that small differential absorptions in regions of high extinctions were real. Typically, spectra were recorded at a scan rate of 3 nm/min and cells of 0.1- and 0.5-mm path lengths were utilized as required.

Warfarin [3-(1-Phenyl-3-oxobutyl)-4-hydroxycoumarin (1)]. Sodium warfarin, U.S.P., was converted to warfarin by acidification with HCl and resolved by the method of West et al.[10] (*S*)-(−)-1: $[\alpha]^{25}_D$ −149.5 (1.0)° (c 1.1, 0.5 N NaOH); CD (×10^{-3}) (0.98 mg/mL of MeOH) $[\theta]_{325}$ 0, $[\theta]_{300}$ −4.4, $[\theta]_{287}$ 0, $[\theta]_{268}$ +21.4, $[\theta]_{236}$ +8.8, $[\theta]_{234}$ 0, $[\theta]_{219}$ −113, $[\theta]_{216}$ 0. (*R*)-(+)-1: $[\alpha]^{25}_D$ +145.9 (1.0)° (c 1.2, 0.5 N NaOH); CD (×10^{-3}) (1.24 mg/mL of MeOH) $[\theta]_{325}$ 0, $[\theta]_{304}$ +6.4, $[\theta]_{287}$ 0, $[\theta]_{263}$ −23.3, $[\theta]_{245,237}$ −9.4, $[\theta]_{235}$ 0, $[\theta]_{219}$ +129, $[\theta]_{212}$ 0.

Phenprocoumon [3-(1-Phenylpropyl)-4-hydroxycoumarin (2)]. Marcumar, U.S.P., was resolved by the method of West et al.[12] (*S*)-(−)-**2**: $[\alpha]^{25}_D$ −120.0 (1.0)° (c 1.5, 95% EtOH); CD (×10^{-3}) (1.32 mg/mL of MeOH) $[\theta]_{335}$ 0, $[\theta]_{308}$ +9.8, $[\theta]_{290}$ 0, $[\theta]_{270}$ −14.8, $[\theta]_{255}$ −8.5, $[\theta]_{240}$ −10.6, $[\theta]_{236}$ 0, $[\theta]_{227}$ +15.9, $[\theta]_{219}$ 0. (*R*)-(+)-**2**: $[\alpha]^{25}_D$ +122.1 (0.6)° (c 1.5, 95% EtOH); CD (×10^{-3}) (1.18 mg/mL of MeOH) $[\theta]_{335}$ 0, $[\theta]_{308}$ −9.0, $[\theta]_{288}$ 0, $[\theta]_{267}$ +12.4, $[\theta]_{248}$ +4.8, $[\theta]_{240}$ +5.7, $[\theta]_{236}$ 0, $[\theta]_{226}$ −15.2, $[\theta]_{220}$ 0.

(+)- and (−)-3-(1-Phenyl-3-oxobutyl)-4-methoxycoumarin (3). To enantiomerically pure warfarin (1), 100 mg in 30 mL of anhydrous ether, was added an excess of ethereal CH_2N_2; the product on evaporation of the excess CH_2N_2 and ether was an oil. (−)-**3** from (−)-1:[5,10] $[\alpha]^{25}_D$ −9.1 (2.0)° (c 1.8, MeOH); CD (×10^{-3}) (3.76 mg/mL of MeOH) $[\theta]_{348}$ 0, $[\theta]_{315}$ +11.1, $[\theta]_{292}$ 0, $[\theta]_{277}$ −9.4, $[\theta]_{258}$ −2.1, $[\theta]_{243}$ −4.3, $[\theta]_{239}$ 0, $[\theta]_{221}$ +13.7, $[\theta]_{218}$ 0. (+)-**3** from (+)-1: $[\alpha]^{25}_D$ +14.2 (2.0)° (c 1.5, MeOH); CD (×10^{-3}) (1.01 mg/mL of MeOH) $[\theta]_{345}$ 0, $[\theta]_{315}$ −8.3, $[\theta]_{292}$ 0, $[\theta]_{276}$ +8.6, $[\theta]_{252}$ +3.0, $[\theta]_{243}$ +4.0, $[\theta]_{239}$ 0, $[\theta]_{222}$ −11.4, $[\theta]_{217}$ 0.

