Fatally Flawed

Refuting the recent study on encyclopedic accuracy by the journal *Nature*

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In its December 15, 2005, issue, the science journal *Nature* published an article that claimed to compare the accuracy of the online *Encyclopædia Britannica* with *Wikipedia*, the Internet database that allows anyone, regardless of knowledge or qualifications, to write and edit articles on any subject.[1] *Wikipedia* had recently received attention for its alleged inaccuracies,[2] but *Nature*'s article claimed to have found that "such high-profile examples [of major errors in *Wikipedia*] are the exception rather than the rule" and that "the difference in accuracy [between *Britannica* and *Wikipedia*] was not particularly great."

Arriving amid the revelations of vandalism and errors in *Wikipedia*, such a finding was, not surprisingly, big news. Within hours of the article's appearance on *Nature*'s Web site, media organizations worldwide proclaimed that *Wikipedia* was almost as accurate as the oldest continuously published reference work in the English language.[3]

Almost everything about the journal's investigation, from the criteria for identifying inaccuracies to the discrepancy between the article text and its headline, was wrong and misleading.

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[1]Jim Giles, "Internet encyclopaedias go head to head," *Nature,* December 15, 2005: 900-01.

[2]John Seigenthaler, "A false Wikipedia 'biography,'" *USA Today,* November 29, 2005 (http://www.usatoday.com/news/opinion/editorials/2005-11-29-wikipedia-edit_x.htm). "Free Encyclopedia Wikipedia.de Has Copyright Issues," DW-World/Deutsche Welle, November 29, 2005 (http://www.dw-world.de/dw/article/0,2144,1796407,00.html). "Wikipedia Caught in Podfather Turf War," *Podcasting News,* December 5, 2005 (http://www.podcastingnews.com/archives/2005/12/wikipedia_caugh_1.html). All accessed March 7, 2006.

[3]Dan Goodin, "Wikipedia Science Topics As Accurate As Britannica-Report," Associated Press, December 14, 2005. Gregory M. Lamb, "Online Wikipedia is not Britannica - but it's close," *Christian Science Monitor,* January 5, 2006 (http://www.csmonitor.com/2006/0105/p13s02-stct.html). "Wikipedia Gets Things Right," *Red Herring,* December 14, 2005 (http://www.redherring.com/Article.aspx?a=14873&hed=Wikipedia+Is+Fairly+Accurate#). "Assessing Wikipedia's Accuracy," *All Things Considered,* December 15, 2005 (http://www.npr.org/templates/story/story.php?storyId=5055388). Julian Dibbell, "Factually Speaking," *Village Voice,* December 22, 2005 (http://villagevoice.com/screens/0552,dibbell,71299,28.html). "Fact or fiction? Online encyclopedias put to the test," *The Age,* December 15, 2005 (http://www.theage.com.au/news/national/online-encyclopedias-put-to-the-test/2005/12/14/1134500913345.html). All accessed March 7, 2006.

That conclusion was false, however, because *Nature*'s research was invalid. As we demonstrate below, almost everything about the journal's investigation, from the criteria for identifying inaccuracies to the discrepancy between the article text and its headline, was wrong and misleading. Dozens of inaccuracies attributed to the *Britannica* were not inaccuracies at all, and a number of the articles *Nature* examined were not even in the *Encyclopædia Britannica*. The study was so poorly carried out and its findings so error-laden that it was completely without merit. We have produced this document to set the record straight, to reassure *Britannica*'s readers about the quality of our content, and to urge that *Nature* issue a full and public retraction of the article.

In rebutting *Nature*'s work, we in no way mean to imply that *Britannica* is error-free; we have never made such a claim. We have a reputation not for unattainable perfection but for strong scholarship, sound judgment, and disciplined editorial review. These practices are the foundation of any reliable reference work, and *Nature*'s careless analysis demeaned them.

Britannica undergoes continuous revision and fact checking. Our editors work unceasingly to revise and improve the encyclopedia and to publish the results in a timely way. We work with thousands of contributors and advisers around the world—scholars and experts all—and maintain a brisk correspondence with our readers as well.[4] We investigate any claims of error that come to our attention, and when one is valid, we fix the error. Where *Nature*'s reviewers found genuine inaccuracies or important omissions in the *Britannica*, we have corrected them, but as a work of research from which conclusions may be drawn, *Nature*'s study was without value. The purpose of this document is to enumerate the scores of serious errors and misjudgments that undermine *Nature*'s study so that its lack of validity can be understood.

Britannica was far more accurate than *Wikipedia* according to the figures;
the journal simply misrepresented its own results.

Misleading Headline

In the pages below we describe the errors *Nature* made in its study, but first a word about the misleading way in which it was presented.

