

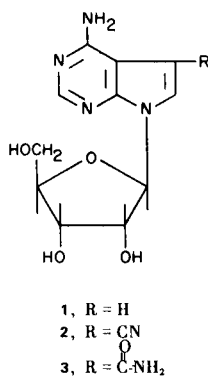
A Study of Electrophilic Substitution in the Pyrrolo[2,3-*d*]pyrimidine Ring (1,2)

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Several 4,5-disubstituted pyrrolo[2,3-*d*]pyrimidines were prepared for the first time *via* electrophilic substitution, *e.g.* halogenation, nitration and sulfonation. PMR data for certain pyrrolo[2,3-*d*]pyrimidines are included which has furnished conclusive evidence that electrophilic substitution occurred at position 5. These pyrrolo[2,3-*d*]pyrimidines, with electron-withdrawing substituents at position 5, are of considerable interest as bases for the preparation of nucleoside derivatives related to tubercidin, toyocamcin and sangivamycin.

The present investigation is part of a study involving pyrrolo[2,3-*d*]pyrimidines and pyrrolo[2,3-*d*]pyrimidine nucleosides. The nucleoside antibiotics, tubercidin (1), toyocamycin (2), and sangivamycin (3) have been shown (4-10) to be 4-substituted or 4,5-disubstituted pyrrolo[2,3-*d*]pyrimidine nucleosides. Toyocamycin has also been shown (9,10) to be identical to the nucleoside antibiotics,



unamycin B (11), antibiotic E-212 (12), and vengicide (13). These naturally occurring pyrrolopyrimidine nucleosides are all 4,5-disubstituted except tubercidin. The first synthesis of a 7-β-D-ribofuranosylpyrrolo[2,3-*d*]pyrimidine by direct ribosidation of a preformed pyrrolo[2,3-*d*]pyrimidine has been recently described (14). It was suggested that an electron-withdrawing substituent on the pyrrole ring facilitated this fusion reaction. This stimulated considerable interest in the preparation of pyrrolo[2,3-*d*]pyrimidines with electron-withdrawing substituents in the pyrrole moiety. The preparation of pyrrolo[2,3-*d*]pyrimidines with substituents in the pyrrole ring has been previously

confined primarily to the use of an appropriately substituted pyrrole derivative followed by ring closure of the pyrimidine moiety. It has been suggested (15) that certain pyrrolo[2,3-*d*]pyrimidines might undergo electrophilic substitution (16) at position 5 or position 6. The specific object of the present investigation was to study the electrophilic substitution of certain readily available pyrrolo[2,3-*d*]pyrimidines.

Treatment of 2-methylthiopyrrolo[2,3-*d*]pyrimidine-4-one (4) (17) with Raney nickel effected a removal of the 2-methylthio group to furnish pyrrolo[2,3-*d*]pyrimidine-4-one (5) which was identical to 5 prepared previously by another method (15). The chlorination of 5 to furnish 4-chloropyrrolo[2,3-*d*]pyrimidine (8) was accomplished in good yield by the treatment of 5 with phosphorus oxychloride (15). A solution of 8 in methylene chloride was treated with *N*-bromoacetamide to afford a crystalline solid which was demonstrated to be a monobromo derivative of 8 as determined by elemental analysis. A visual examination of 8 revealed four possible sites for electrophilic substitution (bromination): C2, C5, C6, and N7.

A pmr spectrum of the reaction product in dms<sub>o</sub>-d<sub>6</sub> exhibited a low broad absorption peak centered at δ 13.1 (1 proton) which was attributed to the proton at N7 and eliminated N7 as a possible site of bromination. If bromination had occurred at C2 then the pmr spectrum would have theoretically exhibited two quartets (AMX system) for the protons residing at C5 and C6. However, the pmr spectrum (Figure 1B) revealed a singlet at δ 8.7 (1 proton) and a doublet (*J* = 2.4 cps) at δ 8.0 (1 proton) which were assigned to the proton at C2 and to a proton residing at either C5 or C6, respectively. This established that electrophilic substitution had indeed occurred in the pyrrole

