

Nothing in Biology Makes Sense Except in the Light of Evolution Theodosius Dobzhansky, 1973

Why is it called the “theory” of evolution?

After all, the origin of species by means of natural selection as proposed by Darwin is a “theory” in the same category with the following “theories”:

1. That the Earth is a slightly compressed sphere.
2. That light is both a wave and a particle.
3. That the ratio of the circumference of a circle to its diameter is π (~3.14159...)

MCB 140, 12-9-07

Darwinian evolution is a **firmly established scientific fact**. The evidence for it is as overwhelming as for several other facts in genetics (which no one seems to argue with, for some reason), for example, that genes lie on chromosomes, or that DNA is copied into mRNA, which is then translated to yield protein.

A small part of the problem is that of semantics:

1. Chromosome “theory” of heredity.
2. Central “dogma” of molecular biology.
3. The “theory” of evolution by natural selection

In all three cases, the word in quotation marks should be “fact”

1 2 3

W. Sutton T.H. Morgan C. Bridges J. Watson F. Crick C. Darwin A. Wallace

MCB 140, 12-9-07

“An alternative to evolution splits a Pennsylvania town” NY Times Jan. 16, 2005

Following is a statement that a school administrator in Dover, PA, is expected to read to high school biology students this week:

“Because Darwin’s theory [of evolution] is a theory, is continues to be tested as new evidence is discovered. The theory is not a fact. Gaps in the theory exist for which there is no evidence. Intelligent Design is an explanation of the origin of life that differs from Darwin’s view. The reference book ‘Of Pandas and People’ is available for students who might be interested in gaining an understanding of what Intelligent Design actually involves.”

“I think we should have a choice: they should teach you both,” said Meagan Hass, 14, while eating pizza after school. “Evolution to me is like we come from monkeys.”

MCB 140, 12-9-07

“Summer for the Gods: the Scopes trial” Edward Larson

NEWS

<http://www.aclupa.org/legal/legaldocket/intelligentdesigncase/dovertrialtranscripts.htm>
“40 days, 40 nights” Matthew Chapman
“Monkey Girl” Edward Humes

Expert witness: the scientists who testified against intelligent design

In 2004, a school board in Dover, Pennsylvania, announced that biology teachers would have to read out a statement about evolution in their lessons. The wording refers to “gaps” in Darwin’s theory and presents the theory of intelligent design as an alternative. It was claimed that a creative intelligence guides evolution. A group of parents filed suit against the board and called on two scientists to testify in court and called on two scientists to testify in support of darwinian theory.

Edward Larson sat down with Kenneth Miller, a cell biologist, and paleontologist Kevin Padian to find out about their day in court.

What they said in court

Kenneth Miller
Cell biologist at Brown University in Providence, Rhode Island

If you invoke a non-random cause, a spirit force or something like ... your research and I decide to test it, I have

Kevin Padian
Paleontologist at the University of California, Berkeley, California

“We’re the first people to admit that science doesn’t know everything and can’t know everything. But on the other hand,

LEAH HASSNER/GEORGETTE CHANG/CONTRIBUTOR

MCB 140, 12-9-07

“Creationism and Evolution: It’s the American Way” – E. Scott, Cell 2006

In US public schools, students cannot receive religious instruction, although comparative religious views can be described. ... Thus, in US public schools, it is not legal to advocate the six-day biblical view of creation as expressed in a literal reading of Genesis in any classroom, nor, since a 1987 Supreme Court decision, is it legal to teach a form of biblical creationism called “creation science,” invented in the 1960s. Creationists have sought to avoid the legal problems of teaching creation science by inventing ‘intelligent design’ (in content a minimalist subset of creation science).”

MCB 140, 12-9-07

How about the rest of the world?

"Outside of the United States, people are dumbfounded by events like these. They find it inexplicable that a powerful, modern industrial nation that routinely sweeps the Nobel prizes in science nonetheless is home to a population almost half of whom rejects one of the foundational ideas of modern science. Why do Americans have such a problem with evolution?"

E. Scott, *Cell* 2006

MCB 140, 12-9-07

A definition from Wikipedia

"Propaganda [from modern Latin: "propagare", "extending forth"] is a concerted set of messages aimed at influencing the opinions or behavior of large numbers of people.

Instead of impartially providing information, propaganda in its most basic sense presents information in order to influence its audience.

The most effective propaganda is often completely truthful, but some propaganda presents facts **selectively** to encourage a particular synthesis, or gives loaded messages in order to produce an **emotional rather than rational** response to the information presented.

The desired result is a change of the cognitive narrative of the subject in the target audience."

Emphasis mine – fdu



David Hume (1711-1776)

Dialogues Concerning Natural Religion

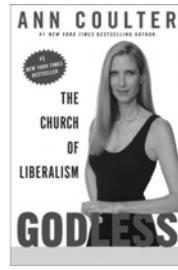
The classical treatise on natural (based on reason) rather than revealed (based on pure spirituality) belief in God.



MCB 140, 12-9-07 11

Ch. 8: "The Creation Myth: On the Sixth Day, God Created Fruit Flies"

"Liberals' creation myth is Charles Darwin's theory of evolution, which is one notch above Scientology in scientific rigor. It's a make-believe story, based on a theory that is a tautology, with no proof in the scientist's laboratory or the fossil record – and that's after 150 years of very determined looking. We wouldn't still be talking about it but for the fact that liberals think evolution disproves God." (p. 199)



MCB 140, 12-9-07 8

"Evolution" – however one defines it – does not "disprove God"

Neither I, nor most scientists, would ever have an argument with a person of religious faith about the legitimacy of the tenets of that faith **from a scientific perspective**.

