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Reaction of β-Aminocrotonamide with *N*-Acylated Amino Acid Esters to give 2-Acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones and Their Ring Closure with Polyphosphoric Acid (PPA)[1)]

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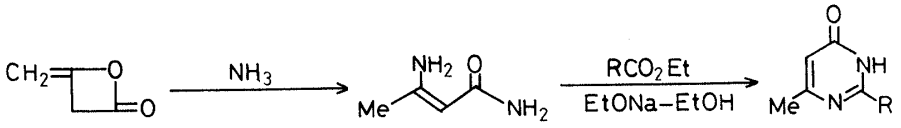
Reaction of β-aminocrotonamide with *N*-acylated amino acid esters in the presence of sodium methoxide gave 2-acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones, some of which, on treatment with polyphosphoric acid (PPA), were transformed into imidazo[1,5-*a*]pyrimidines and imidazo[4,5-*b*]pyridines.

Keywords——β-aminocrotonamide; *N*-acylamino acid ester; pyrimidin-4(3*H*)-one; polyphosphoric acid (PPA); cyclization; rearrangement; imidazo[1,5-*a*]pyrimidine; imidazo[4,5-*b*]-pyridine; ^{1}H-NMR

β-Aminocrotonamide (**1**), which can be readily prepared by the reaction of diketene with ammonia,[2,3)] serves as a reagent for the synthesis of heterocycles such as pyridines and pyrimidines.[4)] Previously, we have reported that **1** reacts with carboxylic acid esters in the presence of sodium ethoxide to give 2-substituted 6-methylpyrimidin-4(3*H*)-ones (**2**).[5)] This reaction is practical for the synthesis of **2** because of the simplicity of the procedure. The present paper reports the reaction of **1** with *N*-acylated amino acid esters to give 2-acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones, and their ring closure with polyphosphoric acid (PPA), which involves a novel rearrangement. The following paper[6)] will describe the synthesis of imidazo[1,5-*a*]pyrimidines from 2-acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones obtained during the present studies.



1 2

Chart 1

When **1** was allowed to react with ethyl hippurate (**3c**) in the presence of sodium methoxide in abs. methanol, 2-benzamidomethyl-6-methylpyrimidin-4(3*H*)-one (**4c**) was obtained. The yields of **4c** under various reaction conditions are shown in Table I. The reaction gave the best yield of **4c** when two and five molar equivalents of **3c** and sodium methoxide based on **1** were used, respectively. Employing this condition, the reaction of **1** with various *N*-acylated amino acid esters (**3a**, **b**, **d**—**i**) was carried out to give 2-acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones (**4a**, **b**, **d**—**i**). The results are summarized in Table II. Similarly, the reaction of **1** with ethyl *N*-acetylprolinate (**5**) gave 2-(1-acetyl-2-pyrrolidinyl)-6-methyl-

pyrimidin-4(3*H*)-one (**6**) in 43% yield.

On the other hand, the reaction of **1** with diethyl *N*-acylaspartates (**7a**, **b**) under similar conditions gave carboxylic acids, but it was difficult to determine spectroscopically whether their structures are 2-(1-acylamino-2-carboxyethyl)-6-methylpyrimidin-4(3*H*)-ones (**8a**, **b**) or 2-(2-acylamino-2-carboxyethyl)-6-methylpyrimidin-4(3*H*)-ones (**9a**, **b**). Diethyl *N*-acetylglutamate (**10**) reacted with **1** to give 6-methyl-2-(2-oxo-5-pyrrolidinyl)pyrimidin-4(3*H*)-one (**11**) and 2,6-dimethylpyrimidin-4(3*H*)-one in 47 and 8% yields, respectively.

A *β*-amino acid ester, ethyl 3-acetamidopropionate (**12**), also reacted with **1** to give 2-(2-acetamidoethyl)-6-methylpyrimidin-4(3*H*)-one (**13**) in 68% yield.

