

Darwin's Black Box by Michael Behe - Selected quotes & page numbers

It was once expected that the basis of life would be exceedingly simple. That expectation has been smashed.

There has been virtually no attempt to account for the origin of specific, complex biomolecular systems. (x)

"Evolution" means a process whereby life arose from non living matter and subsequently developed entirely by natural means. (xi)

the story of the impact of biochemistry on evolution rests solely on the (biochemical) details. (xii)

For more than a century most scientists have thought that virtually all of life .. resulted from natural selection working on random variation.

The cumulative results (of biochemical research) show with piercing clarity that life is based on machines - machines made up of molecules! (p4)

In short, highly sophisticated molecular machines control every cellular process. Thus the details of life are finely calibrated, and the machinery of life enormously complex.

if you search the scientific literature on evolution, and if you focus your search on the question of how molecular machines - the basis of life - developed, you find an eerie and complete silence. The complexity of life's foundation has paralysed science's attempt to account for it. p5

in the absence of evidence .. it is very difficult to prove right or wrong someone who asserts that stepping stones existed in the past but have disappeared. p14

Many people have followed Darwin in proposing that huge changes can be broken down into plausible, small steps over great periods of time. Persuasive evidence to support that position, however has not been forthcoming.

unbridged chasms occur even at the tiniest level of life.

It is the astonishing complexity of subcellular organic structures that has forced the question. How could all this have evolved? p15

Each of the anatomical steps and structures that Darwin thought were simple actually involve staggeringly complicated biochemical processes that cannot be papered over with rhetoric.

That is not to say that random mutation is a myth or that Darwinism fails to explain anything (it explains microevolution very nicely)

The black box of the cell has been opened, and the infinitesimal world that stands revealed must be explained. p24

It is time to put the debate squarely in the open, and to disregard public relations problems. The time for debate is now because at last we have reached the bottom of biology .. and we have discovered a complex world that radically changes the grounds on which Darwinian debates must be contested. p31

Dawkins writes with passion because he believes Darwinism is true. He also believes that atheism is a logical deduction from Darwinism and that the world would be better off if more people shared that view. p33

But the burden of the Darwinians is to answer two questions: First, what exactly are the stages of ... evolution, in all their complex glory? Second, given these stages, how does Darwinism get us from one to the next? p34

Dawkins explanation (s are) is only addressed to the level of what is called gross anatomy. p38

Darwin said " If it could be demonstrated that any complex organ existed which could not possibly have formed by numerous, successive, slight modifications, my theory would completely break down"

An irreducibly complex biological system would be a powerful challenge to Darwinian evolution. Since natural selection can only choose systems that are already working, then if a biological system cannot be produced gradually it would have had to arise as an integrated unit. p39

Dawkins writes "If evolution is not gradual when it comes to explaining the existence of complicated, apparently designed objects, like eyes, it ceases to have any explanatory power at all. Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation" p40

When we descend from the level a whole animal to the molecular level, then in many cases we can make judgement on evolution because all of the parts of many discrete molecular systems are known. p41

a system is irreducibly complex when it has no functional physical precursors p43

The "simplest" self sufficient, replicating cell has the capacity to produce thousands of different proteins and other molecules at different times and under variable conditions. p46

If a system (absolutely) requires several closely matched parts to function then it is irreducibly complex and we can conclude that it was produced (to function) as an integrated unit. p47

Richard Dawkins can simplify to his heart's content, because he wants to convince his readers that Darwinian evolution is "a breeze". In order to understand the barriers to evolution, however, we need to bite the bullet of complexity. p48

Modern biochemistry has shown that the cell is operated by molecular machines. p51

Proteins are the machines that build the structures and carry out the chemical reactions necessary for life. A typical cell contains thousands of different kinds of proteins to perform the many tasks of life.

Typically a protein chain has 50 to 1,000 amino acid links.

Proteins that work in a cell fold up into very precise structures automatically.

It is the shape of a folded protein and the precise positioning of the different kinds of amino acid groups that allow a protein to work. p52/3

The cilium is irreducibly complex requiring microtubules, connectors and motor (proteins for any function.)