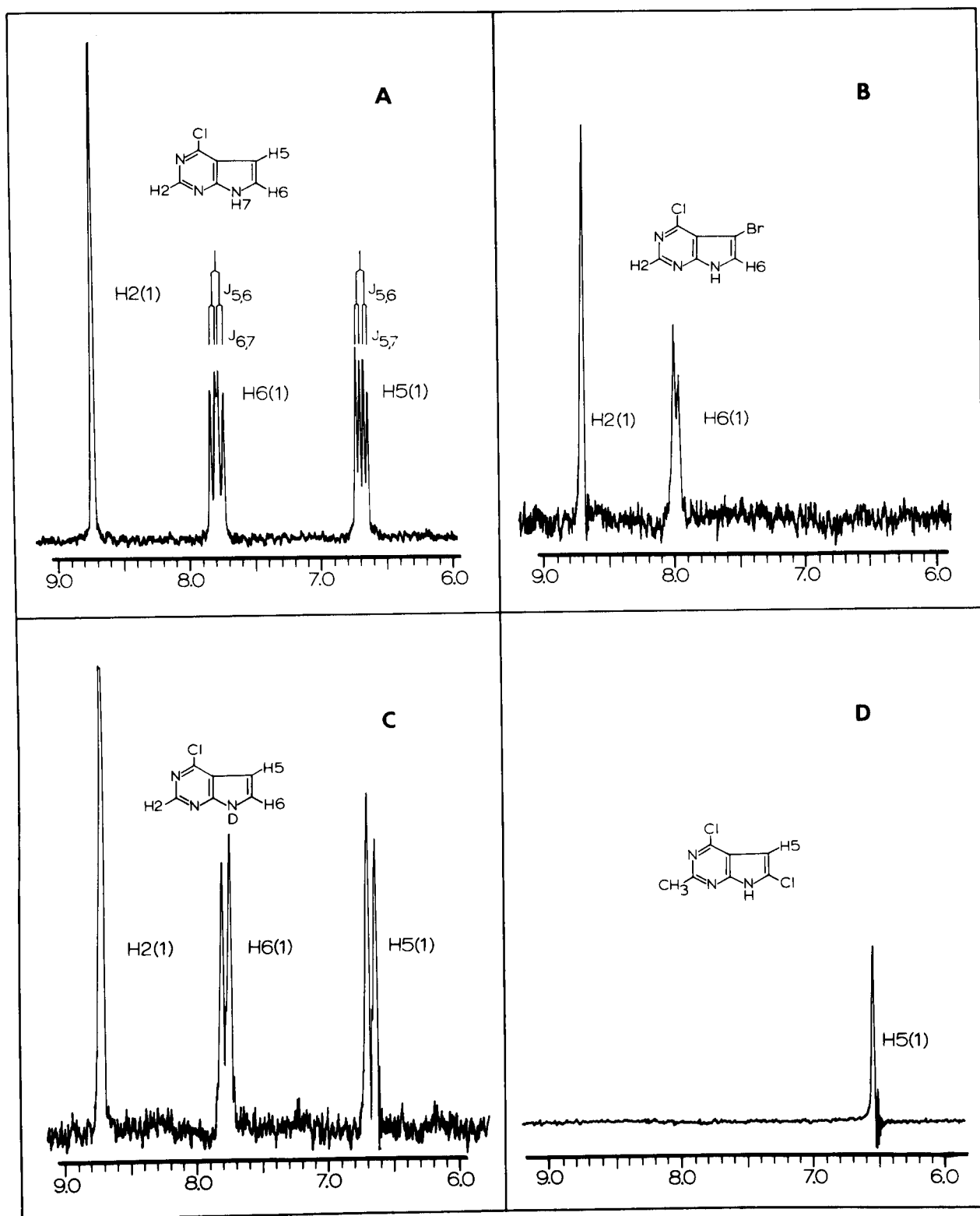
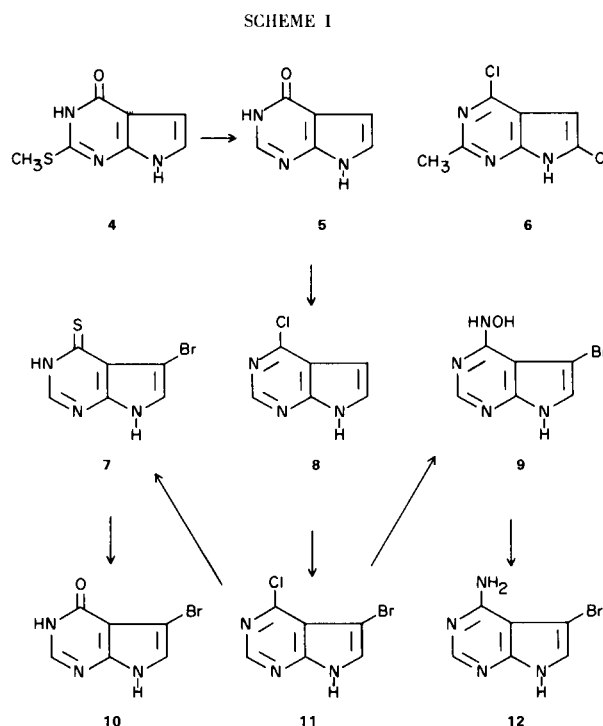


