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(54) **Title:** PROCESS AND INTERMEDIATES FOR PREPARING INTEGRASE INHIBITORS

(57) **Abstract:** The invention provides synthetic processes and synthetic intermediates that can be used to prepare 4-oxoquinolone compounds having useful integrase inhibiting properties.

PROCESS AND INTERMEDIATES FOR PREPARING INTEGRASE INHIBITORS

Priority of Invention

This application claims priority under 35 U.S.C. 119(e) from United States Provisional Patent Application Number 60/971,395, filed 11 September 2007, the contents of which are incorporated herein in their entirety.

Background of the Invention

International Patent Application Publication Number WO 2004/046115 provides certain 4-oxoquinolone compounds that are useful as HIV integrase inhibitors. The compounds are reported to be useful as anti-HIV agents.

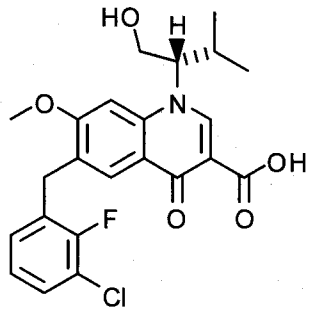
International Patent Application Publication Number WO 2005/113508 provides certain specific crystalline forms of one of these 4-oxoquinolone compounds, 6-(3-chloro-2-fluorobenzyl)-1-[(S)-1-hydroxymethyl-2-methylpropyl]-7-methoxy-4-oxo-1,4-dihydroquinolone-3-carboxylic acid. The specific crystalline forms are reported to have superior physical and chemical stability compared to other physical forms of the compound.

There is currently a need for improved methods for preparing the 4-oxoquinolone compounds reported in International Patent Application Publication Number WO 2004/046115 and in International Patent Application Publication Number WO 2005/113508. In particular, there is a need for new synthetic methods that are simpler or less expensive to carry out, that provide an increased yield, or that eliminate the use of toxic or costly reagents.

Summary of the Invention

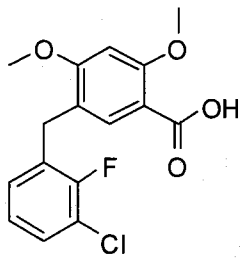
The present invention provides new synthetic processes and synthetic intermediates that are useful for preparing the 4-oxoquinolone compounds reported in International Patent Application Publication Number WO 2004/046115 and in International Patent Application Publication Number WO 2005/113508.

Accordingly, in one embodiment, the present invention provides a method for preparing a compound of formula 10



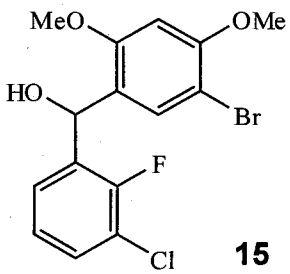
10

or a pharmaceutically acceptable salt thereof, in which a compound of formula 4



4

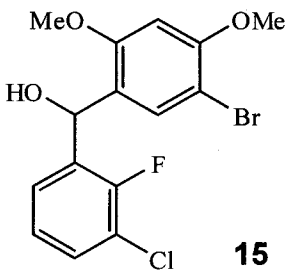
or a salt thereof is prepared and converted into a compound of formula **10**, characterized in that the compound of formula **4** is prepared from a compound of formula **15**



15

or a salt thereof, by the steps of replacing the bromine atom with a carboxyl group, and replacing the hydroxyl group with a hydrogen atom.

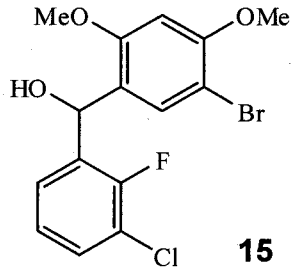
In another embodiment the invention provides a compound of formula **15**:



15

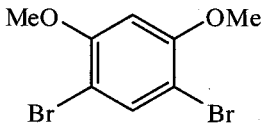
or a salt thereof.

In another embodiment the invention provides a method for preparing a compound of formula **15**:



15

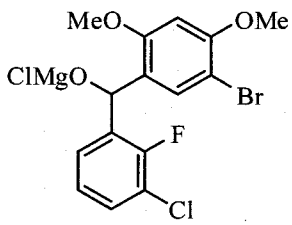
or a salt thereof comprising converting a corresponding compound of formula **14**:



14

to the compound of formula **15** or the salt thereof

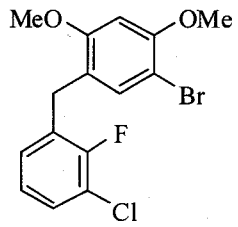
In another embodiment the invention provides a compound of formula **15a**:



15a

that is useful as an intermediate for preparing the 4-oxoquinone compounds.

In another embodiment the invention provides a compound of formula **16**:



16

that is useful as an intermediate for preparing the 4-oxoquinone compounds.

The invention also provides other synthetic processes and synthetic intermediates disclosed herein that are useful for preparing the 4-oxoquinone compounds.

Detailed Description

The following definitions are used, unless otherwise described: halo is fluoro, chloro, bromo, or iodo. Alkyl denotes both straight and branched groups, but reference to an individual radical such as propyl embraces only the straight chain radical, a branched chain isomer such as isopropyl being specifically referred to.

It will be appreciated by those skilled in the art that a compound having a chiral center may exist in and be isolated in optically active and racemic forms. Some compounds may exhibit polymorphism. It is to be understood that the present invention encompasses processes for preparing any racemic, optically-active, polymorphic, tautomeric, or stereoisomeric form, or mixtures thereof, of a compound described herein, it being well known in the art how to prepare optically active forms (for example, by resolution of the racemic form by recrystallization techniques, by synthesis from optically-active starting materials, by chiral synthesis, or by chromatographic separation using a chiral stationary phase).

Specific and preferred values listed below for radicals, substituents, and ranges, are for illustration only; they do not exclude other defined values or other values within defined ranges for the radicals and substituents.

Specifically, C_1-C_6alkyl can be methyl, ethyl, propyl, isopropyl, butyl, iso-butyl, sec-butyl, pentyl, 3-pentyl, or hexyl.

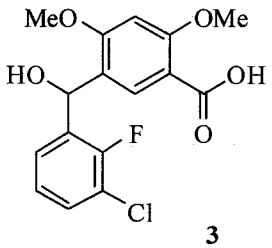
A specific value for R_a is methyl.

A specific value for R_b is methyl.

A specific value for R_c is 1-imidazolyl.

A specific value for R is ethyl.

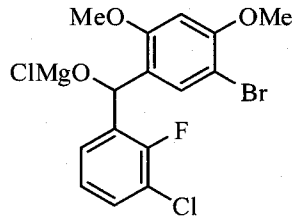
In one embodiment, the compound of formula **4** or a salt thereof is prepared by metalating the compound of formula **15** or a salt thereof and treating with carbon dioxide to provide the compound of formula **3**:



3

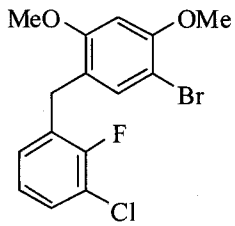
or a salt thereof, and then converting the compound of formula **3** into a compound of formula **4**.

The compound of formula **15** or a salt thereof may be, for example, a salt of formula **15a**



15a

In another embodiment, the compound of formula **15** is converted into a compound of formula **16**



16

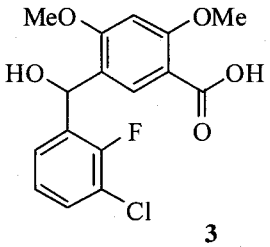
which is then metalated and treated with carbon dioxide to afford a compound of formula **4**.

It will be appreciated that the step of replacing the bromine atom with a carboxyl group is a carboxylation. This step may conveniently be effected by metalation, for example, by treatment with isopropylmagnesium chloride or isopropylmagnesium chloride lithium chloride complex, followed by treatment with carbon dioxide.

It will also be appreciated that the step of replacing the hydroxyl group with a hydrogen atom is a dehydroxylation. This step may be effected by treatment

with a trialkylsilane, such as triethylsilane, conveniently in the presence of trifluoroacetic acid.

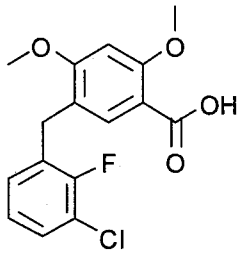
In another embodiment of the invention the compound of formula **15** or a salt thereof is converted to a compound of formula **3**:



3

or a salt thereof. For example, the compound of formula **15** or a salt thereof can be converted to the compound of formula **3** or a salt thereof by metalating the compound of formula **15** or the salt thereof (e.g. by treatment with isopropylmagnesium chloride) and treating with carbon dioxide to provide the compound of formula **3** or the salt thereof.

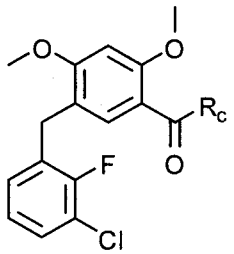
In another embodiment of the invention the compound of formula **3** or the salt thereof is converted to a compound of formula **4**:



4

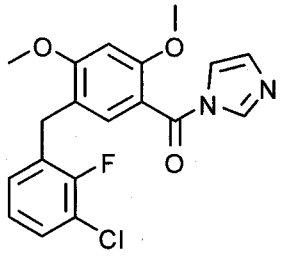
or a salt thereof.

