Electron Deficient Porphyrins III. Facile Syntheses of Perfluoroalkylporphyrins Including Water Soluble Porphyrin[1)]

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A variety of 3-perfluoroalkyl pyrroles were prepared by reaction of β-perfluoroalkyl α,β-unsaturated carbonyl compounds with *p*-tolylsulfonylmethyl isocyanide in moderate yields. Tetrakis(perfluoroalkyl)porphyrins were readily obtained by oxidative cyclization of 3-alkyl-2-hydroxymethyl-4-perfluoroalkylpyrroles in acidic media, including water-soluble 3,8,13,18-tetrakis(*p*-carboxybenzyl)-2,7,12,17-tetrakis(trifluoromethyl)porphyrin. The pK_a value for the monoprotonation of its inner nitrogen is less than 1, while that of Copro-I is 7.2. Diprotonation at the inner nitrogen occurs only in concd HCl, while the pK_a value of the corresponding non-fluoro porphyrin is 4. The reduction potential of 3,8,13,18-tetrakis(*p*-methoxycarboxybenzyl)-2,7,12,17-tetrakis(trifluoromethyl)porphyrin was shifted by 580 mV to a less negative value.

Fluorine substitution of organic substrates, prosthetic groups, and enzymes introduces three new aspects in bioorganic and bioinorganic chemistry. Firstly, it provides a useful nuclear probe for the ^{19}F NMR investigation on the structures and reactions of enzymes. The ^{19}F resonances of fluorine and perfluoroalkyl groups introduced to prosthetic groups and enzymes appear in the wide magnetic field region, sensitively reflecting the local environment around the nuclear probe.[2)] Secondly, electron-deficient porphyrins which have chemically inert substituents on the peripherals have applications to a variety of fields such as biomimetic catalysis and new materials.[3)] Most of the peripheral modified porphyrins, in particular electron-deficient porphyrins reported previously, were functionalized with chemically reactive groups. Perfluoroalkyl groups are inert and highly electron-withdrawing. One final interesting point is the promising antitumor activity of the fluorinated heterocycles.

Kaesler and LeGoff prepared the first perfluoroalkyl porphyrins, where perfluoroalkyl groups are indirectly attached to the porphyrin ring.[4)] Their attempts to prepare a perfluoroalkyl porphyrin from 3,4-di(trifluoromethyl)pyrrole were unsuccessful due to the insufficient reactivity toward cyclotetramerization.[5)] DiMagno and co-workers reported the synthesis of *meso*-tetrakis(perfluoroalkyl)porphyrin.[6)] The reduction potential of its zinc complex showed 670 mV anodic shift compared to the corresponding unsubstituted complex. The substituent effects by *meso*-perfluoroalkyl groups on the reduction potential are similar to those by the β-perfluoroalkyl groups reported in this study. In the previous communication, we have reported the synthesis of electron-deficient tetrakis(trifluoromethyl)etioporphyrin from a 3-trifluoromethylpyrrole derivative by use of copper salt as a template.[7)] Their physicochemical properties due to strong electron-withdrawing trifluoromethyl groups have been characterized by electrochemical measurements, MCD, and ESR studies.[8,3a)] For example, paramagnetic ^{19}F NMR resonances were found to be useful to probe both the low spin ($s = 1/2$) state and the high spin ($s = 5/2$) state of porphyrinatoiron(III) complexes and reconstituted myoglobins with fluorinated heme.[2)] However, synthesis of precursory pyrrole required hazardous manipulation of freshly generated HNO_2 and further steps to complete the Knorr condensation.[9)] In order to overcome these drawbacks, we developed an alternative route, which involves an addition reaction of β-perfluoroalkyl α,β-unsaturated carbonyl compounds[10)] and *p*-tolylsulfonylmethyl isocyanide.[11)] We report a more facile and general pathway to electron-deficient tetrakis(perfluoroalkyl)porphyrins including a water-soluble porphyrin.