Figure 1. Electrophilic Substitution. PMR spectra: **A**, 4-Chloropyrrolo[2,3-*d*]pyrimidine (**8**); **B**, 5-Bromo-4-chloropyrrolo[2,3-*d*]pyrimidine (**11**); **C**, 4-chloropyrrolo[2,3-*d*]pyrimidine (**7d**); **D**, 4,6-dichloro-2-methylpyrrolo[2,3-*d*]pyrimidine (**6**).

moiety of the pyrrolo[2,3-*d*]pyrimidine ring system and there remained only the problem of determining whether the bromo group was at C5 or C6. A pmr spectrum (Figure 1,A) of the starting material (**8**) in  $\text{dms}\text{-d}_6$  exhibited absorption peaks at  $\delta$  12.6 (1 proton as a broad singlet, H7),  $\delta$  8.68 (1 proton singlet, H2), 1 proton quartet centered at  $\delta$  7.78 (H6,  $J = 2.4$  and  $3.6$  cps) and a 1 proton quartet centered at  $\delta$  6.68 (H5,  $J = 2.0$  and  $3.6$  cps). One drop of deuterium oxide was added to the  $\text{dms}\text{-d}_6$  solution of **8** and furnished a pmr spectrum (Figure 1,C) with absorption peaks at  $\delta$  8.68 (1 proton singlet, H2), 1 proton doublet centered at  $\delta$  7.77 (H6,  $J_{5,6} = 3.6$  cps) and a 1 proton doublet centered at  $\delta$  6.68 (H5,  $J_{5,6} = 3.6$  cps). The change from quartets to doublets were attributable to the replacement of hydrogen by deuterium at N7. On the basis of this spectrum, the coupling constants ( $J = 2.4$  and  $2.0$ ) were assigned to  $J_{6,7}$  and  $J_{5,7}$ , respectively. The above assignment of H6 to the absorption peak centered at  $\delta$  7.78 and H5 to the  $\delta$  6.68 absorption peak was made on the basis of reported (18) spectral data for pyrrole and the bicyclic pyrrole derivative, indole. In pyrrole and indole the proton  $\alpha$  to the ring nitrogen exhibits an absorption peak at a lower field than the absorption peak observed for the  $\beta$  proton. In addition, further support for this assignment was obtained when the magnitude of the assigned coupling constants for **8** ( $J_{6,7} = 2.4$  cps and  $J_{5,7} = 2.0$  cps) proved to be analogous to the coupling constants observed between the proton on the ring nitrogen and the  $\alpha$  proton and  $\beta$  proton of certain pyrrole derivatives. Additional evidence for these assignments was obtained from the pmr spectrum (Figure 1,D) of 4,6-dichloro-2-methylpyrrolo[2,3-*d*]pyrimidine (**6**) (19) in  $\text{dms}\text{-d}_6$  which exhibited an absorption peak at  $\delta$  6.6 (1 proton singlet, H5), which is almost identical to the chemical shift assigned to the H5 proton of **8**. A visual inspection (Figure 1) revealed that the chemical shift assigned to the proton at C6 of **8** is very similar to the chemical shift observed for the proton in the pyrrole ring of **11**. Therefore, on the basis of the above pmr spectral data, it was established that electrophilic substitution had occurred at C5 and the structure of **11** was assigned as 5-bromo-4-chloropyrrolo[2,3-*d*]pyrimidine.

