

# Ethics and Integrity in Science

## Dr. Kathleen S. Matthews

The nature of science is cumulative, building upon past discovery to open new insights into the natural world. This unique character of the research enterprise demands a



*Kathleen S. Matthews*

high level of trust in the knowledge base upon which the next steps are constructed. As a consequence, the expectation of ethical behavior in the scientific community is very high. If the foundation for an experiment or theory has been flawed by intention, significant effort and expense are wasted, and careers can be compromised. This need for confidence in the work of others and awareness

that intentional flaws or deceit are necessarily uncovered in attempts to replicate or expand research findings come together to drive a high level of ethical conduct in the scientific community. Each individual scientist inevitably brings a set of perceptions with the potential to bias theory/experimental design or even interpretation, but the multiplicity of critiques that any discovery must undergo — from laboratory group discussions to peer review — ensure a wide variety of corrective inputs.

Intentional violations of the expectations of accuracy in gathering, reporting, and interpreting data or formulating theories are effectively anti-science. Indeed, the fundamental importance of behavior that aligns with the expectations of the profession is reflected in the institution of systems within federal funding agencies to promote research integrity and, when necessary, to investigate lapses in ethical conduct of research. The Office of Research Integrity at NIH, <http://ori.hhs.gov/>, provides links to the research misconduct policies for many federal agencies. The emphasis on this issue is also seen in the requirement for instruction in the ethical conduct of research — from how to collect and analyze data and report results to treatment of animal and human subjects — associated with training grants from federal sources.

The challenges become even more complex for research involving human subjects. For example, “informed consent” is required for participation in clinical research trials, and a widespread view is that this consent is sufficient to render clinical

research ethical. However, others have argued that “informed consent is neither necessary nor sufficient” [1] to establish an ethical base for research involving humans and that a larger set of questions must be addressed before individuals should be enlisted for clinical studies. Ethical lapses of commission or omission in clinical studies have the potential for dire consequences to the participants.

Beyond the larger issues, including fabrication or falsification of data, plagiarism, and other types of misconduct, ethical questions reach deeply into the scientific process and have been addressed from many perspectives [e.g., 2]. One of the most important concerns regards management of data. Interestingly, the majority of research misconduct findings in the federal review processes involve data falsification and fabrication, some simply as the result of poor data recording and management. For this reason, data management practices are emphasized in training scientists. How data are collected and recorded determine their reliability, and undergraduate teaching laboratories make significant efforts to guide students in developing good habits for the future. Data interpretation is particularly important — all data collected should be utilized in framing interpretations and developing hypotheses. Thus, data “selection” is not acceptable, and data inconsistent with the hypothesis guiding the experiments should never be withheld or ignored.

An area of particular concern in the modern computer age is the capacity to manipulate images and datasets, or even fabricate them to one’s own end. This area is of particular concern as the

visual images and data from a variety of sources are digitally recorded and maintained. The conclusions from such fabricated or distorted data can be particularly destructive, both undermining others working in the same area and eroding confidence in the scientific enterprise itself.

The impact of scientific misconduct is reflected in its

own entry in Wikipedia ([http://en.wikipedia.org/wiki/Scientific\\_misconduct](http://en.wikipedia.org/wiki/Scientific_misconduct)), with a section that details this subject further and provides links to renditions of high profile examples of research misconduct. Recent examples include a prominent scientist from Seoul National University (Korea), who was indicted for embezzlement and for fraud based on fabricated data in reports on generating human embryonic stem cells; a research scientist from Bell Labs, who was fired and his doctoral degree revoked by the University of Konstanz for using falsified data in publications

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reporting single-molecule semi-conductor technology; and a professor at the University of Vermont, who, in 2006, was the first academic ordered to serve federal prison time for falsifying data in a research grant application to the NIH and was also found to have fabricated data in ten different published papers. As is evident, the consequences to the perpetrators, as well as to those attempting to replicate fabricated work, can be disastrous.

The ethical responsibilities of scientists encompass not only exercising a high level of integrity in our work, but also include understanding the social and ethical implications of our research [3]. Sharing our excitement in understanding the world/universe and enticing others to engage in that process are part of helping embed science as a part of our society. In particular, scientists are important players in making new policy, and finding a path that introduces our knowledge base into the complexities of political decision-making must be placed in an ethical framework. Roger Pielke [4] has suggested a variety of ways in which scientists can engage in sharing their experience and insight in creative, ethical, and useful ways. Rice University's Baker Institute for Public Policy (BIPP) has been active in inviting scientists to share their expertise and in providing a variety of venues for reflection and discussion. Students interested in becoming involved can engage through the student arm of BIPP or contact Kirstin Matthews (krwm@rice.edu).

Ethical conduct is important in all aspects of our lives, but the very nature of science demands a high level of integrity. Indeed, the essential process of science with its accumulation of knowledge cannot function without honest disclosure. We rely on the honor of our colleagues and their scrupulous efforts to report their observations accurately. Without this element, the structure that we are building will be flawed and eventually collapse. That is not to say that scientists interpret all data correctly or that unintentional mistakes do not occur, but the primary intent required of the scientist is to report what is observed as honestly and completely as possible. What scientists have interpreted incorrectly will be discovered and set right as an integral part of the larger collective process. The necessity for correction because of intentional deceit corrosively undermines the scientific community.

The excitement of science is found in the effort to answer current questions about how things work and then pose new questions unanticipated by present knowledge. Since we often do not recognize what we do not know, a single breakthrough can open unimagined new horizons and render significant change, both in science and society. The discoveries of restriction enzymes, the magnetic properties of atomic nuclei, or Buckyballs (right here at Rice) are examples that have opened whole new territories for investigation and evoked

substantial societal change. For example, without our knowledge of the magnetic properties of nuclei, invasive surgery rather than simple MRI scans would be needed to "see" what is happening inside our bodies.

The on-going scientific process of opening and exploring new territory at the frontiers of knowledge is highly robust because the discovery of error — intentional or otherwise — is inherent in the system. Most scientists exercise a high degree of integrity precisely because the journey beyond the far horizons of our current understanding is exhilarating and we wish nothing to impede our pioneering expeditions into the unknown!

*Dr. Kathleen S. Matthews is the former Dean of Natural Sciences and a Stewart Memorial professor of Biochemistry & Cell Biology.*

### References

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