Transport at the Cellular Level

from a Correspondent

AT the twenty-eighth symposium of the Society for Experimental Biology on transport at the cellular level, held at Westfield College, London, on August 27 to 31, there were, in addition to individual contributions on diffusion of proteins and lipids within membranes and on transport of water, amino acids and other solutes, discussions in depth of several topics. One of these was transport of macromolecules across membranes. W. W. Franke and U. Scheer (University of Freiberg) reviewed evidence that nuclear pores are the main site of passage of macromolecules between nucleus and cytoplasm. Nuclear pore complexes have been isolated and characterized biochemically and morphologically, and their association with ribosomal and other species of RNA studied. The RNA in the pore complex has a higher molecular weight than that in ribosomes, so that it is presumably cleaved either in the pore complex itself or the cytoplasm. Nucleo-cytoplasmic transport of RNA is prevented by inhibitors of oxidative metabolism, transcription or translation.

In contrast to the role of pores in nucleo-cytoplasmic transport, J. O. Lampen (Rutgers University) considered that pores are probably not involved in the movement of newly synthesized proteins from membrane-bound ribosomes across the outer membranes of prokaryotes and eukaryotes. He reviewed evidence for the passage of nascent polypeptide chains through membranes and the occurrence of incompletely folded forms within the membranes. Of special interest is the finding in Lampen's laboratory of a membrane-bound lipophilic penicillinase in *Bacillus licheniformis*; this is a complex of the enzyme with a firmly associated phospholipid molecule.

A second major theme was the transfer of materials between cells and cell components. D. C. Smith (University of Oxford) discussed transfer from symbiotic algae and chloroplasts to host cells. Movement of photosynthate from autotroph to heterotroph is substantial, usually representing 40% or more of the ^{14}C fixed in photosynthesis. The molecules usually involved are glucose, polyols and neutral amino acids, especially alanine. Symbiosis stimulates efflux relative to influx of particular molecules from the autotrophs for reasons not at present understood, and these will doubtless be considered at length in next year's symposium, which will be devoted to symbiosis. C. Slack (University of Glasgow) presented observations of J. H. Subak-Sharpe, P. Goldfarb and herself on metabolic cooperation between mammalian cells in culture with normal phenotypes and others lacking inosinic pyrophosphorylase, adenylic pyrophosphorylase, thymidine kinase or deoxycytidine kinase. Transfer of the products of these enzymes from normal to mutant cells occurs at points of plasma membrane contact, but the enzymes themselves and the corresponding messenger RNAs are probably not transferred.

Metabolic cooperation, like the free passage of ions in electrotonic coupling, almost certainly occurs through gap junctions, the appearance of which was contrasted with that of tight junctions by J.-P. Revel (California Institute of Technology). In electron micrographs of freeze-fractured gap junctions, clusters of particles (presumably proteins) are seen in apposed membranes, and the formation of these junctions as cells come together is presaged by the appearance of relatively large (100 Å), sparse particles in the membranes. A role of particles demonstrable by freeze-fracturing in membrane fusion during mucocyst discharge in *Tetrahymena* was postulated by B. Satir (University of California, Berkeley). Formation of a rosette of particles in the plasma membrane and an annulus of particles in the adjacent mucocyst membrane precede fusion and discharge of the contents of the mucocyst. Fusion rosettes have also been observed in other systems.

The involvement of increased concentrations of cytoplasmic calcium ions and an ATP-dependent contractile system in stimulus-coupled release of growth hormone and other packaged secretions was discussed by J. G. Schofield and his colleagues (University of Bristol) and A. C. Allison and P. Davies (Clinical Research Centre, Harrow). The last authors also presented evidence that a contractile system and metabolic energy are required for phagocytosis and macropinocytosis, the uptake of extracellular fluid into vacuoles visible by light microscopy. In contrast, energy derived from Brownian motion is sufficient for uptake and transport of fluid in microvesicles about 70 nm in diameter. As reviewed by A. E. Wild (University of Southampton), some maternal immunoglobulins are transported across the placenta in pinocytotic vesicles in conditions when they are partially protected from lysosomal digestion.

Several contributors discussed morphological and biochemical aspects of long-distance phloem transport in plants, and there was general agreement that the Münch–Curran hypothesis of movement through a selective membrane followed by a non-selective membrane is still applicable. Whether the selective membrane is the plasma membrane of the companion cell, as advocated by B. Gunning (Queen's University of Belfast), is still uncertain.

There were also several contributions on transport along nerves. Fast transport of noradrenaline and other materials carried within membrane-limited vesicles was contrasted with the much slower transport of soluble enzymes, such as dopa-decarboxylase in adrenergic neurones and choline-acetyltransferase in cholinergic neurones. Transport along nerves is inhibited by colchicine, vinblastine or cytochalasin, and the relative importance of contractile systems related to microtubules and to microfilaments is not yet resolved.

It was clear that some transport mechanisms are common to plant and animal cells, whereas some specialized transport systems are peculiar to each. Comparisons could be illuminating. For example, current concepts of water transport in animal cells, reviewed by J. L. Oschman and his colleagues (Northwestern University, Evanston), resemble in some ways those long ago put forward for plants by Münch, and studies of contractile proteins in isolated amoeba cytoplasm, presented by R. D. Allen (State University of New York, Albany), are applicable to cytoplasmic streaming and other movements.

PLANT GROWTH SUBSTANCES

Gibberellin Biosynthesis

from a Correspondent

THE eighth International Conference on Plant Growth Substances, held at Tokyo from August 26 to September 1, demonstrated recent progress in the study of gibberellin biosynthesis, and also indicated the important role seen for plant membranes in hormone responses *in vitro*.

GC-MS and GC-RC (radiocounting) have become very powerful tools for studies of the chemistry and metabolism of plant growth substances. J. R. Bearder, P. Hedden, J. MacMillan (University of Bristol), B. O. Phinney and C. Wels (University of California, Los Angeles) discussed gibberellin biosynthesis in mutant *B1-41a* of *Gibberella fujikuroi*. This mutant is blocked for gibberellin (GA) biosynthesis between kaurenal and kaurenoic acid. By following the metabolism of intermediates the following pathways have been established:

$$\text{Kaurenoic acid} \to GA_{12}\text{—aldehyde} \to GA_{14}\text{—aldehyde} \to GA_{14}$$

$$GA_{12}\text{—aldehyde} \to GA_{12} \to \text{unknown} \to GA_9,\ GA_{15},\ GA_{24},\ GA_{25}$$

$$GA_9 \to GA_{10},\ GA_{20},\ GA_{40}.\quad GA_{40} \to \text{unknown} \to GA_{11}$$

$$\begin{array}{ccccccc} GA_{14} & \to & \text{unknown} & \to & GA_4 & \to & \underline{GA}_1 \\ \downarrow & & & & \downarrow & & \\ \underline{GA}_{16} & & & & GA_7 & \to & \underline{GA}_3 \end{array}$$