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<table>
<thead>
<tr>
<th>Isotope</th>
<th>Nonradioactive Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{3}$H/$^{51}$Cr</td>
<td>Cell Proliferation Assays, Cell Death Assays, Reverse Transcriptase Assay</td>
</tr>
<tr>
<td>$^{14}$C</td>
<td>CAT ELISA, Glycoconjugate Analysis System</td>
</tr>
<tr>
<td>$^{35}$S</td>
<td>Biotin In Vitro Translation System</td>
</tr>
<tr>
<td>$^{125}$I</td>
<td>Chemiluminescent Western Blotting Kits</td>
</tr>
<tr>
<td>$^{32}$P/$^{33}$P</td>
<td>Genius™ System, Tyrosine Kinase/Phosphorylase Assays</td>
</tr>
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Evidence is mounting against Pierce in the case of the mysterious disappearance of traditional oligonucleotide labeling. The accused has reportedly replaced the conventional time-consuming radioactive labeling procedure with fast, easy-to-use kits for labeling any oligo or other nucleic acid probe. According to eyewitness accounts, users of the new kits avoid the need for custom conjugation, derivatized nucleotides or enzyme reactions.

The kits are described as being a sensitive, non-radioactive labeling method, and have drawn considerable attention, as alkaline phosphatase-labeled probes detected with chemiluminescent substrates are the most sensitive and viable safe alternative to radioisotopes.

Sources close to the case have learned that the new kits are versatile, allowing users to label an oligonucleotide with any conjugate, including cross-linkers, fluorescent labels or biotinylation reagents. There are also reports claiming that probes labeled with this "OligoLink™" remain stable for months—or even years.

Detectives on the case are hindered by the unusually large number of crime scenes to investigate—reported as being hundreds of labs worldwide. Officials believe a recovery of the missing labeling procedure is highly unlikely.

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Also Wanted: OligoLink™ Hybridization Kit—believed to be headed for the area soon.

<table>
<thead>
<tr>
<th>Product #</th>
<th>Description</th>
<th>U.S. Price</th>
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<tbody>
<tr>
<td>17700</td>
<td>OligoLink™ Derivatization Kit</td>
<td>$175</td>
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<td></td>
<td>Includes sufficient materials for two phosphorylated oligonucleotide derivatizations. Contents: Derivatization Reagent, OligoLink™ Purification Matrix, EDC, DTT, Binding Buffer, Wash Buffer, Spin Columns with accessories, Collection Tubes and Instructions</td>
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<tr>
<td>17701</td>
<td>OligoLink™ Alkaline Phosphatase Conjugation Kit</td>
<td>$100</td>
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<tr>
<td></td>
<td>Includes sufficient materials for two oligonucleotide-alkaline phosphatase conjugations. Contents: Activated Alkaline Phosphatase, Conjugation Buffer, Desalting Units, SuperFreeze™ Phosphatase Stabilizer and Instructions</td>
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</table>
Shaded topography of the 12-kilometer-long Asal rift (Djibouti, East Africa). Colors indicate elevations, from -150 meters below (dark blue) to 350 meters above (purple) sea level. The topography results from the tectonic dismemberment over the past 100,000 years of a large central volcano (Fieale) that formed astride the rift zone 300,000 to 100,000 years ago. Reoconstruction of this volcano indicates a spreading rate across the rift of 17 to 29 millimeters per year. See page 1677. [Image: J.-B. De Chabaijer and J.-P. Avouac]

Stabilization of Atomic Hydrogen in Both Solution and Crystal at Room Temperature 1691
R. Sasamori, Y. Okaue, T. Isobe, Y. Matsuda

Stern-Volmer in Reverse: 1693
2:1 Stoichiometry of the Cytochrome c–Cytochrome c Peroxidase Electron-Transfer Complex
J. S. Zhou and B. M. Hoffman

Nanosecond Dynamics of the R→T Transition in Hemoglobin: Ultraviolet Raman Studies 1697
K. R. Rodgers and T. G. Spiro

iaglu, a Gene from Zea mays Involved in Conjugation of Growth Hormone Indole-3-Acetic Acid 1699
J. B. Szerszen, K. Szczyglowski, R. S. Bandurski

An Interleukin-4–Induced Transcription Factor: IL-4 Stat 1701
J. Hou, U. Schindler, W. J. Henzel, T. C. Ho, M. Brasseur, S. L. McKnight