(−)-3-(1-Phenylbutyl)-4-hydroxycoumarin (4). Starting from (*S*)-(−)-1, this compound was prepared by conversion of 1 to the dithioketal and then reduced with Raney Nickel:[10] a white crystalline solid; mp 132.5–133.5 °C; $[\alpha]^{25}_D$ −105 (3)° (c 1.1, 95% EtOH); CD (×10^{-3}) (0.98 mg/mL of MeOH) $[\theta]_{337}$ 0, $[\theta]_{312}$ +8.5, $[\theta]_{292}$ 0, $[\theta]_{275}$ −13.8, $[\theta]_{252}$ −5.9, $[\theta]_{244}$ −9.2, $[\theta]_{238}$ 0, $[\theta]_{230}$ +10.5, $[\theta]_{224}$ 0.

(*SS*)-(+)-, (*SR*)-(−)-, and (*RR*)-(−)-2(3*H*)-2-Methyl-2-methoxy-4-phenyl-5-oxobenzopyrano[3,4-*b*]dihydropyran (5). These compounds were prepared as described previously[16] beginning with enantiomerically pure 1 and were obtained as colorless crystalline solids. (*SS*)-(+)-**5** from (−)-1: mp 178.6–180.0 °C; $[\alpha]^{25}_D$ +33.1 (0.6)° (c 1.9, $CHCl_3$); CD (×10^{-3}) (1.1 mg/mL of MeOH) $[\theta]_{330}$ 0, $[\theta]_{306}$ −8.2, $[\theta]_{288}$ 0, $[\theta]_{268}$ +20.5, $[\theta]_{242}$ +6.7, $[\theta]_{238}$ +7.3, $[\theta]_{236}$ 0, $[\theta]_{218}$ −119, $[\theta]_{216}$ 0. (*SR*)-(−)-**5** from (−)-1: $[\alpha]^{25}_D$ −30.0 (0.8)° (c 0.9, $CHCl_3$); CD (×10^{-3}) (1.38 mg/mL of MeOH) $[\theta]_{325}$ 0, $[\theta]_{305}$ −5.6, $[\theta]_{284}$ 0, $[\theta]_{268}$ +14.5, $[\theta]_{245}$ +6.5, $[\theta]_{237}$ +8.4, $[\theta]_{233}$ 0, $[\theta]_{218}$ −84, $[\theta]_{211}$ 0. (*RR*)-(−)-**5** from (+)-1: $[\alpha]^{25}_D$ −30.7 (1.2)° (c 2.1, $CHCl_3$); CD (×10^{-3}) (10.6 mg/mL of MeOH) $[\theta]_{330}$ 0, $[\theta]_{306}$ +10.3, $[\theta]_{282}$ 0, $[\theta]_{268}$ −22.5, $[\theta]_{248}$ −8.6, $[\theta]_{238}$ −9.7, $[\theta]_{235}$ 0, $[\theta]_{219}$ +122, $[\theta]_{212}$ 0.

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Phosphorus–Nitrogen Compounds. 21. Murine Oncolytic and Antifertility Effect of Adamantylaziridine Compounds[1]

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P,P-Bis(1-aziridinyl)-*N*-adamantylphosphinic amide and *N,N'*-bis(ethylene)-*P*-(1-adamantyl)phosphonic diamide were synthesized as potential anticancer and male antifertility agents. Log *P* values (octanol–water) of the agents were determined and compared to calculated values. Both derivatives displayed intraperitoneal murine antileukemic activity and antifertility effects when given intraperitoneally and orally.

The high antileukemic activity of *P,P*-bis(1-aziridinyl)-*N*-adamantylphosphinic amide (**1**),[2,3] prompted the synthesis and bioevaluation of an analogue, *N,N'*-bis(ethylene)-*P*-(1-adamantyl)phosphonic diamide (**2**). These derivatives can be considered as belonging to the ethylenimine class of anticancer and male antifertility agents. Similar compounds previously investigated for the latter effect are ineffective antispermatogenics when given orally. This paper describes the synthesis and antileukemic activity of **2** and the effect of **1** and **2**, given intraperitoneally and orally, on male fertility in the mouse.

