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Synthesis of Novel Tricyclic Pyrimido[4,5-*b*][1,4]benzothiazepines via Bischler−Napieralski-Type Reactions

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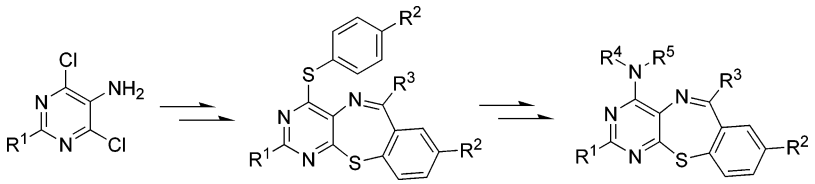

Novel tricyclic pyrimido[4,5-*b*][1,4]benzothiazepines were readily prepared from 5-amino-4,6-bis(arylthio)pyrimidines and carboxylic acids via Bischler−Napieralski-type reactions. The 6-aryl sulfide group of the resulting pyrimido[4,5-*b*][1,4]benzothiazepines could be selectively oxidized to its corresponding sulfoxide, which underwent facile substitution reactions when treated with nucleophiles such as an amine. This synthetic strategy provides an efficient way to access a library of novel heterocyclic compounds that are of interest in drug discovery.

Introduction

The development of privileged heterocyclic scaffolds is a rapidly emerging subject in medicinal chemistry.[1] Pyrimidines and pyrimidine-fused compounds are widely studied because of their interesting pharmacological activities. For example, some pyrrolopyrimidines are reported to have antitumor activities,[2] some aminopyridopyrimidines are novel non-nucleoside adenosine kinase inhibitors,[3] certain furanopyrimidines are potent and selective inhibitors of human cytomegalovirus (HCMV),[4] and 5-substituted furo[2,3-*d*]pyrimidines exhibit potent inhibitory activity against the growth of tumor cells.[5] Another class of heterocyclic scaffolds with celebrated biological activities in the central nervous system is the benzothiazepines.[6,7] For example, clozapine is used as an antipsychotic agent, and benzothiazepine analogues quetiapine and clothiapine have been shown to be atypical antipsychotic agents.[7]

It was therefore reasoned that the fusion of pyrimidine and benzothiazepine may lead to a novel tricyclic heterocyclic scaffold with interesting biological activities. However, only a few studies have been directed to the synthesis of tricyclic benzothiazepines. Brodrock et al. reported a Bischler−Napieralski-type cyclization of 2-benzamidodiaryl sulfides in the preparation of dibenzothiazepines.[8] Subsequently, Hunziker extended the methodology to other dibenzothiazepine derivatives.[9] In 1957, Jarrett and Loudon developed a route by condensing *o*-aminothiophenol with reactive *o*-chlorophenyl alde-

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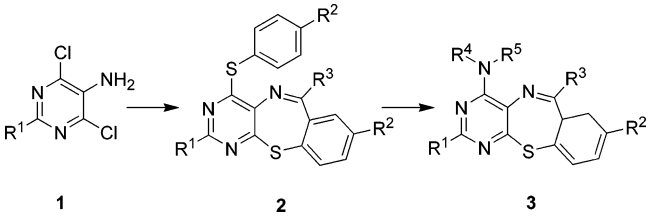
SCHEME 1. Strategy for Preparation of Pyrimido[4,5-*b*][1,4]benzothiazepines



hydes or ketones.[10] This strategy was the focus of several follow-up reports,[11] and Le Roux observed dibenzothiazepine in the arrangement of an azide compound.[12] Thus far, to the best of our knowledge, there is only one report describing the preparation of pyrimidobenzothiazepines from the reactions of 5-amino-6-mercaptopyrimidines with derivatives of *p*-chloronitrobenzene containing a carbonyl group.[13]

Recently, we introduced a new methodology for the efficient synthesis of pyrimidine-fused benzodiazepines via an intramolecular Friedel−Crafts reaction of *N*-methylanilinopyrimidineamines.[14] To expand the scope of the method and access new heterocyclic scaffolds, we envisioned that pyrimido[4,5-*b*][1,4]benzothiazepines could be readily prepared from 5-amino-4,6-dichloropyrimidines **1** in a similar fashion as the pyrimidine-fused benzodiazepines (Scheme 1). Moreover, the resulting pyrimidobenzothiazepines **2** are versatile intermediates and could lead to large libraries of heterocycles as shown in Scheme 1. Herein, the details of these studies are presented.

Results and Discussion

Initially, a synthetic strategy was designed to utilize commercially available 5-amino-4,6-dichloropyrimidine **1** as the starting material according to Scheme 2. Selective substitution of pyrimidine **1** with a thiophenol should yield a monosubstituted compound **4**. A subsequent intramolecular cyclization reaction of pyrimidines **4** with a carboxylic acid should lead to benzothiazepine **5**. A final nucleophilic substitution of the chloro group in compound **5** should generate the corresponding tricyclic products **3** with an extra diversity element.

When 5-amino-4,6-dichloropyrimidine was reacted with 1 equiv of thiophenols, no selectivity toward monosubstitution was observed after extensive investigation of various conditions. The bisphenylthio product **6.1** was always produced in substantial amount under reaction conditions including varying the base catalyst (K_2CO_3 or Et_3N), solvent (*n*-BuOH, DMF or THF), addition orders, and the amount of thiophenol. This observation may be attributed to the high nucleophlicity of thiophenol and high propensity of both chloro groups on pyrimidines **1** toward nucleophilic substitution. In addition, isolation of the monophenylthio-substituted product **4** from the reaction mixture was difficult using conventional flash column chromatography. Furthermore, when a mixture of pyrimidine **4** and bis-substituted pyrimidine **6.1** was subjected to the cyclization with benzoic acid, as shown in Scheme 3, oxazolopyrimidine **7** (presumably derived from pyrimidine **4** via an intramolecular cyclization reaction of the newly formed amide group with the neighboring 6-chloro group) was isolated. It is noteworthy that the formation of oxazolopyrimidines from chloroaminopyrimidines has been reported in the literature.[15] This result indicates that the high reactivity of the 6-chloro group in pyrimidine **4** renders it unsuitable for the proposed cyclization reaction leading to pyrimidobenzothiadiazepines.

Given the unexpected difficulty in preparing the monothio-substituted pyrimidine **4** and more importantly the facile conversion of pyrimidine **4** to oxazolopyrimidine **7**, a modification of the initial route (Scheme 1) was proposed to entail the cyclization of 5-amino-4,6-bisphenylthiopyrimidine **6** and carboxylic acids as shown in Scheme 4. The 6-arylthio group in the cyclized products pyrimidobenzothiazepines **2** can be activated via oxidation to its corresponding sulfoxide before the final nucleophilic substitution reaction.

Preparation of Precursors. Commercially available 5-amino-4,6-dichloropyrimidine **1** was treated with thiophenol or its analogue in reluxing *n*-BuOH in the presence of Et_3N to give 5-amino-4,6-bisphenylthiopyrimidine **6.1** or its corresponding analogues **6.2**, **6.3**, and **6.4** in high yields. O-Methylation of **6.4** afforded compound **6.5**.

