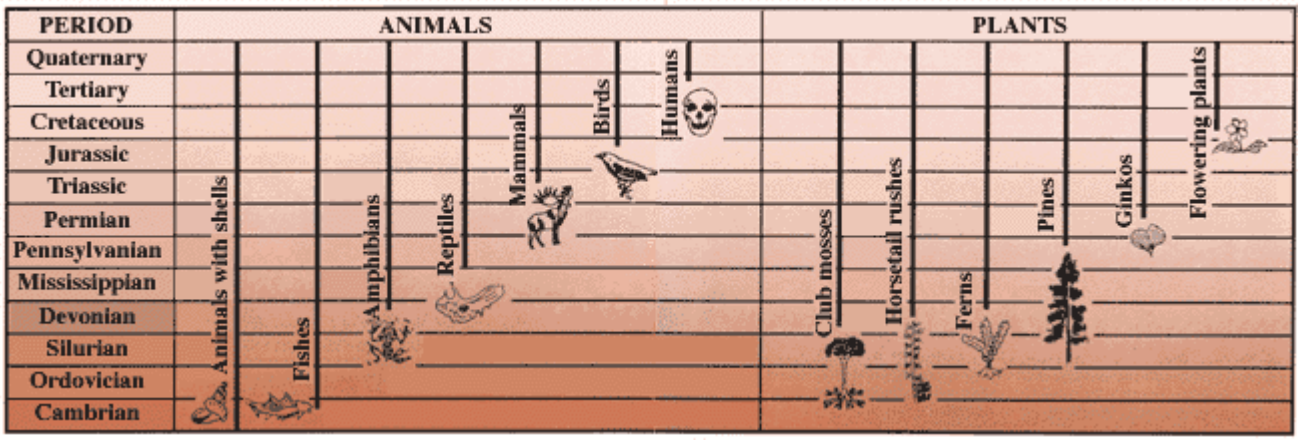


"Many naturalists have especially blamed the diagrammatic figures given in the *Athropogeny* (Haeckel's The Evolution of Man). Certain technical embryologists have brought most severe accusations against me on this account, and have advised me to substitute a larger number of the elaborated figures, as accurate as possible. I, however, consider that diagrams are much more instructive than such figures, especially in popular scientific works...If it is said that my diagrammatic figures are 'inaccurate,' and a charge of 'falsifying science' is brought against me, this is equally true of all the very numerous diagrams which are daily used in teaching. All diagrammatic figures are 'inaccurate.' " (Ernst Haeckel, The Evolution of Man, 3rd edition 1876)