Some evolutionary biologists - like Richard Dawkins - have fertile imaginations. Given a starting point, they almost always can spin a story to get any biological structure you wish. they also tend to ignore details and road blocks that would trip up their scenarios. Science however cannot ultimately ignore relevant details, and at the molecular level, details become critical. p65

The question we must ask of .. indirect scenario(s) is one for which many evolutionary biologists have little patience: but how exactly? p66

Many people assume that somebody must know how the cilium evolved, but a search of the professional literature proves them wrong. Nobody knows. p69

Even though we are told that all biology must be seen through the lens of evolution, no scientist has ever produced a model to account for the gradual evolution of this extraordinary molecular machine. p72

As biochemists have begun to examine apparently simple structures like cilia and flagella, they have discovered staggering complexity, with dozens, even hundreds of precisely tailored parts. Darwinian theory has given no explanation for the cilium or flagellum. p73

Biochemical investigation has shown that blood clotting is a very complex, intricately woven system consisting of a score of interdependent protein parts. p78

Since each step necessarily requires several parts, not only is the entire blood clotting system irreducibly complex, but so is each step in the pathway. p87

Darwin's mechanism of natural selection would actually hinder the formation of irreducibly complex systems such as the clotting cascade.

The bottom line is that clusters of proteins have to be inserted all at once into the cascade. This can only be done by the guidance of an intelligent agent. p96

Blood clotting is a paradigm of the staggering complexity that underlies even apparently simple bodily processes. Faced with such complexity beneath even simple phenomena, Darwinian theory falls silent. p97

There is an elegant trick for making very many different antibodies without requiring enormous quantities of genetic material to code for the proteins. p126

Such a huge number of (necessary) antibodies would take up more than the available coding space in the DNA. p127

At conception there are a number of gene pieces (found in 4 clusters) in the fertilised cell that contribute to making antibodies. There are about 250 gene segments (pieces) in cluster one, 10 gene segments that form cluster 2, 6 segments that comprise cluster 3 and another 8 segments that make up cluster 4.

During the formation of a B cell (antibody making cell) the genome is rearranged and some of it is thrown away. p128

During the formation of antibodies from heavy and light chains, there are thus about a million different combinations of heavy chain sequences and about ten thousand different light chain combinations, giving ten billion different antibodies from just 400 genes. p129

The scientific literature has no answers to the question of the origin of the immune system. p138

Whichever way we turn, a gradualistic account of the immune system is blocked by multiple interwoven requirements.

complexity reaches down to the very bottom of the cell. p139

the cell is a machine

(for example) the mechanism that the cell uses to make AMP is automated, ... and far from simple.

appreciate the complexity of the system, see the number of steps involved. The formation of biological molecules does not happen in some fuzzy minded ... way, it requires specific, highly sophisticated molecular robots to get the job done. p143

(In addition to requiring eight different raw materials) the synthesis of AMP takes thirteen steps and involves twelve enzymes, one of which catalyses two steps. All 13 steps occur to produce just one kind of molecule. (intermediate chemicals produced along the way play no other independent role in the cell.) p149

AMP is required for life on earth... if only the end product of a complicated biosynthetic pathway is used in the cell, how did the pathway evolve by steps? On their face, metabolic pathways where intermediates are not useful present severe challenges to a Darwinian scheme of evolution. P151

(All proposed gradual evolutionary schemes involve the initial availability of the end product (say D), then the subsequent development by some organism, of the ability to manufacture that end product (D) from another existing available intermediary (say C) which is not in such short supply in the primordial alphabet soup. Schemes like these work backwards to end up with the known A-B-C-D scenarios.)

The fact is that no one ever puts real chemical names on any of these mythical letters in the A-B-C-D story. .. because when you put real names on the chemicals, then you have to come up with a real chemical reaction that could make them. No one has done that. p152

The source for the explanation of the development of biochemical pathways given by modern textbooks is Horowitz in 1945. In the intervening years biochemistry has progressed tremendously, but no advance encourages his hypothesis. p154

It's unnerving to think that many of our important ideas about the way the world works were simply picked up unreflectively from the cultural milieu in which we found ourselves. p153

Origin of life workers have never demonstrated that the intermediates in the synthesis of AMP either would have or even could have existed in a prebiotic soup, let alone the sophisticated enzymes for interconverting the intermediates. p155

No one has a clue how the AMP pathway developed. p159

The reader is encouraged to borrow a biochemistry textbook .. and see how many problems for gradualism he or she can spot. p160