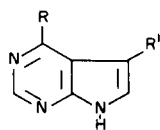
Treatment of **11** with nucleophilic reagents was found to effect a preferential displacement of the 4-chloro group. Ethanolic thiourea at  $70^\circ$  for 1 hour has furnished a good yield of 5-bromopyrrolo[2,3-*d*]pyrimidine-4-thione (**7**) from **11**. The pmr spectrum of **7** in  $\text{dms}\text{-d}_6$  exhibited two low medium-sized absorption peaks centered at  $\delta$  13.2 (1 proton) and  $\delta$  12.6 (1 proton) which would indicate that **7** exists in the thione form in  $\text{dms}\text{-d}_6$ . Treatment of **7** with 30% hydrogen peroxide in concentrated ammonium hydroxide effected a facile conversion of sulfur to oxygen and afforded 5-bromopyrrolo[2,3-*d*]pyrimidine-4-one (**10**).

The structure of **10** was assigned on the basis of a pmr spectrum in  $\text{dms}\text{-d}_6$  [low medium-sized absorption peaks centered at  $\delta$  12.1 (1 proton) and  $\delta$  11.9 (1 proton)]. Nucleophilic displacement of the 4-chloro group from **11** was accomplished with hydroxylamine in 2-propanol at reflux temperature to furnish 5-bromo-4-hydroxylamino-pyrrolo[2,3-*d*]pyrimidine (**9**). Reduction of the hydroxylamino group with Raney nickel afforded the very interesting adenine analog 4-amino-5-bromopyrrolo[2,3-*d*]pyrimidine (**12**).



The introduction of different groups into the 5 position *via* electrophilic substitution was then investigated. Treatment of **5** with concentrated nitric acid furnished a solid material in good yield which was assigned the structure 5-nitropyrrolo[2,3-*d*]pyrimidine-4-one (**13**). Elemental analysis and a bathochromic shift in the ultraviolet absorption spectrum substantiated that nitration had occurred (Table I). The successful chlorination of **13** was accomplished using a mixture of phosphorous oxychloride and *N,N*-dimethylformamide to afford a 63% yield of 4-chloro-5-nitropyrrolo[2,3-*d*]pyrimidine (**14**). The nitro group was assigned to position five on the basis of a pmr spectrum [ $\delta$  7.5 singlet (H6) and  $\delta$  8.85 singlet (H2)]. Nucleophilic displacement of the 4-chloro group of **14** with a mercapto group was effected very smoothly on treatment of **14** with thiourea in ethanol at reflux temperature to afford 5-nitropyrrolo[2,3-*d*]pyrimidine-4-thione (**16**) in 93% yield. The alkylation of **16** with

TABLE I

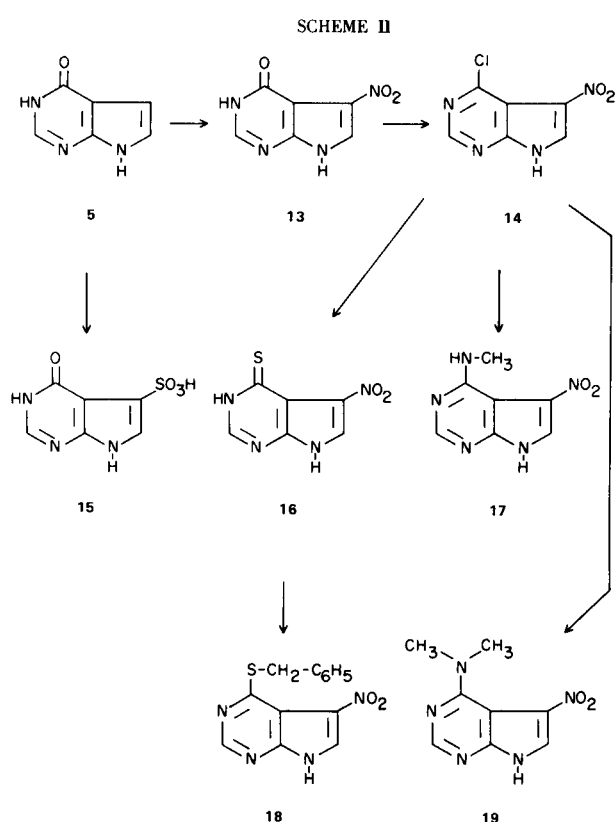
Ultraviolet Absorption Data for Certain Pyrrolo[2,3-*d*]pyrimidines (a)

