Special Report

Funding food science and nutrition research: financial conflicts and scientific integrity

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There has been significant public debate about the susceptibility of research to biases of various kinds. The dialogue has extended to the peer-reviewed literature, scientific conferences, the mass media, government advisory bodies, and beyond. While biases can come from myriad sources, the overwhelming focus of the discussion, to date, has been on industry-funded science. Given the critical role that industry has played and will continue to play in the research process, the International Life Sciences Institute (ILSI) North America Working Group on Guiding Principles has, in this paper, set out proposed conflict-of-interest guidelines, regarding industry funding, for protecting the integrity and credibility of the scientific record, particularly with respect to health, nutrition, and food-safety science. Eight principles are enumerated, specifying ground rules for industry-sponsored research. The paper, which issues a challenge to the broader scientific community to address all bias issues, is only a first step; the document is intended to be dynamic, prompting ongoing discussion and refinement. The Guiding Principles are as follows. In the conduct of public/private research relationships, all relevant parties shall: 1) conduct or sponsor research that is factual, transparent, and designed objectively; according to accepted principles of scientific inquiry, the research design will generate an appropriately phrased hypothesis and the research will answer the appropriate questions, rather than favor a particular outcome; 2) require control of both study design and research itself to remain with scientific investigators; 3) not offer or accept remuneration geared to the outcome of a research project; 4) prior to the commencement of studies, ensure that there is a written agreement that the investigative team has the freedom and obligation to attempt to publish the findings within some specified time-frame; 5) require, in publications and conference presentations, full signed disclosure of all financial interests; 6) not participate in undisclosed paid authorship arrangements in industry-sponsored publications or presentations; 7) guarantee accessibility to all data and control of statistical analysis by investigators and appropriate auditors/ reviewers; and 8) require that academic researchers, when they work in contract research organizations (CRO) or act as contract researchers, make clear statements of their affiliation; require that such researchers publish only under the auspices of the CRO.

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INTRODUCTION

It has been said that "scientific 'truth' is the primary aim that all should pursue in the jungle of academic-industry interactions."[1] The point of scientific endeavor, in the first place, is and should be, the pursuit of truth – nothing more, nothing less – irrespective of financial or other interactions. It goes without saying that seekers of truth must not impose preconceptions on the method or result of their search: they must not have ulterior motives. Throughout modern history, scientists have been guided by rules that ensure the integrity of the pursuit of truth, rules that continue to evolve as the research and communication landscapes change. The purpose of this article is to articulate, in the sophisticated, industrialized, modern world in which we find ourselves, principles defining and protecting the integrity and maintaining the credibility of the scientific record, particularly that part of it devoted to health, nutrition, and food-safety science.

The agricultural, food, and nutrition sciences have come to be a crucial part of evolving health research, which, in turn, plays an ever-growing role in improving the human condition. Although regarded as important determinants of human health, agricultural practices, food processing and safety, and nutritional status do not receive the same attention and funding from the federal research agencies as biomedical research. Federal funds allotted to agricultural, food, and nutrition research amount to approximately $1.8 billion annually (out of a total $2.3 billion US Department of Agriculture research budget), with most of this focusing on agricultural production; in contrast, $28.6 billion is appropriated to the National Institutes of Health.[2] Industry-funded research projects, large and small, comprise a large proportion of all food science and nutrition research[3–5] both for obvious and nonobvious reasons.* US law places the responsibility for product safety and for the truthfulness of label claims on the manufacturer. Clearly, it is in the food industry's interest to conduct the research necessary to meet the legal requirements as well as to improve food-product healthfulness, safety, accessibility, taste, cost, and attractiveness. Most of this research falls outside of the mission of traditional federal funding agencies and would not be done without food industry support. Pursuant to an extensive web of laws and regulatory requirements concerning food and food ingredients that have evolved over the past century, industry scientists and academic researchers who work with industry strive to enhance food quality, studying everything from the safety of ingredients to the evidence in support of health claims that appear on food packaging.

The rationale for food industry funding of research may be less obvious for areas such as the following: research on microbiology,[6,†] toxicology,[7–9,‡] nutrient bioavailability,[10,11] and fortification,[12] all of which lead to enhancement of human health, as well as research on animal breeding and agricultural efficiency, which helps to feed more people. Some such research will be conducted by industry, in-house, while other projects will be contracted out to academic institutions or government or contract research laboratories. Scientists, especially novice researchers, conducting investigations in any of these settings, need principles upon which to rely in conducting their research ethically and with integrity. Clearly, it is essential to preserve the integrity and credibility of food and nutrition science for the benefit of public health and understanding.

