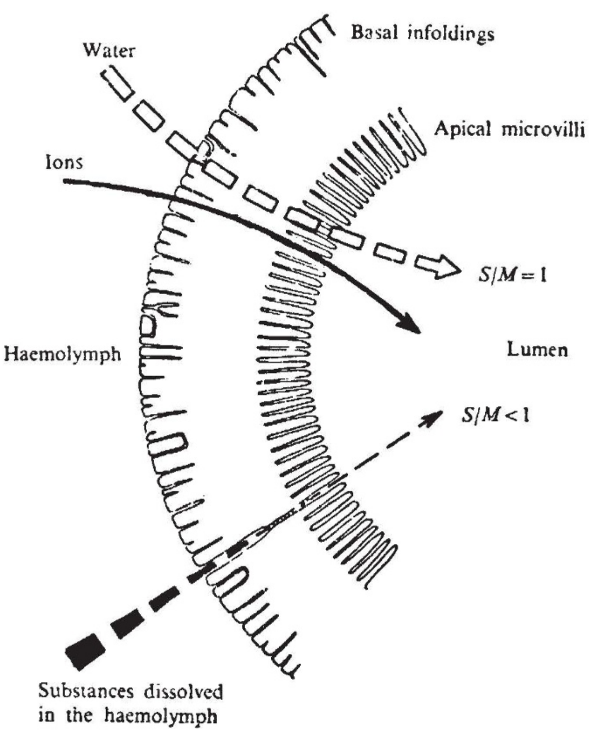
Passive transport of insect urine

from our Insect Physiology Correspondent

IT has long been realised that the Malpighian tubules of insect constitute a filtration-reabsorption system comparable with that of vertebrates. But in the absence of a glomerulus the flow of water is sustained by secretion in the upper region of the tubule, as in the aglomerular kidneys of some fishes, and not by pressure of the blood. Reabsorption of water can occur in the lower segment of the tubules, and in the hindgut and rectum—as in the kidney tubules and cloaca of many vertebrates. As was first shown by Ramsay, the osmotic driving force for the flow of water is produced by the active secretion of ions, particularly potassium; although sodium and chloride can play a part in some insects. The wall of the tubules was believed to be readily permeable to small organic molecules, so that sugars, amino acids and the like entered along with the water; the valuable components were reabsorbed, while toxic materials and waste products were discarded.

This problem of the passive permeability of the Malpighian tubules to organic solutes has now been re-investigated by Maddrell and Gardiner (*J. exp. Biol.*, **60**, 641; 1974) in the blowfly *Calliphora*, the locust *Schistocerca*, the hawk-moth *Manduca* and the blood-sucking bugs *Triatoma* and *Rhodnius*. Some eighteen compounds, labelled with carbon-14 or tritium were used as test substances; mostly amino acids and sugars, but including urea, urea acid and inulin. Most of the experiments were done on Malpighian tubules isolated *in vitro* in appropriate saline solutions; but the results were confirmed by *in vivo* observations. The concentrations of the test substance in the bathing medium (M) and in the secretory product (S) were measured, along with the rate of fluid secretion, which could be varied experimentally by appropriate stimulation. It was found that there was always a linear relation between the M/S ratio and the rate of fluid secretion—as was to be expected if the transport was purely passive, the slope of the line being determined by the permeability of the tubule to the substance in question. There was thus, for example, a very gentle slope for the small molecules of xylose, as compared with the steep slope for the large molecules of inulin. Highly charged molecules penetrate more slowly than those more nearly neutral electrically: thus L-valine accumulates at one fifth the rate of D-xylose. The permeability of the tubules to such materials as inulin (molecular weight 5,200) is surprising. In some experiments, where the tubules are secreting very slowly, inulin may reach a concentration in the secreted fluid nearly 50% of that in the bathing medium. The authors suggest that much of this passive permeability lies in the intercellular spaces (see figure).

These experiments seem to have established the fact that the content of small organic molecules in the Malpighian fluid is determined by a passive non-discriminatory process. This means that the onus for conservation and discrimination resides in the reabsorptive system. Here one is less well informed. The reabsorption of ions by the rectal epithelium has been well studied; and some absorption of amino acids and sugars occurs here. But a large part of the reabsorption probably takes place in the Malpighian tubules themselves, notably in the lower segments, and perhaps in the ileum where this exists. Furthermore, not all 'secretion' by the tubules is passive: some materials such as biliverdin, are transported by a process of endocytosis and exocytosis; the excretion of indigo carmine, which was so widely studied in the last century, presents some curious features that are not fully explained.



Schematic section of the wall of a Malpighian tubule to show the routes of transport of ions and water and diffusion of organic substances through the cell wall. S/M is the ratio of concentrations in the secreted fluid and in the bathing medium or haemolymph.

Modified nucleotides in messenger RNA?

from Alan E. Smith

UNTIL recently it was thought that minor bases were present only in transfer RNA (tRNA) and ribosomal RNA (rRNA), but the difficulties in obtaining sufficient pure messenger RNA (mRNA) prevented definitive analysis of the latter. The presence of poly (A) in mRNA and heterogeneous nuclear RNA (hnRNA) can now be utilised to obtain purified fractions of these species and they can be examined for nucleotide composition without risk of contamination by rRNA and tRNA. In the first issue of *Cell* (**1**, 37–42; 1974), Perry and Kelly reported the results of such an analysis of mouse L-cell mRNA and showed that on average there are about 2.2 methyl groups per 1,000 nucleotides. This compares with about 13 methyl groups per 1,000 in rRNA, and means that an average cellular messenger molecule containing, say, 3,000 nucleotides has about 6 or 7 methyl groups.

HnRNA, on the other hand, contains many fewer methyl groups and Perry and Kelly therefore suggested that in eukaryotic cells methylation like the addition of poly (A) constitutes a post-transcriptional modification of mRNA precursors. These authors, however, did not identify the minor bases present in a specific mRNA species nor did they position them within the molecule.

The first identification and precise location of a minor nucleotide in mRNA has now been reported using a somewhat exotic system. In an elegant paper (*Nucleic Acid Reports*, **1**, 809–822; 1974), Furuichi shows that the mRNA of silkworm cytoplasmic polyhedrosis virus (SCPV) contains a 2′-0-methyl adenylic acid in the 5′ terminal position, and that transcription to give mRNA is intimately coupled to the methylation reaction.

SCPV, like reovirus, contains a frag-