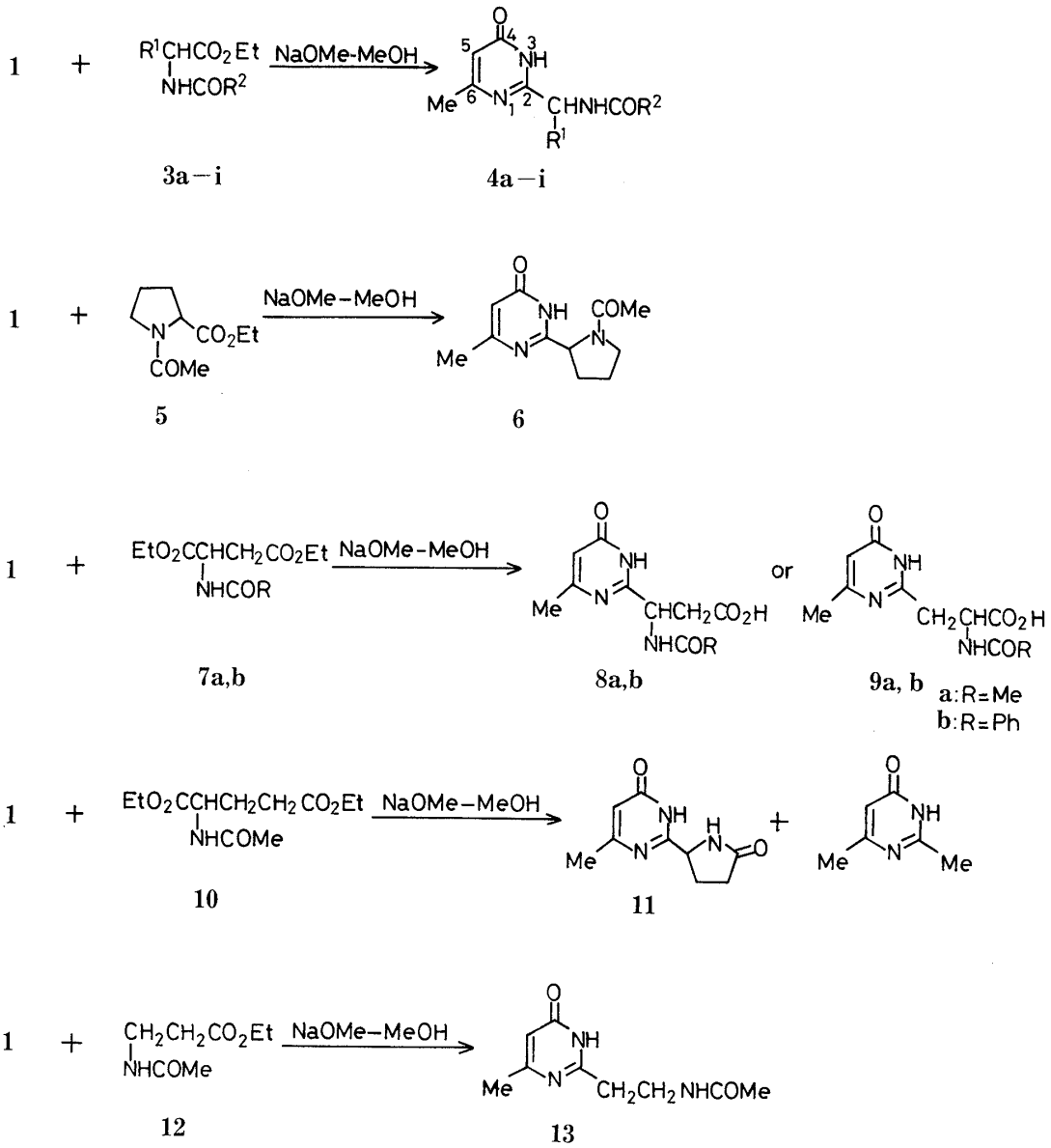
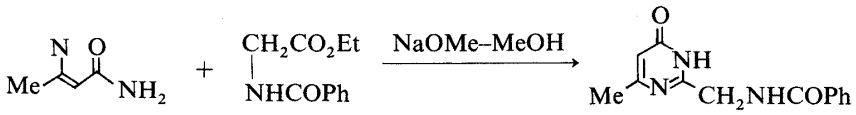


