hepatic arginase activity observed in near-term foetuses would enable arginine that is released into the foetal circulation (Hopkins *et al.*, 1971a) to be metabolized in the liver.

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The Molecular-Weight Factor in the Biliary Excretion of Quaternary Ammonium Cations

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There appears to be a molecular-weight threshold, which varies with species, for the significant biliary excretion (i.e. >5–10% of dose) of organic anions. This threshold appears to be about 325 ± 50 for the rat, 400 ± 25 for the guinea pig and 500 ± 50 for the rabbit (Millburn *et al.*, 1967; Abdel Aziz *et al.*, 1971). A study is now in progress on the biliary excretion of organic cations, and from the results already obtained it would appear that for mono-quaternary cations the molecular-weight threshold for significant biliary excretion is less than for anions and that species variation may not occur to any marked extent.

The cations used contained ^{14}C -labelled methyl groups and the animals were bile-duct-cannulated as described by Abou-El-Makarem *et al.* (1967). In the rat the biliary excretion of the cations *N*-methylpyridinium (mol.wt. 94), trimethylphenylammonium (mol.wt. 136), diethylmethylphenylammonium (mol.wt. 164), dibenzyltrimethylammonium (mol.wt. 226), cetyltrimethylammonium (mol.wt. 284) and tribenzylmethylammonium (mol.wt. 302) was 0.6, 0.5, 6, 27, 15 and 39% of the dose in 3h respectively. These cations were not extensively metabolized and were excreted in the bile mainly unchanged. These results and others in the literature would suggest a threshold value in the region of 225 ± 25 for these cations in the rat.

Preliminary studies with three of the above-mentioned compounds in rats, guinea pigs and rabbits showed no significant species differences in the extent of biliary excretion. Thus the biliary excretion of

trimethylphenylammonium was 0.5% in the three species, whereas for dibenzyltrimethylammonium and tribenzylmethylammonium all three species excreted 30–40% of the dose in the bile in 3h.

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A Kinetic Analysis of Pinocytosis in Rat Yolk-Sac

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Rat visceral yolk-sac, from 17.5-day pregnant animals, was suspended in medium TC 199 containing 10% (v/v) of calf serum and incubated at 37°C. ^{125}I -labelled polyvinylpyrrolidone added to the culture medium (3 µg/ml) was accumulated at a linear rate, up to 7h. In four separate experiments the endocytic index, defined as the volume of medium processed by the tissue in unit time, was $1.92 \pm \text{s.d. } 0.15 \mu\text{l/h}$ per mg of yolk-sac protein. Accumulated polyvinylpyrrolidone was not released from the tissue, and the endocytic index was found to be independent of polyvinylpyrrolidone concentration at least within the concentration range 0.15–15.0 µg/ml.

Similar experiments with as substrate ^{125}I -labelled bovine serum albumin (3 µg/ml), which is digested intracellularly after pinocytosis by rat yolk-sac (Williams *et al.*, 1971), showed a steady tissue concentration of substrate once the rate of accumulation was balanced by the rate of digestion. When this steady state was reached (after about 2h) the rate of release of trichloroacetic acid-soluble radioactivity was linear for at least 5h and was used to calculate the endocytic index. In four separate experiments this value was $15.80 \pm \text{s.d. } 1.29 \mu\text{l/h}$ per mg of yolk-sac protein. Further experiments showed this endocytic index to hold over the concentration range 1.5–52.0 µg of ^{125}I -labelled albumin/ml.

The discrepancy between the two values obtained for the endocytic index could reflect a stimulation by ^{125}I -labelled albumin of the rate of internalization of culture medium, or alternatively a depression by polyvinylpyrrolidone. Such explanations are made unlikely by the concentration-independence of the

endocytic indices and by the results of experiments in which the uptake of polyvinylpyrrolidone was measured in the presence of ^{127}I -labelled albumin. A more likely explanation is that endocytic index cannot be simply equated with the rate of internalization of medium, substrates being internalized both in the fluid phase and adsorbed on the plasma membrane. If this is so, it is clear that albumin is more strongly adsorbed than polyvinylpyrrolidone and that the concentration ranges used in these experiments fall well below the dissociation constants for the surface-substrate complexes.

The results are discussed in relation to theoretical analyses of the kinetics of pinocytosis (see e.g. Jacques, 1969).

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Biology of Water Pollution: Effects and Control

By H. A. HAWKES (*Department of Biological Sciences, University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET, U.K.*)

The discharges of different industrial effluents into rivers have different ecological effects and may thereby cause different types of pollution. Metal mining and processing and chemical manufacturing industries produce toxic effluents that if discharged into a stream have a simple poisoning effect, lowering both the numbers of species and numbers of individuals present. Coal mining and china-clay industry may produce effluents containing a high concentration of suspended solids that produce turbidity in the receiving water, preventing the light penetration necessary for photosynthesis and smothering the animals on the river bed when it settles. This may be considered as a form of physical pollution, another example of which is the discharge of heated effluents at temperatures that adversely affect the life in the river. Industries concerned with the processing of

biological materials, such as food, textiles etc., produce effluents characterized by their high concentration of putrescible organic matter. It is with this type of organic pollution that the industrial biochemist will be more concerned.

The discharge of such effluents has similar effects to the discharge of domestic sewage. The increase in organic matter in the water initially encourages the development of the heterotrophic component of the ecosystem, producing an imbalance in the system. As a result of the heterotrophic activity the organic content in the water is lowered, leading to the re-establishment of a balanced heterotrophic–autotrophic system, a process known as self-purification. In the process, however, oxygen is utilized, and this results in deoxygenation with consequent adverse effects on fish and other life in the river. Factors affecting the oxygen balance in rivers polluted with organic matter have been studied to provide formulations for predicting the deoxygenating effects of a known load of organic pollutant. Under complete deoxygenation anaerobic breakdown of organic matter may occur, especially in the bottom muds of rivers. If toxic material is present in the river the biochemical activity is suppressed and self-purification is retarded. Although the oxygen depletion may be less severe under such conditions, life in the river is affected by the toxicity. As self-purification proceeds the increase in plant nutrients, especially in the case of sewage effluents, results in increased algal growth. The photosynthetic activity contributes to the re-oxygenation of the water.

In the control of organic pollution by different treatment methods, use is made of these natural biochemical purification processes occurring in rivers. Settleable organic matter is separated by sedimentation and is then subjected to anaerobic ‘digestion’. Organic matter in solution and suspension is subjected to biological oxidation, the oxygen being supplied either by ventilation, as in the percolating filter, or by aeration, as in the activated-sludge process. In the oxidation-pond process photosynthesis contributes to the oxygen supply. The efficient operation of such biological-treatment plants involves the controlled activity of the requisite population of organisms and the transfer of materials between the waste and the organisms involved.