

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

## Darwin's Black Box

### The Biochemical Challenge to Evolution

By: Michael J. Behe

سَاهِم فِي الإِعْدَاد: الأُسْتَاذ مُصْطَفَى نَصْر قَدِيح

The Biochemical Challenge to Evolution



WITH A NEW AFTERWORD

# DARWIN'S BLACK BOX

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"A persuasive book. It will speak to the layman and perhaps even to professional evolutionists as well, if they are able to suspend for a little while their own judgment about origins, the ultimate black box."

—*The Washington Times*

MICHAEL J. BEHE

من أشهر الكتب الأجنبية التي رُوِّج لها أنّها مُتخصّصة في نقد نظرية التطور الداروينية، للمؤلف الأمريكي المشهور جداً، المُتخصّص في مجال الكيمياء الحيوية، الدكتور «مايكل بيهي». والكتاب بعنوان: «صندوق داروين الأسود» متوفّر بفضل الله عز وجل باللُّغة العربية، عن طريق «دار الكاتب»، والترجمة من إصدارات «مركز براهين». طبعاً الشيخ «عبد الله الشهري» حفظه الله قدّم للكتاب في الترجمة العربية، والأخ الفاضل «أحمد يحيى» بيّن في مُقدّمة أخرى سبب اختيار هذا الكتاب ضمن الأعمال التي ترجمتها المركز، ولي عتاب عليهم، وسوف أذكره بعد قليل.

الكتاب يتصرّ لنظرية «التصميم الذكي» (ID)، والكتاب ينتقد نظرية التطور في باب مُحدّد جداً، ولعلّ هذا الباب المُحدّد لم يتناوله «داروين» نفسه لأنّه لم يكن معلوماً في أيّامه، ولكنّ المفهوم التطوري الحديث يشمل هذا الباب بكُلّ تأكيد. وهذه نقطة أريد لفت الأنظار إليها لعلّها تُفيد فيما بعد عند نقد النظرية، وعند تناول الآراء المُختلفة للعلماء حولها.

«داروين» في كتابه «أصل الأنواع» لم يتناول في نظريته أيّ تفاصيل على مُستوى الخلية ووظائفها ومكوّناتها، ولكنّه بدأ في التّفكير في نظريته من خلال النّظر في الكائنات الحيّة ككُلّ. «مايكل بيهي» في كتابه هذا، يقول إنّ كل ما هو ظاهر في الكائن الحيّ ككُلّ، بادئ في الأساس من الخلية الحيّة الأولى! وأنّ كلّ تغيير يطرأ على الكائن الحيّ سببه في الأصل تغيير حدّث على مُستوى الخلية الحيّة.

«داروين» لم ينظر للأُمور هكذا، ولم يتكلّم عن أيّ تفاصيل مُتعلّقة بالخلية لتفسير التّغيير والتّفاوت والتّباين الملحوظ بين الكائنات الحيّة المُختلفة، هذا لأنّ الخلية بالنّسبة له كانت بمثابة «الصندوق الأسود» (عنوان كتاب «بيهي»)، أي أنّ الخلية ومُحتوياتها وخصائصها كانت مجهولة تماماً بالنّسبة لـ «داروين»، ولذلك تعامل فقط على مُستوى الكائن الحيّ الكامل.

العتاب الذي أشرتُ إليه مُسبقاً هو عدَم تّنبيه أو تّعليق «مركز براهين» على منهج «بيهي» وتصوره لنظرية

التَّطَوُّر، فإنَّ «بيهي» له تصوُّر عجيب جداً لنظرية التَّطَوُّر، مع نقده له، وهذا التَّصَوُّر قد يُسبِّب بلبلة لبعض النَّاس، في كونه تصوُّر صحيح أم خاطئ؟! وإليكم المزيد من البيان لأهمية هذا الأمر في تصوُّري على الأقل!

هناك أكثر من مُستوى للتَّعامُل مع نظرية التَّطَوُّر، وقد أشار «بيهي» في بداية كتابه هذا إلى المفهوم الذي يتناوله فيما يُخصَّص تعبير «التَّطَوُّر evolution»، وهو يستخدمه بمعنى أشمل وأوسع من مُجرَّد تفسير نشأة الأجناس المُختلفة للكائنات الحيَّة (المعنى الذي استخدمه «داروين» في كتابه أصل الأنواع)، وإنَّما استخدم تعبير التَّطَوُّر كآلية لتفسير كلِّ شيء يُخصَّص الكائنات الحيَّة في إطار مادِّي طبيعي بحت، بما فيها تفسير نشأة الحياة من البداية! وهذا هو المجال الذي ينتقده «بيهي»، فقط لا غير!

كتاب «بيهي» لا يُعتبر نقداً لنظرية التَّطَوُّر بمفهومه التَّقليدي، وإنَّما يُعتبر نقداً لجزئية مُتخصِّصة جداً مُتعلِّقة بموضوع نشأة الحياة على الأرض (origin of life)، فإنَّنا نجد أنَّ «بيهي» في كتابه هذا يعترف بإيما به بفكرة السَّلف المُشترك، وهذه الفكرة أصلٌ أصيلٌ لنظرية التَّطَوُّر التَّقليدية، بل إنَّها من الأفكار الأساسية التي بسببها تنتقد النَّظرية - كمُسلمين - في الأساس! فكيف لا يتمَّ التَّنبيه من قِبَل المركز على أنَّ «بيهي» يؤمن بصحَّة هذه الفكرة!؟

حتى لا أطيل كثيراً في هذا الموضوع، أريد توضيح أنَّ «بيهي» في كتابه هذا لا يعترض إلَّا على نُقطة واحدة دقيقة للغاية، ألا وهي قُدرة نظرية التَّطَوُّر على تفسير وُجود الأنظمة الحيوية المُعقَّدة في الخلية، وليان عجز التَّطَوُّر عن تقديم تفسير أو شرح لكيفية وُجود هذه الأنظمة (عن طريق العشوائية والتَّدرُّج)، فإنَّه يُقدِّم فكرته المشهورة جداً المعروفة بعُنوان: التَّعقيد غير القابل للاختزال أو للتَّبسيط أو للتَّدرُّج.

من خلال قراءة - أحسبها دقيقة - لكتاب «بيهي» هذا، أرى أنَّ تصوُّره لنظرية التَّطَوُّر ليس رفضاً تاماً محضاً، فإنَّه يقبل فكرة السَّلف المُشترك، ويدَّعي أنَّ الأدلة تُشير إليها، ولكنَّه ينتقد فكرة أنَّ الطَّفرات العشوائية والانتخاب الطَّبيعي فقط بمفردهما قادران على تفسير وُجود الخلية بأنظمتها الحيوية المُعقَّدة. وهو في كتابه هذا يقول إنَّ مُصمِّماً ذكياً هو الذي قام بتصميم الخلية بما فيها من أنظمة حيوية مُعقَّدة، ثمَّ وضعها على نظام «الطَّيَّار الآلي»، فتتج عن هذا كلُّ ما نراه حولنا من كائنات حيَّة مُختلفة. وهل هذا إلَّا نظرة مُعدَّلة لنظرية التَّطَوُّر الدَّارويني؟! أقرب في نظري لما

نُسِّمِيهِ بالتَّطَوُّر الإلهي، مع الأخذ في الاعتبار أنَّ الإلهية في الموضوع عند «بيهي» هو أنَّ المصمِّم هو الذي وضع في الخلية كلَّ ما يجعلها قادرة على التَّطَوُّر بالطَّريقة التي يصفها «داروين»!

في النَّهاية أقول إنَّنا كرافضين لنظرية التَّطَوُّر الدَّاروينية، لا نستطيع استخدام موقف «بيهي» في هذا الكتاب لنقد النَّظرية بشكلٍ كاملٍ وشاملٍ، وإنَّما موقفه أقرب لنقد الإلحاد بشكل عام، وإثبات وُجود خالق حكيم مسئول عن نشأة الحياة على الأرض. ونقده للنَّظرية في إطار سَحْب آثارها على ما هو أبعد من مُجرَّد تفسير نشأة الأجناس المُختلفة، وهذا بيِّنُ ظاهر في بداية كتابه، فإنَّ «بيهي» يعترض بوضوح على قُدرة النَّظرية على تفسير كلِّ شيء، حتى نشأة الحياة، فيما يُسمَّى بـ «التَّطَوُّر الكيمائي»، ويبيِّن هذا عن طريق التَّعقيد غير القابل للاختزال.

رفض «بيهي» لكون نظرية التَّطَوُّر قادرة على تفسير وُجود الأنظمة الحيوية المُعقَّدة في الخلية لا يعني بالضرورة أنَّه يرفض الفكرة العامَّة للتَّطَوُّر الموجودة في أذهان الناس، والتي من ضمنها فكرة السَّلف المُشترك، وأستطيع أن أقول أن تصوُّر «بيهي» لفكرة التَّطَوُّر بالتأكيد مُختلفة عن فكرة «ريتشارد دوكينز» عنها، ولكنَّها لا تختلف كثيراً، فهناك أوجه شبه كثيرة وكبيرة، والفارق الرئيسي بين ما يعتقد «بيهي»، وما يعتقد «دوكينز»، هو اعتقاد «بيهي» بأنَّ البداية كانت عن طريق مُصمِّم ذكي، أمَّا بقية القصة التَّطَوُّرية، فلا أعتقد أنَّها سيختلفان كثيراً عليها!

مع كلِّ ما سبق - ومع أسفي على الإطالة - يجب التَّنبيه الشَّديد على أنَّ الكتاب نافع جداً، وهو مُنقسم إلى ثلاثة أقسام، القسم الثاني يحتوي على معلومات علمية دسمة جداً، ولكنَّ مُجرَّد قراءة القسمين الأول والثاني، وما تستطيع فهمه من القسم الثاني، سيُثمر - بإذن الله عز وجل - النِّفع الكثير!

وعتايي الأخير للمركز بسبب أنَّهم قاموا بترجمة الطَّبعة الأولى للكتاب، وليس الطَّبعة المُخصَّصة بمُناسبة مُرور عشرة أعوام على نشر الكتاب، والتي لا تختلف كثيراً عن الطَّبعة الأولى إلا بوجود فصلين إضافيين، أهمُّهما الذي يحتوي على ردود «بيهي» على الذين انتقدوا حُجَّة التَّعقيد غير القابل للاختزال!

الكتاب مُمتاز جداً، ومُمتع جداً، وبغض النَّظر عن موقف «بيهي» العجيب من نظرية التَّطَوُّر ككلِّ، إلا أنَّه يُقدِّم حُجَّة بالغة في صالح المؤمنين، ونقداً لاذعاً للمادِّيَّة والإلحاد، كذلك يُقدِّم تعليقات رائعة مُختصة بطبيعة العلم،

## Preface

- Yet understanding how something works is not the same as understanding how it came to be. For example, the motions of the planets in the solar system can be predicted with tremendous accuracy; however, the origin of the solar system (the question of how the sun, planets, and their moons formed in the first place) is still controversial.<sup>1</sup> Science may eventually solve the riddle. Still, the point remains that understanding the origin of something is different from understanding its day-to-day workings. [Cameron, A. G. W. (1988) «Origin of the Solar System,» Annual Review of Astronomy and Astrophysics, 26, 441-472.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p ix.]
- Since the mid-1950s biochemistry has painstakingly elucidated the workings of life at the molecular level. Darwin was ignorant of the reason for variation within a species (one of the requirements of his theory), but biochemistry has identified the molecular basis for it. Nineteenth-century science could not even guess at the mechanism of vision, immunity, or movement, but modern biochemistry has identified the molecules that allow those and other functions. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p x]
- Evolution is a flexible word.<sup>2</sup> It can be used by one person to mean something as simple as change over time, or by another person to mean the descent of all life forms from a common ancestor, leaving the mechanism of change unspecified. In its full-throated, biological sense, however, evolution means a process whereby life arose from nonliving matter and subsequently developed entirely by natural means. That is the sense that Darwin gave to the word, and the meaning that it holds in the scientific community. And that is the sense in which I use the word evolution throughout this book. [Johnson, P E. (1991) Darwin on Trial, Regnery Gateway, Washington, DC, chap. 5; Mayr, E. (1991) One Long Argument, Harvard University Press, Cambridge, MA, pp. 35-39.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p x, xi]



- So, as a writer who wants people to read my work, I face a dilemma: people hate to read details, yet the story of the impact of biochemistry on evolutionary theory rests solely in the details. Therefore, I have to write the kind of book people don't like to read in order to persuade them of the ideas that push me to write. Nonetheless, complexity must be experienced to be appreciated. So, gentle reader, I beg your patience; there are going to be a lot of details in this book. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p xii.]
- The book is divided into three parts. Part I gives some background and shows why evolution must now be argued at the molecular level—the domain of the science of biochemistry. This portion is largely free from technical details, although some do creep in during a discussion of the eye. Part II contains the «example chapters» where most of the complexity is found. Part III is a nontechnical discussion of the implications of biochemistry's discoveries. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p xii.]

### **Part I: The Box is Opened**

#### **Chapter 1: Lilliputian Biology**

- Biochemistry is the study of the very basis of life: the molecules that make up cells and tissues, that catalyze the chemical reactions of digestion, photosynthesis, immunity, and more.<sup>1</sup> [By biochemistry I mean to include all sciences that investigate life at the molecular level, even if the science is done in a department with another name, such as molecular biology, genetics, or embryology.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p3.]
- Like many great ideas, Darwin's is elegantly simple. He observed that there is variation in all species: some members are bigger, some smaller, some faster, some lighter in color, and so forth. He reasoned that since limited food supplies could not support all organisms that are born, the ones whose chance variation gave them an advantage in the struggle for life would tend to survive and reproduce, outcompeting the less favored ones. If the variation were inherited, then the characteristics of the species would change over time; over great periods, great changes might occur. [Michael J. Behe:

*Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p3, 4.]

- For more than a century most scientists have thought that virtually all of life, or at least all of its most interesting features, resulted from natural selection working on random variation. Darwin's idea has been used to explain finch beaks and horse hoofs, moth coloration and insect slaves, and the distribution of life around the globe and through the ages. The theory has even been stretched by some scientists to interpret human behavior: why desperate people commit suicide, why teenagers have babies out of wedlock, why some groups do better on intelligence tests than other groups, and why religious missionaries forgo marriage and children. There is nothing—no organ or idea, no sense or thought—that has not been the subject of evolutionary rumination. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p4.]
- Almost a century and a half after Darwin proposed his theory, evolutionary biology has had much success in accounting for patterns of life we see around us. To many, its triumph seems complete. But the real work of life does not happen at the level of the whole animal or organ; the most important parts of living things are too small to be seen. Life is lived in the details, and it is molecules that handle life's details. Darwin's idea might explain horse hoofs, but can it explain life's foundation? [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p4.]
- The cumulative results show with piercing clarity that life is based on machines—machines made of molecules! Molecular machines haul cargo from one place in the cell to another along «highways» made of other molecules, while still others act as cables, ropes, and pulleys to hold the cell in shape. Machines turn cellular switches on and off, sometimes killing the cell or causing it to grow. Solar-powered machines capture the energy of photons and store it in chemicals. Electrical machines allow current to flow through nerves. Manufacturing machines build other molecular machines, as well as themselves. Cells swim using machines, copy themselves with machinery, ingest food with machinery. 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p4, 5.]

