Viewpoint

The morality of problem selection in proteomics

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The emerging power of new technologies in proteomics and the biological sciences to alter the human condition demands that scientists hold a new perspective on the social reesponsibilities of their research. Ethical theory can help scientists recognize not only those research projects that are harmful, but also those research paths that can create the greatest improvements in human health on a global scale. Whereas individual choices are important for the direction of scientific research, these choices may have limited social effects if they are not coordinated with larger institutional and inter-institutional structures. The perspective presented here calls for the Human Proteome Organization to recognize the ten most ethically significant proteomes to be characterized, with the hopes of rallying support and directing the research efforts of scientists in the proteomics community toward these goals.

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Academic groups having the advanced technology to perform proteomics research generally also possess the potential to investigate a range of biological problems. Proteomes can be analyzed at the level of tissues, organelles, and protein complexes with the expertise of only a small group of researchers. However, accompanying this diversity of opportunities comes a profound question which brings researchers to some of the limitations of the structure of the modern life sciences and also presents them with a moral dilemma: what subjects should be our priorities for investigation? Multiple factors influence how any academic researcher would answer this question, although we could most likely agree that scientists may want to look for research choices that have the greatest ethical significance and that demonstrate the greatest social responsibility. To successfully determine paths of research that could impact global health and quality of life, scientists will have to organize themselves in such a way to be able to determine which projects deserve emphasis and how to approach these problems most effectively.

Proteomics lies within the realm of the life sciences, which have been recognized as an important area of contribution to economic growth [1]. Technological developments in proteome analysis have the potential to influence the productivity and efficiency of many areas associated with the life sciences, including the agricultural, pharmaceutical and medical industries. Proteins of interest to the agricultural industry include those responsible for crop stress-tolerance, those which confer specific traits related to increased crop yields, and proteins which provide insight into animal diseases. Similarly, through the rapid identification of proteins involved in human diseases, pharmaceutical and biotech companies have the potential to develop novel drugs and vaccines at a much faster pace. The field of proteomics also has the potential to make a substantial impact upon healthcare by identifying disease markers as indicators for prompt and accurate treatment.

Due to the large capital expenditure required to perform proteomics, academic researchers generally need ample funding to carry out any research in this field, limiting research opportunities primarily to those designated by supporting organizations. The majority of funded topics reflect the interests of these groups: governmental funding is primarily oriented toward politically important areas (*i.e.*, research for the stabilization of public health and economic growth), industrial funding is primarily profit

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oriented, and the funding provided by independent organizations reflects their own specific agendas (however, this may be quite generous for socially beneficial research).

The contemporary norms of the life sciences are primarily a result of the enhanced integration of universities and industry that have developed since the beginning of the 1980's [2, 3]. It has been recognized that the academic life sciences are becoming increasingly 'contextualized' [4], and governments are demanding more economic results from public spending on science [1]. It has also been aptly recognized that the gap between 'pure' and 'applied' science is closing, and that perhaps in the future these two realms of science will be indistinguishable [5]. However, despite the trend of moving the life sciences seemingly toward social utility, there are arguments that the practice of biomedical research has become isolated and ineffective in creating new therapies due to unjustified experimental assumptions, and that if the current practices of research are not brought closer to the human condition, then public support for research may diminish [6]. These trends suggest that the research of academic laboratories is subject to the norms of a scientific community with its own limitations, consequently creating restricted prospects for proteomics. Incidentally, some projects of social importance may be underfunded or merely neglected for the pursuit of research projects that will maximize the wealth of scientists and their corporate partners [3]. Furthermore, the products of this research often do not affect the wider public. Despite these constrictions, independent academic researchers can strive to choose the most ethically significant research projects available.

The answer to the question 'toward what goals should we apply our technological and scientific abilities?' essentially depends on an understanding of ethics and the morals that guide our actions, whether this question is ultimately answered by a funding organization or an individual academic researcher. A widely recognized method of applying ethics to practical problems has been demonstrated by Peter Singer in his controversial book *Practical Ethics* [7]. Singer states that ethical problems do not occur when statements of fact are in question, but when "conflicting ethical views give rise to disagreement over what to do." He recognizes that ethical choices are not 'relative', or open for subjective assertions, and that 'reason and argumentation' are essential for determining ethical judgments. However, besides being able to reason or argue in support of a view, Singer adds, "the notion of ethics carries with it the idea of something bigger than the individual. If I am to defend my conduct on ethical grounds, I cannot point only to the benefits it brings me. I must address myself to a larger audience. From ancient times, philosophers and moralists have expressed the idea that ethical conduct is acceptable from a point of view that is somehow universal." Generally, to think ethically, you must regard the interests of others affected by your actions as just as important as your own self-interests.

