

servations of their blockage of starlight, Voyager 2 photographed "on the order of 10^2 new ringlike features . . . interspersed within the main rings, as well as a broad, diffuse, low-optical-depth ring just inside the main ring system." Besides cameras, the spacecraft carried an instrument called a photopolarimeter, which tracked the light of two stars *through* the ring system and recorded the resulting blinks. In addition to measuring the thickness (less than 150 meters) of the outermost of the nine previously known rings, the instrument showed that many of the rings vary not only in width but also in "optical depth," or density. It also revealed a number of "partial rings," or "ring arcs," a phenomenon that had been thought to be improbable at best until earth-based, stellar-occultation observations indicated what appear to be such arcs around the planet Neptune.

One striking characteristic of the Uranian ring system is that it turns out to have almost none of the extremely tiny, "smoke- to dust-sized" particles that scientists expected to be common among the larger chunks. One inference from the missing dust has been the view of some scientists that various processes may be sweeping the finest particles away. This, combined with the observed variations in ring opacity and apparent ring arcs, suggests to some of the Voyager researchers that the rings may be a constantly evolving phenomenon, and perhaps quite young.

The magnetic field: The finding that Uranus even *has* a magnetic field resolved a baffling riddle, which had been fueled by earth-based satellite observations showing what seemed to be an aurora (presumed signs of a field) while Voyager's radioastronomy instrument kept failing to pick up radio emissions that should also have been present. Only five days short of Uranus, the device finally picked up the signals, and then found out the reason for the delay: The axis (dipole) of the Uranian magnetic field is tilted about 60° away from the planet's axis of rotation, presumably directing the signals in a different direction. Furthermore, the Voyager magnetometer team suggests, the radical tilt may be a sign that the polarity of the field is undergoing a reversal, a phenomenon long assumed to have taken place on earth, based on past geologic data, but never actually measured in progress for any planet.

The radioastronomy instrument was also able to determine the length of a Uranian day, 17.24 hours, based on the modulation period of the radio signals.

There is far more in the Voyager 2 data bank, and scientists are likely to study everything to the *n*th degree, given the uncertainty of when another spacecraft may pass that way again. Voyager 2, meanwhile, is due at Neptune in 1989.

— J. Eberhart

Con(tra)ception: Hormonal coin toss

Two research teams at the Salk Institute in La Jolla, Calif., have discovered a reproductive hormone that may one day be useful in the treatment of certain kinds of infertility. Another reproductive hormone, also recently isolated by one of the same research groups, may have potential as a contraceptive. In an unusual demonstration of the body's thriftiness, the hormones are a matched set: Although opposite in activity, they are largely rearrangements of the same components.

The newly discovered hormones are intriguing because they act specifically on the production of follicle-stimulating hormone (FSH), which triggers the development of ova and the production of sperm. Inhibin, one of the recently isolated hormones, acts on the pituitary gland to decrease FSH secretion without affecting levels of other hormones that are often released in tandem. Because of that specificity, says Kenneth Klivington, spokesperson for the research groups, "inhibin provides a potential ideal contraceptive for both men and women."

Unexpected findings during the research on inhibin led to the discovery of a substance that works in the opposite direction, stimulating release of FSH. That substance was reported in the June 19 NATURE. Two forms were isolated at Salk — one named follicle-stimulating hormone releasing protein (FRP) by a group led by Wylie Vale, and the other called activin by a group led by Roger Guillemin. Klivington says it may someday lead to a "choice treatment" for infertility.

Modern contraceptive technology is prone to problems. Even though birth control pills succeed in blocking fertility in women, there are side effects that ripple throughout the hormonal system; and there is no male hormonal contraceptive available at all. The problem for researchers has been the body's intricate dovetailing of the hormones that orchestrate reproductive events.

Scientists have long known that much of the regulation occurs in a hypothalamus-pituitary-gonad hormonal loop: The hypothalamus in the brain stimulates the pituitary to secrete two hormones, FSH and luteinizing hormone (LH), which, among other things, stimulates the production of sex steroids like estrogen and testosterone. Most birth control pills for women use estrogens and other steroids, which can disturb the rest of the hormonal balance. When researchers have attempted to use FSH-inhibiting substances as male birth control, they have been unable to block the release of FSH without also inhibiting LH. That meant

that while production of sperm stopped, levels of sex steroids dropped as well — and so did the steroid-controlled sex drive.

But a contraceptive based on inhibin might block production of sperm or ova without "fouling up background levels of sex steroids," Klivington says. In using it, "you wouldn't mess up the psychological aspects of reproductive behavior."

The activating compounds may turn out to be valuable treatments for men and women who are infertile because of low levels of FSH, Klivington says. Currently, hypothalamic hormone is used to treat some of these cases of infertility, but that hormone is a blunt tool, raising levels of LH along with FSH. That can be a particular problem for women, because inappropriately high levels of LH at the end of the menstrual cycle may actually inhibit follicle selection and egg development.

Applications of the newly discovered hormones are still very much in the realm of the theoretical, researchers warn. For one thing, the work at Salk has used inhibin from animals and has so far been done only in test tubes. But inhibin in humans is very similar to that from animals, according to Anthony Mason at the San Francisco-based biotechnology firm Genentech. Mason worked with Guillemin on the isolation of inhibin. Another recent announcement, in the May 31 LANCET, is encouraging to the researchers: The paper confirms that inhibin can be found circulating in the blood in humans. (According to the researchers, led by Robert McLachlan at Prince Henry's Hospital in Melbourne, Australia, blood levels of inhibin may eventually be used to signal the best time for *in vitro* fertilization.)

One of the most striking aspects of the discoveries has nothing to do with the function of the hormones, according to the Salk Institute researchers, but with the way they are put together. Inhibin is made up of an alpha subunit and one of two possible beta subunits. The activating hormones consist of two of the beta subunits linked together.

The rearrangement to produce different proteins seems to occur at the level of the subunits, the researchers say, rather than at the level of the genes which code for them. Examples of such rearrangements are rare. "If such rearrangements of several gene products are the norm, rather than the exception," Guillemin's team writes, "this process clearly extends the diversity of the final products (and their biological activity) derived from a limited number of genes."

— L. Davis