For example, modern science fails to provide any support for many core tenets of Christianity and Judaism as stated in the book of Genesis (origin of the universe, of the Solar system, origin of life on Earth and of man) or of Christianity as stated in the New Testament (immaculate conception, resurrection and ascension, etc.), but that is completely irrelevant from the perspective of Christians or observant Jews – **by definition**. People are free to **believe** whatever they wish, and what science says or does not say about those beliefs makes no difference whatsoever in that regard.

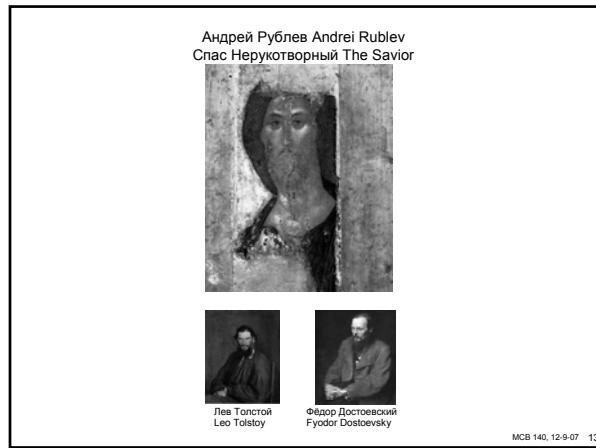
MCB 140, 12-9-07 10

The Core Statements of Faith of the World's Leading Three Religions

οὐτως γαρ ἡγαπήσεν ο θεός τον κοσμὸν ωστε τὸν οὐν αυτοῦ τὸν μονογενῆ εδώκεν ινα πᾶς ο πιστευων εἰς αυτὸν μη αποληπται αλλ ἐχῃ ζωὴν αιωνίου



एकम् सत् वर्णे रा :बहु दा वदन् ता



The scientific method:
a process that is explicitly, by definition, outside the realm
of the spiritual

- i. Observe phenomenon.
- ii. Come up with an explanation for what accounts for it (=a hypothesis).
- iii. Test the hypothesis by doing something (=perform an experiment).
- iv. Look at the data from the experiment.
- v. Determine, whether the conclusions from the experiment are:
 1. consistent with the hypothesis being true → i
 2. consistent with the hypothesis being incorrect → ii
 3. ... nothing (=the data are inconclusive) → iii

Neither creationism, nor "creationism lite" (ID) offer any opportunity to perform steps ii-iv.

MCB 140, 12-9-07 14

A problem

An understanding of the validity of the data supporting evolution requires education and time.

As de Beaumarchais noted, however, it is not necessary to understand things in order to argue about them.

Ann Coulter:
“Survival of the fittest is a tautology”

“The second prong of Darwin’s ‘theory’ is generally nothing but a circular statement: through the process of natural selection, “the fittest” survive. Who are the “fittest”? The ones who survive! Why look – it happens every time! The “survival of the fittest” would be a joke if it weren’t part of the belief system of a fanatical cult infecting the scientific community.” p. 212

MCB 140, 12-9-07 15

Charles Darwin (1859)
The Origin of Species by Means of Natural Selection

1. Living organisms multiply; resources are limited.
2. Organisms vary. Some variation affects survival and reproduction.
3. Like begets like – some variation is heritable.
4. Populations of organisms will evolve: those organisms with characteristics most favourable for survival and reproduction under the particular set of environmental circumstances that a given population is experiencing at the moment will not only have more offspring, but will pass their characteristics onto those offspring.

→ the characteristics seen in the population will change
heritable change in animals → selection by environment → adaptation to environment

MCB 140, 12-9-07 17

An example of Darwinian selection leading to adaptation

“... [T]he notothenioid fish in the Antarctic region, which can survive temperatures that should freeze their blood solid. Studies have shown that in the past 10 million years tiny, incremental changes in the fishes’ DNA have given them the ability to make a strange new kind of antifreeze – an antifreeze that sticks to seed crystals of ice and stops them from growing. **A triumph of natural selection.**”

Michael Behe (2007)
The Edge of Evolution p. 16
emphasis mine – fdu



Brrrrrrrrrrrr

Evolution of antifreeze glycoprotein gene from a trypsinogen gene in Antarctic notothenioid fish. Chen et al Proc Natl Acad Sci U S A. 1997 Apr 15;94(8):3811 - 6
 Freezing avoidance conferred by different types of antifreeze proteins in various polar and subpolar fish species is probably due to active adaptation, but how these unique proteins arose is unknown. We have found that the antifreeze glycoproteins (AFGPs) of the predominant Antarctic fish taxon, the notothenioids, evolved from a pancreatic trypsinogen. We have determined the likely evolutionary process by which this occurred through characterization and analyses of notothenioid AFGP and trypsinogen genes.
 The primordial AFGP gene apparently arose through recruitment of the 5' and 3' ends of an ancestral trypsinogen gene, which provided the secretory signal for the novel translated region, respectively, and the de novo acquisition of a 6 bp ATTA insertion element from the trypsinogen gene prior to create a new protein coding region for the repetitive tripeptide backbone of the antifreeze protein. The small sequence divergence (4.7%) between notothenioid AFGP and trypsinogen genes indicates that the transformation of the proteinase gene into the novel ice-binding protein gene occurred relatively recently, about 5 million years ago. This age of divergence is highly consistent with the estimated times of the opening of the Antarctic Ocean at 10-14 mya, and of the main phyletic divergence of the AFGP bearing notothenioid families at 7-8 mya.
 The notothenioid trypsinogen to AFGP conversion is the first clear example of how an old protein gene spawned a new gene for an entirely new protein with a new function. It also represents a rare instance in which protein evolution, organismal adaptation, and environmental conditions can be linked directly.

