IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF PENNSYLVANIA

TAMMY J. KITZMILLER, et al., Plaintiffs	:	
	:	Case Number
vs.	:	4:04-CV-02688
	:	
DOVER AREA SCHOOL DISTRICT;	:	
DOVER AREA SCHOOL DISTRICT	:	
BOARD OF DIRECTORS,	:	
Defendants	:	

MORNING SESSION

TRANSCRIPT OF PROCEEDINGS
OF BENCH TRIAL

Before: HONORABLE JOHN E. JONES, III

Date : September 26, 2005

Place : Courtroom Number 2, 9th Floor
Federal Building
228 Walnut Street
Harrisburg, Pennsylvania

COUNSEL PRESENT:

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For - Plaintiffs

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For - Defendants

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Official Court Reporter

I N D E X

WITNESSES

For - Plaintiffs:	Direct	Cross	Redirect	Recross
Kenneth R. Miller, Ph.D.	31			

THE COURT: Good morning to all. Counsel, would you enter your appearances starting with counsel for the plaintiffs.

MR. ROTHSCHILD: Good morning, Your Honor. Eric Rothschild from Pepper Hamilton, L.L.P., for the plaintiffs.

MR. HARVEY: Good morning, Your Honor. Steve Harvey, Pepper Hamilton, for the plaintiffs.

MR. WALCZAK: Your Honor, Witold Walczak, American Civil Liberties Union of Pennsylvania, for the plaintiffs.

THE COURT: All right.

MR. GILLEN: Good morning, Your Honor. Patrick Gillen from the Thomas More Law Center for the defendants.

MR. THOMPSON: Good morning, Your Honor. Richard Thompson of the Thomas More Law Center for the defendants.

MR. MUISE: Good morning, Your Honor. Robert Muise from the Thomas More Law Center for the defendants.

THE COURT: And good morning to all of you. Are you prepared to open?

MR. ROTHSCHILD: Yes, I am.

THE COURT: You may do so.

MR. ROTHSCHILD: Good morning, Your Honor. My co-counsel and I represent eleven parents who are challenging the Dover Area School District's change to its biology curriculum. That change to the biology curriculum, which is displayed on your monitor and on the screen, singles out the scientific theory of evolution, among all the scientific concepts taught to Dover High School students, as being suspect and promotes the religious proposition of intelligent design as a competing scientific theory.

Eighteen years ago, the United States Supreme Court, in Edwards versus Aguillard, held that public schools could not teach students creation science because that proposition's core concept of a supernatural creator is religious, not scientific, and therefore violates the establishment clause of the First Amendment to the United States Constitution. The Court recognized that the teaching of creation science was motivated by a religious and cultural agenda, not the improvement of scientific education.

What we will prove at this trial is that the Dover board policy has the same characteristics and the same constitutional defects as the creation science policy struck down in Edwards. You will hear testimony from members of the Dover community, these

parents, teachers, administrators, and board members, about how this change to the curriculum came to be.

Board members announced their interest in the topic of evolution in starkly religious terms. They looked for a book that could provide a religious alternative to evolution, and they found one in Of Pandas and People.

They changed the science curriculum to advance a specific religious viewpoint, and in doing so, they ignored accepted scientific knowledge, failed to avail themselves of the advice of established scientific organizations, and ignored their own science teachers who opposed the change to the science curriculum.

They did everything you would do if you wanted to incorporate a religious topic in science class and cared nothing about its scientific validity. And we will show that the members of the school board that passed this policy expressed their desire to teach creationism over and over and over again. That's their word, "creationism."

As Your Honor will recall, in January, you permitted expedited discovery so these plaintiffs could decide whether to move for a temporary restraining order. We deposed Alan Bonsell and Sheila

Harkins, the last two board presidents, William Buckingham, the head of the curriculum committee when the curriculum change was approved, and Dr. Richard Nilsen, the Dover Area School District's superintendent.

All of them denied media reports that the board had spoken openly about creationism at board meetings leading up to the curriculum change. And they and other witnesses continued to deny such statements in depositions throughout this litigation.

Faced with what appeared to be surprisingly contradictory evidence about what the board members actually said, plaintiffs decided not to seek a temporary restraining order so that this Court could decide this case on a more complete record. Now we have that record.

Matt, could you pull up Exhibit 21. This is superintendent Nilsen's record of what board members said at a board retreat on January 9th, 2002. Matt, could you highlight Item C. Dr. Nilsen reported that Alan Bonsell talked about creationism and prayer at this board retreat.

Could you pull up Exhibit 25. This is Dr. Nilsen's record of what board members said at a board retreat on March 26, 2003. And could you

highlight Section D, again, under Mr. Bonsell. Again, Dr. Nilsen reported Mr. Bonsell as talking about creationism.

Could you pull up Exhibit 26, please. This is Plaintiffs' Exhibit 26. This is a memorandum received by Mr. Michael Baksa, the assistant superintendent for the district, and copied to Dr. Nilsen, the superintendent, reflecting what Mr. Baksa told Bertha Spahr, the head of the Dover High School Science Department, about a board member's views on teaching evolution.

Matt, could you highlight the last sentence of the first paragraph. A board member wanted 50 percent of the topic of evolution to involve the teaching of creationism.

Could you pull up Exhibit 60, please. This is a letter that Board Member Heather Geesey wrote to the York Sunday News on June 27th, 2004. Could you highlight the last paragraph, please. You can teach creationism.

Could you pull up Exhibit 662. This is a draft change to the Dover biology curriculum prepared by Assistant Superintendent Michael Baksa. Could you highlight the bottom section, please, Matt. Creationism. And if you look at the text of this

draft change to the curriculum, it's remarkably similar to the change that was actually approved, though the final version had intelligent design, not creationism.

And the entire Dover community is aware of what Mr. William Buckingham, the chair of the curriculum committee when this curriculum change was passed, has said on this subject. (Tape played.) "Such as creationism." Defendants refusal to admit their advocacy of creationism in the face of overwhelming evidence says everything about their true motives.

What the board did was add creationism to the biology curriculum under its new name, intelligent design. You will hear from Barbara Forrest, an expert on the history of intelligent design. She will describe how the textbook Of Pandas and People that the school district directs its students to was conceived and developed as a creationist book and changed the name of the concept it was promoting to intelligent design after the Edwards decision held that creation science could not be taught.

Indeed, the very definition of intelligent design found in the Pandas book used in Dover is identical to the definition of creationism found in

earlier drafts of that book. The publisher of Pandas, like the Dover Area School Board, employed semantics, wordplay, to obscure its clear religious creationist project.

Dr. Forrest will also describe how the leaders of the intelligent design movement are carrying out a strategy, what they call the Wedge strategy, to overturn the rules of modern science so that you can include supernatural activity, so that science can be Christian and theistic.

You will also hear from John Haught, a theologian, who will explain that intelligent design is not new science. It is old theology, the argument for the existence of God that has been around for centuries. He will also explain that it is not a universal religious view, but rather a particular one accepted by many people of faith but inconsistent with the beliefs of many others.

Intelligent design is not identical in every respect to the creation science previously addressed by the Supreme Court in Edwards and other courts, but in all essential aspects, it is the same. Intelligent design really is a perfect example of evolution. Throughout this century, religious opponents of evolution, concerned that evolution contradicts a

literal reading of the Bible and promotes cultural decay, have employed varying tactics to denigrate or eliminate the theory of evolution in the minds of young students.

They have tried forbidding the teaching of evolution, promoting creationism or creation science as an alternative to evolution, and singling out evolution for special criticism. Each of those tactics have been found unconstitutional by courts. Confronted with that inhospitable legal environment, creationists have adapted to create intelligent design, creationism with the words "God" and "Bible" left out.

They have promoted a book, Of Pandas and People, that invokes a master intellect that shapes clay into living form and then says, we're not referring to anyone in particular. This clever tactical repackaging of creationism does not warrant different treatment under the Constitution.

The intelligent design movement has argued and we expect you will hear defendants argue in this courtroom that intelligent design has improved on creationism by developing a scientific argument for design. Defendants' own experts call it science in its infancy, and if this is true, there is no

educational purpose in test-driving it with high school students.

But intelligent design is not science in its infancy, it's not science at all. You will hear from Kenneth Miller, a biologist; Kevin Padian, a paleontologist; Robert Pennock, a scientific philosopher; and Brian Alters, an expert on teaching science. They will testify about how science is practiced and taught, why evolution is overwhelmingly accepted as a scientific theory, and why intelligent design has no validity as a scientific concept.

There is no data or laboratory work demonstrating intelligent design. It is not a testable hypothesis. It misrepresents established scientific knowledge. Let's be perfectly clear, there is no controversy in the scientific community about the soundness of evolution and that intelligent design is not a scientific topic at all.

Intelligent design has arguments with fancy names like "irreducible complexity" and "specified complexity," but these arguments are not a positive case for intelligent design, just negative attacks on evolution. And even those arguments have not been advanced in the way that real working scientists do every day, by publishing original data in

peer-reviewed scientific journals. In fact, intelligent design admits that it is not science at all unless science is completely redefined to include the supernatural.

At this trial, you will hear the parties use the term "methodological naturalism." Methodological naturalism is the term used to describe science as self-imposed limitation, that it will only consider natural causes for natural phenomena. Science does not consider supernatural explanations because it has no way of observing, measuring, repeating, or testing supernatural events. It doesn't mean that supernatural events, including divine miracles, have not happened, just that science cannot properly make any statements about them.

But intelligent design will not accept the well-established boundaries of science and openly rejects methodological naturalism, the way science has been practiced for centuries. Why? Because it has to. In the end, no matter how many stones intelligent design throws at the theory of evolution, the only alternative it presents for the development and diversity of life, the only explanation for how a bacterial flagellum or the human eye came to be is a miracle, an abrupt appearance, an act of supernatural

creation. That, by itself, establishes intelligent design as a religious argument, not a scientific argument, for the creation of biological life that cannot be taught to public school students.

The district will argue that any constitutional problem with its policy may be ignored because the statement read to students is brief and because it has promised not to teach intelligent design or even allow students to ask questions about it. This limitation, of course, raises the question, what's the point? What possible secular educational purpose could the policy have?

Plaintiffs' scientific and teaching experts will explain that there is none. Worse yet, the statement denigrates the theory of evolution in a way that one of defendants' own experts describes as misleading.

Of course, there is no such thing as a little constitutional violation, and this policy surely isn't one. The Dover board has imposed its particular religious viewpoint on the students at Dover High School and through a newsletter to the entire Dover community.

Viewed in the context of the public statements and actions by the board in developing and

implementing the policy, it can only be viewed by the Dover High School students and Dover community as an expression of the board's religious viewpoint and as favoring a religious view about creation.

In the Edwards decision, the Supreme Court underscored that it must be particularly vigilant in monitoring compliance with the establishment clause in elementary and secondary schools. Families entrust public schools with the education of their children but condition their trust on the understanding that the classroom will not purposely be used to advance religious views that may conflict with the private beliefs of the students and his or her family.

The Dover School Board has violated these parents' trust by imposing its own religious agenda on Dover High School students and the Dover community. And it has clearly divided the Dover community, which could not help but conclude that its high school curriculum now includes a religious proposition, the 21st Century version of creationism.

The evidence that I have described this morning and much more evidence that you will hear during the course of this trial will demonstrate that the board had the purpose of promoting religion and that its policy had that effect.

For those reasons, at the end of trial, we will request that the Court enter an order finding that the Dover School Board's change to its high school biology curriculum is unconstitutional and ask you to permanently enjoin the district from implementing that curriculum change. Thank you, Your Honor.

THE COURT: All right. Thank you, Mr. Rothschild. Mr. Gillen, are you prepared to open?

MR. GILLEN: Thank you, Your Honor. Good morning, Your Honor.

THE COURT: Good morning again to you.

MR. GILLEN: Patrick Gillen again from the Thomas More Law Center on behalf of the defendants in this action, the Dover Area School District and its board of directors. Again I'd like to introduce my colleagues at counsel's table, Dick Thompson and Robert Muise. Absent from the courtroom but valued collaborators in this effort, my colleagues Ed White and Julie Shotzbarger.

Seated behind counsel's table, our clients, the Dover Area School District, through its board of directors, citizens elected by their constituents, represent the interests of the parents and families of the district, the students who are educated through

the hard work of the board, the administration, faculty and staff of Dover Area School District.

Your Honor, it is our pleasure to appear on behalf of our clients today because I am confident that at the conclusion of these proceedings, you will find that the evidence shows that these citizens seated before you today were engaged in a legitimate exercise of their lawful authority where they enacted a modest change to the biology curriculum for the purpose of enhancing science education, for the evidence will show that the purpose and effect truly at issue in this litigation is the purpose and effect of a curriculum change that was worked out after a process of deliberation involving the board, the administration, the science faculty, and the public.

And it resulted in a modest four-paragraph statement which mentions intelligent design, makes students aware of the existence of the theory, makes them aware that it's a theory of the origins of life different from Darwin's theory of evolution. It explains that there's a book in the library, Of Pandas and People, that deals with intelligent design theory or IDT.

In fact, the evidence will show that the more recent statement points students to other books

in the library addressing intelligent design theory and that three of those books are penned by the plaintiffs' experts and critical of the theory. This case is about free inquiry in education, not about a religious agenda.

Your Honor, the evidence will also show that this four-paragraph statement is the total actual effect that the curriculum change has on science instruction in the district, because apart from that four-paragraph statement, science teachers teach evolutionary theory as required by Pennsylvania state standards. The use of texts presents the evolutionary theory. Biology by Miller and Levine, one of the coauthors, Ken Miller, is one of the plaintiffs' experts in this case.

In this way, the evidence will show that while students are taught evolutionary theory, they are merely made aware of the existence of another theory, the intelligent design theory, and that while students are assigned a basal text that presents evolutionary theory, they're merely made aware of the existence of a reference text in the library that deals with intelligent design theory, if they care to check it out. And they are told that they will be tested on evolutionary theory, as required by

Pennsylvania state standards.

Further, the evidence will show that Superintendent Richard Nilsen, in response to concerns addressed by science faculty about the implementation of the curriculum change, issued specific guidelines that intelligent design theory would not be taught, that creationism would not be taught. Teachers would not teach their own religious beliefs.

Now, there's no question, Your Honor, that this final result was worked out through a contentious policy-making process that has led some to liken making legislation to making sausage, a process that involved, at times, heated argument by members of the public, members of the board, false charges and intemperate remarks. But the evidence will show that the consistent goal of the board, as a whole, was to pursue what they believed to be a legitimate educational purpose and to comply with the law.

Alan Bonsell is a perfect example. He came to the board without any background in education of the law, just a sincere desire to serve his fellow citizens. By virtue of his personal reading, he was aware of intelligent design theory and that 300 or so scientists had signed a statement indicating that biologists were exaggerating claims for the theory.

He had read about the famous Piltdown man hoax. He had an interest in creationism. He wondered whether it could be discussed in the classroom. Those questions are not evidence of unconstitutional conduct, Your Honor. They were quite legitimate.

In fact, the evidence will show that on the very day of the March 26th, 2003 board retreat, the assistant superintendent of the district, Mike Baksa, attended a seminar sponsored by the Pennsylvania School Boards Association given by a presenter with a law degree from Harvard, a facilitator who was a professor with a Ph.D. in the history of philosophy of science. They discussed the issue because it was a legitimate issue.

