Bacteria make brain opiate

With genetic engineering techniques, bacteria have been made to produce the mammalian pain-countering chemical beta-endorphin. This compound, naturally produced by the pituitary gland, has been found effective as a painkiller and is currently being tested as a treatment for both depression and schizophrenia (SN: 11/25/78, p. 375). The beta-endorphin now used in clinical tests is produced by laborious chemical synthesis, for approximately $100 per milligram. Bacterial production of the material should reduce its cost substantially and allow more extensive research on its effects.

At the meeting in Washington of the Association of American Physicians, John D. Baxter reported that a gene from mice had been modified and transferred into bacteria. The bacteria produced approximately 80,000 copies per cell, 1 to 2 percent of the bacterial protein synthesis. The scientists used an enzyme to snip beta-endorphin from the product, which included part of a bacterial protein. The resultant beta-endorphin binds to opiate receptors and exhibits an opiate-like action on cells growing in laboratory culture, Baxter says.

Because mouse beta-endorphin differs from the human material in only two of its 31 amino acids, Baxter says it should not be difficult to modify the mouse gene to allow bacteria to produce the human form for possible therapeutic use.

A stretch of mouse DNA for the precursor of beta-endorphin was the starting material in Baxter's work. He and colleagues cleaved the molecule and added one codon to the incomplete message and a stop signal to the end. The gene was connected to a portion of a bacterial gene, beta-galactosidase, in a plasmid as has been done in several other gene-splicing procedures. The work does, however, illustrate several new approaches in synthesis of mammalian proteins by bacteria. Baxter points out, for instance, that there was minimal use of chemically synthesized DNA. In many cases he expects it to be easier to use natural genes than to synthesize genes chemically.

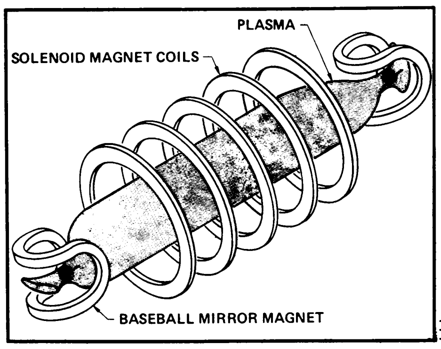
Working with Baxter of the University of California at San Francisco were James L. Roberts, now at Columbia University, John Shine, now at the Australian National University, Ivy Fettes and Nancy Lan. □

TMX: Electric plugs for a magnetic mirror

Confinement is one of the basic necessities for controlled thermonuclear fusion research. A plasma of ions and electrons, in which the fusions are to take place, must be held in some kind of vacuum chamber. Many ideas have been tried; several have shown promise, but the final answer has not yet manifested itself. One of the latest schemes, the so-called TMX or tandem mirror experiment at the Lawrence Livermore Laboratory in California, shows promising results, experimenters working with it report.

The TMX uses two plasmas as end plugs to confine a third between them. It is an outgrowth of research on "magnetic mirrors" that has been going on for more than thirty years, and it is an attempt to repair their greatest deficiency, the tendency for the mirrors to be very transparent.

For fusion purposes a plasma must be hot. Therefore the means of containment must hold it in without letting it touch the walls of the chamber surrounding it. For years it seemed, and to many it still seems, that levitation and containment by a magnetic field was the best method. If the experimental chamber was a cylinder, designers tried to arrange magnetic mirrors at the ends, a field configuration that would contain the plasma by bouncing the ions and electrons back. The best kind of magnetic mirror would have field lines that joined across the ends of the tube. With the electromagnet coils it is possible to make, that geometry is impossible. The best that can be done is to strengthen the field at the ends. This reflects some, but a lot still gets out.



TMX: *A new twist helps confine plasma.*

TMX was designed to lower these end losses. It put a so-called baseball mirror at each end of the solenoidal tube. The baseball mirror gets its name from the shape of its coils, which are like the seams on a ball. It holds a dense plasma with a twisted shape. The combination generates an electric field that serves as a good barrier to migration of particles between the end plasmas and the solenoid plasma. To keep up the barriers the density of the baseball plasmas must be maintained. This means continually feeding them material to replace their losses to the outside world, but by accepting this cost, experimenters can maintain the solenoid plasma in a state nearer to the hopes of fusion technologists. The first TMX experiments give a confinement nine times that possible without the plugs. □

Binary pulsar #3: Astrophysical bonus

Pulsars are rarely found in binary star systems. As Joseph Taylor of the University of Massachusetts points out, of the 300 known pulsars only three, maybe four, are members of binary systems. The identification of the third binary pulsar, which was reported at the meeting of the American Physical Society in Washington at the end of April, is not only a one-in-a-hundred finding for dynamical astronomy. David Helfand of Columbia University reported that it appears also to be the first instance of a neutron star that had been observed by the X radiation rising from its surface and the first time astronomers think they have a photographic image of a pulsar's companion.