Regulation of Alternative Splicing in Vivo by Overexpression of Antagonistic Splicing Factors 1706
J. F. Cáceres, S. Stamm, D. M. Helfman, A. R. Kainer

Coaxially Stacked RNA Helices in the Catalytic Center of the Tetrahymena Ribozyme 1709
F. L. Murphy, Y.-H. Wang, J. D. Griffith, T. R. Cech

Binding of 14-3-3 Proteins to the Protein Kinase Raf and Effects on Its Activation 1713
E. Freed, M. Symons, S. G. Macdonald, F. McCormick, R. Ruggieri

Stimulatory Effects of Yeast and Mammalian 14-3-3 Proteins on the Raf Protein Kinase 1716
K. Irie, Y. Gotoh, B. M. Yashar, B. Errede, E. Nishida, K. Matsumoto

Molecular Evidence That the Myxozoan Protists Are Metazoans 1719

Inhibitory CA1-CA3-Hilar Region Feedback in the Hippocampus 1722
A. Sik, A. Ylinen, M. Penttinen, G. Buzsáki

Molecular Determinants of State-Dependent Block of Na+ Channels by Local Anesthetics 1724
D. S. Ragsdale, J. C. McPhee, T. Scheuer, W. A. Catterall

Role of a Conserved Retinoic Acid Response Element in Rhombomere Restriction of Hexb-1 1728

Control of Thalamocortical Afferent Rearrangement by Postsynaptic Activity in Developing Visual Cortex 1732
Y. Hata and M. P. Stryker

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Noitall. A vast understatement of my true worth.

Science. What new inventions have you made recently?

Noitall. A new time machine that allows me to transport people back to any previous era. Many people say, "I'd like to go back to the good old days, like the 1800's."

Science. Fantastic. How does it work?

Noitall. Top secret—but based on the principle that if you go westward with the speed of light, you keep turning back the clock until you return before you've started.

Science. And what success have you obtained so far?

Noitall. The device is a fantastic success, but no tourists want to use it.

Science. What are you trying to achieve?

Noitall. I am trying to get volunteers to go back to a previous era when life was without current problems—no pollution, no overcrowding, no pesticides, no smog.

Science. And why no volunteers?

Noitall. As you know, I am a man hampered by my strict integrity. I would sacrifice my mother-in-law rather than tell a lie.

Science. And what truth must you tell that ruins your offer to potential volunteers?

Noitall. I have to explain that they must accept all of the previous era—the open spaces, the lack of automobile pollution, and so on, but also the absence of anesthesia, the absence of wonder drugs, a life expectancy of 44 years instead of 74, one-third of all women dying in childbirth, no television, no frozen foods...

Science. But what about those "science is ruining the world" types? They should be anxious to get back to the golden days of the past.

Noitall. That's what has hurt me the most. They apparently haven't understood what they are saying. Given the chance to go back in time, they prefer the here and now. I even plead that the ozone hole was much smaller then.

Science. What about a less drastic offer—just a few years back?

Noitall. They won't even go back a few years. They cite recent inventions like portable telephones, jet travel, microsurgery, better computers, and more efficient cars. Even a few years ago, we lived less well than we do now.

Science. So you have made an invention no one wants to use.

Noitall. It's a shame. Fortunately, I have one hope: a new regulatory law that will require everyone to spend some time in the 18th century.

Science. Why would Congress ever pass a law like that?

Noitall. We will call it an entitlement. Congress will never fail to enact an entitlement. Free travel at government expense is certain to be popular.

Science. And will that cure the "science is awful" crowd?

Noitall. Of course not. The gene for unbridled dedication to a lost cause will always overwhelm the pure logic genes.

Science. But requiring people to live in the 18th century just to prove a point seems too expensive. Can you make them satisfied in any other way?

Noitall. In fact, I am working on some very good computer-designed drugs. One called "factsum" would give you a great drug-induced "high" every time you absorbed an unpleasant fact. If you can't travel to cure your delusions, drug-induced hallucinations may be the next best thing.

Science. Would people get "hooked on facts" and become drug abuse victims?

Noitall. We are aware of that potential problem. We have a corrective drug that we call the "forest from the treeses." We prescribe it for poor souls who can't control their fascination for isolated facts.