In recent years, a growing body of literature has evolved on the subject of conflicts of interest and their potential influence on the integrity of researchers and the scientific record. In these discussions, conflicts are typically treated as disqualifying factors in scientific papers and research; that is, scientists with conflicts of interest are viewed in the literature as being at least partially integrity-compromised, and, even with complete and open disclosure, are regarded, at least to an extent, as of suspect scientific credibility. It is hoped that this article will define and clarify the highly complex issues involved in questions of conflict and scientific bias, particularly with regard to the portion of research funding that originates with the food industry.

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In the interest of beginning this crucial dialogue in a sharply defined and dispassionate manner, the focus of this article will be limited to only one very specific issue and its relationship to bias: financial conflicts of interest and, specifically, funding-based conflicts. It must be pointed out that there is a potential for all funding, from whatever source, public or private, government or industry, to bias behavior, unconsciously or otherwise. The focus of the current article will be on the management of potential bias from industry funding of science. Our goal is to separate monetary considerations from the science – including research design, execution, reporting, publishing, and other factors.

HISTORICAL CONTEXT

From its beginning, the food industry has concerned itself with researching food products and ingredients from the perspective of safe and efficient delivery of food to a rapidly expanding population. Prior to World War II, the overwhelming bulk of food research was funded and carried out by food-industry scientists – there was little public funding of food safety and nutrition research. It was the evolution of American society from the laissez faire environment that existed during the industrial revolution to the complex, public/private sector mixed economy of the more recent past that transformed research funding and higher education in general.

Although the food industry first entered the era of managing financial conflicts in the late 18th century, with the development of proprietary technologies to enhance food preservation and safety, the post-World War II period saw an exponential increase in the administrative challenges of research funding. For example, the number of patents awarded to universities or academic researchers increased by a factor of 10 in the last 2 decades of the last century.[13] Similarly, federal funding of research increased from $405 million to $1.7 billion in a single decade (1960–1970) after the launch of the space race between the United States and the Soviet Union.[14]

In the decades after World War II, in addition to the significant increases in government funding of university research, the United States experienced, in general, rapid evolution of science and technology, transformation and consolidation of agricultural production, and the steady growth of industry, especially those companies involved in public health – in the medical/pharmaceutical, chemical, and food industries. In late 1980, the US Congress passed the Bayh-Dole Act, with the specific intention of stimulating the transfer of technology from government-funded university research to the private sector.[15] This has not been without controversy – both over issues around the diversion of university faculty from basic research and around conflict of interest concerns due to the resulting university-industry partnerships.

The research community and individuals involved in health communications and public policy advocacy became increasingly concerned about the possibility that exogenous interests might influence published results of scientific research.[16,17,§] By late 2000, this concern had become heightened around medical/pharmaceutical practice: a number of articles appeared in the major medical journals[18,19] exploring the financial relationships of the pharmaceutical industry and physicians and their possible effect on physicians' decisions about patient treatment, researchers' decisions concerning study design, and companies' interference in publication, as well as on public health policy in general. Medical and other scientific journals began establishing rules for disclosure of financial conflicts, in an attempt to manage them.

In succeeding years, concern broadened to include other industries, more recently the food industry, with authorities questioning how financial conflicts might impinge on the outcomes of health, nutrition, and food safety research. It was generally acknowledged that the issue was complex and not susceptible to narrow or inflexible remedies, but that has not deterred some groups from concluding that industry-funded science is inherently biased,[20,21] demanding that all industry-funded research whether conducted at contract research facilities or at universities be denied consideration in the formulation of public policy, and also demanding that scientists who have conducted industry-funded research be barred from serving on public policy advisory committees.[22] It is this paper's contention that such efforts are helpful neither to the public nor to the scientific community. Industry funding, while a major component of the scientific landscape, is only one piece of an extremely complex research environment. The twin issues of financial conflict and bias demand a more reasoned approach and skillful management.

DEFINING THE ISSUE

First of all, conflicts of interest are not, in themselves, determinants of bias. Even a massive multiplicity of conflicts, in and of itself, carries with it no certainty of bias.