Cyclization. Various cyclization conditions of 5-amino-4,6-bisphenylthiopyrimidine with benzoic acid in PPA/$POCl_3$ were studied. While no cyclization product was obtained below the temperature of refluxing $POCl_3$, 95% of the desired cyclization product **4** was isolated in the refluxing temperature of $POCl_3$ after 30 h. The reactions of several analogues of 5-amino-4,6-bisphenylthiopyrimidine with a variety of carboxylic acids or derivatives were investigated under the above conditions and the results are shown in Table 1.

The cyclization proceeded faster when R^2 was an electron-donating group (CH_3 or MeO, entries 2.11−2.16, 2.21, and 2.22) compared to those with either a proton R^2 = H (entries 2.1−2.10) or an electron-withdrawing group R^2 = Cl (entries 2.17−2.20). These results indicated that the cyclization favored an electron-rich phenyl ring. The reaction with an aromatic acid (entries 2.1−2.7, 2.11−2.14, 2.17−2.19, 2.21) was in general slower than that with an aliphatic acid (entries 2.8−2.10, 2.15, 2.16, 2.20, 2.22). Among cyclizations with aromatic acids, nicotinic acid (entry 2.2, 2.12, 2.19) was the slowest. The reaction yields were more sensitive to carboxylic acid (R^3) compared to substitution on the thiophenol ring. Higher yields were obtained with aromatic carboxylic acids compared to aliphatic ones. Moreover, the reaction yields were even higher when the phenyl ring of the aromatic acids was substituted by an electron-donating group. The presence of an electron-withdrawing group in the aro-

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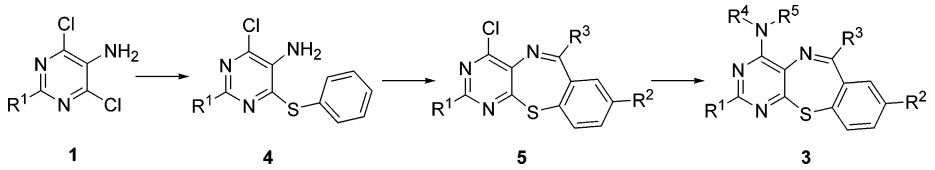
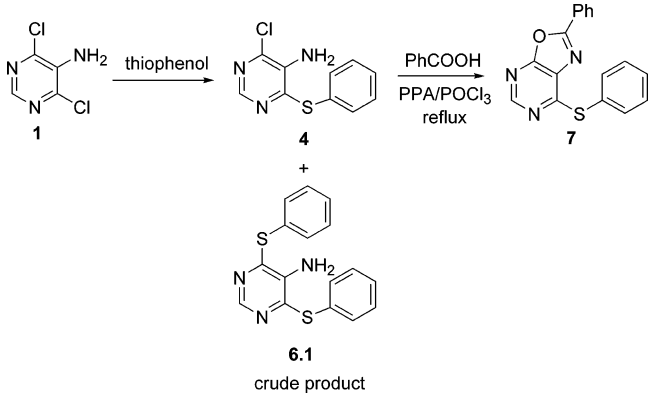
SCHEME 2. Initial Plan To Obtain Pyrimido[4,5-*b*][1,4]benzothiazepines



SCHEME 3. Attempted Cyclization Reaction of Pyrimidines 4 and 6.1

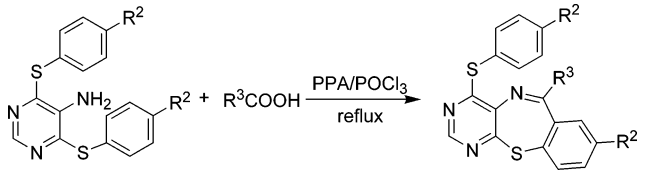


matic acid (NO_2 or F, entries 2.4−2.6, 2.7, 2.14) resulted in loss of the reaction yields.

The above cyclization may be rationalized by a mechanism similar to the Bischler−Napieralski-type reaction as shown in Scheme 5. In refluxing PPA/$POCl_3$, the bis(phenylthio) compound **6** was first acylated to give product **9**, which was in equilibrium with its tautomer **10**. Then structure **10** was converted to imidoyl chloride **11**, which in turn changed to its corresponding nitrilium salt **12**. Nitrilium **12** underwent an intramolecular electrophilic substitution on the phenyl ring and subsequent elimination of hydrogen chloride to yield the final thiazepine skeleton. This mechanism is consistent with similar ones reported in the literature.[15] When R_3 was aromatic, the stable intermediate **11** could be isolated and characterized. In the slowest cyclization (entry 2.19), intermediate **11.19** is the most stable. It was purified and characterized by LC−MS and NMR. The isolation and characterization of intermediate **11.19** provided strong support for the proposed mechanism (Figure 1).

The cyclization results are consistent with the mechanism. The reaction proceeded well with 1.5 equiv of aromatic acids. However, an excess amount of aliphatic acids resulted in a loss of cyclized products due to the formation of imides ($-CH_2CONCOCH_2-$) with the aniline nitrogen. While electron-donating R^2 groups could acti-

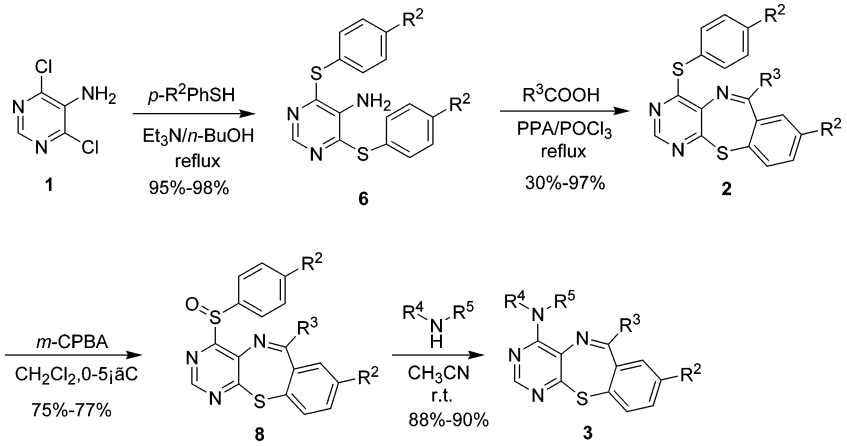
TABLE 1. Cyclization of 5-Amino-4,6-bis(phenylthio)pyrimidine[a]



entry	R^2	R^3	time	yield (%)
2.1	H	Ph	30 h	95
2.2	H	pyridin-3-yl	8 d	93
2.3	H	4′-CH_3-C_6H_4	35 h	97
2.4	H	2′-NO_2-C_6H_4	30 h	70
2.5	H	4′-NO_2-C_6H_4		*a*
2.6	H	3′-NO_2-C_6H_4		*a*
2.7	H	4′-F-C_6H_4	35 h	52
2.8	H	CH_3	14 h	45
2.9	H	$CH_3CH_2CH_2$[c]	14 h	47
2.10	H	$PhCH_2$	12 h	65
2.11	CH_3	Ph	20 h	97
2.12	CH_3	pyridin-3-yl	3 d	97
2.13	CH_3	4′-CH_3-C_6H_4	15 h	96
2.14	CH_3	4′-F-C_6H_4	30 h	80
2.15	CH_3	$CH_3CH_2CH_2$[c]	10 h	67
2.16	CH_3	$PhCH_2$	10 h	60
2.17	Cl	Ph	5 d	98
2.18	Cl	4′-CH_3-C_6H_4	12 d	95
2.19	Cl	pyridin-3-yl	16 d	12[b]
2.20	Cl	$PhCH_2$	32 h	30
2.21	MeO	Ph	18 h	80
2.22	MeO	$PhCH_2$	7 h	30

