The investigators immunized pregnant gilts with either K99 or 987 pili. Piglets suckling the gilts were protected against diarrhea caused by *E. coli* bearing the pili used for immunization, but not against diarrhea caused by bacteria carrying the other pili type. The evidence suggests that the antibodies taken in by the suckling pigs worked, as expected, by inhibiting the attachment of the appropriate *E. coli* strain. Even though these results indicate that full protection of newborn piglets against diarrhea caused by *E. coli* will require a vaccine containing all three pili types, such a trivalent vaccine ought to be feasible. In Europe, where only one pili type is required for protection of piglets, Burroughs-Wellcome is already marketing a vaccine for the disease.

There are indications that inhibition of adhesion may be involved in immunity to *E. coli* infections of humans. Myron Levine and his colleagues at the University of Maryland School of Medicine showed that human volunteers who had previously been infected with *E. coli* were protected against diarrhea after reinfection with the same strain. These individuals excreted the *E. coli* strain to the same degree as the controls, who had not been exposed to the bacteria before and who became ill.

According to Levine, this finding means that cell-killing antibodies did not contribute to the immunity he observed. If they had, the individuals who had become immune as a result of the earlier exposure would have excreted fewer bacteria. Instead, he thinks that antibodies inhibiting bacterial adhesion may explain the lower infection rate of those individuals.

In a pilot study with human volunteers, Levine and Brinton have shown

Cornell Evidence for Fifth Quark

The most widely held view among elementary particle physicists is that the fundamental constituents of matter are entities called quarks and leptons and that there are six varieties of each. The existence of four of the quarks is well established, whereas evidence for the fifth is incomplete and no sign of the sixth has yet appeared. At the 20th International Conference on High Energy Physics, held in Madison, Wisconsin, in July, physicists working at Cornell University's electron-positron colliding beam storage ring, CESR, presented evidence that should nail down the case for the fifth quark, provided that additional substantiating data are obtained in the next several months. Physicists give quarks whimsical names. The first four are called up, down, strange, and charm quarks; the fifth is the bottom or b quark, and the sixth, if found, would be the top or t quark.

Physicists believe that quarks never occur as free, isolated particles but only in combination with other quarks. The particle detected at Cornell was therefore not the bottom quark itself but a meson consisting of a bottom quark and a second quark of another variety, probably an up or down quark. (Quarks also occur in combinations of three to make up the heavier subnuclear particles such as the proton and neutron, which are called baryons.) Discovery of the B meson was not at all unexpected and, in fact, high energy physicists generally assumed that it would be found at Cornell because CESR provides collisions of just the right energy to produce the particle. It may be a year or more before experimenters can collect enough data of the type needed for detailed analysis of the properties of the B meson and thereby be certain of their finding.

Cornell's storage ring was completed just over a year ago. At that time, groups working at the Fermi National Accelerator Laboratory near Chicago and the Deutsches Elektronen-Synchrotron Laboratory in Hamburg, West Germany, had already established the existence of the upsilon family of particles which they conjectured to consist of a bottom quark and a bottom antiquark bound together. Confidence in this interpretation was buoyed by the strong similarity between the family of upsilon particles and the exhaustively studied family of psi particles known to consist of charm quark and antiquark pairs. But the bottom character could not be directly verified because its appearances in the quark and antiquark canceled out each other.

In January of this year, two groups working at Cornell (one consisting of researchers from Cornell, Harvard University, Ithaca College, the University of Rochester, Rutgers University, Syracuse University, and Vanderbilt University; and the other consisting of investigators at Columbia University and the State University of New York at Stony Brook) confirmed the existence of the three upsilon particles found earlier. Then in April, the two Cornell groups announced the discovery of a fourth upsilon at a still higher energy. The fourth particle had a much shorter lifetime than the other three, indicating that it was decaying rapidly by a pathway forbidden to the others. By analogy with the charm quark system where the same pattern occurred, the investigators reasoned that the fourth upsilon was energetic enough to decay into two B mesons, one containing the bottom quark and one containing the bottom antiquark. The first three upsilons presumably did not have enough energy to create the extra up or down quarks needed for the creation of the mesons and therefore decayed by another mechanism in which they were transformed into other varieties of lighter particles.

Since April, the investigators have been analyzing their data for evidence to support this proposition. According to Edward Thorndike of Rochester, one telltale sign of bottom quarks was the presence of leptons (electrons and muons) among the decay products. Karl Berkelman of Cornell, who reviewed the results from CESR at the conference, said the mass of the B meson is between 5.18 and 5.28 billion electron volts (GeV) and its lifetime is less than 3×10^{-11} second, in agreement with theoretical predictions.

This is not the first report of finding the B meson. Last summer an international collaboration working at the European Organization for Nuclear Research (CERN) near Geneva said it had evidence for the particle in experiments with CERN's largest accelerator, a proton synchrotron. During the next several months, the group increased its amount of data by a factor of 4, but the signal for the B meson had disappeared. In the Cornell case this is not likely to happen. A real effect has been observed; it is only the interpretation that is not yet ironclad.

—ARTHUR L. ROBINSON