In another embodiment of the invention the compound of formula **4** is converted to a compound of formula **5'**:



5'

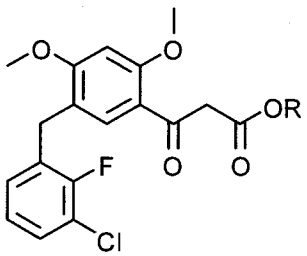
or a salt thereof, wherein R_c is a leaving group (such as halo or 1-imidazolyl). The carboxylic acid functional group of Compound **4** can be converted to an activated species, for example an acid chloride or an acyl imidazolide (Compound **5'**) by treatment with a suitable reagent, such as, for example, thionyl chloride, oxalyl chloride , cyanuric chloride or 1,1'-carbonyldiimidazole in a suitable solvent (e.g., toluene or tetrahydrofuran). Any suitable leaving group R_c can be incorporated into the molecule, provided the compound of formula **5'** can be subsequently converted to a compound of formula **6**. The reaction can conveniently be carried out using about 1 equivalent of 1,1'-carbonyldiimidazole in tetrahydrofuran. In one embodiment, the compound of formula **5'** is a compound of formula **5a**.



5a

The compound of formula **4** may be converted to the compound of formula **5a** by treatment with 1,1'-carbonyldiimidazole.

In another embodiment of the invention a compound of formula **5'** or a salt thereof, can be converted to a compound of formula **6**:

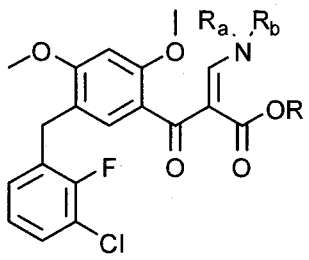


6

or a salt thereof, wherein R is C_1-C_6alkyl. In one embodiment, the compound of formula **5'** is converted to the compound of formula **6** by treatment with the corresponding mono-alkylmalonate salt. An example of a mono-alkylmalonate salt is potassium monoethylmalonate. For example, a compound of formula **5'** can be combined with about 1 to 5 equivalents of a monoalkyl malonate salt and about 1 to 5 equivalents of a magnesium salt in a suitable solvent. Conveniently,

a compound of formula **5'** can be combined with about 1.7 equivalents of potassium monoethyl malonate and about 1.5 equivalents of magnesium chloride. A suitable base, for example triethylamine or imidazole, can be added to the reaction. The reaction can conveniently be carried out at an elevated temperature (e.g., about 100 ± 50 °C) and monitored for completion by any suitable technique (e.g., by HPLC). Upon completion of the reaction, Compound **6** can be isolated using any suitable technique (e.g., by chromatography or crystallization).

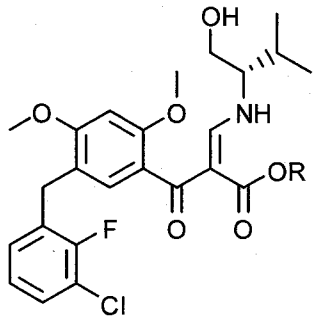
In another embodiment of the invention the compound of formula **6** or a salt thereof, can be converted to a corresponding compound of formula **7**:



7

wherein R_a and R_b are each independently C_1-C_6alkyl; and R is C_1-C_6alkyl. Compound **6** can be converted to an activated alkylidene analog, such as Compound **7**, by treatment with a formate group donor such as a dimethylformamide dialkyl acetal (e.g., dimethylformamide dimethyl acetal) or a trialkylorthoformate. The reaction can be carried out at elevated temperature (e.g., about 100 ± 50 °C). This reaction may be accelerated by the addition of an acid catalyst, such as, for example, an alkanoic acid, a benzoic acid, a sulfonic acid or a mineral acid. About 500 ppm to 1 % acetic acid can conveniently be used. The progress of the reaction can be monitored by any suitable technique (e.g., by HPLC). Compound **7** can be isolated or it can be used directly to prepare a compound of formula **8** as described below.

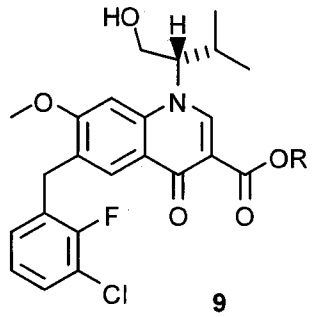
In another embodiment of the invention the compound of formula **7** can be converted to a corresponding compound of formula **8**:



8

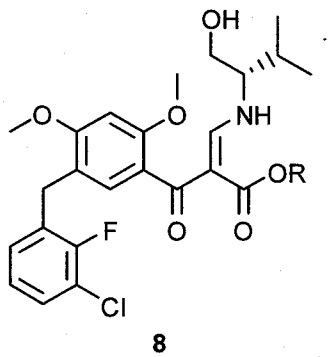
wherein R is C_1-C_6alkyl. Compound **7** can be combined with (*S*)-2-amino-3-methyl-1-butanol (*S*-Valinol, about 1.1 equivalents) to provide compound **8.** The progress of the reaction can be monitored by any suitable technique (e.g., by HPLC). The compound of formula **8** can be isolated or used directly to prepare a compound of formula **9** as described below.

In another embodiment, the invention provides a method for preparing a compound of formula **9**:



9

wherein R is C_1-C_6alkyl, comprising cyclizing a corresponding compound of formula **8**:

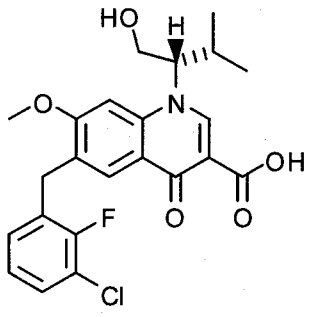


8

Compound **8** can be cyclized to provide Compound **9** by treatment with a silylating reagent (e.g., *N,O*-bis(trimethylsilyl)acetamide, *N,O*-bis(trimethylsilyl)trifluoroacetamide or hexamethyldisilazane). The reaction

can be conducted in a polar aprotic solvent (e.g., dimethylformamide, dimethylacetamide, N-methylpyrrolidinone or acetonitrile). A salt (e.g., potassium chloride, lithium chloride, sodium chloride or magnesium chloride) can be added to accelerate the reaction. Typically, about 0.5 equivalents of a salt such as potassium chloride is added. The reaction may be conducted at elevated temperature (e.g., a temperature of about 100 ± 20 °C) if necessary to obtain a convenient reaction time. The progress of the reaction can be monitored by any suitable technique (e.g., by HPLC). During the workup, an acid can be used to hydrolyze any silyl ethers that form due to reaction of the silylating reagent with the alcohol moiety of compound **8**. Typical acids include mineral acids, sulfonic acids, or alkanoic acids. One specific acid that can be used is aqueous hydrochloric acid. Upon completion of the hydrolysis, Compound **9** can be isolated by any suitable method (e.g., by chromatography or by crystallization). In the above conversion, the silating reagent transiently protects the alcohol and is subsequently removed. This eliminates the need for separate protection and deprotection steps, thereby increasing the efficiency of the conversion.

In another embodiment of the invention the compound of formula **9** is converted to a compound of formula **10**:



10

Compound **9** can be converted to Compound **10** by treatment with a suitable base (e.g., potassium hydroxide, sodium hydroxide or lithium hydroxide). For example, about 1.3 equivalents of potassium hydroxide can conveniently be used. This reaction may be conducted in any suitable solvent, such as, for example, tetrahydrofuran, methanol, ethanol or isopropanol, or a mixture thereof. The solvent can also include water. A mixture of isopropanol and water can conveniently be used. The progress of the reaction can be monitored by any

suitable technique (e.g., by HPLC). The initially formed carboxylate salt can be neutralized by treatment with an acid (e.g., hydrochloric acid or acetic acid). For example, about 1.5 equivalents of acetic acid can conveniently be used. Following neutralization, Compound **10** can be isolated using any suitable technique (e.g., by chromatography or crystallization).

