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α-Aminated Methyllithium by DTBB-Catalysed Lithiation of a *N*-(Chloromethyl) Carbamate

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Abstract

The reaction of *O-tert*-butyl-*N*-(chloromethyl)-*N*-methyl carbamate (**1**) with lithium powder and a catalytic amount of 4,4'-di-*tert*-butylbiphenyl (DTBB, 2.5 mol %) in the presence of different electrophiles [Me_3SiCl, $^{i}BuCHO$, $^{t}BuCHO$, PhCHO, 4-$MeOC_6H_4CHO$, $(CH_2)_4CO$, $MeCO^{n}Pr$, Et_2CO, $MeCO(CH_2)_2CH{=}CH_2$, PhCOMe, $PhCO^{n}Bu$, Ph_2CO] in THF at -78°C leads, after hydrolysis with water, to the expected functionalised carbamates **2**. Carbamates **2** derived from carbonyl compounds are deprotected with hydrogen chloride (for aromatic aldehyde or ketone derivatives) or with a mixture of phenol and trimethylsilyl chloride (for aliphatic aldehyde derivatives) giving substituted 1,2-diols **4**.

Keywords: lithiation; catalysis; lithium and compounds

I. Introduction

The introduction of an aminomethyl group into an organic structure can be carried out following two opposite strategies: (a) the reaction of an imine (**I**) or an iminium salt (**II**) with a nucleophile, or (b) the reaction of an aminomethyl anion (**III**) with an electrophile. Following the Seebach nomenclature [1], the route (a) represents a normal reactivity (using a a^1-reagent), whereas the second case (b) is a typical example of umpolung reactivity (using a d^1-reagent. This consideration reflects the availability of the corresponding starting materials: whereas compounds **I** and **II** are easily available (even commercially available in same cases), anions of type **III** are very unstable intermediates [2,3].

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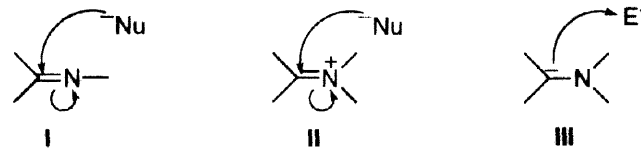
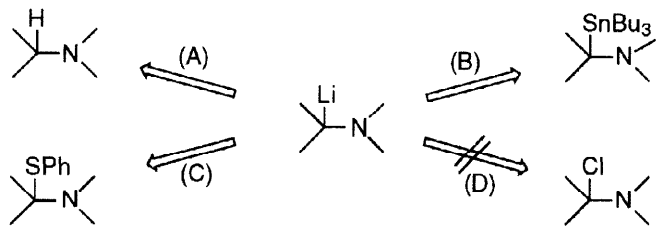


The preparation of intermediates of type **III** can be achieved following three different ways: (1) α-Deprotonation of activated amine derivatives (Method A) [4-20], (2) tin-lithium transmetallation from α-aminated organostannanes (Method B) [21-27], and (3) sulphur-lithium exchange from α-aminated phenyl thioethers (Method C) [28]. However, to the best of our knowledge the other possible route, chlorine-lithium exchange (Method D, which is the usual way to prepare organolithium reagents [29]) has not been used until now to generate this type of d^1-reagent (Scheme 1). We describe in this paper the application of an arene-catalysed lithiation reaction [30,31] of chlorinated precursors [32][1] to prepare α-functionalised organolithium compounds [33,34] by chlorine-lithium exchange under Barbier-type reaction conditions [35,36] [37].[1]

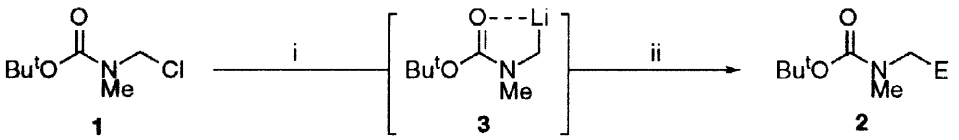


Scheme 1.