During that seminar, Mike Baksa heard the view expressed that it would be useful and good science education to at least introduce a discussion of creationism into the biology curriculum. More importantly, Your Honor, the evidence will show that nothing came of those questions.

During his tenure as board curriculum committee chair, Alan Bonsell never asked for any change to the biology curriculum, the text or instruction. He met with the science teachers in the fall of 2003 and learned that they didn't teach

origins. It was too problematic. They focused on change within species. They mentioned creationism, but they didn't teach it, that's what they told him, because they thought it would be illegal. And that was the end of the matter. He asked legitimate questions. He got legitimate answers. That was the end.

When Bill Buckingham tried to hold up the purchase of the basal text in August of 2004, the text authored by one of the plaintiffs' experts, Bonsell voted against that because he believed the students should have the book recommended by the science faculty, quite apart from whether the board approved the use of Pandas and People.

And on the night, the very night that the board approved the curriculum change at issue here, when the science faculty expressed concerns that the inclusion of the mention of intelligent design in the curriculum would require them to teach it, although they did not teach origins, it was Bonsell who appended the note to the curriculum which made it clear that they would not be required to teach intelligent design theory.

He did that because he understood they did not teach origins, and they understood that

intelligent design theory, as indicated by the subtitle of the book, Of Pandas and People, deals with the question of biological origins.

Your Honor, the evidence will show something very critical in this case, that Bill Buckingham did not exercise a determinative impact on this policy-making process. Not at all. In fact, the evidence will show that the board listened to the science faculty more than it listened to Bill Buckingham.

Bill Buckingham wanted the text, Of Pandas and People, approved with the basal text. He wanted it purchased with school money. He wanted it used in the classroom. He wanted the intelligent design theory presented side by side with evolutionary theory as if in dialogue. The teachers objected, and the board agreed with the teachers.

Now, it's true at the end of the day the board didn't agree with everything the teachers said. The board believed that intelligent design was not creationism. They knew what that was, the Book of Genesis. They concluded that intelligent design was science. They looked at the text of Pandas and People. That's not the Book of Genesis.

They believed it was a legitimate

educational goal to make students aware of the existence of another scientific theory, but they agreed with the teachers' objections that for practical reasons, students shouldn't be taught intelligent design theory.

Your Honor, the evidence will also demonstrate that the board quite rightly concluded that its modest curriculum change would, in fact, enhance the biology curriculum and that the primary effect of their policy would be to advance science education, not religion.

Defendants' expert will show this Court that intelligent design theory, IDT, is science, a theory that's advanced in terms of empirical evidence and technical knowledge proper to scientific and academic specialties. It is not religion. This expert testimony will also demonstrate that making students aware of gaps and problems in evolutionary theory is good science education. It's good liberal education.

Dr. Michael Behe will offer you his opinion in this case. He will explain the basis for his opinion that the insights into the biochemical complexity of the cell, made possible by modern microbiology, have undermined the claims made for natural selection, the mechanism at the center of

evolutionary theory.

Likewise, Dr. Behe will explain that evolutionary theory does have gaps and problems and that it's good science education to make students aware of those gaps and problems, make them aware of the intelligent design theory.

The evidence will show that Dr. Behe takes these positions and posits his thesis of irreducible complexity pointing to design not because evolutionary theory is inconsistent with his religious beliefs. It's not. Not because he believes in creationism. He doesn't. And as he'll explain, creationism and intelligent design are two very different things. Dr. Behe takes these positions because the empirical evidence points in that direction.

You will also hear testimony from Dr. Scott Minnich. Dr. Minnich received his Ph.D. from Iowa State University in 1981. He was a post-doctoral fellow at Purdue and then Princeton. Since 1987, he has taught microbiology extensively at the undergraduate and graduate, including medical school, levels.

Dr. Minnich will testify that IDT is science, not religion. He will explain that design principle, design theory, drives his sophisticated

research in the lab. He will testify that Of Pandas and People is a good text, a little dated, but one that asks critical questions about the mechanism of natural selection, which is a centerpiece of evolutionary theory, that it makes students aware of gaps and problems in the theory. Dr. Minnich will testify that this is good science education and it's good for science.

Dr. Dick Carpenter will also provide testimony. He's an assistant professor in educational leadership at the University of Colorado. He's an expert in educational policy and practice. He will testify that DASD's curriculum policy advances legitimate secular educational goals, promotes critical thinking, gives students a fuller understanding of evolutionary theory, including its strengths and weaknesses, something that's mentioned in the basal text authored by the plaintiffs' expert.

In this way, he'll show that Dover's modest curriculum change actually brings it more into line with Pennsylvania's academic standards, which require that students be able to critically assess the status of existing theories, and, insofar as it helps students grasp the controversy that can surround science, points to a goal that's included in the

Santorum amendment, the No Child Left Behind Act.

Dr. Steven Fuller will also testify for the defendants. He has a master's in philosophy and history of science from Cambridge University, a Ph.D. in the philosophy of science from the University of Pittsburgh. He's the author of eleven books, over 200 articles and chapters and books that have been peer-reviewed.

He was the first post-doctoral fellow in the history of philosophy of science at the United States National Science Foundation, the first research fellow in the Public Understanding of Science at the United Kingdom's Council for Economic and Social Research. His works have been translated into 15 languages. He has been a visiting professor in the United States, Sweden, Denmark, the Netherlands, Israel, and Japan.

Dr. Fuller will testify that intelligent design is science, not religion, that the convention of methodological naturalism, which some would use to disqualify intelligent design theory from science, is by no means a necessary feature of scientific inquiry, and that scientific progress has taken place without any commitment to methodological naturalism.

He will also testify that efforts to disqualify IDT from science based upon causation or

testability or other so-called demarcation criteria, including so-called methodological naturalism, are inherently flawed. Dr. Fuller will explain that intelligent design theory is not creationism. It is not inherently religious. He will also explain, for that matter, that any number of phenomena we now understand, whether it's gravity or the wave-particle duality of quantum mechanics, were once thought to be supernatural.

Finally, Dr. Warren Nord will testify for the defendants. Dr. Nord is a professor in the philosophy of education and philosophy of religion at the University of North Carolina Chapel Hill. Nord will testify that intelligent design theory is not religion. He will explain that efforts to exclude intelligent design theory from science based on so-called methodological naturalism actually result from a philosophical naturalism which is, itself, a nonscientific principle.

He will also explain that from the standpoint of the philosophy of education, liberal education, the thesis posited by intelligent design theorists gains greater strength when seen in a larger context, whether the fine-tuning of the universe which physicists looked at so statistically improbable but

so necessary to support life on earth or work in the area of phenomena such as the mind.

Dr. Nord will also explain the basis for his opinion that the board's modest curriculum change is a step in the right direction for science education and consistent with national science education standards precisely because it makes students aware that there are scientific disputes over claims advanced by rival theories, something students should know in order to have a realistic sense of this critical dimension of scientific progress.

Taken together, this expert testimony will confirm the defendants' judgment by showing that intelligent design theory is not creationism. Indeed, it does not even require the action of a supernatural creator, that intelligent design is not religion or inherently religious, that intelligent design theory is science. It's a theoretical argument advanced in terms of empirical evidence, technical knowledge proper to scientific and academic specialties.

Indeed, the evidence will further show that intelligent design theory is really science in its purest form, the refusal to foreclose possible explanations based on the claims of the dominant theory or the conventions of the day, to proceed from

the same sort of perspective that led Newton to explore and ultimately explicate gravity.

It shares the attitude of those who worked in the field of quantum mechanics, who posited the wave-particle duality, despite the fact that to some it smacked of the supernatural. It shares the determination of scientists who this very day will look at paranormal phenomena or phenomena that defy our current understanding such as the mind.

For just these reasons, the defendants' expert testimony will show that Dover's modest curriculum change embodies the essence of liberal education, an education that frees the mind from the confines, the constraints, the conventions of the day, and, in so doing, promotes the curiosity, the critical thinking, the quest for knowledge that has served our country so well.

In conclusion, Your Honor, I respectfully submit that the evidence will show that the primary purpose and primary effect of Dover's modest but plainly significant curriculum change is to advance the very sort of legitimate educational goal which the United States Supreme Court recognized in Edwards versus Aguillard, what the Supreme Court of the United States acknowledged, with approval, that school boards

could quite properly require the teaching, never mind mention, about the theories of origin for legitimate secular educational purposes.

Your Honor, we look forward to presenting a defense in this case. Thank you.

THE COURT: All right. Thank you, Mr. Gillen. Before we get to our first witness on behalf of the plaintiffs, let me welcome our spectators to this and the parties, of course, and the media to this important case.

We're going to be in -- although this is a relatively large courtroom, we're going to be in fairly close quarters for a while. Those of you who are going to stick around will be here for the next week and for, it looks like, all of October, as well.

I have been struck in the pretrial proceedings with the sense of decorum on the part of the parties and the spectators. I believe that that will continue, so it's not necessary for me to say much besides I want you to do that and respect the witnesses on both sides as they testify and avoid any expressions that would disrupt the Court in any way. I certainly haven't seen that, and I don't expect to see that in this case.

You would do me a favor and you would do

counsel a favor and the parties a favor if you would restrict your movement in and out of the courtroom during testimony to a minimum. That's not to say that you can't leave, but don't leave lightly just because you're bored and you want to go out into the hallway and then filter back in again. If you must leave, that's certainly acceptable, but we want to keep the traffic to a minimum because I think that that keeps us better focused.

We will take breaks at reasonable intervals, and I assure you we'll have lunch, as well, a lunch break, and we will take this in a way that is deliberate and yet recognizes that we're going to be here awhile and we have plenty of time to try this case.

So with that -- now, Mr. Rothschild, you're not going to move for the admission, I don't think, at this point, of any exhibits, or are you with respect to your opening? Do you want to do that?

MR. ROTHSCHILD: No, I'm not, Your Honor.

THE COURT: I assume not. With that, then we can start with your first witness.

MR. WALCZAK: Plaintiffs call Kenneth Miller.

KENNETH R. MILLER, PH.D., called as a

witness, having been duly sworn or affirmed, testified as follows:

THE CLERK: Please be seated and state your name. Please spell your name for the record.

THE WITNESS: Sure. Good morning, Your Honor.

THE COURT: Good morning.

THE WITNESS: My name is Kenneth R. Miller, K-e-n-n-e-t-h, initial is R., M-i-l-l-e-r.

THE COURT: You may proceed.

DIRECT EXAMINATION

BY MR. WALCZAK:

Q. Good morning, Dr. Miller.

A. Good morning.

Q. Where do you live?

A. I live at 142 Martin Street in Rehoboth, Massachusetts.

Q. What do you do?

A. I'm a professor of biology at Brown University.

Q. I'd like to direct your attention to what's been marked as Plaintiffs' Exhibit 214. Do you recognize this document?

A. Yes, I do. It's the first page of my resume or, as we academic guys call it, my curriculum vitae.

Q. Is this a fair and accurate representation of your background?

A. Yes, it is. The individual document is a few months out of date, but, yes, that is.

Q. I'd like to use this to go over your background. Focusing first on your education, you graduated from Brown University in 1970?

A. That's correct.

Q. And then you got a Ph.D.?

A. At the University of Colorado in 1974.

Q. And did you do a Ph.D. dissertation?

A. Yes, I did.

Q. And what was that on?

A. The Ph.D. dissertation was on the structure and location of the coupling factor on the thylakoid membrane or, as I once explained to my mother, I'm trying to figure out and tried to figure out in the thesis how plants capture the energy of sunlight and convert it into chemical energy and food.

Q. Dr. Miller, I'm likely going to have to ask you to explain things the way you would to your mother a number of times during this testimony. Please bear with me.

A. Thank you, sir. I will keep that in mind.

Q. I'd like to focus now on your professional

experience concerning your academic appointments. After you got your Ph.D., what did you do next?

A. I went to Harvard University to join the faculty as a junior faculty member, and I spent two years there in the position of lecturer in biology and then four years as assistant professor of biology.

Q. And then in 1980 you went to Brown University?

A. That's correct. I got a job offer from my undergraduate alma mater and jumped at the chance and returned to Brown in 1980. Two years later I was given tenure and promoted to associate professor, and four years after that, I was promoted to full professor, which is a rank I still hold.

Q. And you continue to teach at Brown today?

A. Yes, sir, I do.

Q. And you've been there consistently since 1980?

A. I have left town once or twice, but, yes, sir, I have been there consistently.

Q. And what do you teach at Brown?

A. I teach courses in molecular and cellular biology, and I also teach what is, in many years, the largest course that a university gives freshmen, an introductory to general biology course.

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Q. Does that freshman-level course include a section on evolution?
A. Yes, it does. No course in biology would be complete without it.
Q. Dr. Miller, are you still involved in scientific research?
A. Yes, sir, I am. Not as much as I used to be, but I have a small lab and I have a couple of undergraduate students who work with me and I continue to do research.
Q. And remembering that I'm on your mother's level, could you just briefly describe the area of your scientific research?
A. Well, I continue to be interested in the structure and function of biological membranes. My main research tool is the electron microscope. And the main area in which I work right now is the process by which proteins go through, pass through biological membranes. And that's very important to cell biologists because it concerns basically how things get where they're supposed to be. Cells depend upon proteins getting to the proper destinations, and I'm trying to work on part of the mechanism of how they get there.
Q. Now, directing your attention, again, on the

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first page still, to professional service and associations, it appears that you are a member of a number of professional associations, for instance, the American Association for the Advancement of Science. What is that?
A. The American Association for the Advancement of Science is, I believe, the largest scientific organization in the United States. It has tens of thousands of members. It includes scientists of all disciplines. And it probably, if any single organization can fairly be said to speak for the scientific community of the United States, it is that association. It's often called simply AAAS.
Q. And I note you're also a member of the American Society for Cell Biology. What is that?
A. The American Society for Cell Biology is one of the largest organizations of experimental biologists in the United States. It has seven or 8,000 members. As many as 12,000 people attend its annual meetings. And it is one of the, as I said, major organizations promoting experimental biology in the country.
Q. Now, I note you have held a number of positions as -- for instance, the chair of the American Society for Cell Biology program committee.

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It looks like you've had two stints as the chair of the education committee. What do those committees do?
A. Well, the program committee is the committee that organizes the scientific program of the annual meeting with more than 3,000 contributed talks and papers. And when I chaired the program committee, I was, in effect, the director of the scientific meeting picking the major talks, the symposia, organizing the poster sessions and so forth.
The education committee is a committee that promotes and supports scientific education at all levels. Almost all of our members teach at one university level or another, whether it's at the graduate level, perhaps in medical school or undergraduate colleges, and we organize programs to help our members stay abreast of new developments in teaching technology and to promote science teaching and education.
The committee also has, as does the society, a very strong interest in promoting K through 12 science education throughout the country, and we often weigh in on important issues that we believe affect the future of science education in the country.
Q. How do you become a chair of these committees?

