cific age groups;

• develop toxicity tests for pesticides tailored to the unique physiology of infants and children;

• make residue limits take into account potential nondietary exposures to pesticides; and

• cut by as much as 90 percent allowable residues of pesticides that may be toxic to children or for which toxicity data remain inconclusive.

Federal researchers have also analyzed pesticide residues in the context of what children eat. In a study published earlier this month, Norma Yess and her colleagues at FDA in Washington, D.C., reviewed data from food assays by the agency's chemists between 1985 and 1991. Though their study includes data on baked goods, infant cereals, infant formulas, and combination dinners (including meat), it focuses on data from 10,600 samples of fresh apples, oranges, bananas, pears, milk, and fruit juices.

A 1992 FDA analysis found that among domestically produced foods in 1991, roughly 40 percent of grains and grain products, 51 percent of fruits, and 32 percent of vegetables contained pesticide residues, notes Ellis Gunderson, a coauthor of the new FDA report.

But pesticide concentrations tend to be within federally allowed limits. Indeed, among the six years of test data FDA analyzed for its new report, less than 0.5 percent of sampled foods violated those limits, the researchers report in the May-June JOURNAL OF THE ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS INTERNATIONAL.

Raw foods tended to have the highest residues, the FDA team found. That's not surprising, they say, because these foods are tested before being washed, peeled, or processed – factors that can reduce pesticide residues by as much as 99 percent. Basing exposure estimates on these residues would probably exaggerate the amount consumers actually eat.

In a broader sense, however, "FDA seriously underreports pesticide residues in the food supply," Wiles charges.

While FDA can screen foods for more than 300 pesticides, not all of its laboratories employ all applicable tests. Among 12 regional FDA labs, seven used three or more multiple-residue screening techniques on 80 percent or more of the foods they tested, the EWG study found. The other five used just one or two screens to test 75 percent or more of their food samples. Not surprisingly, Wiles reports, "the seven most rigorous FDA labs reported twice the percentage of samples with detectable residues of one or more pesticides in apples, pears, bananas, tomatoes, and green beans."

Although FDA's data establish that crops bear multiple residues, federal agencies regulate pesticides as if exposure occurred individually and in isolation, the NAS report notes. In fact, multiple residues on a single crop are common, the EWG study indicates.

The independent labs' analyses of thousands of produce samples from supermarket warehouses indicate that residues of two or more pesticides occur on 62 percent of oranges, 44 percent of apples, and at least 25 percent of all cherries, peaches, strawberries, celery, pears, grapes, and leaf lettuce, notes Wiles. Some carried residues of six to eight pesticides, of which two or more might be suspected carcinogens, he says.

Pending data on how these pesticides may interact, regulators should consider taking a more conservative approach "by assigning toxicity equivalence factors to each of the compounds having a common mechanism of action" and then adding them, the NAS panel argues.

NAS tested this concept with five potentially nerve-damaging organophosphate insecticides used on foods. Based on residues observed for specific crops, the NAS committee found there were at least "weak" data to suggest "that for some children, exposures could be sufficiently high to produce symptoms of acute organophosphate pesticide poisoning."

The NAS panel emphasizes that it found no data showing that any pesticide residues have actually harmed children or infants. However, it did find that certain behaviors – such as eating patterns, food-preparation techniques, and pesticide-use patterns – might combine to put some young children at risk.

Briefed on both the EWG and NAS reports before their release, the EPA, FDA, and the Agriculture Department issued a joint statement on June 25. In it, the Clinton administration pledged to intensify efforts to reduce the use of high-risk pesticides and to develop safer pesticides through regulatory reform and new incentives to pesticide manufacturers. The statement added, "We expect to use the upcoming reports of the NAS and the EWG on children and pesticides as a basis for formulating the legislative and regulatory policies needed to put the administration principles into effect."

– J. Raloff and D. Pendick

A curvy path leads to Fermat's last theorem

After more than 300 years, Fermat's last theorem may finally live up to its common designation as a theorem. In a dramatic announcement that caught the mathematical community completely by surprise, Andrew Wiles of Princeton University revealed last week that he had proved major parts of a significant conjecture in number theory. These results, in turn, establish the truth of Fermat's famous, devilishly simple conjecture.