In another embodiment of the invention the compound of formula **10** can be crystallized by adding a seed crystal to a solution that comprises the compound of formula **10.** International Patent Application Publication Number WO 2005/113508 provides certain specific crystalline forms of 6-(3-chloro-2-fluorobenzyl)-1-[(S)-1-hydroxymethyl-2-methylpropyl]-7-methoxy-4-oxo-1,4-dihydroquinolone-3-carboxylic acid. The entire contents of International Patent Application Publication Number WO 2005/113508 is incorporated herein by reference (in particular, see pages 12-62 therein). The specific crystalline forms are identified therein as Crystal Form II and Crystal Form III. Crystal form II has an X-ray powder diffraction pattern having characteristic diffraction peaks at diffraction angles 2θ(°) of 6.56, 13.20, 19.86, 20.84, 21.22, and 25.22 as measured by an X-ray powder diffractometer. Crystal form III has an X-ray powder diffraction pattern having characteristic diffraction peaks at diffraction angles 2θ(°) of 8.54, 14.02, 15.68, 17.06, 17.24, 24.16, and 25.74 as measured by an X-ray powder diffractometer. International Patent Application Publication Number WO 2005/113508 also describes how to prepare a crystalline form of 6-(3-chloro-2-fluorobenzyl)-1-[(S)-1-hydroxymethyl-2methylpropyl]-7-methoxy-4-oxo-1,4-dihydroquinolone- 3-carboxylic acid that have an extrapolated onset temperature of about 162.1 °C, as well as how to prepare a seed crystal having a purity of crystal of not less than about 70%. Accordingly, seed crystals of 6-(3-chloro-2-fluorobenzyl)-1-[(S)-1-hydroxymethyl-2-methylpropyl]-7-methoxy-4-oxo-1,4-dihydroquinolone-3-carb oxylic acid can optionally be prepared as described in International Patent Application Publication Number WO 2005/113508. Advantageously, the process illustrated in Scheme I below provides a crude mixture of Compound **10** that can be directly crystallized to provide Crystal Form III without additional purification

(e.g. without the prior formation of another polymorph such as Crystal Form II, or without some other form of prior purification), see Example 6 below.

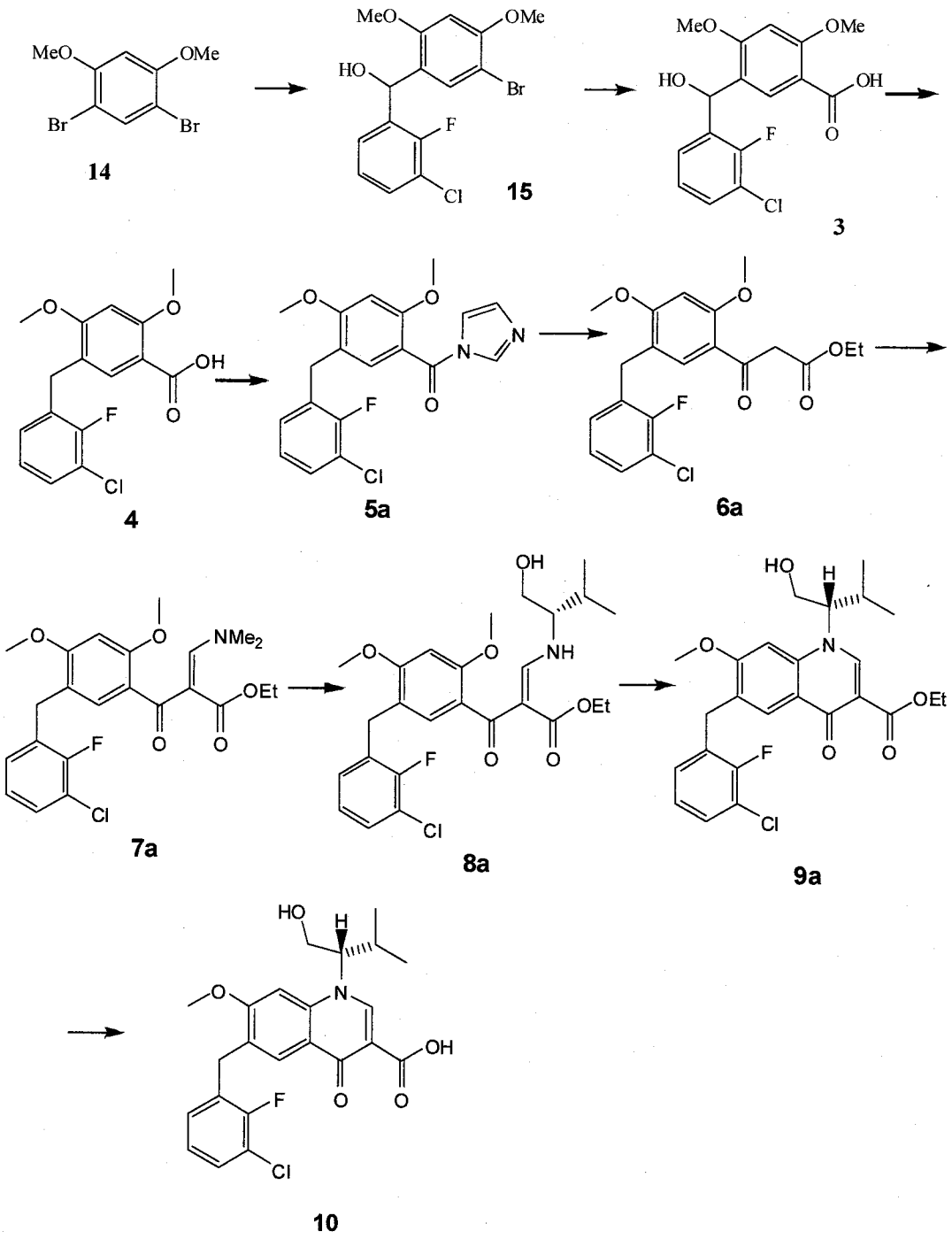
In cases where compounds identified herein are sufficiently basic or acidic to form stable acid or base salts, the invention also provides salts of such compounds. Such salts may be useful as intermediates, for example, for purifying such compounds. Examples of useful salts include organic acid addition salts formed with acids, for example, tosylate, methanesulfonate, acetate, citrate, malonate, tartarate, succinate, benzoate, ascorbate, α-ketoglutarate, and α-glycerophosphate. Suitable inorganic salts may also be formed, including hydrochloride, sulfate, nitrate, bicarbonate, and carbonate salts.

Salts may be obtained using standard procedures well known in the art, for example by reacting a sufficiently basic compound such as an amine with a suitable acid affording an anion. Alkali metal (for example, sodium, potassium, or lithium) or alkaline earth metal (for example calcium or magnesium) salts of carboxylic acids, for example, can also be made.

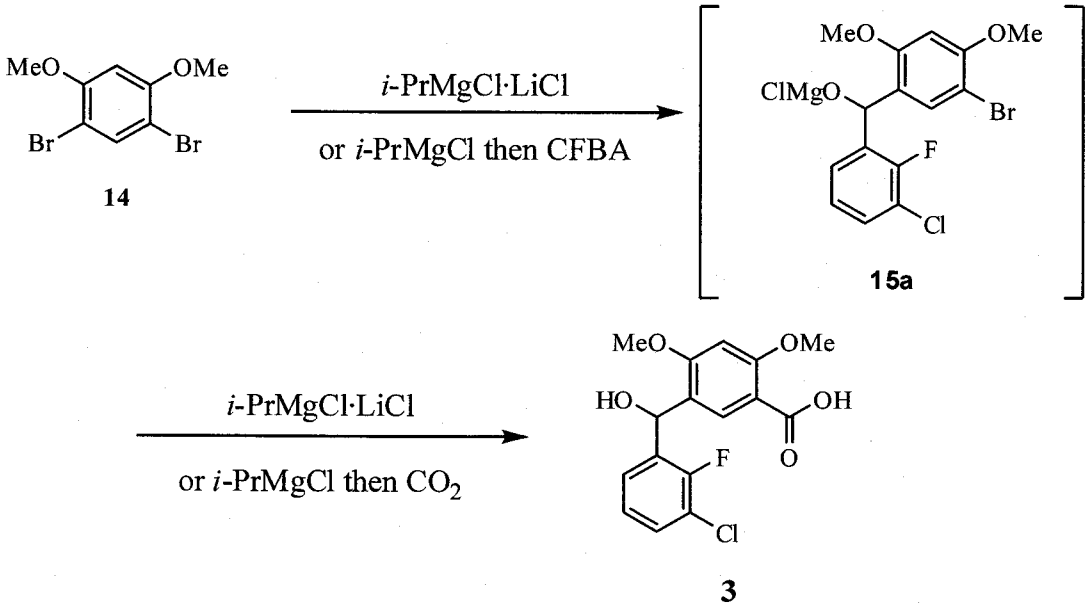
The invention will now be illustrated by the following non-limiting Examples.

An integrase inhibitor of formula **10** can be prepared as illustrated in the following Scheme 1.

SCHEME 1



Example 1: Preparation of Compound **3**



Compound **14** (10 g) was combined with 28 mL of THF and 9 mL of bisdimethylaminoethyl ether before being cooled to 0 °C. Isopropylmagnesium chloride (22.9 mL of a 2.07 M solution in THF) was added and the mixture was allowed to warm to room temperature overnight. Additional isopropylmagnesium chloride (5 mL) was added to improve conversion before 3-chloro-2-fluorobenzaldehyde (4.4 mL) was added. After stirring at ambient temperature for 2 hours 38.6 g of a 14 wt% THF solution of isopropylmagnesium chloride lithium chloride complex was added. After stirring overnight at ambient temperature CO_2 gas was bubbled into the reaction mixture. When conversion was complete the reaction was quenched to pH <3 with 2 M hydrochloric acid. The phases were separated and the organic phase was extracted with ethyl acetate. The combined organic layers were washed with saturated aqueous sodium chloride. The organic phase was concentrated and the product precipitated by the addition of MTBE. The slurry was filtered and the product air dried to yield Compound **3**: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 12.15 (br s, 1H), 7.81 (s, 1H), 7.42 (t, J = 7.2 Hz, 1H), 7.26 (t, J = 6.8 Hz, 1H), 7.15 (t, J = 7.8 Hz, 1H), 6.77 (s, 1H), 6.09 (d, J = 4.7 Hz, 1H), 5.90 (d, J = 4.9 Hz, 1H), 3.84 (s, 3H), 3.80 (s, 3H).