Daniel E. Kosland Jr.
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Meeting the Competition

Philip H. Abelson's editorial "Evolution of industrial research" (15 July, p. 299) describes the restructuring and reduction of research at one American chemical company. The company says that this is necessary in "a fierce and unforgiving global competitive market." There are other, probably better, ways to meet competition. Bennett Harrison, professor of political economy at Carnegie Mellon University, summarized the situation (1):

Faced with the twin prods of higher costs and stronger competition, companies could have opted for the only sensible long-term solution consistent with a rising standard of living: increasing productivity. Major investments in new technology, more constructive and cooperative labor-management relations, and the closer integration of market research and product design with actual production would all have helped. Indeed, during the same period our Japanese, German, Italian, and Scandanavian competitors were pursuing precisely such strategies. Instead, more and more American corporations opted to reduce profitability by cutting costs, especially labor costs.

It is instructive to recall some past actions of American industry that affected its competitive position. The steel industry opted not to install the continuous casting method used in Japan. American automakers did not recognize the oil crisis of the 1970s as a signal to build small cars. New England textile machinery makers standardized and narrowed their lines of products. At the same time the Germans kept innovating and ended up with the business.

Continuous innovation and improvement are essential to remain competitive. A. P. Gelbein (2) has exposed the myth of "the lean, mean, fighting machine syndrome" in which research and development efforts have been downsized. The dream that the company that has cut its own research can buy the innovation elsewhere is just that. The company that develops the new and better process may commercialize it itself, leaving the established company with an outmoded and noncompetitive process. Large companies should also reflect on why they have left the field until small companies. Japan makes goods using 50% less energy than American companies, which places the latter at a competitive disadvantage.

O. Harari (3) reports that more than 75% of the downsizing in Europe and the United States has shown little if any long-term improvement in profitability or productivity. He feels that layoffs result from a knee-jerk crisis mentality. Statistics cited by R. B. Reich (4) indicate that less than half the downsizing firms expecting higher profits, higher productivity, or improved customer service got them. Within a year half of the firms had refilled the positions.

This "evolution of industrial research" will have a ripple effect. There will be less funds to support research universities and fewer jobs for their graduates. In a time of crisis we would hope for more research, not less. Certainly, our society needs new, environmentally benign processes to help us research the goal of a sustainable economy.

Albert S. Matlock
3751 Mill Creek Road,
Hockessin, DE 19707-9725, USA

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3. O. Harari, Manage. Rev. 82, 29 (October 1993).
4. R. B. Reich, Chemtech 24, 7 (March 1994).

Abelson's editorial discussing Alexander MacLachlan's speech about industrial research emphasizes evolution caused by pressures of global research. I suggest that such pressures have always been there and have not always been recognized by those in the field.

Research is something like searching for lost treasure in the sea. The shipwreck tends to scatter the gold on the ocean floor. The search will lead to the exciting find of the first few coins. Further searching will lead to discovery of the casket containing most of the gold nearby. The rest of the coins are scattered nearby, and continued searching leads to fewer and fewer pieces of gold. The search continues to grow more costly, even though technology may improve the techniques used and lower the cost. Finally, the supply of gold coins is exhausted, regardless of the technology and the expense. The search must then begin in another area if more treasure is to be found. Oil companies have experienced this in exploration for new revenue streams for many years.

The fact that a company finds it necessary to curtail research and development means that the return on its research investment is too low. By placing dollars elsewhere, the company can obtain a better return. For many years research chemists have lamented the fact that the "golden age" of research is over, and MacLachlan
certainly shows that the DuPont Company believes that this is so. This means one of two things: either the people going into research are incapable of generating ideas worthy of research (from the standpoint of a return on investment), or such opportunities no longer exist in the field chosen for research. In the case of DuPont, in the field of polymers, when the cost of internal development was too high to be absorbed, it indicated that the area being searched was no longer a rich field and that perhaps one should look elsewhere. However, when a company is very rich, the field must be extremely valuable or the research will not “pay off.”

The standard reply by the industry is, “we’ll buy our research from somewhere else.” This would indicate that the problem is neither the researchers nor the paucity of ideas, but rather is in the guidance of the research or the selection of areas chosen for research. Many times, the decision of where to search is not the choice of those doing the research, but of financial analysts who say, “We have found gold here before, keep searching.” Often, when gold is searched for, silver is found and those paying for the search are not interested. They may not know how to market the silver or feel that only a market for gold exists.