Papers concerning molecular evolution can pretty easily be divided into three separate categories: Chemical synthesis of molecules thought necessary to life (15%), comparisons of DNA or protein sequences (80%), and abstract mathematical models (5%). p166

Almost all of the 20 naturally occurring types of amino acids have been detected in origin of life experiments. p167

Klaus Dose "More than 30 years of experimentation on the origin of life in the fields of chemical and molecular evolution have led to a better perception of the immensity of the problem of the origin of life on Earth rather than to it's solution. At present all discussions on principal theories and experiments in the field either end in a stalemate or in a confession of ignorance" p168

the involvement of some intelligence is unavoidable p169

(The hope in the proposed RNA world) ignores known chemistry and is hope struggling valiantly against experimental data.

undirected chemical reactions overwhelmingly produce undesired products and shapeless goop on the bottom of the test tube. p171

Through the efforts of scientists working on the origin of life we now have a clear idea of the staggering difficulties that would face an origin of life by natural chemical processes. p172

evolutionary biologists make no attempt to test evolutionary scenarios at the molecular level by experiment or calculation. Evolutionary biology is stuck in the fifties with ... imagination running wild.

Biochemistry has, in fact, revealed a molecular world that stoutly resists explanation by the same theory so long applied at the level of the whole organism. Neither of Darwin's starting points - the origin of life, and the origin of vision - has been accounted for by his theory. Darwin never imagined the exquisitely profound complexity that exists even at the most basic levels of life. p173

(Amino acid and protein sequence comparisons between species have shown evidence upon which) many researchers concluded that similar sequences strongly supported descent from a common ancestor. p174

comparing sequences cannot show how a complex biochemical system achieved its function.

To say that Darwinian evolution cannot explain everything in nature is not to say that evolution, random mutation, and natural selection do not occur; they have been observed p175

I believe the evidence strongly supports common descent. p176

No studies asking detailed questions of molecular evolution are to be found.

In fact, evolutionary explanations even of systems that do not appear to be irreducibly complex, such as specific metabolic pathways are missing from the literature. p177

There has never been a meeting, or a book, or a paper on the details of the evolution of complex biochemical systems. p179

Many students learn from their text books how to view the world through the evolutionary lens. However, they do not learn how Darwinian evolution might have produced any of the remarkably intricate biological systems that those texts describe. p183

(What we know, we learn from personal experience, or we accept from authorities we believe to be reliable, but much of what we think we know is not based on either personal experience or authority but has been absorbed some how) p184

Scientists are human too so we can ask how scientists know what they say they know. All scientists rely on authority for almost all of their scientific knowledge.

The nice thing about scientific authority is that it is easy to locate; it's in the library.

Scientific authority rests on published work. The published work must also contain pertinent evidence.

Molecular evolution is not based on scientific authority. There is no publication that describes how molecular evolution of any real, complex, biochemical system either did occur or even might have occurred. p185

The theory of Darwinian molecular evolution has not been published and so it should perish. p186

In the face of the enormous complexity that modern biochemistry has uncovered in the cell, the scientific community is paralysed. p187

Symbiosis theory (that some organelles in cells are derived from earlier organisms incorporated into later cells) may have important points to make about the development of life on earth, but it cannot explain the ultimate origins of complex systems. p189

Complexity theory (a mathematical model) that states that systems with a large number of interacting components spontaneously organise themselves into ordered patterns has been described as "fact free science" p190/1

The straightforward conclusion is that many biochemical systems were designed. The designer knew what the systems would look like when they were completed, then took steps to bring the systems about.

The conclusion of intelligent design flows naturally from the data itself - not from sacred books. It requires no new principles of logic or science. It comes simply from the hard work that biochemistry has done over the last 40 years. p193

Anything could have been purposely arranged .. we cannot know that something has not been designed.

When is it reasonable to conclude, in the absence of first hand knowledge or eye witness accounts that something has been designed? p194

There must be an identifiable purpose for the system, the purpose that requires the greatest amount of the system's internal complexity.