MCB 140, 12-9-07 19

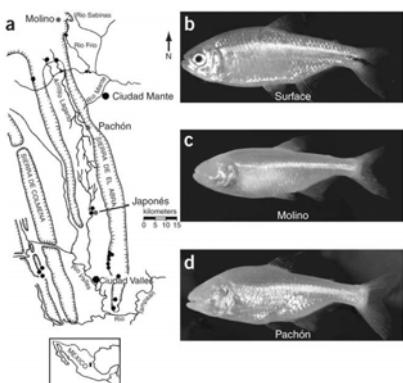
A second example of Darwinian selection leading to adaptation: a real-life Gollum

"There are 86 known troglodytic species of fish. The best studied is the Mexican tetra, identified ... as *Astyanax mexicanus*. A surface, or river-dwelling, sister population of the cave morph lives in southern Texas and northeastern Mexico and can still interbreed with the cave morph."

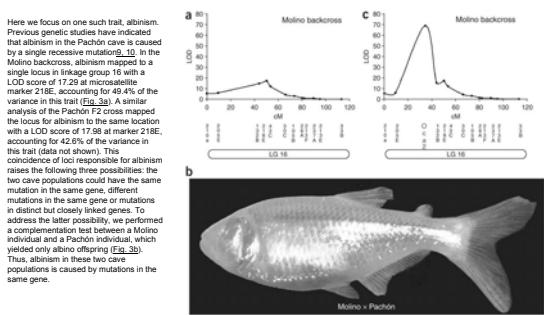


Genetic analysis of cavefish reveals molecular convergence in the evolution of albinism
Nature Genetics 38, 107- 111 (2006)

MCB 140, 12-9-07 20



Genetic analysis of cavefish reveals molecular convergence in the evolution of albinism
Nature Genetics 38, 107- 111 (2006)
 MCB 140, 12-9-07 21

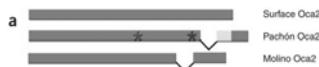


(a) The albino locus in the Molino backcross is in linkage group (LG) 16. The LOD score is plotted against the distance (in cM) across this linkage group.
 (b) An albino Pachón x Molino hybrid, showing noncomplementation.

Genetic analysis of cavefish reveals molecular convergence in the evolution of albinism
Nature Genetics 38, 107- 111 (2006)

MCB 140, 12-9-07 22

The blind leading the sighted



Schematics of the surface, Pachón and Molino Oca2 coding regions. Asterisks in the Pachón Oca2 represent changes in conserved amino acid residues: red asterisk, methionine to valine; blue asterisk, proline to serine! In the Pachón coding sequence, exon 24 is almost completely deleted. Following exon 23 are additional sequence (intron 23), the last few amino acids of exon 24, and the 3' UTR. The Molino coding sequence is identical to that of the surface-fish Oca2 except that exon 21 is missing.

"We have seen that albinism has evolved in two different cave populations through independent changes in the same gene"

Ocular and cutaneous albinism-2 (Oca2): the most commonly mutated gene in cases of human albinism.

MCB 140, 12-9-07 23

OCULOCUTANEOUS ALBINISM, TYPE II; OCA2

- **INHERITANCE :**
 - Autosomal recessive
- **HEAD AND NECK :**
 - **Eyes**
 - Nystagmus
 - Decreased visual acuity
 - Iris translucency
 - Irides blue-gray to light brown
 - **SKIN, NAILS, HAIR :**
 - White at birth
 - Tone does not appreciably change with age
 - Freckles in sun-exposed areas
 - No tanning
 - White to golden blonde or red hair
 - Hair darkens with age



MCB 140, 12-9-07 24

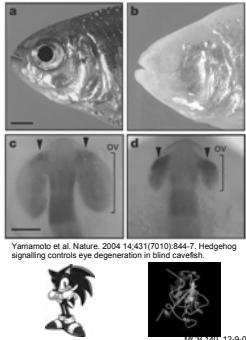
Eyelessness evolved via direct selection pressure, not passive “degeneration”

The patterns of substitution effects differ radically between QTLs of eye or lens size and of metabolic rate. Eyeless alleles at QTLs of eye or lens size have relatively modest but steady decreases of eye or lens size (Figure 1A). In contrast, cave alleles at QTLs affecting metabolic rate have large negative slopes (Figure 1B).

The eye is one of the most energetically expensive tissues, with a metabolism surpassing even that of the brain [9]. Underscoring this high metabolic rate of the eye is the fact that the main function of genetic defects is decreasing the efficiency of mitochondria is blindness (e.g., Leber's hereditary optic neuropathy [10]). The source of eyes might pose a significant burden in the cave environment. Increasing this burden, the vertebrate retina uses more energy than the brain [11] because the majority of the photoreceptor outer disks must be maintained in the hyperpolarized state until they are depolarized by exposure to light [10 and 11]. Oxygen consumption by the vertebrate retina is approximately 50% greater in the dark than in the light [12]. Among living vertebrates, retina is its most active oxygen consumer.

Additional ten percent of the photoreceptor outer disks in vertebrates are shed and renewed each day, and the structure may be completely replaced over 35 times yearly [12].

Protas et al. *Curr Biol* 2007 Mar 6;17(5):425



Yamamoto et al. *Nature*. 2004 414:841(7010):844-7. Hedgehog signalling controls eye degeneration in blind cavefish.

25

Ann Coulter: “Creating a new species is still on evolution’s to-do list”

“Darwin’s disciples simply assert that evolution led from this species to that by the process of random mutation – with cruel nature striking down the genetic losers – and to hell with the fossil record’s showing nothing of the sort.”

MCB 140, 12-9-07 26

What does the fossil record actually say?

Ann Coulter is, by education, a lawyer – she does not study fossils, hence whatever she says on the matter is irrelevant – just as the opinion of a paleontologist would be on matters of law.

Take a class in paleontology (both offered in Fall ’08) ...

