Coral and the mysteries of immunology

The human immune system is quite fancy compared to the systems of most other animals. It has also proved during the intense research of the last decade to be correspondingly harder to understand. "If man's immune system is the Rolls Royce model, then an invertebrate like coral is the bicycle," says marine biologist W. H. Hildemann. "And if we're ever going to know how that Rolls Royce works, we better figure out how the bicycle works first."

Hildemann, a professor at the University of Hawaii at Hilo, presented some bicycle-level information at a session of the American Institute of Biological Sciences meeting last week in Corvallis, Ore. Hildemann and colleagues D. S. Linthicum of the University of California at San Diego and D. C. Vann of the University of Hawaii at Honolulu have just studied the immune reaction mechanisms of reef-building coral. This adds another group of invertebrates to a growing list of lower animals now known to have immune systems. And, more important, the mechanisms of coral immunity fit into the chain of immune responses from primitive to complex that is emerging as researchers study these phenomena in the members of the animal kingdom from primitive to complex. This phylogenetic approach, many hope, will demystify the mysteries of immunity.

It was long believed, Hildemann says, that invertebrates do not have an immune-response capacity. But he and others have in the past four years found evidences of immunity in several coelenterates—hydroids, sea fans and corals—as well as other invertebrates. The mechanisms primitive marine animals use to distinguish and react to "nonself," however, were unknown until now.

Hildemann's team studied coral immune reactions in nature, at the Eniwetok Atoll in the northern Marshall Islands of Micronesia, and in the laboratory. The researchers found three major types of incompatibility reactions. When pieces of the coral from different colonies, but the same species, were joined (either artificially with nylon thread or by natural growth position in the coral reef) the tissues failed to grow together or excreted cement interfaces to prevent the soft tissues of the living coral from touching each other. The excretion of cement required 18 to 20 days and prevented tissue death.

If two different species of coral are joined, the colonies fail to fuse tissues, and a zone of tissue death appears in both colonies within seven days. The third and most severe immune response occurs between the solitary, free-living corals *Fungia fungites* and several other stationary coral species. *Fungia* acted as an aggresive species when it came in contact with foreign coral tissue, attacking and killing the cells of other species within a short time (two to seven days) but not sustaining tissue injury itself.

"These three types of incompatibility reactions demonstrate a range of immune reactions from mild to severe," Hildemann says, and are probably the equivalent of cell-mediated immunity in higher animals. "We don't know yet whether the animals have an immune memory," he says—the equivalent, in other words, of building up antibodies for quick recognition of subsequent attacks. Studies of this will follow.

Studying simple immune systems—bicycles as well as Rolls Royces—is important for several reasons, Hildemann says. "Primitive systems give insight into the evolution of the immune response capacity," he says, "and by doing this give an understanding of the basic mechanisms of the more complex system. Seeing a cell-mediated system in a sense "dissected" from the complicated humoral system of higher animals helps clarify the unique functions of both. There are also likely to be payoffs in environmental science, Hildemann says. "We have an intuitive feeling that killing off parts of the marine ecosystem, with pollutants let's say, would be a mistake for our own survival. But studying immune reactions in primitive marine animals gives us solid information on what kinds of insults animals can put up with, and what the entire marine support system can withstand and still survive. □

Human fetus is successfully treated

Some 2,000 pregnant women a year now undergo amniocentesis, a technique that allows the diagnosis of chromosomal and genetic abnormalities in the unborn human fetus. If a fetus they carry is found to be defective, however, they have only two choices. Either they can let it be born, or they can undergo therapeutic abortion. In brief, there has been virtually no way to correct fetal defects.

Now success in treating a defective fetus, one of the first, is reported in the Aug. 14 NEW ENGLAND JOURNAL OF MEDICINE by Mary G. Ampola of Tufts-New England Medical Center and her pediatrician colleagues. An editorial in the same issue praises their efforts.

The case concerned a woman who had previously given birth to an infant with an inherited disease known as methylmalonic acidemia. The disorder is characterized by an abnormal buildup of acids in the body, recurrent vomiting, developmental retardation and failure to thrive. The infant died three months after birth. So when the woman became pregnant a second time, Ampola and her co-workers suspected that this fetus might also have the disease.

They performed amniocentesis, which consisted of withdrawal of amniotic fluid surrounding the fetus. The fluid contained skin cells from the fetus, which could be examined for abnormal metabolic products reflecting methylmalonic acidemia. Sure enough, the fetus had the disease, and the precise cause, as reflected by amniocentesis, was a defect in vitamin B_{12} synthesis. If not enough vitamin B_{12} is synthesized, there is not enough of the vitamin to serve as coenzyme in the breakdown of certain amino acids in the body. As a result, tremendous amounts of methylmalonic acid accumulate in body fluids and lead to disease.

Since some patients with methylmalonic acidemia have shown clinical improvement after taking large doses of vitamin B_{12}, Ampola and her colleagues gave large doses of the vitamin to the mother in hopes that it would reach the fetus and compensate for the fetus's vitamin deficiency. The treatment reversed excess excretion of methylmalonic acid in the mother's urine, suggesting that the treatment was helping the fetus. And at birth, the baby's urine and blood contained only a moderate increase in methylmalonic acid and very high levels of vitamin B_{12}, which was even stronger proof that the vitamin therapy had helped the child before birth. The baby is now 19 months old and normal. □

Cover Photo

A pair of interacting galaxies in the Southern Hemisphere sky known as ESO (B) IG-138, 29, 30, photographed by the new 4-meter Cerro Tololo telescope in Chile then enhanced with Kitt Peak National Observatory's new Interacting Picture Processing System (see p. 132). Cerro Tololo scientist John Graham has deduced that the two galaxies are about 300 million light-years away. They are receding from us at an estimated velocity of 5,000 kilometers per second.

The larger of the two galaxies exhibits a huge ring about 180,000 light years across which is probably made up of young stars recently formed from neutral hydrogen surrounding the central galaxy. Graham believes that the star formation may have been triggered when the second galaxy passed through the larger disk. The two galaxies are connected by a "tail," and each seems to be similar in shape and in size to our own Milky Way galaxy. But their close passage brought about tidal effects that give the pair their peculiar appearance. In this photo, color enhances the areas of neutral hydrogen.