Begin with definitions – although there are many, the simplest suffice:

Conflict of interest: "A conflict of interest is 'a conflict between the private interests and the official responsibilities of a person in a position of trust.' A conflict of interest thus arises when a person has to play one set of interests against another."[23]

Bias: From the online *Oxford English Dictionary*, bias is an "inclination or prejudice in favour of a particular

person, thing, or viewpoint."[24] "A cognitive bias is something that our minds commonly do to distort our own view of reality."[25]

Or, more rigorously, *bias* is a deviation of either inferences or results from the truth, or any process leading to that kind of systematic deviation. This includes tendencies by which data are reviewed or analyzed, interpreted or published, in a way that yields conclusions that deviate systematically from the truth.[26,27,‖]

So, for example, for researchers, a *conflict* might describe a situation in which a funder has offered financial incentives for research and hopes for a particular research result; it might also describe a situation in which the researcher, for philosophical, religious, or professional reasons, wishes to achieve a certain result. Neither situation necessarily results in a *biased* result – that would depend on a measurable deviation of research results from "the truth" – although much of the literature regrettably confounds *bias* and *conflict*. For that matter, much of the literature confuses conflict with a particular kind of conflict – financial. Unfortunately, even if all conflicts were banished forever, there would still be myriad sources of bias.

There are, for example, the following well-known forms of scientific and publication bias:[28,¶] sample-selection bias, sample-size bias, data-collection bias, data-quality bias, statistical-analysis bias,[29] confounding-variable bias, and publication bias.[30] These are just a few of the more commonly encountered pitfalls leading to skewed research conclusions, but these scientific sources of bias may be easier to identify than other cognitive and emotional causes having nothing to do with the formal research process. Consider the following possible sources of bias: one's previous body of work; one's desire for fame and respect among peers (or, alternatively, desire to achieve iconoclastic stature); religious bias; ethical or values-based bias; philosophical bias; political bias; one's nationality or ethnicity; pressure to publish;[31,#] pressure to win prizes; fear of losing one's job or position; highly personal matters, such as one's physical or mental health issues or one's family's health; the pernicious effect of pack behavior or "group think" facilitated by social or professional networks, either in the physical world or in cyberspace; blogs, Web sites, chat rooms, list serves, and other communication tools of the Internet; financial or funding bias (resulting from all kinds of financial incentives, including gratuities, bribes, grants, free trips, gifts, and cash prizes or the desire to please one's source of funding, either unconsciously or by deliberate arrangement).

The multiplicity and variety of sources of bias in research and in public-health communications generally are extensive, complex, and yet of major importance to scientific research, the integrity of individual study, and the body of scientific literature as a whole. Strategies must be developed for addressing and managing all sources of bias, whether technical, statistical, cognitive, or emotional in origin. These are critically necessary, not just for the scientific community, but also for the well-being of the public. The interpretation of health research and the promotion of public policies resting on that research are far too important to be based on formulas that would address conflicts at the price of excluding the input of a large proportion of food-safety and nutrition scientists.

EXISTING CHECKS ON BIAS

As far as scientific research and communications are concerned, there exist a number of checks to ensure adherence to good practice and to avoid biased conclusions (of course, replication and coherence of scientific findings are the major mechanism by which bias in research is controlled – this section is intended to summarize post-research control mechanisms). First and foremost is the system of scientific peer review that is built not only into publication in scientific journals, but also into the promotion and tenure decisions for individual faculty conducting research at colleges and universities. There are the governance and review processes of academe, in exercising oversight, particularly on industry-funded research projects. Charges of irregularities, errors, and outright scientific fraud are usually investigated by the academic institutions where the research is conducted. However, in one noteworthy case in recent years, a distinguished nutrition researcher resigned his university position fully 9 years after initial charges of fraud were filed in connection with his infant-formula study. In the university's subsequent report, the authors recommended the government monitor scientific misconduct through a new national agency "charged with all aspects of science, *irrespective of funding sources, public or industry* (emphasis added)."[32]

Most importantly, there is peer pressure as a check on bias, the peer pressure of meetings, conferences, e-mail listservs, and discussion boards run by scientific colleagues and, especially, the process of peer review, particularly relied upon by the thousands of scientific journals around the world, but also by other organizations.[33,**] For more than a century, peer review has served to provide a rigorous framework by which research papers and articles can be evaluated prior to their general dissemination – although not foolproof, scientists regard the process as a reliable safeguard against errors and biases, as well as scientific misconduct. However, in recent months a robust debate has been generated about peer review and whether it needs to be refined.[34,35] Donald Kennedy, the former editor-in-chief of *Science*, the journal of the American Association for the Advancement of Science, has offered an eloquent defense of the current peer review process as ". . . a fair system of evaluating and

publishing scientific work – one that offers high confidence in, though not an absolute guarantee of, the quality of the product."[36]