Anyone who read the article with even a modicum of care would have noticed a discrepancy between the headline and the data themselves. While the heading proclaimed that "*Wikipedia* comes close to *Britannica* in terms of the accuracy of its science entries," the numbers buried deep in the body of the article said precisely the opposite: *Wikipedia* in fact had *a third more inaccuracies* than *Britannica*. (As we demonstrate below, *Nature*'s research grossly exaggerated *Britannica*'s inaccuracies, so we cite this figure only to point out the slanted way in which the numbers were presented.) Even if *Wikipedia* were "only" a third more inaccurate than *Britannica*, this would be a large differ-

[4]See Michael J. McCarthy, "It's Not True About Caligula's Horse; Britannica Checked --- Dogged Researchers Answer Some Remarkable Queries," *Wall Street Journal,* April 22, 1999: A1.

ence, especially in a study that focused exclusively on factual accuracy, disregarding other important properties of encyclopedias, such as the organization of information, the quality of writing, and the readability of the articles. Why *Nature* tried to minimize this considerable difference in accuracy is unclear, but the fact is that *Britannica* was far more accurate than *Wikipedia* according to the figures; the journal simply misrepresented its own results.

As we would soon learn, however, this was only the beginning of the investigation's errors and misrepresentations. In the days after the article was published, *Britannica*'s science editors, with the help of our outside advisers and contributors, began reviewing the list of inaccuracies the journal claimed to have found, with the aim of addressing every claim that had validity. We discovered in *Nature*'s work a pattern of sloppiness, indifference to basic scholarly standards, and flagrant errors so numerous they completely invalidated the results. We contacted *Nature*, asking for the original data, calling their attention to several of their errors, and offering to meet with them to review our findings in full, but they declined.

Contrary to the usual practice of making all data freely available in order to facilitate a study's replication by others, *Nature* declined our repeated requests to make the full reports available.

The Study and the Data

According to *Nature*'s description of its study, 42 pairs of articles on scientific subjects, from the *Britannica* and *Wikipedia* respectively, were reviewed by outside experts, mainly academic scientists, who were offered anonymity. (Most of them chose to remain anonymous.) According to a document posted on *Nature*'s Web site, reviewers "were asked to look for three types of inaccuracy: factual errors, critical omissions and misleading statements. . . . The reviews were then examined by *Nature*'s news team and the total number of errors estimated for each article."[5]

The reviewers produced reports for the articles assigned to them, and those reviews were excerpted in the document on the Web. However, contrary to the usual practice of making all data freely available in order to facilitate a study's replication by others, *Nature* declined our repeated requests to make the full reports available. For more on this, see Appendix A.

Even without the original data, however, *Britannica* editors analyzed *Nature*'s findings, using the truncated versions of the reviewer reports posted on the Web and copies of the articles reviewed that we obtained from *Nature*. We identified a multitude of serious flaws in their procedures and conclusions and found that in dozens of cases *Britannica* information that *Nature* claimed to be inaccurate was not inaccurate at all. We review some of *Nature*'s most significant errors below. A more complete list can be found in Appendix B.

[5]"Supplementary information to accompany Nature news article 'Internet encyclopaedias go head to head'" (http://npg.nature.com/news/2005/051212/exref/supplementary_information.doc). Accessed February 23, 2006.

***Nature* reviewed text that was not even from the *Encyclopædia Britannica*.** Several of the articles *Nature* sent its reviewers were not from our core encyclopedia, and in one case it was not from any *Britannica* publication at all.

> Articles on Dolly the Sheep and Steven Wolfram reviewed by *Nature* were taken not from the *Encyclopædia Britannica* but from previous editions of the *Britannica Book of the Year*, which are archived on our site and clearly dated and identified. Yearbook authors are often given greater latitude to express personal views than writers of encyclopedia articles. In the Wolfram article, the *Nature* reviewer disagreed with *Britannica*'s author on the phrasing of two sentences in which point of view figured significantly, and on the basis of those disagreements *Nature*'s editors counted the two points as "inaccuracies" in *Britannica*. In addition to the fact that reviewing yearbook articles in a study of encyclopedias is inappropriate, these particular judgments were simply unfounded. The reviewer was entitled to his or her opinion about how a point might best be presented, but that opinion did not make our author's presentation "inaccurate."
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> *Nature*'s comments on the article "ethanol" were based on text not from the *Encyclopædia Britannica* but from *Britannica Student Encyclopedia*, a more basic work for younger readers. One of the reviewer's comments referred to text that does not appear in any *Britannica* publication.

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***Nature* accused *Britannica* of "omissions" on the basis of reviews of article excerpts, not the articles themselves.** In a number of cases only parts of the applicable *Britannica* articles were reviewed.

> One *Nature* reviewer was sent only the 350-word introduction to *Encyclopædia Britannica*'s 6,000-word article on lipids. For *Nature* to have represented *Britannica*'s extensive coverage of the subject with this short squib was absurd, and it invalidated the findings of omissions alleged by the reviewer, since those matters were covered in sections of the article he or she never saw.
>
> Other reviewers were sent only sections taken from longer articles. For example, what the *Nature* editors referred to as *Britannica*'s "articles" on "kin selection" and "punctuated equilibrium" are actually separate sections of our article on the theory of evolution, written by one of the foremost experts on evolution in the world. What they claimed to be an "article" on field-effect transistors was actually only one section of our article on integrated circuits. For *Nature* to have excerpted our articles in this way was irresponsible.