Compound	R	R <sup>1</sup>	pH 1		pH 11	
			$\lambda$ max nm	$\epsilon$ max	$\lambda$ max nm	$\epsilon$ max
11	Cl	Br	300	2800	278	4550
			268	3260	237	29500
			229	30300		
13	OH	NO <sub>2</sub>	355	13500	394	11300
			227	11200	235 (b)	9900
14	Cl	NO <sub>2</sub>	334	11300	380 (b)	6700
					328	8200
					243 (b)	10700
15	OH	SO <sub>3</sub> H	256	10500	258	10200
16	SH	NO <sub>2</sub>	390	13150	423	9700
			272	9150	285	7650
			237	12300		
19	(CH <sub>3</sub> ) <sub>2</sub> N	NO <sub>2</sub>	357	15300	430	11100
					255	10150
17	CH <sub>3</sub> NH	NO <sub>2</sub>	350	13900	415	12900
					247	11200
18	SCH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	NO <sub>2</sub>	371	10000	393	8050
			270	10450	275	3720
					234 (b)	18000
7	SH	Br	327	12300	315	10200
			278	7600	300 (b)	9200
			224	16600	228	18400
10	OH	Br	267	7700	269	7700
9	NHOH	Br	282	10500	280 (b)	9400
			237	14200	271	9840
					232	7800
12	NH <sub>2</sub>	Br	280	8640	276	8740
			231	20200	225 (b)	12350

(a) Ultraviolet absorption spectra were obtained with a Beckman DK-2 ultraviolet spectrophotometer. (b) Shoulder.

benzylbromide was achieved in aqueous ammonia to furnish 4-benzylthio-5-nitropyrrolo[2,3-*d*]pyrimidine (18). Treatment of 14 with ethanolic methylamine at reflux temperature furnished 4-methylamino-5-nitropyrrolo[2,3-*d*]pyrimidine (17). The preparation of 4-dimethylamino-5-nitropyrrolo[2,3-*d*]pyrimidine (19) was accomplished by the nucleophilic displacement of the 4-chloro group of 14 with anhydrous dimethylamine. The pmr spectra revealed the presence of one exocyclic methyl group absorption peak and two exocyclic methyl group absorption peaks (isochromus) for 17 and 19, respectively.

An additional example of electrophilic substitution in the pyrrolo[2,3-*d*]pyrimidine ring system was provided when the treatment of pyrrolo[2,3-*d*]pyrimidine-4-one (5) with chlorosulfonic acid, below 0°, furnished pyrrolo[2,3-*d*]pyrimidine-4-one-5-sulfonic acid (15).



The above pyrrolo[2,3-*d*]pyrimidines with electron-withdrawing substituents at position 5 are of considerable interest as possible substrates for the preparation of tubercidin, toyocamycin and sangivamycin analogs via the acid catalyzed fusion procedure. Because of their close structural similarity to the biochemically important purines, they are also of interest as potential substrates for the enzymes, nucleoside phosphorylase and nucleotide pyrophosphorylase.

## EXPERIMENTAL (20)

Pyrrolo[2,3-*d*]pyrimidine-4-one (5).

Fifteen grams of 2-methylthiopyrrolo[2,3-*d*]pyrimidine-4-one (17) was dissolved in hot 14% ammonium hydroxide (600 ml.) and ethanol (150 ml.). Forty grams of Raney nickel was added to this solution and additional forty gram lots were added at 15 minute intervals until a total of 240 grams had been added. After the last addition the reaction was allowed to continue at reflux temperature for an additional 1 to 1.5 hours. The Raney nickel was collected by filtration and washed with 250 ml. of the hot reaction solvent mixture. The filtrate was reduced to near dryness and the solid was collected by filtration, yield 5.6-6 g. m.p. 345° dec. The solid was sufficiently pure for use in the following reactions. A small sample was recrystallized from a water-ethanol mixture to furnish a compound identical in all respects to 5 prepared by Davoll (15).