If all of these fail, there is a governmental oversight structure within the granting agencies, such as the Office of Research Integrity in the US Department of Health and Human Services, whose function it is to set policies for government research grants, establish reporting standards, and investigate misconduct.[37] There are the national and local volunteer health organizations that review health science as it unfolds. And, finally, there are the following checks on bias: science writers and journalists, who attend scientific conferences, digest new studies, and communicate them to the public; science associations, such as the National Science Foundation and the National Academies of Science, which regularly review new research and publish articles that are, in turn, read and commented on by member scientists; Congressional hearings that bring to light and publicize the real or perceived biases arising from too-close relations between industry and academia; and, ultimately, public disgrace when research is revealed as deeply flawed.

In any case, given the increasingly broad and complex nature of scientific research and communications, additional recommendations are appropriate for managing the extremely complex issues of financial conflicts and potential bias.

PROPOSED GUIDELINES ON INDUSTRY FUNDING OF RESEARCH

Recognizing that funding, whether through the private or public sector, does not automatically introduce bias into scientific research, it is nonetheless prudent to address both the possibility of bias and the perception of it through explicit guidelines. Based on work commissioned by the International Life Sciences Institute (ILSI) North America Working Group on Guiding Principles, a series of proposals was developed to manage potential biases resulting from conflicts of interest between research investigators and companies wishing to fund their work.

It is our view that disclosure is an essential, but no longer a sufficient, measure to safeguard research from undue influence exerted by funding organizations; managing conflicts, case by case, is the requisite step – managing, that is, by establishing procedures, like the following guidelines, for ensuring research integrity. This should apply across the array of mechanisms through which research is funded currently: in intramural industry and government laboratories; in sponsored grants and contracts; in cooperative agreements, Cooperative Research and Development Agreements, and "platforms" funded jointly by governments and industry, as is the case in the European Union and Australia. While there may be a multitude of mechanisms by which research is funded, designed, conducted, and communicated, these guidelines should be adhered to by all parties, in all respects, in the spirit of openness and honesty that are the aim of this paper (see the footnote to #2 in the guidelines below).

It is also our view that industry participation in the effort to disclose and manage financial conflicts of interest is crucial. Future university-level science students will find their way either into private-sector research occupations or public-sector careers. All need a set of principles to guide their interaction with funding organizations, whether public or private, just as those organizations need principles to guide them in their interactions with academic scientists. Consequently, we propose the following guidelines to serve as a checklist in achieving unbiased research results from industry-funded activities – just as they might be useful guidance in public- or foundation-funded projects.[38,††]

GUIDING PRINCIPLES

In the conduct of public/private research relationships, all relevant parties shall:

1. conduct or sponsor research that is factual, transparent, and designed objectively; according to accepted principles of scientific inquiry, the research design will generate an appropriately phrased hypothesis and the research will answer the appropriate questions, rather than favor a particular outcome;
2. require control of both the study design and the research itself to remain with scientific investigators;[39–42,‡‡]
3. not offer or accept remuneration geared to the outcome of a research project;
4. prior to the commencement of studies, ensure that there is a written agreement that the investigative team has the freedom and obligation to attempt to publish the findings within some specified timeframe;[§§]
5. require, in publications and conference presentations, full signed disclosure of all financial interests;
6. not participate in undisclosed paid authorship arrangements in industry-sponsored publications or presentations;
7. guarantee accessibility to all data and control of statistical analysis by investigators and appropriate auditors/reviewers;[‖‖] and
8. require that academic researchers, when they work in contract research organizations or act as contract researchers, make clear statements of their affiliation; require that such researchers publish only under the auspices of the contract research organizations.

IMPORT AND IMPLICATIONS OF THE GUIDELINES

Obviously, guidelines are just . . . guidelines. They are not law, but if the research community embraces them, or even embraces their spirit, we believe there will be a profoundly beneficial effect on the quality and integrity of research – encouraging responsible oversight and stewardship of scientific research by all funding organizations. Following the guidelines will doubtlessly lead to closer and more open communication between funding bodies and researchers, resulting in a new spirit of collaboration. Still, it must be stressed that each organization wishing to adopt these guidelines needs to develop its own quality-control mechanism to ensure significant compliance.

