



Associated Press

## the World

state that one had to wonder if the true competition was not for the fastest time or best performance but for the most gut-wrenching personal drama. First in professional sports and then in college, the focus on individuals begat graceless end-zone dances and preening for the cameras after monster dunks; for the modern athlete, anonymity is anathema.

"To me, television is at its best when it's simply eavesdropping on events that would have been essentially the same had there been no television," said Bob Costas, NBC's Olympic host and primary baseball voice.

# The Nobels: Dazzled By the Digital Light

By GEORGE JOHNSON

**T**HE Nobel prize in physics is usually bestowed for an abstract theoretical insight or esoteric experimental technique that deepens science's comprehension of the world. And physics being physics, it is often a challenge to explain to anyone but specialists just what the laureates are being honored for. Last year two Dutch physicists were recognized, in the Nobel committee's words, "for elucidating the quantum structure of electroweak interactions." The year before two Americans and a German bagged the prize "for their discovery of a new form of quantum fluid with fractionally charged excitations."

In contrast, this year's award, announced last week in Stockholm, seemed surprisingly down to earth. The three winners will share the prize for the invention of microelectronic chips and other components that lie at the heart of laptop computers, CD players, cell phones, fiber-optic transmission lines and other wonders of the digital age.

But the honor, especially when considered alongside the other big science prizes — for medicine or physiology and for chemistry — was striking in another way. There is no Nobel Prize for computer science. But obliquely and perhaps unconsciously, the judges were using the tools at their disposal to recognize how formidable the notion of information has become, pervading not just the technologies we devise but the way we think about ourselves.

While the physics prize went to three architects of the computer revolution, the chemistry prize went to the inventors of a technique for making plastic conduct electricity — a technology that might one day be used to design cheap, low-energy video displays that can be folded like sheets of stationery. And the physiology prize went to a trio of researchers who helped develop the modern view of the brain as a kind of computer, its neurons trading data as though they were biological chips.

The timing of the awards, each worth about \$913,000, was probably coincidental, but the message was hard to miss: The notion of information has become indispensable for both manipulating and understanding nature.

**H**ALF the physics prize will go to Jack S. Kilby, a 76-year-old retired engineer for Texas Instruments, for

brain. Molecules called neurotransmitters ferry signals from neuron to neuron, the information processors of the nervous system. There are obvious differences between electronic and biological circuitry. Computer chips communicate through simple metal wires. Neurons send their molecular data streams across complex junctions called synapses. And the language of the brain seems to be more complex than the simple binary chattering of computerese. But viewed at the most abstract level, both brains and computers operate the same way, by translating phenomena — sounds, images and so forth — into a code that can be stored and manipulated, giving both creature and their creations a firmer grip on the world.

**D**R. KANDEL has drawn an especially vivid link between the nervous system and electronic circuitry. In classic experiments he showed how learning causes changes in the neurological wiring of a sea slug called *Aplysia*, whose nervous system is so simple that experimenting with it is like tinkering with an old radio. Training the creature to react vigorously to a stimulus, like an annoying squirt of water, causes an increase in the flow of neurotransmitters — biochemical information — across certain synapses, a tweaking of the neurological volume controls. The implication is that more complex brain functions are built from millions of these kinds of processes.

The notion of information has become indispensable in fathoming or fooling Mother Nature.



re players in a movie. They are on a performance for the cam-

legendary as Fisk's home run has, it has, paradoxically, led to the of the true sports legend. As fans on-fed every angle, their imagina-hers. The controversy surrounding mpsey's "Long Count" boxing vic-r Gene Tunney in 1927 would have ttled in a matter of seconds by replay. Even Wilt Chamberlain's 00-point game in 1962 has no visual one can only fathom how dominat-nust have been. Satchel Paige's is a mystery. Today there are no othing left unseen or unexplained.

NS only thirst for greater access, id the Internet is delivering it. iring the recent United States nnis Open, the event's official allowed people to choose between ches rather than the single broad-m on CBS, and even use their s to zoom the cameras in on the

Webcasts of sporting events will vers to choose from dozens of gles and unlimited replays. Vid-s will allow people to relive his-s moments at will. Many fans Fisk's home run. As they click they should thank the rat.

The other half of the money will be split by a Russian and an American physicist — Dr. Zhores I. Alferov and Dr. Herbert Kroemer — for devising tiny devices called semicon-ductor heterostructures, used in the high-speed processing of electronic and optical signals, blips of electricity and light.