Chart 2

Next, the ring closure of pyrimidin-4(3*H*)-ones (**4a**—**c**) with PPA was investigated with the intention of obtaining purine analogues. The results are summarized in Tables III and IV. Namely, heating of **4a** with PPA at 100—110 °C for 3 h gave 2,6-dimethylimidazo-[1,5-*a*]pyrimidin-4(1*H*)-one (**14a**) in 58% yield. Although 4,6-dimethylimidazo[1,5-*a*]pyrimidin-2(1*H*)-one (**14'a**), an isomer of **14a**, can also be considered as a product of this

TABLE I. Reaction of β-Aminocrotonamide (**1**) with Ethyl Hippurate (**3c**)



1 **3c** **4c**

Run	**1** (g, mmol)	**3c** (g, mmol)	Na (g, mg atom)	Abs. MeOH (ml)	Reaction time (h)	Yield of **4c**[a] (g, %)
1	0.5 (5)	1.04 (5)	0.12 (5)	20	23	0.08 (6.7)
2	0.5 (5)	1.04 (5)	0.58 (25)	20	17	0.27 (21.9)
3	0.5 (5)	1.04 (5)	0.12 (5)	10	9	0.45 (36.8)
4	0.5 (5)	2.08 (10)	0.58 (25)	10	1.5	0.89 (73.5)

a) The yield is based on β-aminocrotonamide (**1**).

TABLE II. 2-Acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones (**4a**—**i**)

4	R^1	R^2	Yield (%)	mp (°C)	Recryst. solvent
a	H	Me	75	196—197 (dec).	Methanol–ethyl acetate
b	H	Me_2CH	70	199—201 (dec.)	Methanol
c	H	Ph	79	230—232	Methanol
d	Me	Me	73	216—218	Methanol–ethyl acetate
e	Me	Ph	73	118	Methanol–ethyl acetate
f	CH_2Ph	Me	85	210—213	Ethanol
g	CH_2Ph	Ph	60	278—279	Methanol
h	CH_2CHMe_2	Me	67	175—177	Benzene
i	CH_2CHMe_2	Ph	71	208—209	Ethyl acetate

(continued)

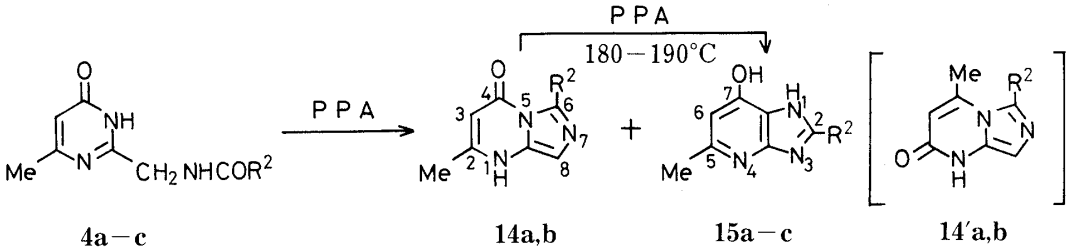
4	IR (Nujol) cm^{-1}		^{1}H-NMR (DMSO-d_6) δ		Formula	Analysis (%) Calcd (Found)		
	Ring C=O	Amide C=O	Ring-Me	Ring-H		C	H	N
a	1688	1660[a]	2.16	6.10	$C_8H_{11}N_3O_2$	53.03 (52.92	6.12 6.14	23.19 23.12)
b	1670	1635[a]	2.10	5.88	$C_{10}H_{15}N_3O_2$	57.40 (57.24	7.23 7.28	20.08 20.32)
c	1660	1635	2.16	6.08	$C_{13}H_{13}N_3O_2$	64.18 (64.60	5.39 5.38	17.28 17.32)
d	1675	1640	2.56	6.70[b]	$C_9H_{13}N_3O_2$	55.37 (55.15	6.71 6.80	21.53 21.59)
e	1665	1640	2.20	6.10	$C_{14}H_{15}N_3O_2$	65.35 (65.39	5.88 5.87	16.33 16.23)
f	1675	1655	2.21	6.06	$C_{15}H_{17}N_3O_2 \cdot 1/5CH_3CO_2Et$	65.68 (65.91	6.49 6.35	14.54 14.41)
g	1658	1635	2.15	6.10	$C_{20}H_{19}N_3O_2$	72.05 (72.12	5.74 5.66	12.61 12.60)
h	1660	1645	2.28	6.19[c]	$C_{12}H_{19}N_3O_2$	60.73 (60.56	8.07 7.99	17.71 17.76)
i	1665	1650[a]	2.20	6.07	$C_{17}H_{21}N_3O_2$	68.20 (68.23	7.07 7.15	14.04 13.90)

a) KBr disk. *b*) In CF_3CO_2H–$CDCl_3$. *c*) In CD_3OD.