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A. I'm often -- when one is named a chair, one receives both congratulations and condolences at the same time. I believe that I was named the chair of the program committee because the newly-elected president of the society in that year, Susan Gerbi, was a colleague of mine and she wanted to leave her imprint on the scientific meeting, and therefore she was very comfortable with me heading the program committee. You might say that I got that job through the old girl network.
The education committee, however, is a different matter. I have been interested in education for quite a long time. I spend a lot of my time and energy teaching at the university level, and I've also been involved in writing textbooks at both the college and the high school level.
My colleagues on the committee and colleagues in the society are aware of that and several elected councils of the society thought that I would be basically the best person to chair that committee.
Q. I note you're also the past editor of a number of journals, for instance, the Journal of Cell Biology, the Journal of Cell Sciences, Advances in Cell Biology. First of all, what are these

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publications?
A. Well, the two journals that you mentioned are two of the leading journals in the field of cell biology. And I served a term as one of a panel of editors on each of these journals, and my function in that respect was to take manuscript submissions, scientific papers that were forwarded to me by the editor-in-chief of the journal, papers that had been submitted for publication, pick out referees or reviewers, often two or three or four scientists to critique those, look for scientific flaws, decide if they should be revised and decide if they have publishable quality. They would then report back to the editor.
I would then make an initial decision, all editors do, on whether or not they were suitable for publication, whether or not they needed to be revised, whether or not they should be rejected, and forward that decision to the editor-in-chief, who would then make the final decision.
In the case of the series Advances in Cell Biology, this was a series of monographs, which are papers, review papers written by individual scientists. And in that case, my authority was somewhat greater and somewhat different in that I

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solicited manuscripts from various scientists who were doing cutting-edge work. I asked them to summarize their work and the work in the field, and I then bundled these 10 or 15 papers a year into this proceeding, which was designed to keep scientists abreast of cutting-edge developments in the field.
Q. I'd like to direct your attention to Page 2 of your curriculum vitae. There's a topic there, it says, Scientific Papers. There are a lot of listings on Pages 2 through 5. Do you know how many are listed there?
A. Actually, I haven't counted them. I think it's in the neighborhood of 45 to 55, somewhere in that vicinity.
Q. Now, the heading there says, Scientific Papers. Is there some particular meaning to that?
A. Yeah, most scientists would understand it right away. What this means, in more specific terms, is that these are scientific research papers that have been published in peer-reviewed scientific journals.
Q. And this concept of peer review, for us non-scientists, what does that mean?
A. Peer review is the essence of the scientific process. It means, basically, that when you've done research that you think is sufficiently important and

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rigorous to merit attention and publication, you send it off to a journal. The journal will then have several of your colleagues in the field, people who can be disinterested, objective, and critical evaluators, tear your paper apart, if they possibly can, try to find flaws, try to find problems with it. The editor will then mediate whether your paper is going to be rejected or perhaps revised a little bit.
But it is the essence -- peer review is the essence of the give and take that goes forward in the scientific community to try to ensure, especially in leading journals, that the papers that are published are scientifically accurate, that they meet the standards of the scientific method, and that they are relevant and interesting to other scientists working in the field.
Q. If you could turn to Page 6. I note there's a heading there that says, Secondary Textbooks and Teaching Materials. And if you could flip over to Page 7 first. At the top there it says, College Textbooks. Are you the author of some college textbooks?
A. Yes, yes, I am. Together with a colleague named Joseph Levine, I have coauthored two college textbooks in general biology that were published by

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the D.C. Heath Company. That company has now gone out of business, and those two textbooks which were published in 1990 and 1993 are out of print. At the peak of their usage, they were used by more than 200 colleges and universities around the country.
We are currently at work on a new college-level manuscript, and we hope to have that published in the years ahead. I notice -- I mentioned the CV was a little bit out of date -- it says, Expected publication, 2005, W. H. Freeman Company. We and our publishers, Freeman, have had a parting of the ways because we had a fundamental disagreement on what this book should be like, so we are currently considering other offers of publication. So this book will not be published this year.
Q. You mentioned that this book is not still in use at the college and university level. Why is that?
A. It's not still in use because it was last copyrighted in 1994, and by science standards, that's an ancient text. Science moves so quickly that material in a textbook that's ten years old is certainly going to be seriously out of date.
And I think that's one of the reasons why even those instructors who liked and really enjoyed working from our book would certainly not use it

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today, simply because there's too much science that has passed under the bridge.
Q. Now, if you would flip back to Page 6 of your curriculum vitae, I note that you have also been the author of a number of high school textbooks. When did you first start writing those textbooks?
A. To be perfectly honest, I first started writing when I was persuaded by Joseph Levine, my coauthor, that this would be a good thing to do, and we first started writing our first manuscript in 1982.
Q. And the first publication was in 1990?
A. The first publication was in 1990, so it took us eight years to go from conceiving and beginning the manuscript to our first publication.
Q. Now, I note there appear to be -- I don't know if it's a number of different editions or these are different books. Could you explain that?
A. Yeah. All of these books have been published by the Prentice Hall Company, which is now a division of Pearson Publishing. And I tried on this to list a number of different editions. The first book -- they all have catchy titles like Biology.
The first book, you'll notice, is simply called Biology, and it came out in five different editions, first through fifth. The second book is

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called, Biology, the Living Science. It came out in two editions. The third book, we liked that original title, I guess, and just went back to plain old Biology, but that is an entirely different book from the earlier Biology.
High school teachers, I have to say, have a way to distinguish these books. They name them by the animals on their cover. So high school teachers will know the first book is the elephant book, the second book is the lioness book, and the current book, the one near the bottom, as the dragonfly book.
So altogether, these books have -- there have been three different books, and they have appeared in the neighborhood of 11 or 12 different editions.
Q. I show you what's been marked as Plaintiffs' Exhibit 31. Is this the cover of the dragonfly book that you mentioned?
A. Yes, sir, it is.
Q. And this is the 2004 edition?
A. This, I believe, is the cover of the 2004 copyright, correct.
Q. And are you working on yet another edition of this book?
A. Yes, sir. This weekend Joe and I were

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working on final revisions for what will be a 2007 copyright of this book, and we are about six months away from starting on a complete rewrite of the entire textbook.
Q. Is this a textbook that's used in the Dover Area School District, to your knowledge?
A. My understanding, sir, is that it is.
Q. And is it used anywhere else besides Dover?
A. It is used in each and every one of the 50 states of the United States and several foreign countries.
Q. Do you know how many high schools use your biology book?
A. I can't give you a number in terms of the number of schools, but I have been told by my publisher that about 35 percent of the high school students in the United States use one or another of the various textbooks we've been discussing.
Q. And what topics are covered in this biology textbook?
A. Soup to nuts. We start out with the nature of science, the nature of biology. We talk about the structure of the cell, cell biology. We talk about molecular biology and genetics, ecology, evolution. We do a phylogenetic survey, which is a biologist's

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term for looking at all the various categories of living things, and we conclude the book by looking at the various systems of the human body.
So we try to provide in the book not a curriculum, but a resource bank from which teachers can draw as they put their curriculum together for the types of courses that students need to take in Pennsylvania and other states to meet state requirements.
Q. And as part of your process in writing and developing these books, are you familiar with, say, the competition, competing high school biology textbooks?
A. Certainly. It is a free market and a competitive market, and it always pays to keep an eye on the competition, so I keep an eye on the other books, as well. And they do the same for us, of course.
Q. And do you send your manuscripts, if that's the right term, to high school teachers for feedback about whether the subject is presented right or for any reason?
A. Yes, we do.
Q. And why do you do that?
A. We do that for a couple of reasons. Joe and

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I are presumed to know the scientific field, but every time we write a chapter and we edit our chapters for each other, we, first of all, send it to a scientific expert to make sure that we've got the science right. Even if it's my own field of cell biology, I'm eager to see a critical opinion from another researcher to see if I got it right.

But we also send these chapters to individual experts in secondary school education, individual high school teachers, and focus groups or panels of high school educators to critique whether or not we have explained things in a way that they think their 14- and 15-year-old students will understand, whether the text is interesting, and whether the text is going to be helpful to them in the classroom in the goal of getting students turned on to science.

Q. So do you make changes in each subsequent edition in response to the feedback you've gotten from high school teachers?

A. Yes, we do, quite a few changes.

Q. Now, isn't it unusual for a research scientist to also be a high school textbook author?

A. I suppose it is.

Q. Why do you do it?

A. Originally, when I was approached by

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Dr. Levine, I told him to take a hike. I said I wasn't interested in this. At the time I was a few months short of a tenure decision, and the only thing that matters at a research university is getting my scientific papers out, getting my grants funded, and getting the respect of my colleagues in the field.

But he managed to show me a few existing books that were used in high schools, and he pointed out at the time I had two young daughters and most scientists would like nothing more than to see their children go into science.

And as I leafed through the books, they were all perfectly okay, but I found two problems with them. One is they were dreadfully boring. I couldn't look at these books and imagine why anyone would want to go into science. And then the second thing is, they sort of gave the impression that everything had been discovered. And any person in experimental science knows that's just not true.

So I called Joe back, and I said, Joe, let's do this, because I'd like to write a book with you that would turn kids on to science, that would tell them about the great unexplored territory that lies out there and would tell them that the most interesting thing one can possibly do, short of a

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career in law, of course, is to have a career in science.

Q. Have you ever testified in court before as an expert witness?

A. No, sir, I have never testified in court as an expert witness.

Q. Have you testified in court on the subject of biology and evolution as you will be doing today?

A. Well, earlier, actually last year, I did testify in federal court as a fact witness in a trial that related to the teaching of evolution.

Q. And what was that case?

A. I believe you'll correct me if I have this slightly wrong, but the case is known as Selman versus Cobb County. And it concerned a case in which the Cobb County Board of Education had attached a warning sticker to all textbooks that contained material about evolution. And this warning sticker or this label had a three-sentence admonition to students.

A number of parents, as I understand the case, a number of parents in the district objected to this sticker being placed on textbooks. They filed a lawsuit in federal court. I was contacted by attorneys for the plaintiffs. They pointed out that my book was one of the ones that had had the sticker

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placed on it, and they asked me if I could come as a witness of fact to tell the Court how textbooks are put together, what the decisions were that I made into my textbook, and perhaps also to comment on whether or not I thought the sticker was an appropriate tool to advance education.

Q. And you did, in fact, testify, I believe it was in November of 2004, in the Selman case?

A. Yes, sir, that's correct, I did.

Q. I'll ask you about your experience with creationism and creationists. Have you been involved with the creationist movement?

A. I suppose you could say I have been involved with the movement, yes.

Q. And could you tell us how you got into this?

A. The very first year that I taught at Brown University, in the fall I taught part of a very large freshman-level introductory biology course. So a lot of students saw me as a new professor at Brown, and I guess they rather liked my energy, enthusiasm, and teaching style.

And in the spring, when I was not teaching, I was setting up my research laboratory, a group of students came to me and they said, we really like your lectures in Bio 11, which was the course. I said,

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gee, thanks a lot.
And they said, there's a fellow whom the Christian students association is bringing to campus. His name is Henry Morris. He is the founder and the president of the Institute for Creation Research in California, and he has dared any scientist on campus to debate him. You're pretty good at giving lectures, why don't you debate this guy? And at first I told the students, no, I'm not interested. And they said, why? And I said, because I'm a cell biologist, I'm not an evolutionary biologist. I want to set up my research lab, so please go away.
But they were very persistent, and they started to pester me and say, well, does that mean this guy is right? I said, no, it doesn't mean this guy is right. And they said, well, if he's not right, why don't you debate him?
So finally I agreed to go ahead and do this. I had a couple of conditions I attached to doing that. I'm glad I did. One of those conditions was that the students would get me audiotapes, books, and pamphlets of the so-called creationism or creation science movement so that I could see what the arguments were that I was likely to face.
And my recollection is I spent almost four

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solid weeks listening to the arguments presented, looking up the arguments, because many of them were in geology and physics and astronomy and way outside of my scientific field, making sure that I understood them and preparing for that debate.
And we finally debated in April of 1981. We had the debate, as it turns out, at the largest building on our campus, which is the hockey rink, and it drew nearly 3,000 people. It was very interesting. And I believe, on the basis of reports of a wager made by the science writer and the religion writer for the Providence Journal, I believe that I prevailed in the debate, though one can never say for sure. And over the next several years, I engaged, I think, in three more debates with scientific creationists.
Q. And have you also written articles critiquing creationism? And I guess I would direct your attention to Page 5 of your curriculum vitae, and there's a section, Articles in Defense of Scientific Integrity.
A. Yes, I have. And this section lists three of them. And these date from the period when I was debating scientific creationists in the early 1980s. I wrote an article for teachers in the American Biology Teacher. I took some of the arguments I had

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faced in the debate and I put answers out in a small journal called Creation Evolution so that other people who might engage in debate could have the benefit of my research and experience on this.
And I also wrote an article for -- an edited volume edited by the very distinguished anthropologist, Ashley Montagu, on scientific creationism in 1984. So, yes, I have written on the subject.
Q. I'm going to ask you about your experience now with intelligent design. Have you been involved in debates, public debates, over the notion of intelligent design?
A. Yes, sir, I have.
Q. And when was the first one?
A. Well, the first one I didn't actually know was going to be about intelligent design. I was approached by an organization of -- I believe of largely Evangelical Christians known as the American Scientific Affiliation, and they asked me if I would come to their summer meeting, I think it was in Asheville, North Carolina, it was in North Carolina, and debate a biochemist from Lehigh University on the subject of a textbook for public schools called Of Pandas and People.

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And I had never heard of the book at the time. They mailed me a copy. I read through the book. And I was unfamiliar with the person who opposed me in debate at that time, but his name was Michael Behe, and as I mentioned, he's a biochemistry professor from Lehigh University. And that was the first place where I heard the term "intelligent design" used in place of the more familiar creation science, which I had debated with various people in the early 1980s.
Q. Was this the only debate you had on intelligent design?
A. No, sir, it isn't. And I'm sorry that I cannot give you an exact number, but if you count point counterpoint debates in print, radio debates, and debates in person, I would expect that probably I have debated on the issue of intelligent design 12 or 13 times, quite a few more times than I debated scientific creationism.
Q. And you have also written articles about intelligent design. I direct your attention to Page 6 under Essays and Reviews. Now, are some of these articles about the concept of intelligent design?
A. Yes, sir, they are. The 1994 article called Life's Grand Design in Technology Review actually

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foreshadowed many of the arguments of intelligent design, so it clearly was on that issue.

And then the last three articles that are listed, the one in Natural History magazine, the one in 2003 in the volume edited by Neil Manson, and the one in 2004, which is listed there in press but now, in fact, has been published -- I said this was just a tad out of date -- all of these deal with intelligent design.

Q. I want to talk about one more listing on your curriculum vitae, and that's on Page 7 under General Audience Books. There is one book there that I think has a provocative title, Finding Darwin's God. What's that about?

A. I meant the title to be provocative. This is a general audience book or a trade book, as publishers call it. And one of the experiences that I had over the years appearing in public and talking about evolution is that many people would tell me that no matter how compelling the scientific arguments were that I made in favor of evolution, they were bothered by the fact that it was perfectly obvious that evolution was an inherently atheistic or God-denying theory.

And I'd just sort of shake my head and shrug

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and say, I don't think so, and point out the fact that I'm a person of faith and a regular churchgoer, and I certainly don't see any conflict. And they would ask me to explain, and I would explain. Another day I would explain, another day I would explain again. And finally I decided, you know, I should probably write a book about this because a lot of people are interested.