- But as I will note later, 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 paralyzed science's attempt to account for it; molecular machines raise an as-yet-impenetrable barrier to Darwinism's universal reach. To find out why, in this book I will examine several fascinating molecular machines, then ask whether they can ever be explained by random mutation/natural selection. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p5.]
- As commonly understood, creationism involves belief in an earth formed only about ten thousand years ago, an interpretation of the Bible that is still very popular. For the record, I have no reason to doubt that the universe is the billions of years old that physicists say it is. Further, I find the idea of common descent (that all organisms share a common ancestor) fairly convincing, and have no particular reason to doubt it. I greatly respect the work of my colleagues who study the development and behavior of organisms within an evolutionary framework, and I think that evolutionary biologists have contributed enormously to our understanding of the world. Although Darwin's mechanism—natural selection working on variation—might explain many things, however, I do not believe it explains molecular life. I also do not think it surprising that the new science of the very small might change the way we view the less small. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p5, 6.]
- Black box is a whimsical term for a device that does something, but whose inner workings are mysterious—sometimes because the workings can't be seen, and sometimes because they just aren't comprehensible. Computers are a good example of a black box. Most of us use these marvelous machines without the vaguest idea of how they work, processing words or plotting graphs or playing games in contented ignorance of what is going on



underneath the outer case. Even if we were to remove the cover, though, few of us could make heads or tails of the jumble of pieces inside. There is no simple, observable connection between the parts of the computer and the things that it does. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p6.]

- It was not until the seventeenth century that an Englishman, William Harvey, introduced the theory that blood flows continuously in one direction, making a complete circuit and returning to the heart. Harvey calculated that if the heart pumps out just two ounces of blood per beat, at 72 beats per minute, in one hour it would have pumped 540 pounds of blood—triple the weight of a man! Since making that much blood in so short a time is clearly impossible, the blood had to be reused. Harvey's logical reasoning (aided by the still-new Arabic numerals, which made calculating easy) in support of an unobservable activity was unprecedented; it set the stage for modern biological thought. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p8.]
- The discovery of an unanticipated Lilliputian world had begun, overturning settled notions of what living things are. Charles Singer, the historian of science, noted that «the infinite complexity of living things thus revealed was as philosophically disturbing as the ordered majesty of the astronomical world which Galileo had unveiled to the previous generation, though it took far longer for its implications to sink into men's minds.» In other words, sometimes the new boxes demand that we revise all of our theories. In such cases, great unwillingness can arise. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p9.]
- The cell theory of life was finally put forward in the early nineteenth century by Matthias Schleiden and Theodor Schwann. Schleiden worked primarily with plant tissue; he argued for the central importance of a dark spot—the nucleus—within all cells. Schwann concentrated on animal tissue, in which it was harder to see cells. Nonetheless he discerned that animals were similar to plants in their cellular structure. Schwann concluded that cells or the secretions of cells compose the entire bodies of animals and plants, and that in some way the cells are individual units with a life of their own. He wrote that «the question as to the fundamental power of organized bodies resolves

itself into that of individual cells.» As Schleiden added, «Thus the primary question is, what is the origin of this peculiar little organism, the cell?» [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p9.]

- Schleiden and Schwann worked in the early to middle 1800s—the time of Darwin's travels and the writing of *The Origin of Species*. To Darwin, then, as to every other scientist of the time, the cell was a black box. Nonetheless he was able to make sense of much biology above the level of the cell. The idea that life evolves was not original with Darwin, but he argued it by far the most systematically, and the theory of how evolution works—by natural selection working on variation—was his own. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p9.]
- The word evolution has been invoked to explain tiny changes in organisms as well as huge changes. These are often given separate names: Roughly speaking, microevolution describes changes that can be made in one or a few small jumps, whereas macroevolution describes changes that appear to require large jumps. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p14]
- On a small scale, Darwin's theory has triumphed; it is now about as controversial as an athlete's assertion that he or she could jump over a four-foot ditch. But it is at the level of macroevolution—of large jumps—that the theory evokes skepticism. 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. Nonetheless, like a neighbor's story about vanishing buttes, it has been difficult to evaluate whether the elusive and ill-defined small steps could exist... until now. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p15.]
- Charles Darwin knew about the eye, too. In *The Origin of Species* Darwin dealt with many objections to his theory of evolution by natural selection. He discussed the problem of the eye in a section of the book appropriately entitled «Organs of Extreme Perfection and Complication.» In Darwin's

thinking, evolution could not build a complex organ in one step or a few steps; radical innovations such as the eye would require generations of organisms to slowly accumulate beneficial changes in a gradual process. He realized that if in one generation an organ as complex as the eye suddenly appeared, it would be tantamount to a miracle. Unfortunately, gradual development of the human eye appeared to be impossible, since its many sophisticated features seemed to be interdependent. Somehow, for evolution to be believable, Darwin had to convince the public that complex organs could be formed in a step-by-step process. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p16.]

- Using reasoning like this, Darwin convinced many of his readers that an evolutionary pathway leads from the simplest light-sensitive spot to the sophisticated camera-eye of man. But the question of how vision began remained unanswered. Darwin persuaded much of the world that a modern eye evolved gradually from a simpler structure, but he did not even try to explain where his starting point—the relatively simple light-sensitive spot—came from. On the contrary, Darwin dismissed the question of the eye's ultimate origin: «How a nerve comes to be sensitive to light hardly concerns us more than how life itself originated.»<sup>4</sup> [Darwin, C. (1872) *Origin of Species*, 6th ed. (1988), New York University Press, New York, p. 151.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p18.]
- Now that the black box of vision has been opened, it is no longer enough for an evolutionary explanation of that power to consider only the anatomical structures of whole eyes, as Darwin did in the nineteenth century (and as popularizers of evolution continue to do today). Each of the anatomical steps and structures that Darwin thought were so simple actually involves staggeringly complicated biochemical processes that cannot be papered over with rhetoric. Darwin's metaphorical hops from butte to butte are now revealed in many cases to be huge leaps between carefully tailored machines—distances that would require a helicopter to cross in one trip. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p22.]

- The key to persuading people was the portrayal of the cells as «simple.» One of the chief advocates of the theory of spontaneous generation during the middle of the nineteenth century was Ernst Haeckel, a great admirer of Darwin and an eager popularizer of Darwin's theory. From the limited view of cells that microscopes provided, Haeckel believed that a cell was a «simple little lump of albuminous combination of carbon,»<sup>7</sup> not much different from a piece of microscopic Jell-O. So it seemed to Haeckel that such simple life, with no internal organs, could be produced easily from inanimate material. Now, of course, we know better. [Farley, J. (1979) *The Spontaneous Generation Controversy from Descartes to Oparin*, Johns Hopkins University Press, Baltimore, p. 73.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p24.]
- Darwin is to our understanding of the origin of vision as Haeckel is to our understanding of the origin of life. In both cases brilliant nineteenth-century scientists tried to explain Lilliputian biology that was hidden from them, and both did so by assuming that the inside of the black box must be simple. Time has proven them wrong. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p24.]
- Inevitably, evolutionary theory began to mean different things to different disciplines; a coherent view of Darwinian evolution was being lost. In the middle of the century, however, leaders of the fields organized a series of interdisciplinary meetings to combine their views into a coherent theory of evolution based on Darwinian principles. The result has been called the «evolutionary synthesis,» and the theory called neo-Darwinism. Neo-Darwinism is the basis of modern evolutionary thought. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p24.]
- One branch of science was not invited to the meetings, and for good reason: it did not yet exist. The beginnings of modern biochemistry came only after neo-Darwinism had been officially launched. Thus, just as biology had to be reinterpreted after the complexity of microscopic life was discovered, neo-Darwinism must be reconsidered in light of advances in biochemistry. The scientific disciplines that were part of the evolutionary synthesis are all

nonmolecular. Yet for the Darwinian theory of evolution to be true, it has to account for the molecular structure of life. It is the purpose of this book to show that it does not. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p24, 25.]

## **Chapter 2: Nuts and Bolts**

- Lynn Margulis is Distinguished University Professor of Biology at the University of Massachusetts. Lynn Margulis is highly respected for her widely accepted theory that mitochondria, the energy source of plant and animal cells, were once independent bacterial cells. And Lynn Margulis says that history will ultimately judge neo-Darwinism as «a minor twentieth-century religious sect within the sprawling religious persuasion of Anglo-Saxon biology.» [Mann, C. (1991) «Lynn Margulis: Science's Unruly Earth Mother,» *Science*, 252, 378-381.] At one of her many public talks she asks the molecular biologists in the audience to name a single, unambiguous example of the formation of a new species by the accumulation of mutations. Her challenge goes unmet. Proponents of the standard theory, she says, «wallow in their zoological, capitalistic, competitive, cost-benefit interpretation of Darwin—having mistaken him. . . . Neo-Darwinism, which insists on (the slow accrual of mutations), is in a complete funk.» [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p26.]
- Paleontologist Niles Eldredge describes the problem: No wonder paleontologists shied away from evolution for so long. It never seems to happen. Assiduous collecting up cliff faces yields zigzags, minor oscillations, and the very occasional slight accumulation of change—over millions of years, at a rate too slow to account for all the prodigious change that has occurred in evolutionary history. When we do see the introduction of evolutionary novelty, it usually shows up with a bang, and often with no firm evidence that the fossils did not evolve elsewhere! Evolution cannot forever be going on somewhere else. Yet that's how the fossil record has struck many a forlorn paleontologist looking to learn something about evolution. [Eldredge, N. (1995) *Reinventing Darwin*, Wiley, New York, p. 95.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p27.]



- Gould has been at the forefront of the discussion of another fascinating phenomenon: the «Cambrian explosion.» Careful searches show only a smattering of fossils of multicellular creatures in rocks older than about 600 million years. Yet in rocks just a little bit younger is seen a profusion of fossilized animals, with a host of widely differing body plans. Recently the estimated time over which the explosion took place has been revised downward from 50 million years to 10 million years—a blink of the eye in geological terms. The shorter time estimate has forced headline writers to grope for new superlatives, a favorite being the «biological Big Bang.» Gould has argued that the rapid rate of appearance of new life forms demands a mechanism other than natural selection for its explanation.<sup>4</sup> [Beardsley, T. «Weird Wonders: Was the Cambrian Explosion a Big Bang or a Whimper?» *Scientific American*, June 1992, pp. 30-31.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p27, 28.]
- Ironically, we have come full circle from Darwin's day. When Darwin first proposed his theory a big difficulty was the estimated age of the earth. Nineteenth-century physicists thought the earth was only about a hundred million years old, yet Darwin thought natural selection would require much more time to produce life. At first he was proven right; the earth is now known to be much older. With the discovery of the biological Big Bang, however, the window of time for life to go from simple to complex has shrunk to much less than nineteenth-century estimates of the earth's age. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p28.]
- The English biologists Mae-Wan Ho and Peter Saunders complain as follows: It is now approximately half a century since the neo-Darwinian synthesis was formulated. A great deal of research has been carried on within the paradigm it defines. Yet the successes of the theory are limited to the minutiae of evolution, such as the adaptive change in coloration of moths; while it has remarkably little to say on the questions which interest us most, such as how there came to be moths in the first place. [Ho, M. W., and Saunders, P.T. (1979) «Beyond Neo-Darwinism—An Epigenetic Approach to Evolution,» *Journal of Theoretical Biology* 78, 589.] [Michael J. Behe:

*Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p28.]

- University of Georgia geneticist John McDonald notes a conundrum: The results of the last 20 years of research on the genetic basis of adaptation has led us to a great Darwinian paradox. Those [genes] that are obviously variable within natural populations do not seem to lie at the basis of many major adaptive changes, while those [genes] that seemingly do constitute the foundation of many, if not most, major adaptive changes apparently are not variable within natural populations. [McDonald, J. F. (1983) «The Molecular Basis of Adaptation,» *Annual Review of Ecology and Systematics* 14, 93.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p28.]
- Australian evolutionary geneticist George Miklos puzzles over the usefulness of Darwinism: What then does this all-encompassing theory of evolution predict? Given a handful of postulates, such as random mutations, and selection coefficients, it will predict changes in [gene] frequencies over time. Is this what a grand theory of evolution ought to be about? [Miklos, G. L. G (1993) «Emergence of Organizational Complexities During Metazoan Evolution: Perspectives from Molecular Biology, Paleontology and Neo-Darwinism,» *Memoirs of the Association of Australasian Paleontologists*, 15, 28.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p28.]
- Jerry Coyne, of the Department of Ecology and Evolution at the University of Chicago, arrives at an unanticipated verdict: We conclude—unexpectedly—that there is little evidence for the neo-Darwinian view: its theoretical foundations and the experimental evidence supporting it are weak. [Orr, H. A., and Coyne, J. A. (1992) «The Genetics of Adaptation: A Reassessment,» *American Naturalist*, 140, 726.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p29.]
- And University of California geneticist John Endler ponders how beneficial mutations arise: Although much is known about mutation, it is still largely a «black box» relative to evolution. Novel biochemical functions seem to be rare in evolution, and the basis for their origin is virtually unknown. [Endler,

J. A., and McLellan, T. (1988) «The Process of Evolution: Toward a Newer Synthesis,» *Annual Review of Ecology and Systematics*, 19, 397.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p29.]

- Mathematicians over the years have complained that Darwinism's numbers just do not add up. Information theorist Hubert Yockey argues that the information needed to begin life could not have developed by chance; he suggests that life be considered a given, like matter or energy. [Yockey, H. (1992) *Information Theory and Molecular Biology*, Cambridge University Press, Cambridge, England, chap. 9.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p29.]
- In 1966 leading mathematicians and evolutionary biologists held a symposium at the Wistar Institute in Philadelphia because the organizer, Martin Kaplan, had overheard «a rather weird discussion between four mathematicians ... on mathematical doubts concerning the Darwinian theory of evolution.»<sup>11</sup> At the symposium one side was unhappy, and the other was uncomprehending. A mathematician who claimed that there was insufficient time for the number of mutations apparently needed to make an eye was told by the biologists that his figures must be wrong. The mathematicians, though, were not persuaded that the fault was theirs. As one said: There is a considerable gap in the neo-Darwinian theory of evolution, and we believe this gap to be of such a nature that it cannot be bridged with the current conception of biology.<sup>12</sup> [11. Kaplan, M. (1967) «Welcome to Participants» in *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*, ed. P. S. Moorhead and M. M. Kaplan, Wistar Institute Press, Philadelphia, p. vii. 12. Schützenberger, M. P. (1967) «Algorithms and the Neo-Darwinian Theory of Evolution» in *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*, ed. P. S. Moorhead and M. M. Kaplan, Wistar Institute Press, Philadelphia, p. 75.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p29.]
- Stuart Kauffman of the Santa Fe Institute is a leading proponent of «complexity theory.» Simply put, it proposes that many features of living

systems are the result of self-organization—the tendency of complex systems to arrange themselves in patterns—and not natural selection: Darwin and evolution stand astride us, whatever the muttering of creation scientists. But is the view right? Better, is it adequate? I believe it is not. It is not that Darwin is wrong, but that he got hold of only part of the truth.<sup>13</sup> [Kauffman, S. (1993) *The Origins of Order*, Oxford University Press, Oxford, England, p. xiii.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p29.]