reaction, the 4(1*H*)-one structure (**14a**) was assigned to the product on the basis of the following ^{1}H-NMR spectral data. That is, in the ^{1}H-NMR spectrum (DMSO-d_6) of **14a** the signal of methyl protons at the 2-position was observed at 2.30 ppm,[7] whereas the ^{1}H-NMR spectrum of **14'a**, prepared by the present authors,[6] showed the signal of methyl protons of the 4-position at lower field (2.64 ppm) due to the effect of the imidazole ring.

On the other hand, when this reaction was carried out at 180—190 °C for 10.5 h, **14a** was not obtained but 7-hydroxy-2,5-dimethylimidazo[4,5-*b*]pyridine (**15a**) was obtained in 86% yield. Similarly, **4b** was heated with PPA at 100—110 °C for 5 h to give the imidazo[1,5-*a*]-pyrimidin-4(1*H*)-one **14b** in 44% yield. Prolonged heating of **4b** at the same temperature gave **14b** and the imidazo[4,5-*b*]pyridine **15b** in 31 and 43% yields, respectively.

Furthermore, compound **4b**, on heating at 180—190 °C, was exclusively transformed into **15b** in 61% yield. On the other hand, heating of **4c** with PPA at 100—110 °C gave the imidazo[4,5-*b*]pyridine **15c** as a sole product in 60% yield. In order to obtain the imidazo-[1,5-*a*]pyrimidine **14c**, **4c** was heated at lower temperature (70—80 °C), but this resulted in the recovery of the starting **4c**.



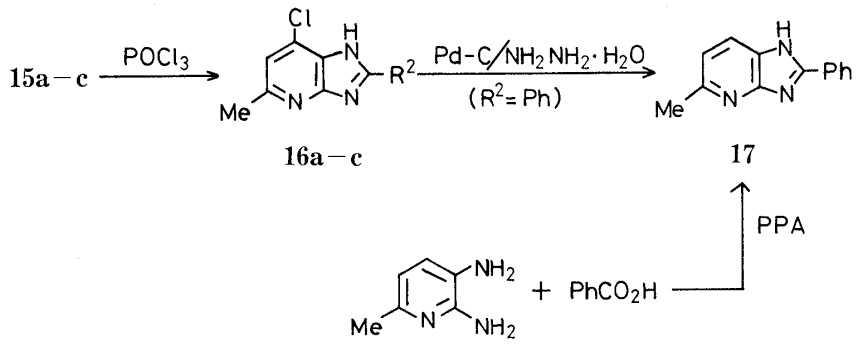


Chart 3

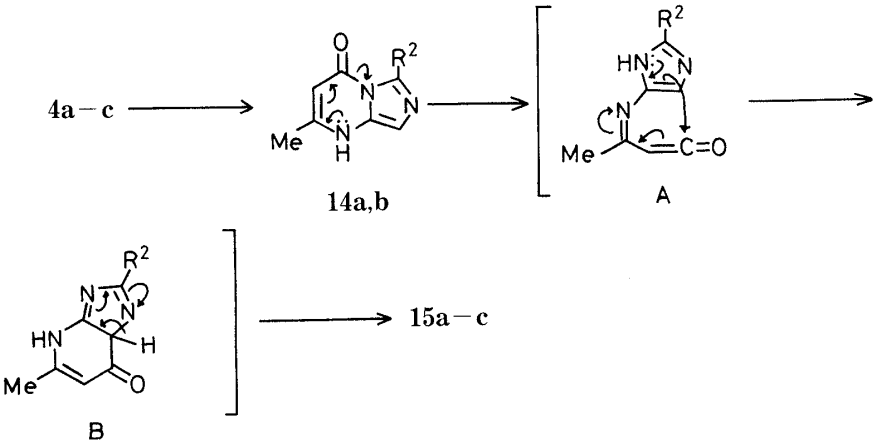


Chart 4

TABLE III. Ring Closure of **4a—c** with PPA to Imdidazo[1,5-*a*]pyrimidines (**14a, b**) and Imidazo[4,5-*b*]pyridines (**15a—c**)

