of doctrinal filibusters than requests for clarification or information. Questions such as methodology, the organization of research and the development of technologies, are obviously more open to controversial social and political interpretations than is, say, mediaeval mathematics; the time range of sectional topics from ancient science, medicine and technology to the development of transport, electronics, constructional engineering and aircraft, rockets and space science, provided most speakers with a forum.

The Kepler symposium at Leningrad was a much smaller and more homogeneous affair. The location was very appropriate because most of Kepler's surviving manuscripts and related papers are in Leningrad, and many of these were included in a small and interesting exhibition of works on and by Kepler. There was also an opportunity to visit the nearby Pulkova observatory, rebuilt following its wartime destruction, and see and discuss many aspects of modern astronomy. Academician Mikhailov opened the proceedings, and was followed by Dr W. Gerlach (Munich) who spoke on Kepler's life and work. Subsequent contributions (not all presented in person) dealt with Kepler's contributions to celestial mechanics, optics, the development of mathematics, gravitation theory, comets, the supernova of 1604, structural crystallography, the origin and derivation of the laws of planetary motion and his neopythagoreanism. There were also contributions on Kepler's connexions with Galileo, his time in Prague, his astronomical instruments, his theory of hypotheses, the Kepler manuscripts in the Soviet Union, as well as his relationship to the interest of modern physicists. Although no particularly outstanding new information or insight into Kepler's work was presented, it was clear that his scientific and methodological achievements continue to be of interest and even inspiration to many historians of science, quite apart, of course, from the historical problems involved.

VIRAL INFECTIONS

Green Monkey Disease

from our Medical Virology Correspondent
In August and September 1967, an outbreak of a severe haemorrhagic fever occurred among monkey handlers and laboratory workers in Marburg, Frankfurt and Belgrade. Thirty-one cases of severe illness with seven deaths were traced to direct contact with the tissues or tissue culture of a batch of African green monkeys (*Cercopithecus aethiops*), which had been trapped in Uganda. Several secondary cases occurred in hos-

pital personnel by contact with the blood of patients and one further case was apparently transmitted by sexual intercourse. Many of the features of the illness, including liver and renal damage, a haemorrhagic diathesis and the association with monkeys originating from Uganda, suggested initially that the infection was caused by yellow fever virus or some other arbovirus. It soon became apparent, however, that this was a previously unrecognized disease caused by an infectious agent probably new to medical science. Today, four years after the infection, the origin of the disease remains obscure.

Studies in several laboratories established that guinea pigs, Rhesus (*Macaca mulatta*) and vervet monkeys could be infected and the agent was subsequently isolated in tissue culture. The structure of the agent, which was named the Marburg virus, is that of an elongated sinuous organism 800–1,000 nm in length but generally curled in the form of a figure 6 or a horseshoe. Single organisms longer than 2 μ were occasionally found in the blood. A periodic cross-striation of 5 nm along the surface and an inner structure of about 65 nm in diameter with a central axis was also described. It was suggested that this agent was related morphologically to the Rhabdovirus family.

The possible origin of the infection has been investigated intensively since the outbreak. The monkeys were sent from Uganda at the time when there was considerable disruption of air traffic during the Six Days war. The monkeys were held overnight in London in a room containing many other animal species including birds and reptiles. A disturbing report from the United States based on serological study of complement-fixing antibodies to the Marburg agent revealed a high prevalence of antibody in many African monkeys. Strickland-Cholmley and Malherbe (*Lancet*, i, 476; 1970) pointed out, however, that the antigen used in the United States was not fully specific and that it probably contained a second non-specific component for the Marburg agent. W. Slencza and his associates (*Amer. J. Epidemiol.*, 93, 496; 1971) were also unable, after extensive studies, to find evidence of infection with the Marburg agent (based on antibody results) in free-living monkeys.

The origin of the infection is thus still unknown and it must therefore be assumed that infection of man may recur. Furthermore, infection may come next time from other species of animals because it is now clear that vervet monkeys are not the maintenance hosts of this bizarre agent and it cannot be predicted where it may next occur.

Protein Kinase in Tumour Viruses

In *Nature New Biology* next week, Strand and August add a protein kinase to the list of enzymes, which includes reverse transcriptase, ligase and nucleases, that have been detected in RNA tumour viruses. The kinase, which is present in mouse leukaemia virus, avian myeloblastosis virus and the non-oncogenic vesicular stomatitis virus, catalyses the phosphorylation of several virion proteins. Its presence in these particles suggests that modification of proteins by phosphorylation may play a part in the interaction between an infecting enveloped virus and its host cell.

The kinase was detected by simply incubating mouse leukaemia virus particles with (γ - ^{32}P) ATP and assaying for the incorporation of ^{32}P into virion proteins. Further experiments established that the kinase seems to be an integral part of the virion and is not adventitious; the phosphorylation reaction is stimulated by added protamine, depends on the presence of metal ions, is inhibited by caffeine and is enhanced by first disrupting the virions with detergent. Cyclic AMP, which stimulates by some two to three-fold the activity of other cellular kinase, and by this route exerts at least some of its regula-

tory effects, stimulates the phosphorylation of leukaemia virus proteins by only 25 to 50 per cent in the absence of protamine and in its presence stimulation is even less marked. As Strand and August remark, this lack of response of the virion kinase to cyclic AMP may mean either that the enzyme already has bound to it this nucleotide or it may lack the regulatory subunit of kinases which binds cyclic AMP.

The virion kinase will phosphorylate exogenous substrates including lysine and arginine rich histones, and a protein of *Escherichia coli* which is one of the two host factors required for the replication *in vitro* of QB RNA and which closely resembles histones. In the absence of added substrates the kinase phosphorylates at least ten different proteins or polypeptides in leukaemia virus particles including the internally located interspecies specific antigen (gs 3) and the two group or species specific antigenic determinants. Chemical tests indicate that serine and threonine residues are phosphorylated. Strand and August have not, however, been able to determine whether or not the glycoproteins in the envelopes of the virions, including the sub-group antigens, are phosphorylated.