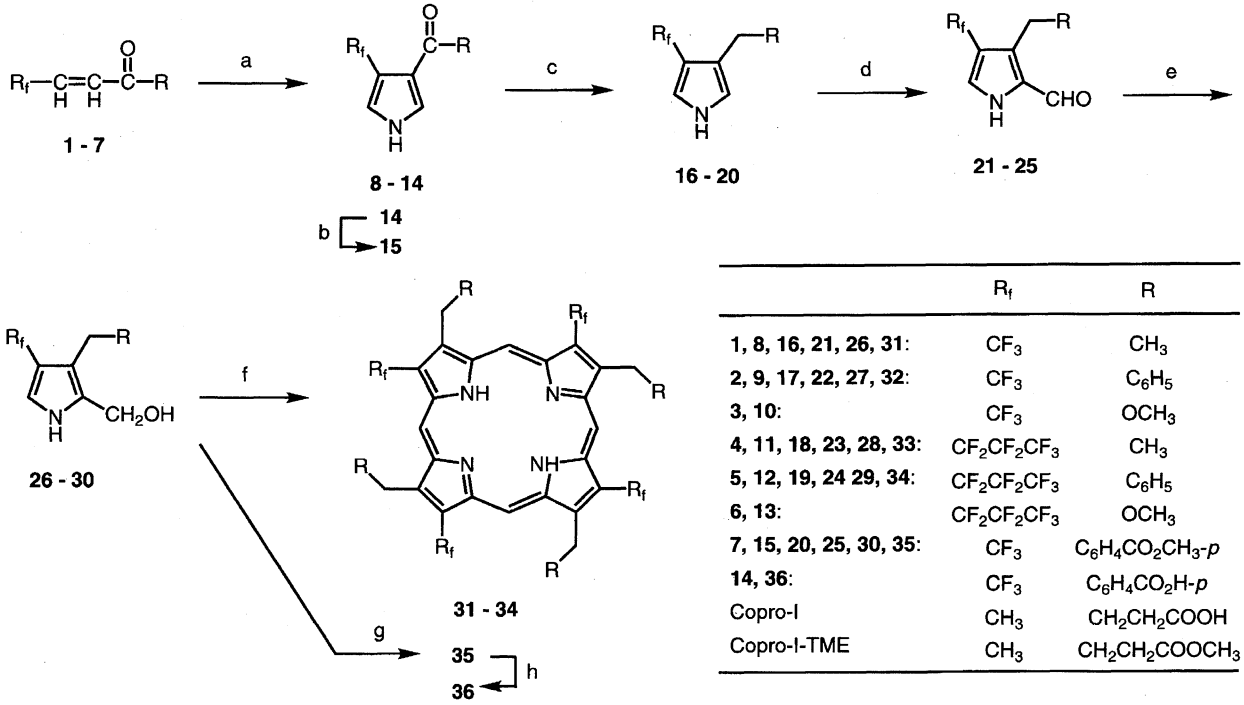
Results and Discussion

Synthesis of β-Perfluoroalkyl α,β-Unsaturated Carbonyl Compounds: Scheme 1 shows the synthetic pathway to perfluoroalkyl porphyrins. The precursors to the perfluoroalkyl pyrrole, β-perfluoroalkyl α,β-unsaturated carbonyl compounds, were prepared by the Wittig reaction between perfluoroalkyl aldehydes (trifluoroacetaldehyde: $R_f = CF_3$ and heptafluorobutyraldehyde: $R_f = CF_2CF_2CF_3$)[10a,10b] and phosphoranes ((acetylmethylene)triphenylphosphorane: $R = COCH_3$, (benzoylmethylene)triphenylphosphorane: $R = COC_6H_5$, (methoxycarbonylmethylene)triphenylphosphorane: $R=COOCH_3$, and [*p*-(methoxycarbonyl)benzoylmethylene]triphenylphosphorane: $R = COC_6H_4COOCH_3$). Each phosphorane obtained by reaction between phosphonium salts and sodium hydroxide aqueous solution was reacted with excess perfluoroalkyl aldehydes in ether at room temperature. Removal of the solvent by distillation, followed by further purification, afforded β-perfluoroalkyl α,β-unsaturated carbonyl compounds **1**—**7** in 43—95% yields. This reaction rapidly proceeded due to the reactivity of the carbonyl carbon being enhanced by electron-withdrawing perfluoroalkyl groups.

Ratios between *E* and *Z* isomers of the synthesized β-perfluoroalkyl α,β-unsaturated carbonyl compounds were determined by gas chromatography and ^{1}H NMR analysis; *E*/*Z*=95.3/4.7 (**1**), 97.9/2.1 (**2**), 90.4/9.6 (**3**), 99.7/0.3 (**4**), 95.6/4.4 (**5**), 93.0/7.0 (**6**), and 99.7/0.3 (**7**). In all the compounds examined, the content of the *E* isomers is higher than 90%. The β-perfluoroalkyl α,β-unsaturated carbonyl compounds thus prepared can be used as building blocks for the synthesis of various perfluoroalkyl analogs of biologically active substances.

Synthesis of β-Perfluoroalkyl Pyrroles: β-Perfluoroalkyl α,β-unsaturated carbonyl compounds **1**—**7** were reacted with *p*-tolylsulfonylmethyl isocyanide in the presence of sodium hydroxide in diethyl ether/dimethyl sulfoxide (2 : 1, v/v) at room temperature. After the usual workup, α-unsubstituted-β-perfluoroalkyl pyrroles **8**—**14** were obtained in 28—86% yields. The total yield from the starting compound was twice as high as that of the Knorr condensation method. This synthetic method facilitated introduction of various perfluoroalkyl, acyl, or alkyl groups at the β-position, and the resultant pyrroles can be easily modified at the α-position.

The perfluoroalkyl pyrroles show characteristic properties such as higher stability toward oxidation and higher melting points than those of the corresponding non-fluoro pyrroles. The pK_a measurement is among the best methods to examine electron-withdrawing effects of the perfluoroalkyl groups. The pK_a values of 3-perfluoroalkyl pyrroles **8**—**13** were determined in a solution of water and a small amount of methanol to dissolve the pyrroles at 25 °C with the usual spectrophotometric method; pK_a = 13.5 (**8**), 13.0 (**9**), 13.3 (**10**), 11.5 (**11**), 11.7 (**12**), and 11.7 (**13**). A remarkable decrease in the basicity of these pyrroles was observed in comparison with that of pyrrole (pK_a = 16.5) due to the strong electron-withdrawing nature of perfluoroalkyl groups. The chemical shifts of the N–H proton in the ^{1}H NMR spectra also reflect this trend. The resonances of the N–H proton appeared downfield from those of the corresponding alkyl pyrroles. These pyrroles are very stable even in strong acid,



	R_f	R
1, 8, 16, 21, 26, 31:	CF_3	CH_3
2, 9, 17, 22, 27, 32:	CF_3	C_6H_5
3, 10:	CF_3	OCH_3
4, 11, 18, 23, 28, 33:	$CF_2CF_2CF_3$	CH_3
5, 12, 19, 24 29, 34:	$CF_2CF_2CF_3$	C_6H_5
6, 13:	$CF_2CF_2CF_3$	OCH_3
7, 15, 20, 25, 30, 35:	CF_3	$C_6H_4CO_2CH_3$-*p*
14, 36:	CF_3	$C_6H_4CO_2H$-*p*
Copro-I	CH_3	CH_2CH_2COOH
Copro-I-TME	CH_3	$CH_2CH_2COOCH_3$

Scheme 1. Synthesis of perfluoroalkyl porphyrins. Reagents: (a) *p*-$CH_3C_6H_4SO_2CH_2NC$, NaH, Et_2O–Me_2SO; (b) CH_3OH, H_2SO_4; (c) $NaBH_4$, BF_3, THF; (d) DMF, $POCl_3$; (e) $NaBH_4$, THF; (f) HBr, EtOH; (g) 1. *p*-TsOH, 2. Chloranil; (h) KOH.

whereas the polyalkylated pyrroles are usually unstable in acidic media.

Reduction of 3-acylpyrroles **8**, **9**, **11**, **12**, and **15** with diborane afforded β-alkylpyrroles **16**—**20** as a colorless oil in 50—98% yields. Vilsmeier formylation of these pyrroles gave 2-formylpyrroles **21**—**25** as colorless crystals in 67—86% yields. Marked difference in electronic effects of alkyl and perfluoroalkyl groups at the β-position lead to exclusive formylation of α-unsubstituted pyrroles at the adjacent position to the alkyl groups, whereas Vilsmeier formylation of unsymmetrical 3,4-dialkyl pyrroles usually gives rise to a mixture of two isomers. Formylation and cyclotetramerization of 3-methoxycarbonyl-4-perfluoroalkylpyrroles **10** and **13** were unsuccessful due to the inactivation by the two electron-withdrawing groups: methoxycarbonyl and perfluoroalkyl groups. Reduction of 2-formylpyrroles **21**—**25** with $NaBH_4$ afforded 2-hydroxymethylpyrroles **26**—**30** as a colorless oil in 81—94% yields. These pyrroles are sensitive to air. When the $CHCl_3$ solutions of **26**—**30** were exposed to air, their color gradually changed to red, due to spontaneous formation of porphyrin. The 2-hydroxymethylpyrroles **26**—**30** were used for the next reaction without purification.

