Nucleoside adducts of vinylporphyrins and vinylchlorins[1]

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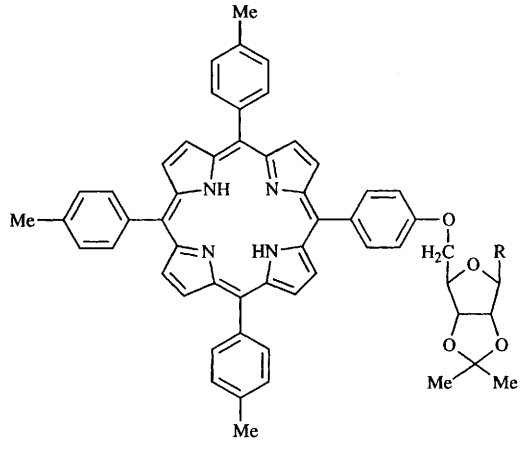
Ethene-linked nucleoside derivatives of porphyrins and chlorins have been synthesized by palladium-catalysed coupling between acetylated 5-chloromercuriuridine and various vinylporphyrins and vinylchlorins. The formation of both the *trans*- (*e.g.* 22, 24, 29) and *gem*- (*e.g.* 23, 30) isomeric products was usually observed in these coupling reactions, and ratios of these isomers were dependent upon the particular substrate employed.

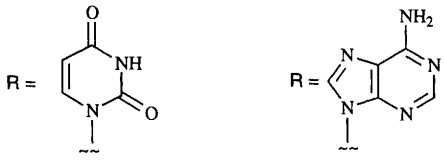
Recently, porphyrins coupled with nucleosides have attracted great attention owing to their strong tumoricidal activity against human maligant melanoma.[2] Heme has long been known to play an important role in cellular differentiation and maturation processes.[3] In view of the toxic actions of AZT on bone marrow stem cells, Abraham *et al.* examined the possibility that heme could exert a protective effect against the bone marrow toxicity of this chemotherapeutic agent. The results of that investigation showed that AZT-induced inhibition of colony-forming unit-erythroid, burst-forming unit-erythroid, and colony-forming unit-granulocyte/macrophage in both murine and human marrow could be counteracted *in vitro* to a considerable degree by concurrently administered heme.[4]

Levere *et al.*[5] examined the possible interactions of AZT and heme on HIV replication to determine whether heme could enhance the antiviral activity of AZT or might alone inhibit viral replication. It was found that heme without AZT directly inhibited virus replication. Neurath *et al.*[6] discovered several porphyrin derivatives were more potent inhibitors of HIV-1 replication than hemin, causing them to study their anti-HIV-1 activity and establish a quantitative structure–activity relationship (QSAR). They applied comparative molecular field analysis for the development of a 3D QSAR model for porphyrins with anti-HIV-1 activity.[7]

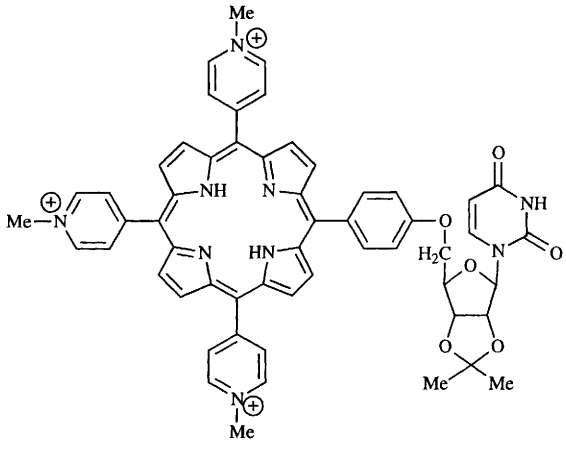
Czuchajowski and co-workers[8] reported the first representatives of porphyrinylnucleosides in 1990. The 5′-*O*-(5-*p*-phenylene-10,15,20-tri-*p*-tolyporphyrin)uridine **1** was obtained by mixing *meso*-*p*-hydroxyphenyl-tri-*p*-tolylporphyrin, 5′-*O*-tosyl-2′,3′-*O*-isopropylideneuridine and sodium hydride in DMF. Porphyrinylnucleoside **2** was similarly obtained from 2′,3′-*O*-isopropylideneadenosine. Water-soluble porphyrinyl-nucleosides (*e.g.* **3**) were also prepared;[2,9] porphyrinyl-uridine **3** at the lowest concentration (10^{-6} mol dm^{-3}), acted as a growth suppressant, but at 2.5×10^{-5} mol dm^{-3} began to stimulate the growth of malignant cells. However, the cobalt(II) derivative of porphyrinyl-dithymidine showed strong concentration-dependent suppression of malignant cells, suggesting that certain porphyrinyl-nucleoside derivatives, some bearing fluorinated nucleosides,[10] may well be useful drug or pro-drug candidates.

Hisatome *et al.*[11,12] have reported the coupling between porphyrins and nucleoside bases such as adenine, thymine, guanine, cytosine or an adenine-thymine pair, whereas Drain *et al.*[13] synthesized a porphyrin containing 5-alkyluracil recognition groups, which self-assembled upon addition of triaminopyrimidines to afford a bisporphyrin supramolecular cage structure. Sessler and co-workers[14,15] also reported the construction of new, non-covalent porphyrin-benzoquinone photosynthetic models that relied on spontaneous cytosine-guanine base-pairing for their pre-organization. A cytosine-sapphyrin conjugate was also prepared[16] which acted as a selective through-membrane carrier for guanosine 5′-monophosphate (GMP) at neutral pH in a model membrane system.





1 **2**



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Owing to the anti-HIV-1 abilities of some nucleoside derivatives and certain porphyrins as discussed above, we believed it would be interesting to synthesize novel porphyrin-nucleoside and chlorin-nucleoside adducts for the study of their potential antiviral and photodynamic activity. A number of years ago we[17] reported the synthesis of a series of substituted porphyrins with unsaturated side chains by using palladium(II)-catalysed carbon–carbon coupling methodology (the Heck reaction), and this reaction gave *trans*-alkene products in excellent yields. This methodology has since been extended by Therien and co-workers.[18] We first coupled styrene to zinc(II) 3,8-bis(chloromercuri)deuteroporphyrin IX dimethyl ester **4** to obtain distyryldeuteroporphyrin IX dimethyl ester **5** (after removal of zinc), and then prepared the same compound in higher yield by treating zinc(II) protoporphyrin IX dimethyl ester **6** with phenylmercuric chloride (Scheme 1). A chlorin, zinc(II) methyl pyropheophorbide-a **7** was also converted into the corresponding styrene derivative **8** by the treatment with phenylmercuric chloride, followed by removal of zinc(II). In the present paper we now expand this methodology to the preparation of nucleoside conjugates.

Results and discussion

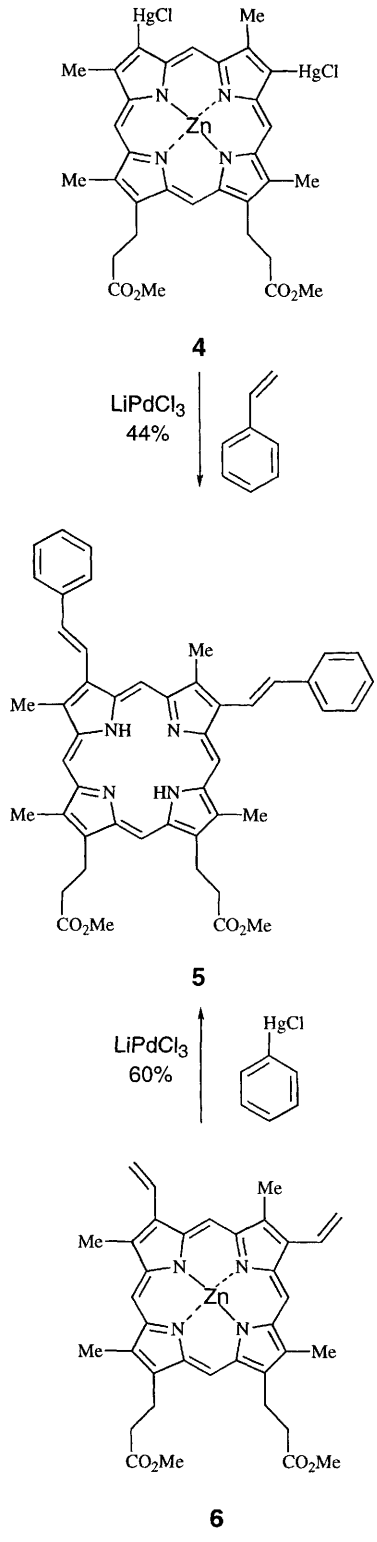
In principle, our target molecules could be obtained by the Heck reaction using vinylporphyrins and mercuri-nucleosides, or alternatively using vinyl-nucleosides and mercuri-porphyrins (see Scheme 1). In practice, our attempts to accomplish either approach were met with serious solubility and work-up (emulsion) problems. For example, 5-chloromercuriuridine **9** was prepared by heating uridine and mercuric acetate and then adding brine. The zinc(II) protoporphyrin IX dimethyl ester **6** in dry DMF was mixed with *ca.* 14 equiv. of 5-chloromercuriuridine **9** and heated before the addition of $LiPdCl_3$ in acetonitrile. Serious solubility and emulsion problems were encountered, so this approach was discontinued. Next, 5-vinyluridine **10** was synthesized;[19,20] the commercially available 5-iodouridine **11** was treated with ethyl acrylate catalysed by $[Pd(PPh_3)_2Cl_2]$ to give (*E*)-5-[2-(ethoxycarbonyl)vinyl]uridine **12**. Hydrolysis of **12** yielded the corresponding (*E*)-5-(2-carboxyvinyl)uridine **13**, which was subsequently decarboxylated to afford the desired 5-vinyluridine **10**. A mixture of mercuriporphyrin **4** and an excess of crude 5-vinyluridine **10** in DMF was treated with pre-formed $LiPdCl_3$ catalyst. Extreme difficulties were experienced once again during the work-up, and no useful product was obtained.

