acids into protein molecules, contain special RNA. Researchers have suggested that before protein synthesis, nucleotides of ribosomal RNA must bind temporarily to nucleotides of messenger RNA, the intermediary between DNA and protein formation. When Sanger and colleagues examined the nucleotide sequences before the start signal of each phiX174 protein, they found that messenger RNA would have a stretch of at least four nucleotides that could bind with the nucleotides at one end of the ribosomal RNA. The sites where ribosomes bind have also been isolated from pieces of messenger RNA both in Sanger's laboratory by Nigel L. Brown and Michael Smith and by Rockefeller University biologists Jeffrey V. Ravetch, Peter Model and Hugh D. Robertson. Two articles also in the Feb. 24 NATURE describe the sequences of these sites and locate the sites on the overall phiX174 map. In all these ribosome binding sites there is a sequence of nucleotides that should be able to form stable base pairs with the end of the ribosomal RNA. The number of these possible base pairs, however, does not reflect how frequently ribosomes bind to each site and make the appropriate protein, so other factors must be involved in control of protein synthesis.

The sequence has certainly not answered all questions. For example, the researchers learned little about what is special about the position on the DNA molecule, the replication origin, where copies of the viral DNA always begin. Sanger found that this origin falls within the gene for protein A, but that area showed no obvious symmetry or special shape.

Furthermore, the analysis opened the possibility of there being even more phiX174 proteins. "With the presence of two pairs of overlapping genes, the genome has more coding capacity than had been originally supposed on the assumption that each gene was physically separate," Sanger says. He points out that there are sites in the A, F, G and H genes where sequences for other proteins could possibly start.

Nobody knows whether the mechanisms uncovered by solving the phiX174 sequence will also appear in organisms that are less limited in total DNA. But molecular biologists now have new phenomena to watch for and plenty to think about. Everything the virus phiX174 is or does should be explicable beginning with that DNA sequence. □

The closest look yet at Phobos

Viking orbiter 1 has provided the closest look ever taken at the Martian moon Phobos (see cover), revealing a wealth of detail and enabling the first accurate calculations of the tiny satelliate's density. A very preliminary look, says Joseph Veverka of Cornell University, suggests about 2 grams per cubic centimeter, consistent with earlier speculation that Phobos resembles carbonaceous chondritic material. Veverka and others feel that this is evidence that Phobos (and Deimos) may be captured objects originally formed far out in the asteroid belt between Mars and Jupiter. The photos have shown many small, bowl-shaped craters which, combined with the flatter floors of larger craters, should yield an estimate of the depth of the planetoid's regolith, or fragmented surface, with substantial implications for its evolution and history. One of Phobos's major mysteries—a series of strange, parallel striations crossing part of the surface—shows up clearly in the closest photos as grooves, about 100 to 200 meters wide and tens of kilometers long, rather than as "chains" of small craters. (Such chains have also been seen, suggesting secondary ejecta from larger craters.) The grooves do not appear on every side. This implies that they are symptoms neither of Mars-caused tidal distortions nor of strata seen edge-on. They could be related to the formation of Phobos's largest crater, Stickney. This will seem even more likely if the other moon, Deimos, has none. □

One man's Mars: No Martians

For months, the Viking project's biologists have been struggling to find a theory that would explain the seemingly conflicting results of their experiments on the Martian surface. Now the first such theory has been offered, and, says Vance Oyama of the National Aeronautics and Space Administration's Ames Research Center, it shows "no need to invoke biological processes."

It is far from universally accepted, and it requires invoking several specialized chemical processes such as catalysis and polymerization. But, says Oyama, it fits all the facts, and elegantly so. Furthermore, if Oyama's theory is correct, it bears not only on the biology-instrument results, but also on the nature of the magnetic material that clings to Viking's test magnets, as well as on atmosphere-surface interactions and even on the early evolution of the planet.

The theory begins with the simplest of photochemical effects in the atmosphere—the dissociation of the dominant carbon dioxide by solar ultraviolet radiation into "activated" carbon monoxide and single atoms of oxygen. With more UV, some of the CO is further dissociated into carbon and oxygen. The carbon then combines with CO to form carbene (C_2O), which in turn combines with still more CO to form the first key element in Oyama's proposal, carbon suboxide, or C_3O_2. The carbon suboxide molecules, Oyama says, can then unite into a carbon suboxide polymer, $(C_3O_2)_N$. All of these reactions, he adds, are known from laboratory studies, and the resulting polymer has a reddish cast very much like that of the Martian surface.

