hydrocarbons such as toluene, nitriles such as acetonitrile, and mixtures thereof.

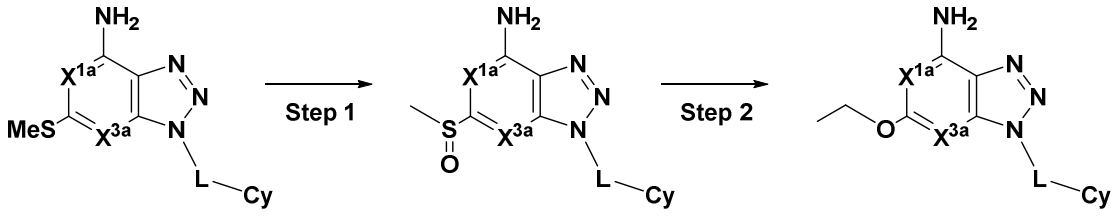
Examples of the metal methoxide include sodium methoxide.

[0209]

The amount of the metal methoxide to be used may be 1.0 to 5.0 equivalent(s), preferably 2.0 to 3.0 equivalents, relative to the Compound (A1'-1) in molar ratio. The reaction may be carried out at room temperature to under heating, for example at room temperature to 50°C, preferably at room temperature.

[0210]

Also, a methylsulfanyl group in R^{X2a} may be converted into an ethoxy group according to the following scheme.



(A1"-2) (A1"-1) (A1")

[wherein the symbols have the same meanings as those described above.]

[0211]

Examples of the embodiment include the following scheme.

The solvent may be any which does not affect the reaction, and examples thereof include amides such as N,N-dimethylformamide and N-methylpyrrolidone; ethers such as tetrahydrofuran and 1,4-dioxane; halogenated aliphatic hydrocarbons such as chloroform and dichloromethane; aromatic hydrocarbons such as toluene; nitriles such as acetonitrile; and mixtures thereof.

Examples of the base include inorganic bases, for example, alkali metal hydrogen carbonates such as sodium hydrogen carbonate; alkali metal carbonates such as potassium carbonate; and alkali metal hydroxides such as sodium hydroxide; and organic bases, for example, alkylamines such as triethylamine and diisopropylethylamine; and pyridines such as pyridine and dimethylaminopyridine.

Examples of the chlorinating agent include thionyl chloride.

[0239]

The amount of the base to be used may be 1.0 to 5.0 equivalent(s), preferably 2.0 to 3.0 equivalents, relative to the Compound (A4'-2) in molar ratio.

The amount of the chlorinating agent to be used may be 30 to 60 equivalents, preferably 40 to 50 equivalents, relative to the Compound (A4'-2) in molar ratio.

The reaction may be carried out at room temperature to

under heating, for example at room temperature to 100°C, preferably at room temperature to 80°C.

[0240]

Step 3

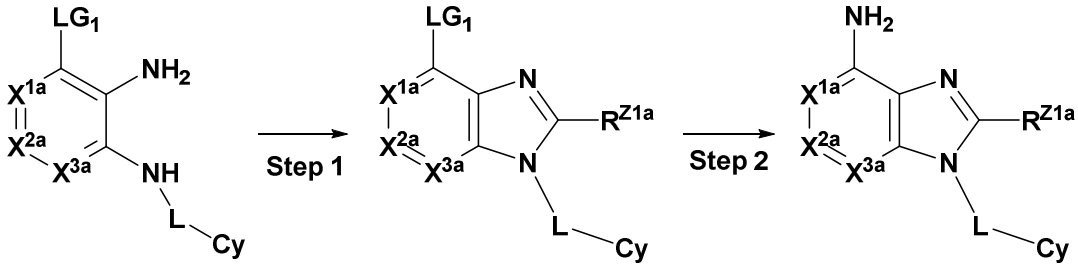
The Compound (A4'-1) prepared in the Step 2 may be reacted in a similar manner to the Step 2 of Scheme 4 to prepare the Compound (A4').