4	R^2	Reaction temp. (°C)	Reaction time (h)	Yield (%)	
				14	15
a	Me	100—110	3	58	—
		180—190	10.5	—	86
b	Me_2CH	100—110	5	44	—
		100—110	10	31	43
		180—190	2.5	—	61
c	Ph	70—80	10	Recovery	
		100—110	10	—	60

TABLE IV. Imidazo[1,5-*a*]pyrimidines (**14a, b**) and Imidazo[4,5-*b*]pyridines (**15a—c, 16a—c**)

Compd.	R^2	mp (°C)	Recryst. solvent	IR (KBr) cm^{-1}	^{1}H-NMR (DMSO-d_6) δ		Formula	Analysis (%) Calcd (Found)		
					2-Me (or 5-Me)	3-H (or 6-H)		C	H	N
14a	Me	200 (dec.)	Acetone	1683	2.30	5.17	$C_8H_9N_3O$	58.89 (58.86	5.56 5.51	25.75 25.54)
14b	Me_2CH	202—203 (dec.)	Ethyl acetate	1685	2.28	5.20	$C_{10}H_{13}N_3O$	62.81 (62.79	6.85 7.09	21.97 21.71)
15a	Me	>310	Water	1620[a]	2.80	7.18[b]	$C_8H_9N_3O$	58.89 (58.67	5.56 5.53	25.75 25.89)
15b	Me_2CH	>300	Methanol	1625[a]	2.33	5.94	$C_{10}H_{13}N_3O$	62.81 (63.06	6.85 7.12	21.97 22.12)
15c	Ph	217	Methanol	1620	2.80	7.15[c]	$C_{13}H_{11}N_3O_2$	68.89 (69.32	4.75 4.92	18.43 18.66)
16a	Me	277 (dec.)	Methanol	1610	2.55	7.19	$C_8H_8ClN_3$	52.90 (53.17	4.44 4.66	23.14 23.32)
16b	Me_2CH	190—191	Benzene	1593	2.67	7.12[d]	$C_{10}H_{12}ClN_3$	57.28 (57.25	5.77 5.66	20.04 20.07)
16c	Ph	240—241	Ethyl acetate	1615	2.59	7.32	$C_{13}H_{10}ClN_3$	64.07 (64.05	4.14 4.16	17.24 17.09)

a) Nujol. *b*) In CF_3CO_2H. *c*) In $CDCl_3$–CF_3CO_2H. *d*) In $CDCl_3$.

Compound **15** would be formed by rearrangement of **14**. In fact, **14a** and **14b** were heated with PPA at 180—190 °C to give **15a** and **15b** in 43 and 56% yields, respectively. Therefore, the mechanism of the conversion of **14** to **15** can be illustrated as shown in Chart 4; *i.e.*, **4**, on treatment with PPA, cyclizes to the imidazo[1,5-*a*]pyrimidine **14**, which undergoes ring fission of the pyrimidine ring to form a ketene intermediate A.[8] Cyclization of A gives the imidazo[4,5-*b*]pyridine **15** *via* an intermediate B. Such a ring transformation is also observed in the rearrangement of pyrido[1,2-*a*]pyrimidine to 1,8-naphthyridine.[9]

Treatment of **15a—c** with $POCl_3$ gave the 7-chloro derivatives **16a—c**. Compound **16c** was treated with hydrazine hydrate in the presence of Pd-C to give 5-methyl-2-phenyl-imidazo[4,5-*b*]pyridine (**17**), which was characterized by the comparison of its spectral data

with those of an authentic sample prepared from 2,3-diamino-6-methylpyridine and benzoic acid according to the literature.[10]

In conclusion, 2-acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones, which were hitherto unknown, have been readily prepared from β-aminocrotonamide (**1**) and *N*-acylated amino acid esters, and have been found to be novel and versatile precursors for the synthesis of purine analogues such as imidazo[1,5-*a*]pyrimidine and imidazo[4,5-*b*]pyridine.