***Nature* rearranged and re-edited *Britannica* articles.** In some cases reviewers were sent patchworks of text taken from two or more articles and pieced together in a way that made a mockery of the original entries. The "article" on "aldol reaction" that the journal sent its reviewer consisted of passages taken selectively from two different *Encyclopædia Britannica* articles and joined together with text evidently written by *Nature*'s editors. This was dishonest, and it completely misrepresented *Britannica*'s published coverage of the subject.

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***Nature* failed to check the factual assertions of its reviewers.** Everyone makes mistakes, even experts, which is why all factual assertions should be verified. *Nature*, however, decided not to do this; they did not even require reviewers to provide sources for their assertions because "it would have been simply too time consuming."[6] Instead, *Nature* assumed that what its reviewers said was true and, when it contradicted something in the *Britannica*, that the reviewer was right and *Britannica* was wrong. The result was predictable.[7] Examples:

> *Nature*'s review of the *Britannica* article "Pythagorean theorem" claimed the *Britannica* misspelled an Italian town that the reviewer said should be spelled "Crotona." However, according to the U.S. Board of Geographic Names, the preferred spelling is in fact "Crotone," as *Britannica* spelled it. Other reliable sources also give "Crotone" as the right spelling. For *Nature*'s editors to have ruled this an error on one reviewer's say-so, without confirming the spelling, was inexcusable.
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> For the article on Subrahmanyan Chandrasekhar, *Nature*'s reviewer quibbled with the dates *Britannica* gave for one of Professor Chandrasekhar's academic appointments and for the publication of his book *Principles of Stellar Dynamics*. Once again, on the basis of these unverified objections, *Nature* ruled *Britannica* to be in error, but we have solid sources for both dates, and we stand by them. See Appendix B for details.

***Nature* failed to distinguish minor inaccuracies from major errors.** By counting up the alleged inaccuracies for both encyclopedias, *Nature* treated all mistakes equally and failed to observe that *Wikipedia* had many more shortcomings of a fundamental kind. Reviewers told the journal that many of the *Wikipedia* articles were "poorly structured and confusing"—a fact that made those arti-

[6] "Supplementary information," 2.

[7] *Nature*'s editors appear to have thought that since their reviewers were scientists, those reviewers' judgments trumped the encyclopedia where there was a disagreement. This was presumptuous, since Britannica engages expert advisers and contributors who are in every way equal to *Nature*'s reviewers. Our distinguished contributors have included more than 110 Nobel laureates.

cles resistant to basic fact checking and thus not suitable for comparison with *Britannica*—yet the fact was buried deep in the article and its methodological implications ignored.

***Nature* counted "errors" and "critical omissions" that did not exist.** As we have said, where reviewers found genuine inaccuracies in the *Britannica*, we corrected them, but dozens of the so-called inaccuracies they attributed to us were nothing of the kind; they were the result of reviewers expressing opinions that differed from ours about what should be included in an encyclopedia article. In these cases *Britannica*'s coverage was actually sound, most often reflecting the considered judgment of editors who have extensive experience in publishing an encyclopedia, in deciding what information should be included in it for the general reader, and in how it should be presented. *Nature*'s reviewers—who were scientists, not encyclopedists—were certainly entitled to their opinions on these matters, but for *Nature* to have ascribed inaccuracies to *Britannica* simply on the basis of their opinions was invalid. For example:

> According to the reviewer of the *Britannica* article "Nobel Prize," the fact that the 1935 Peace Prize was awarded to Carl von Ossietzky in 1936 should have been stated. We disagree. To raise this minor fact and then be required to explain it would, at that point in the Nobel Prize article, have distracted the reader from the main discussion. This was not an omission; it was an editorial judgment. (N.B.: The fact that the award was conferred in 1936 is reported in Ossietzky's biographical article, where it belongs.)
>
> The reviewer of the article on Paul Dirac objected that certain areas of Dirac's work were not covered. Our coverage, however, was appropriate for a general-reference encyclopedia. By design, the 825-word article explained, for the lay reader, Dirac's most significant contributions, not all of them.
>
> The reviewer of the article on the Haber-Bosch process suggested that the article should have shown the chemical equation for the reaction, and *Nature* therefore called its absence from the article an omission. Not so. The article's verbal description of the process was clear and sufficient for the general reader.

Conclusion

"No test is perfect and we acknowledge that any of our reviewers could themselves have made occasional errors," said the editors of *Nature* about their study. "But by choosing reviewers who were highly qualified in the specific area described by each entry, we aimed to subject the encyclopaedia entries to the fairest and most stringent test that we could."[8]

Indeed, perfection is unattainable, and a few mistakes in *Nature*'s analysis could perhaps have been overlooked. But alas, as we have shown above, the study's shortcomings went well beyond "occasional errors." The entire undertaking—from the study's methodology to the misleading way *Nature* "spun" the story—was misconceived. Among other things, while it is important to engage "reviewers who were highly qualified," that alone is not enough: as every editor at *Britannica* knows, even the assertions of experts must be confirmed and their observations considered in the proper context for a general-reference work like *Britannica*. *Nature* failed to take these and so many of the other steps that would have been required to make its research valid. The results were the errors we describe above and in Appendix B.