A comparison study of **1** and **2** was considered of interest since the carbon–phosphorus bond is stronger than an amide linkage and **2** might be resistant to in vivo loss of the adamantyl moiety. In addition, **2** has higher water solubility (0.94% vs. 0.13% for **1**) and an experimentally

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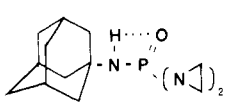
Table I. Effects on Fertility in the Male Mouse

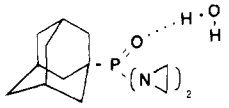
Compd	Dose,[a] mg/kg	Mating periods[b] 1 Nonpreg[c] total	1 Viable[d] total	2 Nonpreg[c] total	2 Viable[d] total	3 Nonpreg[c] total	3 Viable[d] total	4 Nonpreg[c] total	4 Viable[d] total	5 Nonpreg[c] total	5 Viable[d] total
1	Control[e]	3/5	26/27	0/5	61/65	0/5	37/45	1/4	16/29		
	10 ip	4/5	0/1	4/5	0/2	4/4	0/0				
	10 po	4/6	10/13	1/6	25/31	1/6	56/57	1/6	54/54		
2	Control[e]	5/6	12/13	1/6	52/53	1/6	49/51	0/6	71/73	3/6	32/32
	10 ip	3/5	10/17	2/5	13/21	1/5	46/47	2/5	32/33	2/5	31/31
	15 ip	6/6	0/0	2/6	9/29	2/4	23/24	1/6	50/51	2/6	37/37
	22.5 ip	6/6	0/0	5/6	0/9	5/6	0/1	4/6	24/25	0/6	50/51
	33.8 ip	6/6	0/0	6/6	0/0	6/6	0/0	6/6	0/0	6/6	0/0
2	Control[e]	0/6	64/64	1/6	55/55	0/6	56/56	0/6	53/53	1/6	63/66
	10 ip	0/6	60/60	0/6	62/63	2/6	40/40	0/6	78/78	1/5	59/63
	15 po	0/6	48/52	1/5	35/38	1/5	49/50	1/4	30/31	0/6	68/71
	22.5 po	2/6	22/29	1/6	25/34	0/6	61/62	1/6	60/62	0/6	58/61
	33.8 po	0/6	21/39	2/5	19/25	3/6	26/26	2/6	39/49	0/5	55/60

[a] Drugs administered once daily for 5 days to mature male mice (proven breeders). [b] One female mouse (proven breeder) was placed with each male mouse for 7 days. Mating period 1 began 1 week after initiation of the dosage regimen; mating period 2 began 2 weeks after initiation of the dosage regimen, etc. [c] Number of nonpregnant females/total number of females. [d] Number of viable conceptus/total number of conceptus.

determined lower log P value (octanol–water). Calculated log P values[4] for 1 and 2 are +3.08[5] and +3.59,[6] respectively, while experimentally determined log P values are +1.45 (1) and +0.88 (2). This discrepancy may be due to the nature of the P=O bond which is semipolar, instead of double bond, in character[7] and gives rise to strong intramolecular hydrogen bonding in the case of 1 and a high order of intermolecular hydrogen bonding with solvent molecules by 2. On the basis of this one observation the log P value (octanol–water) for phosphoramide intramolecular hydrogen bonding is +1.73 compared to +0.65 for such bonding by other moieties.[4]



1



2

The daily intraperitoneal administration of 1 for 9 days to mice bearing ip L1210 ascites cells resulted in a % T/C value[8] of 244 at 10 mg/kg while 2 proved to be less potent, producing a % T/C value of 243 under equivalent conditions at 50 mg/kg. Greater toxicity was noted with 1 causing deaths at 20 mg/kg while 200 mg/kg of 2 was required to produce fatalities.

When 1 was administered intraperitoneally a pronounced antifertility effect was seen throughout the 3-week test period (Table I). Only two pregnancies occurred in the 14 female mice utilized; the two females designated as "pregnant" contained a total of three conceptus, none viable. Oral administration of 1 did not appreciably reduce the incidence of pregnancy but significantly reduced the litter size during the first 2 weeks after treatment (Table II). After this time recovery apparently occurred.

Compound 2 was studied in a similar manner for a longer period of time using a wider range of doses. Intraperitoneal administration caused complete sterility over the entire testing period in the highest dose group (33.8 mg/kg). Reductions in the number of pregnancies, total number of conceptus per pregnancy, and number of viable conceptus per pregnancy were seen during the first 2–3 weeks of the test period, followed by recovery of fertility. The same compound administered orally resulted in a statistically significant (though less dramatic) reduction in conceptus per pregnancy during the first 2 weeks of the test period in the higher dose groups, followed by recovery. These results are similar to those reported by Jackson[9] for five aziridine agents and suggest that the effect of 1 and 2 during this period of observation is on spermatids and epididymal spermatozoa.