[a] Under the conditions of PPA/$POCl_3$, 1.5 equiv of aromatic acid was added and 1.0 equiv of aliphatic acid was added: (a) trace product was obtained; (b) 80% of intermediate **11.19** was recovered; (c) $CH_3CH_2CH_2COCl$ was utilized.

SCHEME 4. Redesigned Synthetic Route to 4-Phenylthiopyrimido[4,5-*b*][1,4]benzothiazepines



SCHEME 5. Mechanism of Cyclization

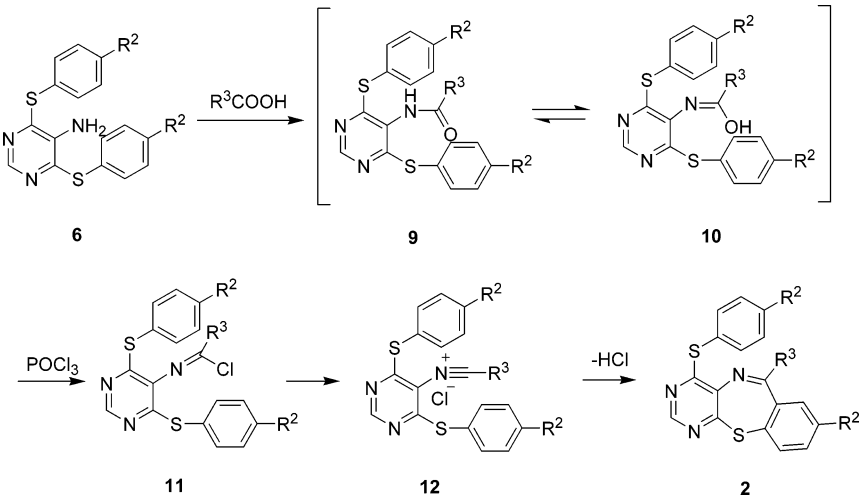
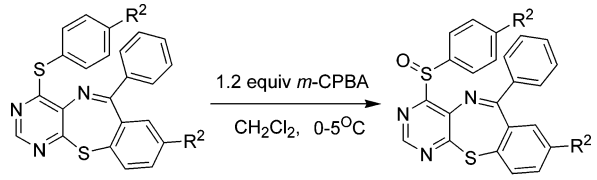
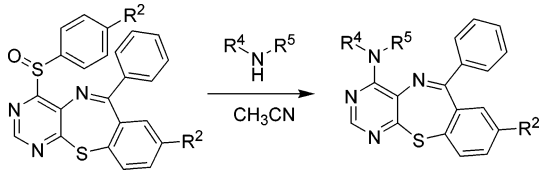


TABLE 2. Selective Oxidation



entry	R^2	time (h)	yield (%)
8.1	H	4	77
8.2	CH_3	3	75
8.3	Cl	4	75

TABLE 3. Substitution with Amines



entry	R^2	R^4	R^5	yield (%)
3.1	H	H	*n*-Bu	90
3.2	H	$-(CH_2)_4-$		90
3.3	CH_3	H	*n*-Bu	88
3.4	Cl	H	*n*-Bu	90

vate the phenyl ring toward an electrophilic substitution, the presence of a methoxy group resulted in attenuated yield. The aromatic acids formed more stable intermediates and cyclization products by conjugation as compared to their aliphilic counterparts. Therefore, they gave a slower reaction rate, and on the contrary, higher yields.

Oxidation and Replacement of the Phenylthio Groups. The 4-phenylthio group was put in by design to provide an entrance to an additional diversity point. The phenylthio compound **2** could be oxidized to its corresponding sulfoxide or sulfone. Although there are two sulfur atoms present in compound **2**, it was anticipated that the sulfur atom that is part of the pyrimidobenzothiazepine ring system should be less prone to oxidation compared to the 4-phenylthio group. Therefore, treatment of compound **2** with *m*-CPBA readily provided the desired sulfoxides **8**, which was achieved by dropwise addition of 1.2 equiv of *m*-CPBA in CH_2Cl_2 at 0 °C (Table 2). Elevated temperature or increase in amount of oxidant resulted in increased amount of byproducts from overoxidation.[16]

The sulfoxide group in compound **8** could be readily replaced by a nucleophilie. To test its versatility, the desired amine-substituted products were obtained with high yields in dry CH_3CN at room temperature in 15 min (Table 3).

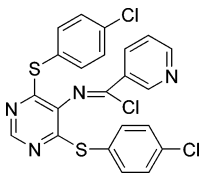


FIGURE 1. Structure of **11.19**.

Conclusion

In conclusion, an efficient methodology for the synthesis of 4-phenylthiopyrimido[4,5-*b*][1,4]benzothiazepines was developed. The reaction of 5-amino-4,6-bisphenylthiopyrimidines with a carboxylic acid under refluxing PPA/$POCl_3$ yielded the desired cyclization products in excellent yields. This transformation can be rationalized by a mechanism similar to the Bischler−Napieralski-type reaction. The aryl sulfide group of the resulting 4-arylthiopyrimido[4,5-*b*][1,4]benzothiazepines can be subjected to selective oxidation and subsequent nucleophilic substitution to produce derivatives with more diversities. This strategy provides an efficient way to access a library of novel compounds that are of interest in drug discovery.

Experimental Section

General Considerations. All reactions were carried out under nitrogen atmosphere. Phosphoryl oxychloride was freshly

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distilled. Acetonitrile was dried over anhydrous K_2CO_3. Dichloromethane was dried over anhydrous $CaCl_2$. All other commercial reagents were used as received without additional purification. Melting points were uncorrected. Mass spectra and HPLC (ELSD) data were recorded on an 1100 LC/MS system using a 4.6 × 50 mm column (5 μm) with a linear gradient of 30−90% (v/v) acetonitrile−water with 0.035% trifluoroacetic acid over 8 min with a flow rate of 3.5 mL/min. Analytical TLC was performed using 2.5 × 5 cm plates coated with a 0.25 mm thickness of silica gel 60 F_{254}. Column chromatography was performed using silica gel G (200−300 mesh). All ^{1}H NMR spectra (300 MHz) are reported as follows: chemical shifts in ppm downfield from TMS as internal standard (δscale) and $CDCl_3$ or DMSO-d_6 as the solvent. Multiplicities are indicated as the following: multiplicity [br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m=multiplet, integration and coupling constant (Hz)]. All ^{13}C NMR spectra (75 MHz) were determined with complete proton decoupling and reported in ppm.