So I wrote a book called Finding Darwin's God, and the subtitle of that book I think is more revealing of content, and that is, A Scientist's Search for Common Ground Between God and Evolution. And what I tried to do in the book was twofold, first to explain why science, sciences and the scientific community, find evolution to be so useful, so valuable, and so compelling as a scientific explanation, and then, secondly, to explain how a person of faith -- although I'm a Roman Catholic, I tried to construe this in a vary broad way so that I would say how a person following any of the great Abrahamic religions could appreciate evolution in the context of their faith. And I hope very much I was successful in doing that.

Q. Now, that's not a scientific publication, you said that's a trade publication?

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A. It certainly is not a scientific publication. Everything that a scientist writes or says is not necessarily a scientific statement or a scientific publication.

MR. WALCZAK: Your Honor, at this time we would proffer Dr. Miller as an expert in biology, evolution, instructional biology materials for high school students, creationism, and intelligent design.

THE COURT: All right. Thank you. Cross-examination?

MR. MUISE: Your Honor, pursuant to the stipulation of the parties, we would agree that the experts are qualified to testify within their area of expertise, the only exception being plaintiffs' expert Barbara Forrest, which we will then, at that time, take the opportunity to voir dire. But we don't have any objections based on that stipulation.

THE COURT: I understand. Thank you, Mr. Muise. You may proceed. And he is admitted for that purpose for the record.

MR. WALCZAK: Thank you.

THE WITNESS: Thank you, Your Honor.

BY MR. WALCZAK:

Q. Dr. Miller, I want to ask you five questions to elicit your opinions about the big issues in this

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case. Do you have an opinion about whether evolution is a testable theory that is accepted by the scientific community?

A. Yes, sir, I do.

Q. And what is your opinion?

A. My opinion is that evolution is an eminently testable theory and that it is broadly and generally accepted by the scientific community.

Q. Do you have an opinion about whether intelligent design is a testable theory that is accepted by the scientific community?

A. Yes, I do.

Q. And what is that opinion?

A. My opinion is that intelligent design is not a testable theory in any sense, and that as such, it is not generally accepted by the scientific community.

Q. Do you have an opinion about whether intelligent design is or even can be properly considered a scientific theory?

A. Yes, I do.

Q. And what is that opinion?

A. My opinion is that intelligent design is not science, and therefore it cannot be construed as a scientific theory in any sense whatsoever.

Q. Do you have an opinion about whether

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intelligent design is a particular religious view, namely a form of creationism?
A. Yes, sir, I do.
Q. And what is that opinion?
A. I believe that intelligent design is inherently religious and it is a form of creationism. It is a classic form of creationism known as special creationism.
Q. Do you have an opinion about whether the four-paragraph statement read by the Dover School District promotes students' understanding of evolution in particular and science generally?
A. Yes, I do.
Q. And what is your opinion?
A. I think the statement by the Dover Board of Education falsely undermines the scientific status of the theory of evolution, and therefore it certainly does not promote student understanding or even critical thinking, and I think it does a great disservice to science education in Dover and to the students of Dover.
Q. Let's now explore the basis for your opinions. What is science?
A. You ask a good question. It's useful, I think, to parse it to where the word comes from. The

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word "science" comes from the Latin word scientias, which means knowledge. And in the most general sense, the word "science" is sometimes used to just say learning systematic knowledge, for example, library science or political science.
But I think that in the context in which the word "science" is going to be used in this case, what we mean by "science" is what we would call natural science, sciences such as chemistry, physics, and astronomy. And natural sciences I think are best described as the systematic attempt to provide natural explanations for natural phenomena.
Q. Are there rules for scientific inquiry?
A. Yes, there are.
Q. And what are these rules?
A. Well, you just heard one of the rules in the definition of science, which is that science tries to provide natural explanations for natural phenomena. So one of the most basic rules of science is that we tend -- what we require, the practitioners of science seek their explanations in the world around us, in things we can test, we can observe, and we can verify.
Now, there are certain rules of procedure, as well. And among those are that scientific inquiry must be open, that it must be subject to duplication,

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replication, test and examination by other scientists. For example, I could never publish a result saying I had made an observation on a particular protein without also telling people what my methods were and how I made that observation. And the point is to make my work and my observation testable.
And then the final and sort of open rule basically is that science is always an activity in which everything in science is open to critical examination, replication, peer review, and discussion by other scientists.
Q. Is this just a view held by Professor Miller?
A. No, I don't think so. I think the way I have described science and the process of science would be generally held by most members in the scientific community.
Q. I'd like to direct your attention to what's been marked as Plaintiffs' Exhibit 649. Do you recognize this publication?
A. Yes, sir, I do.
Q. I note at the bottom it says, National Academy of Sciences. Now, this is an organization that we're going to be hearing about repeatedly. What is the National Academy of Sciences?

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A. Well, if my recollection serves me well, the National Academy of Sciences is an organization that was established by act of Congress, I believe when Abraham Lincoln was president, and it consists of the elite and most accomplished scientists in every scientific field.
One of the greatest honors that an American scientist or, actually, even a foreign scientist, because we have foreign associate members in our national academy, one of the greatest honors that a scientist can receive is to be tapped for membership in the National Academy of Sciences.
I believe the National Academy of Sciences is also charged with advising the president and the Congress on matters of scientific interest and importance.
Q. Are the publications of the National Academy of Sciences something that are reasonably relied on by scientists in the field?
A. Absolutely, yes.
Q. I'd like to direct your attention to Page 27 of Exhibit 649. I've asked you before to highlight a passage on this page. Is that correct, Dr. Miller?
A. Yes, you have.
Q. Could you please read for the record the

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highlighted passage?
A. Be glad to. This is the opening of the third section of this book, and it opens basically by defining science. And it says, and I quote, Science is a particular way of knowing about the world. In science, explanations are restricted to those that can be inferred from confirmable data, the results obtained through observations and experiments that can be substantiated by other scientists. Anything that can be observed or measured is amenable to scientific investigation. Explanations that cannot be based on empirical evidence are not part of science.
Q. Do you agree with that statement?
A. I certainly do.
Q. How long have these rules of science been in effect?
A. I'm tempted to say forever, but I think certainly for the last 200 years of contemporary science, the notion that science -- in other words, all of the 19th Century and all of the 20th Century and now into the 21st -- the notion that science can only deal with empirical data, what we can see, what we can observe, and what we can measure, has been part of the common understanding of science in all people in all cultures.

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Q. So science doesn't -- these rules don't just apply in the United States?
A. No, sir, they don't. I think science might be the closest thing we have on this planet to a universal culture, and these rules apply everywhere.
Q. Why are these rules important?
A. These rules are important because if you don't have these rules, you don't have science. The entire -- human beings are fallible, and I mentioned that science is a human activity. It's a systematic search for natural explanations for natural phenomena.
And if you invoke a non-natural cause, a spirit force or something like that in your research and I decide to test it, I have no way to test it. I can't order that from a biological supply house, I can't grow it in my laboratory. And that means that your explanations in that respect, even if they were correct, were not something I could test or replicate, and therefore they really wouldn't be part of science.
Q. So supernatural causation is not considered part of science?
A. Yeah. I hesitate to beg the patience of the Court with this, but being a Boston Red Sox fan, I can't resist it. One might say, for example, that the reason the Boston Red Sox were able to come back from

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three games down against the New York Yankees was because God was tired of George Steinbrenner and wanted to see the Red Sox win.
In my part of the country, you'd be surprised how many people think that's a perfectly reasonable explanation for what happened last year. And you know what, it might be true, but it certainly is not science, it's not scientific, and it's certainly not something we contest. So, yes, those rules certainly apply.
Q. Does science consider issues of meaning and purpose in the universe?
A. To be perfectly honest, no. Scientists think all the time about the meaning of their work, about the purpose of life, about the purpose of their own lives. I certainly do. But these questions, as important as they are, are not scientific questions.
If I could solve the question of the meaning of my life by doing an experiment in the laboratory, I assure you I would rush off and do it right now. But these questions simply lie outside the purview of science. It doesn't say they're not important, it doesn't say that any answer to these is necessarily wrong, but it does say that science cannot address it. It's a reflection of the limitation of science.

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Q. Could you briefly tell us, how is it that scientists do their work? How is it that you approach a particular problem?
A. There are probably as many ways to approach scientific problems as there are scientists. But I think one of the key questions, one of the key aspects of this is thinking of a question. Now, that's, in many ways, the hardest thing to do. But what we try to do is to look at the natural world and try to narrow down a specific question from the point of view that we can develop a very specific testable hypothesis about that question.
And in many ways, that's the greatest art of being a scientist, because no one tells you how you come up with good questions. But a good question is one that is important, the result will be interesting to other people, other scientists, as well, it will shed light on a natural biological or physical or chemical process, and we can phrase a hypothesis about it in a way that we can actually devise a test.
And once we frame that really good hypothesis, we do an experiment, we go into the field, we look for evidence, we do measurements, we make observations, and we try to gather the data that will be sufficient to confirm or refute the hypothesis.

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And if we confirm it, we don't consider it to be proven, you never prove anything in science, but we consider it to be supported, and then very often we go on and ask another tough question about the same hypothesis. If the hypothesis is refuted, we discard it, go back, think of a better idea. That's as close as I can come to a good description.

Q. So after you have the hypothesis, after you've gone and done the experimentation or observation, is there something you do with the data after that?

A. Oh, excuse me, I'm talking about the work of an individual scientist. And if you think you either have the data that refutes an important hypothesis or data that tends to support and confirm an important hypothesis, if you think this will be of interest to other people in the scientific community, you then gather up your methods, your procedures, your experimental data, might be photographs, might be diagrams, results, tables, gels that we run in the laboratory, something along those lines, and you put them into a scientific publication. You write a paper and you send that paper to a reputable, hopefully a prestigious, if you think it's important work, scientific journal, and you immediately subject it to

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peer review and criticism by your colleagues.

Q. Now, is this peer-review process important? Tell us a little bit of how it works.

A. It's exquisitely important. You don't have science without it. And the way in which it works is, for example, I will write up my research in the manner that I have just described and send it off, perhaps, to Nature or the Journal of Cell Biology or something along those lines.

An editor at the other end will read my work, will consult, perhaps, with other editors, try to find three or four experts in the field who are knowledgeable about the kind of work I'm doing and the questions I'm asking, send it out for review. Those people will then examine the paper. They'll look for methodological flaws. Perhaps I used the wrong reagent, perhaps I used the wrong reaction temperature. They'll look for logical flaws. Perhaps the experimental results I got don't really mean what I think they mean. And they'll also look for novelty.

And by novelty, if the work I'm doing just confirms a hypothesis that has already been abundantly confirmed, nobody really cares, and that's what I mean about novelty. They will then decide if my paper is absolutely fabulous and should go right into the

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journal or if it can be accepted in the journal if I make a few changes, corrections, do another experiment, or basically if I should be sent back to the drawing board saying, this is not worthy of publication in our journal.

The Journal of Cell Biology, for which I served a term as editor, had a rejection rate of about 60 percent, which meant that six papers out of ten were simply sent back saying, we're not going to publish this.

Q. So unless a theory meets these rules of science and has gone through these procedures of science, can it be accepted as a scientific theory?

A. Well, you've actually jumped from sending a scientific paper in to what constitutes a theory and how can a theory be accepted. I have never done any research so grand that I would have described in any of those papers a new theory that I have. Hypotheses, yes, but theories are a whole other level of understanding.

Theories are broad, useful, powerful generalizations that explain and unite a broad range of facts. Theories have to make testable predictions, because otherwise they're not useful as theories. If a theory is enunciated to explain a natural process,

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it has to make predictions that lead to testable hypotheses so that people can go into the laboratory, can make those tests, and can tend to confirm or refute the theory.

Q. But if a theory does not meet these ground rules of science, testability, observability, they are not considered scientific?

A. It's just not a scientific theory, that's correct. And my tongue-in-cheek explanation of the baseball playoffs last year falls into exactly that category. It's not a theory because it's not scientific and it's not testable.

Q. Now, this nonscientific theory, does that mean its wrong?

A. Oh, of course not. I also said, again, thinking about that silly example, a lot of people in my part of the country think that's absolutely true. Explanations that lie out of science can be true, but they're not scientific. And I think that applies to the sort of theory that you were talking about.

MR. WALCZAK: Your Honor, I know, has indicated that we'll take periodic breaks, and this is actually a good breaking point for us.

THE COURT: Yes, I think it's an opportune time for us to break. Let's break for a reasonable

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interval. We'll see what we'll do as far as the duration of the breaks as we go, but we'll probably take at least 20 minutes, I would say, so that people can have an ample break. We may take longer if we need to. So this will be our midmorning break, and we'll stand in recess.

(Recess taken.)

THE COURT: Mr. Walczak, you may continue.

MR. WALCZAK: Thank you, Your Honor.

BY MR. WALCZAK:

Q. Dr. Miller, I want to shift gears. We just talked about the science and the nature of science, and I want to now move to the topic of evolution. What is evolution?

A. You always ask good questions.

Q. Thank you.

A. Most biologists would describe evolution as a process of change over time that characterizes the natural history of life on this planet.

Q. And are there certain core propositions to evolutionary theory?

A. Yeah, I think there are, and I think basically there are three. And the first one is the observation that life really has changed over time, that the life of the past is different or was

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different from the life of the present, and that the natural history of this planet is characterized by a process of change over time.

The second thing, the second core element, I guess, is the principle of common descent, and that is the notion that living things are united by a core of common ancestry, that living things, if you trace them back far enough, show common ancestors that gave rise to the many forms of life today.

And the third core proposition and I think probably the simplest way to state it is the process that drove that change through time from common ancestors and common descent is driven by forces and principles and actions that are observable in the world today. And the key, therefore, is that we can understand how evolution works by looking at what's happening in the world around us today.

Q. And is there a name for that force that drives the change?

A. The force that drives the change, actually, there are many individual forces and processes. Many of them are united under the term of "natural selection."

Q. Now, there's a gentleman named Charles Darwin who played some role here. I was wondering,

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who was Charles Darwin?

A. Charles Darwin was a British naturalist who was born on February 12th, 1809. If memory serves me well, that's a better-than-average day for the history of humankind because Abraham Lincoln was born on exactly the same day.

He lived in Great Britain, he studied natural history and studied theology, became a naturalist, traveled around the world on a British ship called the Beagle, made a number of very interesting observations during that trip and came back from that trip to think, to write, critique his ideas for many years, and then wrote a series of books which are the foundation of what we consider to be modern evolutionary theory.

Q. And what was Darwin's contribution to evolution?

A. Well, one of the -- I think the most interesting and oftentimes overlooked aspects is that the first core proposition of evolution, which is that life has changed over time, was actually appreciated well before Darwin was born.

The great French naturalist Cuvier recognized that the fossils told a record of life in the past and that that record was a record of change,

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and that as life changed into the present, new organisms appeared and old organisms went extinct. So the process of change, what we sometimes today simply call the process of evolution, that was understood well before Darwin.

What Darwin did for the first time was to propose a plausible, workable, and ultimately testable mechanism for the processes that drove that change, and that is the mechanism of natural selection.

