attention to the possibility of a double motor innervation. D. Barker (Hong Kong) and his co-workers, N. K. Chin, M. N. Adal, M. C. Ip and M. Cope, also described much detailed work on the structure, nerve spectra and distribution of spindles in cat muscles. It became obvious that there are points of great interest to both physiologists and histologists still needing to be settled about the complexity of the motor innervation of spindles.

The mechanisms by which sensory endings initiate electrical discharges were considered by C. C. Hunt (Salt Lake City), using the simpler Pacinian corpuscle. The electron micrographs shown by M. C. R. Merrillees (Melbourne) gave an insight into the ultrastructure of both spindle and tendon organ endings and their relation to underlying tissues. A. S. Paintal (New Delhi) directed attention to the less well-known muscle receptors, with small nerve fibres, which probably subserve pressure and pain. K. S. Lim (Indiana) also spoke of the responses of these endings. Other papers dealt with pharmacological studies of spindles (J. E. Pascoe, London, and H.-D. Henatsch, Göttingen); spindle numbers and distribution (Eldred); differentiation of primary and secondary ending discharges (S. Cooper, Oxford); the potentiation of motoneurones by spindle discharges and also human experiments on reflexes involving muscle receptors (S. Homma, M. Kano and K. Takano, Chiba, Japan).

The ideal conditions under which the symposium was held both in the Department of Zoology and in the beautiful surroundings of Hong Kong gave many opportunities for discussions in small groups which did much to bring to light problems of structure and function that may be solved by mutual efforts of the workers in the two fields.

The Hong Kong University Press plans to publish the Proceedings early in 1962. Sybil Cooper

CHEMOTHERAPY OF VIRUS DISEASES

At a meeting of the Fine Chemicals Group of the Society of Chemical Industry held in the Wellcome Foundation on October 6, the subject under discussion was research on the chemotherapy of virus diseases. There are two ways in which this subject can be approached. What might be called the rational approach requires an investigation of the essential components of virus multiplication with special emphasis on those steps which could be readily inhibited. Thus, many substances are known that will inhibit the synthesis of viral nucleic acid or viral protein or that will block the supply of energy required for virus multiplication. The problem is not how to inhibit virus growth but how to inhibit it selectively, without at the same time damaging the host cells. The second approach, the empirical one, seems to have been the favoured approach, and one which has had more success so far.

Dr. A. Isaacs (National Institute for Medical Research) presented the first paper, on interferon. Interferon was first found during an investigation of the phenomenon of viral interference, in which it seems to play an important mediating part. Further investigations suggest that it may also play a part in the immune processes that lead to recovery from virus infections.

Interferon is a protein of molecular weight 63,000 which is produced by cells of a number of different vertebrates in response to infection with a large number of different viruses. Its antiviral activity is usually more apparent in cells of the animal species in which it was made. However, it is active against a wide range of animal viruses although there are differences among viruses in their sensitivity to interferon. It does not prevent adsorption or penetration of virus but it inhibits the replication of viral ribonucleic acid. This probably results from inhibition of an oxidative process of the cell which supplies the energy for viral synthesis. The inhibition seems to affect viral synthesis much more than normal cellular syntheses, however, since human thyroid cells can divide at a rate not grossly different from that of normal cells in the presence of a large amount of interferon.

There is growing evidence that antibody may play a less important part in the processes of recovery from virus infections than has been thought hitherto, and that interferon may play a more important part. This was shown first by experiments in chick embryos of different ages, in which recovery from virus infections is found to be closely related to development of sensitivity to interferon. Secondly, persistence of virus in the lungs of mice of different ages was found to be inversely related to the production of interferon in these animals. Thirdly, two ways of inhibiting the interferon mechanism *in vitro*, namely, increased oxygenation and treatment with cortisone, both have a detrimental effect on the course of virus infections *in vivo*. These findings point to the conclusion that interferon may play an important part in our ability to recover from virus infections and they suggest that it might be possible to assist natural recovery from virus infections by giving interferon therapeutically. This has been carried out successfully in some virus infections of animals and it is hoped that preliminary trials of its action in man will begin shortly.

The second paper was given by Drs. R. Hull and E. W. Hurst (Imperial Chemical Industries, Ltd.) on structure activity in various heterocyclic compounds.

Material tested for possible antiviral activity was obtained from products synthesized for other biological assays, from the synthesis of analogues obtained in the course of following up an antiviral lead already found in the department or elsewhere, and from the synthesis of possible antimetabolites to viral nucleic acid. Heterocyclic compounds constituted the largest section of organic compounds tested and a review was given of structure–activity relationships that had been found in the acridines. 'Mepacrine' was the most active and showed antiviral activity against equine encephalomyelitis, Rift Valley fever and louping ill viruses.

In evaluating experimental work it was important to take into consideration the complex of cell and virus that was studied. Examples were given of compounds which reduced the growth of viruses in the chick embryo but which were not appreciably

active in the mouse. On the other hand, 'Mepacrine', which was active against equine encephalomyelitis virus in the mouse and adolescent rat, was inactive against this virus in the chicken, guinea pig, rabbit and monkey.

