

► Colorado, Kansas and Oklahoma.

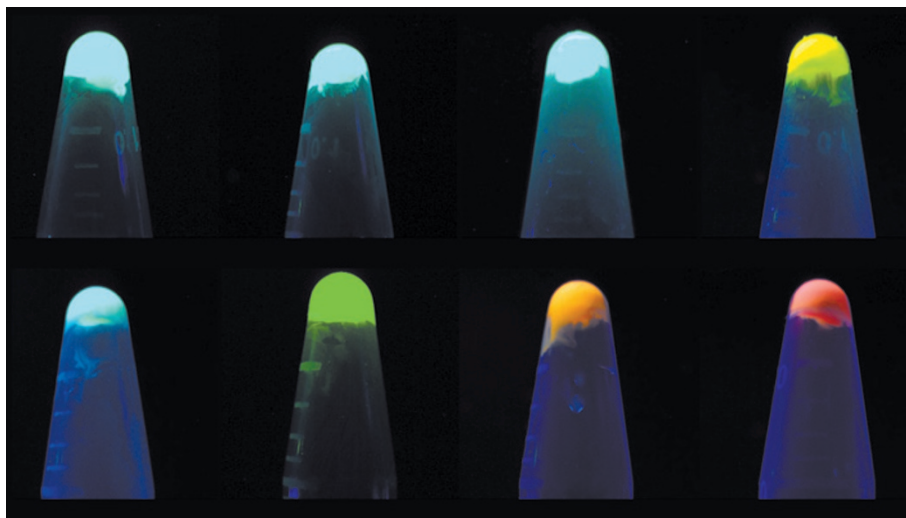
The standards are the first national guidelines to incorporate climate change, which is already taught in some schools. But it has proved daunting for many educators, because the subject requires teaching aspects of biology, physics and chemistry. “It’s a little piece of everything,” says Rouwenna Lamm, deputy director for national outreach at the Alliance for Climate Education in Oakland. The guidelines recommend introducing the subjects early on, teaching students in middle school that human activities, including the burning of fossil fuels, have warmed the planet. As students get older, that idea should be expanded to encompass discussions of climate models and potential policies to limit greenhouse-gas emissions. Likewise, the guidelines recommend teaching evolution before students reach high-school biology classes, the point at which many states tackle concepts such as natural selection and adaptation.

The standards have faced legal challenges in some states, although the framework has so far escaped unscathed. For example, Kansas lawmakers last month narrowly defeated a measure to block state funding to implement the guidelines — quashing the proposal just hours before lawmakers adjourned for the year. In Kentucky, the state board of education unanimously approved the standards on 5 June, but they must now undergo a public hearing and a subsequent legislative review before teaching can begin.

That places the guidelines squarely in the path of a high-powered critic who will help to steer the legislative review: Mike Wilson, Republican state senator and chairman of the Kentucky Senate’s education committee, who is a climate-change sceptic and advocate of intelligent design. “Political correctness bears watching and should never be the arbiter of learning,” he wrote in a May article published in *The Courier-Journal*, a Kentucky newspaper.

Robert Bevins, a toxicologist and president of Kentuckians for Science Education, an advocacy group formed in February in part to push for the adoption of the standards, says that he is gearing up for a hard fight. “Kentucky has a love-hate relationship with science,” he says, noting that the state has a thriving coal industry that has opposed greenhouse-gas regulations and is also home to the Creation Museum near Petersburg.

Richard Innes, an education analyst with the conservative Bluegrass Institute for Public Policy Solutions in Lexington, Kentucky, predicts that the guidelines will be sent back to the state education board for revision after the public hearing this month. But ultimately, he says, “I think the science standards will go through.” ■



Some synthetic fluorescent proteins made by DNA2.0 are now freely available to researchers.

BIOTECHNOLOGY

Bioengineers look beyond patents

Synthetic-biology company pushes open-source models.

BY HEIDI LEDFORD

When DNA2.0, a company that synthesizes made-to-order genes, needed to conduct a few routine experiments using a fluorescent protein, its lawyers dug up more than 1,000 US patents covering their use. DNA2.0 decided to avoid the legal thicket by engineering several dozen fluorescent proteins from scratch. But the company, based in Menlo Park, California, was convinced that something had to change.

Last month, DNA2.0 deposited gene sequences encoding three of its fluorescent proteins into an open-access collection of recipes for DNA ‘parts’, molecular building blocks used to engineer organisms — often bacteria — to carry out specific functions. The company vows not to pursue its patent rights against anyone using the sequences.

Such moves are unusual among larger biotechnology companies, which tend to guard patents fiercely, but for DNA2.0 the choice was strategic, says Claes Gustafsson, the firm’s chief commercial officer. Synthetic biologists aim to bring engineering principles to bear on genetic manipulation, and the field’s success hinges on the creation of standardized parts that can be combined in predictable ways. The company wants to create incentives for other synthetic-biology firms to design custom organisms for which DNA2.0 can synthesize

the parts. “We have a lot of customers in small biotech companies,” Gustafsson says, “and the intellectual-property situation for them is just a nightmare.”

Easing that situation will be a key point of discussion next week at the Sixth International Meeting on Synthetic Biology, to be held in London by the BioBricks Foundation, a non-profit organization based in Cambridge, Massachusetts. As patent disputes heat up in some parts of the industry, synthetic biologists are weighing alternatives such as copyrights, which are more straightforward than patents, and open-source parts registries.