The reaction between zinc(II) protoporphyrin IX dimethyl ester **6** and 5-chloromercuriuridine **9** was chosen for further study because of the ready availability of the reactants. The catalyst $LiPdCl_3$ was added to the porphyrin and mercuriuridine mixture; after a troublesome work-up, a green–brown compound was obtained. A satisfactory ^1H NMR spectrum of this compound was not obtained, but its low-resolution mass spectrum (LRMS) indicated that the molecular weight of the product matched with that of the desired diuridinylporphyrin **14**.

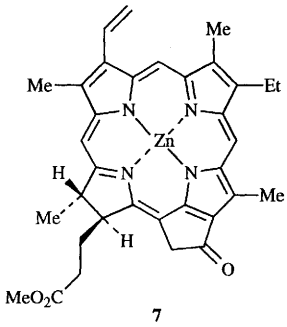
We therefore searched for a better way to carry out this reaction. Since the 5-chloromercuriuridine **9** does not dissolve in DMF, and the final product has only slight solubility in dichloromethane, the hydroxy groups of the former were protected in order to improve its solubility. After numerous trial experiments it was found that heating the mercuriuridine **9** with anhydrous NaOAc in acetic anhydride gave 2′,3′,5′-tri-*O*-acetyl-5-chloromercuriuridine **15** in satisfactory yield. Attempts were also made to protect the hydroxy groups first before the mercuration reaction; the protected uridine **16** was readily prepared using acetic anhydride and pyridine, but attempts to mercurate it were unsuccessful.

3′,5′-Di-*O*-acetyl-5-chloromercuri-2′-deoxyuridine **17** was also synthesized. Interestingly, while 5-chloromercuriuridine **9** gave good results when being heated with sodium acetate in acetic anhydride, this reaction was not successful for 5-chloromercuri-2′-deoxyuridine **18**. The protected 5-chloromercuri-2′-deoxyuridine **17** was obtained by using different catalysts. We tested the catalytic reactivity of both 4-dimethylaminopyridine (DMAP)[21,22] and 4-pyrrolidinopyridine (PPY)[22] in our acylation, and found that in the acylation of 5-chloromercuri-2′-deoxyuridine **18**, DMAP was better than PPY because it catalysed the reaction slowly to completion and the reaction was cleaner than with PPY.

In order to avoid potential complications resulting from mono- and bis-adducts from divinylporphyrins such as



Scheme 1



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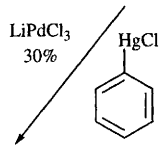

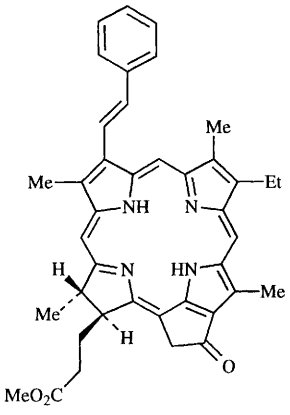

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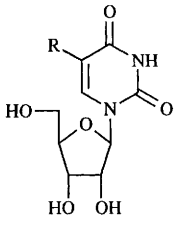
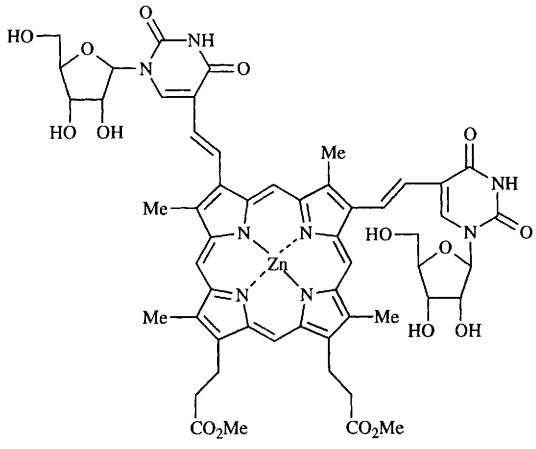


9 R = HgCl
10 R = $CH{=}CH_2$
11 R = I
12 R = $CH{=}CH\text{-}CO_2Et$
13 R = $CH{=}CH\text{-}CO_2H$



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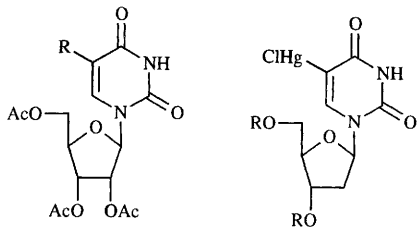
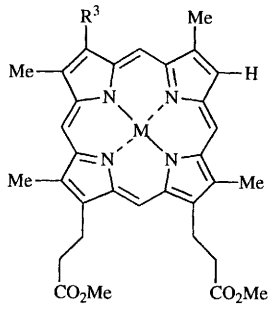
protoporphyrin IX, the reaction between a mono-vinylporphyrin and a mercuriuridine was investigated. 3-Vinyldeuteroporphyrin IX dimethyl ester **19** was prepared from 3-acetyldeuteroporphyrin IX dimethyl ester **20**. Reaction of the zinc(II) complex of 3-vinylporphyrin **21** with the protected 5-mercuriuridine **15** catalysed by $LiPdCl_3$, surprisingly, gave two products. The chromatographically less polar compound was pink, and the other was red; they were separated and treated with acid to remove zinc. The more polar band yielded a compound identified as the *trans*-isomer **22** by its ^1H NMR spectrum (Fig. 1A) in 16.5% yield. The doublets at 7.37 and 8.99 ppm are the two *trans*-vinyl protons with a coupling constant of J = 16.3. The less polar band (19.6% yield) was identified as the *gem*-isomer **23**, again from its ^1H

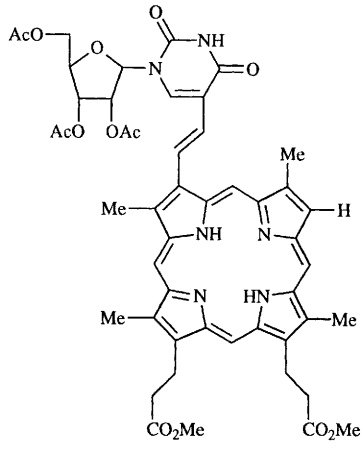


15 R = HgCl
16 R = H

17 R = Ac
18 R = H



19 M = 2H; $R^3 = CH{=}CH_2$
20 M = 2H; R^3 = COMe
21 M = Zn; $R^3 = CH{=}CH_2$



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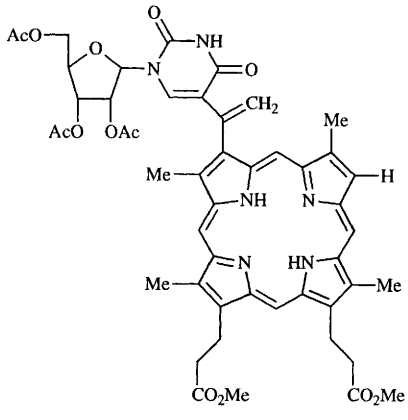

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NMR data [Fig. 1B; $H_aH_bC{=}C$(uridine)porphyrin, δ 6.12, 7.52 (each d, J 1.34 Hz)].