Q. And has evolutionary theory stood still since Darwin's time or has it evolved?

A. It has -- nothing in science stands still, and that's true of evolutionary theory, as well. Charles Darwin lived and worked and wrote at a time when, for the most part, scientists were unaware of the existence of genes, of macromolecules, certainly of DNA, and a host of other tools and techniques by which we study biology today.

And to me, as a scientist, the most remarkable thing about evolutionary theory is that as the science of biochemistry has developed, as the science of cell biology, genetics, molecular biology, and other elements of science have developed, all of these have fit beautifully into the general framework described by Darwin almost 150 years ago.

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Q. So the evolutionary theory draws on many branches of science?
A. Yes, it does.
Q. How has the emergence of modern genetics and molecular biology affected scientists' views of evolution?
A. Well, genetics really is the first one and I think in some historical respects the most interesting within. Charles Darwin, towards the end of his life, was worried about something, and what he was worried about was that favorable characteristics that might appear in organisms might be blended away as they had to mate to reproduce.

So if an individual showed up with a really good characteristic that could be favored by natural selection, its offspring might only have half of that characteristic because Darwin thought that the inheritance of organisms blended in their offspring, and the next generation a quarter and the next generation an eighth, and after a while, no matter how favorable the variation was, it would be gone.

Well, the discovery of genetics, beginning with Gregor Mendel in the 1850s, suddenly answered Darwin's most profound concern because it showed that genetics, inheritance, is particulate. And what I

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mean by that sort of a jargon term in science is that our inheritance is controlled by individual units called genes which are passed from one generation to the next.

And that solved Darwin's problem because it showed that inheritance is not really a blending and that these favorable characteristics can actually be preserved. So modern genetics, basically, we might say, came to the rescue of a potential problem in evolutionary theory.

Things got better when molecular biology added the dimension of DNA and RNA, because for the first time we could understand how evolution could work right down to the level of the molecule. And in every respect, it provided a dramatic confirmation to that general framework.

Q. I think maybe we should take a step back and maybe I can ask you to explain the whole concept of natural selection. What are we talking about here?
A. Well, Darwin and other people were impressed at how much plant and animal breeders could influence the ultimate characteristics by selecting individuals from a breeding population, let's say of horses or rabbits that had a particular characteristic the breeder wanted and allowing them to breed. Plant

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breeders have done the same thing for years. This was the methodology of Luther Burbank when he developed all sorts of beneficial strains of plants.

And Darwin was enough of a naturalist to realize that the same process of selection actually happens in nature. Darwin pointed out there's a struggle for existence, whether we like to admit it or not, and not all organisms are able to pass their genes on to the next generation. Those that do the best in that struggle for existence -- and it's not just a struggle to survive, it's a struggle to find mates, to reproduce, and to raise those offspring. So in many respects things that are very cooperative are important in this struggle.

Darwin realized that those organisms that had the characteristics that suited them best in that struggle, those were the ones that were going to leave their characteristics in the next generation, and he realized that's pretty much what plant and animal breeders do, and therefore over time the average characteristics of a population could change in one direction or another and they could change quite dramatically. And that's the essential idea of natural selection.

Q. And what Darwin didn't understand was

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exactly how that happened because he wasn't -- he didn't have the benefit of genetics at the time?
A. The entire process depends scientifically on what that mechanism of inheritance is. Darwin didn't know it. He couldn't have known it. Nobody knew it at the time. And therefore you might say that when modern genetics came into being by the rediscovering of the work of Gregor Mendel, everything in Darwin's theory was at risk, could have been overturned if genetics turned out to contradict the essential elements of evolutionary theory, but it didn't contradict them, it confirmed them in great detail.
Q. Now, are you able to give us some examples of how modern genetics has applied to evolutionary theory?
A. Well, I can give you quite a few of examples. Would you like me to use a demonstrative that would be useful to the Court?
Q. And you have, at my request, prepared a series of slides that will help you to explain this?
A. Yes, I have, as a matter of fact. I thought that I would start illustrating this by looking at hemoglobin. Hemoglobin is the protein that makes your blood red. It's the oxygen-carrying protein found in red blood cells.

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And in the upper right-hand corner of the slide, there is a molecular diagram of hemoglobin. It's made up of four parts. Those parts are called polypeptides, but we can think of them essentially as four subunits. It has two copies of a part called alpha-globin and two copies of a part called beta-globin.

Now, what modern molecular biology has enabled us to do is to look at exactly where the instructions are that specify these. And you'll notice that the beta-globin -- excuse me, the alpha-globin instructions are specified on Chromosome Number 16 and the beta-globin instructions are specified on Chromosome Number 11.

And as our genome does for many genes, we have multiple copies of these, so we have backups. We've got extra copies of the alpha-globin genes and extra copies of the beta-globin genes, and they have very interesting physiological functions, these multiple copies, which are not relevant right now and therefore we won't get into.

But there's something very interesting about these, and it enables us to test evolution right down to the level of the molecule. And I want to point that out by looking at the beta-globin genes on

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Chromosome Number 11.

If you could advance the slide, please. I've zeroed in on the six copies of the beta-globin gene sequence. Each of these copies is a set of instructions for how you build this polypeptide. Five of them work, but one of them doesn't. It's given the Greek letters psi, beta, and then the number one. And the psi-beta-1 sequence isn't a gene. It doesn't work. It's a pseudogene, and a pseudogene is recognized as a gene because it's so similar to the other five in its DNA sequence, but it has some mistakes. It's broken, and it has a series of molecular errors that render the gene non-functional.

Now, I'd like to show you exactly what those molecular errors are in the next slide. This is a blow-up of the pseudogene. These are the portions that actually do the coding, if it was coded in red here. And you'll notice that there are six distinct mistakes in this gene.

Now, I don't know if I really want to try the patience of the Court in terms of going into the details of molecular biology, but in a very simple way, the altered initiator means that the signal that exists at the front of the gene that says "copy me" is missing. And therefore RNA preliminaries, the

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molecule that copies genes, can't bind, and it never gets expressed.

But even if it did get expressed, it has five other errors that would keep this, the RNA copy of this gene, from being translated. It's missing the start signal. It's got stop codons that would cause the synthetic apparatus to grind to a halt. It's just a mess.

Now, the reason that this is important in evolution is actually very simple, and that is, these errors appear in a gene, they have no functional purpose. And you might ask yourself, what would I do, what would you do if we were to find another organism that didn't just have similar genes but also had a pseudogene in the same spot and had the same set of errors?

There's no reason why evolution would produce a duplicate set of mistakes in two copies of things. It must mean that these two organisms are descended with modification from another organism that had the same set of mistakes.

And if you go on to the next slide, what I'd like to show you are three organisms, the gorilla, the chimpanzee, and the human being that share the exact same set of molecular mistakes.

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Now, why is this significant? One of the core principles of evolution is common descent. One could always argue that because the three species that I've depicted on this slide are all African species, that's where they all come from, they're all primates and they all probably started out living in similar environments, that the functional parts of this gene locus, they might work the same. But you cannot argue that the mistakes should match.

And the fact that all three of these species have matching mistakes leads us to just one conclusion, and that's the same conclusion that Charles Darwin predicted almost a century and a half ago, and that is that these three species share a common ancestor. Matching mistakes are evidence of common ancestry.

Q. And are there other animals that share the same mistakes?

A. Well, we actually don't know, because there are two great apes in which we're waiting on the genome sequence. Those are the orangutan and the Bonobo, pygmy chimpanzee. And if I had to make a friendly bet, I'd bet that they do.

But other primates and other mammals, cats, dogs, horses, they don't have these mistakes. These

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mistakes are unique to the lineage that shows common ancestry of us and these other organisms.

Q. Could you give us another example?

A. Sure, I'm very happy to. The next slide, this is another test of the evolutionary hypothesis of common ancestry.

We have, as I'm sure most people know, 46 chromosomes in our human cells. That means we have 23 pairs of chromosomes because you get 23 from mom and you get 23 from dad, so we've all got 46 total. We've got 23 pairs.

Now, the curious thing about the great apes is they have more. They have, as you can see from the slide, 48 chromosomes, which means they have 24 pairs. Now, what that means, Mr. Walczak, is that you and I, in a sense, are missing a chromosome, we're missing a pair of chromosomes. And the question is, if evolution is right about this common ancestry idea, where did the chromosome go?

Now, there's no possibility that that common ancestry which would have had 48 chromosomes because the other three species have 48, there's no possibility the chromosome could have just got lost or thrown away. Chromosome has so much genetic information on it that the loss of a whole chromosome

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would probably be fatal. So that's not a hypothesis.

Therefore, evolution makes a testable prediction, and that is, somewhere in the human genome we've got to be able to find a human chromosome that actually shows the point at which two of these common ancestors were pasted together. We ought to be able to find a piece of Scotch tape holding together two chromosomes so that our 24 pairs -- one of them was pasted together to form just 23. And if we can't find that, then the hypothesis of common ancestry is wrong and evolution is mistaken.

Go to the next slide. Now, the prediction is even better than that. And the reason for that is chromosomes themselves have little genetic markers in their middles and on their ends. They have DNA sequences, which I've highlighted in here, called telomeres that exist on the edges of the chromosomes.

Then they have special DNA sequences at the center called centromeres, which I've highlighted in red. Centromeres are really important because that's where the chromosomes are separated when a cell divides. If you don't have a centromere, you're in really big trouble.

Now, if one of our chromosomes, as evolution predicts, really was formed by the fusion of two

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chromosomes, what we should find is in that human chromosome, we should find those telomere sequences which belong at the ends, but we should find them in the middle. Sort of like the seam at which you've glued two things together, it should still be there.

And we should also find that there are two centromeres, one of which has, perhaps, been inactivated in order to make it convenient to separate this when a cell divides. That's a prediction. And if we can't find it in our genome, then evolution is in trouble.

Next slide. Well, lo and behold, the answer is in Chromosome Number 2. This is a paper that -- this is a facsimile of a paper that was published in the British journal Nature in 2004. It's a multi-authored paper. The first author is Hillier, and other authors are listed as et al. And it's entitled, The Generation and Annotation of the DNA Sequences of Human Chromosomes 2 and 4.

And what this paper shows very clearly is that all of the marks of the fusion of those chromosomes predicted by common descent and evolution, all those marks are present on human Chromosome Number 2.

Would you advance the slide. And I put this

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up to remind the Court of what that prediction is. We should find telomeres at the fusion point of one of our chromosomes, we should have an inactivated centromere and we should have another one that still works.

And you'll note -- this is some scientific jargon from the paper, but I will read part of it. Quote, Chromosome 2 is unique to the human lineage of evolution having emerged as a result of head-to-head fusion of two acrocentric chromosomes that remain separate in other primates. The precise fusion site has been located, the reference then says exactly there, where our analysis confirmed the presence of multiple telomere, subtelomeric duplications. So those are right there.

And then, secondly, during the formation of human chromosome 2, one of the two centromeres became inactivated, and the exact point of that inactivation is pointed out, and the chromosome that is inactivated in us -- excuse me, the centromere that is inactivated in us turns out to correspond to primate Chromosome Number 13.

So the case is closed in a most beautiful way, and that is, the prediction of evolution of common ancestry is fulfilled by that led-pipe evidence

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that you see here in terms of tying everything together, that our chromosome formed by the fusion from our common ancestor is Chromosome Number 2. Evolution has made a testable prediction and has passed.

Q. So what you're testifying here is that modern genetics and molecular biology actually support evolutionary theory?

A. They support it in great detail. And the closer that we can get to looking at the details of the human genome, the more powerful the evidence has become.

Q. I'd like you to direct your attention to Plaintiffs' Exhibit 127. Do you recognize this document?

A. Yes, I have seen it before. I believe it's a newsletter produced by the Dover Area School District.

Q. And, Matt, if you could highlight. I've highlighted a passage from the second page of the newsletter, and I would like you to read what has been highlighted.

A. Sure. Quote, In simple terms, on a molecular level, scientists have discovered a purposeful arrangement of parts which cannot be

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explained by Darwin's theory. In fact, since the 1950s, advances in molecular biology and chemistry have shown us that living cells, the fundamental units of life processes, cannot be explained by chance.

Q. Is that a true statement?

A. I think neither of those two sentences is a true statement. Would you like me to explain why?

Q. Please.

A. Okay. The first point is the purposeful arrangement of parts. Science doesn't really deal with questions of purpose, value, and meaning. So to say that science has discovered a purposeful arrangement of parts puts science on the other side of this divide of empirical knowledge where it doesn't belong, so that certainly is not true.

As I've just mentioned to you, the arrangement of chromosomes in our genome, the existence of molecular errors, actually fits evolutionary theory remarkably well, so that part of the sentence doesn't hold up, either.

And then the second sentence, to any scientist who is extremely curious, it says, The fundamental units of life processes cannot be explained by chance. I completely agree. Natural selection is not a chance process. Evolution is not

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just random chance. And natural selection is the most unchance-like part of evolutionary theory. So stating that you can't explain something by chance is not equivalent to saying you can't explain it by evolution.

Q. Now, is there research ongoing in this area, molecular biology and genetics?

A. Oh, absolutely. In fact, it's moving so fast that it's difficult to keep up with it.

Q. And, in fact, is there a very recent publication, peer-reviewed publication, that bears on this issue of common descent?

A. Well, the answer to that is, there's more than one. And the one that comes to my mind right away is an issue earlier this month of the scientific journal Nature, which might be the most prestigious scientific journal in the world, which focused on seven or eight papers describing the complete genome analysis of the genome of the chimpanzee.

Q. And if I could direct your attention to what's been marked as Plaintiffs' Exhibit 643, is this the cover of the publication to which you refer?

A. Yes, that is the cover of the September 1st, 2005 issue of the scientific journal Nature. And you can see that the cover story is the chimpanzee genome.

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Q. Matt, if you could turn to -- I believe it's Page 69. Is this the article to which you are referring?

A. Well, it's one of about seven or eight articles on the genome and its implications to which I refer. But this is the prime article that presents the chimpanzee sequence and points out some of the highlights of the sequence. So if one article in this large journal was said to be the cover story, the key article, this is it.

Q. And why is this important?

A. It's important because it introduces an enormous data set, the chimpanzee genome, that we simply didn't have before. And the title of the article I think actually tells you what you're going to find in here.

Initial sequence, because we change these things as we get better data, initial sequence of the chimpanzee genome and in comparison with the human genome. These organisms, as the earlier demonstratives that I presented to the Court show, clearly show a common ancestry with us, but as any observation will tell you, they're not like us. So understanding how we are similar and how we are different from these organisms is a really important

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and exciting problem in biology.
Q. Matt, could you highlight the first sentence. This is the first sentence of the article. Could I ask you to read this, Dr. Miller?
A. Of course. And this is the introductory sentence to the article, and it reads, quote, More than a century ago Darwin and Huxley posited that humans share recent common ancestors with the African great apes. Modern molecular studies have spectacularly confirmed this prediction and have refined the relationships showing that the common chimpanzee, Pan troglodytes, and Bonobo, Pan paniscus or pygmy chimpanzee, are our closest living evolutionary relatives.
Q. It says "spectacularly confirmed." Is that something you routinely find in scientific journals?
A. I think you could read the journal Nature for several years and not see another use of the word "spectacular." It tells you that the authors of this paper are really excited about this data. And, to be perfectly honest, the entire scientific community was excited by the chance to compare this data with our own genome, and that warrants the use of the word "spectacular."
Q. Dr. Miller, isn't evolution just a theory?