We now call on *Nature* to fulfill its commitment to good scholarship and send us the unabridged reviewer reports on which the study was based. And as we have shown here, the facts call for a complete retraction of the study and the article in which it was reported. We call on *Nature* to make the retraction and make it promptly.

[8]"Supplementary information," 1.

Appendix A: The Original Data

We began our analysis of *Nature*'s work with an attempt to get the basic data on which the study was based, none of which accompanied the article itself. More than a week after the article was published, *Nature* posted on its Web site a document that claimed to provide "more detailed information about how our survey was carried out."[9] However, the document did not contain the complete reports submitted by *Nature*'s reviewers. The editors explained how they created the modified report for public consumption in part as follows:

> " . . . we sometimes disregarded items that our reviewers had identified as errors or critical omissions. In particular, as we were interested in testing the entries from the point of view of 'typical encyclopaedia users', we felt that experts in the field might sometimes cite omissions as critical when in fact they probably weren't - at least for a general understanding of the topic. Likewise, the 'errors' identified sometimes strayed into merely being badly phrased - so we ignored these unless they significantly hindered understanding."[10]

This clearly indicates that *Nature*'s editors exercised subjective judgment in redacting the original reports to produce the versions posted on the Web. The original reports, therefore, constituted key data for any complete replication or reanalysis of the findings, so we asked for a copy of those reports. *Nature* refused to give them to us.

[9]"Supplementary information," 1. Accessed February 23, 2006.

[10]Ibid., 2

Appendix B: *Nature*'s Errors

The *Nature* study was based on expert reviews of articles from the *Encyclopædia Britannica* and *Wikipedia*. The reviews themselves are secret, but *Nature* has excerpted them on its Web site. That document is revealing in what it suggests about the questionable methodology of the study. Apparently, *Nature*'s editors took almost every assertion by its reviewers at face value and classified as an inaccuracy any criticism of a *Britannica* article by one of its reviewers, even when the reviewer's statement should clearly have been regarded as an expression of opinion. The editors did not require corroborating sources from their reviewers, and they apparently did little fact checking of their own. As a result, they attributed to *Britannica* dozens of inaccuracies that were in fact nothing of the kind. In this section of our report we reproduce from the document *Nature* posted on its Web site dozens of comments from reviewers that were the basis of alleged inaccuracies in *Britannica*, along with our response. Article titles in this appendix are those that *Nature* gave the texts they sent their reviewers. The titles that appear in brackets are the actual titles of the *Britannica* articles.

Article: Acheulean Industry

Reviewer comment: I would not use the term 'early *Homo sapiens*'. Instead, use *Homo heidelbergensis*.

Britannica response: We do not accept this criticism, which only reflects the point of view of the reviewer. The term "early *Homo sapiens*" cannot simply be swapped for "*Homo heidelbergensis*" without explanation. As is stated elsewhere in the *Britannica*, many paleoanthropologists do categorize some early *H. sapiens* as *H. heidelbergensis*, though many do not. Likewise, some insist that many hominins called *H. erectus* are really *H. ergaster*, though some do not. In a short article like this we have decided not to distract the lay reader by raising such complex issues. We leave these issues to our more substantial articles on human evolution and the various *Homo* species, which have been written and revised by Russell Tuttle of the University of Chicago, Ian Tattersall of the American Museum of Natural History, Erik Trinkaus of Washington University, and G. Philip Rightmire of the State University of New York-Binghamton.

Article: Aldol [actually "chemical compound: Aldol reaction" and "acid-base reaction: Aldol condensation, base-catalyzed"]

Reviewer comments:

1. The aldol REACTION is not the same as the aldol CONDENSATION.
2. Sodium hydroxide is by no means the only base to be used in the aldol and acid catalysed aldol reactions also occur (usually with concomitant loss of water).
3. The reaction steps in the second reaction sequence should be equilibria up to the dehydration step.

4. In particular, there is no mention of the acid catalysed process and scant mention of related reactions.

Britannica response: We do not accept the validity of this review. The reviewer was given a cut-and-paste piece that began with part of a sentence from one *Encyclopædia Britannica* article, finished that sentence with an extract from another article, then reverted to an extract from the first article after a transitional clause inserted by the *Nature* editors. It is simply unacceptable for *Nature* to cut and paste different *Britannica* entries, add its own editorial material, and then pass the resulting pastiche off under *Britannica*'s name.

Article: Archimedes Principle ["Archimedes' principle"]

Reviewer comments:

1. In the fourth sentence the word 'floating' is used to mean 'at rest', and does not necessarily mean that in common parlance.

2. The very last sentence is true only for an object at rest; when a body is moving there are pressure forces, as well as viscous stresses, associated with the motion.

Britannica response: We do not accept these criticisms. Our article begins by defining Archimedes' principle in relation to an object immersed in a fluid at rest, a perfectly reasonable method for explaining this fundamental principle to nonspecialists. Our recent revision of this article, which was in process at the time of the review, retains this method of explanation.