A strong peer-review system coupled with open declarations of research sponsorship in all scientific communications is a mandatory prerequisite for these guidelines to be effective. The second prerequisite is that university and industry policies be promulgated to address the issues raised in these guidelines regarding control of the design and conduct of the research and its publication. It is the responsibility of both the funding entity and the researcher(s) being funded to adhere to the guidelines; existing oversight structures are also encouraged to endorse and adhere to them. Furthermore, it should be understood that failure to embrace the guidelines would raise serious questions about any research project so conducted.

It has been suggested that, in the past, industry-funded research may have revealed a bias toward results favored by the food industry.[21,43] The authors of one publicized study[4] reaching that conclusion proposed several explanations: 1) that food industry companies may wish to demonstrate the superiority of their products to those of competitors; 2) that investigators are influenced by their funding in formulating their research design and/or hypotheses; 3) that industry sponsors of research may suppress unfavorable results; 4) that authors of scientific reviews may deliberately bias their searches and interpretations to the benefit of their industry funders; and 5) that scientific reviews may disproportionately represent studies "arising from industry-supported scientific symposia". Such criticism overlooks the fact that most university research is basic in nature and that companies frequently enter into research agreements with university faculty at a point at which preliminary experiments (whether conducted in the faculty member's lab or the company's lab) have established the proof of concept and, therefore, the likelihood that the research will have positive results is enhanced.

Notwithstanding the obvious observation that scientific reviews conducted by *non*-industry-supported authors are also subject to many potential biases, the eight principles articulated in this paper address all of these possible sources of skewed research. Indeed, if these principles are vigorously adopted as the guidelines they are intended to be, there would be virtually no reason to quarrel with a research conclusion except by disputing the science itself.

In fact, the eight principles articulated here are intended to provide a clear statement of responsibility on all sides – those that are funding activities as well as those being funded – when academic institutions or academicians are recipients of industry funding for research, publication, or presentation. The principles are intended to offer guidance for the food industry and academic researchers who work with industry, when industry-funded research projects are involved. They may be thought of as a checklist to help ensure insulation of any research project from the provision of the resources enabling the project.

Finally, the guidelines are offered as only a first step in creating a firewall against bias in research: this paper is intended to be a dynamic document, prompting ongoing discussion and refinement of the guidelines it presents.

A CHALLENGE TO THE BROADER COMMUNITY

The objectives outlined above may be worthy, though not easy to achieve. But these principles can also serve as an invitation to the broader scientific, science communications, and public policy communities to embrace similar pledges to immunize their work against the myriad potential sources of bias – non-financial as well as financial conflicts. The present article has been necessarily confined to one relatively small aspect of an extremely complex issue. But future discussions could be much wider ranging and much more comprehensive, by embracing all sources of bias and expanding the focus from the very narrow issue of potential bias due to financial conflicts of interest.

Consider the extensive list of biases touched on at the end of the section on definitions above: how constructive might it be for the broader scientific, communications, and public policy communities to adopt guidelines to ensure that their work is free from bias? For example, such guidelines might include pledges of transparency (e.g., voluntary disclosure of all previous research, published articles, and/or policy positions that might influence the present research, article, policy position); disclosure of sources of funding (both of the project at hand and overall funding); disclosure of other potential biases (such as philosophical, religious, ethical, or political orientation; intention to publish or otherwise garner public or political authority or power through publicity; previously announced public positions that might be relevant to the work at hand) and so forth.

Other researchers or groups that are not supported by the food industry (e.g., nongovernmental organizations, foundations, and advocacy or consumer groups) might include in their public communications appropriate promises that their work, to the extent possible, is open and objective (not skewed to a particular conclusion or philosophical view) and controlled by the researcher or cited authority (rather than by a hidden funder or interested party). The checklist provided in the section above on the guidelines' import and implications might prove helpful in designing similar guidelines for other groups.

EXCLUDED ISSUES

It is important to state explicitly what this paper has excluded from consideration. Notwithstanding that all scientific research, whether funded by industry or not, should be subject to the same ethical rules, discussion of all of the following potential institutional sources of bias that can affect the integrity of the published scientific record has been specifically excluded from this paper: foundation-funded research; government-funded research; and work by academicians on advisory panels to industry, grant panels, government advisory panels, nongovernmental organization panels, and voluntarism on behalf of professional societies.