Graphic D: Mousetrap



Graphic E: Geological Periods

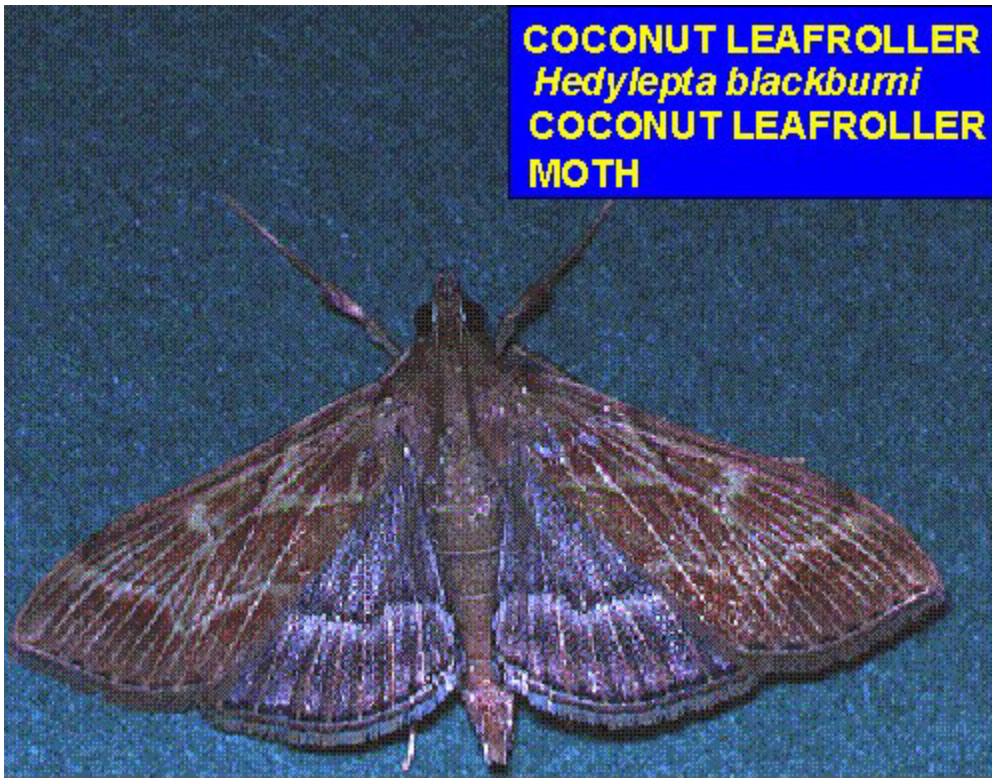


Of all the species that have ever existed on Earth, about 99% are now extinct. It is thought that up to 10 million species are alive today, although only 1.5 million have been discovered. This means that as many as one billion species (or at least 150 million) have lived on the Earth at one time. At least five major mass extinction events have occurred during the history of life on Earth, as well as numerous minor ones. Most of these events were a result of major climatic shifts and changes in sea level, and perhaps in some cases, extraterrestrial (meteorite) impacts. The fossil record bears the indelible mark of these successive waves of extinction, followed by proliferations of new and different life forms.

Graphic F: True Embryos (1997)

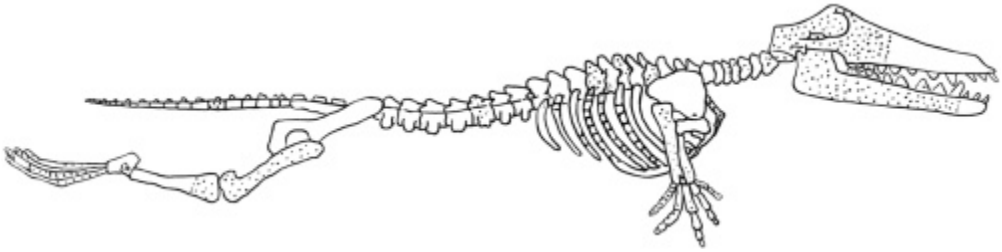
True representations of various embryos (top row fish, chicken, pig, bottom row human) at the "phylotypic" stage by Michael Richardson (1997)

Graphic G: Hawaiian Moth (genus Hedylepta)