Synthesis of a Mixture of 4-Chloro-5-amino-6-(phenylthio)pyrimidine 4 and Its Disubstituted Analogue 5-Amino-4,6-bis(phenylthio)pyrimidine 6.1. 5-Amino-4,6-dichloropyrimidine (0.652 g, 4.00 mmol) and thiophenol (0.485 g, 0.45 mL, 4.40 mmol) were added to a solution of triethylamine (0.81 g, 1.12 mL, 8.00 mmol) in 1-butanol (20 mL). The reaction mixture was stirred and refluxed overnight. It was concentrated in vacuo. CH_2Cl_2 (150 mL) was added to the residue. The organic phase was washed twice with brine (60 mL), dried over anhydrous Na_2SO_4, and concentrated in vacuo to yield the crude product as a solid. Purification by recrystallization from petroleum ether/EtOAc (10:1, v/v) provided a mixture of **4** and **6.1** (1.00 g) as a white solid, which was analyzed and characterized by LC/MS. The ratio of **4** and **6.1** was confirmed by ELSD to be 8:1 by weight. The white solid was used directly in the next step without further purification.

Synthesis of 2-Phenyl-7-(phenylthio)oxazolo[5,4-*d*]pyrimidine 7. The above crude product of 4-chloro-5-amino-6-(phenylthio)pyrimidine **4** and its disubstituted analogue 5-amino-4,6-bis(phenylthio)pyrimidine **6.1** (0.119 g), benzoic acid (0.092 g, 0.75 mmol), and PPA (0.253 g, 0.75 mmol) were dissolved in $POCl_3$ (5.0 mL), and stirred under reflux overnight. The reaction mixture was concentrated in vacuo and diluted with EtOAc (15 mL), and water (15 mL) was added slowly. The water layer was treated with 5 N aqueous NaOH to pH 10 and extracted with EtOAc (2 × 15 mL). The combined EtOAc layer was washed with saturated Na_2CO_3 and brine, dried over anhydrous Na_2SO_4, concentrated in vacuo, and purified by flash chromatography with petroleum ether/EtOAc (20:1, v/v) as eluent to afford 0.10 g of **7** as a white solid: mp 139−140 °C; ^{1}H NMR ($CDCl_3$) δ 8.64 (s, 1 H), 8.28−8.25 (m, 2 H), 7.71−7.67 (m, 2 H), 7.61−7.46 (m, 6 H); ^{13}C NMR ($CDCl_3$) δ 163.5, 162.1, 161.6, 153.7, 135.9, 133.0, 130.1, 129.7, 129.3, 128.4, 126.9, 125.9; ES-MS 306.0 [M + H$^+$].

General Procedure for the Synthesis of 5-Amino-4,6-bis(phenylthio)pyrimidine 6. 5-Amino-4,6-dichloropyrimidine (0.652 g, 4.00 mmol) and thiophenol (0.97 g, 0.9 mL, 8.80 mmol) were added to a solution of triethylamine (1.62 g, 2.24 mL, 16.00 mmol) in *n*-BuOH (20 mL). The reaction mixture was stirred, refluxed overnight, and then concentrated in vacuo. CH_2Cl_2 (150 mL) was added to the residue. The organic phase was washed twice with brine (60 mL), dried over anhydrous Na_2SO_4, and concentrated in vacuo to yield the crude product as a solid. Purification by recrystallization from petroleum ether/EtOAc (10:1, v/v) provided the desired product 5-amino-4,6-bis(phenylthio)pyrimidine **6.1** (1.182 g, 95%) as a yellow solid: mp 80−82 °C; ^{1}H NMR ($CDCl_3$) δ 8.24 (s, 1 H), 7.52−7.47 (m, 4 H), 7.42−7.37 (m, 6 H); ^{13}C NMR ($CDCl_3$) δ 149.6, 148.5, 136.3, 133.8, 129.4, 129.0, 128.9; ES-MS 312.1 [M + H$^+$].

5-Amino-4,6-bis(*p*-tolylthio)pyrimidine (6.2): 95%; white plates; mp 185−186 °C; ^{1}H NMR ($CDCl_3$) δ 8.22 (s, 1 H), 7.40 (d, J = 8.1 Hz, 4 H), 7.21 (d, J = 8.1 Hz, 4 H), 4.17 (s, 2 H), 2.37 (s, 6 H); ^{13}C NMR ($CDCl_3$) δ 150.1, 148.7, 139.2, 135.6, 134.2, 130.2, 125.1, 21.3; ES-MS 340.1 [M + H$^+$].

5-Amino-4,6-bis(*p*-chlorophenylthio)pyrimidine (6.3): 96%; white plates; mp 205−206 °C; ^{1}H NMR (DMSO-d_6) δ 7.98 (s, 1 H), 7.51 (s, 8 H), 5.52 (s, 2 H); ^{13}C NMR (DMSO-d_6) δ 153.1, 151.5, 141.2, 141.0, 139.1, 134.5, 133.0; ES-MS 380.0 [M + H$^+$].

5-Amino-4,6-bis(*p*-hydroxy)phenylthiopyrimidine (6.4): 98%; white powder, mp 226−228 °C; ^{1}H NMR (DMSO-d_6) δ 9.86 (s, 2 H), 7.90 (s, 1 H), 7.30 (d, J = 8.7 Hz, 4 H), 6.82 (d, J = 8.4 Hz, 4 H), 5.17 (s, 2 H); ^{13}C NMR (DMSO-d_6) δ 164.1, 154.9, 151.9, 142.4, 139.8, 121.8, 121.7; ES-MS 344.0 [M + H$^+$].

5-Amino-4,6-bis(*p*-methoxyphenylthio)pyrimidine 6.5. Compound **6.5** was prepared by methylation of compound **6.4** with iodomethane. The procedure was as follows. To a suspension of anhydrous K_2CO_3 (0.415 g, 3.00 mmol) in acetone (5 mL) were added 4,6-bis(*p*-hydroxy)phenylthio-5-aminopyrimidine **6.4** (0.343 g, 1.00 mmol) and iodomethane (0.596 g, 4.20 mmol), and the mixture was refluxed with stirring overnight. After the mixture was cooled to room temperature, the solvent was removed in vacuo. EtOAc (20 mL) was added, and the solution was washed twice with water (10 mL) and dried over anhydrous Na_2SO_4. After evaporation of the solvent, the crude product was purified by recrystallization from EtOAc to provide the desired product **6.5** 0.334 g (90%) as white plates.

5-Amino-4,6-bis(*p*-methoxyphenylthio)pyrimidine (6.5): 90%; white plates; mp 189−191 °C; ^{1}H NMR ($CDCl_3$) δ 8.20 (s, 1 H), 7.46 (d, J = 9.0 Hz, 4 H), 6.94 (d, J = 8.7 Hz, 4 H), 4.13 (s, 2 H), 3.83 (s, 6 H); ^{13}C NMR ($CDCl_3$) δ 160.5, 150.6, 148.7, 136.3, 134.7, 118.7, 115.0, 55.3; ES-MS 372.1 [M + H$^+$].