- In 1871 one of Darwin's critics, St. George Mivart, listed his objections to the theory, many of which are surprisingly similar to those raised by modern critics. "What is to be brought forward (against Darwinism) may be summed up as follows: That «Natural Selection» is incompetent to account for the incipient stages of useful structures. That it does not harmonize with the co-existence of closely similar structures of diverse origin. That there are grounds for thinking that specific differences may be developed suddenly instead of gradually. That the opinion that species have definite though very different limits to their variability is still tenable. That certain fossil transitional forms are absent, which might have been expected to be present. ... That there are many remarkable phenomena in organic forms upon which «Natural Selection» throws no light whatever." [Mivart, St. G. (1871) *On the Genesis of Species*, Macmillan and Co., London, p. 21.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p30.]
- Before going further we should note the obvious: if a poll were taken of all the scientists in the world, the great majority would say they believed Darwinism to be true. But scientists, like everybody else, base most of their opinions on the word of other people. Of the great majority who accept Darwinism, most (though not all) do so based on authority. Also, and unfortunately, too often criticisms have been dismissed by the scientific community for fear of giving ammunition to creationists. It is ironic that in the name of protecting science, trenchant scientific criticism of natural selection has been brushed aside. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p30.]

- The bombardier beetle is an insect of unassuming appearance, measuring about one half-inch in length. When it is threatened by another bug, however, the beetle has a special method of defending itself, squirting a boiling-hot solution at the enemy out of an aperture in its hind section.<sup>16</sup> The heated liquid scalds its target, which then usually makes other plans for dinner. How is this trick done? [Aneshansley, D. J., Eisner, T., Widom, J. M., and Widom, B. (1969) «Biochemistry at 100°C: Explosive Secretory Discharge of Bombardier Beetles,» *Science*, 165, 61; Crowson, R. A. (1981) *The Biology of the Coleoptera*, Academic Press, New York, chap. 15.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p31.]
- The bombardier beetle is a favorite of creationists. (A storybook for children, *Bomby, the Bombardier Beetle* by Hazel May Rue, has been published by the Institute for Creation Research.) They twit evolutionists with the beetle's remarkable defensive system, inviting them to explain how it could have evolved gradually. Richard Dawkins, professor of zoology at Oxford University, has taken up their challenge. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p33.]
- In *The Blind Watchmaker* Dawkins turns his attention briefly to the bombardier beetle. First he cites a passage from *The Neck of the Giraffe*, a book by science writer Francis Hitching, that describes the bombardier beetle's defensive system, as part of an argument against Darwinism: [The bombardier beetle] squirts a lethal mixture of hydroquinone and hydrogen peroxide into the face of its enemy. These two chemicals, when mixed together; literally explode. So in order to store them inside its body, the bombardier beetle has evolved a chemical inhibitor to make them harmless. At the moment the beetle squirts the liquid out of its tail, an anti-inhibitor is added to make the mixture explosive once again. The chain of events that could have led to the evolution of such a complex, coordinated and subtle process is beyond biological explanation on a simple step-by-step basis. The slightest alteration in the chemical balance would result immediately in a race of exploded beetles.<sup>17</sup> [Hitching, F. (1982) *The Neck of the Giraffe*, Pan, London, p. 68.] [Michael J. Behe: *Darwin's Black Box, The*



*Biochemical Challenge to Evolution*, Free Press, New York 2006, p33.]

- Replies Dawkins: A biochemist colleague has kindly provided me with a bottle of hydrogen peroxide, and enough hydroquinone for 50 bombardier beetles. I am about to mix the two together. According to [Hitching], they will explode in my face. Here goes.... Well, I'm still here. I poured the hydrogen peroxide into the hydroquinone, and absolutely nothing happened. It didn't even get warm.... The statement that «these two chemicals, when mixed together; literally explode,» is, quite simply, false, although it is regularly repeated throughout the creationist literature. If you are curious about the bombardier beetle, by the way, what actually happens is as follows. It is true that it squirts a scaldingly hot mixture of hydrogen peroxide and hydroquinone at enemies. But hydrogen peroxide and hydroquinone don't react violently together unless a catalyst is added. This is what the bombardier beetle does. As for the evolutionary precursors of the system, both hydrogen peroxide and various kinds of quinones are used for other purposes in body chemistry. The bombardier beetle's ancestors simply pressed into different service chemicals that already happened to be around. That's how evolution works.<sup>18</sup> [Dawkins, R. (1985) *The Blind Watchmaker*, W. W. Norton, London, pp. 86-87.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p33, 34.]
- Dawkins's explanation for the evolution of the system rests on the fact that the system's elements «happened to be around.» Thus evolution might be possible. But Dawkins has not explained how hydrogen peroxide and quinones came to be secreted together at very high concentration into one compartment that is connected through a sphinctered tube to a second compartment that contains enzymes necessary for the rapid reaction of the chemicals. The key question is this: How could complex biochemical systems be gradually produced? The problem with the above «debate» is that both sides are talking past each other. One side gets its facts wrong; the other side merely corrects the facts. But the burden of the Darwinians is to answer two questions: First, what exactly are the stages of beetle evolution, in all their complex glory? Second, given these stages, how does Darwinism get us from one to the next? [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p33, 34.]

- To point out the problem with his argument, however, let's use what we know of the beetle's anatomy to build the best possible case for the evolution of the bombardier beetle. First, we should note that the function of the bombardier beetle's defensive apparatus is to repel attackers. The components of the system are (1) hydrogen peroxide and hydroquinone, which are produced by the secretory lobes; (2) the enzyme catalysts, which are made by the ectodermal glands; (3) the collecting vesicle; (4) the sphincter muscle; (5) the explosion chamber; and (6) the outlet duct. Not all of these components, though, are necessary for the function of the system. Hydroquinone itself is noxious to predators. A large number of beetle species synthesize quinones that are not even secreted, but which «taste bad.» Initially a number of individual beetles are chewed up and spit out, but a predator learns to avoid their noxious counterparts in the future, and thus the species as a whole benefits from this defense. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p34, 35.]
- Although we seem to have a continuously changing system, the components that control its operation are not known. For example, the collection vesicle is a complex, multicelled structure. What does it contain? Why does it have its particular shape? Saying that «the beetle would benefit from concentrating the hydroquinone in a holding space» is like saying «society benefits from concentrating power in a centralized government»: In both cases the manner of concentrating and the holding vessel are unexplained, and the benefits of either would depend sharply on the details. The collecting vesicle, the sphincter muscle, the explosion chamber, and the exit port are all complex structures in their own right, with many unidentified components. Furthermore, the actual processes responsible for the development of the explosive capability are unknown: What causes a collection vesicle to develop, hydrogen peroxide to be excreted, or a sphincter muscle to wrap around? [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p36.]
- All we can conclude at this point is that Darwinian evolution might have occurred. If we could analyze the structural details of the beetle down to the

last protein and enzyme, and if we could account for all these details with a Darwinian explanation, then we could agree with Dawkins. For now, though, we cannot tell whether the step-by-step accretions of our hypothetical evolutionary stream are single-mutation «hops» or helicopter rides between distant buttes. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p36.]

- Hitching had stated in *The Neck of the Giraffe* that: it is quite evident that if the slightest thing goes wrong en route—if the cornea is fuzzy, or the pupil fails to dilate, or the lens becomes opaque, or the focusing goes wrong—then a recognizable image is not formed. The eye either functions as a whole or not at all. So how did it come to evolve by slow, steady, infinitesimally small Darwinian improvements? Is it really plausible that thousands upon thousands of lucky chance mutations happened coincidentally so that the lens and the retina, which cannot work without each other, evolved in synchrony? What survival value can there be in an eye that doesn't see?<sup>21</sup> [Hitching, pp. 66-67.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p36, 37.]
- Dawkins, grateful that Hitching again leads with his chin, doesn't miss the opportunity: Consider the statement that «if the slightest thing goes wrong ... [if] the focusing goes wrong ... a recognizable image is not formed.» The odds cannot be far from 50/50 that you are reading these words through glass lenses. Take them off and look around. Would you agree that «a recognizable image is not formed»? . . . (Hitching) also states, as though it were obvious, that the lens and the retina cannot work without each other. On what authority? Someone close to me has had a cataract operation in both eyes. She has no lenses in her eyes at all. Without glasses she couldn't even begin to play lawn tennis or aim a rifle. But she assures me that you are far better off with a lensless eye than with no eye at all. You can tell if you are about to walk into a wall or another person. If you were a wild creature, you could certainly use your lensless eye to detect the looming shape of a predator, and the direction from which it was approaching.<sup>22</sup> [Dawkins, pp. 80-81.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p37.]
- Remember that the «light-sensitive spot» that Dawkins takes as his starting

point requires a cascade of factors, including 11-cis-retinal and rhodopsin, to function. Dawkins doesn't mention them. And where did the «little cup» come from? A ball of cells—from which the cup must be made—will tend to be rounded unless held in the correct shape by molecular supports. In fact, there are dozens of complex proteins involved in maintaining cell shape, and dozens more that control extracellular structure; in their absence, cells take on the shape of so many soap bubbles. Do these structures represent single-step mutations? Dawkins did not tell us how the apparently simple «cup» shape came to be. And although he reassures us that any «translucent material» would be an improvement (recall that Haeckel mistakenly thought it would be easy to produce cells since they were certainly just «simple lumps»), we are not told how difficult it is to produce a «simple lens.» In short, Dawkins's explanation is only addressed to the level of what is called gross anatomy. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p38.]

- Darwin knew that his theory of gradual evolution by natural selection carried a heavy burden: If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down.<sup>24</sup> [Darwin, C. (1872) *Origin of Species*, 6th ed. (1988), New York University Press, New York, p. 154.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p39.]
- Well, for starters, a system that is irreducibly complex. By irreducibly complex I mean a single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning. An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to work by the same mechanism) by slight, successive modifications of a precursor system, because any precursor to an irreducibly complex system that is missing a part is by definition nonfunctional. An irreducibly complex biological system, if there is such a thing, 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 to arise as an integrated unit, in one fell swoop, for natural selection to

have anything to act on. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p39.]

- Richard Dawkins explains the problem well: Evolution is very possibly not, in actual fact, always gradual. But it must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes. For if it is not gradual in these cases, 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.<sup>25</sup> [Dawkins, R. (1995) *River Out of Eden*, Basic Books, New York, p. 83.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p40.]
- In biochemistry, a mutation is a change in DNA. To be inherited, the change must occur in the DNA of a reproductive cell. The simplest mutation occurs when a single nucleotide (nucleotides are the «building blocks» of DNA) in a creature's DNA is switched to a different nucleotide. Alternatively, a single nucleotide can be added or left out when the DNA is copied during cell division. Sometimes, though, a whole region of DNA—thousands or millions of nucleotides—is accidentally deleted or duplicated. That counts as a single mutation, too, because it happens at one time, as a single event. Generally a single mutation can, at best, make only a small change in a creature—even if the change impresses us as a big one. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p40.]
- Thus, to go back to the bombardier beetle and the human eye, the question is whether the numerous anatomical changes can be accounted for by many small mutations. The frustrating answer is that we can't tell. Both the bombardier beetle's defensive apparatus and the vertebrate eye contain so many molecular components (on the order of tens of thousands of different types of molecules) that listing them—and speculating on the mutations that might have produced them—is currently impossible. Too many of the nuts and bolts (and screws, motor parts, handlebars, and so on) are unaccounted for. For us to debate whether Darwinian evolution could produce such large structures is like nineteenth century scientists debating whether cells could arise spontaneously. Such debates are fruitless because not all the



components are known. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p41.]

- The first step in determining irreducible complexity is to specify both the function of the system and all system components. An irreducibly complex object will be composed of several parts, all of which contribute to the function. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p42.]
- The second step in determining if a system is irreducibly complex is to ask if all the components are required for the function. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p42.]
- But a motorcycle depends on a source of fuel, and a bicycle has nothing that can be slightly modified to become a gasoline tank. And what part of the bicycle could be duplicated to begin building a motor? Even if a lucky accident brought a lawnmower engine from a neighboring factory into the bicycle factory, the motor would have to be mounted on the bike and be connected in the right way to the drive chain. How could this be done step-by-step from bicycle parts? A factory that made bicycles simply could not produce a motorcycle by natural selection acting on variation—by «numerous, successive, slight modifications»—and in fact there is no example in history of a complex change in a product occurring in this manner. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p44.]
- My previous list of factors that render a mousetrap irreducibly complex was actually much too generous, because almost any device with the five components of a standard mousetrap will nonetheless fail to function. If the base were made out of paper, for example, the trap would fall apart. If the hammer were too heavy, it would break the spring. If the spring were too loose, it would not move the hammer. If the holding bar were too short, it would not reach the catch. If the catch were too large, it would not release at the proper time. A simple list of components of a mousetrap is necessary, but not sufficient, to make a functioning mousetrap. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p45.]

- In order to be a candidate for natural selection a system must have minimal function: the ability to accomplish a task in physically realistic circumstances. A mousetrap made of unsuitable materials would not meet the criterion of minimal function, but even complex machines that do what they are supposed to do may not be of much use. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p45.]

## **Part II: Examining the Contents of the Box**

### **Chapter 3: Row, Row, Row Your Boat**

- As strange as it may seem, modern biochemistry has shown that the cell is operated by machines—literally, molecular machines. Like their man-made counterparts (such as mousetraps, bicycles, and space shuttles), molecular machines range from the simple to the enormously complex: mechanical, force-generating machines, like those in muscles; electronic machines, like those in nerves; and solar-powered machines, like those of photosynthesis. Of course, molecular machines are made primarily of proteins, not metal and plastic. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p51.]
- Proteins are made by chemically hooking together amino acids into a chain. A protein chain typically has anywhere from about fifty to about one thousand amino acid links. Each position in the chain is occupied by one of twenty different amino acids. In this they are like words, which can come in various lengths but are made up from a set of just 26 letters. As a matter of fact, biochemists often refer to each amino acid by a single-letter abbreviation—G for glycine, S for serine, H for histidine, and so forth. Each different kind of amino acid has a different shape and different chemical properties. For example, W is large but A is small, R carries a positive charge but E carries a negative charge, S prefers to be dissolved in water but I prefers oil, and so on. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p52.]
- In the past two decades, however, only two articles even attempted to suggest a model for the evolution of the cilium that takes into account real mechanical considerations. Worse, the two papers disagree with each other

even about the general route such an evolution might take. Neither paper discusses crucial quantitative details, or possible problems that would quickly cause a mechanical device such as a cilium or a mousetrap to be useless. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p68.]

- The first paper, authored by T. Cavalier-Smith, appeared in 1978 in a journal called *BioSystems*.<sup>3</sup> The paper does not try to present a realistic, quantitative model for even one step in the development of a cilium in a cell line originally lacking that structure. Instead it paints a picture of what the author imagines must have been significant events along the way to a cilium. [Cavalier-Smith, T. (1978) «The Evolutionary Origin and Phylogeny of Microtubules, Mitotic Spindles, and Eukaryote Flagella,» *BioSystems*, 10, 93-114.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p68.]
- The second paper, authored nine years later by a Hungarian scientist named Eörs Szathmary and also appearing in *BioSystems*, is similar in many ways to the first paper.<sup>4</sup> Szathmary is an advocate of the idea, championed by Lynn Margulis, that cilia resulted when a type of swimming bacterium called a «spirochete» accidentally attached itself to a eukaryotic cell.<sup>5</sup> The idea faces the considerable difficulty that spirochetes move by a mechanism (described later) that is totally different from that for cilia. The proposal that one evolved into the other is like a proposal that my daughter's toy fish could be changed, step by Darwinian step, into a Mississippi steamboat. [4. Szathmary, E. (1987) «Early Evolution of Microtubules and Undulipodia,» *BioSystems*, 20, 115-131. 5. Bermudes, D., Margulis, L., and Tzertinis, G. (1986) «Prokaryotic Origin of Undulipodia,» *Annals of the New York Academy of Science*, 503, 187-197.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p68, 69.]
- The amount of scientific research that has been and is being done on the cilium—and the great increase over the past few decades in our understanding of how the cilium works—lead many people to assume that even if they themselves don't know how the cilium evolved, somebody must know. But a search of the professional literature proves them wrong. Nobody

knows. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p69.]