That pulsars should so rarely appear in binary systems is a striking difference between them and ordinary stars. The majority of ordinary stars are found in binary or multiple star systems. One suggested explanation for the difference is that pulsars are formed during supernova explosions, and the explosion of one star blows the companion away. If that be true, nevertheless a few companions have survived. Astrophysicists are eager to study them for the light they can throw on the history and physics of pulsars.

Taylor stresses that the rarity of binary pulsars is not a matter of not having looked but of having looked and not seen. A pulsar exhibits its membership in a binary by a cyclic variation in the timing of its pulses. It can be tedious and time consuming to confirm such a variation, but enough pulsars have been observed for long enough to have raised suspicions of binary status in many cases if binary systems were in fact numerous. The observations that showed that this one, PSR 0655+64, is a binary were made by two graduate students, Peter R. Backus and Marc Damashek.

It is a close, quick-moving binary system. The orbital period is 24 hours and 41 minutes and the diameter of the orbit about a million and a half kilometers. The orbit is almost a perfect circle. The eccentricity is less than one part in a thousand, Taylor says. One question for future research is: "Why so circular?" These parameters, which are computed from the pulse timing variations, place some constraints on the nature of the pulsar's companion. Obviously the companion cannot be a giant star that would occupy more space than the orbit nor a violently variable star that would disrupt it. A small star and a quiet one, a white dwarf or a slow variable is Taylor's suggestion.

While Taylor, Backus and Damashek were finding a binary pulsar with the 300-foot radiotelescope at Green Bank, W. Va., Helfand and Robert Novick, also of Columbia University, were looking for neutron stars that radiate X-rays from their surfaces, X-rays generated by thermal processes as ordinary stars radiate light. They figured that some of the older pulsars might be hot enough to do it.

They observed four likely candidates, and found what they believe are such X-rays in two cases. One of these was, in Helfand's phrase, "a great bonus." It coincides with the third binary pulsar. The newly found system is 20 times as close to us as the first binary pulsar, about 1,000 light-years away. Optical pictures show two candidates for the pulsar's companion, a red star and a blue one. If the neutron star is not producing the observed X-rays, says Helfand, either of these may be: the red star in its corona, the blue one on its surface. In a few weeks they hope to be able to choose. Meanwhile the radioastronomers will be refining their position determination from an accuracy of a few minutes of arc to a few seconds of arc. Then the identification of radio pulsar, X-ray source and red or blue star may be definite. □

Body weight and breast cancer survival

Overweight breast cancer patients do not survive as long as do those of average weight. This finding, made by N.F. Boyd of Toronto's Princess Margaret Hospital and colleagues, was reported this week in Washington at the meeting of the American Federation for Clinical Research.

In a ten-year study, Boyd and his coworkers followed the progress of 700 Toronto breast cancer patients. They found that 60 percent of patients weighing less than 140 pounds survived at least five years after surgery, but only 49 percent of those weighing more than 140 pounds survived that long; and that 50 percent of patients weighing less than 140 pounds survived at least 10 years, while only 39 percent of those weighing more than 140 pounds survived that long.

Why would weighing more than over 140 pounds be detrimental to survival from breast cancer? Boyd isn't sure, but he points out that most of the subjects were simply overweight, not just of large body stature. This suggests that body fat may encourage breast cancer, and women who consume high-fat diets have been found to be more likely to get breast cancer in the first place than are women who do not eat such diets (SN: 6/23/79, p. 414). Fat in the diet, or body fat, might possibly switch on excess production of sex hormones which could be involved in triggering breast cancer. Other studies have shown that when overweight premenopausal breast cancer patients had their ovaries (a major source of the hormone estrogen) destroyed, they survived on the average as long as lean premenopausal breast cancer patients. □

High pressure tactics reveal earth interior

Researchers at the Carnegie Institution of Washington are literally squeezing information from the earth. What they've found may revise prevailing theories about the formation of the earth's interior.