Synthesis of 2,7,12,17-Tetrakis(perfluoroalkyl)porphyrins: Acidic cyclotetramerization of 2-hydroxymethylpyrroles **26**—**29** in the presence of hydrobromic acid gave β-perfluoroalkyl porphyrins **31**—**34** as red crystals in 10—30% yields. Highly symmetric frameworks of these porphyrins are verified by their simple spectral patterns of their ^{1}H NMR and the ^{19}F NMR spectra. It has been reported that four types of porphyrin isomers are formed in the cyclization reaction of 2-hydroxymethylpyrrole in the presence of formic acid and formaldehyde dimethyl acetal,[12] although the reaction condition and electronic effect of the β-substituents are different from our case. In our case, however, no unsymmetrical porphyrin isomers formed under the mild conditions. Present synthetic pathway to electron-deficient porphyrins is much more convenient than template synthesis with pyrroles derived from modified Knorr condensation. Furthermore, it provides a facile method for replacement of the methyl group at peripheral positions of naturally occurring porphyrins with the trifluoromethyl group. Total syntheses of hemes substituted with the trifluoromethyl group and paramagnetic ^{19}F NMR investigation on reconstituted heme enzymes with the new hemes are currently underway.

The perfluoroalkylporphyrins can be converted to the corresponding metal complexes. The Cu(II) complex is inert to H_2SO_4: It can be demetallated with a super acid, FSO_3H, as reported previously.[7]

Synthesis and Properties of Water Soluble β-Tetrakis(perfluoroalkyl)porphyrin: The attempt to obtain 3,8,13,18-tetrakis(*p*-methoxycarbonylbenzyl)-2,7,12,17-tetrakis(trifluoromethyl)porphyrin **35** from 2-hydroxymethyl-3-(*p*-methoxycarbonylbenzyl)-4-trifluoromethylpyrrole **30** by the procedure employed in the preparation of β-perfluoroalkyl porphyrins **31**—**34** from 2-hydroxymethylpyrroles **26**—**29** was unsuccessful. We took advantage of treatment with *p*-TsOH followed by oxidation with chloranil.[13] The highly symmetric framework of the porphyrin **35** is verified by the simple spectral patterns of the ^{1}H NMR and the ^{19}F NMR spectra. Trifluoromethylated porphyrins hitherto synthesized have poor solubility in organic solvents, while the porphyrin **35** has comparatively high solubility (ca. 200 mg in 100 mL of $CHCl_3$ at 20 °C). It was hydrolyzed with KOH to the corresponding tetracarboxylic acid **36**. The porphyrin **36** has high solubility in water.

In Table 1 are summarized absorption maxima in electronic spectra and reduction potentials of **35** and **36** compared with those of coproporphyrin I tetramethyl ester (Copro-I-TME) and coproporphyrin I (Copro-I). Each absorption maximum of **35** and **36** shows red shift by about 10—20 and 30—50 nm compared with those of Copro-I-TME and Copro-I, respectively. Comparison of the first and the second reduction potentials of **35** with those of Copro-I-TME shows anodic shift by 580 and 670 mV, respectively. A similar trend was found for the comparison of the reduction potentials of 3,8,13,18-tetraethyl-2,7,12,17-tetrakis(trifluoromethyl)porphyrin **31** with those of etioporphyrin.[8a] Substitution with the strong electron-withdrawing trifluoromethyl group clearly causes the reduction potential shifts to less negative values. Table 2 shows the pK_a values of **36** and Copro-I. The pK_a values for the inner nitrogen diprotonation of Copro-I in buffer solution is 4 at 25 °C, whereas diprotonation of **36** occurs only in concd HCl. For monoprotonation, the pK_a value of Copro-I is 7.2 while that of **36** is less than 1. These results clearly indicate that **36** is a much weaker base than Copro-I. The chemically stable electron-deficient water-soluble porphyrins thus obtained provides us an informative tool to investigate the structure and the reaction behavior of

Table 1. Absorption Maxima in Electronic Spectra[a] and Reduction Potentials[b] of Porphyrin Free Bases

Compounds	λ_{max} (nm)					$E_{1/2}$ (mV vs. SCE)	
						First	Second
35	415	512	543	589	640	−760	−1090
Copro-I-TME[c]	401	498	533	567	621	−1340	−1760
36	412	533	571	604	670		
Copro-I	369	504	539	565	617		

a) The spectra of **35** and Copro-I-TME were measured in CH_2Cl_2. The spectra of **36** and Copro-I were measured in 0.1 M potassium phosphate buffer (pH 9.0). For the structures of Copro-I and Copro-I-TME, see Scheme 1. b) Measured in CH_2Cl_2 (0.1 M $TBAPF_6$). c) Coproporphyrin I tetramethyl ester.

Table 2. Basicity[a] of Water Soluble Porphyrins (**36** and Copro-I)

$$PH_4^{2+} \underset{H^+}{\overset{pK_4}{\rightleftharpoons}} PH_3^{+} \underset{H^+}{\overset{pK_3}{\rightleftharpoons}} PH_2 \underset{H^+}{\overset{pK_2}{\rightleftharpoons}} PH^{-} \underset{H^+}{\overset{pK_1}{\rightleftharpoons}} P^{2-}$$

Compounds	pK_3	pK_4
36	<1.0	
Copro-I	7.2	4.0

a) Measured in modified potassium phosphate buffer at 25 °C.

heme enzymes.

Experimental

Melting points were measured with a Shibata apparatus and are uncorrected. Gas chromatography was performed with a Shimadzu GC-4C gas chromatograph on columns of poly(ethylene glycol) 20M or silicone DC QF-1. Electronic absorption spectra were recorded on a JASCO V-520 UV/vis spectrophotometer. IR spectra were obtained with a Hitachi 260-10 IR spectrometer or a JASCO FT/IR 7300 FT-IR spectrometer. NMR spectra were recorded on a JEOL A 500, a JEOL GX 270, or a JEOL JNM-FX60Q NMR spectrometer. Chemical shifts were measured downfield in parts per million relative to $Si(CH_3)_4$ as an internal reference for ^1H nuclei and $CFCl_3$ as an external reference for ^{19}F nuclei. The reduction potential was determined by cyclic voltammetry using a BAS CV-1B cyclic voltammograph. Mass spectra (MS) were obtained with a Hitachi M-60 mass spectrometer. High resolution mass spectra (HRMS) were obtained with a JEOL JMS-SX102A spectrometer, using FAB ionization and *m*-nitrobenzyl alcohol as a matrix. The pH was read with a TOA HM-30S pH meter.