Isolation of both *trans*- and *gem*-isomers was a surprise. We had earlier reported[17] that the reaction between zinc(II) protoporphyrin IX dimethyl ester **6** and phenylmercuric chloride gave only the *trans*-alkene product **5**. Likewise, Bigge *et al.*[23] reported that the reactions between mercurinucleosides

and styrenes catalysed by tetrachloropalladate afforded exclusively *trans*-products. When the work was extended to divinylporphyrins, we discovered that reaction of zinc(II) protoporphyrin IX dimethyl ester **6** with 2′,3′,5′-tri-*O*-acetyl-5-chloromercuriuridine **15** also gave a mixture of products (TLC analysis). Red compounds were formed along with a green–brown compound (the most polar band on TLC). Separation of this mixture of products gave two major bands. After removal of zinc, the more polar band was identified as the 3,8-*trans*-diuridinylporphyrin **24** by its ^{1}H NMR spectrum; the less polar band was characterized as one of the two isomers: 3-*gem*-8-*trans*-diuridinylporphyrin **25** or 8-*gem*-3-*trans*-*trans*-diuridinylporphyrin **26**, also on the basis of their ^{1}H NMR spectra. No 3,8-*gem*-diuridinyl product was isolated from the reaction mixture.

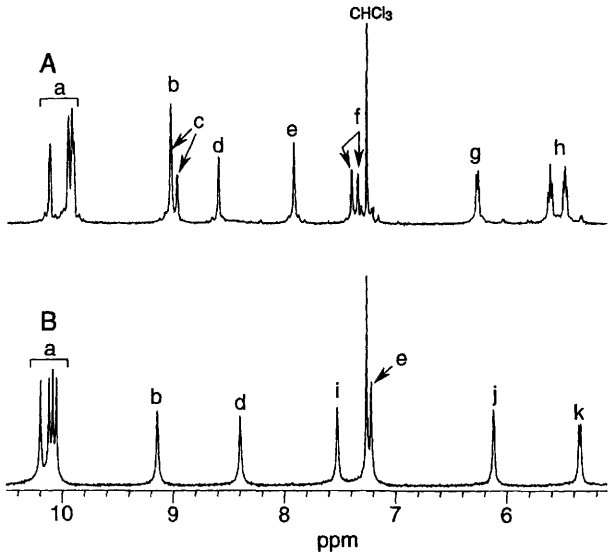
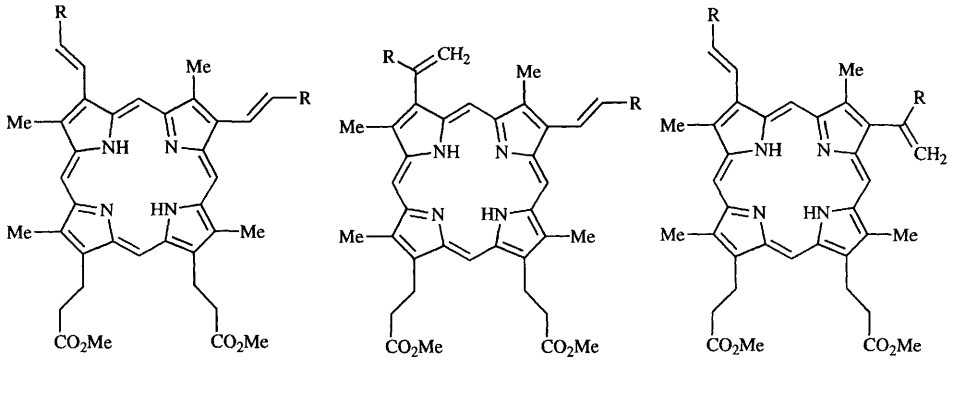


Fig. 1 ^{1}H NMR spectra (5.0–10.5 ppm region only), at 300 MHz in $CDCl_3$, of A, the porphyrin *trans*-adduct **22**; B, the porphyrin *gem*-adduct **23**. Assignments: a, *meso*-H; b, 8-H; c, C*H*=CHU; d, 3-NH; e, 6-H; f, CH=C*H*U; g, 1′-H; h, 2′-H, 3′-H; i, C=CH*H*′; j, C=C*H*H′; k, 1′-H

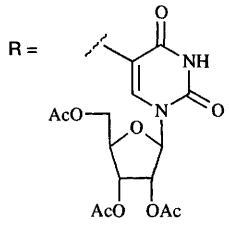
In order to explore the versatility of this reaction, several chlorins were used as substrates. Zinc(II) chlorin e_6 trimethyl ester **27** was treated with mercuriuridine **15** to afford the *trans*-isomer **29** in 29% yield and the *gem*-isomer **30** in 13% yield (*i.e.* ratio of *trans*-:*gem*- 2.2:1). The ^{1}H NMR spectrum of the *trans*-isomer **29** clearly showed the CH=CHuridine protons at δ 8.87 and 7.38 respectively, with a coupling constant of 16.4 Hz; while the ^{1}H NMR spectrum of the *gem*-isomer **30** displayed the H_aH_bC=C(uridine)chlorin resonances at δ 7.38 and 6.02 (J 1.6 Hz). In comparison with the metal-free starting material chlorin e_6 trimethyl ester **28** (664 nm), and *gem*- isomer **30** (660 nm), the long wavelength absorption for *trans*-isomer **29** was observed at 672 nm, the result of extension of the conjugation in the chromophore.

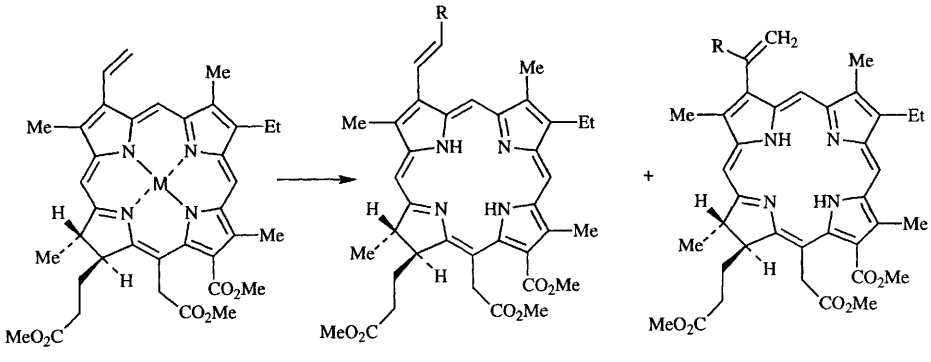
By similar chemistry, zinc(II) methyl 9-deoxypyropheophorbide a **31**, produced both the *trans*-isomer **34** (8.0%



24 **25** **26**

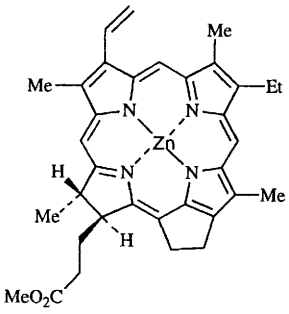
R =





27 M = Zn
28 M = 2H

29 **30**



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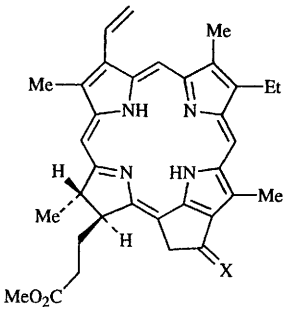
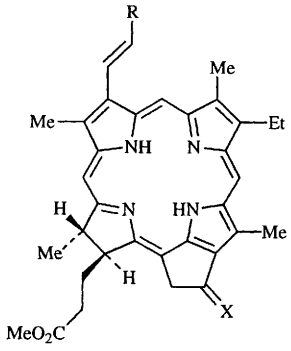
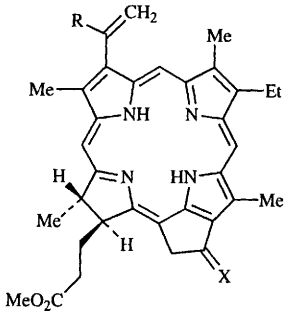