Considering the effects of compound 2 over the entire 5-week test period, the only pronounced effect is a mutagenic one, reflected in a dose-related reduction of viable conceptus in both the oral and intraperitoneal study.

A high order of antifertility and antileukemic activity was found with 1 when administered intraperitoneally. This latter effect may be related to its log P value more closely approximating the log P_0 for penetration to the central nervous system.[10] Compound 2 displayed a good oral antifertility effect relative to other compounds of similar chemical nature previously investigated for this activity.

Experimental Section

Melting points were taken on a Thomas-Hoover apparatus and are uncorrected. Elemental analyses were performed by Atlantic Microlab Inc., Atlanta, Ga., and are within ±0.4% of theoretical values. The NMR spectrum determined using a Varian EM360 spectrometer was consistent with the assigned structure.

***N,N'*-Bis(ethylene)-*P*-(1-adamantyl)phosphonic Diamide (2).** Adamantylphosphonic dichloride (3) was prepared from 1-bromoadamantane, aluminum bromide, and phosphorus trichloride according to the procedure of Stetter and Last.[11] A mixture of aziridine (5.2 g, 0.12 mol) and 3 (4.0 g, 0.016 mol) in anhydrous Et_2O (150 mL) was refluxed for 23 h. The aziridine hydrochloride was removed by filtration and concentration of the filtrate gave white crystalline 2 (3.6 g, 85.7%), mp 140–142 °C. Anal. ($C_{14}H_{23}N_2OP$) C, H, N.

The partitioning method used for log P value determinations was similar to that described by Purcell et al.[12] Since neither 1 nor 2 absorbs ultraviolet light, their concentrations were determined gravimetrically. Compounds 1 and 2 (0.5 g) were shaken at 24 °C for 18 h in separate 250-mL Erlenmeyer flasks containing 50.0 mL of 1-octanol and H_2O each. The layers were isolated by means of a separatory funnel, filtrated into a tared round-bottom flask, and spin evaporated to remove the solvents. The octanol was removed using an azeotropic mixture of the 1-octanol and H_2O, which boils at 99.4 °C as a 10:90 mixture,[13] before transferring to a tared 100-mL round-bottom flask for final evaporation. The flasks were dried in a 70 °C oven, cooled, and weighed. The solubilities of 1 and 2 in H_2O were similarly determined by shaking saturated solutions at 24 °C for 23 h. The melting points of residues from all determinations were found to be identical with authentic samples of compounds 1 and 2.