5,5,5-Trifluoro-3-penten-2-one (1): This compound was prepared by a modified procedure of Molines and Wakselmann.[10c] Into a suspension of (acetylmethylene)triphenylphosphorane (63.6 g, 0.20 mol) in ether (500 mL) was introduced, under nitrogen at room temperature over a period of 2 h, gaseous trifluoroacetaldehyde generated by the dropwise addition of trifluoroacetaldehyde ethyl hemiacetal (71.3 g, 0.50 mol) to polyphosphoric acid (100 mL) at 150—180 °C. The reaction mixture was further stirred for 1 h at room temperature. The triphenylphosphine oxide which separated was removed by filtration. Distillation of the filtrate at 85—87 °C afforded **1** (20.8 g, 75%). The stereoisomer ratio was determined by gas chromatography; *E*/*Z*=95.3/4.7; bp 85—87 °C. Comparison of the spectroscopic data of the product with those of the authentic compound confirmed the structure.[10b]

4,4,4-Trifluoro-1-phenyl-2-butene-1-one (2): This compound was prepared in a similar manner to that for **1**. Yield 81%; *E*/*Z*= 97.9/2.1; bp 200—201 °C; MS *m*/*z* 200 (M^+); IR (liquid film) 1692 (ν(C=O)), 1311, 1280, 1190, and 1140 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 7.88 (m, 2H, *o*-H), 7.56 (m, 4H, *m*,*p*-H, =CHCO–), and 6.96 (d-q, 1H, $=CHCF_3$).

Methyl 4,4,4-Trifluoro-2-butenoate (3): This compound was prepared in a similar manner to that for **1**. Yield 94%; *E*/*Z*= 90.4/9.6; bp 98—102 °C; MS *m*/*z* 154 (M^+); IR (liquid film) 1721 (ν(C=O)), 1310, 1280, 1190, and 1141 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 6.76 (d, 1H, =CHCO–), 6.58 (d-q, 1H, $=CHCF_3$), and 3.83 (s, 3H, CH_3).

5,5,6,6,7,7,7-Heptafluoro-3-heptene-2-one (4): This compound was prepared in a similar manner to that for **1**. Yield 78%; *E*/*Z*=99.7/0.3; bp 64—65 °C; MS *m*/*z* 238 (M^+); IR (liquid film) 1710 and 1698 (ν(C=O)), 1270, 1225, 1180, and 1120 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 6.76 (d, 1H, =CHCO–), 6.68 (d-t, 1H, $=CHCF_3$), and 2.39 (s, 3H, CH_3).

4,4,5,5,6,6,6-Heptafluoro-1-phenyl-2-hexene-1-one (5): This compound was prepared in a similar manner to that for **1**. Yield 76%; *E*/*Z*=95.6/4.4; bp 210—212 °C; MS *m*/*z* 300 (M^+); IR (liquid film) 1693 (ν(C=O)), 1296, 1236, 1188, and 1122 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 7.91 (m, 2H, *o*-H), 7.62 (m, 4H, *m*,*p*-H and =CHCO–), 6.97 (d-t, 1H, $=CHCF_3$).

Methyl 4,4,5,5,6,6,6-Heptafluoro-2-hexenoate (6): This compound was prepared in a similar manner to that for **1**. Yield 95%; *E*/*Z*=93.0/7.0; bp 90—94 °C; MS *m*/*z* 254 (M^+); IR (liquid film) 1722 (ν(C=O)), 1280, 1220, 1196, and 1120 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 6.76 (d, 1H, =CHCO–), 6.63 (d-t, 1H, $=CHCF_3$), 3.84 (s, 3H, CH_3).

4,4,4-Trifluoro-1-(*p*-methoxycarbonylphenyl)-2-butene-1-one (7): This compound was prepared in a similar manner to that for **1**. Yield 43%; *E*/*Z*=99.7/0.3; MS *m*/*z* 258 (M^+); IR (KBr) 1732 and 1688 (ν(C=O)), 1273, 1222, 1209, and 1105 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.10 (m, 4H, C_6H_4), 7.56 (d, 1H, =CHCO–), and 6.95 (d-q, 1H, $=CHCF_3$), and 3.97 (s, 3H, CH_3); ^{19}F NMR ($CDCl_3$) δ = −65.5 (d, CF_3). High resolution mass spectrum (HRMS) (*m*-nitrobenzyl alcohol matrix) Found: *m*/*z* 258.0525 (+8.2 ppm). Calcd for $C_{12}H_9F_3O_3$: M, 258.0504.

3-Acetyl-4-trifluoromethylpyrrole (8). A solution of *p*-tolylsulfonylmethyl isocyanide (780 mg, 4.0 mmol) and **1** (550 mg, 4.0 mmol) in diethyl ether/dimethyl sulfoxide (2 : 1 v/v, 20 mL) was added dropwise to a stirred suspension of 50% sodium hydride (400 mg, 8.3 mmol) in ether (8 mL). After stirring of the reaction mixture for 30 min, water (80 mL) was added, and the mixture was extracted with ether. The ether solution was washed with water, dried over anhydrous $MgSO_4$, and condensed to dryness under reduced pressure. Recrystallization from chloroform/pentane gave **8** (310 mg, 44%) as white crystals. Mp 175—177 °C; MS *m*/*z* 177 (M^+); IR (KBr) 3140 (ν(NH)), 1650 (ν(C=O)), 1238, 1175, 1125, and 1097 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.14 (broad s, 1H, NH), 7.46 and 7.22 (m, 1H, 1H, 5 and 2-H), 2.47 (s, 3H, CH_3); ^{19}F NMR (CD_3OD) δ = −58.4 (s, CF_3). Found: C, 47.60; H, 3.39; N, 7.77; F, 31.90%. Calcd for $C_7H_6F_3NO$: C, 47.47; H, 3.41; N, 7.91; F, 32.18%.