4-Chloro-5-bromopyrrolo[2,3-*d*]pyrimidine (11).

To 25 ml. of methylene chloride was added 1 g. of 4-chloropyrrolo[2,3-*d*]pyrimidine (8) (15) and the reaction mixture was gently heated to effect solution. To this solution was added 25 ml. of methylene chloride containing *N*-bromoacetamide (0.9 g.) and the solution was then heated at reflux temperature for 30 minutes. The methylene chloride was removed *in vacuo* and 20 ml. of water was added to the remaining residue. The solid was collected by filtration and then washed with water to furnish 1.43 g. of product. Recrystallization was accomplished from a minimum amount of 2-propanol to yield 1.24 g. (81.5%) of 11, m.p. 229°.

*Anal.* Calcd. for C<sub>6</sub>H<sub>3</sub>BrClN<sub>3</sub>: C, 31.00; H, 1.30; N, 18.07. Found: C, 31.12; H, 1.34; N, 17.90.

5-Bromopyrrolo[2,3-*d*]pyrimidine-4-thione (7).

One g. of 5-bromo-4-chloropyrrolo[2,3-*d*]pyrimidine (11) and 1 g. of thiourea were suspended in anhydrous ethanol (40 ml.) and the reaction mixture was gently warmed to effect a clear solution. The solution was heated at 70° for 1 hour and then cooled to room temperature. The solid which separated from solution was collected by filtration to furnish a crude yield of 500 mg. The solid was recrystallized from a mixture of water-ethanol (1:1, v:v) to yield 420 mg. (43%) of pale brown crystals (7), m.p. 231° dec.

*Anal.* Calcd. for C<sub>6</sub>H<sub>4</sub>BrN<sub>3</sub>S: C, 31.30; H, 1.75; N, 18.28. Found: C, 31.50; H, 1.86; N, 18.21.

5-Bromopyrrolo[2,3-*d*]pyrimidine-4-one (10).

5-Bromopyrrolo[2,3-*d*]pyrimidine-4-thione (7, 0.1 g.) was dissolved in concentrated ammonium hydroxide (5 ml.) and 1 ml. of hydrogen peroxide (30%) was then added to the clear solution. The solution was stirred at room temperature for 1 hour and the solid which had separated from solution was removed by filtration to yield 60 mg. of crude product. This was recrystallized from a mixture of water-2-propanol to yield 20 mg. (21.5%) of pure product (10), m.p. 270-271° dec.

*Anal.* Calcd. for C<sub>6</sub>H<sub>4</sub>BrN<sub>3</sub>O·½H<sub>2</sub>O: C, 32.30; H, 2.26; N, 18.80. Found: C, 32.84; H, 2.36; N, 18.36.

5-Bromo-4-hydroxylaminopyrrolo[2,3-*d*]pyrimidine (9).

One g. of 5-bromo-4-chloropyrrolo[2,3-*d*]pyrimidine (11) was dissolved in 100 ml. of 2-propanol containing 2 g. of hydroxylamine (21). The solution was heated at reflux temperature for 1.5 hours and then allowed to stand at 5° for 18 hours. The solid which had separated from solution was collected by filtration to

furnish a crude yield of 560 mg. The solid was recrystallized from a mixture of 2-propanol-water (1:1, v:v) to yield 450 mg. (45%) of analytically pure product, m.p. 212° dec.

*Anal.* Calcd. for  $C_6H_5BrN_4O$ : C, 31.40; H, 2.20; N, 24.40. Found: C, 31.18; H, 2.37; N, 24.58.

