amino group. From Fig. 1 it is seen that the intrinsic viscosity plotted against $1/\sqrt{I}$ yielded straight lines; the slopes are given in Table 1. The B-values were obtained as before [1] by graphical extrapolation in a plot of log S against $\log[\eta]_{0.1}$.

The high and similar B-values in Table 1 indicate that all the dextran derivatives are very flexible molecules. This is to be expected because the presence of 95 % or more of α-1,6-linkages [3] in these samples causes contiguous sugar rings to be well separated, and there is therefore most probably a very small effect of the bulkiness of the substituents upon the stiffness of the molecule. The two basic dextran derivatives have considerably lower charge density than the acidic ones. Since the difference between the four B-values is of doubtful significance, it seems, as was the case for polyanions,[1] that the effect of the charge density of the polycation on the B-value is very small. The present results, therefore, strongly suggest that the parameter B may be used as a measure of chain flexibility also for polycations.

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Correction

The title of the article on p. 1855, vol. 25 (1971), should read: Covalent Binding of Proteins to Polysaccharides . . . .

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Ring Inversion in Cyclotrisarcosyl

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Several cyclic oligopeptides of sarcosine have been synthesized recently and their NMR-spectra analyzed.[1] When the temperature of the sample is raised, most of these spectra change, indicating an exchange process whose activation barrier can be determined by a complete line-shape analysis.

For the simplest of these, the cyclic tripeptide, bromoform was chosen as solvent because of the low solubility in other high-boiling solvents and because bromoform permitted the recording of spectra at temperatures up to 145°C. The coalescence point was found to be as high as 145° and since bromoform boils at 150°, only spectra on the low-temperature side of the coalescence point could be recorded. The NMR-spectrum of cyclotrisarcosyl consists at room temperature of five lines, four of which form an AB-quartet centered at $\delta = 4.27$ ppm with $\Delta_{AB} = 1.30$ ppm and $|J| = 15.3$ cps. The fifth line is a singlet positioned at $\delta = 3.10$ ppm. The structure of the spectrum and the integrated areas indicate that the quartet is due to all three methylene groups and that the singlet is due to all three N-methyl resonances. This means that the amide groups are identical and, as Dale and Titlestad [1] pointed out, they must all be *cis* since they cannot all be *trans*. In bromoform solution cyclotrisarcosyl was unstable at elevated temperatures and a decomposition took place. Two new temperature invariant singlets with chemical shifts $\delta = 2.96$ ppm and $\delta = 3.94$ ppm, intensity ratio 3:2, appeared after some time; these correspond to cyclodisarcosyl.[1] The singlet positioned at $\delta = 3.94$ ppm is in the region of the AB-quartet of the trimer, but is very sharp and interferes therefore little with the line-shape analysis. The activation energy $E_a = 17.7$ kcal/mol was computed assuming a transmission coefficient $\varkappa = 1$. The parameters of activation are given in Table 1. In the fitting routines the chemical-shift difference Δ_{AB} between the methylene protons was varied and a decrease in Δ_{AB} with increasing temperature was found. The quality of the spectra does not, however, permit any further conclusions to be

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Table 1. Activation parameters for cyclotrisarcosyl.

T_c (K)	$\Delta G_c^{\ddagger}$ (kcal/mol)	$\Delta H_c^{\ddagger}$ (kcal/mol)	$\Delta S_c^{\ddagger}$ (e.u.)	E_a (kcal/mol)
418.±2.	20.1±0.1	16.9±0.6	−7±2	17.7±0.6

drawn from this shift variation due to unpleasant random errors in the computed Δ_{AB}. The random errors are mainly due to the rapid destruction of the peptide during the recording, causing low-intensity, high-noise spectra.

Ia

Ib

II
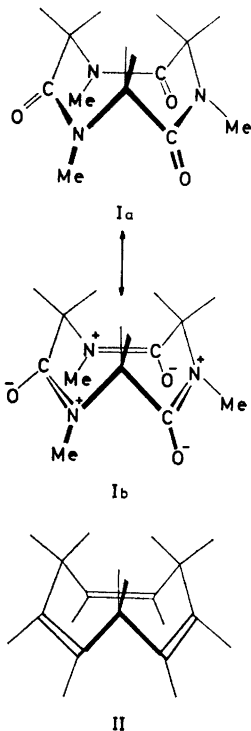
The ring skeleton of the cyclic tripeptide when written with polar resonance structures (Ib) is similar to that of cis,cis,cis-1,4,7-cyclononatriene (II). The activation energy for the crown-to-crown process of this compound has been determined several times by different methods, none of which was a full line-shape analysis, and are found to be much lower than the present tripeptide. Roth [2] found $\Delta G^{\ddagger} = 14.5$ kcal/mol, Radlick and Winstein [3] about 11 kcal/mol, while Untch and Kurland [4] found $E_a = 9.78$ kcal/mol. In six-membered ring systems substitution of carbon with nitrogen increases the inversion barrier; thus Lambert et al. [5] found an energy of activation $E_a = 14.5 \pm 0.5$ kcal/mol in piperidine, considerably higher than the barrier in cyclohexane (10−11 kcal/mol). Cyclotrisarcosyl may also be compared with other nine-membered rings having a saturated carbocyclic ring skeleton. A series of such compounds carrying two gem-dimethyl substituents have inversion barriers in the range 14.8 to 19.2 kcal/mol. [6]

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