Societal Aspects of Synthetic Biology: Organisms and Applications Matter!

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This background paper[1] constitutes an entreaty to scholars investigating societal aspects of synthetic biology: approach synthetic biology specifically, not generically.

Synthetic biology is defined in numerous ways. It can be conducted through diverse processes on divergent types of organisms. It also can be 'used' or 'applied' in potentially unlimited venues to accomplish any of a number of objectives. These sorts of statements should become more than familiar, nearly obligatory introductions to studies of societal aspects of synthetic biology that subsequently fail either to account for or to address the extraordinary variability encompassed by the phrase "synthetic biology." Instead, synthetic biology-related specificity should be used to sharpen inquiries and add analytical depth. Doing so potentially can impart new levels of credibility or power to resulting findings and recommendations.

I am among a set of authors who made a similar point about nanoscale science[2], arguing that "ELSI [ethical, legal, and social issues] scholars should add technical- and application-related forms of specificity to their work and their writings to enhance effectiveness and impact in communicating with one important target audience—members of the nanoscale science community" (p. 193). We asked our fellow ELSI scholars, "what is it, exactly, that we…want nano-scientists, -managers, or –funders to do as a result of our scholarship?" (p. 199). By extension, what goals do those of us participating in this workshop have for the outputs of any research agenda we may propose? Those goals may change over time, but they provide an explicit framework upon which to build a research agenda. That framework also provides a way of gauging the extent to which agenda items individually and collectively align with research goals.

My proclivity is to establish goals that involve the *use,* and not just the production, of research findings. This use- and goal-oriented proclivity undoubtedly influences the emphasis I place on

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[2] Shumpert, BL, AK Wolfe, DJ Bjornstad, S Wang, MF Campa, 2014, "Specificity and engagement: Increasing ELSI's relevance to nano-scientists." *Nanoethics* 8:193–200, DOI 10.1007/s11569-014-0194-x.

specificity, as does our relatively recent focus on “members of the [salient] scientific community”[3] as one target “user” population. Regardless, I believe that specificity can:

- enhance research on an array of societal aspects of synthetic biology, including upstream or public engagement, responsible innovation, public attitudes and opinions, communications, bioethics, governance, costs vs. benefits, and risk;

- improve our collective ability to achieve multiple research goals; and

- increase the “usability” of our research results among multiple target user populations.

To illustrate these points and spur workshop discussion, I briefly mention just two interrelated forms of specificity—type of organism and potential application. Consider, as examples, a few possible types and applications of new or altered DNA: in bacteria intended for therapeutic medical treatment; in bacteria intended for environmental remediation; in algae intended for biofuel production; and in plants intended for food. It seems obvious that societal aspects of synthetic biology vary when used directly in the human body versus in soil, water, or plants. Certainly governance issues vary. Different regulations apply to microbes, plants, and algae within and across agencies. For instance, under the US Environmental Protection Agency's purview, the Toxic Substances Control Act applies to microbes and some algae, but not plants; the Federal Insecticide, Fungicide, and Rodenticide Act applies to plants, not microbes or algae; and the Clean Water Act may apply to algae. Moreover, attitudinal and acceptability issues may vary. We do not currently know what internal calculus respondents use in answering questions about synthetic biology when they are presented with an assortment of potential uses, benefits, or risks. For instance, we do not know whether respondents anchor their responses to what they see as the most positive versus most negative aspects of synthetic biology, or the extent to which answers represent some 'average'. Likewise, we neither know what bias we inadvertently may impose on research in our selection of examples or illustrations nor the extent to which answers based on one set of examples apply to other possibilities.

Even just two specific synthetic biology attributes—organism and application—have substantive, potentially significant, implications for social science research. These attributes influence the settings, processes, and practices associated with R&D, production, and deployment; invoke different sets of regulations; generate different economic or other cost-benefit parameters and ratios; produce different human health and environmental risks, with varying magnitudes and duration; and may lend themselves to markedly different potential misuses (dual use). We should craft a research agenda on societal aspects of synthetic biology that is attentive to specificity.

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[3] In particular, our team has focused on scientists, science managers, and science funders who shape choices about what research to conduct and what to do with the results of that research.