Most often, large companies do not buy their research from other large companies (unless those companies are in trouble themselves), but purchase research from smaller companies or from universities. No doubt, the cost structure for research is better at smaller companies, where overheads tend to be lower. Research can often be purchased from small companies for far less than it is worth, because of the inability of the small company to bear the cost of commercialization, which tends to dwarf research costs. At universities, the cost is lower still, as proved by the tremendous rush by all major companies to align themselves with the industrial transfer folks at the best research universities. Intellectual property rights always present the biggest obstacle in all of these negotiations, because the universities and small companies want a good return for the funds invested, whereas the purchasing companies want those costs to be small in order to provide a higher return. The fact that universities are not charging full costs, that is, the cost of failed research, makes them the cheapest cost provider for purchased research. Serendipitous discovery also provides an incentive for government to fund such research, thus providing industry with research at no direct cost to the purchasing companies. Unfortunately, this opportunity is afforded to all comers, and the mark and the yen have proved to have astonishing purchasing power over the last decade. It’s something like having a fire sale for certain customers who have responded by buying everything in sight.

Those of us in small companies will either find the funds to support our research from those willing to take a high risk for a commensurate return, or progress will cease. Fortunately, in the chemical and biotechnical fields with which I have been associated, there are such people. They are unwilling to pay for research in which vast sums have already been expended because they realize there is little to be found and the cost will be high. But for new and innovative chemistries, there is an amazing quantity of funds available.

Concerning the lack of need for Ph.D.’s, we should remember that in the early days of genetic engineering, 5 to 7 years of postdoctoral experience was the norm. Shortly after the discovery of the value of genetic engineering, these postdocs were commanding a salary 30% higher than other scientists in the area. The universities quickly responded, and salaries became more moderate. Whereas DuPont was reducing its hiring of technically trained people, the biotechnology and pharmaceutical industries quickly took up the output of our universities. It reminds me of the swings in petroleum engineering students and salaries. In 1982, R. L. Whiting of Texas A&M University told me that there were 600 graduates, only two of whom had jobs in petroleum engineering, and two freshman students. Our students have never been slow to determine whether they should enter a field if they have good information about the field. When there are no jobs or the pay is poor, the students will evaporate like the morning dew.

To those who bemoan the poor students, my reply is to tell them that chemical research is rewarding for those who have a new idea of where or how to search. For those who don’t, latch on to someone who does. If you can’t do one of these, get ready to be frustrated by the lack of jobs in research.

Gary Calton
Chairman and Chief Executive Officer,
SRCHEm, Inc.,
5331 Landing Road,
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Predicting Protein Crystal Structures

We write to call attention to a passage in a figure legend of a recent research article by David Barford et al. (1). The article reports the crystal structure of human protein ty-
rosine phosphatase 1B; the legend for figure 3 notes that most of the core secondary structural elements were predicted correctly by Livingston and Barton before the experimental structure was published (2).

The prediction (2), although not perfect, marks a milestone in the development and testing of a new generation of prediction methods that start from an alignment of homologous protein sequences. There are now a dozen examples where most or all of the core secondary structural elements have been successfully predicted for a protein family with the use of (i) methods that extract secondary and tertiary structural information from an analysis of patterns of conservation and variation between homologous protein sequences (3, 4) or (ii) methods that average predictions made by classical methods over a set of aligned homologous sequences (5).

The list of protein secondary structures predicted using the first method includes the protein kinases (4), the Src homology 2 domain (6), the Src homology 3 domain (7), MoFe nitrogenase (8), hemorrhagic metalloproteinase (9), and the extracellular segment of the aspartate receptor of *Escherichia coli* (10), together with protein tyrosine phosphatase (2). In several of these cases, in particular for the first domain of protein kinase (11), the hemorrhagic metalloproteinases (12), the pleckstrin homology domain (see below), the predictions were accurate enough that they were plausibly useful as the starting point for modeling tertiary structure. Further, although the prediction tools do not rely exclusively on automated methods, the fact that these tools are now generating predictions in at least four different laboratories suggests that they are transferable from laboratory to laboratory (14).

Predictions made with the use of the second method have been less consistent in their accuracy. Nevertheless, outstanding results have been obtained with interferon (15), tryptophan synthase (16), and annexin (17). Averaging of classical predictions with some conservation analysis yielded the secondary structure prediction that was used to model the zinc finger domain from transcription factor IIIA (18). Finally, a very good model of the secondary structure of the cytokine receptor was built by combining the second method with a more complete conservation analysis reminiscent of the first method (19).