Antileukemic bioevaluations were performed by the contractors

Table II. Effects on Litter Size and Viability of Conceptus

Compd	Dose,[a] mg/kg	Mating periods[b] 1 Total[c]	1 Viable[d]	2 Total[c]	2 Viable[d]	3 Total[c]	3 Viable[d]	4 Total[c]	4 Viable[d]	5 Total[c]	5 Viable[d]	Total Total[c]	Total Viable[d]
1	Control[e]	13.5 ± 1.5 (2)	13.0 ± 1.0 (2)	12.8 ± 0.4 (5)	12.2 ± 0.9 (5)	9.0 ± 2.3 (5)	7.4 ± 3.1 (5)	9.7 ± 0.9 (3)	5.3 ± 2.9 (3)			11.1 ± 0.9 (15)	9.3 ± 1.4 (15)
	10 ip	1.0 (1)	0.0 (1)	2.0 (1)	0.0 (1)	(0)	(0)					1.5 ± 0.5* (2)[f]	0.0 ± 0.0* (2)
	10 po	6.5 ± 0.5* (2)	5.0 ± 1.0* (2)	6.2 ± 1.8* (5)	5.0 ± 1.8* (5)	11.4 ± 0.7 (5)	11.2 ± 0.9 (5)	10.8 ± 0.7 (5)	10.8 ± 0.7* (5)			9.1 ± 0.8 (17)	8.5 ± 0.9 (17)
2	Control[e]	13.0 (1)	12.0 (1)	10.6 ± 1.9 (5)	10.4 ± 1.9 (5)	10.2 ± 1.2 (5)	9.8 ± 1.4 (5)	12.2 ± 1.0 (6)	11.8 ± 0.9 (6)	10.7 ± 0.7 (3)	10.7 ± 0.7 (3)	11.1 ± 0.6 (20)	10.8 ± 0.6 (20)
	10 ip	8.5 ± 2.2 (2)	5.0 ± 1.4 (2)	7.0 ± 1.5 (3)	4.3 ± 1.2 (3)	11.8 ± 0.5 (4)	11.5 ± 0.5 (4)	11.0 ± 1.5 (3)	10.7 ± 1.2 (3)	10.3 ± 0.9 (3)	10.3 ± 0.9 (3)	9.9 ± 0.6 (15)	8.8 ± 0.9 (15)
	15 ip	(0)	(0)	7.3 ± 0.8 (4)	2.3 ± 0.3 (4)	12.0 ± 1.0 (2)	11.5 ± 0.5 (2)	10.2 ± 0.6 (5)	10.0 ± 0.7 (5)	9.3 ± 2.4 (4)	9.3 ± 2.4 (4)	9.4 ± 0.8 (15)	7.9 ± 1.1* (15)
	22.5 ip	(0)	(0)	9.0 (1)	0.0 (1)	1.0 (1)	0.0 (1)	12.5 ± 0.5 (2)	12.0 ± 0.0 (2)	8.5 ± 1.4 (6)	8.3 ± 1.4 (6)	8.6 ± 1.3 (10)	7.4 ± 1.5* (10)
	33.8 ip	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
2	Control[e]	10.7 ± 1.7 (6)	10.7 ± 1.7 (6)	11.0 ± 0.6 (5)	11.0 ± 0.6 (5)	9.3 ± 0.7 (6)	9.3 ± 0.7 (6)	8.8 ± 1.3 (6)	8.8 ± 1.3 (6)	13.4 ± 0.7 (5)	12.6 ± 0.5 (5)	10.5 ± 0.5 (28)	10.4 ± 0.5 (28)
	10 po	10.0 ± 0.5 (6)	10.0 ± 0.5 (6)	10.5 ± 1.0 (6)	10.3 ± 1.1 (6)	10.0 ± 1.3 (4)	10.0 ± 1.3 (4)	13.0 ± 1.3* (6)	13.0 ± 1.3* (6)	12.6 ± 0.9 (5)	11.8 ± 1.0 (5)	11.3 ± 0.5 (27)	11.1 ± 0.5 (27)
	15 po	8.7 ± 1.4 (6)	8.0 ± 1.6 (6)	7.8 ± 1.1* (5)	7.0 ± 1.3* (5)	10.0 ± 0.6 (5)	9.8 ± 0.4 (5)	10.3 ± 0.7 (3)	10.0 ± 0.6 (2)	11.8 ± 1.1 (6)	11.3 ± 1.2 (6)	9.7 ± 0.5 (25)	9.2 ± 0.6 (25)
	22.5 po	7.3 ± 1.0 (4)	5.5 ± 1.3* (4)	6.8 ± 0.7* (5)	5.0 ± 0.3* (5)	10.3 ± 0.8 (6)	10.1 ± 0.9 (6)	12.4 ± 0.9 (5)	12.0 ± 0.9 (5)	10.2 ± 0.5 (6)	9.7 ± 0.8 (6)	9.5 ± 0.5 (26)	8.7 ± 0.6* (26)
	33.8 po	6.5 ± 0.8* (6)	3.5 ± 0.7* (6)	8.3 ± 0.9* (3)	6.3 ± 0.7* (3)	8.7 ± 1.8 (3)	8.7 ± 1.8 (3)	12.3 ± 1.4 (4)	9.8 ± 1.2 (4)	12.0 ± 0.1 (5)	11.0 ± 1.3 (5)	9.5 ± 0.7 (21)	7.6 ± 0.7* (21)

[a] Drugs administered once daily for 5 days to mature male mice (proven breeders). [b] One female mouse (proven breeder) was placed with each male mouse for 7 days. Mating period 1 began 1 week after initiation of the dosage regimen; mating period 2 began 2 weeks after initiation of the dosage regimen, etc. [c] Total conceptus per pregnancy, including live fetuses, dead fetuses, and resorption sites (mean ± standard error; number in parentheses represents number of pregnant females in that group). [d] Viable conceptus per pregnancy, including only live fetuses (mean ± standard error; number in parentheses represents number of pregnant females in that group). [e] Vehicle, 1% sodium carboxymethycellulose. [f] An asterisk indicates p vs. control < 0.05 (comparisons made using Student's t test only for groups containing at least two pregnant females).

of the National Cancer Institute according to the methods of Geran et al.[14]

The antifertility testing involved a serial-mating procedure similar to that employed by Jackson.[9] Groups of four to six male Swiss albino mice were administered **2**, both ip and orally by gavage, for five consecutive days at doses of 10, 15, 22.5, and 33.8 mg/kg. After a recovery period of 2 days, each male was placed with a female for 1 week. Females were removed and new ones placed with each male at weekly intervals for 5 weeks. Females were sacrificed 19 days after first being placed with the male and determined, via laparotomy, to be nonpregnant or pregnant with live, resorbed, or dead fetuses. Compound 1 was similarly tested at 10 mg/kg, ip and po, for 3 weeks.

