RICHMOND BAY CAMPUS

A Berkeley Lab partnership with UC Berkeley

Powering our vehicles with clean, renewable fuels; recruiting microbial allies to remove toxic pollutants from the environment; discovering the factors that cause healthy cells to turn cancerous—these are just some of the possibilities to be realized from biosciences research at the Lawrence Berkeley National Laboratory (Berkeley Lab). Widely recognized as one of the world's premier research institutes, Berkeley Lab is a U.S. Department of Energy (DOE) national laboratory managed by the University of California (UC). Over the past two decades, Berkeley Lab's mission and staff have outgrown the 200-acre main campus in the hills directly above the UC Berkeley campus. This is especially true for the biosciences, where expanded research in response to national needs has forced programs to be dispersed across five sites spanning 25 miles. To consolidate these programs at a single site, Berkeley Lab has proposed, in partnership with UC Berkekey, the establishment of a second campus with an initial staff of some 800 employees at UC's Richmond Field Station in Richmond, California, a city of approximately 100,000 residents located across the San Francisco Bay from the Golden Gate Bridge. For Berkeley Lab, the Richmond Bay Campus would host cutting-edge bioscience programs designed to provide knowledge that will advance solutions for critical technology problems in bioenergy, environmental systems and the life sciences.

THE PROMISE OF BIOTECHNOLOGY

Through biotechnology, scientists and engineers work with biological systems at the cellular and molecular levels to address society's most intractable problems. Already, biotechnology is being used to combat world hunger, create much needed medical vaccines, restore contaminated environments, and provide renewable energy sources. However, even with revenues in the United States alone approaching $100 billion, we've just begun to tap biotechnology's vast potential. The opportunities that stretch before us to improve our quality of life and standard of living are limited only by the gaps in our scientific knowledge. Filling some of the most critical of those gaps would be the mission of Berkeley Lab's research at Richmond Bay Campus.

THE BIOENERGY CHALLENGE

The global demand for energy, especially for liquid transportation fuels, continues to surge. Replacements for gasoline, diesel and jet fuel that are both sustainable, meaning the supply can be renewed, and carbon-neutral, meaning their use does not increase atmospheric carbon levels, must be developed. Among the best and most near-term candidates are advanced biofuels—liquid fuels produced from the mix of complex sugars in cellulose. Present in all plant biomass, including waste, cellulose is the most abundant organic matter on Earth.

Berkeley Lab is the lead partner in the Joint BioEnergy Institute (JBEI), a DOE Bioenergy Research Center whose mission is to speed development of advanced biofuels made from the cellulosic biomass of non-food crops. These biofuels can replace petroleum-based fuels on a gallon-for-gallon basis, and be used in today's vehicles with no loss of performance. These biofuels can also be used in today's supply infrastructures. At JBEI the focus is on making use of lands not suitable for food crops. In the United States alone, such lands total about 300 million acres, an area nearly three times the size of California. Perennial grasses, such as switchgrass and Giant Miscanthus, can thrive on these lands with little fertilization or irrigation. Growing to more than a dozen feet in height and yielding some 15 tons of dry biomass per acre, such grasses could be ideal biofuel sources if production costs are competitive.

JBEI researchers are studying genes and enzymes in these grasses, and investigating chemical pre-treatments to make it easier and less expensive to extract sugars that can be turned into fuels. For the actual conversion of cellulosic sugars into advanced biofuels, JBEI researchers are using synthetic biology to engineer specialized strains

of two common microbes, E.coli and yeast. Already, the world's first strain of E.coli able to feed on switchgrass and convert its cellulose into gasoline, diesel or jet fuel has been developed. JBEI's 150 scientists, engineers and support staff, currently housed at a facility in Emeryville, would be one of the first research groups to relocate to the Richmond Bay Campus.

RECRUITING MICROBIAL ALLIES TO CLEAN THE ENVIRONMENT

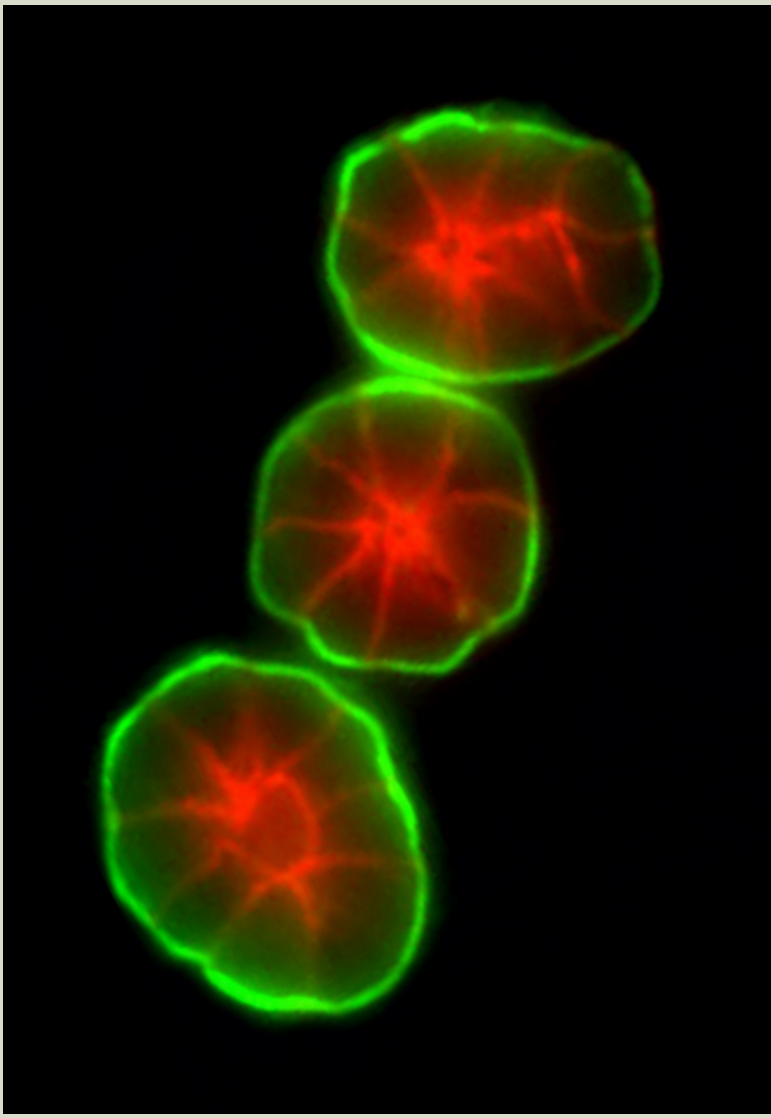
Whether discussing the exterior environments of Earth's major ecosystems or the interior environment of the human body, microbes belong in the conversation. Microorganisms, so-called because a microscope is needed to see them, are everywhere - land, air and water. Nine out of every 10 cells in an adult human are microbes. From producing oxygen, to fixing nitrogen, to decomposing organic matter, microbial activity is fundamental to life on Earth.