IB108, Principles of Paleontology

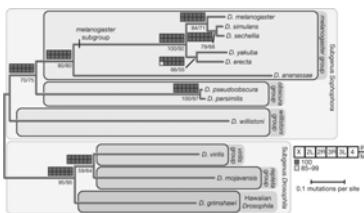
IB183, Evolution of the Vertebrates

... and you will learn, what the fossil record does and does not show. You can also talk to Prof. Kevin Padian, who was one of the two witnesses in the Dover trial on behalf of science.

I am not a paleontologist, I am a molecular geneticist (i.e., I have spent my entire professional life learning about, and studying, how the genome works), and can – and will – speak with educated authority on what the molecular genetic evidence says on the matter.

MCB 140, 12-9-07 27

Evolution of genes and genomes on the *Drosophila* phylogeny. *Nature* 450, 203–208 (8 Nov. 2007)



One of these species, *D. sechellia*—as its name suggests, it is endemic to the Seychelles islands—relies exclusively on one fruit, called the morinda fruit, for egg-laying. This fruit, which smells of gorgonzola and pineapple, is toxic to, and shunned by, *D. melanogaster* and other sibling fruit fly species.

Drosophila species have complex olfactory and gustatory systems used to identify food sources, hazards and mates, which depend on odorant-binding proteins, and olfactory/odorant and gustator receptors (Ors and Grs). The *D. melanogaster* genome has approximately 60 Ors, 60 Grs and 50 odorant-binding protein genes.

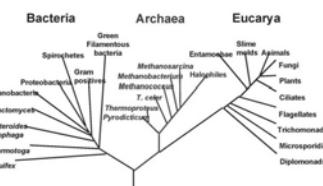
First, the two independently evolved specialists (*D. sechellia* and *D. erecta*) are losing Gr genes approximately five times more rapidly than the generalist species

Second, Or and Gr genes that remain intact in *D. sechellia* and *D. erecta* evolve significantly more rapidly along these two lineages than along the generalist lineages

MCB 140, 12-9-07 28

The genomics evidence unequivocally shows (note: not “argues” or “suggests” – shows) that all life forms on Earth evolved, over billions of years, from a common ancestor, via a lineage tree that is as follows:

Phylogenetic Tree of Life



MCB 140, 12-9-07 29

p53

>CCDS11118_1_prot length=393

```
MEEPQSDPSVEPPLSQETFSDLWKLLPENNVLSPPLPSQAMDDLMILSPDDI
EIQWFTEDPGPDEAPRMPPEAPPVAPAPAAPTAAAPAPAPSVPLOSSVPSO
KTYQGSYGFRLGFLHSGTAKSVTCTYSPALNMFCQLAKTCPVQLWVDST
PPPGTRVRAMAIFYKQSQHMTEVVRRCPHHERCSDSDGLAPPQHLLRVEGN
LRVEYLDDRNTRHSVVVPPYEPPEVGSDCTTHYNYMCNNSCMGGMNRPP
ILTIIITLEDSSGNLLGRNSFEVVRVCACPGDRRRTTEENLRKGPEPHHELP
PGSTKRALPNNTSSPQPKKPLDGEYFTLQIRGRERFEMFRELNEALEL
KDAQAGKEPGGSRAHSSLKSKGQTSRKKLMFKTEGPDS
```

MCB 140, 12-9-07 30

Michael Behe (2007) *The Edge of Evolution*

"Over the next few sections I'll show some of the newest evidence from studies of DNA that convinces most scientists, including myself, that one leg of Darwin's theory – common descent – is correct" p. 65

"Do his creationist fans know that Behe accepts as "trivial" the fact that we are African apes, cousins of monkeys, descended from fish?"
(Dawkins NYT)

MCB 140, 12-9-07 31

Ann Coulter: "Unless you are a bacterium, random mutation cannot produce anything worth having"

"With a few exceptions, the higher organisms are not going to get anything good out of a single mutation. ..."

Behe used discoveries in microbiology to refute Darwinism on Darwin's own terms. ... Behe disproved evolution ... [he] produced various "irreducibly complex" mechanisms of which there are thousands – complex cellular structures. ... A bacterial motor, called a flagellum, depends on the coordinated interaction of 30–40 complex protein parts. The absence of almost any one of the parts would render the flagellum useless..." pp. 203 24

MCB 140, 12-9-07 32

Argument by design

William Paley (1802): *Natural Theology: Or, Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature* (emphasis mine – fdu)

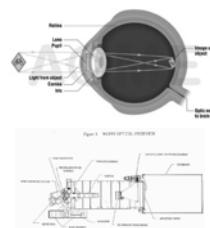
"Is not the eye as manifestly **designed for** seeing, and the ear for hearing, as a pen for writing or a clock for telling the time; and does not such design imply a **designer**? The fact that the universe as a whole is a coherent and efficiently functioning system likewise, in this view, indicates a **divine intelligence** behind it."

MCB 140, 12-9-07 33

"Every indication of contrivance, every manifestation of design, which existed in [a] watch, exists in the works of nature."



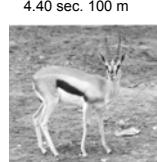
"There is precisely the same proof that the eye was made for vision, as there is that the telescope was made for assisting it."



MCB 140, 12-9-07 34

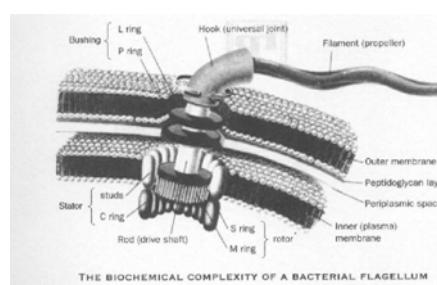


A cheetah (Namibia) *Acinonyx jubatus*
4.40 sec. 100 m



MCB 140, 12-9-07 35

M. Behe: "Irreducible Complexity" of Molecular Machines in Living Beings



THE BIOCHEMICAL COMPLEXITY OF A BACTERIAL FLAGELLUM

MCB 140, 12-9-07 36

M. Behe: “Irreducible Complexity” of Molecular Machines in Living Beings

"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. Similarly, you can't start with a signal sequence and have a protein go a little way towards the lysosome, add a signal receptor protein, go a little further, and so forth. It's all or nothing."