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A. Evolution is just a theory, in the same way that the atomic theory of matter is just a theory, the Copernican theory of the solar system is just a theory, or the germ theory of disease is just a theory. But theories, as I emphasized earlier, are not hunches, they're not unproven speculation. Theories are systems of explanations which are strongly supported by factual observations and which explain whole sets of facts and experimental results.
Q. And how do you distinguish, say, a theory from a fact?
A. A fact is a repeatable, verifiable observation or a result. So, for example, in the earlier demonstratives I showed, it is a fact that there is an altered initiator sequence on the beta-globin pseudogene. It's also a fact that there are five working copies of this gene on Chromosome Number 11. All of these are facts. We can test them, we can verify them, we can put them together.
But facts by themselves don't tell us a whole lot. A very famous biologist once said that without theories to tie them together, biology is just stamp collecting. And what they meant by that was that the production of isolated individual facts is unimportant unless you can tie all those facts

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together in an explanatory framework, and what a theory is is just such a mechanism.
So evolutionary theory takes the sorts of facts that I have pointed out in the last few slides that the Court has looked at and ties them into a coherent whole by common explanation, for example, by the hypothesis of common descent.
Q. So the term "theory" has a particular meaning within science distinct from everyday usage?
A. Absolutely. And when we're out on the street and we say, I have a theory on what the best way to drive to Pittsburgh is given the traffic or I have a theory on whether or not it's going to rain this afternoon, we mean, in ordinary conversation, a hunch, speculation, a guess.
When we say "theory" in science, we mean a broad, overarching, explanatory explanation that's very strongly supported by fact and by factual evidence and that ties all of this together in an explanatory framework that helps us make testable predictions and testable hypotheses. And if it doesn't do that, it's not a scientific theory.
Q. And is your understanding of theory and fact, as those terms are used in science, reflected by the scientific community?

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A. Oh, I think it's fair to say that the understanding that I've expressed here in the Court today is exactly the understanding possessed by the members of the scientific community elsewhere.
Q. I'd like to direct your attention to Plaintiffs' Exhibit 649. And this is, again, the National Academy of Sciences publication?
A. Yes, sir, it is.
Q. And if you could turn to Page 5. And, Matt, if you could pull up the highlighted passage. Dr. Miller, could you read the highlighted text, please, from Page 5 of this publication?
A. Be glad to. Quote, Ironically, facts in science often are more susceptible to change than theories, which is one reason why the word "fact" is not used very much in science, unquote.
Q. So is evolution a theory or a fact?
A. In English, we often use the word "evolution" to refer to two different things. We often use the word "evolution" to refer to the fact that life has changed over time. And in that respect, evolution is as much of a fact as anything else we know about the natural history of this planet.
However, the use of "evolution" as a theory is basically used to describe the mechanisms by which

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those changes took place. And in that respect, evolution is, indeed, a theory because it is a powerful, useful, and predictive explanation of a whole range of scientific facts.

Q. Is evolutionary theory, including natural selection and descent with modification from a common ancestor, generally accepted by the scientific community?

A. It is overwhelmingly accepted by the scientific community.

Q. I'd like to direct your attention, staying on the same publication from the National Academy of Sciences, if we could turn to Page 16. Now, I believe you testified earlier that the National Academy of Sciences is probably the most prestigious scientific association in the country?

A. I think it's probably the most prestigious scientific association in the world.

Q. And have they taken a position on whether evolution is accepted?

A. Yes, they have.

Q. Matt, could you please highlight. Dr. Miller, I'd like you to read the highlighted passage from Page 16, please.

A. Sure. Quote, The concept of evolution

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through random genetic variation and natural selection makes sense of what would otherwise be a huge body of unconnected observations. It is no longer possible to sustain scientifically the view that living things we see today did not evolve from earlier forms or that the human species was not produced by the same evolutionary mechanisms that apply to the rest of the living world, unquote.

Q. I'd like to now direct your attention to Plaintiffs' Exhibit 192. Do you recognize this publication?

A. Yes, I do.

Q. And who publishes this?

A. This is a booklet that was published a few years ago by the National Academy of Sciences.

Q. And is this more recent than the other publication that we were just referring to?

A. I believe it is. I think this was published -- you'll correct me if I'm wrong -- in 1999 or in 2000.

Q. Matt, could you go to Page Roman Numeral VIII, please, and if you could highlight the text. Dr. Miller, I'd like you to read from this National Academy of Sciences publication the highlighted text, please.

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A. Sure, I'd be glad to. Quote, The concept of biological evolution is one of the most important ideas ever generated by the application of scientific methods to the natural world. The evolution of all the organisms that live on earth today from ancestors that lived in the past is at the core of genetics, biochemistry, neurobiology, physiology, ecology, and other biological disciplines. It helps to explain the emergence of new infectious diseases, the development of antibiotic resistance in bacteria, the agricultural relationships among wild and domestic plants and animals, the composition of the earth's atmosphere, the molecular machinery of the cell, the similarities between human beings and other primates, and countless other features of the biological and physical world. As the great geneticist and evolutionist Theodosius Dobzhansky wrote in 1973, quote, Nothing in biology makes sense except in light of evolution, unquote.

Q. Do you agree with that, Dr. Miller?

A. I agree with that wholeheartedly.

Q. You testified earlier that the American Association for the Advancement of Sciences is the largest association of scientists in this country. Do you know whether they have taken a position on whether evolution is accepted in science?

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A. Yes, sir, they have taken a position.

Q. I'd direct your attention to Plaintiffs' Exhibit 654. Do you recognize this?

A. Yes, I do. This is an online feature published by the American Association for the Advancement of Science, and it has a series of questions and answers on evolution and intelligent design.

Q. And do you know whether the statements contained in here are supported by the leadership of the American Association for the Advancement of Science?

A. It is my understanding that they are.

Q. Matt, if you could highlight the text, please. The question that's posed is, is there evidence against contemporary evolutionary theory? And, Dr. Miller, if you could read the answer from the American Association for the Advancement of Science.

A. Sure. The answer reads, quote, No, there are still many puzzles in biology about the particular pathways of the evolutionary process and how various species are related to one another. However, these puzzles neither invalidate nor challenge Darwin's basic theory of descent with modification, nor the theory's present form that incorporates and is

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supported by the genetic sciences. Contemporary evolutionary theory provides the conceptual framework in which these puzzles can be addressed and points towards a way to solve them.
Q. End quote?
A. End quote. Thank you, Counsel.
Q. Are there other associations or organizations of scientists that have taken a similar view on the acceptance of evolution?
A. Yes, there are, literally scores of them.
Q. And can you name a few?
A. I certainly can't give you an exhaustive list, but the American Institute of Biological Sciences, the American Society for Cell Biology, the American Society for Biochemistry and Molecular Biology, the Geophysical Society of the United States, and the American Society of Microbiology, just to name a few.
Q. Are you aware of any scientific societies, academies, or organizations that have taken a contrary position and said that evolutionary theory is not firmly established?
A. I have to tell you that to my knowledge, every single scientific society in the United States that has taken a position on this issue has taken a

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position against intelligent design and in favor of evolution.
Q. Are you aware of any controversy in the scientific community over evolution?
A. Yes, I am. There are controversies in all fields of science, and what I mean by that are points that are held in dispute. For example, the evolution of sex is an enormous and controversial issue in biology.
Q. Sex as in gender?
A. Sex as in gender, as to why, for example, everybody does it, not just talking about us primates, but also oak trees and yeast and all sorts of organisms, as to where gender comes from in terms of sexual reproduction. It's a very important issue within evolutionary theory and certainly not an issue that is solved.
There is also enormous controversy within evolutionary theory on the relative values and weights to give to forces such as natural selection, sexual selection, genetic recombination, horizontal gene transfer, and so forth.
But I think the relevant and the interesting point is that there is no controversy within science over the core propositions of evolutionary theory,

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there is no controversy over whether or not evolution took place, and there is no controversy with respect to the proposition that evolution provides the most useful and invaluable way in which we can extend our understanding of living organisms.
Q. Is evolution just a historical process, or is it still something that's being used today?
A. That's an interesting question, and I've often been approached by people who have told me, well, evolution is a just-so story about our past, and it has no scientific significance in the world today, it's unimportant. I can't think of any statement that I would disagree with more.
Q. Well, let me tell you that an expert for the school district in this case, Professor Scott Minnich, has said that evolution plays little, if any, role in experimental science and that it may actually impede science in the arena of drug-resistant research.
A. I believe, with all due respect, that Dr. Minnich is profoundly mistaken. And drug resistance is a very good example. All of -- any science -- I'm sorry, any physician who develops a specialty in the treatment of infectious diseases had better know about evolution.
And the reason for that is, disease therapy,

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whether it's antibiotic therapy or whether it's antiviral therapy of the sort, for example, that is used to extend the lives of patients with AIDS, any therapy in these infectious diseases is predicated on a profound understanding of the evolutionary processes by which the bacteria or the viruses acquire resistance to the agents that are used against them. And if one doesn't understand the evolution of resistance, one is not going to be a very effective physician.
And that's not the only area. Whole areas of drug research and development use what are known as genetic algorithms or evolutionary methods. And what these scientists often do is to set up in a test tube an evolutionary process where they allow incremental changes to be made automatically by an organism, by replicating molecule, to allow a kind of natural selection in the test tube to develop a better drug than anyone could design on their own. So by mimicking Darwinian evolution, people often in the laboratory will use that as a research tool.
It's also worth noting that an understanding of evolution is absolutely essential in other areas, as well. In agricultural, for example, the use of genetically modified crops in areas around the United

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States -- and much of the food that we eat depends upon genetically modified crops -- the use of the genetically modified crops becomes ineffective if the farmers employing them don't understand the evolutionary mechanisms by which insects can evolve resistance to the insect-fighting proteins which are engineered into the plants. So therefore very careful precautions have to be taken to prevent the process of evolution from taking place.

So I think evolution is at the core of discovering the biological sciences. And there's really no better example of that than that issue of Nature that we highlighted earlier and used as one of the exhibits. Virtually every paper in there uses evolution as a tool to explore what our genome does, what the ape genome does, and how the differences between them make us unique as individuals and organisms. It turns out to be a hard-working theory which is at the core of biological discovery and biological exploration.

Q. Is evolution antireligious?

A. I certainly don't think so, and I devoted a whole book to arguing why I didn't think it was.

Q. Don't some scientists invoke evolution in their arguments to say that, in fact, science and

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evolution is antireligious, it's anti-God?

A. Yes, they do. And I can certainly think of any number of specific examples from distinguished evolutionary biologists like Richard Dawkins or philosophers who have written about evolution like Daniel Dennett or William Paley.

But as I said earlier, it's very important to appreciate that every word that comes forth from the mouth of a scientist is not necessarily science. And every word that one says on the meaning or the importance of evolutionary theory is not necessarily scientific.

Richard Dawkins, for example, has been eloquent in saying that for him, understanding that life and the origin of species has a material cause frees him from the need to believe in a divine being.

I don't know if I've been as eloquent as Richard Dawkins, but I have worked very hard in my own way to say that for me, the notion that we are united in a great chain of being with every other living thing on this planet confirms my faith in a divine purpose and in a divine plan and means that when I go to church on Sunday, I thank the creator for this wonderful and bounteous earth and for the process of evolution that gave rise to such beauty and gave rise

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to such diversity that surrounds us. Those are my sentiments, in the same way that Dawkins' are his. But I'm not speaking scientifically, and I'm not speaking as a scientist, and that's, I think, the critical distinction.

Q. So you wrote a whole book exploring this intersection between science and faith?

A. That's correct.

Q. And is any of that kind of discussion found in your high school biology textbook?

A. No, of course not.

Q. Why?

A. Because it's not scientific. And I've made the point earlier that just when you say something is not scientific doesn't mean it's not important, doesn't mean it's not true, doesn't mean it doesn't concern something that you really and deeply care about. And I deeply care about my own religious beliefs and my faith, and I also deeply care about science, and I wanted to explain to a general audience how I understand the intersection of those two beliefs, not just to reconcile them, but to confirm and enhance both beliefs.

Now, I believe in that very strongly, but I certainly recognize that my views on this are not

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science and they are not scientific. My coauthor, Joseph Levine, who also is a religious person, I have to tell you, has different views of faith, belongs to a different faith, and follows a different religious tradition than I do.

Joe and I both have enormous respect for religion. We both believe that the evolutionary theory is fully compatible with our different religious beliefs, but we also recognize that our religious beliefs are not scientific, that they are philosophical, theological, and deeply personal, and, as such, they don't belong in a science curriculum, and they certainly don't belong in a science textbook.

Q. And they're not found in your high school science textbook?

A. Definitely not.

Q. I want to switch gears here again to the topic of intelligent design. What is intelligent design?

A. As it has been explained to me, intelligent design is the proposition that some features of living things are too complex to have been produced by the process of evolution and therefore they must be attributed to the creative work of a special intelligence or designer who creates these pathways,

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these genes, and these organisms and operates in ways that stand outside of nature and therefore by mechanisms which cannot be scientifically investigated.

Q. Who is the designer?

A. The advocates of intelligent design, over the last ten years, have refused to say. But I have to tell you that when I debated scientific creationists in the early 1980s, they were very fond of saying that life has a design and that design implies a designer and that designer is the creator, it is God.

Q. I'd like to direct your attention to Plaintiffs' Exhibit 124. Do you recognize this document, Dr. Miller?

A. Well, I recognize the last four paragraphs of the document. The first time I saw the rest of the document was in our pretrial discussions at the law offices yesterday. So now I recognize it. But until yesterday, I hadn't seen the whole document.

Q. And to your knowledge, what are the last four paragraphs there?

A. The last four paragraphs, which I certainly recognize, are the administrative statement which was read to students in Dover High School, I believe

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earlier this year, in concordance with the school board's intelligent design policy.

Q. Matt, if you could highlight the third paragraph. Could you please read the highlighted text?

A. Sure. Quote, Intelligent design is an explanation of the origin of life that differs from Darwin's view. The reference book Of Pandas and People is available for students who might be interested in gaining an understanding of what intelligent design actually involves, end quote.

Q. Are you familiar with this textbook, Of Pandas and People?

A. Yes, sir, I am.

Q. And, in fact, is that the book you were debating the first time you debated Michael Behe back in 1995?

A. Yes, that is the book.

Q. To your knowledge, is Pandas representative of intelligent design thinking?

A. I believe that it is. It certainly is put forward as an example of a textbook which had advanced the idea of intelligent design. I am sure that there are people within the intelligent design community who might hold slightly different positions on certain

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isolated issues from Pandas, but I think in general the arguments made in Pandas are representative of intelligent design.

Q. Now, one name that's going to be coming up in this trial, and, actually, the gentleman will be testifying for the school district, is Michael Behe. Are you familiar with his works?

A. Yes, sir, I am.

Q. And are his ideas consistent with what is represented in Of Pandas and People?

A. The answer to that is very much so. In fact, as I read Of Pandas and People, from our experience in the debate, which was in 1995, about a year later a book was published called Darwin's Black Box by Dr. Behe. And when I read through the pages of Darwin's Black Box, I was struck by how many of the arguments used against evolution that are found in Of Pandas and People are also used in Darwin's Black Box.

