Utah center. Voth and Alan Frankel, UCSF's principal investigator, each say that improvements to the technology will be especially crucial to his center's goals.

Single-molecule imaging

David Millar, a biophysicist at the Scripps Research Institute who is part of the Utah team, is using single-molecule fluorescence imaging to decipher the mechanism by which HIV's genetic material is transported from the host cell's nucleus back into the cytoplasm, where the cell's protein factories are hijacked to produce more of the virus. By color-labeling each of the numerous proteins involved in that transport, Millar's lab has been able to observe the sequence of events involved in formation of the large protein complex that transports the viral RNA within the cell.

Millar says the fluorescence technology will be useful for studying many other biological processes, including the mechanism by which ribosomes, the protein factories of the cell, are themselves assembled from some 20 individual proteins and RNA.

The centers are also using multiscale computer simulation, isothermal titration calorimetry, surface plasmon resonance, and fluorescent resonance energy transfer.

The interdisciplinary character of the centers allows the quantitative perspective of the physical scientists to be brought to bear on the biologists, who are more apt to express their findings in descriptive terms, says Gronenborn. "It's very difficult for biologists to put their observations into quantitative terms."

An arranged marriage

"We're bringing together two very different worlds to apply what they know to the problem," says Finzi. The arranged marriage is not without challenges, particularly regarding communication. "We speak different languages, and we don't always understand what the others are doing," says Finzi, who confesses that she has only a basic grasp of the imaging techniques.

The key to interdisciplinary efforts, Voth says, is to focus on one's own area of expertise and let other collaborators do the same. Voth admits that he's not aware of a single "card-carrying physicist" at the Utah-based center.

Frankel says three of the nine principal scientists in his collaboration, including an NMR spectroscopist and a computational expert, have strong physical science backgrounds. Most of the rest are biochemists.

But for all the expertise that's being drawn into the centers, there's no guarantee of success, Finzi cautions. "We think the centers have tremendous potential," she says. "But it's a little like gambling; sometimes you get something marginal, and sometimes you get a big hit."

David Kramer

DOE, Congress to spur carbon sequestration

Even as the US Department of Energy announced the awarding of a fourth grant for assessing the commercial-scale underground sequestration of carbon dioxide, President Bush's science adviser was expressing doubts that efforts to bottle up the greenhouse gas will mitigate global warming.

"We do not currently have a scalable technology for carbon sequestration, and I do not see one coming soon," John Marburger told a meeting of the American Geophysical Union in December 2007. The world's "stunningly large fossil-fuel consumption numbers" and the roughly 27 billion tons of CO_2 released annually "create barriers for any carbon extraction and sequestration scheme," he said. "Any industrial-scale process has environmental impacts, and there are few greater industrial scales than that of power generation. The sequestration industry would have to be of comparable scale."

But despite his misgivings, Marburger admitted that over the long run, carbon capture and storage from coal-fired plants ranks alongside resolving the nuclear waste problem and minimizing nuclear proliferation risks as the best shots for minimizing climate change.

In December, DOE awarded $66.7 million to the Midwest Geological Sequestration Consortium for the fourth of seven proposed large-scale sequestration tests. Those tests are to assess the feasibility of storing millions of tons of CO_2 indefinitely in geologic formations deep underground. Three other awards with a combined value of $318 million were announced in October.

Major energy legislation enacted in 2007 authorized the seven projects and specified that each sequester a minimum of 1 million tons of CO_2 annually. The statute authorizes $240 million annually for the tests through fiscal year 2012, but appropriators provided just half that amount for the current year. To the extent possible, the law says, DOE should locate the projects in various geologic formations and use CO_2 produced in industrial operations. For the Midwest project, the gas will be supplied from fossil fuels burned at an ethanol refinery operated by Archer Daniels Midland Co and will be injected into the Mount Simon sandstone formation, which lies underneath four states.

The new law also authorized $30 million for a peer-reviewed assessment, administered by the Department of the Interior, of the available capacity for geologic sequestration in the US. And the legislation calls for recommendations from the National Academy of Sciences for establishing an interdisciplinary training program to produce specialists in carbon capture and storage.

Separately, $75 million is appropriated for DOE in FY 2008 for FutureGen, a cost-shared project with utilities to build an emissions- and carbon-free, coal-fired generating plant that will also employ geologic CO_2 sequestration.

At least two large-scale sequestration projects have been declared successes. Each year since 1996, Norway's Statoil has been separating about a million tons of CO_2 from natural gas extracted from the North Sea's Sleipner field and injecting it into a formation beneath the field. In doing so, the company avoids paying a steep tax of about 294 kroner (US$55) per ton that Norway has imposed on CO_2 emissions.

The second project, sponsored by DOE, the Canadian government, and several oil companies, met its goal of injecting 5 million tons of CO_2 into the Weyburn oil field in Saskatchewan. The liquefied gas was piped in from a synthetic fuels plant in North Dakota. The project's expenses were offset by revenues from the thousands of barrels of oil that were pushed out of the reservoir each day by the injection. Indeed, CO_2 injection has been employed for years to extract oil that is not recoverable by conventional drilling.

As Marburger pointed out, even if the geological storage proves to be an unqualified success, it will be expensive to adopt. What he didn't say is that in the absence of either a tax on CO_2 emissions or a cap-and-trade regime, industrial emitters will have little or no economic incentive to adopt the technology.

David Kramer

news notes

India's growing science budget. The Indian government has announced a fivefold increase in the education budget between 2007 and 2012 for a series of schemes to increase the number of science and technology researchers. Prime Minister Manmohan Singh announced the news last month at the