Work on simple antimetabolites, in which the furan ring had been substituted for the ribofuranoside moiety in the nucleoside, had led eventually to certain tetrahydropyrimidines which showed activity against viruses of the psittacosis-lymphogranuloma-trachoma group both in the chick embryo and in the mouse. One, 17,025 [5-methoxycarbonyl-6-methyl-4-(5-nitrofuryl)-2-oxo-1,2,3,4-tetrahydropyrimidine] which was sparingly soluble in water, had very low toxicity and was both effective and non-irritant when given by the intramuscular route. It showed, weight for weight, rather less than one-tenth of the activity of chlorotetracycline. Its clinical use might be envisaged (for example, against trachoma) when it was desirable to control an infection by infrequent parenteral therapy rather than by prolonged topical application or by frequent oral dosing.

The third paper, by Drs. D. J. Bauer and P. W. Sadler (Wellcome Laboratories), was concerned with the antiviral action of derivatives of isatin β-thiosemicarbazone on viruses of the pox group. These compounds are known to show antituberculous activity and they were later shown by American workers to have some antiviral action against vaccinia virus. However, the latter work was not followed up until the group at the Wellcome Laboratories commenced detailed investigations of a number of derivatives of isatin β-thiosemicarbazone on a number of different members of the pox virus group. Perhaps the most striking finding has been the selectivity of action of these compounds. Thus, isatin β-thiosemicarbazone and some of its derivatives are very active against vaccinia but have no activity against ectromelia virus; conversely, isatin β-4′ : 4′-dialkylthiosemicarbazone and related compounds are highly active against ectromelia but not at all active against vaccinia virus. This specificity should provide an important clue to the mode of action of these compounds. To the authors it suggested that these compounds were not acting on some cellular enzyme required for viral synthesis, but that they were acting directly on the virus itself.

A most interesting aspect of this work is the finding that *N*-ethylisatin β-thiosemicarbazone, in doses of 0·03 and 0·015 mgm. twice daily for five days, protected infant mice (less than six days old) against fatal infection by the viruses of alastrim and variola major. Dr. Bauer discussed at some length the question of the importance of the treatment of smallpox in these days of vaccination and he concluded that there was a strong case for trying out these compounds in man and that it was reasonable to expect that a specific anti-smallpox drug would be in use within the not too distant future.

ALICK ISAACS

PHOSPHOLIPIDS AND SULPHOLIPIDS

DR. M. MACFARLANE, joint chairman with Prof. D. D. Eley of the joint meeting of the Biochemical Society and the British Biophysical Society on "Phospholipids and Sulpholipids", which was held at the School of Pharmacy, University of London, during October 5–6, underlined its significance by a quotation from the Macleans (1927)[1]. "When we consider the obscurity in which the chemistry of the phospholipids has been shrouded, it is easy to understand that many of the properties and functions ascribed to these bodies are based on little more than imagination." Thirty years later imagination remains in plenty, but an immense amount of accumulated factual evidence was presented at the meeting. The chemical, physical and physico-chemical problems surrounding phospholipids challenge all scientists interested in the structure and functions of the living cell.

With the advent of recent analytical procedures involving chemical[2,3] or enzymatic hydrolysis, paper and silicic-acid chromatography[4], the compositional detail of many animal and plant tissues is progressing fast. Consequently, the phospholipid chemist of to-day recognizes phosphatidylglycerols ; phosphoinositides; the classical ester phosphatides having either serine, ethanolamine or choline as the nitrogenous base; the plasmalogens, being analogous to the phosphatides, but with an aldehyde in place of a fatty acid; the sphingomyelins, the complex phosphoinositols and finally the lysophosphatides. Among many most recent compositional details reported at the meeting was the observation by Dr. G. R. Webster that the ethanolamine base in brain white matter is predominantly present in plasmalogen instead of the more usual phosphatidyl ethanolamine. Dr. E. Lederer, withdrawing earlier claims, pointed out that mycobacteria do not appear to contain any nitrogenous base phospholipids but do yield mixtures of phosphatidyl-inosito-mono, di- and tri-mannosides. Of great interest, however, was his report on the structure of the phosphatidyl-inosito-dimannoside, and of his proof that the 6-*O*-α-D-mannopyranosyl-α-D-mannopyranose is inositol linked, the dimannosides alone being almost as effective as *BCG* vaccine in the protection of animals against tuberculosis.

In plant chloroplasts the major anionic lipids are phosphatidylglycerol and the sulpholipid, 6-sulpho-α-D-quinovopyranosyl-(1 → 1′)-2′ : 3′ diacyl glycerol. The precise formulation of the latter compound has been established by Dr. A. A. Benson in an elegant analytical procedure. The presence of lipid lamellæ in plant chloroplasts and the high-rate of incorporation of carbon-14 dioxide, phosphorus-32 labelled phosphate and sulphur-35 labelled sulphate ions into the anionic lipids during photosynthesis points to at least two functions of phospholipids—namely, interfacial orientation with concomitant orientation of adjacent molecules, such as enzymes, and involvement in translocation of metabolic products.

With commercially available gas chromatography apparatus, each phosphatide can now be examined in terms of its fatty acid composition. This further stage in the dissection of phospholipids was reported on by Dr. G. M. Gray, who compared the mean fatty acid composition of normal tissue phospholipids with those from Landschutz ascites tumour cells. Surprisingly, and perhaps of fundamental importance, the tumour cell phospholipids showed far less variation in the kind of fatty acid acylated. For example, stearic is the predominating saturated acid in all tumour phospholipids, thus differing from normal