Example 2: Preparation of Compound **4**.

Triethylsilane (6.83 g) was added to trifluoroacetic acid (33.13 g) that had been pre-cooled in an ice bath. Compound **3** (10 g) was added to the mixture keeping the temperature below 15 °C. After stirring for 2 h MTBE was added to precipitate the product. The slurry was filtered and the product washed with additional MTBE. After drying, 9.12 g of Compound **4** was isolated: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 12.11 (br s, 1H), 7.47 (s, 1H), 7.42-7.38 (m, 1H), 7.14-7.08 (m, 2H), 6.67 (s, 1H), 3.87-3.84 (m, 8H).

Alternatively, Compound **4** can be prepared as follows.

Triethylsilane (7.50 g) was added to trifluoroacetic acid (49.02 g) that had been pre-cooled in an ice bath. Compound **3** (14.65 g) was added to the mixture keeping the temperature below 15 °C. After stirring for 1 h a solution of 17.63 g sodium acetate in 147 mL methanol was added. The mixture was heated to reflux for 3 hours then cooled to 0 °C. The slurry was filtered and the product washed with additional methanol. After drying 12.3 g of Compound **4** (89.7 % yield) was isolated: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 12.11 (br s, 1H), 7.47 (s, 1H), 7.42-7.38 (m, 1H), 7.14-7.08 (m, 2H), 6.67 (s, 1H), 3.87-3.84 (m, 8H).

Example 3: Preparation of Compound **5a.**

Imidazole (0.42 g) and 1,1'-carbonyldiimidazole (5.49 g) were slurried in 30 mL of THF at ambient temperature. Compound **4** (10 g) was added in one portion and the mixture was stirred at ambient temperature until the reaction was complete by HPLC. The resulting slurry was filtered and the solids washed with MTBE. The solids were dried to yield Compound **5a**: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 7.99 (s, 1H), 7.52 (s, 1H), 7.41-7.38 (m, 1H), 7.30 (s, 1H), 7.12-7.08 (m, 2H), 7.04 (s, 1H), 6.81 (s, 1H), 3.91 (s, 2H), 3.90 (s, 3H), 3.79 (s, 3H).

Example 4: Preparation of Compound **6a**.

Imidazole (0.42 g) and 1,1'-carbonyldiimidazole (5.49 g) were slurried in 30 mL of THF at ambient temperature. Compound **5a** (10 g) was added in one portion and the mixture was stirred at ambient temperature for 4 hours to form a slurry of compound **5a**. In a separate flask, 8.91 g of potassium monoethyl malonate was slurried in 40 mL of THF. Magnesium chloride (4.40 g) was added and the resulting slurry was warmed to 55 °C for 90 minutes. The slurry of Compound **5a** was transferred to the magnesium chloride/potassium monoethyl malonate mixture and stirred at 55 °C overnight. The mixture was then cooled to room temperature and quenched by the dropwise addition of 80 mL of 28 wt% aqueous H_3PO_4. The phases were separated and the organic phase was washed successively with aqueous $NaHSO_4$, $KHCO_3$ and NaCl solutions. The organic phase was concentrated to an oil and then coevaporated with ethanol. The resulting solid was dissolved in 30 mL ethanol and 6 mL water. Compound **6a** was crystalized by cooling. The solid was isolated by filtation and the product was washed with aqueous ethanol. After drying Compound **6a** was obtained: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 7.51 (s, 1H), 7.42-7.38 (m, 1H), 7.12-7.10 (m, 2H), 6.70 (s, 1H), 4.06 (q, J = 7.0 Hz, 2H), 3.89 (s, 8H), 3.81 (s, 2H), 1.15 (t, J = 7.0 Hz, 3H).

Alternatively, Compound **6a** can be prepared as follows.

Carbonyldiimidazole (10.99 g) was slurried in 60 mL of THF at ambient temperature. Compound **4** (20 g) was added in one portion and the mixture was stirred at ambient temperature for 30 min to form a slurry of compound **5**. In a separate flask 15.72 g of potassium monoethyl malonate was slurried in 100 mL of THF. Magnesium chloride (6.45 g) was added and the resulting slurry was warmed to 55 °C for 5 hours. The slurry of Compound **5** was transferred to the magnesium chloride/potassium monoethyl malonate mixture and stirred at 55 °C overnight. The mixture was then cooled to room temperature and quenched onto 120 mL of 28 wt% aqueous H_3PO_4. The phases were separated and the organic

phase was washed successively with aqueous $KHCO_3$ and NaCl solutions. The organic phase was concentrated to an oil and then coevaporated with ethanol. The resulting solid was dissolved in 100 mL ethanol and 12 mL water. Compound **6a** was crystallized by cooling. The solid was isolated by filtation and the product was washed with aqueous ethanol. After drying 21.74 g Compound **6a** (89 % yield) was obtained: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 7.51 (s, 1H), 7.42-7.38 (m, 1H), 7.12-7.10 (m, 2H), 6.70 (s, 1H), 4.06 (q, J = 7.0 Hz, 2H), 3.89 (s, 8H), 3.81 (s, 2H), 1.15 (t, J = 7.0 Hz, 3H).

Example 5: Preparation of Compound **9a**.

Compound **6a** (20 g) was stirred with 6.6 g dimethylformamide dimethyl acetal, 66 g toluene and 0.08 g glacial acetic acid. The mixture was warmed to 90 °C for 4 hours. The mixture was then cooled to ambient temperature and 5.8 g (S)-2-amino-3-methyl-1-butanol was added. The mixture was stirred at ambient temperature for 1 hour before being concentrated to a thick oil. Dimethylformamide (36 g), potassium chloride (1.8 g) and bis(trimethylsilyl)acetamide (29.6 g) were added and the mixture was warmed to 90 °C for 1 h. The mixture was cooled to room temperature and diluted with 200 g dichloromethane. Dilute hydrochloride acid (44 g , about 1N) was added and the mixture stirred at ambient temperature for 20 min. The phases were separated and the organic phase was washed successively with water, aqueous sodium bicarbonate and water. The solvent was exchanged to acetonitrile and the volume was adjusted to 160 mL. The mixture was heated to clarity, cooled slightly, seeded and cooled to crystallize Compound **9a**. The product was isolated by filtration and washed with additional cold acetonitrile. Vacuum drying afforded Compound **9a**: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 8.61 (s, 1H), 7.86 (s, 1H), 7.45 (t, J = 7.4 Hz, 1H), 7.26 (s, 1H), 7.23-7.14 (m, 2H), 5.10 (br s, 1H), 4.62 (br s, 1H), 4.18 (q, J = 7.0 Hz, 2H), 4.03 (s, 2H), 3.96 (s, 3H), 3.92-3.84 (m, 1H), 3.78-3.75 (m, 1H), 2.28 (br s, 1H), 1.24 (t, J = 7.0 Hz, 3H), 1.12 (d, J = 6.4 Hz, 3H), 0.72 (d, J = 6.4 Hz, 3H).

Alternatively, Compound **9a** can be prepared as follows.

Compound **6a** (50 g) was stirred with 17.5 g dimethylformamide dimethyl acetal, 90 g DMF and 0.2 g glacial acetic acid. The mixture was warmed to 65 °C for 3 hours. The mixture was then cooled to ambient temperature and 14.5 g (S)-2-amino-3-methyl-1-butanol and 25 g toluene were added. The mixture was stirred at ambient temperature overnight before being concentrated by distillation. Potassium chloride (4.5 g) and bis(trimethylsilyl)acetamide (80.2 g) were added and the mixture was warmed to 90 °C for 2 h. The mixture was cooled to room temperature and diluted with 250 g dichloromethane. Dilute hydrochloride acid (110 g of ~1N) was added and the mixture stirred at ambient temperature for 30 min. The phases were separated and the organic phase was washed successively with water, aqueous sodium bicarbonate and water. The solvent was exchanged to acetonitrile by distillation. The mixture was heated to clarity, cooled slightly, seeded and cooled to crystallize Compound **9a**. The product was isolated by filtration and washed with additional cold acetonitrile. Vacuum drying afforded 48.7 g (81 % yield) of Compound **9a**: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 8.61 (s, 1H), 7.86 (s, 1H), 7.45 (t, J = 7.4 Hz, 1H), 7.26 (s, 1H), 7.23-7.14 (m, 2H), 5.10 (br s, 1H), 4.62 (br s, 1H), 4.18 (q, J = 7.0 Hz, 2H), 4.03 (s, 2H), 3.96 (s, 3H), 3.92-3.84 (m, 1H), 3.78-3.75 (m, 1H), 2.28 (br s, 1H), 1.24 (t, J = 7.0 Hz, 3H), 1.12 (d, J = 6.4 Hz, 3H), 0.72 (d, J = 6.4 Hz, 3H).

