Genes shed light on photosynthesis

What drives life, according to Nobel laureate Albert Szent-Györgyi, is "a little current, kept up by the sunshine." While scientists have known the mechanism of this current for years, they are just beginning to understand its genetic basis. In a discovery that could elucidate the evolution of higher plants and the action of herbicides, University of California scientists have isolated and sequenced five genes that control the first steps of photosynthesis in bacteria.

John E. Hearst of UC's Lawrence Berkeley Laboratory (LBL), in Berkeley, announced the findings at the Sixth International Congress on Photosynthesis in Brussels, Belgium on Aug. 3, 1983. In addition to being the first to sequence genes of the intitial reactions of bacterial photosynthesis, the LBL team demonstrated that a protein coded for by one of the genes matches one of similar function in spinach and tobacco. According to Hearst, this could mean that nature conserved genetic information for the three billion years that are believed to separate bacteria from higher plants on the evolutionary tree.

The team isolated the genes from *Rhodopseudomonas capsulata,* a purple bacterium found in the part of lakes that contains decaying organic material. In the presence of oxygen, the bacterium grows by respiration, breaking down organic compounds to produce carbon dioxide and water. But when oxygen levels fall, *R. capsulata* uses available sunlight to photosynthesize.

Photosynthesis consists of two steps. In the light reactions, pigment molecules, primarily chlorophyll, absorb and store light energy. In the dark reactions, energy obtained from the light reactions reduces carbon dioxide to carbohydrate.

Before *R. capsulata* can photosynthesize, it must assemble a reaction center that consists of photosynthetic pigments and associated proteins. A nearby light-harvesting area, also consisting of pigments and proteins, funnels photons to the reaction center, where they boost electrons to a higher energy level. The pigments in the reaction center are identical to those in the light-harvesting area; their associated proteins determine their role in photosynthesis.

The genes Hearst's team found code for three proteins that comprise the reaction center and two that participate in light-harvesting reactions. "These proteins bind with pigments, and therefore help determine their function," says Kris M. Zsebo, who helped locate the genes.

After sequencing the five genes and the proteins they code for, the LBL group compared them to a protein that binds pigments and aids in electron transfer in spinach and tobacco. A sequence from one of the bacterial proteins matches that of the plants. According to Zsebo, many herbicides work by binding to this protein, blocking its active site. "Studying bacterial genes," she says, "might aid in figuring out how herbicides work and how some plants develop resistance."

"The homology between bacteria and higher plants is also important in terms of evolution," says Helmut Bagusch, who participated in sequencing the genes. "We think there is only one [fundamental type of] photosynthesis, which means nature did it right the first time around."

According to the group, this finding also gives credence to the theory that chloroplasts, the photosynthetic cells of higher plants, originated as free-living photosynthetic bacteria that found shelter within larger cells in return for trapping light energy. —*S. Steinberg*

Pinning a tail on a comet

Some comets have tails; some do not. At least that is true for visible tails. Now an invisible tail has been found on a comet. The comet is Tempel 2, which completes its elliptical orbit every 5.28 years and comes within the orbit of Mars on its perihelion passage. The tail, or most of it, radiates infrared and was found by the Infrared Astronomy Satellite (IRAS).

On July 13 IRAS noted what appeared to be a large number of objects moving in unison across the sky. Analysis of the data led to the determination by John Davies of the University of Leicester in England that the train of objects was linked to Tempel 2 and was in fact a long tail stretching over 10 degrees of sky. The tail is apparently composed of dust blown off the comet's nucleus by the solar wind. The sun heats the dust enough for it to glow in infrared. Tempel 2 is now on its way out from a perihelion passage on June 1.

Most short period comets do not have visible tails. Now the question is: How many comets without visible tails have invisible ones? Another question is: What is the dust in the tail made of? When the data analysis reveals some of its chemical composition, the tail will be even more interesting, says Dan Green of the Central Bureau for Astronomical Telegrams in Cambridge, Mass. It could be an important input into the problem of what comets are, where they come from and why they are associated with the solar system.

Efforts are underway to photograph the tail and to see if it shows up at all in visible light. In fact a small part of it already has been seen. Green says that a French observer, Jean-Claude Merlin of Le Creusot, has reported seeing a tail extending about four arcminutes from the comet, or 1/50 of the length of the infrared tail. —*D. E. Thomsen*

Sand body hints new oil sources

All that's missing is the heat. On a recent cruise for the Deep Sea Drilling Project (DSDP), researchers found massive sand and sandstone beds, rich in organic material, 4,000 feet beneath the seafloor. Except for the lack of heat necessary to cook the organic matter and break it down into hydrocarbons, the setting is ideal, scientists say, for petroleum formation. The sand body is on the continental rise below waters far deeper than at any site drilled for petroleum to date. The scientific team suggests that "the continental rise off the eastern United States should be seriously evaluated as a petroleum province."

The oil industry generally has ignored the continental rise because no porous rock, such as sandstone, which serves as a reservoir for oil or gas, was thought to exist there. The discovery of the sand body was made on the 93rd leg of the DSDP at a site 270 miles east of Cape Hatteras, N.C. Another condition, rock to cap the sand and prevent the hydrocarbons from diffusing upward, also is present.

With the added impetus of heat or pressure, given sufficient time the conditions would be perfect for petroleum production, scientists report. On the continental rise closer to shore, deposits of hydrocarbons are more likely because sediment would be thicker, creating more pressure and thus more heat, says Philip A. Meyers of the University of Michigan in Ann Arbor. Land-derived organic matter also should be more abundant closer to shore. The DSDP cruise was led by co-chief scientists Jan Van Hinte of the Free University of Amsterdam, the Netherlands, and Sherwood W. Wise Jr., of Florida State University in Tallahassee.

The sands, interlaced with layers of black shale, were deposited about 115 million years ago during the early Cretaceous Period. Within the 700-foot-thick sand body, organic matter abounds. The shale in the sand body contains from 4.1 to 13.6 percent organic matter, the highest percentage found so far at any North Atlantic site. The deposit is capped by about 3,000 feet of impermeable shale. No mature hydrocarbons were found. The buried sand deposit is too shallow to allow enough pressure for the formation of oil or gas from the shale.

Scientists speculate that the sand may have come from large river deltas that fanned across the continental shelf and spilled over into the deep sea basin. It has been widely accepted that during the early Cretaceous, sea levels were rising, and that coral reefs provided a barrier along the mid-Atlantic coast, trapping sediment from the land in vast basins (shoreward from the DSDP site) on the continental shelf. The recent finding throws this assumption into question. —*C. Simon*