Ethical discussions in the life sciences have been primarily 'minimalist' [8], with an emphasis on the consideration of excessive harm in the application of techniques or practices. However, this one-sided focus could possibly have detrimental consequences if another side of bioethics is not developed accordingly. By recognizing unnecessary harm alone, this approach addresses the diversion of research from possible or existing negative consequences, and leaves aside a thorough speculation of the many potential *positive* alternative research choices for social betterment (a morality of problem selection). When the choice of problem selection is looked at from this perspective, it becomes a question of not only whether a certain individual or group is harmed by this research, but it becomes a question of 'can a more ethically significant research choice yet be selected?' Available research programs ignore many ethically important problems, in addition to insufficiently approaching certain problems, such as a more substantial attempt to cure AIDS, which is globally the fourth leading cause of death.

Considering the constraints imposed upon academic research discussed above, how do scientists enable themselves to engage in ethical problems after they have been selected? It has been suggested that scientists should be allowed to be more 'disinterested' and independent, returning scientists to the time of a different set of guiding principles, presumably providing a route to enable researchers to focus on neglected areas of interest [9]. However, in the modern structure of the life sciences, it is likely that an increased independence, insulation, and disassociation of academic researchers could be quite ineffective in successfully scrutinizing and competing with the productivity and influence of truly large-scale research projects (even though the increased 'independence' of scientists is crucial for the proper regulation of industry *via* governmental advisory boards and expert consultations [3]). Furthermore, modern research requires multidisciplinary teams of researchers to be most effective, which could be undermined by individuals with research funds and unfocused approaches. It seems more reasonable to attempt to direct the life sciences than to hold philosophical perspectives, or take actions, that will conflict with higher organizational structures, and corresponding scientific products of a higher order.

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The large capital investment in science and the modern norms of life science research now reveal what biology's long development has hidden: the life sciences are not to satisfy our curiosities, but they are for the productive manipulation of living organisms *in toto*, which has a corresponding new framework of social responsibilities that has emerged with this manipulative power. The new imperatives of research now simply demand that a sufficiently virile moral philosophy can provide direction to the structure of the life sciences. However, the application of ethics at the individual level alone may be insufficient to produce the desired effect in society, and it may be more apt for proteomics researchers to organize and define ethical research choices *for themselves*, thus providing a foundation for a future research agenda.

Recently, Microsoft's founder Bill Gates decided to fund research on ten major diseases in the developing world, with the hope of spurring research into ethically meaningful areas that are currently underfunded [10]. Following Gates' inspiration, the proteomics community could take his initiative one step further and make an independent assessment of the ten most important proteomes to be characterized, based upon technical considerations and discussions at the level of ethics. These designations may not necessarily be as general and daunting as 'the human proteome' or the 'the malaria parasite proteome', but they could be more specific, such as the complete characterization of the malaria parasite plasma membrane proteome, *i.e.*, the proteomes with the greatest significance for developing drugs or vaccines to minimize the effects and spread of the diseases on a global scale. By designating these ten most important projects, the proteomics community will have the opportunity to gain further support of prominent funding groups and the public, as well as focus the community on ethically relevant subjects. Perhaps these selected projects will mirror the priorities that will be funded by Mr. Gates. Or perhaps after a serious look at the possibilities, the designated proteomes will be those previously unconsidered.

In order to direct research efforts in directions with great ethical significance, scientists will have to organize and select ethically meaningful and effective research choices. In this situation, the proteomics community needs an organizational body with ethical responsibility and technical authority to aid researchers in choosing research problems with moral integrity, an organization with the potential to liaise between the proteomics community and organizations such as UNESCO, the World Health Organization, the US National Institutes of Health, and the European Union. A group with this potential is the newly formed Human Proteome Organization (HUPO). By directing scientific research in this manner, the scientific community is a much stronger force in society than a community employing *laissez-faire* policies. The challenge to HUPO is to recognize ethically significant problems needing to be addressed, determine effective experimental approaches, advise the community on these possibilities, and aid researchers in securing funding for these prospective applications.

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