tripeptides in which it was observed that the peptide absorption depends not only on the constituent amino acids but also on the order of arrangement. The variations, however, always remain within the order of magnitude of the values given above. It is concluded from these findings, as well as from studies on other proteins, that peptide bonds show a band with a maximum near 185 mμ and that data collected at 205 mμ mirror this band. The details of this study will be reported elsewhere.

References

1. LEY, H., and ARENDS, B. *Z. physik. Chem.*, **B17**, 177 (1932).
2. RUSOFF, I. I., PLATT, J. R., and BURR, G. O. *J. Am. Chem. Soc.*, **67**, 673 (1945).
3. BRAND, E. *Ann. N. Y. Acad. Sci.*, **47**, 187 (1946).
4. SAIDEL, L. J., and GOLDFARB, A. R. *Federation Proc.*, **10**, 241 (1951).

The Value of Small Lead Shields against the Injurious Effect of Total-Body Irradiation[1]

J. Gershon-Cohen, M. B. Hermel, and J. Q. Griffith, Jr.

Jewish Hospital, Philadelphia, Pennsylvania

Irradiation through small portals has long been recognized by radiologists to suppress hemopoiesis only slightly. Jacobson *et al.* (*1*), by a reverse approach, recently have shown that the lethal effects of total irradiation can be reduced by shielding the spleen alone. This report concerns the protection from lethal effects of whole-body irradiation afforded by lead shielding of other small body segments.

TABLE 1

SURVIVAL RATES

	Irradiation	No. rats	No. survivals	Percentage
Group I	None	20	20	100
Group II	Whole body	20	8	40
Group III	Liver shielded	12	10	83
Group IV	Right lung shielded	9	7	78
Group V	Right lower abdomen shielded	9	6	67

TABLE 3

HEMOGLOBIN (g/100 ml)

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group I	Controls	14.3	14.0	14.4	13.9	14.0	14.4	14.7
Group II	None	14.7	14.2	13.8	13.5	11.7	12.8	14.4
Group III	Liver	13.9	14.3	13.9	13.7	12.4	12.5	14.0
Group IV	Right lung	13.7	13.9	14.5	14.1	13.3	13.1	13.2
Group V	Right lower abdomen	14.0	14.1	14.4	14.5	13.2	14.0	14.2

Young white rats weighing approximately 200 g were divided into five groups. Group I comprised 20 rats receiving no treatment. Group II comprised 20 rats which received 600 r total-body irradiation. In Group III were 12 rats exposed to 600 r total-body irradiation except over the liver, which was shielded by a lead plate ⅛ in. thick, measuring approximately 2.5 × 4.0 cm, put in place by fluoroscopic control. In Group IV were 9 rats treated like those in Group III except that the rectangular lead shield was placed over the right lung. In Group V were 9 rats, also treated like those in Group III except that the lead shield was placed over the right lower abdomen.

The rats were confined to close-fitting compartments in a wooden frame without anesthesia during irradiation. The x-ray factors were 200 kv; 25 ma; 50-cm distance; 0.5 mm Cu and 1.0 mm Al filter; HVL equivalent to 1.1 mm of Cu.

The survival time, the weights, and blood counts of all animals were recorded daily for the first 3 days, then every tenth day thereafter until the end of 30 days.

All the untreated animals in Group I survived, gained weight normally, and showed no disturbance in their blood counts.

The survival rates of all the partially shielded rats were higher than those exposed to whole-body irradiation. Of 20 rats in Group II which received whole-body irradiation, 8 survived. There were 10 survivals of the 12 rats protected over the liver in Group III, 7 survivals of 9 rats protected over the right lung in Group IV, and 6 survivals of 9 rats protected over the right lower abdomen in Group V. These results

TABLE 2

WEIGHTS (IN GRAMS)

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group I	Controls	197	196	197	196	203	208	204
Group II	No shield	214	212	203	197	194	198	215
Group III	Liver	204	203	202	200	208	206	206
Group IV	Right lung	200	199	199	198	197	203	198
Group V	Right lower abdomen	195	195	194	195	194	189	195

[1] This investigation was supported by a grant from the Louis Sitnek Fund of the Eagleville Sanatorium, Eagleville, Pa.