Experimental

Melting points are uncorrected. Infared (IR) spectra were taken with a JASCO A-102 spectrophotometer. Proton nuclear magnetic resonance (^{1}H-NMR) spectra were recorded on a JEOL JNM PMX-60 spectrometer using tetramethylsilane as an internal standard.

Reaction of β-Aminocrotonamide (1) with Ethyl Hippurate (3c)——Compounds **1** (0.5 g, 5 mmol) and **3c** (1.04—2.08 g, 5—10 mmol) were dissolved in a solution of NaOMe–MeOH, prepared from Na (0.12—0.58 g, 5—25 mg atom) and abs. MeOH (10—20 ml). The solution was heated under reflux for 1.5—23 h. After cooling, the reaction mixture was neutralized with 10% HCl. The mixture was concentrated under reduced pressure to give a residue, which was extracted with hot $CHCl_3$. The $CHCl_3$ extract was concentrated under reduced pressure to give a crystalline substance, which was recrystallized from methanol to give 2-benzamidomethyl-6-methylpyrimidin-4(3*H*)-one (**4c**). The results are summarized in Table I.

General Procedure for the Synthesis of 2-Acylaminoalkyl-6-methylpyrimidin-4(3*H*)-ones (4a—i)——Compound **1** (1 g, 0.01 mol) and an *N*-acylated amino acid ester (**3a—i**) (0.02 mol) were dissolved in a solution of NaOMe–MeOH, prepared from Na (1.15 g, 0.05 g atom) and abs. MeOH (20 ml). The solution was refluxed for 2—8 h. After cooling, the reaction mixture was neutralized with 10% HCl. The mixture was concentrated under reduced pressure to give a residue, which was extracted with hot $CHCl_3$. The $CHCl_3$ extract was concentrated under reduced pressure to give a crystalline substance, which was recrystallized from an appropriate solvent to furnish the corresponding product, **4a—i**. The results are summarized in Table II.

2-(1-Acetyl-2-pyrrolidinyl)-6-methylpyrimidin-4(3*H*)-one (6)——Compound **1** (3 g, 0.03 mol) and ethyl *N*-acetylprolinate (**5**) (11.1 g, 0.06 mol) were dissolved in a solution of NaOMe–MeOH, prepared from Na (3.45 g, 0.15 g atom) and abs. MeOH (60 ml). The mixture was refluxed for 8 h. After cooling, the reaction mixture was neutralized with 10% HCl, and concentrated under reduced pressure to give a residue, which was extracted with hot $CHCl_3$. The $CHCl_3$ extract was concentrated under reduced pressure to give a residue, which was subjected to silica gel column chromatography. Elution with ethyl acetate–acetone (5 : 1) gave a crystalline substance which was recrystallized from acetone to furnish **6**, colorless needles, mp 196—199 °C. Yield, 2.8 g (43%). IR (KBr): 1660 cm^{-1}. ^{1}H-NMR ($CDCl_3$) δ: 2.13 (3H, s, acetyl-Me), 2.25 (3H, s, ring-Me), 1.50—2.46 (4H, m, $-CH_2CH_2-$), 3.07—4.17 (2H, m, $N-CH_2-$), 4.73—5.07 (1H, m, CH–N), 6.05 (1H, s, ring-H), 12.00—12.73 (1H, br, NH). *Anal.* Calcd for $C_{11}H_{15}N_3O_2$: C, 59.71; H, 6.83; N, 18.99. Found: C, 59.55; H, 7.03; N, 19.07.

Reaction of 1 with Diethyl *N*-Acetylaspartate (7a)——Compounds **1** (1 g, 0.01 mol) and **7a** (4.62 g, 0.02 mol) were dissolved in a solution of MeONa–MeOH, prepared from Na (1.15 g, 0.05 g atom) and abs. MeOH (20 ml). The solution was refluxed for 5 h. The reaction mixture was concentrated under reduced pressure to give a residue, which was dissolved in a small amount of water. The aqueous solution was treated with Amberlite IR 120-B to give a crystalline substance, which was recrystallized from MeOH–ethyl acetate to furnish **8a** (or **9a**), colorless needles, mp 223—225 °C (dec.). Yield, 1.11 g (46%). IR (KBr): 1670, 1650 (sh), 1600 cm^{-1}. ^{1}H-NMR (DMSO-d_6) δ: 1.87 (3H, s, acetyl-Me), 2.17 (3H, s, ring-Me), 2.79 (2H, d, J=7 Hz, $-CH_2-$), 4.70—5.20 (1H, m, >CH), 6.03 (1H, s, ring-H), 8.28 (1H, d, J=7 Hz, NH), 10.67—12.67 (1H, br, ring-NH). *Anal.* Calcd for $C_{10}H_{13}N_3O_4 \cdot 1/5H_2O$: C, 49.46; H, 5.56; N, 17.30. Found: C, 49.58; H, 5.49; N, 17.12.