- Some bacteria boast a marvelous swimming device, the flagellum, which has no counterpart in more complex cells.<sup>8</sup> In 1973 it was discovered that some bacteria swim by rotating their flagella. So the bacterial flagellum acts as a rotary propeller—in contrast to the cilium, which acts more like an oar. [A good general introduction to flagella can be found in Voet and Voet, pp. 1259-1260. Greater detail about the flagellar motor can be found in the following: Schuster, S. C., and Khan, S. (1994) «The Bacterial Flagellar Motor,» *Annual Review of Biophysics and Biomolecular Structure*, 23, 509-539; Caplan, S. R., and Kara-Ivanov, M. (1993) «The Bacterial Flagellar Motor,» *International Review of Cytology*, 147, 97-164.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p70.]
- The general professional literature on the bacterial flagellum is about as rich as the literature on the cilium, with thousands of papers published on the subject over the years. That isn't surprising; the flagellum is a fascinating biophysical system, and flagellated bacteria are medically important. Yet here again, the evolutionary literature is totally missing. Even though we are told that all biology must be seen through the lens of evolution, no scientist has ever published a model to account for the gradual evolution of this extraordinary molecular machine. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p72.]
- In summary, as biochemists have begun to examine apparently simple structures like cilia and flagella, they have discovered staggering complexity, with dozens or even hundreds of precisely tailored parts. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p73.]
- As the number of required parts increases, the difficulty of gradually putting the system together skyrockets, and the likelihood of indirect scenarios plummets. Darwin looks more and more forlorn. New research on the roles of the auxiliary proteins cannot simplify the irreducibly complex system. The intransigence of the problem cannot be alleviated; it will only get worse.

Darwinian theory has given no explanation for the cilium or flagellum. The overwhelming complexity of the swimming systems push us to think it may never give an explanation. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p73.]

- As the number of systems that are resistant to gradualist explanation mounts, the need for a new kind of explanation grows more apparent. Cilia and flagella are far from the only problems for Darwinism. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p73.]

#### **Chapter 4: Rube Goldberg in The Blood**

- Blood clot formation seems so familiar to us that most people don't give it much thought. Biochemical investigation, however, has shown that blood clotting is a very complex, intricately woven system consisting of a score of interdependent protein parts. The absence of, or significant defects in, any one of a number of the components causes the system to fail: blood does not clot at the proper time or at the proper place. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p78.]
- Blood clotting is on autopilot, and blood clotting requires extreme precision. When a pressurized blood circulation system is punctured, a clot must form quickly or the animal will bleed to death. If blood congeals at the wrong time or place, though, then the clot may block circulation as it does in heart attacks and strokes. Furthermore, a clot has to stop bleeding all along the length of the cut, sealing it completely. Yet blood clotting must be confined to the cut or the entire blood system of the animal might solidify, killing it. Consequently, the clotting of blood must be tightly controlled so that the clot forms only when and where it is required. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p78, 79.]
- The function of the blood clotting system is to form a solid barrier at the right time and place that is able to stop blood flow out of an injured vessel. The components of the system (beyond the fork in the pathway) are fibrinogen, prothrombin, Stuart factor, and proaccelerin. Just as none of the parts of the Foghorn system is used for anything except controlling the fall



of the telephone pole, so none of the cascade proteins are used for anything except controlling the formation of a blood clot. Yet in the absence of any one of the components, blood does not clot, and the system fails. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p86.]

- The king of Siam once asked his wise men for a proverb that would be appropriate for any occasion. They suggested «This, too, shall pass.» Well, in biochemistry an equally appropriate saying for all occasions is «Things are more complicated than they seem.» [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p89.]
- Remember, a mousetrap spring might in some way resemble a clock spring, and a crowbar might resemble a mousetrap hammer, but the similarities say nothing about how a mousetrap is produced. In order to claim that a system developed gradually by a Darwinian mechanism a person must show that the function of the system could «have been formed by numerous successive, slight modifications.» [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p90.]
- In this section I'll reproduce an attempt at an evolutionary explanation of blood clotting offered by Rusell Doolittle. What he has done is to hypothesize a series of steps in which clotting proteins appear one after another. Yet, as I will show in the next section, the explanation is seriously inadequate because no reasons are given for the appearance of the proteins, no attempt is made to calculate the probability of the proteins' appearance, and no attempt is made to estimate the new proteins' properties. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p90, 91.]
- To illustrate the problem, let's do our own quick calculation. Consider that animals with blood-clotting cascades have roughly 10,000 genes, each of which is divided into an average of three pieces. This gives a total of about 30,000 gene pieces. TPA has four different types of domains.<sup>7</sup> By «variously shuffling,» the odds of getting those four domains together<sup>8</sup> is 30,000 to the fourth power, which is approximately one-tenth to the eighteenth power.<sup>9</sup> Now, if the Irish Sweepstakes had odds of winning of one-tenth to the

eighteenth power, and if a million people played the lottery each year, it would take an average of about a thousand billion years before anyone (not just a particular person) won the lottery. A thousand billion years is roughly a hundred times the current estimate of the age of the universe. Doolittle's casual language («spring forth,» etc.) conceals enormous difficulties. The same problem of ultra-slim odds would trouble the appearance of prothrombin («the result of a ... protease gene duplication and ... shuffling»), fibrinogen («a bastard protein derived from .. .»), plasminogen, proaccelerin, and each of the several proposed rearrangements of prothrombin. Doolittle apparently needs to shuffle and deal himself a number of perfect bridge hands to win the game. Unfortunately, the universe doesn't have time to wait. [7. TPA has a total of five domains. Two domains, however, are of the same type. 8. The odds are not decreased if the domains are hooked together at different times—with domains 1 and 2 coming together in one event, then later on domain 3 joining them, and so on. Think of the odds of picking four black balls from a barrel containing black balls and white balls. If you take out four at once, or take two at the first grab and one apiece on the next two grabs, the odds of ending up with four black balls are the same. 9. This calculation is exceedingly generous. It only assumes that the four types of domains would have to be in the correct linear order. In order to work, however, the combination would have to be located in an active area of the genome, the correct signals for splicing together the parts would have to be in place, the amino acid sequences of the four domains would have to be compatible with each other, and other considerations would affect the outcome. These further considerations only make the event much more improbable.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p93, 94.]

- Since two proteins—the proenzyme and its activator—are both required for one step in the pathway, then the odds of getting both the proteins together are roughly the square of the odds of getting one protein. We calculated the odds of getting TPA alone to be one-tenth to the eighteenth power; the odds of getting TPA and its activator together would be about one-tenth to the thirty-sixth power! That is a horrendously large number. Such an event would not be expected to happen even if the universe's ten-billion year life were compressed into a single second and relived every second for ten

billion years. But the situation is actually much worse: if a protein appeared in one step<sup>10</sup> with nothing to do, then mutation and natural selection would tend to eliminate it. Since it is doing nothing critical, its loss would not be detrimental, and production of the gene and protein would cost energy that other animals aren't spending. So producing the useless protein would, at least to some marginal degree, be detrimental. Darwin's mechanism of natural selection would actually hinder the formation of irreducibly complex systems such as the clotting cascade. [10. It is good to keep in mind that a «step» could well be thousands of generations. A mutation must start in a single animal and then spread through the population. In order to do that, the descendants of the mutant animal must displace the descendants of all other animals.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p96.]

- The discussion is meant simply to illustrate the enormous difficulty (indeed, the apparent impossibility) of a problem that has resisted the determined efforts of a top-notch scientist for four decades. Blood coagulation 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p97.]

## Chapter 5: From Here to There

- Ernst Haeckel thought that a cell was a «homogeneous globule of protoplasm.» He was wrong; scientists have shown that cells are complex structures. In particular, eukaryotic cells (which include the cells of all organisms except bacteria) have many different compartments in which different tasks are performed. Just like a house has a kitchen, laundry room, bedroom, and bathroom, a cell has specialized areas partitioned off for discrete tasks. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p101, 102.]
- The fictional space probe is so complicated it hasn't been invented yet, even in a crude way. The authentic cellular system is already in place, and every second of every day, this process happens uncounted billions of time in your body. Science is stranger than fiction. [Michael J. Behe: *Darwin's Black*

*Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p108.]

- Because gated transport requires a minimum of three separate components to function, it is irreducibly complex. And for this reason the putative gradual, Darwinian evolution of gated transport in the cell faces massive problems. If proteins contained no signal for transport, they would not be recognized. If there were no receptor to recognize a signal or no channel to pass through, again transport would not take place. And if the channel were open for all proteins, then the enclosed compartment would not be any different from the rest of the cell. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p109.]
- Because vesicular transport requires several more components than gated transport, it cannot develop gradually from gated transport. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p110.]
- Irreducibly complex systems like mousetraps, Rube Goldberg machines, and the intracellular transport system cannot evolve in a Darwinian fashion. You can't start with a platform, catch a few mice, add a spring, catch a few more mice, add a hammer, catch a few more mice, and so on: The whole system has to be put together at once or the mice get away. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p110, 111.]
- Logging on to a computer database of the professional literature in the biomedical sciences allows you to do a quick search for key words in the titles of literally hundreds of thousands of papers. A search to see what titles have both evolution and vesicle in them comes up completely empty. Slogging through the literature the old-fashioned way turns up a few scattered papers that speculate on how gated transport between compartments of a eukaryotic cell might have developed.<sup>4</sup> But all the papers assume that the transport systems came from preexisting bacterial transport systems that already had all the components that modern cells have. This does us no good. Although the speculations may have something to do with how transport systems could be duplicated, they have nothing to do with

how the initial systems got there. At some point this complex machine had to come into existence, and it could not have done so in step-by-step fashion. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p114, 115.]

- Vesicular transport is a mind-boggling process, no less complex than the completely automated delivery of vaccine from a storage area to a clinic a thousand miles away. Defects in vesicular transport can have the same deadly consequences as the failure to deliver a needed vaccine to a disease-racked city. An analysis shows that vesicular transport is irreducibly complex, and so its development staunchly resists gradualistic explanations, as Darwinian evolution would have it. A search of the professional biochemical literature and textbooks shows that no one has ever proposed a detailed route by which such a system could have come to be. In the face of the enormous complexity of vesicular transport, Darwinian theory is mute. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p115, 116.]

## **Chapter 6: A Dangerous World**

- Terrorism and war threaten us, but they happen infrequently. On a day-to-day basis more people are assaulted by muggers and mayhem in their neighborhood than by exotic groups or foreign countries. The streetwise city dweller will have bars on his window, use an intercom or peephole to see who is at the door, and carry a can of pepper spray when it's time to walk the dog. In lands where such modern conveniences are unknown, stone or wooden walls can be built around the hut to keep out intruders (both two- and four-footed), and a spear is kept by the bed in case the wall is breached. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p118.]
- A cell hopefully trying to evolve such a system in gradual Darwinian steps would be in a quandary. What should it do first? Secreting a little bit of antibody into the great outdoors is a waste of resources if there's no way to tell if it's doing any good. Ditto for making a membrane-bound antibody. And why make a messenger protein first if there is nobody to give it a message, and nobody to receive the message if it did get one? We are led inexorably to the conclusion that even this greatly simplified clonal selection



could not have come about in gradual steps. Even at this simplified level, then, all three ingredients had to evolve simultaneously. Each of these three items—the fixed antibody, the messenger protein, and the loose antibodies—had to be produced by a separate historical event, perhaps by a coordinated series of mutations changing preexisting proteins that were doing other chores into the components of the antibody system. Darwin's small steps have become a series of wildly unlikely leaps. Yet our analysis overlooked many complexities: How does the cell switch from putting the extra oily piece on the membrane to not putting it on? The message system then is fantastically more complicated than our simplified version. Ingestion of the protein, chopping it up, presenting it to the outside on an MHC protein, specific recognition of the MHC/fragment by a helper T cell, secretion of interleukin, binding of interleukin to the B cell, sending the signal that interleukin has bound into the nucleus—the prospect of devising a step-by-step pathway for the origin of the system is enough to make strong men blanch. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p125, 126.]

- Antibodies are like toy darts: they harm no one. Like a «Condemned» sign posted on an old house or an orange «X» painted on a tree to be removed, antibodies are only signals to other systems to destroy the marked object. It is surprising to think that after the body has gone to all the trouble to develop a complex system to generate antibody diversity, and after it has laboriously picked a few cells by the roundabout process of clonal selection, it is still virtually helpless against the onslaught of invaders. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p131, 132.]
- Like the blood-clotting pathway, the complement pathway is a cascade. Inevitably, in both cases one encounters the same problems trying to imagine their gradual production. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p135.]
- The proper functioning of the immune system is a prerequisite for health. Major illnesses such as cancer and AIDS have either their cause or their cure, or both, in the vagaries of the system. Because of its impact on public health, the immune system is a subject of intense interest. Thousands of research

laboratories around the world work on various aspects of the immune system. Their efforts have already saved many lives and promise to save many more in the future. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p136.]

- Although great strides have been made in understanding how the immune system works, we remain ignorant of how it came to be. None of the questions raised in this chapter has been answered by any of the thousands of scientists in the field; few have even asked the questions. A search of the immunological literature shows ongoing work in comparative immunology (the study of immune systems from various species). But that work, valuable though it is, does not address in molecular detail the question of how immune systems originated. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p136.]
- We can look high or we can look low, in books or in journals, but the result is the same. The scientific literature has no answers to the question of the origin of the immune system. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p138.]
- In this chapter I have looked at three features of the immune system—clonal selection, antibody diversity, and the complement system—and demonstrated that each individually poses massive challenges to a putative step-by-step evolution. But showing that the parts can't be built step by step only tells part of the story, because the parts interact with each other. Just as a car without steering, or a battery, or a carburetor isn't going to do you much good, an animal that has a clonal selection system won't get much benefit out of it if there is no way to generate antibody diversity. A large repertoire of antibodies won't do much good if there is no system to kill invaders. A system to kill invaders won't do much good if there's no way to identify them. At each step we are stopped not only by local system problems, but also by requirements of the integrated system. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p138.]
- Diversity, recognition, destruction, toleration—all these and more interact with each other. Whichever way we turn, a gradualistic account of the immune system is blocked by multiple interwoven requirements. As

scientists we yearn to understand how this magnificent mechanism came to be, but the complexity of the system dooms all Darwinian explanations to frustration. Sisyphus himself would pity us. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p139.]

## **Chapter 7: Road Kill**

- A few textbooks mention this problem. The typical explanation is economically expressed by Thomas Creighton: How might the biochemical complexity of metabolic pathways have evolved? In the case of the biosynthetic pathways that produce the building blocks of amino acids, nucleotides, sugars, and so forth, it is likely that these building blocks were originally present in the primordial soup and were used directly. As organisms increased in number, however, these constituents would have become scarce. Any organism that could produce one of them from some unused component of the primordial soup, using a newly evolved enzyme, would have had a selective advantage. Once the availability of that component became limiting, there would have been selection for any organism that could produce it from some other component of the primordial soup. According to this scenario, the enzymes of metabolic pathways would have evolved in a sequence opposite to the one they have in the modern pathway. [Creighton, T. (1993) *Proteins: Structure and Molecular Properties*, W. H. Freeman and Co., New York, p. 131.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p151.]
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- The A□B□C□D story is an old idea that has been passed on unreflectively. It was first proposed in 1945 by N. H. Horowitz in the Proceedings of the National Academy of Sciences. Horowitz sees the problem: Since natural selection cannot preserve nonfunctional characters, the most obvious implication of the facts would seem to be that a stepwise evolution of biosyntheses, by the selection of a single gene mutation at a time, is impossible. [Horowitz, N. H. (1945) «On the Evolution of Biochemical Syntheses,» *Proceedings of the National Academy of Sciences*, 31, 153-157.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge*

*to Evolution*, Free Press, New York 2006, p154.]