The next step is to plug this result into the data from the three different kinds of biology experiments aboard the landers. Oyama's explanation begins with the pyrolytic-release instrument—the one of the three that has suggested reduction processes.

The PR instrument works by exposing a soil sample to an atmosphere that includes CO and CO_2 whose carbon atoms are radioactive carbon 14. After an incubation period, the sample is incinerated, or pyrolyzed, and the resultant gases are monitored for radioactivity as an indication of how much of the CO and/or CO_2 was incorporated into the soil.

During the design of the Viking experiments, it had been suggested by some observers that the radioactive carbon isotopes might kill off the very microorganisms that they were trying to measure. Viking's biologists have long felt that the radioactivity levels are too low to do any damage, and Oyama sees no evidence of life to kill anyway, but the isotopes do play an important role in his explanation of the PR results.

The decay of the carbon 14 (into nitrogen 14) releases a beta particle, he points out, and the energy of this decay product (0.156 MeV, Oyama says), multiplied by the 22 microcuries of radioactivity in each PR "cycle," is more than sufficient to fracture carbon-carbon, carbon-hydrogen or carbon-oxygen bonds. This breakage has the effect of "activating" the red carbon suboxide polymer, making it "receptive" to incorporating the provided carbon monoxide. When the polymer is heated to 625°C, it yields about 4 percent of itself as the original, but now labeled, monomer form, which sticks to the experiment's organic-vapor trap and appears, upon further heating, as the critical "second peak" in the experiment's data.

If water vapor is present in the PR experiment when the sample is exposed to the labeled atmosphere, says Oyama, this second peak is lower. In Oyama's own "gas-exchange" experiment, which exposes a sample to a *non*labeled nutrient solution and simply monitors changes in the composition of the test-cell atmosphere, the prominent release of oxygen is also reduced. But the reason, Oyama says, is very different.

In the Martian atmosphere, the same photodissociative reactions which lead to the formation of carbon suboxide also lead, by another path, to activated oxygen atoms. When these atoms strike alkaline earths such as oxides of magnesium or calcium, or alkaline metals such as sodium or potassium, they can unite to form superoxides which readily release oxygen upon exposure to water vapor. Less oxygen was released in the GEx instrument at the more northerly lander 2 site, says Oyama, because the greater amount of water vapor in the ambient atmosphere had already set it free. The same instrument detected nitrogen, CO and argon—evidence of the desorption of gases physically affixed to the surfaces of the soil grains—but even at lander 2, according to Oyama, there was at least 700 times more oxygen detected in the instrument than could be accounted for by desorption alone. The bulk of the oxygen, he reasons, must then have come from a deeper source, chemically bound to the interior of the soil grains—in other words, from the $Ca(O_2)_2$ and other superoxides.

For the other phase of his theory, Oyama was inspired by thinking not of inanimate rocks but of human beings. When hydrogen peroxide (H_2O_2), commonly used as a disinfectant, is applied to a human wound, it bubbles. This, says Oyama, is due to the iron in the enzyme catalase, which combines catalytically with the H_2O_2 to release bubbles of oxygen. A similar catalytic reaction, he believes, is at work on Mars.

Viking's third biology experiment uses a "labeled-release" instrument that looks for labeled gases given off by soil exposed to a labeled nutrient. The positive indications reported by the instrument presumably represent oxygen that is released from some source and combined with the labeled carbon into $^{14}CO_2$. In Oyama's scenario, hydrogen peroxide formed photochemically in the atmosphere reacts with a catalyst on the soil-grain surfaces to release oxygen that diffuses into the grains, reacting with the alkaline earths and metals to form other superoxides inside. Atmospheric water vapor readily converts the superoxides into *per*oxides, which in turn combines with water in the nutrient to form H_2O_2 that oxidizes the labeled components of the nutrient to release the labeled CO_2.

Comparing the effectiveness and likelihood of formation of various catalysts under Martian conditions, Oyama concludes that the one eligible candidate is a form of iron oxide known as gamma Fe_2O_3 or maghemite. On earth, he says, maghemite is usually found only around the edges of hydrothermal or magmatic activity, since it represents a rather specific temperature transition between about 300°C and 400°C. The abundance of water on earth has converted much of this material into a noncatalytic form, but on Mars, says Oyama, the maghemite has been able to survive virtually unchanged since its formation in what he believes to have been a major episode of volcanic and/or impact heating early in the planet's history. The many signs of apparent water activity seen in Viking's photos, he says, simply suggest that the heating episode occurred after the water was gone.