General Procedure for the Synthesis of 4-(Phenylthio)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine 2.1. 5-Amino-4,6-bis(phenylthio)pyrimidine **6.1** (0.156 g, 0.50 mmol), benzoic acid (0.092 g, 0.75 mmol), and PPA (0.253 g, 0.75 mmol) were dissolved in $POCl_3$ (5.0 mL) and the mixture stirred under reflux for 30 h. The reaction mixture was concentrated in vacuo and diluted with ethyl acetate (15 mL), and water (15 mL) was added slowly. The water layer was treated with 5 N aqueous NaOH to pH 10 and extracted with EtOAc (2 × 15 mL). The combined EtOAc layer was washed with saturated Na_2CO_3 and brine, dried over anhydrous Na_2SO_4, concentrated in vacuo, and purified by flash chromatography with petroleum ether/EtOAc (15:1, v/v) as eluent to afford 0.189 g (95%) of **2.1** as a yellow solid.

4-(Phenylthio)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine (2.1): 95%; yellow solid; mp 171−173 °C; ^{1}H NMR ($CDCl_3$) δ 8.45 (s, 1 H), 7.94−7.91 (m, 2 H), 7.65−7.31 (m, 12 H); ^{13}C NMR ($CDCl_3$) δ 171.2, 166.7, 154.5, 153.0, 139.7, 137.9, 137.5, 137.3, 135.8, 134.0, 132.6, 131.9, 131.4, 130.5, 129.8, 129.6, 128.7, 128.6, 128.5; ES-MS 398.1 [M + H$^+$]. Anal. Calcd for $C_{23}H_{15}N_3S_2$: C, 69.49; H, 3.80; N, 10.57. Found: C, 69.48; H, 3.72; N, 10.62.

4-(Phenylthio)-6-(pyridin-3-yl)pyrimido[4,5-*b*][1,4]-benzothiazepine (2.2): 93%; yellow solid;, mp 241−243 °C; ^{1}H NMR ($CDCl_3$) δ 9.05 (br s, 1 H), 8.78 (br s, 1 H), 8.48 (s, 1 H), 8.34 (dt, J = 8.4, 1.8 Hz, 1 H), 7.67 (dd, J = 7.2, 0.9 Hz, 1 H), 7.61−7.56 (m, 3 H), 7.49−7.41 (m, 5 H), 7.34 (dd, J = 6.6, 1.5 Hz, 1 H); ^{13}C NMR ($CDCl_3$) δ 168.9, 166.9, 154.9, 153.1, 152.4, 151.5, 137.6, 137.3, 136.4, 135.8, 135.4, 134.4, 133.1, 131.0, 129.9, 129.6, 129.0, 128.2, 123.6; ES-MS 399.1 [M + H$^+$].

4-(Phenylthio)-6-(pyridin-3-yl)pyrimido[4,5-*b*][1,4]-benzothiazepine (2.2): 93%; yellow solid; mp 241−243 °C; ^{1}H NMR ($CDCl_3$) δ 9.05 (br s, 1 H), 8.78 (br s, 1 H), 8.48 (s, 1 H), 8.34 (dt, J = 8.4, 1.8 Hz, 1H), 7.67 (dd, J = 7.2, 0.9 Hz, 1H), 7.61−7.56 (m, 3H), 7.49−7.41 (m, 5H), 7.34 (dd, J = 6.6, 1.5 Hz, 1H); ^{13}C NMR ($CDCl_3$) δ 168.9, 166.9, 154.9, 153.1, 152.4, 151.5, 137.6, 137.3, 136.4, 135.8, 135.4, 134.4, 133.1, 131.0, 129.9, 129.6, 129.0, 128.2, 123.6; ES-MS 399.1 [M + H$^+$].

4-(Phenylthio)-6-*p*-tolylpyrimido[4,5-*b*][1,4]-benzothiazepine (2.3): 97%; yellow solid; mp 164−167 °C; ^{1}H NMR ($CDCl_3$) δ 8.44 (s, 1 H), 7.82 (d, J = 8.1 Hz, 2 H), 7.65−7.25 (m, 11 H), 2.45 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.8, 166.4, 154.0, 152.7, 142.3, 137.8, 137.2, 137.1, 136.7, 135.5, 133.7, 132.3, 131.2, 130.2, 129.5, 129.3, 129.2, 128.3, 21.6; ES-MS 412.1 [M + H$^+$].

4-(Phenylthio)-6-(*o*-nitrophenyl)pyrimido[4,5-*b*][1,4]-benzothiazepine (2.4): 70%; yellow solid; mp 190−192 °C; ^{1}H NMR ($CDCl_3$) δ 8.49 (s, 1 H), 8.07 (dd, J = 8.1, 1.2 Hz, 1 H), 7.97 (dd, J = 7.8, 1.2 Hz, 1 H), 7.81 (td, J = 7.8, 1.2 Hz, 1 H), 7.68 (td, J = 8.1, 1.5 Hz, 1 H), 7.62−7.54 (m, 3 H), 7.52 (dd, J = 7.5, 1.5 Hz, 1 H), 7.49−7.43 (m, 3 H), 7.29 (td, J = 8.1, 1.4 Hz, 1 H), 7.09 (dd, J = 7.5, 1.2 Hz, 1 H); ^{13}C NMR ($CDCl_3$) δ 170.1, 167.6, 155.5, 153.7, 149.1, 137.6, 137.5, 137.1, 136.7, 135.9, 134.0, 133.7, 133.4, 132.7, 131.3, 129.9, 129.6, 129.5, 129.0, 128.1, 125.0; ES-MS 443.1 [M + H$^+$].

4-(Phenylthio)-6-(*p*-fluorophenyl)pyrimido[4,5-*b*][1,4]-benzothiazepine (2.7): 52%; yellow solid; mp 197−198 °C; ^{1}H NMR ($CDCl_3$) δ 8.46 (s, 1 H), 7.97−7.92 (m, 2 H), 7.65 (dd, J = 8.0, 1.4 Hz, 1 H), 7.61−7.57 (m, 2 H), 7.54 (dd, J = 7.5, 1.5 Hz, 1 H), 7.48−7.43 (m, 3 H), 7.40 (dd, J = 7.2, 1.2 Hz, 1 H), 7.33 (dd, J = 7.7, 1.7 Hz, 1 H), 7.22−7.14 (m, 2 H); ^{13}C NMR ($CDCl_3$) δ 169.8, 166.9, 165.1 (J = 235.8 Hz), 154.5, 152.9, 137.5, 137.0, 135.8, 135.5, 134.2, 132.8, 132.7 (J = 9.2 Hz), 131.2, 129.9, 129.6, 129.5, 128.7, 128.3, 115.8 (J = 20.6 Hz); ES-MS 416.1 [M + H$^+$].