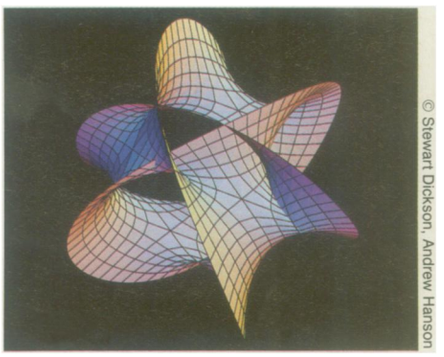
"It's an amazing piece of work," says Peter C. Sarnak, one of Wiles' Princeton colleagues. "The proof hasn't been totally checked, but it's very convincing."

Pierre de Fermat's last theorem goes back to the 17th century, when the French jurist and mathematician asserted that for any whole number n greater than 2, the equation $x^n + y^n = z^n$ has no solution for which x, y, and z are all whole numbers greater than zero.

Fermat scribbled his conjecture in the margin of a page in a mathematics book he was reading. Then, in a tantalizing sentence that was to haunt mathematicians for centuries to come, he added that although he had a wonderful proof of the theorem, he didn't have room to write it.

After Fermat died, scholars could find no trace of the proof in any of his papers. Later, mathematicians proved the conjecture for the exponent $n = 3$ and solved several other special cases. Last year, a massive computer-aided effort by J.P. Buhler of Reed College in Portland, Ore., and Richard E. Crandall of NeXT Computer Inc., in Redwood City, Calif., verified Fermat's last theorem for exponents up to 4 million.

Meanwhile, mathematicians had picked up some valuable hints of a potential avenue to a general proof that the conjecture is true. In the mid-1980s, Gerhard Frey of the University of the Saarlands in Saarbrucken, Germany, unexpectedly uncovered an intriguing link between Fermat's conjecture and a seemingly unrelated branch of mathematics. He found a way to express Fermat's last theorem as a conjecture about elliptic curves – equations generally written in the form $y^2 = x^3 + ax^2 + bx + c$, where a, b, and c are constants.



Visualization of curves associated with the Fermat equation for $n = 3$.

This brought Fermat's problem into an area of mathematics for which mathematicians had already developed a wide range of techniques for solving problems. A number of mathematicians, including Barry Mazur of Harvard University and Kenneth A. Ribet of the University of California, Berkeley, followed up Frey's surprising insight with additional results that ultimately tied Fermat's last theorem to a central conjecture in number theory (SN: 6/20/87, p.397).

Named for Japanese mathematician

Yutaka Taniyama, this conjecture concerns certain characteristics of elliptic curves. A proof of this conjecture would automatically imply that Fermat's last theorem must be true.

Starting about five years ago, Wiles took on the extremely challenging, highly technical task of proving the Taniyama conjecture itself. But he proceeded in such secrecy that even his closest acquaintances and colleagues were unaware of the extent of his effort.

Last week, Wiles was finally ready to reveal that he had proved a significant part of the Taniyama conjecture. He chose to describe his results in his native land during three lectures presented at a workshop at the recently opened Isaac Newton Institute for Mathematical Sciences of the University of Cambridge in England, the university where Wiles had done his doctoral studies. His audience included Mazur, Ribet, and many other experts in this particular specialty.

At the end of his third lecture, almost as an afterthought, Wiles noted that he had proved enough of the Taniyama conjecture to show that Fermat's last theorem was true.

"The feeling in the field had been that the Taniyama relationship – this conjecture for certain curves – was absolutely untouchable, an incredibly deep, very difficult problem to solve," says Princeton's Henri Darmon. "Wiles really shocked the mathematical community by announcing he had proved a large part of the Taniyama conjecture."

By following a course that built on previous, well-understood results, and because of his own reputation for being extremely cautious and careful in his mathematical work, Wiles has already earned a great deal of respect for his proof. Nonetheless, the details of Wiles' 200-page proof need to be checked thoroughly by experts. That might take as long as a year.

"There are a number of subtle points," Darmon says. "But given that he's using fundamental theorems, the basic ideas seem correct."

Five years ago, Yoichi Miyaoka created a considerable stir when he announced that he had proved Fermat's last theorem – using an approach that differed considerably from the one taken by Wiles. However, Miyaoka's proof turned out to be flawed (SN: 4/9/88, p.230).