Oyama's theory will have to stand the test of time, additional data and competing theories. But it does show that looking for life on other worlds has the potential for making valuable contributions in other fields as well. □

Carter revises the science budget

The Carter administration got its first say in science policy matters last week when it published its revisions of the 1978 budget. As incoming President, Carter is given an opportunity to alter the budget of his predecessor before the Congress begins its own decisions on spending. Carter changed little of Ford's authorizations for basic science research. But in the area of energy, Carter made significant changes, emphasizing short-term goals while backing away from distant long-term projects not realizable by the next decade. From breeder reactor projects, Carter cut $199 million, and an additional $80 million was cut from the fusion research budget. At the same time, Carter added $42 million for research on oil and gas recovery and coal conversion techniques.

Of the $80 million cut from Ford's original authorizations for fusion research, $60 million came from magnetic fusion projects. The tokamak fusion project at Princeton lost $20 million, enough to delay completion of the project by six months. The mirror fusion project at Lawrence Livermore was cut $10 million and the 14-MeV Intense Neutron Source at Los Alamos lost all of its $10 million, completely canceling that work. An additional $20 million in operating costs for magnetic fusion was cut across the board. Finally, some five labs lost funds totaling $20 million for laser fusion research.

The single largest cut from the budget for the liquid fast metal breeder reactor came from the Clinch River project in Tennessee, which lost $84.8 million. Officials at ERDA said the loss in funding would set back the criticality date from October 1983 to June 1984. The remainder of $199 million cut from breeder research came from test facilities, fuels and the large plant's design prototype.

While fusion and breeder reactor research did not appear to the new administration to offer quick payoffs, at least in the next decade, the administration regarded fossil fuel research differently. Carter increased funding for more second- and third-generation coal conversion techniques, efforts to improve their efficiency and economic feasibility. New techniques in oil and gas recovery were also emphasized by Carter. Some of this research will concentrate on new polymer field flooding technologies. In addition, Carter increased by $1.8 billion authority for the petroleum storage program. Energy conservation, too, was increased $244 million in 1978 over Ford's request, $160 million of that intended for R&D.

Funding for the National Science Foundation was kept at the same level, despite the hope by some that Carter would increase funds for basic science. Many were pleasantly surprised by the addition of $15 million to the NASA budget. The first $10 million was earmarked for an evaluation and analysis of a future mission to Mars by the 1984 launch opportunity. Included in the evaluation would be a look into the possibility of using rover technology for a new Mars lander and a surface sample return vehicle, as well as studies of new scientific instrumentation.

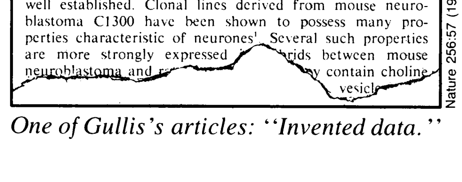
The other $5 million of the NASA budget increase was for a back-up spacecraft for the Landsat D earth resources satellite.

Besides the new administration's efforts to emphasize short-term, quickly realizable goals in energy research, the revised budget also stressed fiscal austerity. Now, the budget goes to the appropriate committees in the Congress where it will be debated, drafted and redrafted for the next six months. □

Researcher admits he faked journal data

A remarkable case of a scientist intentionally falsifying research results is announced in a statement by the man's colleagues in the Feb. 24 NATURE together with a candid admission from the scientist that data in published papers he co-authored "are mere figments of my imagination." The admission totally invalidates the research results in three scientific papers in an important area of biological research dealing with levels of cyclic GMP in neuroblastoma cells and hybrid cells. Data on cyclic AMP in a fourth paper were also falsified. Two of the papers had been published in NATURE.

The new case recalls several other episodes in recent years of faked research results, the most notorious of which was the Summerlin incident with "patchwork mice" (SN: 6/1/74, p. 348). This one differs from earlier cases in that both the accusation and the admission have been


Morphine elevates levels of cyclic GMP in a neuroblastoma X glioma hybrid cell line

THE use of cell lines derived from tumours of the nervous system as models for both neurones and glia has become well established. Clonal lines derived from mouse neuroblastoma C1300 have been shown to possess many properties characteristic of neurones[1]. Several such properties are more strongly expressed ... rids between mouse neuroblastoma and ... y contain choline ... vesicl...

Nature 256:57 (1975)

One of Gullis's articles: "Invented data."