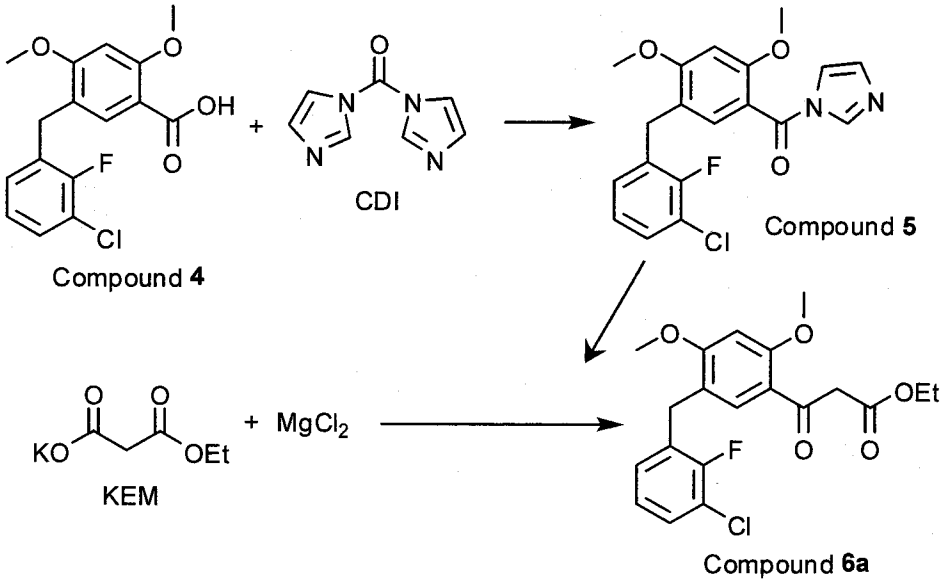
Example 6: Preparation of Compound **10**.

Compound **9a** (6.02 g) was slurried in 36 mL isopropanol and 24 mL of water. Aqueous potassium hydroxide (2.04 g of 45 wt % solution) was added and the mixture warmed to 40 °C. After 3 hours 1.13 g glacial acetic acid was added the mixture seeded with 10 mg of Compound **10**. The mixture was cooled in an ice bath for 2 hours and the solid was isolated by filtration. The cake was washed with aqueous isopropanol and dried to give Compound **10**: ^{1}H NMR (DMSO-d_6, 400 MHz) δ 15.42 (s, 1H), 8.87 (s, 1H), 8.02 (s, 1H), 7.48-7.45 (m, 2H), 7.23 (t, J = 6.8 Hz, 1H), 7.17 (t, J = 7.8 Hz, 1H), 5.18 (br s, 1H), 4.86 (br s, 1H), 4.10 (s,

2H), 4.02 (s, 3H), 3.97-3.96 (m, 1H), 3.79-3.76 (m, 1H), 2.36 (br s, 1H), 1.14 (d, J = 6.3 Hz, 3H), 0.71 (d, J = 6.3 Hz, 3H).

Alternatively, Compound **10** can be prepared from Compound **4** as described in the following illustrative Examples 7-9.

Example 7. Preparation of a Compound of Formula **6a**.



Carbonyldiimidazole and imidazole are combined with anhydrous tetrahydrofuran. Compound **4** is added to this mixture to form Compound **5** and the reaction is monitored by HPLC. In a separate reactor potassium monoethylmalonate is combined with tetrahydrofuran before anhydrous magnesium chloride is added while maintaining the temperature NMT 30 °C. The resulting slurry is warmed to 50 °C and held for at least two hours before the Compound **5** mixture is added. The reaction is monitored by HPLC. Once the formation of Compound **5** is complete, the mixture is cooled to 18 to 25 °C and added to aqueous phosphoric acid to quench. The organic phase is washed with aqueous sodium bisulfate, brine, potassium bicarbonate and brine solutions before being polish filtered. The solvent is exchanged for anhydrous ethanol. Water is added and the mixture is warmed to dissolve solids, cooled to about 40 °C, seeded with Compound **6a** and cooled to 0 to 5 °C. The product is filtered, washed with

cold aqueous ethanol and dried at NMT 40 °C to yield Compound **6a**.

Material	M.W.	Wt. Ratio	Mole Ratio
Compound **4**	324.73	1.000	1.00
THF	72.11	7.11	
Imidazole	68.08	0.042	0.20
CDI	162.15	0.55	1.10
KEM	170.2	0.89	1.70
$MgCl_2$	95.21	0.44	1.50
H_3PO_4 (85 wt%)	98.00	2.3	
$NaHSO_4$	120.06	0.24	
$KHCO_3$	100.12	0.50	
NaCl	58.44	0.48	
SDA 2B-2 EtOH (0.5% heptane)	46.07	~10 kg	

Procedure:

1. Charge 0.55 kg CDI and 0.042 kg imidazole to reactor 1.
2. Charge 2.67 kg THF to reactor 1 and agitate to form a slurry.
3. Charge 1.00 kg Compound **4** to reactor 1 in portions to moderate the CO_2 offgas. This addition is endothermic
4. Charge 0.89 kg KEM to reactor 2.
5. Charge 4.45 kg THF to reactor 2 and agitate to form a slurry.
6. Charge 0.44 kg $MgCl_2$ to reactor 2 (can be added in portions to moderate exotherm).
7. Warm the contents of reactor 2 to 50 °C and agitate at that temperature for at least two hours.
8. Transfer the contents of reactor 1 to reactor 2. Mixture will become thick temporarily if transferred very rapidly.
9. Agitate the contents of reactor 2 for at least 12 hours at 50 °C.
10. Cool the slurry to ambient temperature.
11. Quench the reaction by transferring the reaction mixture onto 7.0 kg of 28 wt% aqueous H_3PO_4 (2.3 kg 85 wt% H_3PO_4 dissolved in 4.7 kg H_2O). This addition is exothermic. Final pH of aqueous layer should be 1-2.

12. Wash the organic (top) phase with 1.2 kg of 20 wt% aqueous $NaHSO_4$ (0.24 kg of $NaHSO_4$ dissolved in 0.96 kg H_2O). Final pH of aqueous layer should be 1-2.

13. Wash the organic (top) phase with 1.2 kg of 20 wt% aqueous NaCl (0.24 kg of NaCl dissolved in 0.96 kg H_2O)

14. Wash the organic (top) phase with 5.0 kg of 10 wt% aqueous $KHCO_3$ (0.50 kg of $KHCO_3$ dissolved in 4.5 kg H_2O). Final pH of aqueous layer should be 8-10.

15. Wash the organic (top) phase with 1.2 kg of 20 wt% aqueous NaCl (0.24 kg of NaCl dissolved in 0.96 kg H_2O). Final pH of aqueous layer should be 7-9.

16. Concentrate the organic phase and exchange the solvent to EtOH.

17. Adjust the concentration to ~3.5 L/kginput.

18. Charge 0.6 volumes of water.

19. Warm 70 – 80 °C to form a clear solution.

20. Cool to 40 °C and seed with 0.1 wt% Compound **6**.

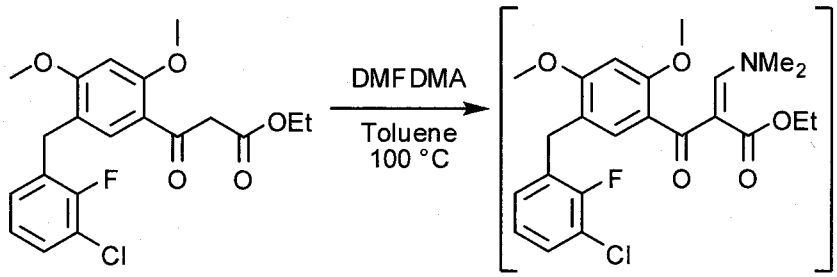
21. Cool slowly to 5 °C.

22. Hold for at least 2 hours.

23. Filter and wash the cake with two 1.35 kg volume portions of 50:50 EtOH:H_2O (1.2 kg EtOH combined with 1.5 kg H_2O).

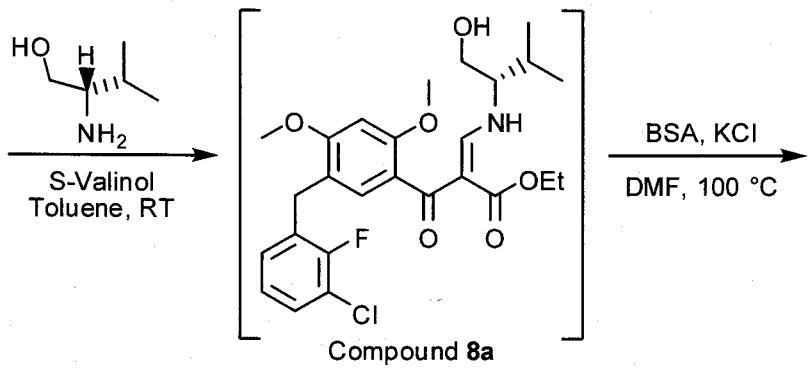
24. Dry the cake at less than 50 °C.

Example 8. Preparation of a Compound of Formula **9a**.