Article: Cambrian Explosion [actually "community ecology: The Cambrian explosion"]

Reviewer comment: Evolution of hard parts at beginning of Cambrian involved much more than development of calcium carbonate.

Britannica response: The article does not claim or imply that calcium carbonate explains all there is to know about hard parts. $CaCO_3$ is clearly used only as an example.

Reviewer comment: Role of oxygen in Cambrian explosion may well have been important, but it involved much more than the evolution of hard parts.

Britannica response: The article does not claim that oxygen had a role only in the development of hard parts.

Reviewer comment: Many suspension feeders, e.g. bryozoans, brachiopods, radiated in Ordovician, not Silurian.

Britannica response: Some forms of suspension feeders radiated in the Ordovician, others in the Silurian. We stand by the author's decision to focus on the Silurian in the context of his article section.

Article: Chandrasehkar, Subrahmanyan ["Chandrasekhar, Subrahmanyan"]

Reviewer comment: Chandrasekhar joined the staff of the University of Chicago, rising from assistant professor of astrophysics (*1937*) to Morton D. Hull etc.

Britannica response: This claim of error is wrong. Chandrasekhar's Nobel biography and Eugene Parker, S. Chandrasekhar Distinguished Service Professor Emeritus, University of Chicago, note that Chandrasekhar was a research associate, not an assistant professor, in 1937. He became assistant professor in 1938.

Reviewer comment: Books: Principles of Stellar Dynamics (*1943*).

Britannica response: We do not accept this. The Library of Congress, our source for publication dates, cites 1942 as the year of publication for this book.

Article: Creutzfeldt-Jakob Disease (CJD)

Reviewer comment: The statement about mutations leading to increased susceptibility to infection is speculative. There is no evidence that mutations lead to sporadic CJD.

Britannica response: We do not accept this criticism of our phrasing. Our adviser agrees that our conditional phrasing is sufficient.

Article: Cloud

Reviewer comments:

1. *'As a mass of air ascends, the lower pressures prevailing at higher levels allow it to expand. In expanding, the air cools adiabatically (i.e., without heat exchange with the surrounding air) until its temperature falls* ~~*below*~~ [to] *the dew point*

2. *upon which the air becomes* ~~*supersaturated*~~ [saturated].

Britannica response: We do not accept these criticisms (which are really just one criticism, not two). We have published a revision of this article that retains the emphasis on supersaturation rather than the transitional stage of saturation.

Reviewer comment: The presence of cloudiness marks smaller diurnal temperature variations. A low overcast layer of cloud acts like a blanket, preventing the temperature from dropping much at night. A clear [night] ~~evening~~ sky, on the other hand, often leads to rapid cooling, with dew, frost, or even fog forming the following morning as a result.

Britannica response: We do not accept this criticism, which misquotes our article. Our article actually says that a clear evening sky "indicates" (not "leads to," as the reviewer claims) rapid cooling. Our recent revision has retained the emphasis on evening, and we stand by this revision.

Article: Dirac, Paul ["Dirac, P.A.M."]

Reviewer comment: There is nothing here about Dirac's work on the monopole - an important omission.

Britannica response: This is not a critical omission. This 825-word article sets out to explain the most significant contributions of Dirac's career, and it does just that.

Reviewer comment: I was surprised to see nothing at all about Dirac's large number hypothesis (1937).

Britannica response: We do not accept this criticism, for the reason cited above.

Reviewer comment: Dirac co-invented QM independently of the Göttingen group after he read Heisenberg's paper. It is therefore misleading to say that he was behind them, except in that first paper.

Britannica response: We stand by this passage, which explains a complicated situation in a way that is appropriate for the lay reader; to do more would introduce an order of detail that does not belong in this article.

Reviewer comment: Dirac produced his transformation /before/ he wrote his book.

Britannica response: We stand by this passage as it is. To state as we do that Dirac developed the transformation theory of quantum mechanics in his book is not at all to imply that he had not worked out the theory before putting pen to paper.

Reviewer comment: It does not mention his discovery of the least action formulation of QM - an extremely important contribution

Britannica response: We do not accept this criticism, for the reason cited above. Note: As part of our physics revision program independent of this review, Alexei Kojevnikov of Georgia State University has written a new article on Dirac that will be published shortly.

Article: Dolly the Sheep [actually not an *Encyclopædia Britannica* article but a 1998 entry from *Britannica Book of the Year* entitled "Life Sciences: A Sheep Named Dolly"]

Reviewer comment: Mitochondria would have been contributed by the donor mammary gland cell, though these do not appear to have survived (much in the way that sperm mitochondria do not contribute to those in the adult animal).

Britannica response: We do not accept this criticism of our 1998 yearbook article. The donor mammary gland cell may well have "contributed" mitochondria, but the mitochondria actually present in Dolly's cells were derived from the donor egg. Our yearbook article from eight years ago cannot be faulted for not referring to mitochondria that did not survive; the article rightly refers to mitochondria that did survive and were present in Dolly's cells. Furthermore, because this is a dated yearbook article, it had no place in a study of encyclopedias.

Article: Ethanol

Reviewer comments:

1. The word 'alcohol' is derived from the Arabic 'al kuhl' but I think the linking of this 'kuhl' with the traditional eye-makeup 'kohl' is dubious.