II. Results and discussion

The reaction of *O-tert*-butyl-*N*-(chloromethyl)-*N*-methyl carbamate (**1**) with an excess of lithium powder (1:7 molar ratio) and a catalytic amount of 4,4'-di-*tert*-butylbiphenyl (DTBB; 1:0.05 molar ratio, 2.5 mol %) in the presence of an electrophile [Me_3SiCl, Bu^iCHO, Bu^tCHO, PhCHO, 4-$MeOC_6H_4CHO$, $(CH_2)_4CO$, $MeCOPr^n$, Et_2CO, $MeCO(CH_2)_2CH{=}CH_2$, PhCOMe, $PhCOBu^n$, Ph_2CO] in THF at -78°C led, after 2 h and subsequent hydrolysis with water, to the expected functionalised carbamates **2a-l** (Scheme 2 and Table 1). The reaction should be carried out at low temperature and under Barbier-type reaction conditions in order to avoid decomposition of the *in situ* generated *N*-lithiomethyl carbamate intermediate **3**. This species, which is probably stabilised by intramolecular coordination between the carbamate oxygen and the lithium atom (CIPE effect [38]), under the reaction conditions assayed prefers to react with the electrophile present in the reaction medium rather than react intra or intermolecularly with the carbamate moiety present in its structure.

[1] For the last paper on this topic from our laboratory see the corresponding reference indicated in the text.



Scheme 2. *Reagents and conditions*: i, Li, DTBB cat. (2.5 mol %), E = Me_3SiCl, ^{i}BuCHO, ^{t}BuCHO, PhCHO, 4-$MeOC_6H_4CHO$, $(CH_2)_4CO$, $MeCO^nPr$, Et_2CO, $MeCO(CH_2)_2CH{=}CH_2$, PhCOMe, $PhCO^nBu$, Ph_2CO, THF, -78°C, 2 h; ii, H_2O.

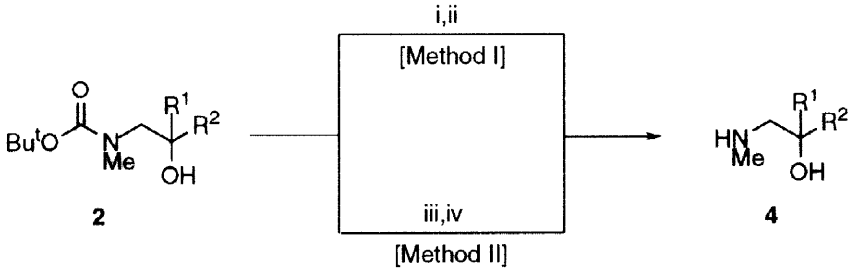
Table 1
Preparation of Compounds **2**

Entry	Electrophile E	Compound **2**[a] No.	X	Yield (%)[b]	R_f[c]
1	Me_3SiCl	**2a**	Me_3Si	69	0.81
2	^{i}BuCHO	**2b**	^{i}BuCHOH	65	0.36
3	^{t}BuCHO	**2c**	^{t}BuCHOH	65	0.45
4	PhCHO	**2d**	PhCHOH	64	0.30
5	4-$MeOC_6H_4CHO$	**2e**	4-$MeOC_6H_4CHOH$	60	0.31
6	$(CH_2)_4CO$	**2f**	$(CH_2)_4COH$	40	0.27
7	Et_2CO	**2g**	Et_2COH	53	0.43
8	$MeCO^nPr$	**2h**	$MeC(OH)^nPr$	35	0.44
9	$MeCO(CH_2)_2CH{=}CH_2$	**2i**	$MeC(OH)(CH_2)_2CH{=}CH_2$	47	0.42
10	PhCOMe	**2j**	PhC(OH)Me	82	0.41
11	$PhCO^nBu$	**2k**	$PhC(OH)^nBu$	48	0.45
12	Ph_2CO	**2l**	Ph_2COH	74	0.68

[a] All products were ≥95% pure (GLC and/or 300 MHz ^{1}H NMR).
[b] Isolated yield after column chromatography [neutral alumina (Florisil® for compounds **2a** and **2b**), hexane/ethyl acetate] based on the starting material **1**.
[c] Silica gel, pentane/ethyl acetate: 4/1.