3-Benzoyl-4-trifluoromethylpyrrole (9): This compound was prepared in a similar manner to that for **8**. Yield 49%; mp 182—183 °C; MS *m*/*z* 239 (M^+); IR (KBr) 3220 (ν(NH)), 1612 (ν(C=O)), 1239, 1190, 1141, and 1110 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.01 (broad s, 1H, NH), 7.71 (m, 2H, *o*-H), 7.49 (m, 3H, *m*,*p*-H), and 7.38 and 6.93 (m, 1H, 1H, 5 2-H); ^{19}F NMR (CD_3OD) δ = −57.8 (s, CF_3). Found: C, 60.18; H, 3.19; N, 5.83; F, 23.93%. Calcd for $C_{12}H_8F_3NO$: C, 60.26; H, 3.37; N, 5.86; F, 23.83%.

Methyl 4-Trifluoromethyl-3-pyrrolecarboxylate (10): This compound was prepared in a similar manner to that for **8**. Yield 36%; mp 168—169 °C; MS *m*/*z* 193 (M^+); IR (KBr) 3160 (ν(NH)), 1700 (ν(C=O)), 1230, 1150, 1117, and 1085 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.03 (broad s, 1H, NH), 7.49 and 7.24 (m, 1H, 1H, 5 and 2-H), 3.85 (s, 3H, CH_3); ^{19}F NMR (CD_3OD) δ = −58.2 (s, CF_3). Found: C, 43.61; H, 2.90; N, 7.30; F, 29.71%. Calcd for $C_7H_6F_3NO_2$: C, 43.53; H, 3.13; N, 7.25; F, 29.51%.

3-Acetyl-4-heptafluoropropylpyrrole (11): This compound was prepared in a similar manner to that for **8**. Yield 39%; mp 176—179 °C; MS *m*/*z* 277 (M^+); IR (KBr) 3175 (ν(NH)), 1652 (ν(C=O)), 1235, 1198, 1179, and 1108 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.00 (broad s, 1H, NH), 7.46 and 7.20 (m, 1H, 1H, 5 and 2-H), and 2.45 (s, 3H, CH_3); ^{19}F NMR (CD_3OD) δ = −81.0 (t, 3F, CF_3) and −102.2 and −124.7 (m, 2F, 2F, $CF_2CF_2CF_3$). Found: C, 38.78; H, 2.13; N, 5.11; F, 47.19%. Calcd for $C_9H_6F_7NO$: C, 39.00; H, 2.18; N, 5.05; F, 47.99%.

3-Benzoyl-4-heptafluoropropylpyrrole (12): This compound was prepared in a similar manner to that for **8**. Yield 44%; mp 161—162 °C; MS *m*/*z* 339 (M^+); IR (KBr) 3160 (ν(NH)), 1622 (ν(C=O)), 1228, 1211, 1171, and 1112 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.66 (broad s, 1H, NH), 7.83 (m, 2H, *o*-H), 7.57 (m, 3H, *m*,*p*-H), and 7.40 and 7.22 (m, 1H, 1H, 5 and 2-H); ^{19}F NMR (CD_3OD) δ = −80.9 (t, 3F, CF_3), and −102.1 and −125.1 (m, 2F, 2F, $CF_2CF_2CF_3$). Found: C, 49.36; H, 2.12; N, 4.30; F, 38.91%. Calcd for $C_{14}H_8F_7NO$: C, 49.57; H, 2.38; N, 4.13; F, 39.21%.

Methyl 3- Heptafluoropropyl- 4- pyrrolecarboxylate (13):

This compound was prepared in a similar manner to that for **8**. Yield 28%; mp 160—162 °C; MS *m/z* 293 (M^+); IR (KBr) 3130 (ν(NH)), 1737 (ν(C=O)), 1230, 1200, 1148, and 1112 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.85 (broad s, 1H, NH), 7.54 and 7.12 (m, 1H, 1H, 2 and 5-H), and 3.82 (s, 3H, CH_3); ^{19}F NMR (CD_3OD) δ = −81.0 (t, 3F, CF_3), and −102.7 and −125.0 (m, 2F, 2F, $CF_2CF_2CF_3$). Found: C, 36.88; H, 1.82; N, 4.91; F, 45.26%. Calcd for $C_9H_6F_7NO_2$: C, 36.88; H, 2.06; N, 4.78; F, 45.37%.

3-(*p*-Carboxybenzoyl)-4-trifluoromethylpyrrole (14): A solution of *p*-tolylsulfonylmethyl isocyanide (3.1 g, 15.9 mmol) and **7** (4.0 g, 15.5 mmol) in diethyl ether/dimethyl sulfoxide (2 : 1 v/v, 54 mL) was added dropwise to a stirred suspension of sodium hydride (1.1 g, 50% in oil, 22.9 mmol) in ether (15 mL). After stirring of the reaction mixture for 30 min, water (200 mL) was added, and the mixture was extracted with ether. The aqueous layer was acidified with 3 mol dm^{-3} HCl. The white precipitate was filtered, washed with aqueous sodium acetate and water, and then dried to give **14** (3.8 g, 86%). Mp 240 °C (decomp); MS *m/z* 283 (M^+); IR (KBr) 3324 (ν(NH)), 1698 and 1629 (ν(C=O)), 1331, 1290, 1236, and 1123 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($(CD_3)_2SO$) δ = 12.24 (broad s, 1H, NH), 12.17 (s, 1H, COOH), 7.96 (m, 4H, C_6H_4), and 7.65 and 7.47 (m, 1H, 1H, 5 and 2-H); ^{19}F NMR ($(CD_3)_2SO$) δ = −55.2 (s, CF_3). HRMS Found: *m/z* 283.0444 (−4.2 ppm). Calcd for $C_{13}H_8F_3NO_3$: M, 283.0456.

3- (*p*- Methoxycarbonylbenzoyl)- 4- trifluoromethylpyrrole (15). Concentrated sulfuric acid (7 mL) was added slowly, with cooling at 0 °C, to **14** (4.0 g, 14.1 mmol) in methanol (58 mL). The reaction mixture was stirred for 15 min and refluxed for 1 h. After stirring of the solution for 30 min, water (300 mL) was added and extracted with chloroform. The chloroform solution was washed with water, dried over anhydrous Na_2SO_4, and condensed to dryness under reduced pressure. Recrystallization from chloroform/pentane gave **15** (4.0 g, 95%) as pale yellow crystals. Mp 156—158 °C; MS *m/z* 297 (M^+); IR (KBr) 3324 (ν(NH)), 1727 and 1628 (ν(C=O)), 1338, 1284, 1236, and 1120 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.62 (broad s, 1H, NH), 7.94 (m, 4H, C_6H_4), 7.22 and 7.20 (m, 1H, 1H, 5 and 2-H), and 3.94 (s, 3H, CH_3); ^{19}F NMR ($CDCl_3$) δ = −57.9 (s, CF_3). HRMS Found: *m/z* 297.0618 (+1.9 ppm). Calcd for $C_{14}H_{10}F_3NO_3$: M, 297.0612.

