TABLE I (*Continued*)

Carbon, %		Hydrogen, %		Nitrogen, %		Sulfur, %		Phosphorus, %		Chlorine, %	
Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found
60.16	59.67	6.58	6.59	4.39	4.53			9.70	9.30		
				9.08	8.65	10.39	11.05				
				13.04	13.27					16.51	16.29
				11.42	11.10						
				15.81	15.93	9.05	9.31				
				7.12	6.84	8.15	8.57	7.88	7.39	17.78	16.74
				9.68	9.37	5.54	5.35	5.36	4.70		
				8.97	9.11	10.26	10.42	9.91	9.40		
37.49	37.89	5.11	5.40	32.79	32.79						
44.70	44.63	3.94	4.04	11.61	11.36						
48.24	48.12	5.06	5.25	7.03	6.90						
50.75	50.88	5.68	5.82	6.58	6.61						
47.80	47.97	6.02	6.37	6.97	7.21						
				5.32	5.59	24.35	24.27				
67.36	67.50	8.35	8.60	7.48	7.53						
59.14	59.52	7.44	7.21								
55.63	55.65	7.67	7.75								
64.67	64.58	5.97	6.07	3.77	3.73						
7.39	7.50	4.96	5.10	17.34	17.90						
11.86	11.89	4.97	5.11	27.65	27.54						
8.17	8.61	4.80	4.78	9.53	9.43						
35.23	35.03	5.08	5.12	11.77	12.32						
37.62	37.13	4.87	5.00	6.28	6.42						
53.72	53.68	6.39	6.46								
44.05	43.66	8.40	8.17	9.34	8.80						
47.02	46.54	7.40	6.98	6.86	6.61						
53.86	53.24	8.22	8.02	5.71	6.00						
48.56	48.62	7.34	7.55	5.67	5.70						
34.28	33.88	8.15	8.30	19.99	20.11						
				12.04	12.01	8.55	7.97				

Substituted 5-Nitrobenzimidazoles[1]

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In connection with studies on the physical and physiological properties of benzimidazole derivatives and continuing our studies[3] on this group of heterocycles we have synthesized a number of substituted 5-nitrobenzimidazoles, 5-nitro-2-methylbenzimidazoles, and 5-nitro-2-hydroxymethylbenzimidazoles. In particular these derivatives are characterized by the presence of alkyl, aryl, and alkaryl substituents on the imino nitrogen of the benzimidazole nucleus.

Benzimidazoles without a substituent group on the imino nitrogen constitute a prototropic system. Monosubstitution in the benzene ring results in only two isomeric forms, a 5- or 6-isomer and a 4- or 7-isomer. Substitution on the imino nitrogen eliminates the possibility for the proton shift between the nitrogen atoms of the imidazole ring and in the case of monosubstitution in the benzene ring identity no longer exists between the 5- and 6-isomers or the 4- and 7-isomers.

The preparation of benzene-ring substituted benzimidazoles in which the hydrogen on the imino

(1) This study was supported by the San Diego County Heart Association.

(2) Taken in part from the M. S. thesis of Jim Julca, 1960.

(3) M. Rope, R. W. Isensee, and L. Joseph, *J. Am. Chem. Soc.*, **74**, 1095, (1952); G. Sandera, R. W. Isensee, and L. Joseph, *J. Am. Chem. Soc.*, **76**, 5173 (1954).

TABLE I

1-SUBSTITUTED 5-NITROBENZIMIDAZOLES, 5-NITRO-2-METHYLBENZIMIDAZOLES, AND 5-NITRO-2-HYDROXYMETHYLBENZIMIDAZOLES

	5-Nitrobenzimidazoles						5-Nitro-2-methylbenzimidazoles						5-Nitro-2-hydroxymethylbenzimidazoles					
	M.p.[a]	Yield, %	Calcd.[b]		Found		M.p.	Yield, %	Calcd.		Found		M.p.	Yield, %	Calcd.		Found	
			C	H	C	H			C	H	C	H			C	H	C	H
CH_3	205–206[c]	44					231–2[d]	40					165	41	52.11	4.34	51.87	4.44
C_2H_5	131–132	81	56.54	4.71	56.84	4.87	176–7[e]	68					162	39	54.50	4.97	54.96	4.82
n-C_3H_7[f]	173–174	54	58.53	5.36	58.70	5.51	124–126	57	60.27	5.93	60.03	6.22	167–168	57	56.17	5.53	56.31	5.87
i-C_3H_7[g]	134–136	90	58.53	5.36	58.25	5.65	225–227	41	60.27	5.93	60.27	6.26	167–168	58	56.17	5.53	56.39	5.77
C_6H_5	162–163	76	65.27	3.76	64.99	4.01	166–168	26	66.27	4.34	66.01	4.01	186–187	53	62.45	4.08	62.90	4.37
$C_6H_5CH_2$[h]	158–159	73	66.40	4.34	66.86	4.52	148–150	30	67.41	4.86	67.23	5.07	205–207	24	63.60	4.59	63.98	4.75

[a] Fisher-Johns hot stage. [b] Analyses by C. F. Geiger, Ontario, Calif. [c] Davies, *J. Pharm. Pharmacol.*, **3**, 420 (1951) gives m.p. 209°. [d] Phillips, *J. Chem. Soc.*, 1931, 1143 gives m.p. 226°. [e] Foster, *J. Chem. Soc.*, 1957, 4687, gives m.p. 176°. [f] Prepared from 2-amino-4-nitro-*n*-propylaniline, m.p. 119–122 (80%); C, 55.41; H, 6.85: Calcd. C, 55.21; H, 6.65. [g] Prepared from 2-amino-4-nitro-*i*-propylaniline, m.p. 123–124 (61%); C, 55.32; H, 6.99: Calcd. C, 55.21; H, 6.65. [h] Prepared from 2-amino-4-nitrobenzylaniline, m.p., 153–154 (79%); C, 64.23; H, 5.56; Calcd. C, 64.30; H, 5.35.

nitrogen has been replaced by a substituent group has been carried out for the most part by direct substitution in the preformed benzimidazole. This leaves doubt concerning the identity of the isomers obtained. The structures of the benzimidazoles reported in this work result unequivocally from the method of synthesis.

EXPERIMENTAL

The compounds were prepared by treating 2,4-dinitrochlorobenzene with the appropriate secondary amine in 1:2 mole ratio in absolute ethanol.[4] The dinitro-substituted anilines were reduced by hydrogen sulfide in ethanolic–ammonium hydroxide solution.[5] The benzimidazoles and methylbenzimidazoles were obtained by treating the diamines with formic and acetic acids, respectively,[6] and the 2-hydroxy-methyl derivatives by the method of Phillips.[7]

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Microbiological Transformations of Steroids. XVII.[1] Dehydrogenation of 5β-Pregnane-3,-11,20-trione 20-Ethylene Ketal by *Septomyxa affinis*

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The ability of the fungus *Septomyxa affinis* (ATCC 6737) to introduce ring A unsaturation into steroids has been described for a variety of substrates.[2,3] A particularly interesting aspect of the dehydrogenating ability of this microorganism is the fact that it dehydrogenates only the 1 and 2 positions of 3-keto steroids of the 5α- or 5β-pregnane series.[3] Other dehydrogenating organisms, such as *Fusarium solani*,[4] *F. caucasicum*,[4]

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