No finite number of secondary structure predictions can prove a method, of course. Because many bona fide predictions are now in the literature, however, prediction verifications have become monthly events. For example, since this letter was first pre-

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pared, two nuclear magnetic resource structures appeared for members of the pleckstrin homology domain family (20). The secondary structure predictions (21) proved to be essentially perfect. These successes should encourage still more groups to try their hand at structure prediction.

Steven A. Benner
Dietlind L. Gerloff
Thomas F. Jenny

Department of Chemistry,
E.T.H. Zürich, CH-8092 Switzerland

References
20. H. S. Yoon et al., Nature 369, 672 (1994); M. J. Macias et al., ibid., p. 675.

Daniel N. Slatkin
Pathologist,
Clinical Research Center,
Brookhaven National Laboratory,
Post Office Box 5000,
Upton, NY 11973-5000, USA

References

Glioblastoma Treatment

In Faye Flam's News & Comment article about opportunities for treatment of brain cancer, "Will history repeat for boron capture therapy?" (22 July, p. 468), I was misquoted as having said, "a small number of glioblastoma patients do survive without treatment." I am not aware of such cases, although a few percent do survive with standard treatments. My identification as a neurosurgeon was also incorrect.

Tadaharu Tsumoto was kind enough to bring these errors to our attention.

Matthew B. Dalva
Lawrence C. Katz
Department of Neurobiology,
Duke University Medical Center,
Durham, NC 27710, USA

Correction: Incorrect References

In our report (1) "Rearrangements of synaptic connections in visual cortex revealed by laser photostimulation" (8 July, p. 235), two errors were made in citing papers from the group of T. Tsumoto.

The first error is in reference 6 on page 258 [Y. Hata, T. Tsumoto, H. Sato, K. Haghara, H. Tamura, J. Neurophysiol. 69, 40 (1993)], which was described as being published in Neurophysiology (USSR). This error seems to have occurred when we left the "J." out of the citation, resulting in a change to "Neurophysiology (USSR)."

The second error is in reference 17 on page 258. Here the reference that we meant to give was "T. Tsumoto, K. Haghara, H. Sato, Y. Hata, Nature 327, 513 (1987)."
Our Competitors' Enzymes Can't Pass The Quality Testing Performed On Gibco BRL Restriction Endonucleases

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<tr>
<th>Assay Performed</th>
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Summary: Seven out of ten restriction endonucleases from each competitor failed one or more of our quality tests.

Enzymes tested in the manufacturers' recommended buffers: BamH I, Bgl I, Cia I, EcoR I, Hind III, Kpn I, Not I, Pst I, Sal I, and Sst I (Sac I)

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The large intestine, humans' largest internal organ, is presently used only to absorb water and electrolytes, although its sacculated nature indicates an evolutionary adaptation to digest cellulose. This intestine's movements are so slow that the first radiologist to observe it said it presented a picture of still life. Much of this inactivity can be attributed to mankind's omnivorous diet. Nonetheless, it follows that, when following an exclusively granivorous, cellulose-digesting diet, our large intestine proves to be much more useful and efficient, since our ancestors up to 50 thousand years ago always used it to digest cellulose fiber. We are presently neglecting a very useful capability that our ancestors adaptively acquired. Humans, as all other primates, were meant to be vegetarian cellulose-digesters and have slim bodies. The size of the human mouth is small for almost any type of omnivorous feeding, making this feature, as well as our powerful teeth, characteristic more of seed-eaters than of carnivorous or omnivorous mammals.

It is inconceivable to think that hominids and their protohominid ancestors lived in the savannas for millions of years and never developed the practice of feeding from gramineous seeds until the discovery of agriculture, or until fire was used to cook food. If we take into consideration that early hominids were already bipeds and tool users, and the seeds from grasses would lightly touch their hands as they walked in the long-grass grasslands, it would be illogical to assume that, in spite of the many vicissitudes they suffered during so many million years of living in the savannas, they never tried to feed from these seeds or that they never thought of removing the seeds with their hands. The author argues that when injuring themselves by removing the seeds, they used a natural small stone tool to protect their hands, which achieved an unanticipated advantage: they improved their efficiency in removing and threshing seeds.