The starting carbamate **1** was prepared from commercially available *O-tert*-butyl-*N*-methyl carbamate by reaction with *para*-formaldehyde and trimethylsilyl chloride following a modification of the reported procedure [39].

We then studied the deprotection of compounds **2**. Two different methods should be used depending on the electrophilic fragment in **2**: for ketone or aromatic aldehyde derivatives the acidic hydrolysis with hydrogen chloride in ethyl acetate followed by treatment with 3M NaOH gave, in general, good results for aminoalcohols **4** (Method I; Scheme 3 and Table 2, entries 3-11). However, for aliphatic aldehyde derivatives it was necessary to use a mixture of phenol and trimethylsilyl chloride in CH_2Cl_2 followed by the same basic treatment but at reflux, to afford the expected aminoalcohols **4** (Method II; Scheme 3 and Table 2, entries 1 and 2).



Scheme 3. *Reagents and conditions*: i, PhOH, Me_3SiCl, CH_2Cl_2, 50 min; ii, 3M NaOH, reflux, 15 min; iii, HCl, EtOAc, 2 h; ii, 3M NaOH.

Table 2
Preparation of Compounds **4**

Entry	Starting material	Method	Compound **4**[a]				
			No.	R^1	R^2	Yield (%)[b]	R_f[c]
1	**2b**	I	**4b**	H	^{i}Bu	86	0.28
2	**2c**	I	**4c**	H	^{t}Bu	85	0.19
3	**2d**	II	**4d**	H	Ph	93	0.32
4	**2e**	II	**4e**	H	4-$MeOC_6H_4$	94	0.72
5	**2f**	II	**4f**	$(CH_2)_4$		98	0.33
6	**2g**	II	**4g**	Et	Et	85	0.24
7	**2h**	II	**4h**	^{n}Pr	Me	83	0.26
8	**2i**	II	**4i**	CH_2=$CH(CH_2)_2$	Me	90	0.30
9	**2j**	II	**4j**	Ph	Me	95	0.26
10	**2k**	II	**4k**	Ph	^{n}Bu	95	0.38
11	**2l**	II	**4l**	Ph	Ph	50	0.25

[a] All products **4b** were >94% pure (300 MHz ^{1}H NMR).
[b] Isolated crude yield of pure compounds based on the starting carbamate **2**.
[c] Silica gel, CH_2Cl_2/MeOH: 4/1.

III. Conclusion

From the results described in this paper we conclude that this methodology is useful for the easy *in situ* generation of a α-aminated organolithium intermediate (d^1-reagent with umpolung reactivity [1]) and its reaction with electrophiles, mainly carbonyl compounds. The final deprotection of the obtained functionalised carbamates affords substituted 1,2-aminoalcohols, which are difunctionalised organic compounds with wide application in synthetic organic chemistry [40].

IV. Experimental section

IV.1. General

For general information see reference [41].

IV.2. Preparation of O-tert-*butyl*-N-*(chloromethyl)*-N-*methyl carbamate* (**1**) [39].

To a suspension of *O-tert*-butyl-*N*-methyl carbamate (1.31 g, 10 mmol), *para*-formaldehyde (0.316 g, 10 mmol) and anhydrous magnesium sulfate (10 g) in benzene (50 ml) was added trimethylsilyl chloride (3.84 ml, 30 mmol) and the resulting mixture was stirred for 3h at room temperature. Then, the mixture was filtered and the filtrate was quickly evaporated (*ca* 1 Torr) without warming to give a residue containing essentially pure (>95% from 300 MHz ^{1}H NMR) title compound (*ca.* quant. yield), which was used inmediatly without further purification: Pale yellow oil, ν (film) 1717 (C=O), 1160, 1135 cm^{-1} (CO); δ_H 1.49 [9H, s, $(CH_3)_3C$], 2.94 (3H, s, CH_3N), 5.30 (2H, s, CH_2); δ_C 28.1 [$(CH_3)_3C$], 33.65 (CH_3N), 62.9 (CH_2), 81.55 [$(CH_3)_3C$], 154.25 (CO_2); *m/z* 179 (M^+, 0.1%), 144 (33), 108 (24), 106 (70), 88 (22), 78 (14), 58 (20), 57 (100), 56 (41), 55 (16), 51 (13), 49 (33), 44 (82), 43 (42), 42 (52), 41 (82), 40 (17) (Found: M^+, 179.0734. $C_7H_{14}NClO_2$ requires 179.0713).