Darwin's Black Box p. 111

MCB 140_12-9-07 3

R. Dawkins NYT 2007

"This style of argument remains as unconvincing as when Darwin himself anticipated it. It commits the logical error of arguing by default. Two rival theories, A and B, are set up. Theory A explains loads of facts and is supported by mountains of evidence. Theory B has no supporting evidence, nor is any attempt made to find any. Now a single little fact is discovered, which A allegedly can't explain. Without even asking whether B can explain it, the default conclusion is fallaciously drawn: B must be correct."

MCB 140, 12-9-07 3

"Behe also spends considerable time on what he alleges is a hopelessly intractable problem in evolutionary immunology: the origin of the mechanism of somatic recombination of antigen receptor genes. He argues that because variable-diversity-joining recombination is dependent on the coexistence of proteins encoded by recombination-activating genes (RAG proteins), recombination signal sequences and antigen receptor gene segments, it is ultimately too complex to have arisen by naturalistic, undirected evolutionary means because the three components could not have come together in a 'fell swoop' and would have been useless individually. In fact, Behe confidently declares that the complexity of the immune system "dooms all Darwinian explanations to frustration". About the scientific literature, Behe claims it has "no answers" as to how the adaptive immune system may have originated".

The diagram illustrates the rearrangement of the IgH locus in a B lymphocyte. It shows the gene structure with four V segments (V1, V2, V3, V4) and three J segments (J1, J2, J3). A recombination event at the V3-J1 junction is shown, leading to the formation of a primary transcript from exons V3, J1, and C. This transcript undergoes splicing to produce the mature mRNA, which is then translated into immunoglobulin heavy chain protein.

MCB 140, 12-9-07 4

M. Behe: "Irreducible Complexity" of Molecular Machines in Living Beings

"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. ... As the number of required parts increases, the difficulty of gradually putting the system together skyrockets ... Darwin looks more and more forlorn ... Darwinian theory has given no explanation for the cilium or the flagellum."

ibid p. 73

MCB 140, 12-9-07 38

From *The Origin of Species* to the origin of bacterial flagella. (2006) Nature Reviews Microbiology 4, 784-790 (October 2006)

"Miller pointed out that the flagellum is modular, in that the T3SS that is responsible for flagellar protein export constitutes a functionally intact subsystem capable of performing a useful function (protein secretion) in the absence of the rest of the flagellar apparatus."

<https://doi.org/10.1007/s00339-019-01031-w> © Springer Nature Switzerland AG 2019

MCB 140, 12-9-07 40

The immune system as an irreducibly complex apparatus?

References from: *Nature Immunology* 7, 433 - 435 (2006);
 Van Gent, D.C., Mizuuchi, K. & Gellert, M. *Science* 271, 1592-1594 (1996).
 Bernstein, A., Schulter, S.F., Bernstein, H. & Marchaloni, J.J. *Proc. Natl. Acad. Sci. USA* 93, 6154-6158 (1996).

Acad. Sci. USA 93, 9454–9459 (1996).
Agrawal, A., Eastman, Q.M. & Schatz, D.C. Nature 394, 744–751 (1998).

Agrawal, A., Eastman, Q.M. & Schatz, D.G. *Nature* **394**, 744-751 (1998).

Hiom, K., Melek, M. & Gellert, M. *Cell* **94**, 463–470 (1998).

Vaandrager, J.W. , Schuuring, E. , Philippo, K. & Kluin, P.M. *Blood* **96**, 1947–1952 (2000)

Clatworthy, A. E., Val

Clatworthy, A.E., Valencia, M.A., Habel, J.E. & Oettinger, M.A. *Mol. Cell* **12**, 489–499 (2003).

Messier, T.L., O'Neill, J.P.

22, 1381–1388 (2003).

Kapitonov, V.V. & Jurka, J. *PLoS Biol.* 3, e181 (2005): Here we demonstrate that the RAG1 core and RSSs were derived from a TPase and TIRs

MCB 140, 12-9-07 42

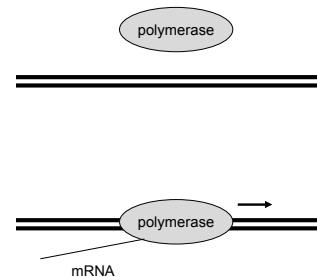
A surprising (for me personally) fact

The author of ID's main text ("Darwin's Black Box"), Michael Behe, has not published a single primary research paper on the bacterial flagellum (see PubMed), his weapon of choice in re-stating Paley's argument. Dr. Behe's area of immediate technical expertise, interestingly, is the same as my own – histones and chromatin. I was surprised to learn that when I looked up Dr. Behe's name in PubMed, because I know from having studied this issue for the past 15 years that chromatin-based genome regulatory circuits – a biological machine of stunning complexity, one that dwarfs the flagellum by comparison – offer some of the strongest evidence available illuminating how supposedly "irreducibly complex machines" have evolved in Darwinian fashion.

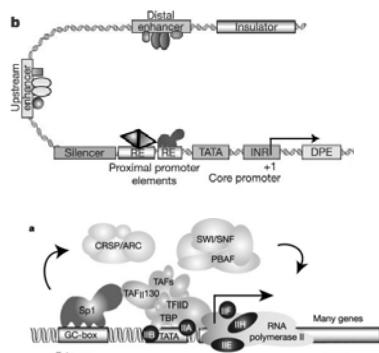
Neither "chromatin" nor "histone" are to be found in the index of Dr. Behe's book, *Darwin's Black Box*.