If Wiles' proof holds up, it does far more than establish Fermat's conjecture as a theorem. Mathematicians now have new techniques – developed by Wiles – for tackling other important, difficult questions in number theory.

"For the specialist, that he has proved Fermat's conjecture is the less exciting part," Darmon says. "His work completely changes the field."

In fact, says Sarnak, "this is not the end of a subject, but the beginning."

– I. Peterson

Evolutionists pick up on one-night stands

Men and women approach one-night stands altogether differently, the result of millions of years of sexual evolution, according to a recent study. This sexual divide hinges on the question of what men and women look for in a mate. It turns out that men leave their standards behind when scouting for a casual liaison, while women consistently maintain theirs.

"From an evolutionary perspective, mating is the most important game around; the more you understand it, the better you'll be at succeeding – or at not being dissatisfied or horrified with what the opposite sex does," says Douglas T. Kenrick, a psychologist at Arizona State University in Tempe. Kenrick and his colleagues researched the differences between men and women's criteria for a mate in the gamut of relationships from one-time sexual encounters through marriage.

The psychologists asked 327 college students to state their criteria for 24 traits, such as intelligence, status, and emotional stability. The students also evaluated themselves on the same traits. Unlike most previous efforts, the study synthesizes two often disparate theoretical approaches: social psychology and evolutionary psychology (SN: 10/12/91, p.232). Combining the two helps reveal the deep-rooted reasons for different mating behavior between men and women, says Kenrick.

The gap between the sexes appeared greatest when students were asked to consider a one-night stand, the study found. In addition, men's standards for a mate correlated less closely with their self-appraisals than did women's, particularly for casual relationships. But when it came to the question of marriage, the differences faded away, with both men and women desiring agreeable, attractive, and emotionally stable mates. The study appears in the June JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY.

Both social and evolutionary psychologists view relationships as a kind of market exchange in which each person seeks the best possible deal, leading to partners of about equal assets coupling up. Social exchange theory, however, emphasizes the role of culture in setting the value of a trait, such as beauty, wealth, or kindness. Social psychologists downplay innate differences between the sexes, emphasizing the impact of socialization on sexual behavior.

Evolutionary psychologists, in contrast, view differences in sexual behavior as a basic aspect of human nature that is shaped by evolution. Therefore, traits that appeal to the opposite sex and help one compete for a mate – such as social dominance in men and physical attractiveness in women – have been favored and passed down. Evolutionary theorists point out that, to our ancestors, social dominance signified the ability to compete well and provide for offspring, while attractiveness and youth indicated the health needed to bear children.

To test evolutionary theory, Kenrick's group reasoned that men and women would differ most when considering a casual liaison. Men would be relatively indiscriminate, given the chance to "enhance their genetic interest with no resource investment," notes Kenrick. Women, who could end up paying a high price for a rash mating session, were expected to be selective.

The study incorporated an important assumption of social psychology – that individuals perceive the costs and benefits of sexual behavior differently depending on the type of relationship pursued. It also applied social psychologists' awareness that men and women take mating seriously.

Many social psychologists continue to hold evolutionary psychology at arm's length because they consider humans' behavioral past outside the purview of present-day experience. But, says Kenrick, "We should not research human mating behavior without asking about its evolutionary significance – just as we ask about all other animals." *– B. Wuethrich*

Cooperation evolves via reward strategy

Birds do it, bees do it, even you and I do it: Instead of selfishly helping only ourselves or our close relatives, we sometimes choose to cooperate with genetic strangers. In the past decade, scientists have suggested that a strategy of "tit-for-tat" guided the evolution of cooperative behavior in the animal world. A creature employing this scheme cooperates with a compatriot on a first encounter, then responds in kind to that animal's subsequent actions, whether cooperative or selfish.

But cooperation may have evolved largely in response to another rule of thumb, according to a report in the July 1 NATURE. A cooperative act that reaps rewards gets retained, in this theory; once it produces a loss, cooperation is abandoned for selfish behavior. The same pattern of "win-stay, lose-shift" governs selfish acts.

Computer simulations find that this strategy eventually outperforms tactics emphasizing tit-for-tat, selfishness, or cooperation alone, yet it facilitates a great deal of cooperation in its own right, assert zoologist Martin Nowak of the University of Oxford in England and mathematician Karl Sigmund of the University of Wien in Austria.

The late B.F. Skinner and other "behav-