2. The author is misunderstanding the term 'methylated spirits' and seems to think that this is alcohol to which methanol has been deliberately added to render it undrinkable. This does not happen. It is called 'methylated' because it still contains *traces* of methanol that have not been removed.

Britannica response: We do not accept the validity of these criticisms. The reviewer has commented on text from the *Britannica Student Encyclopedia*, which is a much more general product for a younger audience, not on text from the *Encyclopædia Britannica*, and apparently (for comment #2) on text from some other source unknown to us.

Article: Field Effect Transistor [actually "integrated circuit: Field-effect transistors"]

Reviewer comment: The second paragraph is wrong in that it does not describe the operation of a known transistor. Some aspects appear correct but the underlying principle described is wrong.

Britannica response: The author of this article, Christopher Saint of the IBM West Coast Design Center, is willing to accept valid notices of inaccuracy in his article, but he simply disagrees with this criticism. We stand by this paragraph and our author.

Article: Haber Process ["Haber-Bosch process"]

Reviewer comment: It really should include an equation that shows $N_2 + 3\ H_2 \rightarrow 2NH_3$.

Britannica response: We stand by this article, which clearly describes the Haber-Bosch process and its importance. The article's verbal description of this process for making ammonia is so clear that the reviewer's recommended addition of a chemical equation is unnecessary.

Article: Kin Selection [actually "evolution: Kin selection and reciprocal altruism"]

Reviewer comment: It's stretching things a bit to say in the last para that 'A queen typically mates with a single male during her lifetime…' This is true of some ants, but is not a general rule for social insects.

Britannica response: We do not accept this criticism. The author of this article, Francisco Ayala, was explaining a general case that often obtains, rather than a complicated case that would be more appropriate for an advanced thesis.

Reviewer comment: Yes, [*Nature reviewer unclear here*] in using the language of individual-level fitness and selection; but this was also a shortcoming of Hamilton's original formulation. Thus to say 'They all carry the same genes…' (para 1) is misleading because what matters is not the totality of genes shared but the probability that relatives share a specific gene (strictly allele), in this case the one coding for the altruistic trait. By the same token, 'individual fitness' is a proxy for allele fitness, again, in this case, specifically the allele for the altruistic trait. Kin selection is THE paradigm of the gene selection argument; it actually makes no sense when couched at the level of individual fitness. The problem cascades through the piece, thus: Par2, lines 4-5 - should be 'A parent has a probability of 0.5 (or a half) of sharing any given gene (again actually allele) with each progeny …' and last line - should be '…because it increases the probability of transmission of the parental gene for caring.'

Britannica response: There is no inaccuracy here. We stand by our author, Francisco Ayala, who insists that the reviewer is wrong through and through: the altruistic behavior is favored by natural selection because relatives share (in fractions depending on the degree of relatedness) all their genes.

Reviewer comment: Para 4, first sentence - I'd say instead that 'Altruism also occurs among unrelated individuals when the benefit of reciprocal cooperation is greater than the average benefit from refusing to cooperate.' [*not ' when the altruist's costs are smaller'*] which are the conditions for the Prisoners' dilemma model to predict mutual cooperation as a stable alternative to defection.

Britannica response: This quibbling over choice of language does not expose inaccuracy. We stand by this passage as written by Francisco Ayala, who prefers to retain his original wording.

Article: Lipid

Reviewer comments:

1. No mention of "saturated" and "unsaturated" fats, or more precisely fatty acids, is made.

2. There is no mention of the propensity of lipids to "self assemble" which is the basis of their ability to form membranes

3. The article uses outdated nomenclature only and fails to use the new more logical system such as phosphatidylcholine in place of lecithin.

Britannica response: We do not accept this review. Our article on lipids is 6,000 words long; the *Nature* reviewer was sent only the 350-word introduction.

Article: Lomborg, Bjorn [actually not an article from the *Encyclopædia Britannica* but an entry from the 2004 *Britannica Book of the Year* entitled "Biographies: Lomborg, Bjørn"]

Reviewer comment: It might have done better to qualify Bjorn's Greenpeace past as not true to call him "a committed Greenpeace environmentalist". I think the "committed" is overstating it.

Britannica response: We do not accept this. This is the reviewer's opinion, and he or she is entitled to it, but it does not make our author's characterization of Lomborg inaccurate.

Article: Meliaceae

Reviewer comment: So short as to be of very little help in identifying the family: it could apply to any of about ten other families, or more.

Britannica response: We do not accept this criticism of our short article on this specific plant family. We are not a botanical encyclopedia and do not pretend to be. Other articles in our set provide information on specific plant species mentioned in this entry, and we also have a long article on the order (Sapindales) to which this family belongs.

Article: Mendeleev, Dmitry ["Mendeleyev, Dmitry Ivanovich"]

Reviewer comment: Declaring him the 17th child is either incorrect or misleading. He is the 13th surviving child of 17 total.