This is a short list of organizational work and funding situations that routinely pose profound challenges to the independence and integrity of scientific research – the list could certainly be lengthened. All these potential sources of bias are outside and beyond the scope of this article, but it is suggested that future papers might explore the ramifications for inappropriate influence of such organizational bias on research or public policy. And it is strongly urged that future investigations into this area be sufficiently broad as to include the many nonscientific and other institutions that routinely play a communications role in science-based public policy.

CONCLUSION

We could lament that this entire effort to manage conflicts of interest and to banish bias in science, is, alas, insufficient. It would be easy to complain that the financial and other pressures on research are too great to channel them neatly. And there are those who will argue that a mere set of guidelines cannot immunize science from error, misinterpretation, or deliberate miscalculation. We have deliberately left aside, for the time, the matter of enforcement mechanisms for these or any guidelines, believing instead that achieving a consensus on best practices in managing conflicts must certainly come before establishing sanctions for failing to adhere to best practices. As professional scientific societies, industry groups, and other organizations that engage regularly with researchers adopt a common set of rules by which to manage these difficult issues, enforcement of guidelines will automatically become increasingly less problematical.

In the end, management of conflicts of interest, and, for that matter, management of scientific biases altogether is a matter of consensus building, not enforcement. And if our choice is to indulge in more of the self-recriminations that have gone on for far too long already, or to construct a workable start to a solution, the path is obvious: it is time to act.

The interpretation of health research and the promotion of public policies resting on that research are far too important for us not to address and try to manage the myriad potential biases that can intrude. Let this effort be a start.

ENDNOTES

* See Fuglie et al.;[3] also see Lesser et al.,[4] which asserts that roughly 29% of beverage research was fully or partially funded by industry. A study by Thomas et al.[5] concluded that roughly 60% to 65% of long-term (1 year or longer) weight-loss trials were funded by industry.

† For industry-funded research that enhanced microbiological safety of food, see Tanaka et al.[6] This research, concerning safety of cheese products, was the precursor to the field of microbiological predictive modeling, which is now widely used by food processors and regulatory agencies to predict the safety of formulated foods.

‡ For beneficial food-industry toxicological research (i.e., research promoting better public health), which was incidentally shared with the US Food and Drug Administration prior to journal publication, see Velasco[7] and Pittet.[8] For US Food and Drug Administration aflatoxin information, see the *Foodborne Pathogenic Microorganisms and Natural Toxins Handbook*.[9]

§ A case in point, the US Food and Drug Administration's refusal in the early 1960s to approve the drug thalidomide, marketed in Europe as a tranquilizer, for use in pregnant women, despite the German manufacturer's "scientific" assurances of its safety. See Burkholz[16] and Silverman[17] for a case history.

‖ For a discussion of bias and the distinction between *bias* and *conflict of interest*, see publications by the National Academy of Sciences[26] and the Federation of American Societies for Experimental Biology.[27]

¶ The sample may not be representative of the population – may be too small; data collection may occur by inappropriate self-reporting or be inaccurately recorded; sample groups may be inappropriately grouped for analysis; confounding variables misjudged or unidentified; journals may refuse to publish null or negative results, or research on issues judged unpopular – all of these applications of scientific process may result in biased conclusions, without the researchers even being aware. For a fuller discussion, see Bulgar et al.[28]

Pressure to publish can also lead to journal-promoted biases, as cited in a recent article by Butler.[31]

** For an organizational example of applied peer review, visit the National Institutes of Health Office of Extramural Research Web site,[33] where the process is used to sift through the many funding applications received by the National Institutes of Health.

†† Note the issues raised in the public health research community over a perceived disproportionate influence of one foundation's funding, documented in recent media coverage.[38]

‡‡ This guideline, separating the science from the funding of it, will be fulfilled in a variety of ways, depending on the specific funding mechanism utilized in a given research project. For descriptions of the significant variety of research arrangements currently used, see guidance offered by the National Institutes of Health;[39] an excellent analysis of conflict of interest management with respect to the varied research funding mechanisms is also offered by the Federation of American Societies for Experimental Biology.[40–42]

§§ For purposes of this guideline, the investigative team may include employees of the sponsoring entity; researchers should agree or commit to publish findings on the key questions/hypotheses they investigate in the study(ies).

‖‖ This guideline is intended to apply to investigators not associated with the funding entity and appropriate scientific auditors – it is not intended to guarantee availability of research data to the general public.

