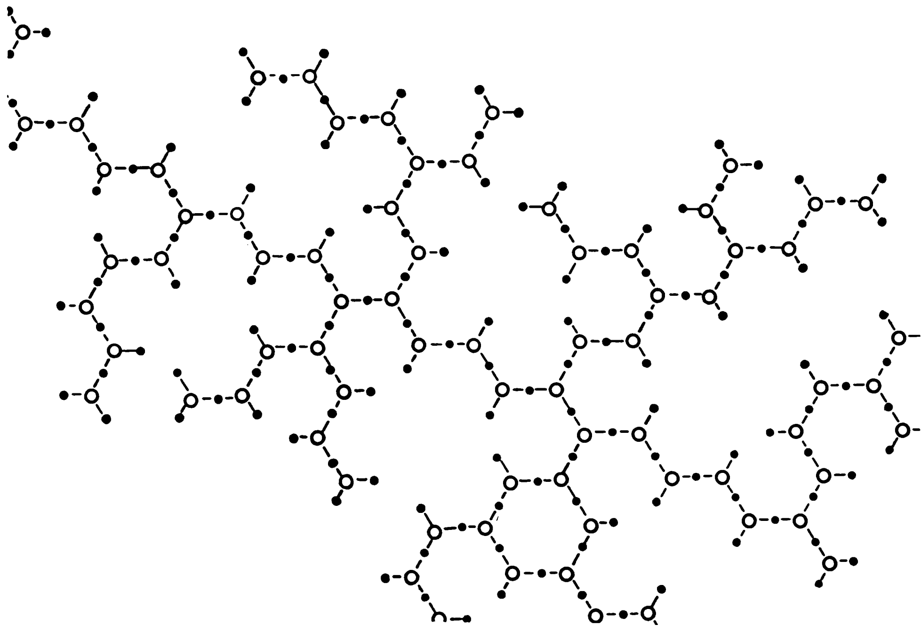
NEW LINKAGES

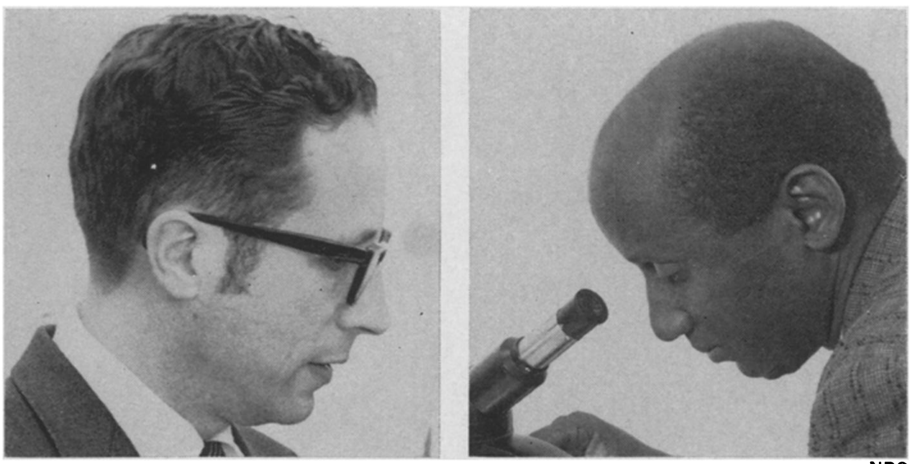
A polymer from water

H_2O molecules bound in chains shake up chemistry



NBS

Linking the molecules of water, this model shows the bonds that tie.



NBS

Stromberg and Grant: The NBS half of the team that pinned down polywater.

A polymer is a giant molecule, formed when a large number of molecules of some substance are induced by temperature and pressure and the presence of a catalyst to string themselves together in long chains. So, for example, ester molecules can be made to string themselves together into polyesters. Polymers are much used in making plastic materials and synthetic fibers.