4-(Phenylthio)-6-methylpyrimido[4,5-*b*][1,4]benzo-thiazepine (2.8): 45%; yellow oil; ^{1}H NMR ($CDCl_3$) δ 8.42 (s, 1 H), 7.55−7.52 (m, 4 H), 7.46−7.42 (m, 5 H), 2.77 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 173.5, 165.9, 153.9, 153.2, 138.9, 137.5, 136.2, 135.5, 133.5, 132.0, 129.5, 129.3, 129.0, 128.2, 29.1; ES-MS 336.0 [M + H$^+$].

4-(Phenylthio)-6-propylpyrimido[4,5-*b*][1,4]benzo-thiazepine (2.9): 47%; yellow solid; mp 166−168 °C; ^{1}H NMR ($CDCl_3$) δ 8.41 (s, 1 H), 7.55−7.46 (m, 4 H), 7.45−7.39 (m, 4 H), 3.01 (t, J = 7.5 Hz, 2 H), 1.90−1.78 (m, 2 H), 1.10 (t, J = 7.5 Hz, 3 H); ^{13}C NMR ($CDCl_3$) δ 176.8, 165.9, 153.8, 153.2, 138.5, 137.6, 136.7, 135.5, 133.5, 131.7, 129.5, 129.2, 129.0, 128.3, 128.1, 43.7, 20.4, 13.9; ES-MS 364.1 [M + H$^+$].

4-(Phenylthio)-6-benzylpyrimido[4,5-*b*][1,4]benzo-thiazepine (2.10): 65%; yellow solid; mp 149−151 °C; ^{1}H NMR ($CDCl_3$) δ 8.42 (s, 1 H), 7.57−7.52 (m, 3 H), 7.48−7.36 (m, 8 H), 7.35−7.20 (m, 3 H), 4.38 (s, 2 H); ^{13}C NMR ($CDCl_3$) δ 175.1, 166.2, 154.4, 153.7, 138.3, 137.7, 137.3, 136.4, 135.8, 133.8, 132.1, 129.8, 129.6, 129.5, 129.2, 128.9, 128.5, 128.3, 127.2, 48.6; ES-MS 412.1 [M + H$^+$].

4-(*p*-Tolylthio)-6-phenyl-8-methylpyrimido[4,5-*b*][1,4]-benzothiazepine (2.11): 97%; yellow solid; mp 210−211 °C; ^{1}H NMR ($CDCl_3$) δ 8.44 (s, 1 H), 7.96−7.93 (m, 2 H), 7.55−7.45 (m, 6 H), 7.33 (dd, J = 7.8, 1.7 Hz, 1 H), 7.25 (d, J = 7.8 Hz, 2 H), 7.13 (d, J = 1.5 Hz, 1 H), 2.40 (s, 3 H), 2.32 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.9, 166.6, 154.1, 152.9, 139.7, 139.5, 138.6, 137.6, 136.8, 135.4, 133.9, 133.5, 133.2, 131.5, 131.4, 130.1, 128.4, 124.6, 21.4, 21.0; ES-MS 426.1 [M + H$^+$].

4-(*p*-Tolylthio)-6-(pyridin-3-yl)-8-methylpyrimido[4,5-*b*][1,4]benzothiazepine (2.12): 97%; yellow solid; mp 266−267 °C; ^{1}H NMR ($CDCl_3$) δ 9.04 (d, J = 1.8 Hz, 1 H), 8.78 (dd, J = 4.8, 1.5 Hz, 1 H), 8.47 (s, 1 H), 8.38 (dt, J = 8.1, 1.8 Hz, 1 H), 7.55−7.36 (m, 5 H), 7.26 (d, J = 8.1 Hz, 2 H), 7.12 (d, J = 1.8 Hz, 1 H), 2.41 (s, 3 H), 2.34 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 168.9, 167.1, 154.9, 153.3, 152.3, 151.6, 140.2, 139.4, 137.7, 137.3, 136.2, 135.7, 135.5, 134.3, 134.2, 134.0, 131.4, 130.5, 124.5, 123.7, 21.7, 21.4; ES-MS 427.1 [M + H$^+$].

4-(*p*-Tolylthio)-6-*p*-tolyl-8-methylpyrimido[4,5-*b*][1,4]-benzothiazepine (2.13): 96%; yellow solid; mp 194−196 °C; ^{1}H NMR ($CDCl_3$) δ 8.43 (s, 1 H), 7.83 (d, J = 8.1 Hz, 2 H), 7.50 (d, J = 8.1 Hz, 1 H), 7.46 (d, J = 8.1 Hz, 2 H), 7.34−7.24 (m, 5 H), 7.13 (d, J = 1.5 Hz, 1 H), 2.45 (s, 3 H), 2.40 (s, 3 H), 2.31 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.7, 166.5, 153.9, 152.8, 142.1, 139.7, 138.6, 137.7, 136.8, 136.7, 135.4, 133.8, 133.5, 133.1, 131.5, 130.1, 129.1, 124.6, 21.5, 21.4, 21.0; ES-MS 440.3 [M + H$^+$].

4-(*p*-Tolylthio)-6-(*p*-fluorophenyl)-8-methylpyrimido-[4,5-*b*][1,4]benzothiazepine (2.14): 80%; yellow solid; mp 152−153 °C; ^{1}H NMR ($CDCl_3$) δ 8.45 (s, 1 H), 7.98−7.93 (m, 2 H), 7.51 (d, J = 7.8 Hz, 1 H), 7.45 (d, J = 8.1 Hz, 2 H), 7.34 (dd, J = 8.1, 1.8 Hz, 1 H), 7.25 (d, J = 8.1 Hz, 2 H), 7.21−7.15 (m, 2 H), 7.11 (d, J = 1.5 Hz, 1 H), 2.40 (s, 3 H), 2.33 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 169.8, 166.9, 165.2 (J = 251.9 Hz), 154.5, 153.1, 140.1, 139.1, 137.8, 136.8, 136.0, 135.9, 135.7, 134.2, 134.0, 133.7, 132.6 (J = 8.6 Hz), 131.6, 130.5, 124.7, 115.8 (J = 21.8 Hz), 21.7, 21.4; ES-MS 444.1 [M + H$^+$].

4-(*p*-Tolylthio)-6-propyl-8-methylpyrimido[4,5-*b*][1,4]-benzothiazepine (2.15): 67%; yellow solid; mp 164−166 °C; ^{1}H NMR ($CDCl_3$) δ 8.40 (s, 1 H), 7.43−7.39 (m, 3 H), 7.30−7.22 (m, 4 H), 3.01 (t, J = 7.2 Hz, 2 H), 2.39 (s, 3 H), 2.38 (s, 3 H), 1.90−1.78 (m, 2 H), 1.10 (t, J = 7.8 Hz, 3 H); ^{13}C NMR ($CDCl_3$) δ 176.7, 166.1, 153.7, 153.3, 139.6, 139.1, 138.3, 137.5, 135.4, 133.3, 133.2, 132.4, 130.0, 128.4, 124.6, 43.5, 21.3, 21.1, 20.4, 13.8; ES-MS 392.1 [M + H$^+$]. Anal. Calcd for $C_{22}H_{21}N_3S_2$: C, 67.48; H, 5.41; N, 10.73. Found: C, 69.39; H, 5.43; N, 10.66.