3-Ethyl-4-trifluoromethylpyrrole (16): To a dried tetrahydrofuran solution (50 mL) of **8** (2.0 g, 11.3 mmol) was added $NaBH_4$ (2.1 g, 55.6 mmol) under nitrogen atmosphere at 0 °C. To this was added dropwise diethyl ether-boron trifluoride (1/1) (10.5 g, 72.8 mmol). The reaction mixture was stirred at room temperature for 1 h, and neutralized by dropwise addition of 5% HCl at 0 °C. The solution was poured into water, washed with saturated aqueous $NaHCO_3$, washed with water, and dried over anhydrous Na_2SO_4. After removal of the solvent under reduced pressure, distillation of the residue at 43—44 °C (5 mmHg, 1 mmHg = 133.322 Pa) afforded **16** (1.8 g, 98%) as a colorless oil. bp 43—44 °C (5 mmHg); MS *m/z* 163 (M^+); IR (liquid film) 3425 (ν(NH)), 1256, 1208, 1127, and 1107 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.12 (broad s, 1H, NH), 7.02 and 6.57 (m, 1H, 1H, 5 and 2-H), 2.16 (q, 2H, CH_2CH_3), and 1.21 (t, 3H, CH_2CH_3); ^{19}F NMR ($CDCl_3$) δ = −55.8 (s, CF_3).

3-Benzyl-4-trifluoromethylpyrrole (17): This compound was prepared in a similar manner to that for **16**. Yield 93%; bp 170—172 °C (4 mmHg); MS *m/z* 225 (M^+); IR (liquid film) 3420 (ν(NH)), 1254, 1202, 1129, and 1107 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 7.95 (broad s, 1H, NH), 7.27 (m, 2H, *o*-H), 7.20 (m, 3H, *m,p*-H), 6.95 and 6.25 (m, 1H, 1H, 5 and 2-H), and 3.88 (s, 2H, $CH_2C_6H_5$); ^{19}F NMR ($CDCl_3$) δ = −57.2 (s, CF_3).

3-Ethyl-4-heptafluoropropylpyrrole (18): This compound was prepared in a similar manner to that for **16**. Yield 86%; bp 40—43 °C (4 mmHg); MS *m/z* 263 (M^+); IR (liquid film) 3495 (ν(NH)), 1229, 1212, 1178, and 1110 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.28 (broad s, 1H, NH), 6.98 and 6.61 (m, 1H, 1H, 5 and 2-H), 2.58 (q, 2H, CH_2CH_3), and 1.20 (t, 3H, CH_2CH_3); ^{19}F NMR ($CDCl_3$) δ = −78.9 (t, 3F, CF_3), and −103.2 and −124.9 (m, 2F, 2F, $CF_2CF_2CF_3$).

3-Benzyl-4-heptafluoropropylpyrrole (19): This compound was prepared in a similar manner to that for **16**. Yield 78%; bp 182—184 °C (4 mmHg); MS *m/z* 325 (M^+); IR (liquid film) 3425 (ν(NH)), 1227, 1206, 1180, and 1110 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.14 (broad s, 1H, NH), 7.28 (m, 2H, *o*-H), 7.20 (m, 3H, *m,p*-H), 6.95 and 6.22 (m, 1H, 1H, 5 and 2-H), and 3.87 (s, 2H, $CH_2C_6H_5$); ^{19}F NMR ($CDCl_3$) δ = −80.5 (t, 3F, CF_3), and −104.7 and −126.5 (m, 2F, 2F, $CF_2CF_2CF_3$).

3-(*p*-Methoxycarbonylbenzyl)-4-trifluoromethylpyrrole (20): This compound was prepared in a similar manner to that for **16**. Yield 50%; mp 107—108 °C; MS *m/z* 283 (M^+); IR (KBr) 3363 (ν(NH)), 1708 (ν(C=O)), 1295, 1240, 1126, and 1095 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 8.44 (broad s, 1H, NH), 7.62 (m, 4H, C_6H_4), 7.06 and 6.36 (m, 1H, 1H, 5 and 2-H), 3.95 (s, 2H, CH_2), and 3.89 (s, 3H, CH_3); ^{19}F NMR ($CDCl_3$) δ = −57.1 (s, CF_3). HRMS Found: *m/z* 283.0817 (−1.1 ppm). Calcd for $C_{14}H_{12}F_3NO_2$: M, 283.0820.

3-Ethyl-4-trifluoromethyl-2-pyrrolecarbaldehyde (21): *N, N*-Dimethylformamide (1.2 g, 16.4 mmol) was added dropwise, with cooling at 0 °C, to phosphoryl chloride (2.6 g, 17.0 mmol) in 1,2-dichloroethane (5 mL) and the complex separated as a thick oil. To this complex was added, with stirring over 5 min, **16** (1.8 g, 11.0 mmol) in 1,2-dichloroethane (4 mL). The reaction mixture was refluxed for 15 min, treated with saturated aqueous sodium acetate (20 mL), and refluxed for an additional 15 min. The 1,2-dichloroethane layer was separated, washed with water, dried over anhydrous Na_2SO_4, and condensed to dryness under reduced pressure. Recrystallization from chloroform/pentane afforded **21** (1.8 g, 86%) as colorless crystals. Mp 90—92 °C; MS *m/z* 191 (M^+); IR (KBr) 3250 (ν(NH)), 1655 (ν(C=O)), 1288, 1219, 1126, and 1090 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.89 (broad s, 1H, NH), 9.70 (s, 1H, CHO), 7.39 (m, 1H, 5-H), 2.91 (q, 2H, CH_2CH_3), and 1.30 (t, 3H, CH_2CH_3); ^{19}F NMR ($CDCl_3$) δ = −56.0 (s, CF_3). Found: C, 50.20; H, 4.13; N, 7.32; F, 29.88%. Calcd for $C_8H_8F_3NO$: C, 50.27; H, 4.22; N, 7.33; F, 29.82%.