Inferences to design do not require that we have a candidate for the role of designer. We can determine that a system was designed by examining the system itself, and we can hold the conviction of design much more strongly than a conviction about the identity of the designer. We can know things were designed because of the ordering of independent components to achieve some end. p196

In some other cases we can say that like anything, it could have been designed, but we cannot tell for sure. p198

As the number or quality of the parts of an interreacting system increase, our judgement of design also increases, and can reach certitude. p199

The fact that biochemical systems can be designed by intelligent agents for their own purposes is conceded by all scientists, even Richard Dawkins.

The question of whether a given biochemical system was designed boils down simply to adducting the evidence to support design.

There are laws of biological reproduction, mutation and natural selection. If a biological structure can be explained in terms of those natural laws, then we cannot conclude that it was designed. (but it still may have been) p203

Might there be an as yet undiscovered natural process that would explain biochemical complexity? We can say that if there is such a process, no one has a clue how it would work. Further it would go against all human experience, like postulating that a natural process might explain computers.

In the face of the massive evidence we do have for biochemical design, ignoring that evidence in the name of a phantom process would be (ridiculous)

We can conclude that at least, cilia, blood clotting and the immune system were designed by an intelligent agent.

Our ability to be confident of the design of the cilium or intracellular transport rests on the same principles as our ability to be confident about the design of anything: the ordering of separate components to achieve an identifiable function that depends sharply on the components. p204

Because the functions depend critically on the intricate interactions of the parts, we must conclude that they are, like a mouse trap, designed.

The designing that is currently going on in the biochemistry laboratories throughout the world is analogous to the designing that preceded the blood clotting system, and the work that was done to cause the first cilium.

It turns out that the cell contains systems that span the range from obviously designed to no apparent design, keeping in mind that anything might have been designed. p205

The idea of intelligent design, like the wheel, is a simple, powerful, obvious idea that has been sidetracked by competition from and contamination with, extraneous ideas. p210

Arguments to design based on the bare assertion of their rightness evaporate like the morning dew when faced with the least scepticism.

Until Darwin, the argument that the world was designed was commonplace. The strength of the argument reached it's zenith with William Paley who brought a wide scientific scholarship to bear in his writings, but, ironically set himself up for refutation by overreaching. p211

Paley's example of a watch is excellent because the watch was not a black box, it's components and their roles were known. p212

Paley is seen as a defeated enemy but exactly where was he refuted? p213

Despite many of his misguided examples, Paley's first paragraph concerning the watch is exactly correct - no one would deny that if you found a watch you would immediately, and with certainty conclude that it had been designed. The reason for the conclusion is just as Paley implied: the ordering of separate components to accomplish a function beyond that of the individual components. p215

His argument would have been greatly improved if he had said less.

Hume said in 1779 that the intelligent design argument is really something called an inference to the best explanation, asserting a fundamental difference between mechanical systems and living systems. This is out of date, destroyed by the advance of science which has discovered the machinery of life. p218

Dawkins rejects design and embraces Darwinism based primarily on an analogy to the random generation then guided generation of a series of letters to form a message. The analogy is transparently false.

Instead of an analogy for natural selection acting on random mutation, the Dawkins scenario is actually an example the very opposite: an intelligent agent directing the construction of an irreducibly complex system. p221

(The argument against intelligent design based on 'imperfection' is flawed because it asserts that just) because something does not fit our idea of the way things ought to be, then it is evidence against design. p222

The conclusion of intelligent design for physically interacting systems rests on the observation of highly specified, irreducible complexity - the ordering of separate, well fitted components to achieve a function that is beyond any of the components themselves.

The argument from imperfection overlooks the possibility that the designer might have multiple motives, with engineering excellence oftentimes relegated to a secondary role.

the reasons that a designer would or would not do anything are virtually impossible to know unless the designer tells you specifically what those reasons are. p223

The scientific literature contains no evidence that natural selection working on mutation can produce either an eye with a blind spot, and eye without a blind spot, an eyelid, a lens, a retina, rhodopsin, or retinal. (Debaters reach their) conclusion in favour of Darwinism based solely on an emotional feeling of the way things ought to be. p224

(Arguments from vestigial organs neglect the fact that) both the functioning organ and the vestigial organ require explanation. p226

The conclusion that some features of life were designed can be made in the absence of knowledge about when the designing took place. p227

Design theory has nothing to say (with any certainty) about a biochemical or biological system unless all the components of the system are known and it is demonstrated that the system is composed of several interacting parts. Intelligent design theory can coexist quite peacefully with the panda's thumb (refer Gould)