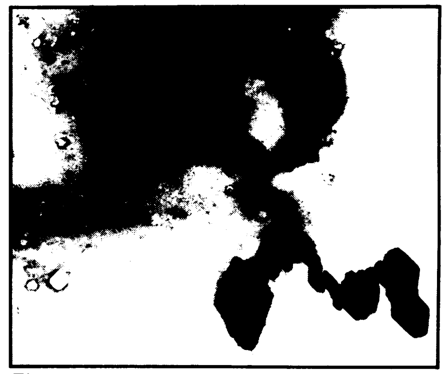
Using a "diamond anvil"—a device that squeezes samples between two diamonds — Peter M. Bell and Ho-Kwang Mao have been able to recreate pressures up to 1.7 million times that on the earth's surface and, using lasers, temperatures up to 3,000°C—conditions similar to those well within the earth's core (SN: 3/10/79, p. 156). Their recent experiments, reported last week at the Carnegie Institution, suggest that the earth's core may not be composed of iron and nickel, as assumed from studies of meteorites, but possibly of iron and oxygen. Moreover, the results may explain how iron dissociated from other minerals during the early stages of the earth's formation and sank to form the core.

Though the earth's core is believed to consist of iron, studies based on the earth's orbit and rotation and the behavior of earthquake shock waves as they pass through the core indicate that it is less dense than pure iron, Bell explained. Based on the composition of meteorites, a less dense iron-nickel alloy core has been favored. But earlier studies by Mao using the high pressure device showed that under the necessary pressures, nickel makes iron more, not less, dense. So the search continued for a lighter partner for iron.

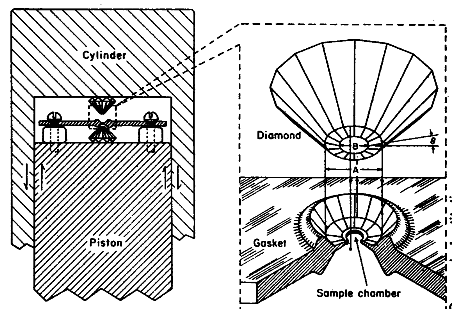
As part of the search, Bell and Mao subjected samples of synthetic basaltic rock — composed of iron, magnesium, potassium, calcium and silicon — to increasing pressures and temperatures. At a pressure 200,000 times that on the earth's surface (200 kilobars), which is equivalent to a depth of about 650 kilometers, they found that nearly all the synthetic basalt forms perovskite — very dense, very stable, diamond-shaped silicate crystals. The important outcast from this structural change is iron, says Bell. Only about 20 percent of the iron enters a perovskite structure, while the remainder forms a mineral called magnesiowüstite, composed of oxides of magnesium and iron.

Interestingly, the depth equivalent at which this chemical transformation occurs is the point within the deep mantle where seismic waves abruptly increase. The pressure-induced change to very dense perovskite may be the cause of this previously unexplained seismic discontinuity, the researchers suggest.

Further increasing the pressure and temperature, the researchers found that the perovskite and magnesiowüstite mixture remains stable to a depth equivalent to 1,600 kilometers. At that point, the iron



Electron microscope image shows crystals with perovskite structure at 200 kbars.



Cross section of diamond-anvil cell. Inset: expanded view of pressure face.

oxides and magnesium oxides begin to separate, Bell says. A complex reaction involving simultaneous oxidation and reduction then occurs, he says, and iron, mixed with very little oxygen, precipitates as a metal. When these reactions occurred in the early earth's interior, according to Bell and Mao, the dense iron sank to the earth's center; oxygen carried to that depth became metallic and lessened the density of the core. The lighter magnesium oxide released from magnesiowüstite rose to the deep mantle, they suggest, reacted with perovskite to remove iron and continued the core-building cycle.

These results, Bell says, bear on several theories about the earth's interior. One current debate questions whether all or only part of the earth's mantle circulates; Bell and Mao's findings suggest that only the upper layer of the mantle churns beneath the crust. "At very high pressure," Bell says, "thermal expansion [the suggested cause of the circulation] declines, so that we can't have convection in the deep mantle." Their findings also support the recent hypothesis of a deep, undifferentiated layer within the mantle (SN: 12/1/79, p. 372). That layer probably exists below the point demarcated by the seismic discontinuity, Bell said at a press conference, and may be composed of perovskite mixed with rare earth elements. In addition, Bell says, the results explain how, if the earth were formed by the accretion of meteorite-like material, it evolved a uniform structure. "The big question in the study of planets," he said, "has been to understand how iron pulls away from magnesium to form the core." □