MCB 140, 12-9-07 43

Transcription: the simplest system (1 protein, no particular DNA sequence required)



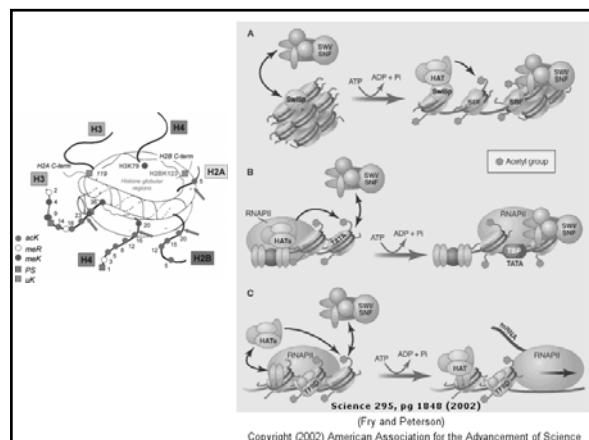
MCB 140, 12-9-07 44



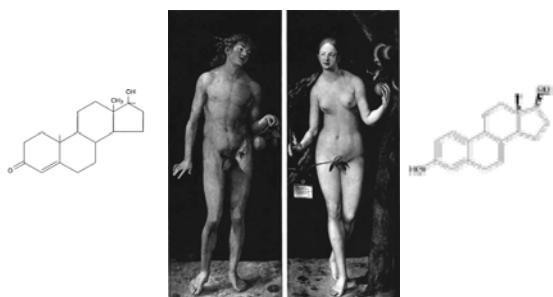
Levine and Tjian (2003)

Nature 424: 147-151

MCB 140, 12-9-07 45



Albrecht Dürer, *Adam and Eve* (Museo del Prado, Madrid)



MCB 140, 12-9-07 46

On estrogen, the estrogen receptor, the snail, the octopus, and the human

Octopus: has both ER and E₂, but ER does not respond to E₂

The *Octopus vulgaris* estrogen receptor is a constitutive transcriptional activator: evolutionary and functional implications. Endocrinology. 2006 Aug;147(8):3861–9

Snail: has only ER, but not E₂

Human: has both ER and E₂, and the latter regulates the former.

Also: evolution of MR and GR.

JW Thornton et al Nat Rev Genet. 2007 Sep;8(9):675-88.



MCB 140, 12-9-07 46

Reading over, yes, Christmas break

Sean Carroll

The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution
Endless Forms Most Beautiful: The New Science of EvoDevo and the Making of the Animal Kingdom

Marc Kirschner, John Gerhart

The Plausibility of Life: Resolving Darwin's Dilemma

Dean AM, Thornton JW (*Nature Reviews Genetics*)

Mechanistic approaches to the study of evolution: the functional synthesis

You're welcome, of course, to read Behe's latest book – his argument, basically, is that some intelligent force has created the core molecular machinery of living cells, and that the transitions from one species to another do not occur by Darwinian natural selection, but occur under the guidance of that same intelligent force.

Note, however, that Behe does not accept the scientific method in its formal sense (p. 233). "I count as 'scientific' any conclusion that relies heavily and exclusively on scientific evidence and standard logic."

Science does not stop at data and logical inference. It continues to experiment that aims to test the results of that inference, compares the results of the experiment to that inference, and if that inference is not supported by the data, well, then we know our inference/logic/initial dataset were flawed.

If you do read Behe's book, be sure to read, at the very least, Sean Carroll's review of it in *Science*, and look at all the papers this lecture has cited.

MCB 140, 12-9-07 49

The “dissenters”?

The Discovery Institute claims that “there is scientific dissent to Darwinism.”

There is (see next slide).

It is appropriate in this context, however, to ask: who are the scientists dissenting? What is their area of immediate technical expertise? How valid is their dissent?

In plain English: do they know what they are talking about, or is theirs just an opinion?

MCB 140, 12-9-07 51

Two final points

- Ideology and science
- Everything is not an adaptation – the limits of genes and genetics

MCB 140, 12-9-07 53

Are supporters of ID underrepresented in academia because they are a “persecuted minority”?

Solidarity with the oppressed flat-Earthers

Nature May 19, 2005

SIR—I was disturbed by your News Feature “Who has designs on your students’ minds?” (*Nature* 434, 1062–1065; 2005), in which the proponents of ID are mostly portrayed as a persecuted minority. They are said to be afraid to reveal their views, and more frequently censored into silence by anti-democratic scientists and administrators.

Your reporter clearly does not realize that “intelligent designers” are not the only minority being persecuted by the scientific establishment. The vast majority of flat-Earthers, tea-leaf readers, astrologers, geocentrists and phlogiston theorists cannot publish their studies in respectable journals. It is rumoured that *Nature* has rejected such papers as a result of the lack of stars bring bibles into the world. I have even heard of a physician who was fired from a university hospital for trying to cure his patients by altering the ratio of blood to yellow bile and phlegm to black bile.

This is a serious News Feature. I am now convinced that by replacing “small, medium and large” with “tall, grande and venti”—as in my local coffee-shop—the disreputable theory of biblical creationism can be turned into a respectable scientific discipline called Intelligent design!

Dan Graur
Department of Biology and Biochemistry,
University of Houston, Houston,
Texas 77204-5001, USA

MCB 140, 12-9-07 50

A SCIENTIFIC DISSENT FROM DARWINISM

Public TV programs, educational policy statements, and science textbooks have asserted that Darwin's theory of evolution fully explains the complexity of living things. The theory of intelligent design (ID) maintains that Darwinism is wrong, and that "all known scientific evidence supports [Darwinian] evolution... it does "absolutely every respectable scientist in the world."

