stabilizing the electron-deficient species. The next stage is the attack on the C-2 cation by a nucleophilic oxygen atom of an alcohol or water to yield a fructoside or fructose.

This work was supported by the Science Research Council and The Distillers Co. Ltd.

- Friis, J. & Ottolenghi, P. (1959). *C. r. Trav. Lab. Carlsberg*, **31**, 259.
 Gascon, S. & Lampen, J. O. (1968). *J. biol. Chem.* **243**, 1567.
 Gascon, S., Neumann, N. P. & Lampen, J. O. (1968). *J. biol. Chem.* **243**, 1573.
 Gascon, S. & Ottolenghi, P. (1967). *C. r. Trav. Lab. Carlsberg*, **36**, 85.
 Neumann, N. P. & Lampen, J. O. (1967). *Biochemistry, Easton*, **6**, 468.
 Shall, S. & Waheed, A. (1968). *Biochem. J.* **111**, 33P.
 von Euler, H. & Landergren, S. (1922). *Biochem. Z.* **131**, 386.
 Waheed, A. & Shall, S. (1967). *Abstr. FEBS 4th Meet., Oslo*, no. 481.

Some Aspects of the Effects of Electrostatic Attraction and of Water-Entropy Changes on the Helical Stability of Deoxyribonucleic Acid

By S. LEWIN. (*Physical-Biochemistry Laboratory, Department of Postgraduate Molecular Biology, North-East London Polytechnic, Forest Road, London E17 4JB, U.K.*)

It is currently considered that there exists a major inter-strand electrostatic repulsion, due to the negatively charged phosphate groups, in DNA, thereby adversely affecting helical stability. This repulsion has been generally considered to be overridden by pro-helix forces that include Watson-Crick hydrogen-bonding, base-stacking hydrophobic interactions and hydrogen-water-bridging (Watson & Crick, 1953; Crothers & Zimm, 1964; for extensive references see Zimm & Kallenbach, 1962; Marmur, Rownd & Schildkraut, 1963; Lewin, 1967*a,b*). Since the phosphate groups are 'neutralized' by their hydrated counter-ions, residual electrostatic repulsions would arise only if the latter were intra-strand sited, whether situated in intra-phosphate or inter-phosphate locations (the latter in accord with Rice & Geiduschek, 1958). However, the hydrated Na^+ ion in the sodium salt of DNA can bridge the two strands when situated inter-strandwise between the respective phosphate groups (Lewin, 1967*a*, 1971).

Stereochemical considerations, based on the construction of several correctly proportioned molecular models of the B-form of the DNA double helix (using Corey-Pauling-Koltun atomic models and Courtauld atomic models) following those of

Wilkins, Stokes & Wilson (1953) and energy considerations lead to the conclusion that the hydrated Na^+ ion bridgings enforce powerful electrostatic attractions. Therefore, non-electrostatic anti-helix forces must exist that are able to override the pro-helix forces under suitable conditions. I have computed that several water displacements can be involved (one of which is concerned with the rupture of water attachments to the amino, imino, ternary nitrogen and carbonyl groups to enable Watson-Crick hydrogen-bonded base-pairing in the formation of the double strand) as well as mechanical strains, one of which occurs along the phosphate-ribose chain, can adversely affect helical stability (Lewin, 1971).

A temperature-rise enforced bulk-water-entropy increase (TS) can offer major anti-helix contributions, one of which is a decreased trend to draw away water molecules from their attachments to the above-listed nucleotide groups, thereby adversely affecting base-pairing. For example, a temperature rise from 10 to 25°C can withhold approximately 1.9 kcal from 1 mol of adenine-thymine and approximately 2.9 kcal from 1 mol of guanine-cytosine base-pairings. Thus the bulk-water-entropy-temperature factor can contribute effectively more to the latter than to the former base-pairings; and this differential contribution may be of paramount importance in ensuring the experimentally noted increased helical stability with increasing guanine-cytosine content of DNA (e.g. Marmur & Doty, 1959).

- Crothers, D. M. & Zimm, B. H. (1964). *J. molec. Biol.* **9**, 1.
 Lewin, S. (1967*a*). *J. theor. Biol.* **17**, 181.
 Lewin, S. (1967*b*). *Studia biophys.* **4**, 29.
 Lewin, S. (1971). *Displacement of Water in Biochemical Reactions*. New York and London: Academic Press (in the Press).
 Marmur, J. & Doty, P. (1959). *Nature, Lond.*, **183**, 1427.
 Marmur, J., Rownd, R. & Schildkraut, C. L. (1963). *Prog. nucleic Acid. Res.* **1**, 231.
 Rice, S. A. & Geiduschek, E. P. (1958). *Discuss. Faraday Soc.* **25**, 215.
 Watson, J. D. & Crick, F. H. C. (1953). *Nature, Lond.*, **171**, 737.
 Wilkins, M. H. F., Stokes, A. R. & Wilson, H. R. (1953). *Nature, Lond.*, **171**, 737.
 Zimm, B. H. & Kallenbach, N. R. (1962). *A. Rev. phys. Chem.* **13**, 171.

Is Synthesis of Glucose 6-Phosphate Dehydrogenase Induced by a Metabolite of Glucose?

By C. D. GREEN, J. SKARDA and J. M. BARRY. (*Department of Agricultural Science, University of Oxford, Oxford OX1 3PF, U.K.*)

Leader & Barry (1969) showed that when mammary tissue from pregnant C3H mice is cultured