The Ethics of Biochemistry

By Ethan Burghardt

With recent advances in biochemistry, it is becoming increasingly difficult to determine what is considered ethical and what should remain morally impermissible. It is clear that scientific advances are permissible as long as they are always beneficial and do not have the potential to be harmful. This conclusion can be drawn from past benefits of biochemistry, ethical codes of current institutions, and the consensus of experts in biochemistry.

The Promises and Perils of Biochemical Advances

The past benefits of biochemistry are quite extensive. Initial discoveries were small but impactful, such as the study of fermentation. The basic understanding of enzymes that was derived from this study became the foundation of one of the most important pillars of science today. Biochemistry was a rather static field until 1953 when the structure of DNA was discovered by Watson, Crick, and Franklin. After this discovery, scientists were given the building blocks of all life, and they naturally wanted to use it for their own purposes (Fruton 1973). Although this advance appears very menacing and unnatural, drawing to mind the picture above, typical of common fears about dangerous and unnatural "Frankenfoods," the advances of biochemistry have actually affected human lives in numerous taken-for-granted, yet beneficial ways.

One of the most prominent examples of is genetically modified organisms or GMOs for short. Scientists have been able to take DNA sequences from different organisms and give them to organisms that otherwise would not have them. A good example of this is something called BT corn. Over the last decade, the prominence of this species of corn has risen to almost 90% of our natural corn supplies. But what is BT corn? Using biochemical techniques, this species of corn was given genes from *Bacillus thuringiensis*, a bacterium that produces natural insecticides and tolerance to many insecticides that are sprayed over crops. Now, farmers have the ability to plant crops without spraying chemical treatments over them. This practice not only saves costs, but also greatly reduces the quantity of nitrates and phosphates that are present in our ecosystem, which is proven to have negative impacts on the environment (Yang et al 2017). Another application of recent biochemistry is in rice, which is a crop that over half of the world's population depends on as a staple food. Transgenic technology has been used to optimize the phenotypic traits of rice, including hardier growth, drought resistance, and higher produce yields. A specific subspecies called "golden rice" has been given genetics from various species, which allows the rice to produce omega oils, vitamin D, and many nutrients found in other foods. This rice allows many developing economies the means to provide balanced nutrition to those in poverty (Bajaj et al 2005).

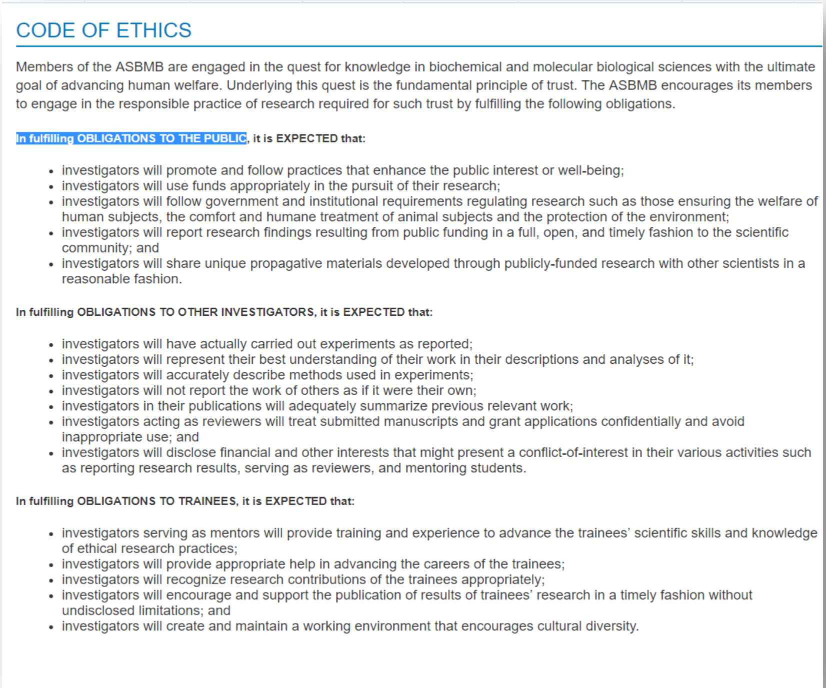
Although extreme, these are just two of examples of the types and benefits of transgenic produce. Many organisms, from crops to fish, have been altered to benefit us.. Most transgenic organisms have simply had their DNA altered to select for pre-existing, desirable traits. In other words, this change causes fish to grow to their largest natural size, crops to grow faster, and produce to have desired appearances. It is clear that these are all examples of beneficial biochemistry. Unfortunately, many of these biochemical technologies are tightly controlled by large companies, which leads to their exploitation.