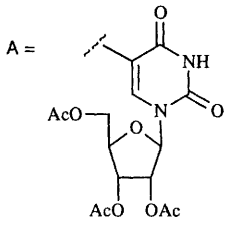
32 X = O
33 X = -OCH_2CH_2O-

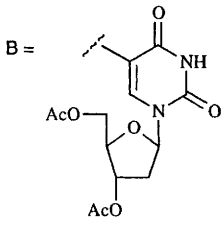


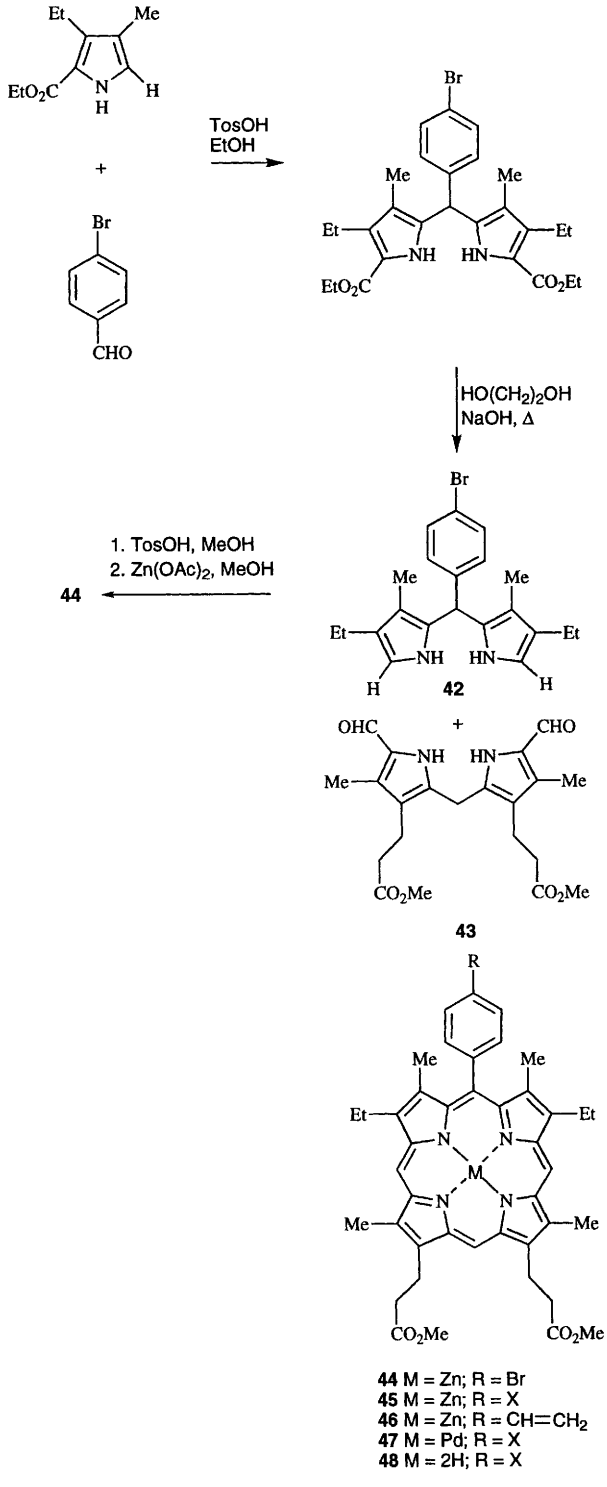
34 X = H_2; R = A
35 X = O; R = A
36 X = -OCH_2CH_2O-; R = A
37 X = -OCH_2CH_2O-; R = B

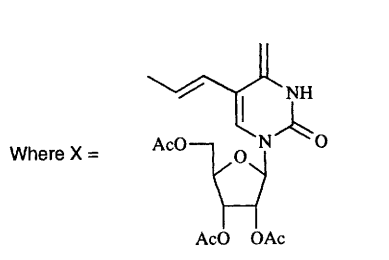


38 X = H_2; R = A
39 X = O; R = A
40 X = -OCH_2CH_2O-; R = A
41 X = -OCH_2CH_2O-; R = B









44 M = Zn; R = Br
45 M = Zn; R = X
46 M = Zn; R = $CH{=}CH_2$
47 M = Pd; R = X
48 M = 2H; R = X

Scheme 2

yield) and the *gem*-isomer, **38** (9.6%). Methyl pyropheophorbide a **32** reacted with the protected 5-mercuriuridine **15** to yield the *trans*-isomer **35**, with only a trace of the *gem*-isomer **39**.

Because the yield of the reaction with **32** was low (17%), we decided to protect the ring E ketone group by formation of the corresponding glycol ketal. Methyl pyropheophorbide a **32** was treated with ethylene glycol and trimethylsilyl chloride to afford methyl 9-glycolketal pyropheophorbide a **33**. The free base of this protected chlorin **33** was treated with the 5-mercuriuridine **15** to give mainly the *trans*-product **36**, with only a very small amount of the *gem*-isomer **40**. Further attempts to separate the two isomers (after insertion of zinc) by using silica gel preparative plates were unsuccessful. Protected methyl pyropheophorbide a **33** was also treated with 5-chloromercuri-2′-deoxyuridine **17** to give a mixture of the *trans*-isomer **37** and a small amount of the *gem*-isomer **41**. Further separation of the isomers also failed.

In a parallel study (Scheme 2), a *meso*-bromophenyl substituted zinc(II) porphyrin **44** was converted into a *meso*-styrene substituted porphyrin **46** by treating it with tributylethenylstannane and [$Pd(PPh_3)_4$]. The *meso*-bromophenylporphyrin **44** was synthesized by a variation of the MacDonald condensation[24] between a 1,9-di unsubstituted dipyrromethane **42** and a 1,9-diformyldipyrromethane **43**. Noticeably, treatment of zinc(II) porphyrin **46** with 5-mercuriuridine **15**, gave only the *trans*-zinc(II) product **45** and the corresponding palladium complex **47** (in good yields). No other isomers were detected. The formation of the palladium complex **47** was presumably due to partial transmetallation during the reaction.

Experimental

Mps were measured on a Thomas/Bristoline microscopic hot-stage apparatus and are uncorrected. Silica gel 60 (70–230 and 230–400 mesh, Merck) or neutral alumina (Merck; usually Brockmann Grade III, *i.e.* deactivated with 6% water) were used for column chromatography. Preparative thin layer chromatography was carried out on 20 × 20 cm glass plates coated with Merck G 254 silica gel (1 mm thick). Analytical thin layer chromatography (TLC) was performed using Merck 60 F254 silica gel (pre-coated sheets, 0.2 mm thick). Reactions were monitored by TLC and spectrophotometry and were carried out under nitrogen and in the dark. ^{1}H NMR spectra were obtained in deuteriochloroform solution at 300 MHz using a General Electric QE300 spectrometer; chemical shifts are expressed in ppm relative to chloroform (7.258 ppm); *J* values are given in Hz. Elemental analyses were performed at the Midwest Microlab, Ltd., Indiana, USA. Unless stated otherwise, electronic absorption spectra were measured in dichloromethane solution using a Hewlett-Packard 8450A spectrophotometer. Mass spectra were obtained at the Mass Spectrometry Facility, University of California, San Francisco, CA.

5-*Chloromercuriuridine* 9

A solution of mercuric acetate (6.63 g) in water (45 cm^3) was added to a solution of uridine (5.0 g) in water (30 cm^3) and the mixture was heated at 50 °C overnight to give a thick white suspension. Saturated brine (15 cm^3) was added to the mixture which was then stirred for 20 min at 50 °C before being cooled to room temperature when 95% ethanol (200 cm^3) was added to it. The resulting white precipitate was filtered off, washed with 95% ethanol and dried, to afford the crude product (8.5 g).

2′,3′,5′-Tri-*O*-acetyl-5-chloromercuriuridine 15

A suspension of 5-chloromercuriuridine **9** (4.53 g) and anhydrous sodium acetate (3.0 g) in acetic anhydride (30 cm^3) and acetonitrile (30 cm^3) was heated at 80 °C for 3 h under nitrogen. After cooling to room temperature, the reaction mixture was poured into ice–water (300 cm^3) and the whole then stirred for 20 min before being extracted with dichloromethane. The combined organic layers were washed with water (×3) and then evaporated. The residue was chromatographed on silica gel with 1.7% methanol in dichloromethane as eluent to afford the title product (2.2 g, 39%), mp 145–148 °C; $\delta_H(CDCl_3)$ 2.06, 2.07, 2.10 (each s, 3 H, CH_3CO), 4.37 (m, 3 H, 4′-H, 2 × 5′-H), 5.30, 5.45 (each br t, 1 H, 2′-H, 3′-H), 5.92 (br d, 1 H, 1′-H), 7.45 (br s, 1 H, 6-H), 9.30 (br s, 3-NH) (Found: C, 29.6; H, 2.9; N, 4.5. Calc. for $C_{15}H_{17}ClHgN_2O_9$: C, 29.70; H, 2.83; N, 4.60%). No satisfactory mass spectrum could be obtained for this compound.

