DNA and pulsar research win 1993 Nobels

Methods that enhance the study of genetic material and the discovery of an unusual type of star garnered this year's Nobel Prizes in Chemistry and Physics.

In physics, Russell A. Hulse, 42, and Joseph H. Taylor Jr., 52, both at Princeton University, were cited for their discovery of a binary pulsar — a pair of rotating neutron stars that has illuminated the study of gravity waves in the universe. In chemistry, Kary B. Mullis, 48, formerly with Xytronyx Inc. in La Jolla, Calif., and Michael Smith, 61, at the University of British Columbia in Vancouver, will share the $825,000 prize for the powerful DNA research techniques each developed.

In 1974, Hulse and Taylor used the 300-meter radio telescope at Arecibo, Puerto Rico, to monitor the beacon-like emissions of a pulsar. This stellar object, called PSR 1913+16, emits bursts of energy about 17 times a second with a steadiness comparable to that of the best atomic clocks. Noticing oddities in the pulsar's emission cycle — believed at the time to be caused by one rapidly rotating neutron star — Hulse and Taylor figured out that a second, companion star must be involved. In fact, the second star of this stellar system has one and a half times the mass of the sun compressed into a ball only 20 kilometers in diameter.

Moreover, by timing signals from the binary pulsar over many years, physicists have further verified aspects of Einstein's theory of general relativity. At a barely detectable level, the two stars are spiraling toward each other and orbiting more quickly — a rate change of only 75 milliseconds per year. But the energy loss in the binary system is significant, falling in line with Einstein's predictions, if one assumes the pulsar emits gravity waves. Thus, many physicists see PSR 1913+16's behavior as good evidence for the existence of these otherwise unseen waves.

Smith's 1978 invention of oligonucleotide-based, site-directed mutagenesis has enabled scientists to "reprogram" the genetic code by changing the order of specific nucleic acids — the building blocks of DNA. The altered DNA then spawns changed proteins, whose actions differ from those of the original proteins.

Scientists had long sought to use nature's own process of mutation to their research advantage. But it was Smith who, during a coffee break at the University of Cambridge in England, conceived of a controlled method of harnessing these DNA coding errors. He saw a way to incorporate tailor-made DNA fragments into a host organism, where they would replicate. Today, researchers use site-directed mutagenesis to "design" proteins, treat genetic diseases, and create medically and commercially useful items such as hemoglobin-enhanced red blood cells, immune cells that attack cancers, and disease-resistant plants with unique qualities.

Mullis received the award for his 1985 invention of the polymerase chain reaction (PCR), now a basic tool of the biotechnology industry. PCR is used to amplify minute samples of DNA in solution by rapid, million-fold replication. During a moonlit mountain drive, Mullis envisioned a way to have one strand of a DNA double helix split and replicate repeatedly, cycling up to 60 times in a few hours. In each PCR cycle, heating causes the intertwined DNA to split into two separate strands. Then, with the help of the enzyme DNA polymerase, the strands replicate themselves from DNA fragments added to the solution.

By the 20th cycle, more than 1 million copies of the original DNA sample exist. Thus, scientists can quickly test for the presence of an infectious agent, such as HIV, or help place criminals at the scene of the crime with a single drop of blood or strand of hair — as part of the process known as DNA fingerprinting. The PCR technique makes possible in-depth genetic studies of plants, animals, and humans, as well as reconstruction of fossilized DNA preserved for millions of years in insects trapped in amber (SN: 10/24/92, p.280). The Royal Swedish Academy of Sciences even acknowledged the movie "Jurassic Park" as a fictional outgrowth of Mullis' PCR technique. *—R. Lipkin*

Weighing risks, benefits of mammography

A Swedish study hints at possible dangers of exposing the breast to doses of ionizing radiation, a finding that raises added questions about the risks of mammography, an X-ray examination that can reveal tumors in their very early stages.

A separate review of eight trials finds no benefit from mammography screening for women in their forties. Both reports appear in the Oct. 20 JOURNAL OF THE NATIONAL CANCER INSTITUTE.

Lars Erik Rutqvist and his colleagues at the Karolinska Hospital in Stockholm studied women who had undergone radiation therapy, which delivers ionizing radiation in doses 100 to 10,000 times higher than that used in a routine mammogram.

This team analyzed data collected from 1,216 women who had received radiation therapy from the 1920s through the 1950s to treat benign breast disease.

Some women with benign breast disease face an increased threat of developing breast cancer; therefore, the researchers also studied a control group of 1,874 women who had this condition but had not received radiation therapy.

Previous studies have suggested that exposure to ionizing radiation at young ages may boost the risk of breast cancer later in life (SN: 11/11/89, p.311). However, some researchers have questioned whether that risk applies to women who are exposed to radiation after age 40.

The new Swedish analysis shows a statistically significant increase in the incidence of breast cancer following radiation therapy for benign breast disease, even among women who received their treatment after age 40.

This study didn't look at the radiation risks for healthy women who get screening mammography. However, it is prudent to assume that there may be a risk—albeit a small one — of developing radiation-induced tumors from mammography, comments Charles Land of the National Cancer Institute (NCI) in Bethesda, Md.

Is that small risk enough to forego screening mammography, which can also identify malignant tumors and thus save lives? For women age 50 and older, as well as women at high risk of breast cancer, scientists say mammography's benefits far outweigh any risk. For women in their forties, however, this study's findings, as well as other evidence, may argue against routine mammography, Land and other scientists believe.

They point to a second report in the NCI journal, this one prepared by Suzanne W. Fletcher of the American College of Physicians in Philadelphia and other participants in a February 1993 NCI workshop on screening for breast cancer.

The authors reviewed the current evidence and confirmed earlier findings that for women age 40 to 49 there appears to be no survival benefit in obtaining regular mammograms.

For women age 50 to 69, however, the review noted that routine mammography reduces the risk of dying from breast cancer. For women in their 70s and older, the panel found too little data to draw any conclusions.

The report's findings regarding women in their forties have drawn the most fire: "It is scientifically unjustified to claim that screening women aged 40-49 is ineffective," according to Edward A. Sickles of the University of California School of Medicine, San Francisco and Daniel B. Kopans of the Harvard Medical School in Boston. Sickles and Kopans wrote an editorial in the same issue of the journal. They contend that the Fletcher report drew on flawed studies.

Nonetheless, NCI has proposed changing its mammography guidelines for healthy fortysomething women. The proposal would have women age 40 to 49 consult with their doctor about the advisability of a mammogram. In the past, NCI recommended a mammogram at one- to two-year intervals for women in that age group. *—K.A. Fackelmann*