BT corn and dozens of other beneficial crops are controlled by massive corporations such as Monsanto, who sell them at excessive profit margins. This is an example of biotechnology being abused for the gain of the few. There are many examples of biotechnology used for impermissible purposes. Consider the concept of "designer babies." Biotechnology could be used to choose the specific phenotypic traits of your children. In theory, it could be used to alter a human embryo to have desirable features, such as increased muscle tone or a specific eye color. This technology, offered for a premium price, is a luxury and is a market that could easily be cornered. It would allow those of higher social status or income to have physically superior children: something that should not be permitted.

When used for legitimate applications, however, biochemistry should be benefitting human life in ways that are ethically permissible. For example, Michigan Technological University is currently conducting research into protein aggregation and the links that this has to neurodegenerative disorders such as Alzheimer's and Lou Gehrig's disease, also known as ALS. Instead of designer babies, biotechnologists could work on eradicating genetic disorders from the human genome, which would protect every single human from such genetic disorders. Perhaps the most empirical evidence of biotechnological science used for the betterment of humanity was the discovery of the polio vaccine by Jonas Salk. Almost immediately after discovering this vaccine, Salk made the vaccine public. Never having patented it, the vaccine was produced so rapidly and cheaply that polio was almost eradicated within the decade. This is the ideal that biochemical science should strive for: utilitarian philosophy where humanity is benefitted at the cost of no one.

The bottom line is that what directly benefits humanity equally and without bias can be considered permissible (Iccarino 2001).. It is clear that limits must be placed on biochemical technology. Although very beneficial outcomes have been observed, there is a potential for these technologies to be abused and used for profit.

Ethics in Biochemistry: Current Practices and Codes



CODE OF ETHICS

Members of the ASBMB are engaged in the quest for knowledge in biochemical and molecular biological sciences with the ultimate goal of advancing human welfare. Underlying this quest is the fundamental principle of trust. The ASBMB encourages its members to engage in the responsible practice of research required for such trust by fulfilling the following obligations.

In fulfilling OBLIGATIONS TO THE PUBLIC, it is EXPECTED that:

- investigators will promote and follow practices that enhance the public interest or well-being;
- investigators will use funds appropriately in the pursuit of their research;
- investigators will follow government and institutional requirements regulating research such as those ensuring the welfare of human subjects, the comfort and humane treatment of animal subjects and the protection of the environment;
- investigators will report research findings resulting from public funding in a full, open, and timely fashion to the scientific community; and
- investigators will share unique propagative materials developed through publicly-funded research with other scientists in a reasonable fashion.

In fulfilling OBLIGATIONS TO OTHER INVESTIGATORS, it is EXPECTED that:

- investigators will have actually carried out experiments as reported;
- investigators will represent their best understanding of their work in their descriptions and analyses of it;
- investigators will accurately describe methods used in experiments;
- investigators will not report the work of others as if it were their own;
- investigators in their publications will adequately summarize previous relevant work;
- investigators acting as reviewers will treat submitted manuscripts and grant applications confidentially and avoid inappropriate use; and
- investigators will disclose financial and other interests that might present a conflict-of-interest in their various activities such as reporting research results, serving as reviewers, and mentoring students.

In fulfilling OBLIGATIONS TO TRAINEES, it is EXPECTED that:

- investigators serving as mentors will provide training and experience to advance the trainees' scientific skills and knowledge of ethical research practices;
- investigators will provide appropriate help in advancing the careers of the trainees;
- investigators will recognize research contributions of the trainees appropriately;
- investigators will encourage and support the publication of results of trainees' research in a timely fashion without undisclosed limitations; and
- investigators will create and maintain a working environment that encourages cultural diversity.

In order to determine what limitations must be placed on biochemical technol-ogy, we must look at the current codes that bind biochemists. Perhaps one of the best examples of this is a code of ethics written by the American Society for Biochemistry and Molecular Biology (Code of Ethics n.d.). In summary, this code outlines three things. The first is the ethical standards surrounding public relations. In this area of scientific ethics, it is imperative that the public remains consistently informed on research, especially research that is publicly funded. This is very important to the scientific community because it dictates the extent of information that publicly funded projects must share. Unfortunately, those most in need of this code are large corporations the biggest abusers of biotechnology. Because the majority of large companies are not publicly funded, there is a very limited amount of information that they are required to share with the public. In fact, there are no overarching organizations that require the publication of research for public reference.

