

Biology

Finding parts for bacterial motors

Depending on what chemical is in the vicinity, a bacterium moves toward or away from it by twirling tiny hairlike projections called flagella that are attached to a molecular "motor" at one end of the organism. When the motor turns counterclockwise, the flagella form into a propeller and the organism swims smoothly forward. In clockwise rotation, the flagella come apart and the bacterium tumbles head over heel, reorienting its swimming direction (SN: 5/12/84, p.298).

How do attracting and repelling chemicals in the environment pass signals across the cell membranes to bring about these responses? Recently, a three-year-old hypothesis that the protein called CheY interacts with another protein in the molecular motor to cause clockwise rotation was strongly confirmed by Philip Matsumura of the University of Illinois in Chicago and Shoshana Ravid and Michael Eisenbach, both of the Weizmann Institute of Science in Rehovot, Israel. Their findings appear in the October PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol. 83, No. 19).

Unlike earlier research done with whole bacteria, these studies were done with only the cellular envelopes including the five to eight flagella. By removing cytoplasm from the experimental setup, Matsumura says, he and his colleagues sidestepped a menagerie of biochemicals that would otherwise obscure interpretations of results. The researchers tethered the envelopes to glass that had been coated with flagella-grabbing antibodies. With a microscope, they could see which way the envelopes were turning.

When the scientists put enough CheY into the liquid medium containing envelopes rotating counterclockwise, rotation would become clockwise. Envelopes already rotating clockwise did not reverse their direction. Also, when the medium exceeded a certain level of acidity, clockwise rotation could not occur even when CheY was present. Yet when acidity was lowered, clockwise rotation resumed.

These findings, says Matsumura, confirm that CheY acts on the protein "switch" responsible for clockwise rotation and also provide some clues to the general question of how chemical signals prompt cellular behavior.

Tropical plants are hot attractions

Flowers are considered pleasing because the elaborate reproductive structures and mechanisms they have evolved are often pretty and sweet-smelling. Less appreciated is the reproductive strategy of literally heating up, used by hundreds of plant species to help attract pollinating insects. While studying the complex insect ecology taking place in these plants deep in the forests of Costa Rica, graduate student Lloyd Goldwasser of the University of California at Berkeley may have identified the masters of this hot strategy.

Goldwasser observed that the flower stalks of seven species in the Araceae family, including philodendrons and "elephant ears," can heat up to more than 105° F at dusk the day before they release pollen. Within an hour, the temperature of the stalks rockets by more than 40° F and then peaks for about 30 minutes before cooling down to the ambient 60° to 65° F by about 10 p.m. When the stalks heat up, they broadcast a "vivid, sweet aroma" that Goldwasser says he was able to smell from as far as a football field away. He says the flower stalks reached 105° F even when he cut them off and put them in a refrigerator.

Scarab beetles, which wing about also at dusk, home in on the aromatic stalks and spend the night there eating and mating. At pollen-releasing time, approximately 24 hours later, the flower stalks heat up to about 90° F and the beetles fly away with cargoes of pollen grains in their guts and on their bodies.



U.C. Berkeley

Physics

Dietrick E. Thomsen reports from Seattle at the meeting of the Optical Society of America

How the blue jay got blue

Scientists may not know how the leopard got its spots, but they are learning how the blue jay, the bluebird and others of that sort got blue. According to Leonard W. Winchester Jr. of the Science and Technology Corp. in Hampton, Va., experiments done more than 100 years ago showed that no pigment can be found in blue jay feathers. Since then, scientists have generally assumed that the blue in the blue jay comes from light scattering, a process of refraction and retransmission of light by tiny transparent objects.

Winchester says he and his research partner, Raymond Leonard of Fairfield (Conn.) University, did not believe this assumption and started spectroscopic experiments with blue jay feathers in the hope of disproving it. Instead, he says, they have proved it.

In the scattering process, because some of the colors in white light are suppressed, others come to predominate in the scattered light. Winchester and Leonard found that the scattering in blue jay feathers is what is technically called Rayleigh scattering, the kind done by spherical objects much smaller than the wavelength of the light. The scatterers are alveolar cells in the barbs of the feathers.

The researchers used tail feathers that had fallen to the bottoms of cages. The Connecticut Audubon Society, which supplied the feathers, refused to pluck live birds.

Scattering is responsible for nearly all of the blue, most of the green and some of the purple in animals, Winchester says. On the other hand, absorption and reflection by a pigment makes canary yellow, and interference of multiply reflected light is responsible for iridescent colors like those in a peacock's tail. Parrot green combines absorption by a yellow pigment with blue due to scattering.

Can all this mean that the bluebird of happiness is an optical illusion?

Blackbody swallows laser light

People working with lasers in laboratories face various hazards from the light. Laser light reflected off the components of whatever apparatus is being used can damage the lens of the eye as well as structures in the back of the eye. It can produce third-degree burns on the skin, damage walls and furniture and even start fires. All these problems were dramatically illustrated in a series of slides shown by Chongwen Guan of the Shanghai (China) Institute of Optics and Fine Mechanics. Furthermore, he says, a psychological survey showed that workers in such laboratories are often reluctant or negligent about using protective goggles.

Therefore, researchers at the institute have developed another form of protection, a "laser safeguard" that uses a kind of blackbody to swallow the reflected light.

The textbook variety of blackbody is a round, dark object, rather like a potbellied stove, with a source of energy inside it. The energy does not escape from the stove; it gets reflected back and forth inside the stove until it is thoroughly smooth and homogenized. Observers inside the blackbody would see radiation representing a single temperature coming at them from all directions. The outside world would not know a blackbody was there unless a small hole in it let a little of its characteristic radiation out.

The Shanghai "laser safeguard" — a tabletop blackbody that is spherical or polyhedral in shape — reverses the process. An opening in the device, which is placed where the reflected laser beam will enter, allows light into the blackbody. Inside the blackbody the light is trapped bouncing back and forth from wall to wall. On each bounce, some of it is absorbed by a coating on the inside of the blackbody, and so it is gradually suppressed.