5-Chloromercuri-2′-deoxyuridine 18

A solution of mercuric acetate (3.0 g) in water (15 cm^3) was added to a solution of 2′-deoxyuridine (2.0 g) in water (10 cm^3) and the mixture was stirred at 50 °C for 2.5 h to form a white precipitate. Saturated brine (5 cm^3) was added to the mixture which was then stirred for 20 min at 50 °C before being cooled to room temperature. 95% Ethanol (100 cm^3) was added to the mixture and the resulting white precipitate was filtered off, washed with 95% ethanol and dried to afford the crude product (3.1 g).

3′,5′-Di-*O*-acetyl-5-chloromercuri-2′-deoxyuridine 17

The 5-mercuri-2′-deoxyuridine **18** was mixed with an equimolar excess each of acetic anhydride and triethylamine and DMAP (0.03–0.07 equiv) and the reaction mixture was stirred at room temperature for 12 h. It was then poured into ice–water. The resulting mixture was stirred for 20 min and then extracted with dichloromethane. The combined extracts were washed with saturated brine (×3) and then evaporated. The residue was chromatographed on a silica gel column with 2.0–2.5% methanol in dichloromethane as eluent to give the title compound (30%), mp 139–142 °C; $\delta_H(CDCl_3)$ 2.18 (s, 6 H, 2 × CH_3CO), 2.55 (m, 2 H, 2 × 2-H), 4.30 (m, 2 H, 2 × 5′-H), 4.38 (m, 1 H, 4′-H), 5.23 (m, 1 H, 3′-H), 6.25 (br t, 1 H, 1′-H), 7.51 (s, 1 H, 6-H) and 8.77 (br s, 3-NH) [Found: C, 29.1; H, 2.85; N, 5.1. Calc. for $C_{13}H_{15}ClHgN_2O_7$: C, 28.47; H, 2.76; N, 5.11%]; *m/z* 549.2 (100%); no satisfactory high-resolution mass spectrum could be obtained for this compound.

Zinc(II) 3,8-bis(chloromercuri)deuteroporphyrin IX dimethyl ester 4

Under an atmosphere of nitrogen, mercuric acetate (0.9 g) in methanol (13 cm^3) was added rapidly but dropwise to zinc(II) deuteroporphyrin IX dimethyl ester (0.43 g) in dry THF (50 cm^3) with stirring. The reaction mixture was kept at 60 °C until the completion of reaction (monitored by TLC); this took *ca.* 5 h. Saturated brine (50 cm^3) was added to the reaction flask and the biphasic mixture was stirred vigorously for 10 min whilst being cooled. It was then diluted with dichloromethane (50 cm^3), washed with water (×4) and evaporated to afford a mixture of 3,8-bis(chloromercuri)porphyrin and 3,8-*meso*-tris(chloromercuri)-porphyrin as shining purple–blue flakes (0.89 g, 116%).[25] No satisfactory melting point, mass spectrum or NMR spectrum could be obtained for this material.

Methyl 13^1-deoxopyropheophorbide a

Sodium boranuide (6.0 g) was added to a solution of compound **32**[26] (1.5 g) in dichloromethane (250 cm^3) and TFA (40 cm^3) over a period of 15 min. The reaction mixture was kept at room temperature until the completion of reaction (monitored by spectrophotometry) after which it was poured into water. The organic layer was separated, washed with water (×3), dried and evaporated to give a residue which was chromatographed on an alumina Grade III column with dichloromethane as eluent. The major band was collected and evaporated and the residue was crystallized from dichloromethane–hexane to give the title compound (1.05 g, 72%), mp 229.5–231.5 °C; λ_{max}/nm (CH_2Cl_2) 402 (ε 197 200), 502 (19 300), 530 (4000), 592 (6000) and 648 (50 900); $\delta_H(CDCl_3)$ 9.90, 9.63, 8.98 (each s, 1 H, *meso*-H), 8.30 (dd, 1 H, $CH{=}CH_aH_b$), 6.36, 6.22 (each dd, 1 H, $CH{=}CH_aH_b$), 4.84 (m, 2 H, 13^2-CH_2), 4.70 (m, 1 H, 18-H), 4.51 (m, 1 H, 17-H), 4.22 (m, 2 H, 13^1-CH_2), 3.85 (q, 2 H, 8-CH_2CH_3), 3.68, 3.67, 3.52, 3.48, (each s, 3 H, OCH_3 and ring CH_3), 2.88–2.10 (m, 4 H, 17-CH_2CH_2), 1.85, (d, 3 H, 18-CH_3), 1.77 (t, 3 H, 8-CH_2CH_3) and 0.18, −1.52 (each s, 1 H, NH) [Found (HRMS): *m/z* 534.2995. $C_{34}H_{38}N_4O_2$ requires *m/z* 534.2995].

Zinc(II) methyl 13^1-deoxopyropheophorbide a 31

The title compound was prepared from methyl 13^1-deoxopyropheophorbide a by the same method described before for metallation of protoporphyrin IX dimethyl ester; mp 215–217 °C; λ_{max}/nm (CH_2Cl_2) 406 (ε 210 000), 508 (7800), 540 (3 700), 578 (6900) and 624 (48 100); $\delta_H(CDCl_3)$ 9.79, 9.56, 8.75 (each s, 1 H, *meso*-H), 8.21 (dd, 1 H, $CH{=}CH_aH_b$), 6.23, 6.05 (each dd, 1 H, $CH{=}CH_aH_b$), 4.71 (m, 2 H, 13^2-CH_2), 4.59 (m, 1 H, 18-H), 4.41 (m, 1 H, 17-H), 3.93 (m, 2 H, 13^1-CH_2), 3.88 (q, 2 H, 8-CH_2CH_3), 3.55, 3.49, 3.45, 3.42, (each s, 3 H, OCH_3 and ring CH_3), 2.80–2.12 (m, 4 H, 17-CH_2CH_2), 1.83, (d, 3 H, 18-CH_3) and 1.76 (t, 3 H, 8-CH_2CH_3) [Found (HRMS): *m/z* 596.2144. $C_{34}H_{36}N_4O_2Zn$ requires *m/z* 596.2130].

Methyl 13^1-ethylenedioxypyropheophorbide a 33

Ethylene glycol (25 cm^3) and trimethylsilyl chloride (2 cm^3) were added to a stirred solution of compound **32** (1.0 g) in dry dichloromethane (200 cm^3). The mixture was stirred at room temperature for 24 h and then poured into ice-cooled aqueous 1 mol dm^{-3} NH_4OH. The organic layer was separated, washed, dried and evaporated to dryness. The residue was chromatographed on alumina Grade III with dichloromethane as eluent

to give the title compound as bright green crystals (700 mg, 65%), mp 180–182 °C (lit.,[27] 182–184 °C); λ_{max}/nm (CH_2Cl_2): 400 (ε 135 000), 500 (16 300), 550 (5400), 598 (7800) and 652 (41 000); δ_H($CDCl_3$) 9.82, 9.68, 8.89 (each s, 1 H, *meso*-H), 8.21 (dd, 1 H, C*H*=CH_aH_b), 6.35, 6.18 (each dd, 1 H, CH=CH_aH_b), 5.12 (q, 2 H, 13^2-CH_2), 4.80–5.50 (m, 5 H, 13^1-OCH_2CH_2O and 18-H), 4.42 (m, 1 H, 17-H), 3.84 (q, 2 H, 8-CH_2CH_3), 3.64, 3.60, 3.55, 3.40 (each s, 3 H, ring CH_3 and OCH_3), 2.80–2.20 (m, 4 H, 17-CH_2CH_2), 1.81, (d, 3 H, 18-CH_3), 1.76 (t, 3 H, 8-CH_2CH_3) and −1.22, −3.06 (each br s, 1 H, NH).