#### 4-Amino-5-bromopyrrolo[2,3-d]pyrimidine (12).

5-Bromo-4-hydroxylaminopyrrolo[2,3-d]pyrimidine (**9**, 0.3 g.) was dissolved in a mixture of ethanol-water (2:1, v:v). Three g. of Raney nickel were added and the mixture was stirred and heated at reflux temperature for 2.5 hours. The catalyst was collected by filtration and washed with hot ethanol (2 x 25 ml.). The filtrate was reduced to dryness *in vacuo* and the residue was recrystallized from a mixture of water-ethanol to yield 60 mg. (21%) of pure product (**12**), m.p. 238-239° dec.

*Anal.* Calcd. for  $C_6H_5BrN_4$ : C, 33.80; H, 2.36; N, 26.20. Found: C, 33.71; H, 2.30; N, 25.93.

#### 5-Nitropyrrolo[2,3-d]pyrimidine-4-one (13).

To 40 ml. of concentrated nitric acid which had been cooled to 5° was added 5 gm. of pyrrolo[2,3-d]pyrimidine-4-one (**5**). The mixture was stirred in an ice bath (5°) for 10 minutes and then allowed to stand at room temperature for 20 minutes. The reaction mixture was then heated on a steam bath for 30 minutes and the mixture was poured onto approximately 150 ml. of crushed ice. The solid was collected by filtration and dried at 25°, to yield 3.5 g. of **13** (52% yield). Reprecipitation from hot 1*N* sodium hydroxide with concentrated hydrochloric acid furnished an analytical sample, m.p. >300°.

*Anal.* Calcd. for  $C_6H_4N_4O_3$ : C, 40.00; H, 2.24; N, 31.10. Found: C, 39.85; H, 2.32; N, 30.85.

#### 4-Chloro-5-nitropyrrolo[2,3-d]pyrimidine (14).

A solution of phosphorus oxychloride (40 ml.) and dimethylformamide (10 ml.) was prepared by slowly adding the dimethylformamide to phosphorus oxychloride while maintaining the temperature below 25°. This solution was then allowed to stand at room temperature for 1 hour. 5-Nitropyrrolo[2,3-d]pyrimidine-4-one (**13**, 5 g.) was then added to this solution and the mixture was heated at reflux temperature for 15 minutes. The solution was poured onto approximately 600 ml. of crushed ice with constant stirring and ice was added as required to assure an excess. The aqueous solution was adjusted to a pH of 4 with concentrated ammonium hydroxide and this solution was extracted with diethyl-ether (2 x 500 ml.) by vigorously stirring the solution and the ether together for 20 minutes. The combined ether extracts were washed with water (2 x 300 ml.) and dried over anhydrous magnesium sulfate. The ether solution was evaporated to dryness *in vacuo* to yield 3.5 g. (63%) of **14**. Crude product was used for subsequent nucleophilic displacements. A small sample was recrystallized from toluene for analysis, m.p. >360°.

*Anal.* Calcd. for  $C_6H_3N_4O_2Cl$ : C, 36.30; H, 1.52; N, 28.20. Found: C, 36.55; H, 1.79; N, 27.93.

#### 4-Methylamino-5-nitropyrrolo[2,3-d]pyrimidine (17).

To 50 ml. of ethanol containing liquid methylamine (1.5 ml.) was added 300 mg. of 4-chloro-5-nitropyrrolo[2,3-d]pyrimidine (**14**). The solution was heated at reflux temperature for 1 hour and the excess methylamine was then removed *in vacuo*. The resulting residue was dissolved in water (5 ml.) and a solid was precipitated from solution with 12*N* hydrochloric acid. Reprecipitation of the solid from hot 1*N* sodium hydroxide, after treatment with charcoal, with 12*N* hydrochloric acid yielded 50 mg. of product. For analysis the product was recrystallized from a

mixture of methanol-ethylacetate, m.p. 345-347° dec.

*Anal.* Calcd. for  $C_7H_7N_5O_2$ : C, 43.50; H, 3.65; N, 36.20. Found: C, 43.67; H, 3.92; N, 36.04.

#### 4-Dimethylamino-5-nitropyrrolo[2,3-d]pyrimidine (19).

To 50 ml. of ethanol containing liquid dimethylamine (1 ml.) was added with stirring 500 mg. of 4-chloro-5-nitropyrrolo[2,3-d]pyrimidine (**14**). The solution was then heated at reflux temperature for 30 minutes. The solid which began to separate from the solution after 15 minutes was collected by filtration and washed thoroughly with ethanol to furnish 330 mg. of **19**. A small sample was recrystallized from ethanol and dried for 1 hour at 100° *in vacuo* over phosphorus pentoxide for analysis, m.p. 344-346° dec.

