A Synthetic Biology Lab in Berkeley

Is public health and safety being considered in the construction of a new biolab in Berkeley?

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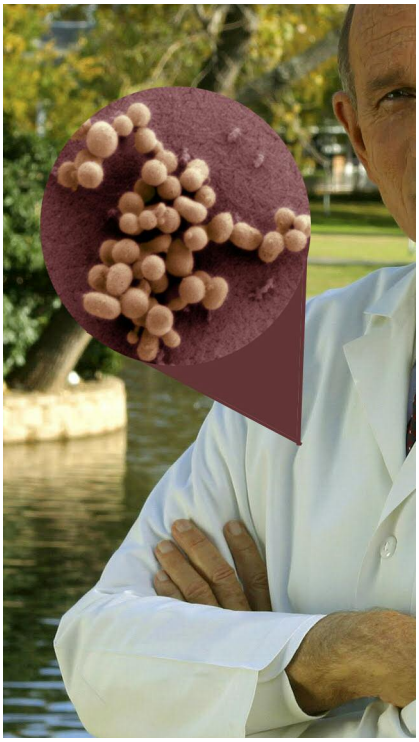

In April of this year, U.C. Berkeley researchers announced the creation of the U. C. Berkeley Synthetic Biology Institute (SBI), which will ramp up efforts to "engineer" cells and biological systems.[1] Part of its research will include experiments that insert manufactured stretches of DNA into existing organisms to create new, self-replicating artificial life forms—experiments that pose implications for worker safety, public health and environmental safety. A collaboration of university and industry, the SBI enterprise is designed to catapult basic research into profit making applications. From a press release, "SBI will be an important link in a constellation of research centers focused on synthetic biology at UC Berkeley and Lawrence Berkeley National Laboratory (LBNL), both of which have made the field a research priority. SBI is unique in its planned collaborations with leading companies, designed to translate leading research on biological systems and organisms efficiently into processes, products, and technologies."[2]

Where this extensive new research will take place is a matter of some speculation. LBNL, managed by U.C. Berkeley but funded by the Department of Energy, is seeking to open a second campus somewhere in the East Bay, across from San Francisco. The new facility hopes to combine three existing facilities presently scattered throughout the cities of Berkeley and nearby Emeryville: the Joint BioEnergy Institute, the Life Sciences Division, and the Joint Genome Institute. Potential sites for a new campus include a number of locations in the City of Berkeley itself.[3]

What do residents make of this idea? Lawsuits have stymied LBNL's effort to expand into the region's Strawberry Canyon watershed, described by activists as "a rich repository of wildlife."[4] Now concern over second campus proposals, which include targeted locations along the west Berkeley shoreline, has centered on issues of job creation, tax revenues, zoning, and predictions of rising sea levels. It remains to be seen whether health and safety issues uniquely associated with this research also will be raised. Do adequate safety protections exist? Or are entirely new safety assessment and reporting methodologies for this research required in order to safeguard worker, public and environmental wellbeing?

Biosafety level (BL) containment labs are ranked from 1-4 according to the risk of harm they pose, with increasing levels indicating increasing danger. Typically, BL1 labs perform research on non-human infectious agents; BL2 labs use biological agents that could infect humans but are assumed to cause only "moderate harm"; BL3 labs experiment with biological agents capable of killing humans but for which there are known antidotes (like anthrax); and BL4 labs conduct research using agents that could kill humans and for which there is no known antidote.

Which safety lab levels will the new campus house? What constitutes "moderate harm?" Will the citizenry of this densely populated urban area know what pathogens are being used for research? Since academic and private interests operate under different safety, liability, and oversight restrictions, which research safety guidelines will apply? What remedies will apply in the event of lab worker injury, or environmental or public safety hazard? Will there be a public safety infrastructure facilitating transparency and accountability? Is the patchwork of voluntary regulatory guidelines from existing agencies adequate?