We invite you to read this book and explore in it the scientific bases of these arguments, upholding the importance of the role of graincollecting in human evolution and behavior.

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**HUMPBACK WHALE STILL HUNTED, mtDNA SHOWS**

**EARTHTRUST TEAM GOES UNDERCOVER**

**PCR* in Hotel Rooms**

HONOLULU - A team working with the environmental group Earthtrust has adapted the tools of molecular biology to document the illegal sale of whale meat. The poaching of endangered species of whales had long been suspected, but due to a technicality of international law, actual data was always difficult to collect. Although whale meat is commonly sold in several nations, scientists are restricted from taking tissue samples across national borders—even if only to conduct DNA analysis.

Enter Earthtrust, the Hawai‘i-based group that first exposed the slaughter of dolphins by deep-sea driftnetters. In 1993, their scientific team of Scott Baker of the University of Auckland & Steve Palumbi of the University of Hawaii developed a protocol for extracting and copying DNA that works well in the field. Baker then flew to Japan to test samples of whale meat obtained in advance by a collection team consisting of an off-duty wildlife officer and a linguist. This team had scouted fish markets and department stores to obtain samples and videotape of whale meat for sale. They relayed the samples to Baker, who set up his lab gear in a hotel room.

Under the rules of the International Whaling Commission, Japanese whalers are permitted to harvest a small number of Southern Hemisphere minke whales—a less threatened species—for population analysis, then sell the meat to finance. It had long been suspected that through this legal loophole, much illicit trade in endangered species was occurring. But data were lacking, and the CITES treaty—an international agreement designed to protect threatened animals worldwide—prohibits the transportation of products from endangered species across national borders. So Baker extracted DNA from the processed whale meat samples, then amplified mtDNA using a portable MiniCycler thermal cycler donated by MJ RESEARCH. In order to adhere to the CITES regulations, Baker separated the synthetic, copied DNA from true whale DNA by using biotinylated primers and streptavidin-coated magnetic beads. He then returned to Hawaii with only copied DNA, which he and Palumbi sequenced and analyzed.

Baker & Palumbi’s data show that among 16 samples identified, 7 were from Southern minke whale, one from North Atlantic minke, one from humpback, 4 from fin whale, 2 from dolphin, and one was likely a beaked whale. These data were presented to the IWC in May and published in a recent issue of Science. Many groups hope that this new method of portable DNA analysis will help authorities enforce existing law, as well as obviate any future need for lethal “research whaling.”

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to be important in the developmental plasticity of thalamocortical afferents in the mammalian somatosensory system (15). In the rat S1 cortex, the excitatory neurotransmitter antagonist D-2-amino-5-phosphonovaleric acid (APV) blocked (suppressed) the rearrangement in the somatotopic pattern of thalamocortical afferents induced by the destruction of a row of vibrissae follicles, but reverse plasticity was not observed. Reverse physiological plasticity in kitten visual cortex was observed only with the strongest GABA_2 agonists (16, 17).

Previous physiological studies (6) did not answer whether the ocular dominance shift toward the closed eye in the muscimol-treated cortex had been caused by the strengthening of inputs to cortical cells from the closed eye or by the weakening of inputs from the open eye. The present findings suggest that both these changes take place in the anatomy, although they do not provide information about events at the synaptic level that might precede the changes in afferent arborizations and determine the synaptic strength. Control of at least four types of anatomical plasticity is now evident: When the postsynaptic cells can respond, there is the well-known (i) increase in the territory covered by arbors of more active afferents with (ii) a complementary decrease of the less active afferents. When postsynaptic responses are prevented, (iii) the territory of less active afferents increases with (iv) a less than complementary decrease in that of the more active afferents. These findings suggest a push-pull mechanism of synaptic plasticity—that without postsynaptic activity, less presynaptic activity gives an input the advantage, whereas with a strong postsynaptic response, the contrary is true.