The research that won the chemistry prize, given to two Americans and a Japanese, Dr. Alan J. Heeger, Dr. Alan G. MacDiarmid and Dr. Hideki Shirakawa, opens up numerous possibilities for data processing, including not just flexible video screens but powerful chips in which single molecules process bits of information.

All these inventions grew from the now commonplace realization that numbers, words, sounds and images — anything that can be described precisely — can be translated into a simple binary code of ones and zeroes and manipulated rapidly and almost flawlessly by machine.

But new technologies are just the beginning of the information revolution. The most intellectually fruitful development has been the cross-fertilization between computer science and neuroscience. Thinking of computers anthropomorphically has become second nature: A programming code is a language; an array of silicon chips is a memory. The prize for medicine or physiology, given to Dr. Arvid Carlsson, Dr. Paul Greengard and Dr. Eric Kandel, is a reminder that the commerce in ideas flows both ways.

The researchers, each in his own manner, have clarified how data circulate inside the

The Nobel medal.

what Dr. Kandel has called "letters in the cellular alphabet of learning."

Next to the brain, the most obvious biological information processor is the genetic machinery of the cell. The design of an organism is encoded into the chemical alphabet of DNA and manipulated to direct the assembly of proteins. Again the trade in ideas flows in both directions: scientists have recently made DNA computers that carry out simple computations inside test tubes.

And in the physics labs, experimenters are playing with simple quantum computers in which individual atoms manipulate bits of data. True to form, some theorists argue that it's not only in captivity that matter behaves this way: All the quarks and electrons in the cosmic wilds are exchanging information each time they interact.

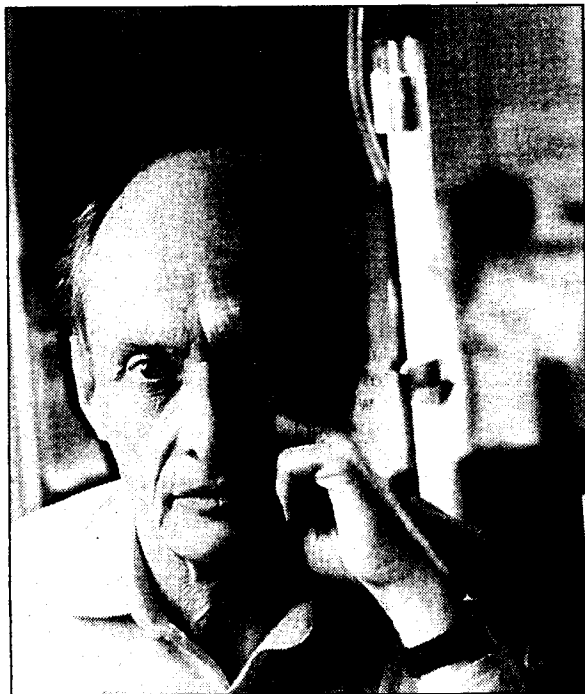
Alfred Nobel's prizes, paid for by the fortune he made from dynamite, began in an age when matter and energy seemed to explain nearly everything. (The first physics prize, in 1901, went to Wilhelm Conrad Roentgen for discovering X-rays.) Last week's prizes finally commemorated science's move into a new era, the information age.

## Nobel in the Family

# : Now I Know What He Does

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Paul Greengard, at Rockefeller University.

When he went south, to Vanderbilt University, I made the mistake of asking what he would be researching. "Thermodynamics of the adenylyl cyclase reaction," he said. That scared me so that I switched the subject to myself. I'd say, "I'm singing in this Broadway show called 'Tenderloin,' and George Abbot is the director and Maurice Evans drives me home." Or: "I'm playing a juvenile delinquent in this soap opera called 'Love of Life.'" Nothing intimidating there. No adenylyl cyclase involved, nothing that would make a person cry.

**F**ATED to be singed by the fires of intellectual achievement burning all around me, I accepted my lot and married a guy whose mother was Mary Chase. Back in the 1940's, she had won a Pulitzer Prize for her play "Harvey." Meanwhile, I still didn't know what my brother did.

But my opinion of my brother's greatness was confirmed by others who kept giving him dinners and awards. The food part was fine, but when they got to the talking part, I was back to square one.

In 1983, Paul came to Rockefeller University in New York, to become the Vincent Astor professor and head of the Laboratory of Molecular and Cellular Neuroscience.

Now, he has won the Nobel Prize in physiology and medicine, an honor he shares with two other scientists. In reporting it, the newspapers said their work on the way brain cells communicate might one day help cure diseases like Parkinson's and Alzheimer's.

I'm thrilled he won. Now I know what he does.