At the Joint Genome Institute (JGI), another DOE multi-institutional partnership led by Berkeley Lab, scientists are studying the genetics of microbes and microbial communities, and applying this knowledge to applications in bioenergy, environmental cleanup, and reducing the effects of carbon emissions on global climate. In their studies of environmental systems, JGI researchers focus on the interaction of microbes with plants, soils and one another. By identifying key genes linked to such activities as degrading contaminants or capturing carbon, JGI researchers are finding safer and more effective ways to remove toxic chemicals and heavy metals from polluted land and water. For example, a recent metagenomic analysis revealed that a bacteria known as Dehalococcoides, produces enzymes that can convert a notorious groundwater pollutant from industrial cleansers into a harmless chemical compound. JGI researchers are also gaining a better understanding of how different ecosystems respond to rising atmospheric carbon levels. For example, a recent study showed how forest floor fungi interact with microbes in plant root zones to break down carbon in the soil and convert it to nutrients. JGI's 175 member staff, currently housed at a facility in Walnut Creek, would also be in the first wave of research groups to relocate to the Berkeley Lab Richmond Bay Campus.

FIGHTING BREAST CANCER

Despite enormous research efforts, breast cancer continues to claim the lives of thousands of women each year. Ground-breaking research at Berkeley Lab over the past three decades has established the critical role in cancer development played by the microenvironment surrounding a breast cell. Scientists in Berkeley Lab's Life Sciences Division are continuing to deepen our understanding of the complex interactions between genes and the environment that determine the fates of living cells. The ultimate goals are improved diagnostics and more effective therapies. For example, one team of Life Sciences researchers recently discovered what takes place at the cellular level to explain why women over the age of 50 account for 75-percent of new breast cancer patients.

Another area of focus for Life Sciences at Berkeley Lab is the impact of low-dose radiation on human health. The link between radiation and DNA damage



BERKELEY LAB AND RICHMOND BAY CAMPUS

A multitude of awards, including 13 Nobel Prizes and 13 National Medals of Science, is testimony to the scientific excellence for which Berkeley Lab is renowned. Founded in 1931 by future Nobel laureate Ernest Lawrence, Berkeley Lab has hosted historical discoveries in physics, chemistry, biology and cosmology. Through other critical research breakthroughs in the energy, environmental, materials and earth sciences, Berkeley Lab has spawned technologies that have generated billions of dollars in revenues and savings, and led to the creation of thousands of jobs. The hallmark of Berkeley Lab science has been Lawrence's philosophy that research is best done through teams of individuals with different fields of expertise, working together in close proximity. To continue this legacy, Berkeley Lab proposes to centralize its biosciences programs at a second site, in partnership with programs at UC Berkeley, which would be known as the Richmond Bay Campus.

that gives rise to cancer is well-established. However, today's standards for predicting biological damage from radiation—critical for radiation-based diagnostics and treatments, and for workers exposed to radiation—are based on data from the World War II atomic bomb blasts. Berkeley Lab researchers are finding evidence that these standards need revamping. For example, a recent study showed that cancer risks may not be directly proportional to low-dose radiation levels, contrary to the standards which hold that risk is directly proportional to dose at all levels of irradiation.

These are just two examples of Life Sciences research at Berkeley Lab. Researchers in this division, among other efforts, are also engaged in major initiatives in biological imaging, bioenergy and structural biology, and a national effort to create a DNA encyclopedia of all the functional elements in the human genome. Currently, approximately 200 staff members of the Life Sciences Division are housed in a facility on Potter Street in the city of Berkeley, across town from Berkeley Lab's main campus. This group would also be slated to relocate to the Richmond Bay Campus.

A VIEW TO THE FUTURE

In keeping with Berkeley Lab's tradition of multidisciplinary team science, our biosciences research is often carried out in collaborations with research in other fields, such as the materials and chemical sciences, earth and climate sciences, and the computational sciences. It is envisioned that key programs within these various fields might also migrate to the Richmond Bay Campus in the future. Also envisioned is a new technology commercialization effort dedicated to transitioning Berkeley Lab's biosciences research into the marketplace.