TABLE 4

AVERAGE RED BLOOD CELL COUNTS (000 Omitted)

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group II	None	8,483	8,480	7,680	8,220	7,050	7,800	8,700
Group III	Liver	8,920	8,800	8,550	8,850	7,400	7,400	8,500
Group IV	Right lung	8,100	8,850	8,650	8,600	8,000	7,600	8,450
Group V	Right lower abdomen	8,714	8,714	9,150	8,750	8,100	8,500	8,500

TABLE 5

AVERAGE WHITE BLOOD CELL COUNTS

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group II	None	7,200	3,700	1,900	1,800	1,950	5,500	7,000
Group III	Liver	7,400	2,450	1,200	1,500	1,900	7,350	8,300
Group IV	Right lung	7,550	2,600	1,400	2,050	2,100	5,100	7,800
Group V	Right lower abdomen	7,150	1,950	1,100	1,450	2,050	6,500	5,700

would suggest that lead shielding of small areas of the body of rats increased the survival time appreciably above that resulting from total-body irradiation with no protection.

Although those shielded over the liver had slightly higher survival rates than those shielded over the right lung or right lower quadrant of the abdomen, the difference in survival rates between the partially shielded groups was not significant (Table 1). There was a slight loss of weight in all treated animals during the first week, but this weight loss was slightly more transient and less marked in the partially protected animals (Table 2).

Whole-body irradiation did not influence hemoglobin levels or red blood cell counts differently from the partially shielded animals. All groups showed a transient small drop in hemoglobin levels and red blood cell counts during the second and third weeks after exposure (Tables 3 and 4).

The white blood cell counts were depressed quickly within 24 hr in all irradiated animals and the counts were lowest during the first 2 weeks after exposure. Thereafter, a gradual improvement occurred, somewhat more rapidly in the partially shielded animals (Table 5). At the end of 4 weeks, the counts were normal again in all groups. The counts in Group V were slightly below normal, but not sufficient to be significant.

The polynuclear counts rose rapidly during the first 3 days in all irradiated animals, but by the tenth day a reversal was noted, when the counts were almost 50% below normal. Thereafter these counts rose to normal levels within 20–30 days, with not much difference among any groups (Table 6).

The lymphocyte counts were depressed rapidly during the first 3 days in all groups, and then this trend was reversed to slightly elevated positions by the tenth day. Thereafter, these counts slowly returned to normal levels (Table 7).

The lead shields used in the experiments covered approximately 15% of the body surface exposed to

TABLE 6

AVERAGE PERCENTAGES OF POLYNUCLEAR CELLS

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group II	None	40	75	74	66	32	15	42
Group III	Liver	44	62	66	80	23	29	40
Group IV	Right lung	47	63	76	68	26	45	30
Group V	Right lower abdomen	51	62	47	78	24	43	28

TABLE 7

AVERAGE PERCENTAGES OF LYMPHOCYTES

	Area shielded	Before treatment	24 hr	48 hr	72 hr	10 days	20 days	30 days
Group II	None	56	20	22	31	65	82	55
Group III	Liver	52	35	28	12	72	67	57
Group IV	Right lung	44	34	20	29	71	50	66
Group V	Right lower abdomen	42	34	48	18	68	49	68

irradiation, and shielded not only organs such as the liver, lung, and intestines, but also the surrounding bony structures, including portions of the spine. The results would indicate that lead shielding of small areas offers some protection against whole-body irradiation without much difference as to the location of the shielded areas. This suggests that it was the protection to the hemopoietic system rather than to organs such as the liver, intestines, or lung that resulted in the increased survival rate. It would seem also from these findings, that the liver, cecum, and lung do not have the same capacity as reported for the spleen (*1*) in sparing the rat from the lethal effects of irradiation.

Reference

1. JACOBSON, L. D., *et al. J. Lab. Clin. Med.*, **35**, 746 (1950).