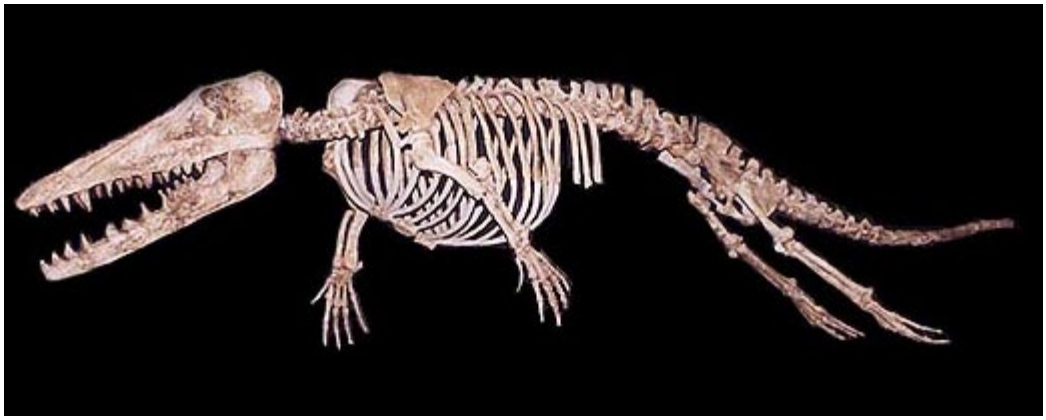


"Hawaii harbors several moths of the genus Hedylepta that feed only on banana plants. Other species of the genus feed on other Hawaiian plants, and similarities of form demonstrate that one of these that feeds on palms is the ancestor of the banana-feeding species. Each of the banana-feeding species is restricted to high mountain forests on only one or two islands, and the reason they must bear a descendant rather than ancestral relationship to the palm-feeding species is that, while palm trees are native Hawaiian plants, banana trees are not. In fact Polynesians first introduced the banana plant to the Hawaiian Islands only about a thousand years ago. This sets an upper limit for the evolution of the new banana-feeding insect species. For all we know, they evolved in a small fraction of this interval." (Stanley, Steven M., "Evolution of Life: Evidence for a New Pattern", Great Ideas Today, Chicago: Encyclopaedia Britannica, 1983, page 21) ; also see Zimmerman, E.C. "Possible Evidence of Rapid Evolution in Hawaiian Moths", 1960 Evolution 14(1):137-138

Graphic H: Ambulocetus Natans ("walking whale that swims")



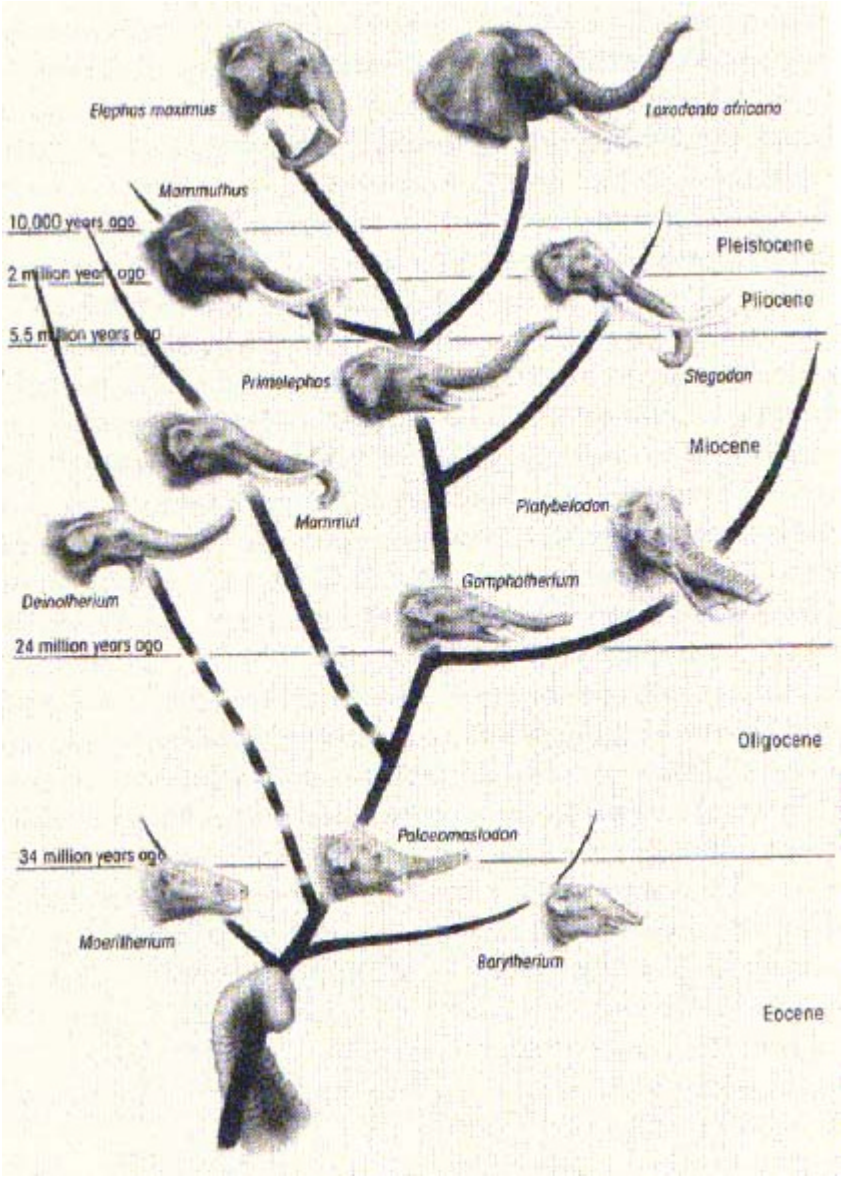
Ambulocetus natans (c. 50 Ma) -- which means "walking whale that swims"
Q: Where was Ambulocetus found? **A:** Ambulocetus has been found in Pakistan, which would have been on the shores of the Tethys sea separating the European archipelago from Africa and Asia.
Q: How big was Ambulocetus? **A:** Ambulocetus was 3m long, which is bigger than many crocodiles.