4-(*p*-Tolylthio)-6-benzyl-8-methylpyrimido[4,5-*b*][1,4]-benzothiazepine (2.16): 60%; yellow solid; mp 179−181 °C; ^{1}H NMR ($CDCl_3$) δ 8.40 (s, 1 H), 7.42 (d, J = 8.1 Hz, 4 H), 7.35−7.18 (m, 8 H), 4.37 (s, 2 H), 2.39 (s, 3 H), 2.34 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 174.7, 166.2, 154.0, 153.6, 139.7, 139.1, 137.8, 137.4, 136.2, 135.4, 133.7, 133.3, 132.6, 130.1, 129.4, 128.5, 128.4, 126.8, 124.5, 48.1, 21.4, 21.2; ES-MS 440.1 [M + H$^+$].

4-(*p*-Chlorophenylthio)-6-phenyl-8-chloropyrimido-[4,5-*b*][1,4]benzothiazepine (2.17): 98%; yellow solid; mp 203−205 °C; ^{1}H NMR ($CDCl_3$) δ 8.46 (s, 1 H), 7.94−7.90 (m, 2 H), 7.61−7.49 (m, 7 H), 7.44−7.40 (m, 2 H), 7.31 (d, J = 2.4 Hz, 1 H); ^{13}C NMR ($CDCl_3$) δ 169.9, 166.3, 154.6, 152.7, 139.0, 138.3, 137.8, 137.1, 136.3, 125.7, 135.3, 135.2, 132.7, 132.3, 131.0, 130.3, 129.9, 128.9, 126.7; ES-MS 466.0 [M + H$^+$].

4-(*p*-Chlorophenylthio)-6-*p*-tolyl-8-chloropyrimido[4,5-*b*][1,4]benzothiazepine (2.18): 95%; yellow solid; mp 192−193 °C; ^{1}H NMR ($CDCl_3$) δ 8.44 (s, 1 H), 7.81 (d, J = 8.1 Hz, 2 H), 7.58−7.47 (m, 4 H), 7.43−7.39 (m, 2 H), 7.33−7.30 (m, 3 H), 2.46 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 169.4, 165.9, 154.1, 152.4, 138.1, 137.6, 137.0, 136.8, 136.0, 135.3, 134.9, 134.8, 132.3, 130.7, 130.1, 129.6, 129.5, 129.4, 126.6, 21.6; ES-MS 480.1 [M + H$^+$].

4-(*p*-Chlorophenylthio)-6-(pyridin-3-yl)-8-chloropyrimido[4,5-*b*][1,4]benzothiazepine (2.19): 12%; yellow solid; mp 264−266 °C; ^{1}H NMR ($CDCl_3$) δ 9.07 (s, 1 H), 8.82 (d, J = 3.6 Hz, 1 H), 8.49 (s, 1 H), 8.32 (dt, J = 8.1, 1.8 Hz, 1 H), 7.61 (d, J = 8.4 Hz, 1 H), 7.56 (d, J = 2.1 Hz, 1 H), 7.54−7.48 (m, 3 H), 7.45−7.41 (m, 2 H), 7.31 (d, J = 2.1 Hz, 1 H); ^{13}C NMR ($CDCl_3$) δ 167.3, 166.2, 154.7, 152.5, 152.4, 151.0, 137.1, 136.9, 136.7, 136.1, 135.5, 135.2, 135.1, 134.4, 132.9, 130.2, 129.6, 126.1, 123.5; ES-MS 467.0 [M + H$^+$].

4-(*p*-Chlorophenylthio)-6-benzyl-8-chloropyrimido[4,5-*b*][1,4]benzothiazepine (2.20): 30%; yellow solid; mp 177−179 °C; ^{1}H NMR ($CDCl_3$) δ 8.42 (s, 1 H), 7.51−7.25 (m, 12 H), 4.35 (s, 2 H); ^{13}C NMR ($CDCl_3$) δ 173.9, 166.0, 154.5, 153.4, 139.3, 137.1, 136.8, 136.3, 135.8, 135.5, 135.0, 132.2, 129.8, 129.6, 129.0, 128.6, 128.2, 127.5, 126.7, 48.4; ES-MS 480.0 [M + H$^+$].

4-(*p*-Methoxyphenylthio)-6-phenyl-8-methoxypyrimido-[4,5-*b*][1,4]benzothiazepine (2.21): 80%; yellow solid; mp 206−209 °C; ^{1}H NMR ($CDCl_3$) δ 8.45 (s, 1 H), 7.99−7.96 (m, 2 H), 7.58−7.48 (m, 6 H), 7.06 (dd, J = 8.4, 3.0 Hz, 1 H), 7.00−6.95 (m, 2 H), 6.83 (d, J = 2.7 Hz, 1 H), 3.85 (s, 3 H), 3.74(s, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.6, 167.2, 161.0, 159.8, 154.4, 153.4, 139.5, 138.2, 137.9, 137.4, 135.2, 131.9, 130.4, 128.7, 128.3, 118.8, 118.4, 116.5, 115.3, 55.9, 55.6; ES-MS 458.1 [M + H$^+$].

4-(*p*-Methoxyphenylthio)-6-benzyl-8-methoxypyrimido-[4,5-*b*][1,4]benzothiazepine (2.22): 30%; yellow solid; mp

175−177 °C; ^{1}H NMR ($CDCl_3$) δ 8.42 (s, 1 H), 7.47−7.43 (m, 4 H), 7.37−7.24 (m, 4 H), 7.00−6.97 (m, 2 H), 6.96−6.94 (m, 1 H), 6.91 (dd, J = 8.9, 2.9 Hz, 1 H), 4.36 (s, 2 H), 3.84 (s, 3 H), 3.74 (s, 3 H); ^{13}C NMR ($CDCl_3$) δ 174.4, 166.7, 161.0, 160.1, 154.3, 154.2, 139.3, 137.6, 137.4, 136.5, 134.9, 129.6, 128.9, 128.0, 127.3, 118.8, 117.6, 115.2, 113.8, 55.8, 55.6, 48.5; ES-MS 472.1 [M + H$^+$].

Synthesis of 4,6-Bis(*p*-chlorophenylthio)-*N*-(chloro(pyridin-3-yl)methylene)-5-aminopyrimidine (11.19): Column chromatography (petroleum ether/EtOAc 15:1, v/v) was used to separate compound **2.19** and **11.19**. Yield of compund **11.19** is 80% as a yellow solid: ^{1}H NMR ($CDCl_3$) δ 9.47 (d, J = 2.4 Hz, 1 H), 8.86 (dd, J = 5.1, 1.8 Hz, 1 H), 8.51 (dt, J = 7.8, 1.8 Hz, 1 H), 8.40 (s, 1 H), 7.52−7.45 (m, 5 H), 7.40−7.36 (m, 4 H); ^{13}C NMR ($CDCl_3$) δ 156.4, 153.9, 153.7, 150.7, 150.6, 136.9, 136.6, 136.0, 134.1, 129.9, 129.5, 125.9, 123.4; ES-MS 503.0 [M + H$^+$].