IV.3 DTBB-Catalysed lithiation of O-tert-*butyl*-N-*(chloromethyl)*-N-*methyl carbamate* (**1**). *Reaction with electrophiles. Isolation of compounds* **2**.

General procedure.- To a green suspension of lithium powder (100 mg, 14 mmol) and DTBB (26 mg, 0.10 mmol) in THF (6 ml) was slowly added (*ca* 15 min) a solution of the starting material **1** (2 mmol) and the corresponding electrophile in THF (4 ml) at -78° C under an argon atmosphere. The reaction mixture was stirred for 2 h at the same temperature and then hydrolysed with water (10 ml). After warming to room temperature the crude mixture was extracted with ether (3x 20 ml), the organic layer was dried over anhydrous Na_2SO_4 and the solvents evaporated (15

Torr) giving a residue, which was purified by column chromatography (neutral alumina or Florisil®, hexane/ethyl acetate; see Table 1, footnote b) affording pure title compounds **2**. Yields and R_f values are included in Table 1. Compounds **2a**, **2c**, **2d**, **2f**, **2g** and **2j**, previously described by us [42], were characterised by comparison of their physical and spectroscopic data with those of authentic samples. Spectroscopic and analytical data, as well as literature references for unknown or partially described compounds follow.

O-tert-*Butyl*-N-*(2-hydroxy-4-methylpentyl)*-N-*methyl carbamate* (**2b**): Pale yellow oil; ν (film) 3447 (OH), 1698 (C=O), 1155 cm^{-1} (CO); δ_H 0.92, 0.94 (3 and 3H, respectively, 2d, *J*=6.4, 7.6, $(CH_3)_2CH$), 1.11-1.21, 1.33-1.42 (1 and 1H, respectively, 2m, CH_2CHCH_3), 1.46 [9H, s, $(CH_3)_3C$], 1.74-1.88 [1H, m, $CH(CH_3)_2$], 2.04 (1H, s, OH), 2.93 (3H, s, CH_3N), 3.04-3.43 (2H, m, CH_2N), 3.87 (1H, br s, CHOH); δ_C 21.95, 23.4 [$(CH_3)_2CH$)], 24.35 [$(CH_3)_2CH$)], 28.35 [$(CH_3)_3C$], 36.1 (CH_3N), 44.15 (CH_2CHOH), 55.85 (CH_2N), 68.95 (CHOH), 79.85 [$(CH_3)_3C$], 157.3 (CO_2); *m/z* 158 [M^+-$(CH_3)_3CO$, 3%], 90 (29), 89 (58), 88 (27), 69 (19), 58 (13), 57 (91), 56 (14), 45 (26), 44 (100), 43 (51), 42 (26), 41 (70) [Found: M^+- $(CH_3)_3CO$, 158.1174. $C_8H_{16}NO_2$ requires 158.1181].

O-tert-*Butyl*-N-*[2-hydroxy-2-(4-methoxyphenyl)ethyl]*-N-*methyl carbamate* (**2e**): Pale yellow oil; ν (film) 3431 (OH), 1682 (C=O), 1613 (ArC=C), 1249, 1172, 1152, 1074 and 1036 cm^{-1} (CO); δ_H 1.45 [9H, s, $(CH_3)_3C$], 2.79 (3H, br s, CH_3N), 3.30-3.55 (2H, m, CH_2N), 3.79 (3H, s, CH_3O), 4.10 (1H, br s, OH), 4.85 (1H, br s, CHOH), 6.87, 7.26 (2 and 2H, respectively, 2d, *J*= 8.5, 8.5, ArCHCH); δ_C 28.3 [$(CH_3)_3C$], 36.25 (CH_3N), 55.15 (CH_3O), 57.4 (CH_2N), 73.05 (CHOH), 80.1 [$(CH_3)_3C$], 113.7, 126.95, 134.45, 158.95 (ArC), 157.75 (CO_2); *m/z* 225 [M^+- $CH_2=C(CH_3)_2$, 2%], 137 (87), 109 (10), 90 (17), 89 (23), 77 (15), 57 (82), 44 (100), 43 (14), 42 (20) [Found: M^+- $CH_2=C(CH_3)_2$, 225.1007. $C_{11}H_{15}NO_4$ requires 225.1001].