Q: How do we know that Ambulocetus is an early form of whale? **A:** Ambulocetus' teeth and skull structure shows that it is a whale. Many other fossils have been found showing early whales with varying sizes of leg and tail (e.g. Pakicetus, Rodhocetus, Dorudon, and the already well known Basilosaurus). The teeth of all of them, including those which were fully aquatic, are very similar, as are their ear structures. Whales separate their ears from the skull -- they "float" in a region of fat. To get sound to the ear, modern whales have a partially hollow jaw that is filled with a special type of fat. When sound waves hit the jaw they are conducted through the fat to a thin bone connection to the ear from the back of the jaw. This thin bone connection has a characteristic "S" shape that is totally unique to the whales, and has proved to be so remarkable to paleontologists over the last two decades. Ambulocetus already had the S-shaped ear bone and had jaws that would have been packed with sound-conducting fat, despite the fact that they seemed to live mostly on land. This implies that the strange way of hearing had initially evolved not for hearing underwater, but for some other purpose (e.g. sensing prey on land).
Q: How do we know that Ambulocetus lived in water as well as on land? **A:** Its long body is shaped rather like an otter, with a broad flattened tail and paddle-like hands and feet. The back legs are very short and strong and would have been powerful in the water, but clumsy on land. All these features suggest that it was a good swimmer, and easily capable of moving on land as well.
Q: How do we know how Ambulocetus swam? **A:** The long body, powerful hind legs, and flattened tail all suggest that Ambulocetus swam a bit like a modern otter. Certainly (like all mammals) its spine would have flexed up and down, not side to side like a fish or a crocodile. Its tail and paddle-like back feet would have helped push it through the water.
Q: How do we know that Ambulocetus lived in fresh as well as salt water? **A:** The fossils so far have all been found in marine sediments, initially suggesting that these were seashore animals. However, there is another clue from an unlikely-sounding source -- their teeth. Paleontologists have made a chemical analysis of Ambulocetus' teeth, and this tells a different story. The teeth were formed early on in the animals' lives, and their chemical composition shows that at that time the animals were in rivers or estuaries, rather than the sea. There are two possible explanations for this strange result. Maybe Ambulocetus went upstream to give birth in fresh water, and then spent its adult life around the seashore. Another alternative is that, rather like modern sea cows, they move freely between fresh water and seawater. Only a few fossils have so far been found, so perhaps we will find some in river deposits soon. **Sources:** see both **P.D. Gingerich** and **J.G.M. Thewissen** on the evolution of whales

Graphic I: Elephant Evolution

Graphic representation of the elephant (proboscidean) evolutionary lineage. The fossil record of their ancestors goes back 50 million years. Source: Miller, Finding Darwin's God, page 96



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