Society in New Orleans last week the initial steps were taken toward the formation of a Division of Biological Physics.

There have always been some physicists who were interested in biological problems, but the feeling of most has been that the physics of a biological molecule, let alone a whole cell, was altogether too complex. Physicists had better study very simple systems, like hydrogen atoms.

Nowadays hydrogen has lost some of its glamor, and more physicists are interested in hemoglobin. Meanwhile biology has become more and more fundamental, and many of its outstanding problems relate to the physical and physicochemical processes that make biological substances do the things they do.

"The study of life is challenging," says Dr. E. C. Pollard of the Pennsylvania State University, "because it may still require new basic laws for its interpretation." A major problem, he points out, is that "our knowledge of the fine structure of any living system is almost nil. I have tried for 12 years to force a decision as to whether a bacterial cell is a miracle of order or a random mixture. No decision can be made. This necessary study is one *par excellence* for the physicist."

Physicists entering biology, he warns, will find that they have badly neglected the liquid state of matter. Life probably requires the liquid state for its existence, he says.

The behavior of hemoglobin in taking up oxygen is an example of the sort of biological question that interests physicists, says Dr. Mitchel Weissbluth of Stanford University. Not only is it important in itself; its mode of action is similar to a class of enzymes that serve as biological catalysts and are of considerable interest to biologists. And hemoglobin is available for study by physicists, says Dr. Weissbluth: It can be crystallized and its structure is well known.

Hemoglobin interests physicists because it shows what they call a cooperative effect. The hemoglobin molecule has four sections. Each section contains an iron atom to which an oxygen atom can become attached. Study shows that the more oxygen atoms a hemoglobin molecule has, the more it is likely to pick up until saturation is reached. In other words, the four iron atoms do not act independently of one another; somehow the state of one of them influences the state of all the others.

Cooperative effects are familiar to physicists from their studies of magnetism. In a magnet the orientation of the magnetic field of one atom influences those of its neighbors. The larger the number of atoms that happen to be aligned in a given direction, the greater is the probability that more atoms will fall into line.

In the magnetic case the atoms influence each other's behavior by magnetic forces that communicate the orientation of their fields and urge their neighbors to get in line. In the case of hemoglobin, says Dr. Weissbluth, how the iron atoms inform each other of the presence or absence of oxygen atoms is precisely the question. The iron atoms are too far apart, between 23 and 35 angstroms, for the means of communication that physicists are familiar with to be effective. An unknown means of conveying the information must be sought, and studies of the shapes of the parts of the hemoglobin molecule and their relations with each other are under way in the hope of throwing some light on the problem.

Ever since Galvani applied electric shocks to frog legs, physical techniques have been used to aid biological investigations. One of the latest is dielectrophoresis, a method for separating particular cells and organelles from liquid suspensions in which they are often mixed with many other objects.

Basic to the method, says Dr. H. A. Pohl of Oklahoma State University, is that cells, though electrically neutral, can be polarized. If they are placed in an electric field, the positive charges within them go to one side, the negative to the other.

Each end of the cell feels a force toward the electrode on its side. If the field is uniform in shape the forces are equal, but in a nonuniform field the force on one side will be stronger and the cell will move toward that side. If the field is driven by an alternating voltage, the polarity of the field will reverse periodically and so will the polarization of the cell, but if the shape of the field stays the same, the stronger force on the cell will remain on the same side, and the cell will move in little jerks toward that side.

When the field reverses, the charges inside the cell must move back and forth. How easily they do this depends on the cell, so that different cells respond best to different frequencies of alternation. By adjusting to the proper frequency one can pull cells of a desired sort out of a mixture. In working out the method Dr. Pohl has been successful with live and dead yeasts and chloroplasts, among others. Some day the method, it is suggested, might be used to separate macromolecules such as hemoglobin from suspensions.

Dr. Pohl's current efforts involve samples the size of microscope slides. Wire electrodes are mounted in the slides and the separation process can be watched through the instrument. For the future he suggests a larger apparatus for bulk separations. □

INEFFECTIVE DRUGS

FDA publishes a list

Four years ago the Food and Drug Administration asked the National Academy of Sciences to evaluate the effectiveness of all drugs marketed between 1938 and 1962—a total of about 3,000 products (SN: 10/17, p. 316).

The NAS study was initiated under a law passed by Congress in 1962 which requires that drugs be not only safe but effective.

The FDA is presently reviewing the findings of the NAS study group, and this week it released a list of 359 drug products that it has found to be either ineffective or to have "an unfavorable benefit-to-risk ratio." This list, according to FDA spokesmen, represents 80 to 90 percent of all the drugs that will ultimately be declared ineffective.

The list includes both prescription and over-the-counter drugs. In the latter group are a number of toothpastes, mouthwashes, nose drops and throat lozenges, including such well-known brands as Colgate Dental Cream with Gardol and Pepsodent and Micrin oral antiseptics. In most of these cases, the FDA has decided that there is insufficient evidence that the product reduces tooth decay or has other therapeutic properties.

Among the prescription drugs are Mycillin Suspension, some Aureomycin products, Signemycin Capsules, Neo-Cortef Nasal Spray and Sulfathiazole Tablets.

Also on the list are a variety of fixed-combination drugs—notably combinations of pencillin and a sulfa drug. Though the active ingredients may be quite effective when used individually or in a different ratio, the NAS found that in each instance the particular combination was either ineffective or provided too much of one of the drugs.

The FDA has taken action to have all 359 drugs removed from the market. Some have already been removed. In other cases, the manufacturers are submitting additional data in an attempt to establish the product's efficacy and persuade the FDA to change its ruling. Some manufacturers are making changes in the products to render them effective.

The majority of the drugs on the list are prescription drugs, and though some of the listed products are actually hazardous, most are simply ineffective for the purpose for which they are advertised, according to the FDA.

The list has been sent to the Department of Defense, Veterans Administration, Public Health Service and other governmental agencies whose drug purchases might be affected.

The agency hopes to complete its review by next summer. □