- Nowhere does he or any other researcher attach names of real chemicals to the mythical letters. 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 sophisticated enzymes for interconverting the intermediates. There is no evidence that the letters exist anywhere outside of de Duve's mind. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p155.]
- Another restless scientist is Stuart Kauffman of the Santa Fe Institute. The complexity of the metabolism of living organisms makes him doubt that a step-by-step approach would work: In order to function at all, a metabolism must minimally be a connected series of catalyzed transformations leading from food to needed products. Conversely, however, without the connected web to maintain the flow of energy and products, how could there have been a living entity to evolve connected metabolic pathways? [Kauffman, S. (1993) *The Origins of Order*, Oxford University Press, New York, p. 344.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p155.]
- Kauffman discusses his ideas in a chapter entitled «The Origin of a Connected Metabolism,» but if you read the chapter from start to finish you will not find the name of a single chemical—no AMP, no aspartic acid, no nothing. In fact, if you scan the entire subject index of the book, you will not find a chemical name there either. John Maynard Smith, Kauffman's old mentor, has accused him of practicing «fact-free science.»<sup>16</sup> That is a harsh accusation, but the complete lack of chemical details in his book appears to justify the criticism. [Smith, J. M. (1995) «Life at the Edge of Chaos?» *New York Review*, March 2, pp. 28-30.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p156.]
- Kauffman and de Duve identify a real problem for gradualistic evolution. The solutions they propose, however, are merely variations on Horowitz's old idea. Instead of A□B□C□D, they simply propose A□B□C□D times one hundred. Worse, as the number of imaginary letters increases, the

tendency is to get further and further away from real chemistry and to get trapped in the mental world of mathematics. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p156.]

- The story of King Midas teaches some obvious lessons: don't be greedy, love is worth more than money, and so forth. But there is another, less obvious lesson about the importance of regulation. It is no enough to have a machine or process (magical or otherwise) that does something; you have to be able to turn it on or off as needed. If the king had wished for the golden touch and the ability to switch it on or off when he wanted, he could have transmuted a few rocks into gold nuggets but not zap his daughter. He could turn the plates to gold, but not the food. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p156.]
- When the regulation of metabolism fails, the result is illness or death. An example is diabetes; the uptake of sugar into cells is slowed, even though sugar molecules that manage to get into cells are otherwise metabolized normally. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p159.]
- The regulation of AMP biosynthesis is a good example of the intricate mechanisms needed to keep the supply of biomolecules at the right level: not too much, not too little, and in the right ratio with related molecules. The problem for Darwinian gradualism is that cells would have no reason to develop regulatory mechanisms before the appearance of a new catalyst. But the appearance of a new, unregulated pathway, far from being a boon, would look like a genetic disease to the organism. This goes in spades for fragile ancient cells, putatively developing step by step, that would have little room for error. Cells would be crushed between the Scylla of unavailability and the Charybdis of regulation. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p159.]
- No one has a clue how the AMP pathway developed. Although a few researchers have observed that the pathway itself presents a severe challenge to gradualism, no one has written about the obstacle posed by the need to regulate a cell's metabolic pathway immediately at its inception. Small wonder—no one wants to write about road kill. [Michael J. Behe: *Darwin's*



*Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p159.]

- The detail was necessary so that the reader could understand exactly what the problems are. Because I spent a lot of time on those systems I didn't have time to get on to other biochemical systems, but this does not imply that they are not also problems for Darwinism. Other examples of irreducible complexity abound, including aspects of DNA replication, electron transport, telomere synthesis, photosynthesis, transcription regulation, and more. The reader is encouraged to borrow a biochemistry textbook from the library and see how many problems for gradualism he or she can spot. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p160.]
- In this chapter I wanted to show that it is not only irreducibly complex systems that are a problem for Darwinism. Even systems that at first glance appear amenable to a gradualistic approach turn out to be major headaches on closer inspection—or when the experimental results roll in—with no reason to expect they will be solved within a Darwinian framework. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p160.]
- If there is a detailed Darwinian explanation for the production of AMP out there, no one knows what it is. Hard-nosed chemists have begun to drown their frustrations in mathematics. AMP is not the only metabolic dilemma for Darwin. The biosynthesis of the larger amino acids, lipids, vitamins, heme, and more run into the same problems, and there are difficulties beyond metabolism. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p161.]

### **Part III: What Does The Box Tell Us?**

#### **Chapter 8: Publish or Perish**

- Nonetheless, some scientists are interested in evolution and have published a large amount of work in the professional literature. If complex biochemical systems are unexplained, what type of biochemical work has been published under the heading of «evolution»? In this chapter you will see what has been studied—and what hasn't. [Michael J. Behe: *Darwin's Black Box, The*

*Biochemical Challenge to Evolution*, Free Press, New York 2006, p165.]

- Each monthly issue of JME contains about ten scientific papers on various aspects of molecular evolution. Ten papers per month means about a hundred papers per year, and about a thousand papers per decade. A survey of a thousand papers in a particular area can give you a pretty good idea of what problems have been solved, what problems are being addressed, and what problems are being ignored. A look back over the last decade shows that the papers in JME can be divided pretty easily into three separate categories: chemical synthesis of molecules thought necessary for the origin of life, comparisons of DNA or protein sequences, and abstract mathematical models. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p166.]
- The origin-of-life question is tremendously important and interesting. Biology must ultimately deal with the question: even if life evolves by natural selection acting on variation, how did life get there in the first place? Publications concerned with the chemical synthesis of molecules thought to be necessary for the origin of life constitute about 10 percent of all papers in JME. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p166.]
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- In light of these well-publicized successes an outsider can be excused for feeling a sense of shock when he stumbles across pessimistic reviews of origin-of-life research in the professional literature, such as one written by Klaus Dose, a prominent worker in the field. In his assessment of the state of the problem, Dose pulls no punches. "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 its solution. At present all discussions on principal theories and experiments in the field either end in stalemate or in a confession of ignorance." [Dose, K. (1988) «The Origin of Life: More Questions than Answers,» *Interdisciplinary Science Reviews*, 13, 348.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p168.]
- A convincing origin-of-life scenario requires that intelligent direction of the

chemical reactions be minimized as far as possible. Nonetheless, the involvement of some intelligence is unavoidable. Reasonable guesses about what substances were available on the early earth—such as Stanley Miller made—are a necessary starting point. The trick for the researcher is to choose a probable starting point, then keep his hands off. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p169.]

- In his book reviewing the difficulties of origin-of-life theories, Robert Shapiro notes that work on proteinoids has produced a startling unanimity of opinion: "[The proteinoid theory] has attracted a number of vehement critics, ranging from chemist Stanley Miller ... to Creationist Duane Gish. On perhaps no other point in origin-of-life theory could we find such harmony between evolutionists and Creationists as in opposing the relevance of the experiments of Sidney Fox" [Shapiro, R. (1986) *Origins: A Skeptic's Guide to the Creation of Life on Earth*, Summit Books, New York, p. 192.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p170.]
- Imagining a realistic scenario whereby natural processes may have made proteins on a prebiotic earth—although extremely difficult—is a walk in the park compared to imagining the formation of nucleic acids such as RNA. The big problem is that each nucleotide «building block» is itself built up from several components, and the processes that form the components are chemically incompatible. Although a chemist can make nucleotides with ease in a laboratory by synthesizing the components separately, purifying them, and then recombining the components to react with each other, undirected chemical reactions overwhelmingly produce undesired products and shapeless goop on the bottom of the test tube. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p171.]
- Gerald Joyce and Leslie Orgel—two scientists who have worked long and hard on the origin of life problem—call RNA «the prebiotic chemist's nightmare.» They are brutally frank: "Scientists interested in the origins of life seem to divide neatly into two classes. The first, usually but not always molecular biologists, believe that RNA must have been the first replicating

molecule and that chemists are exaggerating the difficulties of nucleotide synthesis.... The second group of scientists are much more pessimistic. They believe that the de novo appearance of oligonucleotides on the primitive earth would have been a near miracle. (The authors subscribe to this latter view). Time will tell which is correct" [Shapiro, R. (1986) *Origins: A Skeptic's Guide to the Creation of Life on Earth*, Summit Books, New York, p. 192.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p171.]

- Even if the miracle-like coincidence should occur and RNA be produced, however, Joyce and Orgel see nothing but obstacles ahead. In an article section entitled «Another Chicken-and-Egg Paradox» they write the following: "This discussion ... has, in a sense, focused on a straw man: the myth of a self-replicating RNA molecule that arose de novo from a soup of random polynucleotides. Not only is such a notion unrealistic in light of our current understanding of prebiotic chemistry, but it should strain the credulity of even an optimist's view of RNA's catalytic potential...Without evolution it appears unlikely that a self-replicating ribozyme could arise, but without some form of self-replication there is no way to conduct an evolutionary search for the first, primitive self-replicating ribozyme." .] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p171, 172.]
- In other words, the miracle that produced chemically intact RNA would not be enough. Since the vast majority of RNAs do not have useful catalytic properties, a second miraculous coincidence would be needed to get just the right chemically intact RNA. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p172.]
- Scientists working on the origin of life deserve a lot of credit; they have attacked the problem by experiment and calculation, as science should. And although the experiments have not turned out as many hoped, through their efforts we now have a clear idea of the staggering difficulties that would face an origin of life by natural chemical processes. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p172.]
- In private many scientists admit that science has no explanation for the

beginning of life. [Although many statements within the scientific community's own journals and books are pessimistic, public statements to the news media tend to be of the everything-is-under-control variety. University of Memphis rhetorician John Angus Campbell has observed that «huge edifices of ideas—such as positivism—never really die. Thinking people gradually abandon them and even ridicule them among themselves, but keep the persuasively useful parts to scare away the uninformed.» Campbell, J. A. (1994) «The Comic Frame and the Rhetoric of Science: Epistemology and Ethics in Darwin's Origin,» *Rhetoric Society Quarterly*, 24, 27-50. This certainly applies to the way the scientific community handles questions on the origin of life.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p172, 173.]

- The reason for this peculiar circumstance is that while chemists try to test origin-of-life scenarios by experiment or calculation, evolutionary biologists make no attempt to test evolutionary scenarios at the molecular level by experiment or calculation. As a result, evolutionary biology is stuck in the same frame of mind that dominated origin-of-life studies in the early fifties, before most experiments had been done: 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p173.]
- The second category of papers commonly found in the *Journal of Molecular Evolution*, accounting for about 5 percent of the total, concerns Mathematical models for evolution or new mathematical methods for comparing and interpreting sequence data. (...) Although useful for understanding how gradual processes behave over time, the mathematics assumes that real-world evolution is a gradual random process; it does not (and cannot) demonstrate it. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p173, 174.]



- Although useful for determining possible lines of descent, which is an interesting question in its own right, comparing sequences cannot show how a complex biochemical system achieved its function—the question that most concerns us in this book.<sup>18</sup> By way of analogy, the instruction manuals for two different models of computer put out by the same company might have many identical words, sentences, and even paragraphs, suggesting a common ancestry (perhaps the same author wrote both manuals), but comparing the sequences of letters in the instruction manuals will never tell us if a computer can be produced step-by-step starting from a typewriter. [18. Indeed, some proteins we have discussed in this book have sequences or shapes similar to other proteins. For example, antibodies are shaped similarly to a protein called superoxide dismutase, which helps protect the cell against damage by oxygen. And rhodopsin, which is used in vision, is similar to a protein found in bacteria, called bacteriorhodopsin, which is involved in the production of energy. Nonetheless, the similarities tell us nothing about how vision or the immune system could develop step-by-step. One would have hoped that finding proteins with similar sequences would lead to the proposal of models for how complex biochemical systems might have developed. Conversely, the fact that such sequence comparisons do not help us understand the origins of complex biochemical systems weighs heavily against a theory of gradual evolution.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p175.]
- The three general topics of papers published in JME—the origin of life, mathematical models of evolution, and sequence analyses—have included many intricate, difficult, and erudite studies. Does such valuable and interesting work contradict this book's message? Not at all. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p175.]
- To say that Darwinian evolution cannot explain everything in nature is not say that evolution, **random mutation, and natural selection** do not occur; they have been observed (at least in cases of microevolution) many different times. Like the sequence analysts, **I believe the evidence strongly supports common descent.** But the root question remains unanswered: What has

caused complex systems to form? No one has ever explained in detailed, scientific fashion how mutation and natural selection could build the complex, intricate structures discussed in this book. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p175, 176.]

- In fact, none of the papers published in JME over the entire course of its life as a journal has ever proposed a detailed model by which a complex biochemical system might have been produced in a gradual, step-by-step Darwinian fashion. Although many scientists ask how sequences can change or how chemicals necessary for life might be produced in the absence of cells, no one has ever asked in the pages of JME such questions as the following: How did the photosynthetic reaction center develop? How did intramolecular transport start? How did cholesterol biosynthesis begin? How did retinal become involved in vision? How did phosphoprotein signaling pathways develop? The very fact that none of these problems is even addressed, let alone solved, is a very strong indication that Darwinism is an inadequate framework for understanding the origin of complex biochemical systems. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p176.]
- Attempts to explain the evolution of highly specified, irreducibly complex systems—either mousetraps or cilia or blood clotting—by a gradualism: route have so far been incoherent as we have seen in previous chapters. No scientific journal will publish patently incoherent papers, so no studies asking detailed questions of molecular evolution are to be found. Calvin and Hobbes stories can sometimes be spun by ignoring critical details, as Russell Doolittle did when imagining the evolution of blood clotting, but even such superficial attempts are rare. 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. The reason for this appears to be similar to the reason for the failure to explain the origin of life: a choking complexity strangles all such attempts. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p177.]
- No papers were published in PNAS (Proceedings of the National Academy

of Sciences) that proposed detailed routes by which complex biochemical structures might have developed. Surveys of other biochemistry journals show the same result: sequences upon sequences, but no explanations. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178.]

- The advantage of a book is that it gives the author a lot of room to develop his or her ideas. Setting a new idea in context, bringing in appropriate examples, explaining a lot of detailed steps, meeting many anticipated objections—all of this can take a fair amount of space. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178.]
- A good example in the modern evolution literature is a book called *The Neutral Theory of Molecular Evolution* by Motoo Kimura.<sup>20</sup> In the book he had the room to explain his idea that most sequence changes that occur in DNA and proteins do not affect the way they do their jobs; the mutations are neutral. [Kimura, M. (1983) *The Neutral Theory of Evolution*, Cambridge University Press, New York.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178.]
- A second example is *The Origins of Order* by Stuart Kauffman, who argues that the origins of life, metabolism, genetic programs, and body plans are all beyond Darwinian explanation but may arise spontaneously through self-organization.<sup>21</sup> [Kauffman, S. A. (1993) *The Origins of Order: Self-Organization and Selection in Evolution*, Oxford University Press, New York.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178.]
- Neither book explains biochemical structures: Kimura's work has to do simply with sequences, and Kauffman's is a mathematical analysis. But perhaps in one of the libraries of the world there is a book that tells us how specific biochemical structures came to be. Unfortunately, a computer search of library catalogs shows there is no such book. That isn't too surprising in this day and age; even books like Kimura's and Kauffman's that propose new theories are usually preceded by papers on the topic that are first published in scientific journals. The absence of papers on the evolution of biochemical structures in the journals just about kills any chance of there

being a book published on the matter. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178.]