5-(4-Bromophenyl)-2,8-diethyl-3,7-dimethyldihydrodipyrrin 42

A mixture of 4-bromobenzaldehyde (1.85 g), ethyl 3-ethyl-4-methylpyrrole-2-carboxylate[28] (3.45 g) and toluene-*p*-sulfonic acid (2.0 g) in ethanol (50 cm^3) was heated under reflux overnight until the completion of reaction (monitored by TLC). It was then diluted with dichloromethane, washed with water, aqueous sodium hydrogen carbonate and water, dried (Na_2SO_4) and evaporated to give the diethyl 5-(4-bromophenyl)-2,8-diethyl-3,7-dimethyldihydrodipyrrin-1,9-dicarboxylate as a viscous oil. Ethylene glycol (60 cm^3) and sodium hydroxide (4.0 g) were added to this oil and the suspension was heated at 185 °C for 45 min. It was then cooled to room temperature, diluted with a large amount of water and extracted with light petroleum–ethyl acetate (1 : 1). The combined extracts were washed with water and brine, dried and evaporated to afford the title compound as a viscous oil; δ_H($CDCl_3$) 1.20 (t, 6 H, 2 × CH_2CH_3), 1.77 (s, 6 H, 2 × β-CH_3), 2.46 (q, 4 H, 2 × CH_2CH_3), 5.45 (s, 1 H, C*H*C_6H_4), 6.40 (s, 2 H, 1- and 9-α-H), 7.01, 7.41 (each d, 2 H, phenyl H) and 7.28 (br s, 2 H, 2 × NH).

Zinc(II) 5-(4-bromophenyl)-2,8-diethyl-13,17-bis(2-methoxycarbonylethyl)-3,7,12,18-tetramethylporphyrin 44

A solution of the 1,9-di-unsubstituted dihydrodipyrrin **42** (385 mg) in dichloromethane (250 cm^3) was stirred for 10 min after which it was treated with 1,9-diformyldihydrodipyrrin **43**[29,30] (402 mg) and toluene-*p*-sulfonic acid (2.0 g) dissolved in methanol (50 cm^3). The reaction mixture was stirred overnight under nitrogen and then treated with a concentrated solution of zinc acetate in methanol (50 cm^3) and stirred for 12 h (a slow stream of air was bubbled through the solution). After being washed with water, aqueous sodium hydrogen carbonate and water the mixture was evaporated and the residue was chromatographed on an alumina Grade III column with dichloromethane as eluent to afford the title product (225 mg, 27.8%), mp 260.5–262.5 °C; λ_{max}/nm (CH_2Cl_2) 406 (ε 485 000), 534 (31 800) and 570 (29 200); δ_H($CDCl_3$) 1.76 (t, 6 H, 2 × CH_2CH_3), 2.48, 3.51 (each s, 6 H, ring CH_3), 3.67 (s, 6 H, OCH_3), 3.16 (t, 4 H, CH_2CH_2CO), 3.97 (q, 4 H, 2 × CH_2CH_3), 4.16 (t, 4 H, CH_2CH_2CO), 7.90, 7.95 (each d, 2 H, phenyl H), 9.57 (s, 1 H, *meso*-H) and 9.96 (s, 2 H, *meso*-H); *m*/*z* 812.2 (^{81}Br) (100%).

Zinc(II) 2,8-diethyl-13,17-bis(2-methoxycarbonylethyl)-3,7,12,18-tetramethyl-5-(4-vinylphenyl)porphyrin 46

Tributylvinylstannane (0.04 cm^3) was added to a solution of the porphyrin **44** (45 mg), [$Pd(PPh_3)_4$] (10 mg) and 2 crystals of 2,6-di-*tert*-butyl-4-methylphenol in toluene (10 cm^3). The mixture was heated at reflux for 10 h after which it was cooled to room temperature and passed through an alumina Grade III column, with 0.5% methanol in dichloromethane as eluent, to afford the title product (27 mg, 64%), mp 262–263 °C; λ_{max}/nm (CH_2Cl_2) 406 (ε 486 000), 534 (38 300) and 570 (33 800); δ_H($CDCl_3$) 1.77 (t, 6 H, 2 × CH_2CH_3), 2.50, 3.59 (each s, 6 H, ring CH_3), 3.68 (s, 6 H, OCH_3), 3.23 (t, 4 H, CH_2CH_2CO), 4.01 (q, 4 H, 2 × CH_2CH_3), 4.28 (t, 4 H, CH_2CH_2CO), 5.52, 6.10 (each dd, 1 H, CH=CH_aH_b), 7.10 (dd, 1 H, C*H*=CH_aH_b), 7.81, 8.04 (each d, 2 H, phenyl H), 9.81 (s, 1 H, *meso*-H) and 10.08 (s, 2 H, *meso*-H) [Found (HRMS): *m*/*z* 758.2830. $C_{44}H_{46}N_4O_4Zn$ requires *m*/*z* 758.2810].

3^2-*trans*-[(2′,3′,5′-Tri-*O*-acetyl)uridinylvinyl]deuteroporphyrin IX dimethyl ester 22 and 3^1-[(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]-deuteroporphyrin IX dimethyl ester 23

The zinc(II) porphyrin **21**[31] (65 mg) and 5-chloromercuriuridine **15** (200 mg) were dissolved in dry DMF (4 cm^3) and acetonitrile (3 cm^3). $LiPdCl_3$ in acetonitrile (see below) was added slowly to the porphyrin solution at room temperature. [The palladium catalyst was prepared by refluxing $PdCl_2$ (59 mg) and LiCl (30 mg) in acetonitrile (4 cm^3) for 1 h under nitrogen.] The porphyrin-containing reaction mixture was stirred at room temperature for 15 min and then kept at 30 °C overnight to give two products (TLC). The reaction mixture was cooled to room temperature, diluted with dichloromethane and filtered through a Celite bed. The organic layer was washed with saturated brine (× 3), dried (Na_2SO_4) and evaporated under reduced pressure. The residue was chromatographed on a silica gel column, with 1.2% methanol in dichloromethane as eluent to give two products, collected separately. There was some cross-contamination of each. Further separation was achieved by using silica gel preparative TLC plates, with 2.3% methanol in dichloromethane as developer. The zinc(II) was removed by washing with 10% hydrochloric acid and water.

The more polar compound (16 mg, 16.5%) was identified as 3^2-*trans*-(uridinylvinyl)deuteroporphyrin IX dimethyl ester **22**, mp 116–118 °C; λ_{max}/nm (CH_2Cl_2) 404 (ε 246 000), 504 (21 300), 542 (23 300), 574 (13 900) and 628 (8000); δ_H($CDCl_3$) −4.09 (br s, 2 H, NH), 2.07, 2.19, 2.21 (each s, 3 H, CH_3CO), 3.25 (m, 4 H, CH_2CH_2CO), 3.54, 3.57, 3.64, 3.664, 3.667, 3.70 (each s, 3 H, ring CH_3 and OCH_3), 4.37 (m, 4 H, CH_2CH_2CO), 4.51 (m, 3 H, 3′-H, 2 × 5′-H), 5.48, 5.61 (each t, 1 H, 2′-H, 3′-H), 6.25 (d, $J_{1',2'}$ = 5.2, 1 H, 1′-H), 7.37 (d, J_{trans} 16.3, 1 H, CH=C*H*U), 7.91 (s, 1 H, 6-H), 8.59 (s, 1 H, 3-NH), 8.99 (d, J_{trans} 16.3, 1 H, C*H*=CHU), 9.02 (s, 1 H, 8-H) and 9.90, 9.91, 9.94, 10.16 (each s, 1 H, *meso*-H) [Found (HRMS): *m*/*z* 933.377. $C_{49}H_{52}N_6O_{13}$ requires *m*/*z* 933.367 (M + 1)]. The less polar compound (18.8 mg, 19.6%) was shown to be 3^1-(uridinylvinyl)deuteroporphyrin IX dimethyl ester **23**, mp 114–116 °C; λ_{max}/nm (CH_2Cl_2) 400 (ε 196 700), 498 (15 100), 532 (10 100), 568 (6900) and 620 (3400); δ_H($CDCl_3$) −3.76 (s, 2 H, NH), 0.39, 1.73, 1.82 (each s, 3 H, CH_3CO), 3.09 (m, 2 H, 2 × 5′-H), 3.31 (m, 4 H, 2 × CH_2CH_2CO), 3.58, 3.60, 3.66, 3.68 (each s, 3 H, ring CH_3), 3.72 (s, 7 H, 2 × OCH_3, 4′-H), 4.37, 4.49 (each t, 2 H, CH_2CH_2CO), 4.61, 4.95 (each t, 1 H, 2′-H, 3′-H), 5.36 (d, $J_{1',2'}$ 5.2, 1 H, 1′-H), 6.12 (d, J_{gem} 1.34, 1 H, C=C*H*H′), 7.22 (s, 1 H, 6-H), 7.52 (d, J_{gem} 1.34, 1 H, C=CH*H*′), 8.40 (s, 1 H, 3-NH), 9.14 (s, 1 H, H-8) and 10.06, 10.09, 10.12, 10.20 (each s, 1 H, *meso*-H) [Found (HRMS): *m*/*z* 933.410. $C_{49}H_{52}N_6O_{13}$ requires *m*/*z* 933.367, (M + 1)].

The following compounds were prepared by using the general method described above.