*Anal.* Calcd. for  $C_8H_9N_5O_2 \cdot \frac{1}{2}H_2O$ : C, 45.40; H, 4.41; N, 33.10. Found: C, 45.62; H, 4.53; N, 32.98.

#### 5-Nitropyrrolo[2,3-d]pyrimidine-4-thione (16).

To 125 ml. of ethanol containing 3.42 g. of thiourea was added 3 g. of 4-chloro-5-nitropyrrolo[2,3-d]pyrimidine (**14**). The solution was heated at reflux temperature for 3 hours and the solid which had separated was removed by filtration. The filtrate was taken almost to dryness and the solid was collected and combined with the other solid which had been collected (93%, combined weight of 2.8 g.). The solid was then dissolved in 1*N* sodium hydroxide (boiling), and the solution was treated with charcoal while hot and then filtered. The solid was reprecipitated with 12*N* hydrochloric acid to yield 2.5 g. of pure product (**16**), m.p. 240° dec.

*Anal.* Calcd. for  $C_6H_4N_4O_2S$ : C, 36.65; H, 2.05; N, 28.50. Found: C, 36.84; H, 2.20; N, 28.29.

#### 4-Benzylthio-5-nitropyrrolo[2,3-d]pyrimidine (18).

5-Nitropyrrolo[2,3-d]pyrimidine-4-thione (**16**, 0.5 g.) was dissolved in 75 ml. of 28% ammonium hydroxide and to this solution was added 510 mg. of benzylbromide in 3 ml. of *p*-dioxane. The solution was stirred at room temperature for 18 hours in an open flask. The pH of the solution was then adjusted to 7 with 6*N* hydrochloric acid and the solid was collected by filtration to yield 630 mg. of crude product. The crude product was dissolved in hot 1*N* sodium hydroxide, the solution was treated with charcoal while hot and the pH of the solution was adjusted to 7 with 6*N* hydrochloric acid to yield 500 mg. of solid. For analysis the solid was dissolved in boiling ethanol and then crystallized from solution by the slow addition of water until crystals began to form, m.p. 239-240°.

*Anal.* Calcd. for  $C_{13}H_{10}N_4O_2S$ : C, 54.50; H, 3.49; N, 19.54. Found: C, 54.30; H, 3.46; N, 19.39.

#### Pyrrolo[2,3-d]pyrimidine-4-one-5-sulfonic Acid (15).

Pyrrolo[2,3-d]pyrimidine-4-one (**5**) (3.5 g.) was added slowly to 14 ml. of chlorosulfonic acid which had been cooled to 5°. The temperature of the reaction mixture was maintained below 20° throughout the addition. After complete addition of **5**, the reaction mixture was heated for 15 minutes on a steam bath. The solution was then poured onto 500 ml. of crushed ice and the resulting slurry was reduced in volume to approximately 100 ml. to afford a thick slurry. The solid was collected by filtration and washed with acetone (50 ml.). This crude solid (6.5 g.) was dissolved in hot concentrated ammonium hydroxide and the small amount of undissolved material was removed by filtration. The product was crystallized by acidification of the filtrate with 6*N* hydrochloric acid to a pH of 5. The solid which had separated from solution after standing overnight was collected by filtration to afford **15** (3.8 g.), m.p. >350°.

*Anal. Calcd.* for C<sub>6</sub>H<sub>5</sub>N<sub>3</sub>O<sub>4</sub>S: C, 33.50; H, 2.34; N, 19.55.  
*Found:* C, 33.57; H, 2.71; N, 19.44.

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- (21) Prepared by dissolving 4.2 g. of hydroxylamine hydrochloride in 140 ml. of isopropanol and adding 3.9 g. of potassium hydroxide dissolved in 28 ml. of 2-propanol. The mixture was heated at reflux temperature for 1 hour with stirring and the potassium chloride was then removed by filtration.

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