REFERENCES AND NOTES

7. All surgical procedures were performed with the animals under an anesthetic of N_2O:O_2 (2:1) and halothane (1.5 to 2.5%). A cannula (33-gauge stainless steel needle) connected to an osmotic minipump (Alzet 2002 or 2ML4, Alza) was implanted into one hemisphere of the primary visual cortex of 11 4-week-old kittens (P27-35), and muscimol solution was infused continuously (10 mM in saline; 2.5 μl/hour for 4 weeks or 20 to 30 mM, 0.5 μl/hour for 2 weeks) until the terminal experiment described in (8). For anatomical demonstration of the geniculo-cortical afferent termination, we injected 2% paraformaldehyde (1.7 to 2.1 ml in 20 μl of saline) into one eye 6 to 14 days before the experiment.
8. Animals were anesthetized with N_2O:O_2 (2:1) and Nembutal (2 to 4 mg per kilogram of body weight per hour) during recording experiments. Spike activities of cortical cells were recorded extracellularly with a tungsten microelectrode at various distances anterior to the cannula that was infusing muscimol solution. When no spike activity except for injury discharges was recorded while the electrode was advanced to the depth of 2000 μm at least, we considered the site inactivated by muscimol. The inactivated area extended between 5 and >10 mm anterior to the cannula. After mapping the inactivated area, muscimol infusion was stopped. After a recovery period of 16 to 19 hours, we recorded spike activity and vigorous visual responses in the area of the cortex that had previously been inactivated.
9. Animals were perfused transcardially with saline and then with 4% paraformaldehyde or 2% glutaraldehyde in 0.1 M phosphate buffer. A block of the brain containing the lateral geniculate nucleus was cut (thickness, 50 μm) on the vibratome in the frontal plane. Blocks containing visual cortex were cut (30 μm) on the frozen microtome in the horizontal or sagittal plane. In five animals, the caudal part of the cortex, which includes the primary visual cortex, was unfolded and flattened between two glass slides (J. Olavarría and R. C. Van Sluyters, J. Neurosci. Methods 15, 191 (1985)). The flattened cortex was then cut tangentially (40 μm) on the frozen microtome.
11. Photomontages of labeling in layer IV were made from several sections in which the intensity of labeling was not necessarily uniform, as is evident in Fig. 3A. Because it was necessary to adjust contrasts of labeled ocular dominance patches in different regions to match one another to make the photomontages, one cannot infer the absolute intensity of labeling from photomontages presented in this report. The montages do represent the areas of ocular dominance patches accurately.
12. The size of the inactivated area of cortex was evaluated in animals placed under general anesthesia, a treatment that enhances GABA-mediated inhibition. The inactivated area was probably smaller in alert animals. In the other eight animals, we could not compare these two measures, either because the inactivated area was too large to be located within the part per 12 accessible to our micro-electrode penetrations or because it was difficult to measure the distance on the cortex after flattening the cortex.
16. Other less potent GABA_2 agonists, 3-aminoopropane-sulfonic acid and isoguvacaine, prevented ocular dominance plasticity but did not cause reverse plasticity (P. Feldman, thesis, University of California, San Francisco (1993)).
17. APV treatment at very high concentrations was reported to cause reverse ocular dominance shift in the developing visual cortex (M. F. Bear, A. Kaunschnitz, Q. Gu, W. Singer, J. Neurosci. 10, 909 (1990)).
18. We thank S. Harris for her help during the experiments. This work was supported by NIH grant EY02874 to M.P.S. and by Human Frontiers Science Program long-term fellowship to Y.H.

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The development of these ideas, particularly in the area of dynamical systems, has been extremely rapid, and, in the words of Andreas Weigend and Neil Gershenfeld, the literature is fragmented and anecdotal. In an effort to sort things out, Weigend and Gershenfeld ran a competition in which participants analyzed four data sets. Upon the completion of the competition, a NATO Advanced Research Workshop on Comparative Time Series Analysis was held at the Santa Fe Institute to discuss the results. The present volume is a report of that workshop.

The volume begins with an introduction by Gershenfeld and Weigend covering many aspects of nonlinear time series analysis, the theory of dynamical systems, neural nets, and their own theories about learning and understanding. Reading it is a bit like taking a three-day tour of eight countries: you only know where you are if you have been there before. The balance of the volume is divided into four sections. Section 1 describes the four data sets used in the competition: emissions of NH₃ lasers, a multivariate physiological time series, exchange rate variations, and brightness variations in a white dwarf star. After the competition, a mathematical representation of an unfinished Bach fugue was added, which, in my view, comes perilously close to failing the cuteness test.