3- Benzyl- 4- trifluoromethyl- 2- pyrrolecarbaldehyde (22): This compound was prepared in a similar manner to that for **21**. Yield 77%; mp 92—93 °C; MS *m/z* 253 (M^+); IR (KBr) 3270 (ν(NH)), 1659 (ν(C=O)), 1289, 1230, 1138, and 1111 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.98 (broad s, 1H, NH), 9.50 (s, 1H, CHO), 7.33 (m, 1H, 5-H), 7.28 (m, 2H, *o*-H), 7.18 (m, 3H, *m, p*-H), and 4.22 (s, 2H, $CH_2C_6H_5$); ^{19}F NMR ($CDCl_3$) δ = −55.8 (s, CF_3). Found: C, 61.69; H, 3.89; N, 5.36; F, 22.50%. Calcd for $C_{13}H_{10}F_3NO$: C, 61.66; H, 3.98; N, 5.53; F, 22.51%.

3- Ethyl- 4- heptafluoropropyl- 2- pyrrolecarbaldehyde (23): This compound was prepared in a similar manner to that for **21**. Yield 70%; bp 165—167 °C (2 mmHg); MS *m/z* 291 (M^+); IR (liquid film) 3270 (ν(NH)), 1659 (ν(C=O)), 1281, 1215, 1180, and 1114 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.96 (broad s, 1H, NH), 9.71 (s, 1H, CHO), 7.32 (m, 1H, 5-H), 2.88 (q, 2H, CH_2CH_3), and 1.27 (t, 3H, CH_2CH_3); ^{19}F NMR ($CDCl_3$) δ = −78.8 (s, 3F, CF_3), and −103.9 and −125.0 (m, 2F, 2F, $CF_2CF_2CF_3$). Found: C, 41.47; H, 2.80; N, 4.78; F, 45.39%. Calcd for $C_{10}H_8F_7NO$: C, 41.25; H, 2.77; N, 4.81; F, 45.67%.

3-Benzyl-4-heptafluoropropyl-2-pyrrolecarbaldehyde (24): This compound was prepared in a similar manner to that for **21**. Yield 72%; mp 130—131 °C; MS *m/z* 353 (M^+); IR (KBr) 3260 (ν(NH)), 1654 (ν(C=O)), 1283, 1231, 1190, and 1110 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 9.79 (broad s, 1H, NH), 9.44 (s, 1H, CHO), 7.31 (m, 1H, 5-H), 7.20 (m, 2H, *o*-H), 7.13 (m, 3H, *m,p*-H), and 4.22 (s, 2H, $CH_2C_6H_5$); ^{19}F NMR ($CDCl_3$) δ = −78.7 (s, 3F, CF_3), and −103.7 and −124.7 (m, 2F, 2F, $CF_2CF_2CF_3$). Found: C, 50.88; H, 2.59; N, 4.04; F, 37.56%. Calcd for $C_{15}H_{10}F_7NO$: C, 51.00; H, 2.85; N, 3.77; F, 37.65%.

3-(*p*-Methoxycarbonylbenzyl)-4-trifluoromethyl-2-pyrrolecarbaldehyde (25): This compound was prepared in a similar manner to that for **21**. Yield 67%; mp 122—124 °C; MS *m/z* 311 (M^+); IR (KBr) 3242 (ν(NH)), 1715 and 1657 (ν(C=O)), 1290, 1228, 1134, and 1101 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.13 (broad s, 1H, NH), 9.56 (s, 1H, CHO), 7.58 (m, 4H, C_6H_4), 7.39 (m, 1H, 5-H), 4.30 (s, 2H, CH_2), and 3.90 (s, 3H, CH_3); ^{19}F NMR ($CDCl_3$) δ = −57.2 (s, CF_3). HRMS Found: *m/z* 311.0784 (+4.6 ppm). Calcd for $C_{15}H_{12}F_3NO_3$: M, 311.0770.

3-Ethyl-2-hydroxymethyl-4-trifluoromethylpyrrole (26): To a dried tetrahydrofuran solution (20 mL) of **21** (200 mg, 1.05 mmol) was added $NaBH_4$ (800 mg, 21.2 mmol). The reaction mixture was stirred at room temperature for 5 h, and neutralized by dropwise addition of 5% HCl at 0 °C. The solution was poured into water and extracted with ether. The ether solution was washed with saturated aqueous $NaHCO_3$, washed with water, and dried over anhydrous $MgSO_4$. Removal of the solvent under reduced pressure afforded **26** (164 mg, 81%) as a colorless oil. ^1H NMR ($CDCl_3$) δ = 8.87 (broad s, 1H, NH), 6.85 (m, 1H, 5-H), 4.47 (s, 2H, CH_2OH), 2.37 (q, 2H, CH_2CH_3), and 1.10 (t, 3H, CH_2CH_3). 2-Hydroxymethylpyrrole **26** is sensitive to air, and its color gradually changed to red due to spontaneous formation of porphyrin when the chloroform solution was exposed to air. The pyrrole **26** was used for the next reaction without purification.

3-Benzyl-2-hydroxymethyl-4-trifluoromethylpyrrole (27): This compound was prepared in a similar manner to that for **26**. Yield 84%; ^1H NMR ($CDCl_3$) δ = 8.82 (broad s, 1H, NH), 7.13 (s, 5H, C_6H_5), 6.93 (m, 1H, 5-H), 4.36 (s, 2H, CH_2OH), and 3.91 (s, 2H, $CH_2C_6H_5$).

3-Ethyl-2-hydroxymethyl-4-heptafluoropropylpyrrole (28): This compound was prepared in a similar manner to that for **26**. Yield 92%; ^1H NMR ($CDCl_3$) δ = 8.80 (broad s, 1H, NH), 6.93 (m, 1H, 5-H), 4.63 (s, 2H, CH_2OH), 2.43 (q, 2H, CH_2CH_3), and 1.13 (t, 3H, CH_2CH_3).

3-Benzyl-2-hydroxymethyl-4-heptafluoropropylpyrrole (29): This compound was prepared in a similar manner to that for **26**. Yield 82%; ^1H NMR ($CDCl_3$) δ = 9.51 (broad s, 1H, NH), 7.05 (s, 5H, C_6H_5), 6.83 (m, 1H, 5-H), 4.25 (s, 2H, CH_2OH), and 3.86 (s, 2H, $CH_2C_6H_5$).

2-Hydroxymethyl-3-(*p*-methoxycarbonylbenzyl)-4-trifluoromethylpyrrole (30): This compound was prepared in a similar manner to that for **26**. Yield 94%; ^1H NMR ($CDCl_3$) δ = 9.43 (broad s, 1H, NH), 7.51 (m, 4H, C_6H_4), 6.99 (m, 1H, 5-H), 4.44 (s, 2H, CH_2OH), 3.93 (s, 2H, CH_2), and 3.83 (s, 3H, CH_3).