O-tert-*Butyl*-N-*[2-hydroxy-2-methylpentyl]*-N-*methyl carbamate* (**2h**): Pale yellow oil; ν (film) 3443 (OH), 1673 (C=O), 1165 cm^{-1} (CO); δ_H 0.93 (3H, t, *J*=7.3, CH_3CH_2), 1.14 (3H, s, CH_3COH), 1.20-1.50 (4H, m, CH_2CH_2), 1.47 [9H, s, $(CH_3)_3C$], 2.95 (3H, br s, CH_3N), 3.15, 3.34 (1 and 1H, respectively, 2 br d, *J*=14.5, 14.5, CHHN), 3.90 (1H, br s, OH); δ_C 14.7, (CH_3CH_2), 16.9 (CH_2CH_3), 24.75 (CH_3COH), 28.35 [$(CH_3)_3C$], 37.95 (CH_3N), 43.0 (CH_2CH_2COH), 59.45 (CH_2N), 74.15 (COH), 80.15 [$(CH_3)_3C$], 158.2 (CO_2); *m/z* 231 (M^+, 0.6%), 90 (10), 89 (30), 88 (16), 87 (14), 57 (34), 56 (30), 55 (13), 44 (100), 43 (52) (Found: M^+, 231.1848. $C_{12}H_{25}NO_3$ requires 231.1834).

O-tert-*Butyl*-N-*[2-hydroxy-2-methyl-5-hexenyl]*-N-*methyl carbamate* (**2i**): Pale yellow oil; ν (film) 3411 (OH), 1697, 1668 (C=O) 1642 (C=C), 1162, 1056 cm^{-1} (CO); δ_H 1.15 (3H, s, CH_3COH), 1.47 [9H, s, $(CH_3)_3C$], 1.40-1.60 (2H, m, CH_2COH), 2.12-2.23 (2H, m, $CH_2CH=CH_2$), 2.96 (3H, s, CH_3N), 3.16, 3.36 (2H, 2 br d, *J*=14.4, 14.4, CHHN), 4.00 (1H, s, OH), 4.92-5.08 (2H, m, CH_2=CH), 5.77-5.91 (1H, m, CH_2=CH); δ_C 24.7 (CH_3COH), 27.95 ($CH_2CH=CH_2$), 28.3 [$(CH_3)_3C$], 37.95 (CH_3N), 39.55 ($CH_2CH_2CH=CH_2$), 59.65 (CH_2N), 73.85 (COH), 80.2 [$(CH_3)_3C$], 114.15 (CH_2=CH), 138.95 (CH_2=CH), 158.2 (CO_2); *m/z* 187 [M^+- $CH_2=C(CH_3)_2$, 0.5%], 90 (25), 89 (61), 88 (28), 57 (70), 45 (27), 44 (91), 43 (100), 42 (17) [Found: M^+- $CH_2=C(CH_3)_2$, 187.1222. $C_9H_{17}NO_3$ requires 187.1208].

O-tert-*Butyl*-N-*[2-hydroxy-2-phenylhexyl]*-N-*methyl carbamate* (**2k**): Pale yellow oil; ν (film) 3400 (OH), 3087, 3053, 3026 (ArCH), 1667 (C=O) 1161 cm^{-1} (CO); δ_H 0.83 (3H, t, *J*=7.2, CH_3CH_2), 1.00-2.00 (6H, m, $CH_2CH_2CH_2$), 1.44 [9H, s, $(CH_3)_3C$], 2.45 (3H, s, CH_3N), 3.18, 3.83 (2H, 2d, *J*=14.2, 14.2, CHHN), 5.07 (1H, br s, OH) 7.20-7.45 (5H, m, ArH); δ_C 14.0, (CH_3CH_2), 23.2, 25.15, 39.8 ($CH_2CH_2CH_2$), 28.3 [$(CH_3)_3C$], 37.55 (CH_3N), 61.8 (CH_2N), 78.1 (COH), 80.5 [$(CH_3)_3C$], 125.75, 126.35, 127.95, 144.95 (ArC), 158.85 (CO_2); *m/z* 307 (M^+, 0.8%), 163 (57), 145 (12), 90

(22), 89 (33), 88 (15), 77 (12), 57 (90), 45 (14), 44 (100) ,43 (27) (Found: M^+, 307.2130. $C_{18}H_{29}NO_3$ requires 307.2147).