Evolutionary biologists have recognised that a number of factors might have affected the development of life; common descent, natural selection, migration, population size, founder effects, genetic drift, gene flow, linkage, meiotic drive, transposition and more. The fact that some biochemical systems may have been designed by an intelligent agent does not mean that any of the other factors are not operative, common or important. p229

(Those in other fields than biochemistry) should not invoke design until the molecular sciences show that design has an effect at those higher levels. but researchers should also hesitate before claiming that a particular biological feature has been produced substantially by another mechanism, such as natural selection. Instead, detailed models should be produced to justify the assertion that a given mechanism produced a given biological feature. p230

The theory of intelligent design promises to reinvigorate a field of science grown stale from a lack of viable solutions to dead end problems.

A rigorous theory of intelligent design will be a useful tool for the advancement of science in an area that has been moribund for decades. p231

The results of the cumulative efforts to investigate the cell - to investigate life at the molecular level - is a loud, clear, piercing cry of "DESIGN". The result is so unambiguous and so significant that it must be ranked as one of the greatest achievements in the history of science.

Why should science find it difficult to accept ..? p233

History makes some well meaning people think that the demilitarised zone (between religion and science) should be maintained, with no fraternisation allowed. p237

I agree that evolution is quite compatible with religious views. The compatibility or lack of compatibility, however is irrelevant to the scientific question of whether Darwinian evolution of biochemical systems is true. p239

The giants of science were motivated by a thirst to know the real world. p240

(There is rule that only purely physical, material causes may be invoked in true science that teachers of science) wish to pass on to the younger professional generation.

The anxiety is that if the supernatural were allowed as an explanation, then there would be no stopping it. Is this a reasonable fear?

Like the comet theory for the extinction of dinosaurs, hypotheses for the involvement of an intelligent agent in the development of life or other historical events have to be evaluated on a case by case basis.

The scientific community is not so frail that its healthy scepticism will turn into gullibility.

Science can observe a comet's lingering effects on the modern earth. Similarly, science can see the effects that a designer has had on life. p242

Many people, including many important and well respected scientists, just don't want there to be anything beyond nature. Like young earth creationists, they bring an a priori philosophical commitment to their science that restricts the kinds of explanations they will accept about the physical world. Sometimes this leads to rather odd behaviour. p243

Scientists such as Einstein, Eddington, and Hoyle fudged and twisted in their efforts to resist a scientific theory (the big bang) that flowed naturally from the data because they thought they would be forced to accept unpleasant philosophical or theological conclusions. They weren't; they had other options p245

no scientific theory can compel belief in a positive religious tenet by sheer force of logic p247

Designing life, it could be pointed out, does not require supernatural abilities; rather, it requires a lot of intelligence.

Most people, like me find scenarios (involving aliens or time travel) entirely unsatisfactory, but they are available to those who wish to avoid unpleasant theological implications. p249

Intolerance does not arise when I think that I have found the truth. Rather it comes about only when I think that because I have found it, everyone else should agree with me.. Richard Dawkins has written that anyone who denies evolution is either " ignorant, stupid or insane (or wicked - but I'd rather not consider that)". Philosopher Daniel Dennett compares religious belief to wild animals and he says that parents should be prevented from misinforming their children about the truth of evolution which is so evident to him.

As the weight of scientific evidence shifts dramatically, this point should be kept prominently in mind. Richard Dawkins has said that Darwin made it possible to be an "intellectually fulfilled atheist". The failure of Darwin's theory on the molecular scale may cause him to feel less fulfilled, but no one should try to stop him from continuing his search. p250

Although the fact of design is easily seen in the biochemistry of the cell, identifying the designer by scientific methods might be extremely difficult.

The reluctance of science to embrace the conclusion of intelligent design that it's long, hard labours have made manifest has no justifiable foundation. p251

Now it is the turn of the fundamental science of life, modern biochemistry to disturb.

The resulting realisation that life was designed by an intelligence is a shock to us in the twentieth century. Other centuries had their shocks. Humanity has endured as the centre of the heavens moved

from the earth to beyond the sun, as the history of life expanded to encompass long dead reptiles, as the eternal universe proved mortal. We will endure the opening of Darwin's black box. p253.