The competition had two goals: prediction and characterization. Sections 3 and 4 report on successful entries under these two headings. For prediction, the reports can be grouped into three rough categories: geometric methods, statistical methods, and methods based on neural networks. The distinction between the latter two is illusory. A neural net is essentially nonlinear regression in a black box. For time series analysis, the black box should simulate the brain of a good statistician with an understanding of the process to be modeled. Some may come close. Many don’t. But why accept substitutes? Characterization refers to dimension estimation, identifying chaotic dynamics (for example, by estimating the largest Lyapunov exponent), and detecting determinism and nonlinearity. The final section contains some miscellaneous papers, including two on the difficult problem of spatial chaos.

This book is interesting, entertaining, and more than occasionally instructive. I particularly liked Sauer’s paper on geometric prediction and the cautionary paper by Theiler, Linsay, and Rubin on the spurious detection of nonlinearity in linear models with long-range dependence. None of the papers is bad. Now to complaints. First, the volume does not manage to sort out the aforementioned fragmented and anecdotal literature. Though this would have been a monumental undertaking, a little more progress might have been made. Part of the problem is the sheer enthusiasm of the contributors. Apart from Theiler et al. and Lewis, Ray, and Stevens, who rain ever so gently on the neural net parade, skepticism is not much in evidence. Second, to make the analyses convincing to a wide range of scientists it would have been useful to consider somewhat messier data. There is no shortage. Third, on the technical side, the attitude toward noise in much of this work is rather cavalier. Noise can enter through the process itself (for example, turning a first-order difference equation into a first-order autoregressive process). It can also be observational, so that the process itself is never actually observed. As innocuous as this distinction may seem, it can have important implications for data analysis and modeling. Whole books have been written on the subject. Most of the methods described in this book are based on implicit assumptions (some quite bizarre) about the way in which noise enters the system, and no attention is devoted to the consequences of the alternatives. Finally, I have to wonder whether this exercise is not a little premature. So many basic statistical issues are left unraised—the treatment of noise being just one—that a little more work with pencil and paper seems in order. Despite these reservations, this volume is well worth a look for those interested in modern time series analysis. It may not be the next Box and Jenkins, but it is certainly a step in the right direction.

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Earth’s Glacial Record. M. Deynoux et al., Eds. Cambridge University Press, New York, 1994, xvii, 266 pp., illus. $89.95. World and Regional Geology Series.


Geometric Differentiation. For the Intelligence of Curves and Surfaces. I. R. Porteous. Cambridge Univer-sity Press, New York, 1994, xiv, 301 pp., illus. $54.95.


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CAN YOUR MICROSCOPE DO THIS?

The benefits of seeing your specimens in three dimensions seem obvious. Observe the 3D pair above. Merging them forms a 3D picture containing crucial z-axis information that's missing when either image is viewed independently. Yet there's even more here than meets the eyes.

If you can, merge the 3D pair (if you can't do it without aid, we'll send you a free image-merging lunette with our brochure). You'll notice that the resulting 3D picture appears better than the individual 2D pictures in every respect. Resolution, detail, contrast, and — of course — depth. You can thank the Edge Scientific Instruments™ R400 microscope. You also can thank the most powerful image processor in existence: Your brain.

While your eyes encounter two flat pictures, your brain forms one 3D image. And this image carries additional spatial information — in highlights, shadows, and details — that lets your brain better understand the specimen as it really exists in three dimensions.

Fortunately, you don't have to think about this. It happens automatically, and instantly.

But you should think about the only microscope that gives you 3D images, both for direct observation and for recording. The R400 uses Edge's patented* Multiple Oblique™ illumination to provide high definition 3D images in true color up to the highest magnification available. No computers or image-enhancement tools are necessary — real-time 3D images are available directly at the eyepieces, although they may be acquired for use in an image-processing system as well.

And whether you observe and record your specimens in three dimensions or in two you'll experience significant improvements in resolution, contrast, and depth of field with Multiple Oblique illumination, compared against the finest conventional light microscopes available.

If you'd like to learn more about the most significant new development in light microscopy, please call Edge at (310) 396-9333 and ask for our free brochure. In it you'll find several examples of the R400's 3D photomicrographs as well as a handy image-merging lunette.

To view this 3D pair without aid:
Hold the page close to your nose so each eye aligns with each picture. Relax your gaze, then move the page away slowly until a third picture forms in the center. This is the merged 3D image. Continue moving the page away until the image becomes focused. Edge will send you a free lunette which facilitates merging 3D images. The ability to view printed 3D pairs is an increasingly valuable skill. Shown: Tump yellow mosaic virus crystal, Plan Achromat LWD 10x.