Britannica response: We disagree with the reviewer's implication that there is full agreement that Mendeleyev was the 13th surviving child. Our new article makes it clear that scholars are not uniform in their views on whether Mendeleyev was the 13th or 14th surviving child.

Reviewer comment: The presentation of Mendeleev as a political radical is highly misleading.

Britannica response: The article does not claim that Mendeleyev was a "political radical"-only that he was a Russian of progressive views who supported his students' right to present a petition. Note: As part of our chemistry revision program independent of this review, we have published a new article on Mendeleyev by Bernadette Bensaude-Vincent of University of Paris X - Nanterre.

Article: Neural Network

Reviewer's comment: The following sentence is misleading: "If the total of all the weighted inputs received by a particular neuron surpasses a certain threshold value, the neuron will send a signal to each neuron to which it is connected in the next layer." This suggests that the described procedure is the only one used, which is not the case.

Britannica response: We do not accept this. The article does not imply that the described procedure is the only one used.

Reviewer comment: The following sentence is also misleading: "First, a network can be equipped with a feedback mechanism, known as a back-propagation algorithm that enables it to adjust the connection weights back through the network, training it in response to representative examples." Once again, there are many other training algorithms available in addition to backpropagation.

Britannica response: We do not accept this criticism. The article does not imply that this particular algorithm is the only one used.

Article: Nobel Prize

Reviewer comment: Bibliography lacks the two most important works on the subject, Crawford's The Beginning of the Nobel Institution (1984) and Friedman's The Politics of Excellence (2001), as well as the classic paper in *Nature* (1981).

Britannica response: We do not consider these critical omissions. Our bibliography is quite sufficient, already containing two dozen titles, including two books by Elisabeth Crawford.

Reviewer comment: Omission: That the Nobel Committee for Peace is appointed by the Norwegian Storting (Parliament). Although the committee is allegedly non-political, the appointments are very political.

Britannica response: This is not a critical omission. Our article does not discuss the means by which members of any of the awarding institutions receive their positions. To do so only for the Norwegian Nobel Committee would introduce a lack of balance and unnecessary detail into the article.

Reviewer comment: Unclear/misleading: The 1935 Peace Prize to Ossietzky was awarded in 1936 (it had been reserved in '35). This makes more sense when referring to Hitler's ban on German participation in '37.

Britannica response: We do not consider this a misleading statement. The important fact is that Ossietzky was awarded the 1935 Peace Prize. To state that the 1935 prize had to be awarded in 1936 would oblige us to explain the reason, which at this point would only distract the reader from the main point of the discussion.

Reviewer comment: "Several thousand people are engaged in the committees' efforts to determine the originality and significance of each nominee's contribution, and outside experts are frequently consulted…." Misleading - thousands participate in the nomination process, and by no means are all those who send in nominations impartial, but the actual determination of originality and significance remains with the committee. Use of outside experts is relatively recent and probably not 'frequent', at least in the sciences. The entry gives the impression that the process of evaluation entails a huge communal effort; this is not correct. More correct would be several thousand participate in the process of proposing candidates whose works are claimed to be of highest originality and significance. But evaluation of these candidates remains largely confined to the Swedish or Norwegian committees.

Britannica response: We have corrected the statement that several thousand people are "engaged" in the committees' efforts. However, we stand by our statement that outside experts are frequently consulted during the process-a reasonable statement supported by information available on the Web sites of the Nobel Foundation and the Norwegian Nobel Institute.

Article: Pheromone

Reviewer comment: One might get the impression that a pheromone is a substance, while it usually consists of several in a blend.

Britannica response: We do not accept this criticism. This article does not even discuss the composition of pheromones.

Article: Prion

Reviewer comment: The conclusion that Alzheimer disease or Parkinson disease may arise from molecular mechanisms similar to those that cause prion diseases is not valid. All these disease[s] may share common pathways leading to neurodegeneration but AD or PD are not transmissible diseases (a hallmark of prion diseases).

Britannica response: We stand by this article's statement, which does not even address causal factors-only molecular mechanisms.

Reviewer comment: It should be more clearly stated that prion proteins exist in a normal isoform which is present in all cell types of the body and may adopt a pathogenic conformation that is deleterious to neuronal cells and thus associated with the disease. (Both proteins are called prion proteins, the use of the term "prion protein" to refer only to the pathogenic form is misleading).

Britannica response: We stand by this article's clearly written account of how prions destroy nerve tissue.

Reviewer comment: The entry should refer to Griffith and Alper as the 1st scientists to propose that the infectious agent responsible for TSE may be solely composed of proteins. Prusiner then purified the prion protein form [sic] the infectious agent.

Britannica response: We stand by our editorial decision to leave references to Griffith and Alper out of this article, which focuses on the protein and the principal person associated with it. The contribution of Griffith and Alper to Prusiner's research is described in detail elsewhere in the *Britannica* corpus.

Article: Punctuated Equilibrium [actually "evolution: Gradual and punctuational evolution"]

Reviewer comment: I think this misleads the reader by using terms like "The punctualists maintain..." giving a negative impression of proponents of PE. It seems that the entry is organised as an argument against PE - and doesn't bother much to explain what PE is about.