The following scientists dispute the first claim and stand as living testimony in contradiction to the second. There is no intent here to Dismiss them. It deserves to be heard.

WE ARE SUSPECTIVE OF CLAIMS FOR THE ABILITY OF RANDOM MUTATION AND NATURAL SELECTION TO ACCOUNT FOR THE COMPLEXITY OF LIFE. CAREFUL EXAMINATION OF THE EVIDENCE FOR DARWINIAN THEORY SHOULD BE ENCOURAGED.”

I looked over this list. The majority of individuals are not biologists (they are mathematicians, physicists, chemists, etc). Their dissent, therefore, is irrelevant in this context, much as any opinion of any biologist would be on a highly technical issue of mathematics, physics, chemistry, etc. These individuals lack the formal education to understand the issues involved. I do not like to engage in *ad hominem* attacks, but by signing this, these individuals have brought this criticism onto themselves.

Of the biologists on this list, which are quite few, only one (that I can see) can be described by the expression “an established researcher” (Fred Sigworth, Yale).

MCB 140, 12-9-07 52

Science and Ideology: a Word of Warning

MCB 140, 12-9-07 54

The New York Times May 5, 2007:

At G.O.P. Debate, Candidates Played to Conservatives

"In a new twist on the debate among Republicans over how to balance their religious and secular values, three of the Republican candidates raised their hands at the debate when asked if any of them did not believe in evolution. They were Senator Sam Brownback of Kansas; Mike Huckabee, the former governor of Arkansas; and Representative Tom Tancredo of Colorado."



MCB 140, 12-9-07 55

Simple point

Having US Senators, Representatives, and Governors publicly state that they "do not believe in evolution" is congruent to them saying that they do not believe in Maxwell's "theory" of electromagnetism, or Mitchell's chemiosmotic "hypothesis," or the Schleiden and Schwann cell "theory."

Such blatant invasion of unfettered ideology into science is, to me, redolent of Lysenkoism – a phenomenon the tragic consequences we know all too well – hence is a cause for great concern.

MCB 140, 12-9-07 56

Simple point ctd

People are free to say whatever they choose, but publicly elected officials are required – as per the Establishment Clause of the First Amendment of the US Constitution – to uphold the separation between church and state.

This is what the Senator ought to have said: "The **scientific** evidence supporting evolution is irrefutable and conclusive, and – from a **scientific** perspective – no doubts remain about its validity. As a devout Christian and a biblical literalist, however, **in my private life**, I choose to accept the narrative of Creation offered by the Book of Genesis, however overwhelming the **scientific** evidence to the contrary may be."

MCB 140, 12-9-07 57

Most recently

Kansas board of education and a re-definition of the word "science" to allow for "supernatural" phenomena.

MCB 140, 12-9-07 58

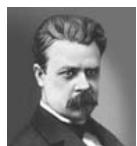
A European Perspective on ID

It is a strange experience for a European biologist to read about the growing support in the United States for so-called "intelligent design," the current name for good old unintelligent creationism. Strangest of all, though, are the recent activities of the Kansas Board of Education. The Kansas Board's proposal to "[change] the definition of science" is unheard of in a western democracy, although similar activities have been common in dictatorships. In Nazi Germany, relativity was considered "Jewish science" and therefore unacceptable, while in the Soviet Union, modern genetics was rejected as unmarxist in favor of the ravings of the charlatan Lysenko. Is this the way the good citizens of Kansas (and the many other states where similar initiatives are seen) want to go? Obviously, there must be a profound ignorance of science and the scientific method among the U.S. public for such a thing to happen (an ignorance that intelligent design supporters evidently hope to perpetuate), and for this, scientists must be held responsible. There is too much looking down at colleagues who engage the public through popular science, such as the late Carl Sagan (1). All scientists, not just biologists, should realize that an attack on the very roots of science concerns every one of them, and accordingly, they should do their utmost to counteract it by actively participating in the debate.
Ejnar J. FJERDINGSTAD Retired Professor of Anatomy, University of Aarhus, Denmark.

Science July 29, 2005

MCB 140, 12-9-07 59

Nikolai Koltsov
Genetics



Sergei Chetverikov
Population genetics



Nikolai Vavilov
Plant genetics and evolution



Trofim Lysenko



Iosif (Josef) Stalin

See the book "Commissar Vanishes" and also:
http://www.newsweek.org/berlinwall/commissar_vanishes/

MCB 140, 12-9-07 60

The two central tenets of Lysenkoism

1. Lamarck was right. Acquired traits can be inherited. From an agricultural perspective, this meant that plant lines with desired characteristics could be obtained by treating a set of plants a certain way, getting them to develop a desired characteristic, and then breeding them. It was then claimed that the F1 would have the parents' trait.
How could inheritance of acquired traits work?!
2. Weissman ("continuity of germ plasm"), Mendel (particulate inheritance) and Morgan (genes lie on chromosomes in the nucleus) are wrong. The entire cell (or the organism) is a carrier of hereditary information. "Gene" and "chromosome" are bourgeois, capitalist inventions.

MCB 140, 12-9-07 61

1948: Apocalypse Now

Annual Meeting of the Soviet Academy of Agricultural Sciences:
Lysenko announces that "Comrade Stalin has not only read my talk, but approves of it."
Result: genetics banned and declared a pseudoscience ("Weissmanism-Morganism-Mendelism").
Geneticists are officially dubbed "fly lovers = people haters" (мухолюбы – человеконенавистники).
Countless geneticists go through the same experience as, earlier, Chetverikov (sent into exile, 1929) and Vavilov (who died in a prison camp, 1943).

