BIOLOGY

Julie Ann Miller reports from the meeting in Cincinnati of the Society for Neuroscience

Sex in the spinal cord

Sex differences in the size and number of cells at specific positions in the brain have been detected among a variety of experimental animals, ranging from birds (SN: 1/26/80, p. 58) to mammals (SN: 3/26/77, p. 205). Now S. Marc Breedlove and Arthur P. Arnold from the University of California at Los Angeles report the first sex differences in a simpler and more accessible part of the nervous system—the spinal cord. Certain nerve cells in the rat are much larger and more numerous in males than in females. These cells, called the spinal nucleus of the bulbocavernosus (SNB), carry signals to two muscles attached to the penis. These muscles seem to be absent in the female.

Hormone exposure before birth is required to produce the male form of the spinal cord cells. Both male and female rats, if exposed to the male hormone testosterone before or just after birth, develop the masculine SNB and the corresponding muscles. The scientists know that the male hormone is directly responsible because the cells have receptors for testosterone but not for estrogen. In addition, among animals that lack receptors for testosterone because of a genetic defect, the males as well as the females have the characteristic feminine spinal cord. The researchers suggest that all rat pups begin with equal numbers of motor neurons and that testosterone in normal males protects some of the nerve cells from death during development.

Light up the white matter

The gray matter has been the focus of the colorful work that visualizes activity in the brain (SN: 11/25/78, p. 372). But there is more to the brain than nerve cell bodies. The long-distance lines of nerve cells are wound with insulating material called myelin. When the myelin breaks down, communication fails, as in diseases such as multiple sclerosis. Bernard W. Agranoff now reports progress on a method of examining myelin without intruding on the brain. Like the work visualizing nerve cells, the myelin procedure uses a radioactively tagged chemical. Agranoff finds that a variety of small organic molecules that are soluble in fat, rather than in water, are able to concentrate in the myelin. Benzene, a representative small molecule, attached to the radioactive isotope iodine-123, has allowed Agranoff to use a scanning procedure to visualize myelin in a monkey's brain. He expects such a technique to help extend information accumulated from animals to the human brain and its diseases.

Bargains in the basement membrane

The layer of material that sits between a nerve ending and its muscle endplate has been considered to be unimportant "glop," if not a potential hindrance to nerve signal transmission. But recent studies have found that this material, called the basement membrane or basal lamina, may be a signal beckoning both nerve and muscle during development or damage repair. If the nerve and muscle are damaged, as each grows back it appears to use the basal lamina as the marker of where to reconstruct the synapse. Lee L. Rubin, Adrienne S. Gordon and U. Jack McMahon are searching for the chemical that thus instructs the nerve and muscle. The Harvard Medical School scientists have applied an extract of basal lamina from the electric organ of eels to chick muscle growing in laboratory culture. They used eels because a large proportion of the preparation is devoted to synapses. Rubin and colleagues find that the eel extract induces the chick muscle to concentrate its receptors as if it were forming synapses. The active ingredient has been partially identified; it seems to be a protein or group of proteins or protein-containing complex that is strongly associated with the membrane.

PHYSICAL SCIENCES

Dietrick E. Thomsen reports from San Diego at the meeting of the American Physical Society Division of Plasma Physics

Firing up Starfire

The purpose of the Starfire project is to develop a plausible design for a standard model production line thermonuclear reactor of the middle 1990s while using the best technological ideas available now (SN: 2/9/80, p. 92). Like similar crystal-ball efforts, this one tends to change its appearance as present-day reality changes.

Several papers at the meeting dealt with aspects of the Starfire design. Some of these suggestions represent extension of the previous design work or filling in of gaps or details. Some would cause substantial design changes.

The basic element in the Starfire design is a tokamak, a particular variety of the thermonuclear device in which fusions are to take place in a heated ionized gas (that is, a plasma) that is confined by magnetic fields. Such a thing must be continuously refueled. M. Marguez-Reines and D. Ehst of Argonne National Laboratory estimate a ratio of 6×10^{-21} atoms per second. Puffing gas into the reactor would be the neatest way to refuel from the engineering point of view, but physics considerations led to examinations of pellet droppings and guns that shoot ready-made plasma into the machine. Marguez-Reines and Ehst recommend what they call a snowplow plasma gun.

So much for refueling. When the reactor is first filled it may be necessary to use neutral gas and make plasma inside. To ionize the gas and preheat it so it starts acting like a plasma, D. Driemeyer of the McDonnell Douglas Astronautics Co. in St. Louis suggests broadcasting microwaves into it; microwaves vibrating at the same frequency as the electrons of this plasma would orbit in the magnetic field present. This resonance would tear the atoms apart and preheat them.

Continuous heating would also be necessary. In the original tokamak concept heating was to be provided by an electric current induced to flow through the plasma itself by magnetic coils surrounding the plasma. V. L. Teofilo, J. Benford and V. Bailey of Physics International Co. in San Leandro offer the design of a heating system that fires beams of electrons with relativistic energies into the plasma. This could provide the start-up heating and initiate and drive the heating current. Thus the magnetic coils for the current (the "ohmic heating coils") could be removed from the design. Since these coils tend to be in the way of mechanisms for getting energy out of the reactor, that would be a plus. Also, the electron heating method would be cheaper in power requirements, its designers say.

Spheromaks stay with you

A tokamak is a toroidal or doughnut-shaped plasma. A spheromak is a doughnut without the hole, a kind of jelly doughnut. The magnetic geometry of the spheromak is simpler. It doesn't have the difficult and complicated coils threading through the hole that characterize a tokamak.

It takes special magnetic and electric conditions to induce a spheromak plasma to form. It was not realized theoretically that they could form until a few years ago. Successful formation of spheromaks was reported about a year ago. But to be potentially useful as fusion plasmas spheromaks have to be stable; they can't be just a passing phase. Work done in the past year shows that they are stable. They have been subjected to a variety of tests, and as John M. Finn of the Naval Research Laboratory put it, "Spheromaks are hearty objects."

These little levitated balls of plasma may some day be useful in practical devices. They are another instance of the tendency to try things and find that they do in fact work. They looked good on paper, they were tried and, to a certain amount of surprise on the part of experienced plasma physicists, they actually were found to exist.