General Procedure for Synthesis of 4-(Phenylsulfinyl)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine 8.1. 4-(Phenylthio)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine **2.1** (0.397 g, 1.00 mmol) was dissolved in CH_2Cl_2 (10 mL) and cooled to 0−5 °C in an ice bath. A solution of *m*-CPBA (0.206 g, 1.20 mmol) in CH_2Cl_2 (15 mL) was added dropwise over 30 min. After being stirred for 3 h, the reaction mixture was treated with saturated $NaHSO_3$, saturated Na_2CO_3, and brine, dried over anhydrous Na_2SO_4, concentrated in vacuo, and purified by flash chromatography with petroleum ether/EtOAc (5:1, v/v) as eluent to afford 0.318 g (77%) of **8.1** as a yellow solid.

4-(Phenylsulfinyl)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine (8.1): 77%; yellow solid; mp 200−202 °C; ^{1}H NMR ($CDCl_3$) δ 8.96 (s, 1 H), 7.92 (br d, J = 6.9 Hz, 2 H), 7.69 (br s, 1 H), 7.66−7.47 (m, 7 H), 7.33 (br s, 3 H), 7.06 (br s, 1 H); ^{13}C NMR ($CDCl_3$) δ 166.0, 157.8, 154.7, 142.9, 136.4, 136.2, 133.9, 132.6, 132.4, 131.6, 130.3, 129.3, 128.7, 128.6, 125.4; ES-MS 414.0 [M + H$^+$].

General Procedure for Synthesis of 4-(*n*-Butylamino)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine 3.1. 4-(Phenylsulfinyl)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine **8.1** (0.413 g, 1.00 mmol) was dissolved in dry CH_3CN (10 mL). *n*-Butylamine (0.219 g, 0.30 mL, 3.00 mmol) was added at room temperature. After being stirred 15 min, the reaction mixture was concentrated in vacuo and purified by flash chromatography with petroleum ether/EtOAc (8:1, v/v) as eluent to afford 0.324 g (77%) of **3.1** as a yellow solid.

4-(*n*-Butylamino)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine (3.1): 90%; yellow oil; ^{1}H NMR ($CDCl_3$) δ 8.30 (s, 1 H), 7.80−7.77 (m, 2 H), 7.63 (dd, J = 7.8, 0.9 Hz, 1 H), 7.55−7.44 (m, 4 H), 7.34 (td, J = 7.2, 0.9 Hz, 1 H), 7.24 (dd, J = 7.8, 1.4 Hz, 1 H), 5.81 (t, J = 5.4 Hz, 1 H), 3.54 (q, J = 6.7 Hz, 2 H), 1.74−1.64 (m, J = 7.4 Hz, 2 H), 1.53−1.41 (m, J = 7.5 Hz, 2 H), 0.99 (t, J = 7.4 Hz, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.9, 158.1, 155.7, 150.1, 139.7, 138.2, 137.4, 133.8, 132.3, 131.5, 130.8, 129.8, 128.7, 128.2, 127.2, 41.3, 31.9, 20.4, 14.1; ES-MS 361.1 [M + H$^+$]. Anal. Calcd for $C_{21}H_{20}N_4S$: C, 69.97; H, 5.59; N, 15.54. Found: C, 70.00; H, 5.76; N, 15.30.

4-(Pyrrolidin-1-yl)-6-phenylpyrimido[4,5-*b*][1,4]benzothiazepine (3.2): 90%; yellow solid; mp 231−232 °C; ^{1}H NMR ($CDCl_3$) δ 8.17 (s, 1 H), 7.81−7.77 (m, 2 H), 7.63 (dd, J = 7.8, 1.5 Hz, 1 H), 7.51−7.34 (m, 5 H), 7.29 (dd, J = 7.8, 1.7 Hz, 1 H), 3.88 (br s, 2 H), 3.63 (br s, 2 H), 2.00 (br s, 2 H), 1.85 (br s, 2 H); ^{13}C NMR ($CDCl_3$) δ 168.0, 156.5, 153.8, 153.7, 139.0, 138.8, 138.2, 133.5, 131.6, 131.3, 129.3, 129.1, 128.7, 128.3, 127.7, 50.0, 29.9; ES-MS 359.1 [M + H$^+$]. Anal. Calcd for $C_{21}H_{18}N_4S$: C, 70.36; H, 5.06; N, 15.63. Found: C, 70.36; H, 5.15; N, 15.82.

4-(*n*-Butylamino)-6-phenyl-8-methylpyrimido[4,5-*b*][1,4]benzothiazepine (3.3): 88%; yellow solid; mp 173−175 °C; ^{1}H NMR ($CDCl_3$) δ 8.28 (s, 1 H), 7.81−7.77 (m, 2 H), 7.56−7.44 (m, 4 H), 7.30 (dd, J = 7.8, 1.5 Hz, 1 H), 7.03 (d, J = 1.5 Hz, 1 H), 5.76 (t, J = 5.6 Hz, 1 H), 3.53 (q, J = 6.7 Hz, 2 H), 2.29 (s, 3 H), 1.73−1.64 (m, 2 H), 1.53−1.41 (m, 2 H), 0.99 (t, J = 7.4 Hz, 3 H); ^{13}C NMR ($CDCl_3$) δ 170.6, 157.7, 155.4, 150.4, 139.5, 138.1, 137.0, 134.7, 133.2, 132.9, 131.1, 130.8, 129.5, 128.4, 126.9, 40.9, 31.6, 21.0, 20.1, 13.8; ES-MS 375.2 [M + H$^+$].

4-(*n*-Butylamino)-6-phenyl-8-chloropyrimido[4,5-*b*][1,4]benzothiazepine (3.4): 90%; yellow solid; mp: 155−157 °C; ^{1}H NMR ($CDCl_3$) δ 8.30 (s, 1 H), 7.79−7.76 (m, 2 H), 7.57−7.45 (m, 5 H), 7.22 (d, J = 2.1 Hz, 1 H), 5.75 (t, J = 5.6 Hz, 1 H), 3.55 (q, J = 6.7 Hz, 2 H), 1.74−1.64 (m, 2 H), 1.53−1.41 (m, 2 H), 0.99 (t, J = 7.5 Hz, 3 H); ^{13}C NMR ($CDCl_3$) δ 169.3, 158.0, 156.1, 150.0, 139.0, 138.6, 136.6, 134.9, 134.6, 132.3, 131.7, 130.3, 129.6, 128.9, 127.0, 41.2, 31.9, 20.4, 14.1; ES-MS 395.1 [M + H$^+$].

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Supporting Information Available: Experimental details; ^{1}H and ^{13}C NMR and LC-MS-ELSD spectra for obtained compounds. This material is available free of charge via the Internet at http://pubs.acs.org.

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