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REFERENCES

1. Eisman JA, Lorenzo JA. Challenges in science and academic-industry interactions. J Bone Miner Res. 2007;22:1654.
2. U.S. Office of Management and Budget. Budget of the United States Government, fiscal year 2006. Available at: http://www.whitehouse.gov/omb/budget/fy2006/. Accessed on August 18, 2008.
3. Fuglie K, Ballenger N, Day K, et al. Agricultural research and development: public and private investments under alternative markets and institutions. U.S. Department of Agriculture Economic Research Service Web site. Available at: http://www.ers.usda.gov/publications/aer735/. Accessed on August 18, 2008.
4. Lesser LI, Ebbeling CB, Goozner M, Wypij D, Ludwig DS. Relationship between funding source and conclusion among nutrition-related scientific articles. PLoS Med. 2007;4:e5.
5. Thomas O, Thabane L, Douketis J, Chu R, Westfall AO, Allison DB. Industry funding and the reporting quality of large long-term weight loss trials. Int J Obes (Lond). 2008;32:1531–1536.
6. Tanaka N, Traisman E, Plantinga P, et al. Evaluation of factors involved in antibotulinal properties of pasteurized process cheese spreads. J Food Prot. 1986;49:526–531.
7. Velasco J. Determination of aflatoxin in peanut and cottonseed soapstocks [letter to the editor]. J Am Oil Chem Soc. 1970;47:414.
8. Pittet A. Keeping the mycotoxins out: experience gathered by an international food company. Nat Toxins. 2006;3:281–287.
9. U.S. Food and Drug Administration. *Foodborne Pathogenic Microorganisms and Natural Toxins Handbook*. Available at: http://www.cfsan.fda.gov/~mow/chap41.html. Published on January 1992. Updated on December 28, 2007. Accessed on March 7, 2008.
10. Davey MW, Van Montagu M, Inzé D, et al. Plant L-ascorbic acid: chemistry, function, metabolism, bioavailability and effects of processing. J Sci Food Agri. 2002;80:825–860.
11. Heaney RP, Davies KM, Chen TC, Holick MF, Barger-Lux MJ. Human serum 25-hydroxycholecalciferol response to extended oral dosing with cholecalciferol. Am J Clin Nutr. 2003;77:204–210.
12. Zhao Y, Martin BR, Weaver CM. Calcium bioavailability of calcium carbonate fortified soymilk is equivalent to cow's milk in young women. J Nutr. 2005;135:2379–2382.
13. Bremer HW. University technology transfer: evolution and revolution. In: *Council on Governmental Relations: 50th Anniversary – Journal of Papers*. Washington, DC: Council on Governmental Relations; 1998:25. Available at: http://cogr.edu/docs/Anniversary.pdf. Accessed on March 28, 2008.
14. Norris JT, Youngers JA. Sponsored program offices in higher education: a continuing evolution responding to federal requirements. In: *Council on Governmental Relations: 50th Anniversary – Journal of Papers*. Washington, DC: Council on Governmental Relations; 1998:33. Available at: http://cogr.edu/docs/Anniversary.pdf. Accessed on March 28, 2008.
15. Patents under the Bayh-Dole Act of 1980. National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) Web site. Available at: http://www.niddk.nih.gov/patient/patent.pdf. Accessed on April 1, 2008.
16. Burkholz H. Giving thalidomide a second chance. U.S. Food and Drug Administration Web site. Available at: http://www.fda.gov/fdac/features/1997/697_thal.html. Accessed on March 7, 2008.