- During a computer search for books on biochemical evolution, you come across a number of juicy titles. For example, a book by John Gillespie was published in 1991 with the enticing name *The Causes of Molecular Evolution*. But it does not concern specific biochemical systems. It is, like Kauffmans, a mathematical analysis that leaves out all of the specific features of organisms, reducing them to mathematical symbols and then manipulating the symbols. Nature is blanched. (I should add that, of course, mathematics is an extremely powerful tool. But math is useful to science only when the assumptions the mathematical analysis starts with are true.) [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p178, 179.]
- The search can be extended, but the results are the same. There has never been a meeting, or a book, or a paper on details of the evolution of complex biochemical systems. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p179.]
- Many scientists are skeptical that Darwinian mechanisms can explain all of life, but a large number do believe it. Since we have just seen that the professional biochemical literature contains no papers or books that explain in detail how complex systems might have arisen, why is Darwinism nonetheless credible with many biochemists? A large part of the answer is that they have been taught as part of their biochemical training that Darwinism is true. To understand both the success of Darwinism as orthodoxy and its failure as science at the molecular level, we have to examine the textbooks that are used to teach aspiring scientists. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p179, 180.]
- One of the most successful texts of biochemistry over the past several decades was first written in 1970 by Albert Lehninger, a professor of biophysics at Johns Hopkins University, and has been updated several times over the years. On the first page of the first chapter of his first textbook, Lehninger mentions evolution. He asks why the biomolecules that occur in

virtually all cells appear to be extraordinarily well fitted to their tasks: In this chapter, the first in a series of 12 devoted to the structures and properties of the major classes of biomolecules, we shall develop the idea that biomolecules should be studied from two points of view. We must of course examine their structure and properties as we would those of nonbiological molecules, by the principles and approaches used in classical chemistry. But we must also examine them in the light of the hypothesis that biomolecules are the products of evolutionary selection, that they may be the fittest possible molecules for their biological function.<sup>24</sup> [Lehninger, A. L. (1970) *Biochemistry*, Worth Publishers, New York, p. 17.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p180.]

- In all, there are nearly 6,000 entries in the index, but only 2 under the heading of «evolution.» The first citation is in a discussion of the sequences of proteins; as discussed earlier, however, although sequence data can be used to infer relationships, they cannot be used to determine how a complex biochemical structure originated. Lehninger's second reference is to a chapter on the origin of life in which he discusses proteinoids and other topics that have not stood the test of time. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p180, 181.]
- The extra references to evolution in the newest edition of the Lehninger text can all be fit into three categories: sequence similarity, comments on the ancestry of cells, and pious but unsupported attributions of a feature to evolution. But none of these, even in principle, can tell us how molecular machinery arose step by step. In no instance is a detailed route given by which any complex biochemical system might have arisen in a Darwinian manner. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p181, 182.]
- A survey of thirty biochemistry textbooks (summarized in Table 8—1) used in major universities over the past generation shows that many textbooks ignore evolution completely. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p182.]
- Many students learn from their textbooks how to view the world through an



evolutionary lens. However, they do not learn how Darwinian evolution might have produced any of the remarkably intricate biochemical systems that those texts describe. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p183.]

- The first way to know something is, of course, through personal experience. (...) The second way to know things is by authority. That is, you rely on some source of information, believing it to be reliable, when you have no experience of your own. So almost every person who has gone to school believes that the earth goes around the sun, even though very few people would be able to tell you how anybody could even detect that motion. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p184.]
- Many people believe democracy is superior to other forms of government even though they haven't lived under any other type. They rely on the authority of textbooks and politicians, and perhaps on verbal or pictorial descriptions of what it's like in other societies. Of course other societies do the same, and most of their defenders rely on authority. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p184.]
- Scientists are people, too, so we can ask how scientists know what they say they know. Like everybody else, scientists know things either through their own experience or through authority. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p185.]

- In the 1950s, Watson and Crick saw a diffraction pattern produced by shining X-rays on fibers of DNA and, using their mathematical abilities, determined that DNA was a double helix. They knew by doing, from their own experience. As an undergraduate I learned DNA is a double helix, but I have never done an experiment to show it; I rely on authority. All scientists rely on authority for almost all of their scientific knowledge. If you ask a scientist how she knows about the structure of cholesterol, or the behavior of hemoglobin, or the role of vitamins, she will almost always point you to the scientific literature rather than to her own records of what she has done in her laboratory. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p185.]
- The nice thing about science is that authority is easy to locate: it's in the library. Watson and Crick's work on DNA structure can be tracked down and read in *Nature*. The structure of cholesterol and other things can be found there as well. So we can say we know the structure of DNA or cholesterol based on scientific authority if papers on those topics are in the literature. If James Watson or a Presidential Science Commission decreed that DNA was made of green cheese, however, but didn't publish supporting evidence in the literature, then we could not say that a belief in cheesy DNA was based on scientific authority. Scientific authority rests on published work, not on the musings of individuals. Moreover, the published work must also contain pertinent evidence. If Watson published a bare statement about the curdled composition of DNA in a paper largely devoted to something else, but provided no relevant support, then we still have no scientific authority to back up the claim. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p185.]
- Molecular evolution is not based on scientific authority. There is no publication in the scientific literature—in prestigious journals, specialty journals, or books—that describes how molecular evolution of any real, complex, biochemical system either did occur or even might have occurred. There are assertions that such evolution occurred, but absolutely none are supported by pertinent experiments or calculations. Since no one knows molecular evolution by direct experience, since there is no authority on which to base claims of knowledge, it can truly be said that ... the assertion

of Darwinian molecular evolution is merely bluster. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p185, 186.]

- «Publish or perish» is a proverb that academicians take seriously. If you do not publish your work for the rest of the community to evaluate, then you have no business in academia (and if you don't already have tenure, you will be banished). But the saying can be applied to theories as well. If a theory claims to be able to explain some phenomenon but does not generate even an attempt at an explanation, then it should be banished. Despite comparing sequences and mathematical modeling, molecular evolution has never addressed the question of how complex structures came to be. In effect, the theory of Darwinian molecular evolution has not published, and so it should perish. But we are here. Plants and animals are here. The complex systems are here. All these things got here somehow: if not in a Darwinian fashion, then how? [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p186.]

## **Chapter 9: Intelligent Design**

- No one at Harvard University, no one at the National Institutes of Health, no member of the National Academy of Sciences, no Nobel prize winner—no one at all can give a detailed account of how the cilium, or vision, or blood clotting, or any complex biochemical process might have developed in a Darwinian fashion. But we are here. Plants and animals are here. The complex systems are here. All these things got here somehow: if not in a Darwinian fashion, then how? [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p187.]
- Clearly, if something was not put together gradually, then it must have been put together quickly or even suddenly. If adding individual pieces does not continuously improve the function of a system, then multiple pieces have to be added together. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p187.]
- For purposes of argument, however, let's suppose that the symbiosis Margulis envisions was in fact a common occurrence throughout the history of life. The important question for us biochemists is, can symbiosis explain the origin of complex biochemical systems? Clearly it cannot. The essence

of symbiosis is the joining of two separate cells, or two separate systems, both of which are already functioning. In the mitochondrion scenario, one preexisting viable cell entered a symbiotic relationship with another such cell. Neither Margulis nor anyone else has offered a detailed explanation of how the preexisting cells originated. Proponents of the symbiotic theory of mitochondria explicitly assume that the invading cells could already produce energy from foodstuffs; they explicitly assume that the host cell already was able to maintain a stable internal environment that would benefit the symbiont. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p189.]

- Because symbiosis starts with complex, already-functioning systems, it cannot account for the fundamental biochemical systems we have discussed in this book. Symbiosis theory may have important points to make about the development of life on earth, but it cannot explain the ultimate origins of complex systems. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p189.]
- For the sake of argument, however, let us suppose that complexity theory is true—that complex mixtures somehow organized themselves, and that had something to do with the origin of life. Granted its premises, can complexity theory explain the complex biochemical systems we have discussed in this book? I don't believe so. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p191.]
- Complexity theory may yet make important contributions to mathematics, and it may still make modest contributions to biochemistry. But it cannot explain the origin of the complex biochemical structures that undergird life. It doesn't even try. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p192.]
- They were designed not by the laws of nature, not by chance and necessity; rather, they were planned. The designer knew what the systems would look like when they were completed, then took steps to bring the systems about. Life on earth at its most fundamental level, in its most critical components, is the product of intelligent activity. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p193.]

- The conclusion of intelligent design flows naturally from the data itself—not from sacred books or sectarian beliefs. Inferring that biochemical systems were designed by an intelligent agent is a humdrum process that requires no new principles of logic or science. It comes simply from the hard work that biochemistry has done over the past forty years, combined with consideration of the way in which we reach conclusions of design every day. Nonetheless, saying that biochemical systems were designed will certainly strike many people as strange, so let me try to make it sound less strange. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p193.]
- What is «design»? Design is simply the purposeful arrangement of parts. With such a broad definition we can see that anything might have been designed. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p193.]
- The scientific problem then becomes, how do we confidently detect design? When is it reasonable to conclude, in the absence of firsthand knowledge or eyewitness accounts, that something has been designed? For discrete physical systems—if there is not a gradual route to their production—design is evident when a number of separate, interacting components are ordered in such a way as to accomplish a function beyond the individual components.<sup>3</sup> The greater the specificity of the interacting components required to produce the function, the greater is our confidence in the conclusion of design. [Detecting design in patterns of coin flips or other systems that do not physically interact is done in other ways. See Dembski, W. (1996) *The Design Inference: Eliminating Chance Through Small Probabilities*, Ph.D. dissertation, University of Illinois.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p194.]
- In considering design, the function of the system we must look at is the one that requires the greatest amount of the system's internal complexity. We can then judge how well the parts fit the function.<sup>4</sup> [This is a judgment call. One can never prove that a particular function is the only one that might be intended—or even that it is intended. But our evidence can get pretty persuasive nonetheless.] [Michael J. Behe: *Darwin's Black Box, The*



*Biochemical Challenge to Evolution*, Free Press, New York 2006, p196.]

- Inferences to design do not require that we have a candidal 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p196.]
- The inference to design can be made with a high degree of confidence even when the designer is very remote. Archeologists digging for a lost city might come across square stones, buried dozens of feet under the earth, with pictures of camels and cats, griffins and dragons. Even if that were all they found, they would conclude that the stones had been designed. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p197.]
- The conclusion that something was designed can be made quite independently of knowledge of the designer. As a matter of procedure, the design must first be apprehended before there can be any further question about the designer. The inference to design can be held with the firmness that is possible in this world, without knowing anything about the designer. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p197.]
- Anyone can tell that Mt. Rushmore was designed—but, as the king of Siam often said, this too shall pass. As time marches and rains fall and winds gust, Mt. Rushmore will change its shape. Millennia in the future, people may pass the mountain and see just the barest hint of faces in the rocks. Could a person conclude that an eroded Mt. Rushmore had been designed? It depends. The inference to design requires the identification of separate components that have been ordered to accomplish a purpose, and the strength of the inference is not an easy matter to quantify. An eroded Mt. Rushmore might give future archeologists fits if they could only see what looked like an ear, a nose, a bottom lip, and maybe a chin, each from a different presidential image. The parts really aren't ordered to each other and might be simply an unusual rock formation. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New

York 2006, p198.]

- As the number and quality of the components that fit together to form the system increases, we can be more and more confident of the conclusion of design. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p198.]
- As the number or quality of the parts of an interacting system increase, our judgment of design increases also and can reach certitude. It is hard to quantify these things.<sup>5</sup> But it is easy to conclude that a system of such detail as the completed bacterial Elvis was designed. [It is hard to quantify design, but it is not impossible, and future research should proceed in this direction. An excellent start has been made by Bill Dembski in his dissertation (Dembski, 1996), which attempts to quantify the design inference in terms of what he calls the «probabilistic resources» of a system.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p199.]
- The new protein is the product of intelligent design. Someone with knowledge of the blood-clotting system sat down at his desk and sketched out a route to produce a protein that would combine the clot-dissolving properties of plasmin with the rapid-activation property of proteins that are cleaved by thrombin. The designer knew what the end product of his work was going to do, and he worked to achieve that goal. After the plan was drawn up, the designer (or his graduate student) went into the laboratory and took steps to carry out the plan. The result is a protein that no one in the world has ever seen before— a protein that will carry out the plan of the designer. Biochemical systems can indeed be designed. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p201.]
- The fact that biochemical systems can be designed by intelligent agents for their own purposes is conceded by all scientists, even Richard Dawkins. In his newest book Dawkins envisions a hypothetical scenario where a leading scientist is kidnaped and forced to work on biological weapons for an evil, militaristic country.<sup>10</sup> The scientist gets help by encoding a message in the DNA sequence of an influenza virus: he infects himself with the altered virus, sneezes on a crowd of people, and patiently waits for the flu to spread

around the world, confident that other scientists will isolate the virus, sequence its DNA, and decipher his code. Since Dawkins agrees that biochemical systems can be designed, and that people who did not see or hear about the designing can nonetheless detect it, then the question of whether a given biochemical system was designed boils down simply to adducing evidence to support design. [Dawkins, R. (1995) *River Out of Eden*, Basic Books, New York, pp. 17-18.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p203.]

- Throughout this book, however, I have shown why many biochemical systems cannot be built up by natural selection working on mutations: no direct, gradual route exists to these irreducibly complex systems, and the laws of chemistry work strongly against the undirected development of the biochemical systems that make molecules such as AMP. Alternatives to gradualism that work through unintelligent causes, such as symbiosis and complexity theory, cannot (and do not even try to) explain the fundamental biochemical machines of life. If natural laws peculiar to life cannot explain a biological system, then the criteria for concluding design become the same as for inanimate systems. There is no magic point of irreducible complexity at which Darwinism is logically impossible. But the hurdles for gradualism become higher and higher as structures are more complex, more interdependent. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p203.]
- 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 to play the role of the detectives who ignore an elephant. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p204.]
- Just because we can infer that some biochemical systems were designed does not mean that all subcellular systems were explicitly designed. Further, some systems may have been designed, but proving their design may be difficult. (...) Detecting design in the cilium might be a piece of cake, but design in another system might be borderline or undetectable. It turns out that the cell contains systems that span the range from obviously designed to no apparent

design. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p205.]

- Since anything could have been designed, and since we need to adduce evidence to show design, it is not surprising that we can be more successful in demonstrating design with one biochemical system and less successful with another. Some features of the cell appear to be the result of simple natural processes, others probably so. Still other features were almost certainly designed. And with some features, we can be as confident that they were designed as that anything was. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p205.]

