Joint Genome Institute in Walnut Creek, California, to take on the creature. Eighteen months later, about 50 biologists and bioinformaticists spent a week poring over the newly assembled draft genome. They identified as many genes as they could and compared the sea squirt sequence to existing genome information, focusing on how various types of genes had changed through time. The results of this effort are reported on page 2157.

The sea squirt's 117 million bases sequenced include 16,000 genes. Among the genes are single and double copies of genes that have multiplied several times in the mouse and human genomes. The sea squirt shares about 60% of its genes with the nematode and fruit fly, whereas about 5% have matches only in the human, mouse, and puffer fish genomes. And about 20% seem unique to *Ciona*, including several involved in the production of a stiff starch called cellulose, the main ingredient in its tunic.

"Every genome is like a history book," explains Peter Holland, an evo-devo biologist at the University of Oxford, U.K. "But the problem is [that] there don't seem to be any dates" for when different genes appeared over the course of evolution. The new sequence, however, should enable biologists to distinguish which genes arose in vertebrates and which predate the split between vertebrates and sea squirts. For example, *Ciona* lacks many vertebrate neural genes and certain immune system genes, suggesting that these came after the split between tunicates and early vertebrates. These additions, says Levine, made possible "probably the most spectacular [vertebrate] innovations": the complex nervous and immune systems.

To Holland, the fact that many genes have multiplied in vertebrates but not in *Ciona* "suggests that something dramatic happened to vertebrates" that caused this great expansion. Take *Smad* genes, which typically help regulate bone development. *Ciona* has five; mice have eight. This change in gene number is "a recurring theme in the analysis of the *Ciona* genome," Rokhsar points out.

Some genes' origins can be pinpointed to a time when the common ancestor to vertebrates and sea squirts thrived. For example, thyroid hormones and receptors are not found in other invertebrates but are present in *Ciona*. "We don't know what they are doing," says Rokhsar, but he suspects that they are involved in the transition from tunicate tadpole to sedentary adult, as they are in frogs' metamorphosis.

Meanwhile, *Ciona*'s unique genes for making cellulose "come out of nowhere," Carroll points out; they have not been found in other animals. Levine sees the genes as "very compelling evidence for remarkable horizontal gene transfer between bacteria and *Ciona*," as the sea squirt seems to have adopted bacterial enzymes needed to use cellulose.

Even more genomes must be sequenced before researchers can say whether Levine is right about the horizontal transfer. And the more genomes the better, evolutionary biologists argue. "As each complete genome unfolds," says Carroll, "we are getting a bigger and better picture of patterns of gene evolution and of gene families." –ELIZABETH PENNISI

RESEARCH INFRASTRUCTURE

NSF Urged to Boost Spending on Facilities

Nobody's talking about changing the National Science Foundation's (NSF's) name to Need to Support Facilities. But the foundation must spend a larger share of its $5 billion budget on research infrastructure to maintain U.S. leadership in science, declares a new report from its oversight body.

An internal survey of NSF's disciplinary offices yielded a wish list of almost $2 billion a year through 2012 for scientific tools ranging from computing networks and research vessels to telescopes and synchrotrons (see table). That's double NSF's current spending level. "The need is greater than we can address with our normal budget mechanisms, and it won't go away," says John White, chancellor of the University of Arkansas, Fayetteville, and chair of the National Science Board task force that produced the 41-page draft report posted this week (www.nsf.gov/nsb; 02-190).

A DECADE OF NEEDED FACILITIES

Price range (in millions)	Total
$1–$10	3950
$10–$50	5400
$50–$250	6800
$250–$500	1700
$500+	1000
TOTAL	**18,850**

Midsized crisis. There's a growing need for moderately priced facilities.

The top spending priority, according to the board, should be advanced cyberinfrastructure —not just more powerful computers but also better storage, analysis, visualization, and distribution tools—to benefit the entire scientific community. This is a broad program, "not just bigger machines at a few places," says board member Anita Jones of the University of Virginia, Charlottesville. But certain disciplines also have big needs, the board says. NSF would have to triple its annual spending on large research facilities—to $350 million—just to eliminate a backlog of detectors, telescopes, and other projects that the board has approved but Congress has yet to fund (*Science*, 14 September 2001, p. 1972). There's also a problem with "mid-sized" facilities—those costing tens of millions of dollars—that are too pricey for individual programs yet too small to rank as a major research installation.

NSF now spends 22% of its budget on tools, a fraction that "is too low," according to the report. The task force would like to see it grow to about 27%, says board member Robert Richardson, vice provost for research at Cornell University. The report, 2 years in the making, expresses the hope that a growing NSF budget will provide "the majority of these additional resources." That's a reference to a projected doubling of NSF's budget over 5 years, a concept that Congress endorsed last month in passing a bill that reauthorizes NSF's programs.

Should the pie not expand rapidly enough, however, NSF officials might have to revisit the thorny issue of striking the right balance between "big" and "little" science. "I think that the PI [principal investigator] community could see it as a threat," says one science policy analyst who had not yet seen the report. At the same time, a university lobbyist speculates that the needs outlined in the report could be used by some federal legislators to help push for a broader economic stimulus package.

The board hopes for feedback from the community before issuing a final version of the report this winter. "The proposed changes are not radical, but they are significant," Richardson told board members before they signed off on the draft report. "And I think people should pay attention." –JEFFREY MERVIS

PATENTING LIFE

Canadian High Court Rejects OncoMouse

OTTAWA—Canadian researchers don't have to worry about paying licensing fees for the use of transgenic animals. The nation's top court ruled last week that higher life forms aren't patentable.

In a 5–4 decision, the Supreme Court of Canada ended Harvard University's 17-year quest to obtain Canadian patent protection for its OncoMouse, ruling that the cancer-prone rodent can't be owned. The court said that OncoMouse, developed by Philip Leder of Harvard Medical School in Boston, isn't an invention under a 1869 Canadian law that protects "any new and useful art, process, machine, manufacture or composition of matter."

Although the court prohibited the patenting of OncoMouse, it did allow Harvard to proceed with applications to protect the process by which the animal is engineered. "We're going to do our best to squeeze all the protection we can out of this judgment,"