And the one that really stuck in my mind was the discussion of the blood clotting cascade in both Dr. Behe's book and in Of Pandas and People. It struck me as essentially -- the two discussions struck me as essentially identical.

Q. We're going to come back to Dr. Behe in a little while. Let's focus now on the book Of Pandas

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and People that's referred to in the four-paragraph statement. If we could turn to Page 150. And Pandas is Plaintiffs' Exhibit 11. And Page 150 is part of the glossary. I'd like you to read for us the highlighted language, which is the Pandas definition of intelligent design.

A. Sure. Quote, Any theory that attributes an action, function, or the structure of an object to the creative mental capacities of a personal agent, period. In biology, the theory that biological organisms owe their origin to a preexistent intelligence, unquote.

Q. Let's take those sentences one at a time. The first sentence, to your mind, does that accurately describe intelligent design as you understand it?

A. I certainly think that it does. In fact, if one does a library search on intelligent design, it will return a large number of engineering, graphic design, and other articles about the intelligent design, let's say, of the courtroom or the intelligent design of a ventilation system or the intelligent design of a microprocessor.

So it is certainly true that the term "intelligent design" can be used in the context of a human designer designing an apparatus, putting

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together a message, and so forth. So I think that's a perfectly accurate statement.
Q. How about the second sentence?
A. The second sentence says, In biology -- and I believe this is the context that is important in the courtroom today -- biology, intelligent design is the theory that biological origins owe their -- excuse me, biological organisms owe their origin to a preexistent intelligence.
And I think that is exactly what intelligent design means. So this is a good glossary and this is a very good definition, because it indicates that organisms originated from the creative power of a preexisting intelligence, and that's a classic doctrine which is known as "special creation."
By definition, that creative force has to have intelligence, takes intelligence to create, and that's exactly what this glossary definition says.
Q. What is the argument in Pandas to support this idea of an intelligent designer?
A. Well, I believe the argument in Pandas that supports -- that is used to support the idea of the intelligent designer takes many forums. For example, Pandas looks at the fossil record of natural history of life on this earth, and it says every time we see

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the sudden appearance of a new or different or novel organisms -- organism, that must be the hand of the designer. That's a classic example of special creation.
Pandas also says anytime we see a complex biochemical system made up of many different interlocking parts, that can only be explained by the actions of an intelligent designer. And Pandas also states that living systems contain complex biological information. And by analogy, since information in the real world -- excuse me, information in human society, in telephone books, in texts, perhaps in the arrangement of transistors in a microprocessor, since that kind of information requires human intelligence, then the information which is in a biological system must have had an intelligence to put it there, too.
Those are -- I'm sure there are other detailed arguments, but those are the general categories by which Pandas makes this argument.
Q. And Pandas does address issues of science, issues of biology, does it not?
A. Yes. Pandas, in every one of its six chapters, sections, excursions, deals with biological organisms, with the question of biological origins, and also with life processes. So it's a book about

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biology, that's correct.
Q. And in your estimation, is the treatment of science, of biology, by Pandas accurate?
A. I think the treatment of biology by Pandas is inaccurate and in many respects downright false in every section of the book.
Q. Are you able to give us some examples about some of the errors that are contained in Of Pandas and People?
A. Sure, I'd be very happy to. My understanding is that you will call some other witnesses who will testify about other errors, but I will certainly be happy to talk about a few that are in my own area of work.
Q. And at my request, have you prepared a couple of slide demonstrations to help you explain these errors in Pandas?
A. Yes, I have.
Q. If we could have molecular trees in Pandas. Could you tell us what this is, Dr. Miller?
A. Yes. What you see on the slide now is the cover of Of Pandas and People and two quotations from various parts of what is known as Section 6 of Pandas, which is the section on biochemical similarities. And with your permission, with the Court's permission,

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I'll read both of those.
THE COURT: You may.
THE WITNESS: The first one is a quotation from Page 36. And what it says is, quote, When the measurements of the similarities between proteins are put side by side, the pattern that emerges contradicts the expectations based on Darwinism, unquote. I should add the emphasis, the boldface on this is mine, it's not from the original.
That point of contradicting what it calls Darwinism or Darwinian expectations is made on the next page, Page 37. Quote, Notice that the cytochrome c of this insect, the silkworm moth, exhibits the same degree of difference from organisms as diverse as humans, penguin, snapping turtle, tuna, and lamprey. The reason this finding is so surprising is that it contradicts the Darwinism expectation. And, once again, the emphasis is mine.
So Pandas, on these two pages, says that when you look at the biochemical similarities between organisms, it tells students those similarities contradict the expectations of evolution. In other words, evolution is wrong.
Can we look at the next slide, please? What you see in this diagram is a table, a data table of

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biochemical similarities from Pandas, and I'm flipping through my own copy so I get the proper reference here. The table appears on Page 37, and I have placed a quotation from Page 37 on the slide.

And referring to this table of differences between 17 organisms, Pandas tells students, quote, Darwinism would predict a greater molecular distance from the insect to the amphibian than to the living fish, yet greater still to the reptile and greater still than that to the mammal, yet this pattern is not found, unquote. And, again, the emphasis is mine.

So what it tells students is, look at the data. That data contradicts the Darwinism expectation. So the message is not subtle, it's very clear, Darwinism is wrong, what it refers to as Darwinism is wrong, and this table tells you something else. That's the message from Pandas, and that's what they tell students.

May we look at the next slide, please? The next slide shows a diagram, and I apologize to the Court for not having this on the slide itself, but the diagram that you see here is from Page 38 of Pandas, and the quotation that I'm using which refers to this phenomena is actually from Pages 139 to 140. And it refers to the same phenomena.

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Now, what the diagram shows is the cytochrome c, which is a protein found in all living organisms, essentially -- it's a very important protein -- it compares the sequence of cytochrome c of the carp, of a fish, and it says that the carp cytochrome c differs from that of the bullfrog by 13 percent, by that of the snapping turtle also by 13 percent, carp to the chicken 14 percent, carp to the rabbit 13 percent, carp to the horse 13 percent.

In other words, it tells students there's the exact same difference between cytochrome c in a fish and an amphibian, a reptile, a bird, and two representative mammals. In other words, they're all the same distance apart.

Now, why is that a problem for evolution, according to Pandas? The quotation explains that. It tells students to use the classic Darwinian scenario, amphibians are intermediate between fish and other land-dwelling vertebrates, therefore analysis of their amino acid should place amphibians in an intermediate position, but it does not.

In other words, that fish should be closer to the amphibian than it is to the turtle, much closer than to the chicken, and much closer still than that to the horses. That's what Pandas tells students.

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Yet the fact that they're all the same distance apart means that the Darwinian, the evolutionary expectation, is contradicted by the data. And that is the message that Pandas tells students, any student who might use it.

Go to the next slide, please. This is not an isolated quotation. This is the entire theme of this particular section, which is one-sixth of the book, which is that evolution has it wrong on molecular similarities.

Here I've gone to Page 139, which is in the excursion or the more detailed section of the book. I've reproduced a facsimile of the page. This time it compares the dogfish shark and its cytochrome c to six different organisms. And basically this chart says they're all about the same distance from the shark. And then it says, instead of a progression of increasing divergence, each vertebrate sequence is equally isolated from the cytochrome sequence for the dogfish, unquote, from Page 139.

As a result of all this data, what Pandas then tells students -- and this is a textbook intended to be used in classes -- quote, In this and countless other comparisons, it has proved impossible to arrange protein sequences in a macroevolutionary series

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corresponding to the expected transitions from fish to amphibian to reptile to mammal, unquote. So, in other words, all these data contradict the prediction of evolution. That is the message of Pandas on page after page and diagram after diagram.

Now, the question that I think anybody using this book might want to consider is, is that true? Is that what the data actually show? Can I have the next slide, please?

Remember the central claim, and this slide reproduces the diagram I have already shown from Page 37 on Pandas. And Pandas claims that finding the same molecular distance between a fish and these organisms contradicts evolution. The reality of the situation is that it does nothing of the sort. Standard evolutionary relationships, which have been known for decades, between these organisms, a mammal, a bird, a reptile, an amphibian, and a fish, actually show that all of these organisms share a common ancestor at an equal molecular distance.

And what that means is, the frog should be just as far removed from that common ancestor as the horse should be. So therefore, when we compare a fish today, the distance from fish to mammal should be the same as the distance from fish to amphibian.

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BY MR. WALCZAK:
Q. I'm sorry, Dr. Miller, could you explain how, on the diagram on the lower right, how do you measure that? How does a biologist or a scientist read that?
A. Fair enough. What this diagram is intended to show is molecular distances between these organisms, in other words, how much their cytochrome c's differ in terms of times since a common ancestor. So in the chart the organisms that are pretty close together are the chicken and the turtle, and they share a recent common ancestor. So we shouldn't be surprised.
Q. I'm sorry, is the common ancestor where you have the Y?
A. Thank you very much for asking that. The common ancestor is at the intersection point right there, which I am now attempting to wave the pointer around. It is at the Y where these two diagrams join. So the relevant comparison here is that all five of these organisms should be, in molecular terms -- all four of these should be equally distant from the fish since the distance all the way down to the common ancestor of all vertebrates predicted by common descent is exactly the same.

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And, incredibly, that is what the data actually show, which is an equal distance from the fish for all the other vertebrates, and that actually doesn't contradict evolution, it provides strong support for it. But students using Pandas would misunderstand this point completely.
May I have the next slide? Now, one might ask whether or not, since Pandas is -- I think is -- your opposing counsel might have mentioned in the opening statement -- a little out of date, whether or not Pandas can be forgiven this mistake, because, after all, it was published in 1993, and, as I emphasized, a lot has happened since then.
What I have placed on the left-hand side of the slide is my rendering of the proper relationships between these organisms supported by data, and on the right-hand slide I have placed a figure from a paper published by Fitch and Margoliash in 1967, 38 years ago, showing molecular similarities based on cytochrome c.
Now, the Fitch and Margoliash picture, as you can see, is much more detailed than the simple one that I included because it includes more organisms. But you'll also note that the molecular tree formulation of diagram -- of the diagram shows exactly

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what I have been pointing out, which is that one does not expect a progression from one organism to another, as Pandas tells students, but one expects a deepening molecular tree so that the relationship of a fish to the other organisms, which are highlighted here in little red boxes, should be the same for every one of these organisms to the fish.
Q. And since 1967, has science contradicted that?
A. Science not only has not contradicted it, but it has confirmed this pattern in one protein and one gene after another. Now, it's worth noting that one of the things that scientists have noticed is that the rate of evolution seems to differ in one gene from another. So sometimes the pace of change is quicker, sometimes the pace of change is slower. But the ultimate pattern of change, with very, very few exceptions, supports the pattern that you see here.
And there's a final point that is worth making. And that is, one might ask, even though this paper appeared 38 years ago and clearly the authors of Pandas should have known about this, is this recent, is this formulation of evolutionary descent, is this something just in the molecular age, that it's brand-new, or is this the core understanding of

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evolution since the first time the idea was formulated? And the last slide that I have in this series will make that point. This is my formulation of the tree of --
Q. I'm sorry, that's in the upper left-hand corner?
A. Thank you very much. The upper left-hand corner of the slide is my formulation, a very simple diagram of the proper relationships between these species. The right-hand side of the slide shows the molecular tree sketched out from Fitch and Margoliash, the paper published in 1967. And, again, the question I pose before the Court is, is this a new idea of relationships just in the molecular age?
I have here a diagram, it's the only figure from the Origin of Species published by Charles Darwin in 1859, and it shows an almost exact match of the tree concept. So any person writing or pretending to teach students about evolution should be aware of the fact that evolution, since its very formulation by Charles Darwin, has held to the idea of the tree as the ancestorial model.
And if you could advance the animation in this slide, whereas what Pandas has done is to argue that a straight line progression like that is actually

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what is expected. That is a -- either a misunderstanding or a deliberate misinforming of students about the nature of evolutionary theory. And what I wrote on this slide is, Pandas misleads students as to the actual predictions of evolutionary theory by pretending that evolution predicts a linear sequence like that. And as I've shown the Court, going back to Charles Darwin, that isn't what it predicts.

Q. Do you have another example of what we might call an error or a misrepresentation of evolutionary theory that is contained in Pandas?

A. I can certainly point to quite a few. I believe that's the last demonstrative that I have prepared from Pandas. Is that correct, sir?

Q. Yes. If we could have the blood clotting test.

A. Okay. Sorry. I had forgotten that I had prepared these demonstratives. Pandas also, in their discussion of molecular similarities, talks about what is known as the blood clotting cascade. And in this particular case, all of us -- hopefully all of us in the courtroom have blood that clots properly. And what that means, of course, when we cut ourselves, we don't just bleed and bleed and bleed and bleed, but

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that cut eventually seals with a blood clot.

That's, in many respects, even more important inside our body, because when we get a bruise, that actually is a result of broken blood vessels, and if that didn't close with a clot, we'd be in serious trouble.

Now, blood clotting is, biochemically, an enormously complicated process. And I have placed a diagram of some of the elements of the clotting pathway on the upper left-hand corner of the slide. It's a diagram that I drew from the Internet. It's not from any exhibits in the court here. It's not from Pandas.

It's the sort of slide -- if people in the court are awed by the complexity of this slide, I would assure you that this is a subject that is used to torture biochemistry students at the undergraduate and graduate level. Everyone agrees that this is complicated.

In the lower right-hand corner, there is a scanned electron micrograph of a red blood cell caught in a clot. And the action of this pathway produces a crosslink protein known as fibrin, which produces a meshwork which actually stabilizes the clot and helps blood to stop flowing.

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Now, I'm going to have to stand up so I can see the slide properly. Is that all right, Your Honor? I'll just talk loud enough so hopefully it will be picked up. Pandas describes this system, and on Page 141, and I quote, it tells students, As we shall see, such interactive systems as illustrated here by the mechanism for a blood clotting are very strong arguments for intelligent design and are virtually impossible to explain in terms of Darwinian evolution, unquote. Now, it's interesting to look into Pandas and say, why is it that this is an argument for design and impossible to explain by evolution?

If you could go to the next slide, please, I'd appreciate it. Here is a page from Pandas describing the blood clotting cascade and a diagram of the cascade and two quotations from Pages 145 and 146. Here is the essence of the argument that students are given in Pandas. From Page 145, quote, Only when all the components of the system are present and in good working order does the system function properly, unquote.

Later in the page and going onto Page 146, it talks about the various proteins in the clotting pathway, and it says, quote, Some of them -- these are

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the clotting proteins -- share discrete regions of their sequences with some others. Does that mean that they derive from one another? It may. But consider that even if this were the case, all of the proteins had to be present simultaneously for the blood clotting system to function, unquote. And the emphasis here is mine.

So the argument made by Pandas is that the reason this is an example of design is because it's a multi-part system, and all of the parts have to be put together, presumably by a creator/designer before the system will work.

Can I have the next slide, please? Well, that's a scientific statement in the sense that it's a claim that all the parts have to be present for the system to work. And because that is a scientific claim, we can investigate it scientifically and see if it is valid.

What I have placed on this slide is my own representation of the blood clotting cascade, which I blew up a little bit to try to make it large enough for the Court to see and to try to emphasize the points that I need to point out to the Court at this point.