### **Chapter 10: Questions About Design**

- The early Greek philosopher Diogenes saw design in the regularity of the seasons: "Such a distribution would not have been possible without Intelligence, that all things should have their measure: winter and summer and night and day and rain and winds and periods of fine weather; other things also, if one will study them closely, will be found to have the best possible arrangement." [Cited in Barrow, J. D., and Tipler, F.J. (1986) *The Anthropic Cosmological Principle*, Oxford University Press, New York, p. 36.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p210.]
- Socrates is said to have observed: "Is it not to be admired ... that the mouth through which the food is conveyed should be placed so near the nose and eyes as to prevent the passage unnoticed of whatever is unfit for nourishment? And canst thou still doubt, Aristodemus, whether a disposition of parts like this should be the work of chance, or of wisdom and contrivance." [Cited in Barrow, J. D., and Tipler, F.J. (1986) *The Anthropic Cosmological Principle*, Oxford University Press, New York, p. 36.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p211.]
- Arguments to design based on the bare assertion of their «rightness» evaporate like the morning dew when faced with the least skepticism. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p211.]

- Richard Dawkins's *The Blind Watch-maker* takes its title from Paley's watch analogy but claims that evolution, rather than an intelligent agent, plays the role of the watchmaker: Paley drives his point home with beautiful and reverent descriptions of the dissected machinery of life, beginning with the human eye... Paley's argument is made with passionate sincerity and is informed by the best biological scholarship of his day, but it is wrong, gloriously and utterly wrong...If [natural selection] can be said to play the role of watchmaker in nature, it is the blind watchmaker. . . . But one thing I shall not do is belittle the wonder of the living «watches» that so inspired Paley. On the contrary, I shall try to illustrate my feeling that here Paley could have gone even further.<sup>4</sup> [Dawkins, R. (1985) *The Blind Watchmaker*, W. W. Norton, London, p. 5.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p213.]
- But exactly where, we may ask, was Paley refuted? Who has answered his argument? How was the watch produced without an intelligent designer? It is surprising but true that the main argument of the discredited Paley has actually never been refuted. Neither Darwin nor Dawkins, neither science nor philosophy, has explained how an irreducibly complex system such as a watch might be produced without a designer. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p213.]
- Paley is at his best when writing about mechanical systems. Concerning the heart, he observes as follows: "It is evident that it must require the interposition of valves—that the success indeed of its action must depend upon these; for when any one of its cavities contracts, the necessary tendency of the force will be to drive the enclosed blood not only into the mouth of the artery where it ought to go, but also back again into the mouth of the vein from which it flowed... The heart, constituted as it is, can no more work without valves that a pump can" [Paley, W. *Natural Theology*, American Tract Society, New York, pp. 110-111.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p214.]
- To be charitable, Paley may have thought that his strong examples made design inevitable, and he used the weak examples as icing on the cake. He



likely didn't anticipate that later opponents would refute his argument by attacking the icing. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p215.]

- The philosopher David Hume argued against design in *Dialogues Concerning Natural Religion*, published in 1779. In *The Blind Watchmaker* Richard Dawkins recalls a dinner conversation with «a well-known atheist» that touched on the subject: I said that I could not imagine being an atheist at any time before 1859, when Darwin's *Origin of Species* was published. 'What about Hume?', replied the philosopher. «How did Hume explain the organized complexity of the living world?» I asked. «He didn't,» said the philosopher. «Why does it need any special explanation?»<sup>9</sup> [Dawkins, R. (1985) *The Blind Watchmaker*, W. W. Norton, London, p. 5.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p217.]
- Dawkins goes on to explain: As for David Hume himself, it is sometimes said that that great Scottish philosopher disposed of the Argument from Design a century before Darwin. But what Hume did was criticize the logic of using apparent design in nature as positive evidence for the existence of a God. He did not offer an alternative explanation for complex biological design.<sup>10</sup> [Dawkins, R. (1985) *The Blind Watchmaker*, W. W. Norton, London, p. 6.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p217.]
- A modern philosopher, Elliott Sober of the University of Wisconsin, in his book *Philosophy of Biology*, explains Hume's reasoning for us in more detail: Hume believes ... we must ask how similar watches and organisms really are. A moment's reflection shows that they are very dissimilar. Watches are made of glass and metal; they do not breathe, excrete, metabolize, or reproduce... The immediate consequence, of course, is that the design argument is a very weak analogy argument. It is preposterous to infer that organisms have a given property simply because watches happen to have it.<sup>11</sup> [Sober, E. (1993) *Philosophy of Biology*, Westview Press, Boulder, Co, p. 34.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p217.]
- But Sober does not agree with Hume: Although Hume's criticism is

devastating if the design argument is an argument from analogy, I see no reason why the design argument must be construed in this way. Paley's argument about organisms stands on its own, regardless of whether watches and organisms happen to be similar. The point of talking about watches is to help the reader see that the argument about organisms is compelling.<sup>12</sup> [Sober, E. (1993) *Philosophy of Biology*, Westview Press, Boulder, Co, p. 34-35.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p217.]

- Incidentally, even by Hume's criteria, the analogy between a watch and a living organism could be made very strong. Modern biochemistry probably could make a watch, or a time-keeping device, out of biological materials—if not now, then certainly in the near future. Many biochemical systems keep time, including the cells that pace the heart, the system that initiates puberty, and the proteins that tell the cell when to divide. Moreover, biochemical components are known that can act as gears and flexible chains, and feedback mechanisms (which are necessary to regulate a watch) are common in biochemistry. Hume's criticism of the design argument that asserts a fundamental difference between mechanical systems and living systems is out of date, destroyed by the advance of science which has discovered the machinery of life. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p218.]
- Sober continues his analysis of Hume: I now turn to Hume's second criticism of the design argument, which is no more successful than the first. . . . [Hume] contends that if we are to have good reason to think that the organisms in our world are the products of intelligent design, then we must have looked at lots of other worlds and observed intelligent designers producing organisms there.<sup>13</sup> [Sober, E. (1993) *Philosophy of Biology*, Westview Press, Boulder, Co, p. 35.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p218, 219.]
- Although Hume's objection to the inductive argument might have been valid in his day, it has been destroyed by the advance of science. Modern biochemistry routinely designs biochemical systems, which are now known to be the basis of life. Therefore we do have experience in observing the

intelligent design of components of life. There have probably been tens of thousands of experiments in which new biochemical systems were put together, and in the future there will be many, many more. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p219.]

- The fatal problems with the analogy are not difficult to see. It was amusingly skewered by Robert Shapiro, a professor of chemistry at New York University, in his book *Origins: A Skeptic's Guide to the Origin of life*, which was published seven years before Sober's book.<sup>15</sup> The fact that a distinguished philosopher overlooks simple logical problems that are easily seen by a chemist suggests that a sabbatical visit to a biochemistry laboratory might be in order. [Shapiro, R. (1986) *Origins: A Skeptic's Guide to the Creation of Life on Earth*. Summit Books, New York, pp. 179-180.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p221.]
- The argument has been echoed by prominent scientists and philosophers, but it is particularly well presented by Kenneth Miller, a professor of biology at Brown University : Another way to respond to the theory of intelligent design is to carefully examine complex biological systems for errors that no intelligent designer would have committed. Because intelligent design works from a clean, sheet of paper, it should produce organisms that have been optimally designed for the tasks they perform. Conversely, because evolution is confined to modifying existing structures, it should not necessarily perfection. Which is it? The eye, that supposed paragon of intelligent design, offers an answer. We have already sung the virtues of this extraordinary organ, but we have not considered specific aspects of its design, such as the neural wiring of its light-sensing units. These photoreceptor cells, located in the retina, pass impulses to a series of interconnecting cells that eventually pass information to the cells of the optic nerve, which leads to the brain. An intelligent designer, working with the components of this wiring, would choose the orientation that produces the highest degree of visual quality. No one, for example, would suggest that the neural connections should be placed in front of the photoreceptor cells—thus blocking the light from reaching them—rather than behind the retina. Incredibly, this is exactly how the human retina is constructed... A more

serious flaw occurs because the neural wiring must poke directly through the wall of the retina to carry the nerve impulses produced by photoreceptor cells to the brain. The result is a blind spot in the retina—a region where thousands of impulse-carrying cells have pushed the sensory cells aside.... None of this should be taken to suggest that the eye functions poorly. It is a superb visual instrument that serves us exceedingly well... The key to the intelligent design theory ... is not whether an organ or system works well but whether its basic structural plan is the obvious product of design. The structural plan of the eye is not.<sup>16</sup> [Miller, K. R. (1994) «Life's Grand Design,» *Technology Review* February/ March, pp. 29-30.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p222, 223.]

- Miller elegantly expresses a basic confusion; the key to intelligent-design theory is not whether a «basic structural plan is the obvious product of design.» 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p223.]
- The most basic problem is that the argument demands perfection at all. Clearly, designers who have the ability to make better designs do not necessarily do so. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p223.]
- The argument from imperfection overlooks the possibility that the designer might have multiple motives, with engineering excellence oftentimes relegated to a secondary role. Most people throughout history have thought that life was designed despite sickness, death, and other obvious imperfections. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p223.]
- In discussing why aliens on other planets might build artificial structures that we could observe from earth, the physicist Freeman Dyson wrote: I do not need to discuss questions of motivation, who would want to do these things or why. Why does the human species explode hydrogen bombs or send

rockets to the moon? It is difficult to say exactly why.<sup>17</sup> [Dyson, J. F. (1966) «The Search for Extraterrestrial Technology» in *Perspectives in Modern Physics*, ed. R. E. Marshak, John Wiley and Sons, New York, pp. 643-644.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p224.]

- When considering whether aliens would try to seed other planets with life, Francis Crick and Leslie Orgel wrote: The psychology of extraterrestrial societies is no better understood than terrestrial psychology. It is entirely possible that extraterrestrial societies might infect other planets for quite different reasons than those we have suggested.<sup>18</sup> [Crick, F. H. C., and Orgel, L. E. (1973) «Directed Panspermia,» *Icarus*, 19, 344.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p224.]
- In their writings, these authors correctly concluded that design could be detected in the absence of information about the designer's motives. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p224.]
- The next problem is that proponents of the argument from imperfection frequently use their psychological evaluation of the designer as positive evidence for undirected evolution. The reasoning can be written as a syllogism: 1. A designer would have made the vertebrate eye without a blind spot. 2. The vertebrate eye has a blind spot. 3. Therefore Darwinian evolution produced the eye. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p224.]
- The scientific literature contains no evidence that natural selection working on mutation can produce either an eye with a blind spot, an eye without a blind spot, an eyelid, a lens, a retina, rhodopsin, or retinal. The debater has reached his conclusion in favor of Darwinism based solely on an emotional feeling of the way things ought to be. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p224.]
- This argument is unconvincing for three reasons. First, because we have not yet discovered a use for a structure does not mean that no use exists. The tonsils were once considered to be useless organs, but an important function



in immunity has been discovered for them. (...) This point also applies on the molecular scale (...) The point here is that Miller's assertion rests on assumptions only. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p226.]

- The second reason why Miller's argument fails to persuade is that even if pseudogenes have no function, evolution has «explained» nothing about how pseudogenes arose. In order to make even a pseudo-copy of a gene, a dozen sophisticated proteins are required: to pry apart the two DNA strands, to align the copying machinery at the right place, to stitch the nucleotides together into a string, to insert the pseudocopy back into the DNA, and much more. In his article Miller has not told us how any of these functions might have arisen in a Darwinian step-by-step process, nor has he pointed to articles in the scientific literature where we can find the information. He can't do that, because the information is nowhere to be found. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p226.]
- Futuyma never explains how a real pelvis or eye developed in the first place, so as to be able to give rise to a vestigial organ later on, yet both the functioning organ and the vestigial organ require explanation. I do not purport to understand everything about design or evolution—far from it; I just cannot ignore the evidence for design. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p226.]
- Additionally, suppose the designer placed into the cell some other systems for which, we cannot adduce enough evidence to conclude design. The cell containing the designed systems then was left on autopilot to reproduce, mutate, eat and be eaten, bump against rocks, and suffer all the vagaries of life on earth. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p228.]
- The production of some biological improvements by mutation and natural selection—by evolution—is quite compatible with intelligent design theory. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p228.]
- Design theory has nothing to say 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p229.]

- Similarly, evolutionary biologists have recognized that a number of factors might have affected the development of life: common descent, natural selection, migration, population size, founder effects (effects that may be due to the limited number of organisms that begin a new species), genetic drift (the spread of «neutral,» nonselective mutations), gene flow (the incorporation of genes into a population from a separate population), linkage (occurrence of two genes on the same chromosome), meiotic drive (the preferential selection during sex cell production of one of the two copies of a gene inherited from an organism's parents), transposition (the transfer of a gene between widely separated species by nonsexual means), and much 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. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p229, 230.]
- The discovery of design expands the number of factors that must be considered by science when trying to explain life. What will be the effect of the awareness of intelligent design on different branches of science? Biologists who are working at the cellular level or above can continue their research without paying much attention to design, because above the cellular level organisms are black boxes, and design is difficult to prove. So those who labor in the fields of paleontology, comparative anatomy, population genetics, and biogeography should not invoke design until the molecular sciences show that design has an effect at those higher levels. Of course, the possibility of design should cause researchers in biology to hesitate before claiming that a particular biological feature has been produced substantially by another mechanism, such as natural selection or transposition. Instead, detailed models should be produced to justify the assertion that a given mechanism produced a given biological feature. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New

York 2006, p230.]

- For those who work at the molecular level, the challenge will be to rigorously determine which systems were designed and which might have arisen by other mechanisms. To reach a conclusion of design will require the identification of the components of an interacting molecular system and the roles they play, as well as a determination that the system is not a composite of several separable systems. To reach a strong presumption of nondesign will require the demonstration that a system is not irreducibly complex or does not have much specificity between its components. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p230.]

## **Chapter 11: Science, Philosophy, Religion**

- The result of these cumulative efforts to investigate the cell—to investigate life at the molecular level—is a loud, clear, piercing cry of «design!» The result is so unambiguous and so significant that it must be ranked as one of the greatest achievements in the history of science. The discovery rivals those of Newton and Einstein, Lavoisier and Schrödinger, Pasteur, and Darwin. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p233.]
- Why does the scientific community not greedily embrace its startling discovery? Why is the observation of design handled with intellectual gloves? The dilemma is that while one side of the elephant is labeled intelligent design, the other side might be labeled God. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p233.]
- The purpose of science is to explain the physical world—a very serious enterprise. However, other academic disciplines (principally philosophy and theology) also are in the business of explaining parts of the world. Although most of the time these disciplines stay out of each other's way, sometimes they conflict. When that happens some dedicated people put their discipline ahead of the goal it is supposed to serve. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p234.]
- A good example of disciplinary chauvinism can be seen in Robert Shapiro's

fine book, *Origins: A Skeptic's Guide to the Creation of Life on Earth*. After presenting a very readable, very devastating critique of scientific studies on the origin of life, Shapiro proclaims his steadfast loyalty—not to the goal of «explaining the physical world,» but to science: Some future day may yet arrive when all reasonable chemical experiments run to discover a probable origin for life have failed unequivocally. Further, new geological evidence may indicate a sudden appearance of life on the earth. Finally, we may have explored the universe and found no trace of life, or process leading to life, elsewhere. In such a case, some scientists might choose to turn to religion for an answer. Others, however, myself included, would attempt to sort out the surviving less probable scientific explanations in the hope of selecting one that was still more likely than the remainder.<sup>1</sup> [Shapiro, R. (1986) *Origins: A Skeptic's Guide to the Creation of Life on Earth*, Summit Books, New York, p. 130.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p234.]