A brief review of just a few incidents of lab worker exposure to hazards suggests that even current biolab regulation and oversight is not adequate. These include Dr. Jeannette Adu-Bobie, who after visiting a New Zealand lab suffered a meningococcal infection from a laboratory strain causing loss of both legs and an arm; Ru-ching Hsia, a Department of Agriculture scientist who became infected by laboratory E.coli strain and lapsed into a coma for a month;, and University of Chicago scientist Malcolm Casadaban, who died after unknowingly being infected with a laboratory plague bacterium.[5] One of this essay's co-authors, molecular

biologist Becky McClain, won a whistle-blower suit against pharmaceutical giant Pfizer after reporting public health and safety concerns.[6] She fell ill after an untrained lab worker used a human infectious genetically engineered virus, without suitable biocontainment, on McClain's personal workspace. She began experiencing periodic paralysis and spinal pain, a result consistent with the DNA-coded effects that had been engineered within the pathogen. Recently, researchers from the U.S. Centers for Disease Control and Prevention (CDC) reported that a University of Illinois laboratory worker was infected by a genetically engineered cowpox laboratory virus, one with which she had never worked. CDC investigators not only found cowpox DNA in many areas around the lab, they also discovered that supposedly harmless stocks of viruses had been contaminated.[7] Problematically, releases of laboratory bio agents are difficult to track since exposures often are not visible to a worker who succumbs to a mystery illness. Scientists can become ill from dangerous biological exposures without knowledge of having endured an exposure.

Public health also is a serious consideration. Severe acute respiratory syndrome (SARS) killed nearly 800 people in 2003. Lab versions of the SARS pathogen are known to have escaped BL 3 and BL 4 labs via infected lab workers.[8] And a few years ago, at Berkeley itself, workers handled deadly Rocky Mountain Spotted Fever (which spreads in the air) without containment when it was mislabeled as harmless.[9] The U.S.'s 2001 anthrax scare[10] and the unknown source of the virulent, antibiotic-resistant strain of E.coli that has recently infected thousands in Europe and, so far, killed 27 raise serious questions about the effectiveness of tracking, as well as accountability.[11]

There is no central authority that coordinates research and planning on synthetic biology. Even though synthetic biology poses serious risks, there are no specific standards for determining threat levels to humans, animals, plants, microorganisms or the environment. Experiments involving the synthesis of completely novel synthetic DNA sequences can make a harmless microbe into a new pathogen with dangerous and far reaching consequences. There are very real concerns that synthetic biology research could result in enhanced virulence, the ability to infect a wider range of organisms, and resistance to antimicrobials, antivirals, vaccines and other treatment or containment responses. As Jonathan Tucker and Raymond Zilinskas explain in "The Promise and Perils of Synthetic Biology," because synthetic microorganisms are self-replicating and capable of evolution, they could proliferate out of control and cause environmental damage and, if they escape from a research laboratory or containment facility, threaten public health. For this reason, they pose a unique risk unlike those associated with toxic chemicals or radioactive materials.[12] Synthetic biology research also raises new issues regarding the degree to which laboratory workers are prepared to engage in such research. Synthetic biology is an interdisciplinary field, involving the activities of chemists, engineers, physicists, and computer scientists as well as biologists. Many practitioners in these fields have never had training, let alone professional experience, in biosafety[13].

The most recent issue of *GeneWatch* featured Lynne Klotz's report on Boston University's feeble risk assessment efforts, undertaken to assure Boston citizens that its lab, which is likely to be conducting research on SARS and the deadly 1918 flu virus, is acceptably safe.[14] The University and the NIH claimed that emergency simulations supported moving ahead with the desired research. The National Research Council did not agree, concluding that "the model did not appear to recognize biological complexities and reflect what is known about disease outbreaks and other biological parameters."[15] In other words, both Boston University and the NIH had conducted a risk analysis that ignored the most basic information actually needed to assess the lab's risks. This cautionary tale should provoke additional public scrutiny of any new biolab facility. Berkeley's City Council, as well as the governing entities of the other Bay Area cities who want the lab, may want to keep track of what unfolds in Boston—remembering that Boston, unlike the San Francisco Bay Area, is not even on a major earthquake fault line. Considering the current limitations of oversight and the problems of accountability of the various public and private partners involved in the project, it is less than clear what steps they are prepared to take in order to ensure the safety of any new facility engaged in synthetic biology research.

Boosters have heavily promoted the theoretical benefits of synthetic biology to the public and local officials. They need now to be much more forthcoming in detailing the very real dangers attendant to such research, including broadly publicizing comprehensive risk assessments. Potential neighbors, and others who stand to be impacted by any facility conducting synthetic biology research, deserve better from the University and its partners, and from government representatives charged with protecting public health and safety. ■■■

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16. The authors acknowledge helpful comments from Stuart Newman.