Reaction of 1 with Diethyl *N*-Benzoylaspartate (7b)——Following the procedure given for compound **8a** (or **9a**), **1** (0.5 g, 0.005 mol) was reacted with **7b** (2.5 g, 0.0085 mol) in a solution of NaOMe–MeOH, prepared from Na (0.58 g, 0.025 g atom) and abs. MeOH (10 ml), to give the product **8b** (or **9b**), colorless needles (MeOH–ethyl acetate), mp 243—245 °C (dec.). Yield, 0.6 g (50%). IR (KBr): 1702, 1650, 1600 cm^{-1}. ^{1}H-NMR (DMSO-d_6) δ: 2.18 (3H, s, ring-Me), 2.91 (2H, d, J=7 Hz, $-CH_2-$), 4.93—5.43 (1H, m, CH), 6.07 (1H, s, ring-H), 7.33—8.10 (5H, m, phenyl-H), 8.78 (1H, d, J=7 Hz, NHCOPh). *Anal.* Calcd for $C_{15}H_{15}N_3O_4 \cdot 1/5H_2O$: C, 59.09; H, 5.09; N, 13.78. Found: C, 59.19; H, 5.06; N, 13.73.

Reaction of 1 with Diethyl *N*-Acetylglutamate (10)——Compounds **1** (1 g, 0.01 mol) and **10** (4.9 g, 0.02 mol) were dissolved in a solution of NaOMe–MeOH, prepared from Na (1.2 g, 0.05 g atom) and abs. MeOH (20 ml). The solution was refluxed for 5 h. After cooling, the reaction mixture was neutralized with 10% HCl, and concentrated under reduced pressure to give a residue, which was extracted with hot $CHCl_3$. The $CHCl_3$ extract was concentrated under reduced pressure to give a residue, which was subjected to silica gel column chromatography. Elution with ethyl acetate gave 0.1 g (8%) of 2,6-dimethylpyrimidin-4(3*H*)-one, colorless needles (acetone), mp 194—195 °C.

Further elution with the same solvent gave the product **11**, colorless needles (acetone), mp 197—198 °C. Yield, 0.9 g (47%), IR (KBr): 1660, 1600 cm^{-1}. ^{1}H-NMR (DMSO-d_6) δ: 2.10—2.43 (7H, m, ring-Me and $-CH_2CH_2-$), 4.33—4.67 (1H, m, CHN), 6.10 (1H, s, ring-H), 7.90 (1H, s, pyrrolidine-NH), 11.60—12.80 (1H, br, ring-NH). *Anal.* Calcd for $C_9H_{11}N_3O_2$: C, 55.95; H, 5.74; N, 21.75. Found: C, 55.90; H, 5.74; N, 21.51.

2-(2-Acetamidoethyl)-6-methylpyrimidin-4(3*H*)-one (13)——Following the general procedure given for compounds **4a—i**, **1** (2.2 g, 0.022 mol) was reacted with ethyl 3-acetamidopropionate (**12**) in a solution of NaOMe–MeOH, prepared from Na (2.57 g, 0.11 g atom) and abs. MeOH, to give the product **13**, colorless needles (MeOH–ethyl acetate), mp 239—241 °C. Yield, 2.92 g (68%). IR (Nujol): 1690, 1650, 1605 cm^{-1}. ^{1}H-NMR (DMSO-d_6) δ: 1.83 (3H, s, acetyl-Me), 2.20 (3H, s, ring-Me), 2.68 (2H, t, J=7 Hz, $-\underline{CH_2}CH_2NH$), 3.20—3.73 (2H, m, $CH_2\underline{CH_2}NH$), 6.05 (1H, s, ring-H), 7.77—8.20 (1H, m, $N\underline{H}COMe$), 11.90—12.53 (1H, br, ring-NH). *Anal.* Calcd for $C_9H_{13}N_3O_2$: C, 55.37; H, 6.71; N, 21.53. Found: C, 55.10; H, 6.63; N, 21.44.