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Book Reviews

Monoamine Oxidase and Its Inhibition. Ciba Foundation Symposium 39. Edited by G. E. W. Wolstenholme and J. Knight. Elsevier-Excerpta Medica-North Holland, Amsterdam, and American Elsevier, New York, N.Y. 1976. 24.6 × 17.5 cm. xii + 415 pp. $29.25.

Monoamine oxidase (MAO) was first described by Mary L. C. Bernheim in 1928 (then Mary Hare of the University of Cambridge), now a youthful heptagenarian at Duke University, to whom this symposium volume is dedicated. MAO has had an exciting and useful history and has remained on center stage of biochemical, therapeutic, and psychiatric studies. For almost 4 decades it was regarded as an entity, but with the refinement of analytical, separation, and behavioral techniques its homogeneity in different organs and species was put to the question. Forty years after its discovery, J. P. Johnston found that MAO existed in two forms, A and B, with different substrate specificities and different rates of inhibition by such newer selective inhibitors as clorgyline and deprenyl. It is not at all clear, however, whether these two forms are not artifacts arising from procedures to wrench the enzyme from subcellular structures with chaotropic reagents during its solubilization. Indeed, a gradual separation of enzyme activity from "environmental" lipids may give rise, conceivably, to the baring of two unlike catalytic sites or conformationally different solubilized forms. These uncertainties are compounded by differences in the results of in vitro and in vivo inhibition studies. The best known property of MAO is its ability to deaminate biogenic amines which play a role in maintaining behavioral "normalcy" and physiological functions such as blood pressure. Clinical inhibition of MAO raises the level of such amines with spectacular effects on depressed states. It seems that inhibition of both forms of MAO is needed for antidepressant success, and yet there are arguments against that. Many measurements of MAO and its inhibition have been made in platelets and in purified preparations from liver; transposing the results of these experiments to brain mitochondria—not to speak of poorly classified affective disorders—has many pitfalls. All these questions are being aired in the present symposium, and the verbatim discussions reprinted at the end of each paper illuminate these unresolved difficulties. Twenty-five contributors and numerous discussants have given their best to make this symposium readable and authoritative. The available MAO inhibitors have been troubled by occasional side effects, and the present symposium with its emphasis on selectivity of inhibition may be the rejuvenating catalyst for newer drugs useful in ambulatory patients.

The book is printed beautifully, an 1882 etching of an old man grieving by van Gogh gracing the jacket and putting the reader in the right mood to delve into the biochemical causes of clinical depression.

University of Virginia **Alfred Burger**

Radiotracer Techniques and Applications. Volume 1. Edited by E. Anthony Evans and Mitsuo Muramatsu. Marcel Dekker, New York, N.Y., and Basel. 1977. 16 × 23.5 cm. xiii + 687 pp. $65.00.

This is the first of a two-volume set on the radiotracer technique as applied to chemistry, biology, and medicine. Except for one chapter dealing with the determination of radioactivity in biological material, the first volume is concerned primarily with chemical subjects.

There are three introductory chapters on the design of radiotracer experiments, selection and properties of radionuclides, and safety aspects of radiotracer experiments which provide a concise summary of their subjects. Although they are a bit telegraphic for the novice reader, there is a good reference list for those who would wish to read more broadly.

The chapters on the preparation of radiotracer compounds, quality control and analyses, storage, and stability are written with great knowledge and experience. They would be read with profit by any who plan to synthesize or use organic radiotracer compounds.

The chapters on the application of radiotracers to the study of reaction kinetics, exchange processes, solution properties, diffusion, and interfacial phenomena are authoritatively written and strike a good balance between theory and practice. They demonstrate very clearly the power of the radiotracer method in elucidating these complex phenomena.

There is a final descriptive chapter on radiotracers in environmental studies that gives the flavor of this application but no great detail.