Britannica response: We stand by this article section. It is fairly and clearly written by our author, Francisco Ayala, who has concluded that the reviewer's comment is an opinion and does not consider this passage to be inaccurate or misleading.

Article: Pythagoras' Theorem ["Pythagorean theorem"]

Reviewer comment: The Italian town is Crotona, not Crotone.

Britannica response: This accusation is simply wrong. The proper modern spelling of this town in Italy is Crotone, according to the U.S. Board on Geographic Names and several reputable atlases.

Article: Quark

Reviewer comment: Quarks possess other quantum properties, not discussed here, which are as fundamental as those which are described. In particular, quarks possess "charges" which give rise to their weak interactions.

Britannica response: This is not a critical omission, and it is not addressed in our recent revision of the article, which rightly focuses on the strong force behavior of quarks as their most important characteristic.

Reviewer comment: Second paragraph: The following statements are misleading: "Quarks appear to be truly fundamental. They have no apparent structure; that is, they cannot be resolved into something smaller." The prevailing view is that quarks are unlikely to be truly fundamental. While no experiment has to date revealed any substructure to quarks, there are strong theoretical reasons to believe that quarks are not fundamental entities, and enormous experimental effort

(including the multi-nation program of the Large Hadron Collider at CERN, in Geneva) is currently being devoted to the search for smaller or more fundamental constituents of matter.

Britannica response: We do not accept this criticism, and it is not addressed in our recent revision of the article. At the present limits of experimentally available energies, quarks are indeed indivisible. Some theorists may say that quarks can be broken into smaller entities, but this is hardly the prevailing view, and the machines that would allow these theories even to be tested will not be available for some time to come.

Article: Royal Greenwich Observatory

Reviewer comment: It was the oldest observatory, or the oldest astronomical institution NOT the oldest scientific institution (that was the Royal Society, est.1666).

Britannica response: We do not accept this. The Royal Greenwich Observatory was indeed the oldest scientific institution in the U.K. The Royal Society was not formally instituted with a home and government funds; it was a chartered association of interested persons who met in various places and raised their own funds.

Article: Royal Society

Reviewer comment: In para. 3, some of the information about current publications is wrong.

Britannica response: We do not accept this criticism. Our characterization of the *Philosophical Transactions* and the *Proceedings* is sufficient.

Article: Thyroid ["thyroid gland"]

Reviewer comment: Does not contain the information that most thyroid hormone is in the form of thyroxine and this is how it is most easily transported e.g. across the blood/brain barrier. However T3 is the biologically active form of the hormone and is produced, partly directly, but also by de-iodination of thyroxine which occurs in tissues.

Britannica response: The article does indeed "contain the information that most thyroid hormone is in the form of thyroxine" and that "T3 is the biologically active form." The metabolism of thyroxine to T3 elsewhere in the body is not a topic for this article, which is on the thyroid gland. Thyroxine-T3 metabolism is discussed elsewhere in the *Encyclopædia Britannica*—e.g., in our article on the endocrine system. Our previously arranged revision does not add anything on this thyroxine-T3 conversion, and we stand by this revision.

Reviewer comment: It does not mention the importance of iodine intake.

Britannica response: Iodine uptake is indeed discussed. Our recent revision retains this discussion, which we feel is appropriate.

Reviewer comment: It does not mention the newborn screening for congenital hypothyroidism.

Britannica response: An article titled "thyroid gland" does not need a reference to newborn screening for congenital hypothyroidism.

Article: Vesalius, Andreas

Reviewer's comment: The name of Galen is mentioned and essential for Vesal´s achievements therefore it should be mentioned that he lived from 129/130 to 199/200 A D , long before the age of Vesal and nearly nobody had dared for centuries to doubt Galen´s results.

Britannica response: We stand by this article, which refers to Galen as "the Greek physician who had served the emperor Marcus Aurelius in Rome and whose books on anatomy were still considered as authoritative in medical education in Vesalius' time." We do not consider it necessary or even helpful to distract the reader at this point with Galen's birth and death dates.

Reviewer comment: We do not know, what Vesal´s goal was, therefore "Vesalius had attained his goal" should be omitted it is a speculation.

Britannica response: We stand by this. The reference to Vesalius having attained his goal is not "speculation"; it is a reasonable scholarly conclusion expressed by the author.

Article: Wolfram, Stephen [actually not an article from the *Encyclopædia Britannica* but an entry from the 2003 *Britannica Book of the Year* entitled "Biographies: Wolfram, Stephen"]

Reviewer comments:

1. Paragraph 1, line 5 has an error. Wolfram does believe in math-based science, but not in TRADITIONAL math, so change "math-based science" to "science based on traditional mathematics."

2. Last paragraph: delete "corporate sellout and" (not true) and change "surely" to "may have."

Britannica response: We do not accept this. These are the reviewer's opinions, and he or she is entitled to them, but they do not make our author's characterization of Wolfram inaccurate. For *Nature* to judge these items inaccuracies on the basis of one reviewer's opinion is invalid. Furthermore, this is not an encyclopedia article; it is a yearbook article and was identified as such on our site. It should not have been included in a study of encyclopedias.