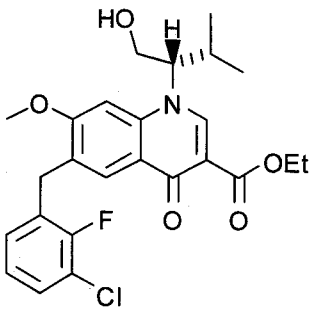


Compound **6a**
$C_{20}H_{20}ClFO_5$
Mol. Wt.: 394.82

Compound **7a**
$C_{23}H_{25}ClFNO_5$
Mol. Wt.: 449.9



Compound **8a**
$C_{26}H_{31}ClFNO_6$
Mol. Wt.: 507.98



Compound **9a**
$C_{25}H_{27}ClFNO_5$
Mol. Wt.: 475.94

Compound **6a** is combined with toluene, *N,N*-dimethylformamide dimethyl acetal and glacial acetic acid before being warmed to 100 °C. The reaction is monitored by HPLC. Once the formation of Compound **7a** is complete the mixture is cooled to 18 to 25 °C before (*S*)-(+)-valinol is added. The reaction is monitored by HPLC. Once the formation of Compound **8a** is complete the

mixture is concentrated. The residue is combined with dimethylformamide, potassium chloride and *N,O*-bistrimethylsilyl acetamide and warmed to 100 °C. The reaction is monitored by HPLC. Once complete the mixture is cooled and dichloromethane is added. Aqueous hydrochloric acid is added to desilylate Compound **9a**. This reaction is monitored by TLC. Once complete the organic phase is washed with water, aqueous sodium bicarbonate and water. The solvent is exchanged for acetonitrile and the mixture warmed. The mixture is seeded and cooled to crystallize Compound **9a**. The product is filtered, washed with cold acetonitrile and dried at NMT 40 °C to yield Compound **9a**.

Material	M.W.	Wt. Ratio	Mole Ratio
Compound **6a**	394.82	1.00	1.00
Toluene	92.14	4.3	
Glacial acetic acid	60.05	0.001	0.007
N,N-dimethylformamide dimethyl acetal	119.16	0.33	1.1
(S)-(+)-Valinol	103.16	0.29	1.1
DMF	73.10	1.8	
KCl	74.55	0.09	0.5
N,O-bis(trimethylsilyl)acetamide	203.43	1.13	2.2
1 N HCl	36.5	2.0	
DCM	84.93	10	
Water	18.02	8	
5% Aq. $NaHCO_3$	84.01	4	
CAN	41.05	QS	
Compound **9a** seeds	475.94	0.005	

1. Charge Reactor 1 with 1.00 kg Compound **6a**.
2. Charge 0.33 kg *N,N*-dimethylformamide dimethyl acetal (1.1 eq), 0.001 kg glacial acetic acid and 3.3 kg toluene to Reactor 1.
3. Warm the mixture to ~100 °C (note that some MeOH may distill during this operation).
4. After 1 h the reaction should be complete by HPLC (~2 % Compound **6a** apparently remaining)[1].
5. Cool the mixture in Reactor 1 to 18 – 25 °C.

6. Charge 0.29 kg (S)-(+)-Valinol (1.1 eq) dissolved in 1.0 kg toluene to Reactor 1 and continue agitation at ambient temperature.
7. After 1 h the reaction should be complete by HPLC (<1 % Compound **6a**).
8. Concentrate the contents of Reactor1 to ~2 L/kg.
9. Charge 1.8 kg DMF, 0.09 kg potassium chloride (0.5 eq,) and 1.13 kg *N,O*-bistrimethylsilyl acetamide (2.2 eq.) to Reactor 1.
10. Warm the mixture in Reactor 1 to ~100 °C.
11. Reaction should be complete in ~1 h (~5% Compound **8a** remaining).
12. Cool the contents of Reactor 1 to 18 – 25 °C.
13. Charge 10 kg DCM to Reactor 1.
14. Charge 2.0 kg 1 N aqueous HCl to Reactor 1 over ~15 min, maintaining the temperature of the mixture < 35 °C.
15. Agitate the mixture for at least 10 min to desilylate Compound **8a**. Monitor the progress of desilylation by TLC.[2]
16. Separate the phases.
17. Wash the organic phase with 4.0 kg water.
18. Wash the organic phase with 4.0 kg 5% aqueous sodium bicarbonate.
19. Wash the organic phase with 4.0 kg water.
20. Concentrate the organic phase by distillation to ~1.5 L/kg Compound **6a**.
21. Solvent exchange to ACN by distillation until a slurry is formed. Adjust the final volume to ~8 L/kg Compound **6a**.
22. Heat the mixture to reflux to redissolve the solid.
23. Cool the solution to 75 °C and charge Compound **9a** seeds.
24. Cool the mixture to 0 °C over at least 2 h and hold at that temperature for at least 1 h.
25. Isolate Compound **9a** by filtration and wash the wet cake with 1.6 kg cold ACN.
26. Dry the wet cake at < 40 °C under vacuum.

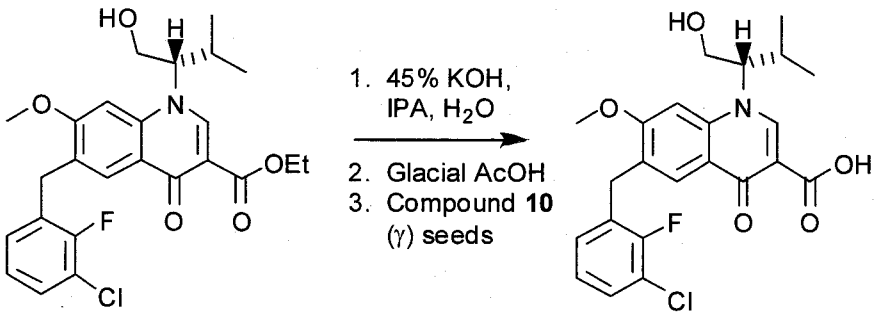
Notes:

1. The HPLC AN of remaining Compound **6a** is exaggerated by a baseline artifact. The HPLC in step shows only 2% of Compound **6a** relative to Compound **8a**. Experiments demonstrated that adding more reagent and extending reaction time typically will not further reduce the observed level of Compound **6a**.

2. TLC method:

   Eluting solvent: 100% ethyl acetate,
   Silylated Compound **9a** Rf: 0.85, Compound **9a** Rf: 0.50.

Example 9. Preparation of a Compound of Formula **10**.



Compound **9a**
$C_{25}H_{27}ClFNO_5$
Mol. Wt.: 475.94

Compound **10, γ-form**

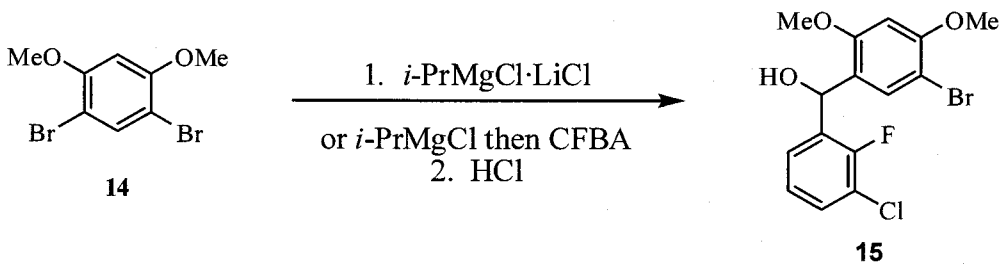
$C_{23}H_{23}ClFNO_5$
Mol. Wt.: 447.88

Compound **9a** is combined with aqueous isopropyl alcohol and warmed to 30 to 40 °C. Aqueous potassium hydroxide is added and the reaction is monitored by HPLC. Once complete, glacial acetic acid is added and the mixture warmed to 60 to 70 °C. The solution is hot filtered and cooled to 55 to 65 °C. The solution is seeded (see International Patent Application Publication Number WO 2005/113508) and cooled to 0 °C. The product is isolated by filtration, washed with cold aqueous isopropyl alcohol and dried at NMT 50 °C to yield Compound **10**.

Material	M.W.	Wt. Ratio	Mole Ratio
Compound **9a**	475.94	1.00	1.00
Isopropyl alcohol	60.10	4.7	
Water	18.02	4.0	
45% KOH	56.11	0.34	1.3
Glacial Acetic Acid	60.05	0.19	1.50
Compound **10** seeds	447.88	0.01	

1. Charge 1.00 kg Compound **9a** to Reactor 1.
2. Charge 4.7 kg isopropyl alcohol and 4.0 kg water to Reactor 1.
3. Charge 0.34 kg 45% aqueous KOH to Reactor 1.
4. Warm the mixture in Reactor 1 to 30 – 40 °C.
5. When hydrolysis is complete add 0.19 kg of glacial acetic acid.
6. Warm the mixture to 60 – 70 °C and polish filter the solution to Reactor 2.
7. Cool the mixture in Reactor 2 to 55 – 65 °C.
8. Seed with Compound 10 (see International Patent Application Publication Number WO 2005/113508) as a slurry in 0.28 volumes of 6:4 isopropyl alcohol:water.
9. Cool the mixture to 18 – 25 °C over at least 2 h and agitate to form a slurry.
10. Cool the mixture to 0 °C and agitate for at least 2 h.
11. Isolate Compound **10** by filtration and wash the cake with 3 x 1S cold isopropyl alcohol:water (6:4) solution.
12. Dry the isolated solids at < 50 °C under vacuum.