3, 8, 13, 18- Tetraethyl- 2, 7, 12, 17- tetrakis(trifluoromethyl)-porphyrin (31): A mixture of **26** (145 mg, 0.75 mmol) and several drops of 48% hydrobromic acid in ethanol (30 mL) was stirred at room temperature for 2 d. The reaction mixture was poured into cold water and extracted with chloroform. The chloroform solution was washed with saturated aqueous $NaHCO_3$, washed with water, and dried over anhydrous Na_2SO_4. After removal of the solvent under reduced pressure, the residual solid was chromatographed on alumina gel with chloroform. Red fractions were collected and evaporated into dryness. Recrystallization from chloroform/methanol gave **31** (39 mg, 30%) as red crystals, which was identified by comparing with physical properties and spectroscopic data of authentic porphyrin.[7)]

3,8,13,18-Tetrabenzyl-2,7,12,17-tetrakis(trifluoromethyl)-porphyrin (32): This compound was prepared in a similar manner to that for **31**. Yield 20%; MS *m/z* 942 (M^+); IR (KBr) 3320 (ν(NH)), 1160, 1118, 1050, and 1039 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.48 (s, 4H, *meso*-H), 7.59 (m, 8H, *o*-H), 7.28 (m, 12H, *m,p*-H), 5.62 (s, 8H, $CH_2C_6H_5$), and −3.38 (s, 2H, NH); ^{19}F NMR ($CDCl_3$) δ = −48.7 (s, CF_3); UV-vis ($CHCl_3$) λ_{max}/nm (relative ratios) 412 (23.3), 509 (1.0), 542 (0.33), 584 (0.34), and 638 (0.15). HRMS Found: *m/z* 942.2629 (+3.9 ppm). Calcd for $C_{52}H_{34}F_{12}N_4$: M, 942.2592.

3,8,13,18-Tetraethyl-2,7,12,17-tetrakis(heptafluoropropyl)-porphyrin (33): This compound was prepared in a similar manner to that for **31**. Yield 11%; MS *m/z* 1094 (M^+); IR (KBr) 3315 (ν(NH)), 1232, 1205, 1188, and 1115 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.47 (s, 4H, *meso*-H), 4.25 (q, 8H, CH_2CH_3), 1.99 (t, 12H, CH_2CH_3), and −3.33 (s, 2H, NH); ^{19}F NMR ($CDCl_3$) δ = −78.2 (t, 12F, CF_3), and −99.1 and −122.8 (m, 8F, 8F, $CF_2CF_2CF_3$); UV-vis ($CHCl_3$) λ_{max}/nm (relative ratios) 409 (17.0), 505 (1.0), 539 (0.39), 580 (0.36), and 635 (0.14). HRMS Found: *m/z* 1094.1675 (−3.3 ppm). Calcd for $C_{40}H_{26}F_{28}N_4$: M, 1094.1711.

3,8,13,18-Tetrabenzyl-2,7,12,17-tetrakis(heptafluoropropyl)-porphyrin (34): This compound was prepared in a similar manner to that for **31**. Yield 10%; MS *m/z* 1342 (M^+); IR (KBr) 3320 (ν(NH)), 1231, 1204, 1189, and 1114 cm^{-1} ($\nu(CF_2CF_2CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.34 (s, 4H, *meso*-H), 7.50 (m, 8H, *o*-H), 7.23 (m, 12H, *m,p*-H), 5.56 (s, 8H, $CH_2C_6H_5$), and −3.28 (s, 2H, NH); ^{19}F NMR ($CDCl_3$) δ = −78.1 (t, 12F, CF_3), and −98.8 and −122.7 (m, 8F, 8F, $CF_2CF_2CF_3$); UV-vis ($CHCl_3$) λ_{max}/nm (relative ratios) 415 (17.1), 510 (1.0), 543 (0.38), 585 (0.37), and 640 (0.10). HRMS Found: *m/z* 1342.2379 (+3.2 ppm). Calcd for $C_{60}H_{34}F_{28}N_4$: M, 1342.2336.

3, 8, 13, 18- Tetra(*p*- methoxycarbonylbenzyl)- 2, 7, 12, 17-tetrakis(trifluorometyl)porphyrin (35): A mixture of **30** (285 mg, 0.91 mmol) and *p*-TsOH·H_2O (64 mg, 0.37 mmol) in dichloromethane (60 mL) was stirred at room temperature for 14 h, and then chloranil (170 mg, 0.69 mmol) was added to the resulting reaction mixture. After stirring at room temperature for 8 h, the dichloromethane solution was washed with saturated aqueous $NaHCO_3$, washed with water, and dried over anhydrous Na_2SO_4. After removal of the solvent under reduced pressure, the residual solid was chromatographed on alumina gel with chloroform. Red fractions were collected and evaporated into dryness. Recrystallization from chloroform/methanol gave **35** (19 mg, 7%) as purple crystals. MS *m/z* 1175 (M^+); IR (KBr) 3330 (ν(NH)), 1724 (ν(C=O)), 1283, 1112, 1040, and 1020 cm^{-1} ($\nu(CF_3)$); ^1H NMR ($CDCl_3$) δ = 10.40 (s, 4H, *meso*-H), 7.80 (m, 16H, C_6H_4), 5.65 (s, 8H, CH_2), 3.82 (s, 12H, CH_3), and −3.31 (s, 2H, NH); ^{19}F NMR ($CDCl_3$) δ = −50.2 (s, CF_3); UV-vis ($CHCl_3$) λ_{max}/nm (ε/$mol^{-1}dm^3cm^{-1}$) 415 (239000), 512 (16400), 543 (4990), 589 (5840), and 640 (2430). HRMS Found: *m/z* 1174.2783 (−2.4 ppm). Calcd for $C_{60}H_{42}F_{12}N_4O_8$: M, 1174.2811.

3,8,13,18-Tetra(*p*-carboxybenzyl)-2,7,12,17-tetrakis(trifluoromethyl)porphyrin (36): Hydrolysis of **35** (20 mg, 17.0 mmol) with 1% aqueous KOH in methanol (50 mL) gave **36** (15 mg, 79%) as purple crystals. IR (KBr) 3295 (ν(NH)), 1710 (ν(C=O)), 1260, 1236, 1112, and 1067 cm^{-1} ($\nu(CF_3)$).

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