Imidazo[1,5-*a*]pyrimidin-4(1*H*)-ones (14a, b)——Compound **4a, b** was heated with PPA (ten-fold excess) at 100—110 °C for 3—5 h. The reaction mixture was poured into ice-water. The solution was neutralized with $NaHCO_3$, and extracted with ethyl acetate. The extract was dried over anhydrous sodium sulfate, and concentrated under reduced pressure to give a crystalline substance, which was recrystallized from an appropriate solvent to furnish the product **14a, b**. The results are summarized in Tables III and IV.

7-Hydroxyimidazo[4,5-*b*]pyridines (15a, b)——Compound **4a** or **b** was heated with PPA (ten-fold excess) at 180—190 °C for 2.5—10.5 h. The reaction mixture was poured into ice-water. The solution was neutralized with $NaHCO_3$, and the precipitated crystals were collected by suction. Recrystallization from an appropriate solvent gave the product, **15a** or **c**.

7-Hydroxy-5-methyl-2-phenylimidazo[4,5-*b*]pyridine (15c)——Compound **4c** (1 g, 0.004 mol) was heated with PPA (5 g) at 100—110 °C for 10 h. The reaction mixture was poured into ice-water. The precipitated crystals were collected by suction, and washed with 5% aqueous $NaHCO_3$ solution. Recrystallization from MeOH gave the product **15c**, colorless needles, mp 217 °C. Yield, 0.56 g (60%).

Conversion of 14a, b to 15a, b——Following the procedure given for compounds **15a, b**, **14a** (0.2 g) and **14b** (0.45 g) were each heated with PPA (ten-fold excess) at 180—190 °C for 2 h to give **15a** (0.086 g) and **15b** (0.25 g) in 43 and 56% yields, respectively.

General Procedure for the Chlorination of 15a—c with $POCl_3$——A suspension of one of **15a—c** in $POCl_3$ (ten-fold excess) was heated at 90 °C for 1—8 h. The excess $POCl_3$ was evaporated off under reduced pressure to give a residue, which was poured into ice-water. The mixture was neutralized with K_2CO_3, and the precipitated crystals were collected by suction. The filtrate was extracted with $CHCl_3$. The $CHCl_3$ extract was dried over anhydrous sodium sulfate, and evaporated under reduced pressure to give crystals. Both crops of crystals were combined, and recrystallized from an appropriate solvent to give the corresponding porudct, **16a—c**. Yields: **16a** (81%), **16b** (91%), **16c** (79%). The results are summarized in Table IV.

5-Methyl-2-phenylimidazo[4,5-*b*]pyridine (17)——1) Hydrazine hydrate (80%, 0.5 ml) and 10% Pd-C (50 mg) were added to a solution of **16c** (0.09 g) in EtOH (10 ml). The mixture was refluxed for 5 min with stirring. The catalyst was filtered off, and the filtrate was concentrated under reduced pressure to give a residue, to which water was added. The precipitated crystals were collected by suction, and recrystallized from ethyl acetate to give the product **17**, colorless needles, mp 207—209 °C. IR (KBr): 1625, 1601 cm^{-1}. ^{1}H-NMR (DMSO-d_6) δ: 2.55 (3H, s, ring-Me), 7.10 (1H, d, J=8 Hz, ring-H), 7.95 (1H, d, J=8 Hz, ring-H), 7.5—8.5 (5H, m, phenyl-H).

2) A mixture of benzoic acid (0.48 g, 0.0044 mol), 2,3-diamino-6-methylpyridine (0.54 g, 0.0044 mol) and PPA (6 ml) was heated at 175 °C for 2 h. The reaction mixture was poured into ice-water. The precipitated crystals were collected by suction, and recrystallized from ethyl acetate to give the product **17**. Yield, 0.64 g (69%).

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