Example 10: Preparation of Compound **15**

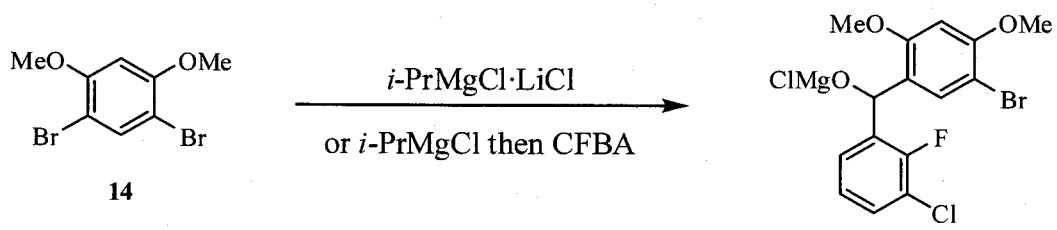


14 **15**

Bisdimethylaminoethyl ether (2.84 g) was dissolved in 42 mL THF and cooled in an ice bath. Isopropylmagnesium chloride (8.9 mL of a 2 M solution in THF) followed by Compound **14** (5 g dissolved in 5 mL THF) were added slowly

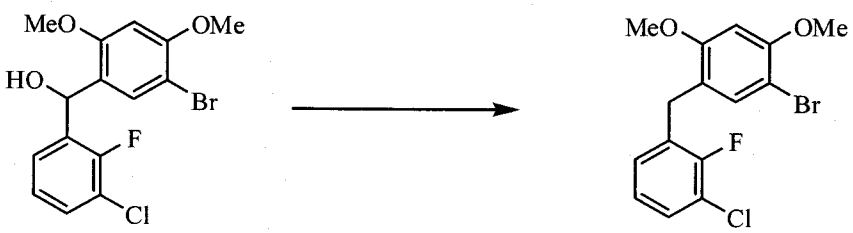
sequentially. The mixture was allowed to warm to ambient temperature and stirred overnight. Next, 2.1 mL of 3-chloro-2-fluorobenzaldehyde was added. After stirring for ~ 1h, the mixture was quenched to pH ~ 7 with 2N HCl. The product was extracted into ethyl acetate and the organic phase was dried over sodium sulfate. The solvent was exchange to heptane to precipitate the product and a mixture of heptanes:MTBE (4:1) was added to form a slurry. After filtration the solid was slurried in toluene, filtered and vacuum dried to yield compound **15**: ^{1}H NMR (CD_3CN, 400 MHz) δ 7.47 (s, 1H), 7.41-7.35 (m, 2H), 7.15 (t, J = 7.4 Hz, 1H), 6.66 (s, 1H), 6.21 (br s, 1H), 3.90 (s, 3H), 3.87 (br s, 1H), 3.81 (s, 3H).

Example 11: Preparation of Compound **15a**



Compound **14** (5 g), isopropylmagnesium chloride (8.9 mL of 2M solution in THF) and THF (56 mL) were combined at ambient temperature and then warmed to 50 °C for ~5 hours. After cooling to ambient temperature and stirring overnight, 2.1 mL of 3-chloro-2-fluorobenzaldehyde was added dropwise to form a slurry. After stirring overnight the solid was isolated by filtration and washing with MTBE to yield compound **15a**.

Example 12: Preparation of Compound **16**



15 **16**

Triethylsilane (1.2 mL) was added to trifluoroacetic acid (2.3 mL) that had been pre-cooled in an ice bath. Compound **15** (1.466 g) was added to the mixture keeping the temperature below 5 °C. After stirring for ~ 2 h ice was added to quench the reaction. The product was extracted with DCM and the organic phase was washed with aq. $NaHCO_3$. The organic phase was dried over Na_2SO_4 and concentrated to dryness. The product was purified by silica gel column chromatography to provide 1.341 g of Compound **16**: ^1H NMR ($CDCl_3$, 400 MHz) δ 7.20 (t, J = 7.0 Hz, 1H), 6.99-6.91 (m, 3H), 6.46 (s, 1H), 3.91 (s, 3H), 3.81 (s, 5H).

The compound of formula **16** can be carboxylated to provide a compound of Formula **4** following a method analogous to that described in Example 1.

Example 13: Alternative Preparation of a Compound of Formula **3**

Compound **14** is combined with anhydrous tetrahydrofuran:dioxane (5:0.9), and the mixture is agitated under a nitrogen atmosphere until a homogeneous solution is achieved. The solution is cooled to -3 °C and 1.3 eq. of *i*-PrMgCl·LiCl in tetrahydrofuran is added. The reaction mixture is agitated at 0 °C until the formation of the mono-Grignard is complete as determined by HPLC analysis. Next, a solution of 1.1 eq. of 3-chloro-2-fluorobenzaldehyde in tetrahydrofuran is added. This mixture is allowed to stir at 0 °C until the formation of Compound **15a** is complete by HPLC. Next, additional *i*-PrMgCl·LiCl solution in tetrahydrofuran (2.5 eq.) is added and the reaction mixture is warmed to about 20 °C. After conversion to the second Grignard intermediate is complete, the reaction mixture is cooled to 3 °C. Anhydrous CO_2

(g) is charged to the reaction mixture at about 5 °C. The reaction mixture is adjusted to about 20 °C. After the carboxylation reaction is complete by HPLC, the reaction mixture is cooled to about 10 °C and water is charged to quench the reaction followed by the addition of concentrated hydrochloric acid to adjust the pH to no more than 3. The reaction mixture is then warmed to about 20 °C. The phases are separated. The organic phase is solvent exchanged to a mixture of isopropyl alcohol and water and the resulting slurry is cooled to about 0 °C. The product is isolated by filtration, washed with a mixture of isopropyl alcohol and water and dried at about 40 °C to yield Compound **3**.

Example 14: Alternative Preparation of Compound of Formula **4**

Trifluoroacetic acid (10 eq.) is charged to a reactor and cooled to 0 °C. Triethylsilane (1.5 eq.) is added maintaining the temperature < 15 °C and the mixture agitated thoroughly. Compound **3** is added to the well-stirred mixture in portions maintaining the temperature < 15 °C. When the reaction is determined to be complete by HPLC, Compound **4** is precipitated by adding a solution of 5 eq. sodium acetate in methanol (13 volumes) maintaining the temperature not more than 45 °C. Warm the slurry to reflux and agitate for 2 to 3 h. The slurry is cooled to about 0 °C and then agitated at that temperature for 2 to 3 h. The product is isolated by filtration, washed with methanol and dried at about 40 °C to yield Compound **4**.

Example 15: Alternative Preparation of a Compound of Formula **9a**

Compound **6a** is combined with dimethylformamide (1.9 vol.), *N,N*-dimethylformamide dimethyl acetal (1.1 eq.) and glacial acetic acid (0.026 eq.) before being warmed to about 65 °C. The reaction is monitored by HPLC. Once the reaction is complete the mixture is cooled to about 22 °C before (*S*)-2-amino-3-methyl-1-butanol (1.1 eq.) and toluene (1.2 volumes) are added. The reaction is monitored by HPLC. Once the reaction is complete the mixture is concentrated. The residue is combined with potassium chloride (0.5 eq) and

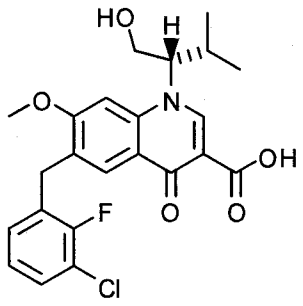
N,O-bis(trimethylsilyl)acetamide (2.5 eq.) and warmed to about 100 °C. The reaction is monitored by HPLC. Once the reaction is complete the mixture is cooled and dichloromethane (6 vol.) is added. Aqueous hydrochloric acid is added to desilylate the product. This reaction is monitored by TLC. Once the reaction is complete the organic phase is washed with water, aqueous sodium bicarbonate and water. The solvent is exchanged for acetonitrile and the mixture is warmed to form a solution. The mixture is seeded and cooled to crystallize Compound **9a**. The product is filtered, washed with cold acetonitrile and dried at NMT 40 °C to yield Compound **9a**.

All publications, patents, and patent documents are incorporated by reference herein, as though individually incorporated by reference. The invention has been described with reference to various specific and preferred embodiments and techniques. However, it should be understood that many variations and modifications may be made while remaining within the spirit and scope of the invention.