Now a group of scientists from the University of Maryland and the National Bureau of Standards, Dr. Ellis R. Lippincott, Dr. Robert R. Stromberg, Dr. Warren H. Grant and Gerald L. Cessac, reports that water molecules can be formed into a polymer, which they call polywater. This discovery, they feel, will have important effects in chemistry, biology, earth sciences and technology.

The present work grows out of reports by some Russian chemists, notably Drs. N. N. Fedyakin and B. V. Deryagin, who said that water condensed in minute capillary tubes showed anomalous properties (SN: 12/21, p. 615). It has lower vapor pressure than ordinary water and higher viscosity. It solidifies at minus 40 degrees C. and forms a glassy solid rather than crystalline ice. It can be up to 1.4 times as dense as ordinary water, and maintains its molecular structure to temperatures as high as 500 degrees C.

The Russian work aroused interest in both Europe and the United States, and several groups have looked for the anomalous water. Some have found it; others have claimed that they could not and attributed the anomalous properties observed by the Russians to some impurity in the samples (SN: 5/3, p. 429).

The Maryland-NBS scientists say that not only have they been able to make polywater with the strange properties, but they also have been able to subject it to spectroscopic studies. "The evidence is overwhelming that it's authentic and not an impurity or surface phenomenon," says Dr. Lippincott.

To be sure, they compared the infrared spectrum with those of 100,000 other substances stored in a computer memory. "It is not a spectrum of any known substance," they conclude.

Analysis of the spectra indicates, they say, that the basic structural unit of polywater is a three-atom group, oxygen-

Univ. of Maryland

Lippincott: Evidence is overwhelming.

hydrogen-oxygen. The two oxygens are located about 2.3 angstroms apart with the hydrogen centered between them at about 1.15 angstroms from each. The unit is held together by so-called hydrogen bonds that are much stronger than those in ordinary water, and this accounts for the high stability of the substance. The hydrogen-bond energy of polywater is between 60 and 100 kilocalories per water formula unit, compared with only 4 kilocalories for ordinary water. The three-atom elements, say the Maryland-NBS chemists, can be arranged either into hexagons or into complicated branched chains to form the polymer.

The possibility of forming such structures leads to the suggestion that other substances containing oxygen-hydrogen groups may form similar polymers. Condensation of anomalous acetone, methanol and acetic acid has been reported from Russia. At Maryland, says Dr. Lippincott, "we have prepared and characterized some other materials." But this part of the work is still in a preliminary stage.

"It seems unbelievable," says Dr. Lippincott, "that water like this hasn't been found before. For two or three hundred years it was never picked up." But he points out that the chemical literature of the past shows indications that some researchers may have come upon polywater without realizing what it was.

"Prof. [Walter A.] Patrick of Johns Hopkins," says Dr. Lippincott, "said that the vapor pressure of water in capillaries was not right. Prof. [J. Leon] Shereshefsky at Howard came out with the flat statement that water in capillaries didn't obey the laws."

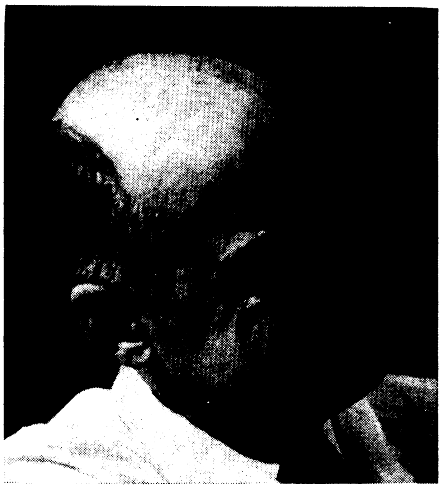
But now that polywater has definitely been identified, says Dr. Lippincott, "the whole concept is going to shake things up." He believes that it probably does exist in nature. If it does, it may play a role in many biological and geophysical processes. It may have to do with the nucleation of water droplets in rain, snow and fog. It may be important in accumulation and adhesion of ice, and it may play a role in the formation and structure of clays.