[0241]

Production method 5

Among the compound represented by the formula (I), a compound wherein the partial structure represented by the formula (I-1) has the structure represented by the formula (I-1-A) may also be prepared according to, for example the following Scheme 5.

Scheme 5



(A1-2) (A5-1) (A5)

[wherein the symbols have the same meanings as those described above.]

[0242]

Examples of the embodiment include the following

alkylamines such as triethylamine and diisopropylethylamine; and pyridines such as pyridine and dimethylaminopyridine.

[0303]

The amount of the Compound (B4-1) to be used may be 1.0 to 5.0 equivalent(s), preferably 2.0 to 3.0 equivalents, relative to the Compound (B4-2) in molar ratio.

The amount of the base to be used may be 1.0 to 5.0 equivalent(s), preferably 2.0 to 3.0 equivalents, relative to the Compound (B4-2) in molar ratio.

The reaction may be carried out at room temperature to under heating, for example at 150°C to 300°C, preferably at 200°C to 250°C.

[0304]

Production method 11

Among the compound represented by the formula (I), a compound wherein the partial structure represented by the formula (I-1) has the structure represented by the formula (I-1-B) may also be prepared according to, for example, the following Scheme 11.

Scheme 11

nonaromatic nitrogen-containing ring (for example, piperidine ring) may be reacted with phenylboronic acid in a solvent (for example, dichloromethane), in the presence of a base (for example, N,N-diisopropylethylamine), and in the presence of a copper catalyst (for example, copper(II) acetate) to be N-phenylated. The reaction may be carried out at room temperature to under heating, preferably at room temperature.

[0397]

(23) N-benzylation of a nonaromatic nitrogen-containing ring

A nonaromatic nitrogen-containing ring may be reacted with benzaldehyde to be N-benzylated. For example, a nonaromatic nitrogen-containing ring (for example, piperidine ring) may be reacted with benzaldehyde in a solvent (for example, dichloromethane), in the presence of a base (for example, N,N-diisopropylethylamine), and in the presence of a reducing agent (for example, sodium triacetoxyborohydride) to be N-benzylated. The reaction may be carried out at room temperature to under heating, preferably at room temperature.

[0398]

(24) Conversion of a dioxaspiro[4.5]decanyl group into an oxocyclohexyl group

A dioxaspiro[4.5]decanyl group may be treated with an

into a corresponding cycloalkyl group. For example, a corresponding starting compound having a cycloalkenyl group (for example, cyclohexenyl group) may be treated with a palladium carbon in a solvent (for example, ethanol) and under hydrogen atmosphere to be converted into a cycloalkyl group (for example, cyclohexyl group). The reaction may be carried out at room temperature to under heating, preferably at room temperature.

[0403]

(29) Formation of an N-pyrimidyl on a nonaromatic nitrogen-containing ring

A nonaromatic nitrogen-containing ring may be reacted with a halogenated pyrimidine to form an N-pyrimidyl. For example, a nonaromatic nitrogen-containing ring (for example, piperidine ring) may be reacted in a solvent (for example, dimethyl sulfoxide), in the presence of a base (for example, potassium carbonate), and at room temperature, and then reacted with a halogenated pyridine (for example, 2-chloropyridine) in the presence of a base (for example, diisopropylethylamine) and under heating (for example, 140°C) to form an N-pyrimidyl.

[0404]

(30) N-alkoxycarbonylation of a nonaromatic nitrogen-containing ring

A nonaromatic nitrogen-containing ring may be reacted

22. The PDE7 inhibitor according to any one of claims 1 to 9 for the treatment or prevention of a disease which is improved by inhibiting PDE7.

23. The compound according to any one of claims 10 to 19 or a pharmaceutically acceptable salt thereof for the treatment or prevention of a disease which is improved by inhibiting PDE7.