- Although many scientists and theologians thought that Darwinian evolution could be reconciled rather easily with the basic beliefs of most religions, publicity always focuses on conflict. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p235.]
- Dickerson's essay makes a useful springboard for considering how the theory of intelligent design fits into science: Science, fundamentally, is a game. It is a game with one overriding and defining rule: Rule No. 1: Let us see how far and to what extent we can explain the behavior of the physical and material universe in terms of purely physical and material causes, without invoking the supernatural. Operational science takes no position about the existence or nonexistence of the supernatural; it only requires that this factor is not to be invoked in scientific explanations. Calling down special-purpose miracles as explanations constitutes a form of intellectual «cheating.» A chess player is perfectly capable of removing his opponent's King physically from the board and smashing it in the midst of a tournament. But this would not make him a chess champion, because the rules had not been followed. A runner may be tempted to take a short-cut across the infield of an oval track in order to cross the finish line ahead of his faster colleague. But he refrains from doing so, as this would not constitute «winning» under

the rules of the sport.<sup>2</sup> [Dickerson's essay can be found in *Journal of Molecular Evolution*, 34, 277 (1992), and *Perspectives on Science & Christian Faith*, 44, 137-138 (1992).] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p238 ,239.]

- In his essay, then, Dickerson does not say scientific evidence has shown that the supernatural has never affected nature (for those concerned about the definition of supernatural, substitute «higher intelligence»). Rather, he argues that in principle, science should not invoke it. The clear implication is that it should not be invoked whether it is true or not. It is relevant to our evaluation of his argument that Dickerson is a member of the American Scientific Affiliation, so he believes in God. He has no a priori reason to think that nothing beyond nature exists, but he thinks it is not good science to offer the supernatural as an explanation for a natural event. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p239.]
- Ken Miller, whose argument from imperfection I analyzed in the last chapter, is like myself a Roman Catholic, and he makes the point in public talks that belief in evolution is quite compatible with his religious views. I agree with him that they are compatible.<sup>4</sup> The compatibility or lack of compatibility, however, is irrelevant to the scientific question of whether Darwinian evolution of biochemical systems is true. [Of course, whether «evolution» and «religion» are compatible depends on your definitions of both. If one takes the position that evolution not only occurred solely by uninterrupted natural law, but that the process is «purposeless» and «unforeseen» in a metaphysical sense, then that does place «evolution» on a collision course with many religious denominations. Phillip Johnson has done an admirable job of pointing out the many ways in which the word evolution is used, and how shifting definitions can confuse public discussion of the issue. Johnson, P. E. (1991) *Darwin on Trial*, Regnery Gateway, Washington, DC.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p239.]
- It is important to note that Dickerson's argument is not itself a scientific one—it was not discovered by an experiment in a laboratory; it is not the



result of mixing chemicals in a test tube; it is not a testable hypothesis. Rather, the argument is philosophy. It may be good philosophy, or it may not. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p239.]

- The final point I wish to make about Richard Dickerson's argument is that although he certainly didn't intend it, it is a prescription for timidity. It tries to restrict science to more of the same, disallowing a fundamentally different explanation. It tries to place reality in a tidy box, but the universe will not be placed in a box. The origin of the universe and the development of life are the physical underpinnings that resulted in a worldful of conscious agents. There is no a priori reason to think that those bedrock events are to be explained in the same way as other physical events. Science is not a game, and scientists should follow the physical evidence wherever it leads, with no artificial restrictions. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p243.]
- The prominent physicist A.S. Eddington probably spoke for many in voicing his utter disgust with such an idea: "Philosophically, the notion of an abrupt beginning to the present order of Nature is repugnant to me, as I think it must be to most; and even those who would welcome a proof of the intervention of a Creator will probably consider that a single winding-up at some remote epoch is not really the kind of relation between God and his world that brings satisfaction to the mind." [The reaction of science to the Big Bang hypothesis, including Eddington's and other prominent physicists, is recounted in Jaki, S. (1980) *Cosmos and Creator*, Regnery Gateway, Chicago.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p244.]
- Nonetheless, despite its religious implications, the Big Bang was a scientific theory that flowed naturally from observational data, not from holy writings or transcendental visions. Most physicists adopted the Big Bang theory and set their research programs accordingly. A few, like Einstein before them, didn't like the extra-scientific implications of the theory and labored to develop alternatives. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p244.]
- The success of the Big Bang model had nothing to do with its religious

implications. It seemed to agree with the Judaeo-Christian dogma of a beginning to the universe; it seemed to disagree with other religions that believed the universe to be eternal. But the theory justified itself by reference to observational data—the expansion of the universe—and not by invoking sacred texts or the mystical experiences of holy men. The model came straight from the observational evidence; it was not fit to a Procrustean bed of religious dogma. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p245, 246.]

- It is interesting (though scientifically irrelevant) that the notion of a cycling universe would be compatible with many religions, including those of the ancient Egyptians, Aztecs, and Indians.<sup>8</sup> [Jaki, S. (1986) *Science and Creation*, Scottish Academic Press, Edinburgh.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p246.]
- Francis Crick also thinks that life on earth may have begun when aliens from another planet sent a rocket ship containing spores to seed the earth. This is no idle thought; Crick first proposed it with chemist Leslie Orgel in 1973 in an article entitled «Directed Panspermia» in a professional science journal called *Icarus*. A decade later Crick wrote a book, *Life Itself*, reiterating the theory; in a 1992 interview in *Scientific American* on the eve of the publication of his latest book, Crick reaffirmed that he thinks the theory is reasonable. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p248.]
- Richard Dawkins has written that anyone who denies evolution is either «ignorant, stupid or insane (or wicked—but I'd rather not consider that.)» [Dawkins, R. (1989) *New York Times*, April 9, 1989, sec. 7, p. 34.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p250.]
- John Maddox, the editor of *Nature*, has written in his journal that «it may not be long before the practice of religion must be regarded as anti-science.» [Maddox, J. (1994) «Defending Science Against Anti-Science,» *Nature*, 368, 185.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p250.]

- In his recent book *Darwin's Dangerous Idea*, philosopher Daniel Dennett compares religious believers—90 percent of the population—to wild animals who may have to be caged, and he says that parents should be prevented (presumably by coercion) from misinforming their children about the truth of evolution, which is so evident to him. [Dennett, D. (1995) *Darwin's Dangerous Idea*, Simon & Schuster, New York, pp. 515-516.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p250.]
- The scientific community contains many excellent scientists who think that there is something beyond nature, and many excellent scientists who do not. How then will science «officially» treat the question of the identity of the designer? Will biochemistry textbooks have to be written with explicit statements that «God did it»? No. The question of the identity of the designer will simply be ignored by science. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p251.]
- The history of science is replete with examples of basic-but-difficult questions being put on the back burner. For example, Newton declined to explain what caused gravity, Darwin offered no explanation for the origin of vision or life, Maxwell refused to specify a medium for light waves once the ether was debunked, and cosmologists in general have ignored the question of what caused the Big Bang. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p251.]
- The philosophical argument (made by some theists) that science should avoid theories which smack of the supernatural is an artificial restriction on science. Their fear that supernatural explanations would overwhelm science is unfounded. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p251.]

### **Afterword: Ten Years Later**

- When I wrote that sentence near the conclusion of *Darwin's Black Box* ten years ago, I had no inkling of how very unsettling some people would find the concept of intelligent design<sup>1</sup> (ID). [What exactly is «intelligent design? In an article in 2001 in the philosophy of science journal, *Biology and Philosophy*, I made an important distinction: «By [intelligent design]

someone might mean that the laws of nature themselves are designed to produce life and the complex systems that undergird it. Without commenting on the merits of the position, let me just say that that is not the meaning I assign to the phrase. By «intelligent design» (ID) I mean to imply design beyond the laws of nature. That is, taking the laws of nature as given, are there other reasons for concluding that life and its component systems have been intentionally arranged, just as there are reasons beyond the laws of nature for concluding a mousetrap was designed? [Unless stated otherwise] whenever I refer to ID I mean this stronger sense of design-beyond-laws.»] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p255.]

- Ten years ago I used the phrase «irreducible complexity»<sup>2</sup> (IC) to shine a spotlight on a large and then-substantially-unappreciated problem for Darwinian evolution—like a mousetrap, almost all of the elegant molecular machinery of the cell needs multiple parts to work. Because of the need for many parts, it is extraordinarily difficult to rigorously envision how systems such as the cilium, flagellum, or blood clotting cascade could have arisen from simpler systems by the «numerous, successive, slight modifications» imagined by Charles Darwin. [The term «irreducible complexity» occurred to me independently. However, I've since learned that the phrase was used earlier in *Templets and the Explanation of Complex Patterns* (Cambridge University Press, 1986) by Case Western Reserve University biologist Michael J. Katz. He appeared to have in mind the same sorts of phenomena as I did.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p257.]
- In a review of *Darwin's Black Box* for the MIT-published *Boston Review*, University of Rochester evolutionary biologist Allen Orr rejected out of hand the maybe-a-toothpick-turned-into-a-mousetrap reasoning of Kenneth Miller: [W]e might think that some of the parts of an irreducibly complex system evolved step by step for some other purpose and were then recruited wholesale to a new function. But this is also unlikely. You may as well hope that half your car's transmission will suddenly help out in the airbag department. Such things might happen very, very rarely, but they surely do not offer a general solution to irreducible complexity.<sup>14</sup> [Orr, H. A. (1996),

«Darwin v. Intelligent Design (Again).» Boston Review, Dec/Jan.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p262.]

- Is the argument simply, as some have caricatured it, that we don't know how Darwinism accounts for biological complexity; and so we naively jump to the conclusion of design? Is it just an «argument from ignorance»?<sup>18</sup> Of course not. (...) design is positively apprehended in the purposeful arrangement of parts. Looked at this way, irreducibly complex systems such as mousetraps and flagella serve both as negative arguments against gradualistic explanations like Darwin's and as positive arguments for design. The negative argument is that such interactive systems resist explanation by the tiny steps that a Darwinian path would be expected to take. The positive argument is that their parts appear arranged to serve a purpose, which is exactly how we detect design. [Blackstone N. W (1997), «Argumentum ad Ignorantium,» *Quarterly Review Biology* 72:445-447.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p263, 264.]
- Rather, says Dawkins, it's what we conclude when we get in touch with our inner engineer: We may say that a living body or organ is well designed if it has attributes that an intelligent and knowledgeable engineer might have built into it in order to achieve some sensible purpose, such as flying, swimming, seeing ... It is not necessary to suppose that the design of a body or organ is the best that an engineer could conceive of. . . . But any engineer can recognize an object that has been designed, even poorly designed, for a purpose, and he can usually work out what that purpose is just by looking at the structure of the object. [Dawkins R. (1986). *The Blind Watchmaker*, Norton, New York, p. 21.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p264.]
- Dawkins doesn't just grudgingly acknowledge some faint impression of design in life; he insists that the appearance of design, which he ascribes to natural selection, is overpowering: «Yet the living results of natural selection overwhelmingly impress us with the appearance of design as if by a master watchmaker, impress us with the illusion of design and planning.»<sup>20</sup> [Dawkins R. (1986). *The Blind Watchmaker*, Norton, New York, p. 21.]



[Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p264.]

- Here, then, is the argument for design in a nutshell: (1) We infer design whenever parts appear arranged to accomplish a function. (2) The strength of the inference is quantitative and depends on the evidence; the more parts, and the more intricate and sophisticated the function, the stronger is our conclusion of design. With enough evidence, our confidence in design can approach certitude. If while crossing a heath we stumble across a watch (let alone a chronometer), no one would doubt—as Paley rightly said—that the watch was designed; we would be as certain about that as about anything in nature. (3) Aspects of life overpower us with the appearance of design. (4) Since we have no other convincing explanation for that strong appearance of design, Darwinian pretensions notwithstanding, then we are rationally justified in concluding that parts of life were indeed purposely designed by an intelligent agent. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p265.]
- A crucial, often-overlooked point is that the overwhelming appearance of design strongly affects the burden of proof: in the presence of manifest design, the onus of proof is on the one who denies the plain evidence of his eyes. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p265.]
- Without strong, convincing evidence to show that Darwin can do the trick, the public is quite rational to embrace design.<sup>21</sup> [Of course other factors besides the quality of the evidence, such as social pressure, can affect a person's judgment. In the scientific and academic communities as a whole there is strong social pressure to dismiss design explanations for life out of hand. The social situation is quite different for the general public.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p266.]
- Darwinian theory has remained dead in the water. The quickest way to illustrate the point is with the very title of a recent paper on the cilium: «Speculations on the evolution of 9+2 organelles and the role of central pair microtubules.» [emphasis added, both here and below] In other words, more interesting conjecture, more beguiling surmise, which have never been in

short supply in Darwinian circles. The abstract of the paper shows the pivotal role of imagination in the story: [Recent advances . . . suggest that these organelles may have served multiple roles in early eukaryotic cells... we speculate that protocilia were the primary determinants of cell polarity and directed motility in early eukaryotes ... we believe that addition of an asymmetric central apparatus ... provided refined directional control. . . . This paper presents hypothesized steps in this evolutionary process, and examples to support these hypotheses.<sup>24</sup> [Mitchell D. R. (2004), «Speculations on the Evolution of 9+2 Organelles and the Role of Central Pair Microtubules.» Biol. Cell, 96:691-696.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p267.]

- There is no publication in the scientific literature—in prestigious journals, specialty journals, or books—that describes how molecular evolution of any real, complex, biochemical system either did occur or even might have occurred. There are assertions that such evolution occurred, but absolutely none are supported by pertinent experiments or calculations. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p270.]
- In his review of Darwin's Black Box shortly after its publication in 1996 University of Chicago microbiologist James Shapiro declared, «There are no detailed Darwinian accounts for the evolution of any fundamental biochemical or cellular system, only a variety of wishful speculations.»<sup>33</sup> Ten years later, nothing has changed. Call them wishful speculations or call them plausible scenarios—both just mean a lack of real answers. [Shapiro, J. (1996), «In the Details . . . What?» National Review, Sept. 16, 62-65. Shapiro's judgment is seconded by Colorado State University emeritus professor of biochemistry Franklin Harold in his book *The Way of the Cell* (Oxford, 2001): «. . .we must concede that there are presently no detailed Darwinian accounts of the evolution of any biochemical system, only a variety of wishful speculations.»] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p271.]
- The conclusion of intelligent design is strengthened by each new example of

elegant, complex molecular machinery or system that science discovers at the foundation of life. In 1996 that elegance already could be clearly seen, and in the past ten years it has greatly increased. There is no reason to expect it to level off any time soon. [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p271.]

- A recent news article in the journal Nature reported on an invitation-only meeting where up-and-coming students could rub elbows with Nobel prize winning scientists. For this year's meeting the organizing committee: ". . . invited scientific academies and other agencies around the world to open competitions for young scientists to attend, then whittled down a list of nearly 10,000 applicants. The final 2005 list of 720 invitees represented a new profile of participant: academically excellent, familiar with societal impacts of their research and fluent in English. They are generally under thirty, but the majority are now Ph.D. students or postdocs." But the students asked surprising questions: "«It is curious to see the questions that students from different cultures ask,» [Günter Blobel (medicine, 1999)] remarked after a discussion on evolutionary biology led by Christian de Duve (medicine, 1974). He was taken aback to find some students expressing so much interest in the «creative guiding hand» of intelligent design."<sup>34</sup> [Abbott A. (2005), «Nobel laureates: Close encounters,» Nature 436:170-171.] [Michael J. Behe: *Darwin's Black Box, The Biochemical Challenge to Evolution*, Free Press, New York 2006, p272.]

الحمد لله الذي بنعمته تتم الصالحات