"Biologists," says Dr. Lippincott, "will want to see whether it has a function in life systems." Phenomena involving membranes and the biology and chemistry that take place at interfaces between different substances are especially interesting, he says.

Quantities of polywater so far made in laboratories are measured in millionths of a liter, but sizeable quantities can be made, thinks Dr. Lippincott. "It's a question of doing the right tricks," he says, "and there would be a lot of it." ◇

INTERFERON

Hard times for a panacea



Merck

Hilleman: Inducers are the answer.

Interferon, once hailed as a panacea for virus diseases from hepatitis to the common cold and possibly even cancer, has fallen from grace in some scientists' eyes. And it is a focus of controversy among those who continue to believe in its future.

When, in 1957, British researchers Alick Isaacs and Jean Lindenmann identified interferon as the body's natural defense against viruses, scientists throughout the world predicted that by giving or inducing natural production of this protein they could immunize persons against invading viruses.

The interferon antiviral system seems to be ubiquitous in animals, as it has also been demonstrated in birds, reptiles and fish. Perhaps it even operates in plants. A malarial parasite of rats was found to produce interferon last year (SN: 10/19, p. 391).

A number of research programs were launched. European researchers generally aimed at finding ways of using interferon itself, while scientists in the United States, contending that the costs and difficulties in obtaining natural interferon were prohibitive, tended to concentrate on a search for materials that would stimulate the protein's natural manufacture in the body. Two years ago, Dr. Maurice Hilleman of the Merck Institute for Therapeutic Research in West Point, Pa., announced that a synthetic chemical called poly I:C, a double-stranded material that mimics the RNA core of many infectious viruses, effectively induces interferon production (SN: 8/17/67, p. 173). "Our hopes are especially high for preventing common colds," he said then, and still maintains his optimism in spite of evidence that poly I:C is toxic. "Toxicity is minimal," he says.

Another interferon devotee, Dr. Samuel Baron of the National Institutes of Health in Bethesda, Md., declared, "Dr. Hilleman's work could be the breakthrough we've been waiting for," and went on this year to show that interferon, induced by poly I:C, cures rabbits of a potentially fatal eye disease caused by herpes simplex viruses (SN: 1/18, p. 60). In still other studies with poly I:C, Dr. Hilton Levy and co-workers, also of NIH, report that the chemical causes tumors to regress, though the mechanism of action, he suggests, is not related to its ability to induce interferon. Within months he plans to initiate clinical trials of poly I:C on terminal cancer patients at NIH.

At Stanford University, Drs. Thomas C. Merigan and Erik DeClercq have taken an architectural approach to inducers, suggesting that by modifying the molecular structure of poly I:C or other double-stranded inducers including Pyran copolymer, they can derive a less toxic material. By substituting sulfur atoms for oxygen atoms, they produce a compound that they believe is less toxic, less susceptible to degradation by enzymes in the body and more potent in inducing a prolonged interferon response. Trials in patients with serious infections, including hepatitis and encephalitis, are under consideration.

But for every hopeful view, there is another that is either entirely negative or somewhere in the middle. At an international meeting of the New York Academy of Sciences the arguments surfaced as authorities debated interferon's future.

From the beginning, interferon studies have yielded conflicting results, partly due to unpurified preparations.

Dr. Ernest C. Herrmann Jr. of the Mayo Clinic says, "I don't think interferon can be made practical," and calls Dr. Hilleman's decision to invest close to a million dollars of Merck money in poly I:C and other inducers a "ridiculous mistake." And Dr. Herbert Kaufman of the University of Florida College of Medicine in Gainesville points out that the interferon system suffers from fatique if it is stimulated continually. "The study of interferon has been disappointing. It is relatively unpromising in therapy. Evidence that the interferon system fatigues suggests it is unlikely we will be able to stimulate it continually."

Dr. Warren Stinebring of the University of Vermont in Burlington is among those who hold that poly I:C's effectiveness is, in fact, dependent on its toxicity. Interferon, he believes, is preformed and stored in cells, ready to