

Ion channels: Touch at the molecular level

When an object presses into your skin — be it a pencil you just picked up or a hand gripping your arm — sensory nerves send a message to your brain. But what exactly sets these nerves firing? Scientists are now analyzing specific pores, or channels, through cell membranes that may be responsible for touch perception, hearing and balance, as well as for the body's regulation of blood pressure, lung inflation, gut distension and other physiological processes.

The idea that mechanical pressure alters membrane channels, which in turn trigger a nerve impulse, has been around for decades. But Frederick Sachs and Falguni Guharay of the State University of New York at Buffalo are the first to find a channel that is *directly* activated by mechanical stress. This channel, through which charged atoms (ions) pass, was discovered not in nerve cells but in chick muscle cells grown in laboratory culture. The scientists suggest that it may be a prototype for the wide variety of specialized mechanoreceptors in the body.

"The nervous system has lots of ion channels," says David Corey of Massachusetts General Hospital in Boston, who has studied mechanisms of hearing and balance. "Some [channels] are activated by voltage, some by chemicals. What is especially significant about the work on mechanical sensation is that it represents a third class of ion channel proteins."

Sachs and Guharay activate the newly discovered channel, which they call the stretch-activated channel, by applying suction to a thin glass pipette attached to the cell membrane. With this method, they have been able to observe the activity of a single channel.

"The ion channel normally opens and shuts randomly," explains Sachs. "Applying pressure biases it to be open more often. And when it's open more often, you get more current flow that ends up stimulating the nerve, and the impulse goes to the brain."

Sensitivity to membrane tension is not characteristic of all ion channels, Sachs says. The scientists have examined several other types of channels that do not show this characteristic.

Among their findings are that activation increases the flow of potassium and sodium ions through the stretch-activated channel, with potassium flowing twice as fast as sodium. They also find that the probability of the channel being open increases exponentially with the square of the membrane tension applied. They propose from these kinetics that the channel has three closed states and one open state. The scientists present further details in the June *JOURNAL OF PHYSIOLOGY*.

The energy for controlling the channel probably comes from the mechanical

force applied. Sachs and Guharay observed that channels in isolated pieces of membrane, with no chemical energy sources, continue to show activity. They hypothesized that the channel is a cylindrical plug of protein transversing the membrane. They then calculated that it would take an enormous molecule to be sufficiently distorted by membrane tension to control the channel. Therefore, the scientists speculate that a cell's network of filaments, the cytoskeleton, serves as "strings" between the stretch-activated channel and distant points on the mem-

brane. These filaments gather force from a large area and convey it to the channel.

The role of this channel in the muscle cells where it has been observed is not yet known. There is evidence that it is also present in some other cells, including nerve and heart cells. But the stretch-activated channel has not been found in some of the other cells examined.

Sachs says that it is now important to look at the specialized mechanoreceptor cells of the body to see how they detect distortion. "I think we now know which questions to ask," he says. "There is little doubt that research on mechanoreception is entering a renaissance."

—J.A. Miller, J. Silberner

Incineration on the high seas

The Environmental Protection Agency's plan to allow commercial waste haulers to burn polychlorinated biphenyls (PCBs), dioxin and other liquid hazardous wastes on special incinerator ships in the Gulf of Mexico has met with fierce opposition from state officials in Texas, Louisiana and Alabama. The attorneys general of these states say they will sue EPA if it goes ahead with the plan. And the issue heated up further last week as the Senate conducted hearings on the proposal.

The Senate is considering a bill introduced by Sen. Alan Cranston (D-Calif.) calling for a three-year moratorium on ocean incineration until the technology has been studied in more detail. In the hearing, before the Senate Committee on Environment and Public Works, William F. Brown, director of marine affairs for Chemical Waste Management of Oak Brook, Ill., one of the three companies awaiting EPA's final approval of ocean incineration, testified that "the intensely hot temperatures of incineration break down toxic waste completely into nontoxic by-products." The company also claims the Gulf of Mexico already receives "100 to 1,000 times more PCBs from the atmosphere" than it would from ocean incineration. Representatives from SeaBurn, Inc., of Greenwich, Conn., and At-Sea Incineration of Elizabeth, N.J., also testified.

Recently passed, more stringent federal regulations restricting the disposal of hazardous wastes in landfills and wells are expected to increase the amount of wastes requiring incineration by 1.7 million metric tons per year in the "near term," according to EPA. The United States will need either 33 incinerator ships or an additional 82 land-based incinerators to meet this demand, according to Office of Technology Assessment spokesperson William D. Barnard.

Operating 170 miles from shore, incinerator ships would burn toxic wastes without the smokestack scrubbers required on land, but EPA says it would require a destruction efficiency of 99.9999 percent for PCBs and dioxins and 99.99

percent for other wastes. And an accident at sea involving such a ship, the agency estimates, could not occur more than once every 1,200 years.

Critics claim, however, that EPA has been at best inconsistent in its handling of Chemical Waste Management's bid to incinerate. The company was charged by EPA with burning dioxin-contaminated waste without authorization during a test at sea three years ago. But EPA has since dropped the charge, prompting the State of Alabama recently to initiate a criminal investigation of EPA. On April 1 EPA issued two conflicting reports on the safety of ocean incineration. While one proclaimed that ocean incineration was an "environmentally sound" waste disposal option, the other, issued by EPA's Science Advisory Board, concluded that EPA's scientific approach to this issue has been "incomplete."

Texas Gov. Mark White believes that EPA must show that an accident at sea could be cleaned up, that the effects of a spill would be reversible and that there would be sufficient liability protection to cover the full impact of an accident at sea. "If it's so safe," he charged at the hearing, "why do they want to go 170 miles out to sea to incinerate?"

—J. Mathewson

Mt. St. Helens is calm

After a month-long eruptive episode (SN: 6/15/85, p. 373) Mt. St. Helens is back to being benign. By the beginning of this week, earthquake activity and movement of the lava dome at the volcano in Washington state had returned to background levels, prompting the U.S. Geological Survey (USGS) to cancel its May 20 eruption advisory.

USGS scientists estimate that 247 cubic feet of material was added to the dome during the latest eruptive episode, emplacing more molten rock into the dome than any other single event since the dome first appeared in October 1980. □