CLAIMS

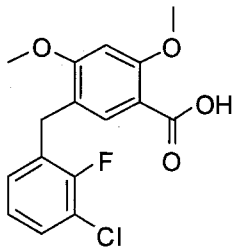
What is claimed is:

1. A method for preparing a compound of formula **10**



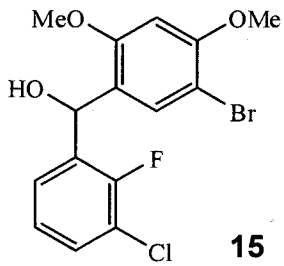
10

or a salt thereof, in which a compound of formula **4**



4

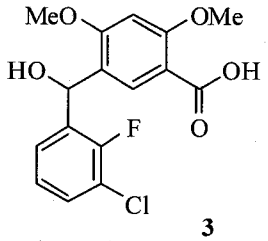
or a salt thereof is prepared and converted into a compound of formula **10**, characterized in that the compound of formula **4** is prepared from a compound of formula **15**



15

or a salt thereof, by the steps of replacing the bromine atom with a carboxyl group, and replacing the hydroxyl group with a hydrogen atom.

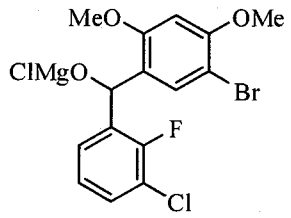
2. A method of claim 1, wherein the compound of formula **4** or a salt thereof is prepared by metalating the compound of formula **15** or a salt thereof and treating with carbon dioxide to provide the compound of formula **3**:



3

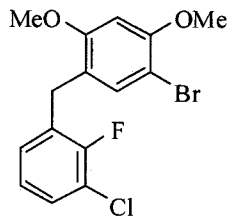
or a salt thereof, and converting the compound of formula **3** to provide the compound of formula **4**.

3. A method of claim 2, wherein the compound of formula **15** or a salt thereof is a salt of formula **15a**



15a

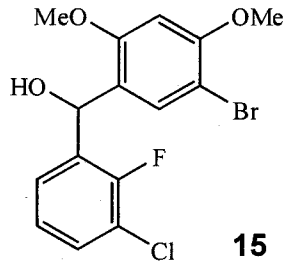
4. A method of claim 1, wherein the compound of formula **15** is converted into a compound of formula **16**



16

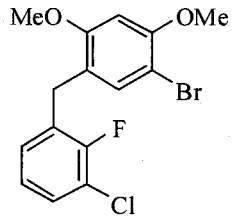
which is then metalated and treated with carbon dioxide to afford a compound of formula **4**.

5. A compound selected from a compound of formula **15**:



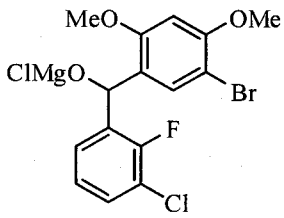
15

or a salt thereof and a compound of formula 16



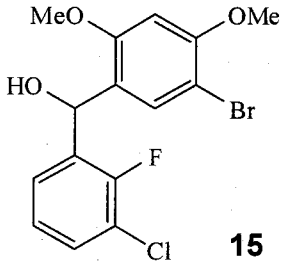
16

6. A compound of claim 5, which is a salt of formula 15a



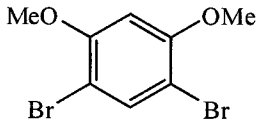
15a

7. A method for preparing a compound of formula **15**:



15

or a salt thereof comprising converting a corresponding compound of formula **14**:

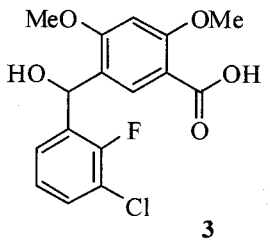


14

to the compound of formula **15** or the salt thereof.

8. The method of claim 7 wherein the compound of formula **14** is converted to the compound of formula **15** or a salt thereof by metalating the compound of formula **14** and treating with 3-chloro-2-fluorobenzaldehyde to provide the compound of formula **15** or the salt thereof.

9. The method of claim 8 further comprising converting the compound of formula **15** or the salt thereof to a compound of formula **3**:

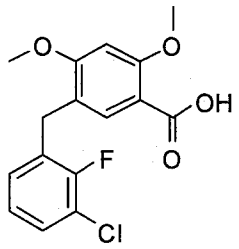


3

or a salt thereof.

10. The method of claim 9 wherein the compound of formula **15** is converted to the compound of formula **3** by metalating the compound of formula **15** and treating with carbon dioxide to provide the compound of formula **3**.

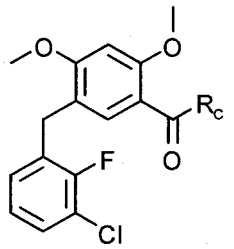
11. The method of claim 10 further comprising converting the compound of formula **3** or the salt thereof to a compound of formula **4**:



4

or a salt thereof.

12. The method of claim 11 further comprising converting the compound of formula **4** or the salt thereof to a compound of formula **5'**:

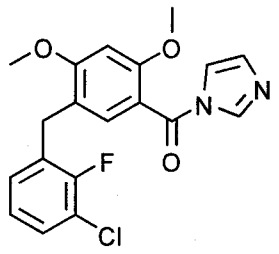


5'

or a salt thereof, wherein R_c is a leaving group.

13. The method of claim 12 wherein R_c is halo or 1-imidazolyl.

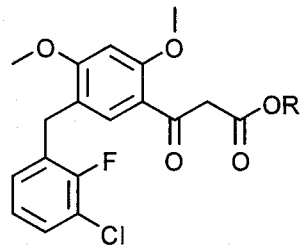
14. The method of claim 13 wherein the compound of formula **5'** is a compound of formula **5a**:



5a

15. The method of claim 14 wherein the compound of formula **4** is converted to the compound of formula **5a** by treatment with 1,1'-carbonyldiimidazole.

16. The method of claim 15 further comprising converting the compound of formula **5'** or a salt thereof, to a compound of formula **6**:



6

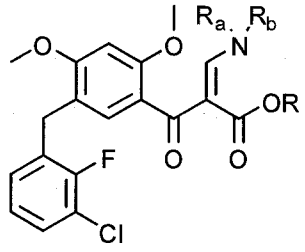
or a salt thereof, wherein R is C_1-C_6alkyl.

17. The method of claim 16 wherein the compound of formula **5'** is converted to the compound of formula **6** by treatment with the corresponding mono-alkylmalonate salt.

18. The method of claim 16 wherein R is ethyl.

19. The method of claim 18 wherein the compound of formula **5'** is converted to the compound of formula **6** by treatment with potassium monoethylmalonate.

20. The method of claim 16 further comprising converting the compound of formula **6** or a salt thereof, to a compound of formula **7**:



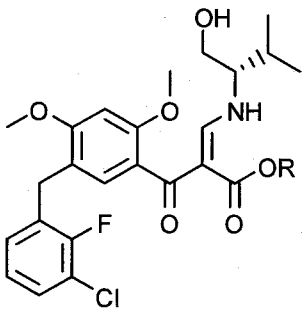
7

wherein R_a and R_b are each independently C_1-C_6alkyl.

21. The method of claim 20 wherein the compound of formula **6** is converted to the compound of formula **7** by treatment with N,N-dimethyformamide dimethyl acetal.

22. The method of claim 21 wherein the treatment with N,N-dimethyformamide dimethyl acetal is carried out in the presence of acetic acid at a temperature of about 100 ± 50 °C.

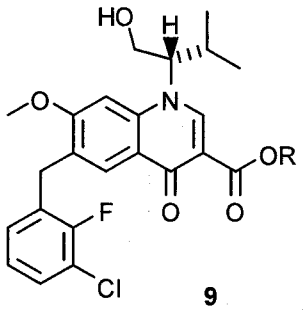
23. The method of claim 20 further comprising converting the compound of formula **7** to a compound of formula **8**:



8

24. The method of claim 23 wherein the compound of formula **7** is converted to the compound of formula **8** by treatment with (*S*)-2-amino-3-methyl-1-butanol.

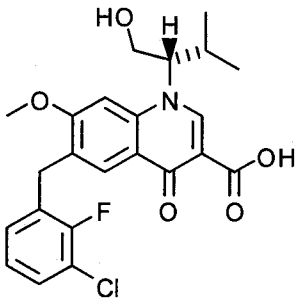
25. The method of claim 23 further comprising converting the compound of formula **8** to a compound of formula **9**:



9

26. The method of claim 25 wherein the compound of formula **8** is converted to the compound of formula **9** by treatment with potassium chloride and *N,O*-bistrimethylsilylacetamide.

27. The method of claim 25 further comprising converting the compound of formula **9** to a compound of formula **10**:



10

28. The method of claim 27 wherein the compound of formula **9** is converted to the compound of formula **10** by treatment with a base.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/076002

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07C41/30 C07C43/225 C07C43/23 C07D215/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 564 210 A (JAPAN TOBACCO INC [JP]) 17 August 2005 (2005-08-17) pages 59-61: steps 1-6 pages 29,32,34,38: schemes	1,5,7
A	WO 2005/113508 A (JAPAN TOBACCO INC [JP]; SATOH MOTOHIDE [JP]; MOTOMURA TAKAHISA [JP]; M) 1 December 2005 (2005-12-01) cited in the application pages 12-17: steps 1-6	1,5,7
P,X	WO 2008/033836 A (GILEAD SCIENCES INC [US]; DOWDY ERIC [US]; CHEN XI [US]; PFEIFFER STEV) 20 March 2008 (2008-03-20) claims 70-76 pages 16,17: schemes examples 13-15	1-28

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 November 2008	18/11/2008

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/076002

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