O-tert-*Butyl*-N-*(2,2-diphenyl-2-hydroxyethyl)*-N-*methyl carbamate* (**2l**): Pale yellow oil; ν (film) 3400 (OH), 1662 (C=O), 1484, 1449 (ArC=C), 1165, 1150 cm^{-1} (CO); δ_H 1.43 [9H, s, $(CH_3)_3C$], 2.24-2.72 (3H, m, CH_3N), 4.08 (2H, s, CH_2N), 5.66-5.84 (1H, br s, OH), 7.10-7.56 (10H, m, ArH); δ_C 28.25 [$(CH_3)_3C$], 37.3 (CH_3N), 60.15 (CH_2N), 78.65 (COH), 80.6 [$(CH_3)_3C$], 126.35, 126.85, 127.9, 145.6 (ArC), 159.05 (CO_2); *m/z* 271 [M^+-CH_2=$C(CH_3)_2$, 3%], 184 (15), 183 (100), 105 (68), 90 (11), 89 (16), 77 (49), 57 (73), 44 (47), 43 (10), 41 (20).

IV.3. Deprotection of carbamates **2**. *Isolation of aminoalcohols* **4**.

Method I [43].- A solution of the corresponding carbamate **2b,c** (1 mmol) in CH_2Cl_2 (10 ml), phenol (2.92 ml, 30 mmol) and trimethylsilyl chloride (1.28 ml, 10 ml) was stirred for 50 min at room temperature under an argon atmosphere. Then, the solvent and the excess of trimethylsilyl choride were evaporated (15 Torr) and the resulting residue was treated with THF (10 ml) and a 3M NaOH solution (15 ml) and refluxed for 15 min. The resulting mixture was cooled at room temperature, extracted with ethyl acetate (4x15 ml) and the organic layer washed with water, dried over anhydrous Na_2SO_4 and evaporated (15 Torr) to give a residue containing the essentially pure title compounds **4** (>95% from 300 MHz ^{1}H NMR).

Method II [42].- A solution of the corresponding carbamate **2d-l** (1 mmol) in ethyl acetate saturated with hydrogen chloride (10 ml) was stirred at room temperature for 2 h. The resulting mixture was then basified with a 3M NaOH solution and extracted with ethyl acetate (3x20 ml). The organic layer was dried over anhydrous Na_2SO_4 and evaporated (15 Torr) to give a residue containing the essentially pure title compounds **4** (>95% from 300 MHz ^{1}H NMR).

Yields and R_f values for compounds **4** are included in Table 2. Compounds **4d** and **4j**, previously described by us [42], were characterised by comparison of their physical and spectroscopic data with those of authentic samples. Spectroscopic and analytical data, as well as literature references for unknown or partially described compounds follow.

3-Methyl-1-methylaminomethylbutanol (**4b**): Pale yellow oil; ν (film) 3361 (NH, OH), 1098, 1028 cm^{-1} (CO); δ_H 0.92, 0.94 [3 and 3H, respectively, 2d, *J*=6.4, 6.4, $CH(CH_3)_2$], 1.10-1.21 [1H, m, $CHHCH(CH_3)_2$], 1.35-1.45 [1H, m, $CHHCH(CH_3)_2$], 1.81 [1H, m, $CH(CH_3)_2$], 2.30-2.50 (3H, m, OH, NH, CHHN), 2.45 (3H, s, CH_3N), 2.64 (1H, dd, *J*=12.0, 2.9, CHHN), 3.71 (1H, m, CHOH); δ_C 22.1, 23.4 [$CH(CH_3)_2$], 24.55 [$CH(CH_3)_2$], 36.0 (CH_3N), 44.35 [$CH_2CH(CH_3)_2$], 57.95 (CH_2N), 67.3 (CHOH); *m/z* 131 (M^+, 0.5%), 74 (4), 56 (2), 44 (100) (Found: M^+, 131.1309. $C_7H_{17}NO$ requires 131.1310).