3^2-*trans*-[(2′,3′,5′-Tri-*O*-acetyl)uridinyl] chlorin e_6 trimethyl ester 29 and 3^1-[(2′,3′,5′-tri-*O*-acetyl)uridinyl]chlorin e_6 trimethyl ester 30

The *trans*-isomer **29** (41.4 mg, 29%) was obtained from zinc(II) chlorin **27**[26] (100 mg), and had mp 148.5–150.5 °C; λ_{max}/nm (CH_2Cl_2) 408 (ε 130 800), 504 (13 300), 536 (9600), 616 (5900) and 672 (48 900); δ_H($CDCl_3$) −1.48, −1.28 (each s, 1 H, NH), 1.70 (t, 3 H, 8-CH_2CH_3), 1.74 (d, 3 H, 18-CH_3), 2.08, 2.181, 2.185 (each s, 3 H, CH_3CO), 2.10–2.70 (m, 4 H, 17-CH_2CH_2), 3.29, 3.52, 3.57 (each s, 3 H, ring CH_3), 3.64, 3.76, 4.27 (each s, 3 H, OCH_3), 3.77 (m, 2 H, 8-CH_2CH_3), 4.38–4.55 (m, 5 H, 17-H, 18-H, H-4′, 2 × 5′-H), 5.29 (q, 2 H, 13^2-CH_2), 5.44, 5.54 (each t, 1 H, 2′-H, 3′-H), 6.24 (d, $J_{1',2'}$ 5.8, 1 H, 1′-H), 7.38 (d, J_{trans} 16.4, 1 H, CH=C*H*U), 7.90 (s, 1 H, 6-H), 8.52 (s, 1 H, 3-NH), 8.87 (d, J_{trans} 16.4, 1 H, C*H*=CHU) and 8.76, 9.59, 9.68 (each s, 1 H, *meso*-H) [Found (HRMS): *m*/*z* 1007.405. $C_{52}H_{58}N_6O_{15}$ requires *m*/*z* 1007.404 (M + 1)]. The *gem*-isomer **30** (19 mg, 13%) was obtained from zinc(II) chlorin **27** (100 mg), mp 136.5–138 °C; λ_{max}/nm (CH_2Cl_2) 400 (ε 218 800), 500

(20 000), 526 (7700), 558 (4200), 606 (8600) and 660 (72 400); $\delta_H(CDCl_3)$ −1.69, −1.42 (each s, 1 H, NH), 1.68 (t, 3 H, 8-CH_2CH_3), 1.73 (d, 3 H, 18-CH_3), 0.57, 1.80, 1.91 (each s, 3 H, CH_3CO), 2.17–2.70 (m, 4 H, 17-CH_2CH_2), 3.24, 3.32, 3.59 (each s, 3 H, ring CH_3), 3.46 (m, 2 H, 2 × 5′-H), 3.67, 3.78, 4.27 (each s, 3 H, OCH_3), 3.72–3.90 (m, 3 H, 8-CH_2CH_3, 4′-H), 4.41–4.50 (m, 2 H, 17-H, 18-H), 4.83, 5.07 (each t, 1 H, 2′-H, 3′-H), 5.33 (q, 2 H, 13^2-CH_2), 5.36 (d, $J_{1',2'}$ 5.3, 1 H, 1′-H), 6.02 (d, J_{gem} 1.6, 1 H, C=CH*H*′), 7.12 (s, 1 H, 6-H), 7.38 (d, J_{gem} 1.6 Hz, 1 H, C=C*H*H′), 8.37 (s, 1 H, 3-NH) and 8.79, 9.43, 9.72 (each s, 1 H, *meso*-H) [Found (HRMS): *m/z* 1007.413. $C_{52}H_{58}N_6O_{15}$ requires *m/z* 1007.404 (M + 1)].

Methyl 13^1-deoxo-3^2-*trans*-[(2′,3′,5′-tri-*O*-acetyl)uridinyl]pyropheophorbide a 34 and methyl 13^1-deoxo-3^1-[(2′,3′,5′-tri-*O*-acetyl)uridinyl]pyropheophorbide a 38

The *trans*-isomer **34** (6.1 mg 8.0%) was obtained from zinc(II) chlorin **31** (50 mg) and had mp 154–156 °C; $\lambda_{max}(CH_2Cl_2)$ 414 (ε 132 900), 506 (16 300), 540 (8200), 600 (5800) and 654 (39 900); $\delta_H(CDCl_3)$ 9.93, 9.55, 8.96 (each s, 1 H, *meso*-H), 9.04 (d, J_{trans} 16.2, 1 H, C*H*=CHU), 8.63 (s, 1 H, 3-NH), 7.92 (s, 1 H, 6-H), 7.41 (d, J_{trans} 16.2, 1 H, CH=C*H*U), 6.26 (d, $J_{1',2'}$ 5.8, 1 H, 1′-H), 5.57, 5.46 (each t, 1 H, 2′-H, 3′-H), 4.84 (m, 2 H, 13^2-CH_2), 4.69 (m, 1 H, 18-H), 4.65–4.35 (m, 4 H, 17-H, 4′-H, 2 × 5′-H), 4.06 (m, 2 H, 13^1-CH_2), 3.84 (q, 2 H, 8-CH_2CH_3), 3.64 (s, 3 H, OCH_3), 3.60, 3.49, 3.42, (each s, 3 H, ring CH_3), 2.88–2.18 (m, 4 H, 17-CH_2CH_2), 2.19, 2.18, 2.05 (each s, 3 H, CH_3CO), 1.86, (d, 3 H, 18-CH_3), 1.73 (t, 3 H, 8-CH_2CH_3) and −1.53, −3.25 (each s, 1 H, NH) [Found (HRMS): *m/z* 903.3981. $C_{49}H_{54}N_6O_{11}$ requires 903.3929 (M + 1)]. The *gem*-isomer **38** (7.3 mg, 9.6%) was obtained from zinc(II) chlorin **31** (50 mg), mp 142–143.5 °C; λ_{max}/nm (CH_2Cl_2) 400 (ε 152 000), 500 (14 900), 540 (3100), 590 (5400) and 642 (36 900); $\delta_H(CDCl_3)$ 9.80, 9.59, 8.96 (each s, 1 H, *meso*-H), 8.36 (s, 1 H, 3-NH), 7.51 (d, J_{gem} 1.0, 1 H, C=C*H*H′), 7.12 (s, 1 H, 6-H) 6.01 (d, J_{gem} 1.0, 1 H, C=CHH′), 5.42 (d, $J_{1',2'}$ 5.8, 1 H, 1′-H), 5.05–4.60 (m, 5 H, 13^2-CH_2, 18-H, 2′-H, 3′-H), 4.53 (m, 1 H, 17-H), 4.10 (m, 2 H, 13^1-CH_2), 3.85 (q, 2 H, 8-CH_2CH_3), 3.76 (m, 1 H, 4′-H), 3.61 (s, 3 H, OCH_3), 3.52, 3.42, 3.37, (each s, 3 H, ring CH_3), 3.20 (m, 2 H, 2 × 5′-H), 2.88–2.20 (m, 4 H, 17-CH_2CH_2), 1.87, 1.76, −0.62 (each s, 3 H, CH_3CO), 1.83, (d, 3 H, 18-CH_3), 1.73 (t, 3 H, 8-CH_2CH_3), −1.66, −3.26 (each s, 1 H, NH) [Found (HRMS): *m/z* 903.3978. $C_{49}H_{54}N_6O_{11}$ requires *m/z* 903.3929 (M + 1)].