MCB 140, 12-9-07 62

Reading

"The Lysenko affair"
David Joravsky

"Lysenko and the tragedy of Soviet science"
Valery Soyfer

"The rise and fall of T. D. Lysenko"
Zhores Medvedev

MCB 140, 12-9-07 63

A perspective

The central phenomenon of Lysenkoism, and the enormity of the nightmare that ensued, was a blatant invasion of ideology into science.

The scientific method was abandoned, and notions were declared "right" or "wrong" based on whether they fit a certain ideology, not whether there are data supporting or refuting them.

It did not matter to Stalin's henchmen in science, what the data showed. The only thing that mattered was whether a certain theory fit the ideology of lysenkoism. Morgan's chromosome "theory" of inheritance, or Avery's 'theory' that DNA carries genetic information were proclaimed as wrong because they were the products of capitalist ideology.

MCB 140, 12-9-07 64

A personal note

When I hear someone in Kansas stating that teaching of ID in schools is a "victory for free speech" – a statement that brings the words "cynicism," "travesty," and "demagoguery" to new shades of meaning – I get chills down my spine.

My home country of Russia has been down this road before. My fellow Russians and I know what this caliber of demagogues is capable of.

See, for example, Washington Post, Nov. 9, 2005

MCB 140, 12-9-07 65

The Danger of Using Darwin/Genetics to Explain/Rationalize Everything

MCB 140, 12-9-07 66

Richard Lewontin (1974)
The Genetic Basis of Evolutionary Change

"... It is by no means certain, what proportion of all evolutionary change arises from natural selection."

Are all features of life – evolutionary adaptations?

MCB 140, 12-9-07 67

Everything an adaptation?

Everything that exists has been selected to be fit and serve "a purpose":

"How *Tyrannosaurus* used its tiny front legs is a scientific puzzle; they were too short even to reach the mouth. They may have been used to help the animal rise from a lying position."



MCB 140, 12-9-07 68

Just So Stories (R. Kipling)

- How the elephant got its trunk
- How the camel got its hump
- Etc.



R. Lewontin

The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme

STEPHEN JAY GOULD AND
RICHARD C. LEWONTIN

Proc. Royal Soc. Lond. (1979)
205: 581.

MCB 140, 12-9-07 70

Dr. Pangloss (Voltaire, *Candide*)

"Things cannot be other than they are...
Everything is made for the best purpose.
Our noses were made to carry spectacles,
so we have spectacles. Legs were clearly
intended for breeches, and we wear
them."



Lewontin and Gould, ctd.

"Such architectural constraints abound, and we find them easy to understand because we do not impose our biological biases. In every fan-vaulted ceiling must have a series of open spaces along the midline of the vault, where the sides of the vault intersect between the pillars. Since the spaces must exist, they are often used for ingenious ornamental effect."

The spaces arise as a necessary by-product of fan vaulting; their appropriate use is a secondary effect."

R. Henig, NYT 4/3/07

Darwinians who study physical evolution distinguish between traits that are themselves adaptive, like having blood cells that can transport oxygen, and traits that are byproducts of adaptations, like the redness of blood. There is no survival advantage to blood's being red instead of turquoise; it is just a byproduct of the trait that is adaptive.

Something similar explains aspects of brain evolution, too, say the byproduct theorists. Which brings us to the idea of the spandrel.

Stephen Jay Gould, the famous evolutionary biologist at Harvard who died in 2002, and his colleague Richard Lewontin from

archeology, where it originally referred to the V-shaped structure formed between two rounded arches. The

structure is not there for any purpose. It is there because that is what happens when arches align.

In architecture, a spandrel is a space of certain dimensions that is created when two arches meet. It creates a

space underneath that is innocuous, just a blank sort of triangle. But if you put a closet there, the under-spandrel space takes on a function, unrelated to the staircase's but useful nonetheless. Either way, functional or nonfunctional, the spandrel under the stairs is a spandrel, an unintended byproduct.

"Natural selection made the human brain big," Gould wrote, "but most of our mental properties and potentials may be spandrels – that is, nonadaptive side consequences of building a device with such structural complexity."

MCB 140, 12-9-07 75

Common themes

Trait X is "Darwinian" = adaptive = biologically explainable and (somehow) justified. "Well, we evolved to be that way, this is in our genes, there is not much we can do about that, is there?"

1. How much experimental evidence is there for that claim? (zero)
2. Who is the person making that claim? Is this person a trained evolutionary biologist? (don't get me started).

MCB 140, 12-9-07 74

We have been down this road before

"It is true that political interpretations of Darwinism have turned out to be quite pliable. Victorian social Darwinists like Herbert Spencer adopted evolutionary theory to justify colonialism and imperialism, opposition to labor unions and the withdrawal of aid to the sick and needy. Francis Galton based his "science" of eugenics on it. Arguing that cooperation was actually what enabled the species to survive, Pyotr Kropotkin used it to justify anarchism."



MCB 140, 12-9-07 75

"A Split Emerges as Conservatives Discuss Darwin" – NYT 5-5-07

"Some of these [conservative] thinkers have gone one step further, arguing that Darwin's scientific theories about the evolution of species can be applied to today's patterns of human behavior, and that natural selection can provide support for many bedrock conservative ideas, like traditional social roles for men and women, free-market capitalism and governmental checks and balances."

MCB 140, 12-9-07 76

S.J. Gould – keep Darwin out of it

"Those who recruit Darwin to support a particular moral or political line should remember that, at best, evolutionary biology may give us some insight into the anthropology of morals -- why some (or most) peoples practice certain values, perhaps for their Darwinian advantage. **But science can never decide the morality of morals.** Suppose we discovered that aggression, xenophobia, selective infanticide and the subjugation of women offered Darwinian advantages to our hunter-gatherer ancestors a million years ago on the African savannahs. **Such a conclusion could not validate the moral worth of these or any other behaviors, either then or now.**"

New York Times 5-29-98

MCB 140, 12-9-07 77