2,2-Dimethyl-1-methylaminomethylpropanol (**4c**) [44]: Pale yellow oil; ν (film) 3312 (NH, OH), 1073 cm^{-1} (CO); δ_H 0.80 [9H, s, $(CH_3)_3C$], 2.37 (3H, s, CH_3N), 2.46 (1H, t, *J*=11.0, CHHN), 2.62 (1H, dd, *J*=12.0, 2.4, CHHN), 3.35 (1H, dd, *J*=11.0, 2.4, CHOH), 5.42 (2H, br s, NH, OH); δ_C 25.6 [$(CH_3)_3C$], 33.9 [$(CH_3)_3C$], 35.45 (CH_3N), 52.2 (CH_2N), 76.6 (CHOH); *m/z* 131 (M^+, 0.1%), 117 (10), 100 (9), 87 (83), 57 (100).

1-(4-Methoxyphenyl)-2-methylamino-1-ethanol (**4e**) [44]: Pale yellow oil; ν (film) 3328 (NH, OH), 3067, 3030, 3005 (ArCH), 1613, 1515 (ArC=C), 1251, 1177, 1030 cm^{-1} (CO); δ_H 2.93 (3H, s, CH_3N), 3.44 (1H, dd, *J*=8.8, 7.6, CHHN), 3.81 (3H, s, CH_3O), 3.86 (1H, t, *J*=8.8, CHHN), 5.42 (1H, t, *J*=8.2, CHOH), 6.92, 7.27 (2 and 2H, respectively, 2d, *J*= 8.7, 8.7, ArCHCH); δ_C 31.05 (CH_3N), 54.45 (CH_3O), 55.3 (CH_2N), 74.15 (CHOH), 114.2, 17.2, 130.5, 160.0 (ArC); *m/z* 163 (M^+- H_2O, 100%), 135 (63), 121 (22), 91 (19), 77 (30), 65 (22), 43 (77).

2-Methylaminomethyl-1-cyclopentanol (**4f**): Pale yellow oil; ν (film) 3329 (NH, OH), 1020, 1050 cm^{-1} (CO); δ_H 1.50-2.00 (8H, m, 4xCH_2 ring), 2.18 (3H, s, CH_3N), 2.72 (2H, s, CH_2N), 3.05 (2H, s, OH, NH); δ_C 23.7 [(CH_2CH_2)$_2$COH], 30.9 (CH_3N), 38.45 [(CH_2CH_2)$_2$COH], 58.8 (CH_2N), 79.15 (COH); *m/z* 129 (M^+, 2%), 100 (11), 86 (14), 67 (20), 55 (12), 44 (100) (Found: M^+, 129.1151. $C_7H_{15}NO$ requires 129.1154).

2-Ethyl-1-methylamino-2-butanol (**4g**): Pale yellow oil; ν (film) 3348 (NH, OH), 1177, 1144, 1108 cm^{-1} (CO); δ_H 0.87 (6H, t, *J*=7.3, 2xCH_3CH_2), 1.48 (4H, q, *J*=7.3, 2xCH_3CH_2), 2.49 (3H, s, CH_3N), 2.54 (2H, s, CH_2N), 2.95 (2H, br s, OH, NH); δ_C 7.65 (2xCH_3CH_2), 29.1 (2xCH_3CH_2), 37.15 (CH_3N), 58.1 (CH_2N), 73.05 (COH); *m/z* 131 (M^+, 0.8%), 102 (86), 98 (14), 87 (60), 84 (100), 73 (14), 71 (20), 69 (73), 71 (29), 69 (73), 67 (13) (Found M^+,131.1296. $C_7H_{17}NO$ requires 131.1310).