The best example of violating the ethical obligation to the public can be seen in the pharmaceutical industry with companies such as Mylan. Mylan has been under scrutiny since early 2016 when it raised the price of its EpiPen products by over 400%. This price hike occurred only eight years after Mylan acquired the patent for the auto injector system that EpiPens utilize. Upon acquiring this patent, Mylan began selling EpiPens for approximately $57, which can now cost upwards of $500 depending on insurance copays. According to *Forbes Magazine* Market Analytics, Mylan raised these prices simply because they could. Their major competitor in the epinephrine market, Sanofi, willingly recalled all of their similar products only months before this raise in prices. Perhaps the most exaggerated instance of pharmaceutical technology exploitation is the company Turing Pharmaceutical, which raised the price of daraprim, a lifesaving drug used in the treatment and prevention of malaria, to near $750 per pill. This is a raise of over five thousand percent, which cannot be considered ethical considering that daraprim is the only available treatment for the vast majority of malaria patients. Also, according to *Forbes*, Turing raised these prices using a similar justification as Mylan. Because they could gouge consumers, they did (Willingham 2016).

The underlying cause of these abuses was the private holding of scientific information. Once patents are acquired, and even while they are being filed, companies are not required to publicly disclose any information regarding their products, according to the United States Patent and Trademark Office (Patents 2017). Other obligations to the public include the appropriate use of public funding or private funding that is given to a public institution.

The second ethical standard is the obligation to peers in the scientific community. This ethical standard includes multiple topics, the largest being the ability for peers to replicate studies. The importance of this standard lies in the main objective of the scientific process. Since repeatability and peer review are integral to building research and the scientific community, it is logical that researchers need to make their work accessible to their peers. Another ethical aspect of this topic is honesty in their findings. Studies that are not fully legitimate are obviously unable to be replicated or verified and are therefore are not ethically acceptable. Lastly,, there is an ethical obligation to trainees in the lab. This obligation mainly concerns assisting in trainee's careers and making contributions to their work. Also, this includes maintaining a laboratory with cultural diversity and inclusivity.

Advances in Biotechnology Call for Additional and Revised Codes

The American Society for Biochemistry and Molecular Biology has set forth an adequate ethical code for general ethics, but as we have seen, there are opportunities for corporations and research groups to abuse the vagueness of some ethical areas. Thus, the scientific community is in need of another ethical code that will contend with and adapt to the state of research. For instance, this code could be similar to the Hippocratic oath for doctors. Not only would this protect the scientific community from legal implications, it would also prevent unethical research material from being created in the first place. This would eliminate the possibility of abusing biotechnology or exploiting it for financial gain. Unfortunately, this vagueness of standards and ethical limitations is a benchmark among professional organizations in the field. The same common and vague standards can be seen with the American Society for Biochemistry and Molecular Biology, the International Union of Biochemistry and Molecular Biology (Code of Ethics… 2016), Biochemistry and Molecular Biology Educators, and many more. What really needs to change in this system is the specificity of ethical standards and the general adoption of stricter criteria to limit what material can be researched.

Finally, the consensus of experts in the field of biochemistry is that if new criteria cannot be drafted immediately, the existing ethical codes need to be revised. This can be seen very prominently within academia, as shown in a paper from the University of Detroit explaining the necessity for post-secondary ethical education, specifically regarding biochemistry. This university has created a course entitled "Recent Advances in Biochemistry Related to Societal

Issues" (Caspers et al) that is required for graduation with biochemistry or molecular biology degrees. This paper states that "the potential for current biochemical research to ameliorate societal problems is frequently offset by public concerns regarding this research. Numerous examples can be found in areas such as gene therapy, genetically engineered organisms, AIDS research, and neurochemistry. Therefore, it is imperative that students are aware of the ethical and societal ramifications of such research" (Caspers et al 2006). The point being made here is that the scientific community and the public both need to examine their actions closely to ensure that their practices are ethical. The main goal of this course is to educate students on identifying and analyzing these dilemmas, because a skill very important to the current generation of students who will be deciding *what is ethical* and *what is not*. Without being adequately informed about ethical dilemmas, today's students can't be expected to make these decisions.

Conclusion

It is evident that ethical dilemmas are present in the biochemical science community. We can see that biotechnology has been very beneficial in the past when used ethically, that current ethical codes are detrimentally vague, and that the scientific community is in consensus regarding updated ethical codes. John Steinbeck once wrote that

> the impulse which drives a man to poetry will send another man into the tide pools and force him to report what he finds there. Why is an expedition to Tibet undertaken, or a sea bottom dredged? Why do men, sitting at the microscope, examine the calcareous plates of a sea-cucumber, and, finding a new arrangement and number, feel an exaltation to and give the new species a name, and write about it possessively? It would be good to know the impulse truly, not to be confused by the 'services to science' platitudes or the other little mazes into which we entice our minds so that they will not know that we are doing. (1)

We, as a scientific community, must delve into new challenges, constantly pushing the boundaries what we collectively know. That being said, it is imperative that we closely monitor the ethicality of our actions, that we not be seduced by those "services to science platitudes," and that we always strive to steer science in the direction that betters the human condition.

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