Lamb, M. J., T. W. McSheehy and C. E. Purdom. M.R.C. Radiobiological Research Unit, Harwell, England. Mutagenic effect of 600 MeV proton irradiation.

Differences in the mutagenic efficiency of radiations of different types and energies have been reported by several authors. These differences have been attributed to differences in the Linear Energy Transfer of the radiations. The present experiments, comparing proton irradiations with X-irradiation (250kVp, 15mA, HVL 1.2mmCu.) are part of a programme to investigate the relative effectiveness of different parts of the proton beam which have different LET values.

Oregon-K male flies 32 ± 3 hours old were exposed to 600 rads of protons or X-rays at dose rates of 150 rad/min and 540 rad/min respectively. Males were mated individually to 2 Cy/BIL females every three days, and the frequency of IInd chromosome recessive lethal mutations was scored among the offspring from 6 successive broods. The results are shown in Table 1. A very pronounced difference between the percentage of mutations induced by protons and X-rays was found in brood IV ($\chi^2 = 9.28$ $p = 0.0022$) but otherwise no significant differences were observed. This may be explained either on the assumption that the irradiated germ cell stages contributing to sperm used in brood IV were much more sensitive to proton than to X-irradiation, or that the mutagenic efficiency of protons was slightly greater than that of X-rays and a slight shift, or sampling error, during the brood sequence concentrated the effect into a single brood.

The second explanation seemed to be more plausible but the results of later experiments suggest that there is no difference between these radiations. In these further experiments 250kVp X-rays (800 rad) were compared with 600 MeV protons (800 rad) and with attenuated protons in the Bragg peak (400 rad). The results are shown in Table 2. In only one brood was there any significant deviation from an RBE value of 1 relative to X-rays. This was brood II of the 600 MeV proton series which was significantly low at the 5% level. Overall analysis, however, showed no deviation from one and there was no indication, therefore, that the increase in frequency of nuclear interaction in the Bragg peak region was accompanied by any increase in genetic effectiveness. (Acknowledgement: We are very grateful to Dr. J. Baarli of CERN for arranging the proton irradiation and advising on the problems of proton dosimetry.)

Table 1

Brood	600 MeV Protons			250 kVp X-rays			χ^2	P
	No. of tests	No. of lethals	%	No. of tests	No. of lethals	%		
I	1288	28	2.17 ± 0.41	800	24	3.00 ± 0.60	1.07	0.30
II	1411	57	4.04 ± 0.52	776	26	3.35 ± 0.65	0.48	0.50
III	1325	82	6.19 ± 0.66	795	51	6.42 ± 0.87	0.013	0.91
IV	1160	97	8.36 ± 0.81	737	34	4.61 ± 0.77	9.28	0.0022
V	1369	41	2.99 ± 0.46	764	28	3.66 ± 0.68	0.51	0.48
VI	1381	27	1.96 ± 0.37	792	11	1.39 ± 0.42	0.64	0.42

Table 2

	Brood	I	II	III	IV	V	VI
Proton Beam							
800 rad	Tests	1246	1176	1119	1077	1050	1292
	Lethals	56	47	107	64	14	15
	%	4.49	4.00	9.58	5.94	1.33	1.16
	RBE	0.95	0.70	0.92	1.28	0.82	1.31
Bragg Peak							
400 rad	Tests	1269	1226	1183	1080	1053	1288
	Lethals	28	42	58	31	8	13
	%	2.21	3.43	4.90	2.87	0.76	1.01
	RBE	0.94	1.23	0.85	1.26	0.87	2.30
X-rays							
800 rad	Tests	1287	1248	1072	1009	1102	1348
	Lethals	61	71	112	46	18	12
	%	4.74	5.69	10.45	4.56	1.63	0.89