A standard and simple and straightforward

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scientific test of the claim that all parts must be present for this to work is simple. Eliminate one of the parts, see if the blood will clot. If it won't clot anymore, the claim might be right. If it will clot, the claim could be wrong.

Well, fortunately nature has actually done that experiment for us. And if you could advance the slide, I'm going to show right now, essentially here's the pathway, and I'm going to propose an experiment which is that we eliminate one of the important factors known as factor 12. That's right here. So there's my experiment. You can do this very easily on PowerPoint, much easier than you can do in the laboratory.

We have just eliminated factor 12, and the question now before the Court is, will blood clot or will it not? Advance the slide, please. It turns out that whales and dolphins have done this experiment for us already. Whales and dolphins, in 1969, well before Pandas was published, were shown to lack factor 12. And the slide contains a reference to an article by Robins, Kasting, and Aggeler from Science Magazine, Volume 166, Page 1420, 1969. And you will note a quotation from the abstract of this article saying, The dolphin intrinsic cascade lacks factor 12,

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unquote.

Now, this is from ancient history, as far as we molecular biologists might be concerned today, because 1969 is pre-molecular. So one might wonder, has that result held up?

Also in the lower left-hand corner of the slide I have pointed out that a paper published in 1998 by Semba, et al., confirms using genome analysis, that whale Hageman factor 12 basically is now a pseudogene in the whale genome. That's why it is not produced. It is, indeed, missing from the clotting cascade.

Whales face many problems on this planet. They're overhunted, they're overfished, but they don't have any problems with their blood clotting. So blood clots just fine, despite missing the factor. So the scientific prediction from Pandas turns out to be wrong.

Q. And the prediction was -- this was known in 1969 is what you're saying?

A. Absolutely, that's correct. So certainly the people writing it should have known. But interestingly, in recent years, you might say the situation has gotten worse.

Q. I'm sorry, worse in what sense?

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A. Worse in the sense that the case that Pandas is trying to make has become even farther removed from scientific reality.

Can I show the next slide, please? Here again is my representation of the various components of the blood clotting cascade. And this time I'd like to propose that we take away not one part, but three. If you'd advance the slide, please. The proposal is that we take away the three parts which are known as the contact phase system. Now, that includes factor 12, which we talked about a second ago, but also factor 11 and also the factor that catalyzes the conversion of 12 to the active form.

Advance the slide, please. Those are the three parts that I propose eliminating. And advance it one more time, please. There they go. They're gone. It turns out these three parts are missing in a vertebrate known as the puffer fish.

And I have placed in the left-hand part of the slide a reference to a paper Jiang and Doolittle, 2003. The title of the paper is, The Evolution of Vertebrate Blood Coagulation as Viewed from a Comparison of Puffer Fish and Sea Squirt Genomes. It appeared in the proceedings of the National Academy of Sciences, a very eminent scientific journal, Volume

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100, Page 7527. And the relevant point here is that they are missing three parts of the system and their blood clots perfectly well. Should we -- Go ahead, a question?

Q. So the prediction in Pandas and what Pandas teaches students has, in fact, been invalidated, refuted by the scientific evidence?

A. It was refuted by the scientific evidence in 1969 that was confirmed by genome studies of the whale, and it has been further refuted by Jiang and Doolittle's study of the contact phase system.

Q. I'd like to go to the third example of what we might consider significant errors or representations contained in Pandas, and that is the concept of new biological information. I was wondering if you could explain what Pandas says about this and then talk a little bit about the science.

A. May I ask the counselor if we have demonstratives on this?

THE COURT: You may, certainly.

THE WITNESS: Do we have a demonstrative on this one?

BY MR. WALCZAK:

Q. We have a copy of Page 7 from Pandas.

A. Okay. That would be just fine. Page 7 from

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the book Of Pandas and People makes the point that biological information and living things contain abundant amounts of information. There certainly is no argument there. The biological information must come from a designer.

And the way in which Pandas makes this argument is by using an example of information from the nonbiological world. So it tells students, if we walk along the beach and we see something written here that says, John loves Mary, that's an example of information from which we immediately infer the existence of an intelligent designer, a designer who thought of the message, coded it in the sand, and used symbols, symbolic language, in order to get that information across.

What Pandas then says is that biological information meets the same standard. And do we have -- have we highlighted part of the text on this page? Okay.

The patterns in biological information are described in this passage from Page 7 in Pandas. And the passage which I will read begins with the following: Quote, Are natural causes capable of producing these kinds of patterns? To say that DNA and protein arose by natural causes, as chemical

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evolution does, is to say that complex coded messages arose by natural causes. It is akin to saying John loves Mary, the message written on the beach, arose from the action of the waves or from the interaction of the grains of sand.

And I'd like to skip to the highlighted portion at the bottom of this and say -- and read to the Court that Pandas tells us, quote, If science is based on experience, then science tells us the message encoded in DNA must have originated from an intelligent cause, unquote.

So Pandas basically tells students all information must come from an intelligent cause, there's information in DNA, and therefore it's just like John loves Mary written on the beach, there must have been somebody there to write it.

Q. And is that correct?

A. No, sir, I don't think it's correct at all. I think there are logical problems with the analogy, and as an experimental scientist, there is strong scientific evidence that this is simply not the case with respect to biological information.

Q. Let's start with the analogy that they make. What's wrong with this analogy to John loves Mary must have been designed by some intelligent designer?

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A. Well, I can think of a lot of things that are wrong with it. The first thing is that the message John loves Mary, which is sitting here in the beach, doesn't have the capacity to replicate as DNA does. It is never passed along in the process of reproduction as DNA is. It can never undergo genetic recombination as DNA can. It can never be subject to natural selection as the organisms and their characteristics coded for by DNA can. In short, that message is not part of a living organism, and the fact that messages in DNA are part of a living organism makes them entirely different.

The second point, however, that the analogy fails is something that any philosopher, any logician would spot in a second. When we look at the John loves Mary sentence, we know, for example, what the -- we know who made that message, and what I mean by that is, we know that a human being made that message because it is the kind of message that human beings make. We also know how that designer, the human being, made that message, probably by scratching a stick or other object into the sand to move the sand apart and create the message. And, finally, from our own ordinary experience, we've seen it happen. So we know the designer, we know the mechanism, and we have

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observed it happen in our own empirical experience.

In the case of inferring a designer for DNA, curiously, the advocates of intelligent design don't meet those standards. They say, we can't tell who the designer is, we cannot know the mechanism, and we also do not know how the designer operated and we've never observed it. Therefore, the comparison between that kind of message and the kind of message in DNA fails even the most basic test of logic.

Q. Now, has there been scientific research done on this proposition of whether or not there are natural explanations for new biological information?

A. Yes, there has, in fact, a great deal.

Q. And could I direct your attention to Plaintiffs' Exhibit 245. Do you recognize this exhibit?

A. Yes, I do. This is a review article that was written in a very prestigious journal, Nature Reviews Genetics, and it's written by Manyuan Long and several other people. And the title of the article is, The Origin of New Genes, Glimpses From the Young and the Old. It's an article that I read immediately, as many scientists did when it came out, because it describes a number of mechanisms by which new genetic information is developed by the processes of

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evolution.
Q. When did this article come out?
A. I believe this was published in the year 2003.
Q. And how does this contradict what Pandas tells students?
A. Well, it contradicts what Pandas tells students in a number of ways. First of all, you remember that Pandas said that all biological information, by analogy to John loves Mary written on the beach, had to be directly encoded by a designer. And what this paper summarizes, because it's a review paper, is it summarizes dozens of research projects in laboratories around the world on different mechanisms by which new biological information arises through the process of evolution by natural selection.
And if we could advance the slide, please, I prepared a slide showing a table from the second page of this article. And thank you very much for zooming in on the table. And what you see on this table are a series of mechanisms by which new genetic information can arise. You'll notice the top one, the area up here talks about exon shuffling. The next one, gene duplication, then retroposition, mobile genetic elements, lateral gene transfer, gene fusion and fish,

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and, finally, de novo gene origination. Every one of these is a distinctly different molecular mechanism that results in the generation of new genetic information. None of them requires a designer, curiously.
Now, the other thing that I find, I think, worthy of the Court's attention is that none of these are hypothetical mechanisms. In every case, the specific genes that have been formed by these mechanisms are listed in the third column of the table. And in the fifth column of the table, there are a series of scientific references documenting the studies that have shown how these genes originated by evolutionary processes.
Q. So this is one article, but, in fact, it talks about many other articles that have done the research to support this proposition?
A. That is correct. This references more than three dozen scientific studies showing the origin of new genetic information by these evolutionary processes.
Q. Let me ask you, because I'm not a scientist, so I'm going to ask you to pretend that I'm your mother here. This notion of creating new biological information through natural pathways, I mean, is that

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a big deal that Pandas gets this wrong?
A. I think it is a very big deal that Pandas gets this wrong, because you have to remember that the core argument of Of Pandas and People is that there is abundant evidence in biological systems not only that evolution is wrong, but also that there is a creator/designer who encoded all of this information into biological systems.
Pandas at one point makes a statement that this information was written by the designer into the various types of organisms at the beginning, which is clearly the description of a creative act. And the only way that it can make that statement is by arguing that information cannot arise by natural mechanisms of the sort described abundantly in this review and summary paper.
Q. So Pandas is just dead wrong on this point?
A. Pandas is wrong on this point, but I think it's more important to point out that Pandas is wrong in a most particular way. Anybody can write a book about science and make a few mistakes, and Lord knows I have made my share of mistakes in trying to summarize science. But the error in Pandas in this respect is systematic, and that is, the errors are all intended to point students towards the acts of special

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creation by the unnamed designer that are designed to encode the information into systems.
So by arguing that studies like this don't exist, that mechanisms like this don't work, Pandas makes the case for the existence of the supernatural special designer or creator.
Q. Now, you've discussed with us three errors in Pandas which come within your field of molecular biology. Are there other what you would consider significant errors or distortions of the science in Pandas?
A. Yes, sir, there are.
Q. And we will have another expert, Professor Padian, who will come in and talk about some of these in more detail, but just briefly, if you could just identify what some of those other errors are.
A. Well, I think the principal one that I would identify for the Court is that Pandas completely misstates the character of the fossil record and the nature of natural history. And one element of that -- I know you will have a paleontologist coming in later to go over that in detail for the Court, but one element of that that I find particularly significant is in Pandas' nearly complete omission of any discussion of what causes extinction.

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Pandas mentions the fact that -- well, actually, Pandas mentions extinction in a few places. Any paleontologist will tell you that more than 99.9 percent of all organisms that have ever existed on this planet have gone extinct. So just about every organism that has ever appeared is now extinct.

Now, evolution, of course, has no problem explaining this because the competition between organisms and continuing genetic change is one of the engines that drives extinction. This is extremely well understood.

But if one proposes to students the existence of an intelligent designer who used his skill and craft and cunning to encode this information and to produce perfectly-designed organisms, the fact that most of them go extinct is an embarrassment. And, in fact, you know, an intelligent designer who designed things, 99.9 percent of which didn't last, certainly wouldn't be very intelligent.

And one of the questions that I think any reasonably inquisitive student will have when they open this book is, if an intelligent designer made all these things, why have they all become extinct if he's so intelligent? And Pandas simply does not address the issue, even though it clearly is going to raise it

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in the mind of any student who uses this book.

THE COURT: Mr. Walczak, I'll tell you that anytime between now and 12:30 that you want to wrap up a line of questioning, you can do so. But I don't want to stop you here if you're in the middle of something.

MR. WALCZAK: Your Honor, I think about five more minutes would be --

THE COURT: That's fine. Let's wrap it up by 12:30, at least.

BY MR. WALCZAK:

Q. Dr. Miller, you talked earlier about the core of propositions of evolution. Does Pandas reject those core propositions or argue that, in fact, they are scientifically incorrect?

A. Yes, sir, it does. It rejects all of them. In my opinion, it dances around the proposition that life has changed over time. It sort of -- it maintains what you might call a reserved indifference to that proposition. It certainly rejects common descent, and it profoundly rejects the third proposition, which is that the process of change can be understood by things that we observe happening in the world around us today.

Q. Let me direct your attention to Page 65 of

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Pandas. Matt, if you could highlight it. Could you read this highlighted passage from Page 65 on Pandas?

A. Of course. Page 65, quote, Adherents of intelligent design assume that in the beginning all basic types of organisms were given a set of genetic instructions that harbored variation but were resilient and stable, unquote.

Q. That's a rejection of natural selection and common descent?

A. It is a profound rejection of this, because basically what it describes is the special creation of all organisms, because it says basic types of organisms, which in earlier parlance might have been referred to as created kinds, were given a set of instructions. In other words, the genetic information was written into them. They couldn't change, they were resilient and stable.

So the picture that any reasonably intelligent student is going to get out of this is that intelligent design means that the designer/creator inserted these instructions into living organisms and they have remained essentially unchanged since that time.

Q. Let me direct your attention now to Pages 99 and 100 of Pandas. I'd ask you to read the

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highlighted passage.

A. Quote, intelligent design means that various forms of life began abruptly through an intelligent agency with their distinctive features already intact, fish with fins and scales, birds with feathers, beaks, and wings, et cetera.

Q. Is that science?

A. No, not at all. And, in fact, anyone would recognize that in a flash as a form of special creation, because what we have here is intelligent design means the various forms began abruptly, and I might add separately, which is what the previous quote implied, and everything was intact. In other words, organisms were created by an intelligent force instantaneously with all of their features present.

Now, I don't know if we have a demonstrative to this, but on Page 99 there is also a graphic that drives home this point in case the verbal -- in case the words are too subtle. Do we have that as a demonstrative?

Q. Could you pull up Page 99?

A. I think, actually, that's fine without further enlargement. And what you see now is Page 99, Of Pandas and People, and you can see that what is presented here is Pandas -- or the view of the fossil

record and natural history that Pandas wishes to show to students, and that is that every single organism began its existence on earth as a result of a creative process with the information inserted into it, as it says, by an intelligent agent. It lasts for a certain time on earth, and then it vanishes due to extinction.

So what we have basically is a series of separate creative events required to bring each individual type of organism into existence. If one wished to understand whether or not Pandas is consistent with the idea of common descent, one look at this graphic tells you huh-uh, because what Pandas clearly shows in this graphic is separate descent of every single basic type of organism.

Q. And is that similar to creation science as it was practiced in the 1980s?

A. It is -- the notion of separate descent is identical to creation science, and the only difference that I can see is that in Pandas the creative events are presumed to be spaced out over time, whereas in creation science, those creative events were presumed to have occurred at the same time or the same six-day period. Other than that, I don't see much to differ them.

MR. WALCZAK: I think, Your Honor, now would

be a good time for me.

THE COURT: All right. We'll take a lunch break now. I might be inclined to say class dismissed for the morning. We'll return at 1:45. I'd ask that you be in your seats promptly at that time so that we can start our afternoon session then. I thank you. We'll stand in recess until 1:45.

(A luncheon recess was taken.)

CERTIFICATION

I hereby certify that the proceedings and evidence are contained fully and accurately in the notes taken by me on the within proceedings and that this copy is a correct transcript of the same.

Dated in Harrisburg, Pennsylvania, this 27th day of September, 2005.

/s/ Lori A. Shuey

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