17. Silverman WA. The schizophrenic career of a "Monster Drug." Pediatrics. 2002;110:404–406.
18. Martin JB, Kasper DL. In whose best interest? Breaching the academic–industrial wall. N Eng J Med. 2000;343:1646–1649.
19. DeAngelis CD. Conflict of interest and the public trust [editorial]. JAMA. 2000;284:2237–2238.
20. Weaver, J. Negative health effects of soft drink consumption confirmed in study. Yale Bulletin & Calendar. 2007;35. Available at: http://www.yale.edu/opa/arc-ybc/v35.n21/story12.html. Accessed on March 5, 2008.
21. Center for Science in the Public Interest. New aspartame safety review "perfectly predictable." Available at: http://www.cspinet.org/new/200709122.html. Published on September 12, 2007. Accessed on March 5, 2008.
22. Letter to U.S. Food and Drug Administration from a consortium of consumer groups. Center for Science in the Public Interest Web site. Available at: http://www.cspinet.org/new/pdf/20071203_final_letter_to_fda_re_proposed_coi_guidance_in_wake_of_erg_report.doc. Published on December 3, 2007. Accessed on March 5, 2008.
23. Coughlin SS, Soskolne CL, Goodman KW. *Case Studies in Public Health Ethics*. Washington, DC: American Public Health Association; 1997.
24. Oxford University Press. Oxford English Dictionary. Available at: http://www.askoxford.com/concise_oed/bias?view=uk. Accessed on April 22, 2008.
25. Meredith W. Twenty-six reasons what you think is right is wrong. Healthbolt. Available at: http://www.healthbolt.net/2007/02/14/26-reasons-what-you-think-is-right-is-wrong/. Published on February 14, 2007. Accessed on December 23, 2007.
26. The National Academies. Policy on committee composition and balance and conflicts of interest for committees used in the development of reports. Available at: http://www.nationalacademies.org/coi/bi-coi_form-0.pdf. Published on May 12, 2003. Accessed on August 16, 2008.
27. Federation of American Societies for Experimental Biology. Guiding principles. In: Recommendations, Tools, and Resources for the Conduct and Management of Financial Relationships Between Academia and Industry in Biomedical Research. Available at: http://opa.faseb.org/pages/advocacy/coi/guiding_principles.html. Accessed on August 16, 2008.
28. Bulgar RE, Heitman E, Reiser SJ. *Ethical Dimensions of the Biological and Health Sciences*. Cambridge, UK: Cambridge University Press; 2002.
29. Bailar JC 3rd. Science statistics and deception. Ann Intern Med. 1986;104:259–260.
30. Allison DB, Faith MS, Gorman BS. Publication bias in obesity treatment trials? Int J Obes Relat Metab Disord. 1996;20:931–937.
31. Butler D. PLoS stays afloat with bulk publishing. Nature. 2008;454:11.
32. Pencharz PB. An examination of research integrity issues pertaining to Memorial University. Available at: http://www.mun.ca/marcomm/public_affairs/issues/pencharz_report_2007.pdf. Published January 2007. Accessed on March 3, 2008.
33. National Institutes of Health (NIH) Office of Extramural Research. Peer review policies & practices. Available at: http://grants.nih.gov/grants/peer/. Accessed on March 5, 2008.
34. Nature Publishing Group. *Nature's* peer review debate. Available at: http://www.nature.com/nature/peerreview/debate/index.html. Accessed on March 5, 2008.
35. Center for Science in the Public Interest, Integrity in Science Watch. Groups decry broken peer review process at EPA. Available at: http://www.cspinet.org/integrity/watch/200709172.html#1. Published on September 17, 2007. Accessed on March 5, 2008.
36. Kennedy D. Confidential review – or not? [editorial]. Science. 2008;319:1009.
37. U.S. Department of Health and Human Services. Office of Research Integrity Web site. Available at: http://ori.dhhs.gov/. Accessed on March 5, 2008.
38. McNeil DG Jr. Gates Foundation's influence criticized. *New York Times*. February 16, 2008. Available at: http://www.nytimes.com/2008/02/16/science/16malaria.html?_r=1&sq=gates%20foundation&st=nyt&oref=slogin&scp=3&pagewanted=print. Accessed on March 7, 2008.
39. National Institutes of Health. Office of Extramural Research Web site. Available at: http://grants.nih.gov/grants/funding/funding_program.htm. Accessed on August 17, 2008.
40. Federation of American Societies for Experimental Biology (FASEB). COI Toolkit: Recommendations, tools, and resources for the conduct and management of financial relationships between academia and industry in biomedical research. Available at: http://opa.faseb.org/pages/Advocacy/coi/Toolkit.htm. Accessed on August 17, 2008.
41. Federation of American Societies for Experimental Biology. Points for consideration in academic-industry relationship agreements. Available at: http://opa.faseb.org/pages/Advocacy/coi/PointsForConsideration_Agreements.pdf. Accessed on August 17, 2008.
42. Federation of American Societies for Experimental Biology. Conducting research. Available at: http://opa.faseb.org/pages/Advocacy/coi/investigators_conducting_research.html. Accessed on August 17, 2008.
43. Williamson E. Farming critics fault industry's influence. Wall Street Journal. April 30, 2008. Available at: http://online.wsj.com/article/SB120951584294254683.html. Accessed on August 17, 2008.