from that of *A* in small features of the kind expected of such isomers; but in several spectral regions it was unlike that of *B*, which resembled *X* very closely. This close similarity of *B* with *X*, and the relationship between *A* and *B*, are being examined further.

The spectra suggest that in some of these compounds where there is a long molecular skeleton, some of the main groups such as NH and C:O are affected by hydrogen-bridge formation, which varies according to the particular skeleton.

The main point is that the spectra support the suggestion that the sulphoximine of methionine is an essential part of the toxic factor. Details of this work will be published later elsewhere.

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[1] Bentley, McDermott, Pace, Whitehead and Moran, *Nature*, **163**, 675 (1949); **164**, 438 (1949); **165**, 150, 735 (1950).
[2] Barnard, Fabian and Koch, *J. Chem. Soc.*, 2442 (1949). Schreiber, *Anal. Chem.*, **21**, 1168 (1949).

## Reduction in Lethal Effect of X-Radiation by Pretreatment with Thiourea or Sodium Ethane Dithiophosphonate

Dale *et al.*[1] showed that carboxypolypeptidase could be protected *in vitro* against X-radiation by a variety of substances. One of these, thiourea, is shown below to reduce the mortality following whole-body irradiation of mice. We also tried a few other substances, selected, like thiourea, in the hope that they would enter cells without being too toxic or too rapidly metabolized, and would protect by competing for hydroxyl radicals. The effect of sodium ethane-dithiophosphonate is of added interest because sodium ethane-monothiophosphonate protects weakly against the radiomimetic substance *bis*-chlorethyl sulphide (mustard gas)[2].

The irradiation technique will be described in fuller detail later. Mice of a *CBA* strain were used, irradiated in groups of four in the specially designed aluminium boxes in which they normally lived. The X-irradiation factors were: 240 kV. 15 m.amp. H.V.L. 1·14 mm. copper, tube distance 167·5 cm., dose-rate 7·59 r./min., dose measured inside cages containing bedding, food hopper and water bottle. By irradiating from below and inserting a stepped aluminium filter, a field uniform to within ± 3 per cent was achieved. Four boxes were irradiated at a time. Test substances were administered intraperitoneally in approximately isotonic solution a few minutes before or after irradiation, using saline as a control.

In experiment 1 a single dose of 875 r. was given. In experiment 2 a sublethal dose of 600 r. was given; three months later the injections were repeated and 875 r. was given. The accompanying table shows that the apparent protective effects of thiourea and dithiophosphonate were highly significant ($p \ll 0{\cdot}01$) and of glycerol barely so ($p = 0{\cdot}08$). It is also clear that thiourea given immediately after the irradiation was ineffective and that saline was not deleterious.

The *CBA* strain used responds very uniformly to radiation and, as judged by the slope of the dose-mortality curve in uninjected controls, the reduction in mortality in experiment 1 is equivalent to a reduction of only 10–15 per cent in the efficiency of the radiation, although the test substances were used in amounts not far from the maximum tolerated. In some circumstances radiation seemed to potentiate the toxic effects of thiourea.

A protective effect has been reported for cysteine[4], for glutathione[5] and for cyanide[6]; but the equivalent reduction in radiation efficiency was not stated.

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[1] Dale, W. M., Davies, J. V., and Meredith, W. J., *Brit. J. Cancer*, **3**, 31 (1949).
[2] Holiday, E. R., Philpot, J. St. L., and Stocken, E. L. (in preparation).
[3] Fisher, R. A., "Statistical Methods for Research Workers", p. 96 (10th edit., Oliver and Boyd).
[4] Patt, H. M., Tyree, E. B., Straube, R. L., and Smith, D. E., *Science*, **110**, 213 (1949).
[5] Chapman, W. H., Sipe, C. R., Eltzholtz, L. C., Cronkite, E. P., and Chambers, F. W., jun., Naval Medical Research Institute, National Naval Medical Centre, Bethesda, Ma., Project *NM* 006 012.08.25.
[6] Bacq, Z. M., Herve, A., Lecomte, J., and Fischer, P., *Science*, **111** 356 (1950).

## Metabolism of Acetate and Propionate in the Ruminant

The volatile acids, acetic, propionic and butyric, which are formed by bacterial fermentation in the paunch of ruminants, assume an important role in the metabolism of these animals. In view of the relatively large amounts of acetate and propionate absorbed, the subsequent metabolic routes of these compounds are of considerable interest, not only from the aspect of the intermediary metabolism of each

| Experiment | Age of mice at beginning of experiment | Sex | Material injected intraperitoneally | No. of mice | No. dying within 30 days | Mean number of days to death | Survival per cent | *p* for difference in mortality from group given saline* |
|---|---|---|---|---|---|---|---|---|
| 1 | 9 weeks | Male only | 2 ml. 0·15*M* saline before | 20 | 18 | 11·8 | 10 | — |
| | | | 2 ml. 0·28*M* thiourea before | 16 | 8 | 14·3 | 50 | 0·01 |
| | | | 2 ml. 0·28*M* thiourea after | 12 | 12 | 11·0 | 0 | — |
| | | | No injection | 12 | 12 | 11·3 | 0 | — |
| 2 | 14 weeks | Male and female in equal numbers | 2–3 ml. 0·15*M* saline | 6 | 6 | 11 | 0 | — |
| | | | 2 ml. 0·28*M* thiourea | 8 | 1 | 26 | 88 | 0·002 |
| | | | 3 ml. 0·1*M* sodium ethanedithiophosphonate | 7 | 1 | 13 | 86 | 0·004 |
| | | | 2 ml. 0·28*M* glycerol | 8 | 4 | 11½ | 50 | 0·08 |
| | | | 2 ml. 0·1*M* sodium thiosulphate | 8 | 5 | 13 | 38 | 0·15 |
| | | | 3 ml. 0·1*M* sodium dithionate | 8 | 8 | 14 | 0 | — |

* *p* was calculated by the exact method for 2 × 2 contingency tables (ref. 3).