Open access to validated molecular components is crucial to the field’s success, says Drew Endy, a synthetic biologist at Stanford University in California. Endy says that synthetic biologists are similar to software engineers, with the genetic code as their programming language. The software industry has favoured open-source approaches and copyright protections, because inventions often come faster than patents can be acquired.

The same holds for synthetic biology: if every genetic building block comes with a patent attached, cellular engineers may end up negotiating legal minefields. Few firms will sue a scientist who infringes a patent in the course of academic research, but young synthetic-biology companies are vulnerable.

Two years ago, the BioBricks Foundation

borrowed elements from the open-source software movement to develop a public agreement for designers of synthetic-biology parts. But the 708 parts in the BioBricks open-source collection come from only three donors: DNA2.0, Endy and Ginkgo BioWorks, a synthetic-biology company in Boston, Massachusetts. Commercial use of some of the highest-impact parts is still kept under lock and key by industry or academic labs.

Mark Fischer, a copyright lawyer at Duane Morris in Boston, and a key architect of the BioBricks agreement, says that it is too soon to judge the project. He says that DNA2.0's contribution to the registry is a sign that the movement is taking off. "I think we're now at the dawn of that happening," says Fischer, who also helped to pioneer open-source software agreements.

The open-source push in synthetic biology has also rekindled talk of copyrighting engineered DNA sequences. Copyrights protect certain types of work from being reproduced without permission, but users may substantially modify those creations. The United States started granting such protections to computer programs in the 1960s.

DNA2.0 plans to find out whether DNA sequences can also be shoehorned into the framework. Last year, the company petitioned for US copyright protection of the DNA sequence for a fluorescent green protein, without success, but has launched an appeal. Its plan, says Christopher Holman, a law professor at the University of Missouri-Kansas City who is working with DNA2.0, is to pursue the appeal until the issue is heard in court.

Copyrights are cheaper, easier alternatives to patents, says Endy. They cost \$35 to register, as opposed to the \$100,000 in legal fees and administrative costs that DNA2.0 says it pays for each patent application it files. But Endy worries about the duration of copyright protections, which can last up to 120 years; patents, by contrast, expire after 20.

And patents are still useful for some inventions, says Gustafsson. DNA2.0 will continue to patent some of its engineered genes and proteins. "We play in the same system as everyone else," says Gustafsson. "But we also want to increase our market size." ■

POLICY

US Senate backs immigration plan

Proposal would lift visa caps for US-trained scientists and engineers.

BY HELEN SHEN

For Gaurav Basu, a graduate scholarship in 2003 helped to fulfil a long-held ambition of pursuing scientific research in the United States. In 2009, Basu, a native of India, earned his PhD in biomedical sciences from Eastern Virginia Medical School in Norfolk.

But Basu is struggling to keep his American dream alive after finishing a postdoctoral fellowship at Old Dominion University in Norfolk in 2011. With his temporary work visa set to expire in 2015, he is now working as a consultant in northern Virginia — and fighting tough odds to stay in the United States permanently by applying for a coveted 'green card'.

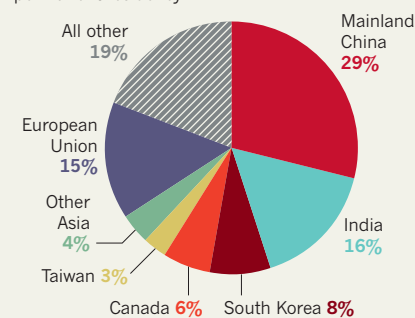
Those green cards could soon flow more freely to scientists such as Basu. After years of debate and many failed attempts, on 27 June the US Senate approved a comprehensive immigration plan that would allow thousands more foreign scientists and engineers to remain in the United States permanently. "It's a phenomenal improvement over the current situation," says Russell Harrison, a senior legislative representative for IEEE-USA in Washington DC, which advocates for US members of the Institute of Electrical and Electronics Engineers.

Under current policy, the number of green cards that can be issued each year is limited to 140,000, a figure that is further reduced by per-country caps. Applicants from countries that send large numbers of immigrants — such as China, India, Mexico and the Philippines — must often wait for years, subsisting on a string of temporary work visas that can be revoked at an employer's discretion.

"Our system is absolutely, utterly broken," says Amy Scott, associate vice-president for federal relations at the Association of

SHORT STAYS?

Most holders of doctoral degrees who have temporary US work visas come from India and China. Many of them have trouble securing permanent residency.



American Universities in Washington DC.

The Senate bill would end country-based caps and exempt researchers in some disciplines from limits altogether. Applicants with master's or doctoral degrees in science, technology, engineering or mathematics (STEM) obtained from US universities would be eligible to tap an unlimited pool of green cards. And, unlike previous proposals, the bill brings biological and biomedical sciences under the STEM umbrella.

According to the most recent statistics from the National Science Foundation, about 25% of the US science and engineering workforce comes from other countries. People from China and India made up nearly half of PhD holders who received temporary work visas in 2009 (see 'Short stays?'). And many of them lead tenuous lives in their adopted country.

Among them is Somiranjana Ghosh, a senior research associate in molecular genetics at Howard University in ▶


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