1-Methyl-1-methylaminomethylbutanol (**4h**) [45]: Pale yellow oil; ν (film) 3254 (NH, OH), 1165, 1094 and 1030 cm^{-1} (CO); δ_H 0.92 (3H, t, *J*=6.7, CH_3CH_2), 1.13 (3H, s, CH_3COH), 1.20-1.47 (4H, m, CH_2CH_2), 2.33 (2H, br s, OH, NH), 2.48 (3H, s, CH_3N), 2.47, 2.54 (1 and 1H, respectively, 2d, *J*=11.9, 11.9, CHHN); δ_C 14.7 (CH_3CH_2), 17.15 (CH_2CH_3), 24.9 (CH_3COH), 37.25 (CH_3N), 42.85 ($CH_2CH_2CH_3$), 61.2 (CH_2N), 71.95 (COH); *m/z* 116 (M^+- CH_3, 0.8%), 88 (6), 70 (4), 45 (39), 44 (100).

1-Methyl-1-methylaminomethyl-4-pentenol (**4i**): Pale yellow oil; ν (film) 3354 (OH, NH), 3075 (C=CH), 1641 (C=C), 1152 and 1101 cm^{-1} (CO); δ_H 1.17 (3H, s, CH_3COH), 1.47-1.70 (2H, m, CCH_2CH_2), 2.10-2.25 (2H, m, CH_2CH=CH_2), 2.51 (3H, s, CH_3N), 2.55-2.90 (4H, m, CH_2N, OH, NH), 4.95, 5.04 (1 and 1H, respectively, 2 dd, *J*=10.1, 1.5, 17.4, 1.5, CH_2=CH), 5.75-5.90 (1H, m, CH_2=CH); δ_C 24.85 (CH_3C), 28.2 (CH_2CH=CH_2), 37.05 (CH_3N), 39.4 (CCH_2CH_2), 61.0 (CH_2N), 70.95 (COH), 114.3 (CH_2=CH), 138.85 (CH_2=CH); *m/z* 143 (M^+, 0.2%), 88 (6), 70 (4), 55 (3), 45 (33), 44 (100), 43 (53), 42 (12) (Found M^+, 143.1319. $C_8H_{17}NO$ requires 143.1310).

1-Phenyl-1-methylaminomethylpentanol (**4k**): Pale yellow oil; ν (film) 3333 (NH, OH), 3085, 3060, 3028 (ArCH), 1602 (ArC=C), 1131, 1067 cm^{-1} (CO); δ_H 0.81 (3H, t, *J*=7.3, CH_3CH_2), 1.18-1.40, 1.65-1.80 (3 and 3H, respectively, 2m, $CH_2CH_2CH_2$), 2.10-2.50 (2H, br s, NH, OH), 2.35 (3H, s, CH_3N), 2.69, 3.05 (1 and 1H, 2d, *J*=11.6, 11.6, CHHN), 7.21-7.45 (5H, m, ArH); δ_C 13.95, (CH_3CH_2), 25.1, 25.4, 40.8 ($CH_2CH_2CH_2$), 36.7 (CH_3N), 62.05 (CH_2N), 75.05 (COH), 125.5, 126.4, 128.1, 145.7 (ArC); *m/z* 163 (M^+- CH_3NHCH_2, 1%), 105 (1), 77 (1), 71 (5), 57 (2), 45 (11), 44 (100) (Found M^+- CH_3NHCH_2, 163.1104. $C_{11}H_{15}O$ requires 163.1123).

2-Methylamino-1,1-diphenyl-1-ethanol (**4l**) [46]: Pale yellow oil; ν (film) 3337 (NH, OH), 1598, 1490 (ArC=C), 1152, 1120, 1057 cm^{-1} (CO); δ_H 2.17 (1H, s, OH), 2.44 (3H, s, CH_3N), 2.40-2.80 (1H, br s, NH), 7.20-7.50 (10H, m, ArH); δ_C 36.5 (CH_3N), 61.05 (CH_2N), 76.15 (COH), 126.0, 126.9, 128.2, 145.5 (ArC); *m/z* 226 (M^+-1, 0.5%), 209 (30), 165 (13), 105 (20), 77 (17), 51 (11), 44 (100).

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VI. References

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