3^2,8^2-*trans*-Bis[(2′,3′,5′-tri-*O*-acetyl) uridinylvinyl]deuteroporphyrin IX dimethyl ester 24 and 3^1-[(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]-8^2-*trans*-[(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]deuteroporphyrin IX dimethyl ester 25 or 8^1-[(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]-3^2-*trans*-[(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]deuteroporphyrin IX dimethyl ester 26

The bis-*trans*-isomer **24** (25.2 mg, 10.3%) was obtained from **6**[32] (120 mg) and had mp 141–143 °C; λ_{max}/nm (CH_2Cl_2) 416 (ε 143 100), 512 (14 700), 550 (16 100), 582 (9100) and 636 (7200); $\delta_H(CDCl_3$ + trace of [^{2}H]-TFA for disaggregation) 1.97, 1.98 (each s, 3 H, CH_3CO), 2.15, 2.17 (each s, 6 H, 2 × CH_3CO), 3.13, 3.20 (each t, 2 H, CH_2CH_2CO), 3.57, 3.58, 3.61, 3.74 (each s, 3 H, ring CH_3), 3.67 (s, 6 H, 2 × OCH_3), 4.41 (m, 10 H, CH_2CH_2CO, 4′-H, 5′-H), 5.39, 5.53 (each m, 2 H, 2′-H, 3′-H), 6.00 (m, 2 H, 1′-H), 7.02, 7.05 (each d, J_{trans} 16.2, 1 H, CH=C*H*U), 7.958, 7.964 (each s, 1 H, 6-H), 9.07, 9.11 (each d, J_{trans} 16.2, 1 H, C*H*=CHU), 10.60 (s, 2 H, *meso*-H) and 10.67, 10.91 (each s, 1 H, *meso*-H) [Found (HRMS): *m/z* 1327.445. $C_{66}H_{70}N_8O_{22}$ requires 1327.468 (M + 1)]. The 3-*gem*-8-*trans*-isomer **25** or 8-*gem*-3-*trans*-isomer **26** were obtained (16.3 mg, 6.7%) from **6** (120 mg) and had mp 142.5–144.5 °C; λ_{max}/nm (CH_2Cl_2) 410 (ε 139 700), 508 (13 800), 544 (12 700), 576 (8600) and 632 (5900); $\delta_H(CDCl_3)$ −3.79 (br s, 2 H, NH), 0.20, 1.72, 1.83, 2.10 (each s, 3 H, CH_3CO), 2.20 (s, 6 H, 2 × CH_3CO), 3.18 (m, 2 H, 2 × H-5′), 3.28 (m, 4 H, 2 × CH_2CH_2CO), 3.54, 3.58, 3.63, 3.69 (each s, 3 H, ring CH_3), 3.67 (s, 7 H, 2 × OCH_3, 4′-H), 4.10–4.60 (m, 7 H, 2 × CH_2CH_2CO, 4′-H, 2 × 5′-H), 4.66, 5.01, 5.44, 5.58 (each m, 1 H, 2′-H, 3′-H), 5.31, 6.21 (each d, 1 H, 1′-H), 6.15 (d, J_{gem} 0.6, 1 H, C=C*H*H′), 7.19, 7.87 (each s, 1 H, 6-H), 7.53 (d, J_{gem} 0.6, 1 H, C=CHH′), 7.36 (d, J_{trans} 16.2, 1 H, CH=C*H*U), 8.87, 8.88 (each s, 1 H, 3-NH), 9.03 (d, J_{trans} 16.2, 1 H, C*H*=CHU), 9.96 (s, 1 H, *meso*-H), 10.07 (s, 3 H, *meso*-H) [Found (HRMS): *m/z* 1327.4534. $C_{66}H_{70}N_8O_{22}$ requires 1327.4682 (M + 1)].

Methyl 3^2-*trans*-[(2′,3′,5′-tri-*O*-acetyl)uridinyl]pyropheophorbide a 35

The *trans*-isomer **35** (5.7 mg, 17%) was obtained from compound **32** (20 mg), mp 129–131 °C; λ_{max}/nm (CH_2Cl_2) 418 nm (ε 276 900), 512 (32 500), 542 (27 900), 616 (23 800) and 674 (123 300); $\delta_H(CDCl_3)$ 1.69 (t, 3 H, 8-CH_2CH_3), 1.81 (d, 3 H, 18-CH_3), 2.08 (s, 3 H, CH_3CO), 2.18 (s, 6 H, 2 × CH_3CO), 2.20–2.80 (m, 4 H, 17-CH_2CH_2), 3.24, 3.47, 3.61 (each s, 3 H, ring CH_3), 3.67 (s, 3 H, OCH_3), 3.70 (m, 2 H, 8-CH_2CH_3), 4.31 (m, 1 H, 17-H), 4.48 (m, 4 H, 18-H, 4′-H, 2 × 5′-H), 5.19 (q, 2 H, 13^2-CH_2), 5.43, 5.53 (each t, 1 H, 2′-H, 3′-H), 6.23 (d, $J_{1',2'}$ 5.4, 1 H, 1′-H), 7.30 (d, J_{trans} 16.2, 1 H, CH=C*H*U), 7.87 (s, 1 H, 6-H), 8.41 (s, 1 H, 3-NH), 8.87 (d, J_{trans} 16.2, 1 H, C*H*=CHU) and 8.58, 9.43, 9.51 (each s, 1 H, *meso*-H); *m/z* 917.5 (M + 1; 100%) [Found (HRMS): *m/z* 916.3647. $C_{49}H_{52}N_6O_{12}$ requires 916.3647].

Zinc(II) 5-[4-*trans*-(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]phenyl-2,8-diethyl-13,17-bis(2-methoxycarbonylethyl)-3,7,12,18-tetramethylporphyrin 45

Zinc(II) complex **45** (10 mg, 29%) was obtained from the porphyrin **46** (25 mg); λ_{max}/nm (CH_2Cl_2, relative absorbances) 406 (1.000), 534 (0.070) and 570 (0.061); *m/z* 1126.4 (100%). Zinc(II) was removed by washing with 10% hydrochloric acid and water to afford its free base porphyrin **48** (97% from compound **45**), mp 139–141 °C; λ_{max}/nm (CH_2Cl_2) 406 (ε 275 700), 502 (23 400), 536 (11 400), 572 (12 300) and 624 (5600); $\delta_H(CDCl_3)$ −3.24 (br s, 2 H, NH), 1.76 (t, 6 H, 2 × CH_2CH_3), 2.18, 2.19, 2.27 (each s, 3 H, CH_3CO), 2.51, 3.67, 3.68 (each s, 6 H, ring CH_3 and OCH_3), 3.31 (t, 4 H, CH_2CH_2CO), 4.01 (q, 4 H, 2 × CH_2CH_3), 4.41 (t, 4 H, CH_2CH_2CO), 4.48 (m, 3 H, 4′-H, 2 × 5′-H), 5.44, 5.48 (each t, 1 H, 2′-H, 3′-H), 6.19 (d, $J_{1',2'}$ 5.5, 1 H, 1′-H), 7.16 (d, J_{trans} 16.4, 1 H, CH=C*H*U), 7.72 (s, 1 H, 6-H), 7.73 (d, J_{trans} 16.4, 1 H, C*H*=CHU), 7.86, 8.05 (each d, 2 H, phenyl H), 8.66 (s, 1 H, 3-NH), 9.96 (s, 1 H, *meso*-H), 10.17 (s, 2 H, *meso*-H); *m/z* 1065.6 (M + 1, 100%) [Found (HRMS): *m/z* 1065.4630. $C_{59}H_{65}N_6O_{13}$ requires *m/z* 1065.4609 (M + 1)].

Palladium(II)5-[4-*trans*-(2′,3′,5′-tri-*O*-acetyl)uridinylvinyl]phenyl-2,8-diethyl-13,17-bis(2-methoxycarbonylethyl)-3,7,12,18-tetramethylporphyrin 47

The palladium(II) complex **47** (17 mg, 44%) was obtained from the porphyrin **46** (25 mg) and had mp 151.5–153.5 °C; λ_{max}/nm (CH_2Cl_2) 400 (ε 314 900), 514 (24 600) and 548 (47 800); $\delta_H(CDCl_3)$ 1.74 (t, 6 H, 2 × CH_2CH_3), 2.177, 2.18, 2.26 (each s, 3 H, CH_3CO), 2.44, 3.55, 3.69 (each s, 6 H, ring CH_3 and OCH_3), 3.25 (t, 4 H, CH_2CH_2CO), 3.93 (q, 4 H, 2 × CH_2CH_3), 4.28 (t, 4 H, CH_2CH_2CO), 4.43 (m, 3 H, 4′-H, 2 × 5′-H), 5.43, 5.48 (each t, 1 H, 2′-H, 3′-H), 6.17 (d, $J_{1',2'}$ 5.5, 1 H, 1′-H), 7.16 (d, J_{trans} 16.3, 1 H, CH=C*H*U), 7.70 (s, 1 H, 6-H), 7.73 (d, J_{trans} 16.3, 1 H, C*H*=CHU), 7.83, 7.98 (each d, 2 H, phenyl H), 8.76 (s, 1 H, 3-NH), 9.91 (s, 1 H, *meso*-H), 10.40 (s, 2 H, *meso*-H); *m/z* (%) 1168.3 (100) [Found (HRMS): *m/z* 1169.3550. $C_{59}H_{63}N_6O_{13}Pd$ requires 1169.3482 (M + 1); Found (HRMS): *m/z* 1168.3380. $C_{59}H_{62}N_6O_{13}Pd$ requires 1168.3404 (*M*)].

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